User Manual

Allen-Bradley

Compact High-speed Counter Module

Catalog Number 1769-HSC

Allen-Bradley • Rockwell Software

Rockwell Automation

Important User Information

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

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

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

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

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

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

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

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

New and Updated Information

This table contains the changes made to this revision.

Topic	Pages
Changes were made to differentiate between the available high speed counters modules.	31, 32, 37, 40, 66, 70, 72, 73, 74, 76, 80, 81, 84, 85, 86, 88, 89, 95, 96, 97, 98, 100, 101, 105, 107, 121

Notes:

Preface

Chapter 1
Module Overview

Chapter 2
Module Operation

Chapter 5

Diagnostics and Troubleshooting

Use this manual if you are responsible for designing, installing, programming, or troubleshooting control systems that use Compact I/O and/or MicroLogix 1500 or CompactLogix controllers.

Packaged Controller Functionality

Both the 1769-L24ER-QBFC1B and 1769-L27ERM-QBFC1B packaged controllers provide the same high-speed counter (HSC) functionality as the 1769-HSC except for the input frequency.

While many features of the 1769-HSC module are available with the embedded high-speed counters, some of the features of the 1769-HSC module are not available with the embedded high-speed counters of the CompactLogix packaged controllers. Features not available on the embedded high-speed counters include rate/timer functions and limited output range control (4 ranges instead of the 16 available with the 1769-HSC module). Specific differences between the 1769-HSC module and the packaged controller functionality are noted throughout this manual.

The CompactLogix Packaged Controllers Quick Start and User Manual, publication IASIMP-QS010, provides wiring diagrams, configuration procedures, and tag descriptions for the embedded high-speed counters.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
CompactLogix System User Manual, publication 1769-UM007	Describes how to install, use, and program your CompactLogix controller.
Compact I/O 1769-ADN DeviceNet Adapter User Manual, publication 1769-UM001	Describes how to install, and use the 1769-ADN DeviceNet adapter.
Compact I/O Selection Guide, publication 1769-SG002	Describes the 1769 Compact I/O modules.
CompactLogix Packaged Controllers Quick Start and User Manual, publication IASIMP-QS010	Provides a quick start and information on how to install, use, and program your CompactLogix packaged controller.
MicroLogix 1500 Programmable Controllers User Manual, publication 1764-UM001	Describes how to install, use, and program your MicroLogix 1500 controller.
MicroLogix Programmable Controllers Family Selection Guide, publication 1761-SG001	Provides an overview of the MicroLogix 1500 system.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, http://www.ab.com	Provides declarations of conformity, certificates, and other certification details.

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

Notes:

Module Overview

The 1769-HSC module is an intelligent counter module with its own microprocessor and I/O that is capable of reacting to high-speed input signals. The module can interface with up to two channels of quadrature or four channels of pulse/count inputs. The signals received at the inputs are filtered, decoded, and counted. They are also processed to generate rate and time-between-pulses (pulse interval) data. Count and rate values can then be used to activate outputs based on user-defined ranges.

IMPORTANT	For the 1769-L23E-QBFC1B and 1769-L23-QBFC1B packaged controllers HSC functionality, there is no processing to generate rate or time-between-pulses data. Only count data is used to activate outputs based on ranges.

The module counts pulses at up to 1 MHz (250 kHz for the packaged controllers) from devices such as proximity switches, pulse generators, turbine flowmeters, and quadrature encoders. The module has four on-board, high-speed switching outputs. These outputs can be under user program or direct module control, based on the count value or frequency.

The 1769-HSC module is compatible with MicroLogix 1500 packaged controllers (1764-LSP/C and 1764-LRP/C modules, firmware revision 6.0 and later), CompactLogix controllers (generic profiles required for firmware revisions prior to 11.0), and the 1769-ADN/B DeviceNet adapter.

Counters

The module is capable of counting pulses in either direction (forward, reverse, up, down). A maximum of four pulse counters (or two quadrature counters) are available. Each 32-bit counter can count to ±2 billion as a ring or linear counter. In addition to providing a count value, the module provides a rate value up to ±1 MHz, dependent upon the type of input (the L23 packaged controller's HSC module functionality does not provide rate values). The rate value (as modified by scalar) is the input frequency to the counter. When the count value is increasing, the rate value is positive. When the count value is decreasing, the rate value is negative.

Counters can also be reset or preset to any value between user-defined minimum and maximum values. Preset can be accomplished from the user program or at a Z-input event. The Z-input can also generate a capture value and/or freeze (gate) the counters.

Inputs

The module features six, high-speed differential inputs labeled ±A0, ±B0, ±Z0, ±A1, ±B1, and ±Z1. These inputs support two quadrature encoders with ABZ inputs and/or up to four discrete count inputs. In addition, x1, x2, and x4 encoder configurations are provided to fully use the capabilities of high resolution quadrature encoders. The inputs can be wired for standard differential line driver output devices, as well as single-ended devices such as limit switches, photo eyes, and proximity sensors. Inputs are optically isolated from the bus and from one another, and have an operational range of 2.6…30V DC.

Outputs

Sixteen outputs are available: four on-board (real) and twelve virtual bits. All 16 outputs can be individually controlled by the module or by the user control program.

The four on-board (real) outputs are DC sourcing, powered by a user-supplied (5…30V DC) power source. These outputs are electronically protected from current overloads and short-circuit conditions. Overcurrent status is monitored and fed back to the user program. Output states are determined by a combination of output data, configuration data, ranges, and overcurrent status.

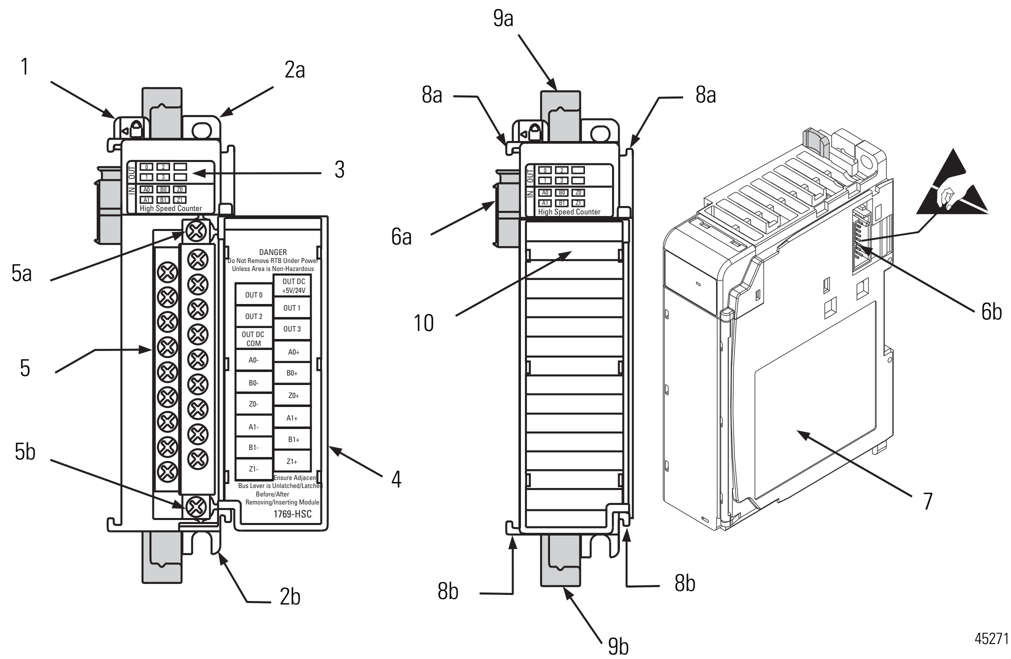
See Output Control Example on page 44 for a description of how the module determines output status.

Hardware Features

The module's hardware features are illustrated in Figure 1. Refer to Chapter 3 on page 45 for detailed information on installation and wiring.

For information about the packaged controllers' hardware features, see the CompactLogix Packaged Controllers Quick Start and User Manual, publication IASIMP-QS010.

Figure 1 - Hardware Features



Item	Description
1	Bus lever
2a	Upper panel mounting tab
2b	Lower panel mounting tab
3	Module status indicators (6 Input, 4 Output, 1 Fuse, 1 OK)
4	Module door with terminal identification label
5	Removable terminal block (RTB) with finger-safe cover
5a	RTB upper-retaining screw
5b	RTB lower-retaining screw
6a	Movable bus connector (bus interface) with female pins
6b	Stationary bus connector (bus interface) with male pins
7	Nameplate label
8a	Upper tongue-and-groove slots
8b	Lower tongue-and-groove slots
9a	Upper DIN-rail latch
9b	Lower DIN-rail latch
10	Write-on label for user identification tags

Status Indicators

The front panel of the 1769-HSC module has a total of 12 status indicators.

For information about the packaged controllers' status indicators, see the CompactLogix Packaged Controllers Quick Start and User Manual, publication IASIMP-QS010.

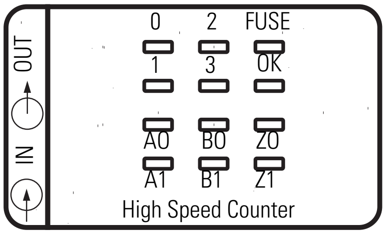


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Table 1 - Diagnostic Indicators

Indicator	Status	Description
0 OUT	Amber	ON/OFF logic status of output 0
1 OUT	Amber	ON/OFF logic status of output 1
2 OUT	Amber	ON/OFF logic status of output 2
3 OUT	Amber	ON/OFF logic status of output 3
FUSE	Red	Overcurrent
OK	Off	No power is applied
	Red (briefly)	Performing self-test
	Solid green	OK, normal operating condition
	Flashing green	OK, module in Program or Fault mode
	Solid red or amber	Hardware error. Cycle power to the module. If problem persists, replace the module.
	Flashing red	Recoverable fault. Reconfigure, reset, or perform error recovery. See Non-critical versus Critical Module Errors on page 113. The OK indicator flashes red for all of the error codes in the Configuration Error Codes table on page 117.
A0	Amber	ON/OFF status of input A0
A1	Amber	ON/OFF status of input A1
B0	Amber	ON/OFF status of input B0
B1	Amber	ON/OFF status of input B1
Z0	Amber	ON/OFF status of input Z0
Z1	Amber	ON/OFF status of input Z1
ALL ON	Possible causes for all status indicators to be On include the following: • Bus error has occurred—controller hard fault. Cycle power. • During load upgrade of controller—normal operation. Do not cycle power during the load upgrade. • All indicators flash on briefly during powerup—normal operation.	

Module Operation

This chapter details the operation of the 1769-HSC module. We strongly suggest that you review this information before configuring your module.

Counter Defaults

When the module powers up, all output array and configuration array values are set to their default values. Refer to Chapter 4 on page 65 or Appendix D on page 149 for default values. All input array values are cleared. None of the module data is retentive through a power cycle.

Power cycling the module has the following effects:

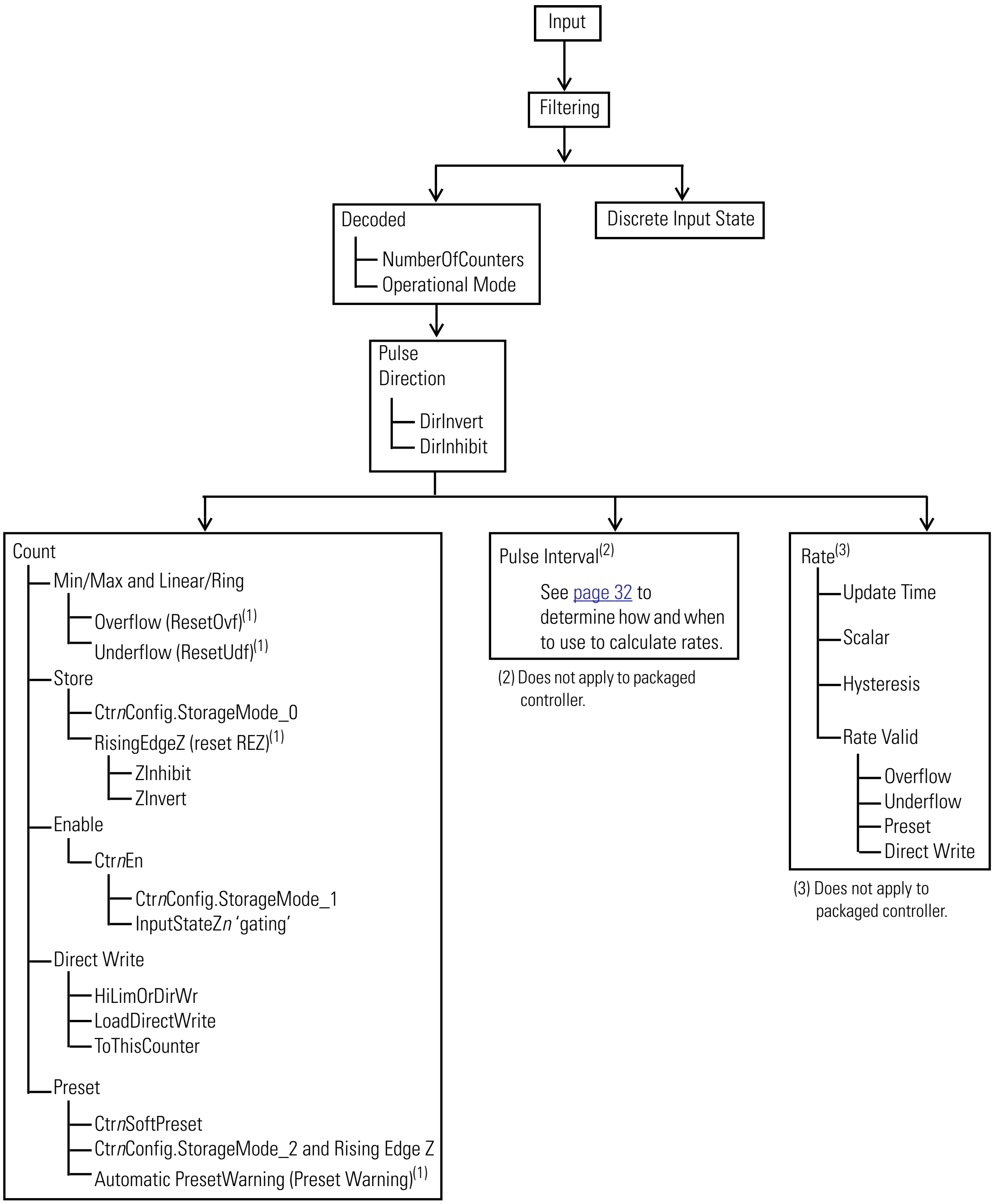
- Clears stored counts and configurations
- Clears faults and flags
- Turns outputs off

Module Operation Block Diagrams

To provide an overview of the module operation, the block diagrams indicate relationships between module functions and configuration parameters.

Inputs

The following diagram illustrates how the inputs function.



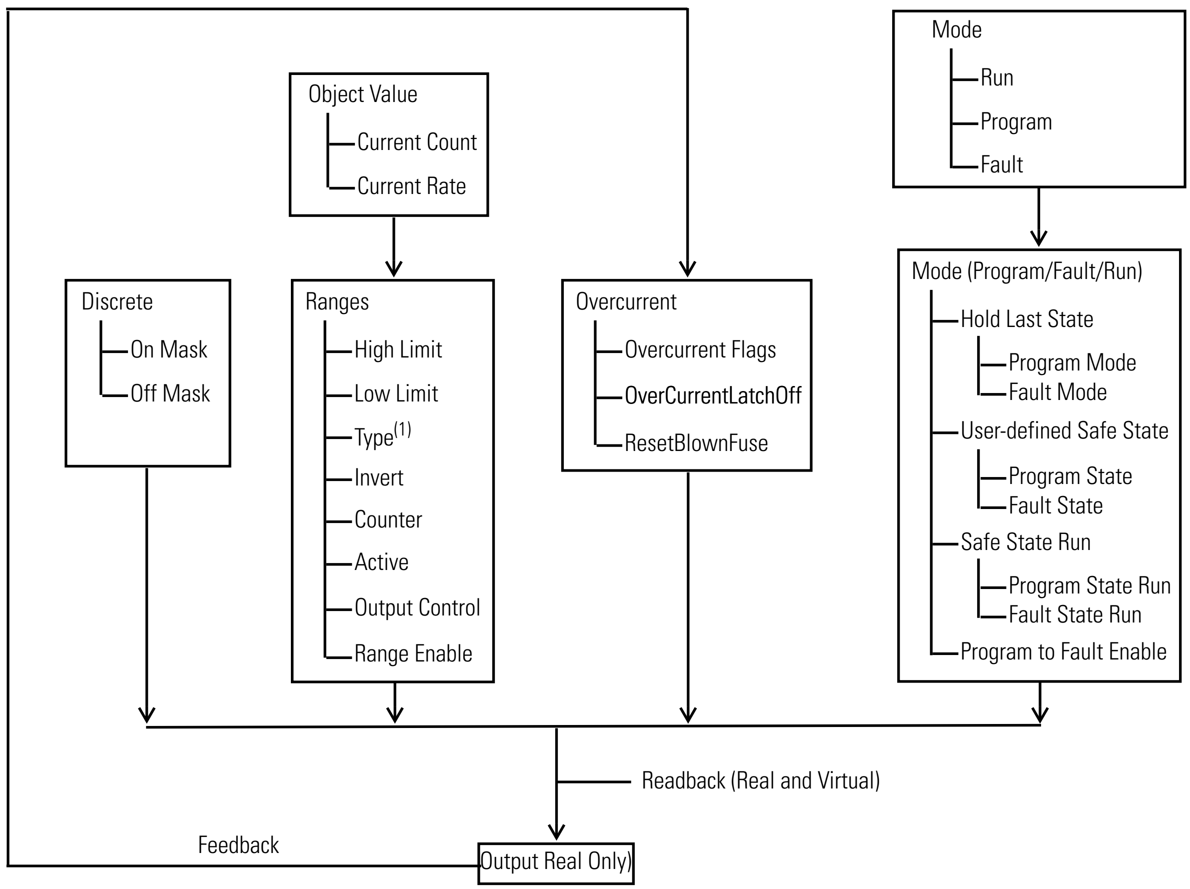
(1) Resets.

(2) Does not apply to packaged controller.

(3) Does not apply to packaged controller.

Outputs

The following diagram illustrates how the outputs function.



(1) In the packaged controller, the Type parameter is fixed at Count because the rate measurement is not supported.

Number of Counters

The module has six input points: A0, B0, Z0, A1, B1, and Z1. Through these inputs, the module can function with 1, 2, 3, or 4 counters depending upon the number of counters and the operational mode configuration of the input points.

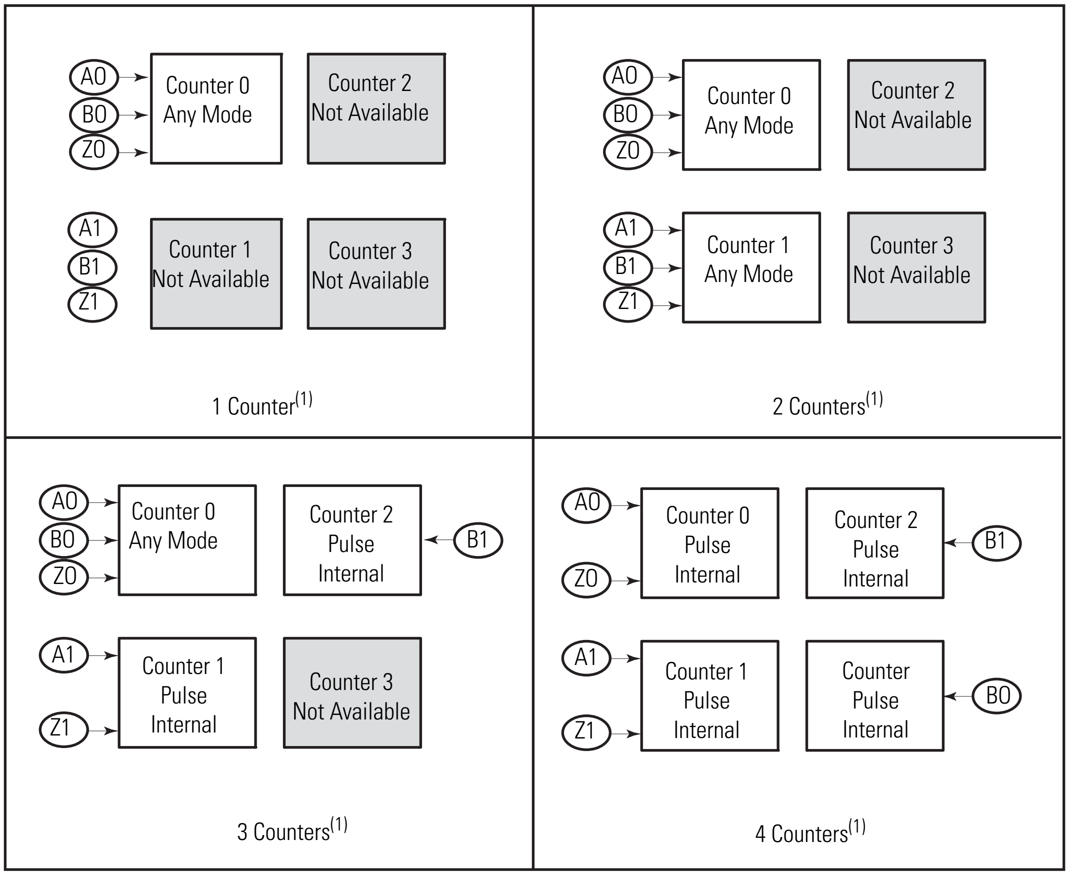
Summary of Available Counter Configurations

The table summarizes the input configurations available for all counters, based on the number of counters.

No. of Counters	Counter	Operational Mode	Gate or Preset Functionality
1 Counter	0	Any	All
	1 through 3	Not available	
2 Counters	0	Any	All
	1	Any	All
	2 and 3	Not available	
3 Counters	0	Any	All
	1	Pulse/Internal Direction	All
	2	Pulse/Internal Direction	None
	3	Not available	
4 Counters	0	Pulse/Internal Direction	All
	1	Pulse/Internal Direction	All
	2	Pulse/Internal Direction	None
	3	Pulse/Internal Direction	None

The counter options and operating modes are summarized in Figure 2.

Figure 2 - Summary of Available Counters



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(1) The number of counters is defined by the NumberOfCounters bits in word 0 of the configuration array.

Input Filtering

In many industrial environments, high frequency noise can be inadvertently coupled to the sensor wires. The module can help reject some noise by means of built-in filters. Inputs are filtered by means of user-selectable, low-pass filters(1) set up during module configuration.

The available nominal pulse width filters are shown in the table.

Input	Filter
A0, A1, B0, B1, Z0, Z1	5 ms, 500 µs, 10 µs, no filter (7.1 ms, 715 µs, 18.5 µs, no filter for the packaged controller)

The filters are selected for each input in the Filter Selection word of the module's configuration array.

TIP The input state bits (InputStateA0 through InputStateZ1) reflect the filter's inputs, but are NOT affected by the signal inhibit or invert operations described on page 30.

Nom Filter Settings		Max Guaranteed Blocked Pulse Width		Min Guaranteed Pass Pulse Width	
Pulse Width	Equivalent Frequency(1)	Pulse Width	Equivalent Frequency(1)	Pulse Width	Equivalent Frequency(1)
No filter	1 MHz	N/A	N/A	250 ns	2 MHz
10 µs	50 kHz	7.4 µs	67.5 kHz	25 µs	20 kHz
500 µs	1 kHz	370 µs	1.35 kHz	1.25 ms	400 Hz
5 ms	100 Hz	3.7 ms	135 Hz	12.5 ms	40 Hz

(1) Equivalent frequency assumes a perfect 50% duty cycle and are for reference purposes only. Hence, the no-filter setting is guaranteed to pass 4 MHz even though the module's maximum is 1 MHz. This lets the sensor and wiring to attenuate the pulse to 25% duty cycle while the module maintains pulse recognition.

Nom Filter Settings		Max Guaranteed Blocked Pulse Width		Min Guaranteed Pass Pulse Width	
Pulse Width	Equivalent Frequency(1)	Pulse Width	Equivalent Frequency(1)	Pulse Width	Equivalent Frequency(1)
No filter	250 kHz	0.83 µs	600 kHz	2.5 µs	200 kHz
18.5 µs	27 kHz	12.3 µs	40.5 kHz	28.6 µs	17.5 kHz
715 µs	700 Hz	495 µs	1.01 kHz	1.25 ms	400 Hz
7.1 ms	70 Hz	4.95 ms	101 Hz	12.5 ms	40 Hz

(1) Equivalent frequency assumes a perfect 50% duty cycle and are for reference purposes only. Hence, the no-filter setting is guaranteed to pass 4 MHz even though the module's maximum is 1 MHz. This lets the sensor and wiring to attenuate the pulse to 25% duty cycle while the module maintains pulse recognition.

IMPORTANT The built-in filters are simple, averaging, low-pass filters. They are designed to block noise pulses of width equal to the values presented in Table Filter Pulse Width and Frequency. Applying full amplitude, 50% duty cycle signals that are of frequency above the selected filter's threshold frequency can result in an average value signal of sufficient amplitude to turn the input on. A transition from no input to the full amplitude, 50% duty cycle signal (or back to no signal) can result in inadvertent input transitions.

(1) Low-pass filters block frequencies above the threshold frequency.

Operational Mode Selection

A count channel's operational mode configuration selection determines how the A and B inputs cause a counter channel to increment or decrement. The six available mode selections are the following:

- Pulse/External Direction Input
- Pulse/Internal Direction Input
- Up and Down Pulse Input
- X1 Quadrature Encoder Input
- X2 Quadrature Encoder Input
- X4 Quadrature Encoder Input

IMPORTANT The operational mode selection is limited by the number of counters selected.

- With two counters selected, Counters 0 and 1 can be assigned any operational mode.
- With three counters selected, Counter 0 can be assigned any mode, but Counters 1 and 2 can only be configured as pulse/internal direction.
- With four counters selected, all counters must be configured for the pulse/internal direction mode.

See Figure 2 on page 19 for the operational modes available for the counters, based on the number of counters configured.

Direction Inhibit and Direction Invert Output Control Bits

These bits apply to all of the counter modes.

TIP When set, the Direction Inhibit bit disables any physical input from affecting count direction.

When set, the Direction Invert bit changes the direction of the counter in all operational modes.

When Direction Inhibit is set, then Direction Invert is the direction.

Pulse/External Direction Mode Selection

In this mode, the B input controls the direction of the counter, as shown in Figure 3. If the B input is low (0), the counter increments on the rising edges of input A. If the input B is high (1), the counter decrements on the rising edges of input A.

TIP Two Output Control bits let you modify the operation of the B input from your control program or during configuration. The Direction Inhibit bit, when set (1), disables the operation of the B input.

The Direction Invert bit, when set (1), reverses the operation of the B input, but only if the Direction Inhibit bit is not set. If the Direction Inhibit bit is set, then the Direction Invert bit controls counter direction:

- When the Direction Inhibit bit is set (1) and Direction Invert = 0, count direction is up (forward).
- When the Direction Inhibit bit is set (1) and Direction Invert = 1, count direction is down (reversed).

Figure 3 - Pulse/External Direction Mode (direction inhibit = 0, direction invert = 0)

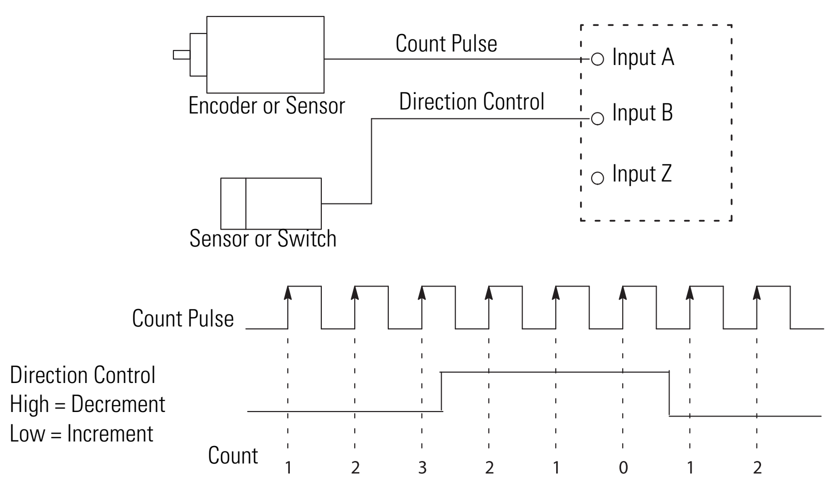


Table 2 - Pulse External Direction Counting

Direction Inhibit Bit	Direction Invert Bit	Input A (count)	Input B (direction)	Change in Count Value
0	0	↑	0 or open	1
		↑	1	-1
		0, 1, ↓	Don’t care	0
0	1	↑	0 or open	-1
		↑	1	1
		0, 1, ↓	Don’t care	0
1	0	↑	0 or open	1
		↑	1	1
		0, 1, ↓	Don’t care	0
1	1	↑	0 or open	-1
		↑	1	-1
		0, 1, ↓	Don’t care	0

See Direction Inhibit and Direction Invert Output Control Bits on page 21 for more information.

Pulse/Internal Direction Mode Selection

When the Pulse/Internal Direction mode is selected, the status of the Direction Invert bit, as controlled by the user program, determines the direction of the counter. The counter increments on the rising edge of the module’s A input when the Direction Invert bit is reset (0). The counter decrements on the rising edge of the A input when the Direction Invert bit is set (1).

Table 3 - Pulse Internal Direction Counting - Counters 0 and 1

Direction Inhibit Bit	Direction Invert Bit	Input A (count)	Input B	Change in Count Value
Don’t care	0	↑	Don’t care	1
		0, 1, ↓	Don’t care	0
Don’t care	1	↑	Don’t care	-1
		0, 1, ↓	Don’t care	0

Table 4 - Pulse Internal Direction Counting - Counters 2 and 3

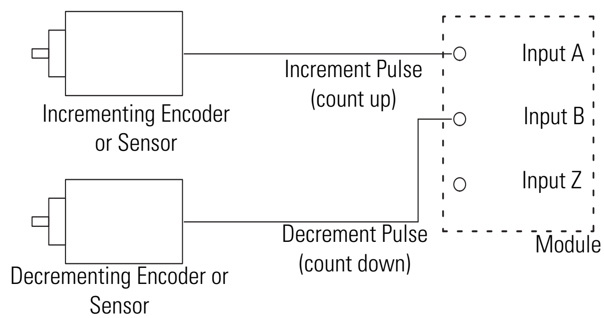
Direction Inhibit Bit	Direction Invert Bit	Input A	Input B (count)	Change in Count Value
Don’t care	0	Don’t care	↑	1
		Don’t care	0, 1, ↓	0
Don’t care	1	Don’t care	↑	-1
		Don’t care	0, 1, ↓	0

Up and Down Pulses Mode Selection

In this mode, the counter channel increments on the rising edge of pulses applied to input A and decrements on the rising edge of pulses applied to input B. When set, the Direction Inhibit bit causes both A and B to increment. When set, the Direction Invert bit causes B to increment and A to decrement. When the Direction Invert and Direction Inhibit bits are both set, both A and B decrement.

TIP When both inputs transition simultaneously or near simultaneously, the net result is no change to the count value.

Figure 4 - Up and Down Pulse Mode (direction inhibit = 0, direction invert = 0)



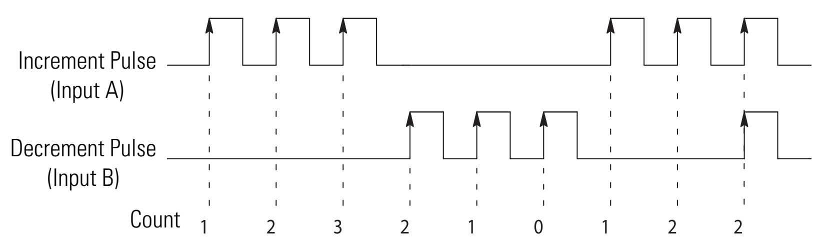


Table 5 - Up and Down Counting

Direction Inhibit Bit	Direction Invert Bit	Input A (count)	Input B (direction)	Change in Count Value
0	0	↑	0, 1, ↓	1
		0, 1, ↓	↑	-1
		↑	↑	0
0	1	↑	0, 1, ↓	-1
		0, 1, ↓	↑	1
		↑	↑	0
1	0	↑	0, 1, ↓	1
		0, 1, ↓	↑	1
		↑	↑	0
1	1	↑	0, 1, ↓	-1
		0, 1, ↓	↑	-1
		↑	↑	0

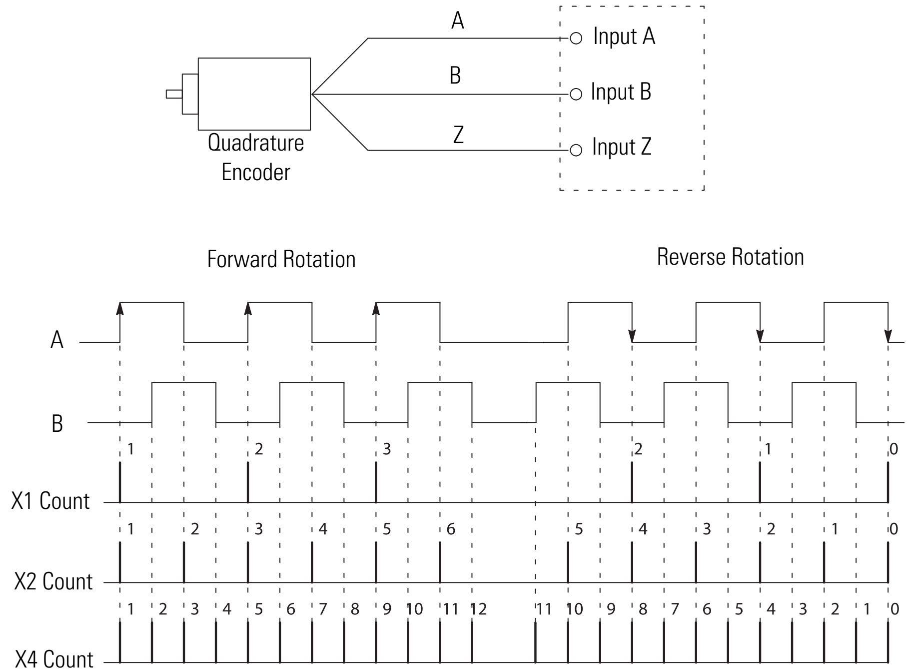
X1 Quadrature Encoder Mode Selection

In this mode, when a quadrature encoder is attached to inputs A and B, the count direction is determined by the phase relation of inputs A and B. If A leads B, the counter increments. If B leads A, the counter decrements. In other words, when B is low, the count increments on the rising edge of input A and decrements on the falling edge of input A. If B is high, all rising transitions on input A are ignored. The counter changes value **only** on one edge of input A as shown in Figure 5.

TIP When both A and B transition at the same time, instead of in the defined 90° phase separation, the quadrature signal is invalid.

For more information see Direction Inhibit and Direction Invert Output Control Bits on page 21 and their effect on Quadrature signals on page 27.

Figure 5 - Quadrature Encoder Modes (direction inhibit = 0, direction invert = 0)



X2 Quadrature Encoder Mode Selection

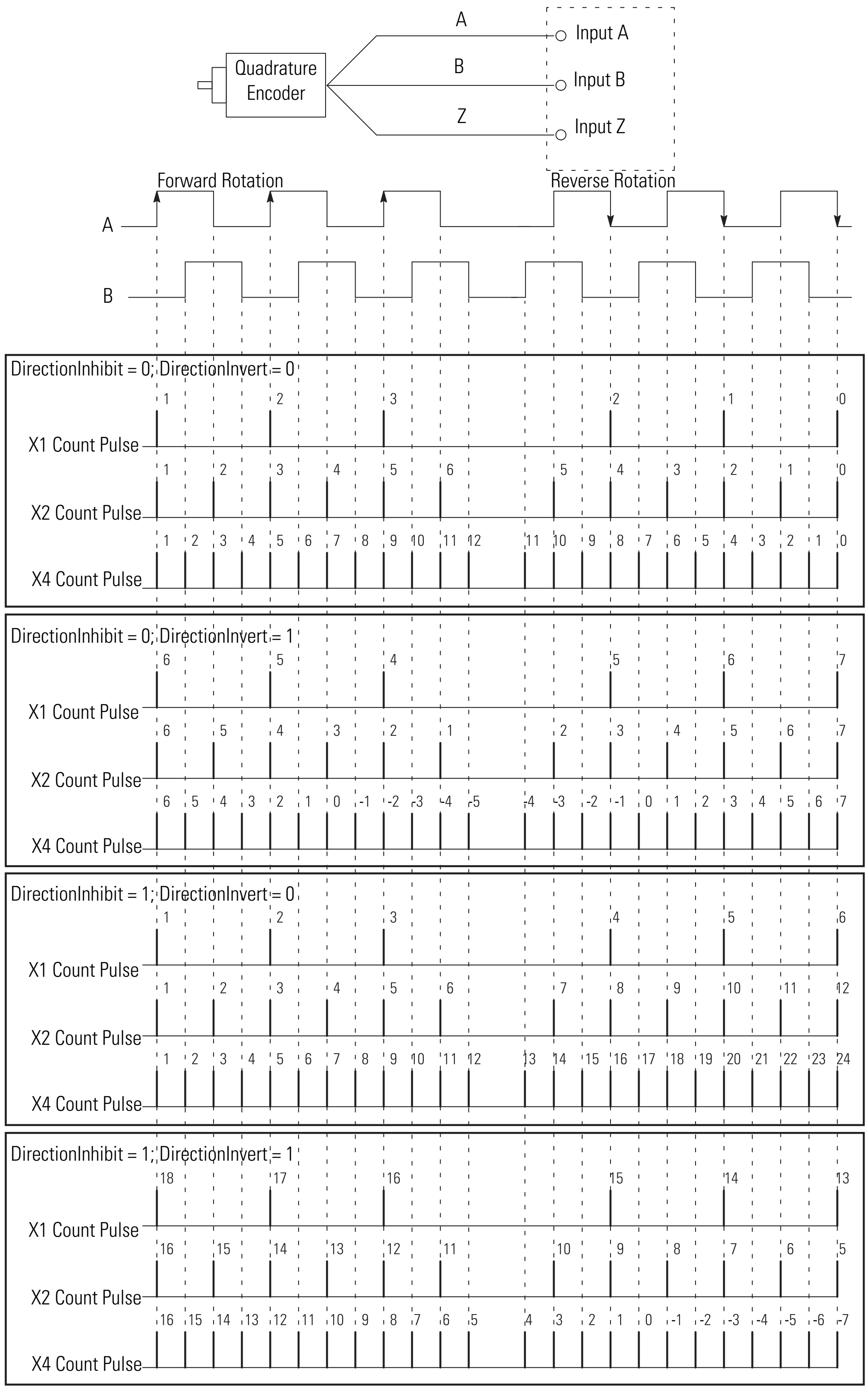
The X2 Quadrature Encoder mode operates much like the X1 Quadrature Encoder except that the resolution is doubled as shown in Figure 5 on page 26.

X4 Quadrature Encoder Mode Selection

The X4 Quadrature Encoder mode operates much like the X1 Quadrature Encoder except that the resolution is quadrupled, as shown in Figure 5 on page 26.

Figure 6 shows how Direction Inhibit and Direction Invert affect the counter.

Figure 6 - Operation Using Various Direction Inhibit and Direction Invert Settings



Input Frequency

Maximum input frequency is determined by the input configuration as shown in the table.

Input Configuration	Input Frequency 1769-HSC Module	Input Frequency Packaged Controller
X4 Quadrature encoder	250 kHz	250 kHz
X2 Quadrature encoder	500 kHz	250 kHz
All other configurations	1 MHz	250 kHz

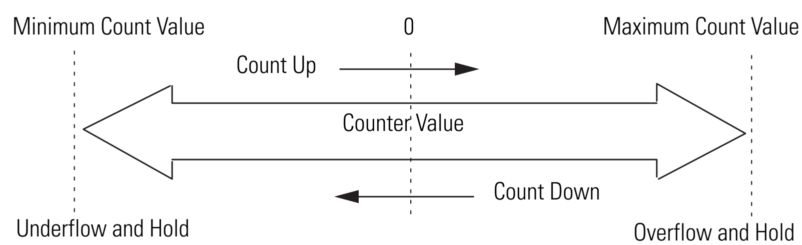
Counter Types

Each of the four possible counters can be configured to stop counting and set a flag at its limits (linear counter) or to rollover and set a flag at its limits (ring counter). A counter's limits are programmed by the Ctr*n*MaxCount and Ctr*n*MinCount words in the module's configuration array. Both types are described below.

Linear Counter

Figure 7 illustrates linear counter operation. In linear operation, the current count (Ctr[*n*].CurrentCount) value remains between, or equal to, the user-programmed minimum count (Ctr*n*MinCount) and maximum count (Ctr*n*MaxCount) values. If the Ctr[*n*].CurrentCount value goes above (>) or below (<) these values, the counter stops counting, and an overflow/underflow bit is set. The overflow/underflow bits can be reset using the Ctr*n*ResetCounterOverflow and Ctr*n*ResetCounterUnderflow bits.

Figure 7 - Linear Counter Diagram

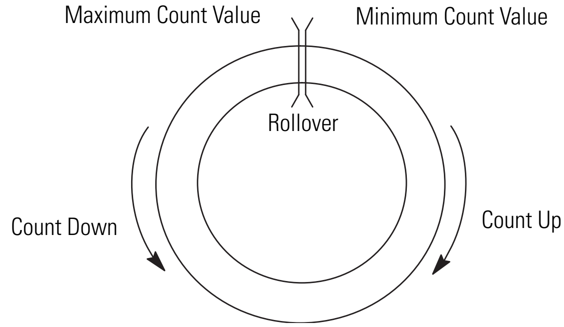


Pulses are not accumulated in an overflow/underflow state. The counter begins counting again when pulses are applied in the proper direction. For example, if you exceed the maximum by 1000 counts, you do not need to apply 1000 counts in the opposite direction before the counter begins counting down. The first pulse in the opposite direction decrements the counter.

Ring Counter

Figure 8 demonstrates ring counter operation. In ring counter operation, the current count (Ctr[*n*].CurrentCount) value changes between user-programmable minimum count (Ctr*n*MinCount) and maximum count (Ctr*n*MaxCount) values. If, when counting up, the counter reaches the Ctr*n*MaxCount value, it rolls over to the Ctr*n*MinCount value upon receiving the next count and sets the overflow bit. If, when counting down, the counter reaches the Ctr*n*MinCount value, it rolls under to the Ctr*n*MaxCount value upon receiving the next count and sets the underflow bit. These bits can be reset using the Ctr*n*ResetCounterOverflow and Ctr*n*ResetCounterUnderflow bits.

Figure 8 - Ring Counter Diagram



Modifying Count Value

The count value (Ctr[*n*].CurrentCount) can be stored, reset, or preset using the Z-input, CtrReset bit in the configuration array, control bits in the output array, or overwritten using a Direct Write command.

Table 6 - Available Z Functions

Setting	For function
Store(1)	On rising edge of Z, store count in the Stored Count input word
Hold	While Z = 1, hold counter at its current value
Preset/Reset	On rising edge of Z, preset the count value to the value in the preset word

(1) If both a store and preset function are configured, the stored count is captured before the preset operation takes place.

IMPORTANT	Because only the Z-inputs are used for external gating and presetting, these functions are not available for Counters 2 and 3, which do not have Z-inputs. All options are always available for Counters 0 and 1, regardless of input operational mode.

Counter Enable/Disable

The counter can be enabled or disabled using the Ctr*n*En control bit. Be aware that disabling the counter does not inhibit any current count loading functions (for example, preset or direct write) or any Z function.

Z Input Functions

There are three Z input functions: store, gate, and Z preset.

Store

The Z-input can be used to capture the current count value even when the counter is counting at full 1 MHz speed.

Gate

The Z-inputs can be used to gate (hold) the counter at its current value regardless of incoming A or B inputs. A gating function is typically one that lets pulses reach the counter (gate open) or not (gate closed).

Z Preset

Preset can be programmed to occur based on the actions of the Z-input signal.

Inhibit and Invert

The Z-input signals can be inverted and/or inhibited, depending on the user configuration of the Ctr*n*ZInvert and Ctr*n*ZInhibit output control bits. If the signal is inhibited, the invert bit **is** the Z signal for the actions described above.

For an explanation of those bits, see Z Inv - Z Invert (CtrnZInvert) on page 93 and Z Inh - Z Inhibit (CtrnZInhibit) on page 93.

Direct Write

You can arbitrarily change the current count value (Ctr[*n*].CurrentCount) to the direct write control value (Range12To15[*n*].HiLimOrDirWr). This ability applies to ranges 12…15. The direct write value takes effect when the Load Direct Write bit (Range12To15[*n*].LoadDirectWrite) transitions from 0 to 1.

If you attempt to preset and load direct write to a counter at the same time, only the preset (Ctr*n*Preset) will take effect.

Preset/Reset

Preset sets the counter to a zero or non-zero value you define. Reset the counter by setting this value (Ctr*n*Preset) to zero.

Counter Reset

Refer to page 73 in Chapter 4 for details on performing a default counter reset for the CMX 5370 L2 packaged controller and the 1769-HSC/B module only. The L23E packaged controller and the 1769-HSC/A module do not have this functionality.

Soft Preset

Preset can be programmed to occur by setting the appropriate output control bits via your control program. Setting the Ctr*n*SoftPreset bit in the output array causes the counter to be preset, changing the count to the value in Ctr*n*Preset.

Z Preset

Preset can be programmed to occur based on the actions of the Z-input signal.

Autopreset

If the module is configured such that Ctr*n*MaxCount < Ctr[*n*].CurrentCount or Ctr*n*MinCount > Ctr[*n*].CurrentCount, then the module will automatically change Ctr[*n*].CurrentCount to the Ctr*n*Preset value and set the Ctr*n*PresetWarning bit.

Rate/Timer Functionality

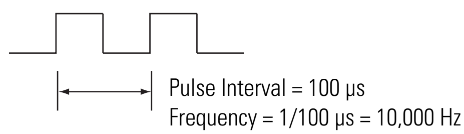
To ensure maximum accuracy, the module offers two different methods to calculate the rate.

- Per Pulse = 1/Pulse Interval
- Cyclic = Number of Pulses/User-defined Time Interval

You select the method used, depending upon the pulse speed as defined below. These are continuously available regardless of input operational mode.

IMPORTANT	The Rate/Timer Functionality information does not apply to the L23E packaged controller.

Pulse Interval Rate Calculation Method



The pulse interval rate method is very accurate for slower rates, that is, when the pulse interval (or time between pulses) is large compared to the system clock timer (1 µs). A timer is used to measure the time between two successive pulses. The inverse of this value is the pulse interval rate. The pulse interval rate cannot be read directly from the module. It needs to be calculated. The calculation can be performed in the user control program.

This method is not as accurate for higher pulse rates. When the pulse interval shrinks, two factors can distort the per pulse calculation. If the pulse interval is close to the measuring timer's clock frequency, 1 MHz, the granularity of the time increments has a greater effect on rate inaccuracy. In addition, the rate can be calculated many times over the course of a single backplane scan. As a result, the rate data obtained at a backplane scan is only that of the very last pair of pulses and disregards the other rate calculations that have occurred during that interval. This can result in rate inaccuracy if the pulses are unevenly spaced.

Cyclic Rate Calculation Method (current rate)

The module continuously calculates rates for each of its four possible counters, regardless of operational mode (for example, up/down count). The 32-bit signed integer rate from each counter is reported in the Ctr[*n*].CurrentRate words of the input array.

In this method, the rates are calculated at the end of a counter's configured cycle time. This is configured via the Ctr*n*CyclicRateUpdateTime configuration word/menu. Valid entries are 1…32,767 ms. The number of net counts, net change in Ctr[*n*].CurrentCount, during that period is converted into a rate value, providing an average pulse rate.

The generalized rate calculation is Rate = Δ count/ Δ time.

IMPORTANT	The rate calculation is based on net counts. If a counter goes up 500 counts and down 300 counts, the net count is 200. Therefore, changes in direction and speed affect the Ctr[n].CurrentRate value.

The cyclic method is better suited to high pulse rates.

Hysteresis Detection and Configuration

Because physical vibration can cause an encoder to generate pulses that you do not wish to consider as valid motion, a hysteresis value is used to eliminate a certain number of pulses in either direction as vibration-generated. These pulses are not used to calculate the Ctr[*n*].CurrentRate value. You program the minimum number of counts that are considered to be valid motion, using the Ctr*n*Hysteresis configuration word/menu. If the change in counts over the update time cycle is equal to or less than the minimum number of programmed counts, the Ctr[*n*].CurrentRate is reported as zero.

This concept is not used to alter actual count values.

IMPORTANT	Hysteresis does not depend on the direction of the change in count. Therefore, creeping, a slow change in count in one direction only, can also be reported as zero frequency when it falls below the hysteresis threshold.

Scalar

You can configure the Ctr*n*Scalar value to scale or convert the raw rate value to application-specific information, such as RPM (Revolutions Per Minute). Setting Ctr*n*Scalar to 1 leaves the rate value in cycles per second (Hertz).

The actual rate equation is the following.

$$\text{Current Rate} = \frac{1000 \times \Delta\ \text{count}}{\text{CyclicRateUpdateTime} \times \text{Scalar}}$$

TIP To configure the Ctr[n].CurrentRate value to show an RPM value, set CtrnScalar to (counts per revolution)/60.

For example, where Ctr0CyclicRateUpdateTime = 80, the encoder has 360 counts per revolution, and the change in Ctr[0]. CurrentCount is 96.

$$\text{Scalar} = \frac{\text{360 counts/revolution}}{\text{60 sec/min}}$$

$$\text{RPM} = \frac{\text{1000 Cyclic Rate Update Time/sec x 96 counts}}{\text{80 Cyclic Rate Update Time x } \frac{\text{360 counts/revolution}}{\text{60 sec/min}}} = \text{200 RPM}$$

Rate Valid

The Ctr[*n*].RateValid bit indicates calculation integrity. When the bit is set, it indicates that the accompanying Ctr[n].CurrentRate value is accurate.

The Ctr[*n*].RateValid bit is reset when the overflow or underflow events have occurred, that is, at rising edges of Ctr[*n*].Overflow or Ctr[*n*].Underflow bits. It also happens when the count is abruptly modified via a preset (Ctr*n*SoftPreset, Ctr*n*CtrPresetWarning or Z based preset event) or direct write (Range12To15[*n*].LoadDirectWrite). When this occurs, the Ctr[*n*].CurrentRate value is frozen at the last known good value so that effects of erroneous rates will not propagate to range comparisons. The value remains frozen until the current cycle time plus one more cycle time are elapsed (this can be up to twice the Ctr*n*CyclicRateUpdateTime). If the overflow/underflow occurrence lasts for more than one cycle time, the value is frozen that entire time plus up to two more cycle times.

Ensure that another overflow/underflow does not happen during this recovery time. The rate will remain invalid until a full update time has occurred with no such events. If the Ctr[*n*].RateValid bit is seldom or never set, the Ctr*n*MinCount and Ctr*n*MaxCount values can be configured too close to each other.

Rate Method Selection

By knowing when to use each method, an optimal rate determination can be made.

TIP Fractional rates are not reported by the module, but can be calculated from Ctr[n].PulseInterval in your control program.

Use the following information to choose the appropriate calculation method. In general, consider the effect of having the count off by ±1 in each method at frequencies of interest to see if the resulting inaccuracy is acceptable.

Per Pulse Method Example

If the frequency of interest has 100 counts (of the 1 µs clock) between pulses, an error of 1 count results in a 1-in-100, or 1%, error. If there are 1000 counts between pulses, then the error is 1-in-1000, or 0.1%. Error for a variety of pulse values is shown below.

Table 7 - Per Pulse Errors

Actual 1 µs Internal Pulses(1)	Reported Pulses	Real Frequency	Reported Frequency	% Error
2	1	500 kHz	1 MHz	100%
9	10	111 kHz	100 kHz	11.1%
101	100	9.901 kHz	10.000 kHz	1.00%
1001	1000	999 Hz	1000 Hz	0.10%
9999	10,000	100.01 Hz	100.00 Hz	0.010%
99,999	100,000	10.00010 Hz	10.00000 Hz	0.001%

(1) 1.9999 can be rounded to 2 and so on.

Cyclic Method

Because the update time is programmable, there is more flexibility in choosing the correct fit when using the Cyclic Method.

Error estimates are shown below for a variety of update times.

Table 8 - Maximum Cyclic Rate Errors

CyclicRateUpdate Time x Scalar	Frequency				
	100 Hz	1 kHz	10 kHz	100 kHz	1 MHz
1	N/A	N/A	20.02%	2.011%	0.210%
10	N/A	20.11%	2.020%	0.210%	0.030%
100	20.01%	2.110%	0.220%	0.031%	0.012%
1000	3.010%	0.310%	0.040%	0.013%	0.010%
10,000	1.210%	0.130%	0.022%	0.011%	0.010%

Output Control

All 16 outputs can be controlled by any of the four counters or by the user's control program, via the output mask function. Output states are determined by count, rate (not supported in packaged controller), ranges, mask configuration data, overcurrent status, and safe state settings and conditions.

The 16 outputs are made up of four real (physical) outputs and 12 virtual outputs. The status of the real and virtual outputs is available to the user program. The real outputs are electronically protected from overloads.

IMPORTANT	To turn outputs on, you must use both the Output On Mask and the Output Off Mask.

Masks

You can use an Output On Mask or an Output Off Mask.

Output On Mask

Using the Output On Mask, all of the module's outputs can be turned on directly by the user control program, like discrete outputs. A bit that is set in the mask turns on the corresponding real or virtual output.

Output Off Mask

The Output Off Mask has veto power over any output. It can turn any or all of the module's outputs off. When a bit in this mask is set to 0, the output will be turned off. Each bit is logically ANDed with the Output On Mask and masks of active and enabled ranges. If the bit in this mask is set to 1, the output can be turned on or off by the ranges, or the Output On Mask. The final result is available as the Readback.*n* bit.

Ranges

For the 1769-HSC module and the embedded HSC in the CMX 5370 L2 packaged controllers, up to 16 dynamically configurable ranges are available. Ranges activate outputs based on the current count value or the current rate value. Each range is programmed with a type, counter number, two limit values, an invert bit, and an output mask.

For the embedded HSC in the L23E packaged controller, up to four dynamically configurable ranges are available. Ranges activate outputs based on the current count value. Each range is programmed with a counter number, two limit values, an invert bit, and an output mask.

Each range is programmed with high and low limits for the chosen value. The range's invert bit indicates whether the range is active between or outside the range limits. When the chosen value fulfills the configuration parameters, the range is active as indicated in the input array. When a range is active and enabled (RangeEn.*n* = 1), the range turns on all outputs indicated by the Range Output Mask except those that are prevented from being enabled by the other factors such as Output Off Mask or Overcurrent. The status of a range is provided by the range active status word, where 1 equals range active and zero equals inactive.

TIP Ranges can be disabled while the module is running using the RangeEn.n bit in the output file. However, even a disabled range will report when it is active or not. For example, an unprogrammed range has limits of 0, and points to the Ctr[0].CurrentCount value. If this value is 0, that range is reported as active.

Count Range

In a non-inverted count range, the outputs are active if the count value is within the user-defined range. In an inverted count range, the outputs are active if the count value is outside the user-defined range. Valid limits for the range are -2…2 billion regardless of programmed minimum and maximum values.

Figure 9 shows all ranges referring to one counter. The module is capable of individually assigning each range to any counter. Each counter can also have a combination of count and rate ranges.

Figure 9 - Count Range Example

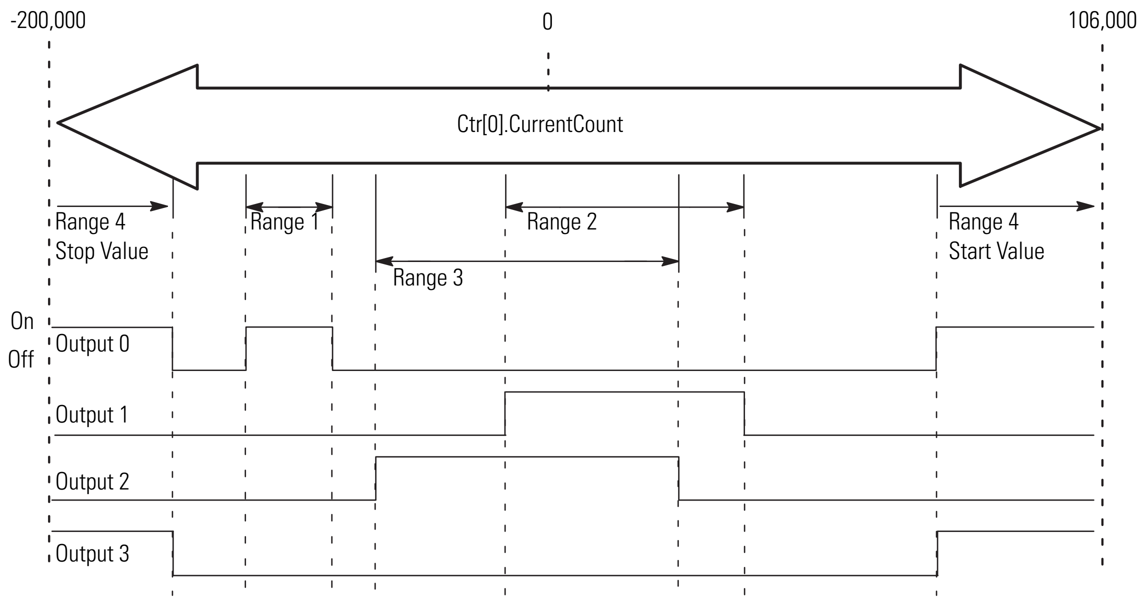


Table 9 - Count Range Example Values

Range	Range Counter Number	Range Type[(1)]	Range Low Limit	Range High Limit	Range Invert Bit	Outputs[(2)] (Range[*n*].OutputControl word)																Outputs Affected
						15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
1	01	0	-7000	-5000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
2	01	0	-1000	4500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
3	01	0	-4000	3000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
4	01	0	-9000	9000	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0 and 3

(1) For Range Type, 0 = count range and 1 = rate range.

(2) Bits 0…3 are real outputs. Bits 4…15 are virtual outputs.

Rate Range

IMPORTANT	The Rate Range information does not apply to the packaged controller.

In a non-inverted rate range, the outputs are active if the rate measurement is within the user-defined range. In an inverted rate range, the outputs are active if the rate measurement is outside the user-defined range. The input rate can be up to 1 MHz in either direction.

Figure 10 shows all ranges referring to one counter. The module is capable of individually assigning each range to any counter. Each counter can also have a combination of count and rate ranges.

Figure 10 - Rate Range Example

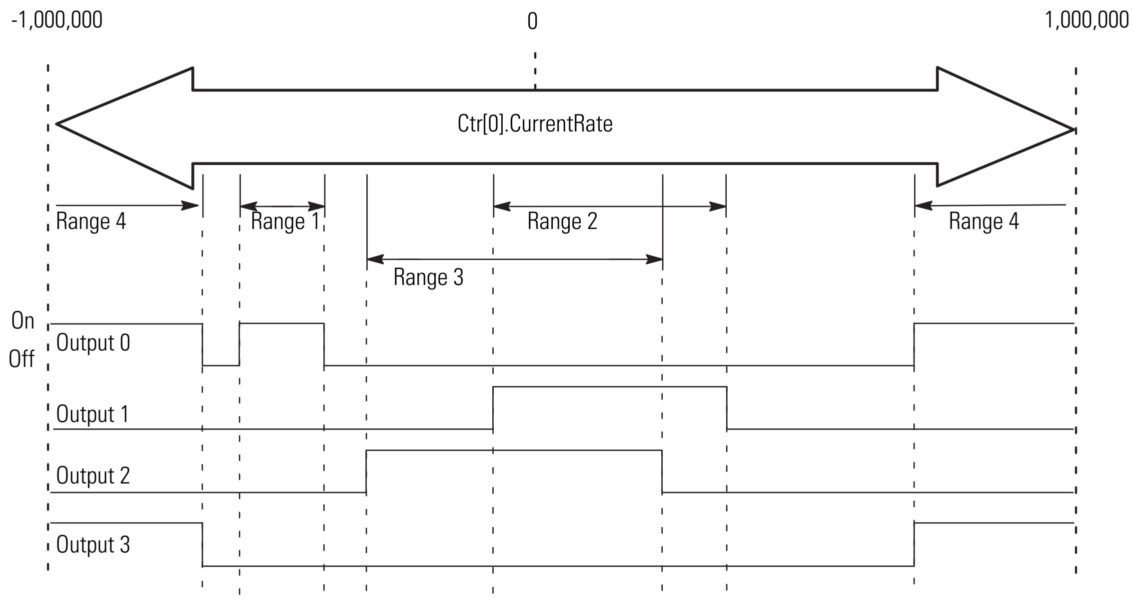


Table 10 - Rate Range Example Values

Range	Range Counter Number	Range Type[1]	Range Low Limit	Range High Limit	Range Invert Bit	Outputs[2] (Range[*n*].OutputControl word) 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Outputs Affected
1	00	1	-7000	-5000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
2	00	1	-1000	4500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
3	00	1	-4000	3000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
4	00	1	-20,000	20,000	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0 and 3

(1) For Range Type, 0 = count range and 1 = rate range.
(2) Bits 0…3 are real outputs. Bits 4…15 are virtual outputs.

Overcurrent

If the module detects a real output point overcurrent condition, it reports it to the input file and turns off that output. You can also program the module to latch each of the four real outputs off, emulating a physical fuse, or to automatically reset. The 12 virtual outputs do not have this function.

When the OvercurrentLatchOff bit is set and an overcurrent situation occurs, even momentarily, the associated real output is latched off until the ResetBlownFuse bit transitions from 0 to 1.

If the OvercurrentLatchOff bit is reset and an overcurrent situation occurs, the output turns off for 1 second and is then retried (auto-reset). The module continues to attempt to turn the output back on until the overcurrent situation is no longer detected and the output is successfully turned back on.

IMPORTANT	The outputs will be on momentarily while they are retried. The length of time they are on depends on the magnitude of the load.

Safe State Control

The 1769-HSC module combines the Hold Last State and User-defined Safe State options with a safe-state run alternative that lets the module to continue to control outputs under program or fault states(1). These Safe State options are not available in the packaged controllers.

Only the physical outputs are affected by safe state settings and conditions. Virtual outputs, inputs, and counting are not affected by program or fault states.

Hold Last State (HLS)

This condition applies depending on the mode of the controller. When the hold last state option is set, the module holds the outputs at the state they were at just before the control system transitioned from Run to Program or Run to Fault.

HLS sets the module according to the values configured for Program mode (described on page 76) and Output Fault mode (described on page 77).

User-defined Safe State (UDSS)

In this configuration, the module sets the outputs to a user-defined safe state when the control system transitions from Run to Program or Run to Fault.

UDSS sets the module according to the values configured for Output Program Value (described on page 77) and Output Fault Value (described on page 78).

(1) The module continues to update the input array and count inputs in all modes. The operation of the outputs will vary according to mode, configuration, and the capabilities of the controller or bus master.

Program State Run (PSR)

Program State Run lets you specify that the output should continue to be controlled by the module as if it were in the Run state. That is, events on the module or changes in the output image will affect the physical outputs without regard to the Program_HLS or UDSS state indicated. When this bit is set, the corresponding Out*n*ProgramMode and Out*n*ProgramValue bits are ignored.

PSR sets the module according to the value configured for Output Program State Run, as described on page 76.

ATTENTION: Selecting this option lets outputs change state while ladder logic is not running. You must take care to assure that this does not pose a risk of injury or equipment damage when selecting this option.

IMPORTANT The prescan initiated by some controllers could have an effect on the outputs. To overcome any changes in physical output states caused by this, retentive output instructions (for example, latch or unlatch) should be used when bit manipulations are done on the output image of this module in ladder logic.

This applies to a wide range of bits when Program State Run is selected, because presetting a counter, enabling a range, changing a mask, and changing module configuration array settings can cause ranges and outputs to change state.

Fault State Run (FSR)

Similar to Program State Run, Fault State Run lets you specify, on a bit basis, that the output should continue to be controlled by the module as if it were Run state. That is, events on the module or changes in the output image will affect the physical outputs without regard to the Fault_HLS or UDSS state indicated. When this bit is set, the corresponding Fault mode and fault value bits are ignored.

FSR sets the module according to the value configured for Output Fault State Run, as described on page 77.

ATTENTION: Selecting this option lets outputs change state while ladder logic is not running. You must take care to assure that this does not pose a risk of injury or equipment damage when selecting this option.

IMPORTANT	The prescan initiated by some controllers can have an effect on the outputs. To overcome any changes in physical output states caused by this, use retentive output instructions (for example, latch or unlatch) when bit manipulations are done on the Output image of this module in ladder logic. This applies to a wide range of bits when Fault State Run is selected, because presetting a counter, enabling a range, changing a mask, and changing configuration array settings can cause ranges and outputs to change state.

Program to Fault Enable (PFE)

The ProgToFaultEn bit lets you select which data value (Program Value or Fault Value) to apply to the output when the Output State Logic state Prog_HLS changes to indicate Fault_HLS.

If PFE is 0, the module leaves the Program value applied. If PFE is set to 1, the Fault value is applied.

TIP If the module is in a safe state such as Program or Fault which is configured to turn an output ON and excessive current is drawn from the output, the output will still turn off according to the programmed OverCurrentLatchOff bit configuration.

The module's Default Safe State configuration is all zeros, resulting in the following:

- Program State = UDSS
- Program Value = OFF
- Program State Run = No
- Fault State = UDSS
- Fault Value = OFF
- Fault State Run = No
- PFE = leave program value applied

Output Control Example

The following example illustrates the module's output control flow. The following conditions are reflected in the Output Control Example on page 44:

- Range 0 is enabled and active.
- Range 1 is disabled.
- Range 2 is enabled but not active.
- An overcurrent condition exists on real output 3.
- OvercurrentLatchOff is set.
- The system is in Run mode.

Table 11 illustrates the step-by-step logical operations that are performed to determine the final output state. For example, Range 1 values do not affect the output because Range 1 is disabled, and the Output Off Mask causes some of the outputs to change to zero because it takes priority over the range masks.

The output parameters shown have been discussed in the previous sections.

Table 11 - Output Control Example

Output Parameter	Mask Information				Logical Operation	Result(1)			
Range 0	0 0 0 1	0 1 1 0	1 1 0 1	0 0 0 1	OR	0 0 0 1	0 1 1 0	1 1 0 1	0 0 0 1
Range 1	0 0 1 0	1 1 1 1	1 1 1 1	0 0 1 0	OR	0 0 0 1	0 1 1 0	1 1 0 1	0 0 0 1
Range 2	0 1 0 0	0 0 0 0	0 0 0 0	1 1 0 0	OR	0 0 0 1	0 1 1 0	1 1 0 1	0 0 0 1
Output On Mask	0 1 0 0	1 0 1 0	1 0 1 0	1 0 0 0	OR	0 **1** 0 1	**1** 1 1 0	1 1 **1** 1	**1** 0 0 1
Output Overcurrent	- - - -	- - - -	- - - -	1 0 0 0	AND	0 1 0 1	1 1 1 0	1 1 1 1	**0** 0 0 1
Output Off Mask	1 1 1 1	0 0 0 0	1 1 1 1	1 1 0 0	AND	0 1 0 1	**0 0 0** 0	1 1 1 1	0 0 0 **0**
Program State Values	- - - -	- - - -	- - - -	1 1 1 1	Override	0 1 0 1	0 0 0 0	1 1 1 1	0 0 0 0
Fault State Values	- - - -	- - - -	- - - -	1 1 1 1	Override	0 1 0 1	0 0 0 0	1 1 1 1	0 0 0 0
Final Output State						0 1 0 1	0 0 0 0	1 1 1 1	0 0 0 0

(1) Bolded text indicates that these values have changed.

Readback/Loopback

The Readback/Loopback function is the feedback of the module's outputs via its input array. This 16-bit image includes both real (4) and virtual (12) outputs.

If the module's output is OFF due to overcurrent, both the Overcurrent status flag and the Readback bit will indicate the condition being 1 and 0, respectively. Conversely, should the output be ON due to any module control, such as UDSS, this will be indicated by Readback.

Installation and Wiring

This chapter explains how to install and wire the 1769-HSC module.

IMPORTANT For information about installing and wiring the packaged controllers, refer to the CompactLogix Packaged Controller Installation Instructions, publication 1769-IN082.

ATTENTION: Environment and Enclosure

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

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

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

In addition to this publication, see the following:

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

North American Hazardous Location Approval

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

ATTENTION: Prevent Electrostatic Discharge

This equipment is sensitive to electrostatic discharge, which can cause internal damage and affect normal operation. Follow these guidelines when you handle this equipment:
- Touch a grounded object to discharge potential static.
- Wear an approved grounding wriststrap.
- Do not touch connectors or pins on component boards.
- Do not touch circuit components inside the equipment.
- Use a static-safe workstation, if available.
- Store the equipment in appropriate static-safe packaging when not in use.

WARNING: Hazardous Location Enclosure

When used in a Class I, Division 2, hazardous location, this equipment must be mounted in a suitable enclosure with proper wiring method that complies with the governing electrical codes.

Power Requirements

The modules receive power through the Compact bus interface from the 5V DC/24V DC system power supply. The maximum current drawn by the modules is shown in the table.

Module Current Draw	5V DC	24V DC
	425 mA	0 mA

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

By sure that power is removed or the area is nonhazardous before proceeding. Repeated electrical arcing causes excessive wear to contacts on both the module and its mating connector. Worn contacts can create electrical resistance that can affect module operation.

WARNING: Removable Terminal Block (RTB) Under Power

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

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

General Considerations

Compact I/O is suitable for use in an industrial environment when installed in accordance with these instructions.

Selecting a Location to Reduce Noise

Most applications require installation in an industrial enclosure to reduce the effects of electrical interference. The module is highly susceptible to electrical noise. Electrical noise coupled to the inputs will reduce the performance (accuracy) of the module.

Group your modules to minimize adverse effects from radiated electrical noise and heat. When selecting a location for a module, position the module away from the following:

- Sources of electrical noise, such as hard-contact switches, relays, and AC motor drives.
- Modules that generate significant radiated heat, such as the 1769-IA16 module. Refer to the module's heat dissipation specification.

In addition, route shielded, twisted-pair analog input and output wiring away from any high voltage I/O wiring.

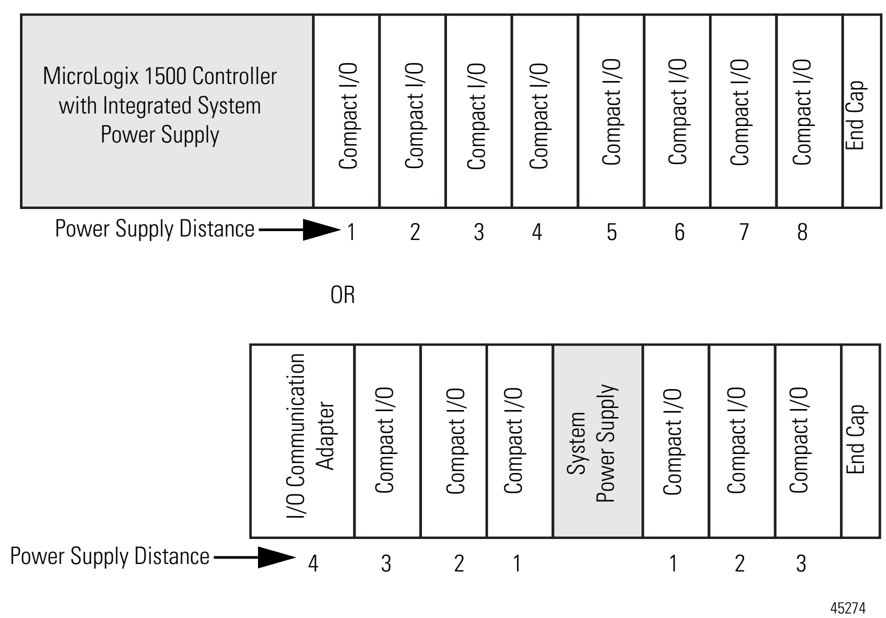
Protect the Circuit Board from Contamination

The printed circuit boards of the modules must be protected from dirt, oil, moisture, and other airborne contaminants. To protect these boards, we recommend installing the system in an enclosure suitable for the environment. Keep the interior of the enclosure should clean and the enclosure door closed whenever possible.

Power Supply Distance

You can install as many modules as your power supply can support. However, the module has a power supply distance rating of four, which means that it can not be more than four modules away from the system power supply.

The illustration provides an example of determining power supply distance.

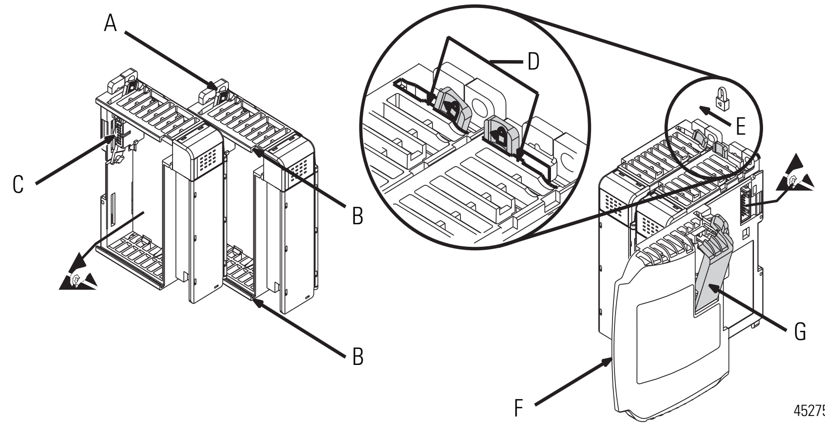


System Assembly

The module can be attached to an adjacent controller, power supply, or I/O module. For mounting instructions, see Panel Mounting on page 50, or DIN Rail Mounting on page 52.

To work with a system that is already mounted, see Replace the Module within a System on page 53.

Refer to the illustration when assembling the Compact I/O system.



1. Disconnect the power.
2. Check that the bus lever of the module (A) is in the unlocked (fully right) position.
3. Use the upper and lower tongue-and-groove slots (B) to secure the modules together.
4. Move the module back along the tongue-and-groove slots until the bus connectors (C) line up with each other.
5. Use your fingers or a small screwdriver to push the bus lever back slightly to clear the positioning tab (D).
6. Move the module's bus lever fully to the left (E) until it clicks, making sure it's locked firmly in place.

> **ATTENTION:** When attaching I/O modules, it is very important that the bus connectors are securely locked together to provide proper electrical connection.

7. Attach an end cap terminator (F) to the last module in the system by using the tongue-and-groove slots as before.
8. Lock the end cap bus terminator (G).

IMPORTANT	A 1769-ECR right- or 1769-ECL left-end cap must be used to terminate the end of the serial communication bus.

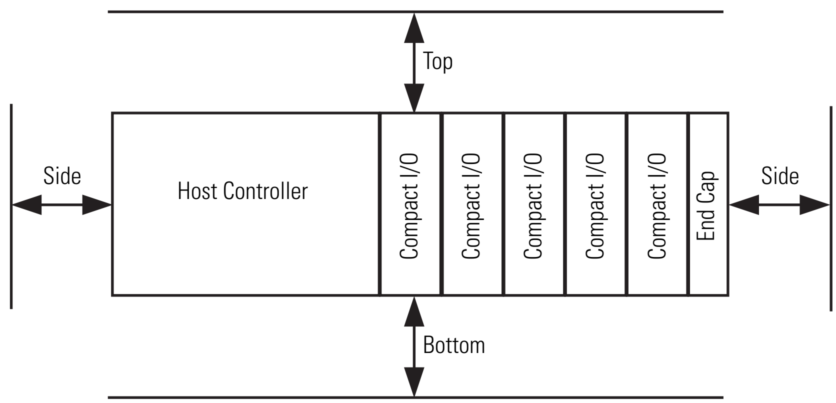
Mount the Module

Use these procedures to mount your module.

ATTENTION: During panel or DIN-rail mounting of all devices, be sure that all debris (metal chips, wire strands) is kept from falling into the module. Debris that falls into the module could cause damage at powerup.

Minimum Spacing

Maintain spacing from enclosure walls, wireways, adjacent equipment, and so forth. Allow 50 mm (2 in.) of space on all sides for adequate ventilation, as shown.

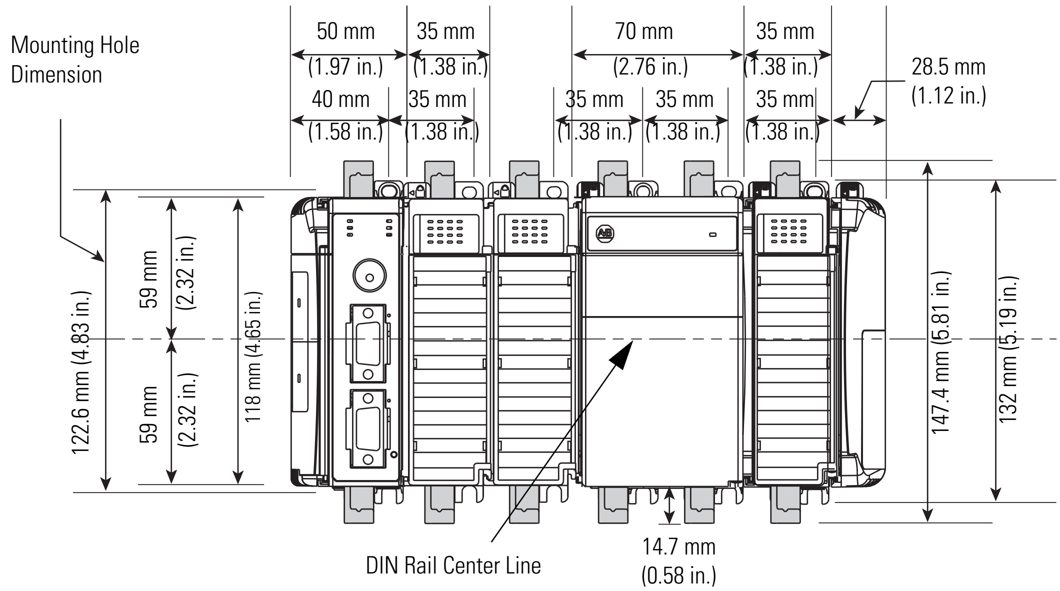


Panel Mounting

Mount the module to a panel by using two screws per module. Use M4 or #8 panhead screws. Mounting screws are required on every module.

ATTENTION: This product is intended to be mounted to a well-grounded mounting surface such as a metal panel. Additional grounding connections from the power supply's mounting tabs or DIN rail (if used) are not required unless the mounting surface cannot be grounded. Refer to Industrial Automation Wiring and Grounding Guidelines, Rockwell Automation publication 1770-4.1, for additional information.

Figure 11 - Compact I/O Module with CompactLogix Controller and Power Supply



Important: Hole spacing tolerance: ±0.04 mm (0.016 in.).

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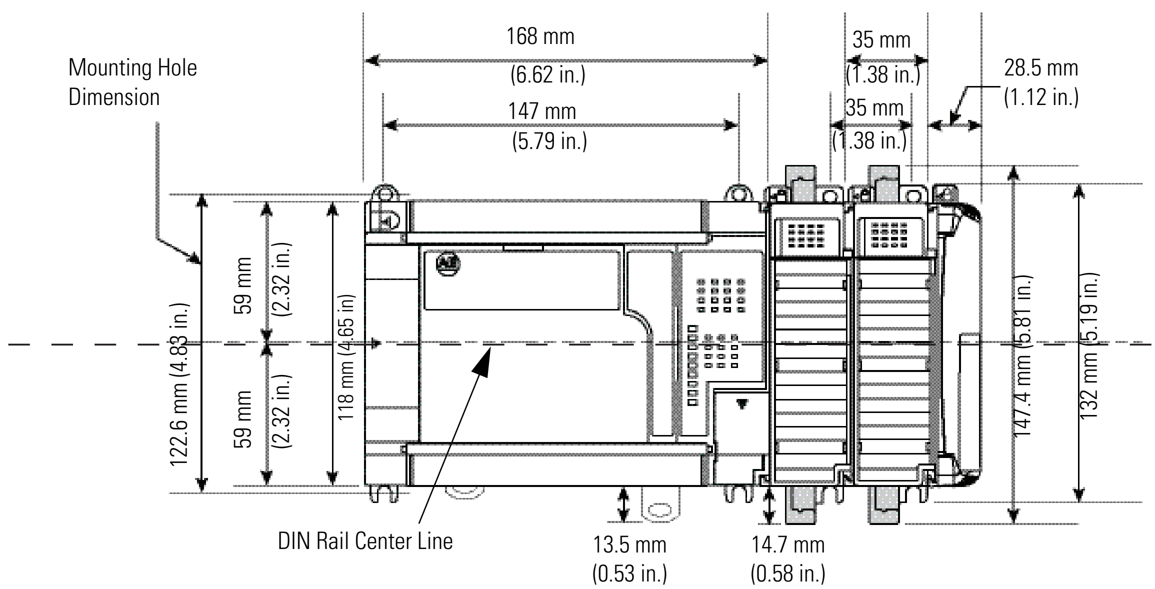
Figure 12 - Compact I/O Module with MicroLogix 1500 Base Unit and Processor



Important: Hole spacing tolerance: ±0.04 mm (0.016 in.).

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Panel Mounting Procedure By Using Modules as a Template

This procedure lets you use the assembled modules as a template for drilling holes in the panel. Due to module mounting hole tolerance, it is important to follow these procedures:

1. On a clean work surface, assemble no more than three modules.
2. Using the assembled modules as a template, carefully mark the center of all module-mounting holes on the panel.
3. Return the assembled modules to the clean work surface, including any previously mounted modules.
4. Drill and tap the mounting holes for the recommended M4 or #8 screw.
5. Place the modules back on the panel, and check for proper hole alignment.
6. Attach the modules to the panel using the mounting screws.

TIP If mounting more modules, mount only the last one of this group and put the others aside. This reduces remounting time during drilling and tapping of the next group.

7. Repeat steps 1 through 6 for any remaining modules.

DIN Rail Mounting

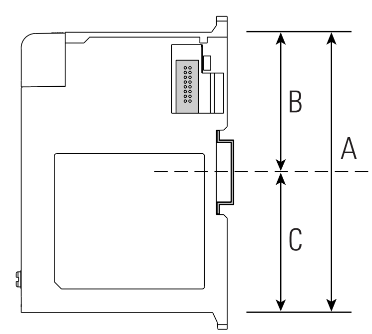
The module can be mounted on the following DIN rails:

- EN 50 022 - 35 x 7.5 mm (1.38 x 0.3 in.)
- EN 50 - 35 x 15 mm (1.38 x 0.59 in.)

1. Before mounting the module on a DIN rail, close the DIN rail latches.
2. Press the DIN rail mounting area of the module against the DIN rail.

   The latches will momentarily open and lock into place.

Figure 13 - DIN Rail Mounting Dimensions



Dimension	Height
A	118 mm (4.65 in.)
B	59 mm (2.325 in.)
C	59 mm (2.325 in.)

Replace the Module within a System

The module can be replaced while the system is mounted to a panel or DIN rail.

1. Remove power, referring to the Warning on page 47.
2. Remove terminal block or disconnect input and/or output wiring from the module.
3. Remove the upper and lower mounting screws from the module (or open the DIN latches using a screwdriver).
4. On the module to be replaced and the right-side adjacent module (or end cap if the module is the last module in the bank), move the bus levers to the right (unlock) to disconnect the module from the adjacent modules.
5. Gently slide the disconnected module forward.

   If you feel excessive resistance, make sure that you disconnected the module from the bus and that you removed both mounting screws (or opened the DIN latches).

TIP	It may be necessary to rock the module slightly from front to back to remove it, or, in a panel-mounted system, to loosen the screws of adjacent modules.

6. Before installing the replacement module, be sure that the bus lever on the right-side adjacent module is in the unlocked (fully-right) position.
7. Slide the replacement module into the open slot.
8. Connect the modules together by locking (fully-left) the bus levers on the replacement module and the right-side adjacent module or end cap.
9. Replace the mounting screws (or snap the module onto the DIN rail).
10. Replace the terminal block or connect the input and/or output wiring to the module.

Field Wiring Connections

Consider these system wiring guidelines when wiring your system.

General Guidelines

- Make sure the system is properly grounded.
- Input and output channels are isolated from the 1769 Compact bus. Input channels are isolated from one another; output channels are not.
- Shielded cable is required for high-speed input signals A, B, and Z. Use individually shielded, twisted-pair cable for lengths up to 300 m (1000 ft).
- Group this module and other low voltage DC modules away from AC I/O or high voltage DC modules.
- Route field wiring away from any other wiring and as far as possible from sources of electrical noise, such as motors, transformers, contactors, and AC devices.
- Routing field wiring in a grounded conduit can reduce electrical noise.
- If field wiring must cross AC or power cables, make sure that they cross at right angles.

Terminal Block Guidelines

- For optimum accuracy, limit overall cable impedance by keeping cable as short as possible. Locate the module as close to input devices as the application permits.
- Tighten terminal screws with care. Excessive tightening can strip a screw.

Grounding Guidelines

- This product is intended to be mounted to a well-grounded mounting surface, such as a metal panel. Additional grounding connections from the module's mounting tabs or DIN rail (if used) are required only when the mounting surface is non-conductive and cannot be grounded.
- Keep shield connection to ground as short as possible.
- Ground the shield drain wire at the 1769-HSC module, input end only.

  Refer to the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for additional installation requirements.

Considerations for Reducing Noise

In high-noise environments, the 1769-HSC module inputs can accept 'false' pulses, particularly when using low frequency input signals with slowly sloping pulse edges. To minimize the effects of high frequency noise on low frequency signals, perform the following:

- Identify and remove noise sources.
- Route input cabling away from noise sources.
- Use your programming software to select low-pass filters on input signals. Filter values depend on the application and can be determined empirically.
- Use devices which output differential signals, such as differential encoders, to minimize the possibility that a noise source will cause a false input.

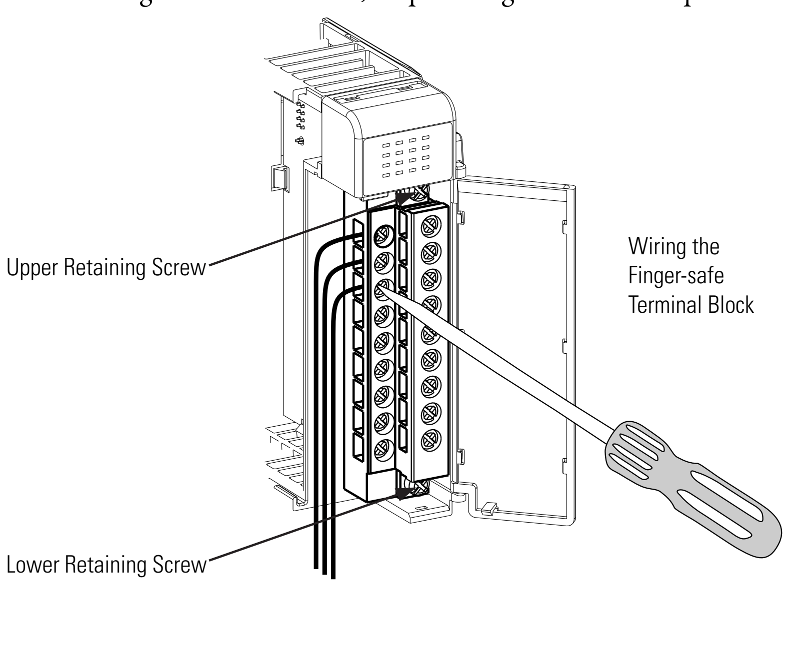
Remove and Replace the Terminal Block

When wiring the module, you do not have to remove the terminal block. If you remove the terminal block, use the write-on label on the side of the terminal block to identify the module location and type.

To remove the terminal block, loosen the upper- and lower-retaining screws. The terminal block will back away from the module as you remove the screws. When replacing the terminal block, torque the retaining screws to 0.46 N•m (4.1 lb•in).

Wire the Finger-safe Terminal Block

When wiring the terminal block, keep the finger-safe cover in place.



Follow these steps.

1. Loosen the terminal screws to be wired.
2. Route the wire under the terminal pressure plate.

   You can use the bare wire or a spade lug. The terminals accept a 6.35 mm (0.25 in.) spade lug.

   TIP The terminal screws are non-captive. Therefore, it is possible to use a ring lug (6.35 mm (0.25 in.) maximum outside diameter with 3.53 mm (0.139 in.) minimum inside diameter) with the module.

3. Tighten the terminal screw making sure the pressure plate secures the wire. Recommended torque when tightening terminal screws is 0.68 N•m (6 lb•in).

   TIP If you need to remove the finger-safe cover, insert a screwdriver into one of the square, wiring holes and gently pry the cover off. If you wire the terminal block with the finger-safe cover removed, you will not be able to put it back on the terminal block because the wires will be in the way.

Wire Size and Terminal Screw Torque

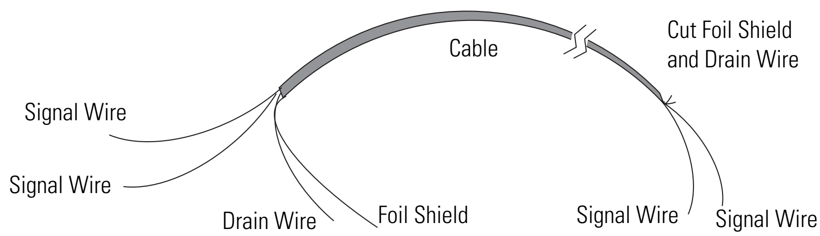
Each terminal accepts up to two wires with these restrictions.

Wire Type		Wire Size	Terminal Screw Torque	Retaining Screw Torque
Solid	Cu-90 °C (194 °F)	0.32... 2.1 mm^2 (22...14 AWG)	0.68 N•m (6 lb•in)	0.46 N•m (4.1lb•in)
Stranded	Cu-90 °C (194 °F)	0.32... 1.3 mm^2 (22...16 AWG)	0.68 N•m (6 lb•in)	0.46 N•m (4.1 lb•in)

Wire the Modules

After the module is properly installed, wire the modules by using this procedure. To provide proper operation and high immunity to electrical noise, always use shielded wire.

> **ATTENTION:** To prevent shock hazard, care should be taken when wiring the module to signal sources. Before wiring any module, disconnect power from the system power supply and from any other source to the module.
>
> Do not wire more than two conductors on any single terminal.



Follow these steps to wire your module.

1. At each end of the cable, strip some casing to expose the individual wires.
2. Trim the signal wires to 5 cm (2 in.) lengths, stripping about 5 mm (0.2 in.) of insulation away to expose the end of the wire.

> **ATTENTION:** Be careful when stripping wires. Wire fragments that fall into a module could cause damage at powerup.

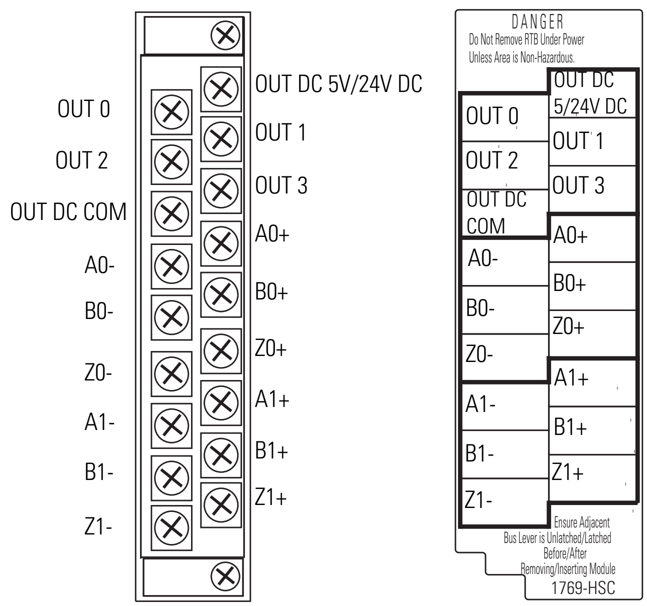
3. At the 1769-HSC module input end of the cable, twist the drain wire and foil shield together, bending them away from the cable, and apply shrink wrap, grounding the shield at this end.
4. At the other end of the cable, cut the drain wire and foil shield back to the cable and apply shrink wrap.
5. Connect the signal wires to the terminal block, connecting the other end of the cable to the input device.
6. Repeat steps 1 through 5 for each channel on the module.

Terminal Door Label

A removable, write-on label is provided with the module. Remove the label from the door, mark the identification of each terminal with permanent ink, and slide the label back into the door. Your markings (ID tag) will be visible when the module door is closed.

Terminal Block Wiring

The input and output terminals are shown below. Both inputs and outputs are isolated from the 1769 Compact bus.



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Wire Diagrams

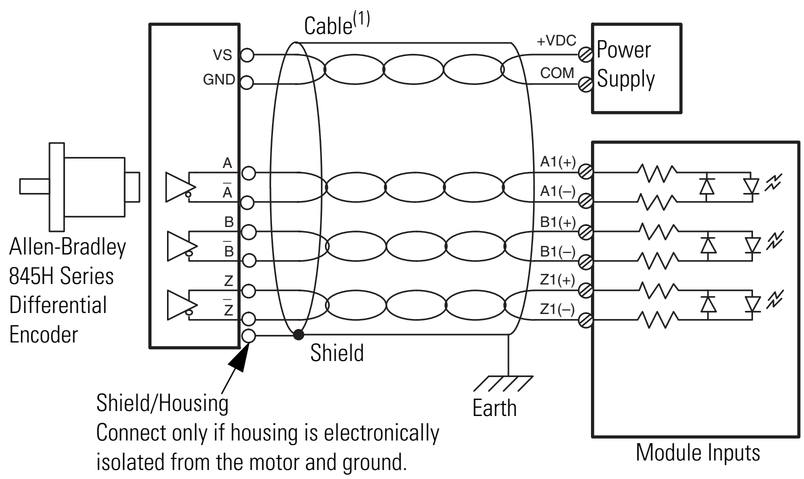
The following pages show wiring examples for a differential encoder, single-ended encoder, and discrete device.

Inputs

The module utilizes differential inputs. Therefore, two input terminals are required for each input point. For example, the A0+ and A0- terminals are required for input point A0. Each input point is isolated from other input points, the 1769 Compact bus, and the entire output terminal group.

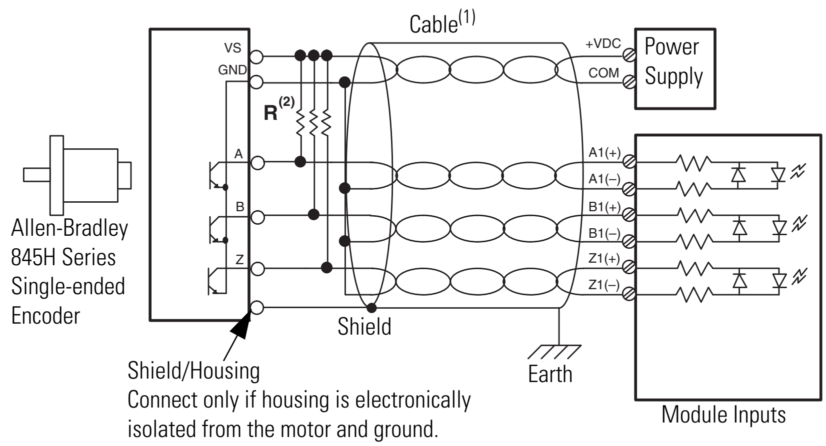
The inputs are compatible with standard differential line driver output devices as well as single-ended devices such as limit switches, photo-eyes, and proximity sensors. Examples of differential and single-ended circuits are shown in Figure 14 and Figure 15.

Figure 14 - Differential Encoder Wiring



(1) Refer to your encoder manual for proper cable type. The type of cable used should be twisted pair, individually shielded cable with a maximum length of 300 m (1000 ft).

Figure 15 - Single-ended Encoder Wiring



(1) Refer to your encoder manual for proper cable type. The type of cable used should be twisted-pair, individually shielded cable with a maximum length of 300 m (1000 ft).

(2) External resistors are required if they are not internal to the encoder. The pull-up resistor (R) value depends on the power supply value. The table below shows the maximum resistor values for typical supply voltages. To calculate the maximum resistor value, use the following formula:

$$R = \frac{VDC - Vmin}{Imin}$$

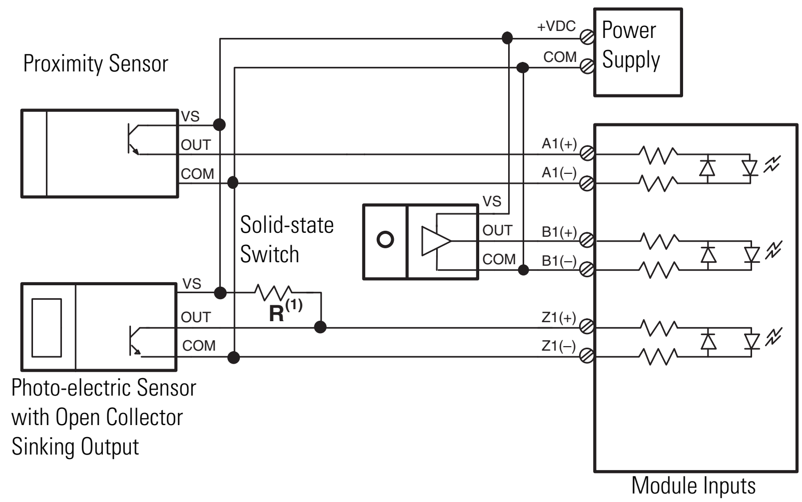
where:
R = maximum pull-up resistor value
VDC = power supply voltage
Vmin = 2.6V DC
Imin = 6.8 mA

Power Supply Voltage (V DC)	Pull-up Resistor Value (R), Max(1)
5	352 Ω
12	1382 Ω
24	3147 Ω

(1) Resistance values can change, depending upon your application.

The minimum resistor (R) value depends on the current sinking capability of the encoder. Refer to your encoder's documentation.

Figure 16 - Discrete Device Wiring



(1) External resistors are required if they are not internal to the sensor. The pull-up resistor (R) value depends on the power supply value. The table below shows the maximum resistor values for typical supply voltages. To calculate the maximum resistor value, use the following formula:

$$R = \frac{VDC - Vmin}{Imin}$$

where:
R = maximum pull-up resistor value
VDC = power supply voltage
Vmin = 2.6V DC
Imin = 6.8 mA

Power Supply Voltage (V DC)	Pull-up Resistor Value (R), Max(1)
5	352 Ω
12	1382 Ω
24	3147 Ω

(1) Resistance values can change, depending upon your application.

The minimum resistor (R) value depends on the current sinking capability of the sensor. Refer to your sensor's documentation.

Outputs

The four output terminals must be powered by a user-supplied external source. User-power range is from 5…30V DC. See the Output Specifications in Appendix A on page 124.

There is no isolation between the outputs, but the outputs are isolated from the inputs and the 1769 Compact bus.

Electronic Protection

The electronic protection of the 1769-HSC module has been designed to provide protection for current overload and short-circuit conditions. The protection is based on a thermal cut-out principle. In the event of a short-circuit or current overload condition on an output channel, that channel will turn off within milliseconds after the thermal cut-out temperature has been reached.

Overcurrent Autoreset Operation

The module detects overcurrent situations and reports them to the backplane in the Out*n*OverCurrent bits of the input array. When the overcurrent condition is detected, the outputs are turned off.

The module can latch outputs off to emulate the behavior of a physical fuse. Use the OvercurrentLatchOff bit to enable or disable this feature. When the OvercurrentLatchOff bit is set and an overcurrent situation occurs (even momentarily) the physical output will be latched off until the ResetBlownFuse bit is cycled from off to on (rising edge triggered). During the latched off time, the Readback.*n* bit in the input array also shows that the output is off.

If the OvercurrentLatchOff bit is not set, the output will be turned off for 1 second and then be retried (if still directed to be on). Retries will repeat until the overcurrent situation is corrected.

The four physical outputs can be latched off only. The virtual outputs are not affected.

IMPORTANT	During the retry period, the physical output and the Readback.n bits will be on briefly (until the overcurrent causes them to shut off again). Take this into consideration and configure your system accordingly.

TIP	Correct short-circuit and overload conditions as soon as possible. If short-circuit and overload conditions occur for extended periods, damage can occur.

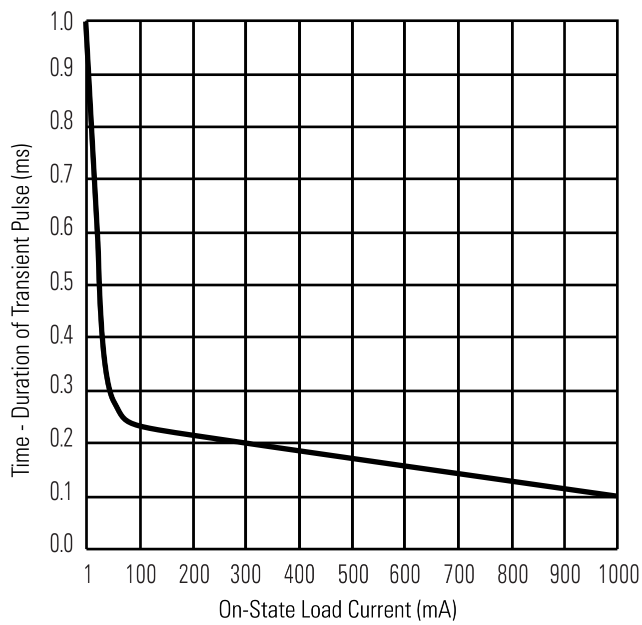
Transistor Output Transient Pulses

The maximum duration of the transient pulse occurs when minimum load is connected to the output. However, for most applications, the energy of the transient pulse is not sufficient to energize the load.

ATTENTION: A transient pulse occurs in transistor outputs when the external DC supply voltage is applied to the output common terminals (for example, via the master control relay). The sudden application of voltage creates this transient pulse. This condition is inherent in transistor outputs and is common to solid state devices. A transient pulse can occur regardless of the controller having power. Refer to your controller's user manual to reduce inadvertent operation.

Figure 17 illustrates that the duration of the transient is proportional to the load current. Therefore, as the on-state load current increases, the transient pulse decreases. Power-up transients do not exceed the time duration shown below, for the amount of loading indicated, at 60 °C (140 °F).

Figure 17 - Transient Pulse Duration as a Function of Load Current



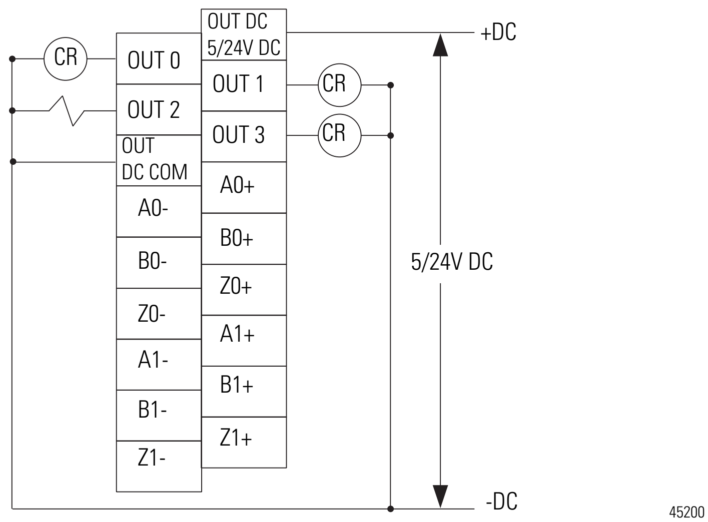
Output Wiring

Basic wiring[1] of output devices[2] to the module is shown in Figure 18.

ATTENTION: Follow these guidelines:

- Miswiring of the module to an AC power source or applying reverse polarity will damage the module.
- Be careful when stripping wires. Wire fragments that fall into a module could cause damage at powerup. Once wiring is complete, make sure the module is free of all metal fragments.

Figure 18 - Output Device Wiring



(1) Recommended Surge Suppression - The module has built-in suppression which is sufficient for most applications, however, for high-noise applications, use a 1N4004 diode reverse-wired across the load for transistor outputs switching 24V DC inductive loads. For additional details, refer to the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

(2) Sourcing Output - Source describes the current flow between the I/O module and the field device. Sourcing output circuits supply (source) current to sinking field devices. Field devices connected to the negative side (DC Common) of the field power supply are sinking field devices. Field devices connected to the positive side (+V) of the field supply are sourcing field devices. **Europe:** DC sinking input and sourcing output module circuits are the commonly used options.

Module Configuration, Output, and Input Data

After installing the 1769-HSC module, you must configure it for operation by using the programming software compatible with the controller, such as RSLogix 500 or RSLogix 5000 software.

TIP Normal counter configuration is done using programming software. In that case, it is not necessary to know the meaning of the bit location. However, some systems let the control program change configuration.

Information on programming the module by using specific controllers and software is contained in the following appendices.

Controller	Software	See
CompactLogix Controller	RSLogix 5000	Appendix B on page 131
MicroLogix 1500 Controller	RSLogix 500	Appendix C on page 141

The table describes the topics in this chapter.

Configure the Module

The module uses three arrays: configuration array, output array, and input array. You configure the module by establishing settings in the configuration and output arrays. The input array shows the data that the module sends to the controller.

IMPORTANT Both the configuration array and output array settings affect the module configuration. Changing certain configuration parameters from defaults can necessitate changing other values to avoid configuration errors.

Configuration Array

The configuration array, which consists of 118 words (46 words for the packaged controller), lets you specify how the module's counters will function. The default value is all zeros with the exception of the following:

- NumberofCounters (see page 75)
- Ctr*n*MaxCount (see page 78)
- Ctr*n*MinCount (see page 79)
- Ctr*n*Scalar (see page 80)
- Ctr*n*CyclicUpdateTime (see page 81)

TIP Normal counter configuration is done using programming software. In that case, it is not necessary to know the bit location. However, some systems let the control program change configuration. Refer to your controller's documentation for details.

IMPORTANT When changing configuration values, verify that only valid configurations are created for the module. For example, changing NumberofCounters from its default of 1 to 0 requires that Ctr1MinCount and Ctr1MaxCount also be set to 0, and so forth.

See the Configuration Error Codes table on page 117 if you encounter configuration errors.

Word 0 contains general configuration bits. Word 1 contains the filter settings. Words 2 through 5 refer to the physical outputs. Words 6 through 45 are counter configuration words. Words 46 through 117 are range configuration words. More detailed descriptions of the configuration words and bits follow the configuration array below.

IMPORTANT Certain values (noted below) cannot be changed while a counter or range is enabled. Attempting to do so will cause a configuration error and the entire configuration array will be rejected until the error is eliminated.

Table 12 - Configuration Array - 1769-HSC Module and CMX 5370 L2 Packaged Controller Embedded HSC

Word	Bit																Function
	15	**14**	**13**	**12**	**11**	**10**	**09**	**08**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**	
0	Individual Counter Reset Disable [1]						NumberOf Counters		Not used			PFE	Not used		Ctr Rst	OCL 0	General Configuration Bits
1	Filter_Z1		Not used	Filter_B1		Not used	Filter_A1		Filter_Z0		Not used	Filter_B0		Not used	Filter_A0		Filter Selection
2	Not used								Out 3 PSR	Out 2 PSR	Out1 PSR	Out0 PSR	Out3 PM	Out2 PM	Out1 PM	Out0 PM	Output Program Mode and Output Program State Run
3	Not used												Out3 PV	Out2 PV	Out1 PV	Out0 PV	Output Program Value

[1] **For the 1769-HSC/B module only**. Bit 12 is Counter 0 reset disable; Bit 13, Counter 1 reset disable; Bit 14, Counter 2 reset disable; Bit 15, Counter 3 reset disable. Counter reset function = 0: reset enable (default), 1: reset disable. See page 73 for details.

Table 12 - Configuration Array - 1769-HSC Module and CMX 5370 L2 Packaged Controller Embedded HSC (Continued)

Word	Bit																Function
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
4	Not used								Out 3 FSR	Out 2 FSR	Out 1 FSR	Out0 FSR	Out3 FM	Out 2 FM	Out1 FM	Out0 FM	Output Fault Mode and Output Fault State Run
5	Not used												Out3 FV	Out 2 FV	Out1 FV	Out0 FV	Output Fault Value
6	Ctr0MaxCount																Counter 0 Maximum Count
7																	
8	Ctr0MinCount																Counter 0 Minimum Count
9																	
10	Ctr0Preset																Counter 0 Preset
11																	
12	Ctr0Hysteresis																Counter 0 Hysteresis
13	Ctr0Scalar																Counter 0 Scalar
14	Ctr0CyclicRateUpdateTime																Counter 0 Cyclic Rate Update Time
15	Not used			Lin-ear	Not used	Storage mode			Not used					Operational mode			Counter 0 Configuration Flags
16	Ctr1MaxCount																Counter 1 Maximum Count
17																	
18	Ctr1MinCount																Counter 1 Minimum Count
19																	
20	Ctr1Preset																Counter 1 Preset
21																	
22	Ctr1Hysteresis																Counter 1 Hysteresis
23	Ctr1Scalar																Counter 1 Scalar
24	Ctr1CyclicRateUpdateTime																Counter 1 Cyclic Rate Update Time
25	Not used			Lin-ear	Not used	Storage mode			Not used					Operational mode			Counter 1 Configuration Flags
26	Ctr2MaxCount																Counter 2 Maximum Count
27																	
28	Ctr2MinCount																Counter 2 Minimum Count
29																	
30	Ctr2Preset																Counter 2 Preset
31																	
32	Ctr2Hysteresis																Counter 2 Hysteresis
33	Ctr2Scalar																Counter 2 Scalar
34	Ctr2CyclicRateUpdateTime																Counter 2 Cyclic Rate Update Time

Table 12 - Configuration Array - 1769-HSC Module and CMX 5370 L2 Packaged Controller Embedded HSC (Continued)

Word	Bit																Function
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
35	Not used			Lin-ear	Not used												Counter 2 Configuration Flags
36	Ctr3MaxCount																Counter 3 Maximum Count
37																	
38	Ctr3MinCount																Counter 3 Minimum Count
39																	
40	Ctr3Preset																Counter 3 Preset
41																	
42	Ctr3Hysteresis																Counter 3 Hysteresis
43	Ctr3Scalar																Counter 3 Scalar
44	Ctr3CyclicRateUpdateTime																Counter 3 Cyclic Rate Update Time
45	Not used			Lin-ear	Not used												Counter 3 Configuration Flags
46	Range0To11[0].HighLimit																Range 0 High Limit
47																	
48	Range0To11[0].LowLimit																Range 0 Low Limit
49																	
50	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 09	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range 0 Output Control
51	Not used							Inv	Not used			Type	Not used		ToThisCtr		Range 0 Configuration Flags
52	Range0To11[1].HighLimit																Range 1 High Limit
53																	
54	Range0To11[1].LowLimit																Range 1 Low Limit
55																	
56	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 09	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range 1 Output Control
57	Not used							Inv	Not used			Type	Not used		ToThisCtr		Range 1 Configuration Flags
58	Range0To11[2].HighLimit																Range 2 High Limit
59																	
60	Range0To11[2].LowLimit																Range 2 Low Limit
61																	
62	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 09	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range 2 Output Control
63	Not used							Inv	Not used			Type	Not used		ToThisCtr		Range 2 Configuration Flags
64	Range0To11[3].HighLimit																Range 3 High Limit
65																	

Table 12 - Configuration Array - 1769-HSC Module and CMX 5370 L2 Packaged Controller Embedded HSC (Continued)

Word	Bit																Function
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
66	Range0To11[3].LowLimit																Range 3 Low Limit
67																	
68	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 09	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range 3 Output Control
69	Not used							Inv	Not used			Type	Not used		ToThisCtr		Range 3 Configuration Flags
70	Range0To11[4].HighLimit																Range 4 High Limit
71																	
72	Range0To11[4].LowLimit																Range 4 Low Limit
73																	
74	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 09	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range 4 Output Control
75	Not used							Inv	Not used			Type	Not used		ToThisCtr		Range 4 Configuration Flags
76	Range0To11[5].HighLimit																Range 5 High Limit
77																	
78	Range0To11[5].LowLimit																Range 5 Low Limit
79																	
80	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 09	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range 5 Output Control
81	Not used							Inv	Not used			Type	Not used		ToThisCtr		Range 5 Configuration Flags
82	Range0To11[6].HighLimit																Range 6 High Limit
83																	
84	Range0To11[6].LowLimit																Range 6 Low Limit
85																	
86	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 09	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range 6 Output Control
87	Not used							Inv	Not used			Type	Not used		ToThisCtr		Range 6 Configuration Flags
88	Range0To11[7].HighLimit																Range 7 High Limit
89																	
90	Range0To11[7].LowLimit																Range 7 Low Limit
91																	
92	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 09	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range 7 Output Control
93	Not used							Inv	Not used			Type	Not used		ToThisCtr		Range 7 Configuration Flags
94	Range0To11[8].HighLimit																Range 8 High Limit
95																	

Table 12 - Configuration Array - 1769-HSC Module and CMX 5370 L2 Packaged Controller Embedded HSC (Continued)

Word	Bit																Function
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
96	Range0To11[8].LowLimit																Range 8 Low Limit
97																	
98	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 09	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range 8 Output Control
99	Not used							Inv	Not used			Type	Not used		ToThisCtr		Range 8 Configuration Flags
100	Range0To11[9].HighLimit																Range 9 High Limit
101																	
102	Range0To11[9].LowLimit																Range 9 Low Limit
103																	
104	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 09	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range 9 Output Control
105	Not used							Inv	Not used			Type	Not used		ToThisCtr		Range 9 Configuration Flags
106	Range0To11[10].HighLimit																Range 10 High Limit
107																	
108	Range0To11[10].LowLimit																Range 10 Low Limit
109																	
110	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 09	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range 10 Output Control
111	Not used							Inv	Not used			Type	Not used		ToThisCtr		Range 10 Configuration Flags
112	Range0To11[11].HighLimit																Range 11 High Limit
113																	
114	Range0To11[11].LowLimit																Range 11 Low Limit
115																	
116	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 09	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range 11 Output Control
117	Not used							Inv	Not used			Type	Not used		ToThisCtr		Range 11 Configuration Flags

Table 13 - Configuration Array - L23E Packaged Controller Embedded HSC

Word	Bit																Function
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
0	Not used						NumberOf Counters		Not used			PFE	Not used		Ctr Rst	OCL 0	General Configuration Bits
1	Filter_Z1		Not used	Filter_B1		Not used	Filter_A1		Filter_Z0		Not used	Filter_B0		Not used	Filter_A0		Filter Selection
2	Not used								Out 3 PSR	Out 2 PSR	Out1 PSR	Out0 PSR	Out3 PSO	Out2 PSO	Out1 PSO	Out0 PSO	Program State for Output and Program State Run for Output
3	Not used												Out3 PVO	Out2 PVO	Out1 PVO	Out0 PVO	Program Value for Output

Table 13 - Configuration Array - L23E Packaged Controller Embedded HSC (Continued)

Word	Bit																Function
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
4	Not used								Out 3 FSR	Out 2 FSR	Out1 FSR	Out0 FSR	Out3 FSO	Out2 FSO	Out1 FSO	Out0 FSO	Fault State for Output and Fault State Run for Output
5	Not used												Out3 FVO	Out2 FVO	Out1 FVO	Out0 FVO	Fault Value for Output
6	Ctr0MaxCount																Counter 0 Maximum Count
7																	
8	Ctr0MinCount																Counter 0 Minimum Count
9																	
10	Ctr0Preset																Counter 0 Preset
11																	
12	Not used																Not used
13	Not used																Not used
14	Not used																Not used
15	Not used			Lin-ear	Not used	Storage mode			Not used					Operational mode			Counter 0 Configuration Flags
16	Ctr1MaxCount																Counter 1 Maximum Count
17																	
18	Ctr1MinCount																Counter 1 Minimum Count
19																	
20	Ctr1Preset																Counter 1 Preset
21																	
22	Not used																Not used
23	Not used																Not used
24	Not used																Not used
25	Not used			Lin-ear	Not used	Storage mode			Not used					Operational mode			Counter 1 Configuration Flags
26	Ctr2MaxCount																Counter 2 Maximum Count
27																	
28	Ctr2MinCount																Counter 2 Minimum Count
29																	
30	Ctr2Preset																Counter 2 Preset
31																	
32	Not used																Not used
33	Not used																Not used
34	Not used																Not used
35	Not used			Lin-ear	Not used												Counter 2 Configuration Flags

Table 13 - Configuration Array - L23E Packaged Controller Embedded HSC (Continued)

Word	Bit 15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	Function
36	Ctr3MaxCount																Counter 3 Maximum Count
37																	
38	Ctr3MinCount																Counter 3 Minimum Count
39																	
40	Ctr3Preset																Counter 3 Preset
41																	
42	Not used																Not used
43	Not used																Not used
44	Not used																Not used
45	Not used			Lin-ear	Not used												Counter 3 Configuration Flags

General Configuration Bits

These configuration bits apply to the 1769-HSC/B module and the CMX 5370 L2 packaged controller embedded HSC.

Configuration Array Word 0	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
General Configuration Bits	Individual Counter Reset Disable(1)						Number of counters		Not used			PFE	Not used		Ctr Reset	OCL O

(1) **For the 1769-HSC/B module only**. Bit 12 is Counter 0 reset disable; Bit 13, Counter 1 reset disable; Bit 14, Counter 2 reset disable; Bit 15, Counter 3 reset disable. Counter reset function = 0: reset enable (default), 1: reset disable. The 1769-HSC/A module does not use bits 12…15 in the configuration array. See page 73 for details.

OCLO - Overcurrent Latch Off (OverCurrentLatchOff)

When set, this bit causes the module to make any overcurrent activity latch the corresponding output off, simulating a physical fuse. When OCLO = 0, it automatically resets. The rising edge of RBF resets the output.

IMPORTANT Do not set this bit while a counter or range is enabled (Ctr0En, Ctr1En, Ctr2En, Ctr3En, or RangeEn set to 1). Attempting to do so will result in a BadModConfigUpdate error.

See page 120 for a list of prohibited settings.

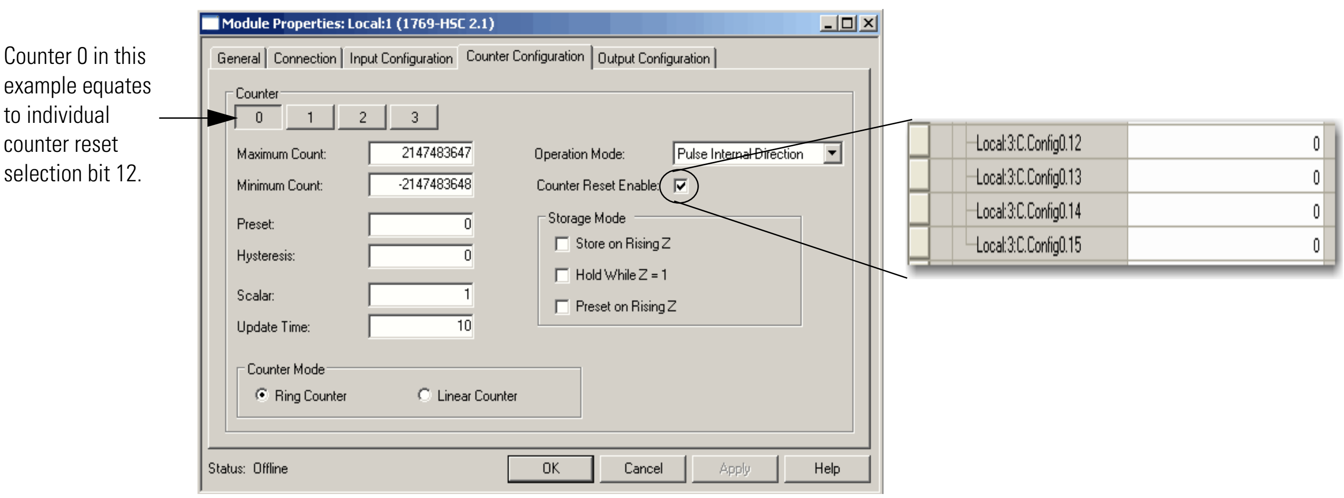
Counter Reset (CtrReset)

Bits 12…15 in the configuration array correspond to the counter reset selection bits for counters 0…3, respectively. The Counter Reset Enable in the Add-On profile lets you select which counter to be enabled or disabled. An enabled checkbox indicates a zero (0) in the respective counter reset selection bits in RSLogix 5000 software.

IMPORTANT	The individual counter reset functionality applies **only** to the 1769-HSC/B module used with CompactLogix controllers and the CMX 5370 L2 packaged controller embedded HSC. You cannot use the individual counter reset functionality with MicroLogix controllers.

If you do not want a counter to reset by default, you must uncheck the box in the Add-On profile for the respective counter reset selection bit. A '1' will display in the configuration array to denote that this bit is disabled from resetting a count. The individual counter reset functionality for the 1769-HSC/B module is reverse logic, with a 0 = enabled and a 1 = disabled, for RSLogix 5000 software.

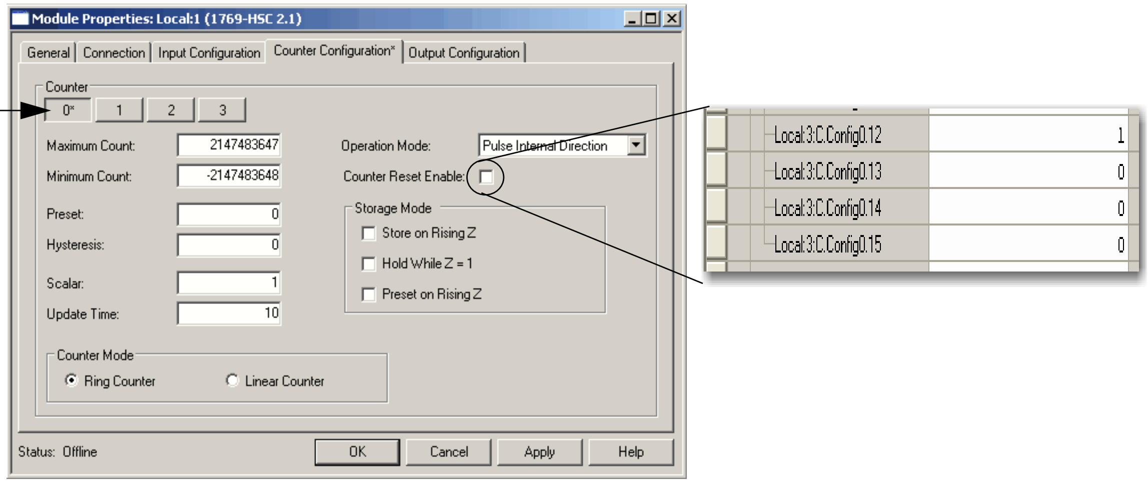
Figure 19 - Configuration for Individual Counter Reset Enable



As shown in Figure 19, the Counter Reset Enable box defaults with a check mark to indicate the respective counter is enabled in the Add-On Profile. Therefore, the individual counter reset functionality is enabled for the selected counter of the 1769-HSC/B module. The corresponding controller tag in RSLogix 5000 software displays a zero (0) for enabled.

Figure 20 - Configuration for Individual Counter Reset Disable

Counter 0 in this example equates to individual counter reset selection bit 12.



As shown in Figure 20, the Counter Reset Enable box has been unchecked to indicate the individual counter reset functionality is disabled for the selected counter of the 1769-HSC/B module. The corresponding controller tag in RSLogix 5000 software shows a one (1) for disabled.

The CtrReset bit, when set, causes the following to occur for both the 1769-HSC/A and 1769-HSC/B modules when the system transitions to Run or the Inhibit Module bit transitions to 0:

- System checks counter reset selection bits 12…15 to determine which counter needs to be reset.(1)
- Only those counters selected for reset are reset to zero.
- The output array is reset to default values until the ModConfig bit is set (1). The default value for the output array is all zeros.
- The input array counter status flags (Overflow, Underflow, RisingEdgeZ, RateValid, PresetWarning) are reset.
- The input array counter values (Current Count(2), StoredCount, CurrentRate and PulseInterval) are also reset to zero.
- Counts are lost and outputs are turned off.

IMPORTANT	For most predictable results, clear the output image of the controller before performing a counter reset (CtrReset) to the 1769-HSC module. This is because CtrReset does not change the controller's output image. CtrReset sets the 1769-HSC module's output array to all zeroes. If any bit is set to 1 in the controller's output image when sent to the module, it will be seen as a state transition and be acted upon.

(1) This applies only to the 1769-HSC/B module and the CMX 5370 L2 packaged controller embedded HSC.
(2) If zero is outside the MinCount and MaxCount limits set in the configuration array, then the Preset value is loaded into CurrentCount instead of zero. This also causes the PresetWarning bit to be set, which, in turn, sets the GenError bit.

PFE - Program to Fault Enable (ProgToFaultEn)

This bit indicates what should happen when the bus controller indicates a change from one condition (Program mode) to another (Fault mode). If this bit is set (1), the safe state operation of all four real outputs changes to that identified by the Fault State and Fault Value words. If this bit is reset (0), the module continues with the operation identified by the Program State and Program Value words.

Number of Counters (NumberOfCounters)

This 2-bit value indicates whether the module uses 1 counter, 2 counters, 3 counters, or 4 counters. The default value is 1 (2 counters).

Bit 01	Bit 00	Counters
0	0	1
0	1	2
1	0	3
1	1	4

IMPORTANT Do not set this value while a counter or range is enabled (Ctr0En, Ctr1En, Ctr2En, Ctr3En, or RangeEn set to 1). Attempting to do so will result in a BadModConfigUpdate error.

See page 120 for a list of prohibited settings.

Filter Selection

Configuration Array Word 1	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Filter Selection	Filter_Z1		Not used	FilterB1		Not used	FilterA1		FilterZ0		Not used	FilterB0		Not used	FilterA0	

This value indicates the nominal filter frequency as shown in the table.

Filters and Corresponding Bits	FilterA0	Bit 1 - FilterA0_1	Bit 0 - FilterA0_0
	FilterB0	Bit 4 - FilterB0_1	Bit 3 - FilterB0_0
	FilterZ0	Bit 7 - FilterZ0_1	Bit 6 - FilterZ0_0
	FilterA1	Bit 9 - FilterA1_1	Bit 8 - FilterA1_0
	FilterB1	Bit 12 - FilterB1_1	Bit 11 - FilterB1_0
	FilterZ1	Bit 15 - FilterZ1_1	Bit 14 - FilterZ1_0
Nominal Frequency Settings	None	0	0
	0.01 ms minimum pulse width (0.0185 ms for the packaged controller)	0	1
	0.5 ms minimum pulse width (0.715 ms for the packaged controller)	1	0
	5 ms minimum pulse width (7.1 ms for the packaged controller)	1	1

IMPORTANT	Do not set these bits while certain counters or ranges are enabled. Attempting to do so will result in a BadModConfigUpdate error. See page 120 for a list of prohibited settings.

Program Mode and Program State Run

Configuration Array Word 2	**15**	**14**	**13**	**12**	**11**	**10**	**09**	**08**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**
Output Program Mode and Output Program State Run	Not used								Out3 PSR	Out2 PSR	Out1 PSR	Out0 PSR	Out3 PM	Out2 PM	Out1 PM	Out0 PM

Program Mode (Out0ProgramMode through Out3ProgramMode)

The program mode bits configure the output for Hold Last State (HLS) or User-defined Safe State (UDSS) during Program State.

- 1 = Hold Last State
- 0 = User-defined Safe State

IMPORTANT	Program Mode and Program State Run apply only to certain controllers. Refer to your controller's documentation for more information. The packaged controllers' embedded HSC does not support this feature.

Program State Run (Out0ProgramStateRun through Out3ProgramStateRun)

Program State Run lets you specify, on a bit basis, that the output should continue to be controlled by the module as if it were in the Run state. That is, events on the module or changes in the output image will affect the physical outputs without regard to the Program_HLS or UDSS state indicated. When this bit is set, the corresponding Program Mode and Program Value bits are ignored.

ATTENTION: Selecting this option lets outputs change state while ladder logic is not running. You must take care to make sure that this does not pose a risk of injury or equipment damage when selecting this option.

IMPORTANT	The prescan initiated by some controllers could have an effect on the outputs. To overcome any changes in physical output states caused by this, retentive output instructions (for example, latch or unlatch) should be used when bit manipulations are done on the Output image of this module in ladder logic. This applies to a wide range of bits when Program State Run is selected, because presetting a counter, enabling a range, changing a mask, and changing configuration array settings can cause ranges and outputs to change state.

Output Program Value (Out0ProgramValue through Out3ProgramValue)

Configuration Array Word 3	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Output Program Value	Not used												Out3 PV	Out2 PV	Out1 PV	Out0 PV

These bits are the values that will be applied to each of the real outputs when User-defined Safe State (UDSS) is set as described and the module is in Program state.

Output Fault Mode and Output Fault State Run

Configuration Array Word 4	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Output Fault Mode and Output Fault State Run	Not used								Out3 FSR	Out2 FSR	Out1 FSR	Out0 FSR	Out3 FM	Out2 FM	Out1 FM	Out0 FM

Output Fault Mode (Out0FaultMode through Out3FaultMode)

These bits configure the output for Hold Last State or User-defined Safe State during a Fault state.

- 1 = Hold Last State
- 0 = User-defined Safe State

Output Fault State Run (Out0FaultStateRun through Out3FaultStateRun)

Similar to Program State Run, Fault State Run lets you specify, on a bit basis, that the output should continue to be controlled by the module as if it were Run state. That is, events on the module or changes in the output image will affect the physical outputs without regard to the Fault_HLS or UDSS state indicated. When this bit is set, the corresponding Fault mode and fault value bits are ignored.

ATTENTION: Selecting this option lets outputs change state while ladder logic is not running. You must take care to make sure that this does not pose a risk of injury or equipment damage when selecting this option.

IMPORTANT The prescan initiated by some controllers could have an effect on the outputs. To overcome any changes in physical output states caused by this, retentive output instructions (for example, latch or unlatch) should be used when bit manipulations are done on the output image of this module in ladder logic.

This applies to a wide range of bits when Fault State Run is selected, because presetting a counter, enabling a range, changing a mask, and changing Configuration Array settings can cause ranges and outputs to change state.

Output Fault Value (Out0FaultValue through Out3FaultValue)

Configuration Array Word 5		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
5	Output Fault Value	Not used												Out3 FV	Out2 FV	Out1 FV	Out0 FV

These bits are the values that will be applied to each of the real outputs when User-defined Safe State is set as described and the module is in Fault state.

TIP Outputs are also affected by PFT above.

Counter Maximum Count (Ctr*n*MaxCount)

Configuration Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
6	Counter 0 Maximum Count	Ctr0MaxCount															
7																	
16	Counter 1 Maximum Count	Ctr1MaxCount															
17																	
26	Counter 2 Maximum Count	Ctr2MaxCount															
27																	
36	Counter 3 Maximum Count	Ctr3MaxCount															
37																	

This is the maximum count value allowed for counter (*n*). The count value cannot exceed this value. Allowable values are Ctr*n*MinCount 1…2,147,483,647 (decimal).

The default value is 2,147,483,647 decimal for counters 0 and 1. The default value is 0 for counters 2 and 3.

IMPORTANT Do not change this value while the counter is enabled. Attempting to do so will result in a BadModConfigUpdate error. See page 120 for a list of prohibited settings.

Counter Minimum Count (Ctr*n*MinCount)

Configuration Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
8	Counter 0 Minimum Count	Ctr0MinCount															
9																	
18	Counter 1 Minimum Count	Ctr1MinCount															
19																	
28	Counter 2 Minimum Count	Ctr2MinCount															
29																	
38	Counter 3 Minimum Count	Ctr3MinCount															
39																	

This is the minimum count value allowed for counter (*n*). The count value cannot fall below this value. This value must be less than Ctr*n*MaxCount or a configuration error occurs. Allowable values are from -2,147,483,648 to Ctr*n*MaxCount - 1.

The default value is -2,147,483,648 decimal for counters 0 and 1. The default value is 0 for counters 2 and 3.

IMPORTANT	Do not change this value while the counter is enabled. Attempting to do so will result in a BadModConfigUpdate error. See page 120 for a list of prohibited settings.

Counter Preset (Ctr*n*Preset)

Configuration Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
10	Counter 0 Preset	Ctr0Preset															
11																	
20	Counter 1 Preset	Ctr1Preset															
21																	
30	Counter 2 Preset	Ctr2Preset															
31																	
40	Counter 3 Preset	Ctr3Preset															
41																	

This value can be used to change the current count value of counter*n* on certain gate (Z*n*) events and when Ctr*n*SoftPreset is used.

Ctr*n*Preset must be greater than or equal to Ctr*n*MinCount and less than Ctr*n*MaxCount. The default value is zero.

Counter Hysteresis (Ctr*n*Hysteresis)

IMPORTANT	The Counter Hysteresis information does not apply to the L23E packaged controller because rate measurement is not supported.

Configuration Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
12	Counter 0 Hysteresis	Ctr0Hysteresis															
22	Counter 1 Hysteresis	Ctr1Hysteresis															
32	Counter 2 Hysteresis	Ctr2Hysteresis															
42	Counter 3 Hysteresis	Ctr3Hysteresis															

The hysteresis value is the number of counts that should be disregarded in the calculation of the cyclic rate. If the count value changes by less than the hysteresis value, the rate is reported as zero, regardless of the actual rate at which the pulses are counted.

IMPORTANT	Do not change this value while the counter is enabled. Attempting to do so will result in a BadModConfigUpdate error. See page 120 for a list of prohibited settings.

Counter Scalar (Ctr*n*Scalar)

IMPORTANT	The Counter Scalar information does not apply to the L23E packaged controller because rate measurement is not supported.

Configuration Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
13	Counter 0 Scalar	Ctr0Scalar															
23	Counter 1 Scalar	Ctr1Scalar															
33	Counter 2 Scalar	Ctr2Scalar															
43	Counter 3 Scalar	Ctr3Scalar															

This value is used to scale the Rate value. The Rate value is divided by the Scalar value. The default value is 1 for counters 0 and 1. The default value is 0 for counters 2 and 3.

Ctr*n*Scalar can be used to determine RPM. To configure the Ctr[*n*].CurrentRate value to show an RPM value, set Ctr*n*Scalar to (counts per revolution)/60.

See page 34 for more information.

IMPORTANT	For any counter being used, do not set Scalar to a value less than one or a configuration error will occur.

IMPORTANT	Do not change this value while the counter is enabled. Attempting to do so will result in a BadModConfigUpdate error. See page 120 for a list of prohibited settings.

Cyclic Rate Update Time (Ctr*n*CyclicRateUpdateTime)

IMPORTANT	The Counter Scalar information does not apply to the L23E packaged controller because rate measurement is not supported.

Configuration Array Words		**15**	**14**	**13**	**12**	**11**	**10**	**09**	**08**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**
14	Counter 0 Cyclic Rate Update Time	Ctr0CyclicRateUpdateTime															
24	Counter 1 Cyclic Rate Update Time	Ctr1CyclicRateUpdateTime															
34	Counter 2 Cyclic Rate Update Time	Ctr2CyclicRateUpdateTime															
44	Counter 3 Cyclic Rate Update Time	Ctr3CyclicRateUpdateTime															

This value is used to set the cyclic rate update time for the CurrentRate calculation. The value indicates the time in milliseconds from 1…32767. An invalid number causes a configuration error. The default value is 10 for counters 0 and 1. The default value is 0 for counters 2 and 3.

IMPORTANT	Do not change this value while the counter is enabled. Attempting to do so will result in a BadModConfigUpdate error. See page 120 for a list of prohibited settings.

See Cyclic Rate Calculation Method (current rate) on page 32 for more information on cyclic rate.

Configuration Flags

Configuration Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
15	Counter 0 Configuration Flags	Not used			Linear	Not used	Storage mode			Not used					Operational mode		
25	Counter 1 Configuration Flags	Not used			Linear	Not used	Storage mode			Not used					Operational mode		
35	Counter 2 Configuration Flags	Not used			Linear	Not used											
45	Counter 3 Configuration Flags	Not used			Linear	Not used											

Operational Mode (CtrnConfig.OperationalMode_0 through CtrnConfig.OperationalMode_2)

These bits apply to Counters 0 and 1 only.

This value determines how the A*0* or A*1* and B*0* or B*1* inputs are decoded when assigned to counter 0 or counter 1.

Set bit			For function
Ctr*n*Config.OperationalMode_2	**Ctr*n*Config.OperationalMode_1**	**Ctr*n*Config.OperationalMode_0**	
0	0	0	Pulse internal direction
0	0	1	Pulse external direction
1	0	0	Quadrature encoder X1
1	0	1	Quadrature encoder X2
1	1	0	Quadrature encoder X4
0	1	0	Up/Down Pulses
0	1	1	reserved
1	1	1	reserved

TIP The Ctr1Config.OperationalMode bits are reserved if the Number of Counters equals 1. Attempting to set reserved bits will result in a configuration error.

IMPORTANT Do not change this value while the counter is enabled. Attempting to do so will result in a BadModConfigUpdate error. See page 120 for a list of prohibited settings.

Storage Mode (CtrnConfig.StorageMode_0 through CtrnConfig.StorageMode_2)

These three bits apply to Counters 0 and 1 only. They define how the module interprets the Z input, as shown below. Each bit works independently. If bit 0 and bit 2 are set simultaneously, a Z event causes the Current Count Value to be stored and then preset.

Set bit	For function
Ctr*n*Config.StorageMode_0	Stores the Current Count Value on the rising edge of Z to Ctr[*n*].StoredCount in the input file.
Ctr*n*Config.StorageMode_1	Holds the counter at its Current Count Value while Z = 1.
Ctr*n*Config.StorageMode_2	Presets the Current Count Value on the rising edge of Z.

IMPORTANT Z = internal Z. Internal Z is the version of the Z input pin as modified by the output array control bits Z Invert and Z Inhibit.

TIP The Ctr1Config.Storage Mode bits are reserved if NumberofCounters_1 and NumberofCounters_0 are set to 00 (one counter). Attempting to set reserved bits will result in a configuration error.

IMPORTANT Do not change this value while the counter is enabled. Attempting to do so will result in a BadModConfigUpdate error. See page 120 for a list of prohibited settings.

Linear (Ctr0Config.Linear through Ctr3Config.Linear)

This bit indicates how the counter operates upon reaching a Ctr*n*MinCount or Ctr*n*MaxCount.

- 0 = Ring Counter
- 1 = Linear Counter

See page 28 for a description of ring and linear counter operation.

IMPORTANT Do not change this value while the counter is enabled. Attempting to do so will result in a BadModConfigUpdate error. See page 120 for a list of prohibited settings.

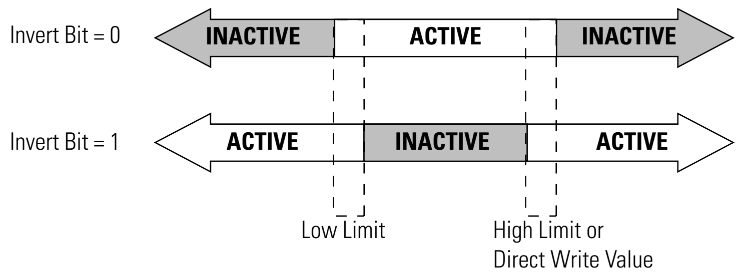
Range High Limit (Range0To11[*n*].HighLimit) and Range Low Limit (Range0To11[*n*].LowLimit)

IMPORTANT	The Range High Limit and Range Low Limit words do not apply to the L23E packaged controller.

Configuration Array Words		**15**	**14**	**13**	**12**	**11**	**10**	**09**	**08**	**07**	**06**	**05**	**04**	**03**	**02**	**01**	**00**
46 and 47	Range 0 High Limit	Range0To11[0].HighLimit															
48 and 49	Range 0 Low Limit	Range0To11[0].LowLimit															
52 and 53	Range 1 High Limit	Range0To11[1].HighLimit															
54 and 55	Range 1 Low Limit	Range0To11[1].LowLimit															
58and 59	Range 2 High Limit	Range0To11[2].HighLimit															
60 and 61	Range 2 Low Limit	Range0To11[2].LowLimit															
64 and 65	Range 3 High Limit	Range0To11[3].HighLimit															
66 and 67	Range 3 Low Limit	Range0To11[3].LowLimit															
70 and 71	Range 4 High Limit	Range0To11[4].HighLimit															
72 and 73	Range 4 Low Limit	Range0To11[4].LowLimit															
76 and 77	Range 5 High Limit	Range0To11[5].HighLimit															
78 and 79	Range 5 Low Limit	Range0To11[5].LowLimit															
82 and 83	Range 6 High Limit	Range0To11[6].HighLimit															
84 and 85	Range 6 Low Limit	Range0To11[6].LowLimit															
88 and 89	Range 7 High Limit	Range0To11[7].HighLimit															
90 and 91	Range 7 Low Limit	Range0To11[7].LowLimit															
94 and 95	Range 8 High Limit	Range0To11[8].HighLimit															
96 and 97	Range 8 Low Limit	Range0To11[8].LowLimit															
100 and 101	Range 9 High Limit	Range0To11[9].HighLimit															
102 and 103	Range 9 Low Limit	Range0To11[9].LowLimit															
106 and 107	Range 10 High Limit	Range0To11[10].HighLimit															
108 and 109	Range 10 Low Limit	Range0To11[10].LowLimit															
112 and 113	Range 11 High Limit	Range0To11[11].HighLimit															
114 and 115	Range 11 Low Limit	Range0To11[11].LowLimit															

These values, which represent a count value or rate value, depending upon the programed Type, are used for range comparison. When the rate value is equal to Range0To11[*n*].HighLimit or Range0To11[*n*].LowLimit, Range*n* changes state, becoming either active or inactive, depending upon the setting of the Range0To11[*n*].Invert bit.

Object Value (Current Count or Current Rate)



TIP Range0To11[*n*].HighLimit must be greater than Range0To11[*n*].LowLimit or a configuration error results.

Range Output Control (Range0To11[*n*].OutputControl)

IMPORTANT The Range Output Control words do not apply to the L23E packaged controller.

Configuration Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
50	Range 0 Output Control	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0
56	Range 1 Output Control	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0
62	Range 2 Output Control	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0
68	Range 3 Output Control	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0
74	Range 4 Output Control	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0
80	Range 5 Output Control	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0
86	Range 6 Output Control	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0
92	Range 7 Output Control	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0
98	Range 8 Output Control	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0
104	Range 9 Output Control	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0
110	Range 10 Output Control	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0
116	Range 11 Output Control	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0

These 16-bit words indicate which outputs should be enabled when a range is active. When range *n* is enabled, this word is combined with the other range output masks as described in Output Off Mask (OutputOffMask.0 through OutputOffMask.15) on page 91 and on page 89.

Range Configuration Flags

IMPORTANT	The Range Configuration Flag information does not apply to the L23E packaged controller.

Configuration Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
51	Range 0 Configuration Flags	Not used							Inv	Not used			Type	Not used		ToThisCtr	
57	Range 1 Configuration Flags	Not used							Inv	Not used			Type	Not used		ToThisCtr	
63	Range 2 Configuration Flags	Not used							Inv	Not used			Type	Not used		ToThisCtr	
69	Range 3 Configuration Flags	Not used							Inv	Not used			Type	Not used		ToThisCtr	
75	Range 4 Configuration Flags	Not used							Inv	Not used			Type	Not used		ToThisCtr	
81	Range 5 Configuration Flags	Not used							Inv	Not used			Type	Not used		ToThisCtr	
87	Range 6 Configuration Flags	Not used							Inv	Not used			Type	Not used		ToThisCtr	
93	Range 7 Configuration Flags	Not used							Inv	Not used			Type	Not used		ToThisCtr	
99	Range 8 Configuration Flags	Not used							Inv	Not used			Type	Not used		ToThisCtr	
105	Range 9 Configuration Flags	Not used							Inv	Not used			Type	Not used		ToThisCtr	
111	Range 10 Configuration Flags	Not used							Inv	Not used			Type	Not used		ToThisCtr	
117	Range 11 Configuration Flags	Not used							Inv	Not used			Type	Not used		ToThisCtr	

ToThisCtr (Range0To11[n].ToThisCounter)

This 2-bit value indicates which counter is used in the range comparison for range *n*, as shown in the table.

Bit 01	Bit 00	Counter
0	0	0
0	1	1
1	0	2
1	1	3

IMPORTANT	If this value is greater than NumberOfCounters, a configuration error occurs.

Type (Range0To11[n].Type)

This bit indicates which type of value to use for the range comparison in range *n*. This value and Range0To11[*n*].ToThisCounter determine the current value that is used in range comparison as the rate or count value.

Range0To11[*n*].Type	Range Type
0	Count Value
1	Rate Value

Inv (Range0To11[n].Invert)

This bit indicates whether the range *n* should be active inside or outside the Range0To11[*n*].Low Limit and Range0To11[*n*].HighLimit window.

- 0 = The range *n* is active when the rate or count value is at or between Range0To11[*n*].Low Limit and Range0To11[*n*].HighLimit. When the range is active, the RangeActive.*n* bit is set. When the range is active and enabled, the outputs indicated in the Range Output Control word are activated.
- 1 = The range *n* is active when the rate or count value is lower than or equal to Range0To11[*n*].LowLimit or higher than or equal to Range0To11[*n*].HighLimit. When the range is active, the RangeActive.*n* bit is set. When the range is active and enabled, the outputs indicated in the Range Output Control word are applied.

TIP	Ranges can be active in overflow, underflow, and rollover situations.

Output Array

The output array, which consists of 34 words, lets you access the module's real-time output data to control the module. The default value is all zeros.

IMPORTANT The output array contains dynamic configuration data. The settings in the output array must be compatible with the settings in the configuration array.

For example, do not attempt to set Counter Control Bits for a given counter in the output array unless NumberOfCounters in the configuration array indicates that the counter is declared to be used.

IMPORTANT All Not used bits (shaded in the Output Array - 1769-HSC Module and CMX 5370 L2 Packaged Controller Embedded HSC table, below) must be set to 0 or the InvalidOutput bit in the input array will be set. When the InvalidOutput bit is set, the entire output array is rejected until an output array that does not have this error is sent.

Table 14 - Output Array - 1769-HSC Module and CMX 5370 L2 Packaged Controller Embedded HSC

Word	Bit																Function
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
0	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Output On Mask
1	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Output Off Mask
2	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	R5	R4	R3	R2	R1	R0	Range Enable
3	Not used																Not used
4	Not used								RBF	Not used							Reset Blown Fuse
5	Not used						RPW	RREZ	Z Inh	Z Inv	D Inh	D Inv	RU	RO	SP	En	Counter 0 Control Bits
6	Not used						RPW	RREZ	Z Inh	Z Inv	D Inh	D Inv	RU	RO	SP	En	Counter 1 Control Bits
7	Not used						RPW	Not used				D Inv	RU	RO	SP	En	Counter 2 Control Bits
8	Not used						RPW	Not used				D Inv	RU	RO	SP	En	Counter 3 Control Bits
9	Not used																Not used
10	Range12To15[0].HiLimOrDirWr																Range High Limit or Direct Write Value
11																	
12	Range12To15[0].LowLimit																Range Low Limit
13																	
14	Range12To15[0].OutputControl																Range Output Control
15	Not used							Inv	Not used		LDW	Type	Not used		ToThisCtr		Range Configuration Flags
16	Range12To15[1].HiLimOrDirWr																Range High Limit or Direct Write Value
17																	
18	Range12To15[1].LowLimit																Range Low Limit
19																	

Table 14 - Output Array - 1769-HSC Module and CMX 5370 L2 Packaged Controller Embedded HSC (Continued)

Word	Bit																Function
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
20	Range12To15[1].OutputControl																Range Output Control
21	Not used							Inv	Not used		LD W	Type	Not used		ToThisCtr		Range Configuration Flags
22	Range12To15[2].HiLimOrDirWr																Range High Limit or Direct Write Value
23																	
24	Range12To15[2].LowLimit																Range Low Limit
25																	
26	Range12To15[2].OutputControl																Range Output Control
27	Not used							Inv	Not used		LD W	Type	Not used		ToThisCtr		Range Configuration Flags
28	Range12To15[3].HiLimOrDirWr																Range High Limit or Direct Write Value
29																	
30	Range12To15[3].LowLimit																Range Low Limit
31																	
32	Range12To15[3].OutputControl																Range Output Control
33	Not used							Inv	Not used		LD W	Type	Not used		ToThisCtr		Range Configuration Flags

Table 15 - Output Array - L23E Packaged Controller Enbedded HSC

Word	Bit																Function
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
0	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Output On Mask
1	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Output Off Mask
2	R3	R2	R1	R0	Not used												Range Enable
3	Not used																Not used
4	Not used								RBF	Not used							Reset Blown Fuse
5	Not used						RPW	RREZ	Z Inh	Z Inv	D Inh	D Inv	RU	RO	SP	En	Counter 0 Control Bits
6	Not used						RPW	RREZ	Z Inh	Z Inv	D Inh	D Inv	RU	RO	SP	En	Counter 1 Control Bits
7	Not used						RPW	Not used				D Inv	RU	RO	SP	En	Counter 2 Control Bits
8	Not used						RPW	Not used				D Inv	RU	RO	SP	En	Counter 3 Control Bits
9	Not used																Not used
10	RangeHighLimit_DWV_0																Range High Limit or Direct Write Value 0
11																	
12	RangeLowLimit_0																Range Low Limit 0
13																	

Table 15 - Output Array - L23E Packaged Controller Enbedded HSC (Continued)

Word	Bit																Function
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
14	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range Output Mask 0
15	Not used							RInv	Not used		LDW		Not used		RCntrNum		Range Configuration Flags 0
16	RangeHighLimit_DWV_1																Range High Limit or Direct Write Value 1
17																	
18	RangeLowLimit_1																Range Low Limit 1
19																	
20	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range Output Mask 1
21	Not used							RInv	Not used		LDW		Not used		RCntrNum		Range Configuration Flags 1
22	RangeHighLimit_DWV_2																Range High Limit or Direct Write Value 2
23																	
24	RangeLowLimit_2																Range Low Limit 2
25																	
26	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range Output Mask 2
27	Not used							RInv	Not used		LDW		Not used		RCntrNum		Range Configuration Flags 2
28	RangeHighLimit_DWV_3																Range High Limit or Direct Write Value 3
29																	
30	RangeLowLimit_3																Range Low Limit 3
31																	
32	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	Range Output Mask 3
33	Not used							RInv	Not used		LDW		Not used		RCntrNum		Range Configuration Flags 3

Output on Mask (OutputOnMask.0 through OutputOnMask.15)

Output Array Word 0	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Output On Mask	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0

This word lets you turn on any output, real or virtual, when the corresponding bit is set. This mask is logically ORed with the range masks but logically ANDed with the Output Off Mask Word described on page 91.

Using the Output On Mask, all of the module's outputs can be turned on directly by the user control program, like discrete outputs. A bit which is set in the mask turns on the corresponding real or virtual output.

See Output Control on page 36 and Output Control Example on page 43 for more information about output determination.

TIP The corresponding Output Off Mask bit must be set to enable this bit.

Output Off Mask (OutputOffMask.0 through OutputOffMask.15)

Output Array Word 1	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Output Off Mask	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0

This word turns OFF any output, real or virtual, when the corresponding bit is reset. This mask has veto power over all the Range masks and the Output On Mask described above. It is logically AND'ed with the results of those masks.

See Output Control on page 36 and Output Control Example on page 43 for more information about output determination.

TIP This mask can be overridden when a safe state is indicated.

Range Enable (RangeEn.0 through RangeEn.15)

Output Array Word 2	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Range Enable	R15	R14	R13	R12	R11	R10	R9	R8	R7	R6	R5	R4	R3	R2	R1	R0

Output Array Word 2	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Range Enable	R3	R2	R1	R0												

When the bit corresponding to the range number is set, Range[*n*].OutputControl is applied whenever the range is active.

RBF - Reset Blown Fuse (ResetBlownFuse)

Output Array Word 4	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Reset Blown Fuse	Not used								RBF	Not used						

When the OvercurrentLatchOff bit is set and an overcurrent condition has occurred, the real output remains off until this bit is cycled from 0 to 1(rising edge).

Control Bits

Output Array Words 5 to 8	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Counter 0 Control Bits (Word 5)	Not used						RPW	RREZ	Z Inh	Z Inv	D Inh	D Inv	RU	RO	SP	En
Counter 1 Control Bits (Word 6)	Not used						RPW	RREZ	Z Inh	Z Inv	D Inh	D Inv	RU	RO	SP	En
Counter 2 Control Bits (Word 7)	Not used						RPW	Not used				D Inv	RU	RO	SP	En
Counter 3 Control Bits (Word 8)	Not used						RPW	Not used				D Inv	RU	RO	SP	En

The control bits for counter (*n*) are described below.

TIP The order of precedence for the Preset and Direct Write actions is as follows:

1. Preset
2. Direct Write

IMPORTANT Setting any of the control bits under certain conditions of the NumberOfCounters value will result in the input error flag, Ctr[*n*].InvalidCounter. For more information, see IC - Invalid Counter (Ctr[1].InvalidCounter to Ctr[3].Invalid Counter) table on page 107.

En - Enable Counter (CtrnEn)

This bit, when set (1), enables the inputs to be counted. When reset (0), this bit inhibits any activity of the A or B inputs from affecting the count, pulse interval, and rate values.

SP - Soft Preset (CtrnSoftPreset)

A 0 to 1 transition of this bit causes counter (*n*) to be preset, changing the count to the value in Ctr*n*Preset.

RCO - Reset Counter Overflow (CtrnResetCounterOverflow)

A 0 to 1 transition of this bit causes the corresponding Ctr[*n*]Overflow bit to be reset.

*RCU - Reset Counter Underflow (Ctr*n*ResetCounterUnderflow)*

A 0 to 1 transition of this bit causes the corresponding Ctr[*n*]Underflow bit to be reset.

*D Inv - Direction Invert (Ctr*n*DirectionInvert)*

This bit, when set, inverts the direction of the counter (*n*) as follows:

- If the Ctr*n*DirectionInhibit bit is set when this bit is 0, the resulting direction is up, increasing counts.
- If the Ctr*n*DirectionInhibit bit is set when this bit is 1, the resulting direction is down, decreasing counts.

*D Inh - Direction Inhibit (Ctr*n*DirectionInhibit)*

This bit, when set, inhibits the direction of the input signal from being used by the module.

*Z Inv - Z Invert (Ctr*n*ZInvert)*

When set, this bit inverts the Z*n* value. The Z*n* value is also affected by the Ctr*n*ZInhibit bit. If the Ctr*n*ZInhibit is set, the module uses Ctr*n*ZInvert for all internal Z activities, preset, hold and store. Input state Z*n* is not affected by this bit.

*Z Inh - Z Inhibit (Ctr*n*ZInhibit)*

When set, this bit inhibits the Z*n* state from being used by the module. However, even if the counter is inhibited, it still will count the pulses at input. For example, if the counter is inhibited with count of 10 and there are 10 more pulses after which it was un-inhibited, then the current count instead of starting with 11 will be 21 for the next pulse.

*RREZ - Reset Rising Edge Z (Ctr*n*ResetRisingEdgeZ)*

A 0 to 1 transition causes the Ctr[*n*].RisingEdgeZ bit to be reset.

*RPW - Reset Counter Preset Warning (Ctr*n*ResetCtrPresetWarning)*

A 0 to 1 transition causes the Ctr[*n*]PresetWarning bit to be reset.

Range High Limit or Direct Write Value (Range12To15[*n*].HiLimOrDirWr)

IMPORTANT For the L23E packaged controllers embedded HSC, the ranges referred to in this section are numbered 0…3 instead of 12…15. The ranges in this section apply to only the 1769-HSC module and the CMX 5370 L2 packaged controllers embedded HSC.

Output Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
10 and 11	Range 12 High Limit Direct Write Value	Range12To15[0].HiLimOrDirWr															
16 and 17	Range 13 High Limit Direct Write Value	Range12To15[1].HiLimOrDirWr															
22 and 23	Range 14 High Limit Direct Write Value	Range12To15[2].HiLimOrDirWr															
28 and 29	Range 15 High Limit Direct Write Value	Range12To15[3].HiLimOrDirWr															

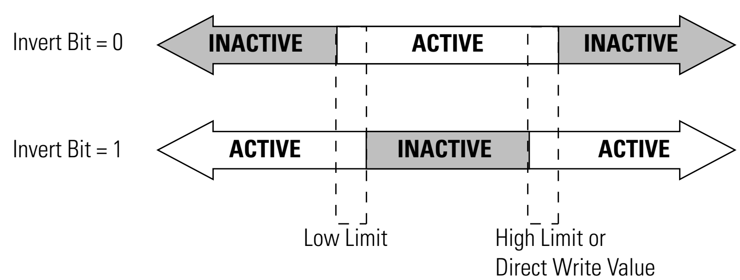
This value can be used in one of two ways, depending on the setting of the Load Direct Write (Range12To15[*n*].LoadDirectWrite) bit.

When Load Direct Write = 0

When Range12To15[*n*].LoadDirectWrite = 0, then Range12To15[*n*].HiLimOrDirWr is used in the range comparison (range represents a count value or a rate value according to the programmed range type, Range12To15[*n*].Type).

When the range value is equal to Range12To15[*n*].HiLimOrDirWr, Range*n* will change state. The range will become active or inactive depending on the Range12To15[*n*].Invert bit.

Range Value (Current Count or Current Rate)



TIP Range12To15[*n*].HiLimOrDirWr must be higher than the Range12To15[*n*].LowLimit or the InvalidRangeLimitn error flag in the input array will be set.

TIP Range12To15[*n*].HiLimOrDirWr can be higher than the maximum rate or count value. For example, when the object value is a rate, Range12To15[*n*].HiLimOrDirWr can be programmed in excess of 1,000,000 with no configuration error.

When Load Direct Write = 1

When Range12To15[*n*].LoadDirectWrite = 1, then Range12To15[*n*].HiLimOrDirWr is used to change the Ctr[*n*].CurrentCount to Range12To15[*n*].HiLimOrDirWr.

When the Range12To15[*n*].LoadDirectWrite bit transitions from 0 to 1, then Range12To15[*n*].HiLimOrDirWr is loaded into Ctr[*n*].CurrentCount (where *n* is the counter indicated in Range12To15[*n*].ToThisCounter).

TIP When Ctr*n*SoftPreset and a Range12To15[*n*].LoadDirectWrite to counter n are indicated at the same time, only the CtrnSoftPreset will occur. When more than one range indicates a Range12To15[*n*].LoadDirectWrite to a single counter, only the one from the lowest designated range will take effect.

Range Low Limit (Range12To15[*n*].LowLimit)

IMPORTANT For the L23E packaged controllers embedded HSC, the ranges referred to in this section are numbered 0…3 instead of 12…15. The ranges in this section apply to only the 1769-HSC module and the CMX 5370 L2 packaged controllers embedded HSC.

Output Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
12 and 13	Range 12 Low Limit	Range12To15[0].LowLimit															
18 and 19	Range 13 Low Limit	Range12To15[1].LowLimit															
24 and 25	Range 14 Low Limit	Range12To15[2].LowLimit															
30 and 31	Range 15 Low Limit	Range12To15[3].LowLimit															

This value is used in the range comparison. It is the complement of the Range12To15[*n*].HiLimOrDirWr value in setting the compare window.

When the rate or count value is equal to Range12To15[*n*].LowLimit, the range will change state – opposite of the action at Range12To15[*n*].HiLimOrDirWr. The range will become active or inactive depending on the Range12To15[*n*].Invert bit.

TIP Range12To15[*n*].LowLimit must be lower than the Range12To15[*n*].HiLimOrDirWr or the InvalidRangeLimit*n* error flag in the input array will be set.

TIP Like Range12To15[*n*].HiLimOrDirWr Range12To15[*n*].LowLimit can extend beyond the minimum rate or count value.

TIP When Range12To15[*n*].LoadDirectWrite is set, Range12To15[*n*].LowLimit is ignored.

Range Output Control (Range12To15[*n*].OutputControl)

IMPORTANT	For the L23E packaged controllers embedded HSC, the ranges referred to in this section are numbered 0…3 instead of 12…15. The ranges in this section apply to only the 1769-HSC module and the CMX 5370 L2 packaged controllers embedded HSC.

Output Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
14	Range 12 Output Control	Range12To15[0].OutputControl															
20	Range 13 Output Control	Range12To15[1].OutputControl															
26	Range 14 Output Control	Range12To15[2].OutputControl															
32	Range 15 Output Control	Range12To15[3].OutputControl															

This 16-bit word indicates which outputs should be on (corresponding bit set in this word) when a range is active. When Range*n* is enabled and active, Range12To15[*n*].OutputControl will be logically OR'ed with other Range12To15[*n*].OutputControl masks and the OutputOnMask.*n* and so forth., as described on page 89.

When Range12To15[*n*].LoadDirectWrite is set, Range12To15[*n*].OutputControl is ignored.

Range Configuration Flags (12To15)

IMPORTANT	For the L23E packaged controllers embedded HSC, the ranges referred to in this section are numbered 0…3 instead of 12…15. The ranges in this section apply to only the 1769-HSC module and the CMX 5370 L2 packaged controllers embedded HSC.

Output Array Words		15	14	13	12	11	10	09	08	07	06	05	04(1)	03	02	01	00
15	Range 12 Configuration Flags	Not used							Inv	Not used		LDW	Type	Not used		ToThisCtr	
21	Range 13 Configuration Flags	Not used							Inv	Not used		LDW	Type	Not used		ToThisCtr	
27	Range 14 Configuration Flags	Not used							Inv	Not used		LDW	Type	Not used		ToThisCtr	
33	Range 15 Configuration Flags	Not used							Inv	Not used		LDW	Type	Not used		ToThisCtr	

(1) Bit 04 is not used for the packaged controller.

ToThisCtr - Range Counter Number (Range12To15[n].ToThisCounter)

This 2-bit value indicates which counter will be used in the range comparison or Range12To15[*n*].LoadDirectWrite. The counter is indicated in the table below.

Bit 01	Bit 00	Counter
0	0	0
0	1	1
1	0	2
1	1	3

If Range12To15[*n*].ToThisCounter is set to a number larger than NumberOfCounters in the configuration array, then the InvalidCtrAssignToRange*n* error bit in the input array will be set.

Type - RangeType (Range12To15[n].Type)

IMPORTANT	For the L23E packaged controllers embedded HSC, the range type is fixed at 0, which sets the range type to count value. The ranges in this section apply to only the 1769-HSC module and the CMX 5370 L2 packaged controllers embedded HSC.

This bit value indicates which type of value to use for the range comparison in Range. That is, the Range12To15[*n*].ToThisCounter, from above, and this Range12To15[*n*].Type value determine the rate or count value, the current value which is compared to, for the range comparison. The type of value is indicated as follows:

- 0 = Count Value
- 1 = Rate Value

When Range12To15[*n*].LoadDirectWrite is set Range12To15[*n*]. Type is ignored.

LDW - Load Direct Write (Range12To15[n].LoadDirectWrite)

A 0 to 1 transition of this bit causes counter (*n*)'s current count value to change to the value of Range12To15[*n*].HiLimOrDirWr.

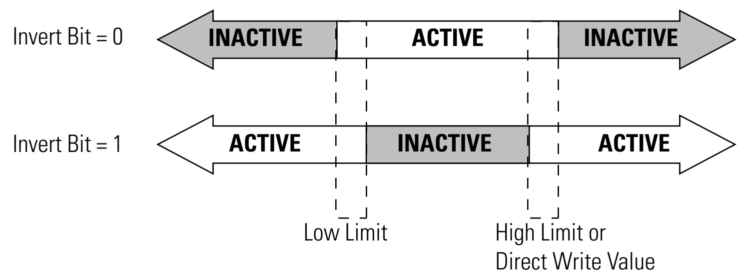
IMPORTANT	The write occurs according to the internal timings of the module and the system. For the most predictable results, the counter should be disabled or stopped while performing this action.

IMPORTANT	If both CtrnSoftPreset and Range12To15[*n*].HiLimOrDirWr transition to 1 during the same Output Array update, only the CtrnSoftPreset occurs. Range12To15[*n*].HiLimOrDirWr is ignored.

Inv - Range Invert (Range12To15[n].Invert)

Indicates the active portion of Range*n*. When Range12To15[*n*].Invert = 0, the outputs are activated when the range value is at or between the Range12To15[*n*].LowLimit and Range12To15[*n*].HiLimOrDirWr. When Range12To15[*n*].Invert = 1, the outputs are activated when the range is at or outside the range limits.

Object Value (Current Count or Current Rate)



Input Array

The input array, which consists of 35 words, allows read-only access to the module's input data via word and bit access. The input array is described below. The functions are described in more detail in the sections following the table.

IMPORTANT	During the non-run states (program and fault), the module continues to update the input array (continues counting). Depending on the bus master, you may not see this.

TIP	Status bits for a particular counter reflect the configuration settings for that counter. To receive valid status, the counter must be enabled and the module must have stored a valid configuration for that counter.

Table 16 - Input Array - 1769-HSC Module and CMX 5370 L2 Packaged Controller Embedded HSC

Word	Bit																Function
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
0	Not used										Z1	B1	A1	Z0	B0	A0	Input State
1	Readback.0 through Readback.15																Readback
2	InvalidRangeLimit12 through InvalidRangeLimit15				InvalidCtrAssignToRange12 through InvalidCtrAssignToRange15				Gen Error	Invalid Output	Mod Config	Not used	Out0Overcurrent through Out3Overcurrent				Status Flags
3	RangeActive.0 through RangeActive.15																Range Active
4	Ctr[0].CurrentCount																Counter 0 Current Count
5																	
6	Ctr[0].StoredCount																Counter 0 Stored Count
7																	

Table 16 - Input Array - 1769-HSC Module and CMX 5370 L2 Packaged Controller Embedded HSC (Continued)

Word	Bit																Function
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
8	Ctr[0].CurrentRate																Counter 0 Current Rate
9																	
10	Ctr[0].PulseInterval																Counter 0 Pulse Interval
11																	
12	Not used									C0PW	RV	Not used	IDW	REZ	CUdf	COvf	Counter 0 Status Flags
13	Not used																Not used
14	Ctr[1].CurrentCount																Counter 1 Current Count
15																	
16	Ctr[1].StoredCount																Counter 1 Stored Count
17																	
18	Ctr[1].CurrentRate																Counter 1 Current Rate
19																	
20	Ctr[1].PulseInterval																Counter 1 Pulse Interval
21																	
22	Not used									C1PW	RV	IC	IDW	REZ	CUdf	COvf	Counter 1 Status Flags
23	Not used																Not used
24	Ctr[2].CurrentCount																Counter 2 Current Count
25																	
26	Ctr[2].CurrentRate																Counter 2 Current Rate
27																	
28	Not used									C2PW	RV	IC	IDW	Not used	CUdf	COvf	Counter 2 Status Flags
29	Not used																Not used
30	Ctr[3].CurrentCount																Counter 3 Current Count
31																	
32	Ctr[3].CurrentRate																Counter 3 Current Rate
33																	
34	Not used									C3PW	RV	IC	IDW	Not used	CUdf	COvf	Counter 3 Status Flags

Table 17 - Input Array - L23E Packaged Controller Enbedded HSC

Word	Bit																Function
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
0	Not used										Z1	B1	A1	Z0	B0	A0	Input State
1	Out 15	Out 14	Out 13	Out 12	Out 11	Out 10	Out 9	Out 8	Out 7	Out 6	Out 5	Out 4	Out 3	Out 2	Out 1	Out 0	DataEcho
2	BadRangeLimit 3…0				BadRangeCtrNum3…0				ERR	UBS	MCfg		OverCurFdbck Output03…0				Status Flags
3	R3	R2	R1	R0	Not used												Range Active
4	PresentCount_0																PresentCount_0
5																	
6	StoredValue_0																StoredValue_0
7																	
8	Not used																Not used
9																	
10	Not used																Not used
11																	
12	Not used									C0PW	Not used	Not used	BDW	REZ	CUdf	COvf	Counter 0 Status Flags
13	Not used																Not used
14	PresentCount_1																PresentCount_1
15																	
16	StoredValue_1																StoredValue_1
17																	
18	Not used																Not used
19																	
20	Not used																Not used
21																	
22	Not used									C1PW	Not used	CNE	BDW	REZ	CUdf	COvf	Counter 1 Status Flags
23	Not used																Not used
24	PresentCount_2																PresentCount_2
25																	
26	Not used																Not used
27																	
28	Not used									C2PW	RV	IC	BDW		CUdf	COvf	Counter 2 Status Flags
29	Not used																Not used
30	PresentCount_3																PresentCount_3
31																	

Table 17 - Input Array - L23E Packaged Controller Enbedded HSC (Continued)

Word	Bit																Function
	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00	
32	Not used																Not used
33																	
34	Not used									C3PW	RV	IC	ID W		CUdf	COvf	Counter 3 Status Flags

Input State (InputStateA0 through InputStateZ1)

Input Array Word 0	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Input State	Not used										Z1	B1	A1	Z0	B0	A0

This word indicates the state of the real (physical) inputs after filtering.

- 1 = On
- 0 = Off

Readback (Readback.0 through Readback.15)

Input Array Word 1	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Readback	Readback.0 through Readback.15															

This input word reflects the counter's module-directed status of all 16 outputs, real and virtual.

- 1 = On
- 0 = Off

Status Flags

IMPORTANT	For the L23E packaged controllers embedded HSC, the ranges referred to in this section are numbered 0…3 instead of 12…15. The ranges in this section apply to only the 1769-HSC module and the CMX 5370 L2 packaged controllers embedded HSC.

Input Array Word 2	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Status Flags	InvalidRangeLimit12 through InvalidRangeLimit15				InvalidCtrAssignToRange12 through InvalidCtrAssignToRange15				Gen Error	Invalid Output	Mod Config	Not used	Out0Overcurrent through Out3Overcurrent			

Output Overcurrent (Out0Overcurrent to Out3OverCurrent)

The output overcurrent bits are set (1) when the module is in an overcurrent condition. These bits also show whether the output is latched off, because the output remains in the off state and these bits remain on until the ResetBlownFuse bit is used.

Module Configured (ModConfig)

Word 2, bit 5 is set by the module after it has accepted all of the configuration data. When set (1), this bit confirms that the module received and accepted valid configuration data. When reset (0), this bit indicates that the module still is checking for errors or contains errors and the old configuration is still being used.

TIP The module takes up to two seconds to validate configuration data.

Invalid Output (InvalidOutput)

- 1 = an unused bit in the output array is set
- 0 = no unused bits in the output array are set

When this error occurs, the entire output array is rejected until an output array that does not have this error is sent.

Error (GenError)

When this bit is set (1), it indicates one or more of the following errors for the input array:

- Out*n*Overcurrent
- InvalidRangeLimit*n*
- InvalidCtrAssignToRange*n*
- InvalidOutput
- Ctr[*n*].Overflow
- Ctr[*n*].Underflow
- Ctr[*n*].InvalidDirectWrite
- Ctr[*n*].InvalidCounter
- Ctr[*n*].PresetWarning

where *n* indicates the counter number.

To determine which error has set the GenError bit, identify which bit is set. This could be done by using a subroutine to examine these bits in the input array.

TIP Ctr[*n*].RateValid does not set the GenError bit.

Invalid Counter Assigned to Range (InvalidCtrAssignToRange12 through InvalidCtrAssignToRange15)

InvalidCtrAssignToRange12 is set when the indicated range in the output array refers to a non-existent counter.

- It is set (1) when Range12To15[*n*].ToThisCounter > NumberOfCounters.
- It is cleared (0) when Range12To15[*n*].ToThisCounter ≤ NumberOfCounters.

When this error occurs, the entire output array is rejected until a valid configuration is detected.

Invalid Range Limit (InvalidRangeLimit12 through InvalidRangeLimit15)

This bit is set when the range limits are invalid according to the limitations indicated in Range12To15[*n*].HiLimOrDirWr and Range12To15[*n*].LowLimit in the output array.

- 1 = Range limits are invalid.
- 0 = no error

When this error occurs, the entire output array is rejected until a valid configuration is detected.

Range Active (RangeActive.0 through RangeActive.15)

Input Array Word 3	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Range Active	RangeActive.0 through RangeActive.15															

Input Array Word 3	15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
Range Active	RA3	RA2	RA1	RA0												

This word reflects the status of all of the ranges. When a count or rate meets the criteria programmed for a given range, the range is active.

- 1 = active
- 0 = inactive/false

TIP When the range is enabled and active, the output mask for that range is applied.

Current Count (Ctr[*n*].CurrentCount)

Input Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
4	Counter 0 Current Count	Ctr[0].CurrentCount															
5																	
14	Counter 1 Current Count	Ctr[1].CurrentCount															
15																	
24	Counter 2 Current Count	Ctr[2].CurrentCount															
25																	
30	Counter 3 Current Count	Ctr[3].CurrentCount															
31																	

This is the 32-bit count value from the counter.

Stored Count (Ctr[*n*].StoredCount)

Input Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
6	Counter 0 Stored Count	Ctr[0].StoredCount															
7																	
16	Counter 1 Stored Count	Ctr[1].StoredCount															
17																	

This is the last stored 32-bit value from counter (*n*). The count value is stored depending on the Ctr*n*Config.StorageMode and Z*n* inputs.

When a storage event occurs, the Ctr[*n*].RisingEdgeZ bit is set, indicating that the value is new. If more than one Z*n* occurs before the Ctr[*n*].RisingEdgeZ bit is reset (using the Ctr*n*ResetRisingEdgeZ bit), the Ctr[*n*].StoredCount word will contain only the last Ctr[*n*].StoredCount value. There is no indication that the data has been overwritten.

Current Rate (Ctr[0].CurrentRate to Ctr[3].CurrentRate)

IMPORTANT	For the L23E packaged controllers embedded HSC, the current rate words do not apply; they are always returned as 0 in the input array. The rate words in this section apply to the 1769-HSC module and the CMX 5370 L2 packaged controllers embedded HSC.

Input Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
8	Counter 0 Current Rate	Ctr[0].CurrentRate															
9																	
18	Counter 1 Current Rate	Ctr[1].CurrentRate															
19																	
26	Counter 2 Current Rate	Ctr[2].CurrentRate															
27																	
32	Counter 3 Current Rate	Ctr[3].CurrentRate															
33																	

This 32-bit value is the current rate value, scaled by Ctr*n*Scalar, from the counter. This uses the Cyclic Rate Calculation Method. See page 32 for more information.

Rate-based ranges use this value for comparisons, even when the Ctr[*n*].RateValid bit is zero.

IMPORTANT	This value is current only when the Ctr[n].RateValid bit is set (1).

Pulse Interval (Ctr[0].PulseInterval and Ctr[1].PulseInterval)

IMPORTANT	For the L23E packaged controllers embedded HSC, the pulse interval words do not apply; they are always returned as 0 in the input array. The pulse interval words in this section apply to the 1769-HSC module and the CMX 5370 L2 packaged controllers embedded HSC.

Input Array Words		15	14	13	12	11	10	09	08	07	06	05	04	03	02	01	00
10	Counter 0 Pulse Interval	Ctr[0].PulseInterval															
11																	
20	Counter 1 Pulse Interval	Ctr[1].PulseInterval															
21																	

This is the time, in microseconds, between the last two pulses for the counter. The pulses indicated here are those transitions on which the count value can change. For example, in quadrature X1 mode, these are the successive rising edges of A only.

If more than two pulses have occurred since the value was last read, the value indicates only the time between the **last two pulses** that have been processed.

Status Flags

Input Array Words		15	14	13	12	11	10	09	08	07	06	05(1)	04	03	02	01	00
12	Counter 0 Status Flags	Not used									C0PW	RV	Not used	IDW	REZ	CUdf	COvf
22	Counter 1 Status Flags	Not used									C1PW	RV	IC	IDW	REZ	CUdf	COvf
28	Counter 2 Status Flags	Not used									C2PW	RV	IC	IDW	Not used	CUdf	COvf
34	Counter 3 Status Flags	Not used									C3PW	RV	IC	IDW		CUdf	COvf

(1) Bit 05 is not used for the packaged controller.

The status bits for the counter (*n*) are described below.

COvf - Count Overflow (Ctr[0].Overflow to Ctr[3].Overflow)

For linear counters, this bit is set when the counter is, or has been, in an overflow condition. For ring counters, this bit is set when the counter has rolled over. COvf is reset when the Ctr*n*ResetCountOverflow bit transitions from 0 to 1.

See Counter Types on page 28 for more information about linear and ring counters.

CUdf - Count Underflow (Ctr[0].Underflow to Ctr[3].Underflow)

For linear counters, this bit is set when the counter is, or has been, in an underflow condition. For ring counters, this bit is set when the counter has rolled under. CUdf is reset when the Ctr*n*ResetCountUnderflow bit transitions from 0 to 1.

See Counter Types on page 28 for more information about linear and ring counters.

REZ - Rising Edge Z (Ctr[0].RisingEdgeZ to Ctr[1].RisingEdgeZ)

This bit is set (1) when Z*n*, as modified by the Ctr*n*ZInvert and Ctr*n*ZInhibit bits, has a rising edge. It is reset (0) by a 0 to 1 transition of the Ctr*n*ResetRisingEdgeZ bit in the output array. *N* is equal to 0 or 1 depending upon which input is used, Z0 or Z1.

IDW - Invalid Direct Write (Ctr[0].InvalidDirectWrite to Ctr[3].InvalidDirectWrite)

IMPORTANT	For the L23E packaged controllers Embedded HSC, the ranges referred to in this section are numbered 0…3 instead of 12…15. The ranges in this section apply to only the 1769-HSC module and the CMX 5370 L2 packaged controllers Embedded HSC.

This bit is set when the Range12To15[*n*].HiLimOrDirWr is invalid. (For example, if Ctr*n*MaxCount < Range12To15[*n*].HiLimOrDirWr or Range12To15[*n*].HiLimOrDirWr < Ctr*n*MinCount.)

When this error occurs, the entire output array is rejected until a valid configuration is detected.

IC - Invalid Counter (Ctr[1].InvalidCounter to Ctr[3].Invalid Counter)

When set (1) this bit indicates that an invalid control bit is set for the counter. Depending on the value of NumberOfCounters, the following errors will occur:

- If NumberOfCounters < 1, then setting one of the control bits for Counter 1 will result in input error flag Ctr[1].InvalidCounter.
- If NumberOfCounters < 2, then setting one of the control bits for Counter 2 will result in input error flag Ctr[2].InvalidCounter.
- If NumberOfCounters < 3, then setting one of the control bits for Counter 3 will result in input error flag Ctr[3].InvalidCounter.

When this error occurs, the entire output array is rejected until an output array that does not have this error is sent.

The control bits are shown on page 92.

RV - Rate Valid (Ctr[0].RateValid to Ctr[3].RateValid)

IMPORTANT	For the L23E packaged controllers Embedded HSC, the RV value does not apply; they are not used and are always set to 0. The RV values in this section apply to the 1769-HSC module and the CMX 5370 L2 packaged controllers Embedded HSC.

This bit is set (1) when the rate value indicated in Ctr[*n*].CurrentRate is current. When this bit is reset (0), Ctr[*n*].CurrentRate is frozen at the last known good value.

This bit is reset when the Ctr[*n*].Overflow or Ctr[*n*].Underflow bits have been set during the last Ctr*n*CyclicRateUpdateTime period.

See page 34 for more Rate Valid reset conditions.

CnPW - Counter Preset Warning (Ctr[0].PresetWarning to Ctr[3].PresetWarning)

This bit is set when Ctr[*n*].CurrentCount has been forced by the module to the Ctr*n*Preset value. This will happen when a configuration array is accepted, which sets the following:

- Ctr*n*MinCount > Ctr[*n*].CurrentCount

  or

- Ctr*n*MaxCount < Ctr[*n*].CurrentCount.

This bit is reset by a 0 to 1 transition of the Ctr*n*ResetCtrPresetWarning bit in the output array.

TIP You must manually reset CnPW, COvf, CUdf and REZ (but not IDW, RV or IC) to enable them to be set again.

Diagnostics and Troubleshooting

This chapter describes how to troubleshoot the module.

Safety Considerations

Safety considerations are an important element of proper troubleshooting procedures. Actively thinking about the safety of yourself and others, as well as the condition of your equipment, is of primary importance.

The following sections describe several safety concerns you should be aware of when troubleshooting your control system.

ATTENTION: Never reach into a machine to actuate a switch because unexpected motion can occur and cause injury.

Remove all electrical power at the main power disconnect switches before checking electrical connections or inputs/outputs causing machine motion.

Status Indicators

When any status indicator on the module is illuminated, it indicates that power is applied to the module.

Stand Clear of the Machine

When troubleshooting any system problem, have all personnel remain clear of the machine. The problem could be intermittent, and sudden unexpected machine motion could occur. Have someone ready to operate an emergency stop switch in case it becomes necessary to shut off power to the machine.

Program Alteration

There are several possible causes of alteration to the user program, including extreme environmental conditions, Electromagnetic Interference (EMI), improper grounding, improper wiring connections, and unauthorized tampering. If you suspect a program has been altered, check it against a previously saved program on an EEPROM or UVPROM memory module.

Safety Circuits

Circuits installed on the machine for safety reasons, like over-travel limit switches, stop push buttons, and interlocks, should always be hard-wired to the master control relay. These devices must be wired in series so that when any one device opens, the master control relay is de-energized, thereby removing power to the machine. Never alter these circuits to defeat their function. Serious injury or machine damage could result.

Module Operation versus Counter Operation

The module performs operations at two levels:

- Module level
- Counter level

Module-level operations include functions, such as powerup, configuration, and communication with a bus master, such as a MicroLogix 1500 controller.

Counter-level operations include counter-related functions, such as data conversion and overflow or underflow detection.

Internal diagnostics are performed at both levels of operation. When detected, module error conditions are immediately indicated by the module status indicator. Both module hardware and configuration error conditions are reported to the controller. Counter overflow or underflow conditions are reported in the module's input data table. Module hardware errors are typically reported in the controller's I/O status file. Refer to your controller manual for details.

Counter Defaults

When the module powers up, all output array and configuration array values are set to their default values. See page 66 in Chapter 4 or Appendix D on page 149 for default values. All input array values are cleared. None of the module data is retained through a power cycle.

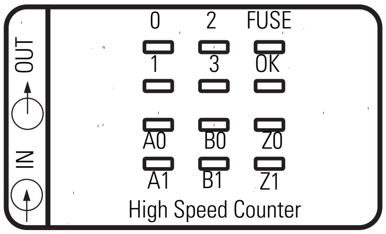
In effect, this means that power cycling clears the module with these results:

- Stored counts are lost.
- Faults and flags are cleared.
- Outputs are off.

The bus master will attempt to write program data to the output array and configuration array.

Module Diagnostics

The 176-HSC module offers power-up, configuration, and post configuration diagnostics.



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Power-up Diagnostics

At module powerup, a series of internal diagnostic tests are performed. These diagnostic tests must be successfully completed or the OK status indicator remains off and a module error results and is reported to the controller.

Table 18 - Diagnostic Indicators

Indicator	Color	Indicates
0 OUT	Amber	ON/OFF logic status of output 0
1 OUT	Amber	ON/OFF logic status of output 1
2 OUT	Amber	ON/OFF logic status of output 2
3 OUT	Amber	ON/OFF logic status of output 3
FUSE	Red	Overcurrent
OK	Off	No power is applied.
	Red (briefly)	Performing self-test.
	Solid Green	OK, normal operating condition.
	Flashing Green	OK, module in Program or Fault mode.
	Solid Red or Amber	Hardware error. Cycle power to the module. If problem persists, replace the module.
	Flashing Red	Recoverable fault. Reconfigure, reset, or perform error recovery. See Non-critical versus Critical Module Errors on page 113. The OK status indicator flashes red for all of the error codes in the Configuration Error Codes table on page 117.
A0	Amber	ON/OFF status of input A0
A1	Amber	ON/OFF status of input A1
B0	Amber	ON/OFF status of input B0
B1	Amber	ON/OFF status of input B1
Z0	Amber	ON/OFF status of input Z0
Z1	Amber	ON/OFF status of input Z1
ALL ON	Possible causes for all status indicators to be on include the following: • Bus Error has occurred: Controller hard fault. Cycle power. • During upgrade of controller: Normal. Do not cycle power during the upgrade. • All status indicators will flash on briefly during power-up. This is normal.	

Configuration Diagnostics

When a configuration is sent, the module performs a diagnostic check to see that the configuration is valid. This results in either a valid ModConfig bit or module configuration error. See the Configuration Error Codes table on page 117 for configuration error codes.

Post Configuration Diagnostics

If the ModConfig bit in the input array is set, then the module has accepted the configuration. Now, on every scan, each channel status flag in the input array is examined. The output array is checked on each scan for compatibility with the configuration array.

Non-critical versus Critical Module Errors

The 1769-HSC module has non-critical and critical errors.

Non-critical Errors

Non-critical module errors are typically recoverable. Non-critical error conditions are indicated by the extended error code. See the Configuration Error Codes table on page 117 for more information.

TIP The OK status indicator will be in a flashing red state for all of the error codes in the Configuration Error Codes table on page 117.

Critical Errors

Critical module errors are conditions that prevent normal or recoverable operation of the system. When these types of errors occur, the system typically leaves the Run or Program mode and enters the fault mode of operation until the error can be dealt with. Critical module errors are indicated in the General Common Hardware Error Codes table on page 116.

Module Error Definition

Module errors are expressed in two fields as four-digit Hex format, with the most significant digit as 'don't care' and irrelevant. The two fields are 'Module Error' and 'Extended Error Information'. The structure of the module error data is shown in Table 19.

Table 19 - Module Error Definition

'Don't Care' Bits				Module Error			Extended Error Information								
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hex Digit 4				Hex Digit 3				Hex Digit 2				Hex Digit 1			

Module Error Field

The purpose of the module error field is to classify module errors into three distinct groups, as described in Table 20. The type of error determines what kind of information exists in the extended error information field. These types of module errors are typically reported in the controller's I/O status file. Refer to your controller manual for details.

Table 20 - Module Error Types

Error Type	Module Error Field Value Bits 11 through 09 (Binary)	Description
No Errors	000	No error is present. The extended error field holds no additional information.
Hardware Errors	001	General and specific hardware error codes are specified in the extended error information field.
Configuration Errors	010	Module-specific error codes are indicated in the extended error field. These error codes correspond to options that you can change directly. For example, the input range or input filter selection.

Extended Error Information Field

Check the extended error information field when a non-zero value is present in the module error field. Depending upon the value in the module error field, the extended error information field can contain error codes that are module-specific or common to all 1769 modules.

TIP If no errors are present in the module error field, the extended error information field will be set to zero.

Hardware Errors

General or module-specific hardware errors are indicated by module error code 1. See the General Common Hardware Error Codes table on page 116 for more information.

Configuration Errors

If you set the fields in the configuration file to invalid or unsupported values, the module ignores the invalid configuration, generates a non-critical error, and keeps operating with the previous configuration.

The Configuration Error Codes table on page 117 lists the possible module-specific configuration error codes defined for the module. Correct the error by providing proper configuration data to the module.

Table 21 describes configuration errors in more general terms.

Table 21 - Error Conditions by Type of Configuration

Programming Words	Error Conditions
General Configuration Bits, Filters and Safe State Words	• Unused or Reserved bit were set. • A counter or counters were running when the general configuration bits or filter and safe state words were sent.
Counter Configuration	• Unused or Reserved bit were set. • Operational Mode is invalid for the counter. (NumberOfCounters may be incorrect.) • Operational Mode is invalid for the counter. (mode selection may be incorrect). • The selected counter was running when the configuration was sent. • Ctr*n*MaxCount ≤ Ctr*n*MinCount • Ctr*n*Hysteresis < 0[1] • Ctr*n*Scalar < 1[1] • Ctr*n*CyclicRateUpdateTime < 1[1] • The preset value is outside its valid range. (Ctr*n*Preset not equal to or between Ctr*n*MinCount or Ctr*n*MaxCount) • Counter was running when the minimum/maximum count value was changed.
Range Configuration	• Unused or Reserved bit were set. • Range0to11[*n*].HighLimit ≤ Range0to11[*n*].LowLimit[1] • Range0To11[*n*].ToThisCounter refers to a non-declared counter (Range0To11[*n*].ToThisCounter > NumberOfCounters)[1]

(1) Does not apply to the packaged controller.

Error Codes

The tables in this section explain the extended error codes for general common hardware errors, configuration errors, and runtime errors.

Table 22 - General Common Hardware Error Codes

Error Type	Hex Equivalent(1)	Module Error Code	Extended Error Information Code	Description	Status of the OK Indicator(2)
		Binary	Binary		
No Error	X000	000	0 0000 0000	OK, normal operating condition.	Solid or flashing green
General Common Hardware Error	X200	001	0 0000 0000	General hardware error; no additional information	Solid red
	X201	001	0 0000 0001	Power-up reset state	Briefly red
	X202	001	0 0000 0010	Bus master incompatibility	Solid red
	X203	001	0 0000 0011	General hardware error	Solid red
	X210	001	0 0000 1010	General microprocessor error	Solid red
	X211	001	0 0000 1011	Microprocessor internal register error	Solid red
	X212	001	0 0000 1100	Microprocessor special function register error	Solid red
	X213	001	0 0000 1101	Microprocessor internal memory error	Solid red
	X214	001	0 0000 1110	Microprocessor timer error	Solid red
	X215	001	0 0000 1111	Microprocessor interrupt error	Solid red
	X216	001	0 0001 0000	Microprocessor watchdog error	Solid red
	X220	001	0 0001 1000	Firmware corrupt	Solid red
	X221	001	0 0001 1001	Firmware checksum error in non-volatile RAM	Solid red
	X222	001	0 0001 1010	Firmware checksum error in RAM	Solid red
	X230	001	0 0001 1110	External RAM test error	Solid red
	X231	001	0 0001 1111	External RAM cell test error	Solid red
	X240	001	0 0010 0100	Gate array loading failed	Solid red
	X250	001	0 0011 0010	External watchdog error	Solid red

(1) X represents the 'Don't Care' digit.

(2) See the Diagnostic Indicators table on page 112 for recommendation based on status indicator operation.

TIP The OK status indicator flashes red for all error codes in the Configuration Error Codes table.

IMPORTANT Only error codes X400…X443 apply to the packaged controller.

Table 23 - Configuration Error Codes

Hex Equivalent[1]	Module Error Code	Extended Error Information Code	Error	Description
	Binary	Binary		
X400	010	0 0000 0000	General Configuration Error	No additional information
X401	010	0 0000 0001	UnusedConfigBitSet	One or more of the unused module configuration bits are set.
X402	010	0 0000 0010	BadModConfigUpdate	Occurs when you attempt to change a forbidden module configuration parameter while a counter or range is still enabled. See Table 24 on page 120 for a list of the forbidden parameters.
X411	010	0 0001 0001	BadCounterNum_1	Nonzero configuration values were entered for Counter 1, when Counter 1 was not available.
X412	010	0 0001 0010	BadCounterNum_2	Nonzero configuration values were entered for Counter 2, when Counter 2 was not available.
X413	010	0 0001 0011	BadCounterNum_3	Nonzero configuration values were entered for Counter 3, when Counter 3 was not available.
X420	010	0 0010 0000	BadCounterMode_0	Operation Mode_0 is set to an invalid value. For example, value is reserved (011 or 111) or nonzero when NumberofCounters = 11.
X421	010	0 0010 0001	BadCounterMode_1	Operation Mode_1 is set to an invalid value. For example, value is reserved (011 or 111) or nonzero when NumberofCounters = 10 or 11.
X430	010	0 0011 0000	BadMin_0	Programmed Ctr0MinCount is greater than the Ctr0MaxCount.
X431	010	0 0011 0001	BadMin_1	Programmed Ctr1MinCount is greater than the Ctr1MinCount.
X432	010	0 0011 0010	BadMin_2	Programmed Ctr2MinCount is greater than the Ctr2MaxCount.
X433	010	0 0011 0011	BadMin_3	Programmed Ctr3MinCount is greater than the Ctr3MaxCount.
X440	010	0 0100 0000	BadPreset_0	The programmed Ctr0Preset is greater than the Ctr0MaxCount or less than the Ctr0MinCount.
X441	010	0 0100 0001	BadPreset_1	The programmed Ctr1Preset is greater than the Ctr1MaxCount or less than the Ctr1MinCount.
X442	010	0 0100 0010	BadPreset_2	The programmed Ctr2Preset is greater than the Ctr2MaxCount or less than the Ctr2MinCount.
X443	010	0 0100 0011	BadPreset_3	The programmed Ctr3Preset is greater than the Ctr3MaxCount or less than the Ctr3MinCount.
X450	010	0 0101 0000	BadHysteresis_0	The Ctr0Hysteresis value is invalid, that is, less than zero.
X451	010	0 0101 0001	BadHysteresis_1	The Ctr1Hysteresis value is invalid, that is, less than zero.
X452	010	0 0101 0010	BadHysteresis_2	The Ctr2Hysteresis value is invalid, that is, less than zero.
X453	010	0 0101 0011	BadHysteresis_3	The Ctr3Hysteresis value is invalid, that is, less than zero.
X460	010	0 0110 0000	BadScalar_0	The Ctr0Scalar value is invalid, that is, less than one.
X461	010	0 0110 0001	BadScalar_1	The Ctr1Scalar value is invalid, that is, less than one when NumberofCounters = 01, 10 or 11.

Table 23 - Configuration Error Codes (Continued)

Hex Equivalent[1]	Module Error Code	Extended Error Information Code	Error	Description
	Binary	Binary		
X462	010	0 0110 0010	BadScalar_2	The Ctr2Scalar value is invalid, that is, less than one when NumberofCounters = 10 or 11.
X463	010	0 0110 0011	BadScalar_3	The Ctr3Scalar value is invalid, that is, less than one when NumberofCounters = 11.
X470	010	0 0111 0000	BadScale_0	The Ctr0CyclicRateUpdateTime is invalid, that is, less than one.
X471	010	0 0111 0001	BadScale_1	The Ctr1CyclicRateUpdateTime is invalid, that is, less than one when NumberofCounters = 01, 10 or 11.
X472	010	0 0111 0010	BadScale_2	The Ctr2CyclicRateUpdateTime is invalid, that is, less than one when NumberofCounters = 10 or 11.
X473	010	0 0111 0011	BadScale_3	The Ctr3CyclicRateUpdateTime is invalid, that is, less than one when NumberofCounters = 11.
X480	010	0 1000 0000	BadRangeLimit_0	The Range0To11[0].LowLimit is greater than or equal to the Range0To11[0].HighLimit.
X481	010	0 1000 0001	BadRangeLimit_1	The Range0To11[1].LowLimit is greater than or equal to the Range0To11[1].HighLimit.
X482	010	0 1000 0010	BadRangeLimit_2	The Range0To11[2].LowLimit is greater than or equal to the Range0To11[2].HighLimit.
X483	010	0 1000 0011	BadRangeLimit_3	The Range0To11[3].LowLimit is greater than or equal to the Range0To11[3].HighLimit.
X484	010	0 1000 0100	BadRangeLimit_4	The Range0To11[4].LowLimit is greater than or equal to the Range0To11[4].HighLimit.
X485	010	0 1000 0101	BadRangeLimit_5	The Range0To11[5].LowLimit is greater than or equal to the Range0To11[5].HighLimit.
X486	010	0 1000 0110	BadRangeLimit_6	The Range0To11[6].LowLimit is greater than or equal to the Range0To11[6].HighLimit.
X487	010	0 1000 0111	BadRangeLimit_7	The Range0To11[7].LowLimit is greater than or equal to the Range0To11[7].HighLimit.
X488	010	0 1000 1000	BadRangeLimit_8	The Range0To11[8].LowLimit is greater than or equal to the Range0To11[8].HighLimit.
X489	010	0 1000 1001	BadRangeLimit_9	The Range0To11[9].LowLimit is greater than or equal to the Range0To11[9].HighLimit.
X48A	010	0 1000 1010	BadRangeLimit_10	The Range0To11[10].LowLimit is greater than or equal to the Range0To11[10].HighLimit.
X48B	010	0 1000 1011	BadRangeLimit_11	The Range0To11[11].LowLimit is greater than or equal to the Range0To11[11].HighLimit.
X490	010	0 1001 0000	BadCtrAssignToRange_0	This error occurs if you try to set Range0To11[0].ToThisCounter to an invalid value (that is, to a counter that is not available due to the number of counters selected).
X491	010	0 1001 0001	BadCtrAssignToRange_1	This error occurs if you try to set Range0To11[1].ToThisCounter to an invalid value (that is, to a counter that is not available due to the number of counters selected).
X492	010	0 1001 0010	BadCtrAssignToRange_2	This error occurs if you try to set Range0To11[2].ToThisCounter to an invalid value (that is, to a counter that is not available due to the number of counters selected).

Table 23 - Configuration Error Codes (Continued)

Hex Equivalent[(1)]	Module Error Code	Extended Error Information Code	Error	Description
	Binary	Binary		
X493	010	0 1001 0011	BadCtrAssignToRange_3	This error occurs if you try to set Range0To11[3].ToThisCounter to an invalid value (that is, to a counter that is not available due to the number of counters selected).
X494	010	0 1001 0100	BadCtrAssignToRange_4	This error occurs if you try to set Range0To11[4].ToThisCounter to an invalid value (that is, to a counter that is not available due to the number of counters selected).
X495	010	0 1001 0101	BadCtrAssignToRange_5	This error occurs if you try to set Range0To11[5].ToThisCounter to an invalid value (that is, to a counter that is not available due to the number of counters selected).
X496	010	0 1001 0110	BadCtrAssignToRange_6	This error occurs if you try to set Range0To11[6].ToThisCounter to an invalid value (that is, to a counter that is not available due to the number of counters selected).
X497	010	0 1001 0111	BadCtrAssignToRange_7	This error occurs if you try to set Range0To11[7].ToThisCounter to an invalid value (that is, to a counter that is not available due to the number of counters selected).
X498	010	0 1001 1000	BadCtrAssignToRange_8	This error occurs if you try to set Range0To11[8].ToThisCounter to an invalid value (that is, to a counter that is not available due to the number of counters selected).
X499	010	0 1001 1001	BadCtrAssignToRange_9	This error occurs if you try to set Range0To11[9].ToThisCounter to an invalid value (that is, to a counter that is not available due to the number of counters selected).
X49A	010	0 1001 1010	BadCtrAssignToRange_10	This error occurs if you try to set Range0To11[10].ToThisCounter to an invalid value (that is, to a counter that is not available due to the number of counters selected).
X49B	010	0 1001 1011	BadCtrAssignToRange_11	This error occurs if you try to set Range0To11[11].ToThisCounter to an invalid value (that is, to a counter that is not available due to the number of counters selected).

(1) X represents the "Don't Care" digit.

The BadModConfigUpdate error conditions are shown in the following table. They occur when you attempt to change a forbidden module configuration parameter while a counter or range is still enabled. To recover from this situation, do the following:

- Correct the configuration problem.
- Reconfigure the module.

TIP Refer to your controller's documentation for available reconfiguration methods.

IMPORTANT Do not change the module settings in Table 24 while counter or range is enabled.

Table 24 - 'BadModConfigUpdate' Error Prohibited Configuration Settings

Configuration Parameters	Array Position		Prohibited from changing when indicated bits (X) are set				
	Word	Bit	Ctr0EN	Ctr1EN	Ctr2EN	Ctr3EN	RangeEN
OverCurrentLatchOff	0	0	X	X	X	X	X
ProgToFaultEn	0	4					
NumberOfCounters	0	8 and 9	X	X	X	X	X
Filter_A0	1	0 and 1	X			X	
Filter_B0	1	3 and 4	X			X	
Filter_Z0	1	6 and 7	X			X	
Filter_A1	1	8 and 9		X	X		
Filter_B1	1	11 and 12		X	X		
Filter_Z1	1	14 and 15		X	X		
Out*n*ProgramMode	2	0 to 3					
Out*n*ProgramStateRun	2	4 to 7					
Out*n*ProgramValue	3	0 to 3					
Out*n*0FaultMode	4	0 to 3					
Out*n*FaultStateRun	4	4 to 7					
Out*n*FaultValue	5	0 to 3					
Ctr0MaxCount Ctr0MinCount Ctr0Preset(1) Ctr0Hysteresis(2) Ctr0Scalar(2) Ctr0CyclicRateUpdateTime(2) Ctyr0Config.OperationMode Ctr0Config.StorageMode Ctr0Config.Linear	6 and 7 8 and 9 10 and 11 12 13 14 15 15 15	-- -- -- -- -- -- 0 to 3 8 to 10 12	X X (1) X X X X X X				

Table 24 - 'BadModConfigUpdate' Error Prohibited Configuration Settings (Continued)

Configuration Parameters	Array Position		Prohibited from changing when indicated bits (X) are set				
	Word	Bit	Ctr0EN	Ctr1EN	Ctr2EN	Ctr3EN	RangeEN
Ctr1MaxCount	16 and 17	--		X			
Ctr1MinCount	18 and 19	--		X			
Ctr1Preset(1)	20 and 21	--		(1)			
Ctr1Hysteresis(2)	22	--		X			
Ctr1Scalar(2)	23	--		X			
Ctr1CyclicRateUpdateTime(2)	24	--		X			
Ctr1Config.OperationalMode	25	0 to 3		X			
Ctr1Config.StorageMode	25	8 to 10		X			
Ctr1Config.Linear	25	12		X			
Ctr2MaxCount	26 and 27	--			X		
Ctr2MinCount	28 and 29	--			X		
Ctr2Preset(1)	30 and 31	--			(1)		
Ctr2Hysteresis(2)	32	--			X		
Ctr2Scalar(2)	33	--			X		
Ctr2CyclicRateUpdateTime(2)	34	--			X		
Ctr2Config.Linear	35	12			X		
Ctr3MaxCount	36 and 37	--				X	
Ctr3MinCount	38 and 39	--				X	
Ctr3Preset(1)	40 and 41	--				(1)	
Ctr3Hysteresis(2)	42	--				X	
Ctr3Scalar(2)	43	--				X	
Ctr3CyclicRateUpdateTime(2)	44	--				X	
Ctr3Config.Linear	45	12				X	
Ranges	46 to 117	--	Can be changed wile counters and ranges are enabled				

(1) Ctr*n*Preset can be changed while Ctr*n*En = 1.
(2) Does not apply to the L23E packaged controllers embedded HSC.

Notes:

Specifications

IMPORTANT	For specifications for the packaged controllers, refer to the CompactLogix Packaged Controller Installation Instructions, publication 1769-IN082.

Table 25 - Technical Specifications - 1769-HSC

Attribute	1769-HSC
Dimensions (H x W x D), approx.	118 x 35 x 87 mm (4.65 x 1.38 x 3.43 in.) Height including mounting tabs is 138 mm (5.43 in.)
Shipping weight (with carton), .	309 g (0.681 lb)
Bus current draw, max	425 mA at 5V DC 0 mA at 24V DC
Heat dissipation	6.21 W The Watts per point, plus the minimum Watts, with all points energized
Isolation voltage	75V (continuous), reinforced Insulation type, channel-to-system and channel-to-channel Type tested at 1200V AC for 2 s
All supply power and/or current ratings	Input: 30V DC 40 °C (104 °F) Output: 1 A per channel, 4 A per module, 30V DC 40 °C (104 °F)
Power supply distance rating	Module cannot be more than four modules away from a system power supply
Recommended cable	Individually shielded, twisted-pair cable (for the type recommended by the encoder or sensor manufacturer)
Wire size	0.32…2.1 mm^2 (22…14 AWG) solid copper wire or 0.32…1.3 mm^2 (22…16 AWG) stranded copper wire rated at 90 °C (194 °F) insulation max
Wiring category	2 - on signal ports(1)
Vendor ID code	1
Product type code	109
Product code	19
Enclosure type rating	None (open-style)
North American temp code	T3C

(1) Use this Conductor Category information for planning conductor routing. Refer to Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1.

Table 26 - Input Specifications - 1769-HSC

Attribute	1769-HSC
No. of inputs	2 quadrature (ABZ) differential inputs
Input voltage range	2.6…30V DC(1)
On-state voltage, max	30V DC(1)
On-state voltage, min	2.6 V DC
On-state current, min	6.8 mA
Off-state voltage, max	1.0V DC
Off-state current, max	1.5 mA
Off-state leakage current, max	1.5 mA
Input current, max	15 mA
Input current, min	6.8 mA
Input impedance, nom	1950 Ω
Pulse width, min	250 nsec
Pulse separation, min	131 nsec
Input frequency, max	1 MHz

(1) See Maximum Input Voltage - 24V DC Operation on page 128

Table 27 - Output Specifications - 1769-HSC

Attribute	1769-HSC
No. of outputs	16 total, 4 physical and 12 virtual
Output voltage range	5…30V DC(1)
On-state voltage, max	User power - 0.1V DC
On-state current, max	1 A per point(2) 4 A per module(3)
On-state current, min	1 mA
On-state voltage drop, max	0.5V DC
Off-state leakage current, max	5 μA
Input current, min	6.8 mA
Turn-on time, max	400 μs(4)
Turn-off time, max	200 μs
Reverse polarity protection	30V DC

(1) See Maximum Output Voltage - 24V DC Operation on page 128.
(2) See Maximum Output Current per Point - 5V DC Operation on page 129 and Maximum Output Current per Point - 24V DC Operation on page 130.
(3) See Maximum Output Current per Module - 5V DC Operation on page 129 and Maximum Output Current per Module - 24V DC Operation on page 130.
(4) Maximum turn-on time applies to output voltage range of 5…7V DC. For output voltages greater than 7V DC, the maximum turn-on time is 200 μs.

Table 28 - Environmental Specifications - 1769-HSC

Attribute	1769-HSC
Temperature, operating IEC 60068-2-1 (Test Ad, Operating Cold), IEC 60068-2-2 (Test Bd, Operating Dry Heat), IEC 60068-2-14 (Test Nb, Operating Thermal Shock)	0…60 °C (32…140 °F)
Temperature, surrounding air, max For UL certified open equipment	40 °C (104 °F)
Temperature, nonoperating IEC 60068-2-1 (Test Ab, Unpackahed Nonoperating Cold), IEC 60068-2-2 (TestBb, Unpackaged Nonoperating Dry Heat), IEC 60068-2-14 (Test Na, Unpackaged Nonoperating Thermal Shock)	-40…85 °C (-40…185 °F)
Relative humidity IEC 60068-2-3e0 (Test Db, Unpackaged Damp Heat)	5...95% noncondensing
Vibration, operating IEC 60068-2-6 (Test Fc, Operating)	5 g @ 10…500 Hz, peak-to-peak
Vibration, relay operation	2 g @ 10…500 Hz(1)
Shock, operating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	30 g, 11 ms panel mounted 20 g, 11 ms DIN rail mounted
Shock, nonoperating IEC 60068-2-27 (Test Ea, Unpackaged Shock)	40 g, panel mounted 30 g, DIN rail mounted
Emissions CISPR 11	Group 1, Class A
ESD immunity IEC 61000-4-2	6 kV contact discharges 8 kV air discharges
Radiated RF immunity IEC 6100-4-3	10V/m with 1 kHz sine-wave 80% AM from 80…2000 MHz 10V/m with 200 Hz 50% Pulse 100% AM at 900 and 1890 MHz 10V/m with 1 kHz sine-wave 80% AM from 2000…2700 MHz
EFT/B immunity IEC 61000-4-4	±2 kV at 5 kHz on power ports ±2 kV at 5 kHz on signal ports
Surge transient immunity IEC 61000-4-5	±1 kV line-line (DM) and ±2 kV line-earth (CM) on power ports ±1 kV line-line (DM) and ±2 kV line-earth (CM) on signal ports ±1 kV line-earth (CM) on shielded ports
Conducted RF immunity IEC 61000-4-6	10V rms with 1 kHz sine-wave 80% AM from 150 kHz…80 MHz

(1) This rating applies for your system if a relay module, such as the 1769-OW8, is used.

Table 29 - Certifications - 1769-HSC[1]

Certification[2]	1769-HSC
c-UL-us	UL Listed Industrial Control Equipment, certified for US and Canada. See UL File E65584
c-UL-us	UL Listed for Class I, Division 2 Group A,B,C,D Hazardous Locations, certified for U.S. and Canada. See UL File E321922
CE	European Union 2004/108/EC EMC Directive, compliant with the following: • EN 61000-6-2; Industrial Immunity • EN 61000-6-4; Industrial Emissions • EN 61131-2; Programmable Controllers (Clause 8, Zone A & B)
C-Tick	Australian Radiocommunications Act, compliant with AS/NZS CISPR 11; Industrial Emissions

(1) When product is marked.

(2) See the Product Certification link at http://www.ab.com for Declarations of Conformity, Certificates, and other certification details.

Throughput and Timing

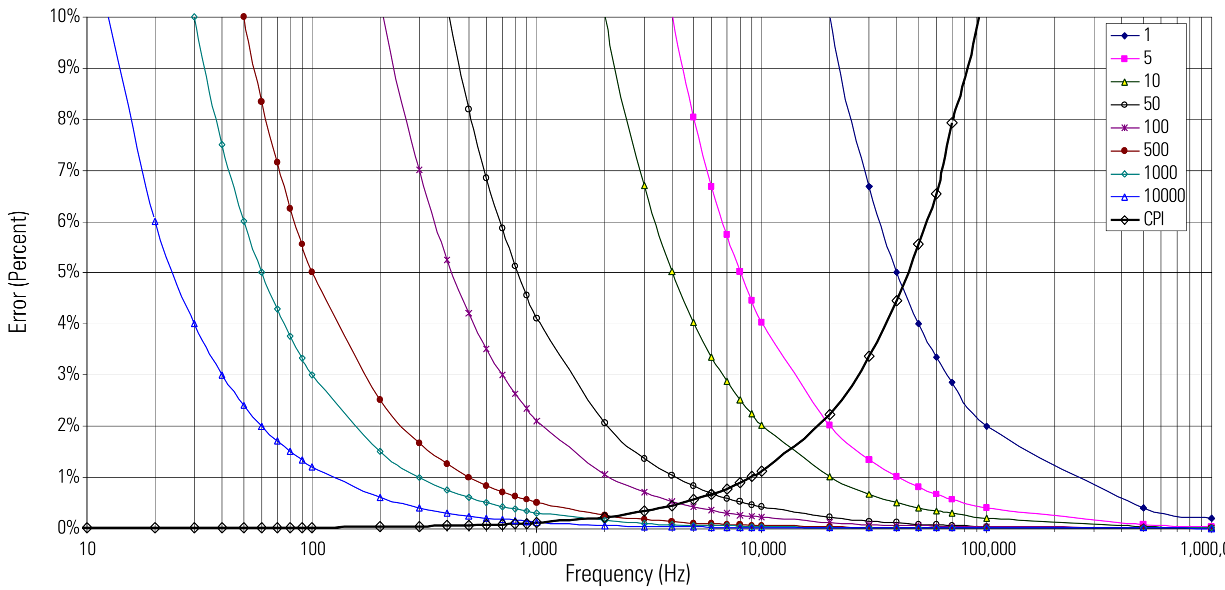
Operation	Description	Timing
Input file update time	The delay between the time the module receives a pulse and when the Compact bus count value is updated.	500 μs, max
Output turn-on time	The time it takes for the real output to reach 90% output voltage after commanded by the module, not including processor scan time.	400 μs, max
Output turn-off time	The time it takes for the real output to reach 10% output voltage after commanded by the module, not including the processor scan time.	200 μs, max
Rate accuracy	The accuracy of the reported rate as compared to actual input rate in the equation: reported rate/actual input rate.	Depends on frequency. See Rate Accuracy on page 127.

Rate Accuracy

The following graph shows rate error at various frequencies. The following trends can assist you in reading the graph:

- Of the lines that rise at low frequencies, the left-most is a 10-second update time (Ctr*n*CyclicRateUpdateTime = 10000).
- The right-most of these lines is a 1-millisecond update time (Ctr*n*CyclicRateUpdateTime = 1).
- The line that rises at high frequencies illustrates Ctr[*n*].PulseInterval.

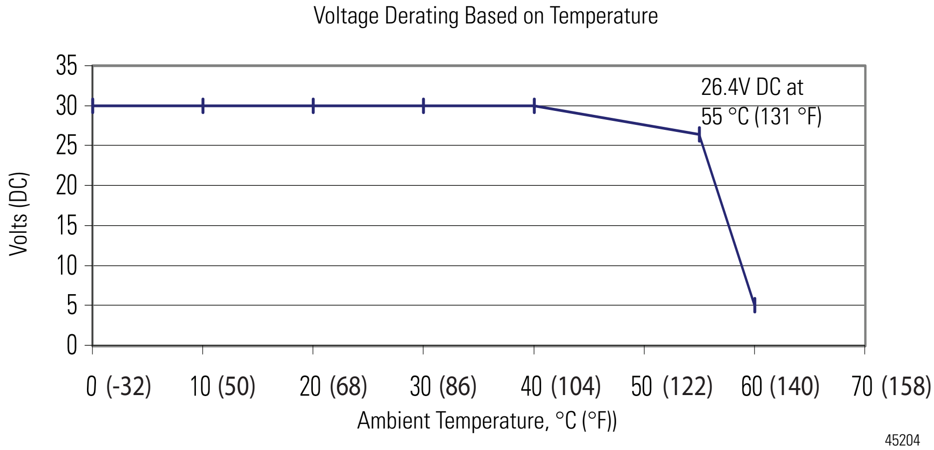
Figure 21 - Rate Errors Comparison



Temperature Derating

Refer to the following figures for 1769-HSC temperature derating.

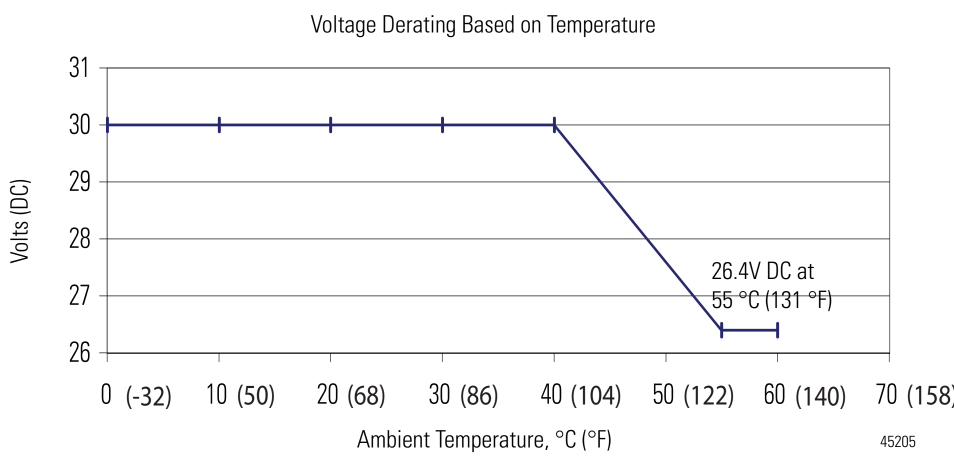
Figure 22 - Maximum Input Voltage - 24V DC Operation



Temperature	Derated Voltage[1]
0…40 °C (-32…104 °F)	30V DC
55 °C (131 °F)	26.4V DC
60 °C (140 °F)	5V DC

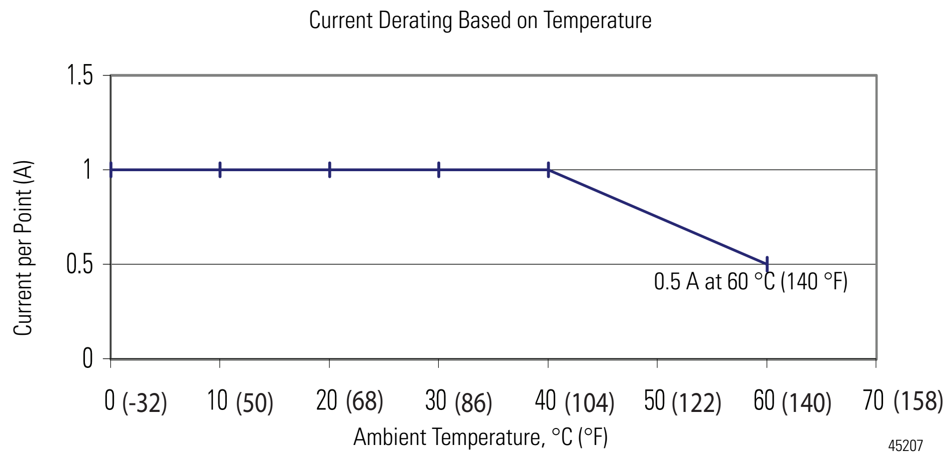
(1) Input voltage derating between 55…60 °C is achieved by using a dropping resistor.
For 24V DC input voltage, use a 2.4 kΩ, ½ W resistor.
For input voltages greater than 24V DC, use a ½ W resistor with value: 125 x (V_{in} - 5V).

Figure 23 - Maximum Output Voltage - 24V DC Operation



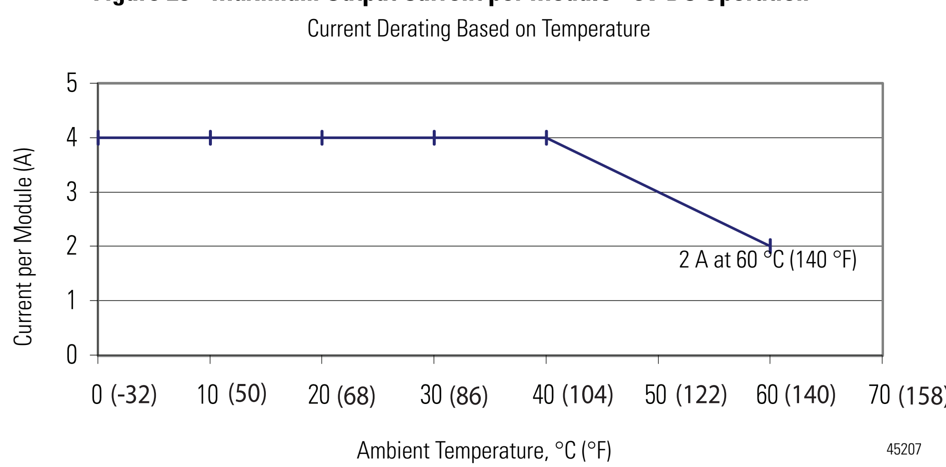
Temperature	Derated Voltage
0…40 °C (-32…104 °F)	30V DC
55…60 °C (131…140 °F)	26.4V DC

Figure 24 - Maximum Output Current per Point - 5V DC Operation



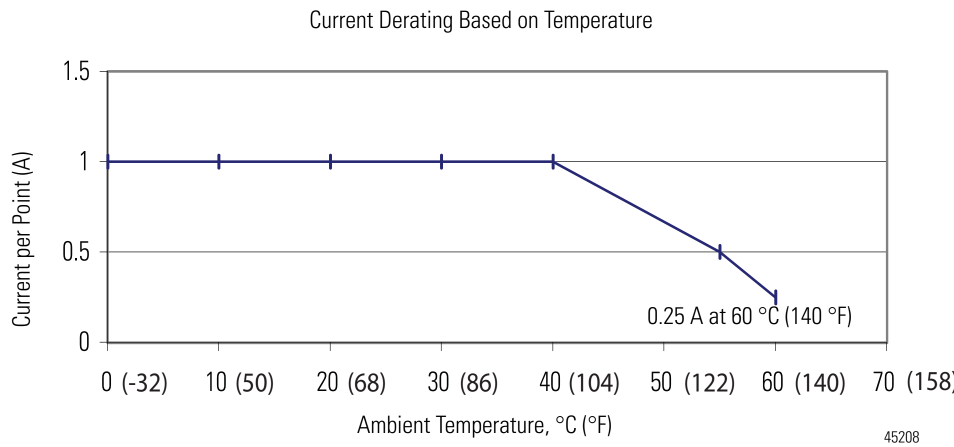
Temperature	Derated Current
0…40 °C (-32…104 °F)	1 A
60 °C (140 °F)	0.5 A

Figure 25 - Maximum Output Current per Module - 5V DC Operation



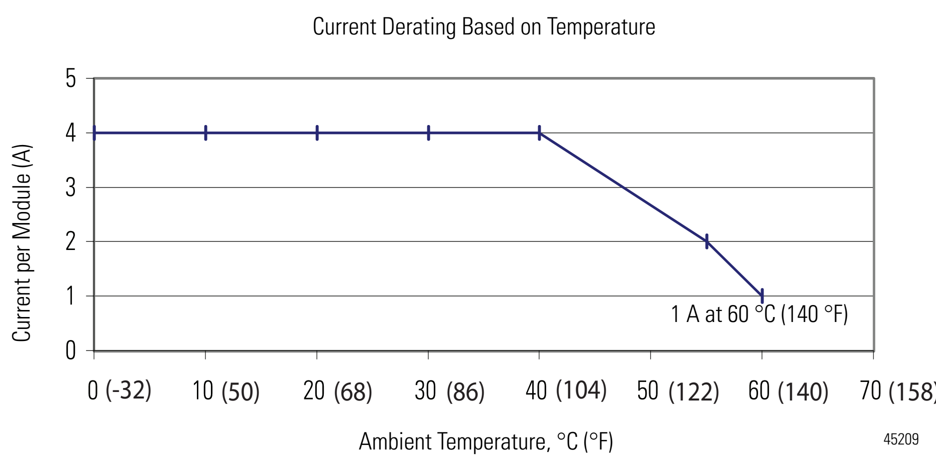
Temperature	Derated Current
0…40 °C (-32…104 °F)	4 A
60 °C (140 °F)	2.0 A

Figure 26 - Maximum Output Current per Point - 24V DC Operation



Temperature	Derated Current
0…40 °C (-32…104 °F)	1 A
55 °C (131 °F)	0.5 A
60 °C (140 °F)	0.25 A

Figure 27 - Maximum Output Current per Module - 24V DC Operation



Temperature	Derated Current
0…40 °C (-32…104 °F)	4 A
55 °C (131 °F)	2 A
60 °C (140 °F)	1 A

Dimensions

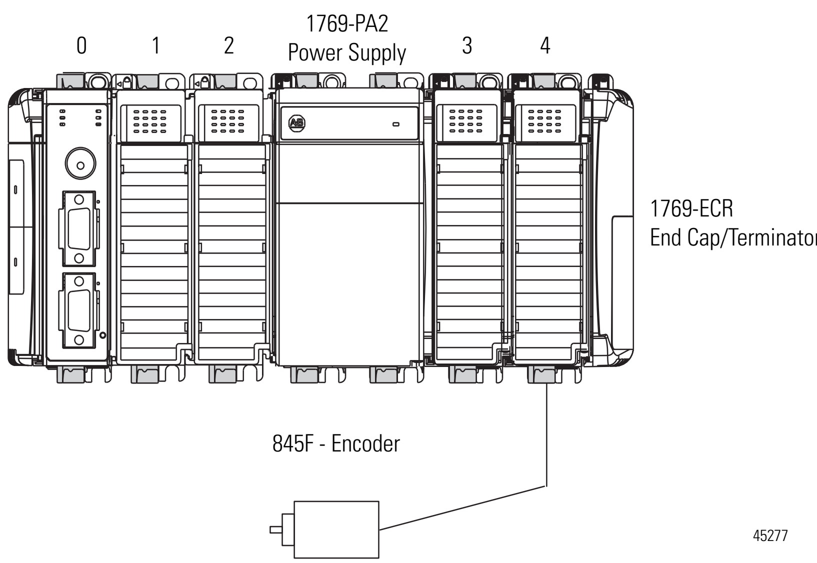
See page 51 in Chapter 3 for these dimensions:

- Compact I/O module with CompactLogix controller and power supply
- Compact I/O module with MicroLogix 1500 base unit and processor

Program a 1769-HSC Module, CompactLogix Controller, and 845F Incremental Encoder with RSLogix 5000 Software

The application example demonstrates how to wire an 845F optical incremental encoder to a 1769-HSC module and ultimately monitor the Current Count value in the CompactLogix controller. We also will control two onboard outputs with two ranges.

System Diagram



Slot	Module
0	1769-L32E
1	1769-IQ6XOW4
2	1769-OV16
3	1769-IF4
4	1769-HSC

845F Encoder Wiring to the 1769-HSC Module

845F Encoder Wire	Color	1769-HSC Terminal
Blue/black wire pair	Blue	A0+
	Black	A0-
White/black wire pair	White	B0+
	Black	B0-
Green/black wire pair	Green	Z0+
	Black	Z0-
Red/black wire pair	Red	24V DC power supply
	Black	24V DC common

Scope

These steps are used in this example.

1. Add the 1769-HSC module into a CompactLogix system by using RSLogix 5000 software.
2. Configure the 1769-HSC module by entering configuration information into Configuration and Output tags created in RSLogix 5000 software for the 1769-HSC module.
3. Monitor the Current Count value from the 1769-HSC module in the Input Tag created for the module.
4. Verify that module outputs 0 and 1 turn on when the Current Counts value is within the specified ranges.

Add a 1769-HSC Module to a CompactLogix System

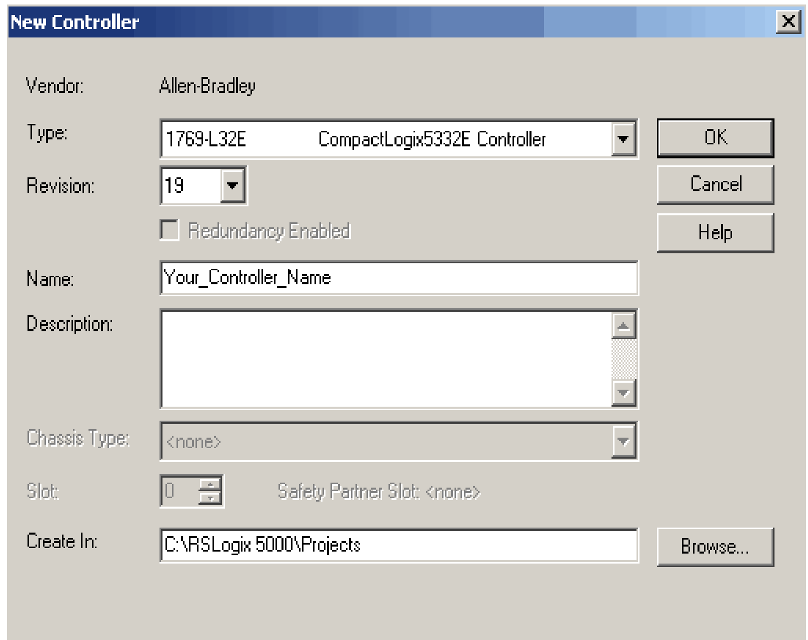
The example in this section uses a 1769-L32E controller to add a 1769-HSC Module into the CompactLogix System by using RSLogix 5000 software.

1. Start the RSLogix 5000 programming software.

   The Quick Start window appears.

2. Click New Project.

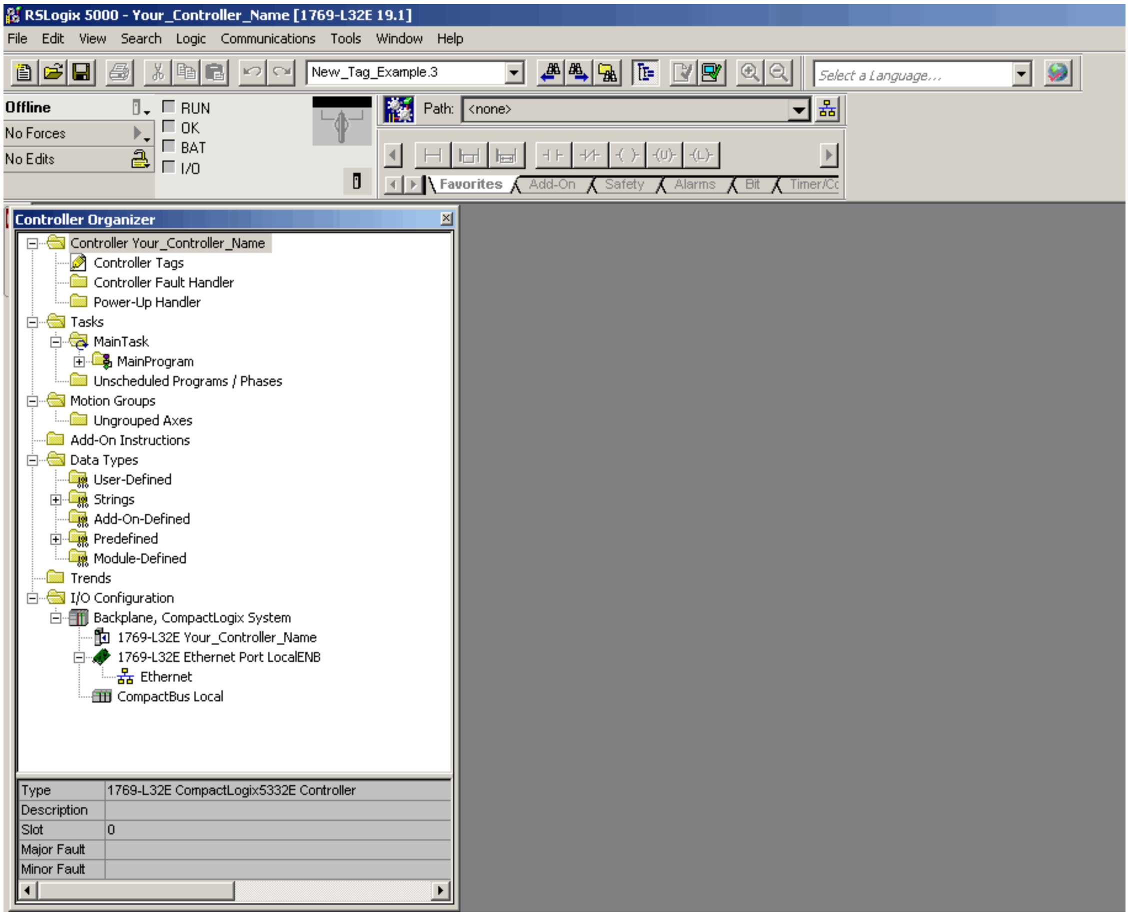
3. Choose your controller and revision number.



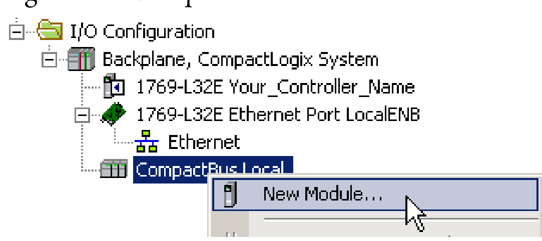
4. Enter a unique controller name.

5. Click OK.

The RSLogix 5000 project window appears.

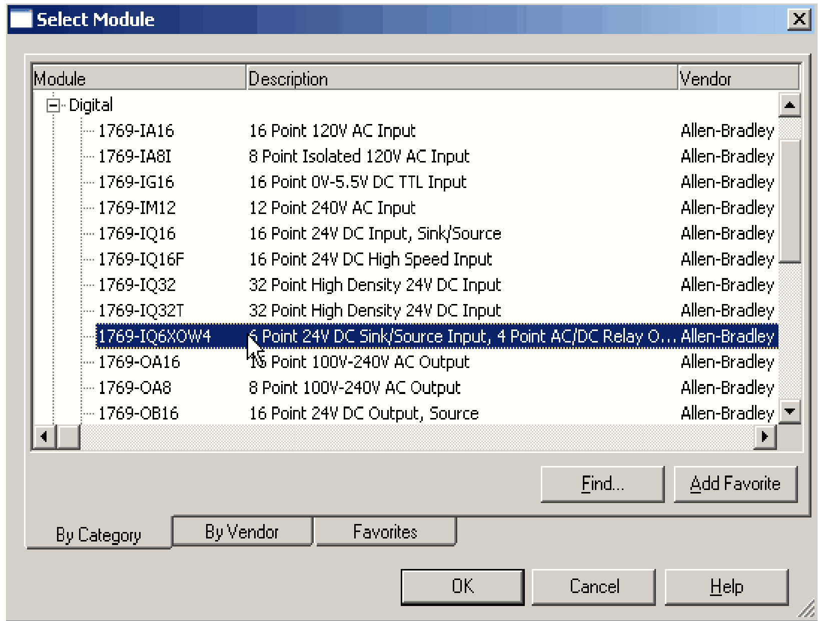


6. Right-click CompactBus Local and select New Module.



The Select Module dialog box appears.

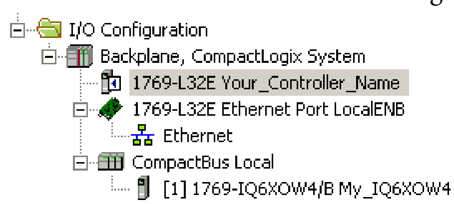
7. Select the left-most I/O module in your 1769 CompactLogix chassis and click OK.



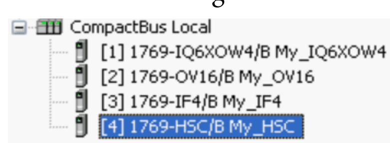
The New Module dialog box appears.

8. In the Name box, type a name and click OK.

   The module is added to the I/O Configuration.



9. Repeat steps 6 through 8 until all of your local I/O modules are added in order from left to right.



In this example, the 1769-IF4 and 1769-HSC /B modules must be configured. For information on configuring the 1769-IF4 module, refer to the Compact I/O Analog Modules User Manual, publication 1769-UM002.

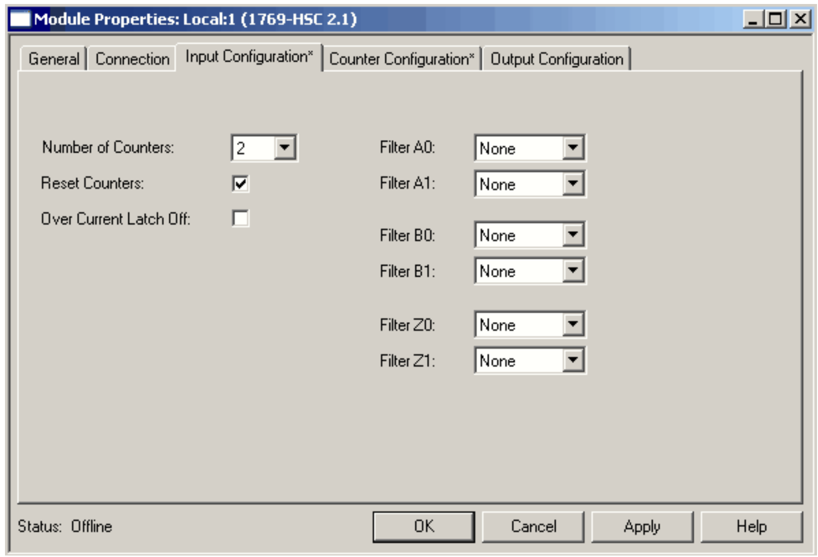
Configure the 1769-HSC Module

When the 1769-HSC module is added to the CompactLogix project, input, output, and configuration tags are automatically created in the Controller Tags area.

1. In the Controller Organizer, double-click the 1769-HSC module.

   The Module Properties dialog box appears.

2. Click the Input Configuration tab.



3. The Number of Counters defaults to 2.

IMPORTANT	The contents of counter 1 must be cleared to save any changes if the number of counters is changed to 1.

4. Click the Reset Counter box to select the designated number of counters for the reset counter functionality.

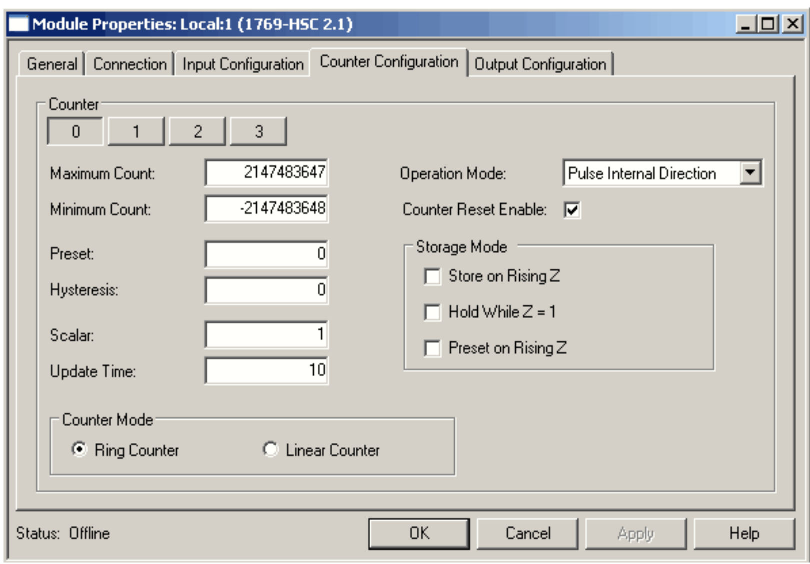
   You select the actual counter on the Counter Configuration dialog box.

5. Click the Counter Configuration tab.

6. Use this information to complete the Counter Configuration tab.

Option	Value
Maximum Count	1,200,000
Minimum Count	0
Preset	0
Hysteresis	0
Scalar	1
Update Time	1
Operation Mode	Choose an operation mode from the pull-down menu, such as Pulse Internal Direction.
Counter Reset Enable	This box displays for 1769-HSC/B modules **only**. The checkbox defaults with a check mark if the selection bit is enabled for this counter on the Add-On profile. Clear the checkbox to disable this counter from resetting. See page 73 for more details.
Storage Mode	Nothing selected
Counter Mode	Ring Counter

Your Counter Configuration tab should look like the example.



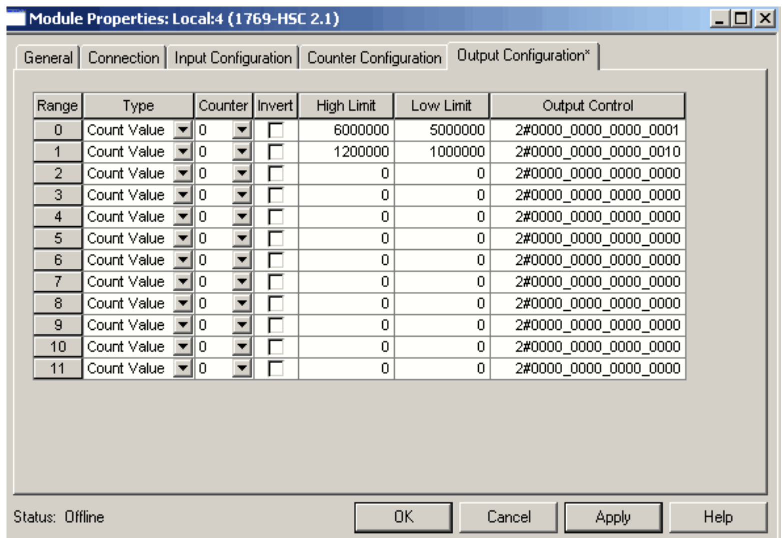
7. Click Apply.

8. Click the Output Configuration tab.

9. Use this information to complete the Output Configuration tab.

Option	**Value**	
	Range 0	**Range 1**
Type	Count Value	Count Value
Counter	0	0
High Limit	600,000	1,200,000
Low Limit	500,000	1,000,000
Output Control	2#0000_0000_0000_0001	2#0000_0000_0000_0010

Your Output Configuration tab should look like the example.



10. Click Apply.

11. In the Controller Organizer, double-click Controller Tags.
12. At the bottom of the window, click Monitor Tags.

    The tags for I/O modules appear in the following format, where 's' is the slot number of the module.

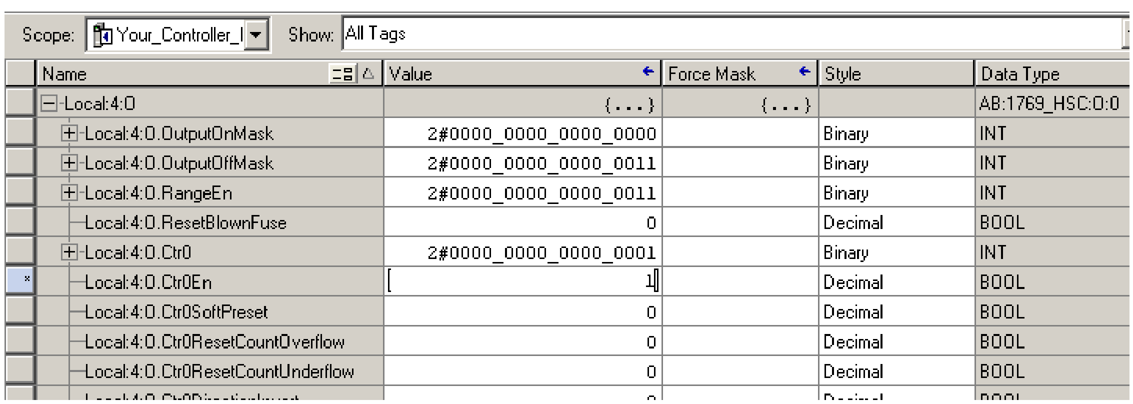
Tag	Description
Local:s:I	Input Image
Local:s:O	Output Image
Local:s:C	Configuration Data

13. Click '+' to expand the output tags (Local:4:0).
14. Use this information to configure these output tags.

Tag	Value
OutputOnMask	2#0000_0000_0000_0000
OutputOffMask	2#0000_0000_0000_0011
RangeEn	2#0000_0000_0000_0011
ResetBlownFuse	0
Ctr0	2#0000_0000_0000_0001(1)

(1) Changing this bit to a 1 changes the Ctr0En tag to 1 when you press Tab.

Your output tags should look like the example.



Monitor the Current Count and Verify Output Operation

In this section, you use the 1769-HSC module's input tags (Local:4:I) to view what is running.

1. Save the program and download it to your controller.
2. Put the controller into Run mode.
3. Spin the shaft on your 845F encoder.

   The Ctr0CurrentCount tag displays the current count data for Counter0 of the 1769-HSC module. For this example, this count is the number of pulses received from the encoder times four (because the operating mode is Encoder X4).

Name	Value	Force Mask	Style	Data Type
+ Local:4:I.RangeActive	2#0000_0000_0000_0000		Binary	INT
+ Local:4:I.Ctr0CurrentCount	0		Decimal	DINT
+ Local:4:I.Ctr0StoredCount	0		Decimal	DINT
+ Local:4:I.Ctr0CurrentRate	0		Decimal	DINT

4. Continue to spin the encoder shaft until the Ctr0CurrentCount value is within the limits set for Range 0 (500,000–600,000).

   The lowest bit of the RangeActive tag turns on.

Name	Value	Force Mask	Style	Data Type
+ Local:4:I.RangeActive	2#0000_0000_0000_0001		Binary	INT
+ Local:4:I.Ctr0CurrentCount	5250000		Decimal	DINT
+ Local:4:I.Ctr0StoredCount	0		Decimal	DINT
+ Local:4:I.Ctr0CurrentRate	0		Decimal	DINT

   InputStates A0, B0, and Z0 toggle on and off reflecting the state of the encoder signals on those inputs as the encoder shaft is moved.

5. Continue to spin the encoder shaft until the Ctr0CurrentCount value is within the limits set for Range 1 (1,000,000–1,200,000) turns bit 1 of the RangeActive tag on.

Name	Value	Force Mask	Style	Data Type
+ Local:4:C	{...}	{...}		AB:1769_HSC
− Local:4:I	{...}	{...}		AB:1769_HSC
+ Local:4:I.Fault	2#0000_0000_0000_000...		Binary	DINT
+ Local:4:I.InputState	2#0000_0000		Binary	SINT
Local:4:I.InputStateA0	1		Decimal	BOOL
Local:4:I.InputStateB0	1		Decimal	BOOL
Local:4:I.InputStateZ0	1		Decimal	BOOL
Local:4:I.InputStateA1	0		Decimal	BOOL
Local:4:I.InputStateB1	0		Decimal	BOOL
Local:4:I.InputStateZ1	0		Decimal	BOOL
+ Local:4:I.Readback	2#0000_0000_0000_0000		Binary	INT

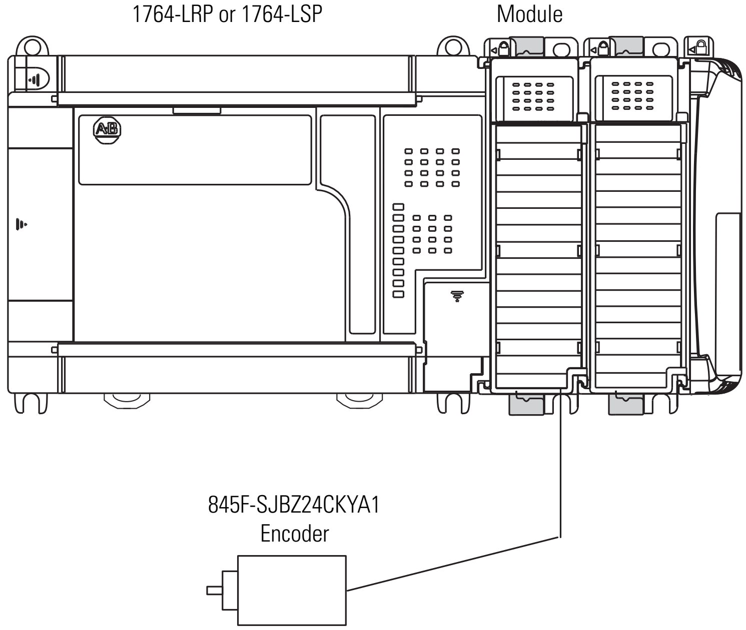
Your 1769-HSC module and encoder are programmed.

Program a 1769-HSC Module, MicroLogix 1500 Controller, and 845F Incremental Encoder with RSLogix 500 Software

This application example demonstrates how to wire an 845F optical incremental encoder to a 1769-HSC module and ultimately monitor the Current Count value in the MicroLogix 1500 controller. We also will control two onboard outputs with two ranges.

IMPORTANT	The individual counter reset functionality in the 1769-HSC/B module applies only to CompactLogix controllers. You cannot use the individual counter reset functionality with MicroLogix controllers.

System Diagram



845F Encoder Wiring to the 1769-HSC Module

845F Encoder Wire	Color	1769-HSC Terminal
Blue/Black Wire Pair	Blue	A0+
	Black	A0-
White/Black Wire Pair	White	B0+
	Black	B0-
Green/Black Wire Pair	Green	Z0+
	Black	Z0-
Red/Black Wire Pair	Red	24V DC Power Supply
	Black	24V DC Common

Scope

These steps are used in this example.

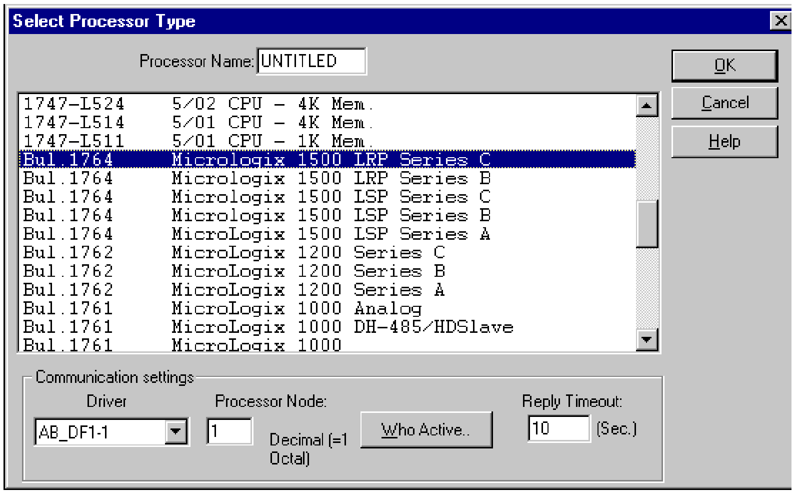
1. Add the 1769-HSC module into a MicroLogix 1500 system by using RSLogix 500 software.
2. Configure the 1769-HSC module by entering configuration information into I/O Configuration created in RSLogix 500 software for the 1769-HSC module.
3. Monitor the Current Count value from the 1769-HSC module.
4. Verify that module outputs 0 and 1 turn on when the Current Count value is within the specified ranges.

Add a 1769-HSC Module to a MicroLogix 1500 System

The example in this section uses a MicroLogix 1500 controller to add a 1769-HSC module into the MicroLogix 1500 system by using RSLogix 500 software.

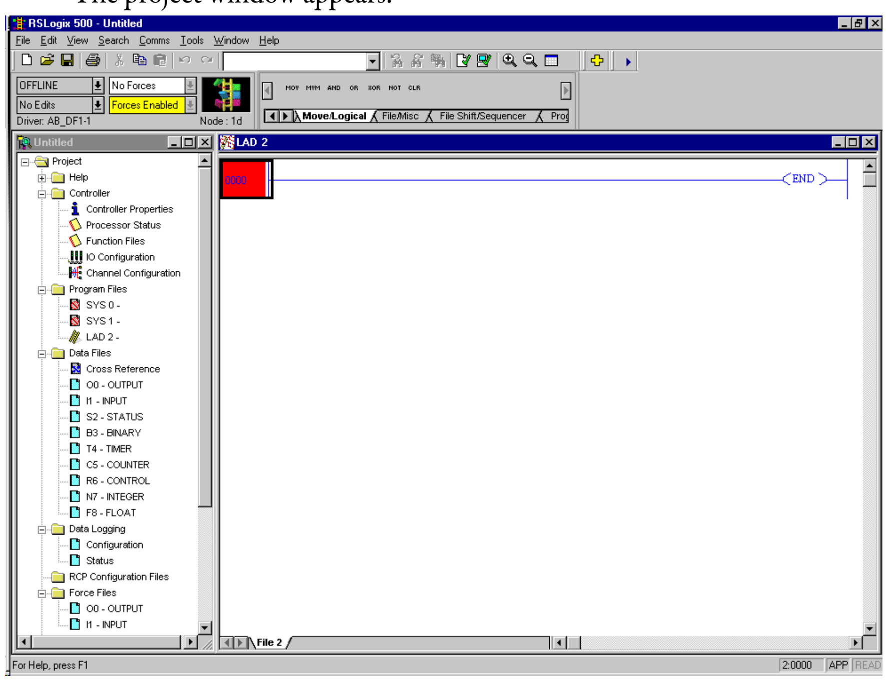
1. Start the RSLogix 500 software.
2. Click New.

   The Select Processor Type dialog box appears.



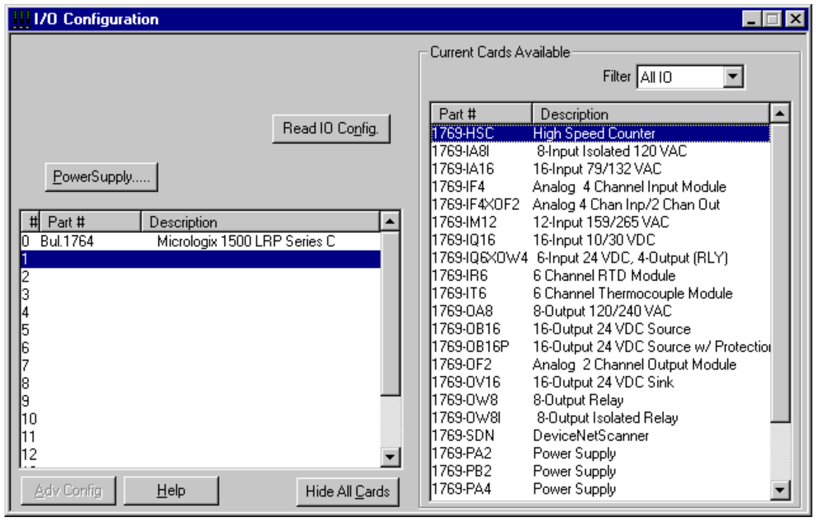
3. Select the correct controller type (Bul.1764 MicroLogix 1500 LRP Series C, for this example).
4. Type a Processor Name and click OK.

   The project window appears.



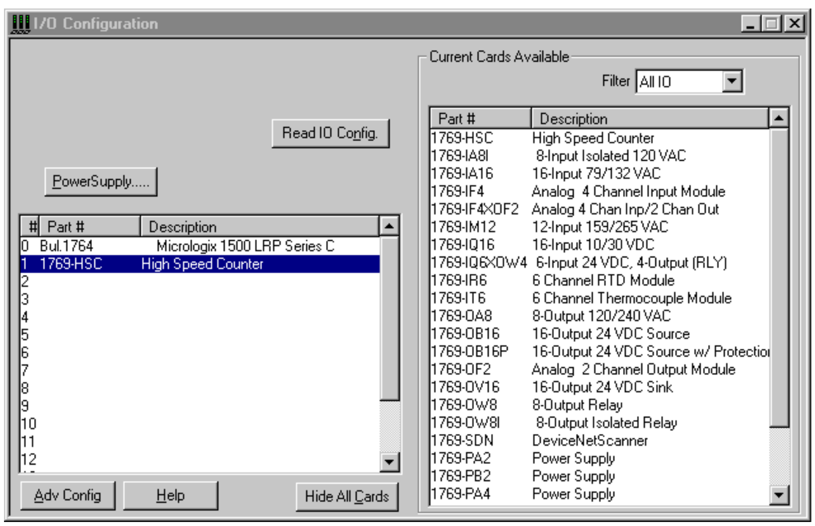
5. To add I/O modules to your project, click I/O Configuration.

   The I/O Configuration dialog box appears.



   This dialog box displays all 1769 I/O modules supported by your MicroLogix 1500 controller.

6. To add the 1769-HSC module to your MicroLogix 1500 system, double-click the module or drop and drag the module to the correct slot (in this example, slot 1).

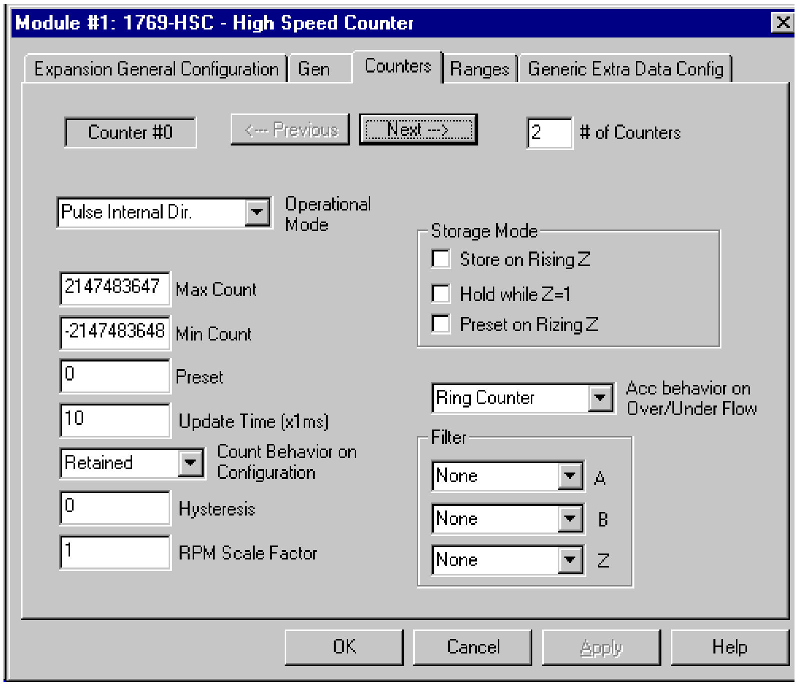


   To continue with configuring the 1769-HSC module, do not close this dialog box.

Configure Your 1769-HSC Module

You configure the 1769-HSC module in an offline project and then download to the MicroLogix 1500 controller.

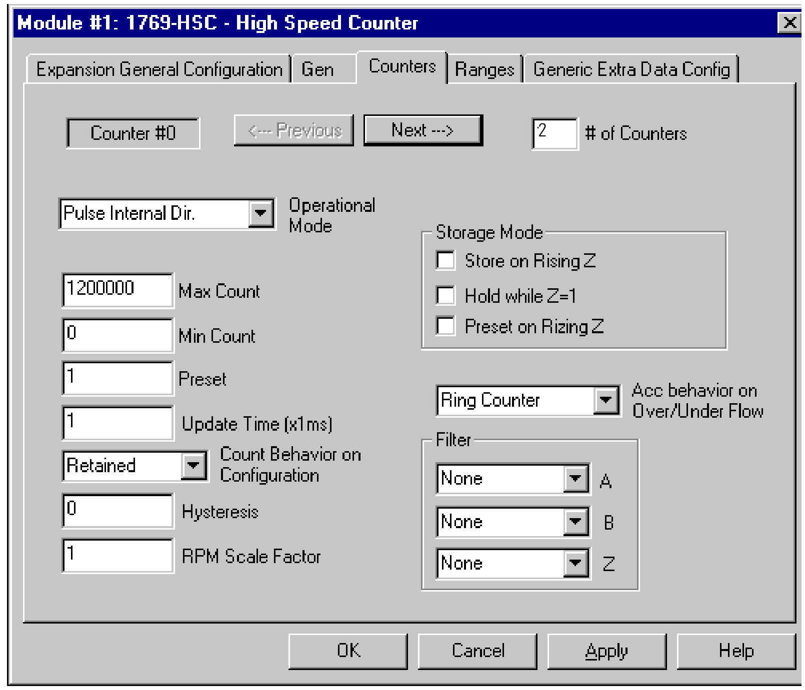
1. To open the 1769-HSC-module configuration file, click Adv Config.
2. To display the counter configuration information with the default values, click the Counters Tab.



3. Use this information to complete the configuration for the Counters tab.

Option	Value
# of Counters	2 (default) Counter 1 contents must be cleared to store changes if the number of counters is changed to 1.
Operational Mode	(Quadrature) Encoder X 4
Max Count	1,200,000
Min Count	0
Preset	1
Update Time	1
Count Behavior on Configuration	Retained
Hysteresis:	0
RPM Scale Factor	1
Storage Mode	All unchecked
Acc behavior Over/Under Flow	Ring Counter
Filters (A, B, Z)	None

Your Counter tab should look like the example below.



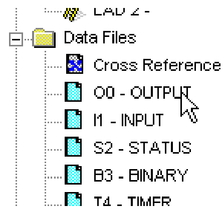
4. Click the Ranges tab to display the counter range configuration window with default values.

5. Use this information to complete the configuration for the Ranges tab.

Option	Value	
	Range #0	**Range #1**
Counter Used	Counter #0	Counter #0
Range Type	Count Value	Count Value
High Limit	600,000	1,200,000
Low Limit	500,000	1,000,000
Range Active	Within the Limits	Within the Limits
Output Mask	0001	0002

6. Click OK.

7. In the Project Menu, under Data Files, click Output.



The 34 words of the output image open. Addresses for these 34 words are Output Word [0] through Output Word [33]. In this example, only the first six words are modified. Output Word [6] through Output Word [33] are for Counters 1–3 and Ranges 12–15, which we are not using in this example.

8. Use this information to configure the first six Output words.

Output Data File	Decimal Value	Description
Output Word [0]	0	Not used
Output Word [1]	3	Enables Outputs 0 and 1 to be controlled by the 1769-HSC module's ranges.
Output Word [2]	3	Enable Ranges 0 and 1
Output Word [3]	0	Not using Interrupts
Output Word [4]	0	Not using Interrupts
Output Word [5]	1	Enable Counter 0

Monitor the Current Count and Verify Output Operation

No program logic is needed for this example. Use these steps to monitor the count and verify the output operation.

1. Save the program and download it to your controller.
2. Put the controller into Run mode.
3. Spin the shaft on your 845F encoder.

   Input words 4 and 5, Current Count, display the current count data for Counter #0 of the 1769-HSC module. In this example, this count is the number of pulses received from the encoder times four (Quadrature Encoder X4 is the operating mode).
4. Continue to spin the encoder shaft until the current count value is within the limits set for Range 0 (500,000–600,000).

   Output 0 turns On only when the current count value is equal to or within the Range 0 limits. Output 1 turns On only when the Current Count value is equal to or within the Range 1 limits (1,000,000–1,200,000). These two outputs are Off for all other values of the Current Count for Counter 0.

You can also use a CPW instruction to monitor 32-bit values via ladder logic.

Programming Quick Reference

This appendix section for the 1769-HSC Module contains at-a-glance lists of the following:

- Configuration array
- Output array
- Input array

IMPORTANT	The information in this appendix does not apply to the packaged controllers.

The default value for the configuration array is all zeros, except where noted.

Table 30 - Configuration Array for the 1769-HSC Module

Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Description		
0	Individual Counter Reset Disable[1]						NumberOfCtrs					PFE			CtrRst	OCLO	GeneralConfigBits	®	OvercurrentLatchOff CtrReset ProgToFaultEn NumberOfCounters_0[2] NumberOfCounters_1
1	Filter_Z1			Filter_B1			Filter_A1		Filter_Z0			Filter_B0			Filter_A0		FilterA0_0, FilterA0_1 -- ...Z1_1		
2									Out3 PSR	Out2 PSR	Out1 PSR	Out0 PSR	Out3 PM	Out2 PM	Out1 PM	Out0 PM	Out0ProgramStateRun --Out3... and Out0ProgramMode -- Out3...		
3													Out3 PV	Out2 PV	Out1 PV	Out0 PV	Out0ProgramValue --- Out3...		
4									Out3 FSR	Out2 FSR	Out1 FSR	Out0 FSR	Out3 FM	Out2 FM	Out1 FM	Out0 FM	Out0FaultStateRun --Out3FaultStateRun and Out0FaultMode -- Out3FaultMode		
5													Out3 FV	Out2 FV	Out1 FV	Out0 FV	Out0FaultValue -- Out3FaultValue		
6 7	Ctr0MaxCount[3]																Ctr0MaxCount		
8 9	Ctr0MinCount[4]																Ctr0MinCount		
10 11	Ctr0Preset																Ctr0Preset		
12	Ctr0Hysteresis																Ctr0Hysteresis		
13	Ctr0Scalar[5]																Ctr0Scalar		
14	Ctr0CyclicRateUpdateTime[6]																Ctr0CyclicRateUpdateTime		
15				Linear		Storage Mode								Operational Mode			Ctr0ConfigFlags	®	Ctr0Config.OperationalMode_0 Ctr0Config.OperationalMode_1 Ctr0Config.OperationalMode_2 Ctr0Config.StorageMode_0 Ctr0Config.StorageMode_1 Ctr0Config.StorageMode_2 Ctr0Config.Linear
16 17	Ctr1MaxCount[3]																Ctr1MaxCount		
18 19	Ctr1MinCount[4]																Ctr1MinCount		
20 21	Ctr1Preset																Ctr1Preset		
22	Ctr1Hysteresis																Ctr1Hysteresis		
23	Ctr1Scalar[5]																Ctr1Scalar		
24	Ctr1CyclicRateUpdateTime[6]																Ctr1CyclicRateUpdateTime		
25				Linear		Storage Mode								Operational Mode			Ctr1ConfigFlags	®	Ctr1Config.OperationalMode_0 Ctr1Config.OperationalMode_1 Ctr1Config.OperationalMode_2 Ctr1Config.StorageMode_0 Ctr1Config.StorageMode_1 Ctr1Config.StorageMode_2 Ctr1Config.Linear
26 27	Ctr2MaxCount[3]																Ctr2MaxCount		
28 29	Ctr2MinCount[4]																Ctr2MinCount		
30 31	Ctr2Preset																Ctr2Preset		
32	Ctr2Hysteresis																Ctr2Hysteresis		
33	Ctr2Scalar[5]																Ctr2Scalar		
34	Ctr2CyclicRateUpdateTime[6]																Ctr2CyclicRateUpdateTime		
35				Linear													Ctr2ConfigFlags	®	Ctr2Config.Linear
36 37	Ctr3MaxCount[3]																Ctr3MaxCount		

Table 30 - Configuration Array for the 1769-HSC Module

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Description		
38 39	Ctr3MinCount[4]																Ctr3MinCount		
40 41	Ctr3Preset																Ctr3Preset		
42	Ctr3Hysteresis																Ctr3Hysteresis		
43	Ctr3Scalar[5]																Ctr3Scalar		
44	Ctr3CyclicRateUpdateTime[6]																Ctr3CyclicRateUpdateTime		
45				Linear													Ctr3ConfigFlags	®	Ctr3Config.Linear
46 47	Range0to11[0].HighLimit																Range0to11[0].HighLimit		
48 49	Range0to11[0].LowLimit																Range0to11[0].LowLimit		
50	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range0to11[0].OutputControl		
51								Inv				Type			ToThisCtr		Range0to11[0].ConfigFlags	®	Range0To11[0].ToThisCounter_0 Range0To11[0].ToThisCounter_1 Range0To11[0].Type Range0To11[0].Invert
52 53	Range0to11[1].HighLimit																Range0to11[1].HighLimit		
54 55	Range0to11[1].LowLimit																Range0to11[1].LowLimit		
56	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range0to11[1].OutputControl		
57								Inv				Type			ToThisCtr		Range0to11[1].ConfigFlags	®	Range0To11[1].ToThisCounter_0 Range0To11[1].ToThisCounter_1 Range0To11[1].Type Range0To11[1].Invert
58 59	Range0to11[2].HighLimit																Range0to11[2].HighLimit		
60 61	Range0to11[2].LowLimit																Range0to11[2].LowLimit		
62	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range0to11[2].OutputControl		
63								Inv				Type			ToThisCtr		Range0to11[2].ConfigFlags	®	Range0To11[2].ToThisCounter_0 Range0To11[2].ToThisCounter_1 Range0To11[2].Type Range0To11[2].Invert
64 65	Range0to11[3].HighLimit																Range0to11[3].HighLimit		
66 67	Range0to11[3].LowLimit																Range0to11[3].LowLimit		
68	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range0to11[3].OutputControl		
69								Inv				Type			ToThisCtr		Range0to11[3].ConfigFlags	®	Range0To11[3].ToThisCounter_0 Range0To11[3].ToThisCounter_1 Range0To11[3].Type Range0To11[3].Invert
70 71	Range0to11[4].HighLimit																Range0to11[4].HighLimit		
72 73	Range0to11[4].LowLimit																Range0to11[4].LowLimit		
74	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range0to11[4].OutputControl		
75								Inv				Type			ToThisCtr		Range0to11[4].ConfigFlags	®	Range0To11[4].ToThisCounter_0 Range0To11[4].ToThisCounter_1 Range0To11[4].Type Range0To11[4].Invert
76 77	Range0to11[5].HighLimit																Range0to11[5].HighLimit		
78 79	Range0to11[5].LowLimit																Range0to11[5].LowLimit		
80	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range0to11[5].OutputControl		
81								Inv				Type			ToThisCtr		Range0to11[5].ConfigFlags	®	Range0To11[5].ToThisCounter_0 Range0To11[5].ToThisCounter_1 Range0To11[5].Type Range0To11[5].Invert
82 83	Range0to11[6].HighLimit																Range0to11[6].HighLimit		
84 85	Range0to11[6].LowLimit																Range0to11[6].LowLimit		
86	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range0to11[6].OutputControl		
87								Inv				Type			ToThisCtr		Range0to11[6].ConfigFlags	®	Range0To11[6].ToThisCounter_0 Range0To11[6].ToThisCounter_1 Range0To11[6].Type Range0To11[6].Invert
88 89	Range0to11[7].HighLimit																Range0to11[7].HighLimit		
90 91	Range0to11[7].LowLimit																Range0to11[7].LowLimit		
92	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range0to11[7].OutputControl		
93								Inv				Type			ToThisCtr		Range0to11[7].ConfigFlags	®	Range0To11[7].ToThisCounter_0 Range0To11[7].ToThisCounter_1 Range0To11[7].Type Range0To11[7].Invert
94 95	Range0to11[8].HighLimit																Range0to11[8].HighLimit		
96 97	Range0to11[8].LowLimit																Range0to11[8].LowLimit		
98	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range0to11[8].OutputControl		
99								Inv				Type			ToThisCtr		Range0to11[8].ConfigFlags	®	Range0To11[8].ToThisCounter_0 Range0To11[8].ToThisCounter_1 Range0To11[8].Type Range0To11[8].Invert
100 101	Range0to11[9].HighLimit																Range0to11[9].HighLimit		
102 103	Range0to11[9].LowLimit																Range0to11[9].LowLimit		
104	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range0to11[9].OutputControl		

Table 30 - Configuration Array for the 1769-HSC Module

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Description		
105								Inv				Type			ToThisCtr		Range0to11[9].ConfigFlags	®	Range0To11[9].ToThisCounter_0 Range0To11[9].ToThisCounter_1 Range0To11[9].Type Range0To11[9].Invert
106 107	Range0to11[10].HighLimit																Range0to11[10].HighLimit		
108 109	Range0to11[10].LowLimit																Range0to11[10].LowLimit		
110	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range0to11[10].OutputControl		
111								Inv				Type			ToThisCtr		Range0to11[10].ConfigFlags	®	Range0To11[10].ToThisCounter_0 Range0To11[10].ToThisCounter_1 Range0To11[10].Type Range0To11[10].Invert
112 113	Range0to11[11].HighLimit																Range0to11[11].HighLimit		
114 115	Range0to11[11].LowLimit																Range0to11[11].LowLimit		
116	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range0to11[11].OutputControl		
117								Inv				Type			ToThisCtr		Range0to11[11].ConfigFlags	®	Range0To11[11].ToThisCounter_0 Range0To11[11].ToThisCounter_1 Range0To11[11].Type Range0To11[11].Invert

(1) Bit 12 is Counter 0; bit 13, Counter 1; bit 14, Counter 2; bit 15, Counter 3. Individual counter reset function = 0: reset enable (default), 1: reset disable. See page 73
(2) The default value for NumberOfCounters is 01 (two counters declared).
(3) The default value for CtrnMaxCount is 2,147,483,647 decimal for counters 0 and 1. The default value is 0 for counters 2 and 3.
(4) The default value for CtrnMinCount is -2,147,483,648 decimal for counters 0 and 1. The default value is 0 for counters 2 and 3.
(5) The default value for CtrnScalar is 1 for counters 0 and 1. The default value is 0 for counters 2 and 3.
(6) The default value for CtrnCyclicRateUpdateTime is 10 for counters 0 and 1. The default value is 0 for counters 2 and 3.

The default value for the input array is all zeroes.

Table 31 - Input Array for the 1769-HSC Module

Word	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Description		
0											Z1	B1	A1	Z0	B0	A0	InputStateA0 -- InputStateZ1		
1	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Readback.0 -- Readback.15		
2	InvalidRangeLimit12…15				InvalidCtrAssignToRange12…15				GenErr	InvOut	MCfg		Out0Overcurrent -- Out3…				Status Flags	→	InvalidRangeLimit12 ... 15 InvalidCtrAssignToRange12 ... 15 GenError InvalidOutput ModConfig Out0Overcurrent0 ... 3
3	R15	R14	R13	R12	R11	R10	R09	R08	R07	R06	R05	R04	R03	R02	R01	R00	RangeActive.0 -- RangeActive.15		
4 5	Ctr[0].CurrentCount																Ctr[0].CurrentCount		
6 7	Ctr[0].StoredCount																Ctr[0].StoredCount		
8 9	Ctr[0].CurrentRate																Ctr[0].CurrentRate		
10 11	Ctr[0].PulseInterval																Ctr[0].PulseInterval		
12										C0PW	RV		IDW	REZ	CUdf	COvf	Ctr[0].StatusFlags	→	Ctr[0].Overflow Ctr[0].Underflow Ctr[0].RisingEdgeZ Ctr[0].InvalidDirectWrite ---------------- Ctr[0].RateValid Ctr[0].PresetWarning
13																	Reserved		
14 15	Ctr[1].CurrentCount																Ctr[1].CurrentCount		
16 17	Ctr[1].StoredCount																Ctr[1].StoredCount		
18 19	Ctr[1].CurrentRate																Ctr[1].CurrentRate		
20 21	Ctr[1].PulseInterval																Ctr[1].PulseInterval		
22										C1PW	RV	IC	IDW	REZ	CUdf	COvf	Ctr[1].StatusFlags	→	Ctr[1].Overflow Ctr[1].Underflow Ctr[1].RisingEdgeZ Ctr[1].InvalidDirectWrite Ctr[1].InvalidCounter Ctr[1].RateValid Ctr[1].PresetWarning
23																	Reserved		
24 25	Ctr[2].CurrentCount																Ctr[2].CurrentCount		
26 27	Ctr[2].CurrentRate																Ctr[2].CurrentRate		
28										C2PW	RV	IC	IDW		CUdf	COvf	Ctr[2].StatusFlags	→	Ctr[2].Overflow Ctr[2].Underflow ---------------- Ctr[2].InvalidDirectWrite Ctr[2].InvalidCounter Ctr[2].RateValid Ctr[2].PresetWarning
29																	Reserved		
30 31	Ctr[3].CurrentCount																Ctr[3].CurrentCount		
32 33	Ctr[3].CurrentRate																Ctr[3].CurrentRate		
34										C3PW	RV	IC	IDW		CUdf	COvf	Ctr[3].StatusFlags	→	Ctr[3].Overflow Ctr[3].Underflow ---------------- Ctr[3].InvalidDirectWrite Ctr[3].InvalidCounter Ctr[3].RateValid Ctr[3].PresetWarning

The default value for the output array is all zeroes.

Table 32 - Output Array for the 1769-HSC Module

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	Description	
0	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	OutputOnMask.0 -- OutputOnMask.15	
1	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	OutputOffMask.0 -- OutputOffMask.15	
2	R15	R14	R13	R12	R11	R10	R09	R08	R07	R06	R05	R04	R03	R02	R01	R00	RangeEn.0 -- RangeEn.15	
3																	Reserved	
4									RBF								ResetBlownFuse	
5							RPW	RREZ	Z Inh	Z Inv	D Inh	D Inv	RCU	RCO	SP	En	Ctr0ControlBits →	Ctr0En Ctr0SoftPreset Ctr0ResetCountOverflow Ctr0ResetCountUnderflow Ctr0DirectionInvert Ctr0DirectionInhibit Ctr0ZInvert Ctr0ZInhibit Ctr0ResetRisingEdgeZ Ctr0ResetCtrPresetWarning
6							RPW	RREZ	Z Inh	Z Inv	D Inh	D Inv	RCU	RCO	SP	En	Ctr1ControlBits	
7							RPW					D Inv	RCU	RCO	SP	En	Ctr2ControlBits	
8							RPW					D Inv	RCU	RCO	SP	En	Ctr3ControlBits	
9																	Reserved	
10 11	Range12To15[0].HiLimOrDirWr																Range12To15[0].HiLimOrDirWr	
12 13	Range12To15[0].LowLimit																Range12To15[0].LowLimit	
14	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range12To15[0].OutputControl.0 ... .15	
15								Inv			LDW	Type			ToThisCtr		Range12To15[0].Config Flags →	Range12To15[0].ToThisCounter_0 Range12To15[0].ToThisCounter_1 Range12To15[0].Type Range12To15[0].LoadDirectWrite Range12To15[0].Invert
16 17	Range12To15[1].HiLimOrDirWr																Range12To15[1].HiLimOrDirWr	
18 19	Range12To15[1].LowLimit																Range12To15[1].LowLimit	
20	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range12To15[1].OutputControl.0 ... .15	
21								Inv			LDW	Type			ToThisCtr		Range12To15[1].Config Flags →	Range12To15[1].ToThisCounter_0 Range12To15[1].ToThisCounter_1 Range12To15[1].Type Range12To15[1].LoadDirectWrite Range12To15[1].Invert
22 23	Range12To15[2].HiLimOrDirWr																Range12To15[2].HiLimOrDirWr	
24 25	Range12To15[2].LowLimit																Range12To15[2].LowLimit	
26	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range12To15[2].OutputControl.0 ... .15	
27								Inv			LDW	Type			ToThisCtr		Range12To15[2].Config Flags →	Range12To15[2].ToThisCounter_0 Range12To15[2].ToThisCounter_1 Range12To15[2].Type Range12To15[2].LoadDirectWrite Range12To15[2].Invert
28 29	Range12To15[3].HiLimOrDirWr																Range12To15[3].HiLimOrDirWr	
30 31	Range12To15[3].LowLimit																Range12To15[3].LowLimit	
32	Out15	Out14	Out13	Out12	Out11	Out10	Out09	Out08	Out07	Out06	Out05	Out04	Out03	Out02	Out01	Out00	Range12To15[3].OutputControl.0 ... .15	
33								Inv			LDW	Type			ToThisCtr		Range12To15[3].Config Flags →	Range12To15[3].ToThisCounter_0 Range12To15[3].ToThisCounter_1 Range12To15[3].Type Range12To15[3].LoadDirectWrite Range12To15[3].Invert

Notes:

History of Changes

This appendix summarizes the revisions to this manual. Reference this appendix if you need information to determine what changes have been made across multiple revisions. This can be especially useful if you are deciding to upgrade your hardware or software based on information added with previous revisions of this manual.

1769-UM006D-EN-P, May 2011

- Changed the hysteresis detection and configuration section to indicate that the Ctr[n].CurrentRate is reported as zero if the change in counts over the update time cycle is equal to or less than the minimum number of programmed counts.
- Added that the individual counter reset function for the 1769-HSC/B module applies to only CompactLogix controllers and not MicroLogix controllers.
- Changed hex equivalent values for general common hardware errors.
- Changed the input file update time to 500 ìs, max.

1769-UM006C-EN-P, November 2010

Updated the counter reset in the configuration array for bits 12…15. The individual counter reset functionality for the 1769-HSC series B module is reverse logic with a 0 = enabled and a 1 = disabled for RSLogix 5000 software. The firmware change applies to only the 1769-HSC series B module.

Notes:

The following terms and abbreviations are used throughout this manual. For definitions of terms not listed here, refer to the Allen-Bradley Industrial Automation Glossary, publication AG-7.1.

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

actuator 1) A device that converts an electrical signal into mechanical motion. 2) In a general sense, any machine/process load device (for example, transducer) of a controller output circuit. See **output device** (page 162).

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

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

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

analog circuit 1) A circuit in which the signal can vary continuously between specified limits. 2) A circuit that provides a continuous function. 3) Contrasted with **digital circuit** (page 159).

asynchronous 1) Lacking a regular time relationship; not related through repeating time patterns. 2) Contrasted with **synchronous** (page 163).

AWG See American wire gauge (page 157).

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

balanced circuit 1) A circuit whose two sides are electrically alike and symmetrical to a common reference point, usually ground. 2) Contrasted with **unbalanced circuit** (page 163).

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

baseband link 1) A communication link with only one channel, encoded by on/off switching. Examples: DH and DH+ links. 2) Contrasted with **carrier-band link** (page 158) and **broadband link** (page 158).

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

broadband link 1) A communication link that can have multiple channels. Each channel signal modulates its own carrier frequency. Example: LAN/1 link. 2) Contrasted with **carrier-band link** (page 158) and **baseband link** (page 157).

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

carrier-band link 1) A communication link with a single channel whose signal modulates a carrier frequency. Example: Data Highway II link. 2) Contrasted with **broadband link** (page 158) and **baseband link** (page 157).

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

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

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

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

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

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

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

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

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

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

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

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

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

differential 1) Pertaining to a method of signal transmission through two wires. The transmission always has opposite states. The signal data is the polarity difference between the wires; when one is high, the other is low. Neither wire is grounded. The circuit can be either a balanced circuit, a floating circuit, or a circuit with a high-impedance path to ground from either end. Usually used in reference to encoders, analog I/O circuits, and communication circuits. 2) Contrasted with **single-ended** (page 163).

digital circuit 1) A switching circuit that has only two states: on and off. 2) A circuit that provides a step function. 3) Contrasted with **analog circuit** (page 157).

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

direct I/O module 1) An I/O module for which each input or output that has an individual connection that corresponds directly to a data table bit or word that stores the value of the signal at that I/O circuit (digital or analog). This lets the ladder logic have direct access to the I/O values. 2) Contrasted with **intelligent I/O module** (page 161).

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

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

duration 1) The time during which something exists or lasts. For example, the length of time that a signal is high can be described as the duration of a pulse. 2) Compare **interval** (page 161) and **period** (page 162).

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

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

- Linear encoder—is a feedback element that directly converts linear position (absolute or incremental) into a digital signal.
- Rotary encoder—is a feedback element that converts rotary position (absolute or incremental) into a digital signal. Often, the directly measured rotary position is used to determine a linear position through gearing.

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

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

factory wiring 1) Wiring completed before the product was shipped from the factory in which it was built. 2) Contrasted with **field wiring** (page 160).

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

field wiring 1) Wiring connected by the user after the user receives the product. 2) Contrasted with **factory wiring** (page 160).

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

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

input See sensor (page 163).

intelligent I/O module 1) An I/O module that provides some on-board processing of input values to control some output values without going through the data table for control by the ladder logic. An intelligent I/O module can have digital I/O circuits, analog I/O circuits, or both. 2) Contrasted with **direct I/O module** (page 159).

interval 1) The length of time between events or states. For example, the length of time between when a signal is high can be described as the interval between pulses. 2) Compare **duration** (page 159) and **period** (page 162).

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

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

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

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

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

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

local I/O 1) I/O connected to a processor across a backplane or a parallel link, thus limiting its distance from the processor. 2) Contrasted with **remote I/O** (page 162).

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

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

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

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

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

node The connection point at which media access is provided.

output device 1) For a computer, a CRT terminal or printer. 2) For a programmable controller, see **actuator** (page 157).

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

period 1) The length of time for a cyclical operation to complete one full cycle. For example, the length of time from one point in a cyclical wave form to the same point in the next cycle of the wave form. 2) Compare **duration** (page 159) and **interval** (page 161).

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

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

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

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

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

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

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

remote I/O 1) I/O connected to a processor across a serial link. With a serial link, remote I/O can be located long distances from the processor. 2) Contrasted with **local I/O** (page 161).

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

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

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

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

single-ended 1) Unbalanced, as when one side is grounded. See **unbalanced circuit** (page 163) 2) Contrasted with **differential** (page 159).

synchronous 1) In step or in phase, as applied to two or more circuits, devices, or machines. 2) Contrasted with **asynchronous** (page 157).

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

unbalanced circuit 1) A circuit whose two sides are electrically dissimilar, as when one side is grounded. 2) Contrasted with **balanced circuit** (page 157).

Notes:

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products.
At http://www.rockwellautomation.com/support/, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/support/.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html, or contact your local Rockwell Automation representative.

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Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

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