ControlLogix High-speed Counter Module

Catalog Number 1756-HSC

Allen-Bradley by ROCKWELL AUTOMATION

User Manual

Original Instructions

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

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

Labels may also be on or inside the equipment to provide specific precautions.

SHOCK HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.

BURN HAZARD: Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.

ARC FLASH HAZARD: Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

Install and Wire the ControlLogix High-speed Counter Module

Chapter 4

Configure the Module

Chapter 5

Chapter 6
Module Diagnostics

Appendix A
Status Indicators

Appendix B
Data Structures

Appendix C
Module History

Appendix D
Application Considerations

This manual describes how to install, configure, and troubleshoot your ControlLogix® High-speed Counter (HSC) module, catalog number 1756-HSC, herein referred to as **the module**.

Based on your module series and firmware revision, there are programming software requirements to use some module features. For more information, see Table 10 on page 83.

Summary of Changes

This table contains the changes that are made to this revision of the publication.

Topic	Page
Updated Appendix D, Application Considerations , in the following sections:	
• Circuit Overview, Series C and D Modules	97
• Detailed Circuit Analysis, Series C and D Modules	99
• +12...+24V Single-ended Driver	100
• Open Collector, Series C and D Modules	103
• Electromechanical Limit Switch	103
• Output Circuits, Series C and D Modules	105

Who Should Use This Manual

You must be able to program and operate a ControlLogix controller and various Allen-Bradley® encoders and sensors to use your module efficiently. In this manual, we assume that you know how to use these products. If you do not, refer to the related user publications for each product, before you attempt to use the module.

Additional Resources

These documents provide information that is related to your module.

Resource	Description
1756 ControlLogix I/O Technical Data, publication 1756-TD002	Provides specifications for the ControlLogix controllers, I/O modules, specialty modules, chassis, power supplies, and accessories.
ControlLogix System User Manual, publication 1756-UM001	Detailed description of how to use your ControlLogix operating system.
ControlLogix Digital I/O Modules User Manual, publication1756-UM058	Detailed description of how to install and use ControlLogix digital I/O modules.
ControlLogix Analog I/O Modules User Manual, publication 1756-UM009	Detailed description of how to install and use ControlLogix analog I/O modules.
RSLogix 5000® Getting Results Guide, publication 9399-RLD300GR.	Provides software installation instructions and to learn how to navigate the software package.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.

You can view or download publications at http://www.rockwellautomation.com/literature. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales office.

Notes:

Module Features

Introduction

The high-speed counter module performs high-speed counting for industrial applications. This chapter provides an overview of the design and features of the module.

What is a High-speed Counter Module?

The module counts pulses by using a Counter or Frequency operational mode. The counts are presented as either 'accumulated count' or 'frequency' depending on the mode that is configured for the module.

You can choose from either one of three Counter modes or one of three Frequency modes when configuring the module. The operational mode that is selected determines how the pulse count is stored and the behavior of the outputs.

You can manipulate the storage of the count values (detailed in Chapter 2). The module evaluates these count values against user configured presets and/or values, thus the response time for activating outputs is performed at a faster rate than evaluating in the controller.

Configuration tags, which are automatically installed with the module during the initial download of the programming software, determine whether the module interprets pulses as:

- accumulated count - values can be 1…16 million.
- frequency - positive or negative depending on the direction of the rotation.

Pulse count values can be calculated by using different types of Counter and Frequency modes. The simple counter uses only input A to count pulses. An encoder uses both input A and input B to count pulses. The relationship between the two channels is how the encoder determines if the count is positive (clockwise) or negative (counterclockwise).

This user manual also details the Frequency operational modes that are available depending on which one is required for your application. Frequency can be calculated in one of three ways:

- frequency (rate measurement).
- period rate.
- continuous rate.

All three Frequency modes determine the frequency of input pulses by counting pulses over a user-defined time interval. If the revolution is spinning in a clockwise direction, the frequency is positive; in a counterclockwise direction it's decreasing (negative) frequency.

See page 25 for more details on Frequency modes.

Pulse counts and frequency values are stored in one of three input tags (based on the mode) as shown in the table.

Table 1 - Mode and Input Tag Values for the 1756-HSC Module

Comm Format = HSC Data-extended		Tags		
Mode	**Mode Description**	**Present Value**	**Stored Value**	**Totalizer**
0	Counter	Accumulated count	Stored value	Directional frequency[1]
1	Encoder X1			
2	Encoder X4			
3	Counter Not Used	—	—	—
4	Frequency (Rate Measurement)[2]	No. of input pulses occurring in sample period	Frequency	Accumulated count[3]
5	Frequency (Period Rate)[2]	No. of 4 MHz pulses occurring in sample period		Accumulated count
6	Frequency (Continuous Rate)[2]			

(1) B-input state defines direction (Counter mode).

(2) Modes where frequency controls the outputs.

(3) Rollover/Preset settings apply.

See Data Structures in Appendix C for a list of tags.

Encoder and Sensor Compatibility

The most common applications that use the ControlLogix® high-speed counter module also use these Allen-Bradley® products:

- Allen-Bradley 845 incremental encoder
- Allen-Bradley Bulletin 872 three-wire DC proximity sensor
- PHOTOSWITCH® series 10,000 photoelectric sensor

Additional encoders and sensors can be connected to and used with the module. For specific compatibility of other encoder and sensor compatibility, check the user publications for each product or consult your local Allen-Bradley representative.

The table shows the type of encoder or sensor that you can choose for your module.

	Pulse Width, Min	Frequency Range	Leakage Current
Proximity	500 ns	1 MHz	250 μA @ 5V DC
Quad Encoder	2 μs	250 kHz	250 μA @ 5V DC

1756-HSC Module Features

This table highlights features of the module.

Feature	Description
Real-time manipulation of preset/ rollover tag settings	Preset and Rollover tags, which provide a reference point to start the count and reset the count to zero, respectively, are included in the Configuration tags at the initial system configuration. The module also has both tags in the Output tag settings to allow the values to be changed in real time when the 1756-HSC Data-extended Comm Format is selected. This feature provides the flexibility of changing counter settings 'on-the-fly' without having to reconfigure all system tags.
Period rate / Continuous Rate frequencies	Both Frequency modes are available with the 1756-HSC module when using the Data-extended Comm Format. Period Rate mode counts internal 4 MHz clock pulses over a used-defined time frame to determine frequency. Continuous Rate mode is similar to Period Rate mode except dynamic outputs can be turned On /Off at pre-determined pulse intervals.
Module-specific tags	Tags are automatically created when you add a 1756-HSC module to your controller project. The module has descriptive tags for using pulse and frequency values, such as Present Value, Stored Value, and Totalizer.

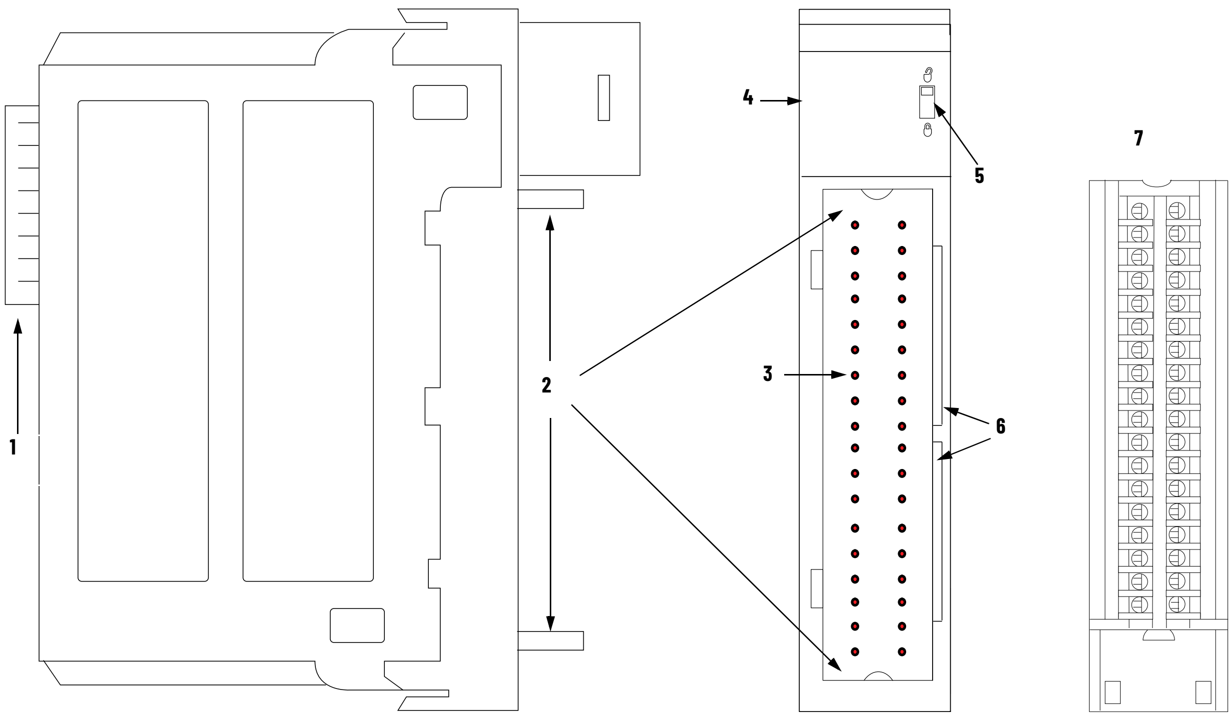
Additional I/O Module Features

This table lists additional features for ControlLogix® I/O modules, including the 1756-HSC module.

Feature	Description
Configuration software	The programming software has a custom interface to configure your module. All module features can be enabled and disabled through the software.
Module fault reporting	I/O modules provide both hardware and software indications when a module fault occurs. Status indicators signal fault conditions. The programming software describes the fault message so you know what action to take to resume normal operation.
Status indicators	Status indicators on the front of the module report the operational status of the module. The input-point status display indicates a particular point's status, including specifics for the input A, B, and Z (reset) points for each channel of the module. The output-point status display indicates the status of four output points on the module.

Feature	Description
Producer/Consumer model	Logix 5000™ controllers let you produce (broadcast) and consume (receive) system-shared tags. The module can produce data without having to be polled first by a controller. The module produces the data and any owner-controller can decide to consume it.
Electronic Keying	See page 66 in Chapter 5 for details.
RIUP	RIUP is an abbreviation for removal and insertion under power. The module can be inserted and removed from the chassis while power is applied. This flexibility allows you to maintain the module, either removing or inserting, without disrupting the rest of the controlled process.

1756-HSC Parts Illustration



Item	Description
1	Backplane connector - The backplane interface for the ControlLogix system connects the module to the backplane.
2	Top and bottom guides - Guides assist in seating the removable terminal block (RTB) onto the module.
3	Connector pins - Input/output, power, and grounding connections are made to the module through these pins with the use of an RTB.
4	Status indicators - Indicators display the status of communication, module health, and presence of input/output devices. Use these indicators to help in troubleshooting.
5	Locking tab - The locking tab anchors the RTB on the module, maintaining wiring connections.
6	Slots for keying - The slots let you mechanically key the RTB to help prevent inadvertently making the wrong wire connections to your module.
7	Removable terminal block - The RTB lets you connect and house the wiring. There are several types of RTBs.

See page 41 for details on RTB types.

Counter Modes

Introduction

This chapter describes the Counter modes for the 1756-HSC module. Topics include:

- types of counting: counter and encoder.
- means of storing the counts.
- modes for manipulating the count.
- tags for control of onboard outputs.

There are three Counter modes that can be selected from the Operational Mode pull-down menu on the Counter Configuration tab. See Chapter 5 for configuration details.

The choices are:

- Counter mode (default).
- Encoder x1 mode.
- Encoder x4 mode.

Counter/Encoder Overview

The Encoder and Counter modes are virtually identical; the only difference is the method that is used to count. There are two counters (using input A and B) per module. Input Z, which is described in more detail later in this chapter, basically affects how the counts are stored based on the selected Storage mode.

In Counter mode, the module reads incoming pulses from input A only and stores the accumulated count value in the Present Value tag. The state of input B determines whether to increment or decrement the count based on whether it's low, floating (count up) or high (count down).

In both Encoder modes, the module uses two channels to read incoming pulses. The module uses the phase relationship between inputs A and B to determine the count value and direction of the rotation.

- Encoder x1- This is a Bidirectional Count mode, counting up or down, using an incremental encoder with direction output.
- Encoder x4 - This is a Bidirectional Count mode, using quadrature encoder signals, with four times the resolution of X1.

The module also offers the convenience of showing directional frequency by using any Counter mode. If the count value is increasing, the frequency is positive in the Totalizer tag. If the count value is decreasing, the frequency is negative in the Totalizer tag.

Table 2 - Where Count Values are Stored in Tags

Mode Description	Present Value Tag	Stored Value Tag	Totalizer Tag
Counter	Accumulated Count	Stored Value	Directional Frequency
Encoder x1			
Encoder x4			

There are several methods for using and manipulating the count values. Based on the state of the Z-input, the module provides four modes of behavior if the application requires storage of the accumulated count value.

- Store and Continue Mode
- Store, Wait, and Resume
- Store and Reset, Wait, and Start
- Store and Reset, and Start

In addition, the module features two software-configurable tags that provide control of the starting and ending points of an accumulated count sequence. These are the tags:

- Preset
- Rollover

The remainder of this chapter details each mode and the different configurations that you can use for specific needs of your module.

Counter Mode

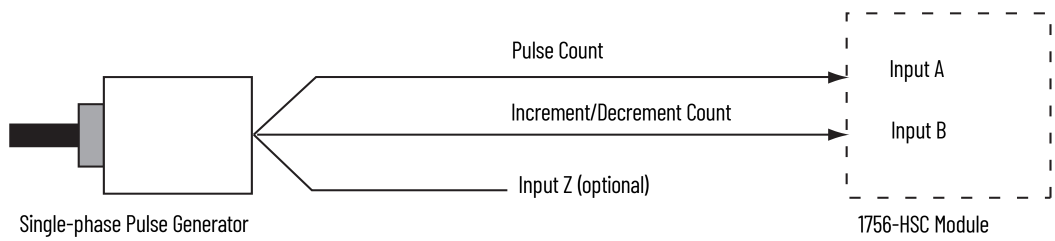
Counter mode is the module's default operational mode that counts incoming pulses using input A. You can control the starting and ending points of the accumulated count depending on how you have configured the module.

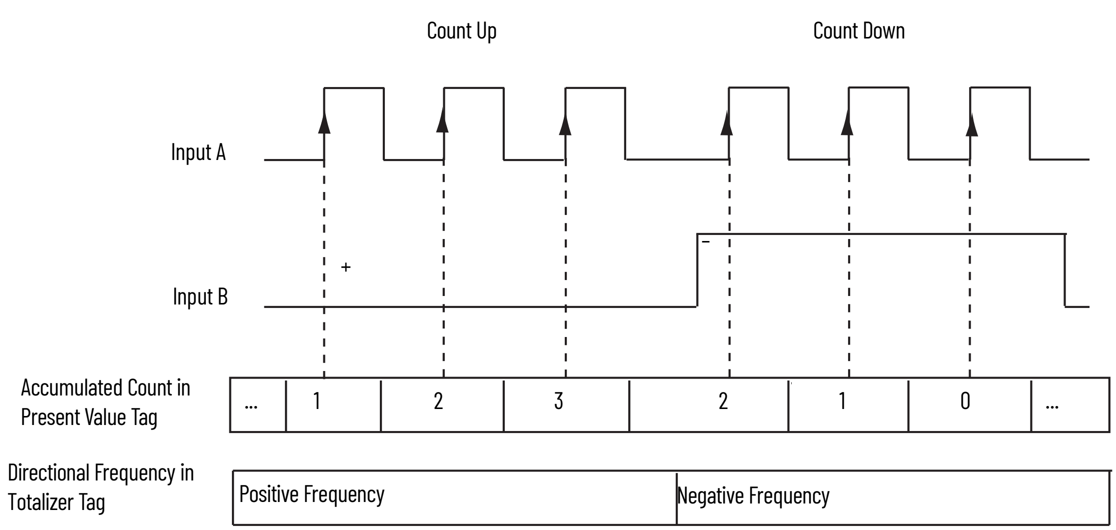
In the Counter mode, the count increases or decreases based on the state of input B, which can be a random signal. If input B is high, the counter counts down. If input B is low or floating (that is, not connected to a voltage source), the counter counts up. Counting is done on the leading edge of input A.

Input B	Direction of Counter
High	Down
Low or floating (not connected)	Up

Input Z is used in Counter mode only if a Store Count mode is enabled. See page 20 for details on the Storage modes.

Counter Mode





Encoder Mode

Encoder mode also counts incoming pulses. However, the phase relationship between two input channels (A and B) determines whether the direction of the count is up or down.

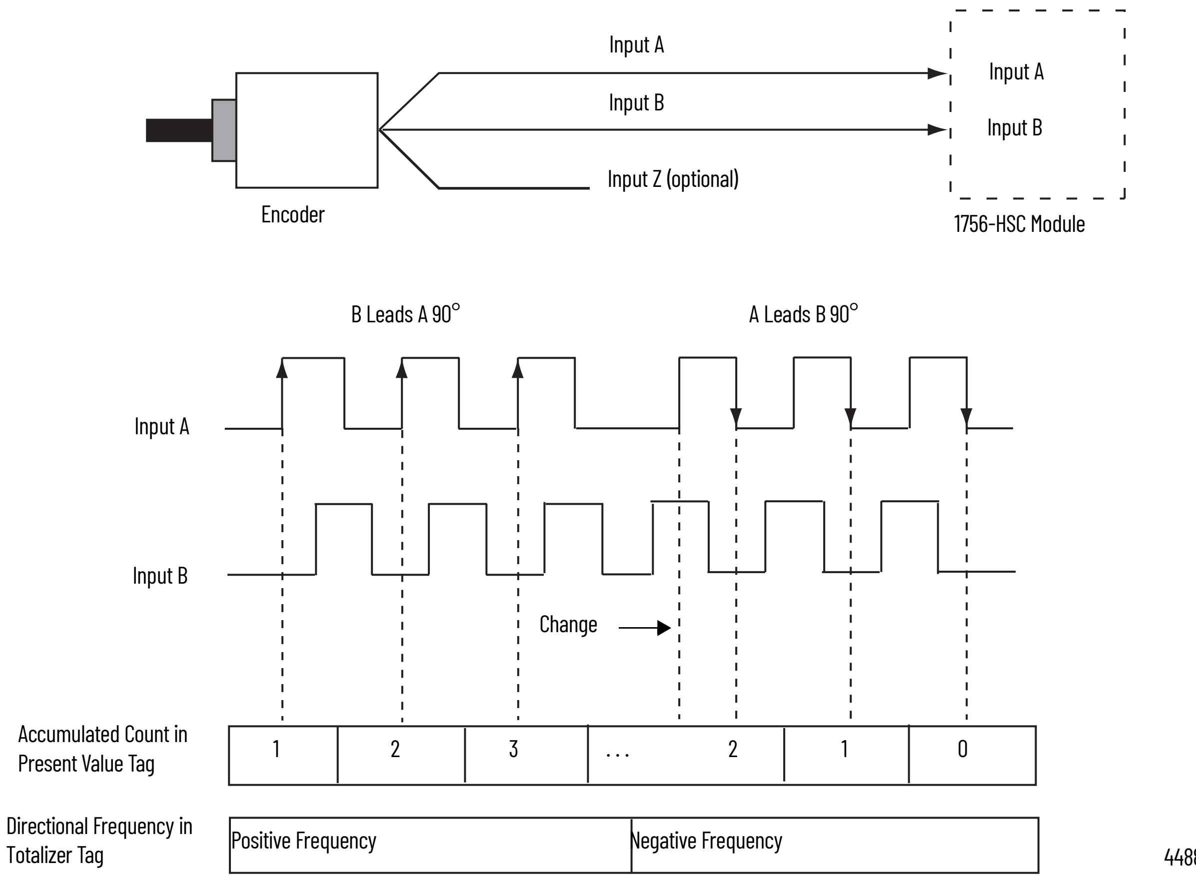
In Encoder x1 mode, an increasing count results when channel B is 90° ahead of channel A. The count is initiated on the rising edge of channel A, and the direction of the encoder is clockwise (positive).

The module produces a decreasing count when channel A is 90° ahead of channel B. The count is initiated on the falling edge of channel A, and the direction is counterclockwise (negative).

By monitoring both the number of pulses and the phase relationships of signals A and B, you can accurately determine the position **and** direction of the rotation.

The illustration shows the phase relationships between channels A and B for the x1 mode. Input Z is used in Encoder mode only if a Store Count mode is enabled. See page 20 for details on the Storage modes.

Encoder x1 Mode

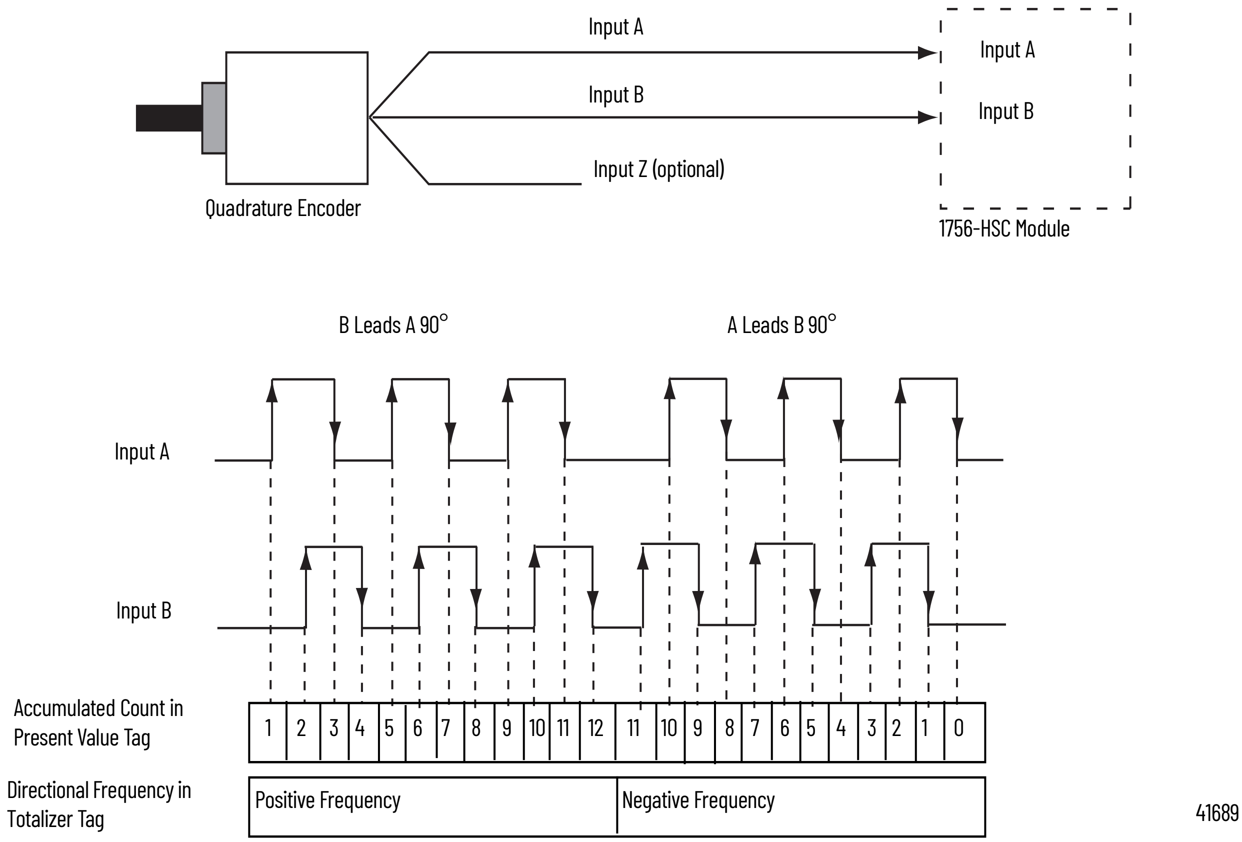


Encoder x4

Encoder x4 mode is identical to x1, except this mode counts on the leading and trailing edges of A and B to provide a greater number of pulse counts. The greater the number of pulse counts the better the module can determine position.

Input Z is used in Encoder mode only if a Store Count mode is enabled. See page 20 for details on the storage modes.

Encoder x4 Mode



Maximum frequency in Encoder x1 and x4 modes = 250 kHz (assuming 50% duty cycle), with a minimum pulse width at this frequency of 2 µs. The module assumes a 90° phase (A/B°) difference between channels.

Preset

Each of the two counters has one preset value that is associated with it. In the Encoder or Counter modes, the preset value represents a reference point (or value) from which the module begins counting. The module can count either up or down from the preset value.

The preset value itself is entered during module configuration. However, you must enter a preset command from either the programming software or ladder logic before it becomes active. Setting the Preset Enable Bit in the Output tag to '1' sends the preset value to the Present Value tag.

Preset values are entered on the Counter Configuration tab of the Module Properties dialog box.

See page 60 for an example of the Counter Configuration tab.

Preset in Output tag

When using the HSC Data-extended Comm Format while configuring the module, the Preset tag is found in both the Configuration and Output tag areas.

The Configuration tag value is populated during software configuration with the Logix 5000™ controller, and sent to the module upon power-up, defining its behavior. This value continues to define module behavior as long as the corresponding tag in the output area is zero.

If the value of the Preset tag in the output area is changed to a nonzero value, the module disregards the value that is sent from the configuration area and use the value in the output area instead. This facilitates easier real-time 'on-the-fly' changes to the preset function.

Rollover

Each of the two counters has one rollover value that is associated with it. When the accumulated count value in the Rollover tag reaches the rollover value, it resets to zero (0) and begins counting again. The rollover value is circular. For example, if the rollover value = 360, the count will be from 358, 359, 0, 1, and so forth, in a positive direction and from 1, 0, 359, 358, and so forth, in a negative direction.

Rollover values are entered on the Counter Configuration tab of the Module Properties dialog box in the programming software or can be changed in ladder logic.

See page 60 for an example of the Counter Configuration tab.

Rollover in Output tag

When using the HSC Data-extended Comm Format while configuring the module, the Rollover tag is found in both the Configuration and Output tag areas.

The Configuration tag value is populated during software configuration with the Logix 5000 controller, and sent to the module upon power-up, defining its behavior. This value continues to define module behavior as long as the corresponding tag in the Output area is zero.

If the value of the Rollover tag in the Output area is changed to a nonzero value, the module disregards the value that is sent from the Configuration area and use the value in the Output area instead. This facilitates easier real-time 'on-the-fly' changes to the Rollover function.

Input Z (Gate/Reset)

Input Z, when active, will change the behavior of an accumulated count value in the Present Value tag, depending upon which of four modes are selected.

- Store and Continue Mode
- Store, Wait, and Resume
- Store and Reset, Wait, and Start
- Store and Reset, and Start

The Storage modes are selected on the Counter Configuration tab on the Module Properties dialog box of the programming software.

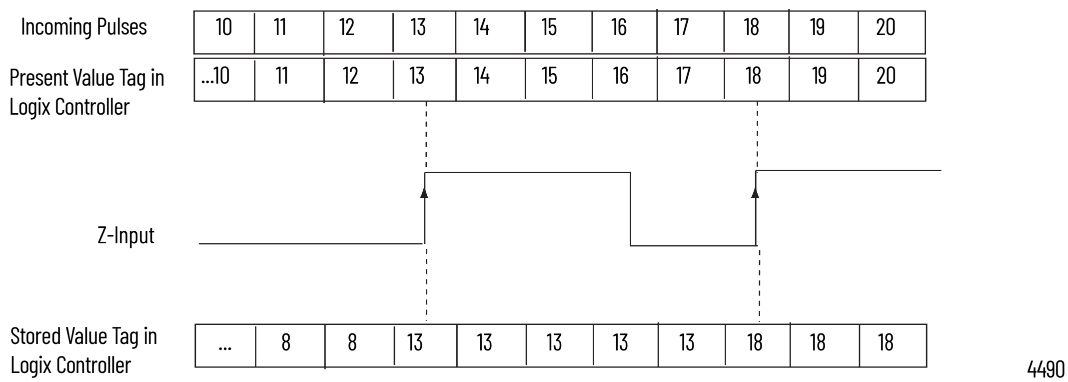
Storage Modes

The store count feature lets the module store the current count value and follow four behavioral paths, depending on which Store mode is selected. The store count is triggered by the state of the Z-input (the gate) on the module.

IMPORTANT	The four modes can be changed while normal module operation continues. Improper use of on-the-fly changes may cause unintended machine operation when the store count is used as a trigger for machine sequencing.

The following illustrations show how the different modes store count values in the Present Value and Stored Value tags.

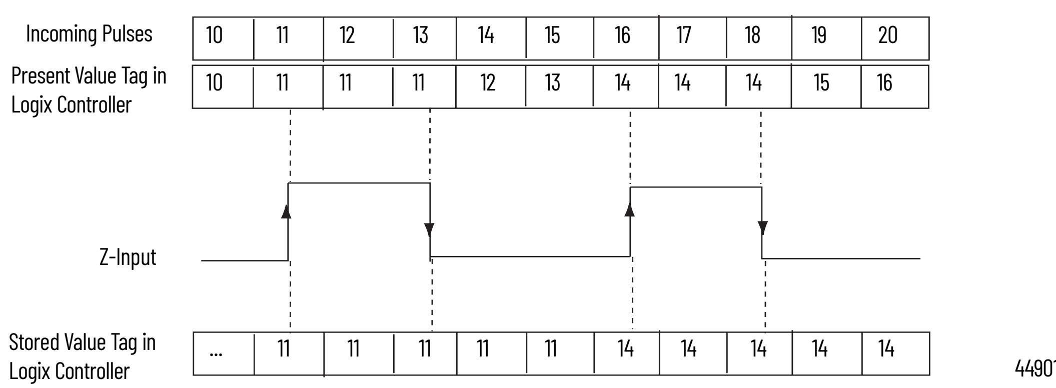
Store and Continue Mode



In the Store and Continue mode, the module:

- reads the Present Value and places it into the Stored Value on the leading edge of Input Z.
- continues to accumulate the Present Value based on presets and incoming pulses.
- retains the Stored Value until new data from the next leading edge of a pulse on Input Z overwrites it.

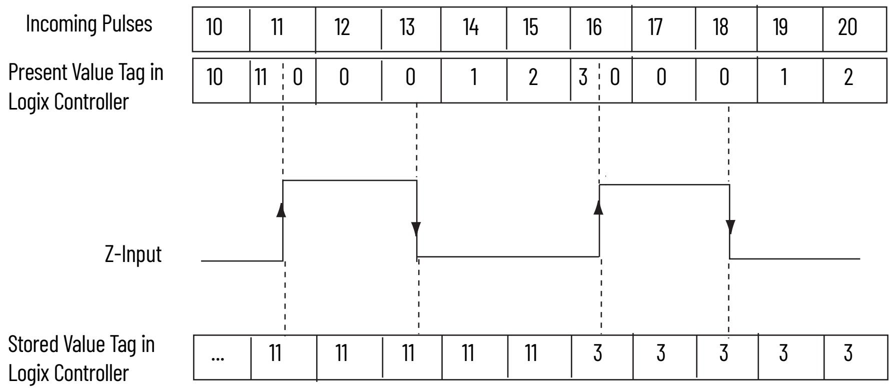
Store, Wait, and Resume



In the Store, Wait and Resume mode, the module:

- reads the Present Value and places it into the Stored Value on the leading edge of Input Z.
- stops accumulating the count in the Present Value as long as the Z-input is high.
- resumes accumulating the count in the Present Value when the Z-input goes low.
- retains the Stored Value until new data from the next leading edge of a pulse on Input Z overwrites it.

Store and Reset, Wait, and Start

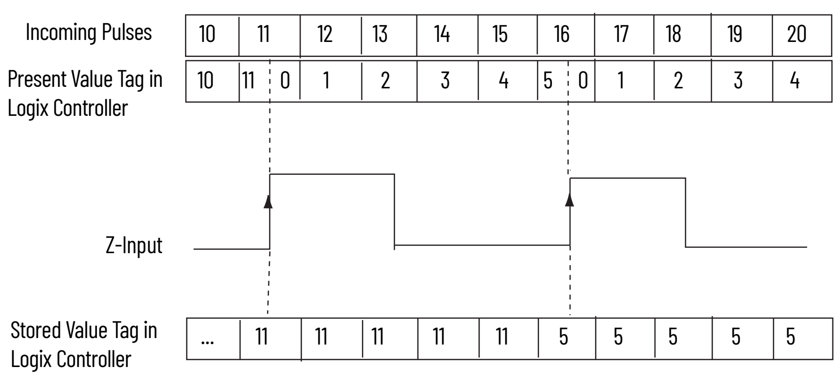


44902

In the Store and Reset, Wait, and Start mode, the module:

- reads the Present Value and places it into the Stored Value on the leading edge of Input Z and resets the count to zero (0) in the Present Value.
- resumes normal counting from zero (0) after the Z-Input goes low.
- retains the Stored Value until it is overwritten by new data from the next leading edge of a pulse on Input Z.

Store and Reset, and Start



44903

In the Store and Reset, and Start mode, the module:

- reads the Present Value and places it into the Stored Value on the leading edge of Input Z and resets the count to zero (0) in Present Value.
- resumes counting from zero (0) regardless of the state of the Z-input.
- retains the Stored Value until new data from the next leading edge of a pulse on Input Z overwrites it.

IMPORTANT	You have the option of selecting either the rising or falling edge of the gate/reset pulse. When the Invert Z Value box is checked on the Counter Configuration tab, the state of the Z input is reversed as illustrated in the four Store modes. For example, in the Store and Reset, and Start mode using the Invert Z, the falling edge of the pulse on Input Z will store the count value in the Stored Value tag and reset the Present Value tag to zero. The counter continues to count while the gate pin is low or high, but the present value is reset to zero (0) on the next falling edge of Input Z.

Outputs

The module has four outputs, which are isolated in pairs (0 and 1, 2 and 3). Each output is capable of sourcing current from an externally supplied voltage up to 30V DC. You must connect an external power supply to each of the output pairs. The outputs can source 1 A DC and are hardware-driven. They turn On or Off in less than 50 µs when the appropriate count value has been reached.

Assign Outputs to Counters

By using configuration tags or the programming software defaults, you can assign the outputs on the module to any of the various counters. You can assign as many as two outputs to a given counter. However, an output may be assigned only once to a counter; it is not possible to use the same output with two different counters.

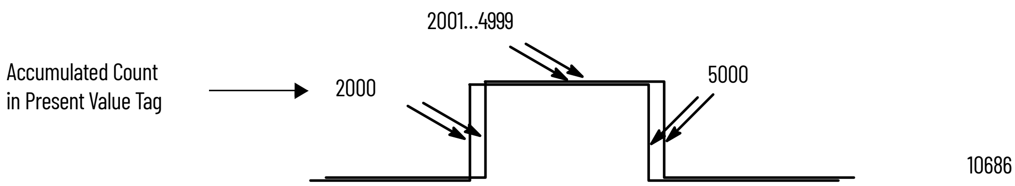
Each output on the module can be turned On and Off at your discretion. The operation of outputs tied to a counter (on the Output Configuration tab of the Module Properties dialog box) is performed independently from the controller scans.

Output Operation

When the outputs for the module are enabled and assigned to a counter, they operate in an On-Off fashion. Up to two On-Off windows may be used for each output. The outputs use a comparison of the Present Value to the values you have programmed in one or both of these tags:

- First Value Output Turns On and First Value Output Turns OFF
- Second Value Output Turns ON and Second Value Output Turns OFF

For example, the 'Output Turns ON' tag is set for a value of 2000 and the 'Output Turns OFF' tag is set for a value of 5000.



In the illustration, the:

- output turns On at the Present Value of 2000.
- output remains energized for 3000 additional counts.
- output turns Off at the Present Value of 5000.

Tying Outputs to Counters

You can jumper any of the outputs to any of the counter inputs on the module's RTB. In this way, it is possible to use the outputs to reset a counter or to cascade counters. If using the outputs this way, verify that the correct input terminals are used to interface with the appropriate output voltage.

Notes:

Frequency Modes

Introduction

This chapter describes the frequency modes that are available with the module when using the HSC Data-extended Comm Format.

The Frequency modes are:

- Frequency - number of input pulses per user-defined time interval.
- Period Rate - number of sampled, internal 4 MHz pulses per user-defined number of incoming pulses, with outputs updated at the **end** of the sample period with the Present Value, Totalizer, and Stored Value tags.
- Continuous Rate - number of sampled, internal 4 MHz pulses per user-defined number of incoming pulses, with outputs updated **throughout** the sample period. The Present Value, Totalizer, and Stored Value tags are updated only at the end of the sample period.

Frequency Overview

Each of the three Frequency modes uses incoming pulse counts in a user-defined interval to determine frequency values. The Stored Value tag contains the calculated frequency and is always positive.

You can select one of three Frequency-operational modes based on the frequency of the incoming signal. Frequency mode is best suited for calculating higher frequencies because you define the sample period that is used to count incoming pulses. At higher frequencies, there are a greater number of pulses to be sampled that results in the ability to calculate frequency at a higher resolution. The Stored Value tag is updated at the end of the selected sample period.

Period Rate and Continuous Rate modes use an internal 4 MHz clock and a user-defined number of incoming pulses that are configured by the Scaler value that results in better performance at lower frequencies, where more 4 MHz pulses are accumulated. Higher Scaler values also help to improve the calculation of high frequency signals as longer pulse durations provide for more 4 MHz pulses to be counted. Therefore, the combination of the Scaler and incoming frequency determines the rate at which the frequency is updated in the Stored Value tag.

The difference between the Period Rate and Continuous Rate modes is the outputs are dynamic (On/Off) throughout the sample period for Continuous Rate while Period Rate outputs are updated only at the end of the sample period. Your desired output behavior should determine whether one uses Period Rate or Continuous Rate modes.

See page 31 for details.

Table 3 - Where Frequency Values are Stored in Tags

<table>
<tr><th>Mode Description</th><th>Present Value Tag</th><th>Stored Value Tag</th><th>Totalizer Tag</th></tr>
<tr><td>Frequency</td><td>No. of input pulses occurring in Sample Period</td><td rowspan="3">Frequency</td><td rowspan="3">Accumulated pulse count</td></tr>
<tr><td>Period Rate Frequency</td><td rowspan="2">No. of 4 MHz pulses occurring in Sample Period</td></tr>
<tr><td>Continuous Rate Frequency</td></tr>
</table>

Frequency Mode

In Frequency mode, the module counts incoming pulses on channel A for a user-specified time interval that is configured in the Scaler tag. At the end of the interval, the module returns a value that represents the sampled number of pulses in the Present Value tag, a value that indicates the incoming frequency in the Stored Value tag and a value that indicates the total number of pulses that have occurred in the Totalizer tag.

When the count and frequency are updated at the end of the sample period, any associated outputs are checked against their associated presets. The output On/Off values are related to the value in the Stored Value tag.

As you increase the Scaler (see Sample Period for Frequency Mode), the accuracy of the frequency and the time between samples increases. In general, if you are measuring a higher frequency, the Scaler can be small. If you are measuring a lower frequency, the Scaler likely is larger.

EXAMPLE Frequency = No. of pulses per sample period/Scaler Time.

For example, if the frequency = 30 Hz, and the Scaler = 100 ms, then the Present Value tag returned = 3, and the Stored Value tag = 30.

Preset and rollover tag settings are active in this Frequency mode. User-defined preset and rollover commands provide control of the starting and ending points of incoming pulses, thus affecting the values in the Totalizer tag.

See page 18 in Chapter 2 for preset and rollover tag details.

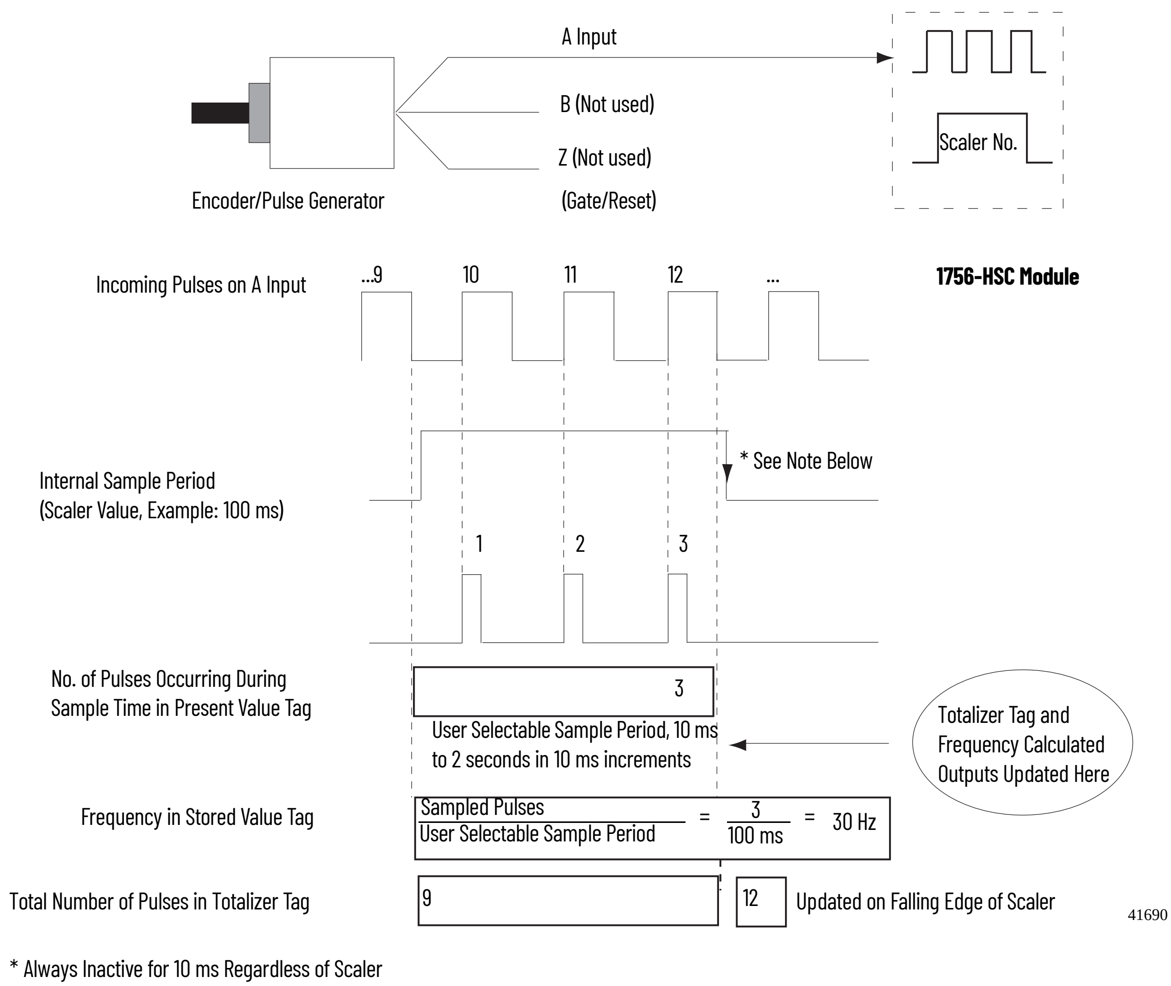
Sample Period for Frequency Mode

As previously mentioned, the Sample Period is a user-defined time frame to count the number of incoming pulses for calculating frequency. This fixed, sample time can be set by varying the Scaler tag, which can range from 10…2000 in 10 ms increments. For example, a Scaler valueof 100 = 100 ms. The default value is 1 second.

IMPORTANT	A Scaler tag value of 0 equals a 1 second time period.

In this frequency illustration, three pulses have been accumulated during the user-selected time period. If you had selected 100 ms as the sample period, the frequency returned to the controller is
Frequency = Counts/Sample period = 3 counts/100 ms = 30 Hz.

Figure 1 - Frequency Mode



Period Rate and Continuous Rate Modes

These two Frequency-operational modes are identical in how they calculate frequency. They determine the frequency of input pulses by counting the number of internal 4 MHz clock pulses over a user-specified number of Z-input signal pulses defined by the Scaler.

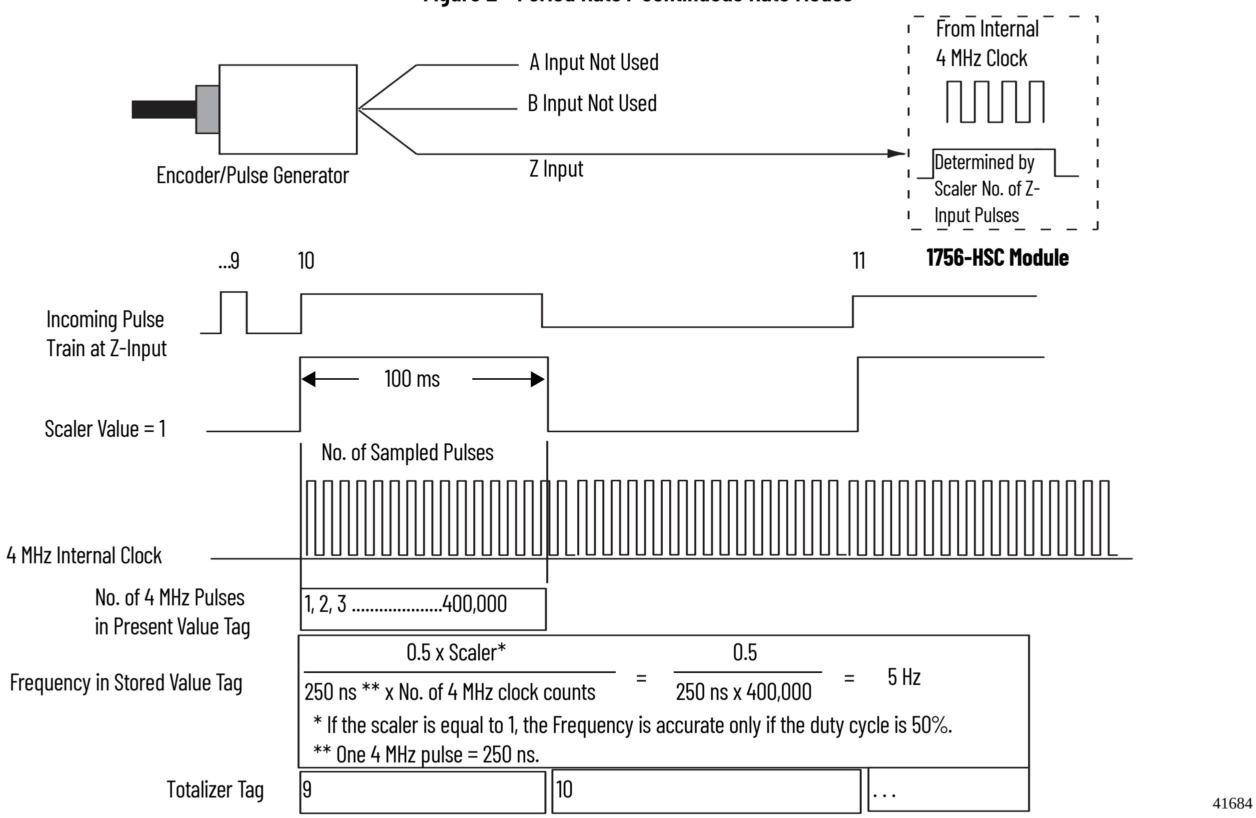
Frequency = 0.5 x Scaler / 250 ns x 4 MHz pulses

At the end of the sample period, the module returns the frequency in the Stored Value tag, the number of internal 4 MHz pulses in the Present Value tag, and a value that indicates the total number of Z-input pulses that have occurred in the Totalizer tag. The output On/Off values are related to the value in the Present Value tag.

IMPORTANT	Preset and rollover settings are not active in Period Rate/ Continuous Rate modes and must be equal to zero.

The difference between these two modes is in the operation of the outputs. In Continuous Rate mode, outputs are dynamically checked against their configured presets. In Period Rate mode, outputs are checked only against their configured presets at the end of the sample period. See page 32 for details.

Figure 2 - Period Rate / Continuous Rate Modes



As the frequency of the incoming pulse train increases, the number of sampled pulses from the 4 MHz clock decreases. Because accuracy is related to the number of 4 MHz pulses received over the sample period, the accuracy decreases with increasing input frequencies at the Z-input. The decrease in accuracy can be lessened by scaling the input frequency by using the Scaler tag.

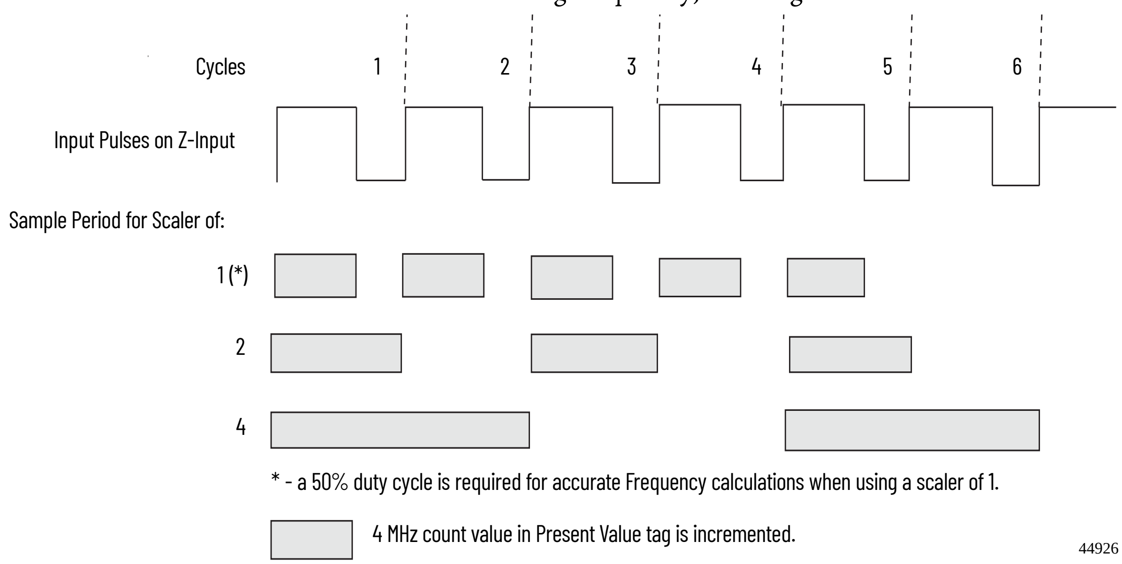
The Scaler configuration lets the incoming pulse train at the Z-input to be divided by a user-defined number. The internal 4 MHz pulses are counted during an input pulse, or multiple pulses if the Scaler is > 1. Measuring multiple input periods increases the accuracy of your measurement.

Acceptable numbers for the scaler are 1, 2, 4, 8, 16, 32, 64, and 128. There is one Scaler value for each counter. The default value for each Scaler is 1; a 0 is equivalent to 1.

Sample Period for Period/Continuous Rate Modes

In Period and Continuous Rate modes, the Scaler value defines the number of half-cycles of the incoming pulse train that comprises the sample period. The 4 MHz count value in the Present Value tag is incremented within the pulse train set by the Scaler tag.

The length of the sample period in time varies with the incoming frequency. The lower the incoming frequency, the longer the time.



IMPORTANT Sample period times scaler must be less than 0.25 seconds or the counter will overflow without providing an overflow indication.

The inverse relationship of the increase in frequency and decrease in sampled pulses is shown in the table.

Table 4 - Inverse Relationship of Frequency and Sampled Pulses

Input Frequency at Z-Input	Scaler Value	No. of 4 MHz Pulses in Present Value Tag
2 Hz	1	1,000,000
	2	2,000,000
	4	4,000,000
5 Hz	1	400,000
	2	800,000
	4	1,600,000
10 Hz	1	200,000
	2	400,000
	4	800,000
20 Hz	1	100,000
	2	200,000
	4	400,000
50 Hz	1	40,000
	2	80,000
	4	160,000
100 Hz	1	20,000
	2	40,000
	4	80,000
200 Hz	1	10,000
	2	20,000
	4	40,000
500 Hz	1	4000
	2	8000
	4	16,000

Output Operation

The Period Rate and Continuous Rate frequency operational modes differ in the operation of their respective onboard outputs. Both modes use count values that you enter in the 'Output Turns On' and 'Output Turns Off' fields on the Output Configuration tab. These user-defined presets turn an output On and Off. These On and Off count values are compared to the internal 4 MHz counts returned in the Present Value tag.

The Period Rate output On/Off presets are checked only once per sample period. Therefore, outputs are only checked against their On/Off values and updated once per scaler number of incoming pulses.

The Continuous Rate output On/Off presets are checked continuously during the sample period. Therefore, outputs are dynamically checked against their On/Off values and can be updated multiple times per scaler number of incoming pulses.

For example, assume that the module was programmed to turn On an output with a count value = 20,000 and Off at a count value = 80,001. Also assume that the incoming frequency resulted in the 4 MHz clock count in the Present Value tag = 40,000 with a scaler of '1'.

In Period Rate mode, the output would always be On because at the end of every sample period the Stored Value, Present Value, and Totalizer tags would be updated and the outputs compared against their On/Off values. The number of 4 MHz counts in the Present Value tag would be 40,000, which is between 20,000 and 80,001, therefore, the output would be On.

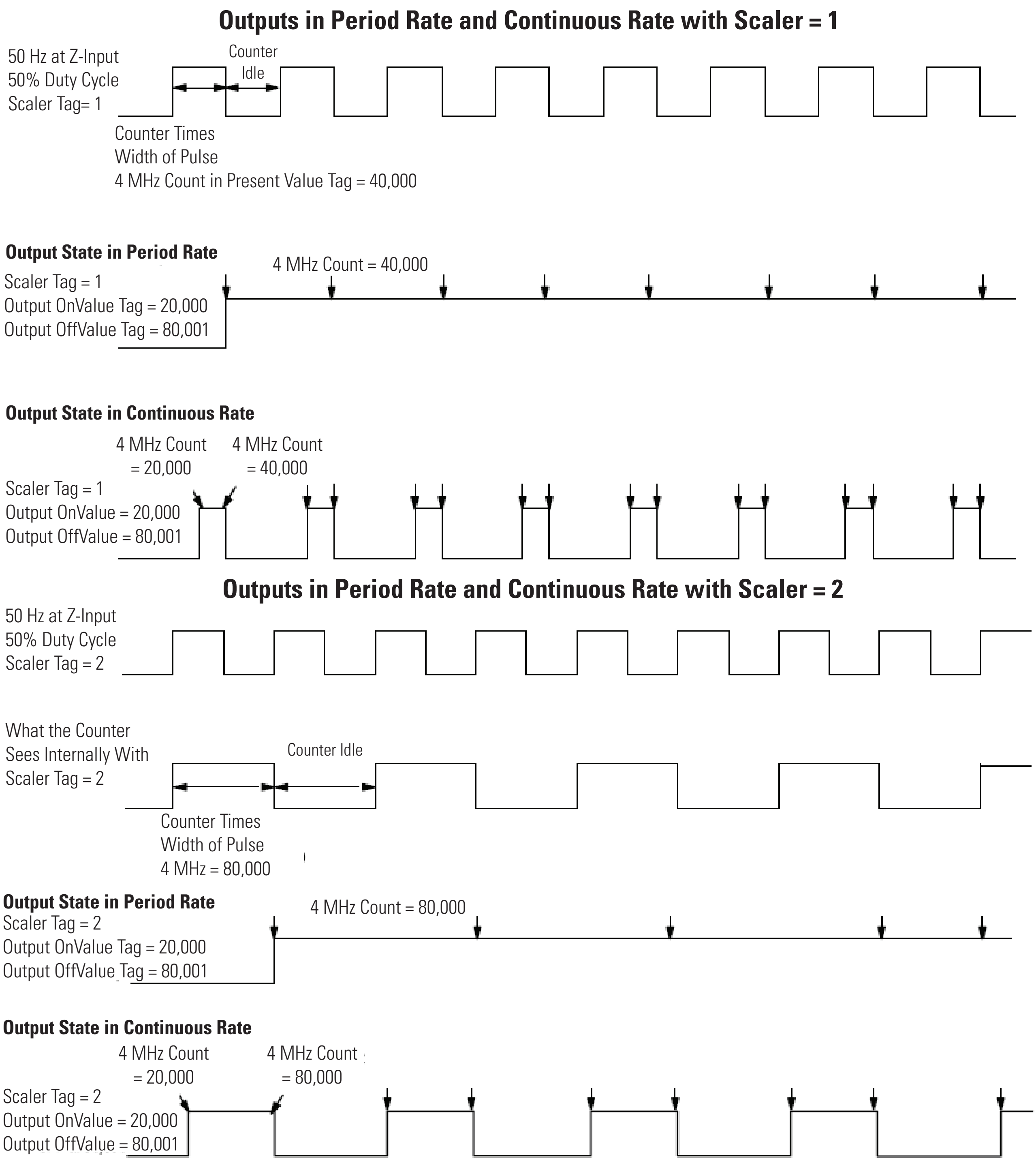
In Continuous Rate mode, the output state would change from Off to On to Off during the incoming external pulse. In this mode, the output presets are checked continuously against the 4 MHz count on the module. Initially, the 4 MHz count is zero and begins incrementing on the leading edge of the incoming pulse. The count continues to increment, whereupon it reaches 20,000 counts and the output turns On. The internal 4 MHz count continues incrementing until 40,000 counts, whereupon the pulse goes low and resets the 4 MHz count to zero, and the cycle repeats.

In both Period Rate and Continuous Rate, the Present Value, Stored Value, and Totalizer tags are updated at the end of the sample period.

See page 32 for square wave examples in Period Rate and Continuous Rate modes.

Period Rate /Continuous Rate Output Examples

These square waves illustrate the difference between Period Rate and Continuous Rate frequency operational modes. All square waves were initiated by applying a 50 Hz signal at the Input Z terminal of a counter that is configured for either Period Rate or Continuous Rate. The output configuration remained constant with an On value of 20,000 counts and an Off value of 80,001 counts. Only the Scaler mode was varied to show the operation of the two modes.



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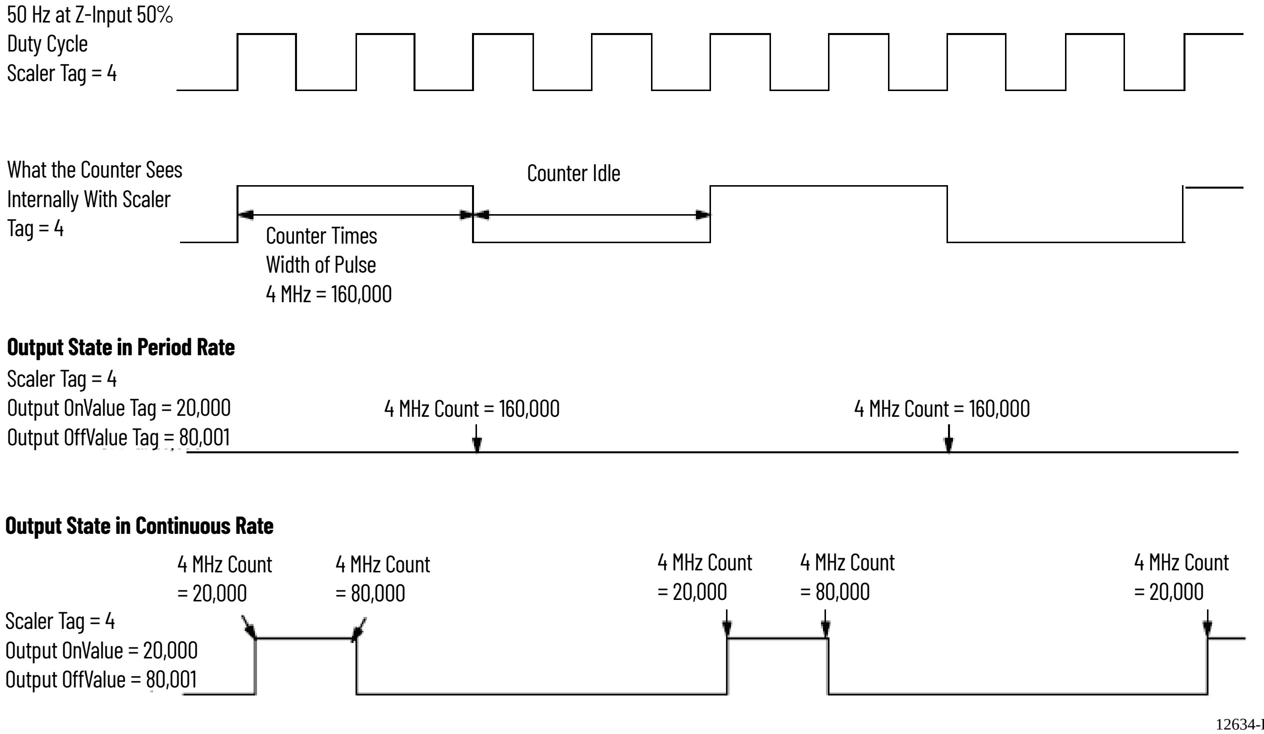
Outputs in Period Rate and Continuous Rate with Scaler = 4



Maximum Frequency

A module is capable of counting up to 16 million counts. However, the maximum rate at which the counter can accept counts depends on the type of signal that is directly connected to the module.

The table lists the acceptable signal levels for the module..

Signal Type	Source Device	Maximum Signal Rate	HSC Channels Supporting Signal
Pulse	Digital Rulers PHOTOSWITCH®	1 MHz with a pulse width > 500 ns	Channel A
Quadrature	Quadrature Encoder	250 kHz	Channels A and B
Frequency (Frequency, Period Rate, Continuous Rate)	Flowmeters	500 kHz with a pulse width > 1 µs	Channel A or Z Input

IMPORTANT Higher signal rates typically require extra caution in the installation and compatibility of the pulse generating device. Be sure to read Appendix D, 'Application Considerations', to verify your device's compatibility.

Notes:

Install and Wire the ControlLogix High-speed Counter Module

Introduction

This chapter describes how to install and maintain the module. If your module is already installed, proceed to page 51.

ATTENTION: Environment and Enclosure
This equipment is intended for use in a Pollution Degree 2 industrial environment, in overvoltage Category II applications (as defined in IEC 60664-1), at altitudes up to 2000 m (6562 ft) without derating.

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR 11. Without appropriate precautions, there may be difficulties with electromagnetic compatibility in residential and other environments due to conducted and radiated disturbances.

This equipment is supplied as open-type equipment. It must be mounted within an enclosure that is suitably designed for those specific environmental conditions that will be present and appropriately designed to prevent personal injury resulting from accessibility to live parts. The enclosure must have suitable flame-retardant properties to prevent or minimize the spread of flame, complying with a flame spread rating of 5VA, V2, V1, V0 (or equivalent) if nonmetallic. The interior of the enclosure must be accessible only by the use of a tool. Subsequent sections of this publication may contain additional information regarding specific enclosure type ratings that are required to comply with certain product safety certifications.

In addition to this publication, see the following:

- Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional installation requirements
- NEMA Standard 250 and IEC 60529, as applicable, for explanations of the degrees of protection provided by enclosures

North American Hazardous Location Approval

This information applies when operating this equipment in hazardous locations.	**Informations sur l'utilisation de cet equipement en environnements dangereux.**
Products marked "CL I, DIV 2, GP A, B, C, D" are suitable for use in Class I Division 2 Groups A, B, C, D, Hazardous Locations and nonhazardous locations only. Each product is supplied with markings on the rating nameplate indicating the hazardous location temperature code. When combining products within a system, the most adverse temperature code (lowest "T" number) may be used to help determine the overall temperature code of the system. Combinations of equipment in your system are subject to investigation by the local Authority Having Jurisdiction at the time of installation.	Les produits marques "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'a une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livre avec des marquages sur sa plaque d'identification qui indiquent le code de temperature pour les environnements dangereux. Lorsque plusieurs produits sont combines dans un systeme, le code de temperature le plus defavorable (code de temperature le plus faible) peut etre utilise pour determiner le code de temperature global du systeme. Les combinaisons d'equipements dans le systeme sont sujettes a inspection par les autorites locales qualifiees au moment de l'installation.
WARNING: EXPLOSION HAZARD • Do not disconnect equipment unless power has been removed or the area is known to be nonhazardous. • Do not disconnect connections to this equipment unless power has been removed or the area is known to be nonhazardous. Secure any external connections that mate to this equipment by using screws, sliding latches, threaded connectors, or other means provided with this product. • Substitution of components may impair suitability for Class I, Division 2. • If this product contains batteries, they must only be changed in an area known to be nonhazardous.	**WARNING:** RISQUE D'EXPLOSION • Couper le courant ou s'assurer que l'environnement est classe non dangereux avant de debrancher l'equipement. • Couper le courant ou s'assurer que l'environnement est classe non dangereux avant de debrancher les connecteurs. Fixer tous les connecteurs externes relies a cet equipement a l'aide de vis, loquets coulissants, connecteurs filetes ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet equipement inadapte a une utilisation en environnement de Classe I, Division 2. • S'assurer que l'environnement est classe non dangereux avant de changer les piles.

ATTENTION: Prevent Electrostatic Discharge
This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:

- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

ATTENTION: The ControlLogix system has been agency certified using only the ControlLogix RTBs (1756-TBCH and 1756-TBS6H). Any application that requires agency certification of the ControlLogix system using other wiring termination methods may require application specific approval by the certifying agency.

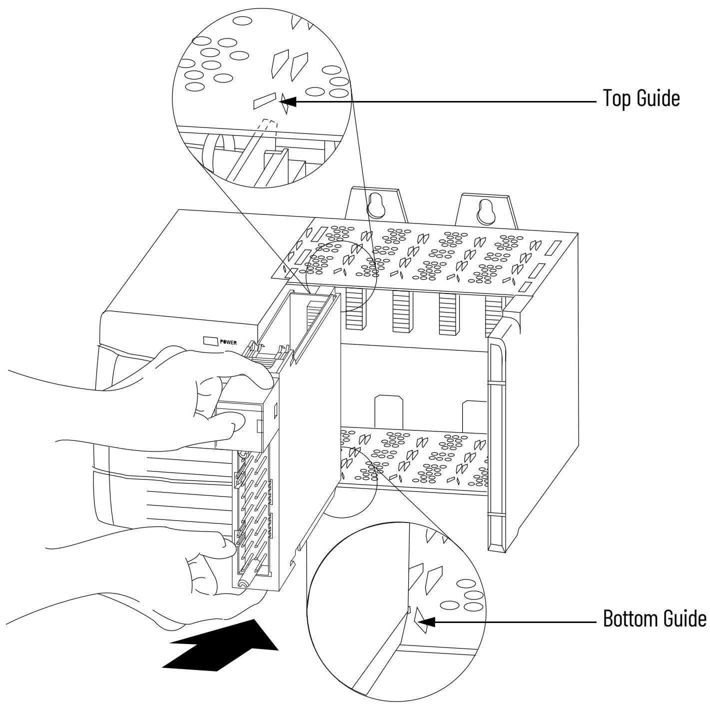
Install the Module

You can install or remove the module while chassis power is applied.

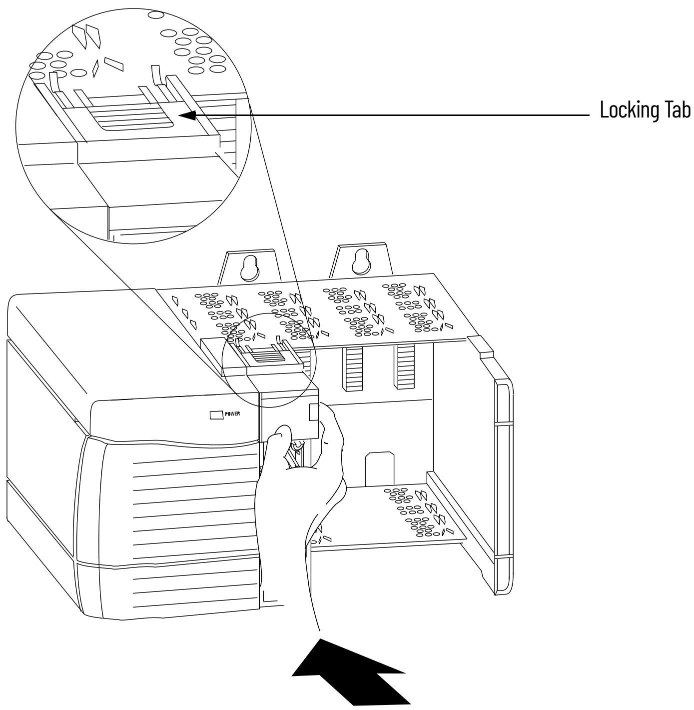
WARNING: When you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.
Be sure that power is removed or the area is nonhazardous before proceeding. Repeated electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance that can affect module operation.

WARNING: When you connect or disconnect the Removable Terminal Block (RTB) with field side power applied, an electrical arc can occur. This could cause an explosion in hazardous location installations.
Be sure that power is removed or the area is nonhazardous before proceeding.

1. Align the circuit board with the top and bottom chassis guides, as shown.



2. Slide the module into the chassis until the module’s top and bottom locking tabs ‘click’.

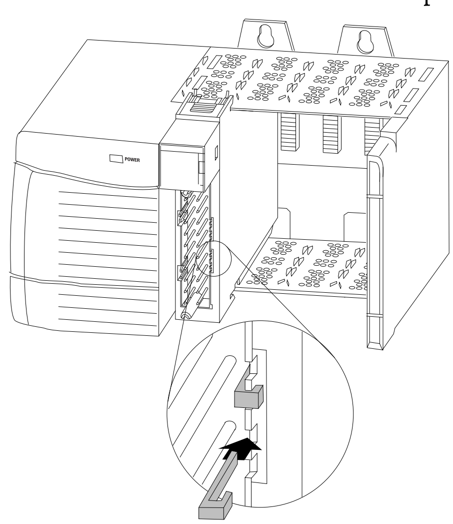


Key the Removable Terminal Block

Key the RTB to help prevent inadvertently connecting the incorrect RTB to your module.

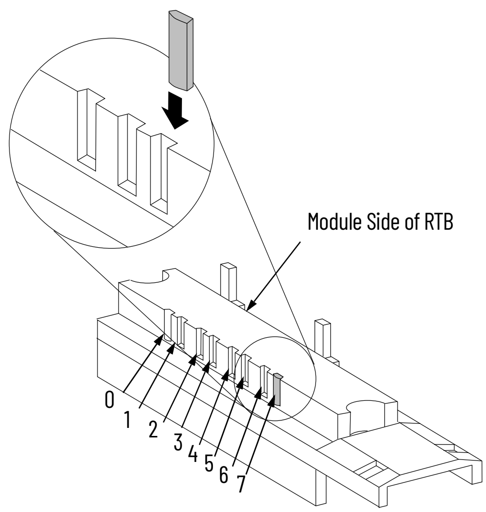
When the RTB mounts onto the module, keying positions match up. For example, if you place a U-shaped keying band in slot 4 on the module, you cannot place a wedge-shaped tab in slot 4 on the RTB or your RTB does not mount on the module.

1. Insert the U-shaped band with the longer side near the terminals, pushing the band on the module until it snaps into place.



2. Key the RTB in positions that correspond to unkeyed module positions.
3. Insert the wedge-shaped tab on the RTB with the rounded edge first.
4. Push the tab onto the RTB until it stops.

IMPORTANT When keying your RTB and module, you must begin with a wedge-shaped tab in slot 6 or 7.



Wiring the Module

Before wiring the module, adhere to these wiring guidelines.

WARNING: If you connect or disconnect wiring while the field-side power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

WARNING: If multiple power sources are used, do not exceed the specified isolation voltage.

WARNING: When using the 1756-TBCH terminal block, do not wire more than two 0.33...1.3 mm^2 (22...16 AWG) conductors on any single terminal. Use only the same size wires with no intermixing of solid and stranded wire types.
When using the 1756-TBS6H terminal block, do not wire more than one conductor on any single terminal.

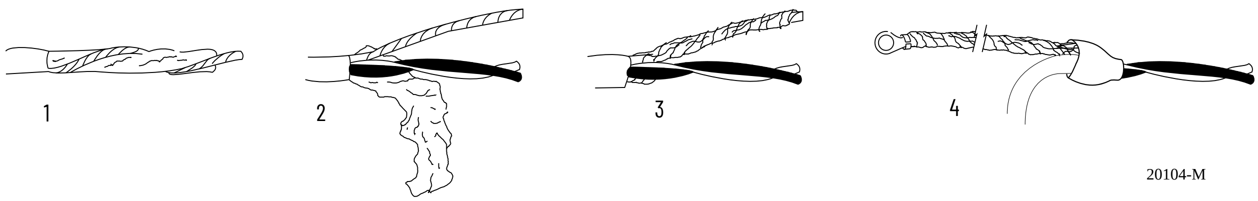
Connect the Wires

You can use an RTB to connect wiring to your module. For most applications, we recommend using Belden 8761 cable. The RTB terminations can accommodate 0.33…1.3 mm² (22…16 AWG) shielded wire. Before wiring the RTB, you must connect ground wiring.

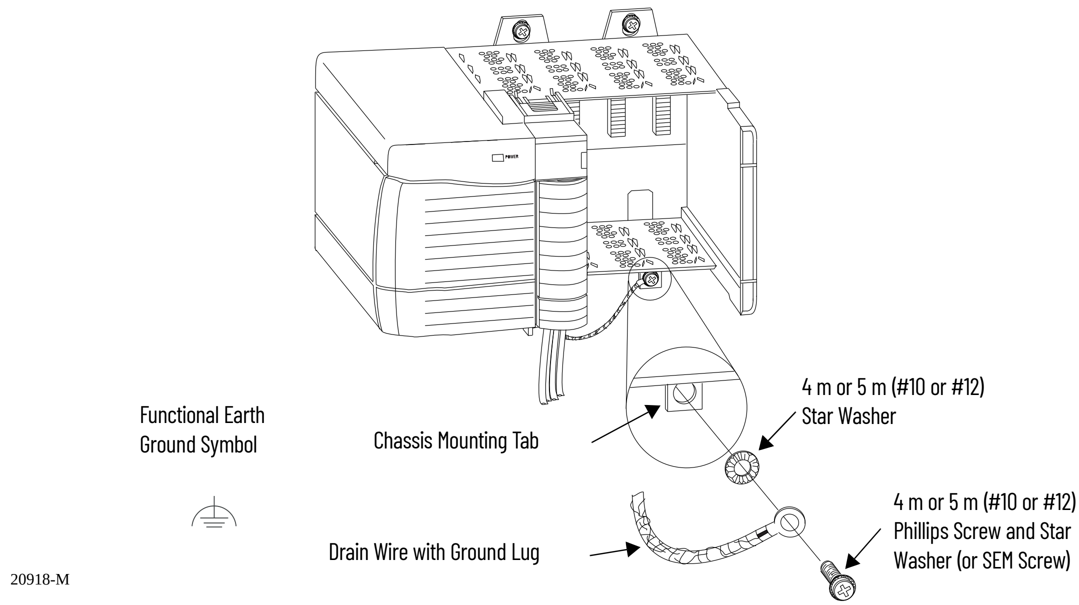
Follow these directions to ground the wiring to the RTB.

IMPORTANT	We recommend you ground the drain wire at the field-side. If you cannot ground at the field-side, ground at an earth ground on the chassis as shown.

1. Remove a length of cable jacket from the connecting cables.
2. Pull the foil shield and bare the drain wire from the insulated wire.



3. Twist the foil shield and the drain wire together to form one strand.
4. Attach a ground lug and apply heat shrink tubing to the exit area.



5. Connect the drain wire to a chassis mounting tab.

   Use any chassis mounting tab that is designated as a functional signal ground. The functional earth ground symbol appears near the tab.
6. When the drain wire is grounded, connect the insulated wires to the field-side.

Connect Ungrounded End of the Cable

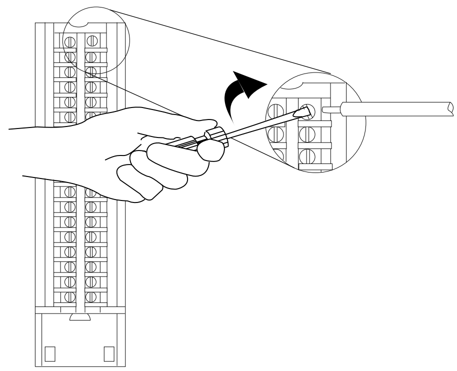
Follow these directions to connect the ungrounded end of the cable.

1. Cut the foil shield and drain wire back to the cable casing and apply shrink wrap.
2. Connect the insulated wires to the RTB.

Two Types of RTBs (each RTB comes with housing)

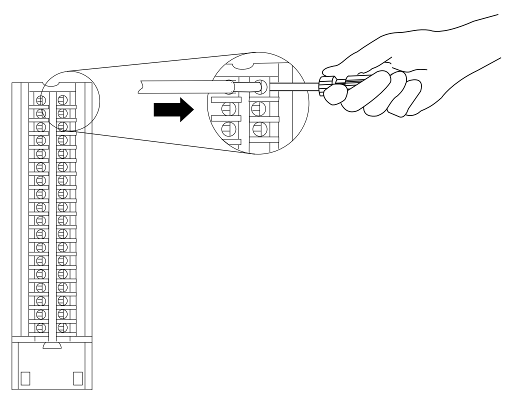
Cage clamp - catalog number 1756-TBCH

1. Insert the wire into the terminal.
2. Turn the screw clockwise to close the terminal on the wire.



Spring clamp - catalog number 1756-TBS6H

1. Insert the screwdriver into the outer hole of the RTB.
2. Insert the wire into the open terminal and remove the screwdriver.



ATTENTION: The ControlLogix system has been agency certified using only the ControlLogix RTBs (catalog numbers 1756-TBCH, 1756-TBNH, 1756-TBSH and 1756-TBS6H). Any application that requires agency certification of the ControlLogix system using other wiring termination methods may require application-specific approval by the certifying agency.

Recommendations for Wiring Your RTB

We recommend that you follow these guidelines when wiring your RTB.

1. Begin wiring the RTB at the bottom terminals and move up.
2. Use a tie to secure the wires in the strain relief (bottom) area of the RTB.
3. Order and use an extended-depth housing (catalog number 1756-TBE) for applications that require heavy gauge wiring.

   See Appendix D for cable considerations.

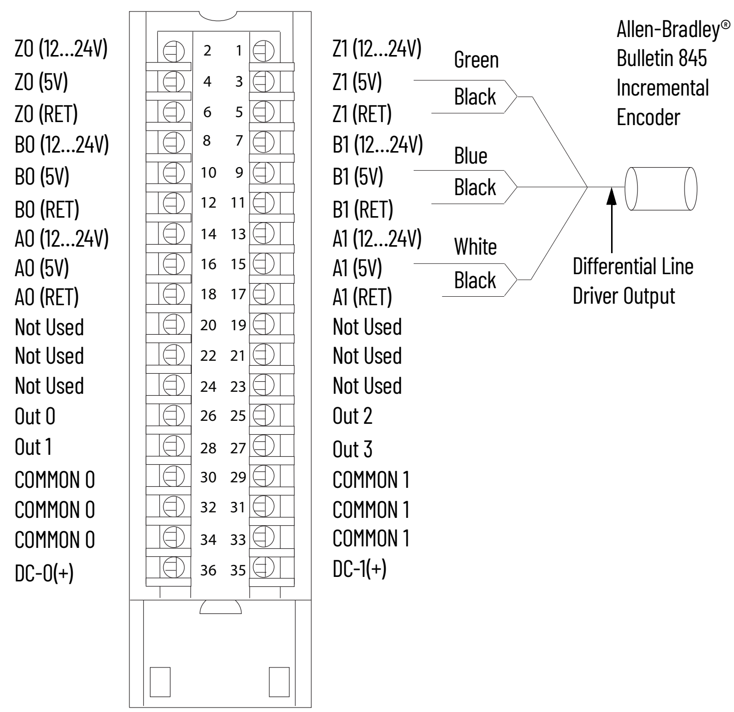
Wire Terminations

These sections provide details about wiring terminations to specific products.

Wire an Allen-Bradley 845 Incremental Encoder

Use the table and diagram to connect the 1756-HSC module to an Allen-Bradley 845 incremental encoder.

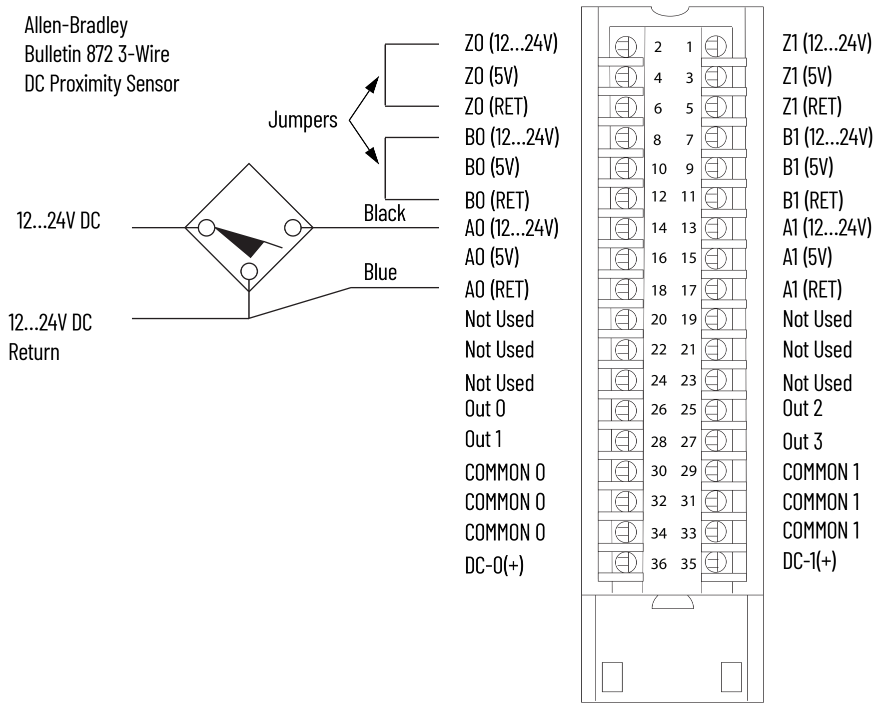
Application	A1 Connections	B1 Connections	Z1 Connections
Differential Line Driver Output (40 mA)	White - A1 5V DC Black of white - A1Return	Blue - B1 5V DC Black of blue - B1 Return	Green - Z1 5V DC Black of green - Z1 Return



Wire an Allen-Bradley Bulletin 872 3-Wire DC Proximity Sensor

Use the table and diagram to connect the 1756-HSC module to an Allen-Bradley 872 three-wire DC proximity sensor.

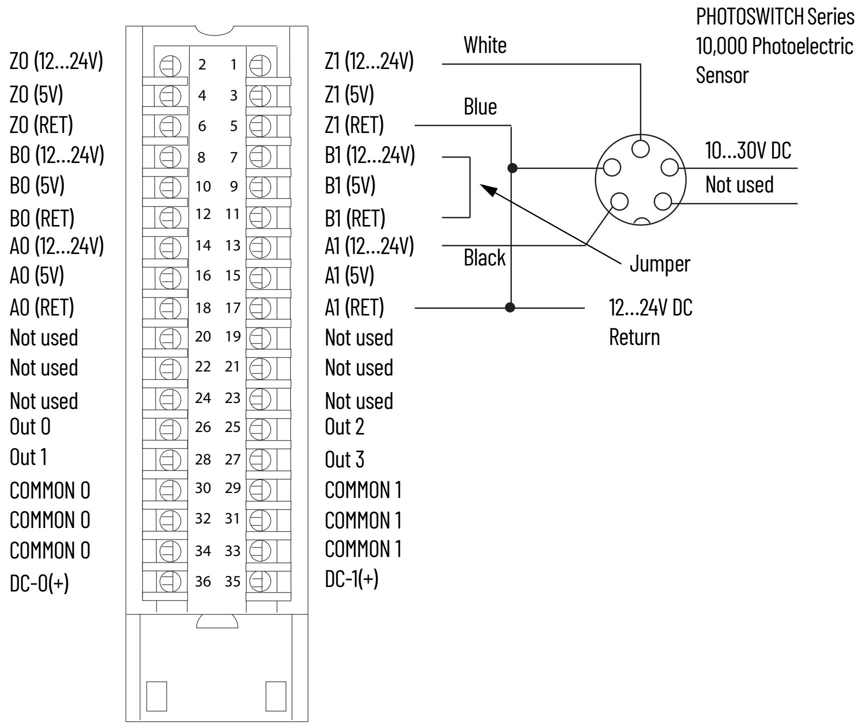
Application	A0 Connections	B0 Connections	Z0 Connections
PNP (Sourcing) N.O.	Black - A0 12...24V DC Blue, PS(-)-A0 Return	Jumper B0 12...24V DC to B0 Return	Jumper Z0 12...24V DC to Z0 Return



Wire a PHOTOSWITCH® Series 10,000 Photoelectric Sensor

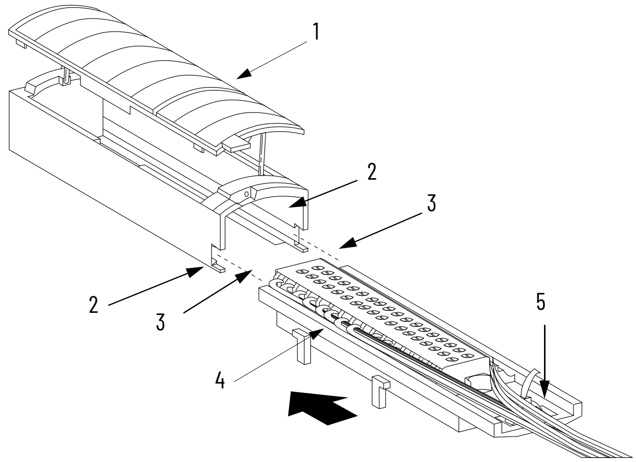
Use the table and diagram to connect wiring to a series 10,000 photoelectric sensor.

Application	A1 Connections	B1 Connections	Z1 Connections
Any	Black - A1 12…24V DC Blue - A1 Return	Jumper B1 12…24V DC to B1 Return	White - Z1 12…24V DC Blue - Z1 Return



Assemble the Removable Terminal Block and Housing

Removable housing covers the wired RTB to protect wiring connections when the RTB is seated on the module. Parts of the 1756-TBCH RTB are identified in the table.



Item	Description
1	Housing cover
2	Groove
3	Side edge of RTB
4	RTB
5	Strain relief area

Follow these steps to attach the RTB to the housing.

1. Align the grooves at the bottom of each side of the housing with the side edges of the RTB.
2. Slide the RTB into the housing until it snaps into place.

IMPORTANT	If additional wire routing space is required for your application, use the extended-depth housing, catalog number 1756-TBE.

Install the Removable Terminal Block

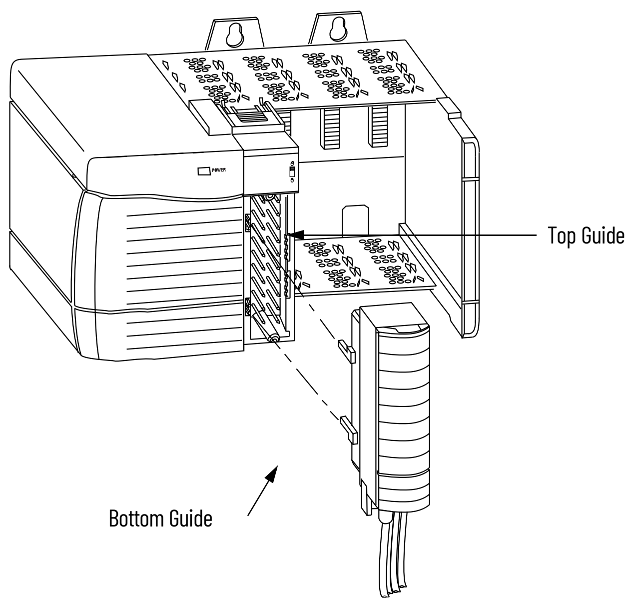
These steps show how to install the RTB onto the module to connect the wiring.

WARNING: When you connect or disconnect the removable terminal block (RTB) with field side power applied, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

Before installing the RTB, verify:

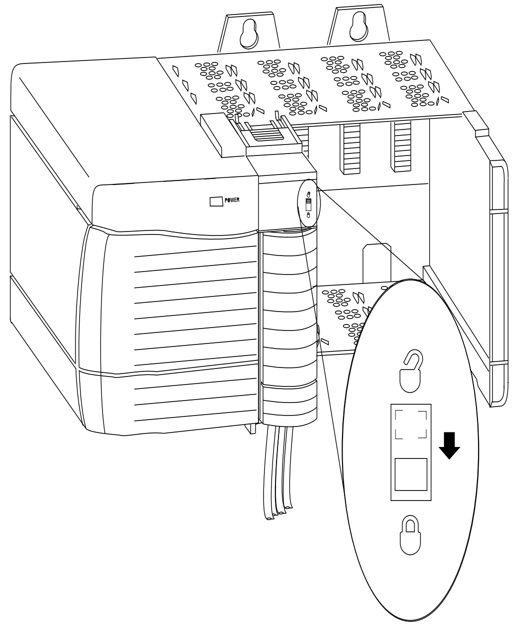
- field-side wiring of the RTB has been completed.
- the RTB housing is snapped into place on the RTB.
- the RTB housing door is closed.
- the locking tab at the top of the module is unlocked.

1. Align the top, bottom, and left side guides of the RTB with the guides on the module.



2. Press quickly and evenly to seat the RTB on the module until the latches snap into place.

3. Slide the locking tab down to lock the RTB onto the module.



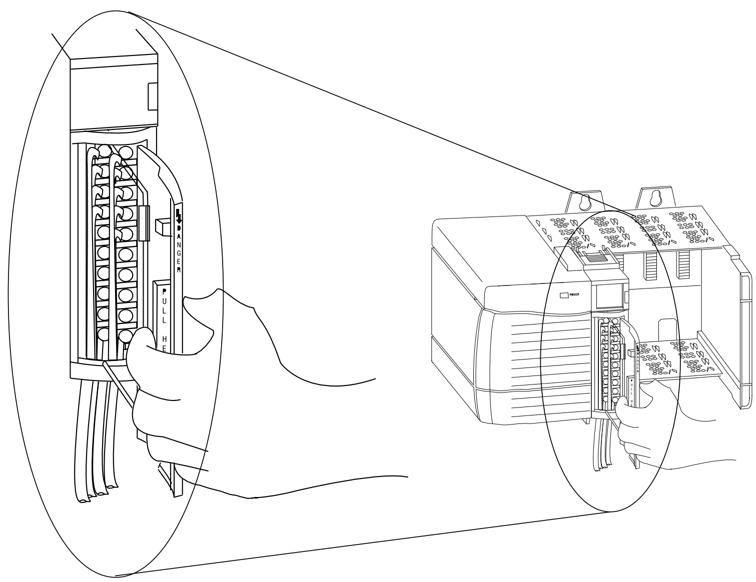
Remove the Removable Terminal Block

If you must remove the module from the chassis, you must first remove the RTB from the module. Do these steps to remove the RTB.

WARNING: When you connect or disconnect the removable terminal block (RTB) with field side power applied, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

1. Unlock the locking tab at the top of the module.
2. Open the RTB door by using the bottom tab.
3. Hold the spot marked PULL HERE and pull the RTB off the module.

IMPORTANT Do not wrap your fingers around the entire door. A shock hazard exists.

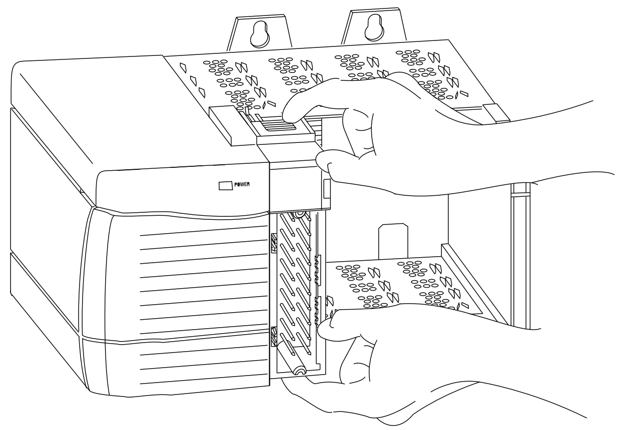


Remove the Module from the Chassis

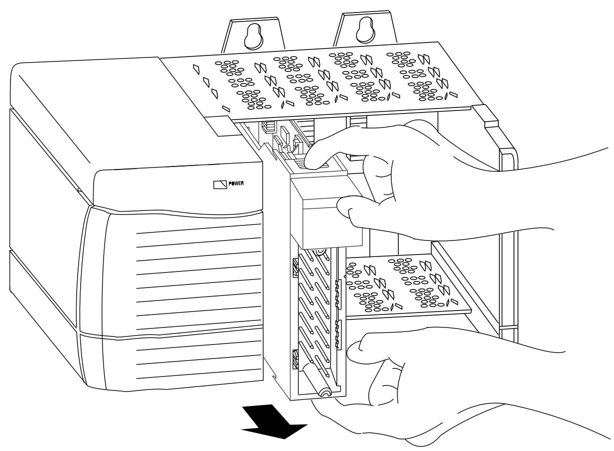
Follow these steps to remove a module from its chassis.

WARNING: When you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.
Be sure that power is removed or the area is nonhazardous before proceeding. Repeated electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts may create electrical resistance that can affect module operation.

1. Push in the top and bottom locking tabs.



2. Pull the module out of the chassis.



Notes:

Chapter 5

Configure the Module

Introduction

This chapter describes how to use the programming software to configure the 1756-HSC module. Your module does not work until it has been configured.

See Appendix C for all firmware and software combinations for the module.

ControlLogix Overview

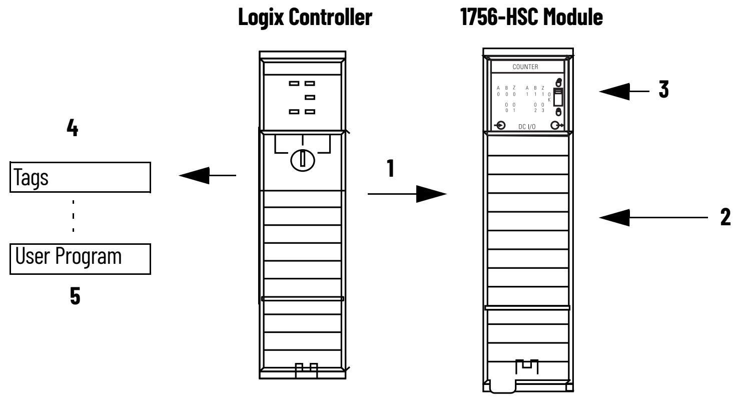
Before configuring your module in a local or remote chassis, you must have an understanding of how the module operates with the controller in the ControlLogix® system. Every module must be owned by a controller. This owner-controller stores configuration data for every module that it owns.

The owner-controller sends configuration information to the modules it owns anytime the module has not been configured; generally this occurs on a module power-up or a controller-initiated reconfigure. Adding the module to the I/O configuration tree of the programming software creates configuration and I/O data structures and tags for the module.

A remote chassis, also known as a networked chassis, contains the module but not the module's owner-controller. See page 53 for important information about running RSNetWorx™ software with a remote chassis.

The illustration shows how the module communicates with its owner-controller. If connections are severed or compromised, the module performs as configured, either setting all outputs to reset (On or Off) or continuous operations.

Figure 3 - Module Communication with its Owner-controller



Path No.	Description
1	Controller transfers configuration data and commands to the module.
2	External devices generate input signals that are transmitted to the module.
3	Module converts signals, stores values, and controls output without being updated by the controller.
4	Controller stores the counts or frequency values in descriptive and easily understood tags.
5	Ladder logic program can store and move data before the inputs trigger new data.

Module communication or multicasting behavior varies depending upon whether it operates in the local chassis or in a remote chassis. The following sections detail the differences in data transfers between these setups.

Direct Connections

A direct connection is a real-time data transfer link between the controller and the device that occupies the slot that the configuration data references. When module configuration data is downloaded to an owner-controller, the controller attempts to establish a direct connection to each of the modules referenced by the data.

One of these events occurs:

- If the data is appropriate to the module found in the slot, a connection is made and operation begins.
- If the configuration data is not appropriate, the data is rejected and an error message displays in the software. In this case, the configuration data can be inappropriate for any of a number of reasons. For example, a module's configuration data may be appropriate except for a mismatch in electronic keying that prevents normal operation.

The controller maintains and monitors its connection with a module. Any break in the connection, such as removal of the module from the chassis while under power, causes the controller to set faults in the data area associated with the module. The programming software can monitor this data area to announce the module's failures.

Local Chassis Operation

The time frame that a module produces its data depends on the options that are chosen during configuration and where in the control system the module physically resides, such as locally or remotely. The requested packet interval (RPI) instructs the module to send its channel and status data to the local chassis backplane at specific time intervals.

IMPORTANT	The RPI value is set during the initial module configuration. This value can be adjusted when the controller is in Program mode. See page 59 for RPI settings.

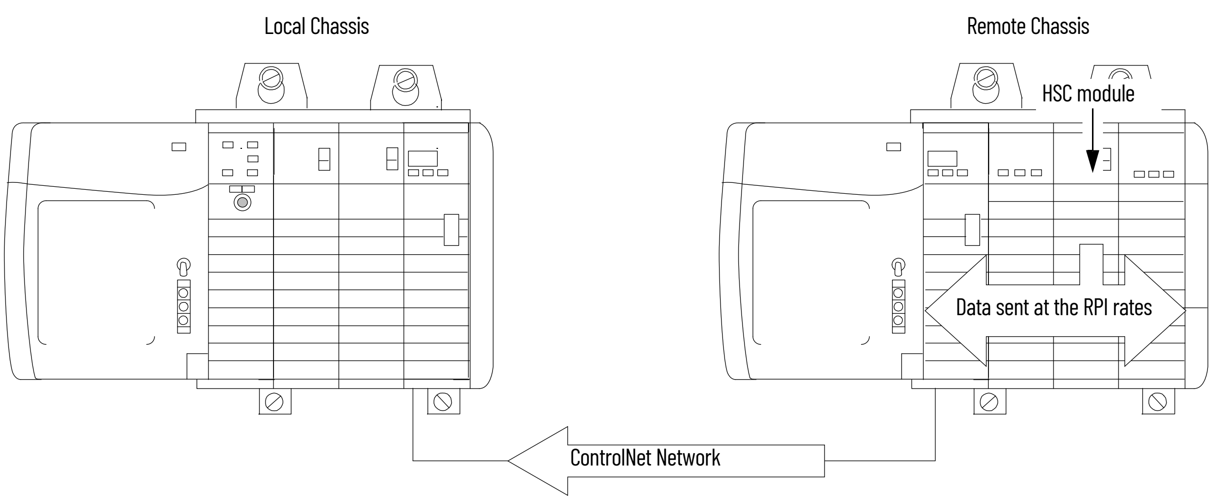
Remote Chassis Operation

If a module resides in a networked chassis, the role of the RPI changes slightly regarding getting data to the owner. The RPI not only defines when the module produces data within its own chassis, but also determines how often the owner-controller receives it over the network.

When an RPI value is specified for a module in a remote chassis, in addition to instructing the module to produce data within its own chassis, the RPI also 'reserves' a spot in the stream of data flowing across the network.

The timing of this 'reserved' spot can fail to coincide with the exact value of the RPI, but the control system guarantees that the owner-controller receives data at least as often as the specified RPI. As shown in the illustration, data from the remote chassis is sent to the ControlNet™ bridge at a rate no slower than the configured RPI.

Figure 4 - Data from Remote Chassis Sent to ControlNet Bridge



You must run RSNetWorx software to enable 1756-HSC modules in a remote ControlNet (networked) chassis. Running RSNetWorx software transfers configuration data to networked modules and establishes a network update time (NUT) for the ControlNet network that is compliant with the desired communication options that are specified for each module during configuration.

If you are not using 1756-HSC modules in a networked ControlNet chassis, running RSNetWorx software is not necessary. However, anytime a controller references a 1756-HSC module in a networked chassis, RSNetWorx software must be run to configure the ControlNet network.

In an Ethernet network with a multicast connection, a module sends new data when prior data has not been transferred for one-quarter of the RPI. For example, if data is being sent every 10 ms and the RPI is set at 100 ms, the data transfer rate is every 30 ms.

Use the Default Configuration

1756-HSC modules in the same chassis as the controller are ready to run as soon as the program download is complete. The default configuration for your module is the Counter operational mode, with none of the outputs tied to counters.

If you choose to write a specific configuration for your application, you must access the module tags and change configuration information **before** you download configuration to the owner-controller and module. Otherwise, you must issue a reconfigure command from the controller.

Access the 1756-HSC data structures through the tag monitor to make specific configuration changes.

See Appendix B for tag descriptions.

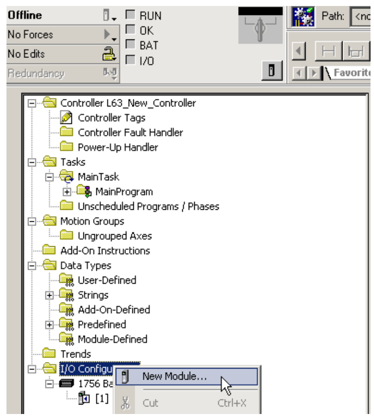
Use the Programming Software, Version 18 or Later, to Configure a Module

After reviewing Chapter 2 and Chapter 3 for a better understanding of the capabilities of your module, you are ready to configure the module by using the programming software, version 18 and later. This section provides instructions and screen facsimiles for creating a module.

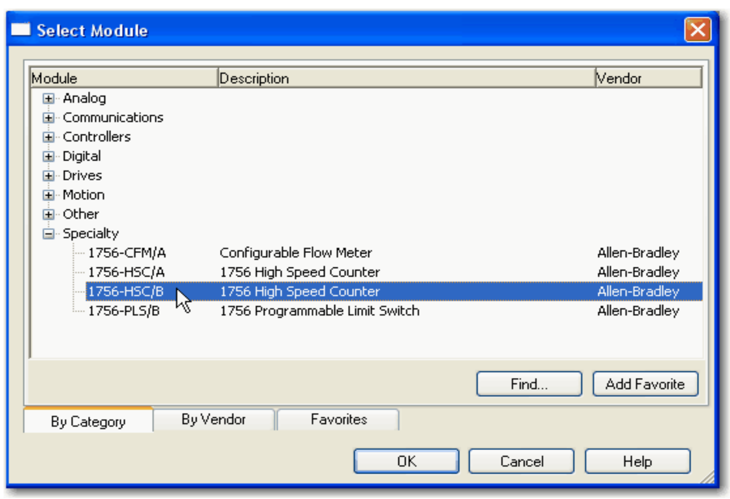
IMPORTANT	Programming software, version 15 and later, lets you add I/O modules online. When using any previous version, you must be offline when you create a new module.

These steps assume that you have started the programming software and have created a controller.

1. On the Controller Organizer, right-click I/O Configuration and choose New Module.

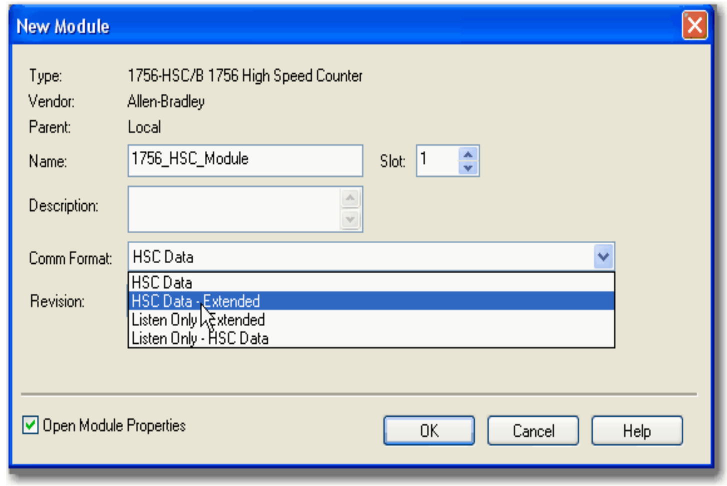


The Select Module dialog box appears.



2. Click the '+' next to Specialty for a list for this module group.
3. Select 1756-HSC and click OK.

The New Module dialog box appears.



4. In the Name box, type a module name.
5. In the Slot box, enter the module's slot number.
6. In the Description box, type an optional description for the module.
7. From the Comm Format pull-down menu, choose a communication format.

   See page 57 for a description of the formats and the associated tags that are created during the download.

IMPORTANT	Make sure you select the correct communication format for your application because you cannot change the selection after the program is downloaded with the controller. You have to reconfigure the module to change the communication format.

8. In the Revision box, make sure to match the actual revision for your module.

   This setting works with the electronic keying to determine the connection.
9. Choose an electronic keying method.

   See page 66 for details.

IMPORTANT	Controllers that have programming software, version 17 or earlier, should use Compatible Keying for the 1756-HSC module. You must upgrade to version 18 or later if Exact Match is required; otherwise, there will be no connection with the controller.

10. Complete one of the following steps to accept default configuration settings or edit configuration data.
    a. To accept the default configuration settings, make sure Open Module Properties is not checked and then click OK.
    b. To configure a custom configuration, make sure Open Module Properties is checked and then click OK.

       The New Module Properties dialog box appears with tabs for entry of additional configuration settings.

Communication Format Options

Multiple controllers can receive data being produced by the module. The communication format determines:

- whether a controller owns or just listens to the information.
- the type of configuration options that are available.
- the tags that are generated during the initial configuration.

This table describes the four communication formats available for the module.

Communication Format	Description
HSC Data	Format used by an owner-controller to invoke the original functionality for the module. 'Data' format generates tag structures identical to those used by older revision 1.*x* HSC modules. This format is compatible with revision 3.*x* HSC firmware but will limit the module to revision 1.*x* functionality.
HSC Data-extended	Format used by an owner-controller to invoke the module for data enhancements in HSC revision 3.*x*. 'Data-extended' format functionality includes Period Rate and Continuous Rate Frequency modes and dynamic control of Preset, Rollover, and Output On/Off values.
Listen-only HSC Data	Format that is used by a controller to listen-only to a module that is using the HSC Data Comm Format that is configured by another controller.
Listen-only Extended	Format that is used by a controller to listen-only to a module that is using the HSC Data-extended Comm Format that is configured by another controller.

IMPORTANT See page 58 for specific modes and tags for the HSC Data and HSC Data-extended Comm Formats.

The table lists the mode number and assigned tags for the HSC Data and HSC Data-extended Comm Formats. The HSC Data format does not create the Totalizer tag, so directional frequency with the counters is not available.

Figure 5 - Communication Format Modes and Tags

Comm Format = HSC Data (1756-HSC Version 1.*x* or later)		**Tags**	
Operational Mode	**Mode (Tag Value)**	**Present Value**	**Stored Value**
Counter	0	Accumulated count	Stored value
Encoder X1	1		
Encoder X4	2		
Counter Not Used	3	—	—
Frequency (Rate Measurement)(1)	4	No. of input pulses occurring in sample period	Frequency in Hz

Comm Format = HSC Data-extended (1756-HSC module version 3.*x* or later)		**Tags**		
Operational Mode	**Mode (Tag Value)**	**Present Value**	**Stored Value**	**Totalizer**
Counter	0	Accumulated count	Stored value	Directional frequency(2)
Encoder X1	1			
Encoder X4	2			
Counter Not Used	3	—	—	—
Frequency (Rate Measurement)(1)	4	No. of input pulses occurring in sample period	Frequency in Hz	Accumulated count(3)
Frequency (Period Rate)(1)	5	No. of 4 MHz pulses occurring in sample period		Accumulated count
Frequency (Continuous Rate)(1)	6			

(1) Modes where frequency controls the outputs.

(2) B-input state defines direction (Counter mode).

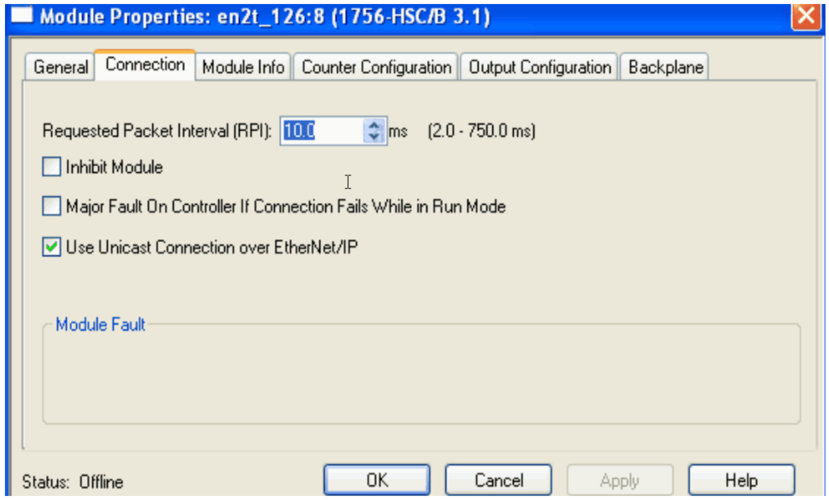
(3) Rollover/Preset settings apply.

See Appendix B for a complete list and description of configuration, input, and output tags.

Set RPI

The Connection tab on the Module Properties dialog box lets you enter a requested packet interval (RPI). The RPI guarantees the slowest rate at which the pulse count values are produced to the owner-controller.

The module's actual data transfer rate can be faster than the RPI setting. But, the RPI provides a defined, maximum time when data is transferred to the owner-controller.



1. Choose from the options in the Connection tab.

Field	Description
Requested Packet Interval (RPI)	Enter an RPI value or use the default.
Inhibit Module	Check the box to prevent communication between the owner-controller and the module. This option allows for maintenance of the module without faults being reported to the controller.
Major Fault On Controller If Connection Fails While in Run Mode	Check the box to create a major fault if there is a connection failure with the module while in Run mode. For important information on this checkbox, see 'Configure a Major Fault to Occur' in the Logix 5000™ Controllers Information and Status Programming Manual, publication 1756-PM015.
Use Unicast Connection on EtherNet/IP	Displays only for 1756-HSC modules using programming software version 18 in a remote EtherNet/IP™ chassis. Use the default checkbox if there are no other controllers in 'Listen' mode. Clear the box if there are other 'listening' controllers in the system.
Module Fault	The fault box is empty if you are offline. The type of fault displays in the text box if a fault occurs when the module is online.

2. Click OK.

Set Up Counter Configuration

The Counter Configuration tab (on the Module Properties dialog box) is identical for both the HSC-Data and HSC Data-extended Comm Formats. However, the HSC Data-extended format includes the addition of the Period Rate and Continuous Rate frequency selections in the Operational Mode pull-down menu.

Be sure to select only features that are compatible with your selected communication format. See page 61 for Counter Configuration tab descriptions.

The Operational modes determine how the incoming pulses are counted. The Storage modes allow the count values to be manipulated if the application requires storage of the accumulated count value.

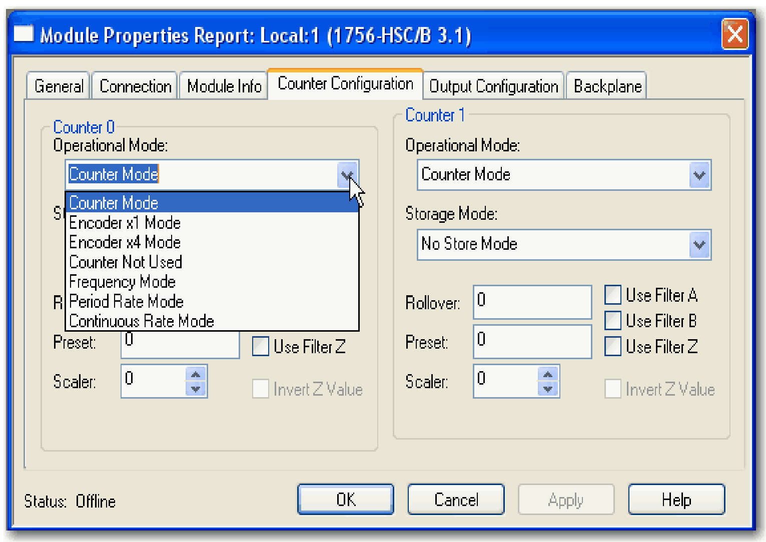
The different operational modes are detailed on page 13 in Chapter 2.

Follow these steps to choose Counter and Storage mode options.

1. On the Modules Properties dialog box, click the Counter Configuration tab.

   The Counter Configuration dialog box appears.

   The dialog box is divided into two halves; one each for the respective channel (0, 1) inputs.



2. Choose counter parameters in the Counter Configuration tab.

Field descriptions and procedures apply for both channel 0 and channel 1.

Field	Description
Operational Mode	Choose an operational mode based on your application requirements. These are the values: • Counter Mode (default) • Encoder x1 Mode • Encoder x4 Mode • Counter Not Used • Frequency Mode • Period Rate (valid only with HSC Data-extended format) • Continuous Rate (valid only with HSC Data-extended format) See Chapter 2 and Chapter 3 for details and illustrations on Counter and Frequency mode operations.
Storage Mode	Choose how the pulse count is stored (with the mode selected in the above field) if required for an accumulated count. These are the values: • No Store Mode (default) • Store and Continue Mode • Store, Wait, and Resume Mode • Store and Reset, Wait, and Start Mode • Store and Reset, and Start Mode See Storage Modes in Chapter 2 for details.
Rollover	Defaults to zero (0), which is the equivalent to a full count range (16,777,214). When the accumulated count value in the Present Value tag reaches the rollover value, it resets to zero (0) and begins counting again. Range is 0…16,777,214. This configuration setting can be overridden by a value in the Output tag for the HSC Data-extended format only. See Rollover in Chapter 2 for details.
Preset	Box defaults to zero (0) if a Preset command is issued. The 1756-HSC module's Present Value tag is set to the present value. Range is 0…Rollover value. This configuration setting can be overridden by a value in the Output tag for only the HSC Data-extended format. See Preset in Chapter 2 for details.
Scaler	Defaults to zero (0). For Frequency mode, the Scaler determines the amount of time in milliseconds the 1756-HSC module counts incoming pulses. Range 0…2000 ms in 10 ms increments. A value of zero (0) is equivalent to 1000 ms. For Period Rate/Continuous Rate modes, pulses are used to count internal 4 MHz pulses. Allowable values are 0, 1, 2, 4, 8, 16, 32, 64, 128, 256. A value of zero is equivalent to 1. Valid with only the HSC Data-extended Comm Format.
Use Filter A Use Filter B Use Filter Z	Select a filter for either Channel 0 and/or Channel 1. See Filter Selections for how the filters affect the signal rate.
Invert Z Value	Box becomes active when a Storage mode is selected other than 'No Store Mode.' When active, Input Z reverses reading the rising or falling edge of the pulse depending on previous usage. If the pulse was read on the rising edge, the module inverts the signal and now reads the falling edge of the pulse.

3. Click OK.

Filter Selections

High-speed inputs can be sensitive to electromagnetic noise. You can manually set Channel 0 inputs and/or Channel 1 inputs to filter out noise or debounce. Debounce is created when a mechanical device changes state (On/Off).

All 1756-HSC module inputs have these characteristics:

- With the filter **disabled** (assuming a 50% duty cycle):
  - module reads at 1 MHz in Counter mode.
  - module reads at 250 kHz in Encoder x1 or Encoder x4 mode.
  - module reads at 500 kHz in Frequency mode.
- With the filter **enabled** (assuming a 50% duty cycle):
  - module counts all pulses at a frequency below 25 Hz.
  - module does not count any pulses at a frequency above 25 Hz.

Digital Filter

IMPORTANT	This functionality, that is, the option to configure the filter, is only available with Series C, firmware revision 4.x or later, modules. Prior versions only allow a fixed filter to be enabled or disabled.

You can use the C.FilterA, C.FilterB, and C.FilterZ tags to digitally configure the filters.

- No Filter (0x00)
- 50 Hz (0x01 for CH0, 0x02 for CH1, 0x03 for both channels)
- 500 Hz (0x04 for CH0, 0x08 for CH1, 0x0C for both channels)
- 5 kHz (0x10 for CH0, 0x20 for CH1, 0x30 for both channels)
- 50 kHz (0x40 for CH0, 0x80 for CH1, 0xC0 for both channels)

Set only one filter bit for each channel. If you set multiple bits, filtering is disabled.

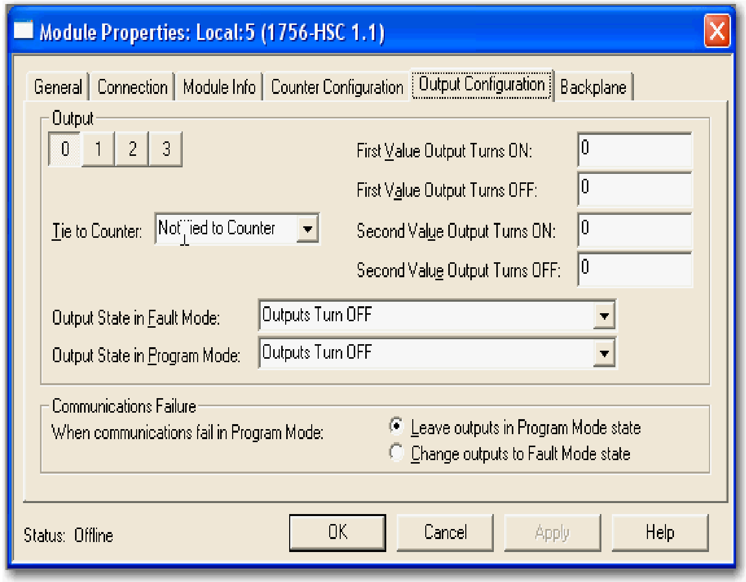
Set Up Output Configuration

The Output Configuration tab (on the Module Properties dialog box) is available for either the HSC Data or HSC Data-extended Comm Format with the module. The tab lets you configure and maintain the four onboard outputs, which compare user-defined values to the Present Value tag to turn outputs On or Off.

Follow these steps to configure the output operation.

1. On the Modules Properties dialog box, click the Output Configuration tab.

   The Output Configuration dialog box appears.



2. Choose output parameters in the Output Configuration dialog box.

Field	Description
Output	Click one of four output buttons to configure the respective output.
Tie to Counter	Choose a mode to determine if an output is tied to a counter. These are the values: • Not Tied to Counter (default) • Tied to Counter 0 • Tied to Counter 1
Output State in Fault Mode Output State in Program Mode	Defaults to Off for both options. These settings determine how you want the behavior of the outputs if a fault occurs, such as a connection loss. These are the values: • Outputs Turn On • Counter Continues to Determine Outputs Operation **Important:** For firmware revision 2 and later, a routine must be added in ladder logic to copy the configuration (C.) output setting to the (O.) output tags. Otherwise, the configuration setting will be overridden by the output tag for values other than Off. See page 64 for ladder logic procedures.
First Value Output Turns ON	Type values to turn the selected output On and Off, respectively. Each pair (First Value, Second Value) can be assigned to an output. The values can be set for the rising or falling edge of the window depending on whether the Invert Z Value is active for an operational mode. For example, a pulse count could turn On at 100 counts and end at 200 counts, or turn Off at 100 counts and turn back On at 200 counts.
First Value Output Turns OFF	
Second Value Output Turns ON	
Second Value Output Turns OFF	
Communications Failure When communications fail in Program Mode	Select the output's status if communication is severed between the module and its owner-controller.

3. Click OK.

Copy Configuration (.C) Output, Rollover, Preset Tags to Output (.O) Tags

The configuration procedures previously described populated the Configuration tags (.C) in the controller memory. Starting with firmware revision 2 for the 1756-HSC module, some of these tags—output, preset, and rollover, are also populated in the Output tags (.O) to facilitate real-time changes of these parameters.

However, the duplication of tag data could result in values being overridden when the HSC Data-extended Comm Format is selected.

IMPORTANT	The override occurs for Fault mode/Program mode output selections other than Off on the Output Configuration tab.

For example, if the outputs are configured to turn ON when in Program mode in the configuration structure and that data is not copied into the output tag structure and is left zero, the output will instead be Off during Program mode.

To coordinate the configuration tags with the output tags, we recommend that you create a ladder logic routine to copy the Configuration tag (.C) output, rollover, and preset definitions to the Output (.O) tags. This helps synchronize the data tags; when the configuration tags are established or modified, the same data is used in the output tags.

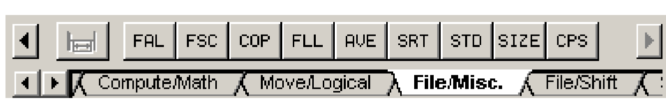
Follow these steps to copy configuration definitions to output tags.

1. On the Controller Organizer, click the '+' in front of Main Task.

   A submenu appears.

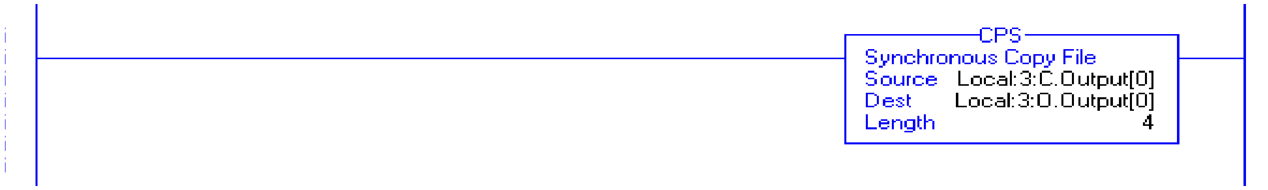
2. Right-click MainRoutine and choose Open.

   A new rung in ladder logic appears.
3. At the top of the ladder logic workspace, click the File/Misc. tab.

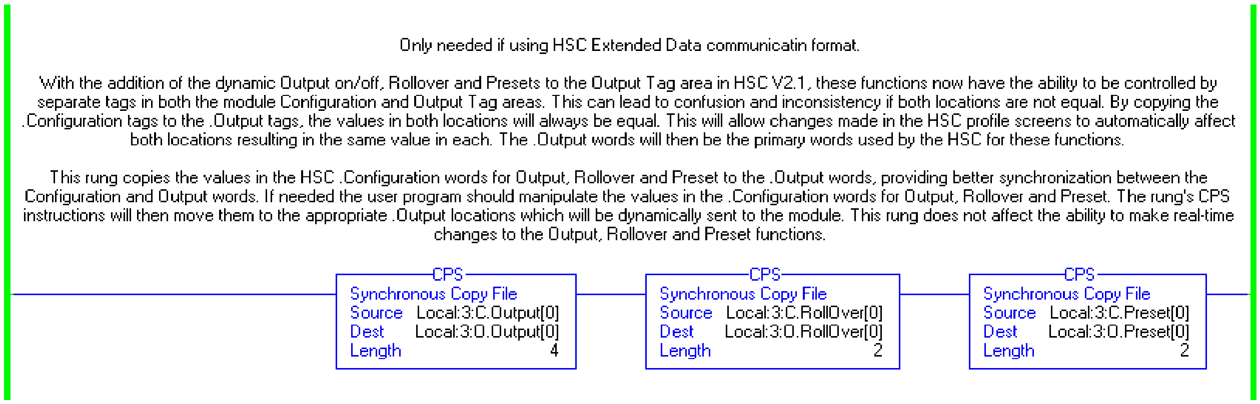


4. Drag-and-drop 'File Synchronous Copy' CPS onto the first rung.
5. Type this information:
   - Source -- Local:3:C.Output[0]
   - Dest -- Local:3:O.Output[0]
   - Length -- 4 (this is the size of the array with four outputs: 0, 1, 2, 3)

Your routine should look like this example for a 1756-HSC module in a slot.



6. Repeat step 4 and step 5 to add two more CPS commands to the same rung.
7. Type the information as shown in the example.



Electronic Keying

When you create a new module, you can choose how specific the keying must be when a module is inserted into the 1756-HSC module's slot in the chassis.

IMPORTANT	Modules that are using Major Revision 3.*x* or later with programming software versions 15...17 must use Compatible Keying. You must upgrade to version 18 if Exact Match is required.

The electronic keying feature automatically compares the expected module, as shown in the I/O Configuration tree, to the physical module before I/O communication begins. You can use electronic keying to help prevent communication to a module that does not match the type and revision expected.

For each module in the I/O Configuration tree, the user-selected keying option determines if, and how, an electronic keying check is performed. Typically, three keying options are available.

- Exact Match
- Compatible Keying
- Disable Keying

You must carefully consider the benefits and implications of each keying option when selecting between them. For some specific module types, fewer options are available.

Electronic keying is based on a set of attributes unique to each product revision. When a Logix 5000 controller begins communicating with a module, this set of keying attributes is considered.

Keying Attributes

Attribute	Description
Vendor	The manufacturer of the module, for example, Rockwell Automation/Allen-Bradley.
Product Type	The general type of the module, for example, communication adapter, AC drive, or digital I/O.
Product Code	The specific type of module, represented by its catalog number, for example, 1756-HSC.
Major Revision	A number that represents the functional capabilities and data exchange formats of the module. Typically, although not always, a later (higher) Major Revision supports at least all data formats supported by an earlier (lower) Major Revision of the same catalog number and, possibly, additional ones.
Minor Revision	A number that indicates the module's specific firmware revision. Minor Revisions typically do not impact data compatibility but can indicate performance or behavior improvement.

You can find revision information on the General tab of a module's Properties dialog box.

General Tab

IMPORTANT	Changing electronic keying selections online may cause the I/O communication connection to the module to be disrupted and may result in a loss of data.

Exact Match

Exact Match keying requires all keying attributes, that is, Vendor, Product Type, Product Code (catalog number), Major Revision, and Minor Revision, of the physical module and the module created in the software to match precisely in order to establish communication. If any attribute does not match precisely, I/O communication is not permitted with the module or with modules connected through it, as in the case of a communication module.

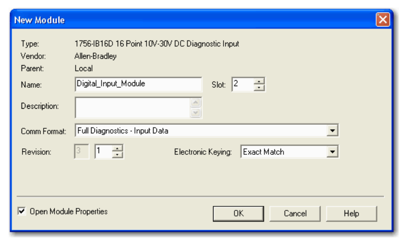
Use Exact Match keying when you need the system to verify that the module revisions are exactly as specified in the project, such as for use in highly-regulated industries.

Exact Match keying is also necessary to enable Automatic Firmware Update for the module via the Firmware Supervisor feature from a Logix 5000 controller.

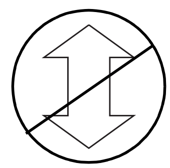
EXAMPLE In this scenario, **Exact Match keying prevents I/O communication**:

The module configuration is for a 1756-IB16D module with module revision 3.1. The physical module is a 1756-IB16D module with module revision 3.2. In this case, communication is prevented because the Minor Revision of the module does not match precisely.

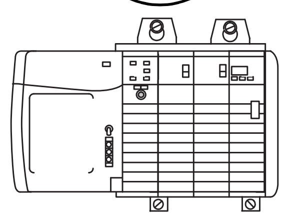
Module Configuration
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IB16D
Major Revision = 3
Minor Revision = 1



Communication is prevented.



Physical Module
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IB16D
Major Revision = 3
Minor Revision = 2



IMPORTANT Changing electronic keying selections online may cause the I/O Communication connection to the module to be disrupted and may result in a loss of data.

Compatible Keying

Compatible Keying indicates that the module determines whether to accept or reject communication. Different module families, communication adapters, and module types implement the compatibility check differently based on the family capabilities and on prior knowledge of compatible products.

Compatible Keying is the default setting. Compatible Keying allows the physical module to accept the key of the module configured in the software, provided that the configured module is one the physical module is capable of emulating. The exact level of emulation required is product and revision specific.

With Compatible Keying, you can replace a module of a certain Major Revision with one of the same catalog number and the same or later, that is higher, Major Revision. In some cases, the selection makes it possible to use a replacement that is a different catalog number than the original. For example, you can replace a 1756-CNBR module with a 1756-CN2R module.

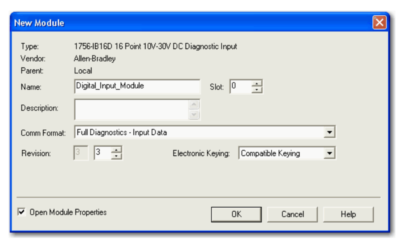
Release notes for individual modules indicate the specific compatibility details.

When a module is created, the module developers consider the module's development history to implement capabilities that emulate those of the previous module. However, the developers cannot know future developments. Because of this, when a system is configured, we recommend that you configure your module by using the earliest, that is, lowest, revision of the physical module that you believe will be used in the system. By doing this, you can avoid the case of a physical module rejecting the keying request because it is an earlier revision than the one configured in the software.

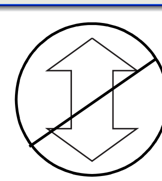
EXAMPLE In this scenario, **Compatible Keying prevents I/O communication**:

The module configuration is for a 1756-IB16D module with module revision 3.3. The physical module is a 1756-IB16D module with module revision 3.2. In this case, communication is prevented because the minor revision of the module is lower than expected and may not be compatible with 3.3.

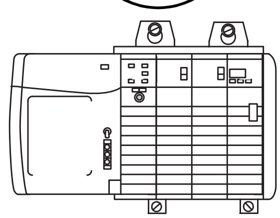
Module Configuration
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IB16D
Major Revision = 3
Minor Revision = 3



Communication is prevented.



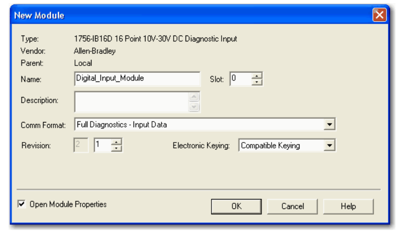
Physical Module
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IB16D
Major Revision = 3
Minor Revision = 2



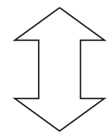
EXAMPLE In this scenario, **Compatible Keying allows I/O communication**:

The module configuration is for a 1756-IB16D module with module revision 2.1. The physical module is a 1756-IB16D module with module revision 3.2. In this case, communication is allowed because the major revision of the physical module is higher than expected and the module determines that it is compatible with the prior major revision.

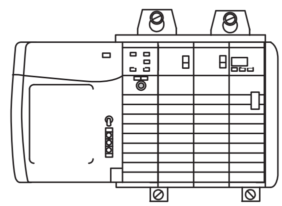
Module Configuration
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IB16D
Major Revision = 2
Minor Revision = 1



Communication is allowed.



Physical Module
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IB16D
Major Revision = 3
Minor Revision = 2



IMPORTANT Changing electronic keying selections online may cause the I/O communication connection to the module to be disrupted and may result in a loss of data.

Disabled Keying

Disabled Keying indicates the keying attributes are not considered when attempting to communicate with a module. Other attributes, such as data size and format, are considered and must be acceptable before I/O communication is established. With Disabled Keying, I/O communication may occur with a module other than the type specified in the I/O Configuration tree with unpredictable results. We generally do not recommend using Disabled Keying.

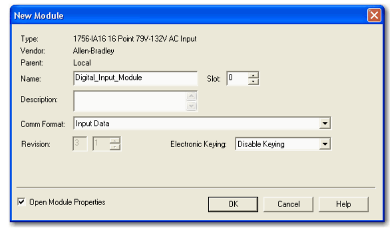
ATTENTION: Be extremely cautious when using Disabled Keying; if used incorrectly, this option can lead to personal injury or death, property damage, or economic loss.

If you use Disabled Keying, you must take full responsibility for understanding whether the module being used can fulfill the functional requirements of the application.

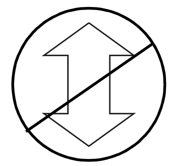
EXAMPLE In this scenario, **Disable Keying prevents I/O communication**:

The module configuration is for a 1756-IA16 digital input module. The physical module is a 1756-IF16 analog input module. In this case, **communication is prevented because the analog module rejects the data formats that the digital module configuration requests**.

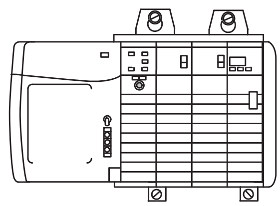
Module Configuration
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IA16
Major Revision = 3
Minor Revision = 1



Communication is prevented.



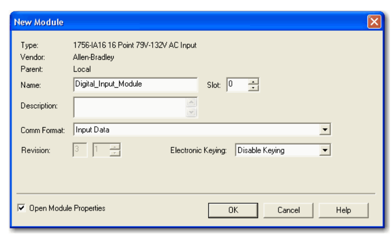
Physical Module
Vendor = Allen-Bradley
Product Type = Analog Input Module
Catalog Number = 1756-IF16
Major Revision = 3
Minor Revision = 2



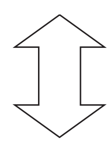
EXAMPLE In this scenario, **Disable Keying allows I/O communication**:

The module configuration is for a 1756-IA16 digital input module. The physical module is a 1756-IB16 digital input module. In this case, communication is allowed because the two digital modules share common data formats.

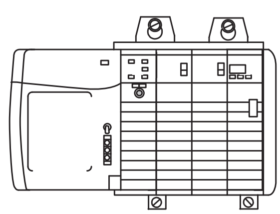
Module Configuration
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IA16
Major Revision = 2
Minor Revision = 1



Communication is allowed.



Physical Module
Vendor = Allen-Bradley
Product Type = Digital Input Module
Catalog Number = 1756-IB16
Major Revision = 3
Minor Revision = 2

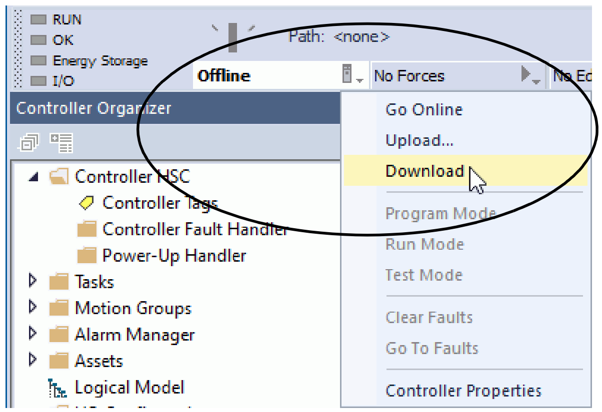


Download Configuration to the 1756-HSC Module

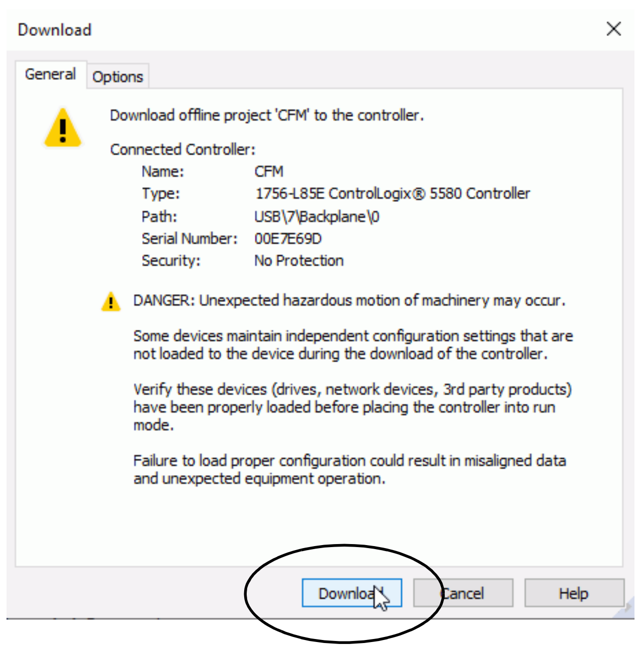
After you have changed the configuration data for a module, the change does not take effect until you download the new program that contains that information. This downloads the entire program to the controller, overwriting any existing programs.

Follow these steps to download the new program.

1. To access the Download option, click the pull-down menu.
2. Click Download.



3. When the Download dialog box appears, read the text and click Download.



This completes the download process.

Notes:

Module Diagnostics

Introduction

This chapter describes error codes and fault conditions to help you troubleshoot the 1756-HSC module.

1756-HSC Error Codes

Errors are displayed on the Connection tab of the Module Properties dialog box in the programming software and in the .EXERR field of the message variable when you reconfigure the module.

The final number of each code represents the channel number that is reporting the error: 1 = channel 0 and 2 = channel 1.

For example, code 16#0011 means that a BADCOUNT has occurred on channel 0.

This table lists possible errors on your 1756-HSC module.

Table 5 - Counter Configuration Errors

Error Code	Definition
16#0011, 16#0012	**BADCOUNT** - Occurs if you set the operational mode to a value of seven or greater
16#0021, 16#0022	**BADSTORE** - Occurs if you set the Storage mode to a value of six or greater or if the Storage mode is set to a nonzero value in Frequency mode
16#0031, 16#0032	**BADROLL** - Occurs if you program a nonzero value in Period Rate/ Continuous Rate frequency modes or if you program a value greater than 0xfffffe
16#0041, 16#0042	**BADPRESET** - Occurs if you program a nonzero value in Period Rate/ Continuous Rate frequency modes or if you program a value equal to or greater than the rollover value
16#0051, 16#0052	**BADSCALE** - Occurs if you take any of these actions in the Counter/ Frequency modes: • Program a value greater than 2000 in Frequency mode • Program a value that is not an integer multiple of 10 in Frequency mode • Program a value whose scaler is not equal to 0 Occurs in Period Rate/Continuous Rate modes if the scaler is not 0, 1, 2, 4, 8, 16, 32, 64, 128, 256

Table 6 - Output Configuration Errors

Error Code	Definition
16#0061, 16#0062, 16#0063, 16#0064	**BADTIE** - Occurs if you attempt to tie an output to a nonexistent counter or if you attempt to tie the output to two counters; valid entries are 0x0, 0x1,or 0x2
16#0071, 16#0072, 16#0073, 16#0074	**BADFAULT** - Occurs if you configure the module for something other than On, Off, or Continue or if the 1756-HSC module receives a communication fault in Run mode; valid entries are 0x0, 0x1, and 0x2
16#0081, 16#0082, 16#0083, 16#0084	**BADPROG** - Occurs if you configure the module for something other than On, Off, or Continue when transitioning from Run mode to Program mode; valid entries are 0x0, 0x1, and 0x2
16#0091, 16#0092, 16#0093, 16#0094	**BADWINDOW** - Occurs if the On/Off values are greater than the 0xfffffe value

Programming Software Diagnostics

In addition to the Status Indicator display on the module, the programming software alerts you to fault conditions.

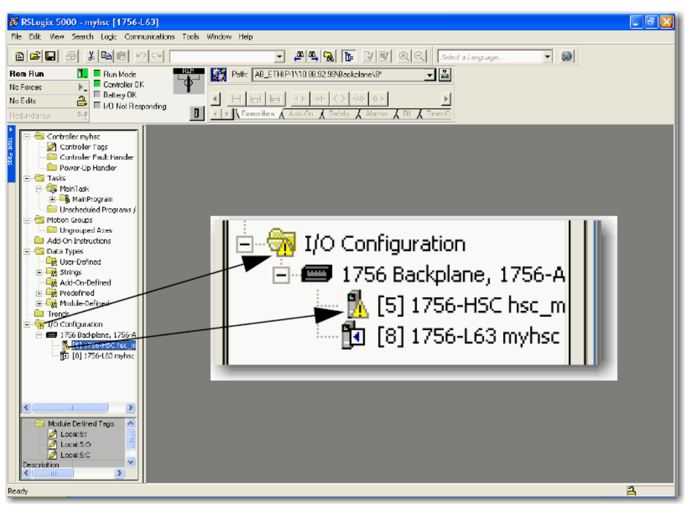
See page 77 for details on status indicators.

Fault conditions in the programming software are reported in one of four ways.

- Warning signal on the main window next to the module - This occurs when the connection to the module is broken.
- Fault message in a window's status line.
- Notification in the Tag Editor - General module faults also are reported in the Tag Editor. Diagnostic faults are reported only in the Tag Editor.
- Status on the Module Info tab.

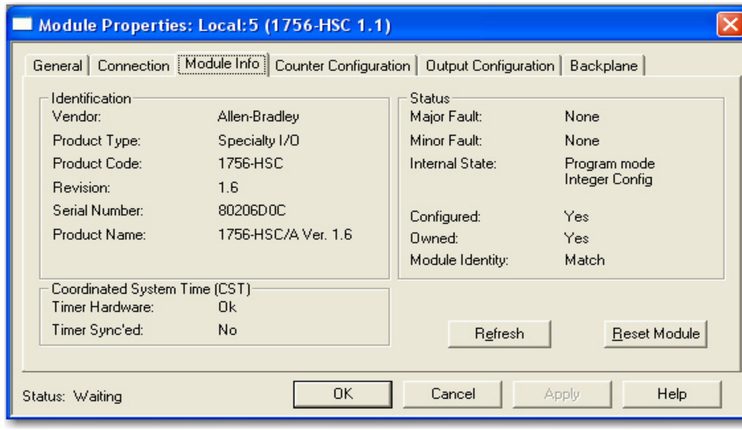
These windows display fault notifications.

Warning Signal on Main Window



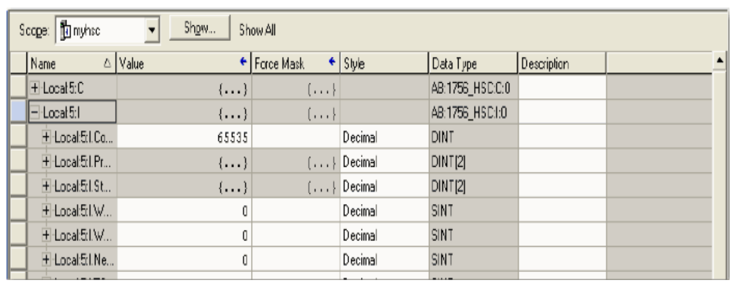
A warning icon displays in the I/O Configuration tree when a communication fault occurs.

Fault Message in Status Line



On the Module Info tab, in the Status section, the Major and Minor Faults are listed along with the Internal State of the module.

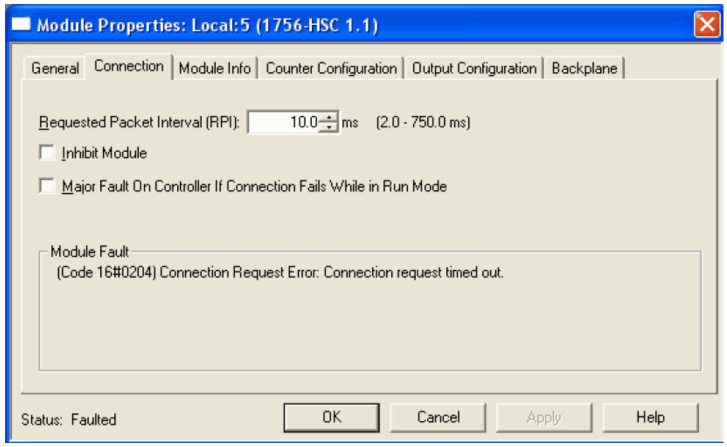
Notification in Tag Editor



The Value field shows 65535 to indicate that the module connection has been broken.

Fault Type Determination

When you are monitoring a module's configuration properties in the programming software and receive a Communication fault message, the Connection tab lists the type of fault under Module Fault.



Troubleshoot the Module

This table describes troubleshooting procedures for the 1756-HSC module.

Description	Take this action
The present count does not move into the stored count when Z-input is pulsed.	1. Make sure that the Storage mode is not set to 0. 2. Make sure that the Z-input pulse width is within the specification (that is, the pulse width is long enough).
The counter does not increment or decrement when there are pulses on the A-input or B-input.	1. Make sure that there is a value on the Rollover register. 2. Make sure that the module is not configured for Frequency mode.
The output does not turn On when the On/Off window is selected and the counter value is within the On/Off window?	Make sure the C.Output[x].ToThisCounter is not set to 0 (which means 'Not Tied to Counter').
The outputs do not turn off despite a module fault.	Make sure the C.Output[x].FaultMode is not set to 1 (which means 'Outputs Turn Off' during a fault).
The module outputs remain On when the owner-controller is in Program mode	Make sure C.Output[x].FaultMode is not set to 1 (which means 'Outputs Turn Off' during a fault.
An output must be forced On.	Set the O.OutputControl[x] bit to 2.
An output must be forced Off.	Set the O.OutputControl[x] bit to 1.

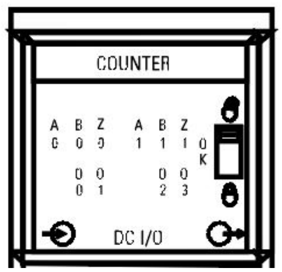
Status Indicators

Introduction

Each module has indicators that show input and output status. Status indicators are on the front of the module.

Status Indicators

The 1756-HSC module uses these status indicators.



The table describes what the status indicators represent, and corrective measures.

Status Indicator	Display	Means	Action Taken
Input (A, B, Z)	Off	Input turned off Input not currently used Wire is disconnected	If you must use the input, check wiring connections
	On/Yellow	Input turned on	None
Output (0, 1, 2, 3)	Off	Output turned off Output not currently used	If you must use the output, check input wiring connections and your ladder program
	On/Yellow	Output turned on	None

Notes:

Data Structures

Configuration, Output, Input

There are three categories of 1756-HSC data structures.

- **Configuration** - structure of data that is sent from the controller to the module upon power-up or user-initiated reconfigure command that defines the HSC module behavior.
- **Output** - structure of data that is continually sent from the controller to the module that can modify the 1756-HSC module behavior.
- **Input** - structure of data that is continually sent from the module to the controller containing the current, operational state of the module.

This section describes the tags that comprise each of these data structures.

Configuration Structure

You must use configuration tags to alter module configuration. The table lists and defines the module configuration tags.

IMPORTANT	Some of the tags in the table below are followed by an '*x*' or a '*y*'. The '*x*' indicates that the same tag information applies for Channel 0 and Channel 1 on the module. The '*y*' indicates that the same tag information applies for the four outputs (0…3) on the module.

Table 7 - 1756-HSC Module Configuration Tags

Name	Data Type	Style	Definition	Change During Operation[1]
C.ProgToFaultEn	BOOL		Determines outputs' state if connection is lost when the owner-controller is in Program mode. 0 = Outputs use Program mode settings. 1 = Outputs use Fault mode settings.	Yes
C.Rollover[*x*] Å	DINT	Decimal	Designates the Rollover value. Values range from 0…16,777,214. **IMPORTANT**: This value must = 0 when you are using Period Rate and Continuous Rate modes.	Yes
⊕ - This setting may be overridden by the output tag setting. See page 18 and page 19 in Chapter 2 for details.				
C.Preset[*x*] Å	DINT	Decimal	Designates the Preset value. Module begins counting at this value. Values range from 0…16,777,214. **IMPORTANT**: This value cannot be ≥ the Rollover value. This value also must = 0 when you are using Period Rate and Continuous Rate modes.	Yes
C.Scaler[*x*]	INT	Decimal	When using Frequency mode, set this value as a multiple of 10 ms between 10-2000. If in Frequency mode and the value is 0, the module defaults to 1 second time base. In Period Rate and Continuous Rate modes, the scaler determines the number of half-cycles of the incoming pulse train in the sample period. The 4 MHz count value in the Present Value tag is incremented within the pulse train set by the Scaler tag. Acceptable numbers for the scaler are: 1, 2, 4, 8, 16, 32, 64, 128, 256. There is one Scaler value for each counter. The default value for each Scaler is 1; a 0 is equivalent to 1.	Yes

Table 7 - 1756-HSC Module Configuration Tags

Name	Data Type	Style	Definition	Change During Operation(1)
C.OperationalMode[*x*]	SINT	Decimal	Designates an operational mode. 0 = Counter mode. 1 = Encoder x1 mode. 2 = Encoder x4 mode. 3 = Counter not used. 4 = Frequency mode. 5 = Period Rate mode. 6 = Continuous Rate mode.	No
C.StorageMode[*x*]	SINT	Decimal	Designates a storage mode. 0 = No store mode. 1 = Store and continue mode. 2 = Store, wait, and resume mode. 3 = Store and reset, wait, and start mode. 4 = Store and reset, and start mode.	Yes
C.ZInvert.*x*	BOOL	Decimal	Designates whether the Z input is inverted. 0 = Do not invert Z input. 1 = Invert Z input.	Yes
C.FilterA.*x*	BOOL	Decimal	Designates whether channel A uses a filter. 0 = Do not use filter. 1 = Use 50 Hz. Refer to Digital Filter on page 62.	Yes
C.FilterB.*x*	BOOL	Decimal	Designates whether channel B uses a filter. 0 = Do not use filter. 1 = Use 50 Hz. Refer to Digital Filter on page 62	Yes
C.FilterZ.*x*	BOOL	Decimal	Designates whether channel Z uses a filter. 0 = Do not use filter. 1 = Use 50 Hz. Refer to Digital Filter on page 62	Yes
⊕ - This setting may be overridden by the output tag setting. See page 18and page 19 in Chapter 2 for details.				
C.Output[*y*].ONValue	DINT	Decimal	Designates the value at which an output turns On. Values range from 0…16,777,214.	Yes
C.Output[*y*].OFFValue ⊕	DINT	Decimal	Designates the value at which an output turns OFF. Values range from 0…16,777,214.	Yes
C.Output[y].ToThisCounter ⊕	SINT	Decimal	Designates the counter to which an output is tied. 0 = Not tied to counter. 1 = Tied to counter (0). 2 = Tied to counter (1).	Yes
C.Output[*y*].FaultMode ⊕	SINT		Selects the behavior an output takes if a controller fault occurs. 0 = Outputs turn OFF. 1 = Outputs turn ON. 2 = Counter continues to determine outputs operation.	Yes
C.Output[*y*].ProgMode ⊕	SINT		Selects the behavior that an output takes when transitioning into Program Mode. 0 = Outputs turn OFF. 1 = Outputs turn ON. 2 = Counter continues to determine outputs operation.	Yes

⊕ - This setting may be overridden by the output tag setting. See page 18 and page 19 in Chapter 2 for details.

(1) Configuration tags can be changed during operation by using a message Module Reconfigure command.

Output Structure

You must use output tags to change module configuration during operation. The table lists and defines the module output tags.

IMPORTANT Some of the tags in the table below are followed by an 'x' or a 'y'. The 'x' indicates that the same tag information applies for Channel 0 and Channel 1 on the module. The 'y' indicates that the same tag information applies for the four outputs (0…3) on the module.

Table 8 - 1756-HSC Module Output Tags

Name	Type	Style	Definition	Change During Operation
O.ResetCounter.*x*	BOOL	Decimal	Resets counter and begins counting. The reset occurs only on a zero to one transition. 0 = Do not reset. 1 = Reset.	Yes
O.LoadPreset.*x*	BOOL	Decimal	Loads preset count value into counter and begins counting. The preset occurs only on a zero to one transition. 0 = No action. 1 = Load preset.	Yes
O.ResetNewDataFlag.x	BOOL	Decimal	Handshaking bit resets data in the I.NewDataFlag.*x* bit after it has been processed. The reset occurs only on a zero to one transition. 0 = Do not reset the flag. 1 = Reset the flag.	Yes
O.OutputControl[*y*]	SINT	Decimal	Overrides current state of output. 0 = Normal operation. 1 = Override value to Off. 2 = Override value to On.	Yes
O.RollOver[*x*] ⊕	DINT	Decimal	Designates the Rollover value. Values range from 0…16,777,214. **IMPORTANT**: This value must = 0 when you are using Period Rate or Continuous Rate modes.	Yes
O.Preset[*x*] ⊕	DINT	Decimal	Designates the Preset value. Module begins counting at this value. Values range from 0…16,777,214. **IMPORTANT**: This value cannot be > the Rollover value. This value also must = 0 when you are using Period Rate or Continuous Rate modes	Yes
O.Output.[y].OnValue ⊕	DINT	Decimal	Designates the value at which an output turns On. Values are 0…16,777,214.	Yes
O.Output.[y].OffValue ⊕	DINT	Decimal	Designates the value at which an output turns Off. Values are 0…16,777,214.	Yes
O.Output.[y].ToThisCounter ⊕	SINT	Decimal	Designates counter to which this output is tied. 0 = Not tied to counter. 1 = Tied to counter (0). 2 = Tied to counter (1).	Yes
O.Output.[y].FaultMode ⊕	SINT	Decimal	Selects the behavior that this output takes if a controller fault occurs. 0 = Outputs turn Off. 1 = Outputs turn On. 2 = Counter continues to determine outputs operation.	Yes
O.Output.[y].ProgMode ⊕	SINT	Decimal	Selects the behavior that this output takes when the owner transitions into Program mode. 0 = Outputs turn Off. 1 = Outputs turn On. 2 = Counter continues to determine outputs operation.	Yes

⊕ - If this setting is ever seen by the module as a nonzero value, it overrides the corresponding configuration tag setting.
See page 18 and page 19 in Chapter 2 for details.

Input Structure

You must use input tags to monitor module status. The table lists and defines the module input tags.

IMPORTANT	Some of the tags in the table below are followed by an '*x*' or a '*y*'. The '*x*' indicates that the same tag information applies for Channel 0 and Channel 1 on the module. The '*y*' indicates that the same tag information applies for the four outputs (0…3) on the module.

Table 9 - 1756-HSC Module Input Tags

Name	Type	Style	Definition
I.CommStatus	DINT	Decimal	Displays module connection status. 0 = Module is connected. 65535 = Module is not connected.
I.PresentValue[*x*]	DINT	Decimal	Displays the current count in the Counter and Encoder modes. Displays counts per sample in Frequency, Period Rate, or Continuous Rate modes. Values range from 0…16,777,214.
I.StoredValue[*x*]	DINT	Decimal	Displays the Stored Count value in the Counter and Encoder modes. Displays the current frequency in Hz in Frequency, Period Rate, and Continuous Rate modes. Values range from 0…16,777,214.
I.Totalizer[*x*]	DINT	Decimal	Displays the current frequency in Hz in Counter and Encoder modes. Displays the total accumulated counts in Frequency, Period Rate, and Continuous Rate modes. Values range from 0…16,777,214.
I.WasReset.*x*	BOOL	Decimal	Displays whether the counter was reset. 0 = Counter was not reset. 1 = Counter was reset.
I.WasPreset.*x*	BOOL	Decimal	Displays whether the Preset value for the counter was loaded. 0 = Preset value was not loaded. 1 = Preset value was loaded.
I.NewDataFlag.*x*	BOOL	Decimal	Displays whether the module received new data on the last scan. 0 = No new data was received. 1 = New data was received.
I.ZState.*x*	BOOL	Decimal	Displays the Z state. 0 = Gate is low. 1 = Gate is high.
I.OutputState.y	BOOL	Decimal	Displays the output state. 0 = Output is low. 1 = Output is high.
I.IsOverridden.y	BOOL	Decimal	Determines whether output is overridden. 0 = Output is using On-Off window. 1 = Output is overridden.
I.CSTTimestamp	DINT[2]		Displays the coordinated system timestamp of the last sample in microseconds.

Module History

Introduction

The table shows the compatible hardware series, firmware revisions, and software versions for the 1756-HSC modules.

IMPORTANT	You can install modules to replace modules of the same series or earlier. For example, you can install a 1756-HSC/B, firmware revision 3.x, to replace a 1756-HSC/A, firmware revision 2.x. However, if the module series and firmware revision on the module in the chassis are not identical to the module configuration for the same slot in the Logix Designer application, Exact Keying is not supported.

Table 10 - Available Firmware and Software Configurations

If you have module hardware	Using firmware revision	And your desired functionality is[1]	Use this version of the programming software[2]	Notes
Series D	5.*x*	Multiple Digital Filters[3]	Same as Series B, firmware revision 3.*x*	At the initial release of this module series and firmware revision, you cannot choose firmware revision 4.x (Series C) nor 5.x (Series D) in your Logix Designer application project. You must use firmware revision 3.x or earlier and either Compatible Keying or Disable Keying. To choose firmware revision 4.x or later, you must install an Add-on Profile when it becomes available. We recommend, that you check the Rockwell Automation Product Compatibility Download Center (PCDC) at http://compatibility.rockwellautomation.com/Pages/home.aspx for an AOP.
Series C	4.*x*			
Series B	3.x	• Period/Continuous Rate • Totalizer	Version 18 and later => Select Major Revision 3 and HSC Data-extended Comm Format	N/A
Series A	2.*x*	Rollover and Preset in Output Tags	Version 18 and later => Select Major Revision 2 and HSC Data-extended Comm Format	To configure the functionality, you can use the Module Properties dialog box or the module tags in the programming software. The Totalizer tags not active.
			Versions earlier than 18 => Use generic profile/HSC ACD file[4]	To configure the functionality, you must use the module tags in the programming software.
	1.*x*	Original[5]	Version 15 and later => Full profile support	To configure the functionality, you can use the Module Properties dialog box or the module tags in the programming software.
			Versions earlier than 15 => Thin profile/tags only	To configure the functionality, you must use the module tags in the programming software.

(1) Each module series supports the same functionality as previous series and what is listed here.

(2) When you use functionality that is not listed for a module, the same programming software requirements apply as the first time the functionality is listed in the table.
For example, a series C, firmware revision 4.x, module supports Rollover and Preset in Output Tags functionality that is first listed for series A, firmware revision 2.x. If you are using the series C, firmware revision 4.x, module with a software version earlier than 18, you must use the generic profile/HSC ACD file option to use Rollover and Preset in Output Tags.

(3) For more information on how to set the digital filter, see page 62.

(4) File is at http://samplecode.rockwellautomation.com.

(5) **IMPORTANT**: 'Original' represents the four primary modes of operation that are initially designed for the 1756-HSC/A module, firmware revision 1.*x*. These modes are Counter, Encoder x1, Encoder x4, and Frequency.

Profile Overview

There are three profiles available for programming your 1756-HSC module depending on your module's firmware, software, and the desired functionality. As shown in the table on page 83, you will use one of these profiles:

- Full profile
- Thin profile
- Generic profile

Full profile support, for software versions 15 and later, include separate Counter and Output Configuration tab dialog boxes that make it easier to enter 1756-HSC operational data via a user-interface that provides error checking and user-friendly data entry. See Chapter 5 for configuring a module with a full profile.

This section describes procedures for using a generic profile and modifying tags with a thin profile.

Software versions before version 15 do not include a user-interface that provides error checking and user-friendly data entry. Instead, configuration tags have to be manually entered during the initial set-up. This is referred to as a thin profile.

A generic profile lets a prior software version use the functionality that's available only for the latest software. For example, a module with software version 13 could use a generic profile to gain the output functionality, available in software version 18, that lets you modify the outputs in real time by changing the rollover and preset values in the output tags.

A generic profile creates non-specific tags, with a name related to the modules slot location. The tag names that are created do not reference any specific 1756-HSC module terminology.

IMPORTANT	To download firmware revisions for your module, go to http://www.rockwellautomation.com/support and choose Downloads. Do not downgrade your module's firmware from firmware revision 3.*x* to 2.*x* or 1*x*. Attempting to downgrade a module's firmware from 3.*x* to 2.*x* or 1*x* will irreversibly damage the module. 1756-HSC modules at firmware revision 2.*x* or 1*x* cannot be flash upgraded to any firmware revision 3.*x* because 3.*x* modules have a hardware update.

Configure a Generic Profile

You use a generic profile if your application requires the use of rollover and preset in output tags and:

- your programming software is earlier than version 18 for either module series A or B.
- your programming software is earlier than version 18 for two additional module Series B modes: Period Rate frequency, Continuous Rate frequency.

A generic profile copies an .ACD file that contains the identical tag structure that is included in software version 18. You must use the 1756-Generic Profile as indicated in the procedures.

Ladder logic lets you copy the module information between the user-defined data types and the module-defined data types to allow the controller and the module to exchange data.

IMPORTANT	Before beginning configuration, you should download this file for either the Series A or Series B application, 'Generic Connection for the 1756-HSC Ser A Rev 2.1/Ser B Rev 3.X'. This file is available at the Rockwell Automation Sample Code website (http://samplecode.rockwellautomation.com).

After you have downloaded and opened the sample code .ACD file, follow these steps to create a generic profile.

1. In the programming software, open or create a project for your controller.

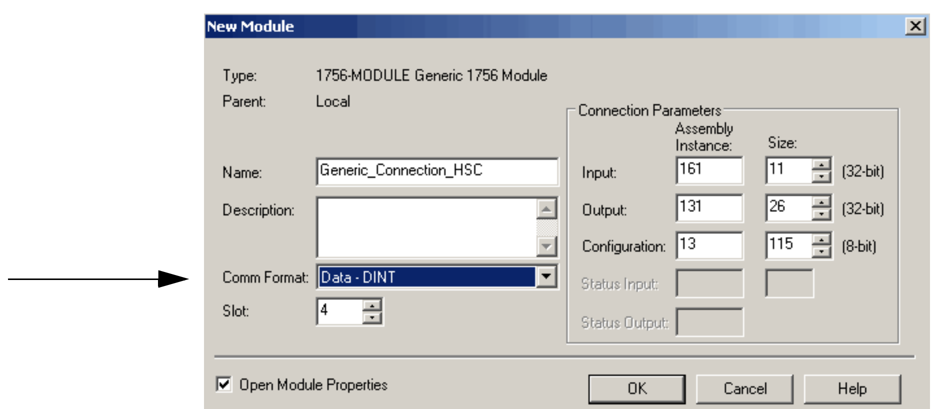
   From the File menu, choose New to access the New Controller dialog box to create a controller name.

2. On the Controller Organizer, right-click I/O Configuration and choose New Module.

   The Select Module window appears.

3. Click the '+' next to Other to display a list of I/O modules.
4. Select a generic module and click OK.

   The New Module dialog box appears.



5. Type a name for the module in the Name box.
6. In the Comm Format pull-down menu, choose Data-DINT.

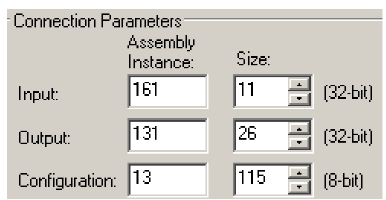
IMPORTANT	**ATTENTION:** The Data-DINT communication format must be chosen to use the correct connection parameters as shown in the sample New Module dialog box. Also, in the generic module configuration, configuration data is created as an array of bytes. User-defined tags are copied over the array that is specified by the communication format selection.

7. Enter a module slot number that is specific to your chassis configuration.

   In the right-side column of the New Module dialog box, there are entry fields for the Connection Parameters. You must set connection parameters for input, output, and configuration for the owner-controller to exchange information with the module.

   The Assembly Instance is a number that identifies what the data looks like that is transferred between the owner-controller and an I/O module.

   The Size box determines how large the connections are between the owner-controller and the I/O module. Connections are sent in sizes matching the selected communication format data type.
8. Enter Connection Parameters exactly as shown in the example below.

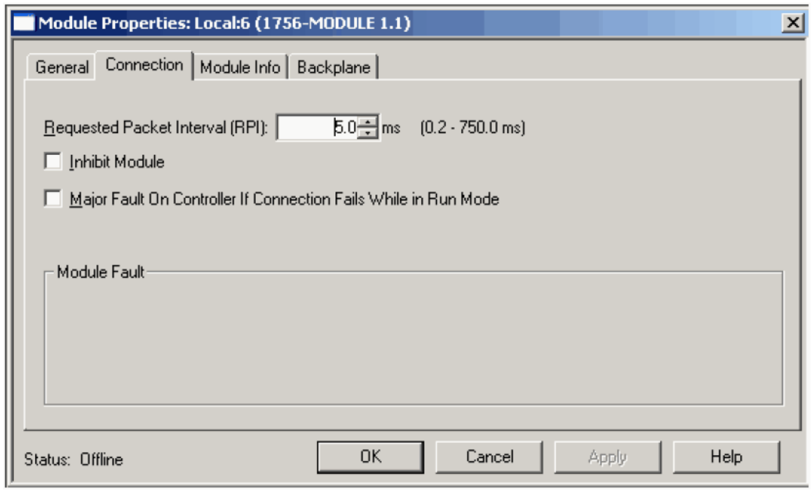


IMPORTANT	The generic connection works only with the matching Assembly Instance and Size parameters that are listed above for the input, output, and configuration settings.

9. Check Open Module Properties to access additional dialog boxes to enter information.

10. Click OK.

    The Module Properties dialog box appears in the Connection tab.



11. Use the default RPI value and check Inhibit Module.
12. Click OK.
13. On the Controller Organizer, right-click I/O Configuration and choose New Module.

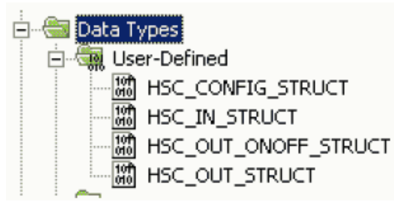
    Add a 1756-HSC module and assign it to an unused chassis slot in your I/O Configuration tree.

    This module will not be used, but the configuration of this profile will aid later in the configuration of the generic module.
14. Click OK.

    The ladder logic copies the module configuration from this profile to the generic profile.
15. Click OK.
16. Save the project.

Copy ACD file

1. Open the copied .ACD file.
2. In the Controller Organizer of the sample project, extend the User-Defined Data Types to view the 1756-HSC data types.



3. Copy and paste each of the User-Defined Data Types (UDTs), one at a time, into your project.
4. Do one of the following to create tags and specify the appropriate 1756-HSC module UDTs for each (HSC_CONFIG, HSC_IN_STRUCT, and HSC_OUT_STRUCT).

Define Your Own Tags

a. To define your own tags, double-click Controller Tags on the Controller Organizer.
b. Click the Edit Tags tab at the bottom of the Controller Tags window.
c. In the blank entry field at the bottom of the window, enter your tag name and data type.

Use Default Tags

a. To use default tags that were imported from the sample download at the start of these procedures, double-click Controller Tags on the Controller Organizer.

b. Click the '+' sign to expand and review each of the three UDTs (HSC_CONFIG, HSC_IN_STRUCT, HSC_OUT_STRUCT).

Name	Value	Force Mask	Style	Data Type
⊟HSC_CONFIG	{...}	{...}		HSC_CONFIG_S...
HSC_CONFIG.ProgToFaul...	0		Decimal	BOOL
⊞HSC_CONFIG.RollOver	{...}	{...}	Decimal	DINT[2]
⊞HSC_CONFIG.Preset	{...}	{...}	Decimal	DINT[2]
⊞HSC_CONFIG.Scaler	{...}	{...}	Decimal	INT[2]
⊞HSC_CONFIG.Operational...	{...}	{...}	Decimal	SINT[2]
⊞HSC_CONFIG.StorageMode	{...}	{...}	Decimal	SINT[2]
⊞HSC_CONFIG.ZInvert	0		Decimal	SINT
⊞HSC_CONFIG.FilterA	0		Decimal	SINT
⊞HSC_CONFIG.FilterB	0		Decimal	SINT
⊞HSC_CONFIG.FilterZ	0		Decimal	SINT

⊟HSC_IN	{...}	{...}		HSC_IN_STRUCT
⊞HSC_IN.CommStatus	0		Decimal	DINT
⊞HSC_IN.PresentValue	{...}	{...}	Decimal	DINT[2]
⊞HSC_IN.StoredValue	{...}	{...}	Decimal	DINT[2]
⊞HSC_IN.Totalizer	{...}	{...}	Decimal	DINT[2]
⊞HSC_IN.WasReset	0		Decimal	SINT
⊞HSC_IN.WasPreset	0		Decimal	SINT
⊞HSC_IN.NewDataFlag	0		Decimal	SINT
⊞HSC_IN.ZState	0		Decimal	SINT
⊞HSC_IN.OutputState	0		Decimal	SINT
⊞HSC_IN.IsOverridden	0		Decimal	SINT
⊞HSC_IN.CSTTimestamp	{...}	{...}	Decimal	DINT[2]

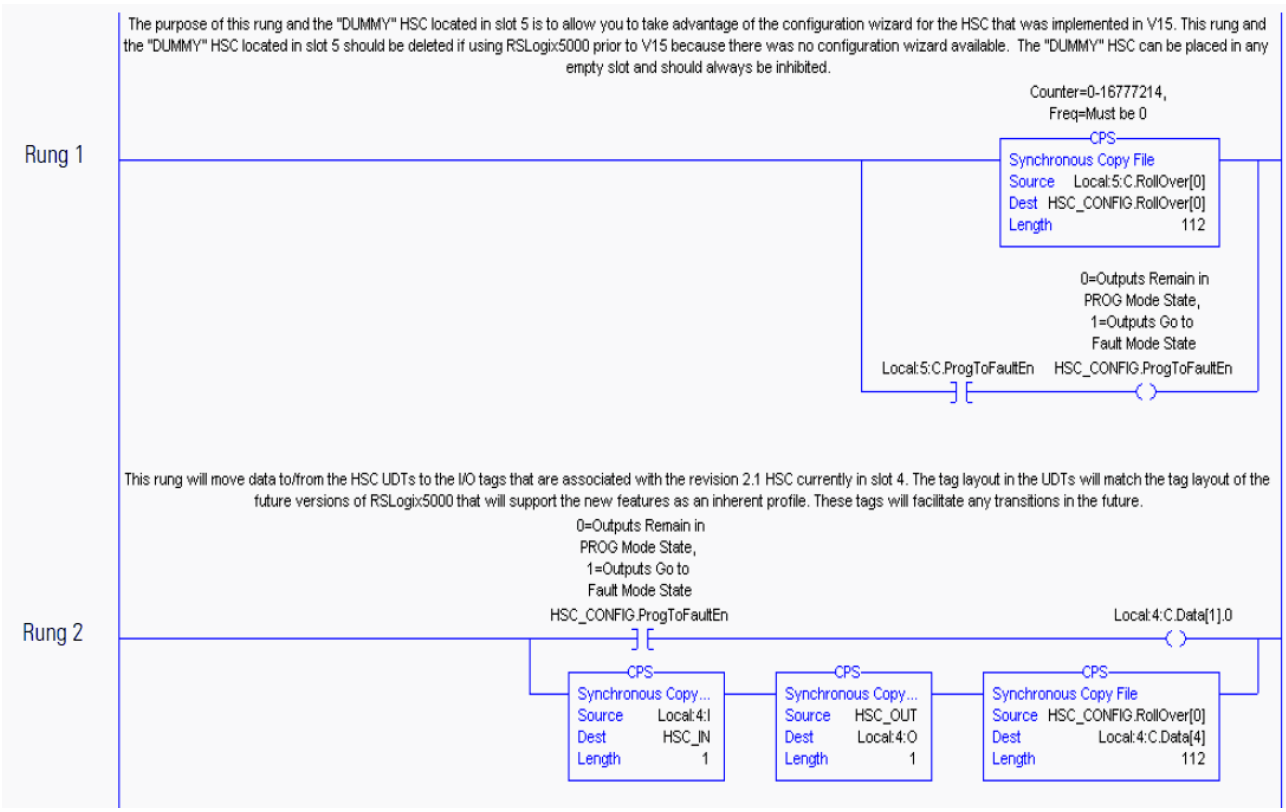
⊟HSC_OUT	{...}	{...}		HSC_OUT_STRU...
⊞HSC_OUT.ResetCounter	0		Decimal	SINT
⊞HSC_OUT.LoadPreset	0		Decimal	SINT
⊞HSC_OUT.ResetNewData...	0		Decimal	SINT
⊞HSC_OUT.OutputControl	{...}	{...}	Decimal	SINT[4]
⊞HSC_OUT.RollOver	{...}	{...}	Decimal	DINT[2]
⊞HSC_OUT.Preset	{...}	{...}	Decimal	DINT[2]
⊞HSC_OUT.Output	{...}	{...}		HSC_OUT_ONOF...

Add Ladder Logic Routines

Ladder logic copies the module information from the user-defined data types to the module-defined data types. Otherwise, the controller and the module cannot communicate.

Follow these necessary steps to copy the ladder logic routine from the example .ACD file.

1. On the Controller Organizer under Tasks, double-click Main Program.
2. Double-click the .ACD file to access the ladder logic.



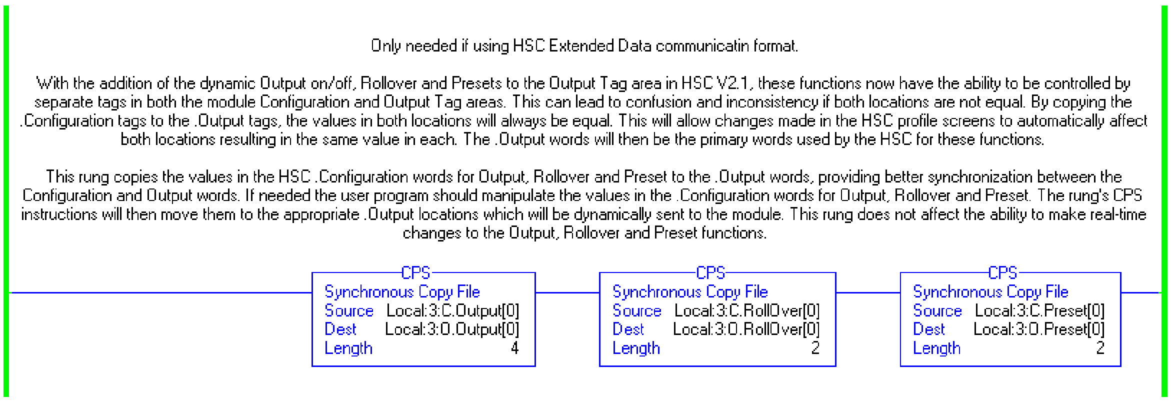
3. Paste the rungs into a routine of your 1756-HSC project.

4. If you are using programming software, version 13 or earlier, or you did not add an unused module in step 13, delete rung 1 of the copied and pasted ladder logic.

IMPORTANT	If you do not leave the unused module in your project, or you have no other 1756-HSC module in your project, you cannot export and then reimport the project as the module-defined tags will not import properly.

A ladder logic routine also is suggested if you are using the HSC Data-extended Comm Format. This option lets you change the output, rollover, and preset configuration settings in the output tags. The duplication of tag data could result in values being overridden when the HSC Data-extended Comm Format is selected.

The optional rung below coordinate the values that are entered in the configuration settings for rollover, preset, and output in the output tag settings. See page 64 in Chapter 5 for procedures.



IMPORTANT	The rung shown above copies the values in the HSC .Configuration words for Output, Rollover, and Preset to the .Output words, providing better synchronization between the Configuration and Output words. If needed, the user program should manipulate the values in the .Configuration words for Output, Rollover, and Preset. The rung's CPS instructions will then move them to the appropriate .Output locations, which will be dynamically sent to the module. This rung does not affect the ability to make real-time changes to the Output, Rollover, and Preset functions.

5. Save your program.

Upgrade Module to Software Version 18 and Later

Follow these steps to convert an older profile to a program with software version 18 and later.

1. Write down the module configuration tag data for the generic profile.

   You need this information for step 4.
2. Delete the generic profile module from your project in the I/O Configuration folder.
3. Create a new module by using the version 18 (or later) profile in the deleted generic profile slot.
4. Reenter the module configuration data that you wrote down in step 1 that matches the generic profile configuration.
5. Do a global search and replace of the prefix for each of the generic references with the tag prefix for the full profile.

   Examples:

- Replace 'HSC_IN' with 'Local:3.I' (for a local module in slot 3).
- Replace 'HSC_OUT' with 'Local:3:O' (for a local module in slot 3).
- Replace 'HSC_CONFIG' with 'Local:3:C' (for a local module in slot 3).

IMPORTANT	A global search and replace is needed only for those tags that are referenced in ladder logic. For example, if there is no configuration tag that is referenced in ladder logic, it's not necessary to perform a search and replace on the .C tags.

6. Download your program.
7. Go to Run mode to execute the ladder logic.

Edit Thin Profile Tags

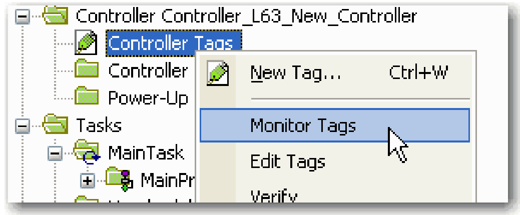
Use this section if you want your module running the original functionality and your version of the programming software is earlier than version 15. Original functionality includes the Counter, Encoder x1, Encoder x4, and Frequency modes.

Programming software earlier than version 15 does not have a user-interface for data entry. A thin profile requires that you manually enter operational modes and output settings in the Controller Tags window.

IMPORTANT	Firmware revision 2.*x* requires that both profiles (thin/full) for software versions 15…17 not have electronic keying set to Exact Match for compatibility with the 1.*x* firmware revision. You must upgrade to version 18 or later if Exact Match is required for electronic keying.

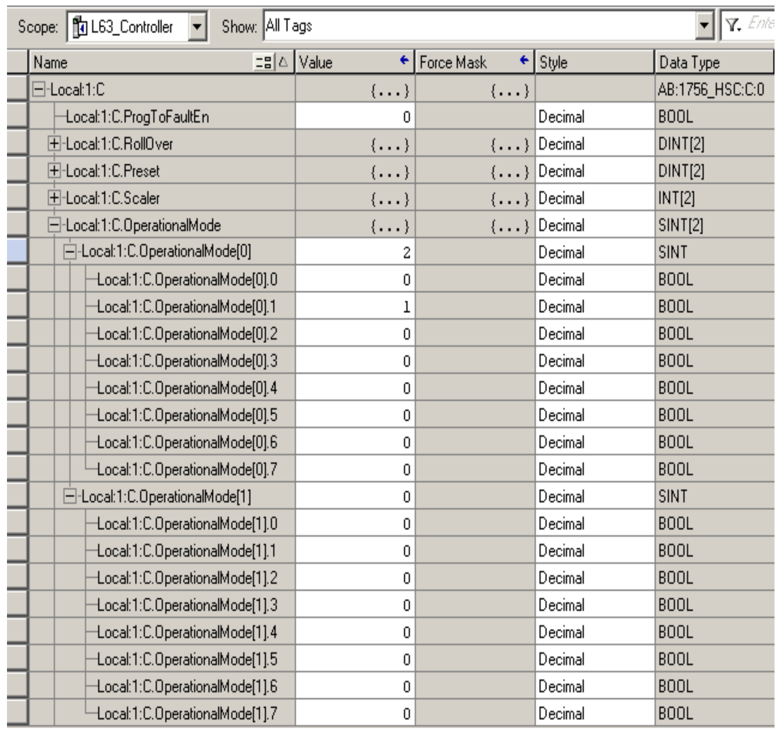
Follow these steps to manually enter tag data.

1. On the Controller Organizer, right-click Controller Tags and choose Monitor Tags.



The Controller Tags window appears.

The name of your controller displays in the Scope field.



Scope: L63_Controller Show: All Tags

Name	Value	Force Mask	Style	Data Type
Local:1:C	{...}	{...}		AB:1756_HSC:C:0
Local:1:C.ProgToFaultEn	0		Decimal	BOOL
Local:1:C.RollOver	{...}	{...}	Decimal	DINT[2]
Local:1:C.Preset	{...}	{...}	Decimal	DINT[2]
Local:1:C.Scaler	{...}	{...}	Decimal	INT[2]
Local:1:C.OperationalMode	{...}	{...}	Decimal	SINT[2]
Local:1:C.OperationalMode[0]	2		Decimal	SINT
Local:1:C.OperationalMode[0].0	0		Decimal	BOOL
Local:1:C.OperationalMode[0].1	1		Decimal	BOOL
Local:1:C.OperationalMode[0].2	0		Decimal	BOOL
Local:1:C.OperationalMode[0].3	0		Decimal	BOOL
Local:1:C.OperationalMode[0].4	0		Decimal	BOOL
Local:1:C.OperationalMode[0].5	0		Decimal	BOOL
Local:1:C.OperationalMode[0].6	0		Decimal	BOOL
Local:1:C.OperationalMode[0].7	0		Decimal	BOOL
Local:1:C.OperationalMode[1]	0		Decimal	SINT
Local:1:C.OperationalMode[1].0	0		Decimal	BOOL
Local:1:C.OperationalMode[1].1	0		Decimal	BOOL
Local:1:C.OperationalMode[1].2	0		Decimal	BOOL
Local:1:C.OperationalMode[1].3	0		Decimal	BOOL
Local:1:C.OperationalMode[1].4	0		Decimal	BOOL
Local:1:C.OperationalMode[1].5	0		Decimal	BOOL
Local:1:C.OperationalMode[1].6	0		Decimal	BOOL
Local:1:C.OperationalMode[1].7	0		Decimal	BOOL

2. Click the '+' in front of the .C (Configuration) tag.

   A list of configuration tags appears.

3. Click the '+' in front of the C.OperationalMode(0) tag.
4. Type a number for the mode that you want to use.

   See page 58 in Chapter 5 for a list of the operational modes and the corresponding tag value.

   The same procedures apply for entering other tag values.

Change Configuration Data Via Message Instruction

Ladder logic uses message instructions to change the module configuration during module operation for software versions 15 and earlier. Message instructions maintain these characteristics:

- Messages use unscheduled portions of system communication bandwidth
- One service is performed per instruction
- Performing module services does not impede module functionality, such as counting incoming pulses

Because message instructions use unscheduled portions of systems communication bandwidth, the services that are requested of a module are not guaranteed to occur within a specific time period. Although the module response typically occurs in less than a second, there is no specific time interval that reflects this response.

Message instructions cause a module service to be performed only once per execution. For example, if a message instruction sends new configuration data to the module, the message instruction must be re-executed to update and send the configuration data in the future.

For procedures, see the Logix 5000™ Controllers Messages Programming Manual, publication 1756-PM012.

Application Considerations

Introduction

This appendix provides background for selecting the appropriate input device for your module, explains the output circuit, and provides you with information for selecting the type and length of input cabling.

Types of Input Devices

To turn on an input circuit in the module, you must source current through the input resistors sufficient to turn on the opto-isolator in the circuit.

If no connection is made to a pair of input terminals, no current flows through the photodiode of the opto-isolator and that channel is off. Its corresponding input status indicator is off.

All six inputs are electrically identical.

There are two basic classes of driver devices built-in to encoders and other pulse sources.

- Single-ended
- Differential

A single-ended driver output consists of a signal and a ground reference. A differential driver consists of a pair of totem-pole outputs driven out of phase. One terminal actively sources current while the other sinks, and there is no direct connection to ground.

Differential line drivers provide reliable, high-speed communication over long wires. Most differential line drivers are powered by 5V, and are more immune to noise than single-ended drivers at any operating voltage.

Any installation must follow customary good wiring practices: separate conduit for low voltage DC control wiring and any 50/60 Hz AC wiring, use of shielded cable, twisted-pair cables, and so forth. For more information, see Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Examples for Selecting Input Devices

These examples help you determine the best input type for your particular application. These examples include:

- 5V differential line driver.
- single-ended driver.
- open collector circuit.
- electromechanical limit switch.

Circuit Overview

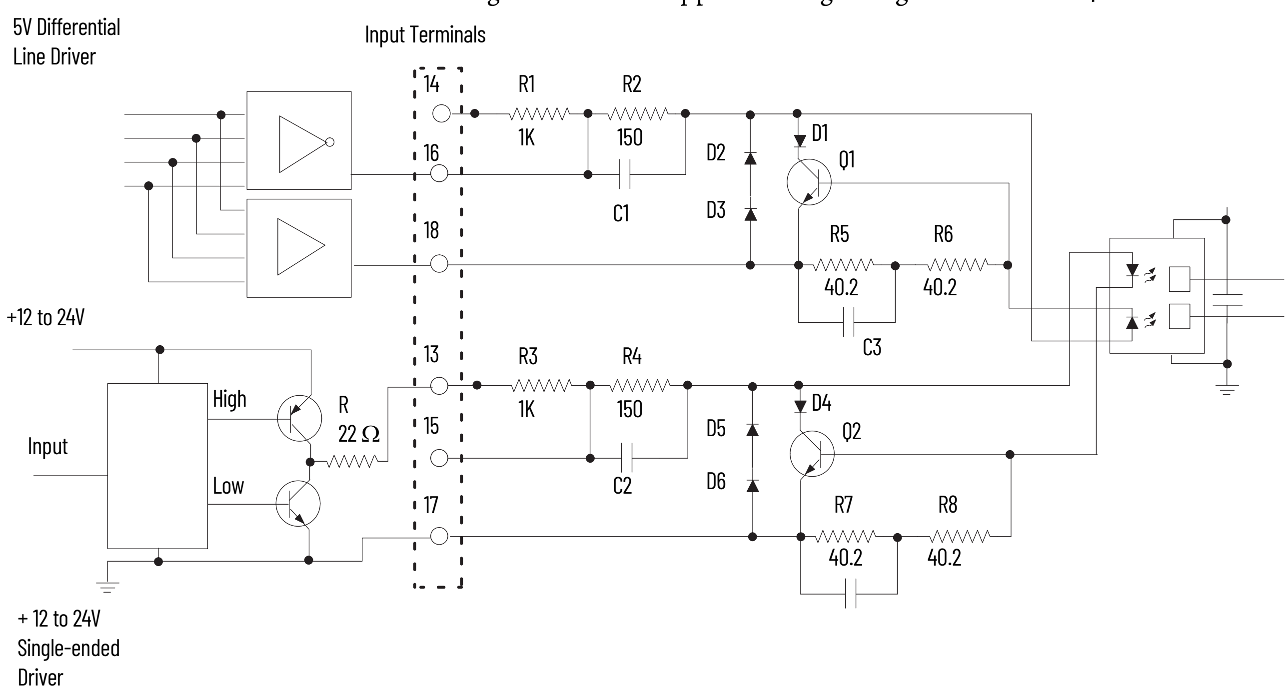
The circuit overview varies based on module series.

Series A and B Modules

To make sure your signal source and the module are compatible, you must understand the electrical characteristics of your output driver and its interaction with the 1756-HSC input circuit.

As shown in the illustration, the most basic circuit consists of R1, R2, the photodiode, and associated circuitry around half of the opto-isolator. The resistors provide first-order current limiting to the photodiodes of the dual high-speed opto-isolator.

When a signal is applied to the 12-24V inputs (pins 13 and 17 in the graphic), the total limiting resistance is R3 + R4 = 1150 Ω. Assuming a 2V drop across the photodiode and R7 and R8, you would have 8…21 mA demanded from the driving circuit as the applied voltage ranged from 12V…24V.

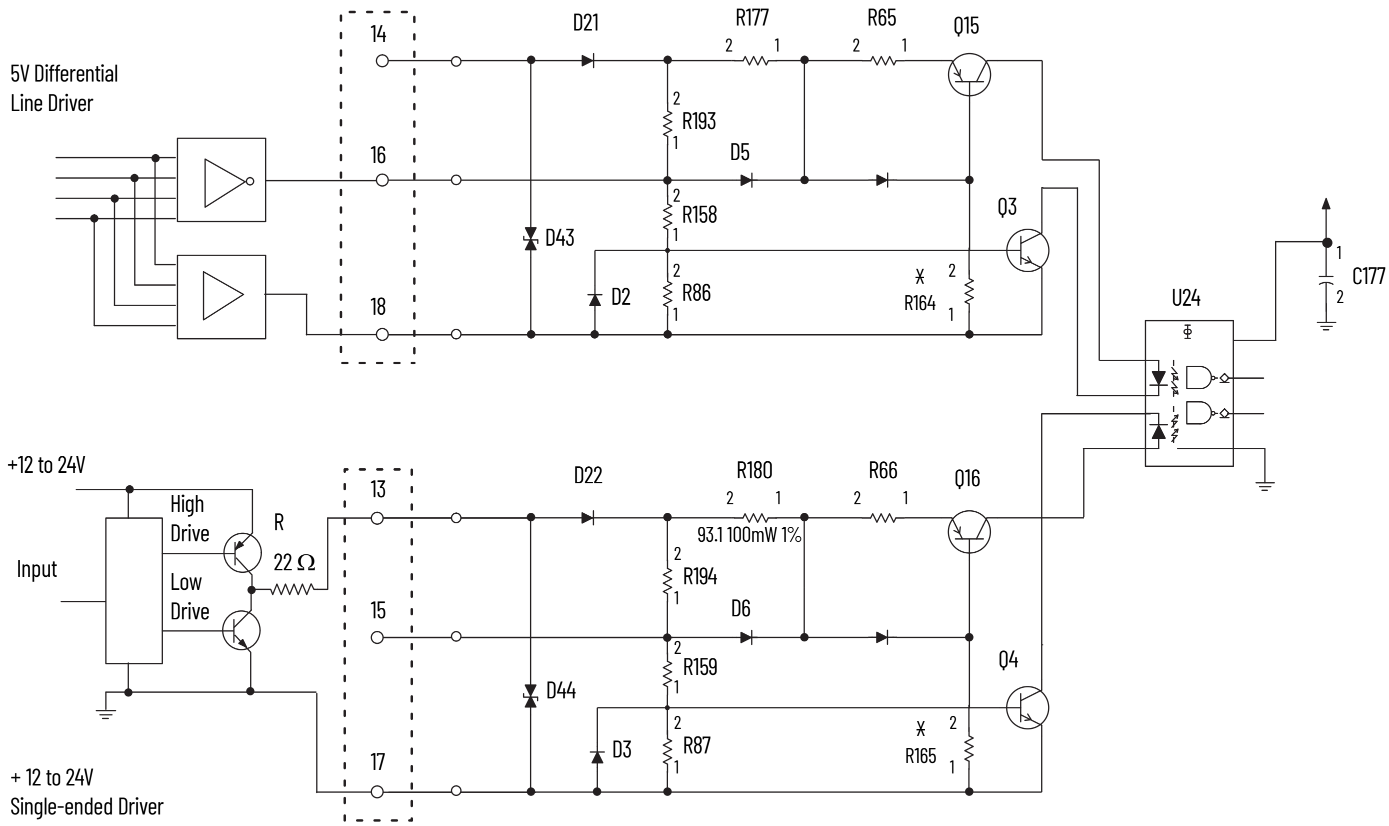


Series C and D Modules

To make sure your signal source and the module are compatible, you must understand the electrical characteristics of your output driver and its interaction with the 1756-HSC input circuit.

As shown in the illustration, the most basic circuit consists of R177, R65, Q15, the photodiode, Q3 and associated circuitry around half of the opto-isolator. The resistors and Q15 provide first-order current limiting to the photodiodes of the dual high-speed opto-isolator.

When a signal is applied to the 12-24V inputs (pins 13 and 17 in the graphic), the total limiting resistance of R180, R66, Q16 and Q4 would demand 5…8 mA from the driving circuit as the applied voltage ranged from 12V…24V.



When a signal is applied to the 5V inputs (pins 16 and 18 in the graphic), the limiting resistance is total of resistance offered by R65, Q15 and Q3. If 5.0V was applied at the input, the current demanded would again be in range of 5-8mA.

Detailed Circuit Analysis

The circuit overview varies based on module series.

Series A and B Modules

In the previous example, we used a constant 2.0V drop across the photodiode and R7-R8. The same voltage drop is present across R5-R6 for Channel 0. To calculate the true photodiode current, consider the photodiode, D1, Q1, R5, and R6 as one circuit. The voltage drop across D1 and Q1 is always equal to the drop across the photodiode and R5-R6. We call this V_{drop}.

First, consider the minimum requirement of I_f = 4 mA. The V_f curves for this photodiode typically have a 1.21…1.29V drop as the junction temperature varies from 70…25 °C. Let's call it 1.25V. With 4 mA current, R5, and R6 drop (80.4 Ω x 4 mA) = 0.32V. Thus, at 4 mA:

$$V_{drop} = (1.25V + 0.32V) = 1.57V.$$

Consider when I_f = 8 mA or above. With the temperature about halfway between 25…70 °C, V_f becomes about 1.25V. R5-R6 will now drop 0.64V (80.4 Ω x 8 mA). That means:

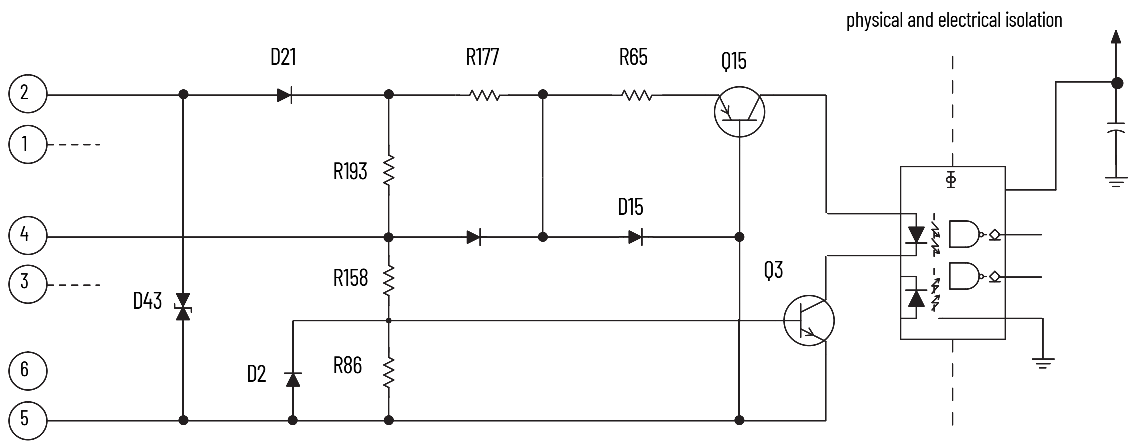
$$V_{drop} = 1.25V + 0.64V = 1.89V.$$

The V_{be} of Q1 is now sufficient to start to turn Q1 on. If the current through the photodiode increases to 9 mA, V_{be} becomes 0.72V and Q1 is fully on. Any additional current (supplied by a 24V applied input) is shunted away from the photodiode and dissipated in Q1 and D1.

Thus, V_{drop} never exceeds about 2.0V regardless of the applied voltage. In addition, it is never less than 1.5V if the minimum of 4 mA is flowing. Although there are some minor temperature effects on the photodiode drop, you can expect the value V_{drop} to be relatively linear from about 1.6V to 2.0V as the current increases from 4-8 mA.

Review the following 5V differential line driver example to see why this is important.

Series C and D Modules



To turn on the circuit, you must source current through the input resistors sufficient to turn on the Q3 and opto-isolator in the circuit. Operating current range for this new input circuit is 5…8mA. If no connection is made to the pair of input terminals, no current flows through the photodiode of the opto-isolator and that gate is OFF (the corresponding input status indicator is OFF).

The photodiode, combined with Q3, requires approximately 1.8V DC total to switch ON. Q15 works as constant current source and maintains constant current flow of approximately 4mA across photo diode. R177 is around 550 Ω R65 is around 93 Ω and Q3 maintains approximately 0.4V drop across it.

The input current magnitude can be determined by:

$$\text{Input current} = \frac{\text{Voltage Drop across Resistor in series with Q15}^{1}}{\text{R177 (only for 1...24V input)} + \text{R65}}$$

CASE A – for 5V DC operation

$$\text{Input current} = \frac{(0.4V^{1})}{93\ \Omega}$$

Input current ≅ 4.3 mA

1. There is approximately a 0.4V drop across R65 that is maintained by Q15 constant current source. A minimum of 4.5V is required to turn on the Input circuit.

CASE B – for 10 V DC to 31.2 V DC operation

If gate input voltage = 10V DC

$$\text{Gate input current} = \frac{(3V^{1})}{550\ \Omega + 93\ \Omega}$$

Gate input current = 4.6 mA

For 10 V input:

$$\text{Input current} = \frac{3\text{ V}}{550\ \Omega + 93\ \Omega}$$

Input current ≅ 4.6 mA

For 31.2 V input:

$$\text{Input current} = \frac{4.29\text{ V}}{550\ \Omega + 93\ \Omega}$$

Input current ≅ 6.6 mA

1. There is approximately a 2.5…4.5 V drop across Resistors in series with Q15 that is maintained by Q15 constant current source. A minimum of approximately 7.5V is required to turn on the Input circuit.

5V Differential Line Driver Example

You want to use a 5V differential line driver in your encoder when you have a long cable run, and/or high input frequency or narrow input pulses (input duty cycle < 50%). The top circuit (page 96) shows a typical 5V differential line driver. The encoder output is connected to the field-wiring arm terminal 16 and is sourcing current and the encoder output to terminal 18 is sinking current.

IMPORTANT	Neither output of the differential line driver can be connected to ground. Damage could occur to your driving device.

To be sure that your device drives the 1756-HSC, you must know the electrical characteristics of the output driver component that is used in your signal source device. The output voltage differential $V_{diff} = (V_{oh} - V_{ol})$ is critical, because this is the drive voltage across the 1756-HSC input terminals 16 and 18, and the photodiode current is a function of Vdiff - Vdrop.

The manufacturer of your shaft encoder or other pulse-producing device can provide information on the specific output device used.

IMPORTANT	Any signal source that uses a standard TTL output device driver that is rated to source 400 μA or less in the high logic state is not compatible with the 1756-HSC module.

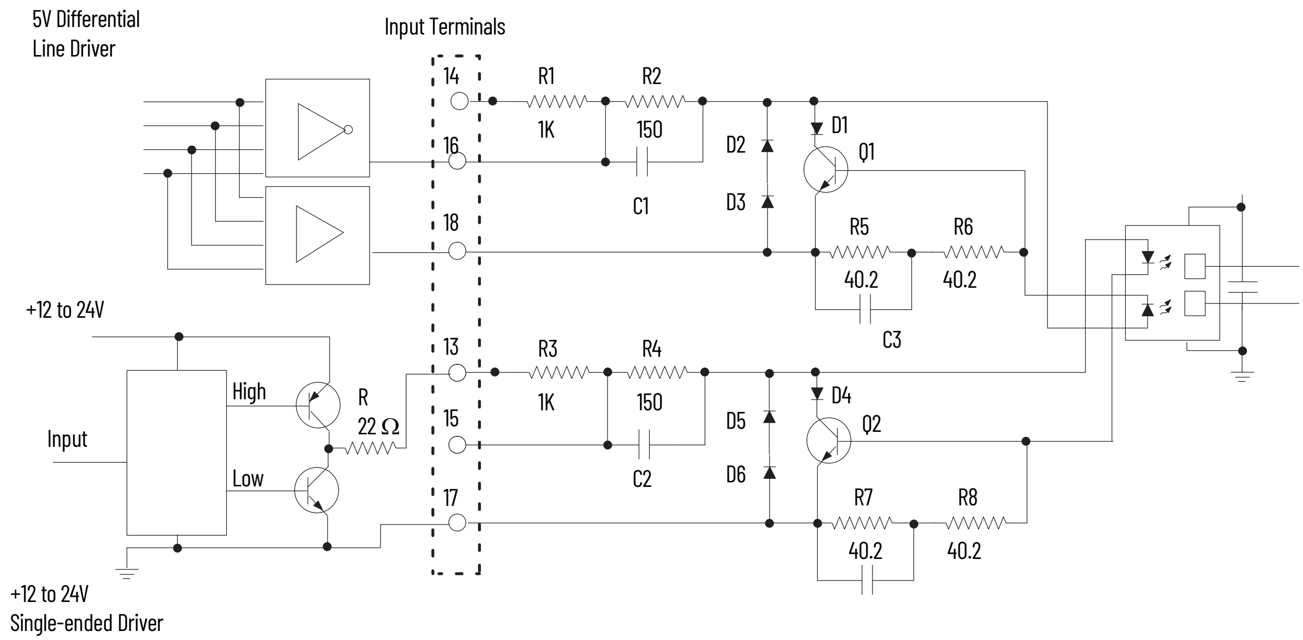
Many popular differential line drivers, such as the 75114, 75ALS192, and the DM8830 have similar characteristics and can source or sink up to 40 mA.

+12 to +24V Single-ended Driver

Some European-made encoders use a circuit similar to the lower circuit in the figure below. The current capable of being sourced is limited only by the 22 Ω resistor in the driver output circuit (R).

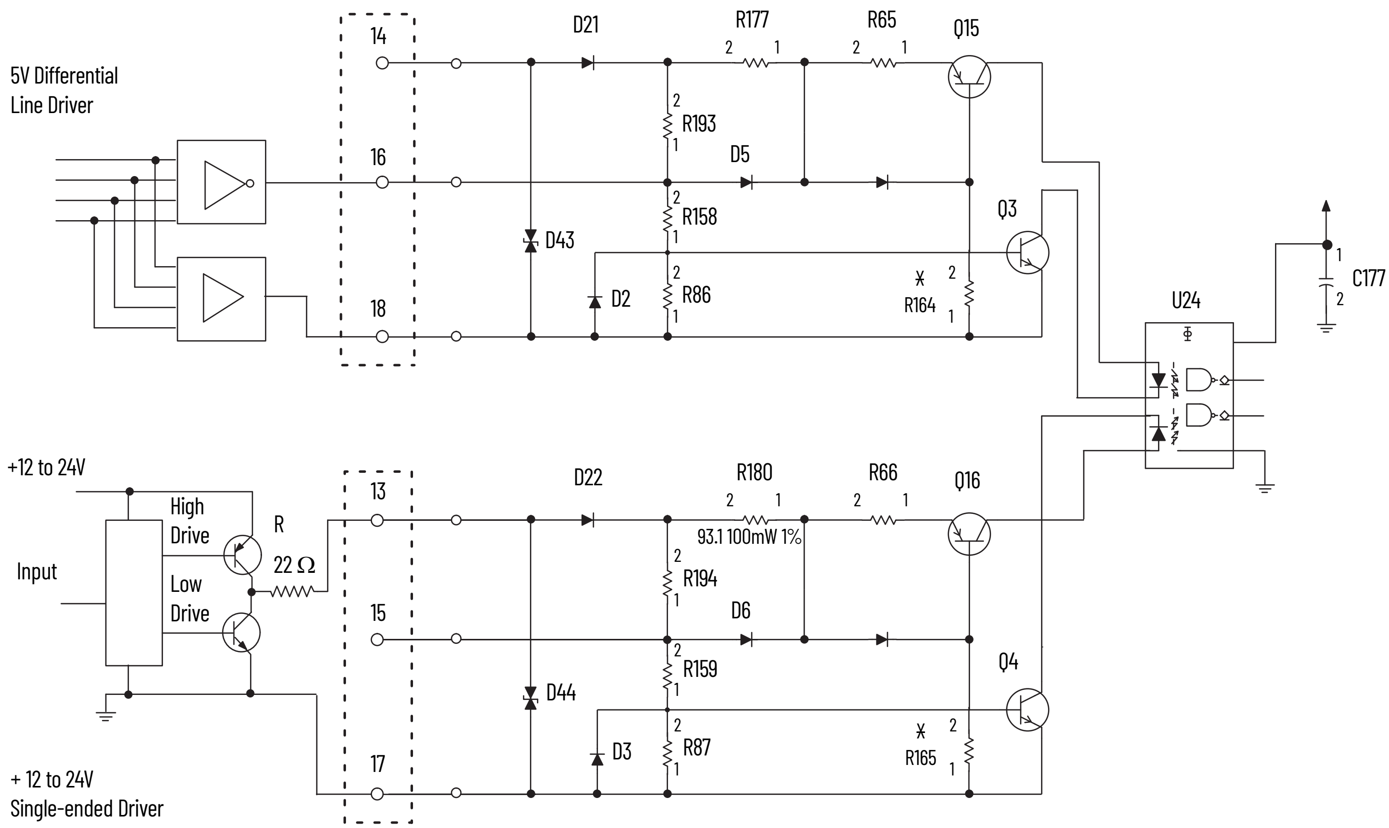
If a 24V supply is used, and this driver supplies 15 mA, the output voltage still would be about 23V (15 mA x 22 Ω = 0.33V, and Vce = .7V).

Series A and B Modules



Series C and D Module

There is a difference between these Series C and Series D modules. In the Series C modules, the D43 and D44 diodes are uni-directional. In the Series D modules, the D43 and D44 diodes are bi-directional, as shown below.



As explained on page 96, the voltage and current required for HSC to operate is within capability of this driver.

Open Collector

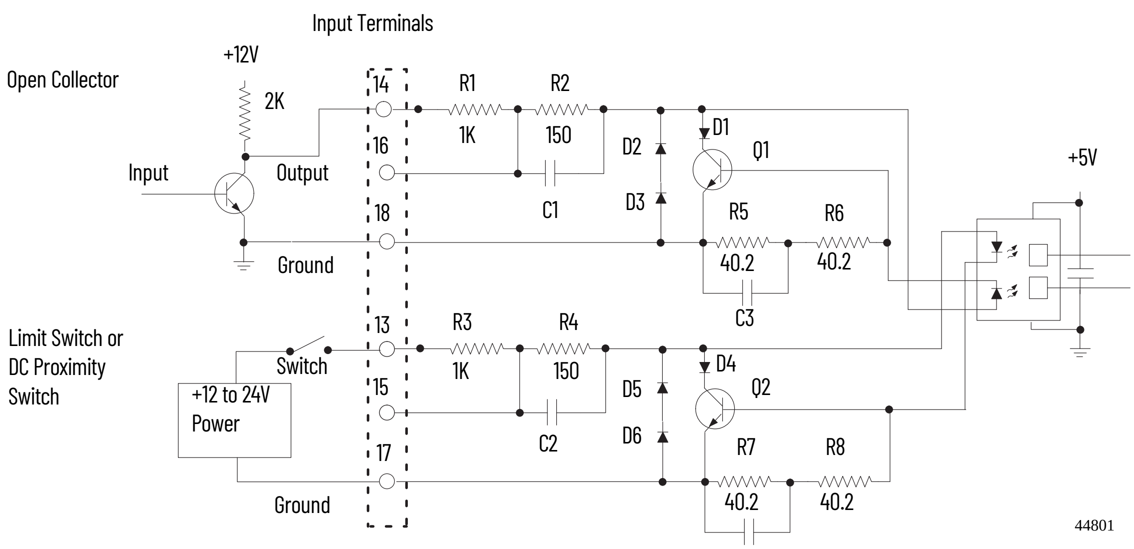
Open collector circuits (the upper circuit on the following circuit) require close attention so that the input voltage is sufficient to produce the necessary source current, since it is limited not only by the 1756-HSC input resistors but also the open collector pull-up.

Choosing input terminals provides some options, as shown in the table. The new circuit requires current flow of around 4-8mA and for 5V input minimum threshold required is 4.5V to recognize input signal and for 12-24V input minimum input voltage of 7.5V is required hence pull up shall be selected accordingly.

Example	Supply Voltage	Input Terminal	Total Impedance	Available Current
1	12	12 to 24V	3.15 kΩ	3.1 mA (insufficient)
2	12	5V	2.15 kΩ	4.6 mA (minimal)
3	24	12 to 24V	3.15 kΩ	6.9 mA (optimal)
4	24	5V	2.15 kΩ	10.2 mA (acceptable)

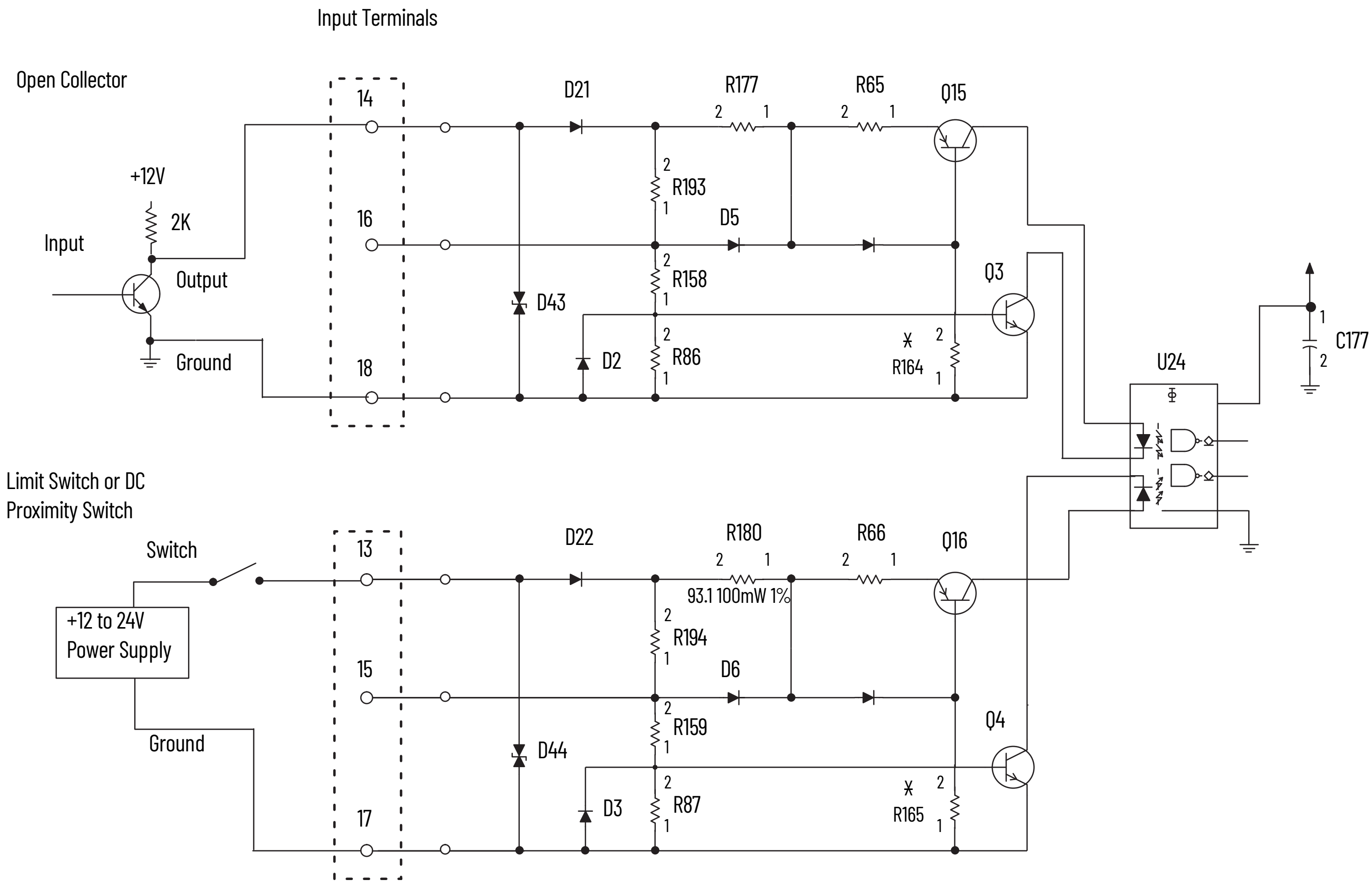
You must increase the supply voltage above 12V to make sure that there is sufficient input current to overcome the additional 2 kΩ pull-up impedance. Keep in mind that you want the available current to be at least 4 mA.

Series A and B Modules



Series C and D Modules

The difference between these series modules is that, in Series C modules, the D43 and D44 diodes are unidirectional. Whereas, in Series D modules, the D43 and D44 diodes are bi-directional, as shown below.



Electromechanical Limit Switch

When using an electromechanical limit switch (the lower circuit in the figure above), we recommend that you enable the input filter via the programming software to filter out switch contact bounce. However, this limits the frequency response to around 70 Hz (Series A and B modules) or 50 Hz (Series C and D modules). As per the digital filter, with Series C and D modules, you can select the frequency response, such as 50 Hz or 500 Hz.

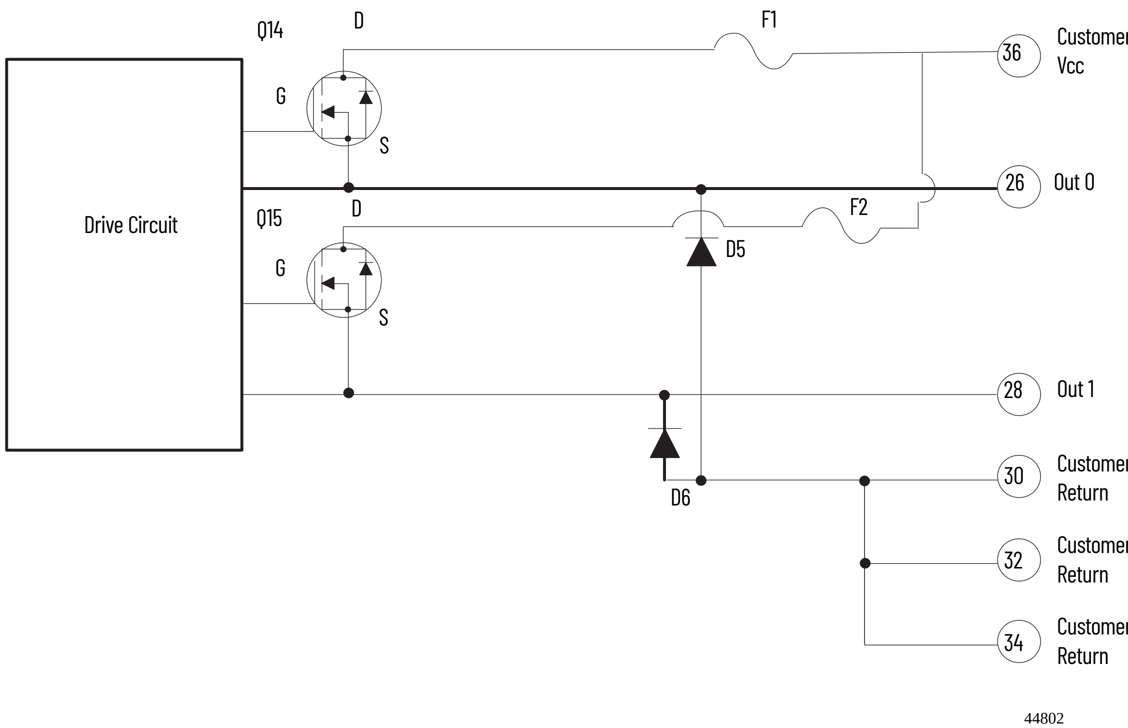
This circuit would be similar when using DC proximity switches, but bounce should not occur unless severe mechanical vibration is present.

Output Circuits

Series A and B

The 1756-HSC module, Series A and B, contains two isolated pairs of output circuits. Customer supplied power, ranging from +5 to +24V DC, is connected internally (through terminal Vcc) to the power output transistors. When an output is turned on, current flows into the drain, out of the source, through the fuse and into the load connected to the ground of the customer supply (customer return). Diodes D5 protect the power output transistors from damage due to inductive loads.

If local electrical codes permit, outputs can be connected to sink current. This is done by connecting the load between the power supply + terminal and the customer Vcc terminal on the field wiring arm. The output terminal is then connected directly to ground (customer return). This wiring method **does not** provide inductive load protection for the power output transistors.

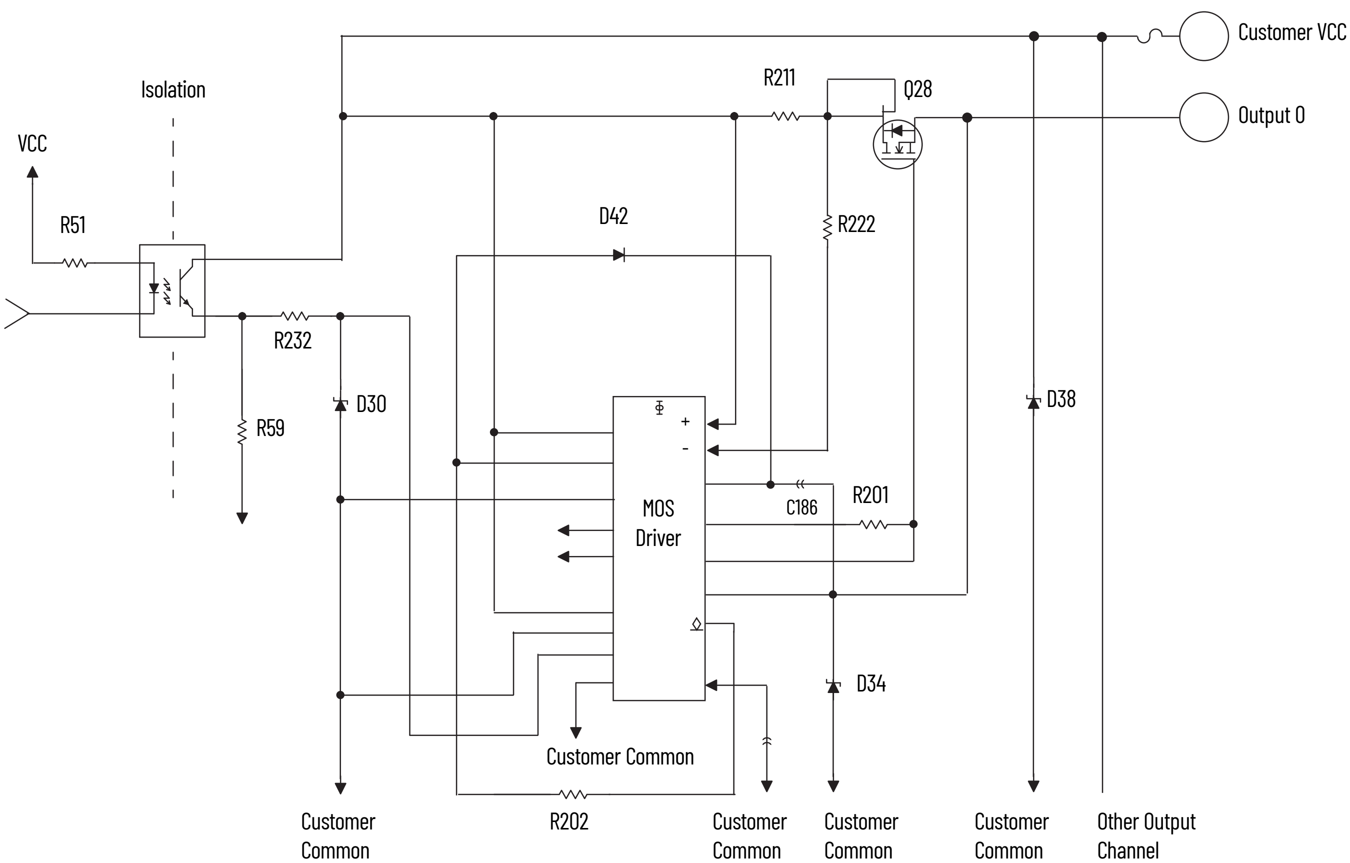


Series C and D

The 1756-HSC module, Series C and D, contains two isolated pairs of output circuits. Customer supplied power, ranging from +5 to +24V DC, is connected internally (through terminal Vcc) to the power output transistors. When an output is turned on, current flows into the drain, out of the source, through the fuse and into the load connected to the ground of the customer supply (customer return).

Diodes D34 in each output circuit protects the power output transistors from damage due to inductive loads.

If local electrical codes permit, outputs can be connected to sink current. This is done by connecting the load between the power supply + terminal and the customer Vcc terminal on the field wiring arm. The output terminal is then connected directly to ground (customer return). This wiring method does not provide inductive load protection for the power output transistors.



Customer-supplied power, ranging from +5V DC…+31.2V DC, is connected internally through terminals 35 (Customer VCC) and 36 (Customer Common) to the power output transistors, for example, Q28 as depicted above.

When an output is turned on, current flows into the source, out of the drain, through the load connected to the ground of the customer supply (customer return). Diode D34 protects the power output transistor Q28 from damage due to inductive loads.

Output transistor Q28 is thermally protected by MOS Driver and turns off at approximately 1.2 A. After an output goes into thermal shutdown, you must fix the cause of the shutdown and toggle the output OFF and ON to re-energize the output.

Application Considerations

A successful installation depends on the type of input driver, input cable length, input cable impedance, input cable capacitance, and frequency of the input.

These sections provide information about these installation factors for the 1756-HSC module.

Input Cable Length

Maximum input cable length depends on the type of output driver in your encoder, the kind of cable that is used, and maximum frequency at which you are running. With a differential line driver, 250 ft or less of high quality, low capacitance cable with an effective shield, and an operating frequency of 250 kHz or less will likely result in a successfully installation.

If you use an open collector, or other single-ended driver, at distances of 250 ft and frequencies of 250 kHz, your chances of success are low. See the table for suggested desirable driver types.

Desirable	Adequate	Undesirable
5V Line Drivers, such as: DM8830 DM88C30 75ALS192 or equivalent	Balanced Single-Ended: any AC or ACT family part or Discrete, balanced circuit or Open-Collector:suitable for frequencies of <50 kHz	Standard TTL or LSTTL Gates

Totem-pole Output Devices

Standard TTL totem-pole output devices, such as 7404 and 74LS04, are usually rated to source 400 μA at 2.4V in the high logic state. This is not enough current to turn on a 1756-HSC input circuit. If your present encoder has this kind of electrical output rating, you cannot use it with the module.

Most encoder manufacturers, including Allen-Bradley, offer several output options for a given encoder model. When available, choose the high current 5V differential line driver.

Cable Impedance

Generally, you want the cable impedance to match the source and/or load as closely as possible. Using 150 Ω Belden 9182 (or equivalent) cable more closely matches the impedance of both encoder and module input circuits than 78 Ω cable, such as Belden 9463. A closer impedance match minimizes reflections at high frequencies.

Termination of one, or both ends, of the cable with a fixed resistor whose value is equal to the cable impedance will not necessarily improve 'reception' at the end of the cable. It will, however, increase the DC load that is seen by the cable driver.

Cable Capacitance

Use cable with a low capacitance as measured per unit length. High capacitance rounds off incoming square wave edges and takes driver current to charge and discharge. Increasing cable length causes a linear increase in capacitance, which reduces the maximum usable frequency. This is especially true for open collector drivers with resistive pull-ups. For example, Belden 9182 is rated at a low 9 pF/foot.

Cable Length and Frequency

When cable length or frequency goes up, your selection of cable becomes even more critical. Long cables can result in changes in duty cycle, rise and fall times, and phase relationships. The phase relationship between channels A and B in Encoder X1 and X4 mode is critical.

The maximum encoder input of 250 kHz is designed to work with Allen-Bradley Bulletin 845H or similar incremental encoders with a quadrature specification of 90° (22°) and a duty cycle specification of 50% (10%). Any additional phase or duty cycle changes caused by the cable reduces the specified 250 kHz specification.

For any application over 100 ft, and/or over 100 kHz, use Belden 9182, a high-performance, twisted-pair cable with 100% foil shield, a drain wire, moderate 150 Ω impedance and low capacitance per unit length.

accumulated value (ACC) The number of elapsed time intervals or counted events.

actuator 1) A device that converts an electrical signal into mechanical motion. 2) In a general sense, any machine/process load device (for example, transducer) of a controller output circuit. See **output device** (page 114).

address 1) A character string that uniquely identifies a memory location. 2) A character string that uniquely identifies the physical location of an input or output circuit.

algorithm A set of procedures used for solving a problem in a finite number of steps.

American wire gauge (AWG) A standard system used for designating the size of electrical conductors. Gauge numbers have an inverse relationship to size; larger numbers have a smaller cross-sectional area. However, a single-strand conductor has a larger cross-sectional area than a multi-strand conductor of the same gauge so that they have the same current-carrying specification.

analog circuit 1) A circuit in which the signal can vary continuously between specified limits. 2) A circuit that provides a continuous function. 3) Contrasted with **digital circuit** (page 111).

asynchronous 1) Lacking a regular time relationship; not related through repeating time patterns. 2) Contrasted with **synchronous** (page 115).

AWG See American wire gauge (page 109).

backplane A printed-circuit board, at the back of a chassis, that provides electrical interconnection between the modules inserted into the chassis.

balanced circuit 1) A circuit whose two sides are electrically alike and symmetrical to a common reference point, usually ground. 2) Contrasted with **unbalanced circuit** (page 115).

bandwidth The range of frequencies over which a system is designed to operate. The bandwidth is expressed in Hertz between the highest and lowest frequencies.

baseband link 1) A communication link with only one channel, encoded by on/off switching. Examples: DH and DH+ links. 2) Contrasted with **carrier-band link** (page 110) and **broadband link** (page 110).

bidirectional I/O module An I/O module whose communication with the scanner or processor is bidirectional and therefore uses both input and output image areas.

broadband link 1) A communication link that can have multiple channels. Each channel signal modulates its own carrier frequency. Example: LAN/1 link. 2) Contrasted with **carrier-band link** (page 110) and **baseband link** (page 109).

bus A single path or multiple parallel paths for power or data signals to which several devices may be connected at the same time. A bus may have several sources of supply and/or several sources of demand.

carrier-band link 1) A communication link with a single channel whose signal modulates a carrier frequency. Example: Data Highway II link. 2) Contrasted with **broadband link** (page 110) and **baseband link** (page 109).

cascade connection A series connection of amplifier stages or links in which the output of one stage feeds the input of the next.

cascading timers/counters A programming technique of using multiple timers and/or counters to extend the range of the timer or counter beyond the maximum values that may be accumulated in a single instruction.

channel A path for a signal. Several channels may share a common link.

chassis A hardware assembly that houses devices such as I/O modules, adapter modules, processor modules, and power supplies.

communication format Format that defines the type of information transferred between an I/O module and its owner controller. This format also defines the tags created for each I/O module.

compatible match An electronic keying protection mode that requires the physical module and the module configured in the software to match according to vendor, catalog number, and major revision. In this case, the minor revision of the module must be greater than or equal to that of the configured slot.

configuration The arrangement and interconnection of hardware components within a system, and the hardware (switch and jumper) and software selections that determine the operating characteristics of the system.

connection The communication mechanism from the controller to another module in the control system.

controlbus The backplane used by the 1756 chassis.

controller A unit, such as a programmable controller or relay panel, that controls machine or process elements.

ControlNet network An open-control network that uses the producer/consumer model to combine the functionality of an I/O network and a peer-to-peer network, while providing high-speed performance for both functions.

Coordinated System Time (CST) Timer value which is kept synchronized for all modules within a single ControlBus chassis. The CST is a 64-bit number with µs resolution.

data 1) A general term for any type of information. 2) In a more restricted sense, data refers to the end-use information in the particular context; thereby excluding the protocol information used to get the end-use information.

data table The part of processor memory that contains I/O values and files where data is monitored, manipulated, and changed for control purposes.

database The entire body of data that has to do with one or more related subjects. Typically, it consists of a collection of data files.

differential 1) Pertaining to a method of signal transmission through two wires. The transmission always has opposite states. The signal data is the polarity difference between the wires; when one is high, the other is low. Neither wire is grounded. The circuit may be either a balanced circuit, a floating circuit, or a circuit with a high-impedance path to ground from either end. Usually used in reference to encoders, analog I/O circuits, and communication circuits. 2) Contrasted with **single-ended** (page 115).

digital circuit 1) A switching circuit that has only two states: on and off. 2) A circuit that provides a step function. 3) Contrasted with **analog circuit** (page 109).

direct connection An I/O connection where the controller establishes an individual connection with I/O modules.

direct I/O module 1) An I/O module for which each input or output that has an individual connection that corresponds directly to a data table bit or word that stores the value of the signal at that I/O circuit (digital or analog). This allows the ladder logic to have direct access to the I/O values. 2) Contrasted with **intelligent I/O module** (page 113).

disable keying Option that turns off all electronic keying to the module. Requires no attributes of the physical module and the module configured in the software to match.

download The process of transferring the contents of a project on the workstation into the controller.

duration 1) The time during which something exists or lasts. For example, the length of time that a signal is high may be described as the duration of a pulse. 2) Compare **interval** (page 113) and **period** (page 114).

electronic keying A system feature which makes sure that the physical module attributes are consistent with what was configured in the software.

encoder Any feedback element that converts linear or rotary position (absolute or incremental) into a digital signal.

- Linear encoder—is a feedback element that directly converts linear position (absolute or incremental) into a digital signal.
- Rotary encoder—is a feedback element that converts rotary position (absolute or incremental) into a digital signal. Often, the directly measured rotary position is used to determine a linear position through gearing.
- Absolute encoder—is a feedback element that generates a digital code that is unique for each absolute position (linear or rotary). An absolute encoder usually provides the digital feedback signal in a Gray code to minimize errors.
- Incremental encoder—is a feedback element that generates a digital signal to indicate each incremental change of position (linear or rotary). An incremental encoder usually provides the digital feedback signal in quadrature form to indicate direction of motion.

encoder bandwidth An expression for maximum encoder speed in Hz. May also refer to the maximum rate at which the control loop can accept encoder signals. The actual bandwidth of the encoder and the capability of the controller to process encoder signals may not be the same.

exact match An electronic keying protection mode that requires the physical module and the module configured in the software to match identically, according to vendor, catalog number, major revision and minor revision.

factory wiring 1) Wiring completed before the product was shipped from the factory in which it was built. 2) Contrasted with **field wiring** (page 112).

field side Interface between user field-wiring and I/O module.

field wiring 1) Wiring connected by the user after the user receives the product. 2) Contrasted with **factory wiring** (page 112).

hysteresis 1) The effect of residual magnetism whereby the magnetization of a ferrous substance lags the magnetizing force because of molecular friction. 2) The property of magnetic material that causes the magnetic induction for a given magnetizing force to depend upon the previous conditions of magnetization. 3) A form of nonlinearity in which the response of a circuit to a particular set of input conditions depends not only on the instantaneous values of those conditions, but also on the immediate past of the input and output signals.

inhibit A ControlLogix process that allows you to configure an I/O module but prevent it from communicating with the owner controller. In this case, the controller does not establish a connection.

input See sensor (page 115).

intelligent I/O module 1) An I/O module that provides some on-board processing of input values to control some output values without going through the data table for control by the ladder logic. An intelligent I/O module may have digital I/O circuits, analog I/O circuits, or both. 2) Contrasted with **direct I/O module** (page 111).

interval 1) The length of time between events or states. For example, the length of time between when a signal is high may be described as the interval between pulses. 2) Compare **duration** (page 112) and **period** (page 114).

I/O module 1) In a programmable controller system, a module (interchangeable plug-in item within a larger assembly) that interfaces directly through I/O circuits to the sensors and actuators of the machine/process.

isolated I/O module A module that has each input or output electrically isolated from every other input or output on that module.

jumper A short conductor with which you can connect two points.

k Kilo. A prefix used with units of measurement to designate a multiple of 1000.

keying Devices that allow only selected pairs of mating connectors to be plugged into each other.

listen-only connection An I/O connection that allows a controller to monitor I/O module data without owning the module.

local I/O 1) I/O connected to a processor across a backplane or a parallel link, thus limiting its distance from the processor. 2) Contrasted with **remote I/O** (page 115).

major revision A module revision that is updated any time there is a functional change to the module resulting in an interface change with software.

minor revision A module revision that is updated any time there is a change to the module that does not affect its function or software user interface.

module slot A location for installing a module. In typical modular construction, modules plug into a backplane; each module slides into a slot that lines it up with its backplane connector.

multicast Data transmissions which reach a specific group of one or more destinations.

network update time (NUT) The smallest repetitive time interval in which the data can be sent on a ControlNet network. The NUT may be configured over the range from 2 ms…100 ms by using the RSNetWorx software.

node The connection point at which media access is provided.

off 1) The inoperative state of a device; the state of a switch or circuit that is open. 2) Contrasted with **on** (page 114).

on 1) The operative state of a device; the state of a switch or circuit that is closed. 2) Contrasted with **off** (page 114).

output device 1) For a computer, a CRT terminal or printer. 2) For a programmable controller, see **actuator** (page 109).

owner-controller The controller that creates and stores the primary configuration and communication connection to a module.

period 1) The length of time for a cyclical operation to complete one full cycle. For example, the length of time from one point in a cyclical wave form to the same point in the next cycle of the wave form. 2) Compare **duration** (page 112) and **interval** (page 113).

power supply A device that converts available power to a form that a system can use—usually converts AC power to DC power.

producer/consumer model Intelligent data exchange system devices in which the high-speed counter module produces data without having been polled first. Devices that need the data (consumers) recognize the data they need and consume it. Therefore, data only needs to be sent out on the network in a single message no matter how large the number of nodes to which it needs to go.

program mode In this mode, the controller program is not executing. Inputs are actively producing data. Outputs are not actively controlled and go to their configured Program mode state.

proximity switch/sensor A switch/sensor that is actuated when an actuating device is moved near it, without physical contact.

pulse A momentary sharp change in voltage, current, or light from its quiescent condition.

quadrature Separation in phase by 90°. Used on single channels of feedback devices, such as encoders and resolvers, to detect the direction of motion.

remote connection An I/O connection where the controller establishes an individual connection with I/O modules in a remote chassis.

remote I/O 1) I/O connected to a processor across a serial link. With a serial link, remote I/O can be located long distances from the processor. 2) Contrasted with **local I/O** (page 113).

removal and insertion under power (RIUP) ControlLogix feature that lets a user install or remove a module or RTB while power is applied.

requested packet interval (RPI) A configured parameter that defines when the module will multicast data.

run mode In this mode, the controller program is executing. Inputs are actively producing data. Outputs are actively controlled.

sensor A digital or analog transducer (a device such as a limit switch, push button switch, pressure sensor, or temperature sensor) that generates an electrical signal through an input circuit to a controller.

single-ended 1) Unbalanced, as when one side is grounded. See unbalanced circuit (page 115) 2) Contrasted with **differential** (page 111).

synchronous 1) In step or in phase, as applied to two or more circuits, devices, or machines. 2) Contrasted with **asynchronous** (page 109).

tag A named area of the controller's memory where data is stored like a variable. For example, an I/O definition file may contain a tag (definition) for each I/O, with each I/O definition containing a unique tag name by which the I/O can be addressed.

unbalanced circuit 1) A circuit whose two sides are electrically dissimilar, as when one side is grounded. 2) Contrasted with **balanced circuit** (page 109).

Notes:

Numerics

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Rockwell Automation Support

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Knowledgebase	Access Knowledgebase articles.	rok.auto/knowledgebase
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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