



## Analog I/O Modules for SLC 500™ Programmable Controllers

(Catalog Numbers 1746-FIO4I, -FIO4V, -NI4, -NIO4I, -NIO4V, -NI8, NI16I, NI16V, -NO4I, and -NO4V)



The 1746 analog I/O modules offer you a wide range of solutions to your analog control applications.

**The 1746-NI4, NIO4I, NIO4V, NO4I, and NO4V are 4-channel analog input, output, and combination modules.** These modules provide high resolution (16-bit inputs, 14-bit outputs) and superior input filtering resulting in a high degree of noise immunity. Combination I/O modules help lower system cost and reduce chassis size by incorporating two analog inputs and two analog outputs on the same module.

**The 1746-FIO4I and FIO4V are 2-input/2-output combination modules ideal for high-speed applications with more rapidly changing analog signals.** These fast response modules are best suited for control of pressure and position in equipment such as hydraulic presses and molding machines.

**The 1746-NI8, NI16I and NI16V modules are high-density, 8- and 16-channel input modules best suited for demanding process control applications with a large number of analog input signals.** These modules provides faster, more accurate measurement and are channel-to-channel configurable for added application flexibility.

## Contents

Overview of Analog Modules . . . . .	3
4-Channel Modules Features and Benefits . . . . .	4
Unique Characteristics of 1746-FIO4I and FIO4V Modules . . . . .	4
4-Channel Modules Hardware Features . . . . .	5
4-Channel Modules Operation . . . . .	5
4-Channel Module Configuration . . . . .	7
4-Channel Modules Wiring . . . . .	9
4-Channel Modules Internal Input and Output Circuits . . . . .	10
4-Channel Modules Specifications . . . . .	11
8- and 16-Channel Modules Features and Benefits . . . . .	14
8- and 16-Channel Modules Hardware Features . . . . .	15
8- and 16-Channel Modules Operation . . . . .	17
8- and 16-Channel Modules Addressing . . . . .	18
8- and 16-Channel Modules Configuration, Data, and Status . . . . .	22
8- and 16-Channel Modules Terminal Blocks and Wiring Guidelines . . . . .	29
8-Channel Modules Wiring Diagrams . . . . .	31
16-Channel Modules Wiring Diagrams . . . . .	33
8- and 16-Channel Modules Internal Input Circuits . . . . .	35
8-Channel Module Specifications . . . . .	35
16-Channel Module Specifications . . . . .	38
Replacing 1746-NI4s with 1746-NI8 or 1746-NI16 . . . . .	41
Determining Power Requirements . . . . .	42
Rockwell Automation Support . . . . .	43

## Overview of Analog Modules

The catalog numbers are coded as follows:

Code	Position	Description
<b>1746-</b>	<b>prefix</b>	bulletin number
<b>F</b>	<b>first letter</b>	faster-response combination analog module
<b>N</b>		higher-resolution 4-, 8-, and 16-channel analog modules
<b>I</b>	<b>second letter</b>	input
<b>O</b>		output
<b>n</b>	<b>number</b>	total number of input and/or output channels
<b>I</b>	<b>last letter</b>	current output (current input for 1746-NI16I)
<b>V</b>		voltage output (voltage input for 1746-NI16V)

For example, the 1746-FIO4I is a faster input/output module with 2 inputs (voltage and/or current selectable) and 2 current outputs.

Module Selection Tables are provided below:

### Input Characteristics

1746-	FIO4I and FIO4V	NI4	NI8	NI16I and NI16V	NIO4I and NIO4V
Number of Inputs	2	4	8	16	2
Voltage Input Ranges <i>Select a current or voltage signal for each channel.</i>	0 to 10V dc - 1 LSB, includes: • 0 to 5V dc • 1 to 5V dc	±10V dc - 1 LSB, includes: • 0 to 10V dc • 0 to 5V dc • 1 to 5V dc			
Current Input Ranges <i>Select a current or voltage signal for each channel.</i>	0 to 21 mA, includes: • 0 to 20 mA • 4 to 20 mA	±20 mA, includes: • 0 to 20 mA • 4 to 20 mA • 0 to 1 mA (NI8 and NI16I only)			
Step response/channel update time	100 µs	60 ms	selectable see page 28	variable see p. 40	60 ms
Input filter at 3 dB	7k Hz	10 Hz	selectable see page 26	selectable see p. 38	10 Hz
Input A/D converter	12-bit	16-bit	16-bit	16-bit	16-bit
Input resolution (I)	9.76 µA/bit	1.22 µA/LSB	1 µA/bit	640 nA/bit	1.22 µA/LSB
Input resolution (V)	2.44 mV/LSB	305.2 µV/LSB	1 mV/bit	312 µV/bit	305.2 µV/LSB
Input coding (I)	0 to 2047	±16,384	depends on data format, see page 25		±16,384
Input coding (V)	0 to 4095	±32,768			±32,768
Input non-linearity, FS = full scale	±0.073% FS	±0.01% FS	±0.01% FS	±0.0015% FS	±0.01% FS
Common Mode Rejection at 60 Hz	50 dB	105 dB	100 dB	≥100 dB	105 dB

### Output Characteristics

1746-	FIO4I	NIO4I	NO4I	FIO4V	NIO4V	NO4V
Number of Outputs	2	2	4	2	2	4
Output range	0 to 21 mA -1 LSB, includes: • 0 to 20 mA • 4 to 20 mA			±10V dc -1 LSB, includes: • 0 to 10V dc • 0 to 5V dc • 1 to 5V dc		
Output D/A converter	14-bit	14-bit	14-bit	14-bit	14-bit	14-bit
Output coding 0 to 21 mA	0 to 32,764	0 to 32,764	0 to 32,764	n/a	n/a	n/a
Output coding ±10V dc	n/a	n/a	n/a	±32,764	±32,764	±32,764

## 4-Channel Modules Features and Benefits

**Single-Slot Module.** Compact I/O structure for your control system.

**User Selectable Inputs.** Lets you configure each input channel for a voltage or current signal from the sensor.

**High Resolution, 16-Bit Inputs and 14-Bit Outputs.** Provides for precision control of analog signals.

**Input Filtering.** Provides higher immunity to electrical noise (1746-Nxxx modules) or a faster input response (1746-FIO4x modules).

**Automatic End-of-Scan I/O Updates.** No need to program special commands to access analog data, reducing programming time.

**Backplane Isolation.** Isolates input signals from the backplane.

**Removable Terminal Blocks.** Lets you replace a module quickly without removing the wiring.

**Choice of Backplane Power or External Power Supply for 1746-NO4I and -NO4V Analog Output Modules.** Provides flexibility to minimize the 24V dc backplane current draw from SLC power supply.

**UL 508 listed, CSA 22.2 142 Approved Class I Division 2, and CE Compliant.** Lets you install modules in these environments.

## Unique Characteristics of 1746-FIO4I and FIO4V Modules

FIO4I and FIO4V modules respond faster because the input filter has been modified to allow for higher frequency signals. As a result, the filter may pass more electrical noise. You must take precautions to thoroughly ground and shield the input transducer, its power supply, and cables. Input characteristics of the 1746 analog modules are shown below:

Characteristic	FIO4I and FIO4V	NI4, NIO4I, NIO4V	NI8
Input Filter at 3 dB	7k Hz	10 Hz	selectable
Common-Mode Rejection at 60 Hz	50 dB	105 dB	≥100 dB

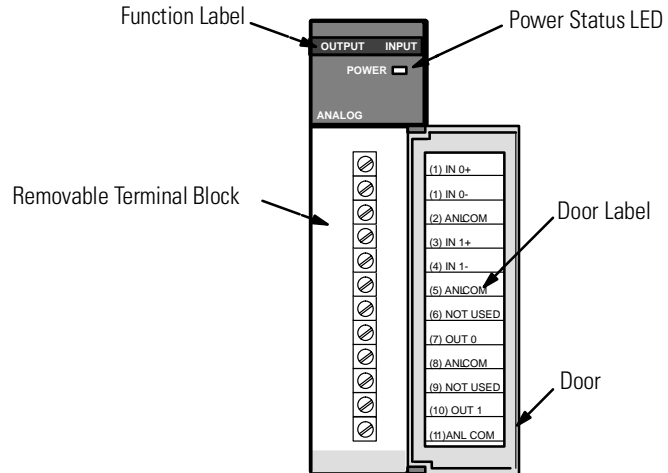
Also, the input resolution of FIO4I and FIO4V modules is considerably less (fewer counts per full scale input) compared to NI4, NI8, NIO4I, and NIO4V modules. For example:

Characteristic	FIO4I and FIO4V	NI4, NIO4I, NIO4V	NI8
0 to 20 mA inputs	0 to 2047 counts	0 to 16,384 counts	±32,768 counts
0 to 10V dc inputs	0 to 4095 counts	0 to 32,767 counts	±32,768 counts

A resolution of 0 to 2047 counts is sufficient for many applications.

## 4-Channel Modules Hardware Features

The module contains a removable terminal block providing connection for the analog input and/or output channels, which is specifically designed to interface with analog current and voltage input signals. The channels can be wired as either single-ended or differential inputs. There are DIP switches on the circuit board for selecting voltage or current input.



Hardware Feature	Function
Function Label	Indicates input, output, or both.
Power Status LED	Indicates when backplane power is applied to the module.
Removable Terminal Block	Provides physical connection to input devices.
Door Label	Permits easy terminal identification.
Door	Protects terminal connections and label.

## 4-Channel Modules Operation

### 4-Channel Modules Characteristics of the Input A/D Converter

The NI4, NIO4I, and NIO4V modules have different A/D converter characteristics than the FIO4I and FIO4V modules. Differences include:

- input signal ranges
- decimal representation of the analog signal (in the input image table)
- number of significant bits to store the decimal representation
- resolution of the input signal

### *NI4, NIO4I, and NIO4V Analog Modules*

The module converts analog input signals to 16-bit binary values for storage in the SLC processor's input image table. The decimal range, number of significant bits, and converter resolution depend on the input range that you use for the channel.

<b>NI4, NIO4I, &amp; NIO4V Input Range</b>	<b>Decimal Range (input image table)</b>	<b>Number of Significant Bits</b>	<b>Nominal Resolution</b>
±10V dc -1 LSB	-32,768 to +32,767	16	305.176µV/LSB
0 to 10V dc -1 LSB	0 to 32,767	15	
0 to 5V dc	0 to 16,384	14	
1 to 5V dc	3,277 to 16,384	13.67	
±20 mA	±16,384	15	1.22070 µA/LSB
0 to 20 mA	0 to 16,384	14	
4 to 20 mA	3,277 to 16,384	13.67	

### *FIO4I and FIO4V Analog Modules*

The module converts analog input signals to 12-bit binary values for storage in the SLC processor's input image table. The decimal range, number of significant bits, and converter resolution depend on the input range that you use for the channel.

<b>FIO4I &amp; FIO4V Input Range</b>	<b>Decimal Range (input image table)</b>	<b>Number of Significant Bits</b>	<b>Nominal Resolution</b>
0 to 10V dc -1LSB	0 to 4095	12	2.4414 mV/LSB
0 to 5V dc	0 to 2047	11	
1 to 5V dc	409 to 2047	10.67	
0 to 20 mA	0 to 2047	11	9.7656 µA/LSB
4 to 20 mA	409 to 2047	10.67	

## **4-Channel Modules Characteristics of the Output D/A Converter**

The analog modules have the same output characteristics.

<b>Module</b>	<b>Output Range</b>	<b>Decimal Range (output image table)</b>	<b>Significant Bits</b>	<b>Resolution</b>
FIO4I NIO4I NO4I	0 to 21 mA -1 LSB	0 to 32,764	13 bits	2.56348 µA/LSB
	0 to 20 mA	0 to 31,208	12.92 bits	
	4 to 20 mA	6,242 to 31,208	12.6 bits	
FIO4V NIO4V NO4V	±10V dc -1 LSB	-32,768 to +32,764	14 bits	1.22070 mV/LSB
	0 to 10V dc -1 LSB	0 to 32,764	13 bits	
	0 to 5V dc	0 to 16,384	12 bits	
	1 to 5V dc	3,277 to 16,384	11.67 bits	

## 4-Channel Module Configuration

This section describes how to set up an analog module.

### Entering Module ID Codes

When configuring an analog module for an SLC 500 system using your programming software, a list of the I/O modules is most likely provided for you. If a list is not provided, you need to enter the module identification code when configuring the slot. Refer to the following table for the appropriate analog module ID code.

Catalog No.	Module ID Code	Catalog No.	Module ID Code
1746-FIO4I	3224	1746-NIO4V	3202
1746-FIO4V	3218	1746-NO4I	5401
1746-NI4	4401	1746-NO4V	5402
1746-NIO4I	3201		

Using the Hand-Held Terminal (HHT) firmware v1.1, enter the proper MODULE ID CODE under the “other” selection. Version 2.0 or later of the HHT firmware provides a list of I/O modules. Refer to the following publications for complete information:

- your programming software’s user manual
- the Hand-Held Terminal User Manual, publication 1747-NP002

### Addressing Analog Modules

#### *1746-NI4*

Each input channel of the NI4 is addressed as a single word in the input image table. The NI4 uses a total of four words in the input image table. The converted values from channels 0 through 3 are addressed as input words 0 through 3 respectively for the slot where the module resides.

*Example* - If you want to address input channel 2 of the NI4 in slot 4, you would address it as input word 2 in slot 4 (I:4.2).

#### *1746-FIO4I, FIO4V, NIO4I, and NIO4V*

Each input channel is addressed as a single word in the input image table and each output channel is addressed as a single word in the output image table. These modules use a total of two input words and two output words.

The converted input values from input channels 0 and 1 are addressed as words 0 and 1 of the slot where the module resides. The output values for the output channels 0 and 1 are addressed as output words 0 and 1 of the slot where the module resides.

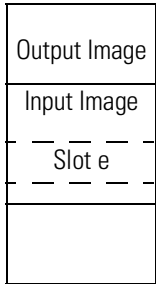
*Example* - If you want to address output channel 0 of the NIO4I in slot 3, you would address it as output word 0 in slot 3 (O:3.0).

*1746-NO4I and NO4V*

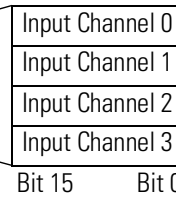
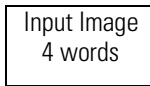
Each output channel of the NO4I and NO4V is addressed as a single word in the output image table. Both modules use a total of four output words. The converted output values from output channels 0 through 3 are addressed as words 0 through 3 respectively for the slot where the module resides.

*Example* - If you want to address output channel 3 of the NO4I in slot 3, you would address it as output word 3 in slot 3 (O:3.3).

**SLC 500 Data Files**



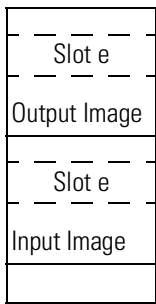
**1746-NO4 Analog Input Module**



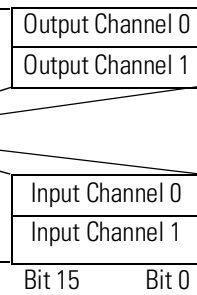
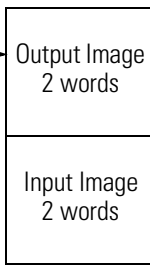
**Address**

Input Channel 0	Word 0	I:e.0
Input Channel 1	Word 1	I:e.1
Input Channel 2	Word 2	I:e.2
Input Channel 3	Word 3	I:e.3

**SLC 500 Data Files**



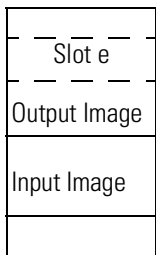
**1746-FIO4I, FIO4V, NIO4I, and NIO4V Analog Combination Modules**



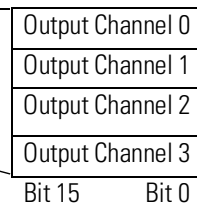
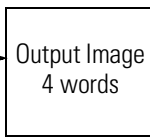
**Address**

Output Channel 0	Word 0	O:e.0
Output Channel 1	Word 1	O:e.1
Input Channel 0	Word 0	I:e.0
Input Channel 1	Word 1	I:e.1

**SLC 500 Data Files**



**1746-NO4I and NO4V Analog Combination Modules**



**Address**

Output Channel 0	Word 0	O:e.0
Output Channel 1	Word 1	O:e.1
Output Channel 2	Word 2	O:e.2
Output Channel 3	Word 3	O:e.3

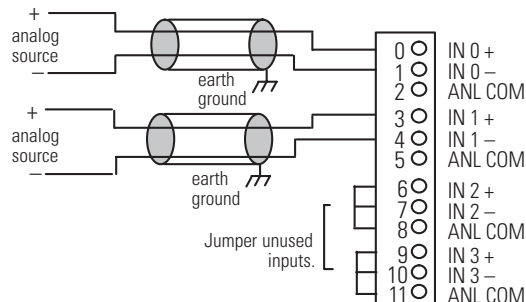


## 4-Channel Modules Wiring

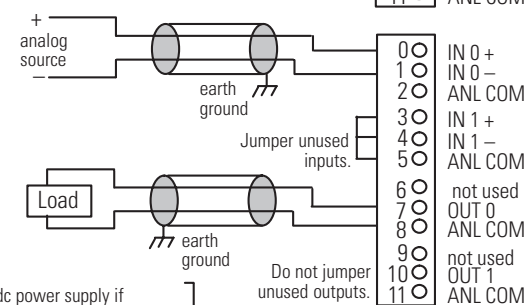
Your module is designed for differential inputs and outputs. Wire them as follows:

### Wiring Differential Analog Inputs and Outputs

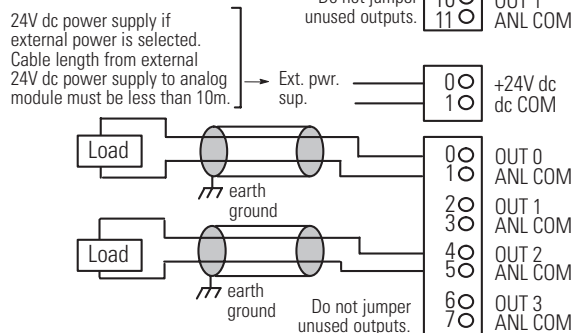
#### 1746-NI4



#### 1746-NIO4I and -NIO4V



#### 1746-NO4I and -NO4V



### IMPORTANT

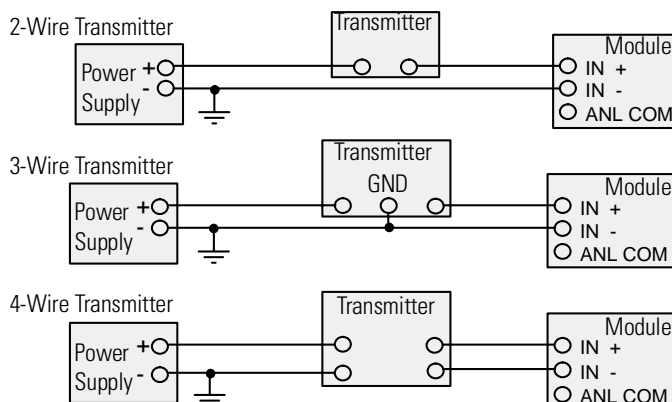
Channels are not isolated from each other. All analog commons (ANL COM) are connected together internally.

### NOTE

The 1746-NO4I and -NO4V analog output modules have connections for user-supplied 24V dc power supplies. When external 24V dc power is used, the module only draws 5V dc current from the SLC backplane.

### Wiring Single-Ended Current-Loop Analog Inputs

As an alternative, you may wire input transmitters having 2-wire, 3-wire, or 4-wire inputs in a single-ended current-loop configuration.



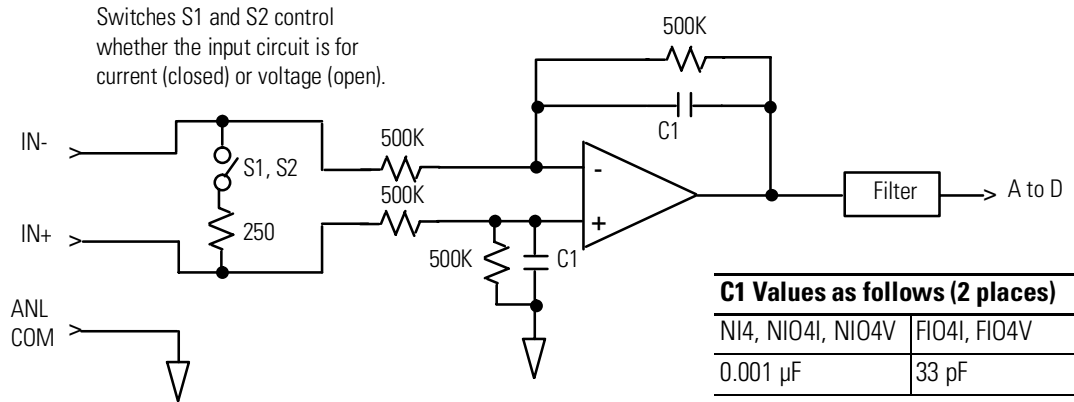
### IMPORTANT

- If using single-ended inputs, take extra precautions for proper grounding and shielding because of the greater noise susceptibility of single-ended inputs.
- The module does not provide loop power for analog inputs. Use a power supply that matches the transmitter specifications.

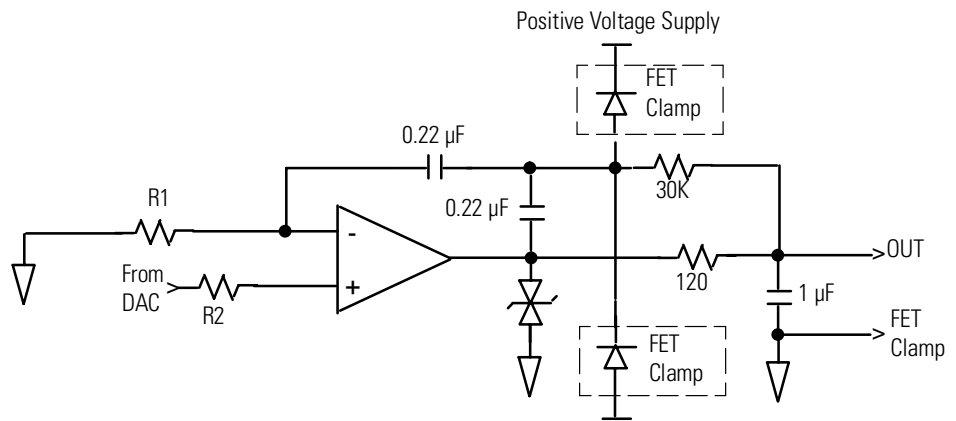
## 4-Channel Modules Internal Input and Output Circuits

The following input and output circuits are provided to help you match the analog module to your input and output devices:

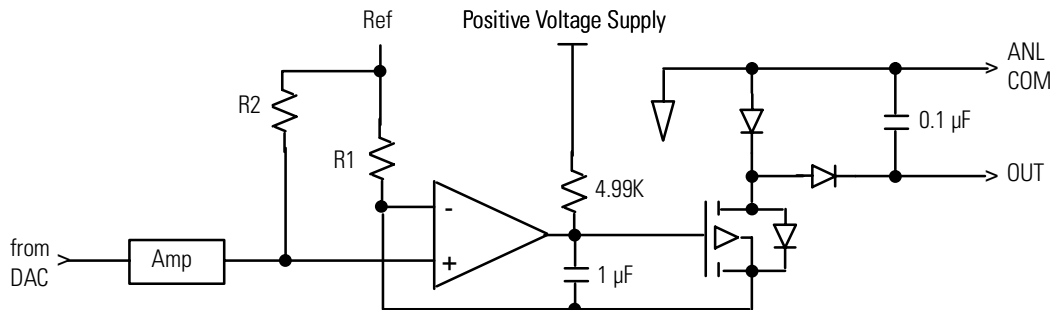
### Input Circuit



### Voltage Output Circuit



### Current Output Circuit



## 4-Channel Modules Specifications

### General Specifications

Catalog Number	ID Code	Input Channels per Module <sup>(1)</sup>	Output Channels per Module <sup>(1)</sup>	Backplane Current	
				5V dc	24V dc
1746-NI4	4401	4 differential, select V or I per channel	N/A	25 mA	85 mA
1746-NIO4I	3201	2 differential, select V or I per channel	2 current outputs	55 mA	145 mA
1746-NIO4V	3202	2 differential, select V or I per channel	2 voltage outputs	55 mA	115 mA
1746-NO4I	5401	N/A	4 current outputs	55 mA	195 mA <sup>(2)</sup>
1746-NO4V	5402	N/A	4 voltage outputs	55 mA	145 mA <sup>(2)</sup>
1746-FIO4I	3224	2 differential, select V or I per channel	2 current output	55 mA	150 mA
1746-FIO4V	3218	2 differential, select V or I per channel	2 voltage outputs	55 mA	120 mA

(1) Input and output channels are isolated from the backplane but not from each other.

(2) The 1746-NO4I and -NO4V analog output modules have connections for user-supplied 24V dc power supplies. When external 24V dc power is used, the module only draws 5V dc current from the SLC backplane. If an external 24V power supply is required, the tolerance must be 24V ±10% (21.6 to 26.4V dc). The user power supplies for SLC modular systems; 1746-P1, -P2, -P4, -P5, or -P6 do not meet this specification.

Description	Specification
SLC Communication Format	16-bit two's compliment binary
Location of LSB in I/O Image Word	0000 0000 0000 0001
Impedance to ANL COM	500K ohms
Impedance, Channel-to-Channel	1M ohms
Field Wiring to Backplane Isolation	500V dc (continuous)
Cable	shielded, Belden #8761 (recommended)
Wire Size	#14 AWG (maximum)
Grounding Wire (optional)	1/4 inch wide (minimum) braid
Terminal Block, 1746-RT28	removable
Installation	single slot in the 1746 I/O Rack
Calibration	factory calibrated
Noise Immunity	NEMA standard ICS 2-230
Environmental Conditions <ul style="list-style-type: none"> <li>Operating Temperature</li> <li>Storage Temperature</li> <li>Relative Humidity</li> </ul>	<ul style="list-style-type: none"> <li>0°C to +60°C (+32°F to +140°F)</li> <li>-40°C to +85°C (-40°F to +185°F)</li> <li>5 to 95% (non-condensing)</li> </ul>
Certification	<ul style="list-style-type: none"> <li>UL 508 listed</li> <li>CSA 22.2 142 approved, Class I Division 2</li> <li>CE compliant for all applicable directives when product or packaging is marked</li> </ul>

## General Input Specifications

Description	1746-NI4, NIO4I, and NIO4V	1746-FIO4I and FIO4V
Step Response (5 to 95%)	60 ms	100 µsec
Converter Resolution	16-bit	12-bit
Conversion Method	sigma-delta modulation	successive approximation
Non-linearity	0.01% of full scale (maximum)	±0.073% of full scale (maximum)
Common Mode Voltage Range	±20V dc	0 to 20V dc (maximum)
Common Mode Rejection Ratio at 10 Hz	50 db	n/a
Common Mode Rejection Ratio at 60 Hz	105 db	50 db (min), 1K ohm imbalance
Normal Mode Rejection at 60 Hz (min.)	55 db	n/a
Channel Bandwidth	10 Hz	7.0K Hz (min) at 3 dB point
Image Format (HEX)	0FFF	0FFF
Track/hold Time to Get Signal before Conversion	n/a for sigma-delta modulation	1.5 µs (nominal)
Signal Convert From Hold	n/a for sigma-delta modulation	6.0 µsec (nominal)
Conversion Time	n/a for sigma-delta modulation	7.5 µsec every 512 µsec (nominal)
Module Throughput Delay	512 µsec (nominal)	1.10 ms (maximum <sup>(1)</sup> ) 512 µsec (typical)

(1) Worst case throughput occurs when the module just misses seeing an event occur.

## Current-Loop Input Specifications

Description	1746-NI4, NIO4I, and NIO4V	1746-FIO4I and FIO4V
Full Scale	20 mA	20 mA
Input Range	±20 mA (nominal) ±30 mA (maximum)	0 to 20 mA (nominal) 0 to 30 mA (maximum)
Current Input Coding	±16,384 for ±20 mA	0 to 2047 counts for 0 to 20 mA
Absolute Maximum Input Voltage	±7.5V dc or 7.5V ac RMS	±7.5V dc or 7.5V ac RMS
Input Impedance	250 ohms	250 ohms (nominal)
Resolution	1.22070 µA per LSB	9.7656 µA per bit
Overall Accuracy at +25°C (+77°F)	±0.365% of full scale	±0.510% of full scale
Overall Accuracy, 0°C to +60°C (+32°F to +140°F)	±0.642% of full scale (maximum)	±0.850% of full scale
Overall Accuracy Drift	+79 ppm/°C of full scale	+98 ppm/°C of full scale (maximum)
Gain Error at +25°C (+77°F)	+0.323% (maximum)	+0.400% of full scale
Gain Error, 0°C to +60°C (+32°F to +140°F)	±0.556% (maximum)	±0.707% of full scale
Gain Error Drift	±67 ppm/°C	±89 ppm/°C (maximum)
Offset Error at +25°C (+77°F)	±7 LSB (maximum)	±2 LSB (typical)
Offset Error, 0°C to +60°C (+32°F to +140°F)	±14 LSB (maximum)	±4 LSB
Offset Error Drift	±0.20 LSB/°C	±0.14 LSB/°C (maximum <sup>(1)</sup> )
Overvoltage Capability	7.5V ac RMS (maximum)	7.5V ac RMS (maximum)

(1) Computed by box method: 2 [maximum offset error] / +60°C.

## Voltage Input Specifications

Description	1746-NI4, NIO4I, and NIO4V	1746-FIO4I and FIO4V
Full Scale	10V dc	10V dc
Input Range	±10V dc -1 LSB	0 to 10V dc -1 LSB
Input Impedance	1M ohms	1M ohms (nominal)
Overvoltage Protection (IN+ to IN-)	220V dc or ac RMS continuously	220V dc or ac RMS, continuously
Resolution	305.176 $\mu$ V per LSB	2.4414 mV per LSB (nominal)
Voltage Input Coding	-32,768 to +32,767 for ±10V dc	0 to 4095 counts for 0 to 10V dc
Overall Accuracy at +25°C (+77°F)	±0.284% of full scale (I)	±0.440% of full scale
Overall Accuracy, 0°C to +60°C (+32°F to +140°F)	±0.504% of full scale (maximum)	±0.750% of full scale
Overall Accuracy Drift	±63 ppm/°C of full scale (maximum)	±88 ppm/°C (maximum)
Gain Error at +25°C (+77°F)	±0.263% (maximum)	±0.323% of full scale
Gain Error, 0 to +60°C (+32°F to +140°F)	±0.461% (maximum)	±0.530% of full scale
Gain Error Drift	±57 ppm/°C (maximum)	±79 ppm/°C (maximum)
Offset Error, +25°C (+77°F)	±7 LSB (maximum)	±4 LSB (maximum)
Offset Error at 0°C to +60°C (+32°F to +140°F)	±14 LSB (maximum)	±2 LSB (typical)
Offset Error Drift	±0.20 LSB/°C (maximum)	±0.14 LSB/°C (maximum <sup>(1)</sup> )

(1) Computed by box method: 2 [maximum offset error] / +60°C.

## Output Specifications

Description	1746-FIO4I, NIO4I, and NO4I	1746-FIO4V, NIO4V, and NO4V
Full Scale	21 mA	10V dc
Output Range	0 to 20 mA -1 LSB (normal)	±10V dc -1 LSB (normal)
Output Coding	0 to 32,764 for 0 to 21 mA	-32,768 to +32,764 for ±10V dc
Output Resolution	2.56348 $\mu$ A per LSB	1.22070 mV per LSB
Converter Resolution	14-bit	14-bit
Location of LSB in I/O Image Word	0000 0000 0000 01XX	0000 0000 0000 01XX
Non-linearity	0.05% of full scale (I)	0.05% of full scale
Conversion Method	R-2R ladder	R-2R ladder
Step Response	2.5 ms (5 to 95%)	2.5 ms (normal)
Load Range	0 to 500 ohms	1K to $\infty$ ohms
Load Current	n/a	10 mA (maximum)
Load Reactance	100 $\mu$ H (maximum)	1 $\mu$ F (maximum)
Over-range Capability	5% (0 to 21 mA -1 LSB)	n/a
Overall Accuracy at +25°C (+77°F)	±0.298% of full scale	±0.208% of full scale
Overall Accuracy, 0°C to +60°C (+32°F to +140°F)	±0.541% of full scale	±0.384% of full scale
Overall Accuracy Drift	±70 ppm/°C of full scale (maximum)	±54 ppm/°C of full scale (maximum)
Gain Error at +25°C (+77°F)	±0.298% of full scale	±0.208% of full scale
Gain Error, 0°C to +60°C (+32°F to +140° F)	±0.516% of full scale	±0.374% of full scale
Gain Error Drift	±62 ppm/°C (maximum)	±47 ppm/°C (maximum)
Offset Error at +25°C (+77°F)	±10 LSB (typical)	±9 LSB (typical)
Offset Error, 0°C to +60°C (+32°F to +140° F)	±12 LSB	±11 LSB
Offset Error Drift	±0.06 LSB/°C (maximum)	±0.05 LSB/°C (maximum)

## 8- and 16-Channel Modules Features and Benefits

**Broader Control Capability.** Small programmable controllers continue to be placed in process control applications demanding higher densities, faster, more accurate measurement and the flexibility to interface to a variety of temperature, pressure, and flow transducers. The 1746-NI8 and 1746-NI16 analog input modules broaden the control capabilities of the SLC 500 to serve these demanding process applications.

**High Density.** These modules provide more efficient use of rack space and lower cost per point compared to competitive analog modules. A color-coded removable terminal block facilitates wiring and module replacement.

**Excellent Performance.** The modules provide excellent performance with accuracy ranging from  $\pm 0.05\%$  to  $\pm 0.15\%$ . Fast step responses range from 7 msec for the 1746-NI8 (no filter option) to 18 msec for the 1746-NI16 (250 Hz filter option) with all channels enabled. The modules provide 14- to 16-bit resolution and can interface to current or voltage signals from various process sensors.

**Diagnostic Feedback.** Machine uptime is increased and troubleshooting time reduced with the help of diagnostic status bits for open-circuit and out-of-range detection. Channel status indicators and a module status indicator are also provided.

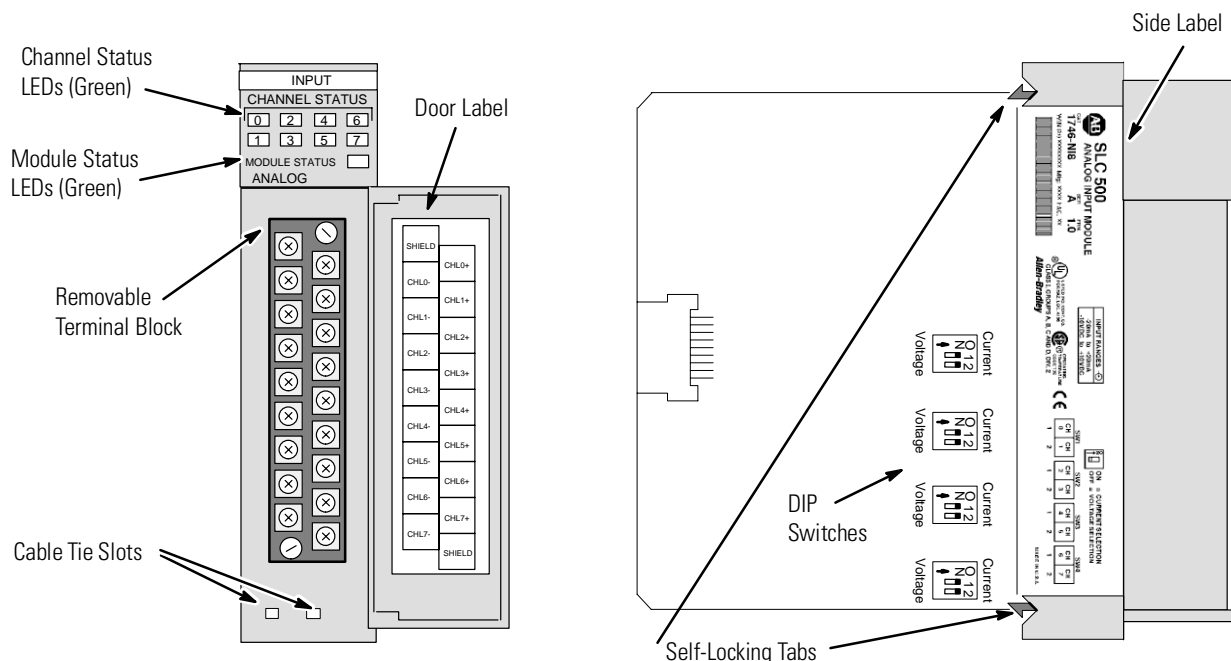
**Software Configurable.** Each channel can be individually configured with the ladder program and can be reconfigured without interrupting CPU operation. An easy-to-use bit configuration table allows the user to choose the input type, data format, filter frequency, and status data best suited to the application. On-board scaling is provided, eliminating the need to program this function with complex ladder programming.

## 8- and 16-Channel Modules Hardware Features

The modules are equipped with removable terminal blocks which provide connection for the analog input channels, and are specifically designed to interface with analog current and voltage input signals. There are no output channels on these modules. Module configuration is done via the user program.

### 1746-NI8

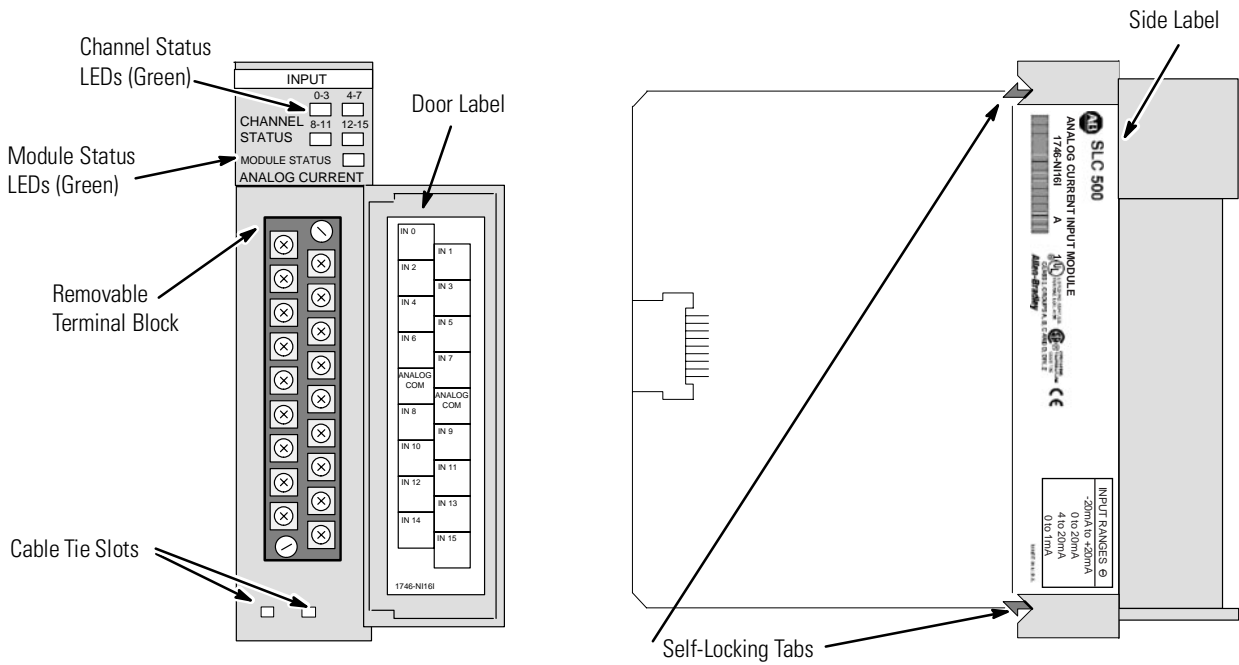
The terminals can be wired as either single-ended or differential inputs. There are DIP switches on the circuit board for selecting voltage or current input.



Hardware Feature	Function
Channel Status LED Indicators	Displays channel operating and fault status.
Module Status LED	Displays module operating and fault status.
Side Label (Nameplate)	Provides module information.
Removable Terminal Block	Provides physical connection to input devices.
Door Label	Permits easy terminal identification.
Cable Tie Slots	Secures and route wiring from module.
Self-Locking Tabs	Secures module in chassis slot.
Voltage/Current Selection DIP Switches	Selects voltage or current input type to match the analog sensor.

### 1746-NI16

The terminals can be wired to 16 single-ended input signals.



Hardware Feature	Function
Channel Status LED Indicators	Displays channel operating and fault status.
Module Status LED	Displays module operating and fault status.
Side Label (Nameplate)	Provides module information.
Removable Terminal Block	Provides physical connection to input devices.
Door Label	Permits easy terminal identification.
Cable Tie Slots	Secures and route wiring from module.
Self-Locking Tabs	Secures module in chassis slot.



## 8- and 16-Channel Modules Operation

The module fits into any single slot, except the processor slot, in either an SLC 500 modular system or an SLC 500 fixed system expansion chassis. It can be used in either Class 1 or Class 3 installations. Class 1 is the default configuration. The module can be configured through the user program for Class 3 which enables user defined data scaling and monitoring of channel status words.

Configuration	Class 1 <sup>(1)</sup>	Class 3
Compatible SLC Processors	SLC 500 fixed, SLC 5/01 and higher	SLC 5/02 and higher
Compatible Chassis	local chassis or remote chassis with a 1747-ASB adapter	local chassis or remote chassis with a 1747-ACN(R) ControlNet adapter
1746-NI8 Input and Output Images	8 input words: 8 channel data words  8 output words: 8 channel configuration words	16 input words: 8 channel data words and 8 channel status words  12 output words: 8 channel configuration words and 4 limit ranges for user-defined scaling data format
1746-NI16 Input and Output Images	output image: 8 words available for configuring 16 channels  input image: 8 words available for 16 data words and 16 status words	output image: 24 words available for configuring 16 channels  input image: 32 words available for 16 data words and 16 status words
Default	Class 1 is the default on power-up	Class 3 is programmable by user

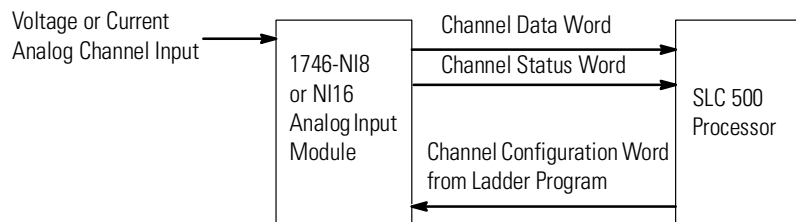
(1) Requires use of Block Transfer in a remote configuration.

### Data Transfer

The module sequentially samples the channels in a continuous loop. Each time a channel is read by the module, that data value is tested by the module for a fault condition (i.e., open-circuit, over-range, and under-range). If such a condition is detected, a unique bit is set in the channel status word and the channel status LED blinks.

The SLC processor reads the converted analog data from the module at the end of the program scan, or when commanded by the ladder program. The processor and module determine that the backplane data transfer was made without error, and the data is used in your ladder program. A graphic representation of this is shown below.

*Data Transfer Between the Module and Processor (shown for one channel)*



## Calibration

### 1746-NI8

The module performs continuous autocalibration for all the channels that are enabled. There is no need to invoke a calibration cycle to compensate for changes in temperature.

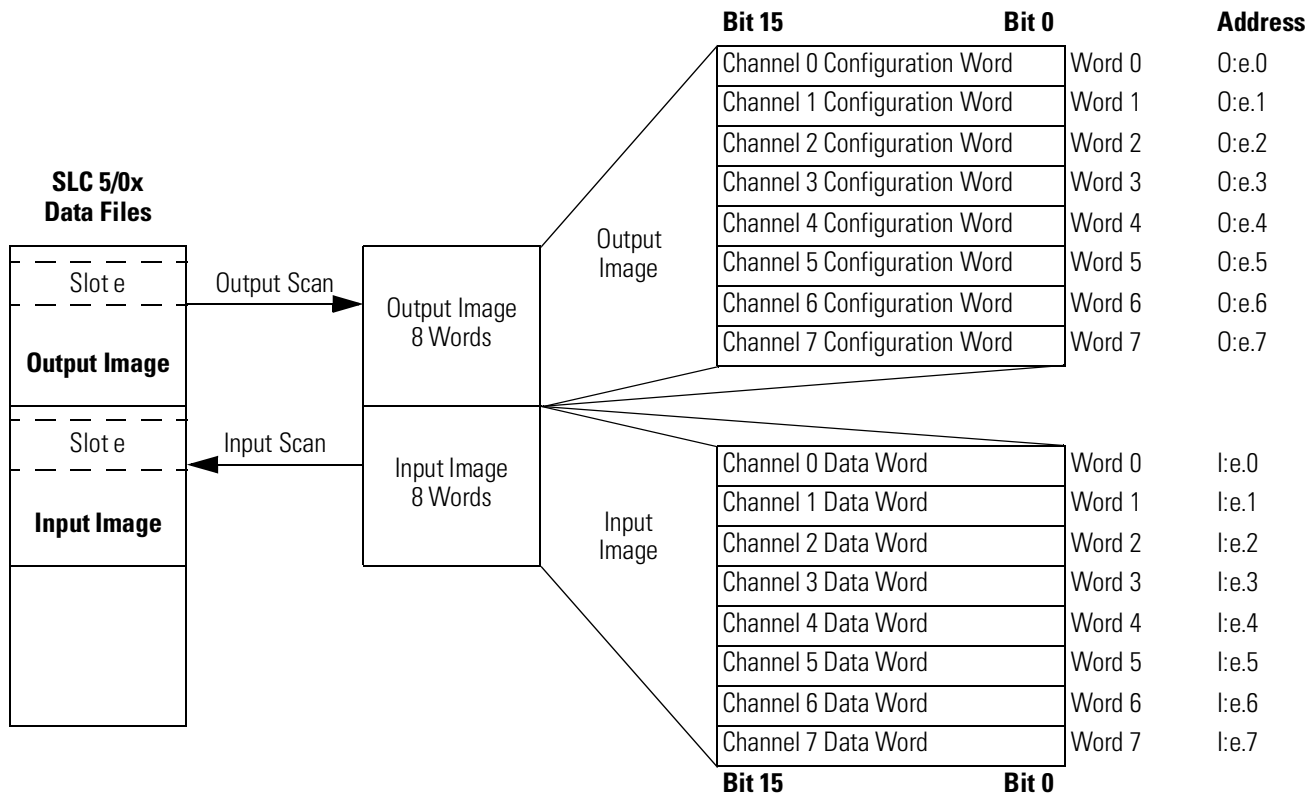
### 1746-NI16

The 1746-NI16 module is factory calibrated and ready for use. Although factory calibration is suitable for most applications, the module can be calibrated by the user. Refer to the *SLC 500™ Analog Input Modules User Manual*, publication 1746-UM001A-US-P, for the calibration sequence.

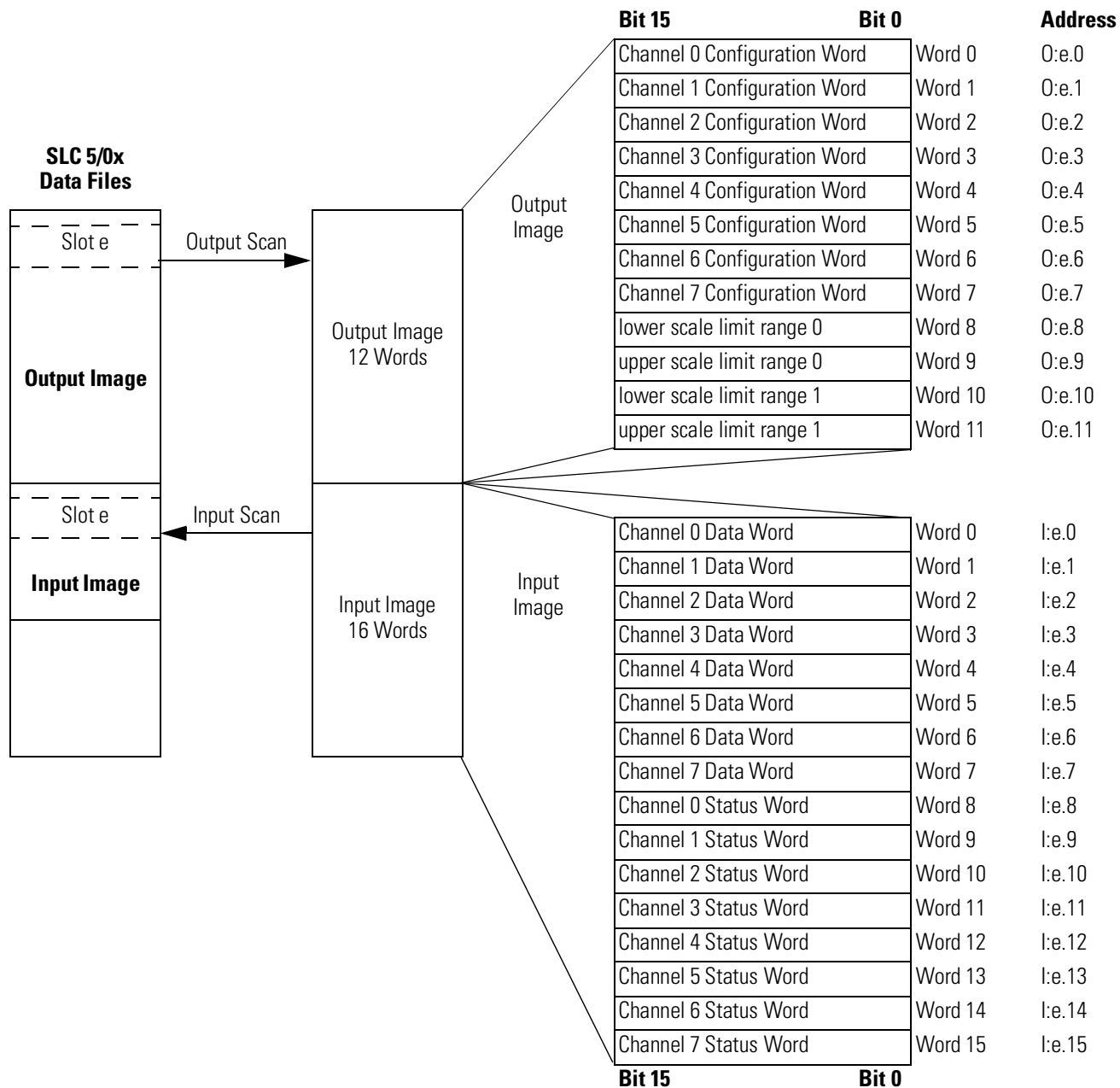
## 8- and 16-Channel Modules Addressing

The following memory maps show you how the input and output image tables are defined for Class 1 and Class 3.

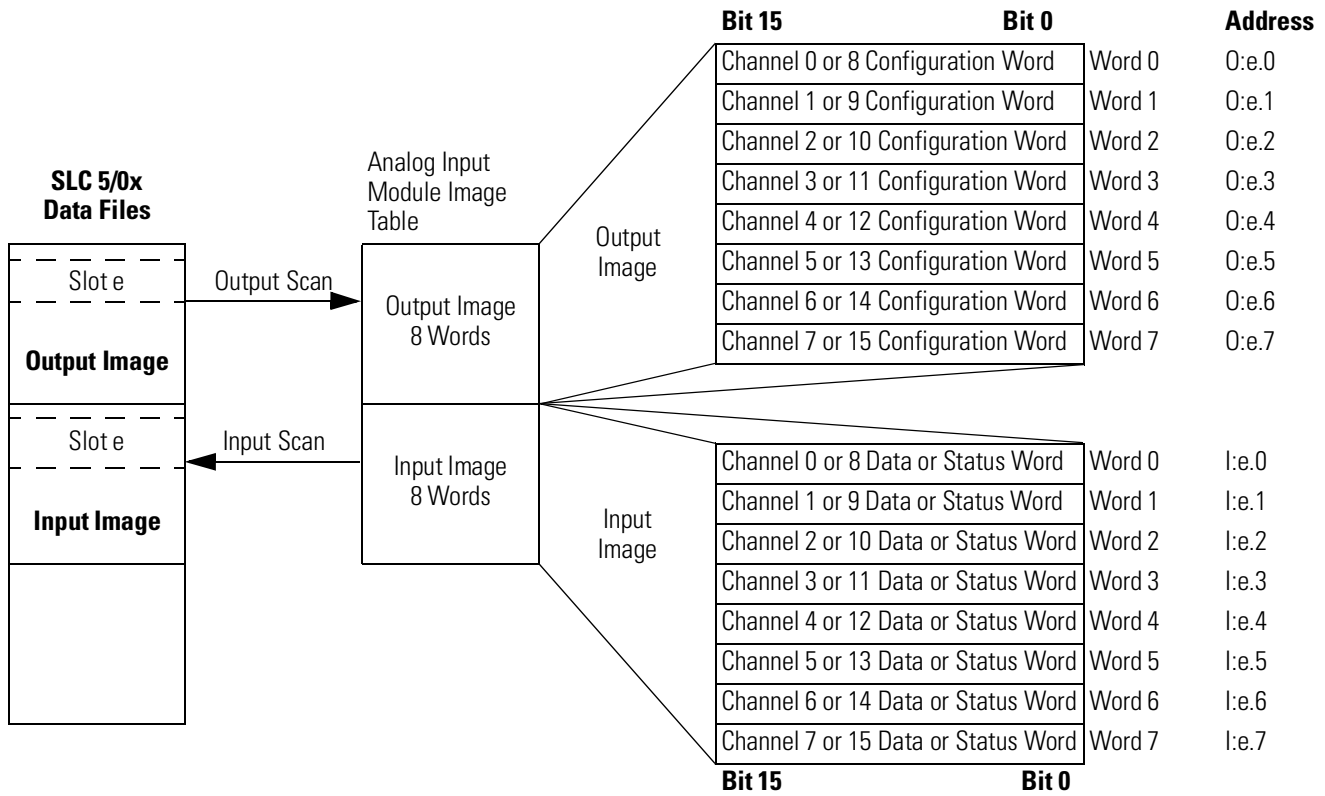
### 1746-NI8 Class 1 Memory Map



### 1746-NI8 Class 3 Memory Map



### 1746-NI16 Class 1 Memory Map

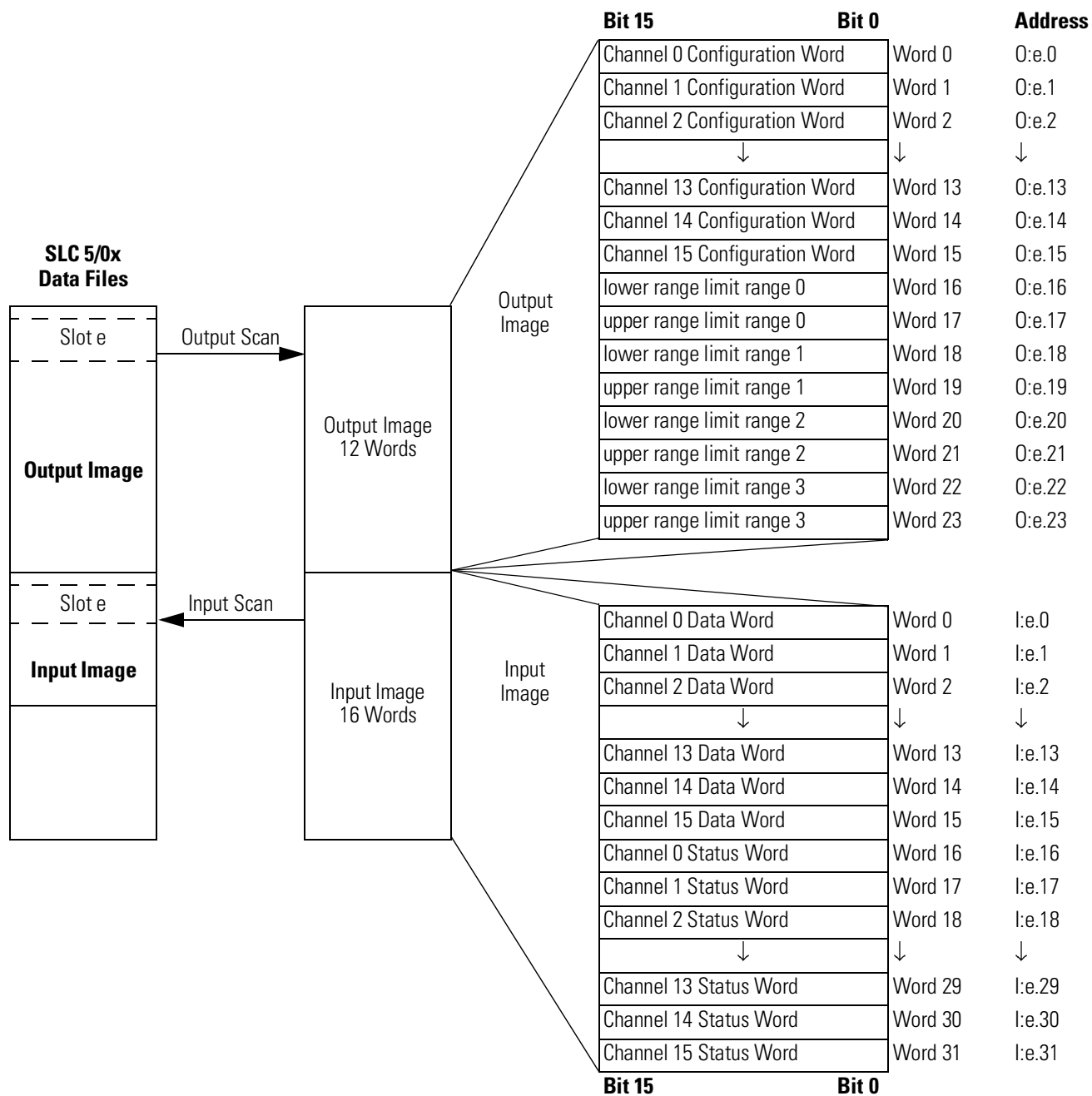


**NOTE**

The 8 output image words can either configure channels 0 to 7 or 8 to 15 depending on how bit 0 is set.

The 8 input image words show either data or status for channels 0 to 7 or 8 to 15. Bits 0 and 1 in the configuration word determine whether status or data is shown.

### 1746-NI16 Class 3 Memory Map



## 8- and 16-Channel Modules Configuration, Data, and Status

### Module ID Code

The module identification code is a unique number encoded for each 1746 I/O module. The code defines for the processor the type of I/O or specialty module residing in a specific slot in the 1746 chassis.

Catalog Number	ID Code	
	Class 1 Interface	Class 3 Interface
1746-NI8	3526	12726
1746-NI16I	3504	10403
1746-NI16V	3505	10406

#### IMPORTANT

All programming software does not support configuration for Class 3 operation.

- Advanced Programming Software (APS) supports Class 3 configuration. After entering the ID code, enter the number input and output words.
- SLC 500 A.I. Series™ Programming Software supports Class 3 configuration. After entering the ID code, enter the number of input and output words.
- RSLogix 500™, version 1.30 or later, supports Class 3 configuration. After entering the ID code, select Class 3 operation.
- Earlier versions of RSLogix 500 will only support configuration for Class 1 operation. Contact Rockwell Software for information on upgrading your software.

### Channel Configuration

Once the module has been installed, each channel on the module can be configured to establish the way the channel will operate. Configure the channel by entering bit values into the configuration word using the programming software. The bit values are defined in the configuration tables. In the table:

- *Engineering units* are 1 mV/step for voltage input types, and 1.0  $\mu$ A/step for current input types.
- The *scaled-for-PID value* is a 14-bit unsigned integer, with 0 representing the low scale value and 16,383 representing the full scale value minus 1 LSB. The input signal range is proportional to your selected input type and scaled into a 0 to 16,383 range, which is standard to the SLC PID algorithm.
- The *proportional count* value is a 16-bit signed integer. The input signal range is proportional to your selected input and scaled into a -32,768 to +32,767 range.
- *User-defined scaling count* (Class 3 operation only) allows the output image data words 8 and 9 (or words 10 and 11) to be selected to represent low scale and high scale limits. The module uses these limits and scales proportionately between them.
- The *1746-NI4 data format* converts the current and voltage signals into 16-bit 2's complement binary values.

## 1746-NI8 Output Image Word Configuration Bit Definitions

To Configure	Option <sup>(1)</sup>		Make these bit settings in the Channel Configuration Word															
			15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Input Type	Set DIP switch to OFF for voltage input.	±10V dc														0	0	0
		1 to 5V dc														0	0	1
		0 to 5V dc														0	1	0
		0 to 10V dc														0	1	1
	Set DIP switch to ON for current input.	0 to 20 mA														1	0	0
		4 to 20 mA														1	0	1
		±20 mA														1	1	0
		0 to 1 mA														1	1	1
Data Format	Engineering Units													0	0	0		
	Scaled-for-PID													0	0	1		
	Proportional Counts													0	1	0		
	1746-NI4 Data Format													0	1	1		
	User Defined (Class 3)													1	0	0		
	User Defined (Class 3)													1	0	1		
	Illegal (configuration error)																	
	Illegal (configuration error)																	
Open Circuit	Zero												0	0				
	Upscale												0	1				
	Downscale												1	0				
	Illegal																	
Filter Frequency	No Filter							0	0	0								
	75 Hz							0	0	1								
	50 Hz							0	1	0								
	20 Hz							0	1	1								
	10 Hz							1	0	0								
	5 Hz							1	0	1								
	2 Hz							1	1	0								
	1 Hz							1	1	1								
Channel Enable	Channel Disabled						0											
	Channel Enabled						1											
Unused	Unused <sup>(2)</sup>		0	0	0	0												

(1) In addition to programming the configuration word, you must also use the DIP switches to select voltage or current.

(2) Be sure that unused bits 12 to 15 are always set to zeros.

## 1746-NI16 Output Image Word Configuration Bit Definitions

To Configure	Option	Make these bit settings in the Channel Configuration Word															
		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
<b>Class 1 Data or Status Configuration</b>	Read Data for Channels 0 to 7															0	0
	Read Data for Channels 8 to 15															0	1
	Read Status for Channels 0 to 7															1	0
	Read Status for Channels 8 to 15															1	1
<b>Class 1 Handshaking</b>	Reset Status Bit 6															0	
	Transmit Channel Configuration															1	
<b>Reserved</b>	Not Used													X			
<b>Input Type</b>	±10V dc or ±20 mA											0	0				
	1 to 5V dc or 4 to 20 mA											0	1				
	0 to 5V dc or 0 to 1 mA											1	0				
	0 to 10V dc or 0 to 20 mA											1	1				
<b>Data Format</b>	Engineering Units								0	0	0						
	Scaled-for-PID								0	0	1						
	Proportional Counts								0	1	0						
	1746-NI4 Data Format								0	1	1						
	User Limit Range 0 (Class 3 Only)								1	0	0						
	User Limit Range 1 (Class 3 Only)								1	0	1						
	User Limit Range 2 (Class 3 Only)								1	1	0						
	User Limit Range 3 (Class 3 Only)								1	1	1						
<b>Calibration</b>	Normal RUN Mode (exit calibration mode)					0	0	0									
	Enter Calibration Mode					0	0	1									
	Perform Zero Calibration					0	1	1									
	Perform Full Scale Calibration					1	0	1									
<b>Filter Frequency</b>	6 Hz		0	0	0												
	10 Hz		0	0	1												
	20 Hz		0	1	0												
	40 Hz		0	1	1												
	60 Hz		1	0	0												
	80 Hz		1	0	1												
	100 Hz		1	1	0												
	250 Hz		1	1	1												
<b>Channel Enable</b>	Channel Disabled	0															
	Channel Enabled	1															



## Channel Data

The channel data word contains a 16-bit integer that represents the value of the analog input channel. The 1746-NI8 module input image uses 8 data words whether the module is in Class 1 or Class 3 mode. The 1746-NI16 input image uses 8 words in Class 1 Mode (bit 0 in the configuration word determines whether channels 0 through 7 or 8 through 15 are displayed). In Class 3 mode, the 1746-NI16 input image uses 16 words.

The converted voltage or current input data values reside in I:e.0 through I:e.7 of the 1746-NI8 module's input image file (I:e.0 through I:e.15 of the 1746-NI16 module's input image file). When an input channel is disabled, its data word is reset to zero.

The tables below show the channel data word values for various input types and data formats. The second table shows the default full-scale values for the proportional counts data format. The table does not imply the entire data value range is usable resolution.

**Channel Data Word Values for Engineering Units**

Input Type	Signal Range	Engineering Units	Engineering Units Scale
±10V dc	-10.25 to +10.25V dc	-10250 to +10250	1 mV/step
0 to 5V dc	-0.5 to +5.5V dc	-500 to +5500	1 mV/step
1 to 5V dc	0.5 to 5.5V dc	500 to 5500	1 mV/step
0 to 10V dc	-0.5 to +10.25V dc	-500 to +10250	1 mV/step
0 to 20 mA	-0.5 to +20.5 mA	-500 to +20500	1.0 uA/step
4 to 20 mA	3.5 to 20.5 mA	3500 to 20500	1.0 uA/step
±20 mA	-20.5 to +20.5 mA	-20500 to +20500	1.0 uA/step
0 to 1 mA	-0.05 to +1.05 mA	-50 to +1050	1.0 uA/step

**Channel Data Word Values for Scaled Data**

Input Type	Signal Range	Scaled-for-PID	Proportional Counts (default)	NI4 Data Format
±10V dc	-10.00 to +10.00V dc	0 to 16383	-32768 to +32767	-32768 to +32767
0 to 5V dc	0.0 to 5.00V dc	0 to 16383	-32768 to +32767	0 to 16384
1 to 5V dc	1.00 to 5.00V dc	0 to 16383	-32768 to +32767	3277 to 16384
0 to 10V dc	0.0 to 10.00V dc	0 to 16383	-32768 to +32767	0 to 32767
0 to 20 mA	0.0 to 20.0 mA	0 to 16383	-32768 to +32767	0 to 16384
4 to 20 mA	4.0 to 20.0 mA	0 to 16383	-32768 to +32767	3277 to 16384
±20 mA	-20.0 to +20.0 mA	0 to 16383	-32768 to +32767	-16384 to +16384
0 to 1 mA	0.0 to 1.00 mA	0 to 16383	-32768 to +32767	0 to 1000 <sup>(1)</sup>

(1) This data format is not supported by the 1746-NI4 module, but is available for the 1746-NI8 module.

## Channel Status

The channel status word can be analyzed bit by bit. In addition to providing information about an enabled or disabled channel, each bit's status (0 or 1) tells you how the input data from the voltage or current analog sensor connected to a specific channel is translated for your application. The bit status also informs you of any error condition and can tell you what type of error occurred. A bit-by-bit examination of the status word is provided in the following table.

### 1746-NI8 Input Image Word Bit Definitions

To Check Status of	These bit settings																Indicate this
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
<b>Input Type</b>														0	0	0	±10 V dc
														0	0	1	1 to 5V dc
														0	1	0	0 to 5V dc
														0	1	1	0 to 10V dc
														1	0	0	0 to 20 mA
														1	0	1	4 to 20 mA
														1	1	0	±20 mA
														1	1	1	0 to 1 mA
<b>Data Format</b>											0	0	0				Engineering Units
											0	0	1				Scaled-for-PID
											0	1	0				Proportional Counts
											0	1	1				1746-NI4 Data Format
											1	0	0				User Defined (Class 3)
											1	0	1				User Defined (Class 3)
																	Illegal (configuration error)
																	Illegal (configuration error)
<b>Open Circuit</b>									0	0							Zero
									0	1							Upscale
									1	0							Downscale
																	Illegal (configuration error)
<b>Filter Frequency</b>						0	0	0									No Filter
						0	0	1									75 Hz
						0	1	0									50 Hz
						0	1	1									20 Hz
						1	0	0									10 Hz
						1	0	1									5 Hz
						1	1	0									2 Hz
						1	1	1									1 Hz
<b>Channel Status</b>					0												Channel Disabled
					1												Channel Enabled
<b>Open-Circuit Error</b>				0													No Error
				1													Open-Circuit Detected
<b>Over-Range Error</b>			0														No error
			1														Over-Range Condition
<b>Under-Range Error</b>		0															No Error
		1															Under-Range Condition
<b>Configuration Error</b>	0																No Error
	1																Configuration Error

**IMPORTANT**

The status word for any disabled channel is always 0000 0000 0000 0000 regardless of any previous setting that may have been made to the configuration word.

## 1746-NI16 Class 1 Input Image Word Bit Definitions

To Check Status of	These bit settings																Indicate this
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
<b>Class 1 Data or Status Configuration</b>															0	0	Data from Channels 0 to 7
															0	1	Data from Channels 8 to 15
															1	0	Status for Channels 0 to 7
															1	1	Status for Channels 8 to 15
<b>Input Type</b>														0	0	±10 V dc or ±20 mA	
														0	1	1 to 5V dc or 4 to 20 mA	
													1	0	0 to 5V dc or 0 to 1 mA		
													1	1	0 to 10V dc or 0 to 20 mA		
<b>Data Format</b>										0	0	0				Engineering Units	
										0	0	1				Scaled-for-PID	
										0	1	0				Proportional Counts	
										0	1	1				1746-NI4 Data Format	
<b>Class 1 Handshaking</b>									0							Ready to Receive Channel Configuration	
									1							Processed Channel Configuration	
<b>Calibration</b>						0	0	0								Normal RUN Mode (exit calibration mode)	
						0	0	1								Calibration Mode Entered	
						0	1	1								Zero Value Calibrated	
						1	0	1								Full Scale Calibrated	
<b>Filter Frequency</b>  Filter frequencies are set for channels 0, 4, 8, and 12 for that channel and the next three channels in that group. Groupings are: (0 to 3), (4 to 7), (8 to 11), and (12 to 15).				0	0	0										6 Hz	
				0	0	1										10 Hz	
				0	1	0										20 Hz	
				0	1	1										40 Hz	
				1	0	0										60 Hz	
				1	0	1										80 Hz	
				1	1	0										100 Hz	
				1	1	1										250 Hz	
<b>Error Conditions</b>	0	0	0													Channel Disabled	
	0	0	1													Faulty Calibration	
	0	1	0													Invalid Calibration Reference	
	0	1	1													Configuration Error	
	1	0	0													Open-Circuit Detected	
	1	0	1													Under-Range Detected	
	1	1	0													Over-Range Detected	
	1	1	1													No Error	

### NOTE

In Class 1 mode, bits 1 and 0 indicate data or status. Bits 15 through 2 contain real data for each channel or status information.

In Class 3 mode, all 16 bits are real data (depending on the data format) or status information.

### 1746-NI16 Class 3 Input Image Word Bit Definitions

To Check Status of	These bit settings																Indicate this
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
<b>Class 1 Data or Status Configuration</b>															0	0	Data from Channels 0 to 7
															0	1	Data from Channels 8 to 15
															1	0	Status for Channels 0 to 7
															1	1	Status for Channels 8 to 15
<b>Input Type</b>														0	0	±10 V dc or ±20 mA	
														0	1	1 to 5V dc or 4 to 20 mA	
														1	0	0 to 5V dc or 0 to 1 mA	
														1	1	0 to 10V dc or 0 to 20 mA	
<b>Data Format</b>									0	0	0					Engineering Units	
									0	0	1					Scaled-for-PID	
									0	1	0					Proportional Counts	
									0	1	1					1746-NI4 Data Format	
									1	0	0					User Limit Range 0	
									1	0	1					User Limit Range 1	
									1	1	0					User Limit Range 2	
									1	1	1					User Limit Range 3	
<b>Calibration</b>						0	0	0								Normal RUN Mode (exit calibration mode)	
						0	0	1								Calibration Mode Entered	
						0	1	1								Zero Value Calibrated	
						1	0	1								Full Scale Calibrated	
<b>Filter Frequency</b>  Filter frequencies are set for channels 0, 4, 8, and 12 for that channel and the next three channels in that group. Groupings are: (0 to 3), (4 to 7), (8 to 11), and (12 to 15).				0	0	0										6 Hz	
				0	0	1										10 Hz	
				0	1	0										20 Hz	
				0	1	1										40 Hz	
				1	0	0										60 Hz	
				1	0	1										80 Hz	
				1	1	0										100 Hz	
				1	1	1										250 Hz	
<b>Error Conditions</b>	0	0	0													Channel Disabled	
	0	0	1													Faulty Calibration	
	0	1	0													Invalid Calibration Reference	
	0	1	1													Configuration Error	
	1	0	0													Open-Circuit Detected	
	1	0	1													Under-Range Detected	
	1	1	0													Over-Range Detected	
	1	1	1													No Error	

**NOTE**

In Class 1 mode, bits 1 and 0 indicate data or status. Bits 15 through 2 contain real data for each channel or status information.

In Class 3 mode, all 16 bits are real data (depending on the data format) or status information.

## 8- and 16-Channel Modules Terminal Blocks and Wiring Guidelines

The modules contain an 18-position, removable terminal block. The terminal pin-outs are shown below.

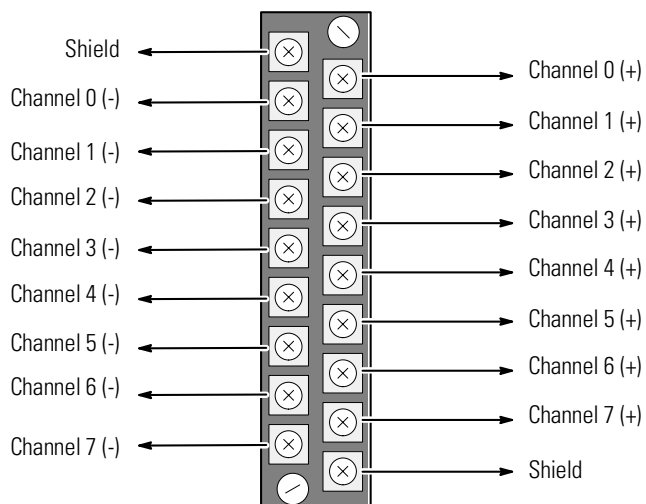
### ATTENTION



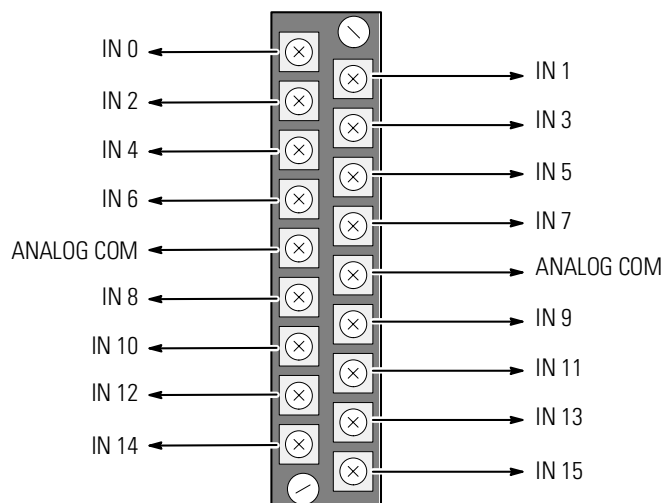
Disconnect power to the SLC before attempting to install, remove, or wire the removable terminal wiring block.

To avoid cracking the removable terminal block, alternate the removal of the slotted terminal block release screws.

### 1746-NI8 Terminal Block



### 1746-NI16 Terminal Block



### Pre-Wired Cables and Terminal Blocks

The following 1492 cables and terminal blocks are available for wiring the 1746-NI16I and 1746-NI16V modules:

Description	Catalog Number	Length
Allen-Bradley Pre-Wired Cable	1492-ACAB005A46	0.5m (1.6 ft)
	1492-ACAB010A46	1.0m (3.3 ft)
	1492-ACAB025A46	2.5m (8.2 ft)
	1492-ACAB050A46	5.0m (16.4 ft)
Allen-Bradley User Terminal Blocks	1492-AIFM8-3	n/a
	1492-AIFM16-F-3	n/a

### Wiring Guidelines

#### ATTENTION



To prevent shock hazard, care should be taken when wiring the module to analog signal sources. Before wiring any analog module, disconnect power from the SLC 500 system and from any other source to the analog module.

Follow the guidelines below when planning your system wiring.

- To limit noise, keep signal wires as far away as possible from power and load lines.
- For proper operation and high immunity to electrical noise, always use Belden™ 8761 (shielded, twisted pair) or equivalent wire.
- Connect the shield drain wire to the earth ground of the chassis.
- Tighten terminal screws using a flat or cross-head screwdriver. Each screw should be turned tight enough to immobilize the wire's end. Excessive tightening can strip the terminal screw. The torque applied to each screw should not exceed 0.7 to 0.9 Nm (6 to 8 in-lbs) for each terminal.
- Follow system grounding and wiring guidelines found in your *SLC 500 Modular Hardware Style Installation and Operation Manual*, publication 1747-6.2.

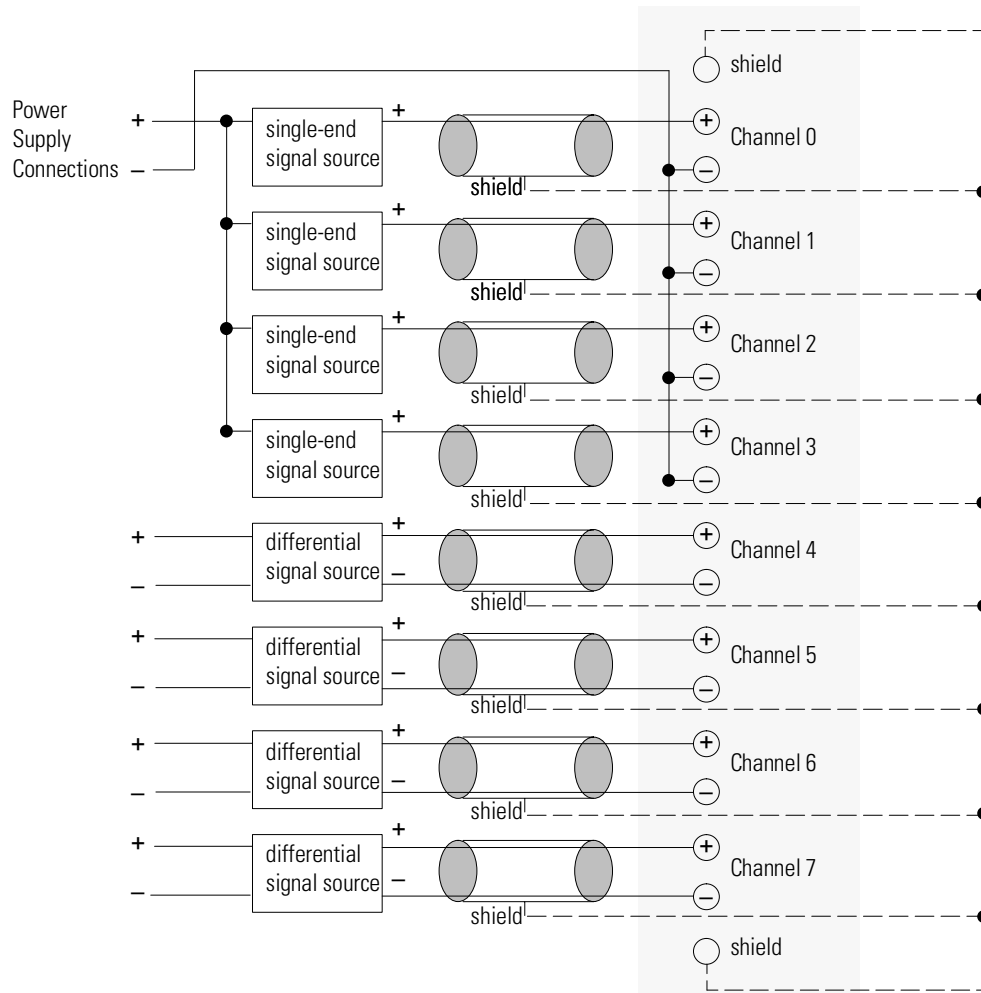
## 8-Channel Modules Wiring 1746-NI8 Wiring Single-Ended and Differential Inputs Diagrams

The diagram below shows typical wiring for the module.

### IMPORTANT

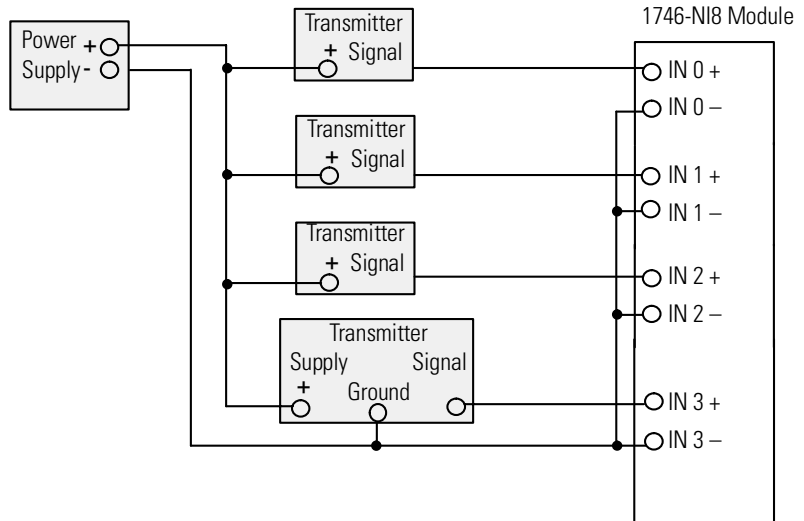
Follow these guidelines when wiring the module.

- Use unshielded communication cable (Belden 8761) and keep the length as short as possible.
- Connect only one end of the cable shield to earth ground.
- Connect the shield drain wires for channels 0 to 3 to the top shield terminal.
- Connect the shield drain wires for channels 4 to 7 to the bottom shield terminal.
- Shield terminals are internally connected to chassis ground which is connected to earth ground via the SLC backplane.
- Single-ended source commons may be jumpered together at the terminal block.
- The channels are not isolated from each other.
- If a differential signal source has an analog common, it cannot and must not be connected to the module.
- The common mode voltage range is  $\pm 10.5$  volts. The voltage between any two terminals must be less than 15 volts when connected in a single-ended configuration.
- The module does not provide power for the analog inputs.
- Use a power supply that matches the transmitter (sensor) specifications.

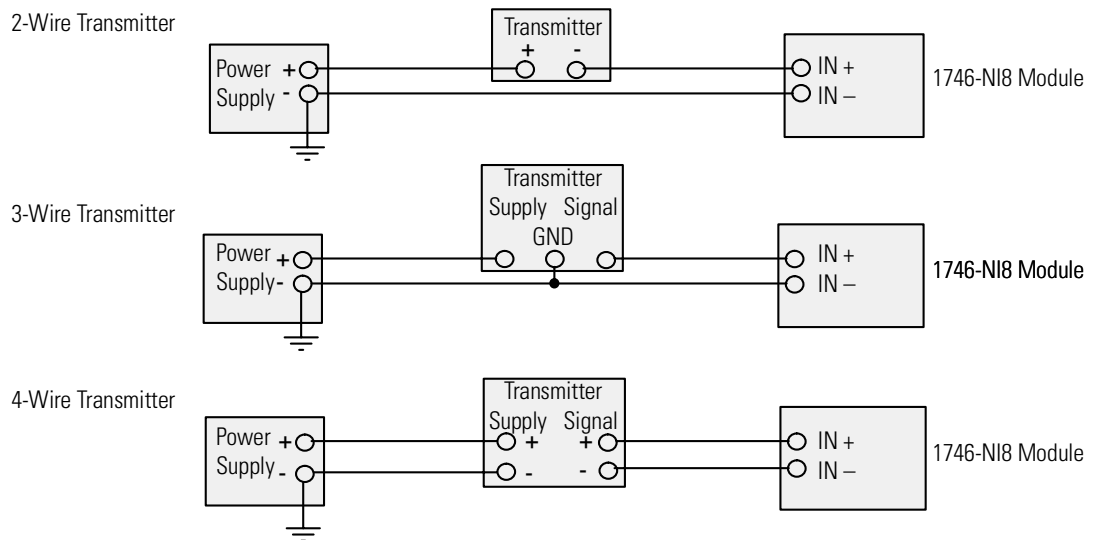


### 1746-NI8 Wiring Schematic for Single-Ended Analog Input Connections

When wiring single-ended analog input devices to the analog input module, the number of total wires necessary can be limited by jumpering all “IN–” terminals together. Note that differential inputs are more immune to noise than single-ended inputs.



### 1746-NI8 Wiring Schematics for 2, 3, and 4-Wire Analog Input Devices



**IMPORTANT**

The module does not provide loop power for analog inputs. Use a power supply that matches the transmitter specifications.

**IMPORTANT**

Follow the guidelines on page 31 when wiring the module.

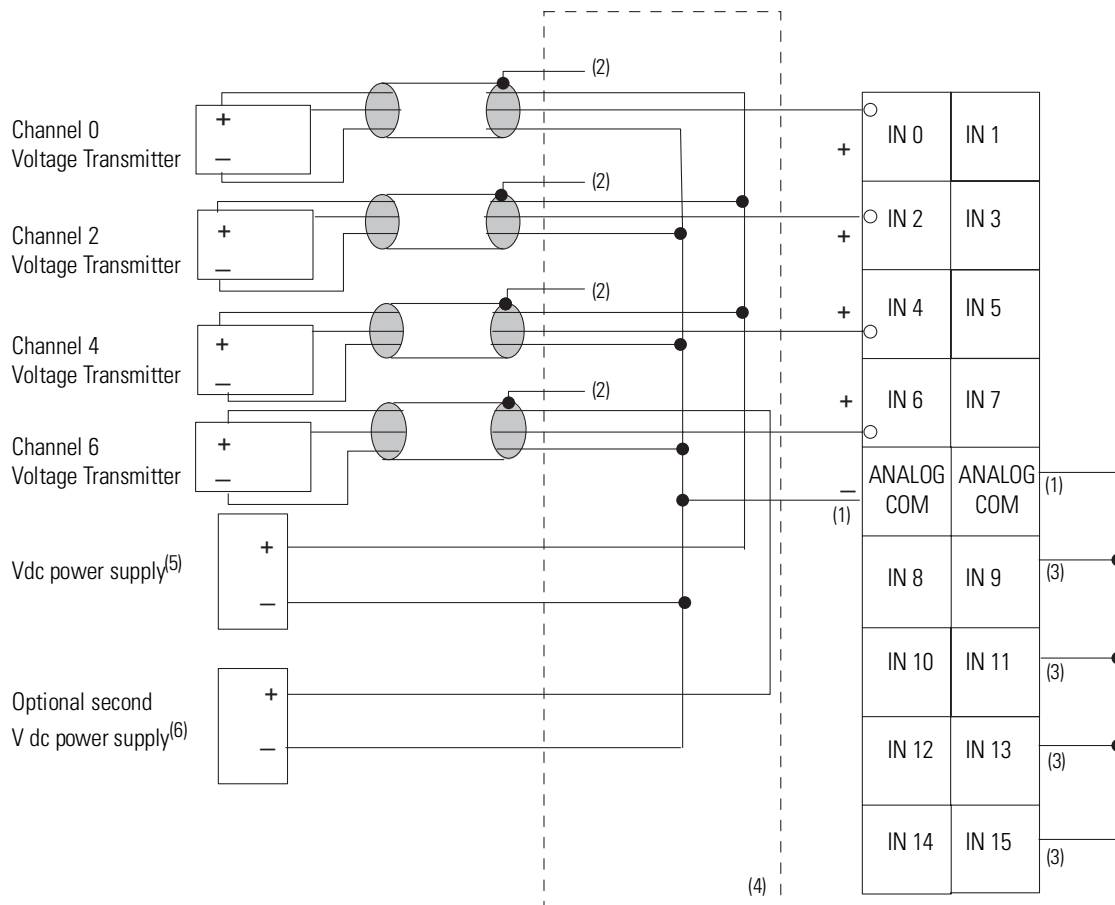


## 16-Channel Modules Wiring Diagrams

### Wiring Single-Ended Inputs

1746-NI16V

The diagram below shows typical wiring for the module.



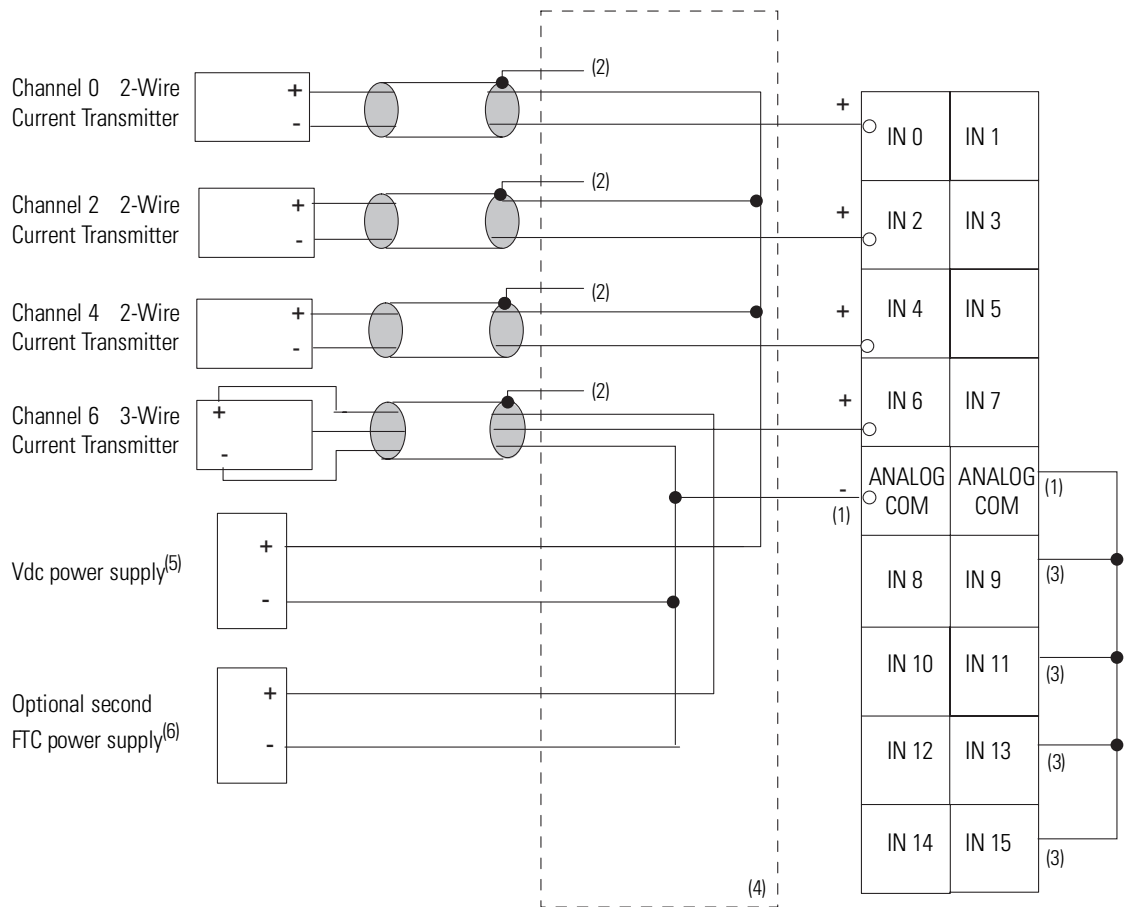
- (1) There are two common terminals for all of the 16 voltage inputs. These two analog common terminals are connected internally.
- (2) All shield wires should be connected to chassis mounting screws.
- (3) Unused channels should be connected to the analog common terminals (0 Volts).
- (4) If separate shielded cables are used for each analog input channel, interposing terminal blocks are needed to terminate up to 16 common wires. Then, 1 to 4 common wires should be wired from the interposing terminal block to the 2 common terminals on the 1746-NI16V module.
- (5) The module does not provide loop power for analog inputs. Use a power supply that matches the transmitter specifications.
- (6) More than one power supply can be used if all supplies are class 2.

#### NOTE

Although the above diagram has 12 unused inputs, only 4 channels are shown connected to the Analog Com as an example.

### 1746-NI16I

The diagram below shows typical wiring for the module.

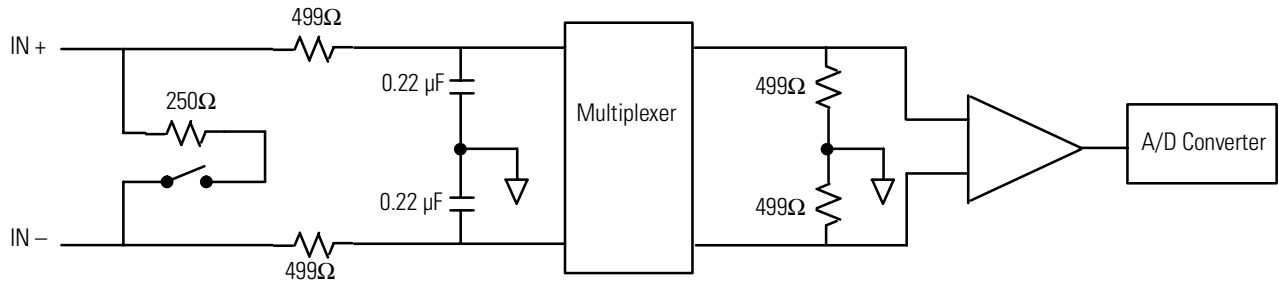


- (1) There are two common terminals for all of the 16 current inputs. These two analog common terminals are connected internally.
- (2) All shield wires should be connected to chassis mounting screws.
- (3) Unused channels should be connected to the analog common terminals (0 Volts).
- (4) If separate shielded cables are used for each analog input channel, interposing terminal blocks are needed to terminate up to 16 common wires. Then 1 to 4 common wires should be wired from the interposing terminal block to the 2 common terminals on the 1746-NI16I module.
- (5) The module does not provide loop power for analog inputs. Use a power supply that matches the transmitter specifications.
- (6) More than one power supply can be used if all supplies are class 2.

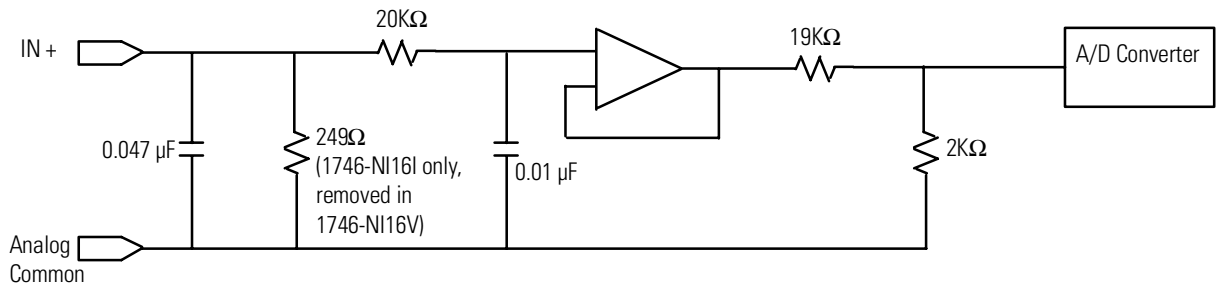
## 8- and 16-Channel Modules Internal Input Circuits

The following input circuits are provided to help you match the analog module to your input device.

### 1746-NI8



### 1746-NI16



## 8-Channel Module Specifications

## Electrical Specifications

Description	Specification
Backplane Current Consumption	<ul style="list-style-type: none"> <li>• 200 mA at 5V dc</li> <li>• 100 mA at 24V dc</li> </ul>
Backplane Power Consumption	3.4W maximum (1.0W at 5V dc, 2.4W at 24V dc)
Number of Channels	8 (backplane isolated)
I/O Chassis Location	Any I/O module slot except slot 0
A/D Conversion Method	Successive approximation, switched capacitor
Input Filtering	Low-pass digital filter with programmable filter frequencies
Normal Mode Rejection (between [+] input and [-] input)	Provided by low-pass filter
Common Mode Rejection (between inputs and chassis ground)	<ul style="list-style-type: none"> <li>• Greater than or equal to 75 dB at DC</li> <li>• Greater than or equal to 100 dB at 50/60 Hz</li> </ul>
Input Filter Frequencies	<ul style="list-style-type: none"> <li>• 1 Hz</li> <li>• 2 Hz</li> <li>• 5 Hz</li> <li>• 10 Hz</li> <li>• 20 Hz</li> <li>• 50 Hz</li> <li>• 75 Hz</li> </ul>
Calibration	The module performs continuous autocalibration.
Isolation	500V ac withstand for 1 minute
Common-Mode Voltage Range	±10.5V (15V maximum between any two input signal terminals when connected in a single-ended configuration)

## Physical Specifications

Description	Specification
LED Indicators	9 green status indicators, one for each of 8 channels and one for module status
Module ID Code	<ul style="list-style-type: none"> <li>Class 1 Interface: 3526</li> <li>Class 3 Interface: 12726</li> </ul>
Recommended Cable	Belden #8761 or equivalent
Maximum Wire Size	Two 14 AWG wires per terminal
Maximum Cable Impedance	<ul style="list-style-type: none"> <li>Voltage Source (with less than 10<math>\Omega</math> impedance): 40<math>\Omega</math> maximum loop impedance, for &lt;1LSB error</li> <li>Current Source (transmitter properly wired to its power supply): 250<math>\Omega</math> maximum loop impedance, to meet common-mode voltage requirements</li> </ul>
Terminal Block	Removable, Allen-Bradley spare part Catalog Number 1746-RT25G

## Environmental Specifications

Description	Specification
Operating Temperature	0°C to +55°C (+32°F to +131°F) in any slot except slot 0 0°C to +60°C (+32°F to +140°F) in right most slot of chassis
Storage Temperature	-40°C to +85°C (-40°F to +185°F)
Relative Humidity	5% to 95% (without condensation)
Certification	<ul style="list-style-type: none"> <li>UL listed</li> <li>CSA approved</li> <li>CE compliant for all applicable directives</li> </ul>
Hazardous Environment Classification	Class I Division 2 Hazardous Environment

## General Input Specifications

Description	Specification
Type of Input (Selectable)	<ul style="list-style-type: none"> <li>±10V dc</li> <li>0 to 5V dc</li> <li>0 to 20 mA</li> <li>±20 mA</li> <li>1 to 5V dc</li> <li>0 to 10V dc</li> <li>4 to 20 mA</li> <li>0 to 1 mA</li> </ul>
Type of Data (Selectable)	<ul style="list-style-type: none"> <li>Engineering Units</li> <li>Scaled-for-PID</li> <li>Proportional Counts (-32,768 to +32,767 range)</li> <li>Proportional Counts (User Defined Range, Class 3 only)</li> <li>1746-NI4 Data Format</li> </ul>
Time to Detect Open Circuit	1 module scan
Input Step Response	See Step Response Time table on page 28.
Non-linearity	0.01% of full scale maximum
Module Update Time	0.75 msec per enabled channel
Channel Turn-On Time	101 to 107 msec maximum
Channel Turn-Off Time	1 to 7 msec maximum
Channel Reconsideration Time	101 to 107 msec maximum

## Input Step Response

Filter Frequency	Step Response Time		
	1% Accuracy <sup>(1)</sup>	0.1% Accuracy <sup>(1)</sup>	0.05% Accuracy <sup>(1)</sup>
1 Hz	730 msec + module update time	1100 msec + module update time	1200 msec + module update time
2 Hz	365 msec + module update time	550 msec + module update time	600 msec + module update time
5 Hz	146 msec + module update time	220 msec + module update time	240 msec + module update time
10 Hz	73 msec + module update time	110 msec + module update time	120 msec + module update time
20 Hz	36.5 msec + module update time	55 msec + module update time	60 msec + module update time
50 Hz	14.5 msec + module update time	22 msec + module update time	24 msec + module update time
75 Hz	10 msec + module update time	15 msec + module update time	18 msec + module update time
no filter	0.5 msec + module update time	0.75 msec + module update time	0.75 msec + module update time

(1) The module accuracy for current inputs is 0.05%, and for voltage inputs is 0.1%.

## Current-Loop Input Specifications

Description	Specification
Current Input (maximum)	±30 mA
Input Impedance	250 ohms
Input Resolution	1 µA
Display Resolution	1 µA
Overall Module Accuracy 0°C to +60°C (+32°F to +140°F)	<ul style="list-style-type: none"> <li>0 to 20 mA, 4 to 20 mA, ±20 mA: ±0.05%</li> <li>0 to 1 mA: ±0.5%</li> </ul>
Overall Module Accuracy Drift	±12 ppm/°C
Gain Error at +25°C (+77°F)	±0.025% (maximum)
Gain Error, 0°C to +60°C (+32°F to +140°F)	±0.05% (maximum)
Gain Error Drift	±12 ppm/°C
Offset Error at +25°C (+77°F)	±2 LSB (maximum)
Offset Error, 0°C to +60°C (+32°F to +140°F)	±3 LSB (maximum)
Offset Error Drift	±0.03 LSB/°C
Overvoltage Capability	7.5V ac RMS (maximum)

## Voltage Input Specifications

Description	Specification
Voltage Input (maximum)	±30V between any two signal terminals
Input Impedance	1 MΩ
Input Resolution	1 mV
Display Resolution	1 mV
Overall Module Accuracy 0°C to +60°C (+32°F to +140°F)	±0.1%
Overall Module Accuracy Drift	±17 ppm/°C
Gain Error at +25°C (+77°F)	±0.05% (maximum)
Gain Error, 0°C to +60°C (+32°F to +140°F)	±0.1% (maximum)
Gain Error Drift	±17 ppm/°C (maximum)
Offset Error, +25°C (+77°F)	±2 LSB (maximum)
Offset Error at 0°C to +60°C (+32°F to +140°F)	±3 LSB (maximum)
Offset Error Drift	±0.03 LSB/°C (maximum)

## 16-Channel Module Specifications

### Electrical Specifications

Description	Specification
Backplane Current Consumption	<ul style="list-style-type: none"> <li>• 125 mA at 5V dc</li> <li>• 75 mA at 24V dc</li> </ul>
Backplane Power Consumption	2.425W maximum (0.625W at 5V dc, 1.8W at 24V dc)
Number of Channels	16 (backplane isolated)
I/O Chassis Location	Any I/O module slot except slot 0
A/D Conversion Method	Sigma-Delta
Input Filtering	Low pass digital filter with programmable filter frequencies
Normal Mode Rejection (between [+] input and [-] input)	Greater than 80 dB at 50/60 Hz
Common Mode Rejection (between inputs and chassis ground)	<ul style="list-style-type: none"> <li>• Greater than or equal to 75 dB at DC</li> <li>• Greater than or equal to 100 dB at 50/60 Hz</li> </ul>
Input Filter Frequencies	<ul style="list-style-type: none"> <li>• 6 Hz</li> <li>• 10 Hz</li> <li>• 20 Hz</li> <li>• 40 Hz</li> <li>• 60 Hz</li> <li>• 80 Hz</li> <li>• 100 Hz</li> <li>• 250 Hz</li> </ul>
Calibration	The 1746-NI16 module is factory calibrated. Although factory calibration is suitable for most applications, the module can be calibrated by the user. Refer to the SLC 500™ Analog Input Modules User Manual, publication 1746-UM001A-US-P, for the calibration sequence.
Isolation	500V ac withstand for 1 minute
Common-Mode Voltage Range	±10.25V relative to the analog common terminal (20.5V maximum between any two signal input terminals)

## Physical Specifications

Description	Specification	
	1746-NI16I	1746-NI16V
LED Indicators	5 green status indicators: one for each group of 4 channels, and one for module status	
Module ID Code	<ul style="list-style-type: none"> <li>Class 1 Interface: 3504</li> <li>Class 3 Interface: 10403</li> </ul>	<ul style="list-style-type: none"> <li>Class 1 Interface: 3505</li> <li>Class 3 Interface: 10406</li> </ul>
Recommended Cable	Belden #8761 or equivalent	
Maximum Wire Size	Two 14 AWG wires per terminal	
Maximum Cable Impedance	With a current source transmitter properly wired to its power supply, 249 $\Omega$ is the maximum loop impedance to maintain common-mode voltage requirements	1250 $\Omega$ is the maximum loop impedance for less than 1 LSB of error. A voltage source with less than 10 $\Omega$ impedance is recommended.
Terminal Block	Removable, Allen-Bradley Catalog Number 1746-RT25G	
Pre-Wired Cable	Allen-Bradley Catalog Number 1492-ACAB005A46, 0.5m (1.6 ft) Allen-Bradley Catalog Number 1492-ACAB010A46, 1.0m (3.3 ft) Allen-Bradley Catalog Number 1492-ACAB025A46, 2.5m (8.2 ft) Allen-Bradley Catalog Number 1492-ACAB050A46, 5.0m (16.4 ft)	
User Terminal Blocks	Allen-Bradley Catalog Number 1492-AIFM8-3 Allen-Bradley Catalog Number 1492-AIFM16-F-3	

## Environmental Specifications

Description	Specification
Operating Temperature	0°C to +60°C (+32°F to +140°F) in any slot except slot 0
Storage Temperature	-40°C to +85°C (-40°F to +185°F)
Relative Humidity	5% to 95% (without condensation)
Certification	<ul style="list-style-type: none"> <li>UL listed</li> <li>C-UL approved</li> <li>CE compliant for all applicable directives</li> </ul>
Hazardous Environment Classification	Class I Division 2 Hazardous Environment

## Input Specifications

Description	Specification	
	1746-NI16I	1746-NI16V
Type of Input (Selectable)	<ul style="list-style-type: none"> <li>0 to 20 mA</li> <li>±20 mA</li> <li>4 to 20 mA</li> <li>0 to 1 mA</li> </ul>	<ul style="list-style-type: none"> <li>±10V dc</li> <li>0 to 5V dc</li> <li>1 to 5V dc</li> <li>0 to 10V dc</li> </ul>
Type of Data (Selectable)	<ul style="list-style-type: none"> <li>Engineering Units</li> <li>Scaled-for-PID</li> <li>Proportional Counts (-32,768 to +32,767 range)</li> <li>Proportional Counts (User Defined Range, Class 3 only)</li> <li>1746-NI4 Data Format</li> </ul>	
Input Impedance	249 Ω	20 MΩ
Maximum Voltage Input without Damage	±8V between any two signal terminals	±30V between any two signal terminals
Current Input (maximum)	±30 mA between analog common and any input terminal	
Time to Detect Open Circuit	less than 5 seconds	
Module Update Time	See table below.	
Input Resolution	640 nA	312 μV
Display Resolution	1 μA	1 mV
Module Error Over Full Operating Temperature Range	0.3%	0.1%
Input Offset Drift with Temperature	360 nA/°C	90 μV/°C
Gain Drift with Temperature	20 ppm/°C	15 ppm/°C
Calibrated Accuracy at 25°C	better than 0.15% of range	better than 0.05% of range

The following table shows the module update time. The module update time is different depending on the number of channels enabled and filter frequency. The fastest module update time occurs when only one channel is enabled on each A/D chip (channels 0, 4, 8, and 12). The slowest module update time occurs when 16 channels are enabled. Refer to the *SLC 500™ Analog Input Modules User Manual*, publication 1746-UM001A-US-P, for tips on reducing the module update time.

Filter Frequency (Hz)	Module Update Time (ms) <sup>(1)</sup>			
	16 Channels Enabled	12 Channels Enabled	8 Channels Enabled	4 Channels Enabled
6	630	473	314	7
10	380	285	190	4
20	194	145	96	4
40	100	75	50	4
60	69	52	34	4
80	54	39	26	4
100	37	27	18	4
250	18	13	9	4

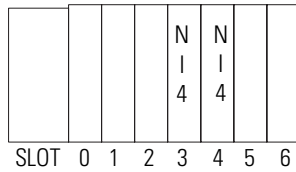
(1) Assuming all of the enabled channels have the filter frequency shown in the first column.



## Replacing 1746-NI4s with 1746-NI8 or 1746-NI16

### 1746-NI4 to 1746-NI8

Addressing is changed from two modules with 4 channels to one module with 8 channels. The input addressing is shown below.



#### 1746-NI4 Input Addressing

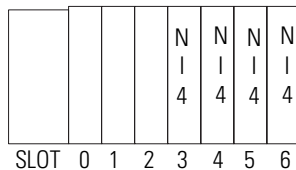
- I:3.0 - Slot 3, Channel 0 Data Word
- I:3.1 - Slot 3, Channel 1 Data Word
- I:3.2 - Slot 3, Channel 2 Data Word
- I:3.3 - Slot 3, Channel 3 Data Word
- I:4.0 - Slot 4, Channel 0 Data Word
- I:4.1 - Slot 4, Channel 1 Data Word
- I:4.2 - Slot 4, Channel 2 Data Word
- I:4.3 - Slot 4, Channel 3 Data Word

#### 1746-NI8 Input Addressing

- I:3.0 - Slot 3, Channel 0 Data Word
- I:3.1 - Slot 3, Channel 1 Data Word
- I:3.2 - Slot 3, Channel 2 Data Word
- I:3.3 - Slot 3, Channel 3 Data Word
- I:3.4 - Slot 3, Channel 4 Data Word
- I:3.5 - Slot 3, Channel 5 Data Word
- I:3.6 - Slot 3, Channel 6 Data Word
- I:3.7 - Slot 3, Channel 7 Data Word

### 1746-NI4 to 1746-NI16

Addressing is changed from four modules with 4 channels to one module with 16 channels. The input addressing is shown below.



#### 1746-NI4 Input Addressing

- I:3.0 - Slot 3, Channel 0 Data Word
- I:3.1 - Slot 3, Channel 1 Data Word
- I:3.2 - Slot 3, Channel 2 Data Word
- I:3.3 - Slot 3, Channel 3 Data Word
- I:4.0 - Slot 4, Channel 0 Data Word
- I:4.1 - Slot 4, Channel 1 Data Word
- I:4.2 - Slot 4, Channel 2 Data Word
- I:4.3 - Slot 4, Channel 3 Data Word
- I:5.0 - Slot 5, Channel 0 Data Word
- I:5.1 - Slot 5, Channel 1 Data Word
- I:5.2 - Slot 5, Channel 2 Data Word
- I:5.3 - Slot 5, Channel 3 Data Word
- I:6.0 - Slot 6, Channel 0 Data Word
- I:6.1 - Slot 6, Channel 1 Data Word
- I:6.2 - Slot 6, Channel 2 Data Word
- I:6.3 - Slot 6, Channel 3 Data Word

#### 1746-NI16 Input Addressing

- I:3.0 - Slot 3, Channel 0 Data Word
- I:3.1 - Slot 3, Channel 1 Data Word
- I:3.2 - Slot 3, Channel 2 Data Word
- I:3.3 - Slot 3, Channel 3 Data Word
- I:3.4 - Slot 3, Channel 4 Data Word
- I:3.5 - Slot 3, Channel 5 Data Word
- I:3.6 - Slot 3, Channel 6 Data Word
- I:3.7 - Slot 3, Channel 7 Data Word
- I:3.8 - Slot 3, Channel 8 Data Word
- I:3.9 - Slot 3, Channel 9 Data Word
- I:3.10 - Slot 3, Channel 10 Data Word
- I:3.11 - Slot 3, Channel 11 Data Word
- I:3.12 - Slot 3, Channel 12 Data Word
- I:3.13 - Slot 3, Channel 13 Data Word
- I:3.14 - Slot 3, Channel 14 Data Word
- I:3.15 - Slot 3, Channel 15 Data Word

#### NOTE

All inputs must be either voltage or current inputs. This also applies when replacing two 1746-NI8s with one 1746-NI16.

## Determining Power Requirements

Analog modules require both 5V dc and 24V dc power from the backplane of the SLC 500 system. However, the 1746-NO4I and 1746-NO4V analog modules can use an external 24V dc power supply. This eliminates the 24V dc backplane power requirement, providing configuration flexibility if SLC power supply loading is critical. These two modules have terminals for external 24V dc power supply connections.<sup>(1)</sup>

When you are using a modular system configuration, add the values shown in the table below to the requirements of all other modules in the SLC chassis to prevent overloading the chassis power supply. The maximum current drawn by the module is shown in the table below.

### IMPORTANT

The analog modules do not supply loop power for the input device. You must supply the appropriate loop power for loop-powered input devices.

Catalog Number	Backplane Current Draw	
	at 5V dc	at 24V dc
1746-FIO4I	55 mA	150 mA
1746-FIO4V	55 mA	120 mA
1746-NI4	35 mA	85 mA
1746-NI8	200 mA	100 mA
1746-NI16I	125 mA	75 mA
1746-NI16V	125 mA	75 mA
1746-NIO4I	55 mA	145 mA
1746-NIO4V	55 mA	115 mA
1746-NO4I <sup>(1)</sup>	55 mA	195 mA <sup>(2)</sup>
1746-NO4V <sup>(1)</sup>	55 mA	145 mA <sup>(2)</sup>

(1) The 24V dc external power connection on a fixed SLC 500 can power an NO4I or NO4V analog module. However, the regulation of the 24V dc external connection on a modular SLC 500 power supplies (catalog numbers 1746-P1, -P2, and -P4) is outside of the requirements of the NO4I and NO4V analog modules and cannot be used.

(2) Omit these values from your SLC power supply loading calculations if you decide to use an external power supply.

Place your analog module in any slot of an SLC 500 modular, or modular expansion chassis, except for the extreme left slot (slot 0) in the first chassis. This slot is reserved for the processor or adapter modules.

### IMPORTANT

For applications using the upper limit of the operating temperature range, the 1746-NI8 module (or multiple 1746-NI8 modules) should be placed in the rightmost slot(s) of the chassis. The specification for operating temperature is:

#### Operating Temperature Range

- 0°C to +55°C (+32°F to +131°F) in any slot except slot 0
- 0°C to +60°C (+32°F to +140°F) in right most slot of chassis

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