Reference Manual

Original Instructions

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.

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).

Notes:

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

Topic	Page
Added cross-references to tables and figures where applicable	Throughout
Updated Commutation Offset Compensation attribute	30, 209, 348, 364, 372, 379
Updated Current Limit Source attribute	31, 349, 365, 372, 379
Added Home Torque Threshold attribute	35, 109, 351
Added Home Torque Time attribute	35, 109, 351
Added PM Motor Extended Speed Permissive attribute	38, 119, 352
Added PM Motor Rotary Bus Overvoltage Speed attribute	39, 123, 353
Added PM Motor Rotary Max Extended Speed attribute	39, 124, 353
Added PM Motor Linear Max Extended Speed attribute	39, 126, 353
Added PM Motor Linear Bus Overvoltage Speed attribute	39, 125, 352
Added DC Bus Output Voltage Reference attribute	31, 273, 349
Added Converter Output Current n attribute	31, 273, 348
Added Converter Output Power n attribute	31, 273, 348, 349
Added Converter Output Rated Current n attribute	31, 273, 349
Added Converter Output Rated Power n attribute	31, 273, 349
Added DC Bus Output Voltage n attribute	31, 273, 349
Added DC Bus Output Voltage Reference n attribute	31, 274, 349
Added Converter Output Capacity n attribute	31, 274, 348
Added Bus Output Overvoltage Factory Limit n attribute	29, 274, 348
Added Bus Output Undervoltage Factory Limit n attribute	29, 274, 348
Added Motor Test Comm Offset Comp attribute	38, 294, 352, 368, 375, 383
Added Motor Test Ld Flux Saturation attribute	38, 285, 352, 368, 375, 383
Added Motor Test Ld Inductance attribute	38, 284, 352, 368, 375, 383
Added Motor Test Lq Flux Saturation attribute	38, 284, 352, 368, 375, 383
Added Motor Test Lq Inductance attribute	38, 284, 352, 368, 375, 383
Added Motor Test Max Speed attribute	38, 285, 352, 368, 375, 383
Updated Operative Current Limit attribute	38, 352, 368, 375, 383
Added Velocity Limit - Motor Max attribute	43, 177, 355, 370, 378, 385
Added Velocity Limit Bus Overvoltage attribute	43, 177, 354, 370, 377, 385
Added Velocity Limit Bus Overvoltage Permissive attribute	43, 177, 354, 370, 377, 385

Topic	Page
Added Velocity Limit Source attribute	44, 174, 355, 370, 378, 385
Added Converter Control Attributes section	273
Updated Table 76, Kinetix 5500 Optional Attributes	347
Added Kinetix 5500 Integrated STO Drive Module Optional Attributes section	355

Introduction

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

The Control Modes chapter provides a reference for the Control Modes and Control Methods. The chapter provides tabled information that explains when you can use an axis attribute in an individual control mode.

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.

The Axis Attributes chapter contains the following information:

- Detailed attribute definitions
- Configurations
- Status
- Faults

Each attribute is in a table, which is organized with the following information:

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

Who Should Use This Manual

This document provides a programmer with details about the AXIS_CIP_DRIVE motion control axis attributes and the Logix Designer application Control Modes.

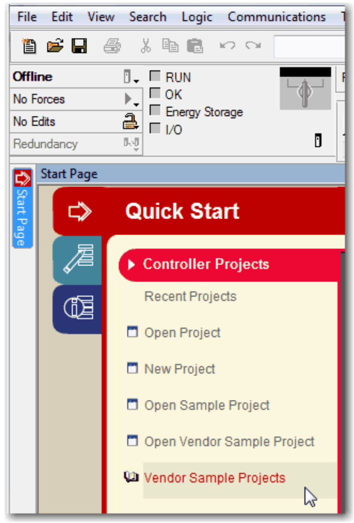
Where to Find Sample Projects

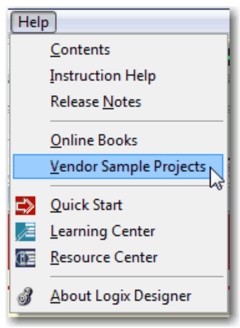
There are three ways to find the sample projects:

- Studio 5000 Logix Designer Main Dialog Box

- Logix Designer Start Page (ALT+F9)
- Logix Designer Help Menu

The default location of the Rockwell Automation sample is:





C:\Users\Public\Documents\Studio 5000\Samples\ENU\V21\Rockwell Automation

There is a PDF file that is named Vendor Sample Projects on the Start Page that explains how to work with the sample projects.

Free sample code is available at: http://samplecode.rockwellautomation.com/.

Additional Resources

These resources contain information about related products from Rockwell Automation.

Resource	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.
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.
Product Certifications website, http://www.rockwellautomation.com/global/certification/overview.page	Provides declarations of conformity, certificates, and other certification details.
Network specifications details, http://www.odva.org	ODVA, is the organization that supports network technologies that are built on the Common Industrial Protocol (CIP) — DeviceNet, EtherNet/IP, CompoNet, and ControlNet.

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

Integrated Motion Axis Control Modes

Use this chapter to get information about Control Modes, Control Methods, and when you can use an axis attribute when in an individual Control Mode.

Control Modes

Motion Control Modes are organized around the idea 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 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 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 lets 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.

Control Modes:

- 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: Frequency Control Method

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 Methods that is related to the Control Modes are listed in Table 1.

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.

Table 1 - Control Method Field 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.i
3…127	-	Reserved	-
128…255	-	Vendor Specific	-

Axis Configuration

The Control Mode and Control Method are derived by the Axis Configuration according to Table 2.

Table 2 - Valid Control Modes

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 the Control Mode diagrams for each axis configuration starting on page 18.

Control Nomenclature

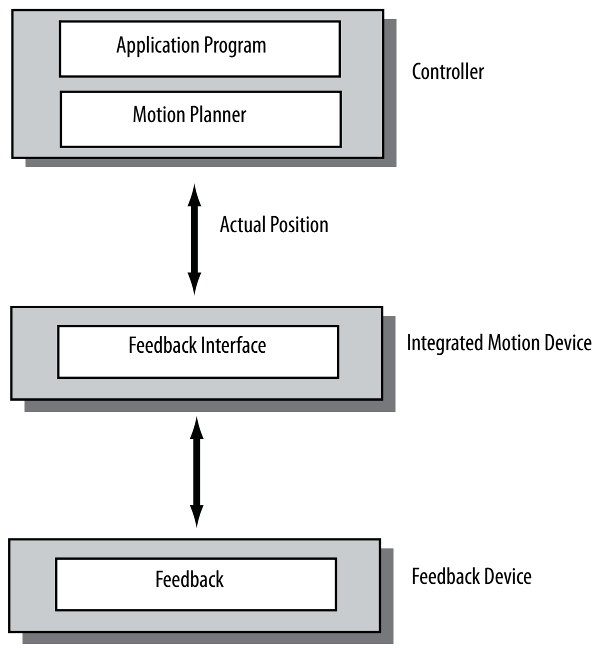
Linear and rotary control applications can affect the control nomenclature. While rotary applications speak of torque and inertia, linear applications speak of force and mass. When we refer to rotary nomenclature, the defined behavior can generally be applied to linear applications by substituting the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

No Control Mode

The Motion Device Axis Object supports a 'No Control' application mode where there is no dynamic motor control function. This mode is often used to support 'Feedback Only' or 'Master Feedback' functionality where a feedback channel in an Integrated Motion on the EtherNet/IP network Drive device is serving as a master feedback source to the rest of the control system. This mode could also apply 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 via the cyclic data connection, but actual position, velocity, and acceleration can be supplied by the device to the controller via the cyclic data channel, if applicable. The No Control mode for Feedback Only functionality is illustrated in Figure 1.

Figure 1 - 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.

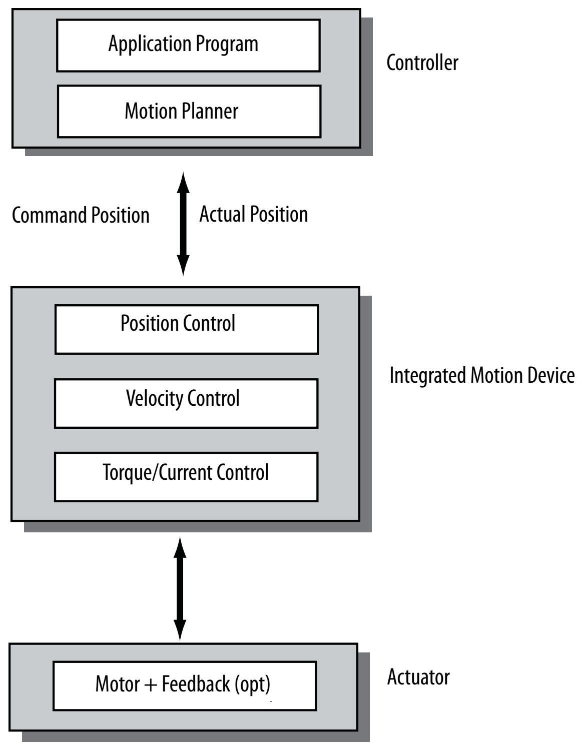
Position Control Mode

In Position Control application mode, either the application control program (command execution function) or the Motion Planner (move trajectory control function) provides a setpoint value to the integrated motion device via the cyclic data connection. The Position Control method can be either open loop or closed loop.

Closed Loop Position Control Method

A motor control device that is 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 Figure 2. The presence of the torque/current control loop sometimes results in this kind of drive being referred to as a vector drive.

Figure 2 - Closed Loop Position Control Method



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

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

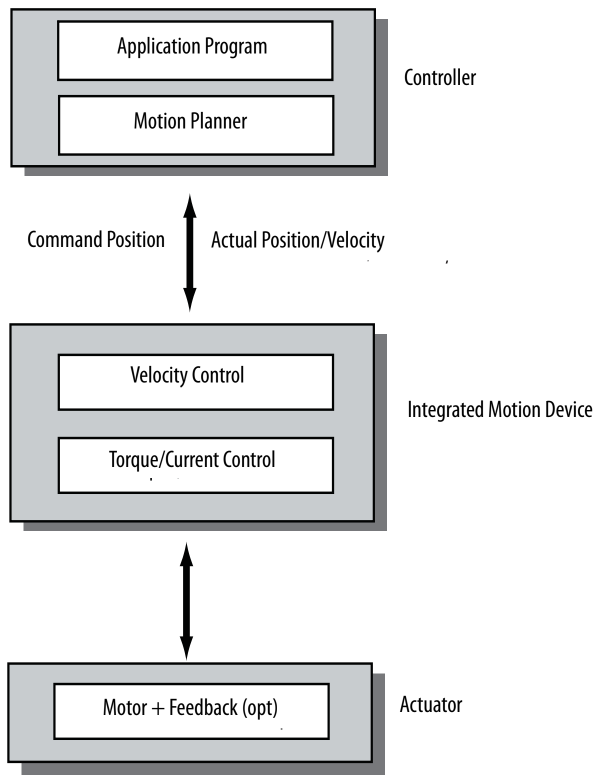
Velocity Control Mode

In Velocity Control application mode, the application control program and Motion Planner provide a setpoint value to the integrated motion device via the cyclic data connection. The Velocity Control method can be either open loop or closed loop.

Closed Loop Velocity Control Method

A motor control device that is 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.

Figure 3 - Closed Loop Velocity Control Method



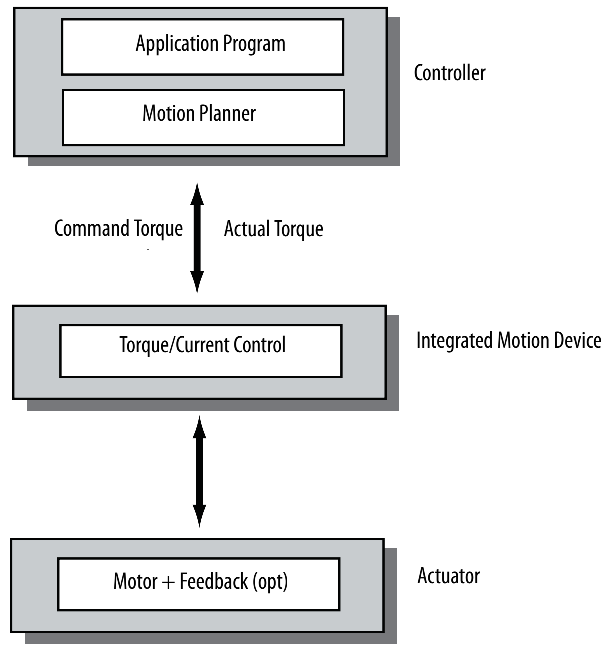
A feedback device for the velocity loop drive configuration is optional. You can achieve tighter speed regulation when by using a feedback device, particularly at low speed. When the feedback device is included, it can be used to return actual position, velocity, and acceleration data to the controller via 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.

Torque Control Mode

In Torque Control application mode, the application control program or the Motion Planner provide torque setpoint values to the device via 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.

Figure 4 - Torque Control Mode



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 via the cyclic data connection.

Required Versus Optional Axis Attributes

In the sections that follow, attributes and services are defined as Required or Optional. 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, see Device Function Codes on page 26.

Required Implementation

If an attribute is marked as Required for a given Device Function Code, then the controller implementation, including configuration and programming software, supports 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 an integrated motion device that supports Velocity Loop operation.

In some cases, an instance 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 Condition Implementation column would show 'R-PM' and 'O-IM'.

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 Condition Implementation column would show 'R-Co' (Controller only) and 'O-Dr' (Drive replicated).

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 in Table 3. In the following example, the attribute PM Motor Resistance is (R) 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 Bus Power Converter or a Feedback Only device or a drive that does not support a PM motor.

Table 3 - Example Attribute with Control Modes

Attribute ID	Access Rule	Attribute	N - No Control		O	C - Closed Loop Control			C/D	Conditional Implementation
			B	E	F	P	V	T		
1327	Set	PM Motor Resistance			R	R	R	R	Yes	PM Motor only

- 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)
- C/D = Controller/Device Replicated Attribute

See Device Function Codes on page 26 for more information.

PM Motor Resistance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	SSV(1)	REAL	0 DB	0	-	Ohms

The PM Motor Resistance attribute is a float that specifies the phase-to-phase, resistance of a permanent magnet motor.

(1) SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

Attributes that have Optional enumerations or bit maps are designated so in the Condition Implementation column as 'O-Enum', or 'O-Bits'. Detail about Optional and Required support for the individual enums 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.

The column marked Derived, the value for an attribute is determined (derived) by the controller, that is based on the value of another attribute and therefore follows the conditional implementation rules of that attribute. 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.

Table 4 - Conditional Implementation Key

Key	Description
AOP	Add-on Profile. Logix Designer component that can be separately installed and used for configuring one or more modules.
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
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)
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-Dr Dscale	O (Optional) - DR (Drive replicated attribute (controller attribute that is replicated in drive) DScale (Motion Scaling Configuration set to Drive Scaling)
O-Enum	Optional enumerations that are associated with attribute, see Required Versus Optional Axis Attributes on page 22
P###	P### refers to the related PowerFlex® drive parameter.
PM	Rotary or Linear Permanent Magnet motor (SPM or IPM) (motor type)
R-Co CScale	R (Required) - Co Controller only attribute that resides only in controller CScale, Motion Scaling Configuration set to Controller Scaling
Rotary Absolute	Feedback Unit - rev; Feedback n Startup Method- absolute
Rotary Motor	Rotary PM motor or Rotary Induction motor (motor type)

Table 4 - Conditional Implementation Key (Continued)

Key	Description
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)
SS	SSI (feedback type)
TM	Tamagawa (feedback type)
TP	Digital Parallel (feedback type)
TT	Digital AqB (feedback type)

Device Function Codes

Based on the variations in Control Mode, and Control Method, we can define a set of basic Device Function Codes that help us 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 integrated motion device. Table 5 lists the Device Function Codes.

Table 5 - Device Function Codes, Control Modes, and Methods

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

By using combinations of these letters, we can designate a specific class of Integrated Motion on the EtherNet/IP network devices 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 so frequently that we have defined special Device Control Function Codes for convenience.

Table 6 - Device Function Code Combinations

Device Code	Combination	Description
B	BE	All Device Functions using No Control Method
O	F	All Device Functions 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)
In addition to these combinations, there are many attributes that are applicable or not applicable to encoderless or sensorless drive operation, for example, Velocity Controlled drives operating without a feedback device. We can use Device Function Codes to specify conditional implementation rules for attributes. To accommodate these situations, we defined the following Device Functions Codes.		
E	Encoder-based device operation	
!E	Encoderless or Sensorless device operation All Active Control Modes that do not use a Feedback device.	
C/D	-	Replicated

Identify Motion Axis Attributes Based on Device Function Codes

Table 7 provides a list of all Motion Axis Attributes specific to the CIP Drive data type. The table identifies whether the attribute is Required, Optional, or Conditional in implementation that is based on a Device Function Code. The C/D column states whether the attribute is replicated in the drive.

For information about the drive supported attributes, see Drive Supported Optional Attributes on page 339.

TIP Each attribute name in Table 7 is a link to its location in Chapter 2, CIP Axis Attributes.

For more information about the PowerFlex drive, see the PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001. There is an appendix that maps the PowerFlex drive parameters to their matching Integrated Motion attribute.

For more information about the Kinetix® drive parameters, see these publications.

- Kinetix 6200 and Kinetix 6500 Modular Servo Drive User Manual, publication 2094-UM002.
- Kinetix 350 Single-axis EtherNet/IP Servo Drives User Manual, publication 2097-UM002.
- Kinetix 5500 EtherNet/IP Servo Drives User Manual, publication 2198-UM001.
- Kinetix 5700 Multi-axis EtherNet/IP Servo Drive User Manual, publication 2198-UM002.

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D[1]	Conditional Implementation	Page
		B	E	F	P	V	T	C/D[2]		
480	Acceleration Command				O	O	O	Yes	MSG Access Only	184
483	Acceleration Feedback 1		R	-	R	R	R	Yes	E, MSG Access Only	184
1454	Acceleration Feedback 2		R	-	R	R	R	Yes	E, MSG Access Only	184
1404 +(n-1)*50	Acceleration Feedback n (General Feedback Signal)		R		R	R	R	Yes	E, MSG Access Only	134
452	Acceleration Feedforward Command		-	-	R	R	-	Yes		173
460	Acceleration Feedforward Gain		-	-	R	R	-	Yes		175
367	Acceleration Fine Command		-	-	O	O	O	Yes		154
485	Acceleration Limit		-	O	O	O	O	Yes		185
482	Acceleration Reference		-	-	O	O	O	Yes		184
481	Acceleration Trim		-	-	O	O	O	Yes		184
53	Actual Acceleration		R	R	R	R	R			74
48	Actual Position		R	R	R	R	R			72
52	Actual Velocity		R	R	R	R	R			73
1376	Actuator Diameter		C	C	C	C	C	Yes	R-Co CScale; O-Dr DScale	130
1377	Actuator Diameter Unit		C	C	C	C	C	Yes	R-Co CScale; O-Dr DScale	130

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D(1)	Conditional Implementation	Page
		B	E	F	P	V	T	C/D(2)		
1374	Actuator Lead		C	C	C	C	C	Yes	R-Co CScale; O-Dr DScale	129
1375	Actuator Lead Unit		C	C	C	C	C	Yes	R-Co CScale; O-Dr DScale	130
1373	Actuator Type		C	C	C	C	C	Yes	R-Co CScale; O-Dr DScale	129
639	Ambient Temperature	O		O	O	O	O	Yes	MSG Access Only	232
732	Analog Input 1	O	-	O	O	O	O	Yes		272
733	Analog Input 2	O	-	O	O	O	O	Yes		272
734	Analog Output 1	O		O	O	O	O	Yes		272
735	Analog Output 2	O	-	O	O	O	O	Yes		272
201	Application Type				R	R	R			294
164	Attribute Error Code		R	R	R	R	R			246
165	Attribute Error ID		R	R	R	R	R			246
873	Auto Sag Configuration		O	O	O	O	O	Yes		227
874	Auto Sag Slip Increment		O	O	O	O	O	Yes		227
876	Auto Sag Start		O	O	O	O	O	Yes		228
875	Auto Sag Start		O	O	O	O	O	Yes		228
51	Average Velocity		R	R	R	R	R			73
81	Average Velocity Timebase		R	R	R	R	R			101
30	Axis Configuration		R	R	R	R	R		O-Enum	69
12	Axis Configuration State		R	R	R	R	R			65
11	Axis Data Type		R	R	R	R	R			67
35	Axis Event Bits		R	R	R	R	R			150
34	Axis Fault Bits		R	R	R	R	R			83
19	Axis Features		R	R	R	R	R		O-Bits	68
106	Axis ID		R	R	R	R	R			66
2	Axis Instance		R	R	R	R	R			64
760	Axis Safety State		O	O	O	O	O	Yes		280
761	Axis Safety Status		O	O	O	O	O	Yes		281
763	Axis Safety Faults		O	O	O	O	O	Yes		282
13	Axis State		R	R	R	R	R			66
33	Axis Status Bits		R	R	R	R	R			81
124	Axis Update Schedule		R	R	R	R	R			67
825	Backlash Compensation Window		-	-	O	-	-	Yes		190
423	Backlash Reversal Offset		-	-	R	-	-		E	190
592	Brake Test Torque		O	O	O	O	O	Yes		227
593	Brake Prove Ramp Time		O	O	O	O	O	Yes		227
594	Brake Slip Tolerance		O	O	O	O	O	Yes		227
576	Break Frequency		-	R	-	-	-	Yes		215
575	Break Voltage		-	R	-	-	-	Yes		214

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D(1)	Conditional Implementation	Page
		B	E	F	P	V	T	C/D(2)		
622	Bus Configuration	O		O	O	O	O			257
2338 + o	Bus Output Overvoltage Factory Limit n	O	-	O	O	O	O			274
2339 + o	Bus Output Undervoltage Factory Limit n	O	-	O	O	O	O			274
688	Bus Overvoltage Factory Limit	O		O	O	O	O	Yes	MSG Access Only	257
704	Bus Overvoltage User Limit	O		O	O	O	O			328
705	Bus Undervoltage User Limit	O		O	O	O	O			328
624	Bus Regulator Action	O		O	O	O	O			324
638	Bus Regulator Capacity	O	-	O	O	O	O	Yes		232
686	Bus Regulator Overtemperature Factory Limit			O	O	O	O	Yes	MSG Access Only	258
702	Bus Regulator Overtemperature User Limit	O		O	O	O	O			328
880	Bus Regulator Reference	O		O	O	O	O	Yes	MSG Access Only	229
687	Bus Regulator Thermal Overload FL			O	O	O	O		MSG Access Only	249
703	Bus Regulator Thermal Overload UL	O		O	O	O	O			249
887	Bus Sharing Group	O		O	O	O	O			326
689	Bus Undervoltage Factory Limit			O	O	O	O	Yes	MSG Access Only	257
623	Bus Voltage Select			O	O	O	O	Yes		324
8	C2C Connection Instance		R	R	R	R	R			65
7	C2C Map Instance		R	R	R	R	R			65
756	CIP APR Faults		C		C	C	C	Yes	R-Co CScale; O-Dr DScale; E, MSG Access Only	268
757	CIP APR Faults - Mfg		C		C	C	C	Yes	R-Co CScale; O-Dr DScale; E, MSG Access Only	268
659	CIP Axis Alarms	O	O	O	O	O	O	Yes		247
660	CIP Axis Alarms - Mfg	O	O	O	O	O	O	Yes	MSG Access Only	247
904	CIP Axis Alarms - RA	O	O	O	O	O	O	Yes		247
672	CIP Axis Exception Action		R	R	R	R	R	Yes	O-Enum	261
673	CIP Axis Exception Action - Mfg		R	R	R	R	R	Yes	MSG Access Only	261
908	CIP Axis Exception Action - RA		R	R	R	R	R	Yes	O-Enum	262
655	CIP Axis Exceptions	R	R	R	R	R	R	Yes	MSG Access Only	246
656	CIP Axis Exceptions - Mfg	R	R	R	R	R	R	Yes	MSG Access Only	246
902	CIP Axis Exceptions -RA	R	R	R	R	R	R	Yes	MSG Access Only	246
657	CIP Axis Faults	R	R	R	R	R	R	Yes		247
658	CIP Axis Faults - Mfg	R	R	R	R	R	R	Yes	MSG Access Only	247
905	CIP Axis Faults - RA	R	C		C	C	C	Yes	R-Co CScale; O-Dr DScale; E, MSG Access Only	247
903	CIP Axis Faults - RA	R	R	R	R	R	R	Yes		247
653	CIP Axis I/O Status	R	R	R	R	R	R	Yes		240
654	CIP Axis I/O Status - Mfg	R	R	R	R	R	R	Yes	MSG Access Only	241
901	CIP Axis I/O Status - RA	R	R	R	R	R	R	Yes		240

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D[1]	Conditional Implementation	Page
		B	E	F	P	V	T	C/D[2]		
650	CIP Axis State	R	R	R	R	R	R	Yes		234
651	CIP Axis Status	R	R	R	R	R	R	Yes		235
652	CIP Axis Status - Mfg	R	R	R	R	R	R	Yes	MSG Access Only	239
900	CIP Axis Status - RA	R	R	R	R	R	R	Yes		239
674	CIP Initialization Faults	R	R	R	R	R	R	Yes		264
675	CIP Initialization Faults - Mfg	R	R	R	R	R	R	Yes	MSG Access Only	264
910	CIP Initialization Faults - RA	R	R	R	R	R	R	Yes		264
676	CIP Start Inhibit	R	-	R	R	R	R	Yes		266
677	CIP Start Inhibits - Mfg	R		R	R	R	R	Yes	MSG Access Only	266
912	CIP Start Inhibits - RA	R	-	R	R	R	R	Yes		266
617	Coasting Time Limit		O	O	O	O	O			218
832	Cogging Compensation Table				O	O	O	Yes	MSG Access Only	195
100	Command Acceleration		-	R	R	R	-			76
768	Command Notch Filter Frequency				O	O		Yes	MSG Access Only	157
96	Command Position		-	R	R	R	-			75
95	Command Torque		-	-	-	R	R			75
360	Command Update Delay Offset		-	-	R	R	-		E	92
99	Command Velocity		-	R	R	R	-			76
564	Commutation Alignment				O	O	O	Yes	E; PM Motor only, O-Enum, MSG Access Only	209
561	Commutation Offset		-	-	R	R	R	Yes	PM Motor only, E	208
850	Commutation Offset Compensation	-	-	-	O	O	O	Yes	E: IPM Motor only	209
563	Commutation Polarity		-	-	O	O	O	Yes	PM Motor only, E	209
562	Commutation Self-Sensing Current		-	-	O	O	O	Yes	PM Motor only, AOP, E	208
N/A	Configuration Bits		R	R	R	R	R			322
21	Controller Update Delay High Limit		O	O	O	O	O			322
22	Controller Update Delay Low Limit		O	O	O	O	O			322
107	Control Method		O	O	O	O	O	Yes	MSG Access Only	71
41	Control Method	R	R	R	R	R	R	Yes	Derived – Axis Config	71
40	Control Mode	R	R	R	R	R	R	Yes	Derived – Axis Config	70
918	Control Module Overtemperature Factory Limit	O	O	O	O	O	O		MSG Access Only	258
920	Control Module Overtemperature User Limit	O	O	O	O	O	O			329
710	Control Power-up Time	O		O	O	O	O	Yes	MSG Access Only	87
82	Conversion Constant		R	R	R	R	R			101
890	Converter AC Input Phasing	O		O	O	O	O			327
891	Converter AC Input Voltage	O		O	O	O	O			327
637	Converter Capacity	O	-	O	O	O	O	Yes		231
693	Converter Ground Current Factory Limit			O	O	O	O	Yes	MSG Access Only	259

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D(1)	Conditional Implementation	Page
		B	E	F	P	V	T	C/D(2)		
709	Converter Ground Current User Limit	O								328
2337 + o	Converter Output Capacity n	O	-	O	O	O	O			274
605	Converter Output Current	O		O	O	O	O			216
2330 + o	Converter Output Current n	O	-	O	O	O	O			273
606	Converter Output Power	O		O	O	O	O			216
2331 + o	Converter Output Power n	O	-	O	O	O	O			273
2332 + o	Converter Output Rated Current n	O	-	O	O	O	O			273
2333 + o	Converter Output Rated Power n	O	-	O	O	O	O			273
684	Converter Overtemperature Factory Limit	O		O	O	O	O	Yes	MSG Access Only	258
700	Converter Overtemperature User Limit			O	O	O	O			328
901	Converter Pre-charge Overload Factory Limit			O	O	O	O	Yes	MSG Access Only	258
921	Converter Pre-charge Overload User Limit			O	O	O	O			329
723	Converter Rated Output Current	O	-	O	O	O	O	Yes	MSG Access Only	270
724	Converter Rated Output Power	O	-	O	O	O	O	Yes	MSG Access Only	270
685	Converter Thermal Overload Factory Limit			O	O	O	O	Yes	MSG Access Only	259
701	Converter Thermal Overload User Limit	O		O	O	O	O			328
715	Cumulative Control Power Cycles	O		O	O	O	O	Yes	MSG Access Only	88
712	Cumulative Energy Usage	O		O	O	O	O	Yes	MSG Access Only	88
714	Cumulative Main Power Cycles	O		O	O	O	O	Yes	MSG Access Only	88
713	Cumulative Motor Revs			O	O	O	O	Yes	MSG Access Only	88
711	Cumulative Run Time	O		O	O	O	O	Yes	MSG Access Only	88
520	Current Command		-	-	R	R	R	Yes		203
840	Current Disturbance		-	-	O	O	O	Yes		204
527	Current Error		-	-	O	O	O	Yes		204
529	Current Feedback		-	-	O	O	O	Yes		205
522	Current Limit Source		-	O	O	O	O	Yes	F Support in V29	204
524	Current Reference		-	-	O	O	O	Yes		204
553	Current Vector Limit		-	O	O	O	O	Yes		207
196	Damping Factor				R	R	R			293
2334 + o	DC Bus Output Voltage n	O	-	O	O	O	O			273
742	DC Bus Output Voltage Reference	O	-	O	O	O	O			273
2336 + o	DC Bus Output Voltage Reference n	O	-	O	O	O	O			274
620	DC Bus Voltage	R	-	R	R	R	R	Yes		228
621	DC Bus Voltage - Nominal	R		R	R	R	R	Yes	MSG Access Only	228
870	DC Injection Brake Current		-	O	O	O	O	Yes		222
872	DC Injection Brake Time		-	O	O	O	O	Yes		222
486	Deceleration Limit		-	O	O	O	O	Yes		186
892	Demonstration Mode Select	O		O	O	O	O			327

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D(1)	Conditional Implementation	Page
		B	E	F	P	V	T	C/D(2)		
960	Digital Input Configuration		0	0	0	0	0			329
730	Digital Inputs	0	-	0	0	0	0	Yes		271
731	Digital Outputs	0	-	0	0	0	0	Yes		271
105	Direct Command Velocity		-	R	-	R	-			77
736	Drive Enable Input Checking	0		0	0	0	0		MSG Access Only	272
200	Drive Model Time Constant		-	-	R	R	R			294
725	Drive Power Structure Class ID			0	0	0	0		MSG Access Only	322
648	Duty Select			0	0	0	0			327
120	Dynamics Configuration Bits		-	R	R	R	-			112
885	External Bus Capacitance	0		0	0	0	0			325
883	External Shunt Power	0		0	0	0	0			325
884	External Shunt Pulse Power	0		0	0	0	0			325
882	External Shunt Regulator ID	0		0	0	0	0			325
886	External Shunt Resistance	0		0	0	0	0			326
1435 + (n-1)*50	Feedback 1 Accel Filter Bandwidth		0	-	0	0	0	Yes	E	145
2404 + (n-1)*50	Feedback 1 Accel Filter Taps		0	-	0	0	0	Yes	E	145
2405 + (n-1)*50	Feedback 1 Battery Absolute		0	-	0	0	0	Yes	E, TM	145
2405 + (n-1)*50	Feedback 1 Battery Absolute		0	-	0	0	0	Yes	E	145
1400	Feedback 1 Catalog Number		0	-	0	0	0	Yes	E, MSG Access Only	134
1417 + (n-1)*50	Feedback 1 Cycle Interpolation		R	-	R	R	R	Yes	E, Not LT, AOP	142
1416 + (n-1)*50	Feedback 1 Cycle Resolution		R	-	R	R	R	Yes	E, Not LT	141
1421 + (n-1)*50	Feedback 1 Data Code		0	-	0	0	0	Yes	E, TP, SS	143
1420 + (n-1)*50	Feedback 1 Data Length		0	-	0	0	0	Yes	E, TP, SS	143
1427 +(n-1)*5	Feedback 1 LDT Recirculations		R	-	R	R	R	Yes	E, LT, MSG Access Only	144
1426 +(n-1)*50	Feedback 1 LDT Type		R	-	R	R	R	Yes	E, LT, MSG Access Only	144
1419 + (n-1)*50	Feedback 1 Length		R	-	R	R	R	Yes	E, Linear Absolute Only	142
2400 + (n-1)*50	Feedback 1 Loss Action		0	-	0	0	0	Yes	E	144
1414 + (n-1)*50	Feedback 1 Polarity		0	-	0	0	0	Yes	E	140
1410 + (n-1)*50	Feedback 1 Resolution Unit		0		0	0	0	Yes	E, MSG Access Only	138
1425 + (n-1)*50	Feedback 1 Resolver Cable Balance		0	-	0	0	0	Yes	E, RS	143
1424 + (n-1)*50	Feedback 1 Resolver Excitation Frequency		0	-	0	0	0	Yes	E, RS	143
1423 + (n-1)*50	Feedback 1 Resolver Excitation Voltage		0	-	0	0	0	Yes	E, RS	143
1422 + (n-1)*50	Feedback 1 Resolver Transformer Ratio		0	-	0	0	0	Yes	E, RS	143
2402 + (n-1)*50	Feedback 1 Scaling Ratio		0	-	0	0	0		E, MSG Access Only	144
1401 + (n-1)*50	Feedback 1 Serial Number		0	-	0	0	0	Yes	E, MSG Access Only	134
1415 + (n-1)*50	Feedback 1 Startup Method		R	-	R	R	R	Yes	E, O-Enum	140
643	Feedback 1 Temperature		0	0	0	0	0	Yes	E, MSG Access Only	232
1418 + (n-1)*50	Feedback 1 Turn		R	-	R	R	R	Yes	E, Rotary Absolute Only	142

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D[1]	Conditional Implementation	Page
		B	E	F	P	V	T	C/D[2]		
1413 + (n-1)*50	Feedback 1 Type		R	-	R	R	R	Yes	E, O-Enum	139
1411	Feedback 1 Unit		R	-	R	R	R	Yes	E	139
1434 + (n-1)*50	Feedback 1 Velocity Filter Bandwidth		O	-	O	O	O	Yes	E	145
2403 + (n-1)*50	Feedback 1 Velocity Filter Taps		O	-	O	O	O	Yes	E	144
2383 + (n-1)*50	Feedback 1S Position		O	-	O	O	O		E, MSG Access Only	135
2384 + (n-1)*50	Feedback 1S Velocity		O	-	O	O	O		E, MSG Access Only	135
1435 + (n-1)*50	Feedback 2 Accel Filter Bandwidth		O	-	O	O	O	Yes	E	145
2404 + (n-1)*50	Feedback 2 Accel Filter Taps		O	-	O	O	O	Yes	E	145
2405 + (n-1)*50	Feedback 2 Battery Absolute		O	-	O	O	O	Yes	E	145
1450	Feedback 2 Catalog Number		-	-	O	O	O	Yes	E, MSG Access Only	134
1417 + (n-1)*50	Feedback 2 Cycle Interpolation		R	-	R	R	R	Yes	E, Not LT, AOP	142
1416 + (n-1)*50	Feedback 2 Cycle Resolution		R	-	R	R	R	Yes	E, Not LT	141
1421 + (n-1)*50	Feedback 2 Data Code		O	-	O	O	O	Yes	E, TP, SS	143
1420 + (n-1)*50	Feedback 2 Data Length		O	-	O	O	O	Yes	E, TP, SS	143
1477 +(n-1)*5	Feedback 2 LDT Recirculations		R		R	R	R	Yes	E, LT, MSG Access Only	144
1476	Feedback 2 LDT Type		R		R	R	R	Yes	E, LT, MSG Access Only	144
1419 + (n-1)*50	Feedback 2 Length		R	-	R	R	R	Yes	E, Linear Absolute Only	142
2400 + (n-1)*50	Feedback 2 Loss Action		O	-	O	O	O	Yes	E	144
1414 + (n-1)*50	Feedback 2 Polarity		O	-	O	O	O	Yes	E	140
1460	Feedback 2 Resolution Unit		O		O	O	O	Yes	E, MSG Access Only	138
1425 + (n-1)*50	Feedback 2 Resolver Cable Balance		O	-	O	O	O	Yes	E, RS	143
1424 + (n-1)*50	Feedback 2 Resolver Excitation Frequency		O	-	O	O	O	Yes	E, RS	143
1423 + (n-1)*50	Feedback 2 Resolver Excitation Voltage		O	-	O	O	O	Yes	E, RS	143
1422 + (n-1)*50	Feedback 2 Resolver Transformer Ratio		O	-	O	O	O	Yes	E, RS	143
2402 + (n-1)*50	Feedback 2 Scaling Ratio		O	-	O	O	O		E, MSG Access Only	144
1401 + (n-1)*50	Feedback 2 Serial Number		O	-	O	O	O	Yes	E, MSG Access Only	134
1415 + (n-1)*50	Feedback 2 Startup Method		R	-	R	R	R	Yes	E, O-Enum	140
644	Feedback 2 Temperature		O	O	O	O	O	Yes	E, MSG Access Only	232
1418 + (n-1)*50	Feedback 2 Turns		R	-	R	R	R	Yes	E, Rotary Absolute Only	142
1413 + (n-1)*50	Feedback 2 Type		R	-	R	R	R	Yes	E, O-Enum	139
1411 + (n-1)*50	Feedback 2 Unit		R	-	R	R	R	Yes	E	139
1434 + (n-1)*50	Feedback 2 Velocity Filter Bandwidth		O	-	O	O	O	Yes	E	145
2403 + (n-1)*50	Feedback 2 Velocity Filter Taps		O	-	O	O	O	Yes	E	144
2383 + (n-1)*50	Feedback 2S Position		O	-	O	O	O		E, MSG Access Only	135
2384 + (n-1)*50	Feedback 2S Velocity		O	-	O	O	O		E, MSG Access Only	135
2432	Feedback 2U Acceleration		O		O	O	O	Yes	E, MSG Access Only	135
2430	Feedback 2U Position		O		O	O	O	Yes	E, MSG Access Only	135
2431	Feedback 2U Velocity		O		O	O	O	Yes	E, MSG Access Only	135

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D(1)	Conditional Implementation	Page
		B	E	F	P	V	T	C/D(2)		
N/A	Feedback Card Type		O		O	O	O		E, AOP	330
250	Feedback Commutation Aligned		-	-	O	O	O	Yes	E, O-Enum, PM Motor only	210
31	Feedback Configuration	R	R	R	R	R	R		O-Enum	136
692	Feedback Data Loss Factory Limit		O	O	O	O	O	Yes	E, MSG Access Only	257
708	Feedback Data Loss User Limit		O	O	O	O	O	Yes		260
43	Feedback Master Select		O					Yes	MSG Access Only	138
42	Feedback Mode		R	R	R	R	R	Yes	Derived - Feedback Configuration	137
690	Feedback Noise Factory Limit		O	O	O	O	O	Yes	MSG Access Only	257
706	Feedback Noise User Limit		O	O	O	O	O	Yes	E	260
2385 + (n-1)*50	Feedback nS Acceleration		O	-	O	O	O		E, MSG Access Only	135
2385 + (n-1)*50	Feedback nS Acceleration		O	-	O	O	O		E, MSG Access Only	135
2382 + (n-1)*50	Feedback nU Acceleration		O	-	O	O	O		E, MSG Access Only	99
2382 + (n-1)*50	Feedback nU Acceleration		O	-	O	O	O		E, MSG Access Only	99
2380 + (n-1)*50	Feedback nU Position		O	-	O	O	O		E, MSG Access Only	135
2380 + (n-1)*50	Feedback nU Position		O	-	O	O	O		E, MSG Access Only	135
2381 + (n-1)*50	Feedback nU Velocity		O	-	O	O	O		E, MSG Access Only	99
2381 + (n-1)*50	Feedback nU Velocity		O	-	O	O	O		E, MSG Access Only	99
1412 + (n-1)*50	Feedback Port Select		O	-	O	O	O			330
691	Feedback Signal Loss Factory Limit		O	O	O	O	O	Yes	E, MSG Access Only	257
707	Feedback Signal Loss User Limit		O	O	O	O	O	Yes	E	260
44	Feedback Unit Ratio		-	-	O	O	-	Yes	E	138
871	Flux Braking Enable		-	O	O	O	O	Yes	Ind Motor only	223
528	Flux Current Error		-	-	O	O	O	Yes		205
530	Flux Current Feedback		-	-	O	O	O	Yes		205
525	Flux Current Reference		-	-	O	O	O	Yes		204
532	Flux Decoupling				O	O	O	Yes	MSG Access Only	205
557	Flux Integral Time Constant		-	-	O	O	O	Yes		207
556	Flux Loop Bandwidth		-	-	O	O	O	Yes		207
558	Flux Up Control		-	O	O	O	O	Yes	Ind Motor only, O-Enum	208
559	Flux Up Time		-	O	O	O	O	Yes	Ind Motor only	208
534	Flux Voltage Output				O	O	O	Yes	MSG Access Only	205
380	Flying Start Enable		-	O	-	O	-	Yes		156
570	Frequency Control Method		-	R	-	-	-	Yes	O-Enum	214
498	Friction Compensation Sliding		-	-	O	O	O	Yes		190
499	Friction Compensation Static		-	-	O	O	O	Yes		191
500	Friction Compensation Viscous		-	-	O	O	O	Yes		191
826/421	Friction Compensation Window		-	-	O	-	-	Yes		191

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D[1]	Conditional Implementation	Page
		B	E	F	P	V	T	C/D[2]		
189	Gain Tuning Configuration Bits		-	-	R	R	R			297
3	Group Instance		R	R	R	R	R			64
981	Guard Faults		-	O	O	O	O	Yes		278
980	Guard Status		-	O	O	O	O	Yes		276
737	Hardware Overtravel Input Checking			O	O	O	O	Yes	MSG Access Only	272
88	Home Configuration Bits		R	-	R	R	R		E	108
86	Home Direction		-	-	R	R	-		E	102
85	Home Mode		R	-	R	R	R		E	102
90	Home Offset		R	-	R	R	R		E	108
89	Home Position		R	-	R	R	R		E	108
113	Home Return Speed		-	-	R	R	-		E	109
87	Home Sequence		R	-	R	R	R		O-Enum, E	102
112	Home Speed		-	-	R	R	-		E	109
74	Home Torque Threshold	-	-	-	O	O	-		E	109
75	Home Torque Time	-	-	-	O	O	-		E	109
245	Hookup Test Commutation Offset		R	-	R	R	R		PM Motor only, E	285
246	Hookup Test Commutation Polarity		R	-	R	R	R		PM Motor only, E	286
109	Hookup Test Distance		R	-	R	R	R		E	289
247	Hookup Test Feedback 1 Direction		R	-	R	R	R		E	286
248	Hookup Test Feedback 2 Direction		R	-	R	R	R		E	286
111	Hookup Test Feedback Channel		R	-	R	R	R		E	289
244	Hookup Test Status		R	R	R	R	R			285
110	Hookup Test Time			R	-	R	-		!E	289
1346	Induction Motor Flux Current		-	R	R	R	R	Yes	Ind Motor only	127
1349	Induction Motor Magnetization Reactance		-	O	O	O	O	Yes	Ind Motor only	127
1345	Induction Motor Rated Frequency		-	R	R	R	R	Yes	Ind Motor only	127
1352	Induction Motor Rated Slip Speed		-	O	O	O	O	Yes	Ind Motor only	128
1351	Induction Motor Rotor Leakage Reactance		-	O	O	O	O	Yes	Ind Motor only	128
1350	Induction Motor Rotor Resistance		-	O	O	O	O	Yes	Ind Motor only	128
1348	Induction Motor Stator Leakage Reactance		-	O	O	O	O	Yes	Ind Motor only	127
1347	Induction Motor Stator Resistance		-	R	R	R	R	Yes	Ind Motor only	127
829	Inertia Observer Configuration				O	O	O	Yes	MSG Access Only	194
831	Inertia Observer Filter Bandwidth				O	O	O	Yes	MSG Access Only	194
20	Inhibit Axis		R	R	R	R	R			66
60	Interpolated Actual Position		R	-	R	R	R		E	75
101	Interpolated Command Position		-	-	R	R	-		E	76
108	Interpolated Position Configuration		R		R	R	R		E	77
59	Interpolation Time		R	-	R	R	R		E	75

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D[1]	Conditional Implementation	Page
		B	E	F	P	V	T	C/D[2]		
636	Inverter Capacity		-	R	R	R	R	Yes		231
640	Inverter Heatsink Temperature			O	O	O	O	Yes	MSG Access Only	232
647	Inverter Overload Action		-	O	O	O	O	Yes	O-Enum	234
645	Inverter Overload Limit			O	O	O	O	Yes	MSG Access Only	233
682	Inverter Overtemperature Factory Limit			O	O	O	O	Yes	MSG Access Only	258
698	Inverter Overtemperature User Limit			O	O	O	O	Yes	MSG Access Only	260
721	Inverter Rated Output Current		-	R	R	R	R	Yes	MSG Access Only	270
722	Inverter Rated Output Power		-	R	R	R	R	Yes	MSG Access Only	270
720	Inverter Rated Output Voltage		-	R	R	R	R	Yes	MSG Access Only	270
N/A	Inverter Support		R	R	R	R	R		AOP	332
641	Inverter Temperature			O	O	O	O	Yes	MSG Access Only	232
683	Inverter Thermal Overload Factory Limit			O	O	O	O	Yes	MSG Access Only	258
699	Inverter Thermal Overload User Limit		-	O	O	O	O	Yes		260
1338	Linear Motor Damping Coefficient		-	O	O	O	O	Yes	Linear Motor only	122
2313	Linear Motor Integral Limit Switch		-	O	O	O	O	Yes	Linear Motor only	122
1336	Linear Motor Mass		-	O	O	O	O	Yes	Linear Motor only	122
1337	Linear Motor Max Speed		-	O	O	O	O	Yes	Linear Motor only	122
679	Linear Motor Overspeed Factory Limit		-	O	O	O	O	Yes	MSG Access Only	257
1334	Linear Motor Pole Pitch		-	R	R	R	R	Yes	Linear Motor only	122
1335	Linear Motor Rated Speed		-	R	R	R	R	Yes	Linear Motor only	122
203	Load Coupling				R	R	R			297
352	Load Inertia Ratio				R	R	R			288
801	Load Observer Acceleration Estimate		-	-	O	O	O	Yes		184
806	Load Observer Bandwidth		-	-	O	O	O	Yes		185
805	Load Observer Configuration		-	-	O	O	O	Yes	O-Enum	185
809	Load Observer Feedback Gain		-	-	O	O	O	Yes		185
807	Load Observer Integrator Bandwidth		-	-	O	O	O	Yes		185
802	Load Observer Torque Estimate		-	-	O	O	O	Yes		184
205	Load Ratio		-	-	R	R	R			291
1370	Load Type		C	C	C	C	C	Yes	R-Co CScale; O-Dr DScale	129
202	Loop Response				R	R	R			296
4	Map Instance		R	R	R	R	R			64
21	Master Input Configuration Bits		-	-	R	R	-		E	89
102	Master Offset		-	R	R	R	-			77
22	Master Position Filter Bandwidth		-	-	R	R	-		E	89
115	Maximum Acceleration		-	R	R	R	-			110
118	Maximum Acceleration Jerk		-	R	R	R	-			111
116	Maximum Deceleration		-	R	R	R	-			110

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D[1]	Conditional Implementation	Page
		B	E	F	P	V	T	C/D[2]		
119	Maximum Deceleration Jerk		-	R	R	R	-			110
573	Maximum Frequency		-	R	-	-	-	Yes		214
114	Maximum Speed		-	R	R	R	-			110
572	Maximum Voltage		-	R	-	-	-	Yes		214
614	Mechanical Brake Control		-	0	0	0	0	Yes		218
616	Mechanical Brake Engage Delay		-	0	0	0	0	Yes		219
615	Mechanical Brake Release Delay		-	0	0	0	0	Yes		219
9	Memory Use		R	R	R	R	R			65
159	Module Alarm Bits		R	R	R	R	R			243
23	Module Alarm Bits		R	R	R	R	R			243
5	Module Channel		R	R	R	R	R			65
6	Module Class Code		R	R	R	R	R			65
163	Module Fault Bits		R	R	R	R	R			241
32	Motion Control Status Attribute Bits		R	R	R	R	R			79
29	Motion Exception Action		R	R	R	R	R			89
24	Motion Fault Bits		R	R	R	R	R			87
79	Motion Polarity		R	R	R	R	R	Yes	Co CScale; Dr DScale	99
78	Motion Resolution		R	R	R	R	R	Yes	Co CScale; Dr DScale	95
45	Motion Scaling Configuration		R	R	R	R	R	Yes	Co !Drive Scaling; Dr Drive Scaling; O-Enum	93
32	Motion Status Bit		R	R	R	R	R			79
77	Motion Unit		R	R	R	R	R	Yes	Co CScale; Dr DScale	95
635	Inverter Overload Protection Method		-	R	R	R	R	Yes		230
1310	Motor Catalog Number		-	R	R	R	R	Yes	R-Co !NV; O-Dr NV	113
1313	Motor Data Source		-	R	R	R	R	Yes	O-Enum	114
1312	Motor Date Code			0	0	0	0	Yes	MSG Access Only	114
1314	Motor Device Code		-	R	R	R	R	Yes		114
523	Motor Electrical Angle		-	-	R	R	R	Yes	PM Motor only	204
1323	Motor Integral Thermal Switch		-	0	0	0	0	Yes		116
1324	Motor Max Winding Temperature		-	0	0	0	0	Yes		117
646	Motor Overload Action		-	0	0	0	0	Yes	O-Enum	233
695	Motor Overspeed User Limit		-	0	0	0	0	Yes		259
680	Motor Overtemperature Factory Limit			0	0	0	0	Yes	MSG Access Only	258
696	Motor Overtemperature User Limit			0	0	0	0	Yes	MSG Access Only	259
694	Motor Phase Loss Limit			0	0	0	0	Yes		259
1317	Motor Polarity		-	0	0	0	0	Yes		115
1319	Motor Rated Continuous Current		-	R	R	R	R	Yes		116
1321	Motor Rated Output Power		-	C	C	C	C	Yes	O-PM; R-IM	116

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D[1]	Conditional Implementation	Page
		B	E	F	P	V	T	C/D[2]		
1320	Motor Rated Peak Current		-	C	C	C	C	Yes	R-PM; O-IM	116
1318	Motor Rated Voltage		-	R	R	R	R	Yes		115
1311	Motor Serial Number		-	O	O	O	O	Yes	MSG Access Only	113
642	Motor Temperature			O	O	O	O	Yes	MSG Access Only	232
1001	Motor Test Comm Offset Comp	-	-	R	R	R	R		IPM Motor only	285
174	Motor Test Counter EMF		-	R	R	R	R		PM Motor only	284
172	Motor Test Flux Current		-	R	R	R	R		Ind Motor only	284
171	Motor Test Inductance		-	R	R	R	R			284
999	Motor Test Ld Flux Saturation	-	-	R	R	R	R		IPM Motor only	285
997	Motor Test Ld Inductance	-	-	R	R	R	R		IPM Motor only	284
998	Motor Test Lq Flux Saturation	-	-	R	R	R	R		IPM Motor only	284
996	Motor Test Lq Inductance	-	-	R	R	R	R		IPM Motor only	284
1000	Motor Test Max Speed	-	-	R	R	R	R		IPM Motor only	285
170	Motor Test Resistance		-	R	R	R	R			283
173	Motor Test Slip Speed		-	R	R	R	R		Ind Motor only	284
175	Motor Test Status		-	R	R	R	R			283
681	Motor Thermal Overload Factory Limit			O	O	O	O	Yes	MSG Access Only	258
697	Motor Thermal Overload User Limit		-	O	O	O	O	Yes		259
1315	Motor Type		-	R	R	R	R	Yes	O-Enum	115
1316	Motor Unit		-	R	R	R	R	Yes		115
1325	Motor Winding to Ambient Capacitance		-	O	O	O	O	Yes		117
1326	Motor Winding to Ambient Resistance		-	O	O	O	O	Yes		117
N/A	Number of Configured Axes		R	R	R	R	R			332
N/A	Number of Configurable Inputs		O	O	O	O	O		FW – only if Digital Input Configuration is supported	332
521	Operative Current Limit		-	O	O	O	O	Yes	F Support in V29	203
14	Output Cam Execution Targets		R	-	R	R	R		E	88
38	Output Cam Lock Status		R	-	R	R	R		E	86
37	Output Cam Pending Status		R	-	R	R	R		E	85
36	Output Cam Status		R	-	R	R	R		E	85
39	Output Cam Transition Status		R	-	R	R	R		E	86
601	Output Current		-	R	R	R	R	Yes		215
600	Output Frequency		-	R	O	O	O	Yes		215
603	Output Power		-	R	R	R	R	Yes		216
602	Output Voltage		-	R	R	R	R	Yes		215
508	Overtorque Limit		-	O	O	O	O	Yes		195
509	Overtorque Limit Time		-	O	O	O	O	Yes		196
1355	PM Motor Extended Speed Permissive	-	-	-	O	O	O		PM Motor only	119

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D(1)	Conditional Implementation	Page
		B	E	F	P	V	T	C/D(2)		
2310	PM Motor Flux Saturation		-	O	O	O	O	Yes	SPM only	118
2315	PM Motor Ld Flux Saturation			O	O	O	O	Yes	IPM only	119
1354	PM Motor Ld Inductance			R	R	R	R	Yes	IPM only	118
1358	PM Motor Linear Bus Overvoltage Speed	-	-	-	O	O	O		Linear PM Motor only	125
1359	PM Motor Linear Max Extended Speed	-	-	-	O	O	O		Linear PM Motor only	126
2314	PM Motor Lq Flux Saturation			O	O	O	O	Yes	IPM only	119
1353	PM Motor Lq Inductance			R	R	R	R	Yes	IPM only	118
1343	PM Motor Force Constant		-	O	O	O	O	Yes	Linear PM Motor only	125
1328	PM Motor Inductance		-	R	R	R	R	Yes	SPM Motor only	118
1344	PM Motor Linear Voltage Constant		-	R	R	R	R	Yes	Linear PM Motor only	125
1342	PM Motor Rated Force		-	O	O	O	O	Yes	Linear PM Motor only	125
1339	PM Motor Rated Torque		-	O	O	O	O	Yes	Rotary PM Motor only	123
1327	PM Motor Resistance		-	R	R	R	R	Yes	PM Motor only	118
1356	PM Motor Rotary Bus Overvoltage Speed	-	-	-	O	O	O		Rotary PM Motor only	123
1357	PM Motor Rotary Max Extended Speed	-	-	-	O	O	O		Rotary PM Motor only	124
1341	PM Motor Rotary Voltage Constant		-	R	R	R	R	Yes	Rotary PM Motor only	123
1340	PM Motor Torque Constant		-	O	O	O	O	Yes	Rotary PM Motor only	123
430	Position Command				R			Yes	MSG Access Only	164
436	Position Error		-	-	R	-	-	Yes		165
444	Position Error Tolerance		-	-	R	-	-	Yes		171
445	Position Error Tolerance Time		-	-	O	-	-	Yes		171
1402 + (n-1)*50	Position Feedback (General Feedback Signal Attributes)		R		R	R	R	Yes	E	134
434	Position Feedback (Position Loop Attributes)		R	-	R	R	R	Yes	E, MSG Access Only	164
365	Position Fine Command		-	-	O	-	-	Yes		154
780	Position Integral Feedback				O			Yes	MSG Access Only	165
442	Position Integrator Bandwidth		-	-	R	-	-	Yes		171
446	Position Integrator Control		-	-	R	-	-	Yes	O-Bits	172
437	Position Integrator Output		-	-	R	-	-	Yes		165
447	Position Integrator Preload		-	-	O	-	-	Yes		172
781	Position Lead Lag Filter Bandwidth		-	-	O	-	-	Yes		172
782	Position Lead Lag Filter Gain		-	-	O	-	-	Yes		172
449	Position Limit - Negative		O		O	O	O	Yes	DScale, E, MSG Access Only	100
448	Position Limit - Positive		O		O	O	O	Yes	DScale, E, MSG Access Only	100
443	Position Lock Tolerance		-	-	R	-	-	Yes		171
441	Position Loop Bandwidth		-	-	R	-	-	Yes		171
N/A	Position Loop Device Update Period			R	R	R	R			331
438	Position Loop Output		-	-	R	-	-	Yes		165

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D[1]	Conditional Implementation	Page
		B	E	F	P	V	T	C/D[2]		
783	Position Notch Filter Frequency		-	-	O	-	-	Yes		172
432	Position Reference		-	-	R	-	-	Yes		164
73	Position Scaling Denominator		R	R	R	R	R			94
72	Position Scaling Numerator		R	R	R	R	R			94
197	Position Servo Bandwidth				R					293
431	Position Trim		-	-	R	-	-	Yes		164
80	Position Units		R	R	R	R	R			101
84	Position Unwind		R	-	R	R	R	Yes	Co CScale; Dr DScale, E	101
75	Position Unwind Denominator		R	-	R	R	R		E	94
74	Position Unwind Numerator		R	-	R	R	R		E	94
627	Power Loss Action		-	O	O	O	O	Yes	O-Enum	229
628	Power Loss Threshold	O	-	O	O	O	O	Yes		229
630	Power Loss Time	O	-	O	O	O	O	Yes		230
117	Programmed Stop Mode		R	R	R	R	R			111
590	Proving Configuration			O	O	O	O	Yes		224
376	Ramp Acceleration		-	O	-	O	-	Yes		156
377	Ramp Deceleration		-	O	-	O	-	Yes		156
378	Ramp Jerk Control		-	O	-	O	-	Yes		156
375	Ramp Velocity - Negative		-	O	-	O	-	Yes		100
374	Ramp Velocity - Positive		-	O	-	O	-	Yes		100
625	Regenerative Power Limit			O	O	O	O			325
63	Registration 1 Negative Edge Position		R	-	R	R	R	Yes	E	149
67	Registration 1 Negative Edge Time		R	-	R	R	R	Yes	E	150
55	Registration 1 Position		R	-	R	R	R		E	74
62	Registration 1 Positive Edge Position		R	-	R	R	R	Yes	E	149
66	Registration 1 Positive Edge Time		R	-	R	R	R	Yes	E	150
57	Registration 1 Time		R	-	R	R	R		E	75
65	Registration 2 Negative Edge Position		R	-	R	R	R	Yes	E	149
69	Registration 2 Negative Edge Time		R	-	R	R	R	Yes	E	150
56	Registration 2 Position		R	-	R	R	R		E	74
64	Registration 2 Positive Edge Position		R	-	R	R	R	Yes	E	149
68	Registration 2 Positive Edge Time		R	-	R	R	R	Yes	E	150
58	Registration 2 Time		R	-	R	R	R		E	75
356	Registration Inputs		R	-	R	R	R		E, AOP	149
613	Resistive Brake Contact Delay		-	O	O	O	O	Yes	PM Motor only	218
1333	Rotary Motor Damping Coefficient		-	O	O	O	O	Yes	Rotary Motor only	120
2312	Rotary Motor Fan Cooling Derating		-	O	O	O	O	Yes	Rotary Motor only	121
2311	Rotary Motor Fan Cooling Speed		-	O	O	O	O	Yes	Rotary Motor only	120

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D(1)	Conditional Implementation	Page
		B	E	F	P	V	T	C/D(2)		
1330	Rotary Motor Inertia		-	O	O	O	O	Yes	Rotary Motor only	120
1332	Rotary Motor Max Speed		-	O	O	O	O	Yes	Rotary Motor only	120
678	Rotary Motor Overspeed Factory Limit		-	O	O	O	O	Yes	MSG Access Only	257
1329	Rotary Motor Poles		-	R	R	R	R	Yes	Rotary Motor only	120
1331	Rotary Motor Rated Speed		-	R	R	R	R	Yes	Rotary Motor only	120
578	Run Boost		-	R	-	-	-	Yes		215
765	Safe Torque Off Action			O	O	O	O	Yes	O-Enum	283
70	Scaling Source		R	R	R	R	R			93
881	Shunt Regulator Resistor Type	O		O	O	O	O			325
629	Shutdown Action	O	-	O	O	O	O	Yes	O-Enum	230
370	Skip Speed 1		-	O	-	-	-	Yes		155
371	Skip Speed 2		-	O	-	-	-	Yes		155
372	Skip Speed 3		-	O	-	-	-	Yes		155
373	Skip Speed Band		-	O	-	-	-	Yes		155
833	SLAT Configuration		-	-	-	O	-	Yes		178
834	SLAT Set Point		-	-	-	O	-	Yes		178
835	SLAT Time Delay		-	-	-	O	-	Yes		178
565	Slip Compensation		-	R	-	-	-	Yes		214
94	Soft Travel Limit - Negative		R	-	R	R	R		E	92
93	Soft Travel Limit - Positive		R	-	R	R	R		E	92
92	Soft Travel Limit Checking		R	-	R	R	R		E	91
50	Start Actual Position		R	R	R	R	R			73
577	Start Boost		-	R	-	-	-	Yes		215
98	Start Command Position		-	R	R	R	-			76
104	Start Master Offset		-	R	R	R	-			77
610	Stopping Action		-	R	R	R	R	Yes	O-Enum	216
612	Stopping Time Limit		-	O	O	O	O	Yes		218
611	Stopping Torque		-	-	R	R	R	Yes		217
49	Strobe Actual Position		R	R	R	R	R			72
97	Strobe Command Position		-	R	R	R	-			72
103	Strobe Master Offset		-	R	R	R	-			77
29	Sync Threshold		O	O	O	O	O			323
169	System Bandwidth		-	-	R	R	R		Derived – Servo BW	293
204	System Damping		-	-	R	R	R		Derived – Damp Factor	292
496	System Inertia		-	-	R	R	O	Yes		190
N/A	Time Sync Support		R	R	R	R	R		Logix Designer	331
N/A	Time Diagnostics		R	R	R	R	R		Logix Designer	331
490	Torque Command		-	-	R	R	R	Yes	MSG Access Only	189

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D(1)	Conditional Implementation	Page
		B	E	F	P	V	T	C/D(2)		
531	Torque Decoupling		-	-	O	O	O	Yes	MSG Access Only	205
555	Torque Integral Time Constant		-	-	O	O	O	Yes		207
827	Torque Lead Lag Filter Bandwidth		-	-	O	O	O	Yes		191
828	Torque Lead Lag Filter Gain		-	-	O	O	O	Yes		191
505	Torque Limit - Negative		-	-	R	R	R	Yes		192
504	Torque Limit - Positive		-	-	R	R	R	Yes		195
554	Torque Loop Bandwidth		-	-	O	O	O	Yes		207
N/A	Torque Loop Device Update Period		-	R	R	R	R			331
502	Torque Low Pass Filter Bandwidth		-	-	O	O	O	Yes		191
503	Torque Notch Filter Frequency		-	-	O	O	O	Yes		191
836	Adaptive Tuning Configuration		-	-	O	O	O	Yes		194
844	Adaptive Tuning Gain Scaling Factor		-	-	O	O	O	Yes		193
837	Torque Notch Filter High Frequency Limit		-	-	O	O	O	Yes		192
838	Torque Notch Filter Low Frequency Limit		-	-	O	O	O	Yes		192
839	Torque Notch Filter Tuning Threshold		-	-	O	O	O	Yes		192
841	Torque Notch Filter Frequency Estimate		-	-	O	O	O	Yes		192
842	Torque Notch Filter Magnitude Estimate		-	-	O	O	O	Yes		193
843	Torque Low Pass Filter Bandwidth Estimate		-	-	O	O	O	Yes		193
232	Torque Offset		-	-	R	R	R			190
591	Torque Prove Current			O	O	O	O	Yes		226
506	Torque Rate Limit		-	-	O	O	O	Yes		195
492	Torque Reference		-	-	R	R	R	Yes		189
493	Torque Reference Filtered		-	-	R	R	R	Yes		189
494	Torque Reference Limited		-	-	R	R	R	Yes		189
507	Torque Threshold		-	-	O	O	O	Yes		195
491	Torque Trim		-	-	R	R	R	Yes		189
533	Torque Voltage Output				O	O	O	Yes	MSG Access Only	205
206	Total Inertia		-	-	R	R	R		Rotary Motor only	291
821	Total Inertia Estimate		-	-	O	O	O	Yes	MSG Access Only	99
207	Total Mass		-	-	R	R	R		Linear Motor only	291
1371	Transmission Ratio Input		C	C	C	C	C	Yes	R-Co CScale; O-Dr DScale	129
1372	Transmission Ratio Output		C	C	C	C	C	Yes	R-Co CScale; O-Dr DScale	129
71	Travel Mode		R	R	R	R	R	Yes	Co CScale; Dr DScale	93
76	Travel Range		R	-	R	R	R		E	94
181	Tune Acceleration		-	-	R	R	R			287
179	Tune Acceleration Time		-	-	R	R	R			287
182	Tune Deceleration		-	-	R	R	R			287
180	Tune Deceleration Time		-	-	R	R	R			287

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D(1)	Conditional Implementation	Page
		B	E	F	P	V	T	C/D(2)		
187	Tune Friction		-	-	R	R	R			288
186	Tune Inertia Mass		-	-	R	R	R			288
188	Tune Load Offset		-	-	R	R	R			288
178	Tune Status		-	-	R	R	R			287
191	Tuning Direction		-	-	R	R	R			290
190	Tuning Select		-	-	R	R	R			290
194	Tuning Speed		-	-	R	R	R			290
195	Tuning Torque		-	-	R	R	R			290
193	Tuning Travel Limit		-	-	R	R	R			290
538	U Current Feedback		-	-	O	O	O	Yes	MSG Access Only	206
541	U Current Offset		-	-	O	O	O	Yes	MSG Access Only	206
535	U Voltage Output		-	-	O	O	O	Yes	MSG Access Only	205
510	Undertorque Limit		-	O	O	O	O	Yes		196
511	Undertorque Limit Time		-	O	O	O	O	Yes		196
539	V Current Feedback				O	O	O	Yes	MSG Access Only	206
542	V Current Offset				O	O	O	Yes	MSG Access Only	206
536	V Voltage Output				O	O	O	Yes	MSG Access Only	206
450	Velocity Command			R	R	R		Yes	MSG Access Only	173
464	Velocity Droop		-	O	O	O	-	Yes		175
455	Velocity Error		-	-	R	R	-	Yes		173
465	Velocity Error Tolerance		-	-	O	O	-	Yes		175
466	Velocity Error Tolerance Time		-	-	O	O	-	Yes		175
454	Velocity Feedback (Velocity Loop Attributes)		R	R	R	R	T	Yes		173
1403+(n-1)*50	Velocity Feedback 1 (General Feedback Signal Attributes)		R		R	R	R		E, MSG Access Only	134
1453	Velocity Feedback 2		R		R	R	R		E, MSG Access Only	134
433	Velocity Feedforward Command		-	-	R	-	-	Yes		164
440	Velocity Feedforward Gain		-	-	R	-	-	Yes		171
366	Velocity Fine Command		-	-	O	O	-	Yes		154
462	Velocity Integrator Bandwidth		-	-	R	R	-	Yes		175
467	Velocity Integrator Control		-	-	R	R	-	Yes	O-Bits	176
456	Velocity Integrator Output		-	-	R	R	-	Yes		174
468	Velocity Integrator Preload		-	-	O	O	-	Yes		176
476	Velocity Limit - Motor Max	-	-	-	N	N	-		V29	177
474	Velocity Limit - Negative		-	O	O	O	-	Yes		177
475	Velocity Limit Bus Overvoltage	-	-	-	N	N	-		V29	177
477	Velocity Limit Bus Overvoltage Permissive	-	-	-	N	N	-		V29	177
473	Velocity Limit - Positive		-	O	O	O	-	Yes		177

Table 7 - Identification of Motion Axis Attributes Based on Device Function Codes (Continued)

ID	Attribute	N - No Control		O	C - Closed Loop Control			C/D(1)	Conditional Implementation	Page
		B	E	F	P	V	T	C/D(2)		
458	Velocity Limit Source	-	-	-	O	O	-		V29	174
471	Velocity Lock Tolerance		-	O	O	O	-	Yes		176
461	Velocity Loop Bandwidth		-	-	R	R	-	Yes		175
	Velocity Loop Device Update Period			R	R	R	R			331
457	Velocity Loop Output		-	-	R	R	-	Yes		174
469	Velocity Low Pass Filter Bandwidth		-	-	O	O	-	Yes		176
790	Velocity Negative Feedforward Gain		-	-	O	O	-	Yes		175
231	Velocity Offset		-	-	R	R	-			174
453	Velocity Reference		-	R	R	R	-	Yes		173
198	Velocity Servo Bandwidth				R					294
472	Velocity Standstill Window		R	R	R	R	R	Yes		176
470	Velocity Threshold		O	O	O	O	O	Yes		176
451	Velocity Trim		-	R	R	R	-	Yes		173
540	W Current Feedback				O	O	O	Yes	MSG Access Only	206
543	W Current Offset				O	O	O	Yes	MSG Access Only	206
537	W Voltage Output				O	O	O	Yes	MSG Access Only	206
54	Watch Position		R	-	R	R	R		E	74
608	Zero Speed			O	O	O	O	Yes		223
609	Zero Speed Time			O	O	O	O	Yes		223

(1) The C/D value identifies the attributes that have a matching, or replicated attributes in the associated device/drive.
(2) The C/D value identifies the attributes that have a matching, or replicated attributes in the associated device/drive.

Motion Instruction Compatibility

Table 8 lists the motion instructions and what Control Modes are available. The compatibility with integrated motion is based on the Axis Configuration and feedback type settings.

Table 8 - Motion Instructions and Control Mode Compatibility for AXIS_CIP_DRIVE

Motion Instruction Name	Abbr.	Feedback Only	Frequency Control	Position Loop	Velocity Loop		Torque Loop
			No Fdbk		Fdbk	No Fdbk	
State Control Instructions							
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 Instructions							
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 Instructions							
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 Instructions							
Motion Coordinated Linear Move	MCLM		c	x	c	c	
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

Table 8 - Motion Instructions and Control Mode Compatibility for AXIS_CIP_DRIVE (Continued)

Motion Instruction Name	Abbr.	Feedback Only	Frequency Control	Position Loop	Velocity Loop		Torque Loop
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 Instructions							
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 Instructions							
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

MSO and MDS execution initiate mutually exclusive modes of operation and execution is conditional on mode. For details on the MSO and MDS instructions, see The Motion Instruction Reference Manual, publication MOTION-RM002.

***** 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 areas denote that Multi-Axis Coordination Motion is designed and tested for position mode operation but not specifically restricted to that axis configuration.

CIP Axis Attributes

Use this chapter to get configuration, status, and fault information about an axis. The controller stores axis information as axis attributes.

For a listing of the attributes that are replicated in the drive, see Identify Motion Axis Attributes Based on Device Function Codes on page 27.

Item	Page
Accessing Attributes	50
Interpreting the Attribute Tables	61
Motion Resolution Value Examples	97
CIP Data Types	317
CIP Error Codes	318

Feedback Attributes	Page
Feedback Attributes	130
General Feedback Info Attributes	134
General Feedback Signal Attributes	134
Feedback Configuration Attributes	136
Feedback Interface Behavior	145

Motion Control Attribute	Page
Motion Control Axis Attributes	60
Motion Control Interface Attributes	64
Motion Control Configuration Attributes	67
Motion Control Signal Attributes	71
No Control (feedback only) Mode	78
Motion Control Status Attributes	79
Motion Planner Configuration Attributes	88
Motion Scaling Attributes	93
Motion Homing Configuration Attributes	102
Motion Dynamic Configuration Attributes	110
Event Capture Attributes	148
Event Capture Behavior	151
Position Control Behavior	165
Current Control Behavior	211
CIP Axis Status Attributes	234
Converter Control Attributes	273
Motion Control Axis Behavior Model	298
State Behavior	306

Loop Control Attributes	Page
Command Reference Generation Attributes	154
Command Generator Signal Attributes	154
Command Generator Configuration Attributes	155
Command Generation Behavior	157
Position Loop Attributes	164
Position Control Behavior	165
Position Loop Configuration Attributes	171
Velocity Loop Attributes	173
Velocity Loop Configuration Attributes	174
Velocity Control Behavior	180
Torque/Force Control Configuration Attributes	190
Torque Control Behavior	196
Current Control Configuration Attributes	207
Frequency Control Signal Attribute	214
Frequency Control Configuration Attributes	214
Stopping and Braking Attributes	216

Guard Safety Attributes	Page
Guard Status	276
Guard Faults	278

Axis Safety Attributes	Page
Axis Safety State	280
Axis Safety Status	281
Axis Safety Faults	282

Motor Attributes	Page
Motor Attributes	112
General Permanent Magnet Motor Attributes	118
General Rotary Motor Attributes	120
General Linear Motor Attributes	122
Rotary PM Motor Attributes	123
Linear PM Motor Attributes	125
Induction Motor Attributes	127
Load Transmission and Actuator Attributes	129

Drive Attributes	Page
Drive Output Attributes	215
DC Bus Control Attributes	228
Power and Thermal Management Status Attributes	230
Power and Thermal Management Configuration Attributes	233
Drive General Purpose I/O Attributes	271
Guard Status Attributes	275

Faults and Alarms Attributes	Page
Module/Node Fault and Alarm Attributes	241
Motor Test Result Attributes	283
Configuration Fault Attributes	246
Exception, Fault, and Alarm Attributes	246
Standard Exceptions	248
Exception Factory Limit Info Attributes	256
Exception User Limit Configuration Attributes	259
Axis Exception Action Configuration Attributes	260
Initialization Faults Attributes	264
Start Inhibit Attributes	266
APR Fault Attributes	268
Fault and Alarm Behavior	315
Exceptions	316

Drive Commissioning and Tuning Attributes	Page
Motor Test Result Attributes	283
Hookup Test Result Attributes	285
Inertia Test Result Attributes	287
Hookup Test Configuration Attributes	289
Inertia Test Configuration Attributes	290
Autotune Configuration Attributes	292

Accessing Attributes

You can access attributes in the Logix Designer application in several ways:

- Get System Value (GSV)
- Set System Value (SSV)
- Message (MSG)
- Axis Tags
- GUI Configuration by using Axis Properties in the Logix Designer application

Access Rule	Description
Set	Set Attribute List service
Get	Get Attribute List service
SSV	Set System Variable instruction
GSV	Get 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.
Get/SSV	Indicates the attribute can only be set programmatically and shall not be set by configuration software.
Set/GSV	Indicates the attribute can only be set by configuration software on initial configuration download and cannot be set programmatically.
T	Templated (Tag) Data

Attribute Access Rules

ATTENTION: 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.

The Access column shows how to access the attribute in the programming software.

Motor Rated Voltage

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	GSV	REAL	0 DB	0	-	Volts (RMS)

Attribute value is updated from drive indirectly via CIP Motion Event Channel. Use a Get System Value (GSV) instruction to get the value.

Command Torque

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

Use the axis tag or a GSV instruction to get the value.

Inhibit Axis

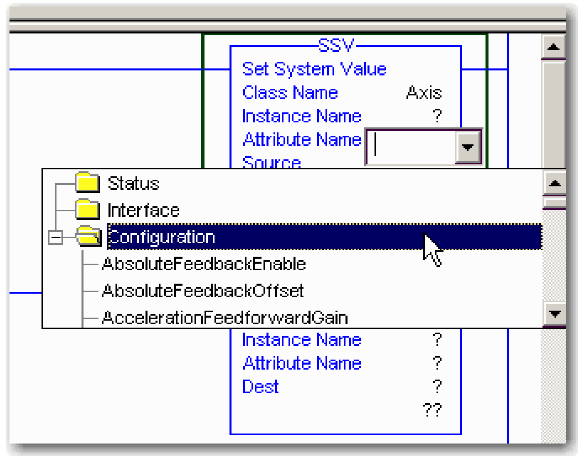
Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required	SSV	SINT	0	-	-	Setting to any non-zero value is treated the same as a value of 1, and results in the attribute being set to a 1. 0 triggers an uninhibit. 1 triggers an inhibit.

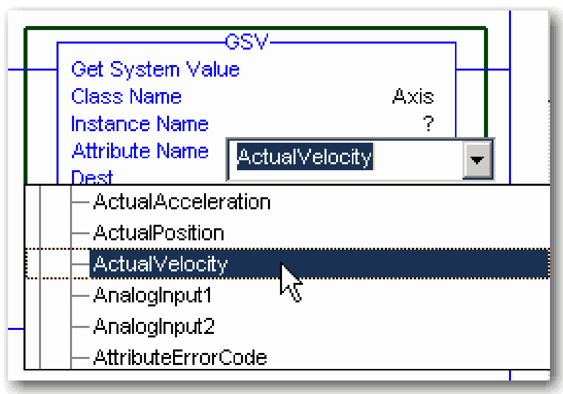
Use a Set System Value (SSV) instruction to set or change the value. Attribute is Get access but can be set via SSV.

If you need to find either Attribute and Class IDs, see Identification of Motion Axis Attributes Based on Device Function Codes on page 27 and the specific drive documentation.

Access Attributes from Ladder Logic

You can find attributes that are accessible through SSV or GSV instructions in Ladder Logic. There are three main categories of attributes: status, interface, and configuration.



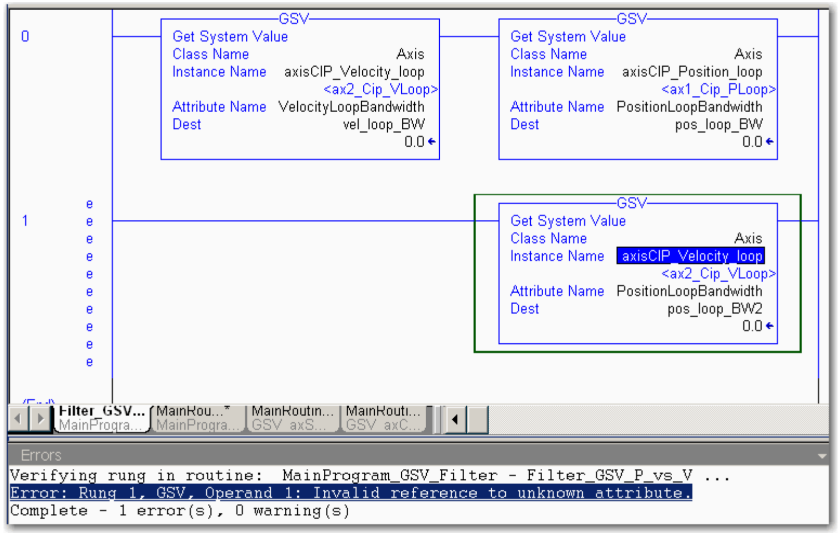


The the GSV and SSV are filtered list for each attribute name, based on the AXIS_CIP_DRIVE configurations P, V, T, N, and F.

Example:

Axis Configuration Type	Attribute Available
Position Loop	PositionLoopBandwidth VelocityLoopBandwidth
Velocity Loop	VelocityLoopBandwidth (only)
Torque Loop	Neither attribute is available.

This ladder illustrates that the GSV/SSV access is filtered based on the axis configuration type, Position Loop, Velocity Loop, Torque Loop, Feedback Only, and Frequency Control.



Access with a MSG (a message) Instruction

See these publications for complete information on programming:

- Logix5000™ Controllers Messages Programming Manual, publication 1756-PM012
- ControlLogix® System User Manual, publication 1756-UM001

See Identification of Motion Axis Attributes Based on Device Function Codes on page 27 for a table listing the attributes and their identification number:

- If you need to find out what optional attributes are supported in the drives, refer to Drive Supported Optional Attributes on page 339.
- If you need to find Attribute and Class IDs related to drives, refer to the specific drive documentation.

Input Filtering

The filtering of the Kinetix® 6500 drive digital inputs can be set manually via a message instruction.

IMPORTANT	Updating these values is not generally necessary. Defaults are set by the drive. For example, in the unusual case where you might what to change the default values for the Input Filter attributes, this can be done using the MSG instruction.

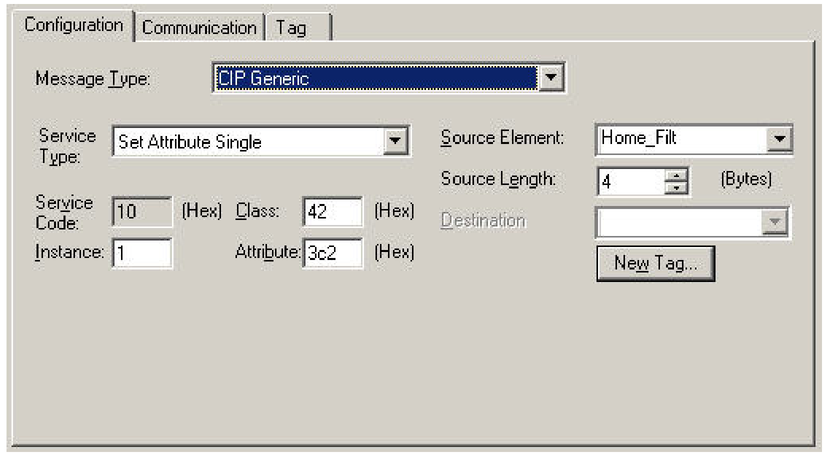
This is accomplished by writing to the following drive attributes:

- 961 (3c1 Hex) - Enable Input Pulse Reject Filter
- 962 (3c2 Hex) - Home Input Pulse Reject Filter
- 963 (3c3 Hex) - Registration 1 Input Pulse Reject Filter
- 964 (3c4 Hex) - Registration 2 Input Pulse Reject Filter
- 965 (3c5 Hex) - Positive Overtravel Input Pulse Reject Filter
- 966 (3c6 Hex) - Negative Overtravel Input Pulse Reject Filter

The values written to the attributes are for the input function, not a specific input. For example, the value written to attribute 962 will set the reject filtering for the Home Input regardless of which input it's assigned to. These filter settings are software filters. The digital input circuitry provides filtering through its RC network.

This example show how to set the Home Input Reject Filter.

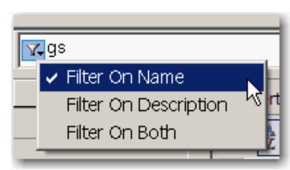
Figure 5 - Message Configuration: Input Filtering



Parameter	Value
Message Type	CIP Generic
Service Type	Set Attribute Single
Class	42 (Hex)
Instance	1
Attribute	3c2 (Hex) --> 962 Dec = 3c2 Hex
Source Element	Home_Filt is a DINT, units are in microseconds.
Source Length	4 bytes
Path	Point to the drive

Tag Filtering

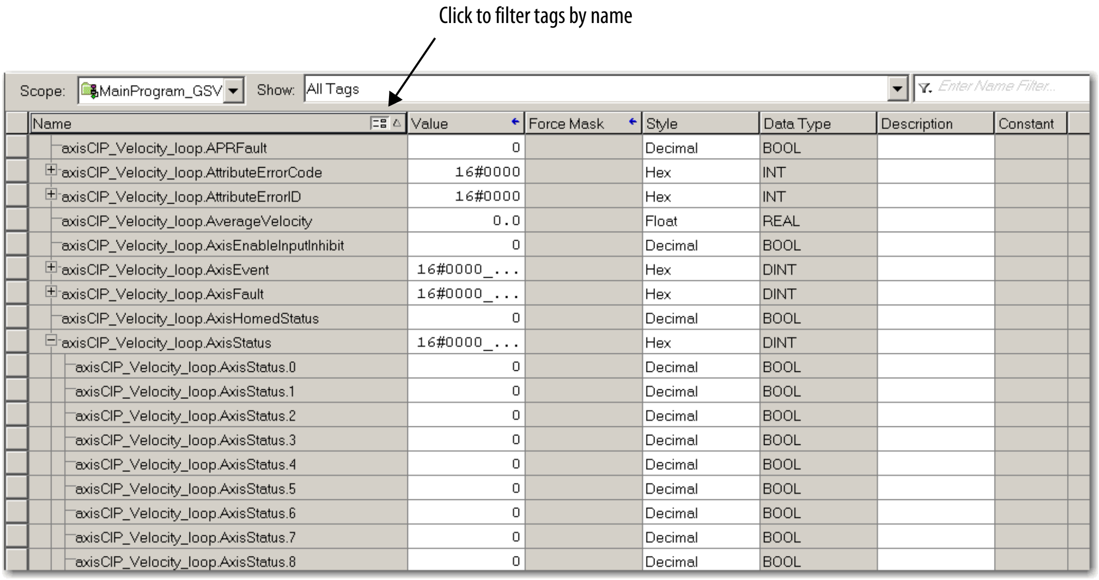
All elements of an axis structure are in a single cross reference that lets you isolate down to the ‘tag.member’ level. You can filter tags based on the tag name, tag description, or both. You can enter the filter value or select a previously entered filter.



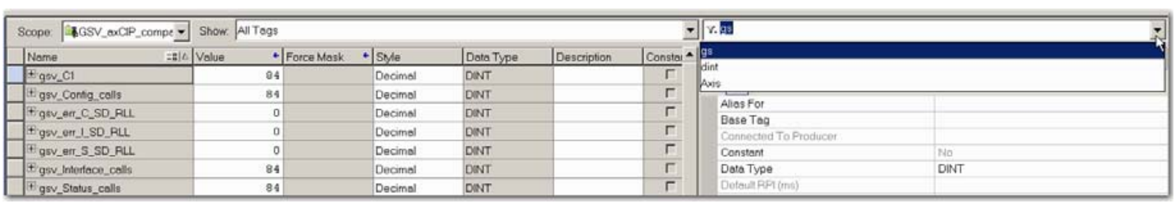
These are the filtering options:

- Filter On Name - Checks whether the filter exists within the tag name. You can enter only valid characters.
- Filter On Description - Checks whether the filter exists within the tag description.
- Filter On Both - Checks whether the filter exists within either the tag name or its description. The filter must appear entirely in either the name or the description.

With the Logix Designer application, you can be selective in the types of tags you want to see at a given time. Filtering is applied to only base tags and not member tags.

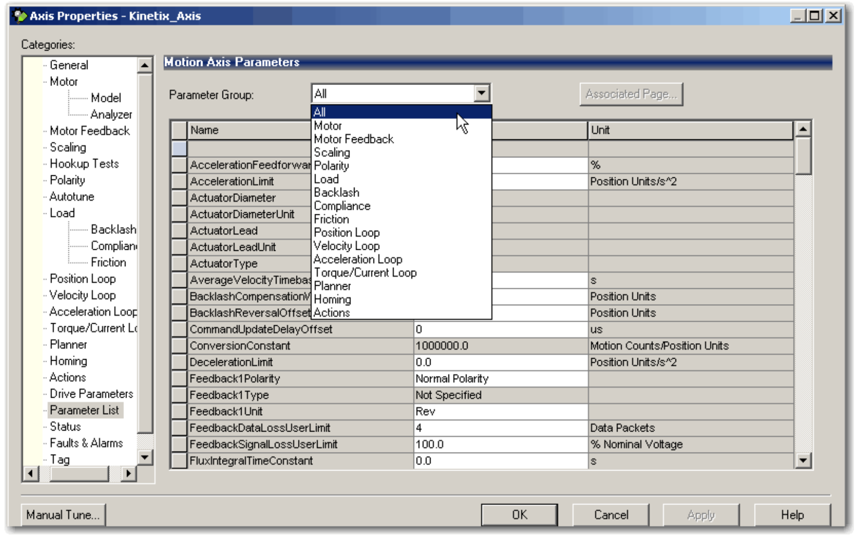


You can filter the type of tag and data type you would like to see listed in the Data Monitor or Tag Editor.

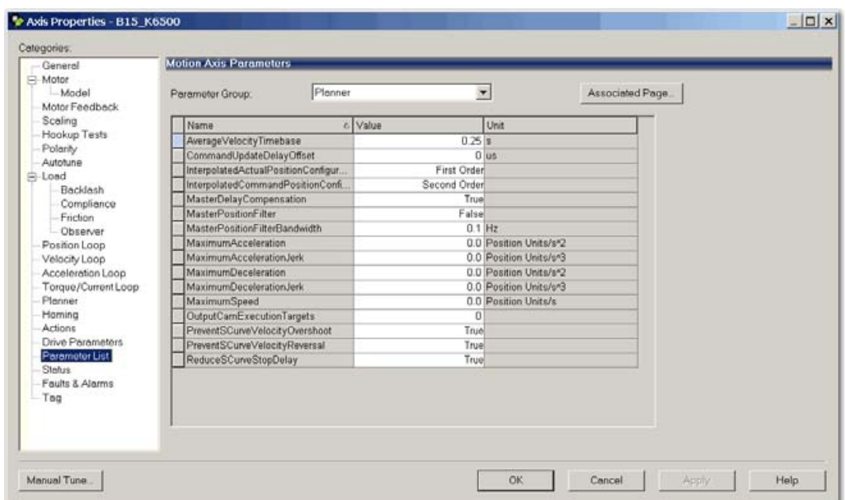


Attribute and Parameter Organization

In the Logix Designer application, the motion axis parameters and attributes are organized by functional group. You will only be presented with the attributes or parameters that are applicable to the category you choose.



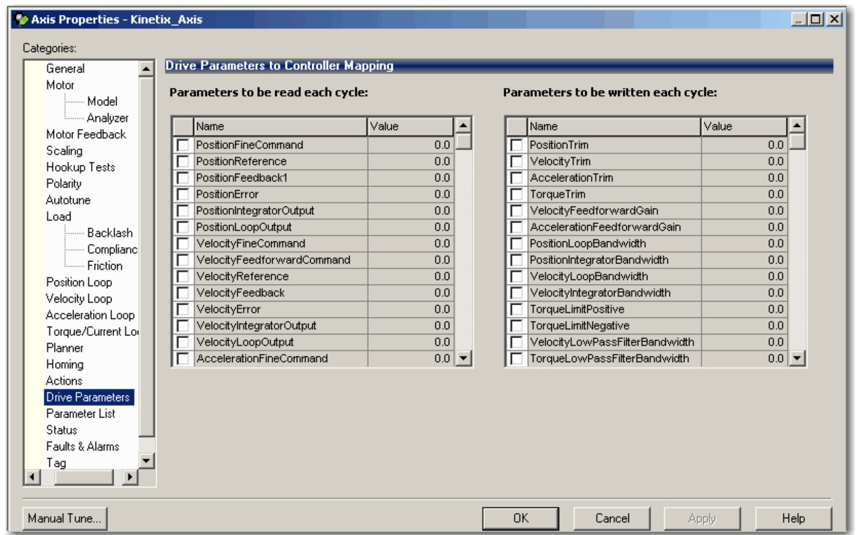
For example, when you choose Planner, only the attributes or parameters that relate to the Planner Group appear.



Accessing Drive Parameters

When getting a drive attribute value, you must configure the system to cyclically update these attributes. Using just a GSV or Axis tag without configuring the system in this way will not get the current attribute value in the drive.

Setting the drive attribute can, however, be done directly with a SSV instruction. Changes to an Axis Tag value will not update the drive parameter without first configuring the system to cyclically update these drive parameters.

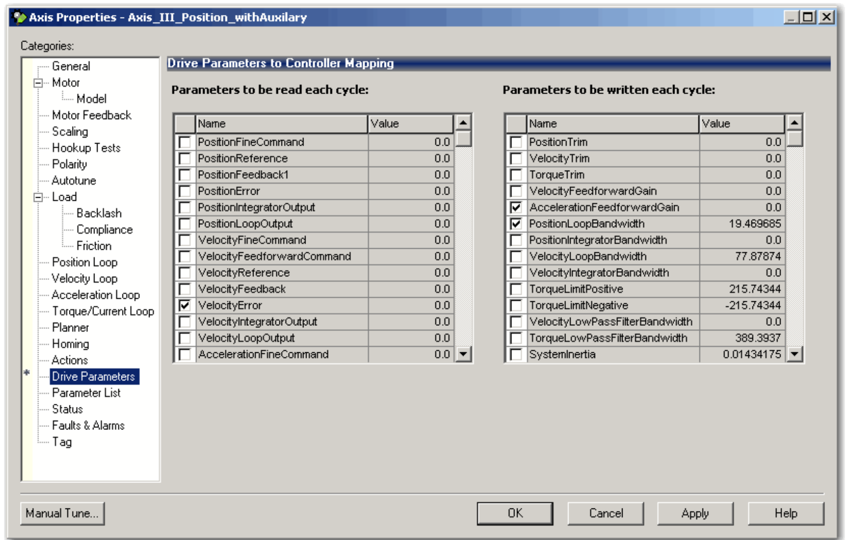


The selection of Drive Parameters is also referred to as Cyclic Read/Write of the integrated motion axis real time attributes.

IMPORTANT Each parameter you select to be transmitted as a Cyclic Read/Write attribute adds overhead to the data exchange between the controller and drive. This impacts network throughput and may require you to increase the Coarse Update Period.

Cyclic Read and Cyclic Write

Cyclic data is real time information, sent and received between the controller and the integrated motion drive at the Coarse Update Period. If you want to make use of cyclic data you must use the Axis tag to access the data, thus provide data at the motion group's Coarse Update Period.



The following is an example of configuration and rung reference by using the following five Cyclic Read/Write Drive Parameters.

There are three Read Parameters:

- Velocity Error
- Motor Electrical Angle
- DC Bus Voltage

There are two Write Parameters:

- Acceleration Feedforward Gain
- Velocity Loop Bandwidth

The attributes that you want to access as Cyclic Read/Write are configured for the CIP Axis on the Drive Parameters page and generally accessed via the Axis Tag.

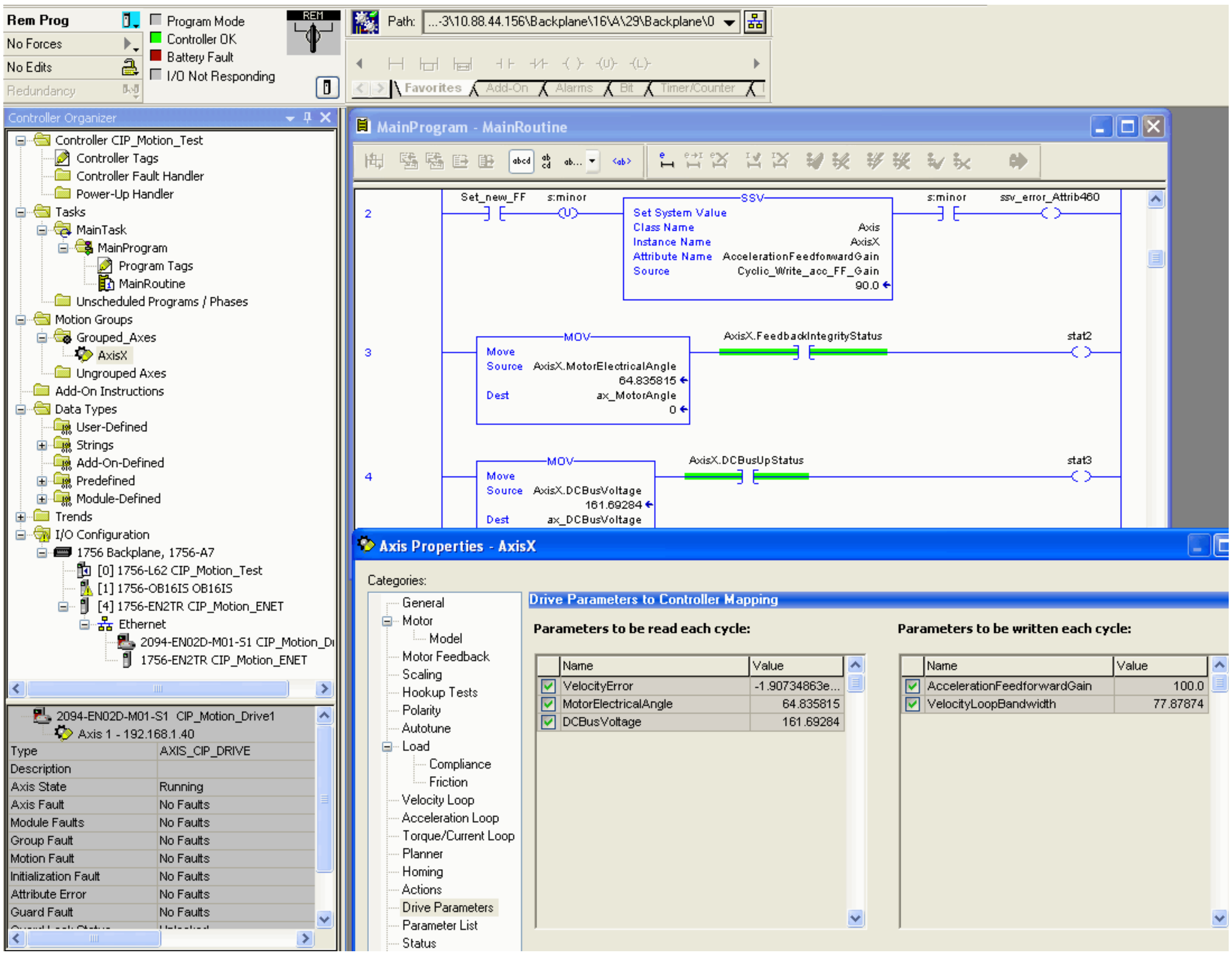
TIP Cyclic write attributes are unique in that they have attribute storage policed by the object handler (either Logix Designer or GSV/SSV) and also have direct tag access which bypass the object validation.

The value written into the tag is validated before being written to the drive and that if that validation fails you will see an 'out of range alarm' and flag it in the axis fault/alarm log but that the value in the tag remains as written by the user. The value of the internal attribute as viewed via GSV or in Logix Designer shows the previously validated value.

See Module Alarm Bit Descriptions on page 244 for more information about module alarm bits.

When you are online, the Cyclic Drive Parameters list is condensed to show only the selected parameters when the Servo Loop=Enabled.

When the Servo Loop=Disabled, all parameters in both the Read and Write list are shown on the page. Additionally, the parameters populated in the list are filtered based on the Axis Configuration.



Motion Control Axis Attributes

The Motion Control Axis Attributes let you configure motion-control system devices, including feedback and drive devices. For drive devices, the Motion Control 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.

Because of the large number of attributes listed in this appendix, they are organized by functional category. Each functional grouping is further organized by first listing the object Status and Signal attributes, followed by the

Configuration attributes. Table 9 lists items to remember when working with the attributes.

Table 9 - Items to Remember

Item	Description
SSV access rule	If an attribute is marked with a 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 RSLogix 5000® software, version 18.00.00, 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 are the same as the attribute name, but with spaces removed. For example, Inhibit Axis would be InhibitAxis.

Interpreting 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.

For a listing of the attributes that are replicated in the drive, see Identify Motion Axis Attributes Based on Device Function Codes on page 27. Table 10 provides an explanation of the information, nomenclature, and abbreviations used in the attribute tables.

Table 10 - Attribute Table Conventions Descriptions

Column Heading	Description
Usage (implementation)	Required — This is a required attribute. The attribute is supported for the listed control modes for each attribute. Optional — This is an optional attribute. The attribute is optionally supported for the listed control modes for each attribute. Optional attributes are based on the specific drive that has been associated. Usage is often based on specific Device Function Codes where the attribute is applicable.
Device Function Codes	B = Bus Power Converters P = Position Loop V = Velocity Control Loop T = Torque Control Loop N = No Control (Feedback Only) F = Frequency Control (V/Hz or VFD), Frequency only supported for PowerFlex® 755 drives C = Closed Loop Control (PI Vector Control) D = All Drives (Closed Loop Vector and Frequency Controlled) E = Encoder present !E = Encoderless/sensorless control, feedback device is **not** present Required - All = All Control Modes Optional - All = All Control Modes For more information about Control Modes and Methods, see Integrated Motion Axis Control Modes on page 15.
Access Rules	GSV — Can be read via the GSV instruction. SSV — Can be written via the SSV instruction. MSG — Message is only used to access drive attributes for which there is not GSV/SSV access. To use a MSG instruction to access information from a drive, you will need the Attribute and Class IDs. See Identification of Motion Axis Attributes Based on Device Function Codes on page 27. If you need drive specific information, see the drive documentation for Attribute and Class ID information. **ATTENTION:** 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 — The attribute is only available in the Logix Designer application through the Axis Properties Dialog boxes.
T	Can be accessed as an Axis Tag.
Data Type	For example, DINT, UINT, SINT, REAL, BOOL See CIP Data Types on page 317.
Default, Minimum, Maximum Range Limits	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 maxint = 2^{15} -1 max dint = 2^{31}-1 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.
Semantics of Values	The meaning of the attribute values. For example: Position Units/Sec. There may be additional information in the description that directly follows the attribute listing.
CST	Coordinated System Time

TIP If you need to find Attribute and Class IDs, see Identification of Motion Axis Attributes Based on Device Function Codes on page 27 and Drive Supported Optional Attributes on page 339.

For more information about Control Modes and Methods, see Integrated Motion Axis Control Modes on page 15.

Table 11 - Device Function Code Combinations

Device Code	Combination	Description
N	BE	All Device Functions using No Control Method
O	F	All Device Functions 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)
In addition to these combinations, there are many attributes that are applicable or not applicable to encoderless or sensorless drive operation, for example, Velocity Controlled drives operating without a feedback device. We can use Device Function Codes to specify conditional implementation rules for attributes. To accommodate these situations, we defined the following Device Functions Codes.		
E	Encoder-based device operation	
!E	Encoderless or Sensorless device operation, all control modes that do not use a Feedback device	
C/D	-	Replicated

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.

Table 12 - 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, degrees, or candy bars.
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%.

Table 12 - Attribute Unit Cross-referencing

Attribute Unit	Applicable Units	Semantics of Values
Power Units	Kw	Kilowatts
Inertia Units	$Kg\text{-}m^2$	$Kilogram\text{-}Meter^2$
Mass Units	Kg	Kilogram
Loop Bandwidth Units	Hz	Hertz
Filter Frequency Units	Hz	Hertz
Counts		Fundamental control unit for distance. For example, feedback counts or planner counts.

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.

For more information about Control Modes and Methods, see Integrated Motion Axis Control Modes on page 15.

Axis Instance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	DINT	-	-	-	Instance Number

The Axis Instance attribute is used to return the instance number of an axis. Major fault records generated for an axis major fault contains only the instance of the offending axis. You would typically use this attribute to determine if this was the offending axis; for example, if the instance number matches.

If you are going to access data by using an MSG instruction, the Axis Instance attribute is required and is just one of the many pieces of data required.

Group Instance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	DINT	-	-	-	Instance Number

Use the Group Instance attribute to determine what motion group this axis is assigned to. The Logix control system currently supports a maximum of 1 group.

Map Instance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	DINT	-	-	-	Instance Number

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	GSV	USINT	255	-	-	Channel Number (0, 1, 2, …). A value of 255 indicates the axis is unassigned.

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	GSV	DINT	-	-	-	Object Class Code

The Module Class Code attribute is the class code of the motion engine in the module; 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	GSV	DINT	-	-	-	Producer/Consumed axis's associated C2C map instance.

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	GSV	DINT	-	-	-	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 via the C2C connection.

Memory Use

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	UINT	-	-	-	105 (0x69) = I/O space 106 (0x6a) = Data Table space

The Memory Use attribute is the controller memory space where the Motion Control Axis exists.

This attribute is initialized as part of the create service when you create the axis.

The programming software 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.

Axis Configuration State

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	USINT	-	-	-	Enumeration 0 = Axis Instance Created 1 = Connection Created 126 = Axis Inhibited 128 = Axis Configured

State of the configuration state machine for an axis. 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	GSV	USINT	-	-	-	Enumeration 0 = Ready 1 = Drive Enable, (direct drive control) 2 = Servo Control 3 = Faulted 4 = Shutdown 5 = Inhibited 6 = Ungrouped (axis unassigned) 7 = No Module 8 = Configuring FW = default

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.

See the Motion Instructions Reference Manual, publication MOTION-RM002, for further details about Axis State.

Inhibit Axis

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	SSV	SINT	0	-	-	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. 0 = triggers an uninhibit. 1 = triggers an inhibit.

The Inhibit Axis attribute is 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 online inhibit process is an intrusive operation in that it affects all axes associated to the same 1756-EN*x*T module as the axis being inhibited. As such, it is expected that the users will trigger this operation with the machine in a safe, nonoperating state. The inhibit process includes the breaking connection to the associated 1756-EN*x*T module and then allowing the module to be reconfigured with or without (depending if you are inhibiting or uninhibiting) this axis.

The inhibit/uninhibit operation will also stop all motion on all axes associated to the same 1756-EN*x*T module, including breaking all gearing relationships. This stop operation follows 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 generally coasts to a stop.

Axis ID

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	DINT	-	-	-	ID

The Axis ID attribute is a unique number assigned to an axis on creation by configuration software. The Axis ID is used to uniquely identify an axis. The Axis ID value is assigned by configuration software at the time of axis creation.

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	GSV	USINT	-	-	-	Enumeration 0 = Base 1 = Alternate 1 2 = Alternate 2 3…255 = Reserved

This attribute 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	-	-	-	ID 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.

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	Semantics of Values
Required - All	GSV	DINT	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 Mode Change (0) 16 = Pass Bus Status (0) 17 = Pass Bus Unload (0) 18…31 = Reserved

Bit	Feature	Description
0	Fine Interpolation (0)	If set, 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)	If set, 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)	If set, indicates that this axis supports the Alarm Log feature. Alarm Log data can therefore be received from the drive via the Alarm bit of the Status Data Set and used to update the controller's Alarm Log.
3	Marker (0)	If set, 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)	If set, 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)	If set, 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)	If set, 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)	If set, 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)	If set, 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)	If set, the axis supports sensorless vector control operation allowing the to drive run in velocity loop or torque loop without an external feedback device. This is equivalent to the S Device Function Code.
10	Drive Scaling (0)	If set, 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)	If set, 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)	If set, 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	Extended Motor Test (0)	If set, 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.

Bit	Feature	Description
14	Control Mode Change (0)	If set, the device supports the ability to change the Control Mode while in the Running state without generating large motion disturbances (bumplesss). 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 shall be generated.
15	Feedback Mode Change (0)	If set, the device supports the ability to change the Feedback Mode while in the Running state without generating large motion disturbances (bumplesss). 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 shall be generated.
16	Pass Bus Status (0)	If set, the associated 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)	If set, 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…31	Reserved	N/A

Axis Configuration

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	USINT	-	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 Axis Configuration attribute determines the general dynamic control behavior of the motion device axis instance.(1)

Table 13 - Axis Configuration and related Control Mode and Method

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

This attribute is used to set both the Control Mode and Control Method attributes according to this table. 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.

(1) See Interpreting the Attribute Tables on page 61 for explanations on the Usage combinations.

Table 14 - Axis Configuration Enumeration Descriptions

Enumeration	Usage	Name	Description
0	R/E O/C	Feedback Only	Feedback Only provides an axis interface to a specific feedback device as a master feedback source. 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.
1	R/F	Frequency Control	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	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	Required - V Optional - P	Velocity Loop	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	Required -T Optional -PV	Torque Loop	Torque Loop selects the PI Vector Control Method that applies feedback to provide closed loop PI control of motor torque via 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	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.
6…255		Reserved	-

Control Mode

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All Derived from Axis Configuration	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 Bits 4…7 = Reserved

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. 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 system view of these control modes are described in detail in Section 1. This table provides a summary of valid Control Modes. For more information about Control Modes, see Integrated Motion Axis Control Modes on page 15.

When modified programmatically, via an 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 because 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

(1) AOP - Default value can be specified by the specific drive profile (AOP).
SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

Table 15 - Control Mode Enumeration Descriptions

Enumeration	Usage	Name	Description
0	R/N	No Control	No motor control is provided in this mode.
1	R/P	Position Control	Device seeks to control the position, or orientation, of the motor.
2	R/PV	Velocity Control	Device seeks to control the velocity of the motor.
3	O/C	Acceleration Control	Device seeks to control the acceleration of the motor.
4	R/C	Torque Control	Device seeks to control the torque output of the motor.
5…15		Reserved	-

Control Method

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All Derived from Axis Configuration	GSV	USINT	0	0	2	Enumeration 0 = No Control 1 = Frequency Control 2 = PI Vector Control 3…255 = Reserved

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. This value is sent to the drive during initialization and cannot be changed during operation.

Table 16 - Control Method Enumeration Description

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 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, 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	-

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 via Logix Designer software. Thus, a Motion Signal attribute may be directly referenced in a program as <axis tag name>,<motion status tag name>, for example, a FeedAxis.ActualPosition.

To avoid the unnecessary processor effort associated with real-time conversion of certain Motion Control Signal tags that are not of interest, you may want to explicitly disable real-time updates of these attributes via the Auto Tag Update attribute of the associated motion group. A subset of the Motion Control Signal Attributes require the Auto Tag Update attribute to be enabled to perform scaling conversion. If disabled, the tag value will be forced to zero. These Motion Control Status Attributes are affected:

- Actual Position
- Actual Velocity
- Actual Acceleration
- Master Offset
- Command Position
- Command Velocity
- Command Acceleration
- Average Velocity

Actual Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	T	REAL	-	-	-	Position Units Tag access is supported by the value and is valid only when Auto Tag Update of the Motion Group Object is enabled.

Actual Position is the current position of an axis in the configured Position Units of that axis. This value is based on time stamped position or velocity feedback data reported to the controller as part of an ongoing cyclic data transfer process. The Actual Position value, when based on time stamped position feedback, is corrected based on its timestamp to be the actual position of the axis at the start of the update cycle in which it is read.

Strobe Actual Position, Strobe Command Position, and Strobe Master Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	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 positions 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.

Because 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.

See Strobe Command Position on page 75 for more information.

See the Motion Instructions Reference Manual, publication MOTION-RM002, for further details about the MGSP instruction.

Start Actual Position

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

Whenever a new Motion Planner instruction starts for an axis, for example, by 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.

See the Motion Instructions Reference Manual, publication MOTION-RM002, for further details about the MAM instruction.

Average Velocity

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	T	REAL	-	-	-	Position Units/Sec Tag access is supported, but value is valid only when Auto Tag Update of the Motion Group Object is enabled.

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 Average Velocity Time base is the length of time over which the average 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 is calculated by using this equation.

$$\frac{1}{\text{Averaged Velocity Timebase [Seconds]} \times K \;\dfrac{\text{Feedback Counts}}{\text{Position Unit}}}$$

For example, on an axis with position units of inches and a conversion constant (K) of 20000, an average velocity time-base of 0.25 seconds results in an average velocity resolution of:

$$\frac{1}{.25 \times 20000} = 0.0002 \;\frac{\text{Inches}}{\text{Second}} = 0.012 \;\frac{\text{Inches}}{\text{Minute}}$$

The minimum Average Velocity Timebase value is one Coarse Update Period as defined by the associated Motion Group Object.

Actual Velocity

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	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 from the current increment to the actual position per Coarse Update Period.

Actual Velocity is a signed 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 one feedback count per coarse update.

Actual Acceleration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	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 Actual Acceleration attribute is the current instantaneously-measured acceleration of an axis in the configured axis Position Units per second. It is calculated as the current increment to the actual velocity per Coarse Update Period.

Actual Acceleration is a signed floating-point value. The resolution does not depend on the Averaged Velocity Timebase, but rather on the constant of the axis and the fact that the internal resolution limit on Actual Velocity is one feedback count per Coarse Update Period^2.

Watch Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	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.

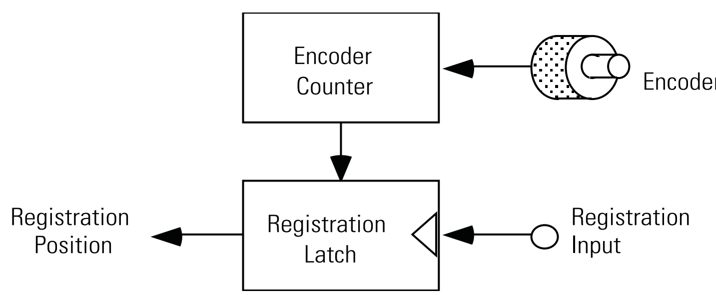
See the Motion Instructions Reference Manual, publication MOTION-RM002, for further details about the MAW instruction.

Registration 1 Position and Registration 2 Position

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

Two Registration Position attributes are provided to independently store the axis position associated with two different registration input events. The Registration Position value is the absolute position of a physical 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 by 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 rearranging this formula.

$$\text{Maximum Speed}\ \frac{\text{Position Units}}{\text{Second}} = \frac{\text{Desired Accuracy}\left[\text{Position Units}\right]}{\text{Delay}}$$

See the Motion Instructions Reference Manual, publication MOTION-RM002, for further details about the MAR instruction.

Registration 1 Time and Registration 2 Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	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	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	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 Torque

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - VT	GSV/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 affect on the axis unless the axis is configured for Torque Loop operation. For this attribute's value to be applied as the torque command, a Motion Drive Start instruction is 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 affect on axis motion. Only CIP Drive Axis data types currently support this capability.

Command Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	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.

Command Position is the desired or commanded position of a physical axis, in the configured Position Units of that axis, as generated by the Motion Planner. Command Position data is typically transferred by the controller to the drive axis together with a time stamp as part of the ongoing cyclic data transfer process. The Command Position value is used as the basis for the command that will be acted upon by the control structure of the drive at the targeted time based on the associated time stamp.

Strobe Command Position

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

The Strobe Actual Position, Strobe Command Position and Strobe Master Offset, and Strobe Command Position attributes are used to simultaneously store a snapshot 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.

Because 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, 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.

- See the Strobe Actual Position, Strobe Command Position, and Strobe Master Offset on page 72 for more information.
- See the Motion Instructions Reference Manual, publication MOTION-RM002, for further details about the MGSP instruction.

Start Command Position

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

Whenever a new Motion Planner instruction starts for an axis, for example, by 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	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 the Motion Planner. 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 planner counts per coarse update.

Command Acceleration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	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, 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 planner counts per Coarse Update Period^2.

Interpolated Command Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E, PV only	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.

Interpolated Position Configuration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PVT	SSV		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.

Master Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV PV only	GSV	T	REAL	-	-	-	Master Position Units Tag access is 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.

Strobe Master Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV PV only	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	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

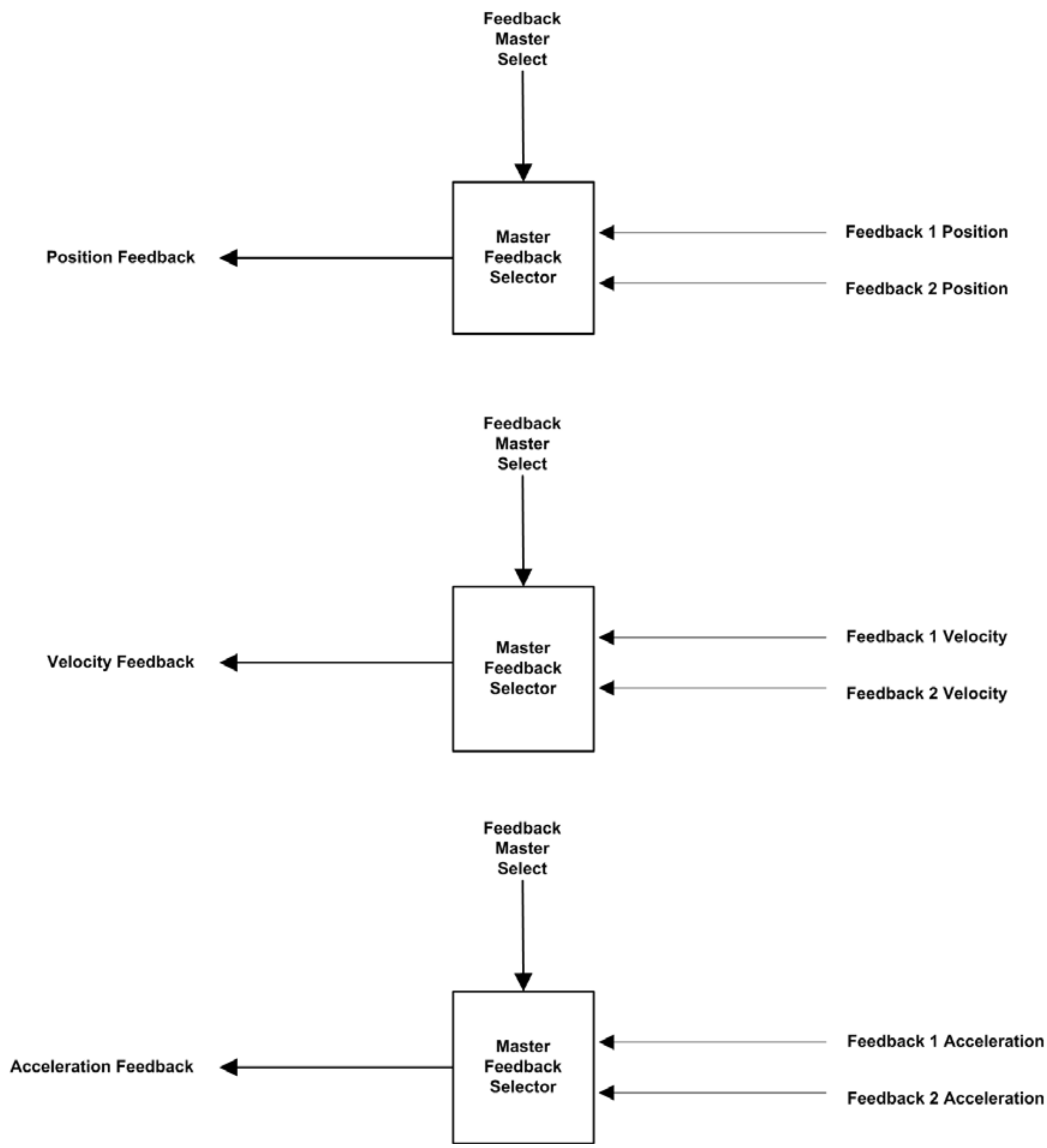
Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FV	SSV	T	REAL	0	$-\infty$	$+\infty$	Position Units/Sec

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. For this attribute's value to be applied as the velocity command, a Motion Drive Start (MDS) instruction is 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.

No Control (feedback only) Mode

No Control mode can be configured to allow for the position, velocity, and acceleration of any one of four possible feedback channels to be accessed by the controller via the Device-to-Controller Connection. These signals can then be distributed across the motion control system as a master axis for gearing and camming operations. In this mode, the Feedback Master Select attribute determines which feedback channel produces the Position, Velocity, and Acceleration Feedback signals.

Figure 6 - No Control (feedback only)



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 on page 148.

Motion Status Bit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	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 = TimeCamLockStatus 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
Bitmapped collection of status conditions associated with the Motion Planner function.							

(1) Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application and are shown in the semantics column.

Table 17 - Motion Control Status Attribute Bit Descriptions

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	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. Decel status bits do not account for drive handling of decel override. Decel status bits only account for commanded decel.
2	Move Status	The MoveStatus bit attribute is set if a Move motion profile is currently in progress. As soon as the Move is completed or superseded by some other motion operation, the MoveStatus bit is cleared.
3	Jog Status	The JogStatus bit attribute is set if a Jog motion profile is currently in progress. As soon as the Jog is completed 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 completed or superseded by some other motion operation, the HomeStatus bit is cleared.

Table 17 - Motion Control Status Attribute Bit Descriptions (Continued)

Bit	Motion Status	Description
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, MGPS, 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	Axis 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 integrated 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. For more information on APR, see the Integrated Motion Configuration and Startup User Manual, publication MOTION-UM003.
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 completed 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 completed 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 is superseded by some other motion operation.
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. While the PositionCamLockStatus = 0, Master Offset changes are applied to the master side of the position cam. There will be no corresponding change to the slave axis side of the position cam.
14	Time Cam Lock Status	Reserved
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 completed 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 completed or stopped, the CoordinatedMotionStatus bit is cleared.
17	Transform State Status	The Transform State Status bit is set if the axis is 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 can not 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 applies only 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 applies only to CIP Drive axis types.

Table 17 - Motion Control Status Attribute Bit Descriptions (Continued)

Bit	Motion Status	Description
21	Reserved	
22	Move Lock Status	The Move Lock Status 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 Move Lock Status bit is 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 Move Lock Status 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	Reserved	
24	Jog Lock Status	The Jog Lock Status 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 Jog Lock Status bit is 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 Jog Lock Status bit is cleared when the Master Axis reverses direction and the Slave Axis stops following the Master Axis. The Jog Lock Status bit is set again when the Slave Axis resumes following the Master Axis.
25	Reserved	
26	Master Offset Move Lock Status	The Master Offset Move Lock Status bit is set when the master axis satisfies the Lock Direction request of a Master Offset Move executed by using MAM instruction. • If the Lock Direction is Immediate Forward Only or Immediate Reverse Only, the Master Offset Move Lock Status bit is 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 Master Offset Move Lock Status bit is cleared when the Master Axis reverses direction and the Slave Axis stops following the Master Axis. The Master Offset Move Lock Status bit is set again when the Slave Axis resumes following the Master Axis.
27	Maximum Speed Exceeded	The Maximum Speed Exceeded bit is set when the axis command velocity at any time exceeds the maximum speed configured for an axis. The bit is 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	GSV(1)	T	DINT	-	-	-	0 = ServoActionStatus 1 = DriveEnableStatus 2 = AxisShutdownStatus 3 = ConfigurationUpdateInProcess 4 = InhibitStatus 5 = DirectControlStatus 6 = Axis Update Status 7…31 = Reserved

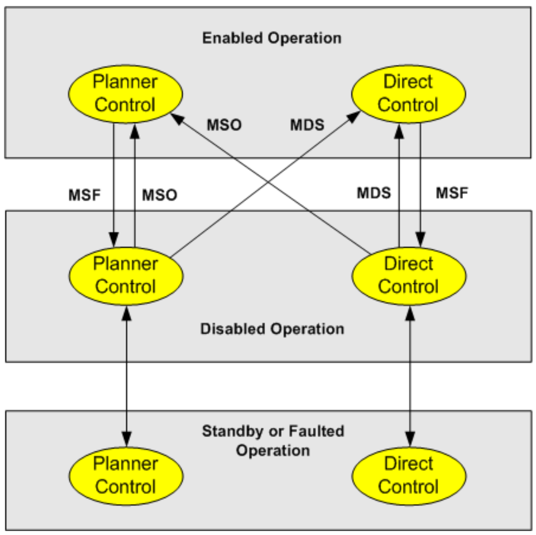
The Axis Status Bits attribute is a collection of basic status conditions associated with the axis. These represent key status conditions used by the system in executing motion control instructions.

(1) Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application and are shown in the semantics column.

Table 18 - Axis Status Bit Descriptions

Bit	Axis Status	Description
0	Servo Action Status	The ServoActionStatus bit attribute is set when the associated axis motor control function is tracking command reference from the controller.
1	Drive Enable Status	The DriveEnableStatus bit attribute is set when the power structure associated with the axis is currently enabled. If the bit is not set, then the power structure associated with the axis 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.

Table 18 - Axis Status Bit Descriptions

<table>
<tr><th>Bit</th><th>Axis Status</th><th>Description</th></tr>
<tr><td>3</td><td>Configuration Update in Process</td><td>The Configuration Update 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 Status Bits attribute provides a method of waiting until the servo configuration data update to the connected 1756-ENxT module is complete before starting a dependent operation.</td></tr>
<tr><td>4</td><td>Inhibit Status</td><td>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.</td></tr>
<tr><td>5</td><td>Direct Control Status</td><td>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, an instruction error occurs.


In Direct Control you don't have to establish or maintain absolute reference position, so when you attempted to execute the MAH and MRP instructions, they will result in an instruction error.
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, MDS, an instruction error occurs. This bit applies only to CIP Drive axis types.
This illustration describes the following behavior.
The Direct Control Status bit is set by the Motion Drive Start instruction (MDS) and once set, can be cleared only 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 be set again only by executing an MDS instruction from the Stopped or Stopping State.</td></tr>
<tr><td>6</td><td>Axis Update Status</td><td>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.
This attribute is intended to be used within an event task triggered upon motion group task. If used within a continuous task, depending on the Base Update Period and the Alternate Update Rate configured for the system, its possible that by the time a continuous task runs another re-scan of the rung that checks the Axis Update Status flag, the flag has already gone through a cycle, say, from 1…0 and back to 1.
• When the axis is scheduled for an update, the Axis Update Status bit is set, regardless of the inhibit state of the drive module that it is associated.
• When you have an inhibited axis, the Axis Update Status bit is always set to true.
For more information about Axis Multiplexing, see the Integrated Motion on the EtherNet/IP Network User Manual, publication MOTION-UM003.</td></tr>
<tr><td>7…31</td><td>Reserved</td><td></td></tr>
</table>

Axis Fault Bits

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV(1)	T	DINT	-	-	-	Bitmap 0 = PhysicalAxisFault 1 = ModuleFault 2 = ConfigurationFault 3 = GroupFault 4 = MotionFault 5 = GuardFault 6 = InitializationFault 7 = APRFault 8 = Safety Fault 9…31 = Reserved

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 axis 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.

(1) Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application and are shown in the semantics column.

Table 19 - Axis Fault Bit Descriptions MAOC

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 - RA, and CIP Axis Fault - Mfg (not supported) attributes.
1	Module Fault	The Module Fault bit attribute is set when one or more faults have occurred related to the 1756-EN*x*T 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 affects all axes associated with the 1756-EN*x*T module. A module fault generally results in the shutdown of all associated axes. Reconfiguration of the 1756-EN*x*T 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 1756-EN*x*T 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 1756-EN*x*T 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 affects 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.
4	Motion Fault	If the Motion Fault bit is set, it indicates that there is one or more fault conditions that 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 there is one or more fault conditions that have occurred related to the embedded Guard Motion safety function of the drive. The specific fault conditions can then be determined through access to the Guard Fault attribute of the associated axis. Guard Faults are applicable only if the drive device is equipped with Hardwired Guard Safety functionality.
6	Initialization Fault	The Initialization Fault bit is set when initialization of a integrated motion device fails for any reason. Specific information concerning the Initialization Fault may be found in the standard CIP Initialization attribute, or manufacturer specific CIP Initialization Fault - RA, and CIP Initialization Fault - Mfg (not supported) attributes associated with the CIP Drive axis data types.
7	APR Fault	The Absolute Position Recovery Fault bit is set during axis configuration when the system is not able to recover the absolute position of the axis. Specific information concerning the APR Fault may be found in the standard APR Fault attribute, or manufacturer specific APR Fault – RA, and APR Fault – Mfg (not supported) attributes associated with the CIP Drive axis data types.
8	Safety Fault	When the Safety Fault bit is set, it indicates that there is one or more fault conditions that 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 via a CIP Safety connection.
9…31	Reserved	-

Axis I/O Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	GSV	T	DWORD	-	-	-	Bitmap 0 = Enable Input 1 = Home Input 2 = Registration 1 Input 3 = Registration 2 Input 4 = Positive Over-travel Input 5 = Negative Over-travel Input 6 = Feedback 1 Thermostat 7 = Resistive Brake Output 8 = Mechanical Brake Output 9 = Motor Thermostat Input

The 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 value, while a value of 1 indicates a logical 1 value.

Axis I/O Status - MFG

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	GSV	T	DWORD	-	-	-	Bitmap 0 = Regenerative Power Input 1 = Bus Capacitor Module Input 2 = Contactor Enable Output 3 = Pre-Charge Input

The Axis I/O Status - MFG attribute is a collection of bits indicating the state of vendor 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.

Axis Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	GSV	T	DWORD	-	-	-	Bitmap 0 = Local Control Status 1 = Alarm Status 2 = DC Bus Up Status 3 = Power Structure Enabled Status 4 = Motor Flux Up Status 5 = Tracking Command Status 6 = Position Lock Status 7 = Velocity Lock Status 8 = Velocity Standstill Status 9 = Velocity Threshold Status 10 = Velocity Limit Status 11 = Acceleration Limit Status 12 = Deceleration Limit Status 13 = Torque Threshold Status 14 = Torque Limit Status 15 = Current Limit Status 16 = Thermal Limit Status 17 = Feedback Integrity Status 18 = Shutdown Status 19 = In Process Status 20 = DC Bus Upload Status 21 = AC Power Loss Status 22 = Position Control Mode 23 = Velocity Control Mode 24 = Torque Control Mode 25…31 = Reserved

The Axis Status attribute is a collection of standard bits indicating the internal status of the motion axis.

Output Cam Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	GSV(1)	T	DINT	-	-	-	Set of Output Cam Status bits.

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 MDOC instruction.

These 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 correspond to an output cam target

(1) Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application and are shown in the semantics column.

Output Cam Pending Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	GSV(1)	T	DINT	-	-	-	Set of Output Cam Pending Status bits.

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 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 MDOC instruction.

(1) Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application and are shown in the semantics column.

Output Cam Lock Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	GSV(1)	T	DINT	-	-	-	Set of Output Cam Lock Status bits.

The Output Cam Lock Status bit is set when an Output Cam has been armed. This would be initiated by executing an 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 MDOC instruction.

(1) Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application and are shown in the semantics column.

Output Cam Transition Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	GSV(1)	T	DINT	-	-	-	Set of Output Cam Transition Status bits.

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 an MDOC instruction.

(1) Direct Tag access is supported. Bit names shown are uses as data type member names in the Logix Designer application and are shown in the semantics column.

Motion Alarm Bits and Motion Fault Bits

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV(1)	T	DINT	-	-	-	Bitmap - MotionAlarm 0 = Reserved 1 = SoftTravelLimitPositiveAlarm 2 = SoftTravelLimit NegativeAlarm 3…31 = Reserved
Required - All	GSV(1)	T	DINT	-	-	-	Bitmap - MotionFault 0 = Reserved 1 = SoftTravelLimitPositiveFault 2 = SoftTravelLimitNegativeFault 3…31 = Reserved

These two attributes are a bitmapped collection of the fault and alarm exception conditions associated with the Motion Planner function. When one of the listed motion exception conditions is detected by the controller, the condition is indicated as a Fault or Alarm according to the associated Motion Exception Action attribute value. In general, alarms are considered warnings by the control system while faults result in some form of action to stop the axis.

This table defines the current list of motion exception conditions from which the Motion Fault and Motion Alarm bits are derived.

Table 20 - Motion Alarm Bits and Motion Fault Bits Descriptions

Bit	Exception	Description
0	Reserved	
1	Soft Travel Limit - Positive	Actual position has exceeded the Soft Travel Limit - Positive value.
2	Soft Travel Limit - Negative	Actual position has exceeded the Soft Travel Limit - Negative value.
3…31	Reserved	-

Soft Travel Limit - Positive

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. A Soft Travel Limit - Positive exception is generated.

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 by 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.

Soft Travel Limit - Negative

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. A Soft Travel Limit - Negative exception is generated.

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 by 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.

See Exception Actions on page 316 for more information.

(1) Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application and are shown in the semantics column.

Axis Statistical Attributes

These are the attributes that provide useful statistics on motion axis operation.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Control Power-up Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
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 Values
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 Values
Optional - BD	MSG		REAL	-	-	-	Kilowatt Hours

Accumulated output energy of the axis.

Cumulative Motor Revs

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
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 Values
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 Values
Optional - BD	MSG		DINT	-	-	-	

Cumulative number of times Control Power has been cycled.

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	GSV(1)	DINT	0	0	8	# of Targets Represents the number of Output Cam nodes attached to this axis.

The Output Cam Execution Targets attribute is used to specify the number of Output Cam nodes attached to the axis. This attribute can to be set only 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.

(1) These attributes can be set **only** when the axis instance is created.

Master Input Configuration Bits

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E PV only	SSV	DINT	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.

Master Position Filter Bandwidth

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E PV only	SSV	REAL	0 1/(4*CUP)	0	1000^2 (1) 1/CUP	Hertz Valid when Master Position Filter is enabled. A value of 0 disables the filter. CUP = Coarse Update Period

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.

(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.

Motion Exception Action

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Logix Designer	USINT	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.

See Stopping Action on page 216 when by using the exception Stop Drive.

Table 21 - Master Input Configuration Bit Descriptions

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 ensures 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. Because 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 generally 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 four times 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 first 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. Because 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. 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.
2…31		Reserved

Table 22 - 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 affect 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 unaffected.
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 affect 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 unaffected.
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.
4	Stop Drive	The Stop Drive action results in the controller 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 device dependent. See Stopping Action on page 216 when by using the exception Stop Drive.
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	SSV	SINT	0	0	1	0 = No 1 = Yes

The Soft Travel Limit Checking attribute is a boolean value that determines if the system should check for a software overtravel condition based on current settings for Soft Travel Limit – Positive, and Soft Travel Limit – Negative.

When the Soft Overtravel Checking 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 while commanding motion in that direction. The travel limits are determined by the configured values for the Soft Travel Limit Positive and Soft Travel Limit Negative 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 Motion Planner. For CIP Drive axis data types, Soft Travel Limit Checking has no affect if the Travel Mode is configured for Cyclic (Rotary) operation. Software travel limit checking is valid only when the Rotary attribute boolean value is set to false, for example, when configured for non-cyclic (Rotary) operation.

Soft Travel Limit Checking has no affect 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.

For more information about Absolute Position Recovery (APR), see the Axis Homed Status on page 80 and the Integrated Motion Configuration and Startup User Manual, publication MOTION-UM003.

Soft Travel Limit, Positive and Negative

Usage	Access	Attribute Name	Data Type	Default	Min	Max	Semantics of Values
Required - E	SSV	Soft Travel Limit - Positive	REAL	0	-maxpos	maxpos	Position Units
Required - E	SSV	Soft Travel Limit - Negative	REAL	0	-maxpos	maxpos	Position Units

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 while commanding motion in the positive direction, a Soft Travel Limit - Positive exception is generated.

Soft Travel Limit - Negative sets the maximum negative travel limit for actual position when Soft Travel Limit Checking is enabled. If this value is exceeded while commanding motion in the negative direction, a Soft Travel Limit - Negative exception is 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.

This attribute provides configurable software travel limits via 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 Soft Travel Limit 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.

When Soft Travel Limit Checking is enabled, appropriate values for the maximum travel for both the Soft Travel Limit Positive and Soft Travel Limit Negative 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	SSV	DINT	0	-1 * MUP	2 * MUP	Seconds 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 or the device applies the command position accordingly to the associated time stamp. A non-zero value would have the affect of phase advancing or retarding the axis position relative to a master axis.

Motion Database Storage Attributes

These are the database storage attributes associated with a Motion Control Axis. These attributes are used to store the original floating point values that are used for subsequent uploads.

System Acceleration Base

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required- All	Logix Designer	REAL	0	-	-	Motor Units/sec^2 @ 100 % Rated

A floating point value that represents the acceleration of the selected unloaded motor based on 100% Rated current. It is used to compute System Inertia. It is used to store the original System Acceleration value also for subsequent upload.

Drive Model Time Constant Base

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required- All	Logix Designer	REAL	.0015	-	-	Seconds

A floating point value that represents the lumped model time constant associated with the drive device for the purposes of computing loop gains. It is used to store the original Drive Model Time Constant value also for subsequent upload. The Drive Model Time Constant Base is computed based on the current loop bandwidth, the velocity loop update time, and the feedback sample period.

Motion Scaling Attributes

These are the basic motion-scaling configuration attributes associated with a Motion Control Axis. These attributes are involved in the 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 the 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	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 Drive Scaling mode the controller is responsible for Position Unwind operations associated with Cyclic Travel Mode.

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 the conversion to equivalent Feedback Counts and Motor Units. In Drive Scaling mode the drive is responsible also for Position Unwind operations associated with Cyclic Travel Mode.

Scaling Source

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	SSV	USINT	0	-	-	Enumeration 0 = From Calculator 1 = Direct Scaling Factor Entry 2…255 = Reserved

The Scaling Source attribute, for example, determines 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 by 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.

Travel Mode

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	SSV/GSV	USINT	0	-	-	Enumeration 0 = Unlimited 1 = Limited (E) 2 = Cyclic (E) 3…255 = Reserved

The Travel Mode attribute determines 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, for example, Encoderless/Sensorless 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	GSV	REAL	1	0+	∞	Position Units

The Position Scaling Numerator attribute is 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	GSV	REAL	1	0+	∞	Motion Unit

The Position Scaling Denominator attribute is 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	GSV	REAL	1	0+	∞	Position Units

The Position Unwind Numerator attribute is 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	GSV	REAL	1	0+	∞	Unwind Cycles

The Position Unwind Denominator attribute is 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	GSV	REAL	1	0+	∞	Position Units

The Travel Range attribute is 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	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.

Motion Resolution

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	SSV	DINT	Default Motion Resolution	1	2^{31}-1	Motion Counts/Motion Unit

The Motion Resolution attribute is an integer value that determines the number of Motion Counts per Motion Unit used by the used by the scaling function to convert between Motion Counts and Feedback Counts.

The Motion Resolution 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.

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.

Motion Resolution/Conversion Constant = Position Units/Motion Unit (rev, inch, or millimeter)

In general, the Motion Resolution value may be configured in Motion Counts per Motion Unit independent of the resolution of the feedback devices used. The control system takes care of scaling Feedback Counts to 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 toTable 23. This value is computed automatically if Scaling Source is 'From Calculator'.

Table 23 - Feedback and Load Type Unit Description

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

Table 23 - Feedback and Load Type Unit Description (Continued)

Feedback Configuration	Load Type	Linear Actuator Unit	Motion Unit
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 Table 24.

Table 24 - Motion Resolution for Scaling Factors

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 rollover, essentially flipping the sign of the axis position value. Motion continues smoothly through the rollover, 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 an anomaly, 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, which could affect 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 the 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 Resolution Value Examples

These examples demonstrate how the Motion Resolution value can be used together with the Conversion Constant to handle various machine applications.

Direct-drive Rotary Shear Application

In this mechanical configuration, there is a rotary motor 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. However, because Motion Resolution is configurable, you can set the Motion Resolution to 300,000 Motion Counts/Motor Rev. 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 with Gearbox Application

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. Because 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 Output to 3. In this way, 300,000 Motion Counts/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 is expressed as Motion Counts per Load millimeter or Load inch, in this, millimeter.

The motor feedback is, however, rotary and resolution expressed in Motor Feedback Counts/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 is 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 Output 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.

Motion Polarity

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	SSV	USINT	0	0	1	Enumeration 0 = Normal Polarity 1 = Inverted Polarity 2…255 = Reserved

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 the 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 Controller Scaling, the Motion Polarity inversion is performed on the controller side of the CIP Motion Connection interface. When the Motion Scaling Configuration is set to Drive Scaling, the Motion Polarity inversion is performed on the drive side of the CIP Motion Connection interface. 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 is defined in Table 25.

Table 25 - Signal Attribute Access

ID	Access	Signal Attribute Name	ID	Access	Signal Attribute Name
1402 + o	Get	Feedback n Position	434	MSG	Position Feedback
1403 + o	Get	Feedback n Velocity	370	Get	Skip Speed 1
1404 + o	Get	Feedback n Acceleration	371	Get	Skip Speed 2
2380 + o	MSG	Feedback nU Position	372	Get	Skip Speed 3
2381 + (n-1)*50	MSG	Feedback nU Velocity	780	MSG	Position Integral Feedback
2382 + (n-1)*50	MSG	Feedback nU Acceleration	436	Get	Position Error
2383 + (n-1)*50	MSG	Feedback nS Position	437	Get	Position Integrator Output
2384 + (n-1)*50	MSG	Feedback nS Velocity	438	Get	Position Loop Output
2385 + (n-1)*50	MSG	Feedback nS Acceleration	450	MSG	Velocity Command
62	Get	Registration 1 Positive Edge Position	451	Set	Velocity Trim
63	Get	Registration 1 Negative Edge Position	452	Get	Acceleration Feedforward Command
64	Get	Registration 2 Positive Edge Position	453	Get	Velocity Reference
65	Get	Registration 2 Negative Edge Position	454	Get	Velocity Feedback
70	Get	Home Event Position	455	Get	Velocity Error
360	Set	Controller Position Command - Integer	456	Get	Velocity Integrator Output
356	Get	Fine Command Position	457	Get	Velocity Loop Output
366	Get	Fine Command Velocity	480	Get	Acceleration Command
367	Get	Fine Command Acceleration	481	Set	Acceleration Trim
430	MSG	Position Command	482	Get	Acceleration Reference
431	Set	Position Trim	483	Get	Acceleration Feedback
432	Get	Position Reference	801	Get	Load Observer Acceleration Estimate
433	Get	Velocity Feedforward Command	802	Get	Load Observer Torque Estimate
434	MSG	Position Feedback	780	MSG	Position Integral Feedback
490	Get	Torque Command	520	Get	Iq Current Command
491	Set	Torque Trim	521	Get	Operative Current Limit
492	Get	Torque Reference	523	Get	Motor Electric Angle
493	Get	Torque Reference - Filtered	545	Get	Iq Current Reference
494	Get	Torque Reference - Limited	525	Get	Id Current Reference
821	MSG	Total Inertia Estimate	840	Set	Current Disturbance

Table 25 - Signal Attribute Access (Continued)

ID	Access	Signal Attribute Name	ID	Access	Signal Attribute Name
527	Get	Iq Current Error	533	Get	Vq Voltage Output
528	Get	Id Current Error	534	Get	Vd Voltage Output
529	Get	Iq Current Feedback	535	Get	U Voltage Output
530	Get	Id Current Feedback	536	Get	V Voltage Output
531	Get	Vq Decoupling	537	Get	W Voltage Output
532	Get	Vd Decoupling	538	Get	U Current Feedback
539	Get	V Current Feedback	540	Get	W Current Feedback
541	Get	U Current Offset	600	Get	Output Frequency
542	Get	V Current Offset	601	Get	Output Current
543	Get	W Current Offset	602	Get	Output Voltage
565	Get	Slip Compensation	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[(1)], 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[(1)], and torque limit attribute values in an axis be sign inverted and swapped with respect to the corresponding attributes in the axis. 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 is defined in Table 26.

Table 26 - Directional Limit Attributes

Directional Limit Attribute Name	Access	ID
Ramp Velocity - Positive	Set	374
Ramp Velocity - Negative	Set	375
Ramp Acceleration[(1)]	Set	376
Ramp Deceleration[(1)]	Set	377
Position Limit - Positive	MSG	448
Position Limit - Negative	MSG	449
Velocity Limit - Positive	Set	473
Velocity Limit - Negative	Set	474
Acceleration Limit[(1)]	Set	485
Deceleration Limit[(1)]	Set	486
Torque Limit - Positive	Set	504
Torque Limit - Negative	Set	505

(1) 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	Logix Designer	STRING	Position Units	-	-	Revs

The Position Unit string attribute lets user-defined engineering units rather than counts to be used for measuring and programming all motion-related values, for example, position, velocity, and acceleration. 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 millimeters 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 the Logix Designer application in the axis configuration dialog boxes to request values for motion-related parameters in the specified Position Units. Software limits the maximum string length to 15 characters.

Average Velocity Timebase

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	SSV	REAL	0.25	0.001 1 CUP	32 1000 CUP	Seconds

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 (CUP) and history array size are ultimately enforced for the Avg Vel Timebase attribute by clamping to limit rather than generating a value out-of-range error. An out-of-range error is given only if the value is outside the fixed Min/Max limits. This was done to avoid implementing complex range limit code based on the Coarse Update Period in RSLogix™ software.

Conversion Constant

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	SSV/GSV	REAL	Default Motion Resolution	10^{-12}	10^{12}	Counts/Position Unit

This attribute is used as a scaling factor allowing axis position, velocity, and acceleration attributes to be displayed or configured in the 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.

Be sure to monitor the ConfigUpdateInProcess following the SSV of any module based attribute before moving on, for example, performing a Servo On. The Conversion Constant attribute is a controller only attribute, but it results in the sending of multiple module based attributes.

Position Unwind

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	SSV	DINT	Default Motion Resolution	1	10^{9}	Counts/Cycle

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.

Motion Homing Configuration Attributes

These are 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	SSV	USINT	1	-	-	Enumeration 0 = Passive 1 = Active (!N) 2…55 = Reserved

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 axes, but does not apply when Axis Configuration is Feedback Only because it requires active control of the axis.

Table 27 - Homing Mode Descriptions

Homing Mode	Description
Active	When Active Homing mode is chosen, the home operation enables the axis, if necessary, and then controls the home process. The difference between Active and Passive modes is that Passive mode does not alter the axis state, nor does it cause any motion. When Active Homing mode is chosen as the Homing mode, the desired homing sequence is then selected by specifying whether a home limit switch and/or the encoder marker is used for this axis. Active Homing sequences always use the trapezoidal velocity profile. If the configured feedback type does not support a marker signal, the `marker' and `switch then marker' homing sequences are not be applicable.
Passive	Passive Homing mode redefines the current absolute position of the axis on the occurrence of a home switch or encoder marker event. Passive Homing mode 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 mode, for a given home sequence, works similarly to the corresponding Active Homing mode sequence, as described above, except that no motion is commanded—the controller just waits for the switch and marker events to occur. If the configured feedback type does not support a marker signal, then the marker and switch homing sequences are not applicable.

Home Direction

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E PV only	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 Homing Mode.

Only valid for position and Velocity Control.

Home Sequence

Required - E	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

The Home Sequence attribute is filtering based on Feedback Type.

Table 28 - Homing Sequence Type Descriptions

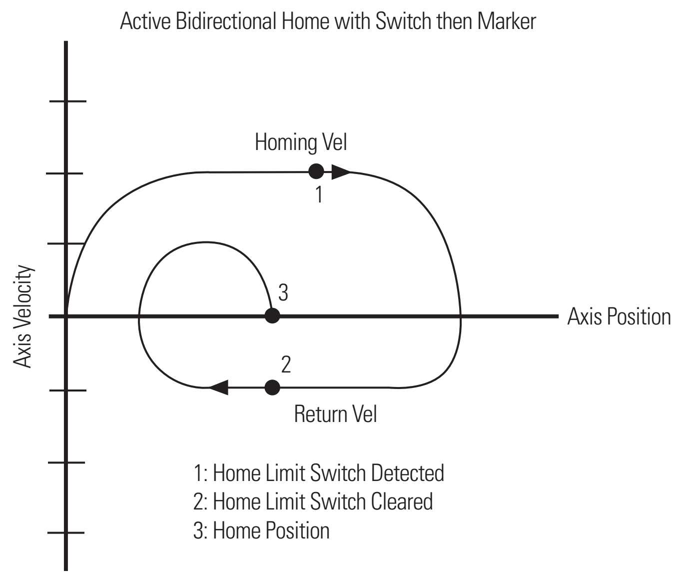
Homing Sequence Types	Description
Active Homing	The available active homing sequences are described in detail below with the assumption that the Home Direction is always forward. Active homing sequences, with the exception of the Immediate home sequence type, employ trapezoidal jog velocity profiles to move the axis while waiting for a homing event to occur. When Active is the configured Home Mode, the Home Sequence attribute is used to specify whether a home limit switch and/or the feedback device marker is to be used for the homing events. The Home Direction attribute determines the directional behavior of jog profiles associated with the specified homing sequence. Unidirectional and Bidirectional refer to whether the jog is to reverse direction after detecting the homing event. Forward and Reverse refer to the direction of the initial jog during the homing process. When active homing is chosen as the homing mode, the desired homing sequence is then selected by specifying whether a home limit switch and/or the encoder marker is used for this axis. Active homing sequences always use the trapezoidal velocity profile.
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.
Active Bidirectional Home with 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 until the home limit switch is detected. The axis then decelerates to a stop and then moves in the opposite direction at the specified Home Return Speed 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. The axis position is updated based on the Home Position and Home Offset. 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 motions for this active homing sequence are shown below.  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 ms) 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 in/s (6 IPM) is specified, the uncertainty of the home position is calculated as shown below: Uncertainty = 0.1 In/sec * 0.01 s = 0.001 in.

Table 28 - Homing Sequence Type Descriptions (Continued)

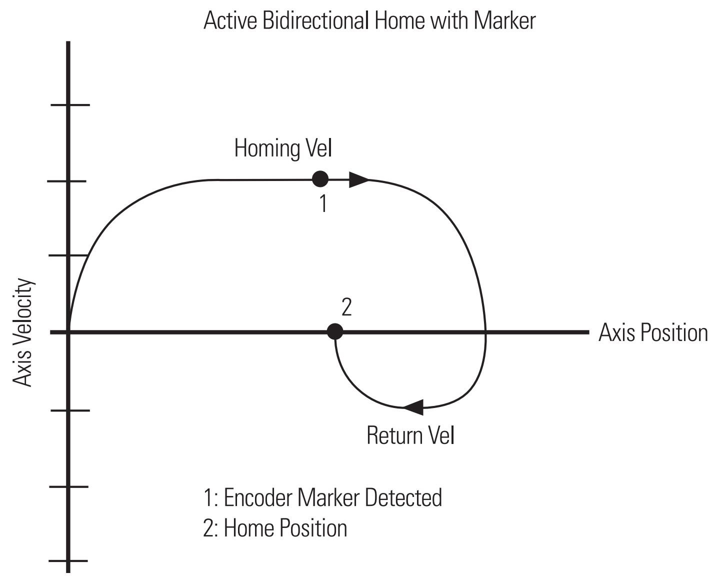
Homing Sequence Types	Description
Active Bidirectional Home with Marker	This active homing sequence is useful for single turn rotary and linear encoder applications because these have only one encoder marker for full axis travel. When this sequence is performed, the axis moves in the specified Home Direction at the specified Home Speed 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. 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 by 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 homing sequence is shown below.  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 ms) and the specified Home Speed. For example, if a Home Speed of 1 in/s (60 IPM) is specified, the uncertainty of the home position is calculated as shown below: Uncertainty = 1 in/s * 0.001 s = 0.000001 in.

Table 28 - Homing Sequence Type Descriptions (Continued)

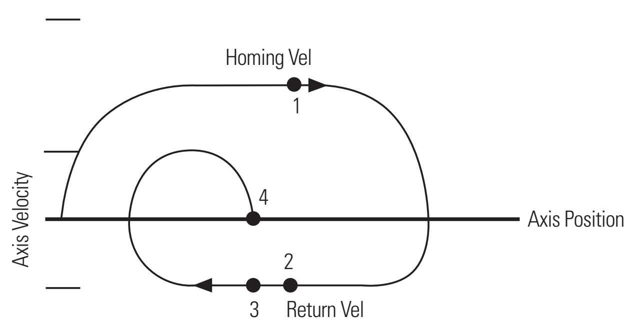
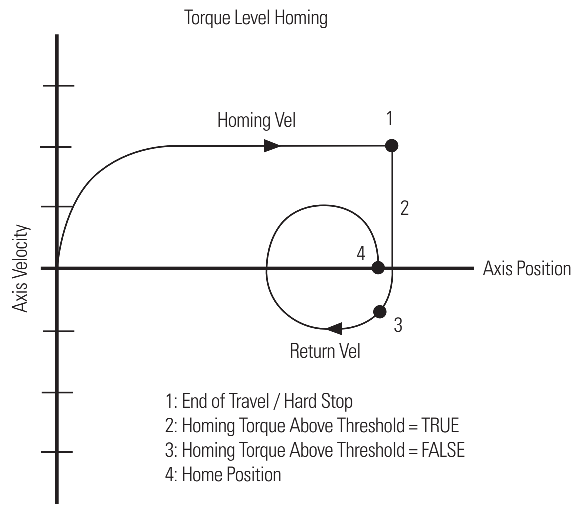
Homing Sequence Types	Description
Active Bidirectional Home with Switch then Marker	This is the most precise active homing sequence available. When this sequence is performed, the axis moves in the specified Home Direction at the specified Home Speed until the home limit switch is detected. The axis then decelerates to a stop and moves in the opposite direction at the specified Home Return Speed 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. 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 by 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 homing sequence is shown below. Active Bidirectional Home with Switch then Marker  1: Home Limit Switch Detected 2: Home Limit Switch Cleared 3: Encoder Marker Detected 4: Home Position 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.
Active Unidirectional Home with Switch	Unidirectional home is usually used when the physical axis can't change directions. This active homing sequence is useful for when an encoder marker is not available and either unidirectional motion is required or a 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 until the home switch is detected. The Home Position is assigned to the axis position at the moment that the limit switch is detected. 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 switch is detected by this value. The controller then continues to move the axis to the Home Position at the specified Home Speed by using a trapezoidal move profile. By setting a Home Offset greater than the deceleration distance, unidirectional motion to the Home Position is ensured. However, if the Home Offset value is less than the deceleration distance, then the axis is simply decelerated to a stop. 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 with 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 until the marker is detected. The Home Position is assigned to the axis position at the moment that the marker is detected. 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 by using a trapezoidal move profile. The axis position are updated based on the Home Position and Home Offset. Even if the Home Offset is zero, the position of updated. Zero is a valid number. By setting a Home Offset greater than the deceleration distance, unidirectional motion to the Home Position is ensured. However, if the Home Offset value is less than the deceleration distance, then the axis is simply decelerated to a stop. 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.

Table 28 - Homing Sequence Type Descriptions (Continued)

Homing Sequence Types	Description
Active Unidirectional Home with Switch then Marker	This active homing sequence is useful for multi-turn cyclic 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 until the home switch is detected. The axis continues in the same direction at the Home Speed until the first marker event is detected. The Home Position is assigned to the axis position at the precise position where the marker was detected, and the axis then decelerates to a stop. 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 by using a trapezoidal move profile. By setting a Home Offset greater than the deceleration distance, unidirectional motion to the Home Position is ensured. However, if the Home Offset value is less than the deceleration distance, then the axis is simply decelerated to a stop. 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.

Table 28 - Homing Sequence Type Descriptions (Continued)

<table>
<tr><th>Homing Sequence Types</th><th>Description</th></tr>
<tr><td>Active Home to Torque</td><td>The Home to Torque Level sequence is a type of homing used when a hard stop is going to be used as the home position, as in a linear actuator. The occurrence of the hard stop is detected by the drive when the output torque to the motor reaches or exceeds the torque level specified by the user. Because the home to torque level 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.
In Torque Level homing, the torque event is the trigger. The Motion Planner decelerates the axis to a stop and reverses direction. The torque event is usually some type of hard stop. Because of this, the physical axis can't move, but the position command is changing. This causes the Position error to increase. If the distance required to decelerate is greater than the Position error Tolerance, an Excessive Position error exception can occur, possibly cancelling the home operation.
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.
Torque Level homing is very similar to Home Switch homing, with the exception that the torque level is used instead of the home switch input. This graphic depicts the Position/Velocity for Torque Level Homing.


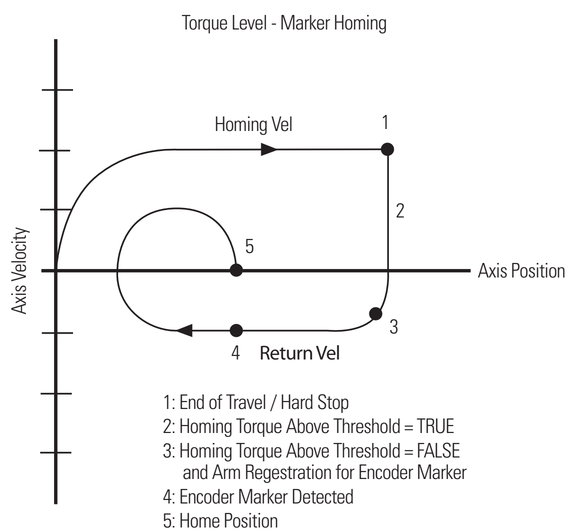
Torque Level-Marker Homing is very similar to Home Switch-Marker Homing, with the exception that the torque level is used instead of the home switch input. This graphic depicts the Position/Velocity for Torque Level-Marker Homing.

</td></tr>
<tr><td>Passive Immediate Home</td><td>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.</td></tr>
</table>

Table 28 - Homing Sequence Type Descriptions (Continued)

Homing Sequence Types	Description
Passive Home with Switch	This passive homing sequence is useful for when an encoder marker is not available or a proximity switch is being used. When this sequence is performed in the Passive Homing Mode, an external agent moves the axis until the home switch is detected. The Home Position is assigned to the axis position at the moment that the limit switch is detected. If 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.
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	SSV	DINT	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.

See Home Direction on page 102 for more information about starting direction.

Home Position

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	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 can be left at the specified Home Position:

- If Bidirectional homing, the axis is left at the Home Position.
- If undirectional homing and Travel Mode = 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), can also be used. (A description of the Maximum Positive and Negative Travel configuration attributes can 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	SSV	REAL	0	-maxpos	maxpos	Position Units

When applied to an active or passive Homing Mode, by 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 bi-directional 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.

Not valid for immediate Home Sequence.

Home Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E PV only	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.

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	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 bi-directional homing sequence as described in the above discussion of the Home Sequence Type attribute.

Valid for non-immediate cases of active Home Mode. Only valid for position and Velocity Control.

Home Torque Threshold

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Opt - E PV only	SSV	REAL	90	0	100	% Home Torque Limit

Sets the minimum torque level needed to detect the hard stop during a Home to Torque sequence. The drive's output torque must exceed the specified Home Torque Threshold for the specified Home Torque Time. The units for Home Torque Threshold are expressed as a percentage of the operative Torque Limit, which during the homing sequence is set to the Home Torque Limit by the controller.

Valid for non-"immediate" cases of "active" Home Mode.

Valid for "home to torque" homing sequences.

Home Torque Time

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Opt - E PV only	SSV	REAL	0.5	0	10^3	Sec

Sets the minimum torque level needed to detect the hard stop during a Home to Torque sequence. The drive's output torque must exceed the specified Home Torque Threshold for the specified Home Torque Time. The units for Home Torque Threshold are expressed as a percentage of the operative Torque Limit, which during the homing sequence is set to the Home Torque Limit by the controller.

Valid for non-"immediate" cases of "active" Home Mode.

Valid for "home to torque" homing sequences.

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	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	SSV	Maximum Acceleration	REAL	FD	0	maxacc	Position Units/Sec^2
Required - FPV	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. These values are 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	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 value 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 executed with its stop mode is 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.

For axes running in Velocity, Torque or Frequency control mode (the latter is only available with CIP), if an axis' Programmed Stop Mode' is set to fast stop then when a controller mode change is done, this axis will have its servo disabled.

There is a time-out period of 60 seconds applied to the programmed stop process, after which the mode change occurs, 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. Four methods of stopping a given axis are currently supported.

The MSG instructions also use the same 60 second time-out as it also holds off mode change until active messages either complete or time-out. Axes running in Velocity, Torque or Frequency control (Frequency control is only available with CIP) and if an axis Programmed Stop Mode is set to fast stop then when a controller mode change is done, this axis will have its servo disabled.

Table 29 - Programmed Stop Mode Methods

Method	Description
Fast Stop	When the Programmed Stop Mode attribute is configured for Fast Stop, the axis is decelerated to a stop by 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 by 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 and Servo Action disabled, but the OK contact is left closed. Unless the drive is configured to provide some form of dynamic breaking, 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 and 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 and Servo Action disabled. Unless the drive is configured to provide some form of dynamic breaking, this results in the axis coasting to a stop. Recovering 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	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 can 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	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 acceleration jerk is specified as a percent of the Maximum. This value is only used by an S-Curve profile.

Maximum Deceleration Jerk can 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	SSV	DWORD	0:1 1:1 2.0	-	-	Bitmap 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.

Table 30 - Dynamics Configuration Bits Descriptions

Bit	Name	Description
0	Reduce S-Curve Stop Delay	Enable/disable the reduction of latency time when stopping motion with S-Curve velocity profile (MAS instruction).
1	Prevent S-Curve Velocity Reversals	Enable/disable 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. This bit limits the velocity overshoot to 50% of the programmed velocity by increasing the acceleration jerk as necessary.
3…31	Reserved	-

Motor Attributes

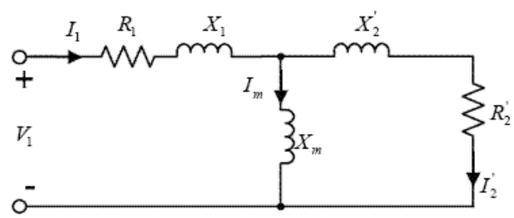
These are the motor configuration attributes associated with a Motion Control Axis that apply to various motor technologies. These motor technologies include three-phase motor rotary, linear, permanent magnet, and induction motors. Motor attributes are organized according to the various motor types.

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

This section defines the minimal set of required attributes to support integrated 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.

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 = ωL, where ω is the rated frequency of the motor. The prime notation, for example, X2', R2', indicates that the actual rotor component values X2 and R2 are referenced to the stator side of the stator-to-rotor winding ratio.

Figure 7 - 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.

General Motor Attributes

These are the general motor attributes that apply to all motor technologies.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Motor Catalog Number

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	Logix Designer	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 - D	MSG	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 Date Code

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D Motor NV	MSG	SHORT STRING	-	-	-	For example, Jan-01-2005

A 16-character string that specifies the manufacturing date of the motor. If the Motor Date Code 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 - D	GSV	USINT	0	-	-	Bits 0-3: Enumeration 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 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 axis 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 the nonvolatile 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 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 rejects 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 - D	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 ensure 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 valid only 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 is accepted by the drive without comparison.

Motor Type

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	SSV/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 are not set by configuration software or sent to the drive.

If Motor Data Source is Motor NV or Drive NV, the Motor Type can 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.

A Motor Type of Rotary Permanent Magnet or Linear Permanent Magnet is specifically associated with Surface Permanent Magnet (SPM) motor technology.

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 - D	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 because 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 - D	SSV(1)	USINT	0 DB	-	-	Enumeration 0 = Normal Polarity 1 = Inverted Polarity 2…255 = Reserved

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.

(1) SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

Motor Rated Voltage

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	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 - D	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	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	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 the 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 - D	GSV	REAL	100 DB	0	200	% 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 motors 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 be used by the drive to determine the absolute thermal capacity limit of the motor, i.e. 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 - D	GSV	SINT	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 check to detect a Motor Overtemperature condition. Connection to the motor thermal switch can be via the motor feedback interface, associated with Axis I/O Status bit, Feedback 1 Thermostat, or via 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 - D	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 - D	GSV	REAL	0 DB	0	∞	Joules /°C

The Motor Winding to Ambient 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 - D	GSV	REAL	0 DB	0	∞	°C/Watt

The Motor Winding to Ambient Resistance attribute is a floating point value that specifies the winding-to-ambient thermal resistance.

General Permanent Magnet Motor Attributes

These are the motor configuration attributes that apply to Permanent Magnet motor types in general.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

PM Motor Resistance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	SSV(1)	REAL	0 DB	0	∞	Ohms

The PM Motor Resistance attribute is a floating point value that specifies the phase-to-phase resistance of a permanent magnet motor.

(1) SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

PM Motor Inductance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D SPM Only	SSV(1)	REAL	0 DB	0	∞	Henries

The PM Motor Inductance attribute is a floating point value that specifies the phase-to-phase inductance of a permanent magnet motor.

(1) SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

PM Motor Flux Saturation

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D SPM Only	MSG Logix Designer	REAL[8]	[100, 100, 100, 100, 100, 100, 100, 100] DB	-	-	% 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	MSG Logix Designer	REAL	0 DB	-	∞	Henries

A floating point value that specifies the phase-to-phase, 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	MSG Logix Designer	REAL	0 DB	-	∞	Henries

A floating point value that specifies the phase-to-phase, 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	MSG Logix Designer	REAL	[100, 100, 100, 100] DB	-	-	% Nominal Inductance

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 Continuous 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	MSG Logix Designer	REAL	100 DB	-	-	% Nominal Inductance

A floating point value that specifies 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 flux 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	USINT	–	–	–	Enumeration: 0 = False 1 = True

This 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 via 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 shall be based on the Bus Overvoltage Speed. If the PM Motor Extended Speed Permissive is True, the Motor Overspeed Limits shall be based on the Max Extended Speed value.

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 - D	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 - D	SSV	REAL	0 DB	0	∞	Inertia Units

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 - D	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 the 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 - D	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 is 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 motor speed, maximum encoder speed, or 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 - D	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 - D	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 - D	GSV	REAL	0	0	∞	% Motor Rated

The Rotary Motor Fan Cooling Derating attribute selects the percent 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.

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 - D	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 millimeters, and is equivalent to the electrical cycle length.

Linear Motor Rated Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	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 - D	SSV	REAL	0 DB	0	∞	Mass Unit

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 - D	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 meter/second. This speed is 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 - D	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 - D	GSV	SINT	0 DB		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.

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 - D	GSV	REAL	0 DB	0	∞	N•m

The PM Motor Rated Torque attribute is a floating point value 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 - D	SSV(1)	REAL	0 DB	0	∞	N•m/A (RMS)

The PM Motor Torque Constant attribute is a floating point value that specifies the torque constant of a rotary permanent magnet motor in Newton-meters per RMS amp.

(1) These configuration attributes cannot be changed with a Set service or SSV instruction if the axis is in the Running state.

PM Motor Rotary Voltage Constant

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	SSV(1)	REAL	0 DB	0	∞	Volts (RMS)/KRPM

The PM Motor Rotary Voltage Constant attribute is a floating point value 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-m/A) = 0.01654 * Ke (V/Krpm).

(1) These configuration attributes cannot be changed with a Set service or SSV instruction if the axis is in the Running state.

PM Motor Rotary Bus Overvoltage Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Option - PVT PM Only	Set	REAL				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 (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 via 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
Option - PVT PM Only	Set	REAL				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 via 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 shall apply this maximum speed value as the Max Value for this attribute.

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 - D	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.

PM Motor Force Constant

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	SSV(1)	REAL	0	0 DB	∞	N/Amp (RMS)

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.

(1) SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

PM Motor Linear Voltage Constant

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	SSV(1)	REAL	0 DB	0	∞	Volts (RMS)/(m/s)

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/second.

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 these equation: Kf (N/A) = 1.732 * Ke (V/(m/s)).

(1) SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

PM Motor Linear Bus Overvoltage Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - PVT PM Only	Set	REAL	–	–	–	m/s

The PM Motor Linear Bus Overvoltage Speed attribute 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 via 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	REAL	–	–	–	m/s

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 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 via 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 shall apply this maximum speed value as the Max Value for this attribute.

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	GSV	REAL	0 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 - D	SSV(1)	REAL	0 DB Eq 19	0	∞	Amps (RMS)

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.

(1) This parameter has a strong motor temperature component that some drives circumvent through various adaptive control or compensation techniques.
SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

Induction Motor Stator Resistance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	SSV(1)	REAL	0 DB Eq 19	0	∞	Ohms

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 R1 in the IEEE motor model.

(1) This parameter has a strong motor temperature component that some drives circumvent through various adaptive control or compensation techniques.
SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

Induction Motor Stator Leakage Reactance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	SSV(1)	REAL	0 DB Eq 19	0	∞	Ohms

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 X1 in the IEEE motor model.

(1) SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

Induction Motor Magnetization Reactance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D (1)	SSV(2)	REAL	0 DB	0	∞	Ohms

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 Xm in the IEEE motor model.

(1) This parameter has a strong motor temperature component that some drives circumvent through various adaptive control or compensation techniques.
(2) SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

Induction Motor Rotor Resistance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D (1)	SSV(2)	REAL	0 DB	0	∞	Ohms

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 R2 in the IEEE motor model.

(1) This parameter has a strong motor temperature component that some drives circumvent through various adaptive control or compensation techniques.
(2) SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

Induction Motor Rotor Leakage Reactance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional	SSV(1)	REAL	0 DB Eq 19	0	∞	Ohms

The Induction Motor Rotor Leakage Reactance 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 X2 in the IEEE motor model.

(1) This parameter has a strong motor temperature component that some drives circumvent through various adaptive control or compensation techniques.

Induction Motor Rated Slip Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	SSV(1)	REAL	0 FD	0	∞	RPM (rotary motor type) m/s (linear motor type)

The Induction Motor Rated Slip Speed attribute represents the amount of slip at motor rated current (full load) and motor rated frequency.

(1) This parameter has a strong motor temperature component that some drives circumvent through various adaptive control or compensation techniques.

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	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 by using a rotary system of units. Linear enumeration indicates that the load is moving linearly and load dynamics are measured by using a linear system of units.

Transmission Ratio Input

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	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	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	GSV	USINT	0 DB	-	-	Enumeration 0 = None (R) 1 = Screw (0) 2 = Belt and Pulley (0) 3 = Chain and Sprocket (0) 4 = Rack & Pinion (0) 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	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	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	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	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.

Feedback Attributes

These are all position feedback related attributes associated with a Motion Control Axis that apply to various feedback device and feedback interface technologies. These feedback interface technologies include the following:

- 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® and Hiperface DSL® (by Stegmann) and EnDat 2.1 & EnDat 2.2 (by Heidenhain). The Usage column for an attribute is often based on the context of the Feedback Type. To facilitate this, abbreviations for the various Feedback Types are defined in Table 31.

Table 31 - Feedback Type Abbreviations

Abbreviation	Feedback Type
ED	EnDat 2.1 and 2.2
HD	Hiperface DSL
HI	Hiperface

Table 31 - Feedback Type Abbreviations

Abbreviation	Feedback Type
INT	Integrated
LT	LDT - Linear Displacement Transducer
RS	Resolver
SC	Sine/Cosine
SL	Stahl SSI
SS	SSI
TM	Tamagawa Serial
TP	Digital Parallel
TT	Digital AqB

This section defines the minimal set of required attributes to support integrated motion device interchangeability. This guarantees that there is sufficient parametric data provided by the controller for any integrated 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 via 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.

Table 32 - Logical Feedback Channel Control Functions

Logical Feedback Channel	Motion Control Function	Master Feedback Function
Feedback 1	Motor Feedback & 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	Redundant Motor Feedback	Redundant Motor Feedback 1
Feedback 4	Redundant Motor Feedback	Redundant Motor 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 the Control Mode is set to No Control for a Motion Control Axis, a different logical feedback channel can be used as the master feedback source, for example, Feedback 1 and Feedback 2. Generally, Feedback 1 is used.

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, 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 and 2.

Attribute IDs are assigned based on the channel number. Support for feedback interface channels 1 and 2 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 follow the Usage rules. A Usage rule of 'Req - E' or 'Opt - E' indicates that the attribute is generally applicable to all Device Function 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. Table 33 outlines these rules.

Table 33 - Feedback Configuration Rules

Feedback Configuration	Feedback 1	Feedback 2
No Feedback	No	No
Master Feedback	Yes	No(1)
Motor Feedback	Yes	No
Load Feedback	Yes(2)	Yes
Dual Feedback	Yes	Yes
Dual Integrator Feedback	Yes	Yes

(1) Feedback 2 channel only needed if Feedback Master Select supports Feedback 2 channel option.
(2) Feedback 1 channel needed for commutation of PM Motors.

General Feedback Info Attributes

These are the general feedback information attributes associated with a Motion Control Axis.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Feedback n Serial Number

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG	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 the Feedback Serial Number is not available, the drive sets this attribute to a Null string.

Feedback n Catalog Number

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG	SHORT STRING	-	-	-	For example, SRM-50

A 32-character string that specifies the catalog number of the device associated with Feedback n. If the Feedback Catalog Number is not available, the drive sets this attribute to a Null string.

General Feedback Signal Attributes

These are the general feedback signal attributes associated with a Motion Control Axis.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Position Feedback n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	MSG	T	DINT	-	-	-	Feedback n Counts

The Position Feedback n attribute is the actual position of the axis based on Feedback n.

Velocity Feedback n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	MSG	T	REAL	-	-	-	Feedback n Units / Sec

Actual filtered velocity of the axis based on Feedback n.

Acceleration Feedback n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	MSG	T	REAL	-	-	-	Feedback n Units / Sec^2

Actual filtered acceleration of the axis based on Feedback n.

Feedback nU Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG	T	REAL	-	-	-	Feedback n Counts Valid for n = 1 or 2

The Feedback nU Position attribute is an actual position of the axis based on unscaled Feedback n.

Feedback nU Velocity

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG	T	REAL	-	-	-	Feedback n Units / Sec Valid for n = 1 or 2

Actual filtered velocity of the axis based on un-scaled Feedback n.

Feedback nU Acceleration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG	T	REAL	-	-	-	Feedback n Units / Sec^2 Valid for n = 1 or 2

Actual filtered acceleration of the axis based on un-scaled Feedback n.

Feedback nS Position

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG	T	REAL	-	-	-	Scaled Feedback n Counts Valid for n = 3 or 4

Actual position of the axis based on scaled Feedback n.

Feedback nS Velocity

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG	T	REAL	-	-	-	Scaled Feedback n Units/ Sec Valid for n = 3 or 4

Actual position of the axis based on scaled Feedback n.

Feedback nS Acceleration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG	T	REAL	-	-	-	Scaled Feedback n Units/ Sec^2 Valid for n = 3 or 4

Actual filtered acceleration of the axis based on scaled Feedback n.

Feedback Configuration Attributes

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

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Feedback Configuration

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	USINT	0 (BF) 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 9…15 = Vendor Specific Bits 5…7 = Reserved

The Feedback Configuration attribute determines how the various available feedback channels are used to implement the selected Control Mode. 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, except in the case of an active redundant feedback source. The Feedback Configuration attribute is used by the controller to set the Feedback Mode attribute that is sent to the drive device.

Table 34 - Feedback Configuration Bit Descriptions

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, as specified by the Feedback Master Select attribute, 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 used only 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	SSV(1)	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 = Dual Int Feedback Bits 9…15= Vendor Specific

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. Bits 4…7 are reserved for future use.

The 4-bit enumerated Feedback Mode attribute determines how the various logical feedback channels are used to implement the selected Control Mode for this axis. 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 Feedback 1, except in the case of an active redundant feedback source.

Table 35 - Feedback Mode Bit Descriptions

Bit	Usage	Name	Description
0	R/S	No Feedback	No Feedback is selected when encoderless/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, as specified by the Feedback Master Select attribute, 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 used only 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	-

See Interpreting the Attribute Tables on page 61 for usage codes.

(1) SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

When modified programmatically, via 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 because that feedback channel has not been configured. Table 36 describes valid Feedback Modes.

Table 36 - Feedback Mode SSV Promotion Rules

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 Master Select

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - N	MSG		USINT	1	-	-	Enumeration: 0 = (Reserved) 1 = Feedback 1 2 = Feedback 2 2…255 = Reserved

Actual filtered acceleration of the axis based on scaled Feedback n.

Feedback Unit Ratio

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E PV only	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 Resolution Unit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG Logix Designer	USINT	0	-	-	Enumeration: 0 = Cycles/Unit (R) 1 = Units/Cycle (O) 2 = Bits/Unit (O) 3…127 = Reserved 128…255 = Vendor Specific

Unit of measure for feedback resolution used by Feedback n Cycle Resolution attribute. Default selection is Cycles/Unit where resolution is expressed in feedback cycles per revolution for rotary feedback devices or per meter for linear feedback devices. If Units/Cycle is selected then Feedback n Cycle Resolution shall be expressed in Nanometers/Cycle for linear feedback devices. This selection is not applicable to rotary devices. If Bits/Unit is selected then Feedback n Cycle Resolution is expressed as 2n Cycles per revolution of a rotary feedback device, where n is the number of bits in the binary position representation of the device. This selection is not applicable for linear devices.

Feedback n Unit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	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 is scalable to the configured Motor Unit; if the Motor Unit is set to Rev, Feedback 1 is set to Rev; if Motor Unit is set to Meter, Feedback 1 Unit is 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	GSV	USINT	0 DB	-	-	Enumeration 0 = Not Specified (R) 1 = Digital AqB (0) 2 = Digital AqB with UVW (0) 3 = Digital Parallel (0) 4 = Sine/Cosine (0) 5 = Sine/Cosine with UVW (0) 6 = Hiperface (0) 7 = EnDat Sine/Cosine (0) 8 = EnDat Digital (0) 9 = Resolver (0) 10 = SSI Digital (0) 11 = LDT (0) 12 = Hiperface DSL (0) 13 = BiSS Digital (0) 14 = Integrated (0) 15 = SSI Sine/Cosine (0) 16 = SSI AqB (0) 17 = BiSS Sine/Cosine (0) 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 type 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.

The `Integrated' Feedback Type is specified for CIP Motion compliant devices with an integral feedback transducer function, for example, a integrated motion encoder.

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 is not set by configuration software nor are they sent to the drive. For example, by selecting the Feedback 1 Type, with or without UVW commutation signals, the device applies the UVW commutation start-up method or the Self-Sense start-up method, respectively. In this case, UVW commutation signals can be derived from UVW tracks integral to the feedback device or via separate Hall sensors in the motor.

All other Feedback 1 Type, selections would apply the Digital commutation start-up 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	SSV(1)	USINT	0	-	-	Enumeration 0 = Normal Polarity 1 = Inverted Polarity 2… 225 = Reserved

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 device's 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.

(1) SSV - This attribute cannot be changed with a SSV instruction if the axis is in the Running state, for example, Tracking Command.

Feedback n Startup Method

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E	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 zeroes the feedback count accumulator at powerup. The first Actual Position value sent to the controller in the Cyclic Data Block of the Device-to-Controller connection at power-up shall be 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 powerup 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 Start-up Method to the Feedback Type selection. In these cases, an attempt by the controller to incorrectly configure the Feedback Startup Method generates a General Status error of Invalid Attribute Value.

Feedback n Cycle Resolution

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E Not LT	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

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 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 represent the pole count of the device. Digital serial cycles, for example, SSI or parallel absolute feedback devices, 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 Table 37.

Table 37 - Feedback Unit and Type Selection

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
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

The default Feedback Startup Method value depends on the associated Feedback Type according to Table 38.

Table 38 - Feedback Type and Startup Method

Feedback Type	Default Feedback Startup Method
Digital AqB	Incremental
Digital Parallel	Absolute
Sine/Cosine	Incremental
Hiperface	Absolute
EnDat Sine/Cosine	Absolute

Table 38 - Feedback Type and Startup Method

Feedback Type	Default Feedback Startup Method
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 Interpolation

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E Not LT	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 because there is no opportunity of device-based interpolation. The effective resolution of the feedback device in Feedback Counts per Feedback Unit is determined by the combination of 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	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…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	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 the 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	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	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 the 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	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	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	GSV	REAL	4000	-	-	Hertz

The Feedback n Resolver Excitation Frequency attribute is the frequency of the sinusoidal excitation signal applied to the designated resolver feedback device. The 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	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 the resolver cable.

Feedback n LDT Type

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E LT	MSG	USINT	0	-	—	Enumeration: 0 = PWM 1 = Start/Stop Rising 2 = Start/Stop Falling 3…255 = Reserved

Determines the LDT type. Options are Start/Stop and PWM. Start/Stop transducers accept an input (interrogate) signal to start the measurement cycle and respond with two pulses on the Return line. Timing can be based on either the Rising or Falling edge. The time between the pulses is proportional to the position. PWM transducers respond to the interrogate signal with a single long pulse on the Return line. The pulse width is proportional to the position.

Feedback n LDT Recirculations

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - E LT	MSG	USINT	1	1	225	# Recirculations

Determines the number of recirculations associated with a PWM type LDT transducer. Multiple recirculations can be used to increase the resolution of the LDT at the expense of increasing the sample period.

Feedback n Loss Action

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	GSV	USINT	0	-	-	Enumeration 0 = GSV Exception (R) 1 = Switch to Sensorless Fdbk (O) 2 = Switch to Redundant Feedback (O) 3…255 = Reserved Valid for n = 1 or 2

The Feedback n Loss Action Valid 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 called the secondary feedback source.

Feedback n Scaling Ratio

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG	LREAL	0	-	-	Scaled Feedback Counts per Feedback n Count

Number of Scaled Feedback Counts per Feedback n Count. This value is used to convert between Position Units to the resolution of another feedback channel to support dynamic switching between feedback channels.

Feedback n Velocity Filter Taps

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	SSV	UINT	1	1	maxint	Delay Taps (n>= 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	SSV	UINT	1	1	maxint	Delay Taps (n>= 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	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	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
Required - E TM	GSV	USINT	1	-	-	Enumeration 0 = No 1 = Yes

The Feedback n Battery Absolute attribute determines if the battery is included in the battery-backed absolute feedback device, such as a Tamagawa Serial encoder. This allows the drive to qualify Feedback Battery Loss and Feedback Battery Low exception conditions.

Feedback Interface Behavior

Feedback Interface Behaviors include Feedback Sources, a Feedback Accumulator, Commutation Unwind and Offset, a Scaling Accumulator, Feedback Filtering, and Velocity and Acceleration Feedback Scaling.

Feedback Sources

Feedback signals can be derived from any of the four different feedback interface channels. The two primary feedback channels employed by the various closed loop control modes are designated Feedback 1 and Feedback 2. This lets the control loops 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. The Feedback Mode attribute determines which feedback source is used by the loop.

Each feedback interface is capable of supporting a number of different feedback device types as enumerated by the Feedback Type attribute. The feedback interface output is the number of feedback counts that the feedback device has moved because the last time the device was sampled. If the feedback device is an absolute device, the feedback interface determines the absolute position of the feedback device at powerup and communicates that value to the Feedback Accumulator to preset the accumulator.

Feedback Accumulator

The role of the Feedback Accumulator depends on the configured Feedback n Startup Method, which can be either Incremental or Absolute. If Incremental is selected, the accumulator simply accumulates changes to the feedback count value, a 32-bit signed integer, with every device update.

If Absolute is selected, the Feedback Accumulator works basically the same way as in Incremental mode. The only difference is the initialization of the accumulator at device powerup. In Incremental mode, the Feedback Accumulator is set to zero, while in Absolute mode, the accumulator is initialized to the absolute position of the feedback device. This allows for the recovery of absolute position through a power-cycle as long as power-off movement of the absolute feedback device is limited to half of the absolute feedback range of the device. There is no device requirement to extend the absolute position range of the feedback device through nonvolatile storage of the accumulator.

This simple absolute feedback handling mechanism is due to the fact that Integrated Motion on the Ethernet/IP network normally places the responsibility of extending the absolute position range of the axis, and establishing the absolute machine position reference on the controller.

Commutation Unwind and Offset

An Electronic Unwind block is also connected to the Feedback 1 interface. This block is designed to unwind, for example, apply modulo of 360 electrical degrees or the position accumulator output to generate a signal that is proportional to the electrical angle of a Permanent Magnet motor based on the Pole Count or Pole Pitch of the motor. To align this signal with the physical ABC windings of the motor rather than the zero of the feedback device, a configurable Commutation Offset is added prior to the Electrical Unwind block.

Scaling Accumulator

In addition to the standard Unscaled Accumulator, the integrated motion feedback interface design also defines a Scaled Accumulator for the secondary feedback channels. The purpose of this accumulator is to scale the Position Feedback n signal of the associated secondary feedback channel to create a scaled version of that signal, Feedback Position nS, which is based on a different feedback count resolution, the resolution of the associated primary feedback channels.

Feedback Filtering

Feedback Filtering is a programmable FIR differencing filter for each feedback channel to estimate velocity based on the change of feedback position over a given number of feedback samples. The simplest, and most common, configuration of the FIR filter is as a simple one tap delay that results in the change in feedback position because the last sample. Additional taps can be used to provide a better estimate of velocity when by using lower resolution feedback devices, but this is at the expense of adding additional delays to the control loop and lowering the bandwidth of the loop.

An advantage of by using a FIR filter for velocity feedback is that the FIR filter is sampling at the device update period. The resulting filter deeply attenuates feedback noise harmonically related to the PWM frequency. Another advantage of the FIR filter is it is manifested as a simple delay and can be easily compensated for, as part of the feedforward strategy.

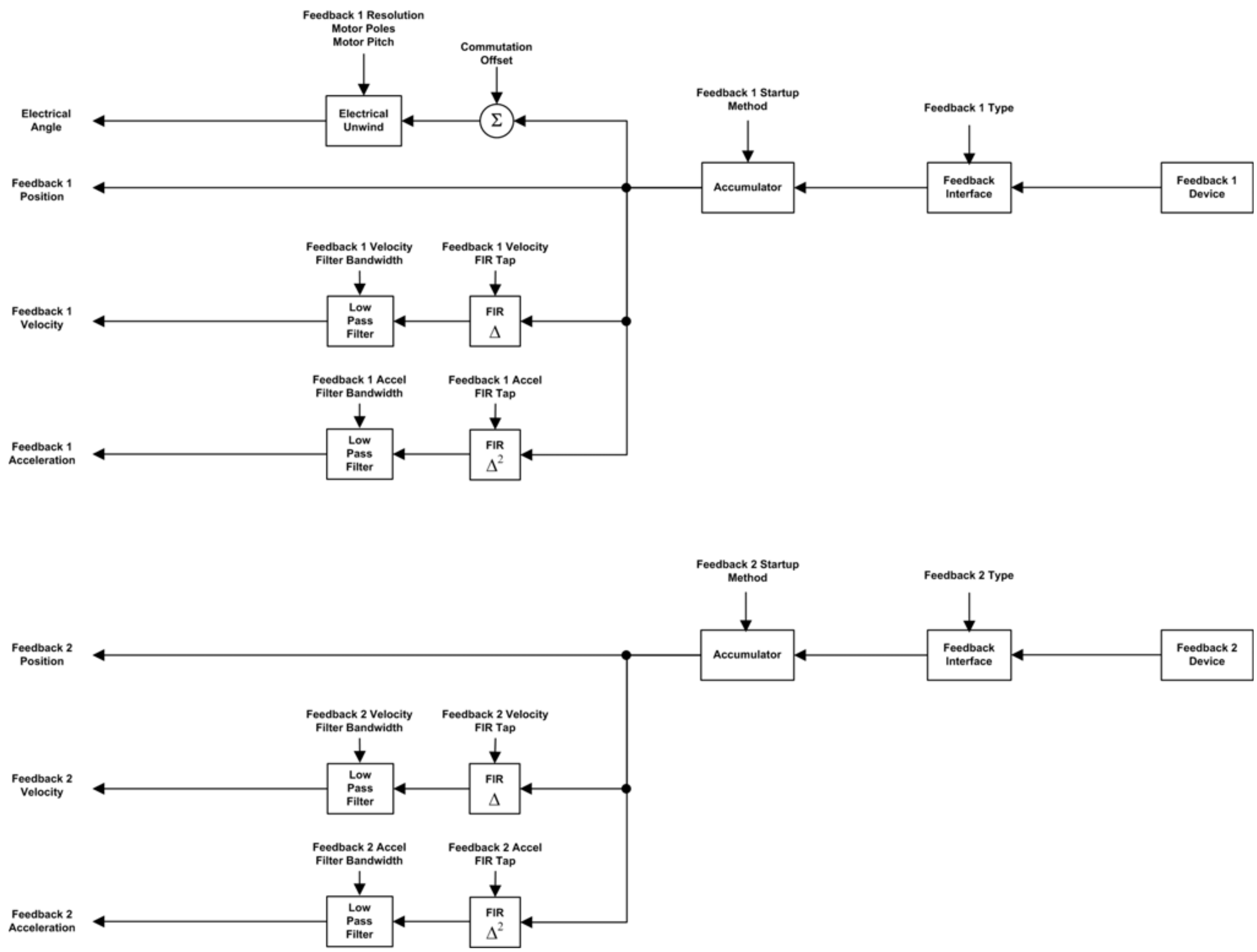
A separate programmable FIR filter is also defined for generating the acceleration feedback estimate. Conceptually, this filter is equivalent to two cascaded FIR differencing filters back-to-back. Separate configuration attributes are used to configure the number of taps used for the acceleration FIR and velocity FIR filters.

In addition to the FIR filters, a configurable low-pass IIR filter is for filtering the velocity and acceleration estimates for each feedback channel. These filters can be used to further reduce the level of quantization noise associated with differencing digital feedback signals. The bandwidth of the velocity and acceleration IIR filters for each feedback channel are individually programmable.

Velocity and Acceleration Feedback Scaling

After filtering, Feedback n Velocity and Feedback n Acceleration signals are scaled by the Feedback n Scaling Ratio to generate the Feedback nS Velocity and Feedback nS Acceleration signals. These signals are distinguished from their source feedback channel by the S suffix, indicating that the signal is a Scaled version of the associated feedback device.

Figure 8 - Feedback Channels 1 and 2



Event Capture Attributes

The event related attributes associated with a Motion Control Axis include registration, marker, and homing events. The Event Capture attributes are designed to support the possibility of up to 16 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 events related attributes are applicable only 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. This lets you implement controller 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.

For more information on registration attributes, see Motion Control Signal Attributes on page 71.

Registration Inputs

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	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	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	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	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	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	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	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	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	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.

Axis Event Bits

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV(1)	T	DINT	-	-	-	Bitmap - AxisFault 0 = WatchEventArmedStatus 1 = WatchEventStatus 2 = RegEvent1ArmedStatus 3 = RegEvent1Status 4 = RegEvent2ArmedStatus 5 = RegEvent2Status 6 = HomeEventArmedStatus 7 = HomeEventStatus 8…31= Reserved

The Axis Event Bits attributes are a collection of basic event conditions. This attribute is for use primarily by the system during execution of various Motion Event instructions.

(1) Direct Tag access is supported. Bit names shown are used as data type member names in the Logix Designer application and are shown in the semantics column.

Table 39 - 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.
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 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. The Home Event Status is set to true when the defined home event sequence is satisfied. • If the home type = Switch, the bit should go TRUE if an MAH instruction is executed and then the Switch is seen. • If the sequence is set for Marker, the Home Event Status bit should go true when the Marker is seen and an MAH is in process.

Event Capture Behavior

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

Event Input Sources

Event input sources currently supported by the object are Registration 1, Registration 2, Marker, and Home Switch. These four event input sources apply to each supported feedback channel.

Event Latches

To facilitate accurate capture of both feedback position and time, hardware event latches are typically implemented as shown in the following block diagram. 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 defined also 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.

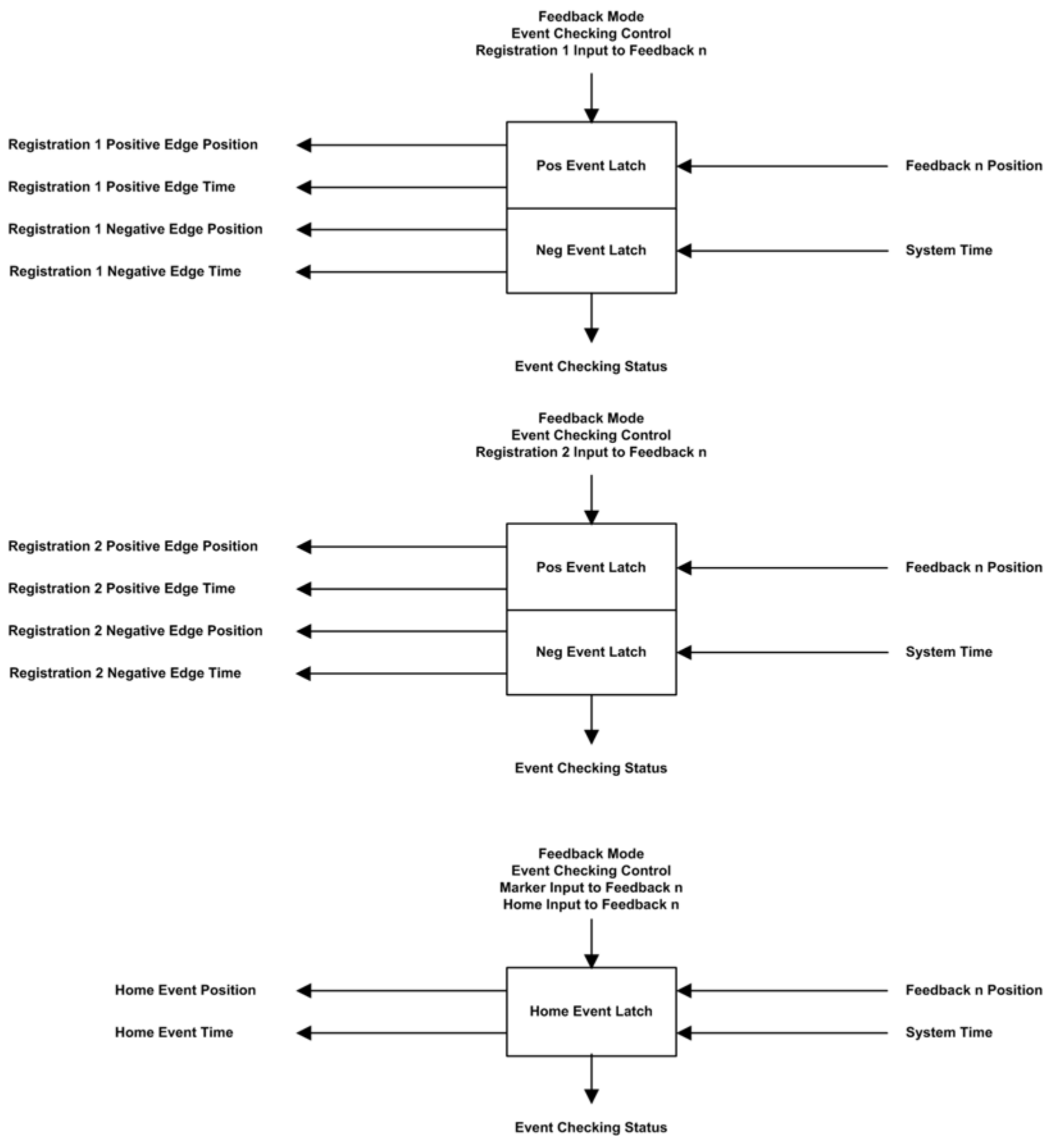
With hardware based event latches, event capture accuracy is, in general, limited only by the latency of the associated event input. Registration and Marker event inputs are lightly filtered so event capture accuracy is on the order of 1µs. In terms of position capture accuracy, that would be calculated 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…10 ms. Thus, to get an accurate position capture based on a home switch input transition, a homing sequence with a slow homing speed is required.

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.

One thing that should be done, however, is to adjust the event time stamp, t_0, should there be a shift in the System Time Offset for the device prior to transmitting to the controller; the event time stamp must always be based on the same System Time reference system at the time of transmission. For example, assume the device's System Time Offset is $Offset_0$ when the event timestamp, t_0, occurred. Assuming that the System Time Offset is t1 at the time that the event is to be transmitted to the controller, then t_0 is adjusted to be t1 prior to transmission with the rest of the associated event data to the controller, for example, $t_1 = t_0 + (Offset_1 - Offset_0)$.

Figure 9 - Event Capture Functionality



Command Reference Generation Attributes

These are the Command Reference Generation attributes related to the Motion Control Axis that converts command position, velocity, acceleration, and torque data output from a controller-based or device-based Motion Planner into corresponding command reference signals to the device's motor control structures. The command reference generator functionality includes fine interpolators, signal selector switches, dynamic limiters, and command notch filters.

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	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	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	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 second Differential Position output value of the Command Position fine interpolator.

Command Generator Configuration Attributes

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

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Skip Speed 1

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

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 half above and half 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	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	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	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	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	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 half at the beginning and half 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 the following:

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

The decelerating Jerk limit value also decreases according to the following:

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	SSV	SINT	0	0	1	0 = Flying Start Disabled 1 = Flying Start Enabled

The Flying Start Enable attribute is a boolean value that 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 configure 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 Enabled 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	SSV	BOOL	0	-	-	Enumerations: 0 = Encoder 1 = Counter EMF 2 = Sweep Frequency

The Flying Start Method attribute 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 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.

Command Notch Filter Frequency

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - PV	MSG	REAL	0	0	10^4	Filter Frequency Units

Controls the center frequency of the notch filter that is applied to the position, velocity, and acceleration command signals. This filter is useful in reducing the effects of anti-resonance when driving a compliant load. The Q, or 1/2Z, of the notch filter is set to 0.707. A value of 0 for this attribute disables this feature.

Command Generation Behavior

Command Generation includes these behaviors: Command Data Sources, Command Fine Interpolation, Command Ramp Generator, Feedforward Signal Selection, and Command Notch Filter.

Command Data Sources

Command data that affects axis motion can come from a variety of sources. The most common command data source is from a controller-based Motion Planner via 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 devices 'control structure at the devices' 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.

Both the Fine Command Interpolator and the Ramp Generator are functions of the Command Generator blocks shown in Figure 10 on page 163.

Command Fine Interpolation

For synchronized, high-performance applications by 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 blocks.

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 1^{st}, 2^{nd}, or 3^{rd} 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, the Motion Device Axis Object recommends a minimum order for the fine interpolators. Because contemporary Motion Planners typically generate their trajectories based on 3^{rd} 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 3^{rd} order, the velocity interpolator is 2^{nd} order, and the acceleration and torque interpolators are both 1^{st} order. Higher order fine interpolators are possible and are left to the vendors discretion.

Position Fine Interpolation Polynomial:

$$P(t) = a0 + a1 * (t-t0) + a2 * (t- t0)^2 + a3 * (t-t0)^3$$

Velocity Fine Interpolation Polynomial:

$$V(t) = b0 + b1 * (t-t0) + b2 * (t- t0)^2$$

Acceleration Fine Interpolation Polynomial:

$$A(t) = c0 + c1 * (t-t0)$$

Torque Fine Interpolation Polynomial:

$$T(t) = d0 + d1 * (t-t0)$$

In these equations, time t_0, represents the Command Target Time for the previous Motion Planner update such that when $t = t0$, the position, velocity, acceleration, and torque 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 0th order coefficients of the polynomials.

$P(t0) = P\_1 = a0$

$V(t0) = V\_1 = b0$

$A(t0) = A\_1 = c0$

$T(t0) = T\_1 = d0$

The higher order polynomial coefficients are calculated such that by the next Motion Planner update, corresponding to Command Target Time, t1, the position, velocity, acceleration, and torque command values are the values sent in the latest Motion Planner update, for example, P0, V0, A0, and T0.

$P(t1) = P0$

$V(t1) = V0$

$A(t1) = A0$

$T(t1) = T0$

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, t0, if there is a shift in the System Time Offset for the device; t0 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, t0, was received as Offset0. If the command interpolation equation is to be applied at t = t1 and the current System Time Offset is defined as Offset1, then t0 is adjusted as follows before executing the polynomial:

Adjusted t0 = t0 + (Offset1 – Offset0)

Alternatively, the values for t, t_0, and t1 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 vendors 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 formula's are as follows:

Position Fine Interpolation Polynomial Coefficients:

$a0 = P_{-1}$

$a1 = 1/T * (\Delta P0 – 1/2*\Delta V0 - 1/6*\Delta A0)$

$a2 = 1/T^2 * (1/2*\Delta V0)$

$a3 = 1/T^3 * (1/6*\Delta A0)$

Velocity Fine Interpolation Polynomial Coefficients:

$b0 = V_{-1}$

$b1 = 1/T * (\Delta V_0 – 1/2*\Delta A0)$

$b2 = 1/T^2 * (1/2*\Delta A0)$

Acceleration Fine Interpolation Polynomial Coefficients (Torque is same form as Accel):

$c0 = A_{-1}$

$c1 = 1/T * \Delta A0$

The above equations are based on the following nomenclature:

T = Controller Update Period

$\Delta P0 = (P0 – P_{-1})$

$\Delta V0 = (V0 – V_{-1}) = (P0 – 2P_{-1} + P_{-2})$

$\Delta A0 = (A0 – A_{-1}) = (V0 – 2V_{-1} + V_{-2}) = (P0 – 3P_{-1} + 3P_{-2} – P_{-3})$

The above polynomial coefficients should be applied to the fine interpolator as soon possible after t is equal to or greater than t0. Applying the new coefficients too early, for example, with significantly less than t0, can create unnecessary error in the command trajectory when connecting the last fine interpolator segment to the new fine interpolator segment at t0.

When t > t1, 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.

Command Ramp Generator

The Ramp Generator feature of the Command Generator block is applied to the Command Data 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 devices' 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.

While a Ramp Generator function could be included in each of the Fine Command Generator blocks for position, velocity, and acceleration commands, this version of the Motion Device Axis Object specification supports only a Ramp Generator in the Velocity Fine Command Generator block.

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.

Feedforward Signal Selection

The Fine Command Generators defined as part of the Motion Device Axis Object 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.

Command Notch Filter

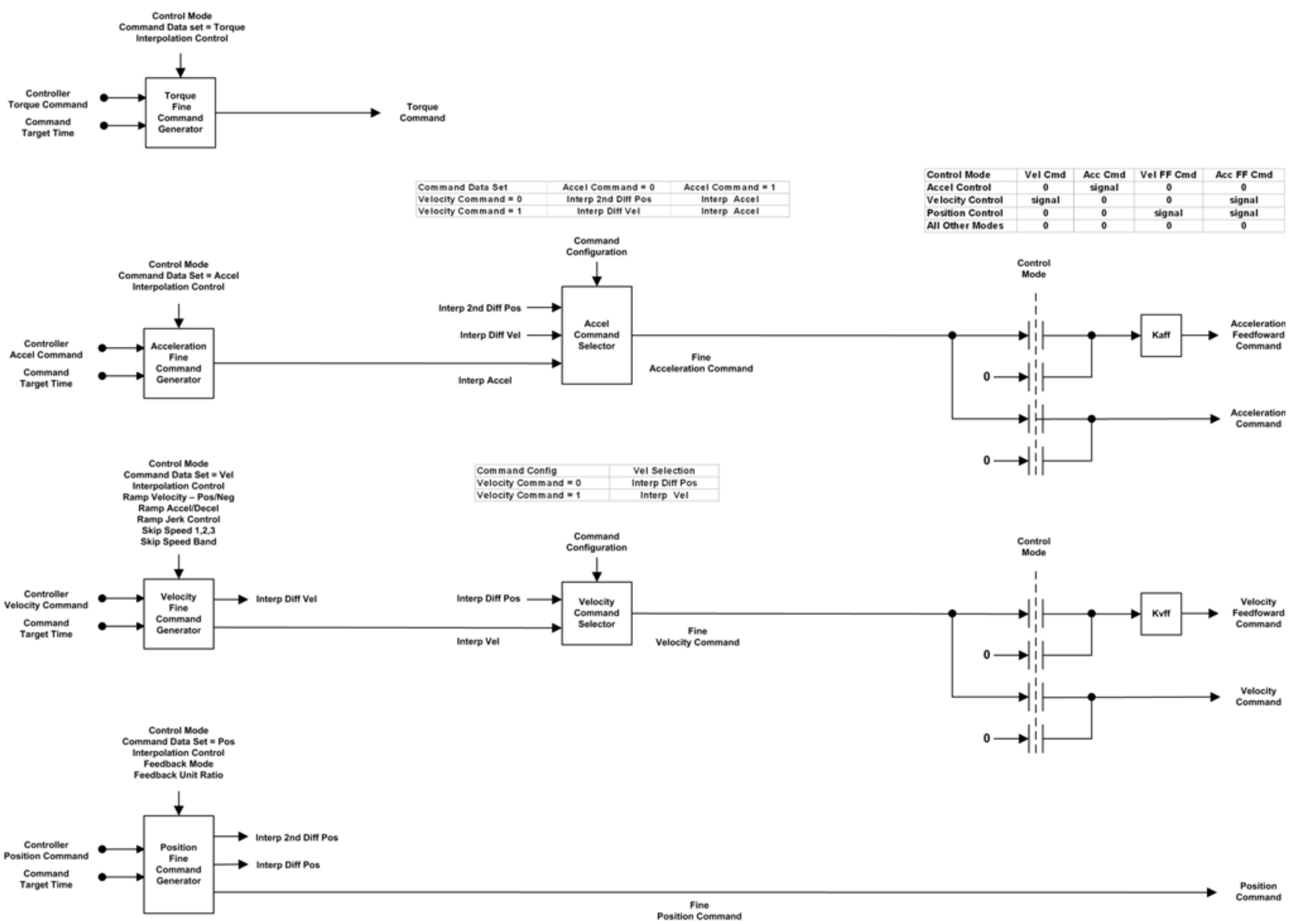
The resulting position command and feedforward signals then pass through a position command notch filter. The purpose of this set of filters is to reduce anti-resonance behavior of a compliant motor load by filtering out any commanded motion around the anti-resonance frequency.

The equation for this filter is as follows:

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

In this equation, Q represents the sharpness of the notch, which is typically hard-coded in the device.

Figure 10 - Command Generator



Control Mode Attributes

These are the control mode attributes associated with a Motion Control Axis. They include Position Loop and Velocity Loop attributes.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Position Loop Attributes

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

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Position Command

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

Command position output from the fine interpolator (if active) into position loop when configured for position loop control.

Position Trim

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	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	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	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 Feedback

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	MSG	T	REAL	-	-	-	Position Units

Position feedback value channeled into the position proportional control summing junction.

Position Integral Feedback

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

Position feedback value channeled into the position integral control summing junction.

Position Error

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

The Position Integrator Output attribute is the output of the 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	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.

Position Control Behavior

In Position Control mode, the only operative Control Method supported is Closed Loop servo control.

Closed Loop Position 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.

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 uses the Feedback 2 channel and the velocity loop uses the Feedback 1 channel. Because 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 via the Unit Scaling block by using the Feedback Unit Ratio.

Position PI Gains

The Proportional Gain of the classic 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.

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 the use of the position integral gain control as described above, 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, 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 tweaked to accommodate velocity loops with finite loop gain. One thing that may force a smaller Velocity Feedforward value is that increasing amounts of feedforward tends to exacerbate axis overshoot. For this reason, feedforward is not recommended for point-to-point positioning applications.

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:

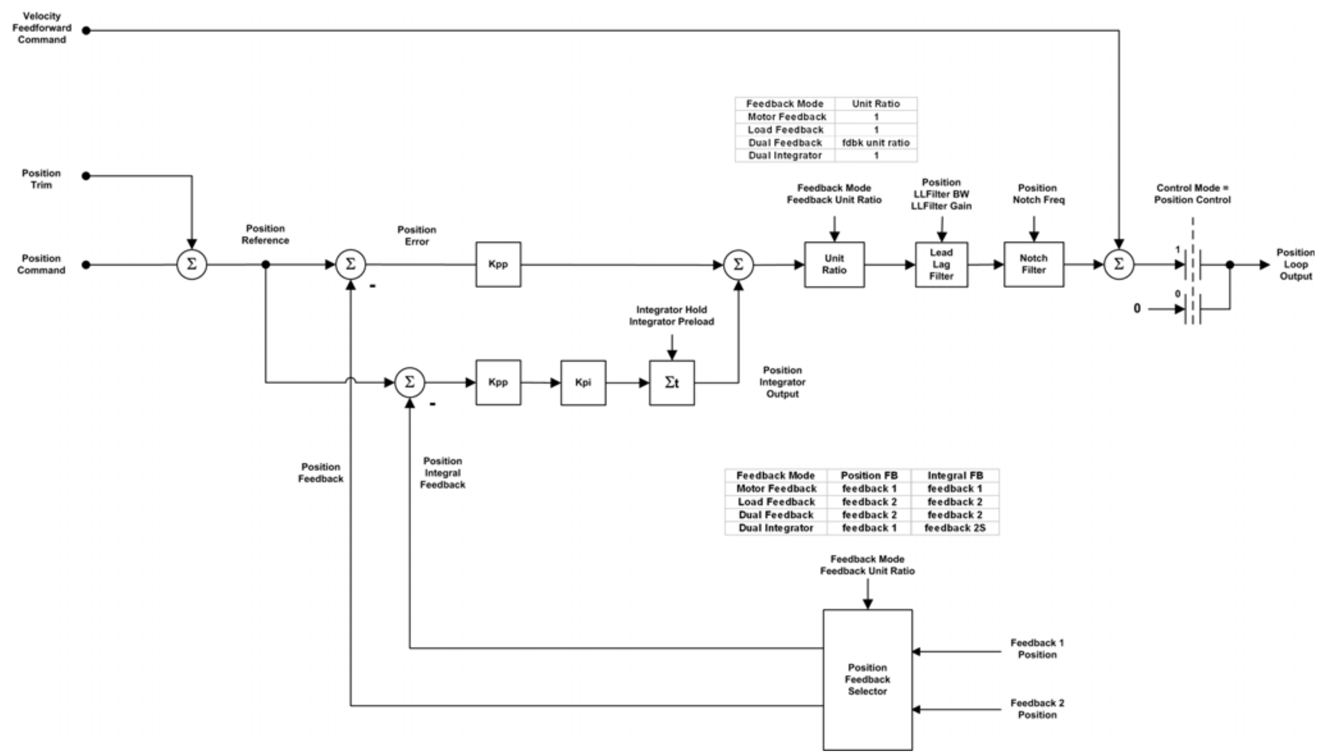
- If Kn > 1, the filter provides lead compensation.
- If Kn < 1, the filter provides lag compensation.
- If Kn = 0 the lead-lag filter becomes a pure low pass filter. If Kn = 1, the filter is disabled.

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:

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

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.

Figure 11 - Closed Loop Position Control



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. Figure 12 on page 170 further defines this open loop Velocity Control method.

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.

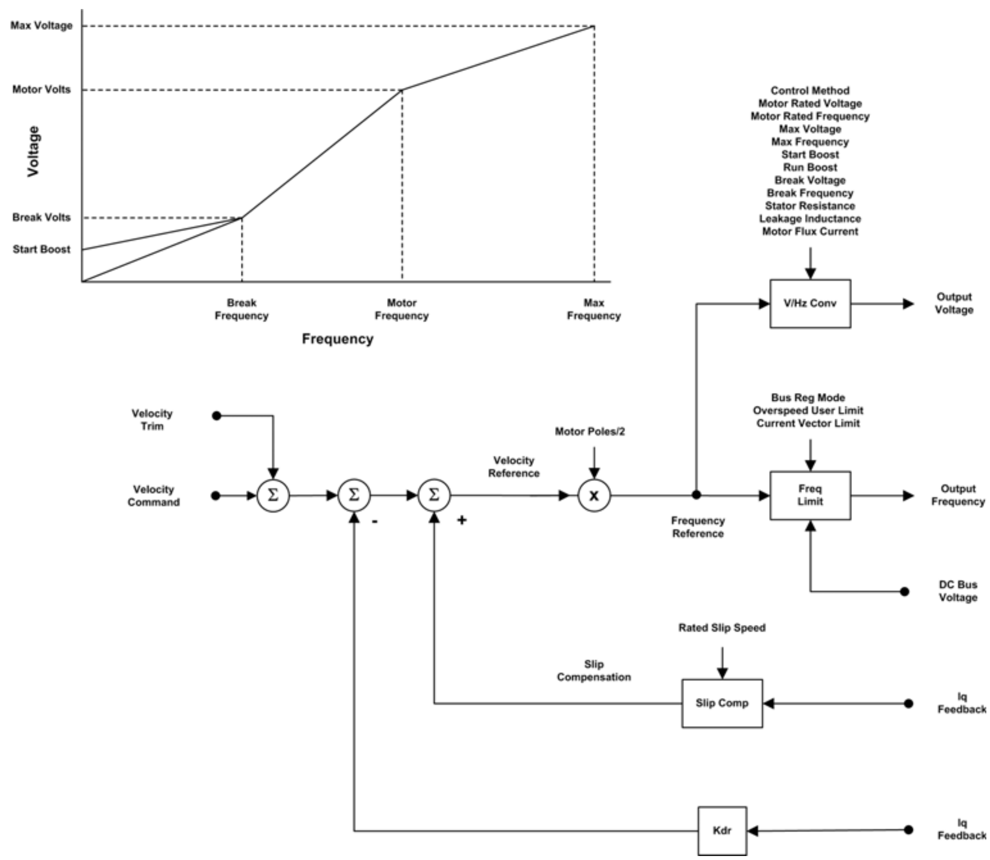
Slip Compensation

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.

Figure 12 - Open Loop Frequency Control



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	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	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	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	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	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	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	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	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 a 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	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	SSV		BYTE	0 0:0 1:0	-	-	Bitmap 0 = Integrator Hold Enable (R) 1 = Auto-Preset (0) 2…7 = Reserved

The Position Integrator Control attribute controls the behavior of the position loop integrator while commanding motion via 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	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.

Velocity Loop Attributes

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

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Velocity Command

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - FPV	MSG	T	REAL	0	-	-	Velocity Units

Command velocity output from fine interpolator (if active) into velocity loop when configured for velocity loop control.

Velocity Trim

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

The Velocity Reference Command is a velocity reference into the 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	GSV	T	REAL	-	-	-	Velocity Units

The Velocity Feedback Command is the actual 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 specified by the Feedback Master Select attribute. If the axis is configured for Frequency Control, the Velocity Feedback signal is derived from the Velocity Reference signal. If the axis is configured for Sensorless Velocity Loop operation, for example, 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	GSV	T	REAL	-	-	-	Velocity Units

The Velocity Error command is the 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	GSV	T	REAL	-	-	-	Accel Units

The Velocity Integrator Output Command is the output of the 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	GSV	T	REAL	-	-	-	Accel Units

The Velocity Loop Output Command is the output of the 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	GSV	T	DINT	-	-	-	Enumeration: 0 = Not Limited 1 = Positive Limit 2 = Negative Limit 3 = Bus Overvoltage Limit 4 = Motor Max Limit 5 - 127 = (Reserved) 128 - 255 = Vendor Specific

The Velocity Limit source specifies the source of the operative velocity limit.

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	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. Because the Velocity Trim value is available as a tag value, real time velocity corrections must be done by using the Velocity Trim attribute.

Acceleration Feedforward Gain

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	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	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	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	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	SSV		REAL	0	0	∞	Velocity Units/Sec/%Rated

The Velocity Droop value 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 be specified in velocity units per percent rated torque output. This parameter is also valid for V/Hz devices and its behavior is nearly identical, but instead of percent rated being related to torque, percent rated is related to current.

Velocity Error Tolerance

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - PV	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 an Excessive Velocity Error exception.

Velocity Error Tolerance Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - PV	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	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 via 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	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	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	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 - FPV	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 fall 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	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 fall 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	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 this velocity limit value is exceeded, the device responds by clamping the velocity reference to this limit and setting the Velocity Limit status bit.

Velocity Limit - Negative

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - FPV	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 this velocity limit value is exceeded, the device responds by clamping the velocity reference to this limit and setting the Velocity Limit status bit.

Velocity Limit - Bus Overvoltage

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - PV	GSV		REAL	0 Eq 21	0	∞	Velocity Units

The Velocity Limit - Bus Overvoltage attribute establishes a limit on the magnitude of the velocity reference value allowed into the velocity summing junction to protect the drive from damage due to bus overvoltage conditions that can occur when disabling a moving PM motor. If the signal entering the velocity limiter exceeds this velocity limit value, and the "Velocity Limit - Bus Overvoltage Permissive" is False, the velocity limiter clamps the velocity reference to this value and sets the Velocity Limit status bit. If the "Velocity Limit - Bus Overvoltage Permissive" is True, or the value of this attribute is 0, this limit is not applied.

Velocity Limit - Motor Max

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - PV	SSV		REAL	0 Eq 21	0	∞ or Motor Max Speed	Velocity Units

The Velocity Limit - Motor Max attribute establishes a limit on the magnitude of the velocity reference value allowed into the velocity summing junction to protect the motor from damage due to an over-speed condition. 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.

If the related optional attribute, Rotary or Linear Motor Max Speed, is supported, software shall apply this maximum speed value as the Max Value for the Velocity Limit - Motor Max attribute.

Velocity Limit - Bus Overvoltage Permissive

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - PV	SSV		USINT	0	0	1	Enumeration: 0 = False 1 = True

The Velocity Limit - Bus Overvoltage Permissive attribute determines whether Velocity Limit - Bus Overvoltage is applied to the velocity limiter. Setting this value to True, removes velocity limit protection against Bus Overvoltage conditions associated with PM motors. In this case it is critical that Bus Overvoltage protection be provided via a resistive brake module or DC bus regulation device.

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. 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 automatically switches 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.
2	SLAT Max Speed/Torque	Drive automatically switches from Torque Control to speed control if Velocity Error > 0 and switches back to Torque Control if Velocity < SLAT Set Point for SLAT Time.

SLAT Set Point

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - V	SSV		REAL	-	-	-	Velocity Units

The SLAT Set Point attribute determines when the Speed Error levels switches from Speed control to Min/Max control.

SLAT Time Delay

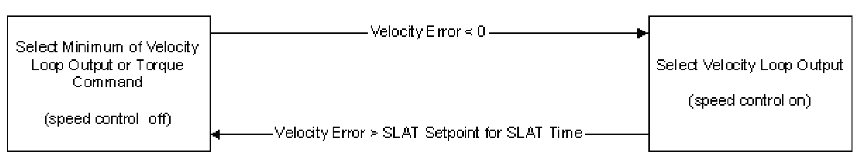
Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - V	SSV		REAL	-	-	-	Seconds

The SLAT Time Delay attribute is the 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 Figure 13. In this state, the torque reference is the minimum, or Min function, of the Velocity Loop Output or the Torque Command.

Figure 13 - 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.

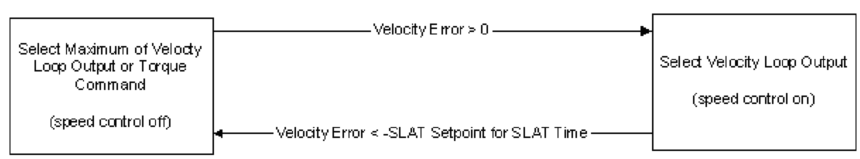
If the mechanical speed limitation is removed, for example, a web break, the motor accelerates and the Velocity Error becomes negative when the motor speed exceeds the Velocity Command. At this time, an automatic transition to speed control occurs and the Velocity Loop Output is selected as the Torque 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 similarly to SLAT Min Speed/Torque mode, except that the signs have changed to allow the feature to work in the negative direction.

Figure 14 - 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.

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

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 as described in Position Control Behavior on page 165.

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 classic 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 classic limiter block to produce the Velocity Reference signal into the velocity loop. The Velocity Limiter block 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 via a classic 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.

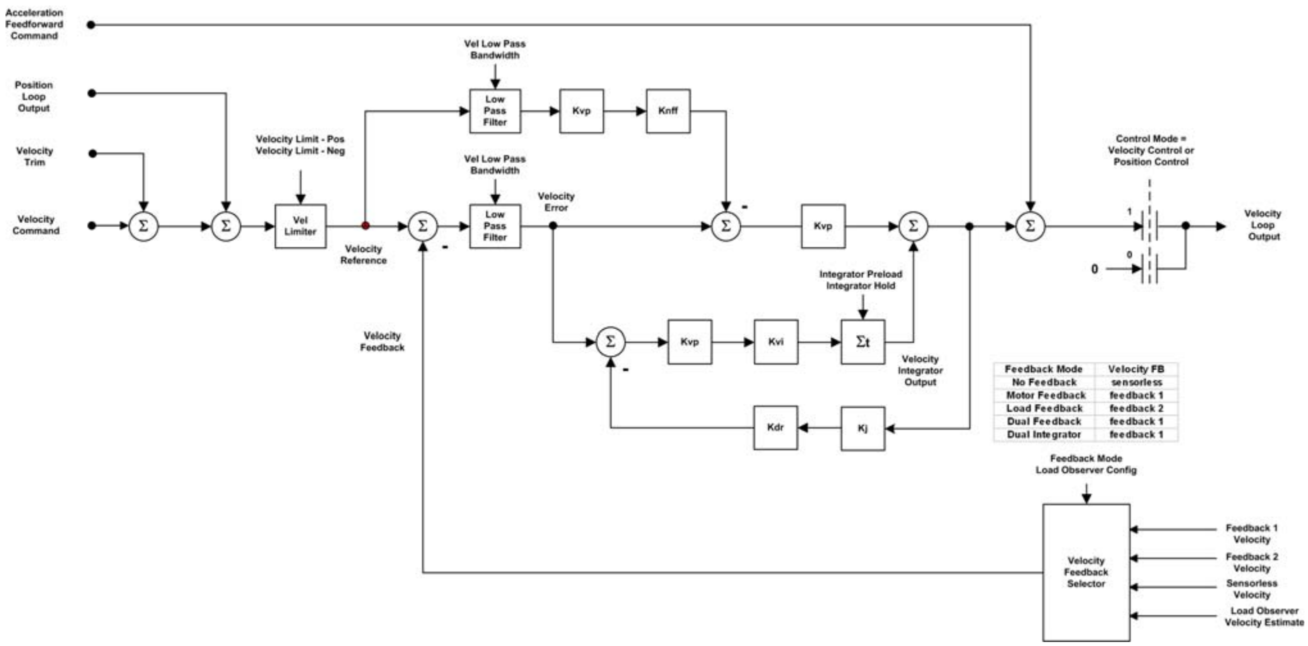
Because many closed loop motion control applications require near zero control loop error, this behavior is not desirable. Again, the position and velocity loop error could be reduced by applying the velocity integral gain control as described above, but the integrator action is still too slow to be 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 tweaked 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.

Figure 15 - Closed Loop Velocity Control



Acceleration Control Attributes

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

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Acceleration Command

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	MSG		REAL	0	-	-	Accel Units

The command acceleration output from fine interpolator (if active) into acceleration loop when configured for acceleration control.

Acceleration Trim

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	SSV	T	REAL	0	-maxacc	maxacc	Accel Units

The Acceleration Trim attribute is an 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	GSV	T	REAL	-	-	-	Accel Units

The Acceleration Reference Command is the acceleration reference into acceleration loop summing junction.

Acceleration Feedback 1

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

The Acceleration Feedback attribute is the 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	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	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.

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	SSV		USINT	If enum 2 is valid: 2 Else 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	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	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	SSV		REAL	0.5	0	∞	

The Load Observer Feedback Gain attribute is a value that, when configured for Acceleration Feedback, multiplies the Load Observers 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	SSV		REAL	0 FD	0	∞	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 - C	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.

Acceleration Control Behavior

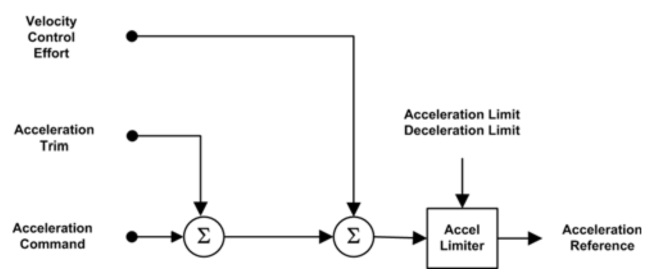
While dynamic motor control via an acceleration command is not common in the industry, Acceleration Control completes the dynamic progression from Velocity Control to Torque Control. The output of the velocity loop, Velocity Loop Output, also has units of acceleration. So, like the other control modes, we 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.

See Torque Control Behavior on page 196 for more information about how torque input is derived.

Acceleration Limiter

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

Figure 16 - Acceleration Limiter



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.

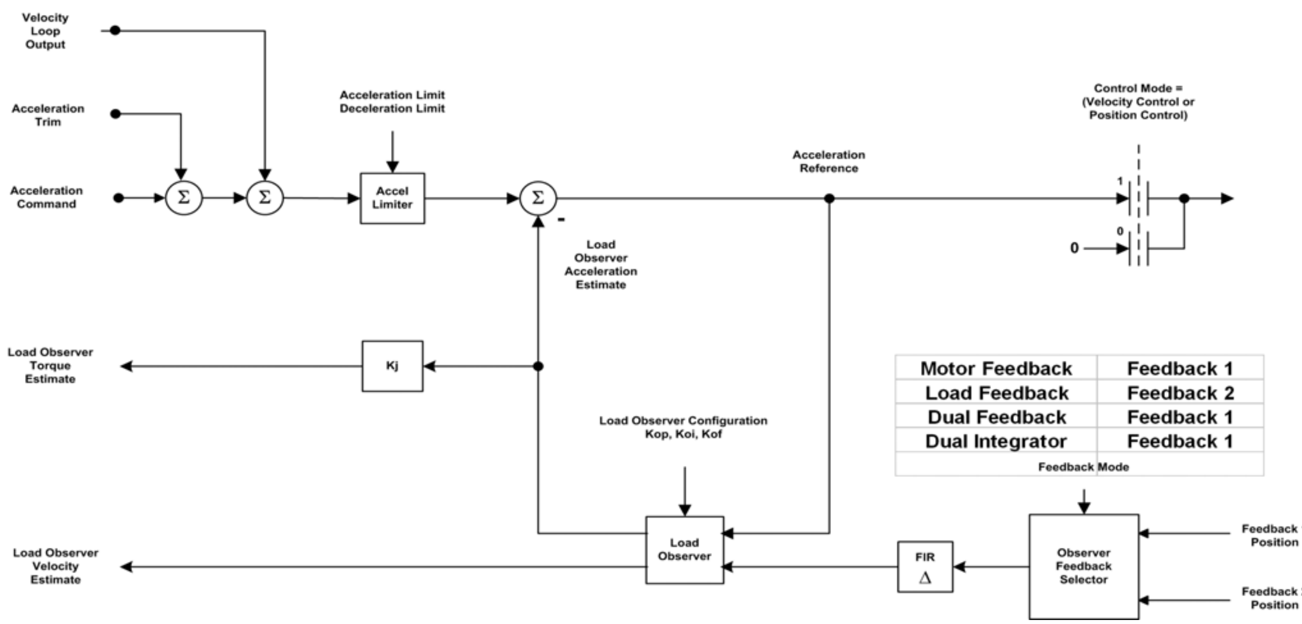
When configured for Acceleration Feedback operation, the Load Observer Acceleration Estimate represents an acceleration feedback signal. Applying this signal to the acceleration reference summing junction forms a closed acceleration loop. Scaling the Load Observer Acceleration Estimate signal by the 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 via 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.

Figure 17 - Acceleration Control with Load Observer



Torque/Force Control Signal Attributes

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

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Torque Command

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

The Torque Command attribute commands the torque output from fine interpolator (if active) into torque input summing junction when configured for Torque Control.

Torque Trim

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

The Torque Trim attribute is an 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	GSV	T	REAL	-	-	-	% Motor Rated

The Torque Reference attribute commands the 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	GSV	T	REAL	-	-	-	% Motor Rated

The Torque Reference Filtered commands the torque reference input signal after torque filter section.

Torque Reference Limited

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

The Torque Reference Limited attribute commands the torque reference input signal after torque limiter section.

Torque Inertia Estimate

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	MSG	T	REAL	-	-	-	% Motor Rated / (Motor Units/Sec^2)

Estimated Total Inertia or mass of the axis based on output of Inertia Observer. This value is directly applied to Kj to adapt to changing load inertia or mass.

Torque/Force Control Configuration Attributes

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

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Torque Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	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 can be sent synchronously to the drive every connection update. Because the Torque Trim value is available as a tag value, real time torque corrections are done by 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	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	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 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 affect 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	SSV		REAL	0	0	∞	Position Units

The Backlash Compensation Window attribute 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	SSV		REAL	0	0	100	% Motor Rated

The Friction Compensation Sliding attribute is the 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	SSV		REAL	0	0	100	% Motor Rated

The Friction Compensation Static attribute is the value added to the current/torque command to offset the effects of static friction, sometimes referred to as sticktion.

Friction Compensation Viscous

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

The Friction Compensation Viscous attribute is the 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	SSV		REAL	0	0	∞	Position Units

The Friction Compensation Window 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	SSV		REAL	0	0	10^4	Filter Frequency Units

The Torque Lead Lag Filter Bandwidth attribute 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	SSV		REAL	1	0	∞	

The Torque Lead Lag Filter Gain 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 1 disables the filter.

Torque Low Pass Filter Bandwidth

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

The Torque Low Pass Filter Bandwidth attribute is the break frequency for the low pass filter applied to the torque reference signal.

Torque Notch Filter Frequency

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

The Torque Notch Filter Frequency attribute is the center frequency of the notch filter applied to the toque 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
Optional - C	SSV	T	REAL	100	-	10^3	% Motor Rated

The Torque Limit Positive attribute is the value that 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.

If an invalid number is applied to the `axis.TorqueLimitPositive' attribute using Cyclic Write, the invalid value is reflected in the axis tag but does not transfer to the drive. Instead, the last valid attribute value continues to be applied to the drive. In this condition, the attribute value applied and acted upon by the drive is not the attribute value reflected by the `axis.TorqueLimitPositive' tag.

Torque Limit - Negative

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

The Torque Limit Negative attribute is the value that 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 Notch Filter High Frequency Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	SSV		REAL	Eq 18	20	2*Eq 18	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	SSV		REAL	Eq 18	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	SSV		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	GSV	T	REAL	-	-	-	Filter Frequency Units

The estimate 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	GSV	T	REAL	-	-	-	% Motor Rated

This estimate 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	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 Notch Filter Tuning 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 Notch Filter Tuning to Gain Stabilization or Notch Filter Tuning 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	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 one any time the Adaptive Tuning Configuration is Disabled or set to Notch Filter Tuning. The value is initialized to one when the drive is power cycled or reset.

Adaptive Tuning Configuration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	SSV		USINT	0	-	-	0 = Disabled 1 = Notch Filter Tuning 2 = Gain Stabilization 3 = Notch Filter Tuning and Gain Stabilization 4…255 = Reserved

The Adaptive Tuning Configuration attribute is an 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 Notch Filter Tuning, the Torque Notch Filter Frequency Estimate attribute value, determined by the Adaptive Tuning function, is applied to the Torque Notch Filter Bandwidth of the associated axis. All other servo loop attributes are applied directly without intervention of the Adaptive Tuning function.

When configured for Gain Stabilization, the servo loop gain values are scaled by the Adaptive Tune Gain Scaling Factor and 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 Tuning and Gain Stabilization, the Torque Notch Filter Frequency Estimate attribute value, determined by the Adaptive Tuning function, is applied to the Torque Notch Filter. In addition, servo loop gain attributes are scaled by the Adaptive Tune Gain Scaling Factor and the Torque Low Pass Filter Bandwidth Estimate is 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 shall persist.

When the Adaptive Tuning Configuration is set to Disabled or Notch Filter Tuning, 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.

Inertia Observer Filter Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	MSG		REAL	100	0	10^4	Filter Frequency Units

Set the frequency for inertia observer low pass filter applied to the Total Inertia Estimate.

Inertia Observer Configuration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	MSG		USINT	0			Enumeration: 0 = Disabled (R) 1 = Inertia Observer (O)

Controls the operation of the Inertia Observer block. The Inertia Observer dynamically measures the total inertia of the system. The Load Torque Observer and the Inertia Observer are mutually exclusive features and, therefore, shall not be enabled at the same time.

Cogging Compensation Table

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	MSG		Struct {UINT, REAL[1024]}			0	Struct { Length, % Motor Rated [ ] }

List of values that represent the cogging torque profile of the motor over one electrical cycle. The 0th element of the array corresponds to an electrical angle of 0 degrees. An ideal motor with no cogging would have a value of 100% for all elements in the array. A value above 100% would provide additional 1/Kt gain to the torque reference, while a value below 100% would reduce the 1/Kt gain.

Torque Limit - Positive

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

The Torque Limit Positive attribute is the value that 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	SSV		REAL	-100 FD	-10^3	0	% Motor Rated

The Torque Limit Negative attribute is the value that 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	SSV		REAL	10^6	0	∞	% Motor Rated/Sec

The Torque Rate Limit attribute 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	SSV		REAL	90 FD	0	10^3	% Motor Rated

The Torque Threshold attribute 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	SSV		REAL	200	0	10^3	% Motor Rated

The Overtorque Limit attribute is the 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 results 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	SSV		REAL	0	0	10^3	Seconds

The Overtorque Limit Time 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 Overtorque feature.

Undertorque Limit

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

The Undertorque Limit attribute is the 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	SSV		REAL	0	0	10^3	Seconds

The Undertorque Limit Time attribute 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.

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.

Torque Input Sources

The Torque Control section can take input from a variety of sources depending on the Control Mode. Input to the Torque Reference path can come via 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 cancelling 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.

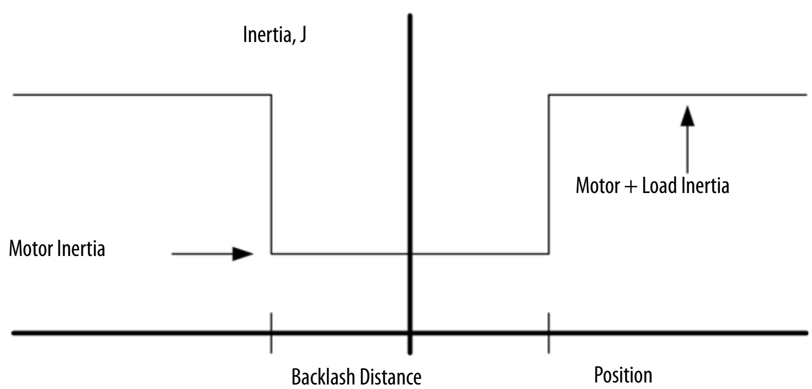
The acceleration units can be expressed in Feedback 1 or Feedback 2 Units based on the Feedback Mode setting. Therefore, in the case where Feedback 2 applies, the acceleration signal needs to be scaled by the Feedback Unit Ratio as shown by the Unit Ratio block in Figure 22 - Torque Control on page 203.

Backlash Compensation

A number of important compensation features are included in the Torque Control diagram. 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.

Figure 18 - Backlash Compensation, Inertia J

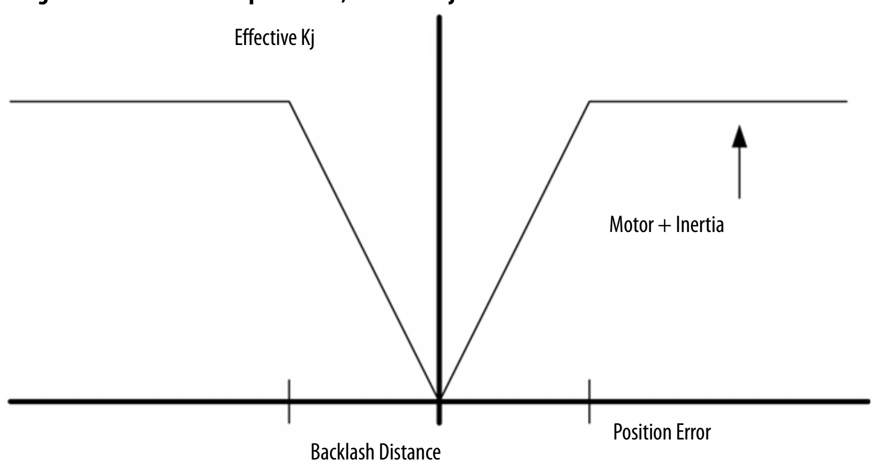


If the Velocity Control loop is tuned for peak performance with the load applied, the axis will be, at best, under-damped and, at worst, unstable in the condition where the gear teeth are not engaged. In the worst case scenario, the motor axis and the input gear oscillates wildly between the limits imposed 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, as shown in Figure 19 - Backlash Compensation, Effective Kj on page 198, that is a function of the position error of the position loop.

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.

Figure 19 - Backlash Compensation, Effective Kj



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.

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.

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.

Figure 20 - Led-Lag Filter

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

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 affect 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:

Figure 21 - Notch Filter Equation

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

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.

Torque Limiter

The Filtered Torque Reference signal passes through a limiter block to produce the Limited Torque Reference signal. The Torque Limiter block 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 limit block is a built in Torque Rate of Change Limit. This feature limits the rate of change of the torque reference output.

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. In other words, the 1/Kt scaling in the block diagram, Figure 22 has a nominal value of 1, for example, 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

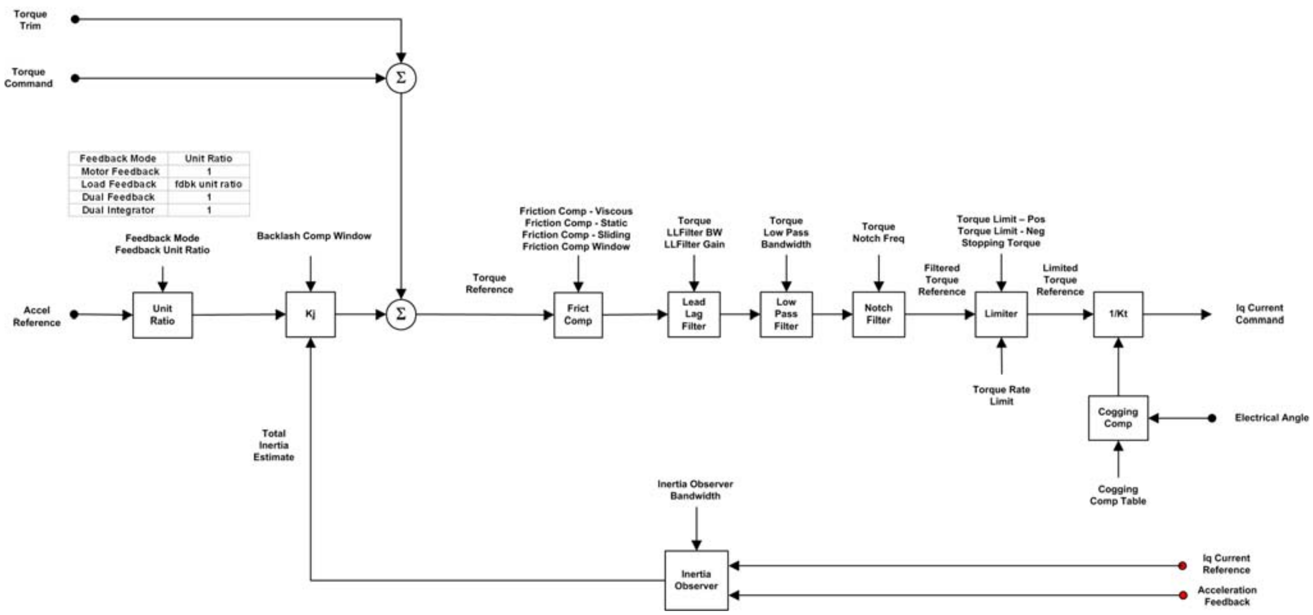
For PM motors, one of the more troublesome Kt variations to contend with is a position dependent variation to Kt known as motor cogging. The Kt scaling factor can be used to compensate for motor cogging by performing a test on the motor that generates a Kt versus Electrical Angle Cogging Compensation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

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 affect the acceleration of the load. By contrast, the Load Observer 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.

Figure 22 - Torque Control



Current Control Attributes

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

Current Command

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	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	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	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 limits when a current limit condition occurs.

Motor Electrical Angle

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

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

Current Disturbance

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

The Current Disturbance attribute injects the 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	GSV	T	REAL	-	-	-	% Motor Rated

The Current Error attribute is the 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	GSV	T	REAL	-	-	-	% Motor Rated

The Flux Current Error attribute is the 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	GSV	T	REAL	-	-	-	% Motor Rated

The Current Feedback attribute is the 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	GSV	T	REAL	-	-	-	% Motor Rated

The Flux Current Feedback attribute is the actual flux current applied to the axis based on current sensor feedback.

Torque Decoupling

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

Signal added to the Iq control loop output to compensate for the effects of Id.

Torque Voltage Output

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

Instantaneous Torque/Force producing output voltage.

Flux Decoupling

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

Signal added to the Id control loop output to compensate for the effects of Iq.

Flux Voltage Output

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

Instantaneous Flux producing output voltage.

U Voltage Output

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	MSG		REAL	-	-	-	Volts

Instantaneous voltage applied to U phase.

V Voltage Output

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	MSG		REAL	-	-	-	Volts

Instantaneous voltage applied to V phase.

W Voltage Output

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	MSG		REAL	-	-	-	Volts

Instantaneous voltage applied to W phase.

U Current Feedback

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	MSG		REAL	-	-	-	Amps

Instantaneous current measured on U phase.

V Current Feedback

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	MSG		REAL	-	-	-	Amps

Instantaneous current measured on V phase.

W Current Feedback

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	MSG		REAL	-	-	-	Amps

Instantaneous current measured on W phase

U Current Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	MSG		REAL	-	-	-	Amps

Offset for U Phase current transducer.

V Current Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	MSG		REAL	-	-	-	Amps

Offset for V Phase current transducer.

W Current Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	MSG		REAL	-	-	-	Amps

Offset for W Phase current transducer.

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	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	SSV	REAL	0 Eq 7	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 uses 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	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 cancellation, 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	SSV	REAL	0 DB	0	∞	Loop Bandwidth Units

The Flux Loop Bandwidth attribute 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 uses 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	SSV	REAL	0	0	∞	Seconds

The Flux Integral Time Constant attribute determines the response time of the flux producing current loop integrator. When used for Pole-Zero cancellation, 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	SSV	USINT	0	-	-	Enumeration 0 = No Delay (R) 1 = Manual Delay (O) 2 = Automatic Delay (O) 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 by whatever means prior to transitioning to the Running state.

Flux Up Time

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D IM	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.

Commutation Offset

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

The Commutation Offset attribute is a value that 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 allowing 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 or Database Offset, the drive shall 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 shall transition to the Start Inhibited state.

If the Commutation Alignment attribute is not set to Controller Offet 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 shall be Start Inhibited.

Commutation Self-Sensing Current

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - CE PM	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	SSV[1]	USINT	0	-	-	Enumeration 0 = Normal 1 = Inverted 2…255 = Reserved

When a PM motor is by using UVW signals for commutation startup, 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 via 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.

(1) SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

Commutation Alignment

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - CE PM	MSG	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) or Database Offset (4) 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 shall result in a Start Inhibit condition. Alignment can be achieved via 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.

Both Default and Valid Commutation Alignment values depend on the selected Feedback 1 Type as defined in the following Semantics section.

Commutation Offset Compensation

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - CE IPM only	Set	REAL	-	-	-	Electrical Degrees

The Commutation Offset Compensation attribute 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.

Feedback Commutation Aligned

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - CE PM	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

The Commutation Alignment parameter is set to Controller Offset (1) or Database Offset (4) 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:

- 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 results in a Start Inhibit condition. Alignment can be achieved via a Commutation Test that measures and sets the Commutation Offset for the motor or by direct user entry.
- Motor Offset (2) derives the commutation offset directly from the motor.
- Self-Sense (3) 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.
- Database Offset (4) 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.

The default commutation alignment value used for the Feedback Commutation Aligned and Commutation Alignment attributes depend on the associated Feedback Type and whether 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 the database, the motor data indicates if the motor is Factory Aligned.

Valid Commutation Alignment values used for the Feedback Commutation Aligned and Commutation Alignment attributes depend on the associated Feedback Type.

Table 40 - Feedback Type and Alignment Descriptions

Default Commutation Alignment			Valid Commutation Alignment Selections
Feedback Type	**Factory Aligned - True**	**Factory Aligned - False**	
Digital AqB	-	Self-Sense	Not Aligned | Self-Sense(1)
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(1)
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

(1) 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.

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.

Current Vector Limiter

The Iq Current Command passes through a Current Vector Limiter block before becoming the Iq Current Reference signal. This limiter block 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.

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.

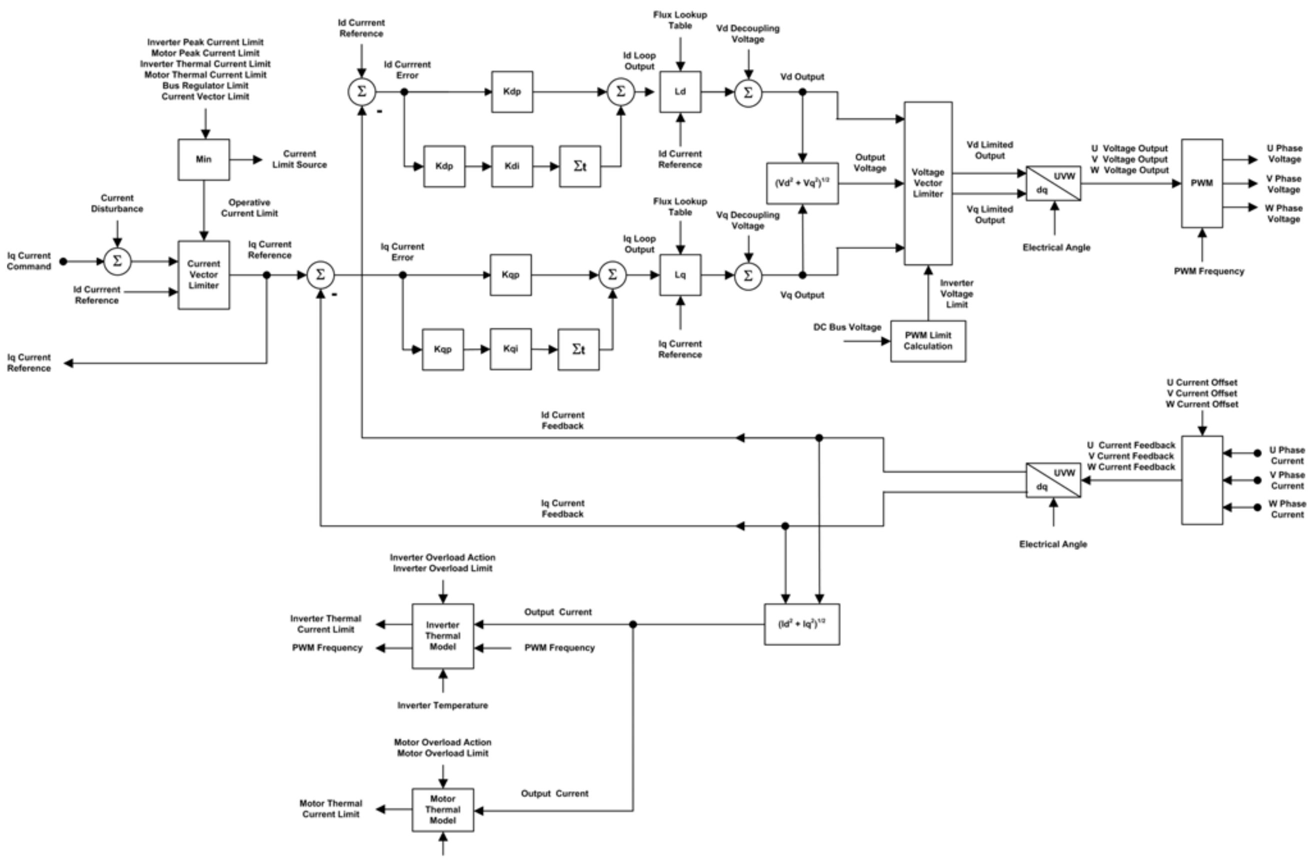
Current Feedback

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.

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.

Figure 23 - Closed Loop Current Vector Control



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	GSV	T	REAL	-	-	-	RPM

The Slip Compensation attribute indicates the actual amount of slip compensation currently being applied.

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	GSV	USINT	0	-	-	Enumeration 0 = Basic Volts/Hertz (R) 1…127 = Reserved 128 = Fan/Pump Volts/Hertz (O) 129 = Sensorless Vector (O) 130 = Sensorless Vector Economy (O) 131…255 = Vendor Specific

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 using 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	SSV	REAL	460	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	SSV	REAL	30	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	SSV	REAL	230	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. It is applicable only in Basic Volts/Hertz mode.

Break Frequency

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

The Break Frequency attribute sets the output frequency of the drive device at the Break Voltage where boost ends. It is applicable only in Basic Volts/Hertz mode.

Start Boost

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - F	SSV	REAL	8.5 Eq 20	0	∞	Volts (RMS)

The Start Boost attribute sets phase-to-phase voltage boost level for starting and accelerating. It is applicable only in Basic Volts/Hertz mode.

Run Boost

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - F	SSV	REAL	8.5 Eq 20	0	∞	Volts (RMS)

The Run Boost attribute sets the phase-to-phase voltage boost level for steady-state speed or deceleration. It is applicable only in Basic Volts/Hertz mode.

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	GSV	T	REAL	-	-	-	Hertz

The Output Frequency attribute is the time averaged output frequency applied to the motor. Frequency value is in terms of electrical cycles.

Output Current

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	GSV	T	REAL	-	-	-	Amps (RMS)

The Output Current attribute is the total time averaged output current applied to the motor.

Output Voltage

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	GSV	T	REAL	-	-	-	Volts (RMS)

The Output Voltage attribute is the total time averaged phase-to-phase output voltage applied to the motor.

Output Power

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	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	GSV	T	REAL	-	-	-	Amps

The Converter Output Current attribute is the Output current generated by the AC/DC Bus Converter. A positive value indicates current flow out of the converter, where the converter 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	GSV	T	REAL	-	-	-	Power Units

The Converter Output Power attribute is the output power generated by the AC/DC 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 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.

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	SSV	USINT	1 for C 0 for F	-	-	Enumeration 0 = Disabled and Coast 1 = Current Decel Disable 2 = Ramped Decel Disable 3 = Current Decel Hold 4 = Ramped Decel Hold 5…127 = Reserved 128…255 = Vendor Specific 128 = DC Injection Brake 129 = AC Injection Brake

When disabling or aborting an axis, via 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 in the Stopped state.
- 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 applied completes 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 the Stopped state the device's inverter power structure shall either be Disabled (Disable selection) and free of torque or actively held (Hold selection) in a static condition.

This attribute does not, in any way, determine the stopping actions applied in response to fault conditions.

Table 41 - Stopping Action Enumeration Definitions

Enumeration	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.
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 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/VF	Ramped Decel and Disable	Current 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 Current 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.
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. The method for generating holding torque is left to the drive vendor's discretion. This stop modes complies with the IEC-60204-1 Category 2 Stop.
5…127		Reserved	
128…255		Vendor Specific	
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 the 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	SSV	REAL	100 FD	0	10^3 FD	% 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 shall use the configured Positive and Negative Peak Current Limits.

Stopping Time Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	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. (See Mechanical Brake Engage Delay semantics section for details on the disable sequence).

If Stopping Time Limit is not supported a factory set timeout may be applied. Stopping Torque can be applied to bring the motor to a successful stop before the device is disabled and all current is removed from the motor.

Coasting Time Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	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 & 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 shall apply the Stopping Time Limit value. If Stopping Time Limit is not supported a factory set timeout may be applied. See Category 0 Stop Sequence on page 220 for details.

Resistive Brake Contact Delay

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

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. 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.

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 applicable only 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	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	SSV	REAL	0	0	10^3	Seconds

When enabling the axis, with an engaged mechanical brake, the Mechanical Brake Release Delay value determines the amount of time the device delays transition from the Starting state to the Running or Testing states. This delay prevents any commanded motion 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	SSV	REAL	0	0	10^3	Seconds

When disabling the motion axis by using a Category 1 Stopping Action, the Mechanical Brake Engage Delay value determines the amount of time the device power structure remains enabled after the axis has decelerated to a stop. This 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.

When disabling the motion axis, the Mechanical Brake Engage Delay value determines the amount of time the inverter power structure remains enabled after the axis has decelerated to a stop. This allows time for an external mechanical brake to engage. The configured Stopping Action determines the type of stopping sequence applied.

Stopping Sequences

There are three different stopping sequences defined by this object. 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.

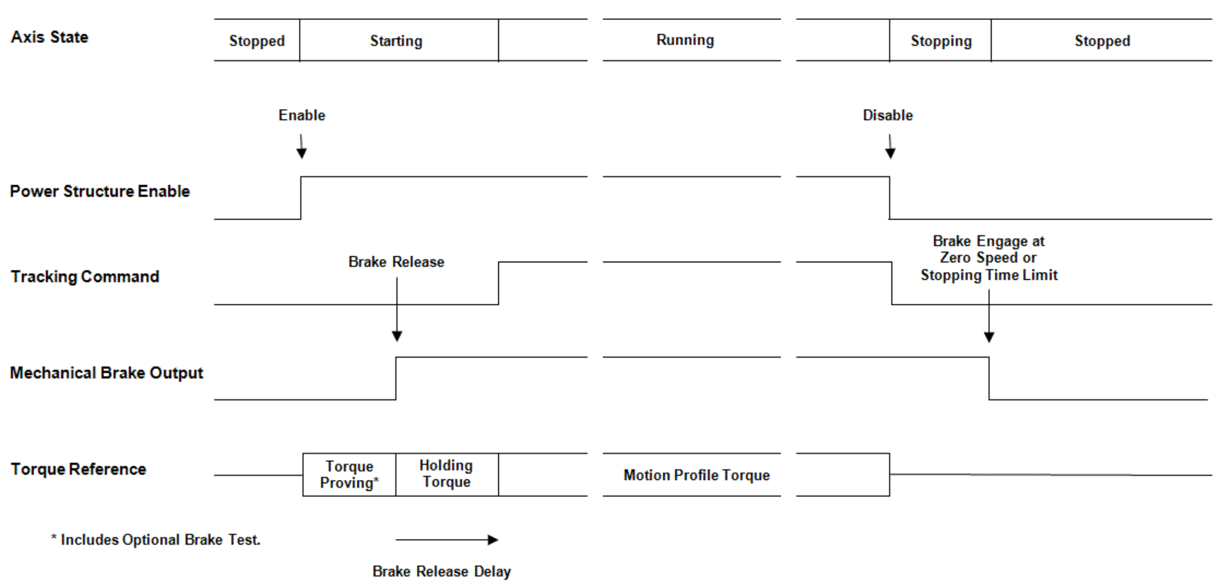
The following stopping sequences are defined in the context of a Disable Request generated stop, where the stopping methods are applied in the Stopping state and the stopping sequences ends up in the Stopped state. In the context of a Major Fault action, these same stopping methods are applied in the 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.

Figure 24 - Brake Control Sequence (Category 0 Stop)

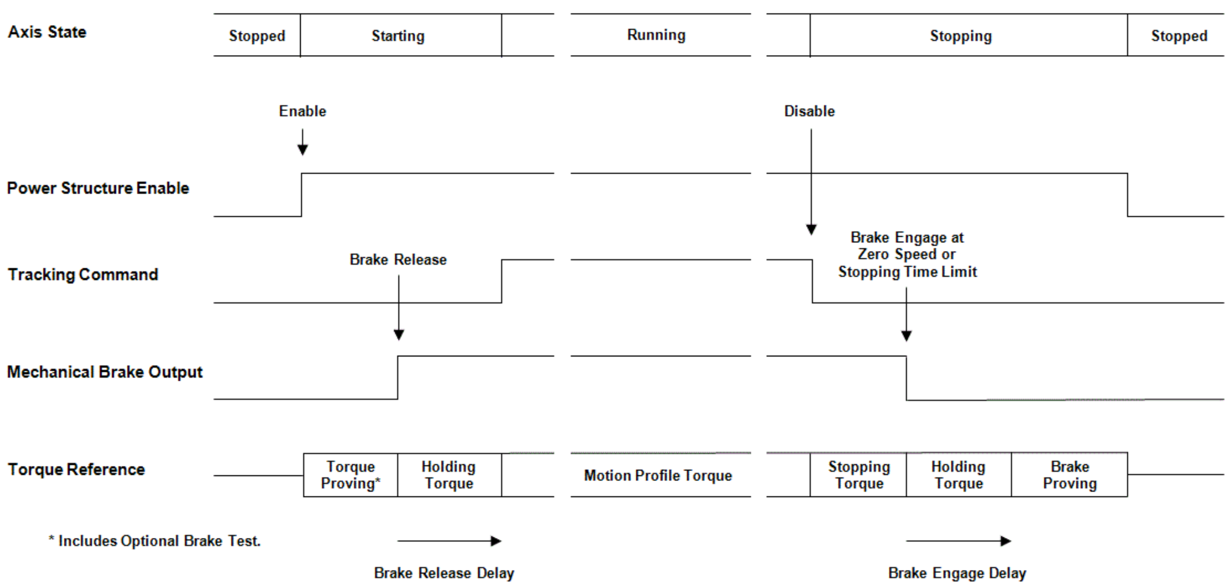


Category 1 Stop Sequence

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.

Figure 25 - Brake Control Sequence (Category 1 Stop)

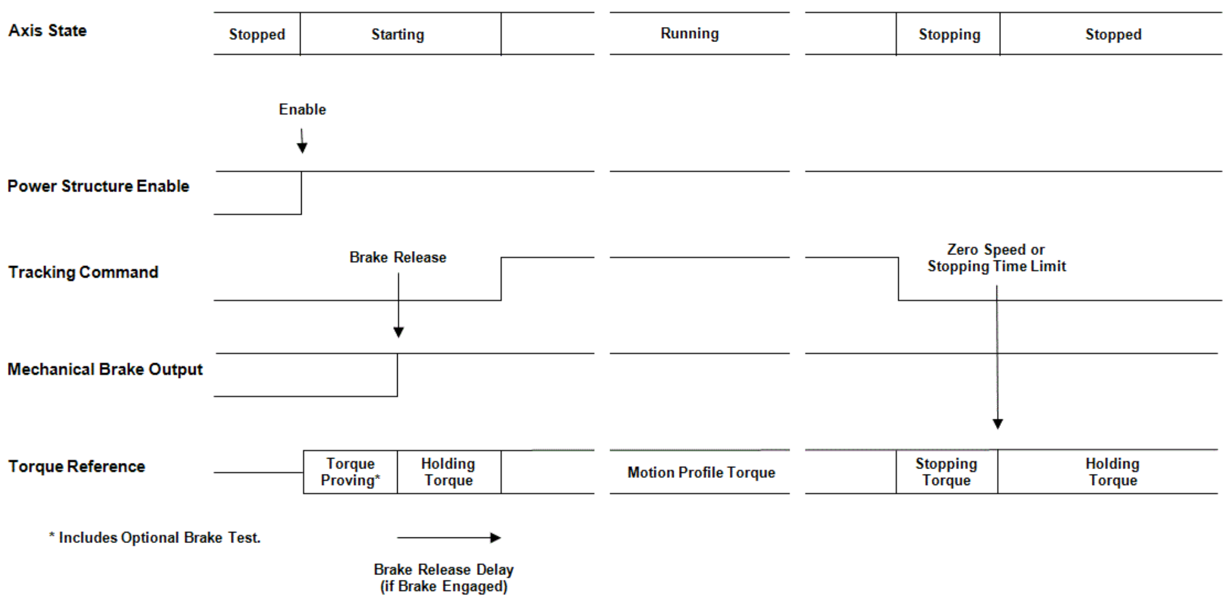


Category 2 Stop Sequence

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.

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.

Figure 26 - Brake Control Sequence (Category 2 Stop)



DC Injection Brake Current

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

The DC Injection Brake Current attribute defines the brake current level injected into the motor stator when you select `DC Injection Brake' as the Stopping Action.

DC Injection Brake Time

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D IM	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 the motor stator when you select `DC Injection Brake' as the Stopping Action.

Flux Braking Enable

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D IM	SSV	SINT	0	0	1	Enumeration 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.

Zero Speed

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	SSV	REAL	0	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.

Zero Speed Time

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	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, this 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 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.

Proving Configuration

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	SSV	USINT	0	-	-	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, for example, 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 attribute semantic sections below.

Proving Sub-Feature Attribute Dependencies

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 Attribute	Attribute Prerequisite
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 Increment

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.

Figure 27 - Drive Enable Sequence with Proving Feature

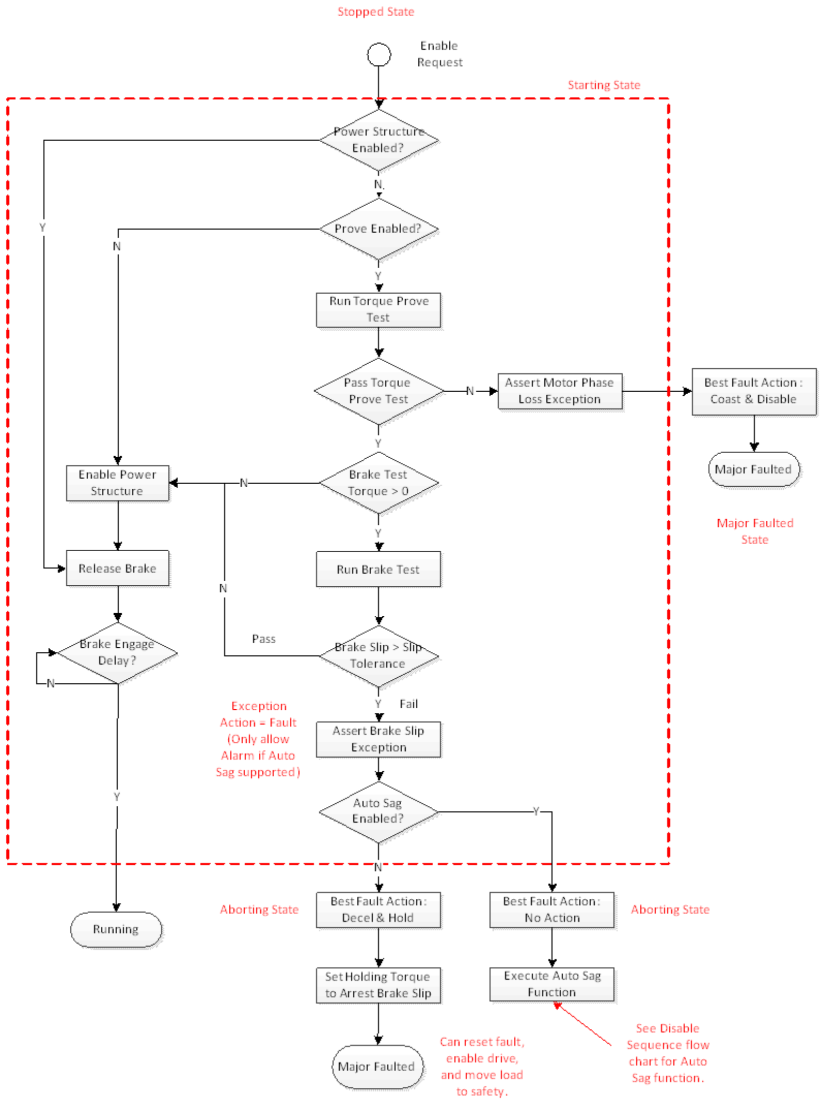
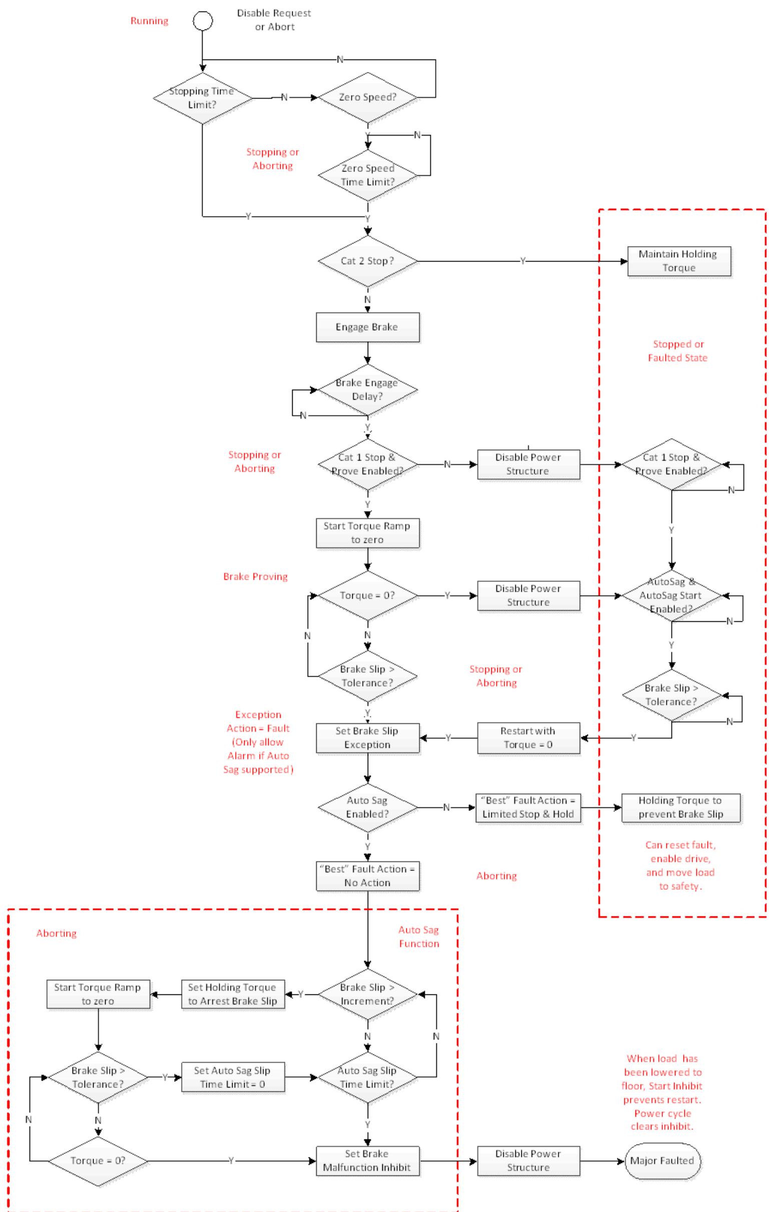


Figure 28 - Drive Disable Sequence with Proving Feature



Torque Prove Current

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	SSV	REAL	0	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 - D E	SSV	REAL	0	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 shall not be performed in the Starting state.

Brake Prove Ramp Time

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D E	SSV	REAL	0	0	10^3	Sec

This attribute determines the amount of time the drive shall 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 - D E	SSV	REAL	0	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.

Auto Sag Configuration

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D E	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 - D E	SSV	REAL	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 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 - D E	SSV	REAL	.25	-	∞	Sec

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 Increment cycles. With no further slip occurring while the motor torque is ramping to zero, the Auto Sag feature transitions to 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 - D E	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.

DC Bus Control Attributes

These are Motion Control Axis attributes associated with DC Bus control, including the functionality to address both under-voltage and over-voltage conditions.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

DC Bus Voltage

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - B, FPV D	GSV	T	REAL	-	-	-	Volts

Measured DC Bus Voltage.

DC Bus Voltage - Nominal

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - BD	MSG	T	REAL	-	-	-	Volts

Normal DC Bus Voltage during operation as determined by averaging the DC Bus Voltage over a device specific time interval. This value is used as the basis for Bus Overvoltage and Undervoltage limits. NOTE: If the device does not support this bus voltage averaging concept, the alternative is to hard code this value.

Bus Regulator Reference

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	MSG	T	REAL	-	-	-	% of Nominal Bus Voltage

Returns the current turn on voltage threshold for the bus regulator.

Power Loss Action

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	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 are set accordingly.

Table 42 - Bus Undervoltage Exception Actions Descriptions

Action	Description
Coast Thru	This 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 the Power Loss Timeout period expires, a Bus Power Loss Exception is generated.
Decel Regen	This action selection configures the drive to regeneratively charge the DC bus by decelerating the motor by 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.
Inertia Regenerative	An inertia regenerative action selection configures the drive to regeneratively charge the DC bus by decelerating the motor by 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	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	SSV		UINT	0 for D 1 for 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 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	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. See Power Loss Action on page 229 for details.

Power and Thermal Management Status Attributes

These are the power and thermal status related attributes associated with a Motion Control Axis.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Motor Overload Protection Method

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	GSV		USINT	-	-	-	Enumeration: 0 = Thermal Model 1 = I^2T Overload

The Motor Overload Protection Method attribute 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
Option - BD	GSV		USINT	-	-	-	Enumeration: 0 = Thermal Model 1 = I^2T Overload

The Inverter Overload Protection Method attribute 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 Motor 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	GSV		USINT	-	-	-	Enumeration: 0 = Thermal Model 1 = I^2T Overload

The Converter Overload Protection Method attribute 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	GSV		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	GSV	T	REAL	-	-	-	% Motor Rated

The Motor Capacity attribute is the real-time estimate of the continuous rated motor thermal capacity used during operation based on the motor thermal model. A value of 100% would indicate that the motor is being used at 100% of rated thermal 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	GSV	T	REAL	-	-	-	% Inverter Rated

The Inverter Capacity attribute is the real-time estimate of the continuous rated inverter thermal capacity used during operation based on the inverter thermal model. A value of 100% would indicate that the inverter is being used at 100% of rated thermal 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	GSV	T	REAL	-	-	-	% Converter Rated

The Converter Capacity attribute is the real-time estimate of the continuous rated converter thermal capacity used during operation based on the converter thermal model. A value of 100% would indicate that the converter is being used at 100% of rated thermal 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	GSV	T	REAL	-	-	-	% Regulator Rated

The Bus Regulator Capacity attribute is the real-time estimate of the continuous rated bus regulator thermal capacity used 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 thermal 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.

Ambient Temperature

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	MSG	T	REAL	-	-	-	°C

Current internal ambient temperature of the device enclosure.

Inverter Heatsink Temperature

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	MSG	T	REAL	-	-	-	°C

Current temperature of the device's inverter heatsink, typically based on an embedded temp sensor.

Inverter Temperature

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	MSG	T	REAL	-	-	-	°C

Current temperature of the power block used in the inverter's power structure, sometimes referred to as the semiconductor junction temperature.

Motor Temperature

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	MSG	T	REAL	-	-	-	°C

Current temperature of the motor stator, typically based on an embedded temp sensor.

Feedback 1 Temperature

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - ED	MSG	T	REAL	-	-	-	°C

Current temperature of the Feedback 1 device.

Feedback 2 Temperature

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - ED	MSG	T	REAL	-	-	-	°C

Current temperature of the Feedback 2 device.

Inverter Overload Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	MSG	T	REAL	-	-	-	% Inverter Rated

Factory set maximum limit for Inverter Capacity that when exceeded triggers the selected Inverter Overload action.

If the drive applies an I^2T inverter overload protection method, then exceeding the specified Inverter Overload Limit results in an overload condition and activates I^2T overload protection. While the inverter is overloaded, the Inverter Capacity attribute value increases to indicate how much of the inverters available I^2T overload capacity has been utilized. When Inverter Capacity reaches 100% of its rated capacity, the drive can optionally trigger an Inverter Overload Action.

When employing an overload protection method based on an inverter thermal model, the Inverter Capacity attribute value represents how much of the inverter's rated thermal capacity, associated with the inverter thermal model, has been utilized. Once the Inverter Capacity value exceeds the Inverter Overload Limit, the drive can optionally trigger a predetermined Inverter Overload Action.

The Inverter Overload Limit can also be used by the drive to determine the absolute thermal capacity limit of the inverter, i.e. the Inverter Thermal Overload Factory Limit, which if exceeded, generates an Inverter Thermal Overload FL exception.

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	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 based 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 motor current 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	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 alarm condition based on an I^2T based 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.

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	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

The CIP Axis State attribute is an enumerated value indicating the state of the motion axis. The CIP Axis State attribute is the correct way on a AXIS_CIP_DRIVE to determine when an axis is in the appropriate state to be operated.

Use the CIP Axis State attribute to condition your logic as needed to make sure the axis is in the right state, including that it's completed the configuration process after download, power up [with battery], or following axis uninhibit, before triggering motion ladder instructions.

See Motion Control Axis Behavior Model on page 298 for more information about axis behavior.

CIP Axis Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	T	DINT	-	-	-	Bitmap 0 = Local Control 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…31 = Reserved

The CIP Axis Status attribute is a 32-bit collection of standard bits indicating the internal status conditions of the motion axis.

Table 43 - CIP Axis Status Bit Descriptions

Bit	Usage	Status Condition	Description
0	R	Local Control	This bit is set if the axis is taking command reference and services from a local interface instead of the remote (Integrated Motion on EtherNet/IP) interface. This bit is based on the current state of the Remote Mode bit of the Node Status attribute.
1	R	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.
2	R/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 an drive axis is in the Pre-Charge state, the transition of the DC Bus Up status bit from 0 to 1 initiates 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 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	R/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	R/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.
5	R/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	R/P	Position Lock	This bit is set if the actual position is within Position Lock Tolerance of command position.
7	O/PV	Velocity Lock	This bit is set if the velocity feedback signal is within Velocity Lock Tolerance of the unlimited velocity reference.
8	R/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.

Table 43 - CIP Axis Status Bit Descriptions (Continued)

Bit	Usage	Status Condition	Description
9	O/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 command signal is below Velocity Threshold.
10	O/FPV	Velocity Limit	This bit is set if the velocity reference signal is currently being limited by the Velocity Limiter.
11	O/C	Acceleration Limit	This bit is set if the acceleration reference signal is currently being limited by the Acceleration Limiter.
12	O/C	Deceleration Limit	This bit is set if the acceleration reference signal is currently being limited by the Deceleration Limiter.
13	O/C	Torque Threshold	This bit is set if the absolute filtered torque reference is **above** the Torque Threshold.
14	R/C	Torque Limit	This bit is set if the filtered torque reference is currently being limited by the Torque Limiter.
15	O/D	Current Limit	This bit is set if the command current, Iq, is currently being limited by the Current Vector Limiter.
16	O/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	R/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 powerup assuming that the feedback device passes any power-up self test required. If Feedback Integrity is cleared, the Axis Homed Status attribute is also cleared. This prevents Soft Overtravel checking. If during operation a feedback exception occurs that could impact the fidelity of the 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 via motion instructions. Note that the Feedback Integrity bit behavior applies to both absolute and incremental feedback device operation.
18	R/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	R	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 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.
20	O/D	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 shall 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 via 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	O/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, i.e. drives that are configured for Shared AC/DC or Shared DC operation. Upon notification of AC Power Loss, drives that have enabled power structures shall assert a Converter AC Power Loss exception and invoke the programmed Axis Exception Action. Disabled drives shall not generate an exception action on AC Power Loss. Thus, no drive faults shall occur on removal of AC Power from a converter as long as no drive power structures drawing power from that converter are enabled.

Table 43 - CIP Axis Status Bit Descriptions (Continued)

Bit	Usage	Status Condition	Description
22	O/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	O/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	O/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. Table 44 lists the resulting CIP Axis Status names associated with the above status conditions.

Table 44 - Standard CIP Axis Status Names

Bit	Object CIP Axis Status Name
0	Local Control Status
1	Alarm Status
2	DC Bus Up Status
3	Power Structure Enabled Status
4	Motor Flux Up Status
5	Tracking Command Status
6	Position Lock Status
7	Velocity Lock Status
8	Velocity Standstill Status
9	Velocity Threshold Status
10	Velocity Limit Status
11	Acceleration Limit Status
12	Deceleration Limit Status
13	Torque Threshold Status
14	Torque Limit Status
15	Current Limit Status
16	Thermal Limit Status
17	Feedback Integrity Status
18	Shutdown Status
19	In Process Status
20	DC Bus Unload Status
21	AC Power Loss Status

Table 44 - Standard CIP Axis Status Names (Continued)

Bit	Object CIP Axis Status Name
22	PositionControlMode
23	VelocityControlMode
24	TorqueControlMode

Many of the Axis Status bits defined in Table 44 are related to the current Axis State as shown in this table.

Bit	Axis Status Bit Name	Initializing	Pre-Charge	Shutdown	Start Inhibit	Stopped	Starting	Running	Testing	Stopping	Aborting	Major Faulted
0	Local Control	x	x	x	x	x	x	x	x	x	x	x
1	Alarm	x	x	x	x	x	x	x	x	x	x	x
2	DC Bus Up	x	0	x	x	1	1	1	1	1	1	x
3	Power Structure Enabled	0	0	0	0	0/1	1	1	1	1	1	0/1
4	Motor Flux Up (IM only)	0	0	0	0	0/1	1	1	1	1	1	0/1
5	Tracking Command	0	0	0	0	0	0	1	0	0	0	0
6	Position Lock	0	0	0	0	0/x	x	x	0	x	x	0/x
7	Velocity Lock	0	0	0	0	0/x	x	x	0	x	x	0/x
8	Velocity Standstill	0	x	x	x	x	x	x	x	x	x	x
9	Velocity Threshold	0	x	x	x	x	x	x	x	x	x	x
10	Velocity Limit	0	0	0	0	0/x	x	x	x	x	x	0/x
11	Acceleration Limit	0	0	0	0	0/x	x	x	x	x	x	0/x
12	Deceleration Limit	0	0	0	0	0/x	x	x	x	x	x	0/x
13	Torque Threshold	0	0	0	0	0/x	x	x	x	x	x	0/x
14	Torque Limit	0	0	0	0	0/x	x	x	x	x	x	0/x
15	Current Limit	0	0	0	0	0/x	x	x	x	x	x	0/x
16	Thermal Limit	x	x	x	x	x	x	x	x	x	x	x
17	Feedback Integrity	x	x	x	x	x	x	x	x	x	x	x
18	Shutdown	0	0	1	0	0	0	0	0	0	x	x
19	In Process	0	x	x	x	x	0	0	1	0	0	0
20	DC Bus Unload	0	0	x	0	0	0	0	0	0	x	x
21	AC Power Loss	0	0	x	0	0	0	0	0	0	x	x
22	Position Control Mode	0	0	0	0	0/x	x	x	x	x	x	0/x
23	Velocity Control Mode	0	0	0	0	0	x	x	x	x	x	0
24	Torque Control Mode	0	0	0	0	0	x	x	x	x	x	0

x = 0 or 1

0/1 = 0 for Category 0 or 1 Stop, 1 for Category 2 Stop

0/x = 0 for Category 0 or 1 Stop, x for Category 2 Stop

Stopping Action Enum.	Stopping Action name	IEC-60204-1
0	Disable & Coast	Category 0 Stop
1	Current Decel & Disable	Category 1 Stop
2	Ramped Decel & Disable	Category 1 Stop
3	Current Decel & Hold	Category 2 Stop
4	Ramped Decel & Hold	Category 2 Stop

CIP Axis Status - RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	T	DWORD	-	-	-	Enumeration 0 = Regernerative Power Input Status 1…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 I/O Status condition.

CIP Axis Status - Mfg

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	MSG	T	DWORD	-	-	-	Enumeration 0…31 = Vendor Specific

Collection of vendor specific bits indicating the internal status of the motion axis.

CIP Axis I/O Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	T	DINT	-	-	-	0…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 value, while a value of 1 indicates a logical 1 value. Any status bits that are not applicable are set to 0.

Table 45 - CIP Axis I/O Status Bit Descriptions

Bit	Usage	Name	Description
0	R/BD	Enable Input	This bit represents the logical state of the Enable Input.
1	R/E	Home Input	This bit represents the logical state of the Home Input.
2	R/E	Registration 1 Input	This bit represents the logical state of the Registration 1 Input.
3	O/E	Registration 2 Input	This bit represents the logical state of the Registration 2 Input.
4	R/P	Positive Overtravel Input	This bit represents the logical state of the Positive Overtravel Input.
5	R/P	Negative Overtravel Input	This bit represents the logical state of the Negative Overtravel Input.
6	O/E	Feedback 1 Thermostat	This bit represents the logical state of the Thermostat input associated with the motor mounted Feedback 1 device.
7	O/D	Resistive Brake Output	This bit represents the logical state of the Resistive Brake Output.
8	O/D	Mechanical Brake Output	This bit represents the logical state of the Mechanical Brake Output.
9	O/D	Motor Thermostat Input	This bit represents the logical state of the Motor Thermostat Input.
10…31		Reserved	-

CIP Axis I/O Status - RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	T	DINT	-	-	-	Enumeration 0 = Regernerative Power Input Status 1 = Bus Capacitor Module Input Status 2 = Shunt Thermal Switch Input Status 3 = Contactor Enable Output 4 = Pre-Charge Input 5…31 = Reserved

The CIP Axis I/O Status - RA attribute is a 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.

Table 46 - CIP Axis I/O Status - RA Bit Descriptions

Bit	Usage	Name	Description
0	D	Regenerative Power Input Status	This bit represents the logical state of the Regenerative Power Input.
1	BD	Bus Capacitor Module Input Status	This bit represents the logical state of the Bus Capacitor Module Input.
2	BD	Shunt Thermal Switch Input Status	This bit represents the logical state of the Shunt Thermal Switch Input
3	BD	Contactor Enable Output	This bit represents the logical state of the Contactor Enable Output
4	BD	Pre-Charge 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 attributes is to append a `Status’ suffix to the CIP Axis I/O Status condition.

CIP Axis I/O Status - Mfg

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	MSG	T	DINT	-	-	-	Enumeration 0…31 = Vendor Specific

Collection of bits indicating the state of vendor 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.

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	GSV	T	DINT	-	-	-	Enumeration 0 = Control Sync Fault 1 = Module Sync Fault 2 = Timer Event Fault 3 = Module Hard Fault 4 = Reserved 5 = Reserved 6 = Module Conn. Fault 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 = Control Clock Sync Fault 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.

This 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	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 affecting 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.
1	Module Sync 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 affecting 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	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	-- Reserved --	
5	-- Reserved --	
6	Module Conn Fault	The Module Connection Fault bit indicates that the CIP Motion C-to-D connection from the controller has timed out.
7	Conn Format Fault	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	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 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	The Control Connection Loss fault bit indicates that the CIP Motion C-to-D connection from the controller has timed out.
15	Reserved	
16	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…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 (40…60 seconds)
17	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	The Duplicate Address Fault bit indicates that a motion device node has been detected on the network that using 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	GSV	T	DINT	-	-	-	Enumeration 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.

TIP Cyclic write attributes are unique in that they have attribute storage policed by the object handler (either Logix Designer or GSV/SSV) and also have direct tag access which bypass the object validation.

The value written into the tag is validated before being written to the drive and that if that validation fails you will see an 'out of range alarm' and flag it in the axis fault/alarm log but that the value in the tag remains as written by the user. The value of the internal attribute as viewed via GSV or in Logix Designer shows the previously validated value.

Table 47 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 Table 47, the terms motion module and motion device are used synonymously.

Table 47 - Module Alarm Bit Descriptions

Bit	Fault 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	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	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	The 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 bit is set when the drive determines that a Cyclic Write attribute value is out of range.
6	Clock Skew Alarm	The 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	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, for example, 10 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	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.
9…31	Reserved	

Table 48 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 Table 48, the terms motion module and motion device are used synonymously.

Table 48 - Module Fault Conditions

Bit	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 affecting 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.
1	Module Sync 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 affecting 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	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	Reserved	
5	Reserved	
6	Module Conn Fault	The Module Connection Fault bit indicates that the CIP Motion C-to-D connection from the controller has timed out.
7	Conn Format Fault	This fault code 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	The Processor Watchdog Fault code 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 code 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	The Control Connection Loss fault code indicates that the CIP Motion C-to-D connection from the controller has timed out.
15	Reserved	
16	Clock Sync Fault	The Clock Sync Fault code indicates that the motion device's local clock has lost synchronization with the master clock for an extended period of time, for example, ~40 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, for example, 40 seconds.
17	Logic Watchdog Fault	The Logic Watchdog Fault code 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	The Duplicate Address Fault code indicates that a motion device node has been detected on the network that by using the same Node Address as this device node. For Ethernet, this address would be the IP Address of the device.
19…31		

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	GSV	T	INT	-	-	-	See CIP Error Codes on page 318 for more information.

The Attribute Error Code attribute is the ASA Error code associated with an erred configuration attribute.

Attribute Error ID

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	T	INT	-	-	-	

The Attribute Error ID attribute is the attribute ID associated with non-zero Attribute Error Code.

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.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

CIP Axis Exceptions

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	MSG	T	LWORD	-	-	-	See Standard Exceptions on page 248 for more information.

A bit map that represents the current state of all standard exception conditions. Each exception has a corresponding Axis Exception Action. Exceptions that are configured to be Ignored are only be visible in this attribute.

CIP Axis Exceptions - Mfg

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	MSG	T	LWORD	-	-	-	See Standard Exceptions on page 248 for more information.

A bit map that represents the current state of all manufacturer specific exception conditions. See the Mfg. Exception Table published in the drive product manual. Each exception has a corresponding Axis Exception Action. Exceptions that are configured to be Ignored are only be visible in this attribute.

CIP Axis Exceptions -RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	MSG	T	LWORD	-	-	-	See Standard Exceptions on page 248 for more information.

A bit map that represents the current state of all Rockwell Automation specific exception conditions. Each exception has a corresponding Axis Exception Action. Exceptions that are configured to be Ignored are only be visible in this attribute.

CIP Axis Faults

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	T	LWORD	-	-	-	See Standard Exceptions on page 248 for more information.

The CIP Axis Faults attribute is 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. When fault bits are set, they 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 - Mfg

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	MSG	T	LWORD	-	-	-	See Standard Exceptions on page 248 for more information.

A bit map that represents the state of all manufacturer specific runtime faults. The bit map is identical to that of the Mfg. 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 - All	GSV	T	LWORD	-	-	-	See Standard Exceptions on page 248 for more information.

The CIP Axis Faults - RA attribute is a bit map that represents the state of all manufacturer specific runtime faults. When fault bits are set, they 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	GSV	T	LWORD	-	-	-	See Standard Exceptions on page 248 for more information.

The CIP Axis Alarms attribute is a bit map that represents the current state of all standard alarm conditions. The bit map is identical to that of the Standard 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. When alarm bits are set, they are not latched and will clear as soon as the underlying exception condition is corrected.

CIP Axis Alarms - Mfg

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - All	MSG	T	LWORD	-	-	-	See Standard Exceptions on page 248 for more information.

A bit map that represents the current state of all manufacturer specific alarm conditions. The bit map is identical to that of the Mfg. 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	GSV	T	LWORD	-	-	-	See Standard Exceptions on page 248.

The CIP Axis Alarms - RA attribute is a bit map that represents the current state of all manufacturer 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. When alarm bits are set, they are not latched and will clear as soon as the underlying exception condition is corrected.

Standard Exceptions

These are 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 of the individual exception conditions is Optional. The Rule column in Table 49 indicates the Device Function Codes where the associated exception is applicable.

The enumeration for all exceptions is as follows:

0 = Ignore (O)

1 = Alarm (O)

2 = Fault Status Only (O)

3 = Stop Planner (O)

For more information about Device Function Codes, listed as rules in the table below, see Device Function Codes on page 26.

Table 49 - Standard Exception Conditions for Position, Velocity, Torque, and Frequency Control Modes

Bit	Rule	Exception	Description
0	-	Reserved	This bit cannot be used because 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	The Permanent magnet motor commutation anomaly is detected. An example would be an illegal state `111' or `000' for UVW commutation signals, S1, S2, and S3.
3	D	Motor Overspeed FL	Motor speed has exceeded its maximum limit given by 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 Fault	Returns the Factory Limit for the Motor Overtemperature FL exception based on a factory set value related to the Motor Max Winding Temperature of the motor.
6	D	Motor Overtemperature UL Fault	Returns the Factory Limit for the Motor Overtemperature FL exception based on a user-defined set value related to the Motor Max Winding Temperature of the motor.
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.
9	D	Motor Phase Loss	The current in one or more motor phases has been lost, or below a factory set threshold or, if supported, the configured Motor Phase Loss Limit. This exception is associated also 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 needs 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 Inverter Overtemperature Factory Limit.
12	-	Reserved	-

Table 49 - Standard Exception Conditions for Position, Velocity, Torque, and Frequency Control Modes (Continued)

Bit	Rule	Exception	Description
13	D	Inverter Thermal Overload FL	Inverter thermal model or I^2T overload value has exceeded its factory set thermal capacity limit given by 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 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 Converter Ground Current Factory Limit.
17	BD	Converter Ground Current UL	Ground Current has exceeded the user-defined limit given by Converter Ground Current User Limit.
18	BD	Converter Overtemperature FL	Converter temperature has exceeded its factory set temperature limit given by Converter Overtemperature Factory Limit.
19	BD	Converter Overtemperature UL	Converter temperature or I^2T overload value has exceeded the user-defined temperature limit given by 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 Converter Thermal Overload Factory Limit.
21	BD	Converter Thermal Overload UL	Converter thermal model has exceeded its user-defined thermal capacity given by Converter Thermal Overload User Limit.
22	BD	Converter AC Power Loss	Multiple AC phases has been lost on the AC line to the converter. This usually happens as a result of opening an AC line contactor. 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 via the 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 has 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	An anomaly has been detected in the Converter's Pre-charge circuitry 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 Bus Regulator Overtemperature Factory Limit.
28	BD	Bus Regulator Overtemperature UL	Bus Regulator temperature has exceeded the user-defined temperature limit given by 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 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 Bus Regulator Thermal Overload User Limit.
31	BD	Bus Regulator Failure	The bus regulator (shunt) module has failed.
32	BD	Bus Capacitor Module Failure	The bus capacitor module has failed.
33	BD	Bus Undervoltage FL	DC Bus voltage level is below the factory set limit given by Bus Undervoltage Factory Limit.
34	BD	Bus Undervoltage UL	DC Bus voltage level is below user-defined limit given by Bus Undervoltage User Limit.
35	BD	Bus Overvoltage FL	DC Bus voltage level is above the factory set limit given by Bus Overvoltage Factory Limit.
36	BD	Bus Overvoltage UL	DC Bus voltage level is above user-defined limit given by 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 Bus Power Loss Time value.
38	BD	Bus Power Blown Fuse	DC Bus power loss due to blown fuse.
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.

Table 49 - Standard Exception Conditions for Position, Velocity, Torque, and Frequency Control Modes (Continued)

Bit	Rule	Exception	Description
40	D	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, page 236, 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.
48	-	Reserved	-
49	D	Brake Slip	Motor displacement has exceeded the Brake Slip Tolerance while the mechanical brake is engaged.
50	D	Hardware Overtravel Positive	The 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	The 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. For a CIP Axis, the Kinetix 6500 Drive has the Velocity Error check = Active (default), for a SERCOS Kinetix 6000 Drive the Velocity Error check = NotActive (default), so an AXIS_CIP_DRIVE gets an occasional 'Drive Error #55 Excessive Velocity Error'. To work around this issue, you can change either of these two CIP Axis attributes: • On the Velocity Loop page: Velocity Error Tolerance, raise the error tolerance. • On the Velocity Loop parameter page: Velocity Error Tolerance Time (0.01 seconds default), raise the time tolerance. If neither of these changes solves this issue, then go to the Actions page and set the Excessive Velocity Error attribute to ignore.
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	-

Table 49 - Standard Exception Conditions for Position, Velocity, Torque, and Frequency Control Modes (Continued)

Bit	Rule	Exception	Description
59	-	Reserved	-
60	ALL	Illegal Control Mode	Controller has specified an unsupported Control Mode or Feedback Mode.
61	D	Enable Input Deactivated	Enable Input has been deactivated while the axis power structure is enabled and supplying current to the DC Bus or motor.
62	ALL	Controller Initiated Exception	Exception generated specifically by controller.
63	ALL	External Input Exception	Exception generated by external input to device.

Standard 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. Table 50 lists the resulting Fault names associated with the above exception conditions.

Table 50 - Standard Fault Names for the Exception Conditions

Bit	Object CIP Axis Fault Name	Bit	Object CIP Axis Fault Name
0		33	Bus Undervoltage FL Fault
1	Motor Overcurrent Fault	34	Bus Undervoltage UL Fault
2	Motor Commutation Fault	35	Bus Overvoltage FL Fault
3	Motor Overspeed FL Fault	36	Bus Overvoltage UL Fault
4	Motor Overspeed UL Fault	37	Bus Power Loss Fault
5	Motor Overtemperature FL Fault	38	Bus Power Blown Fuse Fault
6	Motor Overtemperature UL Fault	39	Bus Power Leakage Fault
7	Motor Thermal Overload FL Fault	40	Bus Power Sharing Fault
8	Motor Thermal Overload UL Fault	41	Feedback Signal Noise FL Fault
9	Motor Phase Loss Fault	42	Feedback Signal Noise UL Fault
10	Inverter Overcurrent Fault	43	Feedback Signal Loss FL Fault
11	Inverter Overtemperature FL Fault	44	Feedback Signal Loss UL Fault
12	Inverter Overtemperature UL Fault	45	Feedback Data Loss FL Fault
13	Inverter Thermal Overload FL Fault	46	Feedback Data Loss UL Fault
14	Inverter Thermal Overload UL Fault	47	Feedback Device Fault
15	Converter Overcurrent Fault	48	
16	Converter Ground Current FL Fault	49	Brake Slip Fault
17	Converter Ground Current UL Fault	50	Hardware Overtravel Positive Fault
18	Converter Overtemperature FL Fault	51	Hardware Overtravel Negative Fault
19	Converter Overtemperature UL Fault	52	Position Overtravel Positive Fault
20	Converter Thermal Overload FL Fault	53	Position Overtravel Negative Fault
21	Converter Thermal Overload UL Fault	54	Excessive Position Error Fault
22	Converter AC Power Loss Fault	55	Excessive Velocity Error Fault
23	Converter AC Single Phase Loss Fault	56	Overtorque Limit Fault
24	Converter AC Phase Short Fault	57	Undertorque Limit Fault
25	Converter Pre Charge Fault	58	
26		59	
27	Bus Regulator Overtemperature FL Fault	60	Illegal Control Mode Fault
28	Bus Regulator Overtemperature UL Fault	61	Enable Input Deactivated Fault
29	Bus Regulator Thermal Overload FL Fault	62	Controller Initiated Fault
30	Bus Regulator Thermal Overload UL Fault	63	External Input Fault
31	Bus Regulator Fault		
32	Bus Capacitor Module Fault		

Rockwell Automation Specific Exceptions

Table 51 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 Table 51 indicates the Device Function Codes where the associated exception is applicable.

The enumeration for all exceptions is as follows:

0 = Ignore (O)

1 = Alarm (O)

2 = Fault Status Only (O)

3 = Stop Planner (O)

Table 51 - Rockwell Automation Specific Exception Descriptions for Position, Velocity, and Torque Control Modes

Bit	Rule	Exception	Description
0	-	-- Reserved --	This bit cannot be used because 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	This occurs when 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	This occurs when 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	N	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	D	Converter Pre-Charge Overload FL	The converter estimates that the pre-charge circuit has exceeded its factory limit due to excessive power cycling.
13	-	Reserved	-
14	D	Excessive Current Feedback Offset	Current in one or more phases has been lost or remains below a preset level.
15	D	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 was reduced due to excessive Junction Temperature or due to Overload Protection.
18	D	Torque Prove Failure	Actual feedback indicates error in torque proving.
19	D	Decel Override	The drive is not following a commanded deceleration because it is attempting to limit bus voltage.

Table 51 - Rockwell Automation Specific Exception Descriptions for Position, Velocity, and Torque Control Modes (Continued)

Bit	Rule	Exception	Description
20	D	Preventative Maintenance	The component has reached its lifetime limit.
21	D	Motor Test Failure	The Motor Test procedure has failed.
22	D	Hardware Configuration	There is an error related to the tracking of optional hardware installation.
23	D	Firmware Change	There are errors or forced configuration changes relating to the firmware update.
24	D	Converter Pre-Charge Input Deactivated	The Pre-Charge Input has been deactivated while the axis power structure is enabled and supplying current to the DC Bus or motor.
25	D	DC Common Bus	An error has been detected related to Common Bus operation.
26	ALL	Runtime Error	Runtime assertions are detected.
27	D	Backplane Communication Error	An error in communicating over the modular backplane.
28	D	Safety Module Communication Error	An error in communicating to the Safety module.
29…62	-	Reserved	-
63	ALL	Product Specific	Product Specific (exotic) exceptions by Sub Code.

Feedback Only Standard Exceptions

This table lists the standard exceptions applicable to No Control mode, Feedback only.

The enumeration for all exceptions is as follows:

0 = Ignore (O)

1 = Alarm (O)

Bit	Exception
41	Feedback Signal Noise FL (0)
42	Feedback Signal Noise UL (0)
43	Feedback Signal Loss FL (0)
44	Feedback Signal Loss UL (0)
45	Feedback Data Loss FL (0)
46	Feedback Data Loss UL (0)
47	Feedback Device Failure (0)
60	Illegal Control Mode (0)
62	Controller Initiated Exception (0)
63	External Exception Input (0)

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. Table 52 lists the resulting Fault names associated with the above exception conditions.

Table 52 - Rockwell Automation CIP Axis Fault Descriptions

Bit	Object CIP Axis Fault Name	Bit	Object CIP Axis Fault Name
0		16	PWM Frequency Reduced Fault
1	Commutation Startup Fault	17	Current Limit Reduced Fault
2	Motor Voltage Mismatch	18	Torque Prove Fault
3		19	Decel Override Fault
4	Feedback Filter Noise Fault	20	Preventative Maintenance Fault
5	Feedback Battery Loss Fault	21	Motor Test Fault
6	Feedback Battery Low Fault	22	Hardware Configuration Fault
7	Feedback Incremental Count Error Fault	23	Firmware Change Fault
8		24	DC Common Bus Fault
9		25	Runtime Error Fault
10	Control Module Overtemperature FL Fault	26	Backplane Communication Error Fault
11	Control Module Overtemperature UL Fault	27	Safety Module Communication Error Fault
12	Converter Pre Charge Overload FL Fault	28	
13	Converter Pre Charge Overload UL Fault	29…62	
14	Excessive Current Feedback Offset Fault	63	Product Specific Fault
15	Regenerative Power Supply Fault		

Rockwell Automation Specific CIP Axis Alarm Names

Table 53 lists the resulting Alarm names associated with the exception conditions in Feedback Only Standard Exceptions on page 254.

Table 53 - Rockwell Automation Specific CIP Axis Alarm Names Descriptions

Bit	Object CIP Axis Alarm Name	Bit	Object CIP Axis Alarm Name
0		19	Decel Override Alarm
1	Commutation Startup Alarm	20	Preventative Maintenance Alarm
2		21	Motor Test Alarm
3		22	Hardware Configuration Alarm
4	Feedback Filter Noise Alarm	23	Firmware Change Alarm
5	Feedback Battery Loss Alarm	24	DC Common Bus Alarm
6	Feedback Battery Low Alarm	25	Runtime Error Alarm
7	Feedback Incremental Count Error Alarm	26	Backplane Communication Error Alarm
8		27	Safety Module Communication Error Alarm
9		28	
10	Control Module Overtemperature FL Alarm	29…62	
11	Control Module Overtemperature UL Alarm	63	Product Specific Alarm
12	Converter Pre Charge Overload FL Alarm		
13	Converter Pre Charge Overload UL 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		

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. 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.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Rotary Motor Overspeed Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	MSG	REAL	-	-	-	RPM

The rotary Motor Overspeed Factory Limit attribute returns the Factory Limit for the Motor Overspeed FL 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.

An Operational Speed Limit is imposed by all Rockwell Automation drive products to comply with a 600 Hz export restriction.

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	MSG	REAL	-	-	-	m/s

The Linear Motor Overspeed Factory Limit attribute returns the Factory Limit for the Motor Overspeed FL 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.

Bus Overvoltage Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	MSG	REAL				Volts

Returns the Factory Limit for the Bus Overvoltage FL exception.

Bus Undervoltage Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	MSG	REAL				Volts

Returns the Factory Limit for the Bus Undervoltage FL exception.

Feedback Noise Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG	UDINT				Noise Counts

Returns the Factory Limit for the Feedback Noise FL exception.

Feedback Signal Loss Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG	REAL				% Nominal Voltage

Returns the Factory Limit for the Feedback Signal Loss FL exception.

Feedback Data Loss Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG	UDINT				Consecutive Lost Data Packets

Returns the Factory Limit for the Feedback Data Loss FL exception.

Control Module Overtemperature Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - All	MSG	REAL				°C
Returns the Factory Limit for the Control Module Overtemperature FL exception.						

Converter Pre-charge Overload Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	MSG	REAL				% Converter Rated
Returns the Factory Limit for the Converter Pre-Charge Overload FL exception.						

Bus Regulator Overtemperature Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	MSG	REAL				°C
Returns the Factory Limit for the Bus Regulator Overtemperature FL exception.						

Motor Overtemperature Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	MSG	REAL				°C
Returns the Factory Limit for the Motor Overtemperature FL exception based on a factory set value related to the Motor Max Winding Temperature of the motor.						

Motor Thermal Overload Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	MSG	REAL				% Motor Rated
Returns the Factory Limit for the Motor Thermal Overload FL exception based on a factory set value related to the Motor Overload Limit rating.						

Inverter Overtemperature Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	MSG	REAL				°C
Returns the Factory Limit for the Inverter Overtemperature FL exception based on a factory set value related to the Inverter Overload Limit rating.						

Inverter Thermal Overload Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	MSG	REAL				% Inverter Rated
Returns the Factory Limit for the Inverter Thermal Overload FL exception.						

Converter Overtemperature Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	MSG	REAL				°C
Returns the Factory Limit for the Converter Overtemperature FL exception.						

Converter Thermal Overload Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	MSG	REAL				% Converter Rated

Returns the Factory Limit for the Converter Thermal Overload FL exception.

Converter Ground Current Factory Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	MSG	REAL	-	-	-	Amps

Returns the Factory Limit for the Converter Ground Current FL exception.

Exception User Limit Configuration Attributes

These are the exception user limit configuration related attributes associated with a Motion Control Axis.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Motor Phase Loss Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	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 disables the motor phase loss test.

Motor Overspeed User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	SSV	REAL	120	0	∞	% Motor Rated

The Motor Overspeed User Limit attribute 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 Overtemperature User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	MSG	REAL	125	0	∞	°C

Sets User Limit for the Motor Overtemperature UL exception.

Motor Thermal Overload User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	SSV	REAL	110	0	∞	% Motor Rated

The Motor Thermal Overload User Limit attribute sets the User Limit for the Motor Thermal Overload UL exception.

Inverter Overtemperature User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	MSG	REAL	125	0	∞	°C

Sets User Limit for the Inverter Overtemperature UL exception.

Inverter Thermal Overload User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	SSV	REAL	110	0	∞	% Inverter Rated

The Inverter Thermal Overload User Limit attribute sets the 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	SSV	UDINT	1	1	2^{31}	Noise Counts

The Feedback Noise User Limit attribute sets the 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	SSV	REAL	100	0	∞	% FL Voltage Drop

The Feedback signal Loss User Limit attribute sets the User Limit for the Feedback Signal Loss UL exception. Feedback interface hardware typically monitors 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	SSV	UDINT	4	1	2^{31}	Consecutive Lost Data Packets

The Feedback Data Loss User Limit attribute sets the 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.

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	Logix Designer	USINT	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 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.
See Stopping Action on page 216 when using the exception Stop Drive.

CIP Axis Exception Action - Mfg

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Logix Designer	USINT	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: (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 manufacturer specific axis exception.
See Stopping Action on page 216 when using the exception Stop Drive.

CIP Axis Exception Action - RA

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All	Logix Designer	USINT	4 (D) 2 (N)	-	-	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 (B) for Converter Only 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 Axis Exception Action Configuration Attributes on page 260 for more information.

See Stopping Action on page 216 when using the exception Stop Drive.

The Axis Exception Action - RA and Axis Exception Action-Mfg (not supported) attributes are 64-element arrays 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 `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 `Invalid Attribute Value' service error code (0x09). For drives that support Rockwell Automation specific axis exceptions, the 64-element CIP Axis Exception-RA array is sent to the drive device as the CIP Axis Exception-Mfg attribute.

Table 54 - CIP Axis Exceptions Action - RA Descriptions

Enumeration	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 drive device (D) to set the associated bit in the Axis Alarm word, but to otherwise not affect 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 unaffected.
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 otherwise does not affect 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 unaffected. 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 device 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.

Table 54 - CIP Axis Exceptions Action - RA Descriptions (Continued)

Enumeration	Usage	Name	Description
4	Required (BD)	Stop Drive	The 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. Standard stopping modes, listed in decreasing levels of deceleration control, are as follows. 1. Ramp Decel 2. Current Limit Decel 3. Coast In general, the `best' stopping mode 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 axis is the state with the most control functionality still available given the exception condition. However, all these final states a fault reset must be executed before the axis can be restored to enabled operation and commanded to move. 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. These are the Axis Fault Action enumerations. 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 • If the application requires exception action that is a more severe stopping action than the factory set `best' method, the controller initiates that action. • If the application requires exception action that is less severe than the factory set `best' method, the controller configures 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 will only be allowed by the device when there is an opportunity, albeit temporal, 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 either 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, for example, the stopping action that requires the lowest level of control functionality. This rule also applies to the Stopping Action associated with a Disable Request. See Stopping Action on page 216
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. This immediately disables 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 `Invalid Attribute Value' service error code (0x09).

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.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

CIP Initialization Faults

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	GSV	T	DINT	-	-	-	See Standard Initialization Faults on page 264.

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 start-up 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	DINT	-	-	-	See Standard Initialization Faults on page 264.

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 start-up 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 - Mfg

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - All	MSG	T	DINT	-	-	-	See manufacturers product information.

A bit map that represents the state of all manufacturer 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.

Standard Initialization Faults

Table 55 defines a list of standard faults associated with the Initialization Faults attribute.

Table 55 - Standard Initialization Faults Bit Descriptions

Bit	Exception	Description
0	Reserved	This bit cannot be used because 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 integrated motion device detected as part of Self-Test.
2	Main Block Checksum Fault	Checksum or CRC error for Main Block of integrated motion device detected as part of Self-Test.

Table 55 - Standard Initialization Faults Bit Descriptions (Continued)

Bit	Exception	Description
3	Nonvolatile Memory Checksum Fault	Checksum or CRC error for NV Memory of integrated motion device detected as part of Self-Test.
4	Commutation Not Configured	The associated PM motor commutation function has not been configured for use.
5…31	Reserved	-

Rockwell Automation Specific Initialization Faults

Table 56 defines a list of Rockwell Automation specific faults associated with the Initialization Faults-RA attribute.

Table 56 - Rockwell Automation Specific Initialization Faults Bit Description

Bit	Exception	Description
0	Reserved	This bit cannot be used because 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	Communication 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.
6	Feedback Absolute Startup Speed	Excessive encoder speed resulted in an error in establishing commutation position.
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	-

Start Inhibit Attributes

These are the Start Inhibit related attributes associated with a Motion Control Axis. Start Inhibits are conditions that prevent transition of the motion axis from the Stopped State into any of the operational states.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

CIP Start Inhibit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	GSV	T	WORD	-	-	-	See Standard Start Inhibits on page 266 for more information.

A bit map that specifies the current state of all standard conditions that inhibits starting of the axis.

CIP Start Inhibits - Mfg

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	MSG	T	WORD	-	-	-	See manufactures product information.

A bit map that specifies the current state of all manufacturer specific conditions that inhibits starting of the axis.

CIP Start Inhibits - RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	GSV	T	WORD	-	-	-	See Standard Start Inhibits on page 266 for more information.

A bit map that specifies the current state of all Rockwell Automation specific conditions that inhibits starting of the axis.

Standard Start Inhibits

Table 57 defines a list of standard start inhibits associated with the Start Inhibits attribute.

Table 57 - Standard Start Inhibit Bit Descriptions

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	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.
4	Commutation Not Configured	The associated PM motor commutation function has not been configured for use.
5	Safe Torque Off Active[1]	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	-

(1) For complete information about Safe Torque Off, see the Kinetix 5500 Servo Drives User Manual, publication 2198-UM001.

Start Inhibit bit names always end with an Inhibit suffix, Axis Enable Input Inhibit.

Rockwell Automation Specific Start Inhibit

Table 58 defines a list of specific start inhibits associated with the Start Inhibits attribute.

Table 58 - Specific Start Inhibit Bit Descriptions

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	Can't run by 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 Proving Configuration is enabled, Control Mode, Feedback Mode, Motor Feedback Type, and Motor Option Configuration will be properly set.
5	Safe Torque Off[1]	The safety function has disabled the power structure. This inhibit condition is limited to Rockwell Automation's vendor specific hard-wired safety feature.
6	Safety Reset Required	The safety reset input needs to be toggled before the safety board allows 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 being held active. This inhibit condition prevents the drive from Starting for as long as the Stop Command remains 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 for as long as the feedback reset process take to complete.
10	Brake Malfunction	This start inhibit is set when the Auto Sag function is enabled. Brake slip is detected based on motor movement exceeding the configured Brake Slip Tolerance while the mechanical brake is engaged. This generally indicates that the mechanical brake may not be capable of holding the load.
11…15	Reserved	-

(1) For complete information about Safe Torque Off, see the Kinetix 5500 Servo Drives User Manual, publication 2198-UM001.

Table 59 maps the Inhibit names above with their the Logix Designer application Inhibit tag names. Start Inhibit bit names always end with an Inhibit suffix.

Table 59 - Start Inhibit Bit Names

Bit	Object CIP Init Fault Name	Bit	Object CIP Init Fault Name
0		6	Safety Reset Required Inhibit
1	Volts Hertz Curve Definition Inhibit	7	Safety Not Configured Inhibit
2	Motor Feedback Required Inhibit	8	Stop Command Active Inhibit
3	Speed Limit Configuration Inhibit		
4	Torque Prove Configuration Inhibit		
5	Safe Torque Off Inhibit		

APR Fault Attributes

The following attribute table contains all APR (Absolute Position Recovery) fault related attributes associated with a Motion Device Axis. 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.

For information on Absolute Position Recovery (APR), see the Integrated Motion Configuration and Startup manual, publication MOTION-UM003.

For more information on how to access an attribute with a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

CIP APR Faults

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG	T	WORD	-	-	-	

The CIP APR Faults attribute is a bit map 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 - Mfg

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - E	MSG	T	WORD	-	-	-	

A bit map that represents the state of all manufacturer 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. 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	MSG	T	WORD	-	-	-	

The CIP APR Faults - RA attribute is a bit map 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

Table 60 defines a list of standard faults associated with the APR Faults attribute.

Table 60 - Standard APR Fault Bit Descriptions

Bit	Exception	Description
0	Reserved	This bit cannot be used because 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	Feedback Integrity bit of CIP Axis Status attribute has transitioned from 1…0 during device operation.
8…15	Reserved	-

Rockwell Automaton Specific APR Fault Table

Table 61 defines a list of Rockwell Automation specific faults associated with the Initialization Faults-RA attribute.

Table 61 - Specific APR Fault Bit Descriptions

Bit	Exception	Description
0	Reserved	This bit cannot be used because 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.

Table 61 - Specific APR Fault Bit Descriptions

Bit	Exception	Description
2	Firmware Error	Used to trap firmware errors that should never happen.
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	-

Axis Info Attributes

These are the attributes that provide information about the associated hardware capabilities of Motion Control Axis.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Inverter Rated Output Voltage

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D	MSG		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	MSG		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	MSG		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	MSG		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	MSG		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.

Drive General Purpose I/O Attributes

These are general purpose attributes for analog and digital I/O associated with the Motion Control Axis.

For more information on how to access an attribute using a MSG instruction, see Access with a MSG (a message) Instruction on page 53.

Digital Inputs

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	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 Input Configuration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	SSV	T	USINT [32]	-	-	-	Bitmap 0 = Unassigned 1 = Enable 2 = Home 3 = Registration 1 4 = Registration 2 5 = Positive Over-travel 6 = Negative Over-travel 7 = Regeneration OK 8 = Bus Capacitor OK 9 = Shunt Thermal Switch OK 10 = Home & Registration 1 11 = Motor Thermostat OK 12 = Pre-Charge OK

The Digital Input Configuration attribute is an array of enumerated values that map configurable digital inputs to specific functions of the drive axis.

Functions that are not mapped to a digital input shall not be checked by the drive, nor generate associated exceptions or events. Associated exception actions in this case are accepted by the device as a “Don’t Care”.

Digital Outputs

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	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.

Digital Output Configuration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	SSV	T	USINT [32]	0	-	-	Bitmap 0 = Unassigned 1 = Contactor Enable 2 = Mechanical Brake Engage 3 = Resistive Brake Engage

The Digital Output Configuration attribute is an array of enumerated values that map configurable digital output to specific functions of the drive axis.

Analog Input 1

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	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	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	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	SSV	T	REAL	0	-100	+100	% Full Scale

The Analog Output 2 attribute is a general purpose analog output 2 level.

Drive Enable Input Checking

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	MSG	T	BOOL	1	0	+100	0 = Disabled 1 = Enabled

Boolean value that controls whether or not the drive shall regularly check the state of the Drive Enable input. When Drive Enable Input Checking is enabled, an inactive Drive Enable input results in a Start Inhibit condition. If the Drive Enable input is deactivated while the drive is enabled, a Drive Enable Input Deactivated exception is generated. If Drive Enable Input Checking is disabled, the drive shall not check the state of the Drive Enable input.

Hardware Overtravel Input Checking

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	MSG	T	BOOL	1	0	1	0 = Disabled 1 = Enabled

Boolean value that controls whether or not the drive shall regularly check the state of the positive and negative Hardware Overtravel inputs. When Hardware Overtravel Input Checking is enabled, an inactive Hardware Overtravel input results in an associated Hardware Overtravel Positive or Negative exception. If Drive Hardware Overtravel Checking is disabled, the drive shall not check the state of the Hardware Overtravel inputs.

Converter Control Attributes

These attributes are DC Bus Converter control signal attributes associated with a Motion Control Axis Object instance.

DC Bus Output Voltage Reference

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	GSV	-	REAL	-	-	-	Volts

Converter output voltage reference signal into the voltage regulation summing junction to be compared with the voltage feedback signal. This value shall equal the DC Output Bus Voltage Set Point when the axis is in the Running state, In all other axis states, the DC Bus Voltage Reference is under local control of the Converter.

Converter Output Current n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	GSV	-	REAL	-	-	-	Amps

Output current generated by Bus Converter power structure instance n when supporting multiple converter power structure DC Bus outputs per axis object instance. 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 n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	GSV	-	REAL	-	-	-	Kilowatts

Output power generated by Bus Converter power structure instance n when supporting multiple converter power structure generated DC Bus outputs per axis object instance. This value is based on the product of the Converter Output Current n and DC Bus Voltage n. 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.

Converter Output Rated Current n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	GSV	-	REAL	-	-	-	Amps (RMS)

Output current rating of Bus Converter power structure instance n when supporting multiple converter power structure generated DC Bus outputs per axis object instance.

Converter Output Rated Power n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	GSV	-	REAL	-	-	-	Kilowatts

Converter output power rating of Bus Converter power structure instance n when supporting multiple converter power structure generated DC Bus outputs per axis object instance.

DC Bus Output Voltage n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	GSV	-	REAL	-	-	-	Volts

Measured DC bus output voltage of Bus Converter power structure instance n when supporting multiple converter power structure generated DC Bus outputs per axis object instance.

This attribute is only applicable to DC Converter Types.

DC Bus Output Voltage Reference n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	GSV	-	REAL	-	-	-	Volts

Converter output voltage reference signal into the voltage regulation summing junction to be compared with the voltage feedback signal. This value shall equal the DC Bus Output Voltage Set Point n when the axis is in the Running state, In all other axis states, the DC Bus Output Voltage Reference is under local control of the Converter.

Power structure instance attributes are only applicable when supporting multiple converter power structure generated DC Bus outputs per axis object instance.

Converter Output Capacity n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	GSV	-	REAL	-	-	-	% Converter Rated

Real-time estimate of the continuous rated thermal capacity of converter power structure instance n that has been 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 thermal capacity as determined by the continuous current rating of the converter.

If the CIP Motion device applies I2T overload protection rather than thermal model based overload protection for converter power structure instance n, 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 I2T calculation. A value of 100% in this case indicates that the converter has used up 100% of its I2T overload capacity.

The converter overload protection method applied by the device is indicated by the Converter Overload Protection Method attribute that applies to all converter power structure instances.

Power structure instance attributes are only applicable when supporting multiple converter power structure generated DC Bus outputs per axis object instance.

Bus Output Overvoltage Factory Limit n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	GSV	-	REAL	-	-	-	Volts

Returns the Factory Limit for the Bus Overvoltage FL 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.

This attribute is only applicable to DC Converter Types.

Bus Output Undervoltage Factory Limit n

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	GSV	-	REAL	-	-	-	Volts

Returns the Factory Limit for the Bus Undervoltage FL 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.

This attribute is only applicable to DC Converter Types.

Guard Status Attributes

The Guard Status attributes are associated with Hardwired safety functionality associated with 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 without the services of a CIP Safety network connection, hence the term Hardwired safety as opposed to Networked Safety. 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

The Guard Status and Guard Fault attributes are defined in the axis to monitor the behavior of Hardwired Drive Safety functionality. The term Guard is used for these status attributes to differentiate these attributes from the standard Safety status attributes associated with Networked Safety functionality that employ a CIP Safety connection.

See the following publications for more information about what happens when a Safe Stop occurs and if the operation leads to a Guard Fault. If this safety operation leads to a Guard Fault, the controller reacts by processing the fault, disabling the planner.

- Kinetix 6200 and Kinetix 6500 Safe Speed Monitoring Safety Reference Manual, publication 2094-RM001
- Kinetix 6200 and Kinetix 6500 Safe Torque Off Safety Reference Manual, publication 2094-RM002
- Kinetix Safe-off Feature Safety Reference Manual, publication GMC-RM002
- See Additional Resources on page 13 for links to publications about Safety Controllers.

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	DINT	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 25…31 = Reserved

Table 62 - 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 cleared only 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, 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 cleared only by a successful safety reset.

Table 62 - Guard Status Bit Descriptions (Continued)

Bit	Name	Description
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 Output	Indicates the current state of the Safe Door output.
17	Guard Door Control Lock	Indicates if the Door Control Output is being commanded to the Locked state.
18	Guard Door Control Output	Indicates the current state of the Safe Door Control output.
19	Guard Door Monitor Input	Indicates the current state of the Door Monitor (DM) input.
20	Guard Door Monitor In Progress	Indicates if the Safe Door Monitoring (DM) function of the safety core is in progress.
21	Guard Lock Monitor Input	Indicates the current state of the Safe Lock Monitoring input.
22	Guard Enabling Switch Monitor Input	Indicates the current state of the Safe Enabling Switch Monitor input.
23	Guard Enabling Switch Monitor In Progress	Indicates if the Safe Enabling Switch Monitor (ESM) monitoring function of the safety core is in progress.
24	Guard Reset Input	Indicates the state of the Safety Reset input used to initiate the return to normal operational state of the safety core.
25	Guard Reset Required	Indicates that the drive's safety function requires a Safety Reset to permit the return to normal operational state.

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 in the device 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

Usage	Access	T	Data Type	Semantics
Optional - D	GSV	T	DINT	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

Table 63 - 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 include safety processor faults, inter-processor communication 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 powerup.
5	Guard Feedback 1 Fault	An anomaly has been detected with the feedback 1 device.
6	Guard Feedback 2 Fault	An anomaly 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.
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.

Table 63 - Guard Faults Bit Descriptions (Continued)

Bit	Name	Description
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.
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.
21	Guard Door Monitor Fault	The Door Monitoring inputs were detected as OFF when they shall 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.
24	Guard Lock Monitor Fault	The Lock Monitoring inputs were detected as OFF when the Door will 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.
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	-

Axis Safety Attributes

Table 64 contains the standard safety functions specified for use by Integrated Motion safety devices, drives, and to interoperate with an external Safety Controller via a CIP Safety connection. These functions appear also as various Axis Safety Status bits.

Axis Safety State

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE Safety Only	GSV	T	UINT	-	-	-	Bitmap 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

8-bit enumeration that indicates the state of the associated Safety Supervisor object of the device. There is only one Safety Supervisor object servicing the CIP Motion device so its state applies to all applicable Axis instances of the device. This means that all instances of this object will have the same state for this attribute.

Table 64 - Axis Safety Status Bit Descriptions

Semantics of Values	Safety Supervisor State	Description
0 = Undefined/Unknown (No Motion Connection)	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.
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 sticky 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 via power cycle or re-connection.
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.

Table 64 - Axis Safety Status Bit Descriptions

Semantics of Values	Safety Supervisor State	Description
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	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 Active 6 = Safe Brake Engaged 7 = Safe Stop 1 Active 8 = Safe Stop 2 Active 9 = Safe Operating Stop Active 10 = Safe Stop Standstill 11 = Safe Motor Temperature Active 12 = Safe Motor Overtemperature 13-15 = (reserved) 16 = Safe Speed Monitoring Active 17 = Safe Speed Monitoring Status 18 = Safe Limited Speed Active 19 = Safe Limited Speed Limit 20 = Safe Limited Accel Active 21 = Safe Limited Accel Limit 22 = Safe Limited Direction Active 23 = Safe Limited Direction Limit 24 = Safe Positive Motion 25 = Safe Negative Motion 26-29 = (reserved) 30 = Safety Output Connection Closed 31 = Safety Output Connection Idle

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 (Attribute 40) of the Safety Stop Functions object associated with this axis instance. The upper 16-bits are the current Safety Limit Status attribute value (Attribute 40) 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 resulting in the axis being Safe Torque Disabled. The Safety Output Connection Idle bit, when set, indicates that the Safety Output Connection's Run/Idle bit is set to Idle resulting in the axis being Safe Torque Disabled.

Axis Safety Faults

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE Safety Only	GSV	T	DWORD	-	-	-	Bitmap 0 = Reserved 1 = Safety Core Fault 2 = Safety Feedback Fault 3 = Safe Torque Off Fault 4 = Safe Stop 1 Fault 5 = Safe Stop 2 Fault 6 = Safe Operating Stop Fault 7 = Safe Brake Fault 8 = Safe Motor Temperature Fault 9…15 = Reserved 16 = Safe Speed Monitor Fault 17 = Safe Limited Speed Fault 18 = Safe Limited Accel Fault 19 = Safe Limited Direction Fault 20…31 = Reserved

The Axis Safety Faults are 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 (Attribute 41) of the Safety Stop Functions object associated with this axis instance. The upper 16-bits is the current Safety Limit Faults attribute value (Attribute 41) of the Safety Limit Functions object associated with this axis instance.

Semantics of Values	Description

The Safe State is entered if a fault is detected:
- Data in input assembly (to safety controller) set to designated Safe State.
- Safe Torque Off is activated: Torque is disabled.
- Safe Brake Control is activated: Mechanical brake is engaged.

When set to 0 = No Fault, if it is set to 1= Faulted, a safety function related fault has been detected.

For more information about the Safe Speed Monitoring object and attribute descriptions, see ODVA Volume 5 CIP Safety specification associated with the Safety Stop Functions at, http://www.odva.org

2 = Safety Feedback Fault	The Safety Feedback Fault (SFF) provides position, velocity, and acceleration data used by Safety Stop Functions. When set to 0, the SFF attribute is operating normally. If it is set to 1, an SSF function related fault has been detected.
3 = Safe Torque Off Fault	The Safe Torque Off (STO) function communicates that power can cause rotation (or motion in the case of a linear motor), is not applied to the motor. The drive does not provide energy to the motor which can generate torque (or force in the case of a linear motor). When set to 0 = No Fault, the STO attribute is operating normally. If it is set to 1= Faulted, an SBC function related fault has been detected.
4…31 = Reserved	-

Safe Torque Off Action

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D Safety Only	SSV	T	USINT	0	-	-	Enumeration 0 = Disabled & Coast 1 = Current Decel & Disable 2 = Ramped Decel & Disable 3 = Current Decel Hold 4 = Ramped Decel Hold 5…127 = Reserved 128…255 = Vendor Specific 128 = DC Injection Brake 129 = AC Injection Brake

When the drive detects a Safe Torque Off (STO) Active condition, as reported by the Axis Safety Status attribute, 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 Stop 0, or Category Stop 1.

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 is disabled.

When the drive detects a Safe Torque Off (STO) Active condition, as reported by the embedded Safety Core via the Axis Safety Status attribute, 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 Stop 0 (0), or Category Stop 1 (1 and 2). The definition for each enumeration shall follow the same enumerations defined for the Stopping Action attribute. 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 shall be disabled, ultimately with safety integrity as enforced by the Safety Core's STO safety function.

For more information on Safe Torque Off Action, see the Kinetix 5500 Servo Drives User Manual, publication 2198-UM001, the Kinetix 5700 Servo Drives User Manual, publication 2198-UM002, and the PowerFlex 527 Adjustable Frequency AC Drive User Manual, publication 520-UM002.

Drive Commissioning Attributes

These are the attributes that are associated with auto-tuning and test services applied to a Motion Control Axis. These attributes are unique to the controller and do not require replication in the Motion Control Device Axis.

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	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	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	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	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	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	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	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	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	GSV		REAL	-	-	-	% 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	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	T	Data Type	Default	Min	Max	Semantics of Values
Required - D IPM Only	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 Comm Offset Comp

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - D IPM Only	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.

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	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	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 is applied to the motor position accumulator 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	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	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 your 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	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 your definition of forward direction, can be used to configure the various polarity attributes for the correct directional sense.

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	GSV		INT	-	-	-	Enumeration 0 = Tune Successful 1 = Tune in Progress 2 = Tune Aborted by User 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	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	GSV		REAL	-	-	-	Seconds

The Tune Deceleration Time attribute returns deceleration time in seconds of the last successful Inertia Test service. These values are used to calculate the Tune Deceleration attribute.

Tune Acceleration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	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	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.

Tune Inertia Mass

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	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 MRAT (Motion Run Axis Tune) 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	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
Require - C	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
Require - C	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.

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	SSV(1)		REAL	1	0	maxpos	Position Units

The Hookup Test Distance attribute is used by the Hookup Test service to determine the amount of motion that is necessary to satisfy a selected hookup test process.

(1) SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

Hookup Test Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - !E	SSV(1)		REAL	10	0	∞	Seconds

The Test Time attribute is used by the Hookup Test service to determine the duration of motion that is necessary to satisfy a selected Hookup Test process. This value is typically set to around 10 seconds.

(1) SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

Hookup Test Feedback Channel

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - E	SSV(1)		USINT	1	1	2	Feedback Channel 1 = Feedback 1 2 = Feedback 2

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.

(1) SSV - These configuration attributes cannot be changed either online or via an SSV instruction if the axis is in the Running state, for example, the Tracking Command bit of CIP Axis Status attribute.

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

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 = Bi-Directional Forward 3 = Bi-Directional Reverse 4…255 = Reserved

This enumerated value determines the direction of the motion profile initiated by the Inertia Test service associated with the MRAT instruction.

Tuning Travel Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	SSV		REAL	0	0	-	Position Units

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 via 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

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

The Tuning Torque attribute value determines the maximum torque used by the Inertia Test service initiated motion profile. This attribute is 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.

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

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

Total Mass represents the combined mass of the linear motor and load in engineering units.

Autotune Configuration Attributes

These are the attributes that are associated with autotune 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	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 * 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.

See System Bandwidth on page 293 for details on these calculations.

The value for this attribute can also be updated via 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	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 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, Feedforward attributes, Torque Low Pass Filter Bandwidth according to the Gain Tuning Configuration Bits setting.

Position Loop Operation

If the drive is configured for Position Loop operation, the following calculations apply:

Position Loop Bandwidth = System bandwidth

Position Integer Bandwidth = 0.16/Damping Factor^2 * System Bandwidth

Velocity Loop Bandwidth = 4 * Damping Factor^2 * System Bandwidth

Velocity Integer Bandwidth = System Bandwidth

Position Error Tolerance = 2 * Max Speed/Position Loop Bandwidth (rad/s)

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 = 0.16/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 that the observer function is enabled, the following calculations are performed:

Load Observer Bandwidth = Velocity Loop BW

Torque Loop Filter Bandwidth = 5 * Velocity Loop Bandwidth

If the Gain Tuning Configuration bit for Tune Torque LP Filter is set, the following calculation is performed:

Torque LP Filter Bandwidth = 5 * Velocity Loop Bandwidth

System Bandwidth Value

The System Bandwidth value can also be updated via 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	SSV		REAL	FD	.05	2.0	

The Damping Factor attribute value is used in calculating the maximum Position and Velocity Servo Bandwidth values during execution of the MRAT (Motion Run Axis Tune) instruction.

In general, the Damping Factor attribute controls the dynamic response of the drive axis. When gains are tuned by using a small damping factor (like 0.7), a step response test performed on the axis would demonstrate under-damped behavior with velocity overshoot. A gain set generated by using a larger damping factor, like 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	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 the 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 (Motion Run Axis Tune) 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	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 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 (Motion Run Axis Tune) instruction. Computing gains based on this maximum value via software 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	SSV		REAL	0.0015 FD	10^{-6}	1	Seconds

The value for the Drive Model Time Constant represents, 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.

Because 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	Logix Designer		SINT/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 autotune software to set the Gain Tuning Configuration Bits attribute that establishes the appropriate gain set application.

The relationship between Application Type and Gain Tuning Configuration Bits is described in the Table 65 and Table 66.

Table 65 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.

Table 65 - Integrator Bandwidth Values

Application Type	Kpi	Kvi	iHold
Custom	-	-	-
Basic	No	No	No
Tracking	No	Yes	No
Point-Point	Yes	No	Yes
Constant Speed	No	Yes	No

Table 66 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.

Table 66 - Feedforward Values

Application Type	Kvff	Kaff
Custom	-	-
Basic	Yes	No
Tracking	Yes	Yes
Point-Point	No	No
Constant Speed	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.

Table 67 - Torque Low Pass Filter

Application Type	Torque Low Pass Filter
Custom	-
Basic	Yes
Tracking	Yes
Point-Point	Yes
Constant Speed	Yes

If Application Type is set to Custom, individual gain calculations can be controlled directly 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 Table 65…Table 67.

Loop Response

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV	Logix Designer		USINT	1	-	-	Enumeration 0 = Low 1 = Medium 2 = High 3…255 = Reserved

The Loop Response attribute is used by configuration and autotune 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 this table.

Table 68 - Applied Damping Factor

Loop Response	Damping Factor	Description
Low	1.5	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 requires lower position and velocity loop bandwidths to maintain stability and minimize motor heating.
Medium	1.0	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.
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.

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	Logix Designer		USINT	0	0	0	Enumeration 0 = Rigid 1 = Compliant 2…255 = Reserved

The Load Coupling attribute is used by configuration and autotune 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	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 Torque Low Pass Filter 9…15 = Reserved

This bit field attribute 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 Run Inertia Test bit determines whether 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 is performed. If the bit is clear, the MRAT will immediately complete without an inertia measurement.

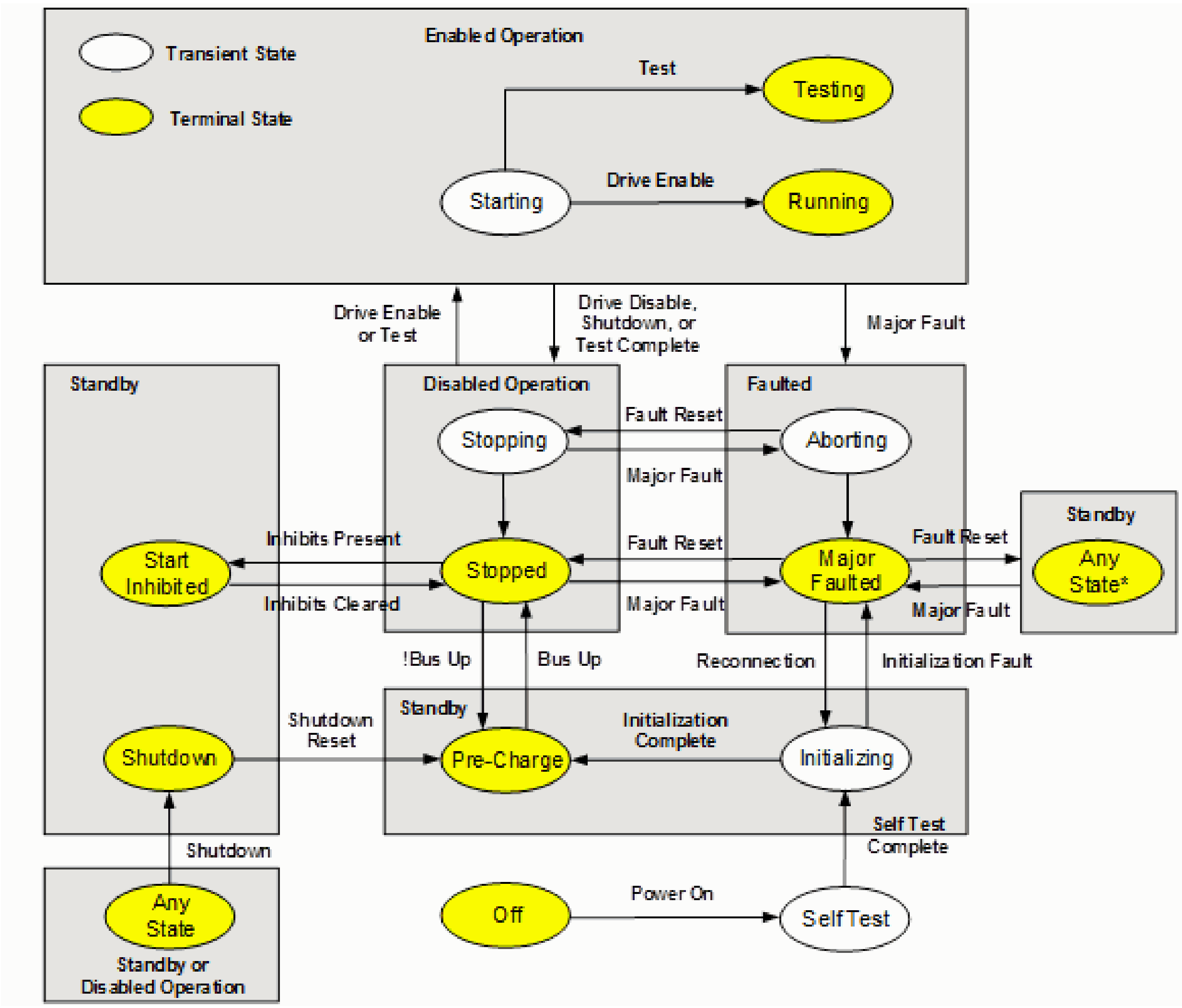
Table 69 - Gain Tuning Configuration Bit Descriptions

Bit	Description
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 affect on Total Inertia or System Bandwidth.
Tune Position Integrator	The Tune Position Integrator bit attribute determines whether 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 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 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 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. Bits 4…7 may not be updated programmatically by SSV instruction unless the Application Type is set to Custom.
Tune Torque Low Pass 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.
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.

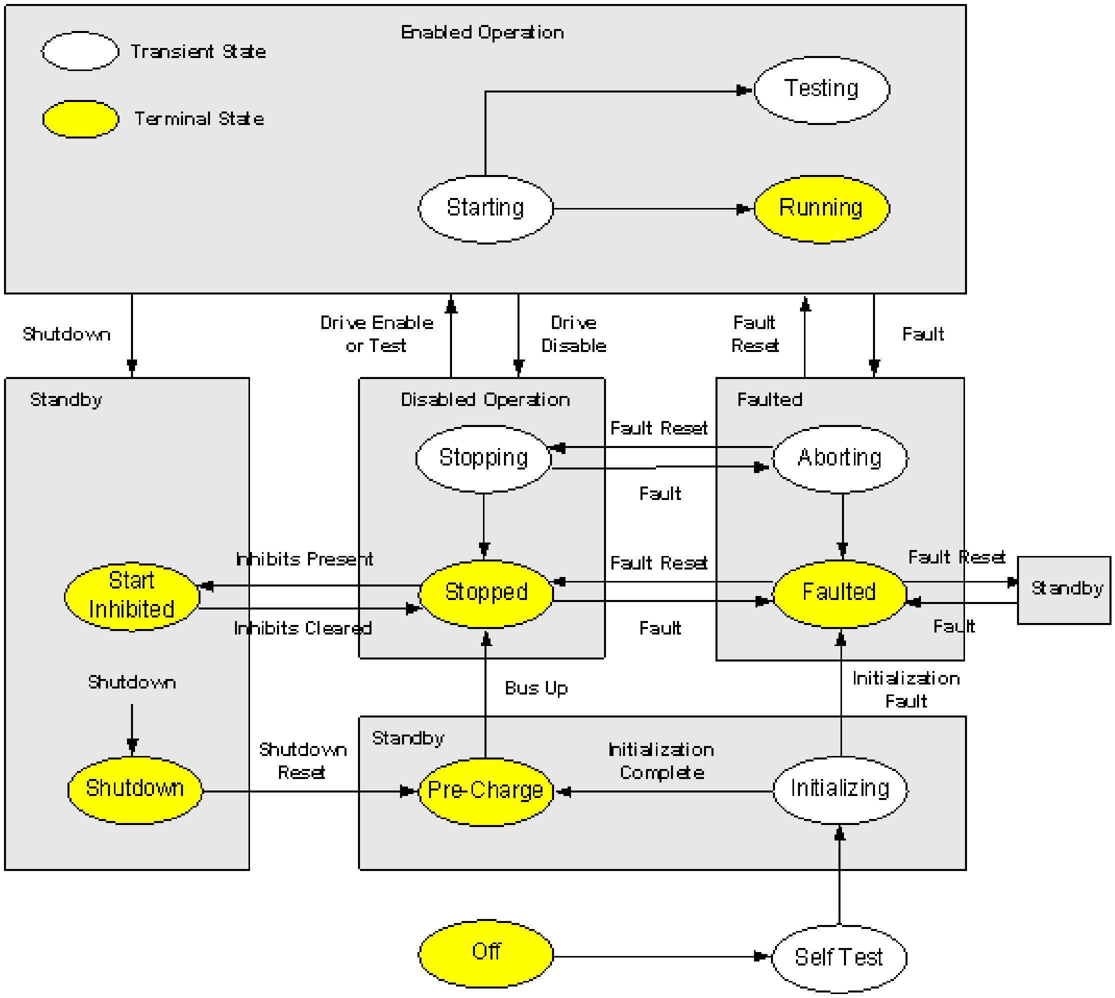
Motion Control Axis Behavior Model

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 via the Axis Control request mechanism or by conditions that occur in either the controller or motion device during operation. Figure 29 shows 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.

Figure 29 - Motion Control Axis Behavior Mode (Active Control)



* Specific Standby State after a Fault Reset is determined by applying Fault Reset State Transition Precedence rules defined at the end of this section.



This table defines the valid transitions for the Axis State Model.

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
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	Fault Reset	SD = 1	Shutdown

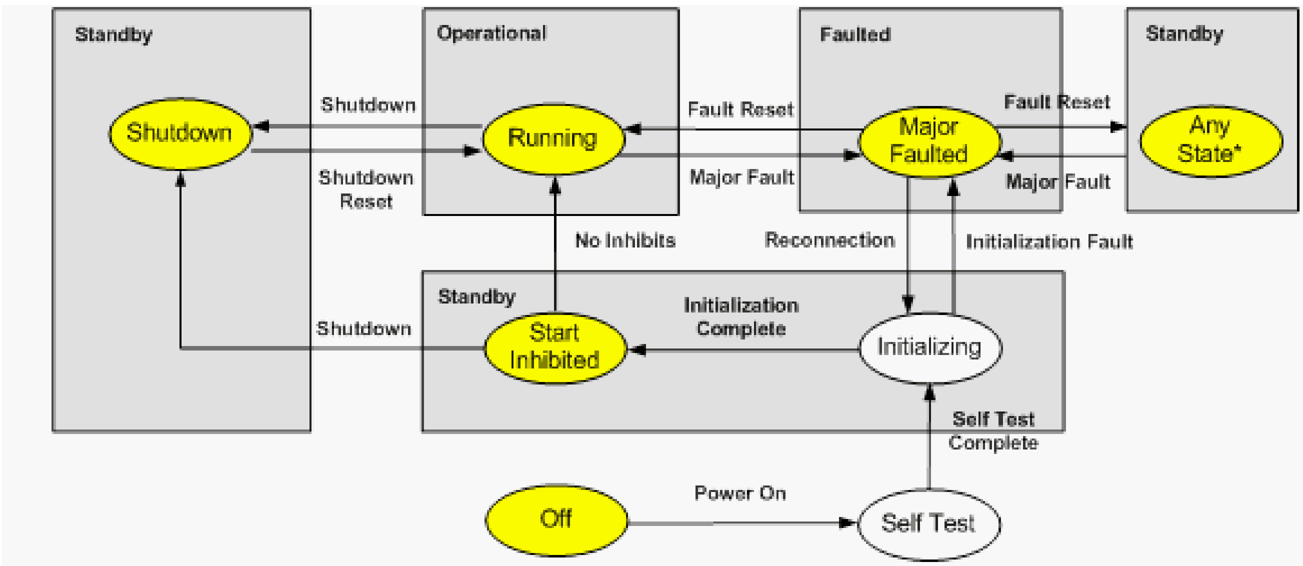
Current State	Event	Conditions	Next State
Major Faulted	Fault Reset	SD = 0, BU = 0	Pre-Charge
Major Faulted	Fault Reset	SD = 0, BU = 1, SI > 0	Start Inhibited
Major Faulted	Fault Reset	SD = 0, BU = 1, SI = 0	Stopped
Major Faulted	Reconnection		Initializing
Stopped	!Bus Up		Pre-Charge
Stopped	Shutdown		Shutdown
Stopped	Major Fault		Major Faulted
Stopped	Start Inhibit		Start Inhibit
Stopped	Enable		Starting
Stopped	Test (Active)		Starting
Starting	Shutdown		Shutdown
Starting	Major Fault		Aborting
Starting	Disable		Stopping
Starting	Start Complete	IP = 0	Running
Starting	Start Complete	IP = 1	Testing
Stopping	Stop Complete	SD = 0	Stopped
Stopping	Stop Complete	SD = 1	Shutdown
Stopping	Major Fault		Aborting
Stopping	Enable	Flying Start Enabled	Starting
Aborting	Stop Complete		Major Faulted
Aborting	Fault Reset		Stopping
Testing	Shutdown		Stopping
Testing	Major Fault		Aborting
Testing	Disable		Stopping
Running	Shutdown		Stopping
Running	Major Fault		Aborting
Running	Disable		Stopping
Any State	Connection Close		Initializing
Any State	Connection Loss		Major Faulted

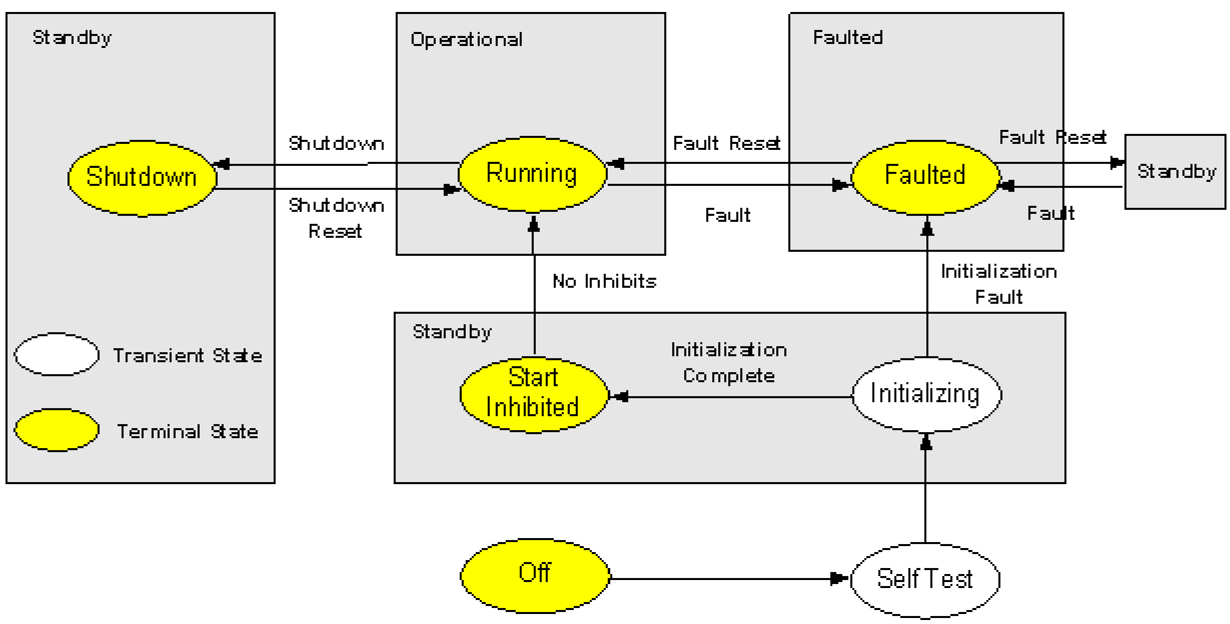
Some of the axis state machine transitions listed previously have dependencies on the current status conditions of the axis defined in this table.

Condition	Symbol	Description
Bus Up	BU	This Axis Status bit is set if the DC bus is charged within the operating range.
Shutdown	SD	This Axis Status bit is set if there is an active shutdown. This is different than the shutdown state. The Shutdown status bit can be active in the faulted state.
In Process	IP	This Axis Status bit indicates a test process associated with service request is active. Note that the In Process bit may be active without the axis state machine being in the testing state.
Start Inhibit	SI	This represents the set of active Start Inhibits. An SI value of 0 indicates no active Start Inhibits. Note that start inhibits can be present without the axis state machine being in the start inhibit state.

When the Motion Control Axis is not actively controlling axis motion (Control Mode = No Control), the state diagram above reduces to the following for a Feedback Only axis or CIP Motion Encoder device type.

Figure 30 - Motion Control Axis Object State Model (Feedback Only)





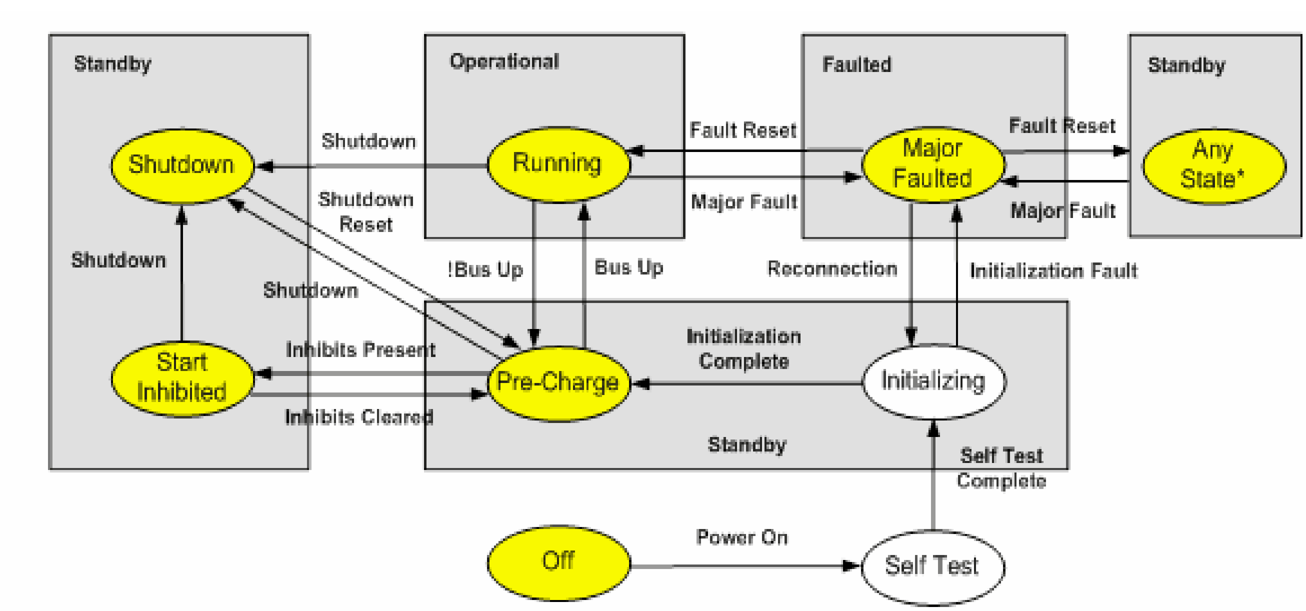
* Specific Standby State after a Fault Reset is determined by applying Fault Reset State Transition Precedence rules defined at the end of this section.

This table defines the valid transitions for the Axis State Model of a Feedback Only axis or CIP Motion Encoder.

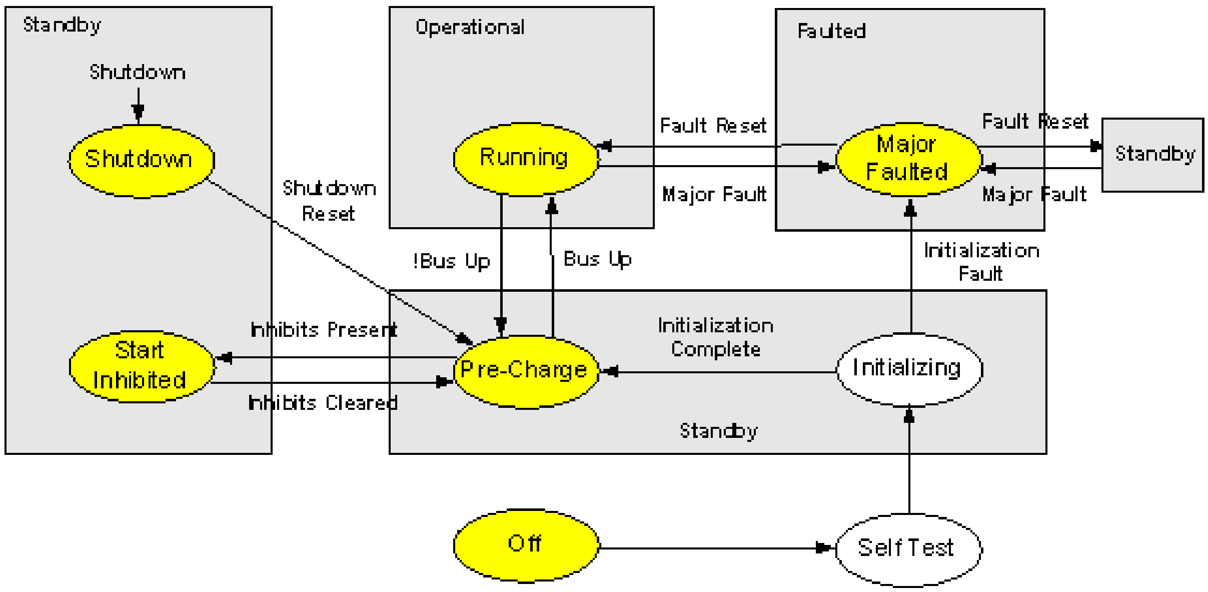
Current State	Event	Conditions	Next State
Off	Power Up		Self Test
Self Test	Self Test Complete		Initializing
Initializing	Initialization Fault		Major Faulted
Initializing	Initialization Complete		Start Inhibited
Shutdown	Major Fault		Major Faulted
Shutdown	Shutdown Reset		Running
Start Inhibited	Shutdown		Shutdown
Start Inhibited	Major Fault		Major Faulted
Start Inhibited	Inhibits Cleared		Running
Major Faulted	Fault Reset	SD = 1	Shutdown
Major Faulted	Fault Reset	SD = 0, SI > 0	Start Inhibited
Major Faulted	Fault Reset	SD = 0, SI = 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

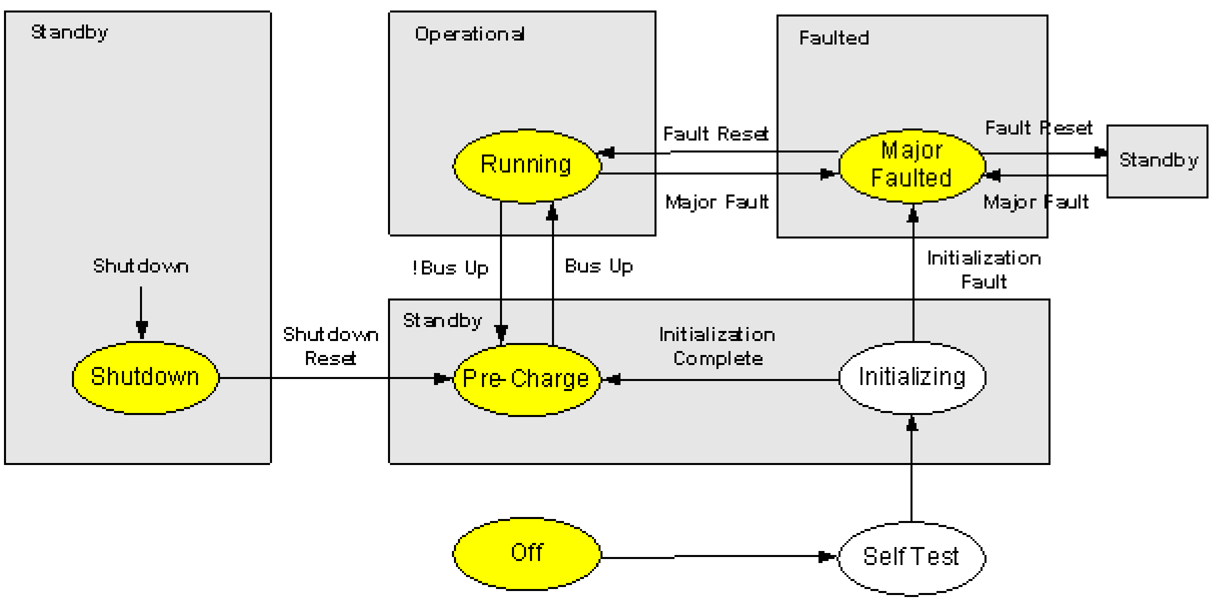
When the Motion Device Axis Object is associated with a CIP Motion Converter, the Active Control state diagram reduces to the following.

Figure 31 - Motion Device Axis Object State Model (Converter)



* Specific Standby State after a Fault Reset is determined by applying Fault Reset State Transition Precedence rules defined at the end of this section.


Standby
Shutdown
Shutdown
Start Inhibited
Operational
Running
Faulted
Fault Reset
Major Faulted
Fault Reset
Standby
Major Fault
Major Fault
Shutdown Reset
!Bus Up
Bus Up
Initialization Fault
Inhibits Present
Pre-Charge
Initialization Complete
Initializing
Inhibits Cleared
Standby
Off
Self Test


Standby
Operational
Faulted
Running
Fault Reset
Major Faulted
Fault Reset
Standby
Major Fault
Major Fault
Shutdown
!Bus Up
Bus Up
Initialization Fault
Shutdown Reset
Standby
Initialization Complete
Shutdown
Pre-Charge
Initializing
Off
Self Test

Valid transitions for the Axis State Model of a CIP Motion Converter axis are explicitly defined in this 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		Start Inhibited
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 Fault
Pre-Charge	Bus Up		Running
Major Faulted	Fault Reset	SD = 1	Shutdown
Major Faulted	Fault Reset	SD = 0	Pre-Charge
Major Faulted	Reconnection		Initializing
Running	!Bus Up		Pre-Charge
Running	Shutdown		Shutdown
Running	Major Fault		Major Faulted
Any State	Connection Close		Initializing
Any State	Connection Loss		Major Faulted

Fault Reset State Transition Precedence

The State Diagrams above are in a 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 depends on other state/status conditions of the axis.

In fact, it may be possible for more than one state condition to be present at the same time, for example, Shutdown, Start Inhibited, and so forth. Because the axis state model can represent only 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

State Behavior

These are the descriptions of each of the states and state transitions of the Motion Control Axis state model.

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 anomaly 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 Identity Object. Clearing this fault can only be accomplished through a power cycle and is most likely the result of a device hardware anomaly.

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 via the CIP Motion connection.

If the CIP Motion device supports standalone 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. If the device receives a subsequent Forward Open service to open a CIP Motion connection, the device disables all axes and transition back to the Initializing state, following the state sequence outlined below.

If the device does not support standalone operation and depends on remote configuration data to be supplied over a CIP Motion connection, the device transitions 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 above 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, shall 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 via a Forward Open service. During this time the CIP Axis State is Unconnected. Once the Forward Open service is successfully processed, the device initializes all attributes to their factory default values, resets all active faults, and 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. During this time the CIP Axis State is unconnected. Any configuration error encountered during this process, for example, due to value out of range or value not applicable, are handled by the device 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 shall 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 shall 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 the device by 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.

The CIP Axis States of Unconnected, Configuring, Synchronizing, and Waiting for Group are defined in more detail in the sections that follow.

If an anomaly 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 so clearing the fault can be accomplished only through a power cycle or a device reset service to the associated Identity Object.

If the CIP Motion connection is intentionally closed for any reason during operation via a Forward Close service, the device clears all active faults and alarms 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 waits for the CIP Motion connections to the device to be re-established by the controller via a Forward Open service. The controller's CIP Axis State shall transition through the various Initialization sub-states as described above.

The Initializing State is classified as an Identity Object Standby state and, therefore, the device ensures that all associated power structures are disabled.

Pre-charge State

In 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 drive device's inverter power structure is always disabled in this state (Power Structure Enabled status bit clear). Any attempt for the controller to enable a drive device via 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 inverter 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 via 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 Motion Planner output to affect axis motion (Tracking Command status bit set). The motion axis remains in the Running state until either a fault occurs or it is explicitly commanded to stop via a 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 device is fully operational. Since there is no active control function, however, the Power Structure Enabled status bit and the Tracking Command status bit s are both clear). The motion axis remains in the Running state until either a fault occurs or it is explicitly commanded to Shutdown via 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). 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 returns to the Stopped state via the Stopping 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 drive device shall execute 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 attribute. Once corrected, the axis state automatically transitions back to the Stopped state.

For an axis with no active control function (Control Mode = No Control), the Start Inhibited axis state prevents transition to the Running state based until specific Start Inhibit conditions are resolved, such as when the associated device is not fully configured for operation. Again, once these conditions are 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 or Shutdown Request is issued to the Motion Device Axis Object in the Starting, Running, or 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 Requests 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 waits until the axis has reached zero speed, or a timeout occurs (see Stopping Time Limit and Coasting Time Limit on page 218), 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, or in the case of a Frequency Control drive device, the criteria are based on Velocity Reference rather than Velocity Feedback. Ultimately, zero speed criteria are left to the vendor's discretion.

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

See Stopping Sequences on page 219 for detailed information.

Aborting State

When a Major Fault occurs in the motion device while the axis is in either the Starting, Running, Testing, or Stopping state, 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 based on the specific fault condition 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 (Category Stop 1 and 2). In some cases, the power structure must be immediately disabled so the axis may coast to a stop while in the Aborting state (Category 0 Stop).

In any case, the drive waits until the axis has reached zero speed, or a timeout occurs, before transitioning to the Major Faulted 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, Velocity Reference is used rather than Velocity Feedback. Ultimately the zero speed criteria are left to the vendor's discretion. See section on Stopping Sequences for details.

When fault 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 via an Axis Control state change request or Motion Planner stop, or indirectly via 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 affect 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 devices results 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 via an Axis Control state change request or Motion Planner stop, or indirectly via 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.

Because 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. Table 70 provides source descriptions of faults.

Table 70 - Fault Type Source

Fault Type	Source
CIP Initialization	These faults can occur only during the Initializing state. You cannot generate an Initialization fault in any other state of the device, for example, faults occurring during operation of the device after transitioning out of the Initializing state. Initialization Faults can apply to a specific axis or to the entire device, 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	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, are 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	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	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. This component of the drive is designed to monitor various critical safety functions of the drive and put the axis in a safe state should any monitored condition fail to operate nominally.
Motion	These faults are generally associated with fault conditions generated by the Motion Planner function. These faults can include conditions related to the input (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.

Table 70 - Fault Type Source (Continued)

Fault Type	Source
Module	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; these faults are primarily communication faults, but can include general hardware faults where these fault conditions are checked during run-time. A CPU watchdog fault is 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 is the Control Sync Fault. The device power structure, if applicable, is disabled when there is a Module Fault present.
Group	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 the controller and are generally associated with the time synchronization function that is common to all axes in the motion group. The devices power structure, if applicable, is disabled when there is a Group Fault present.
Configuration	A configuration fault is generated any time 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 (or a Shutdown fault action initiated by a Major Fault condition) is issued to the device, the targeted axis transitions to the Stopping (or Aborting) state. Once the Stopping (or Aborting) state completes, the axis transitions to the Shutdown (or Major Faulted) state.

The Shutdown state has the same basic characteristics of the Stopped state except that the device's inverter power structure shall be disabled and free of torque (Power Structure Enabled status bit clear) and, depending on the selected Shutdown Action, DC Bus power to the device's power structure shall be dropped (DC Bus Up status bit clear).

This is generally done by opening an AC Contactor Enable output, if applicable, provided by the device 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 protection against unexpected motion.

In the case where a Shutdown fault action is initiated by the device in response to a Major Fault condition, 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 applicable even to a Feedback Only axis where the axis instance is simply associated with a feedback device that has no active control function.

The Shutdown State is classified as an Identity Object Standby state and, therefore, requires that the associated device 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 is 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 is created and not associated with a Motion Group, the axis state is set to the Not Grouped state. A CIP Motion axis is assigned to a Motion Group for the axis 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 for any reason, the associated 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 is 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 must be initiated by you to transition to the Initializing state and restore axis function.

Configuration State

Once a CIP Motion I/O connection has been made to the device, the controller begins to send configuration data via the connection's service channel. At this time the axis state transitions from Unconnected to Configuring. The axis state shall 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 shall 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 shall 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.

Fault and Alarm Behavior

The Motion Device Axis Object's 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 fault, which could be a regular runtime CIP Axis Fault, or Safety Fault, or an Initialization Fault.

The CIP Axis Fault Code and related attributes in the Motion Device Axis are used to report the specific fault condition, time stamp, and fault action to the controller for the purposes of building a fault log. Before we go into detail on this, we will first carefully define the terms used to describe the Fault and Alarm functionality of the Motion Device Axis Object.

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 a variety of actions via 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, that is 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.

CIP Data Types

Table 71 provides descriptions of the CIP Data Type related to the CIP Motion Control Axis.

Table 71 - CIP Data Type Descriptions

Data Type	Data Type Code (in 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

Table 71 - CIP Data Type Descriptions

Data Type	Data Type Code (in hex)	Description	Range
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

CIP Error Codes

Table 72 lists the general ASA error codes.

Table 72 - CIP Error Codes Descriptions

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 is supplied in the object specific status field of the response.
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 is 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 is 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 reports 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 reports the object's current status.
0C	Object can not perform service in its current mode/state.	The object cannot perform the requested service in its current mode/state. The object specific status reports 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, because the Update Service is required before data can be sent via the Transfer Service.
0D	Object already exists.	The requested instance of the object to be created already exists.
0E	Attribute value not settable.	The object attribute is not a settable attribute. The object specific status reports 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 is reported in the extended status.

Table 72 - CIP Error Codes Descriptions (Continued)

Error Code (hex)	Error Name	Description of Error
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 reports 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.
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, have 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 or 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 that 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.
26	IOI Size Invalid.	The Size of the IOI that 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 the DeviceNet specification for details, http://www.odva.org.
29	DNet Member not settable.	See the 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.

Notes:

Module Configuration Attributes

These are the Module Configuration attributes associated with components that are common to all axis instances of a multi-axis integrated motion device or module. The common device components are, for example, an Integral Converter, Bus Regulator, Common Power Supply, Feedback Cards, and Network Interface.

Module Configuration attributes are included in the CIP Motion Control Axis Object implementation and may be included as part of a vendor specific device interface. The Need in Implementation Rules apply for either case.

There are six general categories of module configuration attributes that are defined in the following sections.

Attribute	Description
Module Configuration Block Attributes	Configure elements of the Configuration Block sent in the CIP Motion Forward_Open.
Module Class Attributes	Configure Motion Device Axis Object class attributes associated with the device.
Module Axis Attributes	Configure Motion Device Axis Object axis attributes that apply to a common device component.
Module Feedback Port Attributes	Configure the mapping of feedback ports to feedback channels for each axis instance.
Module Timing Attributes	Configure various time related aspects of the integrated motion device.
Module Support Attributes	Determine the size and content of the configuration data needed by the integrated motion device.

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	Data Type	Default	Min	Max	Semantics of Values
Required - All		BYTE	0	-	-	Bitmap: Bit 0 = Verify Power Structure (O/D) Bits 1…7 = (Reserved)

Collection of bits used for configuration of an associated integrated motion device. Verify Power Structure is used to control whether the drive performs an extended key check against its Drive Class ID.

Drive Power Structure Class ID

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required -D		DINT				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.

Module Class Attributes

The Module Class Attributes are stored in the controller and used to configure Motion Device Axis Object Class attributes associated with the integrated motion device. These attributes generally apply to the integrated motion connection behavior. If these Module Class attributes are included in the CIP Motion Control Axis Object implementation, the attributes are the same for all axis instances associated with the module. In such an implementation, the controller applies only 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	Data Type	Default	Min	Max	Semantics of Values
Optional	Logix Designer	SINT	4	1	10	# of Controller Update Periods

Represents 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	Data Type	Default	Min	Max	Semantics of Values
Optional	Logix Designer	SINT	2	1	10	# of Controller Update Periods

Represents 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	Data Type	Default	Min	Max	Semantics of Values
Optional	Logix Designer	DINT	10000	1	10^{99}	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.						

Module Axis Attributes

The Module Axis attributes are used to configure common components of a integrated motion device, for example, Bus Converter or Bus Regulator 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.

For more information about using a MSG instruction to access an attribute, see Access with a MSG (a message) Instruction on page 53.

Drive Power Structure Axis ID

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Logix Designer	DINT[8]	[ ] = 0	-	-	Array of power structure IDs used to verify if the user selected power structure for each axis instance of a multiaxis 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 multiaxis drive. By contrast, if power structure hardware that is the same for all axis instances of the drive (excluding master feedback axes) the power structure can be identified by using the Drive Power Structure Class ID attribute. For multiaxis 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…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.						

Bus Configuration

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	SSV	USINT	0	-	-	Enumeration 0 = Standalone 1 = Shared AC/DC 2 = Shared DC 3 = Shared DC - Non CIP Converter 4…255 = Reserved

Standalone indicates that DC Bus power supplied by the drive's converter section is applied only to this drive's power structure.

Shared AC/DC indicates 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 derating of the continuous current rating for the Shared AC/DC drive.

Shared DC indicates that this drive is sharing DC bus power generated by an external CIP Motion Converter.

Shared DC - Non CIP Converter indicates 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.

Bus Voltage Select

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	SSV	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; while 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	Data Type	Default	Min	Max	Semantics of Values
Optional -BD	SSV	USINT[8]	[] = 1	-	-	Enumeration 0 = Disabled (O/IM) 1 = Shunt Regulator (O) 2…127 = (reserved) 128…255 = (vendor specific) 128 = Adjustable Frequency (O/IM) 129 = Shunt Then Adjustable Frequency (O/IM) 130 = Adjustable Frequency Then Shunt (O/IM) 131 = Bus Follower (O)

This 8-element array controls the method of operation of the DC Bus Regulator. The attribute addresses the regenerative over-voltage conditions that can occur when decelerating a motor associated with a given axis instance. If Disabled, no regulation is applied to the DC Bus level by this device to control regenerative energy sourced by the motor.

When Shunt Regulator is selected the associated shunt regulation hardware is applied to the DC Bus to dissipate regenerative energy via an internal or external resistor.

When controlling Induction Motors, additional bus regulation methods are available that don't require a shunt regulator. When Adjust Frequency is selected, the output frequency of the device is controlled relative to the speed of the motor to control the amount of regenerative energy pumped into the DC Bus. Different sequential application of shunt regulation and frequency control can be applied to motor.

When Bus Follower is selected, 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 multiaxis drive module can have an independently configured Bus Regulator Action. The indexed elements of this array correspond to axis instances 1…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	Data Type	Default	Min	Max	Semantics of Values
Optional - D	SSV	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 multiaxis drive module can have an independently configured Regenerative Power Limit. The indexed elements of this array correspond to axis instances 1…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.

Shunt Regulator Resistor Type

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	SSV	USINT	0	-	-	Enumeration: 0 = Internal 1 = External 2…255 = Reserved

Defines whether Internal or External Shunt resistor is used.

External Shunt Regulator ID

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	SSV	INT	519	-1	32767	1 = None 0 = Custom 1…32767 = Shunt Regulator ID

Rockwell Automation 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	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	SSV	REAL	0.20	0	∞	Kilowatts

Rockwell Automation 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	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	SSV	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. `Shunt Pulse Power' (Kilowatts) = 75,000 * lbs, where lbs is the weight of the resistor wire element, **not weight of resistor!**

Another 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 and is a function of the element mass.

External Bus Capacitance

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	SSV	REAL	0	0	∞	μF Microfarads

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	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	SSV	REAL	0	0	∞	Ohms

This attribute represents the resistance of the External Shunt Regulator resistor.

Bus Sharing Group

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Logix Designer	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 attribute represents the resistance of the External Shunt Regulator resistor.

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, unaffected.

- 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.

TIP If your program has axes configured as 'slaves' without configuring another axis as a 'master' within that Bus Sharing Group, a validation error occurs during download, for example, aborts download. Be sure to configure at least one master. By default, all axes are assigned to the same Bus Sharing Group (if not stand-alone) so by default this check is met by configuring at least one master.

If you are using Bus Sharing and get a Bus Sharing fault, use Group Shut Down Reset, if possible. If you can't use the Group Shut Down Reset, you will need to do the resets at the axis level. Reset the master first and then reset the slaves.

Duty Select

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Logix Designer	USINT[8]	[ ] = 0	-	-	Enumeration 0 = Normal 1 = Heavy 2 = Light (O) 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 value 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 highest 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	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Logix Designer	USINT	0	-	-	Enumeration 0 = Three-Phase (R) 1 = Single-Phase (O)

Indicates whether the Converter input power to AC line is Single-Phase or Three-Phase.

Converter AC Input Voltage

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Logix Designer	UNIT	230	0	∞	Volts (RMS)

This value configures the drive for the intended AC line voltage applied to the Converter.

Demonstration Mode Select

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Logix Designer	USNIT	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, 50/60 Hz, 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	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Logix Designer	REAL	0	0	∞	°C
Sets User Limit for the Converter Overtemperature UL exception.						

Converter Thermal Overload User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Logix Designer	REAL	100	0	∞	% Converter Rated
Sets User Limit for the Converter Thermal Overload UL exception.						

Converter Ground Current User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Logix Designer	REAL	100	0	∞	% Factory Limit
Sets User Limit for the Converter Ground Current UL exception.						

Bus Regulator Overtemperature User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Logix Designer	REAL	0	0	∞	°C
Sets User Limit for the Converter Ground Current UL exception.						

Bus Regulator Thermal Overload User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Logix Designer	REAL	100	0	∞	% Regulator Rated
Sets User Limit for the Bus Regulator Thermal UL exception.						

Bus Overvoltage User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Logix Designer	REAL	140	0	∞	% Nominal Bus Voltage
Sets User Limit for the Bus Overvoltage UL exception. Unlike the corresponding Factory Limit, which is specified in Volts, the User Limit is based on percent of Nominal Bus Voltage during operation.						

Bus Undervoltage User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Logix Designer	REAL	0	0	100	% Nominal Bus Voltage
Sets User Limit for the Bus Undervoltage UL exception. Unlike the corresponding Factory Limit, which is specified in Volts, the User Limit is based on percent of Nominal Bus Voltage during operation.						

Control Module Overtemperature User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - All	Logix Designer	REAL	0	0	∞	°C

Sets User Limit for the Bus Undervoltage UL exception. Unlike the corresponding Factory Limit, which is specified in Volts, the User Limit is based on percent of Nominal Bus Voltage during operation.

Converter Pre-charge Overload User Limit

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - BD	Logix Designer	REAL	100	0	∞	% Converter Rated

Sets User Limit for the Converter Pre-Charge Overload UL exception.

Digital Input Configuration

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - All	Logix Designer	USINT [8]	[ ] = 0	-	-	Input Configuration Enumeration 0 = Unassigned 1 = Enable 2 = Home 3 = Registration 1 4 = Registration 2 5 = Positive Overtravel 6 = Negative Overtravel 7 = Regeneration 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]]

A two-dimensional array of enumerated values that map configurable digital inputs to specific functions for each drive axis. Each of the 8 possible axis instances can 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 shall be 0.

Functions that are not mapped to a digital input are not checked by the drive, nor generate associated exceptions or events. Associated exception actions in this case are accepted by the device as a `Don't Care'.

Module Feedback Port Attributes

The 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	Data Type	Default	Min	Max	Semantics of Values
Optional - E	Logix Designer	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…8 and feedback channels 1…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	Data Type	Default	Min	Max	Semantics of Values
Optional - E AOP	Logix Designer	INT[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.

Module Timing Attributes

The following attributes configure various time related aspects of an integrated motion device.

Time Sync Support

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All FW	Logix Designer	USINT	2	-	-	Enumeration 0 = No sync support 1 = Low quality 2 = High quality 3…255 = Reserved

Enumeration that reflects the synchronization capability of the device.

Note: This is for firmware use only and does not go to the drive.

- 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 usec. Fine interpolation is not recommended for this time sync implementation. Low Quality time stamp accuracy synchronization is sufficient for Fault and Alarm event logging.
- High Quality
  This enumeration indicates that the device implements has a high quality implementation of CIP Sync time synchronization in hardware protocol resulting in very accurate time stamping, for example, time stamping accuracy better than 10 usec, High Quality time synchronization is appropriate for fine interpolation and registration functionality.

Time Diagnostics

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All FW	Logix Designer	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	Data Type	Default	Min	Max	Semantics of Values
Required - D	Logix Designer	INT		-	-	Microseconds

Used to determine setting of Interpolation Control when in position loop mode.

Velocity Loop Device Update Period

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	Logix Designer	INT		-	-	Microseconds

Used to determine setting of Interpolation Control when in velocity loop mode.

Torque Loop Device Update Period

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - D	Logix Designer	INT		-	-	Microseconds

Used to determine setting of Interpolation Control when in torque loop mode.

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 are 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	Data Type	Default	Min	Max	Semantics of Values
Required - All AOP	Logix Designer	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. This is for anticipated future use by SW and for now it is set to the max # of axes supported.						

Inverter Support

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Required - All AOP	Logix Designer	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, for example, PWM Frequency and Duty Select.						

Number of Configurable Inputs

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - All FW – but only needed if Digital Input Configuration is supported	Logix Designer	USINT[8]	[ ] = 0 4	0	8	# 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]
FW only parameter (does not go to the device) but controls how much of the Digital Input Configuration array is sent to the device for a given axis instance. 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…8. Array elements that are not applicable or configured are set to 0.						

Source of Configurable Inputs

Usage	Access	Data Type	Default	Min	Max	Semantics of Values
Optional - All FW – but only needed if Digital Input Configuration is supported	Logix Designer	USINT[8]	[ ] = 0	0	8	Axis Instance [Axis 1 Inputs, Axis 2 Inputs, Axis 3 Inputs, Axis 4 Inputs, Axis 5 Inputs, Axis 6 Inputs, Axis 7 Inputs, Axis 8 Inputs]
FW 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. 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…8. Array elements that are not applicable or configured are set to 0.						

Notes:

Appendix B

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

Table 73 illustrates the methods used to convert the RSLogix 5000® software L5K file from a project using an existing Allen-Bradley® SERCOS drive to a comparable IM-compliant drive.

Table 73 - Attribute Conversion from SERCOS to Integrated Motion on the Ethernet/IP Network

SERCOS Attribute Name	L5K Example	CIP Axis Attribute Name	Conversion Method
AccelerationDataScaling	2	N/A	
AccelerationDataScalingExp	0	N/A	
AccelerationDataScalingFactor	1	N/A	
AccelerationFeedforwardGain	0	AccelerationFeedforwardGain	Direct
AccelerationLimitBipolar	33000.266	N/A	
AccelerationLimitNegative	-33000.266	DecelerationLimit	Direct
AccelerationLimitPositive	33000.266	AccelerationLimit	Direct
AmplifierCatalogNumber	`2094-AC05-M01’	Module Configuration	
AuxFeedbackRatio	1	FeedbackUnitRatio	1/x
AuxFeedbackResolution	4000	Feedback2CycleResolution	Direct
AuxFeedbackType	`<NA>’	Feedback2Type	Enum Mapping
AuxFeedbackUnit	Rev	Feedback2Unit	Enum Mapping
AverageVelocityTimebase	0.25	AverageVelocityTimebase	Direct
AxisInfoSelect1	<none>	CyclicReadUpdateList	Enum to Attr ID Element 0
AxisInfoSelect2	<none>	CyclicReadUpdateList	Enum to Attr ID Element 1
AxisType	Servo	AxisConfiguration FeedbackConfiguration	Enum Mapping
BacklashReversalOffset	0	BacklashReversalOffset	Direct
BacklashStabilizationWindow	0	BacklashStabilizationWindow	Direct
BrakeEngageDelayTime	0	BrakeEngageDelayTime	Direct
BrakeReleaseDelayTime	0	BrakeReleaseDelayTime	Direct
BusRegulatorID	`<none>’	Module Configuration	
ContinuousTorqueLimit	100	MotorOverloadLimit	Direct
ConversionConstant	200000	ConversionConstant	Direct
DampingFactor	0.8	DampingFactor	Direct
DriveEnableInputFaultAction	Disable Drive	CIPAxisExceptionAction	Enum Mapping
DriveModelTimeConstant	2.89E-04	DriveModelTimeConstant	Direct

Table 73 - Attribute Conversion from SERCOS to Integrated Motion on the Ethernet/IP Network

SERCOS Attribute Name	L5K Example	CIP Axis Attribute Name	Conversion Method
DrivePolarity	Positive	MotionPolarity	Enum Mapping
DriveThermalFaultAction	Disable Drive	CIPAxisExceptionAction	Enum Mapping
DriveUnit	Motor Rev	MotionUnit	Direct
DynamicsConfigurationBits	7	DynamicsConfigurationBits	Direct
FaultConfigurationBits	32	ExceptionAction	Enum Mapping
FeedbackFaultAction	Disable Drive	CIPAxisExceptionAction	Enum Mapping
FeedbackNoiseFaultAction	Disable Drive	CIPAxisExceptionAction	Enum Mapping
FrictionCompensation	0	FrictionCompensation	Direct
FrictionCompensationWindow	0	FrictionCompensationWindow	Direct
HardOvertravelFaultAction	Disable Drive	CIPAxisExceptionAction	Enum Mapping
HomeConfigurationBits	16#0000_0000	HomeConfigurationBits	Direct
HomeDirection	Bi-directional Forward	HomeDirection	Direct
HomeMode	Active	HomeMode	Direct
HomeOffset	0	HomeOffset	Direct
HomePosition	0	HomePosition	Direct
HomeReturnSpeed	0	HomeReturnSpeed	Direct
HomeSequence	Immediate	HomeSequence	Direct
HomeSpeed	0	HomeSpeed	Direct
HomeTorqueLevel	0	HomeTorqueLevel	Direct
InputPowerPhase	Three-Phase	Module Configuration	
IntegratorHoldEnable	Enabled	PositionIntegratorControl VelocityIntegratorControl	Bit 0 Mapping
LoadInertiaRatio	0	LoadInertiaRatio	Direct
MasterInputConfigurationBits	1	MasterInputConfigurationBits	Direct
MasterPositionFilterBandwidth	0.1	MasterPositionFilterBandwidth	Direct
MaximumAcceleration	14025.113	MaximumAcceleration	Direct
MaximumAccelerationJerk	2776994.8	MaximumAccelerationJerk	Direct
MaximumDeceleration	14025.113	MaximumDeceleration	Direct
MaximumDecelerationJerk	2776994.8	MaximumDecelerationJerk	Direct
MaximumNegativeTravel	0	MaximumNegativeTravel	Direct
MaximumPositiveTravel	0	MaximumPositiveTravel	Direct
MaximumSpeed	70.833336	MaximumSpeed	Direct
MotionGroup	\`MyGroup’	MotionGroup	Direct
MotionModule	\`SercosDrive:Ch13’	MotionModule	Direct
MotorCatalogNumber	\`MPL-A310P-M’	MotorCatalogNumber	Direct
MotorFeedbackResolution	1024	Feedback1CycleResolution	Direct
MotorFeedbackType	\`SRM’	Feedback1Type	Enum Mapping
MotorFeedbackUnit	Rev	Feedback1Unit	Enum Mapping
MotorThermalFaultAction	Disable Drive	CIPAxisExceptionAction	Enum Mapping

Table 73 - Attribute Conversion from SERCOS to Integrated Motion on the Ethernet/IP Network

SERCOS Attribute Name	L5K Example	CIP Axis Attribute Name	Conversion Method
OutputCamExecutionTargets	0	OutputCamExecutionTargets	Direct
OutputLPFilterBandwidth	0	TorqueLPFilterBandwidth	Direct
OutputNotchFilterFrequency	0	TorqueNotchFilterFrequecy	Freq Unit Scaling
PhaseLossFaultAction	Shutdown	CIPAxisExceptionAction	Enum Mapping
PositionDataScaling	10	N/A	
PositionDataScalingExp	0	N/A	
PositionDataScalingFactor	1	N/A	
PositionErrorFaultAction	Disable Drive	CIPAxisExceptionAction	Enum Mapping
PositionErrorTolerance	0.3155627	PositionErrorTolerance	Direct
PositionIntegralGain	0	PositionIntegratorBandwidth	$1/2\pi$ * 1000/Kpp
PositionLockTolerance	0.01	PositionLockTolerance	Direct
PositionProportionalGain	528.1571	PositionLoopBandwidth	$1/2\pi$
PositionServoBandwidth	84.058815	N/A	
PositionUnits	Position Units	PositionUnits	Direct
PositionUnwind	200000	PositionUnwind	Direct
PowerSupplyID	`2094-AC05-M01’	Module Configuration	
ProgrammedStopMode	Fast Stop	ProgrammedStopMode	Direct
PWMFrequencySelect	High Frequency	N/A	
ResistiveBrakeContactDelay	0	ResistiveBrakeContactDelay	Direct
RotaryAxis	Linear	RotaryAxis	Direct
RotationalPosResolution	200000	MotionResolution	Direct
ServoLoopConfiguration	Position Servo	AxisConfiguration FeedbackConfiguration	Enum Mapping
SoftOvertravelFaultAction	Disable Drive	MotionExceptionAction	Enum Mapping
StoppingTimeLimit	10	StoppingTimeLimit	Direct
StoppingTorque	288.62973	StoppingTorque	Direct
TestIncrement	0	TestIncrement	Direct
TorqueDataScaling	0	N/A	
TorqueDataScalingExp	0	N/A	
TorqueDataScalingFactor	1	N/A	
TorqueLimitBipolar	288.62973	N/A	
TorqueLimitNegative	-288.62973	TorqueLimitNegative	Direct
TorqueLimitPositive	288.62973	TorqueLimitPositive	Direct
TorqueLimitSource	Not Limited	TorqueLimitSource	Direct
TorqueOffset	0	TorqueOffset	Direct
TorqueScaling	0.01749257	SystemInertia	Conversion Const/Drive Res
TorqueThreshold	0	TorqueThreshold	Direct
TuningConfigurationBits	16#0000_0000	TuningConfigurationBits	Direct
TuningSpeed	0	TuningSpeed	Direct

Table 73 - Attribute Conversion from SERCOS to Integrated Motion on the Ethernet/IP Network

SERCOS Attribute Name	L5K Example	CIP Axis Attribute Name	Conversion Method
TuningTorque	100	TuningTorque	Direct
TuningTravelLimit	0	TuningTravelLimit	Direct
VelocityDataScaling	2	N/A	
VelocityDataScalingExp	0	N/A	
VelocityDataScalingFactor	1	N/A	
VelocityDroop	0	VelocityDroop	Direct
VelocityFeedforwardGain	0	VelocityFeedforwardGain	Direct
VelocityIntegralGain	0	PositionIntegratorBandwidth	$1/2\pi$ * 1000/Kpv
VelocityLimitBipolar	83.333336	N/A	
VelocityLimitNegative	-83.333336	VelocityLimitNegative	Direct
VelocityLimitPositive	83.333336	VelocityLimitPositive	Direct
VelocityOffset	0	VelocityOffset	Direct
VelocityProportionalGain	1352.0822	VelocityLoopBandwidth	$1/2\pi$
VelocityServoBandwidth	215.19055	N/A	
VelocityStandstillWindow	1	VelocityStandstillWindow	Direct
VelocityThreshold	0	VelocityThreshold	Direct
VelocityWindow	1	VelocityWindow	Direct

Drive Supported Optional Attributes

The tables in this chapter 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.

These are the table keys.

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

Logix Designer Application Device Function Codes

- 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)7
- 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

See Device Function Codes on page 26 for more information.

Table 74 - Conditional Implementation Key

Key	Description
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

Table 74 - Conditional Implementation Key (Continued)

Key	Description
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 SSI (feedback type)
SS	SSI (feedback type)
TM	Tamagawa (feedback type)
TP	Digital Parallel (feedback type)
TT	Digital AqB (feedback type)

Kinetix 350 Drive Module Optional Attributes

Table 75 specifies what optional attribute and corresponding control mode functionality is supported by a Kinetix 350 drive module.

Table 75 - Kinetix 350 Drive Module Optional Attributes

ID	Access	Attribute	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	

Table 75 - Kinetix 350 Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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	
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

Table 75 - Kinetix 350 Drive Module Optional Attributes (Continued)

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		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		O	-	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		O	-	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		-	-	N	N	N	0-Enum 2 = Motor Offset (N) 3 = Self-Sense (N)
31	Set*	Feedback Configuration		R	R	R	R	R	0-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	-	

Table 75 - Kinetix 350 Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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 0-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	-	-	-	0-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	
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	

Table 75 - Kinetix 350 Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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	O-IM
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	0-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	-	-	

Table 75 - Kinetix 350 Drive Module Optional Attributes (Continued)

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		-	-	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	0-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
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	

Table 75 - Kinetix 350 Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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

Table 76 specifies what optional attributes and corresponding control mode functionality is supported by the various Kinetix 5500 drive modules. The catalog numbers include the following:

- 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

Table 76 - Kinetix 5500 Optional Attributes

ID	Access	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)

Table 76 - Kinetix 5500 Optional Attributes (Continued)

ID	Access	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
2331	Get	Converter Output Power 1	N	-	N	N	N	N	Vxx

Table 76 - Kinetix 5500 Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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
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	

Table 76 - Kinetix 5500 Optional Attributes (Continued)

ID	Access	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	-	

Table 76 - Kinetix 5500 Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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		-	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	

Table 76 - Kinetix 5500 Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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
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

Table 76 - Kinetix 5500 Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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
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	-	-	-	

Table 76 - Kinetix 5500 Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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	
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

Table 76 - Kinetix 5500 Optional Attributes (Continued)

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

Kinetix 5500 Integrated STO Drive Module Optional Attributes

Table 76 specifies what optional attributes and corresponding control mode functionality is supported by the various Kinetix 5500 drive modules. The catalog numbers include the following:

- 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

Table 77 - Kinetix 5500 Optional Attributes

ID	Access	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

Table 77 - Kinetix 5500 Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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)
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		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	

Table 77 - Kinetix 5500 Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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
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

Table 77 - Kinetix 5500 Optional Attributes (Continued)

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		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	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	

Table 77 - Kinetix 5500 Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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)
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	

Table 77 - Kinetix 5500 Optional Attributes (Continued)

ID	Access	Attribute	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 (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

Table 77 - Kinetix 5500 Optional Attributes (Continued)

ID	Access	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

Table 77 - Kinetix 5500 Optional Attributes (Continued)

ID	Access	Attribute	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		-	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	

Table 77 - Kinetix 5500 Optional Attributes (Continued)

ID	Access	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 Drive Module Optional Attributes

Table 78 specifies what optional attribute and corresponding control mode functionality is supported by the single axis Kinetix 5700 High Power Inverter. The catalog numbers are:

- 2198-S086-ERS3
- 2198-S130-ERS3
- 2198-S160-ERS3

Table 78 - Kinetix 5700 High Power Inverter Optional Attributes

Attribute 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	
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

Table 78 - Kinetix 5700 High Power Inverter Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
1373	Set	Actuator Type	-	N	N	N	N	N	DScale
836	Set	Adaptive Tuning Configuration	-	-	-	N	N	N	V26/Vxx
844	Get	Adaptive Tuning Gain Scaling Factor	-	-	-	N	N	N	V26/Vxx
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/Vxx
874	Set	Auto Sag Slip Increment	-	-	N	N	N	N	V26/Vxx
875	Set	Auto Sag Time Limit	-	-	N	N	N	N	V26/Vxx
876	Set	Auto Sag Start	-	-	N	N	N	N	V26/Vxx
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 (N) 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) Vxx 14: Control Mode Change (N) V26/Vxx 15: Feedback Mode Change (N) Vxx 16: Pass Bus Status (Y) V26/Vxx 17: Pass Bus Unload (Y) V26/Vxx
761	Get	Axis Safety Faults	-	Y	Y	Y	Y	Y	V24
763	Get	Axis Safety State	-	Y	Y	Y	Y	Y	V24
760	Get	Axis Safety Status	-	Y	Y	Y	Y	Y	V24
825	Set	Backlash Compensation Window	-	-	-	Y	-	-	
593	Set	Brake Prove Ramp Time	-	-	N	N	N	N	V26/Vxx
594	Set	Brake Slip Tolerance	-	-	Y	Y	Y	Y	V26/Vxx
592	Set	Brake Test Torque	-	-	Y	Y	Y	Y	V26/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/Vxx
850	Set	Commutation Offset Compensation		-	-	O	O	O	E; IPM Motors only
563	Set	Commutation Polarity	-	-	-	Y	Y	Y	PM Motor only
562	Set	Commutation Self-Sensing Current	-	-	-	N	N	N	PM Motor only 0-Value = 100
637	Get	Converter Capacity	N	-	N	N	N	N	

Table 78 - Kinetix 5700 High Power Inverter Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
605	Get	Converter Output Current	N	-	N	N	N	N	V26/Vxx
606	Get	Converter Output Power	N	-	N	N	N	N	V26/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 Support in V29
524	Get	Current Reference	-	-	-	Y	Y	Y	
553	Set	Current Vector Limit	-	-	Y	Y	Y	Y	
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

Table 78 - Kinetix 5700 High Power Inverter Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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
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	-	-	N	N	N	N	Ind Motor only, 0-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	-	-	-	0-Enum 128 = Fan/Pump Volts/Hertz (N) 129 = Sensorless Vector (N) 130 = Sensorless Vector Economy (N)
498	Set	Friction Compensation Sliding	-	-	-	Y	Y	Y	

Table 78 - Kinetix 5700 High Power Inverter Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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	
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	-	-	N	N	N	N	Ind Motor only, V26/Vxx
1350	Set	Induction Motor Rotor Resistance	-	-	N	N	N	N	Ind Motor only
1348	Set	Induction Motor Stator Leakage Reactance	-	-	N	N	N	N	Ind Motor only, V26/Vxx
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	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	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

Table 78 - Kinetix 5700 High Power Inverter Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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/Vxx
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	-	-	Y	Y	Y	Y	Y-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
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	-	-	Y	Y	Y	Y	
509	Set	Overtorque Limit Time	-	-	Y	Y	Y	Y	
2310	Set	PM Motor Flux Saturation	-	-	Y	Y	Y	Y	PM Motor only
1343	Set	PM Motor Force Constant	-	-	Y	Y	Y	Y	Rotary PM Motor only
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
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	-	-	-	Y	-	-	
781	Set	Position Lead Lag Filter Bandwidth	-	-	-	Y	-	-	
782	Set	Position Lead Lag Filter Gain	-	-	-	Y	-	-	
783	Set	Position Notch Filter Frequency	-	-	-	N	-	-	

Table 78 - Kinetix 5700 High Power Inverter Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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	-	Y	Y	Y	Y	
590	Set	Proving Configuration	-	-	Y	Y	Y	Y	V26/Vxx
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	-	-	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
765	Set	Safe Torque Off Action	-	-	N	N	N	N	0-Enum V26/Vxx 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	-	-	N	-	-	-	
372	Set	Skip Speed 3	-	-	N	-	-	-	
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 1 = Current Decel Disable (F/N) 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	-	-	-	Y	Y	Y	
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	

Table 78 - Kinetix 5700 High Power Inverter Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
502	Set	Torque Low Pass Filter Bandwidth	-	-	-	Y	Y	Y	
843	Get	Torque Low Pass Filter Bandwidth Estimate	-	-	-	N	N	N	V26/Vxx
503	Set	Torque Notch Filter Frequency	-	-	-	Y	Y	Y	
841	Get	Torque Notch Filter Frequency Estimate	-	-	-	N	N	N	V26/Vxx
837	Set	Torque Notch Filter High Frequency Limit	-	-	-	N	N	N	V26/Vxx
838	Set	Torque Notch Filter Low Frequency Limit	-	-	-	N	N	N	V26/Vxx
842	Get	Torque Notch Filter Magnitude Estimate	-	-	-	N	N	N	V26/Vxx
839	Set	Torque Notch Filter Tuning Threshold	-	-	-	N	N	N	V26/Vxx
591	Set	Torque Prove Current	-	-	Y	Y	Y	Y	V26/Vxx
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	-	-	Y	Y	Y	Y	
511	Set	Undertorque Limit Time	-	-	Y	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 (Y)
468	Set	Velocity Integrator Preload	-	-	-	Y	Y	-	
475	Set	Velocity Limit - Bus Overvoltage		-	-	0	0	-	V29
477	Set	Velocity Limit - Bus Overvoltage Permissive		-	-	0	0	-	V29
476	Set	Velocity Limit - Motor Max		-	-	0	0	-	V29
474/326	Set	Velocity Limit - Negative	-	-	Y	Y	Y	-	
473/325	Set	Velocity Limit - Positive	-	-	Y	Y	Y	-	
458	Get	Velocity Limit Source		-	-	0	0	-	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	
608	Set	Zero Speed	-	-	Y	Y	Y	Y	V26/Vxx
609	Set	Zero Speed Time	-	-	Y	Y	Y	Y	V26/Vxx

Table 79 specifies what optional attribute and corresponding control mode functionality is supported by the multi-axis Kinetix 5700 Dual Axis Inverter. The catalog numbers are:

- 2198-D006-ERS3
- 2198-D012-ERS3
- 2198-D020-ERS3
- 2198-D032-ERS3
- 2198-D057-ERS3

Table 79 - Kinetix 5700 Dual Axis Inverter Optional Attributes

Attribute 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	
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	V26/Vxx
844	Get	Adaptive Tuning Gain Scaling Factor	-	-	-	N	N	N	V26/Vxx
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/Vxx
874	Set	Auto Sag Slip Increment	-	-	N	N	N	N	V26/Vxx
875	Set	Auto Sag Time Limit	-	-	N	N	N	N	V26/Vxx
876	Set	Auto Sag Start	-	-	N	N	N	N	V26/Vxx
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 (N) 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) Vxx 14: Control Mode Change (N) V26/Vxx 15: Feedback Mode Change (N) Vxx 16: Pass Bus Status (Y) V26/Vxx 17: Pass Bus Unload (Y) V26/Vxx

Table 79 - Kinetix 5700 Dual Axis Inverter Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
763	Get	Axis Safety Faults	-	Y	Y	Y	Y	Y	V24
760	Get	Axis Safety State	-	Y	Y	Y	Y	Y	V24
761	Get	Axis Safety Status	-	Y	Y	Y	Y	Y	V24
825	Set	Backlash Compensation Window	-	-	-	Y	-	-	
593	Set	Brake Prove Ramp Time	-	-	N	N	N	N	V26/Vxx
594	Set	Brake Slip Tolerance	-	-	Y	Y	Y	Y	V26/Vxx
592	Set	Brake Test Torque	-	-	Y	Y	Y	Y	V26/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/Vxx
850	Set	Commutation Offset Compensation		-	-	O	O	O	E; IPM Motors only
563	Set	Commutation Polarity	-	-	-	Y	Y	Y	PM Motor only
562	Set	Commutation Self-Sensing Current	-	-	-	N	N	N	PM Motor only O-Value = 100
637	Get	Converter Capacity	N	-	N	N	N	N	
605	Get	Converter Output Current	N	-	N	N	N	N	V26/Vxx
606	Get	Converter Output Power	N	-	N	N	N	N	V26/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 Support in V29
524	Get	Current Reference	-	-	-	Y	Y	Y	
553	Set	Current Vector Limit	-	-	Y	Y	Y	Y	
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	O-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

Table 79 - Kinetix 5700 Dual Axis Inverter Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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
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

Table 79 - Kinetix 5700 Dual Axis Inverter Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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	-	-	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	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	
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	-	-	N	N	N	N	Ind Motor only, V26/Vxx
1350	Set	Induction Motor Rotor Resistance	-	-	N	N	N	N	Ind Motor only
1348	Set	Induction Motor Stator Leakage Reactance	-	-	N	N	N	N	Ind Motor only, V26/Vxx
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)

Table 79 - Kinetix 5700 Dual Axis Inverter Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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	-	-	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/Vxx
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	-	-	Y	Y	Y	Y	Y-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
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	-	-	Y	Y	Y	Y	
509	Set	Overtorque Limit Time	-	-	Y	Y	Y	Y	
2310	Set	PM Motor Flux Saturation	-	-	Y	Y	Y	Y	PM Motor only

Table 79 - Kinetix 5700 Dual Axis Inverter Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
1343	Set	PM Motor Force Constant	-	-	Y	Y	Y	Y	Rotary PM Motor only
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
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	-	-	-	Y	-	-	
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	-	Y	Y	Y	Y	
590	Set	Proving Configuration	-	-	Y	Y	Y	Y	V26/Vxx
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	-	-	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
765	Set	Safe Torque Off Action	-	-	N	N	N	N	0-Enum V26/Vxx 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	-	-	N	-	-	-	
372	Set	Skip Speed 3	-	-	N	-	-	-	
373	Set	Skip Speed Band	-	-	Y	-	-	-	
833	Set	SLAT Configuration	-	-	-	-	N	-	
834	Set	SLAT Set Point	-	-	-	-	N	-	

Table 79 - Kinetix 5700 Dual Axis Inverter Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
835	Set	SLAT Time Delay	-	-	-	-	N	-	
610	Set	Stopping Action	-	-	R	R	R	R	0-Enum 1 = Current Decel Disable (F/N) 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	-	-	-	Y	Y	Y	
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	-	-	-	N	N	N	V26/Vxx
503	Set	Torque Notch Filter Frequency	-	-	-	Y	Y	Y	
841	Get	Torque Notch Filter Frequency Estimate	-	-	-	N	N	N	V26/Vxx
837	Set	Torque Notch Filter High Frequency Limit	-	-	-	N	N	N	V26/Vxx
838	Set	Torque Notch Filter Low Frequency Limit	-	-	-	N	N	N	V26/Vxx
842	Get	Torque Notch Filter Magnitude Estimate	-	-	-	N	N	N	V26/Vxx
839	Set	Torque Notch Filter Tuning Threshold	-	-	-	N	N	N	V26/Vxx
591	Set	Torque Prove Current	-	-	Y	Y	Y	Y	V26/Vxx
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	-	-	Y	Y	Y	Y	
511	Set	Undertorque Limit Time	-	-	Y	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 (Y)
468	Set	Velocity Integrator Preload	-	-	-	Y	Y	-	
475	Set	Velocity Limit - Bus Overvoltage		-	-	0	0	-	V29
477	Set	Velocity Limit - Bus Overvoltage Permissive		-	-	0	0	-	V29

Table 79 - Kinetix 5700 Dual Axis Inverter Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
476	Set	Velocity Limit - Motor Max		-	-	O	O	-	V29
474/326	Set	Velocity Limit - Negative	-	-	Y	Y	Y	-	
473/325	Set	Velocity Limit - Positive	-	-	Y	Y	Y	-	
458	Get	Velocity Limit Source		-	-	O	O	-	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	
608	Set	Zero Speed	-	-	Y	Y	Y	Y	V26/Vxx
609	Set	Zero Speed Time	-	-	Y	Y	Y	Y	V26/Vxx

Table 80 specifies what optional attribute and corresponding control mode functionality that is supported by the Kinetix 5700 Diode Front End. These are the support modules that provide the DC power management to the drives. The catalog numbers are:

- 2198-P031
- 2198-P070
- 2198-P141
- 2198-P208

Table 80 - Kinetix 5700 Diode Front End Optional Attributes

Attribute ID	Access Rule	Attribute Name	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
836	Set	Adaptive Tuning Configuration	-	-	-	N	N	N	V26/Vxx
844	Get	Adaptive Tuning Gain Scaling Factor	-	-	-	N	N	N	V26/Vxx
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/Vxx
874	Set	Auto Sag Slip Increment	-	-	N	N	N	N	V26/Vxx
875	Set	Auto Sag Time Limit	-	-	N	N	N	N	V26/Vxx

Table 80 - Kinetix 5700 Diode Front End Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
876	Set	Auto Sag Start	-	-	N	N	N	N	V26/Vxx
19	Set	Axis Features	R	R	R	R	R	R	0-Bits 0: Fine Interpolation (N) 1: Registration Auto-rearm (N) 2: Alarm Log (Y) 5: Hookup Test (N) 6: Commutation Test (N) 7: Motor Test (N) 8: Inertia Test (N) 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) Vxx 14: Control Mode Change (N) V26/Vxx 15: Feedback Mode Change (N) Vxx 16: Pass Bus Status (Y) V26/Vxx 17: Pass Bus Unload (Y) V26/Vxx
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	-	-	-	N	-	-	
593	Set	Brake Prove Ramp Time	-	-	N	N	N	N	V26/Vxx
594	Set	Brake Slip Tolerance	-	-	N	N	N	N	V26/Vxx
592	Set	Brake Test Torque	-	-	N	N	N	N	V26/Vxx
638/262	Get	Bus Regulator Capacity	Y	-	N	N	N	N	
659	Get	CIP Axis Alarms	Y	N	N	N	N	N	
904	Get	CIP Axis Alarms - RA	Y	N	N	N	N	N	
617	Set	Coasting Time Limit	-	-	N	N	N	N	V26/Vxx
850	Set	Commutation Offset Compensation		-	-	O	O	O	E; IPM Motors only
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	Y	-	N	N	N	N	
605	Get	Converter Output Current	Y	-	N	N	N	N	V26/Vxx
606	Get	Converter Output Power	Y	-	N	N	N	N	V26/Vxx
840	Set	Current Disturbance	-	-	-	N	N	N	
527	Get	Current Error	-	-	-	N	N	N	
529	Get	Current Feedback	-	-	-	N	N	N	
522	Get	Current Limit Source	-	-	Y	N	N	N	F Support in V29
524	Get	Current Reference	-	-	-	N	N	N	
553	Set	Current Vector Limit	-	-	N	N	N	N	
870	Set	DC Injection Brake Current	-	-	N	N	N	N	
872	Set	DC Injection Brake Time	-	-	N	N	N	N	

Table 80 - Kinetix 5700 Diode Front End Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
486	Set	Deceleration Limit	-	-	N	N	N	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	-	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	-	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	-	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	-	N	N	N	
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	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)

Table 80 - Kinetix 5700 Diode Front End Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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) 4 = Database Offset (N) Vxx
31	Set*	Feedback Configuration	R	R	R	R	R	R	O-Enum 0 = No Feedback (V/N)(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	-	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	N	N	N	
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
1351	Set	Induction Motor Rotor Leakage Reactance	-	-	N	N	N	N	Ind Motor only, V26/Vxx
1350	Set	Induction Motor Rotor Resistance	-	-	N	N	N	N	Ind Motor only
1348	Set	Induction Motor Stator Leakage Reactance	-	-	N	N	N	N	Ind Motor only, V26/Vxx

Table 80 - Kinetix 5700 Diode Front End Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
647	Set	Inverter Overload Action	-	-	N	N	N	N	O-Enum 1 = Current Foldback (N) 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	O-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	O-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	O-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	O-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	O-Enum 1 = Current Foldback (N)
1322	Set	Motor Overload Limit	-	-	N	N	N	N	
695	Set	Motor Overspeed User Limit	-	-	N	N	N	N	
694	Set	Motor Phase Loss Limit	-	-	N	N	N	N	V26/Vxx
1317	Set	Motor Polarity	-	-	N	N	N	N	
1321	Set	Motor Rated Output Power	-	-	N	N	N	N	O-IM
1320	Set	Motor Rated Peak Current	-	-	N	N	N	N	O-IM
697	Set	Motor Thermal Overload User Limit	-	-	N	N	N	N	

Table 80 - Kinetix 5700 Diode Front End Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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
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	N	N	N	F Support in V29
600	Get	Output Frequency	-	-	R	N	N	N	
508	Set	Overtorque Limit	-	-	N	N	N	N	
509	Set	Overtorque Limit Time	-	-	N	N	N	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	-	-	-	N	-	-	
365	Get	Position Fine Command	-	-	-	N	-	-	
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	-	-	-	N	-	-	
627	Set	Power Loss Action	-	-	N	N	N	N	O-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	-	-	N	N	N	N	V26/Vxx
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

Table 80 - Kinetix 5700 Diode Front End Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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
765	Set	Safe Torque Off Action	-	-	N	N	N	N	0-Enum V26/Vxx 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	-	-	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 1 = Current Decel Disable (F/N) 2 = Ramped Decel Disable (FV/N) 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	-	-	-	N	N	N	
828	Set	Torque Lead Lag Filter Gain	-	-	-	N	N	N	
554	Set	Torque Loop Bandwidth	-	-	-	N	N	N	
502	Set	Torque Low Pass Filter Bandwidth	-	-	-	N	N	N	
843	Get	Torque Low Pass Filter Bandwidth Estimate	-	-	-	N	N	N	V26/Vxx
503	Set	Torque Notch Filter Frequency	-	-	-	N	N	N	
841	Get	Torque Notch Filter Frequency Estimate	-	-	-	N	N	N	V26/Vxx
837	Set	Torque Notch Filter High Frequency Limit	-	-	-	N	N	N	V26/Vxx
838	Set	Torque Notch Filter Low Frequency Limit	-	-	-	N	N	N	V26/Vxx
842	Get	Torque Notch Filter Magnitude Estimate	-	-	-	N	N	N	V26/Vxx
839	Set	Torque Notch Filter Tuning Threshold	-	-	-	N	N	N	V26/Vxx
591	Set	Torque Prove Current	-	-	N	N	N	N	V26/Vxx
506	Set	Torque Rate Limit	-	-	-	N	N	N	
507/334	Set	Torque Threshold	-	-	-	N	N	N	

Table 80 - Kinetix 5700 Diode Front End Optional Attributes

Attribute ID	Access Rule	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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	N	N	N	
511	Set	Undertorque Limit Time	-	-	N	N	N	N	
464/321	Set	Velocity Droop	-	-	N	N	N	-	
465	Set	Velocity Error Tolerance	-	-	-	N	N	-	
466	Set	Velocity Error Tolerance Time	-	-	-	N	N	-	
366	Get	Velocity Fine Command	-	-	-	N	N	-	
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		-	-	0	0	-	V29
477	Set	Velocity Limit - Bus Overvoltage Permissive		-	-	0	0	-	V29
476	Set	Velocity Limit - Motor Max		-	-	0	0	-	V29
474/326	Set	Velocity Limit - Negative	-	-	N	N	N	-	
473/325	Set	Velocity Limit - Positive	-	-	N	N	N	-	
458	Get	Velocity Limit Source		-	-	0	0	-	V29
471	Set	Velocity Lock Tolerance	-	-	N	N	N	-	
469	Set	Velocity Low Pass Filter Bandwidth	-	-	-	N	N	-	
790	Set	Velocity Negative Feedforward Gain	-	-	-	N	N	-	
470/327	Set	Velocity Threshold	-	N	N	N	N	N	
608	Set	Zero Speed	-	-	N	N	N	N	V26/Vxx
609	Set	Zero Speed Time	-	-	N	N	N	N	V26/Vxx

Kinetix 6500 Drive Module Optional Attributes

Table 81 specifies what optional attribute and corresponding control mode functionality is supported by a Kinetix 6500 drive module.

Table 81 - Kinetix 6500 Drive Module Optional Attributes

Attribute ID	Access	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	
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

Table 81 - Kinetix 6500 Drive Module Optional Attributes (Continued)

Attribute ID	Access	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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	O-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	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 (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 O-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	
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

Table 81 - Kinetix 6500 Drive Module Optional Attributes (Continued)

Attribute ID	Access	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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-Enum1 = 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-Enum2 = Motor Offset (Y)3 = Self-Sense (Y)
31	Set*	Feedback Configuration		R	R	R	R	R	0-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	-	

Table 81 - Kinetix 6500 Drive Module Optional Attributes (Continued)

Attribute ID	Access	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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, 0-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	-	-	-	0-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	0-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	
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	

Table 81 - Kinetix 6500 Drive Module Optional Attributes (Continued)

Attribute ID	Access	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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	O-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	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		-	N	Y	Y	Y	
1324	Set	Motor Max Winding Temperature		-	N	N	N	N	
646	Set	Motor Overload Action		-	N	Y	Y	Y	O-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	O-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	
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	-	-	

Table 81 - Kinetix 6500 Drive Module Optional Attributes (Continued)

Attribute ID	Access	Attribute Name	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		-	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	-	
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	

Table 81 - Kinetix 6500 Drive Module Optional Attributes (Continued)

Attribute ID	Access	Attribute Name	B	E	F	P	V	T	Conditional Implementation
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

Table 82 specifies what optional attribute and corresponding control mode functionality is supported by a PowerFlex 527 drive module.

Table 82 - PowerFlex 527 Drive Module Optional Attributes

ID	Access	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	
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	

Table 82 - PowerFlex 527 Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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 0-Value = #
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

Table 82 - PowerFlex 527 Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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	-	-	-	N	N	N	0-Enum 2 = Motor Offset (N) 3 = Self-Sense (Y) 4 = Database Offset (N)
31	Set	Feedback Configuration	R	R	R	R	R	R	0-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, 0-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	-	-	-	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	

Table 82 - PowerFlex 527 Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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
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	

Table 82 - PowerFlex 527 Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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
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	-	-	0-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	0-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

Table 82 - PowerFlex 527 Drive Module Optional Attributes (Continued)

ID	Access	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	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	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	-	-	-	-	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	

Table 82 - PowerFlex 527 Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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	-	
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

Table 83 specifies what optional attribute and corresponding control mode functionality is supported by a PowerFlex 755 drive module.

Table 83 - PowerFlex 755 Standard Drive Module Optional Attributes

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

Table 83 - PowerFlex 755 Standard Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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)
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	
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	
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	

Table 83 - PowerFlex 755 Standard Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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	
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)

Table 83 - PowerFlex 755 Standard Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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		-	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	

Table 83 - PowerFlex 755 Standard Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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	
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	

Table 83 - PowerFlex 755 Standard Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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	-	
834	Set	SLAT Set Point		-	-	-	Y	-	
835	Set	SLAT Time Delay		-	-	-	Y	-	

Table 83 - PowerFlex 755 Standard Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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	Y	V28
609	Set	Zero Speed Time	-	-	Y	Y	Y	Y	V28

PowerFlex 755 Safety Drive Module Optional Attributes

Table 84 specifies what optional attribute and corresponding control mode functionality is supported by a PowerFlex 755 drive module.

Table 84 - PowerFlex 755 Safety Drive Module Optional Attributes

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	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	
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	
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

Table 84 - PowerFlex 755 Safety Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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
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		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	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	
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

Table 84 - PowerFlex 755 Safety Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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	-	
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	

Table 84 - PowerFlex 755 Safety Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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
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)

Table 84 - PowerFlex 755 Safety Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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	-	-	
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

Table 84 - PowerFlex 755 Safety Drive Module Optional Attributes (Continued)

ID	Access	Attribute	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		-	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	
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)

Table 84 - PowerFlex 755 Safety Drive Module Optional Attributes (Continued)

ID	Access	Attribute	B	E	F	P	V	T	Conditional Implementation
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

Notes:

MSG Instruction Access Only Attributes

Table 85 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.

Table 85 - Motion Axis Attributes Available Via Messaging

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
678	CIP APR Faults					C		C	C	C	Yes	R-Co CScale; O-Dr DScale; E, MSG Access Only
679	CIP APR Faults - Mfg					C		C	C	C	Yes	R-Co CScale; O-Dr DScale; E, MSG Access Only
904	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		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		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		MSG Access Only
654	CIP Axis I/O Status - Mfg	X	X	X		R	R	R	R	R		MSG Access Only
652	CIP Axis Status - Mfg	X	X	X		R	R	R	R	R		MSG Access Only
675	CIP Initialization Faults - Mfg	X	X	X		R	R	R	R	R	Yes	MSG Access Only
677	CIP Start Inhibits - Mfg	X	X	X			R	R	R	R		MSG Access Only
832	Cogging Compensation Table							O	O	O		MSG Access Only
768	Command Notch Filter Frequency		X					O	O			MSG Access Only

Table 85 - Motion Axis Attributes Available Via Messaging (Continued)

ID	Attribute	K350	K5500	K6500	PF755	E	F	P	V	T	C/D	Conditional Implementation
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			-	O	O	O	O	Yes	MSG Access Only
685	Converter Thermal Overload Factory Limit						O	O	O	O		MSG Access Only
715	Cumulative Control Power Cycles						O	O	O	O		MSG Access Only
712	Cumulative Energy Usage						O	O	O	O		MSG Access Only
714	Cumulative Main Power Cycles						O	O	O	O		MSG Access Only
713	Cumulative Motor Revs						O	O	O	O		MSG Access Only
711	Cumulative Run Time						O	O	O	O		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					O	O	O	O		MSG Access Only
725	Drive Power Structure Axis ID						O	O	O	O		MSG Access Only
1400	Feedback 1 Catalog Number					O		O	O	O		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					O		O	O	O		E, MSG Access Only
643	Feedback 1 Temperature		X	X		O	O	O	O	O		E, MSG Access Only
1450	Feedback 2 Catalog Number							O	O	O		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					O		O	O	O		E, MSG Access Only
644	Feedback 2 Temperature			X		O	O	O	O	O		E, MSG Access Only
2432	Feedback 2U Acceleration					O		O	O	O		E, MSG Access Only
2430	Feedback 2U Position					O		O	O	O		E, MSG Access Only
2431	Feedback 2U Velocity					O		O	O	O		E, MSG Access Only
692	Feedback Data Loss Factory Limit					O	O	O	O	O		E, MSG Access Only
43	Feedback Master Select					O						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					O	-	O	O	O		E, MSG Access Only
1401 + (n-1)*50	Feedback n Serial Number	X	X	X		O	-	O	O	O		E, MSG Access Only
690	Feedback Noise Factory Limit					O	O	O	O	O		MSG Access Only

Table 85 - Motion Axis Attributes Available Via Messaging (Continued)

ID	Attribute	K350	K5500	K6500	PF755	E	F	P	V	T	C/D	Conditional Implementation
2385 + (n-1)*50	Feedback nS Acceleration					O	-	O	O	O	Yes	E, MSG Access Only
2383 + (n-1)*50	Feedback nS Position					O	-	O	O	O	Yes	E, MSG Access Only
2384 + (n-1)*50	Feedback nS Velocity					O	-	O	O	O	Yes	E, MSG Access Only
2382 + (n-1)*50	Feedback nU Acceleration					O	-	O	O	O	Yes	E, MSG Access Only
2380 + (n-1)*50	Feedback nU Position					O	-	O	O	O	Yes	E, MSG Access Only
2381 + (n-1)*50	Feedback nU Velocity					O	-	O	O	O	Yes	E, MSG Access Only
691	Feedback Signal Loss Factory Limit					O	O	O	O	O		E, MSG Access Only
532	Flux Decoupling							O	O	O		MSG Access Only
534	Flux Voltage Output		X	X				O	O	O		MSG Access Only
737	Hardware Overtravel Input Checking	X					O	O	O	O		MSG Access Only
829	Inertia Observer Configuration			X				O	O	O		MSG Access Only
831	Inertia Observer Filter Bandwidth			X				O	O	O		MSG Access Only
640	Inverter Heatsink Temperature						O	O	O	O		MSG Access Only
645	Inverter Overload Factory Limit						O	O	O	O		MSG Access Only
682	Inverter Overtemperature Factory Limit	X					O	O	O	O		MSG Access Only
698	Inverter Overtemperature User Limit						O	O	O	O		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		O	O	O	O		MSG Access Only, P942
683	Inverter Thermal Overload Factory Limit						O	O	O	O		MSG Access Only
679	Linear Motor Overspeed Factory Limit					-	O	O	O	O	Yes	MSG Access Only
1312	Motor Date Code		X	X			O	O	O	O		MSG Access Only
680	Motor Overtemperature Factory Limit						O	O	O	O		MSG Access Only
696	Motor Overtemperature User Limit						O	O	O	O		MSG Access Only
1311	Motor Serial Number		X	X		-	O	O	O	O	Yes	MSG Access Only
642	Motor Temperature		X				O	O	O	O		MSG Access Only
681	Motor Thermal Overload Factory Limit			X			O	O	O	O		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			O				MSG Access Only, P837
604	PWM Frequency		X				O	O	O	O		MSG Access Only
678	Rotary Motor Overspeed Factory Limit					-	O	O	O	O	Yes	MSG Access Only
490	Torque Command	X	X	X	X	-	-	R	R	R	Yes	MSG Access Only, P761
531	Torque Decoupling							O	O	O		MSG Access Only
533	Torque Voltage Output		X	X				O	O	O		MSG Access Only

Table 85 - Motion Axis Attributes Available Via Messaging (Continued)

ID	Attribute	K350	K5500	K6500	PF755	E	F	P	V	T	C/D	Conditional Implementation
821	Total Inertia Estimate		**X**	**X**	**X**			O	O	O		MSG Access Only, P708
538	U Current Feedback		**X**	**X**				O	O	O		MSG Access Only
541	U Current Offsets			**X**				O	O	O		MSG Access Only
535	U Voltage Output		**X**	**X**				O	O	O		MSG Access Only
539	V Current Feedback		**X**	**X**				O	O	O		MSG Access Only
542	V Current Offsets			**X**				O	O	O		MSG Access Only
536	V Voltage Output		**X**	**X**				O	O	O		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**				O	O	O		MSG Access Only
543	W Current Offsets			**X**				O	O	O		MSG Access Only
537	W Voltage Output		**X**	**X**				O	O	O		MSG Access Only

The following terms and abbreviations are used throughout this manual. For definitions of terms not listed here, refer to the Allen-Bradley Industrial Automation Glossary, publication AG-7.1.

Absolute Position Retention (APR) While Homing creates an absolute machine reference position, the APR bit is designed to retain the absolute position.

Axis An axis is a logical element of a motion control system that controls or monitors of machine movement, or it is associated with a device that controls or monitors movement. Axes can be rotary or linear, physical or virtual, controlled or monitored, or associated with AC/DC power converters or position I/O devices.

Bus Regulator A bus regulator is used to limit the rise in DC Bus voltage level that occurs when decelerating a motor.

CIP Common Industrial Protocol

CIP Motion CIP Motion defines extensions to CIP Common objects and device profiles to support motion control over CIP networks.

CIP Sync CIP Sync defines extensions to CIP Common objects and device profiles to support time synchronization over CIP Networks.

CIP Motion I/O Connection CIP Motion I/O connection is the periodic bidirectional, Class 1, CIP connection between a controller and a drive that is defined as part of the CIP Motion standard.

CIP Motion Drive CIP Motion Drive refers to any drive device that complies with the CIP Motion standard.

CIP Motion Peer Connection Name given to the periodic multicast, producer/consumer, CIP connection between peer devices in a motion control system that is defined as part of the CIP Motion standard. Peer devices could be either controllers or drives.

Closed Loop Closed loop is a method of control where there is a feedback signal of some kind that is used to drive the actual dynamics of the motor to match the commanded dynamics by servo action. In most cases there is a literal feedback device to provide this signal, but in some cases the signal is derived from the motor excitation, for example, sensorless operation.

Converter A converter is a device that generally converts AC input to DC output. A Converter is also commonly called the Drive Power Supply. In the context of a drive system, the Converter is responsible for converting AC Main input into DC Bus power.

Cyclic Data Block The cyclic data block is a high priority real-time data block that is transferred by a CIP Motion connection on a periodic basis.

CIP Sync CIP Sync is the ODVA implementation of the IEEE 1588-2008 standard. The protocol provides a mechanism to synchronize clocks between controllers, I/O devices, and other automation products.

Drive A drive is a device designed to control the dynamics of a motor.

Event Data Block The event data block is a medium priority real-time data block that is transferred by a CIP Motion connection only after a specified event occurs. Registration and marker input transitions are typical drive events.

Get/Read A Get/Read involves retrieving an attribute value from the perspective of Controller side of the interface.

Inverter An inverter is a device that generally converts DC input to AC output. An Inverter is also commonly called the Drive Amplifier. In the context of a drive system, the Inverter is responsible for controlling the application of DC Bus power to an AC motor.

Motion Motion refers to any aspect the dynamics of an axis. In the context of this document it is not limited to servo drives but encompasses all forms of drive based motor control.

Open Loop Open loop is a methods of control where there is no application of feedback to force the actual motor dynamics to match the commanded dynamics. Examples of open loop control are stepper drives and variable frequency drives.

Shunt Regulator A shunt regulator is a specific Bus Regulator method that switches the DC Bus across a power dissipating resistor to dissipate the regenerative power of a decelerating motor.

Service Data Block The service data block is a lower priority real-time data block associated with a service message from the controller that is transferred by a CIP Motion connection on a periodic basis. Service data includes service request messages to access attributes, run a drive based Motion Planner, or perform various drive diagnostics.

Set/Write A Set/Write involves setting an attribute to a specified value from the perspective of Controller side of the interface.

Synchronized Synchronized is a condition where the local clock value on the drive is locked onto the master clock of the distributed System Time. When synchronized, the drive and controller devices may utilize time stamps associated with CIP Motion connection data.

System Time System time is the absolute time value as defined in CIP Sync standard in the context of a distributed time system where all devices have a local clock that is synchronized with a common master clock. In the context of CIP Motion, System Time is a 64-bit integer value in units of microseconds or nanoseconds with a value of 0 corresponding to January 1, 1970.

Time Stamp Time stamp is a system time stamp value associated with the CIP Motion connection data that conveys the absolute time when the associated data was captured or can be also used to determine when associated data is to be applied.

Time Offset Time offset is the System Time Offset value associated with the CIP Motion connection data that is associated with source device. The System Time Offset is a 64-bit offset value that is added to a device's local clock to generate System Time for that device.

Variable Frequency Drive (VFD) Variable Frequency Drive (VFD) is a class of drive products that seek to control the speed of a motor, typically an induction motor, through a proportional relationship between drive output voltage and commanded output frequency. Frequency drives are, therefore, sometimes referred to as a Volts/Hertz drives.

Vector Drive Vector drive is a class of drive products that seek to control the dynamics of a motor via closed loop control which includes, but is not limited to, closed loop control of both torque and flux vector components of motor stator current relative to the rotor flux vector.

Notes:

Numerics

A

P

R

S

T

V

Notes:

Notes:

Rockwell Automation Support

Use the following resources to access support information.

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

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 How Are We Doing? form at http://literature.rockwellautomation.com/idc/groups/literature/documents/du/ra-du002_-en-e.pdf.

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

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

Publication MOTION-RM003H-EN-P - June 2016
Supersedes Publication MOTION-RM003G-EN-P - November 2015