

ControlLogix High-speed Counter Module

Catalog Numbers 1756-HSC



Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication [SGI-1.1](#) available from your local Rockwell Automation® sales office or online at <http://www.rockwellautomation.com/literature/>) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

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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.



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.

IMPORTANT

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

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Summary of Changes

This manual contains new and updated information. Changes throughout this revision are marked by change bars, as shown to the right of this paragraph.

New and Updated Information

This table contains the changes made to this revision.

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About This Publication

The 1756 High-speed Counter module counts incoming pulses from pulse generators, counters, limit switches, and other devices, and can either return a count to the controller or activate on-board outputs for a specific action depending on your application. In the rest of this manual, we refer to the High-speed Counter module as the 1756-HSC module.

The chapters in this manual focus on the configuration and operation of a ControlLogix® 1756-HSC/B module, firmware revision 3.x or later using RSLogix™ 5000 software version 18 or later. Additional capabilities of the 1756-HSC module are highlighted in the appendices, including revised output tags and electrical schematics.

The table outlines the profiles for the 1756-HSC/B module based on your firmware and software configurations.

If you are using the ‘original’ 1756-HSC/A module, with either firmware revision 1.x or 2.x, see [Appendix C](#) for details.

HSC Module Firmware 3.x Configurations

| If you have module | Using firmware revision | And your desired functionality is | Then use the Logix5000™ profile | Comment | |
|--|-------------------------|------------------------------------|---|---|--|
|  <p>Series B</p> | 3.x | Original ⁽¹⁾ | Versions earlier than 15 => Thin profile/tags only | Exact Match Keying not supported | |
| | | | Version 15...17 => Full profile support | | |
| | | | Version 18 and later => Select Major Revision 3 and HSC Data Comm Format | | |
| | | Rollover and Preset in Output Tags | Versions earlier than 18 => Use generic profile/HSC ACD file ⁽²⁾ | | |
| | | | Period/Continuous Rate | Version 18 and later => Select Major Revision 3 and HSC Data-extended Comm Format | |
| | | | | Totalizer | |

⁽¹⁾ Original means the features and module behavior in the initial release of the 1756-HSC/A module, firmware revision 1.x functions and tags. See [Appendix C](#) for details.

⁽²⁾ File is located at <http://samplecode.rockwellautomation.com>.

Who Should Use This Manual

You must be able to program and operate an Allen-Bradley® ControlLogix controller and various Allen-Bradley encoders and sensors to efficiently use your 1756-HSC module. 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 1756-HSC module.

Additional Resources

These documents provide information related to the ControlLogix High-speed Counter 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, publication 1756-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. |

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.

1756-HSC Module Features

Introduction

The High-speed Counter Module (catalog number 1756-HSC) performs high-speed counting for industrial applications. This chapter provides an overview of the design and features of the 1756-HSC/B module.

For other module series, firmware, and/or software information, see [Appendix C](#).

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What is a High-speed Counter Module?

The 1756-HSC 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 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 1756-HSC 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 1756-HSC module during the initial download in RSLogix 5000 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 29](#) 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.

Mode and Input Tag Values for the 1756-HSC/B Module

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

⁽¹⁾ Modes where frequency controls the outputs.

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

⁽³⁾ Rollover/Preset settings apply.

See [1756-HSC Data Structures](#) in Appendix C for a list of tags.

Encoder and Sensor Compatibility

The most common applications using the 1756-HSC module also use the following 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 may be connected to and used with the ControlLogix 1756-HSC 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 μ A @ 5V DC |
| Quad Encoder | 2 μ s | 250 kHz | 250 μ A @ 5V DC |

1756-HSC/B Module Features

This table highlights features of the 1756-HSC/B module.

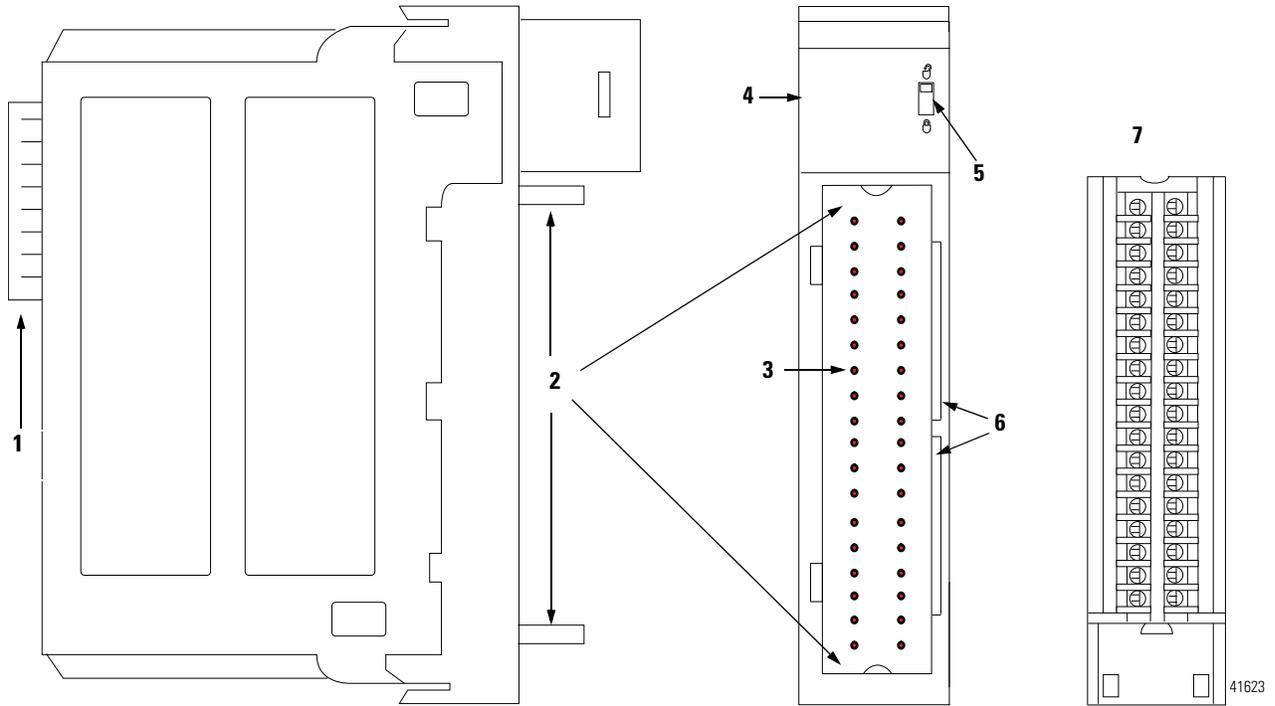
| Feature | Description |
|--|---|
| Real-time manipulation of preset/rollover tag settings | Preset and Rollover tags, which provide a reference point to start the count and reset the count to zero, respectively, are included in the Configuration tags at the initial system configuration. The 1756-HSC/B 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 re-configure all system tags. |
| Period rate / Continuous Rate frequencies | Both Frequency modes are available with the 1756-HSC/B module when using the Data-extended Comm Format. Period Rate mode counts internal 4 MHz clock pulses over a user-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 Logix5000 project. The 1756-HSC module has very descriptive tags for using pulse and frequency values, such as Present Value, Stored Value, and Totalizer. |

Additional I/O Module Features

The following items are additional features for ControlLogix I/O modules, including the 1756-HSC module.

| Feature | Description |
|-------------------------|---|
| Configuration software | RSLogix 5000 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 RSLogix 5000 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 1756-HSC 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 1756-HSC module. The output-point status display indicates the status of four output points on the 1756-HSC module. |
| Producer/consumer model | Logix5000 controllers let you produce (broadcast) and consume (receive) system-shared tags. The 1756-HSC module can produce data without having to be polled first by a controller. The 1756-HSC module produces the data and any owner-controller device can decide to consume it. |
| Electronic Keying | See page 73 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 provide assistance 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 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 46](#) for details on RTB types.

Notes:

Counter Modes

Introduction

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

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

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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 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 1756-HSC 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 1756-HSC/B 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.

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 1756-HSC 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 1756-HSC 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 1756-HSC/B module.

Counter Mode

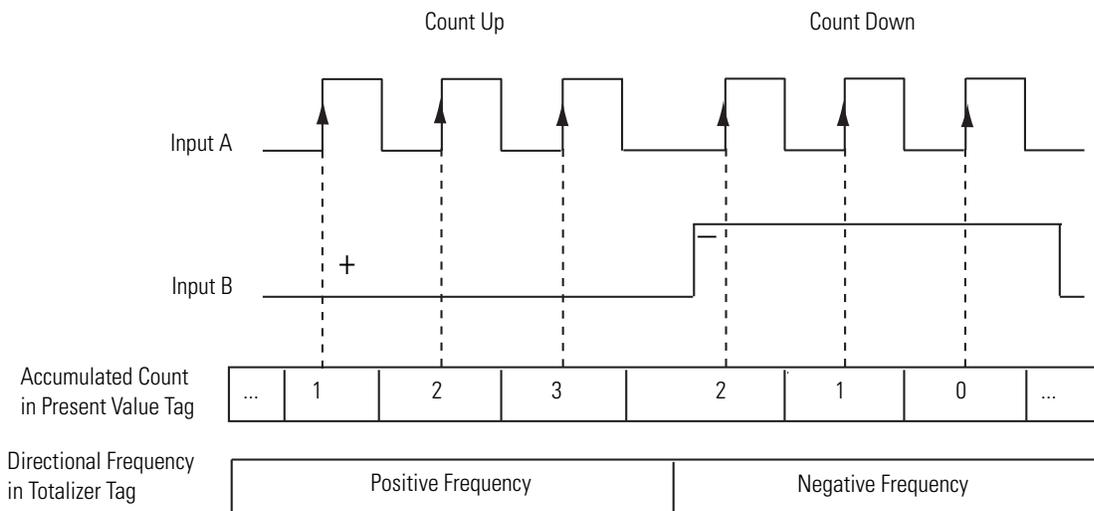
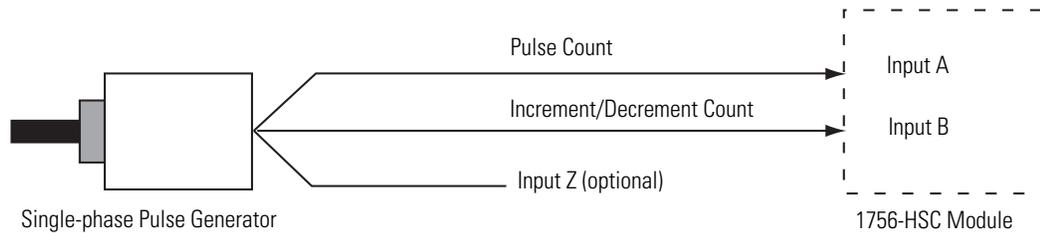
This is the 1756-HSC module's default operational mode that counts incoming pulses using input A. You can control the starting and ending points of the accumulated count depending on how you have configured the module.

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 will count 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 23](#) for details on the Storage modes.

Counter Mode



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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.

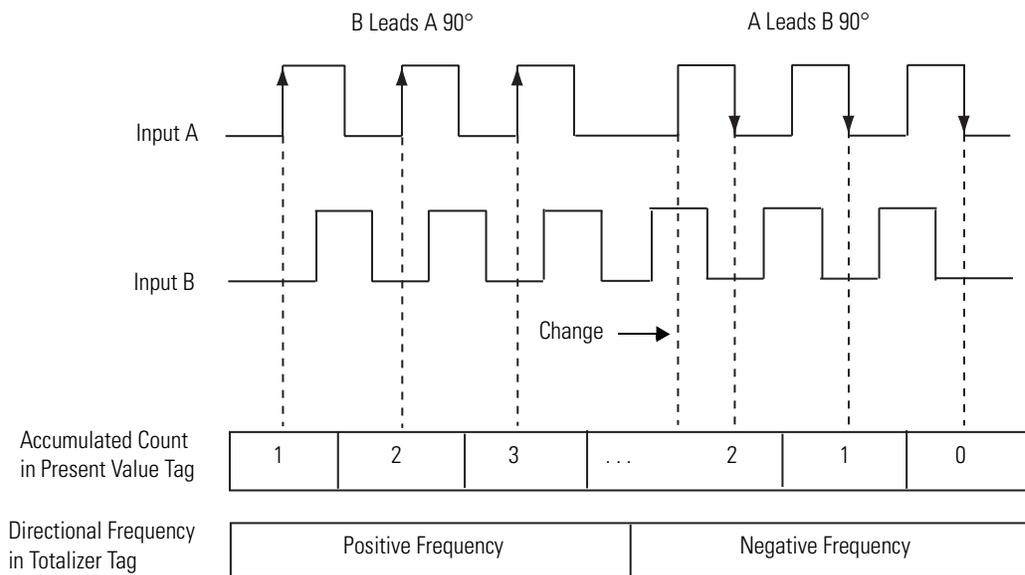
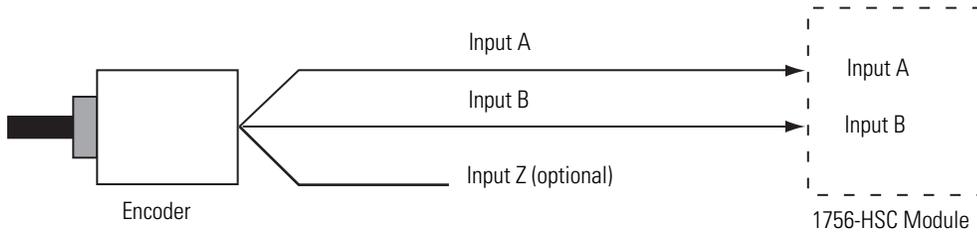
In Encoder x1 mode, an increasing count results when channel B is 90° ahead of channel A. The count is initiated on the rising edge of channel A, and the direction of the encoder is clockwise (positive).

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 23](#) for details on the Storage modes.

Encoder x1 Mode



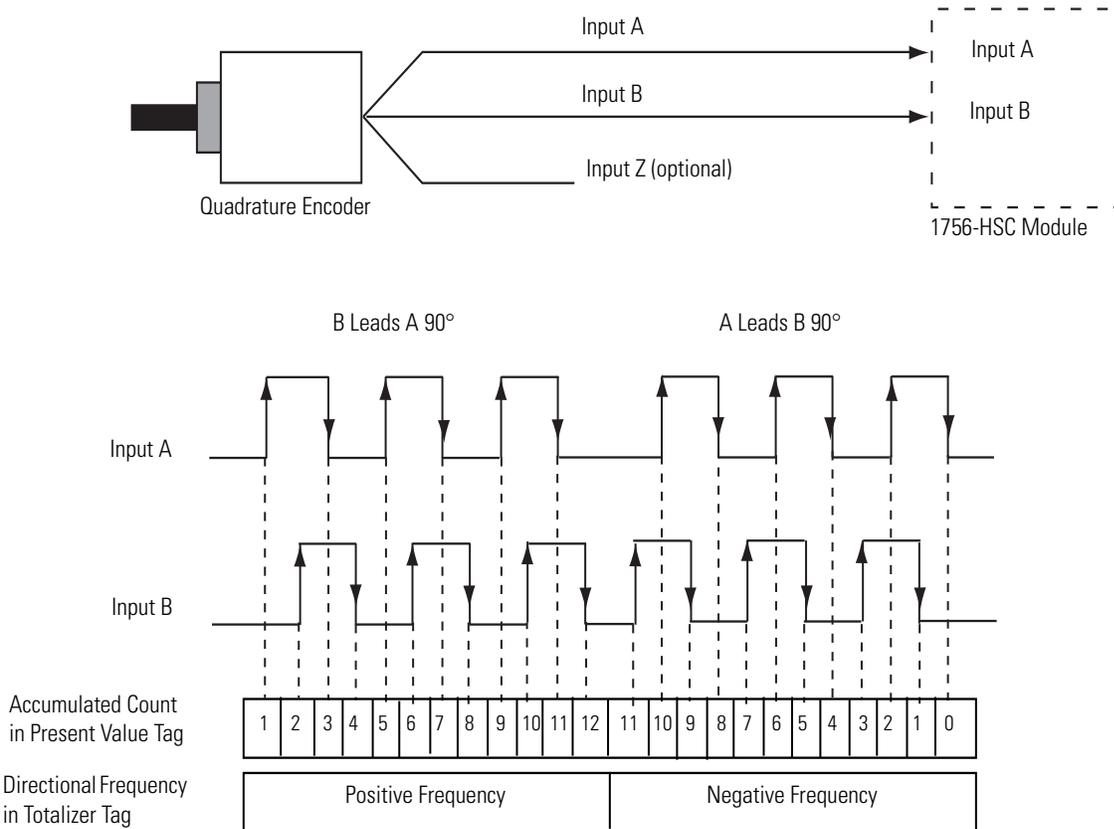
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Encoder x4

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 23](#) for details on the storage modes.

Encoder x4 Mode



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

Preset

Each of the two counters has one preset value 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 RSLogix 5000 programming software or ladder logic before it becomes active. Setting the Preset Enable Bit in the Output tag to '1' will send 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 65](#) 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 will be found in both the Configuration and Output tag areas.

The Configuration tag value is populated during software configuration with the Logix5000 controller, and sent to the module upon powerup, defining its behavior. This value will continue 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 non-zero value, the module will disregard the value 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 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 RSLogix 5000 programming software or can be changed in ladder logic.

See [page 65](#) 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 will be found in both the Configuration and Output tag areas.

The Configuration tag value is populated during software configuration with the Logix5000 controller, and sent to the module upon powerup, defining its behavior. This value will continue 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 non-zero value, the module will disregard the value 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 is 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 RSLogix 5000 programming software.

Storage Modes

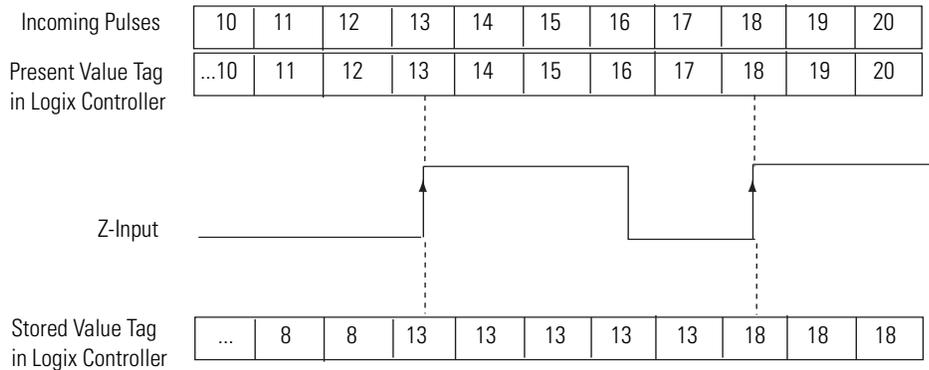
The store count feature allows the module to store the current count value and follow four behavioral paths, depending on which Store mode is selected. The store count is triggered by the state of the Z-input (the gate) on the module.

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

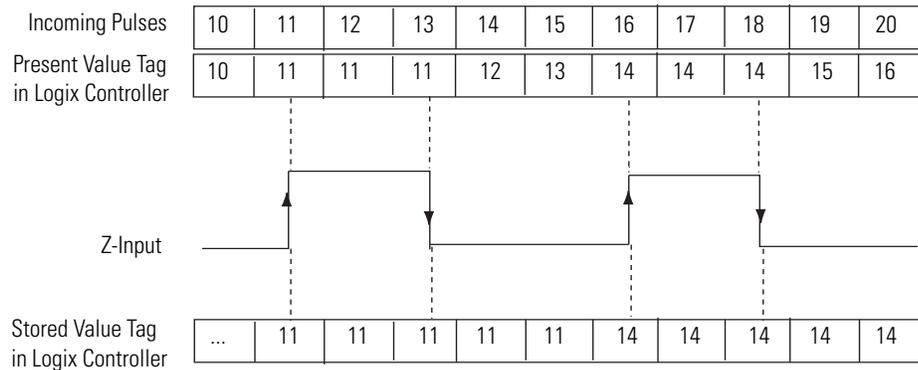


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In the Store and Continue mode, the module:

- 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 it is overwritten by new data from the next leading edge of a pulse on Input Z.

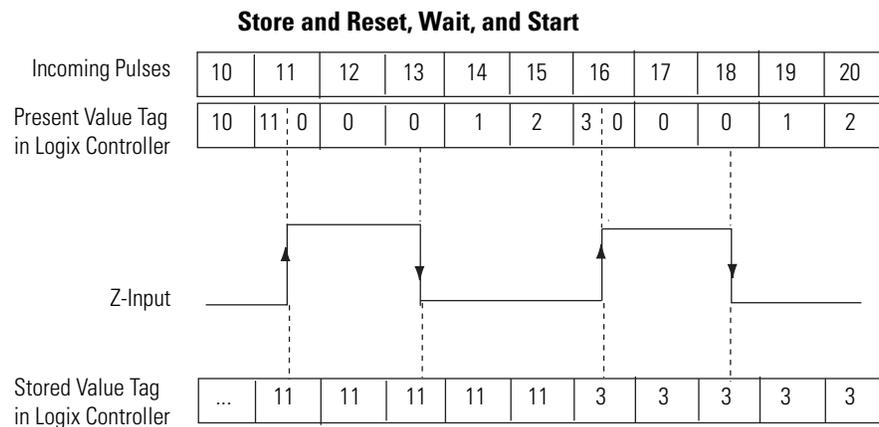
Store, Wait, and Resume



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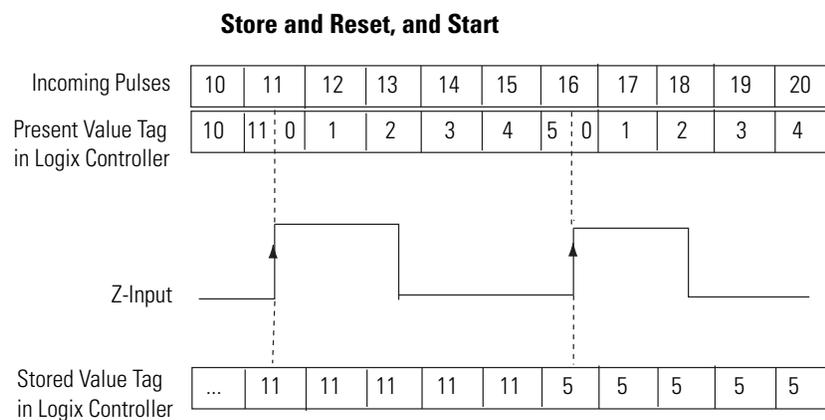
In the Store, Wait and Resume mode, the module:

- 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 it is overwritten by new data from the next leading edge of a pulse on Input Z.



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.



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 it is overwritten by new data from the next leading edge of a pulse on Input Z.

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, 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 μ s when the appropriate count value has been reached.

Assign Outputs to Counters

By using configuration tags or the RSLogix 5000 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's not possible to use the same output with two different counters.

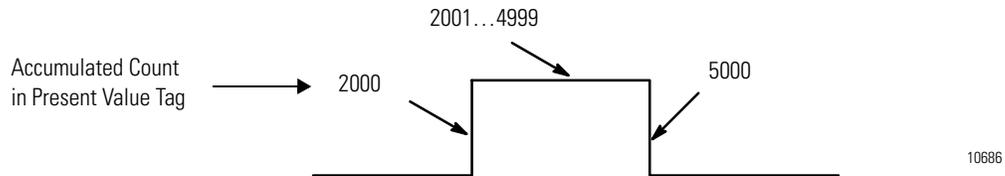
Each output on the 1756-HSC module can be turned On and Off at your discretion. The operation of outputs tied to a counter (on the Output Configuration tab of the Module Properties dialog box) are performed independently from the controller scans.

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 the following 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, make certain 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 1756-HSC/B 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.

| Topic | Page |
|--|------|
| Frequency Mode | 30 |
| Period Rate and Continuous Rate Modes | 32 |
| Output Operation | 35 |
| Period Rate /Continuous Rate Output Examples | 36 |

Frequency Overview

Each of the three Frequency modes use 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 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 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 35](#) for details.

Where Frequency Values are Stored in Tags

| Mode Description | Present Value Tag | Stored Value Tag | Totalizer Tag |
|---------------------------|--|------------------|-------------------------|
| Frequency | No. of input pulses occurring in Sample Period | Frequency | Accumulated pulse count |
| Period Rate Frequency | No. of 4 MHz pulses occurring in Sample Period | | |
| Continuous Rate Frequency | | | |

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 representing the sampled number of pulses in the Present Value tag, a value indicating the incoming frequency in the Stored Value tag and a value indicating 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 will increase. In general, if you are measuring a higher frequency, the Scaler can be small. If you are measuring a lower frequency, the Scaler likely will be 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 22](#) in Chapter 2 for preset and rollover tag details.

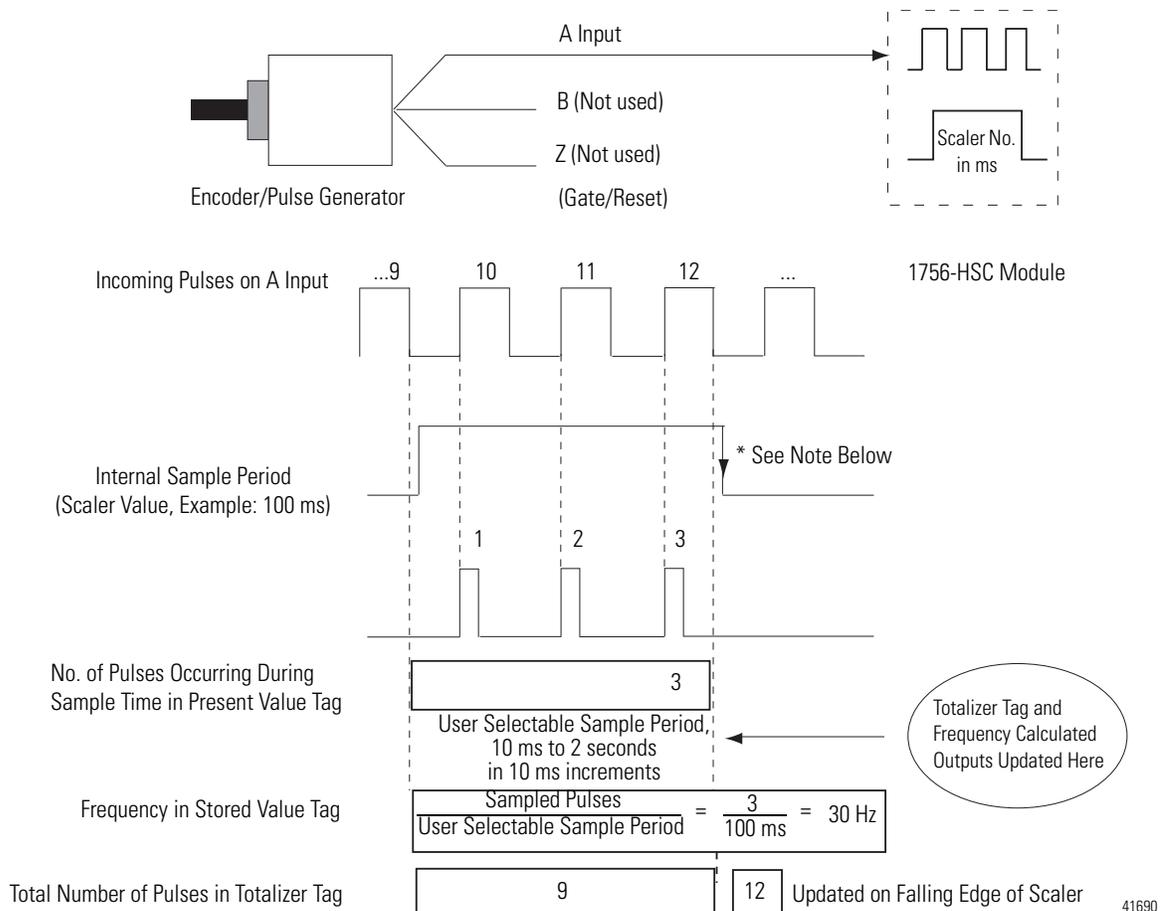
Sample Period for Frequency Mode

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 period of time can be set by varying the Scaler tag, which can range from 10...2000 in 10 ms increments. For example, a Scaler value of 100 = 100 ms. The default value is 1 second.

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

In the following 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.

Frequency Mode



* Always Inactive for 10 ms Regardless of Scaler

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.

$$\text{Frequency} = .5 \times \text{Scaler} / 250 \text{ ns} \times 4 \text{ MHz pulses}$$

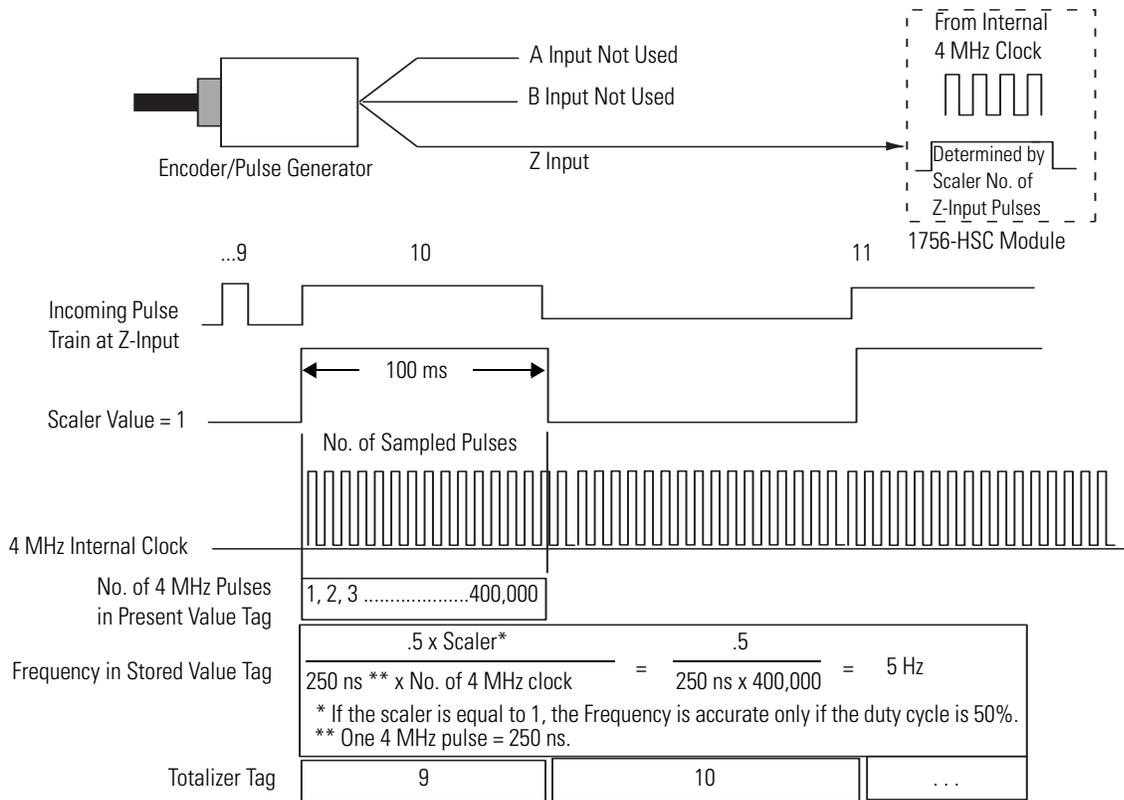
At the end of the sample period, the module returns the frequency in the Stored Value tag, the number of internal 4 MHz pulses in the Present Value tag, and a value indicating the total number of Z-input pulses that have occurred in the Totalizer tag. The output On/Off values are related to the value 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 36](#) for details.

Period Rate / Continuous Rate Modes



41684

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 will decrease with increasing input frequencies at the Z-input. The decrease in accuracy can be lessened by scaling the input frequency through the use of the Scaler tag.

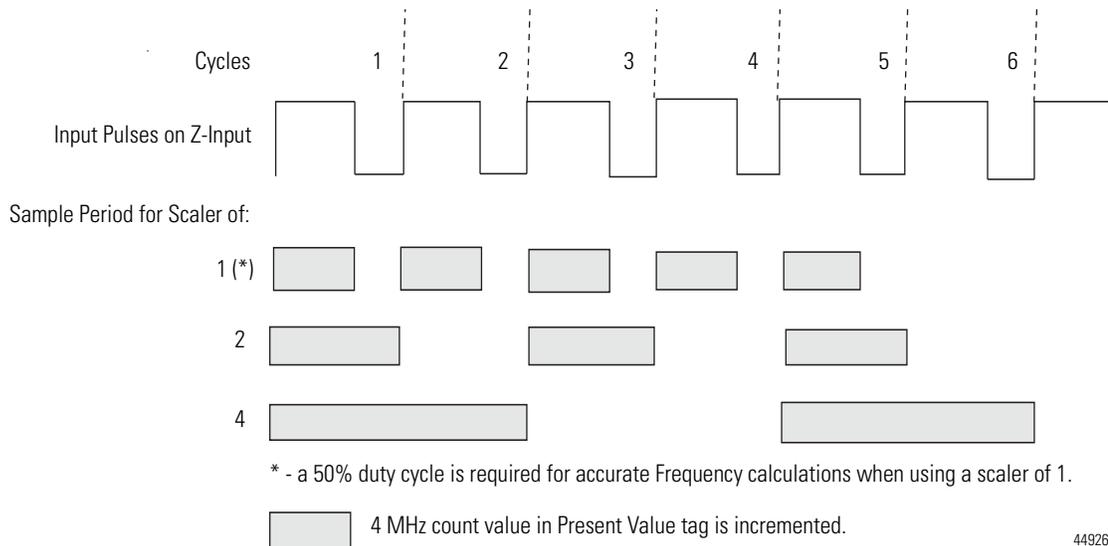
The Scaler configuration allows the incoming pulse train at the Z-input to be divided by a user-defined number. The internal 4 MHz pulses are counted for the duration of an input pulse, or multiple pulses if the Scaler is > 1. Measuring multiple input periods increases the accuracy of your measurement.

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 will vary 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.

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 | 4,000 |
| | 2 | 8,000 |
| | 4 | 16,000 |

Output Operation

The Period Rate and Continuous Rate frequency operational modes differ in the operation of their respective on-board 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.

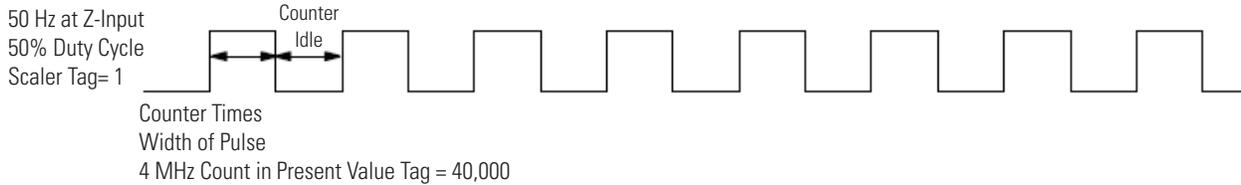
In both Period Rate and Continuous Rate, the Present Value, Stored Value, and Totalizer tags are updated at the end of the sample period.

See [page 36](#) for square wave examples in Period Rate and Continuous Rate modes.

Period Rate /Continuous Rate Output Examples

The following 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 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.

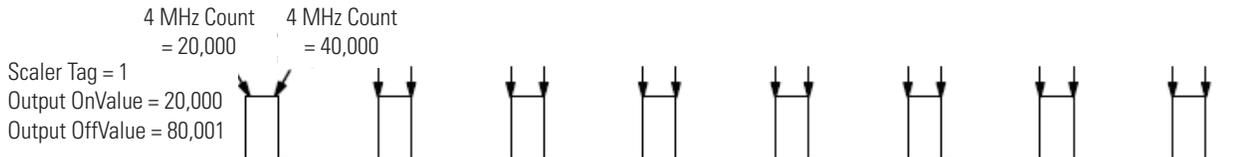
Outputs in Period Rate and Continuous Rate with Scaler = 1



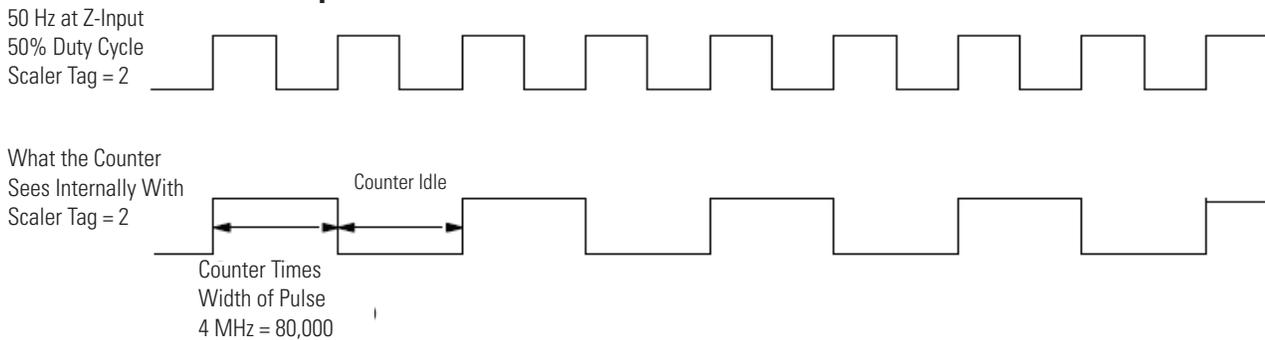
Output State in Period Rate



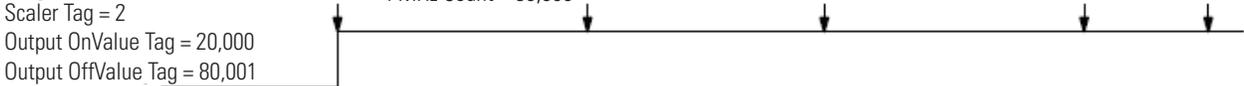
Output State in Continuous Rate



Outputs in Period Rate and Continuous Rate with Scaler = 2



Output State in Period Rate



Output State in Continuous Rate



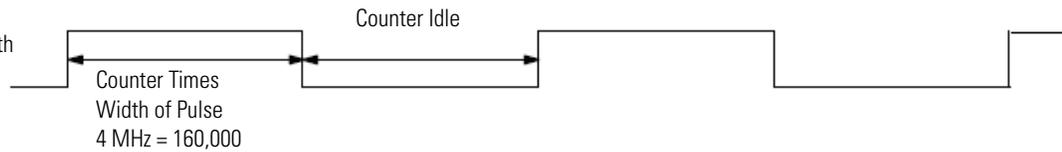
12633-1

Outputs in Period Rate and Continuous Rate with Scaler = 4

50 Hz at Z-Input
50% Duty Cycle
Scaler Tag = 4



What the Counter Sees Internally With Scaler Tag = 4



Output State in Period Rate

Scaler Tag = 4

Output OnValue Tag = 20,000

4 MHz Count = 160,000

4 MHz Count = 160,000

Output OffValue Tag = 80,001

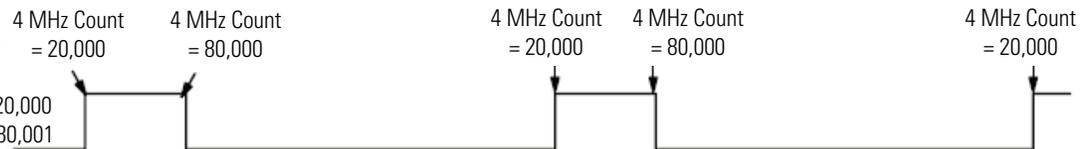


Output State in Continuous Rate

Scaler Tag = 4

Output OnValue = 20,000

Output OffValue = 80,001



12634-1

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 directly connected to the module.

The table lists the acceptable signal levels for the 1756-HSC 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 > 1µs | 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 1756-HSC module. If your module is already installed, proceed to [page 55](#).

| Topic | Page |
|---|------|
| Install the 1756-HSC Module | 41 |
| Key the Removable Terminal Block | 42 |
| Connect the Wires | 44 |
| Wire Terminations | 47 |
| Assemble the Removable Terminal Block and Housing | 50 |
| Install the Removable Terminal Block | 51 |
| Remove the Removable Terminal Block | 52 |
| Remove the Module from the Chassis | 53 |

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

| | |
|---|---|
| <p>The following information applies when operating this equipment in hazardous locations.</p> | <p>Informations sur l'utilisation de cet équipement en environnements dangereux.</p> |
| <p>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.</p> | <p>Les produits marques "CL I, DIV 2, GP A, B, C, D" ne conviennent qu'à une utilisation en environnements de Classe I Division 2 Groupes A, B, C, D dangereux et non dangereux. Chaque produit est livré avec des marquages sur sa plaque d'identification qui indiquent le code de température pour les environnements dangereux. Lorsque plusieurs produits sont combinés dans un système, le code de température le plus défavorable (code de température le plus faible) peut être utilisé pour déterminer le code de température global du système. Les combinaisons d'équipements dans le système sont sujettes à inspection par les autorités locales qualifiées au moment de l'installation.</p> |
| <p>WARNING</p>  | <p>EXPLOSION HAZARD -</p> <ul style="list-style-type: none"> • 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. |
| <p>RISQUE D'EXPLOSION –</p> <ul style="list-style-type: none"> • Couper le courant ou s'assurer que l'environnement est classe non dangereux avant de débrancher l'équipement. • Couper le courant ou s'assurer que l'environnement est classe non dangereux avant de débrancher les connecteurs. Fixer tous les connecteurs externes reliés à cet équipement à l'aide de vis, loquets coulissants, connecteurs filetés ou autres moyens fournis avec ce produit. • La substitution de composants peut rendre cet équipement inadapté à 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 1756-HSC 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.

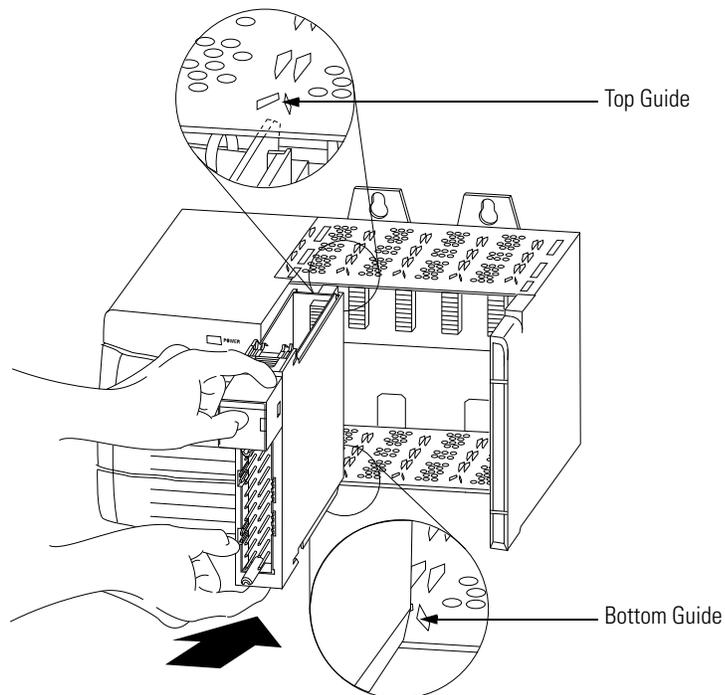
WARNING



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.

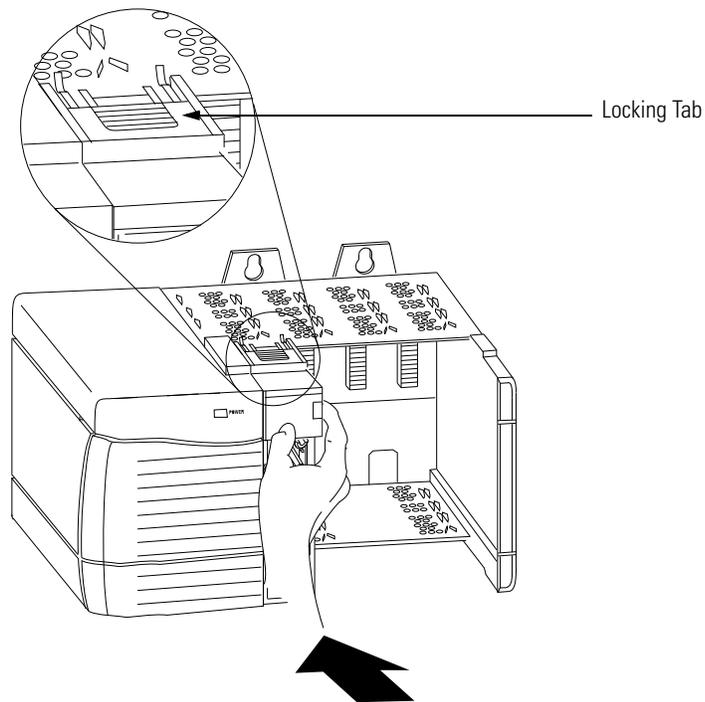
Be sure that power is removed or the area is nonhazardous before proceeding.

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



20861-M

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



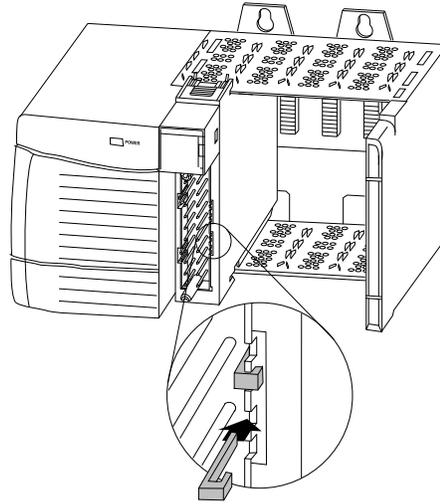
20862-M

Key the Removable Terminal Block

You should key the RTB to prevent inadvertently connecting the incorrect RTB to your module.

When the RTB mounts onto the module, keying positions will 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 will 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.

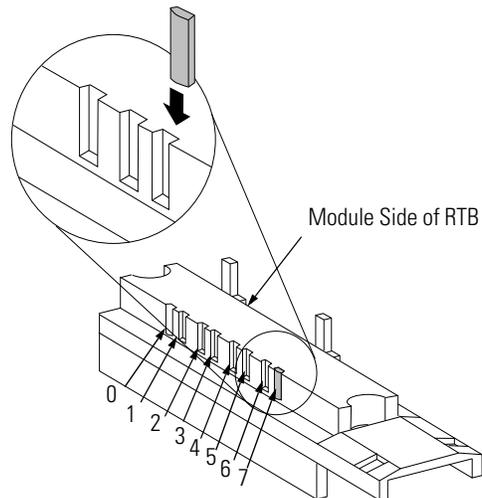


20850-M

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.



20851-M

Wiring the Module

Before wiring the module, adhere to the following 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.

ATTENTION



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

ATTENTION



When using the 1756-TBCH, do not wire more than two 0.33...1.3 mm² (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, do not wire more than 1 conductor on any single terminal.

Connect the Wires

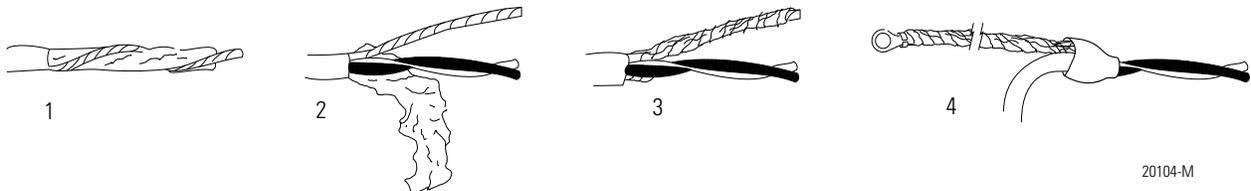
You can use an RTB to connect wiring to your module. For most applications, we recommend using Belden 8761 cable. The RTB terminations can accommodate 0.33...1.3 mm² (22...16 AWG) shielded wire. Before wiring the RTB, you must connect ground wiring.

Follow these directions to ground the wiring to the RTB.

IMPORTANT

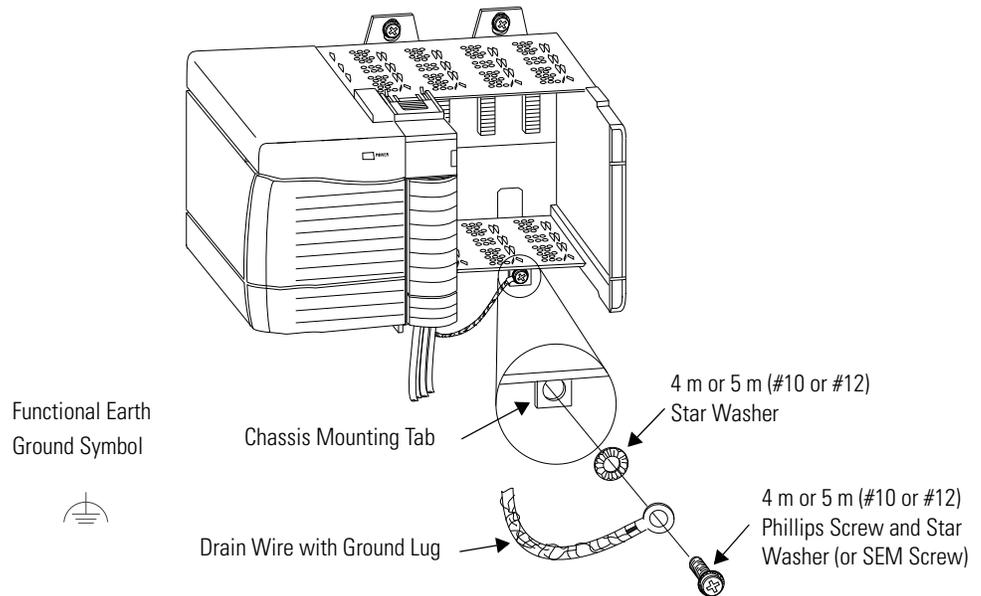
We recommend you ground the drain wire at the field-side. If you cannot ground at the field-side, ground at an earth-ground on the chassis as shown below.

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.



20104-M

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



20918-M

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

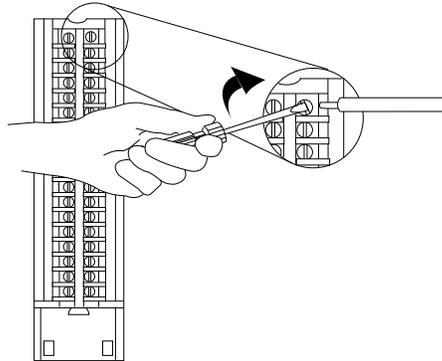
Follow these directions to connect the ungrounded end of the cable.

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

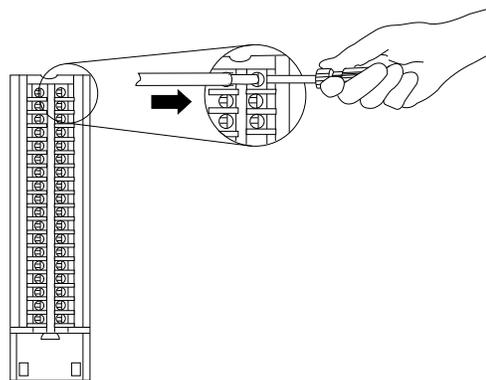
1. Insert the wire into the terminal.
2. Turn the screw clockwise to close the terminal on the wire.



20859-M

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.



20860-M

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.

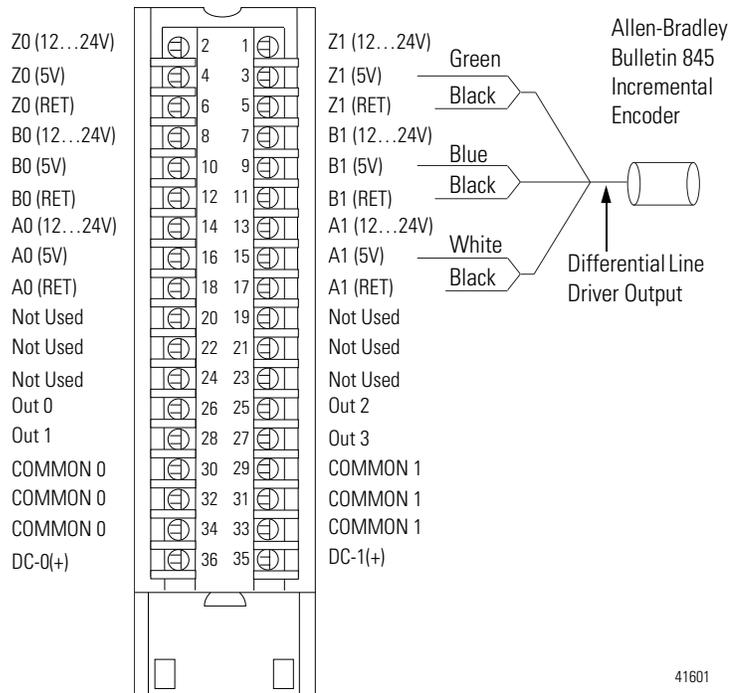
Wire Terminations

The following 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 |

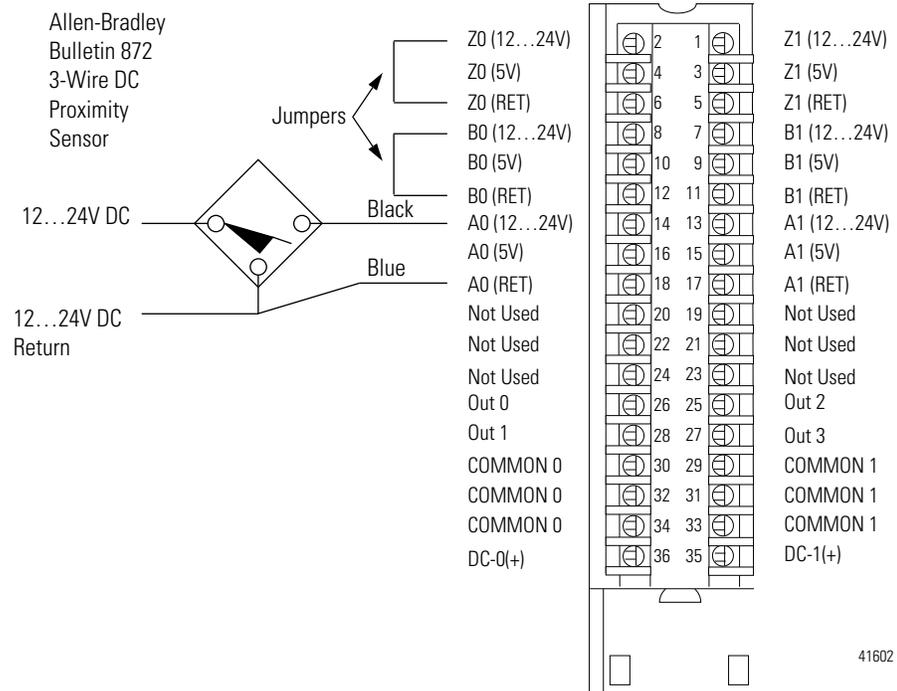


41601

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.

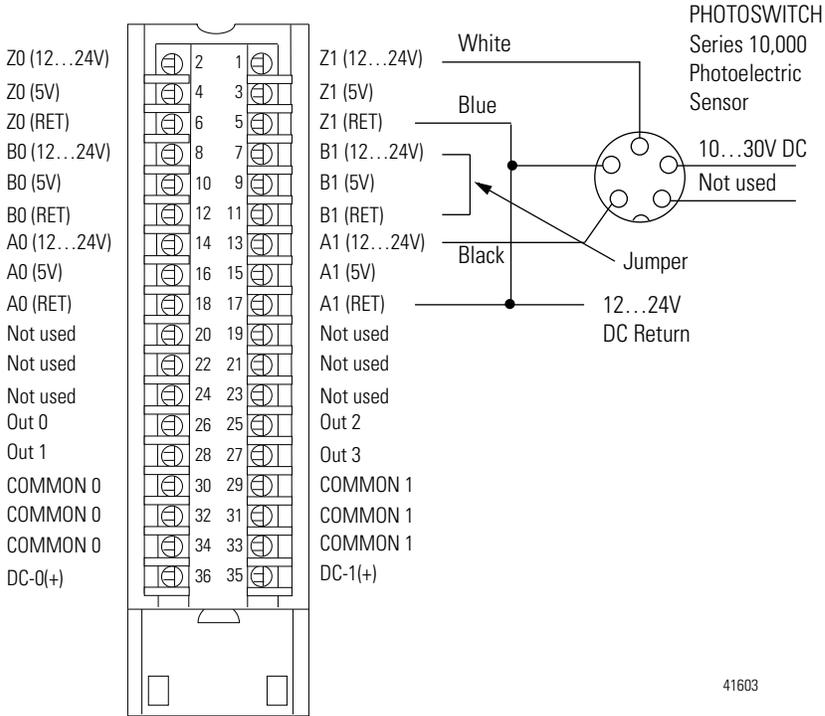
| Application | A0 Connections | B0 Connections | Z0 Connections |
|---------------------|---|------------------------------------|------------------------------------|
| PNP (Sourcing) N.O. | Black - A0 12...24V DC Blue, PS(-)-A0 Return | Jumper B0 12...24V DC to B0 Return | Jumper Z0 12...24V DC to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

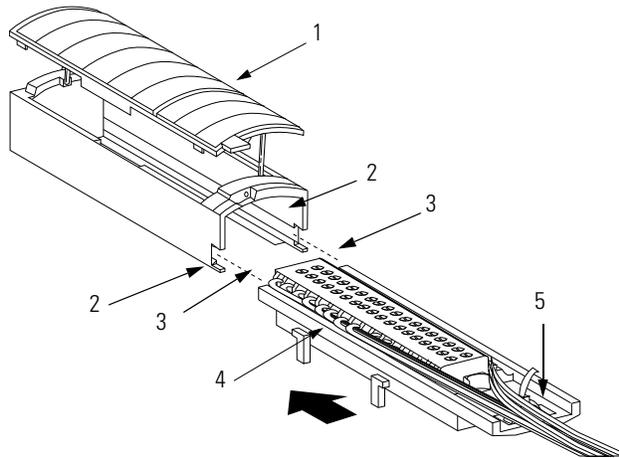
| Application | A1 Connections | B1 Connections | Z1 Connections |
|-------------|--|------------------------------------|--|
| Any | Black - A1 12...24V DC Blue - A1 Return | Jumper B1 12...24V DC to B1 Return | White - Z1 12...24V DC Blue - Z1 Return |



41603

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 (example below) are identified in the table.



20858-M

| 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



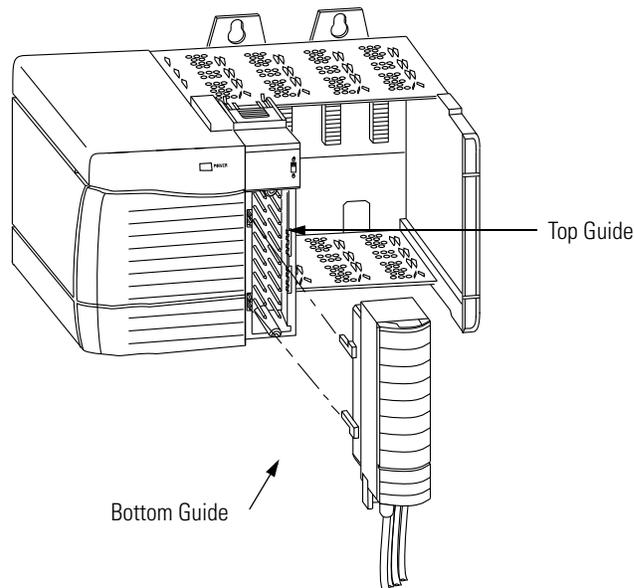
When you connect or disconnect the Removable Terminal Block (RTB) with field side power applied, an electrical arc can occur. This could cause an explosion in hazardous location installations.

Be sure that power is removed or the area is nonhazardous before proceeding.

Before installing the RTB, make certain:

- 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.

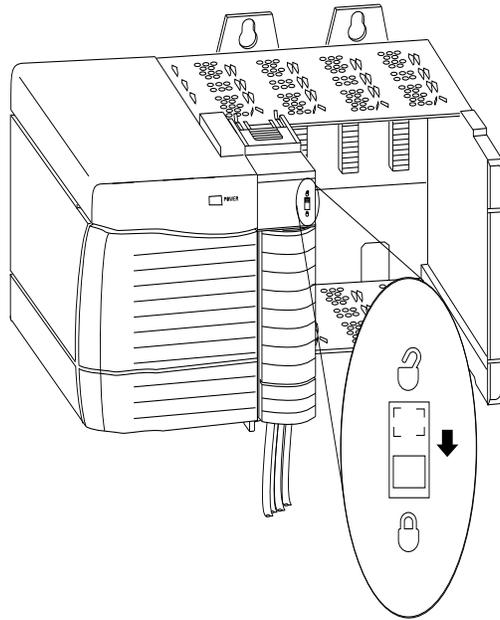
1. Align the top, bottom, and left side guides of the RTB with the guides on the module.



20853-M

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.



20854-M

Remove the Removable Terminal Block

If you need to 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.

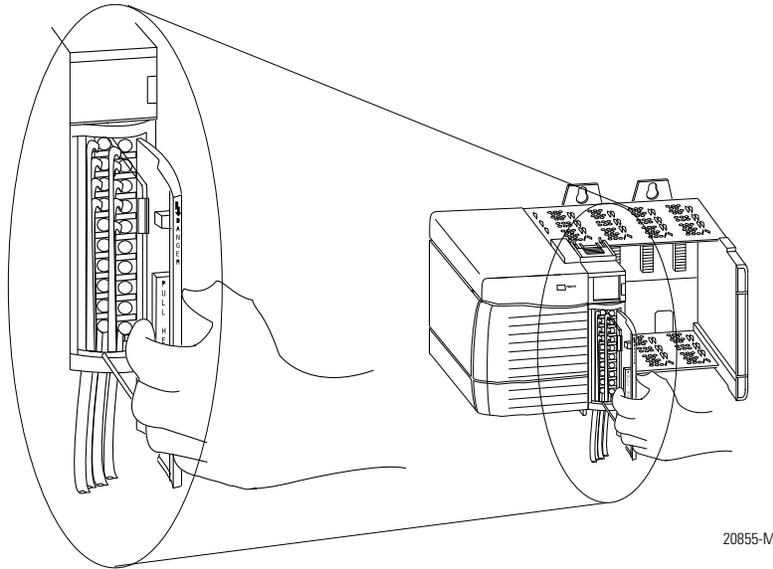
Be sure that power is removed or the area is nonhazardous before proceeding.

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

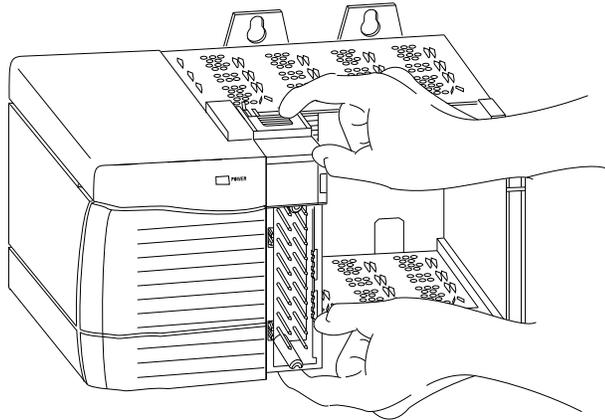
Follow these steps to remove a module from its chassis.

WARNING

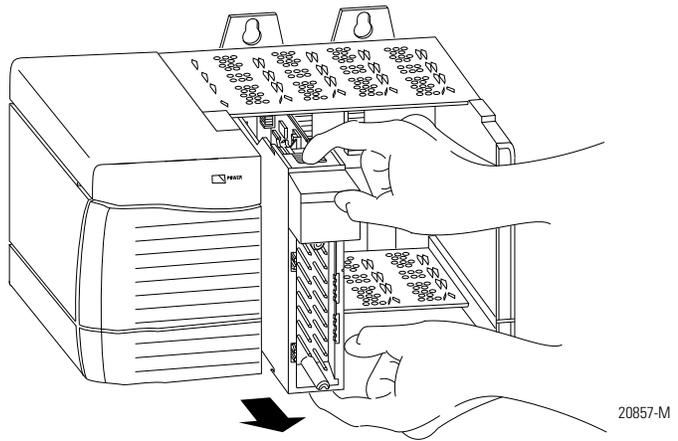
When you insert or remove the module while backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

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.



Configure the 1756-HSC Module

Introduction

This chapter describes how to configure the 1756-HSC/B module, firmware revision 3.x, by using RSLogix 5000 programming software, version 18 and later. Your 1756-HSC module will not work until it has been configured.

See [Appendix C](#) for profiles of the 1756-HSC/A. The instructions include firmware revisions 1.x and 2.x and RSLogix 5000 software versions 15...18.

IMPORTANT

RSLogix 5000 programming software must be installed on your computer to complete the procedures for both default and custom configurations.

For software installation instructions and to learn how to navigate the software package, see the RSLogix 5000 Getting Results Guide, publication [9399-RLD300GR](#).

| Topic | Page |
|---|------|
| ControlLogix Overview | 55 |
| Configure a 1756-HSC/B, Module by using RSLogix 5000 Software, Version 18 and Later | 59 |
| Set Up Counter Configuration | 65 |
| Set Up Output Configuration | 68 |
| Copy Configuration (.C) Output, Rollover, Preset Tags to Output (.O) Tags | 71 |
| Electronic Keying | 73 |
| Download Configuration to the 1756-HSC Module | 79 |

ControlLogix Overview

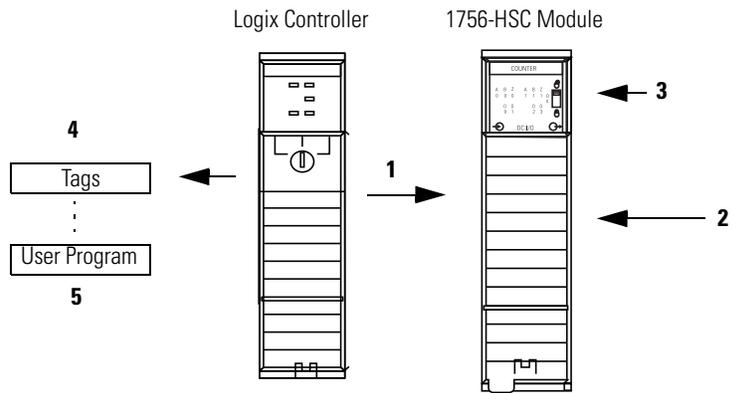
Before configuring your 1756-HSC module in a local or remote chassis, you must have an understanding of how the module operates with the controller in the ControlLogix system. Every 1756-HSC module must be owned by a Logix5000 controller. This owner-controller stores configuration data for every 1756-HSC 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 powerup or a controller-initiated reconfigure. Adding the 1756-HSC module to the I/O configuration tree of the RSLogix 5000 programming software creates configuration and I/O data structures and tags for the 1756-HSC module.

A remote chassis, also known as a networked chassis, contains the 1756-HSC module but not the module’s owner-controller. See [page 57](#) 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 1756-HSC module performs as configured, either setting all outputs to reset (On or Off) or continuous operations.

Module Communication with its Owner-controller



44779

| 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. |

A module’s 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 the following 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 RSLogix 5000 programming software may 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 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 by using the RSLogix 5000 programming software. This value can be adjusted when the controller is in Program mode.

See [page 64](#) for RPI settings.

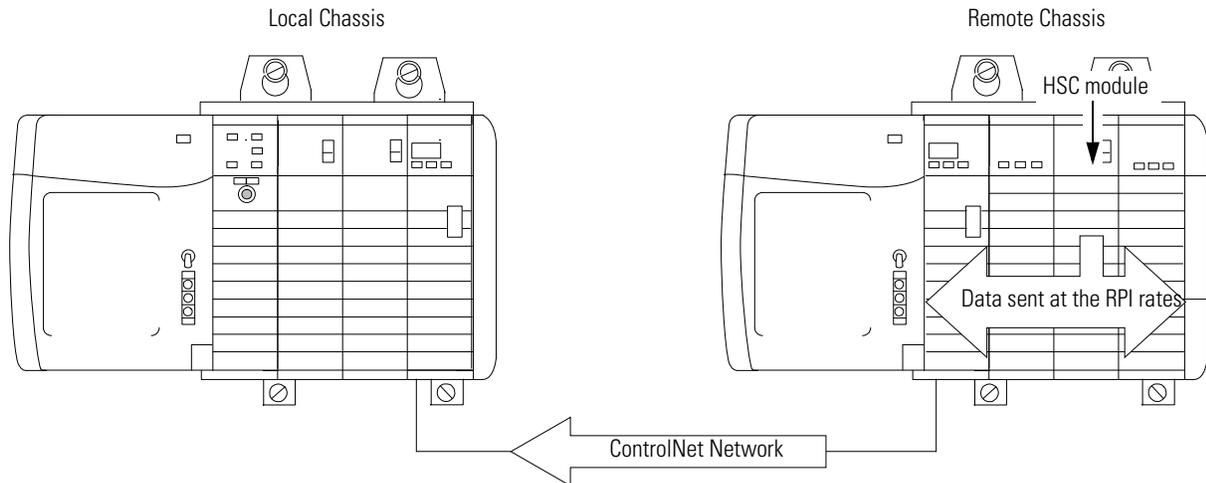
Remote Chassis Operation

If a module resides in a networked chassis, the role of the RPI changes slightly with respect to 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 may not 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 module at a rate no slower than the configured RPI.

Data from Remote Chassis Sent to ControlNet Bridge Module



40947

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 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** downloading 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.

Configure a 1756-HSC/B, Module by using RSLogix 5000 Software, Version 18 and Later

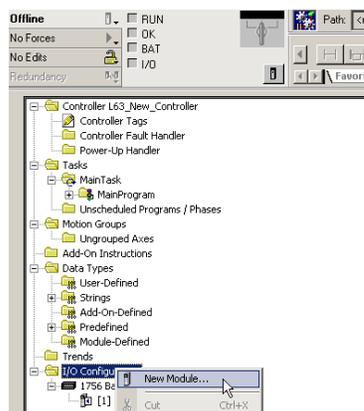
After reviewing [Chapter 2](#) and [Chapter 3](#) for a better understanding of the capabilities of your 1756-HSC/B module, you are ready to configure the module by using RSLogix 5000 programming software, version 18 and later. This section provides instructions and screen facsimiles for creating a 1756-HSC/B module.

IMPORTANT

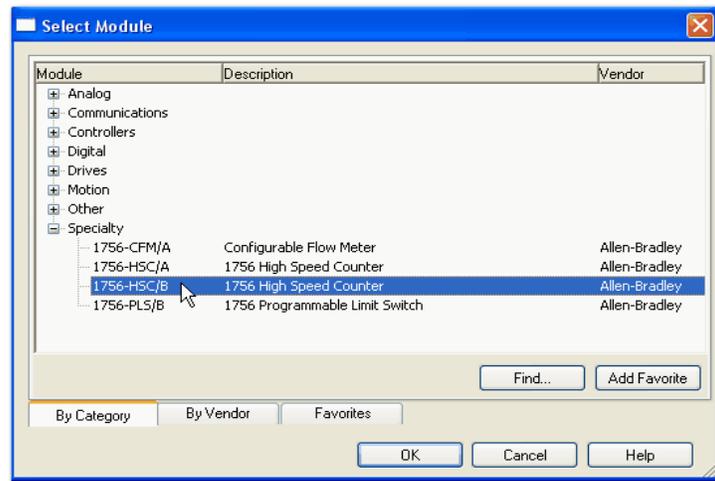
RSLogix 5000 software, version 15 and later, lets you add I/O modules online. When using any previous version, you must be offline when you create a new module.

The following steps assume that you have started the RSLogix 5000 programming software and have created a controller.

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

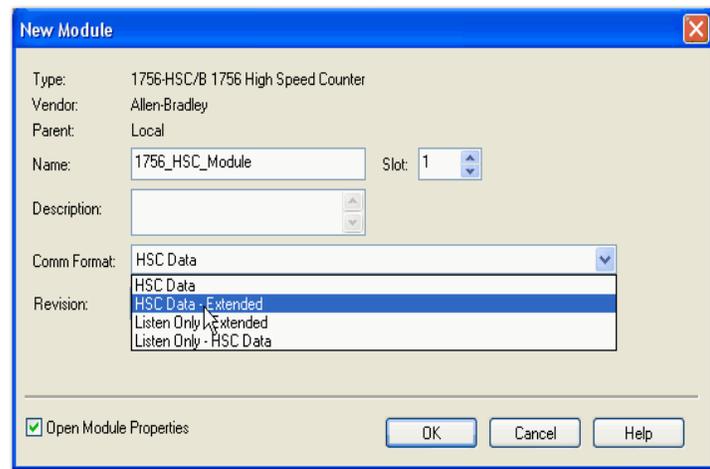


The Select Module dialog box appears.



2. Click the '+' next to Specialty for a list for this module group.
3. Select 1756-HSC/B 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 62](#) 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 will 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 in conjunction with the electronic keying to determine the connection.

9. Choose an electronic keying method.

See [page 73](#) for details.

IMPORTANT

Controllers that have RSLogix 5000 software, version 17 or earlier, should use Compatible Keying for the 1756-HSC/B module. You must upgrade to version 18 or later if Exact Match is required; otherwise, there will be no connection with the controller.

10. Do one of the following to either 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 set up 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 a 1756-HSC 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.

The following table describes the four communication formats available for the 1756-HSC/B module.

| Communication Format | Description |
|----------------------|---|
| HSC Data | Format used by an owner-controller to invoke the original functionality for the 1756-HSC 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 1756-HSC module to revision 1.x functionality. |
| HSC Data-extended | Format used by an owner-controller to invoke the 1756-HSC 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 used by a controller to listen-only to a 1756-HSC module that is using the HSC Data Comm Format that is configured by another controller. |
| Listen-only Extended | Format used by a controller to listen-only to a 1756-HSC module that is using the HSC Data-extended Comm Format that is configured by another controller. |

IMPORTANT

See [page 63](#) 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.

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 | N/A | N/A |
| 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 | N/A | N/A | N/A |
| 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).

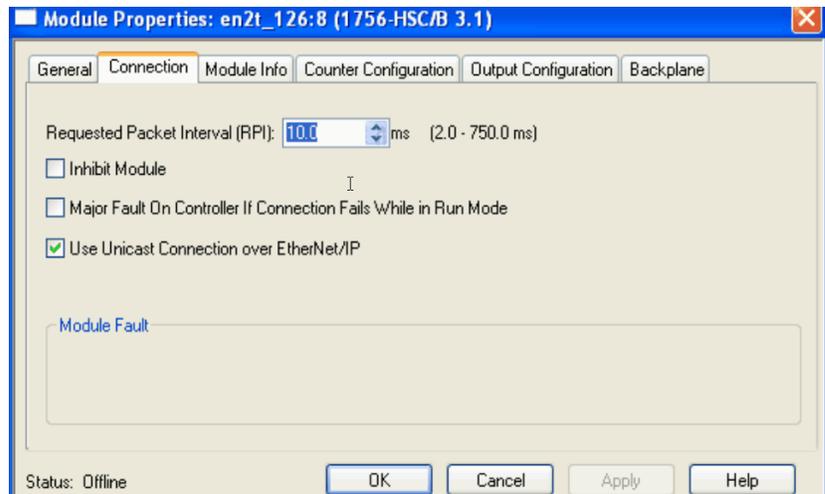
⁽³⁾ Rollover/Preset settings apply.

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 will be produced to the owner-controller.

The module's actual data transfer rate may be faster than the RPI setting. But, the RPI provides a defined, maximum period of 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 1756-HSC module. This option allows for maintenance of the 1756-HSC 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 1756-HSC module while in Run mode. For important information on this checkbox, see 'Configure a Major Fault to Occur' in the Logix5000 Controllers Information and Status Programming Manual, publication 1756-PM015 . |

| Field | Description |
|---------------------------------------|--|
| Use Unicast Connection on EtherNet/IP | Displays only for 1756-HSC modules using RSLogix 5000 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 1756-HSC 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 66](#) 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.

TIP

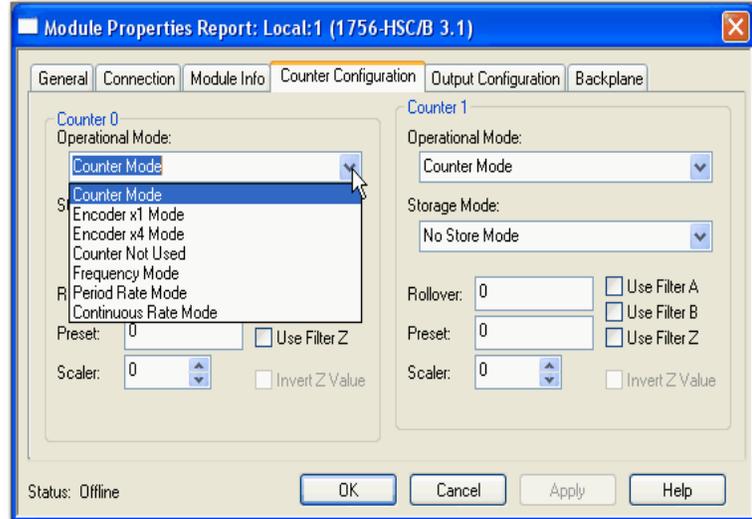
The different operational modes are detailed on [page 17](#) in Chapter 2.

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 | <p>Choose an operational mode based on your application requirements. These are the values:</p> <ul style="list-style-type: none"> Counter Mode (default) Encoder x1 Mode Encoder x4 Mode Counter Not Used Frequency Mode Period Rate (valid with HSC Data-extended format only) Continuous Rate (valid with HSC Data-extended format only) <p>See Chapter 2 and Chapter 3 for details and illustrations on Counter and Frequency mode operations.</p> |

| Field | Description |
|--------------|---|
| Storage Mode | <p>Choose how the pulse count will be stored (with the mode selected in the above field) if required for an accumulated count. These are the values:</p> <ul style="list-style-type: none"> • 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 <p>See Storage Modes in Chapter 2 for details.</p> |
| Rollover | <p>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.</p> <p>Range is 0...16,777,214.</p> <p>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.</p> |
| Preset | <p>Box defaults to zero (0) if a Preset command is issued. The 1756-HSC module's Present Value tag will be set to the present value.</p> <p>Range is 0...Rollover value.</p> <p>This configuration setting can be overridden by a value in the Output tag for the HSC Data-extended format only. See Preset in Chapter 2 for details.</p> |
| Scaler | <p>Defaults to zero (0).</p> <p>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.</p> <p>For Period Rate/Continuous Rate modes, pulses will be used to count internal 4 MHz pulses. Allowable values are 0, 1, 2, 4, 8, 16, 32, 64, 128, 256.</p> <p>A value of zero is equivalent to 1. Valid with the HSC Data-extended Comm Format only.</p> |

| Field | Description |
|--|--|
| 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 the following 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 70 Hz.
 - module does not count any pulses at a frequency above 150 Hz.
 - frequencies between 71...148 Hz the operation is unpredictable and varies with duty cycles.

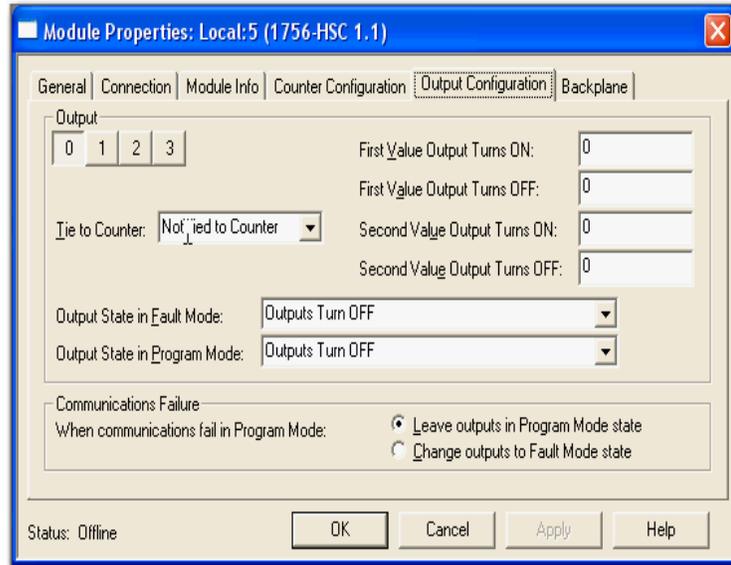
Set Up Output Configuration

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 1756-HSC/B module. The tab lets you set up and maintain the four on-board outputs, which compare user-defined values to the Present Value tag to turn outputs On or Off.

Follow these steps to set up 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • Outputs Turn On • Counter Continues to Determine Outputs Operation <p>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.</p> <p>See page 71 for ladder logic procedures.</p> |

| Field | Description |
|--|--|
| 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.

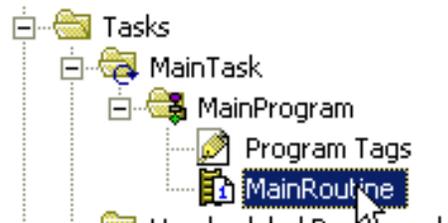
For example, if the outputs are configured to turn ON when in Program mode in the configuration structure and that data is not copied into the output tag structure and is left zero, the output will instead be Off during Program mode.

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 will help synchronize the data tags; when the configuration tags are established or modified, the same data will be 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 sub-menu 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 the following information:

Source -- Local:3:C.Output[0]

Dest -- Local:3:O.Output[0]

Length -- 4 (this is the size of the array with 4 outputs: 0, 1, 2, 3)

Your routine should look like the following 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.

Only needed if using HSC Extended Data communication format.

With the addition of the dynamic Output on/off, Rollover and Presets to the Output Tag area in HSC V2.1, these functions now have the ability to be controlled by separate tags in both the module Configuration and Output Tag areas. This can lead to confusion and inconsistency if both locations are not equal. By copying the .Configuration tags to the .Output tags, the values in both locations will always be equal. This will allow changes made in the HSC profile screens to automatically affect both locations resulting in the same value in each. The .Output words will then be the primary words used by the HSC for these functions.

This rung 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.

The diagram shows a single rung of a ladder logic program with three CPS commands in series. Each command is in a box labeled 'CPS' and contains the following text: 'Synchronous Copy File', 'Source', 'Dest', and 'Length'. The first command has Source Local:3:C.Output[0] and Dest Local:3:O.Output[0] with Length 4. The second command has Source Local:3:C.RollOver[0] and Dest Local:3:O.RollOver[0] with Length 2. The third command has Source Local:3:C.Preset[0] and Dest Local:3:O.Preset[0] with Length 2. The rung is connected to a power rail on the left and a neutral rail on the right.

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 RSLogix 5000 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 RSLogix 5000 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 Logix5000 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, generally 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, that is higher, Major Revision supports at least all of the data formats supported by an earlier, that is 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 may 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 Logix5000 controller.

EXAMPLE

In the following 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

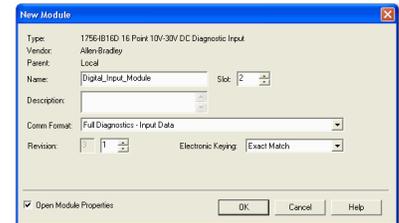
Vendor = Allen-Bradley

Product Type = Digital Input
Module

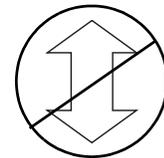
Catalog Number = 1756-IB16D

Major Revision = 3

Minor Revision = 1



Communication is prevented.



Physical Module

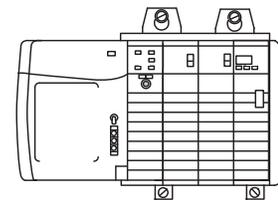
Vendor = Allen-Bradley

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.

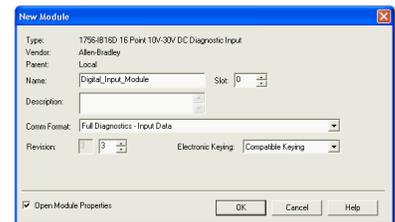
EXAMPLE

In the following scenario, **Compatible Keying prevents I/O communication**:

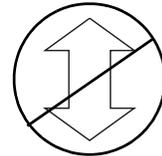
The module configuration is for a 1756-IB16D module with module revision 3.3. The physical module is a 1756-IB16D module with module revision 3.2. In this case, communication is prevented because the minor revision of the module is lower than expected and may not be compatible with 3.3.

Module Configuration

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

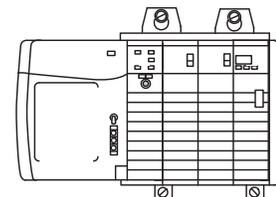


Communication is prevented.



Physical Module

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



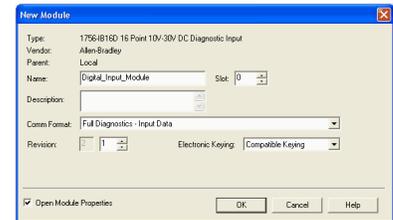
EXAMPLE

In the following scenario, **Compatible Keying allows I/O communication**:

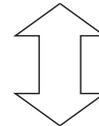
The module configuration is for a 1756-IB16D module with module revision 2.1. The physical module is a 1756-IB16D module with module revision 3.2. In this case, communication is allowed because the major revision of the physical module is higher than expected and the module determines that it is compatible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

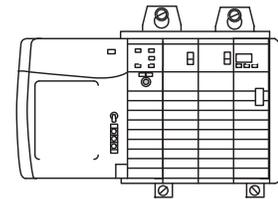


Communication is allowed.



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.

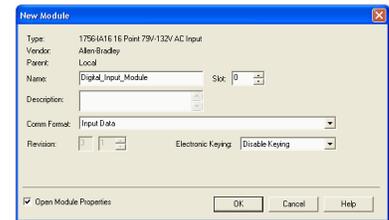
EXAMPLE

In the following scenario, **Disable Keying prevents I/O communication**:

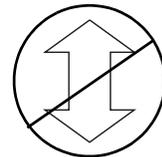
The module configuration is for a 1756-IA16 digital input module. The physical module is a 1756-IF16 analog input module. In this case, **communication is prevented because the analog module rejects the data formats that the digital module configuration requests.**

Module Configuration

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

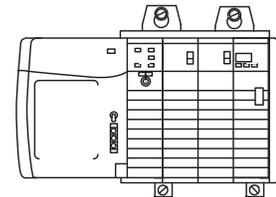


Communication is prevented.



Physical Module

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



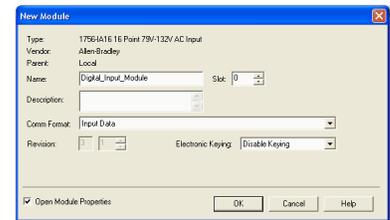
EXAMPLE

In the following scenario, **Disable Keying allows I/O communication**:

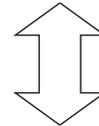
The module configuration is for a 1756-IA16 digital input module. The physical module is a 1756-IB16 digital input module. In this case, communication is allowed because the two digital modules share common data formats.

Module Configuration

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

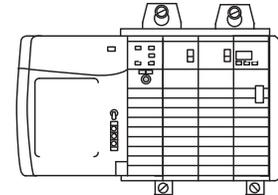


Communication is allowed.



Physical Module

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

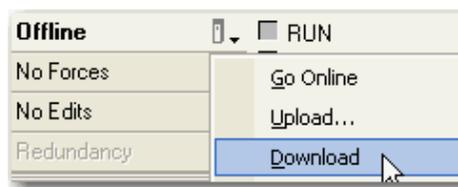


Download Configuration to the 1756-HSC Module

After you have changed the configuration data for a 1756-HSC 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. At the top, left corner of the RSLogix 5000 software program, click the status icon.



2. Choose Download.

The Download dialog box appears.



3. Click Download.

Module Diagnostics

Introduction

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

| Topic | Page |
|----------------------------------|------|
| 1756-HSC Error Codes | 81 |
| RSLogix 5000 Diagnostics | 82 |
| Troubleshoot the 1756-HSC Module | 84 |

1756-HSC Error Codes

Errors are displayed on the Connection tab of the Module Properties dialog box in RSLogix 5000 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.

The following table lists possible errors on your 1756-HSC module.

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 |

Counter Configuration Errors

| Error Code | Definition |
|-------------------|---|
| 16#0051, 16#0052 | <p>BADSCALE - Occurs if you take any of the following actions in the Counter/Frequency modes:</p> <ul style="list-style-type: none"> • 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 <p>Occurs in Period Rate/Continuous Rate modes if the scaler is not 0, 1, 2, 4, 8, 16, 32, 64, 128, 256</p> |

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 |

RSLogix 5000 Diagnostics

In addition to the Status Indicator display on the module, RSLogix 5000 software will alert you to fault conditions.

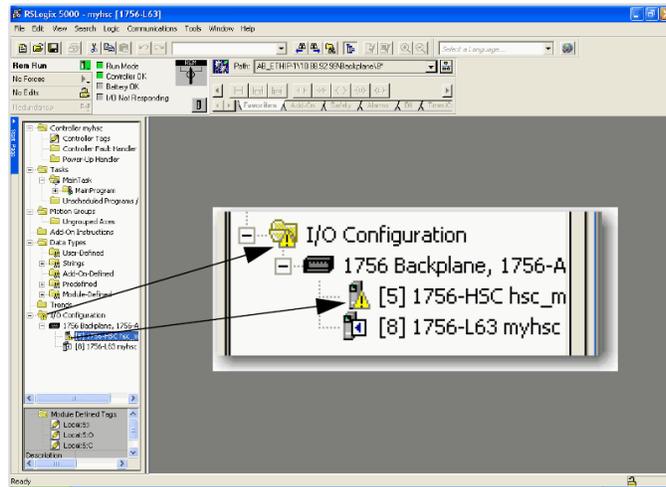
See [page 85](#) for details on status indicators.

Fault conditions in RSLogix 5000 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.

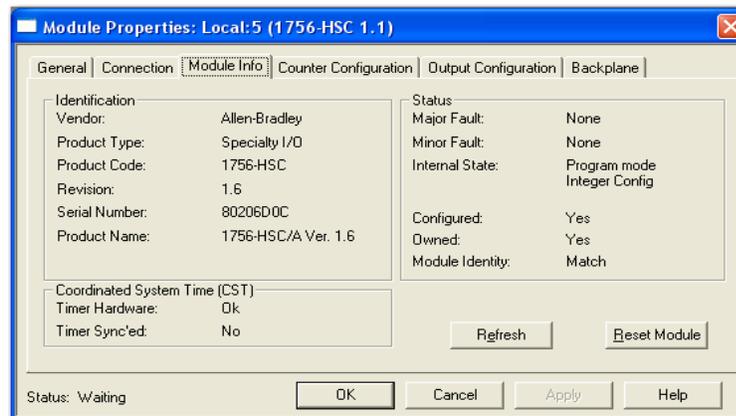
The following windows display fault notification in RSLogix 5000 software.

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

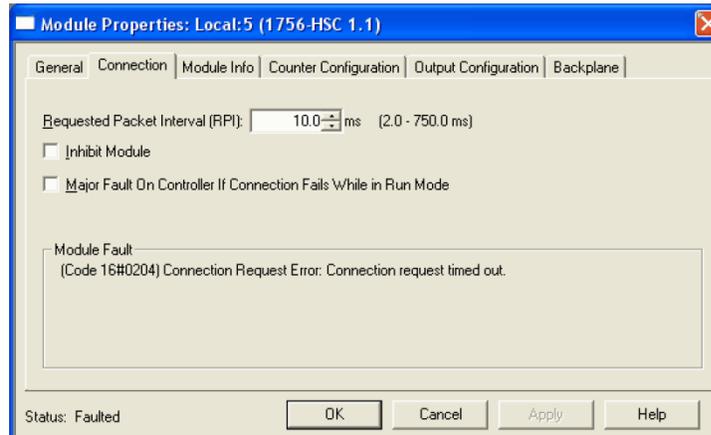
The screenshot shows the Tag Editor window. The 'Scope' is set to 'myhsc'. The table below shows the tag list:

| Name | Value | Force Mask | Style | Data Type | Description |
|-------------------|-------|------------|---------|-----------------|-------------|
| + Local:5:C | {...} | {...} | | AB:1756_HSC:0 | |
| - Local:5:I | {...} | {...} | | AB:1756_HSC:1:0 | |
| + Local:5:I Co... | 65535 | | Decimal | DINT | |
| + Local:5:I Pr... | {...} | {...} | Decimal | DINT[2] | |
| + Local:5:I St... | {...} | {...} | Decimal | DINT[2] | |
| + Local:5:I W... | 0 | | Decimal | SINT | |
| + Local:5:I W... | 0 | | Decimal | SINT | |
| + Local:5:I Ne... | 0 | | Decimal | SINT | |

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 RSLogix 5000 software and receive a Communication fault message, the Connection tab lists the type of fault under Module Fault.



Troubleshoot the 1756-HSC 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. | <ol style="list-style-type: none"> 1. Make sure the Storage mode is not set to 0. 2. Make sure 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. | <ol style="list-style-type: none"> 1. Make sure there is a value on the Rollover register. 2. Make sure 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. |

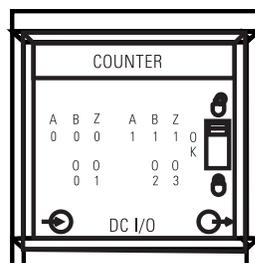
1756-HSC Status Indicators

Introduction

Each 1756-HSC module has indicators that show input and output status. Status indicators are located on the front of the module.

Status Indicators

The 1756-HSC module uses the following 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 disconnected | If you need to 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 need to use the output, check input wiring connections and your ladder program |
| | On/Yellow | Output turned on | None |

Notes:

1756-HSC Data Structures

Configuration, Output, Input

There are three categories of 1756-HSC data structures.

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

IMPORTANT

Some of the tags in the table below are followed by an 'x' or a 'y'. The 'x' indicates the same tag information applies for Channel 0 and Channel 1 on the 1756-HSC module. The 'y' indicates the same tag information applies for the four outputs (0...3) on the 1756-HSC module.

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] ⊕ | 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 22](#) and [page 23](#) in Chapter 2 for details.

1756-HSC Module Configuration Tags

| Name | Data Type | Style | Definition | Change During Operation ⁽¹⁾ |
|----------------------|-----------|---------|--|--|
| C.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 \geq 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 |
| 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 70 Hz. | Yes |
| C.FilterB.x | BOOL | Decimal | Designates whether channel B uses a filter. 0 = Do not use filter. 1 = Use 70 Hz. | Yes |
| C.FilterZ.x | BOOL | Decimal | Designates whether channel Z uses a filter. 0 = Do not use filter. 1 = Use 70 Hz. | Yes |

⊕ - This setting may be overridden by the output tag setting. See [page 22](#) and [page 23](#) in Chapter 2 for details.

1756-HSC Module Configuration Tags

| Name | Data Type | Style | Definition | Change During Operation ⁽¹⁾ |
|--------------------------------|-----------|---------|--|--|
| 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 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 22](#) and [page 23](#) 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 1756-HSC module output tags.

IMPORTANT

Some of the tags in the table below are followed by an 'x' or a 'y'. The 'x' indicates the same tag information applies for Channel 0 and Channel 1 on the 1756-HSC module. The 'y' indicates the same tag information applies for the four outputs (0...3) on the 1756-HSC module.

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 |

1756-HSC Module Output Tags

| Name | Type | Style | Definition | Change During Operation |
|---------------------------------|-------------|--------------|--|--------------------------------|
| 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 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 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 non-zero value, it will override the corresponding configuration tag setting. See [page 22](#) and [page 23](#) in Chapter 2 for details.

Input Structure

You must use input tags to monitor module status. The table lists and defines 1756-HSC module input tags.

IMPORTANT

Some of the tags in the table below are followed by an 'x' or a 'y'. The 'x' indicates the same tag information applies for Channel 0 and Channel 1 on the 1756-HSC module. The 'y' indicates the same tag information applies for the four outputs (0...3) on the 1756-HSC module.

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.CSTimestamp | DINT[2] | | Displays the coordinated system timestamp of the last sample in microseconds. |

Notes:

1756-HSC Module History

Introduction

This appendix describes Logix5000 profiles for 1756-HSC modules:

- Series A, firmware revisions 1.x; 2.x; software versions 15...18.
- Series B, firmware revision 3.x; software versions 15...18.

The table shows the profiles available for your 1756-HSC module based on the series, firmware, and software version that you are running.

| If you have module | Using firmware revision | And your desired functionality is | Then use the Logix5000 profile | Comment |
|--|---|------------------------------------|---|----------------------------------|
|  <p>Series A</p> | 1.x | Original (see Important below) | Versions earlier than 15 => Thin profile/tags only | Tag user-interface only |
| | | | Version 15 and later => Full profile support | Tags with a GUI interface |
| | 2.x | Original (see Important below) | Versions earlier than 15 => Thin profile/tags only | Exact Match Keying not supported |
| | | | Versions 15...17 => Full profile support | |
| | | | Version 18 and later => Select Major Revision 2 and HSC Data Comm Format | |
| | | Rollover and Preset in Output Tags | Versions earlier than 18 => Use generic profile/ HSC ACD File ⁽¹⁾ | Tags with a GUI interface |
| Version 18 and later => Select Major Revision 2 and HSC Data-extended Comm Format | Tags with a GUI interface. Totalizer tags not active. | | | |
|  <p>Series B</p> | 3.x | Original (see Important below) | Versions earlier than 15 => Thin profile/tags only | Exact Match Keying not supported |
| | | | Versions 15...17 => Full Profile Support | |
| | | | Version 18 and later => Select Major Revision 3 and HSC Data Comm Format | |
| | | Rollover and Preset in Output Tags | Versions earlier than 18 => Use generic profile/HSC ACD File ⁽¹⁾ | |
| | | Period/Continuous Rate | Version 18 and later => Select Major Revision 3 and HSC Data-extended Comm Format | |
| | | Totalizer | | |

⁽¹⁾ File is located at <http://samplecode.rockwellautomation.com>.

IMPORTANT

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

1756-HSC 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 93](#), you will use either a:

- 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 prior to 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 1756-HSC 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 will create non specific tags, with a name related to the modules slot location. The tag names created will 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 backflash your module's firmware from firmware revision 3.x to 2.x or 1x. Attempting to backflash or downgrade a module's firmware from 3.x to 2.x or 1x will irreversibly damage the module.

1756-HSC modules at firmware revision 2.x or 1x cannot be flash upgraded to any firmware revision 3.x because 3.x modules have a hardware update.

Configure a Generic Profile

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

- your RSLogix 5000 software is earlier than version 18 for either module series A or B.
- your RSLogix 5000 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 1756-HSC module to exchange data.

IMPORTANT

Before beginning configuration, you should download the following 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 RSLogix 5000 software, open or create a project for your controller.

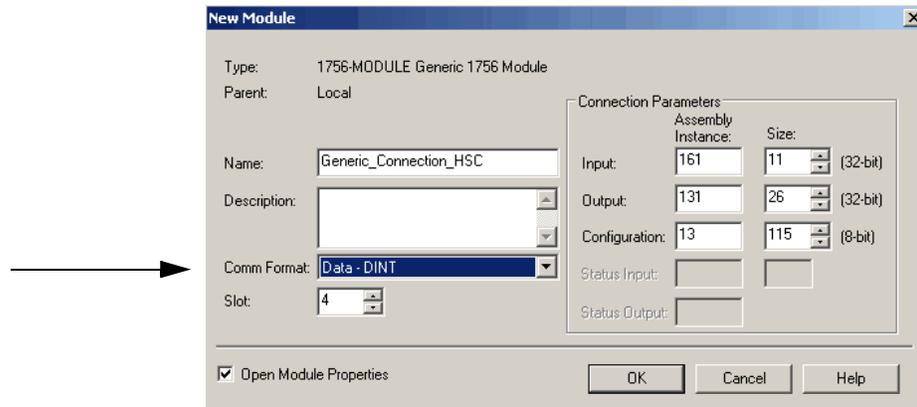
From the File menu, choose New to access the New Controller dialog box to create a controller name.

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

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 specified by the communication format selection.

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

Connection Parameters

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 1756-HSC 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.

| Connection Parameters | | | |
|-----------------------|--------------------|-------|----------|
| | Assembly Instance: | Size: | |
| Input: | 161 | 11 | (32-bit) |
| Output: | 131 | 26 | (32-bit) |
| Configuration: | 13 | 115 | (8-bit) |

IMPORTANT

The generic connection works only with the matching Assembly Instance and Size parameters 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.

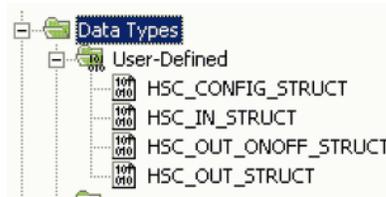
14. Click OK.

The ladder logic in your RSLogix 5000 project will copy 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 in a new instance of RSLogix 5000 software.
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 RSLogix 5000 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 from RSLogix 5000 Software

- a. To use default tags from RSLogix 5000 (which 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.ProgToFoul... | 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.. |

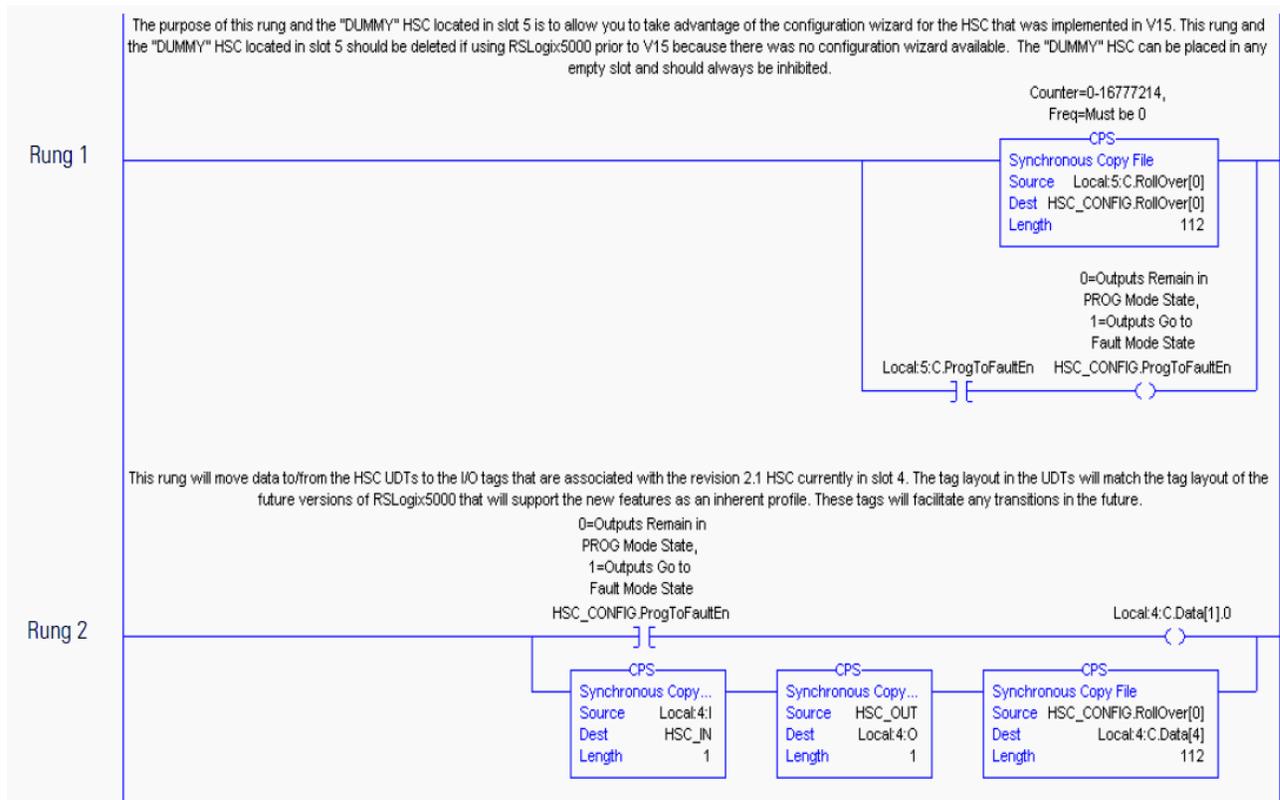
Add Ladder Logic Routines

Ladder logic copies the module information from the user-defined data types to the module-defined data types. Otherwise, the controller and the 1756-HSC module will not be able to 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 RSLogix 5000 software, version 13 or earlier, or you did not add an unused 1756-HSC module in [step 13](#), delete rung 1 of the copied and pasted ladder logic.

IMPORTANT

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

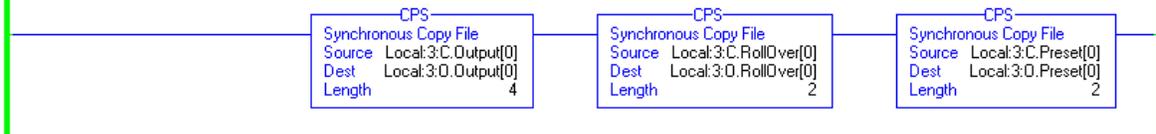
A ladder logic routine also is suggested if you are using the HSC Data-extended Comm Format. This option allows you to change the output, rollover, and preset configuration settings in the output tags. The duplication of tag data could result in values being overridden when the HSC Data-extended Comm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

The optional rung below will coordinate the values entered in the configuration settings for rollover, preset, and output in the output tag settings. See [page 71](#) in Chapter 5 for procedures.

Only needed if using HSC Extended Data communicatin format.

With the addition of the dynamic Output on/off, Rollover and Presets to the Output Tag area in HSC V2.1, these functions now have the ability to be controlled by separate tags in both the module Configuration and Output Tag areas. This can lead to confusion and inconsistency if both locations are not equal. By copying the .Configuration tags to the .Output tags, the values in both locations will always be equal. This will allow changes made in the HSC profile screens to automatically affect both locations resulting in the same value in each. The .Output words will then be the primary words used by the HSC for these functions.

This rung 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.



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

The following steps are for converting an older profile to a program with software version 18 and later.

1. Write down the 1756-HSC module configuration tag data for the generic profile.

You will 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 1756-HSC module by using the version 18 (or later) profile in the deleted generic profile slot.

4. Re-enter the 1756-HSC 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 referenced in ladder logic. For example, if there is no configuration tag 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 1756-HSC module running the original functionality and your version of RSLogix 5000 software is earlier than version 15. Original functionality includes the Counter, Encoder x1, Encoder x4, and Frequency modes.

RSLogix 5000 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.

| 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 63](#) 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 the following 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 requested of a 1756-HSC 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 Logix5000 Controllers Messages Programming Manual, publication [1756-PM012](#).

Application Considerations

Introduction

This appendix provides background for selecting the appropriate input device for your 1756-HSC 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 HSC 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 will be 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

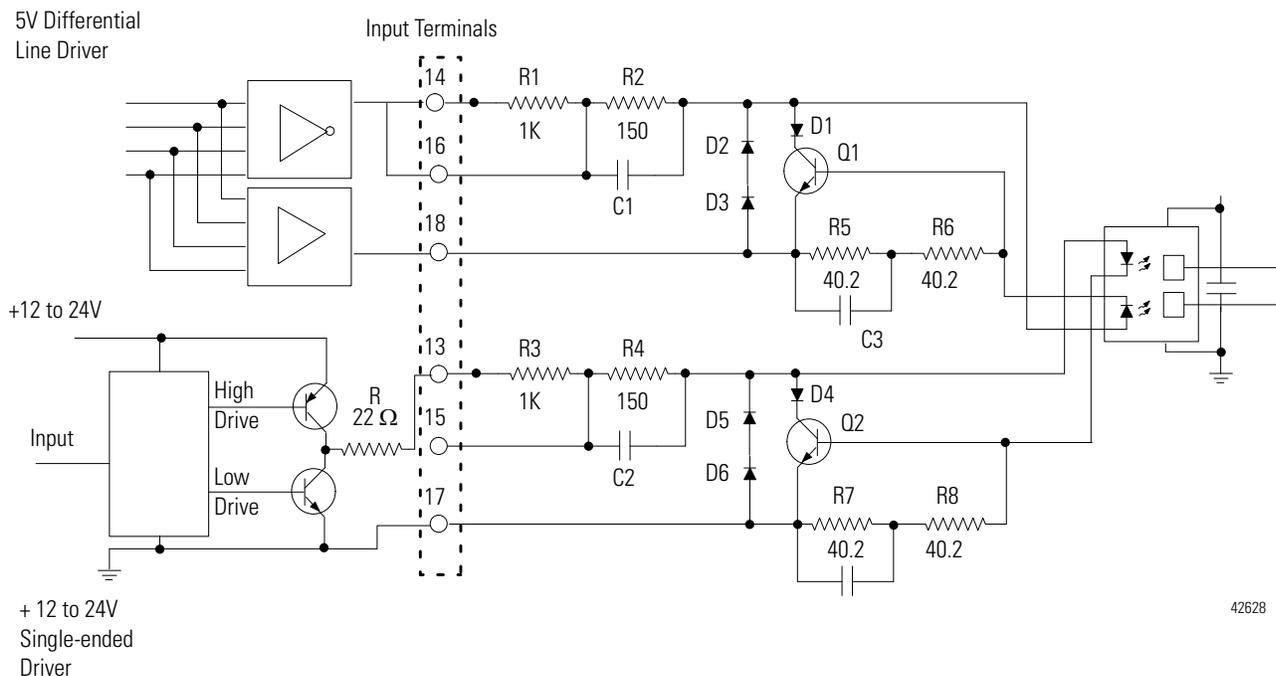
The following examples help you determine the best input type for your particular application. These examples include:

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

Circuit Overview

To make sure your signal source and the 1756-HSC module are compatible, you need to 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 $R1 + R2 = 1150 \Omega$. Assuming a 2V drop across the photodiode and R5 and R6, you would have 8-21 mA demanded from the driving circuit as the applied voltage ranged from 12 to 24V.



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When a signal is applied to the 5V inputs (pins 15 and 16 in the graphic), the limiting resistance is 150Ω . If 5.0V was applied at the input, the current demanded would be $(5.0 - 2.0)/150 = 20 \text{ mA}$.

The previous calculation is necessary because the driving device must cause a minimum of 5 mA to flow through the photodiode.

The optical isolator manufacturer recommends a maximum of 8 mA to flow through the photodiode. This current could be exceeded in the 24V position. To obtain this limit, a DC shunt circuit is included, consisting of D1, Q1, R5 and R6. If the photodiode current exceeds about 8 mA, the drop across R5-R6 will be sufficient to turn Q1 on, and any excess current will be shunted through D1 and Q1 instead of through the photodiode.

If the driving device is a standard 5V differential line driver, D2 and D3 provide a path for reverse current when the field wiring arm terminal 1 is logic low and terminal 2 is logic high. The combined drop is about the same as the photodiode (about 1.4V). The circuit appears more symmetrical, or balanced, to the driver as opposed to just one diode.

Detailed Circuit Analysis

In the previous example, we used a constant 2.0V drop across the photodiode and R5-R6. 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 will call this V_{drop} .

First, consider the minimum requirement of $I_f = 4 \text{ mA}$. The V_f curves for this photodiode typically has 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 will drop $(80.4 \Omega \times 4 \text{ mA}) = 0.32\text{V}$. Thus, at 4 mA:

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

Consider when $I_f = 8 \text{ mA}$ or above. With the temperature about halfway between 25...70 °C, V_f becomes about 1.25V. R5-R6 will now drop 0.64V $(80.4 \Omega \times 8 \text{ mA})$. That means:

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

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.

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

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 106](#)) 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 used in your signal source device. The output voltage differential $V_{\text{diff}} = (V_{\text{oh}} - V_{\text{ol}})$ 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 $V_{\text{diff}} - V_{\text{drop}}$.

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 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.

In general, the output voltage V_{oh} is higher both as the supply voltage and the ambient temperature increase. For example, vendor data for the 75114 shows V_{oh} is about 3.35V at $V_{\text{cc}} = 5\text{ V}$, $I_{\text{oh}} = 10\text{ mA}$ and $25\text{ }^{\circ}\text{C}$ ($77\text{ }^{\circ}\text{F}$). V_{ol} is about 0.075V under the same conditions. This means $V_{\text{differential}} = V_{\text{oh}} - V_{\text{ol}} = 3.27\text{ V}$ if the part is sourcing 10 mA. Looking at the curves, if the part were sourcing 5 mA you would see $V_{\text{diff}} = 3.425 - 0.05 = 3.37\text{ V}$.

Assuming that you could supply 5 mA to the 1756-HSC input terminals, how much voltage across the field-wiring arm terminals would be required? V_{drop} would be about 1.6V as previously noted. And 4 mA through 150 Ω gives an additional 0.60V drop. Thus, you would have to apply about $(1.6\text{V} + 0.60\text{V}) = 2.20\text{V}$ across the terminals to cause a current of 4 mA to flow through the photodiode. The 75114 gives about 3.3V at $V_{\text{cc}} = 5\text{V}$ and 25 °C (77 °F). Thus you know that this driver causes more current to flow than the minimum required at 4 mA.

To determine how much current flows, use the following equation:

$$V_{\text{drive}} - V_{\text{drop}} = V_{\text{resistor}}$$

$$3.3\text{V} - 1.6\text{V} = 1.7\text{V}$$

$$1.5\text{V}/150\ \Omega = 11.3\ \text{mA}$$

As you can see, 1.6V_{drop} is too low.

Remember that V_{drop} varies linearly from about 1.6V to 2.0V as I_f varies from 4...8 mA. Recalculate assuming $V_{\text{drop}} = 2.0\text{V}$.

$$V_{\text{drive}} - V_{\text{drop}} = V_{\text{resistor}}$$

$$3.3\text{V} - 2.0\text{V} = 1.3\text{V}$$

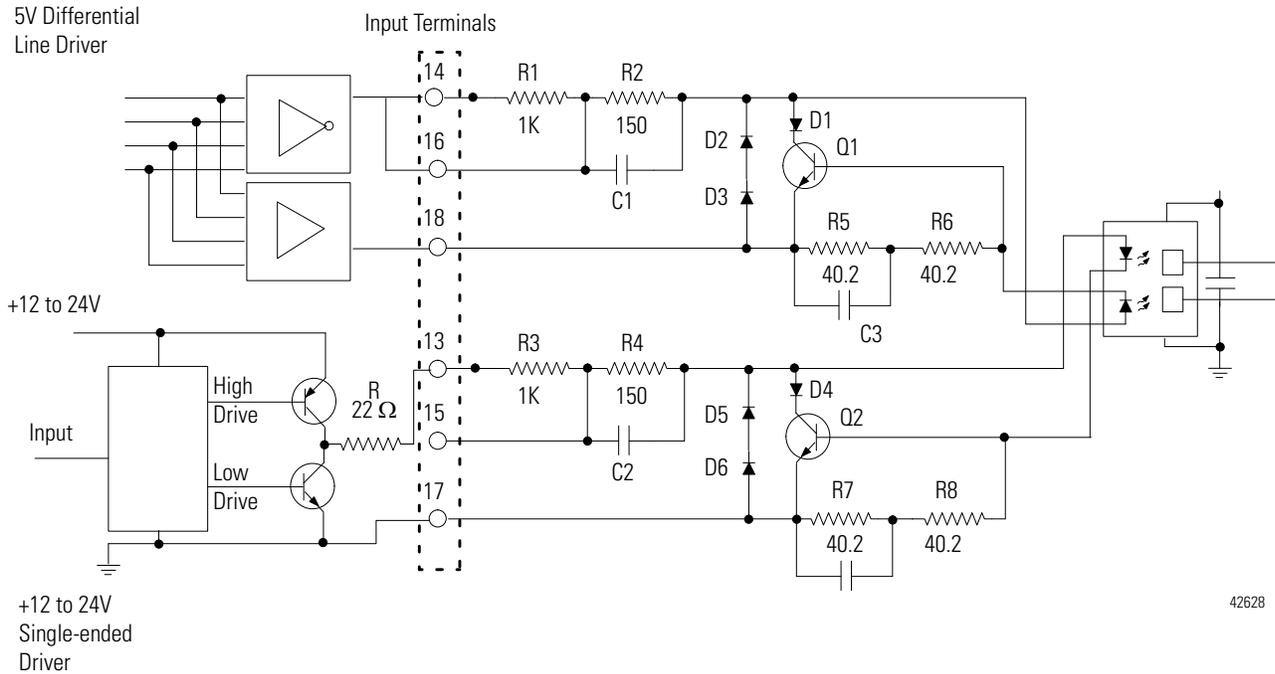
$$1.3\text{V}/150\ \Omega = 8.7\ \text{mA}$$

The resulting 8.7 mA is consistent with our assumption of $V_{\text{drop}} = 2.0\text{V}$ at $I_f = 8\ \text{mA}$. This shows that driver 75114 causes about 8 mA to flow through the photodiode.

+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 ($15 \text{ mA} \times 22 \Omega = 0.33\text{V}$, and $V_{ce} = .7\text{V}$).



If the input is applied to the 12-24V terminal, the current to the photodiode is limited by the series resistance of R3 and R4 (about 1.15 kΩ). A protection circuit consisting of Q2, R7 and R8 is included. If the current through the photodiode exceeds about 8 mA, the voltage across R7 and R8 is sufficient to turn Q2 on, shunting any additional current away from the photodiode. The voltage drop across Q2 is equal to about 2V ($V_{\text{photodiode}} + V_{be} = 2\text{V}$). The current demanded by the 1756-HSC input circuit would be about 18 mA ($23\text{V} - 2\text{V} / 1.18 \text{ k}\Omega = 17 \text{ mA}$) which is well within the capability of this driver.

Open Collector

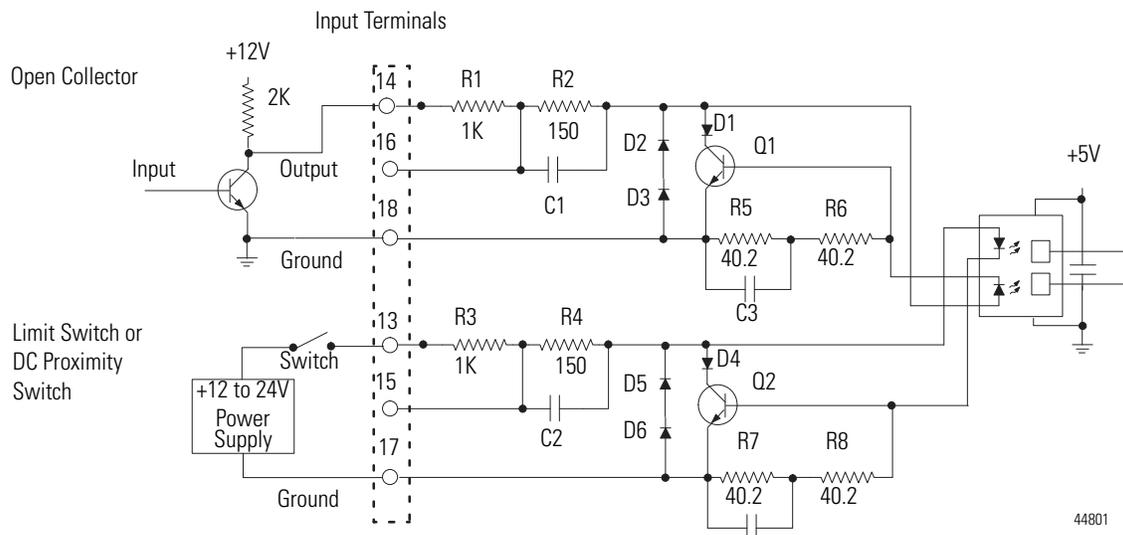
Open collector circuits (the upper circuit on the following circuit) require close attention so that the input voltage is sufficient to produce the necessary source current, since it is limited not only by the 1756-HSC input resistors but also the open collector pull-up.

Choosing input terminals provides some options, as shown in the table. If we assume a 2.0V drop across D1 + Q1, we can use the following equations to calculate the available current:

$$\frac{(\text{Supply Voltage}) - (V_{\text{drop}})}{(\text{Pull-up}) + R1 \text{ (if used)} + (R2)} = \text{Available current}$$

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

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



Electromechanical Limit Switch

When using an electromechanical limit switch (the lower circuit in figure above), it is recommended that you enable the input filter, using RSLogix 5000 software to filter out switch contact bounce. However, this limits the frequency response to around 70 Hz. This circuit would be similar when using DC proximity switches, but bounce should not occur unless severe mechanical vibration is present.

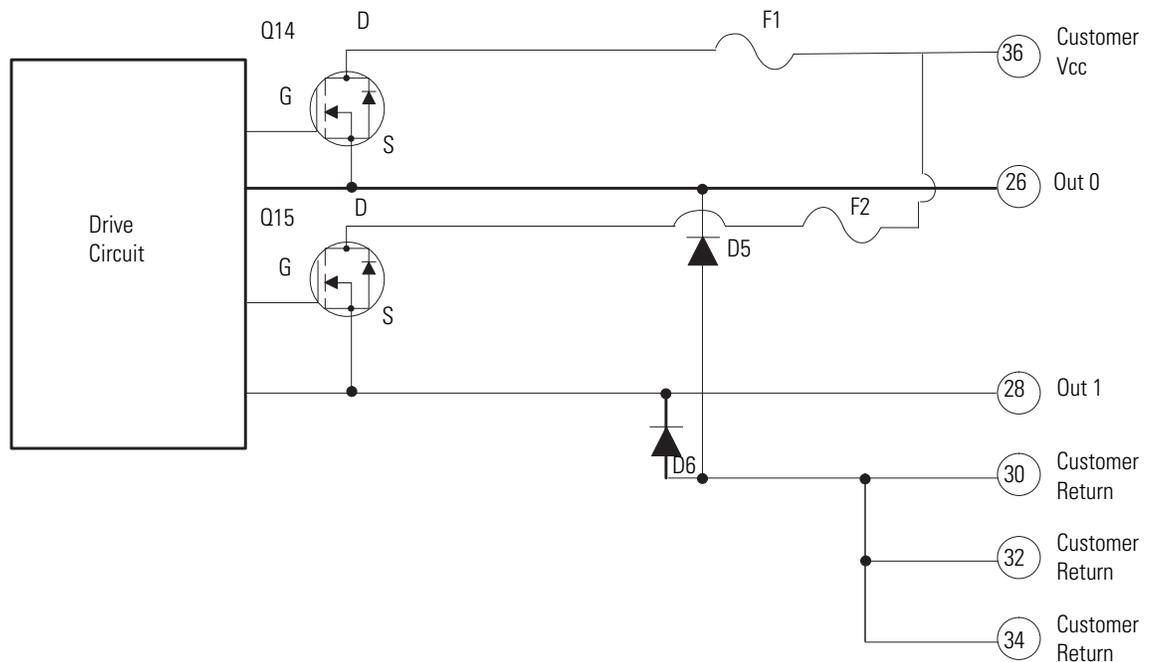
In either case, this example is similar to the Open Collector example and can use the following equation assuming a 2.0V drop across D4 + Q2.

$$\frac{(\text{Supply Voltage}) - (V_{\text{drop}})}{R1 \text{ (if used)} + (R2)} = \text{Available current}$$

Output Circuits

The 1756-HSC module 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 and D6 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). Note that this wiring method **does not** provide inductive load protection for the power output transistors.



44802

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.

The following provides information on 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 used, and maximum frequency at which you will be 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 successful 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. Refer to 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 μ A 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 1756-HSC 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 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 very 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 will reduce 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 120](#)).
- 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 117](#)).
- asynchronous** 1) Lacking a regular time relationship; not related through repeating time patterns. 2) Contrasted with **synchronous** ([page 121](#)).
- AWG** See American wire gauge ([page 115](#)).
- 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 121](#)).
- 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 116](#)) and **broadband link** ([page 115](#)).
- 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 116](#)) and **baseband link** ([page 115](#)).

- 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 115](#)) and **baseband link** ([page 115](#)).
- 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 121](#)).
- 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 115](#)).
- 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 118](#)).
- 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 119](#)) and **period** ([page 120](#)).
- 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 118](#)).

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 118](#)).

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 121](#)).

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 117](#)).

-
- 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 117](#)) and **period** ([page 120](#)).
- 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 120](#)).
- 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 119](#)).
- on** 1) The operative state of a device; the state of a switch or circuit that is closed.
2) Contrasted with **off** ([page 119](#)).

- output device** 1) For a computer, a CRT terminal or printer. 2) For a programmable controller, see **actuator** ([page 115](#)).
- 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 117](#)) and **interval** ([page 119](#)).
- 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 HSC 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 119](#)).
- 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 121](#)) 2) Contrasted with **differential** ([page 117](#)).
- synchronous** 1) In step or in phase, as applied to two or more circuits, devices, or machines. 2) Contrasted with **asynchronous** ([page 115](#)).
- 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 115](#)).

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