Allen-Bradley

ControlLogix High Speed Counter Module

1756-HSC

User Manual

Rockwell Automation

Important User Information

Because of the variety of uses for the products described in this publication, those responsible for the application and use of this control equipment must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes and standards.

The illustrations, charts, sample programs and layout examples shown in this guide are intended solely for purposes of example. Since there are many variables and requirements associated with any particular installation, Allen-Bradley does not assume responsibility or liability (to include intellectual property liability) for actual use based upon the examples shown in this publication.

Allen-Bradley publication SGI-1.1, *Safety Guidelines for the Application, Installation and Maintenance of Solid-State Control* (available from your local Allen-Bradley office), describes some important differences between solid-state equipment and electromechanical devices that should be taken into consideration when applying products such as those described in this publication.

Throughout this manual we use notes to make you aware of safety considerations:

ATTENTION	Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss

Attention statements help you to:

- identify a hazard
- avoid a hazard
- recognize the consequences

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

European Communities (EC) Directive Compliance

If this product has the CE mark it is approved for installation within the European Union and EEA regions. It has been designed and tested to meet the following directives.

EMC Directive

This product is tested to meet the Council Directive 89/336/EC Electromagnetic Compatibility (EMC) by applying the following standards, in whole or in part, documented in a technical construction file:

- EN 50081-2 EMC — Generic Emission Standard, Part 2 — Industrial Environment
- EN 50082-2 EMC — Generic Immunity Standard, Part 2 — Industrial Environment

This product is intended for use in an industrial environment.

Low Voltage Directive

This product is tested to meet Council Directive 73/23/EEC Low Voltage, by applying the safety requirements of EN 61131-2 Programmable Controllers, Part 2 - Equipment Requirements and Tests. For specific information required by EN 61131-2, see the appropriate sections in this publication, as well as the Allen-Bradley publication Industrial Automation Wiring and Grounding Guidelines For Noise Immunity, publication 1770-4.1.

Open style devices must be provided with environmental and safety protection by proper mounting in enclosures designed for specific application conditions. See NEMA Standards publication 250 and IEC publication 529, as applicable, for explanations of the degrees of protection provided by different types of enclosure.

Rockwell Automation Support

Rockwell Automation offers support services worldwide, with over 75 sales/support offices, 512 authorized distributors and 260 authorized systems integrators located throughout the United States alone, as well as Rockwell Automation representatives in every major country in the world.

Local Product Support

Contact your local Rockwell Automation representative for:

- sales and order support
- product technical training
- warranty support
- support service agreements

Technical Product Assistance

If you need to contact Rockwell Automation for technical assistance, please review the troubleshooting information in Appendix A first. If the problem persists, then call your local Rockwell Automation representative.

Your Questions or Comments on this Manual

If you find a problem with this manual, please notify us of it on the enclosed Publication Problem Report.

Introduction

This release of this document contains new information.

New Information

New information is marked by Change Bars in the side column, as shown to the left. lists sections that contain new information.

Section:	Changes
Chapter 3	Additional information about module features
Chapter 4	Updated wiring diagram for connection to an Allen-Bradley Bulletin 872 3-Wire DC Proximity Sensor
Chapter 5	Configuration information
Appendix A	Specification changes
Appendix B	New application considerations

Notes:

What This Preface Contains

This preface describes how to use this manual. The following table describes what this preface contains and its location.

Who Should Use This Manual

You must be able to program and operate an Allen-Bradley Control**Logix**™ Logix5550 Controller and various Allen-Bradley encoders and sensors to efficiently use your ControlLogix High Speed Counter 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 High Speed Counter module.

Purpose of This Manual

This manual describes how to install, configure, use, and troubleshoot your ControlLogix High Speed Counter module.

IMPORTANT In the rest of this manual, we refer to the ControlLogix High Speed Counter module as the HSC module.

Related Terms

This manual uses the following terms:

This term:	Means:
Broadcast	Data transmissions to all addresses
Communications 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
Connection	The communication mechanism from the controller to another module in the control system
ControlBus	The backplane used by the 1756 chassis
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
Direct connection	An I/O connection where the controller establishes an individual connection with I/O modules
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
Electronic keying	A system feature which makes sure that the physical module attributes are consistent with what was configured in the software
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
Field side	Interface between user field wiring and I/O module
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
Listen-only connection	An I/O connection that allows a controller to monitor I/O module data without owning the module
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 (e.g. bug fix)
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 2ms to 100ms using RSNetWorx

Owner controller	The controller that creates and stores the primary configuration and communication connection to a module
Producer/consumer	Intelligent data exchange system devices in which the HSC module produces data without having been polled first
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
Remote connection	An I/O connection where the controller establishes an individual connection with I/O modules in a remote chassis
Removable terminal block (RTB)	Field wiring connector for I/O modules
Removal and insertion under power (RIUP)	ControlLogix feature that allows a user to install or remove a module or RTB while power is applied
Requested packet interval (RPI)	A configurable parameter which 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
Service	A system feature that is performed on user demand
System side	Backplane side of the interface to the I/O module
Tag	A named area of the controller's memory where data is stored like a variable

Related Products and Documentation

The following table lists related ControlLogix products and documentation:

Cat. number:	Document title:	Pub. number:
1756-PA72/B, -PB72/B	ControlLogix Power Supply Installation Instructions	1756-5.67
1756-PA75/A, -PB75/A	ControlLogix Power Supply Installation Instructions	1756-5.78
1756-A4, -A7, -A10, -A13, -A17	ControlLogix Chassis Installation Instructions	1756-5.80
1756 Series	ControlLogix System User Manual	1756-UM001
	ControlLogix Digital I/O Modules User Manual	1756-6.5.8
	ControlLogix Analog I/O Modules User Manual	1756-6.5.9

If you need more information on these products, contact your local Allen-Bradley integrator or sales office for assistance. For more information on the documentation, refer to the Allen-Bradley Publication Index, publication SD499.

Notes:

Chapter 4

Installing and Wiring the ControlLogix High Speed Counter Module

Chapter 5

Configuring the ControlLogix High Speed Counter Module

What is the ControlLogix High Speed Counter Module?

What This Chapter Contains

This chapter describes the ControlLogix HSC module and what you must know and do before you begin to use it.

What is the ControlLogix High Speed Counter Module?

The ControlLogix HSC module is an intelligent I/O module providing four high speed output switching, ON-OFF windows, and using pulses from quadrature encoders, pulse generators, proximity switches and other similar products for counting or frequency.

These high speed digital outputs are dedicated to one of two rotational position sensors and not affected by any changes occurring in the ControlLogix controller. The module outputs provide consistent switch ON and switch OFF times for repeatable speed compensation.

Using the producer/consumer network model, controllers can produce information for any controller that may use it. A single encoder may drive multiple modules as long as it provides the minimum current required for each module.

The HSC is a single-slot module that requires a separate external power supply for its outputs. For more information on specific voltage and current requirements, see the specifications listed in Appendix A.

High speed inputs, as found on the HSC module, may be sensitive to electromagnetic noise. The module contains opto-isolators that minimize the effects of noise, but you should provide grounding methods that keep noise spikes under 2000V for backplane (ControlBus) protection and under 1000V for channel-to-channel protection.

IMPORTANT The HSC module must reside in the same chassis as the Logix5550 controller for maximum performance with the controller.

The following is a list of the features available on the ControlLogix HSC module:

- Removal and insertion under power (RIUP) - a system feature that allows you to remove and insert modules while chassis power is applied
- Operation in any of the following modes: Counter, Encoder X1, Quadrature Encoder (Encoder X4) or Rate Measurement Frequency - each mode allows the HSC module to operate with a specific maximum frequency
- Two configurable channels with up to 3 single-ended or differential (user-defined) inputs per channel
- Four current-sourcing outputs at 5-30V dc with 1A maximum per output that can turn ON and OFF within 300µs
- Class I/Division 2, UL, CSA, and CE Agency Certification

Purpose of the HSC Module

The most common use for the HSC Module is to interface 1 or 2 incremental encoders to the ControlLogix platform. It can also be used to count high speed pulse streams from 1 or 2 discrete devices such as a proximity or photoelectric control.

Using An High Speed Counter Module in the ControlLogix System

An HSC module performs high speed counting for industrial applications. The module interfaces with a ControlLogix Logix5550 controller to report the number of counts at each frequency.

A ControlLogix HSC module mounts in a ControlLogix chassis and uses a Removable Terminal Block (RTB) to connect all field-side wiring.

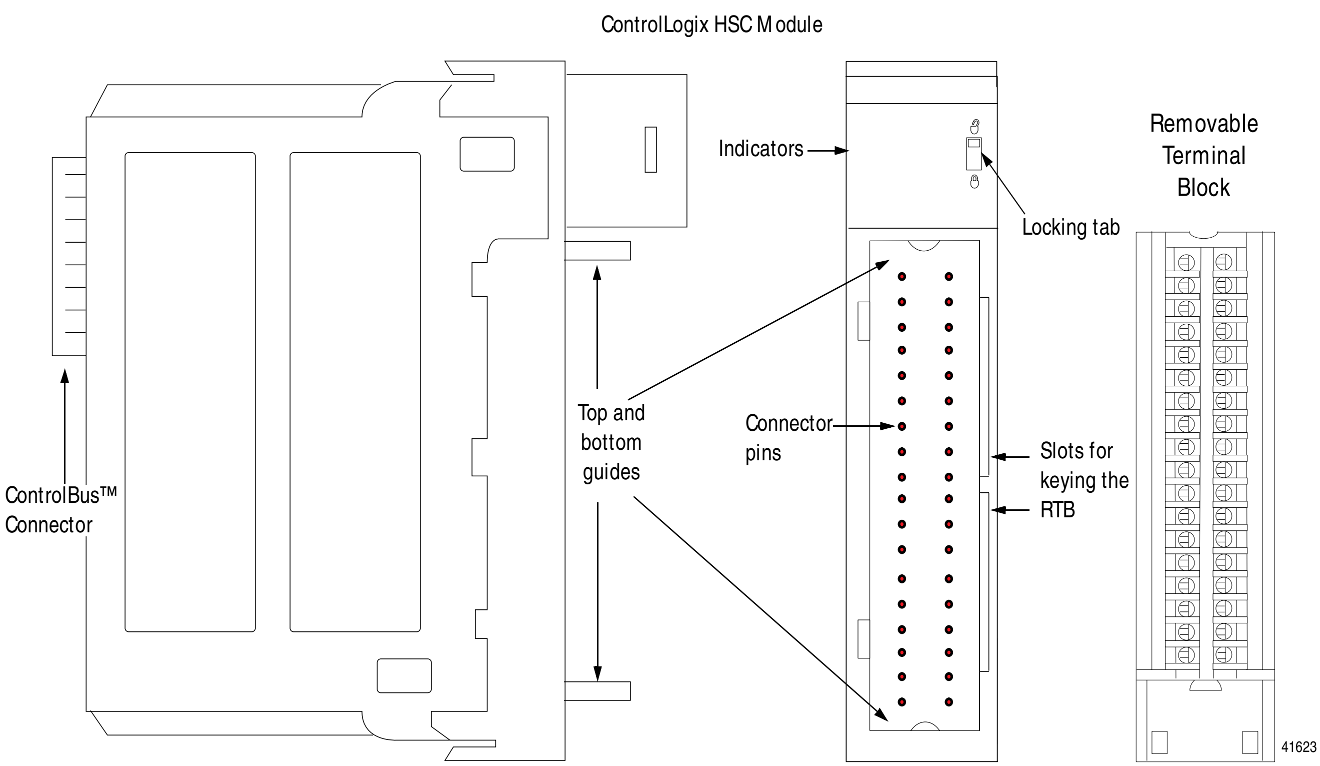
Before you install and use your module you should have already:

- installed and grounded a 1756 chassis and power supply. To install these products, refer to publications 1756-5.67, 1756-5.78 and 1756-5.80.

IMPORTANT A grounded 1756 chassis is not sufficient to minimize encoder noise. You should use continuous overall shielded cable that is properly grounded to a signal ground. The signal ground must be separate from the AC earth ground used to protect personnel.

- ordered and received an RTB and its components. RTBs are **not** included with your module purchase.

Features of the ControlLogix High Speed Counter Modules



ControlBus connector - The backplane interface for the ControlLogix system connects the module to the ControlBus backplane.

Connectors pins - Input/output, power and grounding connections are made to the module through these pins with the use of an RTB.

Locking tab - The locking tab anchors the RTB on the module, maintaining wiring connections.

Slots for keying - Mechanically keys the RTB to prevent inadvertently making the wrong wire connections to your module.

Status indicators - Indicators display the status of communication, module health and presence of input/output devices. Use these indicators to help in troubleshooting.

Top and bottom guides - Guides provide assistance in seating the RTB onto the module.

Preventing Electrostatic Discharge

This module is sensitive to electrostatic discharge when handled outside of the chassis. The module has been tested to withstand an electrostatic discharge while operating within the chassis.

ATTENTION

Electrostatic discharge can damage integrated circuits or semiconductors if you touch backplane connector pins. Follow these guidelines when you handle the module:

- Touch a grounded object to discharge static potential
- Wear an approved wrist-strap grounding device
- Do not touch the backplane connector or connector pins
- Do not touch circuit components inside the module
- If available, use a static-safe work station
- When not in use, keep the module in its static-shield box

Removal and Insertion Under Power

These modules are designed to be installed or removed while chassis power is applied.

ATTENTION

When you insert or remove a module while backplane power is applied, an electrical arc may occur. An electrical arc can cause personal injury or property damage by:

- sending an erroneous signal to your system's field devices causing unintended machine motion or loss of process control.
- causing an explosion in a hazardous environment.

Repeated electrical arcing causes excessive wear to contacts on both the module and its mating connectors. Worn contacts may create electrical resistance that can affect module operation.

Chapter Summary and What's Next

In this chapter you learned about:

- what the ControlLogix HSC module is
- using the HSC module in the ControlLogix system
- preventing electrostatic discharge
- removing and inserting the module under power

Move on to Chapter 2 to learn about High Speed Counter operation within the ControlLogix system.

Notes:

High Speed Counter Operation Within the ControlLogix System

What This Chapter Contains

This chapter describes how the HSC module works within the ControlLogix system.

Ownership and Connections

Every HSC module in the ControlLogix system must be owned by a Logix5550 Controller. This owner-controller stores configuration data for every HSC module that it owns. Other controllers may also talk to the HSC module through the owner-controller.

The owner-controller sends configuration data to the HSC module, defining the module's behavior within the control system. Each HSC module continuously maintains communication with its owner during normal operation. When connections are severed or compromised, the HSC module performs as configured, either setting all outputs to reset (ON or OFF) or continuous operations.

Using RSNetWorx and RSLogix 5000

When an HSC module is created, the I/O configuration portion of RSLogix5000 generates configuration data structures and tags for that HSC module, whether the module is located in a local or remote chassis. A remote chassis, also known as networked, contains the HSC module but not the module's owner-controller.

After creating the HSC module, you can write specific configuration in the module's data structures; you must access the module tags to change information in the data structures. This process is explained in detail in Chapter 5.

IMPORTANT Application-specific configuration data is transferred to the controller during the program download and sent to the HSC module during the initial power-up. After HSC module operation has begun, you must use ladder logic and message instructions to make configuration changes.

Enabling HSC Module Operation in a Remote Chassis

HSC modules in the same chassis as the controller are ready to run as soon as the program download is complete. But you must run RSNetWorx to enable HSC modules in the networked chassis.

Running RSNetWorx transfers configuration data to networked modules and establishes a Network Update Time (NUT) for ControlNet that is compliant with the desired communications options specified for each module during configuration.

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

Follow these general guidelines when configuring HSC modules:

1. Configure all HSC modules for a given controller using RSLogix 5000 and download that information to the controller.

2. If the HSC configuration data references a module in a remote chassis, run RSNetWorx.

IMPORTANT RSNetWorx **must** be run whenever a new module is added to a networked chassis. When a module is permanently removed from a remote chassis, we recommend that RSNetWorx be run to optimize the allocation of network bandwidth.

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 fault status bits in the data area associated with the module. The RSLogix 5000 software may monitor this data area to announce the modules' failures.

High Speed Counter Module Operation

In traditional industrial applications, controllers poll counter modules to obtain their status. Controllers also send commands to the counter modules. Retrieving counter status and sending commands occurs during the normal I/O program scan.

ControlLogix HSC modules do not follow the traditional operational manner. HSC modules are not scanned by an owner-controller once a connection is established. Instead, the HSC module periodically multicasts its status to the controller.

An HSC 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 set-ups.

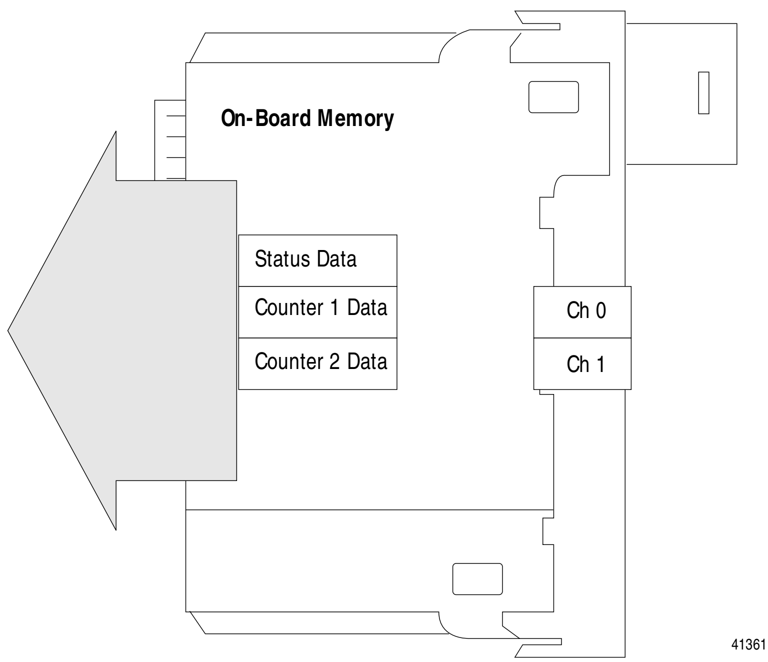
High Speed Counter Modules in a Local Chassis

HSC modules multicast their data periodically. Multicast frequency depends on the options chosen during configuration and where in the control system the module physically resides. The data consumer (i.e. an owner-controller) is responsible for knowing that the format of the new data is integers.

Requested Packet Interval (RPI)

This configurable parameter instructs the module to multicast its channel and status data to the local chassis backplane at specific time intervals.

The RPI instructs the module to multicast the **current contents** of its on-board memory when the RPI expires, (i.e. the module does not update its channels prior to the multicast).



IMPORTANT	The RPI value is set during the initial module configuration using RSLogix 5000. This value can be adjusted when the controller is in Program mode.

High Speed Counter Modules in a Remote Chassis

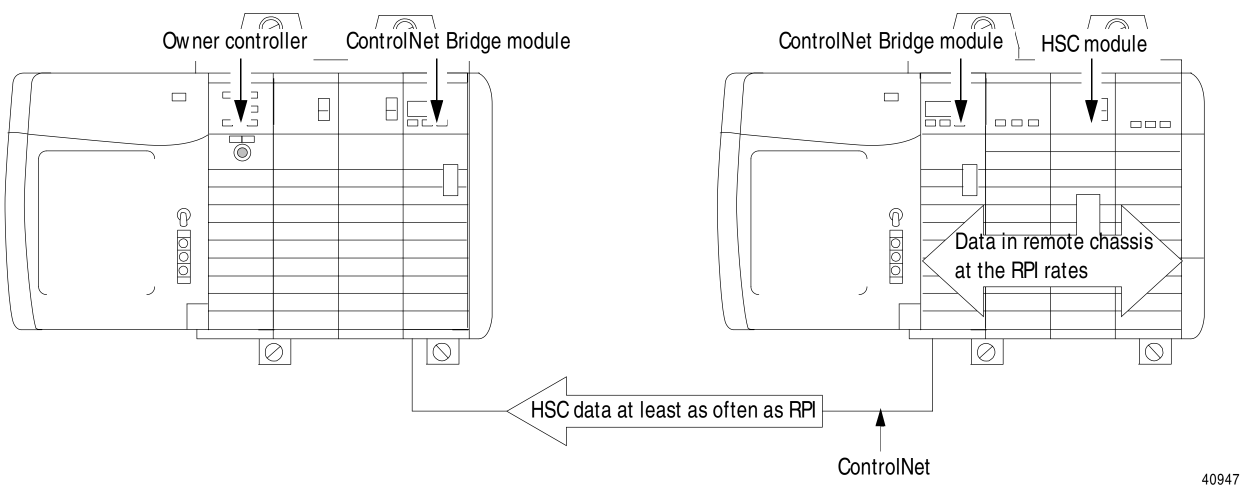
If an HSC module resides in a networked chassis, the role of the RPI changes slightly with respect to getting data to the owner.

The RPI not only defines when the module multicasts data **within its own chassis** (as described in the previous section), but also determines how often the owner controller will receive it over the network.

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

The timing of this "reserved" spot may or 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.

HSC Module in Remote Chassis with RPI Reserving a Spot in Flow of Data



Listen-Only Mode

Any controller in the system can **listen** to the data from any HSC module even if the controller does not own the module (i.e. it does not have to hold the module's configuration data to listen to the module).

During the HSC module creation process in RSLogix 5000, you can specify the 'Listen-Only' Communication Format. For more information on Communication Format, see page 5-6.

Choosing 'Listen-Only' mode allows the controller and module to establish communications without the controller sending any configuration data. In this instance, another controller owns the HSC module.

IMPORTANT

Controllers using the Listen-Only mode continue to receive data multicast from the HSC module as long as a connection between an owner and HSC module is maintained.

If the connection between all owners and the HSC module is broken, the module stops multicasting data and connections to all 'Listening controllers' are also broken.

Chapter Summary and What's Next

In this chapter you learned about:

- ownership and connections
- direct connections
- HSC module operations in a local chassis
- HSC module operations in a remote chassis
- listen-only mode

Move to Chapter 3 to learn about ControlLogix High Speed Counter module features and I/O operation.

ControlLogix High Speed Counter Module Features and I/O Operation

What this Chapter Contains

This chapter describes features of the ControlLogix HSC module.

Determining Encoder and Sensor Compatibility

ControlLogix HSC modules count pulses from encoders, generators and switches. The most common applications using the HSC module also use the following Allen-Bradley products:

- Allen-Bradley 845 incremental encoder
- Allen-Bradley Bulletin 872 3-wire DC proximity sensor
- Photoswitch series 10,000 photoelectric sensor

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

See Table 3.A to choose an encoder or sensor for your HSC module.

Table 3.A
Choosing an Encoder or Sensor for Your HSC Module

	Minimum pulse width:	Frequency range:	Leakage current:
Proximity	500ns	1 MHz	250µA @ 5V dc
Quad Encoder	2µs	250 KHz	250µA @ 5V dc

Features of the ControlLogix High Speed Counter Module

The following features are available with the ControlLogix HSC module:

Removal and Insertion Under Power (RIUP)

The HSC module may be inserted and removed from the chassis while power is applied. This feature allows greater availability of the overall control system because, while the module is being removed or inserted, there is no additional disruption to the rest of the controlled process.

Module Fault Reporting

The HSC module provide both hardware and software indication when a module fault has occurred. LED fault indicators on the module notify the user of fault conditions and RSLogix 5000 graphically displays this fault and includes a fault message describing the nature of the fault.

This feature allows you to determine how your module has been affected and what action should be taken to resume normal operation.

Fully Software Configurable

You use RSLogix 5000 software to configure the HSC module through an easily used and understood interface. All module features can also be enabled and disabled through the messaging portion of the software.

Controller-Scoped Tags

You define tags under the task folder by first creating a 'New Program'. New Programs may be continuous or periodic.

- **Continuous Programs** - When using continuous programs, you should incorporate the 'new data bits' within the ladder program to achieve the most efficient scanning of the task.

- **Periodic Programs** - When using periodic programs, the period selected must correspond to the RPI rate selected on the HSC module. This is particularly important in rate measurement mode where you define the sampling period.

Electronic Keying

Instead of plastic mechanical backplane keys, electronic keying allows the ControlLogix system to control what modules belong in the various slots of a configured system.

During module creation, you must choose one of the following keying options for your I/O module:

- **Exact match** - all of the parameters described below must match or the inserted module will reject a connection to the controller.
- **Compatible match** - all of the parameters described below, except minor revision must match or the inserted module will reject a connection to the controller.

  In this case, the minor revision of the module must be greater than or equal to that of the configured slot.
- **Disable keying** - the inserted module will accept a connection to the controller regardless of its type

ATTENTION

Be extremely cautious when using the disable keying option; if used incorrectly, this option can lead to personal injury or death, property damage or economic loss.

When an I/O module is inserted into a slot in a ControlLogix chassis, the module compares the following information for itself to that of the configured slot it is entering:

- Vendor
- Product Type
- Catalog Number
- Major Revision
- Minor Revision

This feature can prevent the inadvertant operation of a control system with the wrong module in the wrong slot.

Producer/Consumer Model

By using the Producer/Consumer model, ControlLogix HSC modules can produce data without having been polled by a controller first. The modules produce the data and any other owner controller device can decide to consume it.

LED Status Information

The ControlLogix HSC module has LED indicators on the front of the module that allow you to check the module health and operational status.

The following status can be checked with the LED indicators:

- **Input point status** - display indicates a particular points status, including specific indicators for the input A, B, and Z points for each channel
- **Output point status** - display indicates the status of four output points on the module

For examples of LED indicators, see page 6-1.

Full Class I Division 2 Compliance

ControlLogix HSC modules maintain CSA Class I Division 2 system certification. This allows the ControlLogix system to be placed in an environment other than only a 100% hazard free.

IMPORTANT Modules should not be pulled under power, nor should a powered RTB be removed, when a hazardous environment is present.

CE/CSA/UL Agency Certification

ControlLogix HSC modules that have obtained CE/CSA/UL agency certification are marked as such.

Operation in Encoder or Counter Mode

The operation of encoder and count modes is virtually identical. The only difference between the modes is the method used to count.

Use the counter mode to read incoming pulses from a maximum of two pulse counters, pulse generators, mechanical limit switches, or similar devices and return them to the controller as a double integer number (0-16 million). In counter mode, the module counts only input A feedback. Input B determines whether to increment or decrement the count.

Use the encoder modes to read incoming two-phase pulses and return them to the controller as a double integer number (0-16 million). In these modes, the module accepts two-phase feedback and counts up or down depending upon the phase relationship between Input A and Input B for each counter. There are two encoder modes: X1 and X4.

Module operation in the counter/encoder modes is as follows:

- **Counter mode** - Input A counts pulses. Input B is tied high or low to determine count direction, high sets count direction positive (increment) and low set count direction negative (decrement).
- **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 4 times the resolution of X1.

Each counter in encoder/counter mode has the following storage modes associated with it:

- Store/continue
- Store/wait/resume
- Store-reset/wait/start
- Store-reset/start

Each counter in encoder/counter mode has the following software configurable modes associated with it:

- Preset value
- Rollover value
- Z invert
- Output override
- Reset to 0
- Scalar
- Filter A
- Filter B
- Filter Z

Counter Mode

The module counts incoming pulses from a maximum of 2 pulse counters, pulse generators, mechanical limit switches, and other similar devices, and returns a count to the controller in a double integer number (0-16 million).

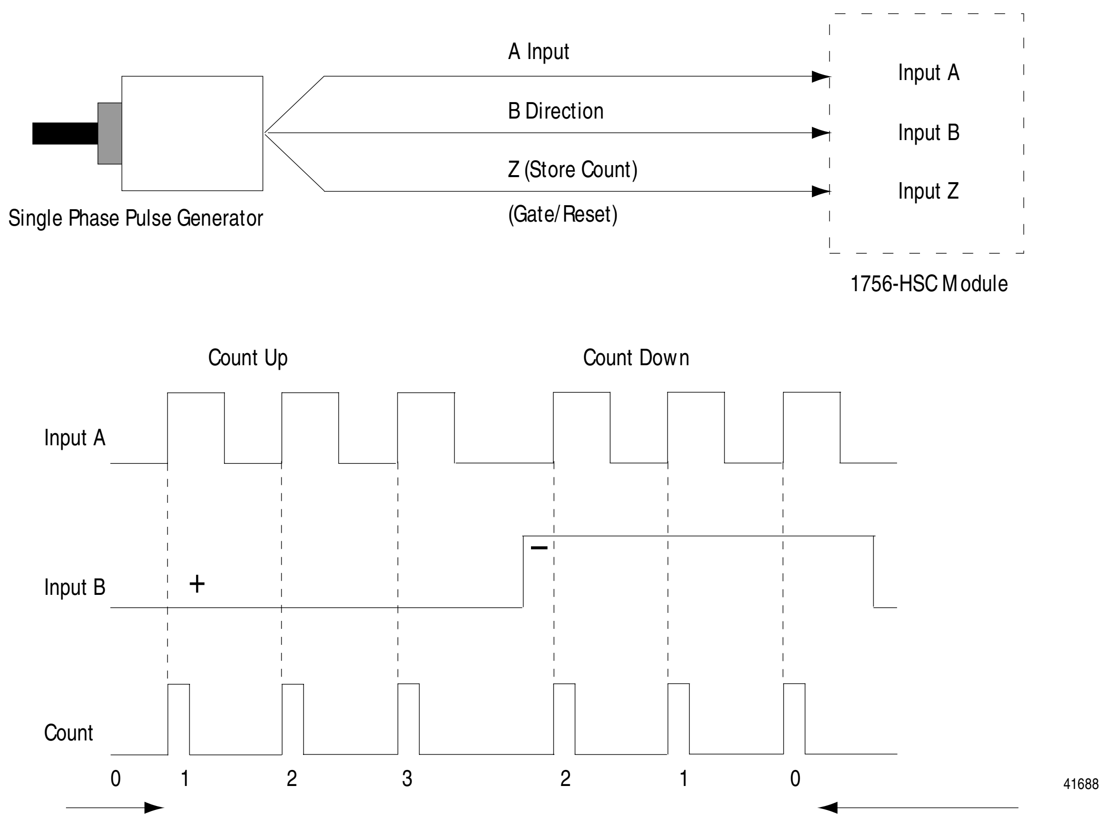
In the counter mode, direction (up counting or down counting) is determined by the input B, which can be a random signal. If Input B is high, the counter will count down. If Input B is low or floating, (that is, not connected), the counter counts up. Counting is done on the leading-edge of Input A.

Table 3.B
Counter Direction

If Input B is:	Counter will count (direction):
High	Down
Low or floating (not connected)	Up

The counter mode accepts only one phase feedback. See Figure 3.1 to understand this relationship.

Figure 3.1
Diagram of Counter Mode



To see the Z input operation, see page 3-10.

Encoder Mode

The encoder mode allows the module to read incoming pulses and return them to the controller as a double integer number (0-16 million).

In this mode, the module accepts two phase feedback. The module senses the relationship between the two phases and counts up or down accordingly.

Encoder X1

Encoder X1 mode uses channel A and channel B to determine direction of the count. The HSC module produces an increasing count when channel B is 90° ahead of channel A. In this case, the count is initiated on the rising edge of channel A.

The HSC module produces a decreasing count when channel A is 90° ahead of channel B. In this case, the count is initiated on the falling edge of channel A.

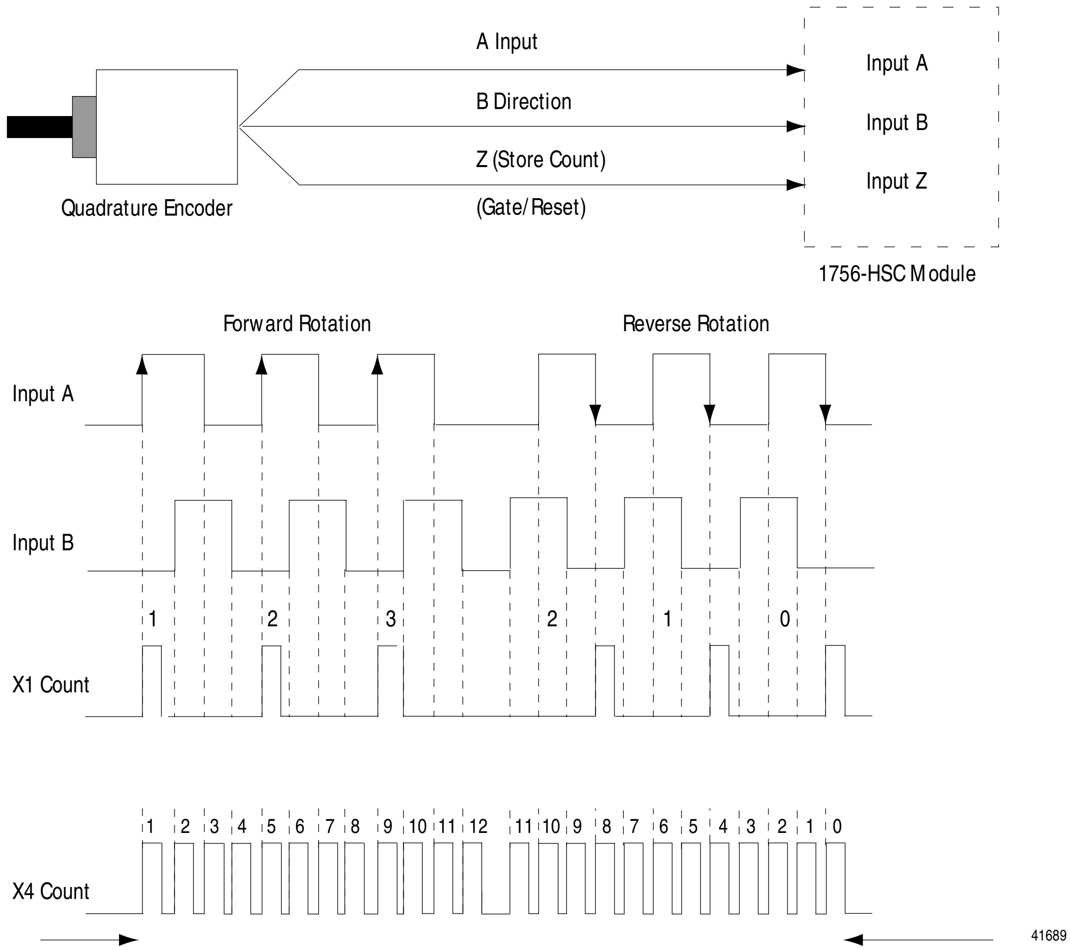
IMPORTANT	The HSC module has a hysteresis of +/-1 count when transitioning from one count direction to another.

Maximum frequency in Encoder X1 mode = 250KHz, with a minimum pulse width at this frequency is 2µs. The HSC module assumes a 90° phase (A/B°) difference between channels.

Encoder X4

Encoder X4 mode is identical to X1, except it uses quadrature signals of channel A and channel B. This mode counts on the leading and trailing edges of A and B. Maximum frequency in Encoder X4 mode = 250KHz, with a minimum pulse width at this frequency of 2µs. The HSC module assumes a 90° phase (I/O°) difference between channels.

Figure 3.2
Diagram of Encoder Mode



Direction of Count

The module can count either up or down, depending upon the phase relationship between the Input A and B for each counter. In encoder applications, the counter will increment on the leading edge of Input A and decrement on the trailing edge of Input A. The relative phase (90° ahead of Input A or 90° behind of Input A) of Input B determines the direction of the count.

You also have the option of X1 and X4 multiplying the input pulses. The figure below shows the relationships between Phases A and B for forward and reverse directions in encoder applications.

Preset Value

Each of the 2 counters has one preset value associated with it. In the encoder or counter modes, the preset value represents a reference point (or count) from which the module begins counting.

The module can count either up or down from the preset value. Preset values are loaded into the count registers through the load preset bits in your ladder logic application. Values can range from 0-16 million. The values generate an error code, though, when the HSC module is operating in Rate Measurement mode.

IMPORTANT Preset values can be changed through a ladder logic application while normal module operation continues or through the RSLogix 5000 tag editor.

Rollover Value

Each of the 2 counters has one rollover value associated with it. When the rollover value is reached by the encoder/counter, it resets to 0 and begins counting again. The rollover value is circular (for example, if you program 360, the count will be from 358, 359, 0, 1, etc. in a positive direction and from 1, 0, 359, 358, etc. in a negative direction).

Values can range from 0-16 million. The values generate an error code, though, when the HSC module is operating in Rate Measurement mode.

In addition to resetting the count to 0, the rollover value also acts as the OFF window if ON-OFF windows are configured such that the OFF window follows the rollover value. For example, you may configure an application with the following values:

- rollover = 359 counts
- ON window = 200 counts
- OFF window = 400 counts

In this example, the output turns ON at 200 counts and turns OFF at 359 counts, the rollover value, rather than the configured OFF window.

IMPORTANT Rollover values can be changed through a ladder logic application while normal module operation continues or through the RSLogix 5000 tag editor.

Also, if you are using the module in **Frequency Mode**, you must set the **Rollover value equal to zero** or the module will not accept configuration.

Software Reset

The counters can also be reset by the Reset Count bits in the tag editor. When one of these bits is set to 1, the associated counter is reset to zero and begins counting. The module can also be reset with the gate/reset feature.

Gate/Reset Input (Z)

There is one gate/reset input for each of the 2 counters. When active, this input is used for the store count feature. The gate/reset input, when active, will function in one of the 4 store count modes outlined below. The gate/reset input is labeled Input Z.

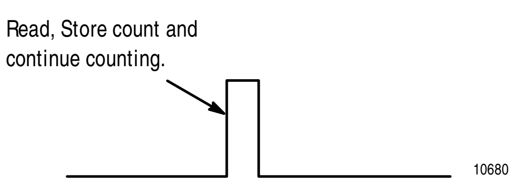
Store Count

The store count feature allows the module to manipulate the current count value as well as the state of the counter. The store count feature is triggered by the state of the Input Z on the module. The stored count of each counter is saved until a new trigger is received. Once received, new values overwrite old values.

IMPORTANT The four modes described below 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.

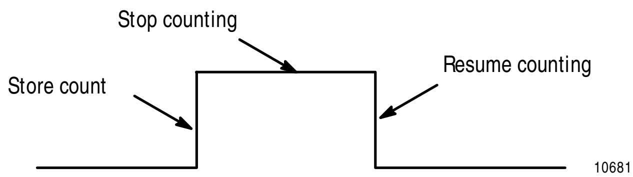
In **mode 1, store/continue**, the leading edge of a pulse on Input Z will cause the current value in the counter to be read and stored. The counter will continue counting. The stored count will be available in the status file. The stored count information will remain until it is overwritten by new data.

Figure 3.3
Store/Continue



In **mode 2, store/wait/resume**, the gate/reset/terminal inhibits counting when the gate/reset input is high. Counting resumes when the input goes low. Mode 2 does not reset the counter, although it does store the count value. The stored count value remains in the module until it is overwritten with a new value.

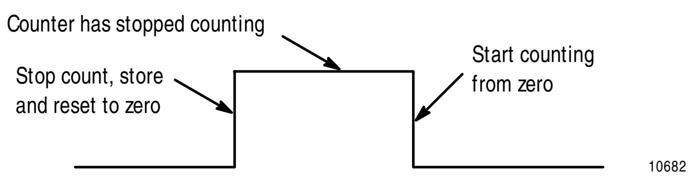
Figure 3.4
Store/Wait/Resume



In **mode 3, store-reset/wait/start**, the rising edge of the pulse on the gate/reset terminal causes the counter to stop counting, store the current count value and reset the count to zero. The counter does not count while the input pulse on the gate/reset terminal remains high.

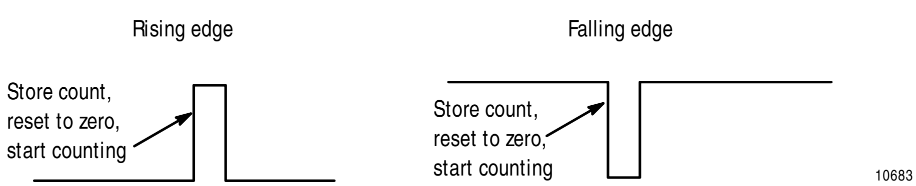
Counting resumes from zero on the falling edge of the pulse at the gate/reset terminal. The stored count value remains in the controller memory until it is overwritten with a new value.

Figure 3.5
Store-Reset/Wait/Start



In **mode 4, store-reset/start**, the rising edge of a pulse input at the gate/reset terminal causes the counter to store the accumulated count value and will reset the counter to zero. The counter continues counting while the gate/reset terminal is high, and the stored count is available. The stored count value remains in the controller memory until it is overwritten with a new value.

Figure 3.6
Store-Reset/Start



Figures 3.3-3.6 show the store count feature operating on the rising edge of the z invert pulse. The user has the option of selecting these same features using the falling edge of the gate/reset pulse. This selection is made through the z invert bit.

The z invert bit is active in the store count mode only.

Operation in Rate Measurement Mode

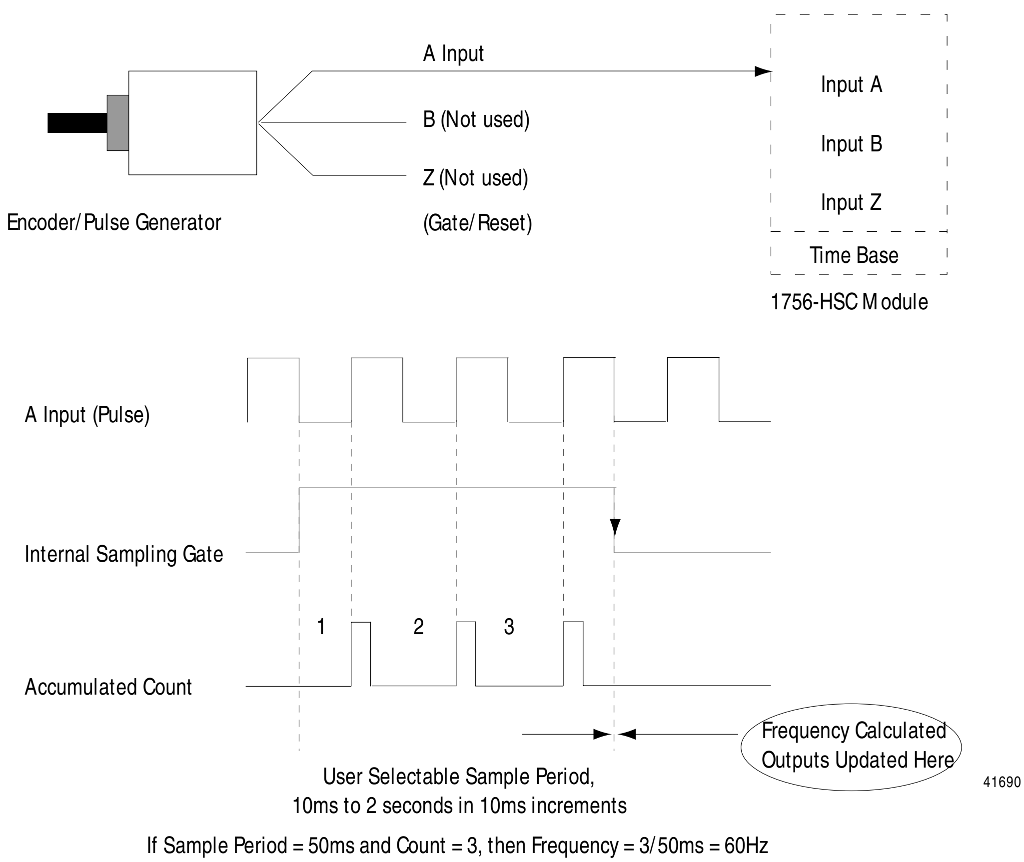
Rate measurement mode counts incoming pulses on channel A for a user-specified time interval. At the end of the interval, the HSC module returns a value representing the sampled number of pulses and a value indicating the incoming frequency. When the count and frequency are updated, any associated outputs are checked against their associated presets.

If set for Rate/Measurement Mode, the module returns the frequency value in the StoredValue[0] tag. The frequency returned is not dependant upon the scaler value you choose. The scaler determines how many counts are returned in the PresentValue[0] tag over the scaler value you choose.

EXAMPLE If the frequency = 1000Hz, and the scaler = 100ms, then the PresentValue returned will = 100, and the StoredValue will = 1000. If the scaler is changed to 10msecs, then the PresentValue will = 10, and the StoredValue will = 1000.

The total count equals the number of pulses received during the sample period. Rate measurement mode operation is shown below.

Figure 3.7
Rate Measurement Mode Operation



In the previous figure, three counts have been accumulated during the user-selected time period. If you had selected 50mS as the sample period, the frequency returned to the Logix5550 controller:

- Frequency = Counts/Sample period = 3 counts/50ms = 60Hz.

If the frequency exceeds 500KHz, the value 999,999 is returned to the controller.

Sample Period

You can set the sample period used in the frequency calculation in the rate measurement mode. Allowable values are 10ms to 2 seconds in 10ms increments. The default value is 1 second.

IMPORTANT	A value 0 in the ladder logic application equals 1 second.

Connection to Channel Inputs

The only user connection used in the rate measurement mode is to input A of the module. The Input B and Input Z terminals are not used in this mode.

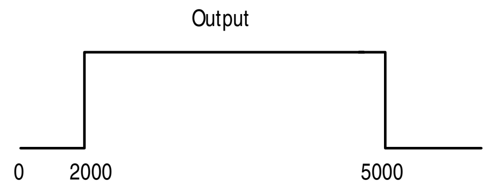
Outputs

The HSC module has 4 outputs, isolated in pairs (0&1, 2&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 1A dc and are hardware-driven. They turn ON or OFF in less than 50µs when the appropriate count value has been reached.

Controlling the ON/OFF Output Status

Each output on the HSC module can be turned ON and OFF at the user's discretion. The operation of output(s) tied to a counter are performed independently from the controller scans.

For example, an HSC module can be programmed to turn ON an output when the count value reaches 2000 and keep the output ON for 3000 counts. In this case, the ON value must be programmed for 2000 counts and the OFF value must be programmed for 5000 counts.



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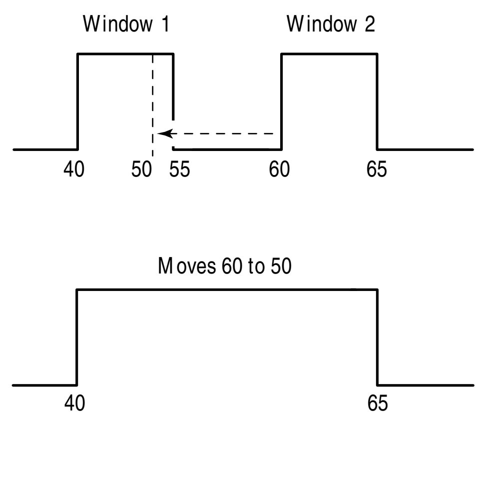
IMPORTANT In counter, **encoder X1** and **encoder X4** operation, values are specified in **counts** (0-16 million). In **rate measurement** operation, values are specified in **frequency** (500KHz maximum).

Up to two ON-OFF windows may be used for each output.

These windows can be overlapped as part of a leading edge advance operation. In this case, the output's conditions maintain the ON condition of either window.



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Manual Override of Outputs

Outputs may be turned ON or OFF by a ladder logic application.

Assigning Outputs to Counters

By setting bits in the configuration data, you can assign the outputs on the module to any of the various counters. You can assign as many as 2 outputs to a given counter. However, an output may be assigned only once to a counter–it is not possible to use the same output with 2 different counters.

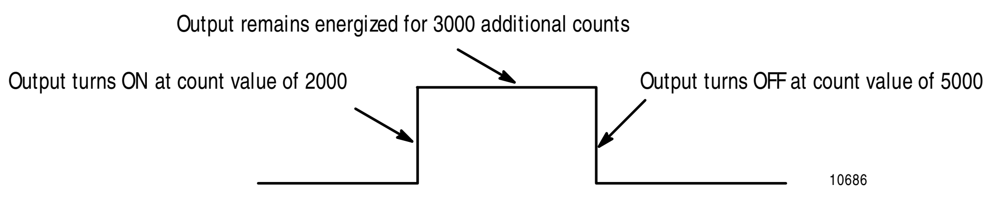
Operation of Outputs

When the outputs for the HSC module are enabled and assigned to a counter, they operate in an ON-OFF fashion.

For example, assume that the module was programmed to turn ON an output when a count value of 2000 was reached. Further, assume that the user desired to have the output remain energized for a period of 3000 counts and then turn OFF. The end result would be that the outputs would turn ON at count of 2000, would remain energized for a period of 3000 additional counts, and would turn OFF at 5000 counts. The ON and OFF values are circular around zero.

In the rate measurement mode, the ON and OFF values associated with each output represent a frequency value instead of a count value. The maximum frequency value which may be entered in an ON or OFF value is 500KHz. See Figure 3.8.

Figure 3.8
ON-OFF Operation of Output



IMPORTANT The HSC module's ON-OFF windows may be changed at any time subsequent to module initialization.

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.

Hysteresis

The HSC module contains a fixed hysteresis of +/- 1 count, based on the encoder. The module will operate in reverse if moved backward in rotation.

Handshaking

A pair of handshaking bits are provided for each counter. These bits are called New Data Flag and Reset New Data Flag bits. They indicate when a stored data value has been most recently updated. These bits are provided for count/accumulate applications, but can be used whenever the stored data is updated at a rate slower than the message instruction time.

The New Data Flag bit can be used by the ladder program to indicate that a store register has been updated by one of the following events:

- An active gate transition in any of the **store count modes**
- The end of the programmed sample period in **rate measurement mode**

The New Data Flag bit is reset in the ladder program by a 0 to 1 transition of the corresponding Reset New Data Flag bit.

IMPORTANT You are not required to use the New Data Flag and Reset New Data Flag bits. The module continues to multicast new data at the RPI. The New Data and Reset New Data features provide a method to eliminate the execution of long tasks needed only when there is a change of state.

Module Maximum Frequency

The HSC module is capable of counting up to 16 million counts from sensors, such as incremental encoders, quadrature encoders, digital rulers, photoswitches and flowmeters. However, the maximum rate at which the counter can accept counts depends on the type of signal directly connected to the module.

The table below lists the signal levels the HSC module accepts.

Table 3.C
Acceptable HSC Signal Levels

Signal Type:	Source Device:	Maximum Signal Rate:	HSC Channels Supporting Signal:
Pulse	Digital Rulers Photoswitch	1MHz @ 5V dc with a pulse width >500ns	Channel A
Quadrature	Quadrature Encoder	250KHz @ 5V dc	Channels A & B
Frequency	Flowmeters	500KHz Pulse/period combinations > 1µs	Channel A

IMPORTANT Higher signal rates typically require the use of 5V dc, TTL or differential driver style outputs from the sensor. The maximum signal rate will not decrease the module update rate of 100µs. This rate remains deterministic for each mode of operation.

Chapter Summary and What's Next

In this chapter you learned about using features common to all ControlLogix analog I/O modules

Move to Chapter 4 to learn how to install and wire your HSC module.

Notes:

Installing and Wiring the ControlLogix High Speed Counter Module

What this Chapter Contains

This chapter describes how to install ControlLogix modules.

Installing the ControlLogix High Speed Counter Module

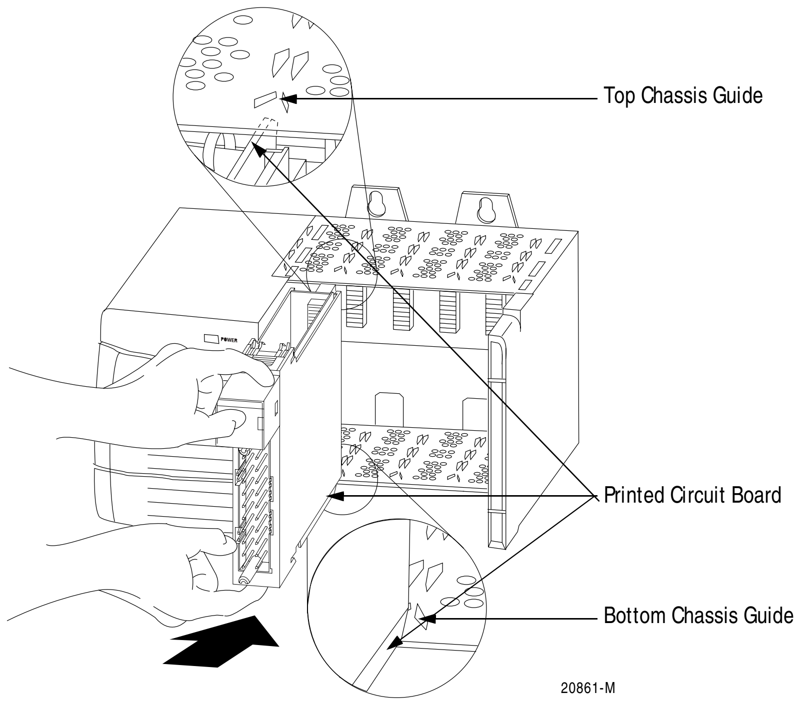
You can install or remove the module while chassis power is applied.

ATTENTION

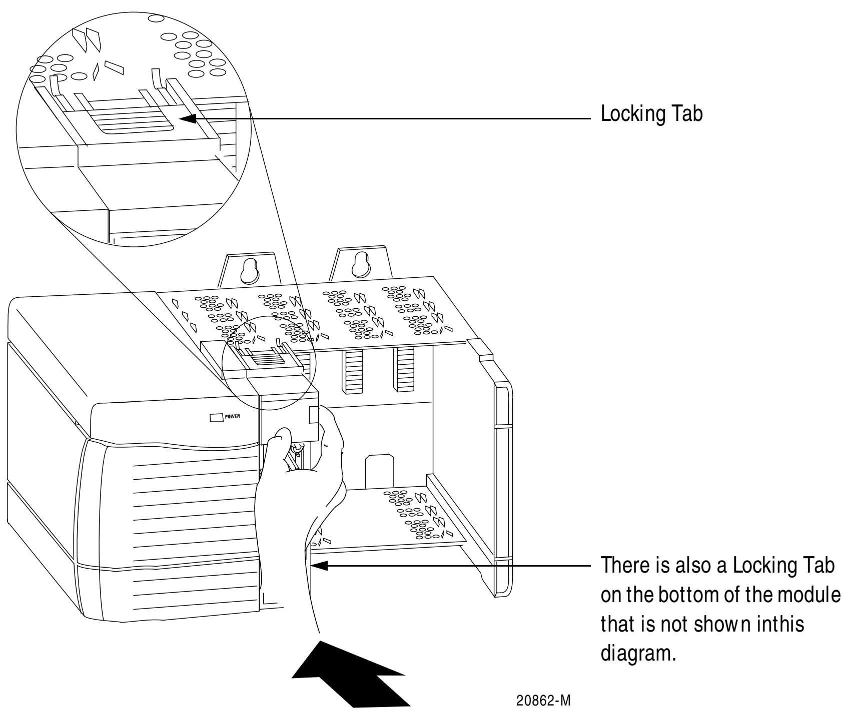
The module is designed to support Removal and Insertion Under Power (RIUP). However, when you remove or insert an RTB with field-side power applied, **unintended machine motion or loss of process control can occur**. Exercise extreme caution when using this feature.

Use the diagrams below to install your HSC module.

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



2. Slide the module into the chassis until module locking tabs ‘click’.



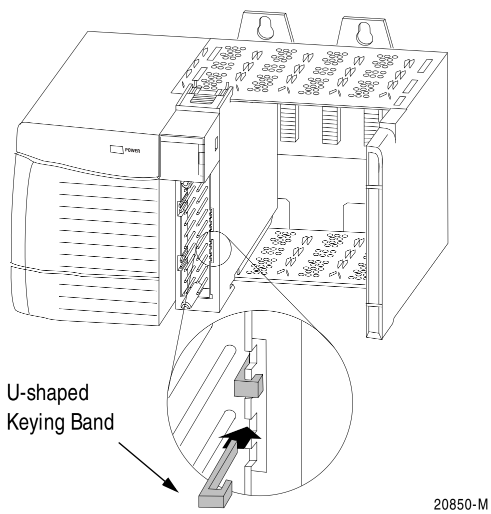
Keying the Removable Terminal Block

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 position #4 on the module, you cannot place a wedge-shaped tab in #4 on the RTB or your RTB will not mount on the module.

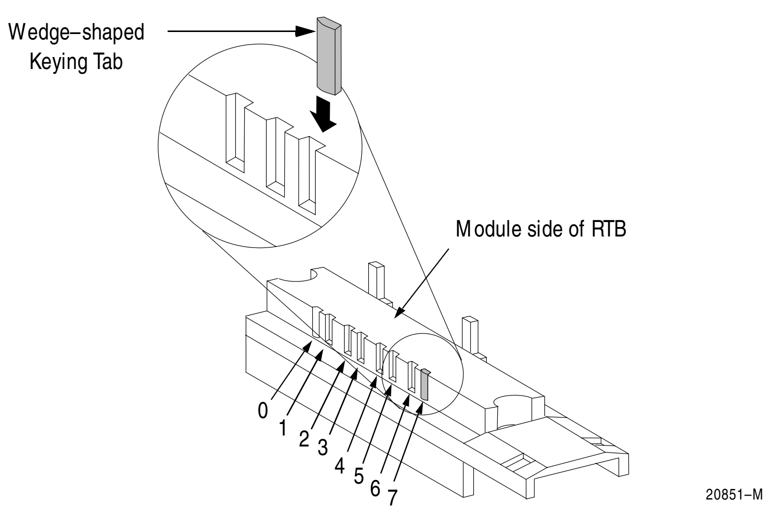
We recommend that you use a unique keying pattern for each slot in the chassis.

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



2. Key the RTB in positions that correspond to unkeyed module positions. Insert the wedge-shaped tab on the RTB with the rounded edge first. 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 position #6 or #7.



Connecting Wiring

You can use an RTB to connect wiring to your module. Follow the directions below to connect wires to the RTB.

For most applications, we recommend using Belden 8761 cable. The RTB terminations can accommodate 22-14 gauge shielded wire. Before wiring the RTB, you must connect ground wiring.

Connect Grounded End of the Cable

1. Ground the drain wire.

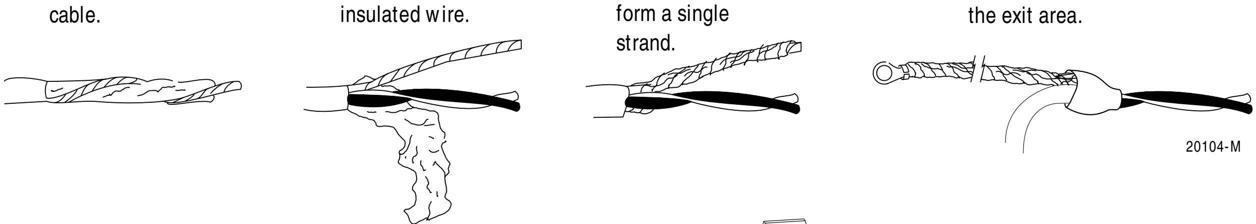
IMPORTANT We recommend you ground the drain wire at the field-side. If you cannot ground at the field-side, ground at an earth ground on the chassis as shown below.

a. Remove a length of cable jacket from the Belden cable.

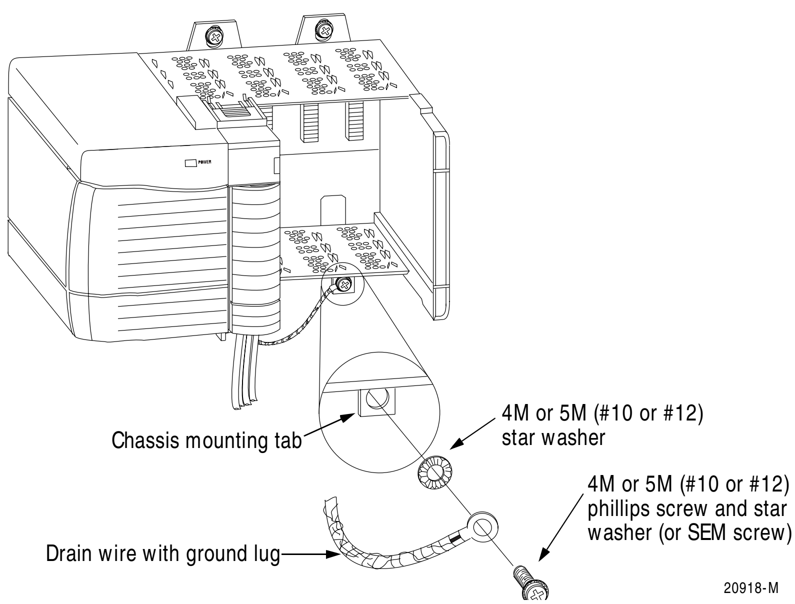
b. Pull the foil shield and bare drain wire from the insulated wire.

c. Twist the foil shield and drain wiretogether to form a single strand.

d. Attach a ground lug and apply heat shrink tubing to the exit area.



e. Connect the drain wire to a chassis mounting tab. Use any chassis mounting tab that is designated as a functional signal ground.



2. Connect the insulated wires to the field-side.

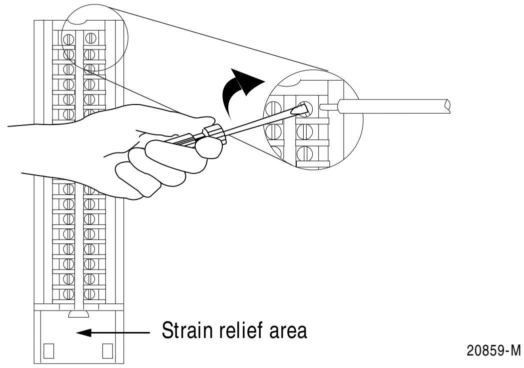
Connect Ungrounded End of the Cable

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, as shown below.

Two Types of RTBs (each RTB comes with housing)

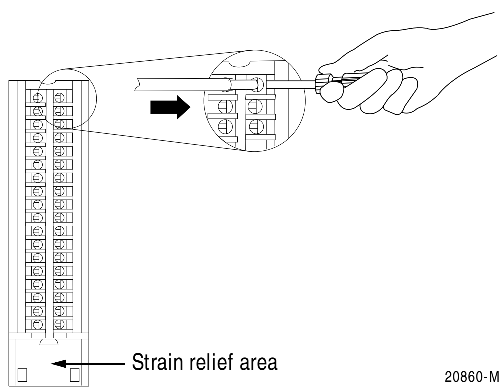
- **Cage clamp** - Catalog number 1756-TBCH

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



- **Spring clamp** - Catalog number 1756-TBS6H

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



Recommendations for Wiring Your RTB

We recommend 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 area of the RTB.
3. Order and use an extended-depth housing (Cat. No.1756-TBE) for applications that require heavy gauge wiring.

Cable Considerations

Although for most applications, we recommend Belden 8761 cable, for more demanding applications (e.g. when frequencies are in the +100KHz and cable length is +100ft), we recommend using Belden 9182 cable for your High Speed Counter module.

Consider the following when wiring your application:

- cable length
- cable impedance
- cable capacitance
- cable frequency
- totem-pole devices

Cable Length

Long cables can result in changes in duty cycle, rise and fall times, and phase relationships. For applications using a differential line driver, we recommend 250ft or less of cable.

For applications using an open collector, or other single-ended driver, we recommend 250 ft or less of any of the following 5V line drivers:

– DM8830
– DM88C30
– 75ALS192

Cable Impedance

We recommend 150Ω Belden 9182 cable for use with encoder and module input circuits.

IMPORTANT	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 increase the dc load seen by the cable driver, though.

Cable Capacitance

High capacitance cable rounds off incoming square wave edges and uses driver current to charge and discharge. Also, remember that increasing cable length causes a linear increase in capacitance.

Cable Frequency

The maximum encoder input of 250KHz is designed to work with Allen-Bradley Bulletin 845H or similar incremental encoders with a quadrature specification of 90^o ($\pm 22^o$) and a duty cycle specification of 50%(±10%). Additional phase or duty cycle changes caused by the cable will reduce the specified 250KHz specification.

Totem-pole Output Devices

Standard TTL totem-pole output devices, usually rated to source 400µA at 2.4V in the high logic state, will not turn on the High Speed Counter module. We recommend using a high current 5V differential line driver when choosing an encoder.

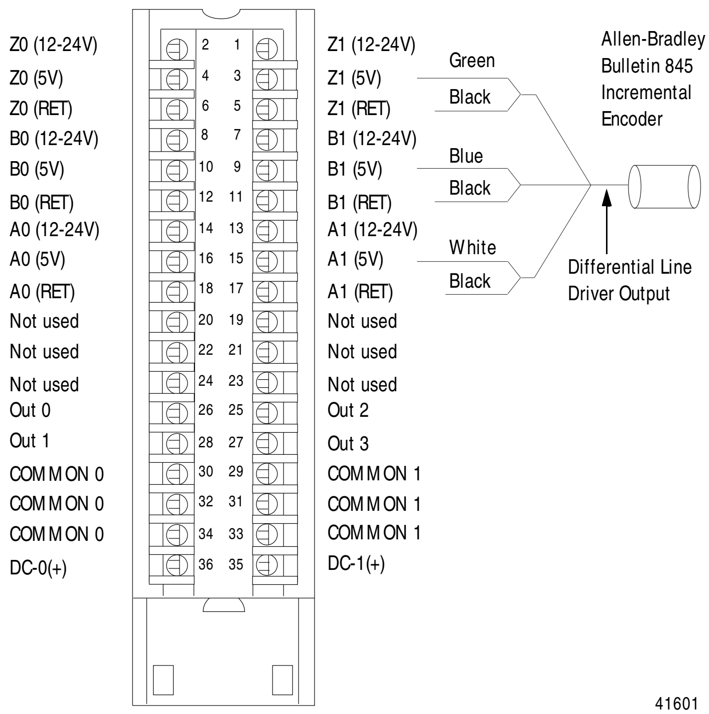
Wiring Terminations

Wiring an Allen-Bradley 845 Incremental Encoder

Use the following tables to connect the High Speed Counter module to an Allen-Bradley 845 incremental encoder:

Table 4.A
Wiring Connections for an Allen-Bradley 845 Incremental Encoder

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

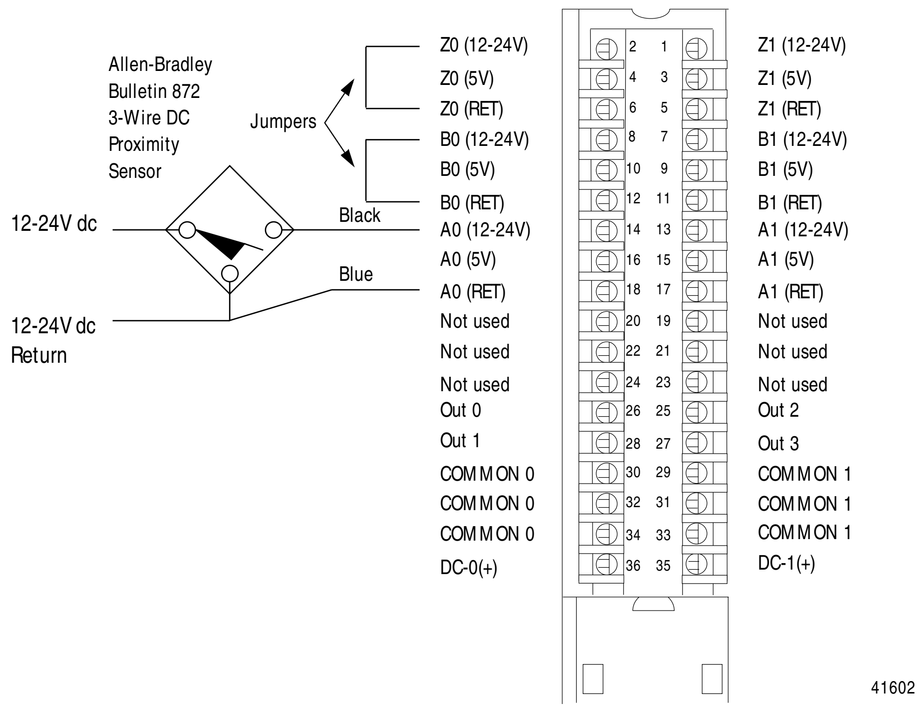


Wiring an Allen-Bradley Bulletin 872 3-Wire DC Proximity Sensor

Use the following table and diagram to connect the High Speed Counter module to an Allen-Bradley 872 3-wire DC proximity sensor:

Table 4.B
Wiring Connections for an Allen-Bradley 872 3-Wire DC Proximity Sensor

Application:	A0 Connections:	B0 Connections:	Z0 Connections:
PNP (Sourcing) N.O.	Black - A0 12-30 Vdc Blue, PS(-)- A0 Return	Jumper B0 12-30 Vdc to B0 Return	Jumper Z0 12-30 Vdc to Z0 Return

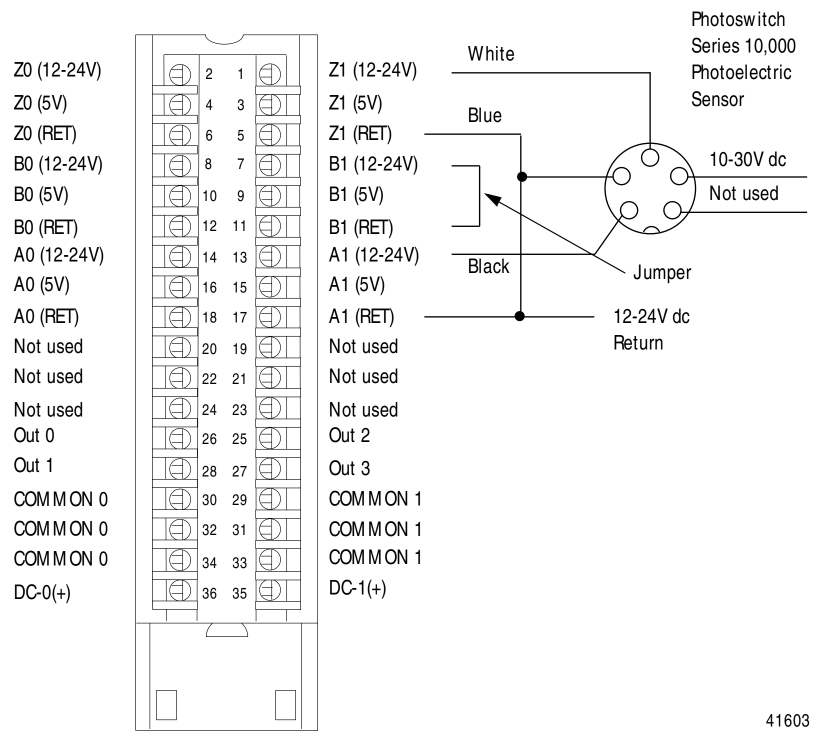


Wiring a Photoswitch Series 10,000 Photoelectric Sensor

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

Table 4.C
Wiring Connections for a Photoswitch Series 10,000 Photoelectric Sensor

Application:	A1 Connections:	B1 Connections:	Z1 Connections:
Any	Black - A1 12-30 Vdc Blue - A1 Return	Jumper B1 12-30 Vdc to B1 Return	White - Z1 12-30 Vdc Blue - Z1 Return

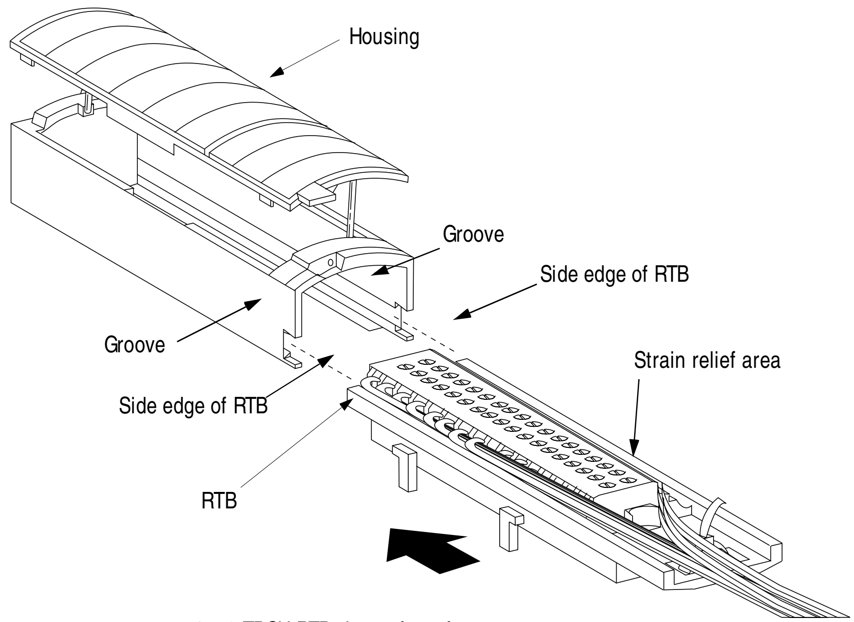


Assembling The Removable Terminal Block and the Housing

Removable housing covers the wired RTB to protect wiring connections when the RTB is seated on the module.

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.



1756-TBCH RTB shown for reference

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

Installing the Removable Terminal Block onto the Module

Install the RTB onto the module to connect wiring.

WARNING

The RTB is designed to support Removal and Insertion Under Power (RIUP). However, when you remove or insert an RTB with field-side power applied, **unintended machine motion or loss of process control can occur**. Exercise extreme caution when using this feature. It is recommended that field-side power be removed before installing the RTB onto the module.

When you remove or insert a module while field-side power is applied, you may cause an electrical arc. An electrical arc can cause personal injury or property damage because it may:

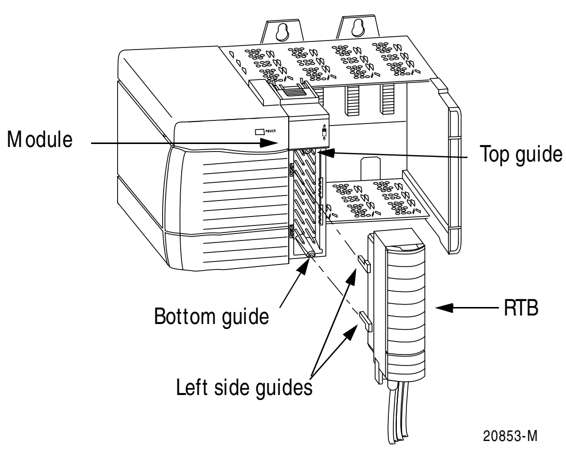
- send an erroneous signal to your system's field devices, causing unintended machine motion or loss of process control.
- cause an explosion in a hazardous environment.

Repeated electrical arcing causes excessive wear to contacts on both module and its mating connector. Worn contacts may create electrical resistance.

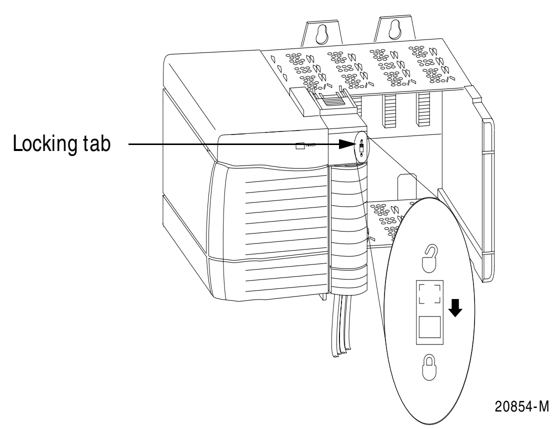
Before installing the RTB, make certain:

- 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 matching guides on the module.



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



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

Removing the Removable Terminal Block from the Module

If you need to remove the module from the chassis, you must first remove the RTB from the module.

ATTENTION

The RTB is designed to support Removal and Insertion Under Power (RIUP). However, when you remove or insert an RTB with field-side power applied, **unintended machine motion or loss of process control can occur**. Exercise extreme caution when using this feature. It is recommended that field-side power be removed before removing the module.

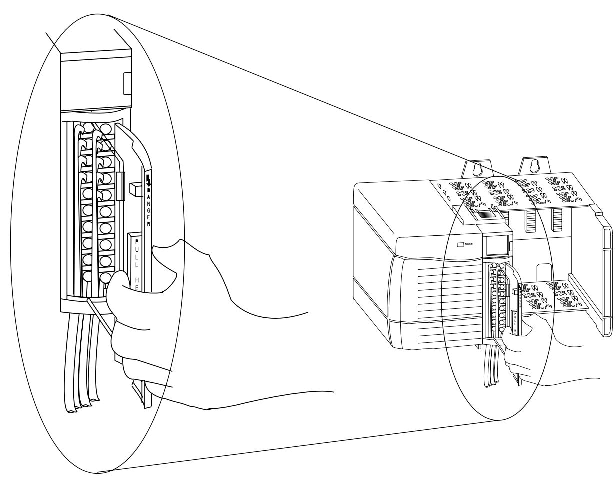
When you remove or insert a module while field-side power is applied, you may cause an electrical arc. An electrical arc can cause personal injury or property damage because it may:

- send an erroneous signal to your system's field devices, causing unintended machine motion or loss of process control.
- cause an explosion in a hazardous environment.

Repeated electrical arcing causes excessive wear to contacts on both module and its mating connector. Worn contacts may create electrical resistance.

1. Unlock the locking tab at the top of the module.
2. Open the RTB door 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.



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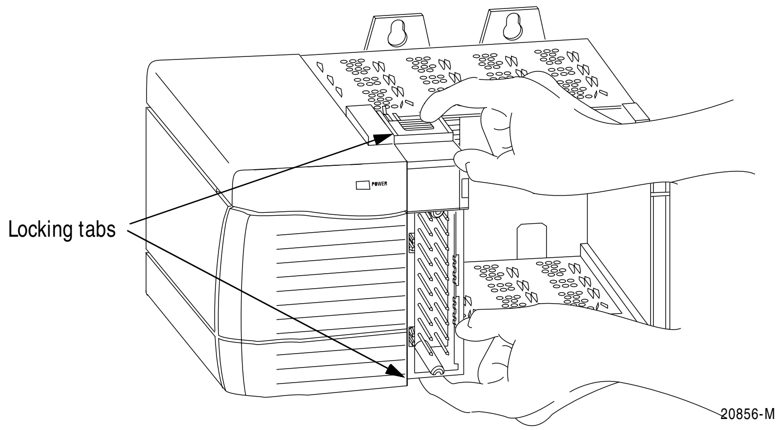
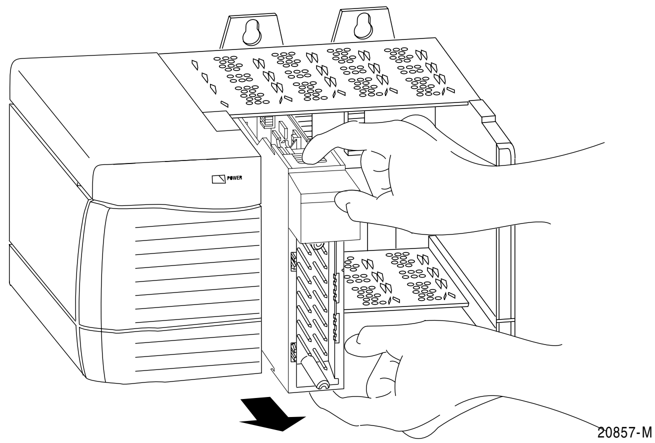
Removing the Module from the Chassis

1. Push in the top and bottom locking tabs.



2. Pull module out of the chassis.



Chapter Summary and What's Next

In this chapter you learned about:

- installing the module
- keying the removable terminal block
- connecting wiring
- assembling the removable terminal block and the housing and installing them onto the module
- removing the removable terminal block from the module
- removing the module from the chassis

Move on to Chapter 5 to learn how to configure your module.

Configuring the ControlLogix High Speed Counter Module

What This Chapter Contains

This chapter describes how to configure the ControlLogix High Speed Counter module. The following table describes what this chapter contains and its location.

Configuring Your High Speed Counter Module

You must configure your module upon installation, either by using the module's default configuration or altering the default configuration for your specific application. The module will not work until it has been configured.

RSLogix 5000 Configuration Software

Use RSLogix 5000 software to write initial configuration for your HSC module. After module operation has begun, you must use ladder logic, and message instructions, to change module configuration.

Overview of the Configuration Process

When you create an HSC module, module-defined data structures and tags are created. The information contained in these structures determines your HSC module's behavior.

The owner-controller sends configuration information to the modules it owns, including any HSC modules, during the download process.

Using the Default Configuration

The default configuration for your HSC module configures the module in counter mode with none of the outputs tied to counters.

Follow these steps to use the initial HSC module specific configuration:

1. Create a new module in RSLogix 5000, see page 5-3.
2. Name the module and set communications options in the software wizard screens, see page 5-4.
3. Download configuration to the owner-controller and HSC module, see page 5-19.

Altering the Default Configuration

To write specific configuration for your application, access the module tags and change configuration information before downloading configuration to the owner-controller and HSC module.

IMPORTANT After HSC module operation has begun, you must use the messaging portion of RSLogix 5000 to change the HSC module configuration.

Follow these steps to write the initial HSC module specific configuration:

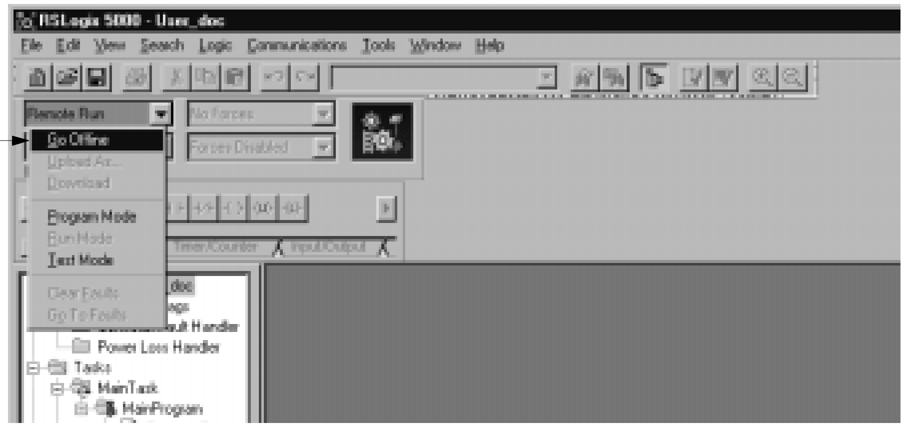
1. Create a new module in RSLogix 5000, see page 5-3.
2. Name the module and set communications options in the software wizard screens, see page 5-4.
3. Access the HSC data structures through the tag monitor to make specific configuration changes, see page 5-17.
4. Download configuration to the owner-controller and HSC module, see page 5-19.

Creating a New Module

After you have started RSLogix 5000 and created a controller, you must create a new HSC module. The wizard allows you to create a new module and set comunications options.

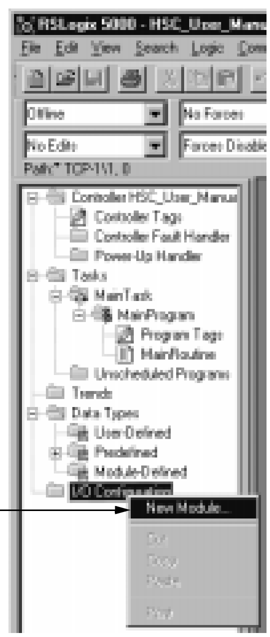
IMPORTANT You must be offline when you create a new module.

If you are not offline, use this pull-down menu to go offline

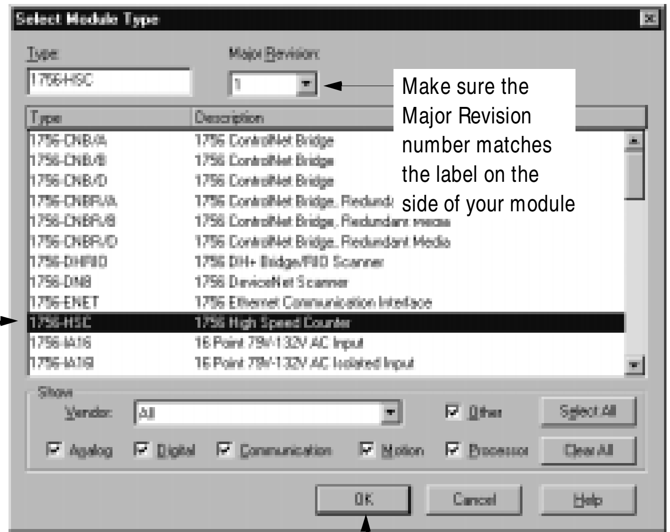


When you are offline, you must select an HSC module.

1. Select I/O Configuration.
2. Click on the right mouse button to display the menu.
3. Select New Module



A screen appears with a list of possible new modules for your application.

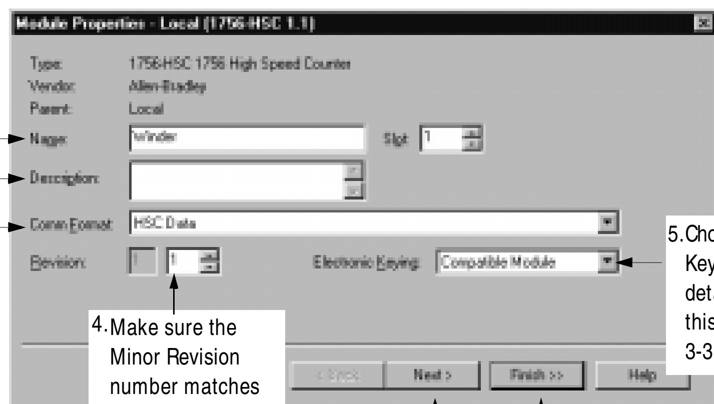


Make sure the Major Revision number matches the label on the side of your module

1. 1. Select a 1756-HSC module

2. Click here

You enter the new module creation wizard.



1. Enter an optional name
2. Enter an optional description
3. Choose a Communications Format (For a detailed explanation of this field see the next page.)
4. Make sure the Minor Revision number matches the label on the side of your module
5. Choose an Electronic Keying method. (For a detailed explanation of this field, got to page 3-3.)

If you want to adjust the communications options, click here Go to page 5-5

If you want to use default configuration, click here and you are finished configuring your module Go to page 5-17

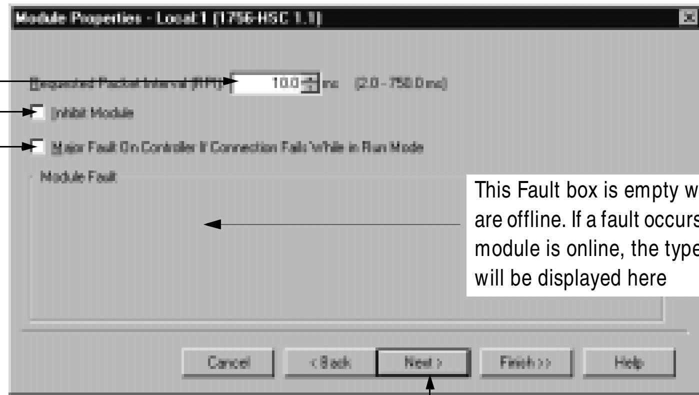
Although each screen maintains importance during online monitoring, two screens that appear during module creation process are not accessible. They are shown here to maintain the graphical integrity of RSLogix 5000.

After the naming page, this screen appears.

Adjust the Requested Packet Interval here

Inhibit the connection to the module here

If you want a Major Fault on the Controller to occur if there is connection failure with the I/O module, click here

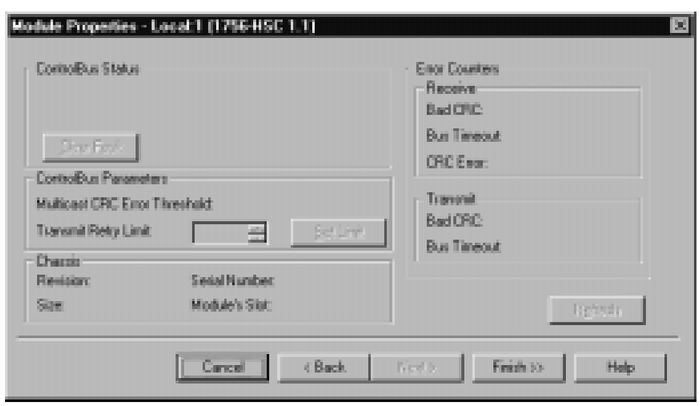


Click here to move to the next page

This screen is used during online monitoring but not initial configuration

Click here to move to the next page

This screen is used during online monitoring but not initial configuration



Communications Format

The communications format determines what type of configuration options are made available, what type of data is transferred between the module and its owner controller. This feature also defines the connection between the controller writing the configuration and the module itself.

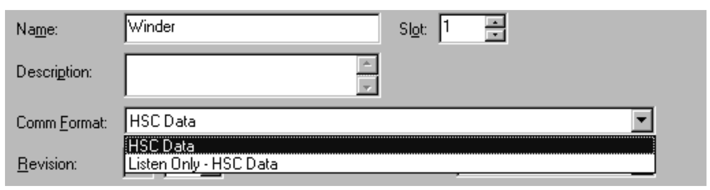
The following communications formats are available for your HSC module:

- **HSC Data** - format used by a controller that wants to own the HSC module and control its configuration data
- **Listen-only-HSC Data** - format used by a controller that wants to listen to the HSC module but not own it

TIP

When you select a Listen-only Communications Format, only the General and Connection tabs appear when you view a module's properties in RSLogix 5000.

The screen below shows the choices available.



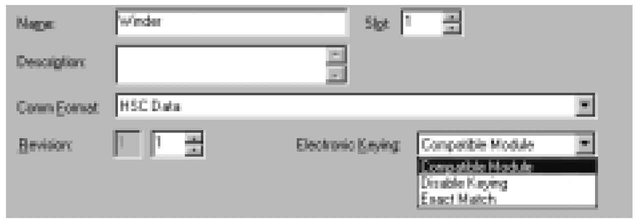
IMPORTANT

Once the module is created, the communications format cannot be changed. The module must be deleted and recreated.

Electronic Keying

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

The screen below shows the choices available.



For a detailed explanation about electronic keying options, see page 3-3.

High Speed Counter Data Structures

There are three categories of HSC data structures.

- **Configuration** - structure used to write HSC configuration upon insertion and to make changes during module operation
- **Output** - structure used to modify counter operation and override the outputs
- **Input** - structure displays the current operational status of the HSC module

Configuration Structure

You must use the Configuration tags to alter HSC module configuration. The following table lists and defines HSC Configuration tags:

Table 5.A
High Speed Counter Module Configuration Tags

Name:	Data Type:	Style:	Definition:	Change During Operation:
C.ProgToFaultEn	BOOL		Sets outputs to their Fault state if connections are lost when the owner-controller is in Program mode. 0 = outputs stay in program mode 1 = outputs use fault mode settings	Yes
C.Rollover[0]	DINT	Decimal	Designates the channel 0 rollover value. Values range from 0 - 16777214 **IMPORTANT**: This value must = 0 when you are using Frequency mode.	Yes
C.Preset[0]	DINT	Decimal	Designates the channel 0 preset value. Module begins counting at this value. Values range from 0 - 16777214 **IMPORTANT**: This value cannot be $\geq$ the rollover value.	Yes
C.Scaler[0]	INT	Decimal	When using period/rate mode, set this value as a multiple of 10ms between 0 - 2000. When using any other mode, set this value = 0.	Yes
C.OperationalMode[0]	SINT	Decimal	Designates channel 0 operational mode. 0 = counter mode 1 = encoder X1 mode 2 = encoder X4 mode 3 = counter not used 4 = frequency mode	No
C.StorageMode[0]	SINT	Decimal	Designates channel 0 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

Table 5.A
High Speed Counter Module Configuration Tags

Name:	Data Type:	Style:	Definition:	Change During Operation:
C.ZInvert.0	BOOL	Decimal	Designates whether channel 0 Z value is inverted. 0 = do not invert Z value 1 = invert Z value	Yes
C.FilterA.0	BOOL	Decimal	Designates whether channel 0 uses filter A. Filter constant = 30ms 0 = do not use filter A 1 = use filter A	Yes
C.FilterB.0	BOOL	Decimal	Designates whether channel 0 uses filter B. Filter constant = 30ms 0 = do not use filter B 1 = use filter B	Yes
C.FilterZ.0	BOOL	Decimal	Designates whether channel 0 uses filter Z. Filter constant = 30ms 0 = do not use filter Z 1 = use filter Z	Yes
C.Rollover[1]	DINT	Decimal	Designates the channel 1 rollover value. Values range from 0 - 16777214 **IMPORTANT**: This value must = 0 when you are using Frequency mode.	Yes
C.Preset[1]	DINT	Decimal	Designates the channel 1 preset value. Module begins counting at this value. Values range from 0 - 16777214 **IMPORTANT**: This value cannot be ≥ the rollover value.	Yes
C.Scaler[1]	INT	Decimal	When using frequency mode, set this value as a multiple of 10ms between 0 - 2000. When using any other mode, set this value = 0.	No
C.OperationalMode[1]	SINT	Decimal	Designates channel 1 operational mode. 0 = counter mode 1 = encoder X1 mode 2 = encoder X4 mode 3 = counter not used 4 = frequency mode	No
C.StorageMod[1]	SINT	Decimal	Designates channel 1 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.1	BOOL	Decimal	Designates whether channel 1 Z value is inverted. 0 = do not invert Z value 1 = invert Z value	Yes

Table 5.A
High Speed Counter Module Configuration Tags

Name:	Data Type:	Style:	Definition:	Change During Operation:
C.FilterA.1	BOOL	Decimal	Designates whether channel 1 uses filter A. 0 = do not use filter A 1 = use filter A	Yes
C.FilterB.1	BOOL	Decimal	Designates whether channel 1 uses filter B. 0 = do not use filter B 1 = use filter B	Yes
C.FilterZ.1	BOOL	Decimal	Designates whether channel 1 uses filter Z. 0 = do not use filter Z 1 = use filter Z	Yes
C.Output[0].ONValue[0]	DINT	Decimal	Designates the first value at which output 0 turns ON. Valid values are 0 - 16,777,214.	Yes
C.Output[0].OFFValue[0]	DINT	Decimal	Designates the first value at which output 0 turns OFF. Valid values are 0 - 16,777,214.	Yes
C.Output[0].ONValue[1]	DINT	Decimal	Designates the second value at which output 0 turns ON. Valid values are 0 - 16,777,214.	Yes
C.Output[0].OFFValue[1]	DINT	Decimal	Designates the second value at which output 0 turns OFF. Valid values are 0 - 16,777,214.	Yes
C.Output[0].ToThisCounter	SINT	Decimal	Designates counter to which output 0 is tied. 0 = not tied to counter 1 = tied to counter (0) 2 = tied to counter (1)	Yes
C.Output[0].FaultMode	SINT		Selects the behavior output 0 takes if a communications fault occurs. 0 = outputs turn OFF 1 = outputs turn ON 2 = counter continues to determine outputs operation	Yes
C.Output[0].ProgMode	SINT		Selects the behavior output 0 takes if when transitioning into Program Mode. 0 = Outputs turn OFF 1 = Outputs turn ON 2 = Counter continues to determine outputs operation	Yes
C.Output[1].ONValue[0]	DINT	Decimal	Designates the first value at which output 1 turns ON. Valid values are 0 - 16,777,214.	Yes
C.Output[1].OFFValue[0]	DINT	Decimal	Designates the first value at which output 1 turns OFF. Valid values are 0 - 16,777,214.	Yes
C.Output[1].ONValue[1]	DINT	Decimal	Designates the second value at which output 1 turns ON. Valid values are 0 - 16,777,214.	Yes
C.Output[1].OFFValue[1]	DINT	Decimal	Designates the second value at which output 1 turns OFF. Valid values are 0 - 16,777,214.	Yes

Table 5.A
High Speed Counter Module Configuration Tags

Name:	Data Type:	Style:	Definition:	Change During Operation:
C.Output[1].ToThisCounter	SINT	Decimal	Designates counter to which output 1 is tied. 0 = not tied to counter 1 = tied to counter (0) 2 = tied to counter (1)	No
C.Output[1].FaultMode	SINT		Selects the behavior output 1 takes if a communications fault occurs. 0 = outputs turn OFF 1 = outputs turn ON 2 = counter continues to determine outputs operation	Yes
C.Output[1].ProgMode	SINT		Selects the behavior output 1 takes if when transitioning into Program Mode. 0 = outputs turn OFF 1 = outputs turn ON 2 = counter continues to determine outputs operation	Yes
C.Output[2].ONValue[0]	DINT	Decimal	Designates the first value at which output 2 turns ON. Valid values are 0 - 16,777,214.	Yes
C.Output[2].OFFValue[0]	DINT	Decimal	Designates the first value at which output 2 turns OFF. Valid values are 0 - 16,777,214.	Yes
C.Output[2].ONValue[1]	DINT	Decimal	Designates the second value at which output 2 turns ON. Valid values are 0 - 16,777,214.	Yes
C.Output[2].OFFValue[1]	DINT	Decimal	Designates the second value at which output 2 turns OFF. Valid values are 0 - 16,777,214.	Yes
C.Output[2].ToThisCounter	SINT	Decimal	Designates counter to which output 2 is tied. 0 = not tied to counter 1 = tied to counter (0) 2 = tied to counter (1)	No
C.Output[2].FaultMode	SINT		Selects the behavior output 2 takes if a communications fault occurs. 0 = outputs turn OFF 1 = outputs turn ON 2 = counter continues to determine outputs operation	Yes
C.Output[2].ProgMode	SINT		Selects the behavior output 2 takes if when transitioning into Program Mode. 0 = outputs turn OFF 1 = outputs turn ON 2 = counter continues to determine outputs operation	Yes
C.Output[3].ONValue[0]	DINT	Decimal	Designates the first value at which output 3 turns ON.	Yes
C.Output[3].OFFValue[0]	DINT	Decimal	Designates the first value at which output 3 turns OFF.	Yes

Table 5.A
High Speed Counter Module Configuration Tags

Name:	Data Type:	Style:	Definition:	Change During Operation:
C.Output[3].ONValue[1]	DINT	Decimal	Designates the second value at which output 3 turns ON.	Yes
C.Output[3].OFFValue[1]	DINT	Decimal	Designates the second value at which output 3 turns OFF.	Yes
C.Output[3].ToThisCounter	SINT	Decimal	Designates counter to which output 3 is tied. 0 = not tied to counter 1 = tied to counter (0) 2 = tied to counter (1)	No
C.Output[3].FaultMode	SINT		Selects the behavior output 3 takes if a communications fault occurs. 0 = outputs turn OFF 1 = outputs turn ON 2 = counter continues to determine outputs operation	Yes
C.Output[3].ProgMode	SINT		Selects the behavior output 3 takes if when transitioning into Program Mode. 0 = outputs turn OFF 1 = outputs turn ON 2 = counter continues to determine outputs operation	Yes

Output Tags

You must use the Output tags to change HSC module configuration during operation. The following table lists and defines HSC Output tags:

Table 5.B
High Speed Counter Module Output Tags

Name:	Type:	Style:	Definition:	Change During Operation:
O.ResetCounter.0	BOOL	Decimal	Resets counter 0 and begins counting. 0 = do not reset 1 = reset	Yes
O.LoadPreset.0	BOOL	Decimal	Loads preset count value into counter 0 and begins counting. 0 = no action 1 = load preset	Yes
O.ResetNewDataFlag.0	BOOL	Decimal	Handshaking bit resets data in the I.NewDataFlag.0 bit after it has been processed. 0 = do not reset the flag 1 = reset the flag	Yes

Table 5.B
High Speed Counter Module Output Tags

Name:	Type:	Style:	Definition:	Change During Operation:
O.ResetCounter.1	BOOL	Decimal	Resets counter 1 and begins counting. 0 = do not reset 1 = reset	Yes
O.LoadPreset.1	BOOL	Decimal	Loads preset count value into counter 1 and begins counting. 0 = no action 1 = load preset	Yes
O.ResetNewDataFlag.1	BOOL	Decimal	Handshaking bit resets data in the I.NewDataFlag.1 bit after it has been processed. 0 = do not reset the flag 1 = reset the flag	Yes
O.OutputControl[0]	SINT	Decimal	Overrides current value for output 0 0 = normal operation 1 = override value to OFF 2 = override value to ON	Yes
O.OutputControl[1]	SINT	Decimal	Overrides current value for output 1 0 = normal operation 1 = override value to OFF 2 = override value to ON	Yes
O.OutputControl[2]	SINT	Decimal	Overrides current value for output 2 0 = normal operation 1 = override value to OFF 2 = override value to ON	Yes
O.OutputControl[3]	SINT	Decimal	Overrides current value for output 3 0 = normal operation 1 = override value to OFF 2 = override value to ON	Yes

Input Tags

You must use the Input tags to monitor HSC module status. The following table lists and defines HSC Input tags:

Table 5.C
High Speed Counter 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[0]	DINT	Decimal	Displays the channel 0 count value. Values range from 0 - 16777214
I.StoredValue[0]	DINT	Decimal	Displays the stored channel 0 count value. The Z input must trigger this counter. Storage mode configuration determines the mode. Values range from 0 - 16777214
I.WasReset.0	BOOL	Decimal	Displays whether the channel 0 counter was reset. 0 = counter was not reset 1 = counter was reset
I.WasPreset.0	BOOL	Decimal	Displays whether the preset value for the channel 0 counter was loaded. 0 = preset value was not loaded 1 = preset value was loaded
I.NewDataFlag.0	BOOL	Decimal	Displays whether channel 0 received new data on the last scan. 0 = no new data was received 1 = new data was received
I.ZState.0	BOOL	Decimal	Displays the channel 0 Z state. 0 = gate is low 1 = gate is high
I.PresentValue[1]	DINT	Decimal	Displays the present channel 1 count value. Values range from 0 - 16777215
I.StoredValue[1]	DINT	Decimal	Displays the stored channel 0 count value. The Z input must trigger this counter. Storage mode configuration determines the mode. Values range from 0 - 16777214
I.WasReset.1	BOOL	Decimal	Displays whether the channel 1 counter was reset. 0 = counter was not reset 1 = counter was reset
I.WasPreset.1	BOOL	Decimal	Displays whether the preset value for the channel 1 counter was loaded. 0 = preset value was not loaded 1 = preset value was loaded

Table 5.C
High Speed Counter Module Input Tags

Name:	Type:	Style:	Definition:
I.NewDataFlag.1	BOOL	Decimal	Displays whether channel 1 received new data on the last scan. 0 = no new data was received 1 = new data was received
I.ZState.1	BOOL	Decimal	Displays the channel 1 Z state. 0 = gate is low 1 = gate is high
I.OutputState.0	BOOL	Decimal	Displays the channel 0 output state. 0 = output is low 1= output is high
I.IsOverridden.0	BOOL	Decimal	Determines whether channel 0 output is overridden 0 = output is using ON-OFF window 1 = output is overridden
I.OutputState.1	BOOL	Decimal	Displays the channel 1 output state. 0 = output is low 1= output is high
I.IsOverridden.1	BOOL	Decimal	Determines whether channel 1 output is overridden 0 = output is using ON-OFF window 1 = output is overridden
I.OutputState.2	BOOL	Decimal	Displays the channel 2 output state. 0 = output is low 1= output is high
I.IsOverridden.2	BOOL	Decimal	Determines whether channel 2 output is overridden 0 = output is using ON-OFF window 1 = output is overridden
I.OutputState.3	BOOL	Decimal	Displays the channel 3 output state. 0 = output is low 1= output is high
I.IsOverridden.3	BOOL	Decimal	Determines whether channel 3 output is overridden 0 = output is using ON-OFF window 1 = output is overridden
I.CSTTimestamp	DINT[2]		

Error Codes

The table below lists possible errors on your HSC module. These errors are displayed on the Connection tab of the Module Properties section in RSLogix 5000 (e.g. see page 6-3) and in the .EXERR field of the message variable when your reconfigure the HSC module.

The final number of each code represents the channel number that is reporting the error: 1 = channel 0
2 = channel 1
For example, code 16#0011 means that a BADCOUNT has occurred on channel 0.

Table 5.D

Counter Configuration Errors	
Error Code:	**Definition:**
16#0011, 16#0012	**BADCOUNT** - Occurs if you set the operational mode to a value of five 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 frequency mode or if you program a value greater than 0xfffffe in frequency mode
16#0041, 16#0042	**BADPRESET** - Occurs if you program a nonzero value in frequency mode or if you program a value equal to or greater than the rollover value in frequency mode
16#0051, 16#0052	**BADSCALE** - Occurs if you take any of the following actions: • 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 scalar is not equal to 0

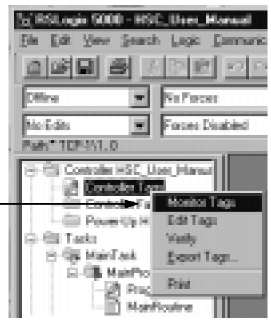
Output Configuration Errors	
Error Code:	**Definition:**
16#0061, 16#0062, 16#0063, 16#0064	**BADTIE** - Occurs if you attempt to tie an output to a nonexistent counter or if you attempt to tie the output to two counters. Valid entries are 0x0, 0x1, or 0x2
16#0071, 16#0072, 16#0073, 16#0074	**BADFAULT** - Occurs if you configure the HSC module for something other than ON, OFF or CONTINUE or if the HSC module receives a communications 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 HSC module for something other 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

Accessing the Tags

When you access tags to change configuration or monitor the I/O data exchange, you have two options.:

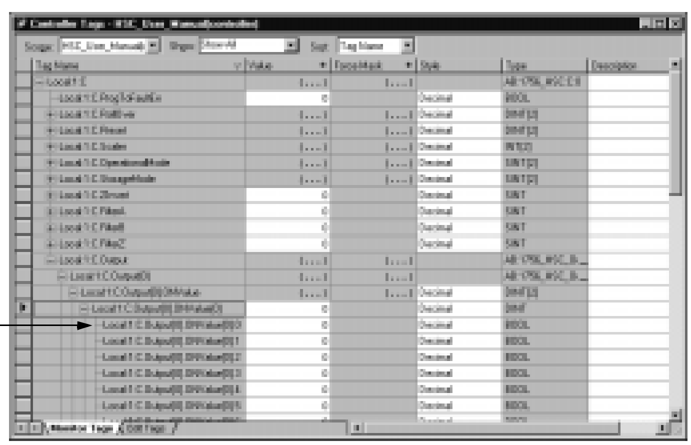
- **Monitor tags** - option allows you to view tags and change their values
- **Edit tags** - option allows you to add or delete tags but not to change their values

1. Select Controller Tags
2. Right-click to display the menu
3. Select Monitor Tags



You can view tags here.

Click on the tag name of the data structure you want to see



Configuration information is listed for each channel on the module.

Changing Configuration Information at the Tags

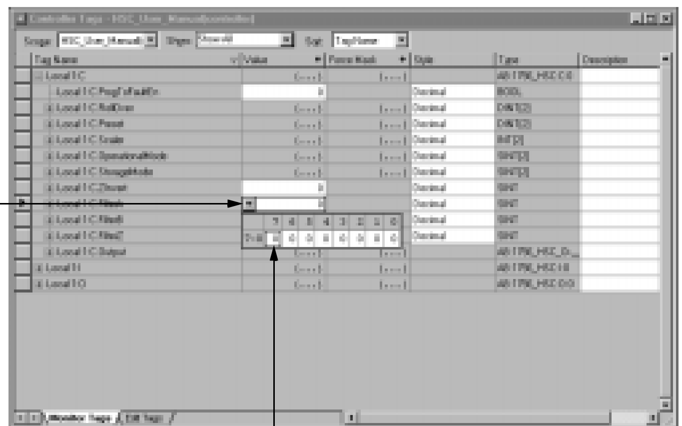
Some configurable features are changed on a module-wide basis and some on a point-by-point basis.

Configurable Features

There are two ways to change the configuration:

- use a pulldown menu
- highlight the value of a particular feature for a particular point and type a new value

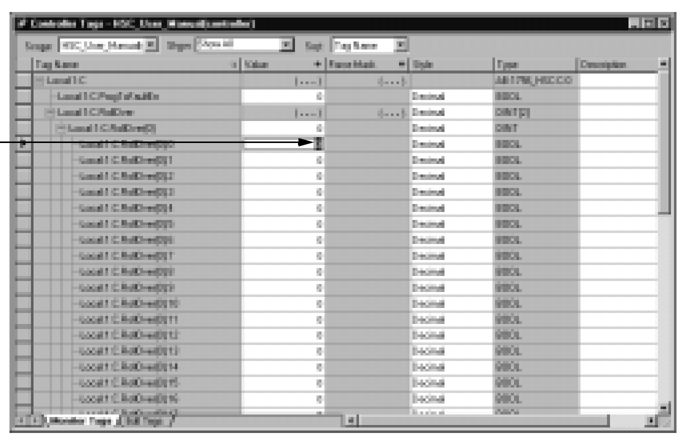
Pulldown menu



1. Click on the far left side of the Value column and a pulldown menu appears.

2. Highlight the point that needs to be changed and type a valid new value.

Highlight value



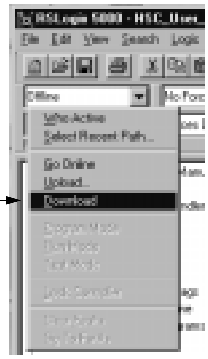
1. Highlight the value of the feature you want to change.

2. Type in the valid new value.

Downloading Configuration Data

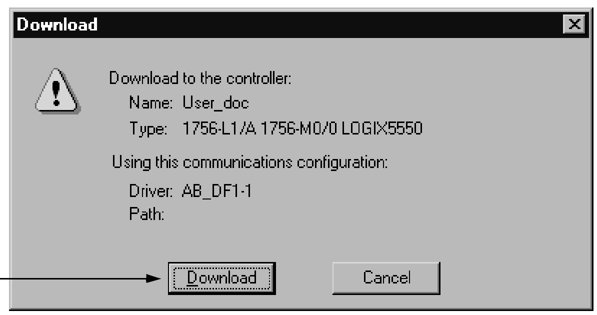
After you have changed the configuration data for an HSC module, the change does not actually take affect until you download the new program which contains that information. This downloads the entire program to the controller overwriting any existing programs.

Pull down this menu and click here to download the new data



RSLogix 5000 verifies the download process with this pop-up screen.

Click here to download new data



This completes the download process.

Changing Configuration During HSC Module Operation

After the HSC module has begun operation, you can only change configuration by using ladder logic and message instructions.

Follow these steps to change HSC module configuration during operation:

1. Access the HSC data structures through the tag monitor to make specific configuration changes, see page 5-17.

2. Use ladder logic and a configuration message instruction to send the configuration changes to the HSC module, see below through page 5-25.

Using Ladder Logic

You must use ladder logic to perform the following operations on your HSC module:

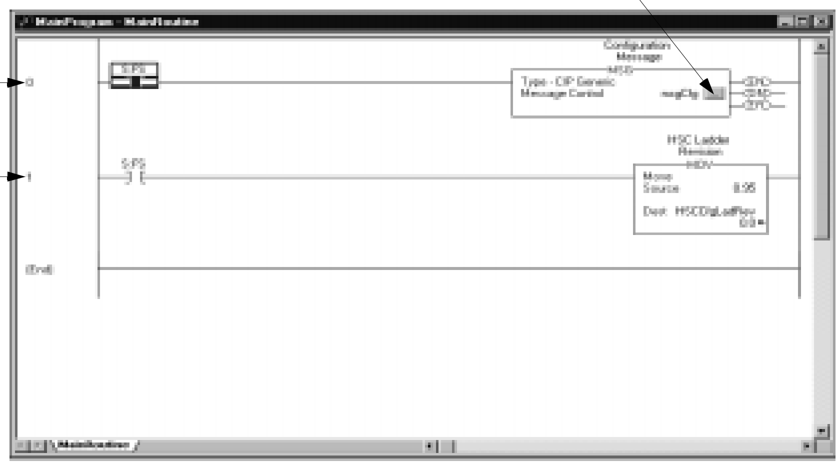
- change configuration
- perform run time services

Ladder logic uses message instructions to exchange data between the controller and HSC module. You can access the ladder logic by double-clicking on the MainRoutine portion of the MainProgram.

Double-click here to enter the Main Routine

Click here to access the configuration message instruction for this rung.

IMPORTANT: Message instructions are explained on page 5-22.



Rung 0 sends the configuration data the 1756-HSC module upon a power-up or program to run transition.

Rung 1 is a MOV instruction.

Using Message Instructions

Ladder logic uses message instructions to change the HSC module configuration during module operation.

Message instructions maintain the following characteristics:

- messages use unscheduled portions of system communications bandwidth
- one service is performed per instruction
- performing module services does not impede module functionality, such as counting incoming pulses

Processing Real-Time Control and Module Services

Because message instructions use unscheduled portions of systems communications bandwidth, the services requested of an 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.

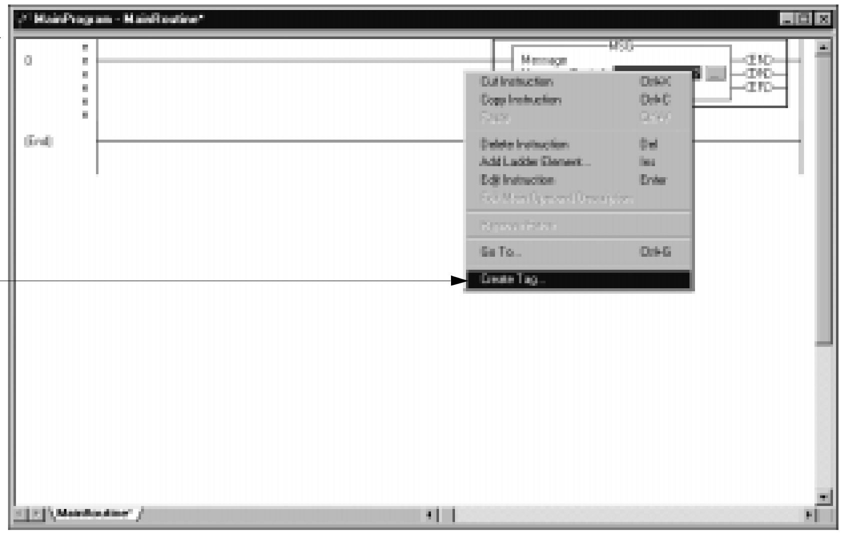
One Service Performed Per Instruction

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

Creating a New Tag

Ladder logic is written in the Main Routine section of RSLogix 5000.

Double-click here to enter the Main Routine

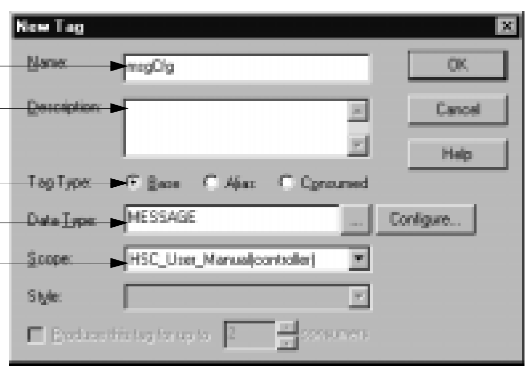


After adding a message instruction to a rung, you must create a tag for the message instruction

1 Right-click on the question mark (?) to see this pull-down menu.
2 Click on Create a Tag.

Fill in the following information when the New Tag pop-up screen appears:

We suggest you name the tag to indicate what module service is sent by the message instruction. For example, the message instruction below is used to write configuration and is named accordingly.



Name the tag here.

Enter an optional description here.

Choose the **Base** Tag Type here.

Choose the **Message** Data Type here.

Choose the **Controller** Scope here.

IMPORTANT: Message tags can only be created with the Controller Scope.

Enter Message Configuration

After creating a new tag, you must enter message configuration.

Click here to see the message configuration pop-up screens

Enter message configuration on the following screens:

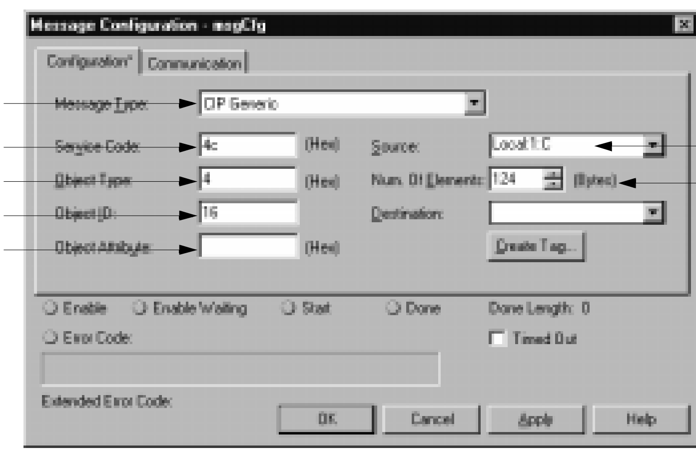
- Configuration pop-up screen
- Communications pop-up screen

A description of the purpose and set-up of each screen follows.

Configuration Pop-Up Screen

This pop-up screen provides information on what module service to perform and where to perform it.

For example, the screen below shows the information needed to send a configuration message (module service) to a 1756-HSC module (where to perform service).



Message Type is CIP Generic

Service Code is 4c

Object Type is 4

Object ID is 16

Object Attribute is left blank

Source is Local:1:C

Num. Of Elements is 124

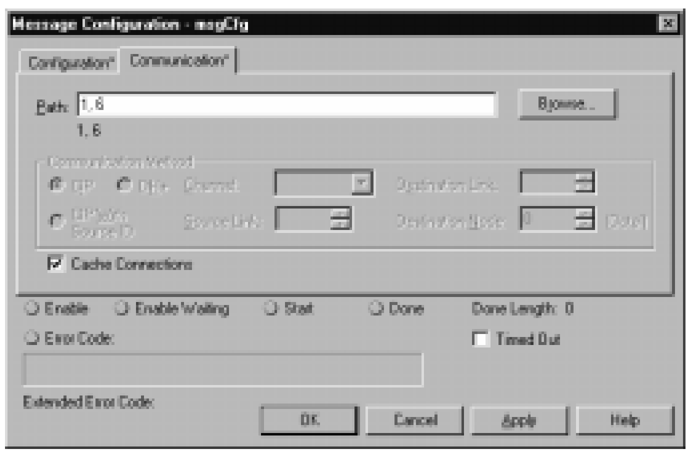
The following table contains information that must be entered on the configuration pop-up screen to perform the example HSC module service:

Table 5.E
Configuration Message Values

Enter the following:	To send a Configuration Message:
Service Code	4c
Object Type	4
Object ID (Channel Number)	16
Source	Local:5:C
Number of Elements	124
Destination	N/A

Communications Pop-Up Screen

This pop-up screen provides information on the path of the message instruction. For example, the slot number of a 1756-HSC module distinguishes exactly which module a message is designated for.



IMPORTANT The path changes, according to the ControlLogix chassis and slot number in which your HSC module resides. Make sure you account for each hop in the message's path.

Setting the Path

If the HSC module resides in the same chassis as the controller, the path contains two digits, accounting for the backplane and slot number of the HSC module.

In the example above, a path of 1,6 is used.

- 1 = backplane between the controller and HSC module
- 6 = slot number in which the HSC is residing

If the HSC module resides in a chassis other than that of the controller, the path must account for each hop. For example, if the HSC module is remotely connected to controller via ControlNet, a longer path of 1,7,2,25,1,4 may be used. These digits account for the following hops:

- 1 = backplane of first chassis
- 7 = slot number of 1756-CNB module providing ControlNet connection
- 2 = ControlNet connection
- 25 = node address of second chassis
- 1 = backplane of second chassis
- 4 = slot number of 1756-HSC module in second chassis

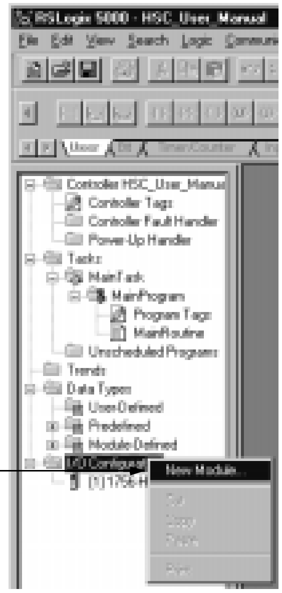
The path described above uses values strictly for example purposes. You must use a path that fits your application.

Configuring HSC Modules in a Remote Chassis

ControlLogix ControlNet Interface modules (1756-CNB or 1756-CNBR) are required to communicate with HSC modules in a remote chassis.

You must configure the communications module in the local chassis and the remote chassis before adding new I/O modules to the program.

1. Create a 1756-CNB or 1756-CNBR module in the local chassis.

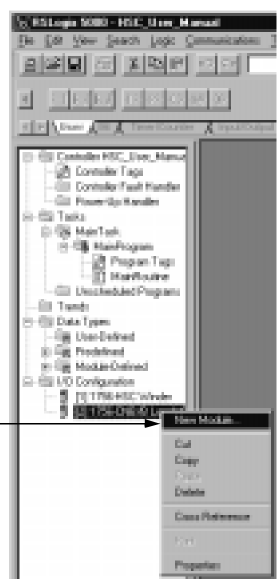


1. Select I/O Configuration.
2. Click on the right mouse button to display the menu.
3. Select New Module

2. Configure the 1756-CNB or 1756-CNBR module.

   For more information on the ControlLogix ControlNet Interface modules, see the ControlLogix ControlNet Interface Installation Instructions, publication 1756-5.32.

3. Create a 1756-CNB or 1756-CNBR module for the remote chassis. Notice that the remote 1756-CNB module is added to the Controller Organizer through the local 1756-CNB module.



1. Select the local communications module
2. Click on the right mouse button and select New Module

4. Configure the remote 1756-CNB or 1756-CNBR module.

5. Add remote HSC modules to your configuration through the remote 1756-CNB or 1756-CNBR module.

1. Select the local communications module
2. Click on the right mouse button and select New Module

Configure remote HSC modules using the same procedures detailed earlier in this chapter to configure local HSC modules.

Chapter Summary and What's Next

In this chapter you learned about:

- configuring the HSC module
- editing module configuration
- configuration tags

Move on to Chapter 6 to troubleshoot your module.

Troubleshooting Your Module

What This Chapter Contains

This chapter describes the indicators on the ControlLogix HSC module and how to use them to troubleshoot the module. The following table describes what this chapter contains and its location.

Using Indicators to Troubleshoot Your Module

Each ControlLogix HSC module has indicators which show input and output status. LED indicators are located on the front of the module.

LED indicators for the HSC module

The 1756-HSC module uses the following status indicators.

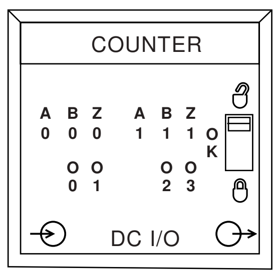


Table 6.A

LED indicator	This display:	Means:	Take this action:
Input (A, B, Z)	Off	Input turned off Input not currently used Wire disconnected	If you need to use the input, check wiring connections

Table 6.A

LED indicator	This display:	Means:	Take this action:
	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

Using RSLogix 5000 to Troubleshoot Your Module

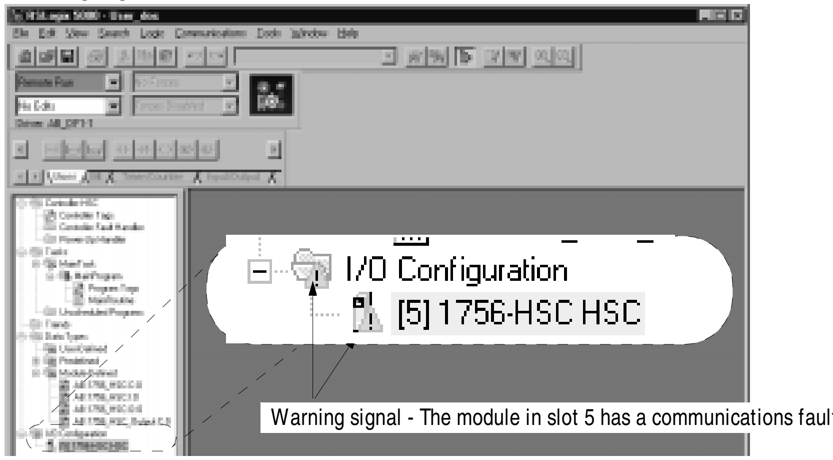
In addition to the LED display on the module, RSLogix 5000 will alert you to fault conditions. You will be alerted in one of four ways:

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

The screens below display fault notification in RSLogix 5000.

Warning signal on main screen

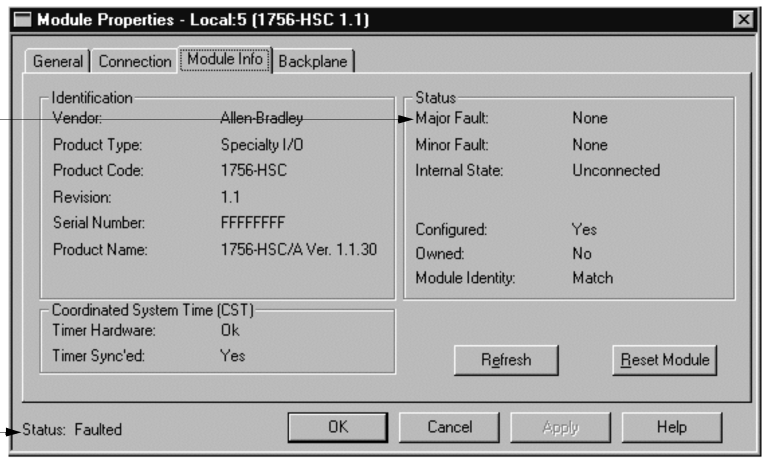
Warning icon when a communications fault occurs or if the module is inhibited



Fault message in status line

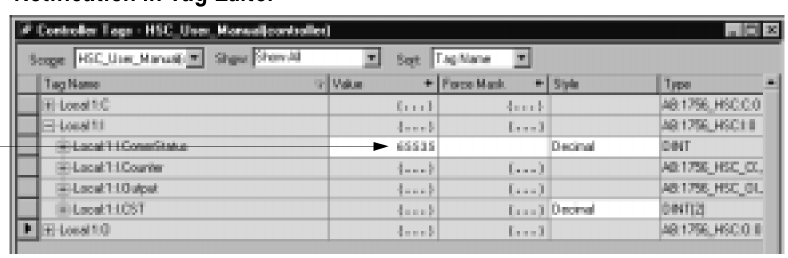
Status section lists Major and Minor Faults and the Internal State of the module

Status line provides information on the connection to the module



Notification in Tag Editor

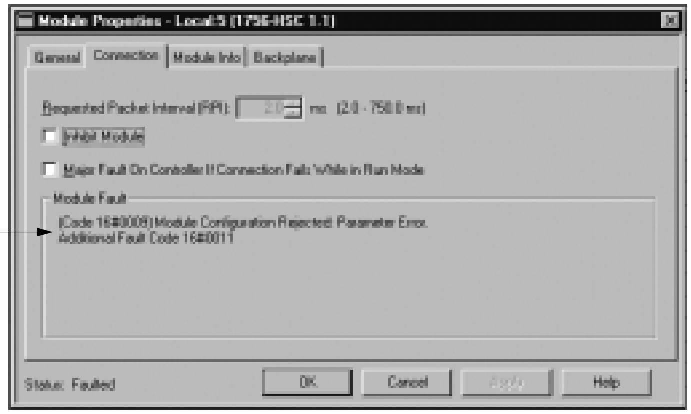
The CommStatus field shows a value of 65535 because the module connection has been broken



Determining Fault Type

When you are monitoring a module's configuration properties in RSLogix 5000 and receive a Communications fault message, the Connection page lists the type of fault.

The fault type is listed here
In this example, Error 16#0011 means Counter 0 was set to an invalid Operational Mode



For a detailed listing of the possible faults, their causes and suggested solutions, see Module Table Faults in the online help and the list on page 5-16.

Solving Common Problems in High Speed Counter Applications

Table lists problems common to high speed counter applications and provides solutions.

Table 6.B
Common Problems with High Speed Counter Applications

Problem:	Possible Solution(s):
When Z is pulsed, the present count does not move into the stored count.	1. Make sure the storage mode is not set to 0. 2. Make sure the z pulse width is within specification (i.e. the pulse width is long enough).
There are pulses on the A input or B input but the counter does not increment or decrement.	1. Make sure there is a value in the Rollover register. 2. Make sure the module is not configured for frequency mode.
The ON/OFF window is selected but the output does not turn ON when the counter value is within the ON/OFF window.	Make sure the C.Output[x].ToThisCounter is **not** selected to 0, which means "Not Tied to Counter."

Table 6.B
Common Problems with High Speed Counter Applications

Problem:	Possible Solution(s):
Despite a module fault, outputs do not turn OFF.	Make sure C.Output[x].FaultMode is **not** selected to 1, which means "Outputs Turn OFF" during a fault.
The owner-controller is in Program Mode but the HSC module outputs remain ON.	Make sure C.Output[x].ProgMode is **not** selected to 1, which means "Outputs Turn ON" when the controller is in Program Mode.
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.

Chapter Summary and What's Next

In this chapter you learned about troubleshooting the module. Move to Appendix A to see specifications for your ControlLogix High Speed Counter module.

Notes:

Specifications

Use this appendix to see the ControlLogix High Speed Counter module specifications.

1756-HSC Specifications

Module Location	1756 ControlLogix Chassis
Backplane Current	300mA @ 5.1V dc , 3mA @ 24V dc (1.6 W)
Maximum Power Dissipation	5.6 W @ 60°C
Thermal Dissipation	19.1 BTU/hr
Number of Counters	2
Inputs per Counter	3 (A, B, Z for Gate/Reset)
Maximum Input Frequency	1 MHz in counter modes (A input) 500 KHz in rate measurement mode (A input) 250 KHz in encoder mode (A/B inputs, X1 or X4) 50Hz with debounce filter enabled
Count Range	0 - 16,777,214
Input Voltage Range 5V Inputs 12-24V Inputs	 4.5-5.5V dc 10-26.4V dc
Input Current Typical Minimum	 15mA 4mA
Number of Outputs	4 (2 outputs/common)
Output Voltage Range	4.5-5.5V dc 10-31.2V dc
Output Current Rating (per point)	20mA @ 4.5-5.5V dc 1.0A @ 10-31.2V dc
Output Control	Any number of outputs is assignable to each counter channel. Each output can have 2 "turn-on" and "turn-off" preset values.
Surge Current/Point	2A for 10 ms every 1s @ 60°C

Minimum Load Current	3mA/point (5V operation) 40mA/point (12-24V operation)
Maximum On-state Voltage Drop/Output	0.55V
Maximum Off-State Leakage Current/Output	300µA/point
Output Delay Time Off to On On to Off	 20µs typical 50µs maximum 60µs typical 300µs maximum
Current Limit	<4A
Output Short Circuit Protection	Electronic Remove load and toggle output On-Off to restore
Reverse Polarity Protection	Yes (If wired incorrectly, module outputs may be permanently disabled)
Isolation Group to Group User to System	 100% tested at 1700V dc for 1s (125 Vac max continuous between groups) 100% tested at 1700V dc for 1s
Module Keying (Backplane)	Software configurable
RTB Screw Torque (Cage clamp)	4.4 inch-pounds (0.4Nm)
RTB Keying	User defined mechanical keying
RTB and Housing	36 Position RTB (1756-TBCH or TBS6H)[2]
Environmental Conditions Operating Temperature Storage Temperature Relative Humidity	 0 to 60°C (32 to 140°F) -40 to 85°C (-40 to 185°F) 5 to 95% non-condensing
Conductors Wire Size Category	22-14 gauge (2mm 2) stranded [1] 3/64 inch (1.2 mm) insulation maximum 1 [2,3]
Screwdriver Width for RTB	1/8 inch (3.2mm) maximum
Agency Certification (when product or packaging is marked)	Listed Industrial Control Equipment Class I Div 2 Hazardous[4] marked for all applicable directives marked for all applicable directives

1 Maximum wire size will require extended housing - 1756-TBE.

2 Use this conductor category information for planning conductor routing as described in the system level installation manual.

3 Refer to publication 1770-4.1, "Industrial Automation Wiring and Grounding Guidelines"

4 CSA certification–Class I, Division 2, Group A, B, C, D or nonhazardous locations.

Application Considerations

Appendix Objectives

This appendix provide background for selecting the appropriate input device for your 1756-HSC module, explain the output circuit, and provide you with information for selecting the type and length of input cabling.

Types of Input Devices

To turn on an input circuit in the 1756-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 12 inputs are electrically identical.

There are 2 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 50/60Hz ac wiring, use of shielded cable, twisted pair cables, etc. Refer to publication 1770-4.1, “Industrial Automation Wiring and Grounding Guidelines” for more information.

Examples for Selecting Input Devices

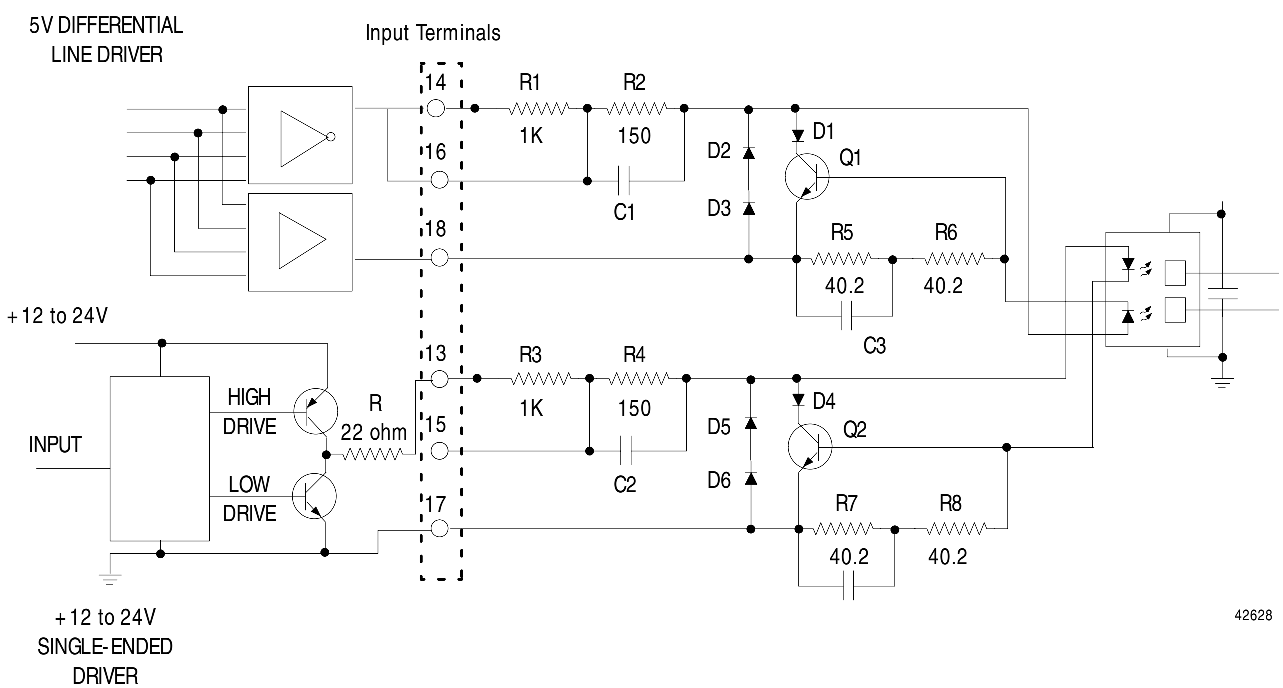
The following examples help you determine the best input type for your particular application. These examples include:

- 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 compatibility, you need to understand the electrical characteristics of your output driver and its interaction with the 1756-HSC input circuit.

As shown below, 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 14 in the graphic), the total limiting resistance is R1 + R2 = 1150 ohms. Assuming a 2V drop across the photodiode and R5 and R6, you would have 8-21mA demanded from the driving circuit as the applied voltage ranged from 12 to 24V.



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

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

The optical isolator manufacturer recommends a maximum of 8mA 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 8mA, 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 at 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 = 4mA. The V_f curves for this photodiode typically has a 1.21 to 1.29V drop as the junction temperature varies from 70°C to 25°C. Let’s call it 1.25V. With 4mA current, R5 and R6 will drop (80.4 ohms x 4mA) = 0.32V. Thus, at 4mA,

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

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

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

The V_{be} of Q1 is now sufficient to start to turn Q1 on. If the current through the photodiode increases to 9mA, 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 4mA 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 4mA to 8mA.

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 B-2) shows a typical 5V differential line driver. The output is connected to the field wiring arm terminal 16 and is sourcing current and the 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 $V_{diff} = (V_{oh} - V_{ol})$ is critical, because this is the drive voltage across the 1756-HSC input terminals 16 and 18, and the photodiode current is a function of Vdiff - Vdrop .

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

Important: Any signal source which uses a standard TTL output device driver rated to source 400µA 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 40mA.

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_{cc} = 5 V, I_{oh} = 10mA and 25°C. V_{ol} is about 0.075V under the same conditions. This means $V_{differential} = V_{oh} - V_{ol}$ = 3.27V if the part is sourcing 10mA. Looking at the curves, if the part were sourcing 5mA you would see V_{diff} = 3.425 - 0.05 = 3.37V.

Assuming that you could supply 5mA 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 4mA through 150 ohms gives an additional 0.60V drop. Thus, you would have to apply about (1.6V + 0.60V) = 2.20V across the terminals to cause a current of 4mA to flow through the photodiode. The 75114 gives about 3.3V at V_{cc} = 5V and 25°C. Thus you know that this driver causes more current to flow than the minimum required at 4mA.

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

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

3.3V - 1.6V = 1.7V

1.5V/150 ohm = 11.3mA

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

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

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

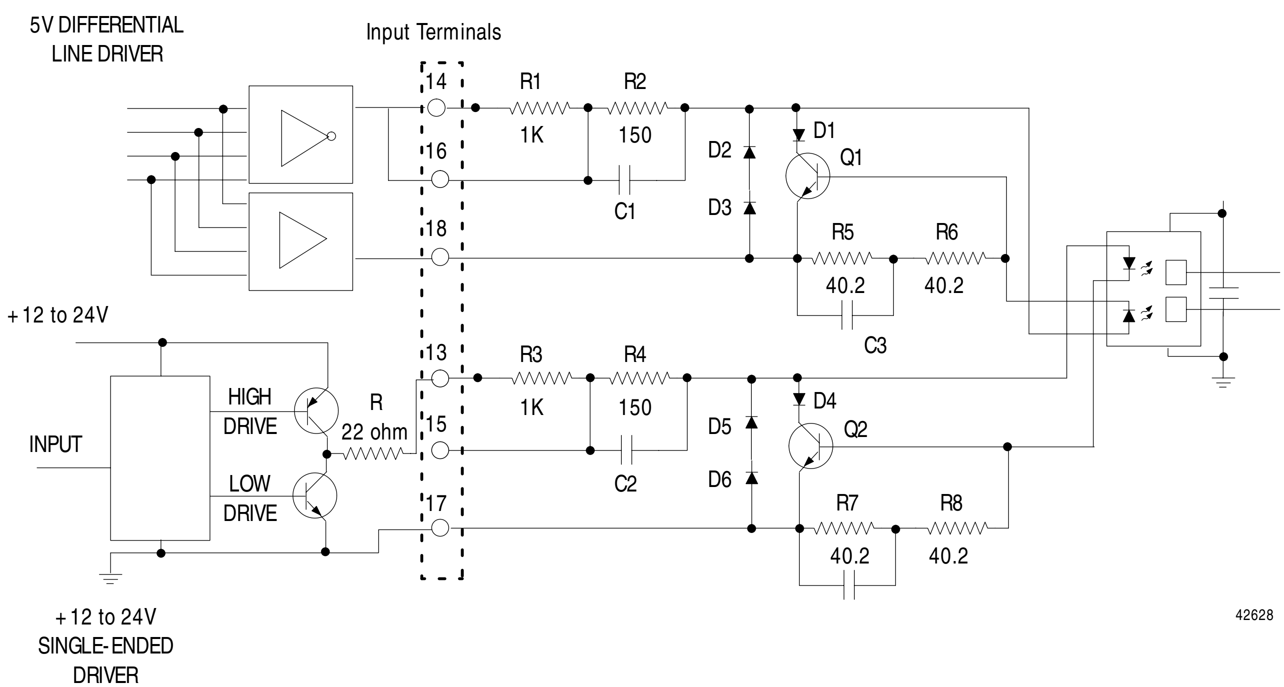
3.3V - 2.0V = 1.3V

1.3V/150 ohm = 8.7mA

The resulting 8.7mA is consistent with our assumption of V_{drop} = 2.0V at I_f = 8mA. This shows that driver 75114 causes about 8mA 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 ohm resistor in the driver output circuit (R). If a 24 volt supply is used, and this driver supplies 15mA, the output voltage would still be about 23V (15mA x 22 ohms = 0.33V, and Vce = .7V).



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 1.15Kohms). A protection circuit consisting of Q2, R7 and R8 is included. If the current through the photodiode exceeds about 8mA, 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 (Vphotodiode + Vbe = 2V). The current demanded by the 1756-HSC input circuit would be about 18mA (23V - 2V/1.18K = 17mA) which is well within the capability of this driver.

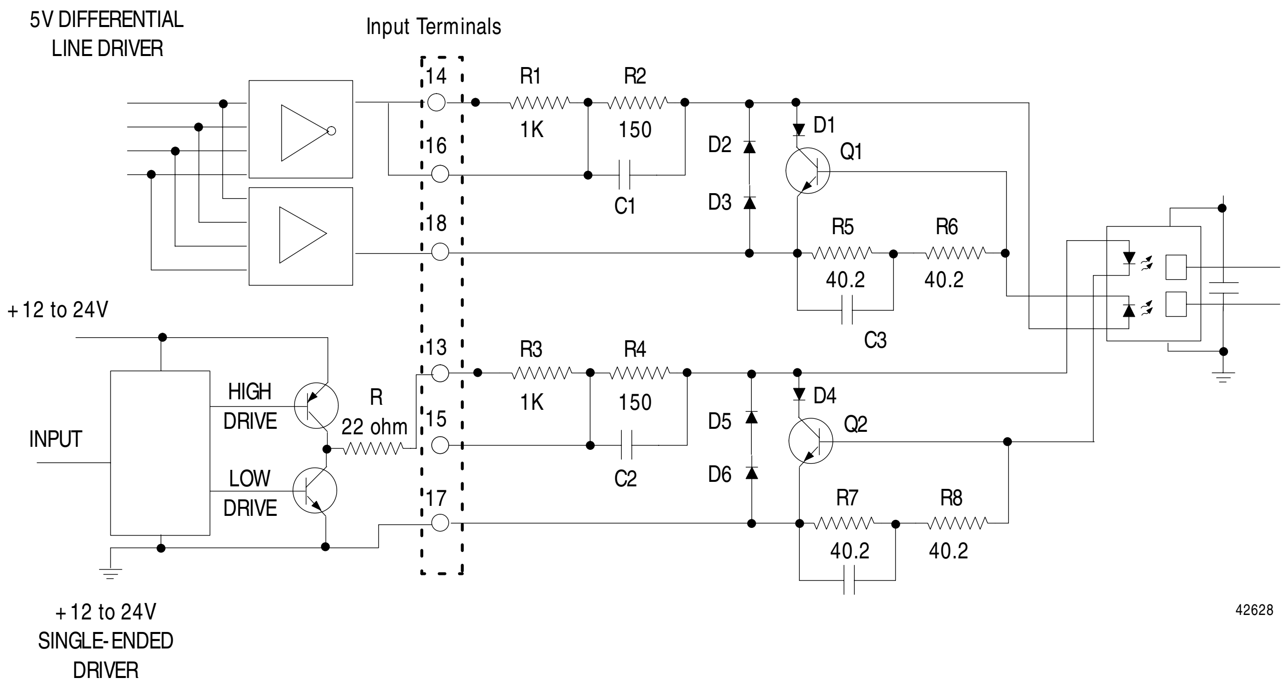
Open Collector

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 below.

Table B.A
Supply Voltage versus Input Terminals

Supply Voltage	Input Terminal	Total Impedance	Available Current
+12	12-24V	3.2K	3.1mA (insufficient)
+12	5V	2.2K	4.5mA (minimal)
+24	12-24V	3.2K	6.8mA (optimal)
+24	5V	2.2K	10mA (acceptable)

In this example, you must increase the supply voltage above +12V to make sure there is sufficient input current to overcome the additional 2K source impedance. Note that there is insufficient current with the jumper in the 12-24V position and a +12V supply.



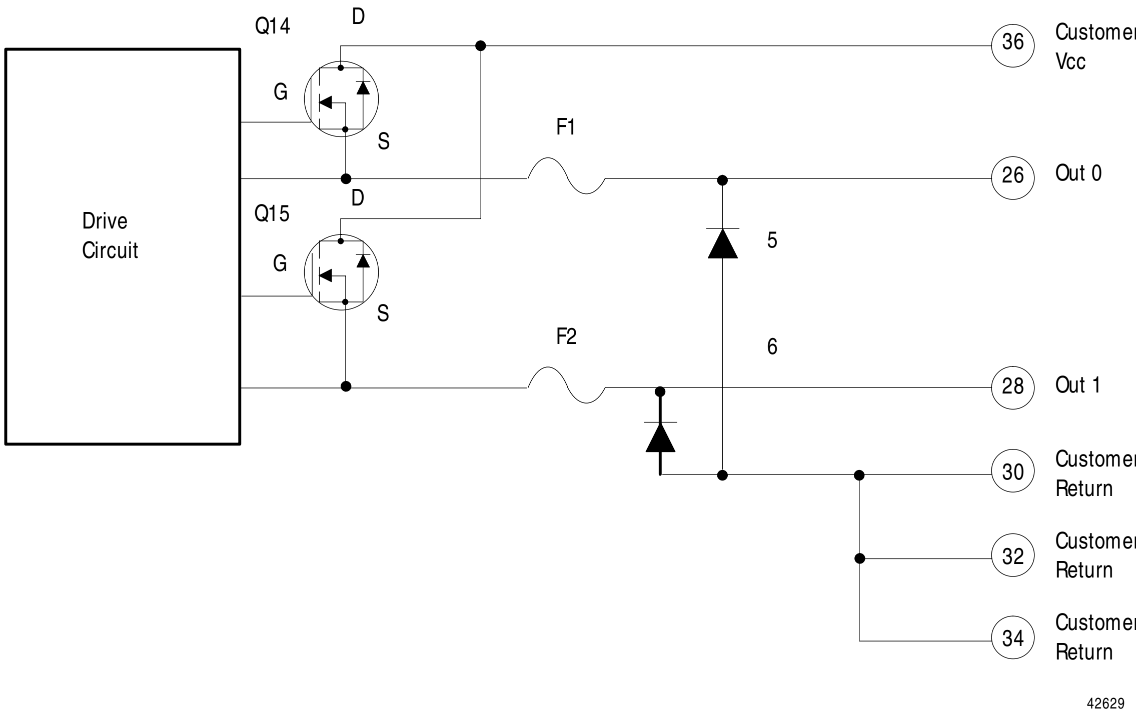
Electromechanical Limit Switch

When using an electromechanical limit switch (the lower circuit in figure above), you must enable the low speed limit filter, using RSLogix 5000 software to filter out switch contact bounce. However, this limits the frequency response to around 30Hz. This circuit would be similar when using dc proximity switches, but bounce should not occur unless severe mechanical vibration is present. In either case, source impedance is very low. If you are using a +12 to +24V power supply use the 12-24V input to add the additional 1K impedance.

Output Circuits

The 1756-HSC module contains 2 isolated pairs of output circuits. Customer supplied power, ranging from +5V 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.



Application Considerations

A successful installation depends on the type of input driver, input cable length, input cable impedance, input cable capacitance, 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 feet or less of high quality, low capacitance cable with an effective shield, and an operating frequency of 250KHz or less will likely result in a successfully installation.

If you use an open collector, or other single-ended driver, at distances of 250 feet and frequencies of 250KHz, your chances of success are low. Refer to the table below 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 <50KHz	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 microamps 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 imedance to match the source and/or load as closely as possible. Using 150 ohm Belden 9182 (or equivalent) cable more closely matches the impedance of both encoder and module input circuits than 78 ohm 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 9pF/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 250KHz 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 250KHz specification.

For any application over 100 feet, and/or over 100KHz, use Belden 9182, a high performance twisted-pair cable with 100% foil shield, a drain wire, moderate 150 ohm inpedance and low capacitance per unit length

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Publication 1756-UM007A-EN-P - October 2000
PN 957345-08
Supersedes Publication 1756-6.5.18 - July 1999