# Overview

This chapter describes the 1746-NI16 analog input module and explains how the SLC 500 processor gathers analog input data from the module. Included is information about:

- the module's hardware and diagnostic features
- an overview of system operation

## General Description

The module receives and stores digitally converted analog data into its image table for retrieval by all fixed and modular SLC 500 processors. The modules, 1746-NI16V and 1746-NI16I, support connections for up to 16 voltage or current analog sensors.

The 1746-NI16 is a multi-class (Class 1 or Class 3) single-slot module. Class 1[(1)] configuration utilizes 8 input words and 8 output words. Class 3 configuration utilizes 32 input words and 32 output words. Fixed and SLC 5/01 processors can only operate as Class 1. When the module is used in a remote I/O chassis with a 1747-ASB, it can only operate in Class 1 mode. The SLC 5/02, SLC 5/03, SLC 5/04 and SLC 5/05 processors can be configured for either Class 1 or Class 3. When the module is used in a remote ControlNet™ chassis with a 1747-ACN(R), it can also operate in either Class 1 or Class 3 mode. Operate the module in Class 3 mode whenever possible.

The 16 high-impedance input channels can be wired as single-ended inputs. The module provides a direct interface to the following input types:

- ±10V dc
- 1 to 5V dc
- 0 to 5V dc
- 0 to 10V dc
- 0 to 20 mA
- 4 to 20 mA
- ±20 mA
- 0 to 1 mA

(1) Requires use of block transfer in a remote configuration.

The data presented to the processor can be configured as:

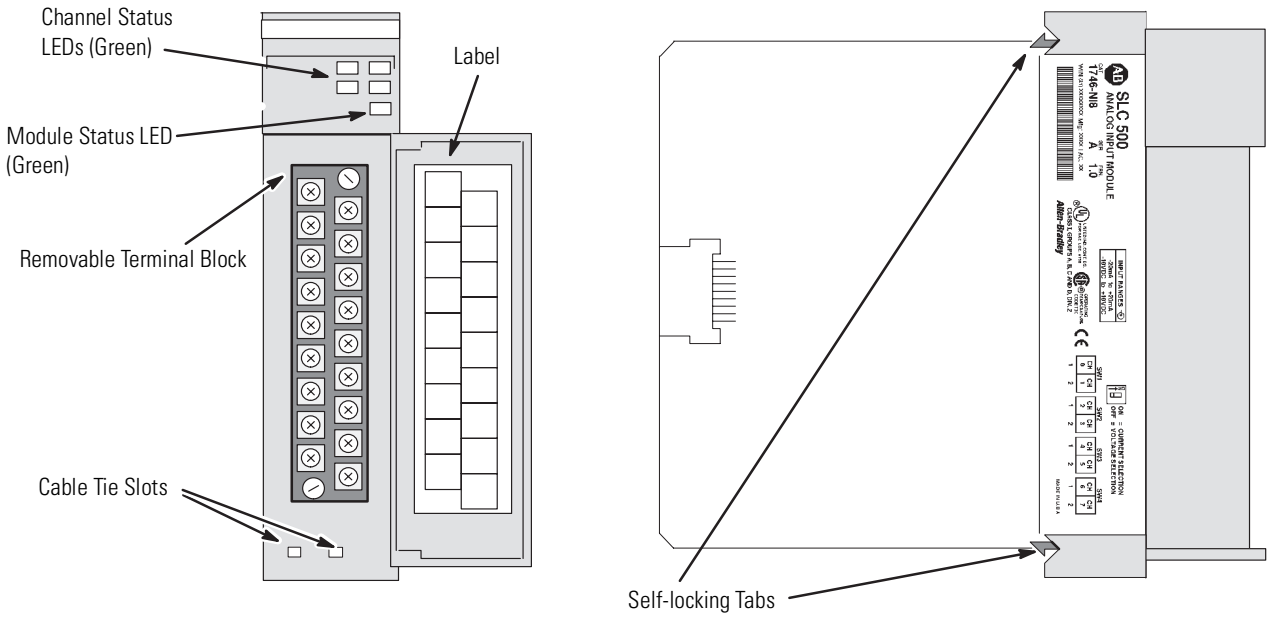
- Engineering Units
- Scaled-for-PID
- Proportional Counts (-32,768 to +32,767 range)
- Proportional Counts with User Defined Range (Class 3 Only)
- 1746-NI4 Data Format

Each input channel also provides open-circuit, out-of-range, and invalid configuration indication via the LED's. These conditions are also displayed in the channel status word.

## Hardware Features

The module fits into any slot, except the processor slot (0), in either an SLC 500 modular system or an SLC 500 fixed system expansion chassis (1746-A2).

The module contains a removable terminal block, providing connection for 16 analog input channels, which are specifically designed to interface with analog current and voltage input signals. The channels can only be wired as single-ended inputs. There are no output channels on the module. The module is configured via the user program. The following graphic displays the main hardware features.



# Preliminary Operating Considerations

This chapter explains how the analog input module and the SLC 500™ processor communicate through the module's input and output image. It lists the preliminary setup and operation required before the module can function in a 1746 I/O system. Topics discussed include how to:

- enter the module ID code
- select the Class 1 or Class 3 interface
- address your 1746-NI16 module
- select the proper input filter for each channel
- calculate the module update time
- interpret the module response to slot disabling

## 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 |
|---|---|
| 1746-NI16I | Class 1 interface 3504<br>Class 3 interface 10403 |
| 1746-NI16V | Class 1 interface 3505<br>Class 3 interface 10406 |

**NOTE** Not all programming software supports configuration for Class 3 operation.

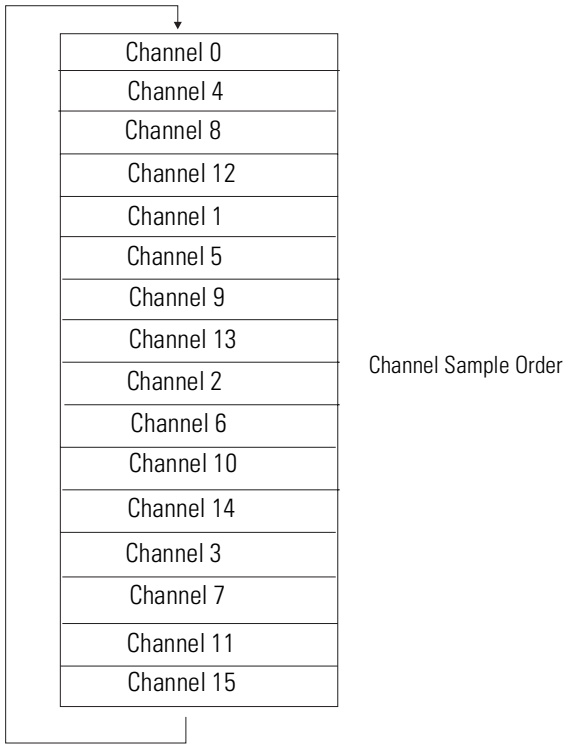
- Advanced Programming Software (APS) supports Class 3 configuration. After entering the ID code (NI16I - 10403, NI16V - 10406), enter 32 input words and 32 output words.
- SLC 500 A.I. Series™ Programming Software supports Class 3 configuration. After entering the ID code (NI16I - 10403, NI16V - 10406), enter 32 input words and 32 output words.
- RSLogix 500™, version 1.30 or later, supports Class 3 configuration. After entering the ID code (NI16I - 10403, NI16V - 10406), select Class 3 operation.
- Earlier versions of RSLogix 500 only support configuration for Class 1 operation. Contact Rockwell Software for information on upgrading your software.

## Class 1 and Class 3 Interface

The 1746-NI16 analog input module has multi-class interface capabilities. 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. Use Class 3 operation whenever possible.

| Configuration | Class 1 | Class 3 |
|---|---|---|
| Compatible SLC Processors | SLC 500 fixed, SLC 5/01, SLC 5/02, SLC 5/03, SLC 5/04 and SLC 5/05 | SLC 5/02, SLC 5/03, SLC 5/04 and SLC 5/05 |
| Compatible Chassis | local chassis or remote chassis with a 1747-ASB module | local chassis or remote ControlNet chassis with a 1747-ACN(R) module |
| Input and Output Images | **output image**:<br>8 words available for configuring 16 channels<br>**input image:**<br>8 words available for 16 data words and 16 status words | **output image:**<br>24 words available for configuring all 16 channels<br>**input image:**<br>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 |

The 1746-NI16 module sequentially samples the channels in a continuous loop according to the following diagram. The next channel in the order is sampled if any channel is disabled.




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.

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| Filter Frequency (Hz) | Update Time 16-Ch (ms)[1] | Update Time 12-Ch (ms)[1] | Update Time 8-Ch (ms)[1] | Update Time 4-Ch (ms)[1] |
|---|---|---|---|---|
| 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.

The hardware architecture has some bearing on how the module firmware works and thus how a user can optimize performance when fewer than all 16 channels are required. You can enable any number of channels you want, but certain channel selections make data available to your ladder program more quickly than others.

The module uses four A/D converters, each multiplexing four input channels. The first A/D is for channels 0 through 3, the second for 4 through 7, and so forth. Although there is room in the configuration data table to select a different filter for each channel, the filter value programmed for the first channel of each A/D is used for all four channels of that A/D. In other words, the filter selection made for channel 0 is used for channels 0 through 3. The selection programmed for channel 4 is applied to channels 4 through 7, and so forth.

If your application requires 12 or fewer of the 16 analog inputs, you can achieve a module update time of about 3/4 of the time listed in the table above for 16 channels if you enable channels in a certain way. Use the first three channels on each A/D, leaving the fourth channel disabled. For example, if you enable channels 0, 1, 2, 4, 5, 6, 8, 9, 10, 12, 13, and 14, your module update time is about 75 ms with the 40 Hz filter instead of 100 ms listed in the table if all 16 inputs are enabled.

Similarly, if you need 8 or fewer channels, you can achieve a module update time of about one-half the 16-channel table values. For example, if you enable only channels 0, 1, 4, 5, 8, 9, 12, 13, the module update time is about 50 ms with a 40 Hz filter.

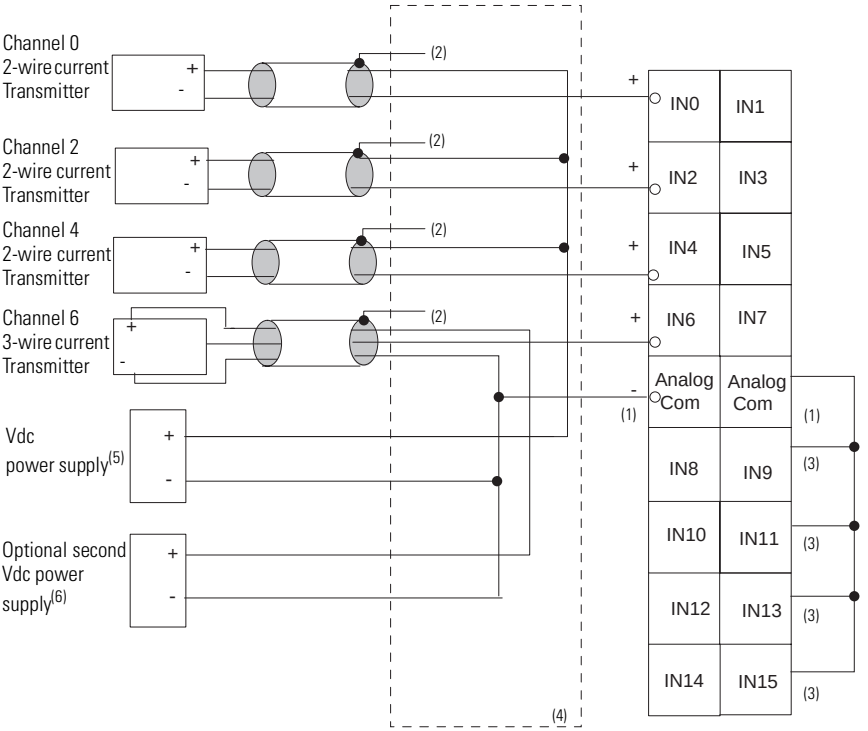
Finally, for very fast response you may use four or fewer channels. This mode exploits the power of dedicating one A/D converter per channel. The A/Ds are considerably faster when they do not have to multiplex inputs.

**NOTE** In this mode, the module provides four channels of data every 4 ms, regardless of filter setting.

**NOTE** The same channels are used on each of the four A/D converters. In the 12-or-fewer-channels example above, note that you are using channels 0, 1, and 2 on each of the four A/D converters, but channel 3 on each remains disabled. If you just enable the first 12 channels (0 to 11) on the module, and leave channels 12 to 15 disabled, your update time is the same as if you had enabled all 16 channels.

## *Wiring Single-Ended Inputs*

The diagram below shows typical wiring for the 1746-NI16I 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.

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

# Specifications

## Electrical Specifications

| Description | Specification |
|---|---|
| Backplane Current Consumption | 125 mA at 5V dc<br>75 mA at 24V dc |
| 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) | >80 dB at 50/60 Hz<br>>75 dB at dc<br>>100 dB at 50/60 Hz |
| Common Mode Rejection (between inputs and chassis ground) | Greater than or equal to 75 dB at DC<br>Greater than or equal to 100 dB at 50/60 Hz |
| Input Filter Frequencies | 6 Hz, 10 Hz, 20 Hz, 40 Hz, 60 Hz, 80 Hz, 100 Hz, 250 Hz |
| Isolation | 500V ac isolation for 1 second |
| Common-Mode Voltage Range | ±10.25V relative to analog common terminal<br>(20.5V maximum between any two signal input terminals) |

## Physical Specifications

| Description | | Specification | |
|---|---|---|---|
| LED Indicators | | 5 green status indicators<br>one for each group of 4 channels and one for module status | |
| Module ID Code | | Class 1 | Class 3 |
| | NI16V | 3505 | 10406 |
| | NI16I | 3504 | 10403 |
| Recommended Cable | | Belden #8761 or equivalent | |
| Maximum Wire Size | | Two 14 AWG wires per terminal | |
| Maximum Cable Impedance | NI16V | Voltage Source (with less than 10Ω impedance): 1250Ω maximum loop impedance, for <1LSB error | |
| | NI16I | Current Source (transmitter properly wired to its power supply): 249Ω maximum loop impedance, to meet common-mode voltage requirements | |
| Terminal Block | | Removable, Allen-Bradley spare part<br>Catalog Number 1746-RT25G | |
| Allen-Bradley Prewired Cables | | 1492-ACAB005A46, 0.5m (1.6 ft.)<br>1492-ACAB010A46, 1.0 m (3.3 ft.)<br>1492-ACAB025A46, 2.5 m (8.2 ft.)<br>1492-ACAB050A46, 5.0 m (16.4 ft.) | |
| Allen-Bradley User Terminal Blocks | | 1492-AIFM8-3<br>1492-AIFM16-F-3 | |

## Environmental Specifications

| Description | Specification |
|---|---|
| Operating Temperature | +0°C to +60°C (+32°F to +140°F) |
| Storage Temperature | -40°C to +85°C (-40°F to +185°F) |
| Relative Humidity | 5% to 95% (without condensation) |
| Agency Certification | UL listed<br>C-UL approved<br>CE compliant for all applicable directives |
| Hazardous Environment Classification | Class I Division 2 Hazardous Environment Groups A, B, C, D |

## Input Specifications

| Description | | Specification |
|---|---|---|
| Type of Input (Selectable) | NI16V | ±10V dc, 1 to 5V, 0 to 5V, or 0 to 10V |
| | NI16I | ±20 mA, 4 to 20 mA, 0 to 1 mA, 0 to 20 mA |
| Type of Data (Selectable) | | Engineering Units (1 mV/step or 1 µA/step)<br>Scaled-for-PID (0 to +16,383 range)<br>Proportional Counts (-32,768 to +32,767 range)<br>Proportional Counts (User Defined Range, Class 3 only)<br>1746-NI4 Data Format |
| Input Impedance | NI16V | 20 MΩ |
| | NI16I | 249 Ω |
| Maximum Voltage Input without damage | NI16V | ±30V between any two signal terminals |
| Maximum Voltage Input without damage | NI16I | ±8V between any two signal terminals |
| Current Input (maximum) | | ±30 mA (Between analog com and any input terminal) |
| Time to Detect Open Circuit | | Less Than 5 seconds |
| Module Update Time | | (1) |
| Input Resolution | NI16V | 312 µV(2) |
| | NI16I | 640 nA |
| Display Resolution | | 1 mV or 1 µA |
| Module Error Over Full Temperature Range (0°C to 60°C, 32°F to 140°F) | NI16V | Voltage input types (±10V dc, 1 to 5V dc, 0 to 5V dc, 0 to 10V dc): ±0.1% |
| | NI16I | Current input types (0 to 20 mA, 4 to 20 mA, 0 to 1mA, ±20 mA): ±0.3% |
| Input Offset Drift with Temperature | NI16V | 90 µV/°C |
| | NI16I | 360 nA/°C |
| Gain Drift with Temperature | NI16V | 15 ppm/°C |
| | NI16I | 20 ppm/°C |
| Calibrated Accuracy at 25°C | NI16V | Better than 0.05% of range |
| | NI16I | Better than 0.15% of range |

(1) Depends on filter selected. Refer to the 1746-NI16 User Manual, publication 1746-UM001A-US-P.

(2) Depends on data mode: Engineering Units or Proportional Counts.