Allen-Bradley

ControlLogix Sequence of Events Module

1756-IB16ISOE (24/48V dc),
1756-IH16ISOE (125V dc)

User Manual

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.ab.com/manuals/gi) 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.

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

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

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Throughout this manual we may 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.

IMPORTANT

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

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
- recognize the consequence

SHOCK HAZARD

Labels may be located on or inside equipment to alert people that dangerous voltage may be present.

BURN HAZARD

Labels may be located on or inside equipment to alert people that surfaces may be dangerous temperatures.

Purpose of This Manual

This manual describes how to use the ControlLogix Sequence of Events module in your ControlLogix application. With this manual, you can learn how to install, configure and troubleshoot the module.

There are two types of ControlLogix Sequence of Events modules, as described in Table Preface.1:

Table Preface.1

Catalog number:	Description:	Availability date:
1756-IB16ISOE	16-point, 10 - 50V dc module	June 2004
1756-IH16ISOE	16-point, 90 - 140V dc module	April 2004

IMPORTANT The two types of Sequence of Events modules have identical functionality, except for the fact that they operate at different voltage levels. Throughout this manual, we use the term *Sequence of Events module* generically. When you read the term, it refers to both types of modules unless specifically noted.

Who Should Use This Manual

This manual is intended for individuals who program ControlLogix control systems, such as:

- software engineers
- control engineers
- application engineers

To most efficiently use the Sequence of Events module, you should be familiar with:

- ControlLogix™ controllers
- ControlLogix ControlNet™ communication modules
- RSLogix 5000™
- RSNetWorx for ControlNet™

What This Manual Contains

Table Preface.2 lists the sections contained in this manual:

Table Preface.2

Section:	Title:
Chapter 1	What is the ControlLogix Sequence of Events Module?
Chapter 2	How Does the Sequence of Events Module Operate in a ControlLogix System?
Chapter 3	Installing the Sequence of Events Module
Chapter 4	Configuring the Sequence of Events Module
Chapter 5	Using the Sequence of Events Module Features
Chapter 6	Using The Sequence of Events Module in CST Per Point Mode
Chapter 7	Using The Sequence of Events Module in FIFO Mode
Chapter 8	Troubleshooting the Sequence of Events Module
Appendix A	Specifications and Module Block Diagrams
Appendix B	Integrating The HiProm GPS Module (1756HP-GPS) into a ControlLogix Sequence of Events Module System
Appendix C	Using the Sequence of Events Module for Absolute First Fault Detection
Appendix D	Using Module Tags
Appendix E	Using Sample RSLogix 5000 Projects with the Sequence of Events Module

Related Documentation

Table Preface.3 lists related ControlLogix documentation that may assist you when using the Sequence of Events module.

Table Preface.3 Related Documentation

Catalog number:	Document title:	Publication number:
1756-A4, -A7, -A10, -A13, -A17	ControlLogix Chassis–Series B Installation Instructions	1756-IN080
1756-PA72/B, -PB72/B	ControlLogix Power Supply Installation Instructions	1756-5.67
1756-PA75, -PB75	ControlLogix Power Supply Installation Instructions	1756-5.78
1756-PH75	ControlLogix 125V DC (90-143V) Power Supply	1756-IN589
1756-Series	ControlLogix Module Installation Instructions (Each module has separate installation document.)	Multiple 1756-IN numbers
1756-CNB, -CNBR	Using ControlNet Communication Modules in Logix5000 Control Systems User Manual	CNET-UM001
1756-Lx	ControlLogix System User Manual	1756-UM001

Preventing Electrostatic Discharge

This module is sensitive to electrostatic discharge.

ATTENTION

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.
- If available, use a static-safe workstation.

When not in use, store the equipment in appropriate static-safe packaging.

Environment and Enclosure

ATTENTION

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

This equipment is considered Group 1, Class A industrial equipment according to IEC/CISPR Publication 11. Without appropriate precautions, there may be potential difficulties ensuring electromagnetic compatibility in other environments due to conducted as well as radiated disturbance.

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 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.

See NEMA Standards publication 250 and IEC publication 60529, as applicable, for explanations of the degrees of protection provided by different types of enclosure. Also, see the appropriate sections in this publication, as well as the Allen-Bradley publication 1770-4.1 (“Industrial Automation Wiring and Grounding Guidelines”), for additional installation requirements pertaining to this equipment.

Chapter 1

What is the ControlLogix Sequence of Events Module?

Chapter 2

How Does the Sequence of Events Module Operate in a ControlLogix System?

Chapter 3

Installing the Sequence of Events Module

Chapter 4

Configuring the Sequence of Events Module

Chapter 5

Using the Sequence of Events Module Features

Chapter 6

Using The Sequence of Events Module in CST Per Point Mode

Chapter 7

Using The Sequence of Events Module in FIFO Mode

What is the ControlLogix Sequence of Events Module?

What This Chapter Contains

This chapter describes the ControlLogix Sequence of Events module.

Table 1.1

What does Sequence of Events Module Do?

The ControlLogix Sequence of Events module is a DC input module that offers sub-millisecond timestamping on a per point basis in addition to providing the basic ON/OFF detection as found on other ControlLogix input modules.

Timestamping is a ControlLogix feature that registers a time reference to a change in input data. In ControlLogix, the time mechanism used for timestamping is the Coordinated System Time (CST).

Timestamping Using the Coordinated System Time (CST)

The Coordinated System Time (CST) is a 64-bit, free-running timer with microsecond (μs) granularity on a ControlLogix backplane. A time master (either a ControlLogix controller or 1756-SYNCH module) generates the timer and sets it on the backplane. All other modules in the chassis have access to the CST and adjust their time reference based on the backplane time reference.

CST cannot easily translate to real-time but serves as a relative time reference. Each module in a chassis has access to this reference. The Sequence of Events module grabs the current CST value at the time of the input state change to timestamp the input data.

You can propagate the same CST value across multiple chassis, effectively making sure that modules in separate chassis use the same time reference in all their operations, if necessary.

You can extend a single CST value across multiple chassis that are physically connected via 1756-SYNCH modules. Additionally, multiple ControlLogix systems–even those that are geographically separated–can use the 1756HP-GPS module to share a common real-time reference. For more information on extending a single CST value across multiple chassis, see Appendix C.

On-Board Data Storage

Once a CST timestamp is captured for an input transition, the module's operational mode impacts how the module functions with respect to:

- what data is stored on-board
- how much data is stored for each input point
- how the data is sent to the controller

The next section briefly describes the two modes of operation available with the Sequence of Events module and how they impact the module's behavior.

Two Modes of Operation

The Sequence of Events module can operate in either of the modes described in Table 1.2:

Table 1.2

Operational mode:	Description:
CST Per Point Mode	The module timestamps up to 2 input transitions per input, one for OFF to ON transitions and another for ON to OFF transitions.
First In First Out (FIFO) Mode	The module timestamps an unlimited number of input transitions, regardless of direction (i.e., either OFF to ON or ON to OFF) or input (i.e., the same input can transition many times and the module will timestamp every transition) and stores them in an on-board buffer. The module is capable of storing the data for up to 160 input transitions in its on-board buffers at a single time. However, if you retrieve data from the buffers effectively, the module will never miss an input transition, regardless of how many occur.

You set the module's operational mode when you choose a communication format during initial module configuration. Depending on operational mode, RSLogix 5000 creates different tags for the Sequence of Events when it is added to a project.

For more information on each mode, see Chapter 6, Using The Sequence of Events Module in CST Per Point Mode and Chapter 7, Using The Sequence of Events Module in FIFO Mode.

What Else Does the Sequence of Event Module Do?

The Sequence of Events module offers additional features that are common to ControlLogix digital input modules, such as:

- Full software configuration via RSLogix 5000
- Removal and insertion under power
- Full Class I Division Compliance
- Agency Certifications (e.g. UL and CSA)

To see a full description of all the features available on your Sequence of Events module, see Chapter 5, Using the Sequence of Events Module Features.

Understanding the Module's Physical Features

ControlLogix modules mount in a ControlLogix chassis and use a Removable Terminal Block (RTB), or a Bulletin 1492 Interface Module cable that connects to an IFM, to connect all field-side wiring. Before you use your module, you should have already:

- installed and grounded a 1756 chassis and power supply. To install these products, refer to the publications listed in Table Preface.3 on page Preface-2.
- ordered and received an RTB or IFM and its components for your application; neither RTBs nor IFMs are included with your module purchase.

Figure 1.1

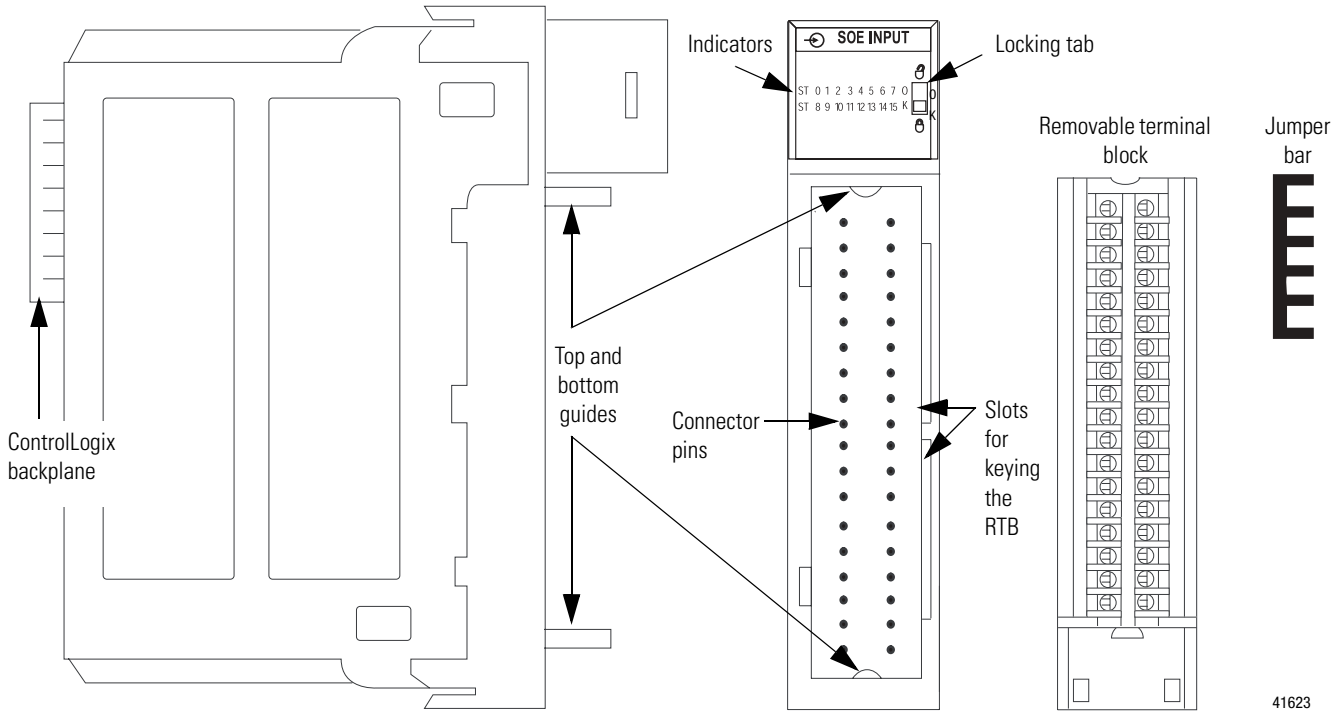


Table 1.3 Physical Features on the ControlLogix Sequence of Events Module

Physical Feature:	Description:
Backplane connector	The backplane connector interface for the ControlLogix system connects the module to the ControlLogix backplane.
Connector pins	Input/output, power and grounding connections are made to the module through these pins with the use of an RTB or IFM.
Locking tab	The locking tab anchors the RTB or IFM cable on the module, maintaining wiring connections.
Slots for keying	Mechanically keys the RTB to prevent inadvertently making the wrong wire connections to your module.
Status indicators	Indicators display the status of communication, module health and input/output devices. Use these indicators to help in troubleshooting.
Top and bottom guides	Guides provide assistance in seating the RTB or IFM cable onto the module.
Jumper bar	Device you can use to connect multiple points in non-isolated wiring application, as shown on page 3-6.

Using Module Identification and Status Information

Each Sequence of Events module maintains specific identification information that separates it from all other modules. This information assists you in tracking all the components of your system. For example, you can track module identification information to be aware of exactly what modules are located in any ControlLogix chassis at any time. While retrieving module identity, you can also retrieve the module's status.

Each module maintains the information listed in Table 1.4:

Table 1.4 Module Identification and Status Information

Module Identification:	Description:
Product Type	Module's product type
Product Code	Module's catalog number
Major Revision	Module's major revision number
Minor Revision	Module's minor revision number

Status	Module's status. Returns the following information:
	• Controller ownership (if any)
	• Whether module has been configured
	• Device Specific Status, such as:
	  • Self-Test
	  • Flash update in progress
	  • Communications fault
	  • Not owned
	  • Internal fault (need flash update)
	  • Run mode
	• Minor recoverable fault
	• Minor unrecoverable fault
	• Major recoverable fault
	• Major unrecoverable fault

Vendor ID	Module manufacturer vendor, for example Allen-Bradley
Serial Number	Module serial number
Length of ASCII Text String	Number of characters in module's text string
ASCII Text String	Module's ASCII text string description

IMPORTANT You must perform a WHO service to retrieve this information.

Chapter Summary and What's Next

In this chapter you read about what the ControlLogix Sequence of Events module is. Chapter 2 explains How Does the Sequence of Events Module Operate in a ControlLogix System?

How Does the Sequence of Events Module Operate in a ControlLogix System?

What This Chapter Contains

This chapter describes how the Sequence of Events module operates in a ControlLogix system.

Table 2.1

Differences Between Sequence of Events Module and Standard Digital I/O

In many aspects, the Sequence of Events module behaves the same as other ControlLogix digital input modules. However, the module offers several significant differences from other ControlLogix digital input modules, including those described in Table 2.2:

Table 2.2

Difference:	Description:
Additional data produced for controller	The Sequence of Events module produces significantly more data for its owner-controller than standard ControlLogix digital input modules. While other input modules only produce ON/OFF and fault status, the Sequence of Events module produces data such as ON/OFF and fault status, timestamp data, indication of whether new data was produced for specific input points or if transitions were not timestamped.
Only one owner-controller per module	While multiple controllers can simultaneously own other digital input modules, the Sequence of Events module only supports a single owner-controller.
Rack-optimized connections not supported	The Sequence of Events module does not support Rack-Optimized Connections from the owner-controller.
Change of State (COS) functionality in Enable CST Capture feature	The module does support Enable CST Capture, a feature used to timestamp input transitions, that is analogous to COS. For more information on Enable CST Capture, see page 2-6.
No listen-only connections	Controllers cannot make listen-only connections to the Sequence of Events module. All connections between the module and its owner-controller are direct connections.
Input filtering on a module-wide basis	Other digital input modules offer input filtering on a per group basis. The Sequence of Events module offers two input filter settings–one for OFF to ON transitions and one for ON to OFF transitions–and is set on a module-wide basis.

Similar Functionality to Standard ControlLogix DC Input Modules

With respect to general module operation in a ControlLogix system, the Sequence of Events module operates similarly to other ControlLogix digital input modules in many ways. This chapter focuses on how the Sequence of Events module's behavior differs from that of other ControlLogix digital input modules.

However, you should be aware of aspects in which the Sequence of Events module is similar to standard ControlLogix digital input modules. For more information on these similarities, see Table 2.3.

Table 2.3 Ways that a Sequence of Events Module Behave Like Other ControlLogix Digital Input Modules

Concept:	Description:
Ownership	Every Sequence of Events module in the ControlLogix system must be owned by a Logix5000 controller. This owner-controller: • stores configuration data for every module that it owns. • can be local or remote in regard to the Sequence of Events module's position. • sends the Sequence of Events module configuration data to define the module's behavior and begin operation with the control system. **This module does not support multiple owner-controllers**.
Using RSNetWorx and RSLogix 5000	The I/O configuration portion of RSLogix5000, v13 or greater, generates the configuration data for each Sequence of Events module in the control system, whether the module is located in a local or remote chassis. A remote chassis, also known as networked, contains the Sequence of Events module but not the module's owner-controller. Remote chassis can be connected to the controller via a scheduled ControlNet or an EtherNet/IP network. Configuration data is transferred to the controller during the program download and subsequently transferred to the appropriate Sequence of Events modules. Sequence of Events modules in the local chassis, and modules in a remote chassis that is connected via the EtherNet/IP network, are ready to run as soon as the configuration data has been downloaded. However, you must run RSNetWorx for ControlNet to enable Sequence of Events modules in a scheduled ControlNet chassis. Running RSNetWorx transfers configuration data to Sequence of Events modules on scheduled ControlNet and establishes a Network Update Time (NUT) for ControlNet that is compliant with the desired communications options specified for each module during configuration. Anytime a controller references a Sequence of Events module in a scheduled ControlNet chassis, you must run RSNetWorx to configure ControlNet. Follow these general guidelines when configuring Sequence of Events modules: 1. Configure all Sequence of Events modules for a given controller using RSLogix 5000 and download that information to the controller. 2. If the module configuration data references a module in a remote chassis connected by scheduled ControlNet, run RSNetWorx. 3. After running RSNetWorx, perform an online save of the RSLogix 5000 project so the configuration information that RSNetWorx sends to the controller is saved. **IMPORTANT**: You **must** run RSNetWorx whenever a new module is added to a scheduled ControlNet chassis. When a module is permanently removed from a remote chassis, we recommend that RSNetWorx be run to optimize the allocation of network bandwidth.

Table 2.3 Ways that a Sequence of Events Module Behave Like Other ControlLogix Digital Input Modules

Concept:	Description:
Making Connections	ControlLogix controllers can make direct or rack connections to digital I/O modules. The controller can only make a direct connection to the Sequence of Events module. **The controller cannot make rack connections to the Sequence of Events module. Additionally, the controller cannot make listen-only connections to the Sequence of Events module.** A direct connection is a real-time data transfer link between the controller and the device that occupies the slot that the configuration data references. When module configuration data is downloaded to an owner-controller, the controller attempts to establish a direct connection to each of the modules referenced by the data. If a controller has configuration data referencing a slot in the control system, the controller periodically checks for the presence of a device there. When a device's presence is detected there, the controller automatically sends the configuration data. If the data is appropriate to the module found in the slot, a connection is made and operation begins. If the configuration data is not appropriate, the data is rejected and an error message appears in the software. In this case, the configuration data can be inappropriate for any of a number of reasons. For example, a module's configuration data may be appropriate except for a mismatch in electronic keying. The controller maintains and monitors its connection with a module. Any break in the connection, such as module faults or removal of the module from the chassis while under power, causes the controller to set fault status bits in the data area associated with the module. RSLogix 5000 monitors connection status to annunciate the modules' failures.
Transmitting Data	In the ControlLogix system, a controller does not poll the Sequence of Events module to obtain input status. When you configure a Sequence of Events module to capture a CST value for a specific transition, the module produces data whenever that input transitions and also at a user-configured rate. The type of input data transmitted and transmission frequency depends on module configuration and where in the control system that input module physically resides. This is called the Producer/Consumer model. The Sequence of Events module produces the input data and the controller consumes the data. All Sequence of Events module inputs are updated asynchronous to the controller's task execution. In other words, an input may be updated in the controller at any time during the controller's execution of the tasks it is configured to run. The input device determines when the input is sent, based on its configuration.
Triggering Event Tasks	You can configure Sequence of Events modules to trigger an event task. The event task offers ControlLogix controller users a task that executes a section of logic immediately when an event (i.e., receipt of new, unseen, data) occurs. Your Sequence of Events module can trigger event tasks. When using a Sequence of Events module to trigger an event task, remember these considerations: • Only one input module can trigger a specific event task. • The input module triggers the event task based on the Enable CST Capture configuration for the module. The Enable CST Capture configuration defines which points prompt the module to produce data if they turn ON or OFF. This production of data triggers the event task. • Typically, Enable CST Capture for only one point on the module. If you Enable CST Capture for multiple points, a task overlap of the event task may occur. For more information on using Event tasks, see the Logix5000 Controllers Common Procedures Programming Manual, publication 1756-PM001.

Propagating a Signal From Field Device to Backplane

As shown in Figure 2.1, the Sequence of Events module receives a signal at the RTB and processes it internally before sending a signal to the ControlLogix backplane via the Requested Packet Interval (RPI) or at na Enable CST Capture occurrence.

However, when you operate the Sequence of Events module, you must account for signal propagation delays that exist during internal processing. Some of these delays are inherent to the module and others can be controlled via the user-defined module configuration.

During processing, the following delays exist:

- hardware delay - varies according to module type (i.e., catalog number) and input transition type (i.e., OFF to ON/ON to OFF)

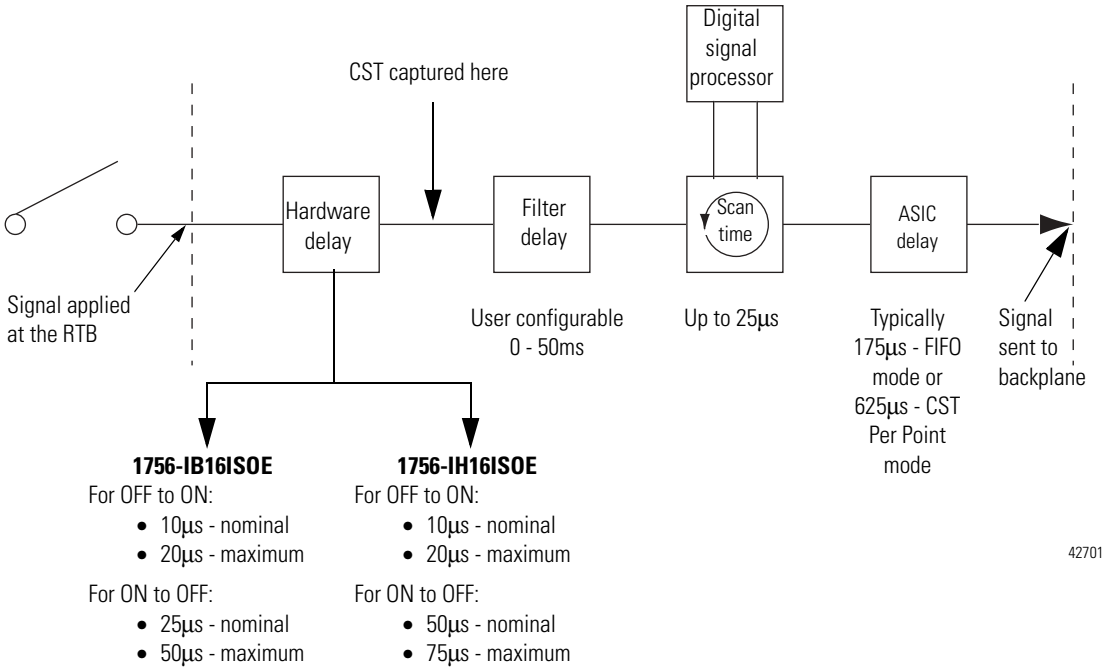
IMPORTANT The hardware delay is relatively consistent across inputs on a module and across modules in a chassis. Therefore, assuming the inputs and modules are used in similar environmental conditions and with similar voltages applied, the hardware delay is a minor consideration affecting timestamping accuracy.

- input filter delay - user-configurable number from 0 to 50ms
- firmware scan time - up to 25µs, depending on when the input transitions relative to the sample time
- ASIC delay - 25µs

Typically, the Sequence of Events module can deliver a signal to the ControlLogix backplane within 275µs in FIFO mode and 725µs in CST Per Point mode after it was received at the removable terminal block (RTB); these 275µs or 725µs numbers represent a scenario where the hardware delay is at maximum levels but no input filter is used.

TIP For fastest propagation of a signal from a field device to the controller, use the module in FIFO mode in a local chassis.

Figure 2.1



EXAMPLE

Many factors (e.g. voltage, operating temperature, if the module is turning ON or OFF) affect the signal propagation delay on a module. But a nominal delay time can be estimated.

For example, if you are **turning ON** a 1756-IB16ISOE module at 24V dc in 25°C conditions, the signal propagation delay is affected by:

- hardware delay to energize the module (nominally 10µS on this module)
- user-configurable input filter time (0 to 50ms)
- firmware scan time (up to 25µs)
- ASIC delay (175µs - FIFO mode/625µs - CST Per Point mode)

In the typical case scenario (i.e., filter time of 0ms), the module has a signal propagation delay of approximately 210µs (FIFO) to 660µs (CST Per Point).

Sequence of Events Module in a Local Chassis

When a Sequence of Events module resides in the local chassis (i.e., the same chassis as the owner-controller), the following two configuration parameters affect how and when an input module multicasts data:

- Requested Packet Interval (RPI)
- Enable CST Capture

Requested Packet Interval (RPI)

This interval specifies the rate at which a module multicasts its data to the controller. The time ranges from 250µs to 750ms and is sent to the module with all other configuration parameters. When the specified time frame elapses, the module multicasts data. This is also called a cyclic update.

Because each operational mode (CST Per Point or FIFO) generates a unique set of controller tags, the operational mode determines exactly what data is sent to the controller at the RPI. For more information on which tags are generated in each operational mode and, therefore, what data is sent to the controller at each RPI, see Appendix D, Using Module Tags.

Enable CST Capture

Enable CST Capture instructs the Sequence of Events module to capture the CST whenever specific input points transition. You can use this feature to instruct the module to capture the CST when the inputs transition from:

- OFF to ON only
- ON to OFF only

or

- both OFF to ON and ON to OFF

When Enable CST Capture is enabled for specific points and transitions occur for those points, the Sequence of Events module not only captures the CST at the transition occurrence but also sends input data to the controller.

Because the RPI and Enable CST Capture functions are asynchronous to the program scan, it is possible for an input to change state during program scan execution. The point must be "buffered" to prevent this. Copy the input data from your input tags to another structure and use the data from there.

TIP To minimize traffic and conserve bandwidth, we recommend you use a larger RPI value if the Enable CST Capture option is used and the module is located in the same chassis as its owner.

IMPORTANT All points on the Sequence of Events module have Enable Capture CST enabled by default for both ON to OFF and OFF to ON.

Additionally, you must specify an RPI regardless of whether you use Enable Capture CST on any input points. The default RPI at module creation in an RSLogix 5000 project is 10ms.

Sequence of Events Module in a Remote Chassis

If your Sequence of Events module physically resides in a chassis other than where the owner-controller is (e.g. a remote chassis connected via ControlNet), the role of the RPI and the module's Enable CST Capture behavior changes slightly with respect to getting data to the owner-controller.

The RPI and Enable CST Capture behavior still define when the module multicasts data **within its own chassis** (as described in the previous section), but only the value of the RPI determines when the owner-controller receives it over the network.

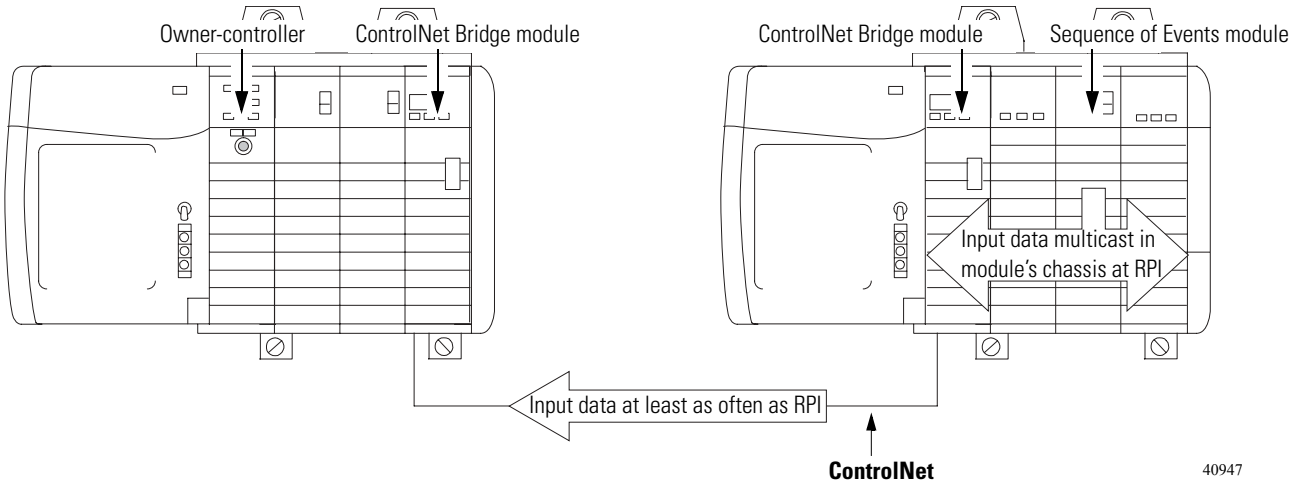
Remote Input Module Connected Via ControlNet

When a Sequence of Events module resides in a remote chassis connected by a scheduled ControlNet network, the RPI:

- instructs the module to multicast data in its own chassis at a specific interval.
- reserves a "spot" in the stream of data flowing across the ControlNet network.

The timing of this "reserved" spot may or may not coincide with the exact value of the RPI, but the control system guarantees that the owner-controller receives data **at least as often** as the specified RPI.

Figure 2.2 Sequence of Events Module in Remote Chassis with Data Coming At Least as Often as RPI



The “reserved” spot on the network and the module’s RPI are asynchronous to each other. This means there are Best and Worst Case scenarios as to when the owner-controller will receive updated channel data from the module in a remote chassis.

Best Case RPI Multicast Scenario

In the Best Case scenario, the module performs an RPI multicast with updated channel data just before the “reserved” network slot is made available. In this case, the owner-controller receives the data almost immediately.

Worst Case RPI Multicast Scenario

In the Worst Case scenario, the module performs an RPI multicast just after the “reserved” network slot has passed. In this case, the owner-controller does not receive data until the next available network slot.

IMPORTANT Enabling the Enable CST Capture feature on an input module in a remote chassis allows the module to multicast data at both the RPI rate and when the input changes state. This helps to **reduce the Worst Case time**.

Table 2.4 summarizes the Best Case and Worst Case scenarios, from the time an input changes state to the time the owner-controller will receive the data:

Table 2.4 Best and Worst Case Scenarios For Remote Input Data Transfer

	Best case scenario	Worst case scenario
Enable CST Capture disabled	Backplane/Network transfer times (<1mS)	Twice the RPI
Enable CST Capture enabled	Backplane/Network transfer times (<1mS)	RPI

When selecting values for the remotely located module's RPI, system throughput is optimized when its RPI value is a power of 2 times the current NUT running on ControlNet.

For example, Table 2.5 shows recommended RPI values for a system using a NUT of 5mS:

Table 2.5 Recommended RPI Values for System Using NUT of 5mS

NUT=5mS	$x2^0$	$x2^1$	$x2^2$	$x2^3$	$x2^4$	$x2^5$	$x2^6$	$x2^7$
Optimal RPI Values (mS)	5mS	10mS	20mS	40mS	80mS	160mS	320mS	640mS

Remote Input Modules Connected Via EtherNet/IP

When the Sequence of Events module is connected to the owner-controller via an EtherNet/IP network, data is transferred to the owner-controller in the following way:

- At the RPI or on an Enable CST Capture event, the module multicasts data within its own chassis.
- The 1756-ENBT module in the remote chassis immediately sends the module's data over the network to the owner-controller as long as it has not sent data within a time frame that is 1/4 the value of the digital input module's RPI.

  For example, if a Sequence of Events module uses an RPI = 100ms, the 1756-ENBT module only sends module data immediately on receiving it if another data packet was not sent within the last 25ms.

Chapter Summary and What's Next

In this chapter you read about how the Sequence of Events module operates in a ControlLogix system.

Chapter 3 explains the Installing the Sequence of Events Module.

Installing the Sequence of Events Module

What This Chapter Contains

This chapter describes how to install the Sequence of Events module.

Table 3.1

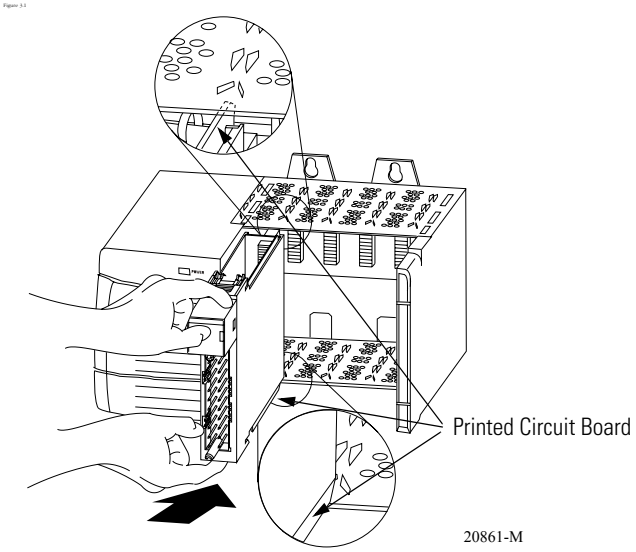
Installing the Sequence of Events Module

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

ATTENTION

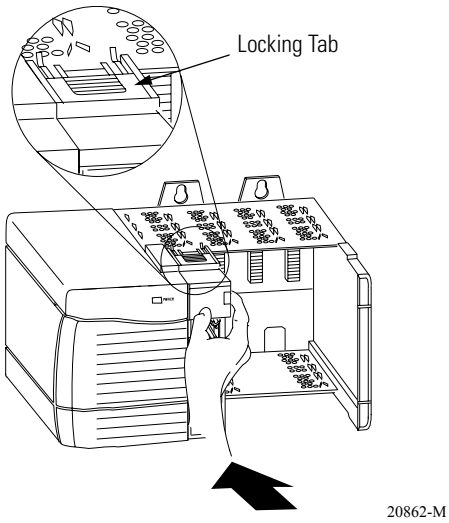
The module is designed to support Removal and Insertion Under Power (RIUP). However, when you remove or insert an RTB with field-side power applied, **unintended machine motion or loss of process control can occur**. Exercise extreme caution when using this feature.

1. Align circuit board with top and bottom chassis guides.



2. Slide module into chassis until module tabs 'click'.

Figure 3.2

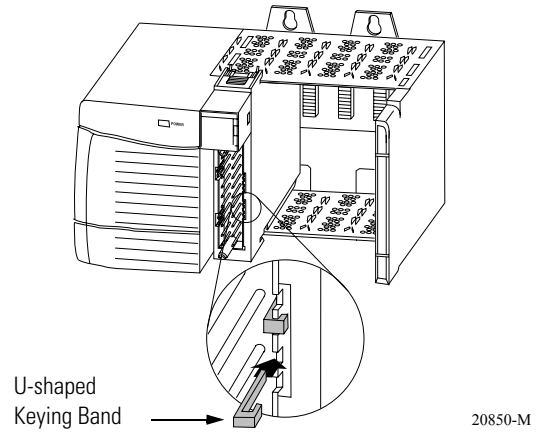


Keying the Removable Terminal Block

Key the RTB to prevent inadvertently connecting the incorrect RTB to your module. When the RTB mounts onto the module, keying positions match up. For example, if you place a U-shaped keying band in position #4 on the module, you cannot place a wedge-shaped tab in #4 on the RTB or your RTB does not mount on the module. We recommend that you use a unique keying pattern for each slot in the chassis.

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

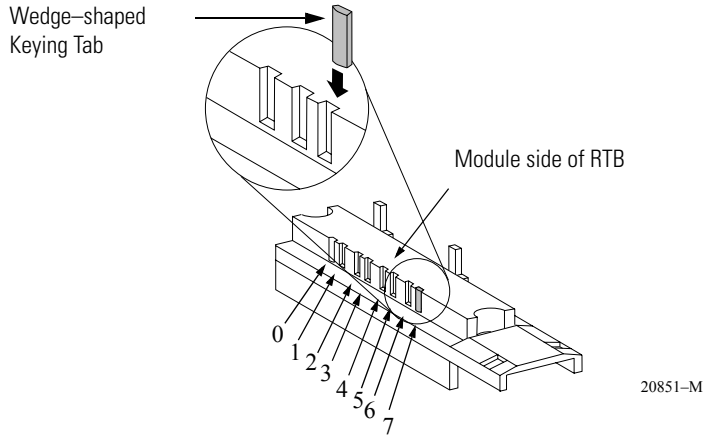
Figure 3.3 .



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

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

Figure 3.4



Connecting Wiring

You can use an RTB or a Bulletin 1492 prewired Interface Module (IFM) to connect wiring to your module. You must connect wires to the RTB. An IFM has been prewired before you received it. If you are using an IFM to connect wiring to the module, skip this section and go to page 3-7.

Wiring the RTB

You can use either of the following RTBs with your Sequence of Events module.

- Cage Clamp RTB - Catalog number 1756-TBCH
- Spring Clamp RTB - Catalog number 1756-TBS6H

Wire the RTB with a 1/8 inch (3.2mm) maximum flat-bladed screwdriver before installing it onto the module.

WARNING

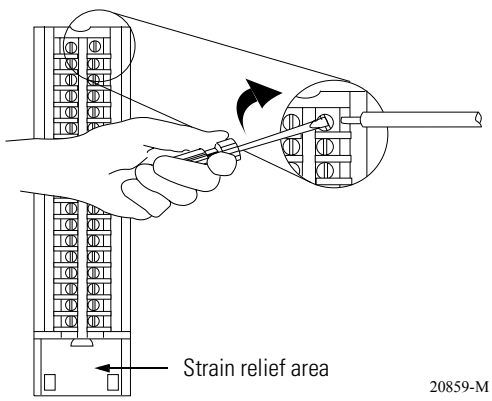
When you connect or disconnect the Removable Terminal Block (RTB) while field side power is on, an electrical arc can occur. This could cause an explosion in hazardous location installations.

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

Cage Clamp RTB

1. Strip 3/8 inch (9.5mm) maximum length of wire.
2. Insert the wire into the open terminal.
3. Turn the screw clockwise to close the terminal on the wire.

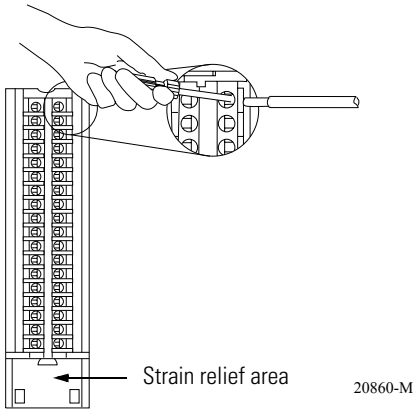
Figure 3.5



Spring Clamp RTB

1. Strip 7/16 inch (11mm) maximum length of wire.
2. Insert the screwdriver into the inner hole of the RTB.
3. Insert the wire into the open terminal and remove the screwdriver.

Figure 3.6



Recommendations for Wiring Your RTB

Consider the following guidelines when wiring your RTB:

- Begin wiring the RTB at the bottom terminals and move up.
- Use a tie to secure the wires in the strain relief area of the RTB.
- The **jumper bar** part number is 97739201. Contact your local Rockwell Automation sales representative to order additional jumper bars, if necessary.
- Order and use an **extended-depth housing** (Catalog number 1756-TBE) for applications that require heavy gauge wiring. For more information, see page 3-8.

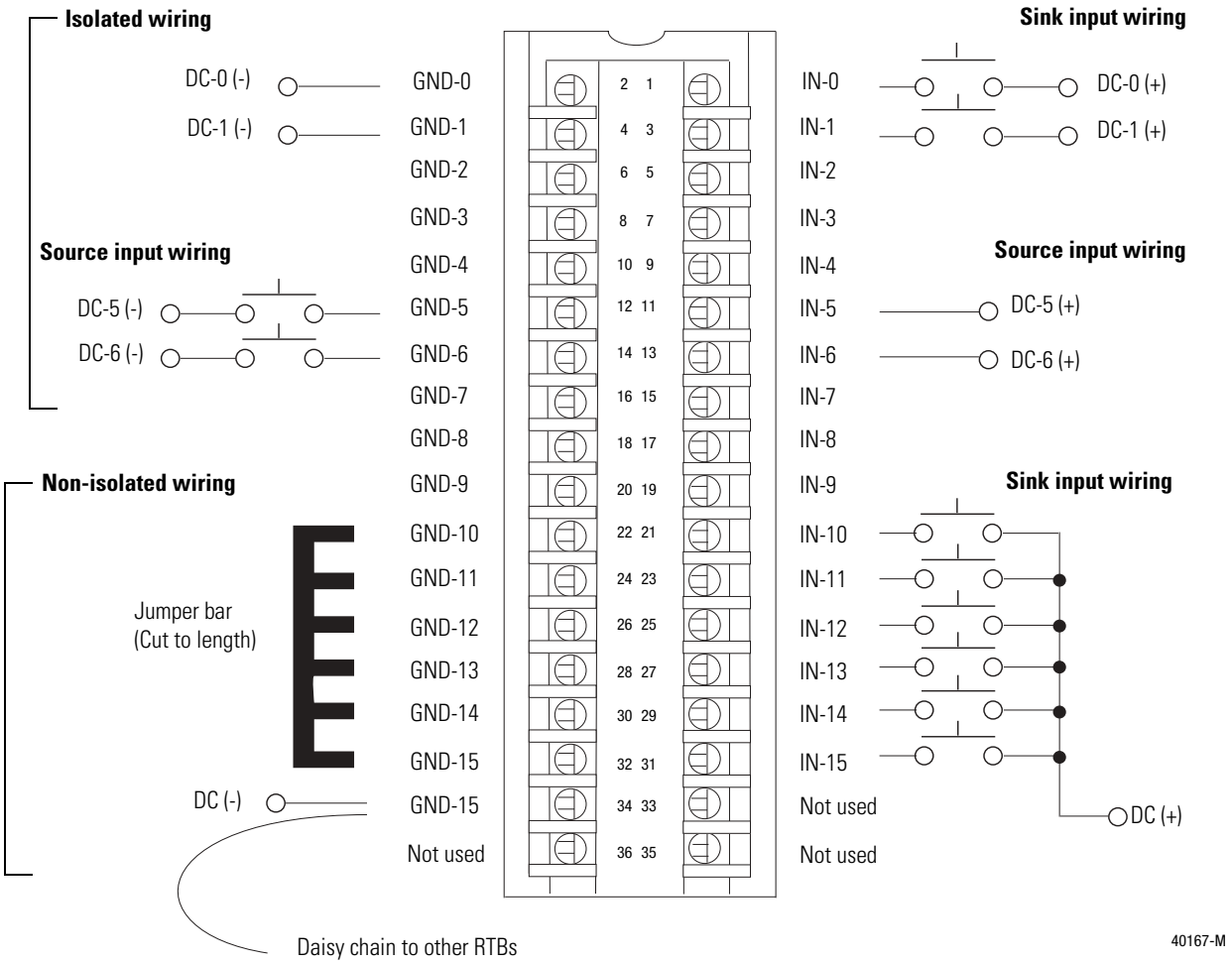
Wiring the Sequence of Events Module

Use Figure 3.7 to wire your Sequence of Events module.

WARNING

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

Figure 3.7



NOTES:

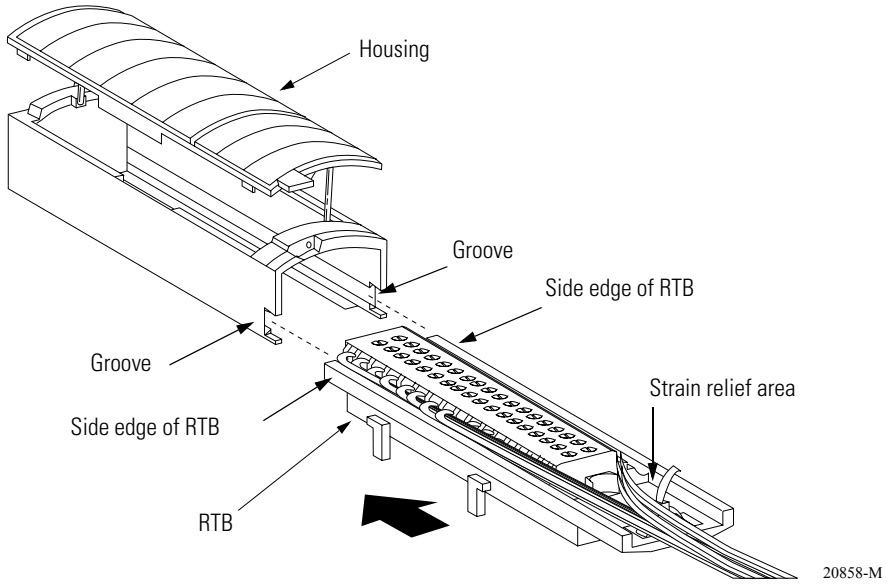
1. All terminals with the same name are connected together on the module. For example, DC (-) can be connected to either terminal marked GND-15.
2. When you use the second GND-15 terminal to daisy chain to other RTBs, always connect the daisy chain to the terminal directly connected to the supply wire, as shown in the example above.
3. If separate power sources are used, do not exceed the specified isolation voltage.
4. Do not connect more than 2 wires to any single terminal.
5. The jumper bar part number is 97739201. Contact your local Rockwell Automation sales representative to order jumper bars, if necessary.

Assembling The Removable Terminal Block and the Housing

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

1. Align the grooves at the bottom of each side of the housing with the side edges of the RTB.

Figure 3.8



1756-TBCH RTB shown for reference

2. Slide the RTB into the housing until it snaps into place.

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

Choosing the Extended-Depth Housing

There are two housing options you must consider when wiring your Sequence of Events module–standard-depth or extended-depth.

When you order an RTB for your module, you receive a standard-depth housing with the RTB. If your application uses heavy gauge wiring, you can order an extended-depth housing. This housing does not come with an RTB.

You can use one of the housings listed in Table 3.2.

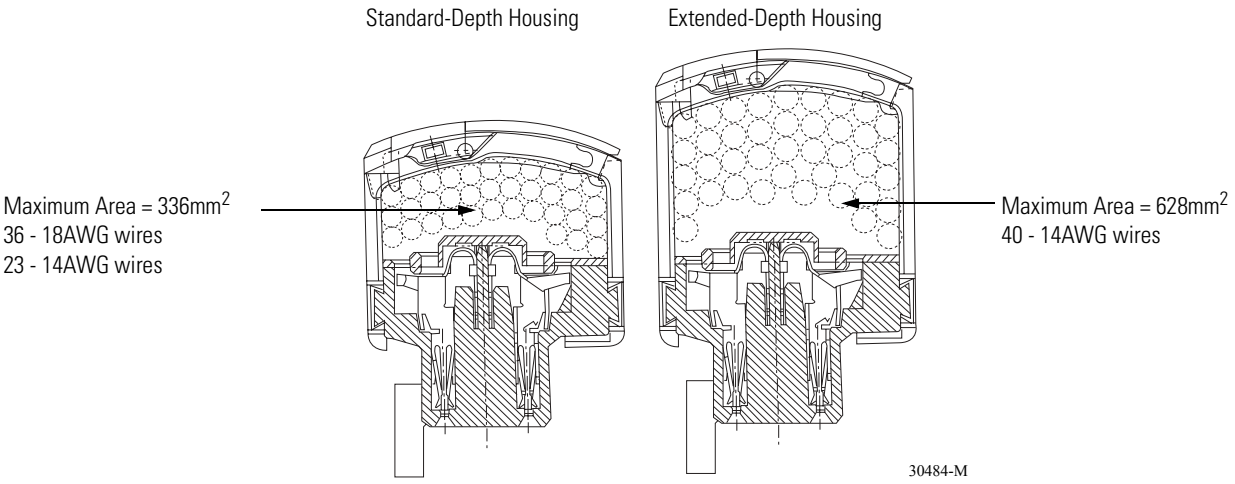
Table 3.2

Use this housing:	with this RTB:	This combination allows up to this capacity of wires:
1756-TBCH	Cage clamp	336 sq. mm
1756-TBS6H	Spring clamp (36-position)	
1756-TBE	Any RTB that uses heavy gauge wiring	628 sq. mm

Figure 3.9 shows the difference, in terms of capacity, between the housing options.

IMPORTANT The housings shown are used with a spring clamp RTB, but the capacity for each remains the same regardless of RTB type.

Figure 3.9



Recommendations for Using the Extended-Depth Housing

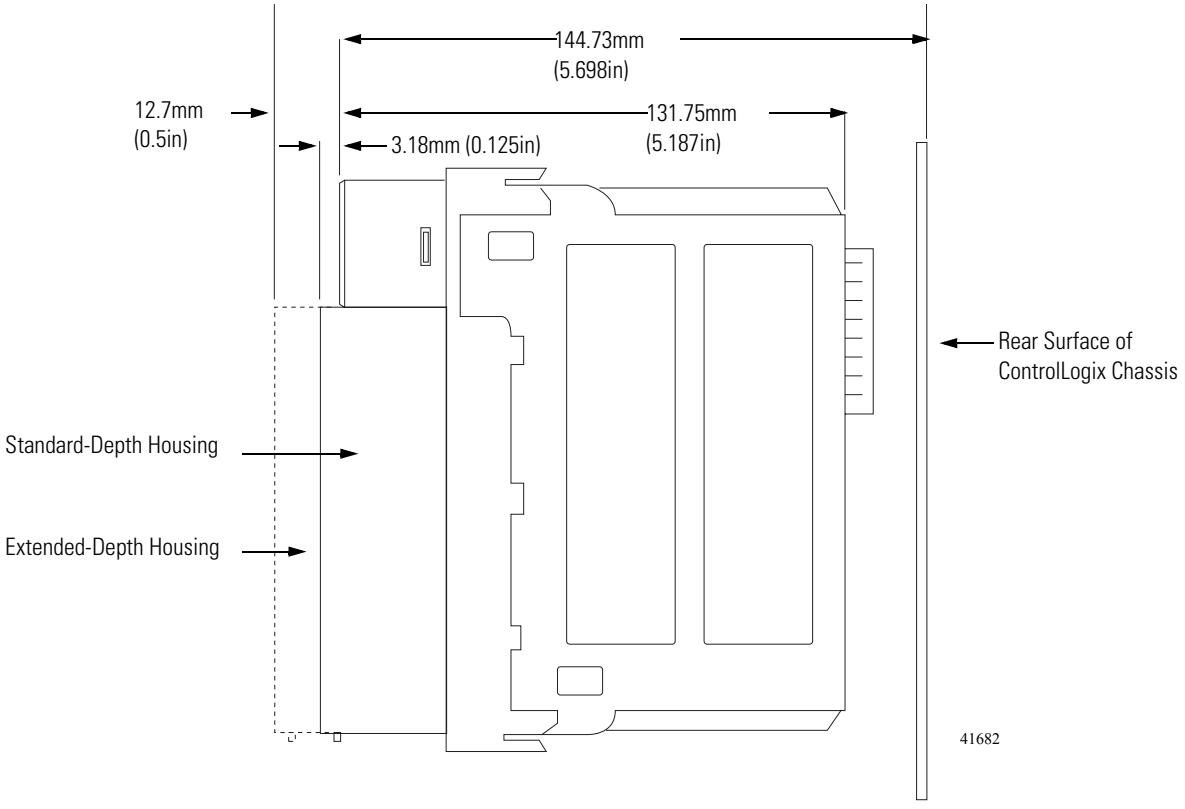
Consider the following recommendations when deciding to use an extended-depth housing on your Sequence of Events module. It is recommended you use the 1756-TBE when:

- using >36 18AWG wires
- using >23 14AWG wires

Cabinet Size Considerations With the Extended-Depth Housing

When you use an extended-depth housing (1756-TBE), the module depth is increased. The diagram below shows the difference, in terms of depth, between a Sequence of Events module using a standard-depth housing and one using an extended-depth housing.

Figure 3.10



IMPORTANT The depth from front of the module to the back of the chassis is as follows:

- standard-depth housing = 147.91mm (5.823in)
- extended-depth housing = 157.43mm (6.198in)

Installing the Removable Terminal Block

Install the RTB onto the module to connect wiring.

ATTENTION

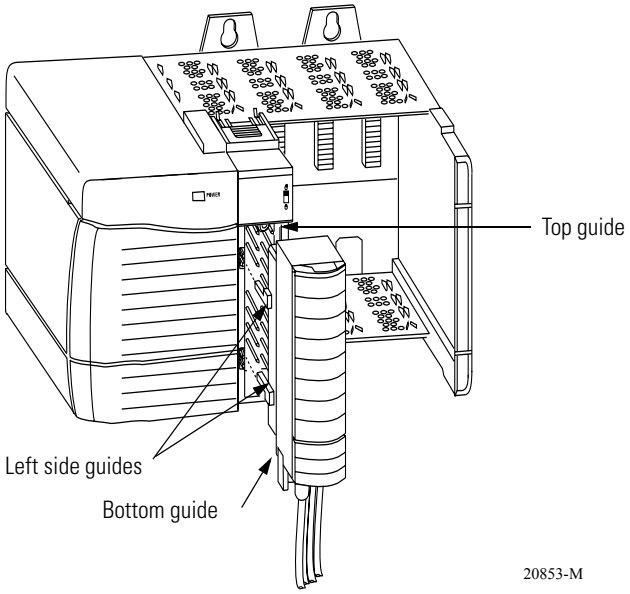
Shock hazard exists. If the RTB is installed onto the module while the field-side power is applied, the RTB will be electrically live. Do not touch the RTB's terminals. Failure to observe this caution may cause personal injury.

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

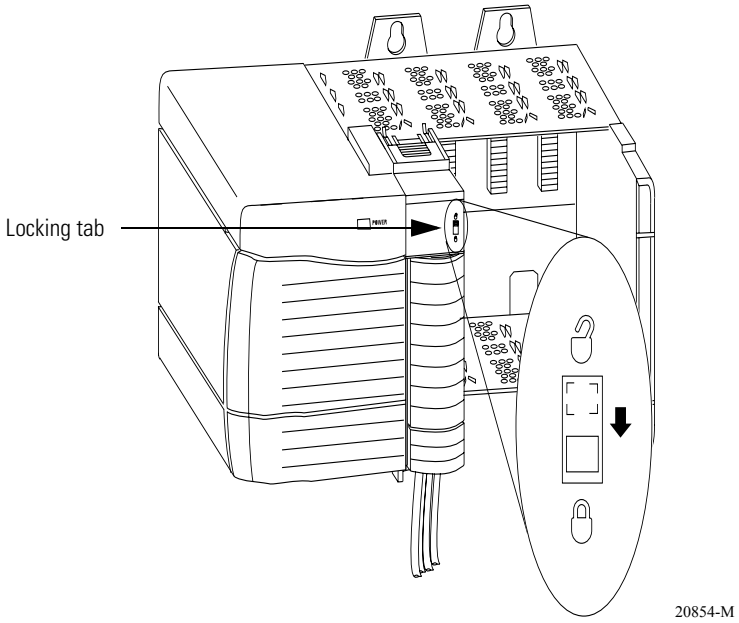
Before installing the RTB, make certain:

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

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



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



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

Removing the Removable Terminal Block

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

ATTENTION

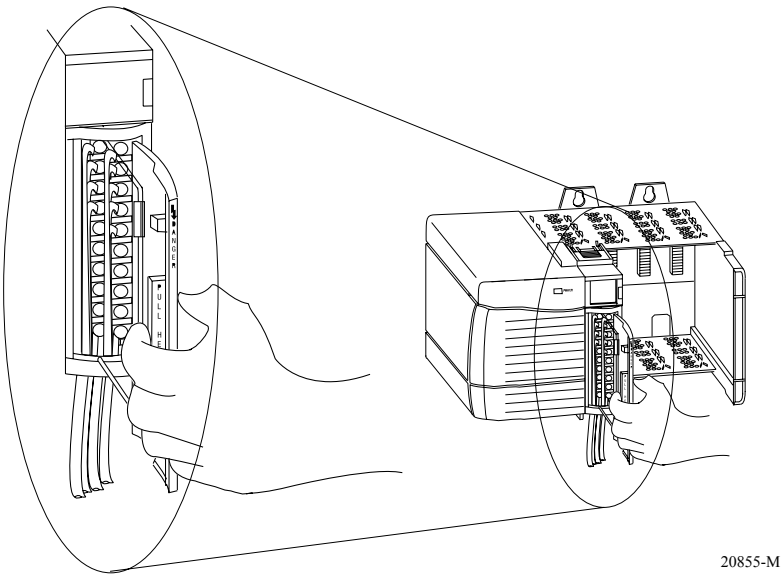
Shock hazard exists. If the RTB is removed from the module while the field-side power is applied, the module will be electrically live. Do not touch the RTB's terminals. Failure to observe this caution may cause personal injury.

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

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

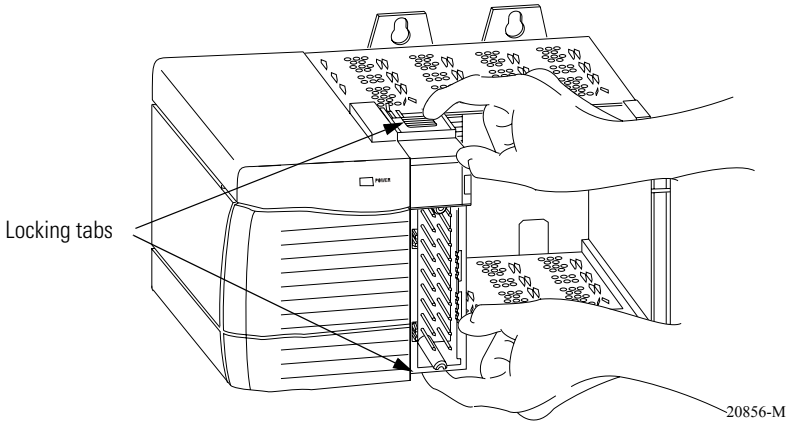
IMPORTANT

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

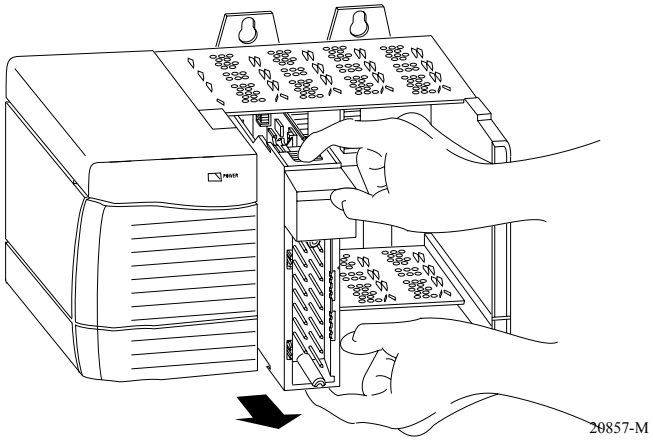


Removing the Module from the Chassis

1. Push in the top and bottom locking tabs.



2. Pull module out of the chassis.



Chapter Summary and What's Next

In this chapter, you read about:

- installing the module.
- keying the RTB and IFM.
- connecting wiring.
- assembling the RTB and the housing.
- installing the RTB or IFM onto the module.
- removing the RTB from the module.
- removing the module from the chassis.

Chapter 4 explains Configuring the Sequence of Events Module.

Configuring the Sequence of Events Module

What This Chapter Contains

This chapter describes how to configure your Sequence of Events module.

Table 4.1

Configuring Your I/O Module

You must configure your module upon installation. The module will not work until it has been configured with at least the default configuration.

IMPORTANT This chapter focuses on configuring I/O modules in a local chassis. To configure I/O modules in a remote chassis, you must follow all the detailed procedures with two additional steps. To see the additional steps, see page 4-9.

RSLogix 5000 Configuration Software

You **must use RSLogix 5000, version 13** to set configuration for your Sequence of Events module. You have the option of accepting default configuration for your module or writing point level configuration specific to your application.

Both options are explained in detail, including views of software screens, in this chapter.

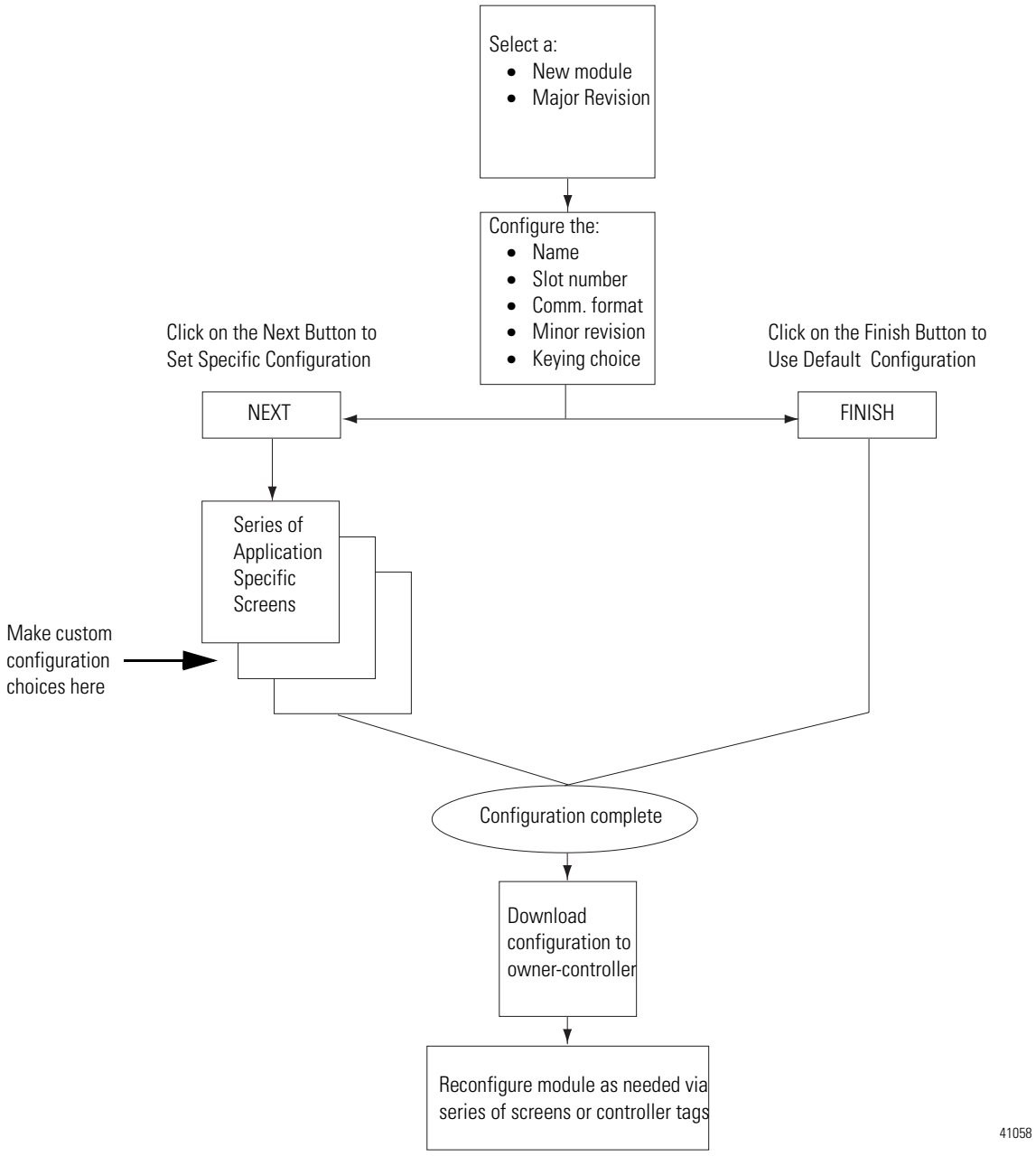
Overview of the Configuration Process

When you use the RSLogix 5000 software to configure a Sequence of Events module, you must perform the following steps:

1. Add the new module to your RSLogix 5000 project.
2. Accept the default configuration or change it to specific configuration for the module.
3. Edit configuration for a module when changes are needed.

Figure 4.1 shows an overview of the configuration process.

Figure 4.1



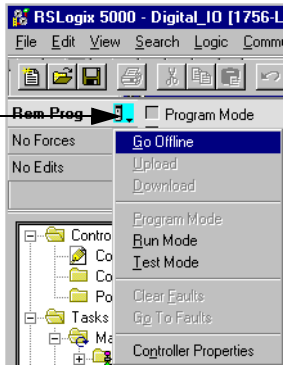
Adding a New Module to Your RSLogix 5000 Project

After you have started RSLogix 5000 and created a controller, you must add a new module to your project. The wizard allows you to create a new module and write configuration. You can use default configuration or write specific configuration for your application.

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

1. If necessary, go offline.

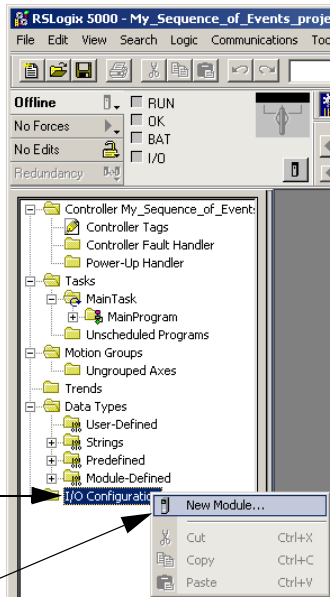
If you are not offline, use this pull-down menu to go offline



2. Add the Sequence of Events module to your RSLogix 5000 project.

A. Right-click on I/O Configuration.

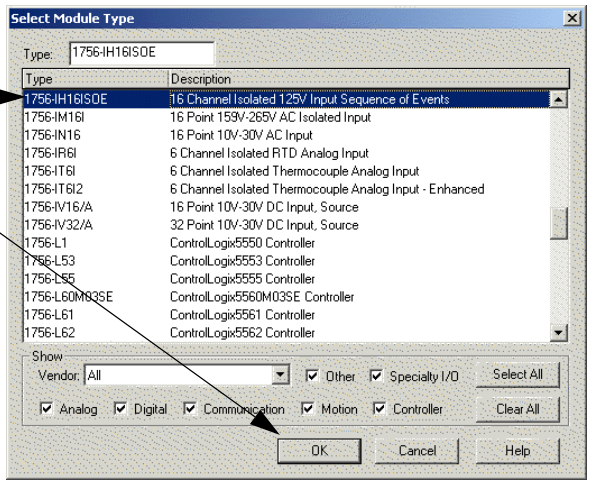
B. Select New Module



3. When the Select Module Type screen appears, select the Sequence of Events module.

A. Select the Sequence of Events module.

B. Click OK.



4. Configure the module. The first screen of the configuration wizard is shown below.

A. Name the module.

B. Select the module's slot number.

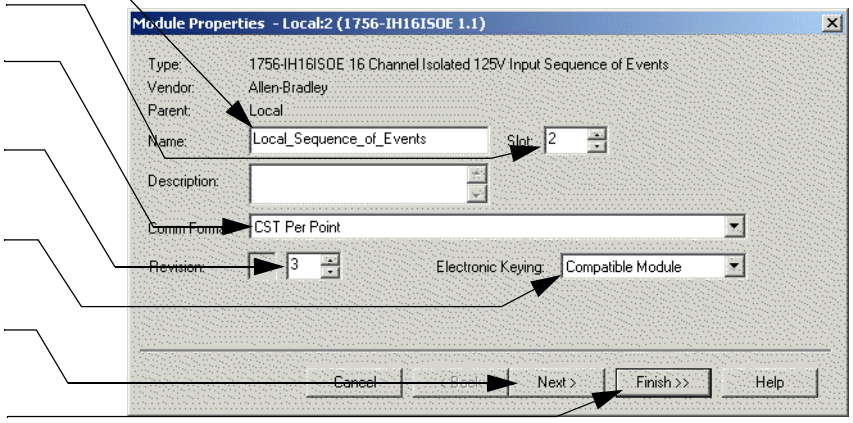
C. Choose a Communications Format. For more information, see page 4-5.

D. Make sure the Minor Revision number matches your module's minor revision.

E. Choose an Electronic Keying method. For more information, see page 5-13.

F. If you are altering the default configuration, click Next. Go to page 4-6.

G. If you are using default configuration, click Finish. Go to page 4-6.



Communications Format

The communications format determines what operational mode your Sequence of Events module uses and, consequently, what tags RSLogix 5000 generates when configuration is complete. Once a module is created, you cannot change the communications format unless you delete and recreate the module.

Table 4.2 lists the communications formats used with input modules:

Table 4.2

If you want the Sequence of Events module to operate in this mode	choose this communication format:
CST Per Point mode	CST Per Point
FIFO mode	CST FIFO Mode

For more information on the Sequence of Events module's operational modes, see page 5-3.

Electronic Keying

Electronic keying allows the ControlLogix system to control what modules belong in the various slots of a configured system.

During module configuration, you must choose one of the following keying options for your Sequence of Events module:

- Exact Match
- Compatible Module
- Disable Keying

For more information on electronic keying, see page 5-13.

Using the Default Configuration

If you use the default configuration and click on Finish, you are done.

Altering the Default Configuration

If you click Next in step 4 on page 4-4, you can write specific configuration for your module in RSLogix 5000.

Some of the screens that appear during this initial module configuration process are blank and are not shown here. However, those screens can be important during online monitoring. To see these screens in use, see Chapter 8, Troubleshooting the Sequence of Events Module.

Write specific configuration for your Sequence of Events module on the following screens.

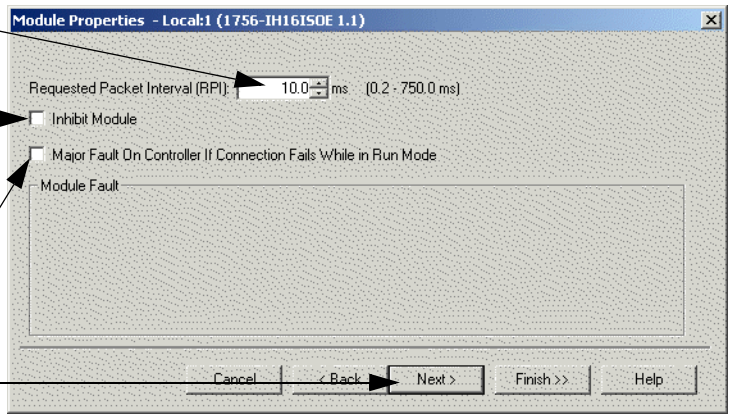
On this screen, you can:

A. Change the RPI. For more information on the RPI, see page 2-6.

B. Inhibit the module. For more information on inhibiting the module, see page 5-15.

C. Make sure a Major Fault occurs on the module's owner-controller if there is a connection failure between the module and the controller.

D. Click Next until you see the screen below.



On this screen, you can:

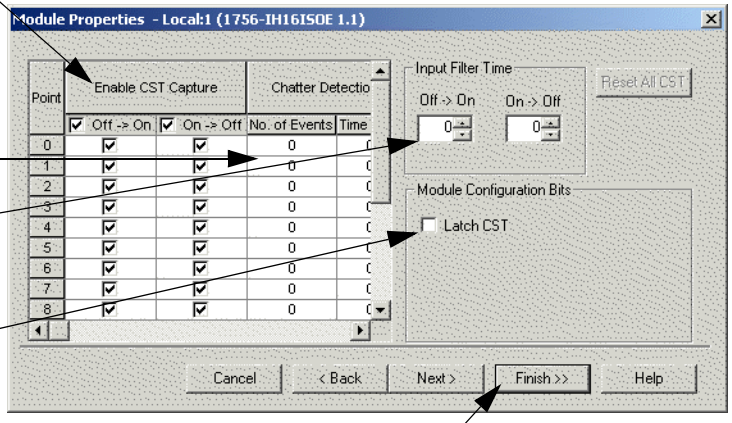
A. Enable CST Capture for each input point. For more information on CST Capture, see page 5-5.

B. Configure Chatter Detection for each input point. For more information on Chatter Detection, see page 5-8.

C. Set the Input Filter Times. For more information on Input Filters, see page 5-10.

D. Click on the box to enable CST Latching. For more information on CST Latching, see page 5-7.

E. Click Finish.



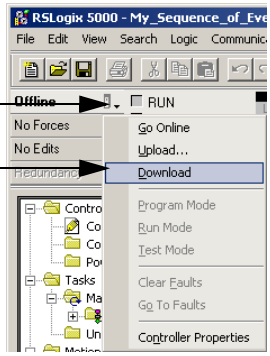
Downloading Configuration

After you write configuration for your Sequence of Events module, the module does not use this configuration until you download it to the owner-controller. The download transfers the entire program to the controller, overwriting any existing program.

Download module configuration as shown below.

A. Click here to see the pull-down menu.

B. Click download.



Depending on your application, a variety of RSLogix 5000 screens may appear to choose a path to your ControlLogix controller and to verify the download. Navigate those screens as best fits your application.

This completes the download process.

Editing Configuration

After you have set configuration for a module, you can review and change your choices. You can change configuration data and download it to the controller while online. This is called **dynamic reconfiguration**.

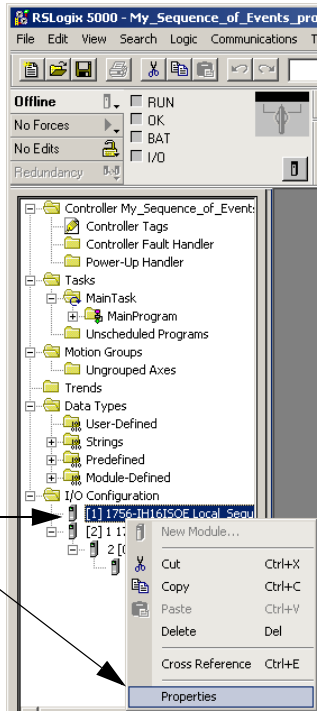
Your freedom to change some configurable features, though, depends on whether the controller is in Remote Run Mode or Program Mode.

IMPORTANT Although you can change configuration while online, you must go offline to add or delete modules from the project.

The editing process begins on the main page of RSLogix 5000.

A. Right-click on the module.

B. Select Properties



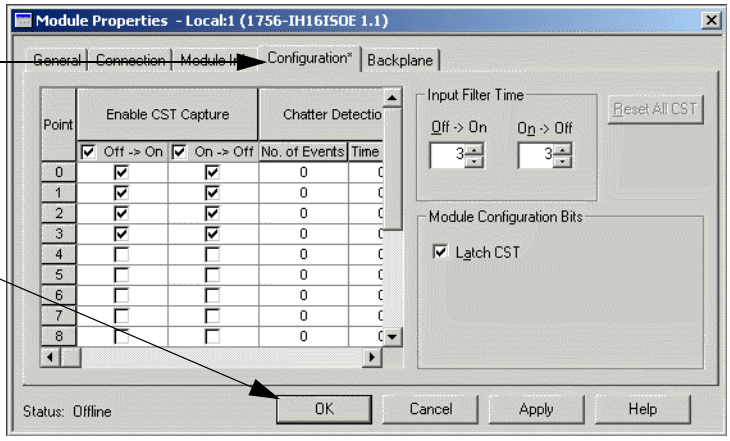
The General tab of the configuration wizard appears. Click on the tab of the page that you want to view or reconfigure and make any appropriate changes.

Make any necessary changes as shown in the example below.

A. Click the tab where you need to reconfigure the module.

In this example, CST Capture was disabled for several input points.

B. When the module is reconfigured, click OK.

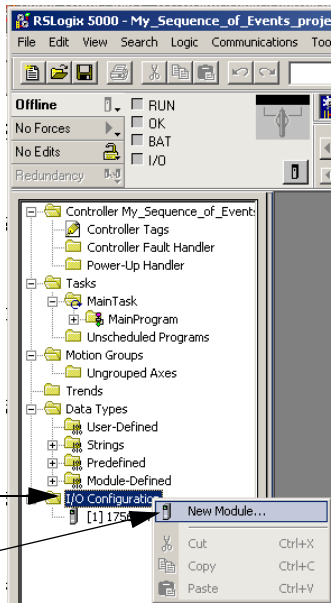


Configuring Modules in a Remote Chassis

ControlLogix ControlNet Interface modules (1756-CNB or 1756-CNBR) or the EtherNet/IP Bridge module (1756-ENBT) are required to communicate with Sequence of Events modules in a remote chassis.

You must configure the communications module in the local chassis and the remote chassis before adding remote Sequence of Events modules to your project.

1. Add a communications module to the local chassis.



A. Right-click on I/O Configuration.

B. Select New Module

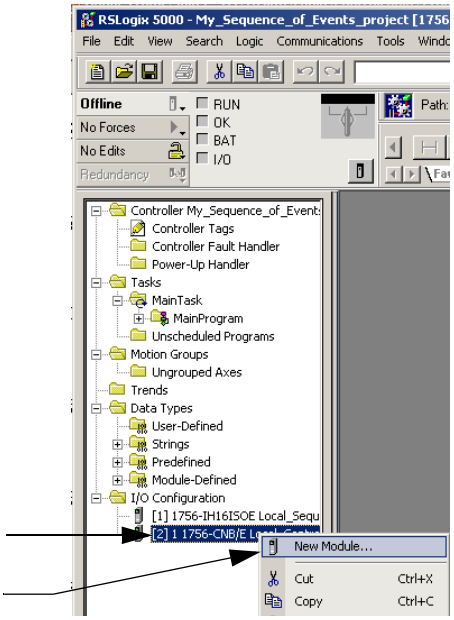
2. Choose a communications module (1756-CNB, 1756-CNBR or 1756-ENBT) for the local chassis.

3. Configure the communications module in the local chassis.

   For more information on the ControlLogix ControlNet Interface modules, see the Using ControlNet Communication Modules in Logix5000 Control Systems user manual, publication CNET-UM001.

   For more information on the ControlLogix EtherNet/IP Bridge module, see the Using EtherNet/IP Communication Modules in Logix5000 Control Systems user manual, publication ENET-UM001.

4. Add a communications module to the remote chassis.



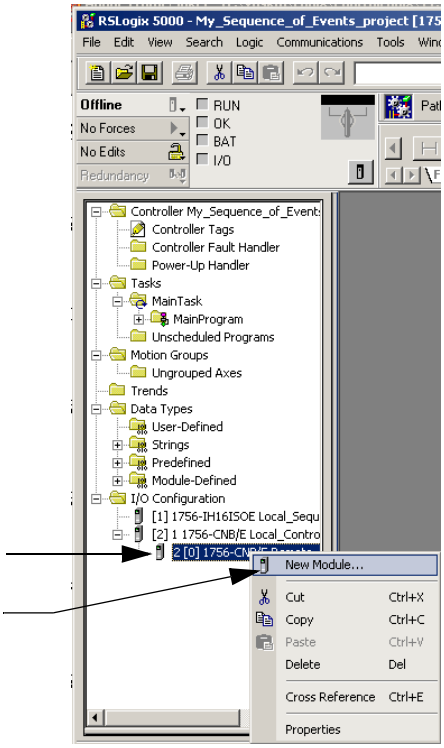
A. Right-click on the local communication module.

B. Select New Module

5. Select a communications module for the remote chassis.

6. Configure the communications module in the remote chassis.

7. Add a Sequence of Events module to the remote chassis.



A. Right-click on the remote communication module.

B. Select New Module

8. Configure the new Sequence of Events module as described earlier in this chapter.

Chapter Summary and What's Next

In this chapter, you read about configuring your Sequence of Events module.

Chapter 5 describes Using the Sequence of Events Module Features.

Notes:

Using the Sequence of Events Module Features

What This Chapter Contains

This chapter describes the features available on the Sequence of Events module.

Table 5.1

Determining Module Compatibility

Primarily, a Sequence of Events module is used to timestamp input data. However, additionally, the module interfaces to sensing devices and detects whether they are ON or OFF. The module also converts ON/OFF signals from user devices to appropriate logic level for use in the processor. Typical input devices include:

- auxiliary contacts
- limit switches

When designing a system using Sequence of Events modules, you must consider:

- the voltage necessary for your application
- whether you need a solid state device
- current leakage
- if your application should use sinking or sourcing wiring.

For more information on compatibility of other Rockwell Automation products to Sequence of Events modules, see the I/O Systems Overview, publication CIG-SO001.

There are two types of features available on the Sequence of Events module:

- Module Features That Can Be Configured - Features that can be adjusted to make sure the module operates as efficiently as possible in your application (e.g., input filter times)

- Other Inherent Module Features - Features that cannot be changed but are still crucial to module functionality (e.g., producer/consumer model)

Module Features That Can Be Configured

Table 5.2 lists features on the Sequence of Events module that can be configured.

Table 5.2

This feature:	is described on:
Two Operational Modes	5-3
Enable CST Capture	5-5
Chatter Detection	5-8
Software Configurable Input Filters	5-10
Latch CST	5-7
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Two Operational Modes

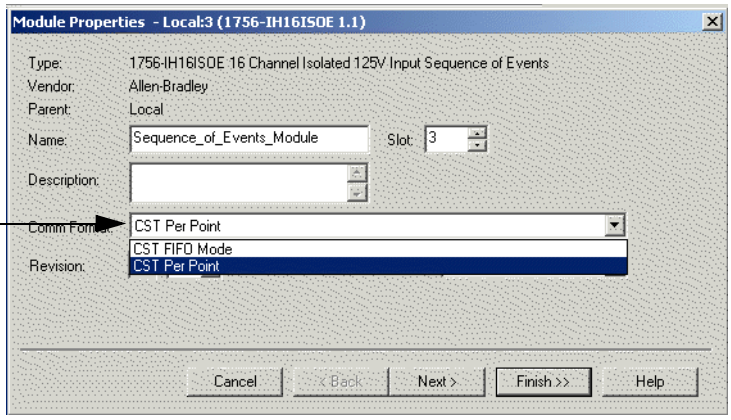
The Sequence of Events module can operate in either of the modes described in Table 5.3:

Table 5.3

Operational mode:	Description:
CST Per Point Mode	The module produces timestamps for up to 2 input transitions per input, one for OFF to ON transitions and another for ON to OFF transitions; these timestamps can occur simultaneously. This is the default setting when you add the module to an RSLogix 5000 project.
First In First Out (FIFO) Mode	The module timestamps an unlimited number of input transitions, regardless of direction (i.e., either OFF to ON or ON to OFF) or input (i.e., the same input can transition many times and the module will timestamp every transition) and stores them in an on-board buffer. The module is capable of storing the data for up to 160 input transitions in its on-board buffer at a single time. However, if you retrieve data from the buffer effectively (i.e., retrieve the data before the module timestamps greater than 160 input transitions), the module can timestamp an infinite number of input transitions. We recommend you use this mode if you want to minimize propagation delay of new input data being reported to the controller. For more information on propagation delay, see page 2-4.

During initial module configuration, you must choose a communication format for the module. The communication format determines the mode in which your module operates. The example screen below shows how to choose your module's communication format and, thus, operational mode.

Use this pull-down menu to choose a communication format.



IMPORTANT Once the module is created in your RSLogix 5000 project, you cannot change the communications format without deleting the module from the project and recreating it.

For more information on using the Sequence of Events module in CST Per Point mode, see Chapter 6.

For more information on using the Sequence of Events module in FIFO mode, see Chapter 7.

Enable CST Capture

Enable CST Capture instructs the Sequence of Events module to timestamp specific input points transitions. You can use this feature to instruct the module to capture the CST when the inputs transition from:

- OFF to ON only
- ON to OFF only

  or

- both OFF to ON and ON to OFF

When Enable CST Capture is enabled for specific points and transitions occur for those points, the Sequence of Events module not only captures the CST at the transition occurrence but also sends input data to the controller.

IMPORTANT

All points on the Sequence of Events module have Enable Capture CST enabled by default for both ON to OFF and OFF to ON transitions.

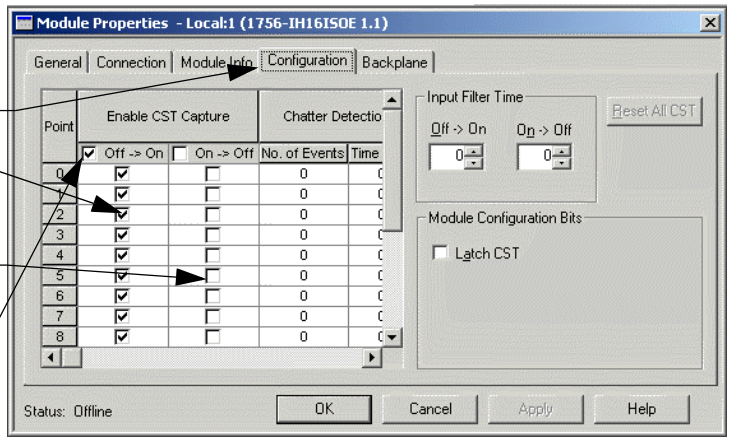
Additionally, you must specify an RPI regardless of whether you use Enable Capture CST on any input points. If a change does not occur within the RPI timeframes, the module will still multicast data at the rate specified by the RPI.

Use the Configuration tab in RSLogix 5000 to set Enable CST Capture, as shown in the example below.

Click the Configuration tab.

- Click on the individual boxes for each input point to enable CST Capture for that point.
- Clear the individual boxes for each input point to disable CST Capture for that point.

You can also use these boxes to enable or disable all points simultaneously.



IMPORTANT

The basic function of Enable CST Capture (i.e., timestamp specific input transitions) occurs whether the Sequence of Events module is used in CST Per Point mode or FIFO mode. However, how the module uses the data from each transition varies slightly depending on the mode in which the module is operating.

- For more information on how Enable CST Capture is used in CST Per Point mode, see page 6-7.
- For more information on how Enable CST Capture is used in FIFO mode, see page 7-9.

Latch CST

Latch CST can be used to prevent the Sequence of Events module from overwriting input data once it is timestamped.

- If Latch CST is **enabled**, the module only timestamps a specific number of input transitions(e.g., the first transition in CST Per Point mode) and ignores future input transitions (at least until the controller clears the timestamp data already received, as described on page 6-12 and page 7-20).
- If Latch CST is **disabled**, the module timestamps every input transition and may overwrite previously recorded timestamp data if the controller does not acknowledge the data quickly enough.

This feature is set on a module-wide basis and is enabled by default.

IMPORTANT

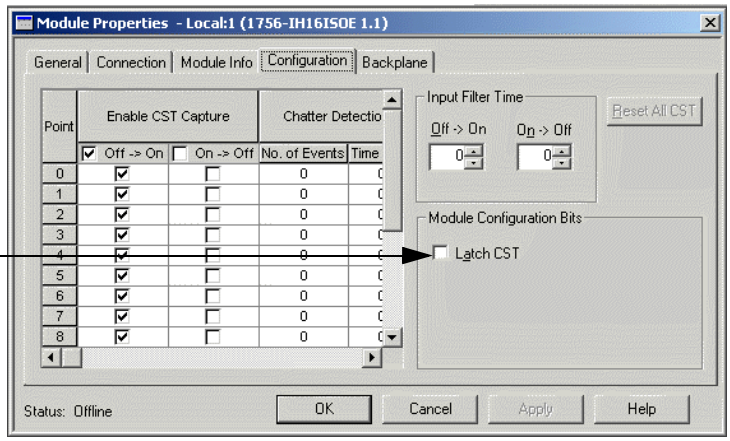
The bullets above provide a general description of how Latch CST works. However, there are slight differences between how the features affects module behavior in each operational mode.

- For more information on how Latch CST is used in CST Per Point mode, see page 6-7.
- For more information on how Latch CST is used in FIFO mode, see page 7-9.

Use the Configuration tab in RSLogix 5000 to enable Latch CST, as shown in the example below.

Click this box to enable the Latch CST feature.

Unclick the box to disable the feature.



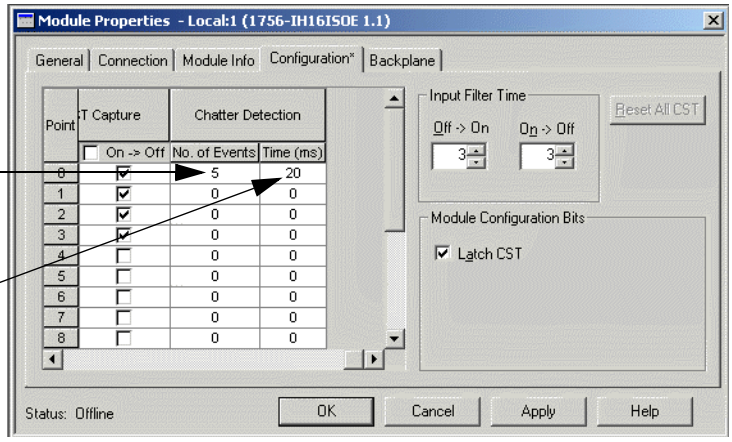
Chatter Detection

To detect a faulty input device wired to the Sequence of Events module, the module can use Chatter Detection to detect a chattering signal from a device connected to one of its inputs (e.g., rapid transitions from a failed contact) and ignore the data. If not accounted for, chatter can cause the module to timestamp invalid input transitions. Typically, chattering signals cause inputs to transition falsely many times in a relatively short period of time.

To configure Chatter Detection for an input, you must define an acceptable number of input transitions within a specific time period.

- If the number of input transitions meets the number specified in the configured time period, the module considers the point in chatter, the input device defective and ignores the last transition (i.e., clears any timestamp data for the transition from its buffer) and all subsequent transitions while still chattering.
- If the number of events in the specific time is less than your defined number, the input will not go into chatter and timestamps are produced for all transitions.
- If an input is chattering, the corresponding fault bit for that input is set.
- Once a point is in chatter, all transitions on that input are ignored until the point is no longer chattering; an input is no longer chattering if the configured chatter time elapses and no new transitions occur on the input.

Use the Configuration tab in RSLogix 5000 to configure Chatter Detection, as shown in the example below.



A. Type the number of events. Range is 2-127 events. Use 0 to disable this feature.

B. Type the time (measured in milliseconds). You can use up to 10,000 milliseconds.

In this example, if 5 events occur on input point 0 within any 20ms time frame, the module considers the point to be chattering.

IMPORTANT When configuring Chatter Detection, make sure the time divided by the number of events is greater than the module's input filter times. For example, in the example above the time (20ms) divided by the number of events (5) = 4. For Chatter Detection to work properly in this case, make sure your input filter < 4ms.

Software Configurable Input Filters

To account for hard contact "bounce", you can configure ON to OFF and OFF to ON input filter times in RSLogix 5000 for your Sequence of Events module. These filters define **how long an input transition must remain in the new state before the module considers the transition valid.**

IMPORTANT Input filters are applied to all inputs on the Sequence of Events module. You cannot apply input filters to individual inputs on the module.

When an input transition occurs, the Sequence of Events module timestamps the transition on the initial edge of the transition and stores data for the transition on-board; the module then scans the input where the transition occurred every 25µs for the length of the filter time setting to verify that the input remains in the new state (i.e., remained OFF or ON).

- If the input remains in the new state for a time period equal to the filter time setting, the module sends data for the transition to the controller.
- If the input changes state again (i.e., returns to the original state) before the length of time of the filter setting has elapsed, the module continues to scan that input for up to 4x the filter setting. During this continued scan period, one of the following events occurs:
  - At some point in the time period that is 4x the length of the input filter setting, the input returns to the transitioned state and remains there for a length of time equal to the filter setting. In this case, the module sends data from the transition to the controller.
  - The input does not remain in the transitioned state for a time period equal to the filter setting at any point in the time period that is 4x the length of the input filter setting. In this case, the module does not consider the original transition valid and drops the timestamp.

See Figure 5.1 on page 5-11 for an example of how the Sequence of Events module's input filters operate.

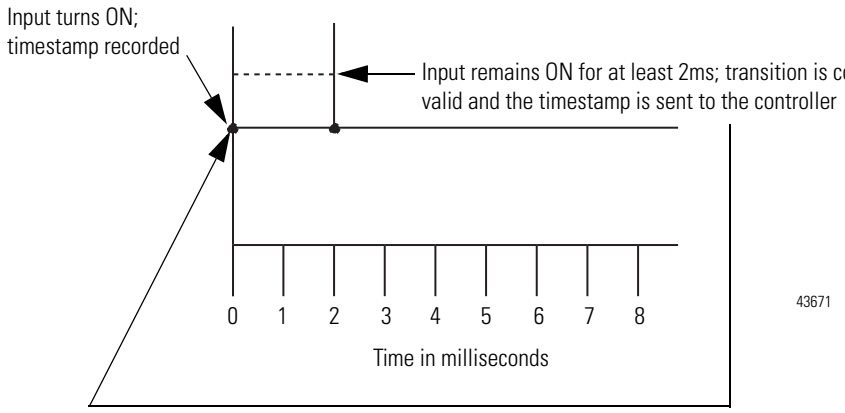
In the example, a Sequence of Events module:

- is Enable CST Capture-enabled for all of its points
- uses a 2ms input filter setting for OFF to ON transitions

Three possible scenarios can result after an input transitioning from OFF to ON in the given circumstances.

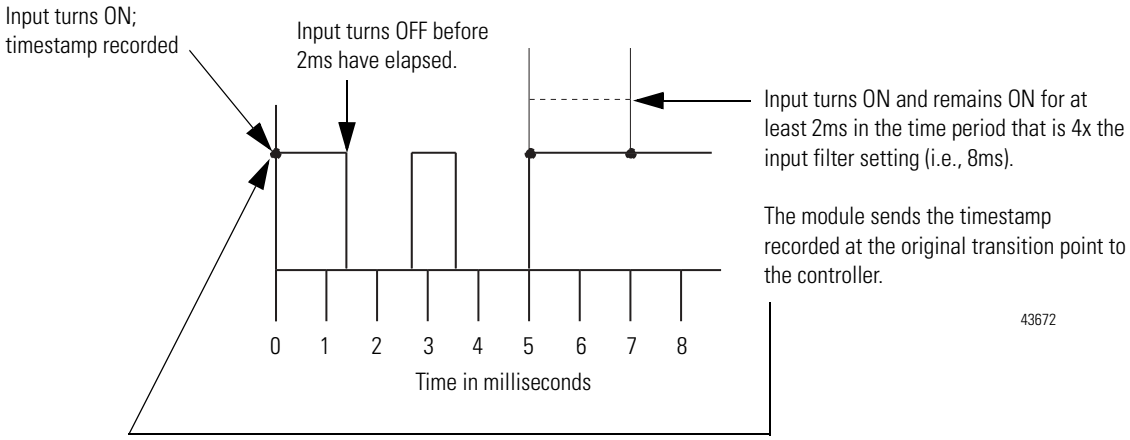
- Scenario #1 (no bounce) – The input turns ON and remains for the full 2ms. In this case, the module considers the transition valid and sends the data recorded at the transition to the controller.

Figure 5.1



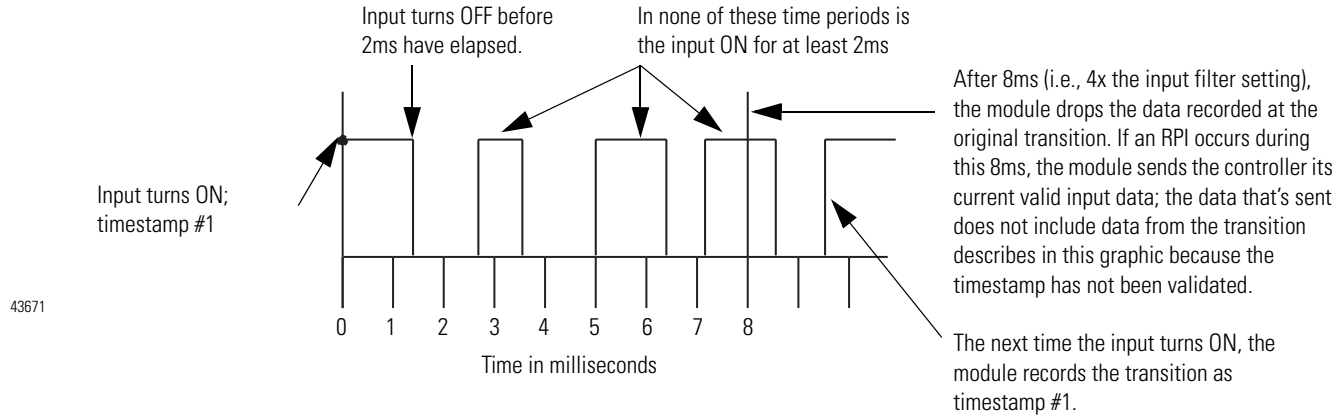
- Scenario #2 – The input turns ON but turns OFF before 2ms (length of the input filter setting) elapses. In this case, the Sequence of Events module continues to scan the input every 25µs for 4x the length of the input filter setting (i.e., for 8ms). At some point in those 8ms, the input turns ON again and remains for at least 2ms (i.e., the input filter setting). In this case, the module considers the transition valid and sends the data timestamped at the original transition to the controller.

Figure 5.2

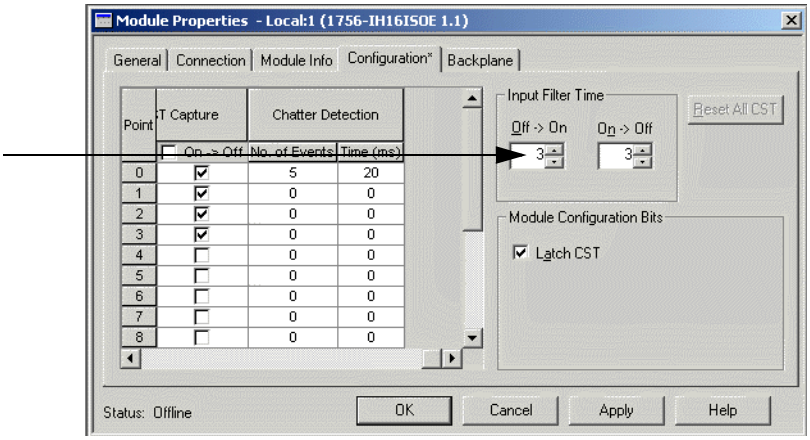


- Scenario #3 – The input turns ON but turns OFF before 2ms (length of the input filter setting) elapses. In this case, the Sequence of Events module continues to scan the input every 25µs for 4x the length of the input filter setting (i.e., for 8ms). In those 8ms, the input never remains ON for at least 2ms (i.e., the input filter setting). In this case, the module considers the transition invalid and drops the data timestamped at the original transition.

Figure 5.3



Use the Configuration tab in RSLogix 5000 to configure Input Filters, as shown in the example below.



Electronic Keying

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

During module configuration, you must choose one of the following keying options for your Sequence of Events module:

- Exact Match
- Compatible Module
- Disable Keying

When the controller attempts to connect to and configure a Sequence of Events module (e.g. after program download), the module compares the following parameters before allowing the connection and configuration to be accepted:

- Vendor
- Product Type
- Product Code
- Major Revision - Change that affects the module's function or RSLogix 5000 interface
- Minor Revision - Change that does not affect the module's intended function or RSLogix 5000 interface

The comparison is made between the keying information present in the module and the keying information in the controller's program, preventing the inadvertent operation of a system with the wrong module in the wrong slot. For example, if you select Exact Match and a module with revision 1.2 is placed in a location configured for a module with revision 1.4, the controller does not make a connection to the new module because of the mismatched revisions.

Table 5.4 describes the keying options available with your module.

Table 5.4

Keying option:	Definition:
Exact Match	All of the parameters listed above must match or the inserted module will reject a connection to the controller.
Compatible Module	The Compatible Match mode allows a Sequence of Events module to determine whether it can emulate the module defined in the configuration sent from the controller. With Sequence of Events modules, the module can emulate older revisions. The module will accept the configuration if the configuration's major.minor revision is less than or equal to the physical module's revision. For example, if the configuration contains a major.minor revision of 1.7, the module inserted into the slot must have a firmware revision of 1.7 or higher for a connection to be made. When a module is inserted with a major.minor revision that is less than the revision for which the slot is configured (i.e., the module has a revision of 1.6 and the slot is configured for a module with revision 1.8), no connection is made between the controller and the I/O module.
	TIP We recommend using Compatible Match whenever possible. Remember, though, with major revision changes, the module only works to the level of the configuration. At the time of this printing, the Sequence of Events module uses a major revision of 1.3[1] However, if a new major revision for the module is released, consider this example. If a slot is configured for a module with major.minor revision of 1.7 and you insert a module with a major.minor revision of 2.3, the module works at the 1.7 level, with respect to module functions that are related to RSLogix 5000 such as interface changes. Bug fixes that are affected by the module's firmware, though, would work at the 2.3 revision level. If possible, we recommend that you make sure configuration is updated to match the revision levels of all I/O modules, including your Sequence of Events module. Failure to do so may not prevent the application from working but may defeat the purpose of upgrading your modules' revision levels.
Disable Keying	The inserted module attempts to accept a connection to the controller regardless of its type.
	ATTENTION  Be extremely cautious when using the disable keying option; if used incorrectly, this option can lead to personal injury or death, property damage or economic loss.
	If keying is disabled, a controller makes a connection with most modules of the same type as that used in the slot configuration. For the ControlLogix Sequence of Events module, if keying is disabled, the controller will only make a connection to another Sequence of Events module. A controller will NOT establish a connection if any of the following conditions exist, even if keying is disabled: • The slot is configured for one module type (e.g. input module) and a module of another type (e.g. output module) is inserted in the slot. • The module inserted into the slot cannot accept some portion of the configuration. For example, if a Sequence of Events module is inserted into a slot configured for a diagnostic input module, the controller cannot make a connection because the module will not accept/process the diagnostic configuration.

(1) Minor revisions are incremented by single counts such that minor level 10 (i.e., major.minor revision level = 1.10) follows minor revision level 9 (i.e., 1.9).

Module Inhibiting

With module inhibiting, you can indefinitely suspend a connection between an owner-controller and a Sequence of Events module. This process can occur in the following way:

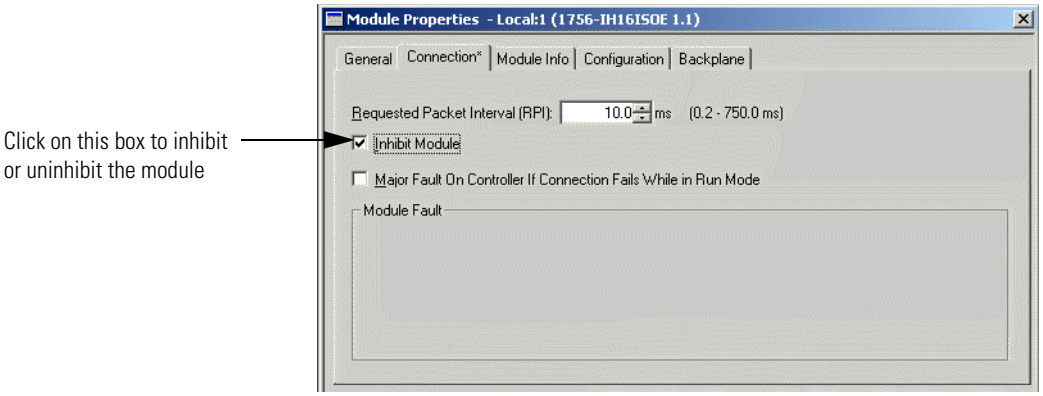
- You write configuration for a Sequence of Events module but inhibit the module to prevent it from communicating with the owner-controller. In this case, the owner-controller does not establish a connection and configuration is not sent to the module until the connection is uninhibited.

The following examples are instances where you may need to use module inhibiting:

- You want to FLASH upgrade your module. We recommend you:
  a. Inhibit the module.
  b. Perform the upgrade.
  c. Uninhibit the module.

- You are using a program that includes a module that you do not physically possess yet, but you do not want the controller to continually look for a module that does not exist yet. In this case, you can inhibit the module in your program until it physically resides in the proper slot.

You can inhibit your Sequence of Events module on the Connection tab in RSLogix 5000, as shown in the example below.



Other Inherent Module Features

Table 5.5 lists features on the Sequence of Events module that cannot be configured.

Table 5.5

This feature:	is described on:
Removal and Insertion Under Power (RIUP)	5-16
Module Fault Reporting	5-16
Fully Software Configurable	5-17
Producer/Consumer Model	5-17
Status Indicator Information	5-18
Full Class I Division 2 Compliance	5-19
Agency Certifications	5-19

Removal and Insertion Under Power (RIUP)

The Sequence of Events module is designed to be installed or removed while chassis power is applied.

WARNING

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

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

Module Fault Reporting

Your Sequence of Events module provides both a hardware and software indication when a module fault occurs. The module's status indicator and RSLogix 5000 graphically display each fault and include a fault message describing the nature of the fault.

This feature allows you to determine how the fault affects your module and what action you should take to resume normal operation. For more information on how to use hardware and software indicators when a module fault occurs, see Chapter 8, Troubleshooting the Sequence of Events Module.

Fully Software Configurable

RSLogix 5000 uses a custom, easily understood interface to write configuration. All module features are enabled or disabled through the I/O configuration portion of the software.

You can also use the software to interrogate your Sequence of Events module to retrieve:

- serial number
- revision information
- product code
- vendor identification
- error/fault information
- diagnostic counters.

By eliminating such tasks as setting hardware switches and jumpers, the software makes module configuration easier and more reliable.

Producer/Consumer Model

By using the Producer/Consumer model, Sequence of Events modules can produce data without having been polled by a controller first. The module produces the data and the owner-controller device consumes it.

Status Indicator Information

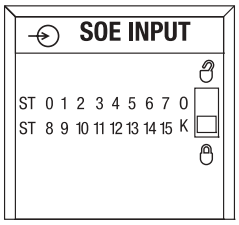
Each Sequence of Events module has LED status indicators on the front of the module that allows you to check the module health and operational status. Table 5.6 describes the module's LED status indicators:

Table 5.6

Status:	Description:
I/O status (*ST* LEDs)	This yellow display indicates the ON/OFF state of the field device.
Module status (*OK* LED)	This red/green display indicates the module's communication/module health status.

The LED status indicators used on the Sequence of Events module are shown in Figure 5.4.

Figure 5.4



For more information on how to use the Sequence of Events module's LED status indicators, and RSLogix 5000, when troubleshooting your application, see Chapter 8, Troubleshooting the Sequence of Events Module.

Full Class I Division 2 Compliance

The Sequence of Events module maintains CSA Class I Division 2 system certification. This allows the ControlLogix system to be placed in an environment other than only a 100% hazard free.

IMPORTANT Modules should not be pulled under power, nor should a powered RTB be removed, in a Class I Division 2 environment.

Agency Certifications

The Sequence of Events module is marked for any agency certifications (e.g. UL, CSA, CE, FM and C-Tick) it has obtained. See the module's label for all agency certifications.

Chapter Summary and What's Next

In this chapter, you read about using the Sequence of Events module's features. Chapter 6 describes the Using The Sequence of Events Module in CST Per Point Mode.

Notes:

Using The Sequence of Events Module in CST Per Point Mode

What This Chapter Contains

This chapter describes how to use the Sequence of Events module in CST Per Point mode.

Table 6.1

Overview of the Mode

In CST Per Point mode, the Sequence of Events module can be configured to timestamp two transitions per input, one in each direction (OFF to ON and ON to OFF).

When specific points that are Enable CST Capture-enabled transition (e.g., input 1 is configured so that Enable CST Capture is enabled for OFF to ON transitions and the input turns ON), the module timestamps the transition with the current CST value on the backplane. The module produces data for the owner-controller when the input filter and chatter detection criteria have been met and at subsequent RPIs.

How Does the Module Store Timestamp Data in CST Per Point Mode?

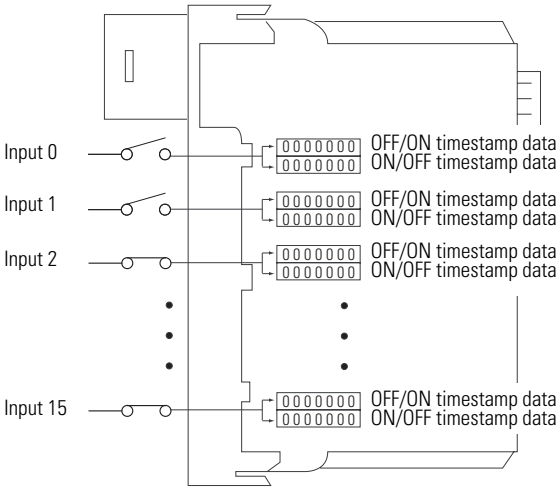
With each timestamped transition, the Sequence of Events module stores data for that point. An overview of how the module stores timestamp data in CST Per Point mode is shown in Figure 6.1:

Figure 6.1

The module is installed, wired to input devices and ready to begin operation. All inputs are configured to timestamp any transition that occurs.

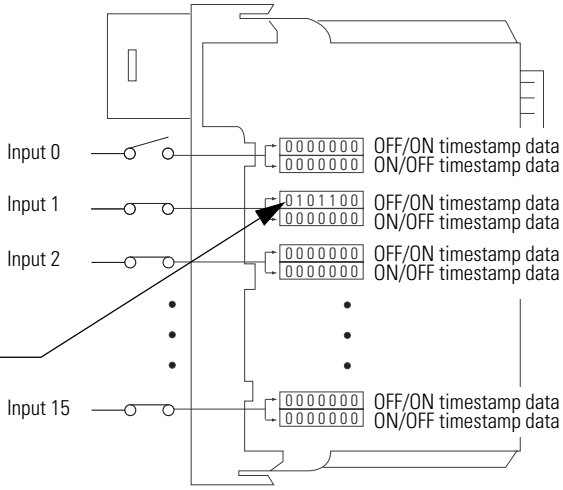
At this point, timestamp data for each input is 0 because no input transitions have occurred.

Note that only 8 bits of the 64-bit CST timestamp are shown.



Input 1 transitions from OFF to ON.

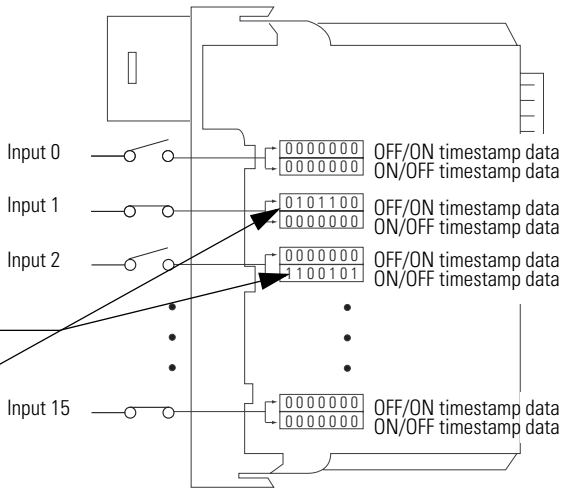
The module timestamps the transition; the module sends the data to the owner-controller (not shown) and also stores it locally.



Input 2 transitions from ON to OFF.

The module timestamps the transition; the module sends the data to the owner-controller (not shown) and also stores it locally.

Note that the module continues to store the timestamp for the OFF to ON transition on input 1.



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When the Sequence of Events module operates in CST Per Point mode, generally the following occurs:

1. You configure the Sequence of Events module to operate in CST Per Point mode via the Communication Format selection.

2. The Sequence of Events module timestamps each transition for inputs that are Enable CST Capture-enabled. The module can timestamp each transition with a unique CST with 25µs resolution.

3. The module sends all of its input data, including the new data from the most recent transition, to the controller immediately after timestamping the transition and passing the input filter to make sure the transition was valid.

4. You copy new data from the controller tags to a separate data structure for later sorting.

5. Once the data is copied to a separate data structure, you may sort the data in the controller to determine the order of events.

Some of these typical events are described in greater detail in the rest of this chapter.

What Are The Typical Applications Where CST Per Point Mode is Used?

CST Per Point mode is typically used in applications that need to determine relative first fault detection after an event cascade occurs. The Sequence of Events module can provide unique timestamps for separate input transitions as long as they occur 25µs apart; you can sort the data resulting from an event cascade to determine where the first input transition occurred in the cascade.

You can also use the 1756HP-GPS module to give the stored CST timestamps a real-time reference. For more information on how to integrate the 1756HP-GPS module into your ControlLogix Sequence of Events system, see Appendix B.

The following are example typical applications for CST Per Point mode:

- Substation automation
- Load-shedding/energy management
- Emergency shutdown systems

Configuring the Module for CST Per Point Mode

You configure the same general set of configurable features (described in Chapter 5) whether you are using the Sequence of Events module in CST Per Point mode or FIFO mode. However, for some features, the module behavior as dictated by the feature, varies according to operational mode. For example, Latch CST impacts the Sequence of Events module behavior slightly differently in CST Per Point mode than in FIFO mode.

You should be aware of the impact the following configurable features have on module behavior in CST Per Point mode:

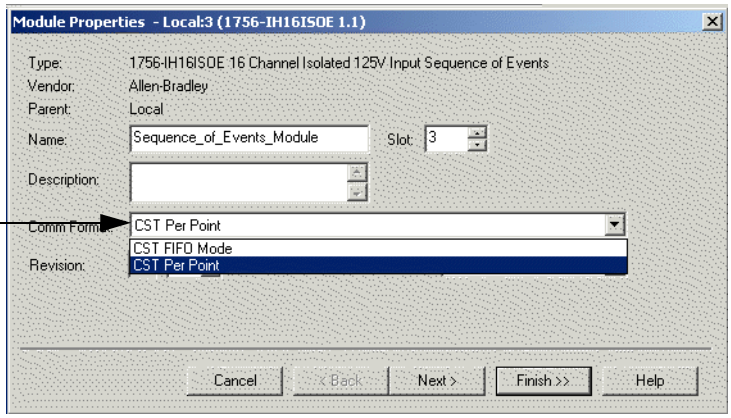
- Communications Format
- Latch CST
- Enable CST Capture
- Universal Coordinated Time (UCT)

Choosing a Communications Format

During initial module configuration, you must choose a communication format for the module. The communications format determines what operational mode your Sequence of Events module uses and, consequently, what tags RSLogix 5000 generates when configuration is complete.

To operate the Sequence of Events module in CST Per Point mode, you must choose the CST Per Point communication format, as shown below.

Use this pull-down menu to choose the CST Per Point communication format.



Using Latch CST in CST Per Point Mode

When enabled, Latch CST prevents the Sequence of Events module from overwriting recorded timestamp data once a transition occurs. This feature is set on a module-wide basis and is enabled by default. Table 6.2 describes how Latch CST affects the module in CST Per Point mode.

Table 6.2

If Latch CST is	the following occurs[1]:
Enabled	The Sequence of Events module timestamps two transitions for each input–one for OFF to ON and one for ON to OFF. If similar transitions occur on inputs where a transition has already been timestamped and the data was not yet acknowledged (for more information on acknowledging data, see page 6-12), the module does not timestamp the new transition. When transitions occur that the Sequence of Events module does not timestamp, the module sets the I.EventOverflow tag for that point to inform the controller that an input transitioned but a timestamp was not produced for the transition. **Typically, Latch CST is enabled in CST Per Point mode**.
Disabled	The Sequence of Events module timestamps each transition for each input as it occurs. In this case, when multiple transitions occur in the same direction on the same input, the module records the new timestamp data, overwriting any previously-recorded data which had yet to be acknowledged (for more information on acknowledging data, see page 6-12). When the Sequence of Events module overwrites data, it sets the I.EventOverflow tag for that point to inform the controller that events have been overwritten.

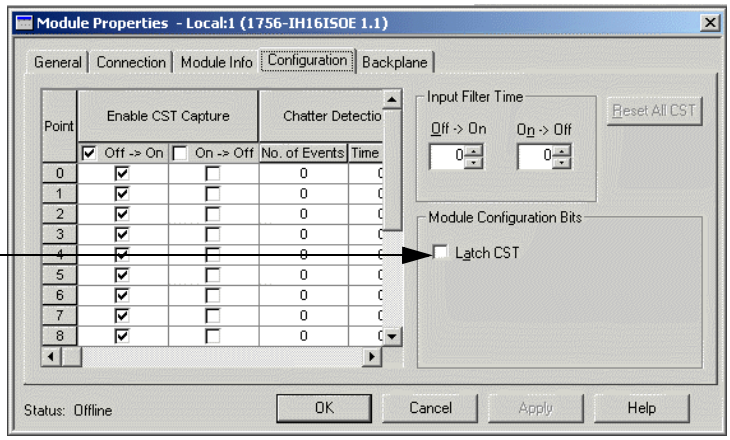
(1) This table assumes the transition occurs on inputs that have Enable CST Capture enabled. If Enable CST Capture is disabled, the module does not timestamp transitions on that input and, therefore, Latch CST does not affect module behavior.

IMPORTANT We suggest you monitor the I.EventOverflow bits to make sure you are aware of when transitions were either not timestamped or when timestamp data was overwritten.

Use the Configuration tab in RSLogix 5000 to enable Latch CST, as shown in the example below.

Click this box to enable the Latch CST feature.

Clear the box to disable the feature.



Using Enable CST Capture in CST Per Point Mode

Regardless of operating mode, Enable CST Capture causes the Sequence of Events module to timestamp specific input transitions. However, keep the following in mind when using this feature in CST Per Point mode:

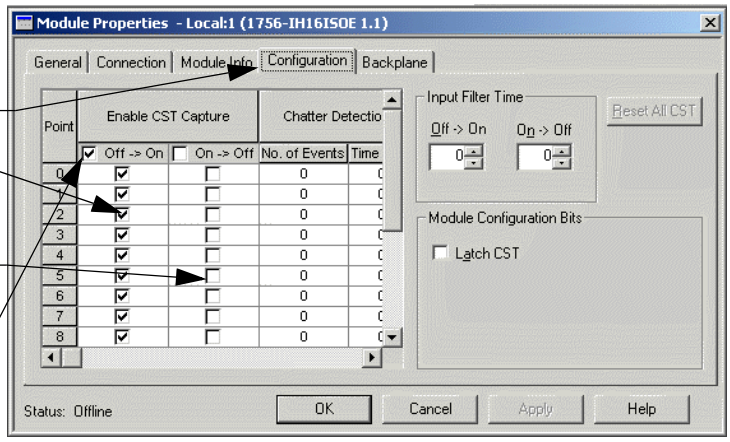
- Typically, Latch CST is enabled in CST Per Point mode. The configuration of this feature (described on page 6-6) determines whether the module timestamps only the first transition on an input or every transition on an input.
- If Latch CST is enabled, the module timestamps only the initial transitions (OFF to ON and ON to OFF) for each input.
- Whenever an input transition is timestamped as a valid transition, the module sends updated input data for all inputs to the controller immediately and at every subsequent RPI.

Use the Configuration tab in RSLogix 5000 to set Enable CST Capture, as shown in the example below.

Click the Configuration tab.

- Click on the individual boxes for each input point to enable CST Capture for that point.
- Clear the individual boxes for each input point to disable CST Capture for that point.

You can also use these boxes to enable or disable all points simultaneously.



Managing the Data in CST Per Point Mode

In CST Per Point Mode, the Sequence of Events module sends all of its input data to the controller immediately after an input transition has been timestamped and at each RPI. You must manage the data coming from the Sequence of Events module.

The following occurs in the process of the managing data coming from the Sequence of Events module in CST Per Point mode:

1. The Sequence of Events module sends data to the controller.
2. The controller copies the relevant portions of the input data to a separate array.
3. At the user's discretion, the controller clears latched timestamp data from the Sequence of Events module via the O.EventAck and O.NewData tags, preparing the module to timestamp the next transition.

This process is described in the rest of this section.

Module Sends Data to the Controller

Figure 6.2 shows an example of the Sequence of Events module sending data to the controller. In the example, the following occurs:

1. Input 1 transitions from OFF to ON. (The input has Enable CST Capture enabled.)
2. The Sequence of Events module timestamps the transition.
3. The module sends its input data, including the transition timestamp from input 1, to the controller.

Figure 6.2

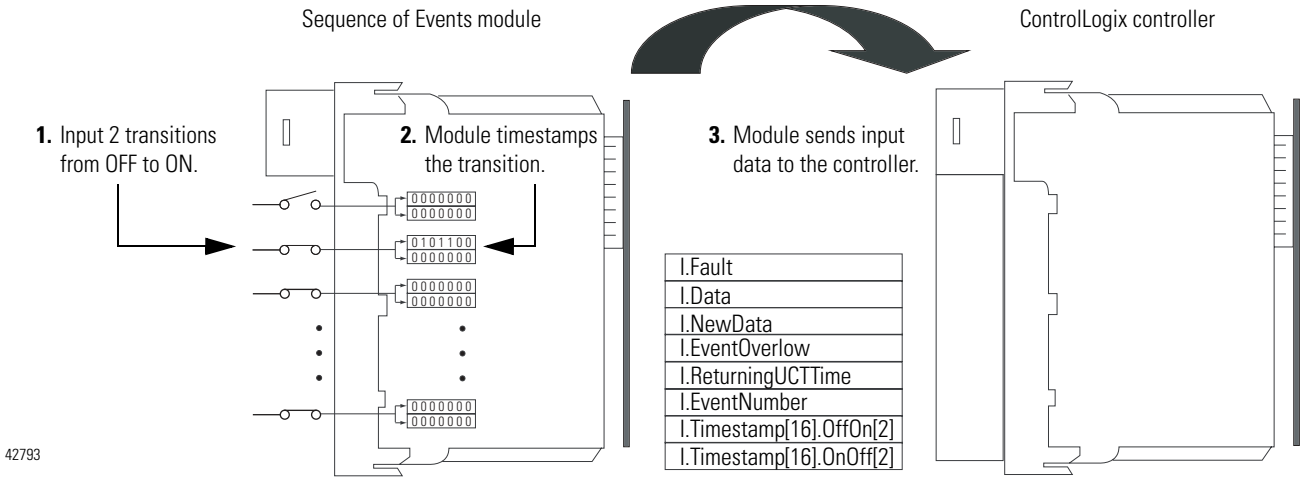


Table 6.3 describes the data that is sent for each input. These tags are sent to the controller immediately after the module timestamps a transition on any input and at each RPI.

Table 6.3 Input Tags in CST Per Point Mode

Tag name:	Set on a Per Point or Modulewide basis:	Description:
I.Fault	Per point(1)	Indicates if a fault has occurred for the input. 0 = no fault 1 = fault – The fault can be chatter or communication fault as described below: • Chatter - The Sequence of Events module can detect chatter on individual inputs and will set the appropriate tag to 1 when chatter exists on an input. For example, if the module has detected chatter on input 4, *I.Fault.4* = 1. • Communication fault - The controller sets this tag to 1 for all 32 bits if a communication fault occurs on the module. This tag clears when the fault that causes the condition no longer exists.
I.Data	Per point(1)	Status of the input point. This data is filtered if the Input Filter feature is used on the module. Thus, an input change must pass through the filter before it is seen in this tag. 0 = input is OFF 1 = input is ON For example, if input 3 is ON, *I.Data.3* = 1.
I.NewData	Per point(1)	Flag indicating if new timestamp data was detected on the input. 0 = no new timestamp data on the input 1 = new timestamp data on the input (since last acknowledged) Because input data for all inputs is sent immediately after each timestamped transition and at each RPI, this tag is useful to quickly determine on which input the transition occurred. For example, if the Sequence of Events module sends new input data to the owner-controller and *I.NewData.5* = 1, you know that at least one of the timestamps for input 5 (i.e., *I.Timestamp[5].OffOn* or *I.Timestamp[5].OnOff*) has new data. This tag only clears when the controller acknowledges the new data or all events on the module are reset. For more information, see page 6-12.
I.EventOverflow	Per point(1)	Set for an input when the module either: • Does not timestamp a transition on the input – The module has Latch CST enabled and a similar transition has already been timestamped on this input but has not been cleared via the EventAck and NewDataAck output tags (see page 6-12). or • Overwrites previously-recorded timestamp data for the input – The module has Latch CST disabled and multiple transitions occur on the input. In this case, timestamp data from new transitions are recorded before previously-recorded transitions were cleared from the input via the EventAck and NewDataAck output tags (see page 6-12). This value is cleared if the module is reset.

Table 6.3 Input Tags in CST Per Point Mode

Tag name:	Set on a Per Point or Modulewide basis:	Description:
I.ReturningUCTTime	Modulewide	Indicates if timestamps are in UCT format rather than CST. 0 = CST format 1 = UCT format For more information on UCT format, see Appendix B.
I.EventNumber.x	Modulewide	Running count of the timestamped transitions; this tag increments by one with each new transition that the module timestamps. In CST Per Point mode, this tag has lesser importance than in FIFO mode. This value is cleared if the module is reset, as described on page 6-14.
I.Timestamp[16].OffOn[2]	Per point	Timestamp value (in CST or UCT format) with an input's OFF to ON transition. This tag is a 16 x 2 32-bit array. There is a 64-bit timestamp per point. This value is cleared after the data has been acknowledged via the *O.EventAck* and *O.NewData* tags. For more information on clearing timestamp data, see page 6-12.
I.Timestamp[16].OnOff[2]	Per point	Timestamp value (in CST or UCT format) with an input's ON to OFF transition. This tag is a 16 x 2 32-bit array. There is a 64-bit timestamp per point. This value is cleared after the data has been acknowledged via the *O.EventAck* and *O.NewData* tags. For more information on clearing timestamp data, see page 6-12.

(1) This tag is a 32-bit tag. The lower 16 bits represent the 16 inputs on the Sequence of Events module.

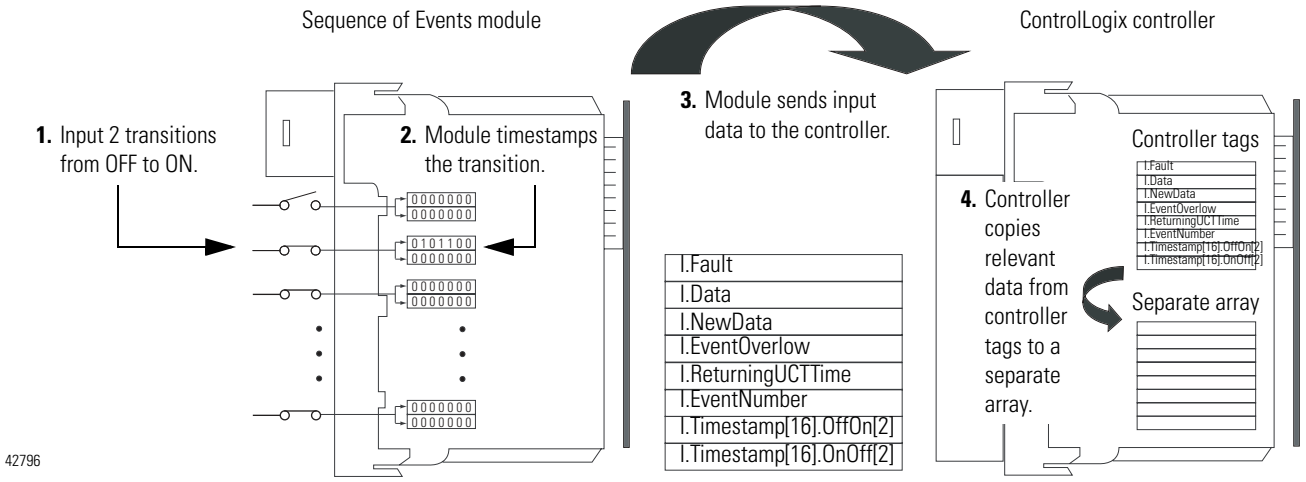
Copying Relevant Input Data to a Separate Data Structure

When the Sequence of Events module sends input data to the controller, the data is stored in the controller tags. We recommend you use a COP or CPS instruction to programmatically copy new timestamp data from the controller tags to a separate array in the controller's memory. Later, you can combine timestamp data from multiple Sequence of Events modules and use a Sort routine to determine the order of events, with relative time reference, that occurred in a specific time period.

IMPORTANT When you copy relevant timestamp data from the controller tags to a separate data structure, make sure you copy enough information for each timestamp that you can differentiate between timestamps for different inputs.

Figure 6.3 shows when to use the COP instruction. In this example, the Sequence of Events module timestamped a transition on input 1 and is sending input data to the controller at each RPI. The controller copies input data from the controller tags to a separate data structure.

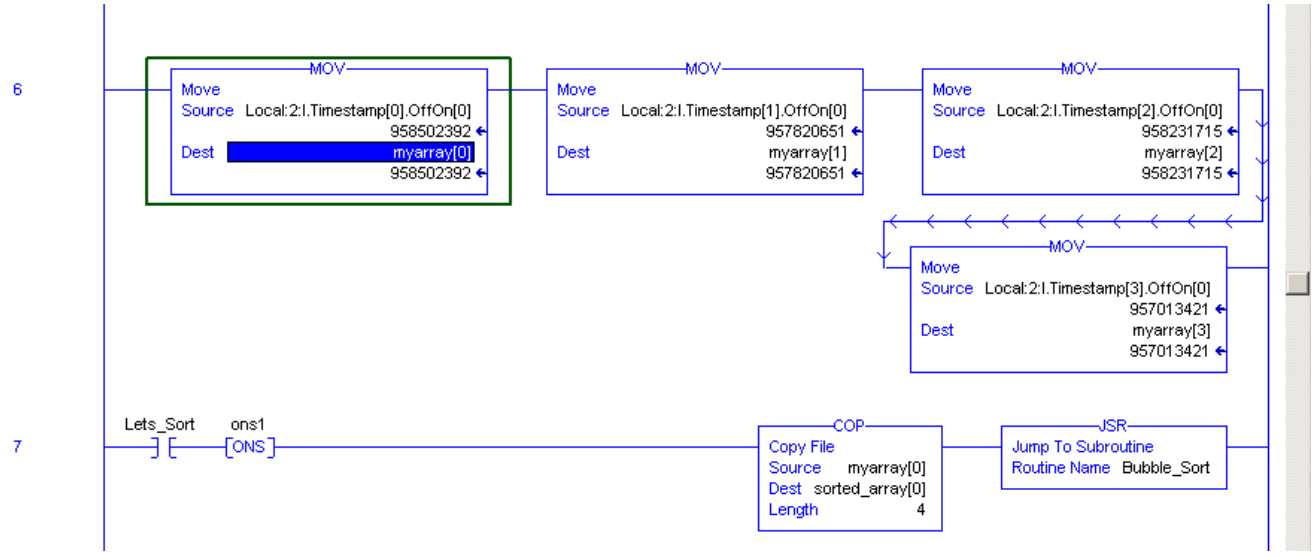
Figure 6.3



Your application determines what input data should be copied from the controller tags to a separate data structure. Although you can copy all the input data to another array, typically, only the data from specific tags is copied.

Figure 6.4 shows an example of ladder logic in which the controller only moves OFF to ON timestamp data for inputs 0 to 3 from the controller tags to a separate data structure named *myarray*. The data in the myarray structure is then moved to another array used to sort the data. In this example, 32 bits of each 64-bit timestamp are moved to the new array.

Figure 6.4



Acknowledging Latched Timestamp Data

In most cases, **Latch CST is enabled** when the module operates in CST Per Point mode. This means that once the module timestamps an input transition, the module will not timestamp another transition in the same direction on the same input until you acknowledge the data from the first timestamped transition; when you **acknowledge data**, you **clear it from the Sequence of Events module**.

To clear data from the Sequence of Events module, you must acknowledge them via the module's output tags. You can clear data in the following ways:

- **Clear latched timestamp data for specific inputs** – As data is acknowledged, it is cleared from the module, and the module will once again timestamp the first new transition for the input in the cleared direction(s).

  To clear timestamp data for specific inputs, you must complete the following steps:

  1. Write to the EventAck tag (i.e., *O.EventAck*) in the input point's output word.
     - 0 = clear only the falling edge timestamp (i.e., I.Timestamp[x].OnOff)
     - 1 = clear only the rising edge timestamp (i.e., I.Timestamp[x].OffOn)
     - 2 = clear both the falling and rising edge timestamps
  2. Change the NewDataAck tag (i.e., *O.NewDataAck*) to a rising edge (i.e., set the tag =1).
     - If the bit = 0, change the bit to 1.
     - If the bit = 1, change the bit to 0, wait for at least one RPI, and change the bit to 1.

     The corresponding I.EventOverflow and I.NewData tags are also cleared.

- **Clear all latched data for the Sequence of Events module** – This transition erases all timestamp data from the module, clearing data from all inputs simultaneously. Once the data is cleared, the module timestamps the first transition in each direction for each input and sends the data to the controller (assuming those inputs are configured with Enable CST Capture enabled in each direction).

  To clear all data for the module, transition the O.ResetEvents tag to 1.

  – If the bit = 0, change the bit to 1.

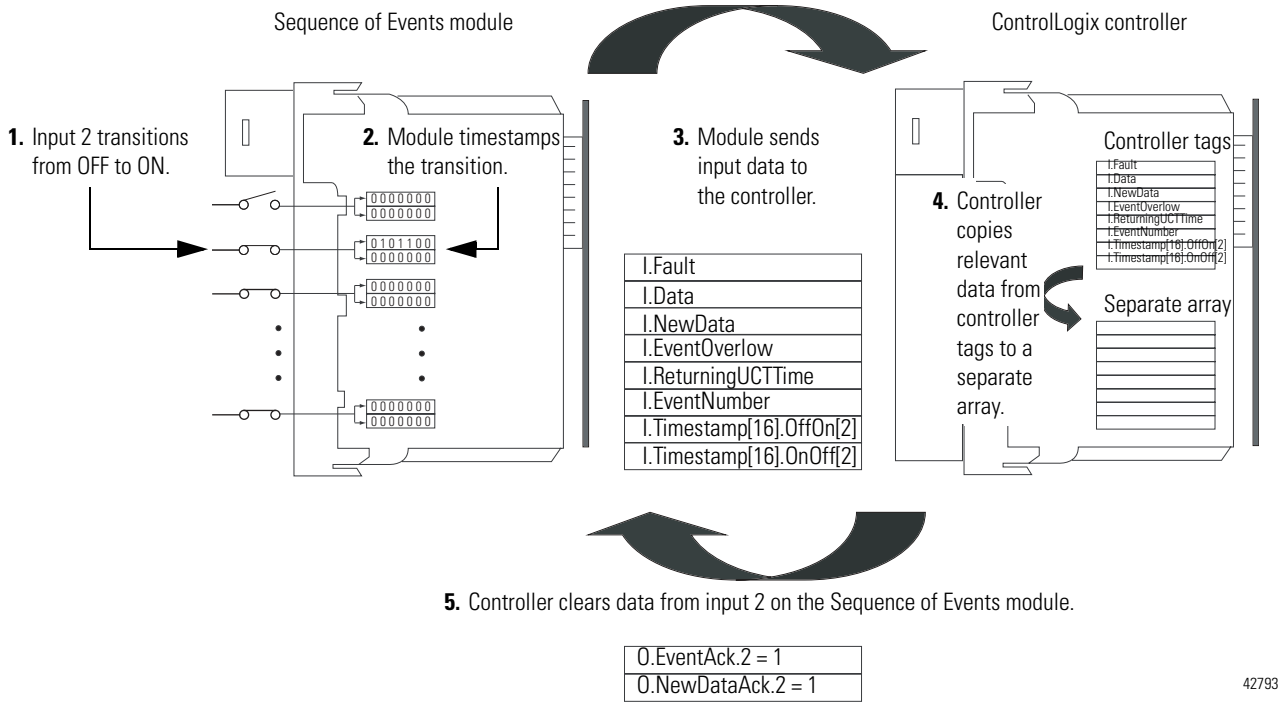
  – If the bit = 1, change the bit to 0, wait for at least one RPI, and change the bit to 1.

Figure 6.5 shows when to clear data from the Sequence of Events module. In this example, the Sequence of Events module sent input data to the controller, and the controller copied the relevant input data to a separate structure. Now, the controller must clear the data from the Sequence of Events module.

In this example, to clear data from the Sequence of Events module, the controller writes the following to the Sequence of Events output word:

- O.EventAck.2 = 1
- O.NewDataAck.2 = 1

Figure 6.5



If **Latch CST is disabled**, the controller does not need to clear timestamp data. In this case, Sequence of Events module sends new data, from subsequent transitions, to the controller as soon as they occur. The controller overwrites timestamp data from the last transition, regardless of whether it saved the data or not.

Sorting the Data

Eventually, you will need to determine the order of events that occurred in a cascade. You must use a Sort routine to determine the order of events. Rockwell Automation offers a sample sort routine that you can use to determine the order of events in an event cascade. For more information, see Appendix E, Using Sample RSLogix 5000 Projects with the Sequence of Events Module.

Clearing All Data From the Module's Buffers At Once

If necessary, you can reset the events in the Sequence of Events module, in effect clearing all data from previously timestamped transitions. In other words, when all data is cleared from the module's buffers, all of the module's input tags return to 0.

To reset events in the module's buffer, transition the O.ResetEvents tag to 1 as described below:

- If the bit = 0, change the bit to 1.
- If the bit = 1, change the bit to 0, wait for at least one RPI, and change the bit to 1.

Once the data is cleared, the module begins timestamping input transitions again and storing them in its on-board buffer.

Chapter Summary and What's Next

In this chapter, you read about using the Sequence of Events module's features. Chapter 7 describes Using The Sequence of Events Module in FIFO Mode.

Using The Sequence of Events Module in FIFO Mode

What This Chapter Contains

This chapter describes how to use the Sequence of Events module in FIFO mode.

Table 7.1

Overview of the Mode

In First In First Out (FIFO) mode, the Sequence of Events module timestamps multiple input transitions on any CST Capture-enabled inputs. The module stores the timestamp data in an on-board buffer that holds data for up to 160 unique transitions and their timestamps.

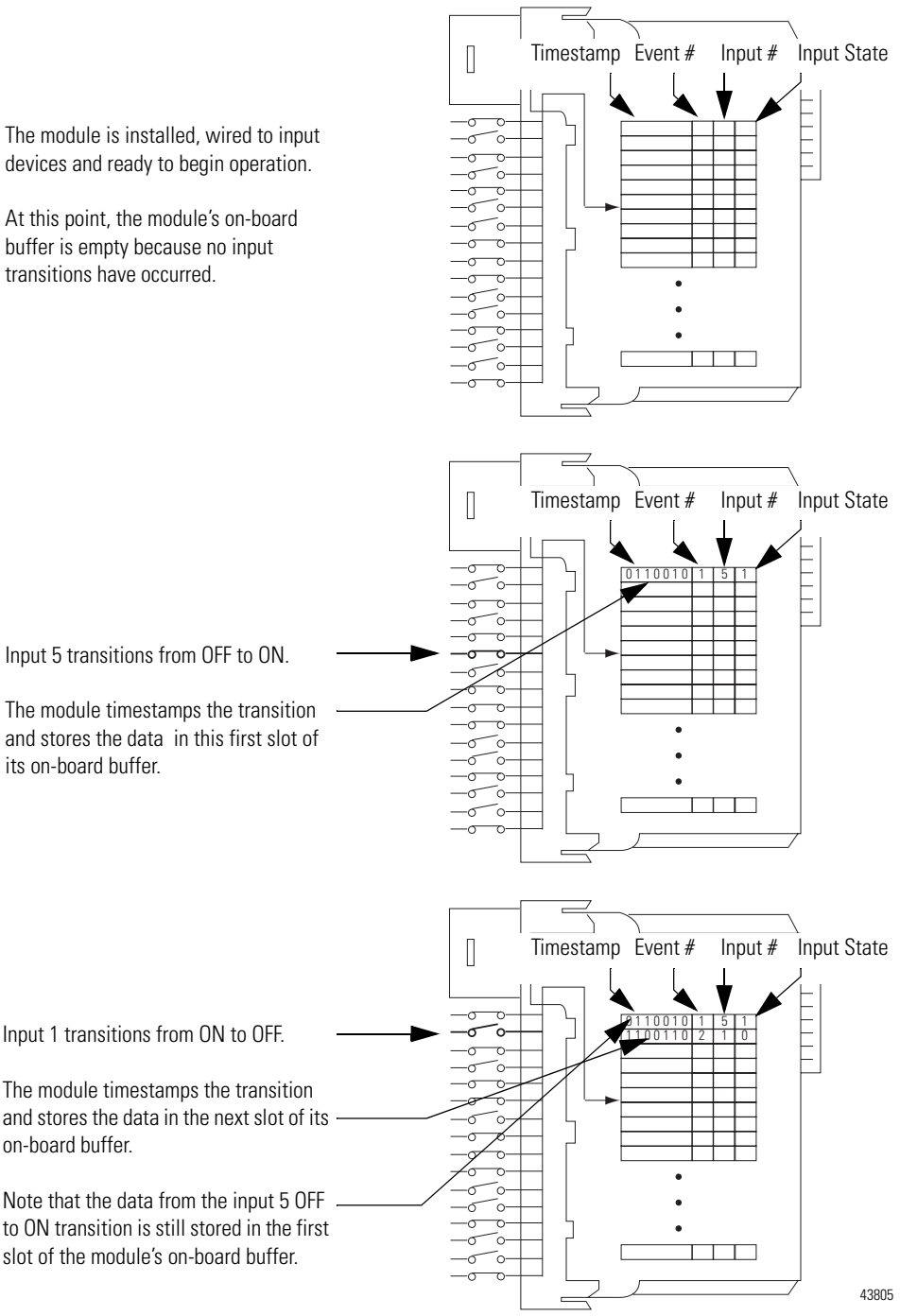
When an input transitions, the module timestamps the event and records specific input data related to the transition. The owner-controller must retrieve the data from the Sequence of Events module using one of the two methods described later in this chapter.

IMPORTANT Keep in mind that, although the Sequence of Events module can store data for up to 160 timestamped transitions in its on-board buffers, if you manage the buffer effectively (i.e., retrieve data in a timely fashion), the module can timestamp an infinite number of input transitions and the controller will be able to retrieve and use the data.

How Does the On-Board Buffer Work in FIFO Mode?

The Sequence of Events module's on-board buffer stores data for up to 160 timestamped transitions at one time. For each transition, specific information is recorded, as shown below and described on page 7-10. The on-board buffer has 160 slots to store timestamp information for input transitions. As the transitions occur, the module timestamps them and fills the 160 slots. The first transition fills the first slot, the second fills the second slot and so forth.

Figure 7.1



Once data is stored on the module, the controller must retrieve it. Typically, the controller retrieves data from the first slot in the on-board buffer; the data in the first slot is also known as the **current event**.

IMPORTANT The current event is the event for which the Sequence of Events module is currently producing data. The current event is **NOT** the most recently-timestamped input transition.

After the controller retrieves the current event data, it acknowledges the data and clears it from the Sequence of Events module's on-board buffers, and the data from the next slot in the buffer becomes the current event (i.e., the module produces this data for the controller).

In FIFO mode, generally the following occurs:

1. You configure the Sequence of Events module to operate in FIFO mode via the Communication Format selection.

2. The Sequence of Events module timestamps each transition and stores the data in its on-board buffer. The module can timestamp each transition with a unique CST as long as the transitions occur 25µs apart.

3. The controller retrieves data from the Sequence of Events module as described in the following steps:
   a. Immediately after the Sequence of Events module timestamps an input transition, it records data in the first slot of its on-board buffer and produces the data for the controller; the data is the current event. The module produces the data from the current event at every subsequent RPI until the controller clears it (as described in step c).
   b. The controller copies the data from the controller tags to a separate data structure for later use.
   c. The controller acknowledges the current event in the Sequence of Events module's buffer by I.EventNumber to O.EventNumber.
   d. Once the current event is cleared from the Sequence of Events module's buffer, data for the next transition stored in the buffer becomes the current event, and the module begins producing this data for the controller as described in step a.

4. The Sequence of Events module timestamps input transitions and records the data in its on-board buffer as long as the buffer is not full (i.e., less than 160 input transitions worth of data is stored in the buffer).

What the Typical Applications Where FIFO Mode is Used?

FIFO mode is intended for use in applications where multiple transitions occur on multiple inputs in relatively rapid succession (i.e., faster than the controller can acknowledge the data as the transitions occur). Because of this intention, the Sequence of Events module uses an on-board buffer to store the data for up to 160 events.

The following are example typical applications for FIFO mode:

- Sequence monitoring
- Process and machine optimization

Configuring the Module for FIFO Mode

You configure the same general set of configurable features (described in Chapter 5) whether you are using the Sequence of Events module in CST Per Point mode or FIFO mode. However, for some features, the module behavior as dictated by the feature, varies according to operational mode. For example, Latch CST impacts the Sequence of Events module behavior slightly differently in CST Per Point mode than in FIFO mode.

You should be aware of the impact the following configurable features have on module behavior in FIFO mode:

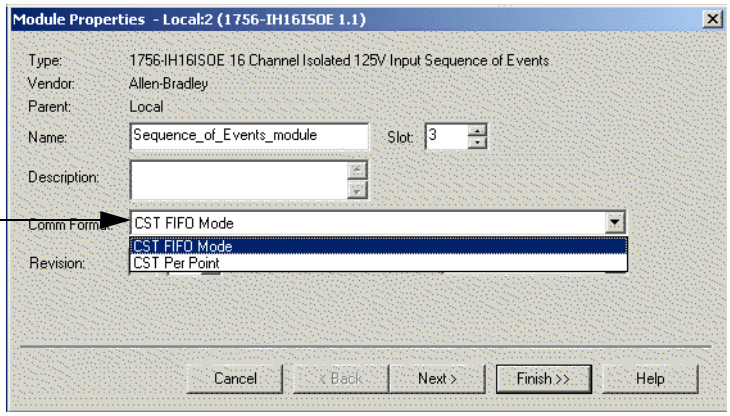
- Communications Format
- Latch CST
- Enable CST Capture

Choosing a Communications Format

During initial module configuration, you must choose a communication format for the module. The communications format determines what operational mode your Sequence of Events module uses and, consequently, what tags RSLogix 5000 generates when configuration is complete.

To operate the Sequence of Events module in FIFO mode, you must choose the FIFO communication format, as shown below.

Use this pull-down menu to choose the CST FIFO Mode communication format.



Using Latch CST in FIFO Mode

When enabled, Latch CST prevents the Sequence of Events module from overwriting input data once it is timestamped. This feature is set on a module-wide basis and is enabled by default.

Table 7.2 describes how Latch CST affects the module in FIFO mode.

Table 7.2

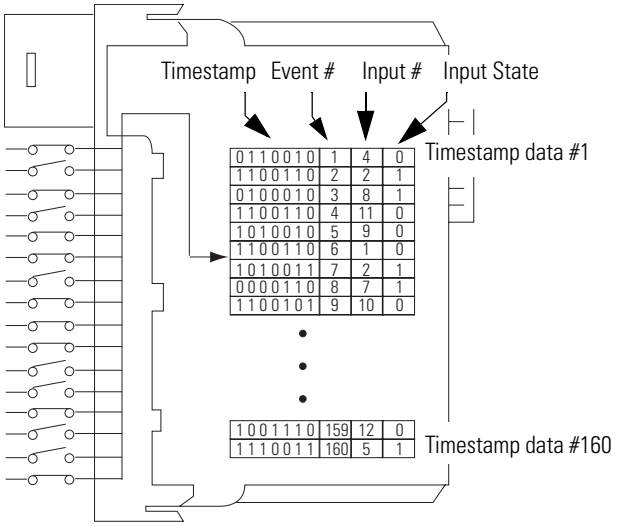
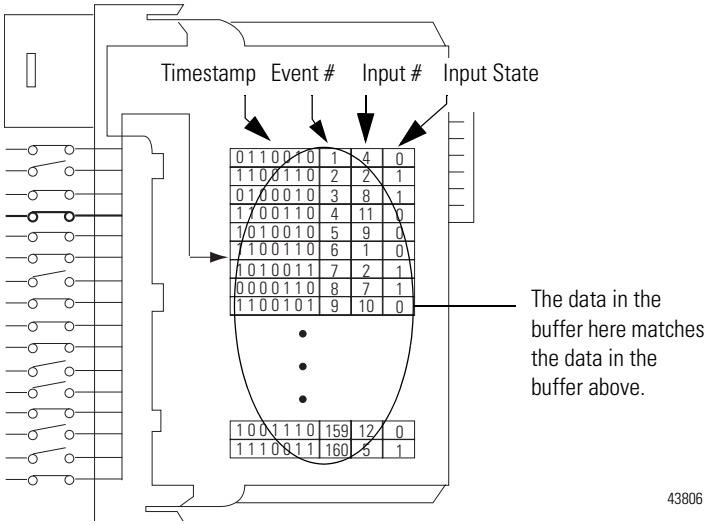
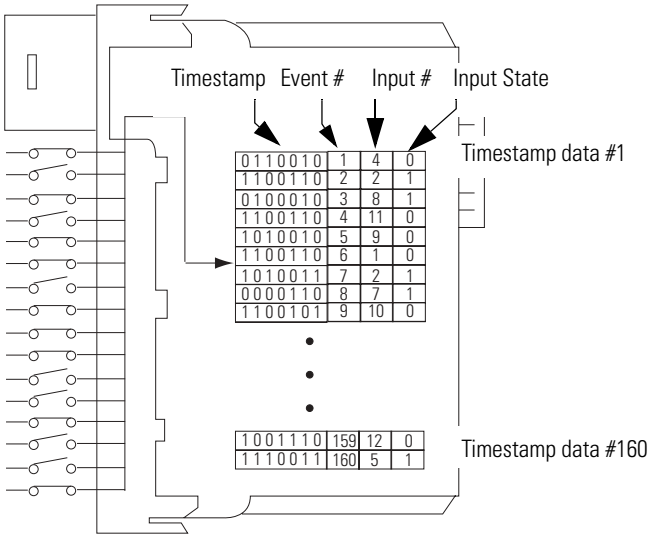
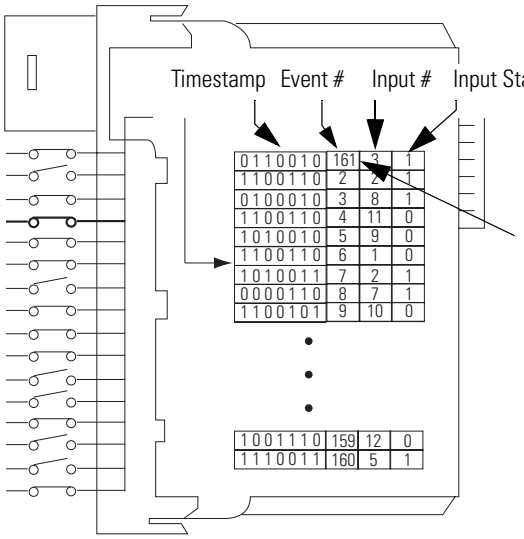
If Latch CST is	the following occurs[1]:
Enabled	The Sequence of Events module timestamps input transitions as they occur, and stores the data for those transitions in its on-board buffer. If you fail to empty the buffer (as described on page 7-10) faster than it is filled, after 160 timestamped input transitions, the module ignores additional transitions. Once the Sequence of Events module buffer is filled, the next input transition is not timestamped and the I.EventOverflow for the point where the transition occurred is set to one to inform the controller that events occurred but were not timestamped. The Sequence of Events module has timestamped and recorded enough input transitions since the controller last retrieved data, that the on-board buffer is full.  Input 3 transitions for OFF to ON. Because Latch CST is enabled and the Sequence of Events module's on-board buffer is full, it does not timestamp the transition. All data in the buffer remains the same, and the module increments the I.EventOverflow tag. 

Table 7.2

If Latch CST is	the following occurs[1]:
Disabled	The Sequence of Events module timestamps input transitions as they occur, and stores the data for those transitions in its on-board buffer. However, the module can only store the data for up to 160 transitions in its on-board storage buffers. If you fail to empty the buffer (as described on page 7-10) faster than it is filled, after 160 timestamped input transitions, the module overwrites the timestamp from the first transition in its on-board buffer with data from the most recent transition. If the Sequence of Events module overwrites data, it sets the I.EventOverflow bit to one for the point where a timestamp was previously recorded but has been deleted to inform the controller that events have been overwritten. The Sequence of Events module has timestamped and recorded enough input transitions since the controller last retrieved data, that the on-board buffer is full.  Input 3 transitions for OFF to ON. Because Latch CST is disabled, the module timestamps the transition and records the data in slot #1 of its on-board buffer. In this case, the oldest data (i.e., data in slot #1) is automatically deleted from the module. The module sets the I.EventOverflow tag for that point.  Note that the timestamp data for event #1 has been deleted from the buffer. The timestamp from the most recent transition overwrites the data in slot #1 and becomes the current event sent to the controller. 43807

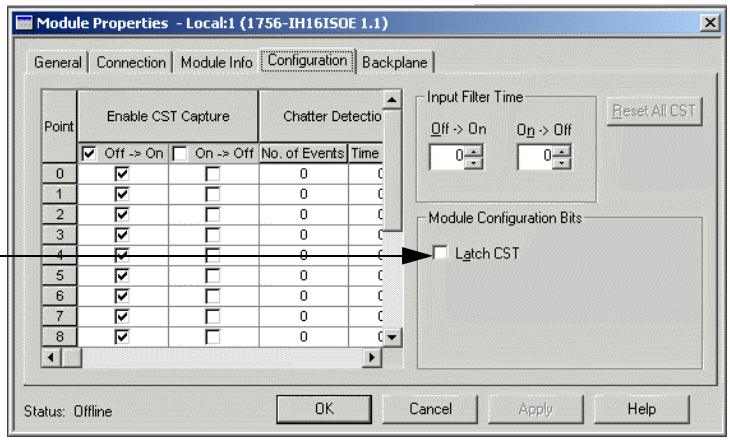
(1) This table assumes the transition occurs on inputs that have Enable CST Capture enabled. If Enable CST Capture is disabled, the module does not timestamp transitions on that input and, therefore, Latch CST does not affect module behavior.

IMPORTANT We suggest you monitor the I.EventOverflow bits to make sure you are aware of when transitions were either not timestamped or when timestamp data was overwritten.

Use the Configuration tab in RSLogix 5000 to enable Latch CST, as shown in the example below.

Click on this box to enable the Latch CST feature.

Clear the box to disable the feature.



Using Enable CST Capture in FIFO Mode

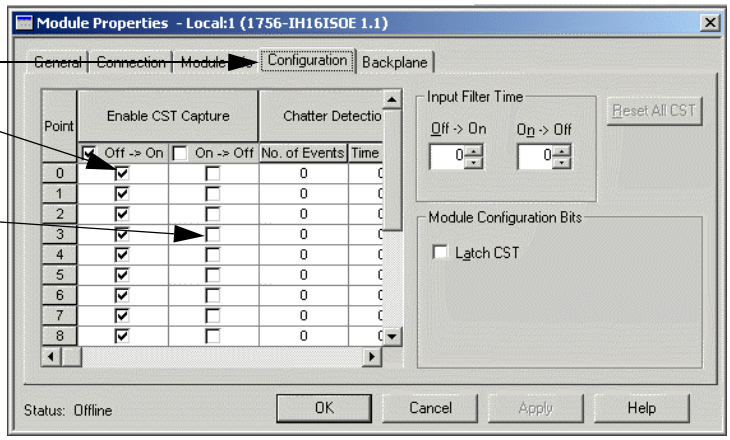
Regardless of operating mode, Enable CST Capture causes the Sequence of Events module to timestamp specific input transitions. However, keep the following in mind when using this feature in FIFO mode:

- The module is capable of timestamping an unlimited number of transitions. However, at any one time the Sequence of Events module can store the data for up to 160 events in its on-board buffer. You must manage the buffer effectively (i.e., retrieve data) to make sure no events are missed or overwritten.
- The controller must retrieve data associated with each input transition from the Sequence of Events module's on-board buffers. See Retrieving Data in FIFO Mode on page 7-10 to learn how to manage the module's on-board storage buffer.
- When the first transition is timestamped, the module sends the data for that specific event, as well as the status of all the other points on the module, to the controller and at every subsequent RPI until the data is acknowledged.
- As subsequent events occur after the first, the module timestamps the transition and records the data for that event in its on-board buffer.

Use the Configuration tab in RSLogix 5000 to set Enable CST Capture, as shown in the example below.

Click the Configuration tab.

- Click on the individual boxes for each input point to enable CST Capture for that point.
- Clear the individual boxes for each input point to disable CST Capture for that point.



Managing the Data in FIFO Mode

In FIFO Mode, the Sequence of Events module sends input data for the current event to the controller immediately after the first input transition has been timestamped and at each RPI. You must manage the data coming from the Sequence of Events module.

The following occurs in the process of the managing data coming from the Sequence of Events module in CST Per Point mode:

1. The controller retrieves current event data from the Sequence of Events module in one of two retrieval methods.

2. The controller copies the relevant portions of the current event data to a separate array.

3. At the user's discretion, controller clears current data from the Sequence of Events module by copying the current event number (I.EventNumber) to the O.EventAck tag, preparing the module send data from the next current event.

This process is described in the rest of this section.

Retrieving Data in FIFO Mode

In FIFO Mode, the Sequence of Events module automatically sends the controller the data from the first timestamped transition in its buffer. The controller must retrieve the data for the remaining timestamped transitions in the Sequence of Events module's buffers.

The controller can retrieve data in one of the following ways:

- Standard Retrieval – By default, the module uses this retrieval method which returns events in order of occurrence.
- Retrieval by Point

Regardless of retrieval method, the controller retrieves data in the format described in Table 7.3 on page 7-11:

Table 7.3 Input Tags in FIFO Mode

Tag name:	Set on a Per Point or Modulewide basis:	Description:
I.Fault	Per point(1)	Indicates if a fault has occurred for the input. 0 = no fault 1 = fault – The fault can be chatter or communication fault as described below: • Chatter - The Sequence of Events module can detect chatter on individual inputs and will set the appropriate tag to 1 when chatter exists on an input. For example, if the module has detected chatter on input 4, *I.Fault.4* = 1. • Communication fault - The controller sets this tag to 1 for all 32 bits if a communication fault occurs on the module. This tag clears when the fault that causes the condition no longer exists.
I.Data	Per point(1)	Status of the input point. This data is filtered if the Input Filter feature is used on the module. Thus, an input change must pass through the filter before it is seen in this tag. 0 = input is OFF 1 = input is ON For example, if input 3 is ON, *I.Data.3* = 1.
I.NewData	Per point(1)	Flag indicating if new timestamp data was detected on the input. 0 = no new timestamp data on the input 1 = new timestamp data on the input (since last acknowledged) Because input data for all inputs is sent immediately after each timestamped transition and at each RPI, this tag is useful to quickly determine on which input the transition occurred. For example, if the Sequence of Events module sends new input data to the owner-controller and *I.NewData.5* = 1, you know that at least one of the timestamps for input 5 (i.e., *I.Timestamp[5].OffOn* or *I.Timestamp[5].OnOff*) has new data. This tag only clears when the controller acknowledges the new data or all events on the module are reset. For more information, see page 7-17.
I.EventOverflow	Per point(1)	Set for an input when the module either: • Does not timestamp an input transition – The module has Latch CST enabled and the module's on-board buffer contains 160 timestamps. In this case, the module does not have room in its on-board buffer to store the timestamp from any additional events and does not timestamp new transitions. or • Overwrites previously-recorded timestamp data – The module has Latch CST disabled and the on-board buffer contains 160 events. In this case, the module continues to timestamp input events. When the module records new transitions, it records the data in its buffer and overwrites the timestamp data from the oldest transition of the 160. This value is cleared if the module is reset or when an event is acknowledged.

Table 7.3 Input Tags in FIFO Mode

Tag name:	Set on a Per Point or Modulewide basis:	Description:
I.EventNumber	Per point[1]	Running count of the timestamped input transitions; this tag increments by one with each new event. The event number is the identifier that uniquely indicates which event the Sequence of Event module is returning to the controller. When you copy this value to the O.EventAck tag, the Sequence of Events module begins producing the next event in its buffer, as the next event becomes the current event. This value is cleared if the module is reset, as described on page 7-20.
I.CSTTimestamp[2]	Per point	64-bit CST timestamp in CST format for the current event. This value is cleared after the data has been acknowledged via the *O.EventAck* tag. For more information on clearing timestamp data, see page 7-17.
I.UCTTimestamp[2]	Per point	64-bit UCT timestamp in Universal Coordinated Time format for the event. UCT is expressed as microseconds elapsed since 1 January 1972. Typically, UCT format is only used in applications that also use the 1756HP-GPS module. For more information on the 1756HP-GPS module, see Appendix B. This value is cleared after the data has been acknowledged via the *O.EventAck* tag. For more information on clearing timestamp data, see page 7-17.
I.EventPoint	Per point	Input that recorded the event. Values are 0 - 15, where 0 = Input 0, 1 = Input 1, etc.
I.EventData	Per point	Indicates if input transitioned OFF or ON. 0 = input transitioned OFF 1 = input transitioned ON
I.ReturningUCTTime	Modulewide	Indicates if timestamps are in UCT format rather than CST. Typically, UCT format is only used in applications that also use the 1756HP-GPS module. For more information on the 1756HP-GPS module, see Appendix B. 0 = CST format only (UCT timestamp = 0 1 = UCT format available also For more information on UCT format, see Appendix B.
I.EventsQueuedCount	Modulewide	Number of events currently stored in the module's buffer that have not been read.

(1) With the Per point tags, there is one bit per input. For example, bit 0 represents input 0, bit 7 represents input 7 and so on.

Standard Retrieval

In Standard Retrieval, the controller retrieves the data for each event in the order in which the events occurred. This retrieval method includes the following:

1. At each RPI, the Sequence of Events produces the **current event** in its on-board buffer.

2. The controller copies relevant input data from the current event to a separate data structure for later use.

3. The controller clears the current event from the Sequence of Events module's on-board buffer by acknowledging the data via the module's output word.

4. When the current event is cleared, the next event in the module's on-board buffer becomes the new current event. If no other events are present, the event data will be 0.

5. The Sequence of Events module produces the new current event as described in step 1.

This process continues as long as the Sequence of Events module timestamps input transitions and the controller continues to retrieve the data for each transition.

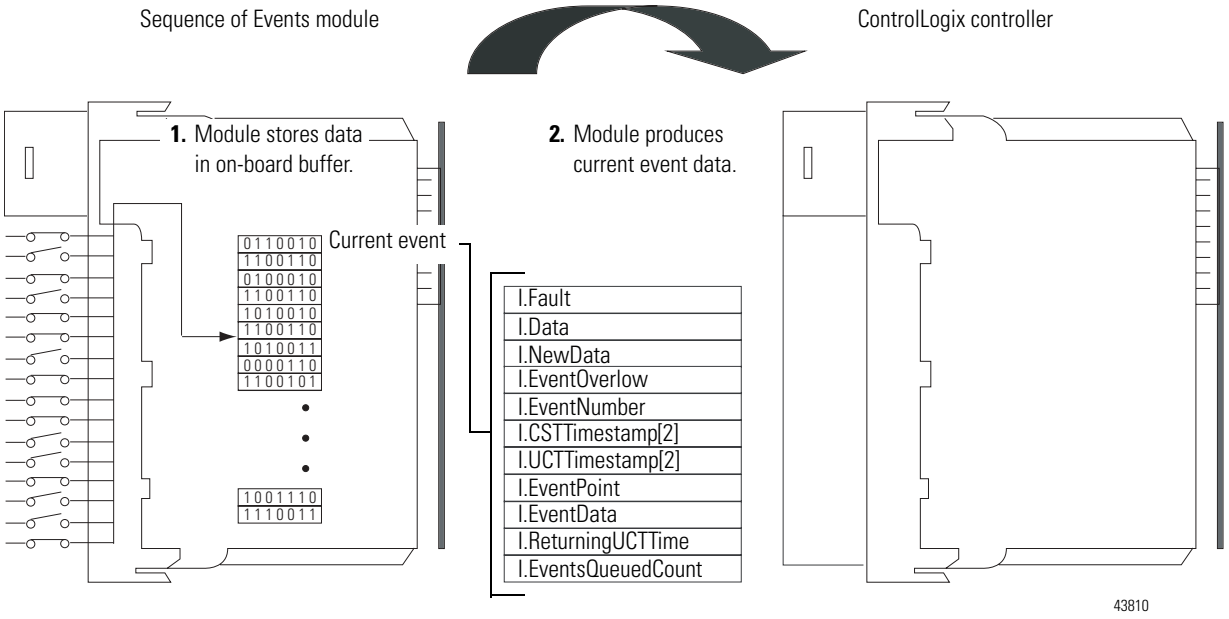
Producing Current Event Data

Figure 7.2 shows an example of the Sequence of Events module producing the current data for the controller to retrieve it.

IMPORTANT Remember, the **current event** is data that the module is currently producing from its on-board buffer at each RPI. For more information on how the Sequence of Events module produces data from its on-board buffer, see page 7-2.

In the example, the Sequence of Events module produces data from the current event for the controller.

Figure 7.2



Copying Relevant Input Data to a Separate Data Structure

At each RPI, the Sequence of Events module sends input data for the current event to the controller; the data is stored in the controller tags. We recommend you use a COP or CPS instruction to programmatically copy relevant input data from the controller tags to a separate array in the controller's memory.

IMPORTANT

When the Sequence of Events module sends current event data at the RPI, it sends data for all the tags described in Table 7.3 on page 7-11. You typically will only need data from specific tags, though. We recommend you only copy data from those tags to a separate array.

For example, if you only need data from the:

- event number (I.EventNumber.x)
- CST timestamp (I.CSTTimestamp[2])
- event point (I.EventPoint.x)
- event data (I.EventData.x)

tags for your application, we recommend you only copy the data from those tags to a separate array.

Later, you can combine data from multiple Sequence of Events modules and use a Sort routine to determine the order of events, with relative time reference, that occurred in a specific time period.

Figure 7.3 shows when to use the COP or CPS instruction. In this example, the Sequence of Events module has produced current event data for the controller at the RPI.

The controller copies the relevant input data from the controller tags to a separate data structure.

Figure 7.3

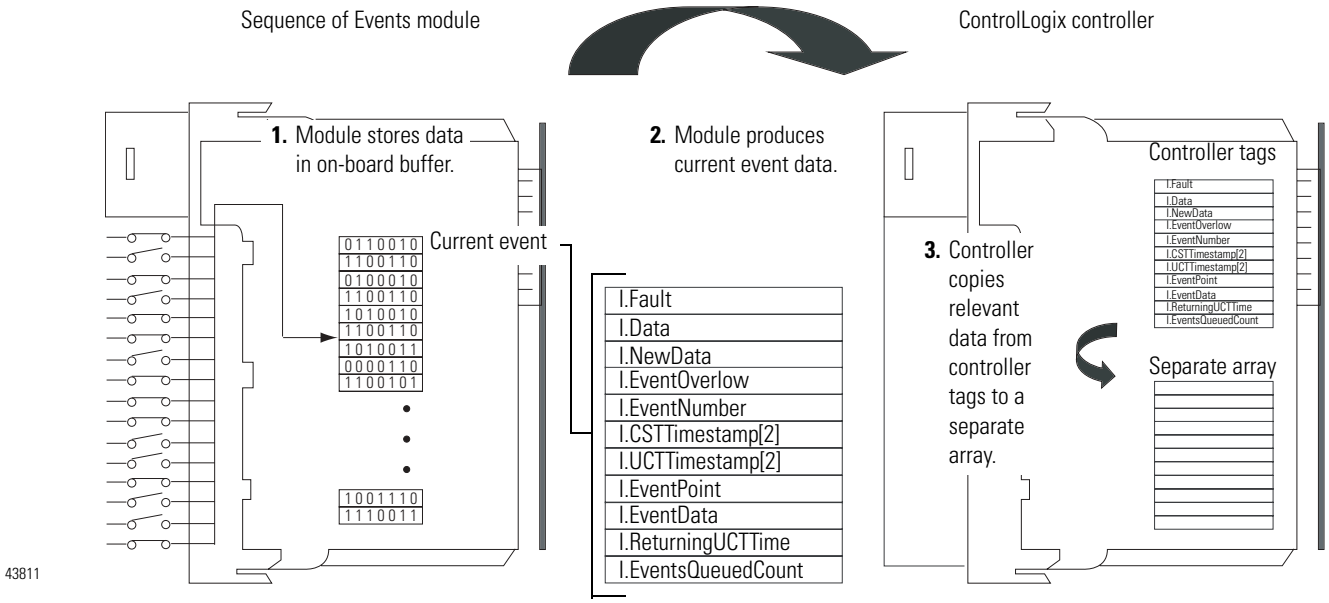
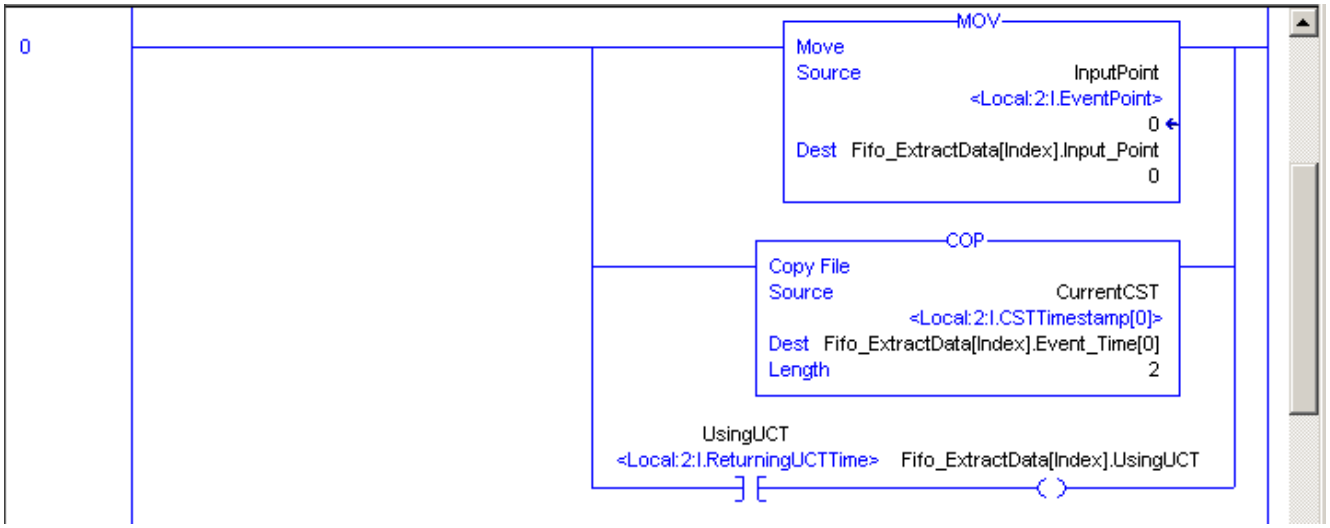


Figure 7.4 shows an example of ladder logic in which the controller only moves the input number (I.EventPoint) and copies the CST timestamp (I.CSTTimestamp) from the controller tags to a separate data structure named *Fifo_ExtractData[Index]*.

Figure 7.4



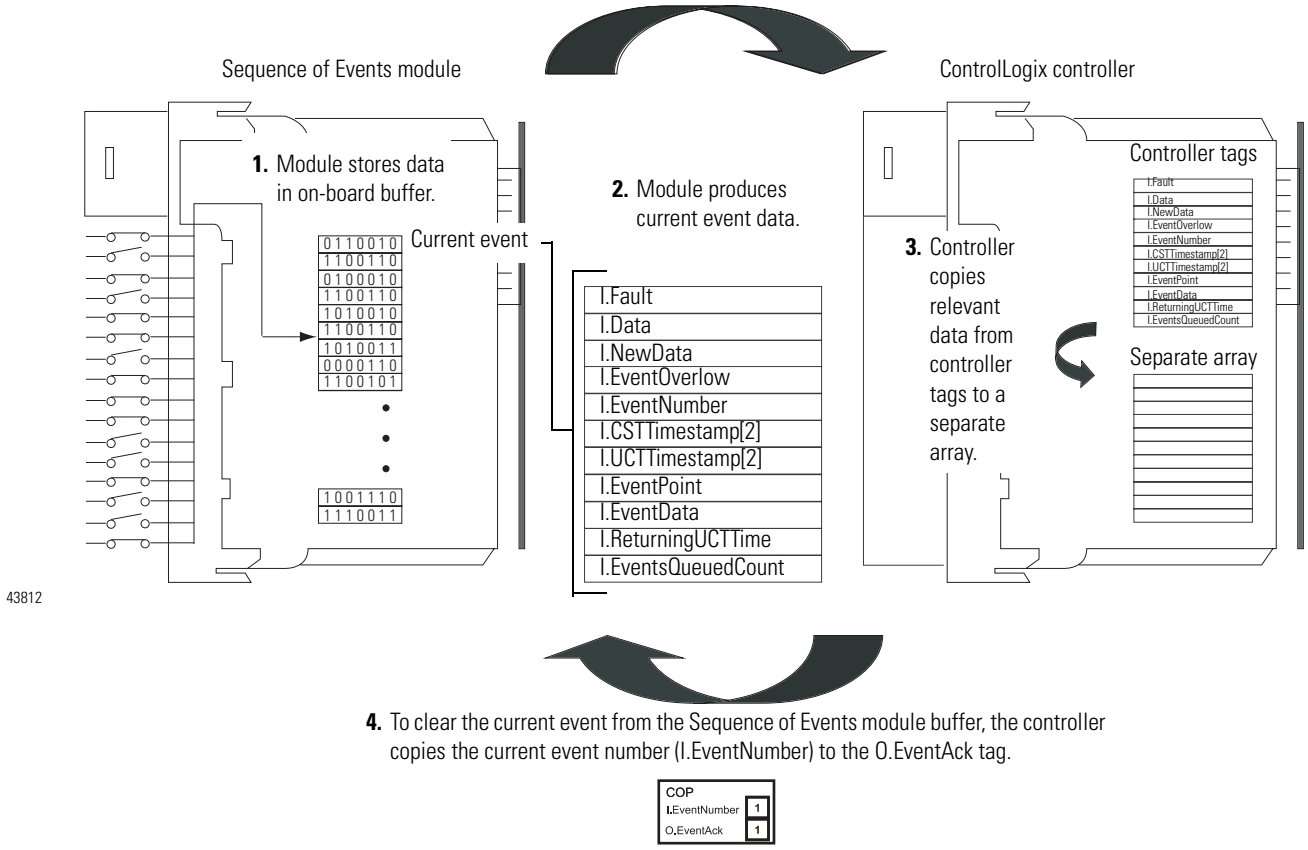
Acknowledging Latched Timestamp Data

In FIFO mode, the Sequence of Events produces data for the current event data at each RPI until the data is acknowledged and, thus, cleared from the buffer.

To clear data for the current event, and begin producing data for the next event in the Sequence of Events module's on-board buffer when using Standard Retrieval, you must copy the event number from the current event (located in the *I.EventNumber* tag) to the module's EventAck tag (i.e., *O.EventAck*).

Figure 7.5 shows how to clear data for the current event from the Sequence of Events module. In this example, the controller has copied relevant input data from the controller tags to a separate data structure. The controller may use a COP or MOV instruction to copy the current event number to the Sequence of Events module's O.EventAck tag and clear the data from the module's on-board buffer.

Figure 7.5



Once the current event data is cleared from the Sequence of Events module's buffer, the module begins producing data for the next event in its buffer at each RPI because that event has become the current event. At this point, the process returns to Producing Current Event Data on page 7-14.

Retrieval by Point

Retrieval by Point is similar to Standard Retrieval by time except that with this method, the controller only retrieves timestamp data for input transitions that occurred on a specific point.

The Sequence of Events module still timestamps input transitions for any events that occur on Enable CST Capture-enabled inputs. The module also stores the data in its on-board buffers as described on page 7-2 for up to 160 input transitions.

IMPORTANT

Although the Sequence of Events module can still store the data for up to 160 timestamped transitions in its on-board buffer **when you use the Retrieval by Point method, the module only stores up to 10 timestamps per input**.

You must manage the module buffer effectively to make sure that the module timestamps all transitions on a specific input.

Consider the following example:

> You are using Retrieve by Point to retrieve timestamp data from input 4, and 10 of the first 34 input transitions that the Sequence of Events module timestamps occur on input 4.
>
> If Latch CST is enabled for the module and you fail to clear any of the timestamp data for input 4 before the input transitions again, the Sequence of Events module will not timestamp the next transition for input 4, even though there are 126 slots still available in the module's on-board buffer.

Additional Module Settings Required with Retrieval by Point Method

By default, the Sequence of Events module operates as if the controller will use Standard Retrieval to retrieve data. To use the Retrieval by Point method, you must change the following two tags in the module's output word:

- O.RetrieveByPoint = 1 (default value is 0)
- O.PointtoRetrieve = *input point for which you want the controller to retrieve data* – For example, if you want to retrieve the data for input 10, you must change this tag to 10.

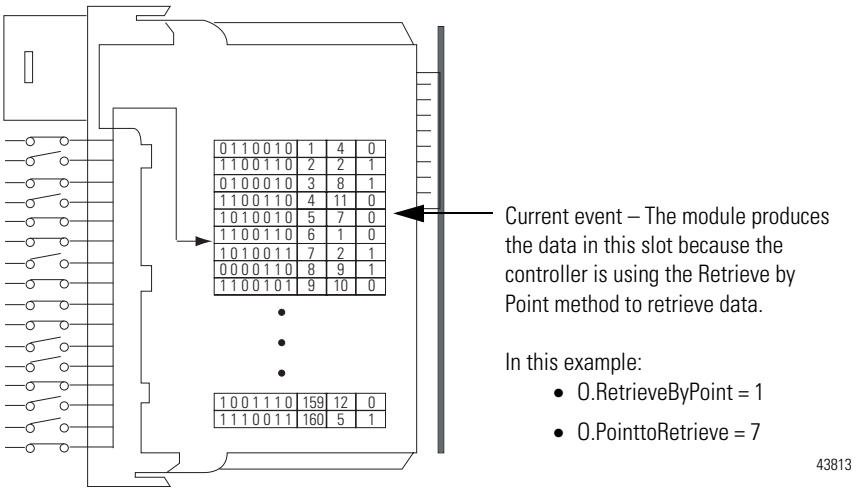
Retrieval Process Similar to Standard Retrieval

After you make the output tag changes listed above, the controller retrieves the data for each transition on the specified input in the order in which the transitions occur. The steps to retrieve the data are the same as those described on page 7-13.

The only exception to the process is that in Retrieval by Point, the current event is not necessarily the data in the first slot of of the on-board buffer. Instead, the current event is the first slot (out of the full 160) that contains data for a transition timestamped at the specified input.

For example, if you are using Retrieval by Point to retrieve data for input 7 and the first transition that occurs on input 7 is the 5th transition the module timestamped, the current event is located in slot 5 of the module's on-board buffer, as shown in Figure 7.6.

Figure 7.6



Clearing All Data From the Module's Buffers At Once

If necessary, you can reset the events in the Sequence of Events module's on-board buffers, in effect clearing all data from previously timestamped transitions. In other words, when all data is cleared from the module's buffers, all of the module's input tags return to 0, except data that is a live, filtered view of the inputs.

To reset events in the module's buffer, transition the O.ResetEvents tag to 1 as described below:

- If the bit = 0, change the bit to 1.
- If the bit = 1, change the bit to 0, wait for at least one RPI, and change the bit to 1.

Once the data is cleared, the module begins timestamping input transitions normally and storing them in its on-board buffer.

Changing Between Retrieval Methods

When using the Sequence of Events module in FIFO mode, you may determine that you need to change retrieval methods. You can change retrieval methods, but keep the following in mind before doing so:

- The change will NOT take effect until all events are acknowledged/cleared from the module's buffers.
- When you change retrieval methods dynamically, the ideal way is to reset events in the module buffers (as described above) and immediately switch FIFO retrieval modes. Make sure you do not need the data being cleared from the module buffer prior to resetting events.

To change retrieval methods, change the O.RetrieveByPoint tag to the new method.

- To use the standard retrieval by time method, O.RetrieveByPoint = 0
- To use the retrieval by point method, O.RetrieveByPoint = 1

Chapter Summary and What's Next

In this chapter, you read about using the Sequence of Events module's features. Chapter 8 describes the Troubleshooting the Sequence of Events Module.

Troubleshooting the Sequence of Events Module

What This Chapter Contains

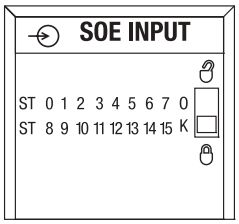
This chapter describes how to troubleshoot the Sequence of Events module.

Table 8.1

Using LED Status Indicators

Your Sequence of Events module has yellow indicators that show individual I/O state and a bi-colored (red/green) indicator that shows module status with an “OK”. Status indicators are located on the front of the module. The LED status indicators used on the Sequence of Events module are shown in Figure 8.1.

Figure 8.1



During power up, an indicator test is done and the following occurs:

- "OK" indicator turns red for 1 second and then turns to flashing green if it has passed the self-test.
- I/O status indicators turn ON for a maximum of 2 seconds and then turn OFF.

Table 8.2 describes how to use the Sequence of Events module's LED status indicators.

Table 8.2

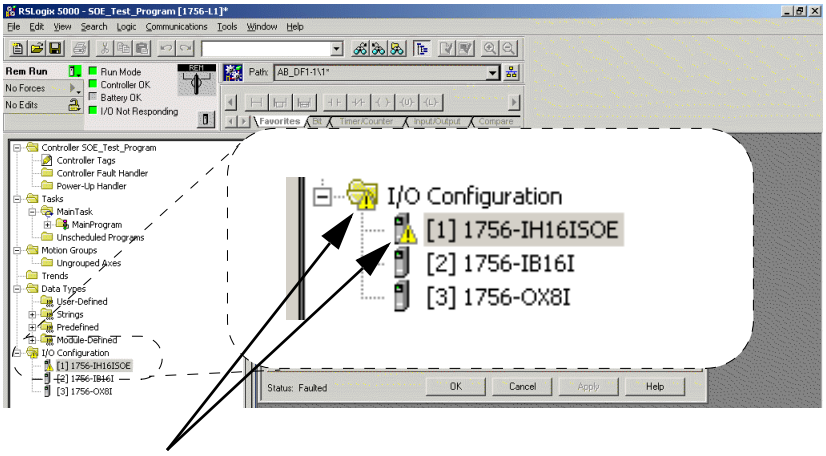
This indicator:	With this display:	Means:	Take this action:
OK	Steady green light	The inputs are being multicast and in normal operating state.	None
	Flashing green light	The module has passed internal diagnostics but is not multicasting inputs.	Configure the module with RSLogix 5000.
	Flashing red light	One of the following: • Previously established communication has timed out • A FLASH update is in progress.	• Check controller and chassis communication. • Finish the update
	Steady red light	An unrecoverable error has occurred on the module.	Replace the module.
I/O State	Yellow	The input is active.	None

Using RSLogix 5000 To Troubleshoot the Module

In addition to the LED status indicators on the module, RSLogix 5000 alerts you to fault and other conditions in one of three ways:

- Warning signal on the main screen next to the module – This occurs when the connection to the module is broken.

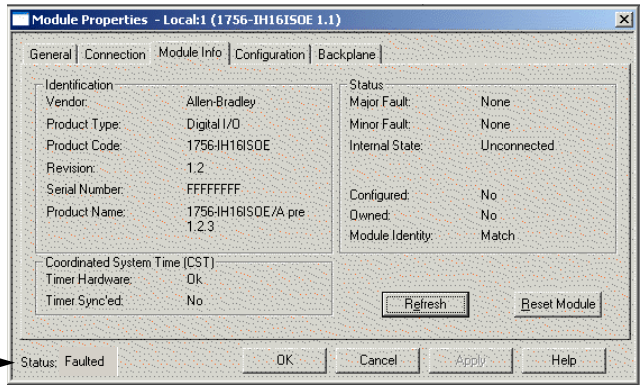
Warning icon appears when a communications fault occurs or if the module is inhibited



Warning signal - The module in slot 1 has a communications fault

- Message in a screen's status line

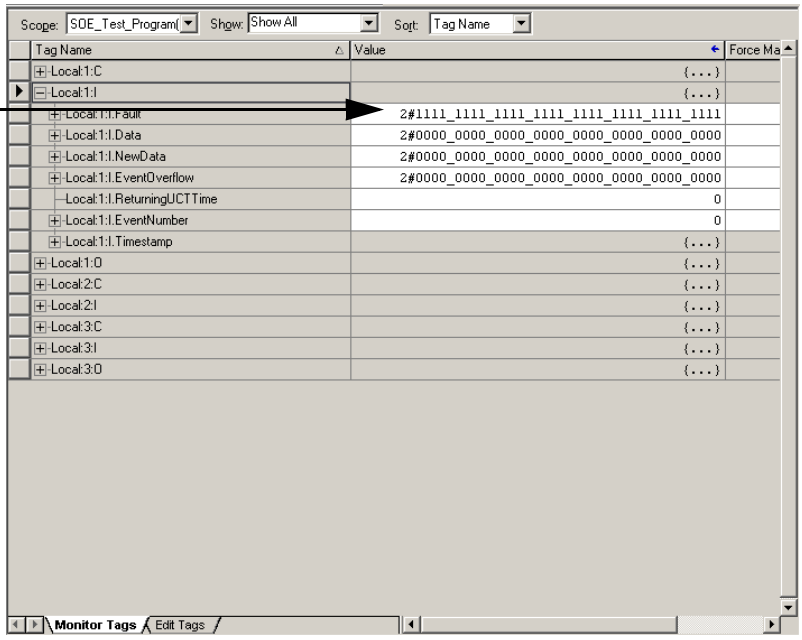
Status line provides information on the module's fault and on the connection to the module



- Notification in the Tag Editor - General module faults are also reported in the Tag Editor. Diagnostic faults are **only** reported in the Tag Editor

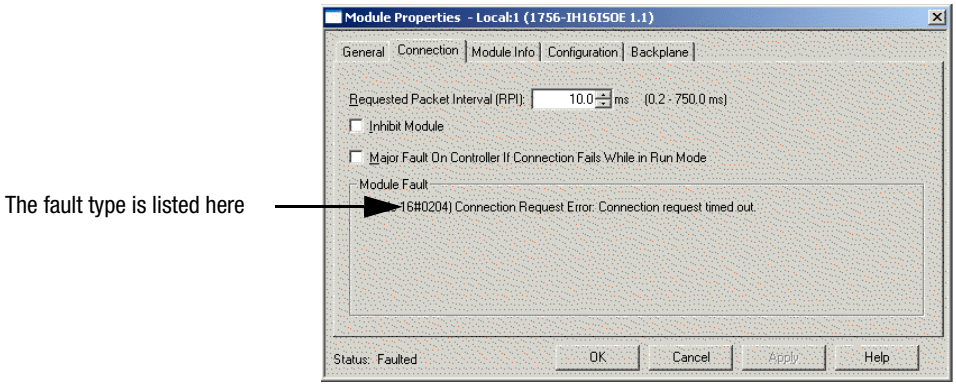
RSLogix 5000 generates 1s in response to a module communication fault.

In this example, a communication fault occurred between the controller and the Sequence of Events module, so the controller automatically writes 1s for all bits in the word.



Determining Fault Type

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



For a detailed listing of the possible faults, their causes and suggested solutions, see Module Faults in the online help.

Chapter Summary and What's Next

In this chapter you learned about troubleshooting the module.

Appendix A lists the Sequence of Events module's Specifications and Module Block Diagrams.

Specifications and Module Block Diagrams

1756-IB16ISOE Specifications

Number of Inputs	16 (Individually isolated)
Module Location	1756 ControlLogix Chassis
Backplane Current	295mA @ 5.1V dc & 2mA @ 24V dc
Backplane Power	1.5W
Maximum Power Dissipation (Module)	5.5W @ 60°C
Thermal Dissipation	17.22 BTU/hr.
On-State Voltage Range	10-55V dc
Nominal Input Voltage	24V dc/48V dc
On-State Current Minimum Nominal Maximum	 2.0mA @ 9V dc 4.5mA @ 24-31V dc 5.1mA @ 48-55V dc
Maximum Off-State Current	1.5mA
Maximum Off-State Voltage	5V dc
Maximum Input Impedance	10.8kΩ@ 55V dc
Input Delay Time OFF to ON ON to OFF	 Hardware Delay (10µs nominal/20µs maximum) + Firmware Scan (up to 25µs) + Input Filter Time (User selectable time: 0ms to 50ms) + ASIC delay (175µs - FIFO/625µs - CST Per Point) Hardware Delay (25µs nominal/50µs maximum) + Firmware Scan (25µs) + Input Filter Time (User selectable time: 0ms to 50ms) + ASIC delay (175µs - FIFO/625µs - CST Per Point)
Timestamp accuracy	100µs
Cyclic Update Time (RPI)	User selectable (250µs minimum/750ms maximum)
Reverse Polarity Protection	Yes
Isolation Voltage Inputs to backplane Input to input	 250V continuous 125V continuous
RTB Screw Torque (Cage clamp)	4.4 inch-pounds (0.4Nm) maximum
Module Keying (Backplane)	Software configurable
RTB Keying	User defined mechanical keying
RTB and Housing	36-Position RTB (1756-TBCH or TBS6H)(1)

Conductors Wire Size Category	 #22 to #14 AWG (0.324 to 2.08 sq. mm) stranded[1] 3/64 inch (1.2mm) insulation maximum 1[2]
Screwdriver Blade Width for RTB	1/8 inch (3.2mm) maximum
Environmental Conditions	
Operational Temperature	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 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): -40 to 85°C (-40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC 60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 30g
Non-operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 80MHz to 1000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz 10V/m with 200Hz 50% Pulse 100%AM at 1890Mhz

EFT/B Immunity	IEC 61000-4-4: ±4kV at 2.5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±1kV line-line (DM) and ±2kV line-earth (CM) on signal ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Oscillatory Surge Withstand	IEEE C37.90.1: 3kV
Enclosure Type Rating	None (open-style)
Agency Certification (when product is marked)	UL UL Listed Industrial Control Equipment CSA CSA Certified Process Control Equipment CSA CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations FM FM Approved Equipment for use in Class I Division 2 Group A,B,C,D Hazardous Locations CE(3) European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions C-Tick(3) Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions EEx(3) European Union 94/9/EC ATEX Directive, compliant with: EN 50021; Potentially Explosive Atmospheres, Protection "n" (Zone 2)

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

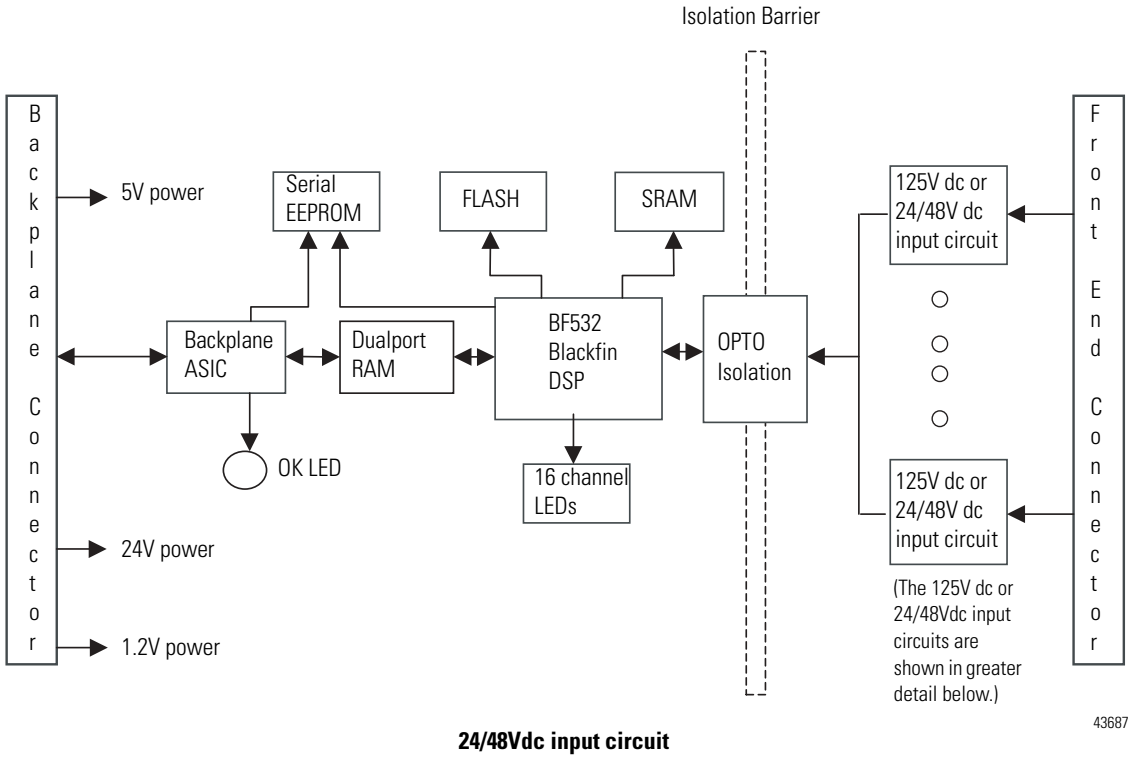
(2) Use this Conductor Category information for planning conductor routing. Refer to Publication 1770-4.1, "Industrial Automation Wiring and Grounding Guidelines".

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

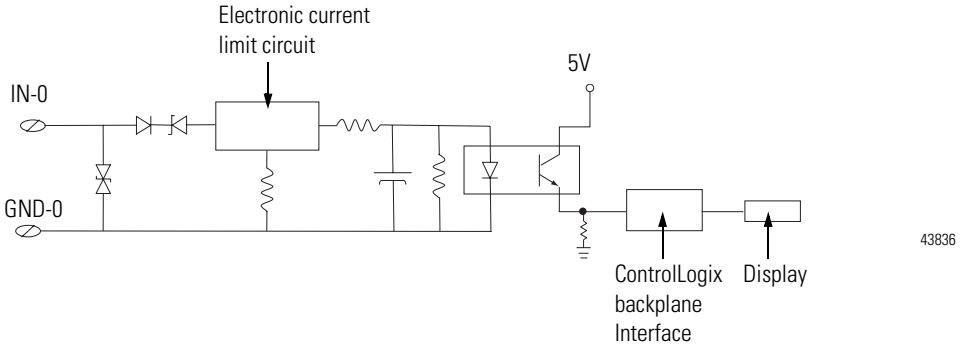
1756-IB16ISOE Module Block Diagram

Figure A.1 shows the Sequence of Events module block diagram.

Figure A.1



24/48Vdc input circuit



1756-IH16ISOE Specifications

Number of Inputs	16 (Individually isolated)
Module Location	1756 ControlLogix Chassis
Backplane Current	275mA @ 5.1V dc & 2mA @ 24V dc
Backplane Power	1.3W
Maximum Power Dissipation (Module)	5.5W @ 60°C
Thermal Dissipation	17.22 BTU/hr.
On-State Voltage Range	90-140V dc
Nominal Input Voltage	125V dc
On-State Current	1.15mA @ 90V dc minimum 1.85mA @ 140V dc maximum
Maximum Off-State Current	0.3mA
Maximum Off-State Voltage	20V dc
Maximum Input Impedance	74.8kΩ
Input Delay Time OFF to ON ON to OFF	 Hardware Delay (10µs nominal/20µs maximum) + Firmware Scan (25µs) + Input Filter Time (User selectable time: 0ms to 50ms) + ASIC delay (175µs - FIFO/625µs - CST Per Point) Hardware Delay (50µs nominal/75µs maximum) + Firmware Scan ((25µs) + Input Filter Time (User selectable time: 0ms to 50ms) + ASIC delay (175µs - FIFO/625µs - CST Per Point)
Timestamp accuracy	100µs
Cyclic Update Time (RPI)	User selectable (250µs minimum/750ms maximum)
Reverse Polarity Protection	Yes
Isolation Voltage Inputs to backplane and Input to input	250V continuous
RTB Screw Torque (Cage clamp)	4.4 inch-pounds (0.4Nm) maximum
Module Keying (Backplane)	Software configurable
RTB Keying	User defined mechanical keying
RTB and Housing	36-Position RTB (1756-TBCH or TBS6H)(1)

Conductors Wire Size Category	 #22 to #14 AWG (0.324 to 2.08 sq. mm) stranded(1) 3/64 inch (1.2mm) insulation maximum 1(2)
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Operational Temperature	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 to 60°C (32 to 140°F)
Storage Temperature	IEC 60068-2-1 (Test Ab, Un-packaged Non-operating Cold), IEC 60068-2-2 (Test Bb, Un-packaged Non-operating Dry Heat), IEC 60068-2-14 (Test Na, Un-packaged Non-operating Thermal Shock): -40 to 85°C (-40 to 185°F)
Relative Humidity	IEC 60068-2-30 (Test Db, Un-packaged Non-operating Damp Heat): 5 to 95% non-condensing
Vibration	IEC 60068-2-6 (Test Fc, Operating): 2g @ 10-500Hz
Operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 30g
Non-operating Shock	IEC 60068-2-27 (Test Ea, Unpackaged Shock): 50g
Emissions	CISPR 11: Group 1, Class A
ESD Immunity	IEC 61000-4-2: 6kV contact discharges 8kV air discharges
Radiated RF Immunity	IEC 61000-4-3: 10V/m with 1kHz sine-wave 80%AM from 80MHz to 1000MHz 10V/m with 200Hz 50% Pulse 100%AM at 900Mhz 10V/m with 200Hz 50% Pulse 100%AM at 1890Mhz

EFT/B Immunity	IEC 61000-4-4: ±4kV at 2.5kHz on signal ports
Surge Transient Immunity	IEC 61000-4-5: ±1kV line-line (DM) and ±2kV line-earth (CM) on signal ports
Conducted RF Immunity	IEC 61000-4-6: 10Vrms with 1kHz sine-wave 80%AM from 150kHz to 80MHz
Oscillatory Surge Withstand	IEEE C37.90.1: 3kV
Enclosure Type Rating	None (open-style)
Agency Certification (when product is marked)	UL UL Listed Industrial Control Equipment CSA CSA Certified Process Control Equipment CSA CSA Certified Process Control Equipment for Class I, Division 2 Group A,B,C,D Hazardous Locations CE[3] European Union 89/336/EEC EMC Directive, compliant with: EN 50082-2; Industrial Immunity EN 61326; Meas./Control/Lab., Industrial Requirements EN 61000-6-2; Industrial Immunity EN 61000-6-4; Industrial Emissions European Union 73/23/EEC LVD Directive, compliant with: EN 61131-2; Programmable Controllers C-Tick[3] Australian Radiocommunications Act, compliant with: AS/NZS CISPR 11; Industrial Emissions

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

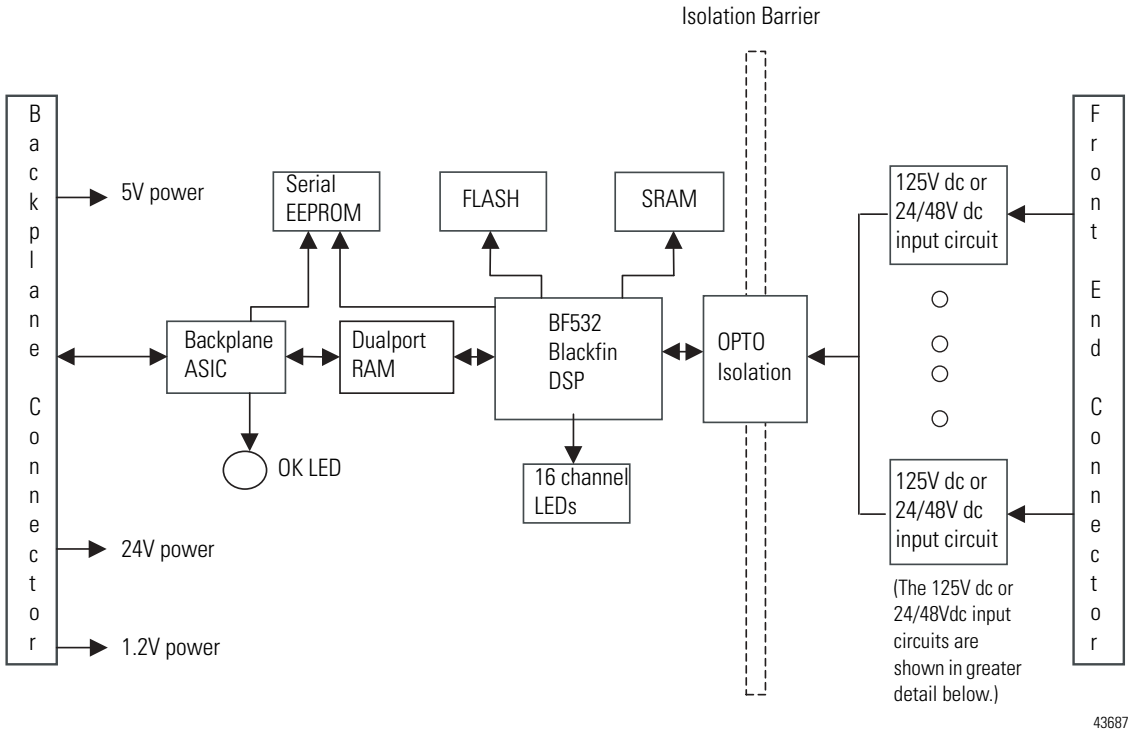
(2) Use this Conductor Category information for planning conductor routing. Refer to Publication 1770-4.1, "Industrial Automation Wiring and Grounding Guidelines".

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

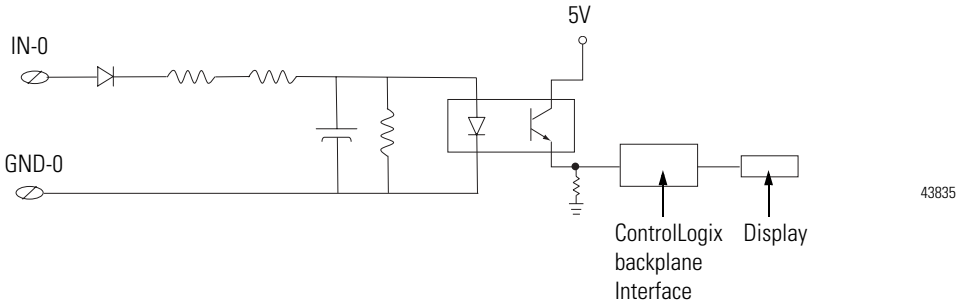
1756-IH16ISOE Module Block Diagram

Figure A.2 shows the Sequence of Events module block diagram.

Figure A.2



125Vdc input circuit



Integrating The HiProm GPS Module (1756HP-GPS) into a ControlLogix Sequence of Events Module System

Overview

Up to this point in this manual, the ControlLogix Sequence of Events module is described as being used for Relative First Fault Detection. In Relative First Fault Detection, the controller sorts the timestamps sent by Sequence of Events module(s) to determine which transition occurred first in an event cascade. However, each timestamp is captured in CST format, a 64-bit number that has little meaning other than to indicate which transition occurred first. The controller determines an order of transitions but not the real-time of each transition.

The most significant benefits to using the 1756HP-GPS module are:

- The 1756HP-GPS module provides a real-time reference for CSTs captured in the ControlLogix system.
- By using the 1756HP-GPS module, you can make sure geographically separated systems operate from a single time reference.
- The 1756HP-GPS module can convert CST format timestamps to a real-time reference.

IMPORTANT

This appendix offers a brief description of how to use the 1756HP-GPS module with the ControlLogix Sequence of Events module.

For more information on how to use the 1756HP-GPS module, see the 1756HP-GPS module user manual, available at:

http://www.hiprom.com

What is the 1756HP-GPS Module?

The 1756HP-GPS module is an integrated GPS product that makes use of Global Positioning System (GPS) technology to derive accurate time that is synchronized with the atomic clocks located on the GPS satellites. The 1756HP-GPS module receives regular transmissions from GPS satellites that deliver time in the Universal Coordinated Time (UCT) format.

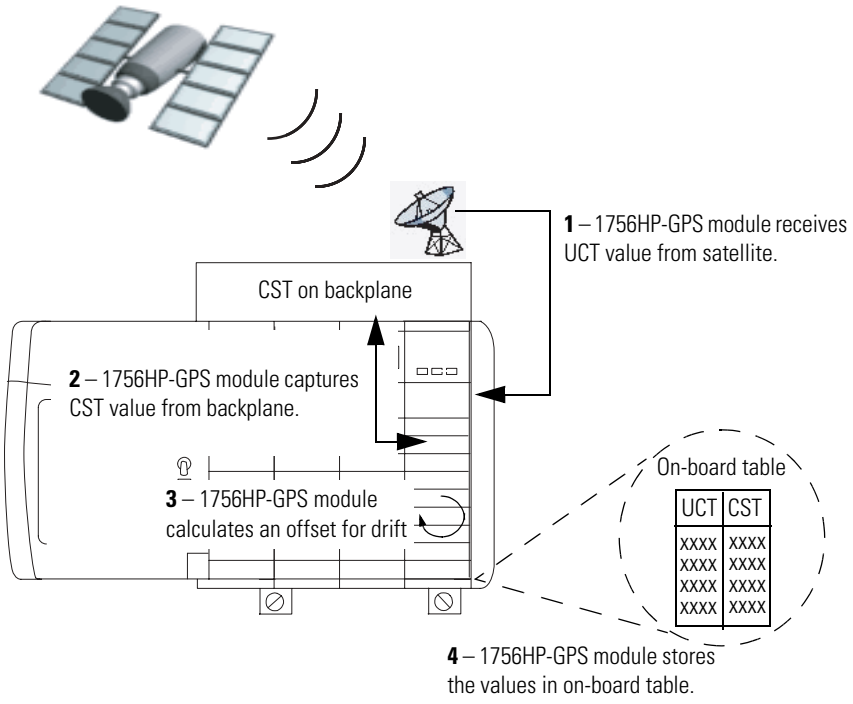
In addition to receiving UCT time, the 1756HP-GPS module also has access to time in CST format because the module resides in the ControlLogix chassis and can obtain the CST from the backplane.

Correlating CST with UCT

As shown in Figure B.1, with every receipt of a UCT value from the satellite (1), the 1756HP-GPS module captures the CST value from the ControlLogix backplane at that moment (2), calculates the necessary offset to account for drift (3) and then stores the values in its on-board table (4). This correlation table provides a real-time equivalent for any CST timestamp in the system.

The table holds one hour's worth of UCT/CST times. Because drift typically exists between the CST clock and the UCT clock, the 1756HP-GPS module records UCT/CST pairs that allow the module to calculate a drift compensation between the two clocks to provide increased synchronization and accuracy.

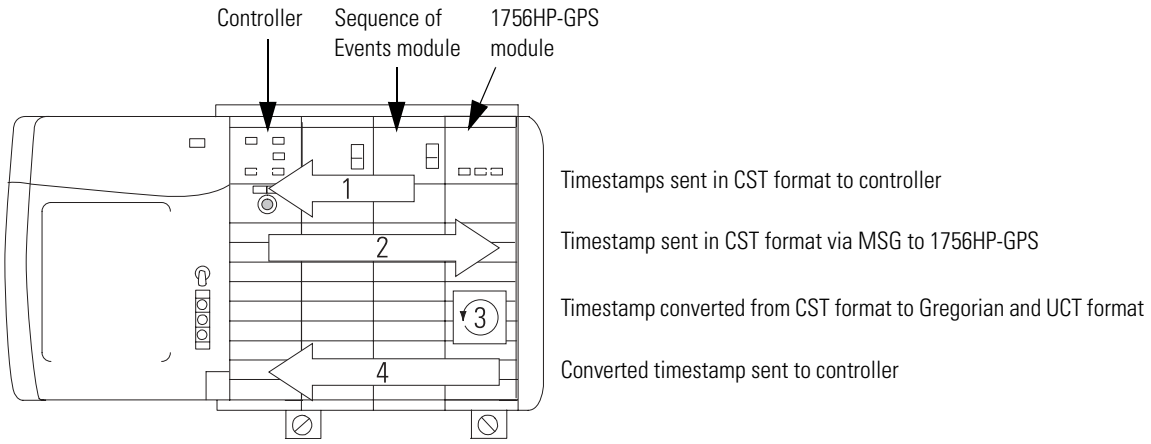
Figure B.1



Using a 1756HP-GPS module, you can convert the CST-format timestamps, received from a ControlLogix Sequence of Events module, into a Gregorian wall clock time (WCT) that is easily understood. Generally, the following occurs in this case:

1. The Sequence of Events module sends timestamps to the controller after an event cascade.
2. The ControlLogix controller sends a message instruction to the 1756HP-GPS module with a CST-format timestamp; you must use one MSG per timestamp.
3. The 1756HP-GPS module converts the CST-format timestamp to UCT and Gregorian wall clock format.
4. 1756HP-GPS module send the new value back to the controller, delivering the value in whatever format the controller requested via the MSG configuration

Figure B.2



Determining the Absolute First Fault Across Multiple Chassis

For simplicity's sake, Figure B.2 shows a system that determines the absolute first fault of devices connected to a single Sequence of Events module in a local chassis. However, the greatest benefit of using the 1756HP-GPS module comes when you need to determine the absolute first fault among devices connected to multiple Sequence of Events modules in remotely located chassis.

To determine absolute first fault among devices connected to multiple Sequence of Events modules in remotely located chassis, you must first synchronize the chassis; in other words, you must make sure all the Sequence of Events modules are working from the same time reference, the CSTs in their respective chassis.

You can synchronize CSTs among multiple ControlLogix chassis via the ControlLogix SynchLink module. This method can only be used if the chassis are located in close enough proximity to physically connect the chassis via SynchLink fiber.

For more information on using SynchLink to synchronize multiple ControlLogix chassis, see Appendix C.

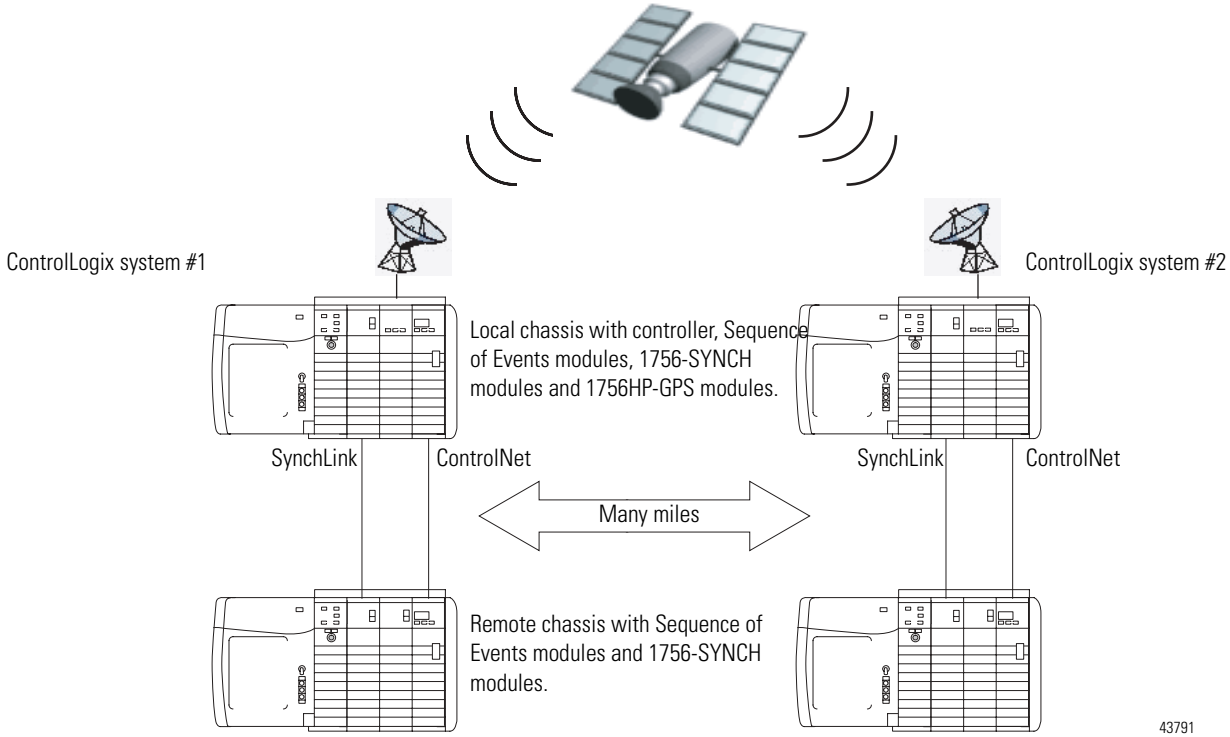
The 1756HP-GPS modules in each system receive a common time from the satellite that can be correlated to CST-format timestamps produced in each system to report an absolute time reference for both systems, effectively synchronizing the chassis.

The 1756HP-GPS module only allows conversion for 1 hour; conversions to UCT should be done shortly after the event is received.

In this example, the following are required:

- The CST in each ControlLogix system must be synchronized across chassis.
- Each ControlLogix system must contain a 1756HP-GPS module.
- Once the controllers in each system receive CST format timestamps, they must send the timestamps to the 1756HP-GPS modules in their respective chassis for conversion to UCT in wall clock format.

Figure B.3



How Does the ControlLogix Controller Retrieve Converted Value from the 1756HP-GPS Module?

Once a ControlLogix controller receives the timestamps from an event cascade, it may send them to the 1756HP-GPS via a message instruction for conversion to either the following formats:

- Wall clock time (WCT) - Format that is easily understood. Typically, the controller requests a conversion to this format for display purposes.
- UCT - This format is a 64-bit value in microseconds, similar to CST except that UCT starts from 1 January 1972. It is most useful to sort data using this field prior to converting to WCT for display purposes.

To convert CST-format timestamps to WCT, you must:

1. Add the 1756HP-GPS module to your RSLogix 5000 project via the Generic Module profile. For more information on how to configure the 1756HP-GPS module in an RSLogix 5000 project, see the 1756HP-GPS module user manual available at http://www.hiprom.com.

2. Send a Message Instruction to the 1756HP-GPS module that uses the configuration listed in Table B.1

Table B.1

Field:	**Value:**
Message Type	CIP Generic
Service Type	Custom
Service Code	32 (hex)
Class	70 (hex)
Instance	1
Attribute	1 (hex)
Source Element	*Controller tag where the CST-format timestamp is located*
Source Length	8
Destination	*Destination tag for reply data*

The screen below shows the Configuration tab for an example MSG.

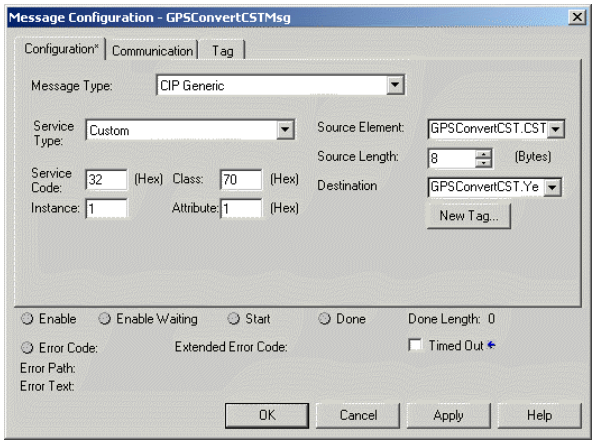


Table B.2 shows the two formats in which a 1756HP-GPS may return timestamp data.

Table B.2

Field	Bytes	Description
Year	4	Gregorian year
Month	4	Gregorian month
Day	4	Gregorian day
Hour	4	Gregorian hour
Minute	4	Gregorian min
Second	4	Gregorian sec
Microsecond	4	Gregorian µSec
UTC	8	Corresponding UCT value
CST	8	Given CST value

Converting Timestamps from CST Format to Universal Coordinated Time Format

By default, the Sequence of Events module uses the CST to timestamp input transitions in CST Per Point mode. You can configure the module to convert CST timestamps to UCT timestamps before sending the data to the owner-controller.

To configure the Sequence of Events module to convert timestamps to UCT in CST Per Point mode, you copy a pair of timestamps (one in CST format and one in UCT format) from the 1756HGPS module to the following tags in the Sequence of Events module's output word:

- O.UCTTime
- O.CSTTime

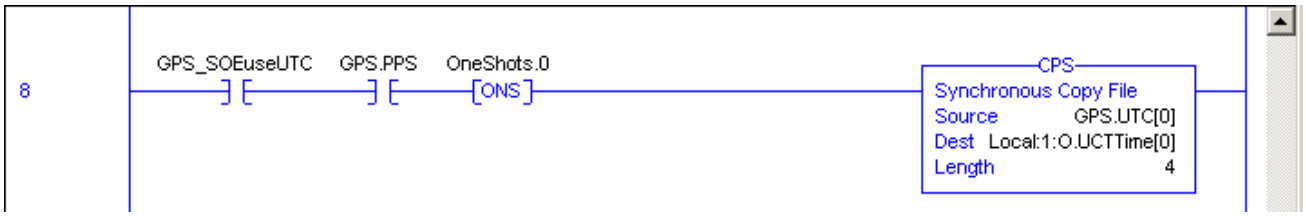
IMPORTANT

If the O.UCTTime and O.CSTTime tags = 0, the Sequence of Events module sends timestamp data to the controller in CST format.

If the O.UCTTime and O.CSTTime tags = a nonzero number, the Sequence of Events module sends timestamp data to the controller in UCT format.

Figure B.4 shows an example of a ladder logic rung that copies the timestamp pair from the 1756HP-GPS module to the Sequence of Events module's output tags. You need to do this for every Sequence of Events module in your system if you want the module to send timestamps in UTC format.

Figure B.4



In this example, the synchronous copy begins at the GPS.UTC tag on the 1756HP-GPS module and copies 4 DINTs (because the Length = 4) worth of data; included in the 4 DINTs is not only the GPS.UTC tag but also the GPS.CST tag. The timestamps are copied to the O.UCTTime and O.CSTTime tags in the Sequence of Events module's output tags.

The GPS.PPS (pulse per second) bit is used to send new pairs once a second at the GPS satellite's tone.

You do NOT need to copy the timestamp pair from the 1756HP-GPS module to the Sequence of Events module's output tags if:

- you convert CST times to UTC manually via messaging to the 1756HP-GPS module. In this case, you must message every timestamp from the Sequence of Events module.

  or

- you only need the relative time of events (e.g., breaker one tripped 3ms after breaker 2).

Figure B.5 shows the difference between using CST and UCT timestamps.

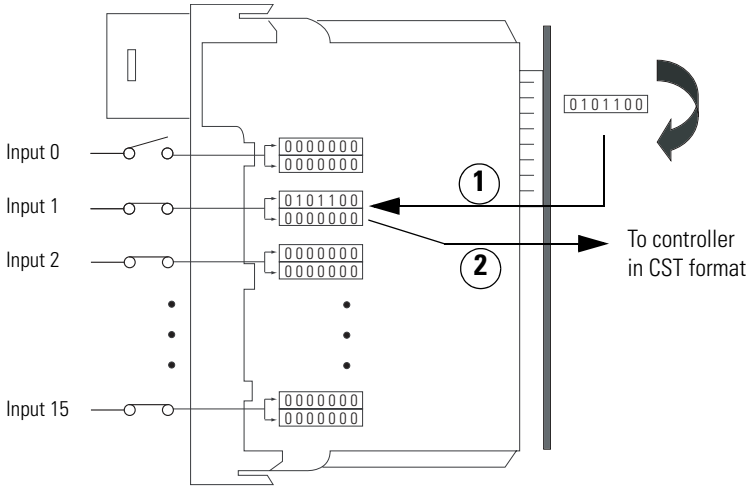
Figure B.5

Module Sends Timestamp in CST Format

The module is configured so that input 1 is Enable CST Capture-enabled for OFF to ON transitions.

When input 1 transitions from OFF to ON, the module:

1. Timestamps the transition
2. Sends input data, with the timestamp in CST format, to the controller.



Module Sends Timestamp in UCT Format

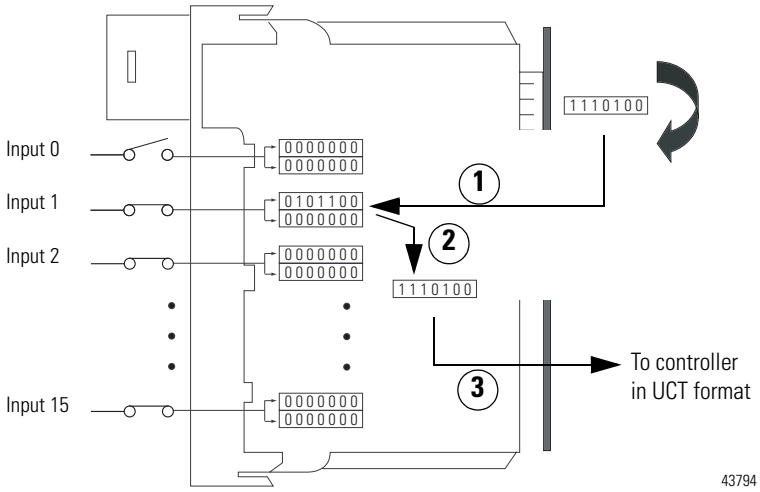
The module is configured so that input 1 is Enable CST Capture-enabled for OFF to ON transitions and to send timestamp data in UCT format. In other words, the controller copied timestamp data to the following tags:

- O.UCTTime
- O.CSTTime

as described on page B-8.

When input 1 transitions from OFF to ON, the module:

1. Timestamps the transition.
2. Converts the timestamp from CST to UCT format.
3. Sends input data, with the timestamp in UCT format, to the controller..



Notes:

Synchronizing CSTs Across Multiple Chassis

Overview

While each ControlLogix chassis uses the CST on its backplane to serve as the single time reference for all modules in the chassis, the CSTs between separate chassis are different from each other by default. You can synchronize CSTs between chassis; synchronization is especially useful when Sequence of Events modules reside in a remote chassis (with respect to the location of the controller).

Some applications must be designed in such a way that a Sequence of Events module cannot reside in the controller's local chassis. Yet, the controller still needs the timestamp from when transitions occur on the remote module in terms it understands. For the timestamp with the input data to make any sense to the controller, the CSTs in the separate chassis must be synchronized. In other words, in this case, any chassis that contain Sequence of Events module must synchronized via SynchLink.

Using a Time Master

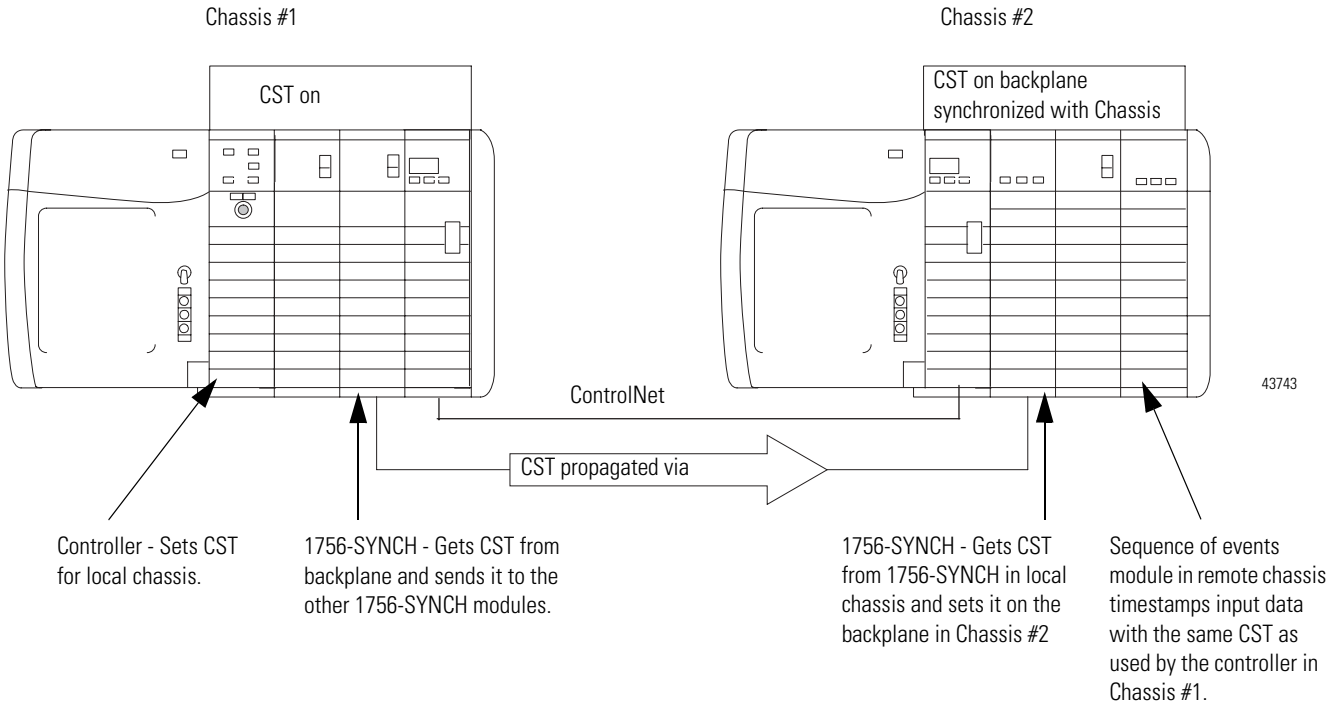
Each ControlLogix chassis can house a time master (ControlLogix controller or 1756-SYNCH module), a device that establishes the CST for a ControlLogix chassis. In a single chassis scenario, the ControlLogix controller typically serves as the time master. When you require CST synchronization across multiple chassis, you need a time master in each chassis and those masters must receive a single CST from a common source.

You can use ControlLogix SynchLink modules (1756-SYNCH) to synchronize CSTs between ControlLogix chassis. In the most basic terms, the following occurs to synchronize time between chassis:

- You must use RSLogix 5000, v13 or greater. (You can synchronize CSTs between chassis with previous versions of RSLogix 5000 but those versions require a ControlLogix controller be located in each chassis. This section describes synchronizing CSTs with v13 or greater.)
- A 1756-SYNCH module is located in each chassis, local and remote.

- The controller in the local chassis typically serves as the time master for its chassis; the 1756-SYNCH module in the local chassis can also serve as the time master.
- The 1756-SYNCH module in the local chassis sends a common CST time reference to 1756-SYNCH modules in remote chassis over a fiber optic connection.
- The 1756-SYNCH module in remote chassis receive the CSTs from the 1756-SYNCH module in the local chassis and use that time to set the CST on the backplane of the chassis where they reside.
- All the other modules in the remote chassis operate with a CST from the backplane that is synchronized with the CST in the controller's chassis.

Figure C.1



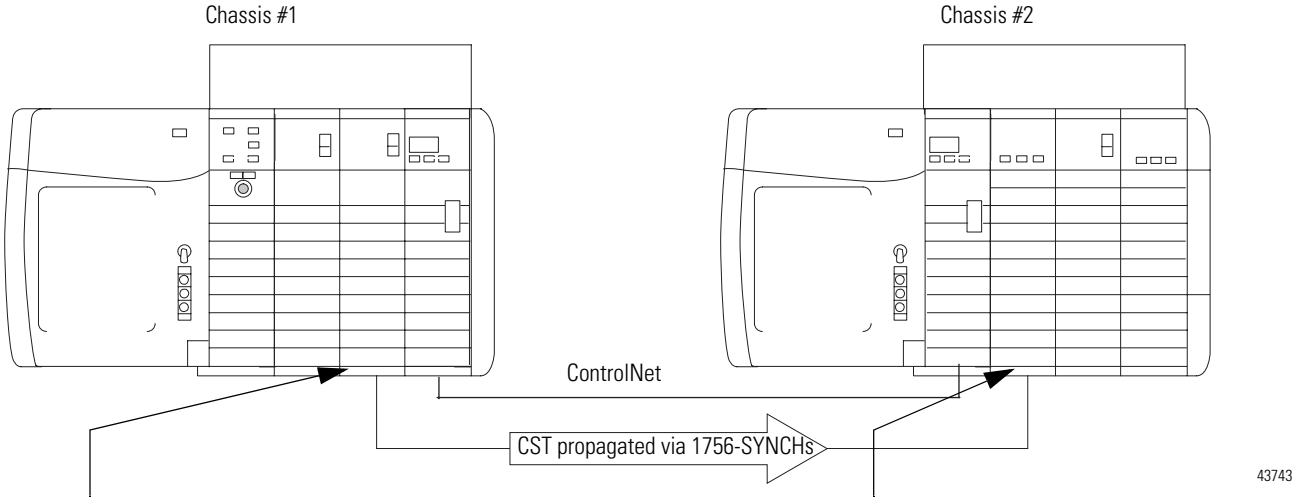
Once the CST is synchronized between chassis, as shown in Figure C.1, the modules in chassis #2 use the same CST as the modules in chassis #1. You can use 1756-SYNCH modules to synchronize CSTs for up to 257 ControlLogix chassis.

Synchronization of CSTs between ControlLogix chassis provides a common CST with no more than +/-5µs drift between chassis.

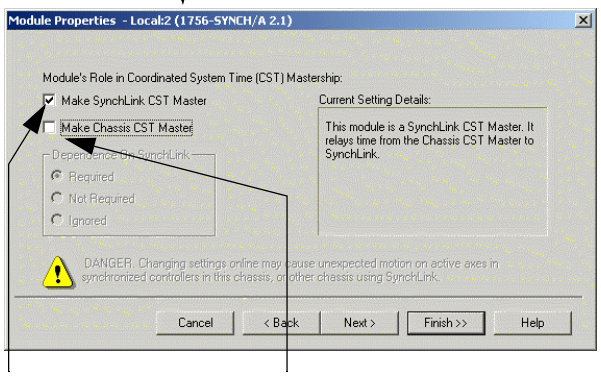
Configuring 1756-SYNCH Modules in RSLogix 5000

The SynchLink module can be configured for multiple mastership and slave roles with respect to the Coordinated System Time and the SynchLink. The 1756-SYNCH modules used in the example on page C-2 require specific configuration for the system to work. Figure C.2 shows the example again but also show what the configuration for each 1756-SYNCH module needs to be.

Figure C.2



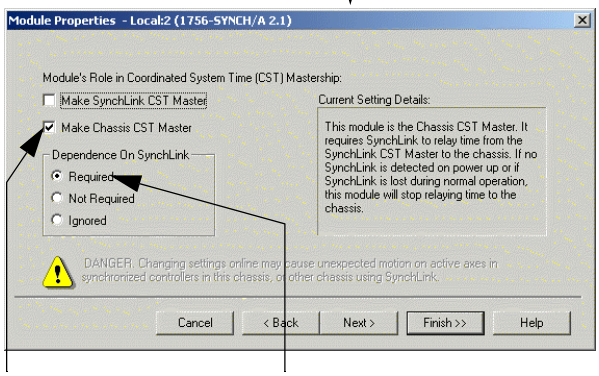
1756-SYNCH - Gets CST from backplane and sends it to the other 1756-SYNCH modules. Configure this 1756-SYNCH module as shown below.



This setting is **required** because the module relays time from its backplane to the SynchLink.

This setting is **recommended**. In this case, you must make sure the ControlLogix controller is configured as the Chassis CST Master.

1756-SYNCH - Gets CST from 1756-SYNCH in local chassis and sets it on the backplane in Chassis #2. Configure this 1756-SYNCH module as shown below.



This setting is **required** because the module relays time from its backplane to the SynchLink.

This Dependence on SynchLink setting is optional for the 1756-SYNCH module. We recommend that when you are using the 1756-SYNCH module with the Sequence of Events module, you use the **Required** option.

For more information on how to configure the 1756-SYNCH module, see ControlLogix SynchLink Module User Manual, publication number 1756-UM521.

Synchronizing Chassis in ControlLogix Redundancy Systems

When Sequence of Events modules are used in ControlLogix Redundancy systems, the chassis that contain the Sequence of Events modules must be synchronized.

Figure C.3 on page C-5 shows an example ControlLogix redundancy system that uses Sequence of Events modules in some of its remote chassis to timestamp input transitions and 1756-SYNCH modules to synchronize CSTs among those remote chassis.

When synchronizing time in ControlLogix redundancy systems that also use Sequence of Events modules, remember the following:

- A time master (either ControlLogix controller or 1756-SYNCH module) must reside in each synchronized chassis.
- All chassis containing Sequence of Events modules must also contain 1756-SYNCH modules that provide a common CST via SynchLink.

IMPORTANT

At the time of this printing (April 2004), ControlLogix Redundancy was only available with ControlLogix controllers version 11.71. To synchronize remote Sequence of Events modules, you must either:

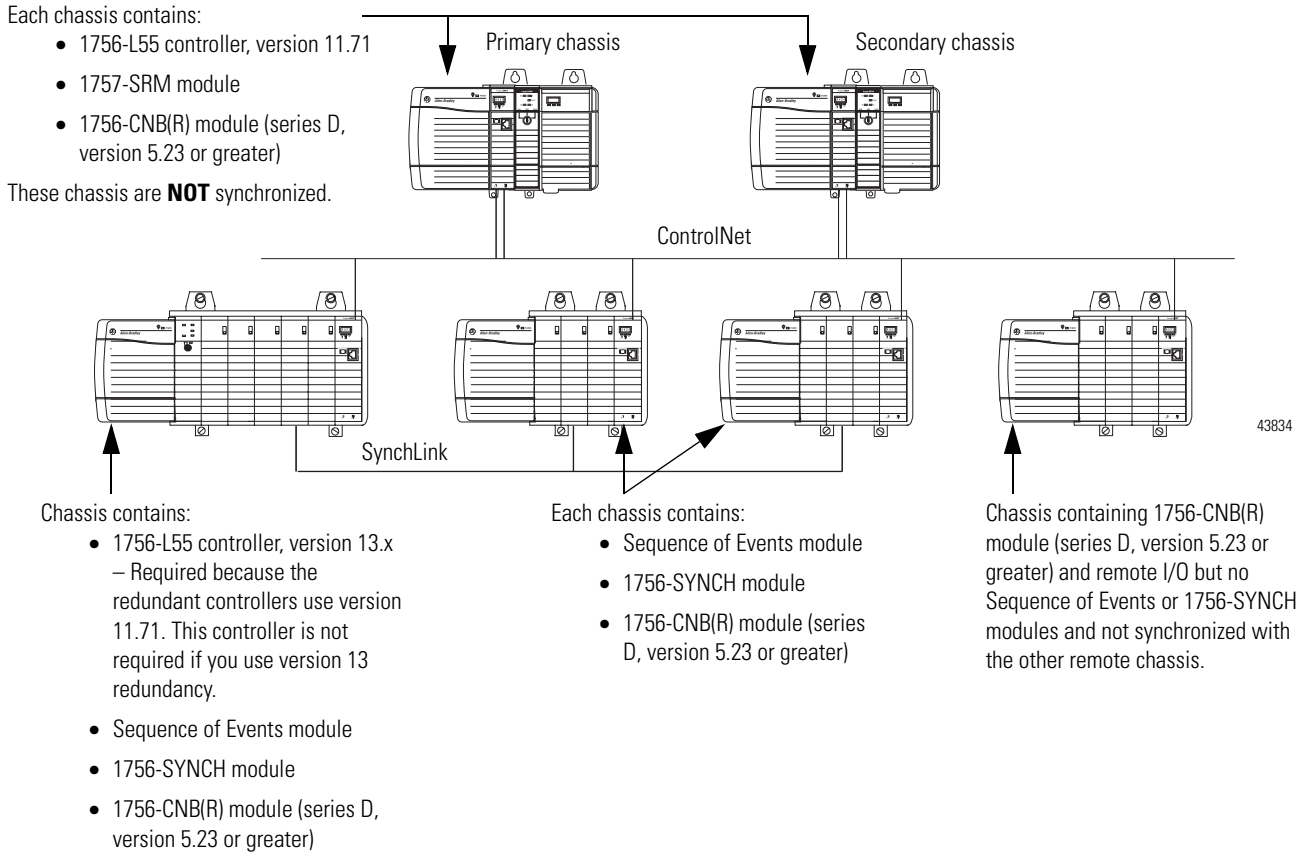
- Use version 13 redundancy across the system

or

- Use version 11.71 for the redundancy controllers and include a ControlLogix controller, version 13, in one of the synchronized remote chassis, as shown in the example.

  In this case, you must use two RSLogix 5000 projects–one for the redundancy controllers (programmed with RSLogix 5000, version 11) and one for the remote chassis controller (programmed with RSLogix 5000, version 13).

Figure C.3



Related SynchLink Documentation

For more information on how to use the 1756-SYNCH module, see:

- SynchLink Design Guide, publication number 1756-TD008
- ControlLogix SynchLink Module User Manual, publication number 1756-UM521.

Notes:

Using Module Tags

Fault and Status Reporting Between the Module and Controllers

Sequence of Events modules multicast fault/status data to the owner-controller. The module maintains a Module Fault Word, the highest level of fault reporting.

Table D.1 describes the tag that can be examined in ladder logic to indicate when a fault has occurred for your Sequence of Events module:

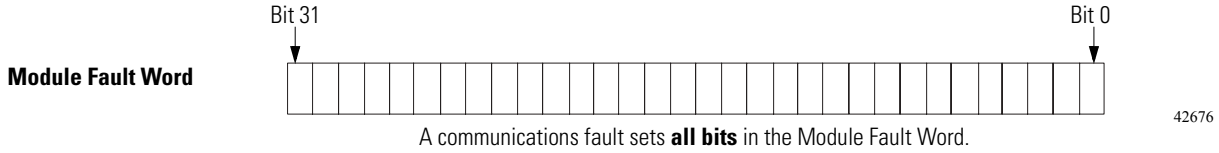
Table D.1

Tag:	Description:
Module Fault Word	This word provides fault summary reporting. It's tag name is Fault.

Each bit corresponds to an individual input.

- If a communication fault occurs on the Sequence of Events module, all 32 bits in the Module Fault Word are set to 1.
- If chatter is detected on any input points, the bit corresponding to that point is set to 1.

Figure D.1



A communications fault sets **all bits** in the Module Fault Word.

Module Tag Names and Definitions

The tags associated with the Sequence of Events module depends on the type of module and the Communications Format chosen during configuration. For each operational mode, there are three sets of tags:

- Configuration
- Input
- Output

Tags Used in CST Point Per Mode

Configuration Tags

Table D.2 describes the configuration tags generated in RSLogix 5000 when you use the Sequence of Events module in CST Per Point Mode.

Table D.2 Configuration Tags in CST Per Point Mode

Tag name:	Type:	Description:
C.LatchEvents	BOOL	Latches events so that timestamp data from an input transition will not be overwritten until acknowledged. 0 = CST not latched (default) 1 = CST latched For more information on Latch CST, see page 5-7.
C.FilterOffOn	SINT	Sets the OFF to ON filter time for all 16 inputs. Times are set in 1ms increments from 0ms to 50ms. 0 = no filtering For more information on Software Configurable Input Filters, see page 5-10.
C.FilterOnOff	SINT	Sets the ON to OFF filter time for all 16 inputs. Times are set in 1ms increments from 0ms to 50ms. 0 = no filtering For more information on Software Configurable Input Filters, see page 5-10.
C.CaptureOffOn.x	DINT	Enables capturing OFF to ON events on a per point basis. If disabled (i.e., set to 0), that point will not record timestamp data for OFF to ON input transitions. 0 = CST Capture disabled for OFF to ON input transitions - This option is useful if you want to avoid using buffer space on the Sequence of Events module for events in which you have no interest. 1 = CST Capture enabled (default) for OFF to ON input transitions For more information on Enable CST Capture, see page 5-5.

Table D.2 Configuration Tags in CST Per Point Mode

Tag name:	Type:	Description:
C.CaptureOnOff	DINT	Enables capturing ON to OFF events on a per point basis. If disabled (i.e., set to 0), that point will not record timestamp data for ON to OFF input transitions. 0 = CST Capture disabled for ON to OFF input transitions - This option is useful if you want to avoid using buffer space on the Sequence of Events module for events in which you have no interest. 1 = CST Capture enabled (default) for ON to OFF input transitions For more information on Enable CST Capture, see page 5-5.
C.ChatterEvents[16]	SINT [16]	Number of events required in ChatterTime[16] period to determine a chatter condition. 0 = Disable Chatter Detection 1 = Illegal value – The number of events must be greater than 1. The maximum value is 127. For more information on Chatter Detection, see page 5-8.
C.ChatterTime[16]	INT [16]	Time period, in milliseconds, in which the number of events in the ChatterEvents tag must occur to declare a chatter condition: For example, if ChatterEvent = 10 and ChatterTime = 20, and 11 events occur on the point in a 20ms time period, chatter is declared on the point. When chatter is declared, the input faults and no longer timestamps transitions that occur on the point. When chatter ceases, the input returns to normal operation. The Sequence of Events module considers chatter to have ceased when the configured chatter time elapses with no transitions occurring on the input. For more information on Chatter Detection, see page 5-8.

Input Tags

Table D.3 describes the input tags generated in RSLogix 5000 when you use the Sequence of Events module in CST Per Point Mode.

Table D.3 Input Tags in CST Per Point Mode

Tag name:	Set on a Per Point or Modulewide basis:	Description:
I.Fault	Per point(1)	Indicates if a fault has occurred for the input. 0 = no fault 1 = fault – The fault can be chatter or communication fault as described below: • Chatter - The Sequence of Events module can detect chatter on individual inputs and will set the appropriate tag to 1 when chatter exists on an input. For example, if the module has detected chatter on input 4, *I.Fault.4* = 1. • Communication fault - The controller sets this tag to 1 for all 32 bits if a communication fault occurs on the module. This tag clears when the fault that causes the condition no longer exists.
I.Data	Per point(1)	Status of the input point. This data is filtered if the Input Filter feature is used on the module. Thus, an input change must pass through the filter before it is seen in this tag. 0 = input is OFF 1 = input is ON For example, if input 3 is ON, *I.Data.3* = 1.
I.NewData	Per point(1)	Flag indicating if new timestamp data was detected on the input. 0 = no new timestamp data on the input 1 = new timestamp data on the input (since last acknowledged) Because input data for all inputs is sent immediately after each timestamped transition and at each RPI, this tag is useful to quickly determine on which input the transition occurred. For example, if the Sequence of Events module sends new input data to the owner-controller and *I.NewData.5* = 1, you know that at least one of the timestamps for input 5 (i.e., *I.Timestamp[5].OffOn* or *I.Timestamp[5].OnOff*) has new data. This tag only clears when the controller acknowledges the new data or all events on the module are reset. For more information, see page 6-12.
I.EventOverflow	Per point(1)	Set for an input when the module either: • Does not timestamp a transition on the input – The module has Latch CST enabled and a similar transition has already been timestamped on this input but has not been cleared via the EventAck and NewDataAck output tags (see page 6-12). or • Overwrites previously-recorded timestamp data for the input – The module has Latch CST disabled and multiple transitions occur on the input. In this case, timestamp data from new transitions are recorded before previously-recorded transitions were cleared from the input via the EventAck and NewDataAck output tags (see page 6-12). This value is cleared if the module is reset.

Table D.3 Input Tags in CST Per Point Mode

Tag name:	Set on a Per Point or Modulewide basis:	Description:
I.ReturningUCTTime	Modulewide	Indicates if timestamps are in UCT format rather than CST. 0 = CST format 1 = UCT format For more information on UCT format, see Appendix B.
I.EventNumber.x	Modulewide	Running count of the timestamped transitions; this tag increments by one with each new transition that the module timestamps. In CST Per Point mode, this tag has lesser importance than in FIFO mode. This value is cleared if the module is reset.
I.Timestamp[16].OffOn[2]	Per point	Timestamp value (in CST or UCT format) with an input's OFF to ON transition. This tag is a 16 x 2 32-bit array. This value is cleared after the data has been acknowledged via the *O.EventAck* and *O.NewData* tags. For more information on clearing timestamp data, see page 6-12.
I.Timestamp[16].OnOff[2]	Per point	Timestamp value (in CST or UCT format) with an input's ON to OFF transition. This tag is a 16 x 2 32-bit array. This value is cleared after the data has been acknowledged via the *O.EventAck* and *O.NewData* tags. For more information on clearing timestamp data, see page 6-12.

(1) With the Per point tags, there is one bit per input. For example, bit 0 represents input 0, bit 7 represents input 7 and so on.

Output Tags

Table D.4 describes the output tags generated in RSLogix 5000 when you use the Sequence of Events module in CST Per Point Mode.

Table D.4 Output Tags in CST Per Point Mode

Tag name:	Type:	Description:
O.EventAck	DINT	To acknowledge reset of event, the controller writes back the EventNumber read to transition buffers in Queuing mode or to unlatch events in 16-point mode. 0 = acknowledging an ON to OFF event 1 = acknowledging an OFF to ON event 2 = acknowledging both ON to OFF and OFF to ON events The NewData tag must also be used to acknowledge the event(s).
O.NewDataAck.x	DINT	Allows NewData bits in the Input word to function as intended. NewData bits are set when a transition occurs and clear only after they are acknowledged via the NewDataAck bit. Typically, the following events occur: • An event occurs on an input. • The Sequence of Events module sets the NewData bit for the input where the event occurred. • The controller records the new data. • The controller acknowledges the new data by causing a 0 to 1 transition on the corresponding NewDataAck bit. • The NewData bit clears. • When another event occurs on the input, the sequence begins at the top bullet in this list. The controller must cause a 0 to 1 transition in this bit to acknowledge new data for an input; in other words, if the NewDataAck bit is 0 when new data is received, the controller must change this bit to 1 to acknowledge the data. If NewDataAck bit is 1 when new data is received, the controller must change this bit to 0 and then to 1 to acknowledge the new data.
O.PointToRetrieve	INT	Not used in this mode
O.ResetEvents	BOOL	Erases all recorded events when transitioned from 0 to 1. Resets most other fields to 0 as well.
O.RetrieveByPoint	BOOL	Not used in this mode

Table D.4 Output Tags in CST Per Point Mode

Tag name:	Type:	Description:
O.UCTTime[2]	DINT [2]	These tags are used to configure the Sequence of Events module to send timestamps to the controller in UCT format. In this case, you must copy a pair of timestamp values from the 1756HP-GPS module (one in UCT format and the other a corresponding CST format value) to these tags. When these tags are nonzero numbers, the Sequence of Events module converts timestamps from CST format to UCT format before sending them to the controller. Additionally, I.ReturningUCTTime = 1. Typically, the following events occur: • A 1756HP-GPS module produces CST/UCT Time pairs that are sent to the controller. • The controller copies the pairs to the Sequence of Events module every pulse per second (PPS). (We recommend you copy the pairs every PPS.) • The Sequence of Events module uses the streams of pairs to calculate UCT timestamps for input data including the use of calculating drift between the clocks. If these tags = 0, the Sequence of Events module sends timestamps in CST format and I.ReturningUCTTime = 0.
O.CSTTime[2]	DINT [2]	

Tags Used in FIFO Mode

Configuration Tags

Table D.5 describes the configuration tags generated in RSLogix 5000 when you use the Sequence of Events module in FIFO Mode.

Table D.5 Configuration Tags in FIFO Mode

Tag name:	Type:	Description:
C.LatchEvents	BOOL	Latches events so that timestamp data from an input transition will not be overwritten until acknowledged. 0 = CST not latched (default) 1 = CST latched For more information on Latch CST, see page 5-7.
C.FilterOffOn	SINT	Sets the OFF to ON filter time for all 16 inputs. Times are set in 1ms increments from 0ms to 50ms. 0 = no filtering For more information on Software Configurable Input Filters, see page 5-10.

Table D.5 Configuration Tags in FIFO Mode

Tag name:	Type:	Description:
C.FilterOnOff	SINT	Sets the ON to OFF filter time for all 16 inputs. Times are set in 1ms increments from 0ms to 50ms. 0 = no filtering For more information on Software Configurable Input Filters, see page 5-10.
C.CaptureOffOn.x	DINT	Enables capturing OFF to ON events on a per point basis. If disabled (i.e., set to 0), that point will not record timestamp data for OFF to ON input transitions. 0 = CST Capture disabled for OFF to ON input transitions - This option is useful if you want to avoid using buffer space on the Sequence of Events module for events in which you have no interest. 1 = CST Capture enabled (default) for OFF to ON input transitions For more information on Enable CST Capture, see page 5-5.
C.CaptureOnOff	DINT	Enables capturing ON to OFF events on a per point basis. If disabled (i.e., set to 0), that point will not record timestamp data for ON to OFF input transitions. 0 = CST Capture disabled for ON to OFF input transitions - This option is useful if you want to avoid using buffer space on the Sequence of Events module for events in which you have no interest. 1 = CST Capture enabled (default) for ON to OFF input transitions For more information on Enable CST Capture, see page 5-5.
C.ChatterEvents[16]	SINT [16]	Number of events required in ChatterTime[16] period to determine a chatter condition. 0 = Disable Chatter Detection 1 = Illegal value – The number of events must be greater than 1. The maximum value is 127. For more information on Chatter Detection, see page 5-8.
C.ChatterTime[16]	INT [16]	Time period, in milliseconds, in which the number of events in the ChatterEvents tag must occur to declare a chatter condition: For example, if ChatterEvent = 10 and ChatterTime = 20, and 11 events occur on the point in a 20ms time period, chatter is declared on the point. When chatter is declared, the input faults and no longer timestamps transitions that occur on the point. When chatter ceases, the input returns to normal operation. The Sequence of Events module considers chatter to have ceased when the configured chatter time elapses with no transitions occurring on the input. For more information on Chatter Detection, see page 5-8.

Input Tags

Table D.6 describes the input tags generated in RSLogix 5000 when you use the Sequence of Events module in FIFO Mode.

Table D.6 Input Tags in FIFO Mode

Tag name:	Set on a Per Point or Modulewide basis:	Description:
I.Fault	Per point(1)	Indicates if a fault has occurred for the input. 0 = no fault 1 = fault – The fault can be chatter or communication fault as described below: • Chatter - The Sequence of Events module can detect chatter on individual inputs and will set the appropriate tag to 1 when chatter exists on an input. For example, if the module has detected chatter on input 4, *I.Fault.4* = 1. • Communication fault - The controller sets this tag to 1 for all 32 bits if a communication fault occurs on the module. This tag clears when the fault that causes the condition no longer exists.
I.Data	Per point(1)	Status of the input point. This data is filtered if the Input Filter feature is used on the module. Thus, an input change must pass through the filter before it is seen in this tag. 0 = input is OFF 1 = input is ON For example, if input 3 is ON, *I.Data.3* = 1.
I.NewData	Per point(1)	Flag indicating if new timestamp data was detected on the input. 0 = no new timestamp data on the input 1 = new timestamp data on the input (since last acknowledged) Because input data for all inputs is sent immediately after each timestamped transition and at each RPI, this tag is useful to quickly determine on which input the transition occurred. For example, if the Sequence of Events module sends new input data to the owner-controller and *I.NewData.5* = 1, you know that at least one of the timestamps for input 5 (i.e., *I.Timestamp[5].OffOn* or *I.Timestamp[5].OnOff*) has new data. This tag only clears when the controller acknowledges the new data or all events on the module are reset. For more information, see page 7-17.
I.EventOverflow	Per point(1)	Set for an input when the module either: • Does not timestamp an input transition – The module has Latch CST enabled and the module's on-board buffer contains 160 timestamps. In this case, the module does not have room in its on-board buffer to store the timestamp from any additional transitions and does not timestamp those transitions. or • Overwrites previously-recorded timestamp data – The module has Latch CST disabled and the on-board buffer contains 160 events. In this case, the module continues to timestamp input transitions. When the module records new transitions, it records the data in its buffer and clears the timestamp data from the oldest transition of the 160. This value is cleared if the module is reset.
I.EventNumber	Per event	Running count of the timestamped input transitions; this tag increments by one with each new event sent. This value is cleared if the module is reset.

Table D.6 Input Tags in FIFO Mode

Tag name:	Set on a Per Point or Modulewide basis:	Description:
I.CSTTimestamp[2]	Per event	64-bit CST timestamp in CST format for the event. This value is cleared after the data has been acknowledged via the *O.EventAck* tag. For more information on clearing timestamp data, see page 7-17.
I.UCTTimestamp[2]	Per event	64-bit UCT timestamp in Universal Coordinated Time format for the event. UCT is expressed as microseconds elapsed since 1 January 1972. Typically, UCT format is only used in applications that also use the 1756HP-GPS module. For more information on the 1756HP-GPS module, see Appendix B. This value is cleared after the data has been acknowledged via the *O.EventAck* tag. For more information on clearing timestamp data, see page 7-17.
I.EventPoint	Per event	Input that recorded the event. Values are 0 - 15, where 0 = Input 0, 1 = Input 1, etc.
I.EventData	Per event	Indicates if input transitioned OFF or ON. 0 = input transitioned OFF 1 = input transitioned ON
I.ReturningUCTTime	Modulewide	Indicates if timestamps are in UCT format rather than CST. Typically, UCT format is only used in applications that also use the 1756HP-GPS module. For more information on the 1756HP-GPS module, see Appendix B. 0 = CST format 1 = UCT format For more information on UCT format, see Appendix B.
I.EventsQueuedCount	Modulewide	Number of events currently stored in the module's buffer that have not been read.

(1) With the Per point tags, there is one bit per input. For example, bit 0 represents input 0, bit 7 represents input 7 and so on.

Output Tags

Table D.7 describes the output tags generated in RSLogix 5000 when you use the Sequence of Events module in FIFO Mode.

Table D.7 Output Tags in FIFO Mode

Tag name:	Type:	Description:
O.EventAck.x	DINT	Clears the current event data from the Sequence of Events module. To clear the current event data, you must COP the current event number (I.EventNumber) to this tag.
O.NewDataAck.x	DINT	Allows NewData bits in the Input word to function as intended. NewData bits are set when a transition occurs and clear only after they are acknowledged via the NewDataAck bit. Typically, the following events occur: • An event occurs on an input. • The Sequence of Events module sets the NewData bit for the input where the event occurred. • The controller records the new data. • The controller acknowledges the new data by causing a 0 to 1 transition on the corresponding NewDataAck bit. • The NewData bit clears. • When another event occurs on the input, the sequence begins at the top bullet in this list. The controller must cause a 0 to 1 transition in this bit to acknowledge new data for an input; in other words, if the NewDataAck bit is 0 when new data is received, the controller must change this bit to 1 to acknowledge the data. If NewDataAck bit is 1 when new data is received, the controller must change this bit to 0 and then to 1 to acknowledge the new data.
O.PointToRetrieve	INT	Determines for which point the module returns events. You can use this bit to query events by point instead of just sequence.
O.ResetEvents	BOOL	Erases all recorded events when transitioned from 0 to 1.
O.RetrieveByPoint	BOOL	Sets the retrieval mechanism for retrieving events. 0 = Retrieve events sequentially 1 = Retrieve events on a per point basis. In this case, the module uses the PointtoRetrieve value to determine which input's events are retrieved.

Table D.7 Output Tags in FIFO Mode

Tag name:	Type:	Description:
O.UCTTime[2]	DINT [2]	These tags are used to configure the Sequence of Events module to send timestamps to the controller in UCT format. In this case, you must copy a pair of timestamp values from the 1756HP-GPS module (one in UCT format and the other a corresponding CST format value) to these tags. When these tags are nonzero numbers, the Sequence of Events module converts timestamps from CST format to UCT format before sending them to the controller. Additionally, I.ReturningUCTTime = 1. Typically, the following events occur: • A 1756HP-GPS module produces CST/UCT Time pairs that are sent to the controller. • The controller copies the pairs to the Sequence of Events module every pulse per second (PPS). (We recommend you copy the pairs every PPS.) • The Sequence of Events module uses the streams of pairs to calculate UCT timestamps for input data including the use of calculating drift between the clocks. If these tags = 0, the Sequence of Events module sends timestamps in CST format and I.ReturningUCTTime = 0.
O.CSTTime[2]	DINT [2]	

Using Sample RSLogix 5000 Projects with the Sequence of Events Module

Overview

Rockwell Automation offers several sample RSLogix 5000 projects to use with your Sequence of Events module. The module timestamps input transitions and provides that data to its owner-controller. However, you must use the data to perform such tasks as:

- detect relative first faults
- determine absolute first faults
- associate real-time with CST-formatted timestamps

Table E.1 describes the sample projects Rockwell Automation offers:

Table E.1

Project:	Description:
GPS_withSOE.ACD	This project uses multiple user-defined data types (UDTs) and one subroutine. The project provides samples on how to manage and buffer information from a 1756HP-GPS module. Many of these messages are optional and dependent on how you implement your specific system. The last rung of this routine provides the interface for communications between the ControlLogix Sequence of Events module and 1756HP-GPS module so the Sequence of Events module will return UTC time instead of CST.
SOE_Module_FifoExtract.ACD	This project uses multiple user-defined data types (UDTs) and subroutines. The project is an example of extracting data from an Sequence of Events module system (multiple modules), with the following constraints: • The modules operate in FIFO mode. • The controller uses Standard Retrieval to retrieve timestamp data from multiple Sequence of Events modules. • Sample of sorting multiple timestamps
ST_BubbleSort.ACD	This project uses two Structured Text subtroutines. The project is an example of easily sorting data.

IMPORTANT Table E.1 only briefly describes the sample projects. The projects have rung-by-rung descriptions to explain why the projects were written as they were. We recommend you open the projects to see exactly how they were written and how to use them.

To access the sample projects, see page E-2.

Accessing the Sample Projects

The sample projects are available at the following locations:

- RSLogix 5000 CD that shipped with v13
- RSLogix 5000 software via the Vendor Sample Project PDF accessible through online help
- Rockwell Automation Technical Support Knowledgebase, available at:
  - http://support.rockwellautomation.com/ – Click on the Knowledgebase link.

Absolute time

Time represented in an easily understood format (i.e., Gregorian format). You must use the 1756HP-GPS module to convert timestamps to absolute time. In this format, time is represented in year, month, day, hour, minute, second and microsecond.

Communications format

Format that defines the operational mode used on the Sequence of Events and, consequently, the type of information transferred between the module and its owner-controller. This format also defines the tags created for each the module.

Compatible match

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

Connection

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

ControlLogix backplane

The backplane used by the 1756 chassis.

Coordinated system time (CST)

Timer value which is kept synchronized for all modules within a single ControlBus chassis

CST Per Point

Operating mode on the Sequence of Events module in which the module timestamps up to 2 input transitions per input, one for OFF to ON transitions and another for ON to OFF transitions.

Current event

Event for which the Sequence of Events module is currently producing data

Direct connection

A connection where the controller establishes an individual connection with the Sequence of Events module.

Disable keying

An electronic keying protection mode that requires no attributes of the physical module and the module configured in the software to match

Download

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

Electronic keying

A feature where modules can be requested to perform an electronic check to make sure that the physical module is consistent with what was configured by the software

Exact 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, major revision and minor revision

First In First Out (FIFO)

Operating mode on the Sequence of Events module in which the module timestamps an unlimited number of input transitions, regardless of direction (i.e., either OFF to ON or ON to OFF) or input (i.e., the same input can transition many times and the module will timestamp every transition) and stores them in an on-board buffer.

Global positioning system (GPS)

A constellation of 24 radio navigation satellites that transmit signals used, by GPS receivers, to determine precise location (position, velocity, and time) solutions.

Inhibit

A ControlLogix process that allows you to configure a Sequence of Events module but prevent it from communicating with the owner-controller. In this case, the controller behaves as if the I/O module does not exist at all.

Interface module (IFM)

A module that uses prewired cable to connect wiring to an I/O module

Major revision

A module revision that is updated any time there is a functional change to the module

Minor revision

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

Owner-controller

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

Program mode

In this mode the following events occur:

- Controller program is not executing.
- Inputs are still actively producing data.

Pulse per second

Process by which the 1756HP-GPS receives the UCT time reference from the navigation sattelites that are part of the GPS system.

Relative time

Time format used when sorting timestamps in CST format. In this case, you cannot easily determine what the 64-bit timestamps represent, but you can determine an order for the timestamps that will provide a relative reference for when a timestamped transition occurred.

Remote connection

A connection where the controller establishes an individual connection with Sequence of Events modules in a remote chassis

Removal and insertion under power (RIUP)

ControlLogix feature that allows a user to install or remove a module or RTB while power is applied

Removable terminal block (RTB)

Field wiring connector for Sequence of Events modules

Requested packet interval (RPI)

The maximum amount of time between broadcasts of I/O data

Run mode

In this mode, the following events occur:

- Controller program is executing
- Inputs are actively producing data

Service

A system feature that is performed on user demand, such as fuse reset or diagnostic latch reset

System side

Backplane side of the interface to the Sequence of Events module

Tag

A named area of the controller's memory where data is stored

Time master

Device, either ControlLogix controller or 1756-SYNCH module, that sets the CST time for a ControlLogix chassis and/or SynchLink system.

Timestamping

ControlLogix process that stamps a change in input data with a relative time reference of when that change occurred

Universal Coordinated Time (UCT)

World standard time format maintained by atomic clocks operated by government organizations around the world. The 1756HP-GPS module reports UTC as a 64-bit unsigned long integer representing the number of elapsed microseconds since 1 January 1972.

Wall clock time (WCT)

Gregorian time format. In this format, time is represented in year, month, day, hour, minute, second and microsecond.

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