User Manual

Original Instructions

Integrated Motion on the EtherNet/IP Network: Configuration and Startup

ControlLogix, CompactLogix, GuardLogix, Compact GuardLogix, Kinetix 350, Kinetix 5500, Kinetix 5700, Kinetix 6500, PowerFlex 527, PowerFlex 755

Allen-Bradley • Rockwell Software

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Important User Information

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

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

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

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

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

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

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

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

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Out of Box Configuration for PowerFlex Drives

Use this manual to configure an integrated motion on the EtherNet/IP™ network application and to start up your motion solution with a Logix controller-based system.

This manual is designed to give you a straightforward approach to an integrated motion control solution. If you have any comments or suggestions, see Documentation Feedback on the back cover of this manual.

Summary of Changes

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

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Additional Resources

These resources contain information about related products from Rockwell Automation®.

Table 1 - Publications About Related Products

Resource	Description
842E-CM Integrated Motion Encoder on EtherNet/IP User Manual, publication 842E-UM002	Describes the necessary tasks to install, wire, and troubleshoot your encoder.
ControlLogix 5580 Controllers Migration Guide, publication 1756-RM100	Provides information about the features and functions of the ControlLogix® 5580 controllers.
ControlLogix 5580 and GuardLogix 5580 Controllers User Manual, publication 1756-UM543	Provides information on how to install, configure, program, and operate ControlLogix 5580 and GuardLogix® 5580 controllers.
CompactLogix 5380 and Compact GuardLogix 5380 Controllers User Manual, publication 5069-UM001	Provides information on how to install, configure, program, and operate CompactLogix™ 5380 and Compact GuardLogix 5380 controllers.
ControlLogix System User Manual, publication 1756-UM001	Describes the necessary tasks to install, configure, program, and operate a ControlLogix system.
EtherNet/IP Network Configuration User Manual, publication ENET-UM001	Describes Ethernet network considerations, networks, and setting IP addresses.
GuardLogix 5570 Controllers User Manual, publication 1756-UM022	Provides information on how to install, configure, and operate GuardLogix 5570 controllers in Studio 5000 Logix Designer® projects, version 21 or later.
GuardLogix 5570 and Compact GuardLogix 5370 Controller Systems Safety Reference Manual, publication 1756-RM099	Provides information on how to meet safety application requirements for GuardLogix 5570 controllers in Studio 5000 Logix Designer projects, version 21 or later.
GuardLogix 5580 and Compact GuardLogix 5380 Controller Systems Safety Reference Manual, publication 1756-RM012	Describes the necessary tasks to install, configure, program, and operate a ControlLogix system.
Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003	Provides a programmer with details about the Integrated Motion on the EtherNet/IP network Control Modes, Control Methods, and AXIS_CIP_DRIVE Attributes.
Kinetix 350 Single-axis EtherNet/IP Servo Drive User Manual, publication 2097-UM002	Provides detailed information on wiring, power, troubleshooting, and integration with ControlLogix, or CompactLogix controller platforms.

Table 1 - Publications About Related Products (continued)

Resource	Description
Kinetix 5500 Servo Drives Installation Instructions, publication 2198-IN001	Provides installation instructions for the Kinetix® 5500 Integrated Axis Module and Axis Module components.
Kinetix 5500 Servo Drives User Manual, publication 2198-UM001	Provides information on installation, configuration, start up, troubleshooting, and applications for the Kinetix 5500 servo drive systems.
Kinetix 5700 Servo Drives User Manual, publication 2198-UM002	Provides information on installing, configuring, start up, troubleshooting, and applications for the Kinetix 5700 servo drive systems.
Kinetix 6200 and Kinetix 6500 Modular Multi-axis Servo Drives User Manual, publication 2094-UM002	Provides information on installation, configuration, start up, troubleshooting, and applications for the Kinetix 6200 and Kinetix 6500 servo drive systems.
Logix 5000 Controllers Motion Instructions Reference Manual, publication MOTION-RM002	Provides a programmer with details about motion instructions for a Logix-based controller.
Logix 5000 Controllers Common Procedures, publication 1756-PM001	Provides detailed and comprehensive information about how to program a Logix 5000™ controller.
Logix 5000 Controllers General Instructions Reference Manual, publication 1756-RM003	Provides a programmer with details about general instructions for a Logix-based controller.
LOGIX 5000 Controllers Advanced Process Control and Drives and Equipment Phase and Sequence Instructions Reference Manual, publication 1756-RM006	Provides a programmer with details about process and drives instructions for a Logix-based controller.
Logix 5000 Controllers Quick Start, publication 1756-QS001	Describes how to get started programming and maintaining Logix5000 controllers.
Motion System Tuning Application Technique, publication MOTION-AT005	Provides detailed information on motion system tuning.
PowerFlex 527 Adjustable Frequency AC Drive User Manual, publication 520-UM002	Provides information on installation, configuration, start up, troubleshooting, and applications for the PowerFlex® 527 drive.
PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001	Provides information that is necessary to install, start-up, and troubleshoot PowerFlex 750-Series Adjustable Frequency AC Drives.
PowerFlex 750-Series AC Drives Reference Manual, publication 750-RM002	Provides detailed drive information including operation, parameter descriptions, and programming of the AC drive.
PowerFlex 755 Drive Embedded EtherNet/IP Adapter User Manual, publication 750COM-UM001	Provides information on installation, configuration, start up, troubleshooting, and applications for the PowerFlex 755 Drive Embedded EtherNet/IP Adapter.
PowerFlex 750-Series Safe Speed Monitor Option Module Safety Reference Manual, publication 750-RM001	These publications provide detailed information on installation, setup, and operation of the 750-Series safety option modules.
PowerFlex 750-Series Safe Torque Off Option Module User Manual, publication 750-UM002	
PowerFlex 755 Integrated Safety - Safe Torque Off Option Module User Manual, publication 750-UM004	
PowerFlex 755/755T Integrated Safety Functions Option Module User Manual, publication 750-UM005	
The Integrated Architecture and CIP Sync Configuration Application Technique, publication IA-AT003	Provides detailed configuration information on CIP™ Sync technology and time synchronization.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation® industrial system.
Product Certifications website, www.rok.auto/certifications	Provides declarations of conformity, certificates, and other certification details.
Network specifications details, http://www.odva.org	ODVA is the organization that supports network technologies that are built on the Common Industrial Protocol (CIP) — DeviceNet™, EtherNet/IP, CompoNet™, and ControlNet™.

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

Components of a Motion System

Controller, Communication, Drive, and Software Options

You need a Logix 5000™ controller with a connection to the EtherNet/IP™ network (either via an embedded Ethernet port or an Ethernet communication module). You also need an Ethernet adapter for the controller (if the controller does not have embedded Ethernet), an Integrated Motion drive (see Table 4), and configuration and programming software.

TIP ControlLogix® 5560 and GuardLogix® 5560 controllers are not supported in Studio 5000 Logix Designer® application, version 21.00.00 and later.

Controller and Ethernet Communication Module Options

A GuardLogix or Compact GuardLogix safety controller is required for motion and safety applications.

Table 2 lists the available controllers and minimum required version of the Studio 5000 Logix Designer application.

Table 2 - Controllers and Required Software Versions

Controller	Studio 5000 Logix Designer Version
ControlLogix 5580 controllers	Version 28 or later
GuardLogix 5580 controllers	Version 31 or later
CompactLogix 5380 controllers	Version 30 or later
Compact GuardLogix 5380 controllers	Version 31 or later
ControlLogix 5570 controllers	Version19 or later
GuardLogix 5570 controllers	Version 20 or later
CompactLogix 5370 controllers	Version 20 or later
Compact GuardLogix 5370 controllers	Version 28 or later

Table 3 provides information on how many motion axes are supported depending on the hardware that is used in your application and the configuration of your axes. For example, you can have eight Position Loop axes per 1756-EN2T module. Each drive requires one TCP and one CIP™ connection. If you have other devices that consume TCP connections on the module, it reduces the number of drives you can support. Only the drives and axes that are configured for Position Loop are limited. Frequency Control, Velocity Loop, and Torque Loop configured drives and axes are not limited.

Table 3 - Supported Axes by Controller Type

Controller		Communication Modules[1]	Supported Axes[3]		
			Position Loop[4]	Other Loop Types	Integrated Motion Drives[5]
ControlLogix 5560, GuardLogix 5560, ControlLogix 5570,GuardLogix 5570 Armor™ ControlLogix 5570, Armor™ GuardLogix 5570 ControlLogix 5580, GuardLogix 5580		1756-EN2T and 1756-EN2TF	8	Up to 100	—
		1756-EN3TR	100	Up to 100	—
		1756-EN2TR	8	Up to 100	—
		1756-EN2T and 1756-EN2F	8	Up to 100	—
		1756-EN2TP	8	Up to 100	—
		1756-EN3TR	100	Up to 256	—
		1756-EN2TR	8	Up to 256	—
ControlLogix 5580, GuardLogix 5580	1756-L81E, 1756-L81ES	Embedded Ethernet[2]	256	Up to 256	100 max nodes
	1756-L82E, 1756-L82ES	Embedded Ethernet[2]	256	Up to 256	175 max nodes
	1756-L83E, 1756-L83ES 1756-L84E, 1756-L84ES	Embedded Ethernet[2]	256	Up to 256	250 max nodes
	1756-L85E	Embedded Ethernet	256	Up to 256	300 max nodes
CompactLogix 5380, Compact GuardLogix 5380	5069-L306ERM, 5069-L306ERMS2	Embedded Ethernet	2	Up to 256	16 max nodes
	5069-L310ERM, 5069-L310ERMS2	Embedded Ethernet	4	Up to 256	24 max nodes
	5069-L320ERM, 5069-L320ERMS2	Embedded Ethernet	8	Up to 256	40 max nodes
	5069-L330ERM, 5069-L330ERMS2	Embedded Ethernet	16	Up to 256	Version 30 and earlier: 50 max nodes Version 31 and later: 60 max nodes
	5069-L340ERM, 5069-L340ERMS2	Embedded Ethernet	20	Up to 256	Version 30 and earlier: 55 max nodes Version 31 and later: 90 max nodes
	5069-L350ERM, 5069-L350ERMS2	Embedded Ethernet	24	Up to 256	Version 30 and earlier: 60 max nodes Version 31 and later: 120 max nodes
	5069-L380ERM, 5069-L380ERMS2	Embedded Ethernet	28	Up to 256	Version 30 and earlier: 70 max nodes Version 31 and later: 150 max nodes
	5069-L3100ERM, 5069-L3100ERMS2	Embedded Ethernet	32	Up to 256	Version 30 and earlier: 80 max nodes Version 31 and later: 180 max nodes
CompactLogix 5370, Compact GuardLogix 5370, Armor CompactLogix 5370, Armor Compact GuardLogix 5370	1769-L18ERM	Embedded Ethernet	2	Up to 100	8 max nodes
	1769-L27ERM	Embedded Ethernet	4	Up to 100	16 max nodes
	1769-L30ERM, 1769-L30ERMS	Embedded Ethernet	4	Up to 100	16 max nodes
	1769-L33ERM, 1769-L33ERMS 1769-L33ERMO, 1769-L33ERMOS	Embedded Ethernet	8	Up to 100	32 max nodes
	1769-L36ERM, 1769-L36ERMS 1769-L36ERMO, 1769-L36ERMOS	Embedded Ethernet	16	Up to 100	64 max nodes
	1769-L37ERM, 1769-L37ERMS, 1769-L37ERMO, 1769-L37ERMOS,	Embedded Ethernet	16	Up to 100	64 max nodes
	1769-L38ERM, 1769-L38ERMS 1769-L38ERMO, 1769-L38ERMOS	Embedded Ethernet	16	Up to 100	80 max nodes

(1) For more information on Ethernet communication modules, see 1756 ControlLogix Communication Modules Specifications Technical Data, publication 1756-TD003.
(2) ControlLogix 5580 and GuardLogix 5580 can also use Ethernet communication modules to communicate on the EtherNet/IP network.
(3) Multiple controllers can control drives on a common 1756-EN*x*T*x* module, so based on the TCP connection limit, up to 128 can be supported.
(4) Only the drives/axes configured for Position Loop are limited. Frequency Control, Velocity Loop, and Torque Loop configured drives/axes are not limited.
(5) If more than the maximum number of I/O modules are configured under the embedded Ethernet Port, a Project Verify error notifies you that the maximum number of nodes on the local Ethernet Port has been exceeded.

Integrated Motion on EtherNet/IP Drive Software Options

The following software is required for use with your system:

- Studio 5000 Logix Designer application (see Table 2 on page 11 for minimum versions for controllers and Table 4 for minimum versions for drives)
- RSLinx® Classic software, version 3.51.00 or later
- For PowerFlex® 755 drives, you need the Add-on Profile, V18 or later.

Integrated Motion on EtherNet/IP Drives

Table 4 lists the EtherNet/IP drives available for integrated motion.

Table 4 - Integrated Motion EtherNet/IP Drives

Drive	Description	Supported Axis Configurations[3]	Power Ratings		Minimum Version of the Studio 5000 Logix Designer Application
842E-CM	The 842E-CM is an ultra-high resolution encoder with EtherNet/IP interface with time synchronization for motion control. These encoders provide 18-bit single-turn resolution and 30-bit multi-turn resolution.	Feedback Only	10…30V		21.00.00
Kinetix® 350[1]	The Kinetix 350 drive is a single-axis EtherNet/IP servo drive with Safe Torque Off (STO) functional safety that supports the Integrated Motion on EtherNet/IP network.	Position Velocity Torque	**Voltage Ranges** 100V AC 1-phase 200V AC 1-phase 200V AC 3-phase 400V AC 3-phase	**Output Power** 0.4…0.8 kW 0.5…3 kW 0.5…3 kW 1…3 kW	21.00.00
Kinetix 5500[1]	The Kinetix 5500 servo drives support the Integrated Motion on EtherNet/IP network. Single-axis and multi-axis, AC, DC, AC/DC, and AC/DC hybrid bus-sharing configurations are possible.	Frequency Control Position Velocity Torque	**Voltage Ranges** 195…264V AC rms 1-phase 195…264V AC rms 3-phase 324…528V AC rms 3-phase	**Output Power** 0.2…1.0 kW 0.3…7.2 kW 0.6…14.9 Kw	21.00.00[4] 24.00.00[5]
	2198-Hxxx-ERS servo drives support hardwired STO with connections to safety inputs.				
	2198-Hxxx-ERS2 servo drives support integrated STO with connections to the safety controller.				

Table 4 - Integrated Motion EtherNet/IP Drives (continued)

Drive	Description	Supported Axis Configurations[3]	Power Ratings		Minimum Version of the Studio 5000 Logix Designer Application
Kinetix 5700[1]	2198-Sxxx-ERS3 (single-axis) and 2198-Dxxx-ERS3 (dual-axis) series A support hardwired and integrated STO with connections to the safety controller (Version26). Series B also support integrated Timed SS1 safety function and (Version 31).	Frequency Control Feedback Only Position Loop Velocity Loop Torque Loop	**Input Voltage Range** 324…528V AC rms, **Output Voltage Range** 3-phase 480V AC rms nominal **Current Range** 2.5…192 A	**Output Power** 1.6…112 kW	**For 1.6…60kW[6]** 26.00.00 **For 90…112kW** 32.00.00
	2198-Pxxx	Non-Regenerative AC/DC Converter	**Input Voltage Range** 324…528V **Current Range** 10…69 A		26.00.00
	2198-Sxxx-ERS4 (single-axis) and 2198-Dxxx-ERS4 (dual-axis) (Version 31) support integrated safe monitor functions with connection to the safety controller.	Frequency Control Feedback Only Position Loop Velocity Loop Torque Loop	**Input Voltage Range** 324…506V AC rms, **Output Voltage Range** 3-phase 480V AC nominal **Current Range** 2.5…192 A	**Output Power** 1.6…112 kW	**For 1.6…60kW**[7] 31.00.00 **For 90…112kW** 32.00.00
	2198-RPxxx	Regenerative AC/DC Converter	**Input Voltage Range** 324…528V **Current Range** 35.3/88.0…207.0/312.0 A	**Output Power** 24…140 kW	32.00.00

Table 4 - Integrated Motion EtherNet/IP Drives (continued)

Drive	Description	Supported Axis Configurations(3)	Power Ratings		Minimum Version of the Studio 5000 Logix Designer Application
Kinetix 6500(1)	The Kinetix 6500 drive is a closed-loop modular servo drive. It consists of an integrated axis (IAM) power module and up to seven axis (AM) power modules, each coupled with a Kinetix 6500 control module. The IAM and AM power modules provide power for up to eight axes. The 2094-EN02D-M01-S0 control modules support Safe Torque Off and 2094-EN02D-M01-S1 control modules support safe-speed monitoring.	Feedback Only Position Velocity Torque	**Voltage Range** 324…528V AC rms 3-phase	**Continuous Output Power** 6.0…45 kW	21.00.00
PowerFlex 527(2)	The PowerFlex 527 is a single-axis EtherNet/IP AC drive with STO feature that supports the Integrated Motion on EtherNet/IP network. Hardwired STO and Integrated STO are supported. It consists of an integrated axis power module and incremental encoder feedback (sold separately).	Frequency Control Position Velocity	**Input Power** 100…600V AC	**Output Power** 0.4...22 kW/0.5...30 Hp / 0.9...62.1 A	24.00.00
PowerFlex 755(2)	The PowerFlex 755 Drive EtherNet/IP AC drive is a closed loop drive. It consists of an integrated axis power module with five option slots for communication, I/O, feedback, safety, and auxiliary control power (sold separately). The PowerFlex 755 drive can control a motor in closed loop and open loop mode.	Frequency Control Position Velocity Torque	**Input Power** 400V AC 480V AC 600V AC 690V AC	**Output Power:** 0.75…1250 kW/2.1…2150 A 1...1750 Hp/2.1...2070 A 1...1400 Hp/1.7...1430 A 7.5...1400 kW/12...1400 A	RSLogix 5000®, version 19.00.00 or later Studio 5000 Logix Designer application, version 21.00.00 or later

(1) For more information on Kinetix servo drives, see Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003.

(2) For more information on PowerFlex drives, see PowerFlex Low Voltage Drives Selection Guide, publication PFLEX-SG002.

(3) For more information about the configuration types, see Configure the Associated Axis and Control Mode on page 47 and the Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003.

(4) Drives with catalog numbers ending in ERS.

(5) Drives with catalog numbers ending in ERS2.

(6) Drives with catalog numbers ending in ERS3.

(7) Drives with catalog numbers ending in ERS4.

Options for PowerFlex 755 Drives

When a PowerFlex 755 drive is used in Integrated Motion on EtherNet/IP mode, the Logix controller and Studio 5000 Logix Designer application are the exclusive owners of the drive (same as Kinetix). An HIM or other drive software tools, such as DriveExplorer™ and DriveTools™ SP, cannot be used to control the drive or change configuration settings. These tools can only be used for monitoring.

The PowerFlex 755 drive contains an EtherNet/IP adapter that is embedded on the main control board. This embedded adapter lets you easily configure, control, and collect drive data over Ethernet networks. The drive can operate also in the integrated motion mode or the existing I/O mode.

The PowerFlex 755 drive has five option ports that can accept a combination of options for control, communication, I/O, feedback, safety, and auxiliary control power. Only one safety option module can be installed on a drive.

There are seven types of peripherals:

- HIM
- I/O
- Communications, Ethernet Standard
- Aux Power(1)
- Safety(2)
- Encoder Interface(3)
- Universal Feedback(3)

Table 5 lists valid peripheral devices and ports for various PowerFlex 755 drives.

(1) Aux power is not supported for Integrated Motion.

(2) Only one safety option module can be installed on a drive.

(3) See Table 6 for supported feedback module combinations.

Table 5 - Peripheral Devices and Ports for PowerFlex 755 Devices That Support Integrated Motion on Ethernet Networks

Drive Catalog Number	Description	Ports
PowerFlex 755-EENET-CM	PowerFlex 755 AC Drive via Embedded Ethernet	4, 5, 6, 7, 8
PowerFlex 755-EENET-CM-S	PowerFlex 755 AC Drive via Embedded Ethernet - Safe Torque Off Option	4 and 5 6 is reserved for safety
PowerFlex 755-EENET-CM-S1	PowerFlex 755 AC Drive via Embedded Ethernet - Safe Speed Monitor Option	4 and 5 6 is reserved for safety
PowerFlex 755-EENET-CM-S3(1)	PowerFlex 755 AC Drive via Embedded Ethernet - Integrated Safe Torque Off Option(2)	4 and 5 6 is reserved for safety
PowerFlex 755-HiPwr-EENET-S4(1)	PowerFlex 755 AC Drive via Embedded Ethernet - Integrated Safety Functions Option(3)	4 and 5 6 is reserved for safety
PowerFlex 755-HiPwr-EENET-CM	PowerFlex 755 High-power AC Drive via Embedded Ethernet	4, 5, 6, 7, 8
PowerFlex 755-EENET-CM-S	PowerFlex 755 High-power AC Drive via Embedded Ethernet - Safe Torque Off Option	4 and 5 6 is reserved for safety
PowerFlex 755-EENET-CM-S1	PowerFlex 755 High-power AC Drive via Embedded Ethernet - Safe Speed Monitor Option	4 and 5 6 is reserved for safety
PowerFlex 755-HiPwr-EENET-CM-S3	PowerFlex 755 High-power AC Drive via Embedded Ethernet - Integrated Safe Torque Off Option	4 and 5 6 is reserved for safety

(1) PowerFlex Drive firmware revision 14 or later required.

(2) Safe Torque Off option module is only available when used with GuardLogix 5580 and Compact GuardLogix 5380 safety controllers.

(3) Integrated Motion support of the Integrated Safety Functions option module is only available when used with GuardLogix 5580 and Compact GuardLogix 5380 safety controllers.

See the manual for your PowerFlex 755 AC Drive safety or communication option for more information on using your specific peripheral device.

Table 6 shows the feedback module combinations that are supported.

Table 6 - Supported Feedback Module Combinations

Option	Supported Module	Catalog Number	Valid Ports
Two Feedback Options	Single Incremental Encoder	20-750-ENC-1	4…8
	Dual Incremental Encoder	20-750-DENC-1	4…8
	Universal Feedback Card	20-750-UFB-1	4…6
Two Feedback Options and One Safe Torque Off Option	Single Incremental Encoder	20-750-ENC-1	4 and 5
	Dual Incremental Encoder	20-750-DENC-1	4 and 5
	Universal Feedback	20-750-UFB-1	4 and 5
	Safe Torque Off	20-750-S	6
Two Feedback Options and One Safe Speed Monitor Option(1)	Single Incremental Encoder	20-750-ENC-1	4 and 5
	Dual Incremental Encoder	20-750-DENC-1	4 and 5
	Universal Feedback	20-750-UFB-1	4 and 5
	Safe Speed Monitor	20-750-S1	6

(1) The safe speed monitor option module must be used with the 20-750-DENC-1 Dual Incremental Encoder module or the 20-750-UFB-1 Universal Feedback module.

For more information, see the Installation Instructions for your PowerFlex 750-Series AC Drive.

Configuration and Startup Scenarios

The two ways to get an integrated motion on the EtherNet/IP network solution to run are to connect the hardware first or configure the software first.

Connect Hardware First

1 - Connect

- Install modules and drives.
- Check software and firmware for the latest revisions.

2 - Configure the controllers and communication modules.

- Open the Logix Designer application.
- Check software and firmware for the latest revisions and update if needed.
- You must configure the controllers and communication modules for time synchronization and motion.
- To configure a project and enable time synchronization, follow the steps in Chapter 2, Create a Project for Integrated Motion on the EtherNet/IP Network on page 21.

3 - Configure the drive module and an axis.

Check drive firmware for the latest revisions and update if needed.

- For Kinetix drives, follow the steps in Chapter 3,Configure Integrated Motion Control Using Kinetix Drives on page 31 or Chapter 4, Configure Integrated Motion Control Using Kinetix 5700 Drives on page 59.
- For a PowerFlex 755 drive, follow the steps in Chapter 5, Configure Integrated Motion Using a PowerFlex 755 Drive on page 99.

  If you are using a PowerFlex 755 drive and are unfamiliar with the integrated motion interface and attributes, see the Integrated Motion on EtherNet/IP appendix in the PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001.

- For a PowerFlex 527 drive, follow the steps in Chapter 6, Configure Integrated Motion Using a PowerFlex 527 Drive on page 129.

4 - Commission

- Download project.
- Follow steps in Chapter 11, Commission an Axis on page 221.

5 - Program

- Follow steps in Appendix B, Out of Box Configuration for PowerFlex Drives on page 305.

Configure Software First

1 - Configure the controllers and communication modules.

- Open the Logix Designer application.
- Check software and firmware for the latest revisions and update if needed.
- You must configure the controllers and communication modules for time synchronization and motion.
- To build a project and enable time synchronization, follow the steps in Chapter 2, Create a Project for Integrated Motion on the EtherNet/IP Network on page 21.

2 - Configure the drive module and configure an axis.

Check drive firmware for the latest revisions and update if needed.

- For Kinetix drives, follow the steps in Chapter 3,Configure Integrated Motion Control Using Kinetix Drives on page 31 or Chapter 4, Configure Integrated Motion Control Using Kinetix 5700 Drives on page 59.
- For a PowerFlex 755 drive, follow the steps in Chapter 5, Configure Integrated Motion Using a PowerFlex 755 Drive on page 99.

If you are using a PowerFlex 755 drive and are unfamiliar with the integrated motion interface and attributes, see the Integrated Motion on EtherNet/IP appendix in the PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001.

For a PowerFlex 527 drive, follow the steps in Chapter 6, Configure Integrated Motion Using a PowerFlex 527 Drive on page 129.

3 - Program

- Follow steps in Appendix B, Out of Box Configuration for PowerFlex Drives on page 305.

4 - Connect

- Install modules and drives.
- Check software and firmware for the latest revisions.

5 - Commission

- Download project.
- Follow steps in Chapter 11, Commission an Axis on page 221.

Help for Selecting Drives and Motors

Motion Analyzer helps you select the appropriate Allen-Bradley® drives and motors that are based on your load characteristics and typical motion application cycles. The software guides you through wizard-like screens to collect information specific to your application.

After you enter the information for your application, such as, load inertia, gearbox ratio, feedback device, and brake requirements, the software generates an easy-to-read list of recommended motors, drives, and other support equipment.

You can access Motion Analyzer at https://motionanalyzer.rockwellautomation.com.

Create a Project for Integrated Motion on the EtherNet/IP Network

This chapter describes how to configure an integrated motion project in the Logix Designer application.

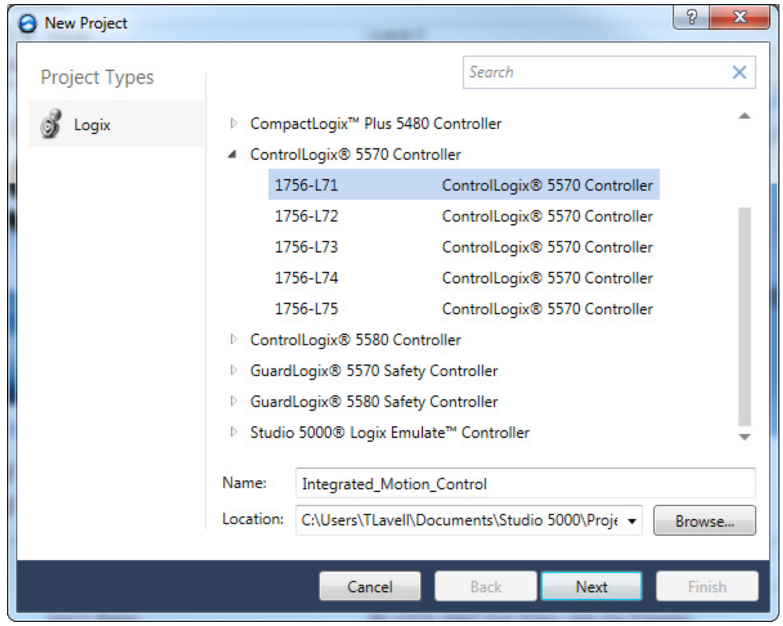
Create a Controller Project

IMPORTANT	For Motion and Safety applications, you must use a GuardLogix® or Compact GuardLogix controller.

Follow these instructions to create a project.

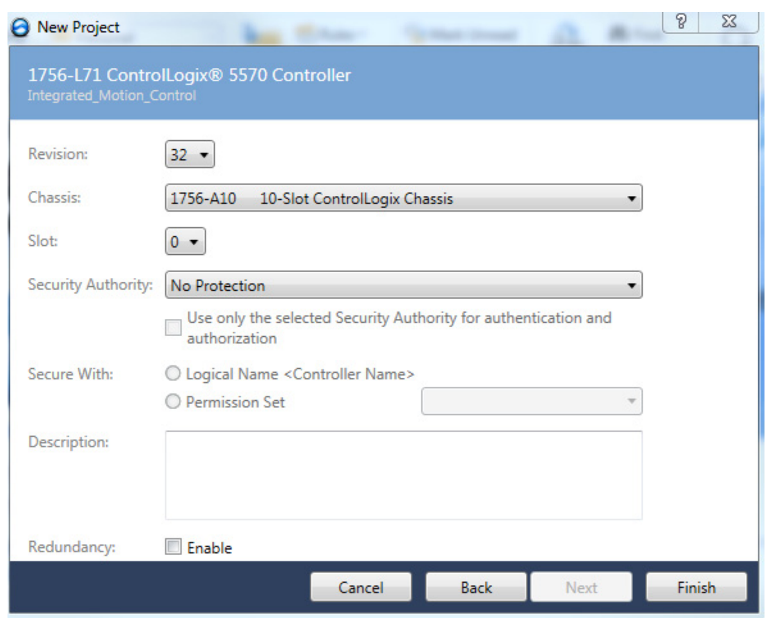
1. On the Studio 5000® dialog box, choose Create New Project.

2. Choose a controller, type a name, and click Next.



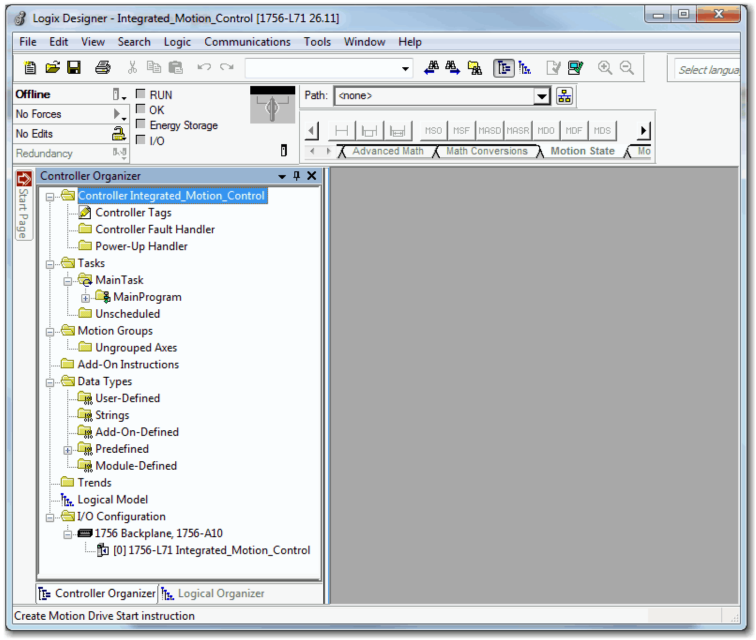
3. Type a Name for the controller.
4. Assign a location (optional).
5. Click Next.

   The Project Configuration dialog box appears.



6. Choose the chassis type.
7. Assign the slot location of the controller.
8. Assign the Security Authority.
9. Type a description (optional).
10. Click Finish.

The Logix Designer application opens with new project.

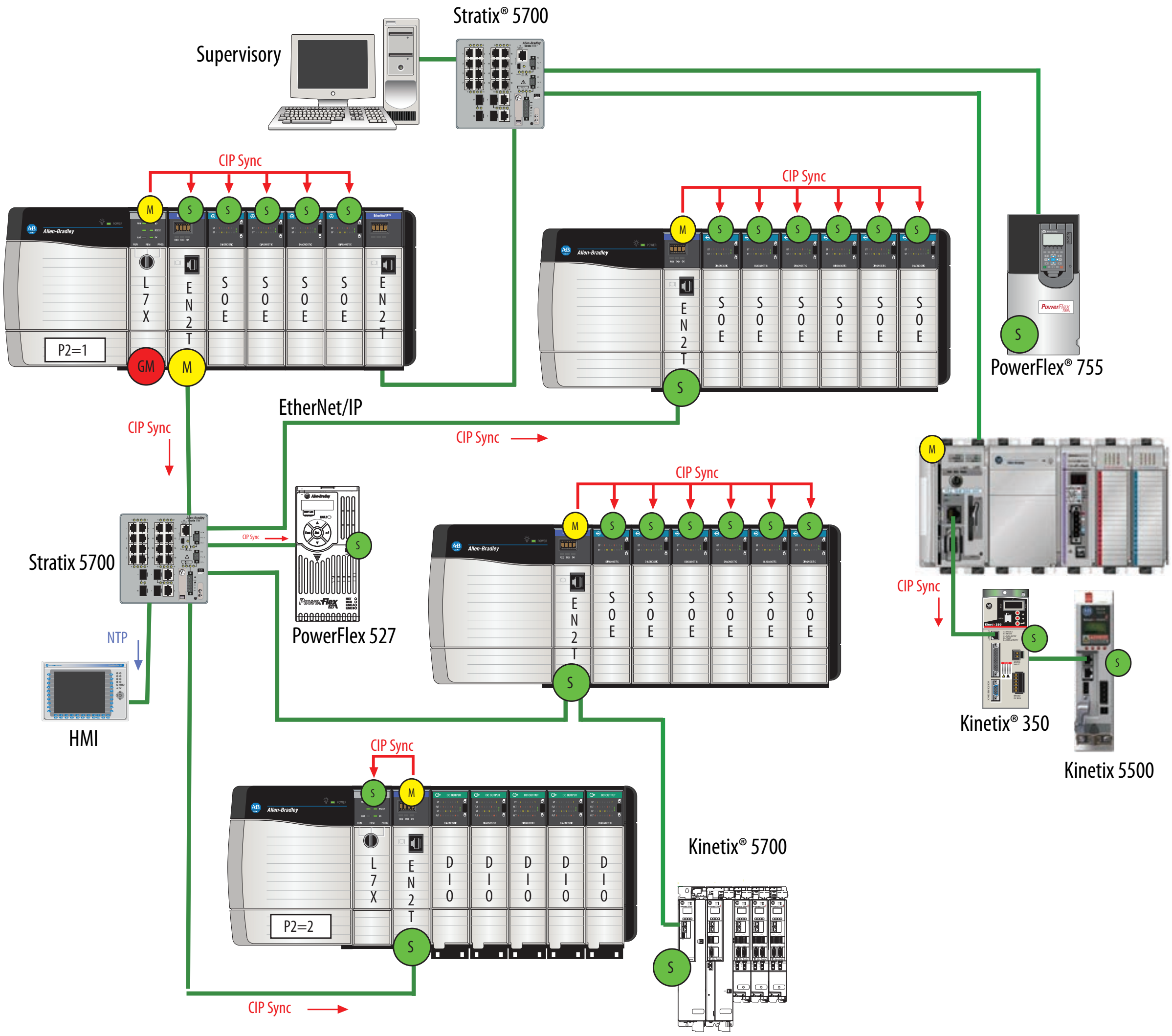


Set Time Synchronization

This technology supports highly distributed applications that require time stamps, sequence of events records, distributed motion control, and increased control coordination. All controllers and communication modules must have time synchronization that is enabled for applications that use integrated motion on the EtherNet/IP™ network.

Time synchronization in the Logix system is called CIP Sync. CIP Sync provides a mechanism to synchronize clocks between controllers, I/O, and other devices that are connected over CIP™ networks and the ControlLogix® or CompactLogix™ backplane. The device with the best clock becomes the Grandmaster time source for your system.

Figure 1 - Star Topology with the ControlLogix Controller as the Grandmaster



GM = Grandmaster (time source)

M = Master

S = Slave

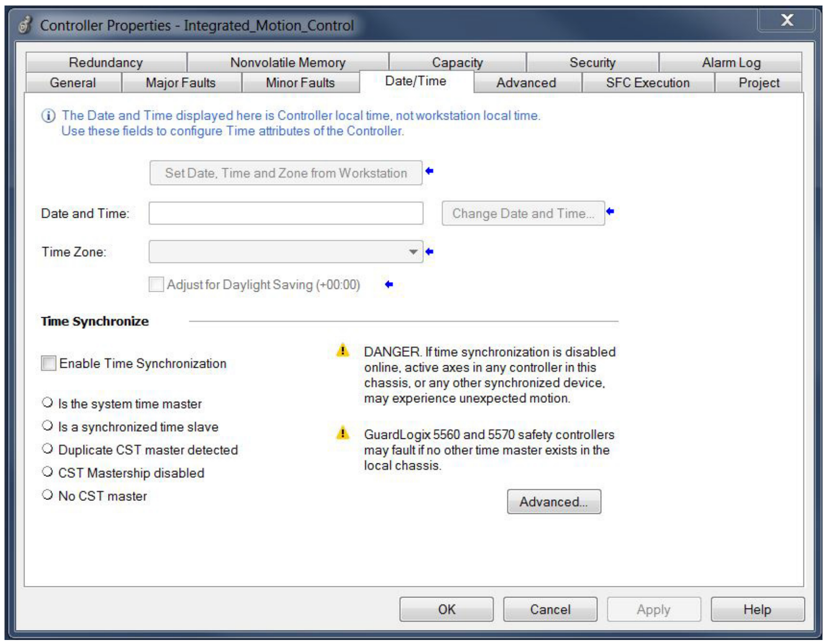
P1 and P2 = Priorities — Priorities are automatically assigned based on their clock quality, which the Best Clock Algorithm determines. In this example, P2=1 is the best quality so it becomes the Grandmaster. If the P2=1 device loses clock quality for some reason, then P2=2 would become the Grandmaster for the system.

The Best Master Clock algorithm determines what device has the best clock. The device with the best clock becomes the Grandmaster time source for your system. All controllers and communication modules must have time synchronization that is enabled to participate in CIP Sync.

See the Integrated Architecture and CIP Sync Configuration Application Technique, publication IA-AT003, for detailed information.

You must enable time synchronization for motion applications. Follow these instructions to enable time synchronization.

1. In the Controller Organizer, right-click the controller and choose Properties.
2. Click the Date/Time tab.
3. Check Enable Time Synchronization.
4. Click OK.



Add an Ethernet Communication Module

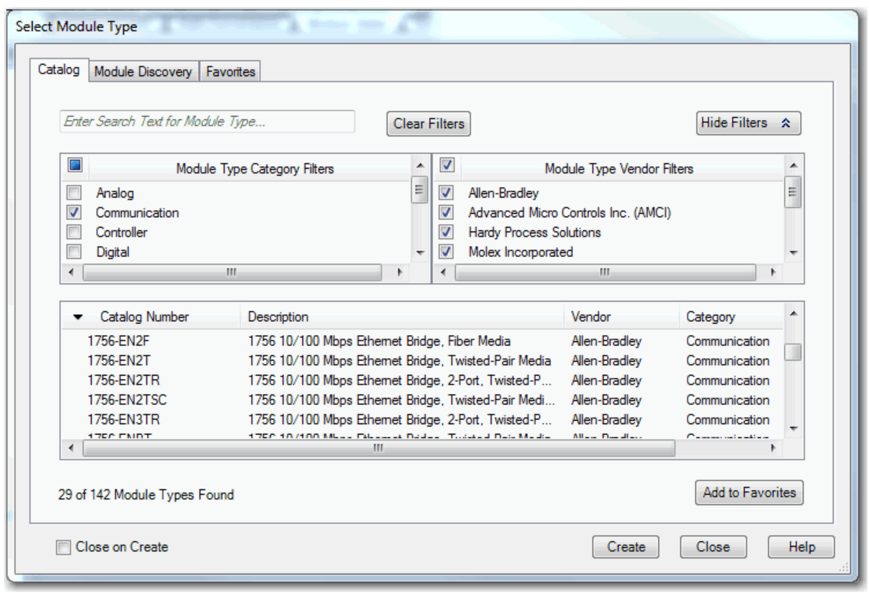
Although ControlLogix 5580 and GuardLogix 5580 controllers can use Ethernet communication modules, only ControlLogix 5560 and 5570 and GuardLogix 5560 and 5570 controllers require an Ethernet communication module for connection to the Ethernet network. See Controller, Communication, Drive, and Software Options on page 11 for more information.

Follow these instructions to add an Ethernet communication module to your project if needed.

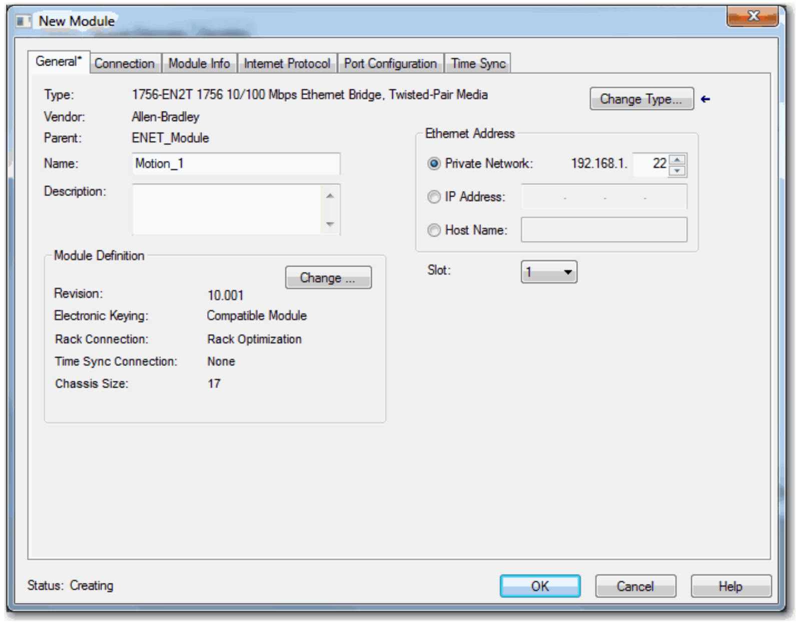
IMPORTANT	For all communication modules, use the firmware revision that goes with the firmware revision of your controller. See the release notes for the firmware of your controller.

1. To add a module, right-click the backplane and choose New Module.
2. Clear the Module Type Category Filters select all checkbox.
3. Check the Communication checkbox.

   On the Select Module Type dialog box, you can filter to the exact type of module you are looking for, which makes your search faster.
4. Under Communications, select the Ethernet module and click Create.



The New Module configuration tabs appear.

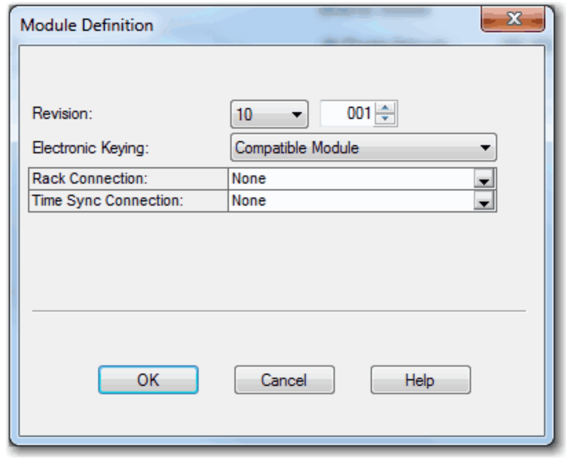


5. Type a name for the module.
6. If you want, type a description.
7. Assign the EtherNet/IP address of the Ethernet module.

   For information on how to create an Ethernet network and setting IP addresses for the communication and motion modules, see these manuals:

   – EtherNet/IP Network Configuration User Manual, publication ENET-UM001
   – PowerFlex® 755 Drive Embedded EtherNet/IP Adapter User Manual, publication, 750COM-UM001
   – Knowledgebase Technote # 66326
   – Converged Plantwide Ethernet (CPwE) Design and Implementation Guide, publication ENET-TD001
8. Assign the slot for the module.
9. In the module definition area, click Change.

10. Choose an Electronic Keying option.

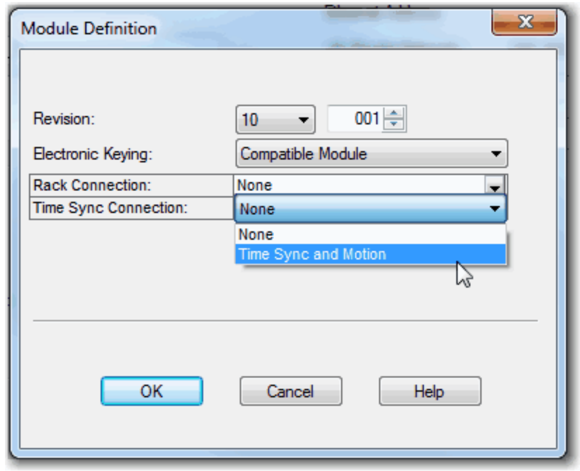


ATTENTION: The electronic keying feature automatically compares the expected module, as shown in the configuration tree, to the physical module before communication begins.
When you are using motion modules, set the electronic keying to either `Exact Match' or `Compatible Keying'.

Never use `Disable Keying' with Ethernet communication and motion modules.

For more information about electronic keying, see the ControlLogix Controller User Manual, publication 1756-UM001.

11. Choose Time Sync and Motion.



IMPORTANT	For CIP Sync time coordination to work in motion control, you must set the Time Sync Connection to Time Sync and Motion on all Ethernet communication modules. The CIP Sync protocol is what enables motion control on the EtherNet/IP network. The Time Sync and Motion selection is available only for firmware revision 3 and later. You must be offline to change the Time Sync and Motion selection. If you are online at a major revision of 1 or 2, you can only change the revision to a 1 or 2. You must go offline to change the module to revision 3 or 4 and return to revision 1 or 2.

IMPORTANT	For CompactLogix 5370 and Compact GuardLogix 5370 controllers, the embedded dual-port Ethernet is automatically set with Time Sync Connection= Time Sync and Motion. To enable Integrated Motion, check the `Enable Time Synchronization' checkbox on the controller time/date tab.

12. Click OK.

IMPORTANT	If you have not enabled time synchronization, you get errors when you try to associate an axis.

Notes:

Configure Integrated Motion Control Using Kinetix Drives

This chapter provides procedures on how to configure integrated motion control by using the Kinetix® 350, Kinetix 5500, and Kinetix 6500 drives. The basic configuration for an integrated motion solution is to associate a drive with motor feedback and an axis configuration type.

For the examples in this chapter, the Kinetix 6500 drive is used and the exceptions for the Kinetix 350, Kinetix 5500 drives noted. See Chapter 4, Configure Integrated Motion Control Using Kinetix 5700 Drives, for Kinetix 5700 configuration information.

See Chapter 8, Configuration Examples for a Kinetix Drive, for examples of axis and feedback configurations.

For information about what attributes are replicated in the drive, see the Integrated Motion on the EtherNet/IP™ network Reference Manual, publication MOTION-RM003.

Add a Kinetix EtherNet/IP Drive

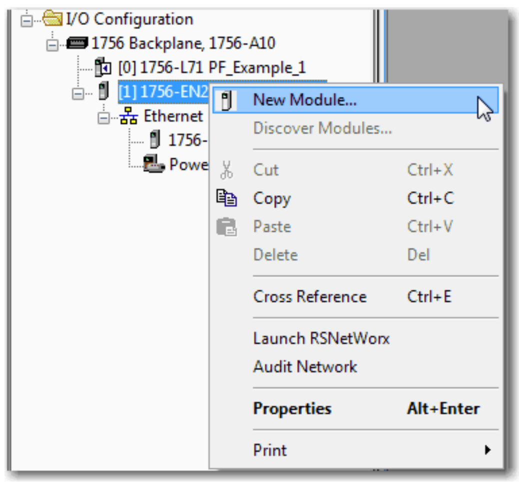
See Table 2 on page 11 to determine the minimum version of the Studio 5000 Logix Designer® application that is required for your drive.

IMPORTANT

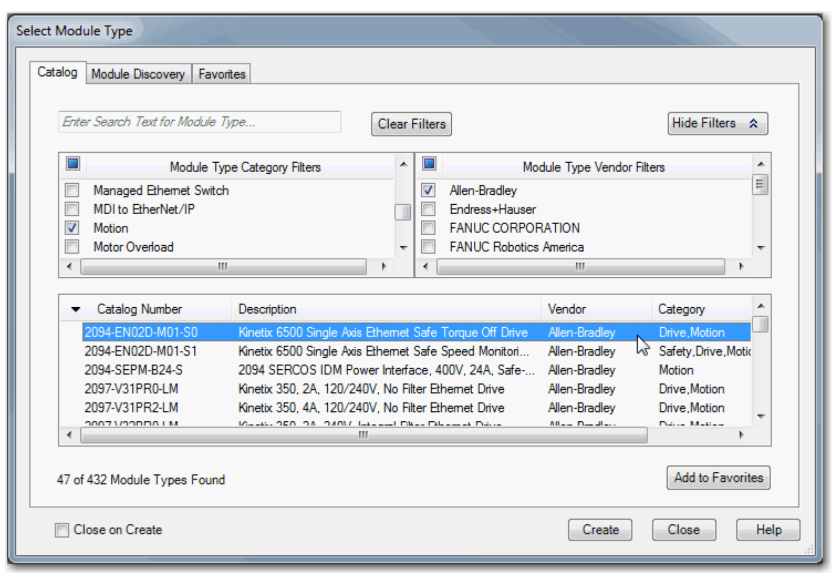
- For complete information on how to configure Kinetix 5500 drives, including drives with integrated safety connections, see the Kinetix 5500 Servo Drives User Manual, publication 2198-UM001.
- For complete information about how to configure the Kinetix 350 drives, see the Kinetix 350 Single-axis EtherNet/I/P Servo Drive User Manual, publication 2097-UM002.
- For complete information about to configure the Kinetix 6500 drives, see the Kinetix 6200 and Kinetix 6500 Modular Multi-axis Servo Drives User Manual, publication 2094-UM002.

Follow these instructions to add a Kinetix drive your project.

1. Right-click the Ethernet network (node) and choose New Module.

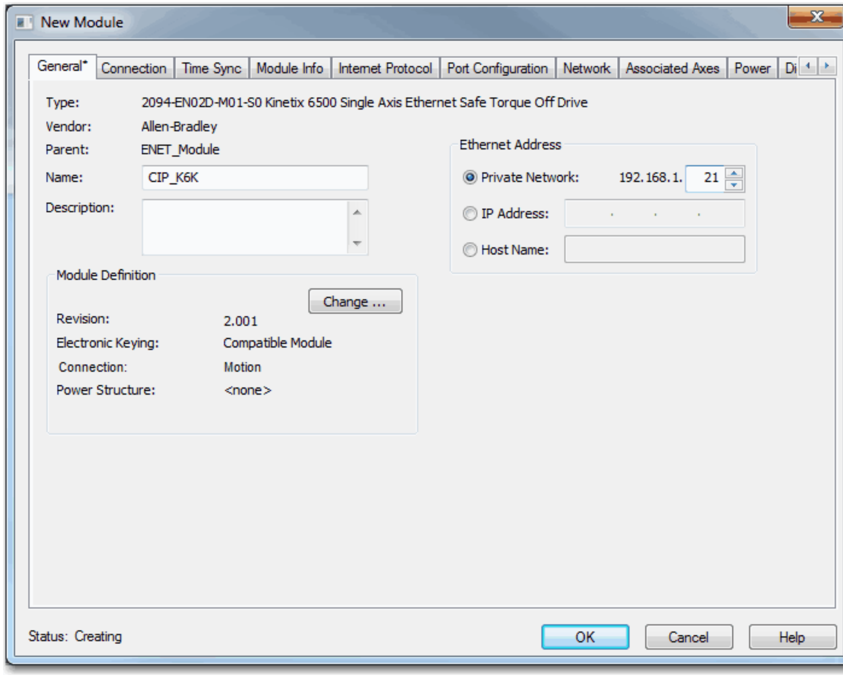


2. To filter the selections, check the Motion checkbox.
3. Choose the Kinetix 350, Kinetix 5500, or Kinetix 6500 drive.



4. Click Create.

5. Type a Name for the module.

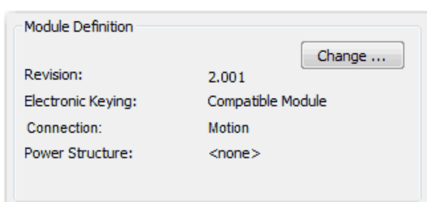


6. Type a description, if desired.
7. Assign an EtherNet/IP address.

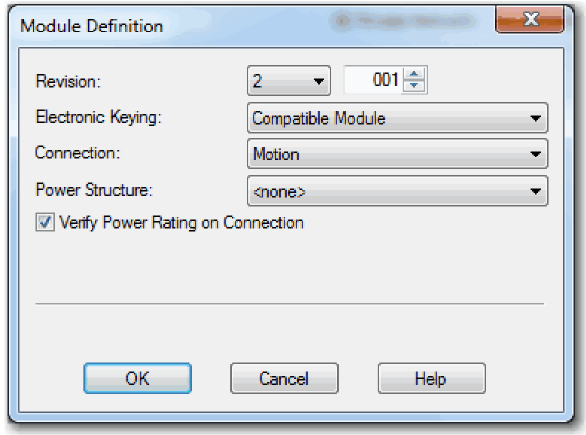
   You can establish the Node address of the drive by entering a private IP address via a thumbwheel switch on the drive for Private Network segments. Use the format 192.168.1.xxx, where the last octet, xxx, is the switch setting.

   See the EtherNet/IP Network Configuration User Manual, publication ENET-UM001, for information on setting IP addresses and other Ethernet network considerations.

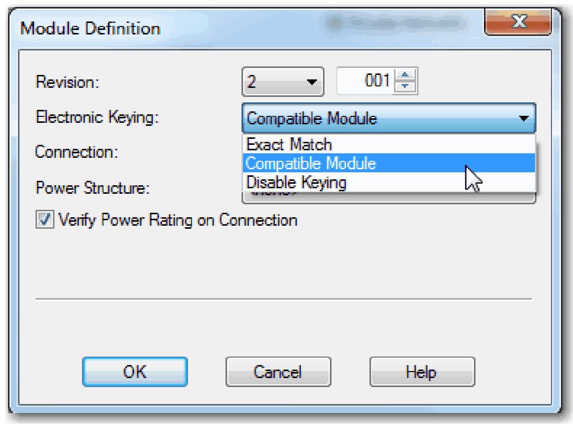
8. Under Module Definition, click Change.



The Module Definition dialog box appears.



9. Choose an Electronic Keying option.



ATTENTION: The electronic keying feature automatically compares the expected module, as shown in the configuration tree, to the physical module before communication begins.
When you are using motion modules, set the electronic keying to either `Exact Match' or `Compatible Keying'.

Never use `Disable Keying' with motion modules.

For more information about electronic keying, see the Electronic Keying in Logix 5000™ Control Systems Application Technique, publication LOGIX-AT001.

10. Assign the appropriate Power Structure.

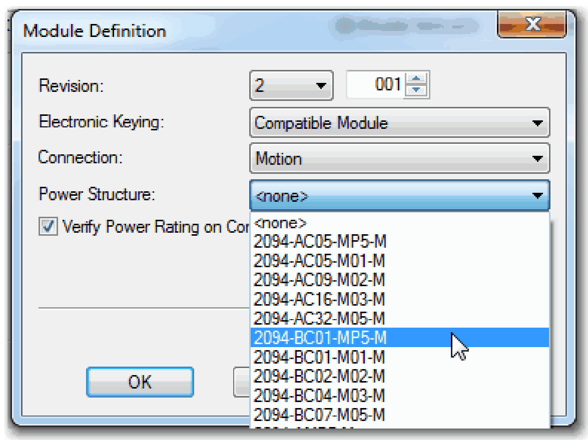
    When you select a Kinetix 6500 drive catalog number, you are specifying only a Control Module. To specify the drive, you must assign a power structure. Some of the drives do not require a power structure.

    TIP You can locate the power-structure reference numbers by doing the following:

    - Check the hardware
    - See the device documentation
    - Reviewing the purchase order or the bill of materials.

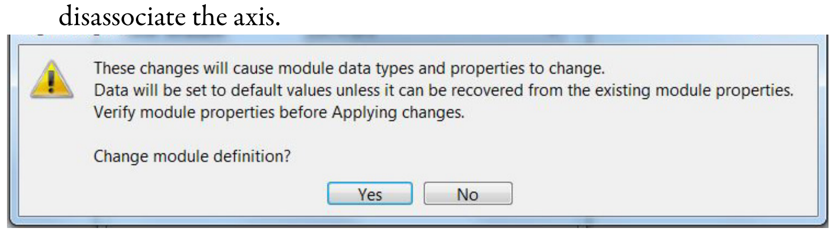
    You assign the power structure for the Kinetix 6500 drive only. Kinetix 350 and Kinetix 5500 drives auto-populate the only power structure available.

11. Check the checkbox if you want to verify the power rating on connection.



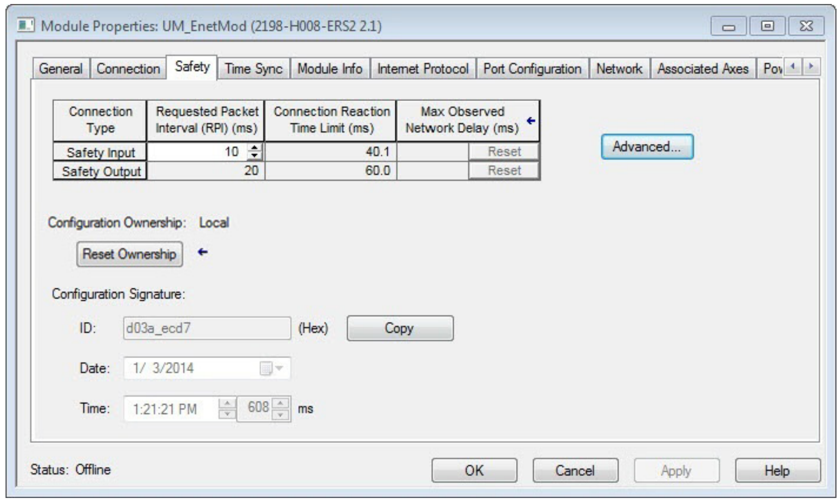
12. Click OK.

    When you change the Module Definition, related parameters also change. By changing the major revision or power structure, the identity of the drive changes. If your drive is associated to an axis, these changes disassociate the axis.



Configure the Safety Category - Kinetix 5500 Drives

The Safety tab provides you with information about the connection between the owner and the 2198-H*xxx*-ERS2 servo drive. The information comes from the controller.



The connection between the owner and the 2198-H*xxx*-ERS2 servo drive is based on the following:

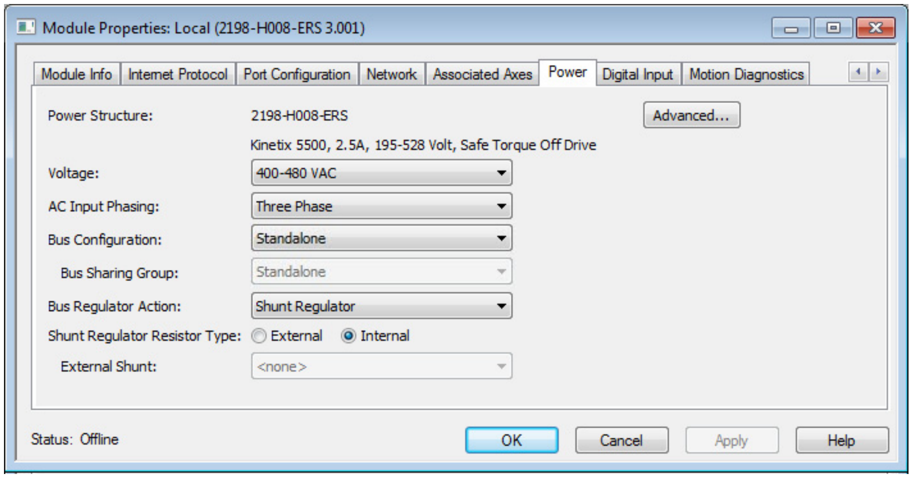
- Servo drive catalog number must be 2198-H*xxx*-ERS2 (integrated)
- Servo drive safety network number
- GuardLogix® slot number
- GuardLogix safety network number
- Path from the GuardLogix controller to the 2198-H*xxx*-ERS2 drive
- Configuration signature

The connection between the GuardLogix controller and the 2198-H*xxx*-ERS2 drive is lost if any differences are detected. The yellow yield icon also appears in the controller project tree after you download the program.

For complete information on how to configure a drive with integrated safety connections, see the Kinetix 5500 Servo Drives User Manual, publication 2198-UM001.

Configure the Power Options

1. Click the Power tab.



IMPORTANT Single-phase operation is possible only when Module Properties > Power tab > Bus Configuration is configured as Standalone and Voltage is configured as 200…240V AC.

IMPORTANT The Logix Designer application enforces shared-bus configuration rules for Kinetix 5500 drives, except for shared AC configurations.

2. From the pull-down menus, choose the power options appropriate for your actual hardware configuration.

ATTENTION: To avoid damage to equipment, make sure the AC input voltage that is configured in the Logix Designer application matches the actual hardware being configured.

Attribute	Menu	Description
Voltage	400-480 VAC	324…528 AC rms input voltage
	200-240 VAC	195…264 AC rms input voltage
AC Input Phasing	• Three Phase • Single Phase	Input power phasing. Kinetix 5500 drives with single-phase operation is limited to 2198-H003-ERS*x*, 2198-H008-ERS*x*, and 2198-H015-ERS*x*.
Bus Configuration (1)	Standalone	Applies to single-axis drives and drives with Shared AC input configurations.
	Shared AC/DC	Applies to converter drives with Shared AC/DC and Shared AC/DC Hybrid input configurations.
	Shared DC	Applies to inverter drives with Shared DC input (common-bus) configurations.

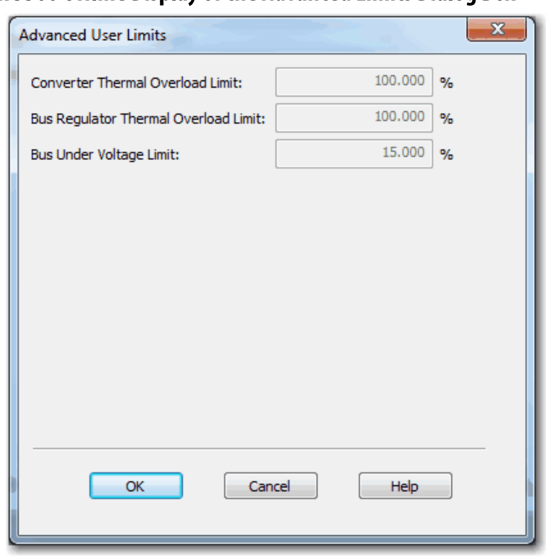
Attribute	Menu	Description
Bus-sharing Group	Standalone	Applies to standalone bus configurations.
	• Group1 • Group2 • Group3…	Applies to any bus-sharing configuration.[2]
Shunt Regulator Action	Disabled	Disables the internal shunt resistor and external shunt option.
	Shunt Regulator	Enables the internal and external shunt options.
Shunt Regulator Resistor Type	Internal	Enables the internal shunt (external shunt option is disabled).
	External	Enables the external shunt (internal shunt option is disabled).
External Shunt [3]	• None • 2097-R6 • 2097-R7	Selects external shunt option. Only the shunt model that is intended for the drive model is shown.

(1) Bus Configuration selection is not applicable to all EtherNet/IP drives.
(2) All drives physically connected to the same shared-bus connection system must be part of the same bus-sharing group in the Logix Designer application.
(3) See the Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003, for more information on the Bulletin 2097 external shunt resistors.

3. Click OK.

You can change the overload and voltage limits when you are offline. You cannot change settings while online but the values are displayed.[1]

Figure 2 - Kinetix 5500 Offline Display of the Advanced Limits Dialog Box



See publication 2198-UM001, Kinetix 5500 Servo Drives, for more information.

(1) Not applicable to the Kinetix 350 drive.

Configure Digital Inputs

Use the Digital Input tab to enter digital input values for the drive module. These offline displays are the default values for the Kinetix 6500 and PowerFlex® 755 Ethernet drives. The appearance of the Digital Input tabs of the PowerFlex 755 drives can vary dependent upon the peripheral device configuration. The Kinetix 350 drive does not have a Digital Input tab.

Figure 3 - Digital Input Tab for the Kinetix 5500 Drive

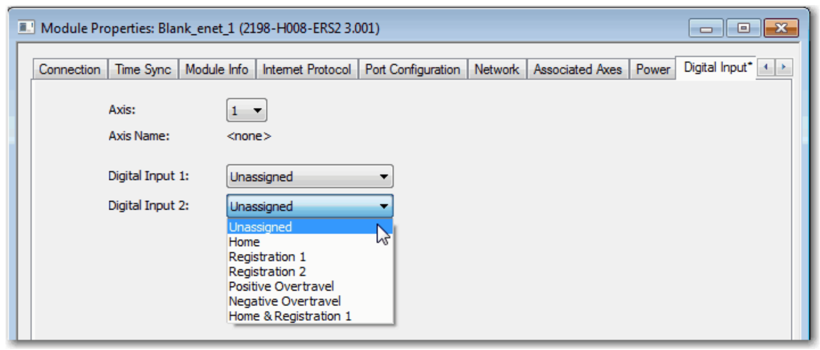


Table 7 - Module Properties: Kinetix 5500 Digital Input Tab Descriptions

Parameter	Description
Digital Input 1 Digital Input 2	Choose one of these values for Digital Input 1 and 2: • Unassigned • Enable • Home • Registration 1 • Registration 2 • Positive Overtravel • Negative Overtravel • Home and Registration 1

Figure 4 - Digital Input Tab for the Kinetix 6500 Drive

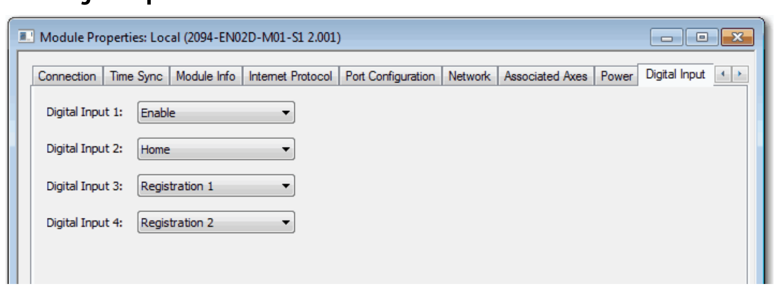


Table 8 - Module Properties: Kinetix 6500 Digital Input Tab Descriptions

Parameter	Description
Digital Input 1 Digital Input 2 Digital Input 3 Digital Input 4	Choose one of these values for Digital Input 1, 2, 3, and 4: • Unassigned • Enable • Home • Registration 1 • Registration 2 • Positive Overtravel • Negative Overtravel • Regeneration OK

Create an Associated Axis

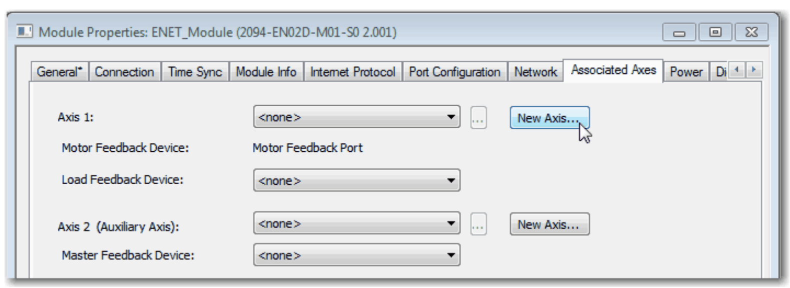
There are two approaches that you can take to create and configure an axis. You can create an axis first and then add the axis to your motion group or you can create your motion group and then add an axis.

The procedure that is outlined in this section takes the approach to create your axis first, add it to your motion group, and then configure the axis.

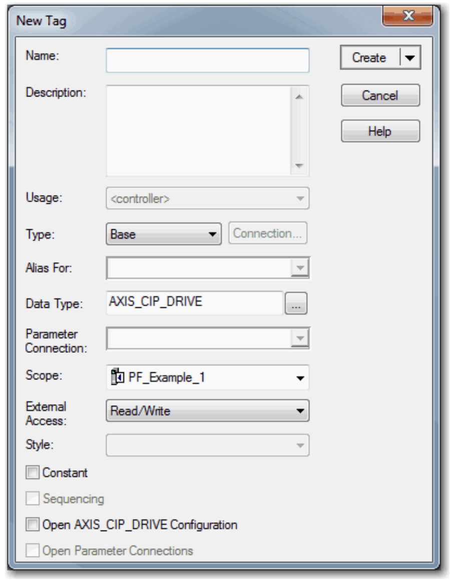
Create an Axis for a Kinetix Drive

Follow these steps to create an axis.

1. To open the Module Properties dialog box, double-click the drive in the Controller Organizer.
2. Click the Associated Axes tab.
3. Click New Axis.



The New Tag dialog box appears.



Notice that the fields in the next steps are automatically entered for the AXIS_CIP_DRIVE data type.

4. Type a Tag name.
5. Type a Description, if desired.
6. Choose the Tag Type.
7. Choose the Data Type AXIS_CIP_DRIVE.
8. Choose the Scope.
9. Choose the External Access.

   For more information about External Data Access Control and Constants, see the Logix5000 Controllers I/O and Tag Data Programming Guide, publication 1756-PM004.

10. Click Create.

Establish Feedback Port Assignments

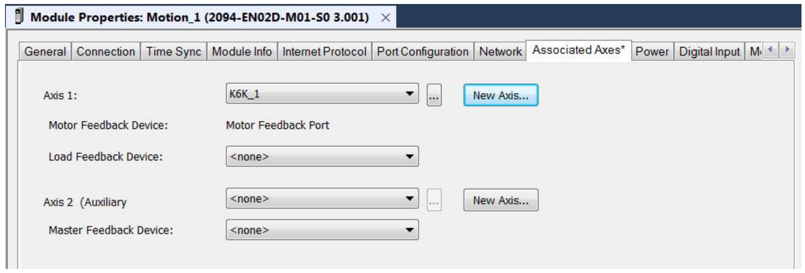
Kinetix 350 and Kinetix 5500 drives have one Motor Feedback Port, which is automatically assigned.

The Kinetix 6500 drive has two feedback ports. Port 1 is reserved for Motor Feedback on the primary axis (Axis_1). Port 2 can be used either as Load Feedback for the primary axis or as a Master Feedback for a secondary feedback only axis (Axis_2).

To establish feedback port assignments for Kinetix 6500 drives, follow these steps.

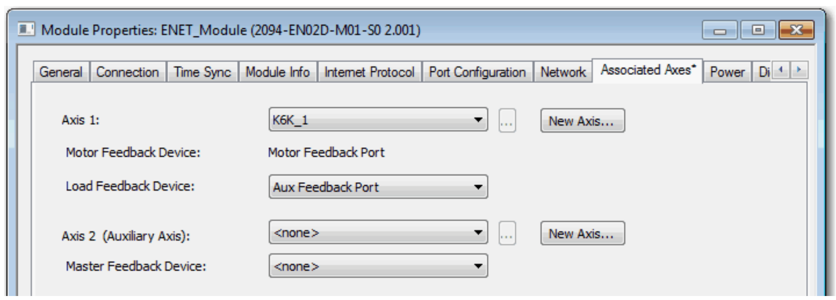
1. To access Module Properties, double-click the Kinetix 6500 drive in the Controller Organizer.
2. Click the Associated Axes tab.

   Notice that the motor feedback is already configured by default.



   The AUX Feedback Port (Port 2) of the drive can be optionally used for load feedback of the primary axis (Axis 1) to support Load or Dual Feedback Configuration.

3. From the Load Feedback Device pull-down menu, choose AUX Feedback Port.



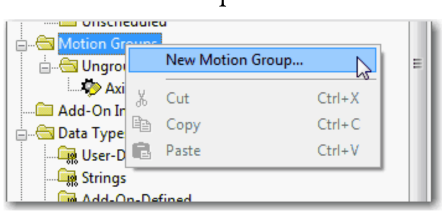
Create a Motion Group

All axes must be added to the Motion Group in your project. If you do not group the axes, they remain ungrouped and unavailable for use. You can only have one Motion Group per Logix controller.

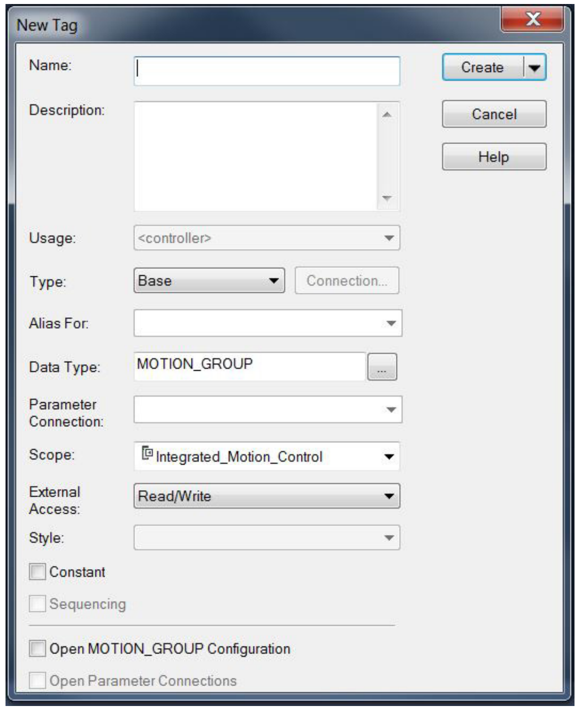
To determine how many axes are supported by your controller system, see Table 3 on page 12, Supported Axes by Controller Type.

To create a motion group, follow these instructions.

1. In the Controller Organizer, right-click Motion Groups and choose New Motion Group.



   The New Tag dialog box appears.

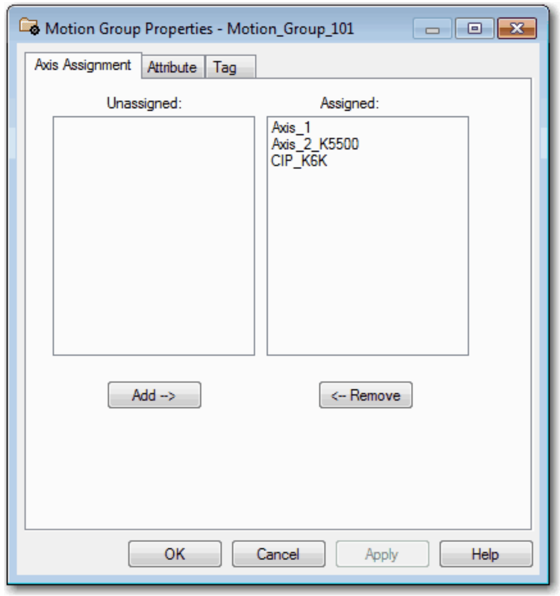


2. Type a Tag name.
3. Type a description, if desired.
4. Choose the Tag Type.
5. Choose the Scope.
6. Choose the External Access.
7. Click Create.

   Your new motion group appears in the Controller Organizer under the Motion Groups folder.
8. Right-click the new motion group and choose Properties.

   The Motion Group Properties dialog box appears.

9. Click the Axis Assignment tab and move your axes (created earlier) from Unassigned to Assigned.



Set the Base Update Period

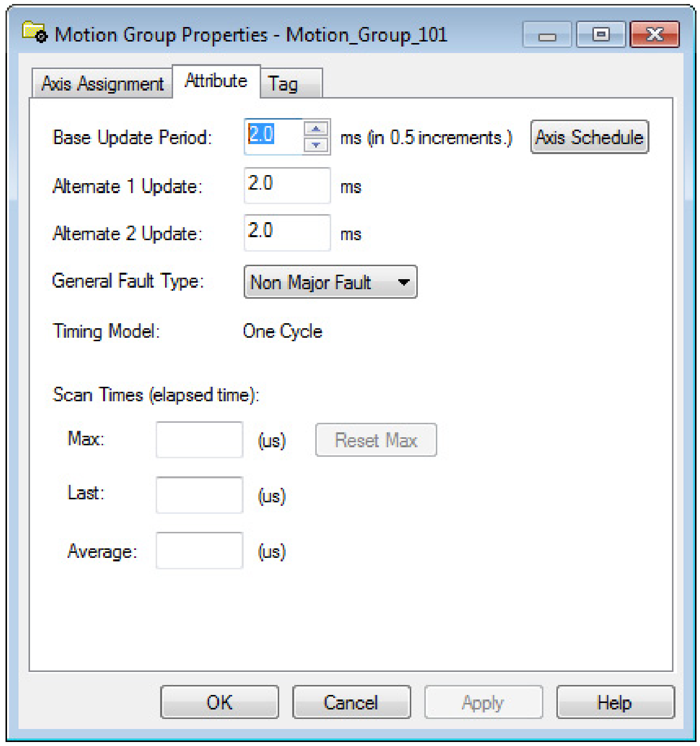
The Base Update Period is basically the RPI rate for Ethernet communication between the controller and the motion module, a Unicast connection.

There are two alternate update periods that you can configure when using the Axis Scheduling function. See Axis Scheduling on page 145 for details.

The Base Update Period determines how often the Motion Task runs. When the Motion Task runs, it interrupts most other tasks regardless of their priority. The Motion Task is the part of the controller that takes care of position and velocity information for the axes.

To set the Base Update Period, follow these steps.

1. Click the Attribute tab in the Motion Group Properties dialog box.

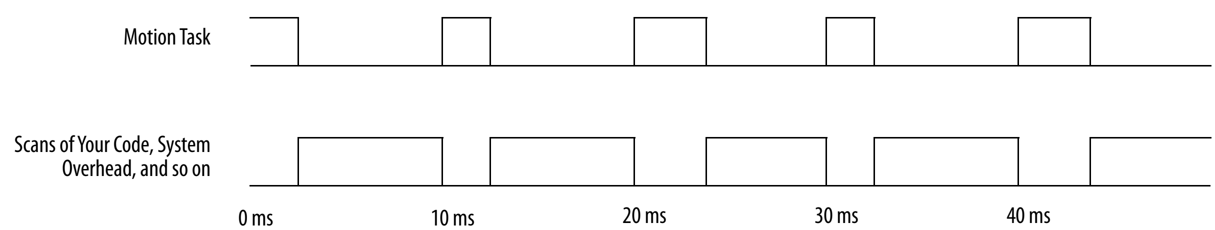


2. Set the Base Update Period to 2.0…32.0 ms.

TIP Check the Last Scan time values. Typically, the value is less than 50% of the Base Update Period.

For the Kinetix 6500 drive, the minimum Base Update Rate is 1 ms.

Figure 5 - Base Update Period Example



In this example, the Base Update Period = 10 ms. Every 10 ms the controller stops scanning your code and whatever else it is doing and runs the motion planner.

The Base Update Period is a trade-off between updating positions of your axes and scanning your code. In general, you do not want the Motion Task to take more than 50% of the overall Logix controller time on average. The more axes that you add to the Motion Group, the more time it takes to run the Motion Task.

For the ControlLogix® 5570 controller, the incremental impact on the Motion Task is roughly at 6…8 drives/ms. Actual impact can vary depending on axis configuration.

For detailed information on the Axis Scheduling function, Axis Assignment tab, and Alternate Update Period Scheduling, see Axis Scheduling on page 145.

Integrated Architecture Builder

To help you determine motion system performance, use the motion performance calculator in the Integrated Architecture Builder (IAB).

The IAB is a graphical software tool for configuring Logix-based automation systems. It helps you select hardware and generate bills of material for applications that include controllers, I/O, networks, PowerFlex drives, On-Machine™ cabling and wiring, motion control, and other devices.

You can find the software at
http://www.rockwellautomation.com/en/e-tools/configuration.html

Configure the Axis Properties

After you add the drive to your project and create the axes, use the Axis Properties dialog boxes to configure the drive. Notice that the dialog boxes change based on your configuration choices, for example, feedback configuration.

Table 9 lists the basic tasks necessary configure a drive.

Table 9 - Category Dialog Boxes to Configure Drives

Category Dialog Box	Perform These Tasks	Page
General	• Assign the axis configuration. • Choose the feedback configuration. • Choose the application type, if applicable. • Choose the loop response (low, medium, or high), if applicable. • If you have not already done so, you can create and associate an axis to a new Motion Group and associate a drive module to the axis.	47
Motor	• Specify a motor with the Data Source = Nameplate data sheet. • Specify a motor with the Data Source = Catalog Number. • Select a motor with the Data Source = Motor NV.	51
Motor Feedback	• Select the Motor Feedback Type.	54
Load Feedback	• Select the Load Feedback Type, if applicable.	55
Scaling	• Configure feedback by choosing the load type, by entering the scaling units, and by choosing the Travel mode. • Enter the Input Transmission and Actuator ratio, if applicable.	222

The parameters that you configure on the General category dialog box result in the presentation of attributes and parameters that are available for the combination of your selections.

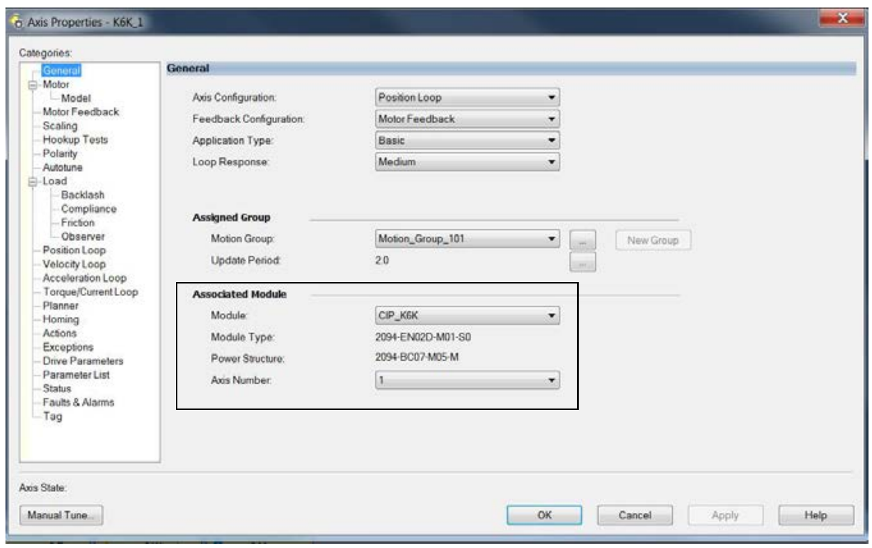
IMPORTANT	All AXIS_CIP_DRIVE Axis Properties dialog boxes are dynamic. Optional attributes and dialog boxes that are related to each integrated motion axis you create come and go based on what combination of axis characteristics you define.

See the Integrated Motion Reference Manual, publication MOTION-RM003, for complete information on Axis Attributes and how to apply Control Modes.

IMPORTANT	Be sure to associate the drive and axis before configuring the axis because the drive determines what optional attributes are supported for the axis.

If you have already created an axis and associated it with a drive, the Associated Module and Axis are shown on the General category of the Axis Properties dialog box. Otherwise, you can select them here.

Figure 6 - General Category Dialog Box



The Axis Number field corresponds to the axes listed on the Associated Axes tab of the Module Properties dialog box. Any feedback port assignments that you made on the Associated Axes tab are also mapped to the drive when you associate an axis and a drive.

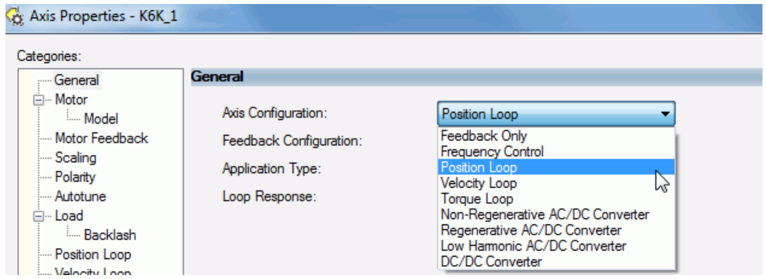
Configure the Associated Axis and Control Mode

Now that the axis is associated to the drive module, meaningful values are available for other axis properties.

For more information on Control Modes, see the Integrated Motion Reference Manual, publication MOTION-RM003.

1. In the Controller Organizer, double-click the Axis that you want to configure.

The Axis Properties General dialog box appears.



2. Choose an Axis Configuration type. For this example, choose Position Loop.

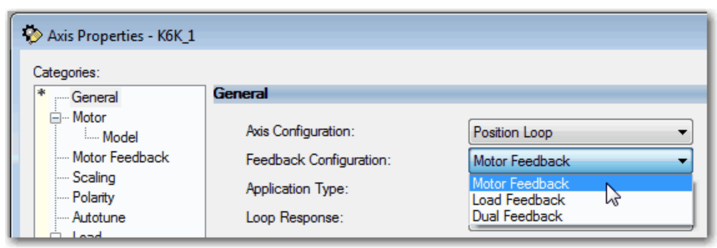
TIP The associated drive determines what Axis and Feedback Configuration choices are presented.

Table 10 compares the axis configuration types for the drives.

Table 10 - Compare the Axis Configuration Types for the Drives

Axis Type	Kinetix 350	Kinetix 5500	Kinetix 6500
Position Loop (P)	Yes	Yes	Yes
Velocity Loop (V)	Yes	Yes	Yes
Torque Loop (T)	Yes	Yes	Yes
Feedback Only (N)	No	Yes	Yes
Frequency Control (F)	No	Yes	No

3. In the Feedback Configuration pull-down menu, choose Motor Feedback.



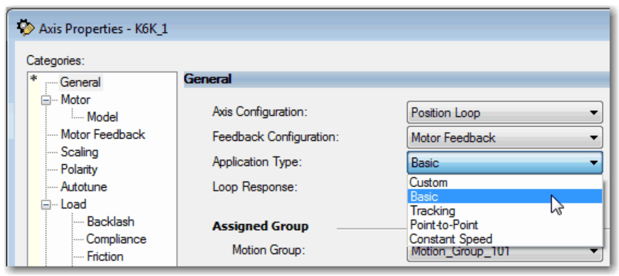
TIP The Kinetix 350 and Kinetix 5500 drives support only Motor Feedback.

Table 11 compares the feedback configuration types for the Kinetix drives.

Table 11 - Compare the Feedback Configuration Types for the Drives

Feedback Type	Axis Type	Kinetix 350	Kinetix 5500	Kinetix 6500
Motor Feedback	Position Loop (P), Velocity Loop (V), Torque Loop (T)	Yes	Yes	Yes
Load Feedback	Position Loop (P), Velocity Loop (V), Torque Loop (T)	No	No	Yes
Dual Feedback	Position Loop (P)	No	No	Yes
Dual Integrator	Position Loop (P)	No	No	No
Master Feedback	Feedback Only (N)	No	Yes	Yes
No Feedback	Velocity Loop (V), Frequency Control (F)	No	Yes	No

4. Choose an Application Type, if applicable.



TIP Application Type defines the servo loop configuration automatically. These combinations determine how the calculations are made that can minimize the need for you to perform an Autotune or a Manual Tune.

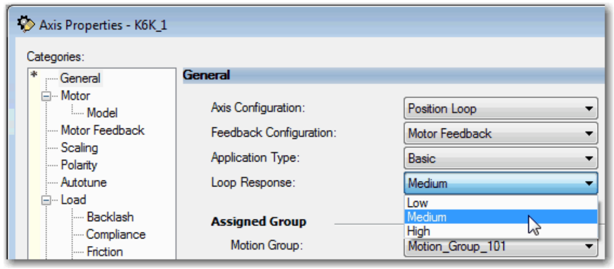
The Application Type determines the type of motion control application. This attribute is used to set the Gain Tuning Configuration Bits. Table 12 illustrates the gains established based on application type.

Table 12 - Customize Gains to Tune

Application Type	Kpi	Kvi	ihold	Kvff	Kaff	torqLPF
Custom(1)	-	-	-	-	-	
Basic (V20 and later)	No	No	No	Yes	No	Yes
Basic (V19 and earlier)	No	No	No	No	No	-
Tracking	No	Yes	No	Yes	Yes	Yes
Point-to-Point	Yes	No	Yes	No	No	Yes
Constant Speed	No	Yes	No	Yes	No	Yes

(1) If you set the type to Custom, you can control the individual gain calculations by changing the bit settings in the Gain Tuning Configuration Bits Attribute.

5. Choose a Loop Response, if applicable.



TIP Loop Response settings also impact the calculations that are made that can minimize the need for you to perform an Autotune or a Manual Tune. The loop response impacts the spacing between the position and velocity loops and the proportional and integral gains. This response impacts how aggressively a given profile is tracked.

Specify the Motor Data Source

The Motor Data Source is where you tell the axis where the motor configuration values are originating. You can select a motor by catalog number from the Motion Database. You can enter motor data from a nameplate or data sheet, or use the motor data that is contained in the drive or motor nonvolatile memory.

On the Motor dialog box you specify what motor you want to use and where the data is coming from:

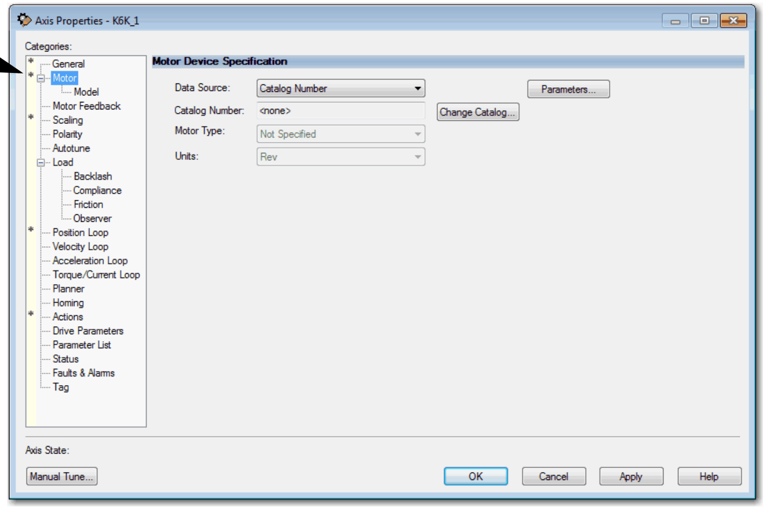
- Specify a motor with the Data Source = Nameplate data sheet.
- Specify a motor with the Data Source = Catalog Number.
- Select a motor with the Data Source = Motor NV.

Choose the Catalog Number as the Motor Data Source

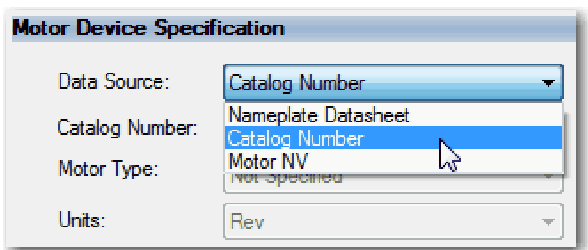
To choose a motor from the Motion Database, follow these steps.

1. If the Axis Properties dialog box is not open, double-click the axis.
2. Go to the Motor dialog box of Axis Properties.

The asterisk next to a category means that you have not applied changes.

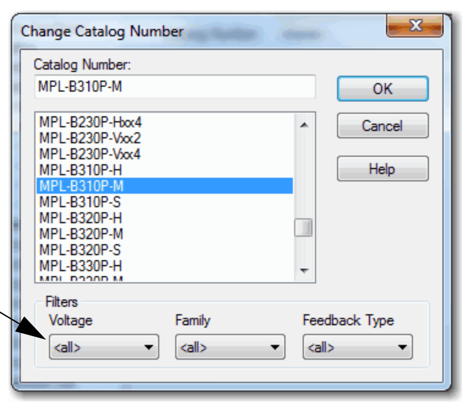


3. From the Data Source pull-down menu, choose Catalog Number.

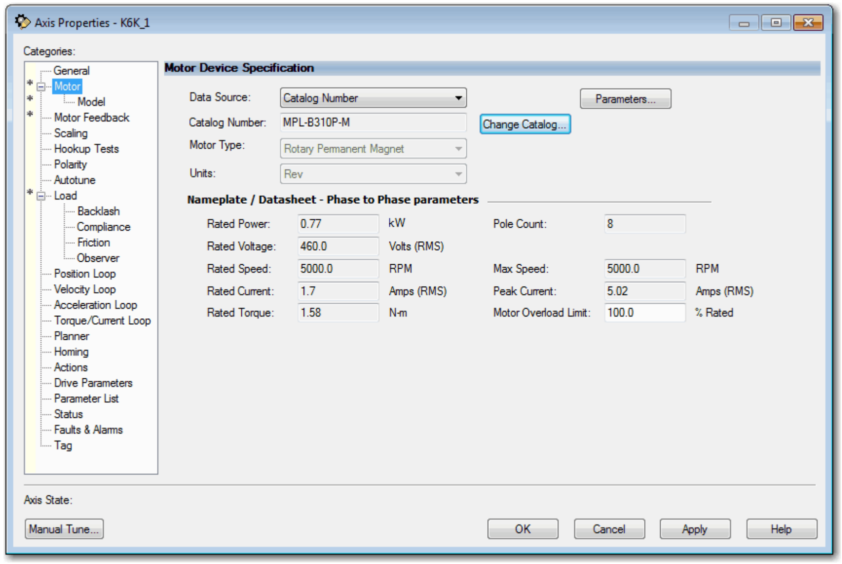


4. Click Change Catalog.
5. Select a motor.

To reduce the size of the list, use these filters.



The Motor category dialog box is now populated with all information that is related to the motor you selected from the Motion Database.



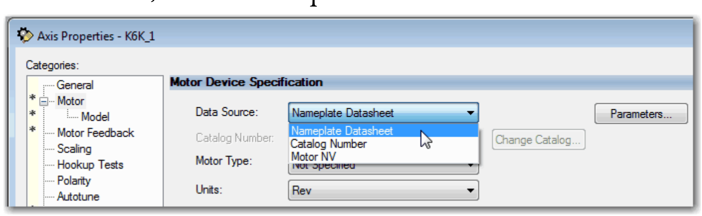
6. Click Apply.

TIP When you use a motor catalog number as the data source, default values are automatically set based on the Application Type and Loop Response settings from the General dialog box.

Choose Nameplate as the Motor Data Source

The Nameplate option requires you to enter the motor specification information from the motor nameplate and the motor data sheet.

1. On the Motor dialog box of Axis Properties, from the Data Source pull-down menu, choose Nameplate data sheet.



2. Choose a motor type.

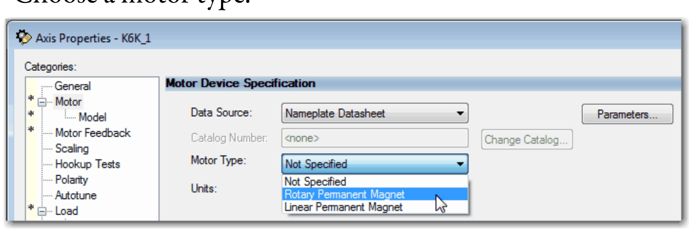
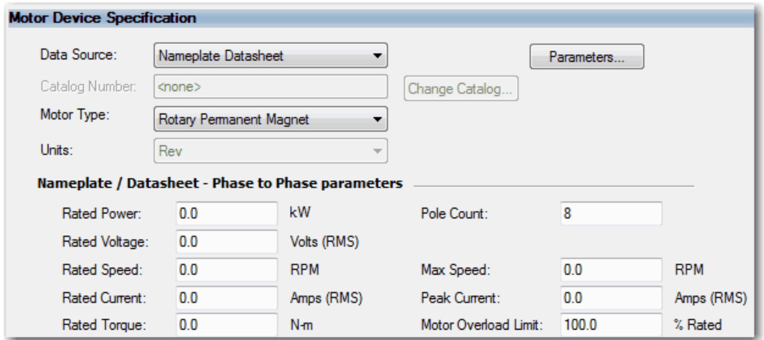


Table 13 shows the motor types and drives that are compatible.

Table 13 - Compatible Motor Types

Motor Type	Kinetix 350	Kinetix 5500	Kinetix 6500
Surface Mount Permanent Magnet	Yes	Yes	Yes
Linear Permanent Magnet	No	Yes	Yes
Rotary Induction	No	Yes	No
Interior Permanent Magnet	No	No	No

Notice that the motor information fields are initialized to defaults.

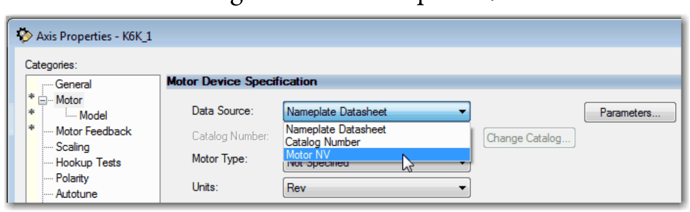


3. Enter the parameter information from the motor Nameplate data sheet and click Apply.

Choose Motor NV as the Motor Data Source

When you choose Motor NV as the data source, the motor attributes are derived from nonvolatile memory of a motor-mounted smart feedback device that is equipped with a serial interface. Only a minimal set of motor and motor feedback (Feedback 1) attributes are required to configure the drive.

1. From the Motor dialog box of Axis Properties, choose Motor NV.



2. Choose the Motor Units that are associated with the motor, either Rev for rotary motor or Meters for linear motor.

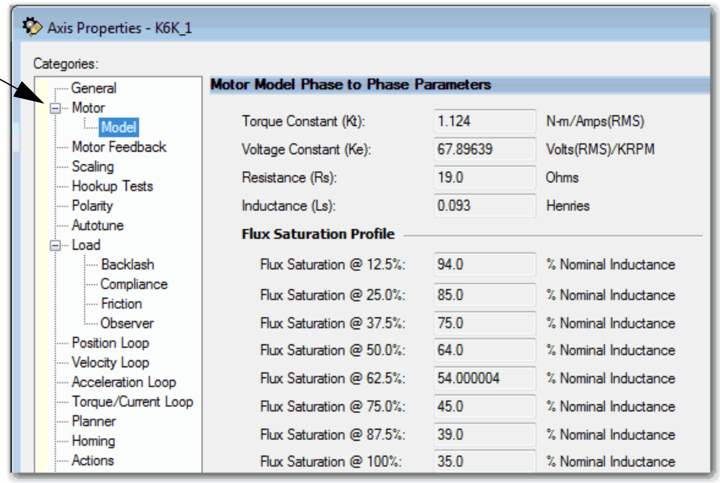
   No other motor information is needed.

3. Click Apply.

Display Motor Model Information

The Motor Model category displays more information that is based on the motor type you select.

The asterisk next to a category means that you have not applied changes.



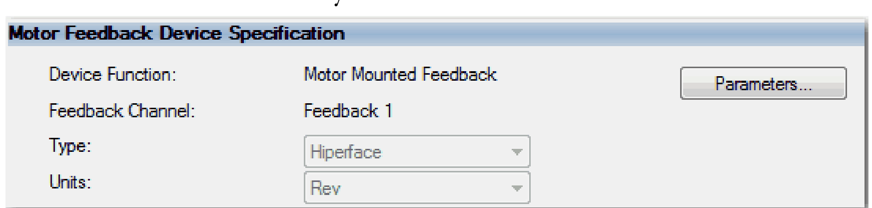
- If the motor data source is Catalog Number, this information is populated automatically.
- If the motor data source is Nameplate data sheet, this information must be entered manually, or by running the optional Motor Analyzer.
- If the motor data source is Motor NV, this dialog box is blank.

Assign Motor Feedback

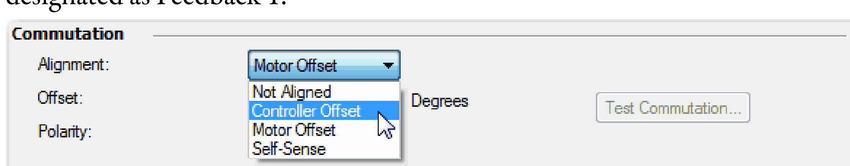
What appears on the Motor Feedback dialog box is dependent on what you select on the General dialog box for Feedback Configuration.

The Motor Feedback dialog box represents the information for the feedback device that is directly coupled to the motor. This dialog box is available if the feedback configuration that is specified on the General dialog box is anything other than Master Feedback.

If the motor that you select has Catalog Number as the data source, all information on this dialog box with be entered automatically. Otherwise you have to enter the information yourself.



Attributes that are associated with the Motor Feedback dialog box are designated as Feedback 1.



If a permanent magnet motor is selected from the Motion Database, the Commutation Alignment is set to Controller Offset. However, if a permanent magnet motor is specified from Nameplate data sheet, you must specify the Commutation Alignment method. The default is set to Not Aligned.

Table 14 - Commutation Alignment Settings

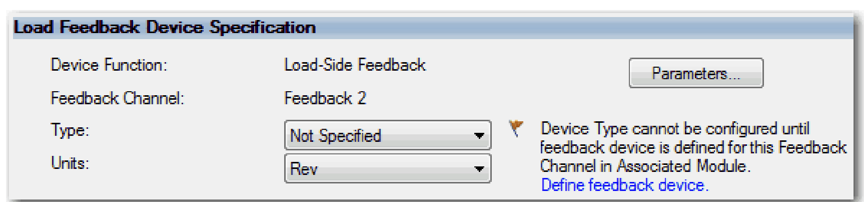
Type	Description
Not Aligned	Not Aligned indicates that the motor is not aligned, and that the Commutation Offset value is not valid. If the Commutation Offset is not valid, the drive cannot use it to determine the commutation angle. Any attempt to enable the drive with an invalid commutation angle results in a Start Inhibit condition.
Controller Offset	Controller Offset applies the Commutation Offset value from the controller to determine the electrical angle of the motor.
Motor Offset	The drive derives the commutation that is offset directly from the motor.
Self-Sense	The drive automatically measures the commutation that is offset when it transitions to the Starting state for the first time after a power cycle. This alignment type generally applies to a PM motor equipped with a simple incremental-feedback device.

In most cases, the Commutation Alignment is set to Controller Offset and the Commutation test is run during commissioning to determine the Commutation Offset and Polarity.

See the Integrated Motion Reference Manual, publication MOTION-RM003, for more information on axis attributes.

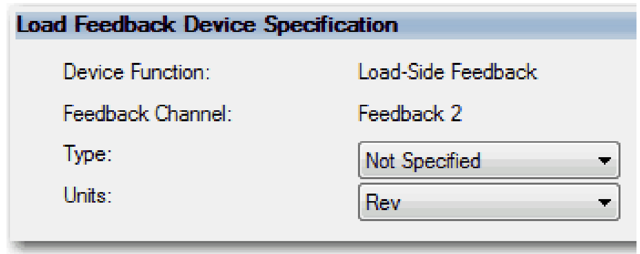
Configure the Load Feedback

The Load Feedback category contains the information from the feedback device that is directly coupled to the load-side of a mechanical transmission or actuator.

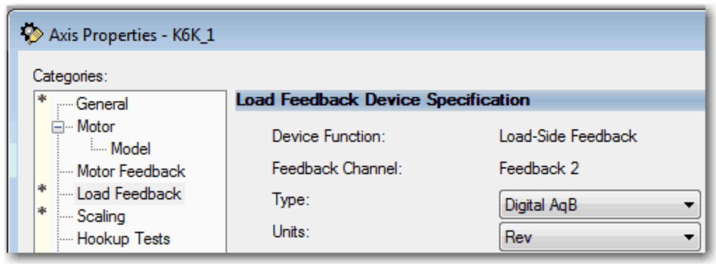


For your convenience, you can use this link to the Module Properties dialog box for the associated drive.

The Load Feedback category is available if the Feedback Configuration that is specified on the General dialog box is Load or Dual.

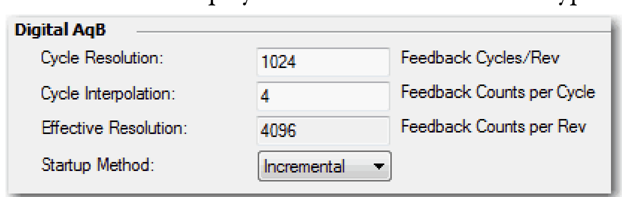


Attributes that are associated with the Load Feedback category are designated Feedback 2.



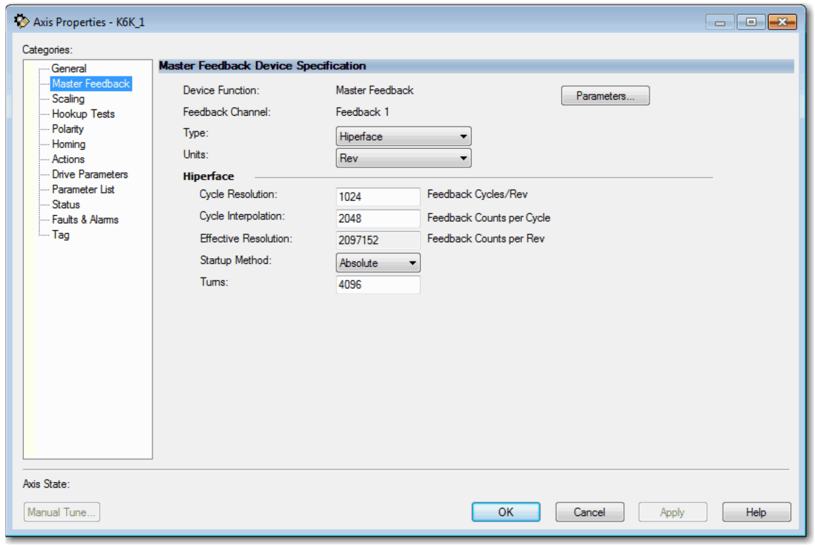
Unlike the Motor Feedback category, you must explicitly enter load feedback-device information on the Load Feedback category, including the Feedback Type. This entry is required because the Load Feedback device is not built into the motor.

Default values are displayed based on the Feedback Type selected.



Configure the Master Feedback

The Master Feedback category is available if the Feedback Configuration that is specified in the General category is Master Feedback. The attributes that are associated with the Master Feedback category are associated with Feedback 1. Again, like the Load Feedback category, you must enter all information.



To verify that motor and feedback device are functioning properly, download to the controller, and continue on to Hookup Tests on page 226.

Configure Feedback Only Axis Properties

To create your external encoder module and configure feedback-only axis properties if you are using the 842E-CM integrated motion encoder on the EtherNet/IP network, see Example 7: 842E-CM Integrated Motion Encoder with Master Feedback on page 183.

Configure Integrated Motion Control Using Kinetix 5700 Drives

This chapter provides procedures on how to configure integrated motion control by using the Kinetix® 5700 drive. The basic configuration for an integrated motion solution is to associate a drive with motor feedback and an axis configuration type.

For information about what attributes are replicated in the drive, see the Integrated Motion on the EtherNet/IP™ network Reference Manual, publication MOTION-RM003.

See Chapter 8, Configuration Examples for a Kinetix Drive, for Kinetix 5700 configuration information.

For complete information on how to configure Kinetix 5700 drives, including drives with integrated safety connections, see the Kinetix 5700 servo drives User Manual, publication 2198-UM002.

Add a Kinetix 5700 EtherNet/IP Drive

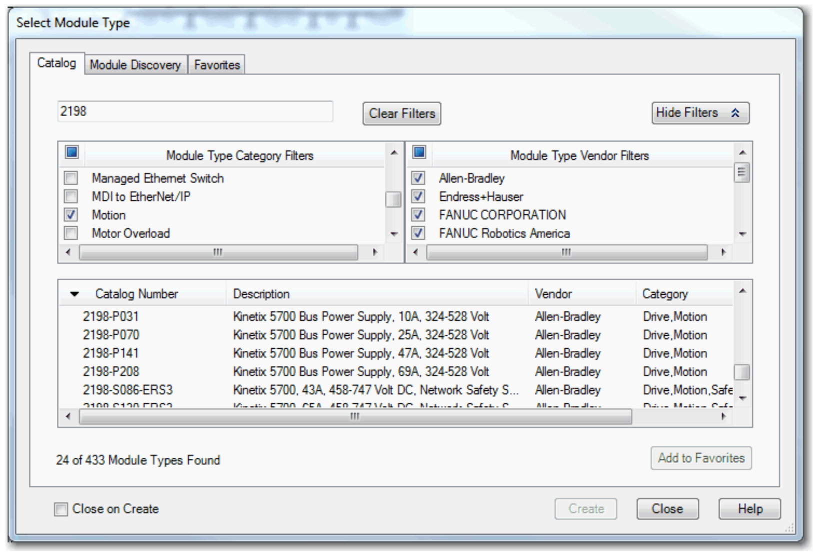
See Integrated Motion on EtherNet/IP Drive Software Options on page 13 to determine the minimum required version of the Studio 5000 Logix Designer® application for your drive.

Configure the DC-bus Power Supply and Associate an Axis

Follow these steps to configure the DC-bus power supply.

1. Below the controller you created, right-click Ethernet and choose New Module.

   The Select Module Type dialog box appears.

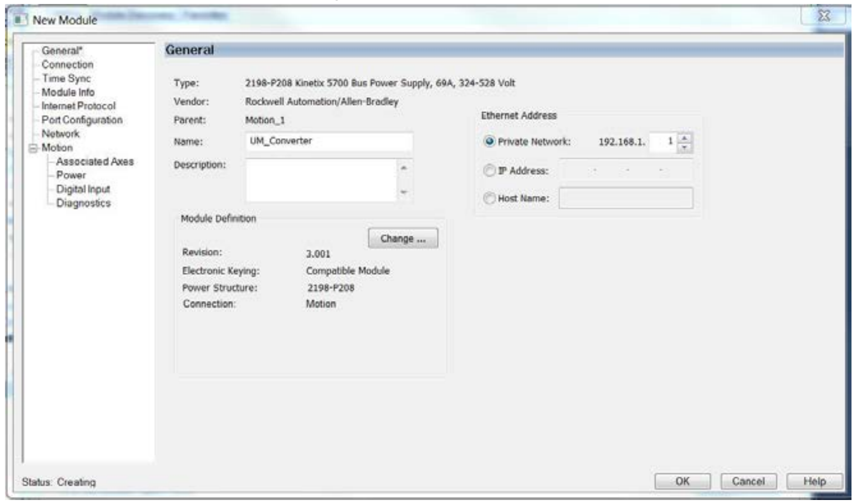


2. By using the filters, check Motion and Allen-Bradley, and select your 2198-Pxxx DC-bus power supply as appropriate for your actual hardware configuration.

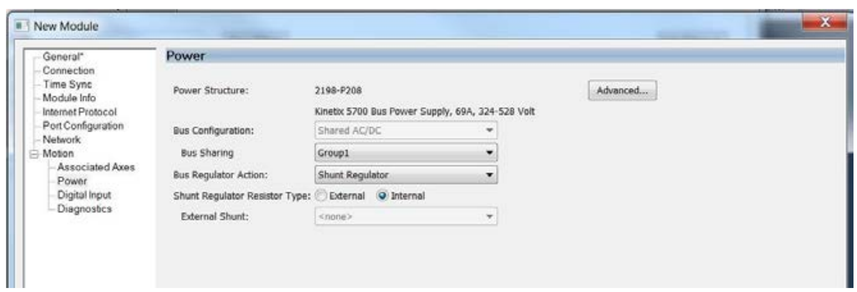
   This example uses a 2198-P208 DC-bus power supply.

3. Click Create.

The New Module dialog box appears.



4. Configure the new drive.
   a. Type the drive Name.
   b. Select a EtherNet/IP address option.
      In this example, the Private Network address is selected.
   c. Enter the address of your 2198-P208 DC-bus power supply.
      In this example, the last octet of the address is 1.
5. Click the Power category.



IMPORTANT	The Studio 5000 Logix Designer application enforces shared-bus configuration rules for Kinetix 5700 drives.

6. From the pull-down menus, choose the power options appropriate for your actual hardware configuration.

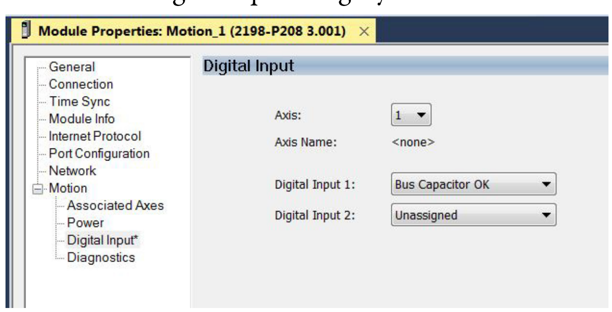
Attribute	Menu	Description
Bus Configuration	Shared AC/DC [1]	Applies to 2198-P*xxx* DC-bus power supply (converter) modules.
Bus-sharing Group [2]	• Group1 • Group2 • Group3…	Applies to any bus-sharing configuration.
Bus Regulator Action	Disabled	Disables the internal shunt resistor and external shunt option.
	Shunt Regulator	Enables the internal and external shunt options.
Shunt Regulator Resistor Type	Internal	Enables the internal shunt (external shunt option is disabled).
	External	Enables the external shunt (internal shunt option is disabled).
External Shunt [3]	• None • 2198-R004, 2198-R014 • 2198-R031, 2198-R127	Selects external shunt option. Only the shunt catalog number intended for the specific DC-bus power supply is shown.

(1) Shared AC/DC bus configuration is the default selection for DC-bus power supplies.
(2) For more information on bus-sharing groups, refer to Kinetix 5700 servo drives User Manual, publication 2198-UM002.
(3) See the Kinetix Servo Drives Specifications Technical Data, publication KNX-TD003, for more information on the Bulletin 2198 external passive shunt resistors.

ATTENTION: To avoid damage to equipment all modules that are physically connected to the same shared-bus connection system must be part of the same Bus-sharing Group in the Studio 5000 Logix Designer application.

7. To close the New Module dialog box, click OK.
8. To close the Select Module Type dialog box, click Close.
9. Right-click the DC-bus power supply that you created in the Controller Organizer and choose Properties.

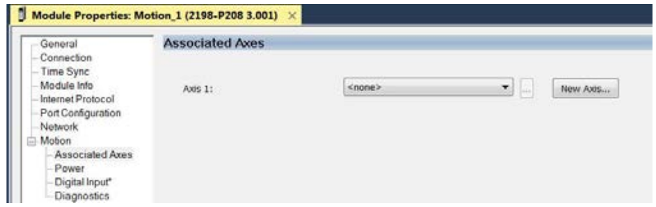
   The Module Properties dialog box appears.
10. Click the Digital Input category.



11. From the Digital Input pull-down menu, choose Bus Capacitor OK to monitor your capacitor module status. Alternately, choose Thermal Switch OK to monitor your shunt thermal switch. You can also choose Bus Conditioner OK to monitor your conditioner monitor status, but this option is only available in major revision 10 or later.

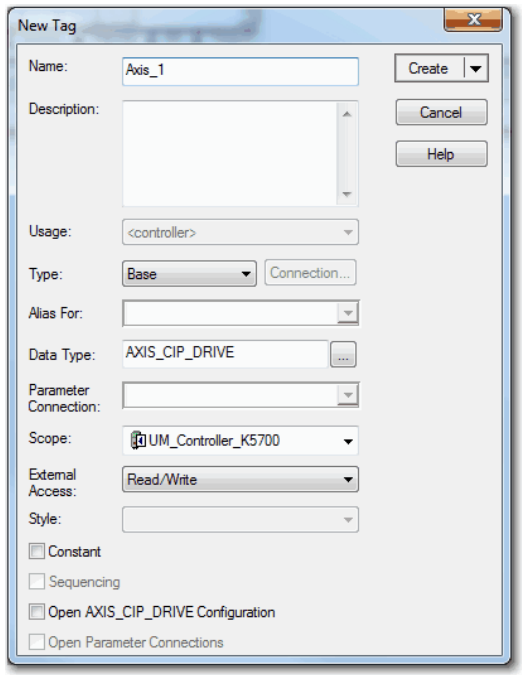
    In this example, Bus Capacitor OK is chosen.

12. Click the Associated Axes category.



13. Click New Axis.

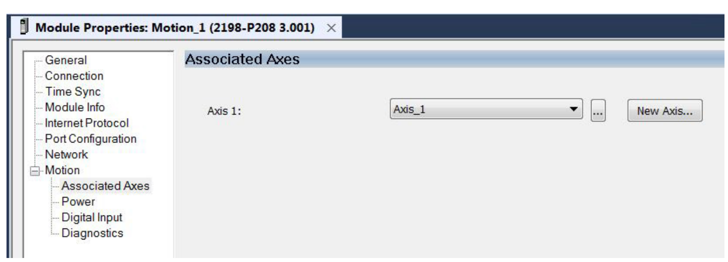
    The New Tag dialog box appears.



14. Type the axis Name.

    AXIS_CIP_DRIVE is the default Data Type.

15. Click Create.



16. Click Apply.

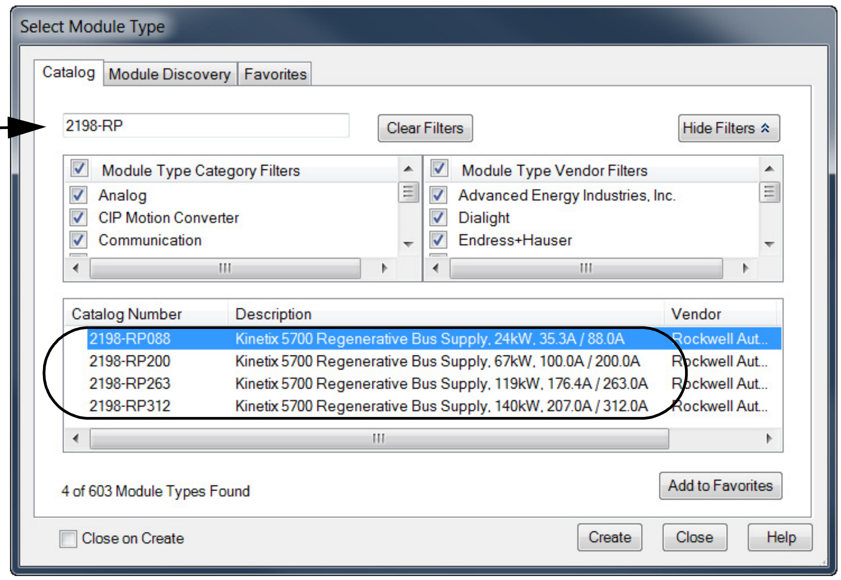
Configure the Regenerative Bus Supply

Follow these steps to configure the regenerative bus supply.

1. Below the controller you created, right-click Ethernet and choose New Module.

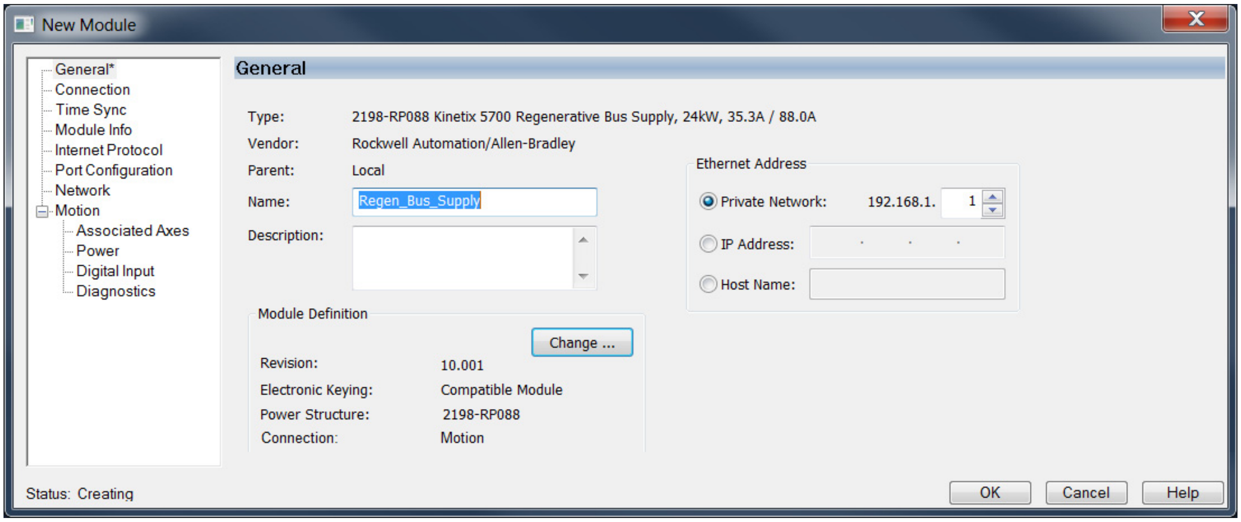
   The Select Module Type dialog box appears.

Enter 2198-RP here to refine your search.

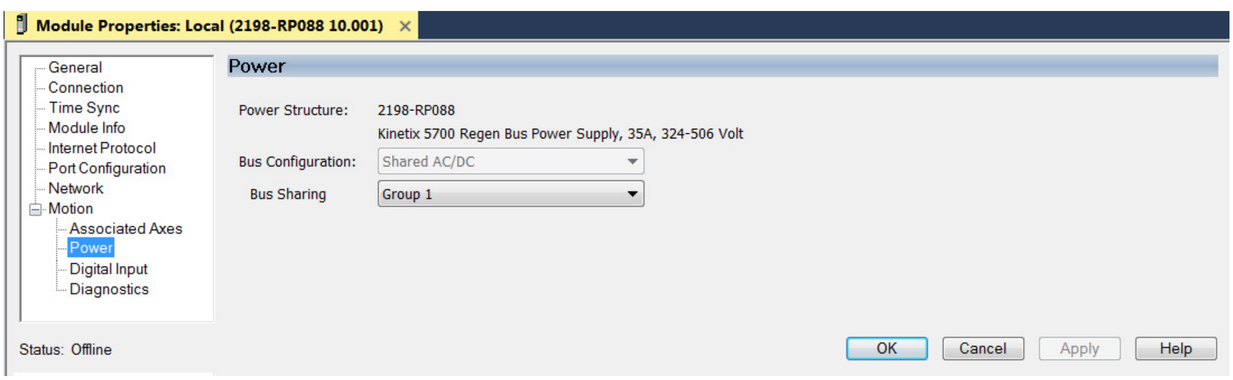


2. By using the filters, check Motion and Allen-Bradley, and select your 2198-RP*xxx* regenerative bus supply as appropriate for your hardware configuration.
3. Click Create.

The New Module dialog box appears.



4. Configure the new module.
   a. Type the module Name.
   b. Select a EtherNet/IP address option.
      In this example, the Private Network address is selected.
   c. Enter the address of your 2198-RP*xxx* regenerative bus supply.
      In this example, the last octet of the address is 1.
5. Click the Power category.



IMPORTANT	The Logix Designer application enforces shared-bus configuration rules for Kinetix 5700 drives.

6. From the pull-down menus, choose the power options appropriate for your hardware configuration.

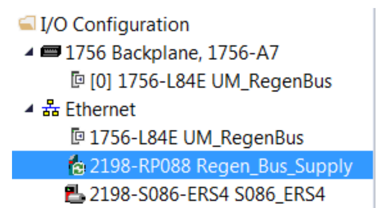
Attribute	Menu	Description
Bus Configuration	Shared AC/DC [1]	Applies to 2198-RP*xxx* regenerative bus supply modules.
Bus-sharing Group	• Group1 • Group2 • Group3…	Applies to any bus-sharing configuration.

(1) Shared AC/DC bus configuration is the default selection for regenerative bus supplies.

ATTENTION: To avoid damage to equipment all modules that are physically connected to the same shared-bus connection system must be part of the same Bus-sharing Group in the Logix Designer application.

7. To close the New Module dialog box, click OK.

8. Your 2198-RP*xxx* regenerative bus supply appears in the Controller Organizer under the Ethernet network in the I/O Configuration folder.



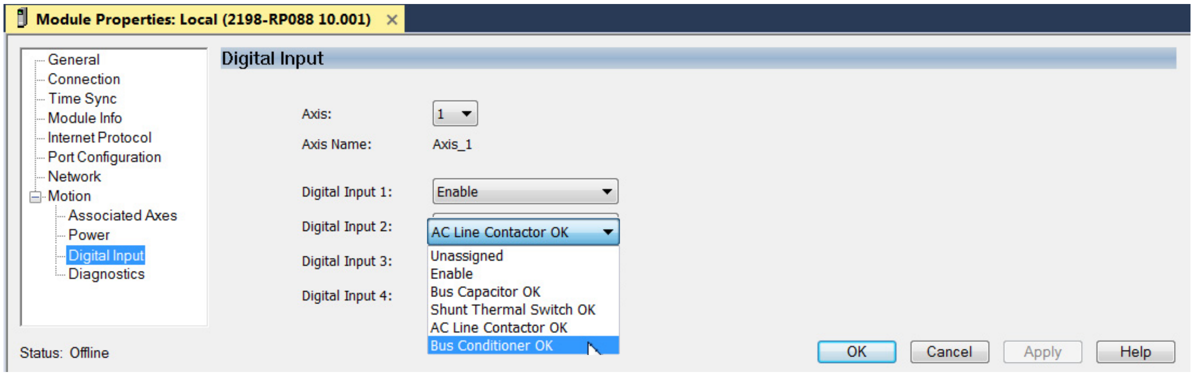
9. Click Close to close the Select Module Type dialog box.

10. Right-click the regenerative bus supply that you created in the Controller Organizer and choose Properties.

    The Module Properties dialog box appears.

    TIP To configure the remaining regenerative bus supply properties, you must close the New Module dialog box and reopen it as the Module Properties dialog box.

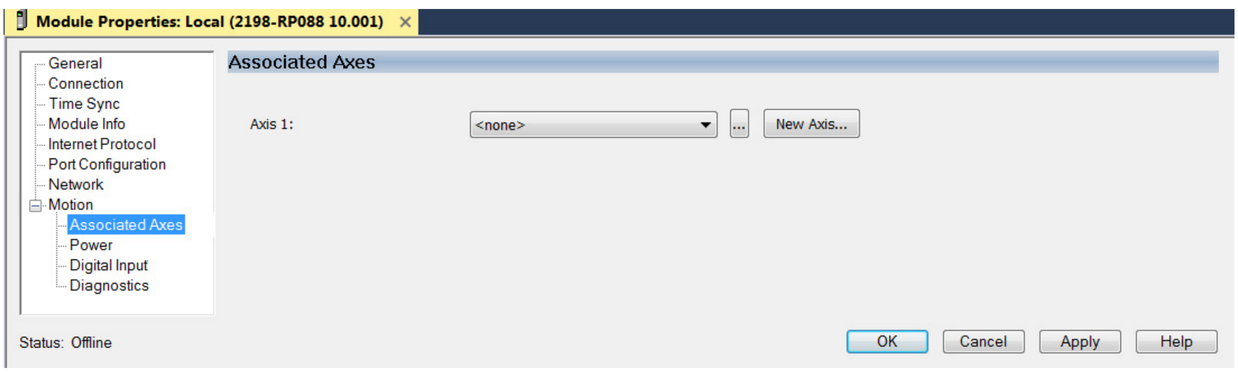
11. Click the Digital Input category.



12. From the Digital Input pull-down menu choose Bus Conditioner OK or AC Line Contactor OK to monitor your DC-bus conditioner module status or the M1 contactor status, respectively, depending on your application.

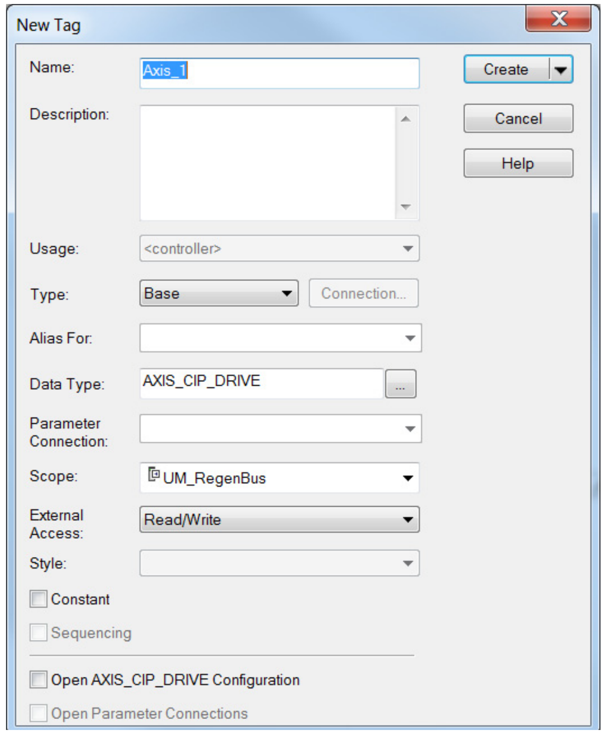
    In this example, Bus Capacitor OK is chosen. For descriptions of the digital inputs, see Table 22 on page 79.

13. Click the Associated Axes category.



14. Click New Axis.

The New Tag dialog box appears.

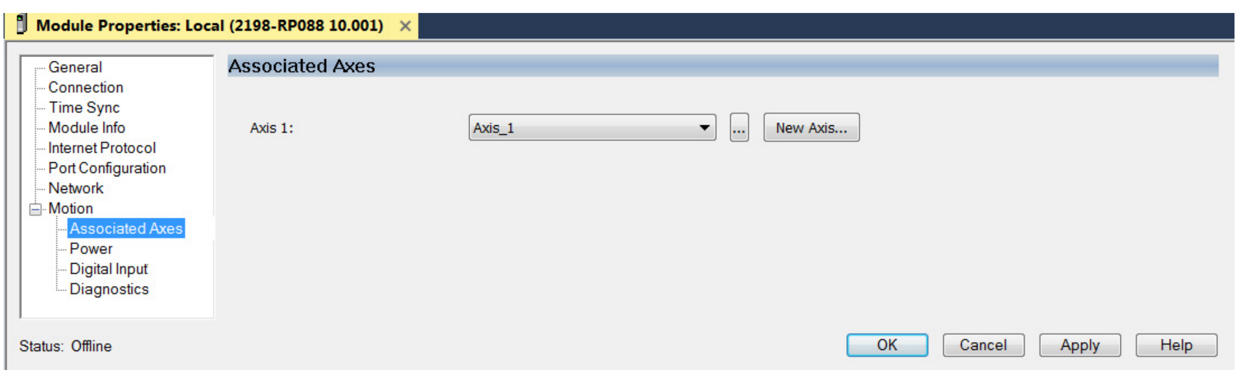


15. Type the axis Name.

    AXIS_CIP_DRIVE is the default Data Type.

16. Click Create.

    The axis (Axis_1 in this example) appears in the Controller Organizer under Motion Groups> Ungrouped Axes and is assigned as Axis 1.



17. Click Apply.

18. Repeat step 1 through step 17 if you have more than one 2198-RP*xxx* regenerative bus supply.

Continue Inverter Configuration

After you have established your Kinetix 5700 inverters in the Logix Designer application, the feedback options must be defined for each axis. Each physical axis supports motor and auxiliary feedback.

Table 15 - Kinetix 5700 Feedback Axis Summary

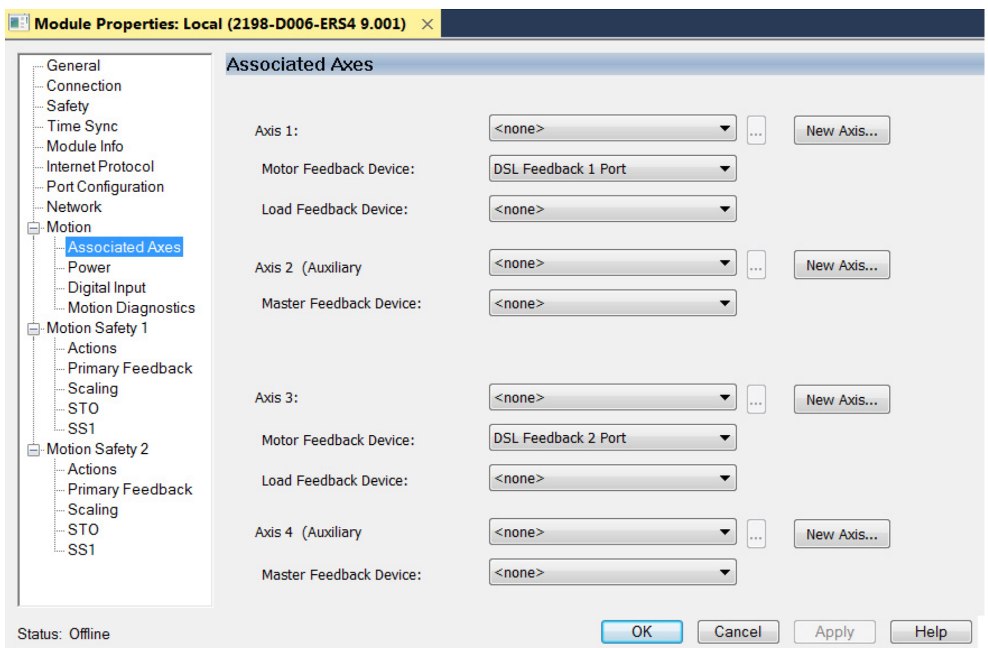
Kinetix 5700 Inverter	Inverter Cat. No.	Motor Feedback	Auxiliary Feedback
Single-axis Inverters	2198-S*xxx*-ERS3 or 2198-S*xxx*-ERS4	1 (axis 1)	1 (axis 2)
Dual-axis Inverters	2198-D*xxx*-ERS3 or 2198-D*xxx*-ERS4	2 (axis 1 and 3)	2 (axis 2 and 4)

Follow these steps to configure the axes for your Kinetix 5700 drive system.

1. Right-click the 2198-*xxxx*-ERS4 inverter that you just created and choose Properties.

   The Module Properties dialog box appears.

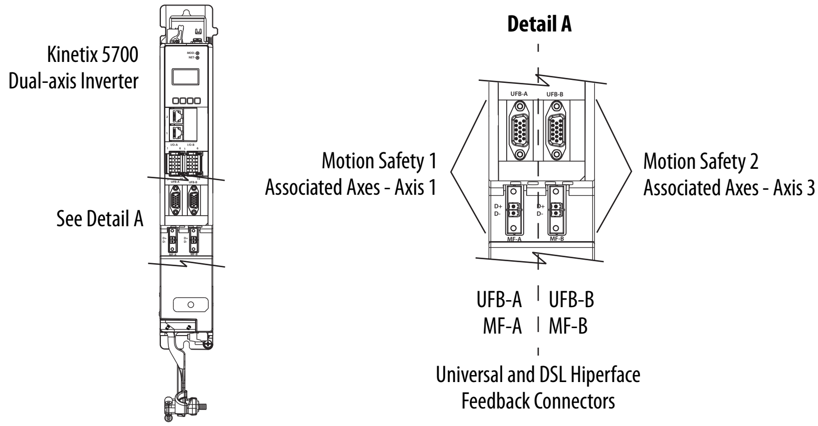
2. Select the Associated Axes category.



In this 2198-D006-ERS4 (dual-axis inverter) example, four axes are possible. Single-axis inverters support only two axes.

- Axis 1 and Axis 2 apply to Motor (DSL) Feedback Connector A (Port 1) and Universal Feedback Connector A (Port 1).
- Axis 3 and Axis 4 apply to Motor (DSL) Feedback Connector B (Port 2) and Universal Feedback Connector B (Port 2).

Figure 7 - Dual-axis Inverter Feedback

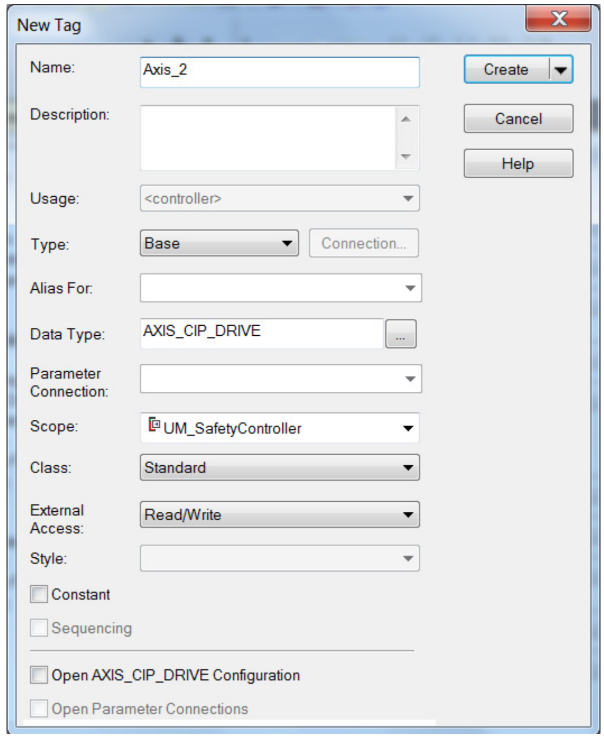


The Feedback Devices are configured for either the DSL Feedback Port or the Universal Feedback Port.

Motor Feedback Options	Description
DSL Feedback Port	Applies to motors and actuators compatible with the 2198-KITCON-DSL connector kit and 2198-H2DCK converter kit (series B or later). These kits plug into the 2-pin motor feedback (MF) connector.
Universal Feedback Port	Applies to motors and actuators compatible with the 2198-K57CK-D15M universal connector kit. These kits plug into the 15-pin universal feedback (UFB) connector.

3. From the Axis *x* pull-down menu, choose an axis to assign to that motor feedback or auxiliary feedback device.
4. From the Feedback Device pull-down menu, choose either DSL Feedback *x* Port or Universal Feedback *x* Port to associate with each axis.
5. Click New Axis.

The New Tag dialog box appears.

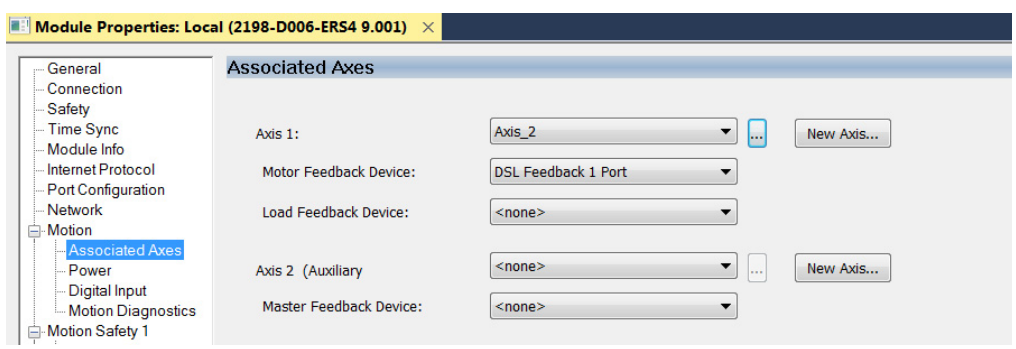


6. Type the axis Name.

   AXIS_CIP_DRIVE is the default Data Type.

7. Click Create.

   The axis (Axis_1 in this example) appears in the Controller Organizer under Motion Groups> Ungrouped Axes and is assigned as Axis 1.



8. Click Apply.

9. Repeat step 1 through step 6 for each 2198-*xxxx*-ERS*x* servo drive.

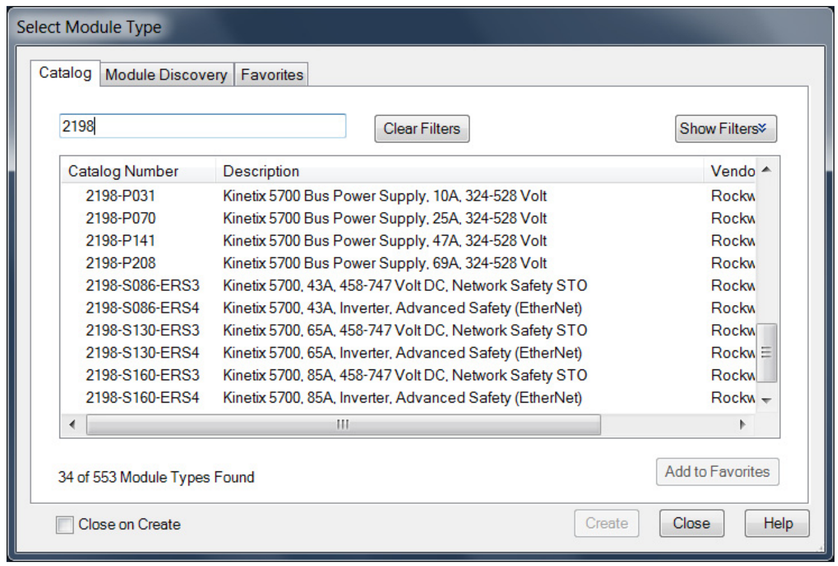
Configure the Inverter Drives

This procedure applies to single-axis and dual-axis inverters with hard-wired or integrated safety connections. In this example, a 2198-D006-ERS4 dual-axis inverter is configured.

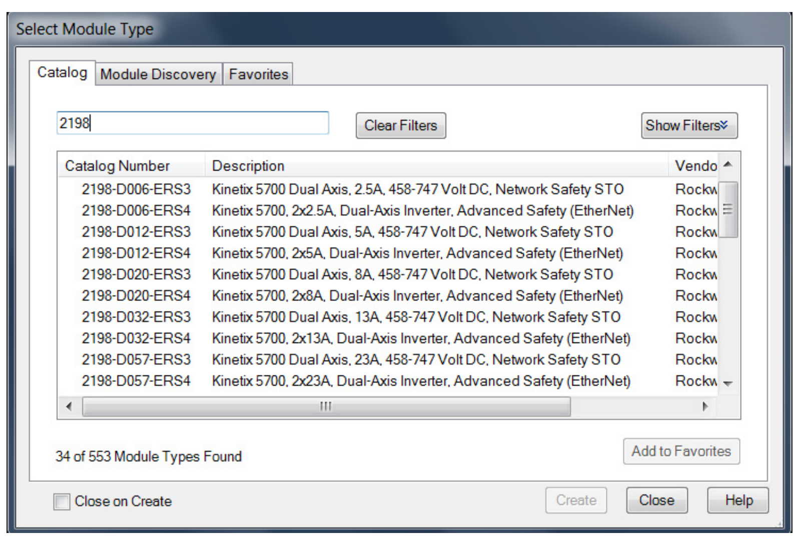
Follow these steps to configure Kinetix 5700 inverter drives.

1. Above the DC-bus power supply (converter) you created, right-click Ethernet and choose New Module.

   The Select Module Type dialog box appears.



This example shows the 2198-S*xxx*-ERS*x* single-axis inverters that you can choose from.

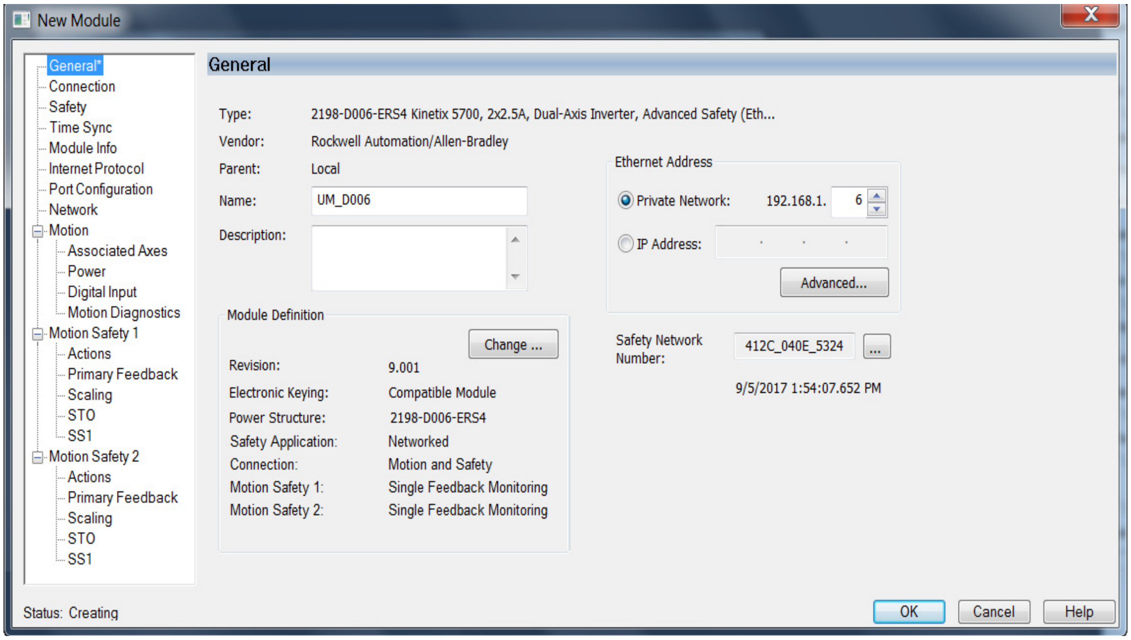


This example shows the 2198-D*xxx*-ERS*x* dual-axis inverters that you can choose from.

2. Enter 2198 to narrow your choices and select your 2198-xxxx-ERS3 or 2198-xxxx-ERS4 inverter as appropriate for your hardware configuration.

3. Click Create.

   The New Module dialog box appears.



4. Configure the new drive.
   a. Type the drive Name.
   b. Select an EtherNet/IP address option.

      In this example, the Private Network address is selected.
   c. Enter the address of your 2198-xxxx-ERSx inverter.

      In this example, the last octet of the address is 6.
   d. Click Advanced if using network address translation with safety connection to add drive module configured IP address.

The fields to configure in the Module Definition dialog box are dependent on your drive, Studio 5000 Logix Designer application version, and drive firmware revision. Use the following table to navigate to the series of steps that are intended for your drive system.

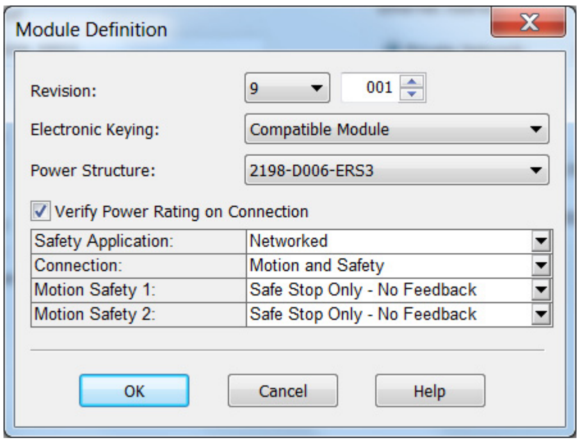
Table 16 - How to Navigate Module Definition

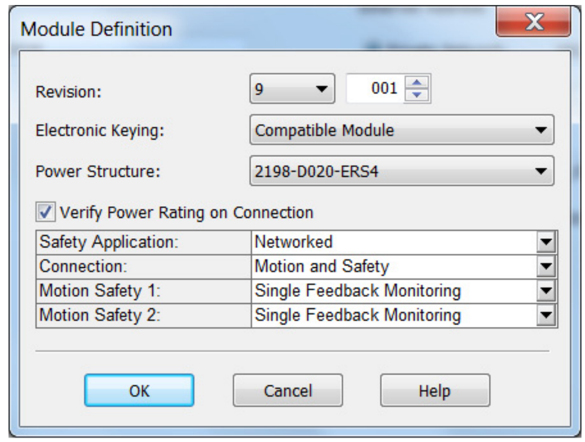
For Drive Cat. No.	Studio 5000 Logix Designer Application Version	Drive Firmware Revision	Go to:
2198-*xxxx*-ERS3	30 or earlier	7 or earlier	Configure Module Definition on page 74
2198-*xxxx*-ERS3 (Series B) 2198-xxxx-ERS4	31 or later	9 or later	Configure Module Definition on page 74

Configure Module Definition

1. Under Module Definition click Change.

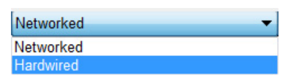
   The Module Definition dialog box appears.





   Depending on the Module Definition revision selection, alternate product features and feedback types can be selected. However, 2198-xxxx-ERS4 drives only appear in drive firmware revision 9.001 or later.

2. From the Safety Application pull-down menu, choose between Hardwired for Hardwired STO mode or Networked for an integrated safety application (see Table 17 for definitions).



IMPORTANT	If the STO bypass jumper wires were applied during machine commissioning or maintenance, they must be removed before the drive can operate in Integrated (Networked) safety mode.

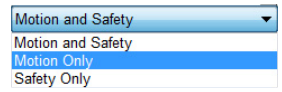
Table 17 - Safety Application Definitions

Safety Application Mode (1)	Safety Functions	Minimum Drive Module Required(2)	Drive Module Connection Options	Minimum Controller Required (2)
Hardwired	Hardwired STO	2198-*xxxx*-ERS3	Motion Only	• ControlLogix® 5570 • CompactLogix™ 5370
Networked	Integrated STO	2198-*xxxx*-ERS3	• Motion and Safety • Motion Only • Safety Only	• GuardLogix® 5570 • CompactLogix 5370
	• Integrated STO • Timed SS1	2198-*xxxx*-ERS3	• Motion and Safety • Motion Only • Safety Only	• GuardLogix 5570 • CompactLogix 5370
	• Integrated STO • Timed SS1 • Monitored SS1 • Controller-based safety functions	2198-*xxxx*-ERS4	• Motion and Safety • Motion Only • Safety Only	• GuardLogix 5580 • CompactLogix 5380

(1) For 2198-D*xxx*-ERS4 (dual-axis) inverters, you must configure axis 1 and 3 as Networked or Hardwired, they cannot be mixed.

(2) Where a ControlLogix or CompactLogix (non-safety) controller is specified, a GuardLogix or Compact GuardLogix controller is backwards compatible, but not necessary for the specified safety application, function, and connection. Also, GuardLogix 5580 and Compact GuardLogix 5380 controllers are backwards compatible with GuardLogix 5570 and Compact GuardLogix 5370 controllers.

3. From the Connection pull-down menu, choose the Connection mode for your motion application (see Table 18 for definitions).

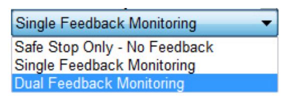


TIP When 'Safety' appears in the Connection mode, integrated safety is implied.

Table 18 - Module Connection Definitions

Connection Mode	Safety Options	Description
Motion and Safety	Integrated mode	This controller manages the motion connections and integrated STO.
Motion Only	• Hard-wired STO mode • Integrated mode if there is a secondary safety controller	• This controller manages the motion connections. • The hard-wired safety inputs control the hard-wired STO. Another controller that has a Safety-only connection to the drive manages the integrated STO.
Safety Only	Integrated mode	• This controller manages the integrated STO. • Another controller that has a Motion-only connection to the drive manages the motion connections.

4. From the Motion Safety *x* pull-down menu, choose the integrated safety type (see Table 19 for definitions).



'Motion Safety' applies to 2198-Sxxx-ERS4 (single-axis) inverters. 'Motion Safety 1' and 'Motion Safety 2' applies to 2198-Dxxx-ERS4 (dual-axis) inverters.

Motion Safety and Motion Safety 1 align with Axis 1 configured in Associated Axes. Motion Safety 2 aligns with Axis 3 configured in Associated Axes.

Table 19 - Motion Safety Definitions

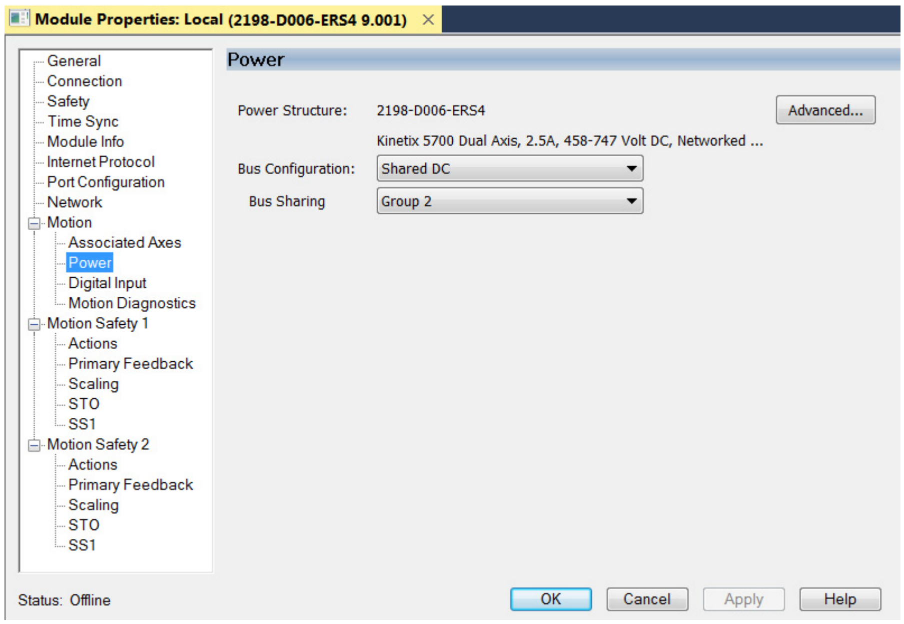
Motion Safety Mode	Safety Application Mode	Module Connection Options	Description
STO Only	Networked	• Motion and Safety • Safety Only	2198-*xxxx*-ERS3 (series A and B): STO function only.
Safe Stop Only - No Feedback			• 2198-*xxxx*-ERS4: STO function and Timed SS1 safe stop functions are available. • 2198-*xxxx*-ERS3 (series B): STO function and Timed SS1 safe stop functions are available.
Single Feedback Monitoring			Primary feedback is used in the safety object for safe monitoring. The feedback can be a SIL rated Hiperface DSL encoder, for example, a VPL-B1003P-Q or W motor used in the DSL Feedback port. This can also be a Sine/Cosine or EnDat device, for example, an MPL-B310P-M motor used in the Universal Feedback port. See the Kinetix 5700 Safe Monitor Functions Safety Reference Manual, publication 2198-RM001, to evaluate SIL levels possible with one feedback device.
Dual Feedback Monitoring			In addition to primary feedback, an external feedback device is used to improve SIL levels. For example, the Bulletin 842HR type encoder can be used in the Universal Feedback port as a Sine/ Cosine device. See the Kinetix 5700 Safe Monitor Functions Safety Reference Manual, publication 2198-RM001, to evaluate SIL levels possible with two feedback devices.

The Safety Network Number (SNN) field populates automatically when the Connection mode includes an integrated Motion and Safety or Safety-only connection. For a detailed explanation of the safety network number, refer to the appropriate GuardLogix controller publication as defined in Additional Resources on page 9.

5. To close the Module Definition dialog box, click OK.
6. Click Apply.

Configure the Power and Safety Options

1. Click the Power category.



IMPORTANT	The Logix Designer application enforces shared-bus configuration rules for Kinetix 5700 drives.

2. From the pull-down menus, choose the power options appropriate for your hardware configuration.

Table 20 - Power Configuration Options

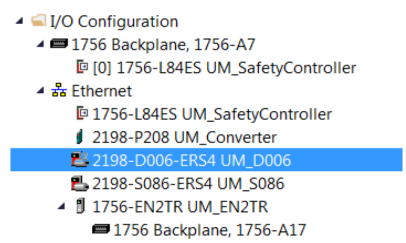
Attribute	Menu	Description
Bus Configuration	Shared DC (2)	Applies to 2198-Sxxx-ERSx and 2198-Dxxx-ERSx inverter drives.
	Shared DC - Non-CIP Motion Converter (3)	Applies to the designated inverter in drive systems that are powered by the 8720MC-RPS regenerative power supply.
Bus Sharing Group (1) (3)	• Group1 • Group2 • Group3…	Applies to any bus-sharing configuration.

(1) For more information on bus-sharing groups, refer to the Kinetix 5700 servo drives User Manual, publication 2198-UM002.
(2) Shared DC bus configuration is the default selection for single-axis and dual-axis inverters.
(3) Because the 8720MC-RPS unit is not an EtherNet/IP network device, the Logix 5000™ controller does not communicate with it. The designated inverter, configured as the Shared DC - Non-CIP Motion Converter, monitors the 8720MC-RPS unit status through a digital input (Regen OK) and communicates with the other inverters to signal when the DC-bus voltage is present.

ATTENTION: To avoid damage to equipment all modules that are physically connected to the same shared-bus connection system must be part of the same Bus-sharing Group in the Studio 5000 Logix Designer application.

3. To close the Module Properties dialog box, click OK.
4. To close the Select Module Type dialog box, click close.

Your 2198-*xxxx*-ERS4 inverter appears in the Controller Organizer under the Ethernet network in the I/O Configuration folder.

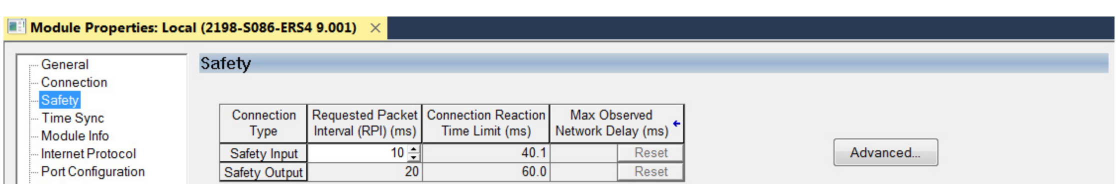


5. Right-click the drive that you created in the Controller Organizer and choose Properties.

The Module Properties dialog box appears.

If	Then
Your application includes integrated safety	Go to step 6 on page 77.
Your application includes hard-wired safety or has no safety connections	Go to Create an Associated Axis and Establish Feedback Assignments for an Inverter Drive on page 80.

6. Click the Safety category.

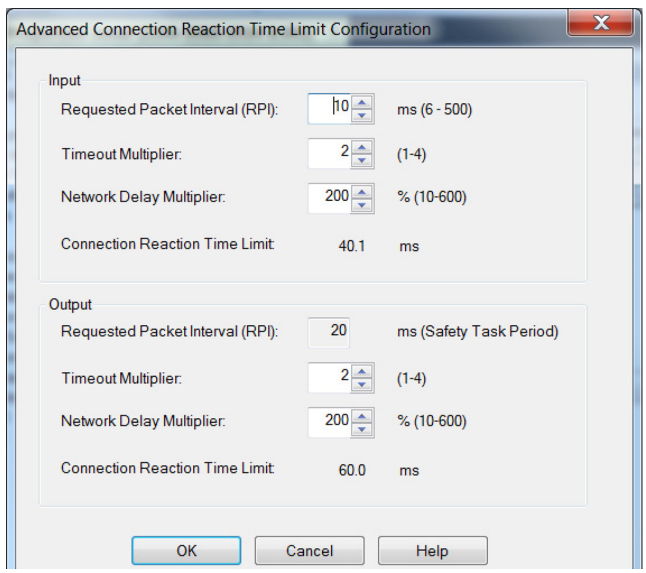


7. The connection between the owner and the 2198-*xxxx*-ERS*x* inverter is based on the following:
   - Servo drive safety network number
   - GuardLogix slot number
   - GuardLogix safety network number
   - Path from the GuardLogix controller to the 2198-*xxxx*-ERS*x* drive
   - Configuration signature

   If any differences are detected, the connection between the GuardLogix controller and the 2198-*xxxx*-ERS*x* inverter is lost, and the yellow yield icon appears in the controller project tree after you download the program.

8. Click Advanced.

   The Advanced Connection Reaction Time Limit Configuration dialog box appears.



   Analyze each safety channel to determine the appropriate settings. The smallest Input RPI allowed is 6 ms. The selection of small RPI values consumes network bandwidth and can cause spurious trips because other devices cannot get access to the network.

   For more information about the Advanced Connection Reaction Time Limit Configuration, refer to the appropriate GuardLogix or Compact GuardLogix Controllers User Manual, which is listed in Additional Resources on page 9.

9. To close the Advanced dialog box, click OK.

10. To save the Safety category parameters, click apply.

Configure Digital Inputs

Figure 8 - Digital Input Tab for the Kinetix 5700 Drive

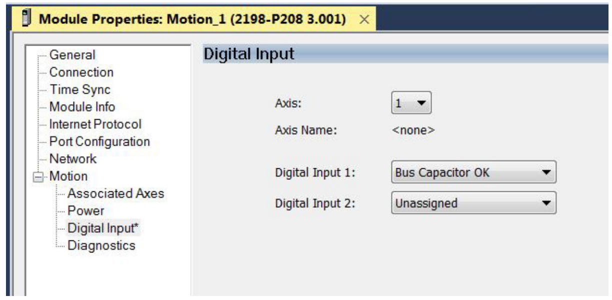


Table 21 - Module Properties: Kinetix 5700 Digital Input Tab Descriptions

Parameter	Description
Digital Input 1 Digital Input 2 Digital Input 3 Digital Input 4	Choose one of these values for Digital Input 1 and 2: • Unassigned • Enable • Home • Registration 1 • Registration 2 • Positive Overtravel • Negative Overtravel • Regeneration OK • AC Line Contactor OK • Bus Capacitor OK • Bus Conditioner OK • Shunt Thermal Switch OK

Table 22 - Understand Digital Input Functions

Functions	Description	Drive Module		
		2198-P*xxx*	2198-*xxxx*-ERS*x*	2198-RP*xxx*
Enable	A 24V DC input is applied to this terminal as a condition to enable each module.	X	X	X
Home	An active state indicates to a homing sequence that the referencing sensor has been seen. Typically, a transition of this signal is used to establish a reference position for the machine axis.	–	X	–
Registration 1	An inactive-to-active transition (also known as a positive transition) or active-to-inactive transition (also known as a negative transition) is used to latch position values for use in registration moves.	–	X	–
Registration 2		–	X	–
Positive Overtravel Negative Overtravel	The positive/negative limit switch (normally closed contact) inputs for each axis require 24V DC (nominal).	–	X	–
Regeneration OK	In the active state the inverters can be enabled. An inactive state indicates that the Bulletin 8720MC-RPS unit is not ready to supply DC-bus power. The inverters cannot be enabled. When a bus group is supplied by an 8720MC-RPS unit, one inverter in the bus group must be configured in the Logix Designer application as Shared-DC Non-CIP Motion™ Converter and assigned to Regeneration OK. This signal is wired from RDY on the 8720MC-RPS unit and indicates to the Kinetix 5700 drive system that the 8720MC-RPS unit is ready to supply power. Enabled inverters enumerate a Bus Power Sharing fault if the Regeneration OK input goes inactive.	–	X	–
AC Line Contactor OK	An active indicates that the AC Line Contactor is working correctly and is capable of charging the DC bus.		X	

Functions	Description	Drive Module		
		2198-P*xxx*	2198-*xxxx*-ERS*x*	2198-RP*xxx*
Bus Capacitor OK	You can configure this input in the Logix Designer application and wire the module status (MS) output from the 2198-CAPMOD-2240 capacitor module to indicate to the inverter that a major fault is present on the capacitor module.	X	X	X
Shunt Thermal Switch OK	When the 2198-R014, 2198-R031, or 2198-R127 external shunt resistor is wired to the DC-bus power supply, this input must be configured in the Logix Designer application to monitor the status of the external shunt module thermal switch and assigned to Shunt thermal switch OK. This function does not apply to the 2198-R004 shunt resistor. You can also use this input to monitor the status of an active shunt module in the system that is connected via the capacitor module or an extension module.	X	X	X
Bus Conditioner OK	You can configure this input in the Logix Designer application and wire the module status (MS) output from the 2198-DCBUSCOND-RP312 conditioner module to indicate to the inverter that a major fault is present on the conditioner module.	X	X	X

Create an Associated Axis and Establish Feedback Assignments for an Inverter Drive

After you establish your Kinetix 5700 inverters in the Studio 5000 Logix Designer application, the feedback options must be defined for each axis. Each physical axis supports motor and auxiliary feedback.

Table 23 - Kinetix 5700 Feedback Axis Summary

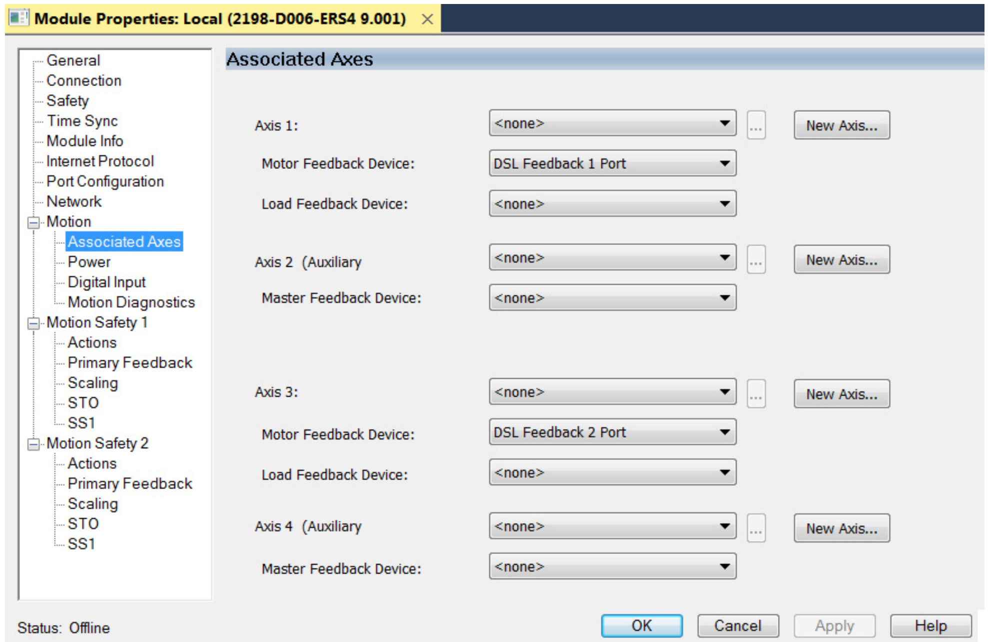
Kinetix 5700 Inverter	Inverter Cat. No.	Motor Feedback	Auxiliary Feedback
Single-axis Inverters	2198-S*xxx*-ERS3 or 2198-S*xxx*-ERS4	1 (axis 1)	1 (axis 2)
Dual-axis Inverters	2198-D*xxx*-ERS3 or 2198-D*xxx*-ERS4	2 (axis 1 and 3)	2 (axis 2 and 4)

Follow these steps to configure the axes for your Kinetix 5700 drive system.

1. Right-click the 2198-*xxxx*-ERS4 inverter that you created and choose Properties.

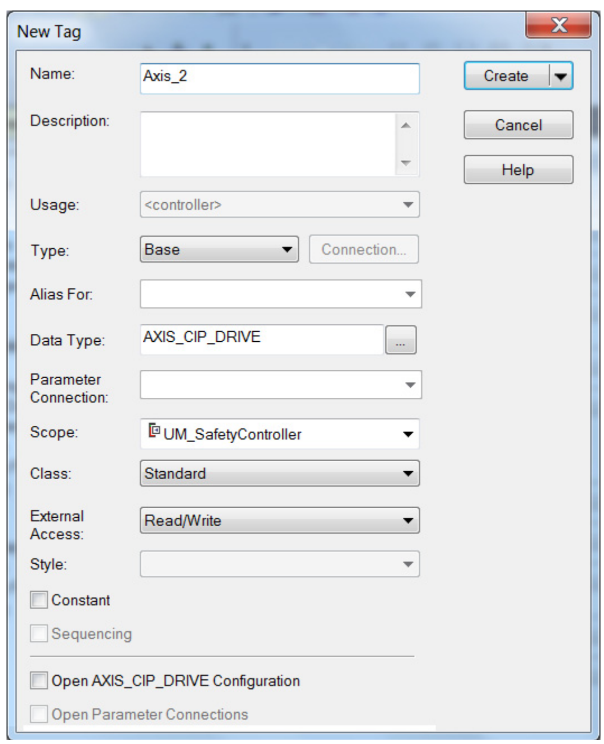
   The Module Properties dialog box appears.

2. Select the Associated Axes category.



3. Click New Axis.

   The New Tag dialog box appears.

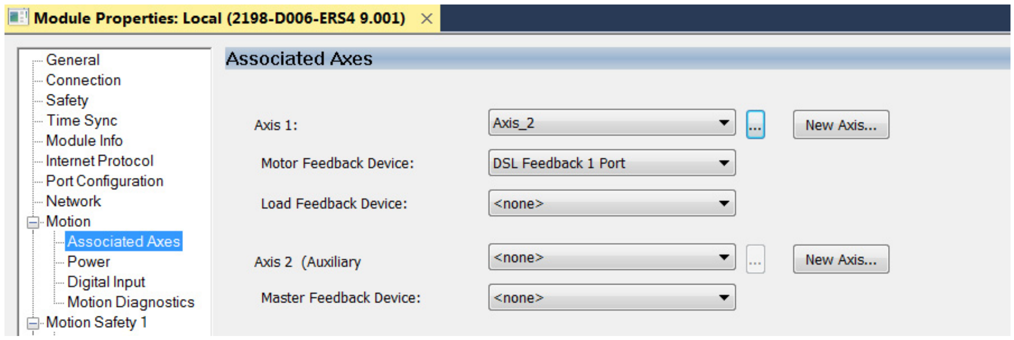


4. Type the axis Name.

   AXIS_CIP_DRIVE is the default Data Type.

5. Click Create.

The axis (Axis_1 in this example) appears in the Controller Organizer under Motion Groups> Ungrouped Axes and is assigned as Axis 1.



6. Click Apply.

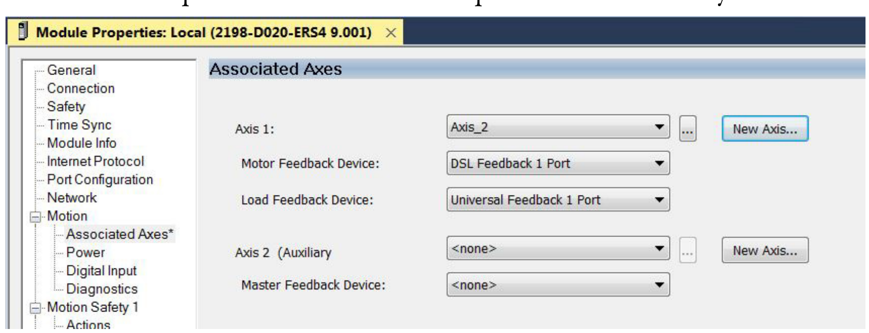
Feedback options must be defined for each axis. Each physical axis supports motor and auxiliary feedback.

The Kinetix 5700 drive has two or four feedback ports. The single-axis inverters support two ports and the dual-axis inverters support four ports. Port 1 is reserved for Motor Feedback on the primary axis (Axis_1). Port 2 can be used either as Load Feedback for the primary axis or as a Master Feedback for a secondary feedback only axis (Axis_2).

Feedback Devices are configured for either the DSL Feedback Port or the Universal Feedback Port.

To establish Feedback Port assignments for K5700 drives, follow these steps.

1. To access the Module Properties, double-click the Kinetix 5700 drive in the Controller Organizer.
2. Click the Associated Axes category.
3. From the Feedback Device pull-down menus, choose either a DSL feedback port or universal feedback port to associate with your axis.



4. Click Apply.

For more information on configuration of Feedback Properties, refer to the Kinetix 5700 servo drives User Manual, publication 2198-UM002. Chapter 8,

Configuration Examples for a Kinetix Drive, also includes a Frequency Control with No Feedback example on page 180.

Create a Motion Group

To determine how many axes your controller system supports, see Table 3 on page 12.

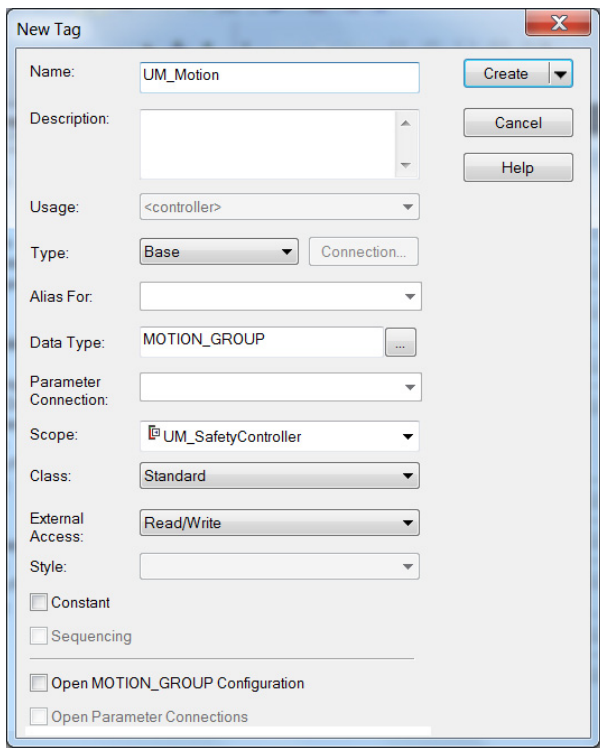
All axes must be added to the Motion Group in your project. If you do not group the axes, they remain ungrouped and unavailable for use.

You must create a Motion Group for an axis to be configured properly.

Follow these steps to configure the motion group.

1. In the Controller Organizer, right-click Motion Groups and choose New Motion Group.

   The New Tag dialog box appears.



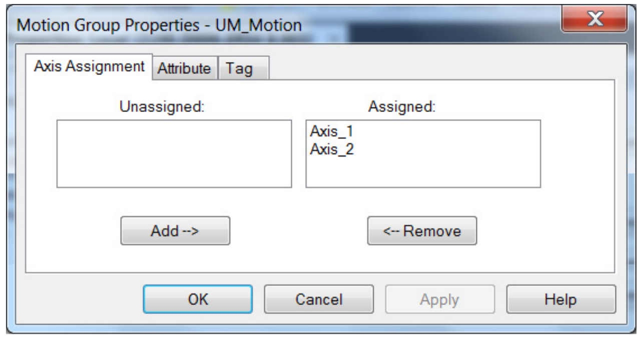
2. Type a Tag name.
3. Type a description, if desired.
4. Choose the Tag Type.
5. Choose the Scope.
6. Choose the External Access.

7. Click Create.

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

8. Right-click the new motion group and choose Properties.

   The Motion Group Properties dialog box appears.



9. Click the Axis Assignment tab and move your axes (created earlier) from Unassigned to Assigned.

Set the Base Update Period

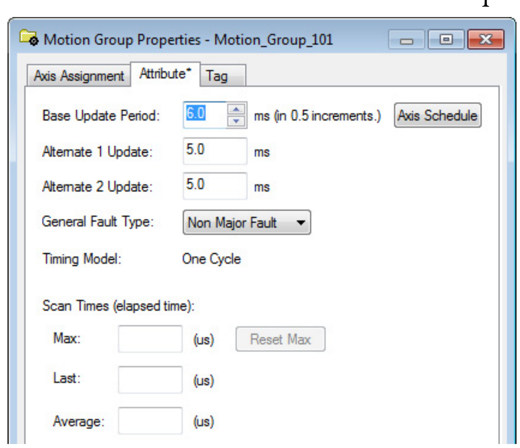
The Base Update Period is the RPI rate for Ethernet communication between the controller and the motion module, a Unicast connection.

There are two alternate update periods that you can configure when using the Axis Scheduling function. See Axis Scheduling on page 145 for details.

The Base Update Period determines how often the Motion Task runs. When the Motion Task runs, it interrupts most other tasks regardless of their priority. The Motion Task is the part of the controller that takes care of position and velocity information for the axes.

To set the Base Update Period, follow these steps.

1. Click the Attribute tab in the Motion Group Properties dialog box.

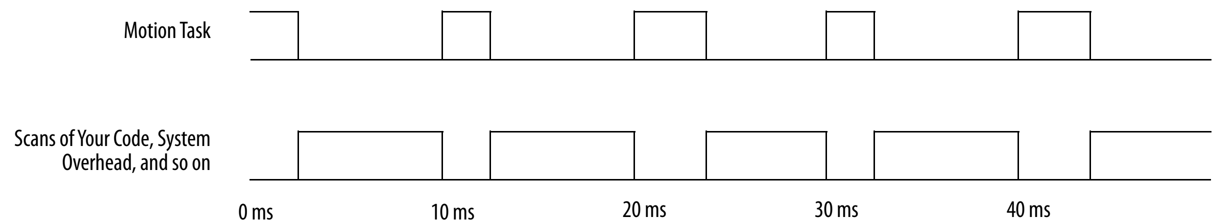


2. Set the Base Update Period to 6.0…32.0 ms.

TIP Check the Last Scan time values. Typically, the value is less than 50% of the Base Update Period.

For the Kinetix 5700 drive, the minimum Base Update Rate is 1 ms.

Figure 9 - Base Update Period Example



In this example, the Base Update Period = 10 ms. Every 10 ms the controller stops scanning your code and whatever else it is doing and runs the motion planner.

The Base Update Period is a trade-off between updating positions of your axes and scanning your code. In general, you do not want the Motion Task to take more than 50% of the overall Logix controller time on average. The more axes that you add to the Motion Group, the more time it takes to run the Motion Task.

For the ControlLogix 5560 controller, the incremental impact on the Motion Task is roughly at 2…3 drives/ms. For the ControlLogix 5570 controller, the incremental impact on the Motion Task is roughly at 6…8 drives/ms. Actual impact can vary depending on axis configuration.

For detailed information on the Axis Scheduling function, Axis Assignment tab, and Alternate Update Period Scheduling, see Axis Scheduling on page 145.

Integrated Architecture Builder

To help you determine motion system performance, use the motion performance calculator in the Integrated Architecture Builder (IAB).

The IAB is a graphical software tool for configuring Logix-based automation systems. It helps you select hardware and generate bills of material for applications that include controllers, I/O, networks, PowerFlex® drives, On-Machine™ cabling and wiring, motion control, and other devices.

You can find the software at http://www.rockwellautomation.com/en/e-tools/configuration.html

Configure the Axis Properties

After you add the drive to your project and create the axes, use the Axis Properties dialog boxes to configure the drive. Notice that the dialog boxes change based on your configuration choices, for example, feedback configuration.

Table 24 lists the basic tasks necessary configure a drive.

Table 24 - Category Dialog Boxes to Configure Drives

Category Dialog Box	Perform These Tasks	Page
General	• Assign the axis configuration. • Choose the feedback configuration. • Choose the application type, if applicable. • Choose the loop response (low, medium, or high), if applicable. • If you have not already done so, you can create and associate an axis to a new Motion Group and associate a drive module to the axis.	88
Motor	• Specify a motor with the Data Source = Nameplate data sheet. • Specify a motor with the Data Source = Catalog Number. • Select a motor with the Data Source = Motor NV.	91
Motor Feedback	• Select the Motor Feedback Type.	95
Load Feedback	• Select the Load Feedback Type, if applicable.	97
Scaling	• Configure feedback by choosing the load type, by entering the scaling units, and by choosing the Travel mode. • Enter the Input Transmission and Actuator ratio, if applicable.	222

The parameters that you configure on the General category dialog box result in the presentation of attributes and parameters that are available for the combination of your selections.

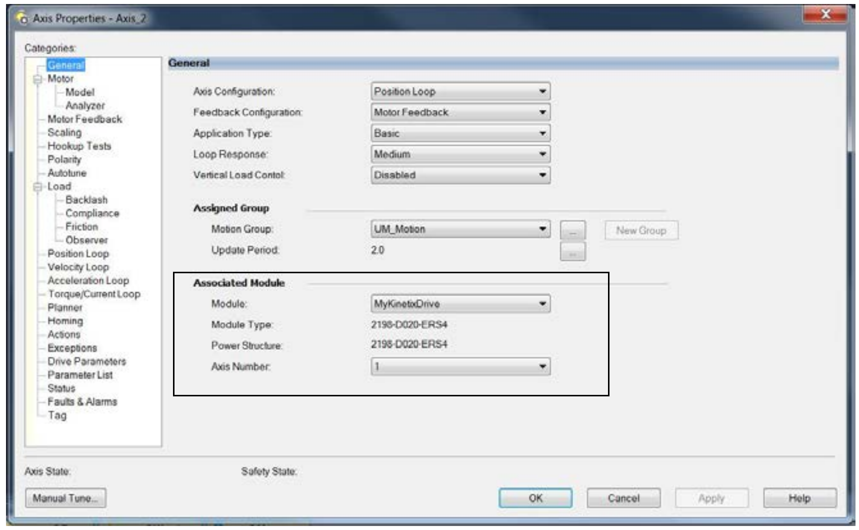
IMPORTANT All AXIS_CIP_DRIVE Axis Properties dialog boxes are dynamic. Optional attributes and dialog boxes that are related to each integrated motion axis you create come and go based on what combination of axis characteristics you define.

See the Integrated Motion Reference Manual, publication MOTION-RM003, for complete information on Axis Attributes and how to apply Control Modes.

IMPORTANT Be sure to associate the drive and axis before when configuring the axis because the drive determines what optional attributes are supported for the axis.

If you have already created an axis and associated in with a drive, the Associated Module and Axis are shown on the General category of the Axis Properties dialog box. Otherwise, you can select them here.

Figure 10 - General Category Dialog Box



^^ for an inverter

ss for a converter

The Axis Number field corresponds to the axes listed on the Associated Axes tab of the Module Properties dialog box. Any feedback port assignments that you made on the Associated Axes tab are also mapped to the drive when you associate an axis and a drive.

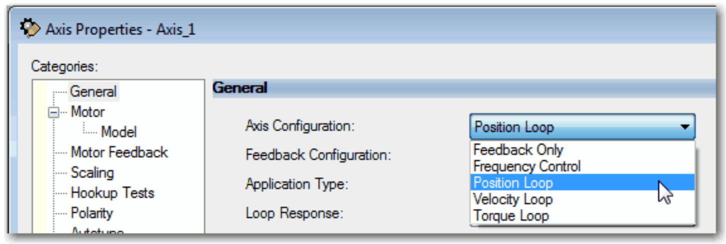
Configure the Associated Axis and Control Mode

Now that the axis is associated to the drive module, meaningful values are available for other axis properties.

For more information on Control Modes, see the Integrated Motion Reference Manual, publication MOTION-RM003.

1. In the Controller Organizer, double-click the Axis that you want to configure.

   The Axis Properties General dialog box appears.



2. Choose an Axis Configuration type. For this example, choose Position Loop.

   TIP The associated drive determines what Axis and Feedback Configuration choices are presented.

   Table 25 compares the axis configuration types for the drives.

Table 25 - Compare the Axis Configuration Types for the Drives

Axis Type	Kinetix 5700 Dual-axis Inverter	Kinetix 5700 Single-axis Inverter	Kinetix 5700 DC Bus Supply	Kinetix 5700 Regenerative Bus Supply
Position Loop (P)	Yes	Yes	No	No
Velocity Loop (V)	Yes	Yes	No	No
Torque Loop (T)	Yes	Yes	No	No
Feedback Only (E)	Yes	Yes	No	No
Frequency Control (F)	Yes	Yes	No	No
Non-Regenerative AC/DC Converter (N)	No	No	Yes	No
Regenerative AC/DC Converter (G)	No	No	No	Yes

3. In the Feedback Configuration pull-down menu, choose Motor Feedback.

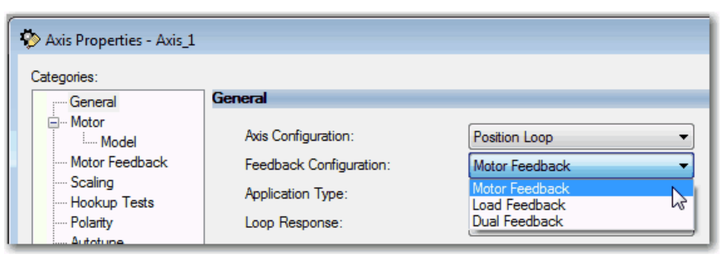


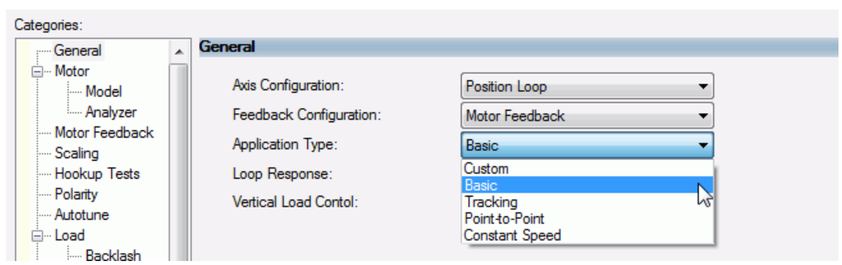
Table 26 compares the feedback configuration types for the Kinetix drives.

Table 26 - Compare the Feedback Configuration Types for the Drives

Feedback Type	Kinetix 5700 Dual-axis Inverter Type	Kinetix 5700 Single-axis Inverter Type	Kinetix 5700 DC Bus Power Supply	Kinetix 5700 Regenerative Bus Supply
Motor Feedback	Position Loop (P), Velocity Loop (V), Torque Loop (T)	Position Loop (P), Velocity Loop(V), Torque Loop (T)	—	—
Load Feedback	Position Loop (P), Velocity Loop (V)	Position Loop (P), Velocity Loop(V)	—	—
Dual Feedback	Position Loop (P)	Position Loop (P)	—	—
Dual Integrator	—	—	—	—
Master Feedback	Feedback Only (E)	Feedback Only (E)	—	—
No Feedback	Frequency Control (F)	Frequency Control (F)	Non-regenerative AC/DC Converter (N)	Regenerative AC/DC Converter (G)

4. Choose an Application Type, if applicable.

TIP The following General Options are available in an inverter configuration.



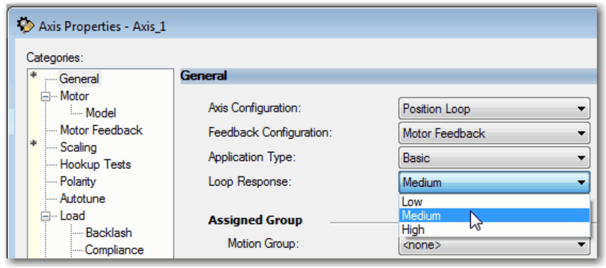
The Application Type determines the type of motion control application. This attribute is used to set the Gain Tuning Configuration Bits. Table 27 illustrates the gains established based on application type.

Table 27 - Customize Gains to Tune

Application Type	Kpi	Kvi	ihold	Kvff	Kaff	torqLPF
Custom(1)	—	—	—	—	—	—
Basic	No	No	No	Yes	No	Yes
Tracking	No	Yes	No	Yes	Yes	Yes
Point-to-Point	Yes	No	Yes	No	No	Yes
Constant Speed	No	Yes	No	Yes	No	Yes

(1) If you set the type to Custom, you can control the individual gain calculations by changing the bit settings in the Gain Tuning Configuration Bits Attribute.

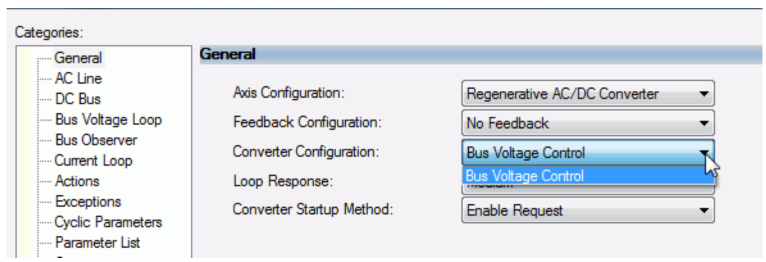
5. Choose a Loop Response, if applicable.



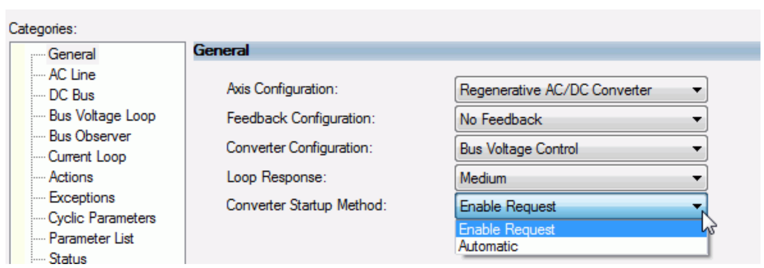
TIP Loop Response settings also impact the calculations that are made that can minimize the need for you to perform an Autotune or a Manual Tune. The loop response impacts the spacing between the position and velocity loops and the proportional and integral gains. This response impacts how aggressively a given profile is tracked.

6. Choose a Converter Configuration, if applicable.

TIP The following General Options are available in an converter configuration.



7. Choose a Converter Startup Method, if applicable.



Specify the Motor Data Source

The Motor Data Source is where you tell the axis where the motor configuration values are originating. You can select a motor by catalog number from the Motion Database. You can enter motor data from a nameplate or data sheet, or use the motor data that is contained in the drive or motor nonvolatile memory.

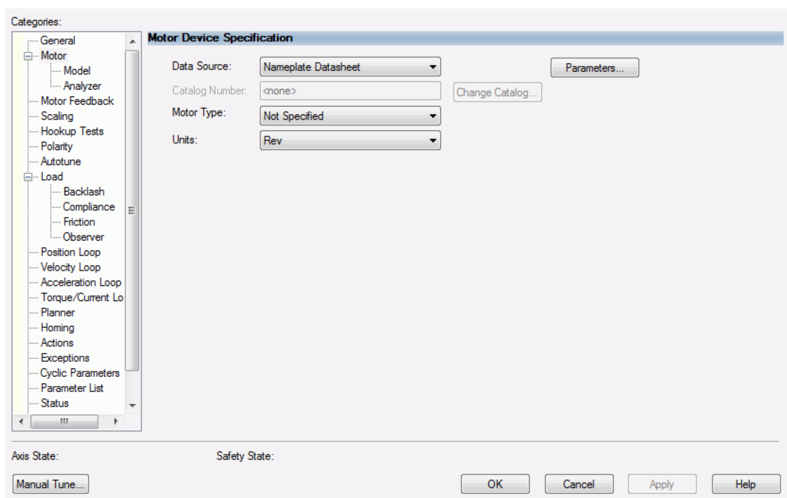
On the Motor dialog box you specify what motor you want to use and where the data is coming from:

- Specify a motor with the Data Source = Catalog Number.
- Specify a motor with the Data Source = Nameplate data sheet.
- Select a motor with the Data Source = Motor NV.

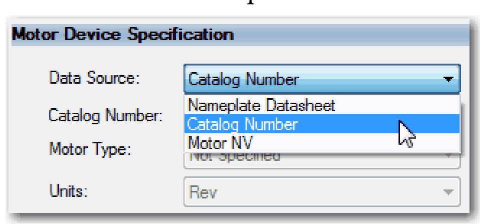
Choose the Catalog Number as the Motor Data Source

To choose a motor from the Motion Database, follow these steps.

1. If the Axis Properties dialog box is not open, double-click the axis.
2. Go to the Motor dialog box of Axis Properties.



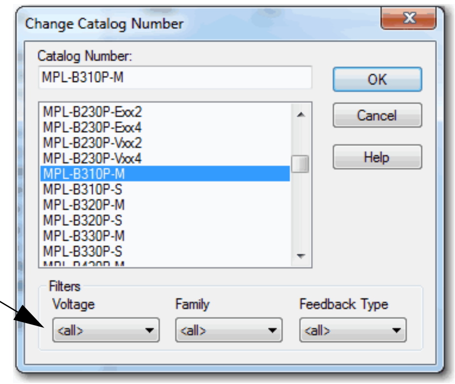
3. From the Data Source pull-down menu, choose Catalog Number.



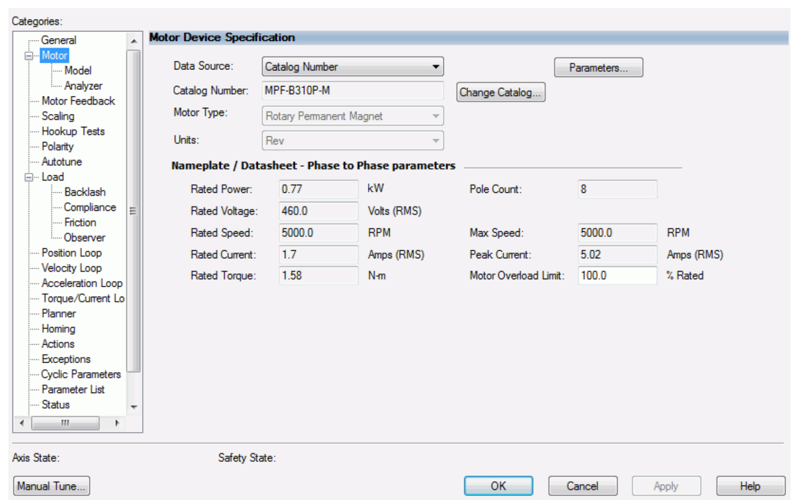
4. Click Change Catalog.

5. Select a motor.

To reduce the size of the list, use these filters.



6. The Motor dialog box is now populated with all information that is related to the motor you selected from the Motion Database.



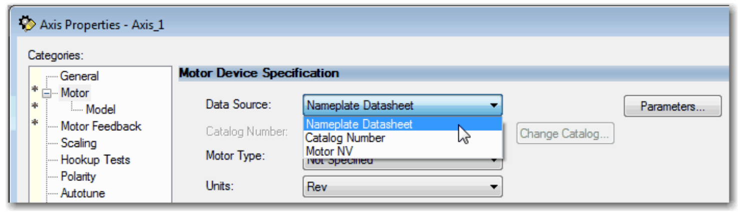
7. Click Apply.

TIP When you use a motor catalog number as the data source, default values are automatically set based on the Application Type and Loop Response settings from the General dialog box.

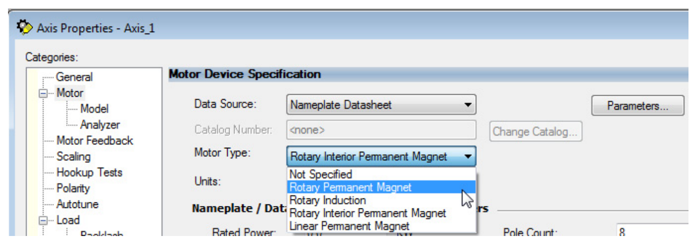
Choose Nameplate as the Motor Data Source

The Nameplate option requires you to enter the motor specification information from the motor nameplate and the motor data sheet.

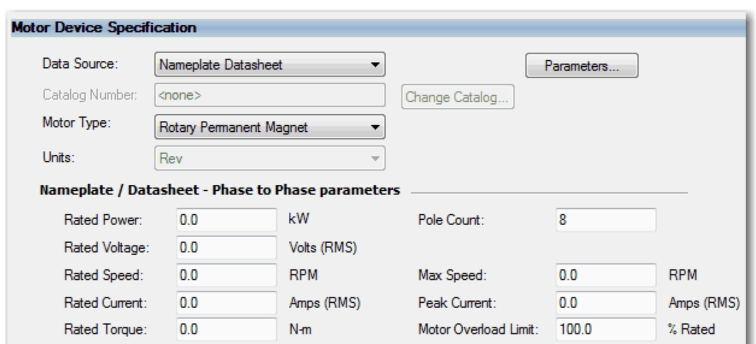
1. On the Motor dialog box of Axis Properties, from the Data Source pull-down menu, choose Nameplate data sheet.



2. Choose a motor type. The following motor types are compatible:
   - Surface Mount Permanent Magnet
   - Linear Permanent Magnet
   - Rotary Induction
   - Interior Permanent Magnet



Notice that the motor information fields are initialized to defaults.

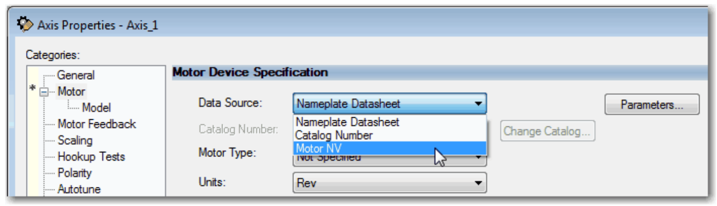


3. Enter the parameter information from the motor Nameplate data sheet and click Apply.

Choose Motor NV as the Motor Data Source

When you choose Motor NV as the data source, the motor attributes are derived from nonvolatile memory of a motor-mounted smart feedback device that is equipped with a serial interface. Only a minimal set of motor and motor feedback (Feedback 1) attributes are required to configure the drive.

1. From the Motor dialog box of Axis Properties, choose Motor NV.



2. Choose the Motor Units that are associated with the motor, either Rev for rotary motor or Meters for linear motor.

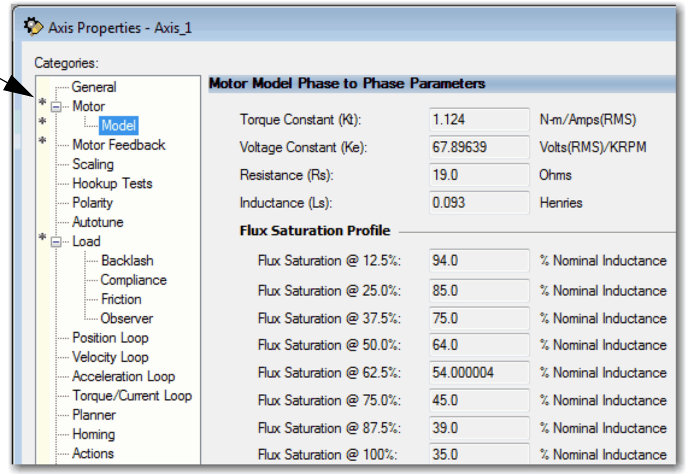
   No other motor information is needed.

3. Click Apply.

Display Motor Model Information

The Motor Model category displays more information that is based on the motor type you select.

The asterisk next to a category means that you have not applied changes.



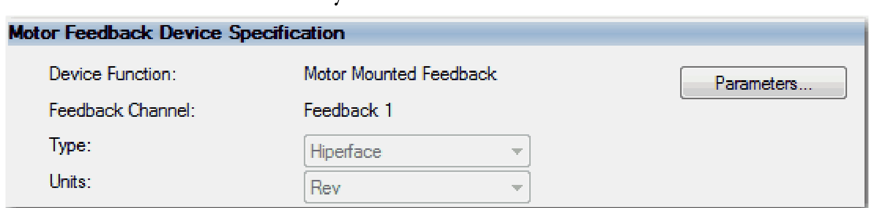
- If the motor data source is Catalog Number, this information is populated automatically.
- If the motor data source is Nameplate data sheet, this information must be entered manually, or by running the optional Motor Analyzer.
- If the motor data source is Motor NV, this dialog box is blank.

Assign Motor Feedback

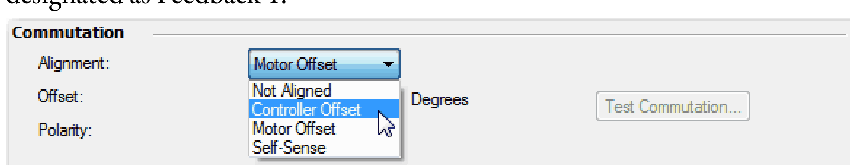
What appears on the Motor Feedback dialog box is dependent on what you select on the General dialog box for Feedback Configuration.

The Motor Feedback dialog box represents the information for the feedback device that is directly coupled to the motor. This dialog box is available if the feedback configuration that is specified on the General dialog box is anything other than Master Feedback.

If the motor that you select has Catalog Number as the data source, all information on this dialog box with be entered automatically. Otherwise you have to enter the information yourself.



Attributes that are associated with the Motor Feedback dialog box are designated as Feedback 1.



If a permanent magnet motor is selected from the Motion Database, the Commutation Alignment is set to Controller Offset. However, if a permanent magnet motor is specified from Nameplate data sheet, you must specify the Commutation Alignment method. The default is set to Not Aligned.

Table 28 - Commutation Alignment Settings

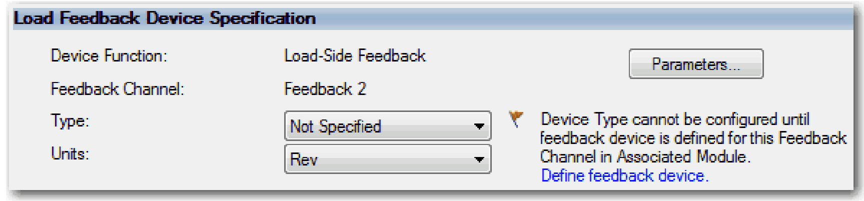
Type	Description
Not Aligned	Not Aligned indicates that the motor is not aligned, and that the Commutation Offset value is not valid. If the Commutation Offset is not valid, the drive cannot use it to determine the commutation angle. Any attempt to enable the drive with an invalid commutation angle results in a Start Inhibit condition.
Controller Offset	Controller Offset applies the Commutation Offset value from the controller to determine the electrical angle of the motor.
Motor Offset	The drive derives the commutation that is offset directly from the motor.
Self-Sense	The drive automatically measures the commutation that is offset when it transitions to the Starting state for the first time after a power cycle. This setting generally applies to a PM motor equipped with a simple incremental-feedback device.

In most cases, the Commutation Alignment is set to Controller Offset and the Commutation test is run during commissioning to determine the Commutation Offset and Polarity.

See the Integrated Motion Reference Manual, publication MOTION-RM003, for more information on axis attributes.

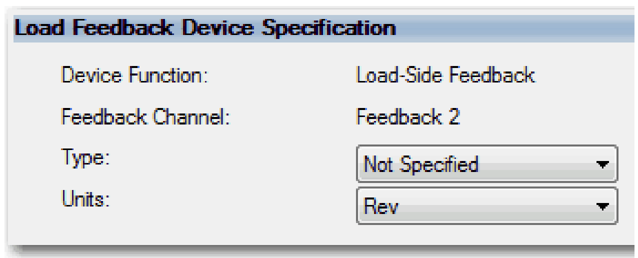
Configure the Load Feedback

The Load Feedback category contains the information from the feedback device that is directly coupled to the load-side of a mechanical transmission or actuator.

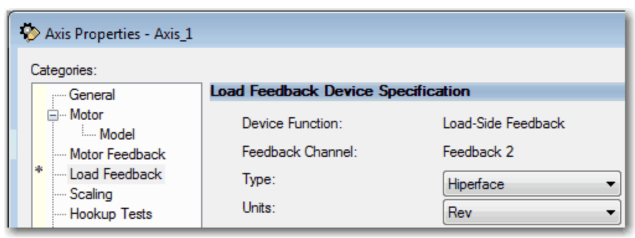


For your convenience, you can use this link to the Module Properties dialog box for the associated drive.

The Load Feedback category is available if the Feedback Configuration that is specified on the General dialog box is Load or Dual.

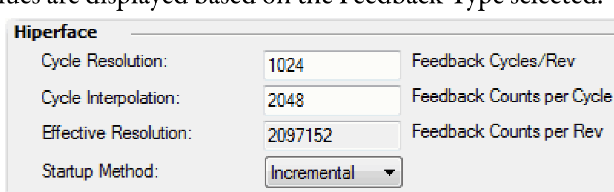


Attributes that are associated with the Load Feedback category are designated Feedback 2.



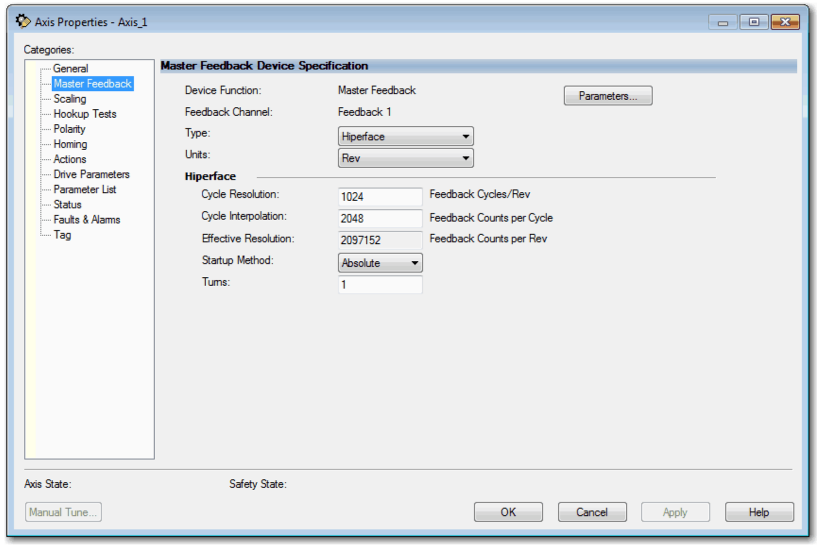
Unlike the Motor Feedback category, you must explicitly enter load feedback-device information on the Load Feedback category, including the Feedback Type. This entry is required because the Load Feedback device is not built into the motor.

Default values are displayed based on the Feedback Type selected.



Configure the Master Feedback

The Master Feedback category is available if the Feedback Configuration that is specified in the General category is Master Feedback. The attributes that are associated with the Master Feedback category are associated with Feedback 1. Again, like the Load Feedback category, you must enter all information.



To verify that motor and feedback device are functioning properly, download to the controller, and continue on to Hookup Tests on page 226.

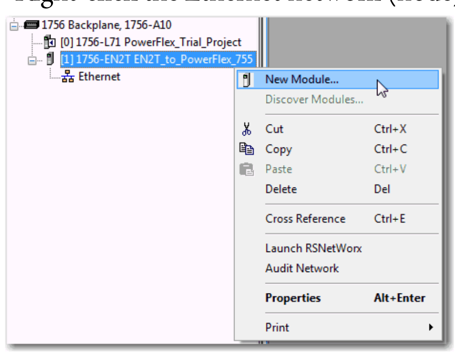
Configure Integrated Motion Using a PowerFlex 755 Drive

This chapter provides procedures on how to configure integrated motion on the EtherNet/IP™ network control by using a PowerFlex® 755 Embedded EtherNet/IP drive. For PowerFlex 755 configuration examples, refer to Axis Configuration Examples for the PowerFlex 527 Drive on page 209.

Add a PowerFlex 755 Drive

Follow these instructions to add the PowerFlex 755 drive to your project.

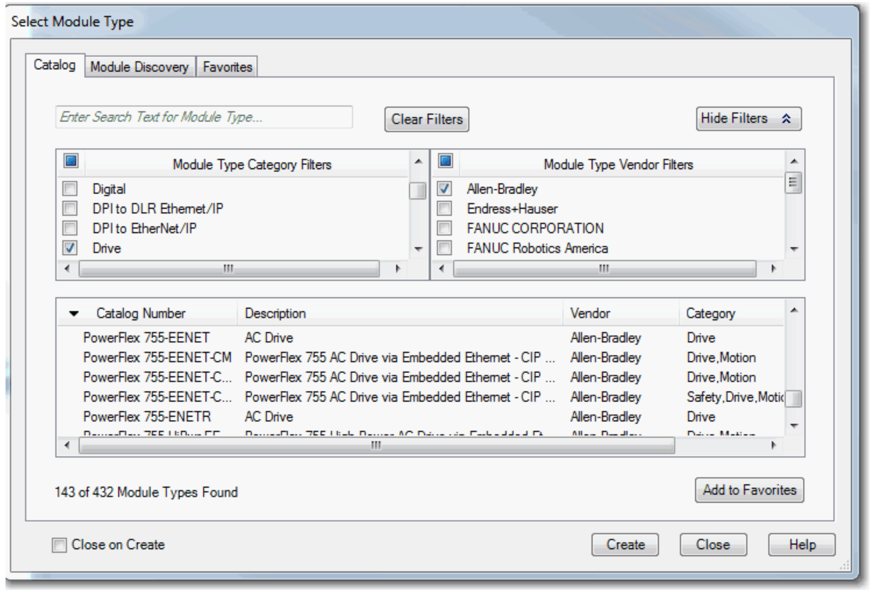
1. Right-click the Ethernet network (node) and choose New Module.



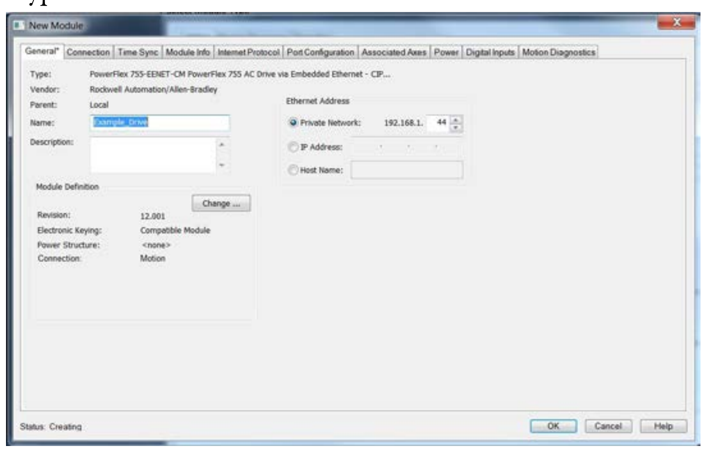
2. Clear the small 'select all' checkboxes, Module Type Category, and Vendor Filters.

3. In the Module Type Vendors Filters window, check Allen-Bradley.

4. In the Module Type Category Filters window, check Drive.



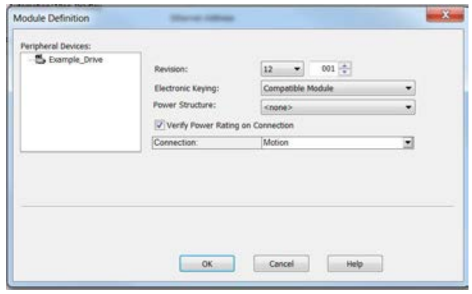
5. Choose the drive and click create.
6. Type a Name for the module.



7. Type a description, if desired.
8. Assign an EtherNet/IP address.

   See these manuals for information about how to configure IP addresses:
   - PowerFlex 755 Drive Embedded EtherNet/IP Adapter User Manual, publication 750COM-UM001
   - EtherNet/IP Network Configuration User Manual, publication ENET-UM001
9. Under Module Definition, click Change.

The Module Definition dialog box appears.



ATTENTION: The electronic keying feature automatically compares the expected module, as shown in the configuration tree, to the physical module before communication begins.

10. From the Electronic Keying pull-down menu, choose an option.

ATTENTION: When using motion modules, the electronic keying must be either `Exact Match' or 'Compatible Keying'.

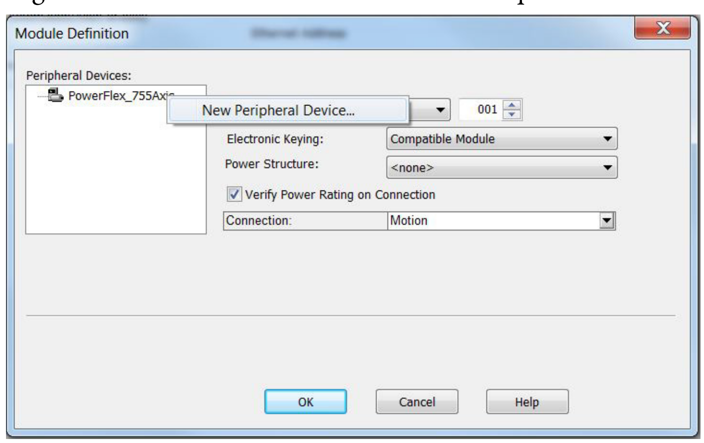
Never use `Disable Keying` with motion modules.

Select a Peripheral Feedback Device and Slot Assignment

Feedback devices on the PowerFlex 755 drives are called peripheral devices. You must assign the port/channel for each device you are using.

Follow these steps to select a feedback device.

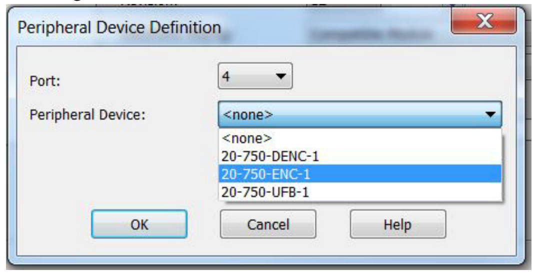
1. Right-click on the device and choose New Peripheral Device.



The peripheral device refers to the type of feedback device you are using with the PowerFlex 755 drive.

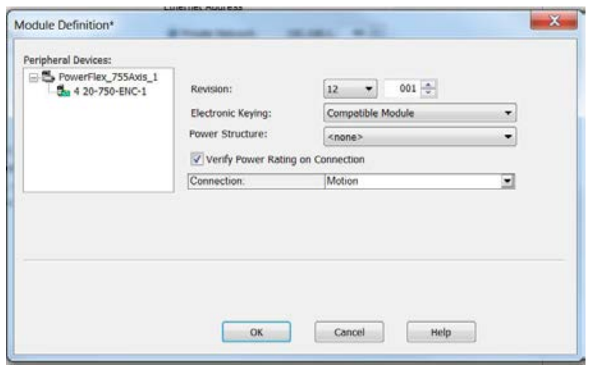
2. From the Port pull-down menu, choose the appropriate port/slot.

3. From the Peripheral Device pull-down menu, choose the appropriate catalog number.



4. Click OK.

The device is added. Notice that the feedback device appears.

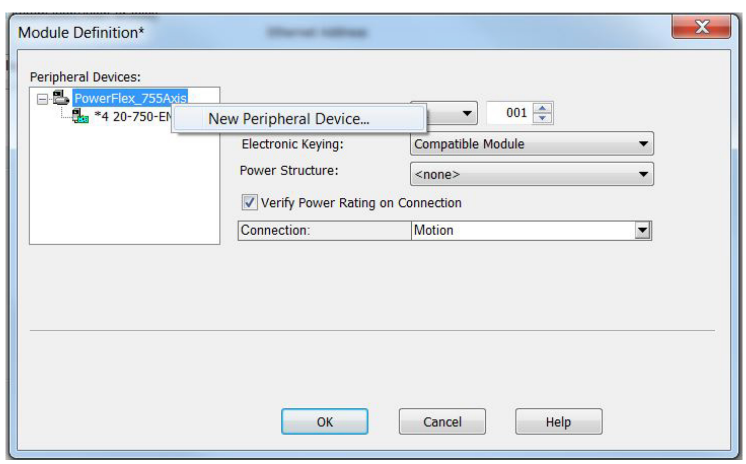


Select an I/O Device

You can also select an I/O card for the peripheral device on port 7.

IMPORTANT	You must select a revision of 12 or later for the module definition revision to add an I/O card to port 7 as a peripheral device.

1. Right-click on the drive and choose New Peripheral Device.

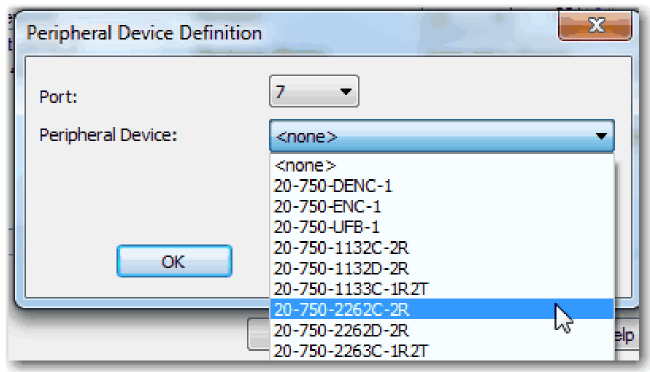


2. From the Port pull-down menu, choose Port 7.

IMPORTANT	For the I/O card Peripheral Device selection: the 20-750-11xx card supports the configuration of four digital inputs, while the 20-750-22xx cards support the configuration of eight digital inputs. Once you select the Peripheral Device, the Digital Inputs tab allows for configuration of the specified digital inputs.

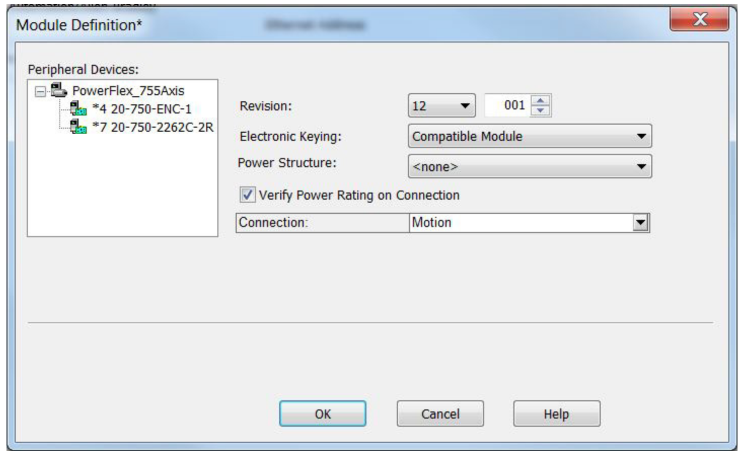
3. From the Peripheral Device pull-down menu, choose the appropriate catalog number.

   This example uses 20-750-2262C-2R.



4. Click OK.

   The device is added. Notice that the feedback device appears.



Assign a Power Structure

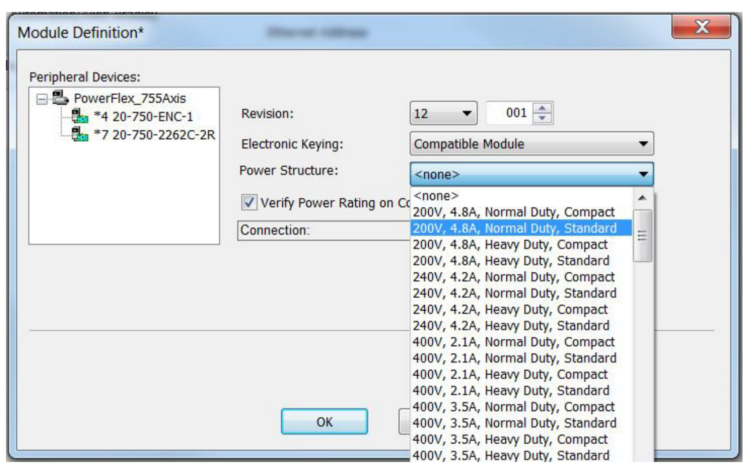
When you select a drive catalog number, you are specifying only a class of drives. You must assign the appropriate power structure that you have installed.

You can locate the power-structure reference numbers in these ways:

- On the actual product, usually on the right side of the drive
- In the device documentation
- On a purchase order

Follow these instructions to complete the drive configuration.

1. From the Power Structure pull-down menu, choose the appropriate power structure.

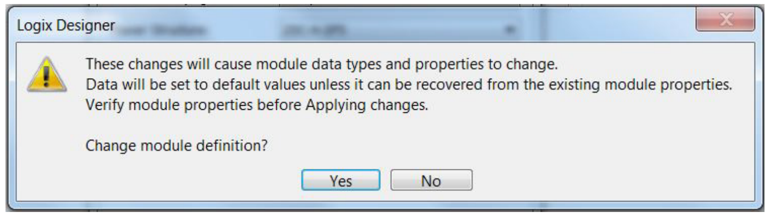


2. Click OK.

IMPORTANT	When you change the major revision on the PowerFlex 755 drive, change the power structure, or change the peripheral feedback device, the axis is no longer associated with the modules.

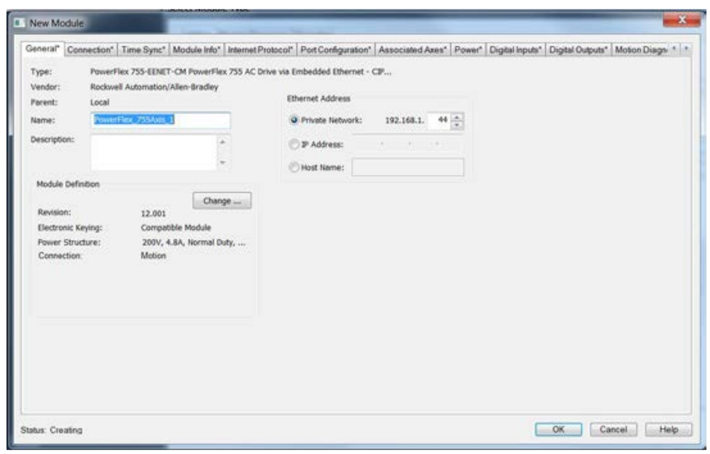
3. Click Yes.

   When you change parameters, other related parameters change as well.



   This message always appears after you have changed a configuration. This message is a reminder that when you change the power structure the identity of the drive changes. If your drive is associated to an axis and you change the power structure, the axis is disassociated.

   Even though a feedback card has been selected, the drive is not configured. You must associate the axis first, and then you have the options to configure a feedback module.



4. On the General Tab, click OK to apply the changes.

Configure Power Options

Use the settings on the power category to set bus regulator action, select shunt resistor type, and configure limits.

Figure 11 - Power Tab for the PowerFlex 755 Drive

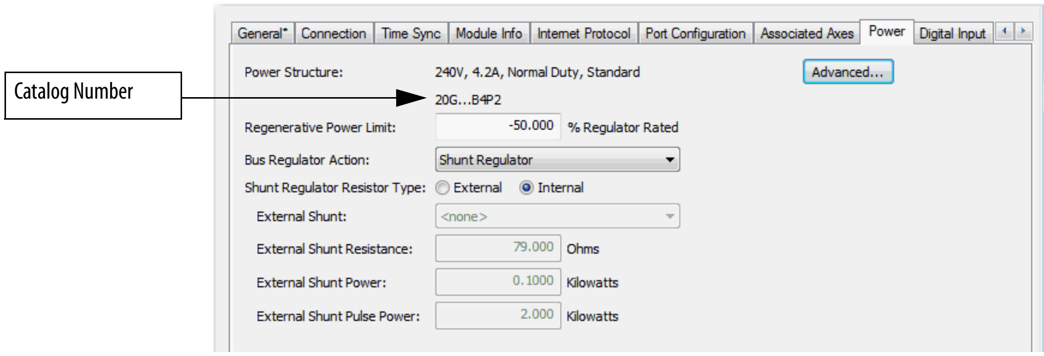


Table 29 - Module Properties: Power Tab Descriptions

Parameter	Description
Power Structure	Displays the drive catalog number and the drive power rating.
Regenerative Power Limit	Enter a negative percentage value for the regenerative power limit.
Bus Regulator Action	Get or Set the bus regulator action to a configuration tag. Valid values include the following: • Disabled • Shunt Regulator • CommonBus Follower
Shunt Regulator Resistor Type	Select either an internal or external shunt. Shunt Regulator Resistor Type appears dimmed in online mode and when Bus Regulator Action is disabled (set to CommonBus Follower). The Kinetix® 350 drive does not support this parameter.
External Shunt	These external shunt values are enabled when the Shunt Regulator Resistor Type is set to External. If you select External for the Shunt Regulator Resistor Type, choose the external shunt value. Valid values include the following: • <none> • Custom • The external shunt regulator catalog numbers
External Shunt Resistance	PowerFlex 755 Drive
External Shunt Power	PowerFlex 755 Drive
External Shunt Pulse Power	PowerFlex 755 Drive

Configure Digital Inputs

Use the Digital Input category to enter digital input values for the drive module. The appearance of this category for the PowerFlex 755 drives can vary dependent upon the peripheral device configuration.

Figure 12 - Digital Input Tab for the PowerFlex 755 Drive

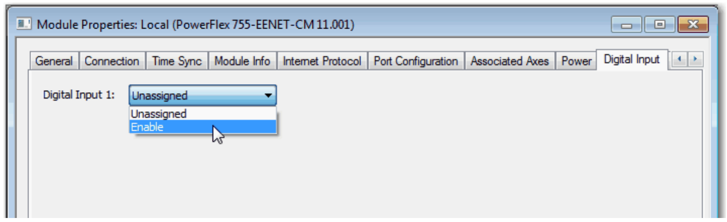


Table 30 - Module Properties: PowerFlex 755 Digital Input Tab Descriptions

Parameter	Description
Digital Input 1	Choose one of these values for Digital Input 1: • Unassigned • Enable

Figure 13 - Digital Inputs Tab for the PowerFlex 755 Drive with Digital I/O Peripheral Device

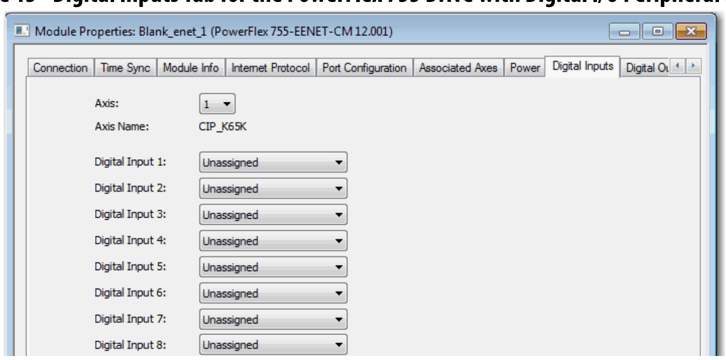


Table 31 - PowerFlex 755 with Digital I/O Peripheral Device Module Properties: Digital Inputs Tab Description

Parameter	Description
Digital Input 1	Choose one of these values for Digital Input 1: • Unassigned • Enable
Digital Input 2 Digital Input 3 Digital Input 4 Digital Input 5 Digital Input 6 Digital Input 7	Choose one of these values for Digital Input 2, 3, 4, 5, 6, and 7: • Unassigned • Positive Overtravel • Negative Overtravel • Regeneration OK • Precharge OK
Digital Input 8	Choose one of these values for Digital Input 8: • Unassigned • Motor Thermostat OK

Configure Digital Outputs

Use the Digital Outputs tab to enter digital output values for the drive module. The Digital Outputs tab applies only to PowerFlex 755 drives that are configured with a Digital I/O card as a peripheral device. The appearance of the Digital Outputs tab can vary dependent upon the peripheral device configuration.

Figure 14 - Digital Outputs Tab for the PowerFlex 755 Drive

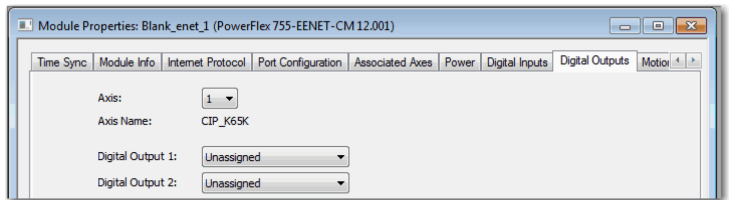


Table 32 - PowerFlex 755 Module Properties: Digital Outputs Tab Descriptions

Parameter	Description
Digital Output 1	Choose one of these values for Digital Input 1: • Unassigned • Contactor Enable • Mechanical Brake Engage
Digital Output 2	Choose one of these values for Digital Output 2: • Unassigned • Contactor Enable

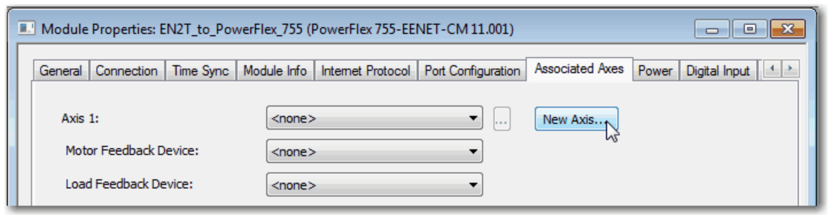
Create an Associated Axis

There are two approaches that you can take to create and configure an axis. You can create an axis first and then add the axis to your motion group, or you can create your motion group and then add an axis. The procedure that is outlined in this section takes the approach to create your axis first, configure the axis, and then add it to your motion group.

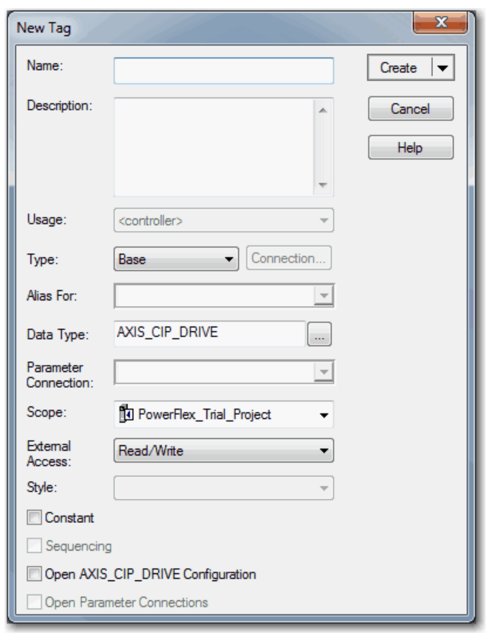
Create an Axis for a PowerFlex 755 Drive

Follow these steps to create an axis.

1. Double-click the drive in the Controller Organizer.
2. Click the Associated Axes tab.
3. Click New Axis.



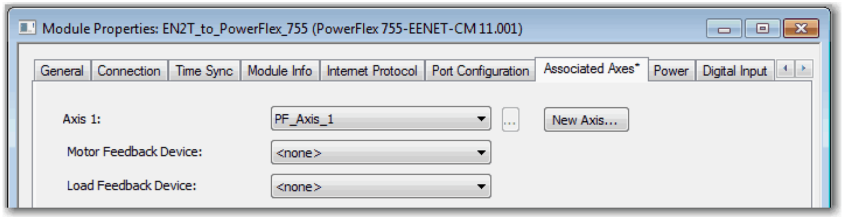
The New Tag dialog box appears.



4. Type the name.
5. Type a Description, if desired.

   The fields in the next steps are automatically entered for the AXIS_CIP_DRIVE data type.
6. Change the Tag Type, Data Type, Scope, and External Access, if needed.

7. Click Create.



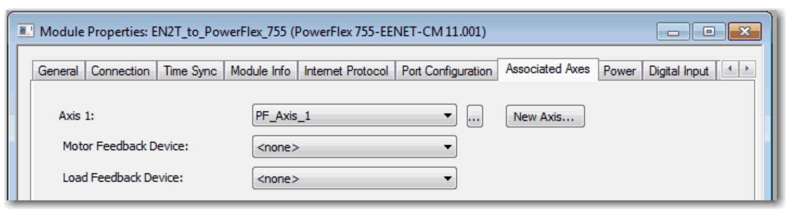
For more information about External Data Access Control and Constants, see the Logix 5000™ Controllers I/O and Tag Data Programming Guide, publication 1756-PM004.

Establish Feedback Port Assignments

The ports and channels that you can select are related to what hardware you have installed. You must manually establish the motor feedback (Port/Channel) assignment for the PowerFlex 755 drive.

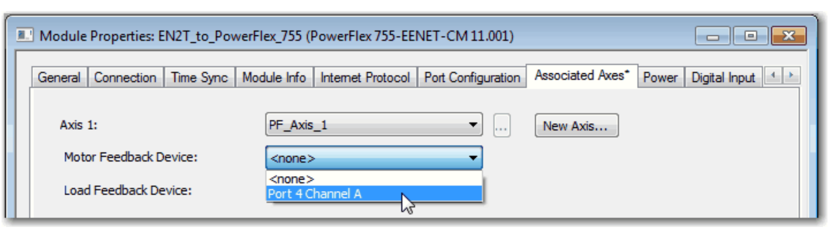
Follow these instructions to associate an axis to the drive by using the Module Properties dialog box for the drive.

1. Right-click the PowerFlex 755 drive and choose Properties.
2. Click the Associated Axes tab.



3. From the Feedback Device pull-down menus, choose the port and channel combination that is applicable to your hardware configuration, which you installed when you added a peripheral device to your drive.

   In this case, Port 4 Channel A is associated with the Motor Feedback device.



4. To apply the changes and close the dialog box, click OK.

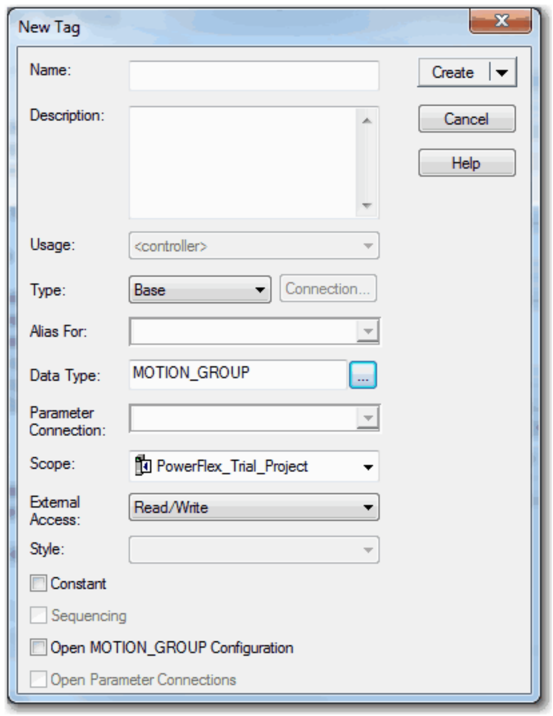
Create a Motion Group

All axes must be added to the Motion Group in your project. If you do not group the axes, they remain ungrouped and unavailable for use.

You must create a Motion Group for an axis to be configured properly.

To determine how many axes your controller system supports, see Table 3 on page 12.

1. In the Controller Organizer, right-click Motion Groups and choose New Motion Group.



2. Type a name.
3. Type a description, if desired.

   The fields in the next steps are automatically entered for the Motion_Group data type.
4. Change the Tag Type, Data Type, Scope, and External Access, if needed.

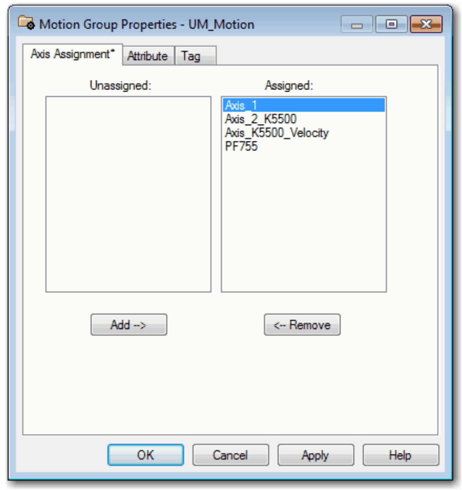
   For more information about External Data Access Control and Constants, see the Logix5000 Controllers I/O and Tag Data Programming Guide, publication 1756-PM004.
5. Click Create.

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

6. Right-click the new motion group and choose Properties.

   The Motion Group Properties dialog box appears.

7. Click the Axis Assignment tab and move your axes (created earlier) from Unassigned to Assigned.



Set the Base Update Period

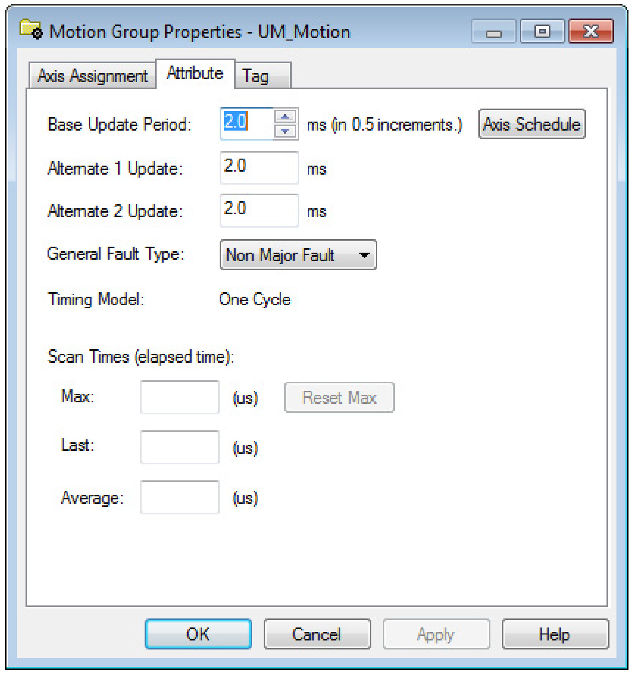
The Base Update Period is basically the RPI rate for Ethernet communication between the controller and the motion module, a Unicast connection. It also sets the motor feedback that is returned from the drive in the drive-to-controller connection.

There are two alternate update periods that you can configure when using Axis Scheduling. See Axis Scheduling on page 145 for details.

The Base Update Period is how often the motion planner runs. When the motion planner runs, it interrupts most other tasks regardless of their priority. The motion planner is the part of the controller that takes care of position and velocity information for the axes.

Follow these steps to set the Base Update Period.

1. Click the Attribute tab in the Motion Group Properties dialog box.



2. Set the Base Update Period to 3.0…32.0 ms.

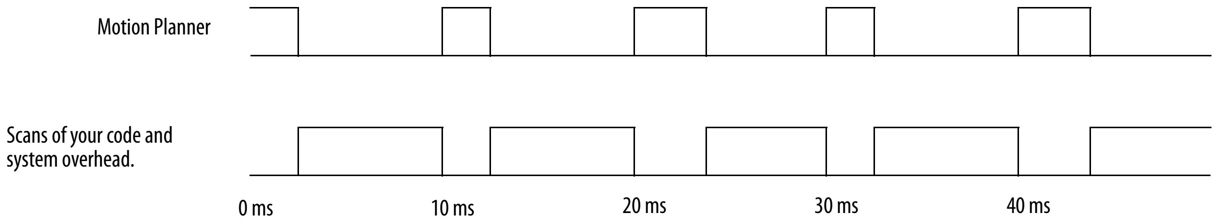
   For the PowerFlex 755 drive, the minimum Base Update Rate 3 ms.

Coarse Update Rate

The position loop for the PowerFlex 755 drive is updated at a rate of 1.024 ms (1024 μs). During each position loop update, the drive can either read or write data to the embedded Ethernet port, but cannot do both operations during the same update. Therefore the drive can receive only new updates every other position loop update event. To read new information from the Motion Planner, the minimum coarse update rate must be 2.5 ms or greater to be sure that no data packets are lost. In this context, the Motion Planner is the controller. If the PowerFlex 755 drive is operated at a coarse update rate of less than 2.5 ms, data packets can be lost. The drive can also fault if enough data packets are missed consecutively. These conditions result in the drive interpolating between missed updates. We recommend a minimum coarse update rate of 3 ms for the PowerFlex 755 drive.

TIP Check to see if the Last Scan time values on the Attribute tab are less. Typically, the value is less than 50% of the Base Update Period.

Figure 15 - Base Update Period Example



In this example, the Base Update Period = 10 ms. Every 10 ms the controller stops scanning your code and whatever else it is doing and runs the motion planner.

The Base Update Period is a trade-off between updating positions of your axes and by scanning your code. For a ControlLogix® 5560 controller or GuardLogix® 5560 safety controller, you can have 4 axes/ms and 8 axes/ms for the ControlLogix 5570 controller.

For detailed information on the Axis Scheduling function, Axis Assignment tab, and Alternate Update Period Scheduling, see Axis Scheduling on page 145.

Integrated Architecture Builder

To help you determine motion system performance, use the motion performance calculator in the Integrated Architecture Builder (IAB).

The IAB is a graphical software tool for configuring Logix-based automation systems. It helps you select hardware and generate bills of material for applications that include controllers, I/O, networks, PowerFlex drives, On-Machine™ cabling and wiring, motion control, and other devices.

You can find the software at
http://www.rockwellautomation.com/en/e-tools/configuration.html

Configure the Axis Properties

After you add the drive to your project and create the axes, use the Axis Properties dialog boxes to configure the drive. Notice that the dialog boxes change based on your configuration choices, for example, feedback configuration.

Table 33 lists the basic tasks necessary configure a drive.

Table 33 - Category Dialog Boxes to Configure Drives

Category Dialog Box	Perform These Tasks	Page
General	• Assign the axis configuration. • Choose the feedback configuration. • Choose the application type, if applicable. • Choose the loop response (low, medium, or high), if applicable. • If you have not already done so, you can create and associate an axis to a new Motion Group and associate a drive module to the axis.	116
Motor	• Specify a motor with the Data Source = Nameplate data sheet. • Specify a motor with the Data Source = Catalog Number. • Select a motor with the Data Source = Motor NV.	119
Motor Feedback	• Select the Motor Feedback Type.	125
Scaling	• Configure feedback by choosing the load type, by entering the scaling units, and by choosing the Travel mode. • Enter the Input Transmission and Actuator ratio, if applicable.	222

The parameters that you configure on the General category dialog box result in the presentation of attributes and parameters that are available for the combination of your selections.

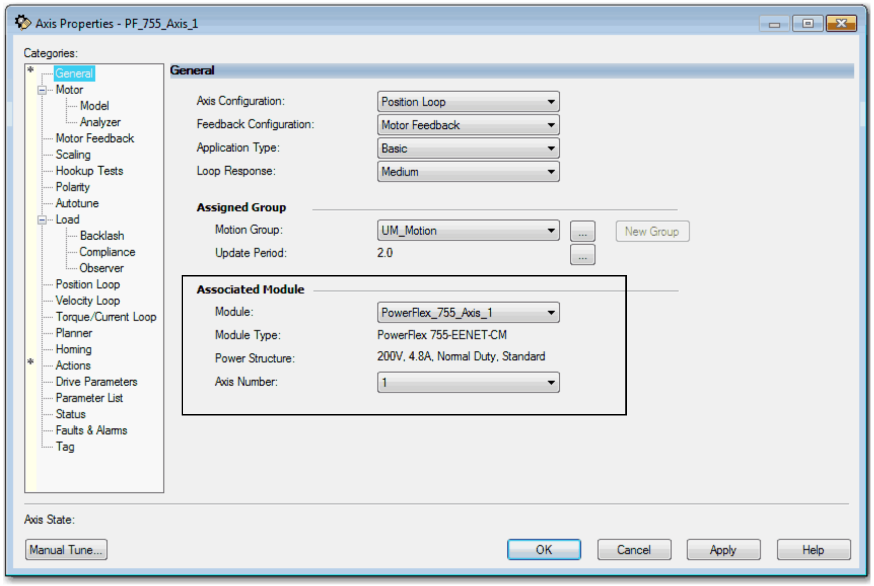
IMPORTANT All AXIS_CIP_DRIVE Axis Properties dialog boxes are dynamic. Optional attributes and dialog boxes that are related to each integrated motion axis you create come and go based on what combination of axis characteristics you define.

See the Integrated Motion Reference Manual, publication MOTION-RM003, for complete information on Axis Attributes and how to apply Control Modes.

IMPORTANT Be sure to associate the drive and axis before when configuring the axis because the drive determines what optional attributes are supported for the axis.

If you have already created an axis and associated in with a drive, the Associated Module and Axis are shown on the General category of the Axis Properties dialog box. Otherwise, you can select them in the dialog box that is shown in Figure 16.

Figure 16 - General Category Dialog Box



The Axis Number field corresponds to the axes listed on the Associated Axes tab of the Module Properties dialog box. Any feedback port assignments that you made on the Associated Axes tab are also mapped to the drive when you associate an axis and a drive.

For more information on how to configure the recommended out-of-box settings for your PowerFlex 755 drive, see Appendix E on page 357.

The axis parameters that you configure on the General dialog box result in the presentation of attributes and parameters that are available for the combination of your selections.

Configure the Associated Axis and Control Mode

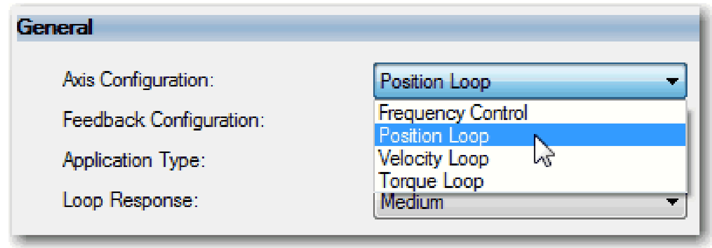
Now that the axis is associated to the drive, meaningful values are available for other axis configuration properties. The combination of the attributes that are selected when configuring an axis and feedback determines the control mode.

See the Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003, for complete information on axis attributes and control modes.

Follow these steps to configure an axis.

1. In the Controller Organizer, double-click the axis that you want to configure.

2. Choose an Axis Configuration.



TIP The associated drive determines what axis and feedback configuration choices are presented.

Table 34 - Compare the Axis Configuration Types for the Drives

Axis Type	PowerFlex 755
Position Loop (P)	Yes
Velocity Loop (V)	Yes
Torque Loop (T)	Yes
Feedback Only (N)	No
Frequency Control (F)	Yes

3. Choose a Feedback Configuration type.

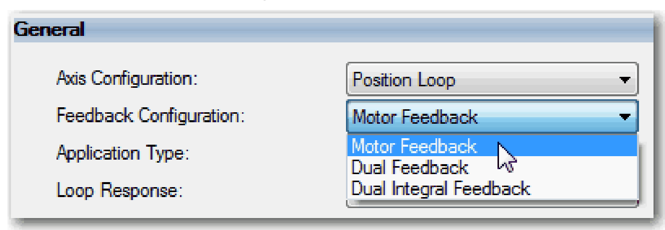


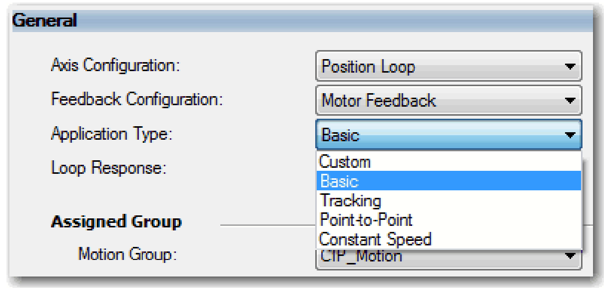
Table 35 compares the feedback type and loop type.

Table 35 - Compare the Feedback Type and Loop Type

Feedback Type	Axis Type	PowerFlex 755
Motor Feedback	Position Loop (P), Velocity Loop (V),Torque Loop (T)	Yes
Motor Feedback	Position Loop (P), Velocity Loop (V)	No
Load Feedback	Position Loop (P), Velocity Loop (V),Torque Loop (T)	No
Dual Feedback	Position Loop (P)	Yes
Dual Integrator	Position Loop (P)	Yes
Master Feedback	Feedback Only (N)	No
No Feedback	Frequency Control (F)	Yes
No Feedback	Velocity Loop (V)	Yes

For a list of available devices, see Table 6 on page 17.

4. Choose an Application Type, if applicable.



TIP Application Type defines the servo loop configuration automatically. These combinations determine how the calculations are made, which can reduce the need to perform an Autotune or a Manual Tune.

The Application Type determines the type of motion control application. This attribute is used to set the Gain Tuning Configuration Bits.

Table 36 provides the gains established base on the application type.

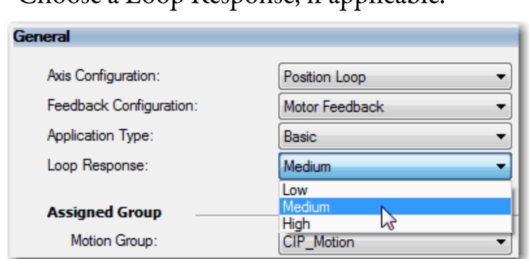
Table 36 - Customize Gains to Tune

Application Type	Kpi	Kvi	ihold	Kvff	Kaff	torqLPF
Custom(1)	-	-	-	-	-	
Basic (V20 and later)	No	No	No	Yes	No	Yes
Basic (V19 and earlier)	No	No	No	No	No	-
Tracking	No	Yes	No	Yes	Yes	Yes
Point-to-Point	Yes	No	Yes	No	No	Yes
Constant Speed	No	Yes	No	Yes	No	Yes

(1) If you set the type to Custom, you can control the individual gain calculations by changing the bit settings in the Gain Tuning Configuration Bits Attribute.

TIP For information about other attribute calculations, see the specific attribute description in the Integrated Motion on the EtherNet/IP Reference Manual, publication MOTION-RM003.

5. Choose a Loop Response, if applicable.



6. Click Apply.

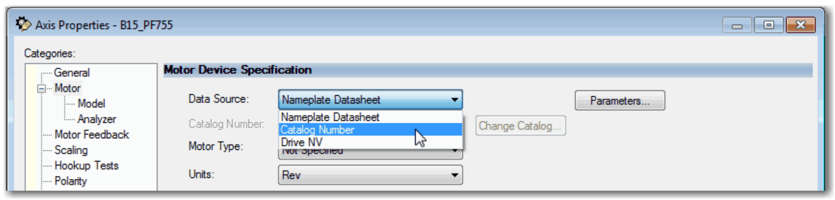
Specify the Motor Data Source

The Motor Data Source is where you tell the axis where the motor configuration values are originating. You can select a motor from the database, nameplate, or nonvolatile memory.

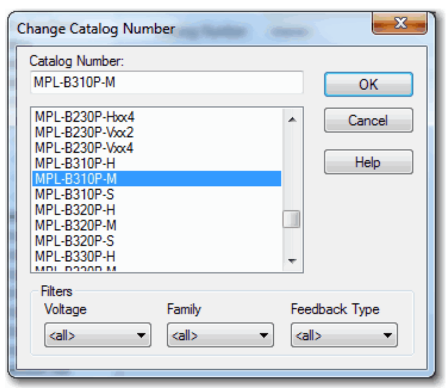
Choose Catalog Number as the Motor Data Source

Follow these steps to identify the specification information that is originating from the Motion Database.

1. If the Axis Properties dialog box is not open, double-click the axis.
2. Click the Motor tab of the Axis Properties dialog box.
3. From the Data Source pull-down menu, choose Catalog Number.

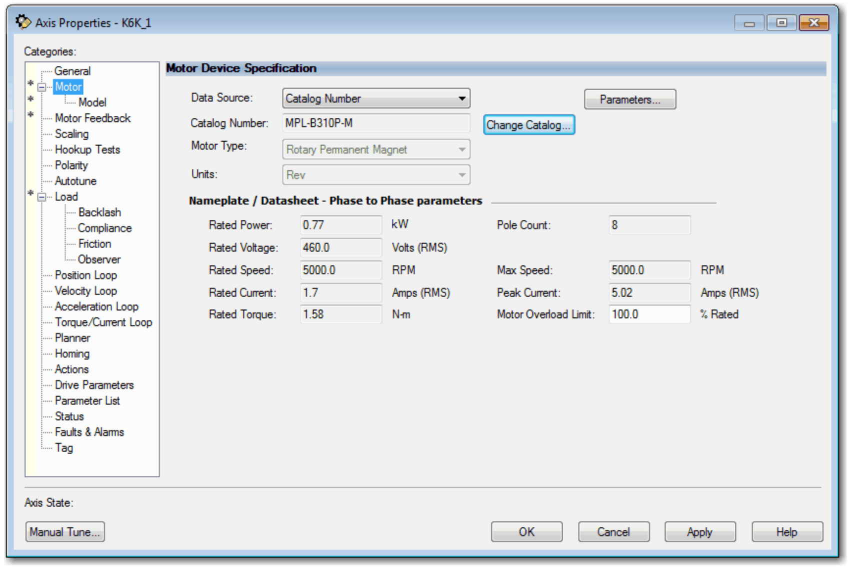


4. Click Catalog Number.
5. Click Change Catalog.
6. Select a motor and click OK.



The Motor dialog box is populated with all information that is related to the motor you selected from the Motion Database.

Figure 17 - Motor Dialog Box



7. Click Apply.

Motor Model Dialog Box

The Motor Model dialog box displays the Motor Model Phase to Phase parameters. The parameters that are available depends on the Motor Data Source. Nameplate data sheet is the only Motor Data Source that lets you input the values. The Motor Analyzer is helpful when configuring the Motor Model dialog box parameters.

See Display Motor Model Information on page 123.

Motor Analyzer Dialog Box

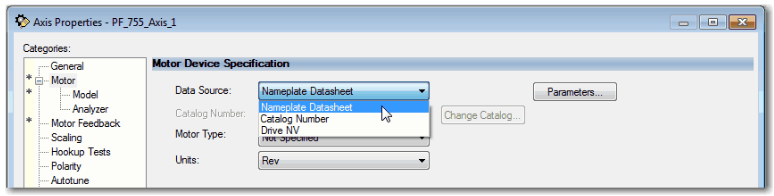
The Motor Analyzer provides the Dynamic Motor Test for an AC drive, such as the PowerFlex 755 drive.

See Motor Analyzer Dialog Box on page 123.

Choose Nameplate as the Motor Data Source

The Nameplate option requires you to enter the motor specification information. You can find the information on the hardware nameplate or product data sheets.

1. From the Motor dialog box of Axis Properties, choose Nameplate data sheet.



2. Choose a motor type.

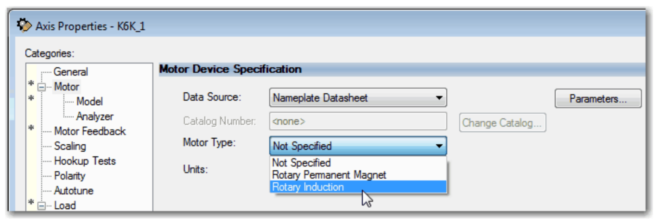
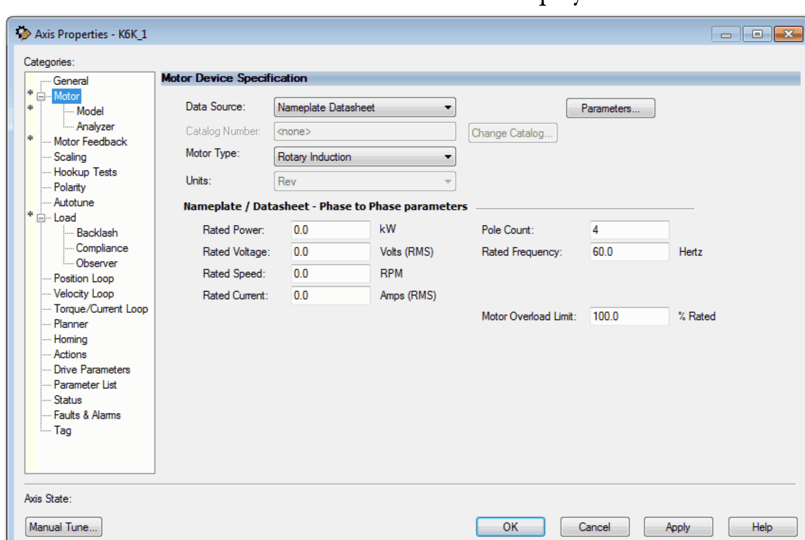


Table 37 shows the motor types that are available.

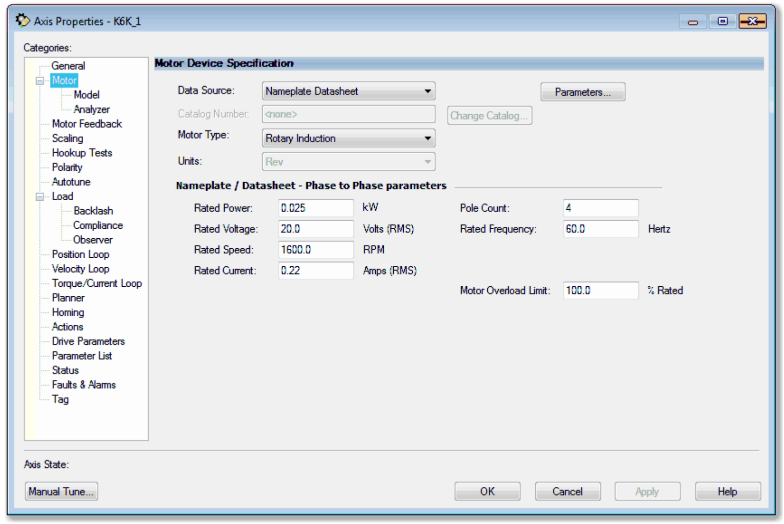
Table 37 - Motor Types

Motor Type	PowerFlex 755	PowerFlex 527
Rotary Permanent Magnet	Yes	No
Linear Permanent Magnet	No	No
Rotary Induction	Yes	Yes

Notice that the motor information fields display zeros.



3. Enter the parameter information from the motor Nameplate data sheet.



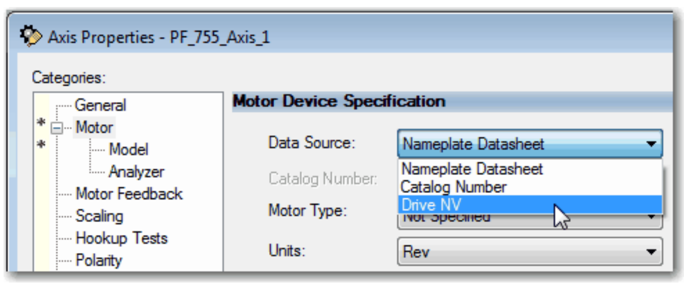
4. Click Apply.

Choose Drive NV as the Motor Data Source

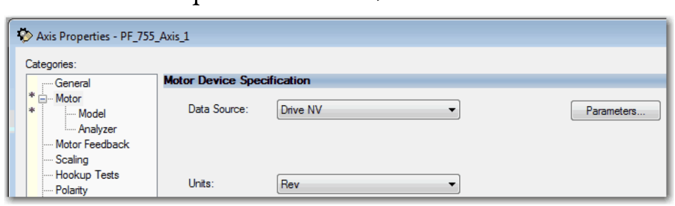
When you choose Drive NV, the motor attributes are derived from the nonvolatile memory of a drive. Only a minimal set of motor and motor feedback (Feedback 1) attributes are required to configure the drive.

Follow these instructions to choose a data source.

1. From the Data Source pull-down menu, choose Drive NV.



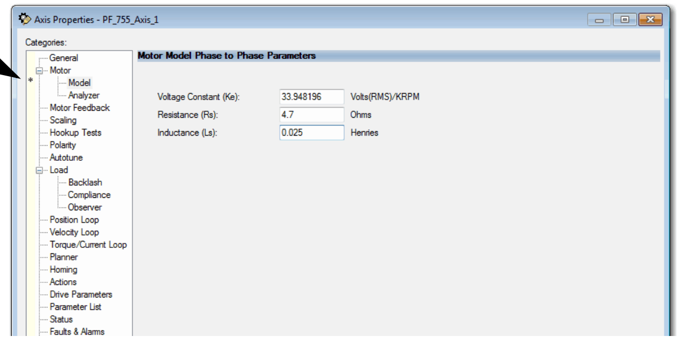
2. From the Units pull-down menu, choose Revolutions or Meters.



Display Motor Model Information

The Motor Model dialog box displays more information that is based on the motor, axis, and feedback configuration types you choose.

The asterisk next to a category means that you have not applied changes.



- If the motor data source is Catalog Number, the fields are populated automatically from the database and the fields are read-only.
- If the motor data source is Nameplate data sheet, you can enter the information.

TIP You can leave the default values, go online, and run a Motor Test to get the proper values from the drive.

See Hookup Tests on page 226.

- If the motor data source is Drive NV, the data comes from the nonvolatile memory of the drive.
- If you select Catalog Number, Motor NV, or Drive NV, the values display as read-only.

Motor Analyzer Dialog Box

The Motor Analyzer provides the following three tests:

- Dynamic Motor
- Static Motor
- Calculate Model

The tests analyze motor parameters for rotary and linear induction motors and permanent magnet motors. The parameters that appear on the tests are dependent on the motor type you choose.

TIP If the motor you are using is a Permanent Magnet, the Dynamic Motor is the only test that appears.

Figure 18 - Motor Analyzer Dialog Box

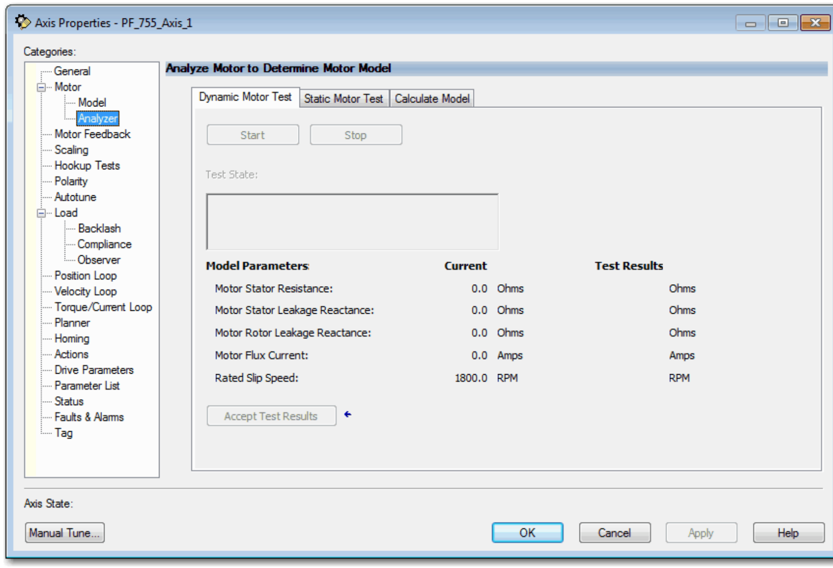


Table 38 - Motor Analyzer Parameters

Parameter	Description
Motor Resistance	Specifies the phase-to-phase, resistance of a permanent magnet motor.
Motor Inductance	Specifies the phase-to-phase, inductance of a permanent magnet motor.
Motor Rotary Voltage Constant	Specifies the voltage, or back-EMF, constant of a rotary permanent-magnet motor in phase-to-phase RMS Volts per KRPM.
Motor Stator Resistance	Specifies the Y circuit, phase-neutral, winding resistance of the stator as shown as R1 in the IEEE motor model.
Motor Stator Leakage Reactance	Specifies the Y circuit, phase-neutral, leakage reactance of the stator winding, at rated frequency, as shown as X1 in the IEEE motor model.
Motor Torque Constant	Specifies the torque constant of a rotary permanent-magnet motor in Newton-meters per RMS amp.
Motor Rotor Leakage Reactance	Specifies the Y circuit, phase-neutral, equivalent stator-referenced leakage inductance of the rotor winding, at rated frequency, as shown as X2 in the IEEE motor model.
Motor Flux Current	Id Current Reference that is required to generate full motor flux. The No Load Motor Rated Current that is commonly found in Induction Motor data sheets closely approximates the value of the Motor Flux Current. The Kinetix 350 does not support this parameter.
Rated Slip	Rated Slip is the amount of slip at motor rated current (full load) and motor rated frequency.

See the Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003, for complete information on Axis Attributes Motor Feedback.

Assign Motor Feedback

The PowerFlex 755 drive requires a peripheral feedback device. As with all parameters, the types of feedback available are dependent on what you select on the General dialog box for Feedback Configuration.

For a list of available devices, see Table 6, Supported Feedback Module Combinations, on page 17.

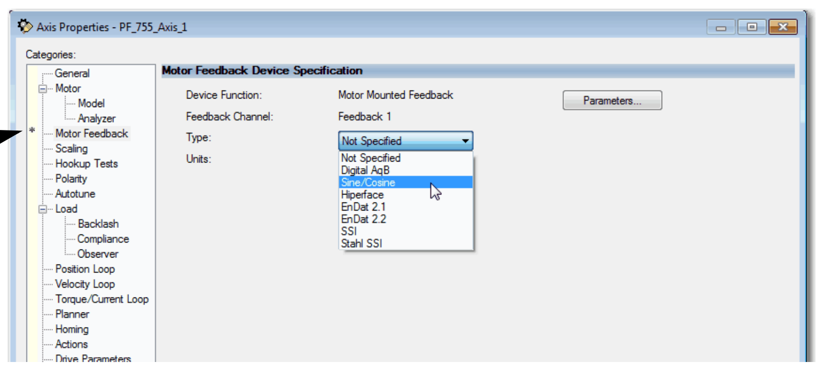
Axis Configuration Type	Parameters
Frequency Control	No Feedback
Position Loop	• Motor Feedback, one mounted device • Dual Feedback, two mounted devices • Dual Integral Feedback, two mounted devices
Velocity Loop	• No Feedback • Motor Feedback, mounted device
Torque Loop	• Motor Feedback, mounted device

The Motor Feedback dialog box contains the information for the feedback device. This category dialog box is not available for Frequency axis configuration and is dependent on the axis configuration type and the motor selection.

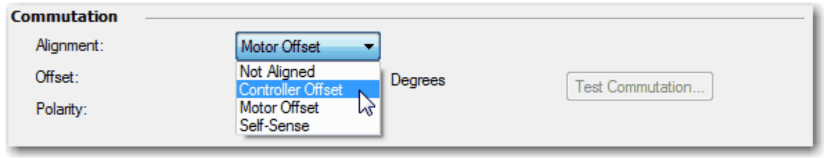
Select a Feedback Type and Units. The type of feedback available depends on the axis and feedback configurations.

1. From the Type pull-down menu, choose the appropriate type of motor feedback.

The asterisk next to a category means that you have not applied changes.



2. Click Apply and OK to exit the Motor Feedback dialog box.
3. Set the commutation alignment type and the percentage of offset.



TIP All commutation attributes apply only to permanent magnet motors.

If you are using a motor that is not in the database, the default is Not Aligned. If the motor is in the database, the alignment is set to Controller Offset.

Table 39 - Commutation Alignment Types

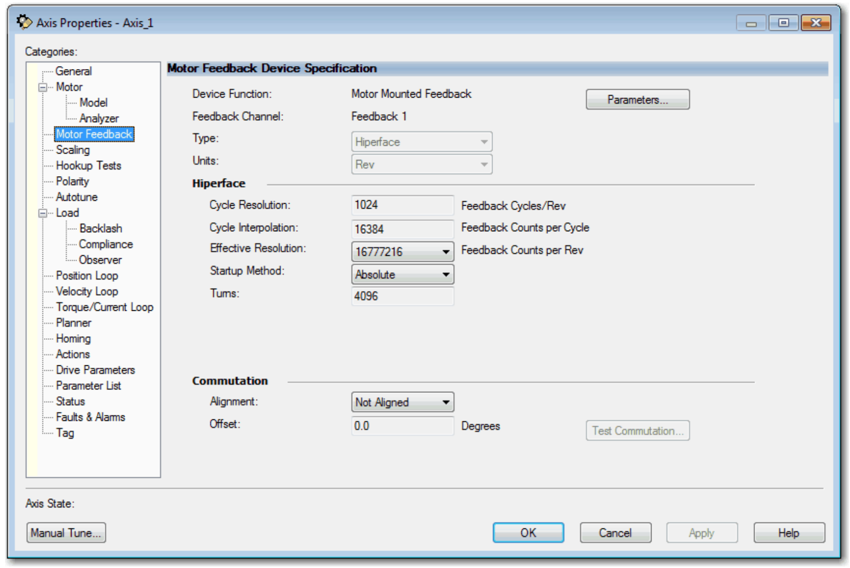
Type	Description
Not Aligned	Not Aligned indicates that the motor is not aligned, and that the Commutation Offset value is not valid. If the Commutation Offset is not valid, the drive cannot use the value to determine the commutation angle. Any attempt to enable the drive with an invalid commutation angle results in a Start Inhibit condition.
Controller Offset	It applies the Commutation Offset value from the controller to determine the electrical angle of the motor.
Motor Offset	The drive derives the commutation that is offset directly from the motor.
Self-Sense	The drive automatically measures the commutation that is offset when it transitions to the Starting state for the first time after a power cycle. This process generally applies to a PM motor equipped with a simple incremental feedback device.

4. Go online with the controller and click Test Commutation.

   When the test is complete, you see the status of the polarity.

The AXIS_CIP_DRIVE axis properties Motor Feedback category recognizes the support of selectable Effective Resolution as defined in the Add-on Profile (AOP) schema for version 28 controller projects. The Motor Feedback category also lets you select between the choices that are presented. Logix Designer application version 28 modifies the feedback types that define support for the 20-bit fixed Effective Resolution in current PowerFlex 755 schemas. The default selection for Nameplate data sheet is 20 bit. Version 28 modifies the feedback type to add the new 24-bit fixed Effective Resolution to the schema. You must select the Effective Resolution field to configure for 24 bit. This modification is in addition to the new SSI Digital support that was added for Major Revision 12 of the PowerFlex 755 drives.

An example of the Motor Feedback category for version 28 with selectable Effective Resolution is shown in the following figure.



See the Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003, for more information on axis attributes.

Notes:

Configure Integrated Motion Using a PowerFlex 527 Drive

This chapter provides procedures on how to configure integrated motion on the EtherNet/IP™ network control by using a PowerFlex® 527 Adjustable Frequency AC drive.

You can include the drive in your Logix Designer application by adding it to a configured EtherNet/IP module or controller and by adding it under the I/O configuration tree. See Create a Controller Project on page 21 for more information.

TIP Before you begin, verify that you know the catalog number for each drive component, the Logix module, or controller that is used in your motion control application.

For more information and examples on PowerFlex 527 axis configuration in Logix Designer application, see Axis Configuration Examples for the PowerFlex 527 Drive on page 209.

For more information on how to configure the recommended out-of-box settings for your PowerFlex 527 drive, see Appendix C on page 339.

For examples of how to test and tune the PowerFlex 527 axes, see the PowerFlex 527 Adjustable Frequency AC Drive User Manual, publication 520-UM002.

Set the Network Configuration

You can set the network configuration by using the LCD display and drive keypad.

1. When the LCD display is showing the Device/Axis state, use the keypad to navigate to SETTINGS -> NETWORK. Then choose either STATIC IP or DHCP.

   The default setting is STATIC IP.

2. If you chose STATIC IP, then you must configure the following settings:
   - IP address
   - Gateway
   - Subnet mask

   If you chose DHCP, the DHCP server automatically configures the three previously listed settings.

Settings are stored in nonvolatile memory. The IP address can also be changed through the Module Configuration dialog box in RSLinx® Classic software. Changes to the IP address take effect after power is cycled or reset. The drive is programmed from the factory to a static IP address of 192.168.1.180.

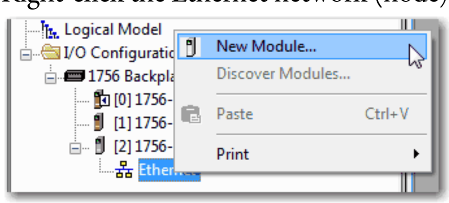
After setting the network configuration, you can view the drive status information in Studio 5000 Logix Designer® or RSLinx Classic and use it in your Logix Designer application.

Add a PowerFlex 527 Drive

IMPORTANT	To configure PowerFlex 527 drives, you must be using the Studio 5000 Logix Designer application, version 24.00 or later.

Follow these instructions to add the PowerFlex 527 drive to your project.

1. Right-click the Ethernet network (node) and choose New Module.

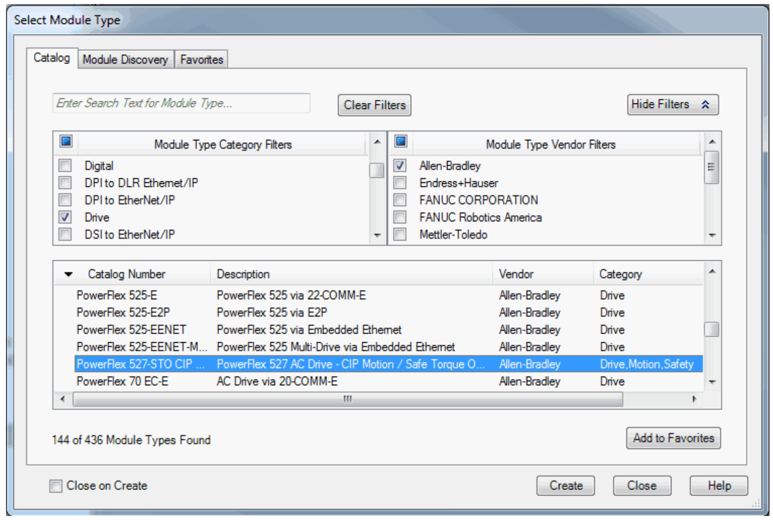


2. Clear the small ‘select all’ checkboxes, Module Type Category, and Vendor Filters.

   Alternatively, you can simply type “527” into the search box and choose the drive.

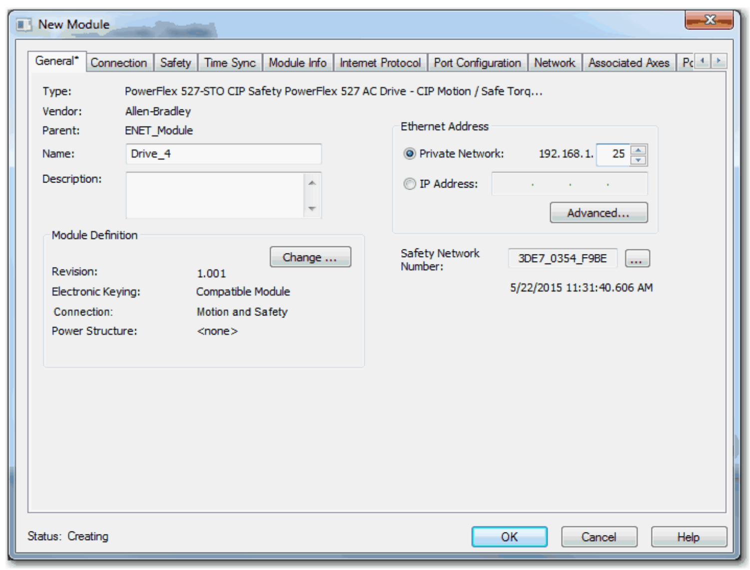
3. In the Module Type Vendor Filters window, check Allen-Bradley.

4. In the Module Type Category Filters window, check Drive.



5. Choose the PowerFlex 527 drive and click create.

   The Module Properties dialog box appears.



6. Configure the new drive.
   a. Type the drive Name.
   b. Type a description, if desired.
   c. Select an EtherNet/IP address option.
      In this example, the Private Network address is selected.
   d. Enter the address of your PowerFlex 527 drive.
      In this example, the last octet of the address is 25.

7. Proceed to Configure the PowerFlex 527 Drive on page 132 to continue configuring your drive.

Configure the PowerFlex 527 Drive

After you have added a PowerFlex 527 drive to your project, you must configure the type of safety connection suitable for your application. See the following sections for instructions on configuration of the drive for the different types of safety connections.

- Configure the Drive with Hard-wired Safety Connections on page 132
- Configure the Drive with Integrated Safety Connections on page 134

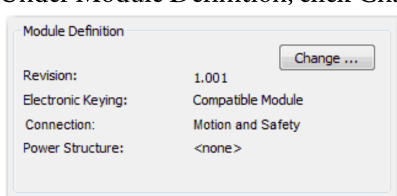
Connection Mode	Controller Needed	Description
Motion only	ControlLogix® 5570, GuardLogix® 5570, CompactLogix™ 5370, ControlLogix 5580, CompactLogix 5380, or Compact GuardLogix 5370(1)	Hard-wired Safe Torque Off (STO) connections are possible. This controller manages Motion. Another controller that has a Safety only connection to the drive manages Safety.
Motion and Safety	GuardLogix 5570, GuardLogix 5580, Compact GuardLogix 5370(1), or Compact GuardLogix 5380	This controller manages Motion and Safety.
Safety only	GuardLogix 5570, GuardLogix 5580, Compact GuardLogix 5370, or Compact GuardLogix 5380	This controller manages Safety. Another controller that has a Motion only connection to the drive manages Motion.

(1) Catalog numbers containing the letter M.

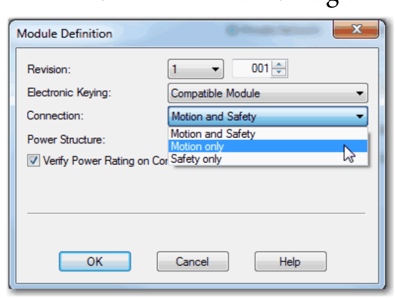
Configure the Drive with Hard-wired Safety Connections

Follow these steps to configure the PowerFlex 527 drives with hard-wired safety.

1. Make sure that you have completed the steps in Add a PowerFlex 527 Drive on page 130 before proceeding.
2. Under Module Definition, click Change.



The Module Definition dialog box appears.



a. From the Electronic Keying pull-down menu, choose an option.

ATTENTION: When using motion modules, the electronic keying must be either `Exact Match‘ or `Compatible Keying‘.

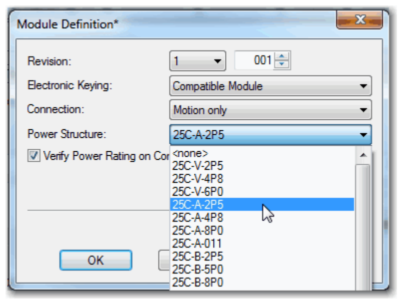
Never use `Disable Keying` with motion modules.

b. From the Connection pull-down menu, choose the Connection mode for your motion application.

In this example, choose Motion only.

TIP When ‘Safety’ appears in the Connection mode, integrated safety is implied.

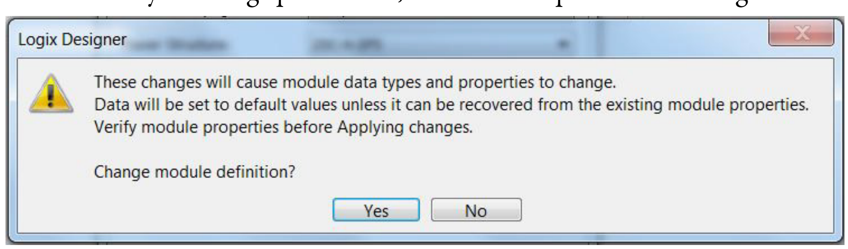
c. From the Power Structure pull-down menu, choose the appropriate power structure.



d. To make sure that the proper power structure that is defined in the profile is the same as the connected drive, check the Verify Power Rating On Connection checkbox. If the two do not match, a connection error occurs, which indicates a power mismatch.

Verify that Power Rating on Connection is checked by default. It is enabled in offline mode.

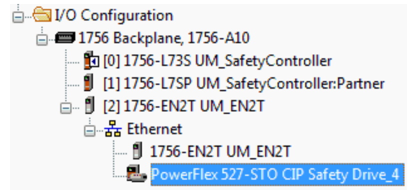
When you change parameters, other related parameters change as well.



This message always appears after you have changed a configuration. This message is a reminder that when you change the power structure the identity of the drive changes. If your drive is associated to an axis and you change the power structure, the axis is disassociated.

3. To close the Logix Designer dialog box, click OK.
4. To close the Module Definition dialog box, click OK.
5. To close the Module Properties dialog box, click OK.

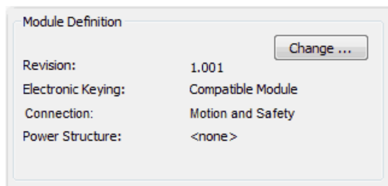
Your PowerFlex 527 drive appears in the Controller Organizer under the Ethernet controller in the I/O configuration folder.



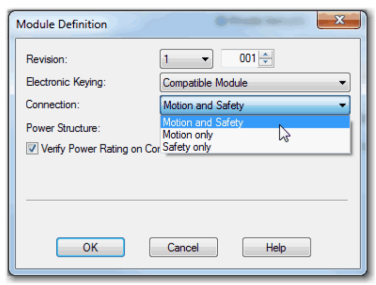
Configure the Drive with Integrated Safety Connections

To configure the PowerFlex 527 drives with integrated safety, follow these steps.

1. Make sure that you have completed the steps in Add a PowerFlex 527 Drive on page 130 before proceeding.
2. Under Module Definition, click Change.



The Module Definition dialog box appears.



a. From the Electronic Keying pull-down menu, choose an option.

ATTENTION: When using motion modules, the electronic keying must be either `Exact Match' or `Compatible Keying'.

Never use `Disable Keying` with motion modules.

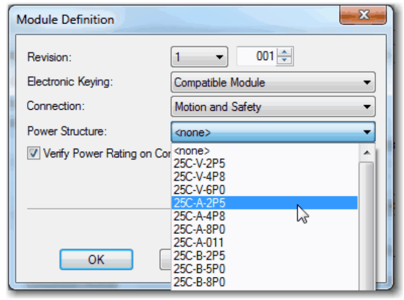
b. From the Connection pull-down menu, choose the Connection mode for your motion application.

In this example, choose Motion and Safety.

TIP When 'Safety' appears in the Connection mode, integrated safety is implied.

The Safety Network Number (SNN) field populates automatically when the Connection mode includes an integrated Motion and Safety or Safety-only connection. For a detailed explanation of the safety network number, see the appropriate GuardLogix and Compact GuardLogix Controller Systems Safety Reference Manual, which is listed in Additional Resources on page 9.

c. From the Power Structure pull-down menu, choose the appropriate power structure.

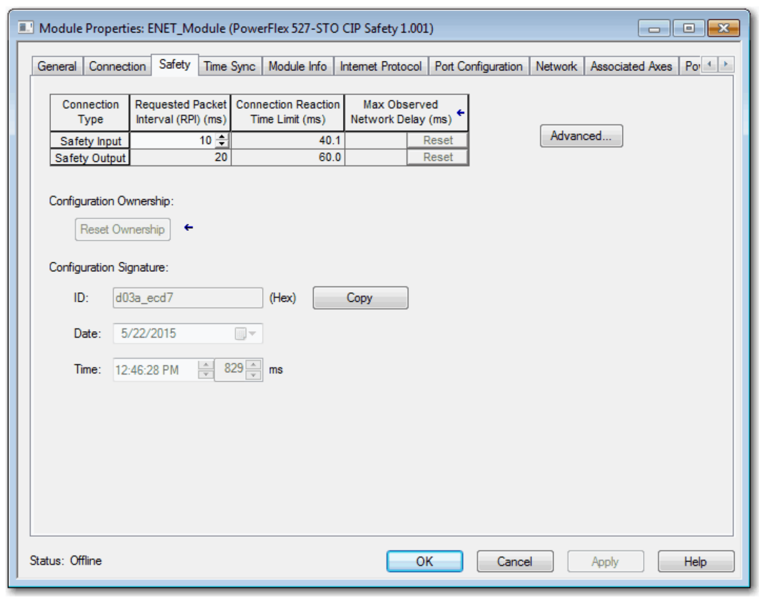


d. To make sure that the proper power structure that is defined in the profile is the same as the connected drive, check the Verify Power Rating On Connection check-box. If the two do not match, a connection error occurs, which indicates a power mismatch.

Verify that Power Rating on Connection is checked by default. It is enabled in offline mode.

3. to close the Module Definition dialog box, click OK.

4. Click the Safety tab.



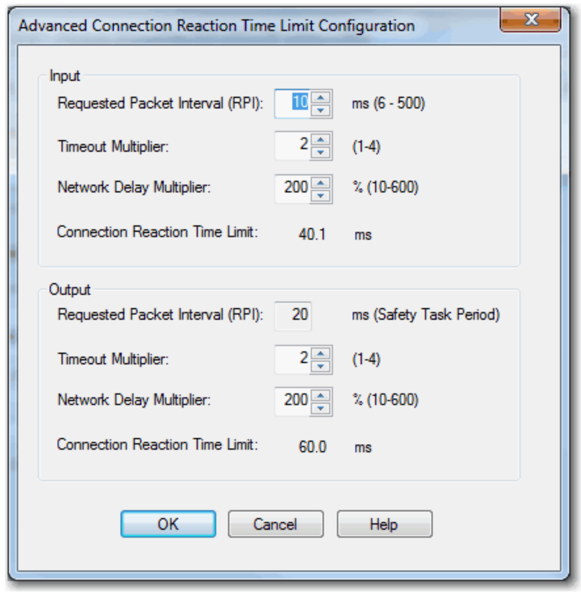
The connection between the controller and the PowerFlex 527 drive is based on the following:

- Drive catalog number must be PowerFlex 527 (integrated)
- Drive Safety Network Number (SNN)
- GuardLogix slot number
- GuardLogix safety network number
- Path from the GuardLogix controller to the PowerFlex 527 drive
- Configuration signature

If any differences are detected, the connection between the GuardLogix controller and the PowerFlex 527 drive is lost. If the connection is lost, the yellow icon appears in the controller organizer after you download the program.

5. Click Advanced.

The Advanced Connection Reaction Time Limit Configuration dialog box appears.



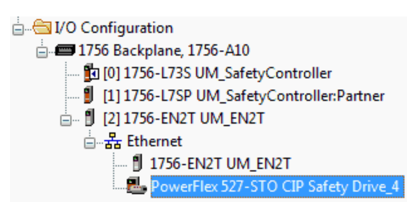
Analyze each safety channel to determine the appropriate settings. The smallest Input RPI allowed is 6 ms. The selection of small RPI values consumes network bandwidth and can cause spurious trips because other devices cannot get access to the network.

For more information about the Advanced Connection Reaction Time Limit Configuration, see the GuardLogix or Compact GuardLogix user manual, which is listed in Additional Resources on page 9.

6. To close the Advanced Connection Reaction Time Limit Configuration dialog box, click OK.

7. To close the Module Properties dialog box, click OK.

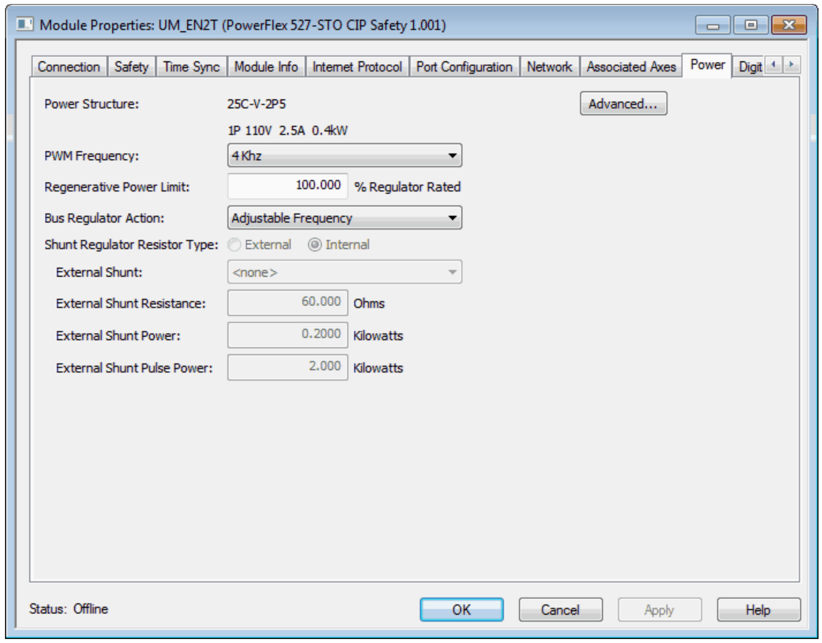
Your PowerFlex 527 drive appears in the Controller Organizer under the Ethernet controller in the I/O Configuration folder.



Configure Power Options

To configure power options, follow these steps.

1. Click the Power tab.



2. From the pull-down menu, choose the power options appropriate for your actual hardware configuration.

Attribute	Menu	Description
PWM Frequency	• 2 kHz • 4 kHz • 8 kHz	The value sets the carrier frequency for the pulse-width modulation (PWM) output to the motor.
Bus Regulator Action	Disabled	This selection disables the internal DC bus voltage regulation feature of the drive. Select this option if there is an external regenerative brake or regenerative line supply that is connected to the drive DC bus.
	Shunt Regulator	This selection is used when either an external shunt resistor is connected to the drive or the internal IGBT is controlling the power dissipation to the resistor.
	Adjustable Frequency (Default)	This selection allows the drive to either change the torque limits or ramp rate of the velocity to control the DC bus voltage. This option is not recommended for positioning applications because it overrides the velocity and the system overshoots or does not stop.
	Shunt then Adjustable Frequency	This selection allows the Shunt resistor to absorb as much energy as it is designed for. The Shunt resistor then transitions to adjustable frequency control if the limit of the resistor has been reached.
	Adjustable Frequency then Shunt	This selection allows for adjustable frequency control of the DC bus. If adjustable frequency control cannot maintain the DC bus within limits, the shunt resistor is activated.
Shunt Regulator Resistor Type	Internal	Not applicable for PowerFlex 527 drives.
	External	Enables the external shunt (internal shunt option is disabled).

3. Click OK.

Configure Digital Inputs

Figure 19 - Digital Inputs Tab for the PowerFlex 527 Drive with Digital I/O Device

Table 40 - PowerFlex 527 Module Properties: Digital Input Tab Descriptions

Parameter	Description
Digital Input 1 Digital Input 2 Digital Input 3 Digital Input 4	Choose one of these values for Digital Input 1, 2, 3, and 4: • Unassigned • Enable • Home[(1)] • Registration 1[(1)] • Registration 2[(1)] • Positive Overtravel • Negative Overtravel

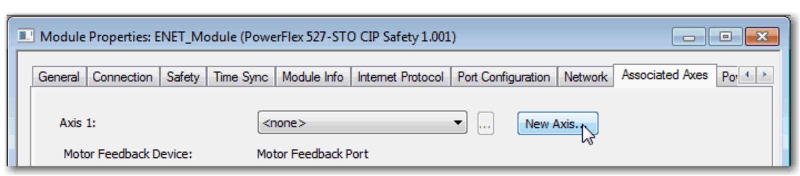
(1) Home, Registration 1, and Registration 2 are only available for Digital Input 1 and Digital Input 2.

Create an Axis for a PowerFlex 527 Drive

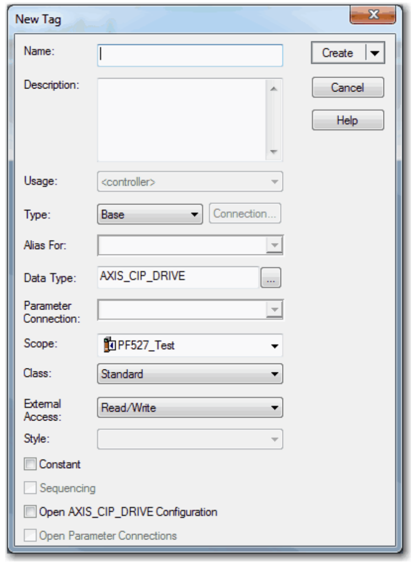
Once you have added a drive, selected the power structure, and assigned a feedback device, you can create and configure an axis. You must apply the changes and exit the Associated Axis dialog box before the option to create an axis becomes available.

There are two approaches that you can take to create and configure an axis. You can create an axis first and then add the axis to your motion group, or you can create your motion group and then add an axis. The procedure that is outlined in this section takes the approach to create your axis first, and then add it to your motion group.

1. Double-click the PowerFlex 527 drive in the controller organizer.
2. Click the Associated Axes tab.
3. Click New Axis.



The New Tag dialog box appears.



4. Type the name.
5. Type a Description, if desired.

   The fields in the next steps are automatically entered for the AXIS_CIP_DRIVE data type.
6. Click OK.

Create the Motion Group

To determine how many axes your controller system supports, see Table 3 on page 12.

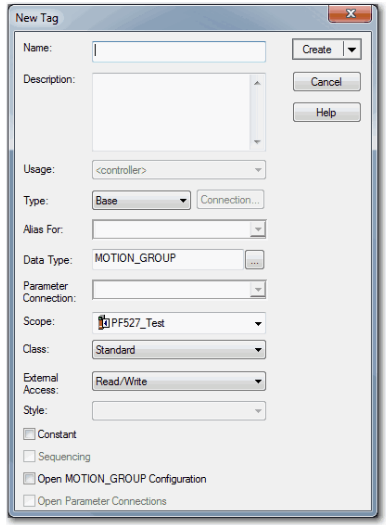
All axes must be added to the Motion Group in your project. If you do not group the axes, they remain ungrouped and unavailable for use.

You must create a Motion Group for an axis to be configured properly.

Follow these steps to configure the motion group.

1. In the Controller Organizer, right-click Motion Groups and choose New Motion Group.

The New Tag dialog box appears.



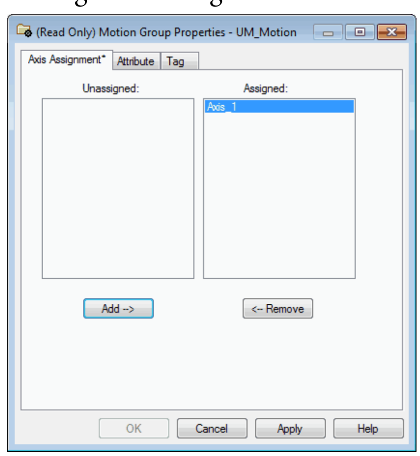
2. Type the new motion group name.
3. Click Create.

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

4. Right-click the new motion group and choose Properties.

   The Motion Group Properties dialog box appears.

5. Click the Axis Assignment tab and move your axes (created earlier) from Unassigned to Assigned.



6. Click the Attributes tab and edit the default values as appropriate for your application.
7. Click OK.

   To get the minimum motion group base-update rate, see Motion Group Base Update Rate on page 342.

Configure the Axis Properties

After you add the drive to your project and create the axes, use the Axis Properties dialog boxes to configure the drive. Notice that the dialog boxes change based on your configuration choices, for example, feedback configuration.

Table 41 lists the basic tasks necessary configure a drive.

Table 41 - Category Dialog Boxes to Configure Drives

Category Dialog Box	Perform These Tasks	Page
General	• Assign the axis configuration. • Choose the feedback configuration. • Choose the application type, if applicable. • Choose the loop response (low, medium, or high), if applicable. • If you have not already done so, you can create and associate an axis to a new Motion Group and associate a drive module to the axis.	142
Motor	• Specify a motor with the Data Source For more information and examples on PowerFlex 527 axis configuration in Logix Designer application, see Axis Configuration Examples for the PowerFlex 527 Drive.	210
Motor Feedback	• Select the Motor Feedback Type. For more information and examples on PowerFlex 527 axis configuration in Logix Designer application, see Axis Configuration Examples for the PowerFlex 527 Drive.	214
Scaling	• Configure feedback by choosing the load type, by entering the scaling units, and by choosing the Travel mode. • Enter the Input Transmission and Actuator ratio, if applicable.	222

The parameters that you configure on the General category dialog box result in the presentation of attributes and parameters that are available for the combination of your selections.

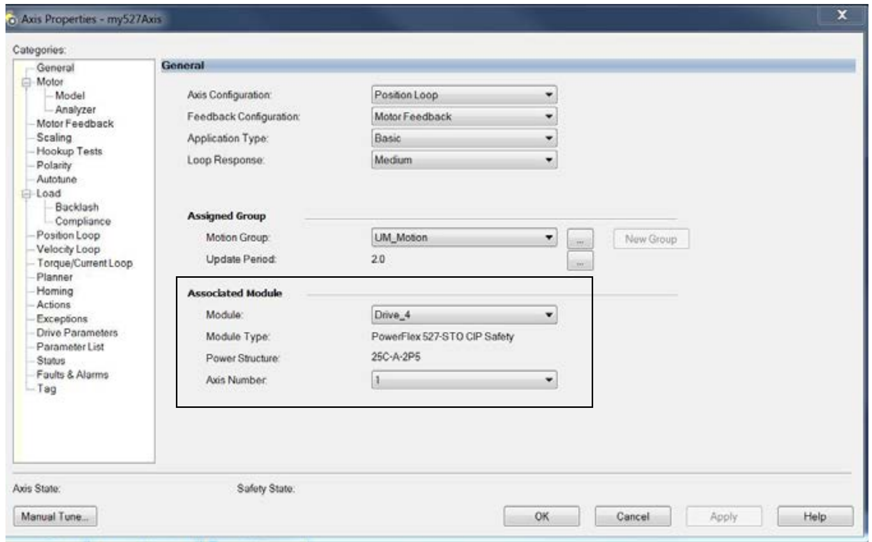
IMPORTANT	All AXIS_CIP_DRIVE Axis Properties dialog boxes are dynamic. Optional attributes and dialog boxes that are related to each integrated motion axis you create come and go based on what combination of axis characteristics you define.

See the Integrated Motion Reference Manual, publication MOTION-RM003, for complete information on Axis Attributes and how to apply Control Modes.

IMPORTANT	Be sure to associate the drive and axis before when configuring the axis because the drive determines what optional attributes are supported for the axis.

If you have already created an axis and associated in with a drive, the Associated Module and Axis are shown on the General category of the Axis Properties dialog box. Otherwise, you can select them in the dialog box that is shown in Figure 20.

Figure 20 - General Category Dialog Box



The Axis Number field corresponds to the axes listed on the Associated Axes tab of the Module Properties dialog box. Any feedback port assignments that you made on the Associated Axes tab are also mapped to the drive when you associate an axis and a drive.

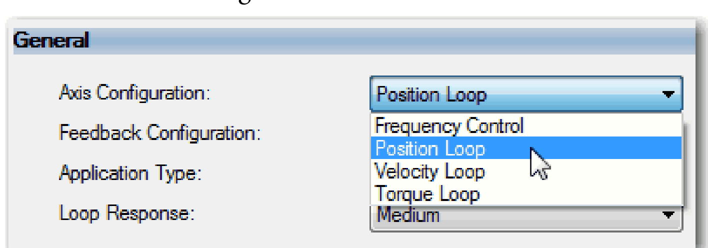
Configure the Associated Axis and Control Mode

Now that the axis is associated to the drive, meaningful values are available for other axis configuration properties. The combination of the attributes that are selected when configuring an axis and feedback determines the control mode.

See the Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003, for complete information on axis attributes and control modes.

Follow these steps to configure an axis.

1. In the Controller Organizer, double-click the axis that you want to configure.
2. Choose an Axis Configuration.



TIP The associated drive determines what axis and feedback configuration choices are presented.

Table 42 - Compare the Axis Configuration Types for the Drives

Axis Type	PowerFlex 527
Position Loop (P)	Yes
Velocity Loop (V)	Yes
Torque Loop (T)	No
Feedback Only (N)	No
Frequency Control (F)	Yes

3. Choose a Feedback Configuration type.

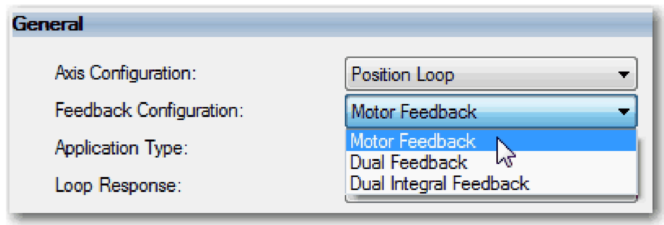
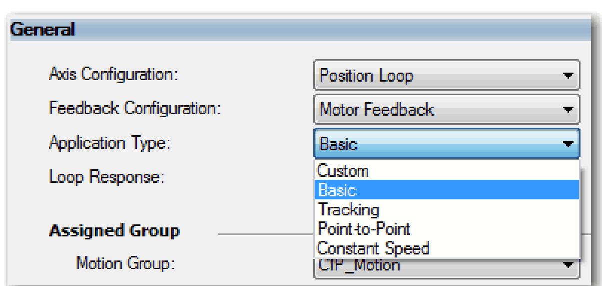


Table 43 compares the feedback type and loop type.

Table 43 - Compare the Feedback Type and Loop Type

Feedback Type	Axis Type	PowerFlex 527
Motor Feedback	Position Loop (P), Velocity Loop (V),Torque Loop (T)	No
Motor Feedback	Position Loop (P), Velocity Loop (V)	Yes
Load Feedback	Position Loop (P), Velocity Loop (V),Torque Loop (T)	No
Dual Feedback	Position Loop (P)	No
Dual Integrator	Position Loop (P)	No
Master Feedback	Feedback Only (N)	No
No Feedback	Frequency Control (F)	Yes
No Feedback	Velocity Loop (V)	No

4. Choose an Application Type, if applicable.



TIP Application Type defines the servo loop configuration automatically. These combinations determine how the calculations are made, which can reduce the need to perform an Autotune or a Manual Tune.

The Application Type determines the type of motion control application. This attribute is used to set the Gain Tuning Configuration Bits.

Table 44 provides the gains established base on the application type.

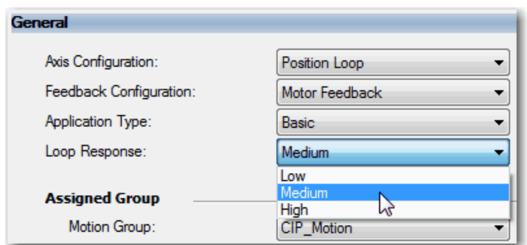
Table 44 - Customize Gains to Tune

Application Type	Kpi	Kvi	ihold	Kvff	Kaff	torqLPF
Custom[1]	-	-	-	-	-	
Basic (V20 and later)	No	No	No	Yes	No	Yes
Basic (V19 and earlier)	No	No	No	No	No	-
Tracking	No	Yes	No	Yes	Yes	Yes
Point-to-Point	Yes	No	Yes	No	No	Yes
Constant Speed	No	Yes	No	Yes	No	Yes

(1) If you set the type to Custom, you can control the individual gain calculations by changing the bit settings in the Gain Tuning Configuration Bits Attribute.

TIP For information about other attribute calculations, see the specific attribute description in the Integrated Motion on the EtherNet/IP Reference Manual, publication MOTION-RM003.

5. Choose a Loop Response, if applicable.



6. Click Apply.

Chapter 7

Axis Scheduling

This chapter describes how to configure the Axis Scheduling feature that is in the Motion Group properties dialog box.

Axis Scheduling provides a way for you to configure drives to run at different update rates. Axis Scheduling can improve the performance of your controllers. You can use Axis Scheduling with integrated motion drives and virtual axes. By using Axis Scheduling, you can optimize your controller, network, and drive performance. For smaller controller applications (CompactLogix™), you can expect to see a significant improvement in system performance.

Many applications have motion drives with different performance requirements. At the simplest level, motion drives can be assigned into a 'fast' and 'slow' update rate groupings.

- The 'fast' group typically includes high-speed coordinated process positioning drives with aggressive PCAM or interpolation profiles and auxiliary functions like registration position/velocity phase correction.
- The 'slow' group typically includes non-coordinated motion drives used for automatic machine reconfiguration, non-coordinated point-to-point motion process drives, or coordinated drives with less aggressive PCAM or gearing functions.

Axis Scheduling is compatible with these products:

- ControlLogix® 5580 controllers
- GuardLogix® 5580 controllers
- CompactLogix™ 5380 controllers
- Compact GuardLogix 5380 controllers
- ControlLogix 5570 controllers
- GuardLogix 5570 controllers
- CompactLogix 5370 controllers
- Compact GuardLogix 5370 controllers
- All Integrated Motion EtherNet/IP™ drives, for example, Kinetix®, PowerFlex®, and other third-party drives

About Axis Scheduling

Axis Scheduling can improve ControlLogix and CompactLogix EtherNet/IP Integrated Architecture® Motion system performance by reducing average Logix controller and EtherNet/IP network utilization. Axis Scheduling supports three separate controller/network motion drive update rates per controller, one rate for high-performance drives, and two additional rates for lower performance drives.

For example, suppose that you have a robot that removes product from a conveyor belt. There are three precision axes on the robot and four general-purpose axes on the conveyor belt. If you configure the controller to run all seven axes at 2 ms to control the precision axes, this setting takes the network utilization of your controller too high. In the past, one option would have been to run all seven axes at 8 ms, but this setting is not fast or precise enough for the robot axes. So you have had to add a second controller and Ethernet module to get the performance you needed. Axis Scheduling lets you configure the axes at different rates that are based on the needs of the application, which balances the motion performance and network utilization of your controller.

With Axis Scheduling, you can configure the axes on the robot to run at a faster base-update rate (2 ms) than the rate of the conveyor (8 ms).

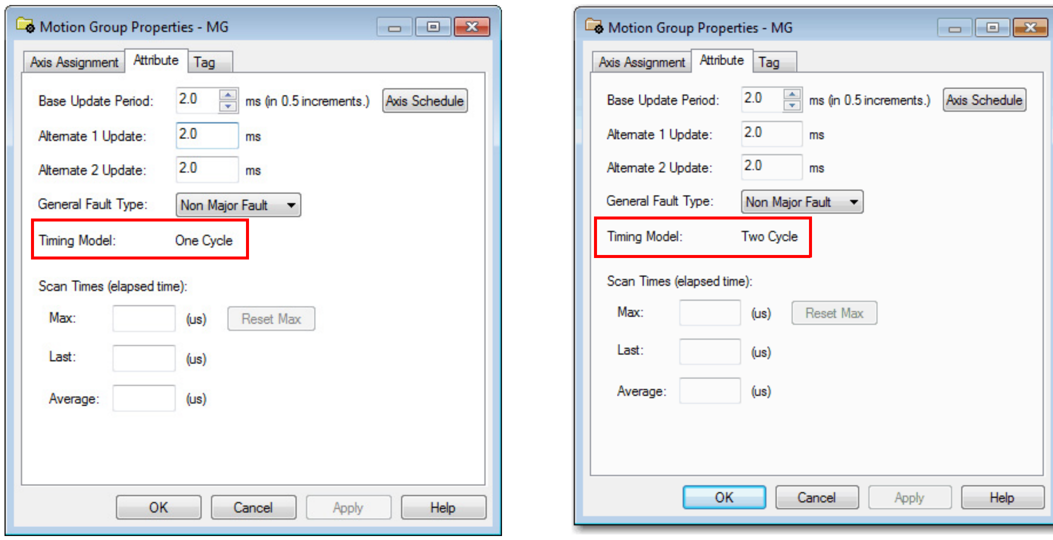
With the ability to configure three update periods, the four conveyor axes can run as one channel, which appears to the controller as one drive. The axes are updated round-robin style; every 2 ms, three of the robot axes and one of the conveyor axes are updated.

During the next update, three robot axes are updated and then the next conveyor axis is updated; eventually all conveyor axes are updated and the process starts again. The controller updates four axes every update period. The controller can handle the load of four axes easier than a load of seven axes. This capability improves the performance of the controller.

Timing Model

The general timing model for the integrated motion on the EtherNet/IP network I/O connection data exchange is described in this section. The Timing Model field on the Attribute tab of the Motion Group Properties dialog box is shown as One Cycle or Two Cycle. See Figure 21 for an example.

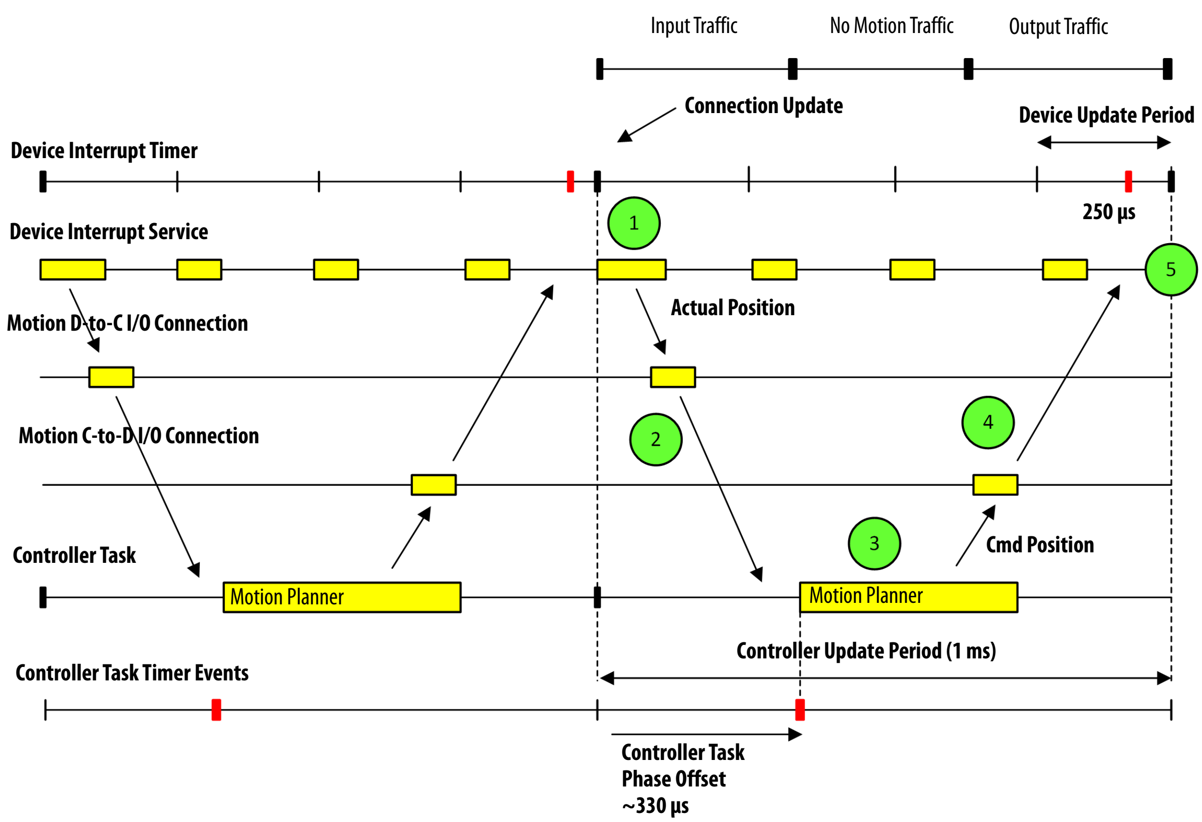
Figure 21 - Timing Model Attribute Examples



One Cycle Timing

The Controller Update Period paces data exchange between the device and the controller with one Device-to-Controller data packet that is sent for every Controller-to-Device data packet received. The Controller-to-Device Connection packets are sent periodically according to the configured Controller Update Period. The Device Update Period, which is the update period at which the device performs its control calculations, is typically much faster than the Controller Update Period. The basic integrated motion on the EtherNet/IP network 1-cycle timing model is shown in Figure 22.

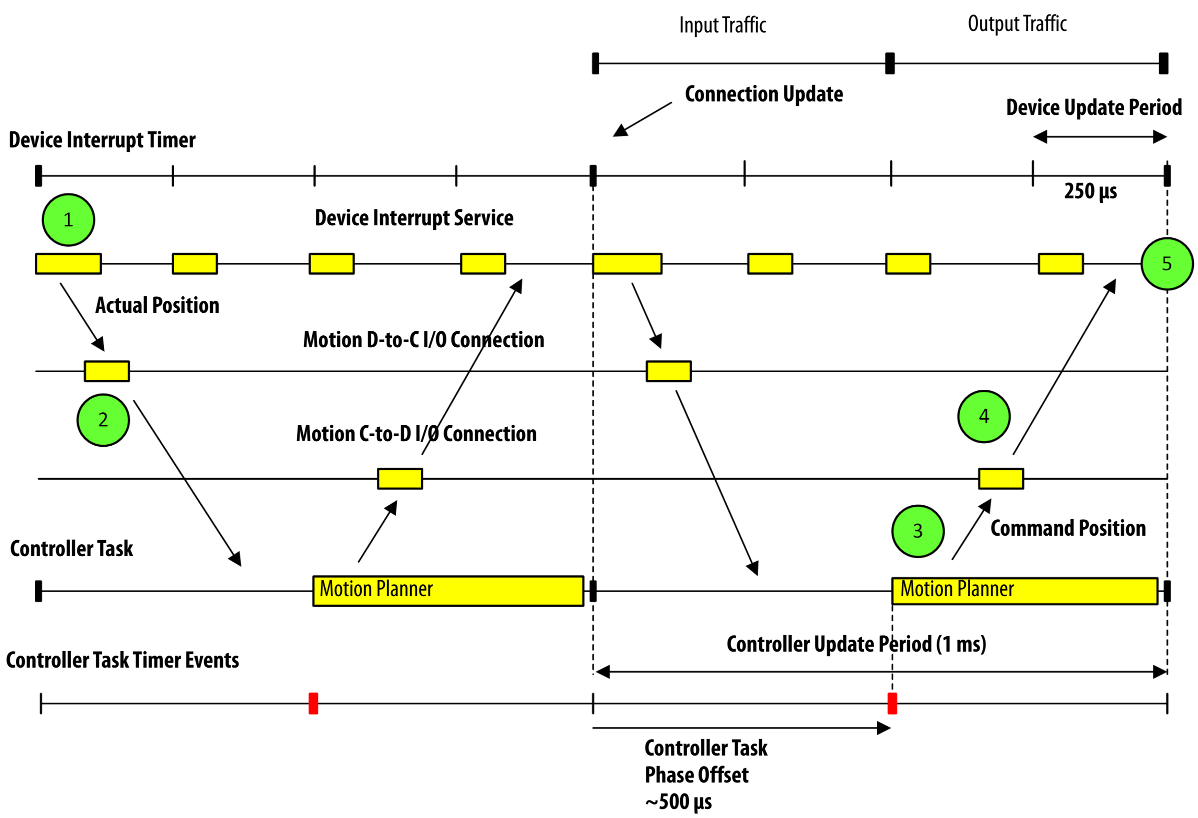
Figure 22 - Integrated Motion on the EtherNet/IP Network One Cycle Timing Model



Two Cycle Timing

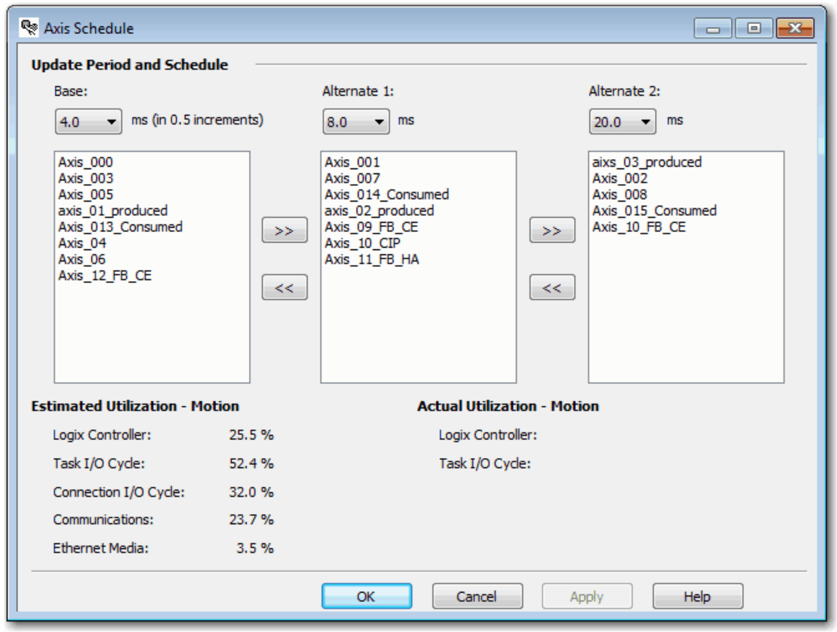
The Two Cycle Timing Model that is shown in Figure 23 begins with the device transmitting the D-to-C connection packet to the controller at the beginning of the update cycle. In this case, the Controller Task does not start until half way through the update cycle. This start point allows more time for the D-to-C connection packet to reach the controller before the Motion Planner task runs. Unlike the One Cycle Timing Model, the C-to-D connection packet is not transmitted back to the device until the next time the Motion Planner task runs. This delay again allows more time for the C-to-D connection packet to reach the device. It takes two connection cycles to complete the I/O data transaction with the device.

Figure 23 - Integrated Motion on the EtherNet/IP Network Two Cycle Timing Model



Axis Scheduling Configuration

In the Studio 5000 Logix Designer application, you use the Axis Schedule Panel, accessible from the Attribute tab of the Motion Group Properties dialog box, to configure the update periods. The Axis Schedule Panel provides a Base Update Period and two alternatives. Information such as Estimated Utilization and Actual Utilization appear on this panel.



The alternative rates for lower performance drives provide a way for multiple drives to be 'multiplexed' through one drive update channel. Axis Scheduling allows multiple drives to be updated by using the same amount of controller and network capacity as used in updating one non-multiplexed drive.

For more information on how to configure a motion group for Kinetix drives, see Create a Motion Group on page 42. For more information on how to configure a motion group for PowerFlex drives, see Create a Motion Group on page 111.

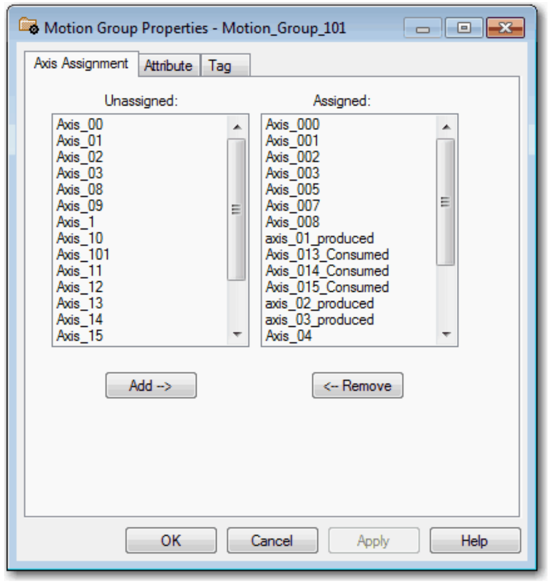
Configure the Update Periods

Follow these steps to configure the update periods:

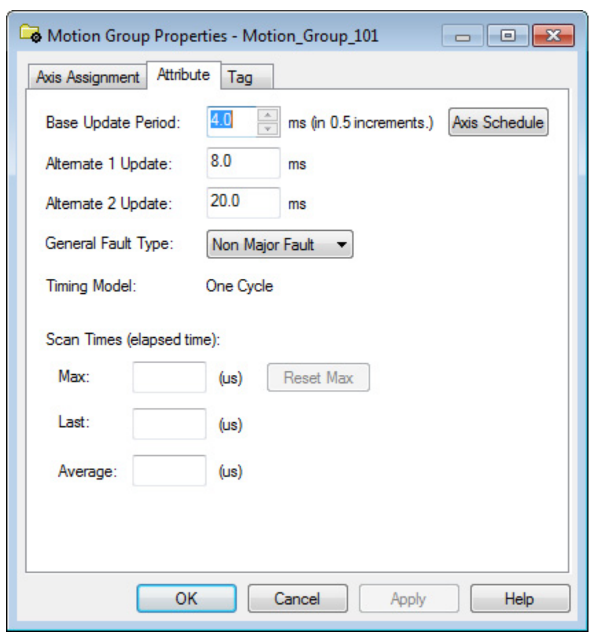
TIP To change all update rates to the same value, refer to the example on page 155.

1. Double-click the Motion Group.

   The Motion Group Properties dialog box appears.



2. Assign axes to the group if necessary.
3. Click Apply.
4. Go to the Attribute tab.

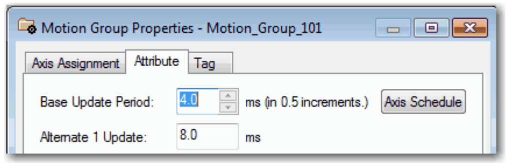


5. Choose a Base Update Period.

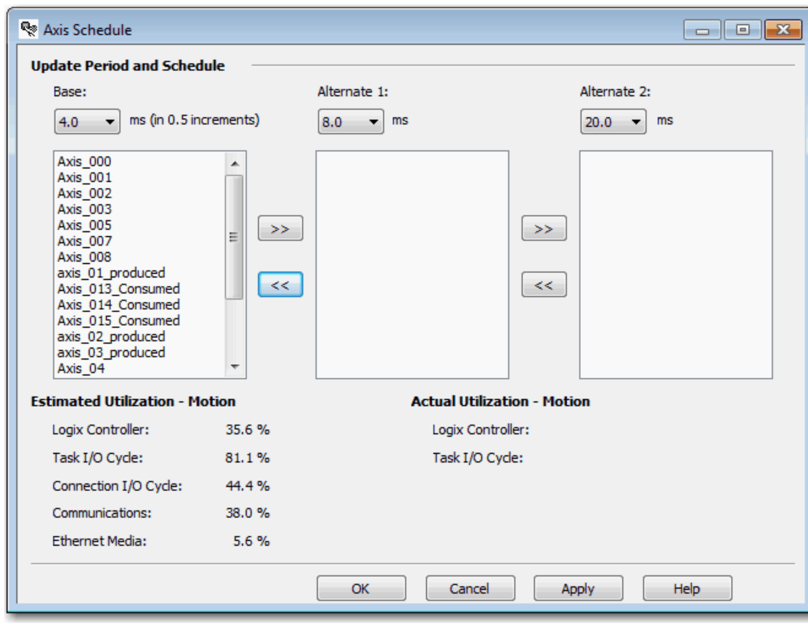
   In this example, the Base Update Period is 4.0 ms and the Alternate 1 and 2 Update Periods are 8 ms and 20 ms. The base period acts as the anchor value for the axis scheduling feature.

   The Alternate Update Periods are multiples of the base. You can edit the Base Update Period when the controller is offline and is read-only when the controller is online. The alternate rates on the Attribute tab are read-only.

6. To go to the Axis Schedule Panel, click the Axis Schedule.



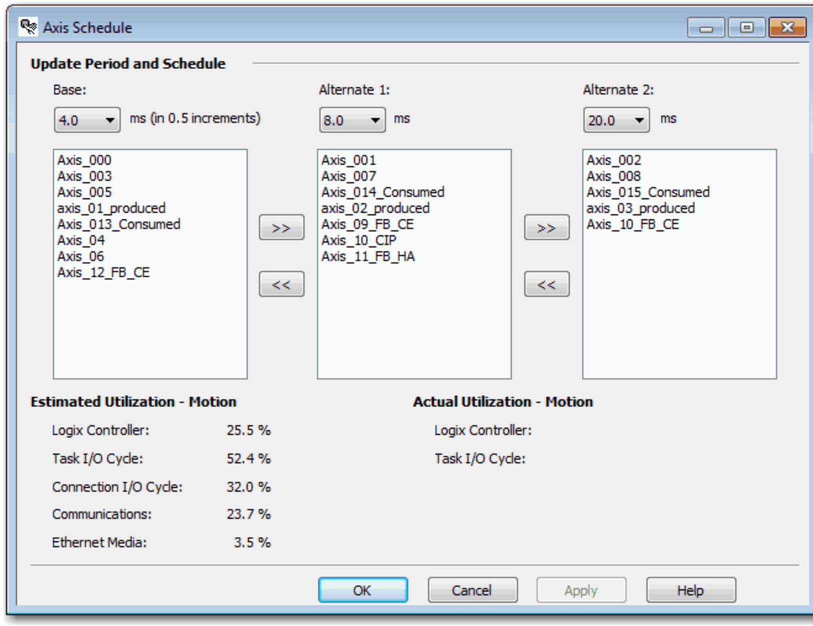
   The Axis Schedule Panel appears.



   The axes that you assigned in the Axis Assignment tab appear in the Base column.

7. To assign the axes to the Alternate Update Periods, use the positioning arrows.

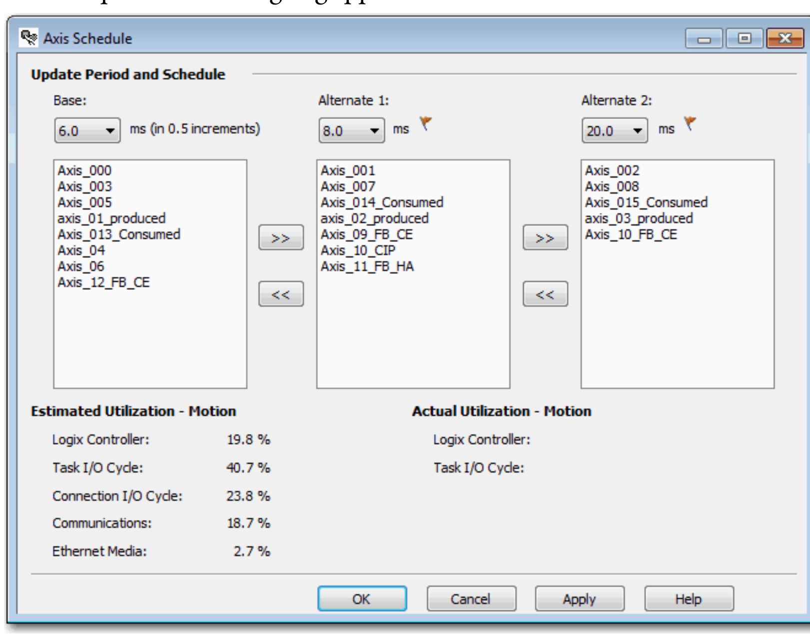
   The axes appear in the Alternate columns.



8. Choose the Alternate 1 Update Period.

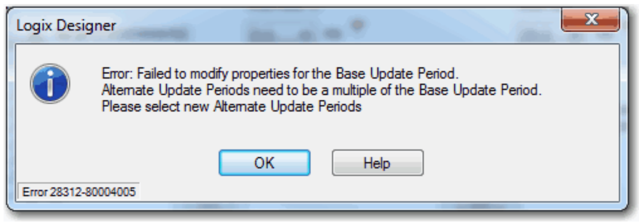
   The multipliers range from 2…32, so if the base update rate is 2.0, the values in the alternate rates are 4, 6, 8, 10, 12…32. If the base update rate is 3.0, the values are 6, 9, 12, 15, and so on.

   If you change the Base rate to a value that the Alternate rate value is not a multiple of, a warning flag appears next to the Alternate rate.



Once an alternate rate is set on the Axis Schedule Panel, the Base Update Period for the group on the Attribute tab becomes disabled. You can still set the base update rate on the Axis Schedule Panel.

A warning appears and the value is set to either 0.5 or 32 if you enter a value outside of the acceptable range.



TIP If the Base Update Period is too small, the controller does not have time to execute non-motion related Ladder Logic.

As a result, the configuration sets the lower limit on the Base Update Period that is based on the number of axes in the group.

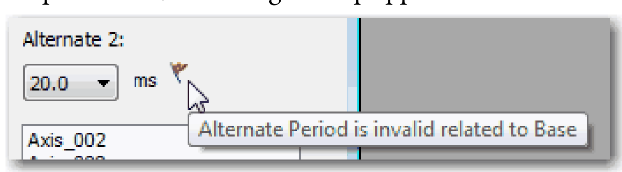
You can use Integrated Architecture Builder (IAB) to determine the performance information that is based on your system configuration.

Too many axes per base rate can indicate one of the following:

- There is not enough time for the motion task to execute, which results in a motion task overlap error.
- There are high-application program scan times, which affect all logic: program logic that supports motion applications and general program logic.

9. Choose the Alternate 2 update period.

   If the base update rate is changed to a value that invalidates the alternate update rates, a warning tool tip appears.

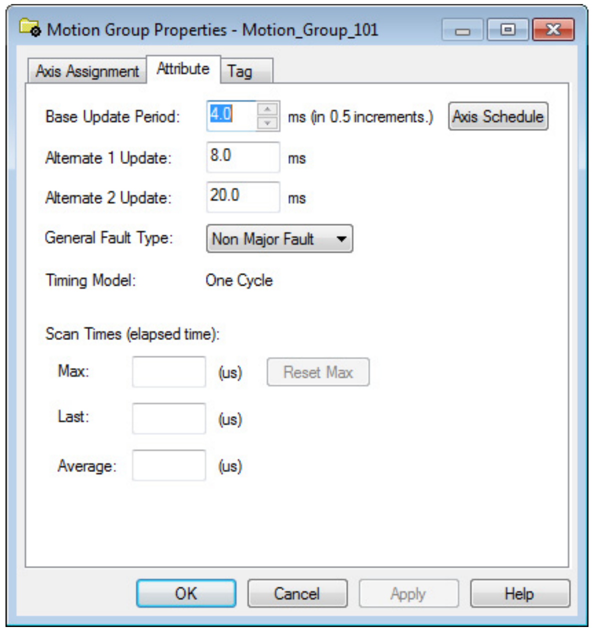


   If you click OK or Apply, a warning box appears that tells you that you must select valid alternate update rates before you apply any changes.

10. Update the periods as required.

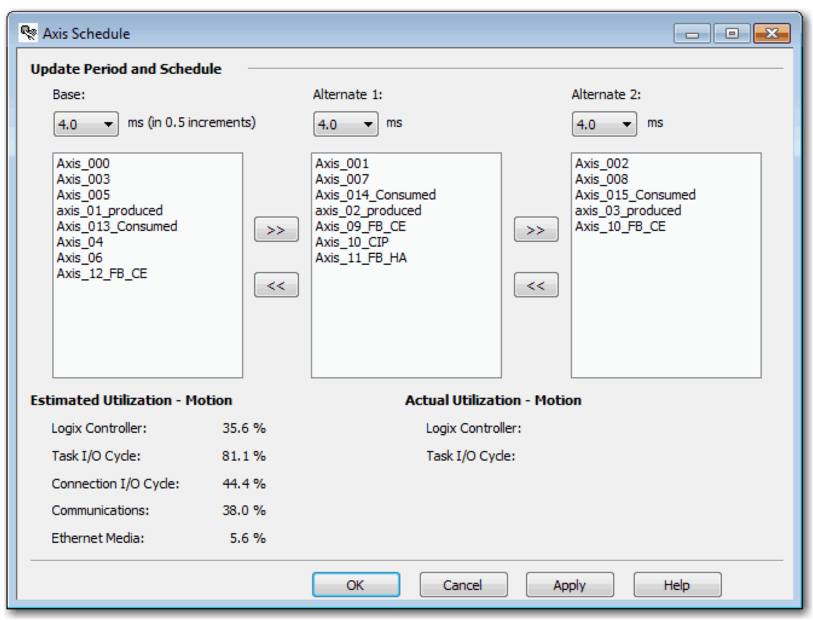
11. Click Apply.

    The Alternate update rates appear on the Attribute tab.

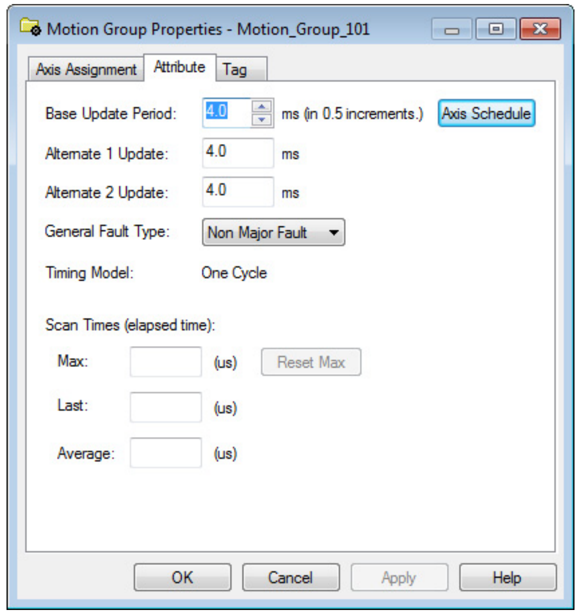


The following example shows what happens on the various dialog boxes when all update rates are changed to the same value.

1. To change all rates to the same value, for example 4 ms, go to the Axis Schedule Panel.

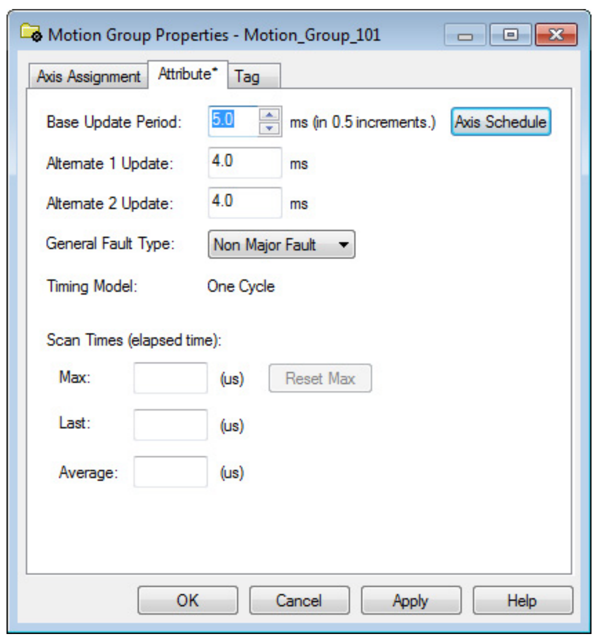


The Base Update Period on the Attribute tab becomes active.

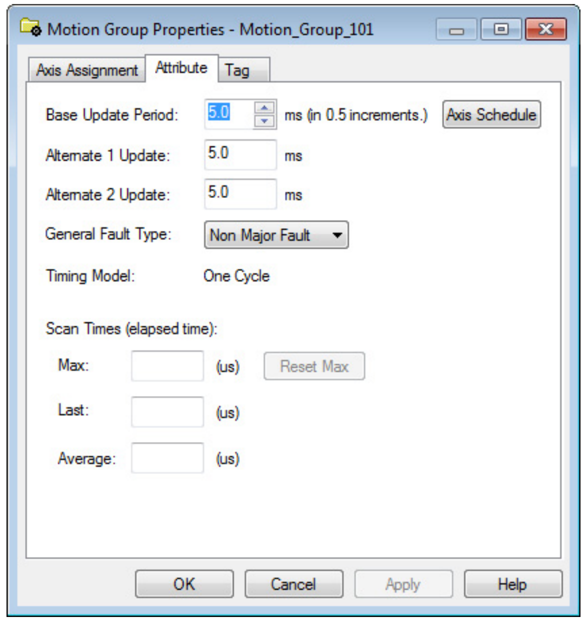


After you have made all update periods in the Axis Schedule Panel, the update period values are the same and the Base Update Period is now active. The Alternate Update Periods are always read-only.

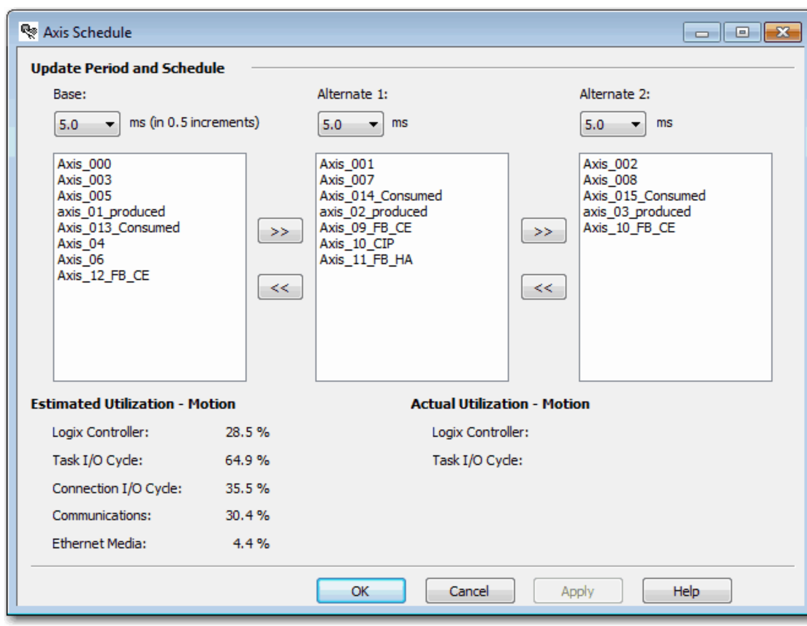
2. Change the Base Update Period.



After you click Apply (or OK), the values in the alternate fields change to match the base.

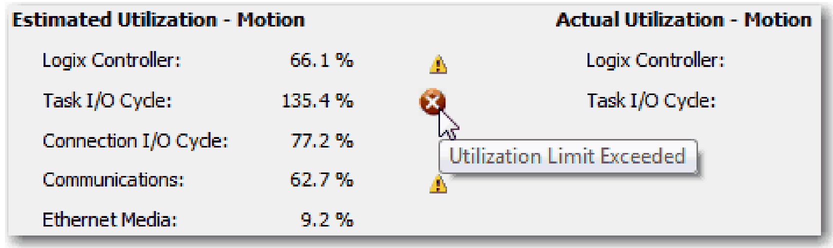


The values are also changed in the Axis Schedule Panel.



Motion Utilization

The following values are updated in real time as you change your configuration. You can see how the utilization metrics are responding to your configuration changes and you can modify your configuration.



- The yellow warning icons indicate that the value is at the borderline of the controller capabilities.
- The red X next to the Task I/O Cycle and Connection I/O Cycle warnings indicates that the value has reached beyond what the motion task cycle can handle.

If you are reaching utilization limits and you only have the Base Update Period that is assigned to axes, start to assign axes to the Alternate Update Periods.

Table 45 - Utilization Parameter Descriptions

Parameter	Description
Estimated Utilization - Motion	Estimated utilization assumes basic default configuration with no active motion planner activity, no transmission statistics, and no cyclic read or write. The estimated percent of time the controller spends on motion while online.
Logix Controller	The estimated percentage of time of the Logix controller that a motion task consumes. If this value exceeds 50%, a warning icon appears. If this value exceeds 80%, an error icon appears.
Task I/O Cycle	The estimated percentage of time available in the update cycle Motion Task to process input, run motion planner, and send output to motion devices. If this value exceeds 100%, a warning icon appears. If this value exceeds (200 connection I/O cycle Cycle)%, an error icon appears.
Connection I/O Cycle	The estimated percentage of time available in the update cycle for input and output data transmission over the motion connection. If this value exceeds 80%, a warning icon appears. If the value exceeds 100%, an error icon appears.
Communications	Shows the estimated percentage of time of the communications controller that the motion connection packets consume. If this value exceeds 50%, a warning icon appears. If this value exceeds 100%, an error icon appears.
Ethernet Media	Shows the estimated percentage of Ethernet media bandwidth that motion-connection packet traffic uses. If the value exceeds 50%, a warning icon appears. If the values exceed 100%, an error icon appears.
Actual Utilization - Motion	Actual utilization is based on measurements that are made by the Logix controller. Actual utilization values can be substantially higher than estimated utilization values depending on factors such as active motion planner activity, transmission statistics, and cyclic read or write data.
Logix Controller	Shows the actual percentage of time of the Logix controller that the motion task consumes.
Task I/O Cycle	Shows the actual percentage of time available in the update cycle for motion task to process input, run motion planner, and send output to motion devices.

Configuration Examples for a Kinetix Drive

This chapter provides typical axis-configuration examples when using Kinetix® 350, Kinetix 5500, Kinetix 6500, and Kinetix 5700 drives. The differences between the Kinetix drives are noted where applicable.

Kinetix 5700 drive configurations are similar to the examples in this chapter. For more examples of how to configure the Kinetix 5700 drive, see the Kinetix 5700 Servo Drives User Manual, publication 2198-UM002.

Example 1: Position Loop with Motor Feedback Only

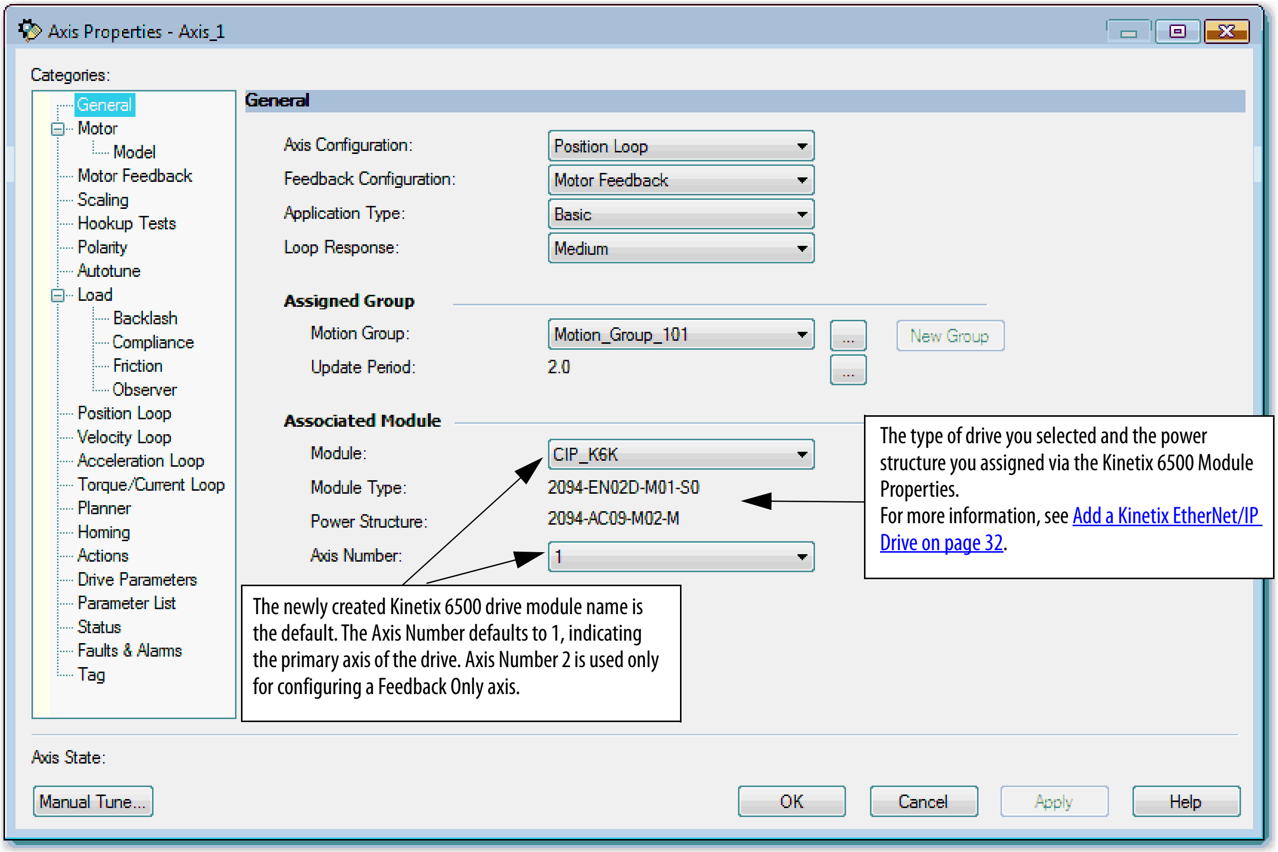
In this example, you create an AXIS_CIP_DRIVE and a Kinetix 6500 drive, which includes the control module and a power structure. You then connect the motor feedback cable to the Motor Feedback port of the Kinetix 6500 drive.

1. Once you have created an AXIS_CIP_DRIVE, open the Axis Properties.
2. From the Axis Configuration pull-down menu, choose Position Loop.
3. From the Feedback Configuration pull-down menu, choose Motor Feedback.

   The axis and feedback configurations determine the control mode.

For more information on the control modes, see the Integrated Motion on the EtherNet/IP network Reference Manual, publication MOTION-RM003.

Figure 24 - Example 1: General Dialog Box, Position Loop with Motor Feedback Only



TIP After you have configured the axis and you change the Axis Configuration type or the Axis Number, some of the configuration information is set to default values. This change can cause some previously entered data to be reset back to its default setting.

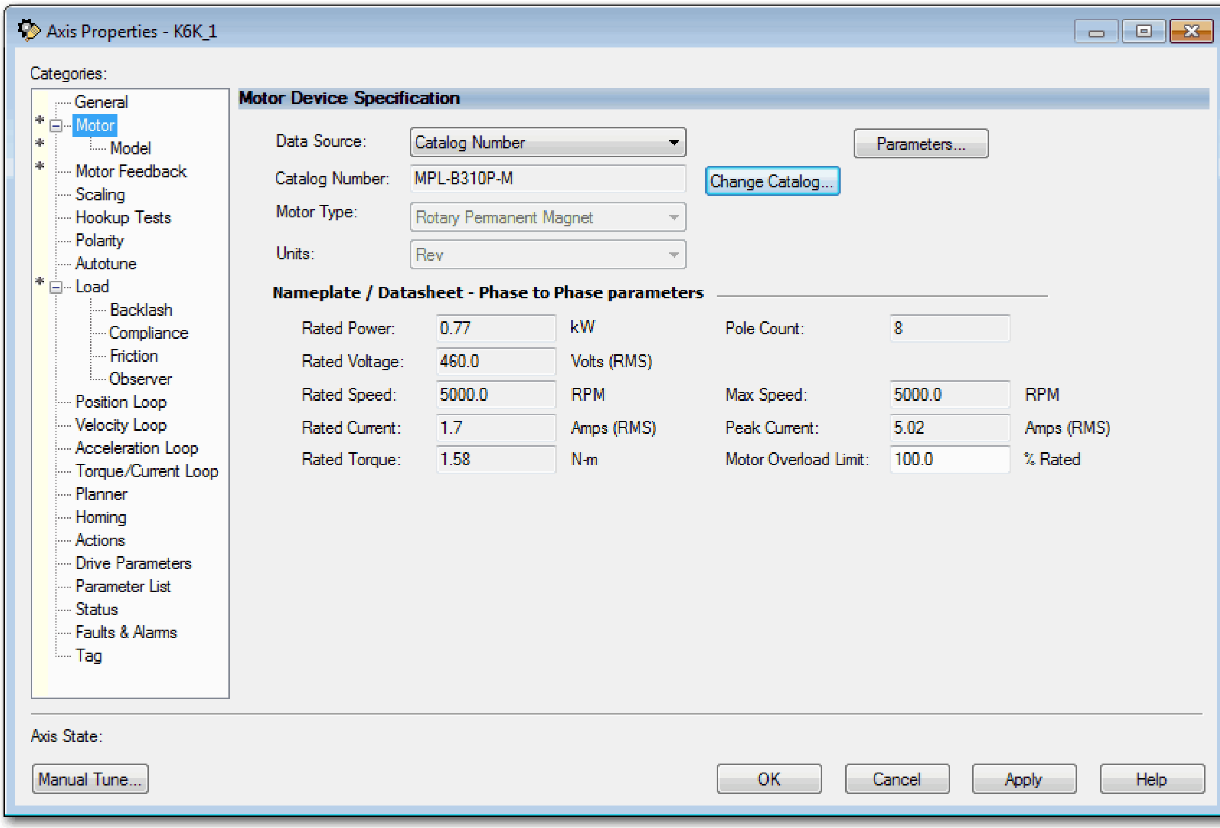
When you select the Position Loop with Motor Feedback, the Motor and Motor Feedback dialog boxes become available.

4. Choose Catalog Number as the Motor Data Source.

5. Click Change Catalog and choose your motor.

   In this case, a MPL-B310P-M motor was chosen.

Figure 25 - Example 1: Position Loop with Motor Feedback Only, Motor Dialog Box

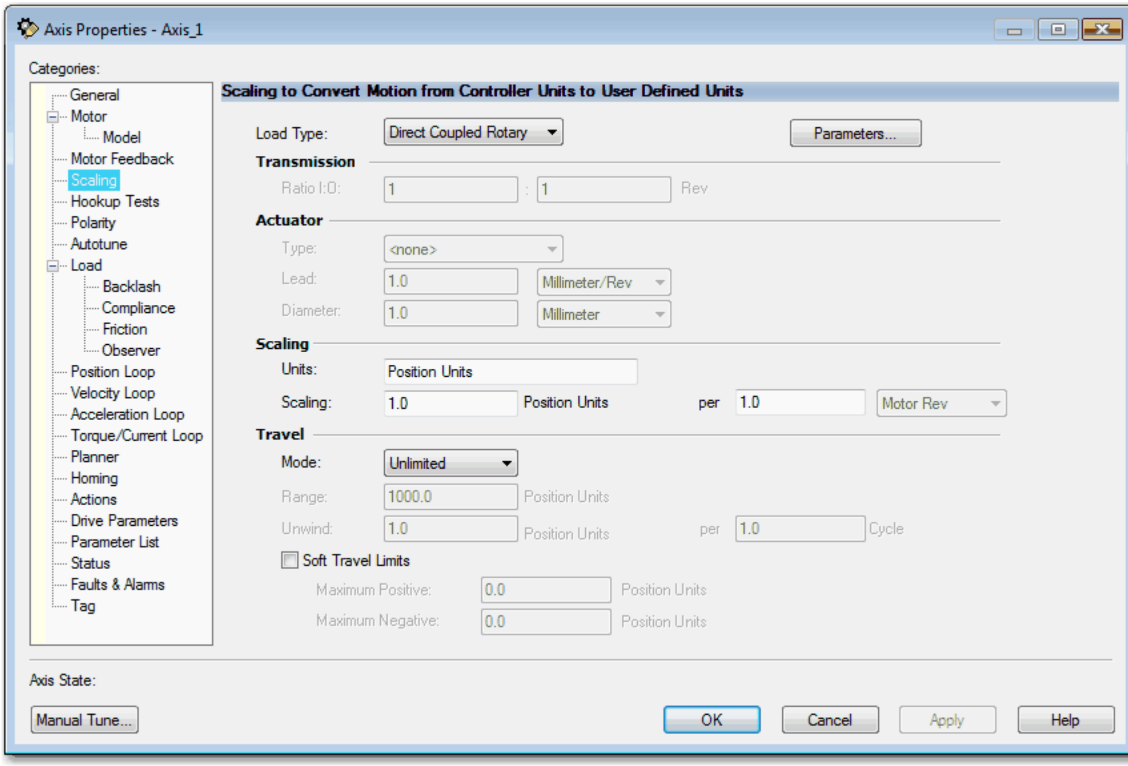


Click Change Catalog to choose motors from the motion database. When you specify your motor this way, the motor specification data is automatically entered for you.

If the motor you are using is not in the Change Catalog list, then it is not in the Motion Database. You have to input the specification data or add a custom motor to the Motion Database that can be selected.

For more information, see Choose Nameplate as the Motor Data Source on page 52.

Figure 26 - Example 1: Position Loop with Motor Feedback Only, Scaling Dialog Box



6. Choose the Load Type.
7. Enter the Scaling Units.
8. Choose the Travel Mode.

   For more information about Scaling, see Scaling on page 222.
9. Click Apply.

   You are now finished configuring the axis for Position Loop with Motor Feedback.

Example 2: Position Loop with Dual Feedback

In this example, you create an AXIS_CIP_DRIVE and a Kinetix 6500 drive, which includes the control module and a power structure. You must configure both feedback ports. You must have two feedback cables that are connected to the Kinetix 6500 drive for one axis.

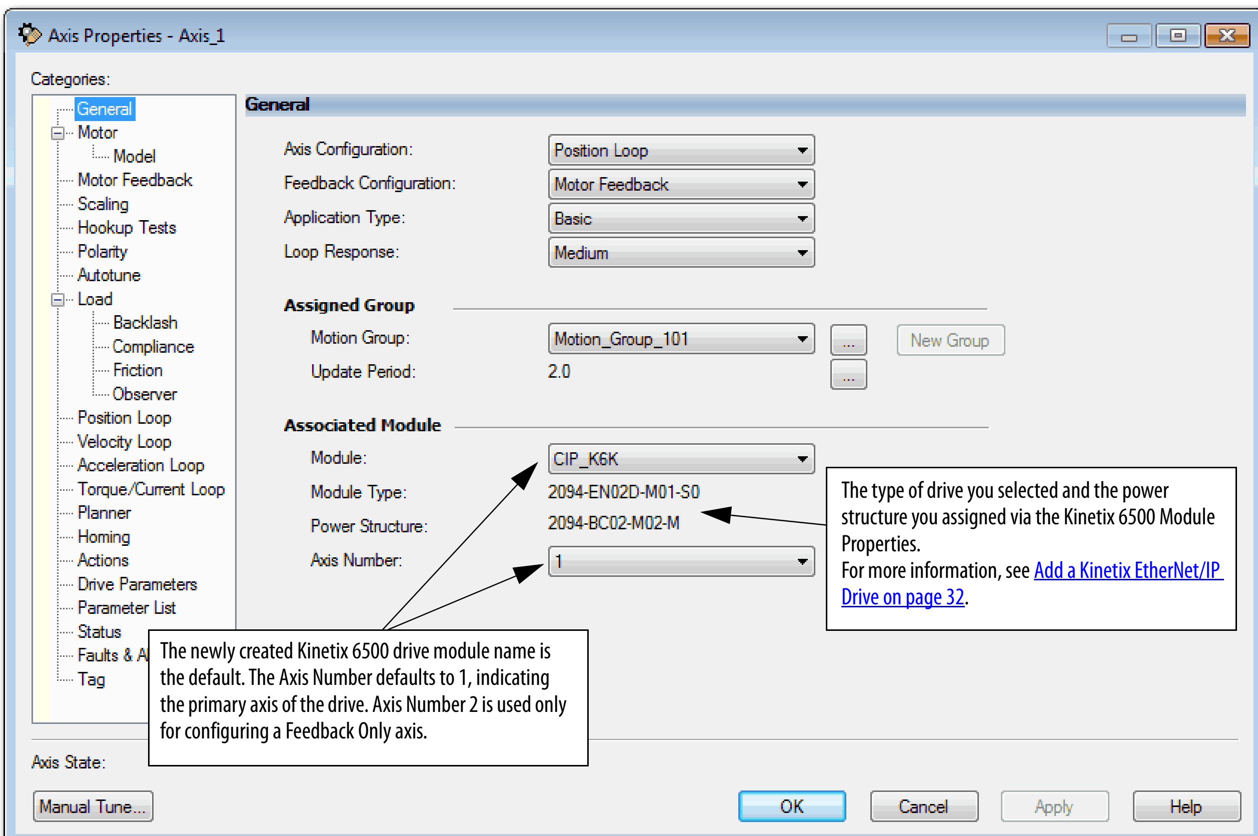
You connect the Motor Feedback cable to the Motor Feedback port, and the Load Feedback cable to the Aux Feedback port of the Kinetix 6500 drive.

1. Once you have created an AXIS_CIP_DRIVE, open the Axis Properties.
2. From the Axis Configuration pull-down menu, choose Position Loop.
3. From the Feedback Configuration pull-down menu, choose Dual Feedback.

   The axis and feedback configurations determine the control mode.

   For more information on the control modes, see the Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003.

Figure 27 - Example 2: Position Loop with Dual Feedback, General Dialog Box



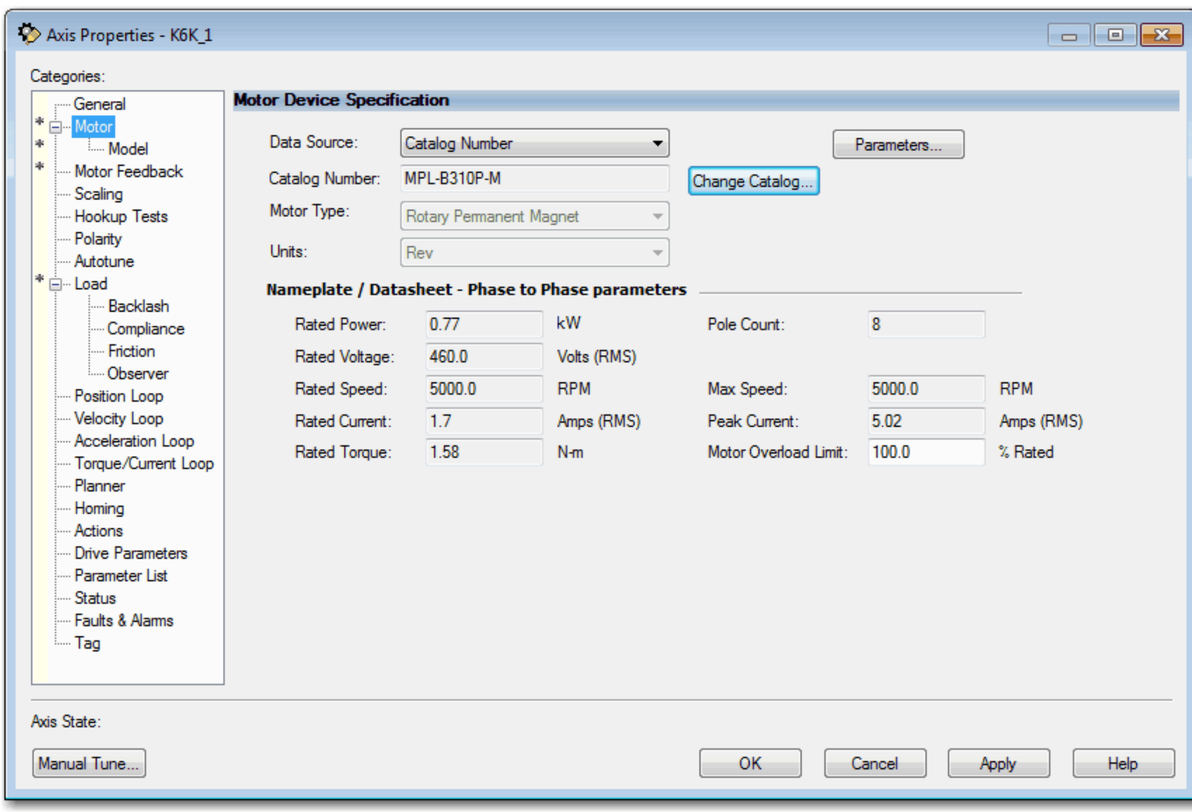
IMPORTANT	After you have configured the axis and you change the Axis Configuration type or the Axis Number, some of the configuration information is set to default values. This change can cause some previously entered data to be reset back to its default setting.

Now that you defined the axis as being a Position Loop with Dual Feedback axis, the Motor, Motor Feedback, and Load dialog boxes become available.

4. From the Data Source pull-down menu, choose Catalog Number.
5. Click Change Catalog and choose your motor.

   In this case, a MPL-B310P-M motor was chosen.

Figure 28 - Example 2: Position Loop with Dual Feedback, Motor Dialog Box



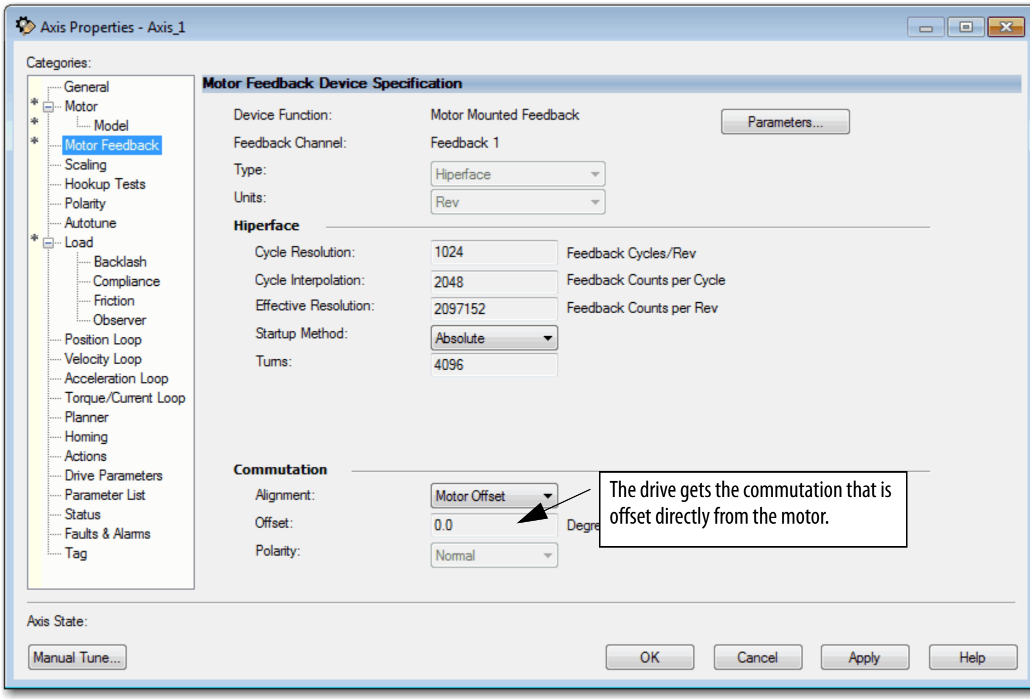
When you select the Data Source for the motor specification, the MPL-B310P-M motor is in the Motion Database, so you can select it by Catalog Number. Notice that the specification data for this motor is automatically entered for you.

If the motor you are using is not in the Change Catalog list, then it is not in the Motion Database. You must input the specification data.

For more information, see Choose Nameplate as the Motor Data Source on page 52.

On the Motor Feedback dialog box, the information is automatically filed in based on your selections on the Motor dialog box.

Figure 29 - Example 2: Position Loop with Dual Feedback, Motor Feedback Dialog Box

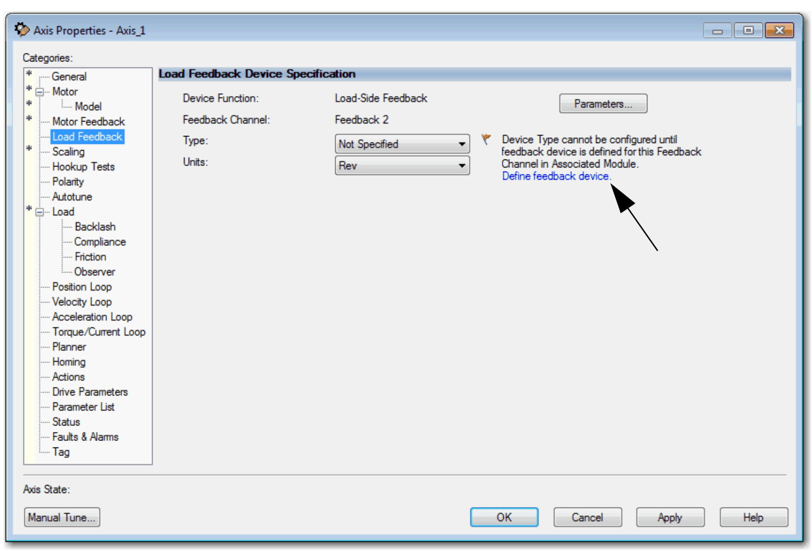


For information about Commutation, see Assign Motor Feedback on page 54 and Applying the Commutation Hookup Test on page 232.

The axis is now configured as the primary feedback. The next task is to configure Feedback 2 on the Load Feedback dialog box.

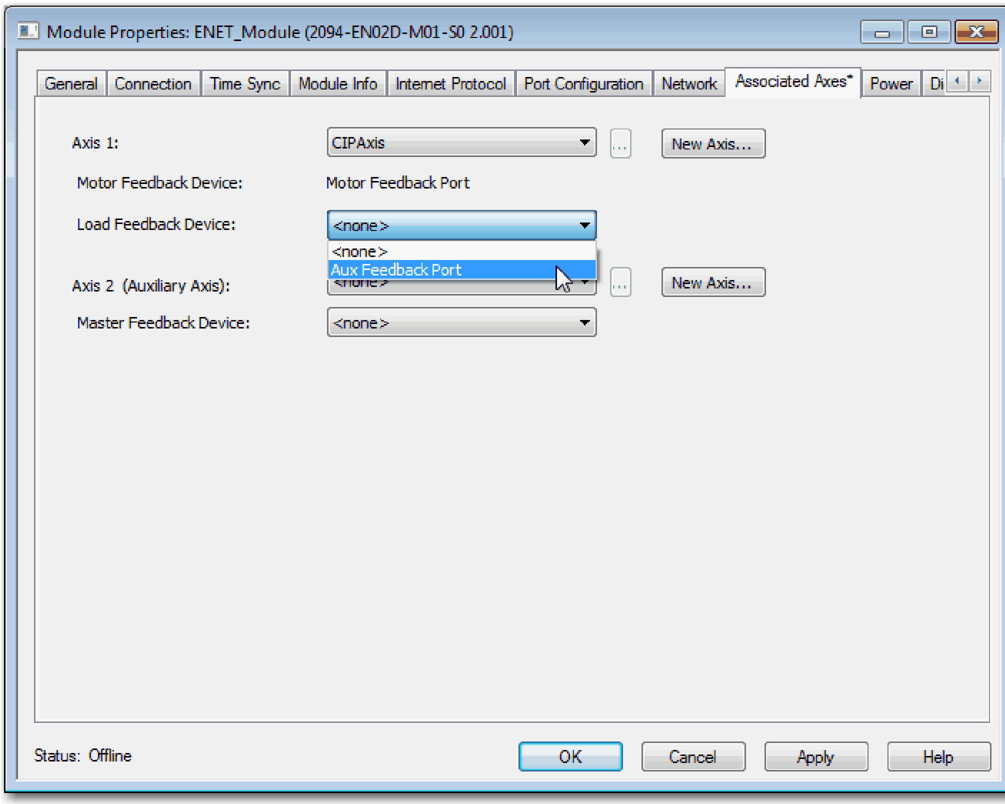
6. To assign the Load Feedback device, click the Define feedback device hyperlink or go to the Module Properties of the drive.

Figure 30 - Example 2: Position Loop with Dual Feedback, Load Feedback Dialog Box, Load-side Feedback



7. From the Load Feedback Device pull-down menu, choose Aux Feedback Port.
8. To apply your changes and return to the Load Feedback dialog box, click OK.

Figure 31 - Example 2: Kinetix 6500 Module Properties, Associated Axis Tab



9. Choose the Feedback Type and Units.

Figure 32 - Example 2: Position Loop with Dual Feedback, Load Feedback Dialog Box

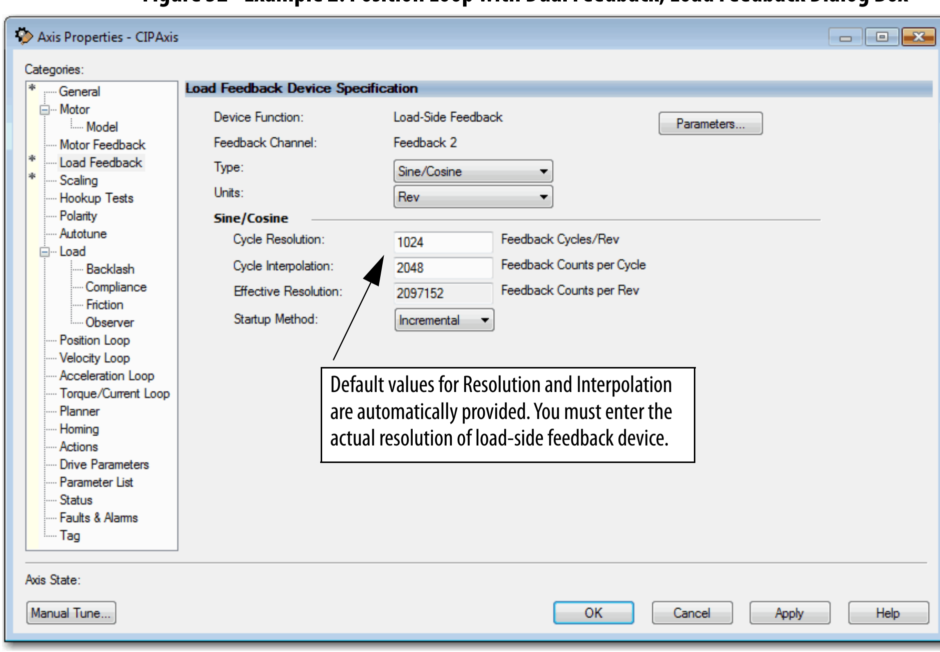
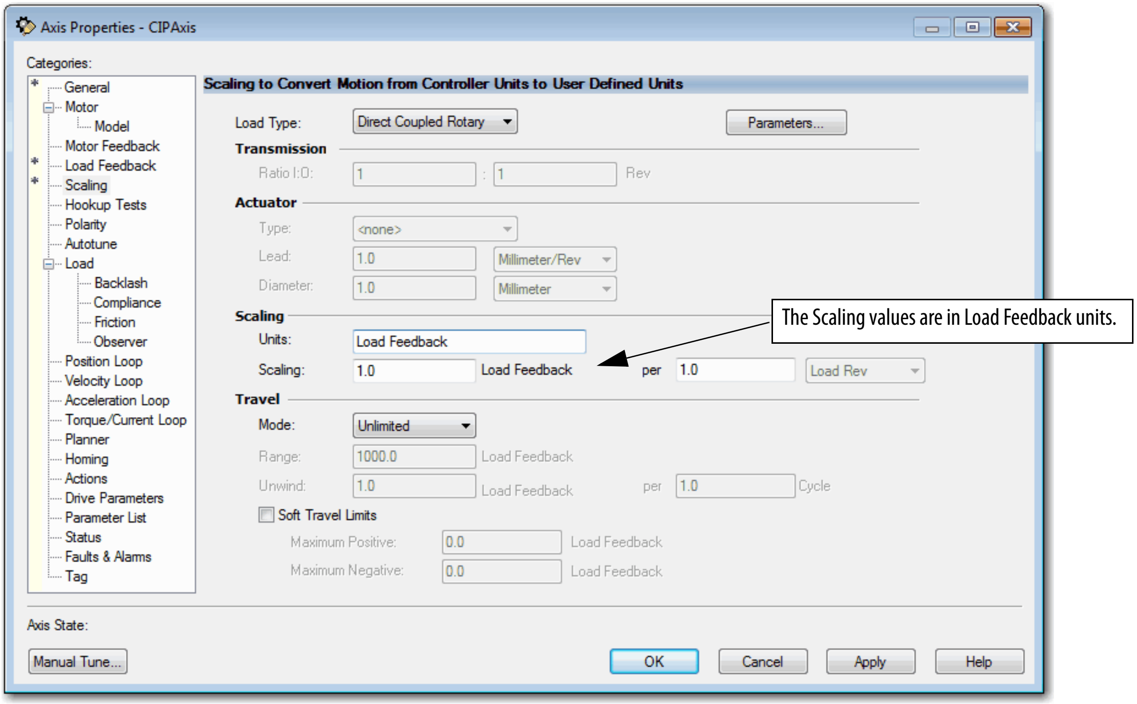


Figure 33 - Example 2: Position Loop with Dual Feedback, Scaling Dialog Box



You are now finished configuring the axis as Position Loop axis with Dual Feedback.

10. To apply your changes and close Axis Properties, click OK.

Example 3: Feedback Only

In this example, you create a half axis AXIS_CIP_DRIVE type by using the AUX Feedback port of the drive for Master Feedback. You must connect the Master Feedback device cable to the Aux Feedback port of the Kinetix 6500 drive.

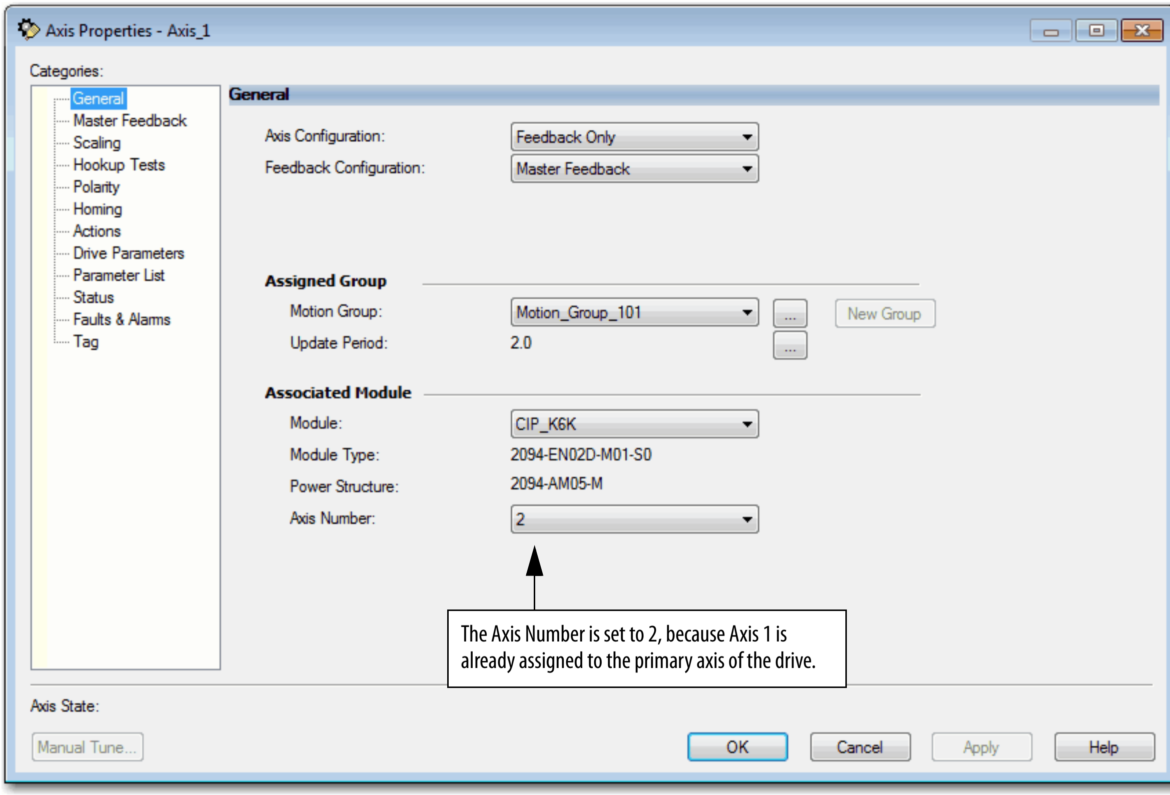
TIP You can use feedback only axes, for example, as a master reference for gearing, with PCAM moves, and MAOC output CAMs.

1. From the Axis Configuration pull-down menu, choose Feedback Only.
2. From the Feedback Configuration pull-down menu, choose Master Feedback.

   This selection determines the control mode.

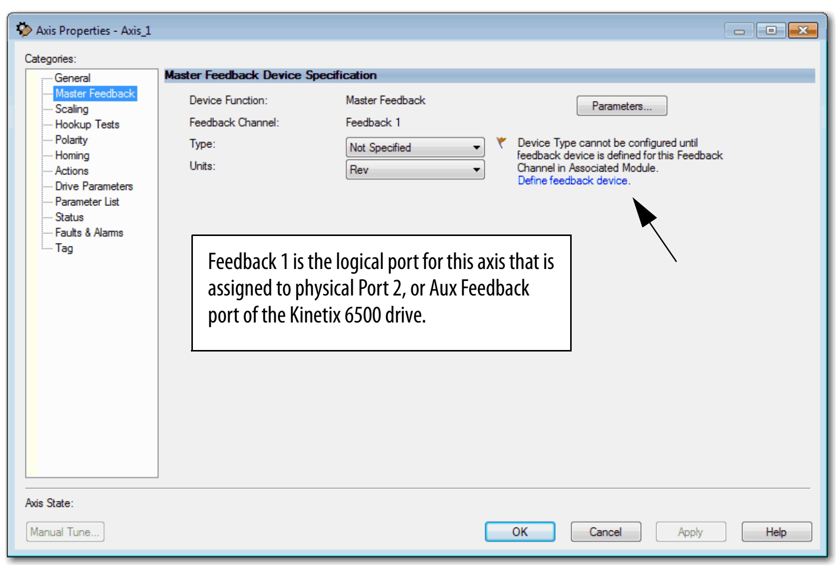
   For more information, see the Integrated Motion on the EtherNet/IP network Reference Manual, publication MOTION-RM003.
3. From the Module pull-down menu, choose the associated module that you want to use for the Master Feedback device.

Figure 34 - Example 3: Feedback Only with Master Feedback, General Dialog Box



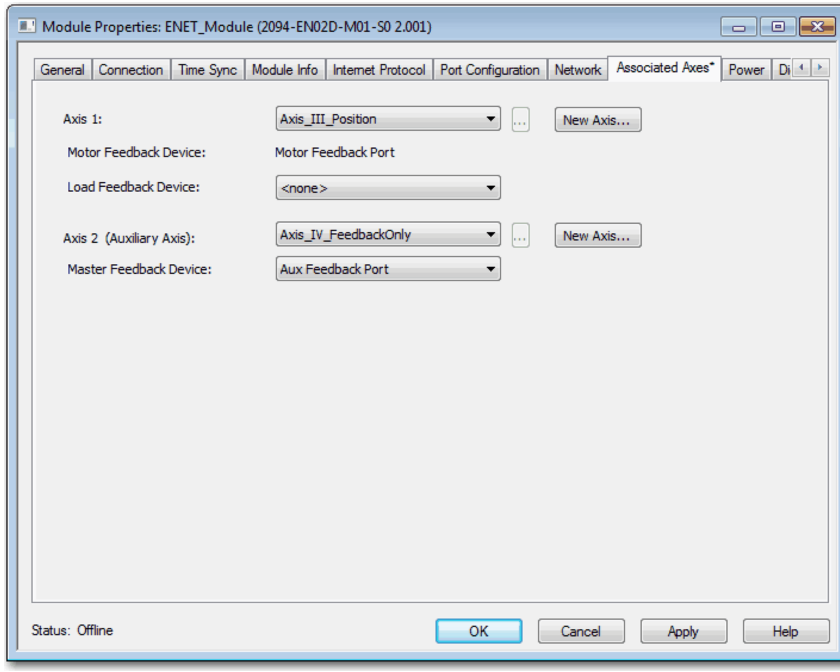
4. To associate the drive with the axis, click the Define feedback device hyperlink.

Figure 35 - Example 3: Feedback Only with Master Feedback, Master Feedback Dialog Box



5. From the Axis 2 (Auxiliary Axis) pull-down menu, choose Axis_IV_Feedback Only to associate the axis.

Figure 36 - Example 3: Master Feedback Dialog Box

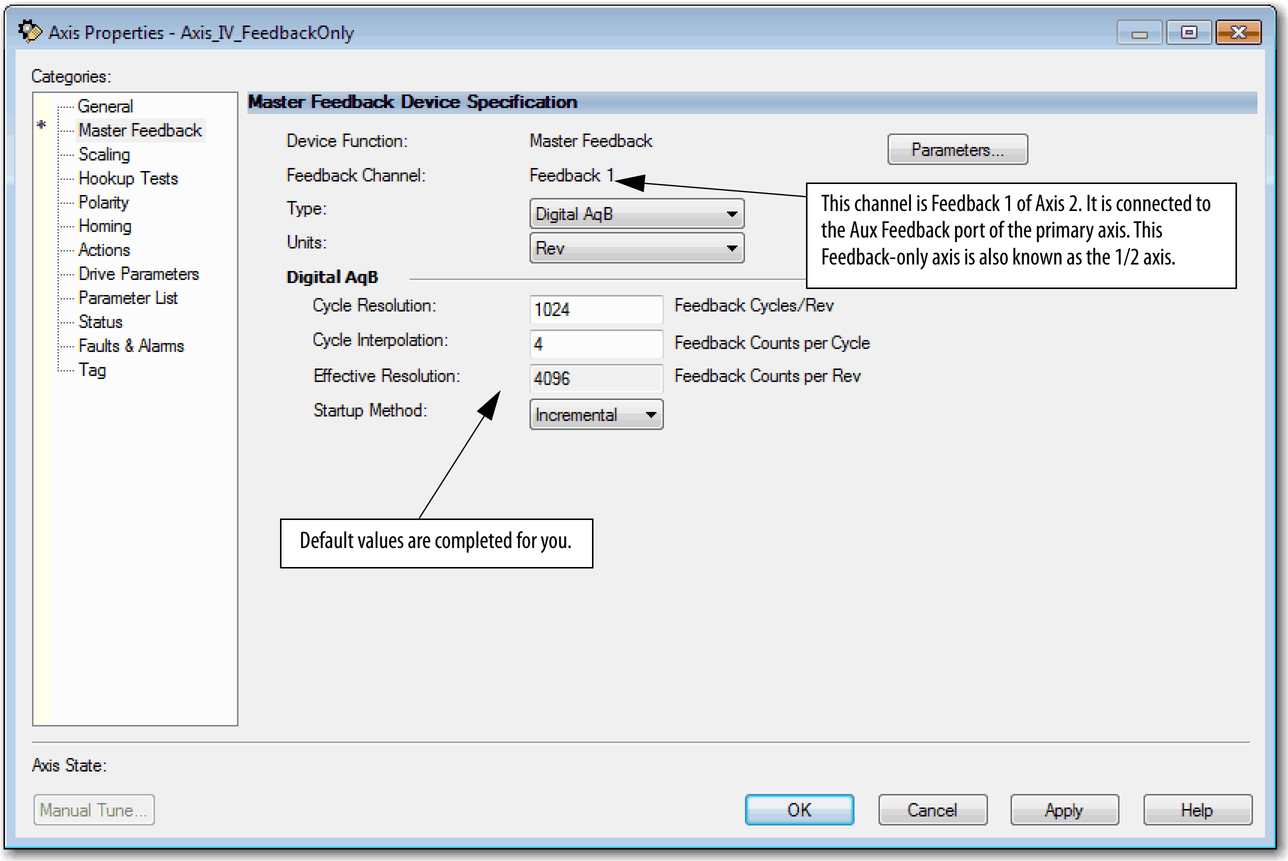


6. From the Master Feedback Device pull-down menu, choose Aux Feedback Port to map the port to the device.

TIP The available ports are different for the Kinetix 5700 drives.

7. To apply your changes and return to Axis Properties, click OK.

Figure 37 - Example 3: Feedback Only with Master Feedback, Master Feedback Dialog Box

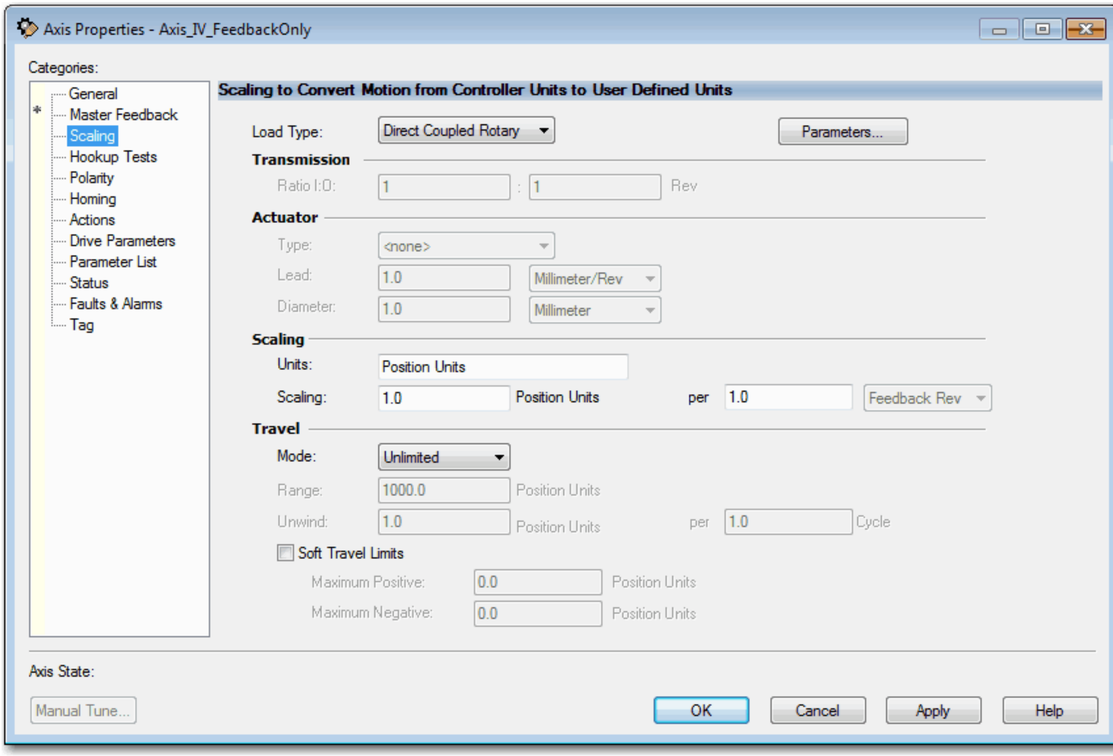


8. From the Type pull-down menu, choose Digital AqB as the feedback type.

9. From the Units pull-down menu, choose Rev.

10. In the appropriate field, type the resolutions of your specific feedback device.

Figure 38 - Example 3: Feedback Only with Master Feedback, Scaling Dialog Box



11. From the Load Type pull-down menu, choose your load type.
12. Enter the Scaling Units.
13. From the Mode pull-down menu, choose your Travel mode.

    For more information about Scaling, see Scaling on page 222.
14. Click Apply.

    You are now finished configuring an axis for Feedback Only.

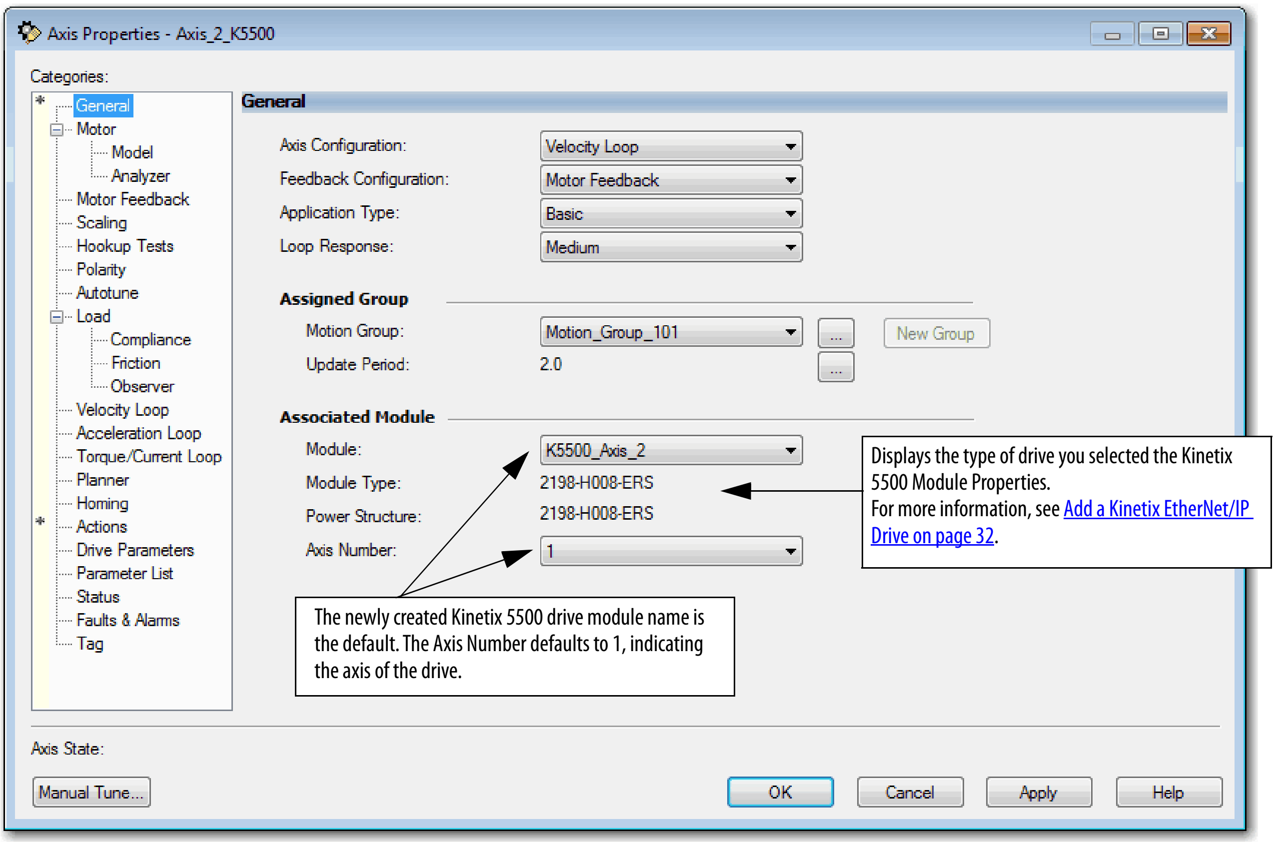
Example 4: Kinetix 5500 Drive, Velocity Loop with Motor Feedback

In this example, you are configuring a Kinetix 5500 servo drive, catalog number 2098-H025-ERS, with motor feedback by using a Rotary Permanent Magnet motor, catalog number VPL-A1001M-P.

You must connect the Motor Feedback cable to the Motor Feedback port of the Kinetix 5500 drive and then configure the feedback port.

1. Once you have added the drive to your project and created an AXIS_CIP_DRIVE, open the Axis Properties.

Figure 39 - Example 4: Velocity Loop with Motor Feedback, General Dialog Box



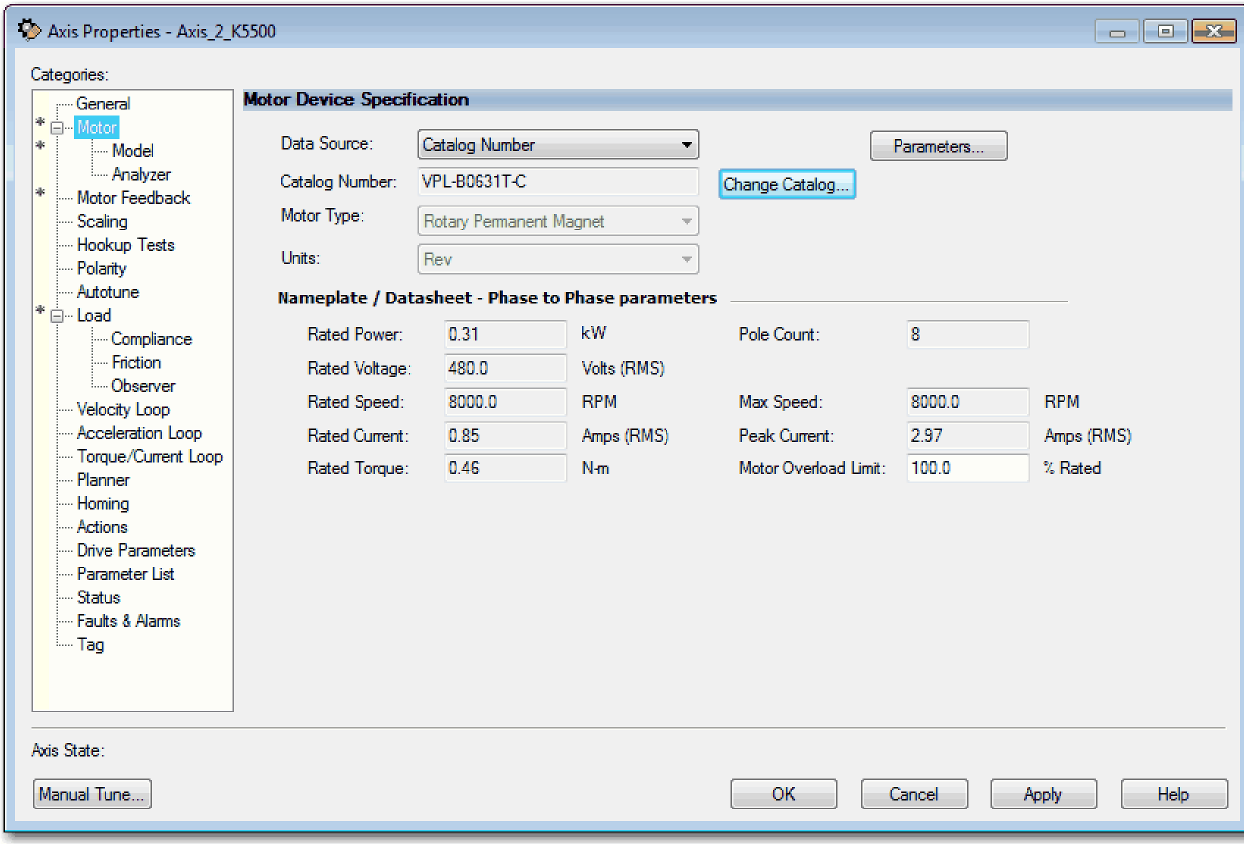
TIP After you have configured the axis and you change the Axis Configuration type or the Axis Number, some of the configuration information is set to default values. This change can cause some previously entered data to be reset back to its default setting.

After you select Velocity Loop with Motor Feedback, the Motor and Motor Feedback dialog boxes become available.

2. Click the Motor dialog box.
3. Choose Catalog Number as the Motor Data Source.

4. Click Change Catalog and choose your motor, for example, catalog number VPL-B0631T-C.

Figure 40 - Example 4: Velocity Loop with Motor Feedback, Motor Dialog Box



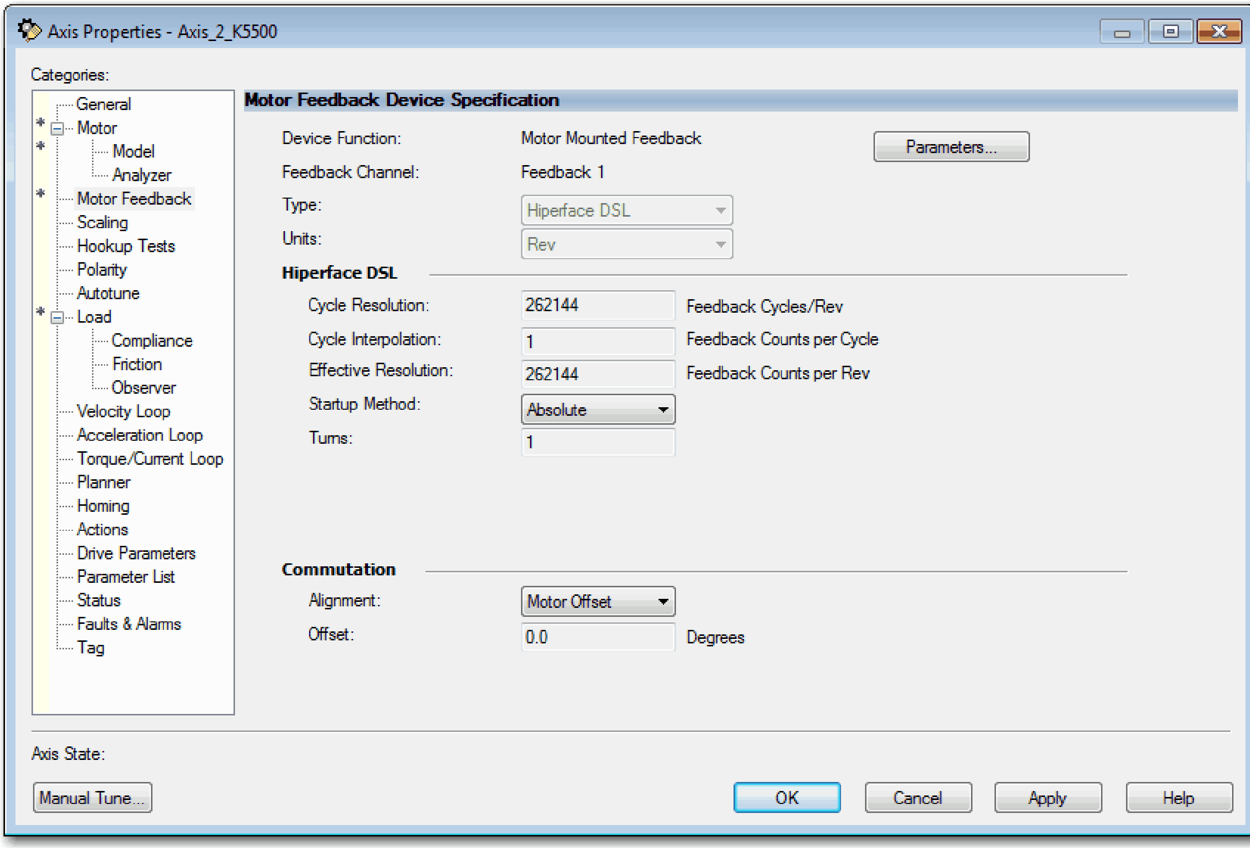
When you select the Catalog Number for the motor specification, the VPL-B0631T-C motor is in the Motion Database. The specification data for this motor is automatically completed for you.

If the motor you are using is not in the Change Catalog list, then it is not in the Motion Database. You must input the specification data or add a custom motor to the Motion Database that can be selected.

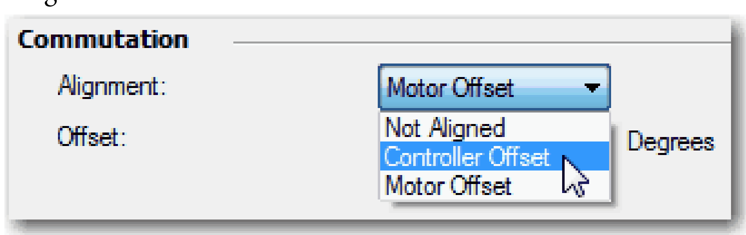
For more information, see Choose Nameplate as the Motor Data Source on page 52.

5. Click the Motor Feedback dialog box.

Figure 41 - Example 4: Velocity Loop with Motor Feedback, Motor Feedback Dialog Box

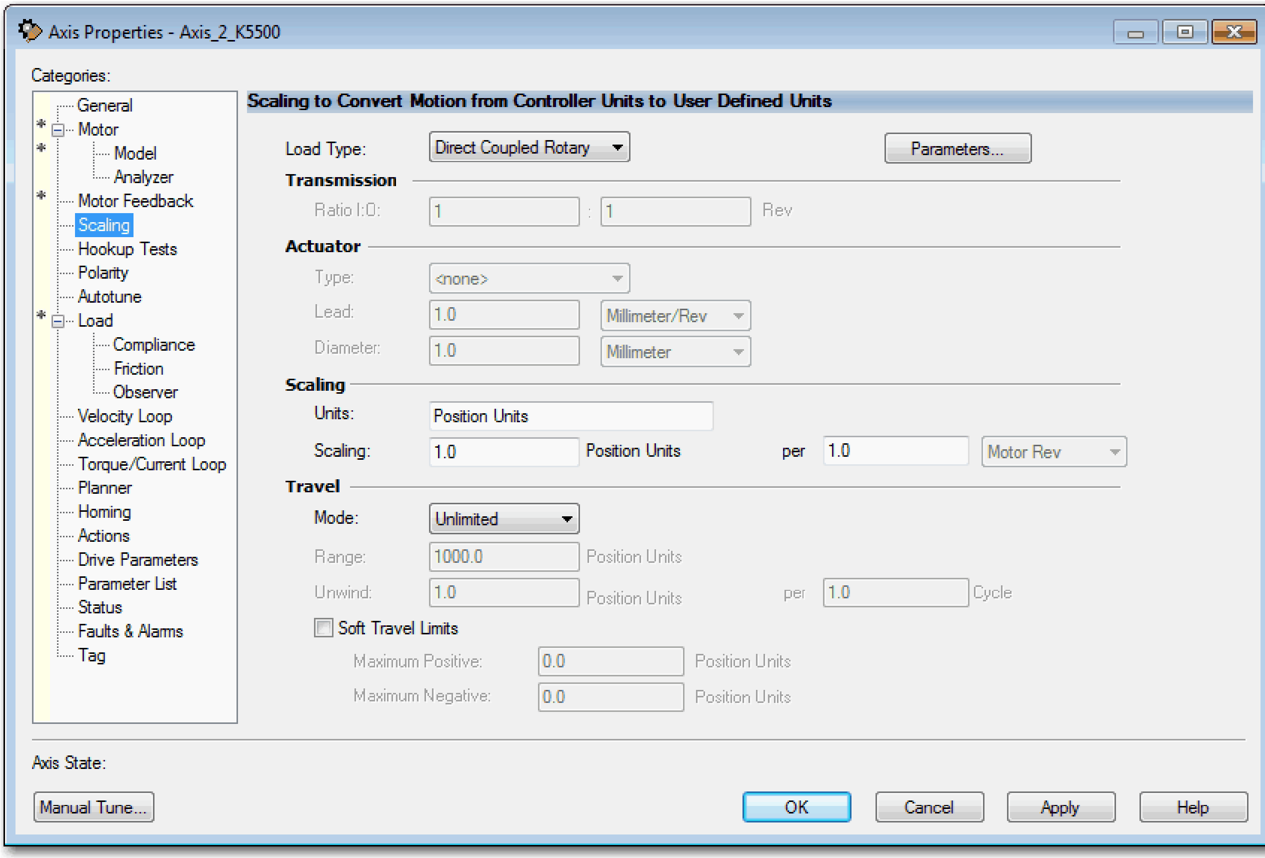


With this drive and motor combination, the Motor-Mounted Feedback that is available is the Hiperface DSL type. The data is automatically populated based on that selection. You can assign the commutation alignment.



6. To adjust the Scaling attributes, click the Scaling dialog box.

Figure 42 - Example 4: Velocity Loop with Motor Feedback, Scaling Dialog Box



7. Choose the Load Type.
8. Enter the Scaling Units.
9. Choose the Travel Mode.

   For more information about Scaling, see Scaling on page 222.
10. Click Apply.

   You are now finished configuring the Kinetix 5500 axis for Velocity Loop with Motor Feedback.

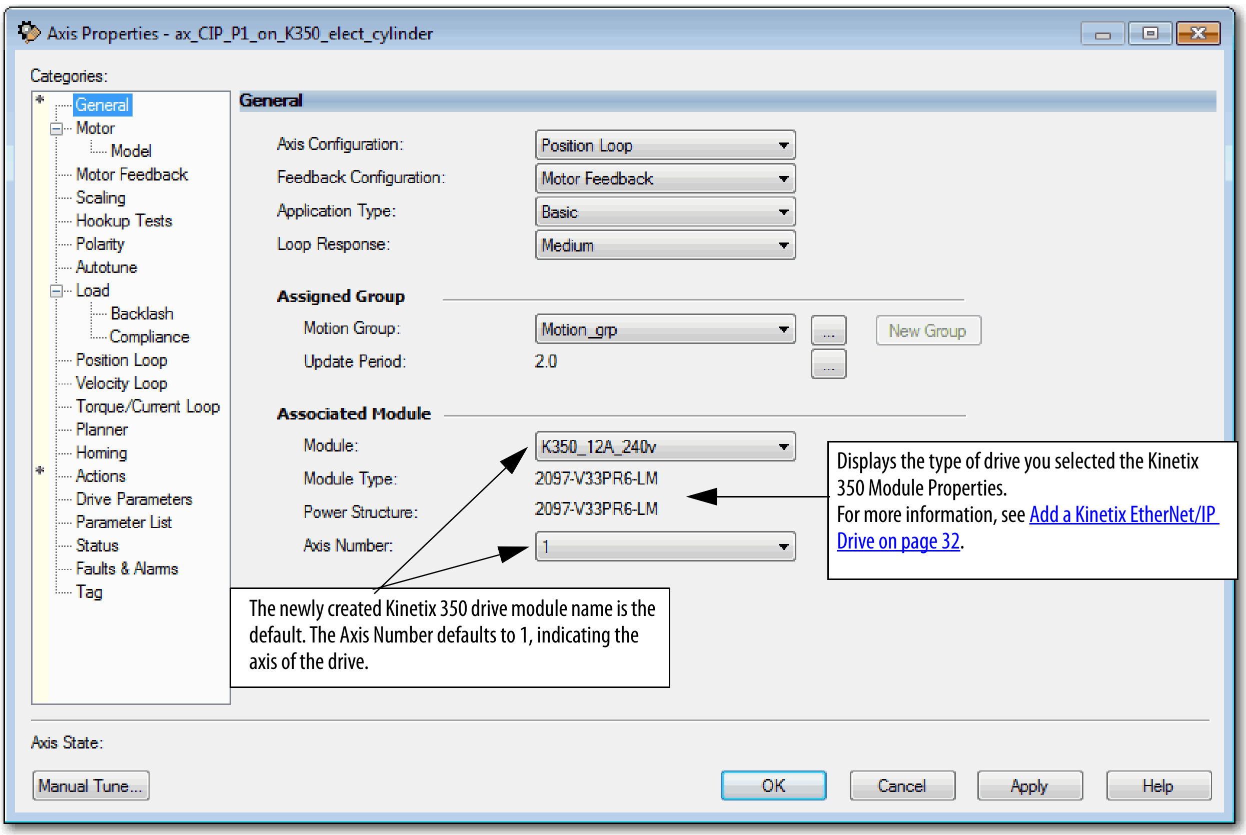
Example 5: Kinetix 350 Drive, Position Loop with Motor Feedback

In this example, create a project with a CompactLogix™ controller, for example, 1769-L36ERM. You are configuring a Kinetix 350 drive, catalog number 2097-V33PR6-LM, with motor feedback by using a Rotary Permanent Magnet motor, catalog number MPAR-A1xxxB-V2A.

You must connect the Motor Feedback cable to the Motor Feedback port of the Kinetix 350 drive and then configure the feedback port.

1. Once you have added the drive to your project and created an AXIS_CIP_DRIVE, open the Axis Properties.

Figure 43 - Example 5: Position Loop with Motor Feedback, General Dialog Box

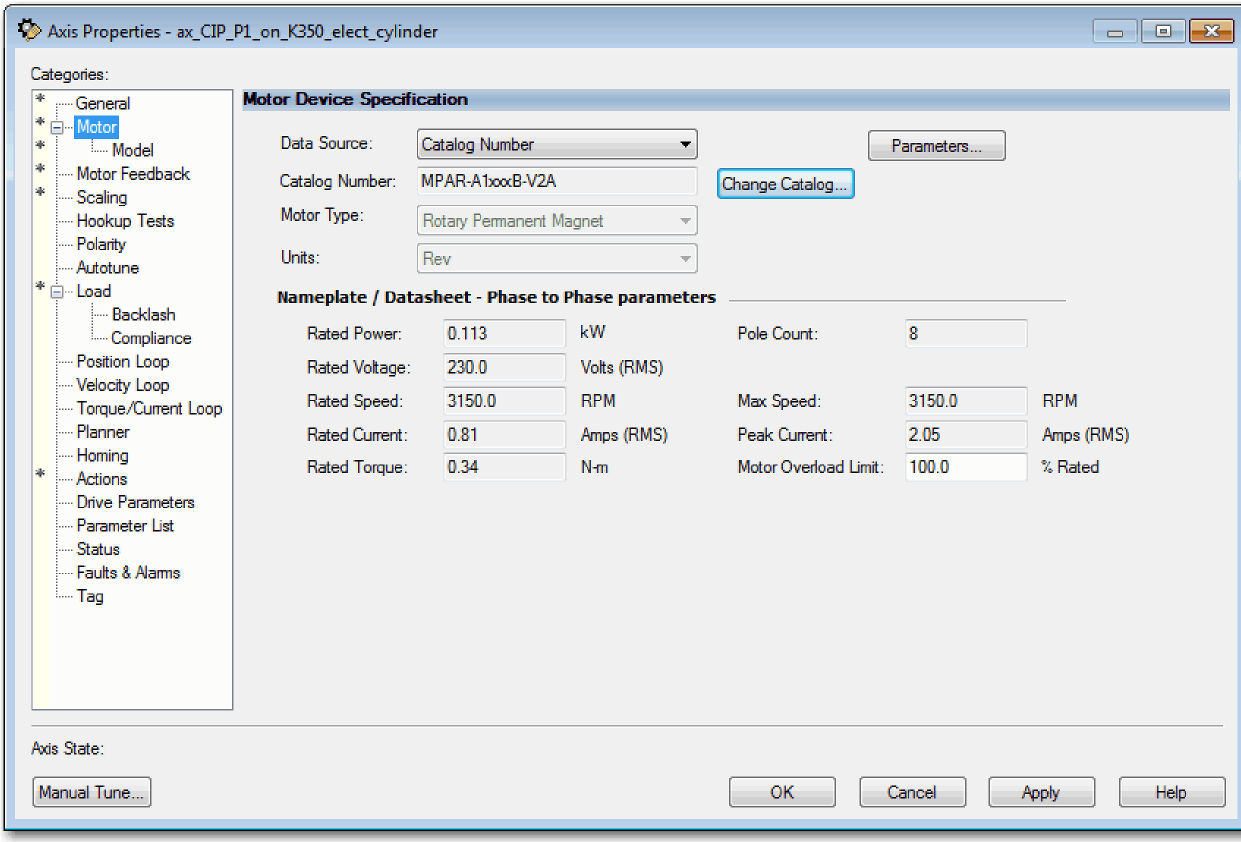


TIP After you have configured the axis and you change the Axis Configuration type or the Axis Number, some of the configuration information is set to default values. This change can cause some previously entered data to be reset back to its default setting.

2. Click the Motor dialog box.
3. Choose Catalog Number as the Motor Data Source.

4. Click Change Catalog and choose your motor, for example, catalog number MPAR-A1xxxB-V2A.

Figure 44 - Example 5: Position Loop with Motor Feedback, Motor Dialog Box



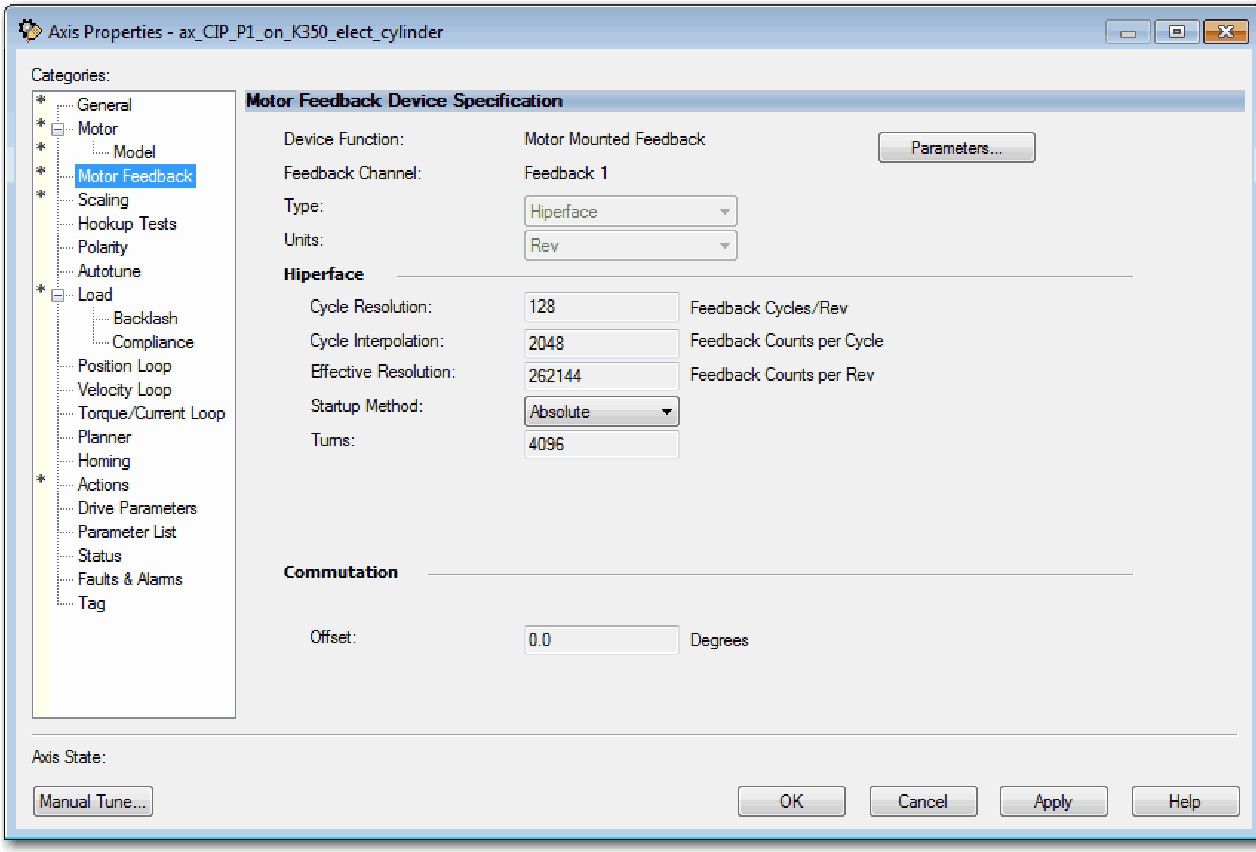
When you select the Catalog Number for the motor specification, the MPAR-A1xxxB-V2A motor is in the Motion Database. The specification data for this motor is automatically completed for you.

If the motor you are using is not in the Change Catalog list, then it is not in the Motion Database. You must input the specification data or add a custom motor to the Motion Database that can be selected.

For more information, see Choose Nameplate as the Motor Data Source on page 52.

5. Click the Motor Feedback dialog box.

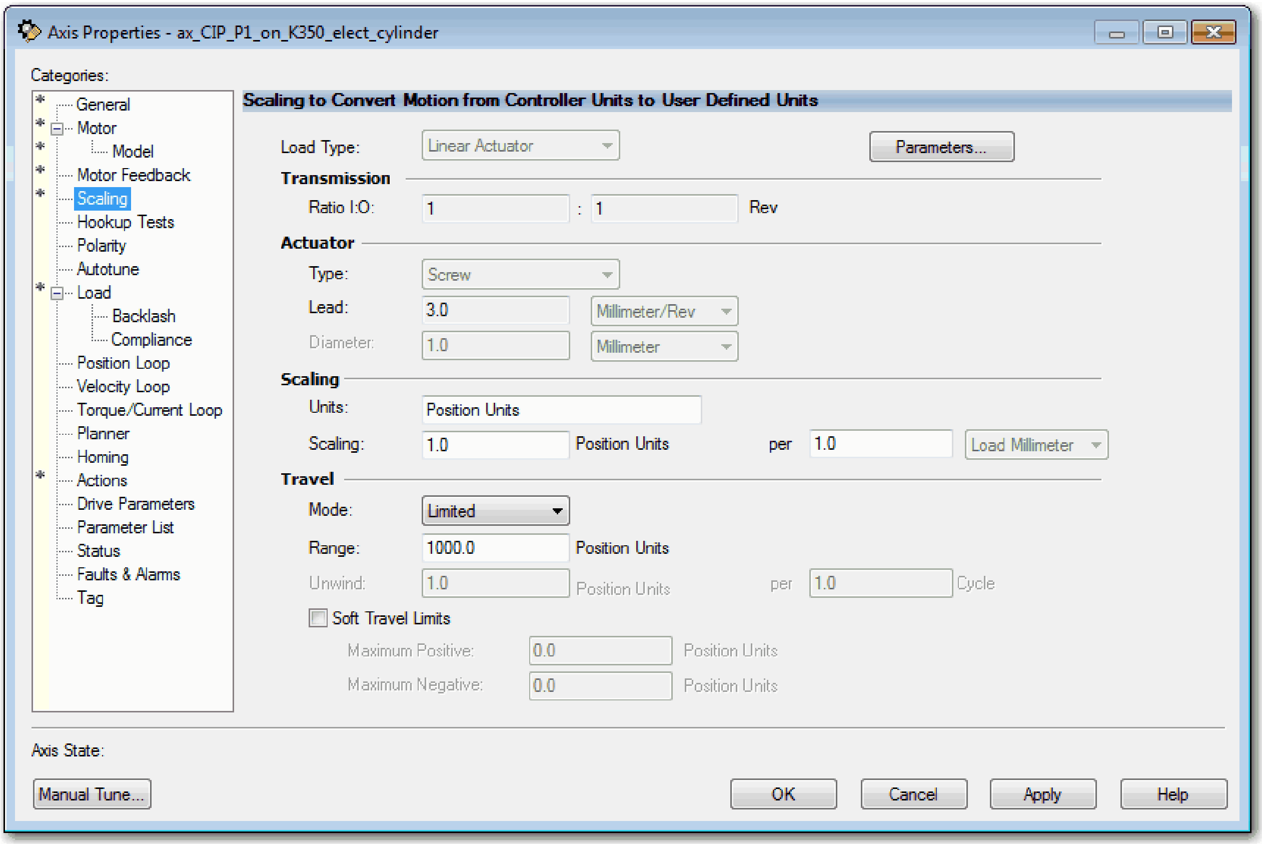
Figure 45 - Example 5: Position Loop with Motor Feedback, Motor Feedback Dialog Box



With this drive and motor combination, the data is automatically populated based on that selection.

6. To adjust the Scaling attributes, click the Scaling dialog box.

Figure 46 - Example 5: Position Loop with Motor Feedback



The default load type is linear actuator.

7. Enter the Scaling Units.
8. Enter the Travel Range.

   For more information about Scaling, see Scaling on page 222.

9. Click OK.

You are now finished configuring the Kinetix 350 axis for Position Loop with Motor Feedback.

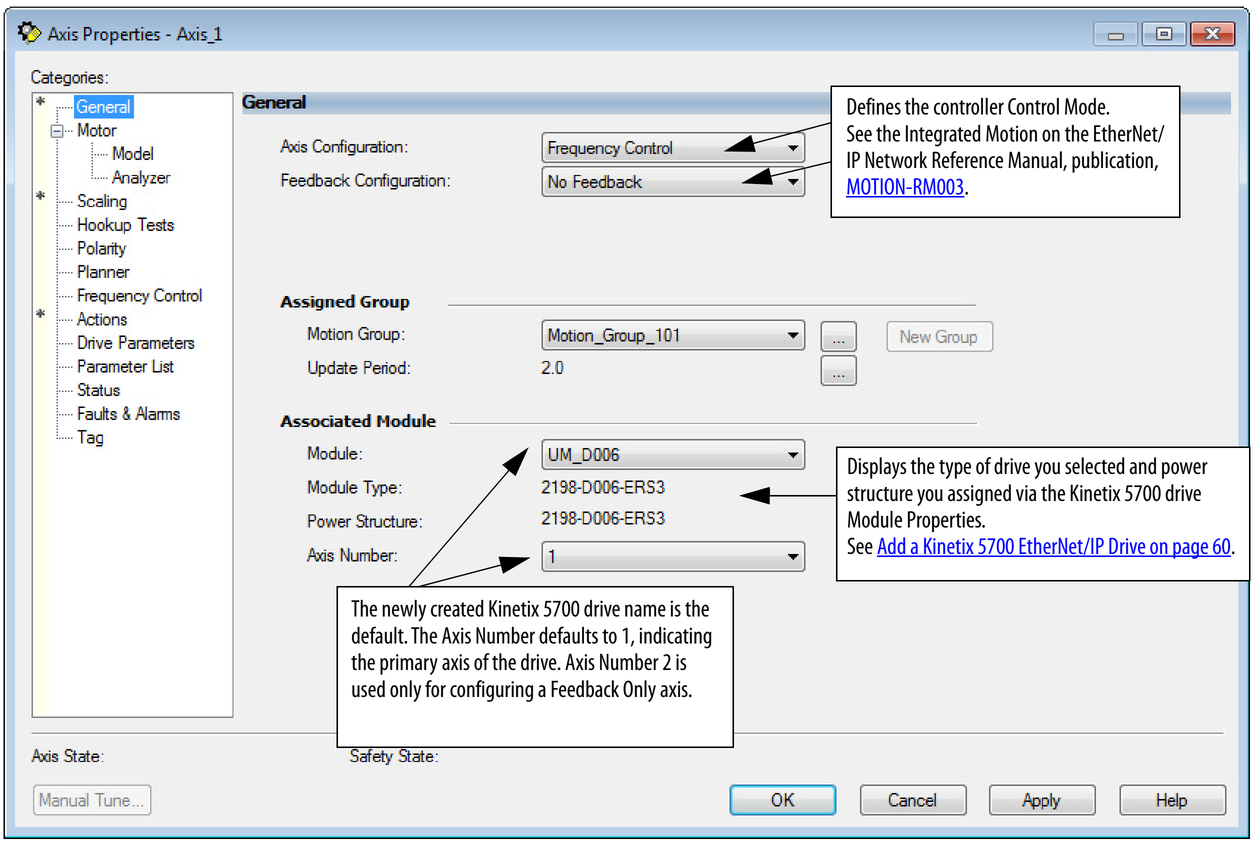
Example 6: Kinetix 5700 Drive, Frequency Control with No Feedback

In this example, create a project with a ControlLogix® controller, for example, 1756-L73S. You are configuring a Kinetix 5700 drive, catalog number 2198-D006-ERS3, with no feedback by using a HPK-Series High-power Servo motor.

1. Once you have added the drive to your project and created an AXIS_CIP_DRIVE, open the Axis Properties.
2. From the Axis Configuration pull-down menu, choose Frequency Control.

   At the Feedback Configuration pull-down menu, No Feedback is the only option.

Figure 47 - Example 6: Frequency Control with No Feedback, General Dialog Box

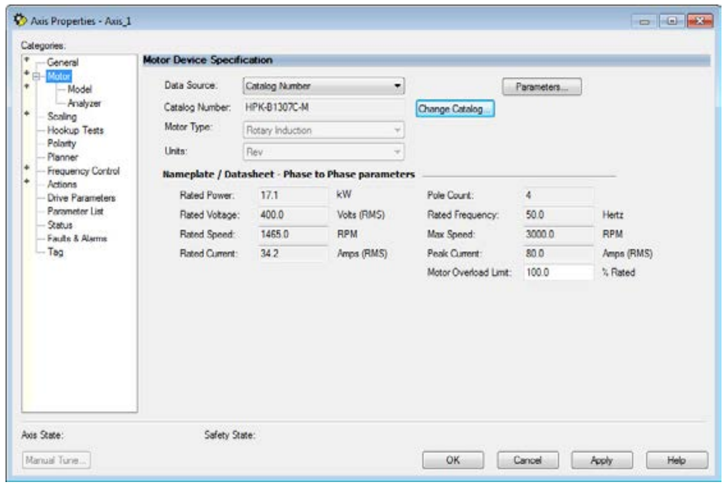


3. From the Data Source pull-down menu, choose a data source.

   In this case, the data source is Catalog Number and the Motion Database provides values for these fields.

   See the Display Motor Model Information on page 54 for more information about data sources.

Figure 48 - Example 6: Frequency Control with No Feedback, Motor Dialog Box

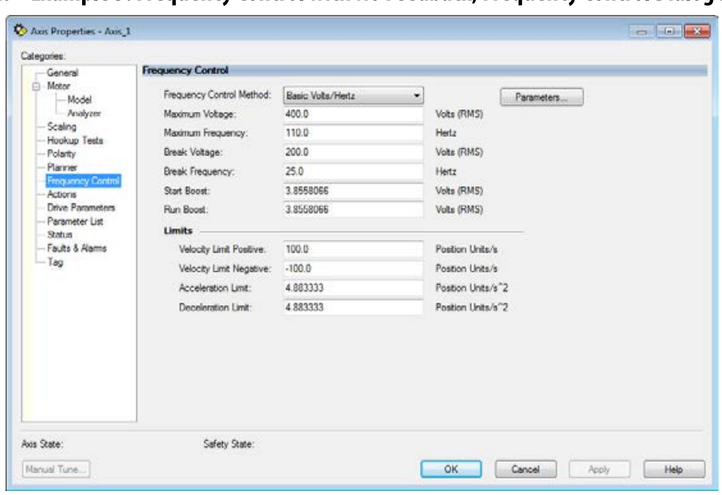


4. From the Frequency Control Method pull-down menu, choose the appropriate method.

   This example uses Basic Volts/Hertz.

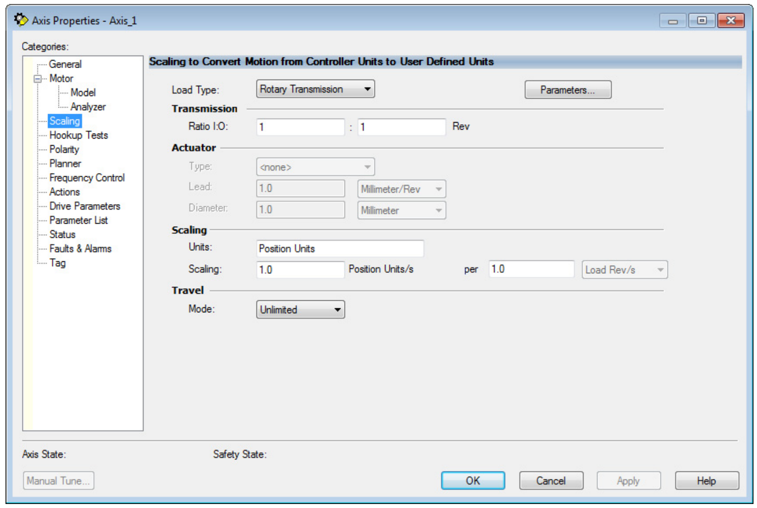
5. Click Apply.

Figure 49 - Example 5: Frequency Control with No Feedback, Frequency Control Dialog Box



6. From the Load Type pull-down menu, choose the appropriate load type.

Figure 50 - Example 6: Frequency Control with No Feedback, Scaling Dialog Box Conversion Units



7. Enter the Transmission Ratio.
8. From the Actuator Type pull-down menu, choose the appropriate actuator, if applicable.
9. Enter the Diameter dimensions.
10. Enter the Scaling Units.

    See the Scaling on page 222 for more information.
11. From the Travel Mode pull-down menu, choose the appropriate travel mode.
12. Click Apply.

You are now finished configuring the axis for Frequency Control with No Feedback.

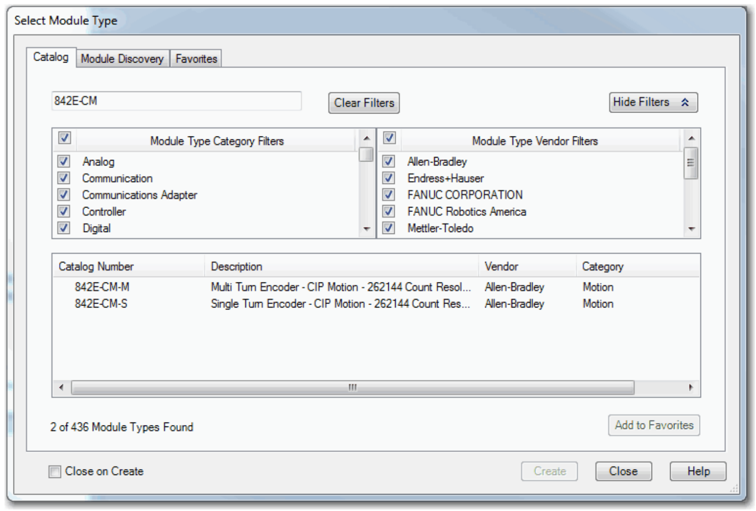
Example 7: 842E-CM Integrated Motion Encoder with Master Feedback

In this example, create a project with a ControlLogix controller, for example, 1756-L73. You are configuring an 842E-CM encoder, catalog number 842-CM-M, with feedback only.

1. In the Controller Organizer, right-click Ethernet under the I/O Configuration folder and choose New Module.

   The Select Module Type dialog box appears.

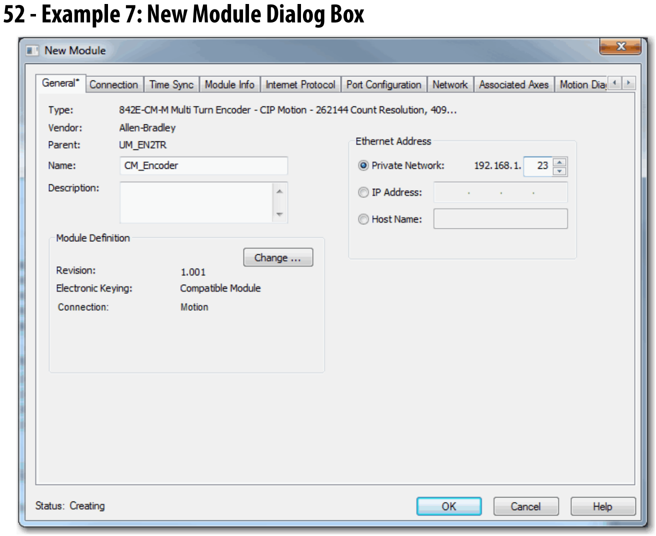
Figure 51 - Example 7: Select Module Type Dialog Box



2. Select your 842E-CM encoder as appropriate for your actual hardware configuration.
3. Click Create.

   The New Module dialog box appears.

Figure 52 - Example 7: New Module Dialog Box



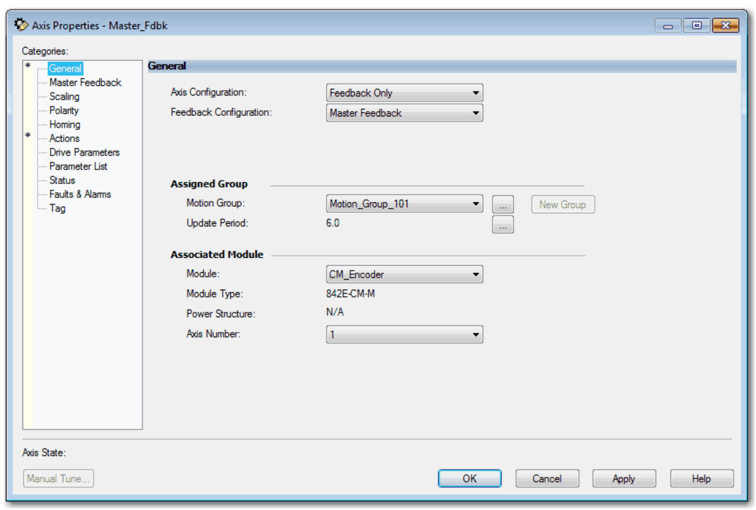
4. Configure the 842E-CM encoder.
   a. Type the encoder Name.
   b. Select an EtherNet/IP address option.
      In this example, the Private Network address is selected.
   c. Enter the address of your EtherNet/IP™ module.
      In this example, the last octet of the address is 23.
5. To close the New Module dialog box, click OK.
6. To close the Select Module, click Close.

   Type dialog box.
7. Right-click the 842E-CM encoder that you created and choose Properties.

   The Module Properties dialog box appears.
8. Configure the Associated Axis tab and the motion group for your 842E-CM encoder.

   In this example, the feedback-only axis is named Master_Fdbk.
9. In the Controller Organizer, right-click the feedback-only axis and choose Properties.
10. Select the General category.

Figure 53 - Example 7: 842E-CM Integrated Motion Encoder with Master Feedback, General Dialog Box

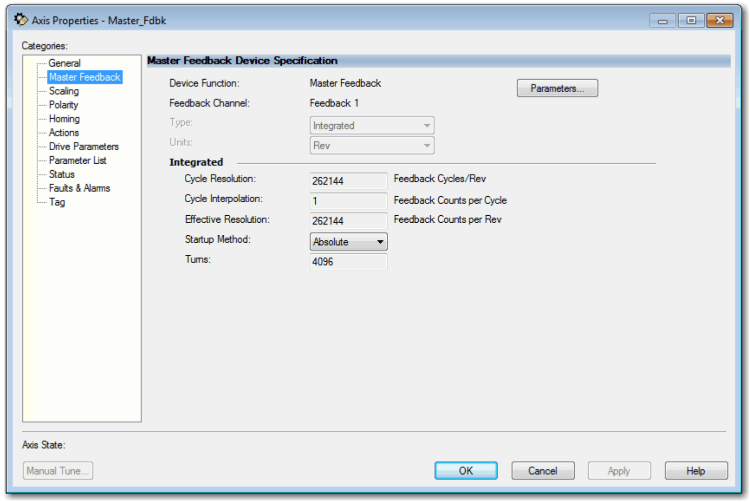


11. From the Module pull-down menu, choose the 842E-CM encoder to associate with your Feedback Only axis.

    The Module Type field populates with the chosen encoder catalog number.

12. Select the Master Feedback category.

Figure 54 - Example 7: 842E-CM Integrated Motion Encoder with Master Feedback, Master Feedback Dialog Box



The Type and Units appear dim. The Cycle Resolution, Cycle Interpolation, Effective Resolution, and Turns are automatically completed with values from the AOP schema. The selections for the Master Feedback category are automatic to make sure that valid values are entered.

13. Click OK.

Notes:

Axis Configuration Examples for the PowerFlex 755 Drive

This chapter provides example axis configurations when using a PowerFlex® 755 drive.

The following six examples are typical axis-configuration applications for the PowerFlex 755 drive:

- Position Loop with Motor Feedback
- Position Loop with Dual Feedback
- Velocity Loop with Motor Feedback
- Velocity Control with No Feedback
- Frequency Control with No Feedback
- Torque Loop with Feedback

Example 1: Position Loop with Motor Feedback Via a UFB Feedback Device

This example describes how to create an AXIS_CIP_DRIVE axis that is associated to a PowerFlex 755 drive with motor feedback via a universal feedback device, catalog number 20-750-UFB-1.

TIP Remember that you already assigned the feedback device when you added the drive to your project.

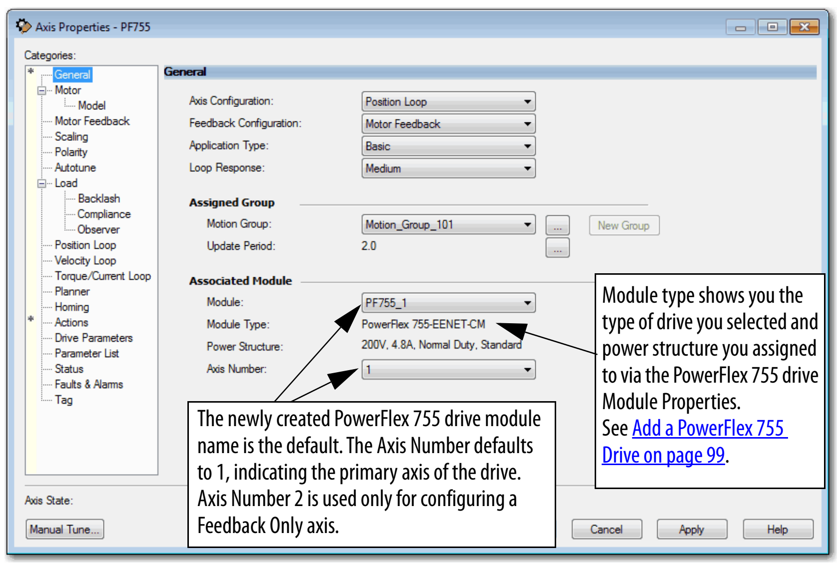
See Create an Axis for a PowerFlex 755 Drive on page 109 for more information about feedback devices.

1. Once you have created an AXIS_CIP_DRIVE, open the Axis Properties.
2. From the Axis Configuration pull-down menu, choose Position Loop.

   When you choose the configuration type, it determines the Control Mode.

   See the Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003.

Figure 55 - Example 1: Position Loop with Motor Feedback, General Dialog Box

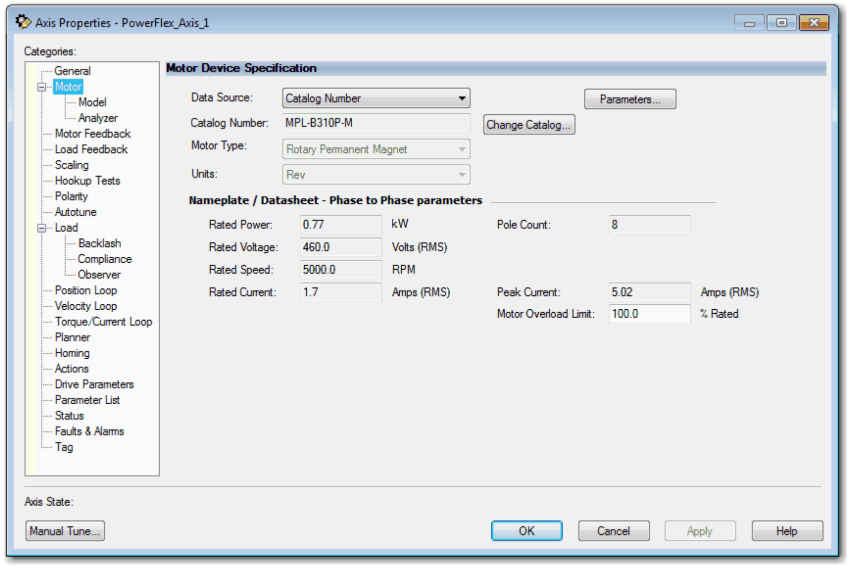


3. From the Feedback Configuration pull-down menu, choose Motor Feedback.

TIP After you have configured the axis and you change the Axis Configuration type or the Axis Number, some of the configuration information is set to default values. This change can cause some previously entered data to be reset back to its default setting.

Now that you defined the axis as being a Position Loop with Motor Feedback, the Motor and Motor Feedback dialog boxes become available.

Figure 56 - Example 1: Position Loop with Motor Feedback, Motor Dialog Box

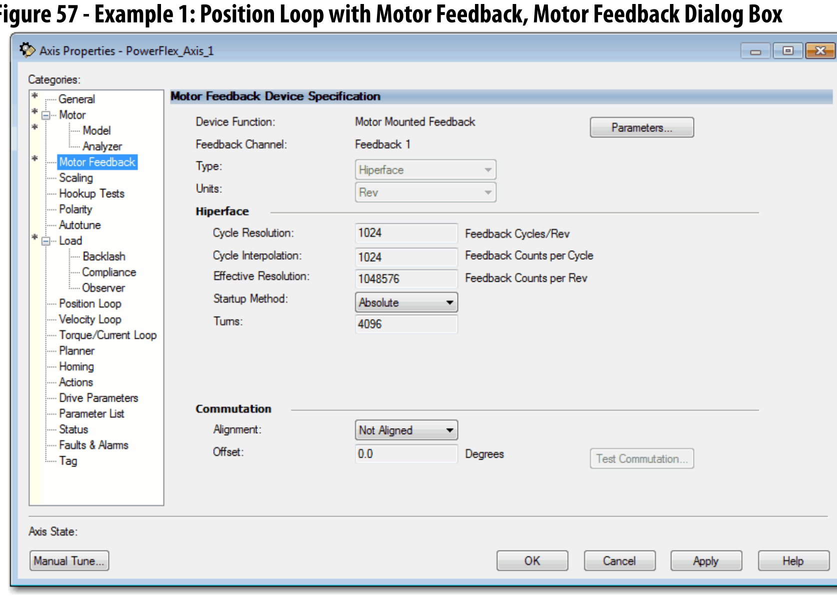


4. Choose Catalog Number as the Data Source.
5. Click Change Catalog and choose a motor.

   When you select the Catalog Number for the motor specification, the MPL-B310P-M motor is in the Motion Database. The specification data for this motor is automatically entered for you. If the motor you are using is not in the Change Catalog list, then it is not in the Motion Database. You have to enter the specification data on your own.

   The Motor Feedback dialog box is automatically filled based on your motor selection.

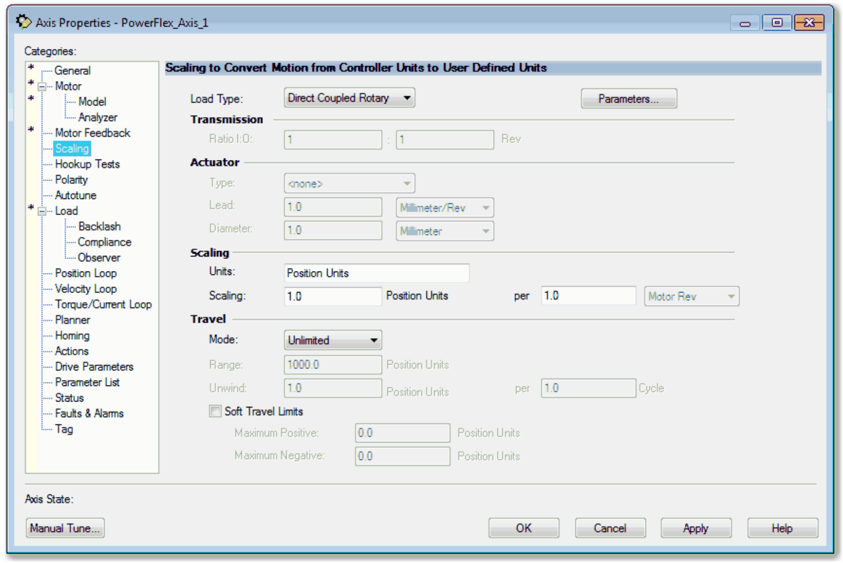
Figure 57 - Example 1: Position Loop with Motor Feedback, Motor Feedback Dialog Box



6. Choose the Commutation Alignment.

   For more information about Commutation, see Assign Motor Feedback on page 54 and Applying the Commutation Hookup Test on page 232.

Figure 58 - Example 1: Position Loop with Motor Feedback, Scaling Dialog Box



7. From the Load Type pull-down menu, choose your type of load.
8. Enter the Scaling Units.
9. From the Travel Mode pull-down menu, choose your Travel Mode.

   For more information about Scaling, see Scaling on page 222.
10. Click Apply and OK to exit Axis Properties.

The axis is now configured for Position Loop with Motor Feedback.

Example 2: Position Loop with Dual Motor Feedback Via a UFB Feedback Device

This example describes how to create an AXIS_CIP_DRIVE axis that is associated to a PowerFlex 755 drive with dual motor feedback via a universal feedback device, catalog number 20-750-UFB-1.

TIP Remember that you already assigned the feedback device when you added the drive to your project.

See Create an Axis for a PowerFlex 755 Drive on page 109 for more information about feedback devices.

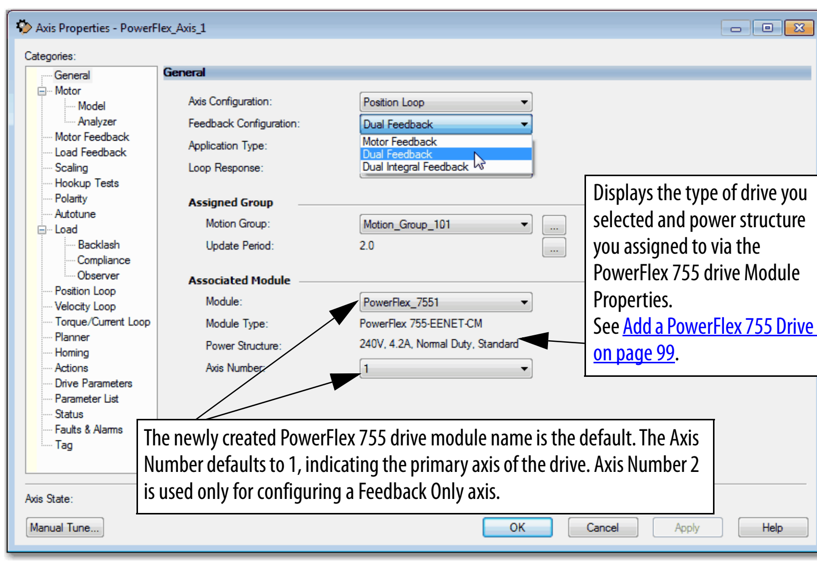
1. Once you have created an AXIS_CIP_DRIVE, open the Axis Properties.

2. From the Axis Configuration pull-down menu, choose Position Loop.
3. From the Feedback Configuration pull-down menu, choose Dual Feedback.

   When you choose the configuration type, it determines the Control Mode.

   See the Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003.

Figure 59 - Example 2: Position Loop with Dual Feedback, General Dialog Box

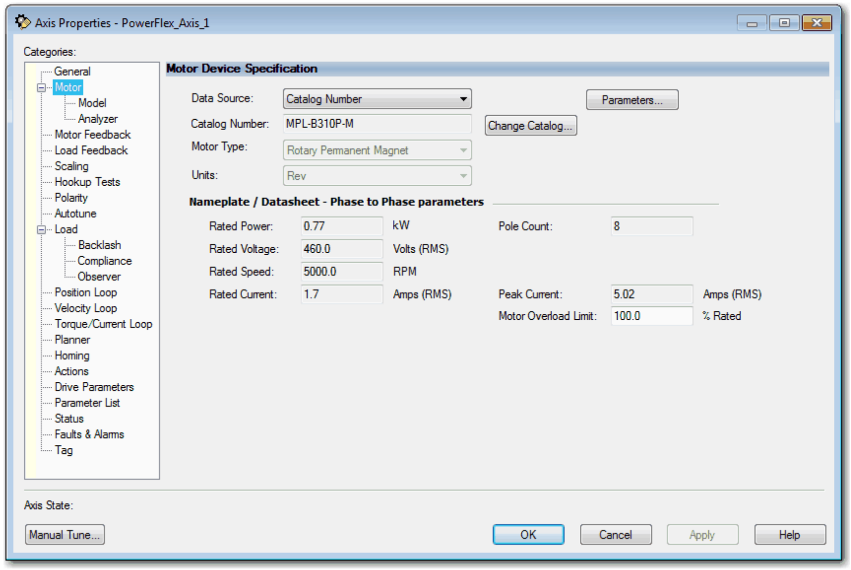


IMPORTANT After you have configured the axis and you change the Axis Configuration type or the Axis Number, some of the configuration information is set to default values. This change can cause some previously entered data to be reset back to its default setting.

Now that you defined the axis as being a Position Loop with Dual Feedback axis, the Motor Feedback, and Load Feedback dialog boxes become available.

4. From the Data Source pull-down menu, choose Catalog Number.

Figure 60 - Example 2: Position Loop with Dual Feedback, Motor Dialog Box



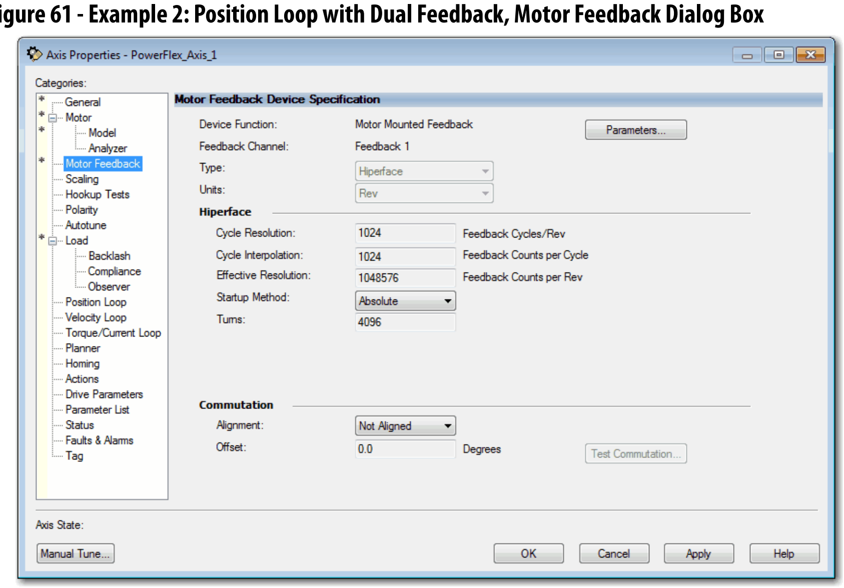
5. Click Change Catalog and choose your motor.

In this case, a MPL-B310P-M motor was chosen.

When you select the Catalog Number for the motor specification, the MPL-B310P-M motor is in the Motion Database. The specification data for this motor is automatically entered for you. If the motor you are using is not listed in Change Catalog, then it is not in the Motion Database. You have to enter the specification data on your own.

The Motor Feedback dialog box is automatically filled based on your motor selection.

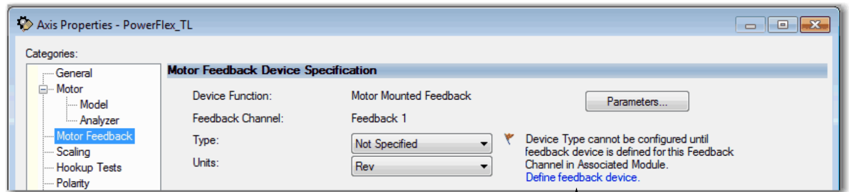
Figure 61 - Example 2: Position Loop with Dual Feedback, Motor Feedback Dialog Box



6. Choose the Commutation Alignment.

   For more information about Commutation, see Applying the Commutation Hookup Test on page 232.

   On the Motor Feedback dialog box, the information is automatic based on your selections on the Motor dialog box.



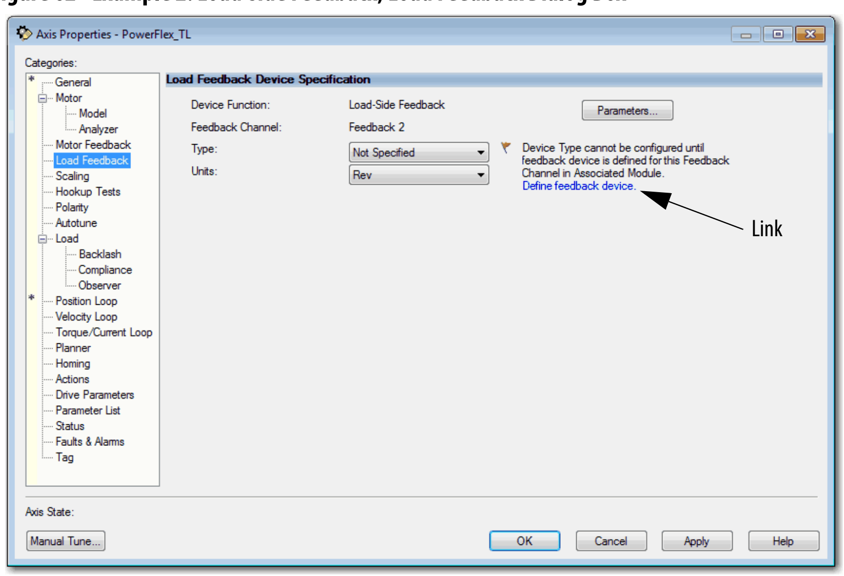
If you have not defined a feedback device, the motor dialog box displays a link to the module definition for the drive.

   The axis is now configured as a Position Loop with two feedback devices. The next task is to configure Feedback 2 on the Load Feedback dialog box.

Follow these instructions to define the Load feedback.

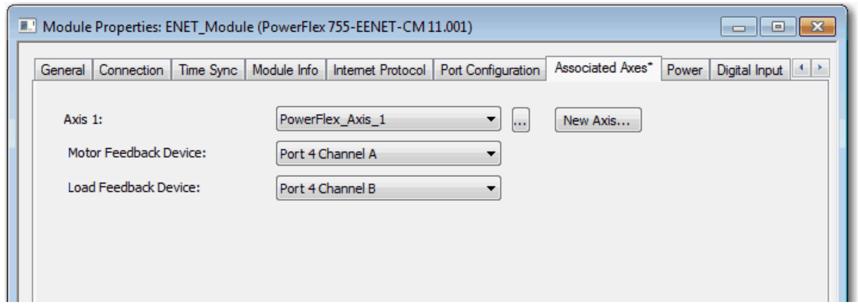
1. From the Load Feedback dialog box, click the Define feedback device hyperlink.

Figure 62 - Example 2: Load-side Feedback, Load Feedback Dialog Box



2. Click Associated Axes in Module Properties dialog box.
3. From the Load Feedback Device pull-down menu, choose the appropriate port/channel for the Load Feedback Device.

Figure 63 - Example 2: PowerFlex 755 Module Properties, Associated Axis Tab



4. From the Type pull-down menu, choose the type of feedback.
5. From the Units pull-down menu, choose the appropriate units.
6. Click Apply.

Figure 64 - Example 2: Load-side Feedback, Load Feedback Dialog Box

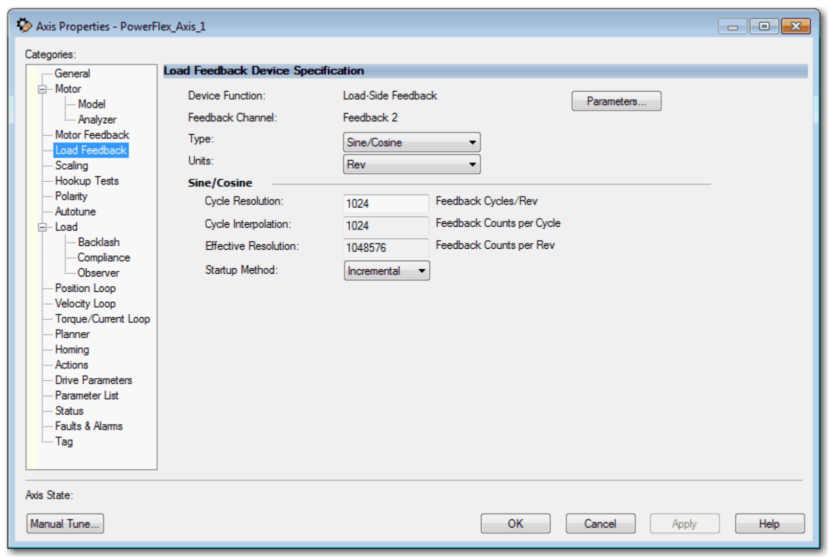
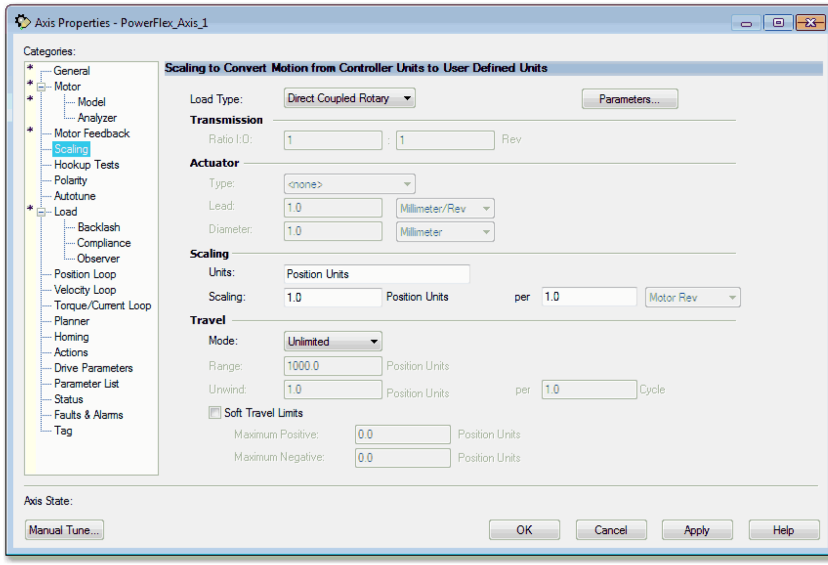


Figure 65 - Example 2: Position Loop with Dual Feedback, Scaling Dialog Box



7. From the Load Type pull-down menu, choose your load type.
8. Enter the Scaling Units.
9. From the Travel Mode pull-down menu, choose a Travel Mode.

   See Scaling on page 222 for more information about Scaling.
10. Click Apply and OK to exit Axis Properties.

You are now finished configuring a PowerFlex 755 drive axis as Position Loop with Dual Feedback.

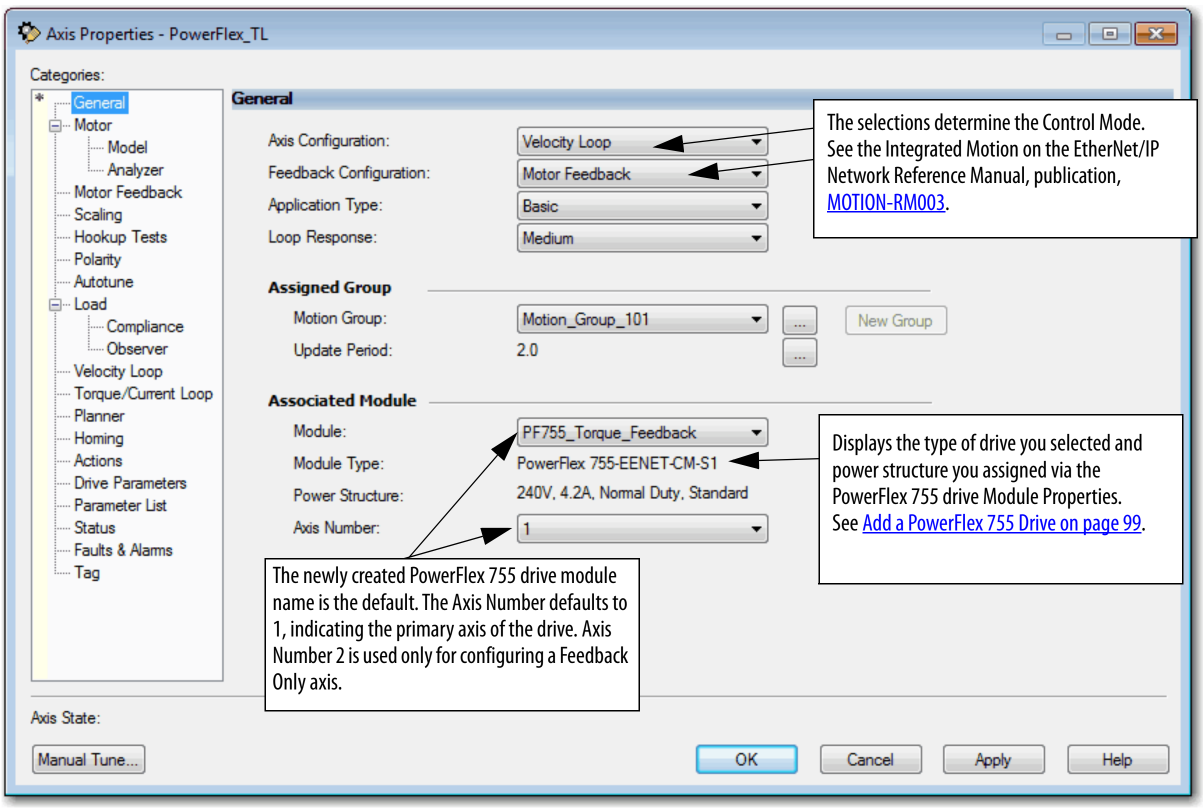
Example 3: Velocity Loop with Motor Feedback Via a UFB Feedback Device

This example describes how to create two AXIS_CIP_DRIVE axes that are associated to a PowerFlex 755 drive with dual motor feedback via a universal feedback device, catalog number 20-750-UFB-1.

TIP Remember that you already assigned the feedback device when you added the drive to your project.

1. Once you have created an AXIS_CIP_DRIVE, open the Axis Properties.
2. Connect the Feedback Port 1 with one feedback cable that is connected to the PowerFlex 755 drive.
3. From the Axis Configuration pull-down menu, choose Velocity Loop.
4. From the Feedback Configuration pull-down menu, choose Motor Feedback.

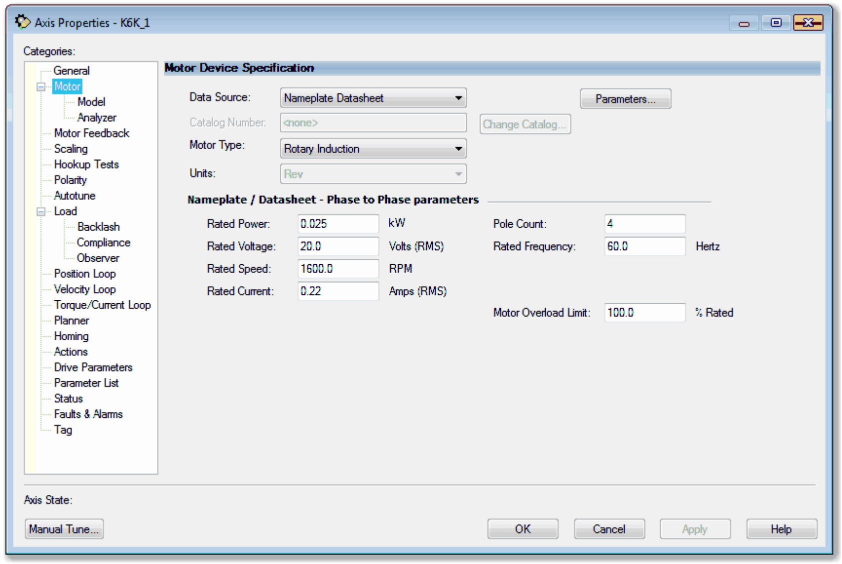
Figure 66 - Example 3: Velocity Loop with Motor Feedback, General Dialog Box



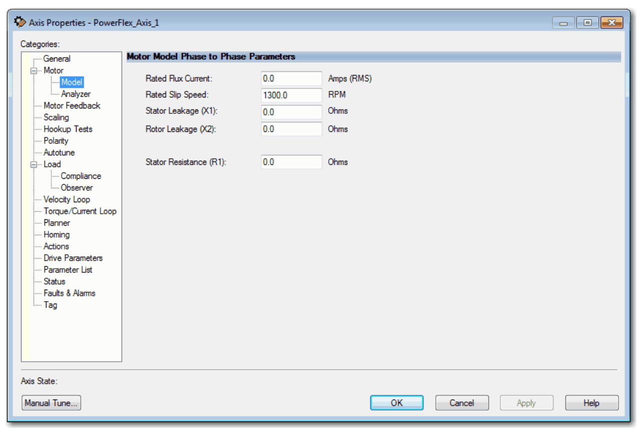
IMPORTANT After you have configured the axis and you change the Axis Configuration type or the Axis Number, some of the configuration information is set to default values. This change can cause some previously entered data to be reset back to its default setting.

Now that you defined the axis as a Velocity Loop with Motor Feedback, the Motor and Motor Feedback dialog boxes become available.

Figure 67 - Example 3: Velocity Loop with Motor Feedback, Motor Dialog Box

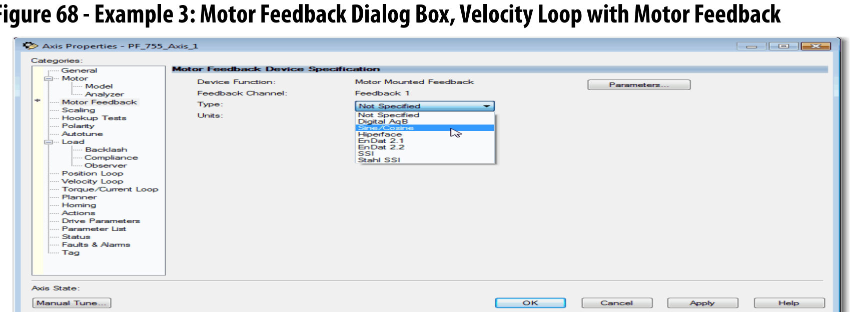


5. From the Data Source pull-down menu, choose Nameplate data sheet.
6. From the Motor Type pull-down menu, choose Rotary Induction.
7. Enter the parameters by using the information from the motor Nameplate or data sheet and click Apply.



8. Enter the parameters on the Motor Model dialog box by using the information from the motor Nameplate or data sheet and click Apply.

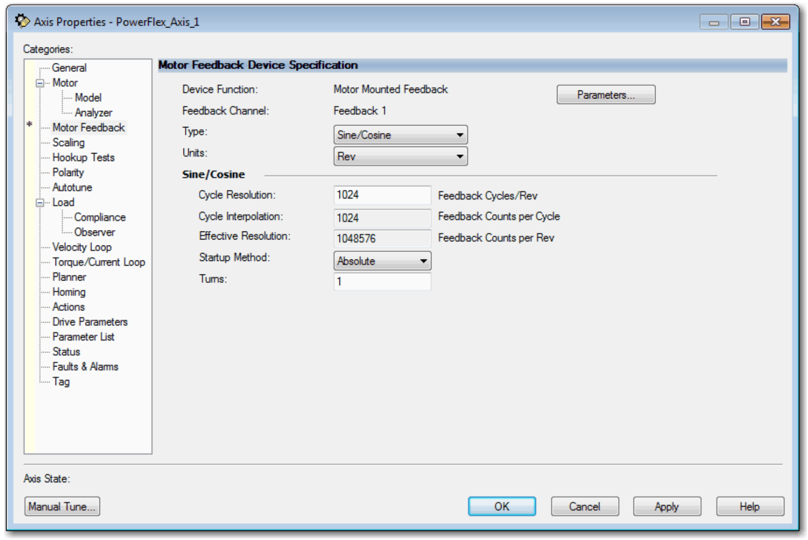
Figure 68 - Example 3: Motor Feedback Dialog Box, Velocity Loop with Motor Feedback



9. From the Type pull-down menu, choose the type of feedback.

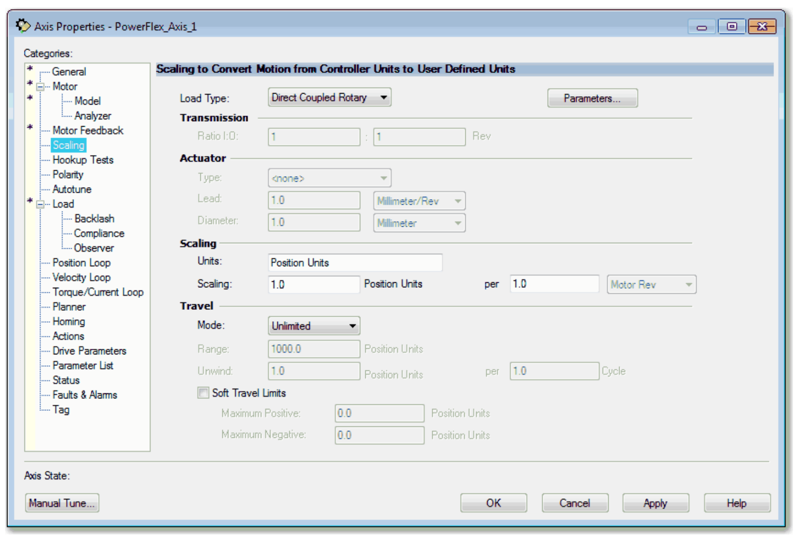
   The fields are populated with the data that relates to the motor and feedback types you chose.

Figure 69 - Example 3: Velocity Loop with Motor Feedback, Motor Feedback Dialog Box



10. Click Scaling.

Figure 70 - Example 3: Velocity Loop with Motor Feedback, Scaling Dialog Box



11. From the Load Type pull-down menu, choose the appropriate load type.
12. Enter the Scaling Units.
13. From the Travel Mode pull-down menu, choose the appropriate Travel Mode.

    See Scaling on page 222 for more information.

14. Click Apply and OK to exit Axis Properties.

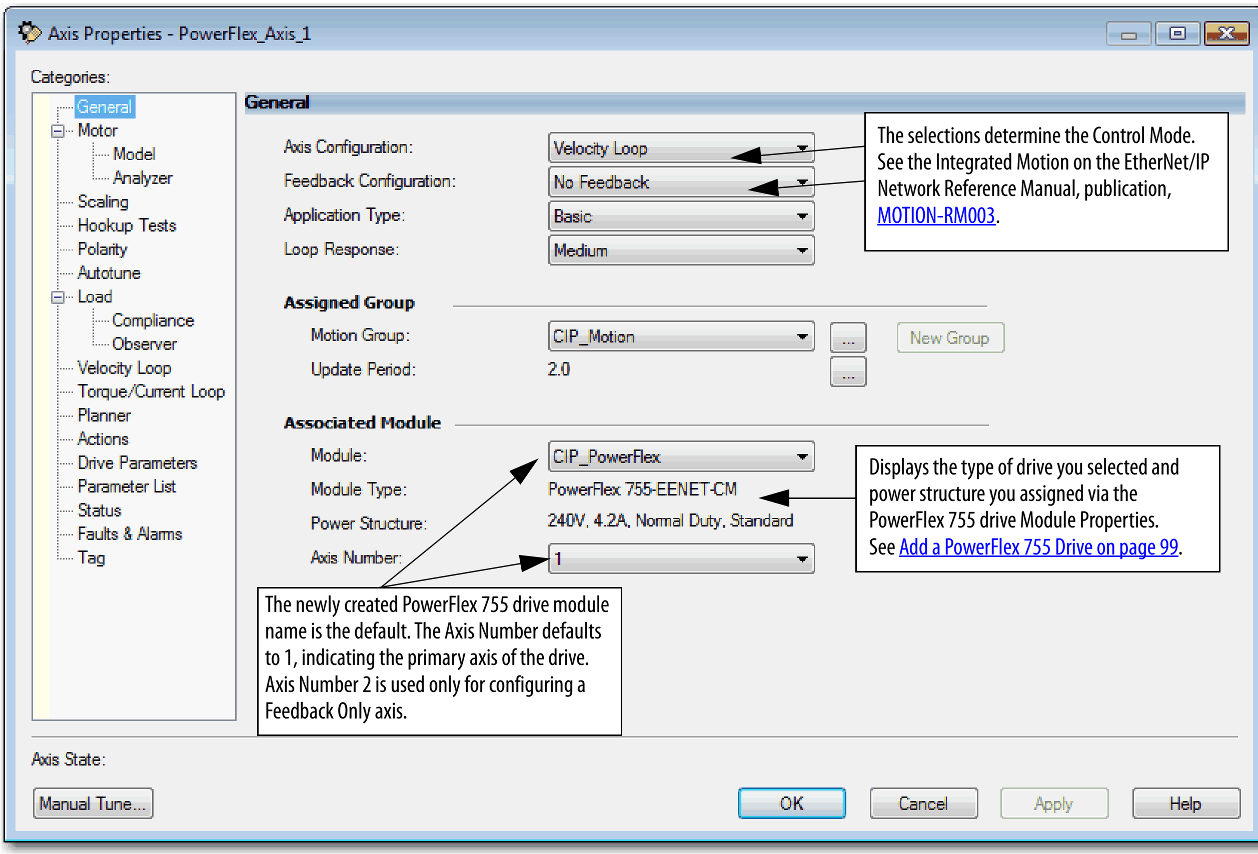
You are now finished configuring the axis as Velocity Loop with Motor Feedback.

Example 4: Velocity Loop with No Feedback

In this example, you create an AXIS_CIP_DRIVE configured for a Velocity Loop with No Feedback axis and associate the axis to the PowerFlex 755 drive.

1. From the Axis Configuration pull-down menu, choose Velocity Loop.
2. From the Feedback Configuration pull-down menu, choose No Feedback.

Figure 71 - Example 4: Velocity Loop with No Feedback, General Dialog Box



3. From the Data Source pull-down menu, choose Nameplate data sheet.

Figure 72 - Example 4: Velocity Loop with No Feedback, Motor Dialog Box

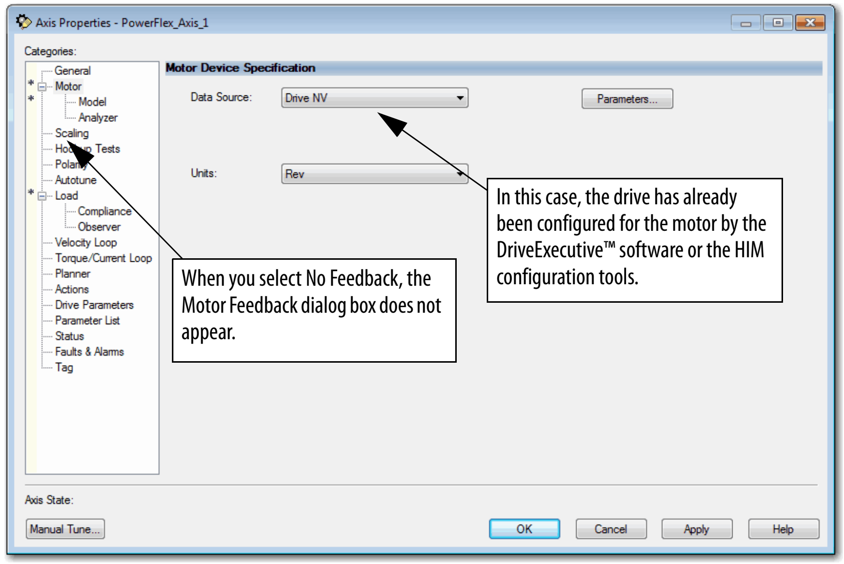
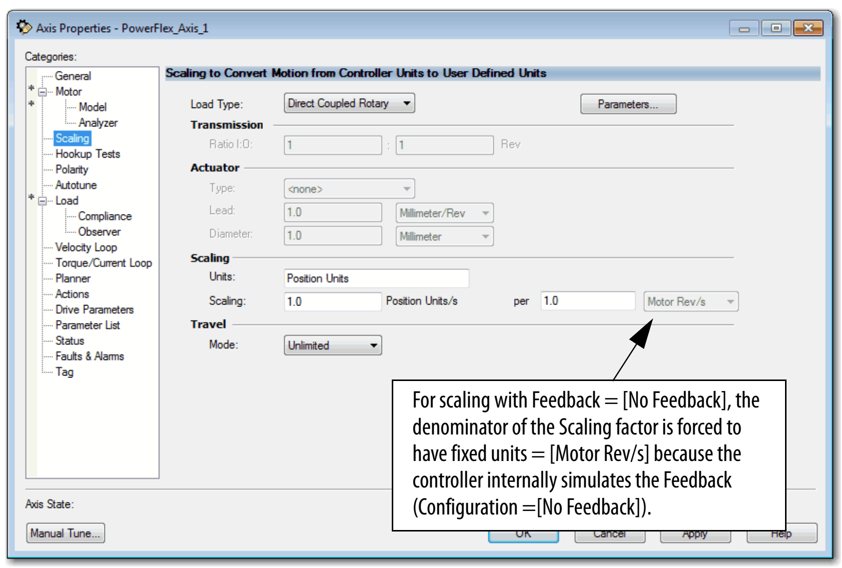


Figure 73 - Example 4: Velocity Loop with No Feedback, Scaling Dialog Box



4. From the Load Type pull-down menu, choose the appropriate load type.

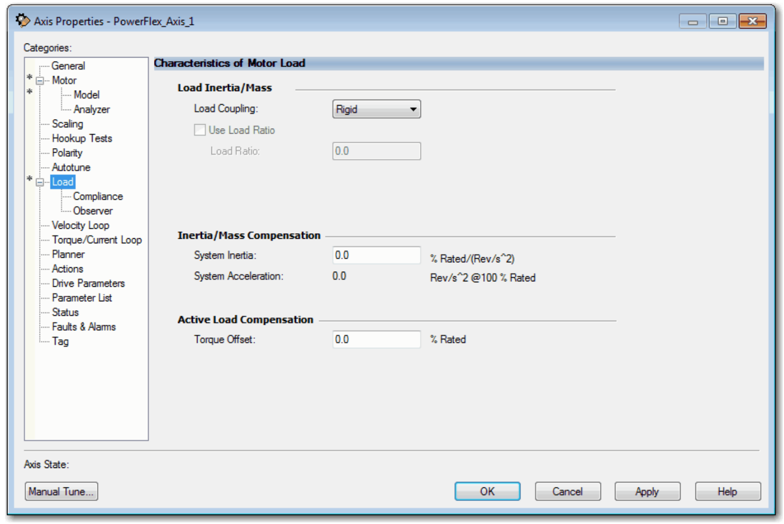
5. Enter the Scaling Units.

6. From the Travel Mode pull-down menu, choose the appropriate Travel Mode.

   See Scaling on page 222 for more information.

7. Click Apply.

Figure 74 - Example 4: Velocity Loop with No Feedback, Load Dialog Box



8. From the Load Coupling pull-down menu, choose the appropriate load coupling.
9. Enter the System Inertia.
10. Enter the Torque Offset, if applicable.

    For more information about the load characteristics, see Load on page 239.

11. Click Apply.

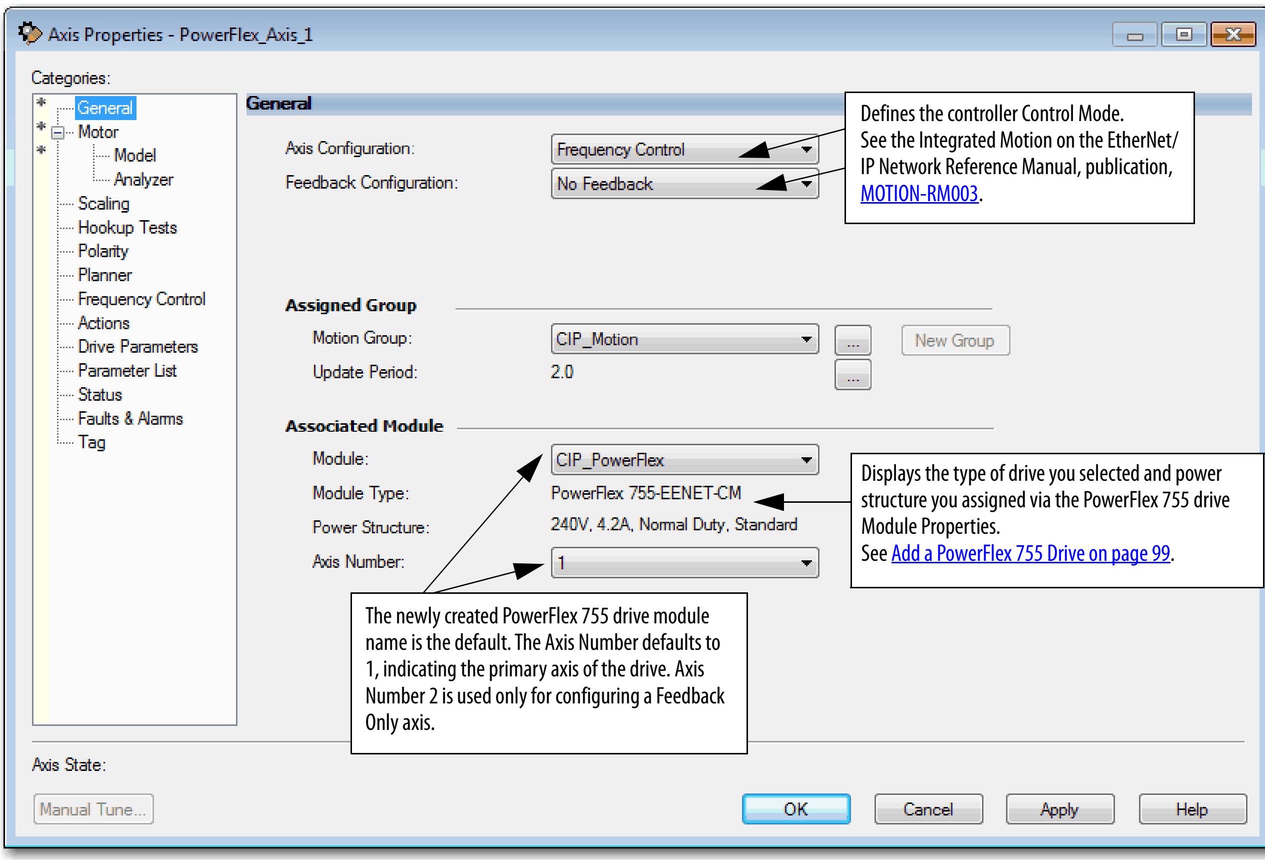
You are now finished configuring an axis as Velocity Loop with No Feedback.

Example 5: Frequency Control with No Feedback

In this example, you are configuring an axis for Frequency Control with No Feedback.

1. Once you have created the AXIS_CIP_DRIVE axis, open the Axis Properties.
2. From the Axis Configuration pull-down menu, choose Frequency Control.
3. From the Feedback Configuration pull-down menu, choose No Feedback.

Figure 75 - Example 5: Frequency Control with No Feedback, General Dialog Box

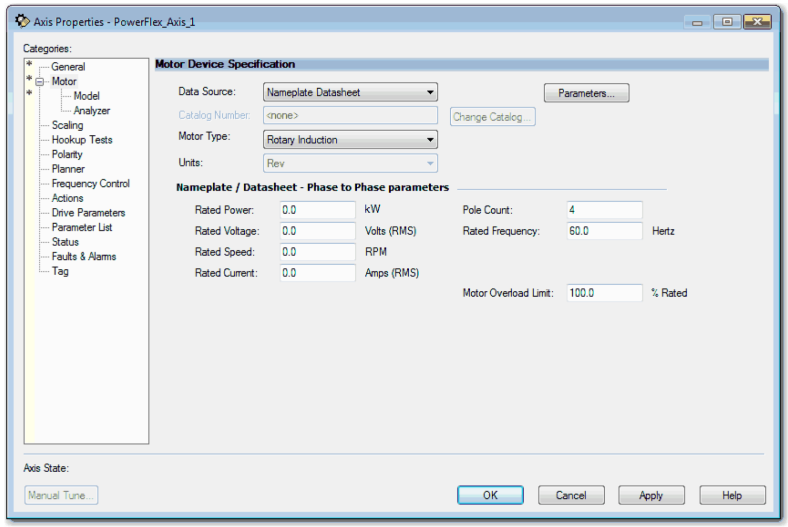


4. From the Data Source pull-down menu, choose a data source.

   In this case, Nameplate data sheet is the Data Source.

   See the Specify the Motor Data Source on page 50 for more information about Data Sources.

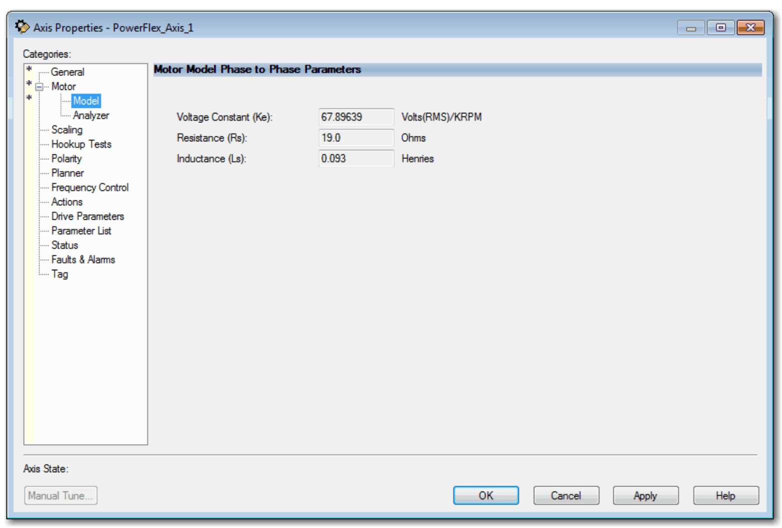
Figure 76 - Example 5: Frequency Control with No Feedback, Motor Dialog Box



In this case, the data source is Catalog Number and the Motion Database provides values for these fields.

See the Display Motor Model Information on page 54 for more information about data sources.

Figure 77 - Example 5: Frequency Control with No Feedback, Motor Model Dialog Box



5. From the Frequency Control Method pull-down menu, choose the appropriate method.
6. Click Apply.

Figure 78 - Example 5: Frequency Control with No Feedback, Frequency Control Dialog Box

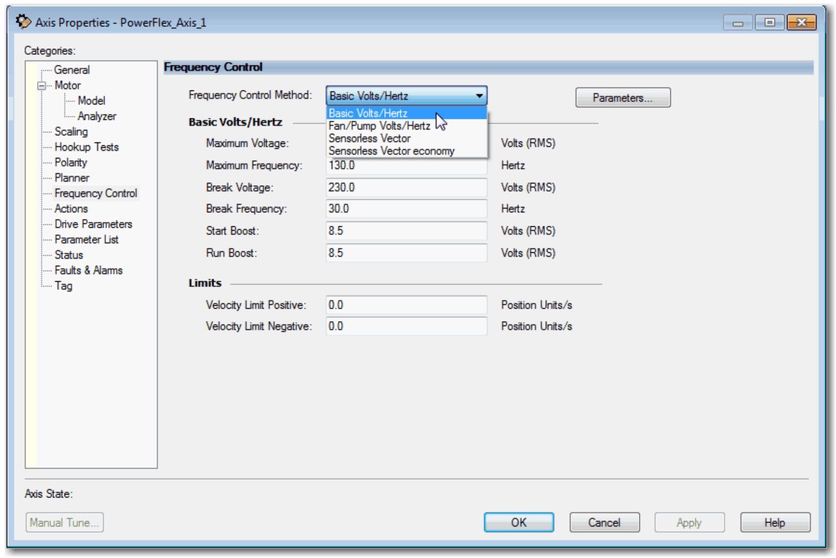


Figure 79 - Example 5: Frequency Control Method, Basic Volts/Hertz

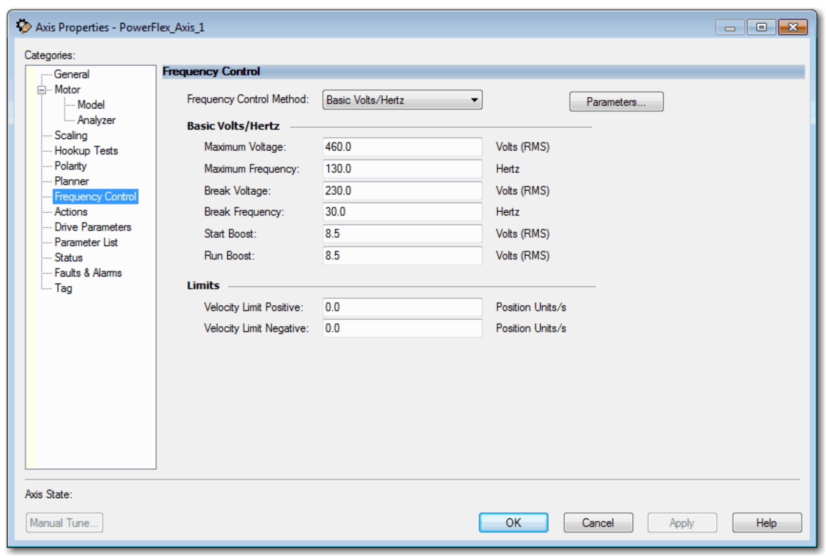
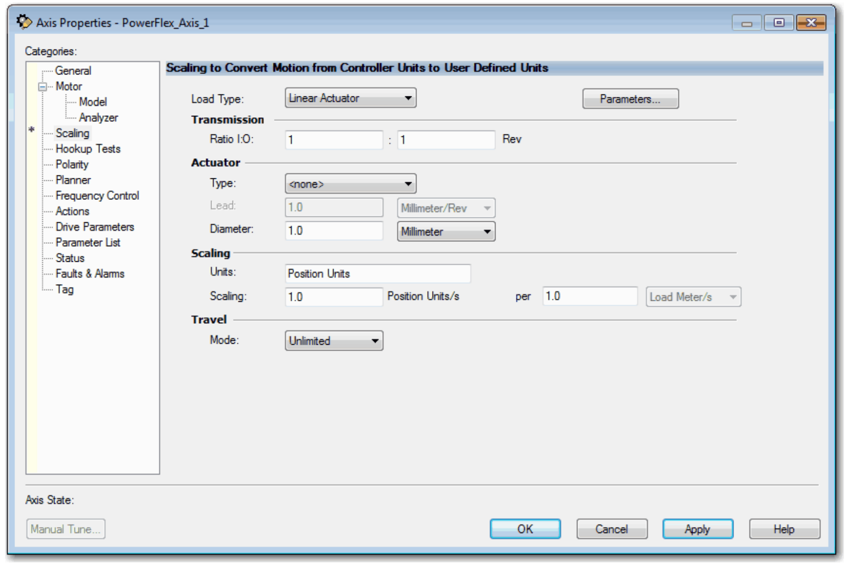


Figure 80 - Example 5: Frequency Control with No Feedback, Scaling Dialog Box Conversion Units



7. From the Load Type pull-down menu, choose the appropriate load type.
8. Enter the Transmission Ratio.
9. From the Actuator Type pull-down menu, choose the appropriate actuator.
10. Enter the Diameter dimensions.
11. Enter the Scaling Units.

    See the Scaling on page 222 for more information.
12. From the Travel Mode pull-down menu, choose the appropriate travel mode.
13. Click Apply.

You are now finished configuring the axis for Frequency Control with No Feedback.

Example 6: Torque Loop with Feedback

In this example, you are configuring the axis for Torque Loop with feedback.

1. Once you have created the AXIS_CIP_DRIVE axis, open the Axis Properties.
2. From the Axis Configuration pull-down menu, choose Torque Loop.
3. From the Feedback Configuration pull-down menu, choose Motor Feedback.

Figure 81 - Example 6: Torque Loop with Motor Feedback, General Dialog Box

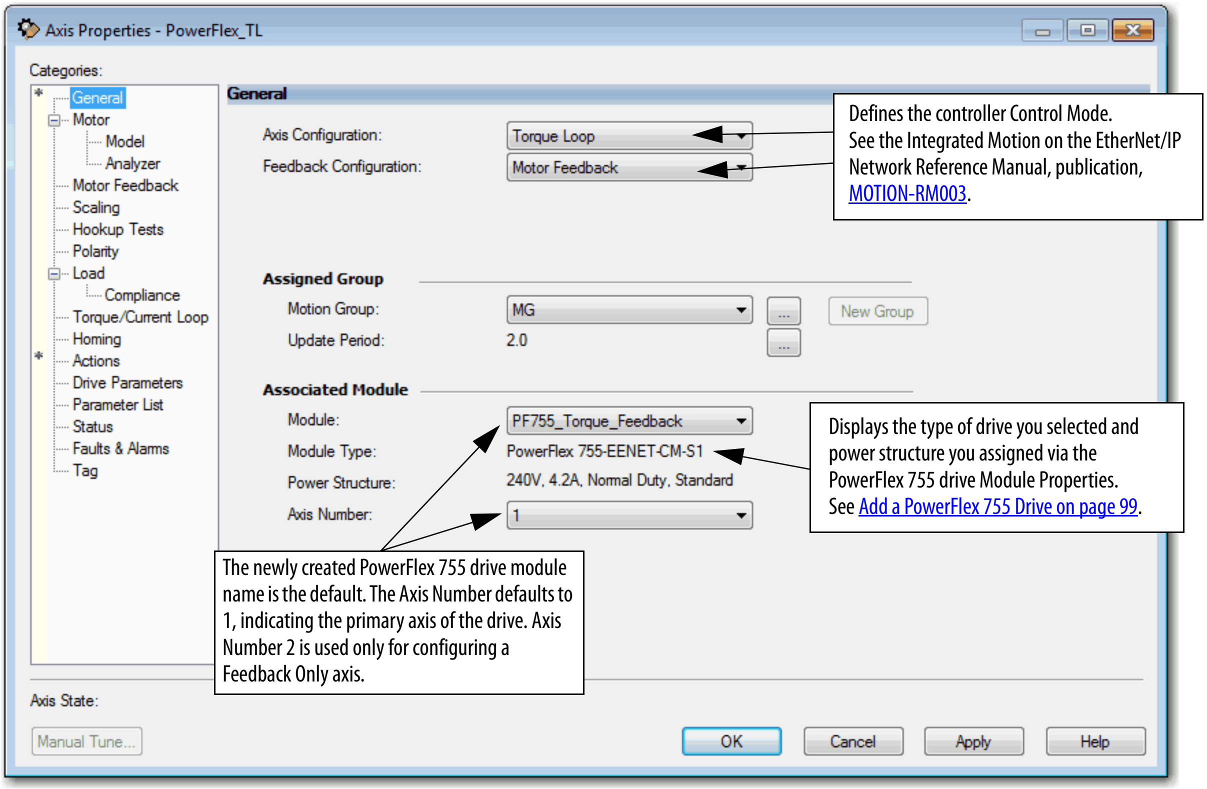


Figure 82 - Example 6: Torque Loop with Motor Feedback, Motor Dialog Box

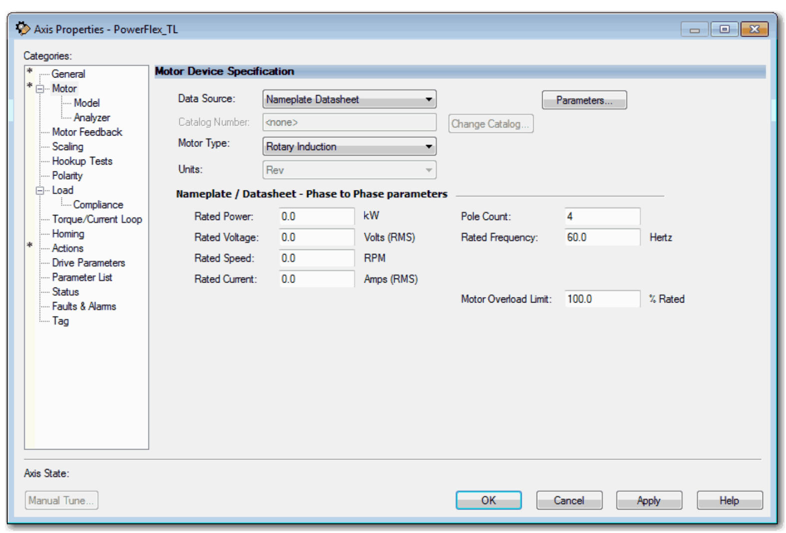
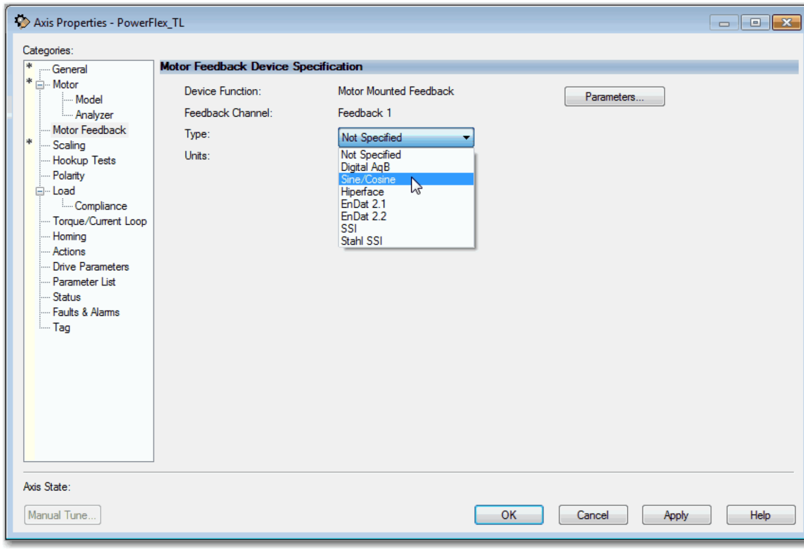


Figure 83 - Example 6: Torque Loop with Motor Feedback, Feedback Type



4. From the Type pull-down menu, choose the appropriate feedback type.

Figure 84 - Example 6: Torque Loop with Motor Feedback, Feedback Type

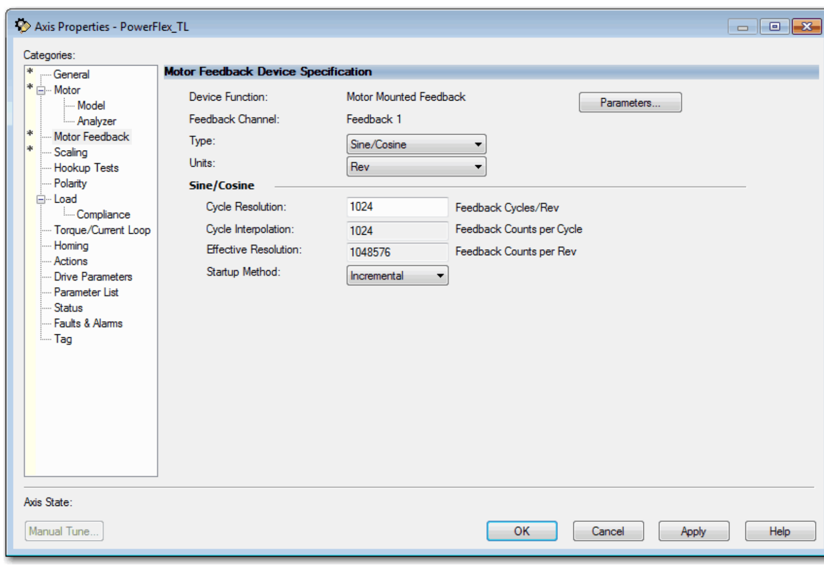
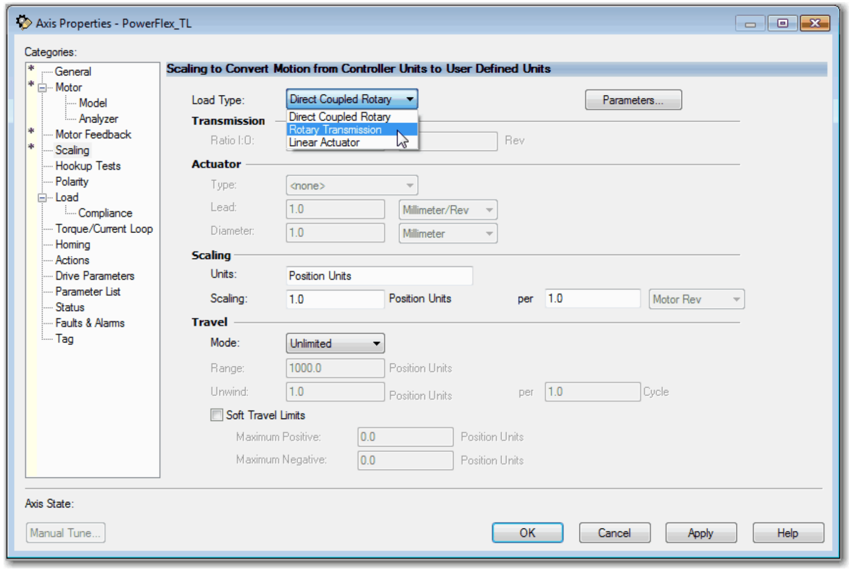
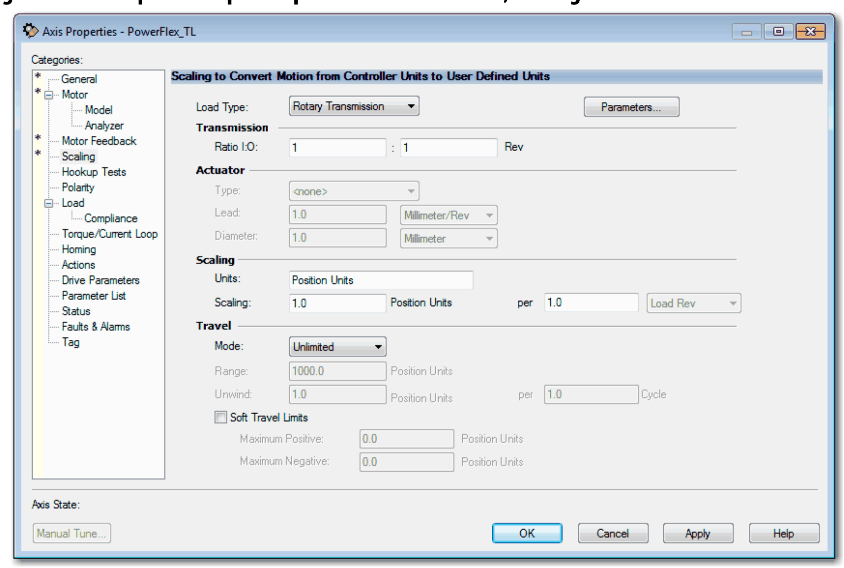


Figure 85 - Example 6: Torque Loop with Motor Feedback, Scaling Load Type



5. From the Load Type pull-down menu, choose the appropriate load type.

Figure 86 - Example 6: Torque Loop with Motor Feedback, Scaling Conversions



6. Enter the Transmission Ratio.
7. Enter the Scaling Units.
8. From the Travel Mode pull-down menu, choose the appropriate travel mode.

   See the Scaling on page 222 for more information.

9. Click Apply.

You are now finished configuring the axis for Torque Loop with Motor Feedback.

Axis Configuration Examples for the PowerFlex 527 Drive

This chapter provides example axis configurations when using a PowerFlex® 527 drive.

The following examples are typical axis-configuration applications for the PowerFlex 527 drive:

- Frequency Control with No Feedback
- Velocity Control with Motor Feedback
- Position Control with Motor Feedback

Example 1: Frequency Control with No Feedback

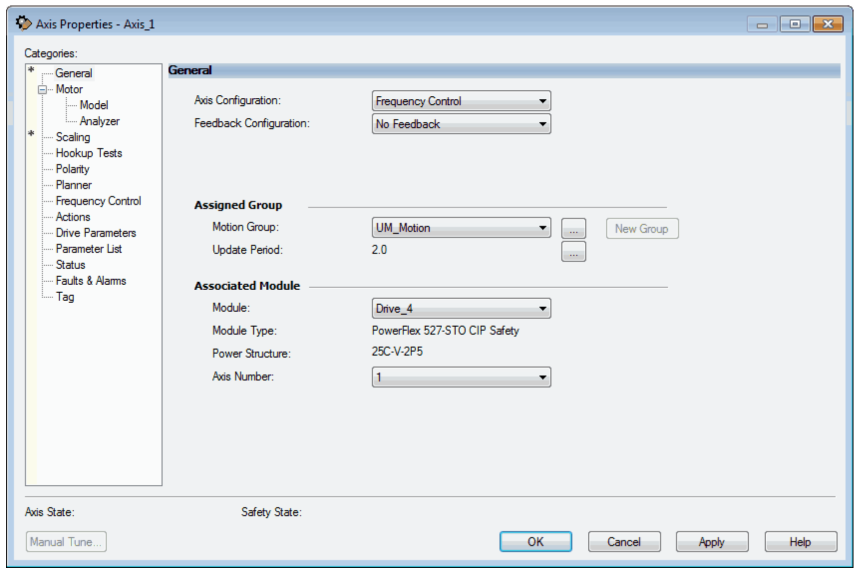
The PowerFlex 527 drives support basic Volts/Hertz (V/Hz), Fan/Pump Volts/ Hertz, Sensorless Vector Control (SVC), and Sensorless Vector Control (SVC) Economy frequency control methods.

Follow these steps to configure the induction motor axis properties.

1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the General category.

   The General and Associated Module dialog box appears.

Figure 87 - Example 1: Frequency Control with No Feedback, General Dialog Box



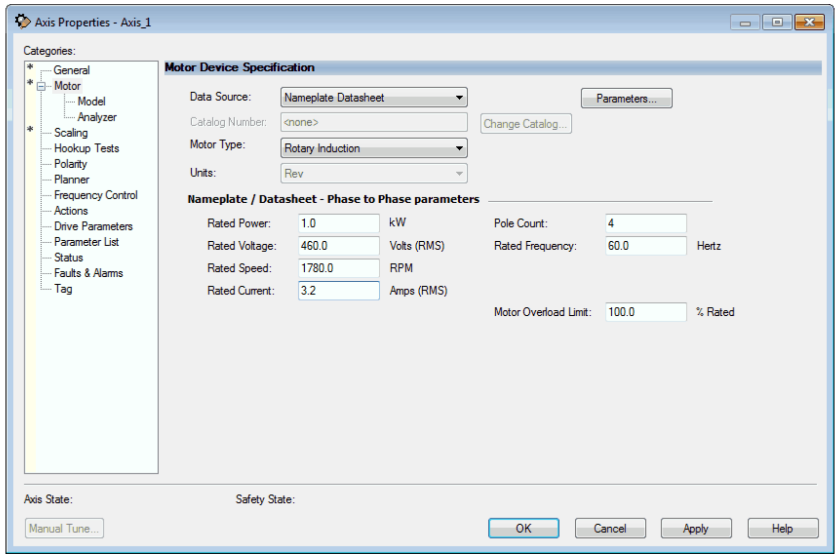
3. From the Axis Configuration pull-down menu, choose Frequency Control.
4. From the Module pull-down menu, your PowerFlex 527 drive.

   The Module Type and Power Structure fields populate with the chosen drive catalog number.
5. Click Apply.

6. Select the Motor category.

   The Motor Device Specification dialog box appears.

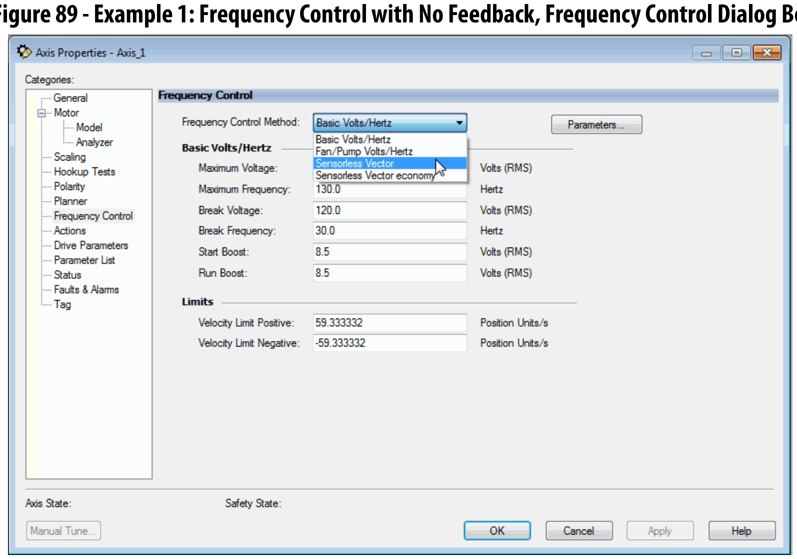
Figure 88 - Example 1: Frequency Control with No Feedback, Motor Device Specification Dialog Box



7. From the Data Source pull-down menu, choose Nameplate data sheet. This selection is the default setting.
8. From the Motor Type pull-down menu, choose Rotary Induction.
9. From the motor nameplate or data sheet, enter the phase-to-phase values.
10. Click Apply.
11. Select the Frequency Control category.

    The Frequency Control dialog box appears.

Figure 89 - Example 1: Frequency Control with No Feedback, Frequency Control Dialog Box



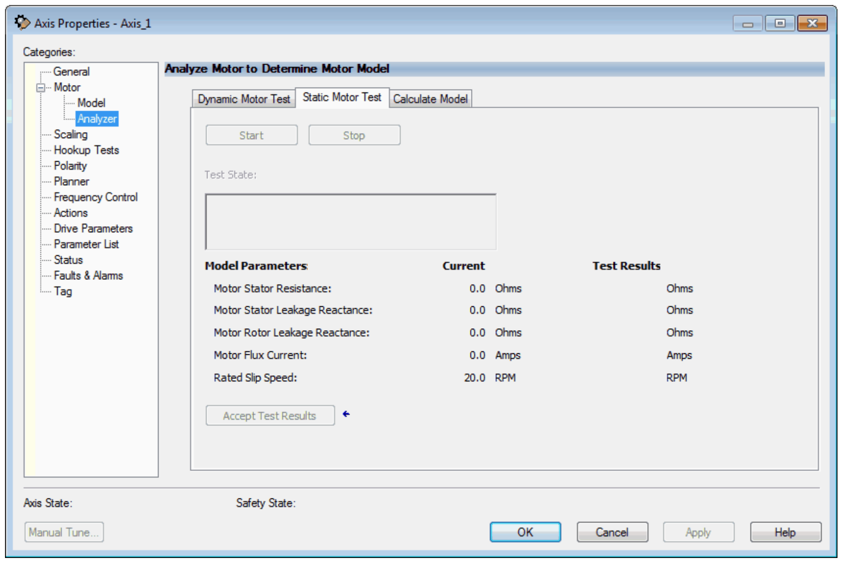
12. From the Frequency Control Method pull-down menu, choose the method appropriate for your application.

13. If you chose the Basic Volts/Hertz method, enter the nameplate data for your motor in the Basic Volts/Hertz fields.

    If you chose the Sensorless Vector method, the Basic Volts/Hertz fields are dimmed.

14. Click Apply.
15. If you chose the Sensorless Vector or Sensorless Vector Economy method, select the Motor > Analyzer category.
16. The Analyze Motor to Determine Motor Model dialog box appears.

Figure 90 - Example 1: Frequency Control with No Feedback, Analyze Motor to Determine Motor Model Dialog Box



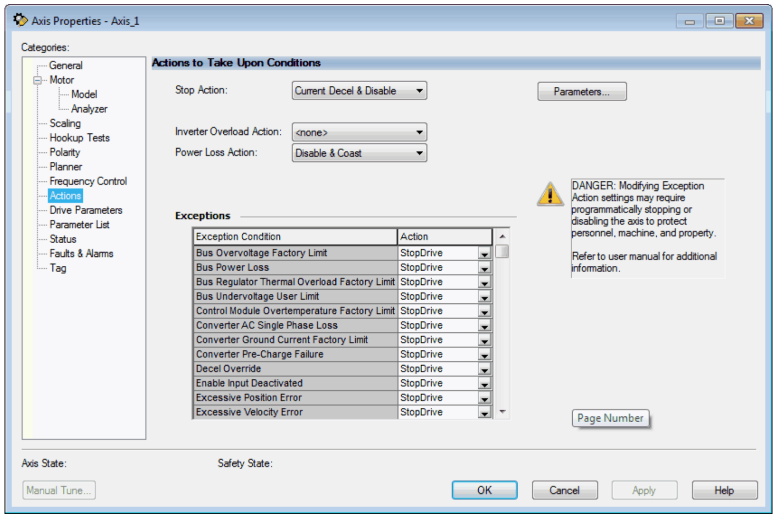
17. Click the Static Motor Test tab.
18. To run the test and measure Motor Stator Resistance, click Start. If you choose the Basic Volts/Hertz category, you can skip this test.

    Some out-of-box settings must be applied here. See Appendix C, PowerFlex® 527 Out-of-Box Configuration on page 339 for more information.

19. Select the Actions category.

    The Actions to Take Upon Conditions dialog box appears.

Figure 91 - Example 1: Frequency Control with No Feedback, Actions to Take Upon Conditions Dialog Box



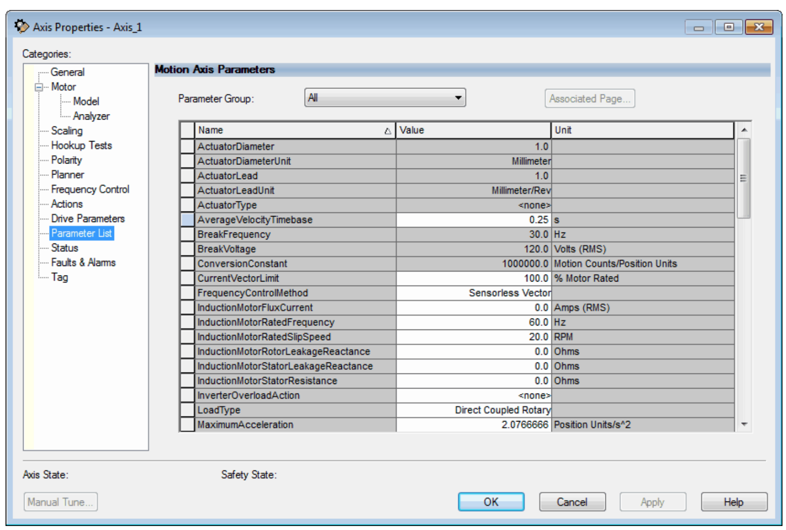
From this dialog box, you can program actions and change the action for exceptions (faults). See the PowerFlex 527 Adjustable Frequency AC Drive User Manual, publication 520-UM002 for more information.

Some out-of-box settings must be applied here. See Appendix C, PowerFlex® 527 Out-of-Box Configuration on page 339 for more information.

20. Select the Parameter List category.

    The Motion Axis Parameters dialog box appears.

Figure 92 - Example 1: Frequency Control with No Feedback, Motion Axis Parameters Dialog Box



From this dialog box, you can program actions and change the action for exceptions (faults). See the PowerFlex 527 Adjustable Frequency AC Drive User Manual, publication 520-UM002 for more information.

To obtain the best performance from the drive, regardless of which control method you are using, configure the recommended out-of-box settings. These settings are described in Appendix C, PowerFlex® 527 Out-of-Box Configuration on page 339.

21. Click OK.
22. Repeat steps 1...21 for each induction motor axis.

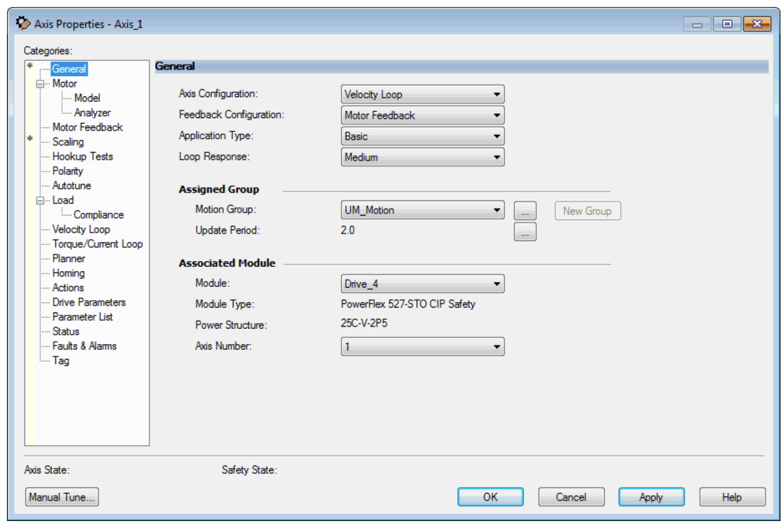
Example 2: Velocity Control with Motor Feedback

Follow these steps to configure the induction motor axis properties.

1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the General category.

   The General and Associated Module dialog box appears.

Figure 93 - Example 2: Velocity Control with Motor Feedback, General Dialog Box



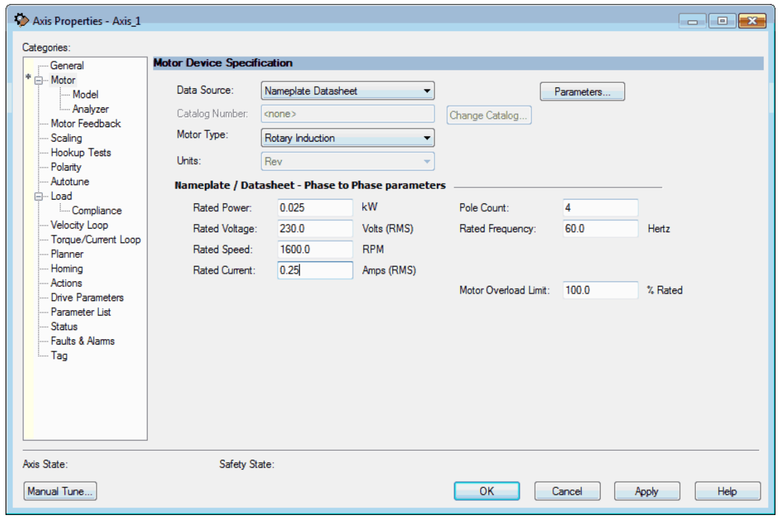
3. From the Axis Configuration pull-down menu, choose Velocity Loop.
4. From the Module pull-down menu, your PowerFlex 527 drive.

   The Module Type and Power Structure fields populate with the chosen drive catalog number.
5. Click Apply.

6. Select the Motor category.

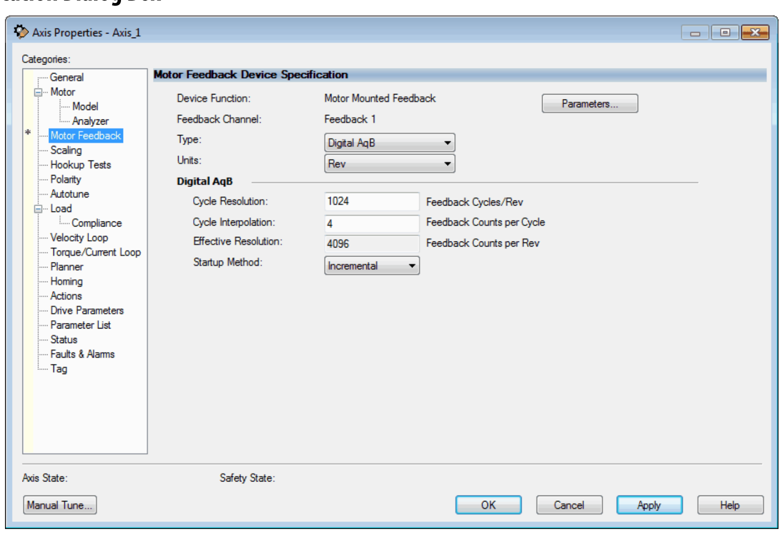
   The Motor Device Specification dialog box appears.

Figure 94 - Example 2: Velocity Control with Motor Feedback, Motor Device Specification Dialog Box



7. From the Data Source pull-down menu, choose Nameplate data sheet. This selection is the default setting.
8. From the Motor Type pull-down menu, choose Rotary Induction.
9. From the motor nameplate or data sheet, enter the phase-to-phase values.
10. Click Apply.
11. Select the Motor Feedback category.

Figure 95 - Example 2: Velocity Control with Motor Feedback, Motor Feedback Device Specification Dialog Box



12. Enter the specifications of your encoder into the fields.
13. Click Apply.

14. Select the Scaling category and edit the values as appropriate for your application.
15. If you changed any settings, click Apply.
16. Select the Actions category.

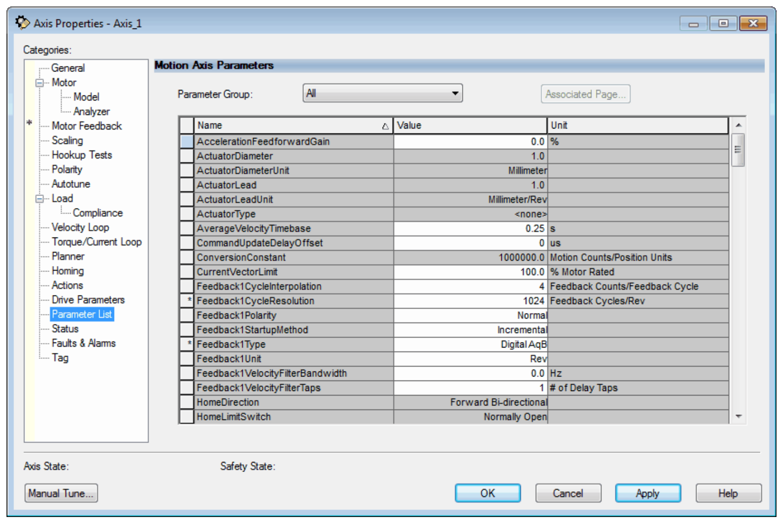
    The Actions to Take Upon Conditions dialog box appears.

    From this dialog box, you can program actions and change the action for exceptions (faults).

    Some out-of-box (OOB) settings must be applied here. See Appendix C on page 339 for more information.
17. Select the Parameter List category.

    The Motion Axis Parameters dialog box appears.

Figure 96 - Example 2: Velocity Control with Motor Feedback, Motion Axis Parameters Dialog Box



From this dialog box, you can program actions and change the action for exceptions (faults). See the PowerFlex 527 Adjustable Frequency AC Drive User Manual, publication 520-UM002 for more information.

To obtain the best performance from the drive, regardless of which control method you are using, configure the recommended out-of-box settings. These settings are described in the PowerFlex 527 Adjustable Frequency AC Drive User Manual, publication 520-UM002.

18. Click OK.
19. Repeat steps 1...18 for each induction motor axis.

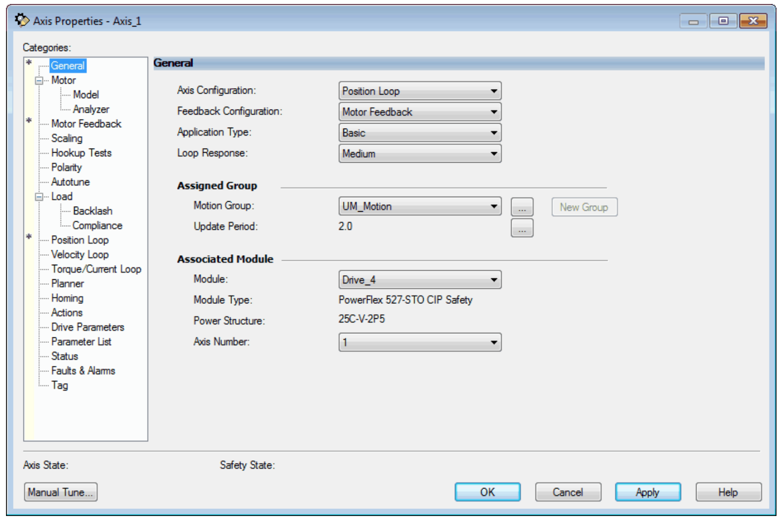
Example 3: Position Control with Motor Feedback

Follow these steps to configure the induction motor axis properties.

1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the General category.

   The General and Associated Module dialog box appears.

Figure 97 - Example 3: Position Control with Motor Feedback, General Dialog Box

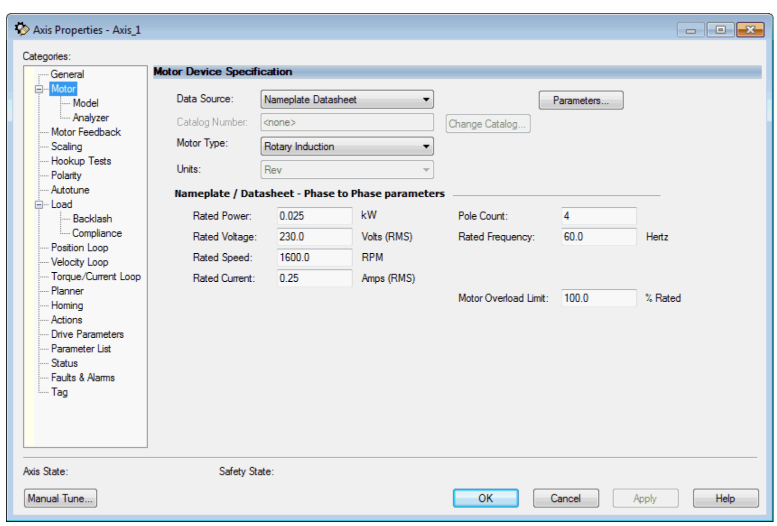


3. From the Axis Configuration pull-down menu, choose Position Loop.
4. From the Module pull-down menu, your PowerFlex 527 drive.

   The Module Type and Power Structure fields populate with the chosen drive catalog number.
5. Click Apply.
6. Select the Motor category.

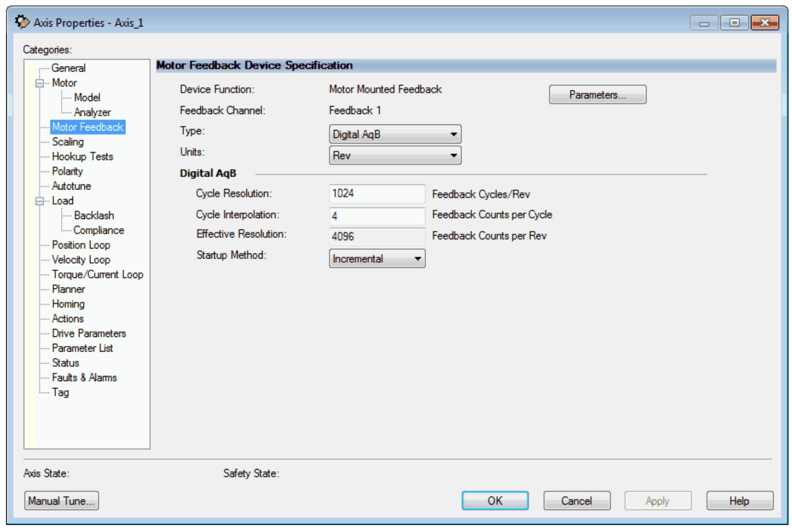
   The Motor Device Specification dialog box appears.

Figure 98 - Example 3: Position Control with Motor Feedback, Motor Device Specification Dialog Box



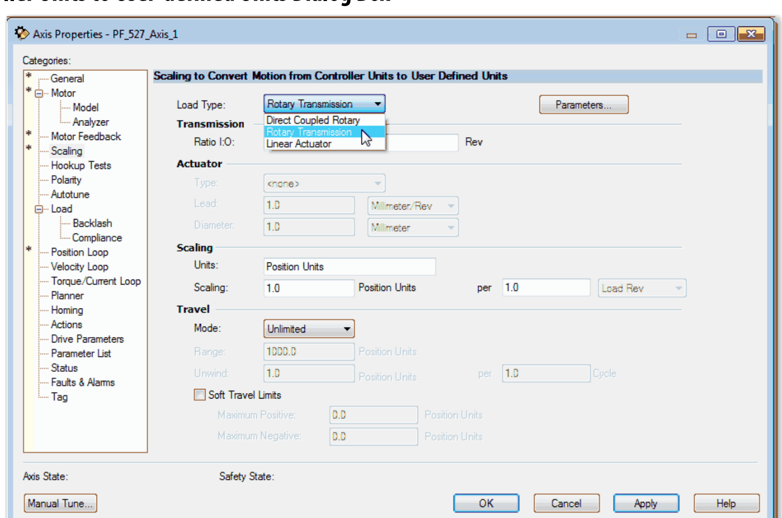
7. From the Data Source pull-down menu, choose Nameplate data sheet. This selection is the default setting.
8. From the Motor Type pull-down menu, choose Rotary Induction.
9. From the motor nameplate or data sheet, enter the phase-to-phase values.
10. Click Apply.
11. Select the Motor Feedback category.

Figure 99 - Example 3: Position Control with Motor Feedback, Motor Feedback Device Specification Dialog Box



12. Enter the specifications of your encoder into the fields.
13. Click Apply.
14. Select the Scaling category and edit the values as appropriate for your application.

Figure 100 - Example 3: Position Control with Motor Feedback, Scaling to Convert Motion from Controller Units to User-defined Units Dialog Box

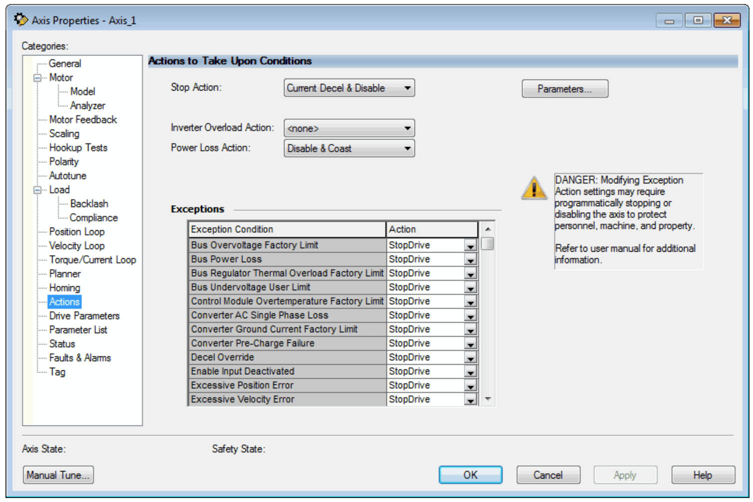


15. If you changed any settings, click Apply.

16. Select the Actions category.

    The Actions to Take Upon Conditions dialog box appears.

Figure 101 - Example 3: Position Control with Motor Feedback, Actions to Take Upon Conditions Dialog Box



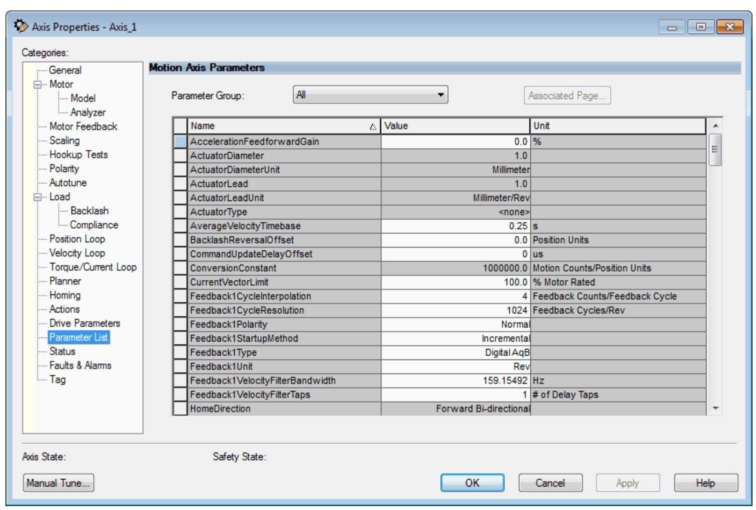
From this dialog box, you can program actions and change the action for exceptions (faults).

Some out-of-box (OOB) settings must be applied here. See Appendix C, PowerFlex® 527 Out-of-Box Configuration on page 339 for more information.

17. Select the Parameter List category.

    The Motion Axis Parameters dialog box appears.

Figure 102 - Example 3: Position Control with Motor Feedback, Motion Axis Parameters Dialog Box



From this dialog box, you can program actions and change the action for exceptions (faults).

To obtain the best performance from the drive, regardless of which control method you are using, configure the recommended out-of-box settings. These settings are described in Appendix C on page 339.

18. Click OK.
19. Repeat steps 1…18 for each induction motor axis.

Commission an Axis

This chapter discusses how to commission an axis for a motion application. Commissioning includes the following:

- Off-line Scaling settings
- How to download a project
- How to run a Hookup Test
- How to perform Tuning
- How to use the Motion Direct Commands

You must commission the axis after you have followed the steps in these sections:

Section	Page
Configure Integrated Motion Control Using Kinetix Drives	21
Configure Integrated Motion Control Using Kinetix 5700 Drives	59
Configure Integrated Motion Using a PowerFlex 755 Drive	99
Configure Integrated Motion Using a PowerFlex 527 Drive	129

Scaling

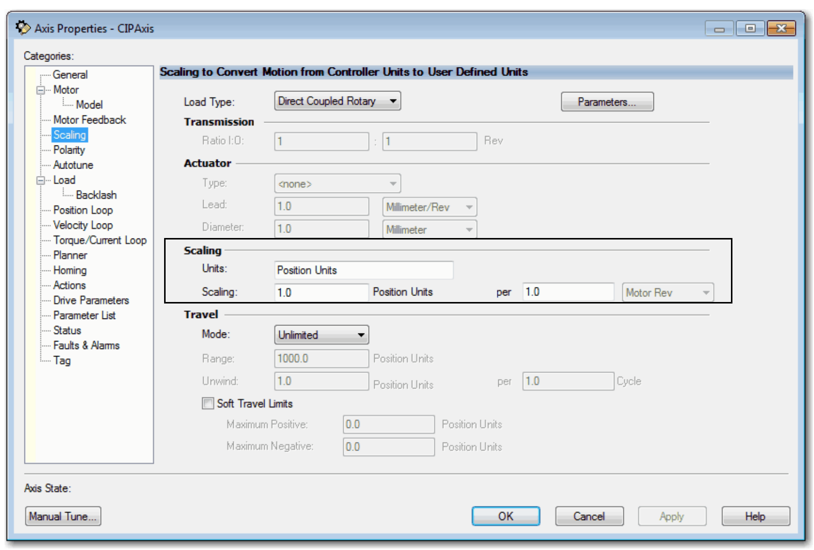
Axis motion can be specified in whatever units you want. In the Scaling dialog box, you configure the motion control system to convert between raw internal-motion units. For example, Feedback Counts or Planner Counts can be converted to your preferred unit of measure, be it revolutions, degrees, meters, or inches.

This conversion involves three key Scaling Factor attributes, Conversion Constant, Motion Resolution, and Position Unwind. If you use the Scaling dialog box, the software calculates the Scaling Factors for you. The only task that you do is select the Load Type that best matches the mechanical linkage between the motor and the load.

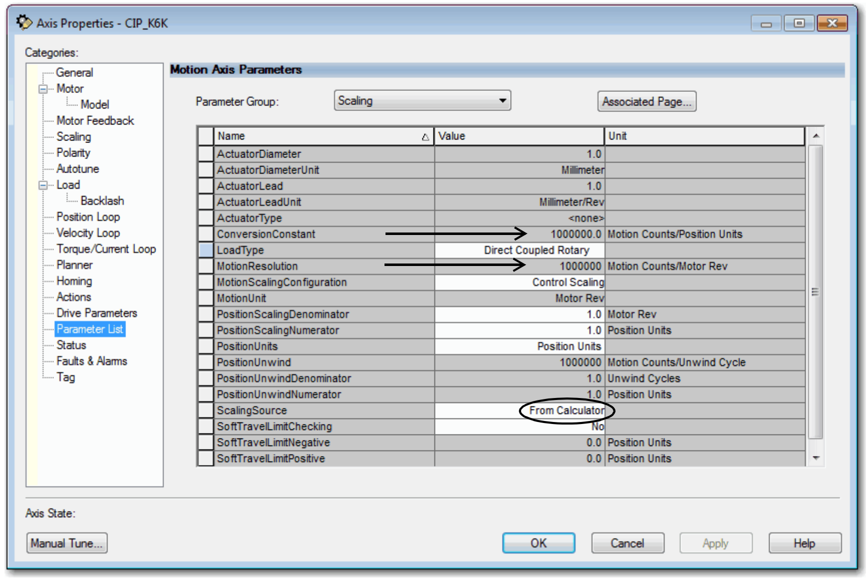
There are four Load types:

- Direct Coupled Rotary
  The load is directly coupled to the linear motor moving mass.
- Direct Coupled Linear
  The load is directly coupled to the linear motor moving mass.
- Rotary Transmission
  The rotational load is coupled to the motor through a geared transmission.
- Linear Actuator
  The linear load is coupled to a rotary motor through a rotary to linear mechanical system.

This figure shows the default Scaling dialog box for a Direct Coupled Rotary load type. By default, the Scaling dialog box is set for 1 'Position Unit' per Motor Rev.



When you click Parameters, you see values for the Conversion Constant and the Motion Resolution, each having a value of 1 million. These values are generated from the software calculator.

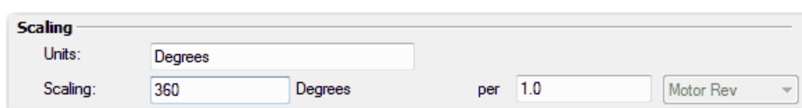


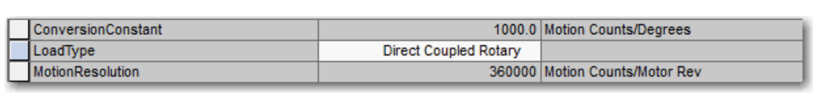
In most cases, the software scaling calculator generates Scaling Factor values that are suitable for the application. But in rare cases, like applications that require online product recipe changes, you can set the Scaling Source attribute to Direct Scaling Factor Entry. This attribute allows you to enter the Scaling Factors.

Direct Coupled Rotary

For a Direct Coupled Rotary load type, you can express Scaling Units for the rotary motor, for example, Degrees.

Here is an example of Direct Coupled Rotary load that is scaled in Degrees and the resulting values for the Conversion Constant and Motion Resolution.

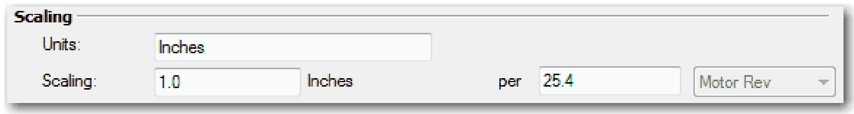




Direct Coupled Linear

For a Direct Coupled Linear load type, you can express Scaling Units for the linear motor, for example, Inches.

Here is an example of Direct Coupled Linear load that is scaled in Inches and the resulting values for the Conversion Constant and Motion Resolution.



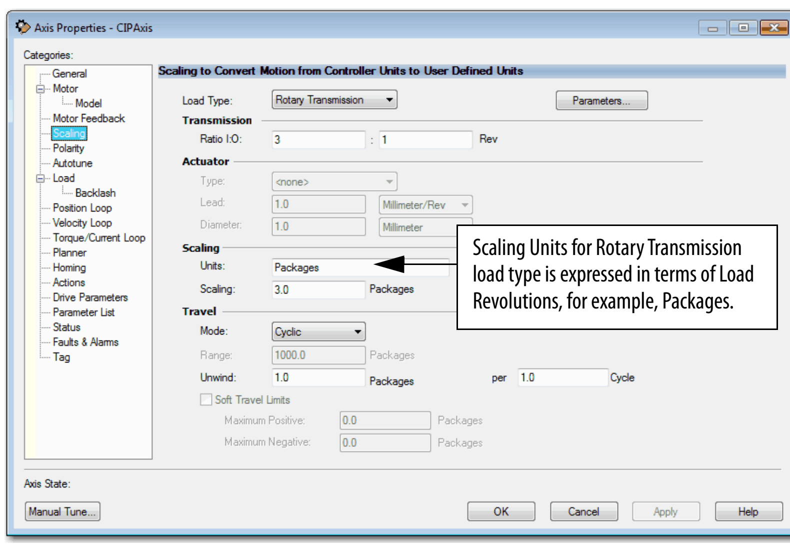
ConversionConstant	25400000.0	Motion Counts/Inches
LoadType	Direct Coupled Rotary	
MotionResolution	1000000	Motion Counts/Motor Rev

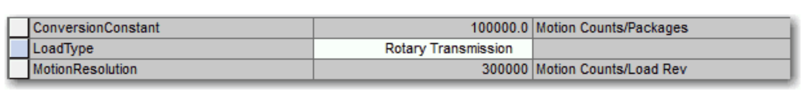
For more information about Conversion Constant and Motion Resolution, see the Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003.

Rotary Transmission

For a Rotary Transmission load type, you enter the Transmission ratio mechanical system. When you allow the software scaling calculator to compute the Scaling Factors by using the Transmission Ratio, it reduces the risks of cumulative errors due to irrational numbers.

Here is an example of Rotary Transmission load that is scaled in Packages (three packages per Load Revolution) and the resulting values for the Conversion Constant and Motion Resolution.

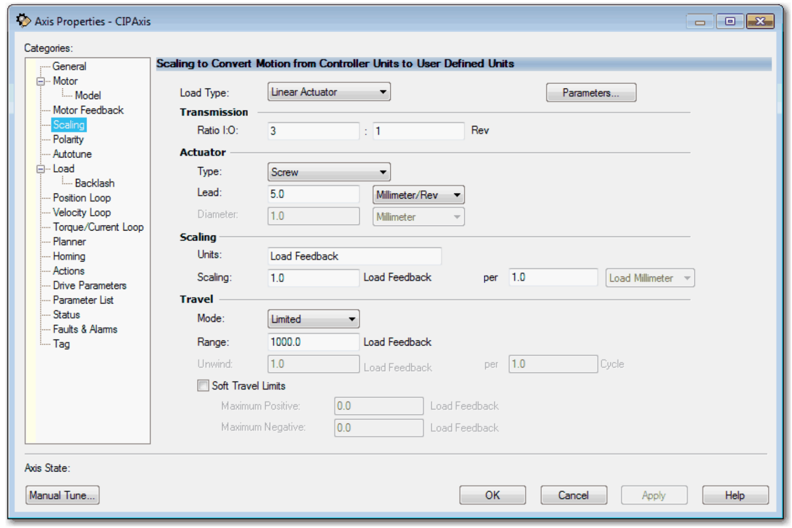




ConversionConstant	100000.0	Motion Counts/Packages
LoadType	Rotary Transmission	
MotionResolution	300000	Motion Counts/Load Rev

Linear Actuator

With the Linear Actuator load type, you can specify the characteristics of the linear actuator mechanics by the Actuator Type.

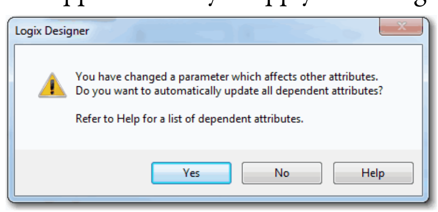


	ConversionConstant	10000.0	Motion Counts/Load Feedback
	LoadType	Linear Actuator	
	MotionResolution	10000	Motion Counts/Load Millimeter

Changing Scaling Factors

Changing Scaling configuration factors can have a significant impact on the calculations of factory defaults for scaling dependent-axis configuration attributes.

If you change a scaling factor that impacts other attributes, the following dialog box appears when you apply the change.



This dialog box gives you the choice to recalculate factory defaults for scaling dependent attributes.

1. To recalculate and apply all dependent attribute values, click Yes.
2. To apply only changes to the scaling attributes, click No.

Once you have applied your configurations, the factory defaults for dynamic configuration attributes, for example, gain, limits, and filter settings are automatically computed. The calculations are based on your drive and motor configuration settings and selection for application type and loop response.

The factory defaults yield a stable operational system that can then be tailored to the specific requirements for many types of machine applications.

You can use Autotune to improve performance if the gain set provided to you by the factory defaults does not satisfy the configuration requirements of your system.

See Autotune on page 235.

Hookup Tests

Use the Hookup Tests dialog box to perform the following:
- Check your cabling
- Adjust motor and feedback polarity
- Establish your sense of positive motion direction
- If applicable, check encoder marker and commutation function

To run any of the Hookup Tests, you must first download your program.

ATTENTION: These tests can actively move the axis even with the controller in remote Program mode:
- Before you do the tests, make sure no one is in the way of the axis.
- Changing motor or feedback after performing the Hookup Test can result in an axis-runaway condition when the drive is enabled.
- To avoid personal injury or damage to equipment, you must remove the load from each axis as uncontrolled motion can occur when an axis with an integral motor brake is released during the test.

The type of drive and the combination of the Axis and Feedback configuration types you choose determine what Hookup tests are available.

Table 46 - Types of Hookup Tests

Test	Description
Marker	Checks that the drive gets the marker pulse. You must manually move the axis for this test.
Motor and Feedback	Tests the polarity of the motor, motion, load, and motor feedback.
Motor Feedback	Tests the polarity of the motor feedback.
Load Feedback	Test the load feedback polarity of the motor.
Commutation	Tests the commutation offset and polarity of a drive.
Master Feedback	Test the master feedback polarity.

Table 47 lists the Hookup Tests that is based on axis configuration and drive type.

Table 47 - Types of Hookup Tests

Axis Type	Feedback Type	Drive(1)	Master Feedback	Motor and Feedback	Motor Feedback	Load Feedback	Marker	Commutation
Feedback Only	Master Feedback	Kinetix® 5500	x				x	
		Kinetix 5700	x				x	x
		Kinetix 6500	x				x	
Frequency Control	No Feedback	Kinetix 5500		x				
		Kinetix 5700		x				x
		PowerFlex® 527		x				
		PowerFlex 755		x				
Position Loop	Motor Feedback	Kinetix 350		x	x		x	
		Kinetix 5500		x	x		x	
		Kinetix 5700		x	x		x	x
		Kinetix 6500		x	x		x	x
		PowerFlex 527		x	x		x	
		PowerFlex 755		x	x		x	x
	Load Feedback	Kinetix 5700		x	x	x	x	x
		Kinetix 6500		x	x	x	x	
	Dual Feedback	Kinetix 5700		x	x	x	x	x
		Kinetix 6500		x	x	x	x (motor)	x (motor)
		PowerFlex 755		x	x	x	x (motor)	x (motor)
	Dual Integrated Feedback	PowerFlex 755		x	x	x	x (motor)	x (motor)
Velocity Loop	Motor Feedback	Kinetix 350		x	x		x	
		Kinetix 5500		x	x		x	
		Kinetix 5700		x	x		x	x
		Kinetix 6500		x	x		x	x
		PowerFlex 527		x	x		x	
		PowerFlex 755		x	x		x	x
	Load Feedback	Kinetix 5700		x	x	x	x	x
		Kinetix 6500		x	x	x	x	x
Torque Loop	No Feedback	PowerFlex 755		x				
	Motor Feedback	Kinetix 350		x	x		x	
		Kinetix 5500		x	x		x	
		Kinetix 5700		x	x		x	x
		Kinetix 6500		x	x		x	x
		PowerFlex 755		x	x		x	x
	Load Feedback	Kinetix 6500		x	x	x	x	x

(1) For the Kinetix 5700 drive, see the Kinetix 5700 Multi-axis Servo Drives User Manual, publication 2198-UM002.

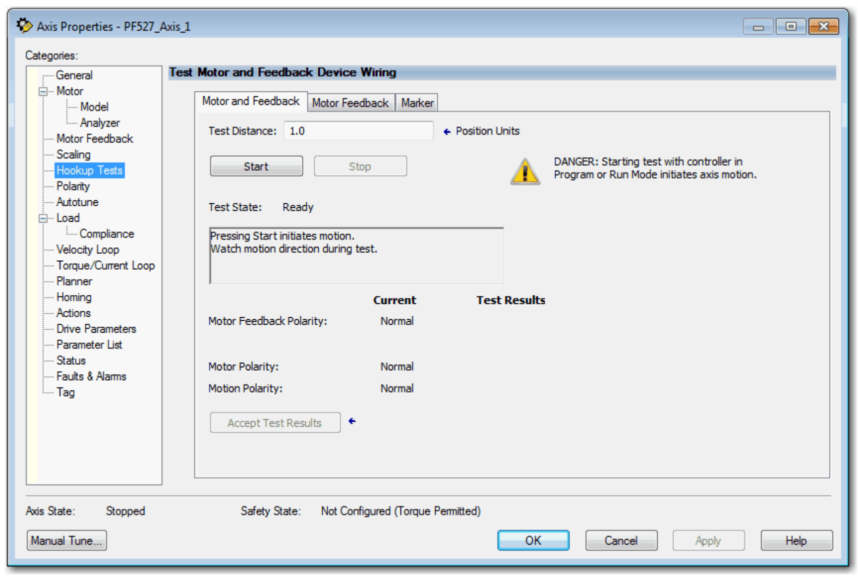
Run a Motor and Feedback Test

The Motor and Feedback Test is the most commonly used Hookup Test because it automatically tests both the motor and feedback wiring and determines correct polarity values.

ATTENTION: These tests make the axis move even with the controller in remote Program mode. Before you do the tests, make sure no one is in the way of the axis.

Follow these steps to perform a Motor and Feedback Hookup Test.

1. Go to the Hookup Tests dialog box.

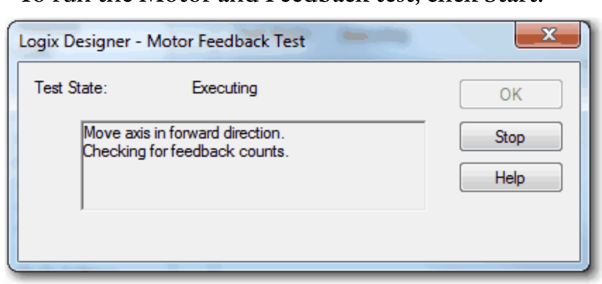


Remember that a blue arrow next to a field means that when you change its value the new value automatically gets written to the controller when you leave the field.

2. Enter the Test Distance.

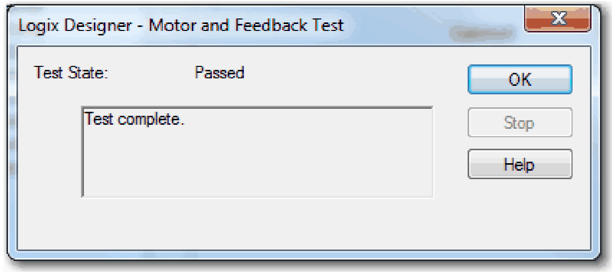
   The Test Distance is the distance that the test moves the axis.

3. To run the Motor and Feedback test, click Start.

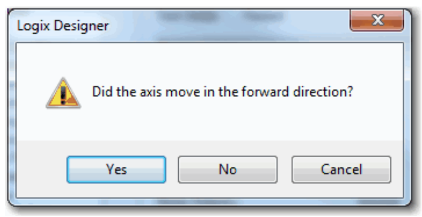


4. The axis moves on its own to test for feedback polarity and proper wiring. To check for proper rotation direction, watch the axis.

   The drive determines that the feedback device is working properly and the test passed.



5. Click OK.

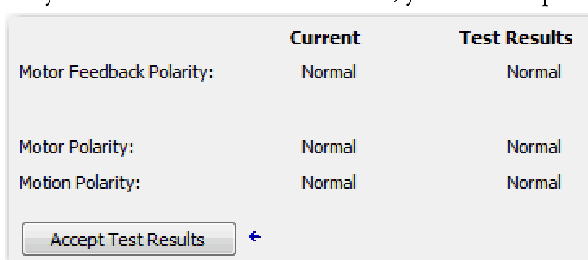


6. If your axis moved in a forward direction, click yes and you see that the test result is Normal.

   If the motor does not move in the forward direction, according to your application the test result is inverted. When you accept test results the Current shows inverted.

   See the Polarity on page 235.

   If you are satisfied with the results, you can accept the test results.



   The test can pass but give you results that you are not expecting. In this case, you can have a wiring problem.

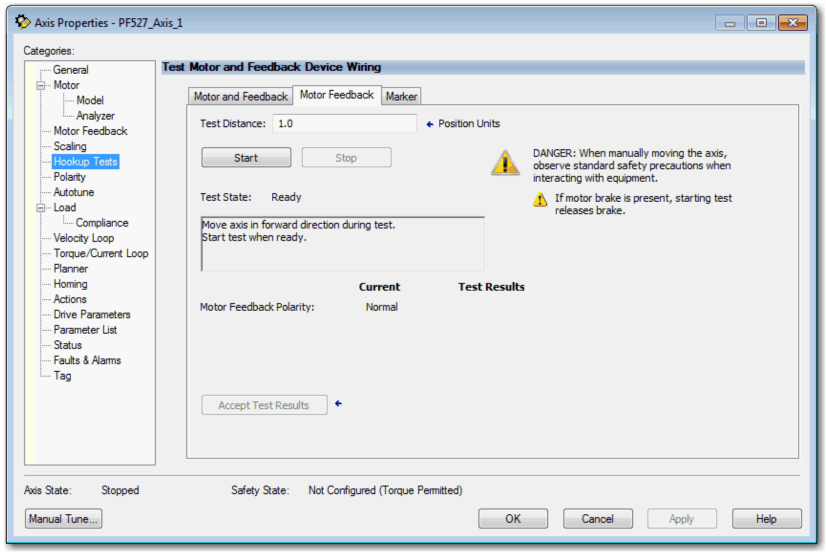
   See the related drive documentation that is listed in the Additional Resources on page 9.

7. Click Yes or No depending on whether the axis moved in the forward direction for your application.
8. Click Accept Results, if the test ran successfully.

Run a Motor Feedback Test

The Motor Feedback Test checks the polarity of the motor feedback. Follow these steps to perform a Motor Feedback test.

1. From the Hookup Tests dialog box, click the Motor Feedback tab.



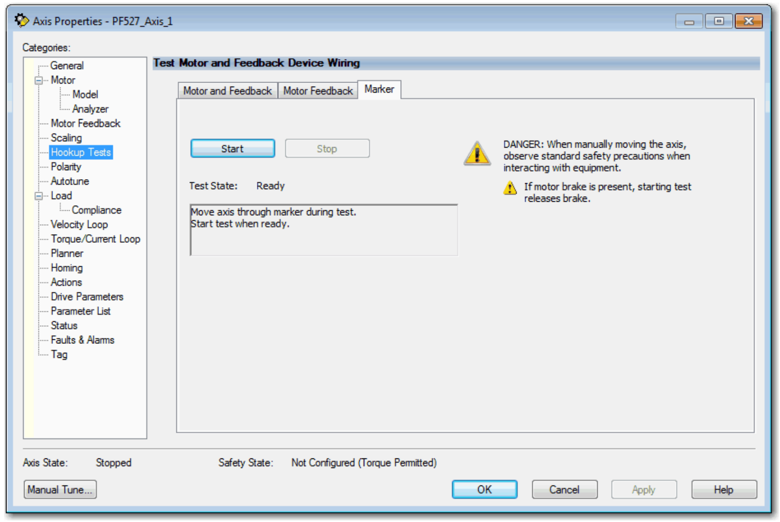
2. Enter the Test Distance.
3. Click Start.

Run a Marker Test

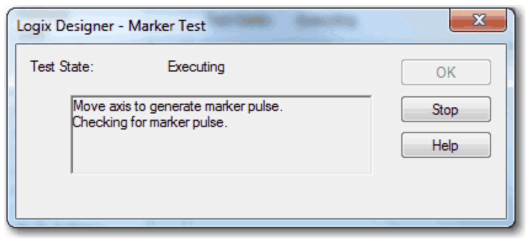
The Marker Test checks that the drive receives the marker pulse from the position feedback device. You must manually move the axis for this test. Follow these steps to perform a Marker test.

1. From the Hookup Tests dialog box.
2. Click the Marker tab.

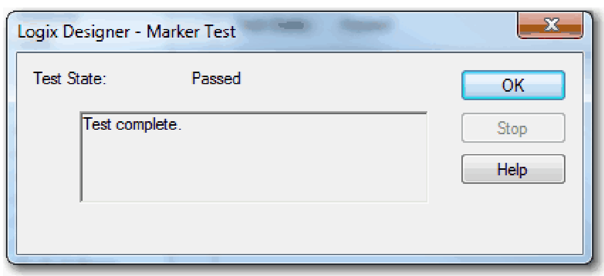
3. To check for the marker pulse, click Start.



4. Manually move the axis until you get the marker pulse.



The drive receives the marker pulse and the test passed.



5. Click OK.

Applying the Commutation Hookup Test

The Commutation Test determines an unknown Commutation Offset and potentially the unknown polarity of the startup commutation wiring. The Commutation Test can be used also to verify both a known Commutation Offset and the polarity startup commutation wiring. This test is applied to third-party or custom Permanent Magnet motors that are not available as a Catalog Number in the Motion Database.

TIP For linear stages, make sure that there is enough available travel, otherwise the commutation test produces a fault.

When a motor needs a Commutation Offset and you are not using Catalog number as the Motor Data Source, you cannot enable the axis.

There are several different cases where the Commutation Hookup Test can be applied to a PM motor:

- Unknown Commutation Offset
- Verification of Known Commutation Offset
- Non-standard or Incorrect Wiring

Unknown Commutation Offset

The primary use for the Commutation Hookup Test is the case where the machine is equipped with a PM motor that has an unknown Commutation Offset.

The Commutation Offset, and potentially Commutation Polarity, can be unknown for different reasons, including an unprogrammed 'smart encoder' or any generic third-party encoder where Commutation Offset is unknown.

TIP The Kinetix 350 and the Kinetix 5500 drives do not support the Commutation Polarity attribute.

Verification of Known Commutation Offset

Another use of the Commutation Test is to verify that the motor is wired correctly and has the expected Commutation Offset. A machine engineer can decide not to correct for a wiring error in software but rather flag a wiring error so that it can be physically corrected. Incorrect wiring of the motor power phases, encoder signal wiring, or commutation signal wiring can show up as an unexpected Commutation Offset.

For example, suppose that a motor was wired in a ‘WUV’ sequence instead of the normal ‘UVW’ sequence. The motor would still rotate in the correct direction, but the Commutation Test indicate that the Commutation Offset was off by a factor of 120 electrical degrees.

After running the Motor and Feedback Hookup Tests, you can run the Commutation Test to determine the specific Commutation Offset and Commutation Polarity. The drive executes the Commutation Test, which includes motor rotation in the positive direction by at least one revolution. The results of the Commutation Test are reported back to compare against the known Commutation Offset and Commutation Polarity to determine if a wiring issue exists.

Non-standard or Incorrect Wiring

The Commutation Test can also be applied to a PM motor that is wired in a non-standard manner or incorrectly. If there is incorrect wiring, it is sometimes desirable to mitigate the problem via software. You can use software mitigation on larger machines where changes to the wiring would be difficult due to the size and location of the wiring.

After running the Motor and Feedback Hookup Tests, you can run the Commutation Test to determine the specific Commutation Offset and Commutation Polarity. The drive executes the Commutation Test, which includes motor rotation in the positive direction by at least one revolution. The results of the Commutation Test are reported back for review. If the results are satisfactory, you can accept the results as part of the stored axis configuration of the controller to establish the correct wiring polarity.

Run a Commutation Test

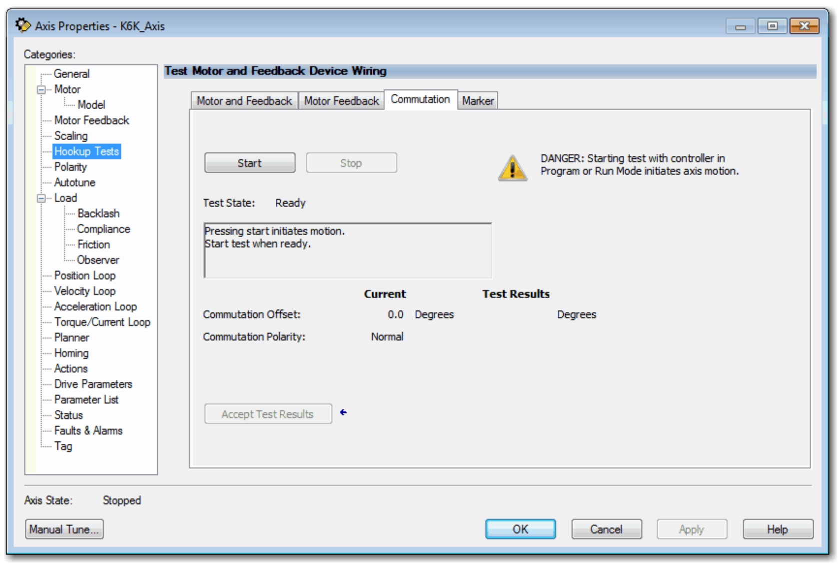
Set the Motor and Feedback Polarity by using the Motor and Feedback Test before running the Commutation Test. This setting helps make sure that the motor spins in the correct direction for the Commutation Test for monitoring the Commutation Angle.

TIP Run the Motor and Feedback Test first to determine that your feedback is working. If the Feedback is not working, the Commutation Test gives you incorrect results or the test times out.

Follow these steps to run a commutation test.

1. To run the Commutation Test to determine the Commutation Offset and Commutation Polarity, click Start.

   TIP The Kinetix 350, Kinetix 5500, and PowerFlex 527 drives do not support the Commutation Polarity attribute.



   The drive executes the Commutation Test, which includes motor rotation in the positive direction by at least one revolution.

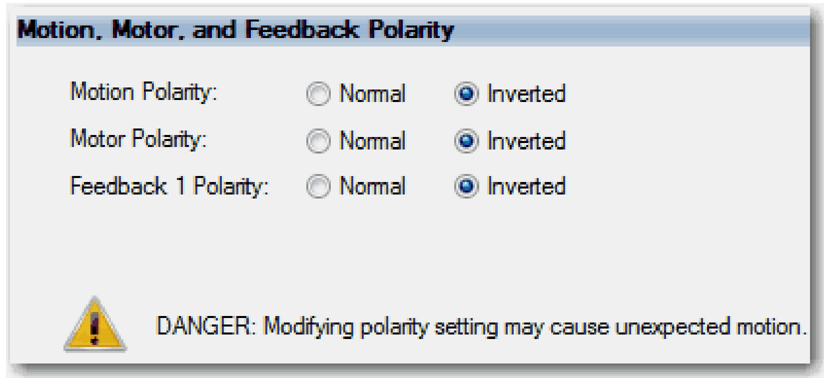
   The results of the Commutation Test appear.

2. If the results are satisfactory, click Accept Test Results.

   Commutation Offset and Polarity results are stored in the controller as part of the axis configuration that is sent to the drive during initialization.

Polarity

If you have run the Motor and Feedback Hookup Test, the settings on the Polarity dialog box are already correct for the application. If the polarity settings are known and cables to the motor and feedback devices are prefabricated and tested, the polarity settings can be entered on this dialog box.



The axis is now ready for operation. You can use Direct Commands to initiate axis motion or you can run your application program. If you find that the dynamic performance of your axis does not meet your system requirements, use Autotune to improve performance.

Autotune

Once you have set the parameters and performed tasks in the General, Motor, Motor Feedback, Scaling, Hookup Test, and Polarity dialog boxes, you are ready to Autotune, if necessary.

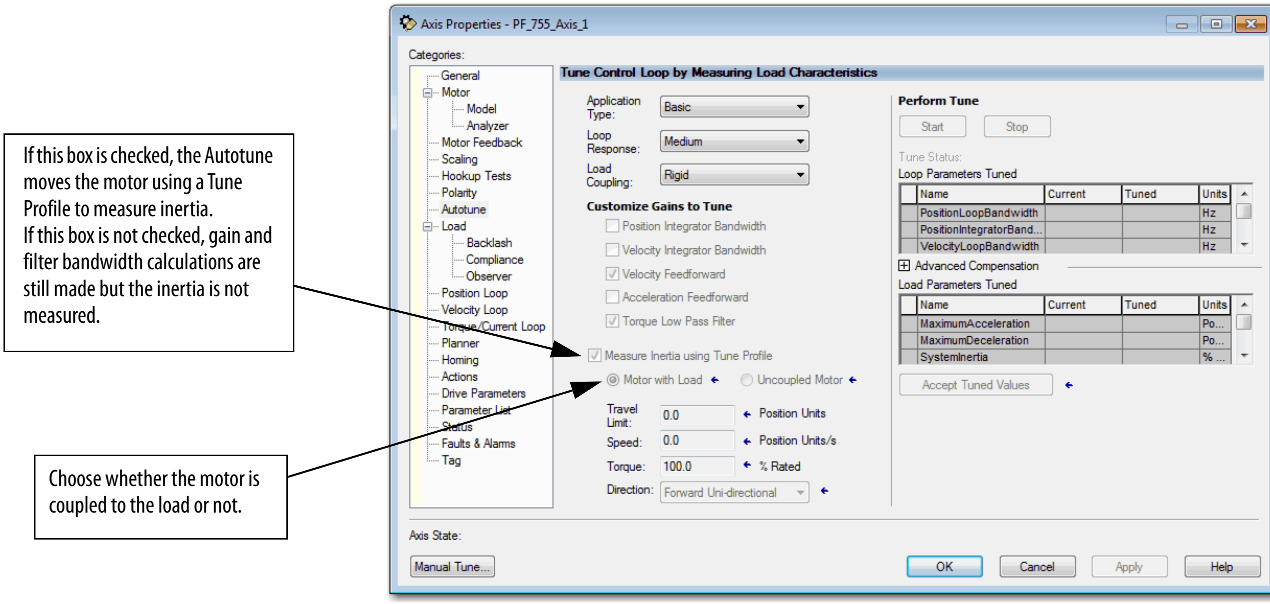
Typically you do not need to use Autotune or Manual Tune. Once you select your drive and use the Motion Database as the data source, the defaults often provide adequate tuning performance. If not, use autotune to adjust the parameters. For detailed tuning information, see the Motion System Tuning Application Technique, publication MOTION-AT005.

ATTENTION: When you tune an axis, it moves even with the controller in Remote Program mode. In that mode, your code is not in control of the axis. Before you tune an axis, make sure no one is in the way of the axis.

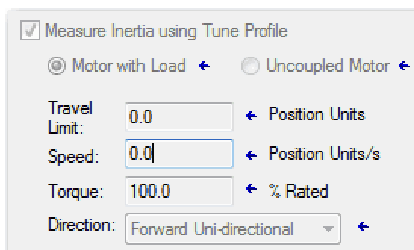
If the drive has not been enabled before (new installation), verify that you have safeguards in place to safely remove power from the drive if there is an unstable situation where the drive can produce undesired motion.

To use the Autotune feature, use the following steps.

1. Click the Autotune dialog box.



To configure the Tune Profile, you enter the Travel Limit, Speed, Torque, and Direction.



2. Set the Travel Limit that is based on the travel constraints of the machine.
3. Set the Speed to the expected operation speed.
4. Set the Torque to the level you want to apply to the motor during the Autotune.

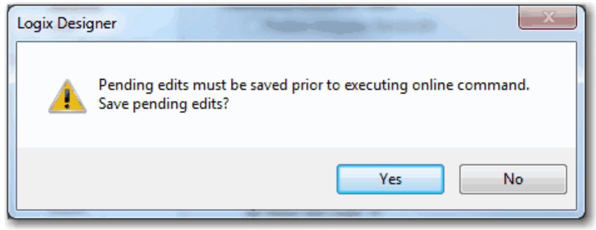
   The default of 100% Rated Torque usually give good results.
5. Set the Direction that is based on machine constrains.

   Unidirectional tune profile measures inertia and friction. Bidirectional tune profile adds measurement of active torque loading.

TIP Blue arrows next to a field means that these values are immediately applied. Once you put a value in the field and then leave that field, it is automatically sent to the controller.

6. Click Start.

This message appears if you have edits that have not been applied. If you do not save edits that are pending, Autotune does not run.

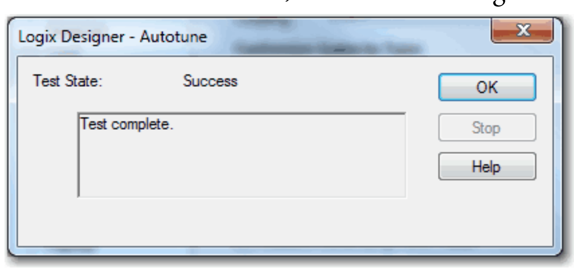


The Autotune status displays Success. A tune configuration fault can occur if any number of attributes are zero.

Fault	Description
Tune Configuration Fault	A tune configuration fault can occur if any number of attributes are zero. This fault occurs only when you use Nameplate Data as the motor data source. The following attributes are checked for zero: • Tuning Torque • Conversion Constant • Drive Model Time Constant • System Damping (Damping Factor) • Rotary Motor Inertia • Linear Motor Mass – The Kinetix 350 drive does not support this attribute. • Motor Rated Continuous Current • PM Motor Rotary Voltage Constant • PM Motor Linear Voltage Constant • Rotary Motor Rated Speed • Linear Motor Rated Speed

The Autotune profile accelerates and decelerates the motor according to the Tune Direction.

Once the Autotune is finished, the test state changes.

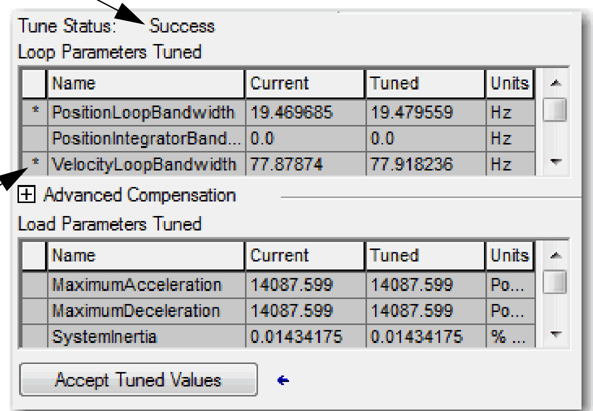


7. Click OK.

   After completing the Autotune profile, the measurements that are made during this process are used to update the fields in the Gains Tuned and Inertia Tuned grids.

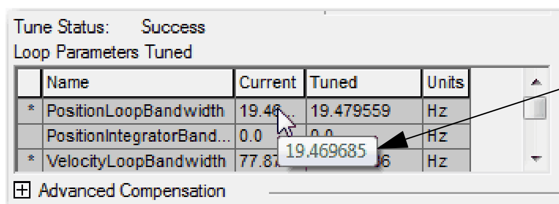
Check your Tune Status

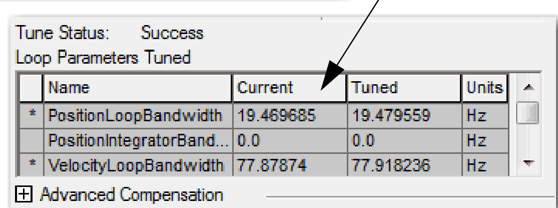
Any value that has an asterisk in the leftmost column has another value from its tuned value.



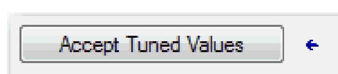
8. You can compare existing and tuned values for your gains and inertias with the prospective tune values.

If the value does not fit in the column, a tool tip appears to show the complete value. You can also change the column widths.





9. Choose to accept the new values and apply them to the controller.



   Now you can run the system with the new gain set and evaluate performance. You can improve the performance by adjusting application type, loop response, and/or load coupling selections.

TIP If your application requires stricter performance, you can further improve performance with manual tuning.

See [When to Manually Tune an Axis on page 275](#).

Load

The Load dialog box contains the characteristics of the motor load. You can also use the values that are provided by autotune. The Autotune automatically sets most of these values:

- If you use the Catalog Number as the Data Source, the Motor Inertia, Total Inertia, and System Inertia are pre-populated with the correct values.
- If you know what the Load Ratio values are, you can enter that information on the Load dialog box or you can use the values that are provided by Autotune.

Figure 103 - Kinetix 6500 Load Dialog Box

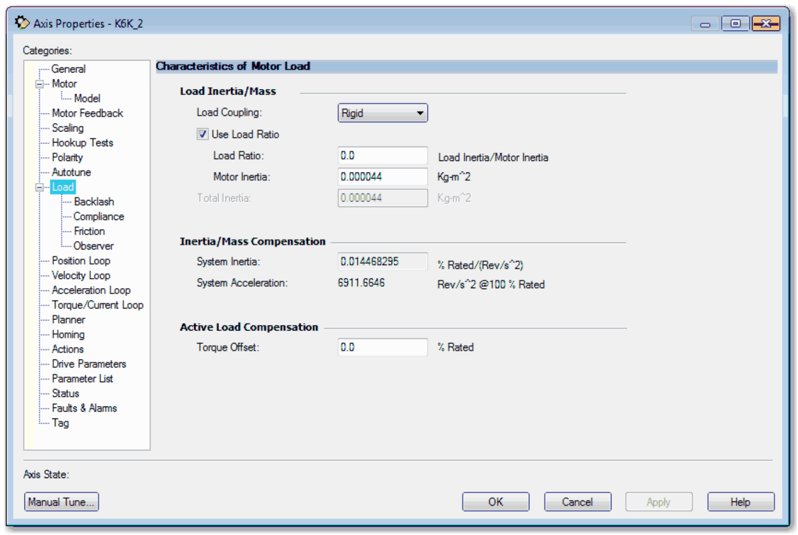


Table 48 - Load Inertia/Mass Parameter Descriptions

Parameter	Description
Load Coupling	Lets you control how tightly the system is physically coupled. Your choices are the following: • Rigid (default) • Compliant Load Coupling appears dimmed when the axis is Servo On.
Inertia Compensation	Inertia compensation controls relate to rotary motors.
Load Ratio	The value of the Load Ratio attribute represents the ratio of the load inertia or mass to the motor inertia, or mass.
Motor Inertia	The Motor Inertia attribute is a float that specifies the unloaded inertia of a rotary motor.
Total Inertia	Total Inertia represents the combined inertia of the rotary motor and load in engineering units.
Inertia/Mass Compensation	Inertia compensation controls relate to rotary motors. Mass compensation controls relate to linear motors.
System Acceleration	System Inertia is recalculated anytime the System Acceleration changes: • System Inertia = 0, if System Acceleration = 0 • System Inertia = 1/System Acceleration • Units are Rev/s^2 @100% Rated

Table 48 - Load Inertia/Mass Parameter Descriptions

Parameter	Description
System Inertia	The torque or force-scaling gain value converts commanded acceleration into equivalent rated torque/force. Properly set, this value represents the total system inertia or mass. System Inertia is a read-only field that is based on Total Inertia. The software recalculates System Acceleration anytime the dependent attributes change: • If the data Source is Motor Catalog Number, the System Acceleration value is read directly from the motion database. • If the Data Source is Nameplate data sheet, the System Acceleration value is calculated. • If the Data Source is Drive NV or Motor NV, this field is blank.
Torque Offset	The Torque Offset attribute provides a torque bias when performing closed-loop control.
Mass Compensation	Mass compensation controls relate to linear motors.
Motor Mass	The mass of the motor displays in Kg units. This control is calculated based on the load inertia ratio. Generally it is not equal to 0 for Kinetix drives.
Total Mass	Total Mass represents the combined mass of the linear motor and load in engineering units.
Load Backlash	This parameter provides backlash configuration options for the load of the motor. The Kinetix 350 does not support this parameter.
Load Compliance	• The Torque Low Pass Filter Bandwidth attribute is the break frequency for the second order low pass filter that is applied to the torque reference signal. • The Torque Notch Filter Frequency attribute is the center frequency of the notch filter that is applied to the toque reference signal. A value of 0 for this attribute disables this feature. • The Torque Lag Filter Gain attribute sets the high frequency gain of the torque reference Lead-Lag Filter. A value greater than one results in a lead function and value less than one results in a lag function. A value of 1 disables the filter. • The Torque Lag Filter Bandwidth attribute sets the pole frequency for the torque reference Lead-Lag Filter. A value of 0 disables the filter. The Kinetix 350 does not support this parameter.
Load Friction	• Sliding Friction Compensation is the value that is added to the current/torque command to offset the effects of coulomb friction. • Compensation Window defines a window around the command position. The Kinetix 350 does not support this parameter.
Load Observer	This parameter configures the operation of the Load Observer. The Kinetix 5500, Kinetix 5700, and Kinetix 6500 drives natively support this parameter.

See the Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003, for detailed descriptions of the AXIS_CIP_DRIVE attributes.

Load Observer

The Load Observer feature is a control loop inside the drive that estimates the mechanical load on the motor and compensates for it. This feature lets the control loops to treat the motor as if it is unloaded and relatively easy to control. The Load Observer automatically compensates for disturbances and load dynamics, such as sudden inertia changes, compliance, backlash, and resonances that are within the bandwidth of the Load Observer.

Benefits of Load Observer

You can use the Load Observer with out-of-box control loop gains, where the load is unknown and thus the Load Inertia Ratio is equal to zero. You can also use the Load Observer with auto-tuned control loop gains, where the Load Inertia Ratio is known or calculated by performing an autotune procedure.

When you enable Load Observer with the recommended out-of-box control loop gains, the Load Observer perform the following:

- Provides relatively high-performance motion control without tuning
- Minimizes the need to retune to account for machine wear over time
- Automatically compensates for changes in vibration and resonance that are within the bandwidth of the Load Observer
- Mitigates periodic identification of in-band resonance to compensate for them

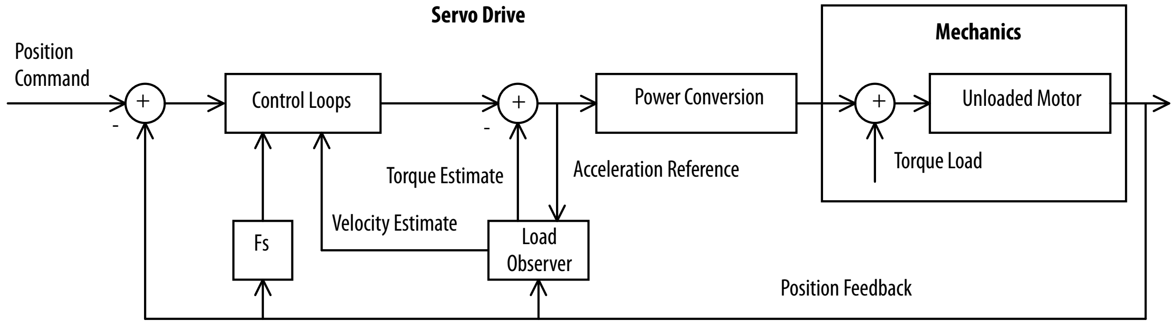
When you use autotuned control loop gains, the Load Observer performs the following:

- Increases system bandwidth
- Reduces tracking errors, so that line speeds can increase
- Provides tighter control of moving parts, which reduces wear and saves on material costs

How Load Observer Functions

The Load Observer acts on the acceleration signal within the control loops and monitors the Acceleration Reference and the Actual Position feedback. The Load Observer models an ideal unloaded motor and generates a load Torque Estimate that represents any deviation in response of the actual motor and mechanics from the ideal model. This deviation represents the reaction torque that is placed on the motor shaft by the load mechanics. Closed-loop operation compensates the deviation, which is estimated in real time. See Figure 104 on page 242 for an example Load Observer block diagram.

Figure 104 - Load Observer Block Diagram



The Load Observer also generates a Velocity Estimate signal that you can apply to the velocity loop. The Velocity Estimate has less delay than the Velocity Feedback signal derived from the actual feedback device. It also helps to reduce high frequency output noise that the aggressive action of the Load Observer on the acceleration reference causes. Together, Load Observer with Velocity Estimate provides the best overall performance for positioning applications. Table 49 describes the Load Observer configuration settings.

Table 49 - Load Observer Configuration Settings

Configuration	Description
Disabled	Load Observer is inactive.
Load Observer Only	Provides a torque estimate only.
Load Observer with Velocity Estimate	The standard Load Observer operation. Provides torque and velocity estimates.
Velocity Estimate Only	Provides only a velocity estimate.
Acceleration Feedback	Provides acceleration feedback by disconnecting the Acceleration Reference to the Load Observer.

Load Observer Configuration

This section applies to only the Load Observer feature for the Kinetix 5500, Kinetix 5700, and Kinetix 6500 drives. Click the Observer tab in the Axis Properties dialog box. Here, the Load Observer mode can be selected with the Configuration pull-down menu. See Table 27 for descriptions of each setting. If Load Observer is enabled, the recommended Configuration setting is Load Observer with Velocity Estimate for positioning applications. Access to Load Observer bandwidth (Kop) and Load Observer Integral Bandwidth (Koi) is also shown. Typically, Koi = 0.

Gains are limited to 500 Hz in drive firmware revision 2.160 and earlier. In drive firmware revision 2.170 and later, the gain limits are increased to 10,430

Hz. Table 50 summarizes the primary difference between the two tuning modes.

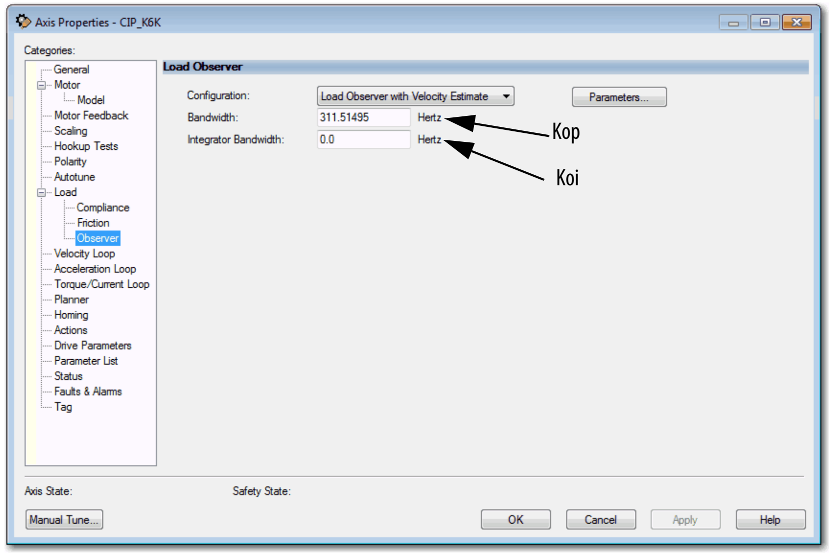
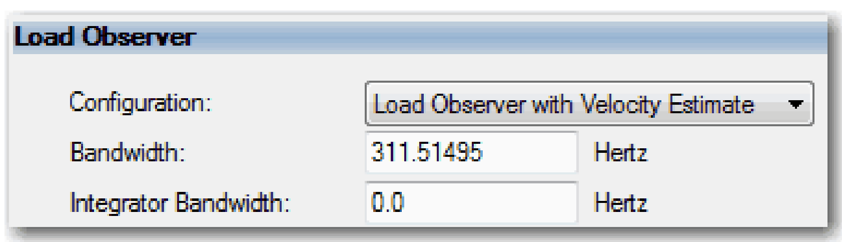


Table 50 - CIP Load Observer Tuning Mode Differences

Tuning Mode	Description (Hz)
Out-of-box or unknown load Load ratio = 0	Load Observer Bandwidth (Kop) = 4 * Velocity Loop Bandwidth (Kvp)
Autotuning or known load Load ration > 0	Load Observer Bandwidth (Kop) = Velocity Loop Bandwidth (Kvp)

The Load Observer can be configured in various ways by using the Load Observer Configuration attribute. The standard configuration is Load Observer with Velocity Estimate. This configuration approximates the load torque and minimizes the phase lag associated with the velocity feedback.

Figure 105 - Load Observer with Velocity Estimate: Kinetix 6500 Drive



For more information, see the Motion System Tuning Application Technique, publication MOTION-AT005.

Adaptive Tuning

The Adaptive Tuning feature is an algorithm inside of the drive. This feature continuously adjusts or adapts various filler parameters and control loop gains to compensate for unknown and changing load conditions while the drive is running. Its primary functions are as follows:

- Automatically adjust torque loop notch and low pass filter parameters to suppress resonance
- Automatically de-tune control loop gains to avoid instability when it is detected

For detailed tuning information, see the Motion System Tuning Application Technique, publication MOTION-AT005.

Benefits of Adaptive Tuning

When Adaptive Tuning is enabled with recommended out-of-box control loop settings, Adaptive Tuning performs the following:

- Automatically suppresses changing resonances
- Minimizes periodic identification of resonance and retuning
- Mitigates the need for a tuning expert
- Reduces decommissioning time, especially for high axis count
- Minimizes the power consumption, machine vibration, and errors

How Adaptive Tuning Functions

Adaptive Tuning is always running in the background to detect motor side resonances. Every few seconds, Adaptive Tuning analyzes the frequency response of torque loop signals to identify, track, and measure resonances. Adaptive Tuning also analyzes the frequency response of the command signal to make sure that dominant command frequencies are not mistaken for resonances. This process is known as command rejection. The action that is taken to change tuning parameters largely depends on the adaptive tuning mode of operation. Relevant parameters are summarized in the table followed by detailed descriptions of how they work in various modes of operation.

Table 51 - Adaptive Tuning Attributes

Parameter Name	Description	Default Value	Range/Units
Torque Notch Filter Low Frequency Limit	Adaptive Tuning identifies resonances that are not associated with the command between these low and high frequency limits with magnitudes above this tuning threshold.	Torque Loop Bw	20…2000 Hz
Torque Notch Filter High Frequency Limit		2000	20…2000 Hz
Torque Notch Filter Tuning Threshold		5	0…100% of motor rated torque
Torque Notch Filter Frequency Estimate	Adaptive Tuning sets this frequency estimate equal to the center frequency of the identified resonance with the highest magnitude.	Torque Notch Filter Frequency or 0 when disabled	20…2000 Hz
Torque Notch Filter Magnitude Estimate	Adaptive Tuning sets this magnitude estimate equal to the magnitude of the identified resonance with the highest magnitude.	0	0…100% of motor rated torque

Table 51 - Adaptive Tuning Attributes

Parameter Name	Description	Default Value	Range/Units
Torque Low Pass Filter Bandwidth Estimate	In modes with Gain Stabilization, Adaptive Tuning incrementally decreases this bandwidth estimate from its default value in 200 Hz increments to suppress additional resonances above the low frequency limit if necessary. Additional resonances are resonances that notch filters do not already suppress.	Torque Low Pass Filter BW or 1500 when disabled	20…2000 Hz
Adaptive Tuning Gain Scaling Factor	In modes with Gain Stabilization, Adaptive Tuning incrementally decreases this gain scaling factor from its default value to stabilize the system if necessary. Resonances that not already suppressed by filters or caused by filter bandwidths that are too close to the closed-loop bandwidth cause instability.	1	0 - max float
Adaptive Tuning Configuration	Controls the Adaptive Tuning feature mode of operation.	Disabled	0 = Disabled 1 = Tracking Notch Filter 2 = Gain Stabilization 3 = Tracking Notch Filter and Gain Stabilization

For the purposes of this manual, resonances are characterized as follows:

- HF resonances are above the low frequency limit
- LF resonances are below the low frequency limit
- MF resonances are slightly above the low frequency limit

Adaptive Tuning Configuration

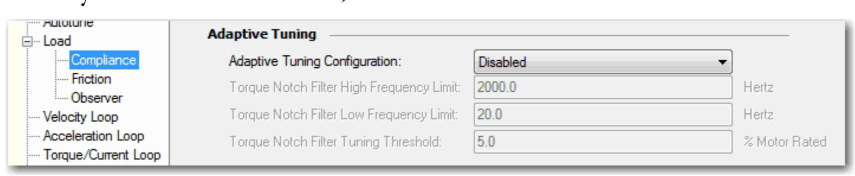
The modes of adaptive tuning operation include:

- Disabled
- Notch Filter Tuning
- Gain Stabilization
- Notch Filter Tuning and Gain Stabilization

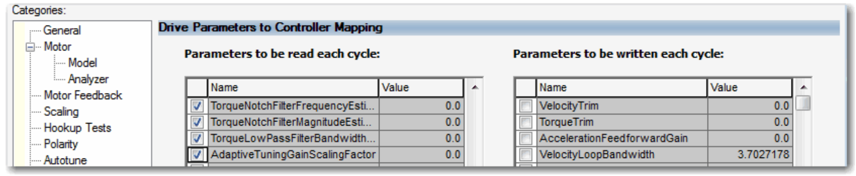
You access adaptive tuning from the Compliance tab on the Load Category page.

Disabled

As previously stated, Adaptive Tuning is always running in the background to identify motor side resonances, even when the feature is disabled.

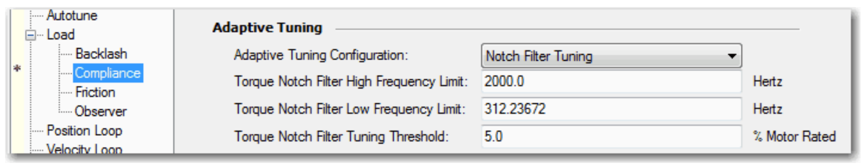


No action is taken to compensate for the identified resonances in this mode. The result is status only, which lets you create custom Ladder Logic to react to changes. This function is useful for condition monitoring, diagnostics, and preventative maintenance purposes in tracking HF resonances that changes over time. In Disabled mode, the high frequency limit, low frequency limit, and turning threshold are dim. As a result, you have to enable Adaptive Tuning to change these settings. The Adaptive Tuning output parameters can be monitored in the Drive Parameters tab of the Axis Properties dialog box.



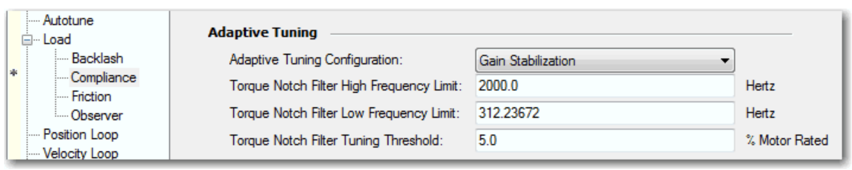
Notch Filter Tuning

Typically the Torque Notch Filter Frequency on the Compliance tab of the Axis Properties dialog box is applied to the torque notch filter. In this mode, the Torque Notch Filter Frequency Estimate is applied to the torque notch filter instead.



Gain Stabilization

Adaptive Tuning performs two primary functions in modes with Gain Stabilization.



Adaptive Tuning enables and tunes the low pass filter to suppress resonances if any are identified above the low frequency limit. Typically the Torque Low Pass Filter Bandwidth that is visible on the Compliance tab of the Axis properties dialog box is applied to the low pass torque filter. With Adaptive Tuning, the Torque Low Pass Filter Bandwidth Estimate is applied to the torque low pass filter instead. The bandwidth estimate is incrementally decreased from its default value until the identified HF resonances are suppressed or an LF resonance or instability occurs.

Adaptive Tuning detunes control loop gains to suppress any remaining resonances and stabilize the system. The Adaptive Tuning Gain Scaling factor scales the following gains:

- Load Observer Bandwidth
- Load Observer Integrator Bandwidth
- Velocity Loop Bandwidth
- Velocity Loop Integrator Bandwidth
- Position Loop Bandwidth

- Position Loop Integrator Bandwidth

The actual control loop gains are the values that are shown in the Axis Properties dialog box multiplied by the gain scaling factor. The scaling factor is incrementally decreased from its default value until the system is stable. When Gain Stabilization is not enabled, the scaling factor is reset to its default value of 1 so that control loop gains are not affected.

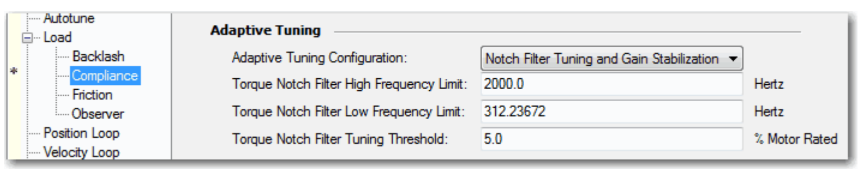
Gain Stabilization is good for situation where there are more resonances than there are notch filters and for keeping the axis stable. Instability and audible noise is caused from the following situations:

- HF resonances that filters do not already suppress
- MF resonances that filters suppress where the filter bandwidths are too close to the closed-loop bandwidth
- LF resonances that result when Load Observer is not applied with the recommended out-of-box settings
- LF resonances that result from classical instability

IMPORTANT	We do not recommend that you enable Gain Stabilization on vertical loads as detuning can cause load drops.

Notch Filter Tuning and Gain Stabilization

Adaptive Tuning applies the Notch Filter Tuning if necessary, followed by Gain Stabilization, if necessary.



Notch Filter Tuning sets the torque notch filter to suppress an HF resonance with the largest magnitude if one exists. Gain Stabilization applies the low pass filter to suppress additional HF resonances if they exist. This function is useful for suppressing more HF resonances than there are notch filters. If the system is unstable, Gain Stabilization incrementally detunes control loops until the system is stable.

The torque notch filter is set to suppress it if it is the only HF resonance or if it is the once with the largest magnitude. If not, the low pass filter is set to suppress it and any other HF resonances. The system is detuned if one or more of the following conditions exist:

- The torque notch filter was set to suppress the MF resonance. The width of the torque notch filter is wide enough or its frequency is close enough to the closed-loop bandwidth to cause instability
- The torque low pass filter was set to suppress the MF resonance, but its bandwidth is close enough to the closed-loop bandwidth to cause instability

- Any additional unsuppressed resonances are present.

Status Bits

The Adaptive Tuning status bits shown in Table 52 let you create custom Ladder Logic to trap errors, debug, and react to changes. This function is useful for condition monitoring, diagnostics, and preventative maintenance purposes.

Table 52 - Adaptive Tuning Status Bits

Name	Bit	Description
Torque Notch Filter Frequency Detected Status	0	Set when resonances are identified between the low and high frequency limits with magnitudes above the tuning threshold. Normally, this bit is clear. This bit is also cleared when the axis transitions to the Running state.
Torque Notch Filter Tune Unsuccessful Status	1	Set when the tracking notch filters do not eliminate all identified resonances. Normally, this bit is clear. This bit is also cleared when the axis transitions to the Running state or when Adaptive Tuning transitions from Disable mode to one of the Tracking Notch modes while in the running state.
Torque Notch Filter Multiple Frequencies Status	2	Set when multiple resonances are identified between the low and high frequency limits with magnitudes above the tuning threshold. Normally, this bit is clear. This bit is also cleared when the axis transitions to the Running state.
Torque Notch Filter Frequency Below Limit Status	3	Set when resonances are identified below the low frequency limit with magnitudes above the tuning threshold. Normally, this bit is clear. This bit is also cleared when the axis transitions to the Running state.
Torque Notch Filter Frequency Above Limit Status	4	Set when resonances are identified above the high frequency limit with magnitudes above the tuning threshold. Normally, this bit is clear. This bit is also cleared when the axis transitions to the Running state.
Adaptive Tune Gain Stabilization Status	5	Set when the gain scaling factor is not equal to one. This setting indicates that the Adaptive Tuning is controlling the low pass filter and adjusting servo loop gains to stabilize the system. Normally, this bit is clear. This bit is also cleared when the axis transitions to the Running state.

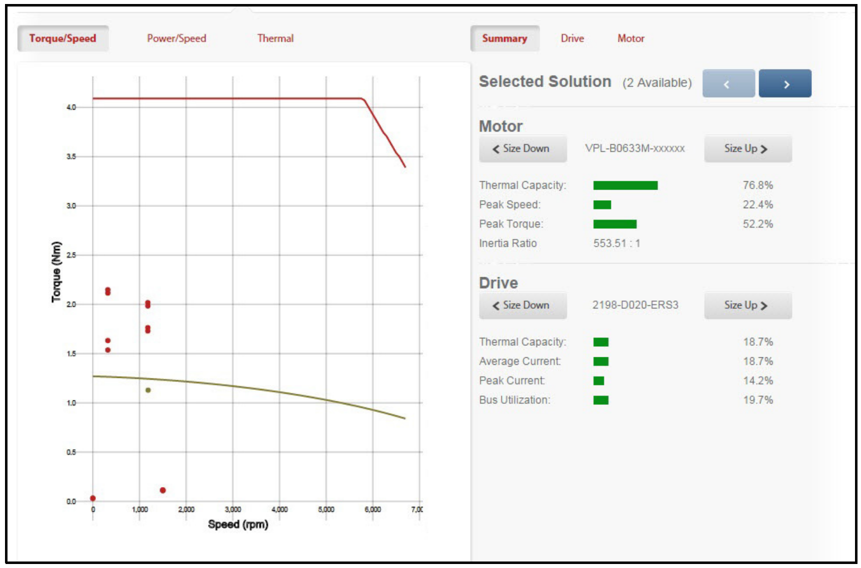
Table 53 describes when output parameters are reset to the default values.

Table 53 - Adaptive Tuning Reset Behavior

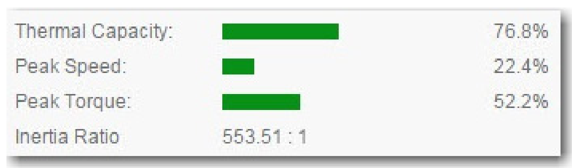
Parameter	When Reset to Default Value
Torque Notch Filter Frequency Estimate	Disabled, Gain Stabilization
Torque Notch Filter Magnitude Estimate	When a resonance is not identified
Torque Low Pass Filter Bandwidth Estimate	Disabled, Tracking Notch Filter
Adaptive Tuning Gain Scaling Factor	Disabled, Tracking Notch Filter

Load Ratio Data from Motion Analyzer

Load Ratio can also be found through Autotune from Motion Analyzer.



If you do not want to run the Autotune, you can manually enter the load ratio from other sources such as Motion Analyzer.



See Help for Selecting Drives and Motors on page 20 for more information about the Motion Analyzer.

Test an Axis with Motion Direct Commands

Motion direct commands let you issue motion commands while you are online without having to write or execute an application program. You must be online to execute a Motion Direct Command. There are several ways to access the Motion Direct Command.

Motion Direct Commands (MDC) are useful when you are commissioning or troubleshooting a motion application. During commissioning, you can configure an axis and monitor the behavior by using Trends in the Controller Organizer. Use of Motion Direct Commands can fine-tune the system with or without load to optimize its performance. When testing and/or troubleshooting, you can issue Motion Direct Commands to establish or re-establish conditions such as Home. Often during initial development, test the system in small manageable areas. These tasks include the following:

- Home to establish initial conditions
- Incrementally Move to a physical position
- Monitor system dynamics under specific conditions

Access Motion Direct Commands for an Axis or Group

To access the Motion Direct Commands for the Motion Group or axis, right-click the Group or Axis in the Controller Organizer and choose Motion Direct Commands.

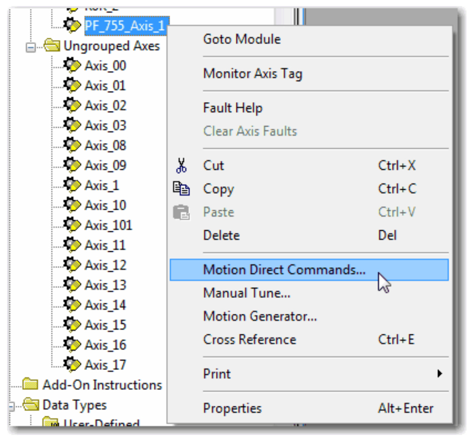
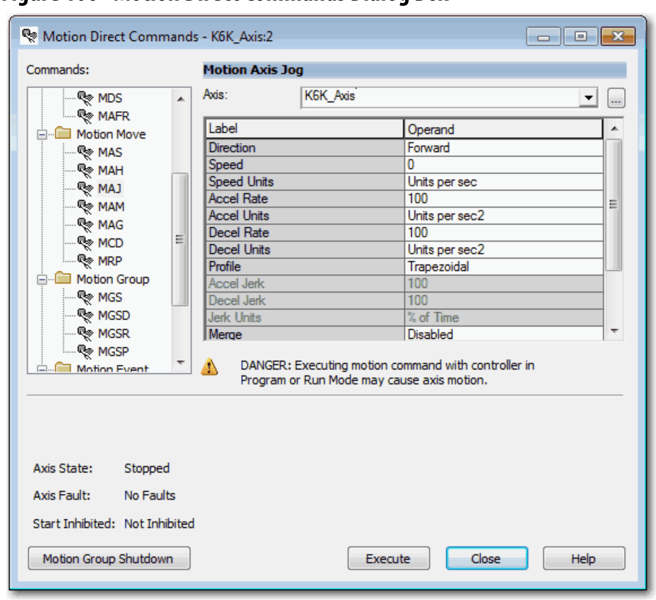
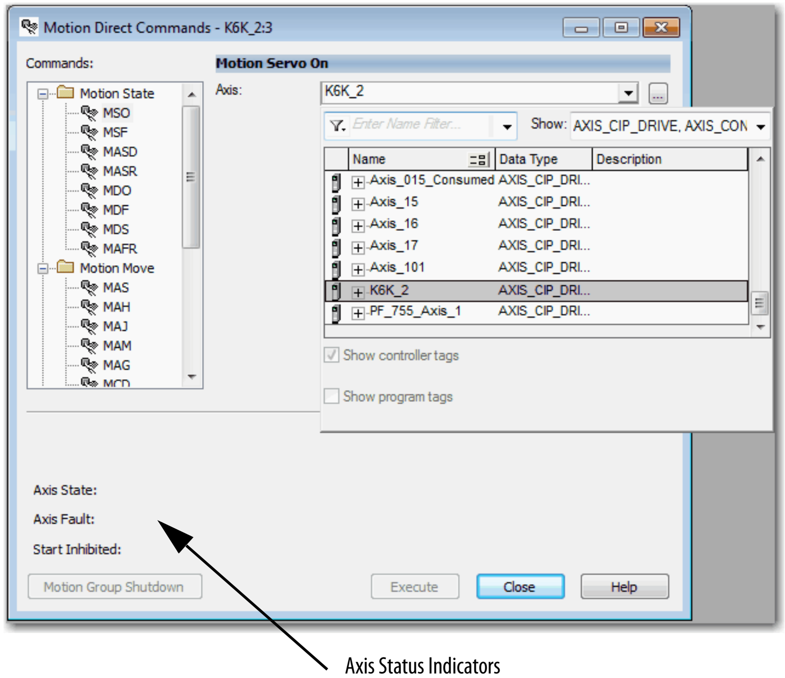


Figure 106 - Motion Direct Commands Dialog Box

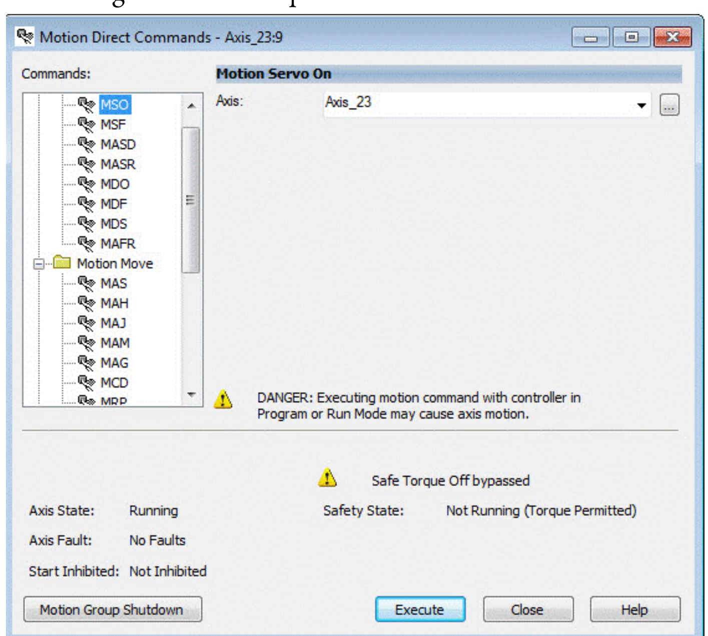


The content of the Motion Direct Command dialog box varies, depending on the command you have chosen. In the Command list, you can either type the mnemonic and the list advances to the closest match or you can choose a command from the Axis pull-down menu. Choose the desired command and its dialog box appears.

You can access an axis by using the pull-down list. Axis status indicators are in this dialog box.



This dialog box is an example of axis indicator values.



IMPORTANT	The device spins at the command velocity once you execute an MDS command if you use a PowerFlex 755 drive in Velocity Mode with Flying Start Enable set to true.

For more information about the Flying Start Attribute, see the Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003.

Understanding STO Bypass When Using Motion Direct Commands

For complete information about Motion Direct Commands in motion control systems including the Safe Torque Off feature, see the publications that are listed in the Additional Resources on page 9.

The drive does not allow motion while the safety controller is in Program mode by default. This condition applies only if a safety connection between the GuardLogix safety controller and the drive was established at least once after the drive was received from the factory.

The drive does not allow motion because the Safety Task is not executed while the GuardLogix® safety controller is in Program mode. This condition applies to applications that run in a single-safety controller (with Motion and Safety connections). The standard controller can transition to Program mode while the safety controller stays in Run mode and continues to execute the Safety Task. This transition occurs when an integrated safety drive has a Motion connection to a standard controller and a separate Safety connection to a dual-safety controller.

However, applicable drive systems are designed with a bypass feature for the STO function in single-safety controller configurations. You can use the Motion Direct Command (MDC) feature to allow motion while following all necessary and prescribed steps per machine safety operating procedures.

ATTENTION: Consider the consequences of allowing motion by using MDC when the controller is in Program mode. You must acknowledge warning messages in the Logix Designer application that warn of the drive bypassing the STO function and unintended motion can occur. The integrated safety drive does not respond to the request of STO function if MDC mode is entered.

ATTENTION: It is your responsibility to maintain machine safety integrity while executing Motion Direct Commands. One alternative is to provide Ladder Logic for Machine Maintenance mode that leaves the controller in Run mode with safety functions executing.

Table 54 defines which drive supports the type of STO functionality.

Table 54 - Drives That Support Safe Torque Off (STO)

Drive	Mechanism	Axis Status	STO Configuration
Kinetix 350 servo drive	Hard-wired	GuardStatus	None
Kinetix 5500 2198-Hxxx-ERS servo drives	Hard-wired	GuardStatus	None
Kinetix 5500 2198-Hxxx-ERS2 servo drives	Integrated	SafetyStatus	Logix Designer application
Kinetix 5700 2198-xxxx-ERS3 servo drives Kinetix 5700 2198-xxxx-ERS4 servo drives	Hard-wired	GuardStatus	None
	Integrated	SafetyStatus	Logix Designer application
Kinetix 6500 servo drives with 2094-EN02D-M01-S0, Safe Torque Off control module	Hard-wired	GuardStatus	Webpage
Kinetix 6500 servo drives with 2094-EN02D-M01-S1, Safe speed monitoring	Hard-wired	GuardStatus	Webpage
PowerFlex 755 drive with Safe Torque Off Option module (20-750-S0)	Hard-wired	GuardStatus	Webpage
PowerFlex 755 drive with Safe Speed Monitor Option module (20-750-S1)	Hard-wired	GuardStatus	Webpage
PowerFlex 755 drive with Integrated Safety - Safe Torque Off Option module (20-750-S3)	Integrated	SafetyStatus	Logix Designer application
PowerFlex 527 drive	Hard-wired	GuardStatus	None
	Integrated	SafetyStatus	Logix Designer application

For detailed information on the Safe Torque Off function, see one of the following publications:

- Kinetix 5500 Servo Drives User Manual, publication 2198-UM001
- Kinetix 5700 Multi-axis Servo Drives User Manual, publication 2198-UM002
- PowerFlex 527 Adjustable Frequency AC Drive User Manual, publication 520-UM002
- PowerFlex 750-Series Safe Speed Monitor Option Module Safety Reference Manual, publication 750-RM001
- PowerFlex 750-Series Safe Torque Off Option Module User Manual, publication 750-UM002
- PowerFlex 755 Integrated Safety - Safe Torque Off Option User Manual, publication 750-UM004

Notes:

Homing

Homing puts your equipment at a specific starting point for operation. This starting point is called the home position. Typically, you home your equipment when you reset it for operation.

When using integrated motion on the EtherNet/IP™ network, all active and passive homes are setting absolute positions as long as an absolute device is being used.

See the Integrated Motion on the EtherNet/IP network Reference Manual, publication MOTION-RM003, for more details about the Homing attributes.

Guidelines for Homing

To configure the homing procedure, you specify the mode (active or passive) and sequence. Based on those selections, you can also choose the home position, an offset for the home position, the direction, and speed. For switch-based sequences, you can also select whether the limit switch is normally open or normally closed.

Table 55 describes guidelines for homing procedures.

Table 55 - Guidelines for the Homing Procedures

Guideline	Description
To move an axis to the home position, use Active homing.	Active homing turns on the servo loop and moves the axis to the home position. Active homing also does the following: • Stops any other motion. • Uses a trapezoidal profile.
For a Feedback-only device, use Passive homing.	Passive homing does not move the axis: • Use passive homing to calibrate a Feedback-only axis to its marker. • If you use passive homing on a servo axis, turn on the servo loop and use a move instruction to move the axis.
For single-turn equipment, consider homing to a marker.	The marker homing sequence is useful for single-turn rotary and linear encoder applications because these applications have only one encoder marker for full axis travel.
For multi-turn equipment, home to a switch or switch and marker.	These homing sequences use a home limit switch to define the home position: • You need a home limit switch if the axis moves multiple revolutions when it runs. Otherwise, the controller cannot tell which marker pulse to use. • For the most precise homing, use both the switch and marker.
If your equipment can't back up, use unidirectional homing.	With unidirectional homing, the axis doesn't reverse direction to move to the Home Position. For greater accuracy, consider using an offset: • Use a Home Offset that is in the same direction as the Home Direction. • Use a Home Offset that is greater than the deceleration distance. • If the Home Offset is less than the deceleration distance does the following: – The axis simply slows to a stop. The axis doesn't reverse direction to move to the Home Position. In this case, the MAH instruction doesn't set the process compete bit. – On a rotary axis, the controller adds one or more revolutions to the move distance. This addition makes sure that the move to the Home Position is unidirectional.
Choose a starting direction for the homing sequence.	Decide which direction you want to start the homing sequence in: • Positive direction—choose a Forward direction. • Negative direction—choose a Negative direction.

Active Homing

When the axis Homing mode is configured as Active, the physical axis is first activated for servo operation. As part of this process, all other motion in process is canceled and appropriate status bits cleared. The axis is then homed by using the configured Home Sequence, which can be Immediate, Switch, Marker, or Switch-Marker. The latter three Home Sequences result in the axis being jogged in the configured Home direction. Then, after the homing sequence is complete, the position is redefined. Based on detection of the home event, the axis is automatically moved to the configured Home Position.

IMPORTANT	The control moves the axis to the unwind position of zero. This movement occurs only when unidirectional active homing is performed on a rotary axis and the Home Offset value is less than the deceleration distance when the home event is detected. This process helps make sure that the resulting move to the Home Position is unidirectional.

Passive Homing

When the axis Homing mode is configured as Passive, the MAH instruction redefines the actual position of a physical axis on the next occurrence of the encoder marker or home sensor. The sequence determines the homing steps. You must set the homing sequence to marker or switch. Passive homing is most commonly used to calibrate Feedback Only axes to their markers or switch. Passive homing is identical to active homing to an encoder marker or switch except that the motion controller does not command any axis motion.

After initiating passive homing (MAH), the axis must be moved past the encoder marker or trip the home switch for the homing sequence to complete properly. In this case, you must set the homing sequence to marker or switch. The motion controller cannot directly command motion for physical Feedback Only axes and must be accomplished via other means.

For closed-loop Servo axes, when configured for Passive Homing, only set the Sequence to Immediate. Then when the MAH is executed, it simply sets the actual position to that of the Position value set in the Homing parameters. There is no physical motion with these settings.

Examples

This section contains examples of active and passive homing.

Active Homing

The examples in Table 56 show different ways to use active homing.

Table 56 - Active Homing Examples

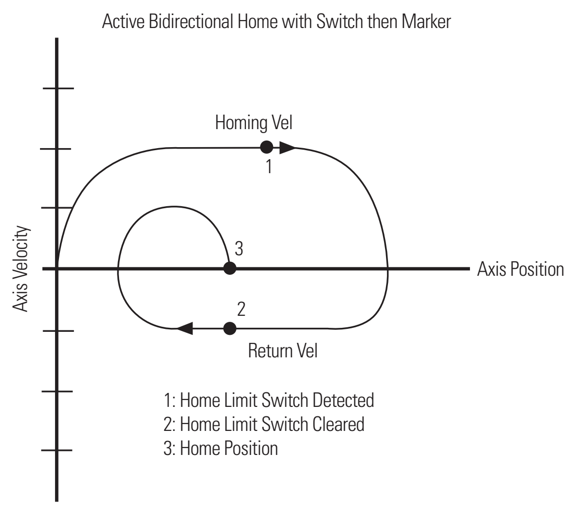
Sequence	Description
Active immediate home	This sequence sets the axis position to the Home Position without moving the axis. If feedback isn't enabled, this sequence enables feedback.
Active home to switch in forward bidirectional	The switch homing sequence is useful for multi-turn rotary and linear applications.  These steps occur during the sequence. 1. The axis moves in the Home Direction at the Home Speed to the home limit switch and stops. 2. The axis reverses direction and moves at the Home Return Speed until it clears the home limit switch and then stops. 3. The axis moves back to the home limit switch or it moves to the Offset position. The axis moves at the Home Return Speed. If the axis is a Rotary Axis, the move back to the Home Position takes the shortest path (that is, no more than a half revolution). If the axis is past the home limit switch at the start of the homing sequence, the axis reverses direction and starts the return leg of the homing sequence. Use a Home Return Speed that is slower than the Home Speed to increase the homing accuracy. The accuracy of this sequence depends on the return speed and the delay to detect the transition of the home limit switch. Uncertainty = Home Return Speed x delay to detect the home limit switch. **Example**: Suppose that your Home Return Speed is 0.1 in./s and it takes 10 ms to detect the home limit switch. Uncertainty = 0.1 in./s x 0.01 s = 0.001 in. The mechanical uncertainty of the home limit switch also affects the homing accuracy.

Table 56 - Active Homing Examples (continued)

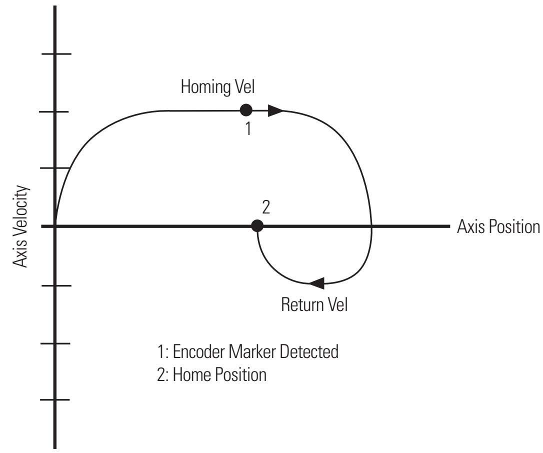
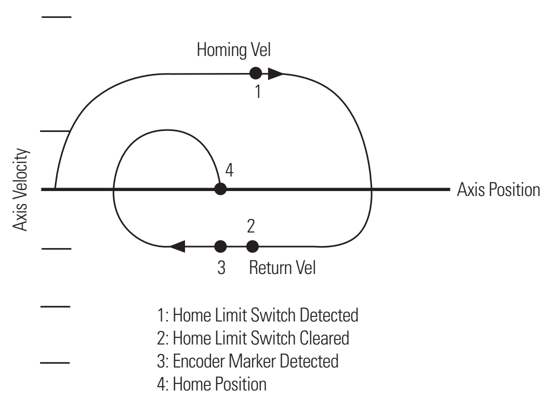
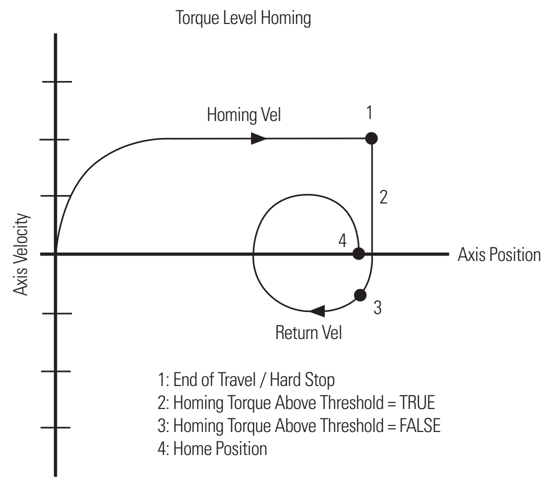
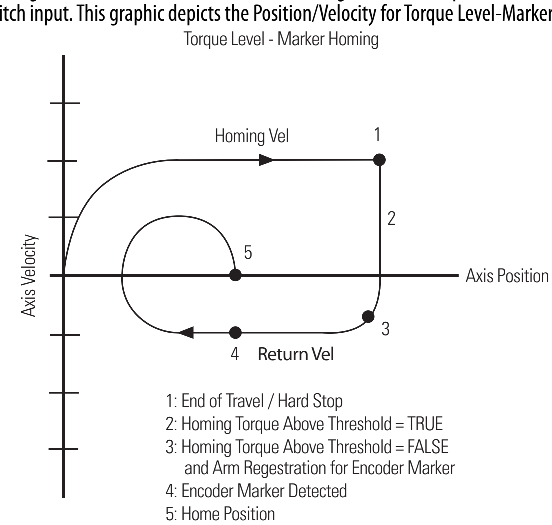
Sequence	Description
Active home to marker in forward bidirectional	The marker homing sequence is useful for single-turn rotary and linear encoder applications because these applications have one encoder marker only for full axis travel. Active Bidirectional Home with Marker  These steps occur during the sequence. 1. The axis moves in the Home Direction at the Home Speed to the marker and stops. 2. The axis moves back to the marker or it moves to the Offset position. The axis moves at the Home Return Speed. If the axis is a Rotary Axis, the move back to the Home Position takes the shortest path (that is, no more than a half revolution). The accuracy of this homing sequence depends on the homing speed and the delay to detect the marker transition. Uncertainty = Home Speed x delay to detect the marker. **Example**: Suppose that your Home Speed is 1 in/s and it takes 1 <Symbol>m<Symbol>s to detect the marker. Uncertainty = 1 In./s x 0.000001 s = 0.000001 in.
Active home to switch and marker in forward bidirectional	This sequence is the most precise active homing sequence available. Active Bidirectional Home with Switch then Marker  These steps occur during the sequence. 1. The axis moves in the Home Direction at the Home Speed to the home limit switch and stops. 2. The axis reverses direction and moves at the Home Return Speed until it clears the home limit switch. 3. The axis continues to move at the Home Return Speed until it gets to the marker. 4. The axis moves back to the marker or it moves to the Offset position. The axis moves at the Home Return Speed. If the axis is a Rotary Axis, the move back to the Home Position takes the shortest path (that is, no more than ½ revolution). If the axis is past the home limit switch at the start of the homing sequence, the axis reverses direction and starts the return leg of the homing sequence.
Active home to switch in forward unidirectional	This active homing sequence is useful for when an encoder marker is not available and either unidirectional motion is required or proximity switch is being used. These steps occur during the sequence. 1. The axis moves in the Home Direction at the Home Speed to the home limit switch. 2. If it's in the same direction as the Home Direction, the axis moves to the Home Offset position.

Table 56 - Active Homing Examples (continued)

Sequence	Description
Active home to marker in forward unidirectional	This active homing sequence is useful for single-turn rotary and linear encoder applications when unidirectional motion is required. These steps occur during the sequence. 1. The axis moves in the Home Direction at the Home Speed to the marker. 2. If it's in the same direction as the Home Direction, the axis moves to the Home Offset position.
Active home to switch and marker in forward unidirectional	This active homing sequence is useful for multi-turn rotary applications when unidirectional motion is required. These steps occur during the sequence. 1. The axis moves in the Home Direction at the Home Speed to the home limit switch. 2. The axis continues to move at the Home Speed until it gets to the marker. 3. If it's in the same direction as the Home Direction, the axis moves to the Home Offset position.
Active Home to Torque	The Home to Torque Level sequence is a type of homing used when a hard stop is going to be used as the home position, as in a linear actuator. Torque Level homing is similar to Home Switch homing, with the exception that the torque level is used instead of the home switch input. This graphic depicts the Position/Velocity for Torque Level Homing.  Torque Level-Marker homing is similar to Home Switch-Marker homing, with the exception that the torque level is used instead of the home switch input. This graphic depicts the Position/Velocity for Torque Level-Marker Homing. 

Passive Homing

The examples in Table 57 show different ways to use passive homing.

Table 57 - Passive Homing Examples

Sequence	Description
Passive Immediate Home	This sequence is the simplest passive homing sequence type. When this sequence is performed, the controller immediately assigns the Home Position to the current axis actual-position. This homing sequence produces no axis motion.
Passive Home with Switch	This passive homing sequence is useful for when an encoder marker is not available or a proximity switch is being used. When this sequence is performed in the Passive Homing mode, an external agent moves the axis until the home switch is detected. The Home Position is assigned to the axis position at the moment that the limit switch is detected. If you are using a Home Offset, then the Home Position is offset from the point where this value detects the switch.
Passive Home with Marker	This passive homing sequence is useful for single-turn rotary and linear encoder applications. When this sequence is performed in the Passive Homing mode, an external agent moves the axis until the marker is detected. The home position is assigned to the axis position at the precise position where the marker was detected. If you are using a Home Offset, then the Home Position is offset from the point where this value detects the marker.
Passive Home with Switch then Marker	This passive homing sequence is useful for multi-turn rotary applications. When this sequence is performed in the Passive Homing mode, an external agent moves the axis until the home switch and then the first encoder marker is detected. The home position is assigned to the axis position at the precise position where the marker was detected. If you are using a Home Offset, then the Home Position is offset from the point where this value detects the marker.

Absolute Position Recovery (APR)

APR is the recovery of the absolute position of an axis that has been machine-referenced after a power cycle or reconnection. The APR feature maintains the machine reference or absolute position through power cycles, program downloads, and even firmware updates under certain conditions. The terms Absolute Position and Machine Reference Position are synonymous.

Absolute position is established by a homing procedure that is initiated by successful execution of an MAH instruction. Once the homing procedure has successfully established a machine reference, the Axis Homed bit is set in the Motion Status attribute, indicating that actual position and command position now have meaning regarding the associated machine.

It is good application programming-practice to qualify dynamic machine operation by homing all axes in the machine before operating the machine. Otherwise, absolute moves to a specific position cannot have any relationship to the position of the axis on the actual machine.

APR Terminology

Table 58 describes terminology that is related to the APR feature.

Table 58 - APR Terminology Descriptions

Term	Description
Absolute Feedback Position	Position value that is read from an absolute feedback device.
Incremental Feedback Position	Position value that is read from an incremental feedback device.
Feedback Position	Value that is read from a feedback device, absolute, or incremental.
Absolute Position Absolute Machine Reference Position Machine Reference Position	Position registers in the Logix 5000™ controllers after the following instructions have been executed on a machine with an absolute or an incremental feedback device: • MAH, machine home • MRP, machine redefine position
A machine home/reference	Establishes a Machine Reference Offset as follows: HomeOffset = ConfiguredHomePosition - AbsoluteFeedbackPosition AbsoluteMachineReferencePosition = AbsoluteFeedback Position + HomeOffset
Absolute Position Recovery (APR)	Recovers the Absolute Machine Reference Position by maintaining the Home Offset through various scenarios as described on page 263.

Position Recovery Considerations for Logix5000 Controllers

There are differences in the way the ControlLogix® 5560, GuardLogix® 5560, and the ControlLogix 5570 controllers recover machine position:

- The ControlLogix 5560 and GuardLogix 5560 controllers have a battery and use a memory card to save information.
- The ControlLogix 5570 controller has a 1756-ESM*xxx* module and uses a memory card to save information.

- The ControlLogix 5560 and GuardLogix 5560 series A controllers have a battery to recover the position after a power cycle but does not support APR.
- The ControlLogix 5560 and GuardLogix 5560 series B controllers recover the position after a download or restore from CompactFlash software card or a firmware update from the ControlFLASH™ software. A battery is not required.
- The ControlLogix 5570 controller with a ControlLogix Controller Energy Storage Module (ESM) works the same as the GuardLogix 5560 series B controller with a battery.
- The ControlLogix 5570 controller without a ControlLogix Controller Energy Storage Module (ESM) works like a ControlLogix 5560 series B controller without a battery.

Absolute Feedback Device

The absolute feedback device permits absolute position be retained through a power cycle. These devices take various forms, but they can all maintain an absolute feedback position while power to the drive and feedback device is off.

When power is turned back on, the drive reads the feedback referenced absolute position from the feedback device. By applying a saved absolute offset to this absolute feedback position, the motion control system can recover the machine referenced absolute position.

Most drive products provide this capability. However, Absolute Position is lost if the drive is swapped out or drive firmware is updated. Integrated motion on the EtherNet/IP network lets you recover Absolute Position through power cycles, program downloads, and firmware updates.

SERCOS Versus Integrated Motion on Ethernet Networks

For a SERCOS axis with absolute feedback, the drive scaling function and absolute position are maintained in the drive. Therefore, the drive scaling function and absolute position can be easily restored in the control after a power cycle or download of a new project. This restoration is accomplished by reading the position from the drive.

By contrast, an integrated motion on the EtherNet/IP network axis supports controller-based scaling where absolute position is maintained in the firmware of the controller. Without the work of the APR feature, absolute position would be lost after a power cycle or project download.

APR Scenarios

ATTENTION: Whenever memory becomes corrupt, you lose position even if you have it stored on a memory card.

Table 59 on page 265 provides detailed information on when the APR feature recovers absolute position. The following assumptions must be considered. In each of these cases, the APR feature restores absolute position and preserves the state of the Axis Homed bit. This feature indicates that the axis has a machine referenced absolute position.

- All relevant axes are integrated motion axes.
- Yes, indicates that machine reference is recovered (for Axes that have been homed).
- No, indicates that machine reference is not recovered (for Axes that have been homed).

Table 59 describes the scenarios whether the APR feature recovers absolute position. In each case that is marked Yes, the APR feature restores absolute position and preserves the state of the Axis Homed bit. This mark indicates that the axis has a machine referenced absolute position.

Table 59 - APR Recovery Scenarios

Controller	Event	Machine Reference Retained
	Controller removal and insertion under power (RIUP) with a battery[1].	Yes
	Controller power cycle with battery.	Yes
	Controller firmware update.	Yes
	Controller update from memory card.	Yes
	Swap two controllers with the same catalog numbers (memory card also swapped).	Yes
	Steps 1.Axes are homed. 2.Project is saved to memory card. 3.Axes are moved and rereferenced. 4.System is restored from memory card. **Result** The system absolute position is restored to rereferenced positions and the Home bit remains set.	Yes
	Steps 1.Axes are homed. 2.Project is saved to memory card. 3.Same memory card is used on machines 2, 3, 4, for example. 4.Axes are homed on machines 2, 3, 4, for example, at different positions. 5.System restore from memory card on each machine. **Result** The system absolute position on each machine becomes restored correctly at its respective position and the Home bit remains set.	Yes
	Change controller (memory card not swapped).	No
	Change controller without a memory card.	No
	Controller power cycle without battery.	No
	Controller removal and insertion under power (RIUP) without battery.	No
	Take the controllers out of two systems with a battery or energy storage module and swap controller. There is no memory card on either controller.	No
	1. Controller remains powered. 2. Power cycle drives. 3. Change feedback device but not motor.	No
	Steps 1. Axes are homed. 2. Project is saved to a memory card. 3. Memory becomes corrupt. 4. System restores from the memory card. **Result** The system absolute position is lost, the axes must be rehomed, and the Home bit is cleared.	No
	Controller power cycle or removal and insertion under power without a battery or energy storage module.	No
	1. Controller and drives remained powered. 2. Hardware feedback failure on an axis.	No
	1. Battery Backed Controller. 2. User program that runs with an axis that is not homed.	No

Table 59 - APR Recovery Scenarios

Controller and drives remained powered	**Event**	**Machine Reference Retained**
	Disconnect and reconnect the Ethernet cable.	Yes
	Disconnect and reconnect the same feedback and/or motor cable on an axis.	Yes
	Inhibit or uninhibit an axis or drive.	Yes
Battery backed controller	**Event**	**Machine Reference Retained**
	Save to a memory card with a homed axis and you initiate the restore.	Yes
	RIUP controller.	Yes
	Cycle power-on controller.	Yes
	Cycle power-on controller that is configured to restore user program from a memory card on power-up.	Yes
	RAM memory becomes corrupt and the user program is restored from the memory card. The machine must be referenced again if RAM memory becomes corrupt. There is no way to retrieve the machine reference positions from a memory card after machine memory becomes corrupt.	No
	User program that runs with a homed axis and you manually restore the user program from a memory card. If you reset the machine reference by using MAH or MRP after storing the user program to a memory card, the MAH and MRP changes are not lost. The APR is not restored to the reference stored on the memory card. The APR is restored to the reference stored in RAM.	Yes
	Battery backed controller: Restore by taking the memory card to another controller. If the other controller has the exact same Axis ID and scaling constants as the memory card, and has homed axes, the APR is not restored to the reference stored on the card. The APR is restored to the reference stored in RAM. The Axis ID attribute is automatically generated when you create an axis in the Logix Designer application. See The Axis ID attribute description in the Integrated Motion on the EtherNet/IP network Reference Manual, publication MOTION-RM003 for more information.	Yes
Change controller	**Event**	**Machine Reference Retained**
	Transfer the memory card from the first controller to the second with the following preconditions. 1. Empty the second controller. There is no user program in the second controller. 2. The user program has been saved on a memory card with integrated motion on the EtherNet/IP network axes homed.	Yes
	Transfer the memory card from the first controller to the second with the following preconditions. 1. The second controller has the same user program with the controller being swapped. 2. The second controller has its axes homed.	Yes
Same controller	**Event**	**Machine Reference Retained**
	Reload the same user program from a memory card. This scenario assumes that the axis is homed in RAM before reload.	Yes
	Update controller firmware from memory card.	Yes
Controller remains powered or power cycled with battery and power cycle drives	**Event**	**Machine Reference Retained**
	Change the drive with the same or different catalog number.	Yes
	Change the motor but not the feedback device.	Yes

Table 59 - APR Recovery Scenarios

Download same program with no hardware changes	**Event**	**Machine Reference Retained**
	Change the name of an axis.	Yes
	Download the same program to the controller.	Yes
	Save As with another filename.	Yes
	Partial Export and then import an axis.	Yes
	Added application logic.	Yes
	Download a project of an existing axis.	Yes
Download same program and no hardware changes	**Event**	**Machine Reference Retained**
	Add an axis.	No for the new axis.
	Copy or cut and paste or drag/drop axis into the same project or another project.	No for the new or pasted axis.
	Export and then import into the same or another project. **Tip:** Save the project as an .ACD file to recover the absolute position.	No
	There are changes to the axis scaling attributes.	No
Position feedback	**Event**	**Machine Reference Retained**
	The position feedback device was disconnected or reconnected.	Yes
Feedback device	**Event**	**Machine Reference Retained**
	The position feedback device was disconnected or reconnected.	Yes
	The feedback device changed.	No
	The position feedback device was swap.	No
	The position feedback device failed.	No
	The position feedback polarity changed.	No
	The Feedback mode changed.	No
When any of these conditions occur, the Axis Homed bit, if set, is cleared indicating that axis position is no longer referenced to the machine. To flag the condition that the Axis Homed bit has been cleared and that the machine referenced absolute position has been lost, an APR Fault is generated. This fault is recoverable and can be cleared via any Fault Reset or Shutdown Reset instruction.		
Restore	**Event**	**Machine Reference Retained**
	Restore from the memory card.	Yes
Inhibit or Uninhibit	**Event**	**Machine Reference Retained**
	Inhibit or uninhibit an axis.	Yes
	Inhibit or uninhibit an I/O module.	Yes
Studio 5000 Logix Designer Application project	**Event**	**Machine Reference Retained**
	Import or export the project download.	No
	Download the project download of new or copied axis.	No

Table 59 - APR Recovery Scenarios

Drive	Event	Machine Reference Retained
	The drive cycled power with incremental feedback.	No
	The drive firmware updated with incremental feedback.	No
	Change the drive.	Yes
	Cycle power to the drive.	Yes
	Cycle power to the drive with absolute feedback.	Yes
	Change the motor, if the motor does not contain a feedback device.	Yes
	The drive firmware was update with absolute feedback.	Yes
	The drive was disconnected or reconnected.	Yes
	The drive was Inhibited or Uninhibited.	Yes
	The drive was swapped with the same feedback.	Yes
Scaling	**Event**	**Machine Reference Retained**
	Scaling signature has changed. The scaling signature changed. This change includes Transmission, Linear Actuator, Motion Resolution, and Motion Unit attribute changes.	No

(1) The term Battery in this table assumes the ControlLogix 5560 or GuardLogix 5560 controller with a battery or a ControlLogix 5570 controller and a 1756-ESMxxx Energy Storage Module. ControlLogix 5580, GuardLogix 5580, CompactLogix™ 5380, and Compact GuardLogix 5380 controllers have embedded energy storage modules.

APR Faults

APR faults are generated during the events and when one of the conditions that are defined in the following APR Fault Conditions is present.

APR Fault Conditions

The axis must be in the homed state for an APR Fault to occur. The Axis Homed Status Bit must be set.

Attribute Changes

A Motion Resolution or an Axis Feedback Polarity attribute has been changed and downloaded to the controller. This change can also happen during the execution of an SSV.

Axis Feedback Changes

The feedback device has been replaced. This change creates an Axis Feedback Serial Number mismatch APR fault.

Axis Feedback mode has changed, for example, axis with feedback changed to axis without feedback or vice versa and downloaded to the controller.

- A user program is downloaded.
- A user program and tags are restored from the memory card.
  - Manual Restore
  - Power-up restore, when configured
- Firmware is updated via ControlFLASH software.
- An SSV to either change Feedback Polarity or one of the attributes, which results in a change to the Motion Resolution attribute.

APR Fault Generation

A project download, restore from a memory card, or a ControlFLASH firmware update after one of these events can cause an APR fault:

- Axis configuration
  - Change in any of the axis attributes that impacts the absolute machine position.
- Attribute changes
  - Offline edits of the axis attributes or configuration do not cause an APR fault until after download occurs.
  - Online edits of certain attributes result in an immediate APR fault. Changing the axis feedback device or feedback polarity without downloading the project also generates an immediate APR fault.
- Axis hardware change or malfunction.
- Axis hardware resource insufficiency.
  - Hardware resource insufficiencies are detected only during download or ControlFLASH firmware update.
- Reconnection of the drive axis.

When an APR fault occurs, the actual position of the axis is set to the feedback reference position of the axis. This value is read from the absolute encoder of the axis. The APR Fault clears the axis homed status bit.

Downloading of a Project

The following checks are made during a download of a project:

1. Does the Axis exist? If not, then it is a new axis and no APR fault occurs or is generated.
2. Does the Scaling Signature match the saved Scaling Signature?
3. Does the Feedback Serial Number match the saved Feedback Serial Number?

If these three checks pass, absolute position is restored.

During operation, the system monitors changes to that following attributes. These attributes do not affect the Scaling Signature or result in the loss of the absolute machine reference and therefore do not generate an APR Fault.

- Conversion Constant
- Position Unwind
- Travel Mode

Care must be taken when changing these values so that the new values are correctly related to the Position Unit of the product and the mechanics of the system. This correlation is typically done as part of a product recipe change. For example, when you are wrapping regular sized candy bars and then you must change and make king sized bars, you would change the conversion constant.

If the Axis Homed status bit is clear, the APR function is bypassed and there is no attempt to restore absolute position. The clear status bit indicates that position has not been absolutely referenced to the machine.

There are two types of APR Faults: Standard APR Faults and RA Specific Faults. APR Faults display in the Axis Properties dialog box, Faults and Alarms.

Table 60 - Standard APR Fault Descriptions

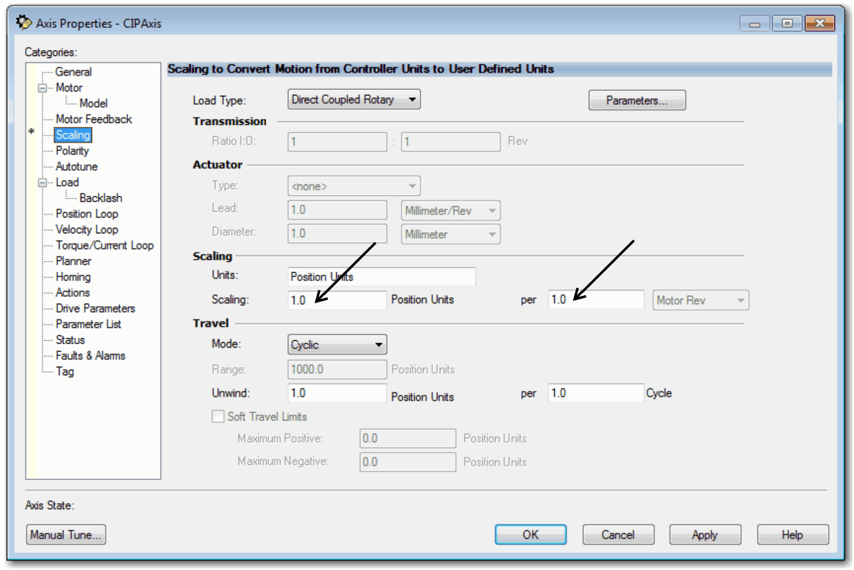
Value	Exception	Description
1	Memory Write Error	Error in saving absolute position data to nonvolatile memory.
2	Memory Read Error	Error in reading absolute position data from nonvolatile memory.
3	Feedback Serial Number Mismatch	Position Feedback Serial Number does not match saved Feedback Serial Number.
4	Buffer Allocation Fault	Caused when there is not enough RAM memory left to save APR data.
5	Scaling Configuration Changed	Scaling attribute configuration for this axis does not match the saved scaling configuration.
6	Feedback Mode Change	Feedback Mode has changed and does not match the saved Feedback Mode configuration.

Table 61 - Rockwell Automation Specific Fault Descriptions

Value	Exception	Description
1	Persistent Media Fault	(L6x) - Means that all six sectors that are reserved for APR in persistent memory are marked as bad. This fault condition is not recoverable: • After you get this fault, the APR feature stops working until you replace the ControlLogix 5560 or GuardLogix 5560 controller. • You never get this error when using a ControlLogix 5570 controller.
2	Firmware Error	Used to trap unexpected firmware errors.

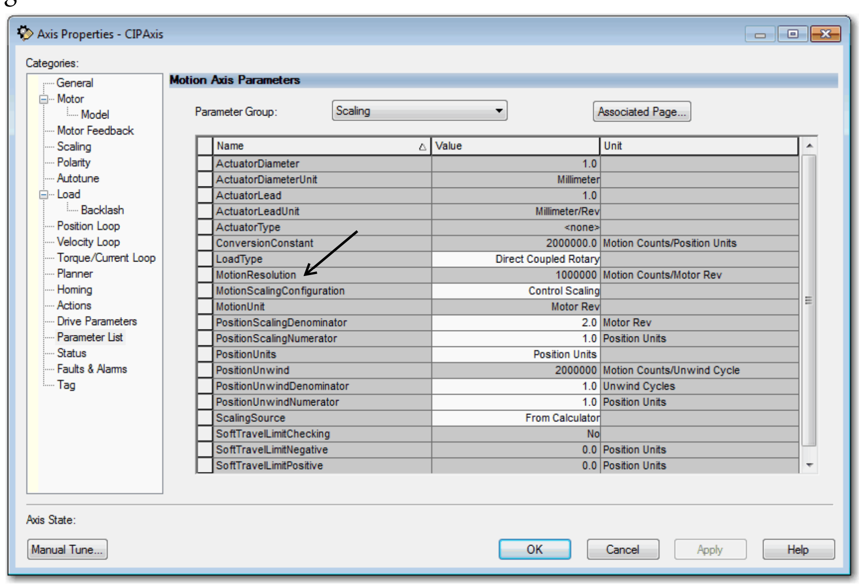
Scaling

Scaling parameters changes can potentially generate an APR fault because internal constants computed from these two parameters can generate a motion resolution change. If this change happens, an APR fault is generated.



Online Scaling

Any change or SSV message that results in a motion resolution change can generate an APR fault.



Resetting an APR Fault

There are three ways to reset an APR Fault:

- Instruction execution:
  - Executing an MAFR
  - Executing an MGSR
  - Executing an MASR
  - Executing an MCSR
- Do the following from the Controller Organizer:
  - Clear the group fault, the software executes an MGSR
  - Clear the axis fault, the software executes an MASR
- Download the same project a second time

Absolute Position Loss without APR Faults

The Absolute Position Recovery is not retained after the following:

- A project is exported, saved as an .L5K, and imported (downloaded)
- A major non-recoverable fault (MNRF)
- A power loss

TIP When you perform an import/export on a project in the RSLogix 5000® software, version 19 or earlier, the axis absolute position is not recovered on download to the controller.

The APR can potentially be restored from a memory card on a ControlLogix 5560 or GuardLogix 5560 controller (if a battery is not present) or on a ControlLogix 5570 controller (if a 1756-ESM*xxx* module is not present) as described on page 262.

- A download of an axis that does not have its home bit set
- Power cycling of an incremental encoder

Behavior of APR for Incremental Encoders

APR for incremental encoders means Absolute Machine Reference Position Retention. When an incremental encoder is homed, the homed bit is set. An APR fault is generated and the home axis bit clears when any of the events or conditions that generate an APR fault for an absolute encoder occur.

For example, the behavior of APR faults for an incremental encoder is identical to that of an absolute encoder. The exception to this behavior is when an incremental encoder is power cycled and its position comes up as 0. Its Absolute Machine Reference Position is lost. An APR fault is not generated.

Saving an ACD File Versus Upload of a Project

The following is an example of a sequence of events that can generate an APR fault.

1. Make an online change to an axis attribute that generates an APR fault.
2. Rehome the axis.

   This action is normally done so APR restores axes positions after a download.
3. Save your project.
4. Download your project.

   You still get an APR fault because saving the project only uploads the tags, not the changed attributes.

IMPORTANT	You must upload the project for the changed attributes to be saved and to help prevent an APR fault on a subsequent download.

Manual Tune

If Autotune does not meet your system specifications, the manual tuning feature lets you customize your tuning parameters. Manual Tuning lets you manually improve motion performance by adjusting system bandwidth, damping factor, and drive loop gains, filters, and compensations via direct online control. Perform a manual tune when you are online with a controller to get a real-time tune of an axis.

When to Manually Tune an Axis

If you are not sure that you must Manual Tune, use this process:

- If the software calculation defaults are acceptable, tuning is complete.
- If the software calculation defaults are not acceptable, perform an Autotune. If the Autotune results are acceptable, tuning is complete.

  See Autotune on page 235 for details.
- If the Autotune results are not acceptable, perform a Manual Tune by using sliders to run equations.

Axis Configuration Types

Manual Tune applies to Position Loop and Velocity Loop axis configurations. Manual Tune is not available for any other axis configurations. If you change the axis configuration to a value other than Position Loop or Velocity Loop while Manual Tune is opened, the contents of the Manual Tune expander becomes disabled. This condition also applies to the Additional Tune functions.

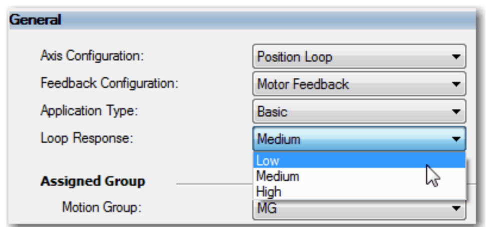
Current Tuning Configuration

Manual Tune displays the current tuning configuration. All parameters on the Manual Tuning dialog box are available while online.

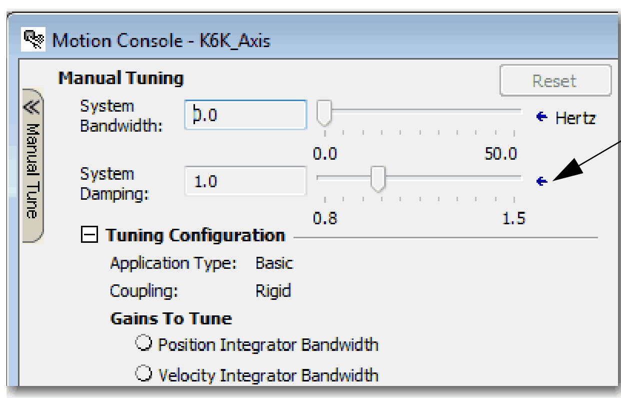
TIP In the RSLogix 5000® software, version 20 and later you can make edits when online. In the RSLogix 5000 software, version 19 and earlier, changes can only be made when online and the SERVO is enabled.

When you adjust the sliders, you can see what gains were updated. When servo is on, the left area of the dialog box lights up. This option gives you real manual tuning capability. When you expand the Tuning Configuration, you are reminded of the application type and coupling (loop response affects the system damping) you selected. These values are governing the displayed values.

There are three Loop Response settings on the General dialog box.



Loop Response relates to the following values for System Damping.
Low = 1.5
Medium = 1.0
High = 0.8

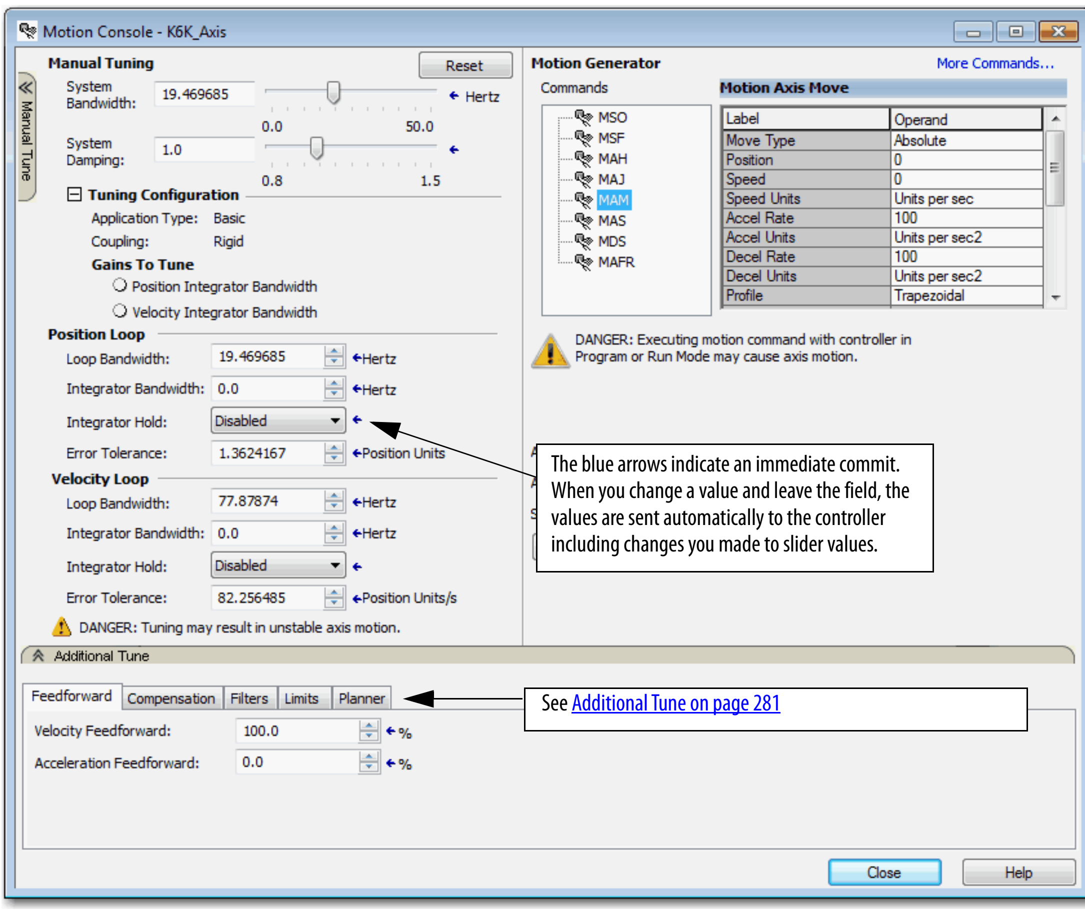


System Damping is for setting the axis Bandwidth and Error Tolerance values.

Loop Responses

This dialog box is where you can enter values for system bandwidth and system damping, which affect the loop gains. You can also individually modify the gains with sliders, bandwidth parameters, or manual changes. The gains and filters that you have tuned by using either default factory values or Autotune are your initial values in the Manual Tune dialog box. Coupling displays how tightly set or how you chose the system to tune.

The Motion Console dialog box displays Manual Tuning and Motion Generator. Use the left of the dialog box to test in an inactive state. As you perform the tune, you can test in an active state with Motion Generator.



ATTENTION: Before you tune or test axis motion, make sure no one is in the way of the axis.

Typically motion does not occur in Program mode but you can test an axis in Remote Program mode by using Motion Direct Commands.

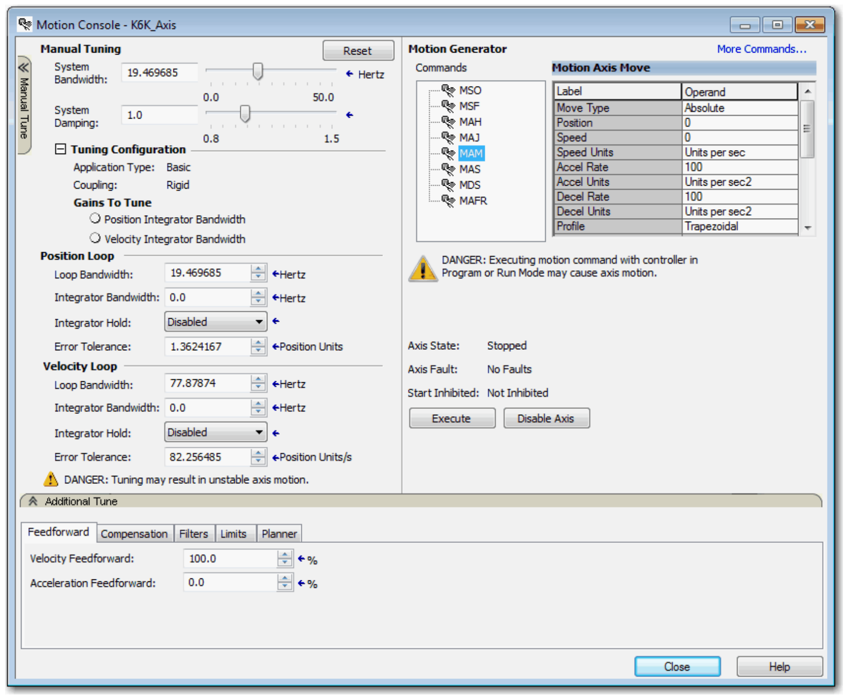
When you tune an axis, your code is **not** in control of the axis.

The tuning procedure tunes the proportional gains. Typically, tune the proportional gains first and see how your equipment runs.

Follow these instructions to tune an axis manually.

1. To open Manual Tune, do one of the following:
   - Double-click an axis while online with a controller.
   - Right-click an axis and choose Manual Tune.
   - Click Manual Tune in the lower left of any category dialog box.

   The Manual Tune dialog box appears.



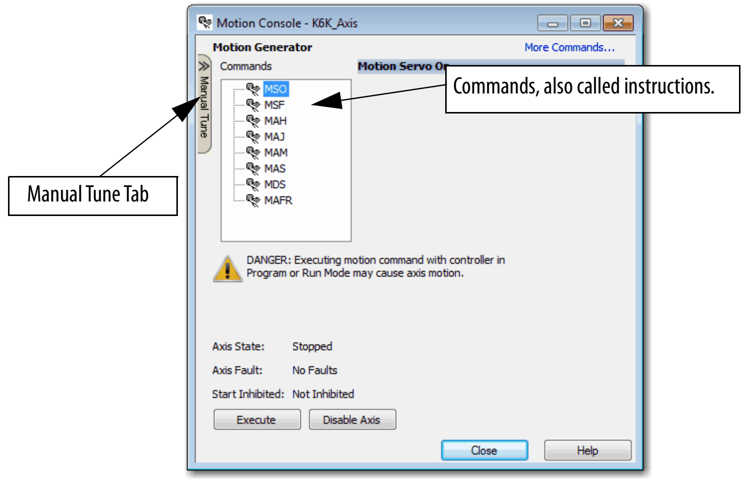
TIP When the Manual Tune dialog box appears, you can find that you cannot see the entire console. You can create more space for the console by reducing the size of the Controller Organizer or by adjusting the toolbars.

2. Adjust your settings according to your application.
3. When you change a value, it is sent to the controller immediately.
4. Execute a command.
5. Watch the result.
6. Make the necessary adjustments and execute a command.

TIP You can click Reset to return to default values.

Motion Generator and Motion Direct Commands

The commands on the Motion Generator give you basic control of a closed-loop servo axis.

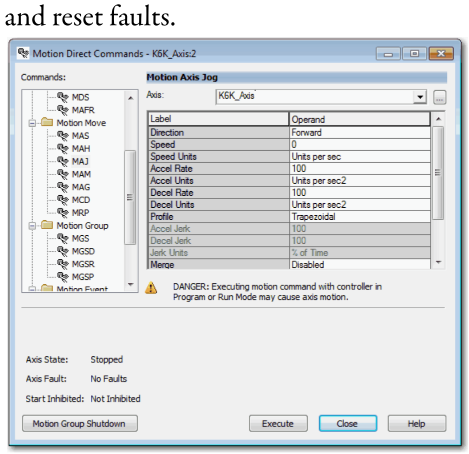


The following instructions are available on the Motion Generator dialog box.

Table 62 - Available Instructions

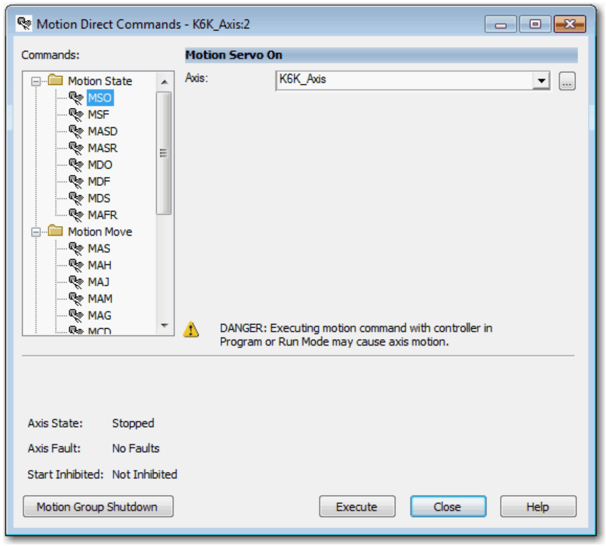
Command	Description
MDS	Motion Drive Start
MSO	Motion Servo On
MSF	Motion Servo Off
MAH	Motion Axis Home
MAJ	Motion Axis Jog
MAM	Motion Axis Move
MAS	Motion Axis Stop
MAFR	Motion Axis Fault Reset

When you click the More Commands link on the Motion Generator, you are taken to the Motion Direct Commands dialog box. In this dialog box, you can observe the effects of the manual tune. You can turn the axis on and off, home and move the axis, and reset faults.



Follow these instructions to use a Motion Direct Command.

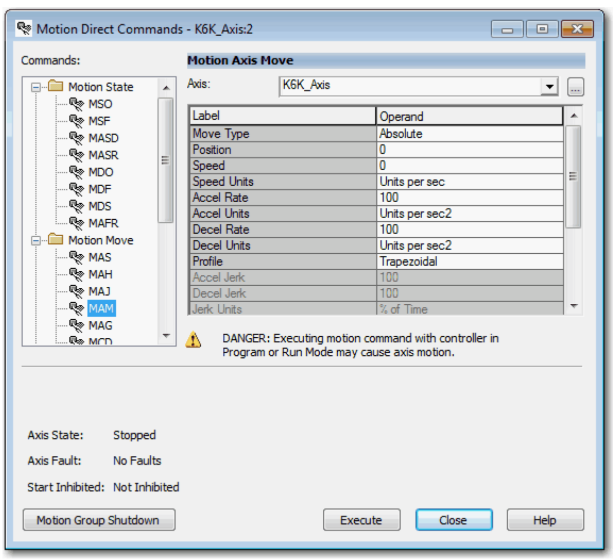
1. Select MSO (Motion Servo On) and click Execute.



2. Click Reset.

   Reset restores all values that were there when you first opened Manual Tune.

3. Select MAM (Motion Axis Move) and click Execute.



4. Click Execute.

   Your drive moves according to your configuration settings.

5. Adjust your settings, if desired.
6. Select another command and click Execute.

Additional Tune

The Additional Tune section gives you access to additional tuning parameters, typically needed for more advanced servo loop settings. Additional Tune provides access to five parameter tabs:

- Feedforward
- Compensation
- Filters
- Limits
- Planner

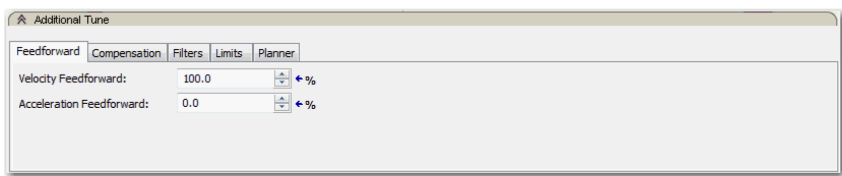
TIP You may have to turn all your toolbars off to see the complete screen. When you are done, choose View>Toolbars>Factory Defaults, or turn on the toolbars you want to see.

The type of drive you are using determines the attributes that appear on the tabs. You may not see all options that are shown in the following sections for your specific application.

See the Integrated Motion on the EtherNet/IP network Reference Manual, publication MOTION-RM003, for detailed information about the AXIS_CIP_DRIVE attributes.

Feedforward Parameters

The Feedforward tab lets you adjust velocity and acceleration feedforward.

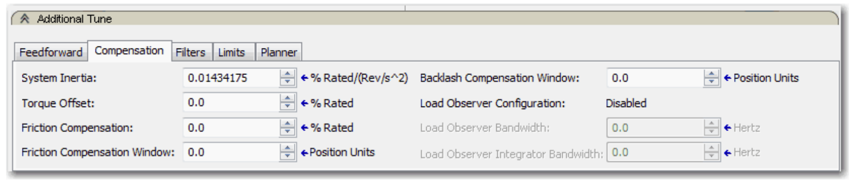


Attribute(1)	Description
Velocity Feedforward	A command signal that is a scaled version of the command velocity profile.
Acceleration	A signal that is a scaled version of the command acceleration profile.

(1) The attributes that you can edit depend on your drive configuration.

Compensation Parameters

The Compensation tab lets you input scaling gain and friction offset values.

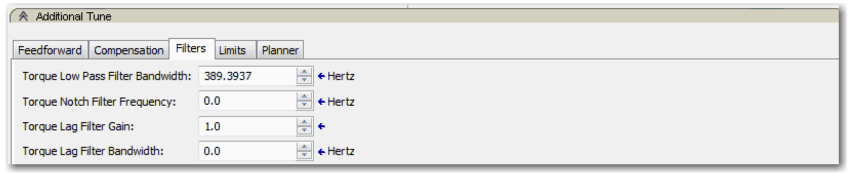


Attribute[1]	Description
System Inertia	Torque or force scaling gain value that converts commanded acceleration into equivalent rated torque/force.
Torque Offset	Provides a torque bias when performing closed-loop control.
Friction	Value that is added to the current/torque command to offset the effects of coulomb friction.
Friction Compensation	Value that is added to the current/torque command to offset the effects of friction. The Kinetix® 350 drive does not support this parameter.
Backlash Compensation	Defines a window around the command position.
Load Observer Configuration	Configures the operation of the Load Observer.
Load Observer Bandwidth	Determines the proportional gain, Kop, of the load observer.
Load Observer Integral Bandwidth	Determines the load observer integral gain, Koi, that together with the Kop, multiplies the integrated error signal within the observer.

(1) The attributes that you can edit depend on your drive configuration.

Filters Parameters

The Filters tab lets you input torque values.

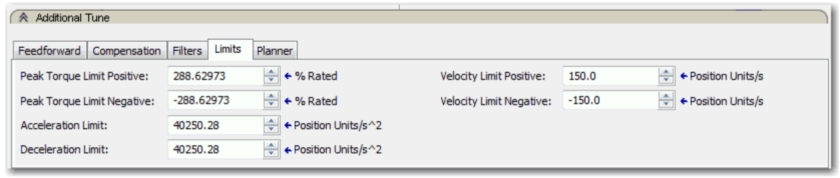


Attribute(1)	Description
Torque Low Pass Filter Bandwidth	Break frequency for the second order low pass filter that is applied to the torque reference signal.
Torque Notch Filter Frequency	Center frequency of the notch filter that is applied to the toque reference signal.
Torque Lag Filter Gain	Sets the high frequency gain of the torque reference Lead-Lag Filter.
Torque Lag Filter	Sets the lag filter that is applied to the torque reference filter.
Adaptive Tuning Configuration	Configured advanced gain tuning options. The modes for the adaptive tuning include: • Disabled • Notch Filter Tuning • Gain Stabilization • Notch Filter Tuning and Gain stabilization
Torque Notch Filter High Frequency Limit	The high frequency limit for vibration suppression. The value must be greater than the Torque Notch Filter Low Frequency Limit value. The default Torque Notch Filter High Frequency limit is 2000 Hertz
Torque Notch Filter Low Frequency Limit	The low frequency limit for vibration suppression. The value must be less than the Torque Notch Filter High Frequency Limit value. The value is tied to the drive model time constant based on motor, drive, and feedback type. The default Torque Notch Filter Low Frequency limit is 100 Hz.
Torque Notch Filter Tuning Threshold	Enter a threshold value for the resonance frequency that the tuning algorithm identifies. The magnitude of an identified natural resonance frequency must be higher than this threshold value to be applied to the Torque Notch Filter Frequency estimate. The default value is 5.0% Motor Rated.

(1) The attributes that you can edit depend on your drive configuration.

Limits Parameters

The Limits tab lets you input peak, velocity, and acceleration or deceleration values.

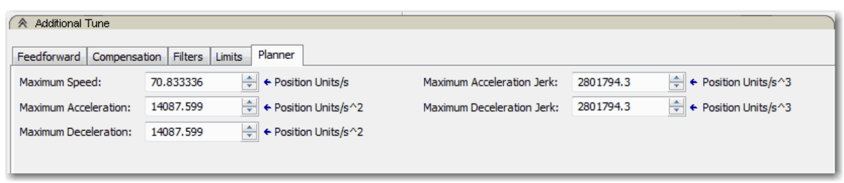


Attribute[1]	Description
Peak Torque Limit	Floating point that is based on calculations using Max Motor Torque, Max Drive Torque, Motor Peak Current, Motor Rated Current, and Drive Peak Current attributes.
Velocity Limit	Positive or Negative velocity reference value.
Acceleration	Defines the maximum acceleration (increase in speed) allowed for the acceleration reference value into the acceleration summing junction. The Kinetix 350 does not support this attribute.
Deceleration	Defines the maximum deceleration (decrease in speed) allowed for the acceleration reference signal into the acceleration summing junction.

(1) The attributes that you can edit depend on your drive configuration.

Planner Parameters

The Planner tab lets you input the maximum values for acceleration and deceleration.



Attribute[1]	Description
Maximum	The value of the Maximum Speed attribute that is used by various motion instructions to determine the steady-state speed of the axis.
Maximum Acceleration and Maximum Deceleration	The Maximum Acceleration and Maximum Deceleration values frequently used by motion instructions, for example, MAJ, MAM, and MCD, to determine the acceleration/deceleration rate to apply to the axis.

(1) The attributes that you can edit depend on your drive configuration.

Configure Torque Values

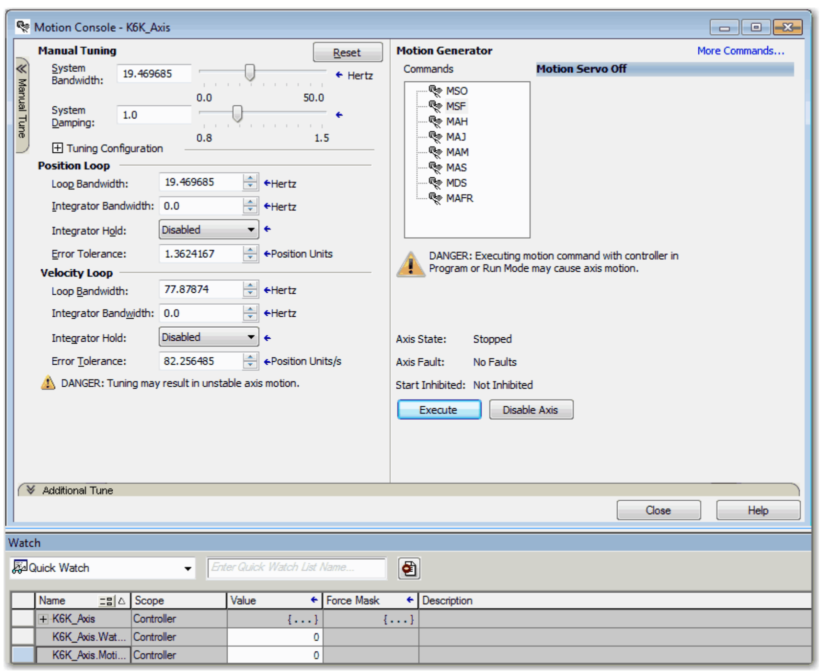
More advanced servo loop settings typically require additional tuning parameters such as torque values. The type of drive you are using determines the values that appear.

Follow these steps to configure torque values:

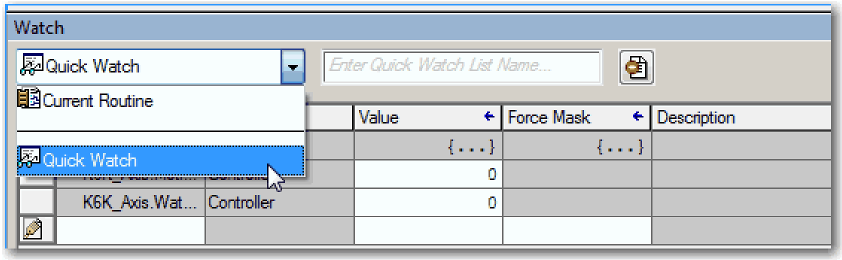
1. Right-click an axis and click Manual Tune.
2. In the bottom left corner of the Manual Console dialog box, click Additional Tune to display the additional tune tabs.
3. To access the torque values, click the Filters tab.
4. Adjust the torque values as desired.
5. After you adjust the values, click Additional Tune to close the tabs.

Monitor Tags with the Quick Watch Window

The Quick Watch window lets you monitor the tags in your program while you are executing commands. To open Quick Watch, press ALT+3 or choose it from the View menu.



You create Quick Watch Lists by choosing Quick Watch from the pull-down menu.



Once you name a Quick Watch List, it available in the ACD, L5K, and L5X files. Make sure to name your lists. Lists that do not have names are lost when you close the software.

Use Motion Generator

This example assumes the following:

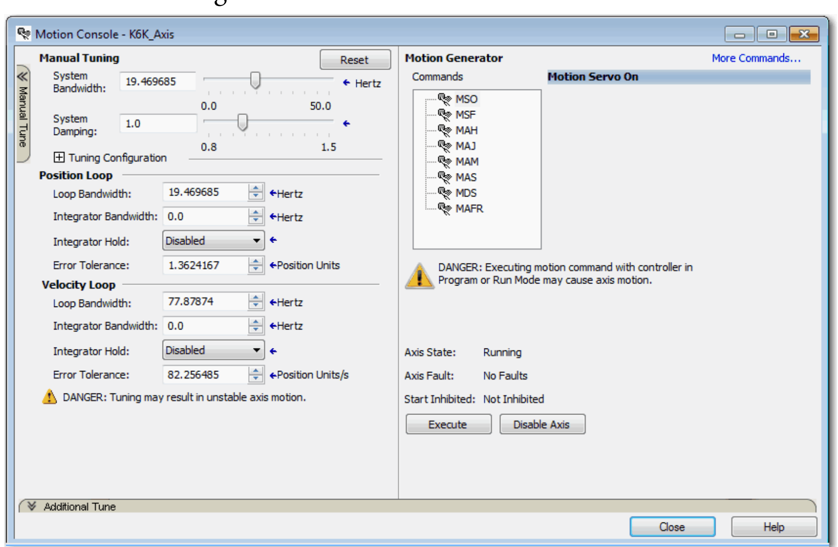
- The servo is off, with session Online
- Axis State: Stopped
- Axis Faults: No Faults

1. Choose MSO (Motion Servo On).

   This selection readies the drive for motion, and enables the servo loop.

2. Click Execute.

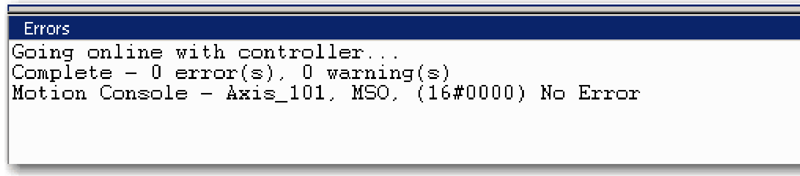
   The axis state goes to Servo = On.



The Motion Console dialog box displays the following:

- Axis State: Running
- Axis Faults: No Faults

The Results window displays the following message.



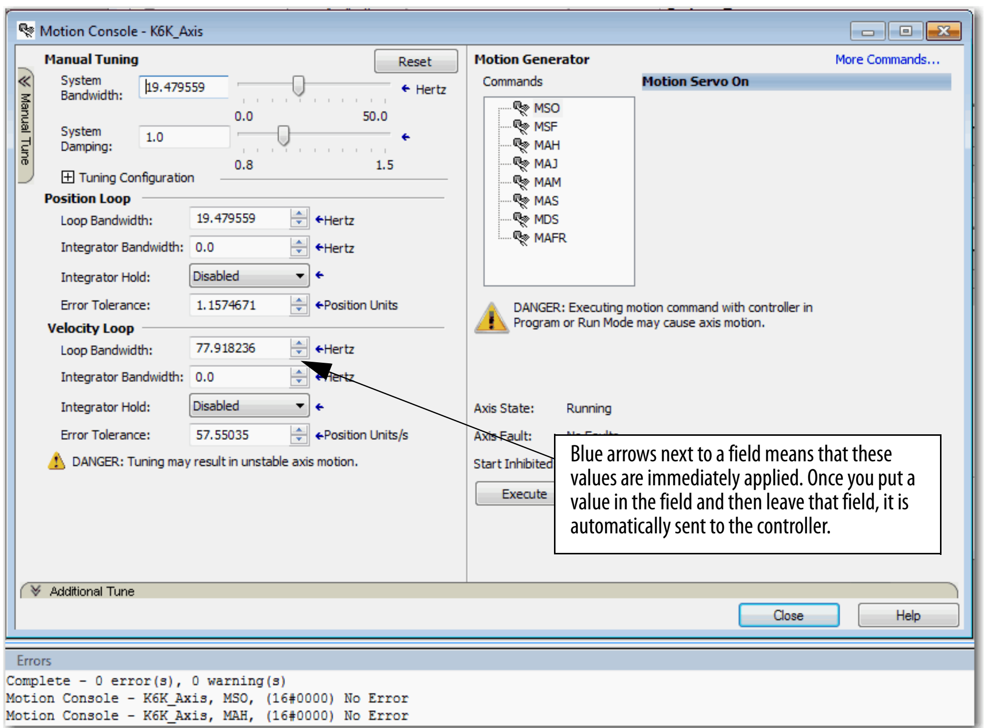
3. Select MAH (Motion Axis Home) and click Execute.

   Use this step to execute the Homing command to establish a feedback positional reference, if a Position loop is being tuned.

   The axis state goes Servo-On, and the controller performs the Axis Home procedure, which is based on the configured Home settings.

   The Motion Console dialog box appears:

   - Axis State: Running
   - Axis Faults: No Faults



   The Results window displays No Error.

4. Choose MAM (Motion Axis Move).

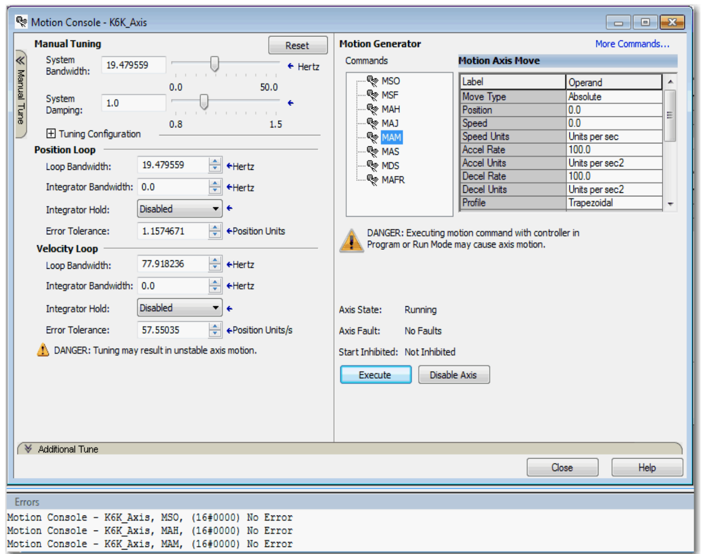
   This step initiates an Axis-Move at the selected speed, acceleration/deceleration, profile, and endpoint position and lets you observe the axis response.

   Before executing this MAM Move, you can initiate a method to observe the axis response during the move.

Some examples include the following:

- Watch-window:
  Quick Watch tag name = Axis_y.ActualPosition or = Axis_y.ActualVelocity
- New Trend with Tags:
  Axis_y.ActualPosition or = Axis_y.ActualVelocity
- Axis Properties:
  Status dialog box = Axis_y.ActualPosition or = Axis_y.ActualVelocity

5. Click Execute.



The controller performs a controlled axis move.

The Motion Console dialog box appears:

- Axis State: Running
- Axis Faults: No Faults

The Results window displays No Error.

6. Observe and verify the Axis response.

   The axis motion moves according to the configured MAM settings:

   – If the settings and response are satisfactory, then tuning is finished and you can close Manual Tune.

   – If the settings or responses are not satisfactory, stay in Manual Tune and adjust the parameters.

Status, Faults, and Alarms

There are four ways to find and view faults and alarms:

- Fault and Alarm Log
- QuickView® Pane
- Tag Monitor, see the individual fault-related attributes
- Drive Status Indicators

Faults and Alarms Dialog Box

The Faults and Alarms dialog box displays the status of faults and alarms in the controller for an axis. The display is read-only except for the ability to clear logs. Fault and alarm entries are displayed only when you are online with a controller.

When online, check or clear the checkboxes in the Show row to show or hide the specified group of entries. Only the last 25 faults and alarms display.

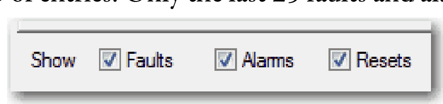


Figure 107 - Faults and Alarms Log

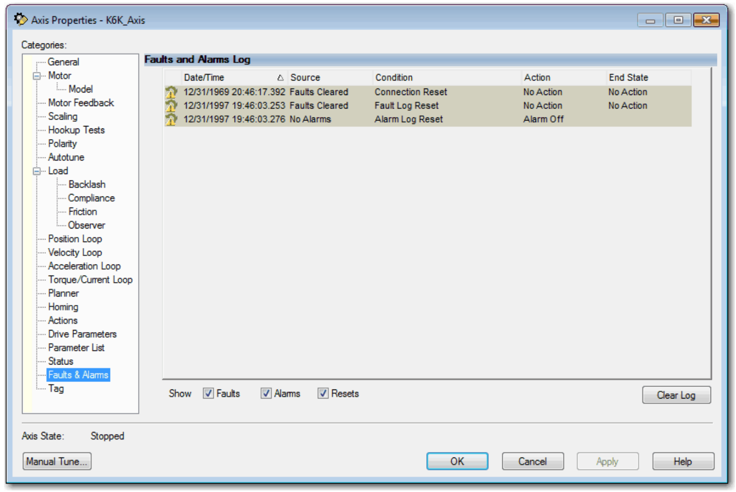


Table 63 describes the parameters for the Faults and Alarms dialog box.

Table 63 - Faults and Alarms Dialog Box Descriptions

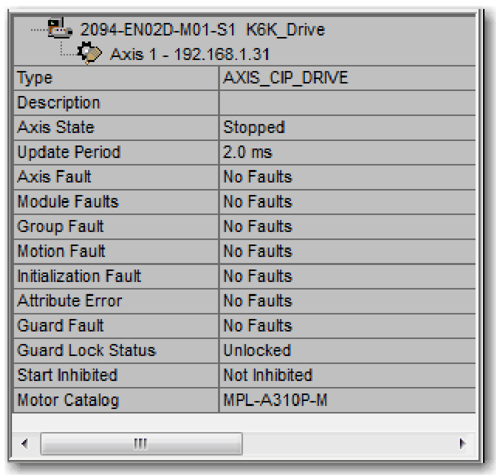
Parameter	Description
Indicator	Displays the following icons to indicate the state of a fault or alarm: • Alarm On • Alarm Off • Fault Occurred • Reset Occurred
Date/Time	Displays the date and time the event occurred. The time stamp is the workstation setting.
Source	Displays the source of the event, for example: • Safety Fault • Module Fault • Group Fault • Axis Fault • Axis Alarm
Condition	Displays detailed information specific to the event category and code. For drive exception conditions, the information is the same text that is used for the condition. This field can contain more information when the Subcode field has been used for that entry. The field is a more detailed entry if both codes are used in the log, for example: • Group Sync Failure • Bus Overvoltage UL • All Axis Faults • Motor Overspeed • Axis Init Fault
Action	Displays the action command that was executed in response to the event as configured in the axis. For instance, in many cases this display indicates that a command sent to a drive, for example: • Planned Stop • Ramped Stop • Limited Stop • Coast • No Action • Alarm Off • Alarm On

Table 63 - Faults and Alarms Dialog Box Descriptions

Parameter	Description
End State	Displays the action result that is returned from the axis, which can be more detailed than the command sent. For instance, a send of disable can result in either Holding, Shutdown or other status, for example: • Stopped - Hold • Stopped - Disable • Shutdown • Shutdown Reset
Faults	Toggles between faults; display or hide.
Alarms	Toggles between alarms; display or hide.
Clear Log	Clears both the fault and alarm logs in the controller for this axis.

QuickView Pane

The QuickView pane gives you a quick summary of faults and alarms that are related to the axis you select in the Controller Organizer. The information includes the type of axis, description, axis state, faults, and alarms.

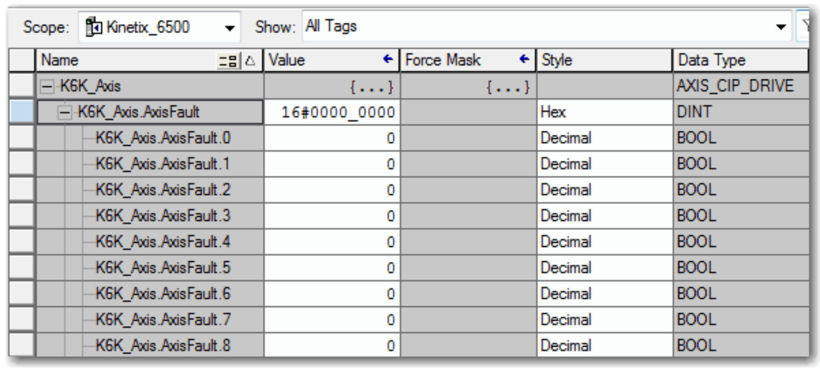


Data Monitor

The Data Monitor is where you can read and write the values that are assigned to specific tags, both online and offline.

You can do the following:

- Type a tag description.
- Change the display style of a value.
- Change a force mask value.
- Sort your tags alphabetically.



Scope: Kinetix_6500 Show: All Tags

Name	Value	Force Mask	Style	Data Type
K6K_Axis	{...}	{...}		AXIS_CIP_DRIVE
K6K_Axis.AxisFault	16#0000_0000		Hex	DINT
K6K_Axis.AxisFault.0	0		Decimal	BOOL
K6K_Axis.AxisFault.1	0		Decimal	BOOL
K6K_Axis.AxisFault.2	0		Decimal	BOOL
K6K_Axis.AxisFault.3	0		Decimal	BOOL
K6K_Axis.AxisFault.4	0		Decimal	BOOL
K6K_Axis.AxisFault.5	0		Decimal	BOOL
K6K_Axis.AxisFault.6	0		Decimal	BOOL
K6K_Axis.AxisFault.7	0		Decimal	BOOL
K6K_Axis.AxisFault.8	0		Decimal	BOOL

Drive Status Indicators

For complete information on drive status indicators, refer to the publications listed in Additional Resources on page 9.

Connection Faults and Errors

The Connection tab provides you with information about the connection condition between the controller and a module. The information comes from the controller.

You can configure the controller so that a loss of connection causes a major fault. Fault codes are as follows:

Major Fault	Configure the controller so that a loss of connection to this module causes a major fault.
Module Faults	Displays the fault code that is returned from the controller and provides details about the fault.

Table 64 describes common connection errors.

Table 64 - Common Connection Errors

Error	Description
Connection Request Error	The controller is attempting to make a connection to the module and has received an error. The connection was not made.
Service Request Error	The controller is attempting to request a service from the module and has received an error. The service was not performed successfully.
Module Configuration Invalid	The configuration in the module is invalid. Module Configuration Rejected - invalid power structure.
Electronic Keying Mismatch	Electronic Keying is enabled and some part of the keying information differs between the software and the module.

Troubleshoot Faults

The controller has these types of motion faults.

Table 65 - Motion Faults

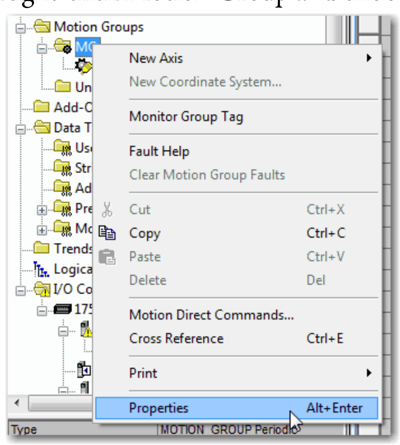
Type	Description	Example
Instruction error	Caused by a motion instruction: • Instruction errors do not affect controller operation. • Review the error code in the motion control tag to see why an instruction has an error. • Fix instruction errors to optimize execution time and make sure that your code is accurate. See Error Codes (ERR) for Motion Instructions, publication MOTION-RM002.	A Motion Axis Move (MAM) instruction with a parameter out of range.
Fault	Caused by an anomaly with the servo loop: • You choose whether motion faults cause major faults. • Can shut down the controller if you do not correct the fault condition.	• Loss of feedback. • Actual position that exceeds an overtravel limit.

Manage Motion Faults

By default, the controller runs when there is a motion fault. As an option, you can configure motion faults to cause a major fault and shut down the controller.

To configure a fault type, follow these steps:

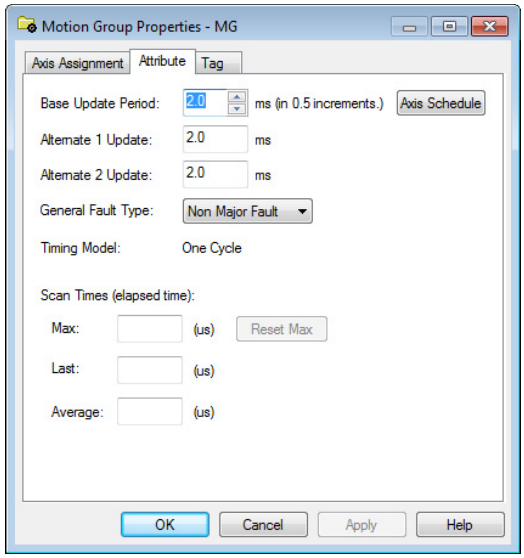
1. Right-click Motion Group and choose Properties.



2. Click the Attribute tab.

3. From the General Fault Type pull-down menu, choose the general fault type.

   If you want any motion fault to cause a major fault and shut down the controller, choose Major Fault. If you choose Non-Major Fault, you must write application code that enables the controller to handle the motion fault.



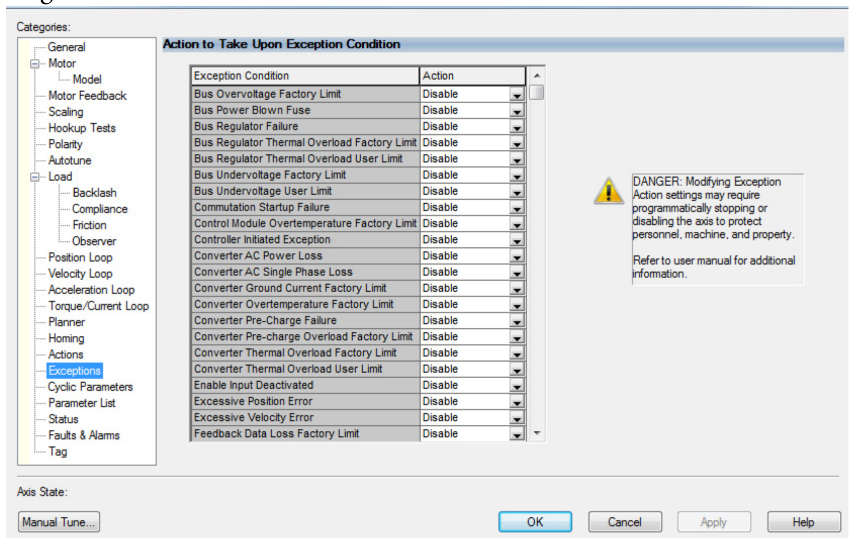
Configure the Exception Actions for AXIS_CIP_DRIVE

Use exception actions to set how an axis responds to different types of faults. The types of faults depend on the type of axis and how you configure it.

The drive the axis is associated with controls the available actions for each Exception. When a fault or alarm occurs, the corresponding fault or alarm axis attributes are set.

See Exception, Fault, and Alarm Attributes in the Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003.

To configure the Exception Actions, open the Axis Properties Exceptions dialog box.



Options for each of the actions and the list of Exceptions can change based on how you configure the drive. If an exception is not possible for a specific drive (as defined by the profile of the drive), then that exception is not shown in this list.

The drive can restrict the list of actions that are taken. When a previously selected entry is no longer supported due to a configuration change, most of the entries default to Disable. In the few cases where Disable does not apply, the default is Fault Status Only. For example, Disable does not apply with a Feedback Only type configuration.

Figure 108 - Action Parameter Group Dialog Box

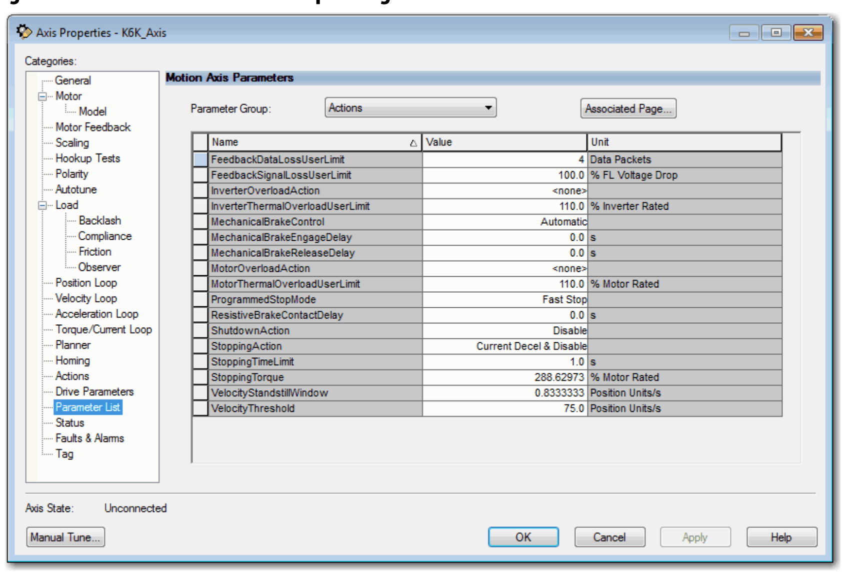


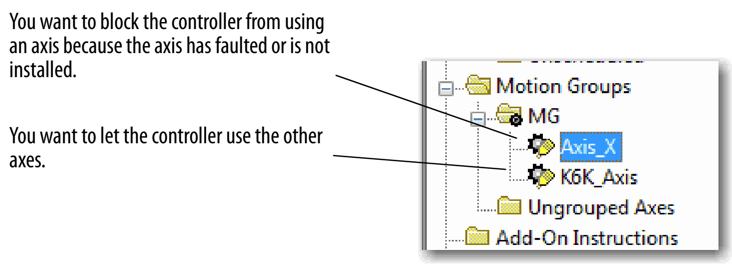
Table 66 - Action Tasks and Related Faults

Task	Choose	Description
Shut down the axis and let it coast to a stop.	Shutdown	Shutdown is the most severe action. Use it for faults that could endanger the machine or the operator if you do not remove power quickly and completely. A fault happens when the following occurs: • Axis servo action is disabled • Servo amplifier output is zeroed • Appropriate drive enable output is deactivated • OK contact of the servo module opens. Use this contact to open the E-stop string to the drive power supply
Stop the axis and let the drive stop the axis where you use the Stopping Action attribute to configure how to stop the drive.	Disable	A fault happens when the following occurs: • Axis servo action is disabled • Servo amplifier output is zeroed • Appropriate drive enable output is deactivated • Drive switches to local servo loop control and the axis are slowed to a stop using the Stopping Torque • The servo action and the power structure are disabled if the axis doesn't stop in the stopping time
Leave the servo loop on and stop the axis at its Maximum Deceleration rate.	Stop Planner	Use this fault action for less severe faults. It is the gentlest way to stop. Once the axis stops, you must clear the fault before you can move the axis. The exception is Hardware Overtravel and Software Overtravel faults, where you can jog or move the axis off the limit.
		A fault happens when the following occurs: • Axis slows to a stop at the Maximum Deceleration Rate without disabling servo action or the servo module Drive Enable output • Control of the servo loop of the drive is maintained • Axis slows to a stop at the Maximum Deceleration rate without disabling the drive
Write your own application code to handle the fault.	Fault Status Only	Use this fault action only when the standard fault actions are not appropriate. With this fault action, you must write code to handle the motion faults. For Stop Motion or Status Only, the drive must stay enabled for the controller to continue to control the axis. Select Status Only to let motion continue only if the drive itself is still enabled and tracking the command reference.
	Ignore	Ignore instructs the device to ignore the exception condition. For some exceptions that are fundamental to the operation of the axis, it is not possible to Ignore the condition.
	Alarm	Alarm action instructs the device to set the associated bit in the Axis Alarm word, but does not otherwise affect axis behavior. For some exceptions that are fundamental to the operation of the device, it is not possible to select this action or any other action that leaves device operation unaffected.

Inhibit an Axis

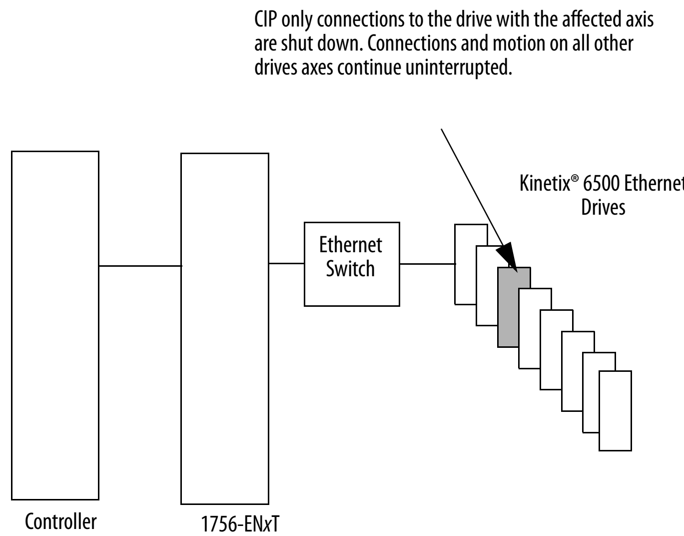
IMPORTANT	You can inhibit an axis only if the axis has been previously synched to the group. If the axis has not been synched to the group, you cannot inhibit the axis.

Inhibit an axis when you want to block the controller from using an axis because the axis has faulted or is not installed. You can also inhibit an axis to let the controller use other axes.



See Example: Inhibit an Axis on page 298 and Example: Uninhibit an Axis on page 299 for more information.

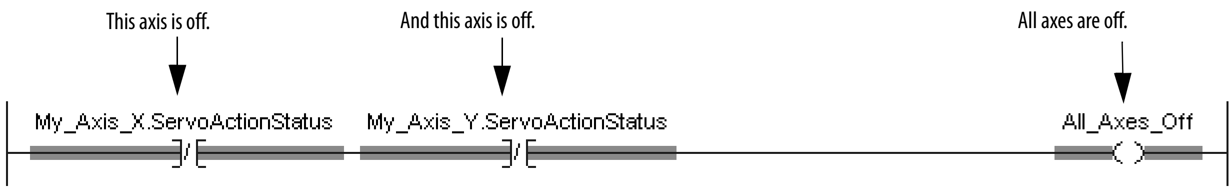
Table 67 - Inhibit Axes

Before you inhibit or uninhibit an axis, turn off all axes.	Before you inhibit or uninhibit an axis, know that inhibit/uninhibit of an axis also affects any half axes in the same drive. 1. Stop all motion in the axis. 2. Use an instruction such as the Motion Servo Off (MSF) for the axis. This process lets you stop motion under your control. Otherwise the axes turn off on their own when you inhibit or uninhibit one of them.  The controller automatically restarts the connections.
To inhibit the axes, inhibit the communication module.	Do you want to inhibit the integrated motion on the EtherNet/IP network axes? • YES—Inhibit the 1756-EN*x*T communication modules. • NO—Inhibit the individual axes. You can inhibit the axes of a module on an individual basis. However, it is more efficient to inhibit all axes at once by inhibiting the module.

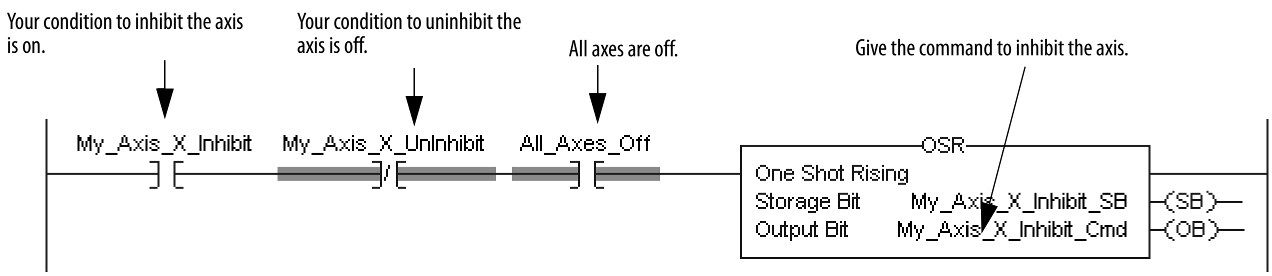
Example: Inhibit an Axis

Important: If you inhibit an axis on a drive, you inhibit all action on the drive, including any half axes. Verify that you are aware of all action on a drive before inhibiting the axis.

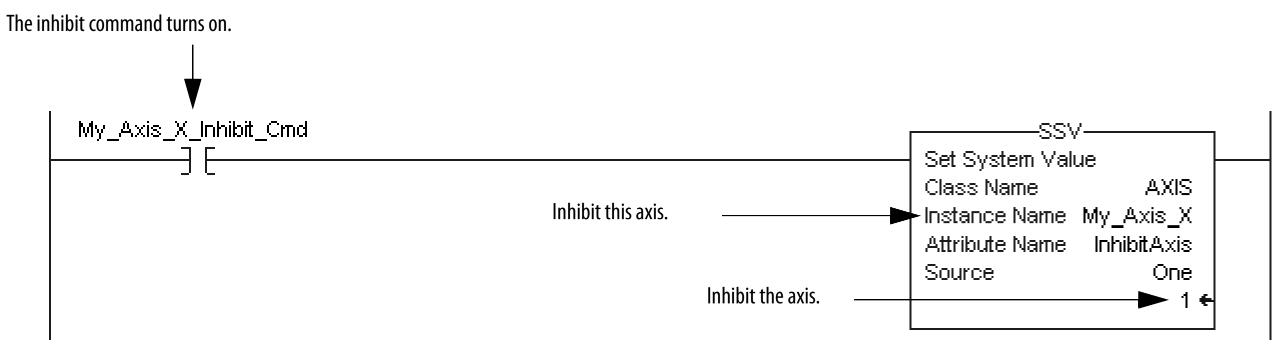
1. **Verify that all axes are off.**



2. **Trigger the inhibit with a one-shot instruction.**



3. **Inhibit the axis.**



4. **Wait for the inhibit process to finish.**

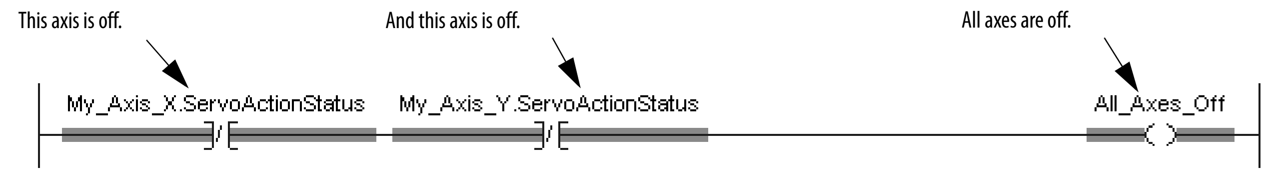
The following have happened:

- The axis is inhibited.
- All uninhibited axes are ready.
- The connections to the motion drive module are running again.

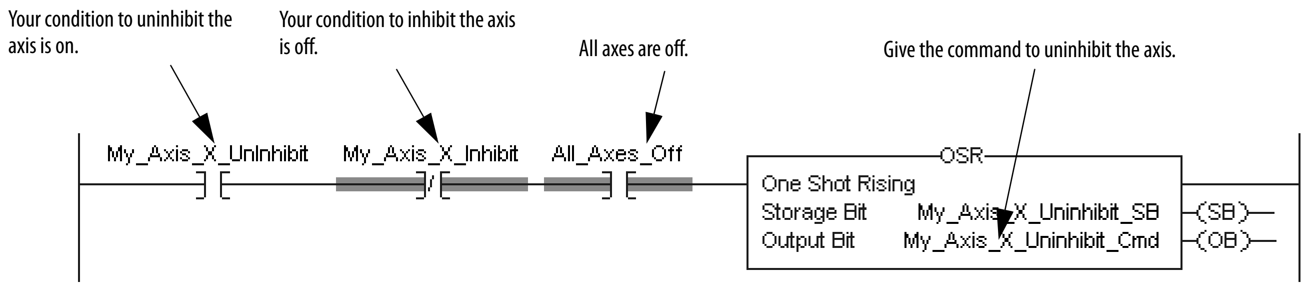
Example: Uninhibit an Axis

Important: If you inhibit an axis on a drive, you inhibit all action on the drive, including any half axes. Verify that you are aware of all action on a drive before inhibiting the axis.

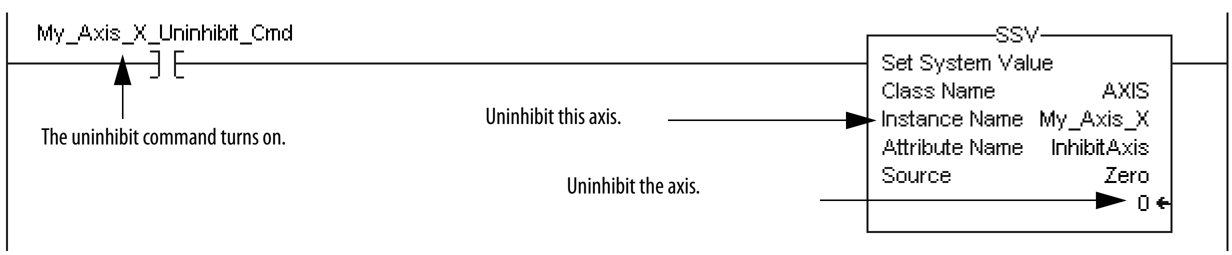
1. **Verify that all axes are off.**



2. **Trigger the uninhibit with a one-shot instruction.**

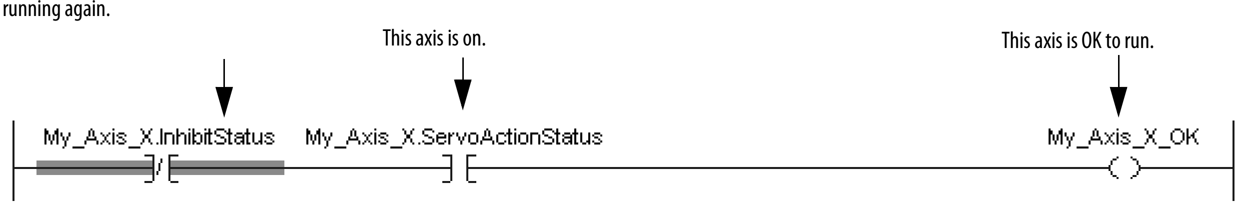


3. **Uninhibit the axis.**



4. **Wait for the inhibit process to finish.**

The following have happened:
- The axis is uninhibited.
- All uninhibited axes are ready.
- The connections to the motion drive module are running again.



Digital I/O Status Indicators

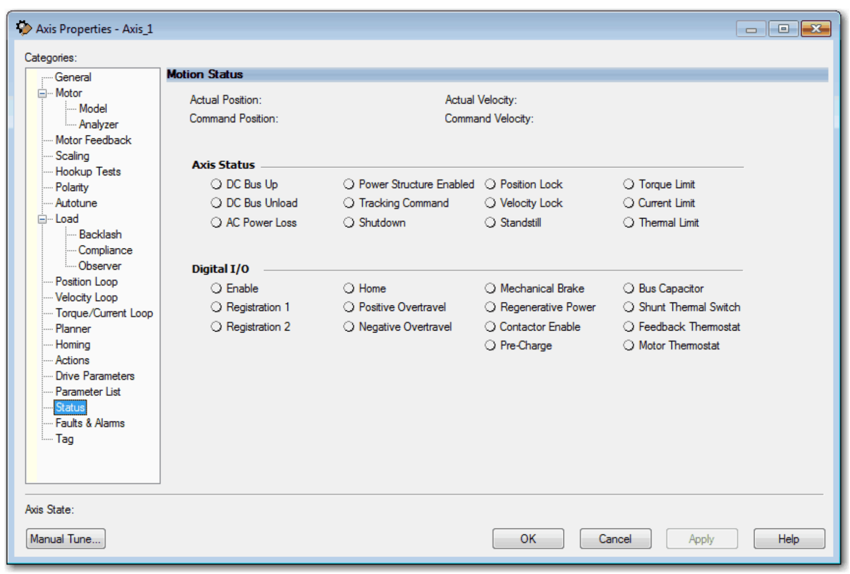
Use the Status category to:

- Display the status of the axis
- View the current state of the axis and CIP Safety™ drive
- Manually adjust axis drive attributes

The status tab displays the following:

- Position Data (Actual and Command)
- Velocity Data (Actual and Command)
- Axis status indicators
  - The indicators light up if the state has been reached. For example, if the Torque Limit is reached, the light next to that limit turns blue.
- Digital I/O status indicators
  - The indicators light up if the state has been reached. For example, if Registration 1 is reached, the light next to Registration 1 turns blue.

You can view the status of the digital I/O indicators in the Status category of the Axis Properties window. An example of the Status category is shown in the following figure.



The following two tables detail the meaning of the status indicators per the axis tags.

Bit	Required/ Optional	Name	Digital I/O	Axis Status	Description
0	R	Enable Input	Off	0	Enable is not active
			On	1	Enable is active
1	R/E	Home Input	Off	0	Home is not active
			On	1	Home is active
2	R/E	Registration 1 Input	Off	0	Reg 1 is not active
			On	1	Reg 1 is active

Bit	Required/ Optional	Name	Digital I/O	Axis Status	Description
3	O/E	Registration 2 Input	Off	0	Reg 2 is not active
			On	1	Reg 2 is active
4	R/P	Positive Overtravel OK Input	Off	0	Overtravel Fault
			On	1	No Overtravel Fault
5	R/P	Negative Overtravel OK Input	Off	0	Overtravel Fault
			On	1	No Overtravel Fault
6	O/E	Feedback 1 OK Thermostat	Off	0	Feedback 1 Thermostat Fault
			On	1	No Feedback 1 Thermostat Fault
7	O/D	Resistive Brake Release Output	Off	0	Motor connected to Brake Resistor
			On	1	Motor connected to Inverter
8	O/D	Mechanical Brake Release Output	Off	0	Brake is Engaged
			On	1	Brake is Released
9	O/D	Motor Thermostat OK Input	Off	0	Thermostat Fault
			On	1	No Thermostat Fault
10…31	-	Reserved	-	-	-

Notes:

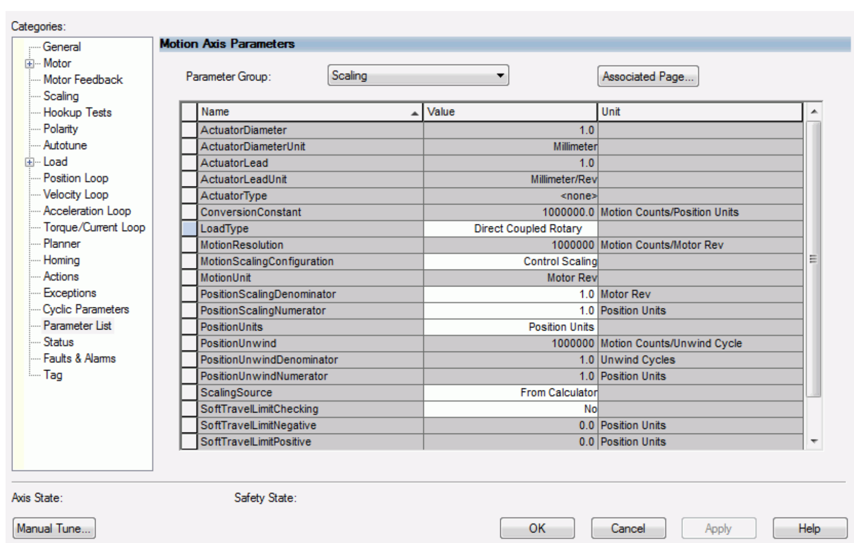
Parameter Group Dialog Boxes

This appendix describes the parameter group dialog-boxes. You can access all parameters that are associated with each category dialog box by clicking Parameters on the dialog box.

Parameter Dialog-box Listings

Each Parameter dialog-box list can contain more attributes than the associated category dialog box. In some cases, attributes that are contained on the Parameter List dialog box are not contained on the associated category dialog box.

Figure 109 - Scaling Parameters



You can configure advanced parameters only on the dialog box for that group. Not all parameters can be set on each category dialog box.

This dialog box is an example of the parameters available for an axis that is configured as a Position Loop. There are six parameters that you can set on the Position Loop and Position Loop Parameter Group dialog boxes.

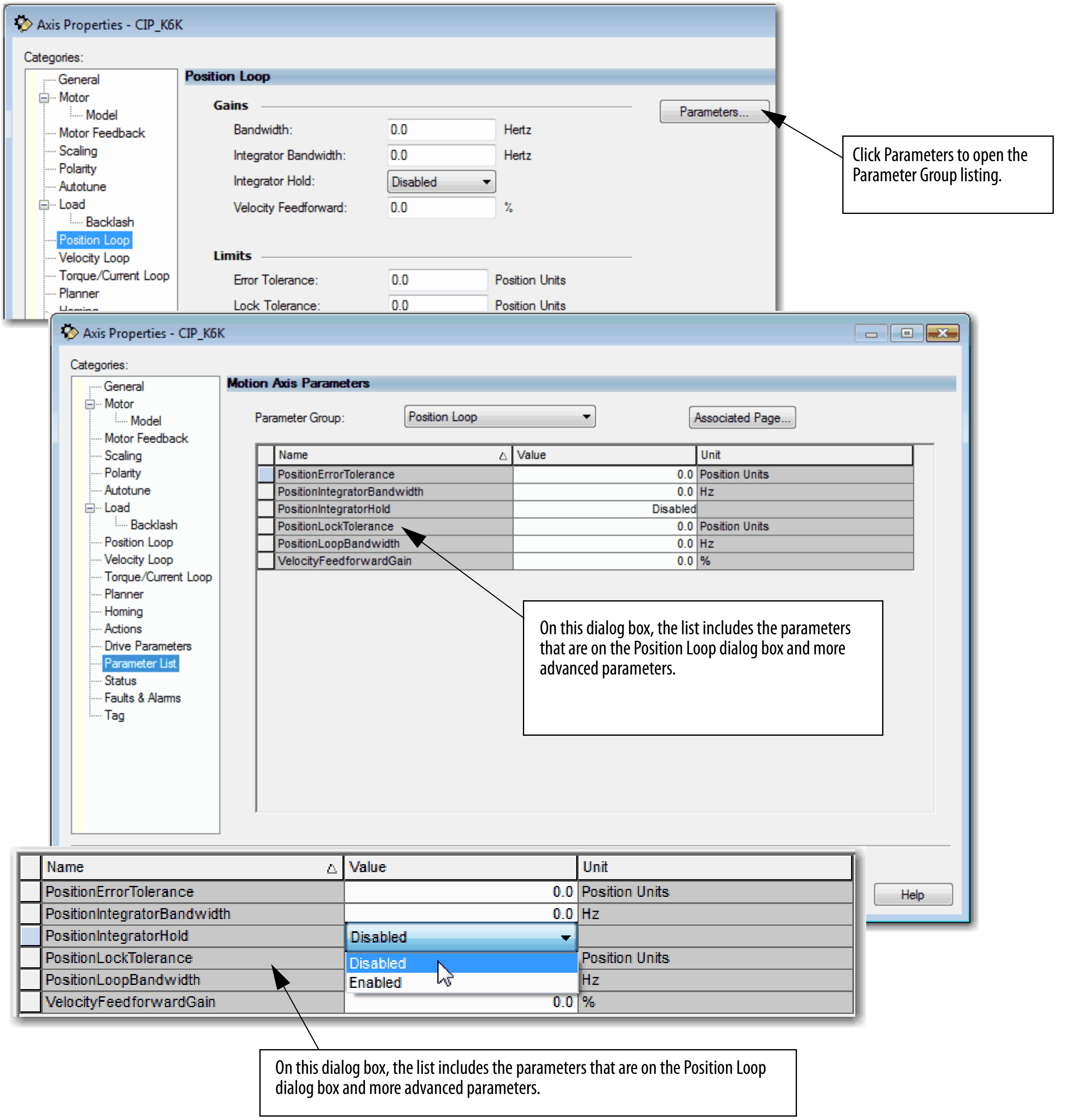
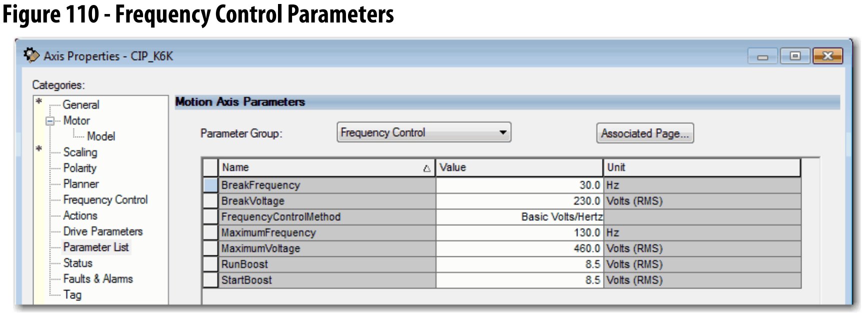


Figure 110 - Frequency Control Parameters



Out of Box Configuration for PowerFlex Drives

This appendix describes how to program a velocity profile and jerk rate.

Program a Velocity Profile and Jerk Rate

You can use either of these motion profiles for various instructions:

- Trapezoidal profile for linear acceleration and deceleration
- S-curve profiles for controlled jerk

Definition of Jerk

The Jerk is the rate of change of acceleration or deceleration.

The jerk parameters apply only to S-curve profile moves that use these instructions:

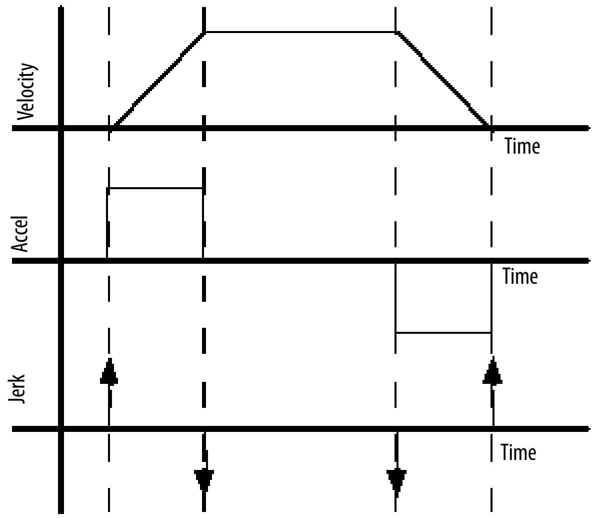
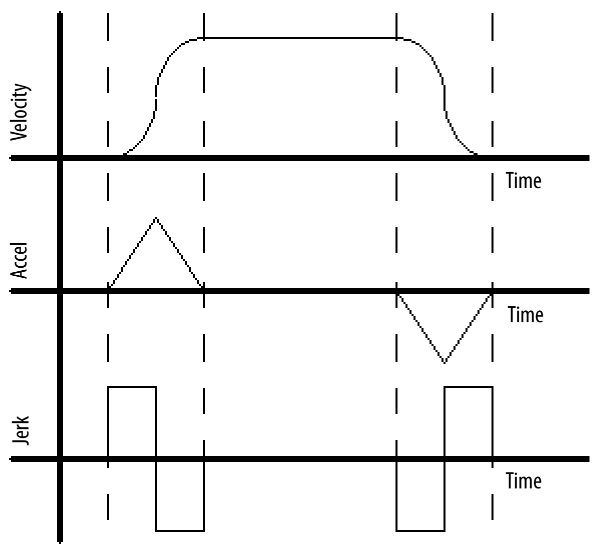
- MAJ
- MAM
- MAS
- MCD
- MCS
- MCCD
- MCCM
- MCLM

For example, if acceleration changes from 0 to 40 mm/s^2 in 0.2 seconds, the jerk is:

$$(40 \text{ mm/s}^2 - 0 \text{ mm/s}^2) / 0.2 \text{ s} = 200 \text{ mm/s}^3$$

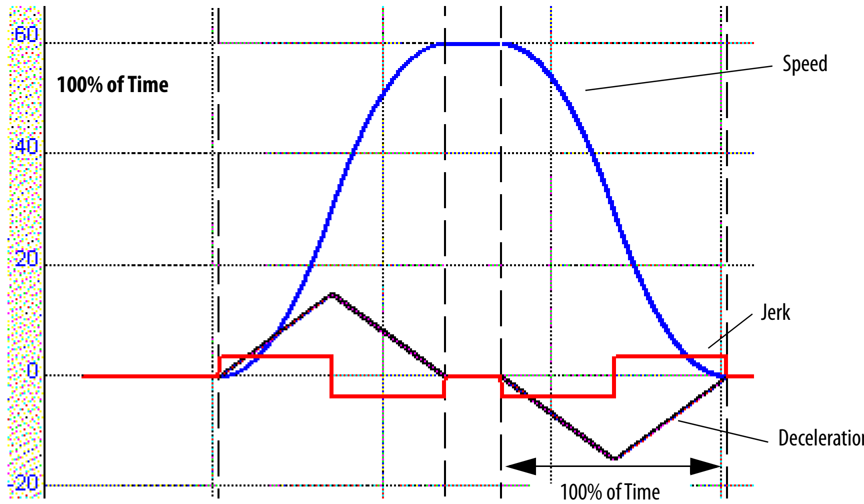
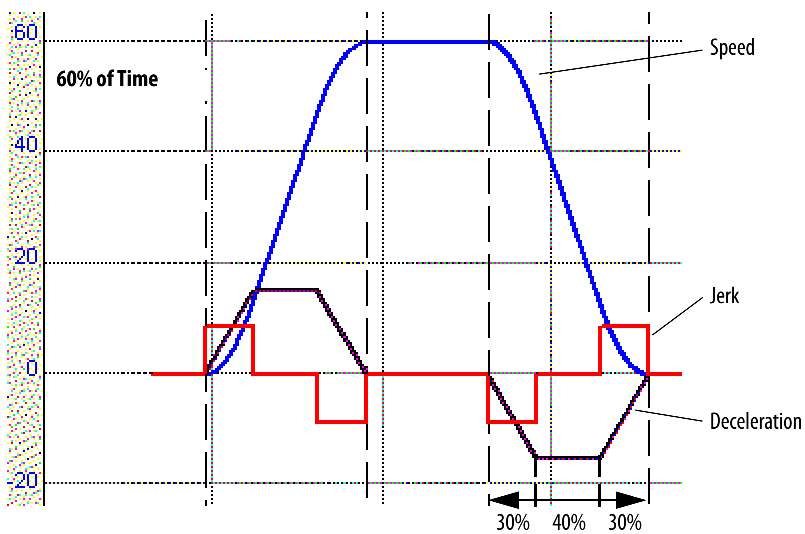
Choose a Profile

Consider cycle time and smoothness when you choose a profile.

If You Want	Choose This Profile	Consideration
• Fastest acceleration and deceleration times • More flexibility in programming subsequent motion	Trapezoidal 	Jerk **doesn't** limit the acceleration and deceleration time: • The Acceleration and Deceleration rates control the maximum change in Velocity. • Your equipment and load get more stress than with an S-curve profile. • Jerk is considered infinite and is shown as a vertical line.
Smoother acceleration and deceleration that reduces the stress on the equipment and load	S-curve 	Jerk limits the acceleration and deceleration time: • It takes longer to accelerate and decelerate than a trapezoidal profile. • If the instruction uses an S-curve profile, the controller calculates acceleration, deceleration, and jerk when you start the instruction. • The controller calculates triangular acceleration and deceleration profiles.

Use % of Time for the Easiest Programming of Jerk

Use % of Time to specify how much of the acceleration or deceleration time has jerk. You don't have to calculate actual jerk values.

<table>
<tr><th>Example</th><th>Profile</th></tr>
<tr><td>100% of Time</td><td>At 100% of Time, the acceleration or deceleration changes the entire time that the axis speeds up or slows down.

</td></tr>
<tr><td>60% of Time</td><td>At 60% of Time, the acceleration or deceleration changes 60% of the time that the axis speeds up or slows down. The acceleration or deceleration is constant for the other 40%.

</td></tr>
</table>

Velocity Profile Effects

Table 68 summarizes the differences between profiles.

Table 68 - Profile Differences

Profile	ACC/DEC	Motor	Priority of Control			
Type	Time	Stress	**Highest to Lowest**			
Trapezoidal	Fastest	Worst	Acc/Dec	Velocity	Position	
S-curve	2X Slower	Best	Jerk	Acc/Dec	Velocity	Position

Jerk Rate Calculation

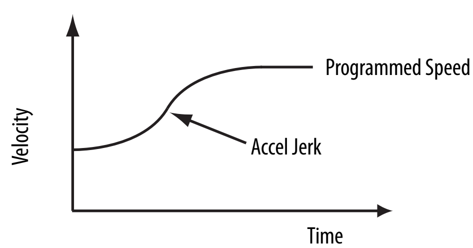
If the instruction uses or changes an S-curve profile, the controller calculates acceleration, deceleration, and jerk when you start the instruction.

The system has a Jerk priority planner. In other words, Jerk always takes priority over acceleration and velocity. Therefore, you always get the programmed Jerk. If a move is velocity-limited, the move does not reach the programmed acceleration and/or velocity.

Jerk Parameters for MAJ programmed in units of % time are converted to engineering units as follows:

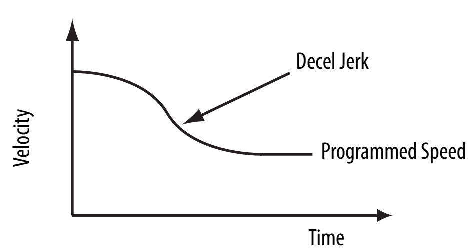
If Start Speed < MAJ Programmed Speed

$$\text{Accel Jerk (Units/Sec}^3\text{)} = \frac{\text{Programmed Accel Rate}^2}{\text{Programmed Speed}} * \left(\frac{200}{\text{\% of Time}} - 1 \right)$$



If Start Velocity > MAJ Programmed Speed

$$\text{Decel Jerk (Units/Sec}^3\text{)} = \frac{\text{Programmed Decel Rate}^2}{\text{Max (Programmed Speed, [Start Speed - Programmed Speed])}} * \left(\frac{200}{\text{\% of Time}} - 1 \right)$$

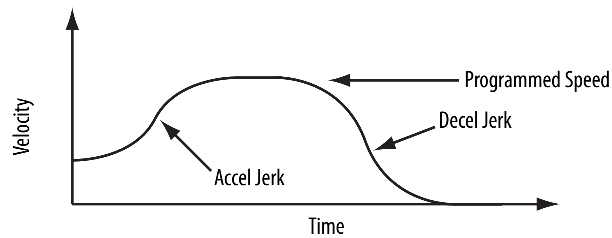


Jerks for programmed moves, such as MAM or MCLM instructions, in units of % time are converted to engineering units as follows:

If Start Speed < Programmed Speed

$$\text{Accel Jerk (Units/Sec}^3\text{)} = \frac{\text{Programmed Accel Rate}^2}{\text{Programmed Speed}} * \left(\frac{200}{\text{\% of Time}} - 1\right)$$

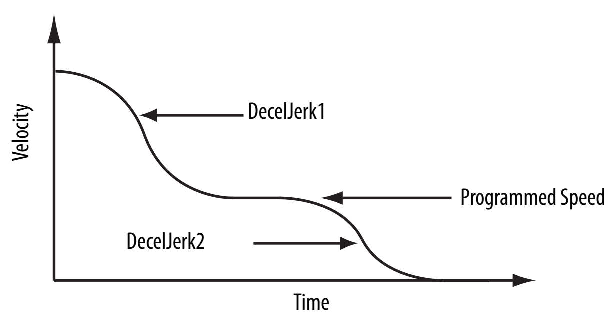
$$\text{Decel Jerk (Units/Sec}^3\text{)} = \frac{\text{Programmed Decel Rate}^2}{\text{Max (Programmed Speed, [Start Speed - Programmed Speed])}} * \left(\frac{200}{\text{\% of Time}} - 1\right)$$



If Start Speed > Programmed Speed

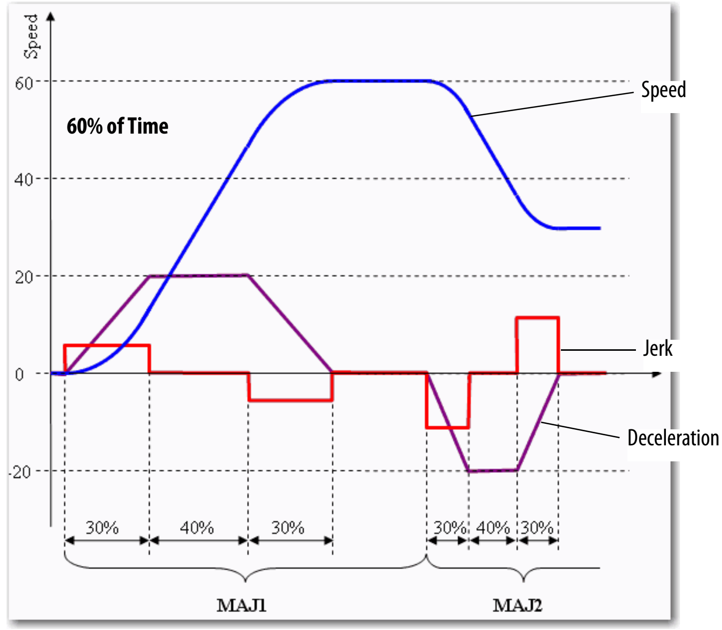
$$\text{DecelJerk1} = \frac{\text{Programmed Decel Rate}^2}{\text{Max (Programmed Speed, [Start Speed - Programmed Speed])}} * \left(\frac{200}{\text{\% of Time}} - 1\right)$$

$$\text{DecelJerk2} = \frac{\text{Programmed Decel Rate}^2}{\text{Programmed Speed}} * \left(\frac{200}{\text{\% of Time}} - 1\right)$$



DecelJerk1 is used while Current Speed > Programmed Speed
DecelJerk2 is used while Current Speed < Programmed Speed

The same '% of time' jerk can result in different slopes for the acceleration profile than on the deceleration profile, dependent on the Speed parameter of the instruction.



The motion planner algorithm adjusts the actual jerk rate so that both the acceleration profile and the deceleration profile contain at least the '% of time' ramp time. If the Start Speed is close to the programmed Speed parameter, the actual percentage of ramp time can be higher than the programmed value.

In most cases, the condition is:

if: (start Speed is == 0.0) OR (start Speed is > 2 * max Speed).

then: you get **programmed** percentage of ramp time

else: you get **higher than programmed** percentage of ramp time

Conversion from % Time to Engineering Units

If you want to convert % of Time to Engineering Units, use these equations.

For Accel Jerk:

$$j_a\,[\%\text{ of Time}] = \frac{2}{1 + \dfrac{j_a\,[EU/s^3]\; v_{max}\,[EU/s]}{a_{max}\,[EU/s^2]}}\;100$$

For Decel Jerk:

$$j_d\,[\%\text{ of Time}] = \frac{2}{1 + \dfrac{j_d\,[EU/s^3]\; v_{max}\,[EU/s]}{d_{max}\,[EU/s^2]}}\;100$$

Jerk Programming in Units/Sec^3

If you want to specify the jerk in 'Units/sec^3' instead of '% of time', adjust your jerk value as follows so that you get the value that you programmed.

$$\text{Temporary Speed} = \frac{\text{Programmed Decel Rate}^2}{\text{Desired Decel Jerk value in Units/Sec}^3}$$

$$k = \frac{\text{Start Speed - Programmed Speed}}{\text{Max (Programmed Speed, Temporary Speed)}}$$

if (k < 1)

- Instruction Faceplate Decel Jerk in Units/Sec^3 = Desired Decel Jerk in Units/Sec^3

else

- Instruction Faceplate Decel Jerk in Units/Sec^3 = Desired Decel Jerk in Units/Sec^3 * k

Unique Program Considerations

If you program a move by using the **% of Time** units, the programming software computes an **Accel Jerk** = a^2/v where a = the programmed **Accel Rate** and v = programmed **Speed.**

Therefore, the higher the programmed speed, the lower the computed Jerk. The system has a Jerk priority planner. In other words, Jerk always takes priority over acceleration and velocity.

Therefore, you always get the programmed Jerk. If a move is velocity-limited, the move does not reach the programmed acceleration and/or velocity. Once you reach the velocity limit for the length of the move, as the velocity is increased, the move takes longer and longer to complete.

Decel Jerk is computed similarly to the Accel Jerk described previously. The only difference is that instead of a^2/v, Decel Jerk = d^2/v, where d = the programmed **Decel Rate**.

EXAMPLE Example #1

Start Speed = 8.0 in/sec

Desired Speed = 5.0 in/sec

Desired Decel Rate = 2.0 in/sec^2

Desired Decel Jerk = 1.0 in/sec^3

Temporary Speed = $(\text{Desired Decel Rate})^2$ / Desired jerk value in Units/Sec^3= 2.0^2 / 1.0 =
= 4.0 in/sec

k = (8.0 - 5.0) / max(5.0, 4.0) = 3.0 / 5.0 =
= 0.6

Because k < 1, we can enter the desired Decel jerk directly in the faceplate

Instruction faceplate Decel jerk in Units/Sec^3 = 1.0 in/sec^3

EXAMPLE Example #2

Start Speed = 13.0 in/sec

Desired Speed = 5.0 in/sec

Desired Decel Rate = 2.0 in/sec^2

Desired Decel Jerk = 1.0 in/sec^3

Temporary Speed = $(\text{Desired Decel Rate})^2$ / Desired jerk value in Units/Sec^3= 2.0^2 / 1.0 =
= 4.0 in/sec

k = (13.0 - 5.0) / max(5.0, 4.0) = 8.0 / 5.0 =
= 1.6

Because k > 1, we have to calculate the Decel jerk to use on the instruction faceplate as:

Instruction faceplate Decel jerk in Units/Sec^3 =

= 1.0 in/sec^3 * 1.6 =

= 1.6 in/sec^3

Which revision do you have?

- 15 or earlier: % of Time is fixed at 100.
- 16 or later: % of Time defaults to 100% of time on projects that are converted from earlier versions. For new projects, you must enter the Jerk value.

Profile Operand

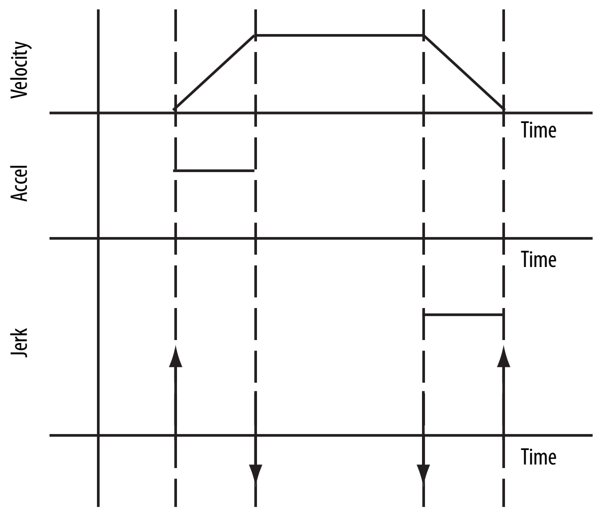
This operand has two profile types:

- Trapezoidal Velocity Profile
- S-curve Velocity Profile

Trapezoidal Velocity Profile

The trapezoidal velocity profile is the most commonly used profile because it provides the most flexibility in programming subsequent motion and the fastest acceleration and deceleration times. Acceleration and deceleration specify the change in velocity per unit time. Jerk is not a factor for trapezoidal profiles. Therefore, it is considered infinite and is shown as a vertical line in the following graph.

Trapezoidal Accel/Decel Time



S-curve Velocity Profile

S-curve velocity profiles are most often used when the stress on the mechanical system and load must be minimized. The acceleration and deceleration time is balanced against the machine stress with two additional parameters, acceleration jerk and deceleration jerk.

The acceleration profile can be set to almost pure rectangular, see Trapezoidal Accel/Decel Time on page 313 (fastest and highest stress), or to triangular, see Programmable S-curve Accel/Decel Time, Acceleration Jerk = 60% of Time on page 315 (slowest, lowest stress), dependent on the Jerk settings.

The typical acceleration profile is a trade-off between stress and speed, as shown in S-curve Accel/Decel Time, Backward Compatibility Setting: Acceleration Jerk = 100% of Time on page 316.

Either you specify the Jerk (either in Units/sec^3 or as a percentage of maximum) or it is calculated from the percentage of time. (Percentage of time is equal to the percentage of ramp time in the acceleration/deceleration profile).

$$j_a\,[EU/s^3] = \frac{a_{max}^{\;2}\,[EU/s^2]}{v_{max}\,[EU/s]}\left(\frac{200}{j_a\,[\%\text{ of time}]} - 1\right)$$

$$j_a\,[EU/s^3] = \frac{d_{max}^{\;2}\,[EU/s^2]}{v_{max}\,[EU/s]}\left(\frac{200}{j_a\,[\%\text{ of time}]} - 1\right)$$

Backward Compatibility

The Jerk of 100% of time produces triangular acceleration and deceleration profiles. These profiles are ones that would have been previously produced as shown in S-curve Accel/Decel Time, Backward Compatibility Setting: Acceleration Jerk = 100% of Time on page 316.

Small Jerk rates, rates less than 5% of time, produce acceleration and deceleration profiles close to rectangular ones, such as the one shown in Trapezoidal Accel/Decel Time on page 313.

IMPORTANT	Higher values of the % of Time result in lower values of Jerk Rate Limits and, therefore, slower profiles. See the following table for reference.

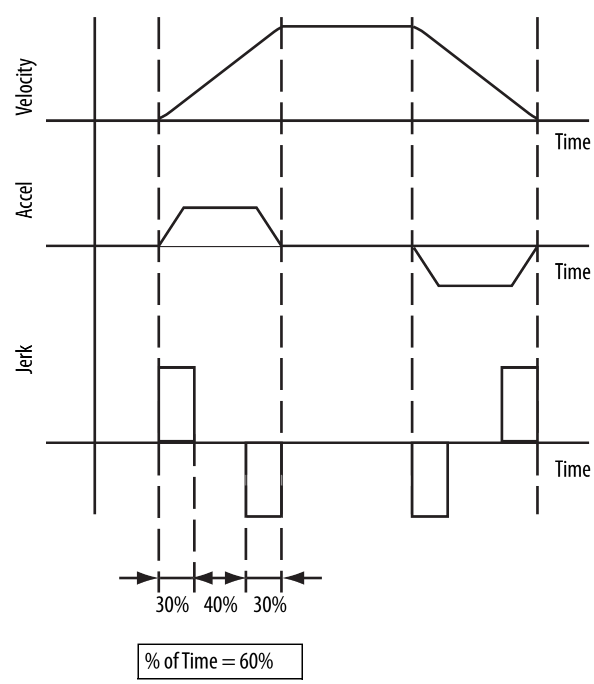
Table 69 - Velocity Versus Jerk

	Trapezoidal Velocity Profile(1)	S-shaped Velocity Profile with 1< = Jerk <100% of Time(2)	S-shaped Velocity Profile with Jerk = 100% of Time(3)
Accel/Decel Jerk in Units/sec^3	∞	$\frac{\text{Max Accel}^2}{\text{Max Velocity}}$ to ∞	$\frac{\text{Max Accel}^2}{\text{Max Velocity}}$
Accel/Decel Jerk in % of Maximum	—	0…100%	—
Accel/Decel Jerk in % of Time	0%	1…100%	100%

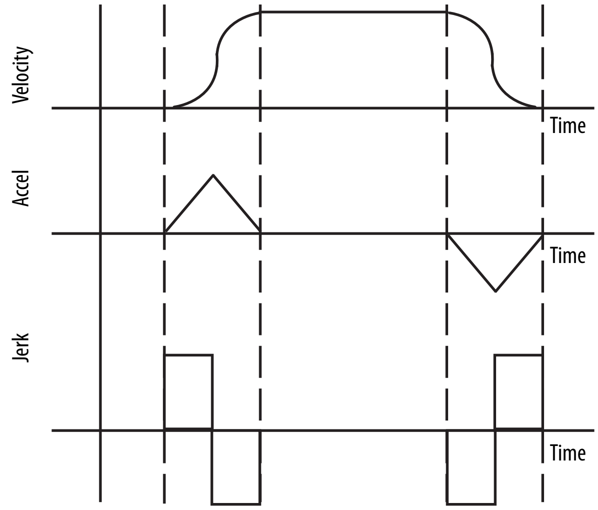
(1) The example on page 313 (labeled Trapezoidal Accel/Decel Time) uses a rectangular acceleration profile.
(2) The example on page 315 (labeled Programmable S-curve Accel/Decel Time, Acceleration Jerk = 60% of Time) uses a trapezoidal acceleration profile.
(3) The example on page 316 (labeled S-curve Accel/Decel Time, Backward Compatibility Setting: Acceleration Jerk = 100% of Time) uses a triangular acceleration profile.

Calculations are performed when an Axis Move, Change Dynamics, or an MCS™ Stop of StopType = Move or Jog is initiated.

Programmable S-curve Accel/Decel Time, Acceleration Jerk = 60% of Time



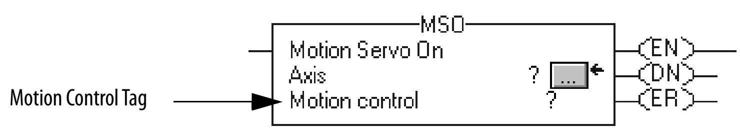
S-curve Accel/Decel Time, Backward Compatibility Setting:
Acceleration Jerk = 100% of Time



Enter Basic Logic

The controller gives you a set of motion control instructions for your axes:

- Use these instructions just like the rest of the Studio 5000 Logix Designer® application instructions. You can program motion control in these programming languages:
  - Ladder diagram (LD)
  - Structured Text (ST)
  - Sequential Function Chart (SFC)
- Each motion instruction works on one or more axes.
- Each motion instruction needs a motion control tag. The tag uses a MOTION_INSTRUCTION data type. The tag stores the status information of the instruction.



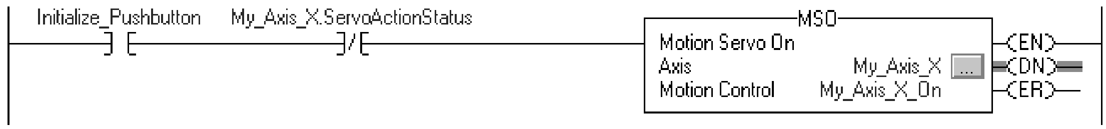
ATTENTION: Use the tag for the motion control operand of motion instruction only once. Unintended operation of the control variables can happen if you reuse the same motion control tag in other instructions.

Example Motion Control Program

This figure is an example of Ladder Logix that homes, jogs, and moves an axis.

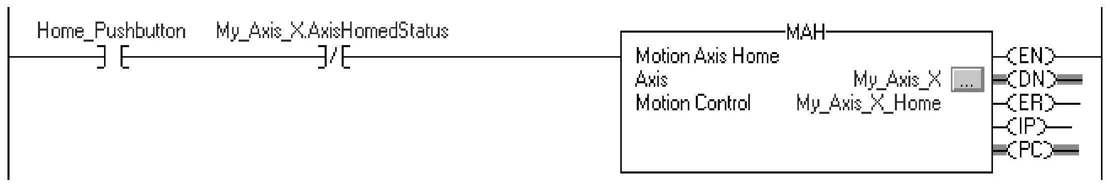
If *Initialize_Pushbutton* = on and the axis = off (*My_Axis_X.ServoActionStatus* = off) then

the MSO instruction turns on the axis.



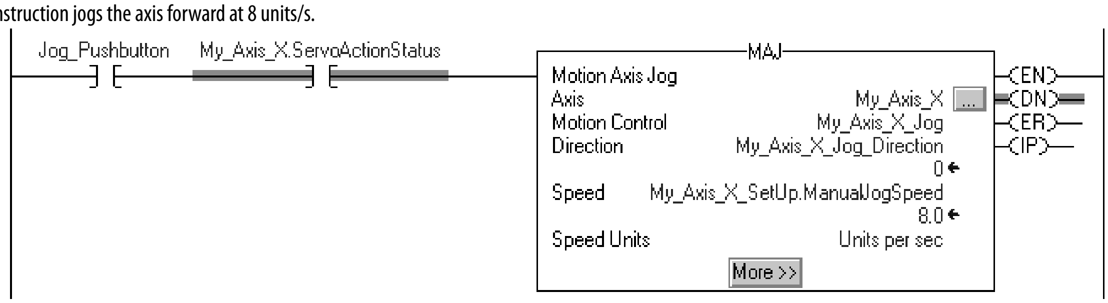
If *Home_Pushbutton* = on and the axis hasn't been homed (*My_Axis_X.AxisHomedStatus* = off) then

the MAH instruction homes the axis.



If *Jog_Pushbutton* = on and the axis = on (*My_Axis_X.ServoActionStatus* = on) then

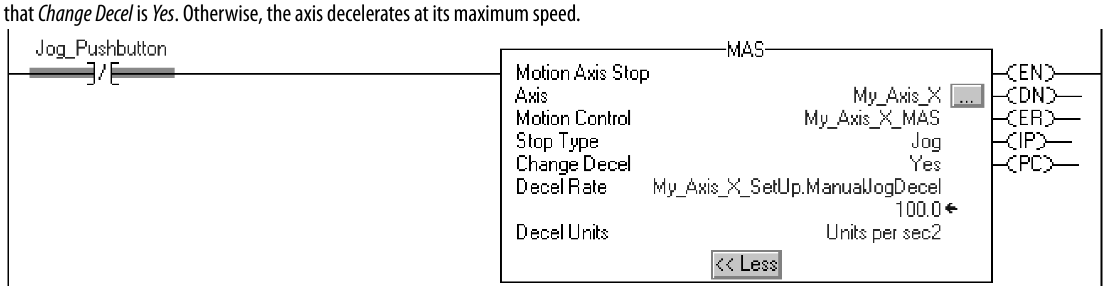
the MAJ instruction jogs the axis forward at 8 units/s.



If *Jog_Pushbutton* = off then

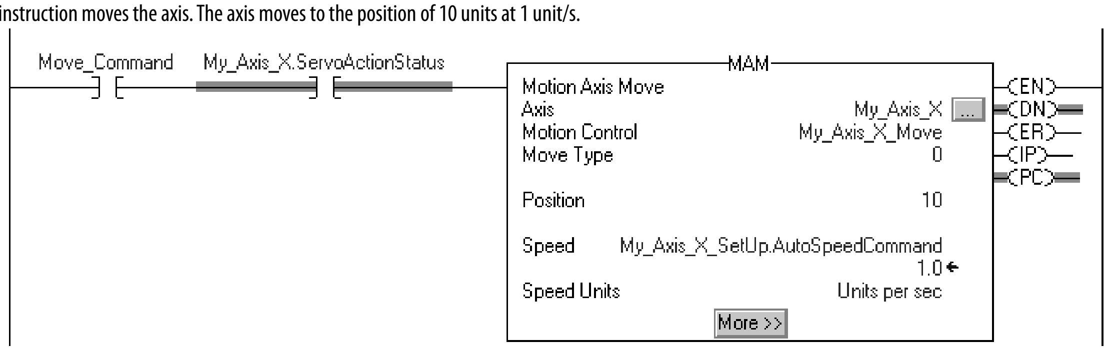
the MAS instruction stops the axis at 100 units/s^2.

Make sure that *Change Decel* is *Yes*. Otherwise, the axis decelerates at its maximum speed.



If *Move_Command* = on and the axis = on (*My_Axis_X.ServoActionStatus* = on) then

the MAM instruction moves the axis. The axis moves to the position of 10 units at 1 unit/s.



Download a Project

Follow these steps to download your program to a controller.

1. With the keyswitch, place the controller in Program or Remote Program mode.
2. From the Communications menu, choose Download.
3. Confirm that you wish to complete the download procedure.
4. Click Download.
5. Once the download is complete, place the controller in Run/Test mode.

   After the project file is downloaded, status and compiler messages appear in the status bar.

Choose a Motion Instruction

Use Table 70 to choose an instruction and see if it is available as a Motion Direct Command.

Table 70 - Available Motion Direct Commands

If You Want To	And	Use This Instruction	Motion Direct Command
Change the state of an axis	Enable the drive and activate the axis loop.	MSO Motion Servo On	Yes
	Disable the drive and deactivate the axis loop.	MSF Motion Servo Off	Yes
	Force an axis into the shutdown state and block any instructions that initiate axis motion.	MASD Motion Axis Shutdown	Yes
	Reset the axis from the shutdown state.	MASR Motion Axis Shutdown Reset	Yes
	Activate the drive control loops for the Integrated Motion on EtherNet/IP network axis and run the motor at the specified speed.	MDS Motion Drive Start	
	Clear all motion faults for an axis.	MAFR Motion Axis Fault Reset	Yes

Table 70 - Available Motion Direct Commands

If You Want To	And	Use This Instruction	Motion Direct Command
Control axis position	Stop any motion process on an axis.	MAS Motion Axis Stop	Yes
	Home an axis.	MAH Motion Axis Home	Yes
	Jog an axis.	MAJ Motion Axis Jog	Yes
	Move an axis to a specific position.	MAM Motion Axis Move	Yes
	Start electronic gearing between two axes.	MAG Motion Axis Gear	Yes
	Change the speed, acceleration, or deceleration of a move or a jog that is in progress.	MCD Motion Change Dynamics	Yes
	Change the command or actual position of an axis.	MRP Motion Redefine Position	Yes
	Calculate a Cam Profile that is based on an array of cam points.	MCCP Motion Calculate Cam Profile	No
	Start electronic camming between two axes.	MAPC Motion Axis Position Cam	No
	Start electronic camming as a function of time.	MATC Motion Axis Time Cam	No
	Calculate the slave value, slope, and derivative of the slope for a cam profile and master value.	MCSV Motion Calculate Slave Values	No
Initiate action on all axes	Stop motion of all axes.	MGS Motion Group Stop	Yes
	Force all axes into the shutdown state.	MGSD Motion Group Shutdown	Yes
	Transition all axes to the ready state.	MGSR Motion Group Shutdown Reset	Yes
	Latch the current command and actual position of all axes.	MGSP Motion Group Strobe Position	Yes
Arm and disarm special event checking functions, such as registration and watch position	Arm the watch-position event checking for an axis.	MAW Motion Arm Watch Position	Yes
	Disarm the watch-position event checking for an axis.	MDW Motion Disarm Watch Position	Yes
	Arm the module registration-event checking for an axis.	MAR Motion Arm Registration	Yes
	Disarm the module registration-event checking for an axis.	MDR Motion Disarm Registration	Yes
	Arm an output cam for an axis and output.	MAOC Motion Arm Output Cam	No
	Disarm one or all output cams connected to an axis.	MDOC Motion Disarm Output Cam	No

Table 70 - Available Motion Direct Commands

If You Want To	And	Use This Instruction	Motion Direct Command
Tune an axis and run diagnostic tests for your control system. These tests include the following: • Motor/encoder hookup test • Encoder hookup test • Marker test Control multi-axis coordinated motion	Run a tuning motion profile for an axis	MRAT Motion Run Axis Tuning	No
	Run one of the diagnostic tests on an axis.	MRHD Motion Run Hookup Diagnostic	No
	Start a linear coordinated move for the axes of a coordinate system.	MCLM Motion Coordinated Linear Move	No
	Start a circular move for the axes of a coordinate system.	MCCM Motion Coordinated Circular Move	No
	Change in path dynamics for the active motion on a coordinate system.	MCCD Motion Coordinated Change Dynamics	No
	Stop the axes of a coordinate system or cancel a transform.	MCS Motion Coordinated Stop	No
	Shut down the axes of a coordinate system.	MCSD Motion Coordinated Shutdown	No
	Start a transform that links two coordinate systems together. This transform is like bidirectional gearing.	MCT Motion Coordinated Transform (1)	No
	Calculate the position of one coordinate system regarding another coordinate system.	MCTP Motion Calculate Transform Position(1)	No
	Transition the axes of a coordinate system to the ready state and clear the axis faults.	MCSR Motion Coordinated Shutdown Reset	No

(1) You can only use this instruction with ControlLogix® 5560 or GuardLogix® 5560 controllers.

Troubleshoot Axis Motion

This section helps you troubleshoot some situations that could happen while you are running an axis.

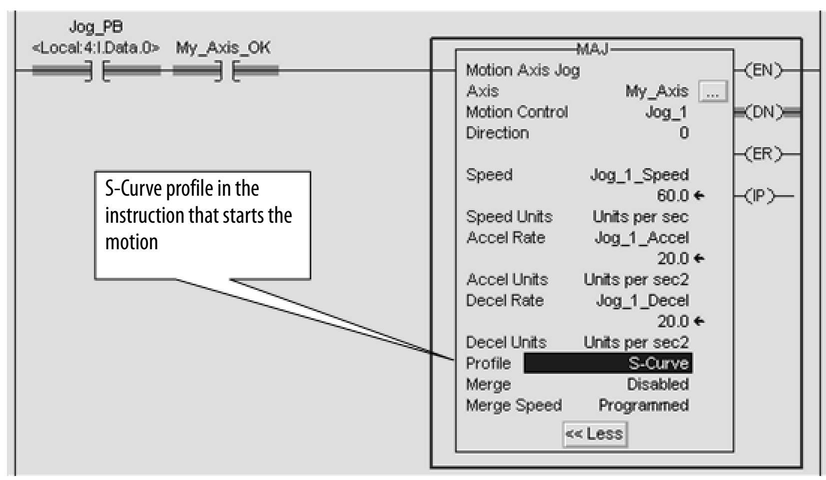
Why Does My Axis Accelerate When I Stop It?

While an axis is accelerating, you try to stop it. The axis accelerates for a short time before it starts to decelerate.

Example

You start a Motion Axis Jog (MAJ) instruction. Before the axis gets to its target speed, you start a Motion Axis Stop (MAS) instruction. The axis continues to speed up and then eventually slows to a stop.

Look For



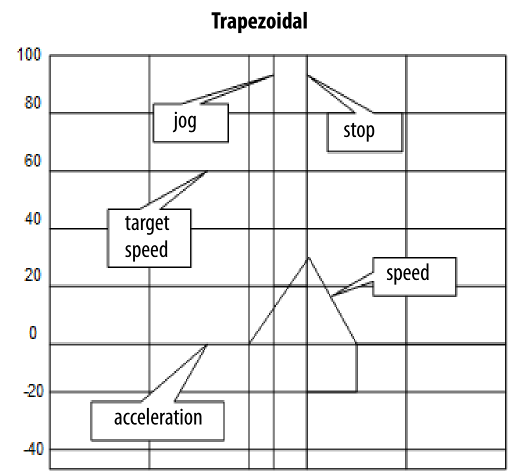
Cause

When you use an S-curve profile, jerk determines the acceleration and deceleration time of the axis:

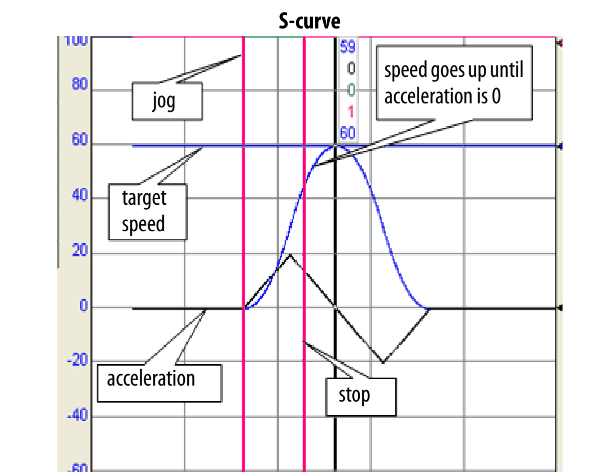
- An S-curve profile has to get acceleration to 0 before the axis can slow down.
- The time that it takes depends on the acceleration and speed.
- In the meantime, the axis continues to speed up.

The following trends show how the axis stops with a trapezoidal profile and an S-curve profile.

Stop While Accelerating



The axis slows down as soon as you start the stopping instruction.



The axis continues to speed up until the S-curve profile brings the acceleration rate to 0.

Corrective Action

If you want the axis to slow down right away, use a trapezoidal profile.

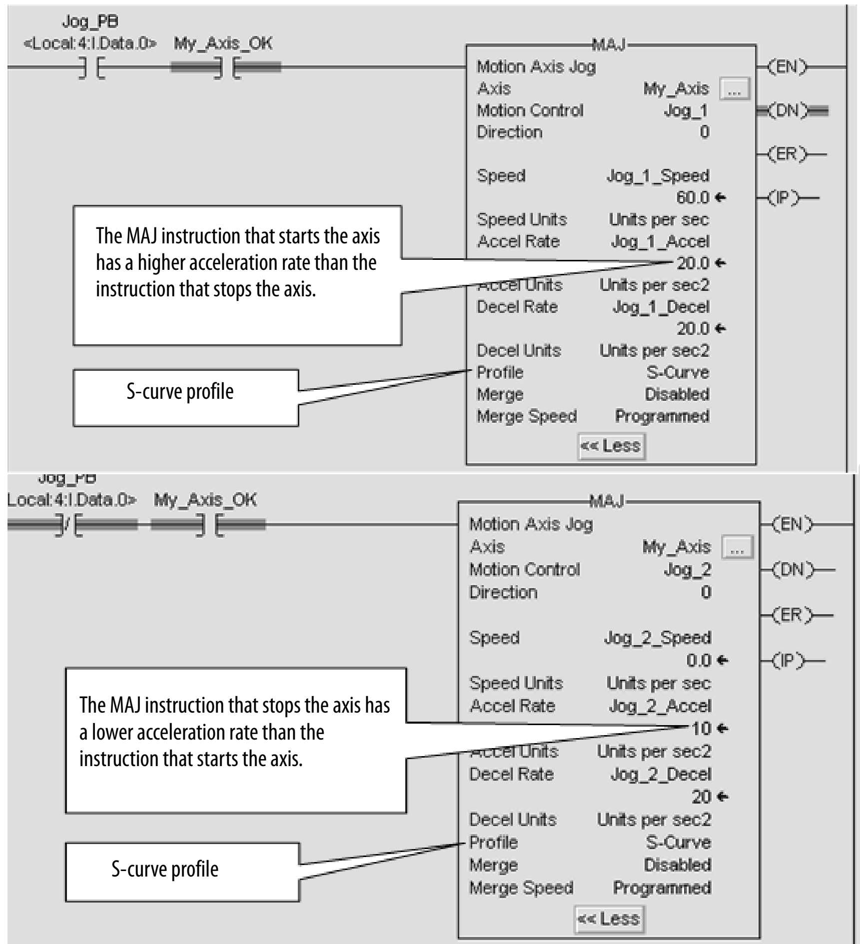
Why Does My Axis Overshoot Its Target Speed?

While an axis is accelerating, you try to stop the axis or change its speed. The axis accelerates and goes past its initial target speed. Eventually it starts to decelerate.

Example

You start a Motion Axis Jog (MAJ) instruction. Before the axis gets to its target speed, you try to stop it with another MAJ instruction. The speed of the second instruction is set to 0. The axis continues to speed up and overshoots its initial target speed. Eventually it slows to a stop.

Look For



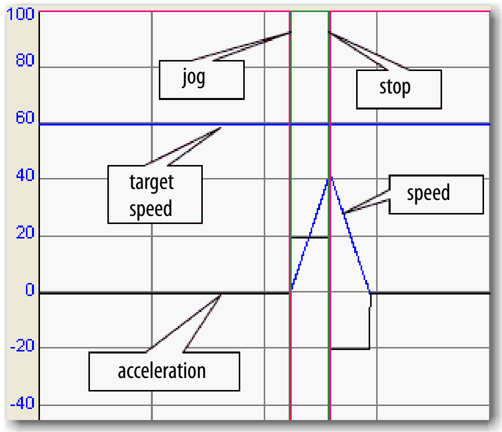
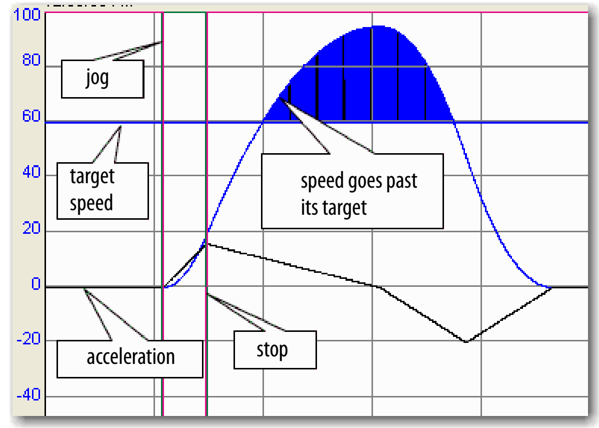
Cause

When you use an S-curve profile, jerk determines the acceleration and deceleration time of the axis:

- An S-curve profile has to get acceleration to 0 before the axis can slow down.
- If you reduce the acceleration, it takes longer to get acceleration to 0.
- In the meantime, the axis continues past its initial target speed.

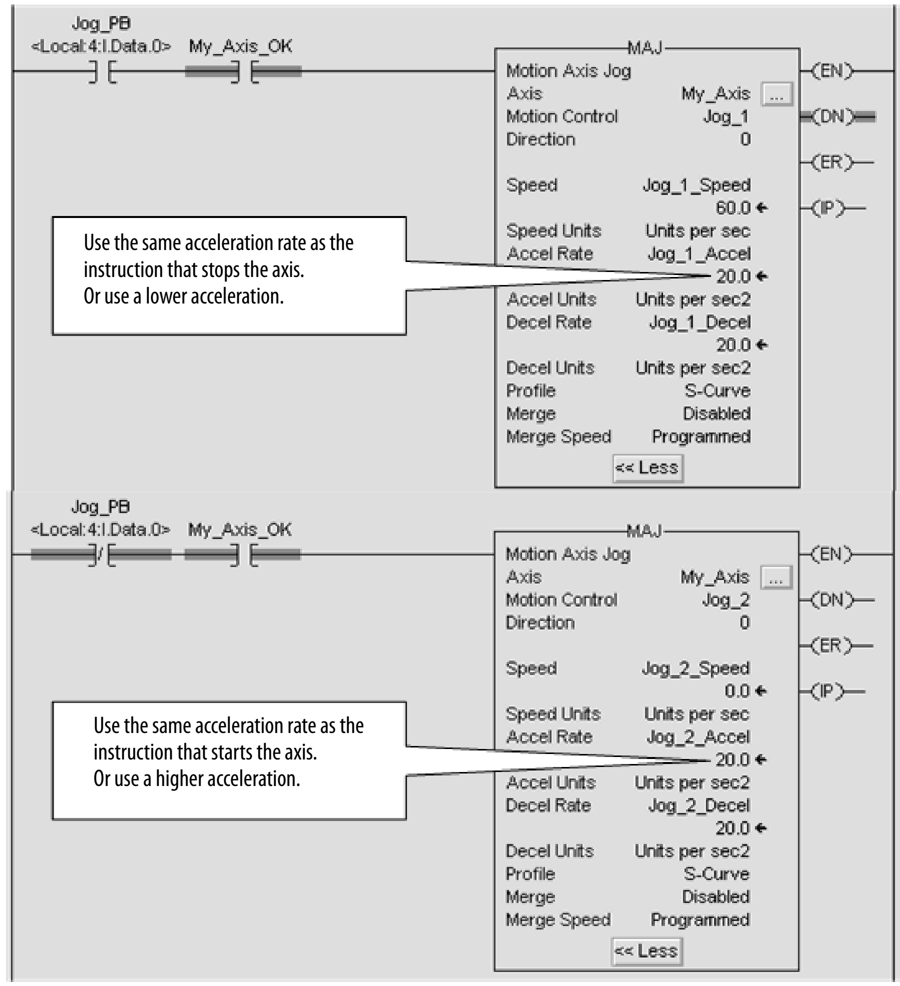
The following trends show how the axis stops with a trapezoidal profile and an S-curve profile.

Stop While Accelerating and Reduce the Acceleration Rate

	Trapezoidal	S-curve
		
	The axis slows down as soon as you start the stopping instruction. The lower acceleration doesn't change the response of the axis.	The stopping instruction reduces the acceleration of the axis. It now takes longer to bring the acceleration rate to 0. The axis continues past its target speed until acceleration equals 0.

Corrective Action

Use a Motion Axis Stop (MAS) instruction to stop the axis or configure your instructions like this example.



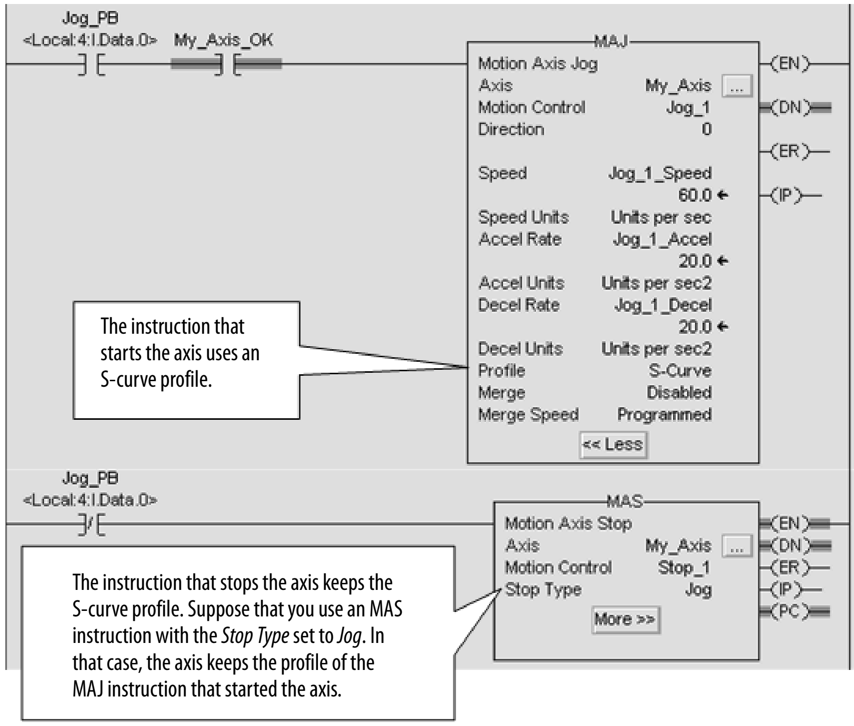
Why Is There a Delay When I Stop and Then Restart a Jog?

While an axis is jogging at its target speed, you stop the axis. Before the axis stops completely, you restart the jog. The axis continues to slow down before it speeds up.

Example

You use a Motion Axis Stop (MAS) instruction to stop a jog. While the axis is slowing down, you use a Motion Axis Jog (MAJ) instruction to start the axis again. The axis doesn't respond right away. It continues to slow down. Eventually it speeds back up to the target speed.

Look For

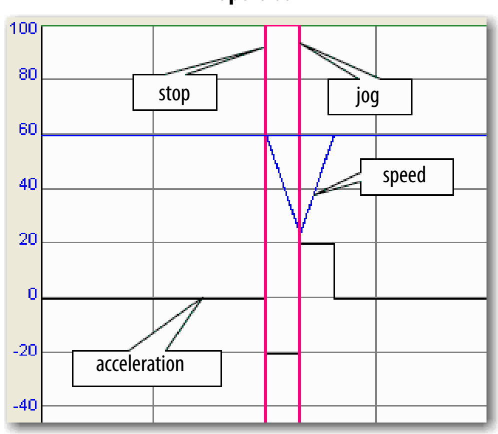


Cause

When you use an S-curve profile, jerk determines the acceleration and deceleration time of the axis. An S-curve profile has to get acceleration to 0 before the axis can speed up again. The following trends show how the axis stops and starts with a trapezoidal profile and an S-curve profile.

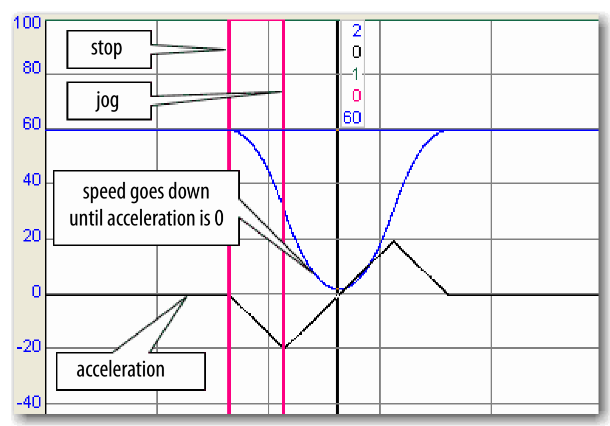
Start While Decelerating

Trapezoidal



The axis speeds back up as soon as you start the jog again.

S-curve



The axis continues to slow down until the S-curve profile brings the acceleration rate to 0.

Corrective Action

If you want the axis to accelerate right away, use a trapezoidal profile.

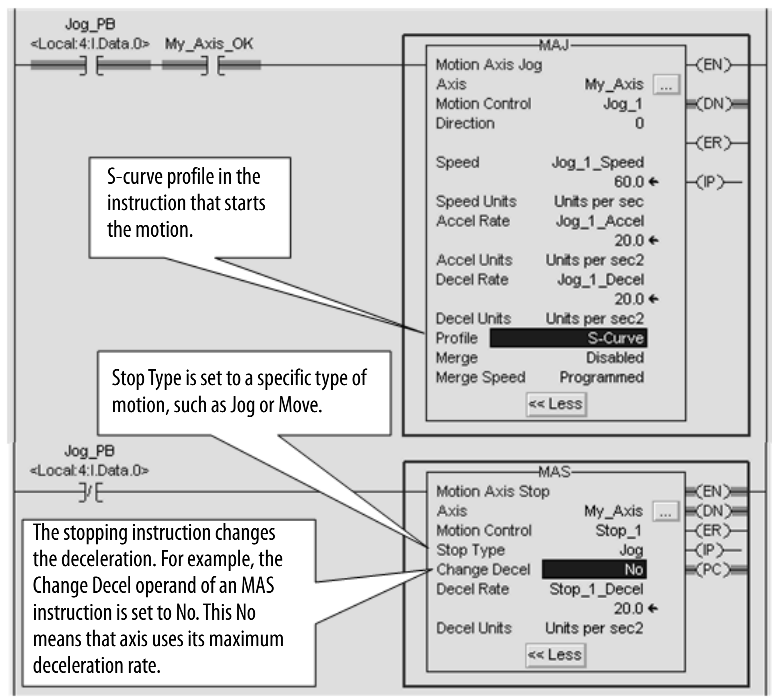
Why Does The Axis Reverse Direction When Stopped and Started?

While an axis is jogging at its target speed, you stop the axis. Before the axis stops completely, you restart the jog. The axis continues to slow down and then reverses direction. Eventually the axis changes direction again and moves in the programmed direction.

Example

You use a Motion Axis Stop (MAS) instruction to stop a jog. While the axis is slowing down, you use a Motion Axis Jog (MAJ) instruction to start the axis again. The axis continues to slow down and then moves in the opposite direction. Eventually it returns to its programmed direction.

Look For



Cause

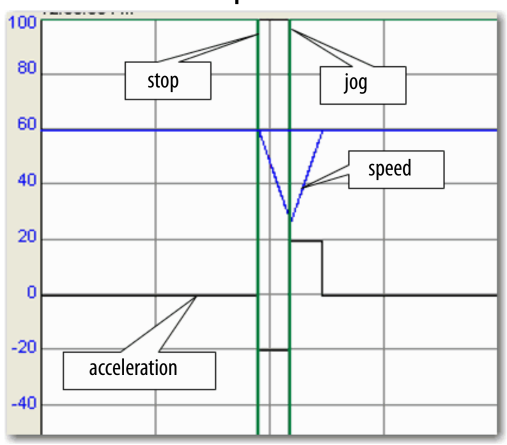
When you use an S-curve profile, jerk determines the acceleration and deceleration time of the axis:

- An S-curve profile has to get acceleration to 0 before the axis can speed up again.
- If you reduce the acceleration, it takes longer to get acceleration to 0.
- In the meantime, the axis continues past 0 speed and moves in the opposite direction.

The following trends show how the axis stops and starts with a trapezoidal profile and an S-curve profile.

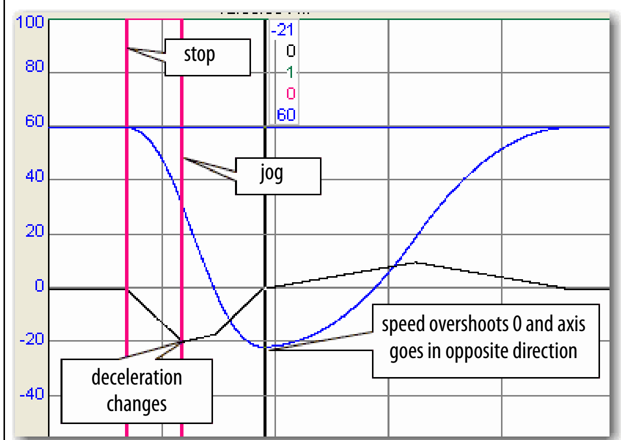
Start While Decelerating and Reduce the Deceleration Rate

Trapezoidal



The axis speeds back up as soon as you start the jog again. The lower deceleration doesn't change the response of the axis.

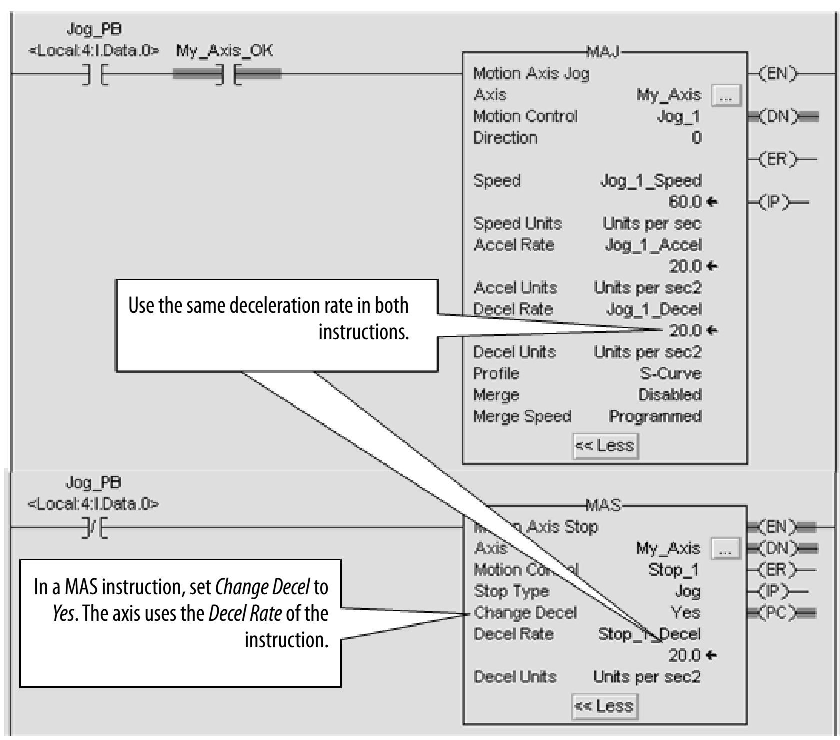
S-curve



The jog instruction reduces the deceleration of the axis. It now takes longer to bring the acceleration rate to 0. The speed overshoots 0 and the axis moves in the opposite direction.

Corrective Action

Use the same deceleration rate in the instruction that starts the axis and the instruction that stops the axis.



Programming with the MDSC Function

Figure 111 shows an example of programming motion with the MDSC functionality. In this example, we illustrate a 50.0 mm move.

Figure 111 - Slave Speed Control from Master with Lock Position, MDSC Time Based

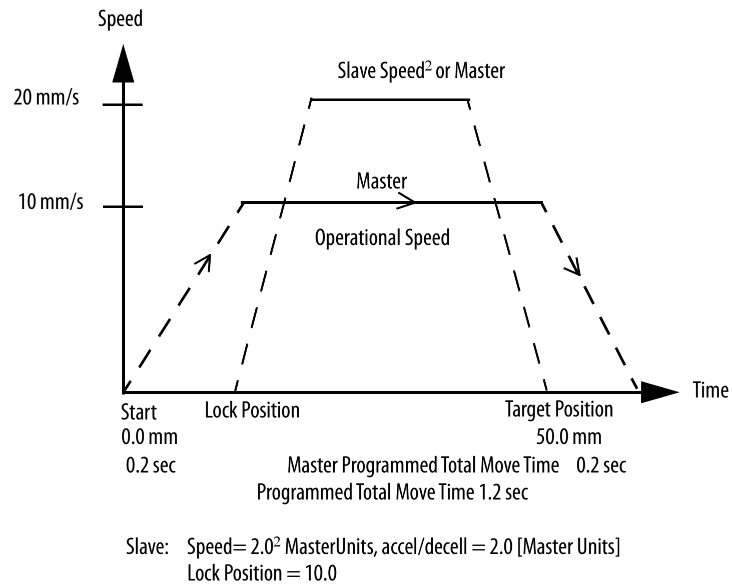
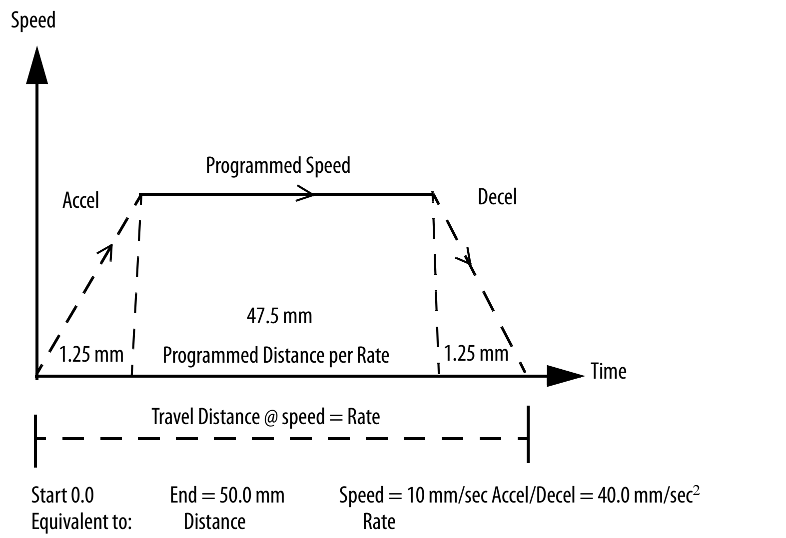


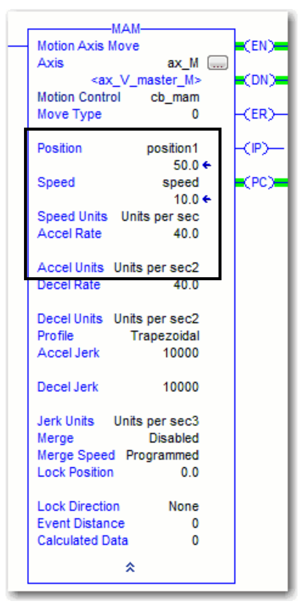
Table 71 - Comparison of the Enumerations for the Motion Instructions

Revision	Operand	Units	Type	Profile
V19 and earlier	Speed	Units/sec	Rate	Trapezoidal, S-curve
(PJerk)	Accel/Decel	Units/sec²	Rate	
	Jerk	Units/sec³	Rate	
		% of time	Time	
	Speed, Accel/Decel, and Jerk	% of max % of units/sec	Rate	
For instructions: MAM, MAJ, MCD, and MAS				
V20	Speed	Units/sec	Rate	Trapezoidal, S-curve
		Sec	Time	Trapezoidal, S-curve
		Master units	Feedback	Trapezoidal, S-curve
	Accel/Decel	Units/sec²	Rate	Trapezoidal, S-curve
		Sec	Time	Trapezoidal, S-curve
		Master units	Feedback	Trapezoidal, S-curve
	Jerk	Units/sec²	Rate	Trapezoidal, S-curve
		Sec	Time	Trapezoidal, S-curve
		Master units	Feedback	Trapezoidal, S-curve
For instructions, MDSC, MAM, MAJ, and MATC				

In Figure 112, we are programming rate. The controller calculates the time of the move: Speed and Accel/Decel as units = units (seconds).

Figure 112 - Programming Rate in RSLogix 5000® Software Version 19 and Earlier





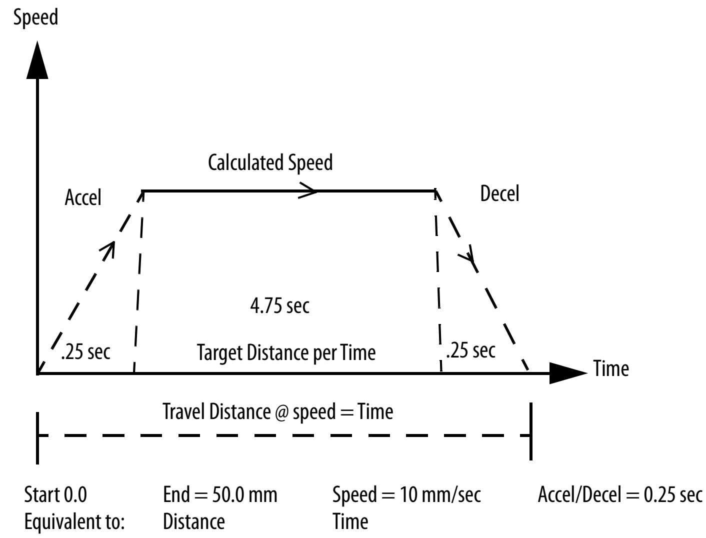
RSLogix 5000 software version 19 and earlier MAM instruction programmed as rate.

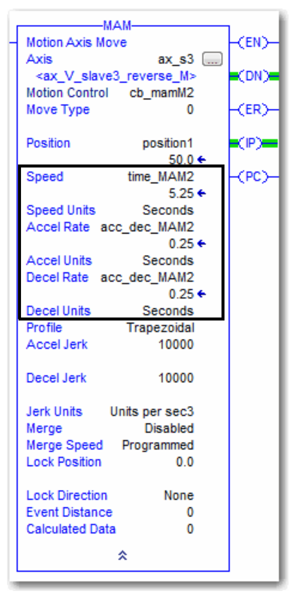
Position 50.0 mm (start 0.0)
Speed 10.0 mm/sec
Accel 40.0 mm/sec^2
Decel 40.0 mm/sec^2

So Travel_Distance = area under the curve [accel + at_speed + decel]
Travel_Distance = 50 mm
Travel_Distance = 50 mm [1.25 mm + 47.5 mm + 1.25 mm

In Figure 113, we are programming time. The controller calculates the speed of the move: Speed and Accel/Decel as time [seconds].

Figure 113 - Programming Time in RSLogix 5000 Software Version 20 and Later





RSLogix 5000 software version 20 and later MAM instruction programmed as time.

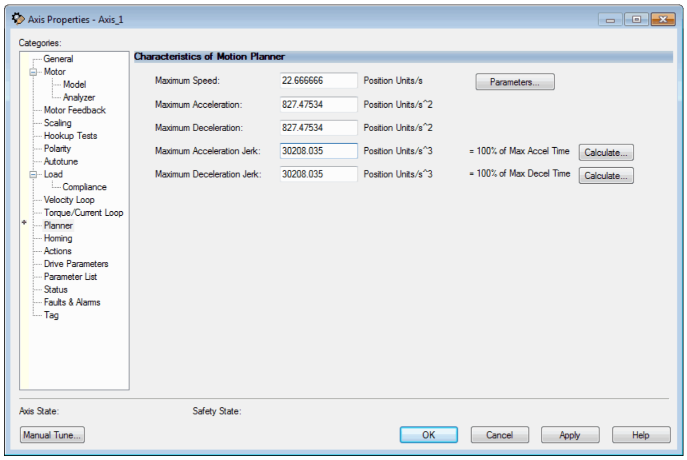
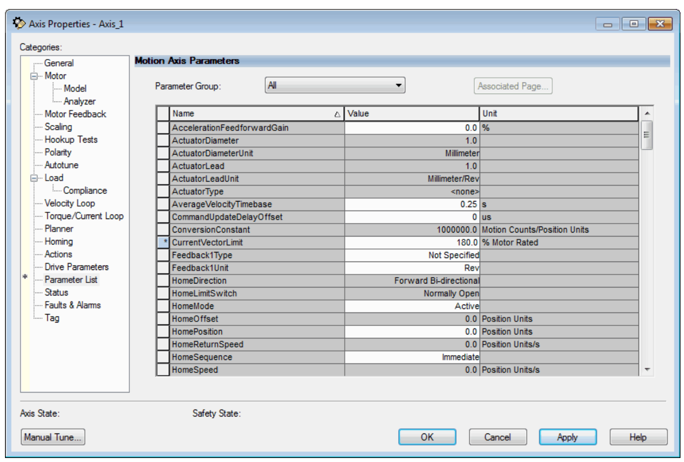
Position	50.0 mm (start 0.0)
Speed	5.25 sec
Accel	0.25 sec
Decel	0.25 sec

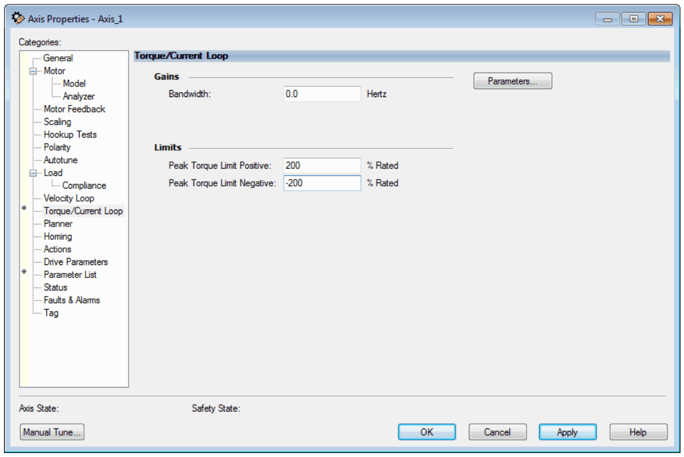
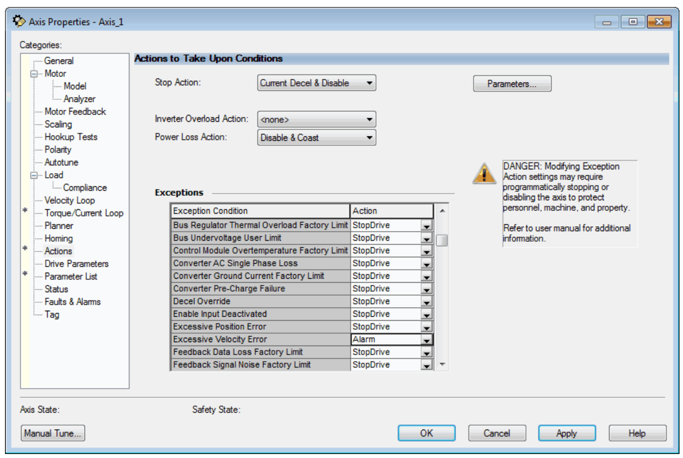
So Travel_Distance = area under the curve [accel + at_speed + decel]
Travel_Distance = 50 mm
Travel_Time = 5.25 sec [0.25 + 4.75 + 0.25 sec]

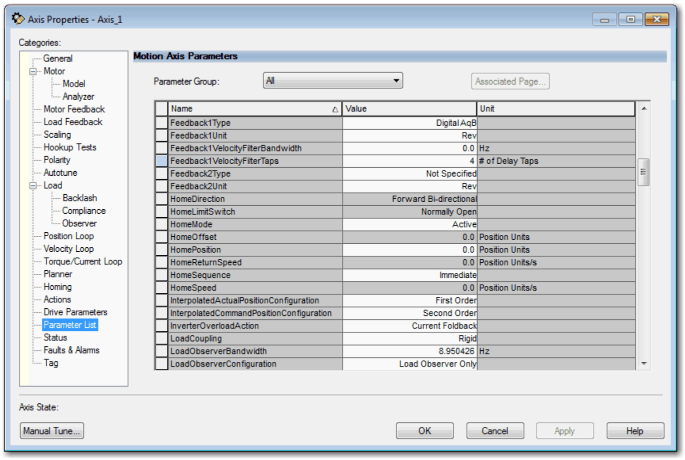
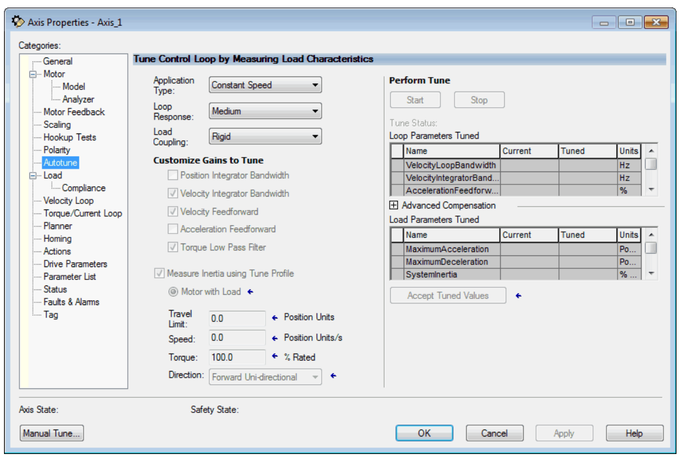
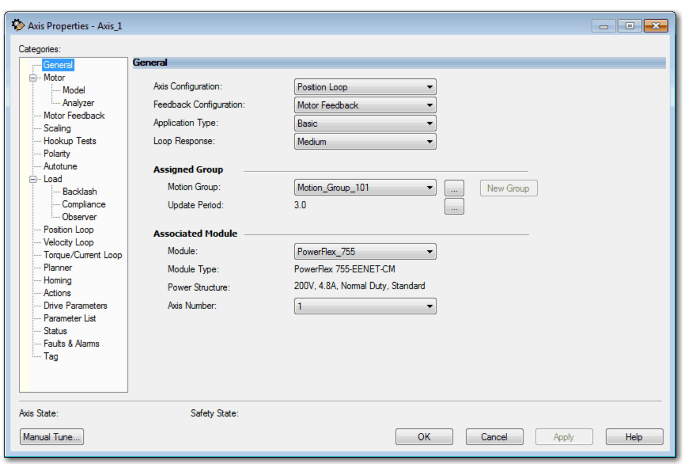
PowerFlex Out-of-Box Configuration

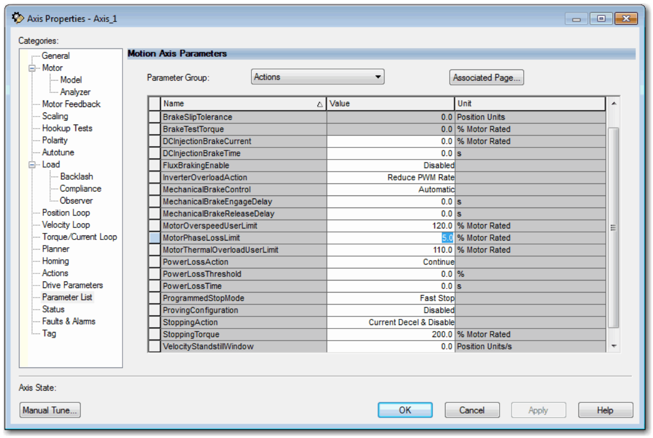
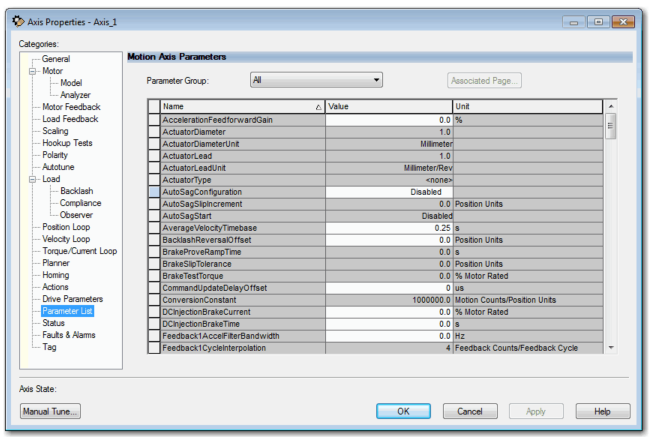
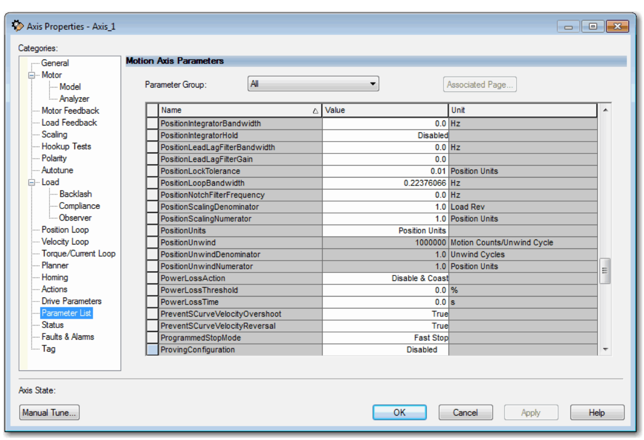
Apply these out-of-box settings first before configuring for your application. This information applies to only the PowerFlex® drive.

Recommended Out-of-Box Settings

<table>
<tr><th rowspan="2">Settings in Studio 5000 Logix Designer Application</th><th rowspan="2">Example</th><th colspan="2">Recommended Configuration</th></tr>
<tr><th>PowerFlex 527</th><th>PowerFlex 755</th></tr>
<tr><td>Ramp Velocity Limit</td><td>
</td><td colspan="2">120% of Motor Rated Speed for Induction Motors</td></tr>
<tr><td>Current Vector Limit</td><td>
</td><td colspan="2">180% of Motor Rated Current</td></tr>
</table>

Settings in Studio 5000 Logix Designer Application	Example	Recommended Configuration	
		PowerFlex 527	**PowerFlex 755**
Torque Limits		200% of Motor Rated Torque	
Velocity Error Tolerance		Change action to alarm	

Settings in Studio 5000 Logix Designer Application	Example	Recommended Configuration	
		PowerFlex 527	PowerFlex 755
Feedback Tap		16	4
Application Type setting in Velocity Loop		Constant Speed	
Motion Group Base Update Rate		4 ms	3 ms

<table>
<tr><th rowspan="2">Settings in Studio 5000 Logix Designer Application</th><th rowspan="2">Example</th><th>Recommended Configuration</th></tr>
<tr><th>PowerFlex 755</th></tr>
<tr><td>Motor Phase Loss Limit(1)</td><td>
</td><td>5% is the typical setting(2)</td></tr>
<tr><td>Auto Sag Configuration</td><td>
</td><td>Disabled(3)</td></tr>
<tr><td>Proving Configuration</td><td>
</td><td>Disabled(4)</td></tr>
</table>

(1) You must use a value of 1% for MotorPhaseLossLimit if your configuration includes a Rotary Permanent Magnet Motor.

(2) Change this parameter to 1% for only Rotary Permanent Magnet Motor configurations.

(3) Auto Sag Configuration must be disabled for the out-of-box configuration to avoid unexpected operation. If you enable this parameter, it opens the Auto Sag Slip Increment and Auto Sag Start parameters for editing.

(4) Proving Configuration must be disabled for the out-of-box configuration to avoid unexpected operation. If you enable this parameter, it opens the Brake Prove Ramp Time, Brake Slip Tolerance, and Brake Test Torque parameters for editing.

IMPORTANT	If your configuration includes a Rotary Permanent Magnet motor, you must change the Phase-Loss limit to 1 ms for operation. If you do not change the Phase-Loss limit to 1 ms, the Commutation Test for the Rotary PM could fail and generate a Motor Phase-Loss Limit fault. Also, the instruction MSO for the Rotary PM can fail and generate a Motor Phase-Loss Limit fault.

Setting the ACO/AVO Attributefor PF527 Drives Only

The attribute ACO/AVO (Analog Current Output/Analog Voltage Output) can be used to set the analog output of the PowerFlex 527 drive to either current (mA) or voltage (V).

Make sure that the Analog Out jumper (J2) is also set to the same value.

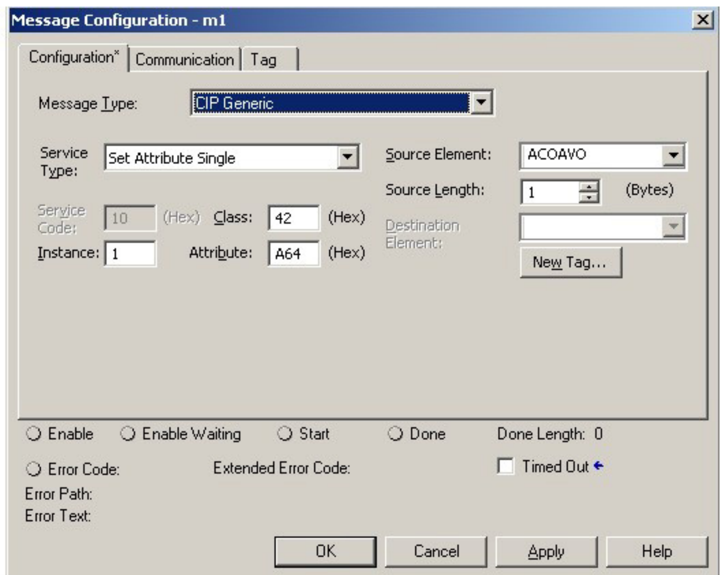


Table 72 - ACO/AVO: MSG

Parameter	Value	Description
Service Code	0x10	Get Attribute Single
Class	0x42	Analog Output
Instance	1	-
Attribute	0xA64	Voltage/Current Mode
Data Type	SINT	Unsigned Short Integer

Table 73 - ACO/AVO: Values

Value	Definition
0	Voltage (V)
1	Current (mA)

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

Absolute Position Retention (APR) While Homing creates an absolute machine reference position, the APR bit is designed to retain the absolute position.

Axis A logical element of a motion control system that exhibits some form of movement. Axes can be rotary or linear, physical, or virtual, controlled, or observed.

Bus Regulator Used to limit the rise in DC Bus voltage level that occurs when decelerating a motor.

CIP™ Common Industrial Protocol.

CIP Sync Defines extensions to CIP Common objects and device profiles to support time synchronization over CIP Networks.

Closed-loop A method of control where there is a feedback signal that is used to drive the actual dynamics of the motor to match the commanded dynamics by servo action. In most cases, there is a literal feedback device to provide this signal, but in some cases the signal is derived from the motor excitation, for example, sensorless operation.

Converter A device that generally converts AC input to DC output. A Converter is also commonly called the Drive Power Supply. In the context of a drive system, the Converter is responsible for converting AC Main input into DC Bus power.

Course (Base) Update Period The base update period of the update task of the motion group, which is specified in milliseconds.

Cyclic Data Block A high priority real-time data block that is an integrated motion on the EtherNet/IP™ network connection transfers on a periodic basis.

Drive A device that is designed to control the dynamics of a motor.

Event Data Block A medium priority real-time data block that an integrated motion on the EtherNet/IP network connection transfers only after a specified event occurs. Registration and marker input transitions are typical drive events.

Get/Read A Get/Read involves the retrieval of an attribute value from the perspective of Controller side of the interface.

Integrated Motion on the EtherNet/IP network I/O Connection The I/O connection is the periodic bidirectional, Class 1, CIP connection between a controller and a drive that is defined as part of the integrated motion on the EtherNet/IP network standard.

Integrated Motion on the EtherNet/IP Network Drive Any drive device that complies with the integrated motion on the EtherNet/IP network standard.

Inverter A device that generally converts DC input to AC output. An Inverter is also commonly called the Drive Amplifier. In the context of a drive system, the Inverter is responsible for controlling the application of DC Bus power to an AC motor.

Motion Any aspect of the dynamics of an axis. In the context of this document, it is not limited to servo drives but encompasses all forms of drive-based motor control.

Motion Group A user-defined grouping of motion axes. A motion group has configuration parameters and status attributes that apply to all axes in the group.

Multiplexing The method by which multiple signals are combined into one signal for transmission.

Multiplex Update Multiplier Number of multiplexed drives that determines the multiplex update period.

Multiplex Update Period Task update period for a Multiplexed Axis.

Open-loop A method of control where there is no application of feedback to force the actual motor dynamics to match the commanded dynamics. Examples of open-loop control are stepper drives and variable-frequency drives.

Safe Torque Off (STO) Provides a method, with sufficiently low probability of failure, to force the power-transistor control signals to a disabled state. When the command to allow torque ceases from the GuardLogix® controller, all drive output-power transistors are released from the On-state.

For complete information about the Safe Torque Off feature, see the Kinetix® Multi-axis servo EtherNet/IP drive User Manual, publication 2198-UM002.

Service Data Block A lower priority real-time data block associated with a service message from the controller that an integrated motion on the EtherNet/IP network connection transfers on a periodic basis. Service data includes service request messages to access attributes, run a drive-based motion planner, or perform various drive diagnostics.

Set/Write A Set/Write involves setting an attribute to a specified value from the perspective of the Controller side of the interface.

Shunt Regulator A specific Bus Regulator method that switches the DC Bus across a power dissipating resistor to dissipate the regenerative power of a decelerating motor.

Synchronized A condition where the local clock value on the drive is locked onto the master clock of the distributed System Time. When synchronized, the drive and controller devices can use time stamps that are associated with an integrated motion on the EtherNet/IP network connection data.

System Time The absolute time value as defined in the CIP Sync standard in the context of a distributed time system where all devices have a local clock that is synchronized with a common master clock. In the context of integrated motion on the EtherNet/IP network, System Time is a 64-bit integer value in units of microseconds or nanoseconds with a value of 0 corresponding to January 1, 1970.

Time Offset The System Time Offset value that is associated with the integrated motion on the EtherNet/IP network connection data that is associated with the source device. The System Time Offset is a 64-bit offset value that is added to the local clock of a device to generate System Time for that device.

Time Stamp A system time stamp value that is associated with the integrated motion on the EtherNet/IP network connection data. The time stamp conveys the absolute time when the associated data was captured, or can be also used to determine when associated data is applied.

Variable Frequency Drive (VFD) A class of drive products that seek to control the speed of a motor, typically an induction motor, through a proportional relationship between drive output voltage and commanded output frequency. Frequency drives are, therefore, sometimes referred to as Volts/Hertz drives.

Vector Drive A class of drive products that seek to control the dynamics of a motor via closed-loop control. These dynamics include, but are not limited to, closed-loop control of both torque and flux vector components of the motor stator current relative to the rotor flux vector.

Notes:

Symbols

Numerics

A

B

C

D

E

N

O

P

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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