FLEX I/O Very High-speed Counter Module

Catalog Number 1794-VHSC

Allen-Bradley

by **ROCKWELL AUTOMATION**

Important User Information

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

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

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

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

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

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

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

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

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

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

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

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

Table of Contents

About This Publication

Read this preface to familiarize yourself with the rest of the manual. It provides information concerning:

- Who should use this manual.
- The purpose of this manual.
- Related documentation.

Rockwell Automation recognizes that some of the terms that are currently used in our industry and in this publication are not in alignment with the movement toward inclusive language in technology. We are proactively collaborating with industry peers to find alternatives to such terms and making changes to our products and content. Please excuse the use of such terms in our content while we implement these changes.

Who Should Use this Publication

You must be able to program and operate an Allen-Bradley® programmable controller to make efficient use of this module.

We assume that you know how to do this in this manual. If you do not, see the appropriate programming and operations manual for the associated programmable controller before you attempt to use this module.

Download Firmware, AOP, EDS, and Other Files

Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes from the Product Compatibility and Download Center at rok.auto/pcdc.

Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and is not intended to reflect all changes.

Topic	Page
Updated template	throughout
Added inclusive language acknowledgment	5
Added chapter on configuration using Studio 5000 Logix Designer	49-50

Additional Resources

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

Additional Resources

Resource	Description
FLEX I/O Selection Guide, publication 1794-SG002	A description and overview of the 1794 series FLEX I/O and FLEX I/O-XT™ modules and compatible control platforms.
FLEX I/O Very High-speed Counter Module Installation Instructions, publication 1794-IN067	Describes how to install the FLEX I/O Very High-speed Counter Module.
FLEX I/O DC Power Supply Installation Instructions, publication 1794-IN069	Describes how to install the FLEX I/O DC Power Supply Catalog Number 1794-PS13, 1794-PS3.
ControlLogix System User Manual, publication 1756-UM001	Detailed information on how to install, configure, and troubleshoot the ControlLogix® module in your ControlLogix application.
EtherNet/IP Modules Installation Instructions, publication ENET-IN002	Describes how to install EtherNet/IP bridges.
Ethernet Reference Manual, publication ENET-RM002	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.

Additional Resources (Continued)

Resource	Description
System Security Design Guidelines Reference Manual, publication SECURE-RM001	Provides guidance on how to conduct security assessments, implement Rockwell Automation products in a secure system, harden the control system, manage user access, and dispose of equipment.
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication IC-TD002	Provides a quick reference tool for Allen-Bradley industrial automation controls and assemblies.
Safety Guidelines for the Application, Installation, and Maintenance of Solid-state Control, publication SGI-1.1	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications.	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at rok.auto/literature.

Overview of the Very High-speed Counter Module

Overview

This chapter gives you information on features of the modules, how the module communicates with controllers and how the module operates.

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Module Description

The FLEX™ I/O Very High-speed Counter (1794-VHSC) module performs high speed counting for industrial applications. The module is an intelligent I/O module that interfaces signals with any Allen-Bradley programmable controller that has Ethernet capability.

The module, once configured for its intended purpose, can continue to operate without Flexbus power.

> **IMPORTANT** Customer power is required for the module, inputs, and outputs.

After scanning the inputs and updating the outputs, the input data is converted to a specified data type in a digital format to be transferred to the processor's data table on request. Command and configuration data is sent from the programmable controller data tables to the module via Ethernet.

Module Features

The 1794-VHSC module counts pulses from encoders (such as Allen-Bradley Bulletin 845), pulse generators or mechanical limit switches, or proximity switches, and returns either a count or frequency in binary format.

The module features include:

- Two counters configurable for three encoder modes, counter mode, period/rate mode, continuous/rate mode, rate measurement, and pulse-width modulation (PWM).
- Four outputs, isolated in pairs.
- Outputs are current-sourcing at 5 or 12...24V DC (0.5 mA max @ 5V; 1 A max @ 12...24V).
- Single-ended or differential inputs.
- 2-phase encoder inputs up to a frequency of 250 kHz (X 4 mode).
- Single-phase counter inputs up to a frequency of 1 MHz.
- Input voltage range of 5V or 24V DC.

- Returns input as count or frequency in binary format.
- Input counts as high as 16,777,215.
- Up to 1 MHz in period/rate or rate measurement frequency modes.
- Outputs can be tied to any or all counter windows.
- Each output has a user-selectable on-off value.
- Outputs can be tied back to an input for cascading.
- Each counter has a user-selectable preset and rollover value.
- Totalization is provided in period/rate, continuous/rate, and rate measurement modes.
- Module can continue counting without Flexbus power (after configuration).
- Outputs have safe state values that can be applied when there is a network failure or the PLC is switched to PROGRAM mode.
- Pulse-width modulation (PWM) mode is available.

The 1794-VHSC module operates in the following modes:

- Counter mode.
- Encoder X1 mode.
- Encoder X2 mode.
- Encoder X4 mode.
- Period/rate mode.
- Continuous/rate mode.
- Rate measurement frequency mode.
- Pulse-width modulation (PWM).

What the Module Does

The Very High-speed Counter module performs high-speed scaling calculation operations for various industrial applications. The module interfaces with a FLEX I/O family EtherNet/IP™ adapter, which then communicates with a programmable controller processor.

The adapter transfers data to and from the module over the Flexbus. Instructions in the programmable controller facilitate this communication and let you write output values and configure the module's mode of operation. describes the communication process.

Figure 1 - FLEX I/O Communication Process

1. The adapter transfers your configuration data to the module.

2. External devices transmit frequency signals to the module.

4. The adapter transfers the data over the Flexbus.

5. The adapter and module determine that the transfer was made without error and input values are within a specified range.

3. The module converts frequency signals into binary format and stores these values until the adapter requests their transfer.

6. EtherNet/IP transfers the data to the programmable controller data table.

1. The adapter transfers your configuration data and commands to the module.

2. External devices generate input signals that are transmitted to the module.

3. The module converts these signals into binary format, and stores these values and controls their output until the adapter requests their transfer.

4. The adapter transfers the data over the Flexbus.

5. The adapter and module determine that the transfer was made without error and inputs values are within a specified range.

6. EtherNet/IP transfers the data to the programmable controller data table.

Notes:

Install Your FLEX I/O VHSC Module

Overview

This chapter describes how to install the 1794-VHSC adapter physically on the DIN rail and connect it to the EtherNet/IP network.

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Before You Install Your Module

Before installing your 1794-VHSC Very High-speed Counter module, you must:

- Calculate the power requirements of all modules in the FLEX I/O system, and,
- Position the keyswitch on the terminal base.

Power Requirements

The current draw through the terminal base determines the terminal base wiring. Verify that the current draw does not exceed 10 A.

⚠️ **ATTENTION:** Total current draw through the terminal base unit is limited to 10 A. Separate power connections may be necessary.

Methods of wiring the terminal base units are shown in <u>Wiring Information on page 16</u>.

Install the Module

Installation of the module consists of:

- Mount the terminal base unit.
- install the 1794-VHSC module into the terminal base unit.
- install the connecting wiring into the terminal base unit.

If you are installing your module into a terminal base unit that is already installed, proceed to <u>Mount on a DIN Rail on page 12</u>.

Mount on a DIN Rail

⚠️ **ATTENTION:** Do not remove or replace a terminal base unit when power is applied. Interruption of the Flexbus can result in unintended operation or machine motion.

Install the Terminal Base Unit

1. Remove the cover plug in the male connector of the unit to which you are connecting this terminal base unit.
2. Check to make sure that the 16 pins in the male connector on the adjacent device are straight and in line so that the mating female connector on this terminal base unit will mate correctly.
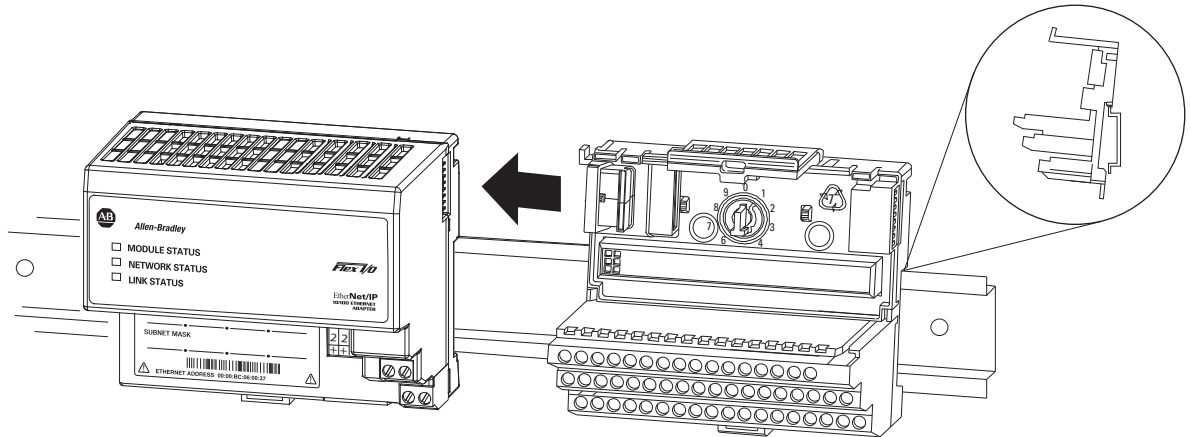
Verify that the female Flexbus connector is fully retracted into the base unit.

3. Position the terminal base at a slight angle and hooked over the top of the 35 x 7.5 mm (1.37 x 0.29 in) DIN rail A (Allen-Bradley part number 199-DR1; 46277-3).
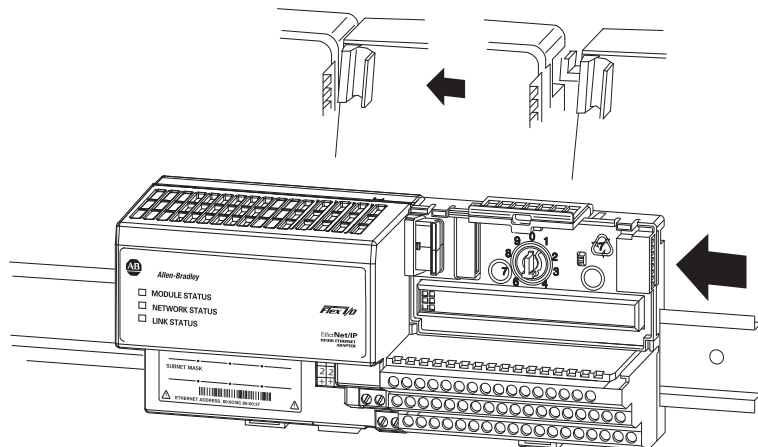
4. Slide the terminal base over tight against the adapter, or proceeding terminal base. Make sure the hook on the terminal base slides under the edge of the adapter, or proceeding terminal base, and the Flexbus connector is fully retracted.
5. Pivot the terminal base onto the DIN rail with the top of the rail hooked under the lip on the rear of the terminal base.
Use caution to make sure that the female Flexbus connector does not strike any of the pins in the mating male connector.

6. Press down on the terminal base unit to lock the terminal base on the DIN rail. If the terminal base does not lock into place, use a screwdriver or similar device to open the locking tab, press down on the terminal base until flush with the DIN rail and release the locking tab to lock the base in place.
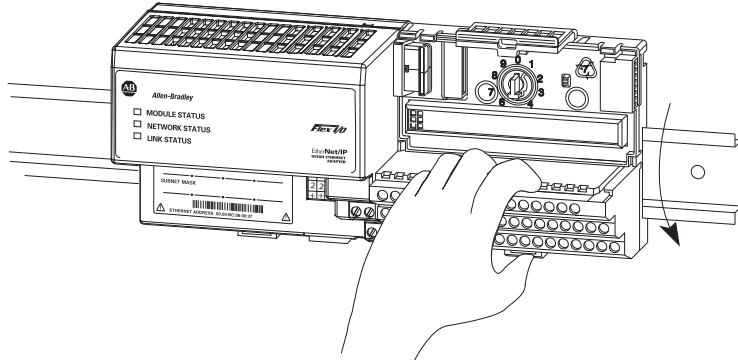
Gently push the Flexbus connector into the side of the adapter, or proceeding terminal base to complete the backplane connection.
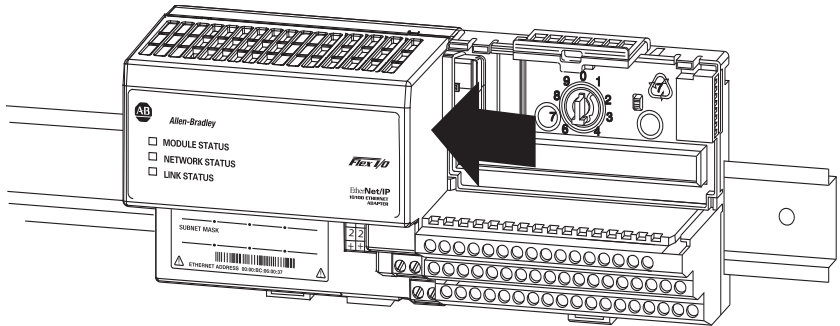
For specific wiring information, see the installation instructions for the module you are installing in this terminal base unit.

7. Repeat the above steps to install the next terminal base unit.
Ensure that the cover of the Flexbus connector on the last terminal base unit is in place.

Mount on a Panel or Wall

Installation of a FLEX I/O system on a wall or panel consists of:

- Laying out the drilling points on the wall or panel.
- Drilling the pilot holes for the mounting screws.
- Mounting the adapter mounting plate.
- Installing the terminal base units and securing them to the wall or panel.

Use the mounting kit 1794-NM1 for panel or wall mounting.

Figure 2 – 1794-NM1 Mounting Kit
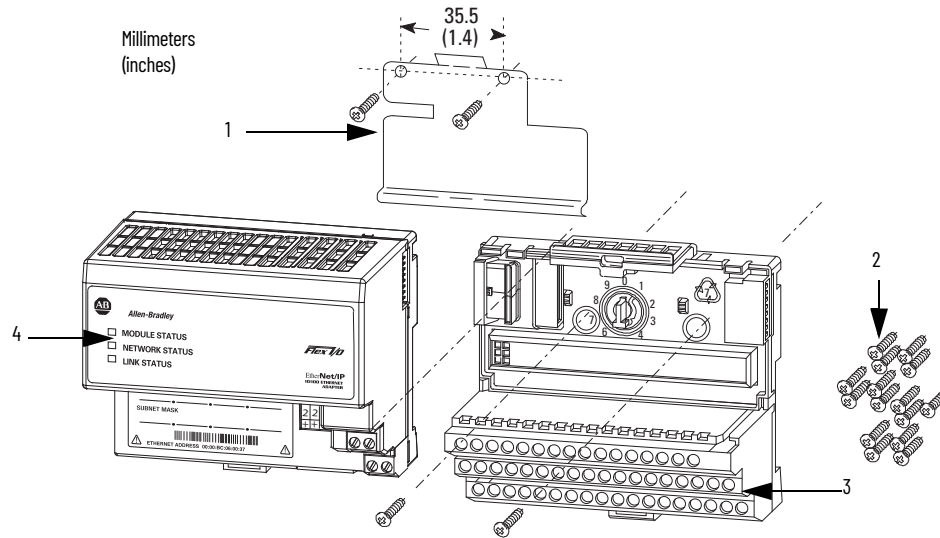
	Description		Description
1	Mounting plate for adapter	3	Terminal base unit (not included)
2	#6 self-tapping screws	4	Adapter (not included)

To install the mounting plate on a wall or panel:

Lay out the required points on the wall or panel as shown in the <u>Figure 3 on page 14</u>.

Figure 3 – Drilling Dimensions for Panel or Wall Mounting
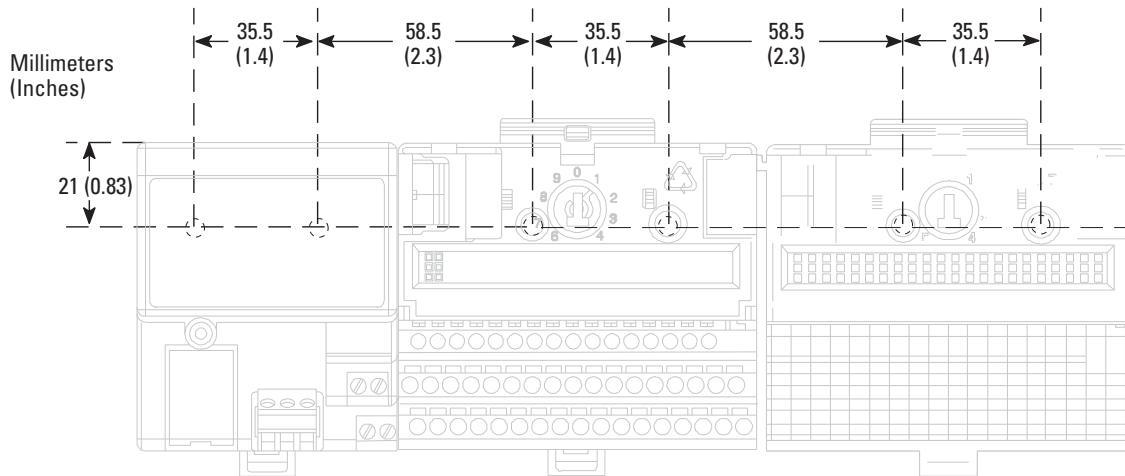
8. Drill the necessary holes for the #6 self-tapping mounting screws.

9. Mount the mounting plate for the adapter using two #6 self-tapping screws – 18 screws are included for mounting up to 8 modules and the adapter.

> **IMPORTANT**   Make certain that the mounting plate is properly grounded to the panel. See Industrial Automation Wiring and Grounding Guidelines, publication <u>1770-IN041</u>.

10. Hold the adapter at a slight angle and engage the top of the mounting plate in the indention on the rear of the adapter.

11. Press the adapter down flush with the panel until the locking lever locks.

12. Position the terminal base unit up against the adapter and push the female bus connector into the adapter.

13. Secure to the wall with two #6 self-tapping screws.

14. Repeat for each remaining terminal base unit.

Mount the 1794-VHSC Module on the Terminal Base

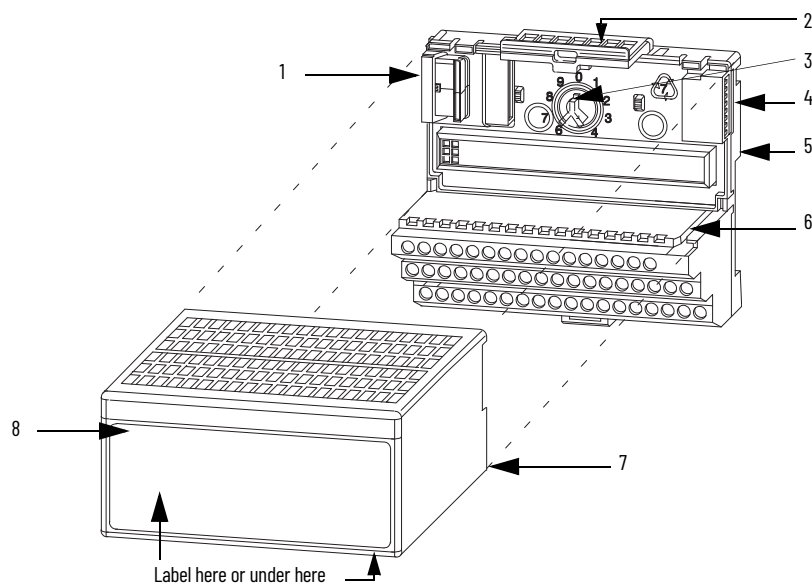The 1794-VHSC module mounts on a 1794-TB3G or 1794-TB3GS terminal base.

1. Rotate keyswitch (3) on terminal base unit (4) clockwise to position 1 as required for the module.
   Do not change the position of the keyswitch after wiring the terminal base.

Figure 4 - FLEX I/O Terminal Base and Very High-speed Counter Parts

Label here or under here

	Description		Description
1	Flexbus connector	5	Base unit
2	Latching mechanism	6	Alignment groove
3	Keyswitch	7	Alignment bar
4	Cap plug	8	Module

2. Make certain the Flexbus connector (1) is pushed all the way to the left to connect with the neighboring terminal base or adapter.
   You cannot install the module unless the connector is fully extended.

3. Make sure the pins on the bottom of the module are straight so they align properly with the connector in the terminal base unit.

⚠ **ATTENTION:** If you remove or insert the module while the backplane power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations. Be sure that power is removed or the area is nonhazardous before proceeding.

4. Position the module (8) with its alignment bar (7) aligned with the groove (6) on the terminal base.

5. Press firmly and evenly to seat the module in the terminal base unit. The module is seated when the latching mechanism is locked into the module.

6. Remove cap plug and attach another terminal base unit to the right of this terminal base unit if necessary.
Make sure that the last terminal base has the cap plug in place.

IMPORTANT	The adapter is capable of addressing eight modules. Do not exceed a maximum of eight terminal base units in your system.

Wiring Information

This section provides essential wiring information for the 1794-TB3G, 1794-TB3GK, and 1794-TB3GS terminal base units. It also includes instructions for connecting wiring to the FLEX I/O module.

Figure 5 - Wire the Terminal Base Units (1794-TB3G shown)

Daisy chaining

24V DC

Note: Do not use any digital modules in this configuration.

Wiring when total current draw is less than 10 A

Individual

24V DC

24V DC

24V DC

Note: Use this configuration if using any digital output modules that could couple transients to the 24V supply.

1794-VHSC module wiring separate from digital wiring.

Wiring when total current draw is greater than 10 A
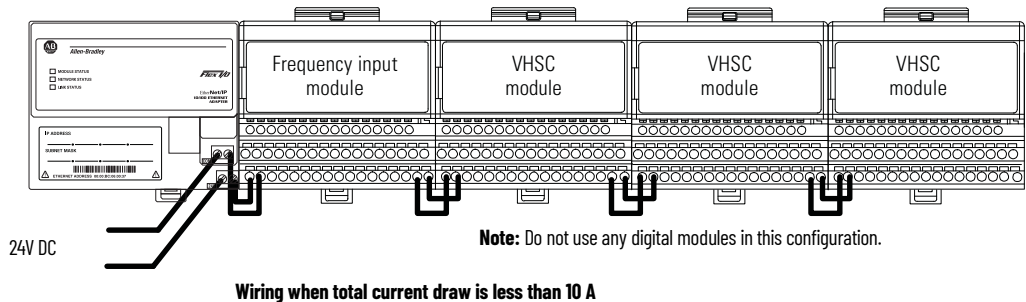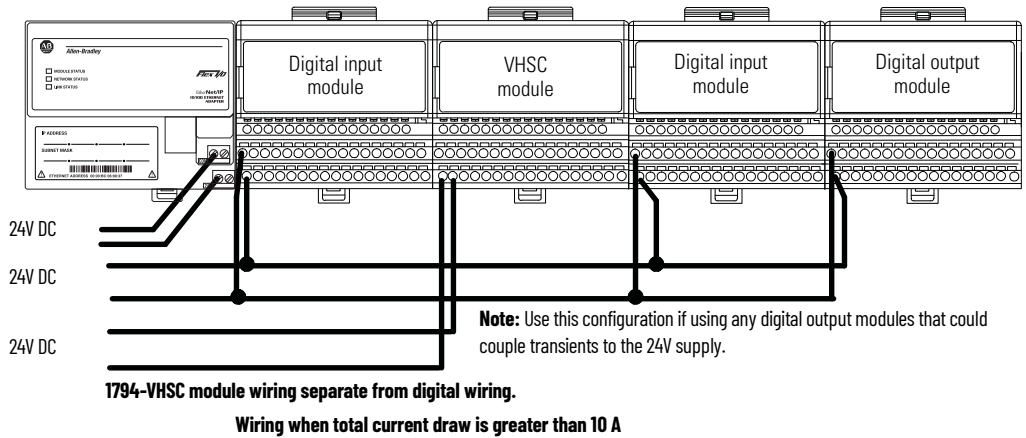
⚠	**ATTENTION:** Take note of the following considerations when wiring your terminal base units: • All modules must be frequency or analog modules for the daisy chain configuration. • Use the individual type of configuration for any "noisy" DC digital I/O modules in your system. • All modules powered by the same power supply must be frequency or analog modules for the combination type of configuration.

Wiring the FLEX I/O VHSC Input module is done using the 1794-TB3G, 1794-TB3GK, or 1794-TB3GS terminal base unit.

Figure 6 - 1794-TB3G, 1794-TB3GK, and 1794-TB3GS Wiring Connections

1794-TB3G or 1794-TB3GK

34 and 50 = 24V DC
35 and 51 = common
16 and 33 = chassis
40...45 = chassis ground

1794-TB3GS

Label placed at top of wiring area

35 and 51 = common
34 and 50 = 24V DC
16 and 33 = chassis ground
40...45 = chassis ground
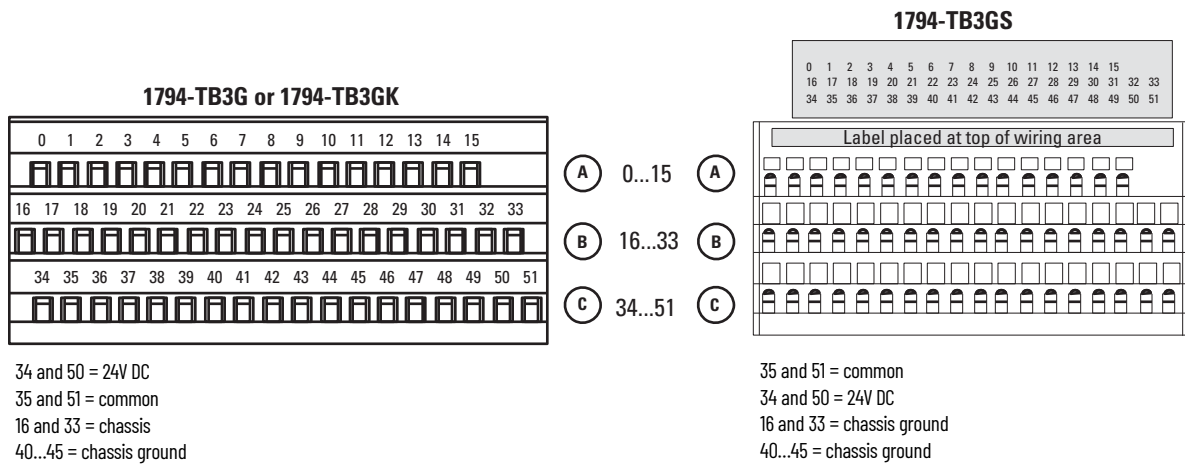
Connect Wiring to the FLEX I/O VHSC Input Module

Wiring to the 1794-VHSC Input module is made through the terminal base unit on which the module mounts.

The module is compatible with the 1794-TB3G, 1794-TB3GK, and 1794-TB3GS terminal base units.

Connect Wiring Using a 1794-TB3G, 1794-TB3GK, or 1794-TB3GS Terminal Base Unit

1. Connect the individual signal wiring to numbered terminals on the 0...15 row (**A**) for 24V inputs (terminals 0...5 and 8...13) and 17...32 row (**B**) for 5V inputs (terminals 17...22 and 25...30) on the terminal base unit. Connect the input devices as shown in Table 1 on page 18.

> ⚠ **ATTENTION:** Do not connect 24V signals to the 5V input terminals. Permanent damage to the module results.

2. Connect individual output wiring to terminals 6, 7 and 14, 15 on the 0...15 row (A) and terminals 23, 24 and 31, 32 on the 16...32 row (B) on the terminal base unit. Connect output return wiring for channels 0, 1, 2, and 3 to terminals 23, 24 31 and 32 respectively. Connect the output devices as shown in Table 1 on page 18

3. Terminate shields to terminals 16 or 33 on row B, or 40...45 on row C.

4. Connect 24V DC to terminal 34 on the 34...51 row (C), and 24V common to terminal 35 on the 34...51 row (C).

> ⚠ **ATTENTION:** To reduce susceptibility to noise, power frequency modules and digital modules from separate power supplies. Do not exceed a length of 10 m (33 ft) for DC power cabling.

5. If daisy chaining the 24V DC power to the next 1794-TB3G, 1794-TB3GK, or 1794-TB3GS base unit, connect a jumper from terminal 50 (24V) on this base unit to terminal 34 and from terminal 51 (24V DC common) to terminal 35 on the next 1794-TB3G, 1794-TB3GK, or 1794-TB3GS base unit.

6. Connect output power wiring to terminals 37 (+) and 39 (-) for outputs 0 and 1, and terminals 46 (+) and 48 (-) for outputs 2 and 3.

> ⚠️ **ATTENTION:** Use extreme care when connecting wiring to an adjacent terminal base unit. Wiring for the 1794-TB3G and 1794-TB3GS terminal base units differs from other 1794 terminal base units.

> ⚠️ **ATTENTION:** Do not daisy chain power or ground from the 1794-TB3G, 1794-TB3GK, or 1794-TB3GS terminal base unit to any AC or DC digital module terminal base unit.

> ⚠️ **ATTENTION:** 24V DC power must be applied to your module before operation. If power is not applied, the module position appears to the adapter as an empty slot in your chassis. If the adapter does not recognize your module after installation is completed, cycle power to the adapter.

Figure 7 - Connections for Terminal Base 1794-TB3G or 1794-TB3GK shown
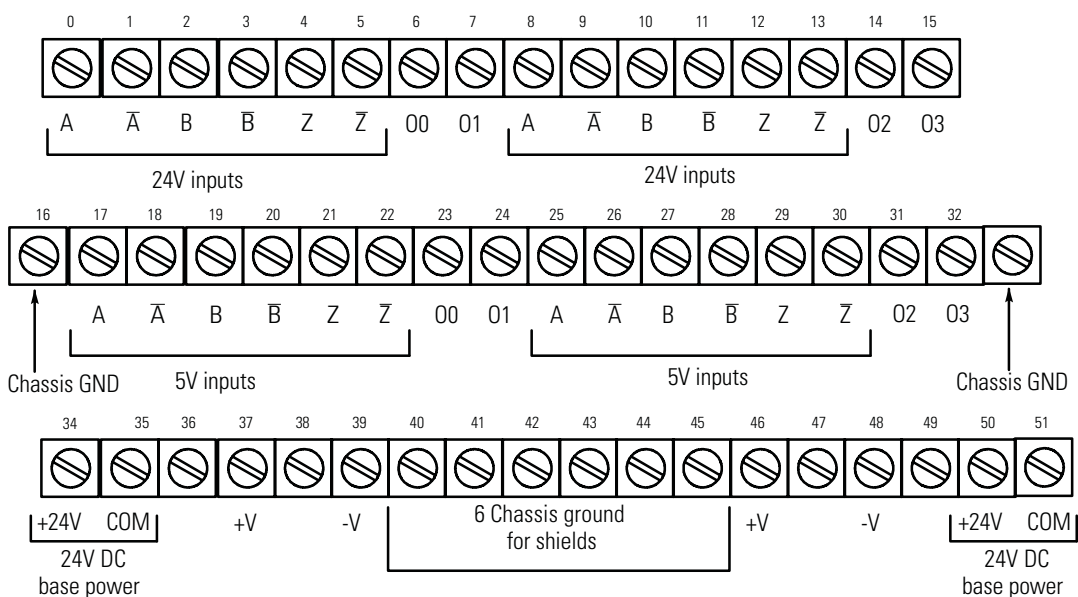
Where: $A, \overline{A}$ - incremental encoder input A (+5V or +24V DC)
$B \ \overline{B}$ - incremental encoder input B (+5V or +24V DC)
$Z, \overline{Z}$ - incremental encoder input Z (+5V or +24V DC)
O = sourcing outputs
R = returns for sourcing outputs

+V = +5V or +24V DC isolated power externally supplied for outputs (1 A max)
-V = negative isolated power connection (1 A max)
+24V DC = 24V DC terminal base power for module
COM = return for +24V DC terminal base power for module
Chassis Gnd = chassis ground for input or output cable shields

Table 1 - Wiring connections for the 1794-VHSC High-Speed Counter Module

| Incremental Encoder Input	Terminal Base Units 1794-TB3G, 1794-TB3GK, 1794-TB3GS	
	Channel 0	Channel 1
+24V Inputs		
Input $\overline{A}$	0	8
Input A	1	9
Input B	2	10
Input $\overline{B}$	3	11
Input $\overline{Z}$	4	12
Input Z	5	13

Table 1 - Wiring connections for the 1794-VHSC High-Speed Counter Module (Continued)

Incremental Encoder Input	Terminal Base Units 1794-TB3G, 1794-TB3GK, 1794-TB3GS				
	Channel 0		Channel 1		
+5V Inputs					
Input A	17		25		
Input A	18		26		
Input B	19		27		
Input B	20		28		
Input Z	21		29		
Input Z	22		30		
Outputs					
Output	Sourcing Out	Return	Output	Sourcing Out	Return
O0	6	23	O1	7	24
O2	14	31	O3	15	32
+24V DC base power	Terminals 34 and 50				
+24V DC COM	Terminals 35 and 51				
+5V or +24V output power	Terminals 37 and 46				
-V output power	Terminals 39 and 48				
Chassis GND	Terminals 16, 33, and 40...45				

ATTENTION: Total current draw through the terminal base unit is limited to 10 A. Separate power connections to the terminal base unit may be necessary.

Figure 8 - Example of Quadrature Encoder Differential Wiring to a 1794-TB3G or 1794-TB3GK Terminal Base Unit
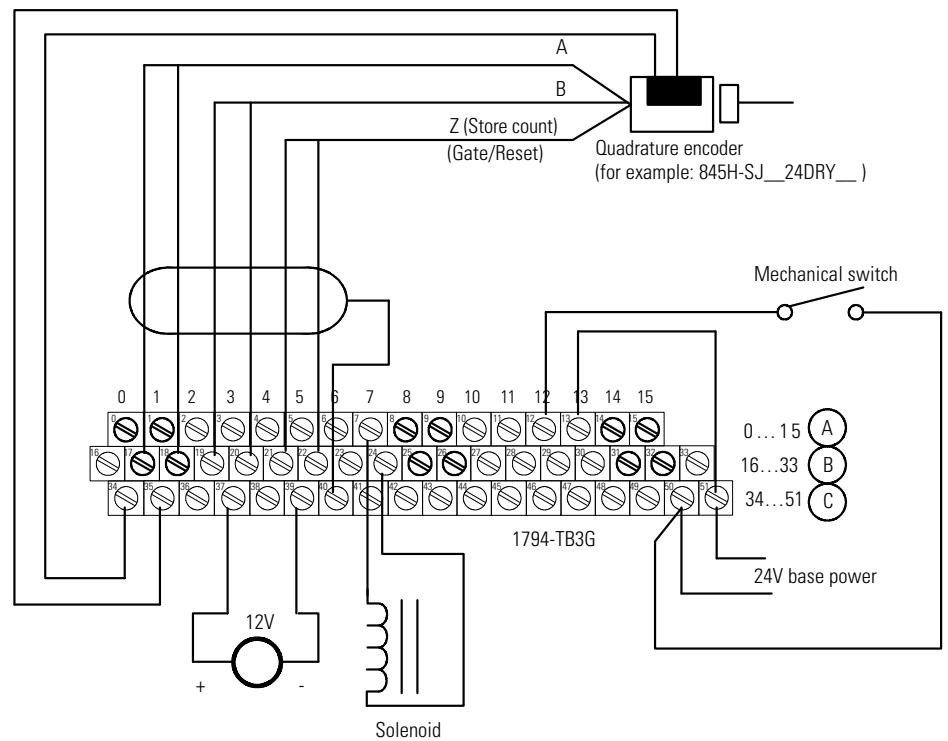
ATTENTION: Keep exposed area of inner conductor as short as possible.

Notes:

Very High-speed Counter Module Features

Overview

This chapter gives you information on features of the modules, how the module communicates with controllers and how the module operates.

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Module Features

The 1794-VHSC module counts pulses from encoders (such as Allen-Bradley Bulletin 845), pulse generators or mechanical limit switches, or proximity switches, and returns either a count or frequency in binary format.

The module features include:

- Two counters configurable for three encoder modes, counter mode, period/rate mode, continuous/rate mode, rate measurement, and pulse-width modulation (PWM).
- Four outputs, isolated in pairs.
- Outputs are current-sourcing at 5 or 12...24V DC (0.5 mA max @ 5V; 1 A max @ 12...24V).
- Single-ended or differential inputs.
- 2-phase encoder inputs up to a frequency of 250 kHz (X 4 mode).
- Single-phase counter inputs up to a frequency of 1 MHz.
- Input voltage range of 5V or 24V DC.
- Returns input as count or frequency in binary format.
- Input counts as high as 16,777,215.
- Up to 1 MHz in period/rate or rate measurement frequency modes.
- Outputs can be tied to any or all counter windows.
- Each output has a user-selectable on-off value.
- Outputs can be tied back to an input for cascading.
- Each counter has a user-selectable preset and rollover value.
- Totalization is provided in period/rate, continuous/rate, and rate measurement modes.
- Module can continue counting without Flexbus power (after configuration).
- Outputs have safe state values that can be applied when there is a network failure or the PLC is switched to PROGRAM mode.
- Pulse-width modulation (PWM) mode is available.

The 1794-VHSC module operates in the following modes:

- Counter mode.
- Encoder X1 mode.
- Encoder X2 mode.
- Encoder X4 mode.
- Period/rate mode.
- Continuous/rate mode.
- Rate measurement frequency mode.
- Pulse-width modulation (PWM).

Encoder or Counter Mode

The operation of encoder and counter modes is identical. The only difference between the two modes is in the type of feedback used.

Use the counter mode if you need the module to read incoming pulses from a maximum of two encoders (single-ended or differential), counters, pulse generators, mechanical limit switches, and so on, and return them to the programmable controller as a binary number (0…16,777,215).

Use the encoder modes if you need the module to read incoming quadrature pulses and return them to the programmable controller as a binary number (0…16,777,215). In these modes, the module accepts two-phase quadrature feedback and counts up or down depending upon the condition of the phase B input for each counter.

The operation of the module in the encoder/counter modes is as follows:

- Counter mode – channel B is direction control (up or down). Channel A input is used for pulse. The count is bidirectional with the direction determined by channel B.
- Encoder X1 – A bidirectional count mode; counting up or down, using quadrature input signals.
- Encoder X2 – A bidirectional count mode, using quadrature input signals, with two times the resolution of X1.
- Encoder X4 – A bidirectional count mode, using quadrature input signals, with four times the resolution of X1.

Each of the counters in encoder/counter mode has values associated with it. These are:

- Preset value
- Rollover value

Counter Mode

The counter mode allows the module to read incoming pulses and return them to the programmable controller processor as a binary number (0…16,777,215).

In the counter mode, direction (up counting or down counting) is determined by the phase B input, which can be a random signal. If Phase B is high, the counter counts down. If phase B is low or floating, that is, not connected, the counter counts up.

Table 2 - Counter Mode Direction

Phase B Input	Count Direction
High	Down
Low or floating (not included)	Up

The module reads incoming pulses from a maximum of two encoders (single-ended or differential), counters, pulse generators, mechanical limit switches, and so forth, and returns a count to the programmable controller processor in a binary number (0...16,777,215).

The counter mode accepts only one-phase feedback. This relationship is shown in .

Figure 9 - Block Diagram of Counter Mode

Outputs updated continuously
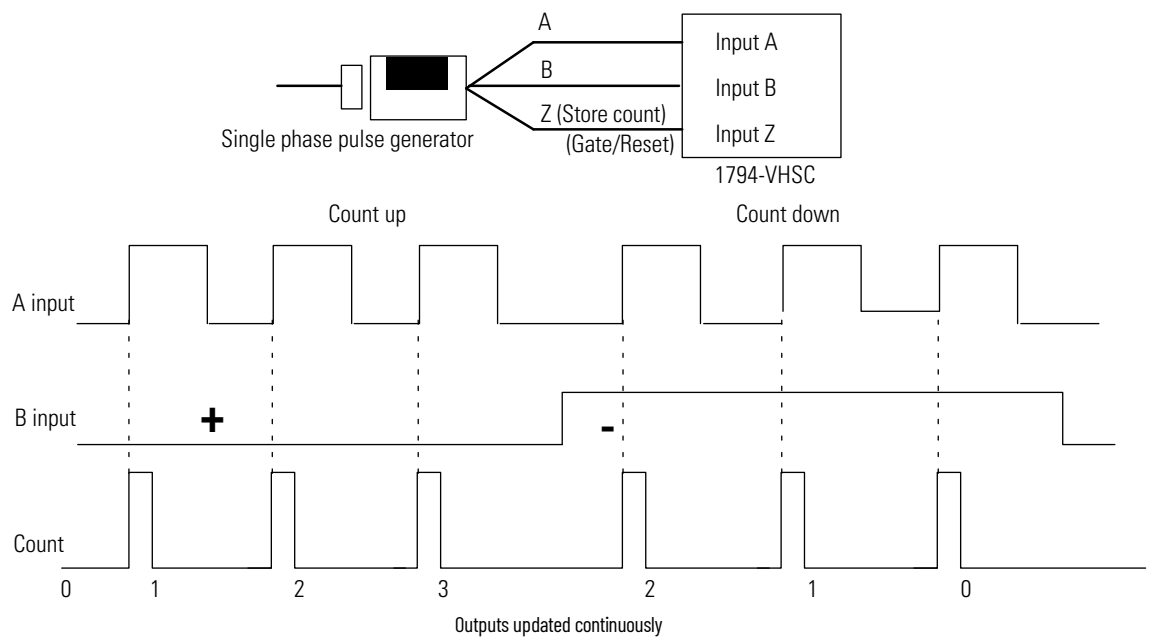
Encoder Mode

The encoder mode allows the module to read incoming pulses and return them to the programmable controller processor as a binary number (0-16,777,215).

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

Encoder X1 mode – quadrature input signals count on the leading edge or the trailing edge of channel A for a bidirectional count. The phase relationship between Channel A and Channel B determines direction — channel A leading, and channel B floating, the count direction is up; Channel A lagging, and Channel B high, the count direction is down.

Encoder X2 mode – quadrature input signals count on the leading edge and the trailing edge of channel A for a bidirectional count. Channel B determines direction —B low (floating), the count direction is up; B high, the count direction is down.

Encoder X4 mode – quadrature input signals count on the leading edge and the trailing edge of channel A and channel B for a bidirectional count. Channel B determines direction — B low (floating), the count direction is up; B high, the count direction is down.

Direction of Count

The module can count either up or down, depending upon the condition of the B input for each counter. In encoder applications, the counter increments on the leading edge of input A, while input B determines the direction of the count.

You also have the option of X1, X2, and X4 multiplying of the input pulses. See Figure 10 for the relationships between inputs A and B for forward and reverse directions in encoder applications.

Figure 10 - Phase Relationship for Forward or Reverse Directions
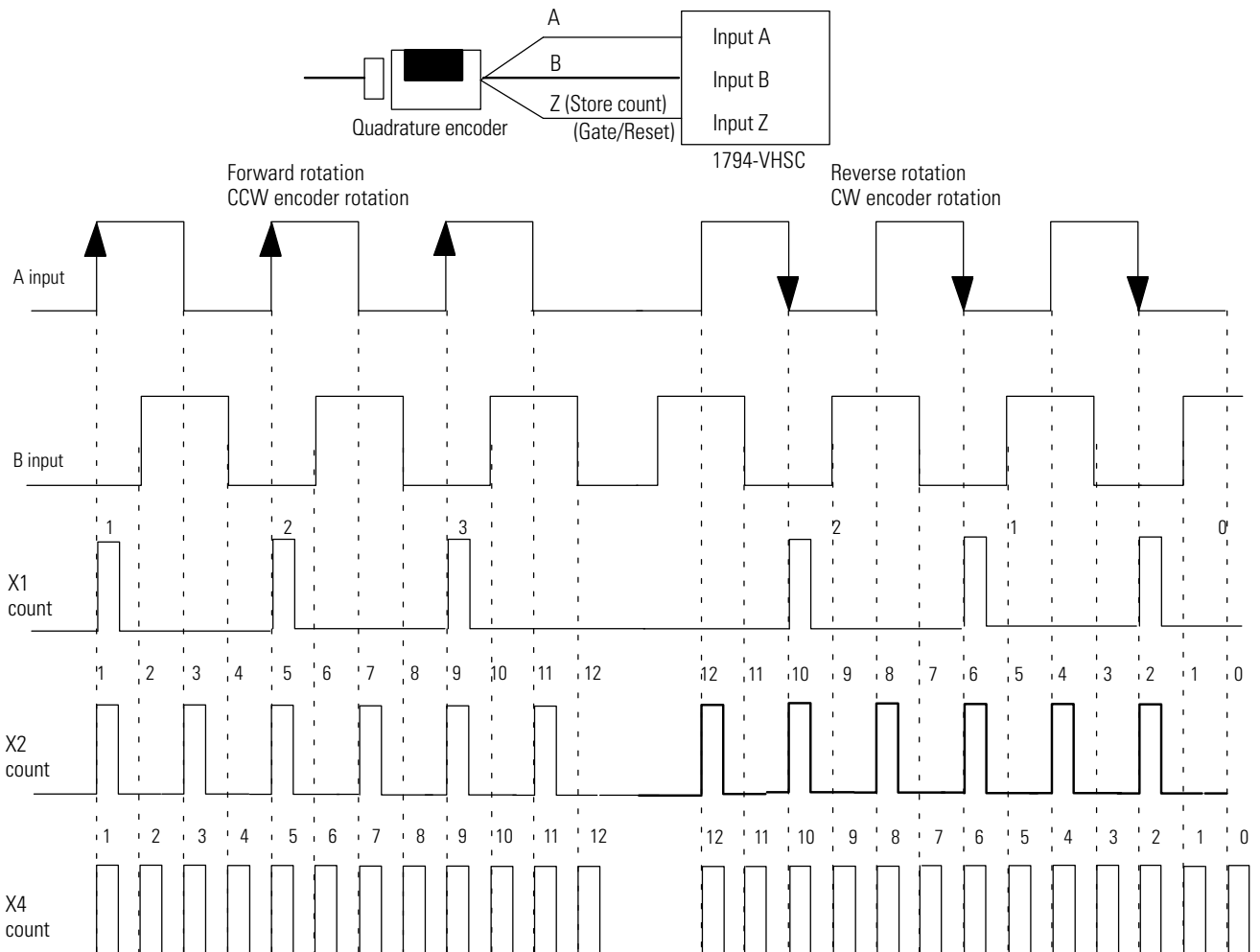
The following paragraphs apply to both encoders and counters.

Preset Value

Each of the two counters has one preset value associated with it. In the encoder or counter modes, the preset value represents a reference point (or count) from which the module begins counting. The module can count either up or down from the preset value. Preset values are loaded into the count registers through the preset count bits. Preset values can range from 0 to 16,777,215 binary.

Rollover Value

Each of the two counters has one rollover value associated with it. When encoder/counter reaches the rollover value, it resets to 0 and begins counting again. The rollover values range from 1 to 16,777,216 binary. The rollover value is circular. For example: if you program 360, the count is from 358, 359, 0, 1, and so on, in a positive direction and from 1, 0, 359, 358, and so on, in a negative direction.

Software Reset

The counters can also be reset by the Reset Count bits found in Word 0, bits 0 and 4 of the Counter Control word. When one of these bits is set to 1, the associated counter is reset to zero and begins counting. The module can also be reset with the Gate/Reset as explained as follows.

Gate/Reset Input

There is one Gate/Reset input for each of the two counters. The Gate/Reset input, when active, functions in one of the four store count mo

Scale Input Count at the Gate/Reset Terminal
You can scale the incoming count at the Gate/Reset terminal. Scaling allows the incoming pulses at Gate/Reset to be divided by a number in the range of 1, 2, 4, 8, 16, 32, 64, and 128.

Store Count
The store count feature allows the module to store the current count value of the associated counter. The state of the Gate/Reset terminal on the module triggers the store count feature. The stored count of each counter is placed in a separate word in the Read Data file. The stored count value remains in the Read Data file until a new trigger pulse is received at the Gate/Reset terminal. When a new trigger pulse is received, the new count value overwrites the old value.

In mode 1, store/continue (see Figure 11), the leading edge of a pulse input on input Z (Gate/Reset) terminal causes the current value in the counter to be

read and stored. The counter continues counting. The stored count is available in the Read Data file. The stored count information remains in the block-transfer read file until the new data overwrites the old data.

Figure 11 - Store/Continue

Read, store count, and
continue counting.
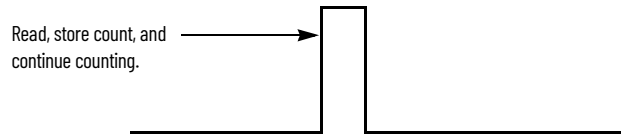
In mode 2, store/wait/resume (see), a rising edge of a pulse input on the Z input (Gate/Reset) terminal reads and stores the current counter value in the Read Data file, and inhibits counting while the Gate/Reset input is high. Counting resumes when the input goes low.
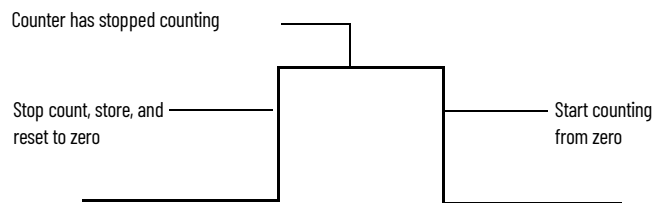
Mode 2 does not reset the counter, although it does store the count value. The stored count is available in the Read Data file. The stored count remains in the Read Data file until the new data overwrites the old data.

Figure 12 - Store/Wait/Resume

Stop counting

Store count   Resume counting
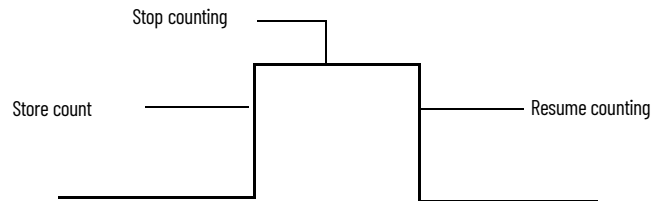
In mode 3, store-reset/wait/start (see), the rising edge of the pulse on input Z (Gate/Reset) terminal causes the counter to stop counting, store the current count value in the Read Data file and reset the count to zero. The counter does not count while the Z input on the Gate/Reset terminal remains high. Counting resumes from zero on the falling edge of the pulse at the Z (Gate/Reset) terminal. The stored count is available in the Read Data file. The stored count remains in the Read Data file until the new data overwrites the old data.

Figure 13 - Store-Reset/Wait/Start

Counter has stopped counting

Stop count, store, and
reset to zero   Start counting
from zero

In mode 4, store-reset/start (see), on the rising edge of a pulse input at the Z (Gate/Reset) terminal causes the counter to store the accumulated count value in the Read Data file, and reset the counter to zero. The counter continues counting while the Z Gate/Reset input is high. The stored count is available in the Read Data file. The stored count remains in the Read Data file until the new data overwrites the old data.

Figure 14 - Store-Reset/Start

The figures show the store count feature operating on the rising edge of the Gate/Reset pulse. You have the option of electing these same features using the falling edge of the Gate/Reset pulse. The gate invert bit is active in the store count, continuous/rate and period/rate modes.

Period/Rate Mode

Use the period/rate mode to determine the frequency of input pulses by counting the number of internal 5 MHz clock pulses over a user-specified number of input signal pulses. At the end of the specified number of pulses, the module returns the frequency and the total number of pulses received.

A channel that is configured for period/rate mode acts as a period rate counter. An internal 5 MHz clock is used as a frequency reference. This clock is gated by the incoming pulse train at the Gate/Reset input. The results of this gating action are the number of pulses or a frequency. The frequency is returned in input file words 0 (LSW) and 1 (MSW) for channel 0 and word 2 (LSW) and 3 (MSW) for channel 1. The total pulses received is stored in input file words 4 (LSW) and 5 (MSW) for channel 0 and words 6 (LSW) and 7 (MSW) for channel 1. Select the period/rate mode by setting the appropriate bits in word 0 of the configuration block.

1794-VHSC modules count the total number of pulses occurring at the Z (Gate/Reset) pin. This function is frequency-limited to 200 Hz X the scaler value. You can reset this count by setting the VR bit.

shows a diagram of the module used in the period/rate mode.

Figure 15 - Period/Rate Mode
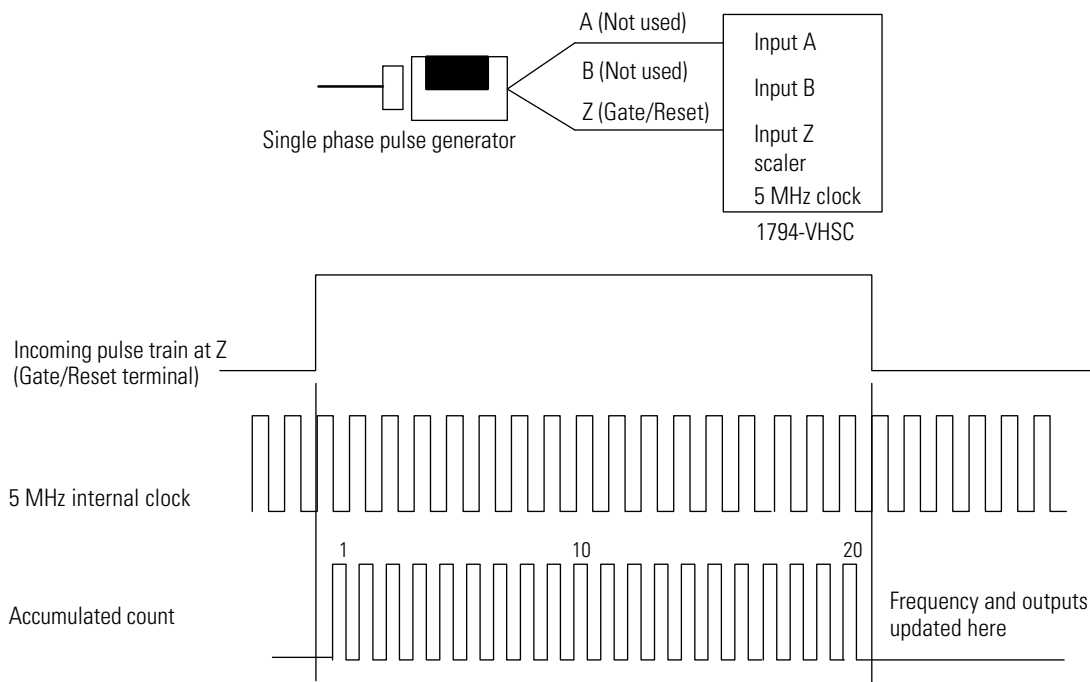
Assumes symmetrical pulse, 50% duty cycle, so period = sample time on X 2 (on and off)
Frequency = 1/period
If count = 25, scaler = 1, and clock period = (1/5 MHz)
Frequency = 1 / [(25/1) X (1/5 MHz) X 2] = 100 kHz

In Figure 15, the incoming pulse train from the Gate/Reset terminal is used to sample pulses from the 5 MHz internal clock. As the frequency of the incoming pulse train at the Gate/Reset terminal increases, the number of sampled pulses from the 5 MHz clock decreases. This relationship is shown in NO TAG. Since accuracy is related to the number of pulses received over the sample period, the accuracy decreases with increasing input frequencies at the Gate/Reset terminal.

To some extent, the decrease in accuracy can be lessened by scaling the input frequency by using a scaler. A scaler value of 1 only returns an accurate input frequency if incoming pulses have a 50% duty cycle.

Table 3 - Relationship Between Sampled Pulses and Input Frequency

Input Frequency at Z (Gate/Reset) Terminal in Hz	Sampled Pulses for 1/2 Cycle of Z (Gate/Reset) Pulse
2	1.25 M
5	500K
10	250K
20	125K
50	50K
100	25K
200	12.5K
500	5K
1 kHz	2.5K

Table 3 - Relationship Between Sampled Pulses and Input Frequency (Continued)

Input Frequency at Z (Gate/Reset) Terminal in Hz	Sampled Pulses for 1/2 Cycle of Z (Gate/Reset) Pulse
2 kHz	1.25 k
5 kHz	500
10 kHz	250
20 kHz	125
50 kHz	50
100 kHz	25

Operation of Scaler

In period/rate mode, the scaler lets the incoming pulse train at the Z (Gate/Reset) terminal be divided by a user-defined number. Acceptable values for the scaler are 1, 2, 4, 8, 16, 32, 64 and 128. There is one scaler value for each counter.

⚠️ **ATTENTION:** Sample period times scaler must be less than 6.71 s to avoid a zero frequency detect indication.

Connection to Counter Inputs

The only input to the module in the period/rate mode is made to the Z (Gate/Reset) terminal. The counter inputs (channel A and B) are not used in the period/rate mode.

Continuous/Rate Mode

The continuous/rate mode is similar to the period/rate mode previously described except the outputs in this mode are dynamic outputs. Use this mode to determine the frequency of input pulses by counting the number of internal 5 MHz clock pulses over a user-specified number of input signal pulses. Each output is turned on as soon as the turn-on count is reached, and turned off as soon as the turn-off count is reached. As the internal 5 MHz clock is counted, the outputs dynamically track the 5 MHz count. This allows you to turn an output on some 5 MHz counts after the Gate/Reset pin goes active, and turn it off some 5 MHz counts later.

1794-VHSC module counts the total number of pulses occurring at the Z (Gate/Reset) terminal. This function is frequency-limited to 200 Hz X the scaler value. This total count is returned in input file words 4 (LSW) and 5 (MSW) for channel 0 and 6 (LSW) and 7 (MSW) for channel 1. You can reset this count by setting the VR bit.

Figure 16 – Period/Rate and Continuous/Rate Output Operation with Scaler of 1
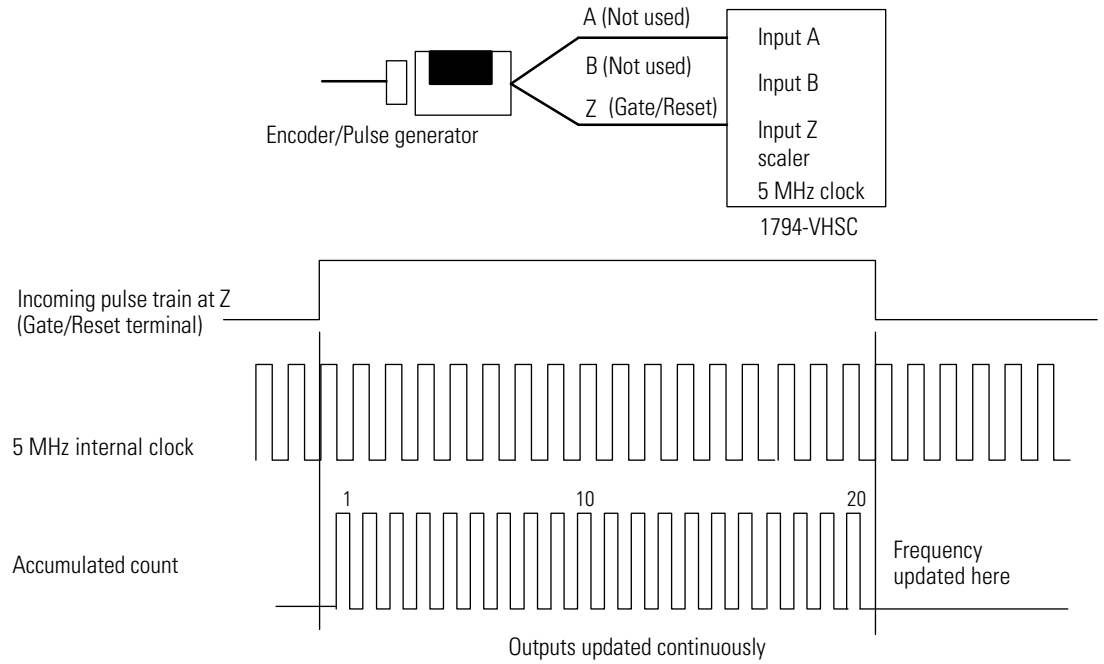
Assumes symmetrical pulse, 50% duty cycle, so period = sample time on X 2 (on and off)
Frequency = 1/period
If count = 25, scaler = 1, and clock period = (1/5 MHz)
Frequency = 1 / [(25/1) X (1/5 MHz) X 2] = 100 kHz

Rate Measurement Mode

Use the rate measurement mode to count incoming pulses for a user-specified time interval. At the end of the interval, the module returns a value that represents the sampled number of pulses and a value that indicates the incoming frequency. When the count and frequency are updated, any associated outputs are checked against their associated presets.

The value that represents the total number of pulses is returned in input file words 4 (LSW) and 5 (MSW) for channel 0 and 6 (LSW) and 7 (MSW) for channel 1. The value that indicates the incoming frequency is returned in words 0 (LSW) and 1 (MSW) and 2 (LSW) and 3 (MSW). The total count equals the running sum of the number of pulses received during the sample period. The operation of rate measurement mode is shown in .

Figure 17 - Operation of the Rate Measurement Mode

If sample period is 50 ms, and count = 3, then frequency = 3/50 ms = 60 Hz
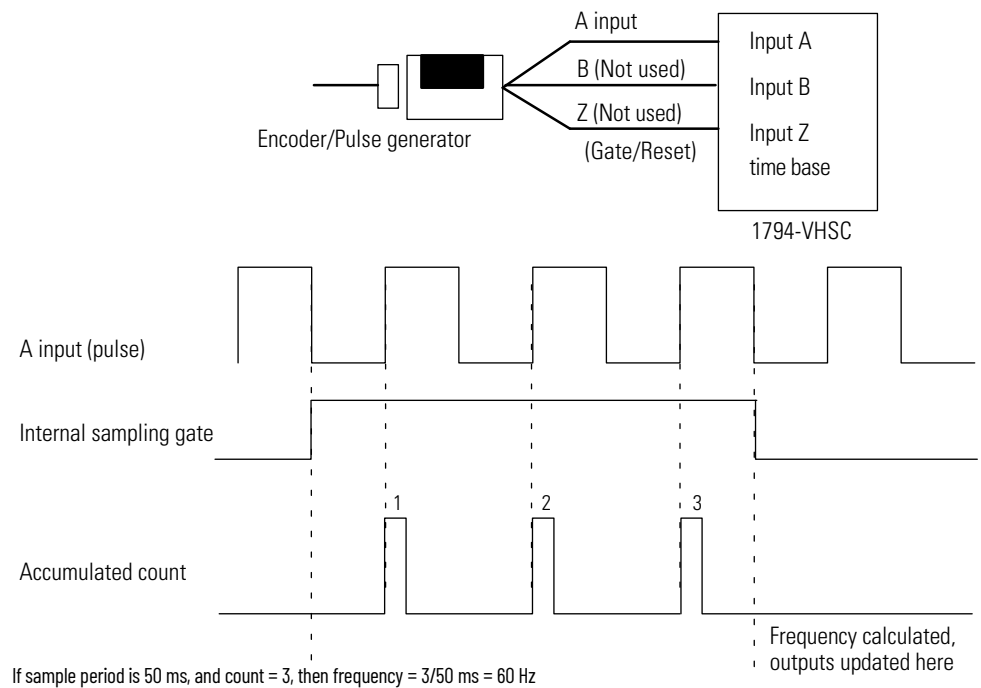
> **EXAMPLE** In Figure 17, three counts have been accumulated during the user-selected time period. If you had selected 50 ms as the sample period, the frequency that is returned to the programmable controller processor would be:
>
> Frequency = Counts/Sample period = 3 counts/50 ms = 60 Hz

Sample Period

You can set the sample period that is used in the frequency calculation in the rate measurement mode. Allowable values are 10 ms to 3 s in 10 ms increments. The default value is 1 s.

Connection to Counter Inputs

The only user connections that are used in the rate measurement mode are to phase A of the module. The Z (Gate/Reset) and channel B terminals are not used in this mode.

Pulse-width Modulation

The module can generate a pulse-width modulation signal that may be tied to any output. By specifying a period (configuration word 2) and gate interval (configuration word 2 or 3) together with the PWM configuration word 2 or 3, a counter and its first ON/OFF window comparator is assigned and the signal generated. The actual duty cycle is specified by output words 2 and 3.

Outputs

The 1794-VHSC module has four outputs, isolated in groups of 2. Each of the outputs can source current and operates between 5V and 24V DC. You must connect an external power supply to each of the outputs. The outputs can source 1 A DC alone or in combination. The outputs are hardware-driven and turn on in about 25 s when the appropriate count value has been reached.

Enable and Force Outputs

Outputs may be forced on or off independent of count or frequency value. To force the outputs, they must first be enabled. You can enable the outputs through a data table word 1, bits 1, 5, 9 and 13 (see Figure 20 on page 40). Once the outputs are enabled, you can force them on by setting bits 0, 4, 8 or 12 in word 1. You can force off the outputs by setting the enable bit to 0.

Assign Outputs to Counter Windows

By setting bits in the configuration block, you can assign the outputs on the module to any of the various counter windows. You can assign any output to any count window with no restrictions.

Operation of Outputs

When the outputs for the 1794-VHSC module are enabled and assigned to a counter window, they operate in an ON-OFF fashion. For example, assume that the module were programmed to turn ON an output when a count value of 2000 was reached. Further, assume that the user desired to have the output remain energized for 3000 counts and then turn OFF. The end result would be that the outputs would turn ON at count of 2000, would remain energized for 3000 additional counts, and would turn OFF at 5000 counts. Figure 18 shows that the ON and OFF values are circular around zero.

Figure 18 - On-Off Operation of Output

Output remains energized for 3000 additional counts

Output turns on at count value of 2000

Output turns off at count value of 5000
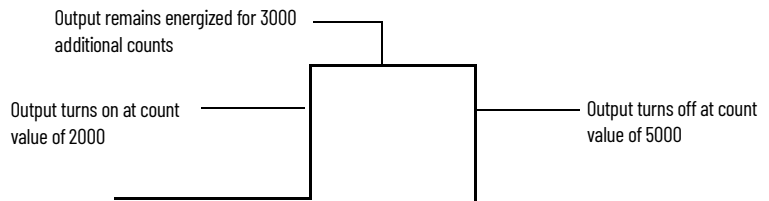
Using output 0 as an example, when the value in Counter ON Value is less than the value in Counter OFF Value, the output turns on at 2000 and off at 5000. If the value in Counter ON Value is greater than the value in Counter OFF Value, the output turns off at 2000 and on at 5000 as shown in Figure 19.

Figure 19 - Effect of Values in On/Off Operation

Output remains energized for 3000 additional counts

Output turns on at count value of 2000

Output turns off at count value of 5000

When values in Counter On Value are less than values in Counter Off Value.

Output turns off at count value of 2000

Output turns on at count value of 5000

When values in Counter On Value are greater than values in Counter Off Value.
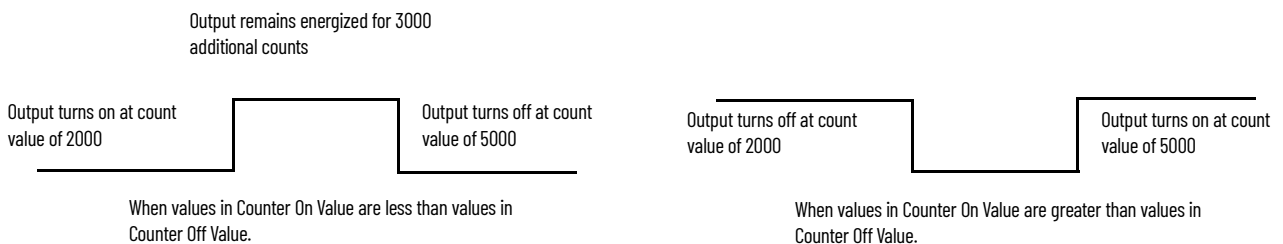
Isolation of Outputs

The module provides 850V DC isolation between each of the outputs and the Flexbus.

Connecting Outputs to Counters

You can connect any of the outputs to any of the counter inputs. In this way, it is possible to use the outputs to reset a counter or to cascade counters. If using the outputs this way, verify that the output voltage is compatible with the chosen input.

Notes:

Communicate With Your Module

Overview

Read this chapter to familiarize yourself with configurable features on the FLEX I/O Very High-speed Counter module.

Topic	Page
Communication Over the I/O Backplane	35
I/O Structure	36
Safe State Data	37
Device Actions	38

Communication Over the I/O Backplane

One 1794-AENT or 1794-AENTR EtherNet/IP adapter can interface up to eight terminal base units with installed FLEX I/O modules, forming a FLEX I/O system of up to eight slots. The adapter communicates to other network system components (typically one or more controllers or scanners, and/or programming terminals) over the EtherNet/IP network. The adapter communicates with its I/O modules over the backplane.
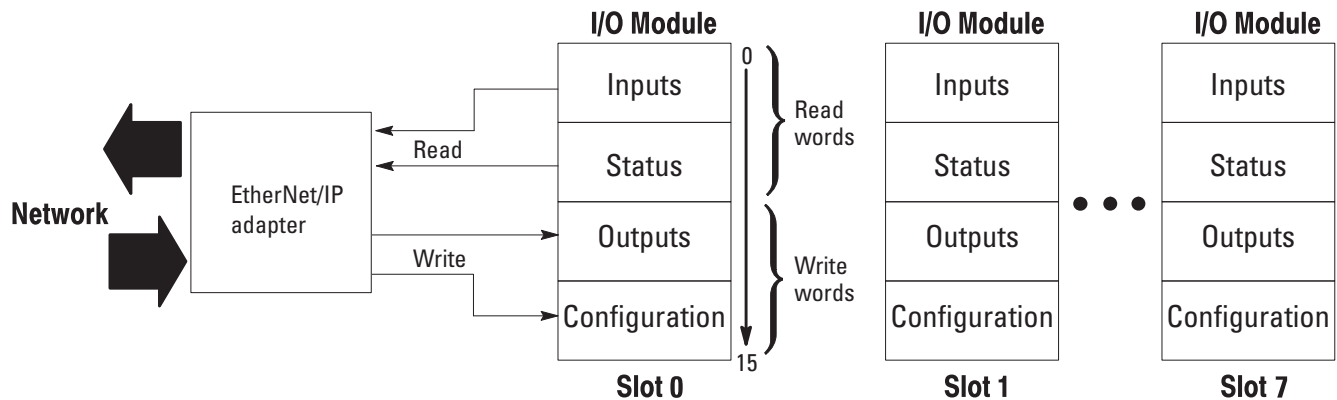
Data is exchanged scheduled when mapped, or unscheduled using EtherNet/IP instructions.

Unscheduled messaging on an EtherNet/IP network is non-deterministic. Your application and your configuration — number of nodes, application program, NUT, amount of scheduled bandwidth that is used, and so on — determine how much time there is for unscheduled messaging.

Module I/O Mapping

The I/O map for the 1794-VHSC module is divided into read words and write words. Read words consist of input and status words, and write words consist of output and configuration words. The number of read words or write words can be 0 or more. The length of each I/O module's read words and write words vary in size depending on module complexity. Each I/O module supports at least one input word or one output word. Status and configuration are optional, depending on the module. The 1794-VHSC module has 9 input words, no status words, 4 output words, and 56 configuration words.

Application of New Configurations

When a configuration is sent to the 1794-VHSC module, it is checked for consistency before being applied. If an error is found in the configuration, the PE bit (input word 8, bit 15) is asserted and the module locally retains its previous configuration. To isolate any problems an improperly configured module may have, the user application program (ladder program, for instance) should monitor this error.

If the configuration is considered acceptable, the counter application specific integrated circuit (ASIC) is disabled — counting is suspended and outputs are shut off — while the ASIC is loaded with the new operational parameters.

I/O Structure

The adapter receives output data in the order of the installed I/O modules. The Output data for Slot 0 is received first, followed by the Output data for Slot 1, and so on, up to slot 7.

The first word of input data that is sent by the adapter is the Adapter Status Word. This is followed by the input data from each slot, in the order of the installed
I/O modules. The Input data from Slot 0 is first after the status word, followed by Input data from Slot 2, and so on, up to slot 7.
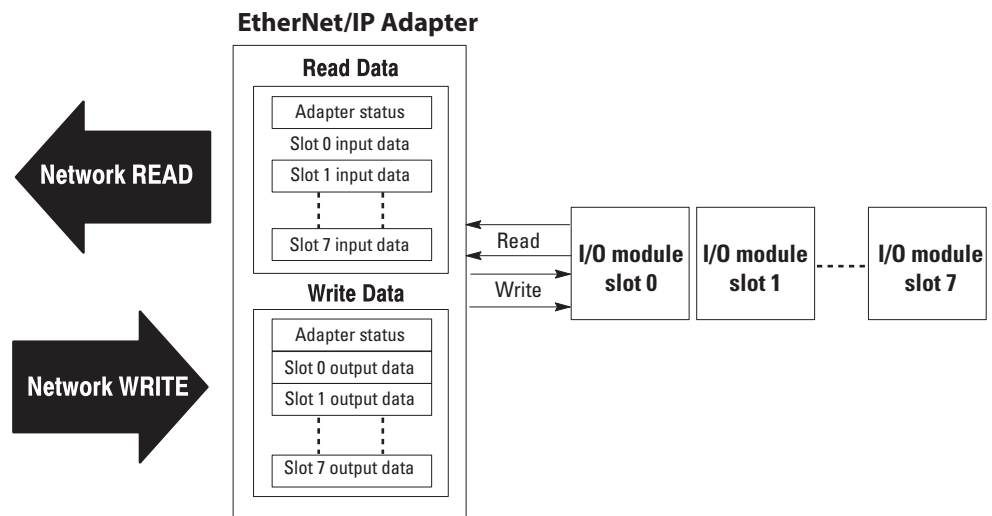
Adapter Input Status Word

The input status word consists of:

- I/O module fault bits — 1 status bit for each slot.
- Node address changed — 1 bit.
- I/O status — 1 bit.

The adapter input status word bit descriptions are show in Table 4.

Table 4 - Input Status Word Bits

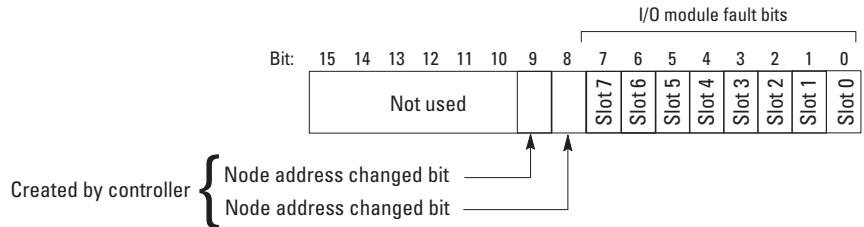| Bit Description	Bit	Explanation
I/O module fault	0	This bit is set (1) when an error is detected in slot position 0.
	1	This bit is set (1) when an error is detected in slot position 1.
	2	This bit is set (1) when an error is detected in slot position 2.
	3	This bit is set (1) when an error is detected in slot position 3.
	4	This bit is set (1) when an error is detected in slot position 4.
	5	This bit is set (1) when an error is detected in slot position 5.
	6	This bit is set (1) when an error is detected in slot position 6.
	7	This bit is set (1) when an error is detected in slot position 7.
Node address changed	8	This bit is set (1) when the node address switch setting is changed since power-up.
I/O state	9	Bit = 0 – idle Bit = 1 – run
	10...15	Not used – set to 0.

Possible causes for an **I/O module fault** are:

- Transmission errors on the FLEX I/O backplane.
- A failed module.
- A module removed from its terminal base.
- An incorrect module inserted in a slot position.
- An empty slot.
- A non-discrete module in the slot.

Safe State Data

The EtherNet/IP adapter does not provide storage for alternate module output data during communication faults or processor idle state. This safe state data is stored in the 1794-VHSC module and may be defined using configuration software. Safe state data assures that a known output is applied to the output devices to maintain a previously designated safe operating condition during the previously mentioned failure modes. This data is sent in the configuration block. For more information on data mapping, see Figure 20 on page 40.

Device Actions

Device actions include:

- Communication fault behavior.
- Idle state behavior.
- Input data behavior upon module removal.

Communication Fault Behavior

You can configure the 1794-VHSC response to a communication fault. Upon detection of a communication fault, the module can:

- Leave the module output data in its last state (hold last state).
- Reset the module output data to zero (reset).
- Apply safe state data to the module output.

Idle State Behavior

The 1794-VHSC module responds to idle state according to the Communication Fault Behavior described above. The module can:

- Leave the module output data in its last state (hold last state).
- Reset the module output data to zero (reset).
- Apply safe state data to the module output.

Input Data Behavior upon Module Removal

I/O module input data that is sent by the adapter upon module removal is configurable. The adapter can:

- Reset the module output data to zero (reset).
- Leave the module output data in the last state before module removal (hold last state).

Frequency/Resolution Enhancement

This mode is only for use in modules with firmware revision D or later.

Frequency/Resolution enhancement is a precise configuration that handles the decimal position adjustment to frequency count. Using this mode allows the module to read the frequency up to two positions to the right or left of the decimal place. For example, a rounded frequency of 13 Hz can be displayed as 1257 or 12.57. The mode is only valid when the module is configured for Period Rate or Continuous Rate.

Frequency/Resolution enhancement reports the frequency back as a floating point value in a single word and allows configuration of decimal places of resolution.

The upper byte of the counter control word (output word 0) is reserved for special mode, Enhancing Frequency/Resolution. In this mode, you can change

significant digits of frequency display based on output word 2 for channel 0 and output word 3 for channel 1. Decimal point placement is absolute positioning. -2 moves the decimal point left 2 places dividing the frequency value by 100; +1 moves the decimal point 1 place, multiplying by 10, and so on. This allows frequency values to fit in a single word.

Apply the Frequency/Resolution Enhancement

To use this mode, proceed as follows.

> ⚠️ **ATTENTION:** Use the enhancement mode with caution since no checks are performed to verify data. Unintended operation can occur.

1. Power up the FLEX chassis, or put the controller into RUN mode, or both. Let the 1794-VHSC module initialize as normal. Wait for the OK indicator on the module to go solid green.
2. You must place ladder logic in your PLC that performs the following:
   a. Set a value between -4 and +2 into output word 2 and/or 3.
   b. Then set (1) the M11 bit in the upper byte of control word 0. When the upper byte of the output word is not zero, the status indicator flashes red, and the TF bit (bit 12, input word 8) is asserted.
   c. Next, reset (0) the M11 bit in the upper byte of output control word 0. Clearing the upper byte of output word 0 restores the module to an operational state, clears the TF bit in input word 8, and returns the indicator to green. The module is now in enhanced mode.
3. To turn off this feature:
   a. Set output word 2 or 3 to zero (no value).
   b. Set (1) the M11 bit.
   c. Then reset (0) the M11 bit.

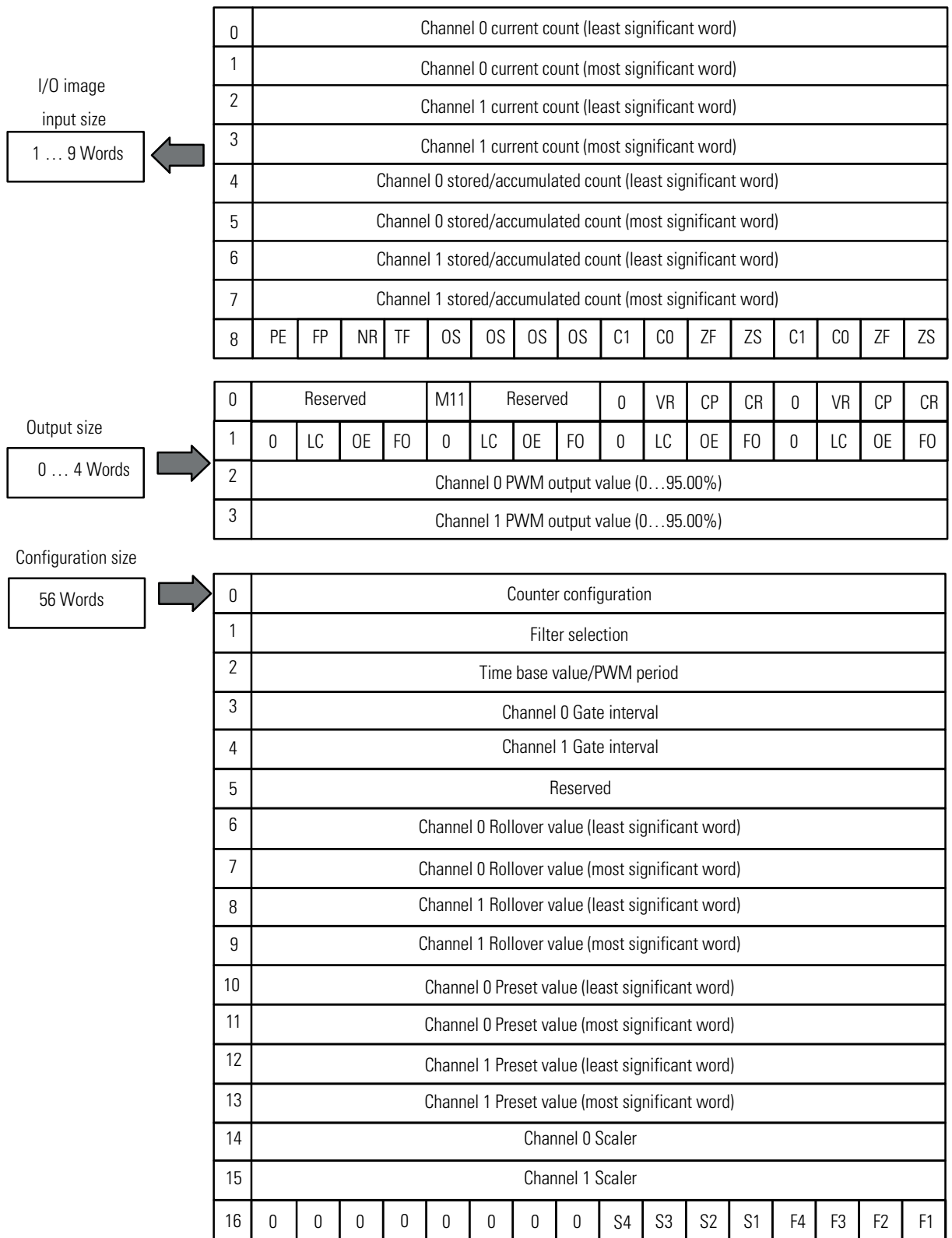**Figure 20 - 1794-VHSC — Very High-speed Counter Module Image Table Mapping**

I/O image

input size

1 … 9 Words

0	Channel 0 current count (least significant word)														
1	Channel 0 current count (most significant word)														
2	Channel 1 current count (least significant word)														
3	Channel 1 current count (most significant word)														
4	Channel 0 stored/accumulated count (least significant word)														
5	Channel 0 stored/accumulated count (most significant word)														
6	Channel 1 stored/accumulated count (least significant word)														
7	Channel 1 stored/accumulated count (most significant word)														
8	PE	FP	NR	TF	OS	OS	OS	OS	C1	C0	ZF	ZS	C1	C0	ZF	ZS

Output size

0 … 4 Words

0	Reserved		M11	Reserved		0	VR	CP	CR	0	VR	CP	CR
1	0	LC	OE	FO	0	LC	OE	FO	0	LC	OE	FO	0	LC	OE	FO
2	Channel 0 PWM output value (0…95.00%)														
3	Channel 1 PWM output value (0…95.00%)														

Configuration size

56 Words

0	Counter configuration														
1	Filter selection														
2	Time base value/PWM period														
3	Channel 0 Gate interval														
4	Channel 1 Gate interval														
5	Reserved														
6	Channel 0 Rollover value (least significant word)														
7	Channel 0 Rollover value (most significant word)														
8	Channel 1 Rollover value (least significant word)														
9	Channel 1 Rollover value (most significant word)														
10	Channel 0 Preset value (least significant word)														
11	Channel 0 Preset value (most significant word)														
12	Channel 1 Preset value (least significant word)														
13	Channel 1 Preset value (most significant word)														
14	Channel 0 Scaler														
15	Channel 1 Scaler														
16	0	0	0	0	0	0	0	0	S4	S3	S2	S1	F4	F3	F2	F1

Figure 20 - 1794-VHSC — Very High-speed Counter Module Image Table Mapping (Continued)

23	First counter 1st Off value (most significant word)
24	First counter 2nd On value (least significant word)
25	First counter 2nd On value (most significant word)
26	First counter 2nd Off value (least significant word)
27	First counter 2nd Off value (most significant word)
28	First counter 3rd On value (least significant word)
29	First counter 3rd On value (most significant word)
30	First counter 3rd Off value (least significant word)
31	First counter 3rd Off value (most significant word)
32	First counter 4th On value (least significant word)
33	First counter 4th On value (most significant word)
34	First counter 4th Off value (least significant word)
35	First counter 4th Off value (most significant word)
36	Second counter 1st On value (least significant word)
37	Second counter 1st On value (most significant word)
38	Second counter 1st Off value (least significant word)
39	Second counter 1st Off value (most significant word)
40	Second counter 2nd On value (least significant word)
41	Second counter 2nd On value (most significant word)
42	Second counter 2nd Off value (least significant word)
43	Second counter 2nd Off value (most significant word)
44	Second counter 3rd On value (least significant word)
45	Second counter 3rd On value (most significant word)
46	Second counter 3rd Off value (least significant word)
47	Second counter 3rd Off value (most significant word)
48	Second counter 4th On value (least significant word)
49	Second counter 4th On value (most significant word)
50	Second counter 4th OFF value (least significant word)
51	Second counter 4th OFF value (most significant word)
52	Counter Control safe state
53	Output Control safe state
54	Channel 0 PWM Safe state
55	Channel 1 PWM Safe state

Table 5 - Bit/Word Definitions

Input Word	Bit	Definition
Word 0	00…15 (00…17)	**Channel 0 current count** – The current count consists of 2 words (32 bits) representing the current count of the 24-bit counter (in encoder, X2 encoder, X4 encoder, PWM) or the frequency (in periodrate, continuousrate, rate measurement). The range of values is (0 < value < 16,777,215).
Word 1	00…15 (00…17)	
Word 2	00…15 (00…17)	**Channel 1 current count** – The current count consists of 2 words (32 bits) representing the current count of the 24-bit counter (in encoder, X2 encoder, X4 encoder, PWM) or the frequency (in period/rate, continuous/rate, rate measurement.). The range of values is (0 < value < 16,777,215).
Word 3	00…15 (00…17)	
Word 4	00…15 (00…17)	**Channel 0 stored/accumulated count** – These are 32-bit long word values representing the stored count of the counter at the time of some specified event.
Word 5	00…15 (00…17)	These words are not updated in counter modes (counter, X1 encoder, X2 encoder, X4 encoder) without store modes selected. With store modes selected, it is the counter value at the time of the specified Z input event. In PWM configuration, it is the counter value at the end of the period specified by the product of the time base times gate interval. In period/rate and continuous/rate, it is the total accumulation of unscaled Z pulses (if scaling is set to 128, the accumulator increases by 128 counts). The maximum frequency that accumulation can follow is (200 Hz X Scaler value). In rate measurement, it is the total number of pulses seen at the A input accumulated over each period as specified by the product of time base times gate interval. The range of values occupy the entire 32-bit size from 0 < value < 4,294,967,295. These words are not cleared by changing the configuration.
Word 6	00…15 (00…17)	**Channel 1 stored/accumulated count** – These are 32-bit long word values representing the stored count of the counter at the time of some specified event.
Word 7	00…15 (00…17)	These words are not updated in counter modes (counter, X1 encoder, X2 encoder, X4 encoder) without store modes selected. With store modes selected, it is the counter value at the time of the specified Z input event. In PWM configuration, it is the counter value at the end of the period specified by the product of the time base times gate interval. In period/rate and continuous/rate, it is the total accumulation of unscaled Z pulses (if scaling is set to 128, the accumulator increases by 128 counts). The maximum frequency that accumulation can follow is (200 Hz X Scaler value). In rate measurement, it is the total number of pulses seen at the A input accumulated over each period as specified by the product of time base times gate interval. The range of values occupy the entire 32-bit size from 0 < value < 4,294,967,295. These words are not cleared by changing the configuration.
Word 8		**Module Channel Status Word**
	00	**Zero input status bit (ZS) for Channel 0** – This bit represents the present status of the Z input. 0 = Off 1 = Input on This bit is unaffected by Z invert, ZI, in the counter configuration word.
	01	**Zero frequency detected bit (ZF) for Channel 0** – Only used during frequency configurations (period/rate, continuous/rate, and rate measurement). In period/rate and continuous/rate, counts are acquired during on state of the Z input. At very low frequencies, the counter saturates, indicating a zero frequency detect. The time it takes to determine a zero frequency in these 2 configurations can be as long as 6.7 s (16,777,215 counts X 1/5 MHz X 2 half cycles of Z). In rate measurement, pulses on Z are counted over a sample interval specified by the product of time base X gate interval. The time to detect a zero frequency is determined by the sample interval example: Time base = 0.100 s, gate interval = 3 is 300 ms to determine ZF.
	02, 03	**Stored/data count bit (C0, C1) for Channel 0** – This count cycles through 00, 01, 10, 11, 00… Each time the stored/accumulated count words are updated, C(0,1) is incremented. The PLC sample rate, including network delay and program scan, must be as fast as or faster than the frequency of the event that updates.
	04	**Zero input status bit (ZS) for Channel 1** – This bit represents the present status of the Z input. 0 = Off 1 = Input on
	05	**Zero frequency detected bit (ZF) for Channel 1** – Only used during frequency configurations (period/rate, continuous/rate, and rate measurement). In period/rate and continuous/rate, counts are acquired during on state of the Z input. At very low frequencies, the counter saturates, indicating a zero frequency detect. The time it takes to determine a zero frequency in these 2 configurations can be as long as 6.7 s (16,777,215 counts X 1/5 MHz X 2 half cycles of Z). In rate measurement, pulses on Z are counted over a sample interval specified by the product of time base X gate interval. The time to detect a zero frequency is determined by the sample interval example: Time base = 0.100 s, gate interval = 3 is 300 ms to determine ZF.
	06, 07	**Stored/data count bit (C0, C1) for Channel 1** – This count cycles through 00, 01, 10, 11, 00… Each time the stored/accumulated count words are updated, C(0,1) is incremented. The PLC sample rate, including network delay and program scan, must be as fast as or faster than the frequency of the event that updates.
	08…11 (10…13)	**Output status indicators (OS)** – Bit 08 corresponds to output 0, bit 09 to output 1, bit 10 to output 2, and bit 11 to output 3. 0 = Output Off 1 = Output On

Table 5 - Bit/Word Definitions (Continued)

Input Word	Bit	Definition
Word 8	12 (14)	**Test/fail bit (TF)** – The upper byte of the counter control word (output word 0) is reserved for special mode, Enhancing Frequency/Resolution. To use this mode, set bit 11, and set a value in output word 2 and/or word 3. When the upper byte of word 0 is not zero, the red module status indicator flashes and the TF bit is asserted to indicate that the module has entered a test-mode state. Clearing the upper byte of output word 0 restores the module to an operation state, clears the TF bit and returns the indicator to green. Change significant digits of frequency display based on word 14 for channel 0 and word 15 for channel 1 (-2 moves decimal point left 2 places dividing the frequency value by 100; +1 moves the decimal point 1 place, multiplying by 10, and so on). This allows frequency values to fit in a single word. **Note:** To use Frequency/Resolution Enhancement feature provides appropriate configuration for each frequency mode (Mode 5, 6, and 7). Firmware revision D changed decimal point placement to absolute positioning. Revision D firmware also checks for placement to be in the range of -4…+2. A value outside the range moves the decimal point to the zero position. Moving the decimal point to the left allows high frequencies (commonly present in rate measurement) to fit within a single word. Moving the decimal point to the right allows low frequencies (commonly present in period and continuous rate modes) to have resolution displayed to 0.1 Hz and 0.01 Hz. Do not use scalars of Z/128, Z/64, Z/32 and Z/16 when using this test mode.
	13 (15)	**Not ready status bit (NR)** – Whenever 24V DC power is applied to the module, the hardware must be initialized. The NR bit is asserted and the red module indicator flashes. If the red indicator continues to flash, and the green indicator momentarily turns on, the 24V DC power is below the module minimum.
	14 (16)	**Field power fault bit (FP)** – If the 24V DC module power drops, the FP bit is asserted, the green module indicator flashes, the module outputs turn off, and the module enters an idle state reporting status as it waits for power to be restored. **Note:** this bit does not indicate status of either output customer power supply.
	15 (17)	**Programming error bit (PE)** – This bit is asserted if incomplete, incorrect, or conflicting sets of configuration parameters are sent to the module. The green module status indicator will flash and an error code is placed in bits 11:0 of the module/channel status word. The module does not enter a normal operating state. Bit definitions are shown in .

Table 6 - Bit/Word Definitions

Output Word	Bit	Definition
Word 0	00…15 (00…17)	**Counter Control Word**
	00	**Channel 0 Counter reset bit (CR)** – A 0 to 1 transition of this bit clears the counter. Outputs are adjusted according to the window compare values.
	01	**Channel 0 Counter preset bit (CP)** – A 0 to 1 transition of this bit sets the counter to the value specified by the preset words. Outputs are adjusted according to the window compare values.
	02	**Channel 0 Value reset bit (VR)** – A 0 to 1 transition of this bit clears the stored/accumulated count words.
	03	This bit is always 0.
	04	**Channel 1 Counter reset bit (CR)** – A 0 to 1 transition of this bit clears the counter. Outputs are adjusted according to the window compare values.
	05	**Channel 1 Counter preset bit (CP)** – A 0 to 1 transition of this bit sets the counter to the value specified by the preset words. Outputs are adjusted according to the window compare values.
	06	**Channel 1 Value reset bit (VR)** – A 0 to 1 transition of this bit clears the stored/accumulated count words.
	07	This bit is always 0.
	08…10 (10…12)	Reserved for factory use.
	11 (13)	**Frequency/Resolution enhancement bit (M11)** Set this bit to 1 for frequency precision configuration (see Word 8, Bit 12 (14) in Table 5 for details on frequency precision configuration). **Note**: You must place a value between -4 and +2 in output word 2 and/or 3 to shift the decimal position accordingly.
	12…15 (14…17)	Reserved for factory use.
Word 1	00…15 (00…17)	**Output Control Word**
	00	**Output 0 Force output bit (FO)** – When set to 1, output is turned on if OE is 1. When FO = 0, output can be controlled by a compare match or as directed by the PWM settings.

Table 6 - Bit/Word Definitions (Continued)

Output Word	Bit	Definition
	01	**Output 0 Output enable bit (OE)** – When set to 1, output can be turned on from a force on, compare match or as directed by the PWM settings. When OE = 0, the associated output is turned off.
	02	**Output 0 Local control bit (LC)** – When set to 1, output is controlled the counter if the Flexbus power is lost (for instance, the module detects a Flexbus reset signal). **Note:** When Flexbus power is lost, communication to the PC is lost. When LC = 0, the module clears its OE bit at a loss of Flexbus power. Set this bit as appropriate in the safe state word, since a communication fault occurs after adapter power is lost.
	03	Not used – set to 0.
	04	**Output 1 Force output bit (FO)** – When set to 1, output is turned on if OE is 1. When FO = 0, output can be controlled by a compare match or as directed by the PWM settings.
	05	**Output 1 Output enable bit (OE)** – When set to 1, output can be turned on from a force on, compare match or as directed by the PWM settings. When OE = 0, the associated output is turned off.
	06	**Output 1 Local control bit (LC)** – When set to 1, output is controlled the counter if the Flexbus power is lost (for instance, the module detects a Flexbus reset signal). **Note:** When Flexbus power is lost, communication to the PC is lost. When LC = 0, the module clears its OE bit at a loss of Flexbus power. Set this bit as appropriate in the safe state word, since a communication fault occurs after adapter power is lost.
	07	Not used – set to 0.
Word 1	08 (10)	**Output 2 Force output bit (FO)** – When set to 1, output is turned on if OE is 1. When FO = 0, output can be controlled by a compare match or as directed by the PWM settings.
	09 (11)	**Output 2 Output enable bit (OE)** – When set to 1, output can be turned on from a force on, compare match or as directed by the PWM settings. When OE = 0, the associated output is turned off.
	10 (12)	**Output 2 Local control bit (LC)** – When set to 1, output is controlled the counter if the Flexbus power is lost (for instance, the module detects a Flexbus reset signal). **Note:** When Flexbus power is lost, communication to the PC is lost. When LC = 0, the module clears its OE bit at a loss of Flexbus power. Set this bit as appropriate in the safe state word, since a communication fault occurs after adapter power is lost.
	11 (13)	Not used – set to 0.
	12 (14)	**Output 3 Force output bit (FO) –** When set to 1, output is turned on if OE is 1. When FO = 0, output can be controlled by a compare match or as directed by the PWM settings.
	13 (15)	**Output 3 Output enable bit (OE)** – When set to 1, output can be turned on from a force on, compare match or as directed by the PWM settings. When OE = 0, the associated output is turned off.
	14 (16)	**Output 3 Local control bit (LC)** – When set to 1, output is controlled the counter if the Flexbus power is lost (for instance, the module detects a Flexbus reset signal). Note: When Flexbus power is lost, communication to the PC is lost. When LC = 0, the module clears its OE bit at a loss of Flexbus power. Set this bit as appropriate in the safe state word, since a communication fault occurs after adapter power is lost.
	15 (17)	Not used – set to 0.
Word 2	00...15 (00...17)	**Channel 0 PWM Output value** – When the module is configured for PWM, the time base is enabled, the counter for the respective channel, its gate interval, rollover and 1st on and 1st off value are used. Ties can be used to direct the PWM signal to any or all outputs. The range of the PWM values is 0 ≤ value ≤ 9500 decimal (for instance, 0.00% ≤ value ≤ 95.00%). The actual duty cycle at the output depends on the turn on and turn off times of the MOSFET, energy storage capability of the cable/load and the resistance from output to return.
Word 3	00...15 (00...17)	**Channel 1 PWM Output value** – When the module is configured for PWM, the time base is enabled, the counter for the respective channel, its gate interval, rollover and 1st on and 1st off value are used. Ties can be used to direct the PWM signal to any or all outputs. The range of the PWM values is 0 ≤ value ≤ 9500 decimal (for instance, 0.00% ≤ value ≤ 95.00%). The actual duty cycle at the output depends on the turn on and turn off times of the MOSFET, energy storage capability of the cable/load and the resistance from output to return.

Table 7 - Configuration Word Definition

Configuration Word	Bit	Definition				
Word 0		**Counter Configuration** – The upper byte of this word configures counter 1, the lower byte configures counter 0.				
	Bits 00…03	03	02	01	00	Counter 0
	Bits 08…11 (10…13)	11 (13)	10 (12)	09 (11)	08 (10)	Counter 1
		0	0	0	0	Counter
		0	0	0	1	Encoder
		0	0	1	0	Encoder X2
		0	0	1	1	PWM
		0	1	0	0	Encoder X4
		0	1	0	1	Period/Rate
		0	1	1	0	Continuous/Rate
		0	1	1	1	Rate Measurement
		Mode Selection				
	Bits 04…07	06	05	04		Counter 0
	Bits 12…14 (14…16)	14 (16)	13 (15)	12 (14)		Counter 1
		0	0	0		Store count disabled
		0	0	1		Mode 1 – store/continue
		0	1	0		Mode 2 – store/wait/resume
		0	1	1		Mode 3 – store/reset/wait/start
		1	0	0		Mode 4 – store/reset/start
	Bit 15 (17)	Invert the Z signal – 0 = Z not inverted; 1 = Z inverted				
Word 1		**Filter Selection – Only 1 filter selection can be chosen at a time. Frequency = 50% duty cycle.**				
	Bits 00…03	03	02	01	00	Counter 0
	Bits 08…11 (10…13)	11 (13)	10 (12)	09 (11)	08 (10)	Counter 1
		0	0	0	0	No filter
		0	0	0	1	50 kHz (10 µs + 0 µs/-1.6 µs)
		0	0	1	0	5 kHz (100 µs + 0 µs/-13.2 µs)
		0	1	0	0	500 Hz (1.0 ms + 0 ms/-1.25 µs)
		1	0	0	0	50 Hz (10.0 ms + 0 ms/-1.25 ms)
	Bit 12 (14)	Input A filter bit (AF) – 0 = not filtered; 1 = apply filter to input				
	Bit 13 (15)	Input B filter bit (BF) – 0 = not filtered; 1 = apply filter to input				
	Bit 14 (16)	Input Z filter bit (ZF) – 0 = not filtered; 1 = apply filter to input				
	Bit 15 (17)	Set to 0.				
Word 2	Bits 00…15 (00…17)	**Time base** – Sets the fundamental time base for both counters. Resolution in ms, with a minimum of 10 ms intervals (10 ms = 10; 1 s = 1000). **Time base must be entered when PWM and rate measurement are configured. The maximum programmed value is 3000.**				
Word 3	Bits 00…15 (00…17)	**Channel 0 Gate interval** – Sets the individual counter gate interval using the time base setting as its time unit. Actual gate interval is time base X gate interval (for instance, time base of 10 X gate interval of 5 = 50 ms). Maximum value is 3 s. **Gate interval must be entered when PWM and rate measurement are configured.**				
Word 4	Bits 00…15 (00…17)	**Channel 1 Gate interval** – Sets the individual counter gate interval using the time base setting as its time unit. Actual gate interval is time base X gate interval (for instance, time base of 10 X gate interval of 5 = 50 ms). Maximum value is 3 s. **Gate interval must be entered when PWM and rate measurement are configured.**				
Word 5	Bits 00…15 (00…17)	Do not use – reserved.				

Table 7 - Configuration Word Definition (Continued)

Configuration Word	Bit	Definition		
Word 6 and 7	Bits 00...15 (00...17)	**Channel 0 Rollover** – Sets the number of counts the counter accumulates before rolling over. For example, a setting of 1000 produces a count sequence of 998, 999, 0, 1, 2... while incrementing; and 2, 1, 0, 999, 998... while decrementing. Rollover is a 32-bit number with a usable range of 16,777,216. In PWM, this value is zero; in count, X1 encoder, X2 encoder and X4 encoder configurations, it must be some specified nonzero number. The value doesn.t matter in period/rate, continuous/rate, and rate measurement configurations.		
Word 8 and 9	Bits 00...15 (00...17)	**Channel 1 Rollover** – Sets the number of counts the counter accumulates before rolling over. For example, a setting of 1000 produces a count sequence of 998, 999, 0, 1, 2... while incrementing; and 2, 1, 0, 999, 998... while decrementing. Rollover is a 32-bit number with a usable range of 16,777,216. In PWM, this value is zero; in count, X1 encoder, X2 encoder and X4 encoder configurations, it must be some specified nonzero number. The value doesn.t matter in period/rate, continuous/rate, and rate measurement configurations.		
Word 10 and 11	Bits 00...15 (00...17)	**Channel 0 Preset** – This word sets the preset value that the counter is loaded with when CP is asserted. This number has a range of 0 ≤ value ≤ 16,777,216.		
Word 12 and 13	Bits 00...15 (00...17)	**Channel 1 Preset** – This word sets the preset value that the counter is loaded with when CP is asserted. This number has a range of 0 ≤ value ≤ 16,777,216.		
Word 14	Bits 00...15 (00...17)	**Channel 0 Scaler** – This word scales the Z signal **in period/rate and continuous/rate modes**. If the filter is applied, the filtered Z signal is scaled. **Set only 1 bit of the Scaler**. Selecting a Scaler causes accumulated counts to be adjusted accordingly (for instance, selecting a Scaler of 128 increases the accumulated count by 128 after 128 Z pulses have been received). **We recommend using the filter to reduce erroneous frequency readings any time you use the Scaler on the Z input.**		
	00	Z	Fmins (frequency at which the 24-bit counter overflows) = 0.149 Hz	
	01	Z/2	Fmins (frequency at which the 24-bit counter overflows) = 0.298 Hz	
	02	Z/4	Fmins (frequency at which the 24-bit counter overflows) = 0.596 Hz	
	03	Z/8	Fmins (frequency at which the 24-bit counter overflows) = 1.192 Hz	
	04	Z/16	Fmins (frequency at which the 24-bit counter overflows) = 2.384 Hz	
	05	Z/32	Fmins (frequency at which the 24-bit counter overflows) = 4.768 Hz	
	06	Z/64	Fmins (frequency at which the 24-bit counter overflows) = 9.537 Hz	
	07	Z/128	Fmins (frequency at which the 24-bit counter overflows) = 19.073 Hz	
Word 15	Bits 00...15 (00...17)	**Channel 1 Scaler** – This word scales the Z signal **in period/rate and continuous/rate modes**. If the filter is applied, the filtered Z signal is scaled. **Set only 1 bit of the Scaler**. Selecting a Scaler causes accumulated counts to be adjusted accordingly (for instance, selecting a Scaler of 128 increases the accumulated count by 128 after 128 Z pulses have been received). **We recommend using the filter to reduce erroneous frequency readings any time you use the Scaler on the Z input.**		
	00	Z	Fmins (frequency at which the 24-bit counter overflows) = 0.149 Hz	
	01	Z/2	Fmins (frequency at which the 24-bit counter overflows) = 0.298 Hz	
	02	Z/4	Fmins (frequency at which the 24-bit counter overflows) = 0.596 Hz	
	03	Z/8	Fmins (frequency at which the 24-bit counter overflows) = 1.192 Hz	
	04	Z/16	Fmins (frequency at which the 24-bit counter overflows) = 2.384 Hz	
	05	Z/32	Fmins (frequency at which the 24-bit counter overflows) = 4.768 Hz	
	06	Z/64	Fmins (frequency at which the 24-bit counter overflows) = 9.537 Hz	
	07	Z/128	Fmins (frequency at which the 24-bit counter overflows) = 19.073 Hz	

Table 7 - Configuration Word Definition (Continued)

Configuration Word	Bit	Definition
Words 16...19	Bits 00 01 02 03 04 05 06 07 Bits 08...15 (10...17)	**Output Ties** – These bits connect the specified output to the appropriate compare window. There are 8 windows, 4 per counter. Each output can be connected to any number of windows, from 1 to 8. F1 = Tie output to first counter 1st window F2 = Tie output to first counter 2nd window F3 = Tie output to first counter 3rd window F4 = Tie output to first counter 4th window S1 = Tie output to second counter 1st window S2 = Tie output to second counter 2nd window S3 = Tie output to second counter 3rd window S4 = Tie output to second counter 4th window Set to 0.
Words 20...51	Bits 00...15 (00...17)	**Counter On and Off** – These words program each of the 4 counter.s (first and second counter) on and off values. The first compare window for each counter is used in PWM, and when programmed for PWM, the associated compare window should remain at 0. The range of each entry is 0 ≤ value ≤ 16,777,215. When a tie is connected to a window comparator, that window must be specified. These windows are always interpreted as counts, regardless of the configuration setting, and can be computed as follows: counts = (Scaler X 2.5E6)/desired frequency (for period/rate and continuous/rate) counts = time base X desired frequency (for rate measurement)
Words 52...55	Bits 00...15 (00...17)	**Safe State Values** – When the controller transitions to PROG mode or a communication fault occurs, the module copies the safe state words into its real time working buffer. The definitions are identical to those in the counter control word, except entering a PWM safe state value outside the range 0...9500 results in a Hold Last State. Word 52 is Counter Control Safe State; word 53 is Output Control Safe State; word 54 is Channel 0 PWM Safe State word 55 is Channel 1 PWM Safe State.

Notes:

Configure the Very High-speed Counter Module

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Create a New Module	49

To initiate communication between the 1794-VHSC Very High-speed Counter module and your controller processor, you must use the Studio 5000 Logix Designer® application.

This chapter describes how to add your FLEX I/O Very High-speed Counter module in a Logix Designer application project. You can use the default module configuration or edit the module configuration.

For more information on how to configure and communicate with the 1794-VHSC Very High-speed Counter module, see the Studio 5000 Logix Designer application manuals and help.

Before You Begin

You must complete the following tasks before you can configure the module:

1. Create a Logix Designer application project.
2. Add a FLEX I/O EtherNet/IP adapter to the project.

Create a New Module

After you create a Logix Designer application project and add a FLEX I/O EtherNet/IP adapter to the project, you can use the following method to add modules to the project.

To add a module, perform the following steps.

1. Right-click Flexbus and choose New Module.
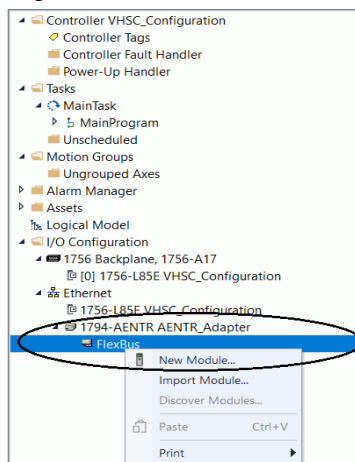
2. Select the module and click Create.

> Type the first few characters of the module catalog number. The list of available modules is reduced.
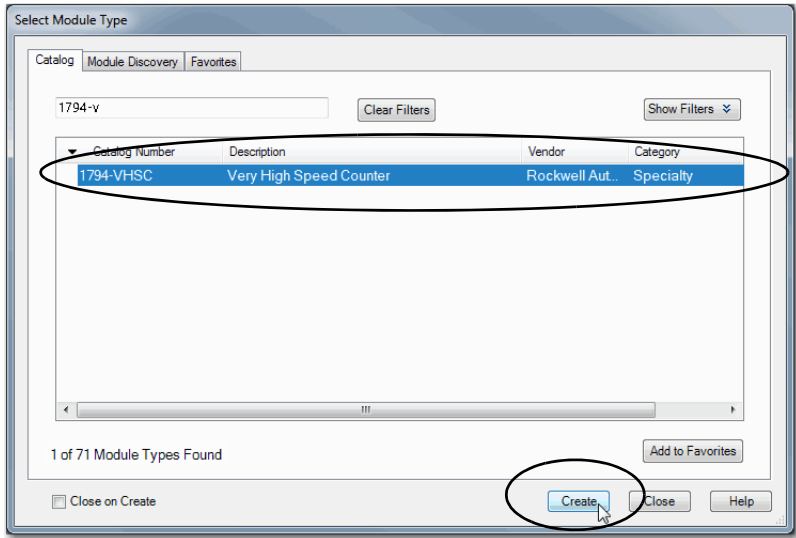
The New Module dialog box appears. It includes a list of categories on the left side. The number and type of categories varies by module type.

3. Click OK to use the default configuration, if desired.

Make changes on the categories that are listed on the left side of the dialog box to create a custom module configuration.
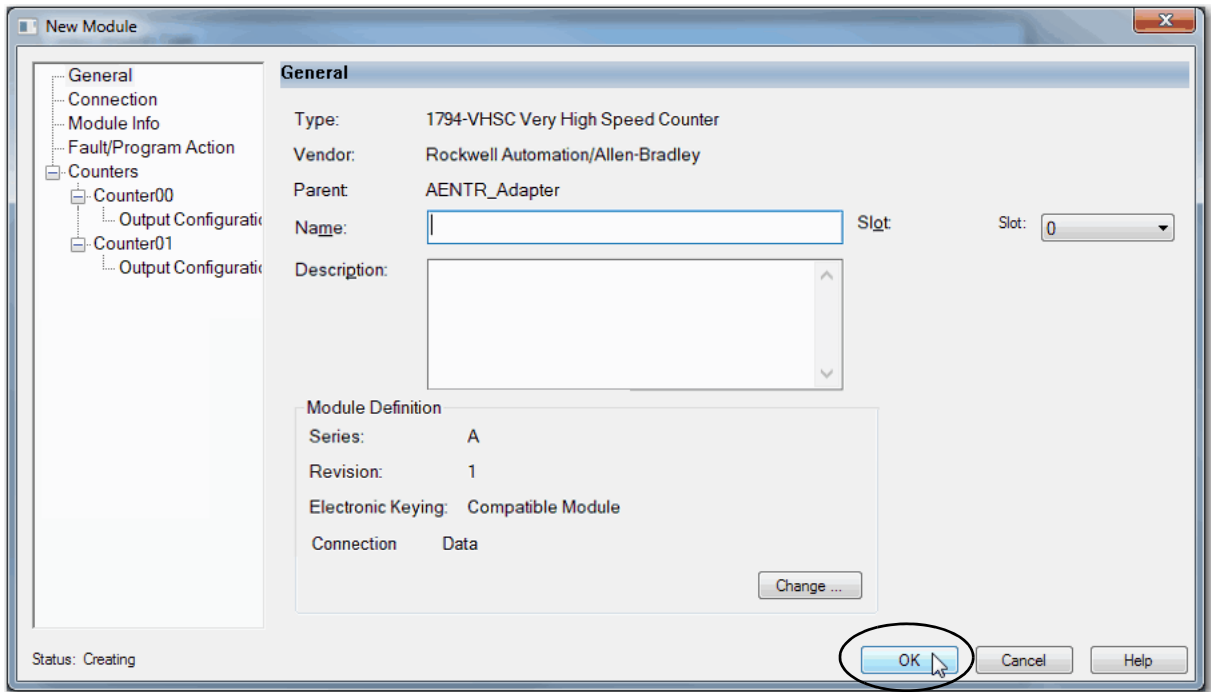
Interpret Status Indicators

Overview

Use this chapter to troubleshoot the Very High-speed Counter module by interpreting the indicators.

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Status Indicators	51
Diagnostic Codes Returned by the Module	52

Status Indicators

The module contains indicators for each of the following:

Figure 21 - 1794-VHSC Module
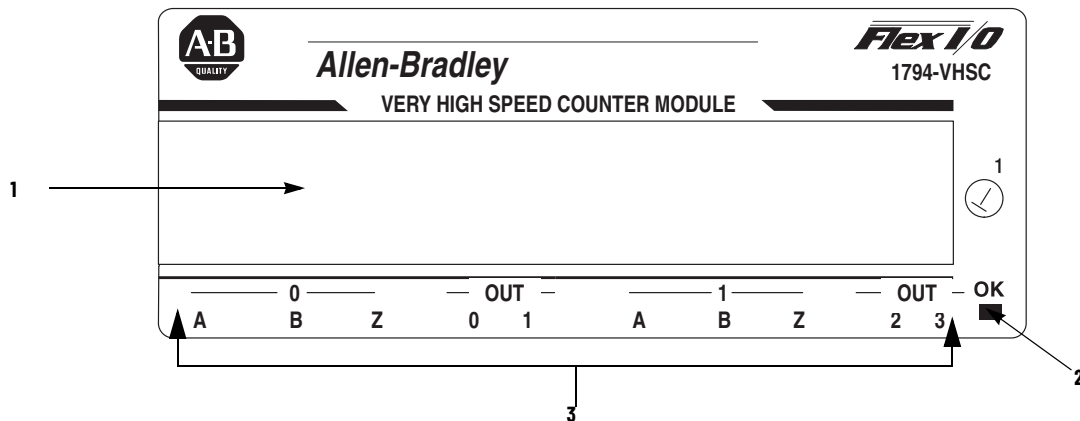
Status Indicators

Indicator	Status	Description
A (status of input A)	Yellow	Input A active.
	Off	Input A not active.
B (status of input B)	Yellow	Input B active.
	Off	Input B not active.
Z (status of input Z)	Yellow	Input Z active.
	Off	Input Z not active.
Out 0, 1, 2, 3	Yellow	Output is on.
	Off	Individual output is off.

Use Table 8 on page 52 to determine the indicator conditions and status.

When an active indicator (yellow) is lighted, a valid signal (active high or active low) is present at the input terminals.

The module power/status indicator (OK) shows power applied to the module, and the status of the module.

Table 8 - Power/Status Indicator Interpretation

Indicator	State	Status
OK	Steady red	• Hardware diagnostic error, TF set to 1 and module/channel status contains error code. • Hardware runtime failure (that is, watchdog timeout), module communication ceases.
	Flashing red	• Module is configuring hardware, NR is set to 1. • Module is in test mode (bits 8…15 of counter control word are nonzero), TF set to 1.
	Flashing red (with occasional flashing green)	Module 24V power is below minimum rating.
	Steady green	Module is active and behaving normally.
	Flashing green	• Module is not configured. • Programming error, PE is set to 1 and error code is supplied in bits 0…11 of module/channel status word. • Field power fault, FP set to 1. • Adapter powered down, and module local power still active. • Network cable disconnected. • Controller in PROG mode.

Diagnostic Codes Returned by the Module

If an incomplete, incorrect, or conflicting sets of configuration parameters is sent to the module, the PE bit is asserted, the green module status indicator flashes, and an error code is displayed in bits 0…11 of the module/channel status word. Table 9 describes the diagnostic codes.

Table 9 - Diagnostics Reported by Input Data Word 8

Read Word	Bit	Indication
Word 8	00	A reserved configuration or mode was programmed.
	01	ZF/BF/AF were selected and no filter was programmed, or multiple filters were selected.
	02	A time base was entered that was not a multiple of 10, or the time base is out of range (>3000, that is 3 s).
	03	A configuration that requires a time base was selected and no gate interval was set, or the gate interval is out of range (>3 s) or the product of time base and gate interval is greater than 3 s.
	04	A rollover of zero was programmed through PWM was not selected; a rollover was programmed and PWM was selected; or the rollover is out of range (1 ≤ rollover ≤16,777,216).
	05	The preset (1 ≤ preset ≤ 16,777,216) is out of range.
	06	A configuration was selected that requires a scalar, and no scalar was programmed or multiple scalars were selected.
	07	A tie has been connected to an unprogrammed window.
	08	Counter 0 window ON and OFF values are equal and not zero or counter 0 window ON and OFF value greater than 16,777,215.
	09	Counter 1 window ON and OFF values are equal and not zero or counter 1 window ON and OFF value greater than 16,777,215.
	10	Reserved
	11	

Notes:

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Rockwell Automation Support

Use these resources to access support information.

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

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Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental information on its website at rok.auto/pec.

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