User Manual

Original Instructions

Allen-Bradley

Encoder Output Module

Catalog Number 2198-ABQE

Important User Information

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

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

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

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.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

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

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

Appendix C

Web Server Interface

Appendix D

Set the Network IP Address

Appendix E

EC Certifications

Notes:

This manual provides high-level system configuration diagrams and detailed instructions on how to implement the Add-on Instructions (AOI) for the Allen-Bradley® encoder output module. Also included is module configuration with the Studio 5000 Logix Designer® application, and troubleshooting.

This manual is intended for engineers or technicians that are directly involved in the installation and wiring of the module, and programmers who are directly involved in the operation, field maintenance, and integration of these modules with the EtherNet/IP communication module or controller.

If you do not have a basic understanding of the encoder output module, contact your local Rockwell Automation sales representative for information on available training courses.

Summary of Changes

This manual contains new and updated information as indicated in the following table.

Topic	Page
Added footnote for Output Frequency attribute to define Frequency Accuracy.	27

Conventions Used in This Manual

These conventions are used throughout this manual:

- The encoder output module is often referred to as 'the module' throughout this manual to simplify the text
- Terms that are composed of two or more words with initial capital letters, but have spacing between the words, are referencing a parameter that is configured in the Logix Designer application. For example, Conversion Constant.
- Terms that are composed of two or more words with initial capital letters, but have no spacing between the words, are referencing a tag or bit. For example, PositionTrackingStatus.
- Bulleted lists such as this one provide information, not procedural steps
- Numbered lists provide steps or hierarchical information

Additional Resources

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

Resource	Description
ControlLogix Communication Module Specifications Technical Data, publication 1756-TD003	Provides ControlLogix® communication module product specifications.
Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003	Product specifications for Kinetix® Integrated Motion over the EtherNet/IP network, Integrated Motion over sercos interface, EtherNet/IP networking, and component servo drive families.
PowerFlex® 750-Series AC Drives Technical Data, publication 750-TD001	Provides detailed information on: • Drive specifications • Option specifications • Fuse and circuit breaker ratings
Encoder Output Module Installation Instructions, publication 2198-IN013	Provides information to mount and install your Allen-Bradley encoder output module.
Kinetix 5500 Servo Drives User Manual, publication 2198-UM001	Provides information to install, configure, startup, and troubleshoot your Kinetix drive system on the EtherNet/IP network.
Kinetix 5700 Servo Drives User Manual, publication 2198-UM002	
Kinetix 6500 Multi-axis Modular Servo Drives User Manual, publication 2094-UM002	
Kinetix 350 Single-axis EtherNet/IP Servo Drives User Manual, publication 2097-UM002	
PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001	Provides detailed information on: • I/O, control, and feedback options • Parameters and programming • Faults, alarms, and troubleshooting
Universal Feedback Connector Kit Installation Instructions, publication 2198-IN010	Provides information to wire and install the 2198-K57CK-D15M connector kit.
System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001	Information, examples, and techniques that are designed to minimize system failures that are caused by electrical noise.
Kinetix Motion Control Selection Guide, publication KNX-SG001	Overview of Kinetix servo drives, motors, actuators, and motion accessories that are designed to help make initial decisions for the motion control products that are best suited for your system requirements.
Integrated Motion on the EtherNet/IP Network Configuration and Startup User Manual, publication MOTION-UM003	Information on configuring and troubleshooting your ControlLogix and CompactLogix™ EtherNet/IP network modules.
Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003	Information on the AXIS_CIP_DRIVE attributes and the Studio 5000 Logix Designer application control modes and methods.
Rockwell Automation Industrial Automation Glossary, publication AG-7.1	A glossary of industrial automation terms and abbreviations.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation® industrial system.

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

Overview

Use this chapter to become familiar with the encoder output module in configurations with integrated motion over EtherNet/IP drive systems.

The Allen-Bradley® encoder output module is a DIN-rail mounted EtherNet/IP network-based standalone module capable of generating output pulses in multiple encoder protocols to a customer-supplied peripheral device (cameras, for example, used in line-scan vision systems). The encoder output module supports real and virtual axes for systems using the integrated motion on EtherNet/IP network.

Catalog Number Explanation

The encoder output module and these accessory kits are available for your EtherNet/IP network installation.

Table 1 - Encoder Output Module Catalog Number

Cat. No.	Output Channels	Encoder Output Connectors	Cable Length, max
2198-ABQE	2	D-sub, 15 pins, female • Output A • Output B	• 100 m (328 ft) Differential • 30 m (98 ft) single-ended (1)

(1) Cable length and/or signal frequency must be de-rated when output supply voltage is above 19V.

Table 2 - Accessory Kit Catalog Numbers

Item	Cat. No.	Description
Universal connector kit	2198-K57CK-D15M	D-sub, 15 pins, male. Connects to encoder output connector and provides camera terminations.
Spare connector and end-anchor set	2198-KITCON-ABQE	• DIN-rail end-anchor set (2 per module) • Replacement 24V wiring plug for control power • Replacement label for recording the IP address

Typical Configurations

These example diagrams illustrate how the encoder output module fits into the typical integrated motion over the EtherNet/IP network drive configuration. Ethernet topology including linear, ring, and star by using ControlLogix®, GuardLogix®, or CompactLogix™ controllers is supported.

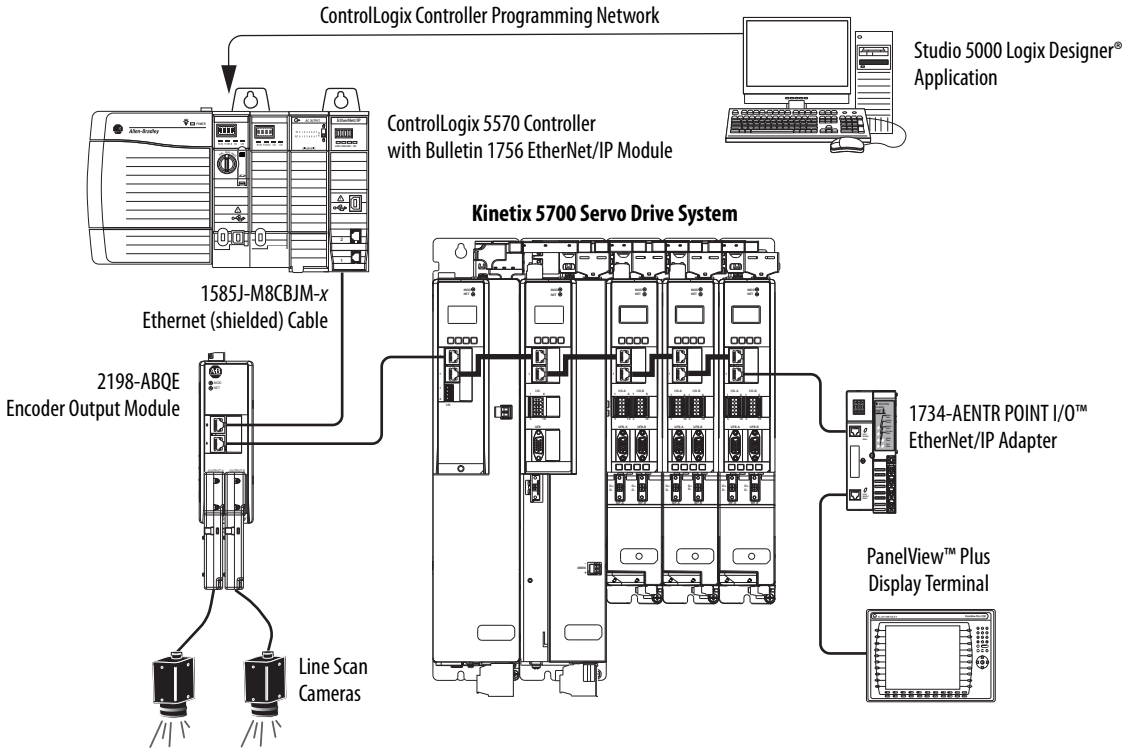
These examples feature the ControlLogix 5570 programmable automation controllers. Other Allen-Bradley controllers, Kinetix® drives, and PowerFlex® drive families with support for integrated motion over the EtherNet/IP network are also compatible with the encoder output module.

See ControlLogix Communication Module Specifications Technical Data, publication 1756-TD003, for more information on ControlLogix 1756-EN2T, 1756-EN2TR, and 1756-EN3TR communication modules.

Linear Topology

In this example, all devices are connected in linear topology. Kinetix 5700 drives and the encoder output module include dual-port connectivity, however, if any device becomes disconnected, all devices downstream of that device lose communication. Devices without dual ports must include the 1783-ETAP module or be connected at the end of the line.

Figure 1 - Linear Communication Installation

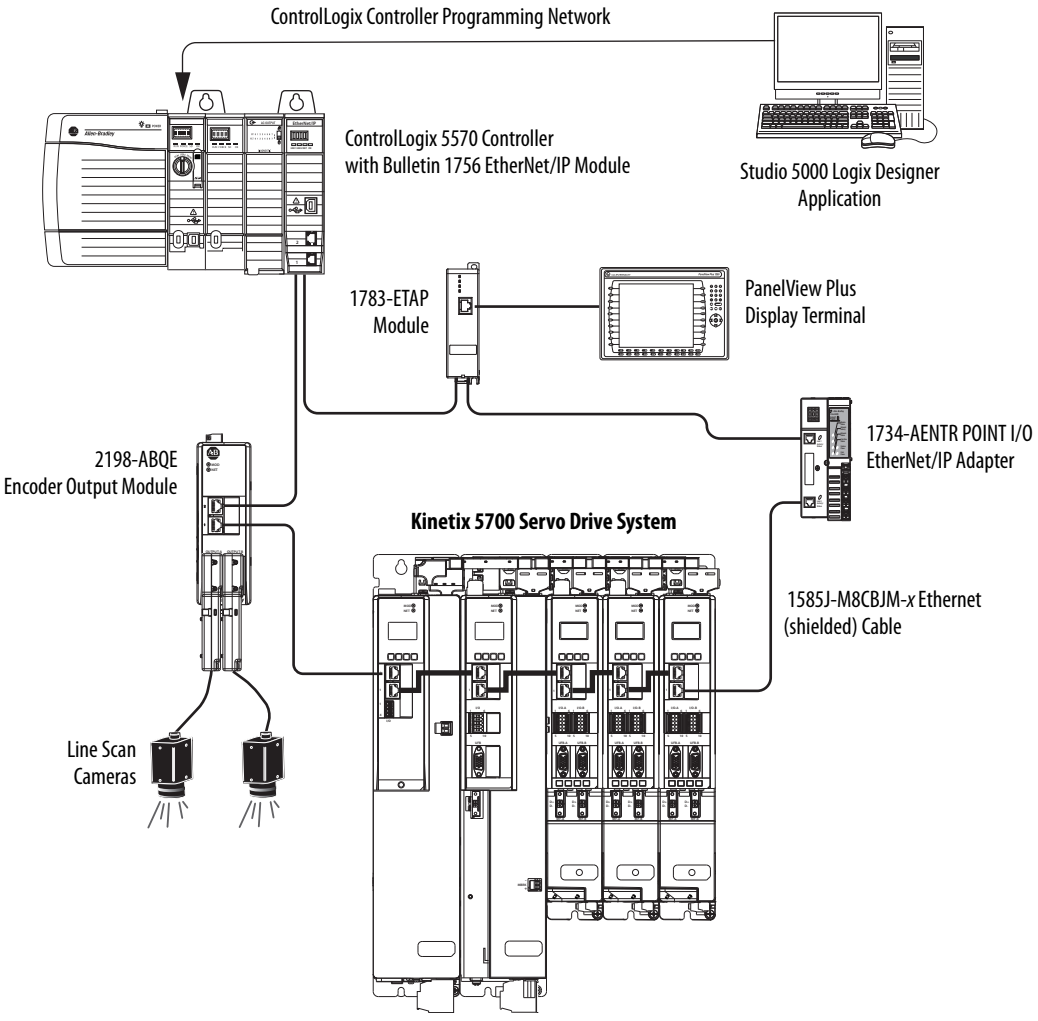


Ring Topology

In this example, the devices are connected by using ring topology. If only one device in the ring is disconnected, the rest of the devices continue to communicate. For ring topology to work correctly, a device level ring (DLR) supervisor is required (for example, the Bulletin 1783 ETAP device). DLR is an ODVA standard. For more information, see the EtherNet/IP Embedded Switch Technology Application Guide, publication ENET-AP005.

Devices without dual ports, for example the display terminal, require a 1783-ETAP module to complete the network ring.

Figure 2 - Ring Communication Installation

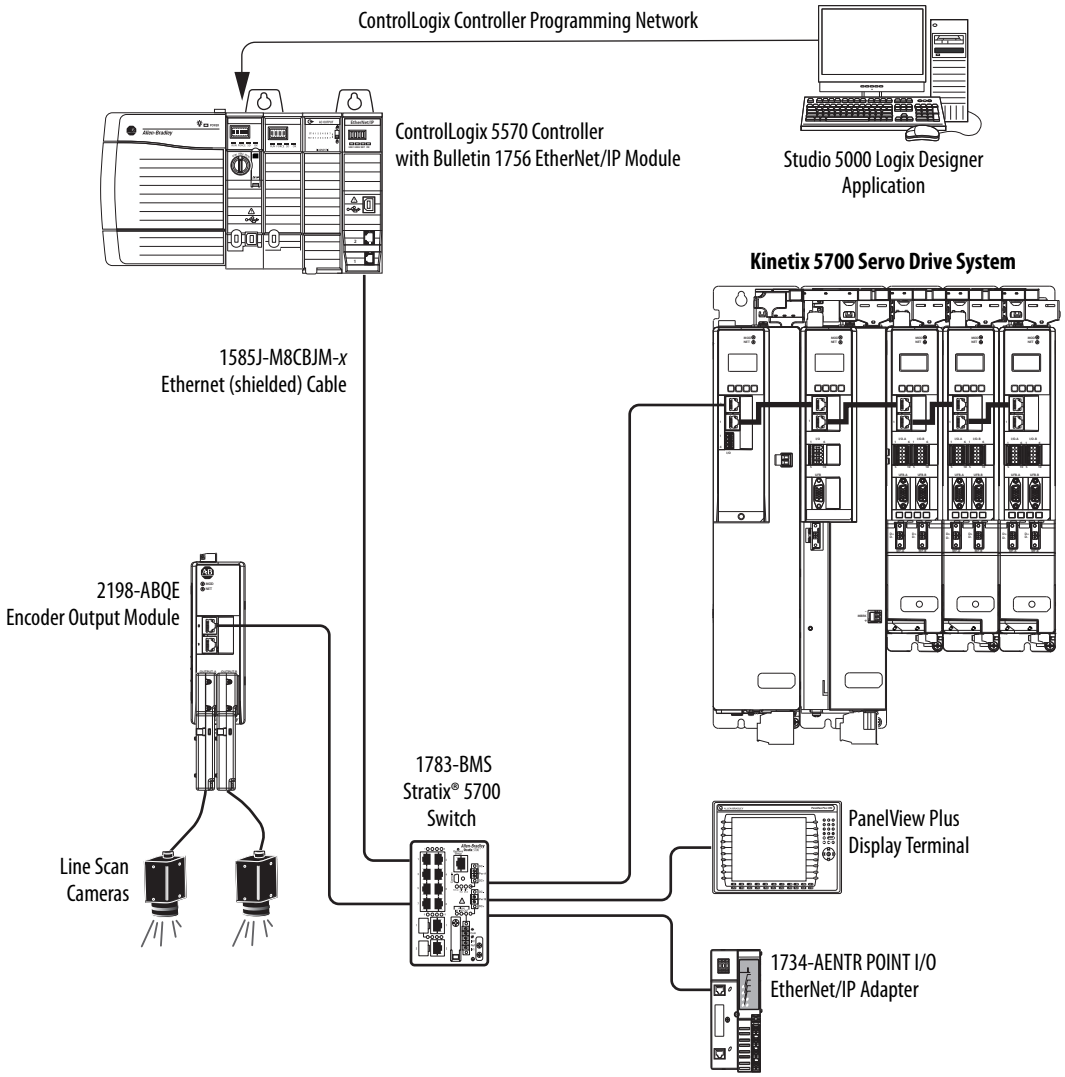


Star Topology

In this example, the devices are connected by using star topology. Each device is connected directly to the switch.

Kinetix 5700 drives and the encoder output module include dual Ethernet ports, so linear topology is maintained from one module to another, but each module operates independently. The loss of one device does not impact the operation of the other devices.

Figure 3 - Star Communication Installation



Functional Description

This chapter introduces the key functions of the encoder output module and the related configurable parameters. For the complete list of module tags, including parameters, see Module Tag and AOI Tag Definitions on 67.

Startup Methods

The encoder output module supports absolute and incremental startup methods to configure the output channels and initiate pulse creation.

Incremental Startup

With incremental startup, PositionTrackingStatus is always true and the module generates pulses in response to any change in the input position.

Absolute Startup

Absolute startup provides the ability for the encoder output module to generate pulses corresponding to the absolute position of the application axis. However, the module generates pulses based on the position of the module channel axis, not the actual application-axis position. See System Overview on page 34, for an explanation of the channel and application axes. The module generates the correct number of pulses if the relationship between the channel axis and the application axis is the following:

$$\text{Channel axis position} = \text{Application axis position} * \text{MAG ratio}$$

However, if there is an offset between the channel axis and the application-axis, then the module does not correctly generate the absolute position of the application axis. For example, an offset can be created if a Motion Redefine Position instruction is executed on the application axis. Once initiated, the module generates pulses at the Frequency Limit to match the absolute position

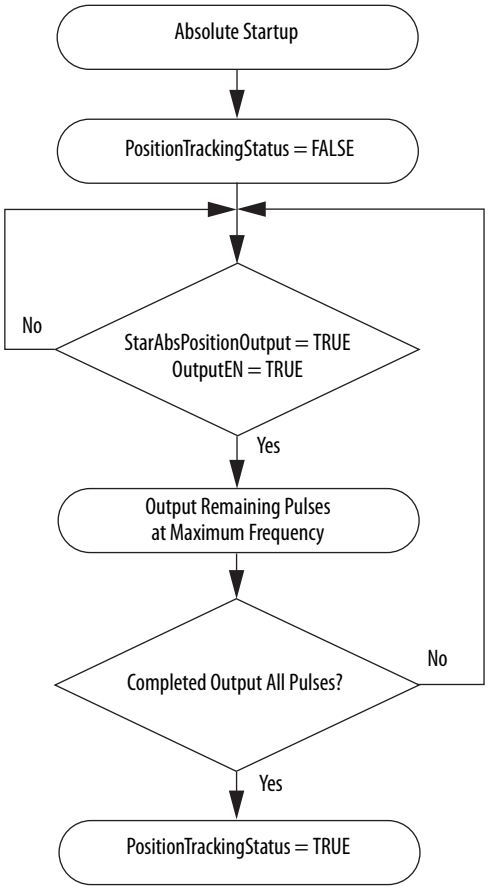
of the channel axis. Pulse generation is initiated by setting the StartAbsPositionOutput bit to the active state. When the output pulse count matches the absolute position of the channel axis, the module sets PositionTrackingStatus to the active state.

The module pauses pulse generation if the StartAbsPositionOutput bit is cleared and PositionTrackingStatus is not yet active. The module resumes pulse generation when the StartAbsPositionOutput bit is set again. Once the module output pulses have caught up with the absolute position of the channel axis and PositionTrackingStatus is true, the module operates incrementally. The StartAbsPositionOutput bit no longer has any effect on the module output.

IMPORTANT You can initiate this startup sequence only once per power cycle or program download. You must reset or cycle power to re-initiate an Absolute Startup.

IMPORTANT The channel axis position must not change during the time period when the output pulses are catching up to the channel axis position. The channel axis position can change after PositionTrackingStatus is active.

Figure 4 - Absolute Startup Method



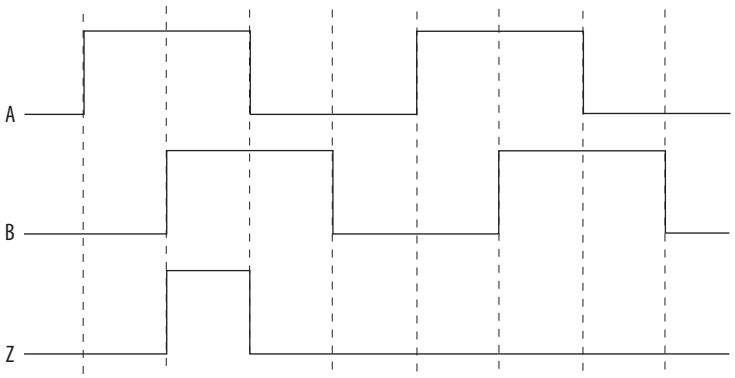
Encoder Types

You can configure the encoder output module output channels to generate digital AqB or step/direction encoder types. The encoder type is selected on the Channels dialog box and the individual Ch0*x* dialog box in the Logix Designer application.

Digital AqB

Digital AqB provides traditional AqB signals consisting of A, B, and Z. The module generates one edge in the A and B signals for one count change in application position input. Signal A leads signal B for positive change in application position input. The marker pulse is generated on the Z signal.

Figure 5 - Digital AqB Timing Diagram

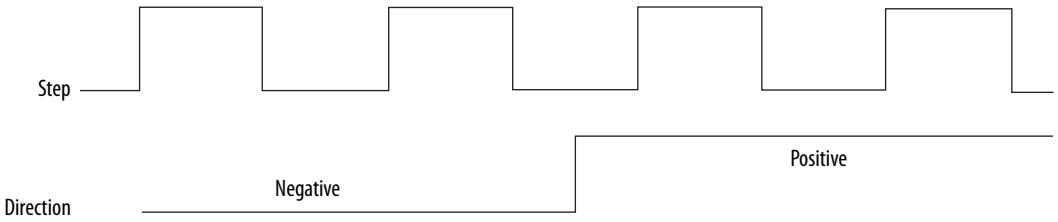


Step/Direction

Step/Direction provides traditional step and direction output signals consisting of Step and Direction. The module generates one edge on the Step signal for one count change in application position input. The Direction signal indicates which direction the application axis is moving. A high-level signal indicates a positive change in the application-axis position input. The Z signal is not active and no marker pulse is generated for the Step/Direction type.

TIP There is no Z signal in Step/Direction mode.

Figure 6 - Step/Direction Timing Diagram



Signal Types

The encoder output module supports differential and single-ended signal types.

Table 3 - Signal Type Descriptions

Signal Type	Description
Differential (default)	Differential mode uses two connections to drive each signal differentially (not referenced to COM). This provides common-mode rejection, enabling longer cable lengths and higher frequencies than single-ended signal types. Differential output signals are powered by an internal 5V DC supply. Differential outputs are RS422 compatible.
Single-ended	Single-ended mode uses a single connection to drive each signal that is referenced to COM. This provides poorer signal integrity compared to differential mode, requiring shorter cable lengths, and lower frequencies. However, some devices that are connected to the module may require single-ended signals. Single-ended outputs are High Threshold Logic (HTL) signal types. The single-ended output drivers are powered by a customer-supplied 12…30V DC power supply.

IMPORTANT Providing an external 12…30V supply for differential outputs or failure to provide 12…30V power for single-ended outputs can result in a FieldlPowerFault. You can observe the 12…30V power supply status from the FieldPowerOff bit.

Other Parameters and Tags

Parameters for the encoder output module are configured in the Studio 5000 Logix Designer® application. For procedures, see Configure the Encoder Output Module on page 33.

Resolution

Each channel of the encoder output module supports a Resolution parameter that is configured in the Logix Designer application. The Resolution is defined as the number of output counts to repeatedly generate the marker pulse on the Z signal for the channel. This is similar to having a marker pulse once per revolution on a rotary encoder.

- The default value is 8,000
- Valid values for this setting are between 4...1,000,000,000 (inclusive)
- This value cannot be blank

TIP The marker pulse is generated only when the encoder type is configured for Digital AqB in the Logix Designer application.

IMPORTANT The Resolution value must be an integer multiple of 4 to properly create the marker pulse. Otherwise, the module does not configure properly and asserts the ConnectionFaulted fault.

IMPORTANT The Resolution parameter is used for defining the Z signal behavior, and does not affect the A and B output signals.

RelativePosition

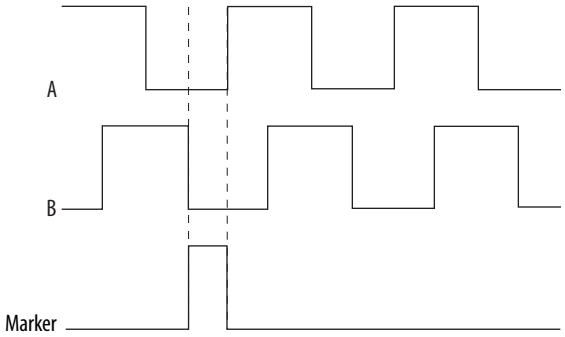
Each channel of the encoder output module reports a RelativePosition in the input assembly. The RelativePosition is the current position within the Resolution and has a range of (0...Resolution -1). The module reports RelativePosition for both encoder types. RelativePosition is reset to 0 when the module is reconfigured by the Logix 5000™ controller or the module is power cycled.

Marker Position

Each channel of the encoder output module supports a Marker Position parameter that is configured in the Logix Designer application. This parameter sets the location of the marker pulse within the Resolution parameter. The marker pulse is located at the marker position relative to the zero position of the Resolution parameter. Figure 7 illustrates how the marker pulse is always gated by the A and B signals and has a width corresponding to one output count.

TIP The marker pulse is also referred to as the Z-signal.

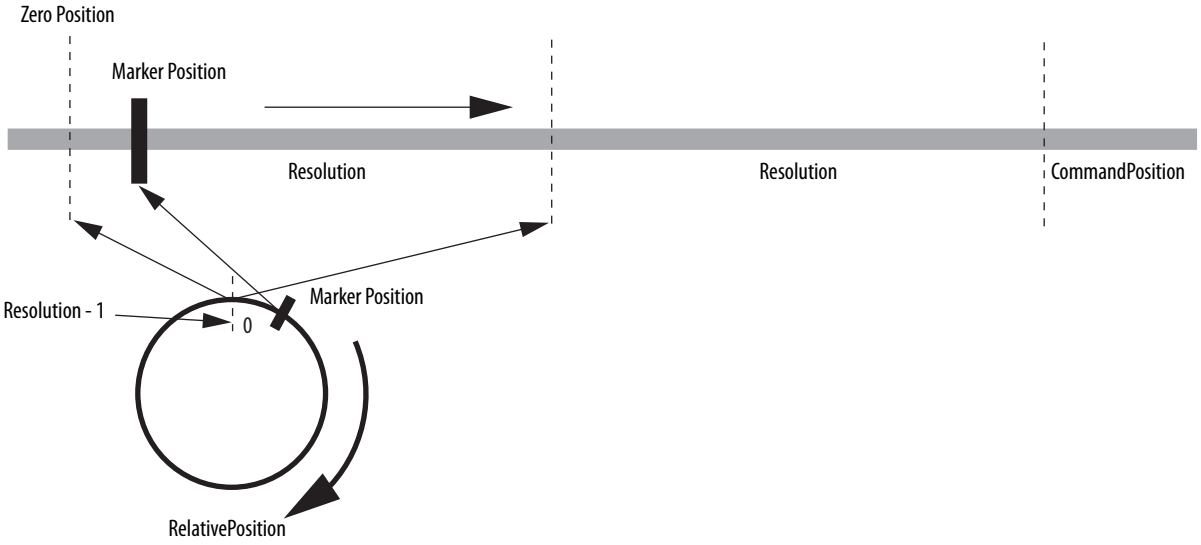
Figure 7 - Marker Position Timing Diagram



Resolution, RelativePosition, and Marker Position Relationships

Figure 8 illustrates the relationships between the Resolution, RelativePosition, and Marker Position. It includes a linear representation of the repeating cycle where RelativePosition changes from 0 to Resolution -1 and repeats. It also shows Marker Position and Zero Position reference within the Resolution. A rotary representation is also included.

Figure 8 - Parameter Relationship Diagram



SetMarkerPosition

During operation, you can adjust the Marker Position parameter by using the SetMarkerPosition bit in the output assembly. An active transition sets Marker Position to the current value of the RelativePosition. There is a latency between the time that application code sets the data member in the output assembly and the module sets the new Marker Position value. To avoid an inaccurate Marker Position setting, do not change the position command while the module is setting the new Marker Position. Changing Marker Position has no effect on the A and B signal outputs.

SetZeroPosition

During operation when the module is in the Running state, you can adjust the zero reference position of RelativePosition by using the SetZeroPosition bit in the output assembly. An active transition sets Zero Position to the current value of the RelativePosition. There is a latency between the time that application code sets the data member in the output assembly and the module sets the new Zero Position value. To avoid an inaccurate Zero Position setting, do not change the position command while the module is setting the new Zero Position. Changing Zero Position has no effect on the A and B signal outputs.

OutputEN

OutputEN is a bit in the module output assembly and works collaboratively with the Add-On Instruction (AOI). The OutputEN bit enables or disables the module output for a specific channel.

IMPORTANT	The OutputEN bit must be active as a precondition for the module to create any output pulses.

IMPORTANT	Homing must not be performed on the channel axis if the channel OutputEN bit is true.

IMPORTANT	The MRP instruction must not be used directly on the encoder output module channel-axis if the channel OutputEN bit is true. The step change of the command position values after the MRP instruction execution can generate a large acceleration/deceleration rate in the module pulse output, which can cause mechanical shock to the machine if it is used as the position command input.

FaultReset

FaultReset is a bit in the module output assembly. FaultReset clears any recoverable major faults.

Frequency Limit

Each module channel supports a Frequency Limit parameter that you can configure in the Logix Designer application. This makes the module compatible with devices that have frequency limits that are lower than the maximum values specified for the module. The module limits the output pulse frequency to the value specified in the Logix Designer application for all encoder types and signal types.

- The signal type determines the allowable range for this limit
- For differential outputs, the range is limited to 0...1,000,000 Hz
- For single-ended outputs, the range is limited to 0...400,000 Hz

Frequency Limit Fault Time

The Frequency Limit Fault Time parameter sets the length of time (mS) that the Frequency Limit alarm can be active before the Frequency Limit fault occurs.

- The default value is 10,000 mS
- Valid values for this setting are between 1...1,000,000 (inclusive)

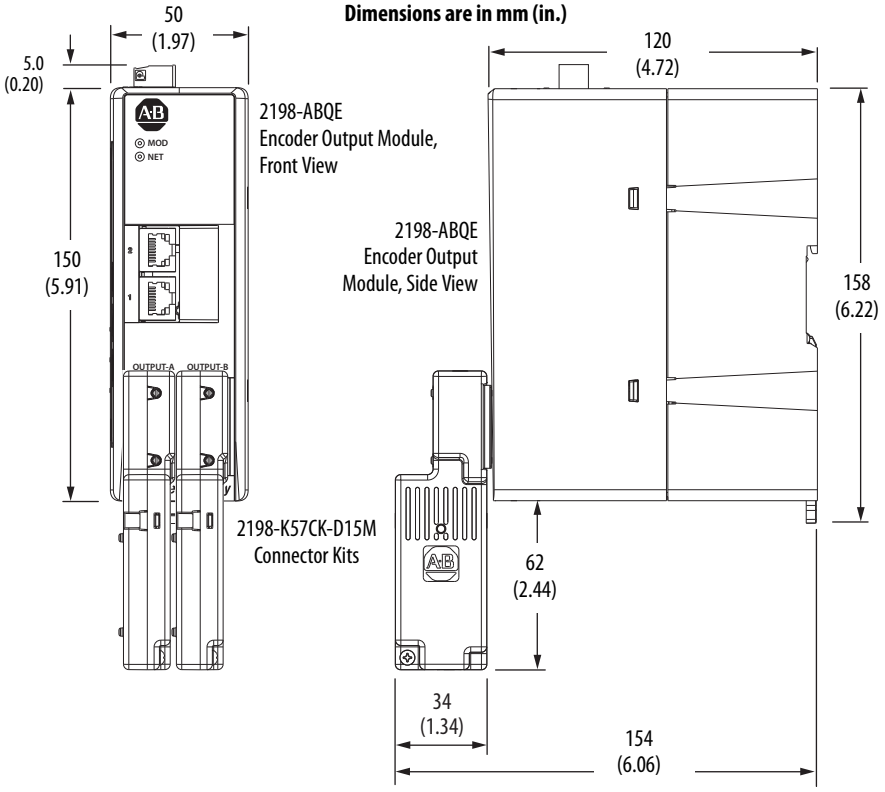
Specifications

Specifications include product dimensions, environmental specifications, and general specifications.

Product Dimensions

Included in this figure are 2198-K57CK-D15M connector kits that are attached to the output connectors. End anchors, used to secure the module on the DIN rail, add 8 mm (0.31 in.) on either side of the module.

Figure 9 - Encoder Output Module with 2198-K57CK-D15M Connector Kits



IMPORTANT

The encoder output module must be DIN-rail mounted, inside a cabinet enclosure (intended for indoor use only) free from moisture (installed in dry location), and used in a manner as specified in this user manual and the Encoder Output Module Installation Instructions, publication 2198-IN013.

The control input power and output supply power of this device must be connected to a SELV and LIM (limited energy circuit) or Class 2 power supply.

Environmental Specifications

Attribute	Operational Range	Storage Range (nonoperating)
Ambient temperature	0…50 °C (32…122 °F)	-40…+70 °C (-40…+158 °F)
Relative humidity	5…95% noncondensing	5…95% noncondensing
Protection class (EN 60529)	IP20	
Degree of pollution (EN 61800-5-1)	2	
Altitude	Up to 2000m (6562 ft) without derating	3000 m (9843 ft) during transport
Vibration	5…55 Hz @ 0.35 mm (0.014 in.) double amplitude, continuous displacement; 55…500 Hz @ 2.0 g peak constant acceleration	
Shock	15 g, 11 ms half-sine pulse (3 pulses in each direction of 3 mutually perpendicular directions)	

General Specifications

Attribute	Value
Control input power (24V) ratings (SELV and LIM or Class 2 power supply)	21.6…26.4V DC (24 V DC, nom) 0.3 A, 7.2 W, max @ 24V DC
Control (input power) inrush current, max	3 A
Control input power connector wire size	16…24 AWG
Output supply power rating for single-ended outputs only (SELV and LIM or Class 2 power supply)	12…30V DC 0.14 A, max
Output connector wire size	16…28 AWG
Output signal type	Differential (RS422) or single-ended
Weight	0.50 kg (1.1 lb)

Notes:

Connect the Encoder Output Module

This chapter provides information for wiring your encoder output module and making output cable connections.

Basic Wiring Requirements

This section contains basic wiring information for the encoder output module.

ATTENTION: Plan the installation of your system so that you can perform all cutting, drilling, tapping, and welding with the system removed from the enclosure. Because the system is of the open type construction, be careful to keep metal debris from falling into it. Metal debris or other foreign matter can become lodged in the circuitry and result in damage to components.

SHOCK HAZARD: To avoid hazard of electrical shock, perform all mounting and wiring of the encoder output module before applying power. Once power is applied, connector terminals can have voltage present even when not in use.

Routing the Power and Signal Cables

When you route power and signal wiring on a machine or system, radiated noise from nearby relays, transformers, and other electronic devices can be induced into I/O communication, or other sensitive low voltage signals. This can cause system faults and communication anomalies.

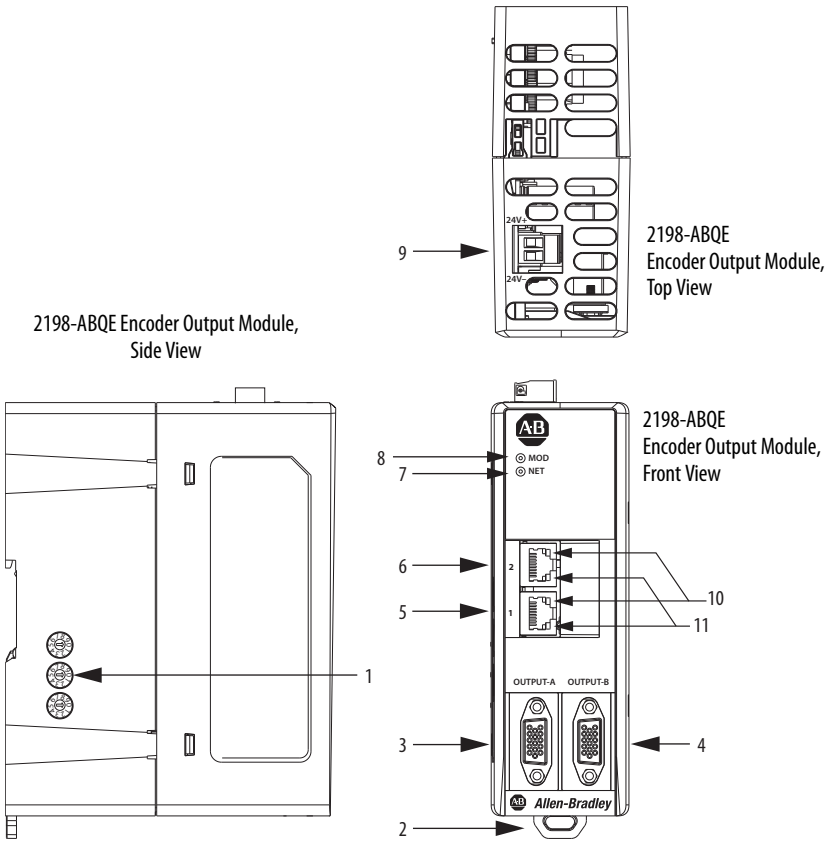
See Output Cable Specifications on page 28 regarding output cables between your 2198-K57CK-D15M connector kits and the receiving devices.

See the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001, for examples of routing high and low voltage cables in wireways.

Features Description

Use this illustration to identify the encoder output module features and indicators.

Figure 10 - Module Features and Indicators



Item	Description
1	IP address switches
2	Mounting latch
3	15-pin output connector - A
4	15-pin output connector - B
5	Ethernet (PORT1) RJ45 connector
6	Ethernet (PORT2) RJ45 connector
7	Network status indicator
8	Module status indicator
9	24V control input power (CP) connector
10	Link speed status indicators
11	Link/Activity status indicators

Table 4 - Control Input Power (CP) Connector Pinout

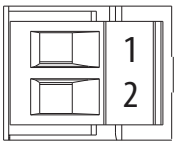
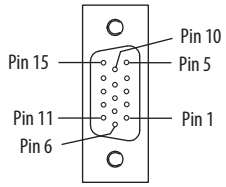
CP Pin	Description	Signal	Pin Orientation
1	24V power supply, customer-supplied	24V+	
2	24V common	24V-	

Table 5 - Output Connector Pinout

Pin	Description	Signal
1	Differential A phase signal – positive (RS422) / differential STEP signal - positive	A+ / Step+
2	Differential A phase signal – negative (RS422) / Differential Step signal – negative (RS422)	A– / Step–
3	Differential B phase signal - positive (RS422) / Differential Direction signal – positive (RS422)	B+ / Direction+
4	Differential B phase signal - negative (RS422) / Differential Direction signal – negative (RS422)	B– / Direction–
5	Differential Z phase signal - positive (RS422)	Z+
6	Reference/Common	COM
7	Reserved	–
8	Single-ended Z phase signal	Z
9	Reserved	–
10	Differential Z phase signal - negative (RS-422)	Z–
11	Reserved	–
12	Single-ended A phase signal / Single-ended Step signal	A / Step
13	Single-ended B phase signal / Single-ended Direction signal	B / Direction
14	Power supply (customer-supplied) for single-ended output signals	PWR
15	Reserved	–

Figure 11 - Pin Orientation for 15-pin Output Connector



Ethernet Communication Specifications

The PORT1 and PORT2 (RJ45) Ethernet connectors are provided for communication with the Logix 5000™ controller and integrated motion on EtherNet/IP drives.

Table 6 - Ethernet Communication Specifications

Attribute	Value
Communication	The drive auto-negotiates speed and duplex modes. These modes can be forced through the Logix Designer application. 100BASE-TX, full duplex is recommended for maximum performance.
Cyclic update period	1.0 ms, min
Embedded switch features	Three-port, cut-through, time correction on IEEE-1588 packets, limited filtering, quality of service with four priority levels
Auto MDI/MDIX crossover detection/ correction	Yes
Port-to-port time synchronization variation	100 ns, max
Cabling	CAT5e shielded, 100 m (328 ft) max

Control Power Specifications

The encoder output module requires 24V DC input power for control circuitry.

IMPORTANT SELV and LIM (limited energy circuit) rated or Class 2 power supply must be used to energize the control circuitry.

Table 7 - Control Input Power Specifications

Attribute	Value
Input voltage	21.6…26.4V DC (24V DC, nom)
Control power AC input current Nom @ 24V DC Inrush, max	 300 mA 3.0 A

Output Signal Specifications

Differential (RS-422) and single-ended high-threshold logic (HTL) signal types are available on the Output A and Output B connectors.

Z-pulse Specifications

Figure 12 illustrates how the Z-pulse delay (t1 and t2) and width are defined. These Z-pulse specifications apply to differential and single-ended outputs.

Figure 12 - Z-pulse Output Waveform

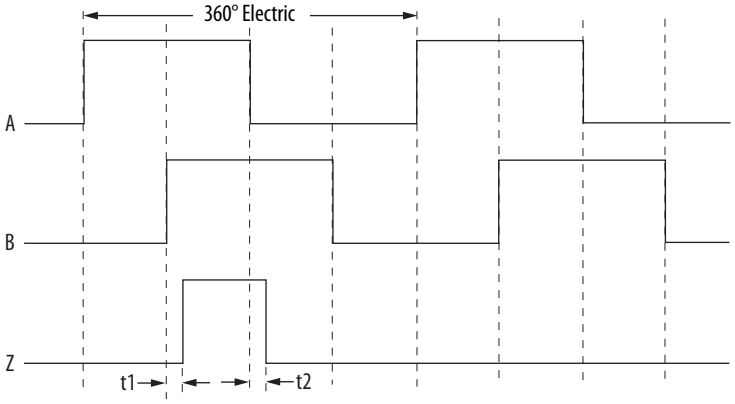


Table 8 - Z-pulse Specifications

Attribute	Value
Z pulse width	90°, electrically
Z pulse delay (rising edge)	|t1| ≤50 ns
Z pulse delay (falling edge)	|t2| ≤100 ns

Differential Output Signals

When differential signal type is selected, no output power supply is required.

Table 9 - Differential Output Specifications

Attribute	Value
Type	RS-422 compliant
Output frequency (1)	1 MHz, max
Short circuit protection	Yes
Galvanic isolation from internal circuitry and control power supply	Yes
Galvanic isolation between Output A and Output B ports	Yes

(1) Frequency accuracy of up to 2% can be expected from 0…250 kHz.

Single-ended Output Signals

When single-ended signal type is selected, a 12...30V DC @ 0.14 A power supply must be connected to pin-14 (PWR) and pin-6 (COM) of the output connector. Because the Output A and B connectors are galvanically isolated from each other in the module, each connector requires a 12...30V DC customer-supplied power supply connection.

Table 10 - Single-ended Output Specifications

Attribute	Value
Type	Single-ended (HTL)
Output frequency (1)	400 kHz, max (depending on cable length and output supply voltage, see Figure 13 on page 28)
Output supply voltage	12…30V DC
Current consumption of output supply	0.14 A, max
Output voltage (LOW)	5V DC, max
Output voltage (HIGH)	• 9V DC min @ V_{PWR}=12…16V (2) • (V_{PWR}-7) V DC min @ V_{PWR}=16…30V (2)
Output current (each channel)	30 mA, max
Protection on output power supply	Reverse polarity, overload
Short circuit protection	Yes
Galvanic isolation from internal circuitry and control power supply	Yes
Galvanic isolation between Output A and Output B ports	Yes

(1) Frequency accuracy of up to 2% can be expected from 0…250 kHz.

(2) V_{PWR} is the actual power supply voltage applied between pin-14 (PWR) and pin-6 (COM).

Figure 13 - Single-ended Output

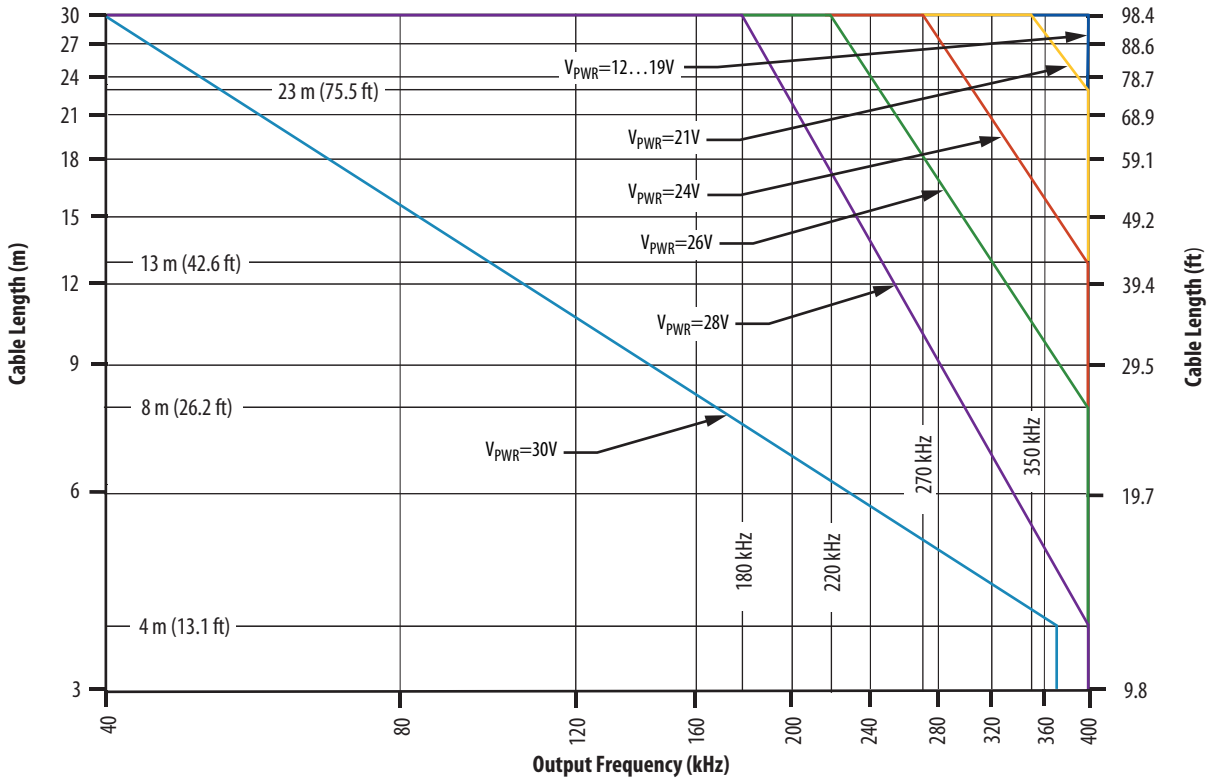


Table 11 - Single-ended Output Legend

Output Supply Voltage V_{PWR}	**Output Frequency, max** kHz (with 30 m cable)	**Cable Length, max @ 400 kHz Outputs** m (ft)
12…19	400	30 (98.4)
21	350	23 (75.5)
24	270	13 (42.6)
26	220	8 (26.2)
28	180	4 (13.1)
30	40	4 (13.1) @370 kHz, max

Output Cable Specifications

Output cables that connect between the 2198-K57CK-D15M connector kits and the receiving devices are customer-supplied.

Table 12 - Output Cable Specifications

Attribute	**Value**
Cable type	Shielded, twisted-pair ≤60 pF/m (18.3 pF/ft) mutual capacitance between conductors within the twisted-pair
Wire size	0.08…1.5 mm^2 (28…16 AWG)
Cable length (differential output)	100 m (328 ft), max
Cable length (single-ended output)	30 m (98 ft), max (depending on output frequency and supply voltage, see Figure 13 on page 28)

Wire the 24V Control Power Input Connector

The 24V power (CP) connector requires 24V DC input for the control circuitry. The connector plug ships with the encoder output module.

Table 13 - CP Connector Wiring Requirements

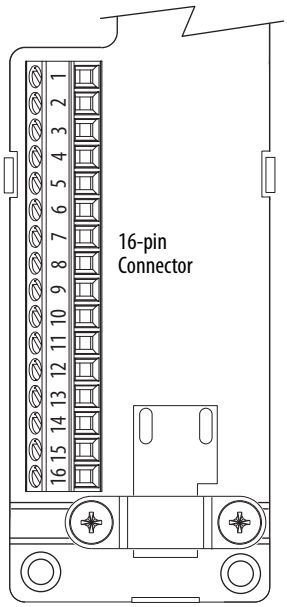
Connects to Terminals		Wire Size mm^2 (AWG)	Strip Length mm (in.)	Torque Value N•m (lb•in)
Pin	Signal			
CP-1 CP-2	24V+ 24V-	0.2…2.5 (24…14)	7.0 (0.28)	0.22…0.25 (1.9…2.2)

Wire the Output Connectors

To meet the output signal specifications (differential and single-ended output signal types), use cable that meets the Output Cable Specifications on page 28.

Use 2198-K57CK-D15M connector kits to terminate wires from your peripheral device to the 15-pin output connectors.

Figure 14 - 2198-K57CK-D15M Connector Kit Wiring Requirements

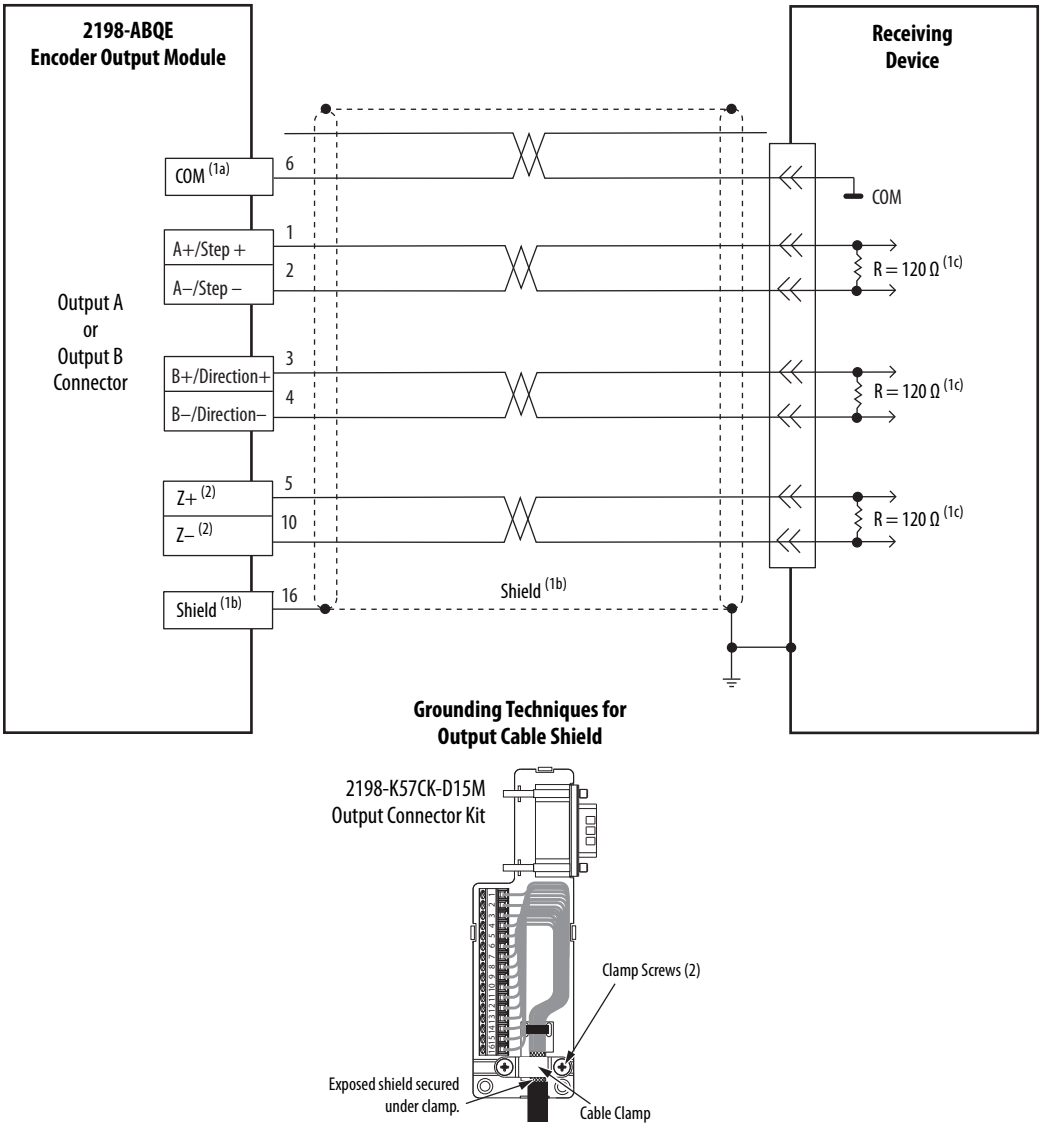


Terminal	Signal	Strip Length mm (in.)	Torque Value N•m (lb•in)
1	A+ / Step+	5.0 (0.2)	0.22…0.25 (1.9…2.2)
2	A– / Step–		
3	B+ / Direction+		
4	B– / Direction–		
5	Z+		
6	COM		
7	–		
8	Z		
9	–		
10	Z–		
11	–		
12	A / Step		
13	B / Direction		
14	PWR		
15	–		
16	Drain		

Interconnect Diagrams

These diagrams illustrate wiring between the 2198-K57CK-D15M connector kit and the receiving device.

Figure 15 - Device Wiring with Differential Outputs



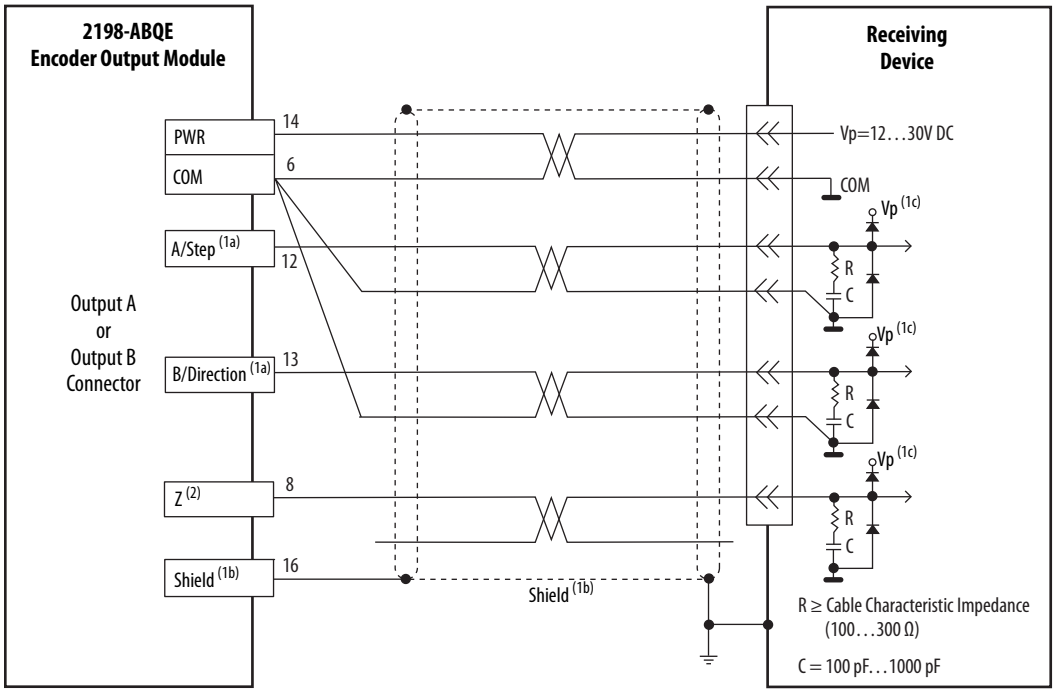
Grounding Techniques for Output Cable Shield

See Universal Feedback Connector Kit Installation Instructions, publication 2198-IN010, for connector kit specifications.

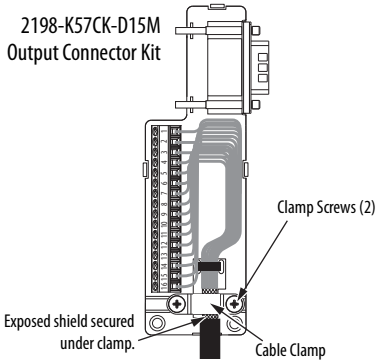
(1) These connections are essential for noise immunity and to meet the signal specifications in Table 9 on page 27.
(a) Connect pin-6 (COM) regardless of encoder type (AqB or Step/Direction).
(b) The cable shield is connected to pin-16 of the 2198-K57CK-D15M connector kit, and must also be grounded on the receiving device side.
(c) The differential outputs must be terminated on the receiving device side with a 120 Ω resistor (R in the wiring diagram).

(2) When Step/Direction encoder type is selected, do not connect pin-5 (Z+) and pin-10 (Z–) because that marker pulse is not generated.

Figure 16 - Device Wiring with Single-ended Outputs



Grounding Techniques for Output Cable Shield



See Universal Feedback Connector Kit Installation Instructions, publication 2198-IN010, for connector kit specifications.

(1) These connections are essential for noise immunity and to meet the signal specifications in Table 10 on page 27.
(a) Each output (A/Step, B/Direction, and Z) must use a separate twisted-pair and their reference wire (except Z signal) must be connected to pin-6 (COM) on encoder output module and COM on receiving device.
(b) The cable shield is connected to pin-16 of the 2198-K57CK-D15M connector kit, and must also be grounded on the receiving device side.
(c) The input circuitry of the receiving device must include the RC termination and diode-clamp circuitry.

(2) When Step/Direction encoder type is selected, do not connect pin-8 (Z) because that marker pulse is not generated.

Notes:

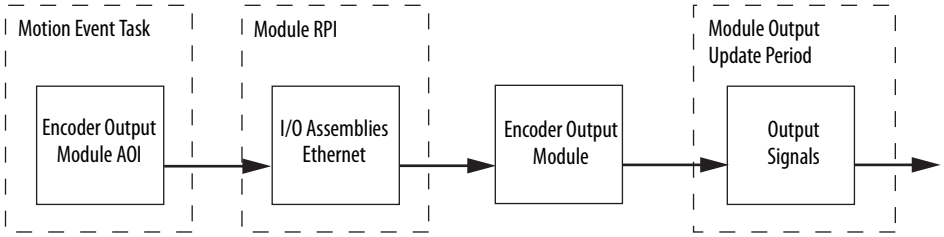
Configure the Encoder Output Module

Use this chapter to configure your encoder output module with the appropriate AOI file by using the Studio 5000 Logix Designer® application.

System Overview

The encoder output module can create output signals for any axis defined in a controller that supports data types AXIS_VIRTUAL or AXIS_CIP_DRIVE. However, the module is not an integrated motion device. It is an I/O device that requires Logix Designer application code as an interface to the axis tag data. The module has no direct interface with the integrated motion sub-system in the Logix 5000™ controller. Part of the application code is provided in the form of an Add-On Instruction (AOI). Figure 17 illustrates the interface between the AOI and the module.

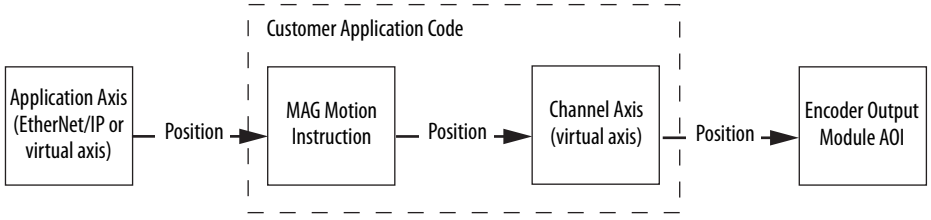
Figure 17 - Encoder Output Module - Timing Model



The AOI is executed in the MotionEvent task so that it can retrieve axis position data at the fastest possible update rate. The AOI assembles all the data necessary for module operation in an output assembly. The assembly data is sent to the module at the Requested Packet Interval (RPI) configured for the module in the Logix Designer application. It is important that the module RPI be set to the minimum coarse update period used for the application axes that are connected to the module. The AOI also receives data from the module in an input assembly at the configured RPI. The module performs interpolation and updates the output signals at a much faster rate than the motion group Base Update Rate. The input and output assemblies have data members that the application code interacts with to control the operation of the module.

Figure 18 illustrates how to connect an application axis (an axis that is used as the reference axis for the encoder output signals) to the AOI. The interface to the AOI is always a virtual axis and is referred to as a channel axis. The MAG instruction is used to create the input/output relationship between the application axis and the channel axis that is used by the AOI. The MAG and module channel axis are required because the encoder output module is not part of the integrated motion system. The MAG instruction can also be used to define the scaling of the output signals to the application axis. See System Scaling Method on page 52 for a description of how to configure the channel axis and MAG instruction. The module RPI must be set to the minimum coarse update period used for the channel axes.

Figure 18 - Encoder Output Module - Logix Designer Application Integration



Set the IP Address Rotary Switches

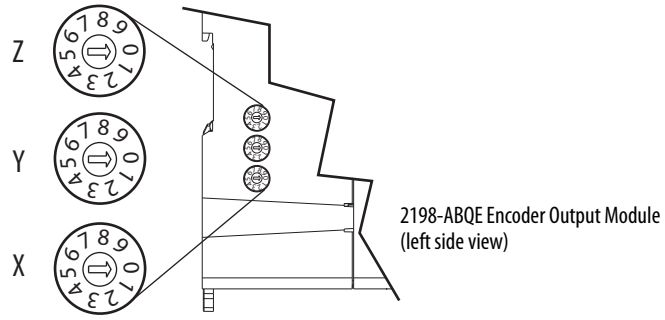
At power up or reset, the encoder output module reads the rotary switches to determine if they are set to a valid number for the last octet of the IP address. Valid numbers range from 001...254.

If the switches are set to a valid number, these conditions result:

- IP address = 192.168.1.xyz (where xyz represents the switch settings)
- Subnet mask = 255.255.255.0
- Gateway address = 192.168.1.1 (0.0.0.0 if the switches are set to 001)

IMPORTANT Because access to the IP address rotary switches is limited after the module is mounted on the panel, set the switches before mounting the module. The rotary switch settings take effect each time power is applied.

Figure 19 - IP Address Rotary Switches



If the rotary switches are not set to a valid number, for example, 000 or 255...999 (except 888, which is used for resetting the module to the factory default settings) the module attempts to use DHCP to set the IP address, however, only if DHCP is enabled.

IMPORTANT DHCP is disabled by default in the initial release of the module with firmware revision 1.4.11. However, DHCP is expected to be enabled in later firmware revisions. To manually enable DHCP, see Set the Network IP Address on page 85.

To set the IP address by using the DHCP tool, see Set the Network IP Address on page 85.

Studio 5000 Logix Designer

You can include the encoder output module in your Studio 5000 Logix Designer application, version 30.00 or later, by adding it to a configured EtherNet/IP module or Logix 5000 controller under the I/O configuration tree. After setting network parameters, you can view the module status information in the Studio 5000® environment and use it in your Logix Designer application.

For help using the Studio 5000 Logix Designer application as it applies to configuring the Logix 5000 controllers, refer to Additional Resources on page 8.

These procedures assume that you have wired your integrated motion on EtherNet/IP network drive system and installed your 2198-ABQE encoder output module.

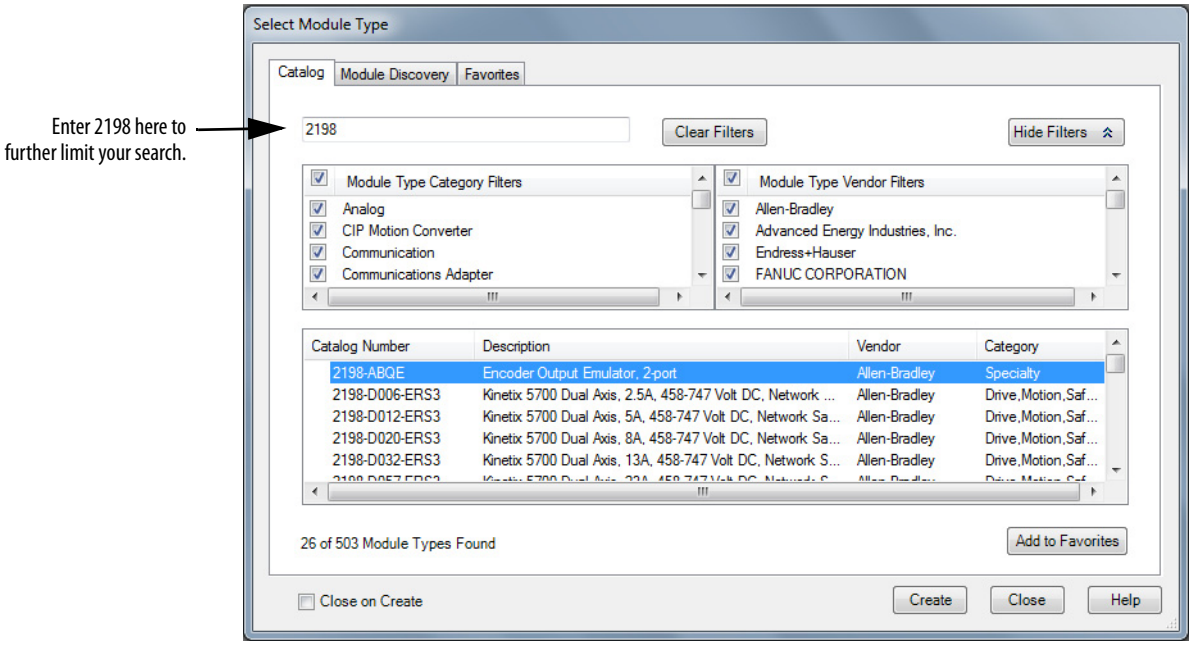
Configure the Encoder Output Module

IMPORTANT To configure the 2198-ABQE encoder output module, you must be using the Logix Designer application, version 30.00 or later. See Chapter 2, beginning on page 13, for descriptions of the Module Properties configuration options.

Follow these steps to configure the encoder output module.

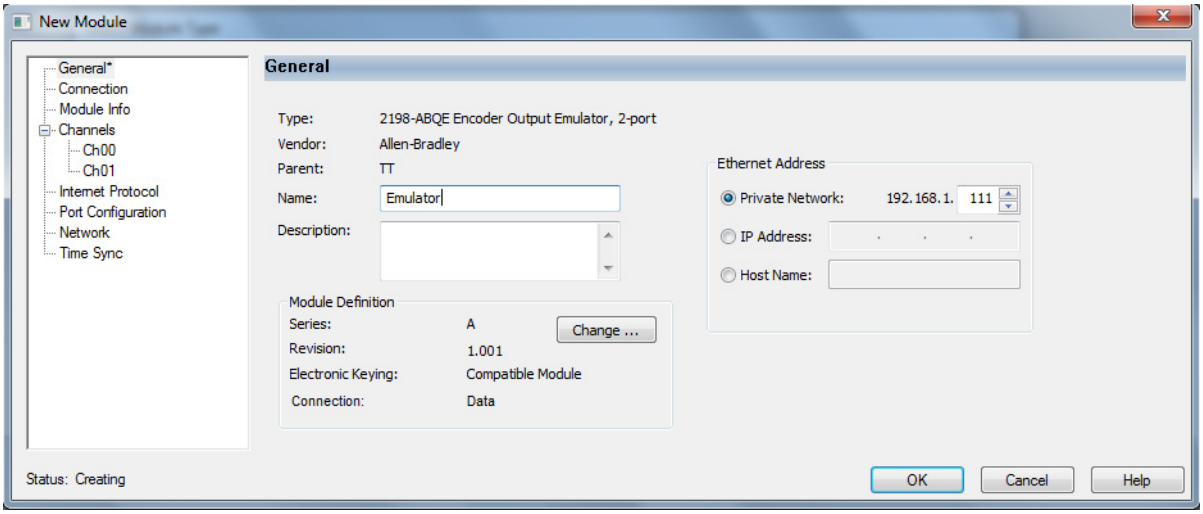
1. Below the controller in the I/O Configuration tree, right-click Ethernet and choose New Module.

   The Select Module Type dialog box appears.



2. By using the filters, check Motion and Allen-Bradley®, and select your 2198-ABQE Encoder Output Module.
3. Click Create.

The New Module dialog box appears.



4. Configure the new module.

   a. Type the module Name.

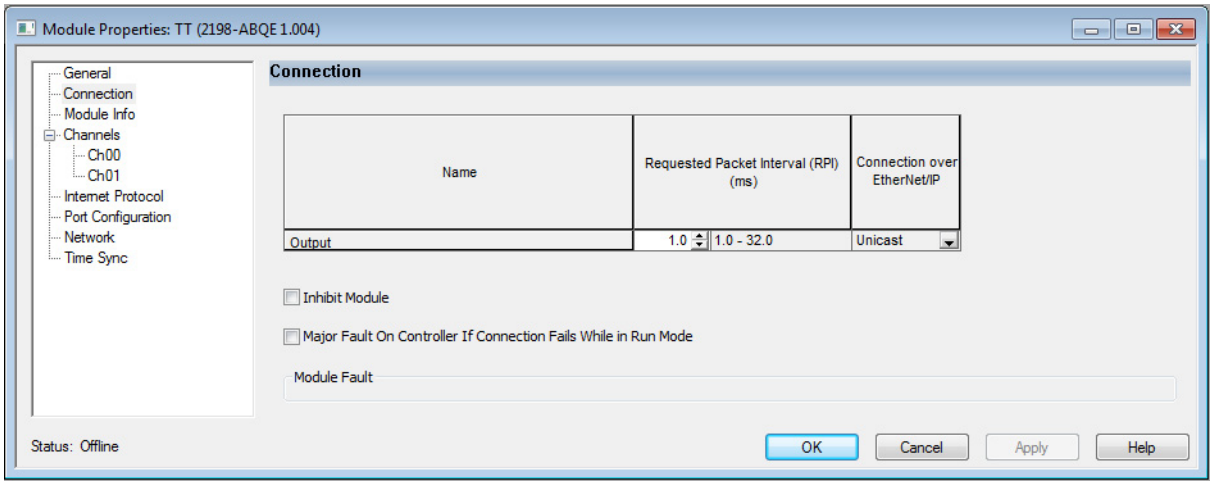
   b. Select an Ethernet Address option.

      In this example, the Private Network address is selected.

   c. Enter the address of your 2198-ABQE Encoder Output Module.

      In this example, the last octet of the address is 111. This must match the IP address switch settings of the module.

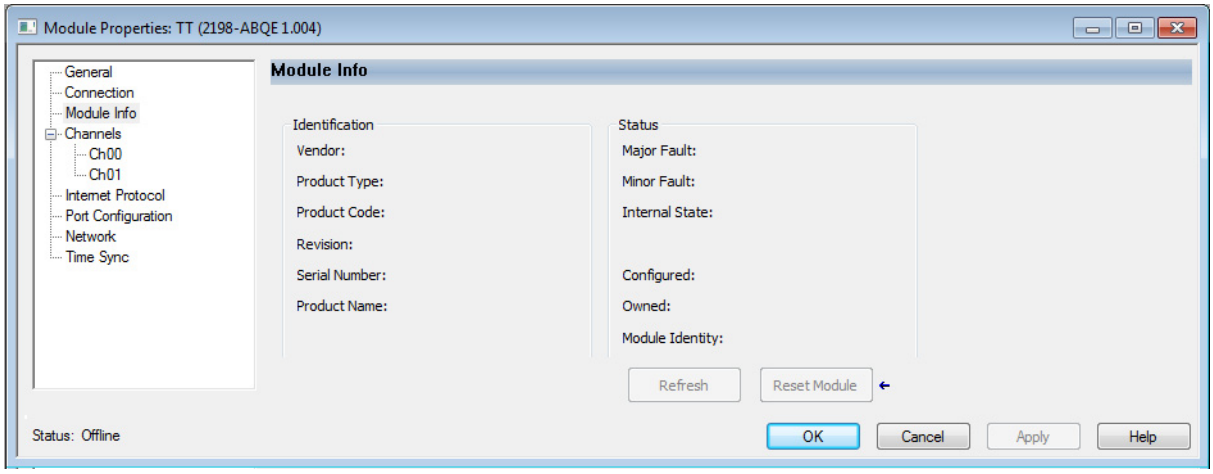
5. Click the Connection tab.



6. Enter the Requested Packet Interval (RPI) for the module.

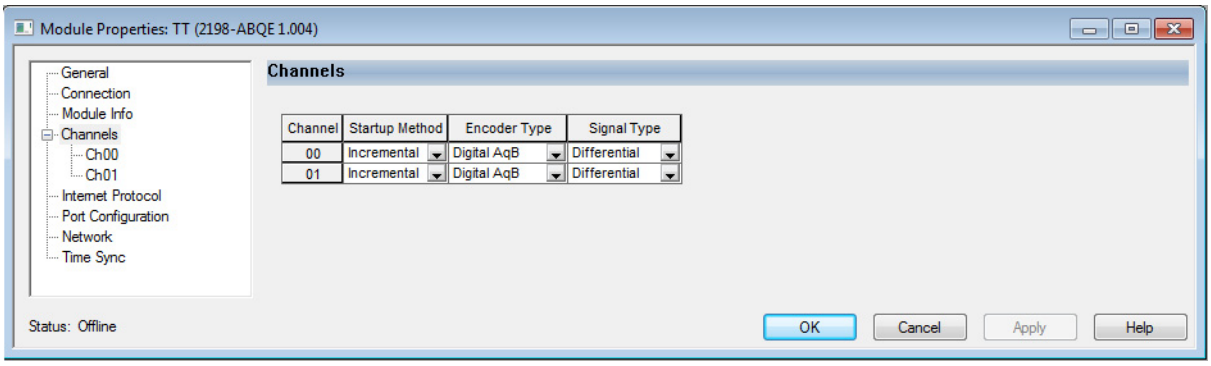
IMPORTANT Set the module RPI to the minimum coarse update period used for the application axes connected to the module.

7. Click the Module Info tab.



From the Module Info tab, you can check module status and information while online with the Logix 5000 controller.

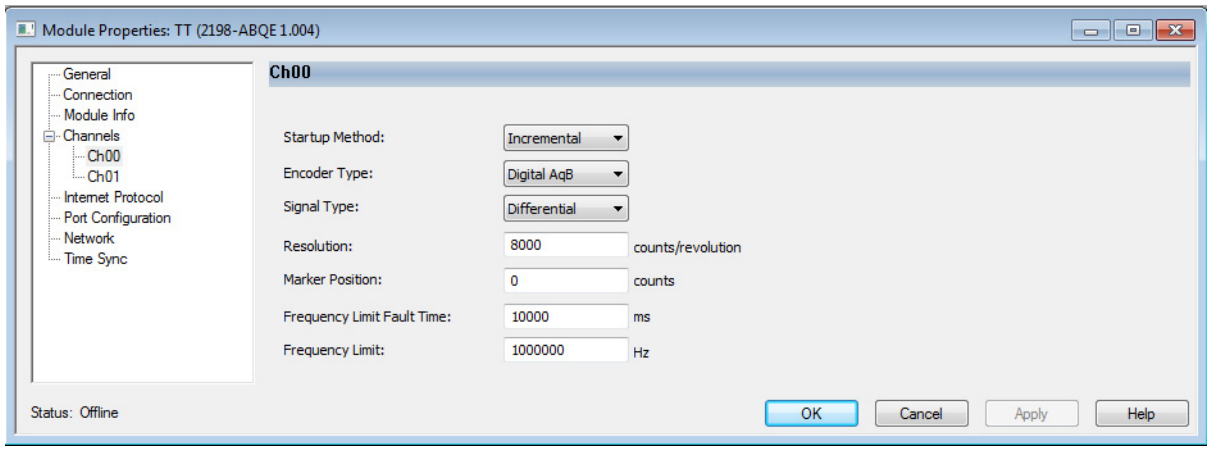
8. Click the Channels tab.



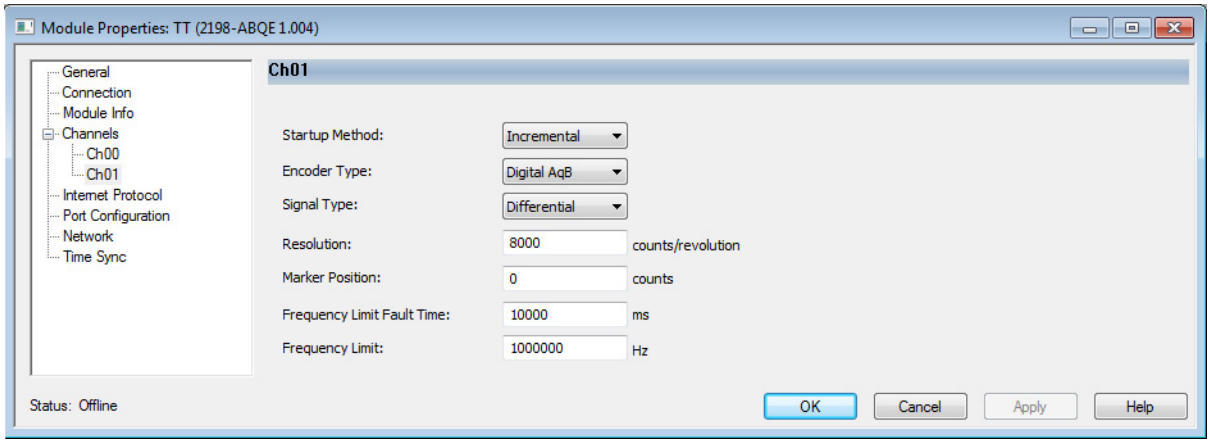
9. From the pull-down menus, choose the channel configuration options appropriate for your application.

   Port Output A corresponds to channel Ch00 and Output B corresponds to channel Ch01. See Chapter 2, beginning on page 13, for descriptions of the Module Properties configuration options.

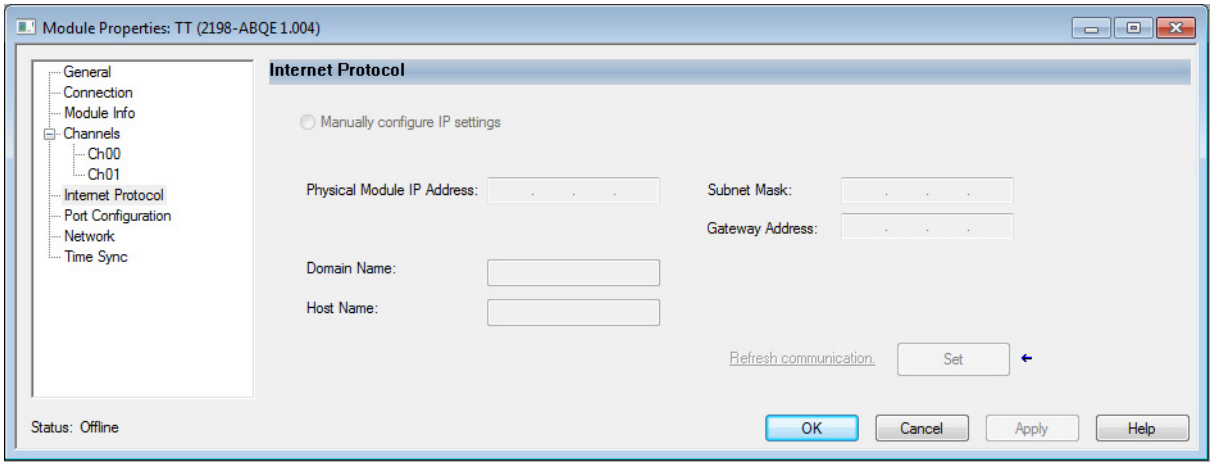
10. Click the Channels>Ch00 tab.



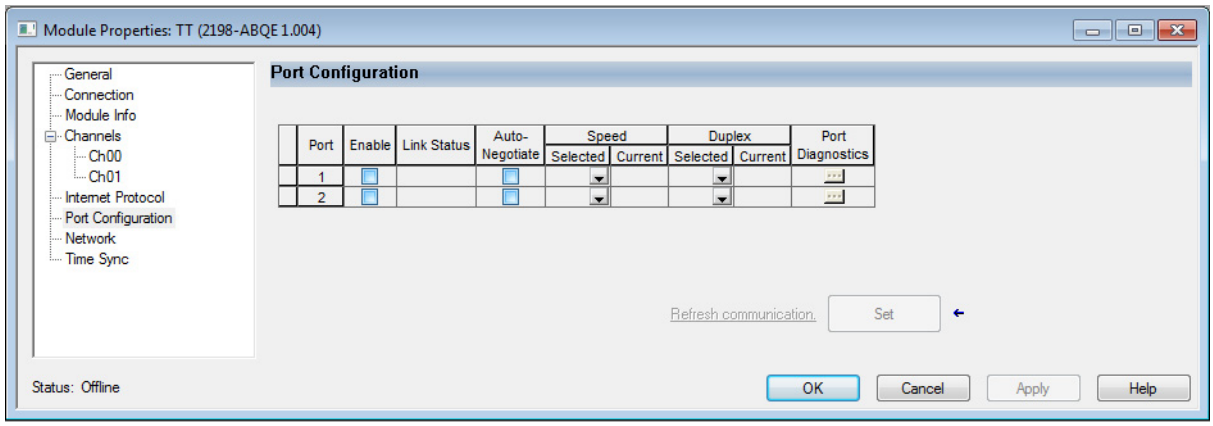
11. Enter Ch00 configuration options appropriate for your application.
12. Click the Channels>Ch01 tab.



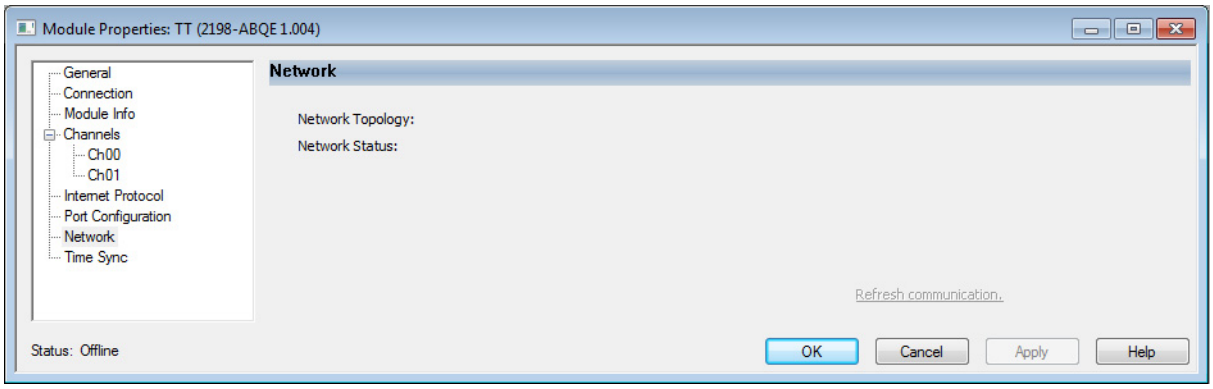
13. If using the second channel of the encoder output module, enter Ch01 configuration options appropriate for your application.
14. Click the Internet Protocol tab.



15. If you are online with the module, you can use this tab to manually configure the IP settings for your application.
16. Click the Port Configuration tab.

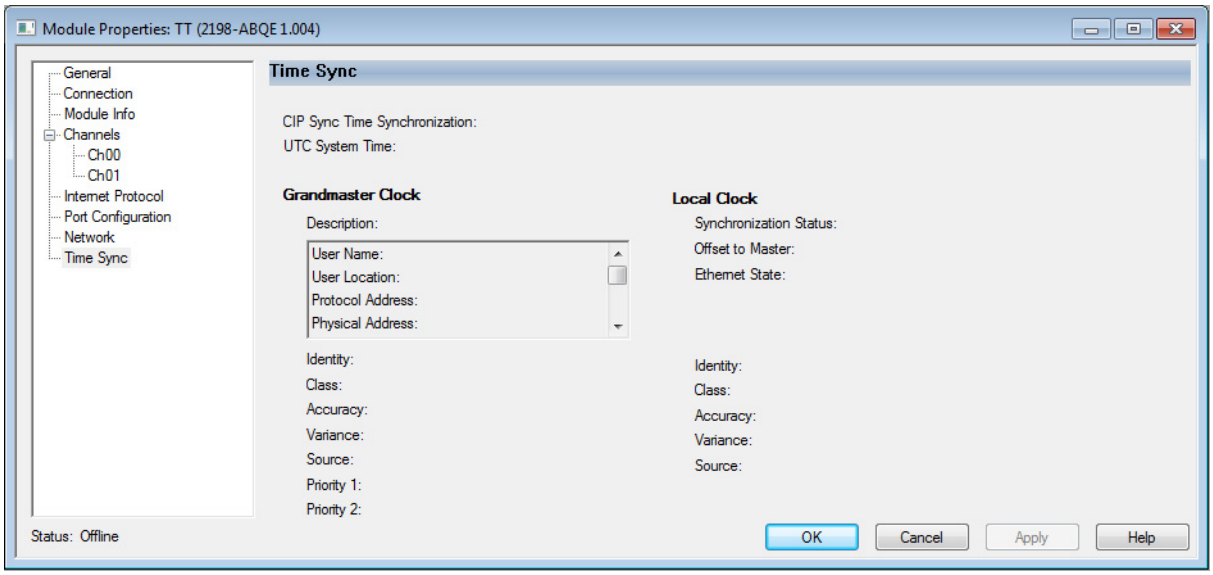


17. If you are online with the module, you can use this tab to manually configure the module's port configuration.
18. Click the Network tab.



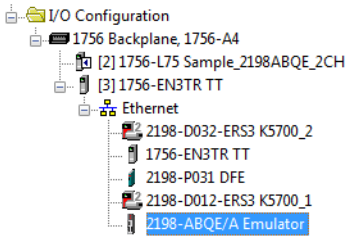
From the Network tab, you can check network status and information while online with the Logix 5000 controller.

19. Click the Time Sync tab.



From the Time Sync tab, you can check time sync information while online with the Logix 5000 controller.

20. Click OK to close the Module Properties dialog box.
21. Your 2198-ABQE Encoder Output Module appears in the Controller Organizer under the Ethernet network in the I/O Configuration folder.



22. Click Close to close the Module Properties dialog box.
23. Repeat step 1 through step 22 if you have more than one 2198-ABQE Encoder Output Module.

Download and Import the Encoder Output Module AOI

The Add-On Instructions (AOI) files for your encoder output module are available for download at the Rockwell Automation® Product Compatibility Download Center (PCDC) website.

Download the AOI Files

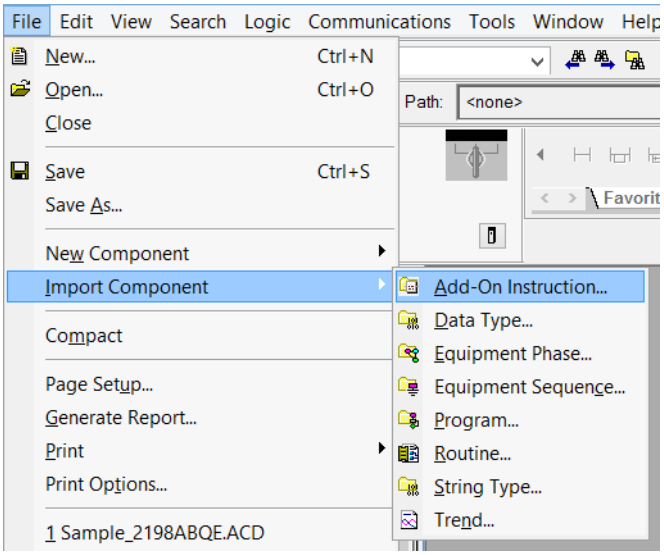
Follow these steps to download the AOI files from the PCDC website.

1. Go to http://compatibility.rockwellautomation.com/Pages/home.aspx and enter 2198-ABQE in the Search PCDC window.
2. Download the AOI files and save them to your personal computer.

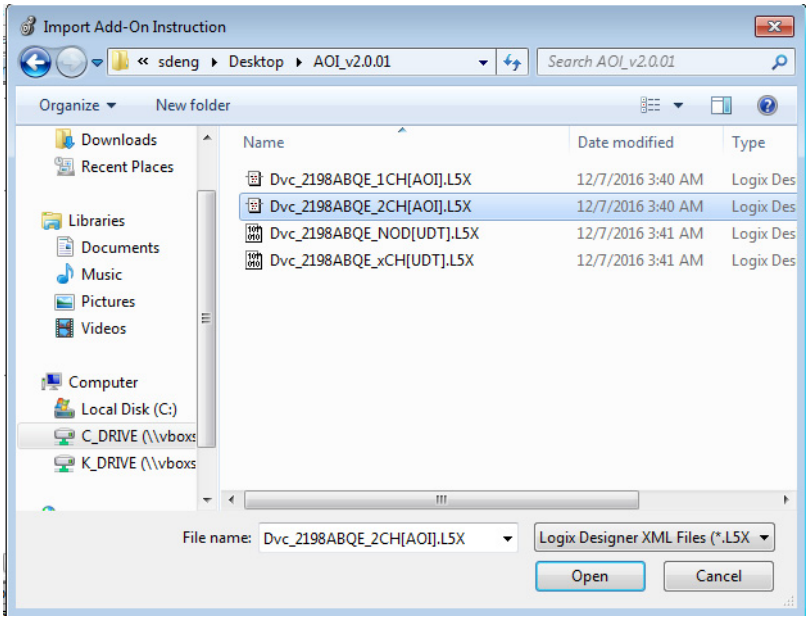
Import the AOI Files

Follow these steps to import the AOI files to your Studio 5000 Logix Designer application.

1. From the File menu, click Import Component>Add-On Instruction.

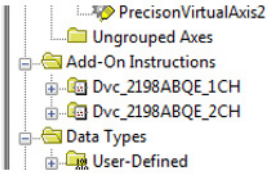


The Import Add-On Instruction dialog box appears.



2. Browse to the AOI files you downloaded and select a file to add to your Logix Designer application.
3. Click Open.
4. Repeat step 2 and step 3 for the other AOI file.

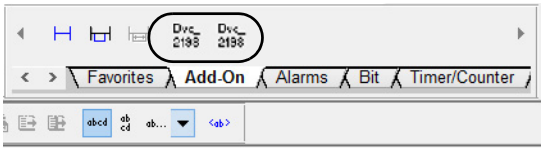
Your AOI files appear in the Controller Organizer under the Add-On Instructions folder.



There are two AOI files. One for use in applications that require one output channel (_1CH). These applications use Output A as the output port.

The other file is for use in applications that require two output channels (_2CH). These applications use Output A and Output B as the output ports.

The AOI files also appear in the ladder code toolbox.

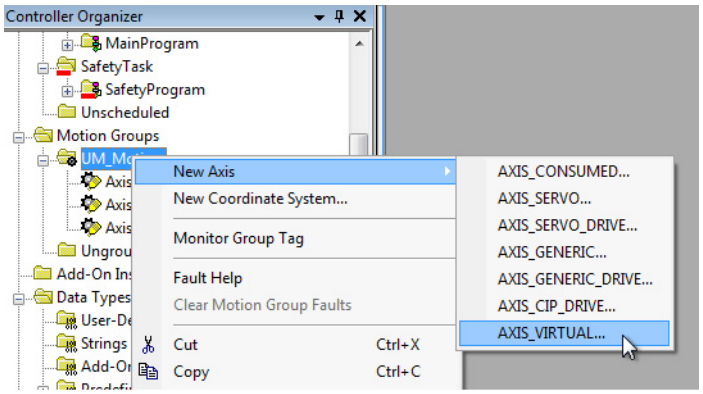


Configure the Channel Axis

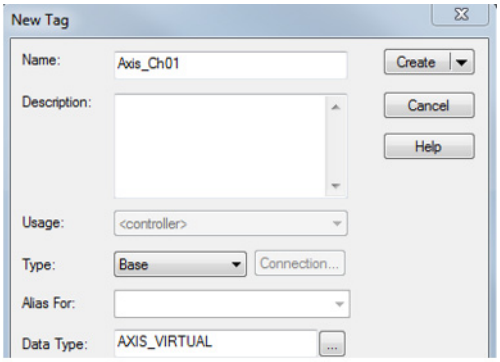
The 2198-ABQE encoder output module has two physical output channels (Output A and Output B). Each physical output channel requires the use of a virtual axis in the Logix Designer application. The Add-On Instruction (AOI) uses the output of the virtual axes, referred to as the channel axes, as inputs to the 2198-ABQE module.

Follow these steps to configure the channel axis in your Logix Designer application.

1. Create the channel axis.
   a. In the Controller Organizer, right-click a motion group and choose New Axis>AXIS_VIRTUAL.

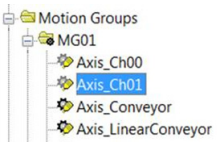


   The New Tag dialog box appears.



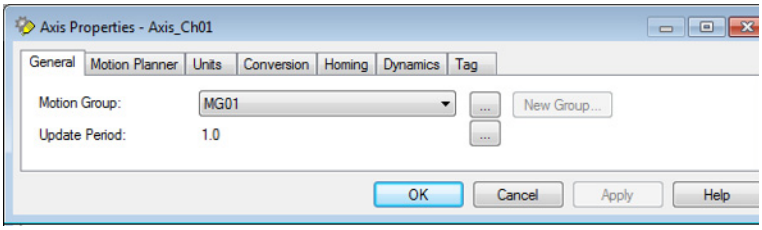
   b. Type the new axis Name.
   c. Click Create.

      Your new axis appears in the Controller Organizer under the Motion Groups folder.



2. Configure the channel axis.
   a. Right-click the new axis and choose Properties.

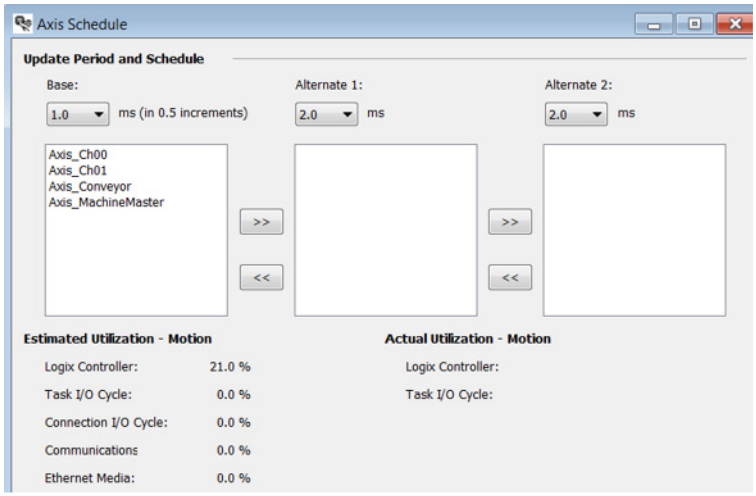
b. The Axis Properties>General tab dialog box appears.



The default Update Period value is 2.0.

c. To change the Update Period, click ... .

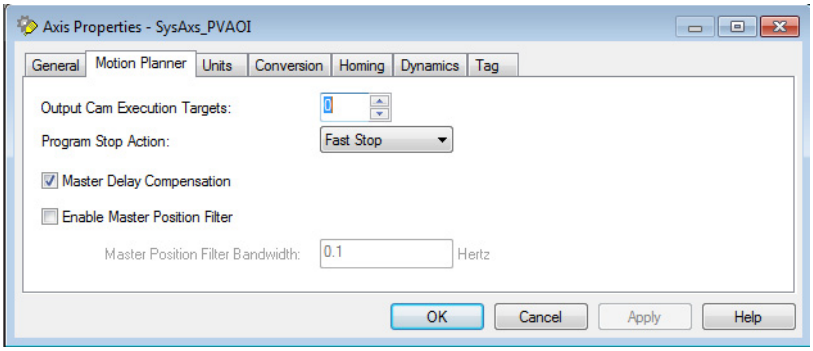
The Axis Schedule dialog box appears.



3. Set the update period for the axes in your motion group by moving them into different update period frames.

IMPORTANT Configure the channel axis, used to drive the AOI, to run in the same CUP subgroup at the same update period as the application axis that is driving it, ideally at the base update period in the base subgroup.

4. Click Apply.
5. Click the Motion Planner tab.



a. Check Master Delay Compensation.

This is the default setting. If the channel axis is configured to gear to the actual position of the application axis, then Master Delay Compensation must be enabled. This is critical to minimize error between the application-axis position and the output pulses that are generated by the module. If the channel axis is configured to gear to the command position of the application axis, Delay Compensation has no effect on the module performance.

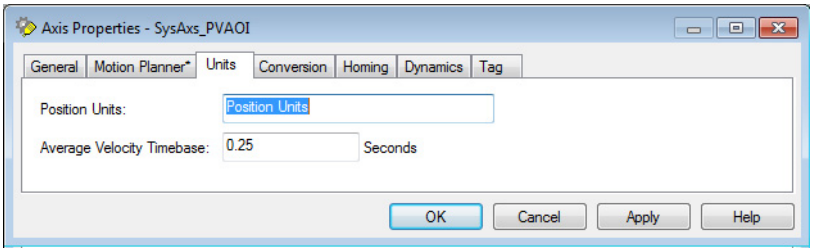
Only in special cases where the application does not require accurate tracking of the application axis' ActualPosition and where a filtered module output is beneficial, should Master Delay Compensation be disabled.

b. Do not check Enable Master Position Filter.

Enabling Master Position Filtering affects the output count and frequency in a manner that causes position counts to be lost.

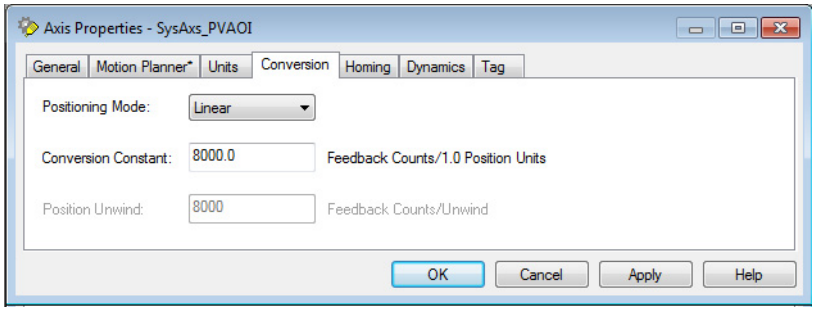
c. Click Apply.

6. Click the Units tab.



The Average Velocity Timebase parameter has no effect on the encoder output module.

7. Click the Conversion tab.



a. From the Positioning Mode pull-down menu, choose Linear.

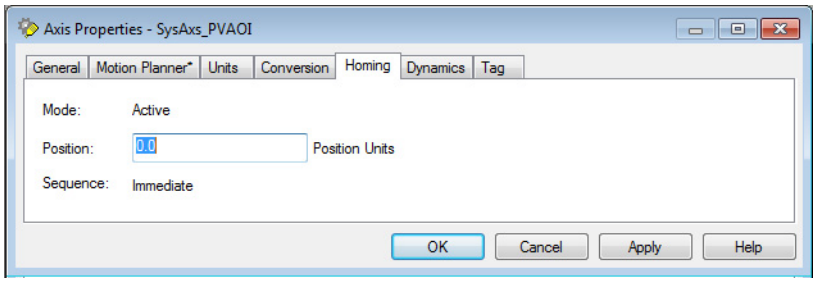
IMPORTANT The channel axis must be set to Linear, otherwise the AOI reports an error. Because the Positioning Mode is Linear, the position range in the module is fixed.

b. Enter the Conversion Constant value.

See System Scaling Method on page 52, to determine the Conversion Constant for your application.

c. Click Apply.

8. Click the Homing tab.



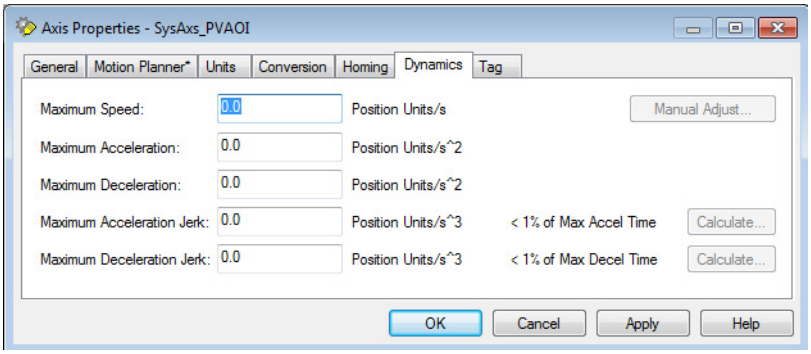
When in Absolute mode, homing the channel axis impacts the output of the module, so when Absolute mode is used, the homing position value is required.

9. Enter a Position value.

See Startup Methods on page 13, for descriptions of the Module Properties configuration options.

10. Click Apply.

11. Click the Dynamics tab.



The AOI sets the Axis Dynamics to the maximum values allowed for the module Conversion Constant settings, so there is no need to change these values.

12. Click OK.

13. Repeat steps step 1 through step 12 to create and configure a second channel axis for the module, if both output channels are used in the application.

Motion Event Task Creation and Application

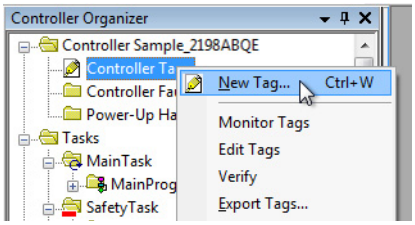
The AOI instructions must be executed in the motion-event periodic task. By utilizing the motion-event periodic task, the application axis' command position information is sent to the encoder output module at the base coarse update period.

Create the AOI Tag

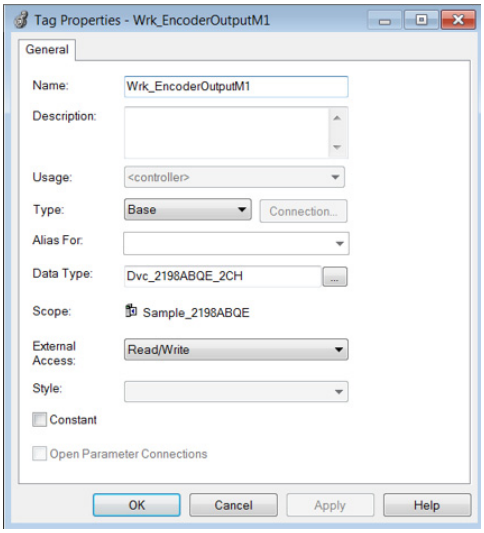
Controller tags, which are used for controlling and using the instructions in the Logix Designer application, exchange data between the Logix 5000 controller and the encoder output module.

Follow these steps to create the AOI tag.

1. In the Controller Organizer, right-click Controller Tags and click New Tag.



The Tag Properties dialog box appears.



2. Type a name for the Tag.

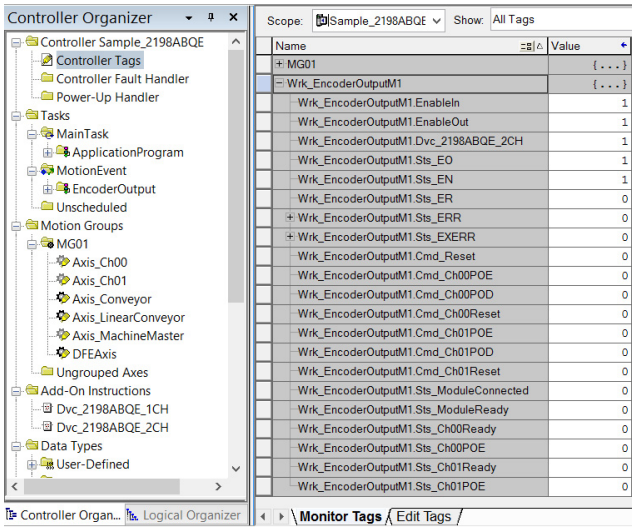
   In this example, the name is Wrk_EncoderOutputM1.

3. In the Data Type field, click the browse button and choose an AOI.

   In this example, Data Type Dvc_2198ABQE_2CH is chosen because two output channels are used. Dvc_2198ABQE_1CH applies when one output channel is used.

4. Click OK.

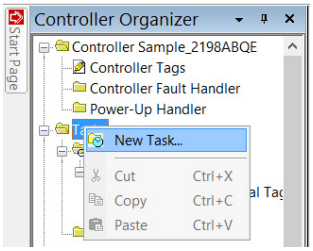
5. The AOI tag that you just created, with the module-defined data types, populates in the Controller Tags group.



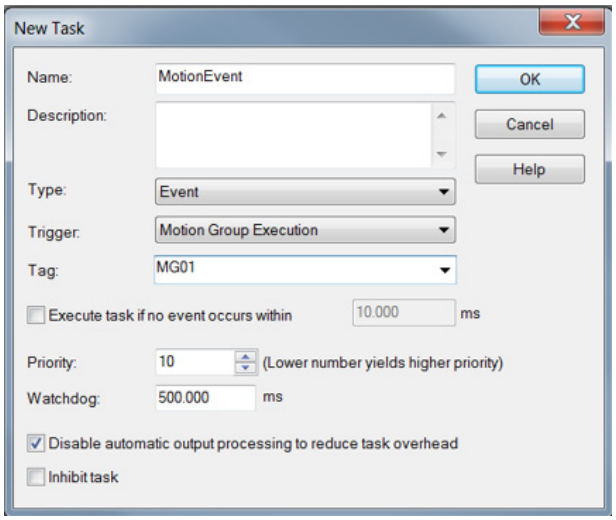
Create Motion Event Task

Follow these steps to create a motion event task for using the AOI.

1. In the Controller Organizer, right-click Tasks and click New Task.



The New Task dialog box appears.



a. Enter a name for the new task.

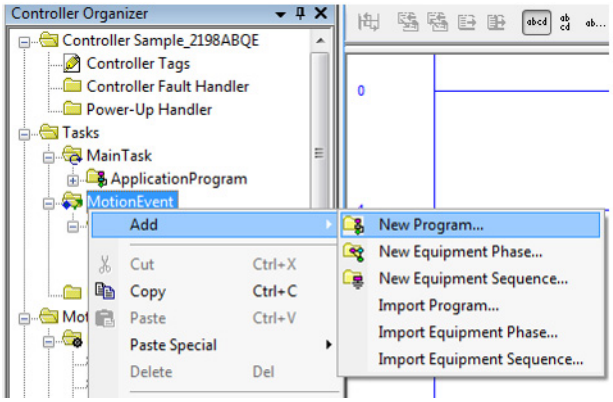
b. From the Type pull-down menu, choose Event.

c. From the Trigger pull-down menu, choose Motion Group Execution.

d. From the Tag pull-down menu, choose the motion group tag.

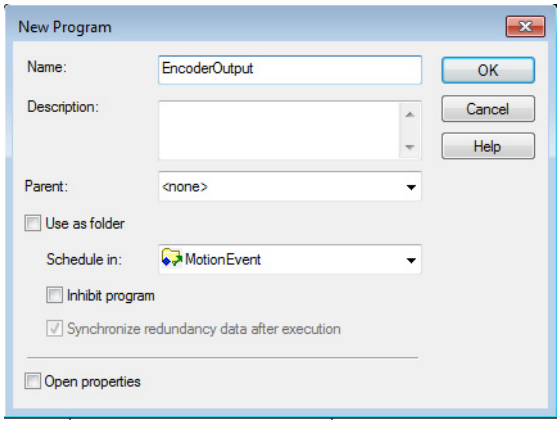
2. Click OK.

   The new MotionEvent task that you just created appears in the Controller Organizer, under Tasks.



3. Right-click MotionEvent, select Add, and click New Program.

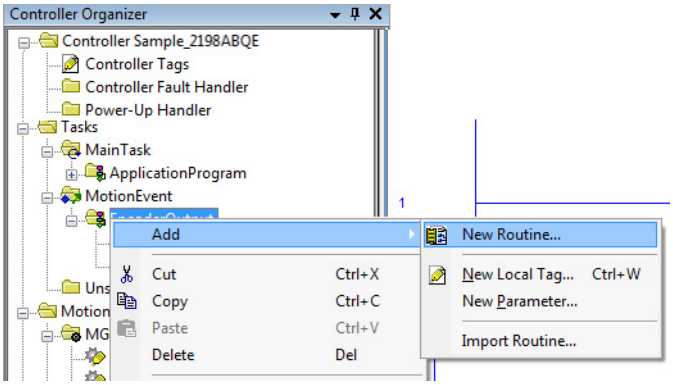
   The New Program dialog box appears.



4. Enter a name for your new program.

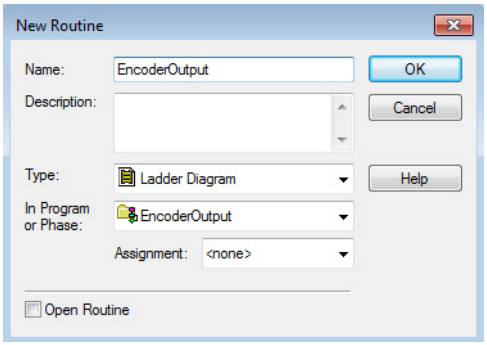
5. Click OK.

The new Motion Event program that you just created appears in the controller organizer, under MotionEvent.



6. Right-click the new Motion Event program, select Add, and click New Routine.

   The New Routine dialog box appears.



7. Enter a name for your new routine.
8. Click OK.

   The new routine that you just created appears in the Controller Organizer, under the MotionEvent program.

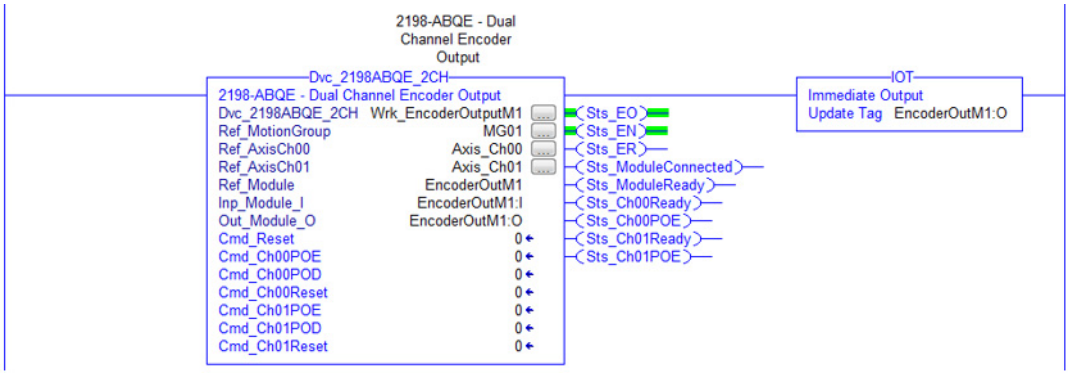
9. Click the new routine, and add the Encoder Output AOI into the new routine.
10. An IOT instruction must also be added after the Encoder Output AOI.
11. Configure the AOI with the appropriate tags.

    See AOI Tag Definitions on page 71, for tag information.

AOI Configuration

In this example, the Dual-channel Encoder Output AOI is shown.

IMPORTANT The AOI must execute continuously while the module is running.



IMPORTANT Many of the output assembly data members for the encoder output module are controlled in the Add-On Instructions and must not be overwritten. Refer to Table 31 and Table 32 on page 69 for more information.

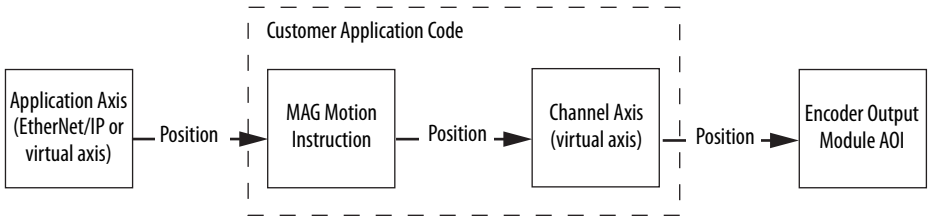
Download the Program

After completing the Logix Designer application and saving the file, you must download your program to the Logix 5000 processor.

System Scaling Method

Use the system scaling method to define the output signals that are generated by the encoder output module. Other methods can be used to achieve the same result. See Appendix B, beginning on page 73, for an explanation of the relationship between the various scaling parameters that impact the encoder output module signals.

Figure 20 - Encoder Output Module - Logix Designer Application Integration

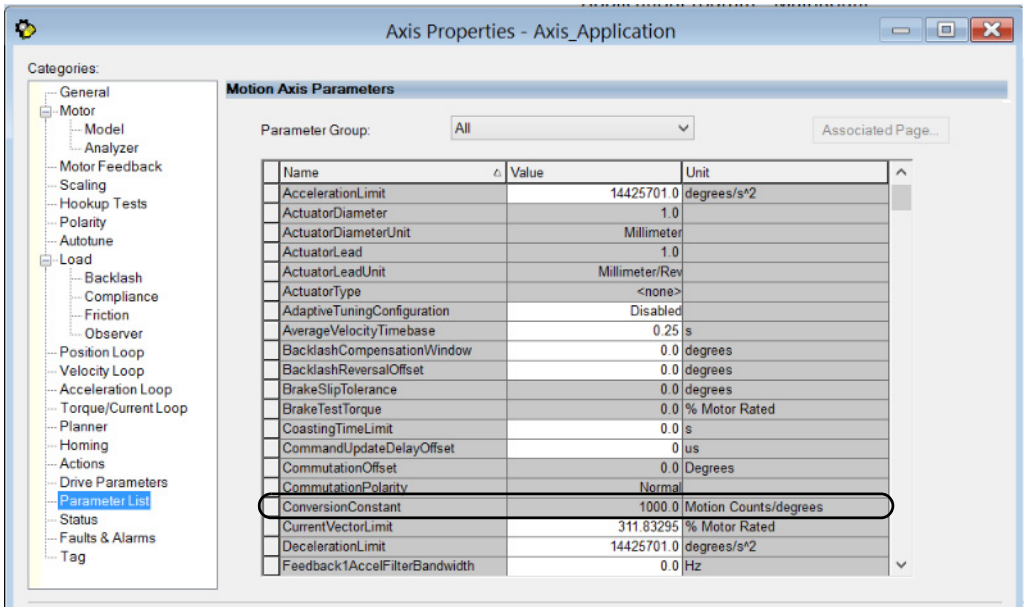


When using the system scaling method, described in this section, the module outputs pulses at the maximum frequency that either the peripheral device can receive or the module can achieve, whichever is the lesser of the two. For this method, the following configuration parameters are used to define the module output pulses:

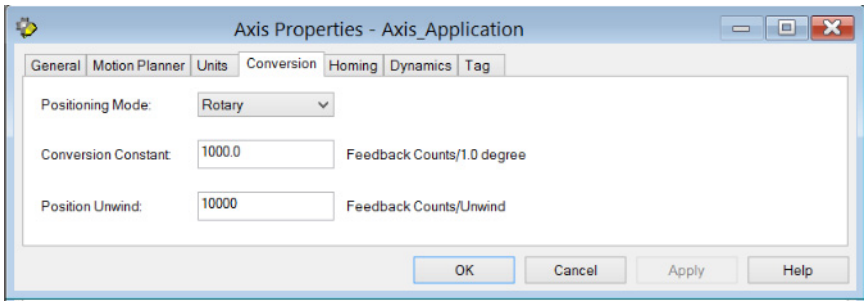
- Conversion Constant for channel axis
- Slave Counts for MAG instruction
- Master Counts for MAG instruction

Conversion Constant for Channel Axis

The Conversion Constant for the channel axis is set to the same value as the Conversion Constant for the application axis. If the application axis is a real axis, you can find the Conversion Constant in the Parameter List tab of the Axis Properties dialog box.



If the application axis is a virtual axis, the Conversion Constant is configured in the Conversion tab of the Axis Properties dialog box.



Slave Counts in MAG Instruction

Use the following equation to determine the Slave Counts operand when using the Fraction Ratio Format in the MAG instruction.

$$\text{Slave Counts} = \frac{\text{Frequency Limit} * \text{Position Scale}}{\text{Speed}}$$

Where:

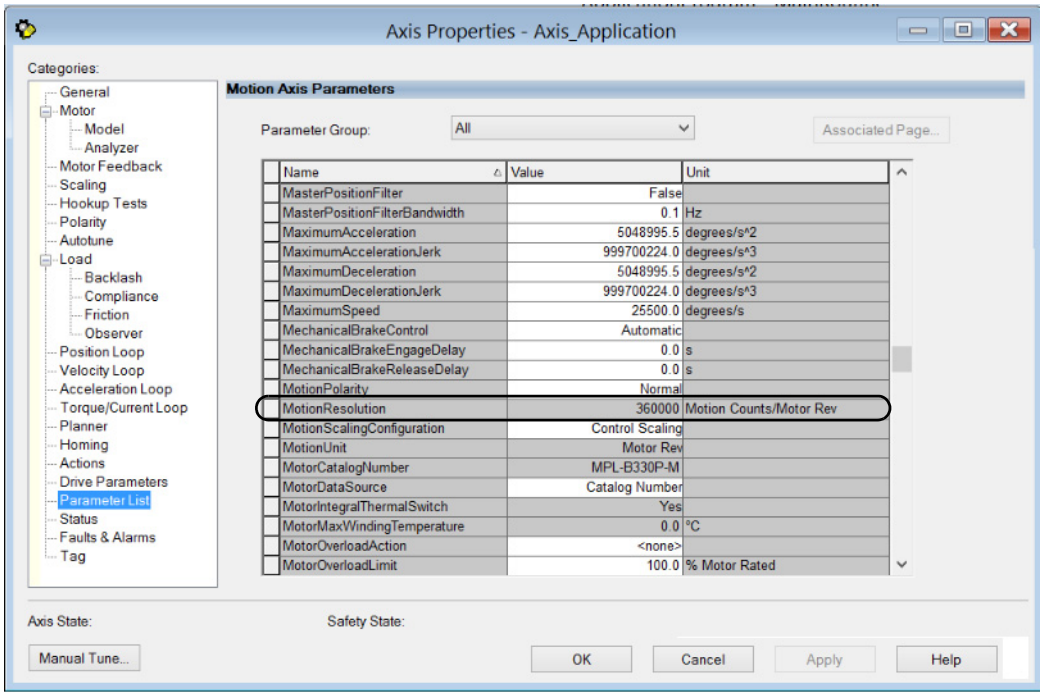
- Slave Counts = slave counts operand in MAG instruction
- Frequency Limit = minimum device frequency limit in counts per second (either the peripheral device or Encoder Output module)
- Position Scale = the ratio of application axis position units to motion units (1)
- Speed = maximum application speed in application-axis position units per second

(1) Motion Units depend on the Load Type selected in the Scaling tab of the Axis Properties. Motion Units are revs for Direct Coupled Rotary, load revs for Rotary Transmission, and load mm for Linear Actuator.

Master Counts in MAG Instruction

The Master Counts operand in the MAG instruction is set to the number of motion counts per motion unit. (1)

If the application axis is a real axis, the Master Counts operand is the MotionResolution value that can be found in the Parameter List tab of the Axis Properties dialog box.



If the application axis is a virtual axis, use the following equation to calculate the Master Counts operand:

$$\text{Master Counts} = \text{Conversion Constant} * \text{Position Scale}$$

Where:

- Master Counts = master counts operand in MAG instruction
- Conversion Constant = conversion constant of the application axis
- Position Scale = the ratio of application axis position units to motion units (1)

(1) Motion Units depend on the Load Type selected in the Scaling tab of the Axis Properties. Motion Units are revs for Direct Coupled Rotary, load revs for Rotary Transmission, and load mm for Linear Actuator.

Application Scaling Example

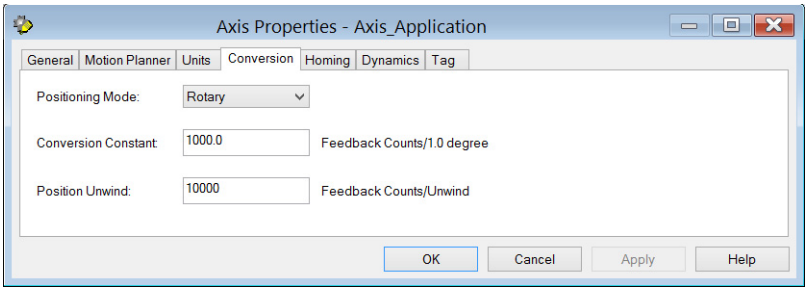
The following example illustrates how to configure the encoder output module to achieve the desired scaling for an application.

The module is used to send encoder signals to a line scan camera. The machine uses a virtual axis to synchronize the motion throughout the machine, so, in this case, the virtual axis is the application axis for the encoder output module. In this example, an AqB signal is generated by the module, so four counts (or pulse edges) are generated for a single encoder pulse cycle. See Digital AqB on page 15 for more information on the relationship between pulses and counts. For each count that the module sends to the camera, the camera takes a single pixel-wide image that is used to construct a final image of the product as it passes by the camera.

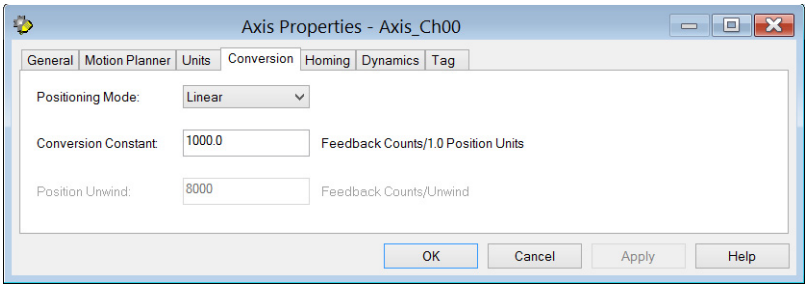
Follow these steps to set the system scaling for the encoder output module.

1. Determine the Conversion Constant for the application axis.

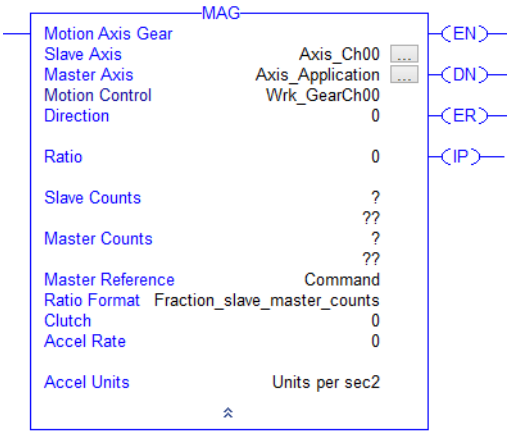
   Because, in this example, the application axis is a virtual axis, you copy the Conversion Constant value from the Conversion tab of the Axis Properties dialog box. The Conversion Constant is application-dependent. For this example, the Conversion Constant is 1000 feedback counts per degree, which is typical when the axis position units are degrees.



2. Enter the Conversion Constant value for the channel axis equal to the Conversion Constant of the application axis.



3. Configure the Motion Axis Gear instruction Ratio Format as Fractional.



4. Calculate and configure the Slave Counts value for the Motion Axis Gear instruction.

$$\text{Slave Counts} = \frac{\text{Frequency Limit} * \text{Position Scale}}{\text{Speed}}$$

The frequency limit is the lesser of the peripheral-device frequency limit and the encoder output module frequency limit. The following points describe the various frequency limits that must be accounted for in this application:

- Because we have chosen the AqB signal type, the module can output signals at a rate of 1,000,000 pulses per second, or 4,000,000 counts per second.
- The camera can receive pulses at a rate of 99,200 pulses per second, or 396,800 counts per second.
- The line scan camera can only capture up to 44,000 line images per second. Because we have specified that the camera takes one line image per count, the frequency limit for the camera is 44,000 counts per second.

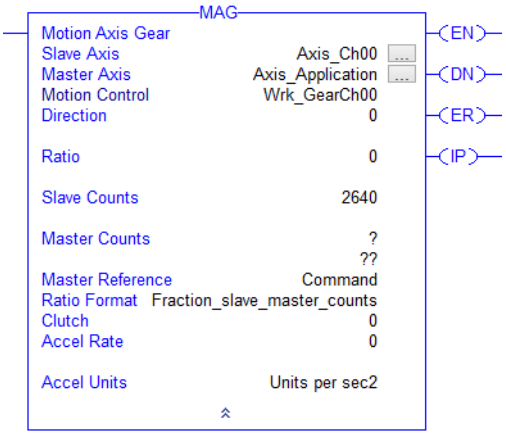
Therefore, the minimum frequency limit for this system is 44,000 counts per second.

The position scale value is the ratio of application-axis position units to motion units. For this example, the position units are degrees, and because the application-axis positioning mode is rotary, the motion units are revolutions. So, the Position Scale value is 360 degrees per revolution.

The speed value is the maximum application speed in position units per second. For this example, the maximum application speed is given as 6000 degrees per second.

Use the following equation to calculate Slave Counts:

$$\text{Slave Counts} = \frac{\left(44{,}000\ \frac{\text{counts}}{\text{s}}\right) * \left(360\ \frac{\text{degrees}}{\text{rev}}\right)}{\left(6000\ \frac{\text{degrees}}{\text{s}}\right)} = 2640\ \frac{\text{counts}}{\text{rev}}$$



5. Calculate and configure the Master Counts value for the Motion Axis Gear instruction.

   $$\text{Master Counts} = \text{Conversion Constant} * \text{Position Scale}$$

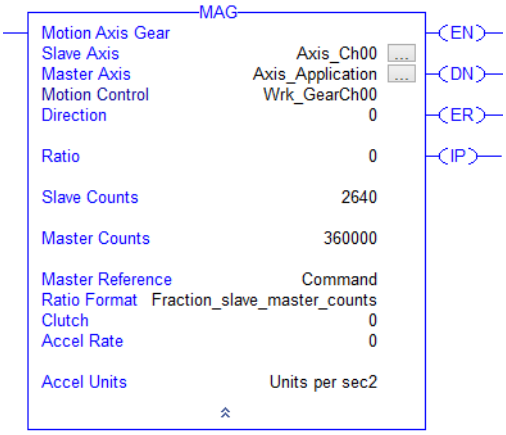
   For this example, the Conversion Constant for the application axis is 1000 feedback counts per degree, which is typical when the axis position units are degrees.

   The position scale value is 360 degrees per revolution.

Use the following equation to calculate Master Counts:

$$\text{Master Counts} = \left(1000\ \frac{\text{counts}}{\text{degrees}}\right) * \left(360\ \frac{\text{degrees}}{\text{rev}}\right) = 360{,}000\ \frac{\text{counts}}{\text{rev}}$$

With this configuration, the following is true:



- 360,000 feedback counts are generated by the application axis for each revolution of the application axis.
- 2640 counts are generated by the encoder output module for each revolution of the application axis.
- When the application axis is moving at the maximum application speed of 6000 degrees per second, the encoder output module generates counts at the rate of 44,000 counts per second, which is the maximum rate that the line scan camera can capture line images.

IOT Instruction Usage

IMPORTANT An IOT instruction must be applied after applying the module's AOI instruction. This instruction is used to transmit the module's Output Assembly data immediately after the AOI executes. If the IOT instruction is not applied, the encoder output module performance is affected.

After completing setting/configuration to the instruction in the Motion Event Task, all output assembly data is updated per the CUP you specified.

IMPORTANT The Update tag in the IOT instruction must match the Output_Module_0 tag in the AOI.

Troubleshoot the Encoder Output Module

This chapter provides troubleshooting tables and related information for your encoder output module.

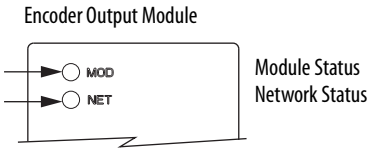
Safety Precautions

Observe the following safety precautions when troubleshooting your encoder output module.

ATTENTION: Do not attempt to defeat or override the module fault circuits. You must determine the cause of a fault and correct it before you attempt to operate the system. Failure to correct the fault could result in personal injury and/or damage to equipment as a result of uncontrolled machine operation.

ATTENTION: Provide an earth ground for test equipment (oscilloscope) used in troubleshooting. Failure to ground the test equipment could result in personal injury.

Interpret Status Indicators



See these troubleshooting tables to interpret the encoder output module status indicators. If a fault condition persists after attempting to troubleshoot the system, contact your Rockwell Automation sales representative for further assistance.

Table 14 - Module Status Indicator

Condition	Status
Steady Off	No power applied to the module.
Steady Green	Module is operational. No device failures or faults exist. If one recoverable channel fault exists, the other channel is fully operational.
Flashing Green	Standby (the module not configured).
Flashing Red	Major recoverable fault. The module detected a recoverable fault, for example, an incorrect or inconsistent configuration. Another condition leading to this status is that both channels have recoverable faults, or only one channel has a non-recoverable fault.
Steady Red	Major unrecoverable fault. The module detected an non-recoverable device fault, or both channels have non-recoverable faults.
Flashing Green/Red	Self-test. The module performs self-test during powerup.

Table 15 - Module Status Indicator with Device Fault

Status	Fault
Steady Red	Runtime Error Fault
Steady Red	Clock Skew Fault
Steady Red	Clock Sync Fault
Flashing Red	Unassigned MAC Address Fault
Flashing Red	Duplicate IP Address Fault
Flashing Red	Processor Watchdog Fault
Flashing Red	Controller Connection Loss Fault

Table 16 - Module Status Indicator with Channel Fault

Status	One Channel	Other Channel
Steady Green	Frequency Fault	No fault
Steady Green	Position Update Fault	No fault
Steady Green	Internal Fault	No fault
Steady Green	Field Power Fault	No fault
Steady Green	Update Period Fault	No fault
Steady Red	Internal Fault	Internal Fault
Flashing Red	All other combinations of 2 channel faults	

Ethernet RJ45 Connectors

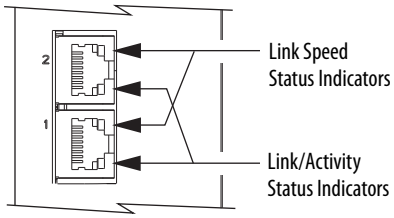


Table 17 - Network Status Indicator

Condition	Status
Steady Off	No power applied to the module or IP address is not configured.
Flashing Green	No connection is established, but module has obtained an IP address.
Steady Green	The connection is established and no timeout has occurred. Normal operation.
Flashing Red	Connection timeout. The connection for which this module is the target, has timed out.
Steady Red	Duplicate IP address. IP address specified is already in use.
Flashing Green/Red	Self-test. The module performs self-test during powerup.

Table 18 - Ethernet Link Speed Status Indicator

Condition	Status
Steady Off	10 Mbit
Steady On	100 Mbit

Table 19 - Ethernet Link/Activity Status Indicator

Condition	Status
Steady Off	No link
Steady On	Link established
Blinking	Network activity

Module Fault Codes

See these troubleshooting tables to identify faults, potential causes, and the appropriate actions to resolve the fault. If the fault persists after attempting to troubleshoot the encoder output module, contact your Rockwell Automation sales representative for further assistance.

Anytime a fault occurs the following status information is available from within the module:

- The module status indicator reflects the module condition. See Module Status Indicator on page 60 for conditions and status.
- The module creates an entry in an internal fault log. Access the fault log through the web server interface. See Appendix C on page 79 for more information.
- The module lists the most recent active fault on the Home tab of the web serve interface.
- Some of the fault conditions are indicated in a data member in the input assembly. See Appendix A on page 67 for more information.

The internal fault log holds 25 records and cannot be cleared.

Non-recoverable major faults require a module power cycle or a module reset. If the module is not communicating with the controller, a module reset is not possible. You can reset recoverable major faults by setting FaultReset in the output assembly.

Table 20 - Fault Code Summary

Fault/Alarm Code Type	Description
Device Fault	A condition that stops the module from creating output pulses on both channels.
Channel Fault	A condition that stops the module from creating output pulses on one channel. The other channel is not affected.
Device Alarm	A condition exists that can prevent normal operation of the module, but does not result in any other action.
Channel Alarm	A condition exists that can prevent normal operation of one channel, but does not result in any other action. The other channel is not affected.

Table 21 - Device Fault Codes

Fault Text on Web Page	Data Member	Fault	Problem	Possible Solutions
RUNTIME ERROR FAULT	<Name>:I:RuntimeErrorFault	Runtime Error Fault	The module firmware encountered an non-recoverable runtime error.	• Cycle control power • Inhibit and Reset the drive • Return the module for repair if fault continues
CLOCK SKEW FAULT	<Name>:I:ClockSkewFault	Clock Skew Fault	The controller time and the module's system time are not the same.	• Cycle control power • Inhibit and Reset the module • Check the controller and Ethernet switch operation
CLOCK SYNC FAULT	<Name>:I:ClockSyncFault	Clock Sync Fault	Module's local clock has lost synchronization with the controller's clock and was not able to resynchronize within the allotted time.	• Check the Ethernet connection • Check the controller and Ethernet switch operation
UNASSIGNED MAC ADDRESS FAULT	N/A	Unassigned MAC Address Fault	The MAC address is missing or invalid.	• Cycle control power • Reset the module • Return the module for repair if the fault continues
DUPLICATE IP ADDRESS FAULT	N/A	Duplicate IP Address Fault	The module and another Ethernet devices on the same subnet have identical IP addresses.	Select an IP address not already in use on the network
PROCESSOR WATCHDOG FAULT	N/A	Processor Watchdog Fault	The processor failed to update in a certain amount of time.	• Cycle control power • Update the module firmware • Return the module for repair if fault the continues
CONTROLLER CONNECTION LOSS FAULT	N/A	Controller Connection Loss Fault	Communication with the controller has been lost.	• Check the Ethernet connection • Check the controller and Ethernet switch operation

Table 22 - Channel Fault Codes

Fault Text on Web Page	Data Member	Fault	Problem	Possible Solutions
FREQUENCY FAULT	<Name>:I:FrequencyFault	Frequency Fault	The output frequency has been limited to the Frequency Limit for a time exceeding the FrequencyFaultLimitTime	• Channel fault reset • Cycle control power • Inhibit and reset the module • Increase the FrequencyFaultLImitTime
INTERNAL FAULT	<Name>:I:InternalFault	Internal Fault	The module cannot generate the output pulses properly or there is a loss of internal power.	• Cycle control power • Inhibit and reset the module • Return the module for repair if the fault continues
FIELD POWER FAULT	<Name>:I:FieldPowerFault	Field Power Fault	• A 12…30V DC field power supply is connected to the output connector when the differential signal type is selected. • The 12…30V DC field power supply is missing when the single-ended signal type is selected.	• Remove the 12…30V DC field power with differential signal type and reset the channel fault. • Connect the 12…30V DC field power with single-ended signal type and reset the channel fault • Remove control power, connect or disconnect field power, then reapply control power
POSITION UPDATE FAULT	<Name>:I:PositionUpdateFault	Position Update Fault	The module has not received an update from the AOI for a specific time. The AOI may be faulted.	Clear the AOI fault and reset the channel fault.
UPDATE PERIOD FAULT	<Name>:I:UpdatePeriodFault	Update Period Fault	The channel Coarse Update Period is >32 ms or < 1 ms.	• Go offline • Reconfigure the Coarse Update Period in the motion group • Download the program to the controller.

Table 23 - Device Alarm Codes

Fault Text on Web Page	Data Member	Alarm	Problem	Possible Solutions
CLOCK SYNC ALARM	<Name>:I:ClockSyncAlarm	Clock Sync Alarm	The module's local clock has lost synchronization with controller's clock for a short time during synchronous operation. Continued loss of synchronization will result in a fault.	• Check the Ethernet connection • Check controller and Ethernet switch operation
CLOCK JITTER ALARM	<Name>:I:ClockJitterAlarm	Clock Jitter Alarm	The synchronization variance has exceeded the threshold while the module is synchronized.	• Check the Ethernet connection • Check the controller and Ethernet switch operation
CLOCK SKEW ALARM	<Name>:I:ClockSkewAlarm	Clock Skew Alarm	The controller time and the module's time are not the same.	• Check the Ethernet connection • Check the controller and Ethernet switch operation
IP ADDRESS MISMATCH	<Name>:I:IPAddressMismatch	IP Address Mismatch	The IP address switches were changed after the module powered up.	Change the IP address switches back

Table 24 - Channel Alarm Codes

Fault Text on Web Page	Data Member	Alarm	Problem	Possible Solutions
FREQUENCY ALARM	<Name>:I:FrequencyAlarm	Frequency Alarm	The output frequency has exceeded the Frequency Limit for a time less than the FrequencyFaultLimitTime.	Lower the output frequency
RPI UPDATE PERIOD MISMATCH	<Name>:I:RPIUpdatePeriod Mismatch	RPI Update Period Mismatch	The module RPI is larger than the Coarse Update Period of the axis associated with this channel.	• Go offline • Reconfigure the motion group Coarse Update Period or module RPI • Download the program to the controller.

Module Fault Behavior

The fault behavior of the encoder output module, as defined in Table 25, is shown in the device fault and channel fault behavior tables.

IMPORTANT The module fault behavior is not configurable in the Studio 5000 Logix Designer® application.

Table 25 - Module Fault Action Definitions

Fault Action	Definition
Disable Channel	The channel with channel fault is disabled and no pulses are output from that channel. The other channel is not affected.
Disable Outputs	Both channels are disabled and no pulses are output from both channels.

Table 26 - Device Fault Behavior

Fault Text on Web Page	Data Member	Fault	Fault Action	
			Disable Channel	Disable Outputs
RUNTIME ERROR FAULT	<Name>:I:RuntimeErrorFault	Runtime Error Fault		X
CLOCK SKEW FAULT	<Name>:I:ClockSkewFault	Clock Skew Fault		X
CLOCK SYNC FAULT	<Name>:I:ClockSyncFault	Clock Sync Fault		X
UNASSIGNED MAC ADDRESS FAULT	N/A	Unassigned MAC Address Fault		X
DUPLICATE IP ADDRESS FAULT	N/A	Duplicate IP Address Fault		X
PROCESSOR WATCHDOG FAULT	N/A	Processor Watchdog Fault		X
CONTROLLER CONNECTION LOSS FAULT	N/A	Controller Connection Loss Fault		X

Table 27 - Channel Fault Behavior

Fault Text on Web Page	Data Member	Fault	Fault Action	
			Disable Channel	Disable Outputs
FREQUENCY FAULT	<Name>:I:FrequencyFault	Frequency Fault	X	
INTERNAL FAULT	<Name>:I:InternalFault	Internal Fault	X	
FIELD POWER FAULT	<Name>:I:FieldPowerFault	Field Power Fault	X	
POSITION UPDATE FAULT	<Name>:I:PositionUpdateFault	Position Update Fault	X	
UPDATE PERIOD FAULT	<Name>:I:UpdatePeriodFault	Update Period Fault	X	

Add-On Instruction Errors

See this troubleshooting table to identify AOI errors and possible solutions to resolve the error. If the error persists after attempting to troubleshoot the program, contact your Rockwell Automation sales representative for further assistance.

Table 28 - Add-On Instruction Errors

Error Value	Description	Possible Solutions
1010	Time synchronization is disabled.	Enable controller time synchronization.
1011	Time synchronization was lost. If the controller is a time slave, time sync has been lost for >60 seconds.	• Check Ethernet connection • Check controller and Ethernet switch operation
1012	A Motion Event Task overrun occurred.	• Decrease the motion group Base Update Period • Decrease the course update period that is associated with the application axis • Reallocate axes to other Logix 5000™ processors
1013	The connected encoder output module is in a faulted state.	See Table 21 on page 62 and Table 22 on page 63 for device and channel fault codes respectively.
1014	Invalid Position mode configuration in the channel axis for the first channel.	Configure the channel axis as linear.
1015	Invalid Position mode configuration in the channel axis for the second channel.	Configure the channel axis as linear.

Notes:

Module Tag and AOI Tag Definitions

This appendix provides module tag definitions and AOI tag definitions for use when configuring encoder output module parameters.

Module-defined Data Types

The following tables list and describe the module-defined data types for the 2198-ABQE encoder output module. The module tags observe the following naming conventions.

In this example, the tag name is EncoderOutM:I.Ch00.State.

- EncoderOutM = name of the encoder output module
- I = tag type

  Tag types include: C (configuration), I (input), and O (output).
- Ch00 = module channel number

  The module has two channels: Ch00 and Ch01.
- State = data member

  In this example, State represents the current state of the channel.

Table 29 - Encoder Output Module - Input Tags (module specific)

Member Name	Type	Description	Valid Values
RunMode	BOOL	Indicates the module's operating state.	0 = Idle 1 = Run mode
ConnectionFaulted	BOOL	Indicates if a connection is running.	0 = Connection running 1 = Connection not running
DiagnosticActive	BOOL	Indicates if any diagnostics are active.	0 = No diagnostics are active 1 = One or more diagnostics are active
CIPSyncValid	BOOL	Indicates whether the module is synced with a 1588 master.	0 = The module is not synchronized and cannot provide a valid output. 1 = The module is synchronized and can provide a valid output.
CIPSyncTimeout	BOOL	Indicates that the module was once synced with a 1588 master, but is no longer synchronized due to a timeout.	0 = A valid time master has not timed out. 1 - A valid time master was detected, but the time master has timed out.

Table 29 - Encoder Output Module - Input Tags (module specific) (continued)

Member Name	Type	Description	Valid Values
DiagnosticSequenceCount	SINT	A counter that increments each time that a distinct diagnostic condition is detected, and when a distinct diagnostic condition transitions from detected to not detected. • Set to zero by product reset or power cycle. • Wraps from 255 (-1)…1 skipping zero.	-128…127 The value of 0 is skipped except during module power-up.
RuntimeErrorFault	BOOL	The module has an internal software error. Communication may be unreliable.	0 = Fault is not active. 1 = Fault is active.
ClockSkewFault	BOOL	The local clock has been skewed with the grandmaster clock for a time exceeding the fault threshold.	0 = Fault is not active. 1 = Fault is active.
ClockSyncFault	BOOL	The local clock has lost synchronization with the grandmaster clock for a time exceeding the fault threshold.	0 = Fault is not active. 1 = Fault is active.
ClockSyncAlarm	BOOL	The local clock has lost synchronization with the grandmaster clock for a time exceeding the fault threshold.	0 = Alarm is not active. 1 = Alarm is active.
ClockJitterAlarm	BOOL	Jitter between the local clock and grandmaster clock has occurred for a time exceeding the alarm threshold.	0 = Alarm is not active. 1 = Alarm is active.
ClockSkewAlarm	BOOL	The local clock has been skewed with the grandmaster clock for a time exceeding the alarm threshold.	0 = Alarm is not active. 1 = Alarm is active.
IPAddressMismatch	BOOL	The IP address switch values have been changed after the module has detected the switch values and used them to set the IP address.	0 = Alarm is not active. 1 = Alarm is active.
SyncStatus	SINT	The module synchronization status.	0 = Synchronized 1 = Not Synchronized 2 = Incorrect Grandmaster Clock 3 = Clock Skewed 4 = Initializing

Table 30 - Encoder Output Module - Input Tags (channel specific)

Member Name	Type	Description	Valid Values
Ch0*x*.FrequencyFault	BOOL	The channel has limited the output frequency to the Frequency Limit for a time period exceeding the Frequency Limit Fault Time.	0 = Fault is not active. 1 = Fault is active.
Ch0*x*.Fault	BOOL	A fault exists that disables the channel output signal.	0 = Fault is not active. 1 = Fault is active.
Ch0*x*.Uncertain	BOOL	Detects if an alarm exists that may adversely affect the channel output signal or if the module has not yet synchronized with the controller.	0 = Uncertain is not active. 1 = Uncertain is active.
Ch0*x*.InternalFault	BOOL	Detects if the channel has an internal hardware error	0 = Fault is not active. 1 = Fault is active.
Ch0*x*.FieldPowerOff	BOOL	Detects if an external power supply is connected. An external supply is required to support single-ended output signals.	0 = An external power supply for single-ended outputs is detected. 1 = An external power supply for single-ended outputs is not detected.
Ch0*x*.FieldPowerFault	BOOL	Detects if the Signal Type and Field Power are compatible. Field power must be disconnected for a Differential signal type. Field power must be connected for a Single-ended signal type.	0 = Fault is not active. 1 = Fault is active.
Ch0*x*.PositionUpdateFault	BOOL	Detects if the channel has not received position updates from the controller for the time threshold.	0 = Fault is not active. 1 = Fault is active.
Ch0*x*.UpdatePeriodFault	BOOL	Detects if the axis update period being emulated on this channel is outside of the capability of the module.	0 = Fault is not active. 1 = Fault is active.
Ch0*x*.FrequencyAlarm	BOOL	Detects if the channel is limiting the output frequency to the Frequency Limit.	0 = Alarm is not active. 1 = Alarm is active.

Table 30 - Encoder Output Module - Input Tags (channel specific) (continued)

Member Name	Type	Description	Valid Values
Ch0*x*.RPIUpdatePeriodMismatch	BOOL	Detects when the RPI of the module connection is higher than the axis update period being emulated on this channel.	0 = Mismatch is not active. 1 = Mismatch is active.
Ch0*x*.UpdateID	SINT	A counter heartbeat to confirm that the AOI is receiving updates from the channel.	-128…127
Ch0*x*.State	SINT	Operational State of the channel.	0 = Initializing 1 = Standby 2 = Stopped 3 = Running 4 = Major Faulted 5 = Minor Faulted
Ch0*x*.PositionTrackingStatus	BOOL	Indicates if the channel output signal is tracking the position input. This is always true for the Incremental startup method. It is true for Absolute startup method once the output signal has caught up to the input position.	0 = Output is not tracking the input position 1 = Output is tracking the input position
Ch0*x*.RelativePosition	DINT	Indicates the current position of the channel within the channel resolution.	0…(Resolution -1)

Table 31 - Encoder Output Module - Output Tags (module specific)

Member Name	Type	Description	Valid Values
LocalClockOffset	DINT [2]	Identifies the amount of clock skew that is allowed between the local clock time and the grandmaster clock time.	$-2^{31}…(2^{31}-1)$
GrandMasterClockID	SINT [8]	Identifier of the location of the grandmaster clock on the network.	-128…127

Table 32 - Encoder Output Module - Output Tags (channel specific)

Member Name	Type	Description	Valid Values
Ch0*x*.OutputEN (1)	BOOL	Enables or disables the channel output pulses.	0 = Output signals are disabled 1 =Output signals are enabled
Ch0*x*.StartAbsPositionOutput	BOOL	Only applies for Absolute Startup Method. A value of 0 pauses pulse-generation once the absolute output has been initiated. A value of 1 starts or resumes pulse generation.	0 = Pause absolute output signals 1 = Start/resume absolute output signals
Ch0*x*.SetZeroPostion	BOOL	A transition from 0 to 1 sets RelativePosition to 0. This does not change the output pulses. It only re-references the RelativePosition.	0 = No change 1 = Set zero position
Ch0*x*.SetMarkerPosition	BOOL	A transition from 0 to 1 sets the marker position to the RelativePosition within the channel Resolution. This changes the location of the marker within the Resolution of the channel.	0 = No change 1 = Set marker position
Ch0*x*.FaultReset (1)	BOOL	A transition from 0 to 1 resets any channel faults. A channel fault will be reasserted if the condition causing the fault remains.	0 = No change 1 = Reset Channel Faults
Ch0*x*.UpdateID (1)	SINT	A counter heartbeat to confirm that the channel is receiving updates from the AOI.	-128…127
Ch0*x*.UpdatePeriod (1)	INT	Identifies the Motion Group update period, in microseconds (ms), for the axis being emulated by this channel.	1000…32000
Ch0*x*.MotionTaskCycleStartTime (1)	DINT [2]	Identifies the time that the motion task started.	$-2^{31}…(2^{31}-1)$
Ch0*x*.CommandPositionInt (1)	DINT	The integer portion of the last position command that is received from the controller, in planner counts.	$-2^{31}…(2^{31}-1)$
Ch0*x*.CommandPositionFrac (1)	REAL	The fractional portion of the last position command that is received from the controller, in planner counts.	Min REAL…Max REAL

(1) These tags are controlled in the AOI and must not be overwritten.

Table 33 - 2198-ABQE Encoder Output Module - Configuration Tags

Member Name	Type	Description	Valid Values
Ch0*x*.StartupMethod	SINT	Identifies the startup method for the channel.	0 = Incremental 1 = Absolute
Ch0*x*.EncoderType	SINT	Identifies the encoder type for the channel.	0 = Digital AqB 1 = Step/Direction
Ch0*x*.SignalType	SINT	Identifies the signal type for the channel.	0 = Differential 1 = Single-ended
Ch0*x*.MarkerPosition	DINT	Identifies the marker pulse position within the channel resolution. This parameter only applies to Digital AqB protocol. The parameter unit is encoder output counts (1 count = 1 signal edge).	0…(Resolution -1)
Ch0*x*.FrequencyLimitFaultTime	DINT	Identifies the fault limit time in milliseconds (ms) for the Frequency Fault. The channel reports the Frequency Fault when the input position change requires an output frequency that exceeds the channel's Frequency Limit for a time exceeding this time limit. The default value is 10,000 ms.	1…1,000,000
Ch0*x*.FrequencyLimit	DINT	Sets the frequency limit of the channel output in Hz. The output frequency is limited when changes in the input position necessitate an output frequency that exceeds this limit. This limit also sets the threshold value of the Frequency Fault and Frequency Alarm. • The module reports the Frequency Fault when the output frequency is at this limit for a time exceeding the FrequencyLimitFaultTime value defined for the channel. • The Frequency Alarm is set whenever the output frequency is limited to this value.	The signal type determines the range for this limit. For differential outputs, the range is limited to 0…1,000,000 Hz For single-ended outputs, the range is limited to 0…400,000 Hz
Ch0*x*.Resolution	DINT	Identifies the number of output counts per desired customer unit. This is also the number of output counts to repeatedly generate the marker pulse for the channel. This value must be an integer multiple of 4 to properly create the marker pulse and configure the module. • The default value is 8,000. • This value cannot be blank.	4…1,000,000,000

AOI Tag Definitions

See these AOI tag definitions when configuring the Add-On Instruction for your encoder output module.

Table 34 - Encoder Output Module AOI Configuration Tags

Tag	Description	Example Values
Dvc_2198ABQE_2CH	AOI tag (created in step 2 of Create the AOI Tag on page 47).	Wrk_EncoderOutputM1
Ref_MotionGroup	Motion group name	MG01
Ref_AxsCh00	Channel axis for channel 0 (created in step 1 of Configure the Channel Axis on page 43).	Axis_Ch00
Ref_AxsCh01	Channel axis for channel 1 (created in step 1 of Configure the Channel Axis on page 43)	Axis_Ch01
Ref_Module	Module name that is configured in the I/O Configuration tree (created in step 4 of the Configure the Encoder Output Module on page 36).	EncoderOutM1
Inp_Module_I	Input assembly data structure of the configured module	EncoderOutM1:I
Out_Module_O	Output-assembly data structure of the configured module	EncoderOutM1:O

Table 35 - Encoder Output Module AOI Command and Status Tags

Tag	Description
Cmd_Reset (1)	Resets the Add-on instruction faults.
Cmd_Ch0xPOE (1) (2)	Set the channel OutputEN bit.
Cmd_Ch0xPOD (1) (2)	Reset the channel OutputEN bit.
Cmd_Ch0xReset (1) (2)	Resets the module channel faults.
Sts_EO	Indicates that the AOI has enabled the rung output. Provides a visible indication of the EnableOut bit for use during programming.
Sts_EN	Indicates that the AOI is being scanned.
Sts_ER	Indicates that an error has occurred in the AOI. When the Sts_ER is set, the error code is in the tag Sts_ERR in the AOI tag data structure. See Table 28 on page 65 for a list of AOI errors.
Sts_ModuleConnected	Indicates that the connection between the controller and the module has been established.
Sts_ModuleReady	Indicates that the module is connected, synchronized, and ready for operation.
Sts_Ch0xReady (2)	Indicates that the channel is ready for operation.
Sts_Ch0xPOE (2)	Indicates that the AOI has enabled the channel pulse output.

(1) You set the tag programmatically.
(2) Tag exists for Channel A and Channel B.

Notes:

Scaling Parameter Relationships

Use this appendix to assist you in understanding the calculations that are involved with determining the Conversion Constant parameter.

System Scaling

The following items affect the scaling relationship between the application axis and the encoder output module output signals.

- Scaling configuration of the application axis
- Scaling configuration of the channel axis
- MAG instruction ratio value

Motion instructions are programmed in position units that are defined by you. The position data members of the axis tag are in user units. The motion planner operates in motion counts and implements conversions between user units and motion counts using the Conversion Constant parameter.

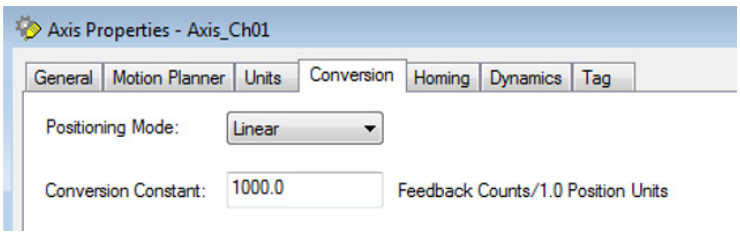
IMPORTANT Understanding the ConversionConstant for virtual and integrated motion over EtherNet/IP network axes is critical to the ability to set the scaling relationship between the application axis and the module output signals.

$$\text{Conversion Constant} = \frac{\text{Motion Counts}}{\text{User Position Units}}$$

For virtual axes, you can set the ConversionConstant in the Studio 5000 Logix Designer® application>Axis Properties>Conversion tab.

TIP The motion counts are called feedback counts for a virtual axis.

Figure 21 - Axis Properties>Conversion Tab



The encoder output module system does not receive position in the user-defined position units, it receives position in motion counts. The AOI gets the slave axis position in motion counts from the axis tag and transfers it to the module. The module applies the slave axis position directly as the encoder output counts. Therefore, you must understand the scaling relationships to configure the MAG ratio and to set an appropriate conversion constant on the slave axis to achieve the desired system scaling.

You can configure the MAG instruction for real or fraction ratio formats. The method that is used to set the module scaling is different depending on the MAG ratio format.

MAG Ratio Format = Real

The planner operates in motion counts, not user units, so it uses an internal representation of the MAG ratio that has units of motion counts. The planner converts the user-defined ratio from user units to motion counts by using the master and slave conversion constant. The ratio value in the planner is shown in Equation 1.

Equation 1

$$\text{MAG.ratio.planner} = \left(\frac{CC_{SLV}}{CC_{MST}}\right) * \text{MAG.ratio.user}$$

Where:

- MAG.ratio.user = MAG ratio that is entered by you (slave user units/master user units)
- MAG.ratio.planner = MAG ratio that is used in the motion planner (slave motion counts/master motion counts)
- CC_{MST} = master conversion constant (motion counts/user unit)
- CC_{SLV} = slave conversion constant (motion counts/user unit)

When the planner executes the MAG instruction, it converts the master position from user units to motion counts by using the master conversion constant. Then it applies the MAG ratio to calculate the slave position in motion counts. Finally, it converts the slave position back to user units by using the slave conversion constant. Equation 2 shows this calculation of the slave position in user units.

Equation 2

$$\text{SLV } Pos_{UU} = \text{MST } Pos_{UU} * CC_{MST} * \left(\frac{\text{MAG.ratio.planner}}{CC_{SLV}}\right)$$

Where:

- SLV Pos_{UU} = slave position in user units
- MST Pos_{UU} = master position in user units

However, the encoder output module system gets the slave position in motion counts. Equation 3 shows the calculation of this value. Equation 3 is almost identical to Equation 2, except Equation 3 omits the final division of the slave conversion constant that converts from motion counts to user units. The planner provides this value to the system in the axis tag.

Equation 3

$$\text{SLV Pos}_{MC} = \text{MST Pos}_{UU} * \text{CC}_{MST} * \text{MAG.ratio.planner}$$

Where:

SLV Pos_{MC} = slave position in motion counts

Substituting Equation 1 into Equation 3 provides the slave position as a function of the MAG ratio that is entered by you.

$$\text{SLV Pos}_{MC} = \text{MST Pos}_{UU} * \text{CC}_{MST} * \left(\frac{\text{CC}_{SLV}}{\text{CC}_{MST}}\right) * \text{MAG.ratio.user}$$

You can simplify this equation by canceling the CC_{MST} term in the numerator and denominator.

$$\text{SLV Pos}_{MC} = \text{MST Pos}_{UU} * \text{CC}_{SLV} * \text{MAG.ratio.user}$$

Finally, Equation 4 shows the result after solving for the relationship between the master position in user units and slave position in motion counts. Equation 4 shows that the module output scaling is determined by the conversion constant of the channel axis that is used as an interface to the AOI and the MAG ratio. The MAG ratio has a range limitation. See the Help file in the Logix Designer application for details.

Equation 4

$$\frac{\text{SLV Pos}_{MC}}{\text{MST Pos}_{UU}} = \text{CC}_{SLV} * \text{MAG.ratio.user}$$

IMPORTANT Equation 4 is a critical relationship to use to set the module output scaling when the MAG Ratio Format is set to Real.

MAG Ratio Format = Fraction

The MAG ratio is expressed as a fraction (numerator and denominator) directly in motion counts, not in user units. Because the planner operates in motion counts, no conversion from user units to motion counts is required. This eliminates the conversion that is shown in Equation 1 when the MAG Ratio Format = Real.

When the planner executes the MAG instruction, it converts the master position from user units to motion counts by using the master conversion constant. Then it applies the MAG fraction to calculate the slave position in motion counts. Finally, it converts the slave position back to user units by using the slave conversion constant. Equation 5 shows this calculation of the slave position in user units.

Equation 5

$$SLV\ Pos_{UU} = MST\ Pos_{UU} * CC_{MST} * \frac{\left(\frac{MAG.SLV\ counts}{MAG.MST\ counts}\right)}{CC_{SLV}}$$

Where:

- MAG.SLV counts = MAG slave fraction that is entered by you
- MAG.MST counts = MAG master fraction that is entered by you
- CC_{MST} = master conversion constant (motion counts / user unit)
- CC_{SLV} = slave conversion constant (motion counts / user unit)
- $SLV\ Pos_{UU}$ = slave position in user units
- $MST\ Pos_{UU}$ = master position in user units

However, the encoder output module system gets the slave position in motion counts. Equation 6 shows the calculation of this value. Equation 6 is almost identical to Equation 5, except Equation 6 omits the final division of the slave conversion constant that converts from motion counts to user units. The planner provides this value to the system in the axis tag.

Equation 6

$$SLV\ Pos_{MC} = MST\ Pos_{UU} * CC_{MST} * \left(\frac{MAG.SLV\ counts}{MAG.MST\ counts}\right)$$

Where:

$SLV\ Pos_{MC}$ = slave position in motion counts

Finally, Equation 7 shows the result after solving for the relationship between the master position in user units and slave position in motion counts. Equation 7 shows that the module output scaling is determined by the conversion constant of the application axis and the MAG fraction values.

Equation 7

$$\left(\frac{\text{SLV Pos}_{MC}}{\text{MST Pos}_{UU}}\right) = CC_{MST} * \left(\frac{\text{MAG.SLV counts}}{\text{MAG.MST counts}}\right)$$

IMPORTANT Equation 7 is a critical relationship to use to set the module output scaling when the MAG Ratio Format is set to Fraction.

When the MAG Ratio Format is set to Fraction, you must determine the conversion constant of the application axis. For a virtual axis, this is in the conversation tab of axis properties. For integrated motion over the EtherNet/IP network axes, the Conversion Constant parameter can be set directly by you, but is more commonly set by the controller. The Conversion Constant value is in the Axis Properties>Scaling category in the Logix Designer application. Click Properties to view the Conversion Constant parameter value. The Conversion Constant can also be accessed by using the SSV instruction. See Figure 22 on page 77 and Figure 23 on page 78 for how to navigate Axis Properties in the Logix Designer application and view the conversion constant.

Figure 22 - Axis Properties>Scaling Category

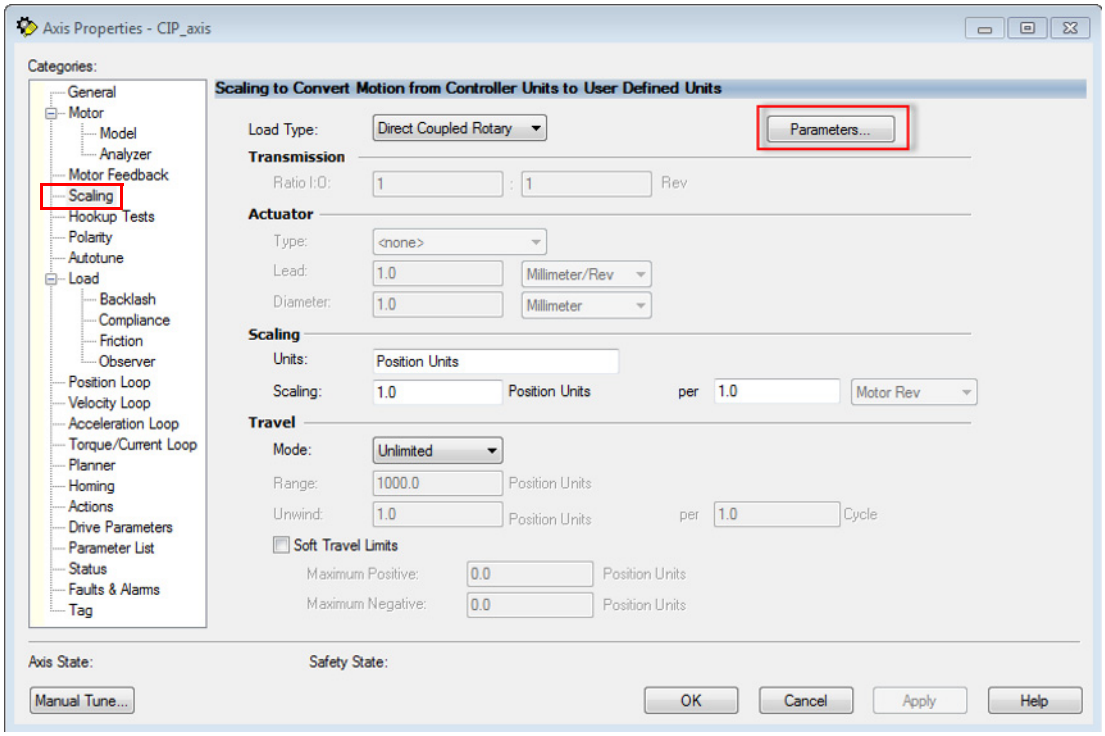
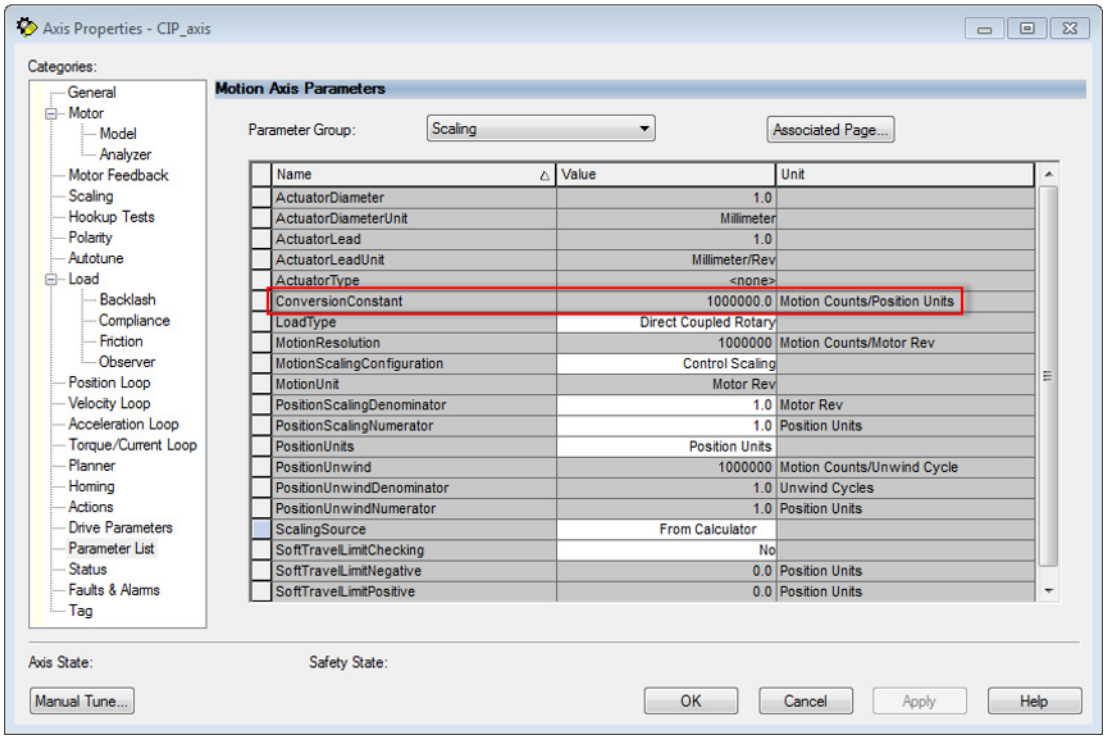


Figure 23 - Axis Properties>Scaling Category>Motion Axis Parameters



Web Server Interface

The 2198-ABQE encoder output module supports a web server interface for common status reporting, fault log, and network configuration attributes.

Overview

The web server interface is accessed through an Ethernet connection between the encoder output module and your personal computer. The module has an IP address, for example, http://192.168.1.1 with the last octet configured on the module. You can access the web server interface with web browsers Microsoft Internet Explorer (version 6.0 or later) or Mozilla Firefox (version 4.0 or later).

To set the IP address of your encoder output module, see Appendix D beginning on page 85 for more information.

Web Server Interface Categories

Table 36 describes how the categories are organized on the web server interface.

Table 36 - Web Server Interface Categories

Main Categories	Subcategories	Page
Home		80
Diagnostics	Device Information	81
	Network Settings	82
	Ethernet Statistics	83
	Network Statistics	84
Fault logs		84

Home Category

From the Home tab, you can monitor many of the drive characteristics.

Figure 24 - Home Tab

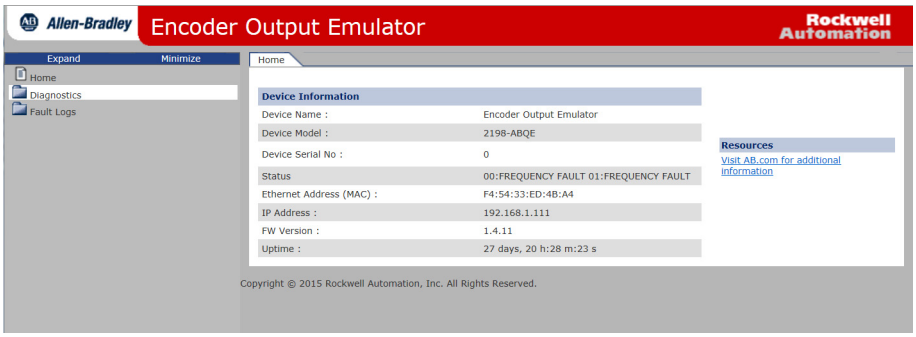


Table 37 - Home Features

Field Name	Status	Description
Device Name		User-defined module name.
Device Model		Allen-Bradley® catalog number.
Status	STANDBY	Connection with controller is not established.
	CONNECTING	Connection with controller is established.
	******FAULT (ALARM)	The module detected a device fault or alarm.
	• 00: xxxx • 01: xxxx	The module detected a channel fault or alarm. • 00: xxxx indicates channel fault/alarm with Ch00 • 01: xxxx indicates channel fault/alarm with Ch01
Ethernet MAC Address		Media Access Control (MAC) hardware address
EtherNet/IP Address		Module IP address
FW Version		Complete firmware revision
Uptime		Cumulative time with control power applied
Resources		Link to http://ab.rockwellautomation.com/

Diagnostics Category

The Diagnostics category includes several tabs for monitoring the module, network, and signal status.

Device Information

From the Dev. Info tab, you can monitor data that can assist with troubleshooting module faults.

Figure 25 - Diagnostics>Dev.Info Tab

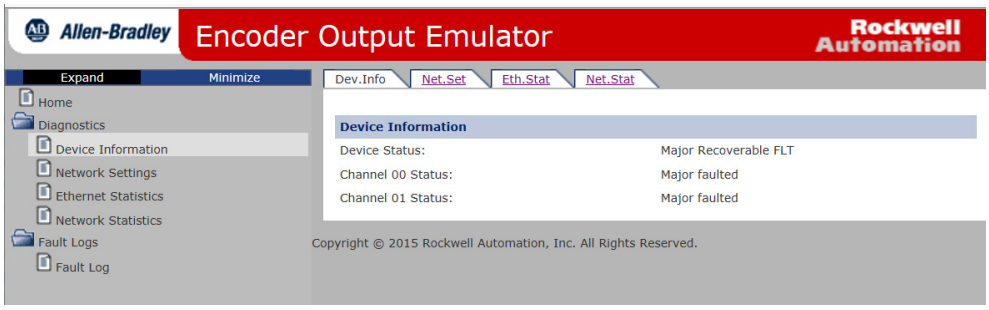


Table 38 - Device Information Features

Field Name	Status	Description
Device Status	Self Testing	Module is running self-test routine. Upon completion, status changes to Standby.
	Standby	Connection is not established or module is not synchronized with the controller.
	Operational	Connection is established and the device is synchronized with the controller.
	Major Recoverable FLT	Major recoverable fault occurred. For example, fault occurred in one or both channels
	Major Unrecoverable FLT	Major non-recoverable fault occurred. For example, device non-recoverable fault or Internal fault occurred in both channels.
	Minor Recoverable FLT	Minor recoverable fault occurred. For example, alarm occurred in one or both channels or alarm occurred in one channel and fault occurred in the other channel.
Channel 00 Status		Status of Output A.
Channel 01 Status		Status of Output B.

Network Settings

From the Net. Set tab, you can monitor the EtherNet/IP network settings.

Figure 26 - Diagnostics>Net. Set Tab

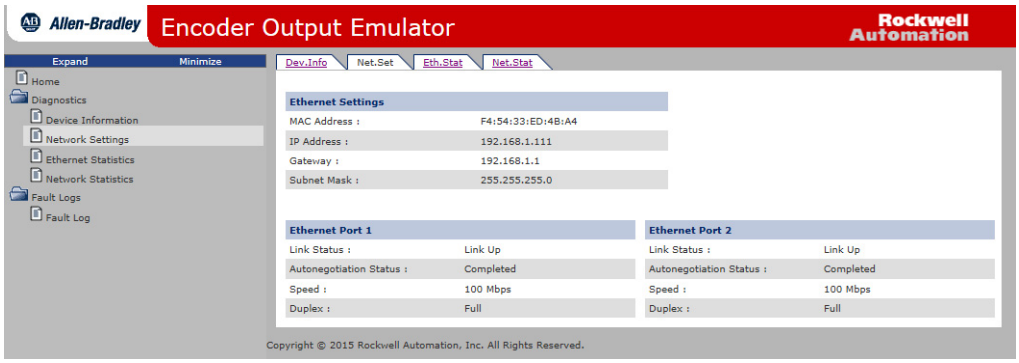


Table 39 - Network Settings Features

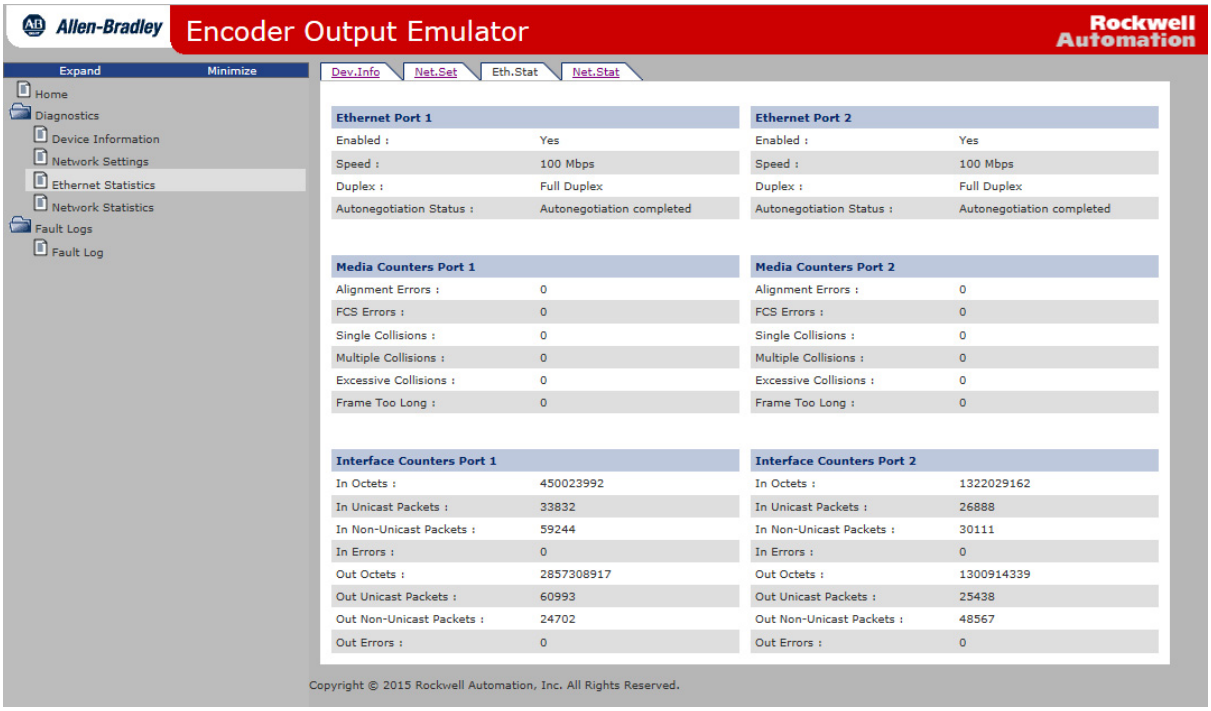
Field Name	Field Subname	Description
Ethernet Settings	Ethernet Address (MAC)	Media Access Control (MAC) hardware address
	IP Address	IP address of the drive
	Gateway	IP address of the default gateway
	Subnet Mask	Subnet mask
Ethernet Port *x* (1)	Link Status	• Link Down -Not connected • Link Up - Connected
	Autonegotiation Status	Negotiation status bits of the Ethernet link object
	Speed	• 10 Mbps • 100 Mbps
	Duplex	• Full-duplex • Half-duplex

(1) Applies to Ethernet ports 1 and 2.

Ethernet Statistics

The Enet. Stat tab displays counters that assist with troubleshooting EtherNet/IP network problems. The interface counters reflect the state of the packets that are received and transmitted to the local MAC address, but exclude packets that traverse the switch, which is destined for another device.

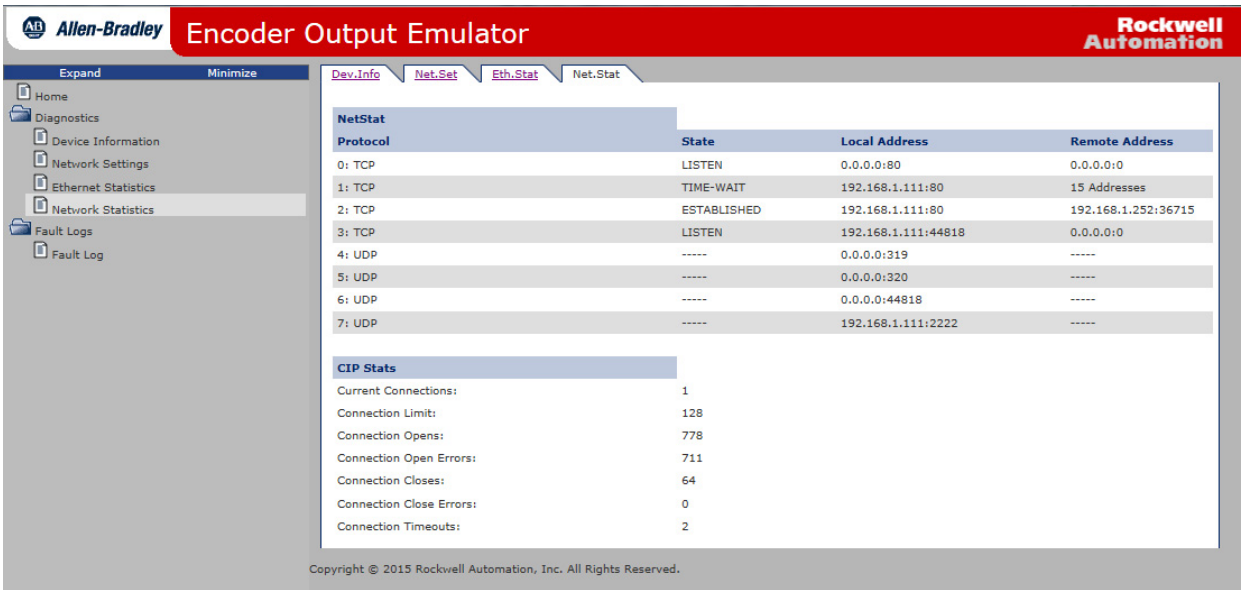
Figure 27 - Diagnostics>Enet. Stat Tab



Network Statistics

The Net. Stat tab displays connections and counters that assist with troubleshooting EtherNet/IP network problems.

Figure 28 - Diagnostics>Net. Stat Tab



Fault Logs Category

The Fault Log tab provides access to the last 25 faults that are logged by the module. The most recent fault is listed at the top.

Figure 29 - Fault Logs>Fault Log Tab

Table 40 - Fault Log Features

Field Name	Description
CIPTime(GMT)	The Grandmaster clock time when the fault occurred.
Uptime	The cumulative time between that last time that control power was applied and the time the fault occurred.
CumulativeUptime	The cumulative time between the first time that control power was applied and the time the fault occurred.
Fault Text	Text describing the fault condition.

Set the Network IP Address

This appendix describes options for setting the IP address of your encoder output module.

Overview

The following tools are available for setting the network Internet Protocol (IP) address:

- Rotary switches on the encoder output module. The switches are for setting the last octet of the static IP address 192.168.1.*xyz* on the Private Network. See Set the IP Address Rotary Switches on page 35 for more information.
- Dynamic Host Configuration Protocol (DHCP) server. The DHCP server is a standalone server that you can use to set an IP address when an address other than 192.168.1.*xyz* is required for your network. The DHCP server sets the module IP address and other Transport Control Protocol (TCP) parameters.

  IMPORTANT The encoder output module does not support BOOTP protocol.

- RSLinx® software can also be used to set the IP address, but in this example RSLinx software is used to enable DHCP.

The encoder output module is shipped with the following configuration:

- Rotary switches are set to 999
- DHCP is disabled
- Factory programmed to a static IP address of 192.168.1.1, gateway 192.168.1.254, and subnet mask 255.255.255.0

IMPORTANT DHCP is disabled by default in the initial release of the module with firmware revision 1.4.11. However, DHCP is expected to be enabled and the factory programmed gateway set to 0.0.0.0 in later firmware revisions.

Enable DHCP in Your Module

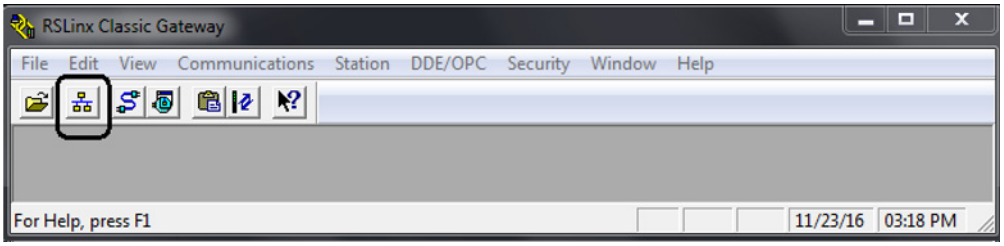
You must enable DHCP before using DHCP to set the IP address in your encoder output module.

Follow these steps to enable DHCP in the module.

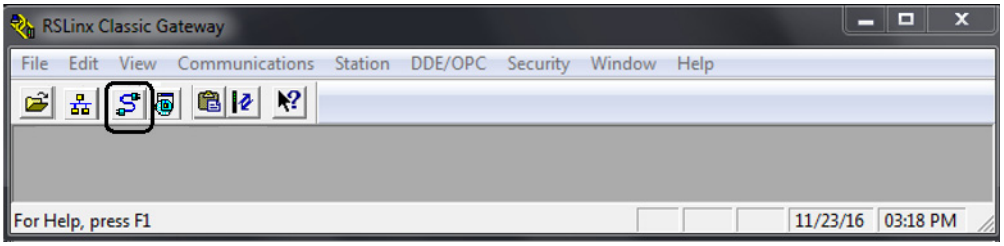
1. Start your RSLinx software.

   The RSLinx Classic Gateway dialog box appears.

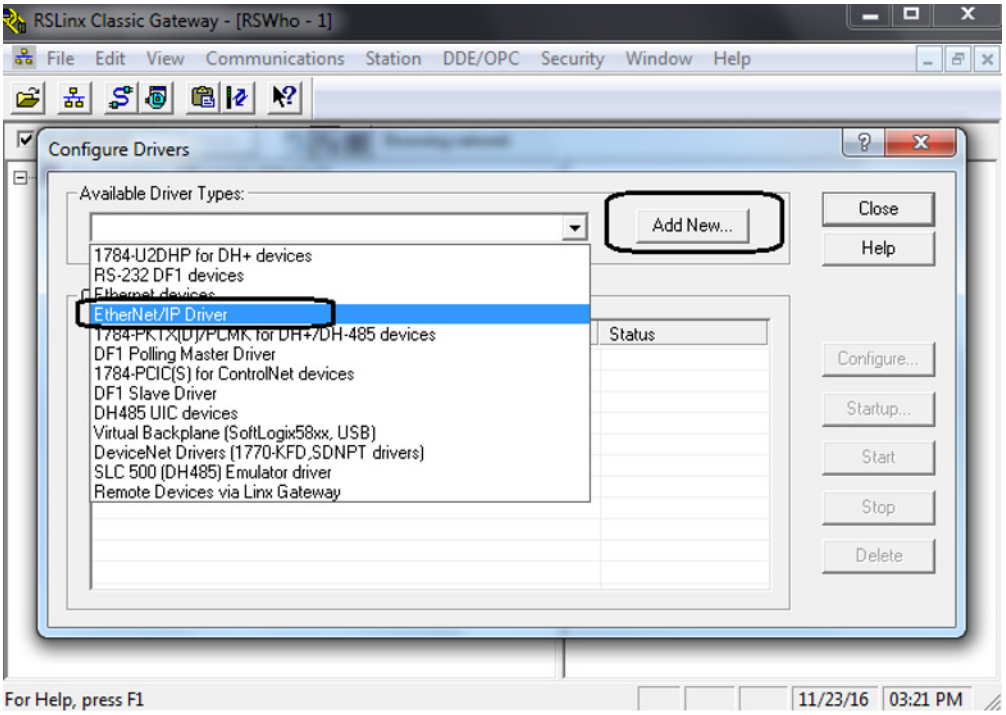
2. From the toolbar, Click the RSWho icon.



3. From the toolbar, Click the Configure Drivers icon.



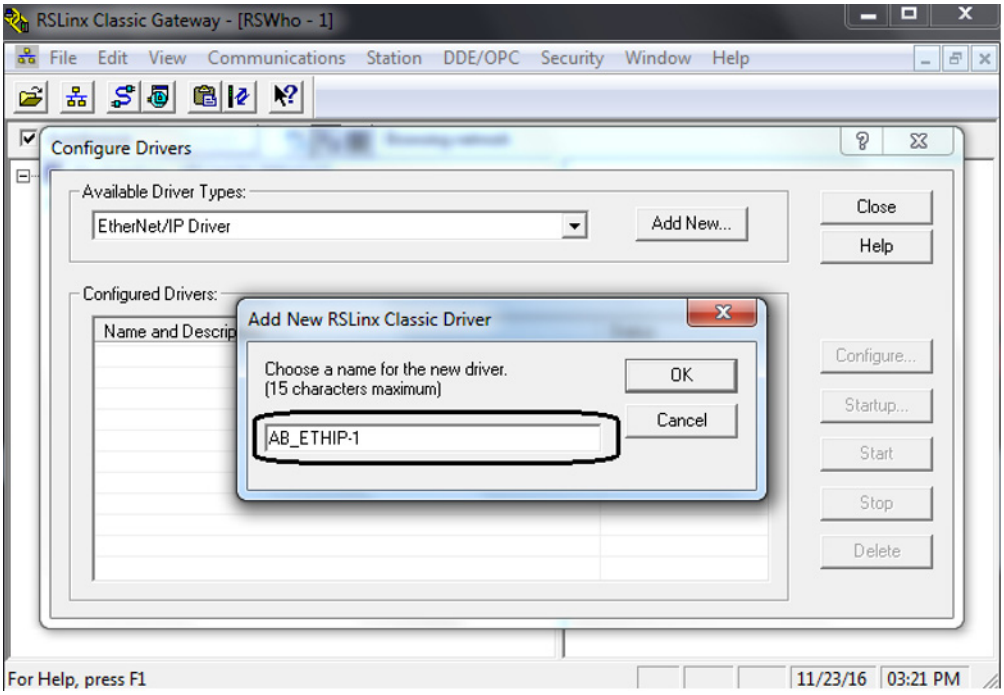
The Configure Drivers dialog box appears.



4. From the Available Drive Types pull-down menu, choose EtherNet/IP Driver.

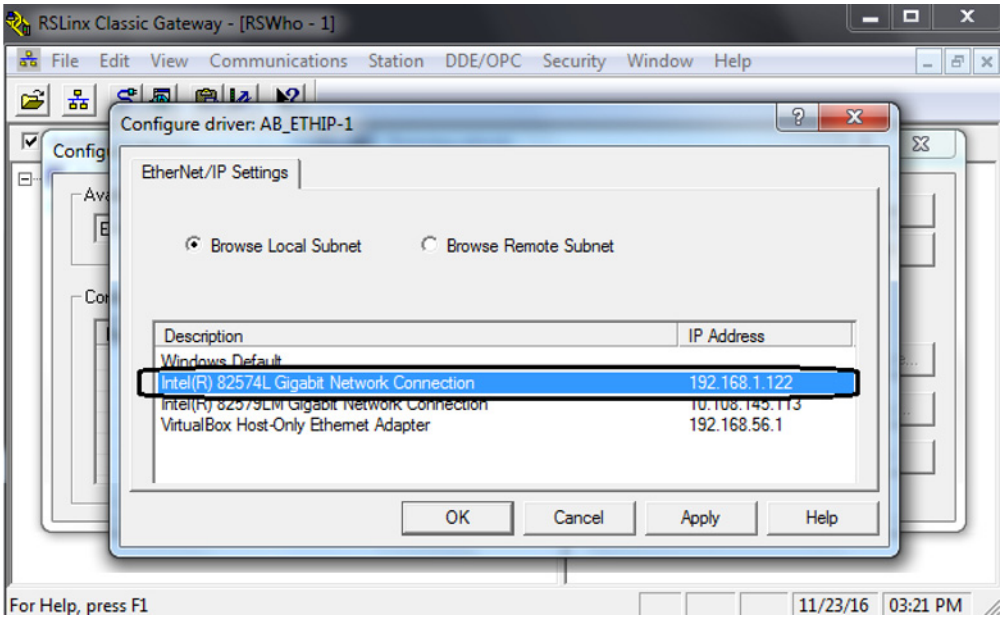
5. Click Add New.

   The Add New RSLinx Classic Driver dialog box appears.



6. Type a name for your new driver and click OK, or click OK to accept the default name.

   In this example, the default driver was accepted. The Configure driver: AB_ETHIP-1 dialog box appears.

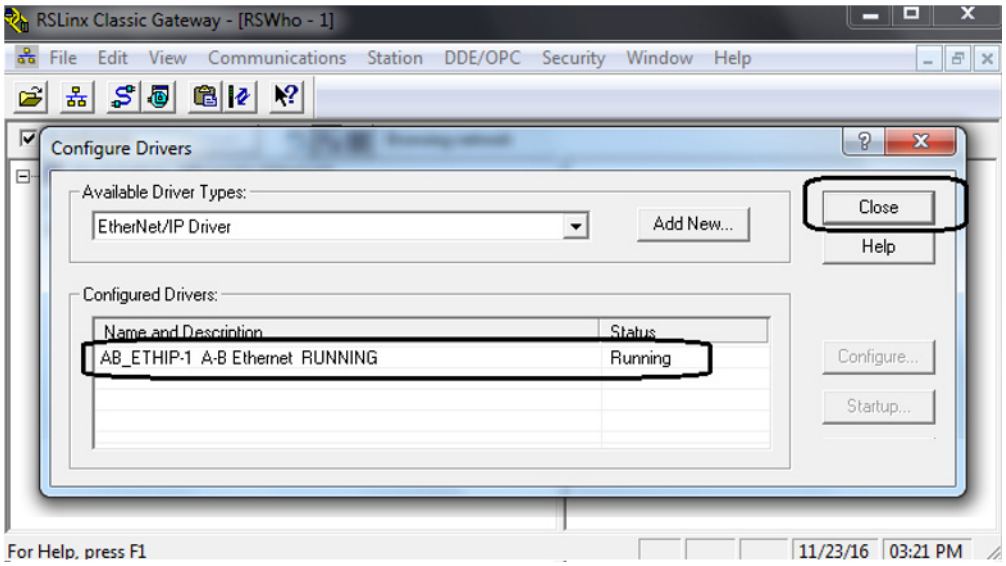


   If your personal computer has multiple network ports, the EtherNet/IP Setting dialog box appears.

7. Select the port that is connected to the subnet of your encoder output module.

8. Click OK.

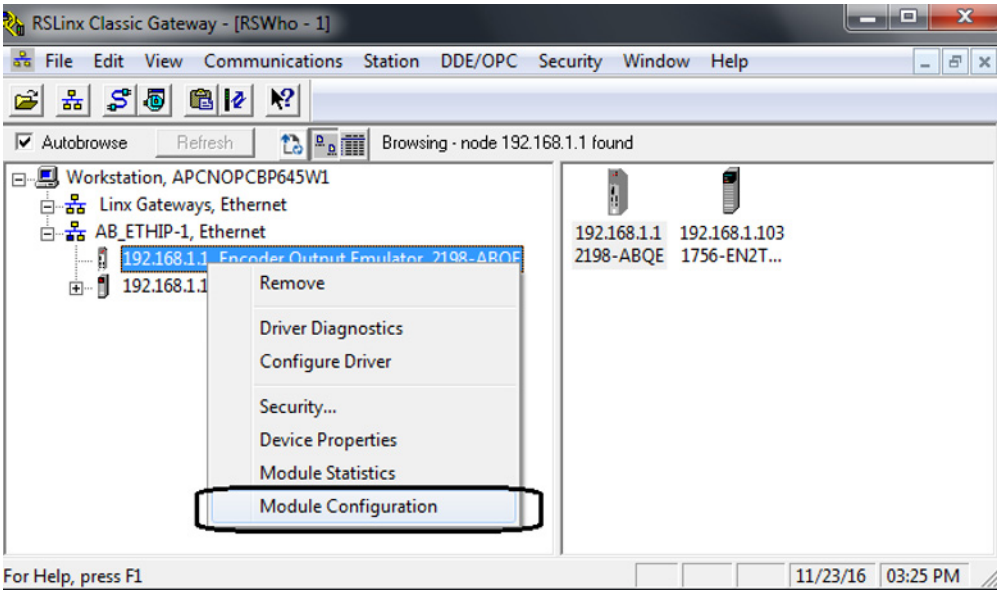
   The EtherNet/IP driver is running.



9. Click Close.

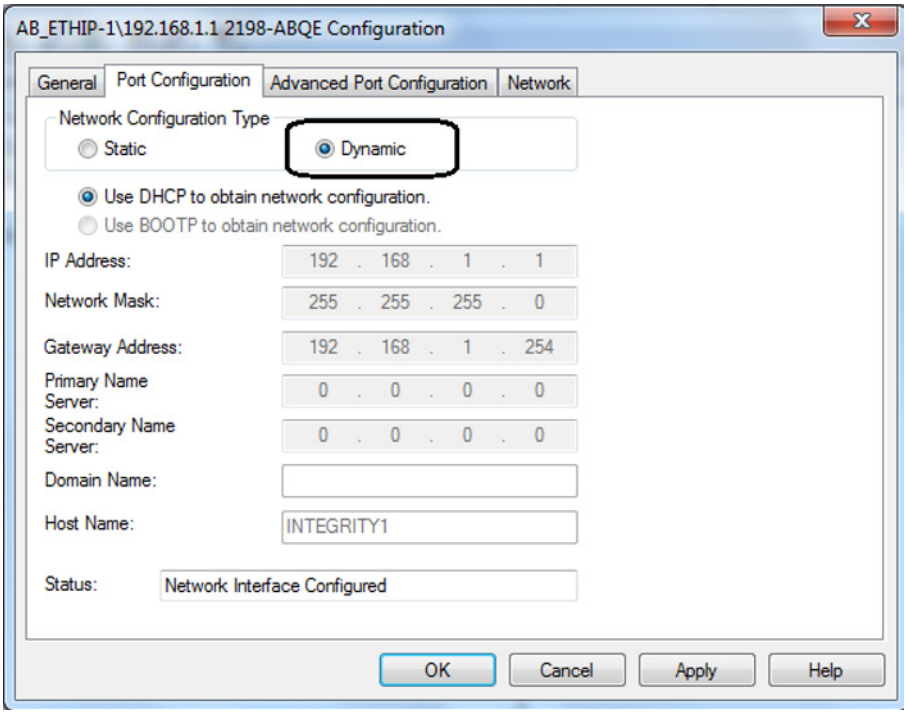
   The module appears under the EtherNet/IP driver.

   TIP The module does not always appear immediately.



10. Right-click the module and choose Module Configuration.

The 2198-ABQE Configuration dialog box appears.



11. Click the Port Configuration tab.
12. Under Network Configuration Type, select Dynamic.
13. Click OK.
14. Cycle power to the module.

    If the rotary switches are set to a value of 000 or 255...999, the module begins to send DHCP requests.

Set the Network IP Address with the DHCP Server

You can use the DHCP server to set the IP address of the module if the following conditions exist at powerup:

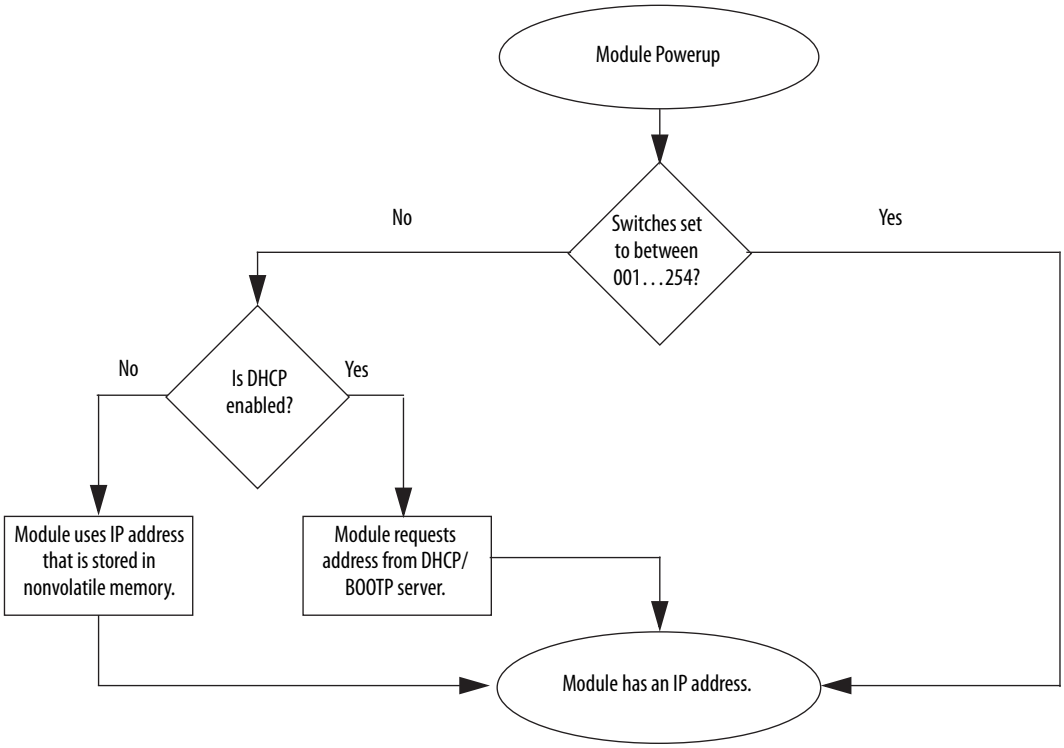
- The rotary switches of the module are not set to a valid number, for example, 000 or 255...999 (except 888, which is used for resetting the module to the factory default settings).
- DHCP is enabled

  To enable DHCP in the encoder output module, see Enable DHCP in Your Module on page 86 for more information.

You can access the DHCP server from one of these locations:

- Programs>Rockwell Software®>BOOTP-DHCP Server
- Tools directory on the Studio5000® installation CD

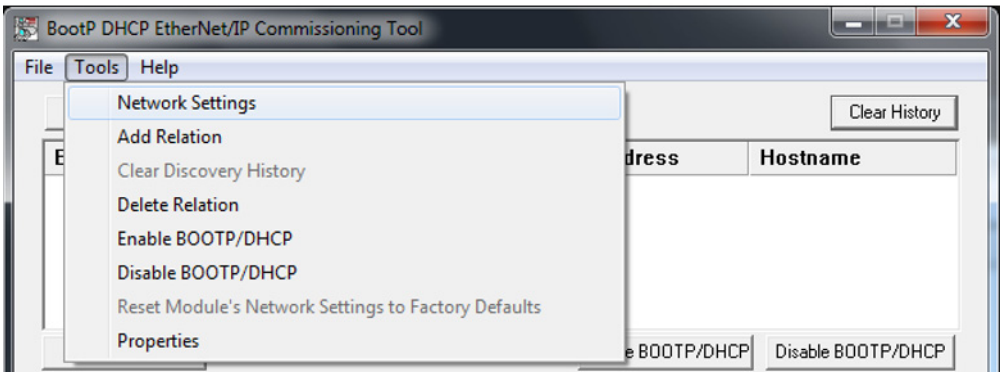
Figure 30 - How the Encoder Output Module IP Address Is Set



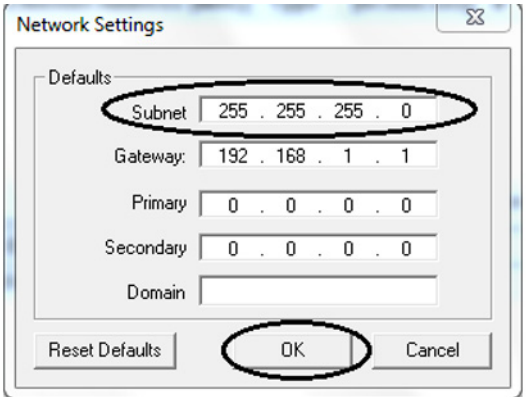
IMPORTANT Before you start the DHCP tool, make sure that you have the hardware (MAC) address of the encoder output module. The hardware address is on the nameplate (left side of module) in a format similar to the following: F4-54-33-ED-4B-B9.

Follow these steps to set the module IP address by using DHCP. In this example, the BOOTP DHCP EtherNet/IP Commissioning Tool is used.

1. Apply power to the encoder output module.
2. Start the BOOTP/DHCP tool software.
3. From the Tools menu, select Network Settings.



The Network Settings dialog box appears.



4. Type the Subnet of the network.

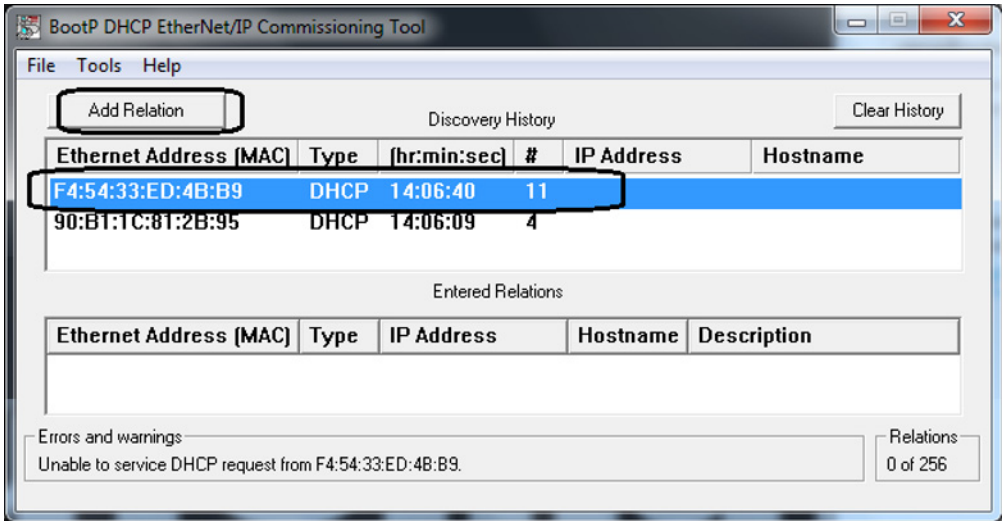
   The Gateway address, Primary and/or Secondary DNS address, and Domain Name fields are optional.

5. Click OK.

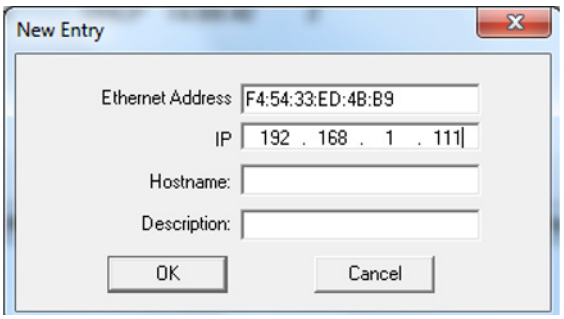
   The Discovery History panel appears with the Ethernet (MAC) addresses of all modules that issue DHCP or BOOTP requests.

6. Select the address that matches your module and go to step 9.

   If your module is not listed, Click Add Relation.



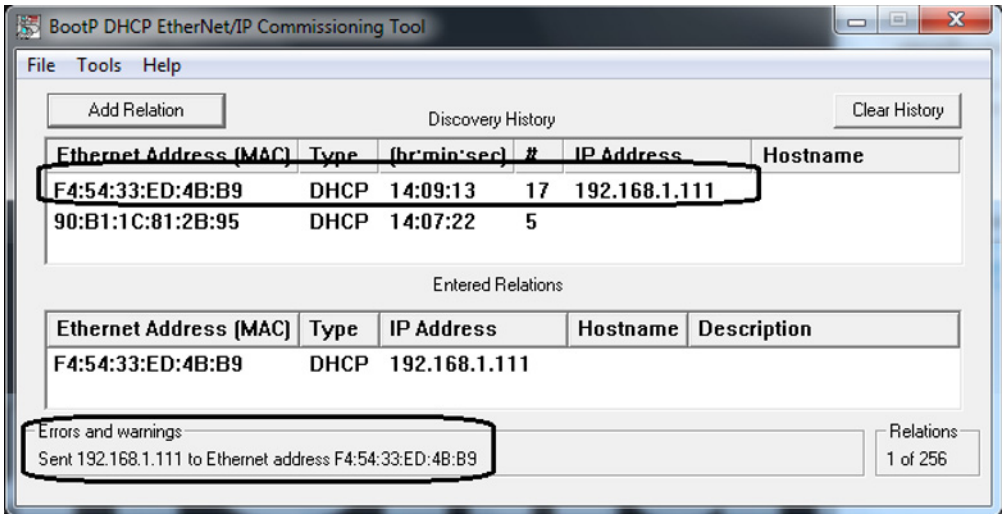
The New Entry dialog box appears.



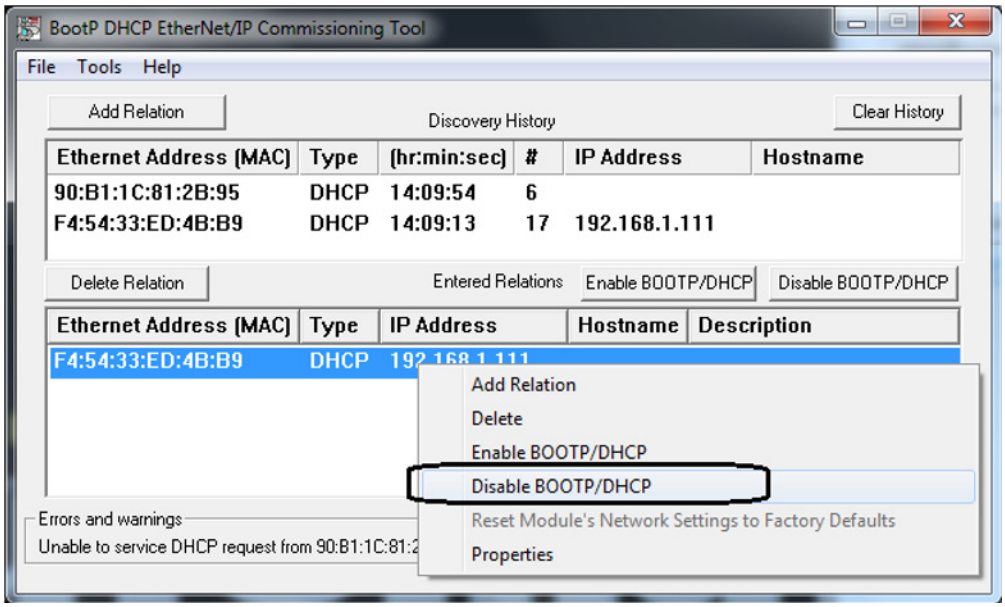
7. In the Ethernet Address field, type the module Ethernet (MAC) address.
8. In the IP field, type an IP address of your choosing.
9. Click OK.

   The Discover History panel appears with the Ethernet address of your module listed.

   The Error and Warnings field shows Sent *xxx.xxx.xxx* to Ethernet address *yy:yy:yy:yy:yy:yy*.

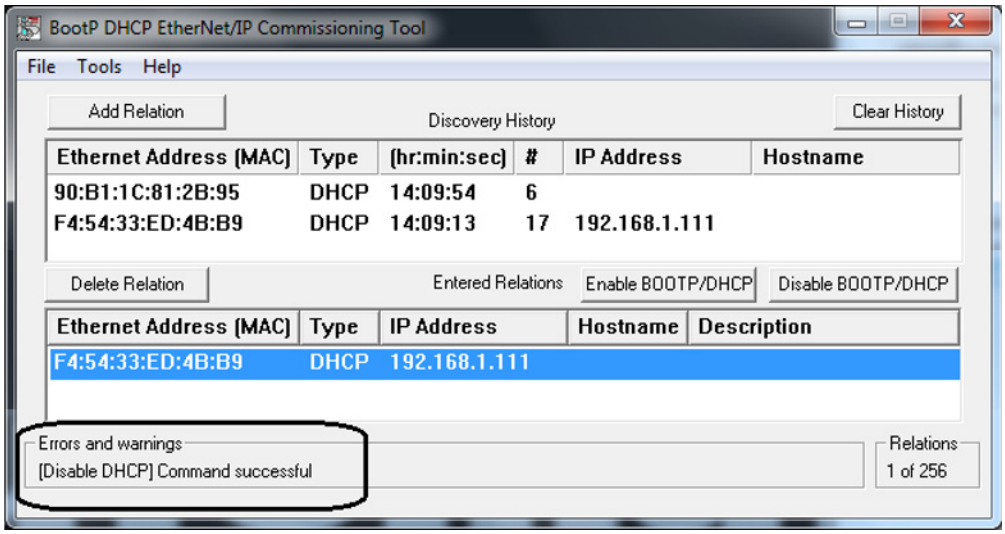


10. Save the IP address to your module.
11. Right-click the module Ethernet address in the Entered Relations panel and select Disable BOOTP/DHCP.



IMPORTANT If you do not disable BOOTP/DHCP before the next powerup, the module clears the current IP configuration and begins sending DHCP requests again.

The Errors and Warnings field confirms the disable command.



The next time that power is cycled, the module uses the configuration that is assigned in the previous steps and does not issue a new DHCP request.

Reset the Module to Factory Default Settings

To reset the module to the factory default settings, set the rotary switches to 888 and cycle module control power.

When the switches are set to 888 during a powerup, a module behaves as follows:

- Factory default settings return (static IP address of 192.168.1.1)
- Ceases communication on all communication ports
- The Module Status indicator transitions to blinking red
- The Network Status indicator transitions to off

Change the switch settings to the value appropriate for your network before cycling power.

Notes:

EC Certifications

This appendix provides encoder output module certification information.

For product certifications and all declarations of conformity (DoC) currently available from Rockwell Automation, go to http://www.rockwellautomation.com.

European Union Directives

If this product is installed within the European Union or EEC regions and has the CE mark, the following regulations apply.

CE Conformity

Conformity with the Low Voltage Directive and Electromagnetic Compatibility (EMC) Directive is demonstrated by using harmonized European Norm (EN) standards that are published in the Official Journal of the European Communities. The safe torque-off circuit complies with the EN standards when installed according to instructions found in this manual.

EMC Directive

This unit is tested to meet Council Directive 2004/108/EC Electromagnetic Compatibility (EMC) by using these standards, in whole or in part:

EN 61800-3 - Adjustable Speed Electrical Power Drive Systems, Part 3 - EMC Product Standard including specific test methods

The product that is described in this manual is intended for use in an industrial environment.

Notes:

Numerics

A

B

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Rockwell Automation Support

Use the following resources to access support information.

Technical Support Center	Knowledgebase Articles, How-to Videos, FAQs, Chat, User Forums, and Product Notification Updates.	https://rockwellautomation.custhelp.com/
Local Technical Support Phone Numbers	Locate the phone number for your country.	http://www.rockwellautomation.com/global/support/get-support-now.page
Direct Dial Codes	Find the Direct Dial Code for your product. Use the code to route your call directly to a technical support engineer.	http://www.rockwellautomation.com/global/support/direct-dial.page
Literature Library	Installation Instructions, Manuals, Brochures, and Technical Data.	http://www.rockwellautomation.com/global/literature-library/overview.page
Product Compatibility and Download Center (PCDC)	Get help determining how products interact, check features and capabilities, and find associated firmware.	http://www.rockwellautomation.com/global/support/pcdc.page

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