

6-channel Temperature-measuring Isolated Analog I/O Modules

This appendix offers reference information regarding the discontinued 6-channel 1756-IR6I, 1756-IT6I, and 1756-IT6I2 ControlLogix® temperature-measuring isolated analog I/O modules.

For information about how to migrate from 6-channel 1756 isolated analog I/O modules to newer 8-channel modules, see *Migrating 6-Channel to 8-Channel 1756 Analog Modules*, publication [1756-RM011](#).

1756-IR6I, 1756-IT6I, and 1756-IT6I2 Module Features

This section describes features specific to temperature-measuring ControlLogix analog modules. These units linearize their respective sensor inputs into a temperature value. The 1756-IR6I module uses ohms for temperature conversions and the two thermocouple modules (1756-IT6I and 1756-IT6I2) convert millivolts.

Data Format Options

Data format determines how the data is returned from the module to the owner-controller and the features that are available to your application.

Features Available in Each Data Format

Data Format	Features Available:	Features Not Available
Integer mode	Multiple input ranges Notch filter Real-time sampling Cold junction temperature is on 1756-IT6I and 1756-IT6I2 modules only	Temperature linearization Process alarms Digital filtering Rate alarms
Floating point mode	All features	N/A

IMPORTANT Integer mode does not support temperature conversion on temperature-measuring modules. If you choose integer mode, the 1756-IR6I is strictly an ohms (W) module and the 1756-IT6I and 1756-IT6I2 are strictly millivolts (mV) 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.

Possible Input Ranges

Module	Range
1756-IR6I	1...487 Ω 2...1000 Ω 4...2000 Ω 8...4080 Ω
1756-IT6I and 1756-IT6I2	-12...+78 mV -12...+30 mV

Notch Filter

An Analog-to-Digital Converter (ADC) filter removes line noise in your application for each channel.

Choose a notch filter that most closely matches the anticipated noise frequency in your application. Each filter time affects the response time of your module. Also, the highest frequency notch filter settings also limit the effective resolution of the channel.

IMPORTANT 60 Hz is the default setting for the notch filter.

Available Notch Filter Settings

Notch Setting	10 Hz	50 Hz	60 Hz (Default)	100 Hz	250 Hz	1000 Hz
Minimum Sample Time (RTS – Integer mode) ⁽¹⁾	102 ms	22 ms	19 ms	12 ms	10 ms	10 ms
Minimum Sample Time (RTS – Floating point mode) ⁽²⁾	102 ms	25 ms	25 ms	25 ms	25 ms	25 ms
0...100% Step Response Time ⁽³⁾	400 ms + RTS	80 ms + RTS	68 ms + RTS	40 ms + RTS	16 ms + RTS	4 ms + RTS
-3 dB Frequency	3 Hz	13 Hz	15 Hz	26 Hz	66 Hz	262 Hz
Effective Resolution	16 bits	16 bits	16 bits	16 bits	15 bits	10 bits

(1) Integer mode must be used for RTS values lower than 25 ms. The minimum RTS value for the module is dependent on the channel with the lowest notch filter setting.

(2) In mV mode, 50 ms minimum, if linearizing.

(3) Worst case setting time to 100% of a step change would include 0...100% step response time plus one RTS sample time.

Real-time Sampling

This parameter instructs the module to scan its input channels and obtain all available data. After the channels are scanned, the module multicasts that data.

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

Underrange/Overrange Detection

This feature detects when a temperature-measuring input module is operating beyond limits set by the input range. For example, if you're using the 1756-IR6I module in the 2...1000 Ω input range and the module resistance increases to 1050 Ω , the overrange detection detects this condition.

This table lists 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.

Low and High Signal Limits on Temperature-measuring Input Modules

Input Module	Available Range	Lowest Signal in Range	Highest Signal in Range
1756-IR6I	1...487 Ω	0.859068653 Ω	507.862 Ω
	2...1000 Ω	2 Ω	1016.502 Ω
	4...2000 Ω	4 Ω	2033.780 Ω
	8...4020 Ω	8 Ω	4068.392 Ω
1756-IT6I and 1756-IT6I2	-12...+30 mV	-15.80323 mV	31.396 mV
	-12...+78 mV	-15.15836 mV	79.241 mV

Sensor Type

Three analog modules, the RTD (1756-IR6I) and Thermocouple modules (1756-IT6I and 1756-IT6I2), let you configure a sensor type for each channel that linearizes the analog signal into a temperature value. The RTD module linearizes ohms into temperature and the Thermocouple modules linearize millivolts into temperature.

IMPORTANT Sensor type modules can only linearize signals to temperature values in the floating point mode.

Available Sensors for Temperature Measuring Modules

Module	Available sensors or thermocouples
1756-IR6I	10 Ω - Copper 427 type. 100 Ω - Platinum 385, Platinum 3916, and Nickel 618 types. 120 Ω - Nickel 618 and Nickel 672 types. 200 Ω - Platinum 385, Platinum 3916, and Nickel 618 types. 500 Ω - Platinum 385, Platinum 3916, and Nickel 618 types. 1000 Ω - Platinum 385 and Platinum 3916 types.
1756-IT6I	B, E, J, K, R, S, T, N, C.
1756-IT6I2	B, E, J, K, R, S, T, N, C, D, TXK/XK (L).

When you select any of the sensor or thermocouple types during configuration, the programming software uses the default values in the scaling box.

Default Signal and Engineering Values

1756-IR6I		1756-IT6I and 1756-IT6I2	
Low signal = 1	Low engineering = 1	Low signal = -12	Low engineering = -12
High signal = 487	High engineering = 487	High signal = 78	High engineering = 78

IMPORTANT The module sends back temperature values over the entire sensor range as long as the low signal value equals the low engineering value and the high signal value equals the high engineering value. The actual numbers that are used in the signal and engineering fields are irrelevant as long as they're equal.

Temperature Limits for 1756-IR6I Sensor Types

1756-IR6I Sensor	Copper 427	Nickel 618	Nickel 672	Platinum 385	Platinum 3916
Low temperature	-200.0 °C (-328.0 °F)	-60.0 °C (-76.0 °F)	-80.0 °C (-112.0 °F)	-200.0 °C (-328.0 °F)	-200.0 °C (-328.0 °F)
High temperature	260.0 °C (500.0 °F)	250.0 °C (482.0 °F)	320.0 °C (608.0 °F)	870.0 °C (1598.0 °F)	630.0 °C (1166.0 °F)

To see how to choose an RTD sensor type, see [page 209](#).

IMPORTANT This table lists temperature limits for sensors using the -12...+78 mV range only. When the -12...+30 mV range is used, temperature limits are truncated to the temperature value that corresponds to 30 mV.

Temperature Limits for 1756-IT6I and 1756-IT6I2 Sensor Types

Thermocouple	B	C	E	J	K	N	R	S	T	D ⁽¹⁾	TXK/XK (L) ⁽¹⁾
Low temperature	300.0 °C (572.0 °F)	0.0 °C (32.0 °F)	-270.0 °C (-454.0 °F)	-210.0 °C (-346.0 °F)	-270.0 °C (-454.0 °F)	-270.0 °C (-454.0 °F)	-50.0 °C (-58.0 °F)	-50.0 °C (-58.0 °F)	-270.0 °C (-454.0 °F)	0 °C (32.0 °F)	-200 °C (-328 °F)
High temperature	1820.0 °C (3308.0 °F)	2315.0 °C (4199.0 °F)	1000.0 °C (1832.0 °F)	1200.0 °C (2192.0 °F)	1372.0 °C (2502.0 °F)	1300.0 °C (2372.0 °F)	1768.1 °C (3215.0 °F)	1768.1 °C (3215.0 °F)	400.0 °C (752.0 °F)	2320 °C (4208 °F)	800 °C (1472 °F)

(1) Sensor types D and L are available only on the 1756-IT6I2 module.

To see how to choose a thermocouple sensor type, see [page 210](#).

Temperature Units

The 1756-IR6I, 1756-IT6I, and 1756-IT6I2 modules provide the choice of working in Celsius or Fahrenheit. This choice affects all channels per module.

To see how to choose temperature units, see [page 209](#).

Input Signal to User Count Conversion

Integer mode does not support temperature conversion on temperature-measuring modules. However, the 1756-IT6I and 1756-IT6I2 modules can use this mode to calculate user counts for both available millivolt ranges.

The straight-line formulas that can be used to calculate or program a Compute (CPT) instruction are shown in this table.

Available Range	User Count Formula
-12...+30 mV	$y = 1388.4760408167676x - 10825.593777483234$ where y = counts; x = mV
12...78 mV	$y = 694.2314015688241x - 22244.5904917152$ where y = counts; x = mV

For example, if you have 24 mV in the -12...+30 mV range, the user counts = 22498. Counts = -20856 for 2 mV in the 12...78 mV range.

For a table with related values, see Knowledgebase Technote, [ControlLogix 1756-IT6I and 1756-IT6I2 mV Input Signal to User Count Conversion](#).

Wire Length Calculations

The rule for determining the maximum thermocouple lead length without error is that the lead length's error must be less than half of the module resolution. This error implies no error is observed nor is recalibration required.

The resolution for the 1756-IT6I and 1756-IT6I2 module, respectively, is:

-12...+30 mV range = 0.7 uV/bit
-12...+78 mV range = 1.4 uV/bit

Based on the schematic on [page 200](#), the module leakage per open-wire current is the bias voltage/pull-up resistance = $0.44V / 20 M\Omega = 22 \text{ nA}$. Hence, the maximum thermocouple loop resistance is the sum of total loop resistance = both leads.

Using this equation, for the -12...+30 mV range the maximum lead resistance is 16 Ω for a maximum of half resolution error ($1/2 \times (0.7 \mu\text{V/bit}) / 22 \text{ nA}$).

For the -12...+78 mV range, the maximum lead resistance is 32 Ω for a maximum of half resolution error ($1/2 \times (1.4 \mu\text{V/bit}) / 22 \text{ nA}$).

For more information, see Knowledgebase Technote, [1756-IT6I and 1756-IT6I2 Thermocouple Lead Length Calculations](#).

Differences Between the 1756-IT6I and 1756-IT6I2 Modules

The 1756-IT6I and 1756-IT6I2 modules support grounded and ungrounded thermocouples. However, in addition to offering access to two more thermocouple types (D and TXK/XK [L]), the 1756-IT6I2 module offers the following:

- A greater cold junction compensation accuracy
- Improved module accuracy

See [page 198](#) for details.

While the 1756-IT6I module can report cold junction temperature differences between channels as high as 3 $^{\circ}\text{C}$ (0.54 $^{\circ}\text{F}$) from the actual temperature, the 1756-IT6I2 module, because it has two cold-junction sensors (CJS), reduces the potential cold-junction error from the actual temperature to 0.3 $^{\circ}\text{C}$ (0.54 $^{\circ}\text{F}$).

It's important that you check that the CJS is fitted locally or remotely, and enabled so in the module channel configuration. If the CJS isn't fitted or if the sensor wiring leads are incorrect (for example, swapped over at the thermocouple cards input), there's a possibility of a negative or positive temperature fluctuation when the thermocouple sensor is warmed.

This table lists the cold junction error from actual temperature, depending on the type of cold junction compensation that is used.

Cold Junction Compensation Types

If you use this module	With this type of cold junction compensation	The cold junction error from actual temperature is
1756-IT6I2	Two cold-junction sensors on an RTB	+/-0.3 $^{\circ}\text{C}$ (0.54 $^{\circ}\text{F}$)
1756-IT6I2	IFM	+/-0.3 $^{\circ}\text{C}$ (0.54 $^{\circ}\text{F}$)
1756-IT6I	One cold junction sensor on an RTB	+/-3.2 $^{\circ}\text{C}$ (5.76 $^{\circ}\text{F}$), max ⁽¹⁾
1756-IT6I	IFM	+/-0.3 $^{\circ}\text{C}$ (0.54 $^{\circ}\text{F}$)

(1) The cold junction error varies for each channel but 3.2 $^{\circ}\text{C}$ (5.76 $^{\circ}\text{F}$) is the maximum error that any channel shows.

Cold Junction Compensation

When using the thermocouple (1756-IT6I and 1756-IT6I2) modules, you must account for additional voltage that can alter the input signal. A small voltage generates at the junction of the thermocouple field wires and the screw terminations of an RTB or IFM. This thermoelectric effect alters the input signal.

To compensate the input signal from your module accurately, you must use a cold junction sensor (CJS) to account for the increased voltage. Because there are differences if you choose to connect sensors via an RTB or IFM, you must configure the module via the programming software to work with the type of CJS used in your application.

Cold Junction Offset Option

The Cold Junction Offset box on the Module Properties Configuration Tab lets you make module-wide adjustments to cold junction compensation values. If you know that your cold junction compensation values are consistently inaccurate by some level, for example, 1.2 °C (2.16 °F), you can enter the value into the box to account for this inaccuracy.

Improved Module Accuracy

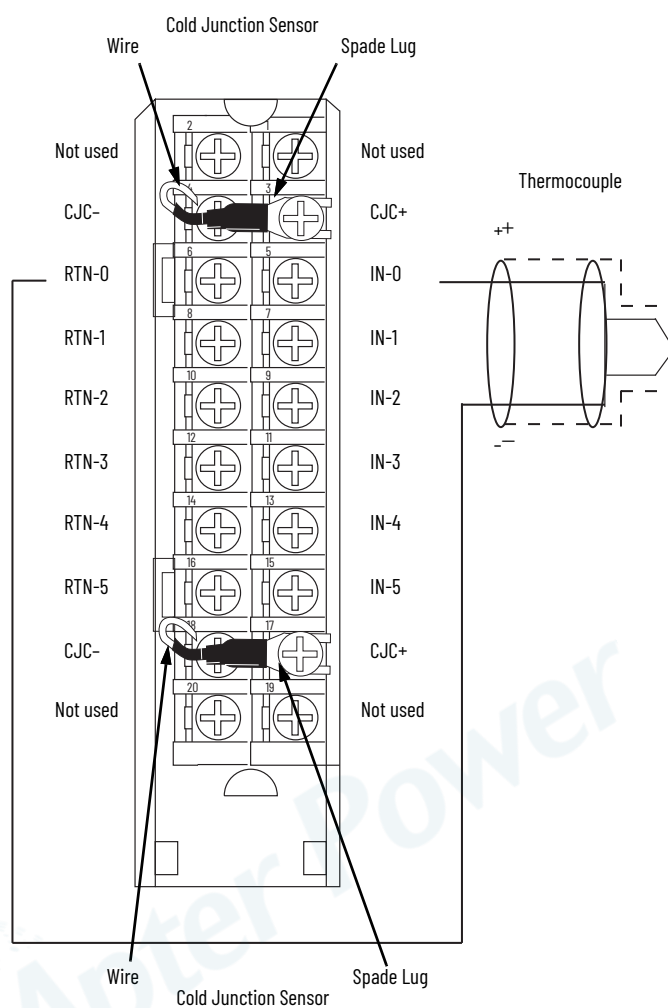
The 1756-IT6I2 offers improved Gain Drift with Temperature and Module Error over Temperature Range specifications when compared to the 1756-IT6I module. This table highlights the differences.

Cat. No.	Gain Drift with Temperature ⁽¹⁾	Module Error over Temperature Range ⁽¹⁾
1756-IT6I	80 ppm	0.5%
1756-IT6I2	25 ppm	0.15%

(1) For a detailed explanation of this specification, see [page 119](#).

For the latest I/O module specifications, see the *1756 ControlLogix I/O Modules Technical Specifications*, publication [1756-TD002](#).

1756-IT6I2 Wiring Example



Keep in mind the following:

- Do not connect more than two wires to any single terminal.



ATTENTION: If you use a separate power source, do not exceed the specific isolation voltage.