Reference Manual

Allen-Bradley

Integrated Motion on the EtherNet/IP Network

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

Allen-Bradley • Rockwell Software

Rockwell Automation

Important user information

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

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice. If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

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

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

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

Reproduction of the contents of this manual, in whole or in part, without written permission of Rockwell Automation, Inc., is prohibited.

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).

This manual contains new and updated information. Use these reference tables to locate new or changed information.

Grammatical and editorial style changes are not included in this summary.

Global changes

This table identifies changes that apply to all information about a subject in the manual and the reason for the change. For example, the addition of new supported hardware, a software design change, or additional reference material would result in changes to all of the topics that deal with that subject.

Subject	Reason
Organization by functional category	Updated throughout to align with the online help.
Access Rule naming conventions	Updated throughout to reflect changes made in this version of Logix Designer application.

New or enhanced features

This table contains a list of topics changed in this version, the reason for the change, and a link to the topic that contains the changed information.

Topic Name	Reason
Stopping and Braking Attributes on page 431	Added Connection Loss Stopping Action attribute. Added Vertical Load Control attribute. Updated descriptions of stopping sequences.
Motion Planner Output Attributes on page 374	Added Motion Planner Output attributes.
Position Control Mode on page 17 Velocity Control Mode on page 18	Added descriptions of Open Loop Position Control Method and Open Loop Velocity Control Method.

Topic Name	Reason
Acceleration Control Attributes on page 187 Acceleration Control Configuration Attributes on page 189 APR Fault Attributes on page 279 Auto-Tune Configuration Attributes on page 258 Axis Exception Action on page 283 Axis Info Attributes on page 234 Axis Safety Status Attributes on page 414 CIP Axis Status Attributes on page 236 Current Control Configuration Attributes on page 196 DC Bus Control Attributes on page 451 Drive General Purpose I/O Attributes on page 249 Event Capture Attributes on page 247 Exception Factory Limit Info Attributes on page 290 Feedback Configuration Attributes on page 304 Frequency Control Configuration Attributes on page 204 Hookup Test Configuration Attributes on page 266 Induction Motor Attributes on page 401 Inertia Test Result Attributes on page 272 Module Configuration Attributes on page 471 Module/Node Fault and Alarm Attributes on page 297 Motion Control Configuration Attributes on page 317 Motion Planner Configuration Attributes on page 367 Position Loop Attributes on page 206 Power and Thermal Management Status Attributes on page 254 Torque/Force Control Configuration Attributes on page 211 Velocity Loop Attributes on page 228 Velocity Loop Configuration Attributes on page 221	Updated minimum, maximum, and default values.
CIP APR Fault - Mfg attribute table removed from APR Fault Attributes on page 279 Converter Control Signal Attributes	Removed unsupported attributes.
Guard Safety Attributes on page 425	Renamed Drive Safety Attributes to Guard Safety Attributes.
Motor Test Result Attributes on page 275	Added Motor Test Bus Overvoltage Speed attribute.
Kinetix 5700 Safety Drive Module Optional Attributes on page 147	Added optional attribute table for the 2198-xxxx-ERS4 safety drive modules.
Kinetix 5700 Safety Drive Module Optional Attributes on page 138	Updated optional attributes for the 2198-xxxx-ERS3 drive modules.
Motion Control Axis Behavior Model on page 51	Updated graphics.
State Behavior on page 61 Exceptions on page 41	Updated descriptions.

Table of contents

Preface

Additional Resources 11
Legal Notices 12

Chapter 1

Integrated Motion on the EtherNet/IP Network

Integrated Motion Axis Control Modes and Methods 16
Control Modes 16
Position Control Mode 17
Velocity Control Mode 18
Torque Control Mode 20
No Control Mode 21
Control Methods 21
Motion Instruction Compatibility 22

Chapter 2

Behavior models used in CIP Motion

Acceleration Control Behavior 25
Acceleration Limiter 26
Load Observer 27
Command Generation Behavior 28
Command Data Sources 29
Command Fine Interpolation 30
Command Ramp Generator 33
Feedforward Signal Selection 34
Command Notch Filter 35
Current Control Behavior 35
Current Vector Limiter 36
Voltage Output 37
Current Feedback 37
Motor Commutation 38
Event Capture Behavior 38
Event Input Sources 39
Event Latches 40
Event Time Stamps 40
Fault and Alarm Behavior 41
Exceptions 41
Absolute Position Recovery 43
Absolute Position Loss without APR Faults 44
APR Fault Conditions 44
APR Fault Generation 45
APR Fault Examples 47
APR Recovery Scenarios 48
Reset an APR Fault 50

Motion Control Axis Behavior Model 51
Active Control Axis Behavior Model 52
Feedback Only Axis Behavior Model 54
CIP Motion Converter Axis Behavior Model 56
Motor Attributes Model 57
Position Control Behavior 58
Position Feedback Selection 59
Position PI Gains 60
Velocity Feedforward 60
Position Loop Output Filters 61
State Behavior 61
Torque Control Behavior 71
Torque Input Sources 72
Inertia Compensation 73
Friction Compensation 75
Torque filters 77
Torque Limiter 78
Torque to Current Scaling 78
Velocity Control Behavior 79
Closed Loop Velocity Control 80
Open Loop Frequency Control 83

Chapter 3

Interpret the Attribute Tables

Attribute Units 90
CIP Data Types 91
Device Function Codes 91
Required vs. Optional Axis Attributes 93
Identify Motion Axis Attributes Based on Device Function Codes 95
Attribute Conversion from SERCOS to Integrated Motion on the Ethernet/IP Network 111
Drive Supported Optional Attributes 114
Kinetix 350 Drive Module Optional Attributes 116
Kinetix 5500 Hardwired STO Drive Module Optional Attributes 122
Kinetix 5500 Integrated STO Drive Module Optional Attributes 130
Kinetix 5700 Safety Drive Module Optional Attributes 138
Kinetix 5700 Advanced Safety Drive Module Optional Attributes 147
Kinetix 6500 Drive Module Optional Attributes 155
PowerFlex 527 Axis Instance Optional Attributes 161
PowerFlex 755 Standard Drive Module Optional Attributes 168
PowerFlex 755 Safety Drive Module Optional Attributes 174
MSG Instruction Access Only Attributes 181

Chapter 4

CIP Axis Attributes

Control Mode Attributes ... 187
Acceleration Control Attributes ... 187
Acceleration Control Configuration Attributes ... 189
Command Reference Generation Attributes ... 191
Command Generator Configuration Attributes ... 191
Command Generator Signal Attributes ... 195
Current Control Configuration Attributes ... 196
Current Control Signal Attributes ... 201
Frequency Control Configuration Attributes ... 204
Frequency Control Signal Attribute ... 206
Position Loop Signal Attributes ... 206
Position Loop Configuration Attributes ... 208
Torque/Force Control Configuration Attributes ... 211
Torque/Force Control Signal Attributes ... 220
Velocity Loop Configuration Attributes ... 221
Velocity Loop Signal Attributes ... 228
Data Attributes ... 233
Axis Info Attributes ... 234
Axis Statistical Attributes ... 235
CIP Axis Status Attributes ... 236
Event Capture Attributes ... 247
Drive Attributes ... 249
Drive General Purpose I/O Attributes ... 249
Drive Output Attributes ... 251
Power and Thermal Management Configuration Attributes ... 252
Power and Thermal Management Status Attributes ... 254
Drive Commissioning and Tuning Attributes ... 257
Auto-Tune Configuration Attributes ... 258
Hookup Test Configuration Attributes ... 266
Hookup Test Result Attributes ... 267
Inertia Test Configuration Attributes ... 269
Inertia Test Result Attributes ... 272
Motor Test Result Attributes ... 275
Faults and Alarms Attributes ... 279
APR Fault Attributes ... 279
Axis Exception Action Configuration Attributes ... 281
Axis Exception Action ... 283
Configuration Fault Attributes ... 287
CIP Error Codes ... 287
Exception Factory Limit Info Attributes ... 290
Exception User Limit Configuration Attributes ... 292
Exception, Fault and Alarm Attributes ... 293
Initialization Faults Attributes ... 295
Standard Initialization Faults ... 296
Rockwell Automation Specific Initialization Faults ... 296

Module/Node Fault and Alarm Attributes 297
Feedback Attributes 302
Feedback Interface Types 302
Feedback Configuration Attributes 304
General Feedback Info Attributes 316
General Feedback Signal Attributes 316
Motion Control Attributes 317
Motion Control Configuration Attributes 317
Motion Control Interface Attributes 323
Motion Control Signal Attributes 330
Motion Control Status Attributes 341
Motion Database Storage Attributes 352
Motion Dynamic Configuration Attributes 354
Motion Homing Configuration Attributes 357
Motion Planner Configuration Attributes 367
Motion Planner Output Attributes 374
Motion Scaling Attributes 375
Motion Resolution Value Examples 386
Motor Attributes 388
General Linear Motor Attributes 388
General Motor Attributes 389
General Permanent Magnet Motor Attributes 396
General Rotary Motor Attributes 399
Induction Motor Attributes 401
Linear PM Motor Attributes 404
Interior Permanent Magnet Motor Attributes 406
Load Transmission and Actuator Attributes 409
Rotary PM Motor Attributes 412
Safety Attributes 414
Axis Safety Status Attributes 414
Guard Safety Attributes 425
Guard Safety Status Attributes 426
Stopping and Braking Attributes 431
Stopping Sequences 445
Proving Operational Sequences 448
DC Bus Control Attributes 451
Start Inhibits Attributes 453
Standard Start Inhibits 454
Rockwell Automation Specific Start Inhibits 455
Exceptions 456
Standard Exceptions 456
Standard CIP Axis Fault and Alarm Names 461
Rockwell Automation Specific Exceptions 465
Rockwell Automation Specific CIP Axis Fault Names 467
Rockwell Automation Specific CIP Axis Alarm Names 468

Chapter 5

Module Configuration Attributes

Module Configuration Block Attributes....471
Module Class Attributes....473
Module Axis Attributes....474
Module Feedback Port Attributes....489
Module Timing Attributes....490
Module Support Attributes....492

Index

Use this manual to review descriptions of the AXIS_CIP_DRIVE attributes and the Studio 5000 Logix Designer® application Control Modes and Methods.

It is intended for use as a reference when programming motion applications.

Additional Resources

Use the following resources to get additional information concerning related products and technologies:

Publication Title	Description
CompactLogix™ 5370 Controllers User Manual, publication 1769-UM021	Describes the necessary tasks to install, configure, program, and operate a CompactLogix 5370 controller.
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.
Integrated Architecture® and CIP Sync Configuration Application Technique, publication IA-AT003	Provides detailed configuration information on CIP Sync Technology and time synchronization.
Integrated Motion on the EtherNet/IP Network Configuration and Startup User Manual, publication MOTION-UM003	Describes how to configure an integrated motion application and to start up your motion solution by using the ControlLogix system.
Kinetix® 6200 and Kinetix 6500 Modular Mutli-axis Servo Drives User Manual, publication 2094-UM002	Provides information on how to install, configure, and troubleshoot applications for your Kinetix 6200 and Kinetix 6500 servo drive systems.
Kinetix 6200 and Kinetix 6500 Safe Speed Monitoring Safety Reference Manual, publication 2094-RM001	Provides information on wiring, configuring, and troubleshooting the safe-speed features of your Kinetix 6200 and Kinetix 6500 drives.
Kinetix 6200 and Kinetix 6500 Safe Torque Off Safety Reference Manual, publication 2094-RM002	Provides information on wiring, configuring, and troubleshooting the safe torque-off features of your Kinetix 6200 and Kinetix 6500 drives.
Kinetix 5500 Servo Drives User Manual, publication 2198-UM001	Provides information on install, configure, and troubleshoot applications for your Kinetix 5500 drive.
Kinetix 5700 Servo Drives User Manual, publication 2198-UM002	Provides information on install, configure, and troubleshoot applications for your Kinetix 5700 drive.
Kinetix 350 Single-axis EtherNet/IP Servo Drives User Manual, publication 2097-UM002	Provides information on install, configure, and troubleshoot applications for your Kinetix 350 Single-axis EtherNet/IP Servo drive.
Kinetix Safe-off Feature Safety Reference Manual, publication GMC-RM002	Provides information on wiring and troubleshooting your Kinetix 6000 and Kinetix 7000 servo drives with the safe torque-off feature.
Logix5000™ Motion Controllers Motion Instructions Manual, publication MOTION-RM002	Provides a programmer with details about motion instructions for motion control.
Logix5000 Controllers Common Procedures, publication 1756-PM001	Provides detailed and comprehensive information about how to program a Logix5000 controller.
Logix5000 Controllers General Instructions Reference Manual, publication 1756-RM003	Provides a programmer with details about general instructions for a Logix-based controller.
Logix5000 Controllers Advanced Process Control and Drives Instructions Reference Manual, publication 1756-RM006	Provides a programmer with details about process and drives instructions for a Logix-based controller.

Publication Title	Description
Motion Coordinate System User Manual, publication MOTION-UM002	Provides details on how to create and configure a coordinate motion system.
PowerFlex® 527 Adjustable Frequency AC Drive User Manual, publication 520-UM002	Provides information that is needed to install, start-up, and troubleshoot PowerFlex 527-Series Adjustable Frequency AC drives.
PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001	Provides information that is needed to install, start-up, and troubleshoot PowerFlex 750-Series Adjustable Frequency AC drives.
PowerFlex 755 Drive Embedded EtherNet/IP Adapter User Manual, publication 750COM-UM001	Provides information on how to install, configure, and troubleshoot applications for the PowerFlex 755 Drive Embedded EtherNet/IP adapter.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation® industrial system.
Rockwell Automation® Product Certifications	Provides declarations of conformity, certificates, and other certification details.
ODVA™ specifications	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 Rockwell Automation distributor or sales representative.

Legal Notices

Copyright Notice

End User License Agreement (EULA)

You can view the Rockwell Automation End-User License Agreement ("EULA") by opening the License.rtf file located in your product's install folder on your hard drive.

Other Licenses

The software included in this product contains copyrighted software that is licensed under one or more open source licenses. Copies of those licenses are included with the software. Corresponding Source code for open source packages included in this product can be located at their respective web site(s).

You may alternately obtain complete Corresponding Source code by contacting Rockwell Automation via our Contact form on the Rockwell Automation website:
http://www.rockwellautomation.com/global/about-us/contact/contact.page.
Please include "Open Source" as part of the request text.

The following open source software is used in this product:

Software	Copyright	License Name	License Text
AngularJS	Copyright 2010-2017 Google, Inc.	MIT License	AngularJS 1.5.9 License
Bootstrap	Copyright 2011-2017 Twitter, Inc. Copyright 2011-2017 The Bootstrap Authors	MIT License	Bootstrap 3.3.7 License
jQuery	Copyright 2005, 2014 JS Foundation and other contributors	MIT License	jQuery 2.1.1 License
OpenSans	Copyright 2017 Google, Inc.	Apache License, Version 2.0	OpenSans License

Trademark Notices

Allen-Bradley, ControlBus, ControlFLASH, Compact GuardLogix, Compact I/O, ControlLogix, CompactLogix, DCM, DH+, Data Highway Plus, DriveLogix, DPI, DriveTools, Explorer, FactoryTalk, FactoryTalk Administration Console, FactoryTalk Alarms and Events, FactoryTalk Batch, FactoryTalk Directory, FactoryTalk Security, FactoryTalk Services Platform, FactoryTalk View, FactoryTalk View SE, FLEX Ex, FlexLogix, FLEX I/O, Guard I/O, High Performance Drive, Integrated Architecture, Kinetix, Logix5000, Logix 5000, Logix5550, MicroLogix, DeviceNet, EtherNet/IP, PLC-2, PLC-3, PLC-5, PanelBuilder, PowerFlex, PhaseManager, POINT I/O, PowerFlex, Rockwell Automation, RSBizWare, Rockwell Software, RSEmulate, Historian, RSFieldbus, RSLinx, RSLogix, RSNetWorx for DeviceNet, RSNetWorx for EtherNet/IP, RSMACC, RSView, RSView32, Rockwell Software Studio 5000 Automation Engineering & Design Environment, Studio 5000 View Designer, SCANport, SLC, SoftLogix, SMC Flex, Studio 5000, Ultra 100, Ultra 200, VersaView, WINtelligent, XM, SequenceManager are trademarks of Rockwell Automation, Inc.

Any Rockwell Automation logo, software or hardware product not mentioned herein is also a trademark, registered or otherwise, of Rockwell Automation, Inc.

Other Trademarks

CmFAS Assistant, CmDongle, CodeMeter, CodeMeter Control Center, and WIBU are trademarks of WIBU-SYSTEMS AG in the United States and/or other countries. Microsoft is a registered trademark of Microsoft Corporation in the United States and/or other countries. ControlNet is a trademark of ControlNet International. DeviceNet is a trademark of the Open DeviceNet Vendors Association (ODVA). Ethernet/IP is a trademark of ControlNet International under license by ODVA.

All other trademarks are the property of their respective holders and are hereby acknowledged.

Warranty

This product is warranted in accordance with the product license. The product's performance may be affected by system configuration, the application being performed, operator control, maintenance, and other related factors. Rockwell Automation is not responsible for these intervening factors. The instructions in this document do not cover all the details or variations in the equipment, procedure, or process described, nor do they provide directions for meeting every possible contingency during installation, operation, or maintenance. This product's implementation may vary among users.

This document is current as of the time of release of the product; however, the accompanying software may have changed since the release. Rockwell Automation, Inc. reserves the right to change any information contained in this document or the software at any time without prior notice. It is your responsibility to obtain the most current information available from Rockwell when installing or using this product.

Environmental Compliance

Rockwell Automation maintains current product environmental information on its website at http://www.rockwellautomation.com/rockwellautomation/about-us/sustainability-ethics/product-environmental-compliance.page

Contact Rockwell

Customer Support Telephone — 1.440.646.3434

Online Support — http://www.rockwellautomation.com/support/

Integrated Motion on the EtherNet/IP Network

Use this manual to review reference descriptions of the AXIS_CIP_DRIVE attributes and the Studio 5000 Logix Designer® application Control Modes and Methods.

Review Control Modes on page 16 for a reference for the Control Modes and Control Methods that explains when you can use an axis attribute in an individual control mode.

To learn about how the different control modes function with attributes review the diagrams provided in Behavior models used in CIP Motion on page 25.

The Control Modes table lists the Motion Axis Attributes specific to the CIP Drive data type. The table identifies the attribute implementation rule as either Required, Optional, or Conditional. Drive replicated attributes are identified also.

Review the Interpret the Attribute Tables on page 87 section for an explanation of how the data for the attributes are organized.

CIP Axis Attributes cover a wide range of drive types. The CIP Axis Attributes on page 185 topics contain:

- Detailed attribute definitions
- Configurations
- Status
- Faults

Each attribute is in a table that includes information about:

- Usage
- Access
- Data type
- Default, minimum, and maximum values
- Semantics of values

Attributes associated with components that are common to all axis instances of a multi-axis CIP Motion device or module are detailed in Module Configuration Attributes on page 471.

Integrated Motion Axis Control Modes and Methods

The Motion Control Axis Object covers the behavior of various motion control system devices that includes feedback devices, drive devices, standalone converters, and motion I/O devices. For drive devices, the Motion Control Axis Object covers a wide range of drive types from simple variable frequency (V/Hz) drives, to sophisticated position control servo drives, with or without integral converters. Many commercial drive products have axes that can be configured with instructions to operate in any one of these different motion control modes depending on the specific application requirements.

Based on the variations in Control Mode, and Control Method a set of basic Device Function Codes have been defined that help organize the many attributes of the Motion Control Axis. Each attribute has a unique identifier (ID).

See also

Control Modes on page 16

Control Methods on page 21

Motion Instruction Compatibility on page 22

Device Function Codes on page 91

Identify Motion Axis Attributes Based on Device Function Codes on page 95

Control Modes

Motion control modes are organized around the general philosophy that position control is the highest form of dynamic control. That is, position control implies velocity control, and velocity control implies acceleration control.

Acceleration is related to torque or force by the inertia or mass of the load; respectively, acceleration control implies torque control. Because motor torque or force is generally related to motor current by a torque or force constant, respectively, torque control implies current control. The torque or force constant can be a function of the motor magnets as in a Permanent Magnet motor, or the induced flux of an Induction motor.

Because acceleration, torque/force, and current are generally related by a constant, these terms are sometimes used interchangeably in the industry. For example, a torque control loop rather than a current control loop. Motion Control Axis Attributes let you differentiate between these control properties. This is useful when the relationship between them is not static, such as when inertia/mass changes with position or time, or when the torque/force constant changes due to temperature change or motor flux variation.

The Control Modes are:

- B - Bus Power Converters (No Control Mode, No Control Method)
- E - Encoder, Feedback Only (No Control Mode, No Control Method)
- P - Position Control Mode
- V - Velocity Control Mode
- T - Torque Control Mode
- F - Velocity Control Mode

Control Nomenclature

Linear and rotary control applications can affect the control nomenclature. While rotary applications speak of torque and inertia, linear applications speak of force and mass. When we refer to rotary nomenclature, the defined behavior can generally be applied to linear applications by substituting the terms, force for torque and mass for inertia. With that understanding, we use torque rather than force in the control mode diagrams without loss of generality.

See also

Position Control Mode on page 17

Velocity Control Mode on page 18

Torque Control Mode on page 20

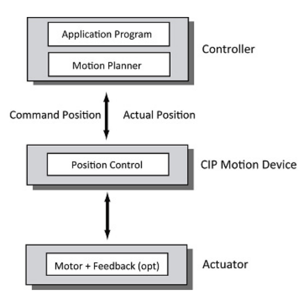
No Control Mode on page 21

Position Control Mode

In Position Control application mode either the application control program (command execution function) or the motion planner (move trajectory control function) provide a setpoint value to the CIP Motion device using the cyclic data connection. The Position Control method can be either open loop or closed loop.

Open Loop Position Control Method

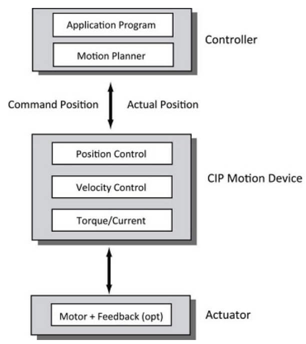
A device configured for open loop position control applies to a class of drive devices called stepper drives. This type of drive is illustrated below.



A feedback device for this configuration is optional. In the absence of a feedback device, actual position can be estimated by the drive and returned to the controller.

Closed Loop Position Control Method

A motor control device configured for closed loop position control is traditionally referred to as position loop drive or position servo drive. A position servo drive implies an inner velocity and torque control loop as shown in following diagram. The presence of the torque/current control loop sometimes results in this kind of drive being referred to as a vector drive.



A feedback device for this configuration is generally required to achieve good positioning accuracy. The feedback device can also be used to return Actual Velocity and Actual Acceleration data to the controller using the cyclic data connection.

In addition to Command Position, the controller can pass Command Velocity and Command Acceleration for the purposes of forward control.

See also

Control Modes on page 16

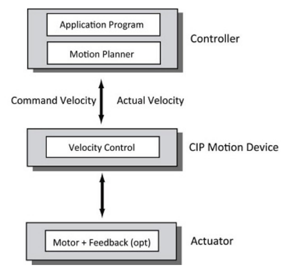
Velocity Control Mode

In Velocity Control application mode the application control program and motion planner provide a setpoint value to the CIP Motion device using the cyclic data connection. The velocity control method can be either open loop or closed loop.

Open Loop Velocity Control Method

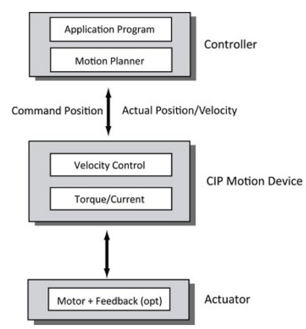
A motor control device configured for open loop velocity control is traditionally referred to as Variable Frequency, or V/Hz, or VFD, drive. This type of drive is illustrated below.

A feedback device for this configuration is optional. In the absence of a feedback device, actual velocity can be estimated by the drive and returned to the controller.



Closed Loop Velocity Control Method

A motor control device configured for closed loop velocity control is traditionally referred to as velocity loop drive or velocity servo drive. A closed loop velocity control drive implies an inner torque/current control loop and therefore is sometimes referred to as a vector drive.

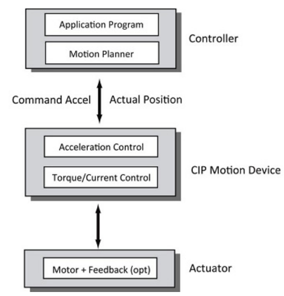


A feedback device for the velocity loop drive configuration is optional. You can achieve tighter speed regulation when using a feedback device, particularly at low speed. When the feedback device is included it may be used to return actual position, velocity, and acceleration data to the controller using the cyclic data connection. When the feedback device is not included, only estimated velocity can typically be returned to the controller.

In addition to Command Velocity, the controller can also pass Command Acceleration for the purposes of forward control.

Acceleration Control Method

While not a mainstream control mode in the industry nor mentioned in the IEC standard, the acceleration control mode is included here to complete the dynamic progression from velocity control to torque control and because the Motion Control Axis Object can support an Acceleration Command, potentially derived from the controller's motion planner. In the acceleration control mode, the application control program and motion planner provide acceleration set-point values to the CIP Motion device using the cyclic data connection. The drive converts the acceleration set-point into a torque command using the estimated system inertia. Acceleration control works in concert with the inner torque/current control loop as shown below.



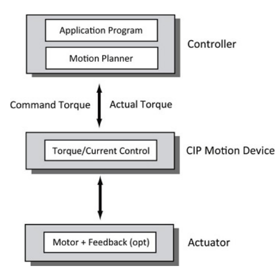
A feedback device for the acceleration control configuration is mandatory and may be used to return actual position, velocity, and acceleration data to the controller using the cyclic data connection.

See also

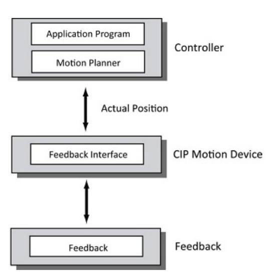
Control Modes on page 16

Torque Control Mode

In Torque Control application mode, the application control program or the motion planner provide torque setpoint values to the device using the cyclic data connection. Because motor current and motor torque are generally related by a torque constant, Kt, torque control is often synonymous with current control.



A position feedback device for this control mode is optional. If a feedback device is present it can be used to return actual position, velocity, and acceleration data to the controller using the cyclic data connection.



See also

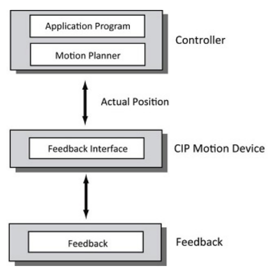
Control Modes on page 16

No Control Mode

The Motion Control Axis Object supports a No Control application mode where there is not dynamic motor control function. This mode is often used to support Feedback Only or Master Feedback functionality where a feedback channel in a CIP Motion Drive device is serving as a master feedback source to the rest of the control system. This mode could also be applied to integrated CIP Motion Encoder device types where the CIP Motion interface is applied directly to an Encoder.

In this No Control mode of operation, no setpoint value is supplied to the CIP Motion device using the cyclic data connection, but actual position, velocity, and acceleration can be supplied by the device to the controller using the cyclic data channel, if applicable. The No Control mode for Feedback Only functionality is illustrated in the following diagram:

No Control (Feedback Only)



No Control mode also applies to other CIP Motion device types, such as standalone Bus Power Converters and dedicated Motion I/O device types. Since there is no feedback channel that is associated with these device types, no actual position is returned to the controller.

See also

Control Modes on page 16

Control Methods

Within this basic control paradigm, there is latitude for different control methods, both closed loop and open loop. By closed loop, it is implied that 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, and in some cases the signal is derived from the motor excitation, for example, sensorless/encoderless operation.

By open loop, it is implied that there is no application of feedback to force the actual dynamics to match the commanded dynamics. While precision and performance are the hallmarks of closed loop control, simplicity and economy are the hallmarks of open loop control.

The Control Method attribute is an 8-bit enumerated code that determines the basic control algorithm. The device applies the algorithm to control the dynamic behavior of the motor that is associated with an axis. The Control Methods related to the Control Modes are listed in the following table.

Control Method Filed Enumeration Definitions

Enumeration	Usage	Name	Description
0	R/N	No Control	No Control is associated with a Control Mode of No Control where there is no explicit motor control that is provided by the device for this axis instance.
1	R/F	Frequency Control	Frequency Control is an "open loop" control method that applies voltage to the motor, generally in proportion to the commanded frequency or speed. This control method is associated with Variable Frequency Drives (VFDs) or so called Volts/Hertz drives.
2	R/C	PI Vector Control	PI Vector Control is a "closed loop" control method that uses actual or estimated feedback for closed loop cascaded PI control of motor dynamics, that is, position, velocity, acceleration, and torque, and always includes independent closed loop PI control of Iq and Id components of the motor current vector.
3...127	-	Reserved	-
128...255	-	Vendor Specific	-

Axis configuration

The Control Mode and Control Method are derived by the Axis Configuration according to the following table.

Axis Configuration	Valid Control Modes
Feedback Only	No Control
Frequency Control	Velocity Control
Position Loop	Position Control Velocity Control Torque Control
Velocity Loop	Velocity Control Torque Control
Torque Loop	Torque Control

See also

Control Modes on page 16

Motion Instruction Compatibility

The following table correlates the motion instructions with the compatible control modes. The compatibility with integrated motion is based on the Axis Configuration and feedback type settings. The motion instructions tables are divided by type.

Use the following key to interpret the column entries:

Symbol	Meaning
x	Control mode is compatible.
#	MSO and MDS execution initiate mutually exclusive modes of operation and execution is conditional on mode.
*	Axis may be used as a master axis reference only for this instruction.
c	Axis may conditionally use Motion Planner instructions if enabled with MSO instruction, otherwise, it errors.
(shaded)	Shaded areas denote that Multi-Axis Coordination Motion is designed and tested for position mode operation but not specifically restricted to that axis configuration.

Category	Motion Instruction Name	Abbr.	Feedback Only	Freq.Cntrl No Feedback	Pos. Loop	Vel. Loop Feedback	Vel. Loop No Feedback	Torque Loop
State Control	Motion Direct Drive On	MDO						
	Motion Direct Drive Off	MDF						
	Motion Servo On	MSO		#	x	#	#	#
	Motion Servo Off	MSF		x	x	x	x	x
	Motion Axis Fault Reset	MAFR	x	x	x	x	x	x
	Motion Axis Shutdown	MASD	x	x	x	x	x	x
	Motion Axis Shutdown Reset	MASR	x	x	x	x	x	x
	Motion Drive Start	MDS		#		#	#	#
Event Control	Motion Arm Watch Position	MAW	x		x	x		x
	Motion Disarm Watch Position	MDW	x		x	x		x
	Motion Arm Registration	MAR	x		x	x		x
	Motion Disarm Registration	MDR	x		x	x		x
	Motion Arm Output Cam	MAOC	x		x	x		x
	Motion Disarm Output Cam	MDOC	x		x	x		x
Move Control	Motion Redefine Position	MRP	x	c	x	c	c	c
	Motion Axis Home	MAH	x		x	c		c
	Motion Axis Jog	MAJ		c	x	c	c	
	Motion Axis Move	MAM		c	x	c	c	
	Motion Change Dynamics	MCD		c	x	c	c	
	Motion Axis Stop	MAS	x	x	x	x	x	x
	Motion Axis Gear	MAG	*	c	x	c	c	*
	Motion Master Driven Axis Control	MDAC	*	c	x	c	c	*
	Motion Axis Position Cam	MAPC	*	c	x	c	c	*
	Motion Axis Time Cam	MATC		c	x	c	c	
Multi-Axis Coordinate	Motion Coordinated Linear Move	MCLM		c	x	c	c	

Category	Motion Instruction Name	Abbr.	Feedback Only	Freq.Cntrl No Feedback	Pos. Loop	Vel. Loop Feedback	Vel. Loop No Feedback	Torque Loop
	Motion Coordinated Circular Move	MCCM		c	x	c	c	
	Motion Coordinated Stop	MCS	x	x	x	x	x	x
	Motion Coordinated Shutdown	MCSD	x	x	x	x	x	x
	Motion Coordinated Shutdown Reset	MCSR	x	x	x	x	x	x
	Motion Coordinated Change Dynamics	MCCD		c	x	c	c	
	Motion Coordinated Transform	MCT		c	x	c	c	
	Motion Calculate Target Position	MCTP	x	c	x	c	c	x
	Motion Master Driven Coordinated Control	MDCC	*	c	x	c	c	*
Motion Configuration	Motion Run Axis Tuning	MRAT			x	x	x	
	Motion Apply Axis Tuning	MAAT						
	Motion Run Hookup Diagnostic	MRHD	x	x	x	x	x	x
	Motion Apply Hookup Diagnostic	MAHD						
Group Control	Motion Group Strobe Position	MGSP	x	x	x	x	x	x
	Motion Group Shutdown	MGSD	x	x	x	x	x	x
	Motion Group Shutdown Reset	MGSR	x	x	x	x	x	x
	Motion Group Stop	MGS	x	x	x	x	x	x

See also

Control Modes on page 16

Control Methods on page 21

Behavior models used in CIP Motion

Control systems and algorithms are used to discuss the CIP motion attributes. Conceptual diagrams and feature descriptions are provided to help orient you to the various components of CIP motion.

Behavior models	
Acceleration Control Behavior on page 25	Motor Attributes Model on page 57
Command Generation Behavior on page 28	Position Control Behavior on page 58
Current Control Behavior on page 35	State Behavior on page 61
Event Capture Behavior on page 38	Torque Control Behavior on page 71
Fault and Alarm Behavior on page 41	Velocity Control Behavior on page 79
Motion Control Axis Behavior Model on page 51	

See also

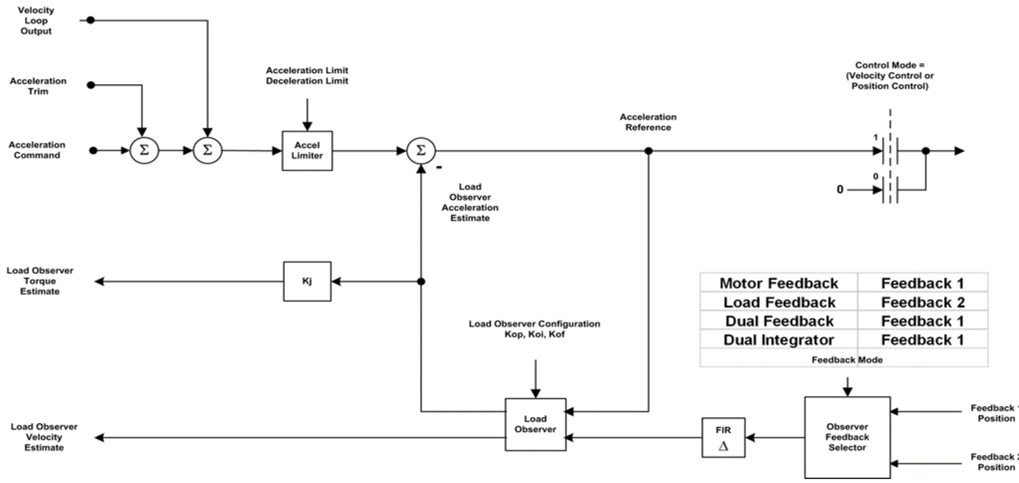
Standard Exceptions on page 456

Interpret the Attribute Tables on page 87

Acceleration Control Behavior

While dynamic motor control through an acceleration command is not common in the industry, Acceleration Control completes the dynamic progression from Velocity Control to Torque Control. The output of the velocity loop, Velocity Loop Output, also has units of acceleration. The sum the contributions of the Acceleration Command, Acceleration Trim, and Velocity Loop Output to form the Acceleration Reference signal that serves as one of the primary inputs to Torque Control behavior. Acceleration Control can optionally include a Load Observer to compensate for mechanical backlash, mechanical compliance, and various load disturbances.

The following diagram provides an overview of the Acceleration Control behavior model, including the Load Observer.



See also

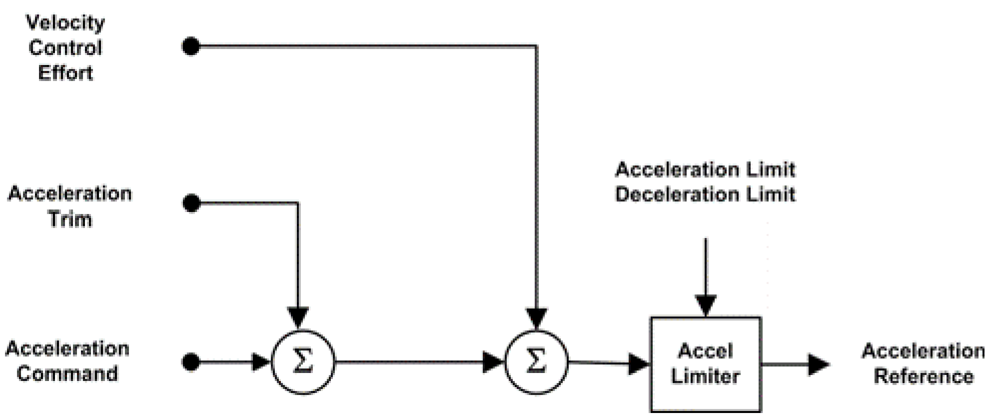
Acceleration Limiter on page 26

Load Observer on page 27

Acceleration Limiter

The output of the acceleration command summing junction signal passes through a limiter to produce the Acceleration Reference signal. The Accel Limiter applies a directional acceleration limit, either the Acceleration Limit or the Deceleration Limit, to the input command signal based on the sign of the signal.

The following diagram illustrates this process.



See also

Load Observer on page 27

Acceleration Control Behavior on page 25

Load Observer

Acceleration Control can optionally include a Load Observer. Feeding the Acceleration Reference into a Load Observer, along with the velocity feedback signal, has been found to be effective in compensating for mechanical backlash, mechanical compliance, and various load disturbances.

The Load Observer's effectiveness in this regard can be thought of as a result of the observer adding virtual inertia to the motor. When the observer is enabled, it functions as an inner feedback loop, like the current loop, but unlike the current loop in that the observer's control loop includes the motor mechanics.

Due to the work of the Load Observer, variations in load inertia, mass, and even the motor's torque/force constant can be nearly eliminated as seen by the velocity loop. In fact, because the Load Observer includes the Acceleration Reference signal as an input, it can provide a velocity estimate signal that has less delay than the velocity feedback estimate generated by the actual feedback device. Thus, applying the Load Observer's velocity estimate to the velocity loop can be used to improve the performance of the velocity loop.

Acceleration Feedback Selection

Feedback to the Load Observer can be derived from either Feedback 1 or Feedback 2. Which feedback source is used by the loop is governed by the Feedback Mode. In general, the Load Observer works best when by using a high resolution feedback device.

Acceleration and Torque Estimates

The output of the Load Observer is the Acceleration Estimate signal that is subsequently applied to the acceleration reference summing junction. When configured for Load Observer operation, the Acceleration Estimate signal represents the error between the actual acceleration. The signal is seen by the feedback device and the acceleration is estimated by the Load Observer. This is based on an ideal model of the motor and load.

By subtracting the Acceleration Estimate signal from the output of the Acceleration Limiter, the Load Observer is forcing the actual motor and load to behave like the ideal model, as seen by the velocity loop. The Acceleration Estimate signal can be seen as a dynamic measure of how much the actual motor and load are deviating from the ideal model. Such deviations from the ideal motor model can be modeled as torque disturbances. Scaling the Load Observer Acceleration Estimate signal by the System Inertia results in the Load Observer Torque Estimate signal. This signal represents an estimate of the motor torque disturbance.

When configured for Acceleration Feedback operation, the Load Observer Acceleration Estimate represents an acceleration feedback signal. Applying this signal to the acceleration reference summing junction forms a closed acceleration loop. Scaling the Load Observer Acceleration Estimate signal by the System Inertia results in the Load Observer Torque Estimate signal. This signal represents an estimate of motor torque.

Load Observer Configuration

The Load Observer can be configured in a variety of ways using the Load Observer Configuration attribute. Standard Load Observer function is enabled by selecting the Load Observer Only.

In addition, the Load Observer's estimated velocity signal can be applied as feedback to the velocity loop by selecting Load Observer with Velocity Estimate or Velocity Estimate Only. Selecting Acceleration Feedback degenerates the Load Observer to an acceleration feedback loop by disconnecting the Acceleration Reference input from the observer. The observer's velocity estimate is not available in this mode of operation.

See also

Acceleration Control Behavior on page 25

Torque Control Behavior on page 71

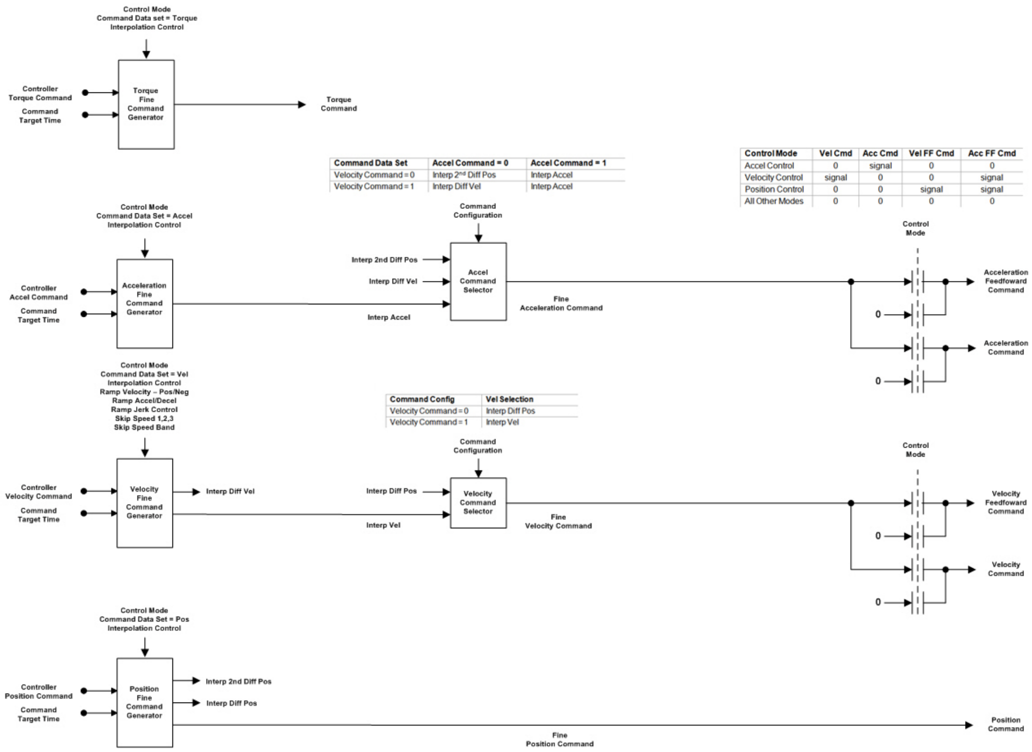
Velocity Control Behavior on page 79

Command Generation Behavior

Command Generation includes these behaviors:

- Command Data Sources
- Command Fine Interpolation
- Command Ramp Generator
- Feedforward Signal Selection
- Command Notch Filter

The following diagram illustrates the interaction command generation behavior:



See also

Command Data Sources on page 29

Command Fine Interpolation on page 30

Command Ramp Generator on page 33

Feedforward Signal Selection on page 34

Command Notch Filter on page 35

Command Data Sources

Command data that impacts axis motion can come from a variety of sources. The most common command data source is from a controller-based Motion Planner using the CIP Motion C-to-D Connection. In this context, command data can take the form of Controller Position, Velocity, Acceleration, and Torque Commands generated by the Motion Planner. The command data elements provided are specified by the Command Data Set attribute, which is based on the selected Control Mode. The primary command data element can be augmented by higher order command elements for the purposes of generating high quality feedforward signals. Alternatively, these higher order command elements can be derived by the device from the primary command data. In either case, a Fine Command Interpolator is generally applied to the Command Data to generate command reference signals to the device's control structure at the device's update rate.

Another source of command data is a local Motion Planner resident within the device. The Motion Device Axis Object defines a rich set of features associated with a device based Motion Planner. These features include support for electronic gearing, camming, moves, and jogs. Through use of the CIP Motion peer-to-peer connection, the gearing and camming functions can be directly linked to a master axis command reference from a producing peer device for high performance line-shafting applications. Alternatively, the master axis command reference can be derived from a local motion axis instance. To facilitate these features, the Motion Planner also supports the ability to establish an absolute position reference to the machine through homing and redefine position operations as well as perform rotary unwind functionality. The device's Motion Planner is controlled by CIP service requests.

Command Data, such as the Controller Velocity Command, can be set directly by the user. In this context, the device must apply its own Ramp Generator function to smoothly accelerate or decelerate the motor to the commanded velocity.

See also

Command Generation Behavior on page 28

Command Fine Interpolation

For synchronized, high-performance applications using CIP Motion, command data is received from the CIP Motion C-to-D Connection or the device's local Motion Planner, and based on the connection's Command Target Update element being set to 'Interpolate', processed by the Fine Interpolator functionality of the Command Generator.

The job of the Fine Interpolator is to compute coefficients to a trajectory polynomial that is designed to reach the command data at its associated Command Target Time. Depending on the specific command data element, the trajectory can follow a 1st, 2^{nd,} or 3rd order polynomial trajectory with initial conditions based on current axis dynamics.

Because the polynomial is a function of time, a new fine command value can be calculated any time the CIP Motion device needs to perform a control calculation. As a result, it is not necessary that the device's control calculation period be integrally divisible into the Controller Update Period.

To improve device interchangeability, a minimum order for the fine interpolators is recommended. Because contemporary Motion Planners typically generate their trajectories based on 3rd order polynomials in position, it is important that the fine interpolators reproduce these trajectories with high fidelity. Therefore, the position fine interpolator is defined as 3rd order, the velocity interpolator is 2nd order, and the acceleration and torque interpolators are both 1st order. Higher order fine interpolators are possible and are left to the device vendor's discretion.

The following table provide a reference to the polynomial equations:

Interpolator name	Equation
Position Fine Interpolation Polynomial	$P(t) = a_0 + a_1 * (t-t_0) + a_2 * (t- t_0)^2 + a_3 * (t-t_0)^3$
Velocity Fine Interpolation Polynomial	$V(t) = b_0 + b_1 * (t-t_0) + b_2 * (t- t_0)^2$
Acceleration Fine Interpolation Polynomial	$A(t) = c_0 + c_1 * (t-t_0)$
Torque Fine Interpolation Polynomial	$T(t) = d_0 + d_1 * (t-t_0)$

In these equations, time (t_0), represents the Command Target Time for the previous Motion Planner update such that when $t = t_0$, the position (P), velocity (V), acceleration (A), and torque (T) command values are equal to the values sent in the previous Motion Planner update, for example, P_{-1}, V_{-1}, A_{-1}, and T_{-1}. This establishes the 0^{th} order coefficients of the polynomials.

- $P(t_0) = P_{-1} = a_0$
- $V(t_0) = V_{-1} = b_0$
- $A(t_0) = A_{-1} = c_0$
- $T(t_0) = T_{-1} = d_0$

The higher order polynomial coefficients are calculated such that by the next Motion Planner update, corresponding to Command Target Time, t_1, the position, velocity, acceleration, and torque command values are the values sent in the latest Motion Planner update, for example, P_0, V_0, A_0, and T_0.

- $P(t_1) = P_0$
- $V(t_1) = V_0$
- $A(t_1) = A_0$
- $T(t_1) = T_0$

Using the above polynomial interpolation equations, the CIP Motion device can compute position, velocity, acceleration, and torque command values at any time by plugging in the current System Time value of the device into the variable, t. This allows the device's control calculation to be performed according to a schedule that is independent of the controller's update schedule.

One thing that must be done, however, is to adjust the Command Target Time, t_0, if there is a shift in the System Time Offset for the device; t_0 and t are always based on the same System Time reference system. For example, assume the device's System Time Offset when the control command timestamp, t_0, was received as $Offset_0$. If the command interpolation equation is to be applied at $t= t_1$ and the current System Time Offset is defined as $Offset_1$, then t_0 is adjusted as follows before executing the polynomial:

- Adjusted $t_0 = t_0 + (Offset_1 – Offset_0)$

Alternatively, the values for t, t_0, and t_1 can be based on local time rather than system time by using the current System Time Offset to convert between System Time to local time. This may be more convenient for the interpolator implementation and is left to the device vendor's discretion.

The polynomial coefficients are computed based on standard formulas that are a function of the history of command values over the last few updates. The number of historical command values used in the formula depends on the order of the polynomial. For example, the 3rd order command position polynomial uses the three previous command position values. For convenience, the interpolator polynomial coefficient formulas are provided in the following table:

Coefficient name	Equations
Position Fine Interpolation Polynomial Coefficients	$a_0 = P_{-1}$ $a_1 = 1/T * (\Delta P_0 - 1/2*\Delta V_0 - 1/6*\Delta A_0)$ $a_2 = 1/T^2 * (1/2*\Delta V_0)$ $a_3 = 1/T^3 * (1/6*\Delta A_0)$
Velocity Fine Interpolation Polynomial Coefficients	$b_0 = V_{-1}$ $b_1 = 1/T * (V - 1/2*\Delta A_0)$ $b_2 = 1/T^2 * (1/2*\Delta A_0)$
Acceleration Fine Interpolation Polynomial Coefficients (Torque is same form as Accel)	$c_0 = A_{-1}$□ $c_1 = 1/T * \Delta A_0$

These equations are based on the following nomenclature:

T = Controller Update Period

$\Delta P_0 = (P_0 - P_{-1})$

$\Delta V_0 = (V_0 - V_{-1}) = (P_0 - 2P_{-1} + P_{-2})$

$\Delta A_0 = (A_0 - A_{-1}) = (V_0 - 2V_{-1} + V_{-2}) = (P_0 - 3P_{-1} + 3P_{-2} - P_{-3})$

The preceding polynomial coefficients should be applied to the fine interpolator as soon possible after t is equal to or greater than t_0. Applying the new coefficients too early, for example, with significantly less than t_0, can create unnecessary error in the command trajectory when connecting the last fine interpolator segment to the new fine interpolator segment at t_0.

When $t > t_1$, the fine interpolation polynomial becomes an extrapolation polynomial. In the absence of a fresh update from the Motion Planner, the extrapolation polynomial can be used to provide estimated command data to the device control structure until fresh Motion Planner command data is available. Once fresh command data is made available, new polynomial coefficients are computed and applied without delay. In this way, the motion control can 'ride-through' occasionally late or with lost connection data packets resulting in a robust distributed motion control network solution. To be clear, late connection data is always applied and never thrown away; late data still represents the freshest data available from the controller and the extrapolation polynomial ensures that the command data is applied in such a way as to maintain a smooth motion trajectory despite variations in command data delivery.

When the update period of the Motion Planner is short enough relative to the dynamics of the command trajectory, or is comparable to the device control calculation period, fine interpolation may not be necessary. The Motion Planner can make this determination by comparing the planner update period to that of the device control calculation period. When fine interpolation is used, the planner adds additional planner update periods to the planner time stamp, so it is advantageous to eliminate this planner update period delay if interpolation is not necessary.

Even though fine interpolation may not be necessary in some cases, it does not mean that the command data is to be applied directly to the device's control structure. It still may be necessary to calculate the above polynomials so the device can extrapolate the command value when the device's control update occurs. That is because, in general, the device's control update time stamp does not need to match the time stamp of the command data.

Finally, there are applications and CIP Motion device types that do not require the dynamic accuracy that time-stamped interpolation and extrapolation provide. Various velocity and Torque Control applications, for example, may fall in this category. In general, command data can also be applied to the control structures of Variable Frequency drives without interpolation or extrapolation.

See also

Command Generation Behavior on page 28

Command Ramp Generator

When operating in Closed Loop Velocity mode, the Ramp Generator feature of the Velocity Fine Command Generator block is applied to the Controller Velocity Command value sent by the controller when the Command Target Update element of the connection is set to 'Immediate' mode. In Immediate mode, the Command Data is applied immediately to the device's control structure. Because there is generally no Motion Planner generating the Command Data in this mode, the Command Data value from the controller can change drastically from one update to the next. To address this condition, a Ramp Generator function is needed to ramp the motor to the new Command Data value within the dynamic limitations of the system. As an example of if the Controller Velocity Command value suddenly changed from 0...30 revolutions per second in Immediate Mode, the Ramp Generator would produce a Fine Velocity Command signal that accelerates the motor to the Controller Velocity Command value based on the configured Ramp Acceleration and Jerk Control attribute values. The Ramp Jerk Control attribute determines what percentage of the acceleration or deceleration ramp is S-Curve with the remaining portion of the ramp governed by the fixed Ramp Acceleration or Deceleration attribute values. If the Command Target Update element of the connection is not set to 'Immediate', the Ramp Generator has no impact on the Fine Velocity Command signal.

While a Ramp Generator function could be included in each of the Fine Command Generator position, velocity, and acceleration commands, this version includes a Ramp Generator only within the Velocity Fine Command Generator. When operating in Frequency Control mode, the Ramp Generator function is integrated into the Frequency Control system.

The Ramp Generator enforces directional velocity limits on the Command Data, ensuring that the Velocity Command never exceeds the configured Maximum Velocity Pos/Neg values.

The Ramp Generator also supports Flying Start functionality. When enabling the drive while the motor is still moving, the Ramp Generator output is initialized to the current speed of the motor. From there, the Ramp Generator smoothly accelerates or decelerates the motor to the current Controller Velocity Command.

Finally, the Ramp Generator supports Skip Bands that are most frequently used in Frequency Control applications when certain speeds excite mechanical resonance frequencies of the motor and load. The Skip Band feature allows three separate Skip Speeds to be defined that shift the Velocity Command signal to avoid, or skip, these problematic speeds. The Skip Speed Band determines the range of speeds centered on the three Skip Speeds that the device avoids:

- If the Velocity Command is within the Skip Band, but below the Skip Speed, the Velocity Command output is set to the Skip Speed, minus half the Skip Speed Band.
- If the Fine Velocity Command is within the Skip Band, but above the Skip Speed, the Velocity Command output is set to the Skip Speed, plus half the Skip Speed Band.

When operating in Frequency Control mode, the Skip Band function is integrated into the Frequency Control system.

See also

Command Generation Behavior on page 28

Feedforward Signal Selection

The Fine Command Generators can generate higher derivatives of the command data input to serve as feedforward signals. The units for the velocity and acceleration feedforward signals are generally different than the derivative units, hence the derivative signals are scaled appropriately. Superior signal quality, however, can be provided by the Motion Planner trajectory generators. The feedforward selection blocks pick the best feedforward signal to apply based on the bits set in the Command Data Set attribute. The best signal is defined as the signal derived by using the fewest differencing operations.

The Fine command position is applied directly to the Position Control loop without any of the typical de-referencing and offsets. It is assumed that these operations are performed by the controller or device based Motion Planner.

Feedforward signals are only applicable for Closed Loop Position and Closed Loop Velocity Control Modes.

See also

Command Generation Behavior on page 28

Command Notch Filter

The position command that results from the command interpolation and feedforward signals then pass through a position command notch filter. The purpose of this set of filters is to reduce anti-resonance behavior of a compliant motor load by filtering out any commanded motion around the anti-resonance frequency.

See also

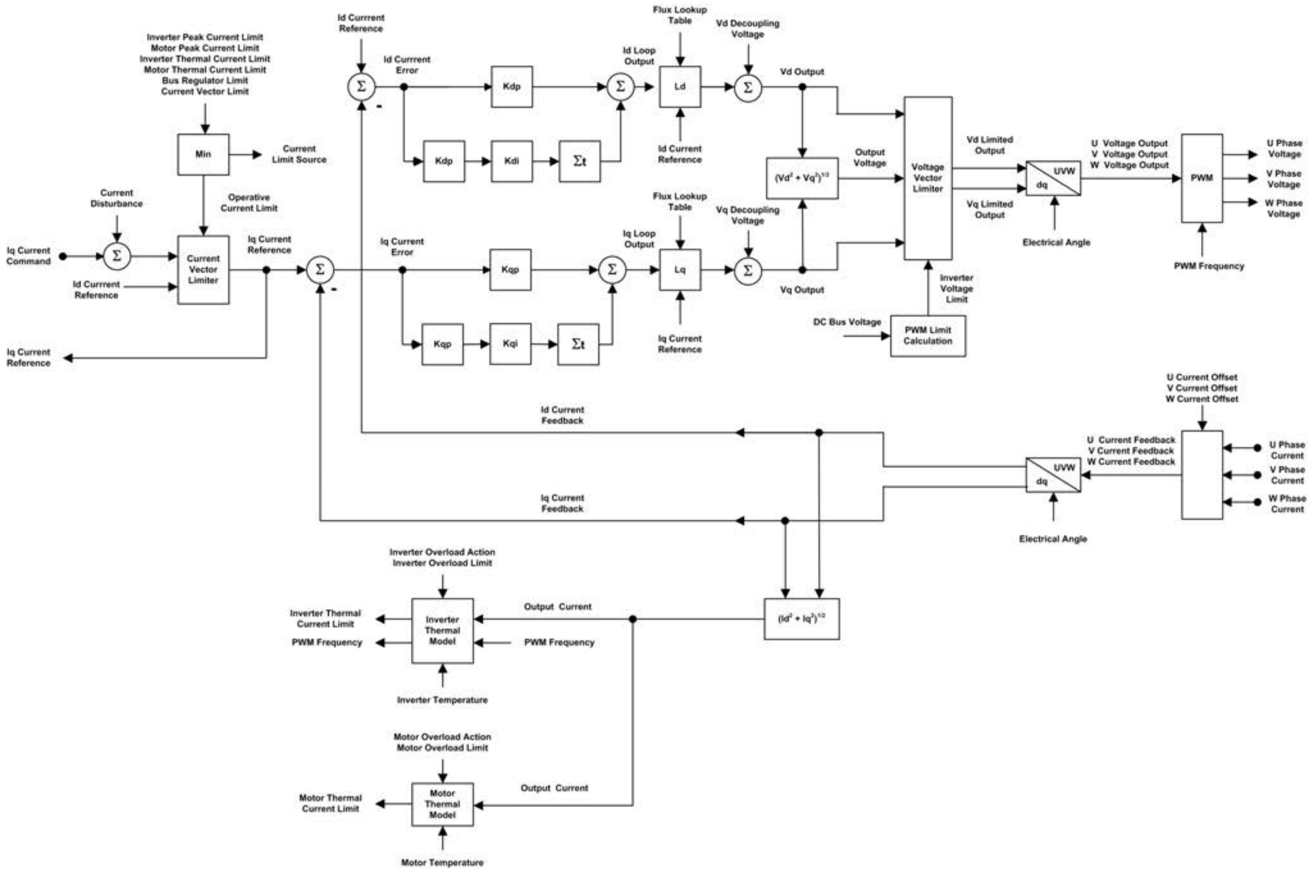
Command Generation Behavior on page 28

Current Control Behavior

In general, motor torque is controlled by controlling the orientation and magnitude of the motor stator current vector with respect to the rotor magnetic flux vector. The Current control loop is responsible for providing this control and is actually composed of two PI loops, one that controls the torque producing current, Iq, and one that controls the flux producing current, Id. It is the quadrature component of current, Iq, that is used for dynamic Torque Control.

In the case of an induction motor, the flux producing current, Id, is solely responsible for generating rotor flux. In the case of permanent magnet motors, rotor flux is generated by the rotor magnets and Id is used only in some cases to extend the speed range of the motor by changing the angle of the stator field relative to the rotor field. In this case, the angle of Iq relative to the rotor field remains the same, for example, at quadrature. However, because the vector combination of Iq and Id determines the stator flux angle relative to the rotor, increasing amounts of Id can shift the stator flux away from quadrature to extend the speed range of the motor at the expense of torque.

The following diagrams show an overview of this behavior model.



See also

Current Vector Limiter on page 36

Voltage Output on page 37

Current Feedback on page 37

Motor Commutation on page 38

Current Vector Limiter

The Iq Current Command passes through a Current Vector Limiter before becoming the Iq Current Reference signal. This limiter computes the combined vector magnitude of the Iq Current Reference and the Id Current Reference signals. The resultant current vector magnitude is compared to the Operative Current Limit that represents the minimum current limit from among a set of potential current limits of the drive device and motor.

If the vector magnitude exceeds the Operative Current Limit, the Iq Current Reference is reduced so the vector magnitude equals the Operative Current Limit. Potential current limit sources can be the Peak Current Limit ratings as well as the

Thermal Limits for the Motor and Drive Inverter. Another possible limit source is the user-configurable Current Vector Limit attribute.

Some of these limits are conditional and dynamic, such as the Motor and Inverter Thermal Current Limits derived from the thermal models for these devices. These limits are active only when the corresponding Motor and Inverter Overload Action attributes are set to provide current fold-back. The thermal current limits in this case would decrease as the simulated temperature of the modeled devices increases. The Bus Regulator Limit is applied only when the motor is regenerating power onto the DC Bus and is based on the Regenerative Power Limit.

With all these potential current limit sources that could be operative, a Current Limit Source attribute identifies the source of the active current limit.

See also

Current Control Behavior on page 35

Voltage Output

The output of each current loop is scaled by the motor inductance to generate a voltage command to the vector transformation block. It is the job of the vector transformation block to transform the torque producing, Vq, and flux producing, Vd, command signals from the rotating synchronous reference frame to the stationary stator reference frame. The resultant U, V, and W Output Voltage values are then applied to the motor by Pulse Width Modulation (PWM). The PWM Frequency is also a configurable attribute.

The magnitude of the Vq, Vd vector is calculated in real time as the total Output Voltage signal. The maximum Output Voltage signal that can be applied to the motor is ultimately limited by the DC Bus Voltage and enforced by the Voltage Vector Limiter. Any attempt to exceed this value results in an Inverter Voltage Limit condition.

See also

Current Control Behavior on page 35

Current Feedback

Current feedback signals to the current loop are provided by two or three current sensors. The signals from these sensors are conditioned and corrected for device specific offsets to become the U, V, and W Current Feedback signals associated with the stationary motor stator frame. These three signals are transformed back to the synchronous reference frame to generate the Iq and Id Current Feedback signals. The magnitude of the Iq, Id current vector is calculated in real-time and used as an input to the thermal models for the inverter and motor.

See also

Current Control Behavior on page 35

Motor Commutation

Motor commutation is critical to closed loop motor control. The orientation of the motor rotor can be determined from a feedback source mounted to the motor. The actual commutation source is the motor feedback device assigned to Feedback 1 or, possibly, the redundant feedback channel assigned to Feedback 1. Once the feedback device is calibrated to the absolute orientation of the rotor by using the Commutation Offset attribute, the commutation block can then generate the true Electrical Angle of the rotor. This signal is used to perform the vector transforms between the rotary and stationary motor frames and can also be used for any other algorithms that require knowledge of rotor position.

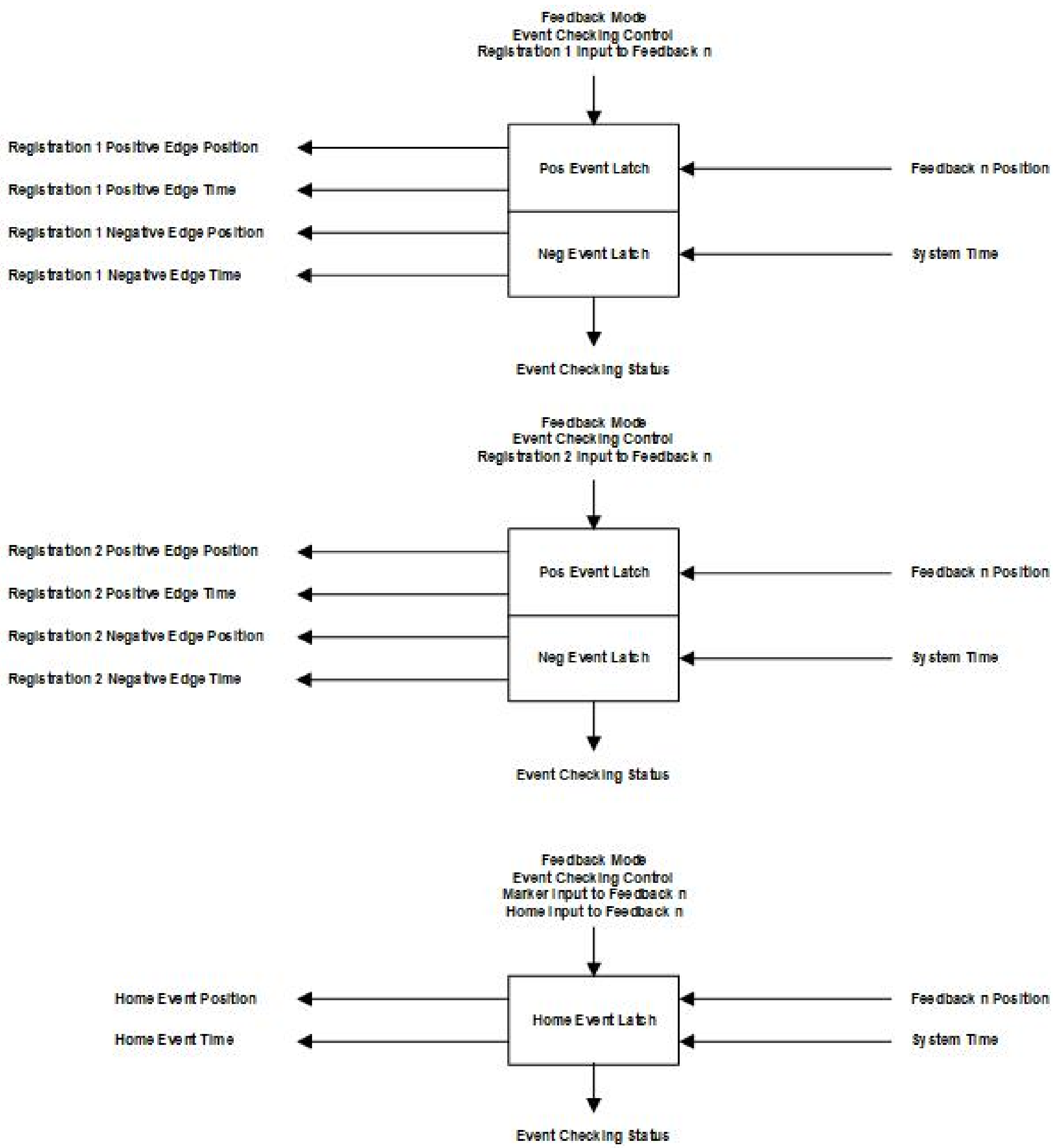
See also

Current Control Behavior on page 35

Event Capture Behavior

Event capture behavior captures both the feedback position and time stamp associated with specific state transitions of selected event input sources.

The following diagram provides an overview of the event capture behavior model.



See also

Event Input Sources on page 39

Event Latches on page 40

Event Time Stamps on page 40

Event Input Sources

The Motion Device Axis Object defines a mechanism to capture both the feedback position and time stamp associated with specific state transitions of selected event input sources. Event input sources currently supported by the object are:

- Registration 1
- Registration 2
- Marker
- Home Switch.

These event input sources apply to each supported feedback channel.

See also

Event Capture Behavior on page 38

Event Latches

To facilitate accurate capture of both feedback position and time, hardware event latches are typically implemented.

Two independent latches are defined for each registration input, one latch to capture positive edge transition events and one to capture negative edge transition events. This design enables capture of both registration events in applications with narrow registration pulses where the rising and falling edges occur nearly simultaneously.

In addition to the registration latches, a separate latch is also defined for the home event capture. The home input event that triggers the Home Event Latch can be any of a number of different combinations of home switch and marker input events, for example, marker transitions, switch transitions, or switch transitions followed by a marker transition.

With hardware-based event latches, event capture accuracy is, in general, only limited by the latency of the associated event input. Registration and Marker event inputs are lightly filtered so event capture accuracy is on the order of 1 microsecond (µsec). In terms of position capture accuracy, that would be calculated as the product of the event capture accuracy and the speed of the axis. Home switch inputs are heavily filtered, in general, and therefore limited to an event capture accuracy of 1 to 10 millisecond (msec). Thus, to get an accurate position capture based on a home switch input transition, a homing sequence with a slow homing speed is required.

See also

Event Capture Behavior on page 38

Event Time Stamps

Because the registration time stamp is passed to the controller as part of the Event Notification data, the controller can apply the event time stamp to the position history of other axes in the system to interpolate their positions. This is particularly useful in applications where it is necessary to determine the location of several axes at the time of a single registration event. The more accurate the time stamp, the more accurately the controller can determine these positions.

See also

Event Capture Behavior on page 38

Fault and Alarm Behavior

The fault and alarm handling functionality addresses both the need for a large and ever-expanding number of specific faults and alarms, the need for programmable actions, and the need for timely reporting of those faults and alarms to the controller. Additionally, no compromises are made to restrict the resolution of the reported faults and alarms, so that the controller always has access to the unique axis condition and a meaningful diagnosis. Numerous Fault and Alarm related attributes can be included in the fixed portion of the cyclic Device-to-Controller Connection so the controller can monitor the condition of the motion axis in real-time, without cumbersome polling.

The CIP Axis Status attribute contains bits to indicate whether an alarm condition is present. The CIP Axis State enumeration indicates when the axis has a major fault, which could be a regular runtime CIP Axis Fault, Safety Fault, or an Initialization Fault. The Axis Fault Code and related attributes are used to report the specific fault condition, time stamp, and fault action to the controller for the purposes of building a fault log.

See also

State Behavior on page 61

Exceptions on page 41

Absolute Position Recovery on page 43

CIP Axis Status Attributes on page 236

Exception, Fault and Alarm Attributes on page 293

Exceptions

Exceptions are runtime conditions that the device continually checks that might indicate improper behavior of the motion axis or operation outside of an allowable range. An exception can result in an alarm, a minor fault, or a major fault, depending on how the associated Axis Exception Action has been configured – an exception can even be configured to be ignored. Exceptions are automatically cleared by the device when the underlying exception condition is no longer present.

Exception Actions

For each exception, the motion axis can be programmed for a variety of actions using the Exception Action attribute. Exception Actions range from generating a major fault that results in the stopping of the motion axis all the way to taking no action at all. The CIP Axis Faults attribute allows the controller to have immediate access to any exceptions that have been configured to generate a major or minor fault. The CIP Axis Alarms attribute allows the controller to have immediate access to any exceptions that have been configured to be reported as alarms.

Alarms

Alarms are runtime exception conditions for which the device is to take no action other than to report as an alarm. Alarms and warnings, therefore, are basically synonymous. On a given device product, some exception conditions may not be able to simply be reported as an alarm without any associated action; for example an IPM fault in which the power module automatically shuts off without software intervention. Alarm conditions are automatically cleared when the underlying exception condition is no longer present.

Faults

Faults can be initialization faults, configuration faults, safety faults, module faults, group faults, motion faults, or runtime exception conditions that the axis has been configured to regard as a fault. Fault conditions can occur in either the controller or motion device. If a runtime fault occurs during an operational state, for example, Running or Testing, it will result in the device stopping (or aborting) all axis motion, either automatically or programmatically. Fault conditions ultimately transition the axis state to the Faulted state. A Fault that results from an exception condition is latched, and does not clear when the exception condition clears. A fault can only be cleared with a Fault Reset. If the fault condition is classified as an 'unrecoverable fault', only a power cycle or a device reset can clear the fault condition.

Start Inhibit Behavior

A Start Inhibit is a condition that inhibits the axis from starting, i.e. transitioning to the Starting state for enabled axis operation. This condition does not generate an exception if a start attempt is made. If the circumstances that led to the Start Inhibit are no longer present, the start inhibit condition is automatically cleared by the device, returning the axis to the Stopped State.

If the motion axis is in the Start Inhibit state it indicates that one or more conditions are present that prevent the axis from transitioning to enabled operation. The Start Inhibits attribute reports the specific condition that is inhibiting the axis.

See also

Motion Control Axis Behavior Model on page 51

State Behavior on page 61

Fault and Alarm Behavior on page 41

Absolute Position Recovery

Absolute Position Recovery (APR) provides support for establishing and maintaining absolute position referenced to a specific machine, commonly called the machine referenced absolute position or just absolute position.

Absolute position is established by a homing procedure 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 with respect to the associated machine.

It is good application programming practice to qualify dynamic machine operation with the Axis Homed bit being set. Otherwise, absolute moves to a specific position may not have any relationship to the position of the axis on the actual machine.

Since the homing procedure usually requires the machine to be taken offline and placed in a manual operating mode, for example, not making product, anything that would require you to rehome one or more axes on the machine is undesirable. This is downtime and costs money. The APR feature maintains the machine reference or absolute position through power cycles, program downloads, and even firmware updates.

Absolute Feedback Device

The absolute feedback device lets absolute position to be retained through a power cycle. These devices take various forms, but they all are capable of maintaining absolute feedback position while power to the drive and to the feedback device is off.

When power is turned back on, the drive reads the feedback referenced absolute position from the feedback device and, 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. But what happens if the drive is swapped out, or the drive firmware is updated? Absolute Position is generally lost.

CIP Motion lets you recover the absolute position not only through power cycles, but also program downloads, and even firmware updates.

SERCOS versus CIP

For a SERCOS axis with absolute feedback, the drive scaling function and absolute position is maintained in the drive and therefore may be easily restored in the control after a power cycle or download of a new project by simply reading the position from the drive.

By contrast, a CIP Motion axis supports controller based scaling where absolute position is maintained in the controller's firmware. Without the work of the APR feature, absolute position would be lost after a power cycle or project download.

See also

APR Fault Conditions on page 44

APR Fault Examples on page 47

APR Fault Generation on page 45

APR Fault Attributes on page 279

Absolute Position Loss without APR Faults

The Absolute Position Recovery is not retained after the following:

- A project is exported, saved as a .L5K or .L5X, and imported (downloaded).
- A major non-recoverable fault (MNRF).
- A power loss.
- On a Control Logix 5570 controller without an ESM

Tip: The APR can potentially be restored from a Secure Digital Card on a ControlLogix 5570 Controller (if a 1756-ESM is not present).

- A download of an axis that does not have its home bit set.
- Power cycling of an incremental encoder.

See also

Absolute Position Recovery on page 43

APR Recovery Scenarios on page 48

APR Fault Examples on page 47

APR Fault Conditions

Absolute Position Recovery (APR) faults are generated during these events and when one of the conditions defined below occurs.

In order for an APR Fault to occur, the axis must be in the homed state. 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 can also happen during the execution of an SSV.

Axis Feedback Changes

The feedback device has been replaced. This creates an Axis Feedback Serial Number mismatch.

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 CompactFlash card.
  - Manual Restore
  - Power up restore, when configured
- Firmware is updated using ControlFLASH.
- An SSV to change:
  - Feedback Polarity or
  - One of the attributes which results in a change to the Motion Resolution attribute.

See also

APR Fault Generation on page 45

APR Fault Attributes on page 279

APR Fault Generation

APR Faults can be generated:

- During initial axis configuration.
- During operation
- When the system fails to recover the absolute position after a power cycle, reset, or a reconnection.

APR faults are detected during these online scenarios.

- Initial configuration (download)
- Reconnection of the drive axis

- Change in any of the axis attributes which impacts the absolute machine position.

When an APR fault occurs, the actual position of the axis is set to the feedback reference position of the axis. The values are read from the absolute encoder. This clears the axis homed status bit.

A download, restore from a CompactFlash card, a restore from a Secure Digital Card, or a ControlFLASH firmware update after one of these events causes the APR fault.

- Axis Configuration
- Attribute Changes
  - Offline edits of the axis attributes or configuration does not cause an APR fault until after download occurs.
  - Online edits of certain attributes will result in an immediate APR fault. Changing the axis feedback device or feedback polarity without downloading the project will also generate an immediate APR fault.
- Axis hardware change or malfunction
- Axis hardware resource insufficiency
  - Hardware resource insufficiencies are only detected during download or ControlFLASH firmware update and will result in an APR fault.

During axis configuration, the following checks are made:

1. Existing Axis?
2. Scaling Signature matches saved Scaling Signature?
3. Feedback Signature matches saved Feedback Signature?

If these three checks pass, generally absolute position is restored.

During operation, the system monitors the following conditions:

1. Feedback Integrity Status bit cleared?
2. Scaling Signature dependent attribute values changed by SSV?

Changes to the following attributes do not impact 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 that the new values are rightly related to the Position Unit of the product and the mechanics of the system. This is typically done as part of a product recipe change.

If the Axis Homed status bit is clear, indicating that position has not been absolutely referenced to the machine, the APR function is bypassed and there is no attempt to restore absolute position.

See also

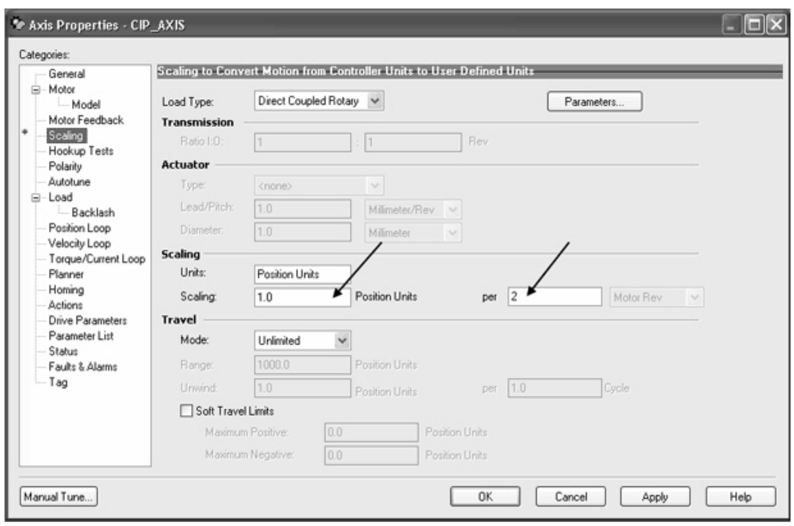
APR Fault Attributes on page 279

APR Fault Examples on page 47

APR Fault Examples

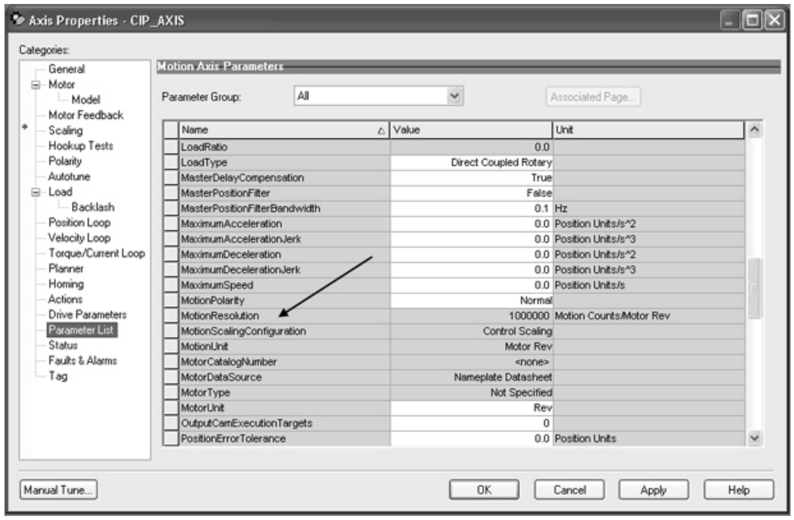
Scaling

Changing the Scaling parameters can potentially generate an APR fault because internal constants computed from these two parameters may generate a motion resolution change. If this happens, an APR fault is generated.



Online Scaling

Any change or SSV message that results in a motion resolution change will generate an APR fault.



See also

[Resetting APR Faults] on [page 50]

[Absolute Position Loss without APR Faults] on [page 44]

[APR Recovery Scenarios] on [page 48]

APR Recovery Scenarios

The following tables provide detailed information on when the APR feature recovers absolute position. The following assumptions need to be taken into consideration. In each of these cases, the APR feature restores absolute position and preserves the state of the Axis Homed bit, indicating that the axis has a machine referenced absolute position.

- All relevant axes are CIP axes.
- Yes, machine reference is recovered (for Axes that have been homed).
- No, machine reference is not recovered (for Axes that have been homed).

Scenario	Event	Machine Reference Retained
Controller	Battery(1)	Yes
	Controller Power Cycle with Battery	Yes
	Controller Removal/Insertion Under Power (RIUP) with Battery	Yes
	Controller Firmware Update	Yes
	Controller CompactFlash Update	Yes
	Controller Swap (Same CF Card)	Yes

Scenario	Event	Machine Reference Retained
	Change Controller	No
	Change Controller without a CompactFlash Card	No
	Controller Power Cycle without Battery	No
	Controller Removal/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 are no CompactFlash or Secure Digital cards on either controller	No
	1. Controller remains powered. 2. Power cycle drives. 3. Change feedback device but not motor	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 running with an axis that is not homed.	No
	Disconnect and reconnect the Ethernet cable.	Yes
	Disconnect and reconnect the same feedback or motor cable on an axis.	Yes
	Inhibit or Uninhibit an axis or drive.	Yes
Battery Backed Controller	Save to a Secure Digital card(2) 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 Secure Digital card on power up.	Yes
	RAM memory becomes corrupt and the user program is restored from the Secure Digital card. If you reset the machine reference using MAH or MRP after storing the user program to a Secure Digital card, the MAH and MRP changes will be lost. The APR will be restored to the reference stored on the card.	Yes
	User program running with a homed axis and you manually restore the user program from a Secure Digital card. If you change the machine reference using MAH or MRP after storing the user program to a Secure Digital card, the MAH and MRP changes will be lost. The APR will be restored to the reference stored on the card.	Yes
	Battery Backed Controller: Restore by taking the Secure Digital card to another controller. If the other controller has the exact same axes configuration and scaling constants as the Secure Digital card and has homed axes.	Sometimes

Scenario	Event	Machine Reference Retained
	Transfer the Secure Digital card from the first controller to the second with the following preconditions: • Empty the second controller. There is no user program in the second controller. • The user program has been saved on a Secure Digital card with CIP Motion axes homed.	Yes
	Transfer the Secure Digital Card from the first controller to the second with the following preconditions: • The second controller has the same user program with the controller being swapped. • The second Controller has axes homed.	Yes
	Reload the same user program from a Secure Digital card. This scenario assumes that the axis is homed in RAM prior to reload.	Yes
	Update controller firmware from Secure Digital card.	Yes
	Change drive with same or different catalog number.	Yes
	Change motor but not feedback device	Yes
Download same program with no hardware changes.	Change the name of an axis.	Yes
	Download the same Logix Designer application program to the controller.	Yes
	Save As with a different file name.	Yes
	Partial Export and then import an axis.	Yes
	Added application logic.	Yes
	Download the Logix Designer application project of Existing Axis.	Yes
	Add an axis.	No for the new axis
	Copy or cut and paste or drag and drop axis into the same project or a another project	No for the new or pasted axis
	Export and then import into the same or another project.	No

(1) The term Battery in this table assumes a ControlLogix 5570 Controller and a 1756-ESMxxx Energy Storage Module.

(2) ControlLogix 5570 Controller

See also

APR Fault Examples on page 47

Absolute Position Loss without APR Faults on page 44

APR Fault Conditions on page 44

Reset an APR Fault

There are three ways to reset an APR Fault.

- Instruction Execution

  Executing an MAFR

  Executing an MGSR

  Executing an MASR

Executing a MCSR

- From the Controller Organizer:

  Clear the group fault, the Logix Designer application executes an MGSR

  Clear the axis fault, the application executes an MASR

- Downloading the same project a second time

See also

APR Fault Examples on page 47

APR Fault Conditions on page 44

APR Fault Generation on page 45

Motion Control Axis Behavior Model

The Motion Control Axis Behavior Model is based on elements of the S88 and Pack/ML standard state models. The current state of the Motion Control Axis is indicated by the CIP Axis State attribute. State transitions can be initiated either directly using the Axis Control request mechanism or by conditions that occur in either the controller or motion device during operation.

Review the diagram for the behavior model to see how the axis state maps to identity object states.

- Active Control Axis Behavior Model on page 52
- Feedback Only Axis Behavior Model on page 54
- CIP Motion Converter Axis Behavior Model on page 56
- Motor Attributes Model on page 57

Fault Reset State Transition Precedence

When an axis is in the Major Faulted state, the axis may transition to one of several different states in response to a Fault Reset event. Which state the axis transitions to is dependent upon other state/status conditions of the axis.

It is possible for more than one state condition to be present at the same time, for example. Shutdown, Start Inhibited, and so forth. Since the axis state model can only represent one state at any given time, the state of the axis is determined according to the following precedence:

1. Major Faulted
2. Shutdown
3. Pre-Charge

4. Start Inhibited

5. Stopped

See also

State Behavior on page 61

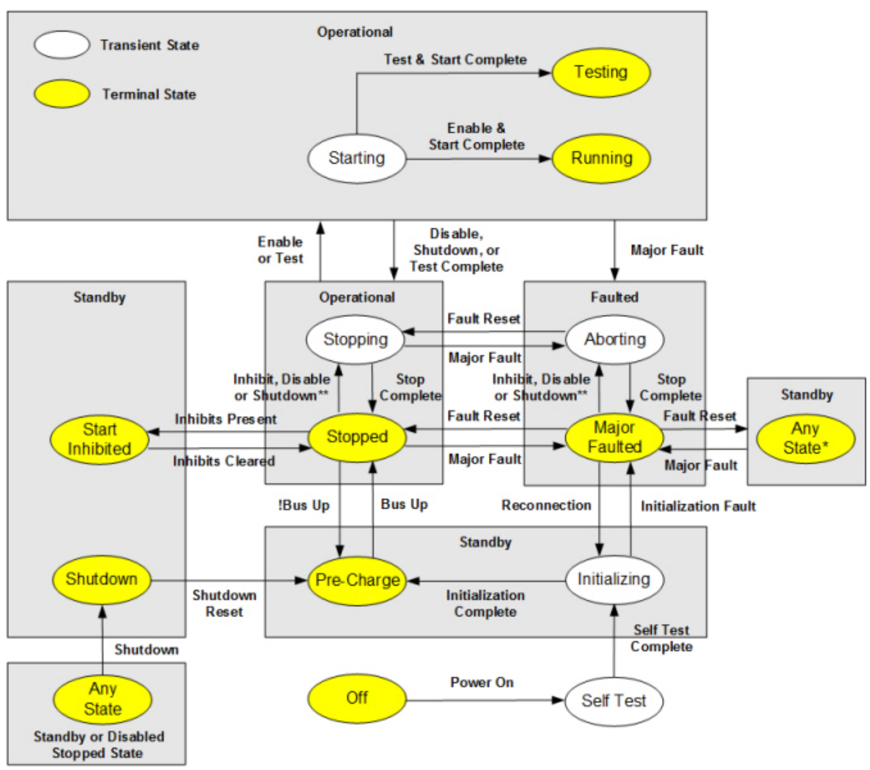
Fault and Alarm Behavior on page 41

Exceptions on page 41

Active Control Axis Behavior Model

The current state of the Motion Control Axis Object instance is indicated by the CIP Axis State attribute. State transitions can be initiated either directly using the Axis Control request mechanism or by conditions that occur in either the controller or motion device during operation.

The following diagram illustrates the basic operating states of the Motion Control Axis when actively controlling axis motion (Control Mode != No Control). Shaded regions show mapping of Axis States to corresponding Identity Object states. State transitions terminating on shaded boxes can transition to any axis state within the box.



Tip: * Specific Standby State after a Fault Reset is determined by applying the Fault Reset State Transition Precedence Rules.

** When an axis is in the Stopped or Major Faulted states with Holding torque (as a result of a Category 2 Stop), a Start Inhibit condition, Disable Request, or Shutdown Request is used to execute the configured Stopping Action.

Valid transitions for the Axis State Model are defined in the following table:

Current State	Event	Conditions	Next State
Off	Power Up		Self Test
Self Test	Self Test Complete		Initializing
Initializing	Initialization Fault		Major Faulted
Initializing	Initialization Complete		Pre-Charge
Shutdown	Major Fault		Major Faulted
Pre-Charge	Shutdown		Shutdown
Pre-Charge	Major Fault		Major Faulted
Pre-Charge	Bus Up		Stopped
Start Inhibited	Shutdown		Shutdown
Start Inhibited	Major Fault		Major Faulted
Start Inhibited	Inhibits Cleared		Stopped
Major Faulted	Shutdown*	Power Structure Enabled = 1	Aborting
Major Faulted	Disable*	Power Structure Enabled = 1	Aborting
Major Faulted	Start Inhibit*	Power Structure Enabled = 1	Aborting
Major Faulted	Fault Reset	Shutdown = 1	Shutdown
Major Faulted	Fault Reset	Shutdown = 0 DC Bus Up = 0	Pre-Charge
Major Faulted	Fault Reset	Shutdown = 0 DC Bus Up = 1 Start Inhibit > 0	Start Inhibited
Major Faulted	Fault Reset	Shutdown = 0 DC Bus Up = 1 Start Inhibit =0	Stopped
Major Faulted	Reconnection		Initializing
Stopped	Shutdown*	Power Structure Enabled = 1	Stopping
Stopped	Disable*	Power Structure Enabled = 1	Stopping
Stopped	Start Inhibit*	Power Structure Enabled = 1	Stopping
Stopped	Start Inhibit	Power Structure Enabled = 0	Start Inhibit
Stopped	Not Bus Up		Pre-Charge
Stopped	Shutdown		Shutdown
Stopped	Major Fault		Major Faulted
Stopped	Enable		Starting
Stopped	Test (Active)		Starting
Starting	Shutdown		Shutdown
Starting	Major Fault		Aborting

Current State	Event	Conditions	Next State
Starting	Disable		Stopping
Starting	Start Complete	In Process = 0	Running
Starting	Start Complete	In Process = 1	Testing
Stopping	Stop Complete	Shutdown = 0	Stopped
Stopping	Stop Complete	Shutdown = 1	Shutdown
Stopping	Major Fault		Aborting
Stopping	Enable	Flying Start Enable = 1	Starting
Aborting	Stop Complete		Major Faulted
Aborting	Fault Reset		Stopping
Testing	Shutdown		Stopping
Testing	Major Fault		Aborting
Testing	Disable		Stopping
Testing	Test Complete		Stopping
Running	Shutdown		Stopping
Running	Major Fault		Aborting
Running	Disable		Stopping
Any State	Connection Close		Initializing
Any State	Connection Loss		Major Faulted

** Event disables the axis power structure after a Category 2 Stop leaves the axis in active hold condition.*

See also

State Behavior on page 61

Fault and Alarm Behavior on page 41

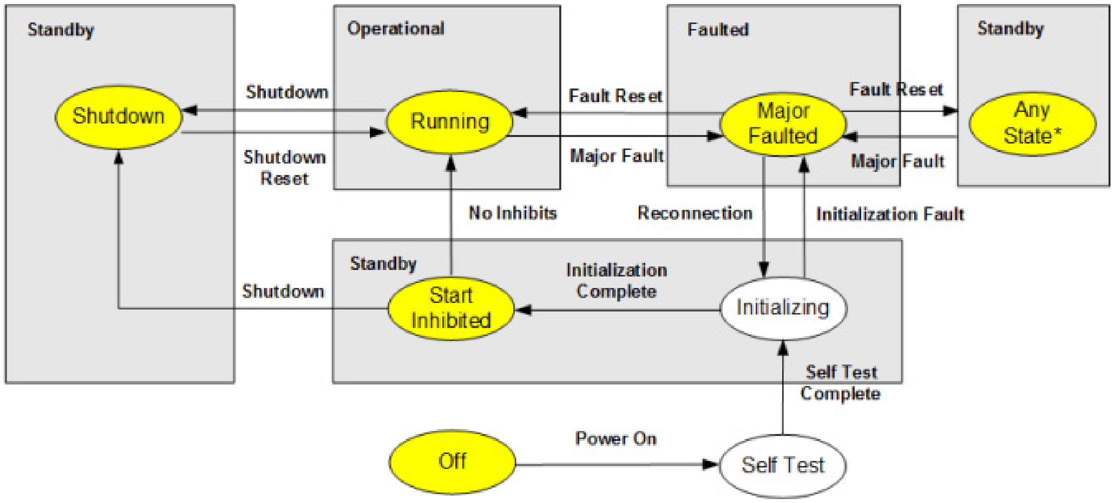
Exceptions on page 41

Stopping Sequences on page 445

CIP Axis Status Attributes on page 236

Feedback Only Axis Behavior Model

When the Motion Control Axis is not actively controlling axis motion (Control Mode = No Control), the state diagram reduces to the following for a Feedback Only axis or CIP Motion Encoder device type. Shaded regions show mapping of Axis States to corresponding Identity Object states. State transitions terminating on shaded boxes can transition to any axis state within the box.



Tip: *Specific Standby state after a fault reset is determined by applying Fault Reset State Transition Precedence rules.

Valid transitions for the Axis State Model of a Feedback Only axis or CIP Motion Encoder are defined in the following table:

Current State	Event	Conditions	Next State
Off	Power Up		Self Test
Initializing	Initialization Fault		Major Faulted
Initializing	Initialization Complete		Start Inhibited
Shutdown	Major Fault		Major Faulted
Shutdown	Shutdown Reset		Running
Start Inhibited	Shutdown		Shutdown
Start Inhibited	Major Fault		Major Faulted
Start Inhibited	Inhibits Cleared		Running
Major Faulted	Fault Reset	Shutdown = 1	Shutdown
Major Faulted	Fault Reset	Shutdown = 0 Start Inhibited > 0	Start Inhibited
Major Faulted	Fault Reset	Shutdown = 0 Start Inhibited = 0	Running
Major Faulted	Reconnection		Initializing
Running	Shutdown		Shutdown
Running	Major Fault		Major Faulted
Any State	Connection Close		Initializing
Any State	Connection Loss		Major Faulted

See also

State Behavior on page 61

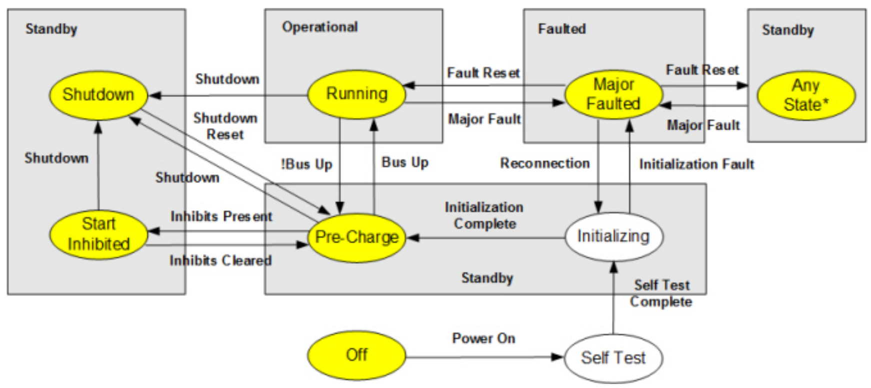
Fault and Alarm Behavior on page 41

Exceptions on page 41

CIP Axis Status Attributes on page 236

CIP Motion Converter Axis Behavior Model

When the Motion Device Axis Object is associated with a CIP Motion Converter, the Active Control state diagram reduces to the following diagram. Shaded regions show mapping of Axis States to corresponding Identity Object states. State transitions terminating on shaded boxes can transition to any axis state within the box.



Tip: *Specific Standby state after a fault reset is determined by applying Fault Reset State Transition Precedence rules.

Valid transitions for the Axis State Model of a CIP Motion Converter axis are explicitly defined in the following table:

Current State	Event	Conditions	Next State
Off	Power Up		Self Test
Self Test	Self Test Complete		Initializing
Initializing	Initialization Fault		Major Faulted
Initializing	Initialization Complete		Pre-Charge
Shutdown	Major Fault		Major Faulted
Shutdown	Shutdown Reset		Pre-Charge
Start Inhibited	Shutdown		Shutdown
Start Inhibited	Major Fault		Major Faulted
Start Inhibited	Inhibits Cleared		Pre-Charge
Pre-Charge	Start Inhibit		Start Inhibited
Pre-Charge	Shutdown		Shutdown
Pre-Charge	Major Fault		Major Faulted
Pre-Charge	Bus Up		Running
Major Faulted	Fault Reset	Shutdown = 1	Shutdown
Major Faulted	Fault Reset	Shutdown = 0	Pre-Charge
Major Faulted	Reconnection		Initializing
Running	Not Bus Up		Pre-Charge

Current State	Event	Conditions	Next State
Running	Shutdown		Shutdown
Running	Major Fault		Major Faulted
Any State	Connection Close		Initializing
Any State	Connection Loss		Major Faulted

See also

State Behavior on page 61

Fault and Alarm Behavior on page 41

Exceptions on page 41

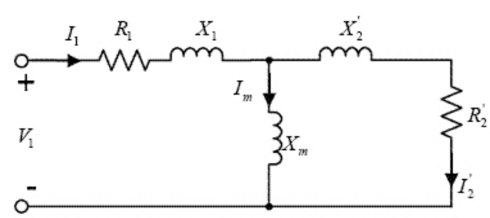
Motor Attributes Model

The Motor Attributes define the minimal set of required attributes to support CIP Motion device interchangeability. This guarantees that there is sufficient parametric data provided by the controller for any CIP Motion compliant device, for example, a drive, to effectively control a given motor.

The Usage category for an attribute is based on the Motor Type. Where needed, Required versus Optional is further differentiated by abbreviations for PM (Permanent Magnet) and IM (Induction Motors). It is implied that these motor attributes are applicable to all drive modes, F, P, V, and T, but not applicable for N (No Control) axis configurations where there is no active motor control function.

For induction motors, the Motion Control Axis leverages the IEEE recommended phase-neutral equivalent circuit motor model based on "Wye" configuration. Reactance values, X, are related to their corresponding Inductance values, L, by $X = \omega L$, where ω is the rated frequency of the motor. The prime notation, for example, X_2', R_2', indicates that the actual rotor component values X_2, and R_2 are referenced to the stator side of the stator-to-rotor winding ratio.

IEEE per Phase Motor Model:



For permanent magnet motors, the Motion Control Axis assumes all motor parameters are defined in the context of a phase-to-phase motor model.

See also

General Motor Attributes on page 389

General Permanent Magnet Motor Attributes on page 396

General Rotary Motor Attributes on page 399

General Linear Motor Attributes on page 388

Induction Motor Attributes on page 401

Linear PM Motor Attributes on page 404

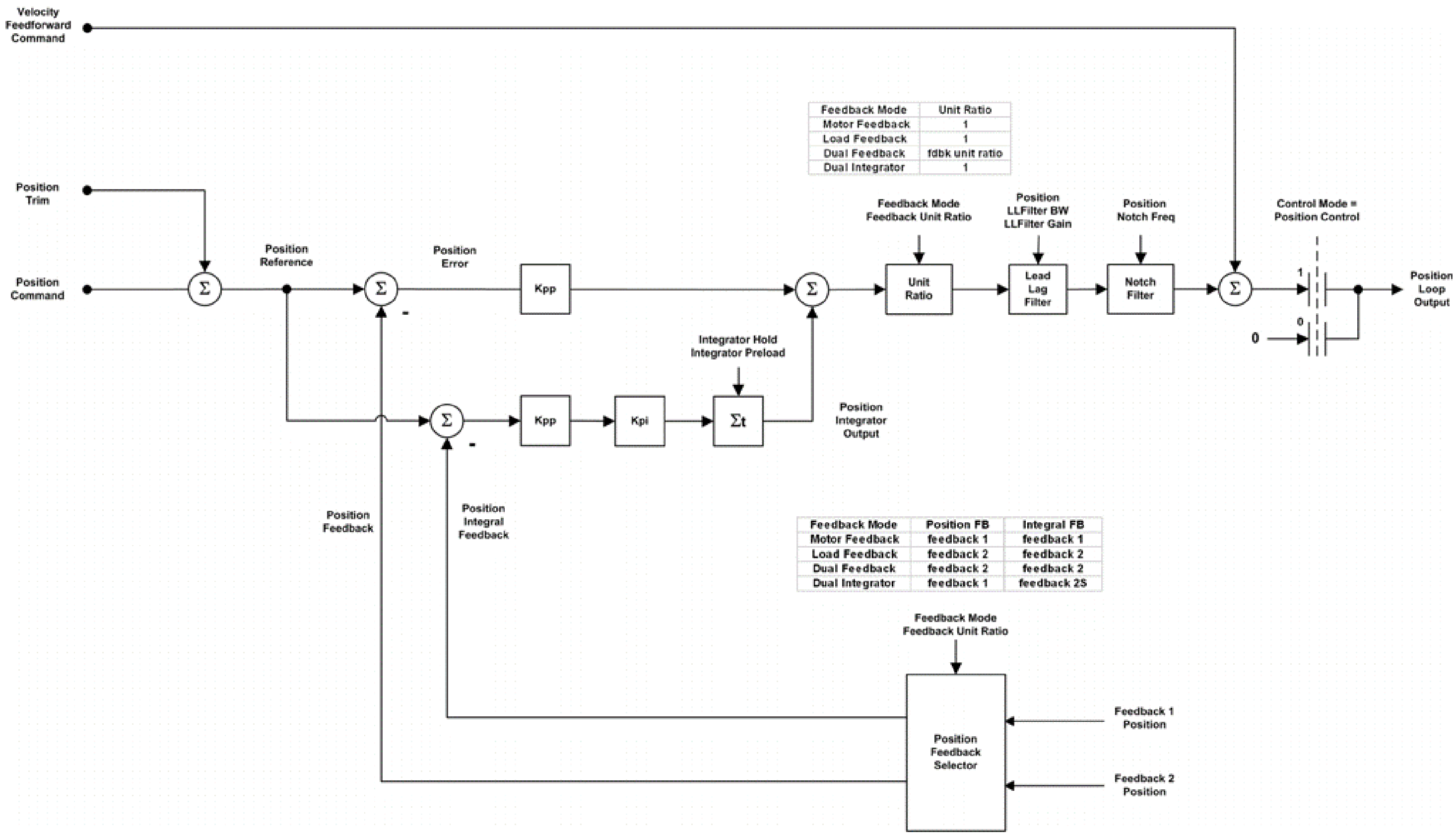
Load Transmission and Actuator Attributes on page 409

Rotary PM Motor Attributes on page 412

Position Control Behavior

In Position Control mode, the only operative Control Method supported is Closed Loop servo control. When performing closed loop Position Control, the device applies the Position Command signal output of the Command Generator to the position loop summing junction. In addition to the Position Command, a Position Trim input is provided that can be used to provide an offset to the position loop. The classic PI control loop generates a Position Loop Output signal to an inner velocity loop.

The following diagram provides an overview of the closed loop position control behavior model.



See also

[Position Feedback Selection](#) on [page 59](#)

[Position PI Gains](#) on [page 60](#)

[Velocity Feedforward](#) on [page 60](#)

[Position Loop Output Filters](#) on [page 61](#)

Position Feedback Selection

Feedback to the PI regulator can be derived from two different feedback channels. This flexibility allows the position loop to operate with either a motor based feedback device that is typically attached to the Feedback 1 channel or a load-side feedback device that is connected to the Feedback 2 channel. Which feedback source is used by the loop is governed by the Feedback Mode attribute.

When the Feedback Mode calls for Dual Feedback operation, the position loop utilizes the Feedback 2 channel and the velocity loop uses the Feedback 1 channel. Since the two feedback channels may not have the same feedback resolution, it is necessary to convert position loop output from Feedback 1 units to Feedback 2 units prior to applying the output to the velocity loop summing junction. This is done by scaling the position loop output using the Feedback Unit Ratio.

See also

Position Control Behavior on page 58

Position PI Gains

The Proportional Gain of the classic proportional-integral (PI) controller sets the unity gain bandwidth of the position loop in radians/second, while the Integral Gain is used to devise the Position Error signal to zero to compensate for the effect of any static and quasi-static torque or forces applied to the load.

See also

Position Control Behavior on page 58

Velocity Feedforward

The inner velocity loop requires a non-zero command input to generate steady-state axis motor velocity. To provide the non-zero output from the device to the motor, a non-zero position loop output is required, which translates to a non-zero position error.

This dynamic error between command position and actual position while moving is often called "following error". Most closed loop motion control applications require zero following error all of the time. This could be achieved to some extent through use of the position integral gain control, but typically the response time of the integrator action is too slow to be effective in high-performance motion control applications. An alternative approach that has superior dynamic response is to use Velocity Feedforward.

The Velocity Feedforward feature is used in Position Control mode to provide the bulk of the Velocity Reference input necessary to generate the desired motor velocity. It does this by scaling the Fine Velocity Command signal output of the Command Generator by the Velocity Feedforward Gain and adding the resultant Velocity Feedforward Command signal to the Position Loop Output generated by the position loop to form the Velocity Reference signal. With this feature, the position loop does not need to generate much effort to produce the required velocity command level, hence the Position Error value is significantly reduced. The Velocity Feedforward Command signal allows the following error of the position control loop to be reduced to nearly zero when running at a constant velocity. This is important in applications such as electronic gearing and synchronization applications where it is necessary that the actual axis position not significantly lag behind the commanded position at any time.

Theoretically, the optimal value for Velocity Feedforward Gain is 100%. In reality, however, the value may need to be adjusted to accommodate velocity loops with finite loop gain. One thing that may force a smaller Velocity Feedforward value is that increasing amounts of feedforward tend to exacerbate axis overshoot. For this reason feedforward is not recommended for point-to-point positioning applications.

See also

Position Control Behavior on page 58

Position Loop Output Filters on page 61

Position Loop Output Filters

A lead-lag filter is provided at the output of the position loop forward path. This filter can be used in the lead configuration to boost position loop bandwidth and increase the stiffness, for example, the ability to resist dynamic load disturbances.

$$G(s) = \frac{Kn*s + wn}{s + wn}$$

In this equation, Kn represents the Lead-Lag Filter Gain, or high frequency gain of the filter (the low frequency gain is always 1), and wn represents the Lead-Lag Filter Bandwidth associated with the pole of the filter:

- If Kn > 1, the filter provides lead compensation.
- If Kn < 1, the filter provides lag compensation.
- If Kn = 0 the lead-lag filter becomes a pure low pass filter.
- If Kn = 1, the filter is disabled.

Finally, a notch filter is included that has been shown to be effective in solving certain types mechanical compliance problems. The equation for this filter is as follows:

$$G(s) = \frac{s^2 + s* wn/(Q*A) + wn^2}{s^2 + s * wn/Q + wn^2}$$

In this equation, Q represents the sharpness of the notch, and A represents the attenuation depth of the notch. In most implementations, the sharpness, Q, and the attenuation depth, A, are hard-coded in the device. In PowerFlex drives the value of Q is 0.62 and the depth is set to 30.

See also

Position Control Behavior on page 58

State Behavior

The Motion Control Axis state model includes the following the states and state transitions.

Off State

This is the state of the Motion Control Axis with power off.

Self Test State

When power is applied to the controller, the controller typically goes through a series of self-test diagnostics. These tests include checking whether the CIP Motion axis is associated with an actual CIP Motion device and that the axis is also properly included in a collection of axes called a Motion Group. All axes in the Motion Group are processed synchronously by the controller's Motion Task.

If an associated CIP Motion device or Motion Group is not found for the axis, the axis state in the controller reflects this condition as No Device, and Not Grouped, respectively. The axis will remain in this state until the problem is corrected. Similarly, when power is applied to the device, or the device is reset, the device also goes through a series of self-test diagnostics and internal device parameters are set to their power-up default values. If unsuccessful, the impacted axis instances transition immediately to the Faulted state by declaring an Initialization Fault that is classified as Un-recoverable according to the terminology defined by the Identify Object. Clearing this fault can only be accomplished through a power cycle and is most likely the result of a device hardware problem.

Once these self tests have been completed successfully by the CIP Motion controller and the associated CIP Motion device, the axis state transitions to the Initializing state where CIP Motion connections are created and the devices are configured by the controller. From this point on, the Axis State value in the controller is influenced by the Axis State value in the device using the CIP Motion connection.

If the CIP Motion device supports stand-alone operation under local control with local configuration data, the device is free to transition from the Self-test state to the Pre-Charge state and on to the Stopped state. Should the device receive a subsequent Forward Open service to open a CIP Motion connection, the device will disable all axes and transition back to the Initializing state, following the state sequence outlined below.

If the device does not support stand-alone operation and depends on remote configuration data to be supplied over a CIP Motion connection, the device will transition to the Initializing state and wait (Standby) for the Forward Open service from the controller to open the CIP Motion Connection.

Initializing State

From the controller's perspective the Initializing state shown in the state models consists of 4 different axis sub-states, Unconnected, Configuring, Synchronizing, and Waiting for Group. While transitioning through these Initializing sub-states, the controller has no access to current Axis State value in the drive. Only after the controller's CIP Axis State completes the Initialization process, does the CIP Axis State value reflect the current Axis State attribute value in the CIP Motion device.

During the Initializing state, the device waits for the CIP Motion connections to the device to be established by the controller using a Forward Open service. Once the Forward Open service is successfully processed, the device initializes all attributes to their factory default values, resets all active faults, resets applicable axis status conditions including the shutdown bit, in preparation for device attribute configuration.

Once connections are established, the controller sends Set services to the device to set the Motion Device Axis Object configuration attributes to values stored in the controller. Any configuration error encountered during this process, such as "value out of range" or "value not applicable", are handled by the device by erring the Set service response. When the CIP Motion device is connected to one or more intelligent motor and feedback components that contain non-volatile configuration data associated with the component, this data will be read by the device prior to responding to related Set services from the controller. This allows the device the opportunity to validate the controller's motor and feedback related configuration data against the configuration data stored in the motor or feedback component. Any validation error encountered during this process will be handled by erring the Set service response with an "Invalid Attribute Value" code (09). Finally, reading the intelligent component data prior to completing the configuration process also allows the serial number of the component to be read by the controller to determine if the component has been replaced. The controller does not complete the configuration process (Configuration Complete) until all configuration attributes have been successfully acknowledged.

If the device supports synchronous operation, the controller then synchronizes with the device using the Group_Sync service. If the device has already been successfully configured, the CIP Axis State transitions to "Synchronizing" until it receives a successful Group_Sync service response.

After the device is fully configured and synchronized with the controller, the controller checks all other axes in the Motion Group to determine if they are also configured and synchronized. During this time, the CIP Axis State is "Waiting for Group". As soon as the controller determines that all axes in the Motion Group are configured and synchronized, Initialization is complete and the CIP Axis State value is thereafter derived directly from the Axis State value of the device in accordance to the state model defined in the Motion Device Axis Object.

If a problem is found during this initialization process, for example, a process that is beyond the scope of a Set service error, the device generates an Initialization Fault. An Initialization Fault is viewed as an unrecoverable fault, only a power cycle or a device reset can clear the fault condition.

If the CIP Motion connection is intentionally closed for any reason during operation using a Forward Close service, the device clears all active faults and returns to the Initializing State. If the CIP Motion connection is lost for any other reason during operation, the device generates a Node Fault and transitions to the

Major Faulted state. In either case the device will wait for the CIP Motion connections to the device to be re-established by the controller using a Forward Open service. Once re-established the controller's CIP Axis State will transition through the various Initialization sub-states.

The Initializing State is classified as an Identity Object Standby state and, therefore, requires that the associated power structure, if applicable, is disabled.

Pre-Charge State

During the Pre-Charge state, when applicable, the device is waiting for the DC Bus to fully charge (DC Bus Up status bit is clear). Once the DC Bus reaches an operational voltage level (DC Bus Up status bit is set), the axis either transitions to the Stopped state (drive axis) or to the Running state (converter axis). The device's power structure is always disabled in this state (Power Structure Enabled status bit clear). Any attempt for the controller to enable the device using the Axis Control mechanism while it is in the Pre-Charge state is reported back to the controller as an error in the Response Status and the axis remains in the Pre-Charge state.

The Pre-Charge State is classified as an Identity Object Standby state and, therefore, requires that the associated power structure, if applicable, is disabled.

Stopped State

In the Stopped state the device's inverter power structure will either be disabled and free of torque (Power Structure Enabled status bit clear) or held in a static condition using an active control loop (Power Structure Enabled status bit set). No motion can be initiated by the device in the Stopped State nor can the device respond to a planner generated command reference (Tracking Command status bit clear). In general, the axis will be at rest, but if an external force or torque is applied to the load, a brake may be needed to maintain the rest condition. In the Stopped state, main power is applied to the device and the DC Bus is at an operational voltage level. If there are any Start Inhibit conditions detected while in this state, the axis transitions to the Start Inhibited state. If an Enable request or one of the Run Test service requests is applied to an axis in the Stopped state, the motion axis transitions to the Starting state.

Starting State

When an Enable request is given to an axis in the Stopped, or Stopping state when performing a Flying Start, the axis immediately transitions to the Starting state. In this state, the device checks various conditions before transitioning to the Running state. These conditions can include Brake Release delay time and Induction Motor flux level. The device control and power structures are activated during the Starting state (Power Structure Enabled status bit set) but the command reference is set to a local static value and will not track the command reference derived from the motion planner (Tracking Command status bit clear). If all the starting conditions are met, the axis state transitions to either the Running state or the Testing state.

Running State

The Running state is where the work gets done. In this state, the device's power structure is active (Power Structure Enabled status bit set) and the selected Control Mode is enabled and actively tracking command data from the controller based or device based motion planner output to impact axis motion (Tracking Command status bit set). In the case of a Feedback Only Control Mode, the Running state simply indicates that the feedback device is fully operational. The motion axis remains in the Running state until either a fault occurs or it is explicitly commanded to stop using an Axis Control request.

In the case of an axis with no active control function (Control Mode = No Control), the Running state simply indicates that the feedback device is fully operational (Power Structure Enabled and the Tracking Command status bits clear). The motion axis remains in the Running state until either a fault occurs or it is explicitly commanded to Shutdown using an Axis Control request.

Testing State

When any one of the Run Test request services is sent to the motion axis while in the Stopped state, for example, services that require an active power structure to execute, the axis immediately transitions to the Starting State (Power Structure Enabled status bit set), and then once the Starting conditions are met, the axis transitions to the Testing state. This Testing state is like the Running state in that the device's power structure is active, but in the Testing state one of the device's built-in test algorithms is controlling the motor, not command data from a motion planner (Tracking Command status bit clear). In the Testing state the device excites the motor in various ways while performing measurements to determine characteristics of the motor and load. The motion axis remains in this state for the duration of the requested test procedure and then stops and returns to the Stopped state. The motion axis can also exit the Testing state by either a fault or an explicit Axis Control request. In all these exit cases, the device executes a Category 0 Stopping Sequence.

Start Inhibited State

The Start Inhibited state is the same as the Stopped state with the exception that the axis has one or more 'start inhibit' conditions that prevent it from successfully transitioning to the Starting state. These conditions can be found in the Start Inhibits attributes. Once corrected, the axis state automatically transitions back to the Stopped state.

For an axis with no active control function (Control Mode = No Control), an axis in the Start Inhibited state is prevented from transitioning to the Running state by one or more specific conditions, such as when the associated feedback device is not fully configured for operation. Again, once corrected, the axis state automatically transitions to the Running state.

The Start Inhibited State is classified as an Identity Object Standby state and, therefore, requires that the associated power structure, if applicable, is disabled.

Stopping State

When a Disable request is issued to the Motion Device Axis Object in the Starting, Running or the Testing states, the axis immediately transitions to the Stopping state. In this state, the axis is in the process of stopping and is no longer tracking command data from the motion planner (Tracking Command status bit clear). A Disable Request executes the configured Stopping Actions while a Shutdown Request executes the configured Shutdown Action.

There are many different Stopping Actions supported by the Motion Device Axis Object. Each of these Stopping Actions executes one of three possible IEC60204-1 Category Stops or Stopping Sequences (Category Stop 0, 1, and 2). Most of these Stopping Actions actively decelerate the axis to a stop (Category Stop 1 and 2). The power structure may remain active (Power Structure Enabled status bit set) as long as the Stopping Action procedure takes to complete. Once the selected Stopping Action procedure has completed, the axis transitions to the Stopped state. When the Stopping Action of "Disable and Coast" is initiated by a Disable Request or a Shutdown Action, the power structure is immediately disabled (Power Structure Enabled status bit clear) and the axis coasts to a stop while in the Stopping state (Category 0 Stop). For all Stopping Sequences, the device will wait until the axis has reached zero speed, or a timeout occurs (as defined by the Stopping Time Limit and Coasting Time Limit attributes), before transitioning to the Stopped state. In some cases, such as when the axis is stationary, this transition can be immediate. The criteria for zero speed is based on Velocity Feedback being less than 1% of motor rated speed or by criteria set by optional Zero Speed and Zero Speed Time attribute values. In the case of a Frequency Control drive device, the criteria are based on Velocity Reference rather than Velocity Feedback.

When an Enable Request is given to an axis in the Stopping state with Flying Start Enabled, the axis will immediately transition to the Starting state.

Aborting State

When a Major Fault occurs in the motion device while the axis is in either the Starting, Running, Testing, or Stopping states, the motion axis immediately transitions to the Aborting state. In this state, the axis is in the process of stopping and is no longer tracking command data from the motion planner (Tracking Command status bit clear). The Aborting state executes the appropriate stopping action as specified by the device vendor. When actively stopping the axis in the

Aborting state, the power structure remains active (Power Structure Enabled status bit set) as long as the stopping action takes to complete. In some cases, the power structure must be immediately disabled so the axis may coast to a stop while in the Aborting state. In any case, the drive will wait until the axis has reached zero speed before transitioning to the Major Faulted state. Once the stopping procedure is complete and the axis has reached zero speed, the axis transitions to the Faulted state. The criteria for zero speed is based on Velocity Feedback being less than 1% of motor rated speed or by criteria set by optional Zero Speed and Zero Speed Time attribute values. In the case of a Frequency Control drive device, Velocity Reference is used rather than Velocity Feedback. In some cases, such as when the axis is stationary, this transition can be immediate.

When faults conditions are detected in the controller that are not visible to the motion device, or when the motion device reports a Minor Fault condition, the controller is responsible for bringing the axis to a stop, either directly using an Axis Control state change request or motion planner stop, or indirectly using a fault handler in the user program. If the Axis State reported by the motion device is Stopping, then the controller sets the CIP Axis State to Aborting based on the presence of the fault condition.

When an Abort Request is issued to the Motion Device Axis Object a Controller Initiated Exception is generated. If the associated Axis Exception Action is set to generate a Major Fault the drive stops the axis according to the configured Stopping Action before transitioning to the Faulted state.

Faulted State

The Motion Device Axis Object defines a Major Faulted state that is identical to the Stopped state (or, if a Shutdown fault action was initiated, the Shutdown state) with the exception that there are one or more Faults active. In other words, a Major Faulted axis is a Stopped (or Shutdown) axis with a Major Fault condition present. The Motion Device Axis Object also defines a Minor Fault as a fault that allows device operation to continue and does not impact the Axis State in the motion device.

There is no such distinction between Major Fault and Minor Fault in the controller; both Major Faults and Minor Faults reported by the drive result in the axis transitioning to the Faulted state in the controller. Thus, in the controller it is not generally true that a Faulted axis is a Stopped (or Shutdown) axis with a Fault condition present. When the motion device reports a Minor Fault condition, or when fault conditions are detected in the controller that are not visible to the motion device, the controller is responsible for bringing the axis to a stop, either directly using an Axis Control state change request or motion planner stop, or indirectly using a fault handler in the user program. Until this is done, the Axis State in the motion device may be something other than the Major Faulted state, perhaps even in the Running state. This is reasonable given that the motion device is only one component in a much bigger motion control system. The CIP Motion controller is responsible for rolling up all the conditions of the system into the Axis State that is presented to you.

Since faults are latched conditions, a Fault Reset is required to clear the faults and, assuming the original fault condition has been removed, the axis transitions to the Axis State of motion device. There are many different sources of Faults: CIP Initialization Faults, CIP Axis Faults, Motion Faults, Module Faults, Group Faults, Safety Faults, and Configuration Faults. The following table describes the sources of these faults:

Fault	Source
CIP Initialization Faults	These faults can only occur during the Initializing state. You cannot generate an Initialization fault in any other state of the drive, for example, faults occurring during operation of the drive after transitioning out of the Initializing state. Initialization Faults can apply to a specific axis or to the entire drive, in which case all device axis instances would indicate the Initialization Fault. The device power structure, if applicable, is disabled when there is a CIP Initialization Fault present.
CIP Axis Faults	As the name implies, CIP Axis Faults apply to a specific device axis instances. CIP Axis Faults are the direct result of Axis Exceptions that are configured to generate a Fault response. These exception conditions may apply to individual axis instances or to all axis instances. In any case, applications may require the device be configured to handle these exceptions differently for different axes. Run time conditions related to Motor, Inverter, Converter, Bus Regulator, and Feedback components, in general, shall be handled as Axis Exceptions. The power structure if applicable, may or may not be disabled when there is a CIP Axis Fault present depending on the specific stopping action applied by the device in response to the fault condition.
Axis Safety Faults	Axis Safety Faults also apply to specific axis instances. Safety Faults are reported by the embedded Safety Core of the device that is responsible for monitoring the condition of various critical safety functions associated with the axis. This embedded Safety Core has a CIP Safety connection to an external Safety Controller. When an Axis Safety Fault occurs, the safety system is responsible for forcing the axis into a Safe State.
Guard Faults	These faults also apply to a specific axis instance. Guard Faults are generated by a fault condition detected in the drive's "Hardwired" safety monitor functionality (SMSC). This component of the drive is designed to monitor various critical safety functions of the drive and put the axis in a safe state if any monitored condition fails to operate nominally.
Motion Faults	These faults are generally associated with fault conditions generated by the motion planner function. These faults can include conditions related to the input (for example, actual position) and output (command position) signals to the motion planner. The device power structure, if applicable, may or may not be disabled when there is a Motion Fault present depending on the specific stopping action applied by the system in response to the fault condition.
Module Faults	These faults apply to the entire motion device and affect all axes associated with that device. These faults can occur at any time during device operation. Module Faults include all Node Faults reported by the device, which are primarily communication faults, but can include general hardware faults where these fault conditions are checked during run-time. A CPU watchdog fault would be an example of a hardware CIP Node Fault. Module Faults also include communication fault conditions detected on the controller side of the motion connection. An example of a controller side Module Fault would be the Control Sync Fault. The device power structure, if applicable, is disabled when there is a Module Fault present with the controller initiating the equivalent of a shutdown fault action.

Fault	Source
Group Faults	These faults are related to the motion group object function and affect all axes associated with the motion group. These faults can occur at any time during device operation. Group Fault conditions are detected by controller and are generally associated with the time synchronization function that is common to all axes in the motion group. The device power structure, if applicable, of every axis associated with the motion group is disabled when there is a Group Fault present with the controller initiating shutdown fault actions.
Configuration Faults	A configuration fault is generated anytime there is an error in sending configuration data to the motion device. Specifically, if the motion device responds to a Set Attribute service with an error, the error condition is reflected as a Configuration Fault along with the Attribute Error Code and Attribute ID. The device power structure, if applicable, is disabled when there is a Configuration Fault present.

Shutdown State

When a Shutdown request is issued to the device or a Shutdown fault action is executed by the device, the targeted axis transitions to the Shutdown state. In the case of a Shutdown request, the axis immediately transitions from whatever state it is currently in to the Shutdown state. The Shutdown state has the same basic characteristics of the Stopped state except that it can be configured using the Shutdown Action attribute to drop the DC Bus power to the device's power structure. This is generally done by opening an AC Contactor Enable output provided by the drive that controls power to the converter. Regardless of whether or not DC Bus power is disconnected, this state requires an explicit Shutdown Reset request from the controller to transition to the Pre-Charge state. If the device is configured to keep the DC Bus power active while in the Shutdown state then the motion axis transitions through the Pre-Charge state to the Stopped state. The Shutdown state offers an extra level of safety against unexpected motion.

In the case where a Shutdown fault action is initiated by the drive in response to an exception condition that is configured to be a Major Fault, the device executes the Shutdown action, but the axis goes to the Faulted state, not the Shutdown state. Similarly, when the axis is in the Shutdown state and a major fault condition occurs, the axis transitions to the Faulted state. In other words, the major fault condition has precedence over the shutdown condition and the shutdown condition can be considered a sub-state. In either of these cases a Fault Reset request from the controller clears the fault and, assuming the original fault condition has been removed, the axis then transitions to the Shutdown state. A Shutdown Reset request from the controller, however, both clears the fault and performs a shutdown reset so, assuming the original fault condition has been removed, the axis transitions to the Pre-Charge state as described above.

In addition to the Shutdown action functionality, the Shutdown state can also be used by the controller to disable any slave gearing or camming motion planner functions that reference this device axis as a master axis. For this reason, the Shutdown state is supported in the case of a Feedback Only Control Mode where the axis instance is simply associated with a feedback device.

The Shutdown State is classified as an Identity Object Standby state and, therefore, requires that the associated power structure, if applicable, is disabled.

No Device State

If the CIP Motion axis instance in the controller is created, but not currently associated with a CIP Motion device, the axis state indicates the No Device state. A CIP Motion axis will be associated with a physical CIP Motion device to function. This condition is checked during the controller Self Test state as qualification for transition to the Initializing state. For this reason the No Device state is considered a controller only sub-state of the Self Test state.

Not Grouped State

If a CIP Motion axis instance is created and not associated with a Motion Group, the axis state is set to the Not Grouped state. A CIP Motion axis will be assigned to a Motion Group in order for the axis instance to be updated by the periodic Motion Task and carry out its function. This condition is checked during the controller Self Test state as qualification for transition to the Initializing state. For this reason, the Not Grouped state is considered a controller only sub-state of the Self Test state.

Axis Inhibited State

If you Inhibit the axis instance for any reason, the associated instance in the CIP Motion connection is eliminated and the axis state transitions to the Axis Inhibited state. If this is the only instance supported by the CIP Motion connection, the connection itself will be closed. The Axis Inhibited state is a controller only sub state of the Self Test state. The Axis Inhibited condition is checked during the controller Self Test state as qualification for transition to the Initializing state. If currently Axis Inhibited, an Un-Inhibit operation will be performed by you to transition to the Initializing state and restore axis function.

Configuring State

Once a CIP Motion I/O connection has been made to the device, the controller begins to send configuration data using the connection's service channel. At this time the axis state transitions from Unconnected to Configuring. The axis state will remain in the Configuring state until the values of all applicable configuration attributes in the device have been set for this axis instance, or until a configuration fault occurs, in which case the axis state transitions to the Faulted state.

Synchronizing State

If the device has not been synchronized to the controller by the time the controller has completed the axis configuration process, the axis state transitions to the Synchronizing state. The axis state will remain in the Synchronizing state until the device has been successfully synchronized as indicated by a successful Group_Sync service response from the device, or a time limit (~60 seconds) is reached, in which case the controller closes the connection and starts the Initialization process over again.

Waiting for Group State

After configuring the axis and synchronizing the device to the controller, the controller checks the status of all other axes in the Motion Group. If there are any other axes in the Motion Group that are still being configured or synchronized, the Axis State will transition to Waiting for Group. Cyclic data exchange over the CIP Motion connection does not occur until all axes in the Motion Group are configured and synchronized. Once all axes in the Motion Group are configured and synchronized, the CIP Axis State transitions to the current Axis State attribute value in the device, typically Pre-Charge or Stopped.

See also

Fault and Alarm Behavior on page 41

Exceptions on page 41

Motion Control Axis Behavior Model on page 51

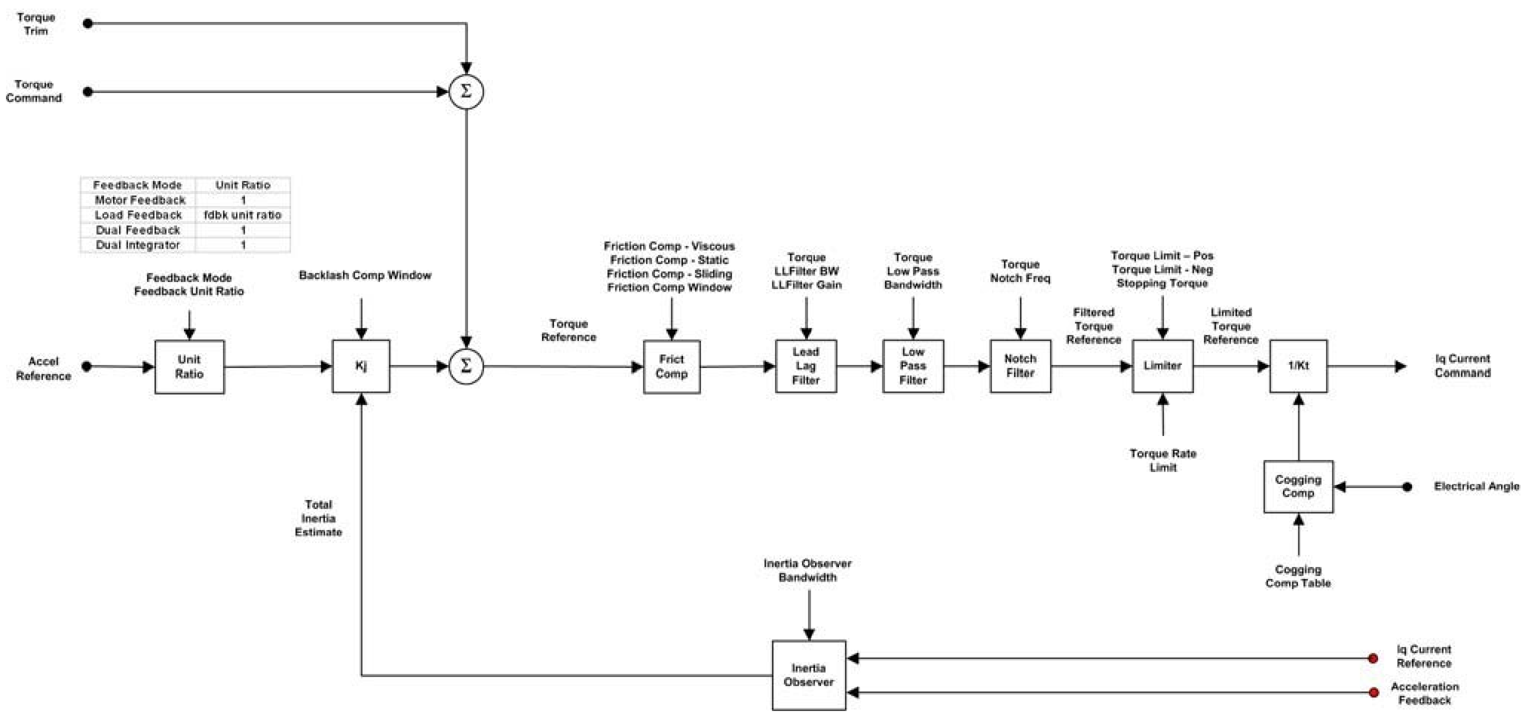
Stopping and Braking Attributes on page 431

Torque Control Behavior

Torque is generally proportional to acceleration and to the torque producing motor current, Iq. The purpose of the Torque Control structure is to combine input signals to create a Torque Reference. The Torque Reference, from a variety of sources, is based on the Control Mode. It applies various filters and compensation algorithms to the Torque Reference to create a Filtered Torque Reference.

The Filtered Torque Reference signal is scaled by the reciprocal of the torque constant, Kt, of the motor to become the Iq Current Command input to the current loop. Because the motor current is also per unitized to the '% Rated' current of the motor, the torque constant, Kt, is nominally 1. In other words, in general it is assumed that 100% rated current produces 100% rated torque.

The following diagram provides an overview of the torque control behavior model:



See also

[Torque Input Sources](#) on [page 72](#)

[Inertia Compensation](#) on [page 73](#)

[Friction Compensation](#) on [page 75](#)

[Torque Filters](#) on [page 77](#)

[Torque Limiter](#) on [page 78](#)

Torque Input Sources

The Torque Control model can take input from a variety of sources depending on the Control Mode. Input to the Torque Reference path can come through the cyclic Torque Command or Torque Trim signal in Torque Control mode. In Position or Velocity Control mode, torque input is derived from the outer velocity loop or acceleration loop by bringing in the resulting acceleration signals and scaling these signals into equivalent torque.

Acceleration to Torque Scaling

Because the acceleration input signals into the Torque Control section are expressed in units of acceleration, a scaling factor, Kj, is needed to convert acceleration units to torque % Rated Torque units. This scaling factor, when properly configured, represents the total System Inertia or mass of the system that includes the motor and the load and has the effect of canceling the effects the system inertia/mass has on control loop response and loop gain settings.

Because the torque units are expressed as % of Rated Torque of the motor, the units for the System Inertia attribute are % Rated per Motor Units/Sec^2.

The acceleration units can be expressed in Feedback 1 or Feedback 2 Units based on the Feedback Mode setting. Therefore, in the case where Feedback 2 applies, the acceleration signal needs to be scaled by the Feedback Unit Ratio as shown by the Unit Ratio.

See also

Torque Control Behavior on page 71

Inertia Compensation on page 73

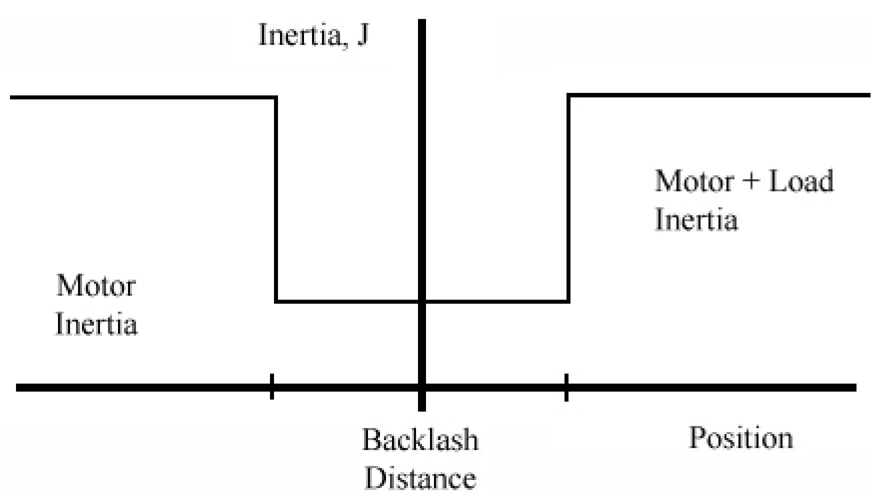
Inertia Compensation

Inertia compensation features are included in the Torque Control behavior model.

Backlash Compensation

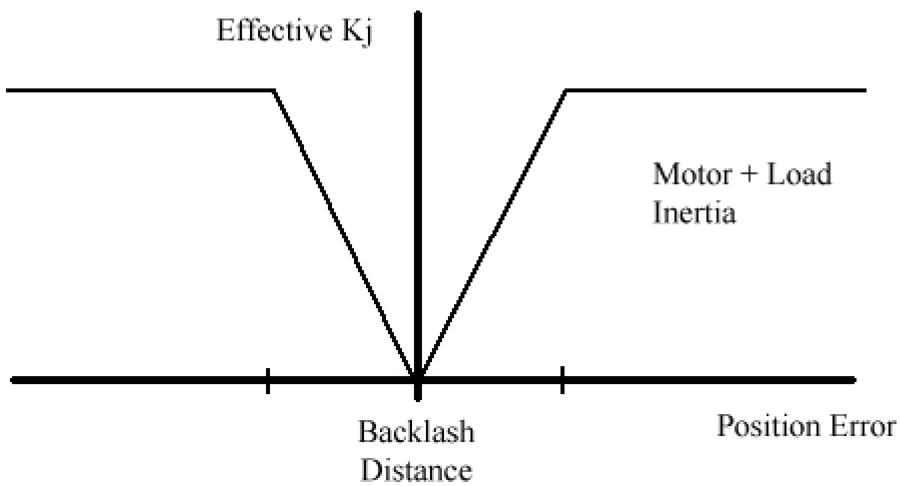
Backlash Compensation is used to stabilize the device control loop behavior in applications with high load inertia ratios and mechanical backlash.

The Backlash Compensation Window attribute is used to control the Backlash Compensation feature. Mechanical backlash is a common problem in applications that use mechanical gearboxes. The problem stems from the fact that until the input gear is turned to the point where its proximal tooth contacts an adjacent tooth of the output gear, the reflected inertia of the output is not felt at the motor. In other words, when the gear teeth are not engaged, the system inertia is reduced to the motor inertia.



If the Velocity Control loop is tuned for peak performance with the load applied, the axis will be, at best, under-damped and, at worst, unstable in the condition where the gear teeth are not engaged. In the worst case scenario, the motor axis and the input gear oscillates wildly between the limits imposed by the output gear teeth. The net effect is a loud buzzing sound when the axis is at rest, commonly referred to as 'gearbox chatter'. If this situation persists, the gearbox will wear out prematurely. To prevent this condition, the conventional approach is to de-tune the velocity loop so that the axis is stable without the gearbox load applied. Unfortunately, system performance suffers.

With a Backlash Stabilization Window value commensurate with the amount of backlash in the mechanical system, the backlash stabilization algorithm is very effective in eliminating backlash-induced instability while still maintaining full system bandwidth. The key to this algorithm is a tapered Kj profile that is a function of the position error of the position loop, illustrated in the following diagram.



The reason for the tapered profile, as opposed to a step profile, is that when the position error exceeds the backlash distance a step profile would create a very large discontinuity in the torque output. This repulsing torque tends to slam the axis back against the opposite gear tooth and perpetuate the buzzing effect. The tapered profile can be qualified to run only when the acceleration command or the velocity command to the control loop structure is zero, for example, when not commanding motion that would engage the teeth of the gearbox.

Properly configured with a suitable value for the Backlash Compensation Window, this algorithm entirely eliminates the gearbox buzz without sacrificing any servo performance. The Backlash Compensation Window parameter determines the width of the window over which backlash stabilization is applied. In general, this value is set equal to or greater than the measured backlash distance. A Backlash Stabilization Window value of zero effectively disables the feature.

Inertia Observer

The Inertia Observer, when enabled, monitors the acceleration of the axis in relationship to the torque producing current command, Iq Current Reference, and estimates the total motor inertia.

The Total Inertia Estimate for the Inertia Observer is fed back to the Kj gain to provide automatic gain control (AGC) with respect to load inertia. This feature can be used to compensate for inertia variation without compromising system performance. The Inertia Observer works on the premise that the motor and load are not subject to externally applied torques or forces that could impact the acceleration of the load. By contrast, the Load Observer in the Acceleration Control behavior model works on the premise that changes in acceleration are due to externally applied torques/forces on the motor and load. Thus, the operation of these two observers are mutually exclusive; they should not be enabled at the same time.

See also

Friction Compensation on page 75

Torque Control Behavior on page 71

Friction Compensation

Friction Compensation applies a compensating directional torque or force to the motor to overcome the effects of friction in the mechanical system, thus minimizing the amount of control effort required. Individual attributes have been defined to support compensation for static friction, sliding (Coulomb) friction, and viscous friction. A compensation window attribute is also provided to mitigate motor dithering associated with conventional friction compensation methods

Static Friction Compensation

It is not unusual for an axis to have enough static friction, commonly called 'sticktion', in Position Control applications that even with a significant position error, the mechanical system refuses to budge. Of course, position integral gain can be used to generate enough output to the drive to correct the error, but this approach may not be responsive enough for the application. An alternative is to use Static Friction Compensation to break the sticktion in the presence of a non-zero position error. This is done by adding, or subtracting, a fixed torque level, as determined by the Static Friction Compensation attribute, to the Torque Reference signal value based on its current sign. This form of friction compensation is applied only when the axis is static, for example, when there is no change in the position command.

The Static Friction Compensation value must be just under the value that would overcome the sticktion. A larger value results in axis 'dither', a phenomena describing a rapid back and forth motion of the axis centered on the commanded position as it overcompensates for the sticktion.

To address the issue of dither when applying Static Friction Compensation, a Friction Compensation Window is applied around the current command position when the axis is at rest. If the actual position is within the Friction Compensation Window, the Static Friction Compensation value is applied to the Servo Output, but scaled by the ratio of the Position Error signal to the Friction Compensation Window. Within the window, the position loop and velocity loop integrators are also disabled to avoid the hunting effect that occurs when the integrators wind up. Thus, once the position error reaches or exceeds the value of the Friction Compensation Window attribute, the full Static Friction Compensation value is applied. Of course, when the Friction Compensation Window be set to zero, this feature is effectively disabled.

A non-zero Friction Compensation Window has the effect of softening the Static Friction Compensation as it's applied to the Torque Reference and reducing the dithering and hunting effects that it can create. This feature generally allows higher values of Static Friction Compensation to be applied, resulting in better point-to-point positioning.

Sliding Friction Compensation

Sliding friction or Coulomb friction, by definition, is the component of friction that is independent of speed as long as the mechanical system is moving. Sliding friction is always less than static friction for a given mechanical system. The method of compensating for sliding friction is basically the same as that for static friction, but the torque level added to the Torque Reference is less than that applied to overcome static friction and is determined by the Sliding Friction Compensation attribute. Sliding Friction Compensation is applied only when the axis is being commanded to move.

Viscous Friction Compensation

Viscous friction, by definition, is the component of friction that increases linearly with the speed of the mechanical system. The method of compensating for viscous friction is to multiply the configured Viscous Friction Compensation value by the speed of the motor and apply the result to the Torque Reference signal. Viscous Friction Compensation is applied only when the axis is being commanded to move.

See also

Torque Filters on page 77

Torque Control Behavior on page 71

Torque filters

The following filters can be applied to provide additional compensation and control to the torque value.

Lead-Lag Filter

A lead-lag filter is provided in the torque reference path. This filter can be used in the lead configuration to boost velocity or acceleration loop bandwidth, or in the lag configuration to compensate the high frequency gain boost associated with compliant load mechanics.

$$G(s) = \frac{Kn*s + wn}{s + wn}$$

In this equation, Kn represents the Lead-Lag Filter Gain, or high frequency gain of the filter (the low frequency gain is always 1), and wn represents the Lead-Lag Filter Bandwidth associated with the pole of the filter:

- If Kn > 1, the filter provides lead compensation.
- If Kn < 1, the filter provides lag compensation.
- If Kn = 0 the lead-lag filter becomes a pure low pass filter.
- If Kn = 1, the filter is disabled.

When used as a lag filter (Kn < 1), this filter can be effective in compensating for the gain boosting effect of natural mechanical resonance frequencies that are within the acceleration/velocity loop bandwidth.

Low Pass Filter

The Low Pass Filter is effective in resonance control when the natural resonance frequency is much higher (>5x) than the control loop bandwidth. This filter works by reducing the amount of high-frequency energy in the device output that excite the natural resonance. The Low Pass Filter design can be single pole or multiple poles. Care should be taken, however, to limit the amount of phase lag introduced by this filter to the control loop to avoid potential instability.

Notch Filter

The notch filters are effective in resonance control when the natural resonance frequency is higher than the control loop bandwidth. Like the Low Pass filter, the notch filter works by significantly reducing the amount of energy in the device output that can excite the natural resonance. It can be used even when the natural resonance frequency is relatively close to the control loop bandwidth. That is because the phase lag introduced by the notch filter is localized around the notch frequency. For the notch filter to be effective, the Notch Filter Frequency has to be set very close to the natural resonance frequency of the load.

A typical equation for the notch filter is as follows:

$$G(s) = \frac{s^2 + s^* wn/(Q^*A) + wn^2}{s^2 + s * wn/Q + wn^2}$$

In this equation, Q represents the sharpness of the notch. In most implementations, the sharpness, Q, is typically hard-coded in the device. The attenuation depth of the notch filter is infinite.

See also

Torque Limiters on page 78

Torque Control Behavior on page 71

Torque Limiter

After undergoing friction compensation and filtering the Torque Reference signal passes through a limiter to produce the Limited Torque Reference signal. The Torque Limiter applies a torque limit to the signal that is based on the sign of the torque reference signal input and the state of the axis.

During normal operation it is the Torque Limit – Positive and Torque Limit – Negative attributes, set by the user, that are applied to the torque reference signal. When the axis is commanded to stop as part of a disable request or major fault condition, the device applies the Stopping Torque Limit.

Also included with the torque limiter is a built-in Torque Rate of Change Limit. This feature limits the rate of change of the torque reference output.

See also

Torque to Current Scaling on page 78

Torque Control Behavior on page 71

Torque to Current Scaling

The final result of all this torque signal filtering, compensation, and limiting functionality is the Filtered Torque Reference signal. When the signal is scaled by the reciprocal of the Torque Constant of the motor, 1/Kt, it becomes the torque producing Iq Current Command signal to the current loop.

Ideally, the relationship between motor torque and motor current is independent of position, time, current, and environmental conditions, the 1/Kt scaling has a nominal value of 1, so that 100% rated torque translates to 100% rated current. In practice, this may not be the case. Compensation can be applied to the 1/Kt value to address these issues at the drive vendors' discretion.

Cogging Compensation

For PM motors, one of the more troublesome Kt variations to contend with is a position dependent variation to Kt known as motor cogging. The Kt scaling factor can be used to compensate for motor cogging by performing a test on the motor that generates a Kt versus Electrical Angle Cogging Compensation table. This table can then be used to compensate for the cogging impact in real- time based on the electrical angle of the motor resulting in smoother motor operation.

See also

[Torque Control Behavior on page 71](#)

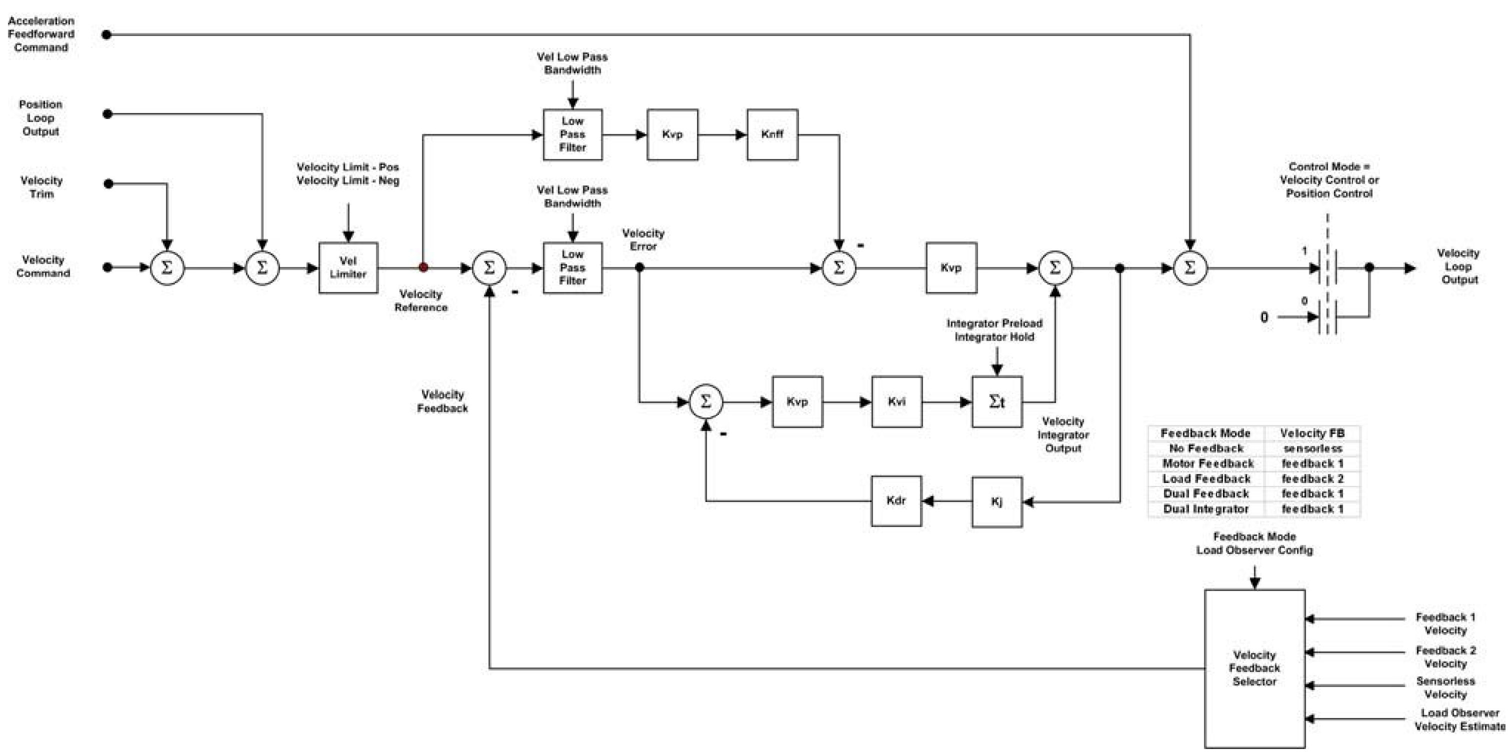
[Velocity Control Behavior on page 79](#)

Velocity Control Behavior

In Velocity Control mode, there are two operative control methods supported, Closed Loop Velocity Control and Open Loop Frequency Control.

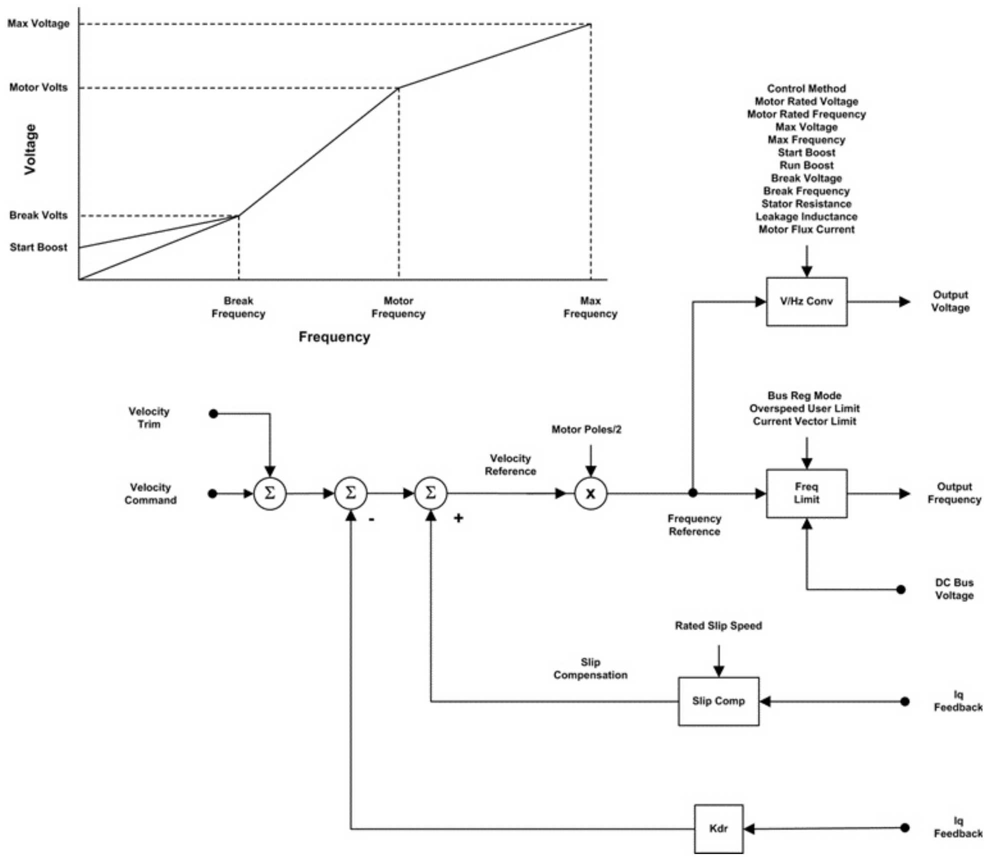
Closed Loop Velocity Control model

Targeted for applications that require tight speed regulation. The following diagram provides an overview of this method.



Open Loop Frequency Control model

Associated with drives that do not have a current control loop and typically drive an induction motor, also known as Volts/Hertz or Variable Frequency Drives (VFDs). The following diagram provides an overview of this method.



See also

Closed Loop Velocity Control on page 80

Open Loop Frequency Control on page 83

Closed Loop Velocity Control

The Closed Loop Velocity Control method is targeted for applications that require tight speed regulation. The command input to the velocity loop can be derived directly from the Velocity Command of the Command Generator when configured for Velocity Control Mode or from the Position Loop Output when configured for Position Control Mode.

When serving as an outer velocity loop in Velocity Control Mode, the device applies the Velocity Command input to the velocity command summing junction to generate the Velocity Reference signal into a PI regulator. Contributing to the velocity command summing junction also is the Velocity Trim input, which can be used in conjunction with an outer control loop to make minor adjustments to the velocity of the motor.

When serving as an inner velocity loop in Position Control Mode, the device applies the Position Loop Output signal to the input of the velocity command summing junction. Input signals that are not applicable to the configured control mode are generally set to zero.

Velocity Limiter

The output of the velocity command summing junction signal passes through a limiter to produce the Velocity Reference signal into the velocity loop. The Velocity Limiter applies a directional velocity limit, either Velocity Limit - Pos or Velocity Limit - Neg, to the velocity command signal input that is based on the sign.

Velocity Feedback Selection

Feedback to the PI regulator can be derived from either of the two available feedback transducers, Feedback 1 or Feedback 2. Which feedback source is used by the loop is governed by the Feedback Mode enumeration. If Feedback Mode is No Feedback, indicating sensorless operation, the Velocity Feedback signal is estimated by the Sensorless Velocity signal generated by the sensorless control algorithm. If an optional Load Observer is configured for Velocity Estimate operation, the Velocity Feedback signal is the Load Observer Velocity Estimate.

Velocity Error Filter

A low pass filter can be optionally applied to the velocity error signal generated by the velocity loop summing junction. The output of this filter becomes the Velocity Error signal that is subsequently operated on by the velocity loop PI control algorithm. When used, the filter is typically set between 5 to 10 times the velocity loop bandwidth. It is recommended that this filter be a two pole IIR filter to maximum its effectiveness at quantization noise filtering.

Velocity Gains

The velocity loop generates a Velocity Loop Output signal to the next inner loop through a PI control loop structure. The Proportional Gain of the controller sets the unity gain bandwidth of the velocity loop in radians/second, while the Integral Gain is used to drive the Velocity Error signal to zero to compensate for any static and quasi-static torque or forces applied to the load. The integrator path includes a Proportional Gain so that units of the Integral Gain represent the bandwidth of the integrator in radians/second.

The integral section of the velocity regulator includes an anti-windup feature. The anti-windup feature automatically holds the regulator's integral term when a limit condition is reached in the forward path. The anti-windup feature is conditioned by the arithmetic sign of the integrator's input. The integrator is held when the input's sign is such that the integrator output moves further into the active limit. In other words, the integrator is allowed to operate (not held) when the input would tend to bring the integrator output value off the active limit.

The integrator may also be configured for integrator hold operation. When the Integrator Hold attribute is set true, the regulator holds the integrator from accumulating while the axis is being commanded to move. This behavior is helpful in point-to-point positioning applications.

An automatic preset feature of the velocity regulator's integral term occurs when a transition is made from a Torque Control mode to speed control, by using the Control Mode selection parameter. Upon transition to speed mode, the speed regulator's integral term is preset to the motor torque reference parameter. If the speed error is small, this provides a 'bumpless' transition from the last torque reference value present just prior to entering speed mode.

Negative Feedforward

Aside from the normal PI control elements, a negative feedforward gain (Knff) is provided to adjust the time response of the velocity regulator. Knff has a range of 0…100%, where 0 disables the function. A value of 30% results in little noticeable overshoot in the speed response to a step input. This can be easily observed when the motor speed is ramped to zero. The effect of negative feedforward is to eliminate backup of the motor shaft. The Knff gain setting has no effect on the stability of the speed regulator. A disadvantage of by using negative feedforward is that it results in a time lag in feedback response to a reference ramp input.

Velocity Droop

Another feature of the velocity regulator is the velocity droop function. The velocity error input to the integral term is reduced by a fraction of the velocity regulator's output, as controlled by the droop gain setting, Kdr. As torque loading on the motor increases, actual motor speed is reduced in proportion to the droop gain. This is helpful when some level of compliance is required due to rigid mechanical coupling between two motors.

Acceleration Feedforward

The velocity loop requires a non-zero velocity loop output to generate steady- state axis motor acceleration. To provide the non-zero output from the drive to the motor, a non-zero velocity error is generally required. In Position Control applications, this non-zero velocity error translates to a non-zero position loop error.

Because many closed loop motion control applications require near zero control loop error, this behavior is not desirable. Again, the position and velocity loop error could be reduced by applying the velocity integral gain control as described above, but the integrator action is still too slow to be very effective. The preferred approach with superior dynamic response is to use Acceleration Feedforward.

The Acceleration Feedforward feature is used to generate the bulk of the Acceleration Reference necessary to generate the commanded acceleration. It does this by scaling the Fine Acceleration Feedforward generated by the Command Generator by the Acceleration Feedforward Gain and adding the resultant Acceleration Feedforward Command signal as an offset to the output of the velocity loop. With this feature, the velocity loop does not need to generate much control effort, thus reducing the amount of control loop error.

Theoretically, the optimal value for Acceleration Feedforward is 100%. In reality, however, the value may need to be adjusted to accommodate variations in load inertia and the torque constant of the motor. Like Velocity Feedforward, Acceleration Feedforward can result in overshoot behavior and should not be used in point-to-point positioning applications.

When used in conjunction with Velocity Feedforward, Acceleration Feedforward allows the following error of the position or Velocity Control loop to be reduced to nearly zero during the acceleration and deceleration phases of motion. This is important in tracking applications that use electronic gearing and camming operations to precisely synchronize a slave axis to the movements of a master axis.

See also

Position Control Behavior on page 58

Velocity Feedforward on page 60

Open Loop Frequency Control

Another Velocity Control method is the open loop Frequency Control method associated with so called Volts/Hertz or Variable Frequency Drives (VFDs) that do not have a current control loop and typically drive an induction motor.

Velocity control with this method is achieved by controlling the voltage and frequency output of the drive device in some manner where voltage is generally proportional to frequency. For an induction motor, the velocity of the motor is determined by the Output Frequency of the drive device divided by the Motor Pole count. This control method is applicable to Velocity Control applications that do not require tight speed regulation and therefore do not require a feedback device.

Basic Volts/Hertz Operation

There are a number of attributes that are used to specify the relationship the drive device uses between output frequency (speed) and output voltage for a given (induction) motor.

The Break Frequency and Break Voltage attributes define the point on the Volts/Hertz curve below which the Start Boost feature is applied. As the name indicates, Start Boost is used to provide a non-zero output voltage to the motor at stand-still to assist startup.

The contribution of Start Boost to the output voltage of the drive device tapers off to zero when the motor reaches the Break Frequency. Above the break point, output voltage and output frequency follow a linear slope to the point defined by the Motor Rated Frequency and Motor Rated Voltage. From this point on, the Volts/Hertz curve follows another linear slope to the point defined by the Max Frequency and Max Voltage attributes. This segment of the Volts/Hertz curve allows for operation above the rated frequency and voltage of the motor in applications where that is required.

Sensorless Vector Operation

Sensorless Vector is an alternative Velocity Control Method that does not require configuration of a Volts/Hertz curve. Instead, by knowing the Stator Resistance and Leakage Inductance of the motor, the drive device can calculate the appropriate Output Voltage required for a given Output Frequency. This method provides better low speed Velocity Control behavior than by using the Basic Volts/Hertz method.

Slip Compensation

When driving an induction motor at a specific frequency, the actual motor velocity is generally less than the command speed, given by the output frequency divided by the motor pole count, by an amount that is proportional to the load torque applied to the motor. This difference in speed is called 'Slip' and is a configuration attribute associated with the motor. The Motion Device Axis Object supports a Slip Compensation feature that is common to Variable Frequency Drives. The amount of Slip Compensation applied to the Velocity Reference is the product of the measured torque producing current, Iq, and the configured Induction Motor Rated Slip Speed.

Velocity Droop

Another feature defined for the Frequency Control method is the droop function. The droop function reduces the velocity reference by a scaled fraction of the torque producing current, Iq, as controlled by the droop gain setting, Kdr. As torque loading on the motor is increased, actual motor speed is reduced in proportion to the droop gain. This is helpful when some level of compliance is required when performing torque sharing between two motors on a common load.

See also

Velocity Control Behavior on page 79

Torque Control Behavior on page 71

Interpret the Attribute Tables

Each attribute table begins with the attribute name as a heading. The tag, GSV/SSV, and MSG names for each of these attributes are the same as the attribute name listed, but with the spaces removed. For example, Inhibit Axis would be InhibitAxis.

This table provides an explanation of the information, nomenclature, and abbreviations used in the attribute tables.

Attribute Table Column Heading Descriptions

Column Heading	Description
Usage (Implementation)	The following identifiers are used for usage: • Required This is a required attribute. It is supported for the listed control modes for each attribute. • Optional This is an optional attribute. It is supported for the listed control modes for each attribute. Optional attributes are based on the specific drive that has been associated. • Replicated For a listing of the attributes that are replicated in the drive see Identify Motion Axis Attributes Based on Device Function Codes on page 95. In the Usage column, you will also see combinations of Usage and Mode, such as the following: C PVT Closed Loop Vector Control Method D FC Drive (Any Frequency Controlled or Vector Controlled drive device) In addition to these combinations there are many attributes that are applicable or not applicable to sensorless drive operation, for example, velocity controlled drives operating without a feedback device. To accommodate these situations, the following Device Function Codes are used: • E Encoder present. • !E Encoderless/sensorless control, feedback device is not present.

Column Heading	Description
Device Control Codes (mode)	The following identifiers are used for Device Function Codes: • Required - All = All Control Modes • Optional - All = All Control Modes If applicable only to specific implementations, the following codes will be used to denote when they apply: • Individual codes: B = Bus Power Converters (No Control Mode, No Control Method) E = Encoder present, Feedback Only (No Control Mode, No Control Method) F= Frequency Control (Velocity Control Mode, Frequency Control Method) P = Position Loop (Position Control Mode, Closed Loop Vector Control Method) V = Velocity Control Loop (Velocity Control Mode, Closed Loop Vector Control Method) T = Torque Control Loop (Torque Control Mode, Closed Loop Vector Control Method) C\D = Identifies the attributes that have a matching, or replicated attributes in the associated device/drive. • Combination codes: B = All device functions using No Control Method -Feedback Only (B, E) O = All device functions using Open Loop Control Methods -Frequency Control (F) C = All device functions using Closed Loop Control Methods (P, V, T) D = All device functions using Control Methods (P, V, T, F) • Encoderless/sensorless drive codes: E Encoder present. (N, P ,V ,T with Feedback device present.) !E Encoderless/sensorless control, feedback device is not present.(Closed Loop Sensorless Vector and Frequency Controlled)

<table>
<tr><th>Column Heading</th><th>Description</th></tr>
<tr><td>Access Rules</td><td>The following identifiers are used for Access Rules:
Get = Get Attribute List service
GSV = Can be read using the GSV Get System Variable instruction.
Get/SSV = Indicates the attribute can only be set programmatically and cannot be set by configuration software.
Set = Set Attribute List service
SSV = Can be written using the Set System Variable instruction
Set/SSV* = Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).
Set/SSV# = Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).
Set/GSV = Indicates the attribute can only be set when the axis is created on download and cannot be changed either online or programmatically.
Set/SSV = Indicates the attribute can only be set by configuration software on initial configuration download and cannot be set programmatically.
MSG
Message is only used to access drive attributes for which there is no GSV/SSV access.
In order to use a MSG instruction to access information from a drive, you will need the Attribute and Class IDs.
Important: You can only access attributes with a message command if they are marked as MSG accessible in tables or text. If you attempt to access an attribute that is not marked as MSG accessible, expect inaccurate data to be returned to the controller.
Logix Designer
This attribute is only available in the Logix Designer application through the Axis Properties Dialog boxes.</td></tr>
<tr><td>T</td><td>Can be accessed as an Axis Tag</td></tr>
<tr><td>Data Type</td><td>For example, DINT, UINT, SINT, REAL, BOOL</td></tr>
<tr><td>Default, Minimum, Maximum Range Limits</td><td>DB = Motion Database
Indicates that the default value comes from the database.
FD = Factory Default computed value
∞ = max float = 3.402.... x 10^{38}
0+ = min float = 1.2.... x 10^{-38}
maxpos = 2^{31}/Conversion Constant
maxspd = 10^3 * maxpos
minspd = minfloat
maxacc = 10^3 * maxspd
minacc = minfloat
- (dash) = Not Applicable
N/A = Not Applicable
Defaults = Unless otherwise specified, all optional attributes default to 0. All reserved and otherwise unused bits and enumerations are set to 0.</td></tr>
</table>

Column Heading	Description
Semantics of Values	The meaning of the attribute values. For example: Position Units / Sec. Tag access is supported by value is valid only when Auto Tag Update of the Motion Group Object is enabled. There may be additional information in the description that directly follows the attribute listing.
CST	Coordinated System Time

See also

Device Function Codes on page 91

CIP Data Types on page 91

Identify Motion Axis Attributes Based on Device Function Codes on page 95

CIP Axis Attributes on page 185

Attribute Units

Attribute Units define the unit nomenclature found in the Semantics of Values column for many of the Motion Control Axis Attributes. In general, attribute values are specified in units that are relevant to motion control engineers.

Attribute Unit Cross-referencing

Attribute Unit	Applicable Units	Semantics of Values
Position Unit	User String	User-defined unit of measure of motion displacement, for example, meters, feet, inches, millimeters, revolutions, or degrees.
Velocity Units	Position Units/Sec	For example, Revs/Sec, Inches/Sec
Accel Units	Position Units/Sec^2	For example, Revs/Sec^2, Inches/Sec^2
Jerk Units	Position Units/Sec^3	For example, Revs/Sec^3, Inches/Sec^3
% Device Rated	%	Defined as the percentage of the continuous rating of the device with 100% implying operation at the continuous rated specification for the device. This unit can be applied to attributes related to speed, torque, force, current, voltage, and power. Applicable devices can be a motor, inverter, converter, or a bus regulator. This unit can be used independent of whether the attribute value represents an instantaneous level or a time-averaged level; the appropriate unit for the device rating is implied. As with all attributes that are in units of %, an attribute value of 100 means 100%.
Power Units	Kw	Kilowatts
Inertia Units	Kg-m^2	Kilogram-$Meter^2$
Mass Units	Kg	Kilogram
Loop Bandwidth Units	Hz	Hertz

Attribute Unit	Applicable Units	Semantics of Values
Filter Frequency Units	Hz	Hertz
Counts		Fundamental control unit for distance. For example, feedback counts or planner counts.

See also

CIP Data Types on page 91

CIP Axis Attributes on page 185

CIP Data Types

This table provides descriptions of the CIP Data Types related to the CIP Motion Control Axis.

Data Type Name	Data Type Code (hex)	Description	Range
BOOL*	C1	Boolean	0 = FALSE; 1 = TRUE
SINT	C2	Short Integer	-128 SINT 127
INT	C3	Integer	-32768 INT 32767
DINT	C4	Double Integer	-2^{31} DINT $(2^{31} – 1)$
LINT	C5	Long Integer	-2^{63} LINT $(2^{63} – 1)$
USINT	C6	Unsigned Short Integer	0 USINT 255
UINT	C7	Unsigned Integer	0 UINT 65536
UDINT	C8	Unsigned Double Integer	0 UDINT $(2^{32} – 1)$
ULINT	C9	Unsigned Long Integer	0 ULINT $(2^{64} – 1)$
REAL	CA	Single Precision Float	See IEEE 754
LREAL	CB	Double Precision Float	See IEEE 754
BYTE	D1	bit string – 8-bits	N/A
WORD	D2	bit string – 16-bits	N/A
DWORD	D3	bit string – 32-bits	N/A
LWORD	D4	bit string – 64-bits	N/A
SHORT STRING	DA	{length, 1-byte characters[n]}	N/A

** BOOL data type is defined by CIP standard to be an 8-bit unsigned integer with enumeration of 0 for False and 1 for True.*

See also

CIP Axis Attributes on page 185

Device Function Codes

The variations in Control Mode and Control Method result in a set of basic Device Function Codes that help organize the many attributes of the Motion Control Axis. Device Function Codes are designated by using a letter identifier or a combination that you can use to determine what attributes are required for implementation of a given CIP Motion device. The list of Device Function Codes is as follows:

Device Function Code		Control Mode	Control Method
B	Bus Power Converters	No Control Mode	No Control Method
E	Encoder, Feedback Only	No Control Mode	No Control Method
P	Position Loop	Position Control Mode	Closed Loop Vector Control Method
V	Velocity Loop	Velocity Control Mode	Closed Loop Vector Control Method
T	Torque Loop	Torque Control Mode	Closed Loop Vector Control Method
F	Frequency Control	Velocity Control Mode	Frequency Control Method (V/Hz or VFD)

Device Function Code Combinations

Using combinations of these letters, a specific class of CIP Motion devices can be designated for the purposes of identifying applicable attributes. For example, 'FV' would refer to the class of all velocity controlled drives, either vector that is controlled or frequency that is controlled. Here are some combinations that appear frequently:

Device Function Code	Represents Combination	Description
B	BE	All Device Functions using No Control Method
O	F	All Device Function using Open Loop Control Methods (Frequency Control)
C	PVT	All Device Functions using Closed Loop Control Methods (PI Vector Control Method)
D	FC	All device functions using Control Methods (Control Method !=No Control)

Conditional Implementations

There are many conditions that impact implementation of attributes. Some examples are, encoderless or sensorless drive operation, velocity controlled drives operating without a feedback device, and attributes that are replicated between the controller and the device. Conditional implementation rules for attributes in these situations are represented by the following Device Functions Codes:

Device Function Code	Description
E	Encoder-based device operation
!E	Encoderless or Sensorless device operation All Active Control Modes that do not use a Feedback device
C/D	Controller/Device Replicated Attribute

See also

Attribute Units on page 90

CIP Data Types on page 91

Required vs. Optional Axis Attributes

In the attribute tables, attributes and services are defined as Required (R) or Optional (O). Required attributes and services must be supported in the implementation of the object. Optional attributes and services may or may not be supported in the implementation and are left to the discretion of the device manufacturer.

For Instance Attributes, the determination of whether a given attribute or service is Required or Optional often depends on the associated Device Function Code.

Required Implementation

If an attribute is marked as Required for a given Device Function Code then the controller implementation, including configuration and programming the software, support that attribute if the end device is intended to operate in that mode. For example, an attribute marked as Required for Device Function Code 'V' is supported by any controller that intends to interface to a CIP Motion device that supports Velocity Loop operation.

In some cases an attribute or service may not even be applicable to a given Device Function Code. This situation is implied when the attribute is defined as neither Required nor Optional for that code.

Conditional Implementation

In some cases attributes have different rules for different conditions; a motor attribute might be Required for Permanent Magnet Motors but Optional for Induction Motors. For that case, a C would be placed under the supported Device Function Codes and the Conditional Implementation column would show the differentiation between the motor types/

Attributes can be 'Required' in the controller, but 'Optional' as a replicated attribute to the drive. Again, a C would be placed under the applicable Device Function Codes and the Conditional Implementation column would show the differentiation between the Controller only and Drive replicated implementation.

Attribute Enumeration and Bit definitions are also designated as Required, Optional, or Conditional, with an appropriate Device Function Code if applicable. If no designation is associated with the Enumeration or Bit definition, then it is assumed that the enumeration is Required in the implementation.

For some attributes, there are conditional implementation rules that extend beyond the Device Function Code. These rules are specified in the Conditional Implementation column of the attribute table.

In the following example table, the attribute PM Motor Resistance is required in the implementation if the device supports Frequency Control, Position Control, Velocity Control, or Torque Control and the device supports Permanent Magnet motors. The attribute is not applicable for a Feedback Only device or a drive that does not support a PM motor.

Attribute ID	Access Rule	Attribute	B	E	F	P	V	T	C/D	Conditional Implementation
1327	Set	PM Motor Resistance			R	R	R	R	Yes	PM Motor Only

To get details about how to specify the attribute, refer to the attributes list for the functional category. For this example, PM Motor Resistance is a member of the General Permanent Magnet Motor Attributes category. The following table provides an example of the details information:

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/SSV*	REAL	0 DB	0	-	Ohms

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

When you are reviewing the tables for an attribute remember that Vendor Specific attributes, attribute enumerations, and bits, are Optional by definition. Attributes that have Optional enumerations or bit maps are designated so in the Condition Implementation column. Details about Optional and Required support for the individual enumerations or bits for these attributes can be found in the detailed attribute behavior tables.

The software queries the specific drive profile, Add-on Profile (AOP), to determine if the Optional attributes listed in the table are supported. Attributes that are marked with an AOP in the Conditional Implementation column have semantics with additional, drive specific, optional behavior that is queried.

If the conditional implementation column reads "Derived", it means that the value for an attribute is determined (derived) by the controller based on the value of another attribute. In this case, the current attribute follows the conditional implementation rules of the attribute from which it is derived. Derived attributes do not need to be downloaded to the controller but do need to be supported by setting the appropriate bits in the Drive Set Attribute Update Bits attribute, if applicable.

Conditional Implementation Key

The following table identifies the key abbreviations used in the conditional column of the attributes tables and provides a description of the condition it represents.

Key	Description
AOP	Add-on Profile. Logix Designer component that can be separately installed and used for configuring one or more modules.
Derived	Implementation rules follow another attribute
Drive Scaling	Drive device supports drive scaling functionality
DSL	Hiperface DSL (feedback type)
E21	EnDat 2.1 (feedback type)
E22	EnDat 2.2 (feedback type)
E	Encoder-based control, a feedback device is present
!E	Encoderless or sensorless control, a feedback device in not present
HI	Hiperface (feedback type)
HD	Hiperface DSL®
IM	Rotary or Linear Induction Motor (motor type)
INT	Integrated
IPM	Rotary or Linear Interior Permanent Magnet motor (motor type)
Linear Absolute	Feedback Unit - meter; Feedback n Startup Method- absolute
Linear Motor	Linear PM motor or Linear Induction motor (motor type)
NV	Motor NV or Drive NV (motor data source)
P###	P### refers to the related PowerFlex® drive parameter.
PM	Rotary or Linear Permanent Magnet motor (SPM or IPM) (motor type)
Rotary Absolute	Feedback Unit - rev; Feedback n Startup Method- absolute
Rotary Motor	Rotary PM motor or Rotary Induction motor (motor type)
Safety only	Applicable to Integrated Motion on the EtherNet/IP network safety devices only
SC	Sine/Cosine (feedback type)
SL	Stahl SSI (feedback type)
SPM	Rotary or Linear Surface Permanent Magnet motor (motor type)
TT	Digital AqB (feedback type)

See also

Control Modes on page 16

Identify Motion Axis Attributes Based on Device Control Codes on page 95

Interpreting the Attribute Tables on page 87

Identify Motion Axis Attributes Based on Device Function Codes

The following table provides an alphabetical list of all Motion Axis Attributes specific to the CIP Drive data type. The table identifies whether the attribute is Required (R), Optional (O), or Conditional (C), in implementation based on the Device Function Code. Attributes that are not applicable for a device function code are denoted by a dash (-).

The Device Function Codes are:

- B – Bus Power Converters (No Control Mode, No Control Method)
- E – Encoder, Feedback Only (No Control Mode, No Control Method)
- P – Position Loop (Position Control Mode, Closed Loop Vector Control Method)
- V – Velocity Loop (Velocity Control Mode, Closed Loop Vector Control Method)
- T – Torque Loop (Torque Control Mode, Closed Loop Vector Control Method)
- F – Frequency Control (Velocity Control Mode, Frequency Control Method)

The C/D column states whether the attribute is replicated in the drive.

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
483/138	Get	T	Acceleration Feedback	-	R	-	R	R	R	Yes	
452	Get	T	Acceleration Feedforward Command	-	-	-	R	R	-	Yes	
460/216	Set	T	Acceleration Feedforward Gain	-	-	-	R	R	-	Yes	
367	Get	T	Acceleration Fine Command	-	-	-	O	O	O	Yes	
485	Set		Acceleration Limit	-	-	O	O	O	O	Yes	
482	Get	T	Acceleration Reference	-	-	-	O	O	O	Yes	
481	Set	T	Acceleration Trim	-	-	-	O	O	O	Yes	
53	Get	T	Actual Acceleration	-	R	R	R	R	R		
48	Get	T	Actual Position	-	R	R	R	R	R		
52	Get	T	Actual Velocity	-	R	R	R	R	R		
1376	Set		Actuator Diameter	-	C	C	C	C	C	Yes	(R) Controller only attribute, Motion Scaling Configuration set to Controller Scaling; (O) Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling
1377	Set		Actuator Diameter Unit	-	C	C	C	C	C	Yes	(R) Controller only attribute, Motion Scaling Configuration set to Controller Scaling; (O) Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling
1374	Set		Actuator Lead	-	C	C	C	C	C	Yes	(R) Controller only attribute, Motion Scaling Configuration set to Controller Scaling; (O) Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
1375	Set		Actuator Lead Unit	-	C	C	C	C	C	Yes	(R) Controller only attribute, Motion Scaling Configuration set to Controller Scaling; (O) Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling
1373	Set		Actuator Type	-	C	C	C	C	C	Yes	(R) Controller only attribute, Motion Scaling Configuration set to Controller Scaling; (O) Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling
836	Set		Adaptive Tuning Configuration	-	-	-	O	O	O	Yes	V26
844	Get	T	Adaptive Tuning Gain Scaling Factor	-	-	-	O	O	O	Yes	V26
732/267	Get	T	Analog Input 1	O	-	O	O	O	O	Yes	
733/268	Get	T	Analog Input 2	O	-	O	O	O	O	Yes	
734	Set	T	Analog Output 1	O	-	O	O	O	O	Yes	
735	Set	T	Analog Output 2	O	-	O	O	O	O	Yes	
201	Set		Application Type	-	-	-	R	R	-		
164	Get	T	Attribute Error Code	R	R	R	R	R	R		
165	Get	T	Attribute Error ID	R	R	R	R	R	R		
873	Set		Auto Sag Configuration	-	-	O	O	O	O	Yes	E, V26
874	Set		Auto Sag Slip Increment	-	-	O	O	O	O	Yes	E, V26
875	Set		Auto Sag Slip Time Limit	-	-	O	O	O	O	Yes	E, V26
876	Set		Auto Sag Start	-	-	O	O	O	O	Yes	E, V26
51	Get	T	Average Velocity	-	R	R	R	R	R		
81	Set		Average Velocity Timebase	-	R	R	R	R	R		
1	Get		Axis Address	R	R	R	R	R	R		
30	Set		Axis Configuration	R	R	R	R	R	R		Optional Enumeration
12	Get		Axis Configuration State	R	R	R	R	R	R		
11	Get		Axis Data Type	R	R	R	R	R	R		
35	Get	T	Axis Event Bits	R	R	R	R	R	R		
34	Get	T	Axis Fault Bits	R	R	R	R	R	R		
19	Set		Axis Features	R	R	R	R	R	R		Optional bit maps
106	Set		Axis ID	R	R	R	R	R	R		
2	Get		Axis Instance	R	R	R	R	R	R		
986	Get	T	Axis Safety Data A	-	-	O	O	O	O	Yes	V31
987	Get	T	Axis Safety Data B	-	-	O	O	O	O	Yes	V31
763	Get	T	Axis Safety Faults	-	O	O	O	O	O	Yes	V24
985	Get	T	Axis Safety Faults - RA	-	O	O	O	O	O	Yes	V31
760	Get	T	Axis Safety State	-	O	O	O	O	O	Yes	V24
761	Get	T	Axis Safety Status	-	O	O	O	O	O	Yes	V24
984	Get	T	Axis Safety Status - RA	-	O	O	O	O	O	Yes	V31

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
13	Get		Axis State	R	R	R	R	R	R		
33	Get	T	Axis Status Bits	R	R	R	R	R	R		
124	Set		Axis Update Schedule	R	R	R	R	R	R		
825	Set		Backlash Compensation Window	-	-	-	O	-	-	Yes	
423	Set		Backlash Reversal Offset	-	-	-	R	-	-		E
593	Set		Brake Prove Ramp Time	-	-	O	O	O	O	Yes	E, V26
594	Set		Brake Slip Tolerance	-	-	O	O	O	O	Yes	E, V26
592	Set		Brake Test Torque	-	-	O	O	O	O	Yes	E, V26
576	Set		Break Frequency	-	-	R	-	-	-	Yes	Basic V/Hz only
575	Set		Break Voltage	-	-	R	-	-	-	Yes	Basic V/Hz only
255	Set		Bus Overvoltage Operational Limit	-	-	-	R	R	R		V29
638/262	Get	T	Bus Regulator Capacity	O	-	O	O	O	O	Yes	
8	Set		C2C Connection Instance	R	R	R	R	R	R		
7	Set		C2C Map Instance	R	R	R	R	R	R		
756	Get		CIP APR Faults	-	C	-	C	C	C	Yes	(R) Controller only attribute, Motion Scaling Configuration set to Controller Scaling; (O) Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling; V27; E
905	Get	T	CIP APR Faults - RA	-	C	-	C	C	C	Yes	(R) Controller only attribute, Motion Scaling Configuration set to Controller Scaling; (O) Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling; V27; E
26	Get		CIP Axis Alarm Log	R	R	R	R	R	R		
127	Get		CIP Axis Alarm Log Count	R	R	R	R	R	R		
28	Set		CIP Axis Alarm Log Reset	R	R	R	R	R	R		
142	Get		CIP Axis Alarm Source	R	R	R	R	R	R		
143	Get		CIP Axis Alarm Source - RA	R	R	R	R	R	R		
659	Get	T	CIP Axis Alarms	O	O	O	O	O	O	Yes	
904	Get	T	CIP Axis Alarms - RA	O	O	O	O	O	O	Yes	
672	Set		CIP Axis Exception Action	R	R	R	R	R	R	Yes	Optional Enumeration
908	Set		CIP Axis Exception Action - RA	R	R	R	R	R	R	Yes	Optional Enumeration
25	Get		CIP Axis Fault Log	R	R	R	R	R	R		
126	Get		CIP Axis Fault Log Count	R	R	R	R	R	R		
27	Set		CIP Axis Fault Log Reset	R	R	R	R	R	R		
657	Get	T	CIP Axis Faults	R	R	R	R	R	R	Yes	
903	Get	T	CIP Axis Faults - RA	R	R	R	R	R	R	Yes	
653	Get	T	CIP Axis I/O Status	R	R	R	R	R	R	Yes	
901	Get	T	CIP Axis I/O Status - RA	R	R	R	R	R	R	Yes	
650	Get	T	CIP Axis State	R	R	R	R	R	R	Yes	

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
651	Get	T	CIP Axis Status	R	R	R	R	R	R	Yes	
900	Get	T	CIP Axis Status - RA	R	R	R	R	R	R	Yes	
168	Set		CIP Controller Get Attr Update Bits	R	R	R	R	R	R		
167	Set		CIP Controller Set Attr Update Bits	R	R	R	R	R	R		
241	Set		CIP Drive Get Attr Update Bits	R	R	R	R	R	R		
240	Set		CIP Drive Set Attr Update Bits	R	R	R	R	R	R		
674	Get	T	CIP Initialization Faults	R	R	R	R	R	R	Yes	
910	Get	T	CIP Initialization Faults- RA	R	R	R	R	R	R	Yes	
144	Get		CIP Start Inhibit Source	R	R	R	R	R	R		
145	Get		CIP Start Inhibit Source - RA	R	R	R	R	R	R		
676	Get	T	CIP Start Inhibits	R	R	R	R	R	R	Yes	
912	Get	T	CIP Start Inhibits - RA	R	R	R	R	R	R	Yes	
617	Set		Coasting Time Limit	-	-	O	O	O	O	Yes	V26
100	Get	T	Command Acceleration	-	-	R	R	R	-		
96	Get	T	Command Position	-	-	R	R	R	-		
95	Set*	T	Command Torque	-	-	-	-	R	R		
360	Set		Command Update Delay Offset	-	-	-	R	R	-		E
99	Get	T	Command Velocity	-	-	R	R	R	-		
561	Set		Commutation Offset	-	-	-	R	R	R	Yes	E; PM Motor only
850	Set		Commutation Offset Compensation	-	-	-	O	O	O	Yes	E; IPM Motor only, V29
563	Set		Commutation Polarity	-	-	-	O	O	O	Yes	E; PM Motor only
562	Set		Commutation Self-Sensing Current	-	-	-	O	O	O	Yes	E; PM Motor only, AOP
618	Set		Connection Loss Stopping Action	-	-	O	O	O	O	Yes	V31
41	Get		Control Method	R	R	R	R	R	R	Yes	Derived – Axis Config
40	Set*		Control Mode	R	R	R	R	R	R	Yes	Derived – Axis Config
82	Set		Conversion Constant	-	R	R	R	R	R		
637	Get	T	Converter Capacity	O	-	O	O	O	O	Yes	
605	Get	T	Converter Output Current	O	-	O	O	O	O	Yes	V26
606	Get	T	Converter Output Power	O	-	O	O	O	O	Yes	V26
520	Get	T	Current Command	-	-	-	R	R	R	Yes	
840	Set	T	Current Disturbance	-	-	-	O	O	O	Yes	
527	Get	T	Current Error	-	-	-	O	O	O	Yes	
529	Get	T	Current Feedback	-	-	-	O	O	O	Yes	
522	Get	T	Current Limit Source	-	-	O	O	O	O	Yes	F Support in V29
524	Get	T	Current Reference	-	-	-	O	O	O	Yes	
553	Set		Current Vector Limit	-	-	O	O	O	O	Yes	
46	Set		Cyclic Read Update List	R	R	R	R	R	R		
47	Set		Cyclic Write Update List	R	R	R	R	R	R		
196	Set		Damping Factor	-	-	-	R	R	R		
620/266	Get	T	DC Bus Voltage	R	-	R	R	R	R	Yes	

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
870	Set		DC Injection Brake Current	-	-	O	O	O	O	Yes	
872	Set		DC Injection Brake Time	-	-	O	O	O	O	Yes	
486	Set		Deceleration Limit	-	-	O	O	O	O	Yes	
730	Get	T	Digital Inputs	O	-	O	O	O	O	Yes	
731	Set	T	Digital Outputs	O	-	O	O	O	O	Yes	
105	Set*	T	Direct Command Velocity		-	R	-	R	-		
200	Set		Drive Model Time Constant	-	-	-	R	R	R		
253	Set		Drive Model Time Constant Base	-	R	R	R	R	R		
254	Set		Drive Rated Peak Current	-	R	R	R	R	R		
120	Set		Dynamics Configuration Bits	-	-	R	R	R	-		
1435	Set		Feedback 1 Accel Filter Bandwidth	-	O	-	O	O	O	Yes	E
2404	Set		Feedback 1 Accel Filter Taps	-	O	-	O	O	O	Yes	E
2405	Set		Feedback 1 Battery Absolute	-	O	-	O	O	O	Yes	E; Tamagawa (feedback type)
1417	Set		Feedback 1 Cycle Interpolation	-	R	-	R	R	R	Yes	E; Not Linear Displacement Transducer (feedback type), AOP
1416	Set		Feedback 1 Cycle Resolution	-	R	-	R	R	R	Yes	E; Not Linear Displacement Transducer (feedback type)
1421	Set		Feedback 1 Data Code	-	O	-	O	O	O	Yes	E; Digital Parallel (feedback type),SSI (feedback type)
1420	Set		Feedback 1 Data Length	-	O	-	O	O	O	Yes	E; Digital Parallel (feedback type),SSI (feedback type)
1419	Set		Feedback 1 Length	-	R	-	R	R	R	Yes	E; Linear Absolute Only
2400	Set		Feedback 1 Loss Action	-	O	-	O	O	O	Yes	E
1414	Set		Feedback 1 Polarity	-	O	-	O	O	O	Yes	E
1425	Set		Feedback 1 Resolver Cable Balance	-	O	-	O	O	O	Yes	E; Resolver (feedback type)
1424	Set		Feedback 1 Resolver Excitation Frequency	-	O	-	O	O	O	Yes	E; Resolver (feedback type)
1423	Set		Feedback 1 Resolver Excitation Voltage	-	O	-	O	O	O	Yes	E; Resolver (feedback type)
1422	Set		Feedback 1 Resolver Transformer Ratio	-	O	-	O	O	O	Yes	E; Resolver (feedback type)
1401	Get		Feedback 1 Serial Number	-	O	-	O	O	O	Yes	E
1415	Set		Feedback 1 Startup Method	-	R	-	R	R	R	Yes	E; Optional Enumeration
1418	Set		Feedback 1 Turns	-	R	-	R	R	R	Yes	E; Rotary Absolute Only
1413	Set		Feedback 1 Type	-	R	-	R	R	R	Yes	E; Optional Enumeration
1411	Set		Feedback 1 Unit	-	R	-	R	R	R	Yes	E
1434	Set		Feedback 1 Velocity Filter Bandwidth	-	O	-	O	O	O	Yes	E
2403	Set		Feedback 1 Velocity Filter Taps	-	O	-	O	O	O	Yes	E
1485	Set		Feedback 2 Accel Filter Bandwidth	-	O	-	O	O	O	Yes	E
2454	Set		Feedback 2 Accel Filter Taps	-	O	-	O	O	O	Yes	E
2455	Set		Feedback 2 Battery Absolute	-	O	-	O	O	O	Yes	E; Tamagawa (feedback type)
1467	Set		Feedback 2 Cycle Interpolation	-	R	-	R	R	R	Yes	E; Not Linear Displacement Transducer (feedback type), AOP

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
1466	Set		Feedback 2 Cycle Resolution	-	R	-	R	R	R	Yes	E; Not Linear Displacement Transducer (feedback type)
1471	Set		Feedback 2 Data Code	-	O	-	O	O	O	Yes	E; Digital Parallel (feedback type),SSI (feedback type)
1470	Set		Feedback 2 Data Length	-	O	-	O	O	O	Yes	E; Digital Parallel (feedback type),SSI (feedback type)
1469	Set		Feedback 2 Length	-	R	-	R	R	R	Yes	E; Linear Absolute Only
2450	Set		Feedback 2 Loss Action	-	O	-	O	O	O	Yes	E
1464	Set		Feedback 2 Polarity	-	O	-	O	O	O	Yes	E
1475	Set		Feedback 2 Resolver Cable Balance	-	O	-	O	O	O	Yes	E; Resolver (feedback type)
1474	Set		Feedback 2 Resolver Excitation Frequency	-	O	-	O	O	O	Yes	E; Resolver (feedback type)
1473	Set		Feedback 2 Resolver Excitation Voltage	-	O	-	O	O	O	Yes	E; Resolver (feedback type)
1472	Set		Feedback 2 Resolver Transformer Ratio	-	O	-	O	O	O	Yes	E; Resolver (feedback type)
1451	Get		Feedback 2 Serial Number	-	-	-	O	O	O	Yes	E
1465	Set		Feedback 2 Startup Method	-	R	-	R	R	R	Yes	E; Optional Enumeration
1468	Set		Feedback 2 Turns	-	R	-	R	R	R	Yes	E; Rotary Absolute Only
1463	Set		Feedback 2 Type	-	R	-	R	R	R	Yes	E; Optional Enumeration
1461	Set		Feedback 2 Unit	-	R	-	R	R	R	Yes	E
1484	Set		Feedback 2 Velocity Filter Bandwidth	-	O	-	O	O	O	Yes	E
2453	Set		Feedback 2 Velocity Filter Taps	-	O	-	O	O	O	Yes	E
250	Set		Feedback Commutation Aligned	-	-	-	O	O	O	Yes	E; PM Motor only, Optional Enumeration
31	Set		Feedback Configuration	R	R	R	R	R	R		Optional Enumeration
708	Set		Feedback Data Loss User Limit	-	O	O	O	O	O	Yes	E
42	Set*		Feedback Mode	-	R	R	R	R	R	Yes	Derived - Fdbk Config
706	Set		Feedback Noise User Limit	-	O	O	O	O	O	Yes	E
707	Set		Feedback Signal Loss User Limit	-	O	O	O	O	O	Yes	E
44	Set		Feedback Unit Ratio	-	-	-	O	O	-	Yes	E
871	Set		Flux Braking Enable	-	-	O	O	O	O	Yes	Ind Motor only
528	Get	T	Flux Current Error	-	-	-	O	O	O	Yes	
530	Get	T	Flux Current Feedback	-	-	-	O	O	O	Yes	
525	Get	T	Flux Current Reference	-	-	-	O	O	O	Yes	
557	Set		Flux Integral Time Constant	-	-	-	O	O	O	Yes	
556	Set		Flux Loop Bandwidth	-	-	-	O	O	O	Yes	
558	Set		Flux Up Control	-	-	O	O	O	O	Yes	Ind Motor only, Optional Enumeration
559	Set		Flux Up Time	-	-	O	O	O	O	Yes	Ind Motor only
380	Set		Flying Start Enable	-	-	O	-	O	-	Yes	
381	Set		Flying Start Method	-	-	O	-	O	-	Yes	V29
570	Set		Frequency Control Method	-	-	R	-	-	-	Yes	Optional Enumeration
498	Set		Friction Compensation Sliding	-	-	-	O	O	O	Yes	

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
499	Set		Friction Compensation Static	-	-	-	O	O	O	Yes	
500	Set		Friction Compensation Viscous	-	-	-	O	O	O	Yes	
826/421	Set		Friction Compensation Window	-	-	-	O	-	-	Yes	
189	Set		Gain Tuning Configuration Bits	-	-	-	R	R	R		
3	Get		Group Instance	R	R	R	R	R	R		
981/243	Get	T	Guard Faults	-	-	O	O	O	O	Yes	
980/242	Get	T	Guard Status	-	-	O	O	O	O	Yes	
1170	Set		Home Acceleration	-	-	-	R	R	-		E
88	Set		Home Configuration Bits	-	R	-	R	R	R		E
1171	Set		Home Deceleration	-	-	-	R	R	-		E
86	Set		Home Direction	-	-	-	R	R	-		E
18	Get		Home Event Task	-	R	R	R	R	R		E
85	Set		Home Mode	-	R	-	R	R	R		E
90	Set		Home Offset	-	R	-	R	R	R		E
89	Set		Home Position	-	R	-	R	R	R		E
113	Set		Home Return Speed	-	-	-	R	R	-		E
87	Set		Home Sequence	-	R	-	R	R	R		Optional Enumeration; E
112	Set		Home Speed	-	-	-	R	R	-		E
1172	Set		Home Torque Limit	-	-	-	R	R	-		E
280	Set		Home Torque Threshold	-	-	-	O	O	-	Yes	E
281	Set		Home Torque Time	-	-	-	O	O	-	Yes	E
245	Get		Hookup Test Commutation Offset	-	R	-	R	R	R		PM Motor only; E
246	Get		Hookup Test Commutation Polarity	-	R	-	R	R	R		PM Motor only; E
109	Set		Hookup Test Distance	-	R	-	R	R	R		E
247	Get		Hookup Test Feedback 1 Direction	-	R	-	R	R	R		E
248	Get		Hookup Test Feedback 2 Direction	-	R	-	R	R	R		E
111	Set		Hookup Test Feedback Channel	-	R	-	R	R	R		E
244	Get		Hookup Test Status	-	R	R	R	R	R		
110	Set		Hookup Test Time	-	-	R	-	R	-		!E
1346	Set		Induction Motor Flux Current	-	-	R	R	R	R	Yes	Ind Motor only
1349	Set		Induction Motor Magnetization Reactance	-	-	O	O	O	O	Yes	Ind Motor only
1345	Set		Induction Motor Rated Frequency	-	-	R	R	R	R	Yes	Ind Motor only
1352	Set		Induction Motor Rated Slip Speed	-	-	O	O	O	O	Yes	Ind Motor only
1351	Set		Induction Motor Rotor Leakage Reactance	-	-	O	O	O	O	Yes	Ind Motor only
1350	Set		Induction Motor Rotor Resistance	-	-	O	O	O	O	Yes	Ind Motor only
1348	Set		Induction Motor Stator Leakage Reactance	-	-	O	O	O	O	Yes	Ind Motor only
1347	Set		Induction Motor Stator Resistance	-	-	R	R	R	R	Yes	Ind Motor only
20	Set		Inhibit Axis	R	R	R	R	R	R		

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
60	Get	T	Interpolated Actual Position	-	R	-	R	R	R		E
101	Get	T	Interpolated Command Position	-	-	-	R	R	-		E
108	Set		Interpolated Position Configuration	-	R	-	R	R	R		E
59	Set	T	Interpolation Time	-	R	-	R	R	R		E
636	Get	T	Inverter Capacity	-	-	R	R	R	R	Yes	
647	Set		Inverter Overload Action	-	-	O	O	O	O	Yes	Optional Enumeration
699	Set		Inverter Thermal Overload User Limit	-	-	O	O	O	O	Yes	
1338	Set		Linear Motor Damping Coefficient	-	-	O	O	O	O	Yes	Linear Motor only
2313	Set		Linear Motor Integral Limit Switch	-	-	O	O	O	O	Yes	Linear Motor only
1336	Set		Linear Motor Mass	-	-	O	O	O	O	Yes	Linear Motor only
1337	Set		Linear Motor Max Speed	-	-	O	O	O	O	Yes	Linear Motor only
1334	Set		Linear Motor Pole Pitch	-	-	R	R	R	R	Yes	Linear Motor only
1335	Set		Linear Motor Rated Speed	-	-	R	R	R	R	Yes	Linear Motor only
203	Set		Load Coupling	-	-	-	R	R	R		
352	Set		Load Inertia Ratio	-	-	-	R	R	R		
801	Get	T	Load Observer Acceleration Estimate	-	-	-	O	O	O	Yes	
806	Set	T	Load Observer Bandwidth	-	-	-	O	O	O	Yes	
805	Set		Load Observer Configuration	-	-	-	O	O	O	Yes	Optional Enumeration
809	Set		Load Observer Feedback Gain	-	-	-	O	O	O	Yes	
807	Set	T	Load Observer Integrator Bandwidth	-	-	-	O	O	O	Yes	
802	Get	T	Load Observer Torque Estimate	-	-	-	O	O	O	Yes	
205	Set		Load Ratio	-	-	-	R	R	R		
1370	Set		Load Type	-	C	C	C	C	C	Yes	(R) Controller only attribute Motion Scaling Configuration set to Controller Scaling; (O) Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling
750	Set		Local Control	O	O	O	O	O	O	Yes	Optional Enumeration
202	Set		Loop Response	-	-	-	R	R	-		
4	Set		Map Instance	R	R	R	R	R	R		
21	Set		Master Input Configuration Bits	-	R	-	R	R	-		E
102	Get	T	Master Offset	-	-	R	R	R	-		
22	Set		Master Position Filter Bandwidth	-	R	-	R	R	-		E
115	Set		Maximum Acceleration	-	-	R	R	R	-		
118	Set		Maximum Acceleration Jerk	-	-	R	R	R	-		
116	Set		Maximum Deceleration	-	-	R	R	R	-		
119	Set		Maximum Deceleration Jerk	-	-	R	R	R	-		
573	Set		Maximum Frequency	-	-	R	-	-	-	Yes	
114	Set		Maximum Speed	-	-	R	R	R	-		
572	Set		Maximum Voltage	-	-	R	-	-	-	Yes	

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
614	Set		Mechanical Brake Control	-	-	O	O	O	O	Yes	
616	Set		Mechanical Brake Engage Delay	-	-	O	O	O	O	Yes	
615	Set		Mechanical Brake Release Delay	-	-	O	O	O	O	Yes	
10	Get		Memory Usage	R	R	R	R	R	R		
9	Get		Memory Use	R	R	R	R	R	R		
159	Get	T	Module Alarm Bits	R	R	R	R	R	R		
5	Set		Module Channel	R	R	R	R	R	R		
6	Set		Module Class Code	R	R	R	R	R	R		
163	Get	T	Module Fault Bits	R	R	R	R	R	R		
23	Get	T	Motion Alarm Bits	-	R	R	R	R	R		
29	Set		Motion Exception Action	-	R	R	R	R	R		
24	Get	T	Motion Fault Bits	-	R	R	R	R	R		
79	Set		Motion Polarity	-	R	R	R	R	R	Yes	Controller only attribute, Motion Scaling Configuration set to Controller Scaling; Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling
78	Set		Motion Resolution	-	R	R	R	R	R	Yes	Controller only attribute, Motion Scaling Configuration set to Controller Scaling; Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling
45	Set		Motion Scaling Configuration	-	R	R	R	R	R	Yes	Controller only attribute, No Drive Scaling; Drive replicated attribute, Drive Scaling; Optional Enumeration
32	Get	T	Motion Status Bits	-	R	R	R	R	R		
77	Set		Motion Unit	-	R	R	R	R	R	Yes	Controller only attribute, Motion Scaling Configuration set to Controller Scaling; Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling
635/259	Get	T	Motor Capacity	-	-	R	R	R	R	Yes	
1310/251	Set		Motor Catalog Number	-	-	C	C	C	C	Yes	(R) Controller only attribute !NV; (O) Drive replicated attribute, NV
1313	Set		Motor Data Source	-	-	R	R	R	R	Yes	Optional Enumeration
1314	Set		Motor Device Code	-	-	R	R	R	R	Yes	
523/263	Get	T	Motor Electrical Angle	-	-	-	R	R	R	Yes	PM Motor only
1323	Set		Motor Integral Thermal Switch	-	-	O	O	O	O	Yes	
1324	Set		Motor Max Winding Temperature	-	-	O	O	O	O	Yes	
646	Set		Motor Overload Action	-	-	O	O	O	O	Yes	Optional Enumeration

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
1322	Set		Motor Overload Limit	-	-	O	O	O	O	Yes	
695	Set		Motor Overspeed User Limit	-	-	O	O	O	O	Yes	
694	Set		Motor Phase Loss Limit	-	-	O	O	O	O	Yes	V26
1317	Set		Motor Polarity	-	-	O	O	O	O	Yes	
1319	Set		Motor Rated Continuous Current	-	-	R	R	R	R	Yes	
1321	Set		Motor Rated Output Power	-	-	C	C	C	C	Yes	O-PM; R-IM
1320	Set		Motor Rated Peak Current	-	-	C	C	C	C	Yes	R-PM; O-IM
1318	Set		Motor Rated Voltage	-	-	R	R	R	R	Yes	
1000	Get		Motor Test Bus Overvoltage Speed	-	-	R	R	R	R		IPM Motor Only, V29
1001	Get		Motor Test Commutation Offset Comp	-	-	R	R	R	R		IPM Motor Only, V29
174	Get		Motor Test Counter EMF	-	-	R	R	R	R		PM Motor only
172	Get		Motor Test Flux Current	-	-	R	R	R	R		Ind Motor only
171	Get		Motor Test Inductance	-	-	R	R	R	R		
999	Get		Motor Test Ld Flux Saturation	-	-	R	R	R	R		IPM Motor Only, V29
997	Get		Motor Test Ld Inductance	-	-	R	R	R	R		IPM Motor Only, V29
998	Get		Motor Test Lq Flux Saturation	-	-	R	R	R	R		IPM Motor Only, V29
996	Get		Motor Test Lq Inductance	-	-	R	R	R	R		IPM Motor Only, V29
170	Get		Motor Test Resistance	-	-	R	R	R	R		
173	Get		Motor Test Slip Speed	-	-	R	R	R	R		Ind Motor only
175	Get		Motor Test Status	-	-	R	R	R	R		
697	Set		Motor Thermal Overload User Limit	-	-	O	O	O	O	Yes	
1315	Set		Motor Type	-	-	R	R	R	R	Yes	Optional Enumeration
1316	Set		Motor Unit	-	-	R	R	R	R	Yes	
1325	Set		Motor Winding To Ambient Capacitance	-	-	O	O	O	O	Yes	
1326	Set		Motor Winding To Ambient Resistance	-	-	O	O	O	O	Yes	
521	Get	T	Operative Current Limit	-	-	O	O	O	O	Yes	F Support in V29
14	Get		Output Cam Execution Targets	-	R	R	R	R	R		E
38	Get	T	Output Cam Lock Status	-	R	-	R	R	R		E
37	Get	T	Output Cam Pending Status	-	R	-	R	R	R		E
36	Get	T	Output Cam Status	-	R	-	R	R	R		E
39	Get	T	Output Cam Transition Status	-	R	-	R	R	R		E
601	Get	T	Output Current	-	-	R	R	R	R	Yes	
600	Get	T	Output Frequency	-	-	R	O	O	O	Yes	
603	Get	T	Output Power	-	-	R	R	R	R	Yes	
602	Get	T	Output Voltage	-	-	R	R	R	R	Yes	
508	Set		Overtorque Limit	-	-	O	O	O	O	Yes	
509	Set		Overtorque Limit Time	-	-	O	O	O	O	Yes	
1082	Get		Planner Actual Position	-	R	R	R	R	R		V30
1081	Get		Planner Command Position - Fractional	-	-	R	R	R	-		V30
1080	Get		Planner Command Position - Integer	-	-	R	R	R	-		V30

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
1355	Set		PM Motor Extended Speed Permissive	-	-	-	O	O	O	Yes	PM Motor only;V29
2310	Set		PM Motor Flux Saturation	-	-	O	O	O	O	Yes	SPM Motor only
1343	Set		PM Motor Force Constant	-	-	O	O	O	O	Yes	Linear PM Motor only
1328	Set		PM Motor Inductance	-	-	R	R	R	R	Yes	SPM Motor only
2315	Set		PM Motor Ld Flux Saturation	-	-	O	O	O	O	Yes	IPM Motor only, V29
1354	Set		PM Motor Ld Inductance	-	-	R	R	R	R	Yes	IPM Motor only, V29
1358	Set		PM Motor Linear Bus Overvoltage Speed	-	-	-	O	O	O	Yes	Linear PM Motor only;V29
1359	Set		PM Motor Linear Max Extended Speed	-	-	-	O	O	O	Yes	Linear PM Motor only;V29
1344	Set		PM Motor Linear Voltage Constant	-	-	R	R	R	R	Yes	Linear PM Motor only
2314	Set		PM Motor Lq Flux Saturation	-	-	O	O	O	O	Yes	IPM Motor only, V29
1353	Set		PM Motor Lq Inductance	-	-	R	R	R	R	Yes	IPM Motor only, V29
1342	Set		PM Motor Rated Force	-	-	O	O	O	O	Yes	Linear PM Motor only
1339	Set		PM Motor Rated Torque	-	-	O	O	O	O	Yes	Rotary PM Motor only
1327	Set		PM Motor Resistance	-	-	R	R	R	R	Yes	PM Motor only
1356	Set		PM Motor Rotary Bus Overvoltage Speed	-	-	-	O	O	O	Yes	Rotary PM Motor only;V29
1357	Set		PM Motor Rotary Max Extended Speed	-	-	-	O	O	O	Yes	Rotary PM Motor only;V29
1341	Set		PM Motor Rotary Voltage Constant	-	-	R	R	R	R	Yes	Rotary PM Motor only
1340	Set		PM Motor Torque Constant	-	-	O	O	O	O	Yes	Rotary PM Motor only
436/131	Get	T	Position Error	-	-	-	R	-	-	Yes	
444/227	Set		Position Error Tolerance	-	-	-	R	-	-	Yes	
445	Set		Position Error Tolerance Time	-	-	-	O	-	-	Yes	
1402	Get	T	Position Feedback 1	-	R	-	R	R	R	Yes	E
1452	Get	T	Position Feedback 2	-	R	-	R	R	R	Yes	E
365	Get	T	Position Fine Command	-	-	-	O	-	-	Yes	
442	Set	T	Position Integrator Bandwidth	-	-	-	R	-	-	Yes	
446	Set		Position Integrator Control	-	-	-	R	-	-	Yes	Optional bit maps
437	Get	T	Position Integrator Output	-	-	-	R	-	-	Yes	
447	Set		Position Integrator Preload	-	-	-	O	-	-	Yes	
781	Set		Position Lead Lag Filter Bandwidth	-	-	-	O	-	-	Yes	
782	Set		Position Lead Lag Filter Gain	-	-	-	O	-	-	Yes	
443/228	Set		Position Lock Tolerance	-	-	-	R	-	-	Yes	
441	Set	T	Position Loop Bandwidth	-	-	-	R	-	-	Yes	
438	Get	T	Position Loop Output	-	-	-	R	-	-	Yes	
783	Set		Position Notch Filter Frequency	-	-	-	O	-	-	Yes	
432	Get	T	Position Reference	-	-	-	R	-	-	Yes	
73	Set		Position Scaling Denominator	-	R	R	R	R	R		
72	Set		Position Scaling Numerator	-	R	R	R	R	R		
197	Set		Position Servo Bandwidth	-	-	-	R	-	-		
431	Set	T	Position Trim	-	-	-	R	-	-	Yes	
80	Set		Position Units	-	R	R	R	R	R		

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
84	Set		Position Unwind	-	R	-	R	R	R	Yes	Controller only attribute, Motion Scaling Configuration set to Controller Scaling; Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling; E
75	Set		Position Unwind Denominator	-	R	-	R	R	R		E
74	Set		Position Unwind Numerator	-	R	-	R	R	R		E
627	Set		Power Loss Action	-	-	O	O	O	O	Yes	Optional Enumeration
628	Set		Power Loss Threshold	O	-	O	O	O	O	Yes	
630	Set		Power Loss Time	O	-	O	O	O	O	Yes	
117	Set		Programmed Stop Mode	R	R	R	R	R	R		
590	Set		Proving Configuration	-	-	O	O	O	O	Yes	V26
376	Set*		Ramp Acceleration	-	-	O	-	O	-	Yes	
377	Set*		Ramp Deceleration	-	-	O	-	O	-	Yes	
378	Set		Ramp Jerk Control	-	-	O	-	O	-	Yes	
375	Set*		Ramp Velocity - Negative	-	-	O	-	O	-	Yes	
374	Set*		Ramp Velocity - Positive	-	-	O	-	O	-	Yes	
16	Get		Registration 1 Event Task	-	R	R	R	R	R		E
63	Get*	T	Registration 1 Negative Edge Position	-	R	-	R	R	R	Yes	E
67	Get*	T	Registration 1 Negative Edge Time	-	R	-	R	R	R	Yes	E
55	Get	T	Registration 1 Position	-	R	-	R	R	R		E
62	Get*	T	Registration 1 Positive Edge Position	-	R	-	R	R	R	Yes	E
66	Get*	T	Registration 1 Positive Edge Time	-	R	-	R	R	R	Yes	E
57	Get	T	Registration 1 Time	-	R	-	R	R	R		E
17	Get		Registration 2 Event Task	-	R	R	R	R	R		E
65	Get*	T	Registration 2 Negative Edge Position	-	R	-	R	R	R	Yes	E
69	Get*	T	Registration 2 Negative Edge Time	-	R	-	R	R	R	Yes	E
56	Get	T	Registration 2 Position	-	R	-	R	R	R		E
64	Get*	T	Registration 2 Positive Edge Position	-	R	-	R	R	R	Yes	E
68	Get*	T	Registration 2 Positive Edge Time	-	R	-	R	R	R	Yes	E
58	Get	T	Registration 2 Time	-	R	-	R	R	R		E
356	Set		Registration Inputs	-	R	-	R	R	R		AOP; E
613/354	Set		Resistive Brake Contact Delay	-	-	O	O	O	O	Yes	PM Motor only
1333	Set		Rotary Motor Damping Coefficient	-	-	O	O	O	O	Yes	Rotary Motor only
2312	Set		Rotary Motor Fan Cooling Derating	-	-	O	O	O	O	Yes	Rotary Motor only
2311	Set		Rotary Motor Fan Cooling Speed	-	-	O	O	O	O	Yes	Rotary Motor only
1330	Set		Rotary Motor Inertia	-	-	O	O	O	O	Yes	Rotary Motor only
1332	Set		Rotary Motor Max Speed	-	-	O	O	O	O	Yes	Rotary Motor only
1329	Set		Rotary Motor Poles	-	-	R	R	R	R	Yes	Rotary Motor only
1331	Set		Rotary Motor Rated Speed	-	-	R	R	R	R	Yes	Rotary Motor only

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
578	Set		Run Boost	-	-	R	-	-	-	Yes	BasicV/Hz and Fan/Pump V/Hz only
766	Set		Safe Stopping Action	-	-	O	O	O	O	Yes	V31
767	Set		Safe Stopping Action Source	-	-	O	O	O	O	Yes	V31
765	Set		Safe Torque Off Action	-	-	O	O	O	O	Yes	V26; Optional Enumeration
759	Set		Safe Torque Off Action Source	-	-	O	O	O	O	Yes	V31
70	Set		Scaling Source	-	R	R	R	R	R		
629	Set		Shutdown Action	O	-	O	O	O	O	Yes	Optional Enumeration
370	Set		Skip Speed 1	-	-	O	-	-	-	Yes	
371	Set		Skip Speed 2	-	-	O	-	-	-	Yes	
372	Set		Skip Speed 3	-	-	O	-	-	-	Yes	
373	Set		Skip Speed Band	-	-	O	-	-	-	Yes	
833	Set		SLAT Configuration	-	-	-	-	O	-	Yes	
834	Set		SLAT Set Point	-	-	-	-	O	-	Yes	
835	Set		SLAT Time Delay	-	-	-	-	O	-	Yes	
565	Get	T	Slip Compensation	-	-	R	-	-	-	Yes	
94	Set		Soft Travel Limit - Negative	-	R	-	R	R	R		E
93	Set		Soft Travel Limit - Positive	-	R	-	R	R	R		E
92	Set		Soft Travel Limit Checking	-	R	-	R	R	R		E
50	Get	T	Start Actual Position	-	R	R	R	R	R		
577	Set		Start Boost	-	-	R	-	-	-	Yes	Basic V/Hz only
98	Get	T	Start Command Position	-	-	R	R	R	-		
104	Get	T	Start Master Offset	-	-	R	R	R	-		
610	Set		Stopping Action	-	-	R	R	R	R	Yes	Optional Enumeration
612/338	Set		Stopping Time Limit	-	-	O	O	O	O	Yes	
611/337	Set		Stopping Torque	-	-	-	R	R	R	Yes	
49	Get	T	Strobe Actual Position	-	R	R	R	R	R		
97	Get	T	Strobe Command Position	-	-	R	R	R	-		
103	Get	T	Strobe Master Offset	-	-	R	R	R	-		
252	Set		System Acceleration Base	-	R	R	R	R	R		
169	Set		System Bandwidth	-	-	-	R	R	R		Derived – Servo BW
204	Set		System Damping	-	-	-	R	R	R		Derived – Damp. Fact.
496	Set	T	System Inertia	-	-	-	R	R	O	Yes	
555	Set		Torque Integral Time Constant	-	-	-	O	O	O	Yes	
827	Set		Torque Lead Lag Filter Bandwidth	-	-	-	O	O	O	Yes	
828	Set		Torque Lead Lag Filter Gain	-	-	-	O	O	O	Yes	
505/333	Set	T	Torque Limit - Negative	-	-	-	R	R	R	Yes	
504/332	Set	T	Torque Limit - Positive	-	-	-	R	R	R	Yes	
554	Set		Torque Loop Bandwidth	-	-	-	O	O	O	Yes	
502	Set	T	Torque Low Pass Filter Bandwidth	-	-	-	O	O	O	Yes	

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
843	Get	T	Torque Low Pass Filter Bandwidth Estimate	-	-	-	O	O	O	Yes	V26
503	Set		Torque Notch Filter Frequency	-	-	-	O	O	O	Yes	
841	Get	T	Torque Notch Filter Frequency Estimate	-	-	-	O	O	O	Yes	V26
837	Set		Torque Notch Filter High Frequency Limit	-	-	-	O	O	O	Yes	V26
838	Set		Torque Notch Filter Low Frequency Limit	-	-	-	O	O	O	Yes	V26
842	Get	T	Torque Notch Filter Magnitude Estimate	-	-	-	O	O	O	Yes	V26
839	Set		Torque Notch Filter Tuning Threshold	-	-	-	O	O	O	Yes	V26
232	Set		Torque Offset	-	-	-	R	R	R		
591	Set		Torque Prove Current	-	-	O	O	O	O	Yes	V26
506	Set		Torque Rate Limit	-	-	-	O	O	O	Yes	
492	Get	T	Torque Reference	-	-	-	R	R	R	Yes	
493	Get	T	Torque Reference Filtered	-	-	-	R	R	R	Yes	
494	Get	T	Torque Reference Limited	-	-	-	R	R	R	Yes	
507/334	Set		Torque Threshold	-	-	-	O	O	O	Yes	
491	Set	T	Torque Trim	-	-	-	R	R	R	Yes	
206	Set		Total Inertia	-	-	-	R	R	R		Rotary Motor only
207	Set		Total Mass	-	-	-	R	R	R		Linear Motor only
1371	Set		Transmission Ratio Input	-	C	C	C	C	C	Yes	(R) Controller only attribute, Motion Scaling Configuration set to Controller Scaling; (O) Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling
1372	Set		Transmission Ratio Output	-	C	C	C	C	C	Yes	(R) Controller only attribute Motion Scaling Configuration set to Controller Scaling; (O) Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling
71	Set		Travel Mode	-	R	R	R	R	R	Yes	Controller only attribute, Motion Scaling Configuration set to Controller Scaling; Drive replicated attribute, Motion Scaling Configuration set to Drive Scaling
76	Set		Travel Range	-	R	-	R	R	R		E
181	Get		Tune Acceleration	-	-	-	R	R	R		
179	Get		Tune Acceleration Time	-	-	-	R	R	R		
182	Get		Tune Deceleration	-	-	-	R	R	R		
180	Get		Tune Deceleration Time	-	-	-	R	R	R		
187	Set		Tune Friction	-	-	-	R	R	R		
186	Set		Tune Inertia Mass	-	-	-	R	R	R		
188	Set		Tune Load Offset	-	-	-	R	R	R		
178	Get		Tune Status	-	-	-	R	R	R		

Attr. ID	Access Rule	Tag	Attribute Name	B	E	F	P	V	T	C/D	Conditional Implementation
191	Set		Tuning Direction	-	-	-	R	R	R		
190	Set		Tuning Select	-	-	-	R	R	R		
194	Set		Tuning Speed	-	-	-	R	R	R		
195	Set		Tuning Torque	-	-	-	R	R	R		
193	Set		Tuning Travel Limit	-	-	-	R	R	R		
510	Set		Undertorque Limit	-	-	O	O	O	O	Yes	
511	Set		Undertorque Limit Time	-	-	O	O	O	O	Yes	
464/321	Set		Velocity Droop	-	-	O	O	O	-	Yes	
455/135	Get	T	Velocity Error	-	-	-	R	R	-	Yes	
465	Set		Velocity Error Tolerance	-	-	-	O	O	-	Yes	
466	Set		Velocity Error Tolerance Time	-	-	-	O	O	-	Yes	
454/134	Get	T	Velocity Feedback	-	R	R	R	R	R	Yes	
433	Get	T	Velocity Feedforward Command	-	-	-	R	-	-	Yes	
440/215	Set	T	Velocity Feedforward Gain	-	-	-	R	-	-	Yes	
366	Get	T	Velocity Fine Command	-	-	-	O	O	-	Yes	
462	Set	T	Velocity Integrator Bandwidth	-	-	-	R	R	-	Yes	
467	Set		Velocity Integrator Control	-	-	-	R	R	-	Yes	Optional bit maps
456	Get	T	Velocity Integrator Output	-	-	-	R	R	-	Yes	
468	Set		Velocity Integrator Preload	-	-	-	O	O	-	Yes	
474/326	Set		Velocity Limit - Negative	-	-	O	O	O	-	Yes	
473/325	Set		Velocity Limit - Positive	-	-	O	O	O	-	Yes	
458	Get	T	Velocity Limit Source	-	-	-	O	O	-	Yes	V29
471	Set		Velocity Lock Tolerance	-	-	O	O	O	-	Yes	
461	Set	T	Velocity Loop Bandwidth	-	-	-	R	R	-	Yes	
457	Get	T	Velocity Loop Output	-	-	-	R	R	-	Yes	
469	Set	T	Velocity Low Pass Filter Bandwidth	-	-	-	O	O	-	Yes	
790	Set		Velocity Negative Feedforward Gain	-	-	-	O	O	-	Yes	
231	Set		Velocity Offset	-	-	-	R	R	-		
453	Get	T	Velocity Reference	-	-	R	R	R	-	Yes	
198	Set		Velocity Servo Bandwidth	-	-	-	R	R	-		
472/329	Set		Velocity Standstill Window	-	R	R	R	R	R	Yes	
470/327	Set		Velocity Threshold	-	O	O	O	O	O	Yes	
451	Set	T	Velocity Trim	-	-	R	R	R	-	Yes	
589	Set		Vertical Load Control	-	-	O	O	O	-	Yes	V31
15	Get		Watch Event Task	-	R	R	R	R	R		E
54	Get	T	Watch Position	-	R	-	R	R	R		E
608	Set		Zero Speed	-	-	O	O	O	O	Yes	V26
609	Set		Zero Speed Time	-	-	O	O	O	O	Yes	V26

See also

[CIP Axis Attributes on page 185]

[Motion Instruction Compatibility on page 22]

Attribute Conversion from SERCOS to Integrated Motion on the Ethernet/IP Network

The following table illustrates the methods used to convert a L5K file from a Logix Designer project that uses an existing Allen-Bradley® SERCOS drive to a comparable CIP Motion compliant drive.

SERCOS Attribute Name	L5K Example	CIP Axis Attribute Name	Conversion Method
MotionGroup	"MyGroup"	MotionGroup	Direct
MotionModule	"SercosDrive:Ch13"	MotionModule	Direct
RotationalPosResolution	200000	MotionResolution	Direct
ConversionConstant	200000	ConversionConstant	Direct
OutputCamExecutionTargets	0	OutputCamExecutionTargets	Direct
PositionUnits	"Position Units"	PositionUnits	Direct
AverageVelocityTimebase	0.25	AverageVelocityTimebase	Direct
RotaryAxis	Linear	RotaryAxis	Direct
PositionUnwind	200000	PositionUnwind	Direct
HomeMode	Active	HomeMode	Direct
HomeDirection	Bi-directional Forward	HomeDirection	Direct
HomeSequence	Immediate	HomeSequence	Direct
HomeConfigurationBits	16#0000_0000	HomeConfigurationBits	Direct
HomePosition	0	HomePosition	Direct
HomeOffset	0	HomeOffset	Direct
HomeSpeed	0	HomeSpeed	Direct
HomeReturnSpeed	0	HomeReturnSpeed	Direct
MaximumSpeed	70.833336	MaximumSpeed	Direct
MaximumAcceleration	14025.113	MaximumAcceleration	Direct
MaximumDeceleration	14025.113	MaximumDeceleration	Direct
ProgrammedStopMode	Fast Stop	ProgrammedStopMode	Direct
MasterInputConfigurationBits	1	MasterInputConfigurationBits	Direct
MasterPositionFilterBandwidth	0.1	MasterPositionFilterBandwidth	Direct
AxisType	Servo	AxisConfiguration FeedbackConfiguration	Enum Mapping
ServoLoopConfiguration	Position Servo	AxisConfiguration FeedbackConfiguration	Enum Mapping
FaultConfigurationBits	32	ExceptionAction	Enum Mapping
AxisInfoSelect1	<none>	CyclicReadUpdateList	Enum to Attr ID Element 0
AxisInfoSelect2	<none>	CyclicReadUpdateList	Enum to Attr ID Element 1

SERCOS Attribute Name	**L5K Example**	**CIP Axis Attribute Name**	**Conversion Method**
VelocityFeedforwardGain	0	VelocityFeedforwardGain	Direct
AccelerationFeedforwardGain	0	AccelerationFeedforwardGain	Direct
PositionProportionalGain	528.1571	PositionLoopBandwidth	1/2p
PositionIntegralGain	0	PositionIntegratorBandwidth	1/2p * 1000/Kpp
VelocityProportionalGain	1352.0822	VelocityLoopBandwidth	1/2p
VelocityIntegralGain	0	PositionIntegratorBandwidth	1/2p * 1000/Kpv
TorqueScaling	0.01749257	SystemInertia	Conversion Const/Drive Res
OutputLPFilterBandwidth	0	TorqueLPFilterBandwidth	Direct
IntegratorHoldEnable	Enabled	PositionIntegratorControl VelocityIntegratorControl	Bit 0 Mapping Bit 0 Mapping
MaximumPositiveTravel	0	MaximumPositiveTravel	Direct
MaximumNegativeTravel	0	MaximumNegativeTravel	Direct
PositionErrorTolerance	0.3155627	PositionErrorTolerance	Direct
PositionLockTolerance	0.01	PositionLockTolerance	Direct
VelocityOffset	0	VelocityOffset	Direct
TorqueOffset	0	TorqueOffset	Direct
FrictionCompensation	0	FrictionCompensation	Direct
FrictionCompensationWindow	0	FrictionCompensationWindow	Direct
BacklashStabilizationWindow	0	BacklashStabilizationWindow	Direct
BacklashReversalOffset	0	BacklashReversalOffset	Direct
HardOvertravelFaultAction	Disable Drive	CIPAxisExceptionAction	Enum Mapping
SoftOvertravelFaultAction	Disable Drive	MotionExceptionAction	Enum Mapping
PositionErrorFaultAction	Disable Drive	CIPAxisExceptionAction	Enum Mapping
FeedbackFaultAction	Disable Drive	CIPAxisExceptionAction	Enum Mapping
FeedbackNoiseFaultAction	Disable Drive	CIPAxisExceptionAction	Enum Mapping
TestIncrement	0	TestIncrement	Direct
TuningTravelLimit	0	TuningTravelLimit	Direct
TuningSpeed	0	TuningSpeed	Direct
TuningTorque	100	TuningTorque	Direct
DampingFactor	0.8	DampingFactor	Direct
DriveModelTimeConstant	2.89E-04	DriveModelTimeConstant	Direct
PositionServoBandwidth	84.058815	N/A	
VelocityServoBandwidth	215.19055	N/A	
TuningConfigurationBits	16#0000_0000	TuningConfigurationBits	Direct
TorqueLimitSource	Not Limited	TorqueLimitSource	Direct
DriveUnit	Motor Rev	MotionUnit	Direct
PositionDataScaling	10	N/A	
PositionDataScalingFactor	1	N/A	
PositionDataScalingExp	0	N/A	
VelocityDataScaling	2	N/A	
VelocityDataScalingFactor	1	N/A	

SERCOS Attribute Name	**L5K Example**	**CIP Axis Attribute Name**	**Conversion Method**
VelocityDataScalingExp	0	N/A	
AccelerationDataScaling	2	N/A	
AccelerationDataScalingFactor	1	N/A	
AccelerationDataScalingExp	0	N/A	
TorqueDataScaling	0	N/A	
TorqueDataScalingFactor	1	N/A	
TorqueDataScalingExp	0	N/A	
DrivePolarity	Positive	MotionPolarity	Enum Mapping
MotorFeedbackType	"SRM"	Feedback1Type	Enum Mapping
MotorFeedbackResolution	1024	Feedback1CycleResolution	Direct
AuxFeedbackType	"<NA>"	Feedback2Type	Enum Mapping
AuxFeedbackResolution	4000	Feedback2CycleResolution	Direct
MotorFeedbackUnit	Rev	Feedback1Unit	Enum Mapping
AuxFeedbackUnit	Rev	Feedback2Unit	Enum Mapping
OutputNotchFilterFrequency	0	TorqueNotchFilterFrequecy	Freq Unit Scaling
VelocityDroop	0	VelocityDroop	Direct
VelocityLimitBipolar	83.333336	N/A	
AccelerationLimitBipolar	33000.266	N/A	
TorqueLimitBipolar	288.62973	N/A	
VelocityLimitPositive	83.333336	VelocityLimitPositive	Direct
VelocityLimitNegative	-83.333336	VelocityLimitNegative	Direct
VelocityThreshold	0	VelocityThreshold	Direct
VelocityWindow	1	VelocityWindow	Direct
VelocityStandstillWindow	1	VelocityStandstillWindow	Direct
AccelerationLimitPositive	33000.266	AccelerationLimit	Direct
AccelerationLimitNegative	-33000.266	DecelerationLimit	Direct
TorqueLimitPositive	288.62973	TorqueLimitPositive	Direct
TorqueLimitNegative	-288.62973	TorqueLimitNegative	Direct
TorqueThreshold	0	TorqueThreshold	Direct
DriveThermalFaultAction	Disable Drive	CIPAxisExceptionAction	Enum Mapping
MotorThermalFaultAction	Disable Drive	CIPAxisExceptionAction	Enum Mapping
DriveEnableInputFaultAction	Disable Drive	CIPAxisExceptionAction	Enum Mapping
StoppingTorque	288.62973	StoppingTorque	Direct
StoppingTimeLimit	10	StoppingTimeLimit	Direct
BrakeEngageDelayTime	0	BrakeEngageDelayTime	Direct
BrakeReleaseDelayTime	0	BrakeReleaseDelayTime	Direct
PowerSupplyID	"2094-AC05-M01"	(Module Configuration)	
BusRegulatorID	"<none>"	(Module Configuration)	
PWMFrequencySelect	High Frequency	N/A	
LoadInertiaRatio	0	LoadInertiaRatio	Direct
AmplifierCatalogNumber	"2094-AC05-M01"	(Module Configuration)	

SERCOS Attribute Name	L5K Example	CIP Axis Attribute Name	Conversion Method
MotorCatalogNumber	"MPL-A310P-M"	MotorCatalogNumber	Direct
AuxFeedbackRatio	1	FeedbackUnitRatio	1/x
ContinuousTorqueLimit	100	MotorOverloadLimit	Direct
ResistiveBrakeContactDelay	0	ResistiveBrakeContactDelay	Direct
MaximumAccelerationJerk	2776994.8	MaximumAccelerationJerk	Direct
MaximumDecelerationJerk	2776994.8	MaximumDecelerationJerk	Direct
DynamicsConfigurationBits	7	DynamicsConfigurationBits	Direct
PhaseLossFaultAction	Shutdown	CIPAxisExceptionAction	Enum Mapping
HomeTorqueLevel	0	HomeTorqueLevel	Direct
InputPowerPhase	Three-Phase	(Module Configuration)	

Drive Supported Optional Attributes

The following tables describe the optional attributes that are supported for the Kinetix 350, Kinetix 5500, Kinetix 5700, Kinetix 6500, PowerFlex 755 Standard, and the PowerFlex 755 Safety drives.

- Kinetix 350 Drive Module Optional Attributes on page 116
- Kinetix 5500 Hardwired STO Drive Module Optional Attributes on page 122
- Kinetix 5500 Integrated STO Drive Module Optional Attributes on page 130
- Kinetix 5700 Drive Module Optional Attributes on page 138
- Kinetix 5700 Advanced Safety Drive Module Optional Attributes on page 147
- Kinetix 6500 Drive Module Optional Attributes on page 155
- PowerFlex 527 Axis Instance Optional Attributes on page 161
- PowerFlex 755 Standard Drive Module Optional Attributes on page 168
- PowerFlex 755 Safety Drive Module Optional Attributes on page 174

The tables use the following abbreviations:

Key	Description
Y	The attribute/enum/bit is supported.
Y#	The attribute was not supported until the major revision of the drive. (indicated by the # value)
N	The attribute/enum/bit is NOT supported.
R	The attribute is required.
O	The attribute is optional.
B	Bus Power Converters (No Control Mode, No Control Method)

Key	Description
E	Encoder, Feedback Only (No Control Mode, No Control Method)
P	Position Loop (Position Control Mode, Closed Loop Vector Control Method)
V	Velocity Loop (Velocity Control Mode, Close Loop Vector Control Method)
T	Torque Loop (Torque Control Mode, Closed Loop Vector Control Method)
F	Frequency Control (Velocity Control Mode, Frequency Control Method)
C/D	Controller/Device Replicated Attribute
AOP	Special device specific semantics needed from AOP
Co	Controller only attribute (controller attribute that resides only in controller)
C/D	Yes = The attribute is replicated in the drive
CScale	Motion Scaling Configuration set to Controller Scaling
Derived	Implementation rules follow another attribute
Dr	Drive replicated attribute (controller attribute that is replicated in drive)
Drive Scaling	Drive device supports drive scaling functionality
DScale	Motion Scaling Configuration set to Drive Scaling
ED	EnDat 2.1 and EnDAT 2.2 (feedback type)
E	Encoder-based control, a feedback device is present
!E	Encoderless or sensorless control, a feedback device in not present
HI	Hiperface (feedback type)
IM	Rotary or Linear Induction Motor (motor type)
Linear Absolute	Feedback Unit - meter; Feedback n Startup Method- absolute
Linear Motor	Linear PM motor or Linear Induction motor (motor type)
LT	LDT or Linear Displacement Transducer (feedback type)
NV	Motor NV or Drive NV (motor data source)
O-Bits	Optional bits associated with bit mapped attribute
O-Enum	Optional enumerations associated with attribute
PM	Rotary or Linear Permanent Magnet motor (motor type)
Rotary Absolute	Feedback Unit - rev; Feedback n Startup Method - absolute
Rotary Motor	Rotary PM motor or Rotary Induction motor (motor type)
SC	Sine/Cosine (feedback type)
SL	Stahl SII (feedback type)
SS	SSI (feedback type)
TM	Tamagawa (feedback type)
TP	Digital Parallel (feedback type)
TT	Digital AqB (feedback type)

See also

Device Function Codes on page 91

Attribute Conversion from SERCOS to Integrated Motion on the Ethernet/IP Network on page 111

MSG Instruction Access Only Attributes on page 181

Kinetix 350 Drive Module Optional Attributes

A Kinetix 350 drive module supports the following optional attributes and corresponding control mode functionalities:

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
367	Get	Acceleration Fine Command		-	-	Y	Y	Y	
485	Set	Acceleration Limit		-	N	N	N	N	
482	Get	Acceleration Reference		-	-	N	N	N	
481	Set	Acceleration Trim		-	-	N	N	N	
1376	Set	Actuator Diameter		N	N	N	N	N	DScale
1377	Set	Actuator Diameter Unit		N	N	N	N	N	DScale
1374	Set	Actuator Lead		N	N	N	N	N	DScale
1375	Set	Actuator Lead Unit		N	N	N	N	N	DScale
1373	Set	Actuator Type		N	N	N	N	N	DScale
732/267	Get	Analog Input 1	Y	-	N	N	N	N	
733/268	Get	Analog Input 2	Y	-	N	N	N	N	
734	Set	Analog Output 1	Y	-	N	N	N	N	
735	Set	Analog Output 2	Y	-	N	N	N	N	
30	Set	Axis Configuration		R	R	R	R	R	0-Enum 0 = Feedback Only (N) 1 = Frequency Control (N) 2 = Position Loop (Y) 3 = Velocity Loop (Y) 4 = Torque Loop (Y)
19	Set	Axis Features		R	R	R	R	R	0-Bits 0 = Fine Interpolation (Y) 1 = Registration Auto-rearm (Y) 2 = Alarm Log (Y) 5 = Hookup Test (Y) 6 = Commutation Test (N) 7 = Motor Test (N) 8 = Inertia Test (Y) 9 = Sensorless Control (N)
763	Get	Axis Safety Faults		0	0	0	0	Y	
760	Get	Axis Safety State		0	0	0	0	Y	
761	Get	Axis Safety Status		0	0	0	0	Y	
825	Set	Backlash Compensation Window		-	-	N	-	-	
638/262	Get	Bus Regulator Capacity		-	N	N	N	N	
659	Get	CIP Axis Alarms		N	N	N	N	N	
904	Get	CIP Axis Alarms - RA		N	N	N	N	N	

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
563	Set	Commutation Polarity		-	-	N	N	N	PM Motor only
562	Set	Commutation Self-Sensing Current		-	-	N	N	N	PM Motor only 0-Value = #
637	Get	Converter Capacity		-	N	Y	Y	Y	
840	Set	Current Disturbance		-	-	N	N	N	
527	Get	Current Error		-	-	Y	Y	Y	
529	Get	Current Feedback		-	-	Y	Y	Y	
522	Get	Current Limit Source		-	-	Y	Y	Y	
524	Get	Current Reference		-	-	Y	Y	Y	
553	Set	Current Vector Limit		-	N	N	N	N	
870	Set	DC Injection Brake Current		-	N	N	N	N	Ind Motor only
872	Set	DC Injection Brake Time		-	N	N	N	N	Ind Motor only
486	Set	Deceleration Limit		-	N	N	N	N	
730	Get	Digital Inputs		-	N	N	N	N	
731	Set	Digital Outputs		-	N	N	N	N	
1435	Set	Feedback 1 Accel Filter Bandwidth		0	-	Y	Y	Y	
2404	Set	Feedback 1 Accel Filter Taps		N	-	N	N	N	
2405	Set	Feedback 1 Battery Absolute		-	-	Y	Y	Y	TM
1421	Set	Feedback 1 Data Code		N	-	N	N	N	TP,SS
1420	Set	Feedback 1 Data Length		N	-	N	N	N	TP,SS
2400	Set	Feedback 1 Loss Action		N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1414	Set	Feedback 1 Polarity		N	-	N	N	N	Check on this
1425	Set	Feedback 1 Resolver Cable Balance		N	-	N	N	N	RS
1424	Set	Feedback 1 Resolver Excitation Frequency		N	-	N	N	N	RS
1423	Set	Feedback 1 Resolver Excitation Voltage		N	-	N	N	N	RS
1422	Set	Feedback 1 Resolver Transformer Ratio		N	-	N	N	N	RS
1401	Get	Feedback 1 Serial Number		N	-	Y	Y	Y	
1415	Set	Feedback 1 Startup Method		R	-	R	R	R	0-Enum 1 = Absolute (Y)
1434	Set	Feedback 1 Velocity Filter Bandwidth		-	-	Y	Y	Y	
2403	Set	Feedback 1 Velocity Filter Taps		N	-	N	N	N	
1485	Set	Feedback 2 Accel Filter Bandwidth		N	-	N	N	N	
2454	Set	Feedback 2 Accel Filter Taps		N	-	N	N	N	
2455	Set	Feedback 2 Battery Absolute		N	-	N	N		TM
1471	Set	Feedback 2 Data Code		N	-	N	N	N	TP,SS
1470	Set	Feedback 2 Data Length		N	-	N	N	N	TP,SS
2450	Set	Feedback 2 Loss Action		N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1464	Set	Feedback 2 Polarity		0	-	N	N	N	

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
1475	Set	Feedback 2 Resolver Cable Balance		N	-	N	N	N	RS
1474	Set	Feedback 2 Resolver Excitation Frequency		N	-	N	N	N	RS
1473	Set	Feedback 2 Resolver Excitation Voltage		N	-	N	N	N	RS
1472	Set	Feedback 2 Resolver Transformer Ratio		N	-	N	N	N	RS
1451	Get	Feedback 2 Serial Number		O	-	N	N	N	
1465	Set	Feedback 2 Startup Method		R	-	R	R	R	O-Enum 1 = Absolute (N)
1484	Set	Feedback 2 Velocity Filter Bandwidth		N	-	N	N	N	
2453	Set	Feedback 2 Velocity Filter Taps		N	-	N	N	N	
250	Set	Feedback Commutation Aligned		-	-	N	N	N	O-Enum 2 = Motor Offset (N) 3 = Self-Sense (N)
31	Set*	Feedback Configuration		R	R	R	R	R	O-Enum 0 = No Feedback (V/N)(T/N) 3 = Load Feedback (PVT/N) 4 = Dual Feedback (P/N) 8 = Dual Integrator Feedback (P/N)
708	Set	Feedback Data Loss User Limit		N	N	N	N	N	
706	Set	Feedback Noise User Limit		N	N	N	N	N	
707	Set	Feedback Signal Loss User Limit		N	N	N	N	N	
44	Set	Feedback Unit Ratio		-	-	N	N	-	
871	Set	Flux Braking Enable		-	N	N	N	N	Ind Motor only
528	Get	Flux Current Error		-	-	N	N	N	
530	Get	Flux Current Feedback		-	-	N	N	N	
525	Get	Flux Current Reference		-	-	N	N	N	
557	Set	Flux Integral Time Constant		-	-	N	N	N	
556	Set	Flux Loop Bandwidth		-	-	N	N	N	
558	Set	Flux Up Control		-	N	N	N	N	Ind Motor only O-Enum 1 = Manual Delay (N) 2 = Automatic Delay (N)
559	Set	Flux Up Time		-	N	N	N	N	Ind Motor only
380	Set	Flying Start Enable		-	N	-	N	-	
570	Set	Frequency Control Method		-	R	-	-	-	O-Enum 128 = Fan/Pump Volts/Hertz (N) 129 = Sensorless Vector (N) 130 = Sensorless Vector Economy (N)
498	Set	Friction Compensation Sliding		-	-	N	N	N	
499	Set	Friction Compensation Static		-	-	N	N	N	
500	Set	Friction Compensation Viscous		-	-	N	N	N	
826/421	Set	Friction Compensation Window		-	-	N	-	-	
981/243	Get	Guard Faults		-	N	N	N	N	
980/242	Get	Guard Status		-	N	Y	Y	Y	

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
1349	Set	Induction Motor Magnetization Reactance		-	N	N	N	N	Ind Motor only
1352	Set	Induction Motor Rated Slip Speed		-	N	N	N	N	Ind Motor only
1350	Set	Induction Motor Rotor Resistance		-	N	N	N	N	Ind Motor only
647	Set	Inverter Overload Action		-	N	Y	Y	Y	0-Enum 1 = Current Foldback (Y) 128 = Reduce PWM Rate (N) 129 = PWM Foldback (N)
699	Set	Inverter Thermal Overload User Limit		-	N	N	N	N	
1338	Set	Linear Motor Damping Coefficient		-	N	N	N	N	Linear Motor only
2313	Set	Linear Motor Integral Limit Switch		-	N	N	N	N	Linear Motor only
1336	Set	Linear Motor Mass		-	N	N	N	N	Linear Motor only
1337	Set	Linear Motor Max Speed		-	N	N	N	N	Linear Motor only
801	Get	Load Observer Acceleration Estimate		-	-	N	N	N	
806	Set	Load Observer Bandwidth		-	-	N	N	N	
805	Set	Load Observer Configuration		-	-	N	N	N	0-Enum 1 = Load Observer Only (N) 2 = Load Observer with Velocity Estimate (N) 3 = Velocity Estimate Only (N) 4 = Acceleration Feedback (N)
809	Set	Load Observer Feedback Gain		-	-	N	N	N	
807	Set	Load Observer Integrator Bandwidth		-	-	N	N	N	
802	Get	Load Observer Torque Estimate		-	-	N	N	N	
1370	Set	Load Type		N	N	N	N	N	DScale
750	Set	Local Control		N	N	N	N	N	0-Enum 1 = Conditionally Allowed (N) 2 = Allowed (N)
614	Set	Mechanical Brake Control		-	N	Y	Y	Y	
616	Set	Mechanical Brake Engage Delay		-	N	Y	Y	Y	
615	Set	Mechanical Brake Release Delay		-	N	Y	Y	Y	
45	Set	Motion Scaling Configuration		R	R	R	R	R	0-Enum 1 = Drive Scaling (N)
1310/251	Set	Motor Catalog Number		-	N	Y	Y	Y	Dr NV
1313	Set	Motor Data Source		-	R	R	R	R	0-Enum 1 = Database (Y) 2 = Drive NV (N) 3= Motor NV (N)
1323	Set	Motor Integral Thermal Switch		-	N	Y	Y	Y	
1324	Set	Motor Max Winding Temperature		-	N	N	N	N	
646	Set	Motor Overload Action		-	N	Y	Y	Y	0-Enum 1 = Current Foldback (Y)
1322	Set	Motor Overload Limit		-	N	Y	Y	Y	
695	Set	Motor Overspeed User Limit		-	N	N	N	N	
1317	Set	Motor Polarity		-	N	N	N	N	Check on this
1321	Set	Motor Rated Output Power		-	N	Y	Y	Y	0-IM

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
1320	Set	Motor Rated Peak Current		-	N	Y	Y	Y	O-IM
697	Set	Motor Thermal Overload User Limit		-	N	N	N	N	
1315	Set	Motor Type		-	R	R	R	R	O-Enum 1 = Rotary Permanent Magnet (Y) 2 = Rotary Induction (N) 3 = Linear Permanent Magnet (N) 4 = Linear Induction (N)
1325	Set	Motor Winding to Ambient Capacitance		-	N	Y	Y	Y	
1326	Set	Motor Winding to Ambient Resistance		-	N	Y	Y	Y	
521	Get	Operative Current Limit		-	-	Y	Y	Y	
600	Get	Output Frequency		-	R	N	N	N	
508	Set	Overtorque Limit		-	N	Y	Y	Y	
509	Set	Overtorque Limit Time		-	N	Y	Y	Y	
2310	Set	PM Motor Flux Saturation		-	N	Y	Y	Y	
1343	Set	PM Motor Force Constant		-	N	Y	Y	Y	Rotary PM Motor only
1342	Set	PM Motor Rated Force		-	N	Y	Y	Y	Rotary PM Motor only
1339	Set	PM Motor Rated Torque		-	N	Y	Y	Y	Rotary PM Motor only
1340	Set	PM Motor Torque Constant		-	-	Y	Y	Y	Rotary PM Motor only
445	Set	Position Error Tolerance Time		-	-	Y	-	-	
365	Get	Position Fine Command		-	-	Y	-	-	
446	Set	Position Integrator Control		-	-	R	-	-	O-Bits 1: Auto-Preset (N)
447	Set	Position Integrator Preload		-	-	N	-	-	
781	Set	Position Lead Lag Filter Bandwidth		-	-	N	-	-	
782	Set	Position Lead Lag Filter Gain		-	-	N	-	-	
783	Set	Position Notch Filter Frequency		-	-	Y	-	-	
627	Set	Power Loss Action		-	N	N	N	N	O-Enum 2 = Decel Regen (N)
628	Set	Power Loss Threshold		-	N	N	N	N	
630	Set	Power Loss Time		-	N	N	N	N	
376	Set*	Ramp Acceleration		-	N	-	N	-	Derived
377	Set*	Ramp Deceleration		-	N	-	N	-	Derived
378	Set	Ramp Jerk Control		-	N	-	N	-	
375	Set*	Ramp Velocity - Negative		-	N	-	N	-	Derived
374	Set*	Ramp Velocity - Positive		-	N	-	N	-	Derived
613/354	Set	Resistive Brake Contact Delay		-	N	N	N	N	PM Motor only
1333	Set	Rotary Motor Damping Coefficient		-	N	N	N	N	Rotary Motor only
2312	Set	Rotary Motor Fan Cooling Derating		-	N	N	N	N	Rotary Motor only
2311	Set	Rotary Motor Fan Cooling Speed		-	N	N	N	N	Rotary Motor only
1330	Set	Rotary Motor Inertia		-	-	Y	Y	Y	Rotary Motor only
1332	Set	Rotary Motor Max Speed		-	-	Y	Y	Y	Rotary Motor only

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
629	Set	Shutdown Action		-	N	N	N	N	0-Enum 1 = Drop DC Bus (N)
370	Set	Skip Speed 1		-	N	-	-	-	
371	Set	Skip Speed 2		-	N	-	-	-	
372	Set	Skip Speed 3		-	N	-	-	-	
373	Set	Skip Speed Band		-	N	-	-	-	
833	Set	SLAT Configuration		-	-	-	N	-	
834	Set	SLAT Set Point		-	-	-	N	-	
835	Set	SLAT Time Delay		-	-	-	N	-	
610	Set	Stopping Action		-	R	R	R	R	0-Enum 2 = Ramped Decel Disable (FPV/N) 3 = Current Decel Hold (PV/N) 4 = Ramped Decel Hold (PV/N) 128 = DC Injection Brake (IM/N) 129 = AC Injection Brake (IM/N)
612	Set	Stopping Time Limit		-	-	Y	Y	Y	
496	Set	System Inertia		-	-	R	R	N	
555	Set	Torque Integral Time Constant		-	-	N	N	N	
827	Set	Torque Lead Lag Filter Bandwidth		-	-	N	N	N	
828	Set	Torque Lead Lag Filter Gain		-	-	N	N	N	
554	Set	Torque Loop Bandwidth		-	-	Y	Y	Y	
502	Set	Torque Low Pass Filter Bandwidth		-	-	Y	Y	Y	
503	Set	Torque Notch Filter Frequency		-	-	Y	Y	Y	
506	Set	Torque Rate Limit		-	-	N	N	N	
507/334	Set	Torque Threshold		-	-	N	N	N	
1371	Set	Transmission Ratio Input		N	N	N	N	N	DScale
1372	Set	Transmission Ratio Output		N	N	N	N	N	DScale
510	Set	Undertorque Limit		-	N	Y	Y	Y	
511	Set	Undertorque Limit Time		-	N	Y	Y	Y	
464/321	Set	Velocity Droop		-	N	N	N	-	
465	Set	Velocity Error Tolerance		-	-	Y	Y	-	
466	Set	Velocity Error Tolerance Time		-	-	Y	Y	-	
366	Get	Velocity Fine Command		-	-	Y	Y	-	
467	Set	Velocity Integrator Control		-	-	R	R	-	0-Bits 1: Auto-Preset (N)
468	Set	Velocity Integrator Preload		-	-	N	N	-	
474/326	Set	Velocity Limit - Negative		-	N	Y	Y	-	
473/325	Set	Velocity Limit - Positive		-	N	Y	Y	-	
471	Set	Velocity Lock Tolerance		-	N	Y	Y	-	
469	Set	Velocity Low Pass Filter Bandwidth		-	-	Y	Y	-	
790	Set	Velocity Negative Feedforward Gain		-	-	N	N	-	
470/327	Set	Velocity Threshold		-	N	Y	Y	-	

Kinetix 5500 Hardwired STO Drive Module Optional Attributes

The hardwired Kinetix 5500 drive modules include the following catalog numbers:

- 2198-H003-ERS, Kinetix 5500, 1A, 195-528 Volt, Safe Torque Off Drive
- 2198-H008-ERS, Kinetix 5500, 2.5A, 195-528 Volt, Safe Torque Off Drive
- 2198-H015-ERS, Kinetix 5500, 5 A, 195 – 528 Volt, Safe Torque Off Drive
- 2198-H025-ERS, Kinetix 5500, 8A, 195- 528 Volt, Safe Torque Off Drive
- 2198-H040-ERS, Kinetix 5500, 13 A, 192-528 Volt, Safe Torque Off Drive
- 2198-H070-ERS Kinetix 5500, 23 A,195–528 Volt, Safe Torque Off Drive

These drive modules support the optional attributes and corresponding control mode functionality as indicated in the following table:

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
367	Get	Acceleration Fine Command		-	-	Y	Y	Y	
485	Set	Acceleration Limit		-	N	Y	Y	N	
482	Get	Acceleration Reference		-	-	Y	Y	N	
481	Set	Acceleration Trim		-	-	N	N	N	
1376	Set	Actuator Diameter		N	N	N	N	N	DScale
1377	Set	Actuator Diameter Unit		N	N	N	N	N	DScale
1374	Set	Actuator Lead		N	N	N	N	N	DScale
1375	Set	Actuator Lead Unit		N	N	N	N	N	DScale
1373	Set	Actuator Type		N	N	N	N	N	DScale
836	Set	Adaptive Tuning Configuration		-	-	Y	Y	Y	V26/V27
844	Get	Adaptive Tuning Gain Scaling Factor		-	-	Y	Y	Y	V26/V27
732/267	Get	Analog Input 1	N	-	N	N	N	N	
733/268	Get	Analog Input 2	N	-	N	N	N	N	
734	Set	Analog Output 1	N	-	N	N	N	N	
735	Set	Analog Output 2	N	-	N	N	N	N	
873	Set	Auto Sag Configuration		-	N	N	N	N	V26/V27
874	Set	Auto Sag Slip Increment		-	N	N	N	N	V26/V27
875	Set	Auto Sag Time Limit		-	N	N	N	N	V26/V27
876	Set	Auto Sag Start		-	N	N	N	N	V26/V27
30	Set	Axis Configuration		R	R	R	R	R	0-Enum0 = Feedback Only (Y) 1 = Frequency Control (Y) 2 = Position Loop (Y) 3 = Velocity Loop (Y) 4 = Torque Loop (Y)

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
19	Set	Axis Features	R	R	R	R	R	R	0-Bits 0 = Fine Interpolation (Y) 1 = Registration Auto-rearm (Y) 2 = Alarm Log (Y) 5 = Hookup Test (Y) 6 = Commutation Test (Y) 7 = Motor Test (Y) 8 = Inertia Test (Y) 9 = Sensorless Control (N) 10 = Drive Scaling (N) Vxx 11 = Ext. Event Block (N) Vxx 12 = Integer Cmd. Pos. (N) Vxx 13 = Ext. Motor Test (N) V29 14 = Control Mode Change (N) V26/V27 15 = Feedback Mode Change (N) Vxx 16 = Pass Bus Status (N) V26/V27 17 = Pass Bus Unload (N) V26/V27 18 = Ext. Speed for SPM (N) V29 19 = Ext. Speed for IPM (N) V29
763	Get	Axis Safety Faults		N	N	N	N	N	V24
760	Get	Axis Safety State		N	N	N	N	N	V24
761	Get	Axis Safety Status		N	N	N	N	N	V24
825	Set	Backlash Compensation Window		-	-	Y	-	-	
593	Set	Brake Prove Ramp Time		-	N	N	N	N	V26/V27
594	Set	Brake Slip Tolerance		-	Y5	Y	Y	Y	V26/V27
592	Set	Brake Test Torque		-	Y5	Y	Y	Y	V26/V27
2338	Get	Bus Output Overvoltage Factory Limit 1	N	-	N	N	N	N	Vxx
2358	Get	Bus Output Overvoltage Factory Limit 2	N	-	N	N	N	N	Vxx
2339	Get	Bus Output Undervoltage Factory Limit 1	N	-	N	N	N	N	Vxx
2359	Get	Bus Output Undervoltage Factory Limit 2	N	-	N	N	N	N	Vxx
638/262	Get	Bus Regulator Capacity	N	-	Y	Y	Y	Y	
659	Get	CIP Axis Alarms	N	Y	Y	Y	Y	Y	
904	Get	CIP Axis Alarms - RA	N	Y	Y	Y	Y	Y	
617	Set	Coasting Time Limit		-	Y	Y	Y	Y	V26/V27
850	Set	Commutation Offset Compensation		-	-	N	N	N	PM Motor only, V29
563	Set	Commutation Polarity		-	-	N	N	N	PM Motor only
562	Set	Commutation Self-Sensing Current		-	-	N	N	N	PM Motor only
637	Get	Converter Capacity	N	-	Y	Y	Y	Y	
2337	Get	Converter Output Capacity 1	N	-	N	N	N	N	Vxx
2357	Get	Converter Output Capacity 2	N	-	N	N	N	N	Vxx
605	Get	Converter Output Current	N	-	Y	Y	Y	Y	V26/V27
2330	Get	Converter Output Current 1	N	-	N	N	N	N	Vxx
2350	Get	Converter Output Current 2	N	-	N	N	N	N	Vxx
606	Get	Converter Output Power	N	-	Y	Y	Y	Y	V26/V27

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
2331	Get	Converter Output Power 1	N	-	N	N	N	N	Vxx
2351	Get	Converter Output Power 2	N	-	N	N	N	N	Vxx
2332	Get	Converter Output Rated Current 1	N	-	N	N	N	N	Vxx
2352	Get	Converter Output Rated Current 2	N	-	N	N	N	N	Vxx
2333	Get	Converter Output Rated Power 1	N	-	N	N	N	N	Vxx
2353	Get	Converter Output Rated Power 2	N	-	N	N	N	N	Vxx
840	Set	Current Disturbance		-	-	N	N	N	
527	Get	Current Error		-	-	Y	Y	Y	
529	Get	Current Feedback		-	-	Y	Y	Y	
522	Get	Current Limit Source		-	Y7	Y	Y	Y	F Support in V29
524	Get	Current Reference		-	-	Y	Y	Y	
553	Set	Current Vector Limit		-	Y	Y	Y	Y	
2334	Get	DC Bus Output Voltage 1	N	-	N	N	N	N	Vxx
2354	Get	DC Bus Output Voltage 2	N	-	N	N	N	N	Vxx
742	Get	DC Bus Output Voltage Reference	N	-	N	N	N	N	Vxx
2336	Get	DC Bus Output Voltage Reference 1	N	-	N	N	N	N	Vxx
2356	Get	DC Bus Output Voltage Reference 2	N	-	N	N	N	N	Vxx
870	Set	DC Injection Brake Current		-	N	N	N	N	
872	Set	DC Injection Brake Time		-	N	N	N	N	
486	Set	Deceleration Limit		-	N	Y	Y	N	
730	Get	Digital Inputs	N	-	N	N	N	N	
731	Set	Digital Outputs	N	-	N	N	N	N	
1435	Set	Feedback 1 Accel Filter Bandwidth		Y	-	Y	Y	Y	
2404	Set	Feedback 1 Accel Filter Taps		Y	-	Y	Y	Y	
2405	Set	Feedback 1 Battery Absolute		N	-	N	N	N	TM
1421	Set	Feedback 1 Data Code		N	-	N	N	N	TP,SS
1420	Set	Feedback 1 Data Length		N	-	N	N	N	TP,SS
2400	Set	Feedback 1 Loss Action		N	-	N	N	N	O-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1414	Set	Feedback 1 Polarity		N	-	N	N	N	
1425	Set	Feedback 1 Resolver Cable Balance		N	-	N	N	N	RS
1424	Set	Feedback 1 Resolver Excitation Frequency		N	-	N	N	N	RS
1423	Set	Feedback 1 Resolver Excitation Voltage		N	-	N	N	N	RS
1422	Set	Feedback 1 Resolver Transformer Ratio		N	-	N	N	N	RS
1401	Get	Feedback 1 Serial Number		Y	-	Y	Y	Y	
1415	Set	Feedback 1 Startup Method		R	-	R	R	R	O-Enum 1 = Absolute (Y)
1434	Set	Feedback 1 Velocity Filter Bandwidth		Y	-	Y	Y	Y	
2403	Set	Feedback 1 Velocity Filter Taps		Y	-	Y	Y	Y	
1485	Set	Feedback 2 Accel Filter Bandwidth		N	-	N	N	N	

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
2454	Set	Feedback 2 Accel Filter Taps		N	-	N	N	N	
2455	Set	Feedback 2 Battery Absolute		N	-	N	N	N	TM
1471	Set	Feedback 2 Data Code		N	-	N	N	N	TP,SS
1470	Set	Feedback 2 Data Length		N	-	N	N	N	TP,SS
2450	Set	Feedback 2 Loss Action		N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1464	Set	Feedback 2 Polarity		N	-	N	N	N	
1475	Set	Feedback 2 Resolver Cable Balance		N	-	N	N	N	RS
1474	Set	Feedback 2 Resolver Excitation Frequency		N	-	N	N	N	RS
1473	Set	Feedback 2 Resolver Excitation Voltage		N	-	N	N	N	RS
1472	Set	Feedback 2 Resolver Transformer Ratio		N	-	N	N	N	RS
1451	Get	Feedback 2 Serial Number		N	-	N	N	N	
1465	Set	Feedback 2 Startup Method		R	-	R	R	R	0-Enum 1 = Absolute (N)
1484	Set	Feedback 2 Velocity Filter Bandwidth		N	-	N	N	N	
2453	Set	Feedback 2 Velocity Filter Taps		N	-	N	N	N	
250	Set	Feedback Commutation Aligned		-	-	Y	Y	Y	0-Enum 2 = Motor Offset (Y) 3 = Self-Sense (N) 4 = Database Offset (N) Vxx
31	Set*	Feedback Configuration	R	R	R	R	R	R	0-Enum 0 = No Feedback (V/Y)(T/N) 3 = Load Feedback (P/N)(V/N)(T/N) 4 = Dual Feedback (P/N) 8 = Dual Integrator Feedback (P/N)
708	Set	Feedback Data Loss User Limit		Y	Y	Y	Y	Y	
706	Set	Feedback Noise User Limit		N	N	N	N	N	
707	Set	Feedback Signal Loss User Limit		N	N	N	N	N	
44	Set	Feedback Unit Ratio		-	-	N	N	-	
871	Set	Flux Braking Enable		-	N	N	N	N	Ind Motor only
528	Get	Flux Current Error		-	-	Y	Y	Y	
530	Get	Flux Current Feedback		-	-	Y	Y	Y	
525	Get	Flux Current Reference		-	-	Y	Y	Y	
557	Set	Flux Integral Time Constant		-	-	N	N	N	
556	Set	Flux Loop Bandwidth		-	-	N	N	N	
558	Set	Flux Up Control		-	Y	Y	Y	Y	Ind Motor only 0-Enum 1 = Manual Delay (Y) 2 = Automatic Delay (Y)
559	Set	Flux Up Time		-	Y	Y	Y	Y	Ind Motor only
380	Set	Flying Start Enable		-	N	-	N	-	
381	Set	Flying Start Method		-	N	-	N	-	0-Enum: V29 1 = Counter EMF (N) 2 = Sweep Frequency (N)

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
570	Set	Frequency Control Method		-	R	-	-	-	0-Enum 128 = Fan/Pump Volts/Hertz (Y) 129 = Sensorless Vector (Y) 130 = Sensorless Vector Economy (N)
498	Set	Friction Compensation Sliding		-	-	Y	Y	Y4	
499	Set	Friction Compensation Static		-	-	Y	Y4	Y4	
500	Set	Friction Compensation Viscous		-	-	Y	Y	Y4	
826/421	Set	Friction Compensation Window		-	-	Y	-	-	
981/243	Get	Guard Faults		-	Y	Y	Y	Y	
980/242	Get	Guard Status		-	Y	Y	Y	Y	
280	Set	Home Torque Threshold		-	-	N	N	-	Vxx
281	Set	Home Torque Time		-	-	N	N	-	Vxx
1349	Set	Induction Motor Magnetization Reactance		-	N	N	N	N	Ind Motor only
1352	Set	Induction Motor Rated Slip Speed		-	Y	N	N	N	Ind Motor only
1351	Set	Induction Motor Rotor Leakage Reactance		-	Y	Y	Y	Y	Ind Motor only, V26/V27
1350	Set	Induction Motor Rotor Resistance		-	N	N	N	N	Ind Motor only
1348	Set	Induction Motor Stator Leakage Reactance		-	Y	Y	Y	Y	Ind Motor only, V26/V27
647	Set	Inverter Overload Action		-	Y	Y	Y	Y	0-Enum 1 = Current Foldback (Y) 128 = Reduce PWM Rate (N) 129 = PWM Foldback (N)
699	Set	Inverter Thermal Overload User Limit		-	Y	Y	Y	Y	
1338	Set	Linear Motor Damping Coefficient		-	N	N	N	N	Linear Motor only
2313	Set	Linear Motor Integral Limit Switch		-	N	N	N	N	Linear Motor only
1336	Set	Linear Motor Mass		-	N	Y	Y	Y	Linear Motor only
1337	Set	Linear Motor Max Speed		-	N	Y	Y	Y	Linear Motor only
801	Get	Load Observer Acceleration Estimate		-	-	Y	Y	Y	
806	Set	Load Observer Bandwidth		-	-	Y	Y	Y	
805	Set	Load Observer Configuration		-	-	Y	Y	Y	0-Enum 1 = Load Observer Only (Y) 2 = Load Observer with Velocity Estimate (Y) 3 = Velocity Estimate Only (Y) 4 = Acceleration Feedback (N)
809	Set	Load Observer Feedback Gain		-	-	Y	Y	Y	
807	Set	Load Observer Integrator Bandwidth		-	-	Y	Y	Y	
802	Get	Load Observer Torque Estimate		-	-	Y	Y	Y	
1370	Set	Load Type		N	N	N	N	N	DScale
750	Set	Local Control	N	N	N	N	N	N	0-Enum 1 = Conditionally Allowed (N) 2 = Allowed (N)
614	Set	Mechanical Brake Control		-	Y	Y	Y	Y	
616	Set	Mechanical Brake Engage Delay		-	Y	Y	Y	Y	
615	Set	Mechanical Brake Release Delay		-	Y	Y	Y	Y	
45	Set	Motion Scaling Configuration		R	R	R	R	R	0-Enum 1 = Drive Scaling (N)

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
1310/251	Set	Motor Catalog Number		-	N	Y	Y	Y	Dr NV
1313	Set	Motor Data Source		-	R	R	R	R	0-Enum 1 = Database (Y) 2 = Drive NV (N) 3 = Motor NV (Y)
1323	Set	Motor Integral Thermal Switch		-	Y5	Y	Y	Y	
1324	Set	Motor Max Winding Temperature		-	Y5	Y	Y	Y	
646	Set	Motor Overload Action		-	Y	Y	Y	Y	0-Enum 1 = Current Foldback (Y)
1322	Set	Motor Overload Limit		-	Y	Y	Y	Y	
695	Set	Motor Overspeed User Limit		-	Y5	Y	Y	Y	
694	Set	Motor Phase Loss Limit		-	N	N	N	N	V26/V27
1317	Set	Motor Polarity		-	Y	Y	Y	Y	
1321	Set	Motor Rated Output Power		-	Y	Y	Y	Y	O-PM
1320	Set	Motor Rated Peak Current		-	Y5	Y	Y	Y	O-IM
697	Set	Motor Thermal Overload User Limit		-	Y	Y	Y	Y	
1001	Get	Motor Test Comm Offset Comp		-	R	R	R	R	IPM Motor Only, V29
999	Get	Motor Test Ld Flux Saturation		-	R	R	R	R	IPM Motor Only, V29
997	Get	Motor Test Ld Inductance		-	R	R	R	R	IPM Motor Only, V29
998	Gett	Motor Test Lq Flux Saturation		-	R	R	R	R	IPM Motor Only, V29
996	Get	Motor Test Lq Inductance		-	R	R	R	R	IPM Motor Only, V29
1000	Get	Motor Test Max Speed		-	R	R	R	R	IPM Motor Only, V29
1315	Set	Motor Type		-	R	R	R	R	0-Enum 1 = Rotary Permanent Magnet (Y) 2 = Rotary Induction (Y) 3 = Linear Permanent Magnet (N) 4 = Linear Induction (N)
1325	Set	Motor Winding to Ambient Capacitance		-	Y5	Y	Y	Y	
1326	Set	Motor Winding to Ambient Resistance		-	Y5	Y	Y	Y	
521	Get	Operative Current Limit		-	Y7	Y	Y	Y	F Support in V29
600	Get	Output Frequency		-	R	Y	Y	Y	
508	Set	Overtorque Limit		-	N	Y	Y	Y	
509	Set	Overtorque Limit Time		-	N	Y	Y	Y	
1355	Set	PM Motor Extended Speed Permissive				N	N	N	V29
2310	Set	PM Motor Flux Saturation		-	N	Y	Y	Y	SPM Motor only
1343	Set	PM Motor Force Constant		-	N	Y	Y	Y	Rotary PM Motor only
2315	Set	PM Motor Ld Flux Saturation			N	N	N	N	IPM Motor only, V29
1358	Set	PM Motor Linear Bus Overvoltage Speed		-	-	N	N	N	V29
1359	Set	PM Motor Linear Max Extended Speed		-	-	N	N	N	V29
2314	Set	PM Motor Lq Flux Saturation			N	N	N	N	IPM Motor only, V29
1342	Set	PM Motor Rated Force		-	N	Y	Y	Y	Rotary PM Motor only
1339	Set	PM Motor Rated Torque		-	N	Y	Y	Y	Rotary PM Motor only
1356	Set	PM Motor Rotary Bus Overvoltage Speed		-	-	N	N	N	V29
1357	Set	PM Motor Rotary Max Extended Speed		-	-	N	N	N	V29
1340	Set	PM Motor Torque Constant		-	N	Y	Y	Y	Rotary PM Motor only

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
445	Set	Position Error Tolerance Time		-	-	Y	-	-	
365	Get	Position Fine Command		-	-	Y	-	-	
446	Set	Position Integrator Control		-	-	R	-	-	0-Bit 1: Auto-Preset (N)
447	Set	Position Integrator Preload		-	-	N	-	-	
781	Set	Position Lead Lag Filter Bandwidth		-	-	Y	-	-	
782	Set	Position Lead Lag Filter Gain		-	-	Y	-	-	
783	Set	Position Notch Filter Frequency		-	-	N	-	-	
627	Set	Power Loss Action		-	N	N	N	N	0-Enum 2 = Decel Regen (N)
628	Set	Power Loss Threshold	N	-	N	N	N	N	
630	Set	Power Loss Time	N	-	N	N	N	N	
590	Set	Proving Configuration		-	Y5	Y	Y	Y	V26/V27
376	Set*	Ramp Acceleration		-	N	-	N	-	Derived
377	Set*	Ramp Deceleration		-	N	-	N	-	Derived
378	Set	Ramp Jerk Control		-	N	-	N	-	
375	Set*	Ramp Velocity - Negative		-	N	-	N	-	Derived
374	Set*	Ramp Velocity - Positive		-	N	-	N	-	Derived
613/354	Set	Resistive Brake Contact Delay		-	N	N	N	N	PM Motor only
1333	Set	Rotary Motor Damping Coefficient		-	N	N	N	N	Rotary Motor only
2312	Set	Rotary Motor Fan Cooling Derating		-	N	N	N	N	Rotary Motor only
2311	Set	Rotary Motor Fan Cooling Speed		-	N	N	N	N	Rotary Motor only
1330	Set	Rotary Motor Inertia		-	N	Y	Y	Y	Rotary Motor only
1332	Set	Rotary Motor Max Speed		-	Y	Y	Y	Y	Rotary Motor only
765	Set	Safe Torque Off Action		-	N	N	N	N	0-Enum 1 = Current Decel Disable (F/N) 2 = Ramped Decel Disable (FV/N) 128 = DC Injection Brake (FPVT/N) 129 = AC Injection Brake (FPVT/N)
629	Set	Shutdown Action	N	-	N	N	N	N	0-Enum 1 = Drop DC Bus (FPVT/N)
370	Set	Skip Speed 1		-	Y	-	-	-	
371	Set	Skip Speed 2		-	Y	-	-	-	
372	Set	Skip Speed 3		-	N	-	-	-	
373	Set	Skip Speed Band		-	Y	-	-	-	
833	Set	SLAT Configuration		-	-	-	Y	-	
834	Set	SLAT Set Point		-	-	-	Y	-	
835	Set	SLAT Time Delay		-	-	-	Y	-	
610	Set	Stopping Action		-	R	R	R	R	0-Enum 1 = Current Decel Disable (F/Y) V26/V27 2 = Ramped Decel Disable (FV/N) 3 = Current Decel Hold (PV/Y) 4 = Ramped Decel Hold (V/N) 128 = DC Injection Brake (FPVT/N) 129 = AC Injection Brake (FPVT/N)

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
612	Set	Stopping Time Limit		-	Y7	Y	Y	Y	F Support in V29
496	Set	System Inertia		-	-	R	R	N	
555	Set	Torque Integral Time Constant		-	-	N	N	N	
827	Set	Torque Lead Lag Filter Bandwidth		-	-	Y	Y	Y	
828	Set	Torque Lead Lag Filter Gain		-	-	Y	Y	Y	
554	Set	Torque Loop Bandwidth		-	-	Y	Y	Y	
502	Set	Torque Low Pass Filter Bandwidth		-	-	Y	Y	Y	
843	Get	Torque Low Pass Filter Bandwidth Estimate		-	-	Y	Y	Y	V26/V27
503	Set	Torque Notch Filter Frequency		-	-	Y	Y	Y	
841	Get	Torque Notch Filter Frequency Estimate		-	-	Y	Y	Y	V26/V27
837	Set	Torque Notch Filter High Frequency Limit		-	-	Y	Y	Y	V26/V27
838	Set	Torque Notch Filter Low Frequency Limit		-	-	Y	Y	Y	V26/V27
842	Get	Torque Notch Filter Magnitude Estimate		-	-	Y	Y	Y	V26/V27
839	Set	Torque Notch Filter Tuning Threshold		-	-	Y	Y	Y	V26/V27
591	Set	Torque Prove Current		-	Y5	Y	Y	Y	V26/V27
506	Set	Torque Rate Limit		-	-	Y	Y	Y	
507/334	Set	Torque Threshold		-	-	Y	Y	Y	
1371	Set	Transmission Ratio Input		N	N	N	N	N	DScale
1372	Set	Transmission Ratio Output		N	N	N	N	N	DScale
510	Set	Undertorque Limit		-	N	Y	Y	Y	
511	Set	Undertorque Limit Time		-	N	Y	Y	Y	
464/321	Set	Velocity Droop		-	Y4	Y	Y	-	
465	Set	Velocity Error Tolerance		-	-	Y	Y	-	
466	Set	Velocity Error Tolerance Time		-	-	Y	Y	-	
366	Get	Velocity Fine Command		-	-	Y	Y	-	
467	Set	Velocity Integrator Control		-	-	R	R	-	0-Bits 1: Auto-Preset (N)
468	Set	Velocity Integrator Preload		-	-	N	N	-	
475	Set	Velocity Limit - Bus Overvoltage		-	-	N	N	-	V29
477	Set	Velocity Limit - Bus Overvoltage Permissive		-	-	N	N	-	V29
476	Set	Velocity Limit - Motor Max		-	-	N	N	-	V29
474/326	Set	Velocity Limit - Negative		-	Y7	Y	Y	-	
473/325	Set	Velocity Limit - Positive		-	Y7	Y	Y	-	
458	Get	Velocity Limit Source		-	-	Y	Y	-	V29
471	Set	Velocity Lock Tolerance		-	N	Y	Y	-	
469	Set	Velocity Low Pass Filter Bandwidth		-	-	Y	Y	-	
790	Set	Velocity Negative Feedforward Gain		-	-	Y	Y	-	
470/327	Set	Velocity Threshold		Y	N	Y	Y	Y	
608	Set	Zero Speed		-	Y5	Y	Y	Y	V26/V27

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
609	Set	Zero Speed Time		-	Y5	Y	Y	Y	V26/V27

Kinetix 5500 Integrated STO Drive Module Optional Attributes

The integrated Kinetix 5500 drive modules include the following catalog numbers:

- 2198-H003-ERS2, Kinetix 5500, 1A, 195-528 Volt, CIP Safe Torque Off Drive
- 2198-H008-ERS2, Kinetix 5500, 2.5A, 195-528 Volt, CIP Safe Torque Off Drive
- 2198-H015-ERS2, Kinetix 5500, 5 A, 195 – 528 Volt, CIP Safe Torque Off Drive
- 2198-H025-ERS2, Kinetix 5500, 8A, 195- 528 Volt, CIP Safe Torque Off Drive
- 2198-H040-ERS2, Kinetix 5500, 13 A, 192-528 Volt, CIP Safe Torque Off Drive
- 2198-H070-ERS2 Kinetix 5500, 23 A,195–528 Volt, CIP Torque Off Drive

These drive modules support the optional attributes and corresponding control mode functionality as indicated in the following table:

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
367	Get	Acceleration Fine Command		-	-	Y	Y	Y	
485	Set	Acceleration Limit		-	N	Y	Y	N	
482	Get	Acceleration Reference		-	-	Y	Y	N	
481	Set	Acceleration Trim		-	-	N	N	N	
1376	Set	Actuator Diameter		N	N	N	N	N	DScale
1377	Set	Actuator Diameter Unit		N	N	N	N	N	DScale
1374	Set	Actuator Lead		N	N	N	N	N	DScale
1375	Set	Actuator Lead Unit		N	N	N	N	N	DScale
1373	Set	Actuator Type		N	N	N	N	N	DScale
836	Set	Adaptive Tuning Configuration		-	-	Y	Y	Y	V26/V27
844	Get	Adaptive Tuning Gain Scaling Factor		-	-	Y	Y	Y	V26/V27
732/267	Get	Analog Input 1	N	-	N	N	N	N	
733/268	Get	Analog Input 2	N	-	N	N	N	N	
734	Set	Analog Output 1	N	-	N	N	N	N	
735	Set	Analog Output 2	N	-	N	N	N	N	
873	Set	Auto Sag Configuration		-	N	N	N	N	V26/V27

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
874	Set	Auto Sag Slip Increment		-	N	N	N	N	V26/V27
875	Set	Auto Sag Time Limit		-	N	N	N	N	V26/V27
876	Set	Auto Sag Start		-	N	N	N	N	V26/V27
30	Set	Axis Configuration		R	R	R	R	R	O-Enum 0 = Feedback Only (Y) 1 = Frequency Control (Y) 2 = Position Loop (Y) 3 = Velocity Loop (Y) 4 = Torque Loop (Y)
19	Set	Axis Features	R	R	R	R	R	R	O-Bits 0 = Fine Interpolation (Y) 1 = Registration Auto-rearm (Y) 2 = Alarm Log (Y) 5 = Hookup Test (Y) 6 = Commutation Test (Y) 7 = Motor Test (Y) 8 = Inertia Test (Y) 9 = Sensorless Control (N) 10 = Drive Scaling (N) Vxx 11 = Ext. Event Block (N) Vxx 12 = Integer Cmd. Pos. (N) Vxx 13 = Ext. Motor Test (N) V29 14 = Control Mode Change (N) V26/V27 15 = Feedback Mode Change (N) Vxx 16 = Pass Bus Status (N) V26/V27 17 = Pass Bus Unload (N) V26/V27 18 = Ext. Speed for SPM (N) V29 19 = Ext. Speed for IPM (N) V29
763	Get	Axis Safety Faults		Y4	Y	Y	Y	Y	V24
760	Get	Axis Safety State		Y4	Y	Y	Y	Y	V24
761	Get	Axis Safety Status		Y4	Y	Y	Y	Y	V24
825	Set	Backlash Compensation Window		-	-	Y	-	-	
593	Set	Brake Prove Ramp Time		-	N	N	N	N	V26/V27
594	Set	Brake Slip Tolerance		-	Y5	Y	Y	Y	V26/V27
592	Set	Brake Test Torque		-	Y5	Y	Y	Y	V26/V27
2338	Get	Bus Output Overvoltage Factory Limit 1	N	-	N	N	N	N	Vxx
2358	Get	Bus Output Overvoltage Factory Limit 2	N	-	N	N	N	N	Vxx
2339	Get	Bus Output Undervoltage Factory Limit 1	N	-	N	N	N	N	Vxx
2359	Get	Bus Output Undervoltage Factory Limit 2	N	-	N	N	N	N	Vxx
638/262	Get	Bus Regulator Capacity	N	-	Y	Y	Y	Y	
659	Get	CIP Axis Alarms	N	Y	Y	Y	Y	Y	
904	Get	CIP Axis Alarms - RA	N	Y	Y	Y	Y	Y	
617	Set	Coasting Time Limit		-	Y	Y	Y	Y	V26/V27
850	Set	Commutation Offset Compensation		-	-	N	N	N	PM Motor only, V29

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
563	Set	Commutation Polarity		-	-	N	N	N	PM Motor only
562	Set	Commutation Self-Sensing Current		-	-	N	N	N	PM Motor only
637	Get	Converter Capacity	N	-	Y	Y	Y	Y	
2337	Get	Converter Output Capacity 1	N	-	N	N	N	N	Vxx
2357	Get	Converter Output Capacity 2	N	-	N	N	N	N	Vxx
605	Get	Converter Output Current	N	-	Y	Y	Y	Y	V26/V27
2330	Get	Converter Output Current 1	N	-	N	N	N	N	Vxx
2350	Get	Converter Output Current 2	N	-	N	N	N	N	Vxx
606	Get	Converter Output Power	N	-	Y	Y	Y	Y	V26/V27
2331	Get	Converter Output Power 1	N	-	N	N	N	N	Vxx
2351	Get	Converter Output Power 2	N	-	N	N	N	N	Vxx
2332	Get	Converter Output Rated Current 1	N	-	N	N	N	N	Vxx
2352	Get	Converter Output Rated Current 2	N	-	N	N	N	N	Vxx
2333	Get	Converter Output Rated Power 1	N	-	N	N	N	N	Vxx
2353	Get	Converter Output Rated Power 2	N	-	N	N	N	N	Vxx
840	Set	Current Disturbance		-	-	N	N	N	
527	Get	Current Error		-	-	Y	Y	Y	
529	Get	Current Feedback		-	-	Y	Y	Y	
522	Get	Current Limit Source		-	Y7	Y	Y	Y	F Support in V29
524	Get	Current Reference		-	-	Y	Y	Y	
553	Set	Current Vector Limit		-	Y	Y	Y	Y	
2334	Get	DC Bus Output Voltage 1	N	-	N	N	N	N	Vxx
2354	Get	DC Bus Output Voltage 2	N	-	N	N	N	N	Vxx
742	Get	DC Bus Output Voltage Reference	N	-	N	N	N	N	Vxx
2336	Get	DC Bus Output Voltage Reference 1	N	-	N	N	N	N	Vxx
2356	Get	DC Bus Output Voltage Reference 2	N	-	N	N	N	N	Vxx
870	Set	DC Injection Brake Current		-	N	N	N	N	
872	Set	DC Injection Brake Time		-	N	N	N	N	
486	Set	Deceleration Limit		-	N	Y	Y	N	
730	Get	Digital Inputs	N	-	N	N	N	N	
731	Set	Digital Outputs	N	-	N	N	N	N	
1435	Set	Feedback 1 Accel Filter Bandwidth		Y	-	Y	Y	Y	
2404	Set	Feedback 1 Accel Filter Taps		Y	-	Y	Y	Y	
2405	Set	Feedback 1 Battery Absolute		N	-	N	N	N	TM
1421	Set	Feedback 1 Data Code		N	-	N	N	N	TP,SS
1420	Set	Feedback 1 Data Length		N	-	N	N	N	TP,SS
2400	Set	Feedback 1 Loss Action		N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1414	Set	Feedback 1 Polarity		N	-	N	N	N	
1425	Set	Feedback 1 Resolver Cable Balance		N	-	N	N	N	RS

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
1424	Set	Feedback 1 Resolver Excitation Frequency		N	-	N	N	N	RS
1423	Set	Feedback 1 Resolver Excitation Voltage		N	-	N	N	N	RS
1422	Set	Feedback 1 Resolver Transformer Ratio		N	-	N	N	N	RS
1401	Get	Feedback 1 Serial Number		Y	-	Y	Y	Y	
1415	Set	Feedback 1 Startup Method		R	-	R	R	R	0-Enum 1 = Absolute (Y)
1434	Set	Feedback 1 Velocity Filter Bandwidth		Y	-	Y	Y	Y	
2403	Set	Feedback 1 Velocity Filter Taps		Y	-	Y	Y	Y	
1485	Set	Feedback 2 Accel Filter Bandwidth		N	-	N	N	N	
2454	Set	Feedback 2 Accel Filter Taps		N	-	N	N	N	
2455	Set	Feedback 2 Battery Absolute		N	-	N	N	N	TM
1471	Set	Feedback 2 Data Code		N	-	N	N	N	TP,SS
1470	Set	Feedback 2 Data Length		N	-	N	N	N	TP,SS
2450	Set	Feedback 2 Loss Action		N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1464	Set	Feedback 2 Polarity		N	-	N	N	N	
1475	Set	Feedback 2 Resolver Cable Balance		N	-	N	N	N	RS
1474	Set	Feedback 2 Resolver Excitation Frequency		N	-	N	N	N	RS
1473	Set	Feedback 2 Resolver Excitation Voltage		N	-	N	N	N	RS
1472	Set	Feedback 2 Resolver Transformer Ratio		N	-	N	N	N	RS
1451	Get	Feedback 2 Serial Number		N	-	N	N	N	
1465	Set	Feedback 2 Startup Method		R	-	R	R	R	0-Enum 1 = Absolute (N)
1484	Set	Feedback 2 Velocity Filter Bandwidth		N	-	N	N	N	
2453	Set	Feedback 2 Velocity Filter Taps		N	-	N	N	N	
250	Set	Feedback Commutation Aligned		-	-	Y	Y	Y	0-Enum 2 = Motor Offset (Y) 3 = Self-Sense (N) 4 = Database Offset (N) Vxx
31	Set*	Feedback Configuration	R	R	R	R	R	R	0-Enum 0 = No Feedback (V/Y)(T/N) 3 = Load Feedback (P/N)(V/N)T/N) 4 = Dual Feedback (P/N) 8 = Dual Integrator Feedback (P/N)
708	Set	Feedback Data Loss User Limit		Y	Y	Y	Y	Y	
706	Set	Feedback Noise User Limit		N	N	N	N	N	
707	Set	Feedback Signal Loss User Limit		N	N	N	N	N	
44	Set	Feedback Unit Ratio		-	-	N	N	-	
871	Set	Flux Braking Enable		-	N	N	N	N	Ind Motor only
528	Get	Flux Current Error		-	-	Y	Y	Y	
530	Get	Flux Current Feedback		-	-	Y	Y	Y	

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
525	Get	Flux Current Reference		-	-	Y	Y	Y	
557	Set	Flux Integral Time Constant		-	-	N	N	N	
556	Set	Flux Loop Bandwidth		-	-	N	N	N	
558	Set	Flux Up Control		-	Y	Y	Y	Y	Ind Motor only 0-Enum 1 = Manual Delay (Y) 2 = Automatic Delay (Y)
559	Set	Flux Up Time		-	Y	Y	Y	Y	Ind Motor only
380	Set	Flying Start Enable		-	N	-	N	-	
381	Set	Flying Start Method		-	N	-	N	-	0-Enum: V29 1 = Counter EMF (N) 2 = Sweep Frequency (N)
570	Set	Frequency Control Method		-	R	-	-	-	0-Enum 128 = Fan/Pump Volts/Hertz (Y) 129 = Sensorless Vector (Y) 130 = Sensorless Vector Economy (N)
498	Set	Friction Compensation Sliding		-	-	Y	Y	Y4	
499	Set	Friction Compensation Static		-	-	Y	Y4	Y4	
500	Set	Friction Compensation Viscous		-	-	Y	Y	Y4	
826/421	Set	Friction Compensation Window		-	-	Y	-	-	
981/243	Get	Guard Faults		-	N	N	N	N	
980/242	Get	Guard Status		-	N	N	N	N	
280	Set	Home Torque Threshold		-	-	N	N	-	Vxx
281	Set	Home Torque Time		-	-	N	N	-	Vxx
1349	Set	Induction Motor Magnetization Reactance		-	N	N	N	N	Ind Motor only
1352	Set	Induction Motor Rated Slip Speed		-	Y	N	N	N	Ind Motor only
1351	Set	Induction Motor Rotor Leakage Reactance		-	Y	Y	Y	Y	Ind Motor only, V26/V27
1350	Set	Induction Motor Rotor Resistance		-	N	N	N	N	Ind Motor only
1348	Set	Induction Motor Stator Leakage Reactance		-	Y	Y	Y	Y	Ind Motor only, V26/V27
647	Set	Inverter Overload Action		-	Y	Y	Y	Y	0-Enum 1 = Current Foldback (Y) 128 = Reduce PWM Rate (N) 129 = PWM Foldback (N)
699	Set	Inverter Thermal Overload User Limit		-	Y	Y	Y	Y	
1338	Set	Linear Motor Damping Coefficient		-	N	N	N	N	Linear Motor only
2313	Set	Linear Motor Integral Limit Switch		-	N	N	N	N	Linear Motor only
1336	Set	Linear Motor Mass		-	N	Y	Y	Y	Linear Motor only
1337	Set	Linear Motor Max Speed		-	N	Y	Y	Y	Linear Motor only
801	Get	Load Observer Acceleration Estimate		-	-	Y	Y	Y	
806	Set	Load Observer Bandwidth		-	-	Y	Y	Y	

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
805	Set	Load Observer Configuration		-	-	Y	Y	Y	0-Enum 1 = Load Observer Only (Y) 2 = Load Observer with Velocity Estimate (Y) 3 = Velocity Estimate Only (Y) 4 = Acceleration Feedback (N)
809	Set	Load Observer Feedback Gain		-	-	Y	Y	Y	
807	Set	Load Observer Integrator Bandwidth		-	-	Y	Y	Y	
802	Get	Load Observer Torque Estimate		-	-	Y	Y	Y	
1370	Set	Load Type		N	N	N	N	N	DScale
750	Set	Local Control	N	N	N	N	N	N	0-Enum 1 = Conditionally Allowed (N) 2 = Allowed (N)
614	Set	Mechanical Brake Control		-	Y	Y	Y	Y	
616	Set	Mechanical Brake Engage Delay		-	Y	Y	Y	Y	
615	Set	Mechanical Brake Release Delay		-	Y	Y	Y	Y	
45	Set	Motion Scaling Configuration		R	R	R	R	R	0-Enum 1 = Drive Scaling (N)
1310/251	Set	Motor Catalog Number		-	N	Y	Y	Y	Dr NV
1313	Set	Motor Data Source		-	R	R	R	R	0-Enum 1 = Database (Y) 2 = Drive NV (N) 3 = Motor NV (Y)
1323	Set	Motor Integral Thermal Switch		-	Y5	Y	Y	Y	
1324	Set	Motor Max Winding Temperature		-	Y5	Y	Y	Y	
646	Set	Motor Overload Action		-	Y	Y	Y	Y	0-Enum 1 = Current Foldback (Y)
1322	Set	Motor Overload Limit		-	Y	Y	Y	Y	
695	Set	Motor Overspeed User Limit		-	Y5	Y	Y	Y	
694	Set	Motor Phase Loss Limit		-	N	N	N	N	V26/V27
1317	Set	Motor Polarity		-	Y	Y	Y	Y	
1321	Set	Motor Rated Output Power		-	Y	Y	Y	Y	0-PM
1320	Set	Motor Rated Peak Current		-	Y5	Y	Y	Y	0-IM
697	Set	Motor Thermal Overload User Limit		-	Y	Y	Y	Y	
1001	Get	Motor Test Comm Offset Comp		-	R	R	R	R	IPM Motor Only, V29
999	Get	Motor Test Ld Flux Saturation		-	R	R	R	R	IPM Motor Only, V29
997	Get	Motor Test Ld Inductance		-	R	R	R	R	IPM Motor Only, V29
998	Gett	Motor Test Lq Flux Saturation		-	R	R	R	R	IPM Motor Only, V29
996	Get	Motor Test Lq Inductance		-	R	R	R	R	IPM Motor Only, V29
1000	Get	Motor Test Max Speed		-	R	R	R	R	IPM Motor Only, V29

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
1315	Set	Motor Type		-	R	R	R	R	0-Enum 1 = Rotary Permanent Magnet (Y) 2 = Rotary Induction (Y) 3 = Linear Permanent Magnet (N) 4 = Linear Induction (N)
1325	Set	Motor Winding to Ambient Capacitance		-	Y5	Y	Y	Y	
1326	Set	Motor Winding to Ambient Resistance		-	Y5	Y	Y	Y	
521	Get	Operative Current Limit		-	Y7	Y	Y	Y	F Support in V29
600	Get	Output Frequency		-	R	Y	Y	Y	
508	Set	Overtorque Limit		-	N	Y	Y	Y	
509	Set	Overtorque Limit Time		-	N	Y	Y	Y	
1355	Set	PM Motor Extended Speed Permissive				N	N	N	V29
2310	Set	PM Motor Flux Saturation		-	N	Y	Y	Y	SPM Motor only
1343	Set	PM Motor Force Constant		-	N	Y	Y	Y	Rotary PM Motor only
2315	Set	PM Motor Ld Flux Saturation			N	N	N	N	IPM Motor only, V29
1358	Set	PM Motor Linear Bus Overvoltage Speed		-	-	N	N	N	V29
1359	Set	PM Motor Linear Max Extended Speed		-	-	N	N	N	V29
2314	Set	PM Motor Lq Flux Saturation			N	N	N	N	IPM Motor only, V29
1342	Set	PM Motor Rated Force		-	N	Y	Y	Y	Rotary PM Motor only
1339	Set	PM Motor Rated Torque		-	N	Y	Y	Y	Rotary PM Motor only
1356	Set	PM Motor Rotary Bus Overvoltage Speed		-	-	N	N	N	V29
1357	Set	PM Motor Rotary Max Extended Speed		-	-	N	N	N	V29
1340	Set	PM Motor Torque Constant		-	N	Y	Y	Y	Rotary PM Motor only
445	Set	Position Error Tolerance Time		-	-	Y	-	-	
365	Get	Position Fine Command		-	-	Y	-	-	
446	Set	Position Integrator Control		-	-	R	-	-	0-Bit 1: Auto-Preset (N)
447	Set	Position Integrator Preload		-	-	N	-	-	
781	Set	Position Lead Lag Filter Bandwidth		-	-	Y	-	-	
782	Set	Position Lead Lag Filter Gain		-	-	Y	-	-	
783	Set	Position Notch Filter Frequency		-	-	N	-	-	
627	Set	Power Loss Action		-	N	N	N	N	0-Enum 2 = Decel Regen (N)
628	Set	Power Loss Threshold	N	-	N	N	N	N	
630	Set	Power Loss Time	N	-	N	N	N	N	
590	Set	Proving Configuration		-	Y5	Y	Y	Y	V26/V27
376	Set*	Ramp Acceleration		-	N	-	N	-	Derived
377	Set*	Ramp Deceleration		-	N	-	N	-	Derived
378	Set	Ramp Jerk Control		-	N	-	N	-	
375	Set*	Ramp Velocity - Negative		-	N	-	N	-	Derived
374	Set*	Ramp Velocity - Positive		-	N	-	N	-	Derived
613/354	Set	Resistive Brake Contact Delay		-	N	N	N	N	PM Motor only

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
1333	Set	Rotary Motor Damping Coefficient		-	N	N	N	N	Rotary Motor only
2312	Set	Rotary Motor Fan Cooling Derating		-	N	N	N	N	Rotary Motor only
2311	Set	Rotary Motor Fan Cooling Speed		-	N	N	N	N	Rotary Motor only
1330	Set	Rotary Motor Inertia		-	N	Y	Y	Y	Rotary Motor only
1332	Set	Rotary Motor Max Speed		-	Y	Y	Y	Y	Rotary Motor only
765	Set	Safe Torque Off Action		-	N	N	N	N	0-Enum 1 = Current Decel Disable (F/N) 2 = Ramped Decel Disable (FV/N) 128 = DC Injection Brake (FPVT/N) 129 = AC Injection Brake (FPVT/N)
629	Set	Shutdown Action	N	-	N	N	N	N	0-Enum 1 = Drop DC Bus (FPVT/N)
370	Set	Skip Speed 1		-	Y	-	-	-	
371	Set	Skip Speed 2		-	Y	-	-	-	
372	Set	Skip Speed 3		-	N	-	-	-	
373	Set	Skip Speed Band		-	Y	-	-	-	
833	Set	SLAT Configuration		-	-	-	Y	-	
834	Set	SLAT Set Point		-	-	-	Y	-	
835	Set	SLAT Time Delay		-	-	-	Y	-	
610	Set	Stopping Action		-	R	R	R	R	0-Enum 1 = Current Decel Disable (F/Y) V26/V27 2 = Ramped Decel Disable (FV/N) 3 = Current Decel Hold (PV/Y) 4 = Ramped Decel Hold (V/N) 128 = DC Injection Brake (FPVT/N) 129 = AC Injection Brake (FPVT/N)
612	Set	Stopping Time Limit		-	Y7	Y	Y	Y	F Support in V29
496	Set	System Inertia		-	-	R	R	N	
555	Set	Torque Integral Time Constant		-	-	N	N	N	
827	Set	Torque Lead Lag Filter Bandwidth		-	-	Y	Y	Y	
828	Set	Torque Lead Lag Filter Gain		-	-	Y	Y	Y	
554	Set	Torque Loop Bandwidth		-	-	Y	Y	Y	
502	Set	Torque Low Pass Filter Bandwidth		-	-	Y	Y	Y	
843	Get	Torque Low Pass Filter Bandwidth Estimate		-	-	Y	Y	Y	V26/V27
503	Set	Torque Notch Filter Frequency		-	-	Y	Y	Y	
841	Get	Torque Notch Filter Frequency Estimate		-	-	Y	Y	Y	V26/V27
837	Set	Torque Notch Filter High Frequency Limit		-	-	Y	Y	Y	V26/V27
838	Set	Torque Notch Filter Low Frequency Limit		-	-	Y	Y	Y	V26/V27
842	Get	Torque Notch Filter Magnitude Estimate		-	-	Y	Y	Y	V26/V27
839	Set	Torque Notch Filter Tuning Threshold		-	-	Y	Y	Y	V26/V27
591	Set	Torque Prove Current		-	Y5	Y	Y	Y	V26/V27
506	Set	Torque Rate Limit		-	-	Y	Y	Y	

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
507/334	Set	Torque Threshold		-	-	Y	Y	Y	
1371	Set	Transmission Ratio Input		N	N	N	N	N	DScale
1372	Set	Transmission Ratio Output		N	N	N	N	N	DScale
510	Set	Undertorque Limit		-	N	Y	Y	Y	
511	Set	Undertorque Limit Time		-	N	Y	Y	Y	
464/321	Set	Velocity Droop		-	Y4	Y	Y	-	
465	Set	Velocity Error Tolerance		-	-	Y	Y	-	
466	Set	Velocity Error Tolerance Time		-	-	Y	Y	-	
366	Get	Velocity Fine Command		-	-	Y	Y	-	
467	Set	Velocity Integrator Control		-	-	R	R	-	0-Bits 1: Auto-Preset (N)
468	Set	Velocity Integrator Preload		-	-	N	N	-	
474/326	Set	Velocity Limit - Negative		-	Y7	Y	Y	-	
473/325	Set	Velocity Limit - Positive		-	Y7	Y	Y	-	
458	Get	Velocity Limit Source		-	-	Y	Y	-	V29
471	Set	Velocity Lock Tolerance		-	N	Y	Y	-	
469	Set	Velocity Low Pass Filter Bandwidth		-	-	Y	Y	-	
790	Set	Velocity Negative Feedforward Gain		-	-	Y	Y	-	
470/327	Set	Velocity Threshold		Y	N	Y	Y	Y	
608	Set	Zero Speed		-	Y5	Y	Y	Y	V26/V27
609	Set	Zero Speed Time		-	Y5	Y	Y	Y	V26/V27

Kinetix 5700 Safety Drive Module Optional Attributes

The Kinetix 5700 single-axis and dual-axis model drives include the following catalog numbers:

- 2198-S086-ERS3, 43A, 458-747 Volt DC, Network Safety STO Drive
- 2198-S130-ERS3, 65A, 458-747 Volt DC, Network Safety STO Drive
- 2198-S160-ERS3, 85A, 458-747 Volt DC, Network Safety STO Drive
- 2198-D006-ERS3, 2.5A, 458-747 Volt DC, Network Safety STO Drive
- 2198-D0012-ERS3, 5A, 458-747 Volt DC, Network Safety STO Drive
- 2198-D020-ERS3, 8A, 458-747 Volt DC, Network Safety STO Drive
- 2198-D032-ERS3, 13A, 458-747 Volt DC, Network Safety STO Drive
- 2198-D057-ERS3, 23A, 458-747 Volt DC, Network Safety STO Drive

These drive modules support the optional attributes and corresponding control mode functionality as indicated in the following table:

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
367	Get	Acceleration Fine Command	-	-	-	Y	Y	Y	
485	Set	Acceleration Limit	-	-	Y	Y	Y	Y	
482	Get	Acceleration Reference	-	-	-	Y	Y	Y	
481	Set	Acceleration Trim	-	-	-	N	N	N	
836	Set	Adaptive Tuning Configuration	-	-	-	Y	Y	Y	V26/V27
844	Get	Adaptive Tuning Gain Scaling Factor	-	-	-	Y	Y	Y	V26/V27
732/267	Get	Analog Input 1	N	-	N	N	N	N	
733/268	Get	Analog Input 2	N	-	N	N	N	N	
734	Set	Analog Output 1	N	-	N	N	N	N	
735	Set	Analog Output 2	N	-	N	N	N	N	
873	Set	Auto Sag Configuration	-	-	N	N	N	N	V26/V27
874	Set	Auto Sag Slip Increment	-	-	N	N	N	N	V26/V27
875	Set	Auto Sag Slip Time Limit	-	-	N	N	N	N	V26/V27
876	Set	Auto Sag Start	-	-	N	N	N	N	V26/V27
19	Set	Axis Features	R	R	R	R	R	R	O-Bits 0: Fine Interpolation (Y) 1: Registration Auto-rearm (Y) 2: Alarm Log (Y) 5: Hookup Test (Y) 6: Commutation Test (Y) 7: Motor Test (Y) 8: Inertia Test (Y) 9: Sensorless Control (N) 10: Drive Scaling (N) Vxx 11: Ext. Event Block (N) Vxx 12: Integer Cmd. Pos. (N) Vxx 13: Ext. Motor Test (N) V29 14: Control Mode Change (N) V26/V27 15: Feedback Mode Change (N) Vxx 16: Pass Bus Status (Y) V26/V27 17: Pass Bus Unload (Y) V26/V27 18: Ext. Speed for SPM (N) V29 19: Ext. Speed for IPM (Y) V29
986	Get	Axis Safety Data A	-	-	Y	Y	Y	Y	V31
987	Get	Axis Safety Data B	-	-	Y	Y	Y	Y	V31
763	Get	Axis Safety Faults	-	Y	Y	Y	Y	Y	V24
985	Get	Axis Safety Faults - RA	-	Y	Y	Y	Y	Y	V31
760	Get	Axis Safety State	-	Y	Y	Y	Y	Y	V24
761	Get	Axis Safety Status	-	Y	Y	Y	Y	Y	V24
984	Get	Axis Safety Status - RA	-	Y	Y	Y	Y	Y	V31
825	Set	Backlash Compensation Window	-	-	-	Y	-	-	
593	Set	Brake Prove Ramp Time	-	-	N	N	N	N	V26/V27
594	Set	Brake Slip Tolerance	-	-	Y	Y	Y	Y	V26/V27
592	Set	Brake Test Torque	-	-	Y	Y	Y	Y	V26/V27

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
2338	Get	Bus Output Overvoltage Factory Limit 1	N	-	N	N	N	N	Vxx
2358	Get	Bus Output Overvoltage Factory Limit 2	N	-	N	N	N	N	Vxx
2339	Get	Bus Output Undervoltage Factory Limit 1	N	-	N	N	N	N	Vxx
2359	Get	Bus Output Undervoltage Factory Limit 2	N	-	N	N	N	N	Vxx
638/262	Get	Bus Regulator Capacity	N	-	N	N	N	N	
659	Get	CIP Axis Alarms	N	Y	Y	Y	Y	Y	
904	Get	CIP Axis Alarms - RA	N	Y	Y	Y	Y	Y	
617	Set	Coasting Time Limit	-	-	Y	Y	Y	Y	V26/V27
850	Set	Commutation Offset Compensation		-	-	N	N	N	PM Motor only, V29
563	Set	Commutation Polarity	-	-	-	Y	Y	Y	PM Motor only
562	Set	Commutation Self-Sensing Current	-	-	-	N	N	N	PM Motor only
618	Set	Connection Loss Stopping Action	-	-	Y	Y	Y	Y	O-Enum V31 1 = Current Decel Disable (F/Y) 2 = Ramped Decel Disable (FV/Y) 3 = Current Decel Hold (PV/N) 4 = Ramped Decel Hold (V/N)
637	Get	Converter Capacity	N	-	N	N	N	N	
2337	Get	Converter Output Capacity 1	N	-	N	N	N	N	Vxx
2357	Get	Converter Output Capacity 2	N	-	N	N	N	N	Vxx
605	Get	Converter Output Current	N	-	N	N	N	N	V26/V27
2330	Get	Converter Output Current 1	N	-	N	N	N	N	Vxx
2350	Get	Converter Output Current 2	N	-	N	N	N	N	Vxx
606	Get	Converter Output Power	N	-	N	N	N	N	V26/V27
2331	Get	Converter Output Power 1	N	-	N	N	N	N	Vxx
2351	Get	Converter Output Power 2	N	-	N	N	N	N	Vxx
2332	Get	Converter Output Rated Current 1	N	-	N	N	N	N	Vxx
2352	Get	Converter Output Rated Current 2	N	-	N	N	N	N	Vxx
2333	Get	Converter Output Rated Power 1	N	-	N	N	N	N	Vxx
2353	Get	Converter Output Rated Power 2	N	-	N	N	N	N	Vxx
840	Set	Current Disturbance	-	-	-	N	N	N	
527	Get	Current Error	-	-	-	Y	Y	Y	
529	Get	Current Feedback	-	-	-	Y	Y	Y	
522	Get	Current Limit Source	-	-	Y7	Y	Y	Y	(F/V29)
524	Get	Current Reference	-	-	-	Y	Y	Y	
553	Set	Current Vector Limit	-	-	Y	Y	Y	Y	
2334	Get	DC Bus Output Voltage 1	N	-	N	N	N	N	Vxx
2354	Get	DC Bus Output Voltage 2	N	-	N	N	N	N	Vxx
742	Get	DC Bus Output Voltage Reference	N	-	N	N	N	N	Vxx

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
2336	Get	DC Bus Output Voltage Reference 1	N	-	N	N	N	N	Vxx
2356	Get	DC Bus Output Voltage Reference 2	N	-	N	N	N	N	Vxx
870	Set	DC Injection Brake Current	-	-	N	N	N	N	
872	Set	DC Injection Brake Time	-	-	N	N	N	N	
486	Set	Deceleration Limit	-	-	Y	Y	Y	Y	
730	Get	Digital Inputs	N	-	N	N	N	N	
731	Set	Digital Outputs	N	-	N	N	N	N	
1435	Set	Feedback 1 Accel Filter Bandwidth	-	Y	-	Y	Y	Y	
2404	Set	Feedback 1 Accel Filter Taps	-	Y	-	Y	Y	Y	
2405	Set	Feedback 1 Battery Absolute	-	N	-	N	N	N	TM
1421	Set	Feedback 1 Data Code	-	N	-	N	N	N	TP,SS
1420	Set	Feedback 1 Data Length	-	N	-	N	N	N	TP,SS
2400	Set	Feedback 1 Loss Action	-	N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1414	Set	Feedback 1 Polarity	-	Y	-	Y	Y	Y	
1425	Set	Feedback 1 Resolver Cable Balance	-	N	-	N	N	N	RS
1424	Set	Feedback 1 Resolver Excitation Frequency	-	N	-	N	N	N	RS
1423	Set	Feedback 1 Resolver Excitation Voltage	-	N	-	N	N	N	RS
1422	Set	Feedback 1 Resolver Transformer Ratio	-	N	-	N	N	N	RS
1401	Get	Feedback 1 Serial Number	-	Y	-	Y	Y	Y	
1415	Set	Feedback 1 Startup Method	-	R	-	R	R	R	0-Enum 1 = Absolute (Y)
1434	Set	Feedback 1 Velocity Filter Bandwidth	-	Y	-	Y	Y	Y	
2403	Set	Feedback 1 Velocity Filter Taps	-	Y	-	Y	Y	Y	
1485	Set	Feedback 2 Accel Filter Bandwidth	-	Y	-	Y	Y	Y	
2454	Set	Feedback 2 Accel Filter Taps	-	Y	-	Y	Y	Y	
2455	Set	Feedback 2 Battery Absolute	-	N	-	N	N	N	TM
1471	Set	Feedback 2 Data Code	-	N	-	N	N	N	TP,SS
1470	Set	Feedback 2 Data Length	-	N	-	N	N	N	TP,SS
2450	Set	Feedback 2 Loss Action	-	N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1464	Set	Feedback 2 Polarity	-	Y	-	Y	Y	Y	
1475	Set	Feedback 2 Resolver Cable Balance	-	N	-	N	N	N	RS
1474	Set	Feedback 2 Resolver Excitation Frequency	-	N	-	N	N	N	RS
1473	Set	Feedback 2 Resolver Excitation Voltage	-	N	-	N	N	N	RS
1472	Set	Feedback 2 Resolver Transformer Ratio	-	N	-	N	N	N	RS

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
1451	Get	Feedback 2 Serial Number	-	Y	-	Y	Y	Y	
1465	Set	Feedback 2 Startup Method	-	R	-	R	R	R	0-Enum 1 = Absolute (Y)
1484	Set	Feedback 2 Velocity Filter Bandwidth	-	Y	-	Y	Y	Y	
2453	Set	Feedback 2 Velocity Filter Taps	-	Y	-	Y	Y	Y	
250	Set	Feedback Commutation Aligned	-	-	-	Y	Y	Y	0-Enum 2 = Motor Offset (Y) 3 = Self-Sense (N) 4 = Database Offset (N) Vxx
31	Set*	Feedback Configuration	R	R	R	R	R	R	0-Enum 0 = No Feedback (V/N)(T/N) 3 = Load Feedback (P/Y)(V/Y)(T/N) 4 = Dual Feedback (P/Y) 8 = Dual Integrator Feedback (P/N)
708	Set	Feedback Data Loss User Limit	-	Y	Y	Y	Y	Y	
706	Set	Feedback Noise User Limit	-	Y	Y	Y	Y	Y	
707	Set	Feedback Signal Loss User Limit	-	Y	Y	Y	Y	Y	
44	Set	Feedback Unit Ratio	-	-	-	Y	Y	-	
871	Set	Flux Braking Enable	-	-	N	N	N	N	Ind Motor only
528	Get	Flux Current Error	-	-	-	Y	Y	Y	
530	Get	Flux Current Feedback	-	-	-	Y	Y	Y	
525	Get	Flux Current Reference	-	-	-	Y	Y	Y	
557	Set	Flux Integral Time Constant	-	-	-	N	N	N	
556	Set	Flux Loop Bandwidth	-	-	-	Y	Y	Y	
558	Set	Flux Up Control	-	-	Y	Y	Y	Y	Ind Motor only 0-Enum 1 = Manual Delay (Y) 2 = Automatic Delay (Y)
559	Set	Flux Up Time	-	-	Y	Y	Y	Y	Ind Motor only
380	Set	Flying Start Enable	-	-	N	-	Y	-	
381	Set	Flying Start Method	-	-	N	-	Y	-	0-Enum: V29 1 = Counter EMF (N) 2 = Sweep Frequency (N)
570	Set	Frequency Control Method	-	-	R	-	-	-	0-Enum 128 = Fan/Pump Volts/Hertz (Y) 129 = Sensorless Vector (Y) 130 = Sensorless Vector Economy (N)
498	Set	Friction Compensation Sliding	-	-	-	Y	Y	Y	
499	Set	Friction Compensation Static	-	-	-	Y	Y	Y	
500	Set	Friction Compensation Viscous	-	-	-	Y	Y	Y	
826/421	Set	Friction Compensation Window	-	-	-	Y	-	-	
981/243	Get	Guard Faults	-	-	Y	Y	Y	Y	
980/242	Get	Guard Status	-	-	Y	Y	Y	Y	
280	Set	Home Torque Threshold	-	-	-	N	N	-	Vxx

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
281	Set	Home Torque Time	-	-	-	N	N	-	Vxx
1349	Set	Induction Motor Magnetization Reactance	-	-	N	N	N	N	Ind Motor only
1352	Set	Induction Motor Rated Slip Speed	-	-	Y	Y	Y	Y	Ind Motor only
1351	Set	Induction Motor Rotor Leakage Reactance	-	-	Y	Y	Y	Y	Ind Motor only, V26/V27
1350	Set	Induction Motor Rotor Resistance	-	-	N	N	N	N	Ind Motor only
1348	Set	Induction Motor Stator Leakage Reactance	-	-	Y	Y	Y	Y	Ind Motor only, V26/V27
647	Set	Inverter Overload Action	-	-	Y	Y	Y	Y	O-Enum 1 = Current Foldback (Y) 128 = Reduce PWM Rate (N) 129 = PWM Foldback (N)
699	Set	Inverter Thermal Overload User Limit	-	-	Y	Y	Y	Y	
1338	Set	Linear Motor Damping Coefficient	-	-	N	Y	Y	Y	Linear Motor only
2313	Set	Linear Motor Integral Limit Switch	-	-	N	N	N	N	Linear Motor only
1336	Set	Linear Motor Mass	-	-	N	Y	Y	Y	Linear Motor only
1337	Set	Linear Motor Max Speed	-	-	N	Y	Y	Y	Linear Motor only
801	Get	Load Observer Acceleration Estimate	-	-	-	Y	Y	Y	
806	Set	Load Observer Bandwidth	-	-	-	Y	Y	Y	
805	Set	Load Observer Configuration	-	-	-	Y	Y	Y	O-Enum 1 = Load Observer Only (Y) 2 = Load Observer With Velocity Estimate (Y) 3 = Velocity Estimate Only (Y) 4 = Acceleration Feedback (N)
809	Set	Load Observer Feedback Gain	-	-	-	Y	Y	Y	
807	Set	Load Observer Integrator Bandwidth	-	-	-	Y	Y	Y	
802	Get	Load Observer Torque Estimate	-	-	-	Y	Y	Y	
1370	Set	Load Type	-	N	N	N	N	N	DScale
750	Set	Local Control	N	N	N	N	N	N	O-Enum 1 = Conditionally Allowed (N) 2 = Allowed (N)
614	Set	Mechanical Brake Control	-	-	Y	Y	Y	Y	
616	Set	Mechanical Brake Engage Delay	-	-	Y	Y	Y	Y	
615	Set	Mechanical Brake Release Delay	-	-	Y	Y	Y	Y	
45	Set	Motion Scaling Configuration	-	R	R	R	R	R	O-Enum 1 = Drive Scaling (N)
1310/251	Set	Motor Catalog Number	-	-	N	Y	Y	Y	Dr NV
1313	Set	Motor Data Source	-	-	R	R	R	R	O-Enum 1 = Database (Y) 2 = Drive NV (N) 3 = Motor NV (Y)
1323	Set	Motor Integral Thermal Switch	-	-	Y	Y	Y	Y	
1324	Set	Motor Max Winding Temperature	-	-	Y	Y	Y	Y	

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
646	Set	Motor Overload Action	-	-	Y	Y	Y	Y	0-Enum 1 = Current Foldback (Y)
1322	Set	Motor Overload Limit	-	-	Y	Y	Y	Y	
695	Set	Motor Overspeed User Limit	-	-	Y	Y	Y	Y	
694	Set	Motor Phase Loss Limit	-	-	N	N	N	N	V26/V27
1317	Set	Motor Polarity	-	-	Y	Y	Y	Y	
1321	Set	Motor Rated Output Power	-	-	Y	Y	Y	Y	Y-PM
1320	Set	Motor Rated Peak Current	-	-	Y	Y	Y	Y	Y-IM
697	Set	Motor Thermal Overload User Limit	-	-	Y	Y	Y	Y	
1325	Set	Motor Winding to Ambient Capacitance	-	-	Y	Y	Y	Y	
1326	Set	Motor Winding to Ambient Resistance	-	-	Y	Y	Y	Y	
521	Get	Operative Current Limit	-	-	Y7	Y	Y	Y	F Support in V29
600	Get	Output Frequency	-	-	R	Y	Y	Y	
508	Set	Overtorque Limit	-	-	N	Y	Y	Y	
509	Set	Overtorque Limit Time	-	-	N	Y	Y	Y	
1355	Set	PM Motor Extended Speed Permissive	-	-	-	Y	Y	Y	V29
2310	Set	PM Motor Flux Saturation	-	-	Y	Y	Y	Y	SPM Motor only
1343	Set	PM Motor Force Constant	-	-	Y	Y	Y	Y	Rotary PM Motor only
1358	Set	PM Motor Linear Bus Overvoltage Speed	-	-	-	N	N	N	V29
1359	Set	PM Motor Linear Max Extended Speed	-	-	-	N	N	N	V29
2314	Set	PM Motor Lq Flux Saturation	-	-	N	Y	Y	Y	IPM Motor only, V29/V29
2315	Set	PM Motor Ld Flux Saturation	-	-	N	Y	Y	Y	IPM Motor only, V29/V29
1342	Set	PM Motor Rated Force	-	-	Y	Y	Y	Y	Rotary PM Motor only
1339	Set	PM Motor Rated Torque	-	-	Y	Y	Y	Y	Rotary PM Motor only
1356	Set	PM Motor Rotary Bus Overvoltage Speed	-	-	-	Y	Y	Y	V29
1357	Set	PM Motor Rotary Max Extended Speed	-	-	-	Y	Y	Y	V29
1340	Set	PM Motor Torque Constant	-	-	Y	Y	Y	Y	Rotary PM Motor only
445	Set	Position Error Tolerance Time	-	-	-	Y	-	-	
365	Get	Position Fine Command	-	-	-	Y	-	-	
446	Set	Position Integrator Control	-	-	-	R	-	-	0-Bits 1: Auto-Preset (Y)
447	Set	Position Integrator Preload	-	-	-	N	-	-	
781	Set	Position Lead Lag Filter Bandwidth	-	-	-	Y	-	-	
782	Set	Position Lead Lag Filter Gain	-	-	-	Y	-	-	
783	Set	Position Notch Filter Frequency	-	-	-	N	-	-	
627	Set	Power Loss Action	-	-	N	N	N	N	0-Enum 2 = Decel Regen (N)

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
628	Set	Power Loss Threshold	N	-	Y	Y	Y	Y	
630	Set	Power Loss Time	N	-	N	N	N	N	
590	Set	Proving Configuration	-	-	Y	Y	Y	Y	V26/V27
376	Set*	Ramp Acceleration	-	-	Y	-	Y	-	Derived
377	Set*	Ramp Deceleration	-	-	Y	-	Y	-	Derived
378	Set	Ramp Jerk Control	-	-	Y	-	Y	-	
375	Set*	Ramp Velocity - Negative	-	-	Y	-	Y	-	Derived
374	Set*	Ramp Velocity - Positive	-	-	Y	-	Y	-	Derived
613/354	Set	Resistive Brake Contact Delay	-	-	N	N	N	N	PM Motor only
1333	Set	Rotary Motor Damping Coefficient	-	-	Y	Y	Y	Y	Rotary Motor only
2312	Set	Rotary Motor Fan Cooling Derating	-	-	N	N	N	N	Rotary Motor only
2311	Set	Rotary Motor Fan Cooling Speed	-	-	N	N	N	N	Rotary Motor only
1330	Set	Rotary Motor Inertia	-	-	Y	Y	Y	Y	Rotary Motor only
1332	Set	Rotary Motor Max Speed	-	-	Y	Y	Y	Y	Rotary Motor only
766	Set	Safe Stopping Action	-	-	Y	Y	Y	Y	0-Enum V31 1 = Current Decel (F/Y) 2 = Ramped Decel (FV/Y)
767	Set	Safe Stopping Action Source	-	-	Y	Y	Y	Y	0-Enum V31 1 = Running Controller (Y)
765	Set	Safe Torque Off Action	-	-	Y	Y	Y	Y	0-Enum V26/V27 1 = Current Decel Disable (F/Y) 2 = Ramped Decel Disable (FV/Y) 128 = DC Injection Brake (FPVT/N) 129 = AC Injection Brake (FPVT/N)
759	Set	Safe Torque Off Action Source	-	-	Y	Y	Y	Y	0-Enum V31 1 = Running Controller (Y)
629	Set	Shutdown Action	N	-	N	N	N	N	0-Enum 1 = Drop DC Bus (FPVT/N)
370	Set	Skip Speed 1	-	-	Y	-	-	-	
371	Set	Skip Speed 2	-	-	Y	-	-	-	
372	Set	Skip Speed 3	-	-	N	-	-	-	
373	Set	Skip Speed Band	-	-	Y	-	-	-	
833	Set	SLAT Configuration	-	-	-	-	Y	-	
834	Set	SLAT Set Point	-	-	-	-	Y	-	
835	Set	SLAT Time Delay	-	-	-	-	Y	-	
610	Set	Stopping Action	-	-	R	R	R	R	0-Enum 1 = Current Decel Disable (F/Y) V26/V27 2 = Ramped Decel Disable (FV/Y) 3 = Current Decel Hold (PV/Y) 4 = Ramped Decel Hold (V/Y) 128 = DC Injection Brake (FPVT/N) 129 = AC Injection Brake (FPVT/N)
612	Set	Stopping Time Limit	-	-	Y7	Y	Y	Y	(F/V26/V27)

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
496	Set	System Inertia	-	-	-	R	R	Y	
555	Set	Torque Integral Time Constant	-	-	-	N	N	N	
827	Set	Torque Lead Lag Filter Bandwidth	-	-	-	Y	Y	Y	
828	Set	Torque Lead Lag Filter Gain	-	-	-	Y	Y	Y	
554	Set	Torque Loop Bandwidth	-	-	-	Y	Y	Y	
502	Set	Torque Low Pass Filter Bandwidth	-	-	-	Y	Y	Y	
843	Get	Torque Low Pass Filter Bandwidth Estimate	-	-	-	Y	Y	Y	V26/V27
503	Set	Torque Notch Filter Frequency	-	-	-	Y	Y	Y	
841	Get	Torque Notch Filter Frequency Estimate	-	-	-	Y	Y	Y	V26/V27
837	Set	Torque Notch Filter High Frequency Limit	-	-	-	Y	Y	Y	V26/V27
838	Set	Torque Notch Filter Low Frequency Limit	-	-	-	Y	Y	Y	V26/V27
842	Get	Torque Notch Filter Magnitude Estimate	-	-	-	Y	Y	Y	V26/V27
839	Set	Torque Notch Filter Tuning Threshold	-	-	-	Y	Y	Y	V26/V27
591	Set	Torque Prove Current	-	-	Y	Y	Y	Y	V26/V27
506	Set	Torque Rate Limit	-	-	-	Y	Y	Y	
507/334	Set	Torque Threshold	-	-	-	Y	Y	Y	
510	Set	Undertorque Limit	-	-	N	Y	Y	Y	
511	Set	Undertorque Limit Time	-	-	N	Y	Y	Y	
464/321	Set	Velocity Droop	-	-	Y4	Y	Y	-	
465	Set	Velocity Error Tolerance	-	-	-	Y	Y	-	
466	Set	Velocity Error Tolerance Time	-	-	-	Y	Y	-	
366	Get	Velocity Fine Command	-	-	-	Y	Y	-	
467	Set	Velocity Integrator Control	-	-	-	R	R	-	0-Bits 1: Auto-Preset (Y)
468	Set	Velocity Integrator Preload	-	-	-	N	N	-	
474/326	Set	Velocity Limit - Negative	-	-	Y	Y	Y	-	
473/325	Set	Velocity Limit - Positive	-	-	Y	Y	Y	-	
458	Get	Velocity Limit Source		-	-	Y	Y	-	V29
471	Set	Velocity Lock Tolerance	-	-	Y	Y	Y	-	
469	Set	Velocity Low Pass Filter Bandwidth	-	-	-	Y	Y	-	
790	Set	Velocity Negative Feedforward Gain	-	-	-	Y	Y	-	
470/327	Set	Velocity Threshold	-	Y	Y	Y	Y	Y	
589	Set	Vertical Load Control	-	-	Y	Y	Y	-	V31
608	Set	Zero Speed	-	-	Y	Y	Y	Y	V26/V27
609	Set	Zero Speed Time	-	-	Y	Y	Y	Y	V26/V27

Kinetix 5700 Advanced Safety Drive Module Optional Attributes

The Kinetix 5700 advanced safety drive modules include the following catalog numbers:

- 2198-S086-ERS4, 43A, Inverter, Advanced Safety Drive
- 2198-S130-ERS4, 65A, Inverter, Advanced Safety Drive
- 2198-S160-ERS4, 85A, Inverter, Advanced Safety Drive
- 2198-D006-ERS4, 2x2 5A, Dual-Axis Inverter, Advanced Safety Drive
- 2198-D0012-ERS4, 2x5A, Dual-Axis Inverter, Advanced Safety Drive
- 2198-D020-ERS4, 2x8A, Dual-Axis Inverter, Advanced Safety Drive
- 2198-D032-ERS4, 2x13A, Dual-Axis Inverter, Advanced Safety Drive
- 2198-D057-ERS4, 2x23A, Dual-Axis Inverter, Advanced Safety Drive

These drive modules support the optional attributes and corresponding control mode functionality as indicated in the following table:

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
367	Get	Acceleration Fine Command	-	-	-	Y	Y	Y	
485	Set	Acceleration Limit	-	-	N	Y	Y	N	
482	Get	Acceleration Reference	-	-	-	Y	Y	N	
481	Set	Acceleration Trim	-	-	-	N	N	N	
836	Set	Adaptive Tuning Configuration	-	-	-	Y	Y	Y	V26/V27
844	Get	Adaptive Tuning Gain Scaling Factor	-	-	-	Y	Y	Y	V26/V27
732/267	Get	Analog Input 1	N	-	N	N	N	N	
733/268	Get	Analog Input 2	N	-	N	N	N	N	
734	Set	Analog Output 1	N	-	N	N	N	N	
735	Set	Analog Output 2	N	-	N	N	N	N	
873	Set	Auto Sag Configuration	-	-	N	N	N	N	V26/V27
874	Set	Auto Sag Slip Increment	-	-	N	N	N	N	V26/V27
875	Set	Auto Sag Slip Time Limit	-	-	N	N	N	N	V26/V27
876	Set	Auto Sag Start	-	-	N	N	N	N	V26/V27

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
19	Set	Axis Features	R	R	R	R	R	R	0-Bits 0: Fine Interpolation (Y) 1: Registration Auto-rearm (Y) 2: Alarm Log (Y) 5: Hookup Test (Y) 6: Commutation Test (Y) 7: Motor Test (Y) 8: Inertia Test (Y) 9: Sensorless Control (N) 10: Drive Scaling (N) Vxx 11: Ext. Event Block (N) Vxx 12: Integer Cmd. Pos. (N) Vxx 13: Ext. Motor Test (N) V29 14: Control Mode Change (N) V26/V27 15: Feedback Mode Change (N) Vxx 16: Pass Bus Status (Y) V26/V27 17: Pass Bus Unload (Y) V26/V27 18: Ext. Speed for SPM (N) V29 19: Ext. Speed for IPM (Y) V29
986	Get	Axis Safety Data A	-	-	Y	Y	Y	Y	V31
987	Get	Axis Safety Data B	-	-	Y	Y	Y	Y	V31
763	Get	Axis Safety Faults	-	Y	Y	Y	Y	Y	V24
985	Get	Axis Safety Faults - RA	-	Y	Y	Y	Y	Y	V31
760	Get	Axis Safety State	-	Y	Y	Y	Y	Y	V24
761	Get	Axis Safety Status	-	Y	Y	Y	Y	Y	V24
984	Get	Axis Safety Status - RA	-	Y	Y	Y	Y	Y	V31
825	Set	Backlash Compensation Window	-	-	-	Y	-	-	
593	Set	Brake Prove Ramp Time	-	-	N	N	N	N	V26/V27
594	Set	Brake Slip Tolerance	-	-	Y	Y	Y	Y	V26/V27
592	Set	Brake Test Torque	-	-	Y	Y	Y	Y	V26/V27
2338	Get	Bus Output Overvoltage Factory Limit 1	N	-	N	N	N	N	Vxx
2358	Get	Bus Output Overvoltage Factory Limit 2	N	-	N	N	N	N	Vxx
2339	Get	Bus Output Undervoltage Factory Limit 1	N	-	N	N	N	N	Vxx
2359	Get	Bus Output Undervoltage Factory Limit 2	N	-	N	N	N	N	Vxx
638/262	Get	Bus Regulator Capacity	N	-	N	N	N	N	
659	Get	CIP Axis Alarms	N	Y	Y	Y	Y	Y	
904	Get	CIP Axis Alarms - RA	N	Y	Y	Y	Y	Y	
617	Set	Coasting Time Limit	-	-	Y	Y	Y	Y	V26/V27
850	Set	Commutation Offset Compensation		-	-	N	N	N	PM Motor only, V29
563	Set	Commutation Polarity	-	-	-	Y	Y	Y	PM Motor only
562	Set	Commutation Self-Sensing Current	-	-	-	N	N	N	PM Motor only

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
618	Set	Connection Loss Stopping Action	-	-	Y	Y	Y	Y	0-Enum V31 1 = Current Decel Disable (F/Y) 2 = Ramped Decel Disable (FV/Y) 3 = Current Decel Hold (PV/N) 4 = Ramped Decel Hold (V/N)
637	Get	Converter Capacity	N	-	N	N	N	N	
2337	Get	Converter Output Capacity 1	N	-	N	N	N	N	Vxx
2357	Get	Converter Output Capacity 2	N	-	N	N	N	N	Vxx
605	Get	Converter Output Current	N	-	N	N	N	N	V26/V27
2330	Get	Converter Output Current 1	N	-	N	N	N	N	Vxx
2350	Get	Converter Output Current 2	N	-	N	N	N	N	Vxx
606	Get	Converter Output Power	N	-	N	N	N	N	V26/V27
2331	Get	Converter Output Power 1	N	-	N	N	N	N	Vxx
2351	Get	Converter Output Power 2	N	-	N	N	N	N	Vxx
2332	Get	Converter Output Rated Current 1	N	-	N	N	N	N	Vxx
2352	Get	Converter Output Rated Current 2	N	-	N	N	N	N	Vxx
2333	Get	Converter Output Rated Power 1	N	-	N	N	N	N	Vxx
2353	Get	Converter Output Rated Power 2	N	-	N	N	N	N	Vxx
840	Set	Current Disturbance	-	-	-	N	N	N	
527	Get	Current Error	-	-	-	Y	Y	Y	
529	Get	Current Feedback	-	-	-	Y	Y	Y	
522	Get	Current Limit Source	-	-	Y	Y	Y	Y	(F/V29)
524	Get	Current Reference	-	-	-	Y	Y	Y	
553	Set	Current Vector Limit	-	-	Y	Y	Y	Y	
2334	Get	DC Bus Output Voltage 1	N	-	N	N	N	N	Vxx
2354	Get	DC Bus Output Voltage 2	N	-	N	N	N	N	Vxx
742	Get	DC Bus Output Voltage Reference	N	-	N	N	N	N	Vxx
2336	Get	DC Bus Output Voltage Reference 1	N	-	N	N	N	N	Vxx
2356	Get	DC Bus Output Voltage Reference 2	N	-	N	N	N	N	Vxx
870	Set	DC Injection Brake Current	-	-	N	N	N	N	
872	Set	DC Injection Brake Time	-	-	N	N	N	N	
486	Set	Deceleration Limit	-	-	N	Y	Y	N	
730	Get	Digital Inputs	N	-	N	N	N	N	
731	Set	Digital Outputs	N	-	N	N	N	N	
1435	Set	Feedback 1 Accel Filter Bandwidth	-	Y	-	Y	Y	Y	
2404	Set	Feedback 1 Accel Filter Taps	-	Y	-	Y	Y	Y	
2405	Set	Feedback 1 Battery Absolute	-	N	-	N	N	N	TM
1421	Set	Feedback 1 Data Code	-	N	-	N	N	N	TP,SS
1420	Set	Feedback 1 Data Length	-	N	-	N	N	N	TP,SS

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
2400	Set	Feedback 1 Loss Action	-	N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1414	Set	Feedback 1 Polarity	-	Y	-	Y	Y	Y	
1425	Set	Feedback 1 Resolver Cable Balance	-	N	-	N	N	N	RS
1424	Set	Feedback 1 Resolver Excitation Frequency	-	N	-	N	N	N	RS
1423	Set	Feedback 1 Resolver Excitation Voltage	-	N	-	N	N	N	RS
1422	Set	Feedback 1 Resolver Transformer Ratio	-	N	-	N	N	N	RS
1401	Get	Feedback 1 Serial Number	-	Y	-	Y	Y	Y	
1415	Set	Feedback 1 Startup Method	-	R	-	R	R	R	0-Enum 1 = Absolute (Y)
1434	Set	Feedback 1 Velocity Filter Bandwidth	-	Y	-	Y	Y	Y	
2403	Set	Feedback 1 Velocity Filter Taps	-	Y	-	Y	Y	Y	
1485	Set	Feedback 2 Accel Filter Bandwidth	-	Y	-	Y	Y	Y	
2454	Set	Feedback 2 Accel Filter Taps	-	Y	-	Y	Y	Y	
2455	Set	Feedback 2 Battery Absolute	-	N	-	N	N	N	TM
1471	Set	Feedback 2 Data Code	-	N	-	N	N	N	TP,SS
1470	Set	Feedback 2 Data Length	-	N	-	N	N	N	TP,SS
2450	Set	Feedback 2 Loss Action	-	N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1464	Set	Feedback 2 Polarity	-	Y	-	Y	Y	Y	
1475	Set	Feedback 2 Resolver Cable Balance	-	N	-	N	N	N	RS
1474	Set	Feedback 2 Resolver Excitation Frequency	-	N	-	N	N	N	RS
1473	Set	Feedback 2 Resolver Excitation Voltage	-	N	-	N	N	N	RS
1472	Set	Feedback 2 Resolver Transformer Ratio	-	N	-	N	N	N	RS
1451	Get	Feedback 2 Serial Number	-	Y	-	Y	Y	Y	
1465	Set	Feedback 2 Startup Method	-	R	-	R	R	R	0-Enum 1 = Absolute (Y)
1484	Set	Feedback 2 Velocity Filter Bandwidth	-	Y	-	Y	Y	Y	
2453	Set	Feedback 2 Velocity Filter Taps	-	Y	-	Y	Y	Y	
250	Set	Feedback Commutation Aligned	-	-	-	Y	Y	Y	0-Enum 2 = Motor Offset (Y) 3 = Self-Sense (N) 4 = Database Offset (N) Vxx

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
31	Set*	Feedback Configuration	R	R	R	R	R	R	0-Enum 0 = No Feedback (V/N)(T/N) 3 = Load Feedback (P/Y)(V/Y)(T/N) 4 = Dual Feedback (P/Y) 8 = Dual Integrator Feedback (P/N)
708	Set	Feedback Data Loss User Limit	-	Y	Y	Y	Y	Y	
706	Set	Feedback Noise User Limit	-	Y	Y	Y	Y	Y	
707	Set	Feedback Signal Loss User Limit	-	Y	Y	Y	Y	Y	
44	Set	Feedback Unit Ratio	-	-	-	Y	Y	-	
871	Set	Flux Braking Enable	-	-	N	N	N	N	Ind Motor only
528	Get	Flux Current Error	-	-	-	Y	Y	Y	
530	Get	Flux Current Feedback	-	-	-	Y	Y	Y	
525	Get	Flux Current Reference	-	-	-	Y	Y	Y	
557	Set	Flux Integral Time Constant	-	-	-	N	N	N	
556	Set	Flux Loop Bandwidth	-	-	-	N	N	N	
558	Set	Flux Up Control	-	-	Y	Y	Y	Y	Ind Motor only 0-Enum 1 = Manual Delay (Y) 2 = Automatic Delay (Y)
559	Set	Flux Up Time	-	-	Y	Y	Y	Y	Ind Motor only
380	Set	Flying Start Enable	-	-	N	-	Y	-	
381	Set	Flying Start Method	-	-	N	-	Y	-	0-Enum: V29 1 = Counter EMF (N) 2 = Sweep Frequency (N)
570	Set	Frequency Control Method	-	-	R	-	-	-	0-Enum 128 = Fan/Pump Volts/Hertz (Y) 129 = Sensorless Vector (Y) 130 = Sensorless Vector Economy (N)
498	Set	Friction Compensation Sliding	-	-	-	Y	Y	Y	
499	Set	Friction Compensation Static	-	-	-	Y	Y	Y	
500	Set	Friction Compensation Viscous	-	-	-	Y	Y	Y	
826/421	Set	Friction Compensation Window	-	-	-	Y	-	-	
981/243	Get	Guard Faults	-	-	Y	Y	Y	Y	
980/242	Get	Guard Status	-	-	Y	Y	Y	Y	
280	Set	Home Torque Threshold	-	-	-	N	N	-	Vxx
281	Set	Home Torque Time	-	-	-	N	N	-	Vxx
1349	Set	Induction Motor Magnetization Reactance	-	-	N	N	N	N	Ind Motor only
1352	Set	Induction Motor Rated Slip Speed	-	-	Y	Y	Y	Y	Ind Motor only
1351	Set	Induction Motor Rotor Leakage Reactance	-	-	Y	Y	Y	Y	Ind Motor only, V26/V27
1350	Set	Induction Motor Rotor Resistance	-	-	N	N	N	N	Ind Motor only
1348	Set	Induction Motor Stator Leakage Reactance	-	-	Y	Y	Y	Y	Ind Motor only, V26/V27

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
647	Set	Inverter Overload Action	-	-	Y	Y	Y	Y	0-Enum 1 = Current Foldback (Y) 128 = Reduce PWM Rate (N) 129 = PWM Foldback (N)
699	Set	Inverter Thermal Overload User Limit	-	-	Y	Y	Y	Y	
1338	Set	Linear Motor Damping Coefficient	-	-	N	N	N	N	Linear Motor only
2313	Set	Linear Motor Integral Limit Switch	-	-	N	N	N	N	Linear Motor only
1336	Set	Linear Motor Mass	-	-	N	Y	Y	Y	Linear Motor only
1337	Set	Linear Motor Max Speed	-	-	N	Y	Y	Y	Linear Motor only
801	Get	Load Observer Acceleration Estimate	-	-	-	Y	Y	N	
806	Set	Load Observer Bandwidth	-	-	-	Y	Y	N	
805	Set	Load Observer Configuration	-	-	-	Y	Y	Y	0-Enum 1 = Load Observer Only (Y) 2 = Load Observer With Velocity Estimate (Y) 3 = Velocity Estimate Only (Y) 4 = Acceleration Feedback (N)
809	Set	Load Observer Feedback Gain	-	-	-	Y	Y	N	
807	Set	Load Observer Integrator Bandwidth	-	-	-	Y	Y	N	
802	Get	Load Observer Torque Estimate	-	-	-	Y	Y	N	
1370	Set	Load Type	-	N	N	N	N	N	DScale
750	Set	Local Control	N	N	N	N	N	N	0-Enum 1 = Conditionally Allowed (N) 2 = Allowed (N)
614	Set	Mechanical Brake Control	-	-	Y	Y	Y	Y	
616	Set	Mechanical Brake Engage Delay	-	-	Y	Y	Y	Y	
615	Set	Mechanical Brake Release Delay	-	-	Y	Y	Y	Y	
45	Set	Motion Scaling Configuration	-	R	R	R	R	R	0-Enum 1 = Drive Scaling (N)
1310/251	Set	Motor Catalog Number	-	-	N	Y	Y	Y	Dr NV
1313	Set	Motor Data Source	-	-	R	R	R	R	0-Enum 1 = Database (Y) 2 = Drive NV (N) 3 = Motor NV (Y)
1323	Set	Motor Integral Thermal Switch	-	-	Y	Y	Y	Y	
1324	Set	Motor Max Winding Temperature	-	-	Y	Y	Y	Y	
646	Set	Motor Overload Action	-	-	Y	Y	Y	Y	0-Enum 1 = Current Foldback (Y)
1322	Set	Motor Overload Limit	-	-	Y	Y	Y	Y	
695	Set	Motor Overspeed User Limit	-	-	Y	Y	Y	Y	
694	Set	Motor Phase Loss Limit	-	-	N	N	N	N	V26/V27
1317	Set	Motor Polarity	-	-	Y	Y	Y	Y	
1321	Set	Motor Rated Output Power	-	-	Y	Y	Y	Y	Y-PM
1320	Set	Motor Rated Peak Current	-	-	Y	Y	Y	Y	Y-IM
697	Set	Motor Thermal Overload User Limit	-	-	Y	Y	Y	Y	

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
1325	Set	Motor Winding to Ambient Capacitance	-	-	Y	Y	Y	Y	
1326	Set	Motor Winding to Ambient Resistance	-	-	Y	Y	Y	Y	
521	Get	Operative Current Limit	-	-	Y	Y	Y	Y	F Support in V29
600	Get	Output Frequency	-	-	R	Y	Y	Y	
508	Set	Overtorque Limit	-	-	N	Y	Y	Y	
509	Set	Overtorque Limit Time	-	-	N	Y	Y	Y	
1355	Set	PM Motor Extended Speed Permissive	-	-	-	Y	Y	Y	V29
2310	Set	PM Motor Flux Saturation	-	-	N	Y	Y	Y	SPM Motor only
1343	Set	PM Motor Force Constant	-	-	N	Y	Y	Y	Rotary PM Motor only
1358	Set	PM Motor Linear Bus Overvoltage Speed	-	-	-	N	N	N	V29
1359	Set	PM Motor Linear Max Extended Speed	-	-	-	N	N	N	V29
2314	Set	PM Motor Lq Flux Saturation	-	-	N	Y	Y	Y	IPM Motor only, V29/V29
2315	Set	PM Motor Ld Flux Saturation	-	-	N	Y	Y	Y	IPM Motor only, V29/V29
1342	Set	PM Motor Rated Force	-	-	N	Y	Y	Y	Rotary PM Motor only
1339	Set	PM Motor Rated Torque	-	-	N	Y	Y	Y	Rotary PM Motor only
1356	Set	PM Motor Rotary Bus Overvoltage Speed	-	-	-	Y	Y	Y	V29
1357	Set	PM Motor Rotary Max Extended Speed	-	-	-	Y	Y	Y	V29
1340	Set	PM Motor Torque Constant	-	-	N	Y	Y	Y	Rotary PM Motor only
445	Set	Position Error Tolerance Time	-	-	-	Y	-	-	
365	Get	Position Fine Command	-	-	-	Y	-	-	
446	Set	Position Integrator Control	-	-	-	R	-	-	0-Bits 1: Auto-Preset (N)
447	Set	Position Integrator Preload	-	-	-	N	-	-	
781	Set	Position Lead Lag Filter Bandwidth	-	-	-	Y	-	-	
782	Set	Position Lead Lag Filter Gain	-	-	-	Y	-	-	
783	Set	Position Notch Filter Frequency	-	-	-	N	-	-	
627	Set	Power Loss Action	-	-	N	N	N	N	0-Enum 2 = Decel Regen (N)
628	Set	Power Loss Threshold	N	-	Y	Y	Y	Y	
630	Set	Power Loss Time	N	-	N	N	N	N	
590	Set	Proving Configuration	-	-	Y	Y	Y	Y	V26/V27
376	Set*	Ramp Acceleration	-	-	Y	-	Y	-	Derived
377	Set*	Ramp Deceleration	-	-	Y	-	Y	-	Derived
378	Set	Ramp Jerk Control	-	-	Y	-	Y	-	
375	Set*	Ramp Velocity - Negative	-	-	Y	-	Y	-	Derived
374	Set*	Ramp Velocity - Positive	-	-	Y	-	Y	-	Derived

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
613/354	Set	Resistive Brake Contact Delay	-	-	N	N	N	N	PM Motor only
1333	Set	Rotary Motor Damping Coefficient	-	-	N	N	N	N	Rotary Motor only
2312	Set	Rotary Motor Fan Cooling Derating	-	-	N	N	N	N	Rotary Motor only
2311	Set	Rotary Motor Fan Cooling Speed	-	-	N	N	N	N	Rotary Motor only
1330	Set	Rotary Motor Inertia	-	-	Y	Y	Y	Y	Rotary Motor only
1332	Set	Rotary Motor Max Speed	-	-	Y	Y	Y	Y	Rotary Motor only
766	Set	Safe Stopping Action	-	-	Y	Y	Y	Y	0-Enum V31 1 = Current Decel (F/Y) 2 = Ramped Decel (FV/Y)
767	Set	Safe Stopping Action Source	-	-	Y	Y	Y	Y	0-Enum V31 1 = Running Controller (Y)
765	Set	Safe Torque Off Action	-	-	Y	Y	Y	Y	0-Enum V26/V27 1 = Current Decel Disable (F/Y) 2 = Ramped Decel Disable (FV/Y) 128 = DC Injection Brake (FPVT/N) 129 = AC Injection Brake (FPVT/N)
759	Set	Safe Torque Off Action Source	-	-	Y	Y	Y	Y	0-Enum V31 1 = Running Controller (Y)
629	Set	Shutdown Action	N	-	N	N	N	N	0-Enum 1 = Drop DC Bus (FPVT/N)
370	Set	Skip Speed 1	-	-	Y	-	-	-	
371	Set	Skip Speed 2	-	-	Y	-	-	-	
372	Set	Skip Speed 3	-	-	N	-	-	-	
373	Set	Skip Speed Band	-	-	Y	-	-	-	
833	Set	SLAT Configuration	-	-	-	-	Y	-	
834	Set	SLAT Set Point	-	-	-	-	Y	-	
835	Set	SLAT Time Delay	-	-	-	-	Y	-	
610	Set	Stopping Action	-	-	R	R	R	R	0-Enum 1 = Current Decel Disable (F/Y) V26/V27 2 = Ramped Decel Disable (FV/Y) 3 = Current Decel Hold (PV/Y) 4 = Ramped Decel Hold (V/Y) 128 = DC Injection Brake (FPVT/N) 129 = AC Injection Brake (FPVT/N)
612	Set	Stopping Time Limit	-	-	Y	Y	Y	Y	(F/V26/V27)
496	Set	System Inertia	-	-	-	R	R	Y	
555	Set	Torque Integral Time Constant	-	-	-	N	N	N	
827	Set	Torque Lead Lag Filter Bandwidth	-	-	-	Y	Y	Y	
828	Set	Torque Lead Lag Filter Gain	-	-	-	Y	Y	Y	
554	Set	Torque Loop Bandwidth	-	-	-	Y	Y	Y	
502	Set	Torque Low Pass Filter Bandwidth	-	-	-	Y	Y	Y	
843	Get	Torque Low Pass Filter Bandwidth Estimate	-	-	-	Y	Y	Y	V26/V27

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
503	Set	Torque Notch Filter Frequency	-	-	-	Y	Y	Y	
841	Get	Torque Notch Filter Frequency Estimate	-	-	-	Y	Y	Y	V26/V27
837	Set	Torque Notch Filter High Frequency Limit	-	-	-	Y	Y	Y	V26/V27
838	Set	Torque Notch Filter Low Frequency Limit	-	-	-	Y	Y	Y	V26/V27
842	Get	Torque Notch Filter Magnitude Estimate	-	-	-	Y	Y	Y	V26/V27
839	Set	Torque Notch Filter Tuning Threshold	-	-	-	Y	Y	Y	V26/V27
591	Set	Torque Prove Current	-	-	Y	Y	Y	Y	V26/V27
506	Set	Torque Rate Limit	-	-	-	Y	Y	Y	
507/334	Set	Torque Threshold	-	-	-	Y	Y	Y	
510	Set	Undertorque Limit	-	-	N	Y	Y	Y	
511	Set	Undertorque Limit Time	-	-	N	Y	Y	Y	
464/321	Set	Velocity Droop	-	-	Y	Y	Y	-	
465	Set	Velocity Error Tolerance	-	-	-	Y	Y	-	
466	Set	Velocity Error Tolerance Time	-	-	-	Y	Y	-	
366	Get	Velocity Fine Command	-	-	-	Y	Y	-	
467	Set	Velocity Integrator Control	-	-	-	R	R	-	0-Bits 1: Auto-Preset (N)
468	Set	Velocity Integrator Preload	-	-	-	N	N	-	
474/326	Set	Velocity Limit - Negative	-	-	Y	Y	Y	-	
473/325	Set	Velocity Limit - Positive	-	-	Y	Y	Y	-	
458	Get	Velocity Limit Source		-	-	Y	Y	-	V29
471	Set	Velocity Lock Tolerance	-	-	Y	Y	Y	-	
469	Set	Velocity Low Pass Filter Bandwidth	-	-	-	Y	Y	-	
790	Set	Velocity Negative Feedforward Gain	-	-	-	Y	Y	-	
470/327	Set	Velocity Threshold	-	Y	Y	Y	Y	Y	
589	Set	Vertical Load Control	-	-	Y	Y	Y	-	V31
608	Set	Zero Speed	-	-	Y	Y	Y	Y	V26/V27
609	Set	Zero Speed Time	-	-	Y	Y	Y	Y	V26/V27

Kinetix 6500 Drive Module Optional Attributes

The following table identifies the optional attributes and corresponding control mode functionality supported by a Kinetix 6500 drive module.

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
367	Get	Acceleration Fine Command		-	-	Y	Y	Y	
485	Set	Acceleration Limit		-	N	Y	Y	N	
482	Get	Acceleration Reference		-	-	Y	Y	N	
481	Set	Acceleration Trim		-	-	N	N	N	

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
1376	Set	Actuator Diameter		N	N	N	N	N	DScale
1377	Set	Actuator Diameter Unit		N	N	N	N	N	DScale
1374	Set	Actuator Lead		N	N	N	N	N	DScale
1375	Set	Actuator Lead Unit		N	N	N	N	N	DScale
1373	Set	Actuator Type		N	N	N	N	N	DScale
732/267	Get	Analog Input 1	B	B	N	N	N	N	
733/268	Get	Analog Input 2	B	B	N	N	N	N	
734	Set	Analog Output 1	B	B	N	N	N	N	
735	Set	Analog Output 2	B	B	N	N	N	N	
30	Set	Axis Configuration		R	R	R	R	R	0-Enum 0 = Feedback Only (Y) 1 = Frequency Control (N) 2 = Position Loop (Y) 3 = Velocity Loop (Y) 4 = Torque Loop (Y)
19	Set	Axis Features		R	R	R	R	R	0-Bits 0 = Fine Interpolation (Y) 1 = Registration Auto-rearm (Y) 2 = Alarm Log (Y) 5 = Hookup Test (Y) 6 = Commutation Test (Y) 7 = Motor Test (N) 8 = Inertia Test (Y) 9 = Sensorless Control (N)
763	Get	Axis Safety Faults		0	0	0	0	Y	
760	Get	Axis Safety State		0	0	0	0	Y	
761	Get	Axis Safety Status		0	0	0	0	Y	
825	Set	Backlash Compensation Window		-	-	Y	-	-	
638/262	Get	Bus Regulator Capacity		-	N	Y	Y	Y	
659	Get	CIP Axis Alarms		Y	N	Y	Y	Y	
904	Get	CIP Axis Alarms - RA		Y	N	Y	Y	Y	
563	Set	Commutation Polarity		-	-	Y	Y	Y	PM Motor only
562	Set	Commutation Self-Sensing Current		-	-	Y	Y	Y	PM Motor only 0-Value = 100
637	Get	Converter Capacity		-	N	Y	Y	Y	
840	Set	Current Disturbance		-	-	N	N	N	
527	Get	Current Error		-	-	Y	Y	Y	
529	Get	Current Feedback		-	-	Y	Y	Y	
522	Get	Current Limit Source		-	-	Y	Y	Y	
524	Get	Current Reference		-	-	Y	Y	Y	
553	Set	Current Vector Limit		-	N	N	N	N	
870	Set	DC Injection Brake Current		-	N	N	N	N	Ind Motor only
872	Set	DC Injection Brake Time		-	N	N	N	N	Ind Motor only
486	Set	Deceleration Limit		-	N	Y	Y	N	

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
730	Get	Digital Inputs		-	N	N	N	N	
731	Set	Digital Outputs		-	N	N	N	N	
1435	Set	Feedback 1 Accel Filter Bandwidth		Y	-	Y	Y	Y	
2404	Set	Feedback 1 Accel Filter Taps		Y	-	Y	Y	Y	
2405	Set	Feedback 1 Battery Absolute		N	-	N	N	N	TM
1421	Set	Feedback 1 Data Code		N	-	N	N	N	TP,SS
1420	Set	Feedback 1 Data Length		N	-	N	N	N	TP,SS
2400	Set	Feedback 1 Loss Action		N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1414	Set	Feedback 1 Polarity		Y	-	Y	Y	Y	
1425	Set	Feedback 1 Resolver Cable Balance		N	-	N	N	N	RS
1424	Set	Feedback 1 Resolver Excitation Frequency		N	-	N	N	N	RS
1423	Set	Feedback 1 Resolver Excitation Voltage		N	-	N	N	N	RS
1422	Set	Feedback 1 Resolver Transformer Ratio		N	-	N	N	N	RS
1401	Get	Feedback 1 Serial Number		Y	-	Y	Y	Y	
1415	Set	Feedback 1 Startup Method		R	-	R	R	R	0-Enum 1 = Absolute (Y)
1434	Set	Feedback 1 Velocity Filter Bandwidth		Y	-	Y	Y	Y	
2403	Set	Feedback 1 Velocity Filter Taps		Y	-	Y	Y	Y	
1485	Set	Feedback 2 Accel Filter Bandwidth		Y	-	Y	Y	Y	
2454	Set	Feedback 2 Accel Filter Taps		Y	-	Y	Y	Y	
2455	Set	Feedback 2 Battery Absolute		N	-	N	N	N	TM
1471	Set	Feedback 2 Data Code		N	-	N	N	N	TP,SS
1470	Set	Feedback 2 Data Length		N	-	N	N	N	TP,SS
2450	Set	Feedback 2 Loss Action		N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1464	Set	Feedback 2 Polarity		Y	-	Y	Y	Y	
1475	Set	Feedback 2 Resolver Cable Balance		N	-	N	N	N	RS
1474	Set	Feedback 2 Resolver Excitation Frequency		N	-	N	N	N	RS
1473	Set	Feedback 2 Resolver Excitation Voltage		N	-	N	N	N	RS
1472	Set	Feedback 2 Resolver Transformer Ratio		N	-	N	N	N	RS
1451	Get	Feedback 2 Serial Number		Y	-	Y	Y	Y	
1465	Set	Feedback 2 Startup Method		R	-	R	R	R	0-Enum 1 = Absolute (Y)
1484	Set	Feedback 2 Velocity Filter Bandwidth		Y	-	Y	Y	Y	
2453	Set	Feedback 2 Velocity Filter Taps		Y	-	Y	Y	Y	
250	Set	Feedback Commutation Aligned		-	-	Y	Y	Y	0-Enum 2 = Motor Offset (Y) 3 = Self-Sense (Y)

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
31	Set*	Feedback Configuration		R	R	R	R	R	O-Enum 0 = No Feedback (V/N) 3 = Load Feedback (PVT/Y) 4 = Dual Feedback (P/Y) 8 = Dual Integrator Feedback (P/N)
708	Set	Feedback Data Loss User Limit		Y	N	Y	Y	Y	
706	Set	Feedback Noise User Limit		N	N	N	N	N	
707	Set	Feedback Signal Loss User Limit		Y	N	Y	Y	Y	
44	Set	Feedback Unit Ratio		-	-	Y	Y	-	
871	Set	Flux Braking Enable		-	N	N	N	N	Ind Motor only
528	Get	Flux Current Error		-	-	Y	Y	Y	
530	Get	Flux Current Feedback		-	-	Y	Y	Y	
525	Get	Flux Current Reference		-	-	Y	Y	Y	
557	Set	Flux Integral Time Constant		-	-	N	N	N	
556	Set	Flux Loop Bandwidth		-	-	N	N	N	
558	Set	Flux Up Control		-	N	N	N	N	Ind Motor only, O-Enum 1 = Manual Delay (N) 2 = Automatic Delay (N)
559	Set	Flux Up Time		-	N	N	N	N	Ind Motor only
380	Set	Flying Start Enable		-	N	-	N	-	
570	Set	Frequency Control Method		-	R	-	-	-	O-Enum 128 = Fan/Pump Volts/Hertz (N) 129 = Sensorless Vector (N) 130 = Sensorless Vector Economy (N)
498	Set	Friction Compensation Sliding		-	-	Y	Y	N	
499	Set	Friction Compensation Static		-	-	Y	N	N	
500	Set	Friction Compensation Viscous		-	-	Y	Y	N	
826/421	Set	Friction Compensation Window		-	-	Y	-	-	
981/243	Get	Guard Faults		-	N	Y	Y	Y	
980/242	Get	Guard Status		-	N	Y	Y	Y	
1349	Set	Induction Motor Magnetization Reactance		-	N	N	N	N	Ind Motor only
1352	Set	Induction Motor Rated Slip Speed		-	N	N	N	N	Ind Motor only
1350	Set	Induction Motor Rotor Resistance		-	N	N	N	N	Ind Motor only
647	Set	Inverter Overload Action		-	N	Y	Y	Y	O-Enum 1 = Current Foldback (Y) 128 = Reduce PWM Rate (N) 129 = PWM Foldback (N)
699	Set	Inverter Thermal Overload User Limit		-	N	Y	Y	Y	
1338	Set	Linear Motor Damping Coefficient		-	N	N	N	N	Linear Motor only
2313	Set	Linear Motor Integral Limit Switch		-	N	N	N	N	Linear Motor only
1336	Set	Linear Motor Mass		-	N	Y	Y	Y	Linear Motor only
1337	Set	Linear Motor Max Speed		-	N	Y	Y	Y	Linear Motor only
801	Get	Load Observer Acceleration Estimate		-	-	Y	Y	Y	

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
806	Set	Load Observer Bandwidth		-	-	Y	Y	Y	
805	Set	Load Observer Configuration		-	-	Y	Y	Y	0-Enum 1 = Load Observer Only (Y) 2 = Load Observer with Velocity Estimate (Y) 3 = Velocity Estimate Only (Y) 4 = Acceleration Feedback (Y)
809	Set	Load Observer Feedback Gain		-	-	Y	Y	Y	
807	Set	Load Observer Integrator Bandwidth		-	-	Y	Y	Y	
802	Get	Load Observer Torque Estimate		-	-	Y	Y	Y	
1370	Set	Load Type		N	N	N	N	N	DScale
750	Set	Local Control		N	N	N	N	N	0-Enum 1 = Conditionally Allowed (N) 2 = Allowed (N)
614	Set	Mechanical Brake Control		-	N	Y	Y	Y	
616	Set	Mechanical Brake Engage Delay		-	N	Y	Y	Y	
615	Set	Mechanical Brake Release Delay		-	N	Y	Y	Y	
45	Set	Motion Scaling Configuration		R	R	R	R	R	0-Enum 1 = Drive Scaling (N)
1310/251	Set	Motor Catalog Number		-	N	Y	Y	Y	Dr NV
1313	Set	Motor Data Source		-	R	R	R	R	0-Enum 1 = Database (Y) 2 = Drive NV (N) 3 = Motor NV (Y)
1323	Set	Motor Integral Thermal Switch		-	N	Y	Y	Y	
1324	Set	Motor Max Winding Temperature		-	N	N	N	N	
646	Set	Motor Overload Action		-	N	Y	Y	Y	0-Enum 1 = Current Foldback (Y)
1322	Set	Motor Overload Limit		-	N	Y	Y	Y	
695	Set	Motor Overspeed User Limit		-	N	N	N	N	
1317	Set	Motor Polarity		-	N	Y	Y	Y	
1321	Set	Motor Rated Output Power		-	N	Y	Y	Y	N-IM
1320	Set	Motor Rated Peak Current		-	N	Y	Y	Y	N-IM
697	Set	Motor Thermal Overload User Limit		-	N	Y	Y	Y	
1315	Set	Motor Type		-	R	R	R	R	0-Enum 1 = Rotary Permanent Magnet (Y) 2 = Rotary Induction (N) 3 = Linear Permanent Magnet (Y) 4 = Linear Induction (N)
1325	Set	Motor Winding to Ambient Capacitance		-	N	Y	Y	Y	
1326	Set	Motor Winding to Ambient Resistance		-	N	Y	Y	Y	
521	Get	Operative Current Limit		-	-	Y	Y	Y	
600	Get	Output Frequency		-	R	Y	Y	Y	
508	Set	Overtorque Limit		-	N	Y	Y	Y	
509	Set	Overtorque Limit Time		-	N	Y	Y	Y	

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
2310	Set	PM Motor Flux Saturation		-	N	Y	Y	Y	PM Motor only
1343	Set	PM Motor Force Constant		-	N	Y	Y	Y	Rotary PM Motor only
1342	Set	PM Motor Rated Force		-	N	Y	Y	Y	Rotary PM Motor only
1339	Set	PM Motor Rated Torque		-	N	Y	Y	Y	Rotary PM Motor only
1340	Set	PM Motor Torque Constant		-	N	Y	Y	Y	Rotary PM Motor only
445	Set	Position Error Tolerance Time		-	-	Y	-	-	
365	Get	Position Fine Command		-	-	Y	-	-	
446	Set	Position Integrator Control		-	-	R	-	-	0-Bits 1: Auto-Preset (N)
447	Set	Position Integrator Preload		-	-	N	-	-	
781	Set	Position Lead Lag Filter Bandwidth		-	-	Y	-	-	
782	Set	Position Lead Lag Filter Gain		-	-	Y	-	-	
783	Set	Position Notch Filter Frequency		-	-	Y	-	-	
627	Set	Power Loss Action		-	N	N	N	N	0-Enum 1 = Coast Thru (N) 2 = Decel Regen (N)
628	Set	Power Loss Threshold		-	N	N	N	N	
630	Set	Power Loss Time		-	N	N	N	N	
376	Set*	Ramp Acceleration		-	N	-	N	-	Derived
377	Set*	Ramp Deceleration		-	N	-	N	-	Derived
378	Set	Ramp Jerk Control		-	N	-	N	-	
375	Set*	Ramp Velocity - Negative		-	N	-	N	-	Derived
374	Set*	Ramp Velocity - Positive		-	N	-	N	-	Derived
613/354	Set	Resistive Brake Contact Delay		-	N	Y	Y	Y	PM Motor only
1333	Set	Rotary Motor Damping Coefficient		-	N	N	N	N	Rotary Motor only
2312	Set	Rotary Motor Fan Cooling Derating		-	N	N	N	N	Rotary Motor only
2311	Set	Rotary Motor Fan Cooling Speed		-	N	N	N	N	Rotary Motor only
1330	Set	Rotary Motor Inertia		-	N	Y	Y	Y	Rotary Motor only
1332	Set	Rotary Motor Max Speed		-	N	Y	Y	Y	Rotary Motor only
629	Set	Shutdown Action		-	N	Y	Y	Y	0-Enum 1 = Drop DC Bus (Y)
370	Set	Skip Speed 1		-	N	-	-	-	
371	Set	Skip Speed 2		-	N	-	-	-	
372	Set	Skip Speed 3		-	N	-	-	-	
373	Set	Skip Speed Band		-	N	-	-	-	
833	Set	SLAT Configuration		-	-	-	N	-	
834	Set	SLAT Set Point		-	-	-	N	-	
835	Set	SLAT Time Delay		-	-	-	N	-	

ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
610	Set	Stopping Action		-	R	R	R	R	0-Enum 2 = Ramped Decel Disable (FPV/N) 3 = Current Decel Hold (PV/Y) 4 = Ramped Decel Hold (PV/N) 128 = DC Injection Brake (IM/N) 129 = AC Injection Brake (IM/N)
612	Set	Stopping Time Limit		-	-	Y	Y	Y	
496	Set	System Inertia		-	-	R	R	N	
555	Set	Torque Integral Time Constant		-	-	N	N	N	
827	Set	Torque Lead Lag Filter Bandwidth		-	-	Y	Y	Y	
828	Set	Torque Lead Lag Filter Gain		-	-	Y	Y	Y	
554	Set	Torque Loop Bandwidth		-	-	Y	Y	Y	
502	Set	Torque Low Pass Filter Bandwidth		-	-	Y	Y	Y	
503	Set	Torque Notch Filter Frequency		-	-	Y	Y	Y	
506	Set	Torque Rate Limit		-	-	Y	Y	Y	
507/334	Set	Torque Threshold		-	-	Y	Y	Y	
1371	Set	Transmission Ratio Input		N	N	N	N	N	DScale
1372	Set	Transmission Ratio Output		N	N	N	N	N	DScale
510	Set	Undertorque Limit		-	N	Y	Y	Y	
511	Set	Undertorque Limit Time		-	N	Y	Y	Y	
464/321	Set	Velocity Droop		-	N	Y	Y	-	
465	Set	Velocity Error Tolerance		-	-	Y	Y	-	
466	Set	Velocity Error Tolerance Time		-	-	Y	Y	-	
366	Get	Velocity Fine Command		-	-	Y	Y	-	
467	Set	Velocity Integrator Control		-	-	R	R	-	0-Bits 1: Auto-Preset (N)
468	Set	Velocity Integrator Preload		-	-	N	N	-	
474/326	Set	Velocity Limit - Negative		-	N	Y	Y	-	
473/325	Set	Velocity Limit - Positive		-	N	Y	Y	-	
471	Set	Velocity Lock Tolerance		-	N	Y	Y	-	
469	Set	Velocity Low Pass Filter Bandwidth		-	-	Y	Y	-	
790	Set	Velocity Negative Feedforward Gain		-	-	Y	Y	-	
470/327	Set	Velocity Threshold		Y	N	Y	Y	Y	

PowerFlex 527 Axis Instance Optional Attributes

The following table identifies the optional attributes and corresponding control mode functionality supported by a PowerFlex 527 drive module.

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
367	Get	Acceleration Fine Command	-	-	-	Y	Y	N	
485	Set	Acceleration Limit	-	-	N	N	N	N	

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
482	Get	Acceleration Reference	-	-	-	N	N	N	
481	Set	Acceleration Trim	-	-	-	N	N	N	
1376	Set	Actuator Diameter	-	N	N	N	N	N	DScale
1377	Set	Actuator Diameter Unit	-	N	N	N	N	N	DScale
1374	Set	Actuator Lead	-	N	N	N	N	N	DScale
1375	Set	Actuator Lead Unit	-	N	N	N	N	N	DScale
1373	Set	Actuator Type	-	N	N	N	N	N	DScale
836	Set	Adaptive Tuning Configuration	-	-	-	N	N	N	Vxx
844	Get	Adaptive Tuning Gain Scaling Factor	-	-	-	N	N	N	Vxx
732/267	Get	Analog Input 1	N	-	Y	Y	Y	N	
733/268	Get	Analog Input 2	N	-	Y	Y	Y	N	
734	Set	Analog Output 1	N	-	Y	Y	Y	N	
735	Set	Analog Output 2	N	-	N	N	N	N	
873	Set	Auto Sag Configuration	-	-	N	N	N	N	Vxx
874	Set	Auto Sag Slip Increment	-	-	N	N	N	N	Vxx
875	Set	Auto Sag Slip Time Limit	-	-	N	N	N	N	Vxx
876	Set	Auto Sag Start	-	-	N	N	N	N	Vxx
19	Set	Axis Features	R	R	R	R	R	R	O-Bits 0 = Fine Interpolation (Y) 1 = Registration Auto-rearm (Y) 2 = Alarm Log (Y) 5 = Hookup Test (Y) 6 = Commutation Test (Y) 7 = Motor Test (Y) 8 = Inertia Test (Y) 9 = Sensorless Control (Y) 10 = Drive Scaling (N) 11 = Ext. Event Block (N) 12 = Integer Cmd. Pos. (N) 13 = Ext. Motor Test (N)
763	Get	Axis Safety Faults	-	N	Y	Y	Y	N	V24
760	Get	Axis Safety State	-	N	Y	Y	Y	N	V24
761	Get	Axis Safety Status	-	N	Y	Y	Y	N	V24
825	Set	Backlash Compensation Window	-	-	-	N	-	-	
593	Set	Brake Prove Ramp Time	-	-	N	N	N	N	Vxx
594	Set	Brake Slip Tolerance	-	-	N	N	N	N	Vxx
592	Set	Brake Test Torque	-	-	N	N	N	N	Vxx
638/262	Get	Bus Regulator Capacity	N	-	N	N	N	N	
659	Get	CIP Axis Alarms	N	N	Y	Y	Y	N	
904	Get	CIP Axis Alarms - RA	N	N	Y	Y	Y	N	
563	Set	Commutation Polarity	-	-	-	N	N	N	PM Motor only
562	Set	Commutation Self-Sensing Current	-	-	-	N	N	N	PM Motor only O-Value = #

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
637	Get	Converter Capacity	N	-	N	N	N	N	
840	Set	Current Disturbance	-	-	-	N	N	N	
527	Get	Current Error	-	-	-	N	N	N	
529	Get	Current Feedback	-	-	-	Y	Y	N	
522	Get	Current Limit Source	-	-	-	N	N	N	
524	Get	Current Reference	-	-	-	N	N	N	
553	Set	Current Vector Limit	-	-	Y	Y	Y	N	
870	Set	DC Injection Brake Current	-	-	N	N	N	N	
872	Set	DC Injection Brake Time	-	-	N	N	N	N	
486	Set	Deceleration Limit	-	-	N	N	N	N	
730	Get	Digital Inputs	N	-	Y	Y	Y	N	
731	Set	Digital Outputs	N	-	Y	Y	Y	N	
1435	Set	Feedback 1 Accel Filter Bandwidth	-	N	-	N	N	N	
2404	Set	Feedback 1 Accel Filter Taps	-	N	-	N	N	N	
2405	Set	Feedback 1 Battery Absolute	-	N	-	N	N	N	TM
1421	Set	Feedback 1 Data Code	-	N	-	N	N	N	TP,SS
1420	Set	Feedback 1 Data Length	-	N	-	N	N	N	TP,SS
2400	Set	Feedback 1 Loss Action	-	N	-	N	N	N	0-Enum 1= Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1414	Set	Feedback 1 Polarity	-	Y	-	Y	Y	N	
1425	Set	Feedback 1 Resolver Cable Balance	-	N	-	N	N	N	RS
1424	Set	Feedback 1 Resolver Excitation Frequency	-	N	-	N	N	N	RS
1423	Set	Feedback 1 Resolver Excitation Voltage	-	N	-	N	N	N	RS
1422	Set	Feedback 1 Resolver Transformer Ratio	-	N	-	N	N	N	RS
1401	Get	Feedback 1 Serial Number	-	N	-	N	N	N	
1415	Set	Feedback 1 Startup Method	-	R	-	R	R	R	0-Enum 1 = Absolute (N)
1434	Set	Feedback 1 Velocity Filter Bandwidth	-	N	-	Y	Y	N	
2403	Set	Feedback 1 Velocity Filter Taps	-	N	-	Y	Y	N	
1485	Set	Feedback 2 Accel Filter Bandwidth	-	N	-	N	N	N	
2454	Set	Feedback 2 Accel Filter Taps	-	N	-	N	N	N	
2455	Set	Feedback 2 Battery Absolute	-	N	-	N	N	N	TM
1471	Set	Feedback 2 Data Code	-	N	-	N	N	N	TP,SS
1470	Set	Feedback 2 Data Length	-	N	-	N	N	N	TP,SS
2450	Set	Feedback 2 Loss Action	-	N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1464	Set	Feedback 2 Polarity	-	N	-	N	N	N	
1475	Set	Feedback 2 Resolver Cable Balance	-	N	-	N	N	N	RS
1474	Set	Feedback 2 Resolver Excitation Frequency	-	N	-	N	N	N	RS

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
1473	Set	Feedback 2 Resolver Excitation Voltage	-	N	-	N	N	N	RS
1472	Set	Feedback 2 Resolver Transformer Ratio	-	N	-	N	N	N	RS
1451	Get	Feedback 2 Serial Number	-	N	-	N	N	N	
1465	Set	Feedback 2 Startup Method	-	R	-	R	R	R	O-Enum 1= Absolute (N)
1484	Set	Feedback 2 Velocity Filter Bandwidth	-	N	-	N	N	N	
2453	Set	Feedback 2 Velocity Filter Taps	-	N	-	N	N	N	
250	Set	Feedback Commutation Aligned	-	-	-	N	N	N	O-Enum 2 = Motor Offset (N) 3 = Self-Sense (Y) 4 = Database Offset (N)
31	Set	Feedback Configuration	R	R	R	R	R	R	O-Enum 0 = No Feedback (V/N)(T/N) 3 = Load Feedback (PVT/N) 4 = Dual Feedback (P/N) 8 = Dual Integrator Feedback (P/N)
708	Set	Feedback Data Loss User Limit	-	N	N	N	N	N	
706	Set	Feedback Noise User Limit	-	N	N	N	N	N	
707	Set	Feedback Signal Loss User Limit	-	N	N	N	N	N	
44	Set	Feedback Unit Ratio	-	-	-	N	N	-	
871	Set	Flux Braking Enable	-	-	N	N	N	N	Ind Motor only
528	Get	Flux Current Error	-	-	-	N	N	N	
530	Get	Flux Current Feedback	-	-	-	Y	Y	N	
525	Get	Flux Current Reference	-	-	-	N	N	N	
557	Set	Flux Integral Time Constant	-	-	-	N	N	N	
556	Set	Flux Loop Bandwidth	-	-	-	N	N	N	
558	Set	Flux Up Control	-	-	N	N	N	N	Ind Motor only, O-Enum 1 = Manual Delay (Y) 2 = Automatic Delay (Y)
559	Set	Flux Up Time	-	-	N	N	N	N	Ind Motor only
380	Set	Flying Start Enable	-	-	N	-	N	-	
570	Set	Frequency Control Method	-	-	R	-	-	-	O-Enum 128 = Fan/Pump Volts/Hertz (Y) 129 = Sensorless Vector (Y) 130 = Sensorless Vector Economy (Y)
498	Set	Friction Compensation Sliding	-	-	-	N	N	N	
499	Set	Friction Compensation Static	-	-	-	N	N	N	
500	Set	Friction Compensation Viscous	-	-	-	N	N	N	
826/421	Set	Friction Compensation Window	-	-	-	N	-	-	
981/243	Get	Guard Faults	-	-	Y	Y	Y	N	
980/242	Get	Guard Status	-	-	Y	Y	Y	N	
1349	Set	Induction Motor Magnetization Reactance	-	-	N	N	N	N	Ind Motor only
1352	Set	Induction Motor Rated Slip Speed	-	-	Y	Y	Y	N	Ind Motor only

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
1351	Set	Induction Motor Rotor Leakage Reactance	-	-	Y	Y	Y	N	Ind Motor only, V24
1350	Set	Induction Motor Rotor Resistance	-	-	N	N	N	N	Ind Motor only
1348	Set	Induction Motor Stator Leakage Reactance	-	-	Y	Y	Y	N	Ind Motor only, V24
647	Set	Inverter Overload Action	-	-	Y	Y	Y	N	0-Enum 1 = Current Foldback (Y) 128 = Reduce PWM Rate (Y) 129 = PWM Foldback (Y)
699	Set	Inverter Thermal Overload User Limit	-	-	N	N	N	N	
1338	Set	Linear Motor Damping Coefficient	-	-	N	N	N	N	Linear Motor only
2313	Set	Linear Motor Integral Limit Switch	-	-	N	N	N	N	Linear Motor only
1336	Set	Linear Motor Mass	-	-	N	N	N	N	Linear Motor only
1337	Set	Linear Motor Max Speed	-	-	N	N	N	N	Linear Motor only
801	Get	Load Observer Acceleration Estimate	-	-	-	N	N	N	
806	Set	Load Observer Bandwidth	-	-	-	N	N	N	
805	Set	Load Observer Configuration	-	-	-	N	N	N	0-Enum 1 = Load Observer Only (N) 2 = Load Observer with Velocity Estimate (N) 3 = Velocity Estimate Only (N) 4 = Acceleration Feedback (N)
809	Set	Load Observer Feedback Gain	-	-	-	N	N	N	
807	Set	Load Observer Integrator Bandwidth	-	-	-	N	N	N	
802	Get	Load Observer Torque Estimate	-	-	-	N	N	N	
1370	Set	Load Type	-	N	N	N	N	N	DScale
750	Set	Local Control	N	N	N	N	N	N	0-Enum 1 = Conditionally Allowed (N) 2 = Allowed (N)
614	Set	Mechanical Brake Control	-	-	N	N	N	N	
616	Set	Mechanical Brake Engage Delay	-	-	N	N	N	N	
615	Set	Mechanical Brake Release Delay	-	-	N	N	N	N	
45	Set	Motion Scaling Configuration	-	R	R	R	R	R	0-Enum 1 = Drive Scaling (N)
1310/251	Set	Motor Catalog Number	-	-	N	N	N	N	Dr NV
1313	Set	Motor Data Source	-	-	R	R	R	R	0-Enum 1 = Database (N) 2 = Drive NV (N) 3 = Motor NV (N)
1323	Set	Motor Integral Thermal Switch	-	-	N	N	N	N	
1324	Set	Motor Max Winding Temperature	-	-	N	N	N	N	
646	Set	Motor Overload Action	-	-	N	N	N	N	0-Enum 1 = Current Foldback (N)
1322	Set	Motor Overload Limit	-	-	Y	Y	Y	N	
695	Set	Motor Overspeed User Limit	-	-	Y	Y	Y	N	
694	Set	Motor Phase Loss Limit	-	-	N	N	N	N	V24

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
1317	Set	Motor Polarity	-	-	Y	Y	Y	N	
1321	Set	Motor Rated Output Power	-	-	Y	Y	Y	N	O-IM
1320	Set	Motor Rated Peak Current	-	-	N	N	N	N	O-IM
697	Set	Motor Thermal Overload User Limit	-	-	Y	Y	Y	N	
1325	Set	Motor Winding to Ambient Capacitance	-	-	N	N	N	N	
1326	Set	Motor Winding to Ambient Resistance	-	-	N	N	N	N	
521	Get	Operative Current Limit	-	-	-	Y	Y	N	
600	Get	Output Frequency	-	-	R	Y	Y	N	
508	Set	Overtorque Limit	-	-	Y	Y	Y	N	
509	Set	Overtorque Limit Time	-	-	Y	Y	Y	N	
2310	Set	PM Motor Flux Saturation	-	-	N	N	N	N	PM Motor only
1343	Set	PM Motor Force Constant	-	-	N	N	N	N	Rotary PM Motor only
1342	Set	PM Motor Rated Force	-	-	N	N	N	N	Rotary PM Motor only
1339	Set	PM Motor Rated Torque	-	-	N	N	N	N	Rotary PM Motor only
1340	Set	PM Motor Torque Constant	-	-	N	N	N	N	Rotary PM Motor only
445	Set	Position Error Tolerance Time	-	-	-	Y	-	-	
365	Get	Position Fine Command	-	-	-	Y	-	-	
446	Set	Position Integrator Control	-	-	-	R	-	-	O-Bits 1 = Auto-Preset (N)
447	Set	Position Integrator Preload	-	-	-	N	-	-	
781	Set	Position Lead Lag Filter Bandwidth	-	-	-	N	-	-	
782	Set	Position Lead Lag Filter Gain	-	-	-	N	-	-	
783	Set	Position Notch Filter Frequency	-	-	-	Y	-	-	
627	Set	Power Loss Action	-	-	Y	Y	Y	N	O-Enum 2 = Decel Regen (Y)
628	Set	Power Loss Threshold	N	-	Y	Y	Y	N	
630	Set	Power Loss Time	N	-	Y	Y	Y	N	
590	Set	Proving Configuration	-	-	N	N	N	N	Vxx
376	Set*	Ramp Acceleration	-	-	Y	-	Y	-	Derived
377	Set*	Ramp Deceleration	-	-	Y	-	Y	-	Derived
378	Set	Ramp Jerk Control	-	-	Y	-	Y	-	
375	Set*	Ramp Velocity - Negative	-	-	Y	-	Y	-	Derived
374	Set*	Ramp Velocity - Positive	-	-	Y	-	Y	-	Derived
613/354	Set	Resistive Brake Contact Delay	-	-	N	N	N	N	PM Motor only
1333	Set	Rotary Motor Damping Coefficient	-	-	N	N	N	N	Rotary Motor only
2312	Set	Rotary Motor Fan Cooling Derating	-	-	N	N	N	N	Rotary Motor only
2311	Set	Rotary Motor Fan Cooling Speed	-	-	N	N	N	N	Rotary Motor only
1330	Set	Rotary Motor Inertia	-	-	N	N	N	N	Rotary Motor only
1332	Set	Rotary Motor Max Speed	-	-	N	N	N	N	Rotary Motor only
629	Set	Shutdown Action	N	-	N	N	N	N	O-Enum 1 = Drop DC Bus (N)

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
370	Set	Skip Speed 1	-	-	Y	-	-	-	
371	Set	Skip Speed 2	-	-	Y	-	-	-	
372	Set	Skip Speed 3	-	-	Y	-	-	-	
373	Set	Skip Speed Band	-	-	Y	-	-	-	
833	Set	SLAT Configuration	-	-	-	-	N	-	
834	Set	SLAT Set Point	-	-	-	-	N	-	
835	Set	SLAT Time Delay	-	-	-	-	N	-	
610	Set	Stopping Action	-	-	R	R	R	R	0-Enum 2 = Ramped Decel Disable (FP/Y) 3 = Current Decel Hold (PV/N) 4 = Ramped Decel Hold (V/N) 128 = DC Injection Brake (FPVT/N) 129 = AC Injection Brake (FPVT/N)
612	Set	Stopping Time Limit	-	-	-	N	N	N	
496	Set	System Inertia	-	-	-	R	R	N	
555	Set	Torque Integral Time Constant	-	-	-	N	N	N	
827	Set	Torque Lead Lag Filter Bandwidth	-	-	-	Y	Y	N	
828	Set	Torque Lead Lag Filter Gain	-	-	-	Y	Y	N	
554	Set	Torque Loop Bandwidth	-	-	-	Y	Y	N	
502	Set	Torque Low Pass Filter Bandwidth	-	-	-	Y	Y	N	
843	Get	Torque Low Pass Filter Bandwidth Estimate	-	-	-	N	N	N	Vxx
503	Set	Torque Notch Filter Frequency	-	-	-	Y	Y	N	
841	Get	Torque Notch Filter Frequency Estimate	-	-	-	N	N	N	Vxx
837	Set	Torque Notch Filter High Frequency Limit	-	-	-	N	N	N	Vxx
838	Set	Torque Notch Filter Low Frequency Limit	-	-	-	N	N	N	Vxx
842	Get	Torque Notch Filter Magnitude Estimate	-	-	-	N	N	N	Vxx
839	Set	Torque Notch Filter Tuning Threshold	-	-	-	N	N	N	Vxx
591	Set	Torque Prove Current	-	-	N	N	N	N	Vxx
506	Set	Torque Rate Limit	-	-	-	N	N	N	
507/334	Set	Torque Threshold	-	-	-	N	N	N	
1371	Set	Transmission Ratio Input	-	N	N	N	N	N	DScale
1372	Set	Transmission Ratio Output	-	N	N	N	N	N	DScale
510	Set	Undertorque Limit	-	-	Y	Y	Y	N	
511	Set	Undertorque Limit Time	-	-	Y	Y	Y	N	
464/321	Set	Velocity Droop	-	-	Y	N	Y	-	
465	Set	Velocity Error Tolerance	-	-	-	Y	Y	-	
466	Set	Velocity Error Tolerance Time	-	-	-	Y	Y	-	
366	Get	Velocity Fine Command	-	-	-	Y	Y	-	
467	Set	Velocity Integrator Control	-	-	-	R	R	-	0-Bits 1 = Auto-Preset (N)
468	Set	Velocity Integrator Preload	-	-	-	Y	Y	-	
474/326	Set	Velocity Limit - Negative	-	-	Y	Y	Y	-	

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
473/325	Set	Velocity Limit - Positive	-	-	Y	Y	Y	-	
471	Set	Velocity Lock Tolerance	-	-	N	Y	Y	-	
469	Set	Velocity Low Pass Filter Bandwidth	-	-	-	Y	Y	-	
790	Set	Velocity Negative Feedforward Gain	-	-	-	N	N	-	
470/327	Set	Velocity Threshold	-	N	N	Y	Y	N	
608	Set	Zero Speed	-	-	N	N	N	N	V24
609	Set	Zero Speed Time	-	-	N	N	N	N	V24

PowerFlex 755 Standard Drive Module Optional Attributes

The following table identifies the optional attributes and corresponding control mode functionality supported by a PowerFlex 755 drive module.

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
367	Get	Acceleration Fine Command		-	-	N	N	N	
485	Set	Acceleration Limit		-	N	N	N	N	
482	Get	Acceleration Reference		-	-	N	N	N	
481	Set	Acceleration Trim		-	-	N	N	N	
1376	Set	Actuator Diameter		N	N	N	N	N	DScale
1377	Set	Actuator Diameter Unit		N	N	N	N	N	DScale
1374	Set	Actuator Lead		N	N	N	N	N	DScale
1375	Set	Actuator Lead Unit		N	N	N	N	N	DScale
1373	Set	Actuator Type		N	N	N	N	N	DScale
732/267	Get	Analog Input 1	N	-	Y	Y	Y	Y	
733/268	Get	Analog Input 2	N	-	Y	Y	Y	Y	
734	Set	Analog Output 1	N	-	Y	Y	Y	Y	
735	Set	Analog Output 2	N	-	Y	Y	Y	Y	
873/2726	Set	Auto Sag Configuration	-	-	Y	Y	Y	Y	V28
874	Set	Auto Sag Slip Increment	-	-	Y	Y	Y	Y	V28
876	Set	Auto Sag Start	-	-	Y	Y	Y	Y	V28
0	Set	Axis Configuration		R	R	R	R	R	O-Enum 0 = Feedback Only (N) 1 = Frequency Control (Y) 2 = Position Loop (Y) 3 = Velocity Loop (Y) 4 = Torque Loop (Y)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
19	Set	Axis Features		R	R	R	R	R	O-Bits 0 = Fine Interpolation (Y) 1 = Registration Auto-rearm (Y) 2 = Alarm Log (Y) 5 = Hookup Test (Y) 6 = Commutation Test (Y) 7 = Motor Test (Y) 8 = Inertia Test (Y) 9 = Sensorless Control (Y)
653	Get	Axis I/O Status	R	R	R	R	R	R	
654	Get	Axis I/O Status - MFG	R	R	R	R	R	R	Vxx
763	Get	Axis Safety Faults		O	O	O	O	Y	
760	Get	Axis Safety State		O	O	O	O	Y	
761	Get	Axis Safety Status		O	O	O	O	Y	
651	Get	Axis Status	R	R	R	R	R	R	
825	Set	Backlash Compensation Window		-	-	N	-	-	
593	Set	Brake Prove Ramp Time	-	-	Y	Y	Y	Y	V28
594	Set	Brake Slip Tolerance	-	-	Y	Y	Y	Y	V28
592	Set	Brake Test Torque	-	-	Y	Y	Y	Y	V28
638/262	Get	Bus Regulator Capacity		-	N	N	N	N	
659	Get	CIP Axis Alarms		Y	Y	Y	Y	Y	
904	Get	CIP Axis Alarms - RA		Y	Y	Y	Y	Y	
563	Set	Commutation Polarity		-	-	N	N	N	PM Motor only
562	Set	Commutation Self-Sensing Current		-	-	N	N	N	PM Motor only O-Value = #
637	Get	Converter Capacity		-	N	N	N	N	
840	Set	Current Disturbance		-	-	N	N	N	
527	Get	Current Error		-	-	N	N	N	
529	Get	Current Feedback		-	-	Y	Y	Y	
522	Get	Current Limit Source		-	-	N	N	N	
524	Get	Current Reference		-	-	N	N	N	
553	Set	Current Vector Limit		-	Y	N	N	N	
870	Set	DC Injection Brake Current		-	Y	Y	Y	Y	Ind Motor only
872	Set	DC Injection Brake Time		-	Y	Y	Y	Y	Ind Motor only
486	Set	Deceleration Limit		-	N	N	N	N	
730	Get	Digital Inputs		-	Y	Y	Y	Y	
731	Set	Digital Outputs		-	N	N	N	N	
1435	Set	Feedback 1 Accel Filter Bandwidth		Y	-	Y	Y	Y	
2404	Set	Feedback 1 Accel Filter Taps		N	-	N	N	N	
2405	Set	Feedback 1 Battery Absolute		N	-	N	N	N	TM
1421	Set	Feedback 1 Data Code		Y	-	Y	Y	Y	TP,SS
1420	Set	Feedback 1 Data Length		Y	-	Y	Y	Y	TP,SS

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
2400	Set	Feedback 1 Loss Action		N	-	N	N	N	0-Enum 1= Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1414	Set	Feedback 1 Polarity		Y	-	Y	Y	Y	
1425	Set	Feedback 1 Resolver Cable Balance		N	-	N	N	N	RS
1424	Set	Feedback 1 Resolver Excitation Frequency		N	-	N	N	N	RS
1423	Set	Feedback 1 Resolver Excitation Voltage		N	-	N	N	N	RS
1422	Set	Feedback 1 Resolver Transformer Ratio		N	-	N	N	N	RS
1401	Get	Feedback 1 Serial Number		N	-	N	N	N	
1415	Set	Feedback 1 Startup Method		R	-	R	R	R	0-Enum 1 = Absolute (Y)
1434	Set	Feedback 1 Velocity Filter Bandwidth		Y	-	Y	Y	Y	
2403	Set	Feedback 1 Velocity Filter Taps		Y	-	Y	Y	Y	
1485	Set	Feedback 2 Accel Filter Bandwidth		N	-	N	N	N	
2454	Set	Feedback 2 Accel Filter Taps		N	-	N	N	N	
2455	Set	Feedback 2 Battery Absolute		N	-	N	N	N	TM
1471	Set	Feedback 2 Data Code		Y	-	Y	Y	Y	TP,SS
1470	Set	Feedback 2 Data Length		Y	-	Y	Y	Y	TP,SS
2450	Set	Feedback 2 Loss Action		N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1464	Set	Feedback 2 Polarity		Y	-	Y	Y	Y	
1475	Set	Feedback 2 Resolver Cable Balance		N	-	N	N	N	RS
1474	Set	Feedback 2 Resolver Excitation Frequency		N	-	N	N	N	RS
1473	Set	Feedback 2 Resolver Excitation Voltage		N	-	N	N	N	RS
1472	Set	Feedback 2 Resolver Transformer Ratio		N	-	N	N	N	RS
1451	Get	Feedback 2 Serial Number		N	-	N	N	N	
1465	Set	Feedback 2 Startup Method		R	-	R	R	R	0-Enum 1= Absolute (Y)
1484	Set	Feedback 2 Velocity Filter Bandwidth		N	-	N	N	N	
2453	Set	Feedback 2 Velocity Filter Taps		N	-	N	N	N	
250	Set	Feedback Commutation Aligned		-	-	Y	Y	Y	0-Enum 2 = Motor Offset (N) 3 = Self-Sense (Y)
31	Set	Feedback Configuration		R	R	R	R	R	0-Enum 0 = No Feedback (V/Y)(T/Y) 3 = Load Feedback (PVT/N) 4 = Dual Feedback (P/Y) 8 = Dual Integrator Feedback (P/Y)
708	Set	Feedback Data Loss User Limit		N	N	N	N	N	
706	Set	Feedback Noise User Limit		N	N	N	N	N	
707	Set	Feedback Signal Loss User Limit		N	N	N	N	N	
44	Set	Feedback Unit Ratio		-	-	Y	N	-	

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
871	Set	Flux Braking Enable		-	Y	Y	Y	Y	Ind Motor only
528	Get	Flux Current Error		-	-	N	N	N	
530	Get	Flux Current Feedback		-	-	Y	Y	Y	
525	Get	Flux Current Reference		-	-	N	N	N	
557	Set	Flux Integral Time Constant		-	-	N	N	N	
556	Set	Flux Loop Bandwidth		-	-	N	N	N	
558	Set	Flux Up Control		-	Y	Y	Y	Y	Ind Motor only, 0-Enum 1 = Manual Delay (Y) 2 = Automatic Delay (Y)
559	Set	Flux Up Time		-	Y	Y	Y	Y	Ind Motor only
380	Set	Flying Start Enable		-	Y	-	Y	-	
570	Set	Frequency Control Method		-	R	-	-	-	0-Enum 128 = Fan/Pump Volts/Hertz (Y) 129 = Sensorless Vector (Y) 130 = Sensorless Vector Economy (Y)
498	Set	Friction Compensation Sliding		-	-	N	N	N	
499	Set	Friction Compensation Static		-	-	N	N	N	
500	Set	Friction Compensation Viscous		-	-	N	N	N	
826/421	Set	Friction Compensation Window		-	-	N	-	-	
981/243	Get	Guard Faults		-	N	N	N	N	
980/242	Get	Guard Status		-	N	N	N	N	
1349	Set	Induction Motor Magnetization Reactance		-	N	N	N	N	Ind Motor only
1352	Set	Induction Motor Rated Slip Speed		-	Y	Y	Y	N	Ind Motor only
1350	Set	Induction Motor Rotor Resistance		-	N	N	N	N	Ind Motor only
647	Set	Inverter Overload Action		-	Y	Y	Y	Y	0-Enum 1 = Current Foldback (Y) 128 = Reduce PWM Rate (Y) 129 = PWM Foldback (Y)
699	Set	Inverter Thermal Overload User Limit		-	N	N	N	N	
1338	Set	Linear Motor Damping Coefficient		-	N	N	N	N	Linear Motor only
2313	Set	Linear Motor Integral Limit Switch		-	N	N	N	N	Linear Motor only
1336	Set	Linear Motor Mass		-	N	N	N	N	Linear Motor only
1337	Set	Linear Motor Max Speed		-	N	N	N	N	Linear Motor only
801	Get	Load Observer Acceleration Estimate		-	-	Y	Y	N	
806	Set	Load Observer Bandwidth		-	-	Y	Y	N	
805	Set	Load Observer Configuration		-	-	Y	Y	N	0-Enum 1 = Load Observer Only (Y) 2 = Load Observer with Velocity Estimate (N) 3 = Velocity Estimate Only (N) 4 = Acceleration Feedback (Y)
809	Set	Load Observer Feedback Gain		-	-	Y	Y	N	
807	Set	Load Observer Integrator Bandwidth		-	-	N	N	N	
802	Get	Load Observer Torque Estimate		-	-	Y	Y	N	

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
1370	Set	Load Type		N	N	N	N	N	DScale
750	Set	Local Control		N	N	N	N	N	0-Enum 1 = Conditionally Allowed (N) 2 = Allowed (N)
614	Set	Mechanical Brake Control		-	N	N	N	N	
616	Set	Mechanical Brake Engage Delay		-	N	N	N	N	
615	Set	Mechanical Brake Release Delay		-	N	N	N	N	
45	Set	Motion Scaling Configuration		R	R	R	R	R	0-Enum 1 = Drive Scaling (N)
1310/251	Set	Motor Catalog Number		-	N	N	N	N	Dr NV
1313	Set	Motor Data Source		-	R	R	R	R	0-Enum 1 = Database (Y) 2 = Drive NV (Y) 3 = Motor NV (N)
1323	Set	Motor Integral Thermal Switch		-	N	N	N	N	
1324	Set	Motor Max Winding Temperature		-	N	N	N	N	
646	Set	Motor Overload Action		-	N	N	N	N	0-Enum 1 = Current Foldback (N)
1322	Set	Motor Overload Limit		-	Y	Y	Y	Y	
695	Set	Motor Overspeed User Limit		-	Y	Y	Y	Y	
694	Set	Motor Phase Loss Limit	-	-	Y	Y	Y	Y	V26
1317	Set	Motor Polarity		-	Y	Y	Y	Y	
1321	Set	Motor Rated Output Power		-	Y	Y	Y	Y	Y-IM
1320	Set	Motor Rated Peak Current		-	N	N	N	N	N-IM
697	Set	Motor Thermal Overload User Limit		-	Y	Y	Y	Y	
1315	Set	Motor Type		-	R	R	R	R	0-Enum 1 = Rotary Permanent Magnet (Y) 2 = Rotary Induction (Y) 3 = Linear Permanent Magnet (N) 4 = Linear Induction (N)
1325	Set	Motor Winding to Ambient Capacitance		-	N	N	N	N	
1326	Set	Motor Winding to Ambient Resistance		-	N	N	N	N	
521	Get	Operative Current Limit		-	-	N	N	N	
600	Get	Output Frequency		-	R	Y	Y	Y	
508	Set	Overtorque Limit		-	Y	Y	Y	Y	
509	Set	Overtorque Limit Time		-	Y	Y	Y	Y	
2310	Set	PM Motor Flux Saturation		-	N	N	N	N	PM Motor only
1343	Set	PM Motor Force Constant		-	N	N	N	N	Rotary PM Motor only
1342	Set	PM Motor Rated Force		-	N	N	N	N	Rotary PM Motor only
1339	Set	PM Motor Rated Torque		-	N	N	N	N	Rotary PM Motor only
1340	Set	PM Motor Torque Constant		-	N	N	N	N	Rotary PM Motor only
445	Set	Position Error Tolerance Time		-	-	Y	-	-	
365	Get	Position Fine Command		-	-	Y	-	-	

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
446	Set	Position Integrator Control		-	-	R	-	-	0-Bits 1 = Auto-Preset (N)
447	Set	Position Integrator Preload		-	-	N	-	-	
781	Set	Position Lead Lag Filter Bandwidth		-	-	Y	-	-	
782	Set	Position Lead Lag Filter Gain		-	-	Y	-	-	
783	Set	Position Notch Filter Frequency		-	-	Y	-	-	
627	Set	Power Loss Action		-	Y	Y	Y	Y	0-Enum 2 = Decel Regen (Y)
628	Set	Power Loss Threshold		-	Y	Y	Y	Y	
630	Set	Power Loss Time		-	Y	Y	Y	Y	
590	Set	Proving Configuration	-	-	Y	Y	Y	Y	V28
376	Set*	Ramp Acceleration		-	Y	-	Y	-	Derived
377	Set*	Ramp Deceleration		-	Y	-	Y	-	Derived
378	Set	Ramp Jerk Control		-	Y	-	Y	-	
375	Set*	Ramp Velocity - Negative		-	Y	-	Y	-	Derived
374	Set*	Ramp Velocity - Positive		-	Y	-	Y	-	Derived
613/354	Set	Resistive Brake Contact Delay		-	N	N	N	N	PM Motor only
1333	Set	Rotary Motor Damping Coefficient		-	N	N	N	N	Rotary Motor only
2312	Set	Rotary Motor Fan Cooling Derating		-	N	N	N	N	Rotary Motor only
2311	Set	Rotary Motor Fan Cooling Speed		-	N	N	N	N	Rotary Motor only
1330	Set	Rotary Motor Inertia		-	N	Y	Y	N	Rotary Motor only
1332	Set	Rotary Motor Max Speed		-	N	N	N	N	Rotary Motor only
629	Set	Shutdown Action		-	N	N	N	N	0-Enum 1 = Drop DC Bus (N)
370	Set	Skip Speed 1		-	Y	-	-	-	
371	Set	Skip Speed 2		-	Y	-	-	-	
372	Set	Skip Speed 3		-	Y	-	-	-	
373	Set	Skip Speed Band		-	Y	-	-	-	
833	Set	SLAT Configuration		-	-	-	Y	-	
834	Set	SLAT Set Point		-	-	-	Y	-	
835	Set	SLAT Time Delay		-	-	-	Y	-	
610	Set	Stopping Action		-	R	R	R	R	0-Enum 2 = Ramped Decel Disable (FPV/Y) 3 = Current Decel Hold (PV/N) 4 = Ramped Decel Hold (PV/Y) 128 = DC Injection Brake (IM/Y) 129 = AC Injection Brake (IM/Y)
612	Set	Stopping Time Limit		-	-	N	N	N	
496	Set	System Inertia		-	-	R	R	N	
555	Set	Torque Integral Time Constant		-	-	N	N	N	
827	Set	Torque Lead Lag Filter Bandwidth		-	-	Y	Y	N	
828	Set	Torque Lead Lag Filter Gain		-	-	Y	Y	N	
554	Set	Torque Loop Bandwidth		-	-	N	N	N	

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
502	Set	Torque Low Pass Filter Bandwidth		-	-	N	N	N	
503	Set	Torque Notch Filter Frequency		-	-	Y	Y	Y	
506	Set	Torque Rate Limit		-	-	N	N	N	
507/334	Set	Torque Threshold		-	-	N	N	N	
1371	Set	Transmission Ratio Input		N	N	N	N	N	DScale
1372	Set	Transmission Ratio Output		N	N	N	N	N	DScale
510	Set	Undertorque Limit		-	Y	Y	Y	Y	
511	Set	Undertorque Limit Time		-	Y	Y	Y	Y	
464/321	Set	Velocity Droop		-	Y	Y	Y	-	
465	Set	Velocity Error Tolerance		-	-	N	N	-	
466	Set	Velocity Error Tolerance Time		-	-	N	N	-	
366	Get	Velocity Fine Command		-	-	Y	Y	-	
467	Set	Velocity Integrator Control		-	-	R	R	-	0-Bits 1 = Auto-Preset (N)
468	Set	Velocity Integrator Preload		-	-	Y	Y	-	
474/326	Set	Velocity Limit - Negative		-	Y	Y	Y	-	
473/325	Set	Velocity Limit - Positive		-	Y	Y	Y	-	
471	Set	Velocity Lock Tolerance		-	Y	Y	Y	-	
469	Set	Velocity Low Pass Filter Bandwidth		-	-	Y	Y	-	
790	Set	Velocity Negative Feedforward Gain		-	-	Y	Y	-	
470/327	Set	Velocity Threshold		N	Y	Y	Y	N	
608	Set	Zero Speed	-	-	Y	Y	Y	Y	V28
609	Set	Zero Speed Time	-	-	Y	Y	Y	Y	V28

PowerFlex 755 Safety Drive Module Optional Attributes

The following table identifies the optional attributes and corresponding control mode functionality supported by a PowerFlex 755 safety drive module.

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
367	Get	Acceleration Fine Command		-	-	N	N	N	
485	Set	Acceleration Limit		-	N	N	N	N	
482	Get	Acceleration Reference		-	-	N	N	N	
481	Set	Acceleration Trim		-	-	N	N	N	
1376	Set	Actuator Diameter		N	N	N	N	N	DScale
1377	Set	Actuator Diameter Unit		N	N	N	N	N	DScale
1374	Set	Actuator Lead		N	N	N	N	N	DScale
1375	Set	Actuator Lead Unit		N	N	N	N	N	DScale
1373	Set	Actuator Type		N	N	N	N	N	DScale
732/267	Get	Analog Input 1	N	-	Y	Y	Y	Y	
733/268	Get	Analog Input 2	N	-	Y	Y	Y	Y	

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
734	Set	Analog Output 1	N	-	Y	Y	Y	Y	
735	Set	Analog Output 2	N	-	Y	Y	Y	Y	
873	Set	Auto Sag Configuration	-	-	Y	Y	Y	Y	V28
874	Set	Auto Sag Slip Increment	-	-	Y	Y	Y	Y	V28
876	Set	Auto Sag Start	-	-	Y	Y	Y	Y	V28
30	Set	Axis Configuration		R	R	R	R	R	O-Enum 0 = Feedback Only (N) 1 = Frequency Control (Y) 2 = Position Loop (Y) 3 = Velocity Loop (Y) 4 = Torque Loop (Y)
19	Set	Axis Features		R	R	R	R	R	O-Bits 0 = Fine Interpolation (Y) 1 = Registration Auto-rearm (Y) 2 = Alarm Log (Y) 5 = Hookup Test (Y) 6 = Commutation Test (Y) 7 = Motor Test (Y) 8 = Inertia Test (Y) 9 = Sensorless Control (Y)
653	Get	Axis I/O Status	R	R	R	R	R	R	
654	Get	Axis I/O Status - MFG	R	R	R	R	R	R	Vxx
763	Get	Axis Safety Faults		O	O	O	O	Y	
760	Get	Axis Safety State		O	O	O	O	Y	
761	Get	Axis Safety Status		O	O	O	O	Y	
651	Get	Axis Status	R	R	R	R	R	R	
825	Set	Backlash Compensation Window		-	-	N	-	-	
593	Set	Brake Prove Ramp Time	-	-	Y	Y	Y	Y	V28
594	Set	Brake Slip Tolerance	-	-	Y	Y	Y	Y	V28
592	Set	Brake Test Torque	-	-	Y	Y	Y	Y	V28
638/262	Get	Bus Regulator Capacity		-	N	N	N	N	
659	Get	CIP Axis Alarms		Y	Y	Y	Y	Y	
904	Get	CIP Axis Alarms - RA		Y	Y	Y	Y	Y	
563	Set	Commutation Polarity		-	-	N	N	N	PM Motor only
562	Set	Commutation Self-Sensing Current		-	-	N	N	N	PM Motor only O-Value = #
637	Get	Converter Capacity		-	N	N	N	N	
840	Set	Current Disturbance		-	-	N	N	N	
527	Get	Current Error		-	-	N	N	N	
529	Get	Current Feedback		-	-	Y	Y	Y	
522	Get	Current Limit Source		-	-	N	N	N	
524	Get	Current Reference		-	-	N	N	N	
553	Set	Current Vector Limit		-	Y	N	N	N	
870	Set	DC Injection Brake Current		-	Y	Y	Y	Y	Ind Motor only

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
872	Set	DC Injection Brake Time		-	Y	Y	Y	Y	Ind Motor only
486	Set	Deceleration Limit		-	N	N	N	N	
730	Get	Digital Inputs		-	Y	Y	Y	Y	
731	Set	Digital Outputs		-	N	N	N	N	
1435	Set	Feedback 1 Accel Filter Bandwidth		Y	-	Y	Y	Y	
2404	Set	Feedback 1 Accel Filter Taps		N	-	N	N	N	
2405	Set	Feedback 1 Battery Absolute		N	-	N	N	N	TM
1421	Set	Feedback 1 Data Code		Y	-	Y	Y	Y	TP,SS
1420	Set	Feedback 1 Data Length		Y	-	Y	Y	Y	TP,SS
2400	Set	Feedback 1 Loss Action		N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1414	Set	Feedback 1 Polarity		Y	-	Y	Y	Y	
1425	Set	Feedback 1 Resolver Cable Balance		N	-	N	N	N	RS
1424	Set	Feedback 1 Resolver Excitation Frequency		N	-	N	N	N	RS
1423	Set	Feedback 1 Resolver Excitation Voltage		N	-	N	N	N	RS
1422	Set	Feedback 1 Resolver Transformer Ratio		N	-	N	N	N	RS
1401	Get	Feedback 1 Serial Number		N	-	N	N	N	
1415	Set	Feedback 1 Startup Method		R	-	R	R	R	0-Enum 1= Absolute (Y)
1434	Set	Feedback 1 Velocity Filter Bandwidth		Y	-	Y	Y	Y	
2403	Set	Feedback 1 Velocity Filter Taps		Y	-	Y	Y	Y	
1485	Set	Feedback 2 Accel Filter Bandwidth		N	-	N	N	N	
2454	Set	Feedback 2 Accel Filter Taps		N	-	N	N	N	
2455	Set	Feedback 2 Battery Absolute		N	-	N	N	N	TM
1471	Set	Feedback 2 Data Code		Y	-	Y	Y	Y	TP,SS
1470	Set	Feedback 2 Data Length		Y	-	Y	Y	Y	TP,SS
2450	Set	Feedback 2 Loss Action		N	-	N	N	N	0-Enum 1 = Switch to Sensorless Fdbk (N) 2 = Switch to Redundant Fdbk (N)
1464	Set	Feedback 2 Polarity		Y	-	Y	Y	Y	
1475	Set	Feedback 2 Resolver Cable Balance		N	-	N	N	N	RS
1474	Set	Feedback 2 Resolver Excitation Frequency		N	-	N	N	N	RS
1473	Set	Feedback 2 Resolver Excitation Voltage		N	-	N	N	N	RS
1472	Set	Feedback 2 Resolver Transformer Ratio		N	-	N	N	N	RS
1451	Get	Feedback 2 Serial Number		N	-	N	N	N	
1465	Set	Feedback 2 Startup Method		R	-	R	R	R	0-Enum 1 = Absolute (Y)
1484	Set	Feedback 2 Velocity Filter Bandwidth		N	-	N	N	N	
2453	Set	Feedback 2 Velocity Filter Taps		N	-	N	N	N	

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
250	Set	Feedback Commutation Aligned		-	-	Y	Y	Y	0-Enum 2 = Motor Offset (N) 3 = Self-Sense (Y)
31	Set	Feedback Configuration		R	R	R	R	R	0-Enum 0 = No Feedback (V/Y)(T/Y) 3 = Load Feedback (PVT/N) 4 = Dual Feedback (P/Y) 8 = Dual Integrator Feedback (P/Y)
708	Set	Feedback Data Loss User Limit		N	N	N	N	N	
706	Set	Feedback Noise User Limit		N	N	N	N	N	
707	Set	Feedback Signal Loss User Limit		N	N	N	N	N	
44	Set	Feedback Unit Ratio		-	-	Y	N	-	
871	Set	Flux Braking Enable		-	Y	Y	Y	Y	Ind Motor only
528	Get	Flux Current Error		-	-	N	N	N	
530	Get	Flux Current Feedback		-	-	Y	Y	Y	
525	Get	Flux Current Reference		-	-	N	N	N	
557	Set	Flux Integral Time Constant		-	-	N	N	N	
556	Set	Flux Loop Bandwidth		-	-	N	N	N	
558	Set	Flux Up Control		-	Y	Y	Y	Y	Ind Motor only 0-Enum 1 = Manual Delay (Y) 2 = Automatic Delay (Y)
559	Set	Flux Up Time		-	Y	Y	Y	Y	Ind Motor only
380	Set	Flying Start Enable		-	Y	-	Y	-	
570	Set	Frequency Control Method		-	R	-	-	-	0-Enum 128 = Fan/Pump Volts/Hertz (Y) 129 = Sensorless Vector (Y) 130 = Sensorless Vector Economy (Y)
498	Set	Friction Compensation Sliding		-	-	N	N	N	
499	Set	Friction Compensation Static		-	-	N	N	N	
500	Set	Friction Compensation Viscous		-	-	N	N	N	
826/421	Set	Friction Compensation Window		-	-	N	-	-	
981/243	Get	Guard Faults		-	Y	Y	Y	Y	
980/242	Get	Guard Status		-	Y	Y	Y	Y	
1349	Set	Induction Motor Magnetization Reactance		-	N	N	N	N	Ind Motor only
1352	Set	Induction Motor Rated Slip Speed		-	Y	Y	Y	N	Ind Motor only
1350	Set	Induction Motor Rotor Resistance		-	N	N	N	N	Ind Motor only
647	Set	Inverter Overload Action		-	Y	Y	Y	Y	0-Enum 1 = Current Foldback (Y) 128 = Reduce PWM Rate (Y) 129 = PWM Foldback (Y)
699	Set	Inverter Thermal Overload User Limit		-	N	N	N	N	
1338	Set	Linear Motor Damping Coefficient		-	N	N	N	N	Linear Motor only
2313	Set	Linear Motor Integral Limit Switch		-	N	N	N	N	Linear Motor only

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
1336	Set	Linear Motor Mass		-	N	N	N	N	Linear Motor only
1337	Set	Linear Motor Max Speed		-	N	N	N	N	Linear Motor only
801	Get	Load Observer Acceleration Estimate		-	-	Y	Y	N	
806	Set	Load Observer Bandwidth		-	-	Y	Y	N	
805	Set	Load Observer Configuration		-	-	Y	Y	N	0-Enum 1= Load Observer Only (Y) 2 = Load Observer with Velocity Estimate (N) 3 = Velocity Estimate Only (N) 4 = Acceleration Feedback (Y)
809	Set	Load Observer Feedback Gain		-	-	Y	Y	N	
807	Set	Load Observer Integrator Bandwidth		-	-	N	N	N	
802	Get	Load Observer Torque Estimate		-	-	Y	Y	N	
1370	Set	Load Type		N	N	N	N	N	DScale
750	Set	Local Control		N	N	N	N	N	0-Enum 1 = Conditionally Allowed (N) 2 = Allowed (N)
614	Set	Mechanical Brake Control		-	N	N	N	N	
616	Set	Mechanical Brake Engage Delay		-	N	N	N	N	
615	Set	Mechanical Brake Release Delay		-	N	N	N	N	
45	Set	Motion Scaling Configuration		R	R	R	R	R	0-Enum 1 = Drive Scaling (N)
1310/251	Set	Motor Catalog Number		-	N	N	N	N	Dr NV
1313	Set	Motor Data Source		-	R	R	R	R	0-Enum 1 = Database (Y) 2 = Drive NV (Y) 3 = Motor NV (N)
1323	Set	Motor Integral Thermal Switch		-	N	N	N	N	
1324	Set	Motor Max Winding Temperature		-	N	N	N	N	
646	Set	Motor Overload Action		-	N	N	N	N	0-Enum 1 = Current Foldback (N)
1322	Set	Motor Overload Limit		-	Y	Y	Y	Y	
695	Set	Motor Overspeed User Limit		-	Y	Y	Y	Y	
694	Set	Motor Phase Loss Limit	-	-	Y	Y	Y	Y	V26
1317	Set	Motor Polarity		-	Y	Y	Y	Y	
1321	Set	Motor Rated Output Power		-	Y	Y	Y	Y	Y-IM
1320	Set	Motor Rated Peak Current		-	N	N	N	N	N-IM
697	Set	Motor Thermal Overload User Limit		-	Y	Y	Y	Y	
1315	Set	Motor Type		-	R	R	R	R	0-Enum 1 = Rotary Permanent Magnet (Y) 2 = Rotary Induction (Y) 3 = Linear Permanent Magnet (N) 4 = Linear Induction (N)
1325	Set	Motor Winding to Ambient Capacitance		-	N	N	N	N	

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
1326	Set	Motor Winding to Ambient Resistance		-	N	N	N	N	
521	Get	Operative Current Limit		-	-	N	N	N	
600	Get	Output Frequency		-	R	Y	Y	Y	
508	Set	Overtorque Limit		-	Y	Y	Y	Y	
509	Set	Overtorque Limit Time		-	Y	Y	Y	Y	
2310	Set	PM Motor Flux Saturation		-	N	N	N	N	PM Motor only
1343	Set	PM Motor Force Constant		-	N	N	N	N	Rotary PM Motor only
1342	Set	PM Motor Rated Force		-	N	N	N	N	Rotary PM Motor only
1339	Set	PM Motor Rated Torque		-	N	N	N	N	Rotary PM Motor only
1340	Set	PM Motor Torque Constant		-	N	N	N	N	Rotary PM Motor only
445	Set	Position Error Tolerance Time		-	-	Y	-	-	
365	Get	Position Fine Command		-	-	Y	-	-	
446	Set	Position Integrator Control		-	-	R	-	-	0-Bits 1: Auto-Preset (N)
447	Set	Position Integrator Preload		-	-	N	-	-	
781	Set	Position Lead Lag Filter Bandwidth		-	-	Y	-	-	
782	Set	Position Lead Lag Filter Gain		-	-	Y	-	-	
783	Set	Position Notch Filter Frequency		-	-	Y	-	-	
627	Set	Power Loss Action		-	Y	Y	Y	Y	0-Enum 2 = Decel Regen (Y)
628	Set	Power Loss Threshold		-	Y	Y	Y	Y	
630	Set	Power Loss Time		-	Y	Y	Y	Y	
590	Set	Proving Configuration	-	-	Y	Y	Y	Y	V28
376	Set*	Ramp Acceleration		-	Y	-	Y	-	Derived
377	Set*	Ramp Deceleration		-	Y	-	Y	-	Derived
378	Set	Ramp Jerk Control		-	Y	-	Y	-	
375	Set*	Ramp Velocity - Negative		-	Y	-	Y	-	Derived
374	Set*	Ramp Velocity - Positive		-	Y	-	Y	-	Derived
613/354	Set	Resistive Brake Contact Delay		-	N	N	N	N	PM Motor only
1333	Set	Rotary Motor Damping Coefficient		-	N	N	N	N	Rotary Motor only
2312	Set	Rotary Motor Fan Cooling Derating		-	N	N	N	N	Rotary Motor only
2311	Set	Rotary Motor Fan Cooling Speed		-	N	N	N	N	Rotary Motor only
1330	Set	Rotary Motor Inertia		-	N	Y	Y	N	Rotary Motor only
1332	Set	Rotary Motor Max Speed		-	N	N	N	N	Rotary Motor only
629	Set	Shutdown Action		-	N	N	N	N	0-Enum 1 = Drop DC Bus (N)
370	Set	Skip Speed 1		-	Y	-	-	-	
371	Set	Skip Speed 2		-	Y	-	-	-	
372	Set	Skip Speed 3		-	Y	-	-	-	
373	Set	Skip Speed Band		-	Y	-	-	-	
833	Set	SLAT Configuration		-	-	-	Y	-	

ID	Access Rule	Attribute	B	E	F	P	V	T	Conditional Implementation
834	Set	SLAT Set Point		-	-	-	Y	-	
835	Set	SLAT Time Delay		-	-	-	Y	-	
610	Set	Stopping Action		-	R	R	R	R	0-Enum 2 = Ramped Decel Disable (FPV/Y) 3 = Current Decel Hold (PV/N) 4 = Ramped Decel Hold (PV/Y) 128 = DC Injection Brake (IM/Y) 129 = AC Injection Brake (IM/Y)
612	Set	Stopping Time Limit		-	-	N	N	N	
496	Set	System Inertia		-	-	R	R	N	
555	Set	Torque Integral Time Constant		-	-	N	N	N	
827	Set	Torque Lead Lag Filter Bandwidth		-	-	Y	Y	N	
828	Set	Torque Lead Lag Filter Gain		-	-	Y	Y	N	
554	Set	Torque Loop Bandwidth		-	-	N	N	N	
502	Set	Torque Low Pass Filter Bandwidth		-	-	N	N	N	
503	Set	Torque Notch Filter Frequency		-	-	Y	Y	Y	
506	Set	Torque Rate Limit		-	-	N	N	N	
507/334	Set	Torque Threshold		-	-	N	N	N	
1371	Set	Transmission Ratio Input		N	N	N	N	N	DScale
1372	Set	Transmission Ratio Output		N	N	N	N	N	DScale
510	Set	Undertorque Limit		-	Y	Y	Y	Y	
511	Set	Undertorque Limit Time		-	Y	Y	Y	Y	
464/321	Set	Velocity Droop		-	Y	Y	Y	-	
465	Set	Velocity Error Tolerance		-	-	N	N	-	
466	Set	Velocity Error Tolerance Time		-	-	N	N	-	
366	Get	Velocity Fine Command		-	-	Y	Y	-	
467	Set	Velocity Integrator Control		-	-	R	R	-	0-Bits 1: Auto-Preset (N)
468	Set	Velocity Integrator Preload		-	-	Y	Y	-	
474/326	Set	Velocity Limit - Negative		-	Y	Y	Y	-	
473/325	Set	Velocity Limit - Positive		-	Y	Y	Y	-	
471	Set	Velocity Lock Tolerance		-	Y	Y	Y	-	
469	Set	Velocity Low Pass Filter Bandwidth		-	-	Y	Y	-	
790	Set	Velocity Negative Feedforward Gain		-	-	Y	Y	-	
470/327	Set	Velocity Threshold		N	Y	Y	Y	N	
608	Set	Zero Speed	-	-	Y	Y	Y	-	V28
609	Set	Zero Speed Time	-	-	Y	Y	Y	-	V28

MSG Instruction Access Only Attributes

The following table lists the attributes that are available to a specific drive via messaging. The P### references in the Conditional Implementation column refer to the related PowerFlex drive parameter.

ID	Attribute	K350	K5500	K6500	PF755	E	F	P	V	T	C/D	Conditional Implementation
480	Acceleration Command		X	X				O	O	O		MSG Access Only
1404 +(n-1)*50	Acceleration Feedback (General Feedback Signal)	X	X	X		R		R	R	R		E, MSG Access Only
1454	Acceleration Feedback 2			X		R		R	R	R		E, MSG Access Only
639	Ambient Temperature						O	O	O	O		MSG Access Only
688	Bus Overvoltage Factory Limit	X					O	O	O	O		MSG Access Only
686	Bus Regulator Overtemperature Factory Limit						O	O	O	O		MSG Access Only
687	Bus Regulator Thermal Overload Factory Limit			X			O	O	O	O		MSG Access Only
880	Bus Regulator Reference				X		O	O	O	O		MSG Access Only, P375
689	Bus Undervoltage Factory Limit						O	O	O	O		MSG Access Only
756	CIP APR Faults					C		C	C	C	Yes	R-Co CScale; O-Dr DScale; E, MSG Access Only
757	CIP APR Faults - Mfg					C		C	C	C	Yes	Vxx; R-Co CScale; O-Dr DScale; E, MSG Access Only
905	CIP APR Faults - RA					C		C	C	C	Yes	R-Co CScale; O-Dr DScale; E, MSG Access Only
660	CIP Axis Alarms - Mfg		X	X		O	O	O	O	O		Vxx; MSG Access Only
673	CIP Axis Exception Action - Mfg	X	X	X		R	R	R	R	R		MSG Access Only
655	CIP Axis Exceptions	X	X	X		R	R	R	R	R		MSG Access Only
656	CIP Axis Exceptions - Mfg	X	X	X		R	R	R	R	R		Vxx; MSG Access Only
902	CIP Axis Exceptions - RA					R	R	R	R	R	Yes	MSG Access Only
658	CIP Axis Faults - Mfg	X	X	X		R	R	R	R	R		Vxx; MSG Access Only
654	CIP Axis I/O Status - Mfg	X	X	X		R	R	R	R	R		Vxx; MSG Access Only
652	CIP Axis Status - Mfg	X	X	X		R	R	R	R	R		Vxx; MSG Access Only
675	CIP Initialization Faults - Mfg	X	X	X		R	R	R	R	R	Yes	Vxx; MSG Access Only
677	CIP Start Inhibits - Mfg	X	X	X			R	R	R	R		Vxx; MSG Access Only
832	Cogging Compensation Table							O	O	O		MSG Access Only
768	Command Notch Filter Frequency		X					O	O			MSG Access Only
564	Commutation Alignment		X	X				O	O	O		E; PM Motor only, O- Enum, MSG Access Only
900	Control Module Overtemperature Factory Limit					O	O	O	O	O		MSG Access Only
710	Control Power-up Time						O	O	O	O		MSG Access Only
693	Converter Ground Current Factory Limit						O	O	O	O		MSG Access Only
684	Converter Overtemperature Factory Limit						O	O	O	O		MSG Access Only
901	Converter Precharge Overload Factory Limit						O	O	O	O		MSG Access Only
723	Converter Rated Output Current		X	X		-	O	O	O	O	Yes	MSG Access Only

724	Converter Rated Output Power		X			-	0	0	0	0	Yes	MSG Access Only
685	Converter Thermal Overload Factory Limit						0	0	0	0		MSG Access Only
715	Cumulative Control Power Cycles						0	0	0	0		MSG Access Only
712	Cumulative Energy Usage						0	0	0	0		MSG Access Only
714	Cumulative Main Power Cycles						0	0	0	0		MSG Access Only
713	Cumulative Motor Revs						0	0	0	0		MSG Access Only
711	Cumulative Run Time						0	0	0	0		MSG Access Only
621	DC Bus Voltage - Nominal	X	X	X	X		R	R	R	R		MSG Access Only, P12
736	Drive Enable Input Checking	X					0	0	0	0		MSG Access Only
725	Drive Power Structure Axis ID						0	0	0	0		MSG Access Only
1400	Feedback 1 Catalog Number					0		0	0	0		E, MSG Access Only
1427	Feedback 1 LDT Recirculations					R		R	R	R		E, LT, MSG Access Only
1426	Feedback 1 LDT Type					R		R	R	R		E, LT, MSG Access Only
1410	Feedback 1 Resolution Unit					0		0	0	0		E, MSG Access Only
643	Feedback 1 Temperature		X	X		0	0	0	0	0		E, MSG Access Only
1450	Feedback 2 Catalog Number							0	0	0		E, MSG Access Only
1477	Feedback 2 LDT Recirculations					R		R	R	R		E, LT, MSG Access Only
1476	Feedback 2 LDT Type					R		R	R	R		E, LT, MSG Access Only
1460	Feedback 2 Resolution Unit					0		0	0	0		E, MSG Access Only
644	Feedback 2 Temperature			X		0	0	0	0	0		E, MSG Access Only
2432	Feedback 2U Acceleration					0		0	0	0		E, MSG Access Only
2430	Feedback 2U Position					0		0	0	0		E, MSG Access Only
2431	Feedback 2U Velocity					0		0	0	0		E, MSG Access Only
692	Feedback Data Loss Factory Limit					0	0	0	0	0		E, MSG Access Only
43	Feedback Master Select					0						Vxx, MSG Access Only
1427 +(n-1)*50	Feedback n LDT Recirculations					R	-	R	R	R		E, LT, MSG Access Only
1426 +(n-1)*50	Feedback n LDT Type					R	-	R	R	R		E, LT, MSG Access Only
2402 + (n-1)* 50	Feedback n Scaling Ratio					0	-	0	0	0		E, MSG Access Only
1401 + (n-1)* 50	Feedback n Serial Number	X	X	X		0	-	0	0	0		E, MSG Access Only
690	Feedback Noise Factory Limit					0	0	0	0	0		MSG Access Only
2385 + (n-1)* 50	Feedback nS Acceleration					0	-	0	0	0	Yes	E, MSG Access Only

2383 + (n-1)* 50	Feedback nS Position					0	-	0	0	0	Yes	E, MSG Access Only
2384 + (n-1)* 50	Feedback nS Velocity					0	-	0	0	0	Yes	E, MSG Access Only
2382 + (n-1)* 50	Feedback nU Acceleration					0	-	0	0	0	Yes	E, MSG Access Only
2380 + (n-1)* 50	Feedback nU Position					0	-	0	0	0	Yes	E, MSG Access Only
2381 + (n-1)* 50	Feedback nU Velocity					0	-	0	0	0	Yes	E, MSG Access Only
691	Feedback Signal Loss Factory Limit					0	0	0	0	0		E, MSG Access Only
532	Flux Decoupling							0	0	0		MSG Access Only
534	Flux Voltage Output		X	X				0	0	0		MSG Access Only
737	Hardware Overtravel Input Checking	X					0	0	0	0		MSG Access Only
829	Inertia Observer Configuration			X				0	0	0		MSG Access Only
831	Inertia Observer Filter Bandwidth			X				0	0	0		MSG Access Only
640	Inverter Heatsink Temperature						0	0	0	0		MSG Access Only
645	Inverter Overload Factory Limit						0	0	0	0		MSG Access Only
682	Inverter Overtemperature Factory Limit	X					0	0	0	0		MSG Access Only
698	Inverter Overtemperature User Limit						0	0	0	0		MSG Access Only
721	Inverter Rated Output Current	X	X	X	X	-	R	R	R	R	Yes	MSG Access Only, P21
722	Inverter Rated Output Power	X	X	X	X	-	R	R	R	R	Yes	MSG Access Only, P22
720	Inverter Rated Output Voltage	X	X	X	X	-	R	R	R	R	Yes	MSG Access Only, P20
641	Inverter Temperature		X		X		0	0	0	0		MSG Access Only, P942
683	Inverter Thermal Overload Factory Limit						0	0	0	0		MSG Access Only
679	Linear Motor Overspeed Factory Limit					-	0	0	0	0	Yes	MSG Access Only
1312	Motor Date Code		X	X			0	0	0	0		MSG Access Only
680	Motor Overtemperature Factory Limit						0	0	0	0		MSG Access Only
696	Motor Overtemperature User Limit						0	0	0	0		MSG Access Only
1311	Motor Serial Number		X	X		-	0	0	0	0	Yes	MSG Access Only
642	Motor Temperature		X				0	0	0	0		MSG Access Only
681	Motor Thermal Overload Factory Limit			X			0	0	0	0		MSG Access Only
1354	PM Motor Ld Inductance				X							MSG Access Only
1353	PM Motor Lq Inductance				X							MSG Access Only
430	Position Command	X	X	X	X			R				MSG Access Only, P759
434	Position Feedback (Position Loop Attributes)	X	X	X	X	R	-	R	R	R	Yes	E, MSG Access Only, P847

780	Position Integral Feedback		X		X			0				MSG Access Only, P837
604	PWM Frequency		X				0	0	0	0		MSG Access Only
678	Rotary Motor Overspeed Factory Limit					-	0	0	0	0	Yes	MSG Access Only
490	Torque Command	X	X	X	X	-	-	R	R	R	Yes	MSG Access Only, P761
531	Torque Decoupling							0	0	0		MSG Access Only
533	Torque Voltage Output		X	X				0	0	0		MSG Access Only
821	Total Inertia Estimate		X	X	X			0	0	0		MSG Access Only, P708
538	U Current Feedback		X	X				0	0	0		MSG Access Only
541	U Current Offsets			X				0	0	0		MSG Access Only
535	U Voltage Output		X	X				0	0	0		MSG Access Only
539	V Current Feedback		X	X				0	0	0		MSG Access Only
542	V Current Offsets			X				0	0	0		MSG Access Only
536	V Voltage Output		X	X				0	0	0		MSG Access Only
450	Velocity Command	X	X	X	X		R	R	R			MSG Access Only, P760
1403	Velocity Feedback 1	X	X	X	X	R		R	R	R		E, MSG Access Only, P131
1453	Velocity Feedback 2			X	X	R		R	R	R		E, MSG Access Only, P131
1403 +(n-1)*50	Velocity Feedback n (General Feedback Signal Attributes)	X	X	X	X	R	-	R	R	R	Yes	E, MSG Access Only, P131
540	W Current Feedback		X	X				0	0	0		MSG Access Only
543	W Current Offsets			X				0	0	0		MSG Access Only
537	W Voltage Output		X	X				0	0	0		MSG Access Only

CIP Axis Attributes

The CIP Axis Attributes let you configure motion-control system devices that include feedback devices and drive devices. For drive devices, the CIP Axis Attributes cover a wide range of drive types from simple variable frequency (V/Hz) drives, to sophisticated position-control servo drives. Many commercial drive products have axes that can be configured to operate in any one of these different motion-control modes, depending on the specific application requirements.

The CIP Axis Attributes are organized to address the broad range of functionality. Because of the large number of attributes, they are organized by functional category.

Control Mode Attributes

Acceleration Control Attributes on page 187	Frequency Control Configuration Attributes on page 204
Acceleration Control Configuration Attributes on page 189	Position Loop Attributes on page 206
Command Generator Configuration Attributes on page 191	Position Loop Configuration Attributes on page 208
Command Generator Signal Attributes on page 195	Torque/Force Control Configuration Attributes on page 211
Command Reference Generation Attributes on page 191	Torque/Force Control Signal Attributes on page 220
Current Control Attributes on page 201	Velocity Loop Configuration Attributes on page 221
Current Control Configuration Attributes on page 201	Velocity Loop Signal Attributes on page 228
Frequency Control Signal Attribute on page 206	

Data Attributes

Axis Info Attributes on page 234	CIP Axis Status Attributes on page 236
Axis Statistical Attributes on page 235	Event Capture Attributes on page 247

Drive Attributes

Drive General Purpose I/O Attributes on page 249	Power and Thermal Management Configuration Attributes on page 252
Drive Output Attributes on page 251	Power and Thermal Management Status Attributes on page 254

Drive Commissioning and Tuning Attributes

Autotune Configuration Attributes on page 258	Inertia Test Configuration Attributes on page 269
Hookup Test Configuration Attributes on page 266	Inertia Test Result Attributes on page 272
Hookup Test Result Attributes on page 267	Motor Test Result Attributes on page 275

Faults and Alarms Attributes

APR Fault Attribute on page 279	Exception User Limit Configuration Attributes on page 292
Axis Exception Action Configuration Attributes on page 281	Exception, Fault, and Alarm Attributes on page 293
Configuration Fault Attributes on page 287	Initialization Faults Attributes on page 295
Exception Factory Limit Info Attributes on page 290	Module/Node Fault and Alarm Attributes on page 297

Feedback Attributes

Feedback Attributes on page 302	General Feedback Info Attributes on page 316
Feedback Configuration Attributes on page 304	General Feedback Signal Attributes on page 316

Motion Control Attributes

Motion Control Configuration Attributes on page 317	Motion Dynamic Configuration Attributes on page 354
Motion Control Interface Attributes on page 323	Motion Homing Configuration Attributes on page 357
Motion Control Signal Attributes on page 330	Motion Planner Configuration Attributes on page 367
Motion Control Status Attributes on page 341	Motion Planner Output Attributes on page 374
Motion Database Storage Attributes on page 352	Motion Scaling Attributes on page 375

Motor Attributes

General Linear Motor Attributes on page 388	Interior Permanent Magnet Motor Attributes on page 406
General Motor Attributes on page 389	Linear PM Motor Attributes on page 404
General Permanent Magnet Motor Attributes on page 396	Load Transmission and Actuator Attributes on page 409
General Rotary Motor Attributes on page 399	Rotary PM Motor Attributes on page 412
Induction Motor Attributes on page 401	

Safety Attributes

Axis Safety Status Attributes on page 414	Guard Safety Status Attributes on page 426
Guard Safety Attributes on page 425	

Stopping and Braking Attributes

DC Bus Control Attributes on page 451	Stopping and Braking Attributes on page 431
Start Inhibit Attributes on page 453	

General attribute characteristics

Keep the following items in mind while reviewing the attribute tables:

Item	Description
SSV access rule	If an attribute is marked with an SSV access rule, it is implied that the attribute also supports GSV access.
Vendor specific bits	Vendor specific bits, and enumerations provide space for drive vendors to provide additional product features. For Logix Designer software version 18, all defined vendor specific bits are Rockwell Automation specific.
Optional attributes	Unless otherwise specified, all optional attributes default to 0.
Attribute name	The tag and GSV/SSV names for each of these attributes should be the same as the attribute name but with spaces removed. For example, Inhibit Axis would be InhibitAxis.

See also

Standard Exceptions on page 456

Interpret the Attribute Tables on page 87

Control Mode Attributes

The following attribute tables contain control mode related attributes associated with a Motion Control Axis Object instance.

Acceleration Control Attributes

These are the acceleration related attributes associated with a Motion Control Axis.

Acceleration Trim

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/ SSV	T	REAL	0	-max accel	max accel	Accel Units

Additional acceleration command added to the acceleration loop summing junction.

Acceleration Reference

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/ GSV	T	REAL	-	-	-	Accel Units

Command acceleration reference into acceleration loop summing junction.

Acceleration Feedback

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/ GSV	T	REAL	-	-	-	Accel Units

Actual acceleration of the axis based on the selected feedback device.

Load Observer Acceleration Estimate

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/ GSV	T	REAL	-	-	-	Accel Units

Output of the Load Observer that, when the Load Observer block is enabled, is applied to the acceleration reference summing junction. In the Load Observer configuration, this signal compensates for disturbances to the load relative to an ideal load model. When the Load Observer is configured to operate in Acceleration Feedback Only mode, this signal is the estimated acceleration feedback signal used to close the acceleration loop. When the Load Observer is disabled, this signal is 0.

Load Observer Torque Estimate

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/ GSV	T	REAL	-	-	-	% Motor Rated

Product of the Load Observer Acceleration Estimate signal and the current System Inertia value, Kj. In the Load Observer configuration, this signal represents the estimated torque disturbances to the load relative to an ideal load model. When the Load Observer is configured to operate in Acceleration Feedback Only mode, this signal is an estimate of the applied motor torque. When the Load Observer is disabled, this signal is 0.

See also

Acceleration Control Configuration Attributes on page 189

Motion Control Configuration Attributes on page 317

Velocity Control Mode on page 18

Acceleration Control Configuration Attributes

These are the acceleration control configuration attributes associated with a Motion Control Axis.

Load Observer Configuration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV		USINT	0	-	-	Enumeration 0 = Disabled (R) 1 = Load Observer Only (0) 2 = Load Observer with Velocity Estimate (0) 3 = Velocity Estimate Only (0) 4 = Acceleration Feedback (0) 5...255 = Reserved

The Load Observer Configuration attribute configures the operation of the Load Observer. The Load Observer dynamically measures the active load torque applied to the motor load for the purpose of load disturbance compensation. Selecting the Velocity Estimate configures the observer to dynamically estimate velocity based on an internal model of the motor and load. When Velocity Estimate is selected, this signal is applied to the velocity loop to provide superior control loop performance. The Velocity Estimate may be used in combination with the Load Observer by selecting Load Observer with Velocity Estimate. The Acceleration Feedback configuration applies acceleration feedback to the control loop structure to improve stability and performance. In effect, Acceleration Feedback is like adding virtual inertia to the motor thus reducing the Load Ratio.

Load Observer Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV	T	REAL	FD	0	∞	Loop Bandwidth Units

The Load Observer Bandwidth attribute determines the proportional gain, Kop, of the load observer. This value represents the unity gain bandwidth of the load observer.

Load Observer Integrator Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV	T	REAL	0	0	∞	Loop Bandwidth Units

The Load Observer Integrator Bandwidth attribute determines the load observer integral gain, Koi, that together with the Kop, multiplies the integrated error signal within the observer. This value represents the bandwidth of the integrator beyond which the integrator is ineffective. A value of 0 for this attribute disables the integrator.

Load Observer Feedback Gain

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV		REAL	0.5	0	∞	

The Load Observer Feedback Gain attribute is a value that, when configured for Acceleration Feedback, multiplies the Load Observer's acceleration output signal before applying it as feedback to the acceleration reference summing junction. The output of this gain term is the Load Observer Acceleration Estimate signal. If not configured for Acceleration Feedback operation, this attribute has no effect.

Acceleration Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV		REAL	0 FD		∞	Accel Units

The Acceleration Limit attribute defines the maximum acceleration (increasing speed) allowed for the acceleration reference value into the acceleration summing junction. If this acceleration limit value is exceeded, the device responds by clamping the acceleration reference to this limit and setting the Acceleration Limit status bit.

Deceleration Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV		REAL	0 FD	0	∞	Accel Units

The Deceleration Limit attribute defines the maximum deceleration (decreasing speed) allowed for the acceleration reference signal into the acceleration summing junction. If this deceleration limit value is exceeded, the device responds by clamping the acceleration reference to this limit and setting the Deceleration Limit status bit.

See also

Acceleration Control Attributes on page 187

Motion Control Configuration Attributes on page 317

Command Reference Generation Attributes

These are the command reference generation functionality of the device that converts command position, velocity, acceleration, and torque data output from a controller-based or device-based motion planner into corresponding command references signals to the device's motor control structures. The command reference generator functionality includes fine interpolators, signal selector switches, dynamic limiters, command notch filters.

See also

Command Generator Signal Attributes on page 195

Command Generator Configuration Attributes on page 191

Command Generator Configuration Attributes

The following are the command generator configuration attributes associated with a Motion Control Axis:

Skip Speed 1

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - F	Set/SSV	REAL	0	-∞	∞	Velocity Units

The Skip Speed 1 attribute sets the central speed of a skip speed band within which the device does not operate. The skip speed value is signed.

Skip Speed 2

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - F	Set/SSV	REAL	0	-∞	∞	Velocity Units

The Skip Speed 2 attribute sets the central speed of a skip speed band within which the device does not operate. The skip speed value is signed.

Skip Speed 3

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - F	Set/SSV	REAL	0	-∞	∞	Velocity Units

The Skip Speed 3 attribute sets the central speed of a skip speed band within which the device does not operate. The skip speed value is signed.

Skip Speed Band

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - F	Set/SSV	REAL	0	0	∞	Velocity Units

When operating in Closed Loop Velocity mode, the Fine Velocity Command block also supports Skip Bands that are most frequently used in applications where certain speeds excite mechanical resonance frequencies of the motor and load.

The Skip Speed Band attribute determines the speed window around a skip speed that cannot be commanded. Any command set-point within this window is adjusted by the Skip Speed block to fall at either the upper or lower Skip Speed Band boundary value. The device can smoothly accelerate or decelerate through the skip speed band based on the ramp generator block but may not operate at a set speed within the band. The Skip Speed Band is distributed ½ above and ½ below the skip speed. This Skip Speed Band attribute applies to all skip speeds supported in the device. A value of 0 for this attribute disables this feature.

Ramp Velocity - Positive

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - FV Derived from Max Speed	Get/SSV	REAL	0	0	∞	Velocity Units

The Ramp Velocity - Positive attribute is a positive value that defines the maximum positive velocity command output of the Ramp Generator.

Ramp Velocity - Negative

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - FV Derived from Max Speed	Get/SSV	REAL	0	-∞	0	Velocity Units

The Ramp Velocity - Negative attribute is a negative value that defines the maximum negative velocity command output of the Ramp Generator.

Ramp Acceleration

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - FV Derived from Max Accel	Get/SSV	REAL	0	0	∞	Accel Units

The Ramp Acceleration attribute is a positive value that defines the maximum acceleration (increasing speed) of the velocity command output by the Ramp Generator.

Ramp Deceleration

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - FV Derived from Max Decel	Get/SSV	REAL	0	0	∞	Accel Units

The Ramp Deceleration attribute is a positive value that defines the maximum deceleration (decreasing speed) of the velocity command output by the Ramp Generator.

Ramp Jerk Control

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - FV	Get/SSV	REAL	0	0	100	%

The Ramp Jerk Control attribute sets the percentage of accel or decel time that is applied to the speed ramp as jerk limited S Curve based on a step change in velocity. The S Curve time is added ½ at the beginning and ½ at the end of the ramp. A value of 0 results in no S-Curve, for example, a linear acceleration or deceleration ramp.

A value of 100% results in a triangular acceleration profile with the peak being the configured ramp acceleration or deceleration.

As the Jerk Control value increases the derived accelerating jerk value decreases based on:

0.5 * 0.01 * Jerk Control * Ramp Vel Positive / Ramp Accel

and the decelerating Jerk limit value also decreases according to:

0.5 * 0.01 * Jerk Control * Ramp Vel Negative / Ramp Decel.

Flying Start Enable

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - FV	Set/SSV	BOOL	0	0	1	0 = Flying Start Disabled 1 = Flying Start Enabled

The Flying Start Enable attribute is a Boolean value which enables or disables the Flying Start feature of the device. When Flying Start Enable is true and the motion axis is enabled, the device determines the current velocity of the motor, using either the configured Flying Start Method or, if not supported, a method that is left to the drive vendor's discretion. This operation is done as part of the Starting State initialization activities. Just prior to transitioning to the Running state, the device presets the output of the Ramp Generator to the current velocity. In this way, the motor seamlessly ramps from its current velocity to the commanded velocity from the controller. When Flying Start Enable is false, the motor velocity is irrelevant and a preset of 0 is applied to the Ramp Generator output.

Some drive vendors do not allow the Flying Start feature to be disabled when connected to a feedback device. To support this behavior, these drives do not support the Flying Start Enable attribute, but do support the Flying Start Method attribute.

Flying Start Method

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - FV	Set/SSV	USINT	0	-	-	Enumerations: 0 = Encoder Only (R) 1 = Counter EMF (O) 2 = Sweep Frequency (O)

The Flying Start Method attribute is an enumerated value which establishes the method used to "catch" a moving motor when the drive is enabled. The configured Flying Start Method is applied if Flying Start Enable is true or if the Flying Start Enable attribute is not supported.

When Encoder Only is selected, the drive uses encoder feedback to determine the current speed of the motor to initialize the Ramp Generator output. This method is not applicable without a connected feedback device. If Encoder Only is selected without a connected feedback device, the Flying Start function is effectively disabled.

When Counter EMF is selected, the drive determines the speed of the motor by measuring the motor's Counter EMF and applying the estimated speed to the Ramp Generator output.

When Sweep Frequency is selected the drive applies an algorithm that excites the motor at a predetermined frequency and, while "sweeping" the frequency to zero, checks for the motor current to change sign when the frequency matches the speed of the motor. The drive then applies this speed to the to the Ramp Generator output.

See also

Command Generator Signal Attributes on page 195

Command Generator Signal Attributes

These are the command generator signal attributes associated with a Motion Control Axis.

Position Fine Command

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - P	Get/GSV	T	REAL	-	-	-	Position Units

The Position Fine Command attribute is the output value from the Command Position fine interpolator.

Velocity Fine Command

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - PV	Get/GSV	T	REAL	-	-	-	Velocity Units

The Velocity Fine Command attribute is the output value from the Command Velocity fine interpolator. When no Command Velocity signal is present when performing position control, this signal can be derived by scaling the Differential Position output value of the Command Position fine interpolator.

Acceleration Fine Command

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/GSV	T	REAL	-	-	-	Accel Units

The Acceleration Fine Command attribute is the output value from the Command Acceleration fine interpolator. When no Command Acceleration signal is present when performing position or velocity control, this signal can be derived by scaling the Differential Velocity output value of the Command Velocity fine interpolator. If no Command Velocity signal is present, the Interpolated Command Acceleration signal can be derived by scaling the 2nd Differential Position output value of the Command Position fine interpolator.

See also

Command Generator Configuration Attributes on page 191

Current Control Configuration Attributes

These are the current control configuration attributes associated with a Motion Control Axis.

Current Vector Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - CF	Set/SSV	REAL	100 FD	0	10^3	% Motor Rated

Current Vector Limit value applied to current vector limiter to provide a configurable limit to the magnitude of the current vector.

Torque Loop Bandwidth

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV	REAL	0 FD	0	∞	Loop Bandwidth Units

The Torque Loop Bandwidth attribute determines the Iq Proportional Gain value that multiplies the Iq Current Error signal before applying it to the Iq decoupling summing junction as part of the torque producing current loop. In cases where the torque producing current loop is controlled by something other than the traditional PI regulator, the Torque Loop Bandwidth is used by the drive to provide single parametric control of the current loop bandwidth. If the Flux Loop Bandwidth is not supported, the drive will use the Torque Loop Bandwidth for tuning both the torque producing and flux producing current loops.

Torque Integral Time Constant

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV	REAL	0	0	∞	Seconds

The Torque Integral Time Constant value determines the response time of the torque producing current loop integrator. When used for Pole-Zero cancelation, this value is set to the electrical time constant of the motor. A value of 0 for the Torque Integral Time Constant disables the integrator.

Flux Loop Bandwidth

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV	REAL	0 DB	0	∞	Loop Bandwidth Units

Determines the Id Proportional Gain value that multiplies the Id Current Error signal before applying it to the Iq decoupling summing junction as part of the flux producing current loop. In cases where the flux producing current loop is controlled by something other than the traditional PI regulator, the Flux Loop Bandwidth is used by the drive to provide single parametric control of the current loop bandwidth. If the Flux Loop Bandwidth is not supported, the drive will use the Torque Loop Bandwidth for tuning both the torque producing and flux producing current loops.

Flux Integral Time Constant

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV	REAL	0	0	∞	Seconds

The Flux Integral Time Constant value determines the response time of the flux producing current loop integrator. When used for Pole-Zero cancelation, this value is set to the electrical time constant of the motor. A value of 0 for the Flux Integral Time Constant disables the integrator.

Flux Up Control

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional- D (IM)	Set/SSV	USINT	0	-	-	Enumeration 0 = No Delay (R) 1 = Manual Delay (0) 2 = Automatic Delay (0) 3…255 = Reserved

When the motion axis is enabled, DC current is applied to an induction motor to build stator flux before transitioning to the Running state. This attribute controls how an induction motor is to be fluxed in the Starting state prior to transitioning to the Running state. If No Delay is selected the axis transitions immediately to the Running state while the motor flux is building. With Manual Delay, the axis remains in the Starting state for the Flux Up Time to allow time for the motor to be fully fluxed. With Automatic Delay, the drive device determines the amount of time to delay to fully flux the motor based on motor configuration attribute data or measurements.

If this attribute is not supported in the implementation, it is recommended that the drive establish induction motor flux using alternative means prior to transitioning to the Running state.

Flux Up Time

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D (IM)	Set/SSV	REAL	0	0	10^3	Seconds

The Flux Up Time attribute sets the amount of time the drive device allows to build full motor flux before transitioning to the Running state.

Feedback Commutation Aligned

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - CE (PM)	Set/GSV	USINT	0 DB	-	-	Enumeration 0 = Not Aligned (R) 1 = Controller Offset (R) 2 = Motor Offset (0) 3 = Self-Sense (0) 4 = Database Offset (0) 5...255 = Reserved

This enumerated parameter is set to Controller Offset (1) when the motor mounted absolute feedback device is to be aligned with the stator windings of the PM motor according to the Commutation Offset value. In some cases the Commutation Offset can be preset to a value established by factory alignment of the motor feedback device relative to the motor stator windings.

A setting of Not Aligned (0) indicates that the motor is not aligned, and that the Commutation Offset value is not valid. If the Commutation Offset is not valid, it cannot be used by the drive to determine the commutation angle. Any attempt to enable the drive with an invalid commutation angle will result in a Start Inhibit condition.

Alignment can be achieved using a Commutation Test that measures and sets the Commutation Offset for the motor or by direct user entry. If this attribute is set to Motor Offset (2) the drive derives the commutation offset directly from the motor. If set to Self-Sense (3) the drive automatically measures the commutation offset when it transitions to the Starting state for the first time after a power cycle. This generally applies to a PM motor equipped with a simple incremental feedback device.

Commutation Offset

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - CE (PM)	SSV#/ GSV	REAL	0 DB	0		Electrical Degrees

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

The Commutation Offset attribute specifies the commutation offset of the PM motor mounted feedback device in units of electrical degrees. This attribute specifies the offset from a commutation reference position defined by applying DC current into the A terminal and out of the shorted B and C terminals of the motor and letting the rotor to move to its magnetic null position relative to the stator. On an absolute encoder or resolver, the offset is the difference from the device's zero absolute position and the commutation reference position. On an incremental encoder or Hall sensor with UVW signals, the offset is the difference between the position corresponding to a transition of the commutation device's W (S3) channel (with the U (S1) channel high and the V (S2) channel low) and the commutation reference position. The commutation offset is only applicable to the motor mounted Feedback 1 device.

When the optional Commutation Alignment attribute is supported and set to Controller Offset, the drive will apply the Commutation Offset value from the controller to determine the electrical angle of the motor. In this case, a valid Commutation Offset value must be entered by the user, read from the Motor Database, or determined by the Commutation Test. In the unusual case where the commutation offset is also stored in the motor, and differs significantly from Commutation Offset value from the controller, the drive will transition to the Start Inhibited state

If the Commutation Alignment attribute is not set to Controller Offset or Database Offset, the Commutation Offset value from the controller is ignored by the drive and the drive must determine its internal commutation offset value by other means. Without a valid commutation offset, the drive will be Start Inhibited.

Commutation Self-Sensing Current

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - CE (PM)	Set/GSV	REAL	100	0	200	% Motor Rated

When a PM motor feedback drive device is an incremental encoder without UVW tracks for commutation, a Self-Sensing algorithm is run during the Starting state that determines the Commutation Offset to apply to the position feedback.

This algorithm applies a current to the motor stator to orient the rotor to establish the motor commutation phasing.

Commutation Polarity

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - CE (PM)	Set/ SSV*	USINT	0	-	-	Enumeration 0 = Normal 1 = Inverted 2...255 = Reserved

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

When a PM motor is using UVW signals for commutation start up, it is critical that the UVW phases of the commutation device follow the phasing of the motor. Normal polarity implies UVW phasing according to factory specification when the commutation device is moving in the factory defined positive direction. Inverted polarity effectively switches the UVW phasing to UWV thus reversing the directional sense of the commutation device. If it is determined through a Commutation Test that the phasing of the motor and the phasing of the commutation device have opposite polarity, this attribute can be used to compensate for the mismatch.

Commutation Offset Compensation

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - CE (IPM Only)	SSV#/ GSV	REAL	0	0	∞	Electrical Degrees

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

This value specifies the change in the Commutation Offset value in units of electrical degrees as a linear function of current. When the Iq current is +100% of rated continuous current, the Commutation Offset value is decreased by the value of this attribute. When the Iq current is -100% the Commutation Offset is increased by the value of the attribute. This attribute is used by the drive to compensate for changes in the optimal Commutation Offset angle that can occur as a function of motor current.

Commutation Alignment

The Default Commutation Alignment value used for the Feedback Commutation Aligned and Commutation Alignment attributes depends on the associated Feedback Type and whether or not the motor commutation device is Factory Aligned. When the Motor Data Source is from Datasheet, it is assumed that the motor is not Factory Aligned. When the Motor Data Source is from Database, motor data in the database indicates if the motor is Factory Aligned.

The following table correlates the default commutation alignment with the valid commutation alignment selections.

Default Commutation Alignment			Valid Commutation Alignment Selections
Feedback Type	**Factory Aligned - True**	**Factory Aligned - False**	
Digital AqB	-	Self-Sense*	Not Aligned | Self-Sense
Digital AqB with UVW	Database Offset	Not Aligned	Not Aligned | Database Offset | Controller Offset | Self-Sense
Digital Parallel	Database Offset	Not Aligned	Not Aligned | Database Offset | Controller Offset
Sine/Cosine	-	Self-Sense*	Not Aligned | Self-Sense
Sine/Cosine with UVW	Database Offset	Not Aligned	Not Aligned | Database Offset | Controller Offset | Self-Sense
Hiperface	Motor Offset*	Not Aligned	Not Aligned | Database Offset | Controller Offset | Motor Offset | Self-Sense
EnDat Sine/Cosine	Motor Offset*	Not Aligned	Not Aligned | Database Offset | Controller Offset | Motor Offset | Self-Sense
EnDat Digital	Motor Offset*	Not Aligned	Not Aligned | Database Offset | Controller Offset | Motor Offset
Resolver	Database Offset	Not Aligned	Not Aligned | Database Offset | Controller Offset
SSI Digital	Database Offset	Not Aligned	Not Aligned | Database Offset | Controller Offset
Hiperface DSL	Motor Offset*	Not Aligned	Not Aligned | Database Offset | Controller Offset | Motor Offset
BiSS Digital	Motor Offset*	Not Aligned	Not Aligned | Database Offset | Controller Offset
SSI Sine/Cosine	Database Offset	Not Aligned	Not Aligned | Database Offset | Controller Offset | Self-Sense
SSI AqB	Database Offset	Not Aligned	Not Aligned | Database Offset | Controller Offset | Self-Sense
BiSS Sine/Cosine	Database Offset	Not Aligned	Not Aligned | Database Offset | Controller Offset | Self-Sense
Tamagawa Serial	Motor Offset*	Not Aligned	Not Aligned | Database Offset | Controller Offset | Motor Offset
Stahl SSI	Database Offset	Not Aligned	Not Aligned | Database Offset | Controller Offset

* *If optional Commutation Alignment enumerations Self-Sense and Motor Offset are not supported by the drive, the create time default Commutation Alignment of Not Aligned is retained.*

See also

CIP Axis Attributes on page 185

Current Control Signal Attributes

These are the current control signal related attributes associated with a Motion Control Axis.

Current Command

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Get/GSV	T	REAL	-	-	-	% Motor Rated

The Current Command attribute represents the instantaneous value of the commanded torque producing current signal, Iq, prior to passing through the vector current limiter. It is tied directly to the output of torque reference path after the 1/Kt scaling that represents the torque effort to be applied to the drive's torque producing Iq current loop. The nominal value for 1/Kt is 1 based on 100% rated torque being produced by 100% rated current.

Operative Current Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Get/GSV	T	REAL	-	-	-	% Motor Rated

The Operative Current Limit attribute represents the operative current limit based on multiple limit sources.

Current Limit Source

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Get/GSV	T	DINT	-	-	-	Enumeration 0 = Not Limited 1 = Inverter Peak Current Limit 2 = Motor Peak Current Limit 3 = Inverter Thermal Current Limit 4 = Motor Thermal Current Limit 5 = Shunt Regulator Limit 6 = Current Vector Limit 7 = Brake Test Limit 8…127 = Reserved 128…255 = Vendor Specific

The Current Limit Source attribute represents the operative source of a current limit when a current limit condition occurs.

Motor Electrical Angle

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C PM Motor	Get/GSV	T	REAL	-	-	-	Degrees

The Motor Electrical Angle attribute is the calculated electrical angle of the motor based on motor pole count, commutation offset, and selected feedback device.

Current Reference

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/GSV	T	REAL	-	-	-	% Motor Rated

The Current Reference attribute is the current reference signal, Iq, into the torque current loop summing junction.

Flux Current Reference

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/GSV	T	REAL	-	-	-	% Motor Rated

The Flux Current Reference attribute is the command current reference, Id, into the flux producing current loop summing junction.

Current Disturbance

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV	T	REAL	-	-	-	% Motor Rated

Injected torque producing current command used to excite motor as part of Frequency Analysis service.

Current Error

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/GSV	T	REAL	-	-	-	% Motor Rated

Error between commanded and actual current that is the output of the torque producing, q-axis, current loop summing junction.

Flux Current Error

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/GSV	T	REAL	-	-	-	% Motor Rated

Error between commanded and actual current that is the output of the flux producing, d-axis, current loop summing junction.

Current Feedback

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/GSV	T	REAL	-	-	-	% Motor Rated

Actual torque current applied to the axis based on current sensor feedback.

Flux Current Feedback

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/GSV	T	REAL	-	-	-	% Motor Rated

Actual flux current applied to the axis based on current sensor feedback.

See also

Current Control Configuration Attributes on page 196

CIP Axis Attributes on page 185

Frequency Control Configuration Attributes

These are the Frequency Control Configuration attributes associated with the Frequency Control method of operation of a Motion Control Axis.

Frequency Control Method

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - F	Set/GSV	USINT	0	-	-	Enumeration 0 = Basic Volts/Hertz (R) 1...127 = Reserved 128 = Fan/Pump Volts/Hertz (0) 129 = Sensorless Vector (0) 130 = Sensorless Vector Economy (0) 128...255 = Vendor Specific

The Frequency Control Method attribute identifies the control method associated with the axis.

The Basic Volts/Hertz control method applies voltage to the motor generally in direct proportion to the commanded frequency or speed.

Sensorless Vector enhances the Basic Volts/Hertz algorithm by utilizing current vectors Iq and Id for superior control at low speeds.

Fan/Pump Volts/Hertz is based on the Basic Volts/Hertz but is specifically tailored for fan/pump applications.

Sensorless Vector Economy applies the Sensorless vector algorithm but seeks to reduce energy consumption when the applied load is less than 50% of rating.

Maximum Voltage

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - F	Set/SSV	REAL	460 FD	0	∞	Volts (RMS)

The Maximum Voltage attribute sets the highest phase-to-phase voltage the drive device can output.

Maximum Frequency

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - F	Set/SSV	REAL	130 FD	0	∞	Hertz

The Maximum Frequency attribute sets the highest frequency the drive device can output.

Break Voltage

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - F	Set/SSV	REAL	230 FD	0	∞	Volts (RMS)

The Break Voltage attribute sets the phase-to-phase output voltage of the drive device at the Break Frequency where boost ends.

Only applicable in Basic V/Hz mode.

Break Frequency

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - F	Set/SSV	REAL	30 FD	0	∞	Hertz

The Break Frequency attribute sets the output frequency of the drive device at the Break Voltage where boost ends.

Only applicable in Basic V/Hz mode.

Start Boost

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - F	Set/SSV	REAL	8.5 FD	0	∞	Volts (RMS)

The Start Boost attribute sets phase-to-phase voltage boost level for starting and accelerating.

Only applicable in Basic V/Hz mode.

Run Boost

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - F	Set/SSV	REAL	8.5 FD	0	∞	Volts (RMS)

The Run Boost attribute sets the phase-to-phase voltage boost level for steady-state speed or deceleration.

Only applicable in Basic V/Hz mode and Fan/Pump V/Hz modes.

See also

CIP Axis Attributes on page 185

Frequency Control Signal Attribute

This attribute is the signal attribute associated with the Frequency Control method of operation of a Motion Control Axis.

Slip Compensation

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - F	Get/GSV	T	REAL	-	-	-	RPM

Indicates the actual amount of slip compensation currently being applied.

See also

Frequency Control Configuration Attributes on page 204

CIP Axis Attributes on page 185

Position Loop Signal Attributes

These are the position loop signal related attributes associated with a Motion

Control Axis.

Position Trim

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Set/SSV	T	REAL	0	-maxpos	maxpos	Position Units

The Position Trim attribute is an additional position command added to the Position Command to generate the Position Reference signal into the position loop summing junction.

Position Reference

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Set/GSV	T	REAL	-	-	-	Position Units

The Position Reference attribute is the command position reference signal into the position loop summing junction to be compared with a position feedback signal.

Velocity Feedforward Command

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Get/GSV	T	REAL	-	-	-	Velocity Units

The Velocity Feedforward Command attribute is a command signal that represents a scaled version of the command velocity profile. This signal is the Velocity Fine Command signal scaled by Velocity Feedforward Gain and applied to the output of the position loop.

Position Error

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Get/GSV	T	REAL	-	-	-	Position Units

The Position Error attribute is the error between commanded and actual position that is the output of the position loop summing junction.

Position Integrator Output

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Get/GSV	T	REAL	-	-	-	Velocity Units

The Position Integrator Output attribute is the output of position integrator representing the contribution of the position integrator to Position Loop Output.

Position Loop Output

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Get/GSV	T	REAL	-	-	-	Velocity Units

The Position Loop Output attribute is the output of the position loop forward path representing the total control effort of the position loop.

See also

Position Control Mode on page 17

Position Loop Configuration Attributes on page 208

CIP Axis Attributes on page 185

Position Loop Configuration Attributes

These are the position loop configuration attributes associated with a Motion Control Axis.

Velocity Feedforward Gain

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Set/SSV		REAL	0	0		%

The Velocity Feedforward Gain attribute multiplies the Velocity Feedforward Command signal to form the Velocity Feedforward Command that is applied to the velocity loop summing junction.

Position Loop Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Set/SSV	T	REAL	100 FD	0		Loop Bandwidth Units

The Position Loop Bandwidth attribute determines the proportional gain, Kpp, of the position loop that multiplies the Position Error signal. This value represents the unity gain bandwidth of the position loop beyond which the position loop is ineffective.

Position Integrator Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Set/SSV	T	REAL	0 FD	0	∞	Loop Bandwidth Units

The Position Integrator Bandwidth attribute determines the position loop integral gain, Kpi, which together with the Kpp, multiplies the integrated Position Error signal. This value represents the bandwidth of the position integrator beyond which the integrator is ineffective. A value of 0 for this attribute disables the integrator.

Position Lock Tolerance

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Set/SSV		REAL	0.01 FD	0	∞	Position Units

The Position Lock Tolerance attribute establishes a window around the current command position. When the actual position is within this window the Position Lock status bit is set. When actual position falls outside this window, the Position Lock status bit is cleared.

Position Error Tolerance

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Set/SSV		REAL	0 FD	0	∞	Position Units

The Position Error Tolerance attribute determines the absolute maximum Position Error value that can be tolerated without causing an Excessive Position Error exception.

Position Error Tolerance Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - P	Set/SSV		REAL	0	0	10^3	Sec

The Position Error Tolerance Time attribute determines the maximum amount of time that the Position Error Tolerance can be exceeded without generating an exception.

Position Lead Lag Filter Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - P	Set/SSV		REAL	0	0	10^4	Filter Frequency Units

The Position Lead Lag Filter Bandwidth attribute sets the pole frequency for the position regulator Lead-Lag Filter. A value of 0 disables the filter.

Position Lead Lag Filter Gain

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - P	Set/SSV		REAL	0	0	∞	

The Position Lead Lag Filter Gain attribute sets the high frequency gain of the position regulator Lead-Lag Filter. A value greater than 1 results in a lead function and value less than 1 results in a lag function. A value of 1 disables the filter.

Position Notch Filter Frequency

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - P	Set/SSV		REAL	0	0	10^4	Filter Frequency Units

The Position Notch Filter Frequency attribute controls the center frequency of the notch filter that is applied to the velocity reference signal of the velocity loop summing junction. A value of 0 for this attribute disables this feature.

Position Integrator Control

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Set/SSV		BYTE	0 0:0 1:0	-	-	Bitmap 0 = Integrator Hold Enable (R) 1 = Auto-Preset (O) 2…7 = Reserved

The Position Integrator Control attribute controls the behavior of the position loop integrator while commanding motion through the controller. When the integrator hold enable bit is set, the integrator is held while motion is being commanded with a non-zero velocity. When clear, the integrator runs without qualification. When the auto-preset bit is set, the integrator preload value is automatically loaded with the current velocity command when there is a control mode change between velocity control and position control. If clear, the integrator is loaded with the configured position integrator preload value.

Position Integrator Preload

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - P	Set/SSV		REAL	0	0	∞	Velocity Units

The Position Integrator Preload attribute is a value assigned to the position integrator when the position control loop is enabled.

See also

Position Loop Attributes on page 206

Position Control Mode on page 17

CIP Axis Attributes on page 185

Torque/Force Control Configuration Attributes

These are the torque/force control configuration attributes associated with a Motion Control Axis.

Torque Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set/SSV		REAL	0	-100	+100	% Motor Rated

The Torque Offset attribute provides a torque bias when performing closed loop control. This value is summed together with the Torque Trim value which is sent synchronously to the drive every connection update. Since the Torque Trim value is available as a tag value, real time torque corrections are done using the Torque Trim attribute. For the Torque Offset value to have effect, Torque Trim must be selected for Cyclic Write.

System Inertia

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV Optional - T	Set/SSV	T	REAL	0 FD	0	∞	% Motor Rated / (Motor Units/Sec^2)

Torque or force scaling gain value that converts commanded acceleration into equivalent rated torque/force. Properly set, this value represents the total system inertia or mass.

Backlash Reversal Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Set/SSV		REAL	0	0	∞	Position Units

The Backlash Reversal Offset attribute value is used to compensate for positional inaccuracy introduced by mechanical backlash. Backlash manifests itself when an axis is commanded to reverse direction. During such a reversal there is a small amount of displacement of the motor that does not translate to displacement of the load due to mechanical play in the machine, for example, through the gearing or ball-screw. As a result, there is an error in the control system's indication of the actual position for the axis versus the true position of the mechanical load, that error being equal to the lost displacement due to the mechanical backlash.

Compensation for this positioning error due to mechanical backlash can be achieved by adding a directional offset, specified by the Backlash Reversal Offset attribute, to the motion planner's command position before sending to the drive.

Whenever the commanded velocity changes sign (a reversal), the Logix controller will add, or subtract, the offset value from the current commanded position. This causes the servo to immediately move the motor to the other side of the backlash window and engage the load. It is important to note that the application of this directional offset is completely transparent to the user; the offset does not have any impact on the value of the Command Position attribute. If a value of zero is applied to the Backlash Reversal Offset, the feature is effectively disabled. Once enabled by a non-zero value, and the load is engaged by a reversal of the commanded motion, changing the Backlash Reversal Offset can cause the axis to shift as the offset correction is applied to the command position.

Backlash Compensation Window

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - P	Set/SSV		REAL	0	0	∞	Position Units

Defines a window around the command position. When the actual position is within this window, the effective System Inertia gain is reduced by a factor of the ratio of the Position Error and the Backlash Compensation Window. When the actual position is outside the window, the configured System Inertia gain is applied.

Friction Compensation Sliding

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV		REAL	0	0	100	% Motor Rated

Value added to the current/torque command to offset the effects of coulomb friction.

Friction Compensation Static

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV		REAL	0	0	100	% Motor Rated

Value added to the current/torque command to offset the effects of static friction (sometimes referred to "sticktion").

Friction Compensation Viscous

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV		REAL	0	0	100	% Motor Rated / (Motor Units/Sec)

Value added to the current/torque command to offset the effects of viscous friction, for example, friction that is proportional to speed.

Friction Compensation Window

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - P	Set/SSV		REAL	0	0	∞	Position Units

Defines a window around the command position. When the actual position is within this window, the effective Friction Compensation value is reduced by a factor of the ratio of the Position Error and the Friction Compensation Window. When the actual position is outside the window, or when the axis is being commanded to move, the normal friction compensation algorithm applies.

Torque Lead Lag Filter Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV		REAL	0	0	10^4	Filter Frequency Units

Sets the pole frequency for the torque reference Lead-Lag Filter. A value of 0 disables the filter.

Torque Lead Lag Filter Gain

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV		REAL	1	0		

Sets the high frequency gain of the torque reference Lead-Lag Filter. A value greater than 1 results in a lead function and value less than 1 results in a lag function. A value of 0 results in a first order low pass filter function. A value of 1 disables the filter.

Torque Low Pass Filter Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV	T	REAL	0 FD	0	10^4	Filter Frequency Units

Break frequency for the low pass filter applied to torque reference signal.

Torque Notch Filter Frequency

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV		REAL	0	0	10^4	Filter Frequency Units

Center frequency of the notch filter applied to the torque reference signal. A value of 0 for this attribute disables this feature.

Torque Limit - Positive

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set/SSV		REAL	100 FD	0	10^3	% Motor Rated

This positive value determines the maximum positive torque that can be applied to the motor. If the device attempts to exceed this value, the torque command is clamped to this value.

Torque Limit - Negative

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set/SSV		REAL	-100 FD	-10^3	0	% Motor Rated

This negative value determines the most negative torque value that can be applied to the motor. If the device attempts to apply a more negative torque than this limit, the torque command is clamped to this value.

Torque Rate Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV		REAL	10^6	0	∞	% Motor Rated / Sec

Limits the rate of change of the torque reference signal.

Torque Threshold

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV		REAL	90 FD	0	10^3	% Motor Rated

Specifies the threshold for the Filtered Torque Reference signal magnitude that when exceeded, results in the Torque Threshold status bit being set.

Overtorque Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV		REAL	200	0	10^3	% Motor Rated

Maximum limit for the torque producing Iq Current Feedback signal magnitude. When the Iq Current Feedback signal is greater than this value for the duration specified by Overtorque Limit Time attribute, the result is an Overtorque Limit exception. This feature lets the device generate an exception if there is a sudden increase in load torque during operation. This condition could occur if a bearing fails, a hard stop is reached, or there is some other mechanical failure.

Overtorque Limit Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV		REAL	0	0	10^3	Seconds

Specifies the amount of time allowed in an Overtorque Limit condition before generating an Overtorque Limit exception. A value of 0 for this attribute disables the Undertorque feature.

Undertorque Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV		REAL	10	0	10^3	% Motor Rated

Minimum limit for the torque producing Iq Current Feedback signal magnitude. When the Iq Current Feedback is less than this value for the duration specified by Undertorque Limit Time attribute, the result is an Undertorque Limit exception. This feature lets the device generate an exception if there is a sudden decrease in load torque during operation. This condition could occur, for example, if a load coupling breaks or a tensioned web material breaks.

Undertorque Limit Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV		REAL	0	0	10^3	Seconds

Specifies the amount of time allowed in an Undertorque Limit condition before generating an Undertorque Limit exception. A value of 0 for this attribute disables the Undertorque feature.

Adaptive Tuning Configuration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV		USINT	0	-	-	Enumeration: 0 = Disabled 1 = Tracking Notch 2 = Gain Stabilization 3 = Tracking Notch and Gain Stabilization 4-255 = Reserved

Enumerated value that controls operation of the Adaptive Tuning function. This function periodically collects axis torque data and analyzes this data to identify resonances and closed loop instabilities in the system.

When Adaptive Tuning Configuration is Disabled the configured values for all servo loop attributes of the associated axis are applied directly without intervention of the Adaptive Tuning function.

When configured for Tracking Notch, the Torque Notch Filter Frequency Estimate attribute value, determined by the Adaptive Tuning function, is applied to the Torque Notch Filter as part of the control loop update. The configured Torque Notch Filter Frequency attribute is not overwritten as a result of this operation. All other servo loop attributes are applied directly without intervention of the Adaptive Tuning function.

When configured for Gain Stabilization, the Load Observer Bandwidth, Load Observer Integrator Bandwidth, Velocity Loop Bandwidth, Velocity Loop Integrator Bandwidth, Position Loop Bandwidth, and Position Loop Integrator Bandwidth attribute values are scaled by the Adaptive Tune Gain Scaling Factor as part of the control loop update. The configured values of these attributes are not overwritten as a result of this operation. The Torque Low Pass Filter Bandwidth Estimate is also applied to the Torque Low Pass Filter Bandwidth. In this configuration, the value of the Torque Notch Filter Frequency attribute is applied directly to the notch filter without intervention of the Adaptive Tuning function

When configured for Notch Filter and Gain Stabilization, the Torque Notch Filter Frequency Estimate attribute value, determined by the Adaptive Tuning function, is applied to the Torque Notch Filter as part of the control loop update. The configured Torque Notch Filter Frequency attribute is not overwritten as a result of this operation. The Load Observer Bandwidth, Load Observer Integrator Bandwidth, Velocity Loop Bandwidth, Velocity Loop Integrator Bandwidth, Position Loop Bandwidth, and Position Loop Integrator Bandwidth attributes are scaled by the Adaptive Tune Gain Scaling Factor as part of the control loop update. The configured values of these attributes are not overwritten as a result of this operation. The Torque Low Pass Filter Bandwidth Estimate is also applied to the Torque Low Pass Filter Bandwidth.

Even if Disabled, the Adaptive Tuning function runs periodically to collect drive data while the axis is in the Running state. When a resonance frequency is detected that meets the configured Notch Tuning criteria, the frequency of the resonance is loaded to the Torque Notch Filter Frequency Estimate attribute. The magnitude of the resonance is also loaded to the Torque Notch Filter Magnitude Estimate. The Adaptive Tuning status bits in the CIP Axis Status RA attribute are updated each time the Adaptive Tuning function is executed.

The configured Notch Tuning criteria are that the magnitude of the resonance frequency, not associated with the command, be above the configured Torque

Notch Filter Tuning Threshold and that the frequency of the resonance be between the configured Torque Notch Filter Low Frequency Limit and Torque Notch Filter High Frequency Limit.

The Adaptive Tuning function sets the Torque Notch Filter Frequency Estimate to the identified resonant frequency with the largest magnitude that meets the configured Notch Tuning criteria.

A state machine, as defined in the functional requirements specification, determines the Adaptive Tune Gain Scaling Factor and the Torque Low Pass Filter Bandwidth Estimate. The current state also determines which drive parameters are updated. The transition logic for the state machine is dependent on the Adaptive Tuning status bits of the CIP Axis Status RA attribute and the Adaptive Tuning Configuration.

When the drive axis is in any other state besides the Running state, the Adaptive Tuning function is turned off and does not collect data.

When the drive transitions out of the Running state, the present values of all the Adaptive Tuning status bits and output estimates will persist. When the drive transitions into the Running state, the values of all the Adaptive Tuning status bits are set to 0 and output estimates will persist until they are updated by the Adaptive Tuning feature.

When the Adaptive Tuning Configuration is set to Disabled or Tracking Notch, the Adaptive Tune Gain Scaling Factor is reset to one. In this case the configured Torque Notch Filter Frequency, Torque Low Pass Filter Bandwidth, Load Observer Bandwidth, Load Observer Integrator Bandwidth, Velocity Loop Bandwidth, Velocity Loop Integrator Bandwidth, Position Loop Bandwidth, and Position Loop Integrator Bandwidth attribute values are not impacted by the Adaptive Tuning function.

Torque Notch Filter High Frequency Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV		REAL	FD	20	2*FD	Filter Frequency Units

This value sets the upper limit on the Torque Notch Filter Frequency Estimate value for the Adaptive Tuning function. The frequency of an identified natural resonance must be lower than this limit to be applied to the Torque Notch Filter Frequency Estimate.

Torque Notch Filter Low Frequency Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV		REAL	FD	20	2000	Filter Frequency Units

This value sets the lower limit on the Torque Notch Filter Frequency Estimate value for the Adaptive Tuning function. The frequency of an identified natural resonance must be higher than this limit to be applied to the Torque Notch Filter Frequency Estimate.

Torque Notch Filter Tuning Threshold

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set/SSV	T	REAL	5	0	100	% Motor Rated

To be identified as a resonance frequency by the Adaptive Tuning function, the resonance magnitude must exceed the Torque Notch Filter Tuning Threshold. 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.

Torque Notch Filter Frequency Estimate

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/GSV	T	REAL	-	-	-	Filter Frequency Units

This value represents the resonance frequency with the highest magnitude above the Torque Notch Filter Tuning Threshold and between the Torque Notch Filter Low Frequency Limit and the Torque Notch Filter High Frequency Limit as identified by the Adaptive Tuning function.

The Torque Notch Filter Frequency Estimate value is initialized to zero when the drive is power cycled or reset.

Torque Notch Filter Magnitude Estimate

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/GSV	T	REAL	-	-	-	% Motor Rated

This value represents the maximum magnitude for resonant peaks found above the Torque Notch Filter Tuning Threshold and between the Torque Notch Filter Low Frequency Limit and the Torque Notch Filter High Frequency Limit as identified by the Adaptive Tuning function.

The Torque Notch Filter Magnitude Estimate value is initialized to zero when the drive is power cycled or reset.

Torque Low Pass Filter Bandwidth Estimate

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/GSV	T	REAL	-	-	-	Filter Frequency Units

This value represents the Bandwidth of the Torque Low Pass Filter when the Adaptive Tuning Configuration is equal to Gain Stabilization or Tracking Notch and Gain Stabilization. The value is modified by the Adaptive Tuning function. The value is initialized to the Torque Low Pass Filter Bandwidth when the Adaptive Tuning Configuration transitions from Disabled or Tracking Notch to Gain Stabilization or Tracking Notch and Gain Stabilization. The Torque Low Pass Filter Bandwidth Estimate value is initialized to zero when the drive is power cycled or reset.

Adaptive Tuning Gain Scaling Factor

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/GSV	T	REAL	-	-	-	Applied Gain/Configured Gain

This value proportionally scales the servo loop gain attributes of the associated axis. The value is modified by the Adaptive Tuning function. The value is reset to 1 any time the Adaptive Tuning Configuration is Disabled or set to Tracking Notch. The value is initialized to 1 when the drive is power cycled or reset.

See also

Torque Force Control Signal Attributes on page 220

Velocity Control Mode on page 18

Torque/Force Control Signal Attributes

These are the torque/force signal related attributes associated with a Motion Control Axis.

Torque Trim

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set/SSV	T	REAL	-	$-\infty$	∞	% Motor Rated

Additional torque command added to the torque input summing junction.

Torque Reference

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Get/GSV	T	REAL	-	-	-	% Motor Rated

Commanded torque reference input signal before torque filter section representing the sum of the Torque Command and Torque Trim signal inputs.

Torque Reference Filtered

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Get/GSV	T	REAL	-	-	-	% Motor Rated

Commanded torque reference input signal after torque filter section.

Torque Reference Limited

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Get/GSV	T	REAL	-	-	-	% Motor Rated

Commanded torque reference input signal after torque limiter section.

See also

Torque Control Mode on page 20

Torque/Force Control Configuration Attributes on page 211

Velocity Loop Configuration Attributes

These are the velocity loop configuration attributes associated with a Motion Control Axis.

Velocity Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	Set/SSV		REAL	0	-maxspd	maxspd	Velocity Units

The Velocity Offset attribute can be used to provide a velocity bias when performing velocity control. This value is summed together with the Velocity Trim value which is sent synchronously to the drive every Coarse Update Period.

Since the Velocity Trim value is available as a tag value, real time velocity corrections will be done using the Velocity Trim attribute.

Acceleration Feedforward Gain

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	Set/SSV		REAL	0	0	∞	%

The Acceleration Feedforward Gain attribute is a value that multiplies the Acceleration Fine Command signal to form the Acceleration Feedforward Command that is applied to the acceleration loop summing junction. 100% Acceleration Feedforward applies the full Acceleration Fine Command signal to the output of the velocity loop.

Velocity Loop Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	Set/SSV	T	REAL	260 FD	0	∞	Loop Bandwidth Units

The Velocity Loop Bandwidth attribute is a value that determines the proportional gain, Kvp, of the velocity loop that multiplies the Velocity Error signal. This value represents the unity gain bandwidth of the velocity loop.

Velocity Integrator Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	Set/SSV	T	REAL	0 FD	0	∞	Loop Bandwidth Units

The Velocity Integrator Bandwidth attribute determines the velocity loop integral gain, Kvi, which together with the Kvp, multiplies the integrated Velocity Error signal. This value represents the bandwidth of the velocity integrator beyond which the integrator is ineffective. A value of 0 for this attribute disables the integrator.

Velocity Negative Feedforward Gain

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - PV	Set/SSV		REAL	0	0	∞	%

The Velocity Negative Feedforward Gain attribute is a value that reduces or eliminates velocity overshoot by subtracting a portion of the velocity reference signal from the velocity error.

Velocity Droop

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - FPV	Set/SSV		REAL	0	0	∞	Velocity Units / Sec / % Rated

Velocity Droop value that provides compliance to the velocity integrator by subtracting a portion of the velocity loop effort from the velocity error input to the velocity integrator. The presence of the Torque/Force scaling gain, Kj, in the droop signal path lets Velocity Droop to be specified in velocity units per % rated torque output. This parameter is also valid for V/Hz devices and its behavior is nearly identical, but instead of % rated being related to torque, % rated is related to current.

Velocity Error Tolerance

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - PV	Set/SSV		REAL	0 FD	0	∞	Velocity Units

The Velocity Error Tolerance attribute determines the absolute maximum Velocity Error value that can be tolerated without causing a Excessive Velocity Error exception.

Velocity Error Tolerance Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - PV	Set/SSV		REAL	0.01	0	∞	Seconds

The Velocity Error Tolerance Time attribute determines the maximum amount of time that the Velocity Error Tolerance can be exceeded without generating an exception.

Velocity Integrator Control

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	Set/SSV		BYTE	0 0:0 1:0	-	-	Bitmap 0 = Integrator Hold Enable (R) 1 = Auto-Preset (0) 2...7 = Reserved

The Velocity Integrator Control attribute controls the behavior of the velocity loop integrator while commanding motion through the controller. When the integrator hold enable bit is set, the integrator is held while motion is being commanded with a non-zero velocity. When clear, the integrator runs without qualification. When the auto-preset bit is set, the integrator preload value is automatically loaded with the current torque command when there is a control mode change between torque control and velocity control. If clear, the integrator is loaded with the configured velocity integrator preload value.

Velocity Integrator Preload

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - PV	Set/SSV		REAL	0	0	∞	Accel Units

The Velocity Integrator Preload attribute is a value assigned to the velocity integrator when the velocity control loop is enabled.

Velocity Low Pass Filter Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - PV	Set/SSV	T	REAL	0	0	10^4	Filter Frequency Units

The Velocity Low Pass Filter Bandwidth attribute controls the bandwidth of the Low Pass Filter applied to the Velocity Error signal. Recommended implementation is a two pole IIR filter. A value of 0 for this attribute disables this feature.

Velocity Threshold

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - ED	Set/SSV		REAL	0 FD	0	∞	Velocity Units

The Velocity Threshold attribute defines a minimum absolute velocity. If the magnitude of the Velocity Feedback signal is less than this value, the Velocity Threshold status bit is set. If the axis is configured for Frequency Control, the Velocity Feedback signal is derived from the Velocity Reference signal.

Velocity Lock Tolerance

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - PV	Set/SSV		REAL	1 FD	0	∞	Velocity Units

The Velocity Lock Tolerance attribute establishes a window around the unlimited velocity reference signal. When the Velocity Feedback signal is within this window the Velocity Lock status bit is set. When Velocity Feedback signals falls outside this window, the Velocity Lock status bit is cleared.

Velocity Standstill Window

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - ED	Set/SSV		REAL	1 FD	0	∞	Velocity Units

The Velocity Standstill Window attribute establishes a window around zero speed. When the Velocity Feedback signal is within this window the Velocity Standstill status bit is set. When Velocity Feedback signal falls outside this window, the Velocity Standstill status bit is cleared. If the axis is configured for Frequency Control, the Velocity Feedback signal is derived from the Velocity Reference signal.

Velocity Limit - Positive

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - FPV	Set/SSV		REAL	0 FD	0	∞	Velocity Units

The Velocity Limit - Positive attribute defines the most positive velocity reference value into the velocity summing junction. If the signal entering the velocity limiter exceeds this velocity limit value, the device responds by clamping the velocity reference to this limit and sets the Velocity Limit status bit.

Velocity Limit - Negative

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - FPV	Set/SSV		REAL	0 FD	-∞	0	Velocity Units

The Velocity Limit - Negative attribute is a negative value that defines the most negative velocity reference value allowed into the velocity summing junction. If the signal entering the velocity limiter exceeds this velocity limit value, the device responds by clamping the velocity reference to this limit and sets the Velocity Limit status bit.

Slat Configuration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - V	SSV		BYTE	-	-	-	0 = SLAT Disabled 1 = SLAT Min Speed/Torque 2 = SLAT Max Speed/Torque

The Slat Configuration attribute configures the Speed Limited Adjustable Torque feature. The SLAT Configuration enumeration determines how the drive controls torque for this axis instance. In order to support applications that require Speed Limited Adjustable Torque (SLAT) control, the Min/Max torque control enumerations provide a feature to automatically switch to and from speed control under certain conditions. In either SLAT mode the drive will operate in one of two min/max states - speed control off or on.

Bit	Name	Description
0	SLAT Disabled	SLAT function is disabled. Normal Velocity Loop operation.
1	SLAT Min Speed/Torque	Drive will automatically switch from torque control to speed control if Velocity Error < 0 and switch back to torque control if Velocity Error > SLAT Setpoint for SLAT Time.
2	SLAT Max Speed/Torque	Drive will automatically switch from torque control to speed control if Velocity Error > 0 and switch back to torque control if Velocity Error < -SLAT Set Point for SLAT Time

SLAT Set Point

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - V	Set/SSV		REAL	-	-	-	Velocity Units

Speed Error level to switch from Speed control to Min/ Max control.

SLAT Time Delay

Time delay after SLAT Set Point is reached to switch from Speed control to Min/ Max control.

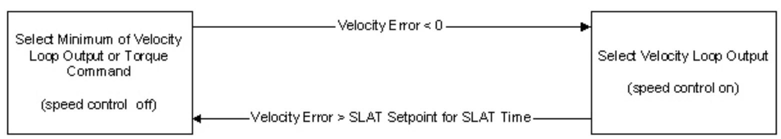
Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - V	Set/SSV		REAL	-	-	-	Seconds

Time delay after SLAT Set Point is reached to switch from Speed control to Min/ Max control.

SLAT Min Speed/Torque Mode

In SLAT Min Speed/Torque mode (SLAT Configuration = 1) the drive defaults to the state with speed control off (leftmost state) shown in the figure below. In this state, the torque reference is the minimum, or Min function, of the Velocity Loop Output or the Torque Command.

Min Mode



When used for SLAT control, an application dependent Velocity Command is applied to the drive. When the motor's speed is mechanically limited, this reference is at a level that results in saturation of the velocity loop output. In this state, the 'Min' select operation selects the smaller Torque Command value. The Velocity Error is positive in value equal to the Velocity Command.

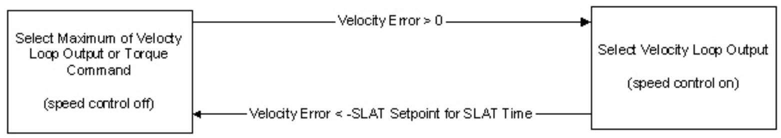
If the mechanical speed limitation is removed (example web break), the motor accelerates and the Velocity Error becomes negative when the motor speed exceeds the Velocity Command. At this time, an automatic transition to speed control occurs and the Velocity Loop Output is selected as the Torque Reference, regardless of the value of the Torque Command. Coincident with the transition into speed control, a preset operation will occur within the velocity loop. This preset will force the velocity loop integrator to match the internal torque reference value, at the time of the mode transition.

In Min mode the drive remains in speed control until the Velocity Error exceeds the configured SLAT Set-point attribute value for a period of time given by the SLAT Time Delay attribute. When these two conditions are met, speed control is turned off and the 'Min' select operation becomes active. This condition would occur if the mechanical constraint was restored.

SLAT Max Speed/Torque Mode

For SLAT Max Speed/Torque mode (SLAT Configuration = 2) the SLAT control operates similar to SLAT Min Speed/Torque mode, except that the signs have changed to allow the feature to work in the negative direction.

Max Mode



The active 'Max' select function will select the larger, or Max function, of the Velocity Loop Output or the Torque Command. The Velocity Command value is a negative quantity and so when the motor speed is mechanically limited, the Velocity Error is a negative value, and the Velocity Loop Output is a saturated (limited) to a negative value. The Torque Command is also negative, but smaller in magnitude, so it becomes selected by the 'Max' operation.

The forced transition to speed control occurs when the Velocity Error value becomes positive such as when the mechanical limitation is removed. A preset of the velocity loop's integral term occurs, as before.

When, by restoring the mechanical constraint, the Velocity Error becomes negative again and less than the negated SLAT Set-point parameter value for a SLAT Time delay, speed control is turned off and the 'Max' select operation becomes active.

See also

Position Loop Attributes on page 206

Position Loop Configuration Attributes on page 208

Velocity Loop Attributes on page 228

Velocity Loop Signal Attributes

These are the velocity control signal related attributes associated with a Motion Control Axis.

Velocity Trim

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Set/SSV	T	REAL	0	-maxspd	maxspd	Velocity Units

Additional velocity command added to the velocity loop summing junction.

Acceleration Feedforward Command

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	Get/GSV	T	REAL	-	-	-	Accel Units

The Acceleration Feedforward Command attribute is a signal that represents a scaled version of the command acceleration profile. This signal is the Acceleration Fine Command signal scaled by Acceleration Feedforward Gain and applied to the output of the velocity loop.

Velocity Reference

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Get/GSV	T	REAL	-	-	-	Velocity Units

Command velocity reference into velocity loop summing junction, or in the case of Frequency Control, the signal that is scaled to become the Frequency Reference.

Velocity Feedback

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/GSV	T	REAL	-	-	-	Velocity Units

Actual velocity of the axis applied to the velocity summing junction, if applicable, based on Control Mode selection. In most cases the Velocity Feedback signal is derived directly from the feedback device specified by the Feedback Mode selection. If the axis is configured for Feedback Only mode, Velocity Feedback represents the actual velocity of the feedback device. If the axis is configured for Frequency Control, the Velocity Feedback signal is derived from the Velocity Reference signal. If configured for Sensorless Velocity Loop operation, i.e. Feedback Mode set to No Feedback, Velocity Feedback is estimated by the sensorless control algorithm.

Velocity Error

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	Get/GSV	T	REAL	-	-	-	Velocity Units

Error between the velocity reference and velocity feedback value that is the output of the velocity loop summing junction.

Velocity Integrator Output

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	Get/GSV	T	REAL	-	-	-	Accel Units

Output of velocity integrator representing the contribution of the velocity integrator to Velocity Loop Output.

Velocity Loop Output

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	Get/GSV	T	REAL	-	-	-	Accel Units

Output of velocity forward path representing the total control effort of the velocity loop.

Velocity Limit Source

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional- PV	Get/GSV	T	DINT	-	-	-	Enumeration: 0 = Not Limited 1 = Positive Limit 2 = Negative Limit 3 = Bus Overvoltage Limit 4 = Max Extended Speed Limit 5 - 127 = (Reserved) 128 – 255 = Vendor Specific

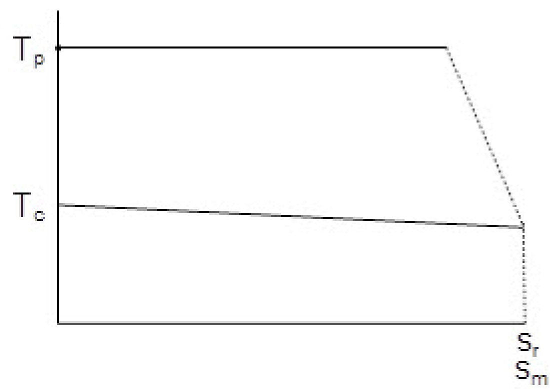
The Velocity Limit Source attribute is an enumerated value that specifies the source of the operative velocity limit.

Velocity Limiter Extensions

Permanent magnet (PM) motor applications sometimes require drives to provide extensions to the velocity limiter function to protect the drive electronics and motor from potentially destructive overspeed conditions when operating at speeds above the motor's rating. The Velocity Limiter serves to protect the drive and motor when applied in these high speed applications.

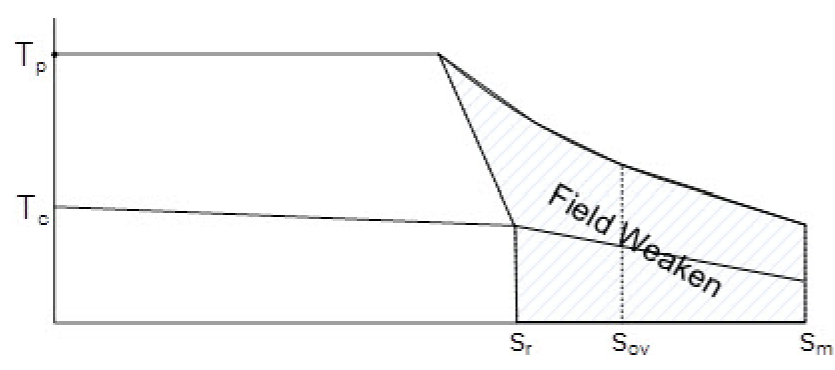
PM Motor Torque-Speed Curve

A generalized Torque-Speed curve for a PM motor is shown in the following graph. The two curves shown define the continuous (T_c) and peak torque (T_p) capabilities of the motor. PM motors typically specify a 'rated speed' (S_r) based on rated voltage and continuous torque and also a 'max speed' (S_m) based on the maximum operating speed. Often the specified rated speed and max speed for the motor are set to the same value.



Field Weakening

PM motors can also be operated using a technique called "field weakening" to extend the top speed capability of the motor. Field weakening uses active current vector control to reduce the effective magnetic field strength from the permanent magnets, enabling higher speeds at the expense of lower torque production. While the use of field weakening to significantly extend motor speed range is more common for Interior PM (IPM) motors, the speed range of Surface-mount PM (SPM) motors can be significantly extended as well. The following graph illustrates the PM Motor Torque-Speed Curve with Field Weakening.



When the drive applies field weakening to a PM motor to reach higher than rated speed, the drive's motor current vector control algorithm effectively decreases the motor Ke. This reduces the resulting Counter EMF (CEMF) voltage to be less than the DC bus voltage. However, if this active current vector control is suddenly removed, the Ke value would revert to the nominal value and the CEMF voltage would increase rapidly. Active control of motor current is lost whenever the power structure is disabled. So the concern is when the power structure is disabled with the motor still spinning. This can be the case when the drive executes a Category 0 Stop due to a control initiated Disable Request, a Major Fault action, or a Safe Torque Off activation.

Three speed values are shown in the preceding figure. As defined in the first figure, the rated speed (S_r) corresponds to operation at rated voltage and continuous torque. This is the maximum continuous torque that can be achieved without field weakening. S_{OV} is the speed at which the CEMF voltage from the nominal Ke would be equivalent to the maximum DC Bus Voltage rating of the drive, or the DC Bus Overvoltage Limit.

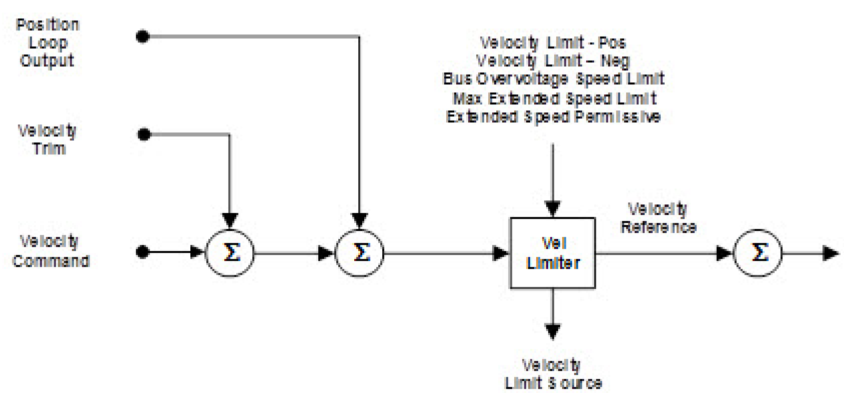
If active motor current control is removed while the motor is operating at speeds above S_{OV}, the CEMF voltage results in a DC Bus overvoltage condition that can damage the drive and, possibly, other drives sharing the same DC Bus.

S_m is the absolute maximum operating speed of the motor based on mechanical constraints. For a rotary motor, S_m would be given by the Rotary Motor Max Speed attribute.

Major damage to devices connected to the DC Bus can occur when the PM motor is allowed to run between S_{OV} and S_m and the drive's power structure is disabled.

Velocity Limiter Behavior Diagram

The following diagram shows the extensions that have been added to the Velocity Limiter to help manage the inherent risks of high speed PM motor operation. In addition to the existing Velocity Limit - Positive/Negative attributes that can be used to limit the Velocity Reference signal, two new limits have been defined based on S_{OV} and S_m defined above. Specifically, the PM Motor Rotary - Bus Overvoltage Speed and PM Motor Linear Bus Overvoltage Speed attributes establish an absolute limit on the Velocity Reference signal that corresponds to S_{OV}. This speed limit can only be exceeded if the PM Motor Extended Speed Permissive attribute is set to True. The PM Motor Rotary Max Extended Speed and PM Motor Linear Max Extended Speed attributes establish an absolute limit on the Velocity Reference signal that corresponds to S_m. The Velocity Limit function limits the Velocity Reference signal to the minimum of these attribute values. The Velocity Limit Source attribute indicates the source of the velocity limit.



Through these extensions to the Velocity Limiter function, a drive that supports field weakening can be configured to safely manage extended speed operation, only allowing operation above S_{OV} by setting the PM Motor Extended Speed Permissive attribute. Systems that can run safely above S_{OV} are generally equipped with a DC Bus Regulator or a Resistive Brake Module.

See also

Position Loop Attributes on page 206

Position Loop Configuration Attributes on page 208

Velocity Loop Configuration Attributes on page 221

General Permanent Magnet Motor Attributes on page 396

Data Attributes

These attribute tables contain attributes associated with general data about to a Motion Control Axis Object instance.

Axis Info Attributes

These are the attributes that provide information about the associated hardware capabilities of Motion Control Axis.

Inverter Rated Output Voltage

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Get/GSV		REAL	-	-	-	Volts (RMS)

The Inverter Rated Output Voltage attribute is the drive inverter output voltage rating. This value is hard coded in the device.

Inverter Rated Output Current

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Get/GSV		REAL	-	-	-	Amps (RMS)

The Inverter Rated Output Current attribute is the drive inverter output current rating. This value is hard coded in the device.

Inverter Rated Output Power

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Get/GSV		REAL	-	-	-	Kilowatts

The Inverter Rated Output Power attribute is the drive inverter output power rating. This value is hard coded in the device.

Converter Rated Output Current

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Get/GSV		REAL	-	-	-	Amps (RMS)

The Converter Rated Output Current attribute is the drive converter output current rating. This value is determined by the motion axis from the associated converter.

Converter Rated Output Power

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Get/GSV		REAL	-	-	-	Kilowatts

The Converter Rated Output Power attribute is the drive converter output power rating. This value is determined by the motion axis from the associated converter.

See also

Drive Output Attributes on page 251

Power and Thermal Management Configuration Attributes on page 252

Axis Statistical Attributes

These are the attributes that provide useful statistics on motion axis operation.

Control Power-up Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of value
Optional - BD	MSG		REAL	-	-	-	Seconds

Elapsed time since axis control power was last applied.

Cumulative Run Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of value
Optional - BD	MSG		REAL	-	-	-	Hours

Accumulated time that the axis has been powering the Running state.

Cumulative Energy Usage

Usage	Access	T	Data Type	Default	Min	Max	Semantics of value
Optional - BD	MSG		REAL	-	-	-	Kilowatt Hours

Accumulated output energy of the axis.

Cumulative Motor Rev

Usage	Access	T	Data Type	Default	Min	Max	Semantics of value
Optional - D	MSG		LINT	-	-	-	

Cumulative number of times motor shaft has turned. (Rotary Motors Only).

Cumulative Main Power Cycles

Usage	Access	T	Data Type	Default	Min	Max	Semantics of value
Optional - BD	MSG		DINT	-	-	-	

Cumulative number of times AC Mains has been cycled.

Cumulative Control Power Cycles

Usage	Access	T	Data Type	Default	Min	Max	Semantics of value
Optional - BD	MSG		DINT	-	-	-	

Cumulative number of times Control Power has been cycled.

See also

Interpret the Attribute Tables on page 87

CIP Axis Status Attributes

These are the device status attributes associated with a Motion Control Axis. Any status bits that are not applicable are set to 0.

CIP Axis State

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/GSV	T	USINT	-	-	-	Enumeration 0 = Unconnected 1 = Pre-Charge 2 = Stopped 3 = Starting 4 = Running 5 = Testing 6 = Stopping 7 = Aborting 8 = Faulted 9 = Start Inhibited 10 = Shutdown 11 = Axis Inhibited 12 = Not Grouped 13 = No Module 14 = Configuring 15 = Synchronizing 16 = Waiting for Group 17-255 = Reserved

Enumerated value indicating the state of the motion axis.

CIP Axis Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/GSV	T	DINT	-	-	-	Enumeration: 0 = Local Contrl 1 = Alarm 2 = DC Bus UP 3 = Power Structure Enabled 4 = Motor Flux UP 5 = Tracking Command 6 = Position Lock 7 = Velocity Lock 8 = Velocity Standstill 9 = Velocity Threshold 10 = Velocity Limit 11 = Acceleration Limit 12 = Deceleration Limit 13 = Torque Threshold 14 = Torque Limit 15 = Current Limit 16 = Thermal Limit 17 = Feedback Integrity 18 = Shutdown 19 = In Process 20 = DC Bus Unload 21 = AC Power Loss 22 = Position Control Mode 23 = Velocity Control Mode 24 = Torque Control Mode 25 - 31 = Reserved

The CIP Axis Status attribute is a 32-bit collection of standard bits indicating the internal status conditions of the motion axis.

CIP Status Bit Descriptions

Bit	Usage	Status Condition	Description
0	Required	Local Control	This bit is set if axis is taking command reference and services from local interface instead of the remote (CIP Motion) interface. This bit is based on the current state of the Remote Mode bit of the Node Status attribute.
1	Required	Alarm	This bit is set if the axis has detected one or more exception conditions configured to generate an alarm. This bit is clear if there are no current axis alarm conditions.

Bit	Usage	Status Condition	Description
2	Required/ BD	DC Bus Up	This bit is set for a drive axis if the DC Bus has charged up to an operational voltage level based on direct measurement and, if applicable, the Converter Bus Up Status bit associated with external CIP Motion converter(s) supplying DC Bus power to this device is also set. If the drive's Bus Configuration attribute is set to "Shared DC - Non CIP Converter" the drive may also check the status of its associated external Non-CIP Motion converter. When a drive axis is in the Pre-Charge state, the transition of the DC Bus Up status bit from 0 to 1 initiates a state transition to the Stopped State. Once set, the DC Bus Up bit is cleared when the DC Bus voltage has dropped below an operational voltage level, or the Converter Bus Up Status bit associated with external CIP Motion converter(s) supplying DC Bus power to this device is cleared. For a converter axis, this bit is set if the DC Bus has charged up to an operational voltage level based on direct measurement alone. When a converter axis is in the Pre-Charge state, the transition of the DC Bus Up status bit from 0 to 1 initiates a state transition to the Running state. Once set, the DC Bus Up bit is cleared when the DC Bus voltage has dropped below an operational voltage level, independent of the state of the Converter Bus Up Status bit.
3	Required/ D	Power Structure Enabled	This bit is set if the axis amplifier is energized and capable of generating motor flux and torque. The value of the Power Structure Enabled bit is determined by the Axis State and the configured Stopping Action attribute value.
4	Required/ D	Motor Flux Up	This bit is set if motor flux for an induction motor has reached an operational level. Transition of the Motor Flux Up bit is initiated in the Starting State according to the configured Flux Up Control attribute value. This bit is only applicable to Induction Motor types.
5	Required/ D	Tracking Command	This bit is set if the axis control structure is actively tracking the command reference from the motion planner. The Tracking Command bit is directly associated with the Running state of the Axis State Model.
6	Required/ P	Position Lock	This bit is set if the actual position is within the Position Lock Tolerance of the command position.
7	Optional/ PV	Velocity Lock	This bit is set if the velocity feedback signal is within the Velocity Lock Tolerance of the unlimited velocity reference.
8	Required/ ED	Velocity Standstill	This bit is set if the velocity feedback signal is within Velocity Standstill Window of 0. For a Frequency Control drive this bit is set if the velocity reference signal is within Velocity Standstill Window of 0.
9	Optional/ ED	Velocity Threshold	This bit is set if the absolute velocity feedback signal is below Velocity Threshold. For a Frequency Control drive this bit is set if the absolute velocity reference signal is below the Velocity Threshold.
10	Optional/ FPV	Velocity Limit	This bit is set if the velocity reference signal is currently being limited by the Velocity Limiter.
11	Optional/ C	Acceleration Limit	This bit is set if the acceleration reference signal is currently being limited by the Acceleration Limiter.
12	Optional/ C	Deceleration Limit	This bit is set if the acceleration reference signal is currently being limited by the Deceleration Limiter.

Bit	Usage	Status Condition	Description
13	Optional/ C	Torque Threshold	This bit is set if the absolute filtered torque reference is above the Torque Threshold.
14	Required/ C	Torque Limit	This bit is set if the filtered torque reference is currently being limited by the Torque Limiter.
15	Optional/ D	Current Limit	This bit is set if the command current, Iq, is currently being limited by the Current Vector Limiter.
16	Optional/ D	Thermal Limit	This bit is set if Current Vector Limit condition of the axis is being limited by any of the axis's Thermal Models or I^2T Thermal Protection functions.
17	Required/ E	Feedback Integrity	This bit, when set, indicates that the feedback device is accurately reflecting changes to axis position, and there have been no conditions detected that would compromise the quality of the feedback position value. The bit is set at power-up assuming that the feedback device passes any power-up self-test required. If, during operation, a feedback exception occurs that could impact the fidelity of axis position, the bit is immediately cleared. The bit remains clear until either a fault reset is executed by the drive or the drive is power cycled. Fault Resets can be generated directly by the drive or initiated by the controller using motion instructions. Note that the Feedback Integrity bit behavior applies to both absolute and incremental feedback device operation.
18	Required/ BD	Shutdown	This bit is set when the axis is in the shutdown state or in the faulted state but would transition to the shutdown state if the faults were cleared. Therefore, the Shutdown bit is closely associated with the Shutdown State of the Axis State Model.
19	Required	In Process	This bit is set for the duration of an active process. An example of active process would be an operation initiated by a Run Motor Test, Run Hookup Test, or Run Inertia Test to request service. An active process that requires the enabling of the axis power structure results in a transition to the Testing State of the Axis State Model.

Bit	Usage	Status Condition	Description
20	Optional/ BD	DC Bus Unload	This bit is set by a CIP Motion converter, or a CIP Motion drive containing an integral converter, or a CIP Motion drive connected to an external non-CIP converter, to indicate that the converter cannot continue supplying DC Bus power to other drives on a shared DC Bus. This is usually the result of a shutdown fault action initiated by the drive or converter, or a shutdown request from the controller. Thus, when the DC Bus Unload bit is set, the Shutdown bit (bit 18) should also be set. When there is no AC Contactor Enable output to drop the DC Bus, a method is needed to unload the converter from all other drives sharing the DC Bus. By monitoring the DC Bus Unload status bit, the control system can propagate Bus Power Sharing exceptions to all drives on the shared DC Bus that are configured for Shared AC/DC or Shared DC operation. This Bus Power Sharing exception invokes the configured Exception Action that, by default, disables the drive power structure, thereby unloading the bus. The Bus Power Sharing Fault on these drives is a persistent fault that cannot be cleared as long as the DC Bus Unload bit is set on this originating drive or converter. The control system will simply regenerate the Bus Power Sharing Faults based on the DC Bus Unload status bit still being set. Note that only the originating drive or converter with the DC Bus Unload condition can cause Bus Power Sharing Faults on other shared drives. In other words, no device with a Bus Power Sharing Fault can cause a Bus Power Sharing exception on other shared drives by setting its DC Bus Unload bit. This qualification prevents DC Bus recovery deadlock. To recover full DC Bus operation, the originating drive with the DC Bus Unload condition must first be reset through a Shutdown Reset Request. Once clear, the Bus Power Sharing Faults on the shared drives can then be successfully cleared by either a Fault Reset Request, or a Shutdown Reset Request, allowing these drives to become operational.
21	Optional/ BD	AC Power Loss	This bit is set when a CIP Motion converter, or a CIP Motion drive containing an integral converter, or a CIP Motion drive connected to an external non-CIP converter, has detected a loss of AC input power. This bit is cleared when AC input power is determined to be sufficient for converter operation. When an AC Power Loss condition is detected by a converter supplying power to other drives over a shared DC Bus, a method is needed to generate a Converter AC Power Loss exception on any drive whose power structure is enabled. To accomplish this, the control system monitors the AC Power Loss status bits of converters supplying DC Bus power and propagates AC Power Loss status to all drives on the shared DC Bus, such as drives that are configured for Shared AC/DC or Shared DC operation. Upon notification of AC Power Loss, drives that have enabled power structures will assert a Converter AC Power Loss exception and invoke the programmed Axis Exception Action. Disabled drives will not generate an exception action on AC Power Loss. Thus, no drive faults will occur on removal of AC Power from a converter as long as no drive power structures drawing power from that converter are enabled.

Bit	Usage	Status Condition	Description
22	Optional/ C	Position Control Mode	When set, this bit indicates that axis position is being actively controlled by the Position Loop. Position Control Mode is only applicable when the axis is enabled and using the PI Vector Control Method. The "Position Control Mode" status bit is cleared whenever the active Control Mode is changed from Position Control to Velocity Control or Torque Control. This status bit is clear if the drive axis is disabled.
23	Optional/ C	Velocity Control Mode	When set, this bit indicates that axis velocity is being actively controlled by the Velocity Loop. Velocity Control Mode is only applicable when the drive axis is enabled and using the PI Vector Control Method. The "Velocity Control Mode" status bit is cleared whenever the active Control Mode is changed from Velocity Control to Position Control or Torque Control. This status bit is clear if the drive axis is disabled.
24	Optional/ C	Torque Control Mode	When set, this bit indicates that axis velocity is being actively controlled by the Torque (Current) Loop. Torque Control Mode is only applicable when the drive axis is enabled and using the PI Vector Control Method. The "Torque Control Mode" status bit is cleared whenever the active Control Mode is changed from Torque Control to Position Control or Velocity Control. This status bit is clear if the drive axis is disabled.
25-31	-	Reserved	-

The naming convention for individual bits within the CIP Axis Status attributes is to append a 'Status' suffix to the CIP Axis Status condition. This table lists the resulting CIP Axis Status tags associated with the above status conditions.

Bit	Tag
0	LocalControlStatus
1	AlarmStatus
2	DCBusUpStatus
3	PowerStructureEnabledStatus
4	MotorFluxUpStatus
5	TrackingCommandStatus
6	PositionLockStatus
7	VelocityLockStatus
8	VelocityStandstillStatus
9	VelocityThresholdStatus
10	VelocityLimitStatus
11	AccelerationLimitStatus
12	DecelerationLimitStatus
13	TorqueThresholdStatus
14	TorqueLimitStatus
15	CurrentLimitStatus
16	ThermalLimitStatus
17	FeedbackIntegrityStatus
18	ShutdownStatus

Bit	Tag
19	InProcessStatus
20	DCBusUnloadStatus
21	ACPowerLossStatus
22	PositionControlMode
23	VelocityControlMode
24	TorqueControlMode

CIP Axis Status - RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	T	DINT	-	-	-	Enumeration 0 = Torque Notch Filter Frequency Detected 1 = Torque Notch Filter Tuning Unsuccessful 2 = Torque Notch Filter Multiple Frequencies 3 = Torque Notch Filter Frequency Below Limit 4 = Torque Notch Filter Frequency Above Limit 5 = Adaptive Tune Gain Stabilization Active 6 - 31 = Reserved

The CIP Axis Status attribute is a 32-bit collection of Rockwell Automation specific bits indicating various internal status conditions of the motion axis. Any status bits that are not applicable are set to 0.

CIP Axis Status- RA Status Bit Descriptions

Bit	Usage	Status Condition	Description
0	Optional/ C	Torque Notch Filter Frequency Detected	This bit is set when the Adaptive Tuning function has detected a resonance frequency between the Torque Notch Filter Low Frequency Limit and the Torque Notch Filter High Frequency Limit with magnitude above the Toque Notch Filter Tuning Threshold. Otherwise, the bit is clear. This bit is cleared by the Adaptive Tuning function when the Axis state transitions to the Running state.

Bit	Usage	Status Condition	Description
1	Optional/ C	Torque Notch Filter Tuning Unsuccessful	When the Adaptive Tuning Configuration is set to Enabled, this bit is set when an update to the Torque Notch Filter Estimate, applied to the Torque Notch Filter, does not eliminate all resonances between the Torque Notch Filter Low Frequency Limit and the Torque Notch Filter High Frequency Limit with magnitude above the Toque Notch Filter Tuning Threshold. Otherwise, the bit is clear. This bit is cleared by the Adaptive Tuning function when the Axis state transitions to the Running state or, when in the Running state, the Adaptive Tuning Configuration transitions from Disabled to one of the Torque Notch Filter Tuning enumerations.
2	Optional/ C	Torque Notch Filter Multiple Frequencies	This bit is set when, the Adaptive Tuning function, identifies multiple resonant frequencies that are between the Torque Notch Filter Low Frequency Limit and the Torque Notch Filter High Frequency Limit whose magnitudes are above the Toque Notch Filter Tuning Threshold. Otherwise, the bit is clear. This bit is cleared by the Adaptive Tuning function when the Axis state transitions to the Running state.
3	Optional/ C	Torque Notch Filter Frequency Below Limit	This bit is set when the Adaptive Tuning function identifies a frequency that is below the Torque Notch Filter Low Frequency Limit but whose magnitude is higher than the configured Toque Notch Filter Tuning Threshold. Otherwise, the bit is clear. This bit is cleared by the Adaptive Tuning function when the Axis state transitions to the Running state.
4	Optional/ C	Torque Notch Filter Frequency Above Limit	This bit is set when the Adaptive Tuning function identifies a frequency that is above the Torque Notch Filter High Frequency Limit but whose magnitude is higher than the configured Toque Notch Filter Tuning Threshold. Otherwise, the bit is clear. This bit is cleared by the Adaptive Tuning function when the Axis state transitions from disabled to enabled operation.
5	Optional/ C	Adaptive Tune Gain Stabilization Active	This bit is set when the Adaptive Tune Gain Scaling Factor is not equal to one. This indicates that the Adaptive Tuning function is actively adjusting servo loop gain values and the Torque Low Pass Filter Bandwidth value to improve system stability. This bit is cleared by the Adaptive Tuning function when the Axis state transitions to the Running state.
6-31	-	Reserved	-

The naming convention for individual bits within the CIP Axis Status RA attributes is to append a 'Status' suffix to the CIP Axis Status RA condition. This table lists the resulting CIP Axis Status RA tags associated with the above status conditions.

Bit	Tag
0	TorqueNotchFilterFreqDetected
1	TorqueNotchFilterTuneUnsuccessful
2	TorqueNotchFilterMultipleFreq
3	TorqueNotchFilterFreqBelowLimit
4	TorqueNotchFilterFreqAboveLimit
5	AdaptiveTuneGainStabilization

CIP Axis I/O Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	T	DINT	-	-	-	Enumeration: 0 =Enable Input 1 =Home Input 2 = Registration 1 Input 3 = Registration 2 Input 4 = Positive Overtravel OK Input 5 = Negative Overtravel OK Input 6 = Feedback 1 Thermostat OK Input 7 = Resistive Brake Release Output 8 = Mechanical Brake Release Output 9 = Motor Thermostat OK Input 10 - 31 =Reserved.

The CIP Axis I/O Status attribute is a 32-bit collection of bits indicating the state of standard digital inputs and outputs associated with the operation of this motion axis. A value of zero for a given input bit indicates a logical 0 (false) value, while a value of 1 indicates a logical 1 (true) value. For example a value of 1 for the Positive Overtravel OK Input indicates that Positive Overtravel OK is true and there is no positive overtravel condition present. Conversely a value of 0 would indicate the Positive Overtravel OK Input is false and there is a positive overtravel condition present. Similarly, a value of 1 (true) for the Mechanical Brake Release Output indicates that the mechanical brake is released. Any status bits that are not applicable will be set to 0.

CIP Axis I/O Status Bit Descriptions

Bit	Usage	Status Condition	Description
0	Required/ BD	Enable Input	This bit represents the logical state of the Enable Input.

Bit	Usage	Status Condition	Description
1	Required/ E	Home Input	This bit represents the logical state of the Home Input.
2	Required/ E	Registration 1 Input	This bit represents the logical state of the Registration 1 Input.
3	Optional/ E	Registration 2 Input	This bit represents the logical state of the Registration 2 Input.
4	Required/ P	Positive Overtravel OK Input	This bit represents the logical state of the Positive Overtravel OK Input.
5	Required/ P	Negative Overtravel OK Input	This bit represents the logical state of the Negative Overtravel OK Input.
6	Optional/ E	Feedback 1 Thermostat OK Input	This bit represents the logical state of the Thermostat OK input associated with the motor mounted Feedback 1device.
7	Optional/ D	Resistive Brake Release Output	This bit represents the logical state of the Resistive Brake Release Output.
8	Optional/ D	Mechanical Brake Release Output	This bit represents the logical state of the Mechanical Brake Release Output.
9	Optional/ D	Motor Thermostat OK Input	This bit represents the logical state of the Motor Thermostat OK Input.
10-31	-	Reserved	-

The naming convention for individual bits within the CIP Axis I/O Status attributes is to append a 'Status' suffix to the CIP Axis Status condition. This table lists the resulting CIP Axis I/O Status tags associated with the above status conditions.

Bit	Tag
0	EnableInputStatus
1	HomeInputStatus
2	Registration1InputStatus
3	Registration2InputStatus
4	PositiveOvertravelInputStatus
5	NegativeOvertravelInputStatus
6	Feedback1ThermostatInputStatus
7	ResistiveBrakeOutputStatus
8	MechanicalBrakeOutputStatus
9	MotorThermostatInputStatus

CIP Axis I/O Status - RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	T	DINT	-	-	-	Enumeration: 0 = Regenerative Power OK Input 1 = Bus Capacitor Module OK Input 2 = Shunt Thermal Switch OK Input 3 = Contactor Enable Output 4 = Pre-Charge OK Input 5 - 31 = Reserved

Collection of bits indicating the state of Rockwell Automation specific digital inputs associated with the operation of this motion axis. A value of zero for a given input bit indicates a logical 0 value, while a value of 1 indicates a logical 1 value.

CIP Axis I/O Status - RA Bit Descriptions

Bit	Usage	Name	Description
0	Optional/ D	Regenerative Power OK Input	This bit represents the logical state of the Regenerative Power Input.
1	Optional/ BD	Bus Capacitor Module OK Input	This bit represents the logical state of the Bus Capacitor Module Input.
2	Optional/ BD	Shunt Thermal Switch OK Input	This bit represents the logical state of the Shunt Thermal Switch Input.
3	Optional/ BD	Contactor Enable Output	This bit represents the logical state of the Contactor Enable Output.
4	Optional/ BD	Pre-Charge OK Input	This bit represents the logical state of the Pre-Charge Input.
5-31	-	Reserved	-

The naming convention for individual bits within the CIP Axis I/O Status - RA attributes is to append a 'Status' suffix to the CIP Axis Status - RA condition. This table lists the resulting CIP Axis I/O Status -RA tags associated with the above status conditions.

Bit	Tag
0	RegenerativePowerInputStatus
1	BusCapacitorModuleInputStatus
2	ShuntThermalSwitchInputStatus
3	ContactorEnableOutputStatus
4	PreChargeInputStatus

See also

CIP Axis Attributes on page 185

Motion Control Axis Behavior Model on page 51

Event Capture Attributes

These are the event related attributes associated with a Motion Control Axis. These include registration, marker, and homing events. The Event Capture attributes are designed to support the possibility of up to 7 active events per controller update period. The basis for all Time Stamp attributes is absolute System Time and follows the CIP Sync standard with 0 corresponding to January 1, 1970. Within the Logix controller, the System Time for event time stamps are converted to the local CST by applying the local System Time Offset to the event time stamp. In general, these event related attributes are only applicable when there is an associated position feedback device; if the axis is configured for Encoderless or Sensorless operation, the event functionality is not applicable.

The Motion Control Axis supports two independent registration input channels per device axis instance that can be triggered on either the rising or falling edges of the signal. If the device hardware implementation allows, event time and position data can be captured for all four event conditions simultaneously. The Event Capture attributes also support Auto-rearm for registration events. This allows for controller implementation of important features like Windowed Registration and Registration Pattern Recognition.

The Motion Control Axis also supports Home Switch, Marker and Switch-Marker events for homing functionality on a per axis basis. The Marker events are typically generated by the configured position feedback device for the associated device axis.

Registration Inputs

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/GSV		USINT	0	0	10	

The Registration Inputs attribute determines the number of Registration Inputs supported by this device axis instance. Maximum value is determined by drive device profile.

Registration 1 Positive Edge Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/GSV	T	REAL	-	-	-	Position Units

The Registration 1 Positive Edge Position attribute is the feedback position latched on the rising edge of the Registration Input 1.

Registration 1 Negative Edge Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/GSV	T	REAL	-	-	-	Position Units

The Registration 1 Negative Edge Position attribute is the feedback position latched on the falling edge of the Registration Input 1.

Registration 2 Positive Edge Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/GSV	T	REAL	-	-	-	Position Units

The Registration 2 Positive Edge Position attribute feedback position latched on the rising edge of the Registration Input 2.

Registration 2 Negative Edge Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/GSV	T	REAL	-	-	-	Position Units

The Registration 2 Negative Edge Position attribute feedback position latched on the falling edge of the Registration Input 2.

Registration 1 Positive Edge Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/GSV	T	DINT	-	-	-	CST Time in Microseconds

The Registration 1 Positive Edge Time attribute is the CST time stamp on the rising edge of the Registration Input 1.

Registration 1 Negative Edge Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/GSV	T	DINT	-	-	-	CST Time in Microseconds

The Registration 1 Negative Edge Time attribute is the CST time stamp on the falling edge of the Registration Input 1.

Registration 2 Positive Edge Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/GSV	T	DINT	-	-	-	CST Time in Microseconds

The Registration 2 Positive Edge Time attribute is the CST Time stamp on the rising edge of the Registration Input 2.

Registration 2 Negative Edge Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/GSV	T	DINT	-	-	-	CST Time in Microseconds

The Registration 2 Negative Edge Time attribute is the CST Time stamp on the falling edge of the Registration Input 2.

See also

Motion Control Signal Attributes on page 330

Motion Control Status Attributes on page 341

Drive Attributes

These attribute tables contain attributes associated with the drive. Drive attributes reside both on the controller and on the drive.

Drive General Purpose I/O Attributes

These are the attributes that provide to general purpose analog and digital I/O associated with the Motion Control Axis.

Digital Inputs

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Get/GSV	T	DWORD	-	-	-	Vendor Specific Bit Map

The Digital Inputs attribute is a 32-bit word with whose bits can be assigned by the vendor to general purpose digital inputs.

Digital Outputs

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set/SSV	T	DWORD	0	-	-	Vendor Specific Bit Map

The Digital Outputs attribute is a 32-bit word with whose bits can be assigned by the vendor to general purpose digital outputs.

Analog Input 1

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Get/GSV	T	REAL	-	-	-	% Full Scale

The Analog Input 1 attribute is a general purpose analog input 1 level.

Analog Input 2

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Get/GSV	T	REAL	-	-	-	% Full Scale

The Analog Input 2 attribute is a general purpose analog input 2 level.

Analog Output 1

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set/SSV	T	REAL	0	-100	+100	% Full Scale

The Analog Output 1 attribute is a general purpose analog output 1 level.

Analog Output 2

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set/SSV	T	REAL	0	-100	+100	% Full Scale

The Analog Output 2 attribute is a general purpose analog output 2 level.

See also

CIP Axis Status Attributes on page 236

Drive Output Attributes

These are the inverter output related attributes associated with a Motion Control Axis.

Output Frequency

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - F Optional - C	Get/GSV	T	REAL	-	-	-	Hertz

The Output Frequency attribute is the time averaged output frequency applied to motor. Frequency value is in terms of electrical cycles.

Output Current

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Get/GSV	T	REAL	-	-	-	Amps (RMS)

The Output Current attribute is the total time averaged output current applied to motor.

Output Voltage

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Get/GSV	T	REAL	-	-	-	Volts (RMS)

The Output Voltage attribute is the total time averaged phase-to-phase output voltage applied to motor.

Output Power

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Get/GSV	T	REAL	-	-	-	Power Units

The Output Power attribute is the mechanical output power of the motor. This value represents the product of applied motor torque/force and motor speed. If the axis is configured for Frequency Control, the Velocity Feedback signal is derived from the Velocity Reference signal.

Converter Output Current

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Get/GSV	T	REAL	-	-	-	Amps

The Converter Output Current is the output current generated by the Bus Converter. A positive value indicates current flow out of the converter, where the converter is supplying DC bus power to attached loads. A negative value indicates current flow into the converter, where the converter is absorbing "regenerative" power from attached loads.

Converter Output Power

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Get/GSV	T	REAL	-	-	-	Power Units

The Converter Output Power is the output power generated by the Bus Converter. This value is based on the product of the Converter Output Current and DC Bus Voltage. A positive value indicates power flow out of the converter, where the converter is supplying DC bus power to attached loads. A negative value indicates power flow into the converter, where the converter is absorbing "regenerative" power from attached loads.

See also

Drive General Purpose I/O Attributes on page 249

Power and Thermal Management Configuration Attributes on page 252

Power and Thermal Management Configuration Attributes

These are the power and thermal configuration related attributes associated with a Motion Control Axis.

Motor Overload Action

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV		USINT	0	-	-	Enumeration 0 = None (R) 1 = Current Foldback (O) 2...127 = Reserved 128...255 = Vendor specific

The Motor Overload Action attribute selects the device's response to a motor overload condition based on an I^2T or motor thermal model based overload protection method. When a motor thermal model is employed, the motor overload condition occurs when the motor thermal model indicates that the Motor Capacity has exceeded the Motor Overload Limit. In the case of the I^2T overload protection method, the motor overload condition occurs when the motor current, in percent of rated continuous motor current, exceeds the Motor Overload Limit. The Motor Overload Action provides opportunities to mitigate the overload condition without stopping operation.

Motor Overload Action functionality is independent of the motor overload exception action functionality.

No explicit action is taken by the device in the overload condition if None is the selected overload action. Selecting the Current Foldback action, however, results in a reduction of the motor current command in proportion to the percentage difference between Motor Capacity and the Motor Overload Limit,, or in the case of the I^2T overload protection method, in proportion to the difference between the motor current, in percent of rated continuous motor current, and the Motor Overload Limit.

Inverter Overload Action

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV		USINT	0	-	-	Enumeration 0 = None (R) 1 = Current Foldback (O) 2...127 = Reserved 128...255 = Vendor Specific 128 = Reduce PWM Rate 129 = PWM - Foldback

The Inverter Overload Action attribute selects the device's response to an inverter overload condition based on an I^2t or inverter thermal model based overload protection method. When an inverter thermal model is employed the inverter overload alarm condition occurs when the inverter thermal model indicates that the Inverter Capacity has exceeded the Inverter Overload Limit. In the case of the I^2T overload protection method, the inverter overload condition occurs when the inverter current, in percent of rated continuous inverter current, exceeds the Inverter Overload Limit.

The Inverter Overload Action provides opportunities to mitigate the overload condition without stopping operation. Inverter Overload Action functionality is independent of the motor overload exception action functionality.

An overload alarm condition can also be generated by exceeding the limits of the device's power block thermal model that includes switching losses that have a dependency on the PWM Frequency.

No explicit action is taken by the device in the overload condition if None is the selected overload action. Selecting the Current Foldback action, however, results in a reduction of the inverter current in proportion to the percentage difference between Inverter Capacity and the Inverter Overload Limit, or in the case of the I^2T overload protection method, in proportion to the difference between the inverter current, in percent of rated continuous inverter current, and the Inverter Overload Limit.

If an inverter overload condition occurs due to the power block thermal model, two additional overload actions can be applied. Selecting Reduce PWM Rate can be used to reduce heat generated by switching losses in the inverter power structure. When PWM - Foldback is selected the device first reduces the PWM rate and then, if necessary, reduces the Inverter Thermal Current Limit.

See also

Power and Thermal Management Status Attributes on page 254

Power and Thermal Management Status Attributes

These are the power and thermal status related attributes associated with a Motion Control Axis.

Motor Overload Protection Method

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Get/GSV	T	USINT	-	-	-	Enumeration: 0 = Thermal Model 1 = I^2T Overload

The Motor Overload Protection Method attribute is an enumerated value indicates what motor overload protection method is being used by the CIP Motion device.

Thermal Model motor overload protection applies the measured motor current to an internal motor thermal model to detect a motor overload condition.

I^2T Overload motor overload protection applies an I^2T calculation once the motor current exceeds the product of the Motor Overload Limit and the Motor Rated Continuous Current that indicates a motor overload condition.

Inverter Overload Protection Method

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional- BD	Get/GSV	T	USINT	-	-	-	Enumeration: 0 = Thermal Model 1 = I^2T Overload

This enumerated value indicates what inverter overload protection method is being used by the CIP Motion device.

Thermal Model inverter overload protection applies the measured motor current to an internal inverter thermal model to detect an inverter overload condition.

I^2T Overload inverter overload protection applies an I^2T calculation once the inverter current exceeds the product of the Inverter Overload Limit and the Inverter Rated Continuous Current that indicates an inverter overload condition.

Converter Overload Protection Method

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional- BD	Get/GSV	T	USINT	-	-	-	Enumeration: 0 = Thermal Model 1 = I^2T Overload

This enumerated value indicates what converter overload protection method is being used by the CIP Motion device.

Thermal Model converter overload protection applies the measured converter current to an internal converter thermal model to detect a converter overload condition.

I^2T Overload converter overload protection applies an I^2T calculation once the converter current exceeds the converter overload current limit that indicates a converter overload condition.

Bus Regulator Overload Protection Method

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional- BD	Get/GSV	T	USINT	-	-	-	Enumeration: 0 = Thermal Model 1 = I^2T Overload

This enumerated value indicates what bus regulator overload protection method is being used by the CIP Motion device.

Thermal Model converter overload protection applies the measured bus regulator current to an internal bus regulator thermal model to detect a bus regulator overload condition.

I^2T Overload bus regulator overload protection applies an I^2T calculation once the bus regulator current exceeds the factory set bus regulator overload current limit that indicates a bus regulator overload condition.

Motor Capacity

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Get/GSV	T	REAL	-	-	-	% Motor Rated

The Motor Capacity attribute is the real-time estimate of the continuous rated motor thermal capacity utilized during operation based on the motor thermal model. A value of 100% would indicate that the motor is being used at 100% of rated capacity as determined by the continuous current rating of the motor. If the drive device applies I^2T overload protection rather than thermal model based overload protection, the Motor Capacity value is zero until the motor current exceeds the product of the Motor Overload Limit and the Motor Rated Continuous Current. Once in an overload condition the Motor Capacity increases from 0 according to the I^2T calculation. A value of 100% in this case indicates that the drive has used up 100% of the motor's I^2T overload capacity.

The motor overload protection method applied by the drive device is indicated by the Motor Overload Protection Method attribute.

Inverter Capacity

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Get/GSV	T	REAL	-	-	-	% Inverter Rated

The Inverter Capacity attribute is the real-time estimate of the continuous rated inverter thermal capacity utilized during operation based on the inverter thermal model. A value of 100% would indicate that the inverter is being used at 100% of rated capacity as determined by the continuous current rating of the inverter. If the drive device applies I^2T overload protection rather than thermal model based overload protection, the Inverter Capacity value is zero until the inverter current exceeds the product of the factory set Inverter Overload Limit and the continuous current rating of the inverter. Once in an overload condition the Inverter Capacity increases from 0 according to the I^2T calculation. A value of 100% in this case indicates that the drive has used up 100% of the inverter's I^2T overload capacity.

The inverter overload protection method applied by the drive device is indicated by the Inverter Overload Protection Method attribute.

Converter Capacity

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Get/GSV	T	REAL	-	-	-	% Converter Rated

The Converter Capacity attribute is the real-time estimate of the continuous rated converter thermal capacity utilized during operation based on the converter thermal model. A value of 100% would indicate that the converter is being used at 100% of rated capacity as determined by the continuous current rating of the converter. If the CIP Motion device applies I^2T overload protection rather than thermal model based overload protection, the Converter Capacity value is zero until the converter current exceeds its factory set overload current rating. Once in an overload condition the Converter Capacity increases from 0 according to the I^2T calculation. A value of 100% in this case indicates that the converter has used up 100% of its I^2T overload capacity.

The converter overload protection method applied by the device is indicated by the Converter Overload Protection Method attribute.

Bus Regulator Capacity

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Get/GSV	T	REAL	-	-	-	% Regulator Rated

The Bus Regulator Capacity attribute is the real-time estimate of the continuous rated bus regulator thermal capacity utilized during operation based on the bus regulator thermal model. A value of 100% would indicate that the bus regulator is being used at 100% of rated capacity as determined by the continuous current rating of the bus regulator.

If the CIP Motion device applies I^2T overload protection rather than thermal model based overload protection, the Bus Regulator Capacity value is zero until the bus regulator current exceeds its factory set overload current rating. Once in an overload condition the Bus Regulator Capacity increases from 0 according to the I^2T calculation. A value of 100% in this case indicates that the bus regulator has used up 100% of its I^2T overload capacity.

The bus regulator overload protection method applied by the device is indicated by the Bus Regulator Overload Protection Method attribute.

See also

Power and Thermal Management Configuration Attributes on page 252

Drive Commissioning and Tuning Attributes

The attribute tables contain attributes associated with auto-tuning and test services applied to a Motion Control Axis Object instance. These attributes are unique to the controller and do not require replication in the Motion Control Device Axis Object.

Auto-Tune Configuration Attributes

These are the attributes that are associated with auto-tune configuration of a Motion Control Axis.

System Damping

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C (Derived from Damping Factor)	Set/SSV		REAL	1	0.5	2.0	

A Set or SSV to the System Damping attribute value calculates and updates the System Bandwidth based on the current Drive Model Time Constant value (DMTC) and then calculates and updates the applicable loop gain attribute values. The System Damping attribute is designed to be used to implement a single 'knob' Manual Tuning procedure.

A larger damping factor increases the ratio between the inner and outer Loop Bandwidths. In general, the System Damping attribute controls the dynamic response of the overall control loop.

- Position Loop Operation

  If the drive is configured for Position Loop operation, the following calculation is performed and the resulting value applied to the System Bandwidth attribute:

  System Bandwidth = 1/16 Damping Factor^4 * 1/DMTC

- Velocity Loop Operation

  If the drive is configured for Velocity Loop operation the following calculation is applied:

  System Bandwidth = 1/4 Damping Factor^2 * 1/DMTC

- Load Coupling

  If the Load Coupling is a 'Compliant' selection and the Use Load Ratio bit is set in the Gain Tuning Configuration Bits attribute, then the resultant System Bandwidth above is divided by the Load Ratio value.

  System Bandwidth /= (Load Ratio + 1)

- System Bandwidth Value

  In addition to updating the System Bandwidth value, the equations associated with setting the System Bandwidth value are also run.

  The value for this attribute can also be updated using the Damping Factor attribute. When derived from the Damping Factor attribute, no calculations are performed; the System Damping attribute value is simply updated. An SSV to the System Damping attribute also updates the Damping Factor attribute value.

The value for this attribute can also be updated through a Set service to the Damping Factor attribute. When derived from the Damping Factor attribute, no calculations are performed; the System Damping attribute value is simply updated.

A Set or SSV to the System Damping attribute also updates the Damping Factor attribute value.

System Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C (Derived from Servo Bandwidth)	Set/SSV		REAL	0	0	∞	Loop Bandwidth Units

A Set or SSV to the System Bandwidth attribute value calculates and updates the applicable loop gain attribute values based on the current System Damping (Z). The System Bandwidth attribute is designed to be used to implement a single 'knob' Manual Tuning procedure. If the drive is configured for Velocity Loop operation, the System Bandwidth is equivalent to the bandwidth of the velocity loop. If the drive is configured for Position Loop operation, the System Bandwidth is equivalent to the bandwidth of the position loop. In addition to calculating and updating the Loop Bandwidth attribute values, an update to this attribute also updates the Integral Bandwidth attributes as well as the Feedforward attributes according to the Gain Tuning Configuration Bits setting.

The following configurations impact the calculations for this attribute as follows:

- Position Loop Operation

  If the drive is configured for Position Loop operation the following calculations apply:

  Position Loop Bandwidth = System Bandwidth

  Position Integer Bandwidth = 0.25 Damping Factor^2 * System Bandwidth

  Velocity Loop Bandwidth = 4 * Damping Factor^2 * System Bandwidth

  Velocity Integer Bandwidth = System Bandwidth

  Velocity Error Tolerance = 2 * max(Max Accel, Max Decel) / Velocity Loop Bandwidth (rad/s)

- Velocity Loop Operation

If the drive is configured for Velocity Loop operation the following calculations apply:

Velocity Loop Bandwidth = System Bandwidth

Velocity Integer Bandwidth = 0.25/Damping Factor^2 * System Bandwidth

Velocity Error Tolerance = 2 * max(Max Accel, Max Decel) / Velocity Loop Bandwidth (rad/s)

- Load Observer Configuration

  If the Load Observer Configuration setting indicates the observer function is enabled, the following calculations are performed:

  Load Observer Bandwidth = Velocity Loop Bandwidth

- Gain Tuning Configuration

  If the Gain Tuning Configuration bit for Tune Torque LP Filter is set, the following calculation is performed:

  Torque LP Filter BW = 5 * Velocity Loop BW.

The System Bandwidth value can also be updated through a Set service to the Position Servo Bandwidth or Velocity Servo Bandwidth attributes depending on Axis Configuration. If configured for Position Loop, System Bandwidth is updated by a set to Position Servo Bandwidth. If configured for Velocity Loop, System Bandwidth is updated by a set to Velocity Servo Bandwidth. When derived from either of these attributes, no calculations are performed; the System Bandwidth attribute value is simply updated.

A Set or SSV to the System Bandwidth attribute also updates Position Servo Bandwidth or Velocity Servo Bandwidth attributes depending on Axis Configuration. If configured for Position Loop, the Position Servo Bandwidth is updated. If configured for Velocity Loop, Velocity Servo Bandwidth is updated.

Damping Factor

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	Set/SSV		REAL	FD	0.5	2.0	-

The Damping Factor attribute value is used in calculating the maximum Position and Velocity Servo Bandwidth values during execution of the Motion Run Axis Tune (MRAT) instruction. In general the Damping Factor attribute controls the dynamic response of the drive axis. When gains are tuned using a small damping factor (such as 0.7), a step response test performed on the axis would demonstrate under-damped behavior with velocity overshoot. A gain set generated using a larger damping factor (such as 1.0) would produce a system step response that has no overshoot and works well for most applications.

A set to the Damping Factor attribute also updates the System Damping attribute value to support Manual Tuning.

Position Servo Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Set/SSV		REAL	FD	0		Loop Bandwidth Units

The value for the Position Servo Bandwidth represents the unity gain bandwidth of the position loop that is to be used by software Autotune function to calculate the position loop gains. The unity gain bandwidth is the frequency beyond which the position servo is unable to provide any significant position disturbance correction. In general, within the constraints of a stable servo system, the higher the Position Servo Bandwidth the better the dynamic performance of the system. A maximum value for the Position Servo Bandwidth is generated by the MRAT instruction. Computing gains based on this maximum value software Autotune procedure results in a dynamic response in keeping with the current value of the Damping Factor.

A set to the Position Servo Bandwidth attribute while configured for Position Loop operation also updates the System Bandwidth attribute value to support Manual Tuning.

Velocity Servo Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	Set/SSV		REAL	FD	0		Loop Bandwidth Units

The value for the Velocity Servo Bandwidth represents the unity gain bandwidth of the velocity loop that is to be used by the software Autotune function to calculate the velocity loop gains. The unity gain bandwidth is the frequency beyond which the velocity servo is unable to provide any significant position disturbance correction. In general, within the constraints of a stable servo system, the higher the Velocity Servo Bandwidth is the better the dynamic performance of the system. A maximum value for the Velocity Servo Bandwidth is generated by the MRAT instruction. Computing gains based on this maximum value using the software's Autotune procedure results in a dynamic response in keeping with the current value of the Damping Factor.

A set to the Velocity Servo Bandwidth attribute while configured for Velocity Loop operation also updates the System Bandwidth attribute value to support Manual Tuning.

Drive Model Time Constant

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set/ SSV#		REAL	0.0015 FD	10^{-6}	1	Seconds

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

The value for the Drive Model Time Constant represents a lumped model time constant for the drive's current loop and is used to calculate the Velocity and Position Servo Bandwidth values. The Drive Model Time Constant is the sum of the drive's current loop time constant, the feedback sample period, calculation delay, and the time constant associated with the velocity feedback filter. This value is set by software based on the specific drive amplifier and motor feedback selection.

Since the bandwidth of the velocity feedback filter is determined by the resolution of the feedback device, the value for the Drive Model Time Constant is smaller when high resolution feedback devices are selected.

Application Type

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	Set/GSV		USINT	1	-	-	Enumeration: 0 = Custom 1 = Basic 2 = Tracking 3 = Point-to-Point 4 = Constant Speed 5-255 = Reserved

This attribute specifies the type of motion control application and is used by configuration and auto-tune software to set the Gain Tuning Configuration Bits attribute that establishes the appropriate gain set the application.

The relationship between Application Type and Gain Tuning Configuration Bits is described in the following tables.

The first table shows which Integrator Bandwidth values are applicable based on the Application Type. Separate bits are defined in the Gain Tuning Configuration Bits attribute to enable tuning of Position Integrator Bandwidth, Kpi, and Velocity Integrator Bandwidth, Kvi. The Integrator Hold, iHold, setting applies to any active integrators.

Application Type	Kpi	Kvi	iHold
Custom	-	-	-

Application Type	Kpi	Kvi	iHold
Basic	no	no	no
Tracking	no	yes	no
Point-Point	yes	no	yes
Const. Spd.	no	yes	no

The next table shows which Feedforward values are applicable based on the Application Type. Separate bits are defined in the Gain Tuning Configuration Bits attribute to enable tuning of Velocity Feedforward, Kvff, and Acceleration Feedforward, Kaff.

Application Type	Kvff	Kaff
Custom	-	-
Basic	yes	no
Tracking	yes	yes
Point-Point	no	no
Const. Spd.	yes	no

Finally, the Torque Low Pass Filter bit enables tuning of the Torque Low Pass Filter Bandwidth. This bit is set for all Application Types except Custom,

Application Type	Torque LP Filter
Custom	-
Basic	yes
Tracking	yes
Point-Point	yes
Const. Spd.	yes

If Application Type is set to Custom, individual gain calculations can be controlled directly by the user by changing the bit settings in the Gain Tuning Configuration Bits attribute. If the Application Type is not Custom, these bit settings may not be altered, thus maintaining the fixed relationship to the Application Type as defined in the preceding tables.

Loop Response

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	Set/GSV		USINT	1	-	-	Enumeration: 0 = Low 1 = Medium 2 = High 3-255 = Reserved

The Loop Response attribute is used by configuration and auto-tune software to determine the responsiveness of the control loops. Specifically, configuration software uses the Loop Response attribute to determine the value for the Damping Factor, Z, used in calculating individual gain values. The Damping Factor value applied is based on the enumerated Loop Response value according to the following table:

Loop Response	Damping Factor
Low	1.5
Medium	1.0
High	0.8

A High setting for Loop Response is best suited for systems that demand the highest level of control performance. Generally these are rigid mechanical systems with relatively light load inertia/mass, for example, Load Ratio < 3.

A Medium Loop Response setting is best suited for general purpose control applications with modest loading, for example Load Ratio < 10. This setting can accommodate both rigid and compliant mechanical systems.

A Low setting for Loop Response is best suited for systems that control heavy load inertia/mass, for example, Load Ratio > 10. The heavy load inertia/mass of these systems generally required lower position and velocity loop bandwidths to maintain stability and minimize motor heating.

Overall system performance can be improved for a given Loop Response setting by compensating for the load inertia/mass by setting the System Inertia value to the Total Inertia of the mechanical system.

Load Coupling

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set/GSV		USINT	0	-	-	Enumeration: 0 = Rigid 1 = Compliant 2-255 = Reserved

The Load Coupling attribute is used by configuration and auto-tune software to determine how the loop gains are derated based on the current Load Ratio. In high performance applications with relatively low Load Ratio values or rigid mechanics, typically no derating is applied. For applications with relatively high Load Ratios and compliant mechanics, derating the loop gains based on the Load Ratio is recommended. The derating simply divides the nominal loop bandwidth values by a factor of the Load Ratio + 1.

Gain Tuning Configuration Bits

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set/ SSV#		WORD	1 Bits 4-7 FD	-	-	Bit Field 0 = Run Inertia Test 1 = Use Load Ratio 2 = Reserved 3 = Reserved 4 = Tune Pos Integrator 5 = Tune Vel Integrator 6 = Tune Vel Feedforward 7 = Tune Accel Feedforward 8 = Tune Toque LP Filter 9...15 = Reserved

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

This Gain Tuning Configuration Bits attribute value is a bit field attribute that controls the loop gain-tuning calculations.

Bits 4-7 may not be updated programmatically by SSV instruction unless the Application Type is set to Custom.

The following table provides detailed descriptions for the bits of this attribute:

Bit Name	Description
Run Inertia Test	This bit determines whether or not the MRAT tuning instruction will send a Test Inertia service to the drive to perform an inertia measurement. If this bit is set the Inertia Test will be performed. If the bit is clear, the MRAT will immediately complete without an inertia measurement.
Use Load Ratio	This bit determines if Load Ratio is used in calculating Total Inertia and System Bandwidth calculations. If this bit is set, Load Ratio will be used in these calculations. If this bit is clear, Load Ratio will not have any impact on Total Inertia or System Bandwidth.
Tune Position Integrator	The Tune Position Integrator bit attribute determines whether or not the auto-tuning algorithm calculates a value for the Position Integrator Bandwidth. If this bit is clear (false) the value for the Position Integrator Bandwidth is set to zero, disabling the integrator.
Tune Velocity Integrator	The Tune Velocity Integrator bit attribute determines whether or not tuning algorithms calculate a value for the Velocity Integrator Bandwidth. If this bit is clear (false) the value for the Velocity Integrator Bandwidth is set to zero, disabling the integrator.
Tune Velocity Feedforward	The Tune Velocity Feedforward bit attribute determines whether or not tuning algorithms calculate a value for the Velocity Feedforward Gain. If this bit is clear (false) the value for the Velocity Feedforward Gain is set to zero.
Tune Acceleration Feedforward	The Tune Acceleration Feedforward bit attribute determines whether or not tuning algorithms calculate a value for the Acceleration Feedforward Gain. If this bit is clear (false) the value for the Acceleration Feedforward Gain is set to zero.

Bit Name	Description
Tune Torque LP Filter	The Tune Torque LP Filter bit attribute determines whether or not tuning algorithms calculate a value for the Torque Low Pass Filter Bandwidth. If this bit is clear (false) the value for the Torque Low Pass Filter Bandwidth is not calculated or altered by the gain tuning algorithms.

See also

Motor Test Status Attributes on page 275

Hookup Test Configuration Attributes on page 266

Inertia Test Configuration Attributes on page 269

Hookup Test Configuration Attributes

These are the attributes that are associated with hookup test configuration applied to a Motion Control Axis.

Hookup Test Distance

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/ SSV*		REAL	1	0	maxpos	Position Units

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The Hookup Test Distance attribute is used by the Hookup Test service to determine the amount of motion that is necessary to satisfy selected hookup test process.

Hookup Test Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - !E	Set/ SSV*		REAL	10	0	∞	Seconds

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The Test Time attribute is used by the Hookup Test service to determine the duration of motion that is necessary to satisfy selected Hookup Test process. This value is typically set to around 10 seconds.

Hookup Test Feedback Channel

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/ SSV*		USINT	1	1	2	Feedback Channel 1 = Feedback 1 2 = Feedback 2

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The Test Feedback Channel attribute is used by the Hookup Test service when the 'Feedback' test is selected to determine which feedback channel to test.

See also

Motor Test Status Attributes on page 275

Inertia Test Status Attributes on page 272

Hookup Test Status Attributes on page 267

Inertia Test Configuration Attributes on page 269

Auto-Tune Configuration Attributes on page 258

Hookup Test Result Attributes

These are the attributes that are associated with hookup result status applied to a Motion Control Axis

Hookup Test Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/GSV		USINT	-	-	-	Enumeration 0 = Test Process Successful 1 = Test in Progress 2 = Test Process Aborted 3 = Test Process Timed-out 4 = Test Process Faulted 5 = Test Failed - no feedback 1 counts 6 = Test Failed - no feedback 2 counts 7...255 = Reserved

The Hookup Test Status attribute returns status of the last Run Hookup Test service on the targeted drive axis. The Hookup Test Status attribute can be used to determine when the hookup test service has successfully completed. Conditions may occur, however, that make it impossible for the drive to properly perform the operation. When this is the case, the test process is automatically terminated and a test error is reported that is stored in the Hookup Test Status output parameter.

Hookup Test Commutation Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E PM	Get/GSV		REAL	-	-	-	Electrical Degrees

The Hookup Test Commutation Offset reports the measured commutations offset of a PM motor during the Commutation Test. This represents the value that will be applied to the motor position accumulator in order to align the Electrical Angle signal with motor stator windings. This value can be used to configure the Commutation Offset attribute.

Hookup Test Commutation Polarity

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E PM	Get/GSV		USINT	-	-	-	Enumeration 0 = Normal 1 = Inverted 2…255 = Reserved

The Hookup Test Commutation Polarity reports if the UVW phasing of the Encoder or Hall Sensor match the phasing of the Motor. If the motor and UVW commutation phasing do not match the Commutation Polarity is Normal. If it is determined that the phasing for the motor and commutation device do not match, this parameter reports that the Commutation Polarity is Inverted. This value can be used to configure the Commutation Polarity attribute.

Hookup Test Feedback 1 Direction

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/GSV		USINT	-	-	-	Enumeration 0 = Positive 1 = Negative 2…255 = Reserved

The Hookup Test Feedback 1 Direction attribute reports the direction of axis travel during the last hookup test as seen by the drive's feedback 1 device. A value of 0 (positive) indicates that the direction of motion as observed by the drive's feedback 1 device was positive, for example, increasing counts. Note that the value for Hookup Test Feedback 1 Direction, as determined by the hookup test, does not depend on the current feedback, motor, or motion polarity attribute configuration. This value, combined with the user's definition of forward direction, can be used to configure the various polarity attributes for the correct directional sense.

Hookup Test Feedback 2 Direction

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/GSV		USINT	-	-	-	Enumeration 0 = Positive 1 = Negative 2…255 = Reserved

The Hookup Test Feedback 2 Direction attribute reports the direction of axis travel during the last hookup test as seen by the drive's feedback 2 device. A value of 0 (positive) indicates that the direction of motion as observed by the drive's feedback 2 device was positive, for example, increasing counts. Note that the value for Hookup Test Feedback 2 Direction, as determined by the hookup test, does not depend on the current feedback, motor, or motion polarity attribute configuration. This value, combined with the user's definition of forward direction, can be used to configure the various polarity attributes for the correct directional sense.

See also

Motor Test Status Attributes on page 275

Inertia Test Status Attributes on page 272

Hookup Test Configuration Attributes on page 266

Inertia Test Configuration Attributes on page 269

Auto-Tune Configuration Attributes on page 258

Inertia Test Configuration Attributes

These are the attributes that are associated with inertia test configuration applied to a Motion Control Axis.

Tuning Select

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	SSV#		USINT	0	-	-	Enumeration 0 = Total Inertia 1 = Motor Inertia 2…255 = Reserved

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

This enumerated attribute is used by the Auto-tuning software to determine where the measured inertia results of the test are to be stored. If set to 'motor test', the measured inertia is stored in the Rotary Motor Inertia attribute or Linear Motor Mass attribute. If set to 'total inertia', the measured inertia is applied to the Total Inertia attribute or Total Mass attribute.

Tuning Direction

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	SSV#		USINT	0	-	-	Enumeration 0 = Unidirectional Forward 1 = Unidirectional Reverse 2 = Bidirectional Forward 3 = Bidirectional Reverse 4...255 = Reserved

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

This enumerated value determines the direction of the motion profile initiated by the Inertia Test service associated with the Motion Run Axis Tuning (MRAT) instruction.

Tuning Travel Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	SSV#		REAL	0	0	maxpos	Position Units

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

The Tuning Travel Limit attribute is used by the Inertia Test service, associated with the MRAT instruction, to limit the excursion of the axis during the test. If, while performing the Inertia Test motion profile, the drive determines that the axis will not be able to complete the profile before exceeding the Tuning Travel Limit, the drive will terminate the profile and report that the Tuning Travel Limit was exceeded through the Tune Status attribute. This does not mean that the Tuning Travel Limit was actually exceeded, but that had the tuning process gone to completion that the limit would have been exceeded.

Tuning Speed

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	SSV#		REAL	0	0	∞	Position Units / Sec

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

The Tuning Speed attribute value determines the maximum speed used by the Inertia Test service initiated motion profile. This attribute should be set to the desired maximum operating speed of the motor prior to running the test. The tuning procedure will measure maximum acceleration and deceleration rates based on ramps to and from the Tuning Speed. Thus, the accuracy of the measured acceleration and deceleration capability is reduced by tuning at a speed other than the desired operating speed of the system.

Tuning Torque

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	SSV#		REAL	100	0	∞	% Rated

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

The Tuning Torque attribute value determines the maximum torque used by the Inertia Test service initiated motion profile. This attribute will be set to the desired maximum safe torque level prior to running the test. The default value is 100%, which yields the most accurate measure of the acceleration and deceleration capabilities of the system. In some cases a lower tuning torque limit value may be desirable to limit the stress on the mechanics during the tuning procedure. In this case the acceleration and deceleration capabilities of the system are extrapolated based on the ratio of the tuning torque to the maximum torque output of the system. Note that the extrapolation error increases as the Tuning Torque value decreases.

Load Ratio

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	SSV#		REAL	0	0	∞	Rotary Motor: Load Ratio = (total inertia / motor inertia) - 1. Linear Motor: Load Ratio = (total mass / motor mass) - 1.

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

The Load Ratio attribute's value represents the ratio of the load inertia or mass to the motor inertia or mass.

The value for Load Ratio may be known by the user or may be measured as part of a software initiated Autotune process.

When Use Load Ratio bit is set in the Gain Tuning Configuration Bits attribute, configuration software uses the value of Load Ratio to compute Total Inertia/Mass and System Inertia attributes.

The Load Ratio value may also be used in calculations associated with System Damping attribute.

Total Inertia

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C (Rotary Motor)	SSV#		REAL	FD	0	∞	Inertia Units

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

Total Inertia represents the combined inertia of the rotary motor and load in engineering units.

Total Mass

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C (Linear Motor)	SSV#		REAL	FD	0	∞	Mass Units

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

Total Mass represents the combined mass of the linear motor and load in engineering units.

See also

Motor Test Status Attributes on page 275

Hookup Test Status Attributes on page 267

Hookup Test Configuration Attributes on page 266

Inertia Test Status Attributes on page 272

Auto-Tune Configuration Attributes on page 258

Inertia Test Result Attributes

These are the attributes that are associated with inertia result status applied to a Motion Control Axis.

Tune Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Get/GSV		INT	-	-	-	Enumeration 0 = Tune Successful 1 = Tune in Progress 2 = Tune Aborted 3 = Tune Time-out Fault 4 = Tune Failed - Servo Fault 5 = Axis Reached Tuning Travel Limit 6 = Axis Polarity Set Incorrectly 7 = Tune Measurement Error 8 = Tune Configuration Error

The Tune Status attribute returns status of the last run Inertia Test service that initiates a process on the targeted drive axis. The Tune Status attribute can, thus, be used to determine when the Inertia Test initiated operation has successfully completed. Conditions may occur, however, that make it impossible for the drive to properly perform the operation. When this is the case, the Inertia Test process is automatically aborted and a failure reported that is stored in the Tune Status output parameter.

Tune Acceleration Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Get/GSV		REAL	-	-	-	Seconds

The Tune Acceleration Time attribute returns acceleration time in seconds for the last successful Inertia Test service. This value is used to calculate the Tune Acceleration attribute.

Tune Deceleration Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Get/GSV		REAL	-	-	-	Seconds

The Tune Deceleration Time attribute returns deceleration time in seconds of the last successful Inertia Test service. This value is used to calculate the Tune Deceleration attribute.

Tune Acceleration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Get/GSV		REAL	-	-	-	Position Units / Sec^2

The Tune Acceleration attribute returns the measured peak acceleration of the last successful Inertia Test service. This value is used to calculate the Tune Inertia Mass value of the axis, and is also used to determine the tuned values for the Maximum Acceleration attribute. The Tune Acceleration value represents the estimated acceleration at the configured torque limit of the system.

Tune Deceleration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Get/GSV		REAL	-	-	-	Position Units / Sec^2

The Tune Deceleration attribute returns the measured peak deceleration of the last successful Inertia Test service. This value is used to calculate the Tune Inertia Mass value of the axis, and is also used to determine the tuned values for the Maximum Deceleration attribute. The Tune Acceleration value represents the estimated deceleration at the configured torque limit of the system.

Tune Inertia Mass

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set/SSV		REAL	0	0	∞	% Motor Rated / (Motor Units/Sec^2)

The Tune Inertia Mass value represents the estimated inertia or mass for the axis as calculated from the measurements made during the last Motion Run Axis Tune (MRAT) initiated tuning process. This value may also be set directly by software tuning tools or programmatically.

Tune Friction

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set/SSV		REAL	0	0	∞	% Rated

This floating point value represents the amount of friction measured during the last successful Inertia Test profile. This value can be used to configure the Friction Compensation feature of the drive. This value may also be set directly by software tuning tools or programmatically.

Tune Load Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set/SSV		REAL	0	-∞	∞	% Rated

This floating point value represents the active load offset measured during the last successful Inertia Test profile. This value can be used to set the Torque Offset of the drive to cancel out the active load torque/force. This value may also be set directly by software tuning tools or programmatically.

Load Inertia Ratio

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set/SSV		REAL	0	0	∞	Load Inertia / Motor Inertia

This floating point value represents the load ratio calculated by MRAT based on the measurements made during the last successful Inertia Test profile. The Load Inertia Ratio attribute's value represents the ratio of the load inertia to the motor inertia. Or in the case of a linear motor, the load mass over the motor mass. This value can be used to set the Load Ratio attribute value as part of an Autotune process. This value may also be set directly by software tuning tools or programmatically.

See also

Motor Test Status Attributes on page 275

Hookup Test Status Attributes on page 267

Hookup Test Configuration Attributes on page 266

Inertia Test Configuration Attributes on page 269

Auto-Tune Configuration Attributes on page 258

Motor Test Result Attributes

These are the attributes that are associated with result status applied to a Motion Control Axis.

Motor Test Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Get/GSV		USINT	-	-	-	Enumeration 0 = Test Process Successful 1 = Test in Progress 2 = Test Process Aborted 3 = Test Process Timed-out 4 = Test Process Faulted 5…255 = Reserved

The Motor Test Status attribute returns status of the last Run Motor Test service on the targeted drive axis. The Motor Test Status attribute can be used to determine when the motor test service has successfully completed. Conditions may occur, however, that make it impossible for the drive to properly perform the operation. When this is the case, the test process is automatically terminated and a test error is reported that is stored in the Motor Test Status output parameter.

Motor Test Resistance

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Get/GSV		REAL	-	-	-	Ohms

This floating point value represents the stator resistance of an induction or permanent magnet motor as measured by the Motor Test procedure.

Motor Test Inductance

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Get/GSV		REAL	-	-	-	Henries

This floating point value represents the motor inductance of an induction or permanent magnet motor as measured by the Motor Test procedure.

Motor Test Flux Current

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D IM Only	Get/GSV		REAL	-	-	-	Amps

This floating point value represents the motor flux current of an induction motor as measured by the Motor Test procedure.

Motor Test Slip Speed

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D IM Only	Get/GSV		REAL	-	-	-	RPM: rotary motor type m/s: linear motor type

This floating point value represents the slip speed of an induction motor as measured by the Motor Test procedure.

Motor Test Counter EMF

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D PM Only	Get/GSV		REAL	-	-	-	Volts

This floating point value represents the measured Counter EMF (CEMF) of a PM motor at Rated Speed by the Motor Test procedure.

Motor Test Lq Inductance

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D IPM Only	Get/GSV		REAL	-	-	-	Henries

This floating point value represents the phase-to-phase q-axis motor inductance measured by the Motor Test procedure.

Motor Test Ld Inductance

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D IPM Only	Get/GSV		REAL	-	-	-	Henries

This floating point value represents the phase-to-phase d-axis motor inductance measured by the Motor Test procedure.

Motor Test Lq Flux Saturation

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D IPM Only	Get/GSV		REAL [8]	-	-	-	% Nominal Inductance

This floating point value represents the phase-to-phase q-axis stator inductance of the motor as measured by the Motor Test procedure expressed as a percentage of the measured Nominal Inductance, Lq, at 25%, 50%, 75%, 100%, 125%, 150%, 175% and 200% rated continuous current.

Motor Test Ld Flux Saturation

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D IPM Only	Get/GSV		REAL	-	-	-	% Nominal Inductance

This floating point value represents the phase-to-phase d-axis stator inductance of the motor as measured by the Motor Test procedure expressed as a percentage of the measured Nominal Inductance, Ld, at 100% rated continuous current.

Motor Test Bus Overvoltage Speed

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D IPM Only	Get/GSV		REAL	-	-	-	RPM (rotary motor type) m/s (linear motor type)

This floating point value represents the maximum speed of the motor without exceeding the operational DC bus overvoltage limit, as determined by the Motor Test procedure.

Motor Test Commutation Offset Comp

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D IPM Only	Get/GSV		REAL	-	-	-	Electrical Degrees

This floating point value represents the change in motor Commutation Offset at rated continuous current as measured by the Motor Test procedure.

See also

Hookup Test Status Attributes on page 267

Inertia Test Status Attributes on page 272

Hookup Test Configuration Attributes on page 266

Inertia Test Configuration Attributes on page 269

Faults and Alarms Attributes

The following attribute tables contain fault and alarm related attributes associated with a Motion Control Axis Object instance.

APR Fault Attributes

The following attribute table contains all APR (Absolute Position Recovery) fault related attributes associated with a Motion Device Axis, including standard APR faults and Rockwell Automation specific APR faults. APR Faults are conditions that can occur during the device initialization process when trying to restore the absolute position of an axis. Unlike Initialization Faults, these faults are recoverable and may be cleared with a Fault Reset request.

CIP APR Faults

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - E	Get/GSV	T	WORD	-	-	-	Bit map: 0 = Reserved 1 = Memory Write Error 2 = Memory Read Error 3 = Feedback Serial Number Mismatch 4 = Buffer Allocation Fault 5 = Scaling Configuration Changed 6 = Feedback Mode Changed 7 = Feedback Integrity Loss 8…15 = Reserved

The CIP APR Faults attribute is a bit mapped value that represents the state of all standard APR (Absolute Position Recovery) faults. An APR fault is generated when the system fails to recover the absolute position of the axis after power cycle, reset, or reconnection. APR faults are detected during the initial configuration or initialization of the drive axis.

When an APR fault occurs, the actual position of the axis is no longer correlated to the position of the axis prior to the power cycle, reset, or reconnect. Examples of standard APR faults are feedback serial number mismatch, and scaling configuration change. APR faults are recoverable and can be cleared with a Fault Reset request.

CIP APR Faults - RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - E	Get/GSV	T	WORD	-	-	-	Bit map: 0 = Reserved 1 = Persistent Media Fault 2 = Firmware Error 3 = Feedback Battery Loss 4…15 = Reserved

The CIP APR Faults - RA attribute is a bit mapped value that represents the state of all Rockwell Automation specific APR (Absolute Position Recovery) faults. An APR fault is generated when the system fails to recover the absolute position of the axis after power cycle, reset, or reconnection. APR faults are detected during the initial configuration or initialization of the drive axis. When an APR fault occurs, the actual position of the axis is no longer correlated to the position of the axis prior to the power cycle, reset, or reconnect. These faults are specific to Rockwell Automation APR implementation. APR faults are recoverable and can be cleared with a Fault Reset request.

Standard APR Faults

The following table defines a list of standard faults associated with the APR Faults attribute.

Standard APR Fault Descriptions

Bit	Exception Name	Description
0	-- Reserved --	This bit cannot be used since the Fault Code is defined by the associated exception bit number and Fault Code of 0 means no fault condition is present.
1	Memory Write Error	Error in saving absolute position data to NV memory.
2	Memory Read Error	Error in reading absolute position data from NV 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 has changed and does not match the saved scaling configuration.
6	Feedback Mode Changed	Feedback Mode has changed and does not match the saved Feedback Mode configuration.
7	Feedback Integrity Loss	The Feedback Integrity bit of CIP Axis Status attribute has transitioned from 1 to 0 during device operation.
8...15	-- Reserved --	

Rockwell Automation Specific APR Faults

The following table defines a list of Rockwell Automation specific faults associated with the APR Faults-RA attribute.

Bit	Exception Name	Description
0	-- Reserved --	This bit cannot be used since the Fault Code is defined by the associated exception bit number and Fault Code of 0 means no fault condition is present.
1	Persistent Media Fault	(L6x) - Means that all 6 sectors reserved for APR in Persistent Memory (for example, NAND flash) are marked as bad. This is not a recoverable fault condition.
2	Firmware Error	Used to trap firmware errors that should never happen.

Bit	Exception Name	Description
3	Feedback Battery Loss	Battery powered Absolute Feedback device has failed to maintain absolute position through a power cycle due to low battery level or disconnected battery power.
4...15	-- Reserved --	

The APR Fault exception names in the preceding tables have corresponding Logix Designer APR Fault tag names. The naming conventions for the tag names are to remove the spaces from the fault bit name and then append the "APRFault" suffix. For example "Memory Write Error" becomes "MemoryWriteErrorAPRFault".

See also

Absolute Position Recovery Functionality on page 43

APR Recovery Scenarios on page 48

Axis Exception Action Configuration Attributes

These configuration attributes control the action performed by the device as a result of an exception condition. A unique exception action is defined for each supported exception condition.

CIP Axis Exception Action

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set	USINT [64]	4 (D) 2 (E) 4 (B)	-	-	Enumeration for Drive Modes (D) 0 = Ignore (O) 1 = Alarm (O) 2 = Fault Status Only (O) 3 = Stop Planner (O) 4 = Stop Drive (R) 5 = Shutdown (R) Enumeration for Feedback Only (E) 0 = Ignore (O) 1 = Alarm (O) 2 = Fault Status Only (R) 3 = N/A 4 = N/A 5 = Shutdown (R) Enumeration for Bus Power Converters (B) 0 = Ignore (O) 1 = Alarm (O) 2 = Fault Status Only (O) 3 = n/a 4 = Stop Drive (R) 5 = Shutdown (R) 6...254 = Reserved 255 = Unsupported (O)

The CIP Axis Exception Action attribute is a 64-element array of enumerated bytes that specifies the action for the associated standard axis exception.

CIP Axis Exception Action - RA

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set	USINT [64]	4 (D) 2 (E) 4 (B)	-	-	Enumeration for Drive Modes (D) 0 = Ignore (O) 1 = Alarm (O) 2 = Fault Status Only (O) 3 = Stop Planner (O) 4 = Stop Drive (R) 5 = Shutdown (R) Enumeration for Feedback Only (E) 0 = Ignore (O) 1 = Alarm (O) 2 = Fault Status Only (R) 3 = N/A 4 = N/A 5 = Shutdown (R) Enumeration for Bus Power Converters (B) 0 = Ignore (O) 1 = Alarm (O) 2 = Fault Status Only (O) 3 = n/a 4 = Stop Drive (R) 5 = Shutdown (R) 6...254 = Reserved 255 = Unsupported

The CIP Axis Exception Action attribute is a 64-element array of enumerated bytes that specifies the action for the associated Rockwell Automation specific axis exception.

See also

Axis Exception Action on page 283

Axis Exception Action

The Axis Exception Action attributes are 64-element array of enumerated bytes that specifies the action for the associated standard or manufacturer specific exception, respectively. For a given exception, certain exception actions may not be supported. Attempting to do so results in an "Invalid Attribute Value" service error code (0x09). Each device product must specify the available actions for each exception that is supported. If a specific exception is not supported by the device, the only valid exception action enumeration is 'Unsupported'. Attempting to write any other value to the element associated with an unsupported exception results in an "Invalid Attribute Value" service error code (0x09) that is generated while the project is online with the controller. For drives that support Rockwell

Automation specific axis exceptions, the 64-element CIP Axis Exception-RA array is sent to the drive device.

Axis Exception Action Definitions

Enum.	Usage	Name	Description
0	Optional	Ignore	Ignore instructs the device to completely ignore the exception condition. For some exceptions that are fundamental to the operation of the axis, it may not be possible to Ignore the condition.
1	Optional	Alarm	Alarm action instructs the device to set the associated bit in the Axis Alarm word but to otherwise not impact axis behavior. For some exceptions that are fundamental to the operation of the device, it may not be possible to select this action or any other action that leaves device operation unimpacted.
2	Optional (BD) Required (E)	Fault Status Only	Fault Status Only instructs the device to set the associated bit in the Axis Faults word but to otherwise not impact axis behavior. It is up to the controller to programmatically bring the axis to a stop in this condition. For some exceptions that are fundamental to the operation of the device, it may not be possible to select this action or any other action that leaves device operation unimpacted. Converters (B) executing a Fault Status Only exception action continue to supply DC Bus Power and do not set the DC Bus Unload bit in Axis Status attribute and therefore do not disable drives in the converter's Bus Sharing Group.
3	Optional (D)	Stop Planner	Stop Planner instructs the drive device (D) to set the associated bit in the Axis Faults word and instructs the Motion Planner to perform a controlled stop of all planned motion at the configured Max Decel rate. For some exceptions that are fundamental to the operation of the device, it may not be possible to select this action or any other action that leaves device enabled.

Enum.	Usage	Name	Description
4	Required (BD)	Stop Drive	Stop Drive action results in the drive device (D) both setting the associated bit in the Axis Faults word and bringing the axis to a stop based on the factory set "best" available stopping method. This "best" stopping method includes both the method of decelerating the motor to a stop and the final state of the power structure given the expected level of control still available. The level of axis control available depends on the specific exception condition and on the configured control mode. The available deceleration methods are defined by the Stopping Action attribute. (See the *Stopping Action* section following this table for additional information.) If the application requires exception action that is a more severe stopping action than the factory set "best" method, the controller will initiate that action. If the application requires an exception action that is less severe than the factory set "best" method, the controller will configure the device axis instance for a Minor Fault exception action and handle the fault directly. This may put device and motor components at risk and is only be allowed by the device when there is an opportunity for the device to remain operational. This is important in applications where the value of the product is higher than the value of the motor or device. When the Stop Drive exception action is applied to a converter device (B), stopping action is not applicable (0 = No Action). The final states of Disable or Shutdown for the converter are applicable, however, with Shutdown executing the configured Shutdown Action. In the Shutdown case, the DC Bus Unload bit of the converter's Axis Status attribute is set to generate a Bus Sharing exception on all drives in the converter's Bus Sharing Group. When multiple major faults occur with different stopping actions, the most severe of the associated stopping actions is applied, that is, the stopping action that requires the lowest level of control functionality. This rule also applies to the Stopping Action associated with a Disable Request.
5	Required (All)	Shutdown	While the final axis state after a Major Fault is the Major Faulted state, the Shutdown Exception Action forces the power structure into the Shutdown state, immediately disabling the drive's power structure. If Shutdown Action is configured to do so, this action also drops DC Bus power to the drive's power structure. Therefore, the Shutdown action overrides the drive's best stopping method. An explicit Shutdown Reset is required to restore the drive to an operational state.
6-254		Reserved	-
255		Unsupported	The Unsupported Exception Action is the value assigned to Exceptions that are not supported by the device. Trying to assign an Exception Action other than Unsupported to an exception that is not supported by the device results in an "Invalid Attribute Value" service error code (0x09).

Stopping action

Standard stopping actions, listed in decreasing levels of deceleration control, are as follows:

1. Ramp Decel
2. Current Limit Decel
3. Coast

In general, the "best" stopping action is the most controlled deceleration method still available given the exception condition.

The final state of the power structure in response to the Major Fault exception action can be any one of the following states that are listed in decreasing levels of control functionality:

1. Hold (stopped with Holding Torque)
2. Disable (stopped with Power Structure Disabled)
3. Shutdown (stopped with Shutdown Action)

The "best" final state of the power structure is the state with the most control functionality still available given the exception condition.

In all these final states a fault reset must be executed before the axis can be restored to enabled operation and commanded to move.

If a Start Inhibit condition is present at the time of the exception, the best final state for the exception action can only be Disable or Shutdown.

The specific stopping action and final state associated with a given Stop Drive exception action is captured in the Axis Fault Action attribute that is included in the Fault Log record. Axis Fault Action enumerations are as follows:

Enumeration	Description
Stop Action Enumerations	0 = No Action 1 = (reserved) 2 = Ramped Stop 3 = Torque Limited Stop 4 = Coast
State Change Enumerations	0 = No Action 1 = Hold 2 = Disable 3 = Shutdown

See also

Axis Exception Action Configuration Attributes on page 281

Exceptions on page 41

Exception, Fault and Alarm Attributes on page 293

Stopping and Braking Attributes on page 431

Configuration Fault Attributes

These are the configuration fault related attributes associated with a Motion Control Axis.

Attribute Error Code

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/GSV	T	INT	-	-	-	Refer to CIP Error Codes

CIP Error code returned by the erred set list service to the module.

Attribute Error ID

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Ger/GSV	T	INT	-	-	-	

Attribute ID associated with non-zero Attribute Error Code.

See also

CIP Error Codes on page 287

Exception, Fault, and Alarm Attributes on page 293

Identify Motion Axis Attributes Based on Device Function Codes on page 95

CIP Error Codes

These are general CIP error codes that can be returned by the Attribute Error Code attribute.

CIP Error Codes

Error Code (hex)	Error Name	Description of Error
00	Success	Service was successfully performed by the object specified.
01	Connection failure	A connection related service failed along the connection path.
02	Resource unavailable	Resources needed for the object to perform the requested behavior were unavailable. Further object specific information should be supplied in the object specific status field of the response.

Error Code (hex)	Error Name	Description of Error
03	Invalid value in object specific data parameter of a service request	A portion of the data supplied as an object specific data parameter of a service was invalid. The verification of the data is specified in the object definition of the object reporting the error.
04	IOI segment error	The IOI segment identifier or the segment syntax was not understood by the processing node. The word offset to the first segment of the IOI that is not understood should be supplied in the first word of the object specific status field of the response. The offset is zero based and calculated from the first word following the IOI Size in the message IOI processing stops when an IOI segment error is encountered.
05	IOI destination unknown	The IOI is referencing an object class, instance or structure element that is not known or is not contained in the processing node. The word offset to the first segment component that references something that is unknown or not present in the processing node should be supplied in the first word of the object specific status field of the response. The offset is zero based and calculated from the first word following the IOI Size in the message. IOI processing stops when an IOI destination unknown error is encountered.
06	Partial transfer	Only part of the expected data was transferred.
07	Connection lost	The messaging connection was lost.
08	Unimplemented service	The service requested was not implemented or defined for this class or instance object.
09	Invalid attribute value	The value of an attribute of the object or class is invalid. The object specific status should report the attribute number and the status code of the first attribute refusing data.
0A	Attribute list error	An attribute in the Get_Attribute_List or Set_Attribute_List response has a non–zero status.
0B	Already in requested mode/state	The object is already in the mode/state being requested by the service. The object specific status should report the object's current status.
0C	Object cannot perform service in its current mode/state	The object cannot perform the requested service in its current mode/state. The object specific status should report the object's current status. For example, this error would be returned if a Transfer Service request was sent to the NVS Object before a Update Service request was received since the Update Service is required before data can be sent using the Transfer Service.
0D	Object already exists	The requested instance of object to be created already exists.
0E	Attribute value not settable	The object attribute is not a settable attribute. The object specific status should report the number of the attribute refusing data.
0F	Access permission does not allow service	The access permissions do not allow the object to perform the service. The access permissions available to the object should be reported in the extended status.
10	Device's mode/state does not allow object to perform service	The device containing the object does not allow the object to perform the service in the device's current mode/state. The object specific status should report the device's current status. For example, a controller may have a key switch which when set to the 'hard run' state causes Service Requests to several different objects to fail, for example, program edits. This error code would then be returned.

Error Code (hex)	Error Name	Description of Error
11	Reply data too large	The data to be transmitted in the response buffer is larger than the allocated response buffer, therefore, no data was transferred.
12	Fragmentation of a primitive value	The service specified an operation that is going to fragment a primitive data value, for example, halve a REAL data type.
13	Not enough data	The service did not supply enough data to perform the specified operation.
14	Undefined attribute	The attribute specified is not defined for the class or object.
15	Too much data	The service supplied more data than was expected (depending on the service and the object, the service may still be processed).
16	Object does not exist	The object specified does not exist in the device.
17	Service fragmentation sequence not currently in progress	The fragmentation sequence for this service is not currently active for this data.
18	No stored attribute data	The attribute data of this object was not saved prior to the requested service.
19	Store operation failure	The attribute data of this object was not saved due to some failure during the attempt.
1A	Bridging failure, request packet too large for network	The service request packet was too large for transmission on a network in the path to the destination. The bridge device was forced to abort the service.
1B	Bridging failure, response packet too large for network	The service response packet was too large for transmission on a network in the path from the destination. The bridge device was forced to abort the service.
1C	Missing attribute list entry data	The service did not supply an attribute in a list of attributes that was needed by the service to perform the requested behavior.
1D	Invalid attribute value list	The service is returning the list of attributes supplied with status information for those attributes that were invalid.
1E	Embedded service error	An embedded service resulted in an error.
1F	Connection Related Failure	A service failed because of an error condition related to the processing of a connection related service. This can occur during connected and unconnected messaging. The same extended status codes used for General Status Error Code 01 are returned for this error's extended status.
20	Invalid Parameter	Obsolete
21	Write–once value or medium already written	An attempt was made to write to a write-once medium (for example, WORM drive, PROM) that has already been written, or to modify a value that cannot be changed once established.
22	Invalid Reply Received	An invalid reply is received, for example, reply service code does not match the request service code, or reply message is shorter than the minimum expected reply size. This error code can serve for other causes of invalid replies.
23	CST not coordinated	The Coordinated System Time (CST) value is not yet within the tolerance where it can accept an update. Try again.
24	Connection Scheduling Error	Obsolete
25	Key Failure in IOI	The Key Segment which was included as the first segment in the IOI does not match the destination module. The object specific status will indicate which part of the key check failed.

Error Code (hex)	Error Name	Description of Error
26	IOI Size Invalid	The Size of the IOI which was sent with the Service Request is either not large enough to allow the Request to be routed to an object or too much routing data was included.
27	Unexpected attribute in list	An attempt was made to set an attribute that cannot be set at this time.
28	DNet Invalid Member ID	See DeviceNet specification for details: http://www.odva.org/
29	DNet Member not settable	See DeviceNet specification for details: http://www.odva.org/
2A - CF	Reserved for future system use	This range of error codes has been reserved for future system use.
D0 - FF	Reserved for future system use	This range of error codes has been reserved for use by object and class specific services, or for development before registration.

See also

Configuration Fault Attributes on page 287

Exception Factory Limit Info Attributes

These are the exception limit related attributes associated with a Motion Control Axis. Exception Limit attributes define the conditions under which a corresponding exception is generated during motion axis operation that has the potential of generating either a fault or alarm. They are typically associated with temperature, current, and voltage conditions of the device that are continuous in nature. Factory Limits (FL) for exceptions are usually hard coded in the device and typically result in a major fault condition. User Limits (UL) for exceptions are configurable and typically used to generate a minor fault, or alarm condition. For this reason, the User Limits are generally set inside the corresponding Factory Limits. Note that the triggering of a User Limit exception does not preclude triggering of the corresponding Factory Limit exception; the two exception trigger conditions are totally independent of one another.

Rotary Motor Overspeed Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Get/GSV	REAL	-	-	-	RPM

Returns the Factory Limit for the Motor Overspeed Factory Limit exception based on a factory set value determined by the Rotary Motor Rated Speed or Rotary Motor Max Speed attribute values, or by operational speed limits enforced by the drive vendor. The drive may take the minimum of any of these values as the Factory Limit.

When PM Motor Rotary Bus Overvoltage Speed and PM Motor Rotary Max Extended Speed attributes are supported and non-zero, the drive uses these values to determine the Rotary Motor Overspeed Factory Limit. The PM Motor Extended Speed Permissive value determines which limit to apply. If the PM

Motor Extended Speed Permissive is False, the Rotary Motor Overspeed Factory Limit will be based on the PM Motor Rotary Bus Overvoltage Speed. If the PM Motor Extended Speed Permissive is True, the Rotary Motor Overspeed Factory Limit will be based on the PM Motor Rotary Max Extended Speed value.

For Rockwell Automation drives, when PM Motor Extended Speed Permissive is False, the Motor Overspeed Factory Limit = 1.25 * Bus Overvoltage Speed, or the speed limit corresponding to the Bus Overvoltage Factory Limit, whichever is less. When PM Motor Extended Speed Permissive is True, the Motor Overspeed Factory Limit = 1.25 * Max Extended Speed value.

The Operational Speed Limit on all Rockwell Automation drive products is 600 Hz. The following formula is used to calculate the operational speed limit:

Operational Speed Limit (RPM) = 590 (Hz) * 120 / Rotary Motor Poles

Linear Motor Overspeed Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Get/GSV	REAL	-	-	-	m/s

Returns the Factory Limit for the Motor Overspeed Factory Limit exception based on a factory set value determined by the Linear Motor Rated Speed or Linear Motor Max Speed attribute values, or by operational speed limits enforced by the drive vendor. The drive may take the minimum of any of these values as the Factory Limit.

When PM Motor Linear Bus Overvoltage Speed and PM Motor Linear Max Extended Speed attributes are supported and non-zero, the drive uses these values to determine the Linear Motor Overspeed Factory Limit. The PM Motor Extended Speed Permissive value determines which limit to apply. If the PM Motor Extended Speed Permissive is False, the Linear Motor Overspeed Factory Limit will be based on the PM Motor Linear Bus Overvoltage Speed. If the PM Motor Extended Speed Permissive is True, the Linear Motor Overspeed Factory Limit will be based on the PM Motor Linear Max Extended Speed value.

For Rockwell Automation drives, when PM Motor Extended Speed Permissive is False, the Motor Overspeed Factory Limit = 1.25 * Bus Overvoltage Speed, or the speed limit corresponding to the Bus Overvoltage Factory Limit, whichever is less. When PM Motor Extended Speed Permissive is True, the Motor Overspeed Factory Limit = 1.25 * Max Extended Speed value

See also

Exceptions on page 41

Exception User Limit Configuration Attributes on page 292

Exception User Limit Configuration Attributes

These are the exception user limit configuration related attributes associated with a Motion Control Axis.

Motor Phase Loss Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	REAL	5	0	100	% Motor Rated

Sets the minimum motor phase current for the Motor Phase Loss exception. The current in each motor phase must exceed this value during the motor phase loss test or a Motor Phase Loss exception occurs. Decreasing this attribute's value lowers sensitivity to phase loss conditions. A value of 0 will effectively disable the motor phase loss test.

Motor Overspeed User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	REAL	FD	0	∞	% Motor Rated

Sets the Overspeed User Limit relative to the Rotary Motor Rated Speed or Linear Motor Rated Speed that is allowable before throwing a Motor Overspeed UL exception.

Motor Thermal Overload User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	REAL	110	0	∞	% Motor Rated

Sets User Limit for the Motor Thermal Overload UL exception.

Inverter Thermal Overload User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	REAL	110	0	∞	% Inverter Rated

Sets User Limit for the Inverter Thermal Overload UL exception.

Feedback Noise User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	Set/SSV	UDINT	1	1	2^{31}	Noise Counts

Sets User Limit for the Feedback Noise Overload UL exception. Example of Noise Counts would be simultaneous transitions of the A and B channel of a quadrature encoder feedback device.

Feedback Signal Loss User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	Set/SSV	REAL	100	0	∞	% FL Voltage Drop

Sets User Limit for the Feedback Signal Loss UL exception. Feedback interface hardware typically monitor average voltage levels on incoming signals. Feedback Signal Loss conditions occur when the average voltage levels drop below a percentage of voltage drop allowed by the Feedback Signal Loss Factory Limit.

Feedback Data Loss User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	Set/SSV	UDINT	4	1	2^{31}	Consecutive Lost Data Packets

Sets User Limit for the Feedback Data Loss UL exception. For digital feedback devices, feedback interface hardware monitors the integrity of data transferred over the serial connection to the feedback device. Feedback Data Loss conditions occur when two or more consecutive data packets are lost or corrupted.

See also

Exceptions on page 41

Exception, Fault, and Alarm Attributes on page 293

Standard Exceptions on page 456

Exception, Fault and Alarm Attributes

These are the exception, fault, and alarm related attributes associated with a Motion Control Axis. Exceptions are conditions that can occur during motion axis operation that have the potential of generating faults or alarms based on the Exception Action configuration.

CIP Axis Faults

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/GSV	T	LWORD	-	-	-	Refer to Standard Exceptions

A bit map that represents the state of all standard runtime faults. The bit map is identical to that of the CIP Axis Exceptions attribute. Fault bits when set are latched until a fault reset occurs. A fault reset clears the runtime fault bits, but the bits set again immediately if the underlying exception condition is still present. Any exceptions whose Axis Exception Action is configured to ignore or report as alarms do not appear in this attribute.

CIP Axis Faults - RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required	Get/GSV	T	LWORD	-	-	-	Refer to Rockwell Automation Specific Exceptions

A bit map that represents the state of all Rockwell Automation specific runtime faults. Fault bits when set are latched until a fault reset occurs. A fault reset clears the runtime fault bits, but the bits set again immediately if the underlying exception condition is still present. Any exceptions whose Axis Exception Action is configured to ignore or report as alarms do not appear in this attribute.

CIP Axis Alarms

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - All	Get/GSV	T	LWORD	-	-	-	Refer to Standard Exceptions

A bit map that represents the current state of all standard alarm conditions. The bit map is identical to that of the CIP Axis Exceptions attribute. Only exception conditions whose Axis Exception Action is configured to report as an alarm appear in this attribute, and will not be reported in the CIP Axis Faults attribute. Alarm bits when set are not latched and will clear as soon as the underlying exception condition is corrected.

CIP Axis Alarms - RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional- All	Get/GSV	T	LWORD	-	-	-	Refer to Rockwell Automation Specific Exceptions

A bit map that represents the current state of all Rockwell Automation specific alarm conditions. Only exception conditions whose Axis Exception Action is configured to report as an alarm appear in this attribute, and will not be reported in the CIP Axis Faults attribute. Alarm bits when set are not latched and will clear as soon as the underlying exception condition is corrected.

See also

Exceptions on page 41

Module Node Fault and Alarm Attributes on page 297

Standard Exceptions on page 456

Rockwell Automation Specific Exceptions on page 465

Initialization Faults Attributes

These are the initialization fault related attributes associated with a Motion Control Axis. Initialization Faults are conditions that can occur during the device initialization process that prevent normal operation of the device.

CIP Initialization Faults

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	T	DWORD	-	-	-	Refer to Standard Initialization Faults

A bit map that represents the state of all standard initialization faults. These faults prevent any motion, and do not have configurable fault actions. Examples of initialization faults are corrupted memory data, calibration errors, firmware startup problems, or an invalid configuration attribute value. Initialization faults cannot be cleared with a Fault Reset service, although a power-cycle provides a new attempt at initialization.

CIP Initialization Faults - RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	T	DWORD	-	-	-	Refer to Rockwell Automation Specific Initialization Faults

A bit map that represents the state of all Rockwell Automation specific initialization faults. These faults prevent any motion, and do not have configurable fault actions. Examples of initialization faults are corrupted memory data, calibration errors, firmware startup problems, or an invalid configuration attribute value. Initialization faults cannot be cleared with a Fault Reset service, although a power-cycle provides a new attempt at initialization.

See also

Rockwell Automation Specific Initialization Faults on page 296

Standard Initialization Faults on page 296

Standard Initialization Faults

This table defines a list of standard faults associated with the Initialization Faults attribute.

Standard Initialization Fault Descriptions

Bit	Exception	Description
0	Reserved	This bit cannot be used since the Fault Code is defined by the associated exception bit number and Fault Code of 0 means no fault condition is present.
1	Boot Block Checksum Fault	Checksum or CRC error for Boot Block of CIP Motion device detected as part of Self-Test.
2	Main Block Checksum Fault	Checksum or CRC error for Main Block of CIP Motion device detected as part of Self-Test.
3	Nonvolatile Memory Checksum Fault	Checksum or CRC error for NV Memory of CIP Motion device detected as part of Self-Test.
4...31	Reserved	

See also

Rockwell Automation Specific Initialization Faults on page 296

Initialization Faults Attributes on page 295

Standard Start Inhibits on page 454

Rockwell Automation Specific Initialization Faults

This table defines a list of Rockwell Automation specific faults associated with the Initialization Faults-RA attribute.

Rockwell Automation Specific Initialization Faults Bit Descriptions

Bit	Exception	Description
0	Reserved	This bit cannot be used since the Fault Code is defined by the associated exception bit number and Fault Code of 0 means no fault condition is present.
1	Feedback Data Corruption	Smart Encoder Data Corruption detected.
2	Feedback Data Range	Data within a motor data blob is out of range.
3	Feedback Communication Startup	Communications with a smart encoder could not be established.
4	Feedback Absolute Overspeed	Excessive speed was detected in the battery-backed encoder while power was off.
5	Feedback Absolute Power Off Travel	The power-off travel range of the battery-backed encoder has been exceeded.

Bit	Exception	Description
6	Feedback Absolute Startup Speed	The absolute encoder was not able to accurately determine the position after power-up due to speed greater than 100 RPM.
7	Commutation Offset Uninitialized	The commutation offset stored in a third-party motor has not been initialized.
8	Reserved	-
9	Reserved	-
10	Reserved	-
11	Reserved	-
12	Invalid FPGA Image	The FPGA image is incompatible with hardware operation.
13	Invalid Board Support Package	The board support package is incompatible with hardware operation.
14	Invalid Safety Firmware	The safety firmware is not compatible with the drive firmware, or the main safety firmware is missing.
15	Power Board	Power Board checksum error.
16	Illegal Option Card	The Main Control Board has detected an illegal option installed in the port.
17	Option Storage Checksum	Option data storage checksum failed.
18	Reserved	-
19	Module Voltage Mismatch	IAM detects a voltage rating mismatch on the modular backplane.
20	Unknown Module	Unknown module is detected on the modular backplane.
21	Factory Configuration Error	Factory Configuration Data is missing or invalid.
22	Illegal Address	AM Node Address is out of range (>254).
23	Series Mismatch	SERCOS AMs have been detected by the CIP IAM.
24	Open Slot	IAM detects an open slot on the modular backplane.
25...31	Reserved	-

See also

Rockwell Automation Specific Exceptions on page 465

Rockwell Automation Specific CIP Axis Alarm Names on page 468

Rockwell Automation Specific CIP Axis Fault Names on page 467

Rockwell Automation Specific Start Inhibits on page 455

Module/Node Fault and Alarm Attributes

These are the module/node fault and alarm related attributes associated with a Motion Control Axis.

Module Fault Bits

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/GSV	T	DWORD	-	-	-	Bitmap 0 = Control Sync Fault 1 = Module Sync Fault 2 = Timer Event Fault 3 = Module Hard Fault 4 = Reserved 5 = Reserved 6 = Reserved 7 = Conn. Format Fault 8 = Local Mode Fault 9 = CPU Watchdog Fault 10 = Clock Jitter Fault 11 = Cyclic Read Fault 12 = Cyclic Write Fault 13 = Clock Skew Fault 14 = Control Conn. Fault 15 = Reserved 16 = Module Clock Sync Fault 17 = Logic Watchdog 18 = Duplicate Address 19...31 = Reserved

This bit field is a roll-up of module scoped fault conditions that can include synchronization faults detected on either side of the CIP Motion connection. All defined Node Fault Codes are mapped into bits in this attribute. The controller generally applies a shutdown fault action when a Module Fault occurs and recovery generally requires module reconnection or reconfiguration.

The following table defines a list of conditions associated with the Module Fault Bits attributes. While the Module Fault Bits attribute is marked as Required in the CIP Motion device implementation, support for each of the individual fault conditions therein is left Optional. In this table the terms motion module and motion device are used synonymously.

Bit	Module Fault Name	Device Node Fault Name	Description
0	Control Sync Fault	-	The Control Sync Fault bit attribute is set when the Logix controller detects that several consecutive connection updates from the motion module have been missed. This condition results in the automatic shutdown of the associated motion module. The Logix controller is designed to "ride-through" a maximum of four missed position updates without issuing a fault or adversely impacting motion in progress. Missing more than four position updates in a row constitutes a problematic condition that warrants shutdown of the motion module. This bit is cleared when the connection is reestablished.

Bit	Module Fault Name	Device Node Fault Name	Description
1	Module Sync Fault	Control Connection Update Fault	The Module Sync Fault bit attribute is set when the motion module detects that several consecutive connection updates in a row from the Logix processor module have been missed or that an update has been excessively late as determined by the Controller Update Delay High Limit attribute value. This condition results in the automatic shutdown of the motion module. The motion module is designed to "ride-through" a maximum of missed or late updates without issuing a fault or adversely impacting motion in progress. Missed or late update that exceed the Controller Update Delay High Limit result in the Module Sync Fault condition. This bit is cleared when the connection is reestablished.
2	Timer Event Fault	-	The Timer Event Fault bit attribute is set when the associated motion module has detected a problem with the module's timer event functionality used to synchronize the motion module's control loops. The Timer Event Fault bit can only be cleared by reconfiguration or power cycle of the motion module.
3	Module Hard Fault	Hardware Fault	If the Module Hardware Fault bit attribute is set it indicates that the associated motion module has detected a hardware problem that, in general, is going to require replacement of the module to correct.
4 - 6	Reserved	-	
7	Conn Format Fault	Data Format Error	This fault bit indicates that an error has occurred in the data format between the controller and the device, for example, a Format Revision mismatch.
8	Local Mode Fault	-	The Local Mode Fault is set when the controller is locked in Local Mode operation.
9	CPU Watchdog Fault	Processor Watchdog Fault	The Processor Watchdog Fault bit indicates that the processor associated with the device node has experienced an excessive overload condition that has tripped the associated processor watchdog mechanism.
10	Clock Jitter Fault	-	The Clock Jitter Fault bit is set when there is excessive clock jitter between the controller and the motion device.
11	Cyclic Read Fault	-	The Cyclic Read Fault is set when the controller detects a runtime error associated with the Cyclic Read mechanism.
12	Cyclic Write Fault	-	The Cyclic Write Fault is set when the controller detects a runtime error associated with the Cyclic Write mechanism.
13	Clock Skew Fault	Clock Skew Fault	Clock Skew Fault bit indicates that the motion device has detected significant difference between the device's System Time and the controller's System Time that prevented the device from switching to synchronous operation after a time out period.
14	Control Conn Fault	Control Connection Loss Fault	The Control Connection Loss fault bit indicates that the CIP Motion C-to-D connection from the controller has timed out.
15	Reserved	-	

Bit	Module Fault Name	Device Node Fault Name	Description
16	Clock Sync Fault	Clock Sync Fault	The Clock Sync Fault bit indicates that the motion device's local clock has lost synchronization with the master clock for an extended period of time (40 to 60 seconds) during synchronous operation. This fault condition is an indication that the local IEEE 1588 clock has lost synchronization with the master and was not able to resynchronize within the allotted timeout (such as 40 to 60 seconds).
17	Logic Watchdog Fault	Logic Watchdog Fault	The Logic Watchdog Fault bit indicates that an auxiliary logic component (for example, FPGA, or ASIC) associated with the device node has experienced an excessive overload condition that has tripped the associated logic watchdog mechanism.
18	Duplicate Address Fault	Duplicate Address Fault	The Duplicate Address Fault bit indicates that a motion device node has been detected on the network that uses the same Node Address as this device node. For Ethernet, this address would be the IP Address of the device.
19-31	Reserved	-	

Module Alarm Bits

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/GSV	T	DWORD	-	-	-	Bitmap 0 = Control Sync Alarm 1 = Module Sync Alarm 2 = Timer Event Alarm 3 = CPU Overload Alarm 4 = Clock Jitter Alarm 5 = Out of Range Alarm 6 = Clock Skew Alarm 7 = Clock Sync Alarm 8 = Node Address Alarm 9...31 = Reserved

This bit field is a roll-up of module scoped alarm conditions that can include synchronization alarms detected on either side of the CIP Motion connection. All defined Node Alarm Codes are mapped into bits in this attribute.

The following table defines a list of conditions associated with the Module Alarm Bits attributes. While the Module Alarm Bits attribute is marked as Required in the CIP Motion device implementation, support for each of the individual fault conditions therein is left Optional. In this table the terms motion module and motion device are used synonymously.

Bit	Alarm Name	Device Node Alarm Name	Description
0	Control Sync Alarm	-	The Control Sync Alarm bit attribute is set when the Logix controller detects that several consecutive connection updates from the motion module have been missed.
1	Module Sync Alarm	Control Connection Update Alarm	The Module Sync Alarm bit attribute is set when the motion module detects that several consecutive connection updates in a row from the Logix processor module have been missed or that an update has been excessively late as determined by the Controller Update Delay Low Limit attribute value. This bit is cleared after 10 seconds without another alarm condition.
2	Timer Event Alarm	-	The Timer Event Alarm bit attribute is set when the associated motion module has detected a problem with the module's timer event functionality used to synchronize the motion module's control loops. The Timer Event Alarm bit can only be cleared by reconfiguration or power cycle of the motion module.
3	Processor Overload Alarm	Processor Overload Alarm	The Processor Overload Alarm bit indicates that the host processor associated with motion device is experiencing overload conditions that could eventually lead to a fault.
4	Clock Jitter Alarm	Clock Jitter Alarm	Clock Jitter Alarm bit indicates that the Sync Variance has exceeded the Sync Threshold while the motion device is running in Sync Mode.
5	Out of Range Alarm	-	The Out of Range Alarm indicates that the motion device has detected that a Cyclic Write attribute value has exceeded its allowed range.
6	Clock Skew Alarm	Clock Skew Alarm	Clock Skew Alarm bit indicates that the motion device has detected significant difference between the device's System Time and the controller's System Time that is preventing the device from switching to synchronous operation.
7	Clock Sync Alarm	Clock Sync Alarm	The Clock Sync Alarm bit indicates that the motion device's local clock has lost synchronization with the master clock for a short period of time (such as 10 to 20 seconds) during synchronous operation. This alarm condition can also occur when a change in the master clock source has been detected. The Clock Sync Alarm is an indication that the local IEEE-1588 clock has shifted back to its start-up mode to quickly synchronize into the master clock.
8	Node Address Alarm	Node Address Alarm	The Node Address Alarm bit indicates that the Node Address setting of the device has been changed during motion device operation and may no longer be valid.
19-31	Reserved	-	

See also

Exceptions on page 41

Standard Exceptions on page 456

Exception Factory Limit Info Attributes on page 290

Exception User Limit Configuration Attributes on page 292

Feedback Attributes

The following position feedback related attribute tables associated with a Motion Control Axis apply to various feedback device and feedback interface technologies.

Feedback Interface Types

Feedback interface technologies include:

- Digital AqB (digital A quad B signals)
- Sine/Cosine (analog A quad B signals)
- Digital Parallel (parallel digital bit interface)
- SSI (Synchronous Serial Interface)
- LDT (Linear Displacement Transducer)
- Resolver

Other modern feedback interfaces supported are: Hiperface (by Stegmann) and EnDat 2.1 and EnDat 2.2 (by Heidenhain). The Usage column for a feedback attribute is based on the context of the Feedback Type. Abbreviations for the various Feedback Types are defined in this table:

Feedback Type abbreviations

Abbreviation	Feedback Type
TT	Digital AqB
TP	Digital Parallel
SC	Sine/Cosine
HI	Hiperface
ED	EnDat 2.1 and 2.2
INT	Integrated
RS	Resolver
SS	SSI
LT	LDT - Linear Displacement Transducer
TM	Tamagawa
SL	Stahl SSI

This section defines the minimal set of required attributes to support CIP Motion device interchangeability. This guarantees that there is sufficient parametric data provided by the controller for any CIP Motion compliant drive to effectively interface to a wide range of feedback device types.

Multiple feedback device interfaces are currently defined by the Motion Control Axis per axis to serve specific control or master feedback functions. These feedback devices are accessed using their assigned logical channels, for example, Feedback 1 and Feedback 2. Each logical feedback channel is mapped to a physical feedback interface port of the device, for example Port 1, and Port 2.

Logical Feedback Channel Control Functions

Logical Feedback Channel	Motion Control Function	Master Feedback Function
Feedback 1	Motor Feedback and Commutation	Master Feedback 1
Feedback 2	Load-side Feedback	Master Feedback 2
Feedback 3	Vendor Specific	Vendor Specific
Feedback 4	Vendor Specific	Vendor Specific
Feedback 3 (Rockwell Automation)	Redundant Motor Feedback	Redundant Master Feedback 1
Feedback 4 (Rockwell Automation)	Redundant Load-side Feedback	Redundant Master Feedback 2

When the Control Mode is set to something other than No Control, Feedback 1 is associated with the motor mounted feedback device while Feedback 2 is associated with the load-side or machine mounted feedback device. Feedback 1 is always required for PM Motor commutation.

When Control Mode is set to No Control for a Motion Control Axis, different logical feedback channels can be used as the master feedback source, for example, Feedback 1 and Feedback 2. Generally, Feedback 1 is used.

For Rockwell Automation devices Feedback 3 is used to provide a redundant logical feedback channel for Feedback 1 while Feedback 4 is used to provide a redundant logical channel for Feedback 2.

To minimize the length of the feedback attribute tables below, the letter *n* in the generic Feedback n attribute name is used to specify the associated feedback channel number. Valid channel numbers for open standard feedback attributes of the Motion Control Axis are 1, 2, 3 and 4.

Attribute IDs are assigned based on the channel number. Support for feedback interface channels 1, 2, 3 and 4 are optional in the device implementation. If no feedback interface channel is present in the device the associated set of feedback channel attributes are not applicable.

However, if hardware support for any of these feedback channels is available in a given device, these attributes are clearly applicable in the implementation and will follow the Usage rules. A Usage rule of 'Req - E' or 'Opt - E' indicates that the attribute is generally applicable to all Device Control Codes where the feedback channel itself is applicable, hence the 'E' for Encoder.

If a specific logical feedback channel, feedback n, is not applicable based on the current feedback configuration, then attributes for feedback n are not applicable; no feedback configuration attributes for that channel are set by configuration software, nor are any such attributes sent to the drive device. This table outlines these rules:

Feedback Configuration	Feedback 1	Feedback 2
No Feedback	No	No
Master Feedback	Yes	No
Motor Feedback	Yes	No
Load Feedback	Yes(1)	Yes
Dual Feedback	Yes	Yes
Dual Integrator Feedback	Yes	Yes

(1)Feedback 1 channel is needed for commutation of PM Motors.

See also

General Feedback Info Attributes on page 316

General Feedback Signal Attributes on page 316

Feedback Configuration Attributes on page 304

Feedback Configuration Attributes

The Feedback Configuration attributes determines how the various available feedback channels are used to implement the selected Control Mode.

Feedback Configuration

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/GSV	USINT	0 (B, F) 1 (E) 2 (C)	0	15	Enumeration: 0 = No Feedback 1 = Master Feedback 2 = Motor Feedback 3 = Load Feedback 4 = Dual Feedback 5-7 = Reserved 8 = Dual Int Feedback 8-15 = Reserved

When configured, this attribute also sets the initial value for Feedback Mode. This 4-bit enumerated value determines how the various logical feedback channels are used to implement the selected Control Mode for this axis instance.

Feedback Configuration enumerations provide support for multi-feedback device control functionality for the various active device Control Modes, for example, where the device is actively controlling the motor based on feedback. In these active device Control Modes it is assumed that logical channel, Feedback 1, is attached directly to the motor while Feedback 2 is attached to the load side of the mechanical transmission. Commutation signals for a PM motor are always derived from the Feedback 1. The Feedback Configuration attribute is used by the controller to set the Feedback Mode attribute that is sent to the drive device.

The following table provides descriptions of the Feedback Configuration enumerations:

Bit	Usage	Name	Description
0	R/S	No Feedback	No Feedback is selected when sensorless open loop or closed loop control is desired. When performing open loop control, no feedback signal is required. In closed loop control, the required feedback signal is estimated by a sensorless control algorithm based on motor phase voltage and current signals.
1	R/N	Master Feedback	Master Feedback assigns an uncommitted feedback channel to this device axis instance to serve as a master feedback source when the device is configured for No Control mode
2	R/C	Motor Feedback	When Motor Feedback is selected, then commutation, acceleration, velocity, and position feedback signals are all derived from motor mounted Feedback 1
3	O/C	Load Feedback	When Load Feedback is selected, then motor-mounted Feedback 1 is only used for PM motor commutation while load-side Feedback 2 is used for position, velocity, and acceleration.
4	O/P	Dual Feedback	When Dual Feedback is selected, then motor mounted Feedback 1 is used for commutation, acceleration, and velocity, and load-side Feedback 2 is used strictly for position.
5…7	-	Reserved	-
8	O/P	Dual Integrator Feedback	Dual Integral Feedback means that motor-mounted Feedback 1 is used for commutation, acceleration, velocity, and position proportional control, and load-side Feedback 2 is used only for integral position control. This optimizes the stiffness of the control loop at low frequency.
9…15	-	Reserved	-

Feedback Mode

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All Derived from Feedback Configuration	Get/SSV*	USINT	0	0	15	Bits 0-3: Feedback Mode Enumeration 0 = No Feedback 1 = Master Feedback 2 = Motor Feedback 3 = Load Feedback 4 = Dual Feedback 5…7 = Reserved 8…15 = Vendor Specific 8 = Dual Int Feedback 4…7 = Reserved

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*						

The Feedback Mode attribute determines how the various available feedback channels are used to implement the selected Control Mode. This attribute is transferred to the device as part of the Cyclic data block. Currently only bits 0-3 are used to enumerate the Feedback Mode configuration.

Feedback Mode enumerations provide support for multi-feedback device control functionality for the various active device Control Modes, for example, where the device is actively controlling the motor based on feedback. In these active device Control Modes it is assumed that logical channel, Feedback 1, is attached directly to the motor while Feedback 2 is attached to the load side of the mechanical transmission. Commutation signals for a PM motor are always derived from the Feedback 1, except in the case of an active redundant feedback source.

Bit	Usage	Name	Description
0	R/S	No Feedback	No Feedback is selected when sensorless open loop or closed loop control is desired. When performing open loop control, no feedback signal is required. In closed loop control, the required feedback signal is estimated by a sensorless control algorithm based on motor phase voltage and current signals.
1	R/N	Master Feedback	Master Feedback assigns an uncommitted feedback channel to this device axis instance to serve as a master feedback source when the device is configured for No Control mode.
2	R/C	Motor Feedback	When Motor Feedback is selected, then commutation, acceleration, velocity, and position feedback signals are all derived from motor mounted Feedback 1.
3	O/C	Load Feedback	When Load Feedback is selected, then motor-mounted Feedback 1 is only used for PM motor commutation while load-side Feedback 2 is used for position, velocity, and acceleration.
4	O/P	Dual Feedback	When Dual Feedback is selected, then motor mounted Feedback 1 is used for commutation, acceleration, and velocity, and load-side Feedback 2 is used strictly for position.
5-7	-	Reserved	-
8	O/P	Dual Integrator Feedback	Dual Integral Feedback means that motor-mounted Feedback 1 is used for commutation, acceleration, velocity, and position proportional control, and load-side Feedback 2 is used only for integral position control. This optimizes the stiffness of the control loop at low frequency.
9-15	-	Reserved	-

When modified programmatically, using SSV, the Feedback Mode value cannot be set to an enumeration that the Feedback Configuration cannot support. For example if the Feedback Configuration is set for Motor Feedback, the Feedback Mode cannot be changed to Load Feedback since that feedback channel has not been configured.

Feedback Mode SSV Promotion Rules

The following table describes valid Feedback Modes.

Feedback Configuration	Valid Feedback Modes
No Feedback	No Feedback
Master Feedback	Master Feedback
Motor Feedback	Motor Feedback No Feedback
Load Feedback	Load Feedback Dual Feedback Motor Feedback No Feedback
Dual Feedback	Dual Feedback Load Feedback Motor Feedback No Feedback

Feedback Unit Ratio

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E PV only	Set/GSV	REAL	1 FD	-	-	Feedback 1 Units per Feedback 2 Unit

The Feedback Unit Ratio attribute is the number of Feedback 1 Units per Feedback 2 Unit. This value is also used by the drive to convert between feedback 2 counts to feedback 1 counts when configured for load feedback or dual feedback operation.

Feedback n Unit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/GSV	USINT	0 DB	-	-	Enumeration 0 = Rev 1 = Meter 2…127 = Reserved 128…255 = Vendor

The Feedback n Unit attribute is a unit of measure for the designated feedback device. The Feedback Unit for Feedback 1 and any redundant feedback device for Feedback 1 must be scalable to the configured Motor Unit; if the Motor Unit is set to Rev, Feedback 1 Unit must be set to Rev; if Motor Unit is set to Meter, Feedback 1 Unit will be set to Meter. Feedback devices with a Feedback Unit of Rev are considered "rotary" devices, while Feedback devices with a Feedback unit of Meter are considered "linear" devices.

Feedback n Type

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/GSV	USINT	0 DB	-	-	Enumeration 0 = Not Specified (R) 1 = Digital AqB (O) 2 = Digital AqB with UVW (O) 3 = Digital Parallel (O) 4 = Sine/Cosine (O) 5 = Sine/Cosine with UVW (O) 6 = Hiperface (O) 7 = EnDat Sine/Cosine (O) 8 = EnDat Digital (O) 9 = Resolver (O) 10 = SSI Digital (O) 11 = LDT (O) 12 = Hiperface DSL (O) 13 = BiSS Digital (O) 14 = Integrated (O) 15 = SSI Sine/Cosine (O) 16 = SSI AqB (O) 17 = BiSS Sine/Cosine (O) 18…127 = Reserved 128…255 = Vendor Specific 128 = Tamagawa Serial 129 = Stahl SSI

The Feedback n Type attribute identifies the type of feedback device connected to the associated Feedback interface. Drive support for any individual feedback types is left to the discretion of the device manufacturer. However if a specific feedback type is supported, attributes associated with that type are generally required in the implementation.

When Feedback n Type is set to Not Specified, all Feedback n configuration attribute values associated with this feedback device are considered Not Applicable and will not be set by configuration software nor will they be sent to the drive. If the optional Commutation Startup Method attribute is not supported by the device, or the Commutation Startup Method is set to From Feedback Type, the Feedback 1 Type can be used to implicitly specify the commutation startup method.

For example, by selecting the Feedback 1 Type with or without UVW commutation signals the device applies the UVW commutation startup method or the Self-Sense startup method, respectively. In this case, UVW commutation signals can be derived from UVW tracks integral to the feedback device or using separate Hall sensors in the motor. All other Feedback 1 Type selections would apply the Digital commutation startup method.

In the case of a motor mounted feedback device, if Motor Data Source is Motor NV or Drive NV, the Feedback 1 Type may not be known to the controller but is known by the drive, so the drive can operate in this case without specifying the Feedback 1 Type.

In the case of a motor mounted feedback device, if the Motor Data Source is Datasheet or Database, an unspecified Feedback 1 Type, when received by the drive device during configuration, indicates that the motor feedback configuration has not been defined and therefore results in a Configuration Fault indicating an Invalid Attribute Value.

Feedback n Polarity

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	Set/SSV*	USINT	0	-	-	Enumeration 0 = Normal Polarity 1 = Inverted Polarity 2...225 = Reserved

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The Feedback n Polarity attribute is an enumerated value used to establish the direction of change in the feedback counter in response to positive motion of the associated feedback device. Normal polarity is defined as that which results in increasing feedback counts when the feedback device is hooked up and moved in the positive direction according to the devices published specifications.

Inverted polarity internally switches the polarity of the feedback accumulator so that the feedback counts decrease when the feedback device moves in the positive direction. This attribute can be used to make the direction of travel agree with the user's definition of positive travel and can be used in conjunction with the Motor Polarity bit to provide negative feedback, when this feedback channel is used for closed loop control.

Feedback n Startup Method

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/GSV	USINT	Default Startup Method DB	-	-	Enumeration 0 = Incremental (R) 1 = Absolute (O) 2...255 = Reserved

The Feedback n Startup Method attribute determines how the device applies the feedback count value during drive startup. When configured for Incremental mode, the device zeros the feedback count accumulator at power-up. The first Actual Position value sent to the controller in the Cyclic Data Block of the

Device-to-Controller connection at power-up is zero. This is an indication to the controller that the drive has been power-cycled and the drive axis needs to be homed to establish a machine reference position.

When configured for Absolute mode, the device initializes the feedback count accumulator at power-up to the absolute feedback position value read from the feedback device. When the feedback device's absolute position range is less than the 32-bit signed integer representation of the feedback count accumulator, the absolute position is sign extended to a 32-bit signed value. While there are many Feedback Types that support Absolute startup, there are a few strictly incremental types that do not: Digital AqB, and Sine/Cosine.

Some device vendors tie the Feedback Startup Method to the Feedback Type selection. In these cases, an attempt by the controller to incorrectly configure the Feedback Startup Method will generate a General Status error of Invalid Attribute Value.

The default Feedback Startup Method value depends on the associated Feedback Type according to the following table:

Feedback Type	Default Feedback Startup Method
Digital AqB	Incremental
Digital Parallel	Absolute
Sine/Cosine	Incremental
Hiperface	Absolute
EnDat Sine/Cosine	Absolute
EnDat Digital	Absolute
Resolver	Absolute
SSI Digital	Absolute
LDT	Absolute
Hiperface DSL	Absolute
BiSS Digital	Absolute
Integrated	Absolute
SSI Sine/Cosine	Absolute
SSI AqB	Absolute
BiSS Sine Cosine	Absolute
Tamagawa Serial	Absolute
Stahl SSI	Absolute

Feedback n Cycle Resolution

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E Not LT	Set/GSV	UDINT	Default Feedback Resolution DB	1	max dint	Cycles/Unit (Rotary): Feedback Cycles / Rev Cycles/Unit (Linear): Feedback Cycles / m Unit/Cycle (Linear): nm / Feedback Cycle Bits/Unit (Rotary): 2^n Cycles / Rev (Rotary) where n = #Bits

The Feedback n Cycle Resolution attribute determines the resolution capability of the associated feedback device. Units for this attribute are determined by the Feedback n Resolution Unit and the rotary or linear Feedback n Unit as shown in the Semantics column. For rotary feedback devices, this value is expressed as the number of Feedback Cycles per Revolution of the device, or alternatively by the number of bits in the binary position representation of the device per Revolution. For linear feedback devices, this value represents the either the number of Feedback Cycles per Meter (m), or the number of nanometers (nm) per Feedback Cycle.

Cycles for a Digital AqB device represent the 'line' resolution of the encoder. Cycles for a Sin/Cos device represent the sinusoidal 'cycle' resolution of the encoder. Cycles for a Resolver is the 'pole' count of the device. For digital serial (e.g. SSI) or parallel absolute feedback devices, Cycles represent the 'step' or 'count' resolution of the device.

The default Feedback Resolution value used for the Feedback Cycle Resolution attributes depends on the associated Feedback Type and Feedback Unit selection according to the following table:

Default Feedback Resolution vs. Feedback Type and Feedback Unit

Feedback Type	Feedback Resolution Feedback Unit = Revs	Feedback Resolution Feedback Unit = Meters
Digital AqB	1024 cycles/rev	4096 cycles/m
Digital Parallel	1024 cycles/rev	4096 cycles/m
Sine/Cosine	1024 cycles/rev	4096 cycles/m
Hiperface	1024 cycles/rev	4096 cycles/m
EnDat Sine/Cosine	2048 cycles/rev	8192 cycles/m
EnDat Digital	131072 cycles/rev	655360 cycles/m
Resolver	2 cycles/rev	8 cycles/m
SSI Digital	524288 cycles/rev	2097152 cycles/m
LDT	-	-
Hiperface DSL	131072 cycles/rev	655360 cycles/m

Feedback Type	Feedback Resolution Feedback Unit = Revs	Feedback Resolution Feedback Unit = Meters
BiSS Digital	524288 cycles/rev	2097152 cycles/m
Integrated	131072 cycles/rev	2097152 cycles/m
SSI Sine/Cosine	1024 cycles/rev	4096 cycles/m
SSI AqB	1024 cycles/rev	4096 cycles/m
BiSS Sine Cosine	1024 cycles/rev	4096 cycles/m
Tamagawa Serial	131072 cycles/rev	655360 cycles/m
Stahl SSI	1024 cycles/rev	4096 cycles/m

Feedback n Cycle Interpolation

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E Not LT	Set/GSV	UDINT	4 DB	1	max dint	Feedback Counts / Feedback Cycle

The Feedback n Cycle Interpolation attribute is the number of interpolated Feedback Counts per Feedback Cycle. For a Digital AqB device the device's feedback interface hardware can generally support interpolation values of 1, 2, or 4. For a Sin/Cos, Hiperface, EnDat, or Resolver feedback device the number is generally much larger and determined by the interpolation capability of the device feedback interface hardware. A value of 1024 is typical in this case. For digital serial, for example, SSI, or parallel absolute feedback device interfaces, this value is always 1 since there is no opportunity for device-based interpolation. The effective resolution of the feedback device in Feedback Counts per Feedback Unit is determined by the combination of the Feedback Cycle Resolution and the Feedback Cycle Interpolation attribute values.

Feedback n Turns

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E Rotary Absolute	Set/GSV	UDINT	1 DB	1	max dint	Feedback Units (Rev)

The Feedback n Turns attribute is the maximum number of shaft turns specified for a rotary absolute feedback device to maintain its absolute position reference. Typical rotary absolute feedback devices specify an absolute number of turns that typically range from 1 to 4096 in powers of 2. This attribute can be used by the control system to determine the maximum Feedback Count range of the absolute feedback device, this being the product of the feedback cycle resolution, interpolation, and turns.

Feedback n Length

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E Linear Absolute	Set/GSV	REAL	1 DB	0.001	∞	Meters

The Feedback n Length attribute is the specified length of a linear absolute feedback device. Typical linear absolute feedback devices specify length in Meters. This attribute can be used by the control system to determine the maximum travel range of absolute feedback device in Feedback Counts, this being the combination of the feedback cycle resolution, interpolation, and length.

Feedback n Data Length

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E TP, SS	Set/GSV	USINT	16	8	32	# of Bits

The Feedback n Data Length attribute is the number of feedback data bits transferred over the digital serial or parallel data interface channel of a feedback device.

Feedback n Data Code

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E TP, SS	Set/GSV	USINT	0	-	-	Enumeration 0 = Binary 1 = Gray 2…255 = Reserved

The Feedback n Data Code attribute is the type of feedback data bit encoding used by designated serial or parallel data interface channel of a feedback device.

Feedback n Resolver Transformer Ratio

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E RS	Set/GSV	REAL	1	-	-	-

The Feedback n Resolver Transformer Ratio attribute is the Transformer Ratio specification of the designated resolver feedback device.

Feedback n Resolver Excitation Voltage

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E RS	Set/GSV	REAL	0	-	-	Volts (RMS)

The Feedback n Resolver Excitation Voltage attribute sets the sinusoidal excitation voltage applied to the rotor of the designated resolver feedback device.

Feedback n Resolver Excitation Frequency

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E RS	Set/GSV	REAL	4000	-	-	Hertz

The Feedback n Resolver Excitation Frequency attribute is the frequency of sinusoidal excitation signal applied to the designated resolver feedback device. Valid frequency range or values for this attribute depends on the specific device hardware interface.

Feedback n Resolver Cable Balance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E RS	Set/GSV	REAL	100	0		%

The Feedback n Resolver Cable Balance attribute adjusts the relative amplitude of the Sine and Cosine signals from the resolver to compensate for impact of resolver cable.

Feedback n Loss Action

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	Set/GSV	USINT	0	-	-	Enumeration 0 = Set Exception (R) 1 = Switch to Sensorless Fdbk (0) 2 = Switch to Redundant Feedback (0) 3…255 = Reserved Valid for n = 1 or 2

The Feedback n Loss Action attribute specifies the action taken in the event of a loss of Feedback 1 signal. Valid actions are to simply handle as an Exception, or automatically switch to Sensorless operation where feedback is estimated based on motor current and voltage signals, or automatically switch to a scaled version of a redundant feedback device. In the case of redundant feedback, Feedback 1 is called the primary feedback source and the redundant channel is the called the secondary feedback source.

Feedback n Velocity Filter Taps

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	Set/SSV	UINT	1	1	maxint	Delay Taps (>= 1)

The Feedback n Velocity Filter Taps attribute determines the number of delay taps used in the FIR Filter differencing algorithm to estimate velocity from Feedback n. A simple difference of 1 sample period is equivalent to a 1 delay tap.

Feedback n Accel Filter Taps

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	Set/SSV	UINT	1	1	maxint	Delay Taps (>= 1)

The Feedback n Accel Filter Taps attribute determines the number of delay taps used in the FIR Filter differencing algorithm to estimate acceleration from Feedback n. The Acceleration FIR filter can be implemented as two cascaded FIR filters each configured according to the Feedback n Acceleration Filter Tap setting. A simple difference of 1 sample period is equivalent to 1 delay tap.

Feedback n Velocity Filter Bandwidth

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	Set/SSV	REAL	0 FD	0	∞	Filter Frequency Units

The Feedback n Velocity Filter Bandwidth attribute controls the bandwidth of the Low Pass Filter applied to the raw velocity signal from Feedback n. A value of 0 for this attribute disables this feature.

Feedback n Accel Filter Bandwidth

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	Set/SSV	REAL	0	0	∞	Filter Frequency Units

The Feedback n Accel Filter Bandwidth attribute controls the bandwidth of the Low Pass Filter applied to the raw acceleration signal from Feedback n. A value of 0 for this attribute disables this feature.

Feedback n Battery Absolute

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E TM	Set/GSV	USINT	0	-	-	Enumeration 0 = No 1 = Yes

The Feedback n Battery Absolute attribute determines if a battery is included in a battery-backed absolute feedback device. This allows the drive to qualify Feedback Battery Loss and Feedback Battery Low exception conditions.

See also

Feedback Attributes on page 302

General Feedback Info Attributes on page 316

General Feedback Signal Attributes on page 316

Interpreting the Attribute Tables on page 87

General Feedback Info Attributes

These are the general feedback information attributes associated with a Motion Control Axis.

Feedback n Serial Number

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	Get	SHORT STRING	-	-	-	For example, 0012003400560078

The Feedback n Serial Number attribute is a 16-character string that specifies the serial number of the device associated with Feedback n. If it is not possible for the drive to read the Serial Number from the feedback device the drive sets this attribute to a Null string.

See also

Feedback Attributes on page 302

General Feedback Signal Attributes on page 316

Feedback Configuration Attributes on page 304

General Feedback Signal Attributes

These are the general feedback signal attributes associated with a Motion Control Axis.

Position Feedback n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/GSV	T	DINT	-	-	-	Feedback n Counts

The Position Feedback n attribute is the actual position of the axis based on Feedback n.

See also

Feedback Attributes on page 302

General Feedback Signal Attributes on page 316

Feedback Configuration Attributes on page 304

Motion Control Attributes

The following attribute tables contain motion control related attributes associated with a Motion Control Axis Object instance.

Motion Control Configuration Attributes

These are the basic motion control configuration attributes associated with a motion control axis. These attributes govern the overall behavior of the motion control axis.

Axis features

Usage	Access	Data Type	Default	Min	Max	Value Description
Required - All	Set/ GSV	DWORD	0	-	-	Bitmap 0 = Fine Interpolation (0) 1 = Registration Auto-rearm (0) 2 = Alarm Log (0) 3 = Marker (0) 4 = Home Switch (0) 5 = Hookup Test (0) 6 = Commutation Test (0) 7 = Motor Test (0) 8 = Inertia Test (0) 9 = Sensorless Control (0) 10 = Drive Scaling (0) 11 = Extended Event Block (0) 12 = Integer Command Position (0) 13 = Ext. Motor Test (0) 14 = Control Mode Change (0) 15 = Feedback Model Change (0) 16 = Pass Bus Status (0) 17 = Pass Bus Unload (0) 18 = Ext. Speed for SPM (0) 19 = Ext. Speed for IPM (0) 20...31 = Reserved

The following table provides descriptions of the bit specified Axis feature attribute values.

Bit	Motion Status	Description
0	Fine Interpolation (0)	Indicates that the axis supports fine interpolation of command data based on command target time. Fine interpolation is used to provide smoother command reference signals when the drive update period is smaller than the controller update period.
1	Registration Auto-rearm (0)	Indicates that the axis supports the automatic re-arming mechanism for registration inputs. This feature is required for windowed registration support.
2	Alarm Log (0)	Indicates that this axis supports the Alarm Log feature. Alarm Log data is received from the drive using the Alarm bit of the Status Data Set and updates the Alarm Log of the controller.
3	Marker (0)	Indicates that the axis position feedback device supports a marker function. This functionality is required for Homing Sequences that employ the marker signal and for the marker Hookup Test.
4	Home Switch (0)	Indicates that the axis supports a home switch input. This functionality is required for Homing Sequences that employ the home switch input signal.
5	Hookup Test (0)	The axis supports a Hookup Test service. This service is required to perform a Hookup Test (MRHD) to check wiring to the motor and feedback components.
6	Commutation Test (0)	The axis supports a Commutation Test as part of the Hookup Test service. This service is required to perform a Hookup Test (MRHD) to check commutation wiring and determine the Commutation Offset.
7	Motor Test (0)	The axis supports a Motor Test service. This service is required to perform a Motor Test (MRMT) to measure motor model parameters.
8	Inertia Test (0)	The axis supports an Inertia Test service. This service is used as part of the Auto Tune (MRAT) that measures inertia.
9	Sensorless Control (0)	The axis supports sensorless control operation letting the drive run in velocity loop mode without an external feedback device.
10	Drive Scaling (0)	The device supports Drive Scaling functionality where the device is able to scale feedback counts to planner counts and manage absolute position.
11	Extended Event Block (0)	The device supports the extended Event Data Block format. This format supports additional features generally associated with Drive Scaling functionality, such as Watch Position events and Windowed Registration.
12	Integer Command Position (0)	The device requires Command Position Format to be a DINT (32-bit signed integer) data type. If not set, the device supports the standard LREAL (64-bit floating point) Command Position data type.
13	Ext. Motor Text (0)	The device supports the extended motor data format for the Motor Test service. This format supports transfer of vendor specific motor parameters and is required for the Motor Test service to support IPM motors.
14	Control Mode Change (0)	The device supports changes to the Control Mode while in the Running state without generating large motion disturbances (bumpless). An example of such a mode change would be to switch from Position Control to Torque Control using an SSV instruction. If a particular Control Mode change is not supported by the device, a Configuration Fault will be generated.

Bit	Motion Status	Description
15	Feedback Mode Change (0)	The device supports the ability to change the Feedback Mode while in the Running state without generating large motion disturbances (bumpless). An example of such a mode change would be to switch from Load Feedback to Motor Feedback using an SSV instruction. If a particular Feedback Mode change is not supported by the device, a Configuration Fault will be generated.
16	Pass Bus Status (0)	The device supports passing Converter Status bits, Bus Up and AC Power Loss, in the Control Status element of the C2D Connection's Axis Instance header when configured for DC Bus Sharing. The states of these Bus Status bits are determined by the controller based on the Bus Up and AC Power Loss bits passed in the Axis Status element of the D2C Connection's Cyclic Data of Converters or Drives (Bus Masters) that also support the Pass Bus Status feature. If clear, the associated device does not support Bus Up and AC Power Loss bits in the C2D Connection. Furthermore, if clear, the Bus Up and AC Power Loss status bits received by the controller in the device's D2C connection are not passed on to any other devices.
17	Pass Bus Unload (0)	The associated device is capable of generating a Bus Sharing exception based on Bus Unload request bit passed in the Control Status element of the C2D Connection's Axis Instance header. In this case, the controller passes a Bus Unload request to the device if any Converter or Drive (Bus Masters) in its Bus Sharing Group requests a Bus Unload. If clear, the controller is responsible for generating a Bus Sharing exception for this device axis in response to a Bus Unload request from any Converter or Drive (Bus Masters) in its Bus Sharing group.
18	Ext. Speed for SPM (0)	The device supports extending the speed range of an SPM motor through field weakening to speeds that require methods to protect drives from destructive DC Bus Overvoltage conditions. To manage that risk, the Extended Speed feature provides additional PM motor attributes including a PM Motor Extended Speed Permissive attribute.
19	Ext. Speed for IPM (0)	The device supports extending the speed range of an IPM motor through field weakening to speeds that require methods to protect drives from destructive DC Bus Overvoltage conditions. To manage that risk, the Extended Speed feature provides additional PM motor attributes including a PM Motor Extended Speed Permissive attribute.

Axis configuration

Usage	Access	Data Type	Default	Min	Max	Value Description
Required - All	Set/GSV	USINT	AOP*	0	5	Enumeration 0 = Feedback Only (0) 1 = Frequency Control (0) 2 = Position Loop (0) 3 = Velocity Loop (0) 4 = Torque Loop (0) 5 = Converter Only (0) 6…15 = Reserved

* The default value can be specified by the specific drive profile (AOP).

The axis configuration attribute determines the general dynamic control behavior of the motion device axis instance.

This attribute is used to set both the Control Mode and Control Method attributes according to the following table:

Axis Config	Control Mode	Control Method
Converter Only	No Control	No Control
Feedback Only	No Control	No Control
Frequency Control	Velocity Control	Frequency Control
Position Loop	Position Control	PI Vector Control
Velocity Loop	Velocity Control	PI Vector Control
Torque Loop	Torque Control	PI Vector Control

The axis configuration attribute is an enumerated value that determines the general dynamic control behavior of the motion device axis instance. This attribute is used by the controller to set the Control Mode attribute that is sent to the drive as part of the cycle connection, and also determines Control Method attribute configuration. So, when axis configuration is set by configuration software, control mode and control method are also updated.

The following table provides descriptions of the Axis configuration attribute values:

Enumeration	Usage	Name	Description
0	R/N O/C	Feedback Only	Provides an axis interface to a specific feedback device as a master feedback source. The Control Mode and Control Method are set to No Control in this configuration, indicating that there is no dynamic control capability associated with this axis.
1	R/F	Frequency Control	Selects the Frequency Control Method that applies voltage to the motor, generally in proportion to the commanded frequency or speed. Accordingly, the Control Mode attribute is set to Velocity Control.
2	R/P	Position Loop	Selects the PI Vector Control Method that applies feedback to provide closed loop cascaded PI control of motor position, velocity, and torque, and includes closed loop control of Iq and Id components of the motor current vector. Accordingly, the Control Mode attribute is set to Position Control.
3	R/V O/P	Velocity Loop	Selects the PI Vector Control Method that applies feedback to provide closed loop cascaded PI control of motor velocity, and torque, and includes closed loop control of Iq and Id components of the motor current vector. Accordingly, the Control Mode attribute is set to Velocity Control.
4	R/T O/PV	Torque Loop	Selects the PI Vector Control Method that applies feedback to provide closed loop PI control of motor torque through control of Iq and Id components of the motor current vector. Accordingly, the Control Mode attribute is set to Torque Control.
5	R/B O/D	Converter Only	Provides an axis interface to a standalone power converter device. Both the Control Mode and Control Method are set to No Control in this configuration, indicating that there is no dynamic control capability associated with this axis.

Control Mode

Usage	Access	Data Type	Default	Min	Max	Value Description
Required - All Derived from Axis Configuration	Get/ SSV[1]	BYTE	0	0	4	Enumeration 0 = No Control 1 = Position Control 2 = Velocity Control 3 = Acceleration Control 4 = Torque Control 5…15 = Reserved

(1) SSV - These configuration attributes cannot be changed online or using an SSV instruction if the axis is in the Running state, for example the Tracking Command bit of the CIP Axis Status attribute.

The Control Mode attribute determines the general dynamic control behavior of the drive device axis instance and consists of a 4-bit enumeration. This value is derived from the axis configuration attribute value during initialization. This attribute is transferred to the device as part of the Cyclic data block.

When modified programmatically, using SSV, the Control Mode value cannot be set to an enumeration that the current Axis Configuration cannot support. For example if the axis configuration is set for Velocity Loop, the Control Mode cannot be changed to Position Loop since position loop attributes have not been configured. This table provides a list of valid Control Modes for a given axis configuration:

Axis Configuration	Valid Control Modes
Converter Only	No Control
Feedback Only	No Control
Frequency Control	Velocity Control
Position Loop	Position Control Velocity Control Torque Control
Velocity Loop	Velocity Control Torque Control
Torque Loop	Torque Control

The Control Mode attribute is a 4-bit enumeration that determines the specific dynamic behavior of the motor that the device is to control for this axis instance. The following table provides descriptions of valid Control Modes.

Enumeration	Usage	Name	Description
0	R/N	No Control	No motor control is provided in this mode but interface to a specific feedback device as a master feedback source is possible using the Feedback Configuration attribute.
1	R/P	Position Control	Controls the position, or orientation, of the motor.

Enumeration	Usage	Name	Description
2	R/PV	Velocity Control	Controls the velocity of the motor.
3	O/C	Acceleration Control	Controls the acceleration of the motor.
4	R/C	Torque Control	Controls the torque output of the motor.
5...15		Reserved	-

Control Method

The Control Method (derived from axis configuration) attribute is an 8-bit enumerated code that determines the basic motor control algorithm applied by the device to control the dynamic behavior of the motor.

Usage	Access	Data Type	Default	Min	Max	Value Description
Required - All Derived from Axis Configuration	Get/ GSV	USINT	0	0	2	Enumeration 0 = No Control 1 = Frequency Control 2 = PI Vector Control 3...255 = Reserved

This value is sent to the drive during initialization and cannot be changed during operation.

Enumeration	Usage	Name	Description
0	R/N	No Control	Associated with a Control Mode of No Control where there is no explicit motor control provided by the device for this axis instance.
1	R/F	Frequency Control	An open loop control method that applies voltage to the motor, generally in proportion to the commanded frequency or speed. This control method is associated with Variable Frequency Drives (VFDs) or so called Volts/Hertz drives.
2	R/C	PI Vector Control	A closed loop control method that uses actual or estimated feedback for closed loop cascaded PI control of motor dynamics, for example, position, velocity, acceleration, and torque, and always includes independent closed loop PI control of Iq and Id components of the motor current vector.
3...127		Reserved	-
128...255		Vendor Specific	-

See also

Interpreting the Attribute Tables on page 87

Control Modes on page 16

Control Mode Attributes on page 187

Motion Control Interface Attributes

The Motion Control Interface attributes are used by the Logix Designer application to support the interface to an axis. Interface attributes are used to customize what choices appear on the properties pages and help you structure a motion axis.

Tip: Remember that the attributes that appear in the Logix Designer application are dependent on the current Control Mode.

Axis Address

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get	DINT	-	-	-	Absolute Address

Absolute Address of Motion Control Axis Object data structure. The Axis Address attribute is used to return the actual physical address in memory where the axis instance is located.

Axis Instance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/ GSV	DINT	-	-	-	Instance Number

Instance Number assigned to this instance of the Motion Control Axis Object. The Axis Instance attribute is used to return the instance number of an axis. An example of using this attribute is responding to an axis major fault. Major fault records contain the axis instance of the offending axis. Use this attribute to query an axis instance and determine if the instance number matches the fault record.

The Axis Instance attribute is required when accessing an attribute using a MSG instruction.

Group Instance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/ GSV	DINT	-	-	-	Instance Number

Instance Number of the Motion Group assigned to this instance of the Motion Control Axis Object. Use the Group Instance attribute to determine what motion group this axis is assigned to.

Map Instance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ GSV	DINT	-	-	-	Instance Number

I/O Map Instance Number assigned to this instance of the Motion Control Axis Object. The Map Instance attribute associates an axis to a specific motion compatible module by specifying the I/O map entry representing the module. This value is set to 0 for virtual and consumed data types.

Module Channel

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ GSV	USINT	255	-	-	Channel Number (0, 1, 2, . . .) A value of 255 indicates the axis is unassigned.

Channel number of the module assigned to this instance of the Motion Control Axis Object. The Module Channel attribute associates an axis to a specific channel on a motion compatible module by specifying the Module Channel attribute.

Module Class Code

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ GSV	DINT	-	-	-	Object Class Code

Object class code of the motion engine in the module. The Module Class Code attribute is the class code of the object in the motion module which is supporting motion; for example 0xAF is the object ID of the Servo Module Axis residing in the 1756-M02AE module.

C2C Map Instance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ GSV	DINT	-	-	-	Producer/Consumed axis's associated C2C map instance

Producer/Consumed axis's associated C2C map instance. When the Axis Data Type attribute is specified to be 'Consumed' then this axis is associated to the consumed data by specifying both the C2C Map Instance and the C2C Connection Instance. For all other Axis Data Types if this axis is to be produced then this attribute is set to 1 (one) to indicate that the connection is off of the local controller's map instance.

C2C Connection Instance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ GSV	DINT	-	-	-	Producer/Consumed axis's associated C2C connection in reference to the C2C map instance

Producer/Consumed axis's associated C2C connection in reference to the C2C map instance. If this axis is to be produced, then this attribute is set to the connection instance under the local controller's map instance (1) that will be used to send the remote axis data through the C2C connection.

Memory Use

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/ GSV	UINT	-	-	-	105 (0x69) = I/O space 106 (0x6a) = Data Table space

Controller memory space where this instance of the Motion Control Axis Object exists. This attribute is initialized as part of the create service when you create the axis.

The Logix Designer programming application uses this attribute to create axis instances in I/O memory for axes that are either to be produced or consumed.

The Memory Use attribute can only be set as part of an axis create service and is used to control which controller memory the object instance is created in.

Memory Usage

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get	DINT	-	-	-	Bytes

Amount of memory consumed for this instance of the Motion Control Axis Object. The Memory Use attribute can be used to determine the amount of memory the created instance consumes in bytes.

Axis Data Type

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get	USINT	-	-	-	Enumeration: 0 = Feedback 1 = Consumed 2 = Virtual 3 = Generic 4 = Servo 5 = Servo Drive 6 = Generic Drive 7 = CIP Drive

Associated tag data type for this instance of the Motion Control Axis Object. This attribute is initialized as part of the create service when you create the axis.

The Axis Data Type attribute and is used to determine which data template, memory format, and set of attributes are created and applicable for this axis instance. This attribute can only be set as part of an axis create service.

Axis Configuration State

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/ GSV	USINT	-	-	-	Enumeration 0 = Axis Instance Created 1 = Connection Created 126 = Axis Inhibited 128 = Axis Configured

State of the configuration state machine for this instance of the Motion Control Axis Object. The Axis Configuration State attribute is used for troubleshooting purposes to indicate where in the axis configuration state-machine this axis presently is. Even consumed and virtual axes will utilize this attribute. This attribute is valid for all physical and non-physical data types.

Axis State

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get	USINT	-	-	-	Enumeration 0 = Ready 1 = Drive Enable, (direct drive control) 2 = Servo Control 3 = Faulted 4 = Shutdown 5 = Inhibited 6 = Ungrouped 7 = No Module 8 = Configuring (FW default)

State of this instance of the Motion Control Axis. Indicates the operating state of the axis. Examples of possible states include: axis-ready, drive enable, servo control, axis faulted, axis shutdown, axis inhibited, and axis unassigned.

Watch Event Task

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get	DINT	-	-	-	-

User Event Task that will be triggered to execute when a Watch event occurs.

This attribute is set through internal communication from the user Task object to the Axis object when the Task trigger attribute is set to select this attributes of an

Axis. It cannot be set directly by an external device. It is available to be read externally for diagnostic information.

The Watch Event Task attribute indicates which user Task will be triggered when a watch event occurs. An instance value of 0 indicates that no event task has been configured to be triggered by the Watch Event.

The user Task is triggered at the same time that the Process Complete bit is set for the instruction that armed the watch event.

Registration 1 Event Task

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get	DINT	-	-	-	-

User Event Task that will be triggered to execute when a Registration 1 event occurs.

This attribute is set through internal communication from the user Task object to the Axis object when the Task trigger attribute is set to select this attributes of an Axis. It cannot be set directly by an external device. It is available to be read externally for diagnostic information.

The Registration 1 Event Task attribute indicates which user Task will be triggered when a Registration 1 event occurs. An instance value of 0 indicates that no event task has been configured to be triggered by the Registration 1 Event.

The user Task is triggered at the same time that the Process Complete bit is set for the instruction that armed the registration event.

Registration 2 Event Task

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get	DINT	-	-	-	-

User Event Task that will be triggered to execute when a Registration 2 event occurs.

This attribute is set through internal communication from the user Task object to the Axis object when the Task trigger attribute is set to select this attributes of an Axis. It cannot be set directly by an external device. It is available to be read externally for diagnostic information.

The Registration 2 Event Task attribute indicates which user Task will be triggered when a Registration 2 event occurs.An instance value of 0 indicates that no event task has been configured to be triggered by the Registration 2 Event.

The user Task is triggered at the same time that the Process Complete bit is set for the instruction that armed the registration event.

Home Event Task

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get	DINT	-	-	-	-

User Event Task that will be triggered to execute when a Home event occurs.

This attribute is set through internal communication from the user Task object to the Axis object when the Task trigger attribute is set to select this attributes of an Axis. It cannot be set directly by an external device. It is available to be read externally for diagnostic information.

The Home Event Task attribute indicates which user Task will be triggered when a home event occurs. An instance value of 0 indicates that no event task has been configured to be triggered by the Home Event.

The user Task is triggered at the same time that the Process Complete bit is set for the instruction that armed the home event.

Inhibit Axis

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ SSV	SINT	0	-	-	0 triggers an uninhibit. 1 triggers an inhibit. Setting to any non-zero value is treated the same as a value of 1, and results in the attribute being set to a 1.

Used to initiate putting an axis into the inhibit state.

This feature is designed for the following situations:

- To park an unused or faulted axis so that the application program can continue to run without the unused or faulted axis.
- To allow a 'generic' application program to be developed for a family of similar machines that may vary in axis count such that it can be configured during runtime to match the configuration of the specific machine.

The on-line inhibit process is an intrusive operation in that it impacts all axes associated to the same motion module as the one being inhibited. As such it is expected that the users will trigger this operation with the machine in a safe, non-operating, state. The inhibit process includes breaking connection to the associated motion module and then allowing the module to be reconfigured with or without (depending if you are inhibiting or un-inhibiting) this axis.

The inhibit/un-inhibit operation will also stop all motion on all axes associated to the same motion module including breaking all gearing relationships. This stop operation follows that of the shutdown fault action; servo action is immediately disabled as is the drives power structure. Unless some external form of braking capability is applied the axis will generally coast to a stop.

Axis ID

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ GSV	DINT	-	-	-	ID

Unique number assigned to axis on creation by configuration software.

The Axis ID is used by the Absolute Position Recovery feature during a configuration software download to determine if a given axis is a new axis or pre-existing axis. If the axis existed prior to the download, the controller saves critical absolute position data associated with the axis before continuing the download. Using the Axis ID, the controller is able to match the saved absolute position data with the pre-existing axis and recover absolute position. Using the saved data, absolute position will be recomputed to account for any motion that occurred while the download was in process or while power was off.

Axis Update Schedule

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ GSV	USINT	-	-	-	Enumeration: 0 = Base 1 = Alternate 1 2 = Alternate 2 3-255 = Reserved

Determines the update schedule for the associated axis instance.

The default schedule setting of Base results in the axis being updated with every scan of Motion Task, or the Base Update Period of the Motion Group. Alternate 1 and Alternate 2 schedule selections result in the axis being updated at multiples of the Base Update Period given by the Alternate 1 and Alternate 2 Update Multiplier attribute values of the Motion Group, or Alternate 1 Update Period and Alternate 2 Update Period, respectively.

Axis Data Type

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	USINT	-	-	-	Enumeration: 0 = Feedback 1 = Consumed 2 = Virtual 3 = Generic 4 = Servo 5 = Servo Drive 6 = Generic Drive 7 = CIP Drive

Associated tag data type for this instance of the Motion Control Axis Object.

The Axis Data Type attribute and is used to determine which data template, memory format, and set of attributes are created and applicable for this axis instance.

See also

CIP Axis Attributes on page 185

Motion Control Axis Behavior Model on page 51

Motion Control Signal Attributes

The Motion Control Signal Attributes associated with the axis provide access to the current and historical position, velocity, and acceleration information of the axis. These values may be used as part of the user program to implement sophisticated real-time computations associated with motion control applications.

Important:	Configuration of Scaling page parameters is required for any attributes expressed in position, velocity, or acceleration units to return meaningful values.

All Motion Control Signal Attributes support Direct Tag Access through the Logix Designer application. Thus, a Motion Signal attribute may be directly referenced in a program as <axis tag name>.<motion status tag name>. For example, FeedAxis.ActualPosition.

To avoid the unnecessary processor effort associated with real-time conversion of certain Motion Status tags that are not of interest to the user, you need to explicitly activate real-time update of these attributes using the Auto Tag Update attribute of the associated motion group. A subset of the Motion Control Signal Attributes must have the Auto Tag Update attribute enabled to perform scaling conversion. If disabled, the tag value will be forced to zero. The following attributes are impacted:

- Actual Position
- Actual Velocity

- Actual Acceleration
- Master Offset
- Command Position
- Command Velocity
- Command Acceleration
- Average Velocity

The following are the signal attributes associated a Motion Control Axis:

Actual Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/GSV	T	REAL	-	-	-	Position Units Tag access is supported by the value is valid only when Auto Tag Update of the Motion Group Object is enabled.

The Actual Position attribute is the current absolute position of an axis, in the configured Position Units of that axis. This value is based on data reported to the Logix Processor as part of an ongoing synchronous data transfer process which results in a delay of one Coarse Update Period. Thus, the Actual Position value that is obtained is the actual position of the axis one Coarse Update Period ago.

Tag access supported but value is valid only when Auto Tag Update of the Motion Group Object is enabled.

Strobe Actual Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/GSV	T	REAL	-	-	-	Position Units

Strobe Command Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Get/GSV	T	REAL	-	-	-	Position Units

Strobe Actual Position and Strobe Command Position attributes are used to simultaneously store a snap-shot of the actual, command position, and master offset position of an axis when the MGSP (Motion Group Strobe Position) instruction is executed. The values are stored in the configured Position Units of the axis.

Since the MGSP instruction simultaneously stores the actual and command positions for all axes in the specified group of axes, the resultant Strobe Actual Position and Strobe Command Position values for different axes can be used to perform real-time calculations.

For example, the Strobe Actual Positions can be compared between two axes to provide a form of slip compensation in web handling applications.

Start Actual Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/GSV	T	REAL	-	-	-	Position Units

Whenever a new motion planner instruction starts for an axis (for example, using a MAM instruction), the value of the axis command position and actual position is stored at the precise instant the motion begins. These values are stored as the Start Command Position and Start Actual Position respectively in the configured Position Units of the axis.

Start Positions are useful to correct for any motion occurring between the detection of an event and the action initiated by the event. For instance, in coil winding applications, Start Command Positions can be used in an expression to compensate for overshooting the end of the bobbin before the gearing direction is reversed.

If you know the position of the coil when the gearing direction was supposed to change, and the position at which it actually changed (the Start Command Position), you can calculate the amount of overshoot, and use it to correct the position of the wire guide relative to the bobbin.

Average Velocity

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/GSV	T	REAL	-	-	-	Position Units / Sec

The Average Velocity attribute is the current speed and direction of an axis in the configured Position Units per second of the axis.

Unlike the Actual Velocity attribute value, it is calculated by averaging the actual velocity of the axis over the configured Average Velocity Timebase for that axis. Average velocity is a signed value with the sign indicating the direction the axis is currently moving.

The resolution of the Average Velocity variable is determined by the current value of the Averaged Velocity Timebase parameter, and the configured Conversion Constant (feedback counts per Position Unit) for the axis. The Average Velocity

Timebase determines the length over which the Average Velocity is computed. The greater the Average Velocity Timebase value, the better the speed resolution, but the slower the response to changes in speed.

The Average Velocity resolution in Position Units per second may be calculated using this equation.

$$\frac{1}{\text{Averaged Velocity Timebase [Seconds]} \times K \ \frac{\text{Feedback Counts}}{\text{Position Units}}}$$

For example, on an axis with position units of inches and a conversion constant (K) of 20000, an averaged velocity time-base of 0.25 seconds results in an average velocity resolution of:

$$\frac{1}{0.25 \times 20000} = 0.0002 \ \frac{\text{Inches}}{\text{Second}} = 0.012 \ \frac{\text{Inches}}{\text{Minute}}$$

The minimum Average Velocity Timebase value is one Coarse Update Period defined by the associated Motion Group Object.

Tag access supported but value is valid only when Auto Tag Update of the Motion Group Object is enabled.

Actual Velocity

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/ GSV	T	REAL	-	-	-	Position Units / Sec Tag access is supported but the value is valid only when Auto Tag Update of the Motion Group Object is enabled.

The Actual Velocity attribute is the current instantaneously measured speed and direction of an axis, in the configured axis Position Units per second. It is calculated as the current increment to the actual position per coarse update interval.

Actual Velocity is a signed floating point value—the sign (+ or -) depends on which direction the axis is currently moving. Its resolution does not depend on the Averaged Velocity Timebase, but rather on the conversion constant of the axis and the fact that the internal resolution limit on actual velocity is 1 feedback count per coarse update.

Tag access supported but value is valid only when Auto Tag Update of the Motion Group Object is enabled.

Actual Acceleration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/ GSV	T	REAL	-	-	-	Position Units / Sec^2 Tag access supported but the value is valid only when Auto Tag Update of the Motion Group Object is enabled.

The Actual Acceleration attribute is the current instantaneously measured acceleration of an axis in the configured axis Position Units per second per second. It is calculated as the current increment to the actual velocity per coarse update interval.

Actual Acceleration is a signed floating-point value. Its resolution does not depend on the Averaged Velocity Timebase, but rather on the Conversion Constant of the axis and the fact that the internal resolution limit on actual velocity is 1 feedback count per Coarse Update Period^2.

Tag access supported but value is valid only when Auto Tag Update of the Motion Group Object is enabled.

Watch Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/ GSV	T	REAL	-	-	-	Position Units

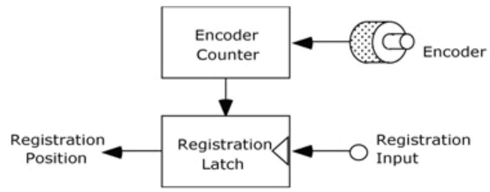
The Watch Position attribute is the current set-point position of an axis, in the configured axis Position Units, as set up in the last, most recently executed, MAW (Motion Arm Watch) instruction for that axis.

Registration 1 Position and Registration 2 Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/ GSV	T	REAL	-	-	-	Position Units

Two registration position attributes are provided to independently store axis position associated with two different registration input events. The Registration Position value is the absolute position of a physical or virtual axis (in the position units of that axis) at the occurrence of the most recent registration event for that axis.

This figure shows how the registration position is latched by the registration input when a registration event occurs. The latching mechanism can be implemented in the controller software (soft registration) or, for greater accuracy, in physical hardware (hard registration).



The Registration Latch mechanism is controlled two Event Control instructions, MAR (Motion Arm Registration) and MDR (Motion Disarm Registration).

The accuracy of the registration position value, saved as a result of a registration event, is a function of the delay in recognizing the specified transition (typically 1 μsec for hardware registration) and the speed of the axis during this time. The uncertainty in the registration position is the distance traveled by the axis during this interval as shown in this equation:

$$\text{Uncertainty} = \text{Axis Speed}\left[\frac{\text{Position Units}}{\text{Seconds}}\right] \times \text{Delay}$$

Use the formula given above to calculate the maximum registration position error for the expected axis speed. Alternatively, you can calculate the maximum axis speed for a specified registration accuracy by re-arranging this formula:

$$\text{Maximum Speed}\frac{\text{Position Units}}{\text{Second}} = \frac{\text{Desired Accuracy}[\text{Position Units}]}{\text{Delay}}$$

Registration 1 Time and Registration 2 Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/ GSV	T	DINT	-	-	-	CST time in microseconds

The two Registration Time values contain the lower 32-bits of CST time at which their respective registration events occurred. Units for this attribute are in microseconds.

Interpolation Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/ SSV	T	DINT	-	-	-	CST time to Interpolation

The Interpolation Time attribute is the 32-bit CST time used to calculate the interpolated positions. When this attribute is updated with a valid CST value, the Interpolated Actual Position and Interpolated Command Position values are automatically calculated.

Interpolated Actual Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/ GSV	T	REAL	-	-	-	Position Units

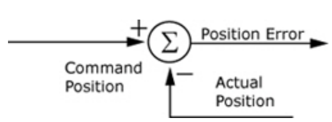
The Interpolated Actual Position attribute is the interpolation of the actual position, based on past axis trajectory history, at the time specified by the Interpolation Time attribute.

Command Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Get/ GSV	T	REAL	-	-	-	Position Units Tag access is supported but the value is valid only when Auto Tag Update of the Motion Group Object is enabled.

The Command Position attribute is the desired or commanded position of a physical axis, in the configured Position Units of that axis, as generated by the controller in response to any previous motion Position Control instruction. Command Position data is transferred by the Logix Processor to a physical axis as part of an ongoing synchronous data transfer process which results in a delay of one Coarse Update Period. Thus, the Command Position value that is obtained is the command position that will be acted upon by the physical servo axis one Coarse Update Period from now.

The figure below shows the relationship between Actual Position, Command Position, and Position Error for an axis with an active servo loop. Actual Position is the current position of the axis as measured by the feedback device, for example an encoder. Position error is the difference between the Command and Actual Positions of the servo loop, and is used to drive the motor to make the actual position equal to the command position.



Command position is useful when performing motion calculations and incremental moves based on the current position of the axis while the axis is moving. Using command position rather than actual position avoids the introduction of errors due to the position error of the axis at the time the calculation is performed.

Tag access supported but value is valid only when Auto Tag Update of the Motion Group Object is enabled.

Strobe Command Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Get/ GSV	T	REAL	-	-	-	Position Units

Strobe Actual Position, Strobe Command Position and Strobe Master Offset attributes are used to simultaneously store a snap-shot of the actual, command position, and master offset position of an axis when the MGSP (Motion Group Strobe Position) instruction is executed. The values are stored in the configured Position Units of the axis.

Since the MGSP instruction simultaneously stores the actual and command positions for all axes in the specified group of axes, the resultant Strobe Actual Position, Strobe Command Position and Strobe Master Offset values for different axes can be used to perform real-time calculations. For example, the Strobe Actual Positions can be compared between two axes to provide a form of slip compensation in web handling applications.

Start Command Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Get/ GSV	T	REAL	-	-	-	Position Units

Whenever a new motion planner instruction starts for an axis (for example, using a MAM instruction), the value of the axis command position and actual position is stored at the precise instant the motion begins. These values are stored as the Start Command Position and Start Actual Position respectively in the configured Position Units of the axis.

Start Positions are useful to correct for any motion occurring between the detection of an event and the action initiated by the event. For instance, in coil winding applications, Start Command Positions can be used in an expression to compensate for overshooting the end of the bobbin before the gearing direction is reversed.

If you know the position of the coil when the gearing direction was supposed to change, and the position at which it actually changed (the Start Command Position), you can calculate the amount of overshoot, and use it to correct the position of the wire guide relative to the bobbin.

Command Velocity

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Get/ GSV	T	REAL	-	-	-	Position Units / Sec Tag access is supported but the value is valid only when Auto Tag Update of the Motion Group Object is enabled.

The Command Velocity is the commanded speed and direction of an axis, in the configured axis Position Units per second, as generated by any previous motion instructions. It is calculated as the current increment to the command position per coarse update interval. Command Velocity is a signed value—the sign (+ or -) depends on which direction the axis is being commanded to move.

Command Velocity is a signed floating-point value. Its resolution does not depend on the Averaged Velocity Timebase, but rather on the conversion constant of the axis and the fact that the internal resolution limit on command velocity is 0.00001 feedback counts per coarse update.

Tag access supported but value is valid only when Auto Tag Update of the Motion Group Object is enabled.

Command Acceleration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Get/ GSV	T	REAL	-	-	-	Position Units / Sec^2 Tag access is supported but the value is valid only when Auto Tag Update of the Motion Group Object is enabled.

The Command Acceleration attribute is the commanded speed and direction of an axis, in the configured axis Position Units per second per second, as generated by any previous motion instructions. It is calculated as the current increment to the command velocity per coarse update interval. Command Acceleration is a signed value: the sign (+ or -) depends on which direction the axis is being commanded to move.

Command Acceleration is a signed floating-point value. Its resolution does not depend on the Averaged Velocity Timebase, but rather on the conversion constant of the axis and the fact that the internal resolution limit on command velocity is 0.00001 feedback counts per Coarse Update $Period^2$.

Tag access supported but value is valid only when Auto Tag Update of the Motion Group Object is enabled.

Command Torque

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - VT	Get/ SSV	T	REAL	0	-∞	+∞	% Rated

The Command Torque attribute is the commanded torque in units of percent Rated Torque of the motor. This tag value is transferred by the Logix Processor to a physical axis as part of an ongoing synchronous data transfer process. Unlike Command Position, Command Velocity, and Command Acceleration, the Command Torque attribute is not generated by the motion planner. Instead, the value may be written directly by the application program.

Command Torque has no effect on the axis unless the axis is configured for Torque Loop operation. In order for the this attribute's value to be applied as the torque command, a Motion Drive Start instruction will be executed, which in turn sets the Direct Torque Control Status bit of the Motion Status Bits attribute. If this bit is not set, the Command Torque value has no effect on axis motion. Only CIP Drive Axis data types currently support this capability.

Interpolated Command Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E PV only	Get/ GSV	T	REAL	-	-	-	Position Units

The Interpolated Command Position attribute is the interpolation of the commanded position, based on past axis trajectory history, at the time specified by the Interpolation Time attribute.

Master Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV PV only	Get/ GSV*	T	REAL	-	-	-	Master Position Units Tag access supported but the value is valid only when Auto Tag Update of the Motion Group Object is enabled.

The Master Offset attribute is the position offset that is currently applied to the master side of the position cam. The Master Offset is returned in master position units. The Master Offset shows the same unwind characteristic as the position of a linear axis. Tag access is supported but the tag value is valid only when Auto Tag Update of the Motion Group Object is enabled

Strobe Master Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV PV only	Get/ GSV	T	REAL	-	-	-	Master Position Units

The Strobe Master Offset attribute is the position offset that was applied to the master side of the position cam when the last Motion Group Strobe Position (MGSP) instruction was executed. The Strobe Master Offset is returned in master position units. The Strobe Master Offset shows the same unwind characteristic as the position of a linear axis.

Start Master Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV PV only	Get/ GSV	T	REAL	-	-	-	Master Position Units

The Start Master Offset attribute is the position offset that was applied to the master side of the position cam when the last Motion Axis Move (MAM) instruction with the move type set to Absolute Master Offset or Incremental Master Offset was executed. The Start Master Offset is returned in master position units. The Start Master Offset shows the same unwind characteristic as the position of a linear axis.

Direct Command Velocity

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FV	Get/ SSV	T	REAL	-	-∞	+∞	Position Units / Sec

The Direct Command Velocity attribute provides tag access to the velocity command for the specified axis. This can be used to directly control the speed of a motor when an associated drive is configured for velocity control mode. In order for this attribute's value to be applied as the velocity command, a Motion Drive Start instruction will be executed, which in turn sets the Direct Velocity Control Status bit of the Motion Status Bits attribute. If this bit is not set, the Direct Command Velocity value has no effect on axis motion. Only CIP Drive Axis data types currently support this capability.

Interpolated Position Configuration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/ SSV	T	DWORD	0:0 1:1	-	-	Bitmap 0 = 2nd Order Actual Position Interpolation 1 = 2nd Order Command Position Interpolation

This bit mapped attribute configures the interpolation algorithm used to calculate Interpolated Actual Position and Interpolated Command Position based on axis position history based on the current value of Interpolation Time.

The 2nd Order Actual Position Interpolation bit controls the order of the interpolation algorithm used to calculate Interpolated Actual Position based on Interpolation Time. If the bit is set, 2nd order interpolation is used. If the bit is clear, 1st order interpolation is used. Generally, 2nd order interpolation results in more accurate estimates of position, but if the actual position signal has high levels of quantization noise, 1st order interpolation gives better results.

The 2nd Order Command Position Interpolation bit controls the order of the interpolation algorithm used to calculate Interpolated Command Position based on Interpolation Time. If the bit is set, 2nd order interpolation is used. If the bit is clear, 1st order interpolation is used. Generally, 2nd order interpolation results in more accurate estimates of position, but if the command position signal has high levels of quantization noise, 1st order interpolation gives better results.

See also

Motion Control Interface Attributes on page 323

Motion Control Status Attributes

These are the motion control status attributes associated with a Motion Control Axis. The Axis Event Bits are located in Event Capture Attributes.

Motion Status Bits

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/ GSV[1]	T	DINT	-	-	-	Bitmap 0 = AccelStatus 1 = DecelStatus 2 = MoveStatus 3 = JogStatus 4 = GearingStatus 5 = HomingStatus 6 = StoppingStatus 7 = AxisHomedStatus 8 = PositionCamStatus 9 = TimeCamStatus 10 = PositionCamPendingStatus 11 = TimeCamPendingStatus 12 = GearingLockStatus 13 = PositionCamLockStatus 14 = Reserved 15 = Master Offset Move Status 16 = CoordinatedMotionStatus 17 = TransformStateStatus 18 = ControlledByTransformStatus 19 = DirectVelocityControlStatus 20 = DirectTorqueControlStatus 21 = MovePendingStatus 22 = MoveLockStatus 23 = JogPendingStatus 24 = JogLockStatus 25 = MasterOffsetMovePendingStatus 26 = MasterOffsetMoveLockStatus 27 = MaximumSpeedExceeded 28…31 = Reserved

[1] *Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application.*

This is a bitmapped collection of status conditions associated with the motion planner function.

Motion Axis Status Bits Descriptions

This table provides descriptions of the various Motion Axis Status Bits:

Bit	Motion Status	Description
0	Accel Status	The Acceleration and Deceleration Status bit attributes (AccelStatus and DecelStatus) can be used to determine if the axis is currently being commanded to accelerate or decelerate. If neither bit is set then the axis is running at steady state velocity or at rest.
1	Decel Status	
2	Move Status	The MoveStatus bit attribute is set if a Move motion profile is currently in progress. As soon as the Move is complete or superseded by some other motion operation, the MoveStatus bit is cleared.

Bit	Motion Status	Description
3	Jog Status	The JogStatus bit attribute is set if a Jog motion profile is currently in progress. As soon as the Jog is complete or superseded by some other motion operation, the JogStatus bit is cleared.
4	Gearing Status	The GearingStatus bit attribute is set if the axis is currently Gearing to another axis. As soon as the gearing operation is stopped or superseded by some other motion operation, the GearStatus bit is cleared.
5	Homing Status	The HomingStatus bit attribute is set if a Home motion profile is currently in progress. As soon as the Home is complete or superseded by some other motion operation, the HomeStatus bit is cleared.
6	Stopping Status	The StoppingStatus bit attribute is set if there is a stopping process currently in progress. As soon as the stopping process is complete, the Stopping Status bit is cleared. The stopping process is used to stop an axis (initiated by an MAS, MGS, MGSP, Stop Planner fault action, or mode change). This bit is no longer associated with the gearing Clutch bit (MAG with Clutch selected), which for I4B has been explicitly named the GearingLockStatus bit.
7	Homed Status	The HomedStatus bit attribute is cleared at powerup or reconnection. The bit is set to 1 by the MAH instruction upon successful completion of the configured homing sequence. This bit would be later cleared if the axis entered the shutdown state. The HomedStatus bit is set by the MAH instruction upon successful completion of the configured homing sequence. This bit indicates that an absolute machine reference position has been established. When this bit is set, operations that require a machine reference, such as Software Overtravel checking can be meaningfully enabled. The HomedStatus bit is cleared under the following conditions: 1. Download, Control power cycle, or Reconnection with Incremental Feedback device. 2. Absolute Position Recovery (APR) fails with Absolute Feedback device. 3. Feedback Integrity bit is cleared by CIP Motion drive. The HomedStatus bit is directly used by the control system to qualify the Software Overtravel checking function. Thus, if the HomedStatus bit is clear, Soft Overtravel checking will not occur even if the Soft Overtravel Checking bit is set.
8	Position Cam Status	The PositionCamStatus bit attribute is set if a Position Cam motion profile is currently in progress. As soon as the Position Cam is complete or superseded by some other motion operation, the PositionCamStatus bit is cleared.
9	Time Cam Status	The TimeCamStatus bit attribute is set if a Time Cam motion profile is currently in progress. As soon as the Time Cam is complete or superseded by some other motion operation, the TimeCamStatus bit is cleared.
10	Position Cam Pending Status	The PositionCamPendingStatus bit attribute is set if a Position Cam motion profile is currently pending the completion of a currently executing cam profile. This would be initiated by executing an MAPC instruction with Pending execution selected. As soon as the current position cam profile completes, initiating the start of the pending cam profile, the PositionCamPending Status bit is cleared. This bit is also cleared if the position cam profile completes, or superseded by some other motion operation.
11	Time Cam Pending Status	The TimeCamPendingStatus bit attribute is set if a Time Cam motion profile is currently pending the completion of a currently executing cam profile. This would be initiated by executing an MATC instruction with Pending execution selected. As soon as the current time cam profile completes, initiating the start of the pending cam profile, the TimeCamPending status bit is cleared. This bit is also cleared if the time cam profile completes, or superseded by some other motion operation.

Bit	Motion Status	Description
12	Gearing Lock Status	The GearingLockStatus bit attribute is set whenever the slave axis is locked to the master axis in a gearing relationship according to the specified gear ratio. The clutch function of the gearing planner is used to ramp an axis up, or down, to speed in a gearing process (MAG with Clutch selected). During the intervals where the axis is clutching, the GearingLockStatus bit is clear.
13	Position Cam Lock Status	The PositionCamLockStatus bit attribute is set whenever the master axis satisfies the starting condition of a currently active Position Cam motion profile. The starting condition is established by the Start Control and Start Position parameters of the MAPC instruction. As soon as the current position cam profile completes, or is superseded by some other motion operation, the Position Cam Lock bit is cleared. In unidirectional master direction mode, the PositionCamLockStatus bit clears when moving in the wrong direction and sets when moving in the correct direction.
15	Master Offset Move Status	The MasterOffsetMoveStatus bit attribute is set if a Master Offset Move motion profile is currently in progress. As soon as the Master Offset Move is complete or superseded by some other motion operation, the MasterOffsetMoveStatus bit is cleared.
16	Coordinated Motion Status	The CoordinatedMotionStatus bit attribute is set if any coordinated motion profile is currently active upon this axis. As soon as the Coordinated Motion is complete or stopped, the CoordinatedMotionStatus bit is cleared.
17	Transform State Status	The Transform State Status bit is set if the axis in involved in a transform. The axis is in one of the coordinate systems specified in an active MCT instruction. True will indicate the axis is involved in a transform, false will indicate it is not.
18	Controlled By Transform Status	The Controlled By Transform Status bit is set if the axis is under transform control. True indicates the axis is under transform control and false indicates it is not under transform control. An axis under transform control cannot be commanded to move.
19	Direct Velocity Control Status	When the Direct Velocity Control Status bit is set, the axis speed is directly controlled by the Direct Command Velocity value. This bit is set by the Motion Drive Start instruction (MDS) and only applies to CIP Drive axis types.
20	Direct Torque Control Status	When the Direct Torque Control Status bit is set, the axis torque is directly controlled by the Command Torque value. This bit is set by the Motion Drive start instruction (MDS) and only applies to CIP Drive axis types.
21	Move Pending Status	-
22	Move Lock Status	The MoveLockStatus bit is set when the master axis satisfies the Lock Direction request of a Motion Axis Move (MAM) Instruction. If the Lock Direction is Immediate Forward Only or Immediate Reverse Only the MoveLockStatus bit will be set immediately when the MAM is initiated. If the Lock Direction is Position Forward Only or Position Reverse Only the bit will be set when the Master Axis crosses the Master Lock Position in the specified direction. The MoveLockStatus bit is cleared when the Master Axis reverses direction and the Slave Axis stops following the Master Axis. The MoveLockStatus bit is set again when the Slave Axis resumes following the Master Axis.
23	Jog Pending Status	-

Bit	Motion Status	Description
24	Jog Lock Status	The JogLockStatus bit is set when the master axis satisfies the Lock Direction request of a Motion Axis Jog (MAJ) Instruction. If the Lock Direction is Immediate Forward Only or Immediate Reverse Only the JogLockStatus bit will be set immediately when the MAJ is initiated. If the Lock Direction is Position Forward Only or Position Reverse Only the bit will be set when the Master Axis crosses the Master Lock Position in the specified direction. The JogLockStatus bit is cleared when the Master Axis reverses direction and the Slave Axis stops following the Master Axis. The JogLockStatus bit is set again when the Slave Axis resumes following the Master Axis.
25	Master Offset Move Pending Status	-
26	Master Offset Move Lock Status	The MasterOffsetMoveLockStatus bit is set when the master axis satisfies the Lock Direction request of a Master Offset Move executed using MAM instruction. If the Lock Direction is Immediate Forward Only or Immediate Reverse Only the MasterOffsetMoveLockStatus bit will be set immediately when the MAM is initiated. If the Lock Direction is Position Forward Only or Position Reverse Only the bit will be set when the Master Axis crosses the Master Lock Position in the specified direction. The MasterOffsetMoveLockStatus bit is cleared when the Master Axis reverses direction and the Slave Axis stops following the Master Axis. The MasterOffsetMoveLockStatus bit is set again when the Slave Axis resumes following the Master Axis.
27	Maximum Speed Exceeded	The MaximumSpeedExceeded bit is set when the axis command velocity at any time exceeds the maximum speed configured for an axis. The bit will be cleared when the axis velocity is reduced below the maximum speed.

Axis Status Bits

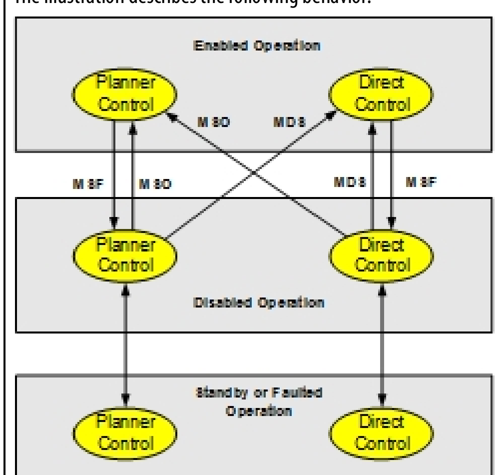
Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/ GSV[1]	T	DWORD	-	-	-	0 = ServoActionStatus 1 = DriveEnableStatus 2 = AxisShutdownStatus 3 = ConfigurationUpdateInProcess 4 = InhibitStatus 5 = DirectControlStatus 6 = AxisUpdateStatus 7...31 = Reserved

[1] *Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application.*

The Axis Status Bits attribute is a collection of basic status conditions associated with the axis. These represent key status conditions used by the system in executing motion control instructions.

This table provides descriptions of the Axis Status Bits:

Bit	Axis Status	Description
0	Servo Action Status	The ServoActionStatus bit attribute is set when the associated axis is under servo control. If the bit is not set then servo action is disabled.
1	Drive Enable Status	The DriveEnableStatus bit attribute is set when the Drive Enable output of the associated physical axis is currently enabled. If the bit is not set then physical servo axis Drive Enable output is currently disabled.

2	Axis Shutdown Status	The AxisShutdownStatus bit attribute is set when the associated axis is currently in the Shutdown state. As soon as the axis is transitioned from the Shutdown state to another state, the Shutdown Status bit is cleared.
3	Configuration Update in Process	The Configuration Update in Process Status Bits attribute provides a method for monitoring the progress of one or more specific module configuration attribute updates initiated by either online configuration or an SSV in the user program. As soon as such an update is initiated, the Logix processor sets the ConfigurationUpdateInProcess bit. The bit remains set until the Set Attribute List reply comes back from the servo module indicating that the data update process was successful. Thus the Configuration Update In Process Status Bits attribute provides a method of waiting until the servo configuration data update to the connected motion module is complete before starting a dependent operation.
4	Inhibit Status	The InhibitStatus bit attribute is set when the axis is in the inhibited state. This bit can also be used to determine when an inhibit/uninhibit operation has been completed (for example, connections have been shutdown, reconnected and then the reconfiguration process completed). During the inhibit/uninhibit process this bit will remain in the previous state and then once it completes it will be updated to the new state.
5	Direct Control Status	When the Direct Control Status bit is set, axis motion is driven by the Direct Velocity Control and Direct Torque Control functions. In this mode, the Motion Planner functionality is disabled. So if you attempt to move the axis with a Motion Planner instruction, for example, MAM, MAJ, and MAG, a ran instruction error occurs. In Direct Control, you do not have to establish or maintain absolute reference position. So, when you attempt to execute the MAH and MRP instructions, an instruction error occurs. When the Direct Control Status bit is clear, axis motion is controlled by the Motion Planner. If you attempt to move the axis in this mode with a Direct Control instruction, for example, an MDS, an instruction error occurs. This bit only applies to CIP Drive axis types. The illustration describes the following behavior.  The Direct Control Status bit is set by the Motion Drive Start instruction (MDS) and once set, can only be cleared by executing an MSO instruction from the Stopped or Stopping State. Similarly, once the Direct Control Status bit is cleared by the Motion Servo On instruction (MSO), the bit can only be set again by executing an MDS instruction from the Stopped or Stopping State.
6	Axis Update Status	The Axis Update bit indicates whether or not this axis instance was updated in last execution of Motion Task. In general, axis instances are updated in Motion Task according to their Axis Update Schedule. Thus, a given axis instance may or may not be updated during Motion Task execution. When inspected as part of an Event Task triggered by Motion Group Execution, the Axis Update bit can be used to qualify program instructions based on whether or not the axis was updated by the preceding Motion Task.

Axis Fault Bits

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/GSV[1]	T	DWORD	-	-	-	Bitmap 0 = PhysicalAxisFault 1 = ModuleFault 2 = ConfigurationFault 3 = GroupFault 4 = MotionFault 5 = GuardFault 6 = InitializationFault 7 = APRFault 8 = SafetyFault 9...31 = Reserved

[1] *Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application.*

The Axis Fault Bits attribute is a collection of basic fault types associated with the axis. Each valid axis fault type is assigned a bit in this word. Any fault condition associated with a given fault type will result in the setting of the appropriate fault bit.

Each bit in the Axis Fault Bits attribute represents a roll-up of the associated fault types. One or more faults of a given fault type result in the associated bit of the Axis Fault Bits attribute being set.

This table provides descriptions of the Axis Fault Bits:

Bit	Name	Description
0	Physical Axis Fault	If the Physical Axis Fault bit is set, it indicates that one or more fault conditions have been reported by the physical axis. The specific fault conditions can then be determined through access to the axis data type specific fault attributes of the associated physical axis. For Servo axis data types, Physical Axis Faults map to the Servo Faults attribute. For Servo Drive axis data types Physical Axis Faults map to the Drive Faults attribute. For CIP Drive axis data types Physical Axis Faults map to the standard CIP Axis Faults attribute or manufacturer specific CIP Axis Faults
1	Module Fault	The Module Fault bit attribute is set when one or more faults have occurred related to the motion module associated with the selected axis. The specific fault conditions can then be determined through access to the Module Fault attribute of the associated axis. Usually a module fault impacts all axes associated with the motion module. A module fault generally results in the shutdown of all associated axes. Reconfiguration of the motion module is required to recover from a module fault condition.
2	Configuration Fault	The Configuration Fault bit is set when an update operation targeting an axis configuration attribute of an associated motion module has failed. Specific information concerning the Configuration Fault may be found in the Attribute Error Code and Attribute Error ID attributes associated with the motion module.
3	Group Fault	The Group Fault bit attribute is set when one or more faults have occurred related to the motion group associated with the selected axis. The specific fault conditions can then be determined through access to the Group Fault attribute of the associated motion group. Usually a group fault impacts all axes associated with the motion group. A group fault generally results in the shutdown of all associated axes. Reconfiguration of the entire motion subsystem is required to recover from a group fault condition.

Bit	Name	Description
4	Motion Fault	If the Motion Fault bit is set, it indicates that one or more fault conditions have occurred related to the Motion Planner function. The specific fault conditions can then be determined through access to the Motion Fault attribute of the associated axis.
5	Guard Fault	If the Guard Fault bit is set, it indicates that one or more fault conditions have occurred related to the Guard Motion safety function. The specific fault conditions can then be determined through access to the Guard Motion attribute of the associated axis. Guard Faults are only applicable if the drive device is equipped with Guard Safety functionality.
6	Initialization Fault	The Initialization Fault bit is set when initialization of a CIP Motion drive fails for any reason. Specific information concerning the Initialization Fault may be found either in the standard CIP Initialization attributes or in the manufacturer specific CIP Initialization Fault attributes associated with the CIP Drive axis data types.
7	APR Fault	The APR (Absolute Position Recovery) Fault bit is set when during axis configuration the system is not able to recover the absolute position of the axis. Specific information concerning the APR Fault may be found either in the standard APR Fault attributes or int he manufacturer specific APR Fault attributes associated with the CIP Drive axis data types.
8	Safety Fault	If the Safety Fault bit is set, it indicates that there is one or more fault conditions have occurred related to the axis safety function. The specific fault conditions can then be determined through access to the Axis Safety Fault attributes of the associated axis. Safety Faults are only applicable if the motion device supports "Networked" Safety functionality through a CIP Safety connection.

Axis Event Bits

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/GSV[1]	T	DWORD	-	-	-	Bitmap - AxisFault 0 = WatchEventArmedStatus 1 = WatchEventStatus 2 = RegEvent1ArmedStatus 3 = RegEvent1Status 4 = RegEvent2ArmedStatus 5 = RegEvent2Status 6 = HomeEventArmedStatus 7 = HomeEventStatus 8... 31= Reserved

[1] *Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application.*

The Axis Event Bit attributes are a collection of basic event conditions. This attribute is for use primarily by the system during execution of various Motion Event instructions.

Axis Event Bit Descriptions

Bit	Name	Description
0	Watch Event Armed Status	The Watch Event Armed Status bit attribute is set when a watch event has been armed through execution of the MAW (Motion Arm Watch) instruction. This bit is cleared when either a watch event occurs or a MDW (Motion Disarm Watch) instruction is executed.

Bit	Name	Description
1	Watch Event Status	The Watch Event Status bit attribute is set when a watch event has occurred. This bit is cleared when either another MAW (Motion Arm Watch) instruction or a MDW (Motion Disarm Watch) instruction is executed.
2	Registration 1 Event Armed Status	The Registration 1 Event Armed Status bit attribute is set when a registration checking has been armed for registration input 1 through execution of the MAR (Motion Arm Registration) instruction. This bit is cleared when either a registration event occurs or a MDR (Motion Disarm Registration) instruction is executed for registration input 1.
3	Registration 1 Event Status	The Registration 1 Event Status bit attribute is set when a registration event has occurred on registration input 1. This bit is cleared when either another MAR (Motion Arm Registration) instruction or a MDR (Motion Disarm Registration) instruction is executed for registration input 1.
4	Registration 2 Event Armed Status	The Registration 2 Event Armed Status bit attribute is set when a registration checking has been armed for registration input 2 through execution of the MAR (Motion Arm Registration) instruction. This bit is cleared when either a registration event occurs or a MDR (Motion Disarm Registration) instruction is executed for registration input 2.
5	Registration 2 Event Status	The Registration 2 Event Status bit attribute is set when a registration event has occurred on registration input 2. This bit is cleared when either another MAR (Motion Arm Registration) instruction or a MDR (Motion Disarm Registration) instruction is executed for registration input 2.
6	Home Event Armed Status	The Home Event Armed Status bit attribute is set when a home event has been armed and is used by the Home instruction (MAH) to manage various homing events that occur during the configured homing sequence. This bit is cleared when a home event occurs.
7	Home Event Status	The Home Event Status bit attribute is set when a home event has occurred and is used by the Home instruction (MAH) to manage various homing events that occur during the configured homing sequence. This bit is cleared when another MAH (Motion Axis Home) instruction is executed.

Output Cam Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/ GSV[1]	T	DWORD	-	-	-	Set of Output Cam Status bits.

[1] *Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application.*

The Output Cam Status bit is set when an Output Cam has been initiated. The Output Cam Status bit is reset when the cam position moves beyond the cam start or cam end position in "Once" execution mode with no Output Cam pending or when the Output Cam is terminated by a Motion Disarm Output Cam (MDOC) instruction.

The attributes and all the output cam status words are bit patterns where each bit refers to an output cam target. For example, bit 0 is output cam target 0 and so on. This is true of all the output cam status words. Each of these bits corresponds to an output cam target.

Output Cam Pending Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/ GSV[1]	T	DWORD	-	-	-	Set of Output Cam Pending Status bits.

[1] *Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application.*

The Output Cam Pending Status bit is set if an Output Cam is currently pending the completion of another Output Cam. This would be initiated by executing an Motion Arm Output Cam (MAOC) instruction with Pending execution selected. As soon as this output cam is armed, being triggered when the currently executing Output Cam has completed, the Output Cam Pending bit is cleared. This bit is also cleared if the Output Cam is terminated by a Motion Disarm Output Cam (MDOC) instruction.

Output Cam Lock Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/ GSV[1]	T	DWORD	-	-	-	Set of Output Cam Lock Status bits.

[1] *Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application.*

The Output Cam Lock Status bit is set when an Output Cam has been armed. This would be initiated by executing a Motion Arm Output Cam (MAOC) instruction with Immediate execution selected, when a pending output cam changes to armed, or when the axis approaches or passes through the specified axis arm position. As soon as this output cam current position moves beyond the cam start or cam stop position, the Output Cam Lock bit is cleared. This bit is also cleared if the Output Cam is terminated by a Motion Disarm Output Cam (MDOC) instruction.

Output Cam Transition Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/ GSV[1]	T	DWORD	-	-	-	Set of Output Cam Transition Status bits.

[1] *Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application.*

The Output Cam Transition Status bit is set when a transition between the currently armed and the pending Output Cam is in process. Therefore, each

Output Cam controls a subset of Output Bits. The Output Cam Transition Status bit is reset, when the transition to the pending Output Cam is complete or when the Output Cam is terminated by a Motion Disarm Output Cam (MDOC) instruction.

Motion Alarm Bits and Motion Fault Bits

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Get/ GSV[1]	T	DWORD	-	-	-	Bitmap - MotionAlarm 0 = Reserved 1 = SoftTravelLimitPositiveAlarm 2 = SoftTravelLimitNegativeAlarm 3...31 = Reserved
Required - All	Get/ GSV[1]	T	DWORD	-	-	-	Bitmap - MotionFault 0 = Reserved 1 = SoftTravelLimitPositiveFault 2 = SoftTravelLimitNegativeFault 3...31 = Reserved

[1] *Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application.*

Motion Alarm Bits and Motion Fault Bits Descriptions

Bit	Name	Description
0	Reserved	-
1	SoftTravelLimitPositiveAlarm SoftTravelLimitPositiveFault	This exception condition occurs when Soft Travel Checking is enabled and when actual position has exceeded the configured Soft Travel Limit - Positive attribute value while commanding motion in the positive direction. If the Motion Exception Action for this bit is set for Stop Planner, the faulted axis can be moved or jogged back inside the soft travel limits. Any attempt, however, to move the axis further beyond the Soft Travel Limit - Positive value using a motion instruction will result in an instruction error. For commanded axes, the Soft Travel Fault can be cleared with a Fault Reset while the axis position is beyond the Soft Travel Limit - Positive value to allow the axis to be moved back within the Soft Travel Limits. As long as the axis is not commanded to move further away from the travel limit, no Soft Travel Limit Fault shall be generated.

Bit	Name	Description
2	SoftTravelLimitNegativeAlarm SoftTravelLimitNegativeFault	This exception condition occurs when Soft Travel Checking is enabled and when actual position has exceeded the configured Soft Travel Limit - Negative attribute value while commanding motion in the negative direction. If the Motion Exception Action for this bit is set for Stop Planner, the faulted axis can be moved or jogged back inside the soft travel limits. Any attempt, however, to move the axis further beyond the Soft Travel Limit - Negative value using a motion instruction will result in an instruction error. For commanded axes, the Soft Travel Limit Fault can be cleared with a Fault Reset while the axis position is beyond the Soft Travel Limit - Negative value to allow the axis to be moved back within the Soft Travel Limits. As long as the axis is not commanded to move further away from the travel limit, no Soft Travel Limit Fault shall be generated.
3...31	Reserved	-

See also

Event Capture Attributes on page 247

Exceptions on page 41

Event Capture Attributes on page 247

APR Fault Attributes on page 279

Motion Database Storage Attributes

The following are the Motion Database Storage attributes associated with a Motion Control Axis.

System Acceleration Base

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set		REAL	0 DB	-	-	Motor Units/sec^2 @ 100 % Rated

This floating point value represents the acceleration of the selected unloaded motor based on 100% Rated current and used to compute System Inertia. This attribute is used to store the original System Acceleration value for subsequent upload.

Drive Model Time Constant Base

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set		REAL	.0015 DB	-	-	Sec

This floating point value represents the lumped model time constant associated with the drive device for the purposes of computing loop gains. This attribute is used to store the original Drive Model Time Constant value for subsequent upload. The Drive Model Time Constant Base (DMTC_Base) is computed based on the current loop bandwidth, the velocity loop update time and the feedback sample period according to the following formula:

DMTC_Base = 2 * 1/(2*PI*Current Loop Bandwidth(Hz)) + Velocity Loop Update Period + Feedback Sample Period/2

Drive Rated Peak Current

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set		REAL	0 DB	-	-	Amps

This floating point value represents the peak current rating associated with the drive device and used to compute peak torque and acceleration limits. This attribute is used to store the original Drive Rated Peak Current value for subsequent upload.

Bus Overvoltage Operational Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set		REAL	0 DB	-	-	Volts

This floating point value represents the maximum DC Bus voltage level that can be sustained during drive operation, which is used to calculate the factory default value for PM Motor Rotary Bus Overvoltage Speed or the PM Motor Linear Bus Overvoltage Speed associated with PM motor types. This attribute is used to store the Bus Overvoltage Operational Limit value used in this calculation for subsequent upload.

See also

Auto-Tune Configuration Attributes on page 258

Motor Test Result Attributes on page 275

Hookup Test Result Attributes on page 267

Inertia Test Result Attributes on page 272

Motion Dynamic Configuration Attributes

These are the motion dynamic configuration attributes associated with a Motion Control Axis.

Maximum Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Set/ SSV	REAL	FD	0	maxspd	Position Units / Sec

The value of the Maximum Speed attribute is used by various motion instructions to determine the steady-state speed of the axis. These instructions all have the option of specifying speed as a percent of the Maximum Speed attribute value for the axis. This value is typically set to ~90% of the maximum speed rating of the motor. This provides sufficient 'head-room' for the axis to operate at all times within the speed limitations of the motor.

Maximum Acceleration and Maximum Deceleration

Usage	Access	Attribute Name	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Set/ SSV	Maximum Acceleration	REAL	FD	0	maxacc	Position Units / Sec^2
Required - FPV	Set/ SSV	Maximum Deceleration	REAL	FD	0	maxacc	Position Units / Sec^2

The Maximum Acceleration value is frequently used by motion instructions, (for example, MAJ, MAM, and MCD) to determine the acceleration rate to apply to the axis. These instructions all have the option of specifying acceleration as a percent of the Maximum Acceleration for the axis. This value is typically set to ~85% of the maximum acceleration rate of the axis. This provides sufficient 'head-room' for the axis to operate at all times within the acceleration limits of the drive and motor.

The Maximum Deceleration attribute value is frequently used by motion instructions, (for example, MAJ, MAM, and MCD), to determine the deceleration rates to apply to the axis. These instructions all have the option of specifying deceleration as a percent of the Maximum Deceleration for the axis. This value is typically set to ~85% of the maximum deceleration rate of the axis. This provides sufficient 'head-room' for the axis to operate at all times within the deceleration limits of the drive and motor.

Programmed Stop Mode

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ SSV	USINT	0	-	-	Enumeration 0 = Fast Stop (default) 1 = Fast Disable 2 = Hard Disable 3 = Fast Shutdown 4 = Hard Shutdown

The Programmed Stop Mode attribute determines how a specific axis will stop when the Logix processor undergoes a critical processor mode change or when an explicit MGS (Motion Group Stop) instruction is executed with its stop mode set to 'programmed'.

There are currently four modes defined for the Logix processor: Program Mode, Run Mode, Test Mode, and Faulted Mode. Any mode change into or out of program mode (prog - >run, prog->test, run->prog & test->prog) will initiate a programmed stop for every axis owned by that processor.

There is a time-out period of 60 seconds applied to the programmed stop process, after which the mode change will occur, even if motion on one or more axes has not stopped. Each individual axis can have its own Programmed Stop Mode configuration independent of other axes. Five methods of stopping a given axis are currently supported.

Method	Description
Fast Stop	When the Programmed Stop Mode attribute is configured for Fast Stop, the axis is decelerated to a stop using the current configured value for Maximum Deceleration. Servo action is maintained after the axis motion has stopped.
Fast Disable	When the Programmed Stop Mode attribute is configured for Fast Disable, the axis is decelerated to a stop using the current configured value for Maximum Deceleration. Servo action is maintained until the axis motion has stopped at which time the axis is disabled, for example, Drive Enable disabled, and Servo Action disabled.
Hard Disable	When configured for Hard Disable, the axis is immediately disabled, for example, Drive Enable disabled, Servo Action disabled, but the OK contact is left closed. Unless the drive is configured to provide some form of dynamic braking, this results in the axis coasting to a stop.
Fast Shutdown	When configured for Fast Shutdown, the axis is decelerated to a stop as with Fast Stop but, once the axis motion is stopped, the axis is placed in the Shutdown state, for example, Drive Enable disabled, Servo Action disabled, and the OK contact opened. Recovering from the Shutdown state requires execution of one of the axis or group Shutdown Reset instructions (MASR or MGSR).
Hard Shutdown	When configured for Hard Shutdown, the axis is immediately placed in the Shutdown state, for example, Drive Enable disabled, Servo Action disabled. Unless the drive is configured to provide some form of dynamic braking, this results in the axis coasting to a stop. To recover from the Shutdown state requires execution of one of the axis or group Shutdown Reset instructions (MASR or MGSR).

Maximum Acceleration Jerk

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Set/ SSV	REAL	FD	0	∞	Position Units / Sec^3

The Maximum Acceleration Jerk attribute value is used by motion instructions, for example, MAM and MAJ, to determine the acceleration jerk to apply to the axis when the acceleration jerk is specified as a percent of the Maximum. This value is only used by an S-Curve profile.

Maximum Acceleration Jerk may be calculated in terms of a percent of acceleration time spent while S-Curving.

In this case, 0 <= %time <= 100 %

Maximum Deceleration Jerk

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Set/ SSV	REAL	FD	0	∞	Position Units / Sec^3

The Maximum Deceleration Jerk attribute value is used by motion instructions, for example, MAM and MAJ, to determine the deceleration jerk to apply to the axis when the deceleration jerk is specified as a percent of the Maximum. This value is only used by an S-Curve profile.

Maximum Deceleration Jerk may be calculated in terms of a percent of deceleration time spent while S-Curving.

In this case, 0 <= %time <= 100 %

Dynamics Configuration Bits

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Set/ SSV	DWORD	0:1 1:1 2.0	-	-	0 = Reduce S-Curve Stop Delay 1 = Prevent S-Curve Velocity Reversals 2 = Reduced Extreme Velocity Overshoot 3...31 = Reserved

This attribute is a collection of bits that control the operation of the motion planner dynamics.

Bit	Name	Description
0	Reduce S-Curve Stop Delay	Enables or disables the reduction of latency time when stopping motion with S-Curve velocity profile (MAS instruction).

Bit	Name	Description
1	Prevent S-Curve Velocity Reversals	Enables the prevention of unwanted velocity reversals when the deceleration rate is being dynamically changed (MAS instruction).
2	Reduced Extreme Velocity Overshoot	This bit limits the velocity overshoot to 50% of the programmed velocity by increasing the acceleration jerk as necessary.
3...31	Reserved	

See also

CIP Axis Attributes on page 185

Motion Control Axis Behavior Model on page 51

Motion Homing Configuration Attributes

Homing functionality provides a means to establish a machine reference position, or Home Position, for the associated axis. In general, these homing configuration attributes are only applicable when there is an associated position feedback device; if the drive is configured for Encoderless or Sensorless operation, the homing function is not applicable.

The following tables describe the motion homing configuration attributes associated with a Motion Control Axis.

Home Mode

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/SSV	USINT	1	-	-	Enumeration 0 = Passive 1 = Active (!N) 2...55 = Reserved

The Home Mode attribute determines if homing actively moves the axis to generate the homing event or if the axis is to be moved by some external agent to generate the homing event.

There are two Homing Modes supported by the Motion Axis: active and passive. Active homing is the most common homing procedure for physical servo axes but does not apply when Axis Configuration is Feedback Only since it requires active control of the axis.

Homing Mode	Description
Active	When active homing is chosen as the homing mode, the desired homing sequence is then selected by specifying whether or not a home limit switch, a specified torque level, and/or the encoder marker is used for this axis. Active homing sequences always use the trapezoidal velocity profile with dynamics defined by Home Speed, Home Return Speed, Home Acceleration, and Home Deceleration. The following Home Sequence attribute section describes the available active homing sequences. If the configured feedback type does not support a marker signal, the 'marker,' 'switch then marker,' and 'home to torque then marker' homing sequences are not applicable.

Homing Mode	Description
Passive	Passive homing redefines the current absolute position of the axis on the occurrence of a home switch, encoder marker, or home to torque event. Passive homing is most commonly used to calibrate uncontrolled axes, although it can also be used with controlled axes to create a custom homing sequence. Passive homing, for a given home sequence, works similar to the corresponding active homing sequence, as described above, except that no motion is commanded-the controller just waits for the switch, marker, or torque events to occur. If the configured feedback type does not support a marker signal, the marker and switch then marker, and home to torque then marker homing sequences are not applicable.

Home Direction

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E PV Only	Set/SSV	USINT	1	-	-	Enumeration 0 = Unidirectional forward 1 = Bidirectional forward 2 = Unidirectional reverse 3 = Bidirectional reverse 4...255 = Reserved

The Home Direction attribute is the starting direction of a Homing Sequence when configured for active Home Mode.

This attribute is only valid for position and velocity control.

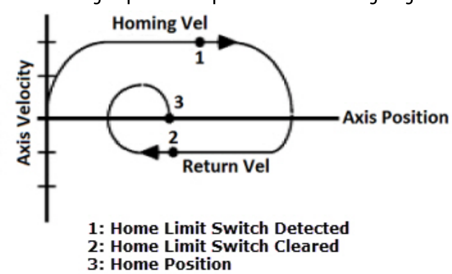
Home Sequence

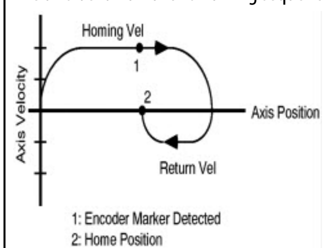
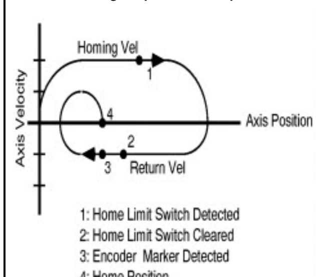
Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/SSV	USINT	0	-	-	Enumeration 0 = Immediate (default) 1 = Home to switch (0) 2 = Home to marker (0) 3 = Home to switch then marker (0) 4 = Home to torque (0) 5 = Home to torque then marker (0) 6...255 = Reserved

Determines the motion sequencing used to trigger the desired homing events. Filtering of optional enumerations based on available hardware support and feedback interface hardware.

Home Sequence Descriptions

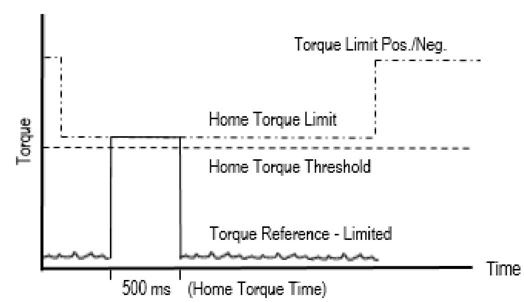
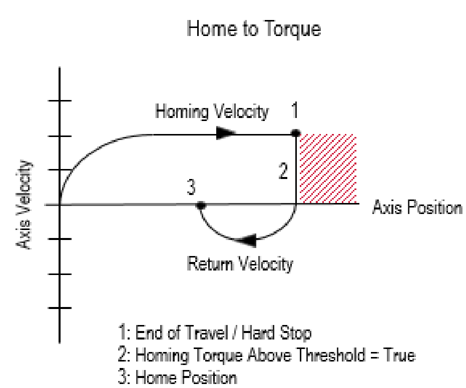
Homing Sequence Types	Description
Active Immediate Home	This is the simplest active homing sequence type. The axis actual position and command positions are updated based on the configured Home Position.

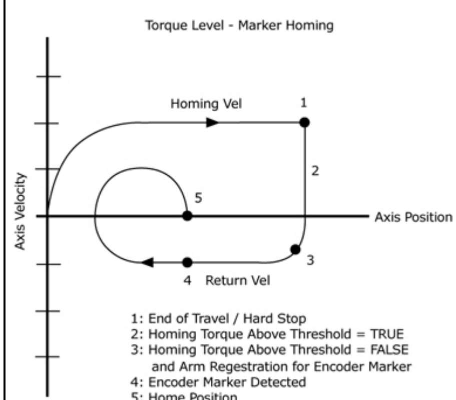
Homing Sequence Types	Description
Active Bidirectional Home to Switch	This active homing sequence is useful when an encoder marker is not available. When this sequence is performed, the axis moves in the specified Home Direction at the specified Home Speed and Home Acceleration until the home limit switch is detected. The axis then decelerates to a stop at the specified Home Deceleration and then moves in the opposite direction at the specified Home Return Speed and Home Acceleration until the home limit switch is cleared. When the home limit switch is cleared, axis position is immediately redefined to be equal to the Home Position and the axis decelerates to a stop at the specified Home Direction. If Home Offset is non-zero, then the Home Position will be offset from the point where the home switch is cleared by this value. Once the axis decelerates to a stop at the specified Home Deceleration, the controller then moves the axis back to the Home Position at the Home Return Speed and Home Acceleration using a trapezoidal move profile. If the axis is configured in Cyclic Travel Mode, the move back to the Home Position takes the shortest path, for example, no more than ½ revolution. The axis behavior for this active homing sequence is depicted in the following diagram:  If the controller detects that the state of the home switch at the start of the homing sequence is active, the controller immediately reverses the homing direction and begins the return leg of the homing sequence. Neglecting the mechanical uncertainty of the home limit switch, the accuracy of this homing sequence depends on the time uncertainty in detecting the home limit switch transitions. The position uncertainty of the home position is the product of the maximum time for the control to detect the home limit switch (~10 milliseconds) and the specified Home Return Speed. For this reason, the Home Return Speed is often made significantly slower than the Home Speed. For example, if a Home Return Speed of 0.1 inches per second (6 IPM) is specified, the uncertainty of the home position is calculated as shown below: Uncertainty = 0.1 Inch/Sec * 0.01 Sec = 0.001 Inch.

Homing Sequence Types	Description
Active Bidirectional Home to Marker	This active homing sequence is useful for single turn rotary and linear encoder applications since these have only one encoder marker for full axis travel. When this sequence is performed, the axis moves in the specified Home Direction at the specified Home Speed and Home Acceleration until the marker is detected. The Home Position is then assigned to the axis position corresponding to the marker location, and the axis decelerates to a stop at the specified Home Deceleration. If Home Offset is non-zero, then the Home Position will be offset from the point where the marker is detected by this value. The controller then moves the axis back to the Home Position at the specified Home Return Speed and Home Acceleration using a trapezoidal move profile. If the axis is configured as a Cyclic Travel Mode, the move back to the Home Position takes the shortest path (for example, no more than ½ revolution). The axis behavior for this homing sequence is depicted in the following diagram:  The accuracy of this homing sequence depends only on the time delay in detecting the marker transition. The position uncertainty of the home position is the product of the maximum delay for the control to detect the marker pulse (~1 microsecond) and the specified Home Speed. For example, if a Home Speed of 1 inches per second (60 IPM) is specified, the uncertainty of the home position is calculated as shown below: Uncertainty = 1 Inch/Sec * 0.000001 Sec = 0.000001 Inch.
Active Bidirectional Home to Switch then Marker	This is the most precise active homing sequence available. When this sequence is performed, the axis moves in the specified Home Direction at the specified Home Speed and Home Acceleration until the home limit switch is detected. The axis then decelerates to a stop at the specified Home Deceleration and moves in the opposite direction at the specified Home Return Speed and Home Acceleration until the home limit switch is cleared. After clearing the home limit switch, the axis continues in the same direction at the Home Return Speed until the first encoder marker is detected. The Home Position is assigned to the axis position at the moment that the marker is detected, and the axis then decelerates to a stop at the specified Home Deceleration. If Home Offset is non-zero, then the Home Position will be offset from the point where the marker is detected by this value. The controller then moves the axis back to the Home Position at the specified Home Return Speed and Home Acceleration using a trapezoidal move profile. If the axis is configured in Cyclic Travel Mode, the move back to the Home Position takes the shortest path (for example, no more than ½ revolution). Axis behavior for this active homing sequence is depicted in the following diagram:  If the controller detects that the state of the home switch at the start of the homing sequence is active, the controller immediately reverses the homing direction and begins the return leg of the homing sequence.

Homing Sequence Types	Description
Active Unidirectional Home to Switch	Unidirectional home is usually used when the physical axis cannot change directions. This active homing sequence is useful when an encoder marker is not available and either unidirectional motion is required or proximity switch is being used. When this sequence is performed in the Active Homing Mode, the axis moves in the specified Home Direction at the specified Home Speed and Home Acceleration until the home switch is detected. If the Home Offset is zero, the Home Position is assigned to the axis position at the moment that the limit switch is detected and the axis decelerates to a stop at the specified Home Deceleration. If Home Offset is non-zero, then the Home Position will be offset from the point where the switch is detected by this value. The controller then continues to move the axis to the Home Position at the specified Home Speed and Home Acceleration using a trapezoidal move profile. By setting a Home Offset greater than the deceleration distance, unidirectional motion to the Home Position is insured. However, if the Home Offset value is less than the deceleration distance, then the axis is simply decelerated to a stop at the specified Home Deceleration. The axis does **not** reverse direction to move to the Home Position. In this case, the PC-bit leg of the associated MAH instruction is not set when the IP-bit leg is cleared. In the case where this homing sequence is performed on a cyclic axis and the Home Offset value is less than the deceleration distance when the home event is detected, the control automatically adds one or more revolutions to the move distance. This guarantees the resulting move to the Home Position is unidirectional.
Active Unidirectional Home to Marker	This active homing sequence is useful for single turn rotary and linear encoder applications when unidirectional motion is required. When this sequence is performed in the Active Homing Mode, the axis moves in the specified Home Direction at the specified Home Speed and Home Acceleration until the marker is detected. If the Home Offset is zero, the Home Position is assigned to the axis position at the moment that the marker is detected and the axis decelerates to a stop at the specified Home Deceleration. If Home Offset is non-zero, then the Home Position will be offset from the point where the marker was detected by this value. The controller then continues to move the axis to the Home Position at the specified Home Speed and Home Acceleration using a trapezoidal move profile. The axis position is updated based on the Home Position and Home Offset. Even if the Home Offset is zero, the position is updated. Zero is a valid number. By setting a Home Offset greater than the deceleration distance, unidirectional motion to the Home Position is insured. However, if the Home Offset value is less than the deceleration distance, then the axis is simply decelerated to a stop at the specified Home Deceleration. The axis does **not** reverse direction to move to the Home Position. In this case, the PC-bit leg of the associated MAH instruction is not set when the IP-bit leg is cleared. In the case where this homing sequence is performed on a cyclic axis and the Home Offset value is less than the deceleration distance when the home event is detected, the control automatically adds one or more revolutions to the move distance. This guarantees the resulting move to the Home Position is unidirectional.

Homing Sequence Types	Description
Active Unidirectional Home to Switch then Marker	This active homing sequence is useful for multi-turn rotary applications when unidirectional motion is required. When this sequence is performed in the Active Homing Mode, the axis moves in the specified Home Direction at the specified Home Speed and Home Acceleration until the home switch is detected. The axis continues in the same direction at the Home Speed until the first marker event is detected. If the Home Offset is zero, the Home Position is assigned to the axis position at the precise position where the marker was detected, and the axis decelerates to a stop at the specified Home Deceleration. The axis position is updated based on the Home Position and Home Offset. If Home Offset is non-zero, then the Home Position will be offset from the point where the marker was detected by this value. The controller then continues to move the axis to the Home Position at the specified Home Speed and Home Acceleration using a trapezoidal move profile. By setting a Home Offset greater than the deceleration distance, unidirectional motion to the Home Position is insured. However, if the Home Offset value is less than the deceleration distance, then the axis is simply decelerated to a stop at the specified Home Deceleration. The axis does **not** reverse direction to move to the Home Position. In this case, the PC-bit leg of the associated MAH instruction is not set when the IP-bit leg is cleared. In the case where this homing sequence is performed on a cyclic axis and the Home Offset value is less than the deceleration distance when the home event is detected, the control automatically adds one or more revolutions to the move distance. This guarantees the resulting move to the Home Position is unidirectional. If the controller detects that the state of the home switch at the start of the homing sequence is active, the controller immediately establishes the Home Position based on the current axis position, and if allowed by the unidirectional motion constraint, begins to move to the Home Position.

Homing Sequence Types	Description
Active Home to Torque	The Home to Torque sequence is applicable when a hard stop is used to establish the home position, as is a common practice for a linear actuator. The occurrence of the hard stop is detected by the drive when the output torque to the motor reaches or exceeds the Home Torque Threshold for the specified Home Torque Time. Since the Home to Torque sequence relies on the mechanical end of travel for operation, Unidirectional homing will not be possible so only Forward Bidirectional and Reverse Bidirectional are allowed. A delay filter is implemented in the drive to reduce any false/nuisance triggers when there is a spike in the torque feedback upon enabling or jobbing the motor under the load. At the start of the Home to Torque sequences, the controller overrides the Torque Limit Positive/Negative attribute values in the drive with the Home Torque Level value and overrides the Position and Velocity Error Tolerances, saving the original values. The drive then begins monitoring the torque reference signal, waiting for it to exceed the Home Torque Threshold. The torque level must exceed the Home Torque Threshold for an interval given by Home Torque Time to avoid false/nuisance trips due to the torque disturbances that can occur while moving the motor under load. The following timing diagram depicts the Torque Limit adjustments, Home Torque Limit, and Home Torque Threshold behavior during the Home to Torque sequence:  The Home to Torque sequence is similar to Home to Switch, with the exception that the torque level is used instead of the home switch input. When this sequence is performed, the axis moves in the specified Home Direction at the specified Home Speed and Home Acceleration until a hard stop is detected, such as when motor torque has exceeded the Home Torque Threshold for a period equal to Home Torque Time. At this point, Home Position is calculated. The axis then decelerates to a stop at the specified Home Deceleration. If Home Offset is non-zero and would not place the Home Position of the axis further into the hard stop, the axis moves to the Home Position at the Home Return Speed and Home Acceleration and Home Deceleration using a trapezoidal move profile. Finally, the controller restores overridden drive attributes to their saved original values. Axis behavior for this homing sequence is depicted in the following diagram: 

Homing Sequence Types	Description
Active Home to Torque then Marker	Like the Home to Torque sequence, the Home to Torque then Marker sequence is applicable when a hard stop is used as the home position, as is common for a linear actuator, and the feedback device is equipped with an encoder marker signal. The occurrence of the hard stop is detected when the commanded torque applied to the motor reaches or exceeds the user specified torque level. Since the Home to Torque sequence relies on the mechanical end of travel for operation, Uni-directional homing will not be possible so only Forward Bi-directional and Reverse Bi-directional are allowed. A delay filter is implemented in the drive to reduce any false/nuisance triggers when there is a spike in the torque feedback upon enabling or jogging the motor under load. By including the encoder marker in the homing sequence this is the most precise homing operation available for torque level based homing. When this sequence is performed, the axis moves in the specified Home Direction at the specified Home Speed and Home Acceleration until a hard stop is detected, such as when the Home Torque Threshold is exceeded for a period equal to Home Torque Time. The axis then reverses direction, first decelerating at the Home Deceleration rate, then moving away from the hard stop using the Home Acceleration to reach the Home Return Speed, until the first encoder marker is detected. Once the marker has been detected, the Home Position is calculated. The axis then decelerates to a stop at the specified Home Deceleration and the controller restores overridden drive attributes to their saved original values. If the calculated Home Position is not beyond the hard stop, the axis moves to the Home Position at the Home Return Speed and Home Acceleration and Home Deceleration using a trapezoidal move profile. Axis behavior for this homing sequence is depicted in the following diagram: 
Passive Immediate Home	This 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 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 Home Offset is non-zero, then the Home Position will be offset from the point where the switch is detected by this value.
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 Home Offset is non-zero, then the Home Position will be offset from the point where the switch is detected by this value.

Homing Sequence Types	Description
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 Home Offset is non-zero, then the Home Position will be offset from the point where the switch is detected by this value.

Home Configuration Bits

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/SSV	DWORD	0x00	-	-	Bitmap 0 = Reserved 1 = Home Switch Normally Closed 2...31 = Reserved

The Home Configuration Bits attribute determines homing related behavior such as the sense of the home switch contacts.

The Home Switch Normally Closed bit attribute determines the normal state of the home limit switch used by the homing sequence. The normal state of the switch is its state prior to being engaged by the axis during the homing sequence. For example, if the Home Switch Normally Closed bit is set (true) then the condition of the switch prior to homing is closed. When the switch is engaged by the axis during the homing sequence, the switch is opened, which constitutes a homing event.

Home Position

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/SSV	REAL	0	-maxpos	maxpos	Position Units

If Travel Mode is Cyclic: 0 <= home pos < unwind

The Home Position is the desired absolute position for the axis after the specified homing sequence has been completed. After an active homing sequence has completed, the axis is left at the specified Home Position.

- If bidirectional homing, then the axis is left at the Home Position.
- If unidirectional homing and TravelMode=Cyclic, then the axis is left at the Home Position

Otherwise, the axis is not at the home position and the axis position is based on the Home Position.

In most cases, Home Position is set to zero, although any value, within the Maximum Positive and Negative Travel limits of the axis (if enabled), may also be used. (A description of the Maximum Positive and Negative Travel configuration attributes may be found in the Servo and Drive Axis Object specifications.) For a cyclic axis, the Home Position is constrained to be a positive number less than the Position Unwind value divided by the Conversion Constant.

Home Offset

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/SSV	REAL	0	-maxpos	maxpos	Position Units

When applied to an active or passive Homing Mode, using a non-immediate Home Sequence, the Home Offset is the desired position offset of the axis Home Position from the position at which the home event occurred. The Home Offset is applied at the end of the specified homing sequence before the axis moves to the Home Position. In most cases, Home Offset is set to zero.

After an active bidirectional homing sequence has completed, the axis is left at the specified Home Position. If the Home Offset is non-zero, the axis will then be offset from the marker or home switch event point by the Home Offset value. If the Home Offset is zero, the axis will sit right on top of the marker or home switch point.

This is not valid for immediate Home Sequence.

Home Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E PV Only	Set/SSV	REAL	0	0	maxspd	Position Units / Sec

The Home Speed attribute controls the speed of the jog profile used in the first leg of an active homing sequence as described in the above discussion of the Home Sequence Type attribute.

This is valid for non-immediate cases of active Home Mode. Only valid for position and velocity control.

Home Return Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E PV Only	Set/SSV	REAL	0	0	maxspd	Position Units / Sec

The Home Return Speed attribute controls the speed of the jog profile used after the first leg of an active bidirectional homing sequence as described in the above discussion of the Home Sequence Type attribute.

This is valid for non-immediate cases of active Home Mode. Only valid for position and velocity control.

Home Acceleration

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E PV Only	Set/SSV	REAL	0	0	maxacc	Position Units / Sec^2

The Home Acceleration attribute controls the acceleration of the velocity profile used in an active Home Sequence attribute.

Home Deceleration

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E PV Only	Set/ SSV	REAL	0	0	maxacc	Position Units / Sec^2

The Home Deceleration attribute controls the deceleration of the axis as it comes to a stop in an active homing sequence as described in the Home Sequence attribute.

Home Torque Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E PV Only	Set/ SSV	REAL	0	0	100	Position Units / Sec^2

The Home Deceleration attribute controls the deceleration of the axis as it comes to a stop in an active homing sequence as described in the Home Sequence attribute.

See also

Motion Control Configuration Attributes on page 317

Motion Control Status Attributes on page 341

Motion Planner Configuration Attributes

These are the motion planner attributes associated with a Motion Control Axis.

Output Cam Execution Targets

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Get/ GSV[1]	DINT	0	0	8	# of Targets Represents the number of Output Cam nodes attached to this axis.

[1] This attribute can be set only when the axis instance is created.

The Output Cam Execution Targets attribute is used to specify the number of Output Cam nodes attached to the axis. This attribute can only be set as part of an axis create service and dictates how many Output Cam Nodes are created and associated to that axis. Each Output Cam Execution Target requires approximately 5.4k bytes of data table memory to store persistent data. With four Output Cam Execution Targets per axis, an additional 21.6k bytes of memory is required for each axis.

The ability to configure the number of Output Cam Execution Targets for a specific axis reduces the memory required per axis for users who do not need Output Cam functionality, or only need 1 or 2 Output Cam Execution Targets for a specific axis. Each axis can be configured differently.

Master Input Configuration Bits

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E PV only	Set/SSV	DWORD	0x01 0:1 1:0	-	-	Bitmap 0 = Master Delay Comp 1 = Master Position Filter 2…31 = Reserved

This attribute controls the master axis input signal feeding the gearing and camming functions of the motion planner, including the Master Position Filter and Master Delay Compensation.

Bit	Name	Description
0	Master Delay Compensation	By default, both the Position Camming and Gearing functions, when applied to a slave axis, perform Master Delay Compensation to compensate for the delay time between reading the master axis command position and applying the associated slave command position to the input of the slave's servo loop. When the master axis is running at a fixed speed, this compensation technique insures that the slave axis command position accurately tracks the actual position of the master axis; in other words, Master Delay Compensation allows for zero tracking error when gearing or camming to the actual position of a master axis. This feature, while necessary in many applications, doesn't come without a price. The Master Delay Compensation algorithm extrapolates the position of the master axis at the predicted time when the command position will be applied to the slave's servo loop. Since master axis position is measured in discrete feedback counts and is inherently noisy, the extrapolation process amplifies that noise according to the total position update delay. The total position update delay is proportional to the Coarse Update Period of the motion group. The Master Delay Compensation feature also includes an extrapolation filter to filter the noise introduced by the extrapolation process. The time constant of the filter is fixed at 4x the total position update delay (independent of the Master Position Filter Bandwidth), which again is a function of the Coarse Update Period. The Logix engine currently implements a 1st order extrapolation algorithm that results in zero tracking error while the master axis is moving at constant velocity. If the master axis accelerates or decelerates the tracking error is non-zero and proportional to the acceleration or deceleration rate and also proportional to the square of the total position update delay time. Clearly, from both a noise and acceleration error perspective, minimizing the Coarse Update Period is vital. In some applications there is no requirement for zero tracking error between the master and the slave axis. In these cases, it may be beneficial to disable the Master Delay Compensation feature to eliminate the disturbances the extrapolation algorithm introduces to the slave axis. When the Master Delay Compensation feature is disabled (bit cleared), the slave axis will appear to be more responsive to movements of the master, and run generally smoother than when Master Delay Compensation feature is enabled (bit set). However, when the master axis is running at a constant velocity, the slave will lag the master by a tracking error that is proportional to the speed of the master. Note that Master Delay Compensation, even if explicitly enabled, is not applied in cases where a slave axis is gearing or camming to the master axis' command position. Since the Logix controller generates the command position directly, there is no intrinsic master position delay to compensate for.
1	Master Position Filter	The Master Position Filter bit controls the activity of an independent single-poll low-pass filter that effectively filters the specified master axis position input to the slave's gearing or position camming operation. When enabled (bit set), this filter has the effect of smoothing out the actual position signal from the master axis, and thus smoothing out the corresponding motion of the slave axis. The trade-off for smoothness is an increase in lag time between the response of the slave axis to changes in motion of the master. Note that the Master Position Filter also provides filtering to the extrapolation noise introduced by the Master Delay Compensation algorithm, if enabled. When the Master Position Filter bit is set, the bandwidth of the Master Position Filter is controlled by the Master Position Filter Bandwidth attribute, see below. This can be done by setting the Master Position Filter bit and controlling the Master Position Filter Bandwidth directly. Setting the Master Position Filter Bandwidth to zero can be used to effectively disable the filter.

Bit	Name	Description
2...31		Reserved

Master Position Filter Bandwidth

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E PV only	Set/ SSV	REAL	0 1/(4*CUP)	0	1000(1) 1/CUP	Hertz Valid when Master Position Filter is enabled. A value of 0 disables the filter. CUP = Coarse Update Period

(1) Minimum Range limits based on Coarse Update Period are ultimately enforced for Master Position Filter Bandwidth attribute by clamping to limit rather than generating a value out of range error. Only if the value is outside the fixed Min/Max limits is an out of range error given. This was done to avoid implementing complex range limit code based on the Coarse Update Period in the Logix Designer application.

The Master Position Filter Bandwidth attribute controls the activity of the single-poll low-pass filter that filters the specified master axis position input to the slave's gearing or position camming operation. When enabled, this filter has the effect of smoothing out the actual position signal from the master axis, and thus smoothing out the corresponding motion of the slave axis. The trade-off for smoothness is an increase in lag time between the response of the slave axis to changes in motion of the master.

If the Master Position Filter is disabled, the Master Position Filter Bandwidth has no effect.

Motion Exception Action

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set	USINT [32]	4 (D) 2 (N)	-	-	Enumeration for Drive Modes (D) 0 = Ignore 1 = Alarm 2 = Fault Status Only 3 = Stop Planner 4 = Stop Drive 5 = Shutdown Enumeration for Feedback Only 0 = Ignore 1 = Alarm 2 = Fault Status Only 3 = N/A 4 = N/A 5 = Shutdown

Array of enumerated exception actions assigned to the currently defined Motion Exception conditions.

This table defines the actions that may be taken by the controller in response to the exception condition.

Motion Exception Action

Enumeration	Name	Description
0	Ignore	Ignore instructs the controller to completely ignore the exception condition. For some exceptions that are fundamental to the operation of the planner, it may not be possible to Ignore the condition.
1	Alarm	Alarm action instructs the controller to set the associated bit in the Motion Alarm Status word but to not otherwise impact axis behavior. For some exceptions that are fundamental to the operation of the planner, it may not be possible to select this action or any other action that leaves axis operation unimpacted.
2	Fault Status Only	Fault Status Only instructs the controller to set the associated bit in the Motion Fault Status word but to not otherwise impact axis behavior. It is up to the controller to programmatically bring the axis to a stop in this condition. For some exceptions that are fundamental to the operation of the planner, it may not be possible to select this action or any other action that leaves axis operation unimpacted.
3	Stop Planner	Stop Planner instructs the controller to set the associated bit in the Motion Fault Status word and instructs the Motion Planner to perform a controlled stop of all planned motion at the configured Max Decel rate. For some exceptions that are fundamental to the operation of the planner, it may not be possible to select this action or any other action that leaves the axis enabled.

Enumeration	Name	Description
4	Stop Drive	The Stop Drive action results in the controller both setting the associated bit in the Motion Fault Status word, abruptly stopping the motion planner, and bringing the axis to a stop by disabling the axis. The method used to decelerate the axis when there is a drive associated with the axis is the best available stopping method for the specific fault condition and is drive dependent.
5	Shutdown	Shutdown forces the axis into the Shutdown state, abruptly stops the motion planner, disables any gearing or camming operation that specifies this axis as a master axis, and immediately disables the associated drive's power structure. If configured to do so by the Shutdown Action attribute, the drive device may also open a contactor to drop DC Bus power to the drive's power structure. An explicit Shutdown Reset is required to restore the drive to an operational state.
6...254	Reserved	
255	Unsupported	The Unsupported Exception Action is the value assigned to Exceptions that are not supported in the implementation. Trying to assign an Exception Action other than Unsupported to an exception that is not supported results in an error.

Soft Travel Limit Checking

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/ SSV	BOOL	0	0	1	0 = No 1 = Yes

This is a Boolean value that determines if the system should check for software overtravel condition based on current settings for Soft Travel Limit - Positive, and Soft Travel Limit - Negative.

When the Soft Overtravel Checking Boolean is set to true the motion planner checks the current Actual Position of the axis and issues an exception condition if the Soft Travel Limits in either direction are exceeded. The travel limits are determined by the configured values for the Maximum Positive Travel and Maximum Negative Travel attributes. Soft Travel Limit checking is not a substitute, but rather a supplement, for hardware overtravel fault protection that uses hardware limit switches to directly stop axis motion at the drive and deactivate power to the system.

If the Soft Travel Limit Checking value is set to false (default), then no software travel limit checking is done by the planner. Note that software travel limit checking is only valid when the Rotary attribute Boolean value is set to false, for example, when configured for non-cyclic operation.

Soft Travel Limit Checking has no impact until the Axis Homed Status bit is set in the Motion Status Bits attribute; there is no point in checking absolute position of the axis if an absolute position reference frame has not been established for the machine.

Soft Travel Limit, Positive and Negative

Usage	Access	Attribute Name	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/ SSV	Soft Travel Limit - Positive	REAL	0	-maxpos	maxpos	Position Units
Required - E	Set/ SSV	Soft Travel Limit - Negative	REAL	0	-maxpos	maxpos	Position Units

The Soft Travel Limit - Positive attribute sets the maximum positive travel limit for actual position when Soft Travel Limit Checking is enabled. If this value is exceeded, a Soft Overtravel exception is generated.

The Soft Travel Limit - Negative attribute sets the maximum negative travel limit for actual position when Soft Travel Limit Checking is enabled. If this value is exceeded, a Soft Overtravel exception is generated.

This attribute provides configurable software travel limits through the Soft Travel Limit - Positive and Soft Travel Limit - Negative attributes. If the axis is configured for Soft Travel Limit Checking, and the axis passes outside these travel limits, a Software Travel exception condition occurs. In the case of a controlled axis, when the axis is outside the travel limits and no motion is being commanded or motion is being commanded to bring the axis back within the soft travel range, the Soft Travel Limit exception is NOT generated. This facilitates recovery from an existing Soft Travel Limit condition. In this case, a Fault Reset can be executed to clear the fault, allowing the axis to be enabled, and then simply commanded back inside the travel limits. For an uncontrolled axis, such as Feedback Only axis, a Soft Travel Limit exception is always generated when the axis is outside the travel limits. In this case the axis must be moved back inside the Travel Limits by some other means. Any attempt to clear the Travel Limit fault in the uncontrolled axis case while outside the travel limits results in an immediate re-issue of the Soft Travel Limit exception.

When Soft Travel Limit Checking is enabled, appropriate values for the maximum travel in both the Maximum Positive and Maximum Negative Travel attributes need to be established with Soft Travel Limit - Positive value always greater than Soft Travel Limit - Negative value. Both of these values are specified in the configured Position Units of the axis.

Command Update Delay Offset

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E PV only	Set/ SSV	DINT	0	-1 * MUP	2 * MUP	microseconds MUP = Multiplex Update Period

Use the Command Update Delay Offset attribute to introduce a time offset to the command as part of the Master Delay Compensation feature of the control system used by gearing and camming functions. Generally this value should be set to 0 since the device applies the command position according to the associated time stamp. A non-zero value would have the effect of phase advancing or retarding the axis position relative to a master axis.

See also

Motion Control Status Attributes on page 341

Absolute Position Recovery on page 43

Motion Planner Output Attributes

These are the motion planner output attributes associated with a Motion Control Axis.

Planner Command Position - Integer

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Get/ GSV	DINT	-	-	-	Planner Counts

This attribute value is the integer component of Motion Planner generated command position in planner counts. The command position data type is represented internally as a 64-bit floating point value that Motion Task restricts to a signed 32-bit integer range. The resulting range restricted Double Floating point value can therefore be expressed as two 32-bit attributes to preserve precision. This is accomplished by representing the command position (compos) as $x + y$, where x is the signed integer component (this attribute) and y is the signed floating point fractional component. x and y are defined using the following equations:

$$x = (\text{int})\text{compos}$$

$$y = (\text{float})(\text{compos} - x)$$

Planner Command Position - Fractional

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	Get/ GSV	REAL	-	-	-	Planner Counts

This attribute value is the fractional component of Motion Planner generated command position in planner counts. Representing the command position (compos) $x + y$, where x is the signed integer component and y is the signed floating point fractional component (this attribute). x and y are defined using the following equations:

$$x = (\text{int})\text{compos}$$

$y = (\text{float})(\text{compos} - x)$.

Planner Actual Position

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - ED	Get/ GSV	DINT	-	-	-	Planner Counts

This attribute value is the Motion Planner generated actual position in planner counts. The internal 64-bit signed integer representation of actual position is range limited by Motion Task to a signed 32-bit integer.

See also

Motion Planner Configuration Attributes on page 367

Interpret the Attribute Tables on page 87

Motion Scaling Attributes

These are the basic motion scaling configuration attributes associated with a Motion Control Axis. These attributes are involved in conversion between position, speed, and acceleration expressed in Motion Counts and Motion Units, and the user-defined Position Unit of the axis. The motion scaling function is also involved in conversion of Motion Counts to/from Feedback Counts, and Motion Units to/from Feedback Units.

Motion Scaling Configuration

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/GSV	USINT	0	-	-	Enumeration 0 = Control Scaling (R) 1 = Drive Scaling (O) 2…255 = Reserved

The Motion Scaling Configuration attribute determines whether the scaling function is performed by the controller or the drive. The Control Scaling selection configures the control system to perform the scaling calculations in the controller. In this mode, the controller interacts with the drive in terms of Feedback Counts or Motor Units, hence no scaling operations are required by the drive. Also, in Control Scaling mode the controller is responsible for Position Unwind (Cyclic Unwind for device axis objects) operations associated with Cyclic Travel Mode (Cyclic Unwind Control for device axis objects).

The Drive Scaling selection configures the control system to perform the scaling calculations in the drive device. In this mode, the controller interacts with the drive in terms of Motion Counts or Motion Units and the drive is responsible for conversion to equivalent Feedback Counts and Motor Units. Also, in Drive

Scaling mode the drive is responsible for Position Unwind (Cyclic Unwind) operations associated with Cyclic Travel Mode (Cyclic Unwind Control).

Scaling Source

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ SSV#	USINT	0	-	-	Enumeration: 0 = From Calculator 1 = Direct Scaling Factor Entry 2-255 = reserved

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

Enumerated attribute used to determine whether the scaling factors are going to be entered directly from the user or calculated based on Position Scaling, Position Unwind, and Travel Range values. When entered directly, the scaling factors, for example, Conversion Constant, Position Unwind, and Motion Resolution are expressed in units of "counts". When using the scaling calculator, the scaling factors are calculated based on values entered by the user in the preferred units of the application without requiring any knowledge of "counts".

Important:	Configuration of Scaling page parameters is required for any attributes expressed in position, velocity, or acceleration units to return meaningful values.

Scaling Calculations are performed by Logix Designer application whenever the Scaling attribute values change. Scaling attributes are defined as Position Scaling Numerator, Position Scaling Denominator, Position Unwind Numerator, Position Unwind Denominator, Travel Mode, and Travel Range. The purpose of the Scaling Calculation is to generate the key Scaling Factors used to convert between the user defined Position Units and the quantized Motion Count units used by the control system. The set of Scaling Factor attributes consist of Motion Resolution, Conversion Constant, and Position Unwind.

The specific Scaling Calculations performed by the Logix Designer application depend on the Travel Mode setting as follows:

Cyclical Travel:

- Max Resolution = Int((2^31-1) * (Pos Scaling Num/Pos Scaling Denom) / (Unwind Num/Unwind Denom))
- Base Resolution = Minimum (Default Motion Resolution, Max Resolution)
- Motion Resolution = (Pos Scaling Num*Unwind Denom) * (10^(Int (Log10(Base Resolution/(Pos Scaling Num*Unwind Denom)))))
- Conversion Constant = Motion Resolution * (Pos Scaling Denom/Pos Scaling Num)

- Unwind = Conversion Constant * (Unwind Num/Unwind Denom)

Limited Travel:

- Max Resolution = Int((2^31-1) * (Pos Scaling Num/Pos Scaling Denom) / Travel Range)
- Base Resolution = Minimum (Default Motion Resolution, Max Resolution)
- Motion Resolution = Pos Scaling Num * (10^(Int (Log10(Base Resolution/Pos Scaling Num))))
- Conversion Constant = Motion Resolution * (Pos Scaling Denom/Pos Scaling Num)

Unlimited Travel:

- Base Resolution = Default Motion Resolution
- Motion Resolution = Pos Scaling Num * (10^(Int (Log10(Base Resolution/Pos Scaling Num))))
- Conversion Constant = Motion Resolution * (Pos Scaling Denom/Pos Scaling Num)

When Scaling Calculations are performed, Logix Designer application sets the Scaling Source to "from calculator". If any of the Scaling Factor attributes is changed directly by the user either through Logix Designer or through programmatic access, Scaling Source is set to "direct entry". The "direct entry" setting indicates that the Scaling Factors are no longer consistent with the current Scaling attribute values.

Travel Mode

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ SSV#	USINT	0	-	-	Enumeration: 0 = Unlimited 1 = Limited (E) 2 = Cyclic (E) 3-255 = reserved

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

Enumerated attribute used to determine the travel constraints of the axis. Unlimited travel is for axes that run continuously without limit but are not cyclic. Limited travel is for axes that have imposed limits to their travel, usually due to mechanical limitations. Cyclic travel is for axes whose position repeats as part of a product cycle. While the axis may run continuously, the position value is bound between 0 and the Position Unwind value. If the Feedback Configuration = No

Feedback, such as with Sensorless/Encoderless operation, then the only valid Travel Mode setting is "Unlimited".

Position Scaling Numerator

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ GSV	REAL	1	0+	∞	Position Units

A floating point value used by the scaling calculator to determine the number of Position Units per Position Scaling Denominator units (Motion Units).

Position Scaling Denominator

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ GSV	REAL	1	0+	∞	Motion Unit

A floating point value used by the scaling calculator to determine the number of Motion Units per Position Scaling Numerator units (Position Units).

Position Unwind Numerator

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/ GSV	REAL	1	0+	∞	Position Units

A floating point value used by the scaling calculator to determine the number of Position Units per Position Unwind Denominator units (Unwind Cycles). This value is only used by the calculator if cyclic Travel Mode is selected.

Position Unwind Denominator

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/ GSV	REAL	1	0+	∞	Unwind Cycles

A floating point value used by the scaling calculator to determine the number of Unwind Cycles per Position Unwind Numerator units (Position Units). This value is only used by the calculator if cyclic Travel Mode is selected.

Travel Range

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/ GSV	REAL	1	0+	∞	Position Units

A floating point value used by the scaling calculator to determine the maximum travel range in Position Units for a limited Travel Mode position scaling calculation.

Motion Unit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ GSV	USINT	0	-	-	Enumeration 0 = Motor Rev 1 = Load Rev 2 = Feedback Rev 3 = Motor mm 4 = Load mm 5 = Feedback mm 6 = Motor inch 7 = Load inch 8 = Feedback inch 9 = Motor Rev/s 10 = Load Rev/s 11 = Motor m/s 12 = Load m/s 13 = Motor inch/s 14 = Load inch/s 15...255 = Reserved

The Motion Unit attribute determines the unit of measure used to express the Motion Resolution used by motion planner functions. A Motion Unit is the standard engineering unit of measure for motion displacement. Motion Units may be configured as Revs, Inches, or Millimeters depending on the specific application.

Motion Resolution

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ SSV#	DINT	Default Motion Resolution	1	2^{31}-1	Motion Counts / Motion Unit

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

The Motion Resolution attribute is an integer value that determines the number of Motion Counts per Motion Unit used by the scaling function to convert between Motion Counts and Feedback Counts. This attribute determines how many Motion Counts there are in a Motion Unit. A Motion Count is the fundamental unit of displacement used by the Motion Planner and a Motion Unit is the standard engineering unit of measure for motion displacement. Motion Units may be configured as Revs, Inches, or Millimeters depending on the specific application.

All command position, velocity, and acceleration data is scaled from the user's preferred Position Units to Motion Units for the Motion Planner based on the Motion Resolution and Conversion Constant. The ratio of the Conversion Constant to Motion Resolution determines the number of Position Units in a Motion Unit as described using the following formula.

- Conversion Constant / Motion Resolution = Motion Units (revs, inches, or millimeters) / Position Unit

Conversely, all actual position, velocity, and acceleration data from the Motion Planner is scaled from Motion Units to the user's preferred Position Units based on the Motion Resolution and Conversion Constant. The ratio of Motion Resolution and the Conversion Constant determines the number of Position Units in a Motion Unit as described using the following formula:

- Motion Resolution / Conversion Constant = Position Units / Motion Unit (rev, inch, or millimeter)

In general, the Motion Resolution value may be may be configured in Motion Counts per Motion Unit independent of the resolution of the feedback device(s) used. The drive's scaling function takes care of scaling between Feedback Counts and Motion Counts. Providing a configurable Motion Resolution value is particularly useful for addressing Fractional Unwind applications where it is necessary to have an integer number of Motion Counts per Unwind Cycle.

Valid Motion Unit attribute selections are determined by the Feedback Configuration, Load Type, and Linear Actuator Unit (Lead Unit or Diameter Unit) values according to the following table:

Feedback Configuration	Load Type	Linear Actuator Unit	Motion Unit
No Feedback	Direct Rotary	-	Motor Rev/s
No Feedback	Rotary Transmission	-	Load Rev/s
No Feedback	Linear Actuator	mm/rev | mm	Load m/s
No Feedback	Linear Actuator	inch/rev| inch	Load inch/s
Master Feedback	Direct Rotary	-	Feedback Rev
Master Feedback	Direct Linear	-	Feedback mm
Master Feedback	Rotary Transmission	-	Load Rev
Master Feedback	Linear Actuator	mm/rev | mm	Load mm
Master Feedback	Linear Actuator	inch/rev| inch	Load inch
Motor Feedback	Direct Rotary	-	Motor Rev
Motor Feedback	Direct Linear	-	Motor mm
Motor Feedback	Rotary Transmission	-	Load Rev
Motor Feedback	Linear Actuator	mm/rev |mm	Load mm
Motor Feedback	Linear Actuator	inch/rev | inch	Load inch
Load | Dual Feedback	Direct Rotary	-	Load Rev
Load | Dual Feedback	Direct Linear	-	Load mm
Load | Dual Feedback	Rotary Transmission	-	Load Rev
Load | Dual Feedback	Linear Actuator	mm/rev | mm	Load mm
Load | Dual Feedback	Linear Actuator	inch/rev | inch	Load inch

The Default Motion Resolution value used for scaling factors, Motion Resolution, Conversion Constant, and Position Unwind, depends on the Motion Unit selection according to the following table:

Motion Unit	Default Motion Resolution
Motor|Load|Feedback Rev	1,000,000
Motor|Load|Feedback mm	10,000
Motor|Load|Feedback Inch	200,000
Motor|Load|Feedback Rev/s	1,000,000
Motor|Load|Feedback m/s	10,000,000
Motor|Load|Feedback Inch/s	200,000

Travel Range Limit

Because the position parameters are sometimes internally limited to signed 32-bit representation, the Motion Resolution parameter impacts the travel range. In such a case, the equation for determining the maximum travel range based on Motion Resolution is as follows:

- Travel Range Limit (in Motion Units) = +/- 2,147,483,647 / Motion Resolution

Based on a default value of 1,000,000 Motion Counts per Motion Unit, the range limit is 2,147 Motion Units. When the axis position exceeds this value, the position accumulators roll-over, essentially flipping the sign of the axis position value. Motion continuous smoothly through the roll-over but the position values are obviously not contiguous. This is nominal operation in Unlimited Travel Mode. While it is relatively rare for this travel range limitation to present a problem, say in point-to-point positioning applications, it is a simple matter to lower the Motion Resolution to increase the travel range. The downside of doing so is that the position data is then passed with lower resolution that could impact the smoothness of motion. Selecting Limit Travel Mode sets the Motion Resolution value close to the maximum value that complies with the specified Travel Range of the application.

Fractional Unwind

In some cases, however, you may also want to specifically configure Motion Resolution value to handle fractional unwind applications or multi-turn absolute applications requiring cyclic compensation. In these cases where the Position Unwind value for a rotary application does not work out to be an integer number of Motion Counts, the Motion Resolution attribute may be modified to a value that is integer divisible by the Position Unwind value. This is done automatically when selecting the Cyclic Travel Mode.

Motion Polarity

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ SSV#	USINT	0	0	1	Enumeration: 0 = Normal Polarity 1 = Inverted Polarity 2-255 = (Reserved)

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

When Motion Scaling Configuration is set for Drive Scaling, Motion Polarity can be used to switch the directional sense of the motion control system. A Normal setting leaves the sign of the motion control command and actual signal values unchanged from their values in the drive control structure. An Inverted setting flips the sign of the command signal values to the drive control structure and flips the sign of the actual signal values coming from the drive control structure. Motion Polarity can therefore be used to adjust the sense of positive direction of the motion control system to agree with the positive direction on the machine.

When the Motion Scaling Configuration is set to Drive Scaling, the Motion Polarity inversion is performed between the CIP Motion Connection interface and the drive control structure. When the Motion Scaling Configuration is set to Controller Scaling, the Motion Polarity inversion is performed exclusively by the controller.

To maintain directional consistency, the signs of all Signal Attribute values read from the drive control structure or being written to the drive control structure are determined by Motion Polarity. A comprehensive list of these Signal Attributes and their access rules is defined in the following table:

ID	Access Rule	Signal Attribute Name
1402+o	Get	Feedback n Position
1403+o	Get	Feedback n Velocity
1404+o	Get	Feedback n Acceleration
62	Get	Registration 1 Positive Edge Position
63	Get	Registration 1 Negative Edge Position
64	Get	Registration 2 Positive Edge Position
65	Get	Registration 2 Negative Edge Position
70	Get	Home Event Position
360	Set*	Controller Position Command - Integer
365	Get	Fine Command Position
366	Get	Fine Command Velocity
367	Get	Fine Command Acceleration
370	Set	Skip Speed 1
371	Set	Skip Speed 2

ID	Access Rule	Signal Attribute Name
372	Set	Skip Speed 3
430	Get	Position Command
431	Set*	Position Trim
432	Get	Position Reference
433	Get	Velocity Feedforward Command
436	Get	Position Error
437	Get	Position Integrator Output
438	Get	Position Loop Output
450	Get	Velocity Command
451	Set*	Velocity Trim
452	Get	Acceleration Feedforward Command
453	Get	Velocity Reference
454	Get	Velocity Feedback
455	Get	Velocity Error
456	Get	Velocity Integrator Output
457	Get	Velocity Loop Output
480	Get	Acceleration Command
481	Set*	Acceleration Trim
482	Get	Acceleration Reference
483	Get	Acceleration Feedback
801	Get	Load Observer Acceleration Estimate
802	Get	Load Observer Torque Estimate
490	Get	Torque Command
491	Set*	Torque Trim
492	Get	Torque Reference
493	Get	Torque Reference - Filtered
494	Get	Torque Reference - Limited
821	Get	Total Inertia Estimate
520	Get	Iq Current Command
521	Get	Operative Current Limit
523	Get	Motor Electrical Angle
524	Get	Id Current Reference
525	Get	Id Current Reference
840	Set	Current Disturbance
527	Get	Iq Current Error
528	Get	Id Current Error
529	Get	Iq Current Feedback
530	Get	Id Current Feedback
565	Get	Slip Compensation
600	Get	Output Frequency

ID	Access Rule	Signal Attribute Name
601	Get	Output Current
602	Get	Output Voltage
603	Get	Output Power

Motion Polarity can also have an impact on directional position, velocity, acceleration, and torque limit attributes. When the Motion Scaling Configuration is set to Drive Scaling, inverting Motion Polarity requires that positive and negative position, velocity, acceleration*, and torque limit values be both sign inverted and swapped between the CIP Motion Connection interface and the drive's internal control structure.

When the Motion Scaling Configuration is set to Controller Scaling, inverting Motion Polarity requires that positive and negative position, velocity, acceleration, and torque limit attribute values in Motion Control Axis Object be inverted and swapped with the corresponding attributes in the Motion Device Axis Object. For example entering a "Velocity Limit – Positive" value in the controller of 100 revs/sec would result in a "Velocity Limit – Negative" value of -100 revs/sec in the drive device.

A comprehensive list of these Directional Limit Attributes and their access rules is defined in the following table:

ID	Access Rule	Attribute Name
374	Set	Ramp Velocity - Positive
375	Set	Ramp Velocity - Negative
376	Set	Ramp Acceleration
377	Set	Ramp Deceleration
448	Set	Position Limit - Positive
449	Set	Position Limit - Negative
473	Set	Velocity Limit - Positive
474	Set	Velocity Limit - Negative
485	Set	Acceleration Limit*
486	Set	Deceleration Limit*
504	Set	Torque Limit - Positive
505	Set	Torque Limit - Negative

** Acceleration and Deceleration Limits are unsigned positive values and, therefore, do not need to be sign inverted.*

Position Units

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set	STRING	"Position Units"	-	-	"Revs"

The Position Units string attribute allows user-defined engineering units rather than "counts" to be used for measuring and programming all motion-related values (position, velocity, acceleration, etc). Position Units can be different for each axis and should be chosen for maximum ease of use in the machine application. For example, linear axes might use Position Units of "Inches", "Meters", or "mm" while rotary axes might use Position Units of "Revs" or "Degrees".

The Position Units attribute can support an ASCII text string of up to 32 characters. This string is used by Logix Designer application in the axis configuration dialogs to request values for motion-related parameters in the specified Position Units. In this case, the software limits the maximum string length to 15 characters.

Average Velocity Timebase

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ SSV#	REAL	0.25	0.001 (1 coarse update period)	32 (1000 coarse update period)	Sec

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

This attribute determines the period of time over which the system computes Average Velocity for this axis instance.

Range limits based on coarse update period and history array size are ultimately enforced for Average Velocity Timebase attribute by clamping to limit rather than generating a value out of range error. Only if the value is outside the fixed Min/Max limits is an out of range error given.

Conversion Constant

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/ SSV#	REAL	Default Motion Resolution	10^{-12}	10^{12}	Counts/Position Unit

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

This attribute is used as a scaling factor allowing axis position, velocity, and acceleration attributes to be displayed or configured in the user's preferred units specified by the Position Unit string attribute. Specifically, the Conversion Constant, is used by the motion system to scale the axis position units into motion planner counts and vice versa. The Conversion Constant represents the number of counts of the motion planner per Position Unit.

Position Unwind

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	Set/ SSV#	DINT	Default Motion Resolution	1	10^9	Counts/Cycle

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

If the axis is configured for cyclic Travel Mode, a value for the Position Unwind attribute is required. This is the value used to perform electronic unwind of the cyclic axis' position. Electronic unwind operation provides infinite position range for cyclic axes by subtracting the position unwind value from both the actual and command position every time the axis completes a machine cycle. To avoid accumulated error due to round-off with irrational conversion constants, the unwind value is expressed as an integer number of feedback counts per cycle.

See also

Motion Resolution Value Examples on page 386

Motion Resolution Value Examples

Motion Resolution is one of the Motion Scaling attributes. These examples demonstrate how the Motion Resolution value may be used together with the Conversion Constant to handle various machine applications.

Direct-Drive Rotary Shear Application

In this mechanical configuration a rotary motor is directly driving a rotary shear drum equipped with three knives to cut a product to specified length, thus producing three products per revolution of the output shaft. Because the default Motion Resolution value is 1,000,000 Motion Counts/Motor Rev and the user's Position Unit is, say, Products, the Conversion Constant would be 1,000,000/3 Motion Counts/Product. This is particularly problematic when configured to perform an Unwind operation every product cut cycle where a 1/3 count error would accumulate with every cycle. But, because Motion Resolution is configurable, you can simply set the Motion Resolution to 300,000 Motion Counts/Motor Rev and the Conversion Constant could then be set to 100,000 Motion Counts/Motor Rev, and a Rotary Unwind value of 100,000 Motion Counts/Cycle.

Because the Conversion Constant is now a clean rational number, this system scales without any loss of mechanical precision, for example, a move of three Products would move the output shaft exactly one revolution. By setting the Travel Mode to Cyclic, entering Position Scaling of three Products per Motor Rev, and a Position Unwind value of one Product per Cycle, appropriate values for scaling factors, Motion Resolution, Conversion Constant, and Rotary Unwind are automatically calculated.

The control system is responsible for scaling Motion Counts into equivalent Motor Feedback Counts. In this case, because the motor is directly coupled to the load, one rotation of the shearing drum translates to one revolution of the motor feedback device. Assuming that the motor feedback device is a typical optical encoder with 4000 Feedback Counts/rev, a displacement of 300,000 Motion Counts would be scaled by the control system to be 4000 Feedback Counts.

Rotary Shear Application with Gearbox

Instead of the motor directly driving the rotary shear drum, in this application example the motor is driving the shearing drum through a 3:1 gearbox. Since the Motion Unit is tied to the load, for example, Load Rev, the Motion Resolution, Conversion Constant, and Rotary Unwind determined in the example above apply equally well to this application.

The scaling of Motion Counts to Motor Feedback Counts, however, is not the same due to the presence of the gearbox. In this case, one revolution of the shearing mechanism translates to three revolutions of the motor. Nevertheless, the control system has a count scaling feature that performs this scaling automatically. This is done by selecting a Rotary Transmission as the Load Type, and setting the Transmission Ratio Output to 1, and the Transmission Ratio Input to 3. In this way, 300,000 Motion Counts per Load Rev is scaled exactly to 12,000 Motor Feedback Counts, or three Motor Revs.

Rotary Motor with Gearbox/Ball-Screw Application

Because this is a linear application, Motion Resolution would be expressed as Motion Counts per Load millimeter m or Load inch, in this case, say millimeter.

The motor feedback would, however, be rotary and resolution expressed in Motor Feedback Counts per Motor Rev, in our case 4000 Feedback Counts per Motor Rev. The default Motion Resolution is 1,000,000 Motion Counts per millimeter and if the Position Unit is, say, centimeters, the Conversion Constant would be 10,000,000 Motion Counts per centimeter. This would be automatically calculated by entering a Position Scaling of 1 centimeter per 10 millimeters.

Given that our application uses a 4:1 gearbox and a 5 mm pitch ball-screw, 5 mm of ball-screw travel translates to 4 revolutions of the motor, or 16,000 Feedback Counts. Again, the control system's count-scaling feature performs this scaling automatically. This is done by selecting Linear Actuator as the Load Type, setting the Transmission Ratio Output to 1, and the Transmission Ratio Input to 4, setting the Actuator Type to be "Screw", and the Lead to 5 mm/rev. In this way, 5,000,000 Motion Counts, or 5 mm worth of screw displacement, is scaled exactly to 16,000 Motor Feedback Counts, or exactly 4 Motor Revs.

See also

Motion Scaling Attributes on page 375

Motor Attributes

These are the motor configuration attributes associated with a Motion Control Axis that apply to various motor technologies. These motor technologies include three-phase motor rotary, linear, permanent magnet and induction motors. Motor attributes are organized according to the various motor types.

General Linear Motor Attributes

These are the motor configuration attributes that apply specifically to linear motor types.

Linear Motor Pole Pitch

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/GSV	REAL	50 DB	0	∞	mm

The Linear Motor Pole Pitch attribute is a floating point value that specifies the pole pitch of a linear motor in units of meters, and is equivalent to the electrical cycle length.

Linear Motor Rated Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/GSV	REAL	0 DB	0	∞	m/s

The Linear Motor Rated Speed attribute is a floating point value that specifies the nameplate rated speed of a linear motor. For PM motors, this is generally specified at rated voltage based on either rated current, rated force, or rated power. For induction motors this value is the speed of the motor driven at rated frequency under rated force load. This value is synonymous with the term base speed.

Linear Motor Mass

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/SSV#	REAL	0 DB	0	∞	Mass Unit

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

The Linear Motor Mass attribute is a floating point value that specifies the unloaded moving mass of a linear motor.

Linear Motor Max Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/GSV	REAL	0 DB	0	∞	m/s

The Linear Motor Max Speed attribute is a floating point value that specifies the absolute maximum operating speed of a linear motor in units of m/s. This speed may be determined by the limitations of the motor, limitations of the drive power structure, or by limitations of the mechanical system, whichever is less. Specifically, this value can represent the maximum safe operating speed, maximum continuous no-load speed, maximum continuous encoder speed, or maximum continuous bearing speed of the motor. This value can be used by the drive to determine the Linear Motor Overspeed Factory Limit.

Linear Motor Damping Coefficient

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/GSV	REAL	0 DB	0	∞	N/(m/s)

The Linear Motor Damping Coefficient attribute is a floating point value that specifies the damping, or viscous friction, associated with a linear motor.

Linear Motor Integral Limit Switch

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/GSV	BOOL	0 DB	0	1	0 = No 1 = Yes

The Linear Motor Integral Limit Switch attribute is a Boolean value that specifies if the motor has integral limit switches.

See also

General Motor Attributes on page 389

General Permanent Magnet Motor Attributes on page 396

Induction Motor Attributes on page 401

Linear PM Motor Attributes on page 404

General Motor Attributes

These are the general motor attributes that apply to all motor technologies.

Motor Catalog Number

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set	SHORT STRING	-	-	-	For example, MPL-B310F

The Motor Catalog Number attribute is a string, up to 32-characters, that specifies the motor catalog number. In the controller this is a settable attribute and is used to identify a specific motor record in the Motion Database when Motor Data Source is set to Database. In the drive Motor Catalog Number is a gettable attribute and can be used to identify a specific motor when Motor Data Source is not from the Motion Database. In this case, if the Motor Catalog Number is not available to the drive, the drive sets this attribute to a Null string.

Motor Serial Number

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Get	SHORT STRING	-	-	-	For example, 0012003400560078

The Motor Serial Number attribute is a 16-character string that specifies the serial number of the motor. If the Motor Catalog Number is not available, the drive sets this attribute to a Null string.

Motor Data Source

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/GSV	USINT	0	-	-	Bits 0-3: Enum 0 = Datasheet (R) 1 = Database (O) 2 = Drive NV (O) 3 = Motor NV (O) 4…127 = Reserved 128…255 = Vendor specific

The Motor Data Source attribute specifies the source of motor data for the drive.

- **Datasheet** implies that the motor configuration attributes are entered by the user from a motor datasheet or from motor nameplate data.
- **Database** means that configuration software pulls the motor data from a motor database based on catalog number during the drive configuration process.
- **Drive NV** implies that the motor attributes are derived directly from the drive's nonvolatile memory. In this mode, only a minimal set of motor and motor feedback (Feedback 1) are required to configure the drive.

- **Motor NV** implies that the motor attributes are derived from non-volatile memory of a motor-mounted smart feedback device equipped with a serial interface. Again, in this mode, only a minimal set of motor and motor feedback (Feedback 1) are required to configure the drive.

In both Drive NV and Motor NV cases, the specific motor and motor feedback attributes that are sent or not sent to the drive during configuration are identified in the CIP Drive Set Attr Update Bits attribute table.

Motor and motor feedback attributes sent to the drive device in Drive NV or Motor NV are merely to confirm that the controller and the drive have the agreement on the values of attributes critical to scaling operation. If the NV attribute values in the drive differ from the values set by the controller, the drive will reject the values with General Status indicating an Invalid Attribute Value. The current list of motor and motor feedback attributes sent to the drive in the NV modes are as follows:

1. Motor Unit
2. Feedback 1 Unit
3. Feedback 1 Type
4. Feedback 1 Startup Method
5. Feedback 1 Cycle Resolution
6. Feedback 1 Cycle Interpolation
7. Feedback 1 Turns
8. Feedback 1 Length

Motor Device Code

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/GSV	UDINT	0 DB	0	2^{32}-1	-

The Motor Device Code attribute is a unique number assigned to a motor catalog number. This value is used to insure that the motor and integral motor mounted feedback device configuration data delivered from the controller matches the actual motor and feedback data connected to the drive.

This comparison is only valid in the case where the Motor Data Source is Datasheet or Database driven and the motor is equipped with a smart feedback device. If the codes do not match, a negative acknowledge is given by the drive.

Motor Device Codes are assigned by the motor manufacturer. A value of 0 for the Motor Device Code will be accepted by the drive without comparison.

Motor Type

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/GSV	USINT	0 DB	-	-	Enumeration 0 = Not Specified (R) 1 = Rotary Permanent Magnet (O) 2 = Rotary Induction (O) 3 = Linear Permanent magnet (O) 4 = Linear Induction (O) 5 = Rotary Interior Permanent Magnet (O) 6...127 = Reserved 128...255 = Vendor Specific

The Motor Type attribute is an enumeration that specifies the motor technology.

When Motor Type is set to Not Specified, all motor configuration attribute values associated with the motor are considered Not Applicable and will not be set by configuration software nor will they be sent to the drive.

If Motor Data Source is Motor NV or Drive NV, the Motor Type may not be known to the controller but is known by the drive, so the drive can operate in this case without specifying the Motor Type. In this case, the Motor Type is not sent to the drive.

If Motor Data Source is Datasheet or Database, an unspecified Motor Type, when received by the drive device during configuration, indicates that the motor configuration has not been defined and therefore results in a Configuration Fault indicating an Invalid Attribute Value.

Motor Unit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/GSV	USINT	0	-	-	Enumeration 0 = Rev (R for Rotary motor types) 1 = Meter (R for Linear motor types) 2...127 = Reserved 128...255 = Vendor Specific

The Motor Unit attribute is a unit of measure for motor displacement. This attribute is also used for sensorless operation since the Feedback Unit in that case is not known. Motor Unit selection is based on Motor Type.

Motor Polarity

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/SSV*	USINT	0 DB	-	-	Enumeration 0 = Normal Polarity 1 = Inverted Polarity 2...255 = Reserved

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The Motor Polarity attribute is an enumerated value used to establish the direction of motor motion when the windings are phased according to factory specification. Normal polarity is defined as the direction of motor travel when the ABC motor winding leads are hooked up according to the drives published specifications. Inverted polarity effectively switches the ABC phasing to ACB so that the motor moves in the opposite direction in response to a positive drive output.

You can use the Motor Polarity attribute to make the direction of travel agree with the user's definition of positive travel. It can be used in conjunction with the Feedback Polarity bit to provide negative feedback, when closed loop control is required. When commutating a PM motor, it is imperative that the commutation phase sequencing match the motor phase sequencing to properly control the motor.

Motor Rated Voltage

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/GSV	REAL	0 DB	0	∞	Volts (RMS)

The Motor Rated Voltage attribute is a floating point value that specifies the nameplate AC voltage rating of the motor. This represents the phase-to-phase voltage applied to the motor to reach rated speed at full load.

Motor Rated Continuous Current

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/GSV	REAL	0 DB	0	∞	Amps (RMS)

The Motor Rated Continuous Current attribute is a floating point value that specifies the nameplate AC continuous current rating of the motor. This represents the current applied to the motor under full load conditions at rated speed and voltage. Any positive number. This is a database number and should not be changed.

Motor Rated Peak Current

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - PM Optional - IM	Set/GSV	REAL	0 DB	0	∞	Amps (RMS)

The Motor Rated Peak Current attribute is a floating point value that specifies the peak or intermittent current rating of the motor. The peak current rating of the motor is often determined by either the thermal constraints of the stator winding or the saturation limits of PM motor magnetic material.

Motor Rated Output Power

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - IM Optional - PM	Set/GSV	REAL	0 DB	0	∞	Power Units

The Motor Rated Output Power attribute is a floating point value that specifies the nameplate rated output power rating of the motor. This represents the power output of motor under full load conditions at rated current, speed and voltage.

Motor Overload Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/GSV	REAL	100 DB	0	200 DB	% Motor Rated

The Motor Overload Limit attribute is a floating point value that specifies the maximum thermal overload limit for the motor. This value is typically 100%, corresponding to the power dissipated when operating at the continuous current rating of the motor, but can be significantly higher if, for example, cooling options are applied. How the Motor Overload Limit is applied by the drive depends on the overload protection method employed.

For induction motors, this attribute is often related to the Service Factor of the motor. The Service Factor is defined in the industry as a multiplier which, when applied to the rated power or current of the motor, indicates the maximum power or current the motor can carry without entering an overload condition.

Regardless of the Motor Type, if the drive applies an I^2T motor overload protection method, then exceeding the specified Motor Overload Limit results in an overload condition and activates I^2T overload protection. While the motor is overloaded, the Motor Capacity attribute value increases to indicate how much of the motor's available I^2T overload capacity has been utilized. When Motor Capacity reaches 100% of its rated capacity, the drive can optionally trigger a Motor Overload Action.

When employing an overload protection method based on a motor thermal model, the Motor Capacity attribute value represents how much of the motor's rated thermal capacity, associated with the motor thermal model, has been utilized. Once the Motor Capacity value exceeds the Motor Overload Limit, the drive can optionally trigger a predetermined Motor Overload Action.

The Motor Overload Limit can also used by the drive to determine the absolute thermal capacity limit of the motor, for example, the Motor Thermal Overload Factory Limit, that if exceeded, generates a Motor Thermal Overload FL exception.

Motor Integral Thermal Switch

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/GSV	BOOL	0 DB	0	1	0 = No 1 = Yes

The Motor Integral Thermal Switch attribute is a Boolean value that specifies if the motor has an integral thermal switch to detect a Motor Overtemperature condition. Connection to the motor thermal switch can be through the motor feedback interface, associated with Axis I/O Status bit, Feedback 1 Thermostat, or through a discrete digital input to the drive, associated with Axis I/O Status bit, Motor Thermostat. The method of interface to the thermal switch is left to the drive vendor's discretion.

Motor Max Winding Temperature

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/GSV	REAL	0 DB	0	∞	°C

The Motor Max Winding Temperature attribute is a floating point value that specifies the maximum winding temperature of the motor.

Motor Winding to Ambient Capacitance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/GSV	REAL	0 DB	0	∞	Joules/°C

The Motor Winding to Ambient Thermal Capacitance attribute is a floating point value that specifies the winding-to-ambient thermal capacitance.

Motor Winding to Ambient Resistance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/GSV	REAL	0 DB	0	∞	°C/Watt

The Motor Winding to Ambient Thermal Resistance attribute is a floating point value that specifies the winding-to-ambient thermal resistance.

See also

Motor Attributes on page 57

Induction Motor Attributes on page 401

Linear PM Motor Attributes on page 404

Load Transmission and Actuator Attributes on page 409

Rotary PM Motor Attributes on page 412

General Permanent Magnet Motor Attributes

These are the motor configuration attributes that apply to Permanent Magnet motor types in general.

PM Motor Resistance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/SSV*	REAL	0 DB	0	-	Ohms

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The PM Motor Resistance attribute is a floating point value that specifies the phase-to-phase, resistance of a permanent magnet motor.

PM Motor Inductance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required (SPM Only)	Set/SSV*	REAL	0 DB	0	-	Henries

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The PM Motor Inductance attribute is a floating point value that specifies the phase-to-phase, inductance of a permanent magnet motor.

PM Motor Flux Saturation

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional (SPM Only)	Set	REAL [8]	[100, 100, 100, 100, 100, 100, 100, 100] DB	0	100	% Nominal Inductance

The PM Motor Flux Saturation attribute is an array of floating point values that specify the amount of flux saturation in the motor as a function of current. The units for the nominal inductance values are percent, such that a value of 100% means no saturation, and 90% means the inductance is 90% of its value at zero current.

The first array entry specifies the flux saturation value at 12.5% of the Peak Current Rating; the second entry specifies the value at 25%, and so on up to the last entry, which specifies the value at 100% of the Peak Current Rating. (At zero current, the motor is assumed to have no saturation, for example, an implied value of 100%.)

PM Motor Lq Inductance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required (IPM Only)	Set/SSV*	REAL	0 DB	0	∞	Henries

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The PM Motor Lq Inductance attribute is a floating point value that specifies the phase-to-neutral, q-axis, inductance of an interior permanent magnet motor.

PM Motor Ld Inductance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required (IPM Only)	Set/SSV*	REAL	0 DB	0	∞	Henries

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The PM Motor Ld Inductance attribute is a floating point value that specifies the phase-to-neutral, d-axis, inductance of an interior permanent magnet motor.

PM Motor Lq Flux Saturation

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional (IPM Only)	Set	REAL [8]	[100, 100, 100, 100, 100, 100, 100, 100] DB	0	100	% Nominal Inductance

The PM Motor Lq Flux Saturation attribute is an array of floating point values that specify the amount of q-axis flux saturation in the motor as a function of current. The units for q-axis flux saturation values are percent of Nominal Inductance, such that a value of 100% means no saturation, and 90% means the inductance is 90% of its value at zero current given by the PM Motor Lq Inductance attribute.

The first array entry specifies the flux saturation value at 25% of the Continuous Current Rating; the second entry specifies the value at 50%, and so on up to the last entry, which specifies the value at 200% of the Peak Current Rating. (At zero current, the motor is assumed to have no saturation, for example, an implied value of 100%.)

PM Motor Ld Flux Saturation

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional (IPM Only)	Set	REAL	100 DB	0	100	% Nominal Inductance

The PM Motor Lq Flux Saturation attribute is an array of floating point values that specify the amount of d-axis flux saturation in the motor at rated current. The units for d-axis flux saturation values are percent of Nominal Inductance, such that a value of 100% means no saturation, and 90% means the inductance is 90% of its value at zero current given by the PM Motor Ld Inductance attribute.

The PM Motor Ld Flux Saturation value specifies the d-axis saturation at 100% of the Continuous Current Rating.

PM Motor Extended Speed Permissive

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - PVT (PM Only)	Set/SSV	USINT	0	0	1	Enumeration: 0 = False 1 = True

The PM Motor Extended Speed Permissive attribute value determines whether the speed of a PM motor is allowed to exceed the Bus Overvoltage Speed. Setting this value to True removes velocity limit protection against Bus Overvoltage conditions associated with Rotary and Linear PM motors. In this case it is critical that Bus Overvoltage protection be provided through a resistive brake module or DC bus regulation device to avoid drive damage.

Specifically, the PM Motor Extended Speed Permissive determines if the Bus Overvoltage Speed is applied to the velocity limiter function. The Bus Overvoltage Speed is only applied to the velocity limiter if the PM Motor Extended Speed Permissive is False.

The PM Motor Extended Speed Permissive value also determines the values of the Motor Overspeed Factory Limit and Motor Overspeed User Limit that provide overspeed protection. If the PM Motor Extended Speed Permissive is False, the Motor Overspeed Limits will be based on the Bus Overvoltage Speed. If the PM Motor Extended Speed Permissive is True, the Motor Overspeed Limits will be based on the Max Extended Speed value.

See also

General Motor Attributes on page 389

Induction Motor Attributes on page 401

Linear PM Motor Attributes on page 404

Motor Attributes on page 57

Rotary PM Motor Attributes on page 412

General Rotary Motor Attributes

These are the motor configuration attributes that apply specifically to rotary motor types.

Rotary Motor Poles

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/GSV	UINT	PM: 8 IM: 4 DB	2	max int	

The Rotary Motor Poles attribute is an integer that specifies the number of poles per revolution for rotary motors. This value is always an even number, as poles always exist in pairs.

Rotary Motor Inertia

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/SSV#	REAL	0 DB	0	∞	Inertia Units

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
# Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).						

The Rotary Motor Inertia attribute is a floating point value that specifies the unloaded inertia of a rotary motor.

Rotary Motor Rated Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/GSV	REAL	0 DB	0	∞	RPM

The Rotary Motor Rated Speed attribute is a floating point value that specifies the nameplate rated speed of a rotary motor. For PM motors, this is generally specified at rated voltage based on either rated current, rated torque, or rated power. For induction motors this value is the speed of the motor driven at rated frequency under rated torque load. This value is synonymous with the term base speed.

Rotary Motor Max Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/GSV	REAL	0 DB	0	∞	RPM

The Rotary Motor Max Speed attribute is a floating point value that specifies the absolute maximum operating speed of a rotary motor in units of RPM. This speed may be determined by the limitations of the motor, limitations of the drive power structure, or by limitations of the mechanical system, whichever is less. Specifically, this value can represent the maximum safe operating speed, maximum continuous no-load speed, maximum encoder speed, maximum continuous motor bearing speed, or maximum motor speed based on the drive power structure voltage limit. This value can be used by the drive to determine the Rotary Motor Overspeed Factory Limit.

Rotary Motor Damping Coefficient

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/GSV	REAL	0 DB	0	∞	N-m/Radians/sec

The Rotary Motor Damping Coefficient attribute is a floating point value that specifies the damping, or viscous friction, associated with a rotary motor.

Rotary Motor Fan Cooling Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/GSV	REAL	0	0	∞	RPM

The Rotary Motor Fan Cooling Speed attribute selects the output speed of the motor below which the Motor Rated Continuous Current is derated due to the reduced effectiveness of an integral fan cooling system.

Rotary Motor Fan Cooling Derating

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/GSV	REAL	0	0	∞	% Motor Rated

The Rotary Motor Fan Cooling Derating attribute selects the % derating of the motor when the motor is operating at a speed below the specified Motor Fan Cooling Speed. A value of 70% would indicate that the motor can only run at 70% rated continuous current when operating below the Motor Fan Cooling Speed.

See also

General Motor Attributes on page 389

General Permanent Magnet Motor Attributes on page 396

General Linear Motor Attributes on page 388

Rotary PM Motor Attributes on page 412

Induction Motor Attributes

These are the motor configuration attributes that apply specifically to induction motor types.

Induction Motor Rated Frequency

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	Set/GSV	REAL	60 DB	0	∞	Hertz

The Induction Motor Rated Frequency attribute is a floating point value that specifies the nameplate frequency rating of an induction motor.

Induction Motor Flux Current

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/SSV*	REAL	0 DB FD	0	∞	Amps (RMS)

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The Induction Motor Flux Current attribute is an ID Current Reference that is required to generate full motor flux. This value is closely approximated by the No Load Motor Rated Current commonly found in Induction Motor data sheets.

Induction Motor Stator Resistance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/SSV*	REAL	0 DB FD	0	∞	Ohms

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The Induction Motor Stator Resistance attribute is a floating point value that specifies the Y circuit, phase-neutral, winding resistance of the stator as shown as R_1 in the IEEE motor model.

Induction Motor Stator Leakage Reactance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/SSV*	REAL	0 DB FD	0	∞	Ohms

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The Induction Motor Stator Leakage Reactance attribute is a floating point value that specifies the Y circuit, phase-neutral, leakage reactance of the stator winding, at rated frequency, as shown as X_1 in the IEEE motor model.

Induction Motor Magnetization Reactance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional[1]	Set/SSV*	REAL	0 DB	0	∞	Ohms

Usage	Access	Data Type	Default	Min	Max	Semantics of Values

[1] *This parameter has a strong motor temperature component that some drives circumvent through various adaptive control or compensation techniques.*

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The Induction Motor Magnetization Reactance attribute is a floating point value that specifies the Y circuit, phase-neutral, magnetizing reactance of the motor, at rated frequency, as shown as X_m in the IEEE motor model.

Induction Motor Rotor Resistance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional[1]	Set/SSV*	REAL	0 DB	0	∞	Ohms

[1] *This parameter has a strong motor temperature component that some drives circumvent through various adaptive control or compensation techniques.*

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The Induction Motor Rotor Resistance attribute is a floating point value that specifies the phase-neutral equivalent stator-referenced winding resistance of the rotor as shown as R_2' in the IEEE motor model.

Induction Motor Rotor Leakage Resistance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/SSV*	REAL	0 DB FD	0	∞	Ohms

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The Induction Motor Rotor Leakage Resistance attribute is a floating point value that specifies the Y circuit, phase-neutral, equivalent stator-referenced leakage inductance of the rotor winding, at rated frequency, as shown as X_2' in the IEEE motor model.

Induction Motor Rated Slip Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/SSV*	REAL	0 FD	0	∞	RPM (rotary motor type) m/s (linear motor type)

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The Induction Motor Rated Slip Speed attribute represents the amount of slip at motor rated current (full load) and motor rated frequency.

See also

General Motor Attributes on page 389

General Permanent Magnet Motor Attributes on page 396

Linear PM Motor Attributes on page 404

Motor Attributes on page 57

Rotary PM Motor Attributes on page 412

Linear PM Motor Attributes

These are the motor configuration attributes that apply specifically to linear PM motor types.

PM Motor Rated Force

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/GSV	REAL	0 DB	0	∞	N

The PM Motor Rated Force attribute is a floating point value that specifies the nameplate continuous force rating of a linear permanent magnet motor in Newtons (N).

PM Motor Force Constant

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/SSV*	REAL	0	0 DB	∞	N/Amp (RMS)

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The PM Motor Force Constant attribute is a floating point value that specifies the force constant of a linear permanent magnet motor in Newtons per RMS Amp.

PM Motor Linear Voltage Constant

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/SSV*	REAL	0 DB	0	∞	Volts (RMS) / (m/s)

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The PM Motor Linear Voltage Constant attribute is a floating point value that specifies the voltage, or back-EMF, constant of a linear permanent magnet motor in phase-to-phase RMS Volts per meter/sec.

If the optional PM Motor Force Constant, Kf, is not explicitly supported in the implementation, the value may be computed from the PM Motor Linear Voltage Constant, Ke, according to this equation: $Kf\ (N/A_{rms}) = 1.732 * Ke\ (V_{rms}/(m/s))$

PM Motor Linear Bus Overvoltage Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - PVT (PM Only)	Set/GSV	REAL	0 FD	0	∞	m/s

The PM Motor Linear Bus Overvoltage Speed attribute value corresponds to the linear motor speed at which the back-EMF of the motor equals the maximum operational bus voltage of the drive. When the extended speed range of a PM motor is not permitted (PM Motor Extended Speed Permissive is False), this value can be used to limit motor speed to protect the drive from damage due to bus overvoltage conditions that can occur when disabling a PM motor at high speed.

When configured for Position Loop or Velocity Loop operation, this bus overvoltage protection includes limiting the magnitude of the velocity reference value allowed into the velocity summing junction to the Bus Overvoltage Speed Limit value using the velocity limiter function. If the signal entering the velocity limiter exceeds this velocity limit value, and the PM Motor Extended Speed Permissive is False, the velocity limiter clamps the velocity reference to this value and sets the Velocity Limit status bit. If the PM Motor Extended Speed Permissive is True, or the value of this attribute is 0, this limit is not applied.

When the extended speed range of a PM motor is not permitted, overvoltage protection is also provided through motor overspeed detection based on the Motor Overspeed Factory Limit and Motor Overspeed User Limit. Exceeding these limits results in a Motor Overspeed FL or UL Axis Exception. Overspeed detection is the only source of protection when the axis is configured for Torque Loop operation.

PM Motor Linear Max Extended Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - PVT (PM Only)	Set/SSV	REAL	0 FD	0	∞ or Linear Motor Max Speed	m/s

When the extended speed range of a PM motor is permitted (PM Motor Extended Speed Permissive is True) the PM Motor Linear Max Extended Speed attribute value can be used to limit the speed of a linear motor to protect the motor or load from damage due to an overspeed condition.

When configured for Position Loop or Velocity Loop operation, this overspeed protection includes limiting the magnitude of the velocity reference value allowed into the velocity summing junction using the velocity limiter function. If the signal entering the velocity limiter exceeds this velocity limit value, the velocity limiter clamps the velocity reference to this value and sets the Velocity Limit status bit. If the value of this attribute is 0, this limit is not applied.

When the extended speed range of a PM motor is permitted, overspeed protection is also provided through motor overspeed detection based on the Motor Overspeed Factory Limit and Motor Overspeed User Limit. Exceeding these limits results in a Motor Overspeed FL or UL Axis Exception. Overspeed detection is the only source of protection when the axis is configured for Torque Loop operation.

If the related optional attribute, Rotary or Linear Motor Max Speed, is supported, software will apply this maximum speed value as the Max Value for this attribute.

See also

General Permanent Magnet Motor Attributes on page 396

General Rotary Motor Attributes on page 399

General Linear Motor Attributes on page 388

Induction Motor Attributes on page 401

Velocity Loop Signal Attributes on page 228

Interior Permanent Magnet Motor Attributes

The following attribute tables list the motor configuration attributes that apply only to Interior Permanent Magnet (IPM) motor types.

PM Motor Lq Flux Inductance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	SSV	REAL	0 DB	0	-	Henries

A floating point value that specifies the phase-to-neutral, q-axis, inductance of an interior permanent magnet motor.

PM Motor Ld Flux Inductance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	SSV	REAL	0 DB	0	-	Henries

A floating point value that specifies the phase-to-neutral, d-axis, inductance of an interior permanent magnet motor.

PM Motor Ld Flux Saturation

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	SSV	REAL	100 DB	0	100	% Nominal Inductance

An array of floating point values that specify the amount of d-axis flux saturation in the motor at rate current. The units for d-axis flux saturation values are percent of Nominal Inductance, such that a value of 100% means no saturation, and 90% means the inductance is 90% of its value at zero current given by the PM Motor Ld Inductance attribute. The PM Motor Ld Flux Saturation value specifies the d-axis flux saturation at 100% of the Continuous Current Rating.

PM Motor Ld Flux Saturation

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	SSV	REAL	100 DB	0	100	% Nominal Inductance

An array of floating point values that specify the amount of d-axis flux saturation in the motor at rate current. The units for d-axis flux saturation values are percent of Nominal Inductance, such that a value of 100% means no saturation, and 90% means the inductance is 90% of its value at zero current given by the PM Motor Ld Inductance attribute. The PM Motor Ld Flux Saturation value specifies the d-axis flux saturation at 100% of the Continuous Current Rating.

Commutation Offset Compensation

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - CE	SSV	REAL	0	0	-	Electrical Degrees

This value specifies the change in the Commutation Offset value in units of electrical degrees as a linear function of current. When the Iq current is +100% of rated continuous current, the Commutation Offset value is decreased by the value of this attribute. When the Iq current is -100% the Commutation Offset is increased by the value of the attribute. This attribute is used by the drive to compensate for changes in the optimal Commutation Offset angle that can occur as a function of motor current.

Motor Test Lq Inductance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	GSV	REAL	-	-	-	Henries

This floating point value represents the phase-to-phase q-axis motor inductance measured by the Motor Test procedure.

Motor Test Ld Inductance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	GSV	REAL	-	-	-	Henries

This floating point value represents the phase-to-phase d-axis motor inductance measured by the Motor Test procedure.

Motor Test Lq Flux Saturation

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	GSV	REAL [8]	-	-	-	% Nominal Inductance

This array of floating point values represents the phase-to-phase q-axis stator inductance of the motor as measured by the Motor Test procedure expressed as a percentage of the measured Nominal Inductance, Lq, at 25%, 50%, 75%, 100%, 125%, 150%, 175% and 200% rated continuous current.

Motor Test Ld Flux Saturation

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	GSV	REAL	-	-	-	% Nominal Inductance

This floating point value represents the phase-to-phase d-axis stator inductance of the motor as measured by the Motor Test procedure expressed as a percentage of the measured Nominal Inductance, Ld, at 100% rated continuous current.

Motor Test Max Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	GSV	REAL	-	-	-	RPM (rotary motor type) m/s (linear motor type)

This floating point value represents the maximum speed of the motor as determined by the Motor Test procedure.

Motor Test Commutation Offset Comp

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	GSV	REAL	-	-	-	Electrical Degrees

This floating point value represents the change in motor Commutation Offset at rated continuous current as measured by the Motor Test procedure.

See also

Interpret the Attribute Tables on page 87

Motion Control Configuration Attributes on page 317

Load Transmission and Actuator Attributes

These are the motor configuration attributes that apply specifically to rotary transmission and linear actuator mechanisms associated with the axis.

Load Type

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/GSV	USINT	0 DB	-	-	Enumeration 0 = Direct Rotary 1 = Direct Linear 2 = Rotary Transmission 3 = Linear Actuator 4...255 = Reserved

The Load Type attribute is used to determine how the load is mechanically linked to the motor. Direct enumerations indicate that the motor is directly coupled to the load. Rotary enumerations indicate that the load is rotating and load dynamics are measured using a rotary system of units. Linear enumeration indicate that the load is moving linearly and load dynamics are measured using a linear system of units.

Transmission Ratio Input

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/GSV	DINT	1 DB	1	2^{31}-1	Input Shaft Revs

The Transmission Ratio Input attribute is an integer number of input shaft revolutions per transmission cycle associated with the rotary transmission.

Transmission Ratio Output

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/GSV	DINT	1 DB	1	2^{31}-1	Output Shaft Revs

The Transmission Ratio Output attribute is an integer number of output shaft revolutions per transmission associated with the rotary transmission.

Actuator Type

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/GSV	USINT	0 DB	-	-	Enumeration 0 = None (R) 1 = Screw (O) 2 = Belt and Pulley (O) 3 = Chain and Sprocket (O) 4 = Rack & Pinion (O) 5…255 = Reserved

The Actuator Type attribute indicates the type of mechanism used for linear actuation.

Actuator Lead

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/GSV	REAL	1 DB	0+	∞	Actuator Lead Units

The Actuator Lead attribute is a floating point value that represents the lead or pitch of a screw actuator that is a measure of the linear movement of the screw mechanism per revolution of the screw shaft.

Actuator Lead Unit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/GSV	USINT	0	-	-	Enumeration 0 = mm/Rev 1 = Inch/Rev 2...255 = Reserved

The Actuator Lead Unit attribute indicates the units of the Actuator Lead attribute.

Actuator Diameter

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/GSV	REAL	1	0+		Actuator Diameter Units

The Actuator Diameter attribute is a floating point value that represents the diameter of the pulley, sprocket, or pinion used to convert rotary motion into tangential linear displacement of the load. The Actuator Diameter is internally converted to circumference of the pulley, sprocket, or pinion to determine the amount of tangential displacement per revolution.

Actuator Diameter Unit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Set/GSV	USINT	0	-	-	Enumeration 0 = mm 1 = Inch 2...255 = Reserved

The Actuator Diameter Unit attribute is a value that indicates the units of the Actuator Diameter attribute.

See also

Motor Attributes on page 57

General Motor Attributes on page 389

General Permanent Magnet Motor Attributes on page 396

General Rotary Motor Attributes on page 399

General Linear Motor Attributes on page 388

Rotary PM Motor Attributes

These are the motor configuration attributes that apply specifically to rotary motor types.

PM Motor Rated Torque

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/GSV	REAL	0 DB	0	∞	N-m

The PM Motor Rated Torque attribute is a float that specifies the nameplate continuous torque rating of a rotary permanent magnet motor.

PM Motor Torque Constant

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	Set/SSV*	REAL	0 DB	0	∞	N-m/Amp (RMS)

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The PM Motor Torque Constant attribute is a float that specifies the torque constant of a rotary permanent magnet motor in Newton-meters per RMS Amp.

PM Motor Rotary Voltage Constant

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	Set/SSV*	REAL	0 DB	0	∞	Volts (RMS) / KRPM

** Indicates the attribute cannot be set while the drive power structure is enabled (Power Structure Enable bit in CIP Axis Status is true).*

The PM Motor Rotary Voltage Constant attribute is a float that specifies the voltage, or back-EMF, constant of a rotary permanent magnet motor in phase-to-phase RMS Volts per KRPM.

If the optional PM Motor Torque Constant, Kt, is not explicitly supported in the implementation the value may be computed from the PM Motor Rotary Voltage Constant, Ke, according to this equation: $Kt\ (N\text{-}m/A_{rms}) = 0.01654 * Ke\ (V_{rms}/Krpm)$.

PM Motor Rotary Bus Overvoltage Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - PVT PM Only	Set/GSV	REAL	0 FD	0	∞	RPM

This value corresponds to the rotary motor speed at which the back-EMF of the motor equals the maximum operational bus voltage of the drive. When the extended speed range of a PM motor is not permitted, this value can be used to limit motor speed to protect the drive from damage caused from bus overvoltage conditions that occur when disabling a PM motor at high speed.

When configured for Position Loop or Velocity Loop operation, this bus overvoltage protection includes limiting the magnitude of the velocity reference value allowed into the velocity summing junction to the Bus Overvoltage Speed Limit value using the velocity limiter function. If the signal entering the velocity limiter exceeds this velocity limit value, and the PM Motor Extended Speed Permissive is False, the velocity limiter clamps the velocity reference to this value and sets the Velocity Limit status bit. If the PM Motor Extended Speed Permissive is True, or the value of this attribute is 0, this limit is not applied.

When the extended speed range of a PM motor is not permitted, overvoltage protection is also provided through motor overspeed detection based on the Motor Overspeed Factory Limit and Motor Overspeed User Limit. Exceeding these limits results in a Motor Overspeed FL or UL Axis Exception. Overspeed detection is the only source of protection when the axis is configured for Torque Loop operation.

PM Motor Rotary Max Extended Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - PVT PM only	Set/SSV	REAL	0 FD	0	∞ or Rotary Motor Max Speed	RPM

When the extended speed range of a PM motor is permitted (PM Motor Extended Speed Permissive is True), this value can be used to limit the speed of a rotary motor to protect the motor or load from damage due to an overspeed condition.

When configured for Position Loop or Velocity Loop operation, this overspeed protection includes limiting the magnitude of the velocity reference value allowed into the velocity summing junction using the velocity limiter function. If the signal entering the velocity limiter exceeds this velocity limit value, the velocity limiter clamps the velocity reference to this value and sets the Velocity Limit status bit. If the value of this attribute is 0, this limit is not applied.

When the extended speed range of a PM motor is permitted, overspeed protection is also provided through motor overspeed detection based on the Motor Overspeed Factory Limit and Motor Overspeed User Limit. Exceeding these limits results in a Motor Overspeed FL or UL Axis Exception. Overspeed detection is the only source of protection when the axis is configured for Torque Loop operation.

If the related optional attribute, Rotary or Linear Motor Max Speed, is supported, software will apply this maximum speed value as the Max Value for this attribute.

See also

General Motor Attributes on page 389

General Permanent Magnet Motor Attributes on page 396

General Rotary Motor Attributes on page 399

Motor Attributes on page 57

Velocity Loop Signal Attributes on page 228

Safety Attributes

The following attributes tables contains attributes associated with safety functionality.

Axis Safety attributes are used with integrated CIP Safety functionality associated with a Motion Device Axis Object instance included in a CIP Motion Safety Drive. These attributes reflect the current state of an embedded Safety Core within for a CIP Motion Safety Drive device that is designed to interoperate with an external Safety Controller using a CIP Safety network connection. For this reason, integrated safety functions are also referred to as "networked safety".

Guard Safety attributes are used with built-in Safety functionality associated with a Motion Device Axis Object instance. These built-in safety attributes relate to the behavior of a configurable Safety Core (SMSC) within the drive that executes basic drive safety functions using hardwired safety inputs and safety outputs without the services of a CIP Safety network connection.

Axis Safety Status Attributes

The following attribute tables contains axis attributes used with the integrated Safety functionality associated with a Motion Device Axis Object instance included in a CIP Motion Safety Drive. These attributes reflect the current state of an embedded Safety Core within for a CIP Motion Safety Drive device that is designed to interoperate with an external Safety Controller using a CIP Safety connection.

In the Logix Integrated Architecture, many of the safety functions can be executed either in the drive or in the associated safety controller. A unique feature of the architecture is that regardless of where the safety function is executed, the Axis Safety Status and Axis Safety Fault information reported by these safety functions is the same. This is achieved by the Safety Status Pass Thru feature where safety functions executing in the safety controller transmit their fault and status information to the drive via the Safety Output Assembly where this information is combined with the fault and status information of safety function executing in the Safety Core of the drive. The combined safety function fault and status data is then "Passed Thru" to the associated Motion Device Axis Object instance attributes.

The following table identifies the supported safety functions:

Short Name	Full Name	Control	Drive	Description
STO	Safe Torque Off	No	Yes	Disables associated drive power structure.
SBC	Safe Brake Control	Yes	No	Engages safety brake.
SS1	Safe Stop 1	Yes	Yes	Monitors Category 1 Stop followed by STO.
SS2	Safe Stop 2	Yes	No	Monitors Category 2 Stop followed by SOS.
SOS	Safe Operating Stop	Yes	No	Monitor standstill condition for movement.
SMT	Safe Motor Temperature	No	No	Monitor motor temperature for overtemperature.
SLT	Safely-limited Torque	No	Yes	Prevents the motor from exceeding the specified torque limit.
SLA	Safely-limited Acceleration	No	No	Monitor acceleration exceeding configured limit.
SLS	Safely-limited Speed	Yes	No	Prevents the motor from exceeding the specified speed limit.
SDI	Safe Direction	Yes	No	Monitor for change in direction of travel.
SSM	Safe Speed Monitor	Yes	No	Monitor speed exceeding configured limit.
SLP	Safely-limited position	Yes	No	Prevents the motor shaft from exceeding the specified position limit(s).
SCA	Safe CAM	Yes	No	Monitors whether the motor shaft position is within a specified range.
SFX	Safe Feedback Interface	Yes	No	Scales and references safety feedback data.

The Axis Safety State, Axis Safety Status, and Axis Safety Fault attributes defined below are based on the values read from attributes resident in objects associated with the Safety Core and are used by the motion control system to monitor the behavior of the Safety Core via the CIP Motion connection.

Axis Safety State

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE Safety only	Get/GSV	T	UINT	-	-	-	Enumeration: 0 = Unknown (No Motion Connection) 1 = Self-Testing 2 = Configured (No Safety Connection) 3 = Self-Test Exception 4 = Running 5 = Recoverable Fault 6 = Unrecoverable Fault 7 = Configuring 8 = Not Configured 9-50 = Reserved by CIP 51 = Not Configured (Torque Permitted) 52 = Running (Torque Permitted) 53-99 = Device Specific 100-255 = Vendor Specific

The Axis Safety State attribute is an 8-bit enumerated value that indicates the state of the associated Safety Supervisor object of the device as it applies to this axis instance. There is only one Safety Supervisor object servicing the CIP Motion device so its state generally applies to all applicable Axis instances of the device. This means that all instances of this object generally have the same state for this attribute.

The two exceptions to this general state behavior are the Waiting for TUNID with Torque Permitted (state=51) and Executing with Torque Permitted (state=8) states that have axis specific qualification. When the Safety Supervisor State is Waiting for TUNID with Torque Permitted, if the Axis Safety Status bit, Safe Torque Disabled, is set, the Axis Safety State is set to Waiting for TUNID. When the Safety Supervisor State is Executing with Torque Permitted, if the Axis Safety Status bit, Safe Torque Disabled, is set, the Axis Safety State is Executing.

Axis Safety State Bit Descriptions

Bit	Safety Supervisor State	Description
0 = Undefined/Unknown (No MotionConnection)	Undefined	No motion connection has been opened to the drive. Actual safety state is unknown.
1 = Self-Testing	Self-Testing	The safety function of drive has been initialized; all attributes given appropriate defaults and safety faults have been reset. Device is performing tests to determine if it is qualified to execute its safety function.

Bit	Safety Supervisor State	Description
2 = Configured (No Safety Connection)	Idle	The safety function of drive has been initialized, successfully completed self-testing, and has a valid safety configuration. However, the device is not executing the operational components of its safety functions. Configuring and Configured are persistent states that are preserved through power cycles.
3 = Self-Test Exception	Self-Test Exception	The safety function of drive has detected an exception condition during self-testing. The details of the exception are stored in the appropriate attribute values of the Safety Supervisor object.
4 = Running	Executing	The safety function of drive is fully configured with an open safety output connection and executing. In this state, the drive is operational and free to apply torque to the motor as long as there are no safety demands.
5 = Recoverable Fault	Abort	The safety function of drive is in a faulted state that can be recovered by cycling the power or reconnecting the drive.
6 = Unrecoverable Fault	Critical Fault	The safety function of drive is in a faulted state for which there is no recovery other than replacing the module.
7 = Configuring	Configuring	The safety function of drive has been initialized, successfully completed self-testing, and is in the process of receiving a valid configuration from a safety controller. Configuring and Idle are persistent states that are preserved through power cycles.
8 = Not Configured	Waiting for TUNID	The safety function of drive has exited Self-testing and recognizes that it has the out-of-box default configuration values, for example it has not been configured by a safety controller. The drive remains in this state until a safety controller initiates the configuration process. Application of torque to the motor is NOT permitted in this state.
9...50 = Reserved	-	-
51 = Not Configured (Torque Permitted)	Waiting for TUNID with Torque Permitted	Same behavior as Not Configured state with the exception that the drive axis is operational and the safety function will permit application of torque to the motor.
52 = Running (Torque Permitted)	Executing with Torque Permitted	Same behavior as Running state with the exception that the drive axis is operational and the safety function will permit application of torque to the motor. Entering this state from the Running state requires a successful STO Mode change service applied while the safety controller is in Program Mode.
53...99 = Device Specific	-	-
100...255 = Vendor Specific	-	-

Axis Safety Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE Safety only	Get/GSV	T	DWORD	-	-	-	Bitmap: 0 = Safety Fault 1 = Safety Reset Request 2 = Safety Reset Required 3 = Safe Torque Off Active 4 = Safe Torque Disabled 5 = Safe Brake Control (SBC) Active 6 = Safe Brake Control (SBC) Engaged 7 = Safe Stop 1 (SS1) Active 8 = Safe Stop 2 (SS2) Active 9 = Safe Operating Stop (SOS) Active 10 = Safe Operating Stop (SOS) Standstill 11 = Safe Motor Temperature (SMT) Active 12 = Safe Motor (SMT) Overtemperature 13...15 = (reserved) 16 = Safe Speed Monitoring (SSM) Active 17 = Safe Speed Monitoring (SSM) Status 18 = Safe Limited Speed (SLS) Active 19 = Safe Limited Speed (SLS) Limit 20 = Safe Limited Accel (SLA) Active 21 = Safe Limited Accel (SLA) Limit 22 = Safe Direction (SDI) Active 23 = Safe Direction (SDI) Limit 24 = Safe Positive Motion 25 = Safe Negative Motion 26 = Safe CAM (SCA) Active 27 = Safe CAM (SAC) Status 28 = Safe Limited Position (SLP) Active 29 = Safe Limited Position (SLP) Limit 30 = Safety Output Connection Closed 31 = Safety Output Connection Idle

The Axis Safety Status attribute is a collection of bits indicating the status of the standard safety functions for the axis as reported by the embedded Safety Core of the device. The Axis Safety Status word is a concatenation of two 16-bit safety status attributes. The lower 16-bits are the current Safety Stop Status attribute value of the Safety Stop Functions object associated with this axis instance. The upper 16-bits are the current Safety Limit Status attribute value of the Safety Limit Functions object associated with this axis instance with the exception of the two most significant bits that are masked off to accommodate two Safety Output Connection status bits. Specifically, the Safety Output Connection Closed bit, when set, indicates that the Safety Output Connection has either not been opened or has been closed. The Safety Output Connection Idle bit, when set, indicates that the Safety Output Connection's Run/Idle bit has been set to Idle.

For Rockwell Automation safety drive devices, the safety status data from the drive's Safety Core may include safety status from the Safety Controller through the Pass Thru data included in the Safety Output assembly. This allows the Axis Safety Status attribute to reflect safety function status conditions regardless of where the safety function is executed, be it in the Safety Controller, or the drive's Safety Core.

Axis Safety Status - RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE Safety only	Get/GSV	T	DWORD	-	-	-	Bitmap: 0 = Safe Brake Integrity 1 = Safe Feedback Homed 2…31 = (reserved)

The Axis Safety Status - RA attribute is a collection of bits indicating the status of the Rockwell Automation specific safety functions for the axis as reported by the embedded Safety Core of the device. For Rockwell Automation safety drive devices, the safety status data from the drive's Safety Core may include safety status from the Safety Controller through the Pass Thru data included in the Safety Output assembly. This allows the Axis Safety Status RA attribute to reflect safety function status conditions regardless of where the safety function is executed, be it in the Safety Controller, or the drive's Safety Core.

Axis Safety Faults

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE Safety only	Get/GSV	T	DWORD	-	-	-	Bitmap: 0 = (reserved) 1 = Safety Core Fault 2 = Safety Feedback Fault 3 = Safe Torque Off Fault 4 = Safe Stop 1 (SS1) Fault 5 = Safe Stop 2 (SS2) Fault 6 = Safe Operating Stop (SOS) Fault 7= Safe Brake (SBC) Fault 8 = Safe Motor Temperature Fault (SMT) 9…15 = (reserved) 16 = Safe Speed Monitor (SSM) Fault 17 = Safe Limited Speed (SLS) Fault 18 = Safe Limited Accel (SLA) Fault 19 = Safe Direction (SDI) Fault 20 = Safe CAM (SCA) Fault 21 = Safe Limited Protection (SLP) Fault 22…29 = (reserved) 30 = Safety Validator Fault 31 = Safety Abort Fault

The Axis Safety Faults attribute is a collection of bits indicating the safety fault status of the axis associated with standard safety functionality as reported by the embedded Safety Core of the device. When a safety fault condition occurs, the Safety Core forces the axis into a Safe State and the corresponding bit is set in the Axis Safety Faults attribute. An active safety fault bit remains latched even if the underlying safety fault condition is cleared by the Safety Core. A Fault Reset Request to the associated axis clears the safety fault bits, but the bits immediately set again if the underlying safety fault condition is still present. The Axis Safety Faults word is a concatenation of two 16-bit safety fault attributes. The lower 16-bits is the current Safety Stop Faults attribute value of the Safety Stop Functions object associated with this axis instance. The upper 16-bits is the current Safety Limit Faults attribute value of the Safety Limit Functions object associated with this axis instance.

For Rockwell Automation safety drive devices, the safety fault status data from the drive's Safety Core may include safety faults from the Safety Controller through the Pass Thru data included in the Safety Output assembly. This allows the Axis Safety Faults attribute to reflect safety function fault conditions regardless of where the safety function is executed, be it in the Safety Controller, or the drive's Safety Core.

Axis Safety Faults - RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE Safety only	Get/GSV	T	DWORD	-	-	-	Bitmap: 0 = (reserved) 1 = Safety Feedback Interface (SFX) Fault 2...31 = (reserved)

The Axis Safety Faults - RA attribute is a collection of bits indicating the safety fault status of the axis associated with Rockwell Automation specific safety functionality as reported by the embedded Safety Core of the device. When a safety fault condition occurs, the Safety Core forces the axis into a Safe State and the corresponding bit is set in the Axis Safety Faults RA attribute. An active safety fault bit remains latched even if the underlying safety fault condition is cleared by the Safety Core. A Fault Reset Request to the associated axis clears the safety fault bits, but the bits immediately set again if the underlying safety fault condition is still present.

For Rockwell Automation safety drive devices, the safety fault status data from the drive's Safety Core may include safety faults from the Safety Controller through the Pass Thru data included in the Safety Output assembly. This allows the Axis Safety Faults RA attribute to reflect safety function fault conditions regardless of where the safety function is executed, be it in the Safety Controller, or the drive's Safety Core.

Safe Torque Off Action

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D Safety Only	Set/ SSV#		USINT	FD 1 for C 0 for F	-	-	Enumeration: 0 = Disable and Coast 1 = Current Decel and Disable 2 = Ramped Decel and Disable 3-127 = (reserved) 128-255 = (vendor specific) 128 = DC Injection Brake 129 = AC Injection Brake

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

When the drive detects a Safe Torque Off (STO) Active condition that was not initiated by a Safe Stop 1 (SS1) Active condition, as reported by the embedded Safety Core through the Axis Safety Status attribute, and the Safe Torque Off

Action Source is set to Connected Drive, this value determines the stopping method to apply to the motor. Each Safe Torque Off Action enumeration initiates one of two defined Stopping Sequences, Category 0 Stop, or Category 1 Stop. The definition for each enumeration will follow the same enumerations defined for the Stopping Action attribute.

Category 1 Stop enumerations of Current Decel & Disable or Ramped Decel & Disable are often used in conjunction with a configured delay (for example, STO to Safe Brake Control (SBC) Delay or STO Delay) between the STO Active condition and Safe Torque Disabled to allow the drive to bring the motor to a controlled stop and engage a brake prior to disabling the power structure. This capability is particularly important for vertical load applications.

The final state after the Stopping Sequence is applied is the Start Inhibited state or, in the case of a Safety Fault initiated STO activation, the Major Faulted state. In either final state the device's inverter power structure will be disabled, ultimately with safety integrity as enforced by the Safety Core's STO safety function.

Safe Torque Off Action Source

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D Safety Only	Set/ SSV#		USINT	0	-	-	Enumeration: 0 = Connected Drive (R) 1 = Running Controller (O) 2-127 = (reserved) 128-255 = (vendor specific)

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

The Safe Torque Off Action Source attribute determines whether the drive or the controller initiates the stopping sequence in response a STO Active condition in the Axis Safety Status attribute that was not initiated by an SS1 or Safe Stop 2 (SS2) Active condition.

When configured for Connected Drive (default), the drive will initiate the stopping sequence according to the selected Safe Torque Off Action. However, the drive must have an open connection to the controller for the configured stopping action to occur. If the drive is not connected, the drive would have already initiated the configured Connection Loss Stopping Action.

When configured for Running Controller, the stopping sequence is initiated by the connected controller as long as the controller connection's "Run/Idle" bit in the Real Time (RT) Header is indicating Run Mode. This allows the controller to provide a programmed stopping action. If the controller is in Idle Mode, i.e. not actively running the application program, the connected drive will initiate the stopping sequence according to the configured Safe Torque Off Action. This selection is only valid if the connected controller is supplying the "Run/Idle" Real Time header.

Safe Stopping Action

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D Safety Only	Set/ SSV#		USINT	0	-	-	Enumeration: 0 = Current Decel 1 = Ramped Decel 2-127 = (reserved) 128-255 = (vendor specific)

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

When an SS1 or SS2 Active condition occurs, as indicated by the Axis Safety Status attribute, and the Axis Safety Stopping Source is set to Connected Drive, this value determines the stopping method the drive is to apply to the motor. The selected stopping method is applied while in the Stopping state and the final state after the stopping method completes is the Stopped state. In this final state the device's inverter power structure will either be Disabled and free of torque, if initiated by an SS1 Active status bit, or actively held (Hold selection) in a static condition if initiated by an SS2 Active status bit.

Safe Stopping Action Bit Descriptions

Bit	Required/Optional	Name	Description
0	R/C O/F	Current Decel	Current Decel leaves the power structure and any active control loops enabled while stopping. If configured for position control mode, the drive forces the position reference to hold its current value until the axis reaches zero speed. Once at zero speed the position reference is immediately set equal to the actual position to hold the axis at standstill. If in velocity control mode, the drive forces the velocity reference to zero. In either case, forcing the position or velocity reference signals to a fixed value results in a rapid increase in control loop error of the moving axis that saturates the output current of the drive to the configured Stopping Torque that brings the motor to a stop. In torque control mode, the drive directly applies the configured Stopping Torque to the torque command signal to decelerate the motor. When the velocity feedback value reaches zero speed, the torque command is set to zero. In frequency control mode the Current Vector Limit attribute, rather than the Stopping Torque attribute, is used to regulate the stopping current. Once stopped, or the configured Stopping Time, or factory limit expires, the Current Decel stopping action is complete.

Bit	Required/Optional	Name	Description
1	O/FV	Ramped Decel	Current Decel & Disable also leaves the power structure and any active control loops enabled while stopping but uses the Ramp Generator associated with the Velocity Fine Command Generator block to decelerate the motor to a stop. When initiating a Current Decel & Disable Stop, the Ramp Generator is immediately activated and the drive no longer follows command from the controller. The Ramp Generator input is initialized to zero and the output is initialized to the current speed of the motor, thus causing the Ramp Generator output to ramp the motor from its current speed down to zero according to the ramp control parameters. Once stopped, or the configured Stopping Time or factory timeout limit expires, the Ramped Decel stopping action is complete.
2-127		Reserved	
128-255		Vendor Specific	

Safe Stopping Action Source

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D Safety Only	Set/ SSV#		USINT	0	-	-	Enumeration: 0 = Connected Drive (R) 1 = Running Controller (O) 2-127 = (reserved) 128-255 = (vendor specific)

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

This attribute determines whether the drive or the controller initiates the stopping sequence in response to an SS1 or SS2 Active bit transition in the Axis Safety Status attribute.

When configured for Connected Drive (default), the drive will initiate the stopping sequence according to the selected Safe Stopping Action. However, the drive must have an open connection to the controller for the configured stopping action to occur. If the drive is not connected, the drive would have already initiated the configured Connection Loss Stopping Action.

When configured for Running Controller, the stopping sequence is initiated by the connected controller as long as the controller connection's "Run/Idle" bit in the Real Time (RT) Header is indicating Run Mode. This allows the controller to provide a programmed stopping action. If the controller is in Idle Mode, i.e. not actively running the application program, the connected drive will initiate the stopping sequence according to the configured Safe Stopping Action. This selection is only valid if the connected controller is supplying the "Run/Idle" Real Time header.

Axis Safety Data A

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE	Get/GSV		DWORD	-	-	-	General Purpose Data Container

A 32-bit container holding general purpose Safety Data passed from the Safety Controller thru the Safety Pass Thru object attribute, Safety Pass Thru Data A.

Axis Safety Data B

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE	Get/GSV		DWORD	-	-	-	General Purpose Data Container

A 32-bit container holding general purpose Safety Data passed from the Safety Controller thru the Safety Pass Thru object attribute, Safety Pass Thru Data B.

See also

Guard Safety Attributes on page 425

Guard Safety Status Attributes on page 426

Guard Safety Attributes

These are the attributes associated with the built-in Safety functionality of an axis. These attributes relate to the behavior of a configurable Safety Core within the drive that executes basic drive safety functions using hardwired safety inputs and safety outputs. These functions do not require the services of a CIP Safety network connection. This safety functionality covers the following safety functions as defined by IEC-61800-5-2, EN-954-1, and IEC-60204 standards:

- Safe Restart
- Safe Stop
- Safe Limited Speed
- Safe Speed Monitoring
- Safe Maximum Speed
- Safe Direction Monitoring
- Safe Door Monitoring
- Safe Door Monitoring

The Guard Status and Guard Fault attributes are defined in the axis to monitor the behavior of built-in Drive Safety functionality. The term Guard is used for these status attributes to differentiate these attributes from the Safety status attributes associated with the integrated Safety functionality provided by a CIP Safety connection.

See also

Guard Safety Status Attributes on page 426

Guard Safety Status Attributes

The Guard Status attribute is a collection of bits indicating the safety status of the motion axis.

Guard Status

Usage	Access	T	Data Type	Semantics of Values
Optional - D	GSV	T	DWORD	Bitmap 0 = Guard OK 1 = Guard Config Locked 2 = Guard Gate Drive Output 3 = Guard Stop Input 4 = Guard Stop Request 5 = Guard Stop In Progress 6 = Guard Stop Decel 7 = Guard Stop Standstill 8 = Guard Stop Output 9 = Guard Limited Speed Input 10 = Guard Limited Speed Request 11 = Guard Limited Speed Monitor In Progress 12 = Guard Limited Speed Output 13 = Guard Max Speed Monitor In Progress 14 = Guard Max Accel Monitor In Progress 15 = Guard Direction Monitor In Progress 16 = Guard Door Control Lock 17 = Guard Door Control Output 18 = Guard Door Monitor Input 19 = Guard Door Monitor In Progress 20 = Guard Lock Monitor Input 21 = Guard Enabling Switch Input 22 = Guard Enabling Switch In Progress 23 = Guard Reset Input 24 = Guard Reset Required 25 = Guard Stop Input Cycle Required 26 = Reserved - Waiting for Stop Request Removal 27...31 = Reserved

Guard Status Bit Descriptions

Bit	Name	Description
0	Guard OK	Indicates if the drive is free of any Guard Fault conditions.
1	Guard Config Locked	Indicates that configuration data for the drive safety core has been locked and cannot be modified.
2	Guard Gate Drive Output	Indicates the state of the Gate Drive (MP OUT) circuit used to disable the drive power structure.
3	Guard Stop Input	Indicates the current state of the Safe Stop input.
4	Guard Stop Request	Indicates if a safe stop operation has been requested. The safe stop request can be initiated by the Safe Stop Input or in response to a Safety Fault. The bit is only cleared by a successful safety reset.
5	Guard Stop In Progress	Indicates if the Safe Stop (SS) function of the safety core is in progress. This bit is set when the Safe Stop input transitions from on to off and clears at the end of the stop delay or when a safety fault occurs.
6	Guard Stop Decel	Indicates if the Safe Stop (SS) function of the safety core is actively decelerating the axis. This bit is set after the monitoring delay expires and clears at the end of the stop delay or when a fault occurs.
7	Guard Stop Standstill	Indicates if the Safe Stop (SS) function of the safety core is in the safe stopped mode, for example, when it has successfully stopped the axis and is performing zero speed monitoring. This bit is set after the stop delay expires and clears when a fault occurs.
8	Guard Stop Output	Indicates the current state of the Safe Stop output.
9	Guard Limited Speed Input	Indicates the current state of the Safe Limited Speed (SLS) input.
10	Guard Limited Speed Request	Indicates if a safe speed operation has been requested. The safe stop request can be initiated by the Safe Limited Speed input. The bit is only cleared by a successful safety reset.
11	Guard Limited Speed Monitor In Progress	Indicates if the Safe Speed (SLS/SSM) monitoring function of the safety core is actively checking speed. This bit is set when the Safe Limited Speed input transitions from on to off and the associated monitoring delay has expired.
12	Guard Limited Speed Output	Indicates the current state of the Safe Limited Speed (SLS) output.
13	Guard Max Speed Monitor In Progress	Indicates if the Safe Max Speed (SMS) monitoring function of the safety core is in progress.
14	Guard Max Accel Monitor In Progress	Indicates if the Safe Max Accel (SMA) monitoring function of the safety core is in progress.
15	Guard Direction Monitor In Progress	Indicates if the Safe Direction Monitoring (SDM) function of the safety core is in progress.
16	Guard Door Control Lock	Indicates if the Door Control Output is being commanded to the Locked state.
17	Guard Door Control Output	Indicates the current state of the Safe Door Control output.
18	Guard Door Monitor Input	Indicates the current state of the Door Monitor (DM) input.
19	Guard Door Monitor In Progress	Indicates if the Safe Door Monitoring (DM) function of the safety core is in progress.
20	Guard Lock Monitor Input	Indicates the current state of the Safe Lock Monitoring input.

Bit	Name	Description
21	Guard Enabling Switch Input	Indicates the current state of the Safe Enabling Switch Monitor input.
22	Guard Enabling Switch Monitor In Progress	Indicates if the Safe Enabling Switch Monitor (ESM) monitoring function of the safety core is in progress.
23	Guard Reset Input	Indicates the state of the Safety Reset input use to initiate return to normal operational state of the safety core.
24	Guard Reset Required	Indicates that the drive safety function requires a Safety Reset to permit return to normal operational state.
25	Guard Stop Input Cycle Required Status	Indicates that the drive safety function requires a Stop Input Cycle to permit return to normal operational state.
26	Reserved (Waiting for Stop Request Removal)	
27-31	Reserved	

Guard Faults

Usage	Access	T	Data Type	Semantics
Optional - D	GSV	T	DWORD	Bitmap 0 = (Reserved - Combined Faults) 1 = Guard Internal Fault 2 = Guard Configuration Fault 3 = Guard Gate Drive Fault 4 = Guard Reset Fault 5 = Guard Feedback 1 Fault 6 = Guard Feedback 2 Fault 7 = Guard Feedback Speed Compare Fault 8 = Guard Feedback Position Compare Fault 9 = Guard Stop Input Fault 10 = Guard Stop Output Fault 11 = Guard Stop Decel Fault 12 = Guard Stop Standstill Fault 13 = Guard Stop Motion Fault 14 = Guard Limited Speed Input Fault 15 = Guard Limited Speed Output Fault 16 = Guard Limited Speed Monitor Fault 17 = Guard Max Speed Monitor Fault 18 = Guard Max Accel Monitor Fault 19 = Guard Direction Monitor Fault 20 = Guard Door Monitor Input Fault 21 = Guard Door Monitor Fault 22 = Guard Door Control Output Fault 23 = Guard Lock Monitor Input Fault 24 = Guard Lock Monitor Fault 25 = Guard Enabling Switch Monitor Input Fault 26 = Guard Enabling Switch Monitor Fault 27 = Guard Feedback 1 Voltage Monitor Fault 28 = Guard Feedback 2 Voltage Monitor Fault 29 = Reserved (RLM Reset Fault) 30…31 = Reserved

The Guard Faults attribute is a collection of bits indicating the safety faults of the drive axis. When a safety fault condition occurs the safety core processor always requests a Safe Stop operation and notifies the drive controller to set the appropriate Guard Faults bit. This bit remains latched even if the safety fault condition is cleared in the safety core. A Fault Reset Request to the associated axis clears the safety fault bits, but the bits set again immediately if the underlying safety fault condition is still present.

Guard Faults Bit Descriptions

Bit	Name	Description
0	Reserved - Combined Faults	
1	Guard Internal Fault	An internal fault has been detected by the Safety Core hardware. This can includes safety processor faults, inter-processor communications faults, safety power supply faults, and gate drive circuitry.
2	Guard Configuration Fault	The safety configuration data is invalid.
3	Guard Gate Drive Fault	Indicates that the Gate Drive (MP OUT) circuit used to disable the drive power structure has detected an error.
4	Guard Reset Fault	The Safety Reset input was ON at power up.
5	Guard Feedback 1 Fault	A problem has been detected with the feedback 1 device.
6	Guard Feedback 2 Fault	A problem has been detected with the feedback 2 device.
7	Guard Feedback Speed Compare Fault	A speed miss-compare was detected between the two feedback devices.
8	Guard Feedback Position Compare Fault	A position discrepancy was detected between the two feedback devices.
9	Guard Stop Input Fault	A fault has been detected on the Safe Stop input(s).
10	Guard Stop Output Fault	A fault has been detected on the Safe Stop cascading outputs.
11	Guard Stop Decel Fault	A speed fault was detected during the deceleration monitoring.
12	Guard Stop Standstill Fault	Zero speed was not detected by the end of the stop delay.
13	Guard Stop Motion Fault	Motion was detected after stop was detected and the door unlocked.
14	Guard Limited Speed Input Fault	A fault has been detected on the Safe Limited Speed input(s).
15	Guard Limited Speed Output Fault	A fault has been detected on the Safe Limited Speed outputs.
16	Guard Limited Speed Monitor Fault	The Safe Limited Speed has been exceeded.
17	Guard Max Speed Monitor Fault	The Safe Maximum Speed has been exceeded.
18	Guard Max Accel Monitor Fault	The Safe Maximum Acceleration has been exceeded.
19	Guard Direction Monitor Fault	Motion in the restricted direction has been detected.
20	Guard Door Monitor Input Fault	A fault has been detected on the Door Monitoring input(s).
21	Guard Door Monitor Fault	The Door Monitoring inputs were detected as OFF when they should have been ON.
22	Guard Door Control Output Fault	A fault has been detected on the Door Control outputs.
23	Guard Lock Monitor Input Fault	A fault has been detected on Lock Monitoring input(s).

Bit	Name	Description
24	Guard Lock Monitor Fault	The Lock Monitoring Inputs were detected as OFF when the Door should have been locked or the Lock Monitoring Inputs were detected as ON when the Door was opened.
25	Guard Enabling Switch Monitor Input Fault	A fault has been detected on the Enabling Switch Monitor (ESM) input(s).
26	Guard Enabling Switch Monitor Fault	The Enabling Switch Monitor (ESM) Inputs were detected as OFF when they should have been ON.
27	Guard Feedback 1 Voltage Monitor Fault	Monitored voltage level for the Feedback 1 device is out of allowed range for operation.
28	Guard Feedback 2 Voltage Monitor Fault	Monitored voltage level for the Feedback 2 device is out of allowed range for operation.
29	Reserved (RLM Reset Fault)	
30...31	Reserved	

See also

Guard Safety Attributes on page 425

Stopping and Braking Attributes

These are the active stopping and braking related attributes associated with a Motion Control Axis.

Stopping Action

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	Set/ SSV#	USINT	FD 1 for C 0 for F	-	-	0 = Disable and Coast 1 = Current Decel and Disable 2 = Ramped Decel and Disable 3 = Current Decel and Hold 4 = Ramped Decel and Hold 5...127 = Reserved 128...255 = Vendor Specific 128 = DC Injection Brake 129 = AC Injection Brake

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

When disabling or aborting an axis, through a Disable Request or an Abort Request this value determines the stopping method to apply to the motor. Each supported Stopping Action initiates one of three Stopping Sequences (IEC60204-1 Category Stops 0, 1, and 2).

- In the case of a Disable Request, the stopping method is applied while in the Stopping state and the final state after the stopping method is completed is the Stopped state.
- In the case of an Abort Request, the stopping method is applied while in the Aborting state and the final state after the stopping method completes is the Major Faulted state.

In either final state the device's inverter power structure will either be Disabled (Disable selection) and free of torque or actively held (Hold selection) in a static condition. This attribute has no impact or relationship to the planner generated acceleration and deceleration profiles. This attribute does not, in any way, determine the stopping actions applied in response to fault conditions.

Connection Loss Stopping Action

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/ SSV#	USINT	FD 1 for C 0 for F	-	-	0 = Disable and Coast 1 = Current Decel and Disable 2 = Ramped Decel and Disable 3 = Current Decel and Hold 4 = Ramped Decel and Hold 5...127 = Reserved 128...255 = Vendor Specific

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

When a CIP Motion connection loss is detected, this value determines the stopping method to apply to the motor. Each supported Stopping Action initiates the associated Stopping Sequence (IEC60204-1 Category Stops 0, 1, and 2). If the connection is closed intentionally using a Forward Close service, the selected stopping method is applied while in the Stopping state and the final state after the stopping method completes is the Initializing state. If the connection is unintentionally lost and the resulting Node Fault generated, the selected stopping method is applied while in the Aborting state and the final state after the stopping method completes is the Major Faulted state. In either final state the device's inverter power structure will either be Disabled (Disable selection) and free of torque or actively held (Hold selection) in a static condition.

Connection Loss Stopping Action

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Opt - D	Set/ SSV#	USINT	FD 1 for C 0 for F	-	-	Enumeration: 0 = Disable and Coast 1 = Current Decel and Disable 2 = Ramped Decel and Disable 3 = Current Decel and Hold 4 = Ramped Decel and Hold 5-127 = (reserved) 128-255 = (vendor specific)

 # Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

When a CIP Motion connection loss is detected, this value determines the stopping method to apply to the motor. Each supported Stopping Action initiates the associated Stopping Sequence (IEC60204-1 Category Stops 0, 1, and 2). If the connection is closed intentionally using a Forward Close service, the selected stopping method is applied while in the Stopping state and the final state after the stopping method completes is the Initializing state. If the connection is unintentionally lost and the resulting Node Fault generated, the selected stopping method is applied while in the Aborting state and the final state after the stopping method completes is the Major Faulted state. In either final state the device's inverter power structure will be either Disabled (Disable selection) and free of torque or actively held (Hold selection) in a static condition.

Stopping Action Enumeration Definitions

Enum.	Usage	Name	Description
0	R/D	Disable and Coast	Disable and Coast immediately disables the device power structure and active control loops, which causes the motor to coast unless some form of external braking is applied. This is equivalent to an IEC-60204-1 Category 0 Stop.

Enum.	Usage	Name	Description
1	R/C O/F	Current Decel and Disable	Current Decel and Disable leaves the power structure and any active control loops enabled while stopping. If configured for position control mode, the drive forces the position reference to hold its current value until the axis reaches zero speed. Once at zero speed the position reference is immediately set equal to the actual position to hold the axis at standstill. If in velocity control mode, the drive forces the velocity reference to zero. In either case, forcing the position or velocity reference signals to a fixed value results in a rapid increase in control loop error of the moving axis that saturates the output current of the drive to the configured Stopping Torque that brings the motor to a stop. In torque control mode, the drive directly applies the configured Stopping Torque to the torque command signal to decelerate the motor. When the velocity feedback value reaches zero speed, the torque command is set to zero. Once stopped, or the configured Stopping Time or factory time limit expires, the drive disables the power structure and control loops. This stop mode complies with the IEC-60204-1 Category 1 Stop. In frequency control mode the Current Vector Limit attribute, rather than the Stopping Torque attribute, is used to regulate the stopping current.
2	O/FV	Ramped Decel and Disable	Ramped Decel and Disable also leaves the power structure and any active control loops enabled while stopping but uses the Ramp Generator associated with the Velocity Fine Command Generator block to decelerate the motor to a stop. When initiating a Ramped Decel and Disable Stop, the Ramp Generator is immediately activated and the drive no longer follows command from the controller. The Ramp Generator input is initialized to zero and the output is initialized to the current speed of the motor, thus causing the Ramp Generator output to ramp the motor from its current speed down to zero according to the ramp control parameters. Once stopped, or the configured Stopping Time or factory timeout limit expires, the device disables the power structure and control loops. This stop mode also complies with the IEC-60204-1 Category 1 Stop.
3	O/PV	Current Decel and Hold	Current Decel and Hold behaves like Current Decel and Disable, but leaves the power structure active with holding torque to maintain the stopped condition. The method for generating holding torque is left to the drive vendor's discretion. This stop mode complies with the IEC-60204-1 Category 2 Stop. The Current Decel and Hold stopping action is not allowed if a Start Inhibit condition is present. If a Start Inhibit condition is present, a Current Decel and Disable will be initiated instead.
4	O/V	Ramped Decel and Hold	Ramped Decel and Hold behaves like Ramped Decel and Disable, but leaves the power structure with holding torque to maintain the stopped condition. This stop modes also complies with the IEC-60204-1 Category 2 Stop. The Ramped Decel and Hold stopping action is not allowed if a Start Inhibit condition is present. If a Start Inhibit condition is present, a Ramped Decel and Disable will be initiated instead.
5...127		Reserved	
128...255		Vendor Specific	

Enum.	Usage	Name	Description
128	O/D	DC Injection Brake	DC Injection Brake immediately applies the configured DC Injection Brake Current to the motor to create a static flux field to bring an induction motor to a stop before disabling the power structure.
129	O/D	AC Injection Brake	AC Injection Brake decreases the device output frequency from its present value to zero at the rate determined by the configured Deceleration Limit. Stopping action is accomplished by lowering the output frequency below the motor rotor speed where regeneration does not occur and instead mechanical energy is dissipated in the motor as heat.

Stopping Torque

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set/SSV	REAL	100 FD	0	10^3	% Motor Rated

When disabling or aborting an axis, this value determines the maximum amount of torque producing current available to stop the motor when the Stopping Action is set to Current Decel. If this attribute is not supported, the drive device will use the configured Positive and Negative Peak Current Limits.

Stopping Time Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	REAL	1	0	10^3	Seconds

When disabling or aborting an axis, this parameter determines the maximum amount of time the drive allows to reach zero speed as part of the Category 1 or Category 2 Stop sequence. Action taken by the drive once the time limit is reached depends on the Stop Category. For a Category 1 Stop, the drive continues to apply Stopping Torque while engaging the brake. For a Category 2 Stop the drive continues to apply Stopping Torque but does not engage the brake. If Stopping Time Limit is not supported a factory set timeout may be applied.

Coasting Time Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	REAL	0	0	10^3	Seconds

When disabling or aborting an axis, this parameter determines the maximum amount of time the drive allows to reach zero speed as part of the Category 0 "Disable and Coast" Stop sequence. Action taken by the drive if the time limit is reached is to engage the brake and advance to the Stopped state. If this attribute is not supported, the Coasting Time Limit applies the Stopping Time Limit value. If Stopping Time Limit is not supported a factory set timeout may be applied.

Resistive Brake Contact Delay

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D (PM)	Set/SSV	REAL	0	0	10^3	Seconds

When an external resistive brake is used, the Resistive Brake Contact Delay can be set to delay the enabling of the device power structure until after the resistive brake has had time to connect the motor to the drive device. When an external resistive brake is used, an external contactor switches the UVW motor leads from the inverter power structure to an energy dissipating resistor to stop the motor. Note that this switching does not occur instantaneously and so enabling the power structure too early can cause electrical arcing across the contactor. To prevent this condition, the Resistive Brake Contact Delay can be set to the maximum time that it takes to fully close the contactor across the UVW motor lines so when the axis is enabled, the inverter power structure is not enabled until after the Resistive Brake Contact Delay Time has expired. Resistive Brake operation is only applicable to PM Motor types.

The following sequence further defines how the Resistive Brake Contact Delay factors into the overall Enable Sequence that may also include the operation of a Mechanical Brake.

Enable Sequence:

1. Switch to Starting state.
2. Activate Resistive Brake contactor to connect motor to inverter power structure.
3. Wait for "Resistive Brake Contact Delay" while Resistive Brake contacts close.
4. Enable inverter power structure.
5. Activate Mechanical Brake output to release brake.
6. Wait for "Mechanical Brake Release Delay" while brake releases.
7. Transition to Running state.

Mechanical Brake Control

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	USINT	0	-	-	Enumeration 0 = Automatic 1 = Brake Release 2…225 = Reserved

The Mechanical Brake Control attribute governs the operation of the drive's Mechanical Brake Output that controls the mechanical brake mechanism. When set to Automatic, the Mechanical Brake is under the control of the axis state machine. The sequencing for the brake is described in detail by the Mechanical Brake Engage Delay and Mechanical Brake Release Delay attributes. When set to Brake Release, the brake is unconditionally released, and no longer under the control of the axis state machine.

Mechanical Brake Release Delay

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	REAL	0 FD	0	10^3	Seconds

When enabling the axis, the Mechanical Brake Release Delay value determines the amount of time the device will delay transition from the Starting state to the Running or Testing states. This delay prevents any commanded motion of the motion axis until the external mechanical brake has had enough time to disengage. If supported, a Torque Proving operation is included in this sequence prior to releasing the brake.

Enable Sequence:

1. Switch to Starting state.
2. Activate Resistive Brake contactor to connect motor to inverter power structure.
3. Wait for "Resistive Brake Contact Delay" while Resistive Brake contacts close.
4. Enable inverter power structure.
5. Perform (optional) Torque Proving operation to verify motor control of load.
6. Activate Mechanical Brake output to release brake.

7. Wait for "Mechanical Brake Release Delay" while brake releases.

8. Transition to Running (or Testing) state.

Mechanical Brake Engage Delay

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	REAL	0 FD	0	10^3	Seconds

When disabling the motion axis using a Category 1 Stopping Action, the Mechanical Brake Engage Delay value determines the amount of time the device power structure will remain enabled after the axis has decelerated to standstill. This attribute allows time for an external mechanical brake to engage. The configured Stopping Action determines the type of stopping sequence applied. If supported, a Brake Proving operation is included in the Category 1 stopping sequence prior to disabling the power structure.

Zero Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	REAL	1 FD	0	∞	% Motor Rated

This attribute sets the speed threshold associated with the zero speed criteria of the stop sequence. Zero Speed is specified as a percent of motor rated speed. When Zero Speed Time attribute is supported, this attribute sets the speed threshold where the zero speed timer starts. When the axis speed has been below the Zero Speed threshold for Zero Speed Time the axis has satisfied the zero speed criteria. In all but Category 2 stops, this results in action to engage the mechanical brake. If this attribute is not supported, the zero speed threshold is left to the vendor's discretion and typically set to 1% of motor rated speed. Axis speed in the above description is based on the Velocity Feedback signal, or in the case of a Frequency Control drive, axis speed is based on Velocity Reference signal.

When supporting a Load Observer, the zero speed criteria is not based on the Velocity Estimate since that signal can differ considerably from the actual speed of the motor. When the Load Observer is configured to apply the Velocity Estimate to the velocity loop summing junction as Velocity Feedback, the zero speed criteria must be based on the velocity feedback signal input to the Load Observer.

Zero Speed Time

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	REAL	0	0	10^3	Sec

This attribute sets the amount of time that the axis speed must be below the zero speed threshold, set by the Zero Speed attribute or established by the drive vendor, before satisfying the zero speed criteria. In all but Category 2 stops, when this attribute is set it results in action to engage the mechanical brake. If this attribute is not supported, the amount of time needed to satisfy the zero speed criteria is left to the vendor's discretion and typically is immediate (0). Axis speed in the above description is based on the Velocity Feedback signal, or in the case of a Frequency Control drive, axis speed is based on Velocity Reference signal.

When supporting a Load Observer, the zero speed criteria is not based on the Velocity Estimate since that signal can differ considerably from the actual speed of the motor. When the Load Observer is configured to apply the Velocity Estimate to the velocity loop summing junction as Velocity Feedback, the zero speed criteria must be based on the velocity feedback signal input to the Load Observer.

Vertical Load Control

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - FPV	Set/GSV	USINT	0	-	-	Enumeration: 0 = Disabled 1 = Enabled 2 - 255 = Reserved

This enumerated value allows the drive to tailor motor control behavior for vertical load applications. When the Enabled enumeration is selected, the drive attempts, whenever possible, to avoid applying Category 0 stop actions in response to Major Fault conditions. The drive may tailor other aspects of its behavior to best handle vertical loads.

Proving Configuration

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	USINT	0 FD	-	-	Enumeration: 0 = Disabled 1 = Enabled 2 - 255 = Reserved

This attribute enables the operation of the drive's Torque Proving and Brake Proving functions that work in conjunction with mechanical brake control. When

Proving is enabled, the mechanical brake must be set as soon as the drive is disabled. When the brake is under the control of the axis state machine this is automatic. But when controlled externally, failure to set the brake when the drive is disabled can cause a free fall condition on a vertical application.

When enabled, the drive performs a Torque Prove test of the motor current while in the Starting state to "prove" that current is properly flowing through each of the motor phases before releasing the brake. Should the Torque Prove test fail, a Motor Phase Loss exception is generated.

While Torque Proving functionality is applicable to drive Control Modes that are not capable of generating reliable holding torque based on a feedback device, such as Frequency Control and Sensorless Velocity Control, Torque Proving should not be used in these modes for applications where holding torque is critical to safe operation, such as in a typical lift or crane application.

If the optional Brake Test Torque attribute is supported, the Torque Prove test also includes a proactive Brake Test to ensure the mechanical brake is functioning properly. Should the Brake Test detect brake slip, a Brake Slip exception is generated.

When Proving is enabled, the drive also performs a Brake Prove test while in the Stopping or Aborting states to "prove" proper mechanical brake function before the drive power structure is disabled. Should the Brake Prove test detect brake slip a Brake Slip exception is generated.

Unless another vendor specific method is used to address a Brake Slip condition in the Stopping or Aborting state, the appropriate Fault Action for the Brake Slip exception is Torque Limited Stop and Hold. This Fault Action applies holding torque to arrest the brake slip and transitions the axis to the Major Faulted state.

In general, Brake Proving functionality is only applicable to drive Control Modes that are capable of generating holding torque based on a feedback device. Brake Proving is therefore not applicable to Frequency Control or Sensorless Velocity Control modes.

When Proving is enabled, and the Auto-Sag feature is supported, upon detection of a brake slip condition, the drive has the capability of safely lowering the load to the ground in a controlled series of increments. The Auto Sag Configuration attribute is used to enable this feature. In addition to Brake Slip initiating a Brake Slip exception, the drive also generates a Brake Malfunction start inhibit when the Auto Sag feature is enabled.

When Proving, Auto Sag, and Auto Sag Start are all enabled, the drive also monitors for brake slip in the Stopped or Faulted states. If brake slip is detected, the drive power structure is automatically started to arrest the slip allowing the Auto Sag function to safely lower the load to the ground. Upon detection of brake slip, a Brake Slip exception is generated along with a Brake Malfunction start inhibit.

The sequencing of the torque and brake "prove" tests are described in detail by the Mechanical Brake Engage Delay and Mechanical Brake Release Delay attributes.

The Proving feature includes a number of optional Sub-Features, many of which depend on support of other Proving feature attributes. The following table defines these attribute dependencies.

Proving Sub-Feature	Controlling Attributes	Attribute Prerequisites
Torque Prove	Torque Prove Current	Proving Configuration
Brake Test	Brake Test Torque Brake Slip Tolerance	Proving Configuration
Brake Prove	Brake Prove Ramp Time Brake Slip Tolerance	Proving Configuration
Auto Sag	Auto Sag Configuration Auto Sag Slip Increment	Proving Configuration Brake Prove Ramp Time Brake Slip Tolerance
Auto Sag Start	Auto Sag Start	Proving Configuration Brake Prove Ramp Time Brake Slip Tolerance Auto Sag Configuration Auto Sag Slip Tolerance

Proving tests are performed when enabling or disabling the drive axis. During these state transitions a series of operations are performed by the drive to ensure the proper function of the motor (Torque Proving) and the brake (Brake Proving).

Torque Prove Current

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	REAL	0 FD	0	10^3	% Motor Rated

This attribute sets the percent of motor rated torque applied to the motor by the Torque Prove test as part of the Torque Proving function executed in the Starting state. The Torque Prove test applies current to the motor to "prove" that current is properly flowing through each of the motor phases before releasing the brake.

Brake Test Torque

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - DE	Set/SSV	REAL	0 FD	0	10^3	% Motor Rated

This attribute sets the percent of motor rated torque applied to the motor by the Brake Test as part of the Torque Proving function executed in the Starting state. This Brake Test proactively tests the ability of the mechanical brake to hold the maximum anticipated load before releasing the brake and allowing operation. Should the Brake Test detect brake slip, a Brake Slip exception is generated.

If the Brake Test Torque attribute value is 0 the Brake Test is not performed in the Starting state.

Brake Prove Ramp Time

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - DE	Set/SSV	REAL	0 FD	0	10^3	Seconds

This attribute determines the amount of time the drive will take to ramp the applied torque of the motor down to zero during the Brake Proving test in the Stopping or Aborting state. The Brake Prove Ramp Time determines the ramp down rate of the applied torque output by dividing the Torque Limit by the Brake Prove Ramp Time. The Torque Limit in this case is the maximum of the configured Torque Limit Positive and Torque Limit Negative values. The Brake Prove test is performed to check for brake slip before the power structure is disabled.

Brake Slip Tolerance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - DE	Set/SSV	REAL	0 FD	0	∞	Position Units

This attribute determines the amount of brake slip allowed after the brake is engaged. If this tolerance is exceeded while the brake is engaged, a Brake Slip exception is generated. Brake slip can therefore be monitored in any axis state where the brake is engaged.

DC Injection Brake Current

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	REAL	0	0	10^3	% Motor Rated

The DC Injection Brake Current attribute defines the brake current level injected into an induction motor stator when DC Injection Brake is selected as the Stopping Action. This attribute is specified as a percent of motor rated speed.

DC Injection Brake Time

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV	REAL	0	0	10^3	Seconds

The DC Injection Brake Time attribute defines the amount of time that the DC brake current is injected into an induction motor stator when DC Injection Brake is selected as the Stopping Action. This attribute is specified in seconds.

Flux Braking Enable

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D (IM)	Set/SSV	BOOL	0	0	1	0 = Flux Braking Disabled 1 = Flux Braking Enabled

The Flux Braking Enable attribute is a Boolean value that determines if the drive device is to apply additional flux current to the induction motor in an effort to increase motor losses and reduce the deceleration time while in the Stopping state. This feature is useful when there is no Shunt Regulator or Regenerative Brake available.

Auto Sag Configuration

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - DE	Set/SSV	USINT	0	-	-	Enumeration: 0 = Disabled 1 = Enabled 2-255 = (reserved)

This attribute is used to enable the optional Auto Sag feature that, in the event of detected a brake slip condition, safely lowers the load to the floor in a series of controlled Auto Sag Slip Increments. When a brake slip condition is detected and Auto Sag is enabled, the drive not only sets the standard Brake Slip exception, but the drive also sets the Brake Malfunction start inhibit. This prevents the drive from restarting after the load has been safely lowered to the floor.

Auto Sag Slip Increment

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - DE	Set/SSV	REAL	0	0	∞	Position Units

This attribute sets the incremental amount of brake slip allowed by the drive's optional Auto Sag function before restoring holding torque. When brake slip occurs, the drive allows this amount of displacement and then automatically enables the power structure and applies holding torque to arrest the slip. The drive then ramps the motor torque to zero based on the Brake Prove Ramp Time while checking for slip. Should brake slip continue, the cycle repeats. In crane and lift applications, this repeating "Auto Sag" cycle is designed to lower the load in a controlled series of Auto Sag Slip Increments until the load reaches the ground.

Auto Sag Time Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - DE	Set/SSV	REAL	0.25	0	∞	Seconds

This attribute sets the time limit over which the drive checks for brake slip as performed by the Auto Sag function before restoring holding torque. When brake slip occurs, the drive allows this amount of time before automatically enabling the power structure and applying holding torque. The drive then ramps the motor torque to zero based on the Brake Prove Ramp Time while checking for slip. Generally, in a brake slip situation, the Auto Sag Slip Time Limit expires when the load reaches the ground after one or more Auto Sag Slip Increment cycles. With no further slip occurring while the motor torque is ramping to zero, the Auto Sag feature transitions the axis to the Major Faulted state and the drive power structure is disabled.

The optional Auto Sag Slip Time Limit attribute is not required by the Auto Sag feature. If not supported, a vendor specific value for the Auto Sag Slip Time is applied, typically 0.25 seconds.

Auto Sag Start

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - DE	Set/SSV	USINT	0	-	-	Enumeration: 0 = Disabled 1 = Enabled 2-255 = (reserved)

When the Auto Sag Configuration attribute is set to Enabled, this attribute is used to enable the Auto Sag function in the Stopped or Faulted state. When Auto Sag Start is enabled, the drive monitors the load for possible brake slip and should the amount of brake slip exceed the Brake Slip Tolerance a Brake Slip exception is generated, along with a Brake Malfunction start inhibit. When this occurs, the drive power structure is enabled (Started) without holding torque and the axis transitions to the Aborting State. The drive continues to monitor brake slip and when the amount of slip exceeds the Auto Sag Slip Increment holding torque is applied to the motor to arrest the brake slip. The drive then ramps the motor torque to zero based on the Brake Prove Ramp Time while again checking for slip. Should brake slip continue and exceed the Auto Sag Slip Increment, holding torque is applied and the cycle repeats. In crane and lift applications, this repeating "Auto Sag" cycle is designed to lower the load in a controlled series of Auto Sag Slip Increments until the load reaches the ground.

See also

Stopping Sequences on page 445

Proving Operation Sequences on page 448

State Behavior on page 61

Motor Attributes on page 57

CIP Axis Attributes on page 185

Stopping Sequences

There are three different stopping sequences defined for stopping and braking related attributes. These three stopping sequences align with the following IEC-60204-1 Stop Categories:

- Category 0 Stop: Drive immediately disables inverter power structure.
- Category 1 Stop: Drive decelerates motor to a stop and then disables power structure.
- Category 2 Stop: Drive decelerates motor to a stop and then applies holding torque.

All actions initiated by the control or the drive to stop the axis or disable its associated inverter power structure must execute one of these three stopping sequences. Category 0 and Category 1 Stop sequences coordinate the disabling of the drive power structure with brake operation and in some cases, optional Brake Proving functionality.

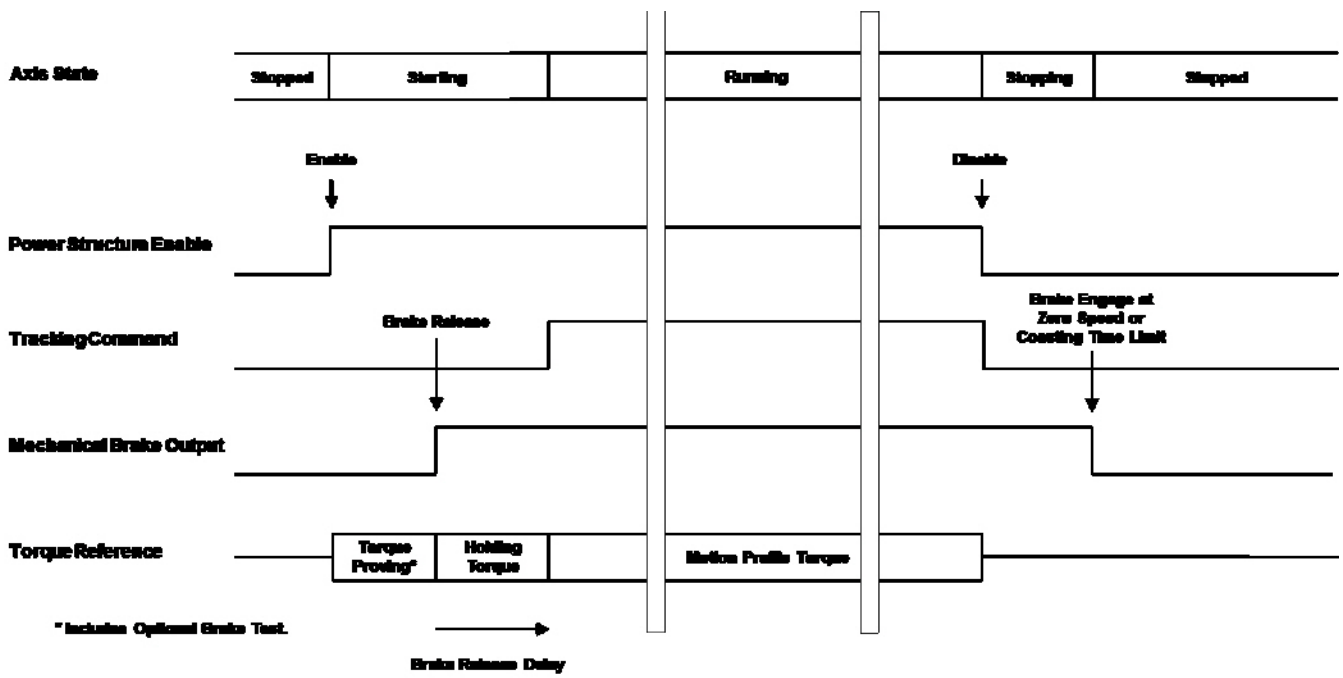
The following stopping sequences are defined in the context of a Disable Request generated stop, where the stopping methods are applied in the Stopping state and the stopping sequences ends up in the Stopped state. In the context of a Major Fault action, these same stopping methods are applied in the Aborting state and the stopping sequences end up in the Major Faulted state. In the context of a Shutdown Request, the Category 0 stopping method below is applied in the Stopping state and the stopping sequence ends up in Shutdown state.

Category 0 Stop Sequence

Inverter is immediately disabled. Brake Proving is not applicable.

1. Switch to Stopping state
2. Disable inverter power structure.
3. Deactivate Resistive Brake contactor to disconnect motor from inverter power structure.
4. Wait for zero speed or "Coasting Time Limit" or a factory set timeout, whichever occurs first.
5. Transition to Stopped state.
6. Deactivate Mechanical Brake output to engage brake.

The following diagram illustrates Category 0 Stop Sequence:

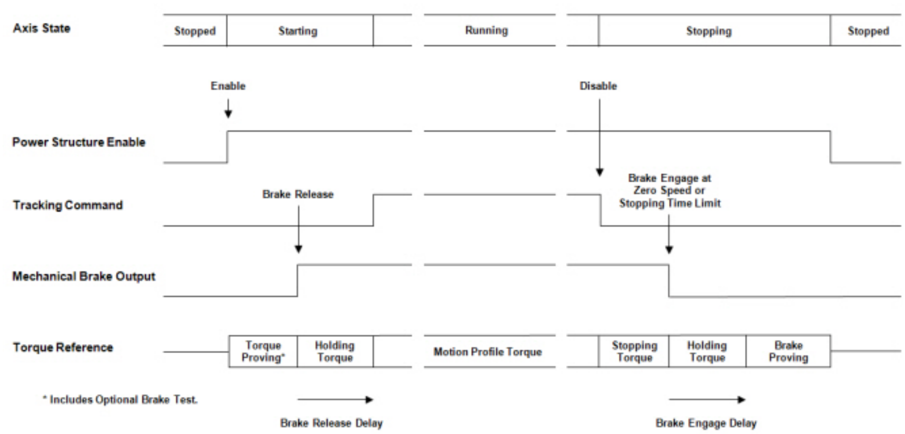


Category 1 Stop Sequence

Torque applied to stop the motor before the inverter is disabled. Brake Proving is applicable.

1. Switch to Stopping state.
2. Apply "Current Decel" or "Ramp Decel" method to stop motor.
3. Wait for zero speed or 'Stopping Time Limit' or a factory set timeout, whichever occurs first.
4. Deactivate Mechanical Brake output to engage brake.
5. Wait for "Mechanical Brake Engage Delay" while brake engages.
6. Perform (optional) Brake Proving operation to verify brake control of load.
7. Disable inverter power structure.
8. Transition to Stopped state.
9. Deactivate Resistive Brake contactor to disconnect motor from inverter power structure.

The following diagram illustrates a Category 1 Stop Sequence:



Category 2 Stop Sequence

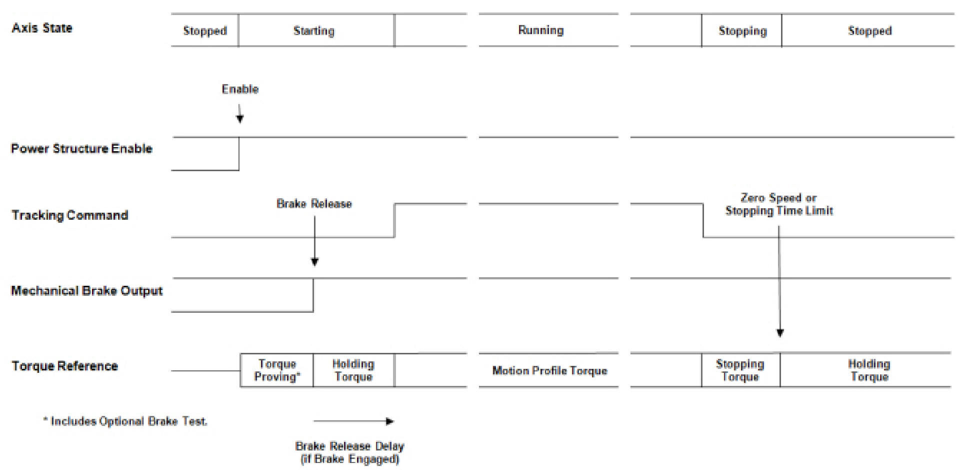
Torque is applied to stop the motor and inverter is left enabled to provide holding torque. The mechanical brake is not used. Brake Proving is not applicable. A Category 2 Stop is only allowed in no Start Inhibit condition is present.

1. Switch to Stopping state.
2. Apply "Current Decel" or "Ramp Decel" method to stop motor.
3. Wait for zero speed or "Stopping Time Limit" or a factory set timeout, whichever occurs first.

4. Transition to Stopped state.

A Category 2 stop sequence is not allowed if initiated by a Disable Request or fault action with a Start Inhibit condition present. If a Start Inhibit condition is present, a Category 1 stop sequence is initiated instead, using the same stopping method (Current Decel or Ramped Decel) that would have been applied by the Category 2 stop sequence. Category 2 stop sequences are also not allowed if initiated by a Start Inhibit condition with the axis in the Stopped state or Major Faulted state with Holding torque. In this case, the drive initiates a Category 1 stop sequence instead, using the same stopping method (Current Decel or Ramped Decel) that would have been applied by the configured Category 2 Stopping Action.

The following diagram illustrates a Category 2 Stop Sequence:



Tip: Recommended criteria for Zero Speed is based on Velocity Feedback, or in the case of Frequency Control drive, based on Velocity Reference. Zero Speed criteria can be established explicitly through optional Zero Speed and Zero Speed Time attributes or implicitly as 1% of motor rated speed or left to the drive vendor's discretion.

See also

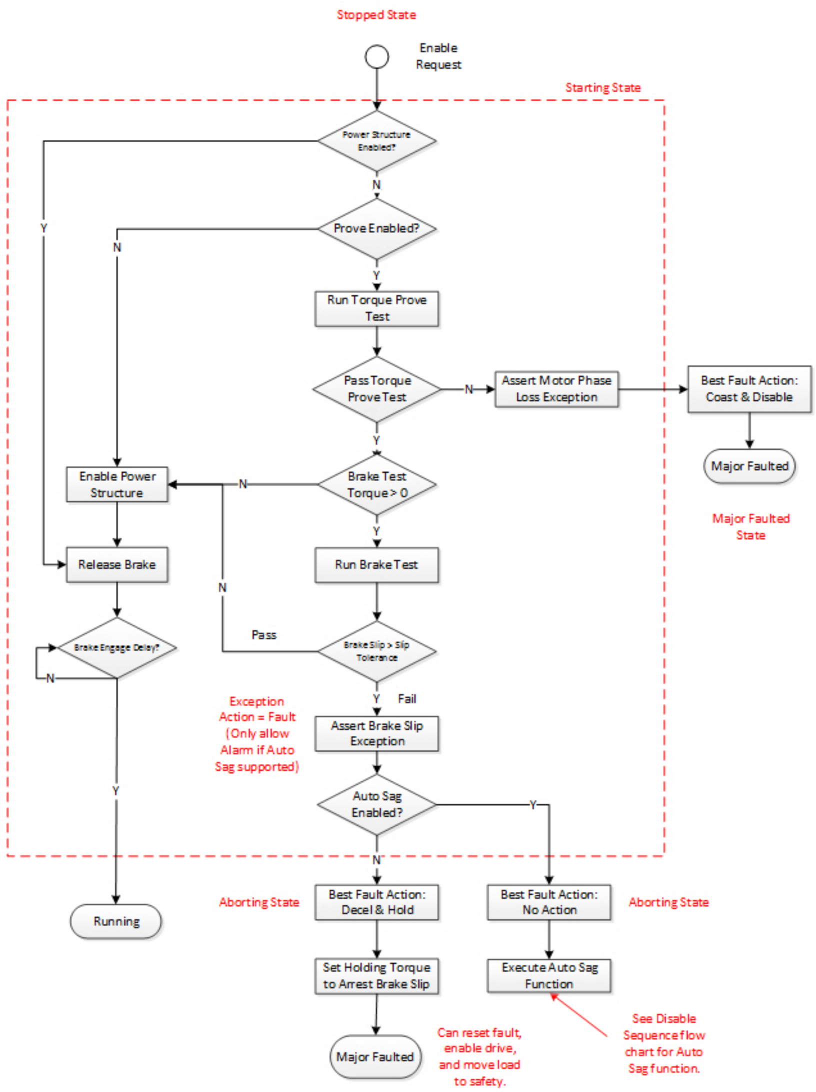
Stopping and Braking Attributes on page 431

Proving Operational Sequences

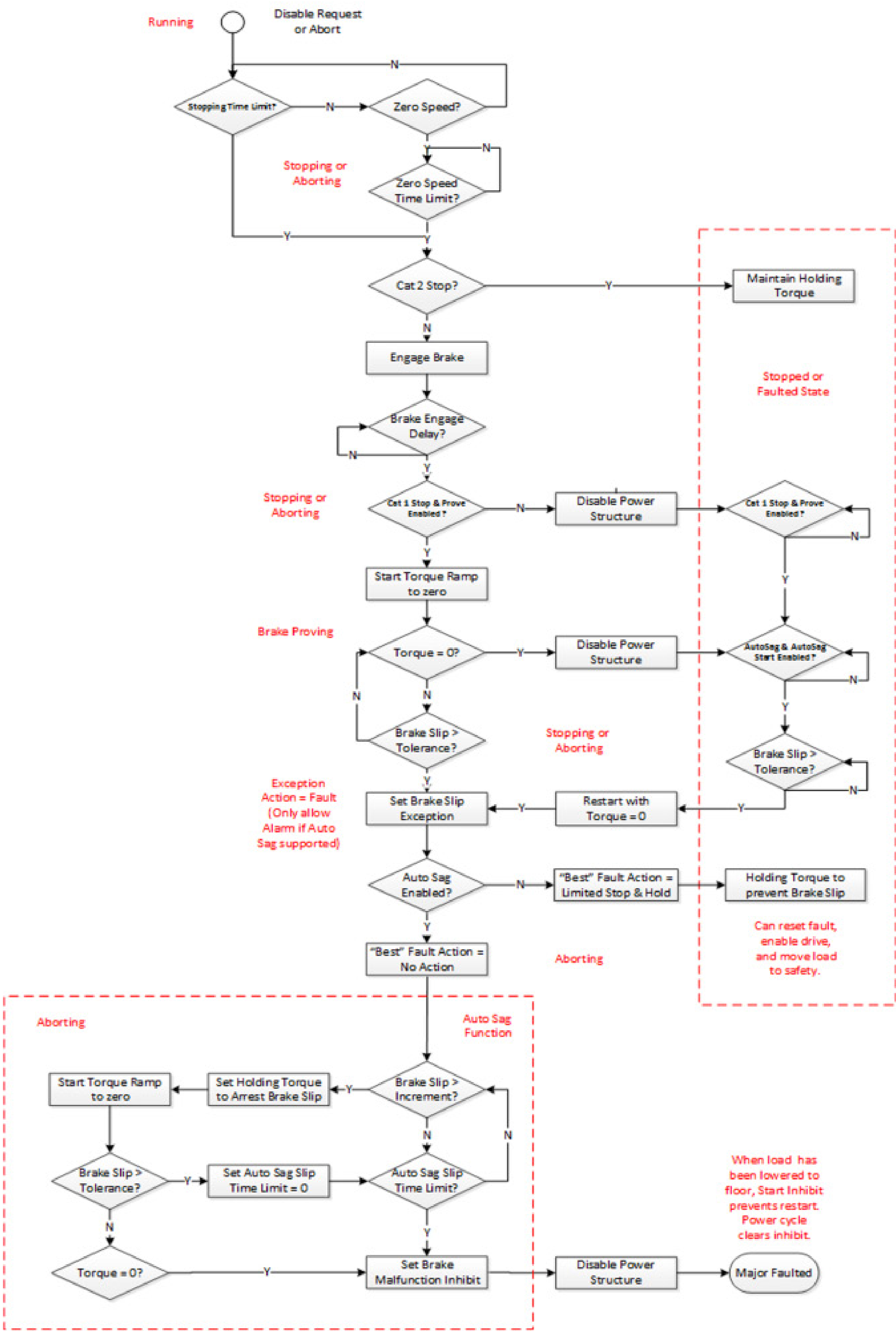
Proving tests are performed when enabling or disabling the drive axis. During these state transitions a series of operations are performed by the drive to ensure the proper function of the motor (Torque Proving) and the brake (Brake Proving).

The following flow charts define these operational sequences in the context of a drive enable transition and a drive disable or abort transition.

Drive Enable Sequence with Proving Tests



Drive Disable Sequence with Proving Test



See also

Stopping and Braking Attributes on page 431

Stopping Sequences on page 445

DC Bus Control Attributes

These are Motion Control Axis attributes associated with DC Bus control including functionality to address both under-voltage and over-voltage conditions.

DC Bus Voltage

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - BD	Get/GSV	T	REAL	-	-	-	Volts

Measured DC Bus Voltage. For inverters and DC Converter Types, the DC Bus measured is an input to the device. For all other Converter Types, the DC Bus measured is an output of the device.

Power Loss Action

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set/SSV		USINT	1	-	-	Enumeration 0 = Continue (Ignore) (R) 1 = Coast Thru (R) 2 = Decel Regen (O) 3...127 = Reserved 128...255 = Vendor Specific

Set the reaction to a DC Bus under-voltage condition when the DC Bus drops below a hard-coded threshold in the device or the configured Power Loss Threshold. This provides a specific (configured) response to an incoming power loss while the drive/motor is running.

A **Continue** action selection configures the drive to ignore the power loss condition and continue to run for as long as possible. A Bus Undervoltage exception may occur if the DC Bus Voltage falls below the Factory or User Limits. Otherwise, operation will continue until the low voltage power supplies drop out. There may be concerns operating the power structure below the point where the gate drives start to lose power where this could possibly result in drive damage. The Bus Undervoltage Exception Actions will be set accordingly.

A **Coast Thru** action selection configures the drive to zero the PWM output of the drive while leaving the axis in the Running state. If the incoming power returns before the timeout period, given by the Power Loss Time, the drive automatically starts to control the motor again. If, however, the power doesn't return before Power Loss Timeout period expires, a Bus Power Loss Exception is generated.

A **Decel Regen** action selection configures the drive to regeneratively charge the DC bus by decelerating the motor using the bus regulator to regulate the bus voltage at a predetermined level. When incoming power is restored the drive returns to normal operation. If, however, the drive reaches zero speed or the Power Loss Time period expires before the incoming power has restored, the drive power structure is disabled and a Bus Power Loss exception is generated.

Power Loss Threshold

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set/SSV		REAL	0	0	10^3	%

Sets the Level for Power Loss as percent of nominal DC Bus Voltage. If this value is 0, the hard-coded threshold is used.

Shutdown Action

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set/SSV		UINT	0 (D) 1 (B)	-	-	Enumeration 0 = Disable (R) 1 = Drop DC Bus (R/B) (O/D)) 2…127 = Reserved 128…255 = Vendor Specific

Shutdown Action selects the device's action when transitioning to the Shutdown state as a result of a Shutdown Request, or in response to a Major Fault action where the best available stopping action is Disable and Coast.

Disable, the default action, immediately disables the device's power structure according to the Category 0 Stop Sequence.

If Drop DC Bus is selected, action can be taken to drop the DC Bus voltage as well. This is generally done by opening an AC Contactor Enable output provided by the drive that controls power to the converter.

In either case, the Shutdown Action executes the Category 0 Stop Sequence.

Power Loss Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set/SSV		REAL	0	0		Seconds

Sets the timeout value before a Bus Power Loss Exception is generated by the drive in response to a Power Loss condition. For details, see the Power Loss Action attribute table earlier in this topic.

See also

Motion Planner Configuration Attributes on page 367

State Behavior on page 61

Start Inhibits Attributes

These are the Start Inhibit related attributes associated with a Motion Control Axis Object instance. Start Inhibits are conditions that prevent transition of the motion axis from the Stopped State into any of the operational states.

CIP Start Inhibits

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Get/GSV	T	WORD	-	-	-	Enumeration: 0 = Reserved 1 = Axis Enable Input 2 = Motor Not Configured 3 = Feedback Not Configured 4 = Commutation Not Configured 5 = Safe Torque Off Active 6 - 15 = Reserved

A bit map that specifies the current state of all standard conditions that inhibits starting of the axis.

CIP Start Inhibits - RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Get/GSV	T	WORD	-	-	-	Enumeration: 0 = Reserved 1 = Volts Hertz Curve Definition 2 = Motor Feedback Required 3 = Speed Limit Configuration 4 = Torque Prove Configuration 5 = Safe Torque Off 6 = Safety Reset Required 7 = Safety Not Configured 8 = Stop Command Active 9 = Feedback Device Reset 10 = Brake Malfunction 11 - 15 = Reserved

A bit map that specifies the current state of all Rockwell Automation specific conditions that inhibits starting of the axis.

See also

Standard Start Inhibits on page 454

Rockwell Automation Specific Start Inhibits on page 455

CIP Axis Attributes on page 185

Standard Start Inhibits

This table defines the list of standard start inhibits associated with the Start Inhibits attribute.

Bit	Inhibit Condition	Description
0	-- Reserved --	This bit cannot be used since the Start Inhibit Code is defined by the associated bit number and Start Inhibit Code of 0 means no fault condition is present.
1	Axis Enable Input	Axis Enable Input is not active.
2	Motor Not Configured	The associated motor has not been configured for use.
3	Feedback Not Configured	The associated feedback device has not been configured. The offending feedback channel is encoded in the associated Fault/Alarm Sub Code.
4	Commutation Not Configured	The associated PM motor commutation function has not been configured for use.
5	Safe Torque Off Active	The integrated Safe Torque Off safety function is active based on the Safe Torque Off Active bit (bit 3) of the Axis Safety Status attribute being set.
6-15	-- Reserved --	

This table maps the Standard Start Inhibit bits with their Logix Designer Start Inhibit tag names. Start Inhibit bit names always end with an Inhibit suffix.

Bit	Tag
0	NA
1	AxisEnableInputInhibit
2	MotorNotConfiguredInhibit
3	FeedbackNotConfiguredInhibit
4	CommutationNotConfiguredInhibit
5	SafeTorqueOffActiveInhibit

See also

Start Inhibit Attributes on page 453

Rockwell Automation Specific Start Inhibits on page 455

Axis Safety Status Attributes on page 414

Rockwell Automation Specific Start Inhibits

The following table defines a list of standard start inhibits associated with the **Start Inhibits** attribute.

Bit	Inhibit Condition	Description
0	-- Reserved --	This bit cannot be used because the Start Inhibit Code is defined by the associated bit number and Start Inhibit Code of 0 means no fault condition is present.
1	Volts Hertz Curve Definition	Conflict exists in the V/Hz curve definition.
2	Motor Feedback Required	Cannot run using the selected motor control mode with Primary Feedback or Alternate Feedback set as open loop.
3	Speed Limit Configuration	Speed Ref Limit Conflict, either Minimum Forward Speed Limit exceeds Maximum Forward Speed Limit, or Minimum Reverse Speed Limit exceeds Maximum Reverse Speed Limit.
4	Torque Prove Configuration	When Torque Prove Configuration is enabled, Control Mode, Feedback Mode, Motor Feedback Type and Motor Option Configuration must be properly set.
5	Safe Torque Off	The safety function has disabled the power structure.
6	Safety Reset Required	The safety reset input needs to be toggled before the safety board will allow motion again.
7	Safety Not Configured	The embedded safety function of the drive has not been configured.
8	Stop Command Active	There is an active Stop Command present. For example, the Stop button on the drive is behind held active. This inhibit condition prevents the drive from starting when the Stop Command is active.
9	Feedback Device Reset	The feedback device is being reset. A feedback device reset process is typically performed after a Feedback Loss condition. This inhibit condition prevents the drive from Starting until the feedback reset process is completed.

Bit	Inhibit Condition	Description
10	Brake Malfunction	The start inhibit is set when the Auto Sag function is enabled, and the brake slip is detected based on motor movement exceeding the configured Brake Slip Tolerance while the mechanical brake is engaged. This typically indicates that the mechanical brake may not be capable of holding the load.
11...15	Reserved	

This table maps the Start Inhibit bits with their Logix Designer Start Inhibit tag names. Start Inhibit bit names always end with an Inhibit suffix.

Bit	Tag
0	NA
1	VoltsHertzCurveDefinitionInhibit
2	MotorFeedbackRequiredInhibit
3	SpeedLimitConfigurationInhibit
4	TorqueProveConfigurationInhibit
5	SafeTorqueOffInhibit
6	SafetyResetRequiredInhibit
7	SafetyNotConfiguredInhibit
8	StopCommandActiveInhibit
9	FeedbackDeviceResetInhibit
10	BrakeMalfunctionInhibit

See also

Start Inhibit Attributes on page 453

Standard Start Inhibits on page 454

CIP Axis Attributes on page 185

Exceptions

The various motion attributes can result in exceptions that can be configured to present either a fault or alarm.

Standard Exceptions

The following table lists the standard exception conditions associated with the CIP Axis Exceptions, CIP Axis Faults, and CIP Axis Alarms attributes. While the CIP Axis Exceptions, CIP Axis Faults, and CIP Axis Alarms attributes are all required in the CIP Motion device implementation, support for each individual exception condition is optional.

The **Rule** column in the following table indicates the Device Function Codes where the associated exception is applicable.

- B = Converters
- D = Frequency, Position, Velocity, and Torque Control modes
- E = Feedback Only

The enumerations for exceptions is as follows:

- 0 = Ignore (All)
- 1 = Alarm (All)
- 2 = Fault Status Only (B, D)
- 3 = Stop Planner (D)

Standard exceptions

Array Index	Rule	Exception	Description
0	-	Reserved	This bit cannot be used since the alarm codes and fault code are defined by the associated exception bit number and an alarm code or fault code of 0 means no alarm or fault condition is present.
1	D	Motor Overcurrent	Motor current has exceeded its rated peak or instantaneous current limit.
2	D	Motor Commutation	Permanent magnet motor commutation problem detected, such as an illegal state '111' or '000' for UVW commutation signals, S1, S2, and S3.
3	D	Motor Overspeed FL	Motor speed has exceeded the Motor Overspeed Factory Limit attribute associated with the motor type.
4	D	Motor Overspeed UL	Motor speed has exceeded the user-defined speed limit given by Motor Overspeed User Limit.
5	D	Motor Overtemperature FL	Motor temperature has exceeded the Motor Overtemperature Factory Limit, or the integrated motor thermal switch has tripped.
6		--Reserved--	
7	D	Motor Thermal Overload FL	Motor thermal model or I^2T overload value has exceeded its factory set thermal capacity limit given by Motor Thermal Overload Factory Limit.
8	D	Motor Thermal Overload UL	Motor thermal model or I^2T overload value has exceeded its user-defined thermal capacity given by Motor Thermal Overload User Limit.

Array Index	Rule	Exception	Description
9	D	Motor Phase Loss	The current in one or more motor phases is lost, or is below a factory setting threshold or, if supported, the configured Motor Phase Loss Limit. This exception is also associated with the optional Torque Prove function that tests motor current against an engaged mechanical brake. During normal operation in the Running state, the motor phase loss test cycles through the three motor currents checking that current in each motor phase exceeds the threshold level. When the phase being checked exceeds the level, the check is advanced to the next phase. If any phase fails to exceed the level within a vendor specific time period, for example, one second, this exception is issued. The motor phase loss test only runs when the motor is running above a vendor specified speed. When Torque Proving is enabled, the motor phase current is checked during the Starting state. The current is applied to the motor at a fixed angle that is known to produce current in all three motor phases; hence this test takes very little time to execute. The Motor Phase Loss Limit is used to determine if the drive can produce torque. The measured current in all three phases need to exceed this level for a pass to occur.
10	D	Inverter Overcurrent	Inverter current has exceeded the factory set peak or instantaneous current limit.
11	D	Inverter Overtemperature FL	Inverter temperature has exceeded its factory set temperature limit given by the Inverter Overtemperature Factory Limit.
12		--Reserved--	
13	D	Inverter Thermal Overload FL	Inverter thermal model or I^2T overload value has exceeded its factory set thermal capacity limit given by the Inverter Thermal Overload Factory Limit.
14	D	Inverter Thermal Overload UL	Inverter thermal model or I^2T overload value has exceeded its user-defined thermal capacity given by the Inverter Thermal Overload User Limit.
15	BD	Converter Overcurrent	Converter current has exceeded the factory set peak or instantaneous current limit.
16	BD	Converter Ground Current FL	Ground Current has exceeded its factory set current limit given by the Converter Ground Current Factory Limit.
17	BD	Converter Ground Current UL	Ground Current has exceeded user-defined limit given by the Converter Ground Current User Limit.
18	BD	Converter Overtemperature FL	Converter temperature has exceeded its factory set temperature limit given by the Converter Overtemperature Factory Limit.
19	BD	Converter Overtemperature UL	Converter temperature has exceeded the user-defined temperature limit given by the Converter Overtemperature User Limit.
20	BD	Converter Thermal Overload FL	Converter thermal model or I^2T overload value has exceeded its factory set thermal capacity limit given by the Converter Thermal Overload Factory Limit.

Array Index	Rule	Exception	Description
21	BD	Converter Thermal Overload UL	Converter thermal model or I^2T overload value has exceeded its user-defined thermal capacity given by the Converter Thermal Overload User Limit.
22	BD	Converter AC Power Loss	Multiple AC phases have been lost on the AC line to the converter. When associated with an external converter in a Shared AC/DC or Shared DC bus configuration, the AC Power Loss condition detected by the converter can be conveyed using the CIP Motion connection's Control Status element. Generally, this exception is not asserted unless the device's power structure is enabled.
23	BD	Converter AC Single Phase Loss	One AC phase have been lost on the AC line to the converter.
24	BD	Converter AC Phase Short	A short has been detected between an AC phase and another AC phase or ground.
25	BD	Converter Pre-Charge Failure	A problem has been detected in the pre-charge circuitry of the converter preventing the DC Bus from charging to an acceptable voltage level.
26		--Reserved--	-
27	BD	Bus Regulator Overtemperature FL	Bus Regulator temperature has exceeded its factory set temperature limit given by the Bus Regulator Overtemperature Factory Limit.
28	BD	Bus Regulator Overtemperature UL	Bus Regulator temperature has exceeded the user-defined temperature limit given by the Bus Regulator Overtemperature User Limit.
29	BD	Bus Regulator Thermal Overload FL	Bus Regulator thermal model or I^2T overload value has exceeded its factory set thermal capacity limit given by the Bus Regulator Thermal Overload Factory Limit.
30	BD	Bus Regulator Thermal Overload UL	Bus Regulator thermal model or I^2T overload value has exceeded its user-defined thermal capacity given by the Bus Regulator Thermal Overload User Limit.
31	BD	Bus Regulator Failure	The bus regulator (shunt) module in a multi-axis system has a failed.
32	BD	Bus Capacitor Module Failure	The bus capacitor module failed.
33	BD	Bus Undervoltage FL	DC Bus voltage level is below the factory set limit given by the Bus Undervoltage Factory Limit.
34	BD	Bus Undervoltage UL	DC Bus voltage level is below user-defined limit given by the Bus Undervoltage User Limit.
35	BD	Bus Overvoltage FL	DC Bus voltage level is above the factory set limit given by the Bus Overvoltage Factory Limit.
36	BD	Bus Overvoltage UL	DC Bus voltage level is above user-defined limit given by the Bus Overvoltage User Limit.
37	BD	Bus Power Loss	DC Bus voltage level is below the Bus Power Loss Threshold for more than the timeout period specified by the Bus Power Loss Time value.
38	BD	Bus Power Fuse Blown	DC bus power loss due to blown fuse.

Array Index	Rule	Exception	Description
39	D	Bus Power Leakage	DC Bus power leak has been detected when configured for Standalone operation. This can occur when the drive, configured for Standalone operation, is incorrectly wired to share DC bus power.
40	BD	Bus Power Sharing	An external converter sharing DC Bus power with this drive in a Shared AC/DC or Shared DC configuration has requested that this drive stop consuming power from the shared DC Bus. This may require that the drive be disabled to remove its DC Bus Power load from the failed converter. When there is no communication link between this drive and the external converter, the controller can monitor the DC Bus Unload bit of the converter axes and, if set, it can initiate Bus Power Sharing exceptions on all drives associated with the failed converter. See the DC Bus Unload status bit definition associated with the Axis Status attribute for a detailed description of this behavior.
41	E	Feedback Signal Noise FL	Noise induced A/B channel state changes (illegal states) from a feedback device were detected by the drive. Specifically, the number of these noise events that have occurred on this channel has exceeded the Feedback Noise Factory Limit. The offending feedback channel number is encoded in the associated fault/alarm sub code.
42	E	Feedback Signal Noise UL	Noise induced A/B channel state changes (illegal states) from a feedback device were detected on a feedback channel. Specifically, the number of these noise events that have occurred on this channel has exceeded the Feedback Noise User Limit. The offending feedback channel is encoded in the associated fault/alarm sub code.
43	E	Feedback Signal Loss FL	One or more A/B channel signals from a feedback device are open, shorted, missing, or severely attenuated. Specifically, the detected voltage levels of the signals are below the Feedback Loss Factory Limit. The offending feedback channel is encoded in the associated fault/alarm sub code.
44	E	Feedback Signal Loss UL	One or more A/B channel signals from a feedback device are open, shorted, missing, or severely attenuated. Specifically, the detected voltage levels of the signals are below the Feedback Loss User Limit. The offending feedback channel is encoded in the associated fault/alarm sub code.
45	E	Feedback Data Loss FL	The number of consecutive missed or corrupted serial data packets over the serial data channel from a feedback device has exceeded the Feedback Data Loss Factory Limit. The offending feedback channel is encoded in the associated fault/alarm sub code.
46	E	Feedback Data Loss UL	The number of consecutive missed or corrupted serial data packets over the serial data channel from a feedback device has exceeded the Feedback Data Loss User Limit. The offending feedback channel is encoded in the associated fault/alarm sub code.
47	E	Feedback Device Failure	The feedback device has detected an internal error. The offending feedback channel is encoded in the associated Fault/Alarm Sub Code.
48	-	Reserved	-

Array Index	Rule	Exception	Description
49	D	Brake Slip	Motor displacement exceeds the brake slip tolerance while the mechanical brake is engaged.
50	D	Hardware Overtravel Positive	Axis moved beyond the physical travel limits in the positive direction and activated the Positive Overtravel limit switch. If the CIP Axis Exception Action for this condition is set for Stop Planner, the faulted axis can be moved or jogged back inside the hardware overtravel limit. Any attempt, however, to move the axis further beyond the hardware overtravel limit using a motion instruction will result in an instruction error.
51	D	Hardware Overtravel Negative	Axis moved beyond the physical travel limits in the negative direction and activated the Negative Overtravel limit switch. If the CIP Axis Exception Action for this condition is set for Stop Planner, the faulted axis can be moved or jogged back inside the hardware overtravel limit. Any attempt, however, to move the axis further beyond the hardware overtravel limit using a motion instruction will result in an instruction error.
52		--Reserved--	
53		--Reserved--	
54	P	Excessive Position Error	The Position Error value of the position control loop has exceeded the configured value for Position Error Tolerance.
55	PV	Excessive Velocity Error	The Velocity Error value of the velocity control loop has exceeded the configured value for Velocity Error Tolerance.
56	C	Overtorque Limit	Motor torque has risen above user-defined maximum torque level given by Overtorque Limit.
57	C	Undertorque Limit	Motor torque has dropped below user-defined minimum torque level given by Undertorque Limit.
58	-	Reserved	-
59	-	Reserved	-
60	All	Illegal Control Mode	Controller has specified an unsupported Control Mode or Feedback Mode
61	BD	Enable Input Deactivated	Enable has been deactivated while the axis is in Running state.
62	All	Controller Initiated Exception	Exception generated specifically by controller.
63	All	External Input Exception	Exception generated by external input to device.

See also

Rockwell Automation Specific Exceptions on page 465

Standard CIP Axis Fault and Alarm Names

Based on the Exception Action configuration, Exception conditions can become Faults or Alarms. The naming convention for Faults is to append a 'Fault' suffix to the Exception name. Similarly, the convention for Alarms is to append an 'Alarm' suffix to the Exception name.

This table lists the resulting Fault names associated with the Standard Exception conditions.

Standard CIP Axis Fault Names

Bit	Object CIP Axis Fault Name
0	--Reserved--
1	Motor Overcurrent Fault
2	Motor Commutation Fault
3	Motor Overspeed FL Fault
4	Motor Overspeed UL Fault
5	Motor Overtemperature FL Fault
6	--Reserved--
7	Motor Thermal Overload FL Fault
8	Motor Thermal Overload UL Fault
9	Motor Phase Loss Fault
10	Inverter Overcurrent Fault
11	Inverter Overtemperature FL Fault
12	--Reserved--
13	Inverter Thermal Overload FL Fault
14	Inverter Thermal Overload UL Fault
15	Converter Overcurrent Fault
16	Converter Ground Current FL Fault
17	Converter Ground Current UL Fault
18	Converter Overtemperature FL Fault
19	Converter Overtemperature UL Fault
20	Converter Thermal Overload FL Fault
21	Converter Thermal Overload UL Fault
22	Converter AC Power Loss Fault
23	Converter AC Single Phase Loss Fault
24	Converter AC Phase Short Fault
25	Converter Pre Charge Fault
26	--Reserved--
27	Bus Regulator Overtemperature FL Fault
28	Bus Regulator Overtemperature UL Fault
29	Bus Regulator Thermal Overload FL Fault
30	Bus Regulator Thermal Overload UL Fault
31	Bus Regulator Fault
32	Bus Capacitor Module Fault

Bit	Object CIP Axis Fault Name
33	Bus Undervoltage FL Fault
34	Bus Undervoltage UL Fault
35	Bus Overvoltage FL Fault
36	Bus Overvoltage UL Fault
37	Bus Power Loss Fault
38	Bus Power Blown Fuse
39	Bus Power Leakage Fault
40	Bus Power Sharing Fault
41	Feedback Signal Noise FL Fault
42	Feedback Signal Noise UL Fault
43	Feedback Signal Loss FL Fault
44	Feedback Signal Loss UL Fault
45	Feedback Data Loss FL Fault
46	Feedback Data Loss UL Fault
47	Feedback Device Fault
48	--Reserved--
49	Brake Slip Fault
50	Hardware Overtravel Positive Fault
51	Hardware Overtravel Negative Fault
52	--Reserved--
53	--Reserved--
54	Excessive Position Error Fault
55	Excessive Velocity Error Fault
56	Overtorque Limit Fault
57	Undertorque Limit Fault
58	--Reserved--
59	--Reserved--
60	Illegal Control Mode Fault
61	Enable Input Deactivated Fault
62	Controller Initiated Fault
63	External Input Fault

Standard CIP Axis Alarm Names

This table lists the resulting Alarm names associated with the Standard Exception conditions.

Bit	Object CIP Axis Alarm Name
0	--Reserved--
1	Motor Overcurrent Alarm

2	Motor Commutation Alarm
3	Motor Overspeed FL Alarm
4	Motor Overspeed UL Alarm
5	Motor Overtemperature FL Alarm
6	--Reserved--
7	Motor Thermal Overload FL Alarm
8	Motor Thermal Overload UL Alarm
9	Motor Phase Loss Alarm
10	Inverter Overcurrent Alarm
11	Inverter Overtemperature FL Alarm
12	--Reserved--
13	Inverter Thermal Overload FL Alarm
14	Inverter Thermal Overload UL Alarm
15	Converter Overcurrent Alarm
16	Converter Ground Current FL Alarm
17	Converter Ground Current UL Alarm
18	Converter Overtemperature FL Alarm
19	Converter Overtemperature UL Alarm
20	Converter Thermal Overload FL Alarm
21	Converter Thermal Overload UL Alarm
22	Converter AC Power Loss Alarm
23	Converter AC Single Phase Loss Alarm
24	Converter AC Phase Short Alarm
25	Converter Pre Charge Alarm
26	--Reserved--
27	Bus Regulator Overtemperature FL Alarm
28	Bus Regulator Overtemperature UL Alarm
29	Bus Regulator Thermal Overload FL Alarm
30	Bus Regulator Thermal Overload UL Alarm
31	Bus Regulator Alarm
32	Bus Capacitator Module Alarm
33	Bus Undervoltage FL Alarm
34	Bus Undervoltage UL Alarm
35	Bus Overvoltage FL Alarm
36	Bus Overvoltage UL Alarm
37	Bus Power Loss Alarm
38	Bus Power Blown Fuse Alarm
39	Bus Power Leakage Alarm
40	Bus Power Sharing Alarm
41	Feedback Signal Noise FL Alarm
42	Feedback Signal Noise UL Alarm

43	Feedback Signal Loss FL Alarm
44	Feedback Signal Loss UL Alarm
45	Feedback Data Loss FL Alarm
46	Feedback Data Loss UL Alarm
47	Feedback Device Alarm
48	--Reserved--
49	Brake Slip Alarm
50	Hardware Overtravel Positive Alarm
51	Hardware Overtravel Negative Alarm
52	--Reserved--
53	--Reserved--
54	Excessive Position Error Alarm
55	Excessive Velocity Error Alarm
56	Overtorque Limit Alarm
57	Undertorque Limit Alarm
58	--Reserved--
59	--Reserved--
60	Illegal Control Mode Alarm
61	Enable Input Deactivated Alarm
62	Controller Initiated Alarm
63	External Input Alarm

See also

Standard Exceptions on page 456

Rockwell Automation Specific Exceptions on page 465

Rockwell Automation Specific Exceptions

This table defines a list of Rockwell Automation specific exception conditions associated with the CIP Axis Exceptions-RA, CIP Axis Faults-RA, and CIP Axis Alarms-RA attributes. While the CIP Axis Exceptions - RA, CIP Axis Faults - RA, and CIP Axis Alarms - RA attributes are all Required in the CIP Motion device implementation, support for each of the individual exception conditions therein is left Optional.

The **Rule** column in the following table indicates the Device Function Codes where the associated exception is applicable.

- B = Converters
- D = Frequency, Position, Velocity, and Torque Control modes
- E = Feedback Only

The enumerations for exceptions is as follows:

- 0 = Ignore (All)
- 1 = Alarm (All)
- 2 = Fault Status Only (B, D)
- 3 = Stop Planner (D)

Rockwell Automation Specific Exception Table

Bit	Rule	Exception Name	Description
0	-	-- Reserved --	This bit cannot be used since the Alarm Codes and Fault Code are defined by the associated exception bit number and an Alarm Code or Fault Code of 0 means no alarm or fault condition is present.
1	D	Commutation Startup Failure	The self-sensing commutation startup algorithm failed.
2	D	Motor Voltage Mismatch	The motor voltage is incompatible with the applied drive voltage.
3	-	-- Reserved --	
4	E	Feedback Filter Noise	Excessive levels of noise have been detected by the digital feedback filter.
5	E	Feedback Battery Loss	The battery charge level is too low and encoder power has been removed possibly resulting in loss of absolute position.
6	E	Feedback Battery Low	The battery charge level is too low but encoder power has not yet been removed. This is intended as a warning that if encoder power is lost absolute feedback position could be lost.
7	E	Feedback Incremental Count Error	The periodic check of the incremental encoder position against the absolute encoder position or Hall edges indicates they are out of tolerance.
8	-	-- Reserved --	
9	-	-- Reserved --	
10	ALL	Control Module Overtemperature FL	Kinetix: The control module temperature has exceeded its limit. Rhino: The temperature sensor on the Main Control Board detected excessive heat.
11		--Reserved--	
12	BD	Converter Pre-Charge Overload FL	Converter estimates that the pre-charge circuit has exceeded its factory limit due to excessive power cycling.
13		--Reserved--	
14	BD	Excessive Current Feedback Offset	Current in one or more phases has been lost or remains below a preset level.
15	BD	Regenerative Power Supply Failure	The hardware Regeneration OK input was deactivated while the drive was enabled.
16	D	PWM Frequency Reduced	Carrier Frequency foldback due to excessive Junction Temperature.
17	D	Current Limit Reduced	Current Limit reduced due to excessive Junction Temperature or due to Overload Protection.
18	D	Torque Prove Failure	Actual feedback indicates error in torque proving.

Bit	Rule	Exception Name	Description
19	D	Decel Override	The drive is not following a commanded deceleration because it is attempting to limit bus voltage.
20	D	Preventative Maintenance	Component has reached lifetime limit.
21	D	Motor Test Failure	Motor Test procedure has failed.
22	D	Hardware Configuration	Error related to the tracking of optional hardware installation.
23	ALL	Firmware Change	Errors or forced configuration changes relating to firmware update.
24	BD	Converter Pre-Charge Input Deactivated	The Converter Pre-Charge Input is deactivated while the axis power structure is enabled, and is supplying current to the DC Bus or motor.
25	BD	DC Common Bus	Error has been detected related to Common Bus operation.
26	ALL	Runtime Error	Runtime assertions detected.
27	D	Backplane Communication Error	Error in communicating over the modular backplane.
28	D	Safety Module Communication Error	Error in communicating to the Safety module.
29...62	-	-- Reserved --	
63	ALL	Product Specific	Product Specific (exotic) exceptions by Sub Code.

Based on the Exception Action configuration, Exception conditions can become Faults or Alarms. The naming convention for Faults is to append a "Fault" suffix to the Exception name. Similarly, the convention for Alarms is to append an "Alarm" suffix to the Exception name.

See also

Rockwell Automation Specific CIP Axis Alarm Names on page 468

Rockwell Automation Specific CIP Axis Fault Names on page 467

Rockwell Automation Specific Initialization Faults on page 296

Rockwell Automation Specific Start Inhibits on page 455

Standard Exceptions on page 456

Rockwell Automation Specific CIP Axis Fault Names

Based on the Exception Action configuration, Exception conditions can become Faults or Alarms. The naming convention for Faults is to append a **Fault** suffix to the Exception name. Similarly, the convention for Alarms is to append an **Alarm** suffix to the Exception name. This table lists the resulting Fault names associated with the above exception conditions.

Rockwell Automation Specific CIP Axis Fault Names

Bit	Object CIP Axis Fault Name
1	Commutation Startup Fault
2	Motor Voltage Mismatch
4	Feedback Filter Noise Fault
5	Feedback Battery Loss Fault
6	Feedback Battery Low Fault
7	Feedback Incremental Count Error Fault
10	Control Module Overtemperature FL Fault
12	Converter Pre Charge Overload FL Fault
14	Excessive Current Feedback Offset Fault
15	Regenerative Power Supply Fault
16	PWM Frequency Reduced Fault
17	Current Limit Reduced Fault
18	Torque Prove Fault
19	Decel Override Fault
20	Preventative Maintenance Fault
21	Motor Test Fault
22	Hardware Configuration Fault
23	Firmware Change Fault
24	Converter Pre-Charge Input Deactivated Fault
25	DC Common Bus Fault
26	Runtime Error Fault
27	Backplane Communication Error Fault
28	Safety Module Communication Error Fault
63	Product Specific Fault

See also

Rockwell Automation Specific Exceptions on page 465

Rockwell Automation Specific CIP Axis Alarm Names on page 468

Rockwell Automation Specific Initialization Faults on page 296

Rockwell Automation Specific Start Inhibits on page 455

Rockwell Automation Specific CIP Axis Alarm Names

The following table lists the resulting Alarm names associated with the Rockwell Automation specific exception conditions.

Bit	Object CIP Axis Alarm Name
1	Commutation Startup Alarm
4	Feedback Filter Noise Alarm

Bit	Object CIP Axis Alarm Name
5	Feedback Battery Loss Alarm
6	Feedback Battery Low Alarm
7	Feedback Incremental Count Error Alarm
10	Control Module Overtemperature FL Alarm
12	Converter Pre Charge Overload FL Alarm
14	Excessive Current Feedback Offset Alarm
15	Regenerative Power Supply Alarm
16	PWM Frequency Reduced Alarm
17	Current Limit Reduced Alarm
18	Torque Prove Alarm
19	Decel Override Alarm
20	Preventative Maintenance Alarm
21	Motor Test Alarm
22	Hardware Configuration Alarm
23	Firmware Change Alarm
24	Converter Pre-Charge Input Deactivated Alarm
25	DC Common Bus Alarm
26	Runtime Error Alarm
27	Backplane Communication Error Alarm
28	Safety Module Communication Error Alarm
63	Product Specific Alarm

See also

Rockwell Automation Specific Exceptions on page 465

Rockwell Automation Specific CIP Axis Fault Names on page 467

Rockwell Automation Specific Initialization Faults on page 296

Rockwell Automation Specific Start Inhibits on page 455

Module Configuration Attributes

The following attribute tables contains Module Configuration attributes associated with components that are common to all axis instances of a multi-axis CIP Motion device or module. Examples of these common device components are a Bus Converter, Bus Regulator, Common Power Supply, Feedback Cards, Network Interface, and so on. Module Configuration attributes may be included in the CIP Motion Control Axis Object implementation or they may be included as part of a vendor specific device interface. In the Rockwell Automation implementation, these attributes appear as data elements of the Configuration Tag (C-tag) data structure associated with each drive devices connection's Map Object instance. These C-tag elements are not accessible as object attributes and therefore cannot be referenced programmatically using SSV, GSV, or MSG instructions. The Need in Implementation Rules apply for either case.

The following general categories of module configuration attributes that are defined:

Category	Usage
Module Configuration Block Attributes on page 471	Used to configure elements of the Configuration Block sent in the CIP Motion Forward_Open.
Module Class Attributes on page 473	Used to configure Motion Device Axis Object class attributes associated with the device.
Module Axis Attributes on page 474	Used to configure Motion Device Axis Object axis attributes that apply to a common device component.
Module Feedback Port Attributes on page 489	Used to configure the mapping of feedback ports to feedback channels for each axis instance.
Module Timing Attributes on page 490	Used to configure various time related aspects of the CIP Motion device.
Module Support Attributes on page 492	Used to determine the size and content of the configuration data needed by the CIP Motion device.

See also

CIP Axis Attributes on page 185

Interpret the Attribute Tables on page 87

Module Configuration Block Attributes

The following collection of Module Class Attributes are stored in the controller and sent to the module as part of the Configuration Block of the Forward_Open service.

Configuration Bits

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All			BYTE	0	-	-	Bitmap: 0 = Verify Power Structure (O/D) 1 = Networked Safety Bit Valid (O/D) 2 = Allow Networked Safety (O/D) 3…7 = Reserved

This attribute is a collection of bits used for configuration of an associated CIP Motion device. Each bit is either true or false.

- 'Verify Power Structure' bit is used to control whether the drive performs an "extended key" check against its Drive Class ID.
- 'Networked Safety Bit Valid' bit determines if the 'Allow Networked Safety' bit (bit 2) of this attribute is valid and is enforced by the drive.
- 'Allow Networked Safety' bit determines if the drive is allowed to accept a Propose_TUNID service request from a Safety Controller to establish safety ownership and subsequent safety connections.

Drive Power Class ID

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D			DINT	0	-	-	Unique ID of the power structure used to verify if the user selected power structure matches that of the drive device.

If power structure varies with the axis instances of a multi-axis drive device then a value of 0 is applied to this attribute and the controller uses the Drive Power Structure Axis ID to verify matching power structure associated with each axis.

See also

Module Configuration Attributes on page 471

Module Feedback Port Attributes on page 489

Module Class Attributes

The following collection of Module Class Attributes are stored in the controller and used to configure Motion Device Axis Object Class attributes associated with the CIP Motion device. These attributes generally apply to the CIP Motion connection behavior. If these Module Class attributes are included in the CIP Motion Control Axis Object implementation, the attribute values are the same for all axis instances associated with the module. In such an implementation, the controller need only apply the Module Class attribute value for one of the axis instances to configure the corresponding Motion Device Axis Object Class attribute of the device.

Controller Update Delay High Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional	Set		SINT	4	1	10	# of Controller Update Periods

Represents the high limit delay threshold for a Controller to Device (C-to-D) Connection update. This delay is specified in units of Controller Update Periods. Exceeding this limit results in a Control Connection Update Fault.

Controller Update Delay Low Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional	Set		SINT	2	1	10	# of Controller Update Periods

Represents the low limit delay threshold allowed for a Controller to Device (C-to-D) Connection update. This delay is specified in units of Controller Update Periods. Exceeding this limit results in a Control Connection Update Alarm.

Sync Threshold

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional	Set		DINT	10000	1	10^9	Nanoseconds Default: device dependent minimum value

Determines the threshold for the Observed Variance of System Time below which the Motion Device Axis Object is considered synchronized. The Group_Sync service uses this as a criterion for a successful response.

See also

Module Axis Attributes on page 474

Module Configuration Attributes on page 471

Module Axis Attributes

Module Axis attributes are used to configure common components of a CIP Motion device, for example the Bus Converter, Bus Regulator, and so on, that apply to all axis instances of the device. If these Module Class attributes are included in the CIP Motion Control Axis Object implementation, the attribute values are the same for all axis instances associated with the device. This is generally enforced by configuration software.

If the value for a given Module Configuration attribute is not the same for each axis instance of the device, the Module Configuration attribute value for instance 1 determines the configuration of the device component.

Device Power Structure Axis ID

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set		DINT[8]	[] = 0	-	-	Array of power structure IDs used to verify if the user selected power structure for each axis instance of a multi-axis drive matches that of the drive's actual power structure. [Axis 1 ID, Axis 2 ID, Axis 3 ID, Axis 4 ID, Axis 5 ID, Axis 6 ID, Axis 7 ID, Axis 8 ID]

The element values of this array represent an ID assigned by the drive vendor that identifies the power structure associated to a given axis instance. This allows different power structures to be applied to specific axis instances of a multi-axis drive. By contrast, if power structure hardware is the same for all axis instances of the drive (excluding master feedback axes) the power structure can be identified by simply using the Drive Power Structure Class ID attribute. For multi-axis drives, the Drive Power Structure Axis ID can be included as part of the data segment in the CIP Motion connection's Forward Open service to confirm that the power structure for a given axis instance matches the configuration in the controller. The indexed elements of this array correspond to axis instances 1 thru 8. Individual elements of this attribute are only applicable to axis instances whose associated Inverter Support bit is set. Array elements that are not applicable are set to 0. Axis instances with power structures that are not configured are set to 0, indicating to the drive that the Drive Power Structure Axis ID for these axis instances do not need to be checked.

PWM Frequency

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set		UINT[8]	[] = 0	[] = 0	[] = 2^{16}	Hertz [Axis 1 PWM Freq, Axis 2 PWM Freq, Axis 3 PWM Freq, Axis 4 PWM Freq, Axis 5 PWM Freq, Axis 6 PWM Freq, Axis 7 PWM Freq, Axis 8 PWM Freq]

This 8-element array sets the carrier frequency for the Pulse Width Modulation output to the motor. Drive derating is required at higher PWM frequencies due to switching losses. Current loop update time is tied directly to the PWM frequency so loop performance generally increases with increasing PWM rate. Note that each drive instance in a multi-axis drive module can have an independently configured PWM frequency. The indexed elements of this array correspond to axis instances 1 thru 8. Individual elements of this attribute are only applicable to axis instances whose associated Inverter Support bit is set. Array elements that are not applicable or not configured are set to 0.

Bus Configuration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		USINT	0	-	-	Enumeration: 0 = Standalone 1 = Shared AC/DC 2 = Shared DC 3 = Shared DC - Non CIP Converter 4 = Shared DC/DC 5 - 255 = Reserved

This enumerated selection specifies how the DC Bus is going to be used.

- "Standalone" specifies that DC Bus power supplied by the drive's converter section is applied only to this drive's power structure.
- "Shared AC/DC" specifies that the converter associated with this CIP Motion device is to supply and share DC Bus power with other drives. This would typically result in de-rating of the continuous current rating for the Shared AC/DC drive.

- "Shared DC" specifies that this drive is sharing DC bus power generated by another Shared AC/DC or Shared DC/DC CIP Motion drive, or external CIP Motion Converter.
- "Shared DC - Non CIP Converter" specifies that this drive is receiving DC bus power generated by an external AC/DC converter that is not CIP Motion compliant and distributing its DC bus power to other CIP Motion drives. A drive configured for "Shared DC - Non CIP Converter" is responsible for communicating the state of the external converter to the control system as if the external converter were integrated with the drive. Specifically, this communication includes the Bus Up and DC Bus Unload status bits reflecting the current state of associated external converter.
- "Shared DC/DC" specifies that the converter associated with this CIP Motion device supplies and shares DC bus power with other Shared DC devices. DC/DC converters may convert input DC bus power from a Shared AC/DC converter to a different DC bus output voltage level to supply one or more Shared DC drives. It may also simply distribute DC bus power from a Shared AC/DC converter to multiple Shared DC drives without any conversion. A Shared DC/DC converter has a unique capability in that it can be both a bus master for a bus group and a bus slave in a different bus group.

Bus Voltage Select

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set		USINT	0	-	-	Enumeration: 0 = High (115V, 230V, 460V) 1 = Low (100V, 200V, 400V) 2 - 255 = (reserved)

This value indicates the expected bus voltage level of the drive application. High bus voltage selection is usually associated with drive running on the North American power grid, when operating in Europe a Low Bus Voltage selection would be appropriate. This parameter can be used to compensate for these different bus voltage levels in the current loop.

Bus Regulator Action

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		USINT[8]	[]=1	-	-	Enumeration: 0 = Disabled 0) 1 = Shunt Regulator (0) 2-127 = (reserved) 128 - 255 = (vendor specific) Rockwell Automation 128 = Adj. Frequency (O/IM) 129 = Both – Shunt first (O/IM) 130 = Both – Freq first (O/IM) 131 = Bus Follower (0)

This 8-element array controls the method of operation of the DC Bus Regulator that addresses the regenerative over-voltage conditions that can occur when decelerating a motor associated with a given axis instance.

- "Disabled" specifies that no regulation is applied to the DC Bus level by this device to control regenerative energy sourced by the motor.
- "Shunt Regulator" method applies the associated shunt regulation hardware to the DC Bus to dissipate regenerative energy through an internal or external resistor.

When controlling Induction Motors, additional bus regulation methods are available that don't require a shunt regulator.

- "Adjust Frequency" method controls the output frequency of the device relative to the speed of the motor to control the amount of regenerative energy pumped into the DC Bus.
- "Both - Shunt first" and "Both - Freq first" methods allow for different sequential application of shunt regulation and frequency control to be applied to the motor.
- "Bus Follower" method indicates that the DC Bus is generated by an external converter rather than an integral converter. No bus regulation is applied to the DC Bus level and the drive does not generate an exception if the DC Bus is still active when the DC Bus contactor of the integrated converter is open. In this context, the integral converter is not connected to AC power.

Note that each drive instance in a multi-axis drive module can have an independently configured Bus Regulator Action. The indexed elements of this array correspond to axis instances 1 thru 8. Individual elements of this attribute are only applicable to axis instances whose associated Inverter Support bit is set. Array elements that are not applicable or not configured are set to 0.

Regenerative Power Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set		REAL[8]	[]=100	[]=0	[]=∞	% Motor Rated

This 8-element array limits the amount of power allowed to transfer between the motor and the DC Bus during regenerative braking of the motor load for a given axis instance. When using an external shunt resistor, set this value to its maximum value. Since this is regenerative power, the value of the limit is negative.

Note that each drive instance in a multi-axis drive module can have an independently configured Regenerative Power Limit. The indexed elements of this array correspond to axis instances 1 thru 8. Individual elements of this attribute are only applicable to axis instances whose associated Inverter Support bit is set. Array elements that are not applicable or not configured are set to 0.

Converter Regenerative Power Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	100	0	∞	% Converter Rated

Limits the amount of regenerative power allowed to transfer from the DC Bus to the converter. When using an external shunt resistor, set this value to its maximum value. Since this is regenerative power, the value of the limit is negative.

Converter Type

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		USINT	0	-	-	Enumeration: 0 = AC/DC Non-Regenerative 1 = AC/DC Regenerative 2 = DC/DC Non-Regenerative 3 = DC/DC Regenerative 4-127 = (reserved) 128-255 = (vendor specific)

Enumerated list used to identify the type of Bus Converter. In the CIP Motion specification the term 'Converter' applies to any device function that converts AC or DC input power to DC Bus output power that may be used by Inverter power structures to drive motors.

- "AC/DC Non-Regenerative" represents the class of devices that convert AC input power to DC output power. They do not have the capability to transfer energy back to the AC main supply.
- "AC/DC Regenerative" represents the class of devices that convert power between AC and DC sources. They have the capability to transfer energy bidirectionally between an AC main supply and DC bus in both directions. These devices provide active control to regulate energy transfer between AC main and DC bus.
- "DC/DC Non-Regenerative" represents the class of devices that convert DC input power to DC output power. They do not have the capability to transfer energy back to the primary DC bus supply.
- "DC/DC Regenerative" represents the Class of devices that convert power between two DC sources. They have the capability to transfer energy between a primary DC bus and a secondary DC bus in both directions. These devices may provide active control to regulate energy transfer between the primary and secondary buses.

DC Bus Output Voltage Set Point

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	0	0	∞	Volts

Sets the reference voltage used to actively regulate the DC Output Bus Voltage of the converter when in the Running state.

Shunt Regulator Resistor Type

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		USINT	0	-	-	Enumeration: 0 = Internal 1 = External 2-255 = (reserved)

This attribute defines whether an Internal or External Shunt resistor is used.

External Shunt Regulator ID

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		INT	-1	-1	32767	-1 = None 0 = Custom 1-32767 = Shunt Regulator ID

Rockwell specific identifier for the External Shunt Regulator. A value of 0 indicates use of a custom shunt regulator that requires user configuration.

External Shunt Power

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	0.20	0	∞	Kilowatts

Rockwell specific identifier for the External Shunt Regulator. A value of 0 indicates use of a custom shunt regulator that requires user configuration.

External Shunt Pulse Power

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	0	0	∞	Kilowatts

This attribute is used when an external shunt resistor has been configured. This attribute value specifies the power that can be delivered to the external shunt resistor for one second, without exceeding the rated element temperature.

There are approximations to help determine this attribute if this information is not available from your vendor.

First approximation method, calculate 'Shunt Pulse Power' (Kilowatts) = 75,000 * lbs, where lbs is the weight of the resistor wire element (not the weight of the resistor).

Another method is that the thermal time constant = 'Shunt Pulse Power' (Kilowatts) / 'Shunt Power' (Kilowatts) sometimes referred to as thermal mass.- the time for the resistor element to reach 63% of rated temperature with applied rated Kilowatts.

A third method for determining this value: The pulse Kilowatts for 1 second is twice the watt rating of a 2 second pulse. In other words, the watt*sec rating is a constant if the pulse duration is short compared to the thermal time constant of the resistor ad is a function of the element mass.

External Bus Capacitance

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	0	0	∞	Microfarads (μF)

This attribute represents the external DC Bus capacitance when the associated drive is acting as a Common Bus Leader, supplying DC Bus power to one or more Common Bus Followers. This attribute is not applicable when the Bus Regulator Action is set to Common Bus Follower. The attribute is applicable when the Bus Regulator Action is set to Disable or Shunt Regulator.

External Shunt Resistance

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	0	0	∞	Ohms

This attribute represents the resistance of the External Shunt Regulator resistor.

Bus Sharing Group

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		USINT	0	-	-	Enumeration: 0 = Standalone 1 = Bus Group 1 2 = Bus Group 2 3 = Bus Group 3 4 = Bus Group 4 5 = Bus Group 5 6 = Bus Group 6 7 = Bus Group 7 8 = Bus Group 8 9 = Bus Group 9 10 = Bus Group 10 11 = Bus Group 11 12 = Bus Group 12 13 = Bus Group 13 14 = Bus Group 14 15 = Bus Group 15 16 = Bus Group 16 17 = Bus Group 17 18 = Bus Group 18 19 = Bus Group 19 20 = Bus Group 20 21 = Bus Group 21 22 = Bus Group 22 23 = Bus Group 23 24 = Bus Group 24 25 = Bus Group 25

This enumerated selection indicates the Bus Sharing Group the drive is assigned to. Physically, a Bus Sharing Group represents a collection of drives that are wired together in a Shared AC/DC or Shared DC Bus Configuration. Assignment to a Bus Sharing Group limits the DC Bus Unload action initiated by a converter in the group, and the resultant Bus Power Sharing exceptions, to Shared AC/DC and Shared DC drives in the converter's assigned Bus Group. Drives assigned to other Bus Groups are, therefore, unimpacted.

If the drive's Bus Configuration indicates Standalone operation, the only valid enumeration for the Bus Sharing Group is Standalone.

If the drive's Bus Configuration indicates Shared AC/DC or Shared DC operation, the drive should be assigned to a specific Bus Group. The Standalone enumeration in this case is invalid.

If the drive supports the optional Bus Configuration attribute, the Bus Sharing Group is required in the drive profile implementation.

Duty Select

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set		USINT[8]	[] = 0	-	-	Enumeration: 0 = Normal 1 = Heavy 2 = Light (0) 3-255 = (reserved) [Axis 1 Duty Select, Axis 2 Duty Select, Axis 3 Duty Select, Axis 4 Duty Select, Axis 5 Duty Select, Axis 6 Duty Select, Axis 7 Duty Select, Axis 8 Duty Select]

This 8-element array indicates the duty level of the drive application and balances the continuous and intermittent overload capacity of the drive and motor accordingly. Since this value is tied to a specific drive inverter and motor, the setting can vary for each axis instance supported by a multi-axis drive module. The indexed elements of this array correspond to axis instances 1 thru 8. Individual elements of this attribute are only applicable to axis instances whose associated Inverter Support bit is set. Array elements that are not applicable or configured are set to 0.

- "Normal" Duty provides nominal continuous rating at the expense of lower overload capacity.
- "Heavy" Duty provides highest overload capacity at the expense of a lower continuous rating.

- "Light" Duty provides highest continuous rating at the expense of lower overload capacity.

Specification for the continuous and overload ratings under Normal, Heavy, and Light Duty are left to the discretion of the drive vendor.

Duty Select is used to determine the level of thermal protection for the motor and the inverter during drive operation.

Converter AC Input Phasing

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		USINT	0	-	-	Enumeration: 0 = Three-Phase (R) 1 = Single-Phase (O) 2-255 = (reserved)

This attribute indicates whether the converter input power to AC line is Single-Phase or Three-Phase.

Converter AC Input Voltage

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		UINT	230	0	∞	Volts (RMS)

This value configures the drive for the intended AC line voltage applied to the converter.

Demonstration Mode Select

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		USINT	0	0	1	Enumeration: 0 = Inactive 1 = Active 2-255 = (reserved)

Activating Demonstration Mode, or 'Demo Mode', allows the associated converter and inverter power structures to operate using Single-Phase, 110/120 VAC, 50/60Hz, AC line input. Converter and inverter performance is significantly limited as compared to standard operation with Demo Mode inactive. All converter and inverter modules in a shared DC bus configuration should have the same Demo Mode setting to avoid faulting.

The purpose of Demo Mode is to allow demonstration of products in non-industrial environments. It is not intended for use in real motion applications.

Converter Overtemperature User Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	0	0	∞	Degrees Celsius (°C)

This attribute sets the user limit for the Converter Overtemperature UL exception.

Converter Thermal Overload User Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	100	0	∞	% Converter Rated

This attribute sets the user limit for the Converter Thermal Overload UL exception.

Converter Ground Current User Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	100	0	∞	% Factory Limit

This attribute sets the user limit for the Converter Ground Current UL exception.

Bus Regulator Overtemperature User Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	0	0	∞	Degrees Celsius (°C)

This attribute sets the user limit for the Bus Regulator Overtemperature UL exception.

Bus Regulator Thermal Overload User Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	100	0	∞	% Regulator Rated

This attribute sets the user limit for the Bus Regulator Thermal UL exception.

Bus Overvoltage User Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	140	0	∞	% Nominal Bus Voltage

This attribute sets the user limit for the Bus Overvoltage UL exception. Unlike the corresponding Factory Limit, which is specified in Volts, the User Limit is based on the percentage of Nominal Bus Voltage during operation.

Bus Undervoltage User Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - All	Set		REAL	0	0	100	% Nominal Bus Voltage

This attribute sets the user limit for the Bus Undervoltage UL exception. Unlike the corresponding Factory Limit, which is specified in Volts, the User Limit is based on the percentage of Nominal Bus Voltage during operation

Control Module Overtemperature User Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - All	Set		REAL	0	0	∞	Degrees Celsius (°C)

This attribute sets the user limit for the Control Module Overtemperature UL exception.

Converter Pre-Charge Overload User Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	100	0	∞	% Converter Rated

This attribute sets the user limit for the Converter Pre-Charge Overload UL exception.

Digital Output Configuration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - All	Set		REAL	[]=0	-	-	Enumeration: 0 = Unassigned 1 = Contactor Enable 2 = Mechanical Brake 3 = Resistive Brake 4-255 = (reserved) [Axis 1 Output Config[8], Axis 2 Output Config[8], Axis 3 Output Config[8], Axis 4 Output Config[8], Axis 5 Output Config[8], Axis 6 Output Config[8], Axis 7 Output Config[8], Axis 8 Output Config[8]]

This attribute is a 2 dimensional array of enumerated values that map configurable digital output to specific functions for each drive axis. Each of the 8 possible axis instances may support up to 8 configurable digital outputs. The Logix controller distributes the Digital Output Configuration array elements to each axis instance of the device. The Digital Output Configuration attribute in the device is defined as a 32 element array of which only the first 8 elements are supported by this 8x8 Digital Output Configuration array definition. The remaining elements of the 32 element array are set to 0.

Digital Input Configuration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - All	Set		REAL	[]=0	-	-	Enumeration: 0 = Unassigned 1 = Enable 2 = Home 3 = Registration 1 4 = Registration 2 5 = Positive Overtravel 6 = Negative Overtravel 7 = Regenerative Power OK 8 = Bus Capacitor OK 9 = Shunt Thermal Switch OK 10 = Home & Registration 1 11 = Motor Thermostat OK 12 = Pre-Charge OK 13-255 = (reserved) [Axis 1 Input Config[8], Axis 2 Input Config[8], Axis 3 Input Config[8], Axis 4 Input Config[8], Axis 5 Input Config[8], Axis 6 Input Config[8], Axis 7 Input Config[8], Axis 8 Input Config[8]]

This attribute is a 2 dimensional array of enumerated values that map configurable digital inputs to specific functions for each drive axis. Each of the 8 possible axis instances may support up to 8 configurable digital inputs. The Logix controller distributes the Digital Input Configuration array elements to each axis instance of the device. The Digital Input Configuration attribute in the device is defined as a 32 element array of which only the first 8 elements are supported by this 8x8 Digital Input Configuration array definition. The remaining elements of the 32 element array are set to 0.

Functions that are not mapped to a digital input are not checked by the drive, and do not generate associated exceptions or events. Associated exception actions in this case are accepted by the device and ignored.

DC Bus Output Voltage Set Point n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	0	0	∞	Volts

This attribute sets the reference voltage used to actively regulate the DC Bus Output Voltage output of Bus Converter power structure instance n when in the Running state.

Power structure instance attributes are only applicable when supporting multiple converter power structure generated DC Bus outputs per axis object instance

Bus Output Overvoltage User Limit n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	0	0	∞	% DC Bus Voltage Set Point n

This attribute sets the User Limit for the Bus Overvoltage UL exception associated with the DC Bus output of DC converter power structure instance n when supporting multiple converter power structure generated DC Bus outputs per axis object instance. Unlike the corresponding Factory Limit, which is specified in Volts, the User Limit is based on percent of the corresponding DC Bus Voltage Set Point n during operation.

This attribute is only applicable to DC Converter Types.

Bus Output Undervoltage User Limit n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Set		REAL	0	0	100	% DC Bus Voltage Set Point n

This attribute sets the User Limit for the Bus Undervoltage UL exception associated with the DC Bus output of DC converter power structure instance n when supporting multiple converter power structure generated DC Bus outputs per axis object instance. Unlike the corresponding Factory Limit, which is specified in Volts, the User Limit is based on percent of the corresponding DC Bus Voltage Set Point n during operation.

This attribute is only applicable to DC Converter Types.

See also

Standard Exceptions on page 456

Module Feedback Port Attributes on page 489

Module Configuration Attributes on page 471

Module Feedback Port Attributes

Module Axis attributes are used to configure the feedback ports of the device module. Each device module may be equipped with multiple feedback ports that can be freely mapped to the various feedback channels of a CIP Motion axis instance.

Feedback Port Select

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - E	Set		USINT[8][4]	[] = 0	-	-	Enumeration: 0 = Unused 1 = Port 1 2 = Port 2 3 = Port 3 4 = Port 4 5 = Port 5 6 = Port 6 7 = Port 7 8 = Port 8 9 = Port 9 10 = Port 10 11 = Port 11 12 = Port 12 13-255 = Reserved

This attribute is organized as 8x4 array with 8 corresponding to the maximum number of axes supported by a given drive device module and 4 representing the number of logical feedback channels per axis. The 8x4 indexed array elements of this array correspond to axis instances 1 thru 8 and feedback channels 1 thru 4, respectively. The individual elements of this array are enumerated values associated with the 'Feedback n Port Select' attribute in the Motion Device Axis Object. The controller's module interface function uses the Feedback Port Select information to set the Feedback n Port Select attributes for each axis instance of the CIP Motion device.

Feedback Card Type

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - E AOP	Set		USINT[8][4]	[] = 0	-	-	Feedback Card ID#

This attribute is organized as 8x4 array with 8 corresponding to the maximum number of axes supported by a given drive device module and 4 representing the number of logical feedback channels per axis. The individual elements of this array are numeric identifiers associated with the specific feedback interface hardware assigned to this feedback port. The list of supported Feedback Types is determined by the feedback interface hardware selection. Configuration software uses this information to filter the Feedback Type list associated with the port. This multidimensional array follows the same indexing rules as the Feedback Port Select.

See also

Feedback Attributes on page 302

Module Timing Attributes on page 490

Module Configuration Attributes on page 471

Module Timing Attributes

The following attributes configure various time related aspects of CIP Motion device.

Time Sync Support

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All FW	Set		USINT	2	-	-	Enumeration: 0 = No sync support 1 = Low quality 2 = High quality 3-255 = (reserved)

Controller firmware only enumerated parameter (does not go to the drive) which reflects the time synchronization capability of the device.

- No Sync: This enumeration indicates that the device does not support CIP Sync time synchronization and therefore cannot interpret or generate time stamps.
- Low Quality: This enumeration indicates that the device has a low quality implementation of CIP Sync time synchronization protocol. Latency associated with the software time sync algorithm limits time stamp accuracy to no better than 10 microseconds (μsec). Fine interpolation is not recommended for this time sync implementation. Low Quality time synchronization is sufficient for Fault and Alarm event logging.
- High Quality: This enumeration indicates that the device has a high quality implementation of CIP Sync time synchronization protocol resulting in very accurate time stamping (better than 10 μsec). High Quality time synchronization is appropriate for fine interpolation and registration functionality.

Time Diagnostics

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All FW	Set		BYTE	0	-	-	Bitmap: 0: Enable Time Statistics 1: Reset Transmission Statistics 2-7: (reserved)

Controller firmware only parameter (does not go to the drive) which controls whether timing diagnostic data is requested from the drive.

- Enable Time Statistics - enable timing diagnostic data.
- Reset Transmission Statistics - when the controller sees this bit set to a one it will reset transmission statistics and then clear the bits.

Position Loop Device Update Period

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Set		INT		-	-	Microseconds

Used to determine setting of Interpolation Control when in position loop mode.

Velocity Loop Device Update Period

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Set		INT		-	-	Microseconds

Used to determine setting of Interpolation Control when in velocity loop mode.

Torque Loop Device Update Period

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	Set		INT		-	-	Microseconds

Used to determine setting of Interpolation Control when in torque loop mode.

See also

Control Modes on page 16

[Module Support Attributes](#) on [page 492](#)

[Module Configuration Attributes](#) on [page 471](#)

Module Support Attributes

The following AOP Module C-tag parameters are used by configuration software to determine the size of various array data needed to configure the CIP Motion device and whether attributes associated with the converter function will be sent to the CIP Motion device. These parameters are not attributes of any object and are not sent to the CIP Motion device.

Number of Configured Axes

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All AOP			SINT	2	0	8	# of axes

Configuration software only parameter (does not go to the device), representing the number of axes in this device configured for use.

Inverter Support

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All AOP			SINT	1	-	-	Bitmap: 0: Axis 1 Inverter 1: Axis 2 Inverter 2: Axis 3 Inverter 3: Axis 4 Inverter 4: Axis 5 Inverter 5: Axis 6 Inverter 6: Axis 7 Inverter 7: Axis 8 Inverter

Configuration software only bitmapped attribute (does not go to the device), where each bit determines if an axis instance supports an Inverter power structure. This attribute impacts Inverter specific attributes, such as PWM Frequency and Duty Select.

Number of Configurable Inputs

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - All FW*			USINT[8]	[] = 0	0	8	Number of inputs [Axis 1 Inputs, Axis 2 Inputs, Axis 3 Inputs, Axis 4 Inputs, Axis 5 Inputs, Axis 6 Inputs, Axis 7 Inputs, Axis 8 Inputs]

Firmware only parameter (does not go to the device) that controls how much of the Digital Input Configuration array is sent to the device for a given axis instance.

Important: This attribute is only needed if Digital Input Configuration is supported.

The number of configurable inputs can vary for each axis instance supported by a multi-axis drive module. The indexed elements of this array correspond to axis instances 1 thru 8. Array elements that are not applicable or configured are set to 0.

Source of Configurable Inputs

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - All FW*			USINT[8]	[] = 0	0	8	Number of inputs [Axis 1 Input Source, Axis 2 Input Source, Axis 3 Input Source, Axis 4 Input Source, Axis 5 Input Source, Axis 6 Input Source, Axis 7 Input Source, Axis 8 Input Source]

Firmware only parameter (does not go to the device) that specifies the axis instance that sources the configurable digital inputs for a given axis of the device.

Important: This attribute is only needed if Digital Input Configuration is supported.

While axis instances generally provide their own set of configurable inputs, in some cases axis instances, like feedback only axis instances, utilize the digital inputs from another axis instance. The Source of Configurable Inputs element can be used to identify another axis instance as the source for its digital inputs. The indexed elements of this array correspond to axis instances 1 thru 8. Array elements that are not applicable or configured are set to 0.

See also

Module Axis Attributes on page 474

Module Configuration Attributes on page 471

A

attribute units 94
attributes
- command generator configuration 209
- command generator signal 213
- command reference generation 209
- configuration fault 307
- current control configuration 214
- current control signal 220
- DC bus control 490
- drive general purpose I/O 270
- drive output 271
- event capture 267
- exception factory limit info 311
- exception user limit configuration 313
- exception, fault and alarm 315
- feedback configuration 326
- frequency control configuration 222
- frequency control signal 224
- general feedback info 339
- general feedback signal 339
- general linear motor 421
- general motor 423
- general permanent magnet motor 430
- general rotary motor 433
- guard safety 462
- guard safety status 462
- hookup test configuration 286
- hookup test result 287
- identify motion axis attributes based on device function codes 100
- induction motor 435
- inertia test configuration 290
- inertia test result 293
- interior permanent magnet motor 440
- intialization faults 316
- linear PM motor 438
- load transmission and actuator 443
- module axis 514
- module class 513
- module configuration block 511
- module feedback port 529
- module support 532
- module timing 530
- module/node fault and alarm 319
- motion control configuration 340
- motion control interface 347
- motion control signal 355
- motion control status 367
- motion database storage 380
- motion dynamic configuration 382
- motion homing configuration 385
- motion planner configuration 399
- motion planner output 407
- motion scaling 408
- motor test result 296
- position loop configuration 226
- position loop signal 225
- power and thermal management configuration 272
- power and thermal managment status 274
- required vs optional axis attributes 97
- rotary PM motor 446
- standard initialization 317
- standard start inhibits 493
- start inhibits 492
- stopping and braking 468
- torque/force control configuration 229
- torque/force control signal 238
- velocity loop configuration 239
- velocity loop signal 246

B

Behavior models 29
- Acceleration Control Behavior 29
- Command Generation Behavior 32
- Current Control Behavior 39
- Event Capture Behavior 42
- Fault and Alarm Behavior 45
- Motion Control Axis Behavior 55

C

CIP data types 95
Control Methods 23
- No Control Mode 23
- Position Control Mode 19
- Torque Control Mode 22
- Velocity Control Mode 20

D

device function codes 96

E

exceptions 496

Rockwell Automation support

Rockwell Automation provides technical information on the web to assist you in using its products. At http://www.rockwellautomation.com/support you can find technical and application notes, sample code, and links to software service packs. You can also visit our Support Center at https://rockwellautomation.custhelp.com for software updates, support chats and forums, technical information, FAQs, and to sign up for product notification updates.

In addition, we offer multiple support programs for installation, configuration, and troubleshooting. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/services/online-phone.

Installation assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator available at http://www.rockwellautomation.com/locations, or contact your local Rockwell Automation representative.

New product satisfaction return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

Documentation feedback

Your comments will help us serve your documentation needs better. If you have any suggestions on how to improve this document, complete the feedback form, publication RA-DU002.

Rockwell Otomasyon Ticaret A.Ş., Kar Plaza İş Merkezi E Blok Kat:6 34752 İçerenköy, İstanbul, Tel: +90 (216) 5698400

www.rockwellautomation.com

Power, Control and Information Solutions Headquarters

Americas: Rockwell Automation, 1201 South Second Street, Milwaukee, WI 53204-2496 USA, Tel: (1) 414.382.2000, Fax: (1) 414.382.4444
Europe/Middle East/Africa: Rockwell Automation NV, Pegasus Park, De Kleetlaan 12a, 1831 Diegem, Belgium, Tel: (32) 2 663 0600, Fax: (32) 2 663 0640
Asia Pacific: Rockwell Automation, Level 14, Core F, Cyberport 3, 100 Cyberport Road, Hong Kong, Tel: (852) 2887 4788, Fax: (852) 2508 1846

Rockwell Automation Publication MOTION-RM003I-EN-P - February **2018**

Supercedes Publication MOTION-RM003H-EN-P - June 2016