Non-isolated Analog Voltage/Current Input Modules (1756-IF16 and 1756-IF8)

This chapter describes features specific to ControlLogix® non-isolated, analog voltage/current input modules.

The non-isolated analog voltage/current input modules support all the features that are described in this chapter and Chapter 3.

Choose a Wiring Method

The 1756-IF16, 1756-IF16K, 1756-IF8, and 1756-IF8K modules support single-ended, differential, and high-speed mode differential wiring methods.

Examples of each of these wiring methods on the 1756-IF16 and 1756-IF16K modules begin on page 43. Examples of each of these wiring methods on the 1756-IF8 and 1756-IF8K modules begin on page 47.

Single-ended Wiring Method

Single-ended wiring compares one side of the signal input to the signal ground. This difference is used by the module to generate digital data for the controller.

When using the single-ended wiring method, all input devices are tied to a common ground. The use of single-ended wiring and the common ground maximizes the number of usable channels on the module (eight channels for the 1756-IF8 and 1756-IF8K modules and 16 channels for the 1756-IF16 and 1756-IF16K modules).

Differential Wiring Method

The differential wiring method is recommended for applications that can have separate signal pairs or a common ground isn't available. Differential wiring is recommended for environments where improved noise immunity is needed.

IMPORTANT	This wiring method lets you use only half of the channels on a module. You can use only eight channels on the 1756-IF16 and 1756-IF16K modules and four channels on the 1756-IF8 and 1756-IF8K modules.

In differential mode, the channels aren't totally isolated from each other. If multiple differential input signals have different voltage common references, one channel could affect the reading of another channel. If this condition can't be avoided, then wire these inputs on different modules or replace the non-isolated module with an isolated input module.

High-speed Mode Differential Wiring Method

You can configure the 1756-IF16, 1756-IF16K, 1756-IF8, and 1756-IF8K modules for a high-speed mode that gives you the fastest data updates possible. When using the high-speed mode, remember these conditions:

- This mode uses the differential wiring method.
- This mode only allows use of one out of every four channels on the module.

Update times for applications that use the high-speed mode can be found on page 35.

Choose a Data Format

Data format determines the format of the data that is returned from the module to the owner-controller and the features that are available to your application. There are many possible Input Module Communication Formats to choose from when you configure your module.

When you choose a Communication Format, you can select one of two data formats:

- Integer mode
- Floating point mode

Features Available in Each Data Format

Data Format	Features Available	Features Not Available
Integer mode	Multiple input ranges Module filter Real-time sampling	Process alarms Digital filtering Rate alarms Scaling
Floating point mode	All features	See the following

IMPORTANT	When using the 1756-IF16 or 1756-IF16K module in single-ended mode (that is, 16-channel mode) with a floating point data format, process and rate alarms aren't available. This condition only exists when the 1756-IF16 or 1756-IF16K module is wired for single-ended mode. The 1756-IF8 or 1756-IF8K isn't affected.

Features Specific to Non-Isolated Analog Input Modules

The following features are specific to the 1756-IF16, 1756-IF16K, 1756-IF8, and 1756-IF8K modules.

Multiple Input Ranges

You can select from a series of operational ranges for each channel on your module. The range designates the **minimum** and **maximum signals** that are detectable by the module.

1756-IF16, 1756-IF16K, 1756-IF8, and 1756-IF8K Module Input Ranges

Module	Possible Ranges
1756-IF16, 1756-IF16K, 1756-IF8, and 1756-IF8K	-10…+10V 0…5V 0…10V 0…20 mA

For an example of how to choose an input range for your module, see page 84.

Module Filter

The module filter is a built-in feature of the analog-to-digital converter that attenuates the input signal, which begins at the specified frequency. This feature is applied on a module-wide basis.

The module attenuates the selected frequency by approximately -3 dB or 0.707 of the applied amplitude. This selected frequency is also called the bandwidth of the module.

An input signal with frequencies above the selected frequency is attenuated more, while frequencies below the selection receive no attenuation.

A by-product of the filter selection, in addition to frequency rejection, is the minimum sample rate (RTS) that is available. For example, in floating point mode, the 1000 Hz selection does not attenuate any frequencies less than
1000 Hz, but allows sampling of all 16 channels within 18 ms. But the
10 Hz selection attenuates all frequencies above 10 Hz and allows only sampling of all 16 channels within 488 ms.

IMPORTANT	The default setting for the module filter is 60 Hz. This setting provides approximately 3 dB of filtering of a 60 Hz input.

See this table to choose a module filter setting.

Filter Selections with Associated Performance Data

Module Filter Setting (-3 dB)(1) (2)	Wiring Mode	10 Hz	50…60 Hz (Default)	100 Hz	250 Hz	1000 Hz
Minimum sample time (RTS) Integer mode	Single-ended Differential High-speed differential	488 ms 244 ms 122 ms	88 ms 44 ms 22 ms	56 ms 28 ms 14 ms	28 ms 14 ms 7 ms	16 ms 8 ms 5 ms
Minimum sample time (RTS) Floating point mode	Single-ended Differential High-speed differential	488 ms 244 ms 122 ms	88 ms 44 ms 22 ms	56 ms 28 ms 14 ms	28 ms 14 ms 7 ms	18 ms 11 ms 6 ms
Effective resolution		16 bits	16 bits	16 bits	14 bits	12 bits

(1) For optimal 50…60 Hz noise rejection (>80 dB), choose the 10 Hz filter.
(2) Worst case setting time to 100% of a step change is double the RTS sample times.

Real-time Sampling

This parameter instructs the module how often to scan its input channels and obtain all available data. After the channels are scanned, the module multicasts that data. This feature is applied on a module-wide basis.

During module configuration, you specify a real-time sampling (RTS) period and a requested packet interval (RPI) period. Both of these features instruct the module to multicast data, but only the RTS feature instructs the module to scan its channels before multicasting.

Underrange/Overrange Detection

This alarm feature detects when the non-isolated input module is operating beyond limits set by the input range. For example, if you're using the 1756-IF16 or 1756-IF16K module in the 0V…10V input range and the module voltage increases to 11V, the overrange detects this condition.

Table 13 shows the input ranges of non-isolated input modules and the lowest/highest signal available in each range before the module detects an underrange/overrange condition.

Module Input Ranges and Lowest/Highest Signal

Input Module	Available Range	Lowest Signal in Range	Highest Signal in Range
1756-IF16, 1756-IF16K, 1756-IF8, and 1756-IF8K	+/- 10V 0V…10V 0V…5V 0 mA…20 mA	-10.25V 0V 0V 0 mA	10.25V 10.25V 5.125V 20.5 mA

IMPORTANT	Be careful when 'disabling all alarms' on the channel because it also disables the underrange/overrange detection feature. If alarms are disabled, overrange/underrange is zero and the only way you can discover a wire-off detection is from the input value itself. If you must detect a wire-off status, do not 'disable all alarms'. We recommend that you disable only unused channels so extraneous alarm bits aren't set.

Digital Filter

The digital filter smooths input data noise transients for all channels on the module. This feature is applied on a per channel basis.

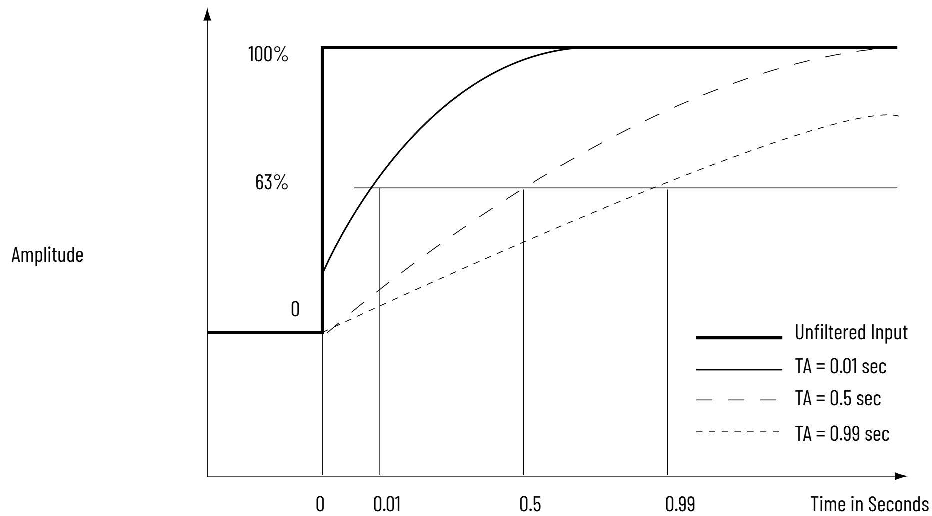
The digital filter value specifies the time constant for a digital first order lag filter on the input. It's specified in units of milliseconds. A value of 0 disables the filter.

The digital filter equation is a classic first order lag equation.

$$Yn = Yn\text{-}1 + \frac{[\Delta t]}{\Delta t + TA}(X_n - Y_n\text{-}1)$$

Yn = Present output, filtered peak voltage (PV)
Yn-1 =Previous output, filtered PV
Δt = Module channel update time (seconds)
TA = Digital filter time constant (seconds)
Xn = Present input, unfiltered PV

This illustration uses a step input change to illustrate the filter response. You can see that when the digital filter time constant elapses, 63.2% of the total response is reached. Each additional time constant achieves 63.2% of the remaining response.



To see how to set the Digital Filter, see page 84.

Process Alarms

Process alarms alert you when the module has exceeded configured high or low limits for each channel. You can latch process alarms. These are set at
four user configurable alarm trigger points.

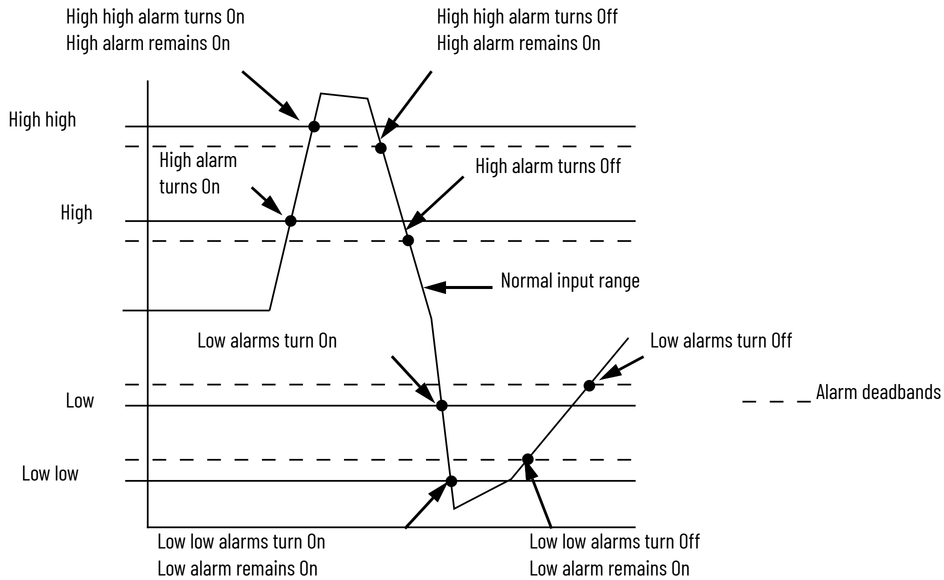
- High high
- High
- Low
- Low low

IMPORTANT	Process alarms aren't available in integer mode or in applications using a 1756-IF16 or 1756-IF16K module in the single-ended, floating point mode. The values for each limit are entered in scaled engineering units.

Alarm Deadband

You can configure an alarm deadband to work with the process alarms. The deadband allows the process alarm status bit to remain set, despite the disappearance of the alarm condition, as long as the input data remains within the deadband of the process alarm.

This illustration shows input data that sets each of the four alarms at some point during module operation. In this example, latching is disabled; therefore, each alarm turns Off when the condition that caused it to set ceases to exist.



To see how to set Process Alarms, see page 87.

Rate Alarm

The rate alarm triggers if the rate of change between input samples for each channel exceeds the specified trigger point for that channel.

IMPORTANT	Rate alarms aren't available in integer mode or in applications that use a 1756-IF16 or 1756-IF16K module in the single-ended, floating point mode. The values for each limit are entered in scaled engineering units.

For example, if you set the 1756-IF16 or 1756-IF16K module (with normal scaling in volts) to a rate alarm of 1.0 V/s, the rate alarm only triggers if the difference between measured input samples changes at a rate > 1.0 V/s.

If the module's RTS is 100 ms (that is, sampling new input data every 100 ms) and at time 0, the module measures 5.0 volts and at time 100 ms measures
5.08V, the rate of change is (5.08V - 5.0V) / (100 ms) = 0.8 V/s. The rate alarm does not set as the change is less than the trigger point of 1.0 V/s.

If the next sample taken is 4.9V, the rate of change is (4.9V…5.08V)/
(100 ms)=-1.8V/s. The absolute value of this result is > 1.0V/s, so the rate alarm sets. Absolute value is applied because the rate alarm checks for the magnitude of the rate of change being beyond the trigger point, whether a positive or negative excursion.

Wire Off Detection

The 1756-IF16, 1756-IF16K, 1756-IF8, and 1756-IF8K modules alert you when a signal wire only has been disconnected from one of its channels or the RTB has been removed from the module. When a wire-off condition occurs for this module, two events occur:

- Input data for that channel changes to a specific scaled value.
- A fault bit is set in the owner-controller that can indicate the presence of a wire-off condition.

Because the 1756-IF16, 1756-IF16K, 1756-IF8, and 1756-IF8K modules can be applied in voltage or current applications, differences exist as to how a wire-off condition is detected in each application.

IMPORTANT	Be careful when 'disabling all alarms' on the channel because it also disables the underrange/overrange detection feature. If alarms are disabled, overrange/underrange is zero and the only way you can discover a wire-off detection is from the input value itself. If you must detect a wire-off status, do not 'disable all alarms'. We recommend that you disable only unused channels so extraneous alarm bits aren't set.

This table details the events that occur when a wire-off condition occurs in various applications.

Wire-Off Conditions

Condition	Events
Single-ended Voltage Applications Single-Ended Current	• Input data for odd-numbered channels changes to the scaled value associated with the underrange signal value of the selected operational range in floating point mode (minimum possible scaled value) or -32,767 counts in integer mode The ChxUnderrange (x = channel number) tag is set to 1 • Input data for even-numbered channels changes to the scaled value associated with the overrange signal value of the selected operational range in floating point mode (maximum possible scaled value) or 32,767 counts in integer mode The ChxOverrange (x= channel number) tag[1] is set to 1
Differential Voltage	• Input data for that channel changes to the scaled value associated with the overrange signal value of the selected operational range in floating point mode (maximum possible scaled value) or 32,768 counts in integer mode The ChxOverrange (x= channel number) tag is set to 1
Differential Current Applications	• Input data for that channel changes to the scaled value associated with the overrange signal value of the selected operational range in floating point mode (maximum possible scaled value) or 32,768 counts in integer mode The ChxOverrange (x= channel number) tag is set to 1

(1) For more information about tags in the tag editor, see Appendix A.

In current applications, wire-off detection occurs for one of the following reasons:

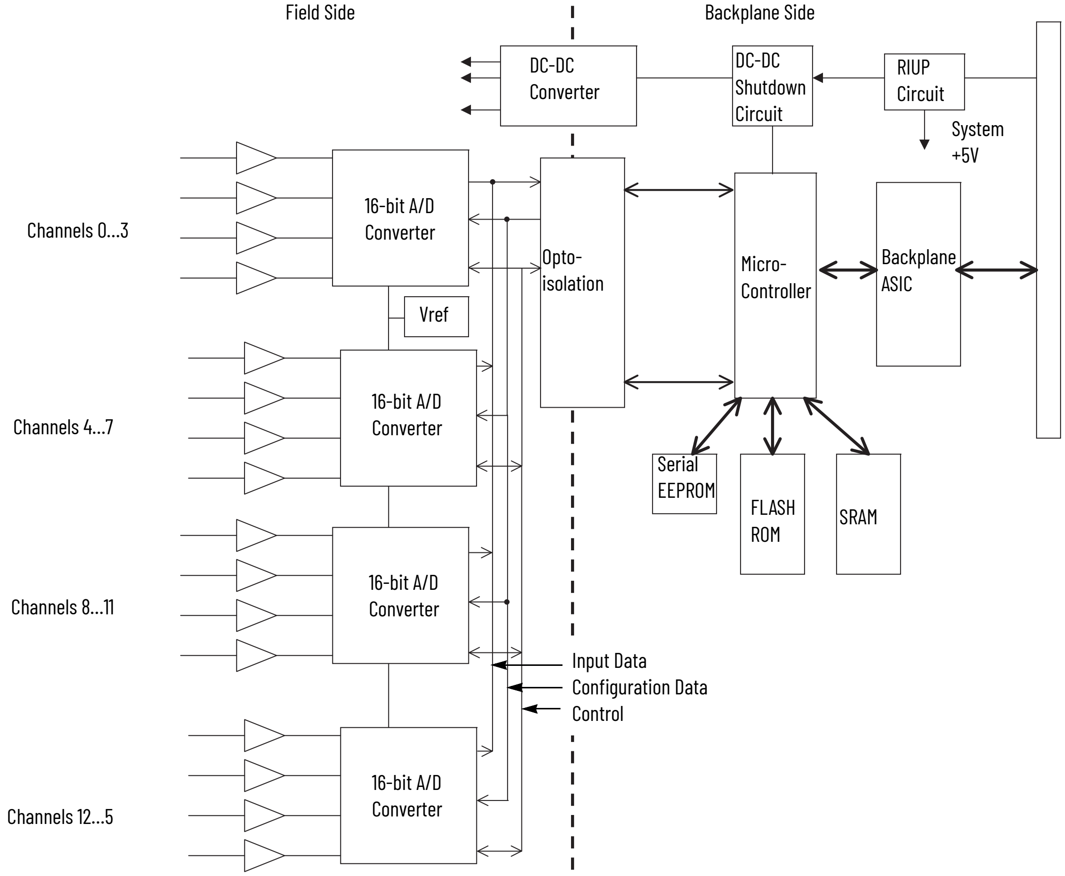
Because the RTB has been disconnected from the module

Both the signal wire and/or the jumper wire have been disconnected

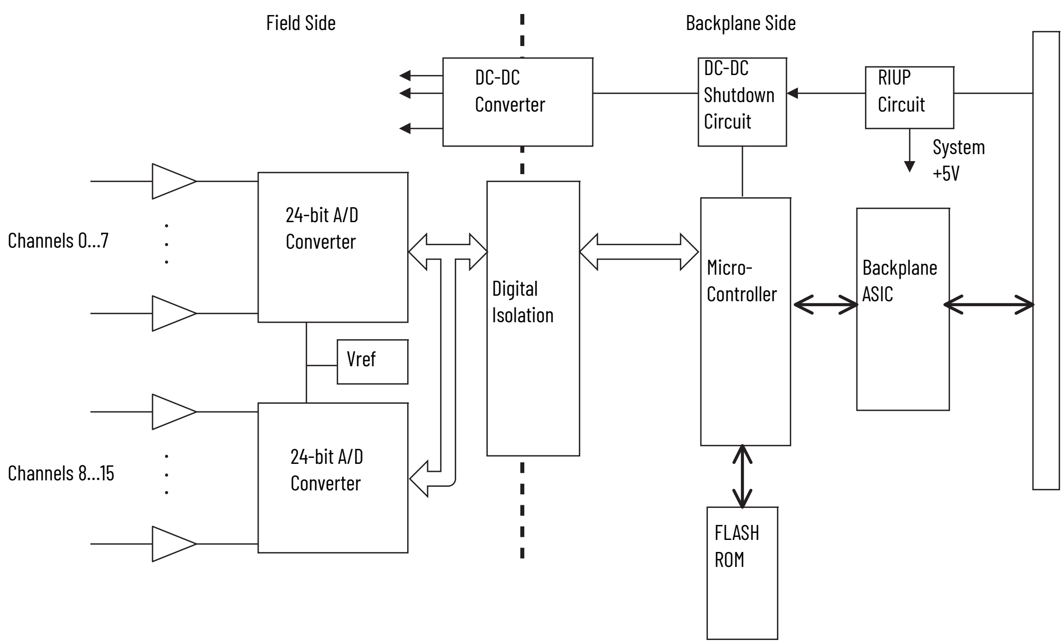
Use Module Block and Input Circuit Diagrams

This section shows the block diagrams for 1756-IF16 and 1756-IF16K series A and B modules.

1756-IF16/A, 1756-IF16K/A Module Block Diagram

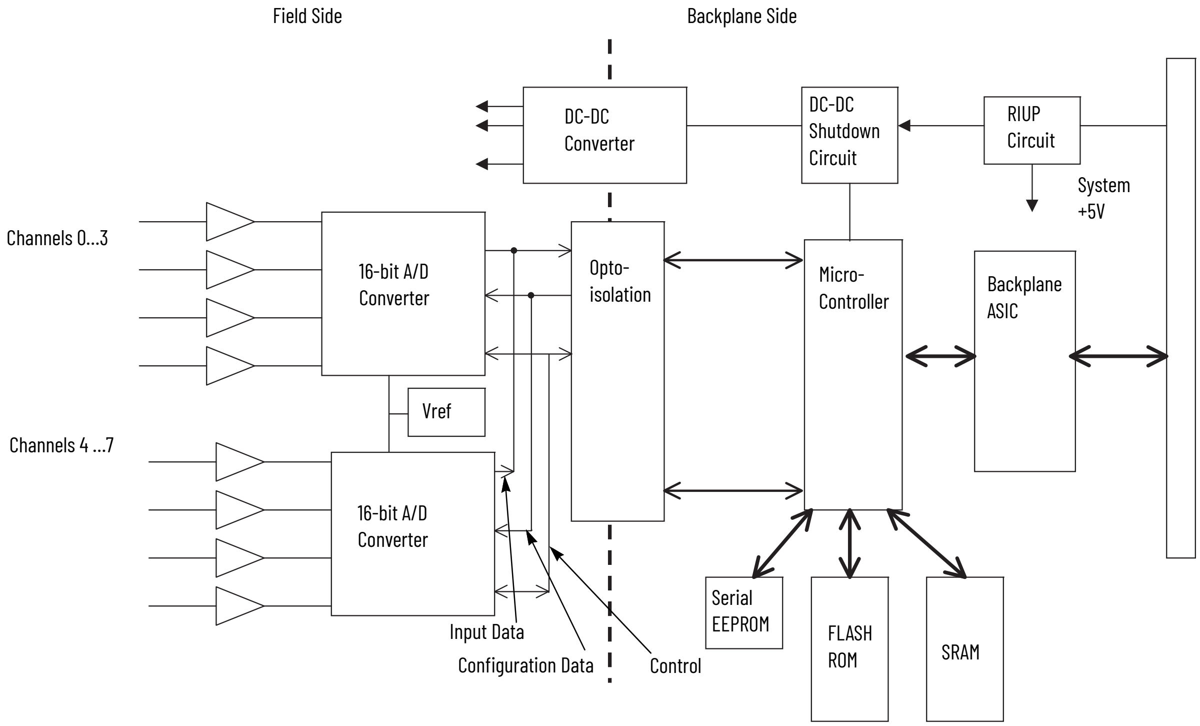


1756-IF16/B, 1756-IF16K/B Module Block Diagram



This section shows the block diagrams for 1756-IF8 and 1756-IF8K series A and B modules.

1756-IF8/A, 1756-IF8K/A Module Block Diagram



1756-IF8/B, 1756-IF8K/B Module Block Diagram