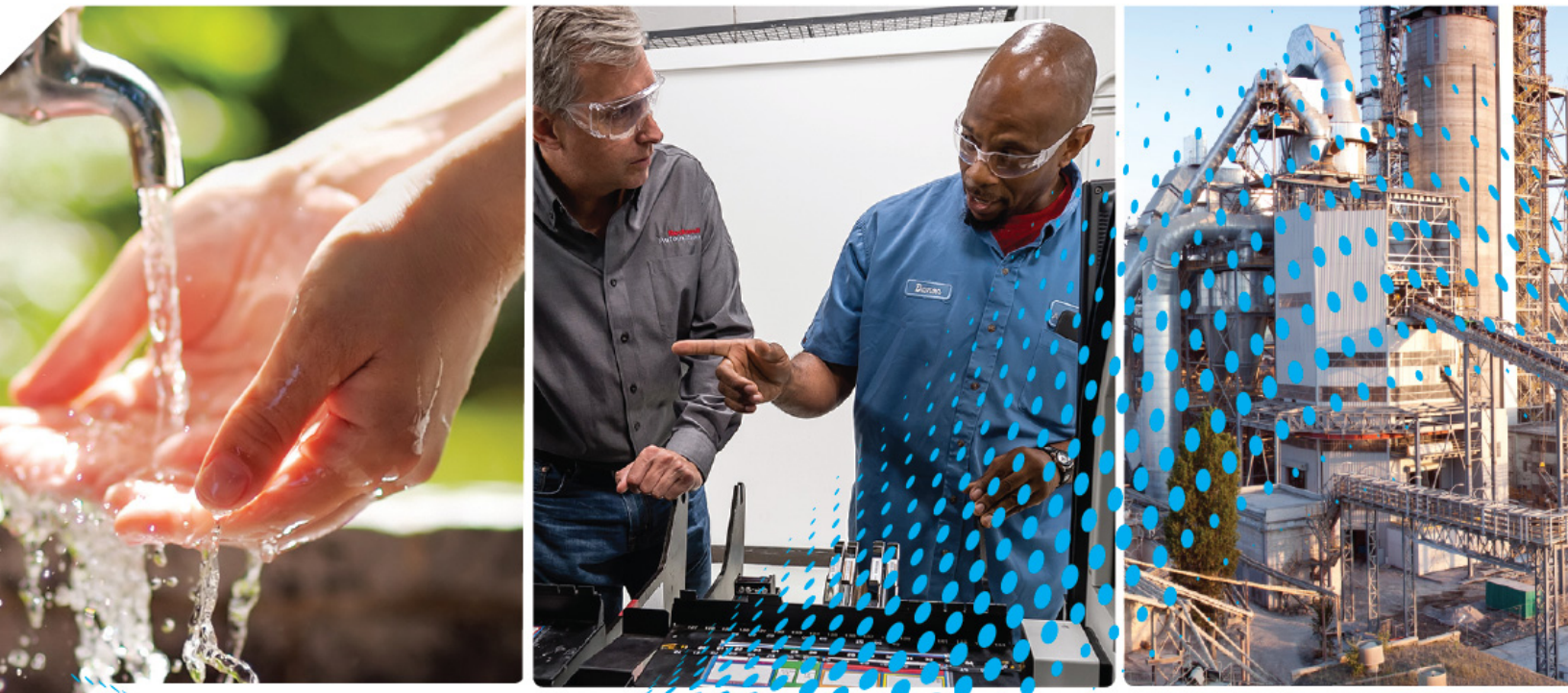
This manual links to Kinetix 5700 System Fault Codes, publication 2198-RD003 for fault codes; download the spreadsheet now for offline access.



ArmorKinetix System

Catalog Numbers 2198-DSD016-ERS2, 2198-DSD016-ERS5, 2198-DSD024-ERS2, 2198-DSD024-ERS5, 2198-DSM016-ERS2-A075, 2198-DSM024-ERS2-A075, 2198-DSM016-ERS2-B075, 2198-DSM024-ERS2-B075, 2198-DSM016-ERS2-A100, 2198-DSM024-ERS2-A100, 2198-DSM016-ERS2-B100, 2198-DSM024-ERS2-B100, 2198-DSM016-ERS2-A115, 2198-DSM024-ERS2-A115, 2198-DSM016-ERS2-B115, 2198-DSM024-ERS2-B115, 2198-DSM016-ERS2-A130, 2198-DSM024-ERS2-A130, 2198-DSM016-ERS2-B130, 2198-DSM024-ERS2-B130, 2198-DSM016-ERS5-A075, 2198-DSM024-ERS5-A075, 2198-DSM016-ERS5-B075, 2198-DSM024-ERS5-B075, 2198-DSM016-ERS5-A100, 2198-DSM024-ERS5-A100, 2198-DSM016-ERS5-B100, 2198-DSM024-ERS5-B100, 2198-DSM016-ERS5-A115, 2198-DSM024-ERS5-A115, 2198-DSM016-ERS5-B115, 2198-DSM024-ERS5-B115, 2198-DSM016-ERS5-A130, 2198-DSM024-ERS5-A130, 2198-DSM016-ERS5-B130, 2198-DSM024-ERS5-B130, 2198-PIM070

Allen-Bradley
by ROCKWELL AUTOMATION

User Manual

Original Instructions

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.

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

WARNING: Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.

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

These 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).

The following icon may appear in the text of this document.

Identifies information that is useful and can help to make a process easier to do or easier to understand.

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This manual provides detailed installation instructions for mounting and wiring your ArmorKinetix® power interface modules (PIM), distributed servo drive modules (DSD), and distributed servo motor modules (DSM). Also included is system configuration with the Studio 5000 Logix Designer® application, integration of your drive modules with a Logix 5000™ controller, system startup, and troubleshooting.

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

In this manual, when referring to a DSx module, the topic applies to either a distributed servo drive (DSD) module or a distributed servo motor (DSM) module.

Access Fault Codes

For ArmorKinetix system fault code descriptions and possible solutions, see Kinetix 5700 System Fault Codes, publication 2198-RD003; download the spreadsheet for offline access.

Download Firmware, AOP, EDS, and Other Files

Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes from the Product Compatibility and Download Center at rok.auto/pcdc.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation. You can view or download publications at rok.auto/literature.

Table 1 - Additional Resources

Resource	Description
Kinetix® Rotary Motion Specifications Technical Data, publication KNX-TD001	Product specifications for Kinetix VPL, VPC, VPF, VPH, VPS, Kinetix MPL, MPM, MPF, MPS; Kinetix TL and TLY, Kinetix RDB, Kinetix MMA, and Kinetix HPK rotary motors.
Kinetix Linear Motion Specifications Technical Data, publication KNX-TD002	Provides product specifications for Kinetix MPAS and MPMA linear stages, Kinetix VPAR, MPAR, and MPAI electric cylinders, Kinetix LDAT linear thrusters, and Kinetix LDC linear motors.
Kinetix 5700, 5500, 5300, and 5100 Servo Drives Specifications Technical Data, publication KNX-TD003	Provides product specifications for Kinetix Integrated Motion over the EtherNet/IP network and EtherNet/IP networking servo drive families.
Kinetix Rotary and Linear Motion Cable Specifications Technical Data, publication KNX-TD004	Product specifications for Kinetix 2090 motor and interface cables.
Kinetix Servo Drive Performance Specifications per Ecodesign Regulation (EU) 2019/1781 Technical Data, publication KNX-TD006	Provides energy efficiency performance data for Rockwell Automation Kinetix servo drives. This data supports IE2 compliance of Kinetix servo drives per EU 2019/1781.
Kinetix 5700 System Fault Codes Reference Data, publication 2198-RD003	Provides the fault codes for Kinetix 5700 servo drives and ArmorKinetix system modules.
Kinetix 5700 Safe Monitor Functions Safety Reference Manual, publication 2198-RM001	Provides a description of integrated stopping functions and safe monitoring functions with a GuardLogix® controller and Kinetix 5700 servo drives.
ArmorKinetix Safe Monitor Functions Safety Reference Manual, publication 2198-RM007	Provides a description of integrated stopping functions and safe monitoring functions with a GuardLogix® controller and ArmorKinetix modules.
ArmorKinetix 2090 Cables and Connectors Installation Instructions, publication 2090-IN053	Provides information for the ArmorKinetix 2090 cables.
Knowledgebase Technote ArmorKinetix DSD/DSM Frequently Asked Questions	Knowledgebase technote provinding additional information for ArmorKinetix module functions.
1321 Power Conditioning Products Technical Data, publication 1321-TD001	Provides information on typical use cases, specifications, terminations, and dimensions of 1321 line reactors.
System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001	Provides information, examples, and techniques designed to minimize system failures caused by electrical noise.
Servo Drive Installation Best Practices Application Technique, publication MOTION-AT004	Best practice examples to help reduce the number of potential noise or electromagnetic interference (EMI) sources in your system and to make sure that the noise sensitive components are not affected by the remaining noise.

Table 1 - Additional Resources (Continued)

Resource	Description
Kinetix 5700 Drive Systems Design Guide, publication KNX-RM010	System design guide to select the required (drive specific) drive module, power accessory, feedback connector kit, and motor cable catalog numbers for your Kinetix 5700 drive system, including ArmorKinetix modules.
Motor Nameplate Datasheet Entry for Custom Motor Applications Application Technique, publication 2198-AT002	Provides information on the use of nameplate data entry for custom induction motors and permanent-magnet motors that are used in applications with Kinetix 5700 servo drives.
Vertical Load and Holding Brake Management Application Technique, publication MOTION-AT003	Provides information on vertical loads and how the servo motor holding-brake option can be used to help keep a load from falling.
Motion System Tuning Application Technique, publication MOTION-AT005	Provides information on tuning a Kinetix drive system.
Integrated Motion on the EtherNet/IP Network Configuration and Startup User Manual, publication MOTION-UM003	Provides information on configuring and troubleshooting your ControlLogix® and CompactLogix™ EtherNet/IP network modules.
Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003	Provides information on the AXIS_CIP_DRIVE attributes and the Studio 5000 Logix Designer application Control Modes and Methods.
GuardLogix® 5570 Controllers User Manual, publication 1756-UM022	Provides information on how to install, configure, program, and use ControlLogix controllers and GuardLogix controllers in Studio 5000 Logix Designer projects.
GuardLogix 5580 Controllers User Manual, publication 1756-UM543	
Compact GuardLogix 5370 Controllers User Manual, publication 1769-UM022	Provides information on how to install, configure, program, and use CompactLogix and Compact GuardLogix controllers.
Compact GuardLogix 5380 Controllers User Manual, publication 5069-UM001	
GuardLogix 5570 and Compact GuardLogix 5370 Controller Systems Safety Reference Manual, publication 1756-RM099	Provides information on how to achieve and maintain Safety Integrity Level (SIL) and Performance Level (PL) safety application requirements for GuardLogix and Compact GuardLogix controllers.
GuardLogix 5580 and Compact GuardLogix 5380 Controller Systems Safety Reference Manual, publication 1756-RM012	
FactoryTalk® Motion Analyzer™ System Sizing and Selection Tool website rok.auto/motion-analyzer	Comprehensive motion application sizing tool used for analysis, optimization, selection, and validation of your Kinetix Motion Control system.
EtherNet/IP Network Devices User Manual, ENET-UM006	Describes how to configure and use EtherNet/IP devices to communicate on the EtherNet/IP network.
Ethernet Reference Manual, ENET-RM002	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.
CIP Security with Rockwell Automation Products Application Technique, publication SECURE-AT001	Provides information on CIP Security, including which Rockwell Automation products support CIP Security.
System Security Design Guidelines Reference Manual, SECURE-RM001	Provides guidance on how to conduct security assessments, implement Rockwell Automation products in a secure system, harden the control system, manage user access, and dispose of equipment.
ControlFLASH™ User Manual, publication 1756-UM105	Provides guidance on how to use ControlFLASH or ControlFLASH Plus software to upgrade drive firmware. Refer to your product release notes to determine whether it supports firmware upgrades by using ControlFLASH or ControlFLASH Plus software.
ControlFLASH™ Plus Quick Start Guide, publication CFP-QS001	
Safety Guidelines for the Application, Installation, and Maintenance of Solid-State Control, publication SGI-1.1	Designed to harmonize with NEMA Standards Publication No. ICS 1.1-1987 and provides general guidelines for the application, installation, and maintenance of solid-state control in the form of individual devices or packaged assemblies incorporating solid-state components.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
Product Certifications website, rok.auto/certifications	Provides declarations of conformity, certificates, and other certification details.

Start

Use this chapter to become familiar with the ArmorKinetix® system and obtain an overview of installation configurations.

About the ArmorKinetix System

On-machine drives include Distributed Servo Motor (DSM) and Distributed Servo Drive (DSD). Both are single axis inverters and can be powered by a Diode Front End (DFE) module. The connection between the in-cabinet system and the on-machine inverters is established by using the Power Interface Module (PIM) that distributes DC power and communication signals by using a single cable (hybrid cable). Each PIM module can support up to 24 axes. If more than 24 axes are needed, you can use multiple PIM modules.

Table 2 - ArmorKinetix System Overview

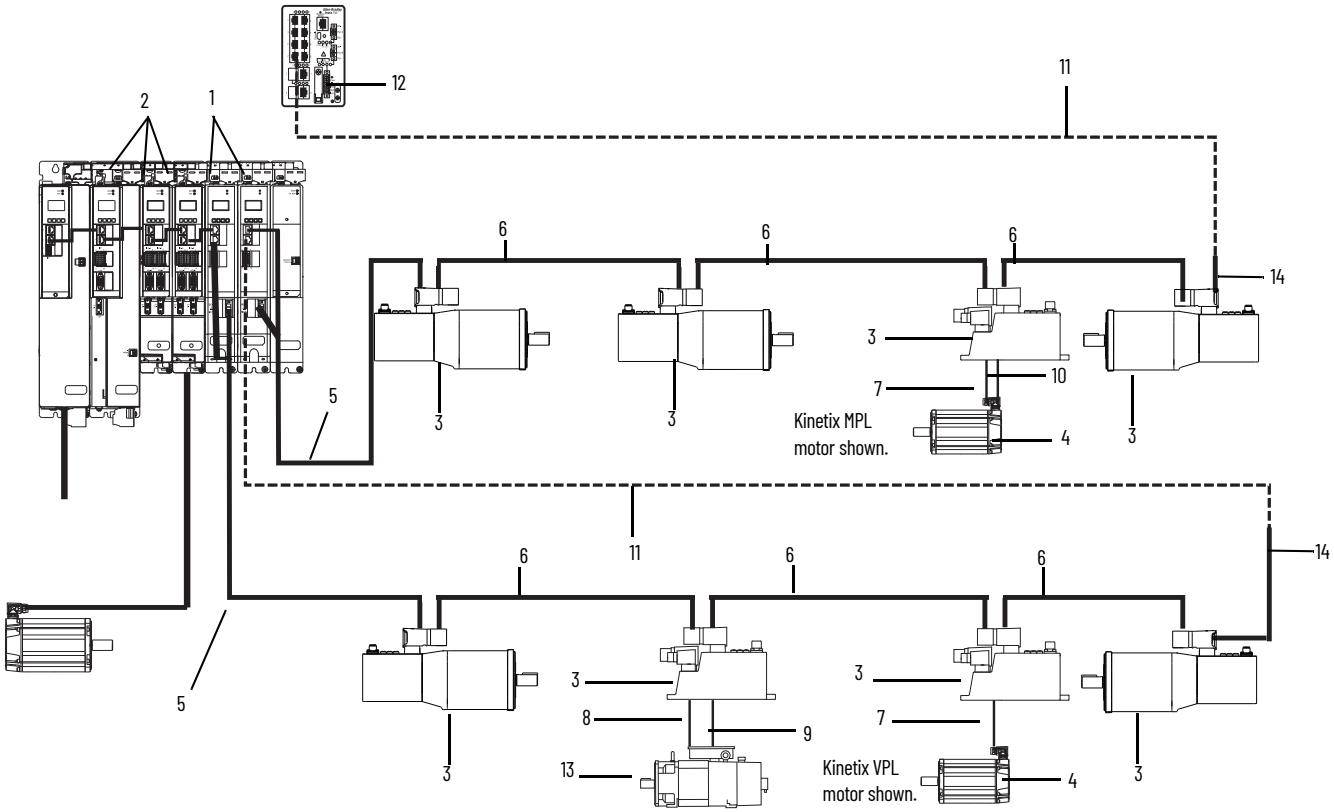
Drive System Component	Cat. No.	Description
DC-bus Power Supply	2198-P*xxx*	Converter power supply with 200V and 400V-class (three-phase) AC input. Provides output current in a range of 10.5…69.2 A. Systems typically consist of one module, however, up to three modules in parallel is possible. Parallel modules increase available power for 2198 modules.
ArmorKinetix Power Interface Module (PIM)	2198-PIM070	The PIM module provides the connection between the in-cabinet system and the on-machine inverter. This module distributes DC power and communication signals to the DSD and DSM modules by using a single cable (hybrid cable). Each PIM module can support up to 24 axes.
ArmorKinetix System Single-axis Distributed Servo Drives (DSD)	2198-DSD0xx-ERS2 2198-DSD0xx-ERS5	Single-axis inverters with current ratings up to 8 A rms. Drives feature TÜV Rheinland-certified Safe Torque Off function with integrated safety connection options, PLe and SIL 3 safety ratings, and support for Hiperface DSL, and Hiperface encoder feedback. The DSD modules also support Timed and Monitored SS1 drive-based stopping functions, and support for controller based Safe Stop 1 and safe speed monitoring functions over the Ethernet network.
ArmorKinetix System Single-axis Distributed Servo Motors (DSM)	2198-DSM0xx-ERS2 2198-DSM0xx-ERS5	Single-axis motor/inverter with maximum continuous torque of 11.9 Nm and peak torque of 31.2 Nm with speeds up to 8000 rpm. The -ERS2 motor/inverters feature TÜV Rheinland-certified Safe Torque Off function with integrate safety connection, PLe, and SIL 3 for Hiperface DSL feedback only. The modules also support Timed SS1 drive-based stopping functions. The 2198-DSMxxx-ERS5 modules also support Timed and Monitored SS1 drive-based stopping functions, and support for controller-based Safe Stop 1 and Safely-limited Speed functions.
Kinetix® 5700 Capacitor Module	2198-CAPMOD-2240	Use for energy storage, external active-shunt connection, and to extend the DC-bus voltage to another inverter cluster. Modules are zero-stacked with servo drives and use the shared-bus connection system to extend the external DC-bus voltage in applications up to 104 A. Can parallel with itself or with another accessory module for up to 208 A with required 2198-KITCON-CAPMOD2240 kit that includes flexible bus-bars.
Kinetix 5700 Extension Module	2198-CAPMOD-DCBUS-IO	The extension module, paired with a capacitor module or DC-bus conditioner module, is used to extend the DC-bus voltage to another inverter cluster in systems with ≥104 A current and up to 208 A.
Kinetix 5700 DC-bus Conditioner Module	2198-DCBUSCOND-RP312	Decreases the voltage stress on insulation components in an inverter system and used to extend the DC-bus voltage to another inverter cluster. Modules are zero-stacked with servo drives and use the shared-bus connection system to extend the external DC-bus voltage in applications up to 104 A. Can parallel with itself or with another accessory module for up to 208 A with required 2198-KITCON-DCBUSCOND kit that includes flexible bus-bars.
Shared-bus Connector Kits	2198-TCON-24VDCIN36 2198-*xxxx*-P-T 2198-BARCON-*xx*DCAC100	24V input wiring connectors, T-connectors, and bus-bars for most Kinetix 5700 drive modules that use the 24V shared-bus connection system (optional).
	2198-BARCON-*xx*DC200 2198-KITCON-ENDCAP200	DC-bus links (55, 85, 100, and 220 mm) and end caps for the DC-bus shared-bus connection system (required and included with each respective drive module). DC-bus links (165, 275, and 440 mm) are optional and do not ship with any modules.
PIM Connector Kit	2198-KITCON-PIM070	Replacement connector kit.
Kinetix 5700 System Mounting Toolkit	2198-K5700-MOUNTKIT	Use to position the drive modules and identify drill-holes for mounting your Kinetix 5700 servo drive system.
Encoder Output Module	2198-ABQE	The Allen-Bradley® encoder output module is a DIN rail mounted EtherNet/IP™ network-based standalone module capable of outputting encoder pulses to a customer-supplied peripheral device (cameras, for example, used in line-scan vision systems).

Table 2 - ArmorKinetix System Overview (Continued)

Drive System Component	Cat. No.	Description
Logix 5000® Controller Platform	1769 5069	Integrated Motion on the EtherNet/IP network in CompactLogix™ 5370, CompactLogix 5380, and CompactLogix 5480 controllers and Integrated Safety in Compact GuardLogix® 5370 and Compact GuardLogix 5380 controllers. Linea, and Device Level Ring (DLR) topology is supported.
	1756-L8*x*E module 1769-ERM module 5069-L3*xxx*ERM module	EtherNet/IP network communication modules for use with ControlLogix® 5570, ControlLogix 5580, GuardLogix 5570, and GuardLogix 5580 controllers. Linear and Device Level Ring (DLR) topology is supported.
Studio 5000® Environment	N/A	Studio 5000 Logix Designer® application, version 35.00 or later, with an Add-on Profile (AOP), provides support for programming, commissioning, and maintaining the CompactLogix, ControlLogix, and GuardLogix controller families. Download AOP files from the Product Compatibility and Download Center at rok.auto/pcdc.
Rotary Servo Motors	Kinetix VP motors	• Compatible 400V-class motors include Kinetix VPL, VPF, VPH, and VPS servo motors. • Compatible 200V-class motors include Kinetix VPL, VPF, and VPH servo motors.
	Kinetix MP motors	Compatible 200V and 400V-class motors include Kinetix MPL, MPM, MPF, and MPS servo motors.
Linear Actuators	Kinetix VPAR and MPAR, actuators Kinetix LDAT	Compatible actuators include 400V-class Kinetix VPAR and MPAR electric cylinders, and Kinetix LDAT linear thrusters.
Linear Motors	Kinetix LDC	Compatible motors include Kinetix LDC iron-core (200V and 400V-class) linear motors.
Induction Motors	N/A	Induction motors with open-loop frequency control and closed-loop control are supported.
Cables	2090-CDHIFS-12AF*xxxx*	This cable connects the Power Interface Module (PIM) to either the ArmorKinetix Distributed Servo Motor (DSM) or the Distributed Servo Drive (DSD).
	2090-CDHP1S-12AF*xxxx*, 2090-CDHP1S-12AFJ	This cable connects a DS*x* module to a DS*x* module (where DS*x* is either a DSM module or a DSD module).
	2090-CSBM1P7-14AF*xx*	This cable connects motor power to a Kinetix MPL motor and motor power/feedback to a Kinetix VPL motor.
	2090-CPWFLP7-14AF*xx*	This cable connects the DSD to induction motors.
	2090-CFBM7S7-CDAF*xx*	This cable connects the Kinetix motor feedback to the distributed servo drive.
	2090-CFBFLS7-CDAF*xx*	This cable connects a Kinetix or induction motor feedback for single or dual loop functionality to the DSD module.
	2090-CDET	The hybrid connector communication extension has only the communication/Ethernet pins populated on the M23 side, and passes through to an M12 X-coded Ethernet connection on the other side.
	1585J-M8CBJM-*x*	Ethernet cables are available in standard lengths. Shielded cable is required to meet EMC specifications.
Connector Terminator	2090-CDHT	DS*x* hybrid connector output terminator.
	2090-CDFT	DSD feedback connector terminator.
	2090-CDPT	DSD power connector terminator.
AC Line Filters	2198-DBR20-F, 2198-DBR40-F, 2198-DBR90-F, 2198-DBR200-F	2198 three-phase AC line filters are required to meet CE and UK and are available for use with DC-bus power supplies and regenerative bus supplies.
Line Reactors	1321-3R*xx-x*	The 1321 line reactors help keep equipment running longer by absorbing many of the power line disturbances that can shut down your power supply.
AC Contactor	100-C*xxxxx* 100-D*xxxxx* 100-E*xxxxx*	The AC three-phase contactor control string must be wired in series with the contactor-enable relay at the CED connector to make sure that three-phase power is removed under various fault conditions to protect the power supply.
24V DC Power Supply	1606-XL*xxx*	1606 24V DC power supply for control circuitry, digital inputs, safety, and motor brake.
External Passive Shunt Resistors	2198-R014, 2198-R031, 2198-R127, 2198-R004	2198 external passive-shunt resistors for use when the DC-bus power supply internal shunt capability is exceeded. Not for use with regenerative bus supplies.
External Active Shunts	N/A	External active shunts from Rockwell Automation Encompass™ partner, Powerohm Resistors, Inc. or Bonitron, Inc., are available for connecting to 2198 DC-bus power supplies.

Typical Hardware Configurations

Each ArmorKinetix PIM module supports up to 24 ArmorKinetix DSD and/or DSM modules. Total cable length for the ArmorKinetix system [PIM, DSD (including motor connections), and DSM modules] is 140 m (459 ft) maximum.



Item	Description	Item	Description
1	ArmorKinetix PIM Modules	8	ArmorKinetix DSD to Induction Motor Power Cable (2090-CPWFLP7-14AF*xx*) 1...4 m (3.28...13.12 ft)
2	Kinetix 5700 Servo Drives	9	ArmorKinetix DSD to Induction Motor Feedback or Stand-alone Feedback Cable (2090-CFBFLS7-CDAF*xx*) 1...4 m (3.28...13.12 ft)
3	ArmorKinetix DSD or DSM Module	10	ArmorKinetix DSD to Kinetix Motor Feedback Cable (2090-CFBM7S7-CDAF*xx*) 1...4 m (3.28...13.12 ft)
4	Kinetix VPL or Kinetix MPL Motor	11	Ethernet patchcord, 1 Gigabit with hybrid connector to connect to communication extension 85 m (278 ft) max. (1585D-M8UGDM, 1585D-M8TGDE, or 1585D-E8TGDE)
5	ArmorKinetix PIM to DS*x* Hybrid Cable (2090-CDHIFS-12AF*xxxx*) 3...50 m (9.8...164 ft)	12	Managed Ethernet Switch
6	ArmorKinetix DS*x* to DS*x* Hybrid Cable (2090-CDHP1S-12AF*xxxx*) 0.5...30 m (1.64...98.4 ft)	13	Induction Motor
7	ArmorKinetix DSD to Kinetix Motor Power/Feedback Cable (2090-CSBM1P7-14AF*xx*) 1...4 m (3.28...13.12 ft)	14	Communication Extension Jumper Cable (2090-CDET)

Communication Configurations

The ArmorKinetix System supports linear and ring Ethernet topology by using ControlLogix, GuardLogix, or CompactLogix controllers.

These examples feature the ControlLogix 5580 programmable automation controllers with support for integrated motion and integrated safety over the EtherNet/IP network. Other Allen-Bradley controllers are also compatible with the ArmorKinetix modules.

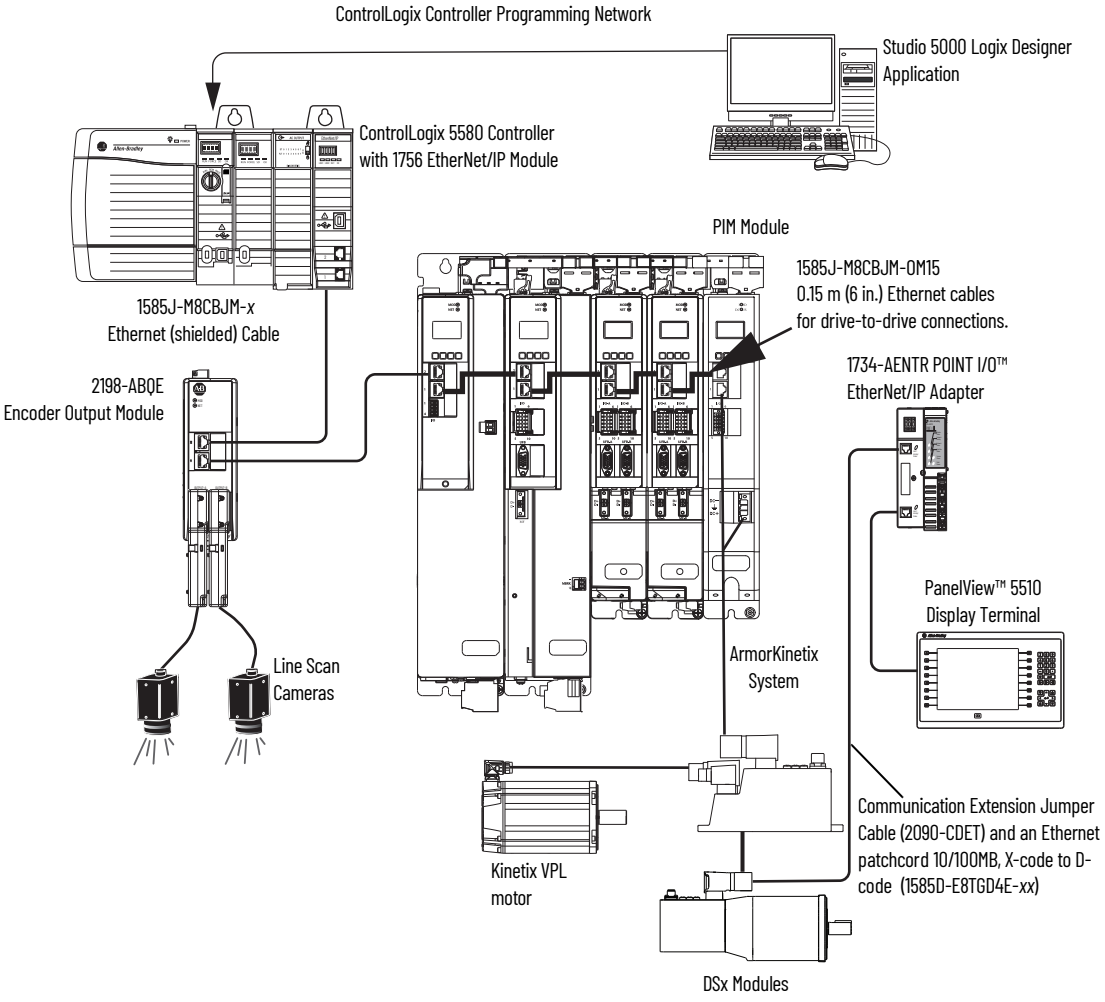
Refer to ControlLogix Communication Module Specifications Technical Data, publication 1756-TD003, for more information on ControlLogix 1756-EN2T, 1756-EN2TR, 1756-EN3TR, and 1756-EN4TR communication modules.

These example configurations use the 2198-P*xxx* DC-bus power supply.

Linear Topology

In this example, all devices are connected by using linear topology. The ArmorKinetix System modules include dual-port connectivity, however, if any device becomes disconnected, all devices downstream of that device lose communication. Devices without dual ports must include the 1783-ETAP module or be connected at the end of the line.

Figure 1 - ArmorKinetix System Linear Communication Installation

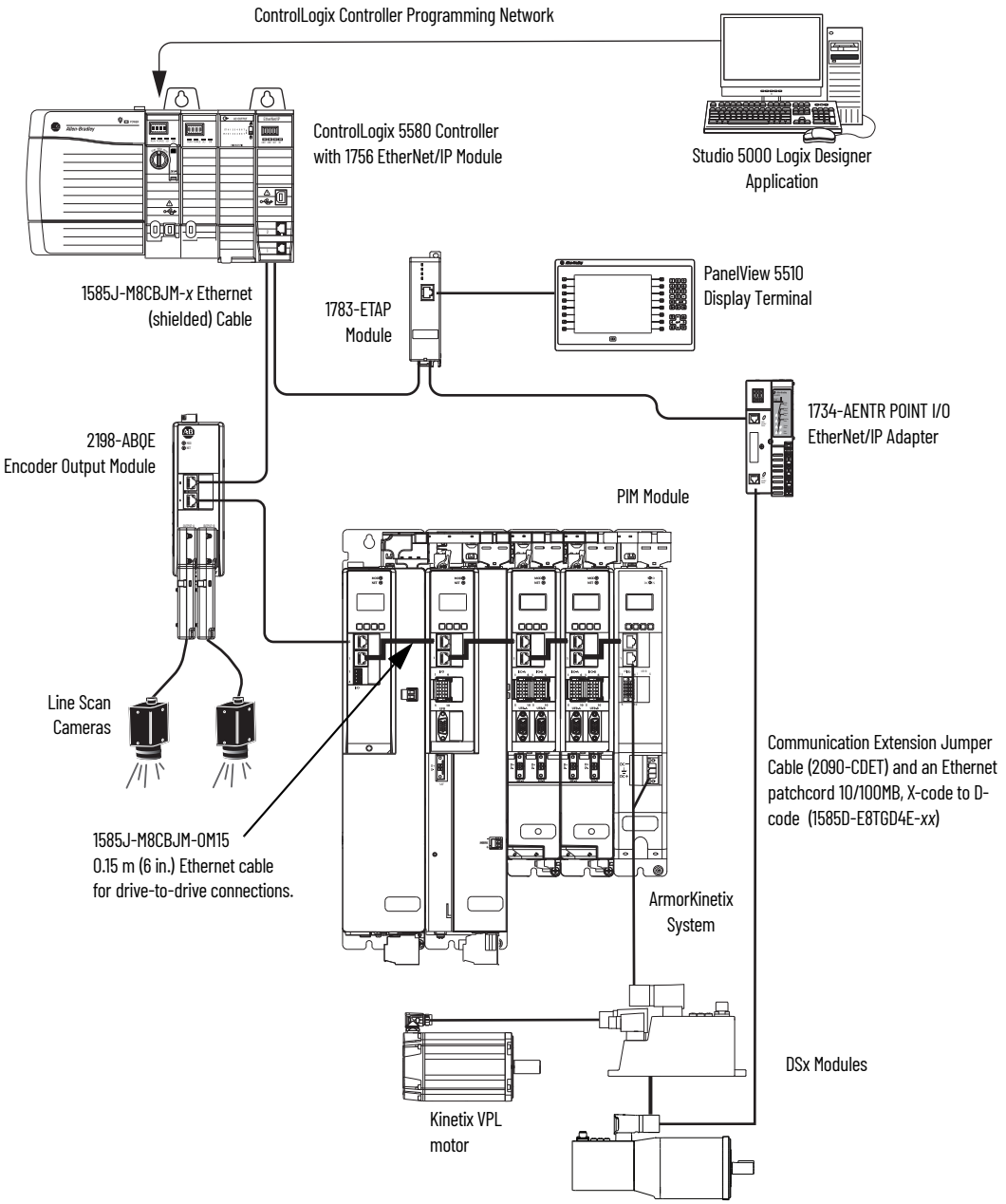


Device Level Ring Topology

In this example, the devices are connected by using ring topology. If only one device in the ring is disconnected, the rest of the devices continue to communicate. For ring topology to work correctly, a device level ring (DLR) supervisor is required (for example, the 1783 ETAP device). DLR is an ODVA standard. For more information, refer to the EtherNet/IP Device Level Ring Application Technique, publication ENET-AT007.

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

Figure 2 - ArmorKinetix System Ring Communication Installation



DC-bus Power Supply Input Power Configurations

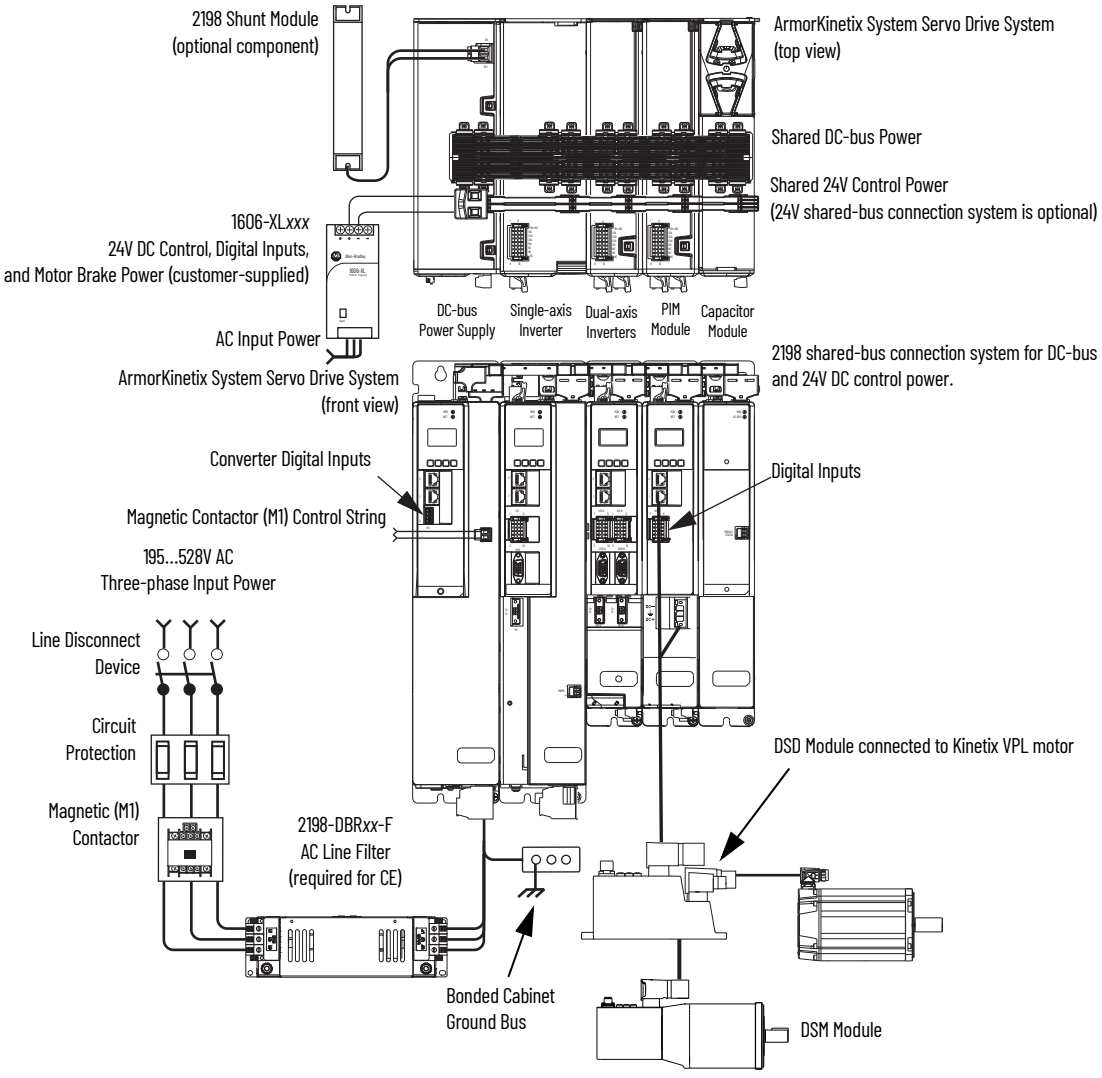
A single 2198-P*xxx* DC-bus (converter) power supply can supply the ArmorKinetix System drive system with 276...747V shared DC-bus power. For additional output power (kW) you can install two or three 2198-P208 DC-bus power supplies. You can also extend the DC-bus to additional inverter clusters via accessory modules.

Typical DC-bus Power Supply Configuration Example

In this multi-axis example, AC input power is fed to the DC-bus (converter) power supply. One single-axis (inverter) module, one dual-axis (inverter), and one PIM module support five axes of motion. The PIM module connects to one DSD module, which is connects to a Kinetix VPL motor, and a DSM module. The DC-bus power supply is mounted on the far left and the inverters are positioned on the right, but the reverse mounting order (right to left) is also possible.

Digital inputs are wired to sensors and the control circuitry at the IOD connectors. The contactor-enable relay protects the DC-bus power supply in the event of shutdown fault conditions.

Figure 3 - Typical DC-bus Power Supply Installation

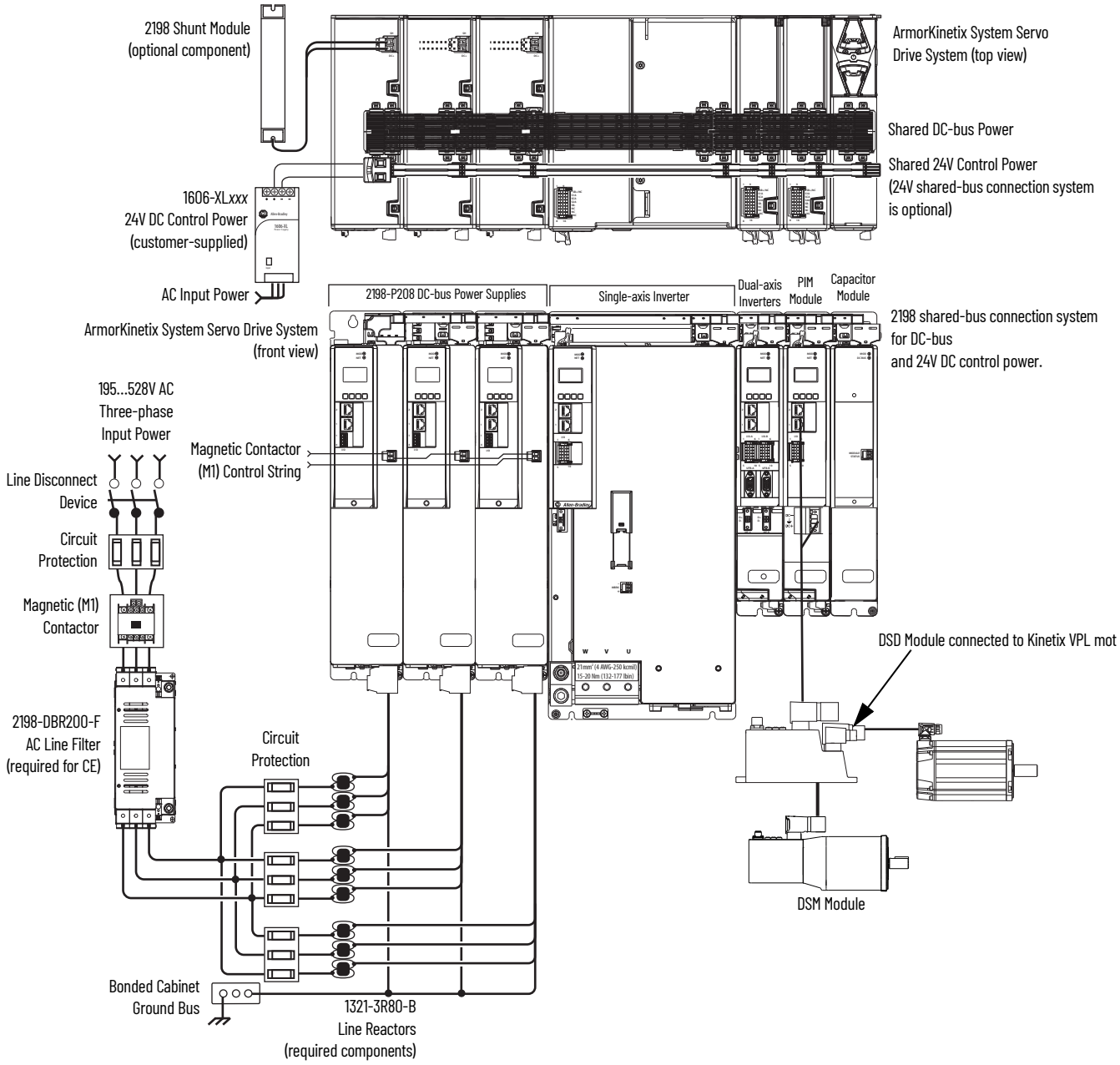


Multiple DC-Bus Power Supply Configuration Example

In this example, three DC-bus (converter) power supplies all receive AC input power and feed the inverter modules for increased output power.

Contactor enable relays from each of the DC-bus power supplies are wired in series to protect the DC-bus power supply in the event of shutdown fault conditions.

Figure 4 - Multiple DC-bus Power Supply Installation

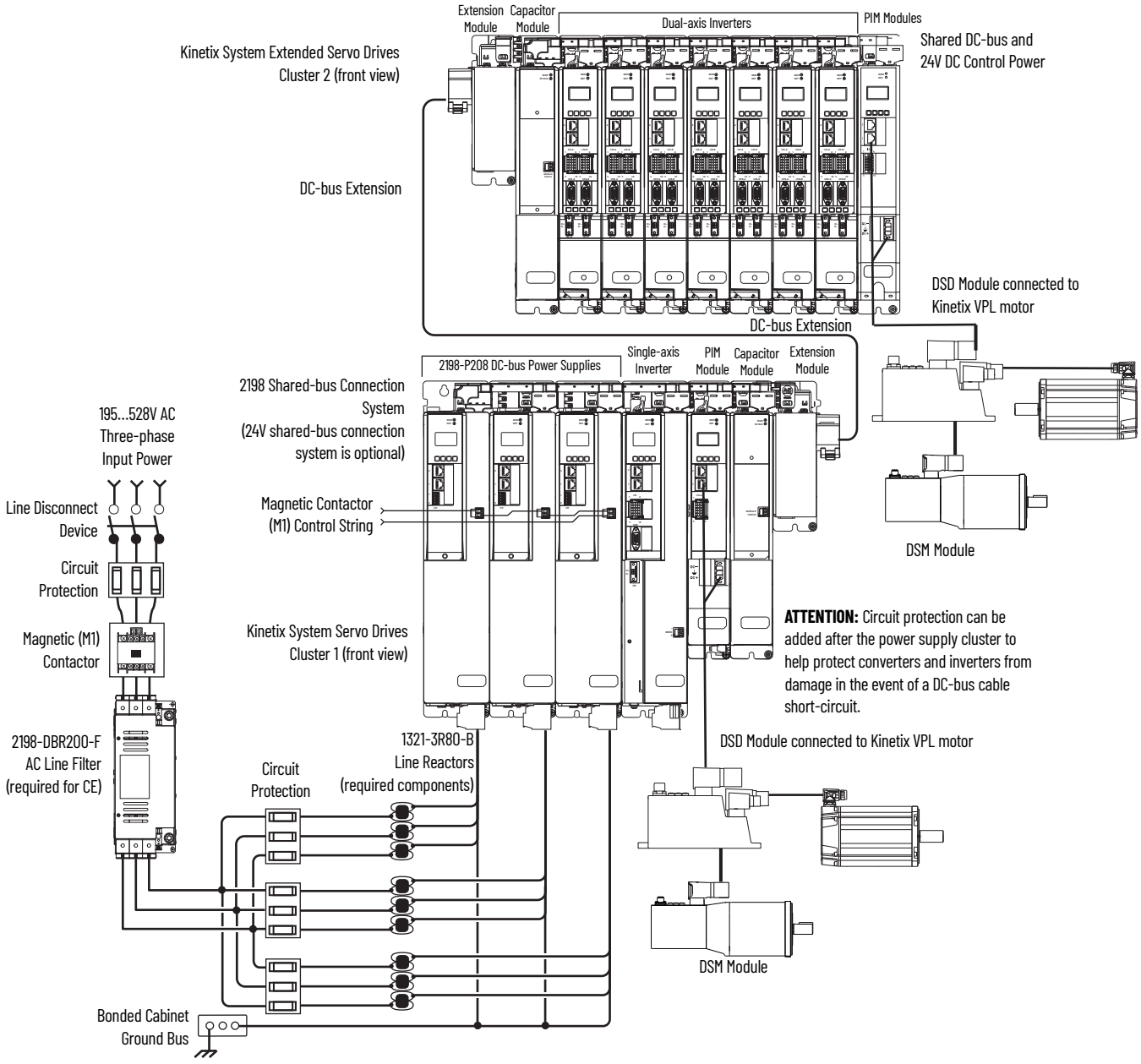


IMPORTANT When two or three DC-bus power supplies are wired together in the same drive cluster, they must all be catalog number 2198-P208.

Extended DC-bus Configuration Example

In this example, two drive clusters in the same cabinet are connected by the same 276...747V DC bus voltage. Kinetix 5700 accessory modules provide connection points for the DC-bus at the end of cluster 1 and the beginning of cluster 2. The Kinetix 5700 servo drive system is capable of up to 208 A DC-bus current. Two accessory modules are needed when the DC-bus system current exceeds 104 A. See Accessory Module Selection on page 32 for more information on the when accessory modules are required.

Figure 5 - Extended DC-bus Installation

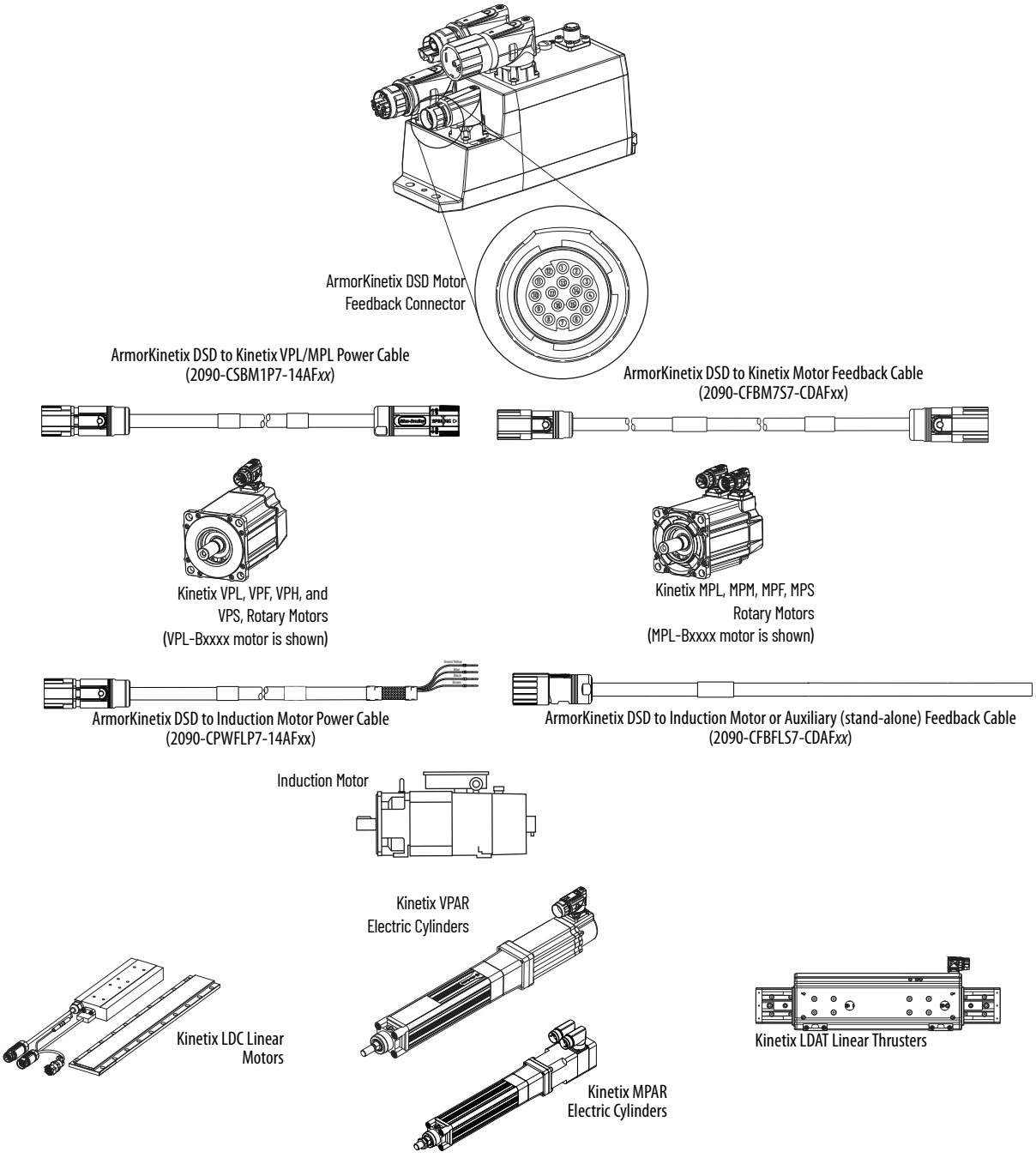


IMPORTANT When two or three DC-bus power supplies are wired together in the same drive cluster, they must all be catalog number 2198-P208.

Motor Feedback Configurations for ArmorKinetix DSD

Feedback connections are made at the motor feedback (MF) connector on the DSD. These examples illustrate how you can make these connections. To see motor power and brake connections, refer to Chapter 5 on page 71.

Figure 6 - Feedback Configuration Example



Integrated Safety Configurations

The GuardLogix or Compact GuardLogix safety controller issues the safe torque-off (STO) or safe stop (SS1) command over the EtherNet/IP network and the ArmorKinetix DS*x* module executes the command.

Table 3 - Integrated Functional Safety Support

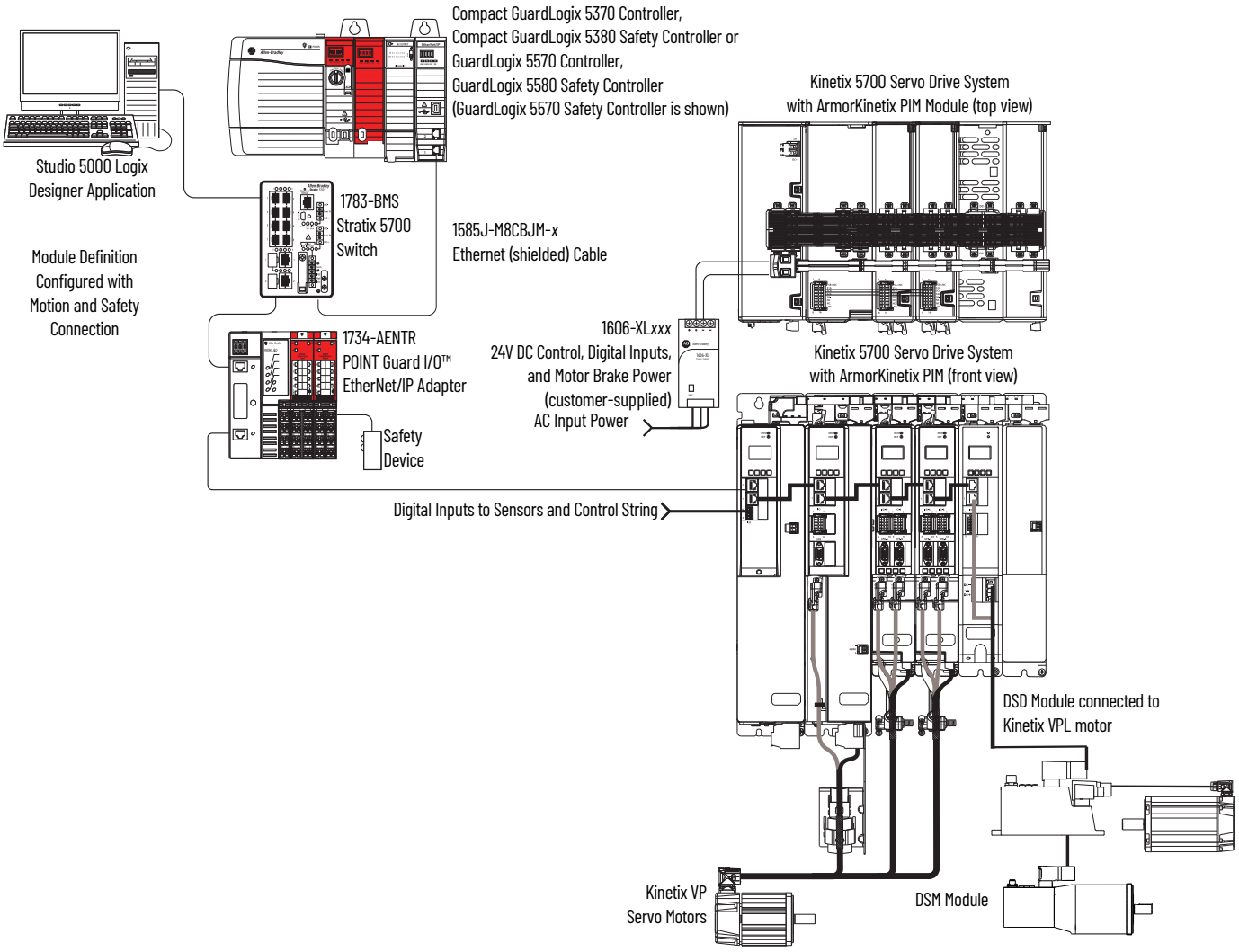
Integrated Safety Over the EtherNet/IP™ Network	Safety Function	ArmorKinetix DSD Cat. No.	ArmorKinetix DSM Cat. No.	Minimum Controller [1] Required
Drive-based stopping functions	Timed Safe Stop 1 (SS1)	2198-DSD*xxx*-ERS2 2198-DSD*xxx*-ERS5	2198-DSM*xxx*-ERS2 2198-DSM*xxx*-ERS5	• GuardLogix 5580 • CompactGuardLogix 5380
	Monitored Safe Stop 1 (SS1)	2198-DSD*xxx*-ERS5	2198-DSM*xxx*-ERS5	
Controller-based stopping functions	• Monitored Safe Stop 1 (SS1) • Safe Stop 2 (SS2)			
Controller-based monitoring functions	• Safe Operational Stop (SOS) • Safely Limited Speed (SLS) • Safety Limited Position (SLP) • Safe Direction (SDI)			
Safety feedback function	Safety Feedback Interface (SFX)			
Integrated STO mode	Safe Torque-off (STO)	2198-DSD*xxx*-ERS5	2198-DSM*xxx*-ERS5	
		2198-DSD*xxx*-ERS2	2198-DSM*xxx*-ERS2	• GuardLogix 5570 • CompactGuardLogix 5370

(1) Where a ControlLogix or CompactLogix (non-safety) controller is specified, a GuardLogix or Compact GuardLogix controller is backwards compatible. Also, GuardLogix 5580 and Compact GuardLogix 5380 controllers are backwards compatible with GuardLogix 5570 and Compact GuardLogix 5370 controllers.

In this example, a single GuardLogix safety controller makes the Motion and Safety connections.

IMPORTANT If only one controller is used in an application with Motion and Safety connections, it must be a GuardLogix or Compact GuardLogix safety controller. For more information, see the Integrated Functional Safety Support table on page 20.

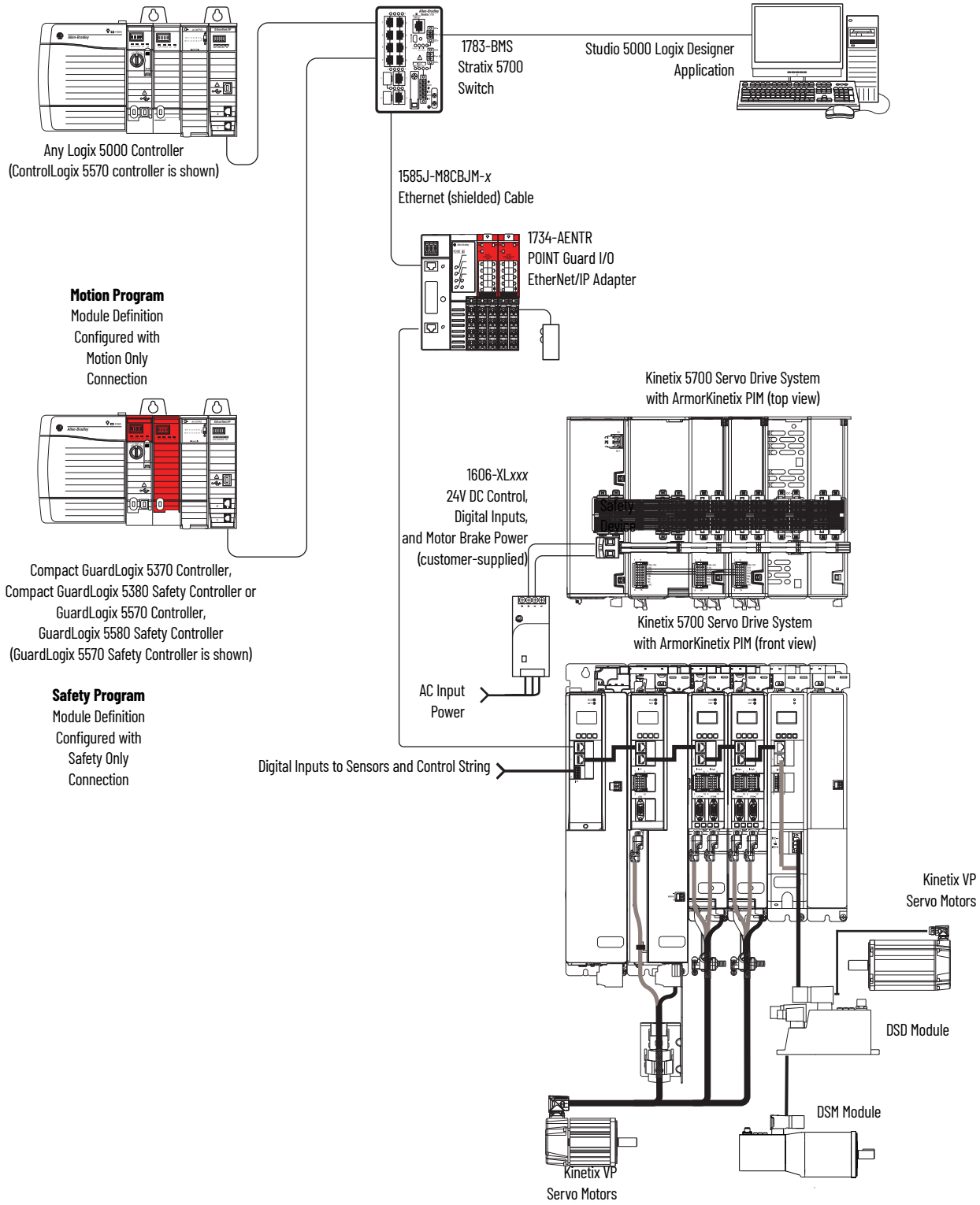
Figure 7 - Motion and Safety Configuration (single controller)



In this example, a non-safety controller makes the Motion-only connection and a separate GuardLogix safety controller makes the Safety-only connection.

IMPORTANT If two controllers are used in an application with Motion Only and Safety Only connections, the Safety Only connection must be a GuardLogix or Compact GuardLogix safety controller and the Motion Only connection must be any Logix 5000 controller. For more information, see the Integrated Functional Safety Support table on page 20.

Figure 8 - Motion and Safety Configuration (multi-controller)



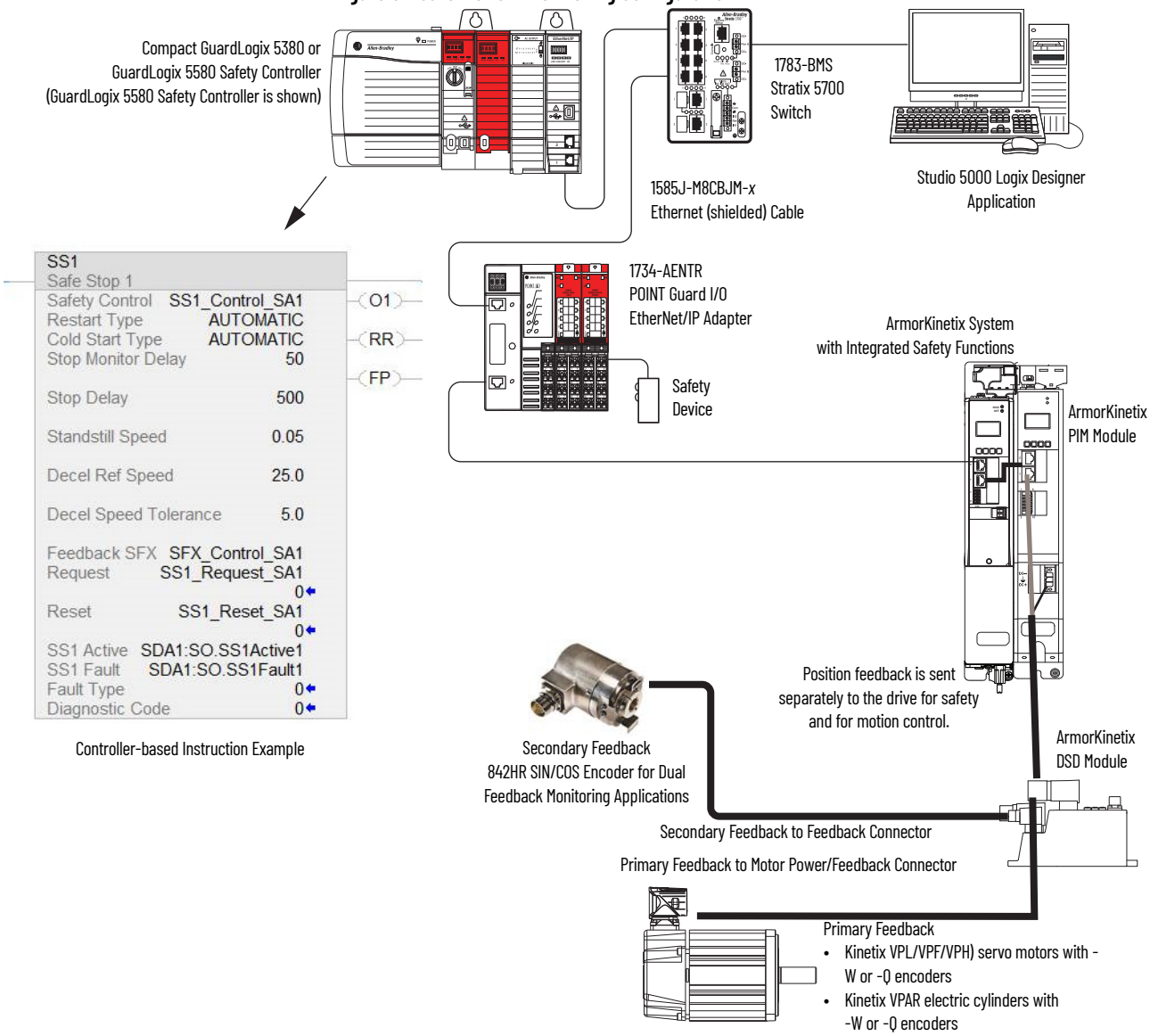
Safe Stop and Safe Monitor Configurations

ArmorKinetix System modules are capable of safe stop and safe monitor functions via drive-based and controller-based integrated safety over the EtherNet/IP network.

IMPORTANT For applications with safe stop and safe monitor safety functions, the GuardLogix 5580 or Compact GuardLogix 5380 controllers must be used. For more information, see the Integrated Functional Safety Support table on page 20.

In this example, the SS1 stopping function is used in a motion and safety controller-based configuration with dual-feedback monitoring.

Figure 9 - Safe Motion-monitoring Configuration



Catalog Number Explanation

ArmorKinetix System drive module catalog numbers and performance descriptions.

Table 4 - ArmorKinetix System Drive Module Catalog Numbers

ArmorKinetix System Modules	Cat. No.	Continuous Output Current to Bus A_{DC} rms	Module Width mm	Continuous Output Power		Output Current	
				240V Input kW	480V Input kW	Rated Continuous A 0...pk	Peak[1] A 0...pk
DC-bus Power Supply (195...528V AC rms, three-phase input power)	2198-P031 2198-P070	10.5 25.5	55	3.5 8.5	7 17	–	–
	2198-P141 2198-P208	46.9 69.2	85	15.5 23.0	31 46	–	–
PIM Module	2198-PIM070	24	55	8	16	–	–
DSM, 200V-class	2198-DSM016-ERSx-A0751E-xx1xAx 2198-DSM016-ERSx-A0752E-xx1xAx 2198-DSM024-ERSx-A0753C-xx1xAx 2198-DSM024-ERSx-A0753E-xx1xAx	–	79.5	0.38 0.63 0.59 0.67	–	2.90 4.80 4.01 5.50	9.12 17.61 18.60 21.50
	2198-DSM016-ERSx-A1001C-xx1xAx 2198-DSM016-ERSx-A1002C-xx1xAx 2198-DSM024-ERSx-A1003C-xx1xAx 2198-DSM024-ERSx-A1003E-xx1xAx		89.4	0.51 1.03 0.87 1.31	–	3.31 6.24 5.95 9.12	10.38 20.33 20.20 27.40
	2198-DSM016-ERSx-A1152B-xx1xAx 2198-DSM024-ERSx-A1152E-xx1xAx 2198-DSM024-ERSx-A1153A-xx1xAx 2198-DSM024-ERSx-A1153C-xx1xAx		98.3	0.98 1.41 0.93 1.32	–	5.94 10.10 5.83 8.11	21.19 30.80 21.33 29.36
	2198-DSM016-ERSx-A1303A-xx1xAx 2198-DSM024-ERSx-A1303B-xx1xAx 2198-DSM024-ERSx-A1304A-xx1xAx 2198-DSM024-ERSx-A1306A-xx1xAx		113.7	0.94 1.37 1.55 1.44	–	5.81 8.78 8.72 9.72	31.00 29.50 29.87 29.70
DSM, 400V-class	2198-DSM016-ERSx-B0751M-xx1xAx 2198-DSM016-ERSx-B0752M-xx1xAx 2198-DSM024-ERSx-B0753F-xx1xAx 2198-DSM024-ERSx-B0753M-xx1xAx		79.5	–	0.54 0.81 0.65 0.78	2.70 4.81 3.75 5.64	9.12 18.90 18.90 21.09
	2198-DSM016-ERSx-B1001M-xx1xAx 2198-DSM016-ERSx-B1002M-xx1xAx 2198-DSM024-ERSx-B1003F-xx1xAx 2198-DSM024-ERSx-B1003T-xx1xAx		89.4	–	1.02 1.86 1.65 1.77	3.37 6.12 5.79 8.62	10.38 20.33 20.20 23.94
	2198-DSM016-ERSx-B1152F-xx1xAx 2198-DSM024-ERSx-B1152T-xx1xAx 2198-DSM024-ERSx-B1153E-xx1xAx 2198-DSM024-ERSx-B1153F-xx1xAx		98.3	–	1.40 2.16 1.75 2.20	5.93 10.41 5.83 7.86	21.19 29.70 21.33 30.16
	2198-DSM016-ERSx-B1303C-xx1xAx 2198-DSM024-ERSx-B1303F-xx1xAx 2198-DSM016-ERSx-B1304C-xx1xAx 2198-DSM024-ERSx-B1304E-xx1xAx 2198-DSM024-ERSx-B1306C-xx1xAx		113.7	–	1.83 2.68 1.75 2.71 2.25	5.89 8.78 6.67 8.26 9.72	18.04 29.50 22.07 28.65 29.70
DSD	2198-DSD016-ERSx 2198-DSD024-ERSx	–	79.5	1.8 2.75	3.6 5.5	7.5 11.3	22.6 33.8

(1) Peak duration is 100 ms on and 900 ms off.

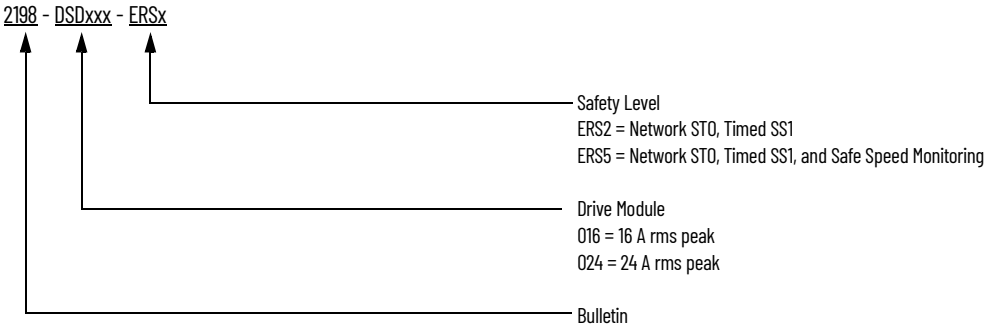
Table 5 - Shared-bus Connector Kit Catalog Numbers for ArmorKinetix

Shared-bus Connector Kits Cat. No.	Drive Module Cat. No.	Application	Description
2198-TCON-24VDCIN36 (1) (2)	2198-P031, 2198-P070, 2198-P141, 2198-P208 2198-CAPMOD-2240	24V DC input power to control bus	24V DC input wiring connector
2198T-W25K-P-IN (1) (2)	2198T-W25K-ER, 2198-RP263, 2198-RP312, 2198-S263-ERSx, 2198-S312-ERSx		
2198-H040-D-T	2198-PIM070	Control power sharing	Control power T-connector
2198-H040-P-T	2198-D006-ERSx, 2198-D012-ERSx 2198-D020-ERSx, 2198-D032-ERSx 2198-CAPMOD-2240, 2198-DCBUSCOND-RP312	Control power sharing	Control power T-connector with bus bars, 55 mm
2198-H070-P-T	2198-D057-ERSx, 2198-S086-ERSx, 2198-S130-ERSx	Control power sharing	Control power T-connector with bus bars, 85 mm
2198-S160-P-T	2198-S160-ERSx	Control power sharing	Control power T-connector with bus bars, 100 mm
2198T-W25K-P-T	2198T-W25K-ER		
2198-S312-P-T	2198-S263-ERSx, 2198-S312-ERSx	Control power sharing	Control power T-connector with bus bars, 220 mm

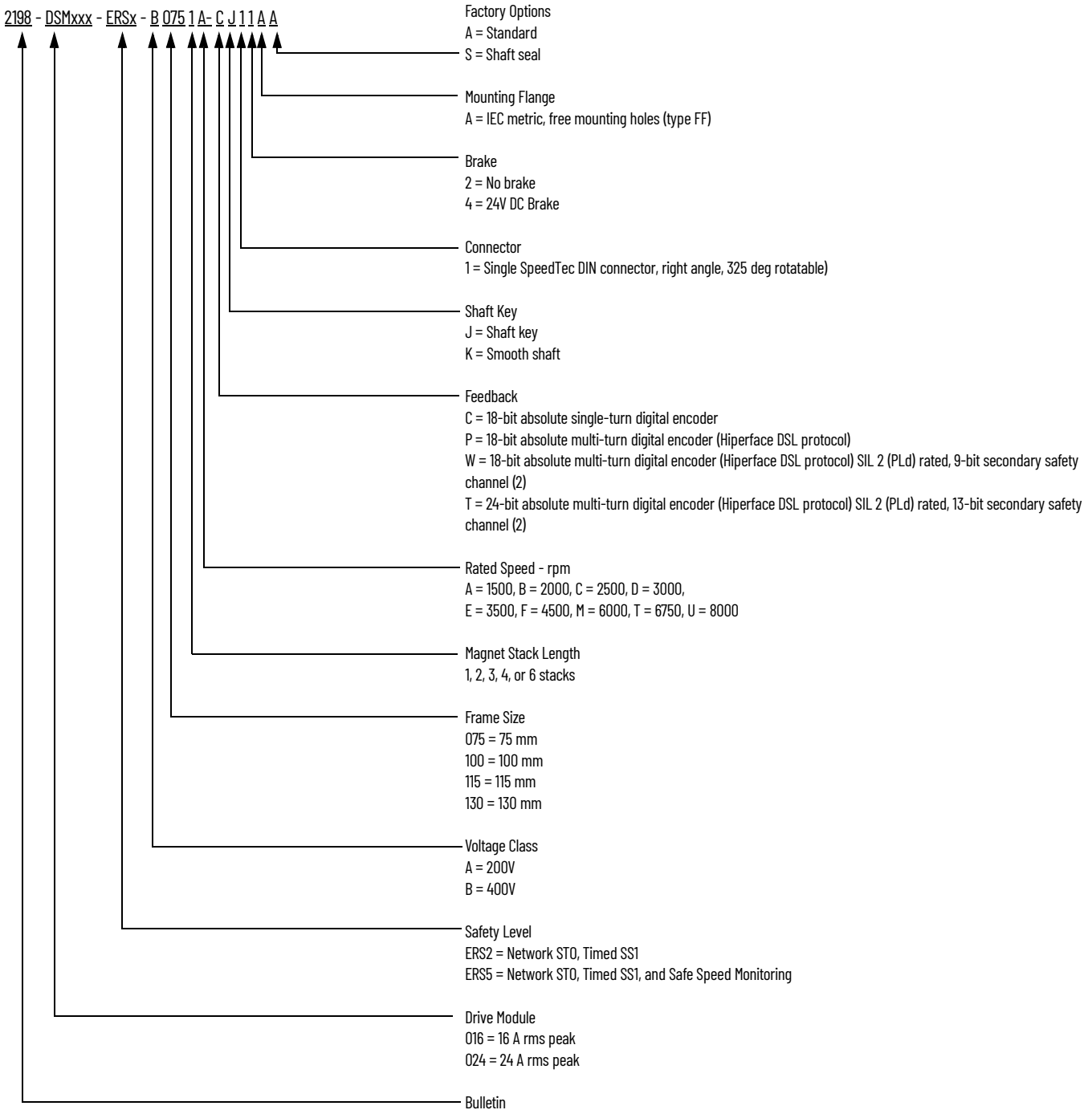
(1) The input wiring connector can be inserted into any drive module (mid-stream in the drive system) to begin a new 24V control bus when the maximum current value is reached. However, the input connector must always extend the 24V DC-bus from left to right. The 2198T-W25K-P-IN male plug is physically larger than the male plug on 2198-TCON-24VDCIN36.

(2) For module amp ratings and connector wire size information, see 24V DC Control Power Input Connector on page 57, and CP Connector Plug Wiring Specifications table on page 76, respectively.

Catalog Numbers - ArmorKinetix DSD Modules



Catalog Numbers - ArmorKinetix DSM Modules



Agency Compliance

If this product is installed within the European Union and has the CE mark, or within the United Kingdom and has the UKCA mark, the following regulations apply.

ATTENTION: Meeting CE and UK requires a grounded system, and the method of grounding the AC line filter and drive module must match. Failure to do this renders the filter ineffective and can cause damage to the filter. For grounding examples, refer to Grounded Power Configurations on page 72.

For more information on electrical noise reduction, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

To meet CE and UK requirements, these requirements apply:

- Install an AC line filter (catalog number 2198-DBR*xx*-F) for input power with 50 mm (1.97 in.) minimum clearance between the 2198-P*xxx* DC-bus power supply. Minimize the cable length as much as possible.
- Bond DC-bus power supplies, PIM modules, inverter modules, capacitor modules, and line filter grounding screws by using a braided ground strap as shown in Figure 44 on page 75.
- When using the 2198-P070 DC-bus power supply above 45 °C (113 °F) with stranded input power wiring, conductors must be single-core 6 mm^2 stranded copper with 90 °C minimum rating.
- Use Kinetix 2090 single motor cables with Kinetix VP motors and actuators. Use Kinetix 2090 motor power/brake and feedback cables for other compatible Allen-Bradley motors and actuators. Motor cable shield-clamp on the drive must be used.
- Combined motor power cable length for all axes on the same DC bus must not exceed:
  - 1200 m (3937 ft) for 2198-P031, 2198-P070, 2198-P141, and 2198-P208, DC-bus power supplies when paired with 2198-DBR*xx*-F line filters.
- PIM module to last DSx module must not exceed:
  - 140 m (459 ft)
- DSD module to motor cables must not exceed:
  - 4 m (13 ft).
- Install the ArmorKinetix System PIM module inside an approved enclosure.
- Segregate input power wiring from control wiring and motor cables.

Refer to Appendix A on page 169 for input power wiring and drive/motor interconnect diagrams.

Notes:

Installation Guidelines

System Design Guidelines

Use the information in this section when planning to mount your system components on the panel.

For on-line product selection and system configuration tools, including AutoCAD (DXF) drawings of the product, refer to rok.auto/systemtools.

Cable Length Restrictions and System Sizing

This section provides guidelines for sizing an ArmorKinetix® system. For accurate, detailed sizing, use FactoryTalk® Motion Analyzer™ software (version 2.000 or later) rok.auto/motion-analyzer. For more information and a sizing estimation method, refer to Size Multi-axis Shared-bus Configurations on page 189.

When sizing your system, note the following:

- Maximum cable length between the PIM module and a DS*x* module is 50 m (164 ft).
- Maximum cable length between DS*x* modules is 30 m (98 ft).
- Maximum cable length (motor power and feedback) between a DSD module and a motor is 4 m (13 ft).
- Combined cable length for all ArmorKinetix modules that are connected to one PIM module is 140 m (459 ft).

The following items limit the number of ArmorKinetix modules that can be used in a system.

1. The control power load, which consists of these load sources:
   - Internal load (constant)
   - Parking brake load
2. The continuous and intermittent load on the DC bus of all modules.

PIM Module Guidelines

Mounting

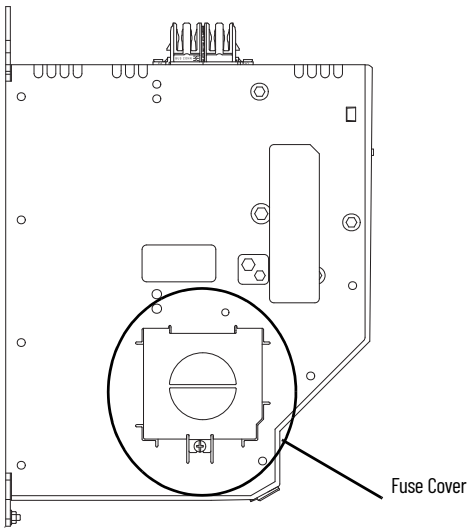
- To comply with UL, CE, and UK requirements, the ArmorKinetix power interface module (PIM) must be part of a Kinetix 5700 system that is enclosed in a grounded conductive enclosure rated IP20 minimum protection as defined in EN/IEC 60529 such that it is not accessible to an operator or unskilled person. The Kinetix 5700 system enclosure provides UL Type 1 and IP66 protection.
- The panel installed inside the enclosure for mounting the system components must be on a flat, rigid, vertical surface that is not subjected to shock, vibration, moisture, oil mist, dust, or corrosive vapors.
- Size the enclosure so as not to exceed the maximum ambient temperature rating. Consider heat dissipation specifications for all components.
- Use high-frequency (HF) bonding techniques to connect the modules, enclosure, machine frame, and motor housing, and to provide a low-impedance return path for high-frequency (HF) energy and reduce electrical noise.

See the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001, to better understand the concept of electrical noise reduction.

Fuses

The 2198-PIM070 module uses internal fuses (see Figure 10) for short-circuit protection of the DC bus. The recommended fuse is Bussmann FWP-50A14Fa.

Figure 10 - PIM Fuse Location



Enclosure Selection

Heat dissipation of the PIM module is shown in and Table 6. To size the enclosure you need heat dissipation data from all equipment inside the enclosure (such as the Logix controller, PIM module, and other Kinetix 5700 modules). Once the total amount of heat dissipation (in watts) is known, you can calculate the minimum enclosure size.

Table 6 - Power Dissipation Specifications - Percent of PIM Module Control Power

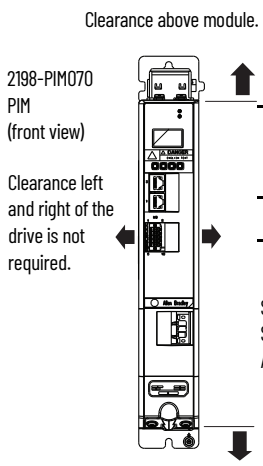
Control Power Input	Power Dissipation as % of PIM Module Control Power Output Rating Watts[1]					Heat Dissipation Formulas [2]
Input Voltage DC	**20%**	**40%**	**60%**	**80%**	**100%**	
24V	10	15	19	24	29	Y = 23.5*x* + 5.3

(1) Power output rating of 100% is 4 A at 58V output (applicable when 3-phase is not present).
(2) *x* is percent of PIM module control power output rating: any value from 0.0...1.0.

Minimum Clearance

This section provides information to assist you in sizing your cabinet and positioning your ArmorKinetix PIM module:

- Additional clearance is required for cables and wires or the shared-bus connection system connected to the top of the drive.
- Additional clearance is required if other devices are installed above and/or below the drive and have clearance requirements of their own.
- Additional clearance left and right of the drive is required when mounted adjacent to noise sensitive equipment or clean wire ways.
- The recommended minimum cabinet depth is 300 mm (11.81 in.).



Drive Cat. No.	Clearance Above mm (in.)	Clearance Below mm (in.)
2198-PIM070	40 (1.57)	40 (1.57)

See the Kinetix 5700, 5500, 5300, and 5100 Servo Drives Specifications Technical Data, publication KNX-TD003, for ArmorKinetix PIM module dimensions.

Distributed Servo Drive and Distributed Servo Motor Module Guidelines

The DS*x* module can mount in any orientation without derating. DS*x* module installation must comply with all local regulations and use of equipment and installation practices that promote safety and electromagnetic compatibility.

All DS*x* modules include a mounting pilot for aligning the module on a machine. Recommended mounting screws are stainless steel, size M5. Tighten the mounting screws to 6.4 N•m (57 lb•in).

ATTENTION: Unmounted motors, disconnected mechanical couplings, loose shaft keys, and disconnected cables are dangerous if power is applied. Identify (tag-out) disassembled equipment and restrict access to (lock-out) the electrical power.
Before applying power to the motor, remove the shaft key and other mechanical couplings that could be thrown from the shaft.

ATTENTION: Verify that cables are installed and restrained to prevent uneven tension or flexing at the connector. Provide support at 3 m (10 ft) intervals throughout the cable run.
Excessive and uneven lateral force at the cable connector can result in the connector's environmental seal opening and closing as the cable flexes.

BURN HAZARD: Outer surfaces of the DSD module can reach high temperatures, 80 °C (176 °F), during operation.
Outer surfaces of the DSM module can reach high temperatures, 125 °C (275 °F), during motor operation.

Take precautions to prevent accidental contact with hot surfaces. Consider module surface temperature when selecting motor mating connections and cables.

Failure to observe these safety procedures could result in personal injury or damage to equipment.

Additionally, consider the following items:

- Obtain the specified DSM thermal rating by mounting the module on a surface with heat dissipation equivalent to a aluminum heatsink of the following size:
  - For DSM modules of frame size 100...130: 304.8 x 304.8 x 12.7 mm (12 x 12 x 0.5 in.)
  - For DSM modules of frame size 75: 254 x 254 x 6.25 mm (10 x 10 x 0.25 in.)
- Do not install the motor with DSD module or DSM module in an area with restricted airflow, and keep other devices that produce heat away from the motor.

Accessory Module Selection

These are the requirements for accessory modules.

Table 7 - Introduction to ArmorKinetix Accessory Modules

Accessory Module Cat. No.	Accessory Module	Description
2198T-W25K-P-T	Control power T-connector	Use the shared-bus connection system to extend AC input power, 24V control power, and DC-bus power from drive-to-drive in shared-bus multi-axis configurations.
2198-BARCON-55DC200	DC-bus link, 55 mm, 208 A	DC-bus link kits are used to extend DC-bus power from drive-to-drive in DC-bus multi-axis configurations. DC-bus links are rated for 208 A, maximum bus-bar current.
2198-CAPMOD-2240	Capacitor Module	Use for energy storage and to extend the DC-bus voltage to another inverter cluster. Modules are zero-stacked with servo drives and use the shared-bus connection system to extend the external DC-bus voltage in applications up to 104 A. Can parallel with itself or with another accessory module for up to 208 A.
2198-CAPMOD-DCBUS-IO	Extension Module	The extension module, paired with a capacitor module or DC-bus conditioner module, is used to extend the DC-bus voltage to another inverter cluster in systems with ≥104 A current and up to 208 A.
2198-DCBUSCOND-RP312	DC-bus Conditioner Module	Decreases the voltage stress on insulation components in an inverter system with long cable lengths and used to extend the DC-bus voltage to another inverter cluster. Modules are zero-stacked with servo drives and use the shared-bus connection system to extend the external DC-bus voltage in applications up to 104 A. Can parallel with itself or with another accessory module for applications up to 208 A.

On the following pages (by power supply) are system configurations showing which accessory modules are required. The examples account for single (power supply) clusters, extended clusters, maximum system current, the input-power ground configuration, and total motor-cable length.

DC-bus Power Supply Systems

The following system configurations illustrate the minimum number of accessory modules required.

Figure 11 - DC-bus Power Supply Example/Extended Cluster (104 A, max)

This example includes:
- 3 Secondary Bus groups
- 2 Drive clusters

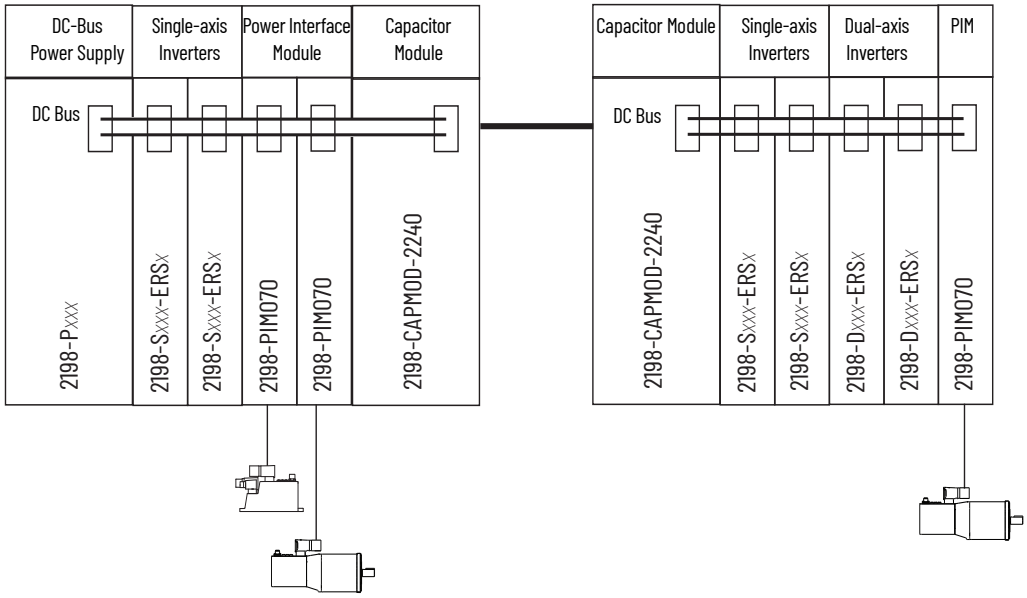
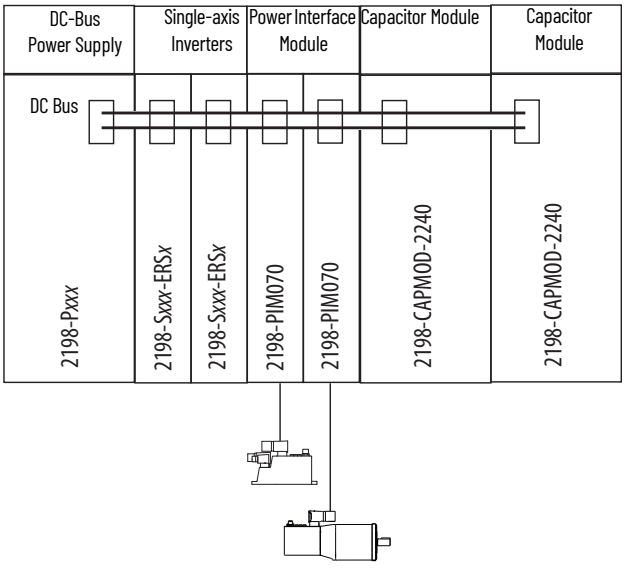


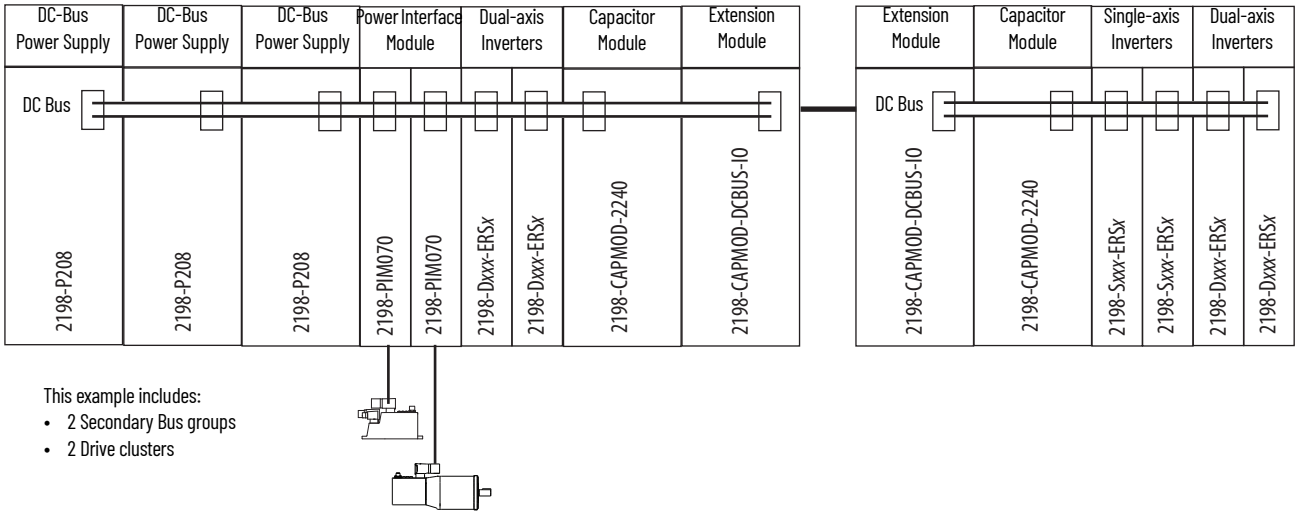
Figure 12 - DC-bus Power Supply Example/Multiple Capacitor Modules

This example includes:
- 2 Secondary Bus groups
- 1 Drive cluster



IMPORTANT In both of these examples, the Kinetix 5700 drive system with ArmorKinetix PIM module includes two accessory modules per cluster. Flexible bus bars are included with only the 2198-CAPMOD-DCBUS-IO extension module. So, if you have two capacitor modules, two DC-bus conditioner modules, or a capacitor module and DC-bus conditioner module mounted side by side, you must order the 2198-KITCON-CAPMOD2240 or 2198-KITCON-DCBUSCOND connector set separately.

Figure 13 - Multiple DC-bus Power Supply Example/Extended Cluster (208 A, max)



IMPORTANT The systems that are shown are typical. The maximum number of inverter modules depends on the maximum system capacitance precharge capability of the power supply. With multiple 2198-P208 modules, there is more precharge capability. When there are two or three DC-bus power supplies, they must be catalog number 2198-P208.

Refer to Appendix B on page 189 for more system sizing information.

IMPORTANT The regenerative bus supply is not compatible with the ArmorKinetix system.

In-cabinet Electrical Noise Reduction

See the Kinetix 5700 Servo Drives User Manual, publication 2198-UM002, for information on best practices that minimize the possibility of noise-related failures as they apply specifically to Kinetix 5700 and ArmorKinetix system installations. For more information on the concept of high-frequency (HF) bonding, the ground plane principle, and electrical noise reduction, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

HF Bond for Modules

Bonding is the practice of connecting metal chassis, assemblies, frames, shields, and enclosures to reduce the effects of electromagnetic interference (EMI).

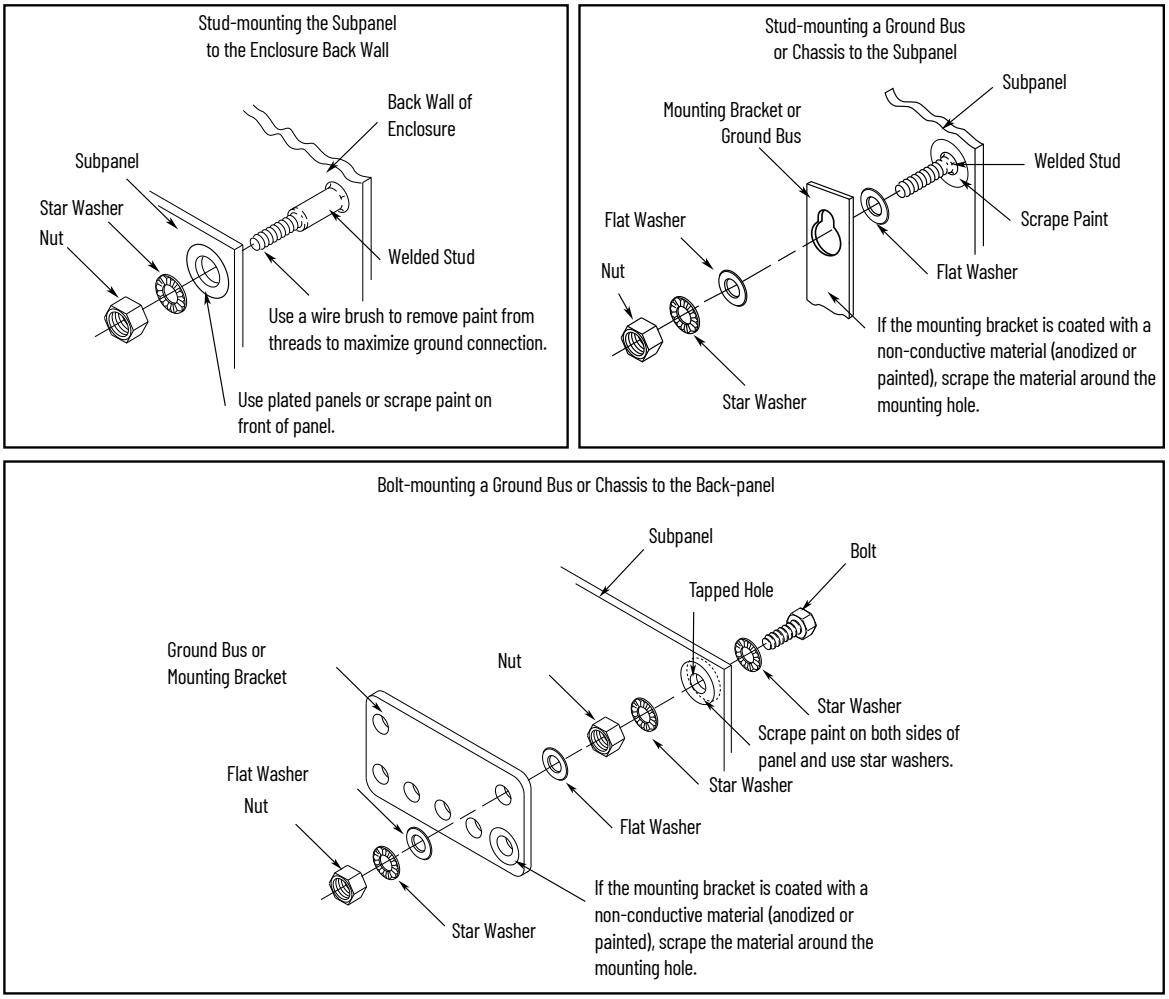
Unless specified, most paints are not conductive and act as insulators. To achieve a good bond between the in-cabinet drive module and subpanel, surfaces need to be paint-free or plated. Bonding metal surfaces creates a low-impedance return path for high-frequency energy.

IMPORTANT To improve the bond between the in-cabinet module and subpanel, construct your subpanel out of zinc plated (paint-free) steel.

Improper bonding of metal surfaces blocks the direct return path and allows high-frequency energy to travel elsewhere in the cabinet. Excessive high-frequency energy can effect the operation of other microprocessor controlled equipment.

These illustrations show details of recommended bonding practices for painted panels, enclosures, and mounting brackets.

Figure 14 - Recommended Bonding Practices for Painted Panels

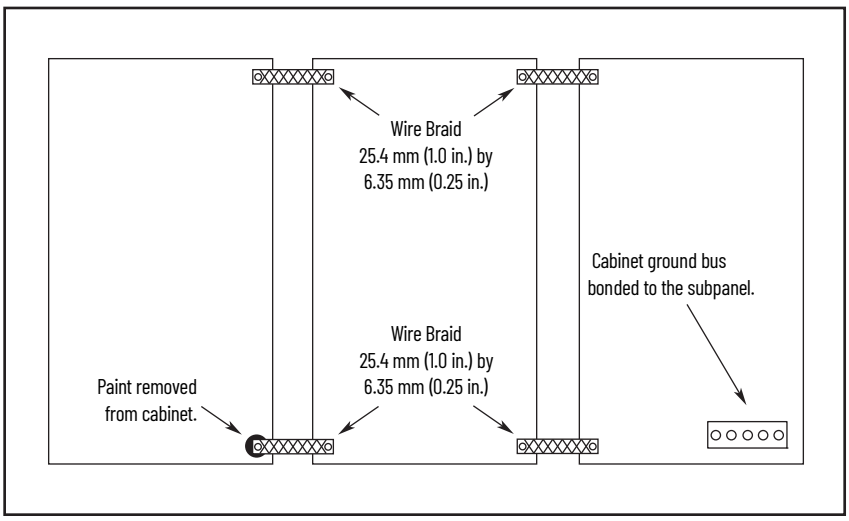


HF Bond for Multiple Subpanels

Bonding multiple subpanels creates a common low impedance exit path for the high-frequency energy inside the cabinet. Subpanels that are not bonded together do not necessarily share a common low impedance path. This difference in impedance can affect networks and other devices that span multiple panels:

- Bond the top and bottom of each subpanel to the cabinet by using 25.4 mm (1.0 in.) by 6.35 mm (0.25 in.) wire braid. As a rule, the wider and shorter the braid is, the better the bond.
- Scrape the paint from around each fastener to maximize metal-to-metal contact.

Figure 15 - Multiple Subpanels and Cabinet Recommendation



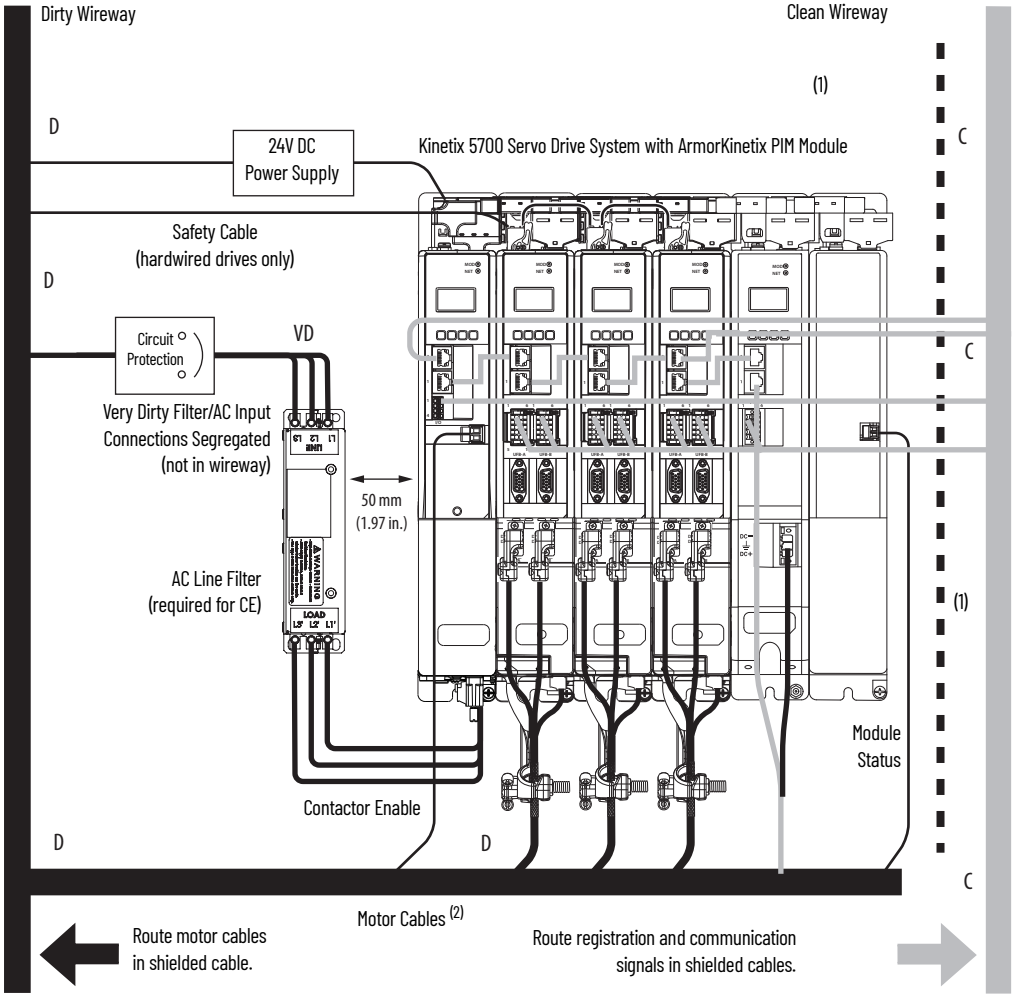
Establish Noise Zones

The Kinetix 5700 DC-bus system power can be supplied by the 2198-P*xxx* DC-bus power supply.

Observe these guidelines when routing cables used with the ArmorKinetix PIM module:

- The clean zone (C) is right of the drive system and includes the digital inputs wiring and Ethernet cable (gray wireway).

Figure 16 - Noise Zones (DC-bus power supply)



(1) When space to the right of the module does not permit 150 mm (6.0 in.) segregation, use a grounded steel shield instead. For examples, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.
(2) When the 2198-H2DCK feedback converter kit or 2198-K57CK-D15M universal feedback kit is used, feedback cable routes in the clean wireway.

Cable Categories for ArmorKinetix Systems

These tables indicate the best zone for running cables and wires. The tables also show how the use of ferrite sleeves and shielded cable can reduce the noise effects of dirty and very-dirty wires and cables.

Table 8 - DC-bus Power Supply

Wire/Cable	Power Supply Cat. No.	Connector	Zone			Method	
			Very Dirty	Dirty	Clean	Ferrite Sleeve	Shielded Cable
L1, L2, L3 (shielded cable)	2198-P*xxx*	IPD	–	X	–	–	X
L1, L2, L3 (unshielded cable)			X	–	–	–	–
DC-/DC+ (DC bus)	2198-P*xxx*	DC	Bus-bar only, no wiring connector.				
DC+/SH (passive shunt)	2198-P*xxx*	RC	–	X	–	–	–
CONT EN– and CONT EN+ (M1 contactor)	2198-P*xxx*	CED	–	X	–	–	–
24V DC	2198-P*xxx*	CP	–	X	–	–	–
Dedicated digital inputs	2198-P*xxx*	IOD	–	X	–	–	–
Ethernet (shielded cable)	2198-P*xxx*	PORT1 PORT2	–	–	X	–	X

Table 9 - PIM Modules

Wire/Cable	Connector	Zone			Method	
		Very Dirty	Dirty	Clean	Ferrite Sleeve	Shielded Cable
DC-/DC+ (DC bus)	DC	Bus-bar only, no wiring connector.				
24V DC	CP	–	X	–	–	–
Hybrid cable from PIM to DS*x*	PC	–	X	–	–	–
Registration input	IOD	–	–	X	–	X
Dedicated digital inputs (other than registration inputs)		–	X	–	–	–
Ethernet (shielded cable)	PORT1 PORT2	–	–	X	–	X

Table 10 - Capacitor Module or DC-bus Conditioner Module

Wire/Cable	Connector	Zone			Method	
		Very Dirty	Dirty	Clean	Ferrite Sleeve	Shielded Cable
DC-/DC+ (DC bus)	DC	Bus-bar only, no wiring connector.				
DC-/DC+	M8 Stud	–	X	–	–	–
24V DC	CP	–	X	–	–	–
Module status	MS	–	X	–	–	–

Table 11 - Extension Module

Wire/Cable	Connector	Zone			Method	
		Very Dirty	Dirty	Clean	Ferrite Sleeve	Shielded Cable
DC-/DC+ (DC bus)	DC	Bus-bar only, no wiring connector.				
DC-/DC+	M8 Stud	–	X	–	–	–

Mount the ArmorKinetix System

This chapter provides installation procedures for mounting your ArmorKinetix® PIM module to the system panel and installing DC-bus links and 24V shared-bus connector kits to the module. Installation information is also provided for mounting the ArmorKinetix DSD and DSM modules.

This procedure assumes that you have prepared your panel and understand how to bond your system. For installation instructions regarding equipment and accessories not included here, refer to the instructions that came with those products.

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

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

In-cabinet Modules

The ArmorKinetix PIM, Kinetix® 5700 DFE module, and an optional capacitor module are mounted in the enclosure.

Determine Mounting Order

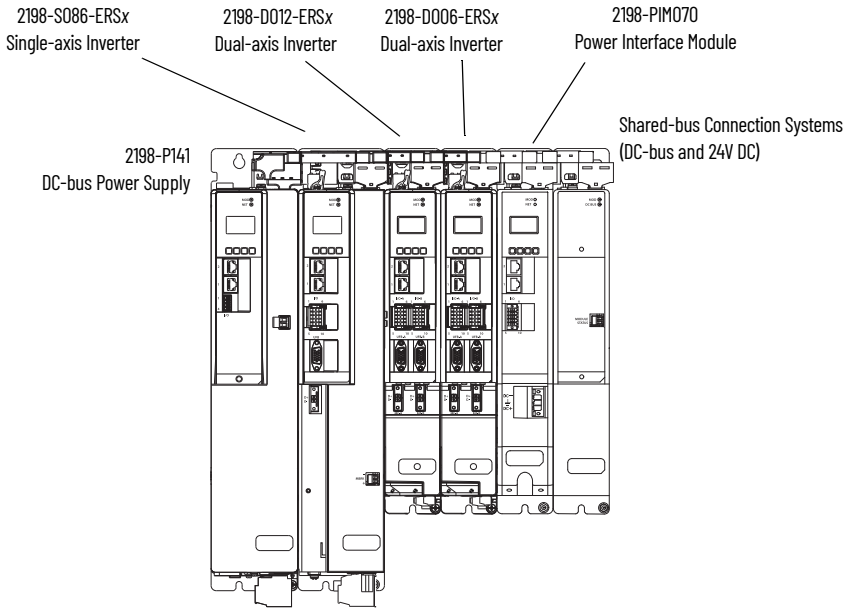
Mount the DC-bus power supply on the far right or far left, whichever makes the best use of panel space. See Figure 17 for an example.

IMPORTANT The PIM module can be placed anywhere left or right from the power supply. We recommend that you mount inverter modules according to power rating (highest to lowest) from left to right (or right to left) starting with the highest power rating.

Table 12 - ArmorKinetix System Single-axis Inverter Modules

Attribute	2198-PIM	2198-DSD016-ERSx	2198-DSD024-ERSx
Continuous Power Output, nom (200V)	8.0 kW	1.8 kW	2.7 kW
Continuous Power Output, nom (400V)	16.0 kW	3.5 kW	5.5 kW

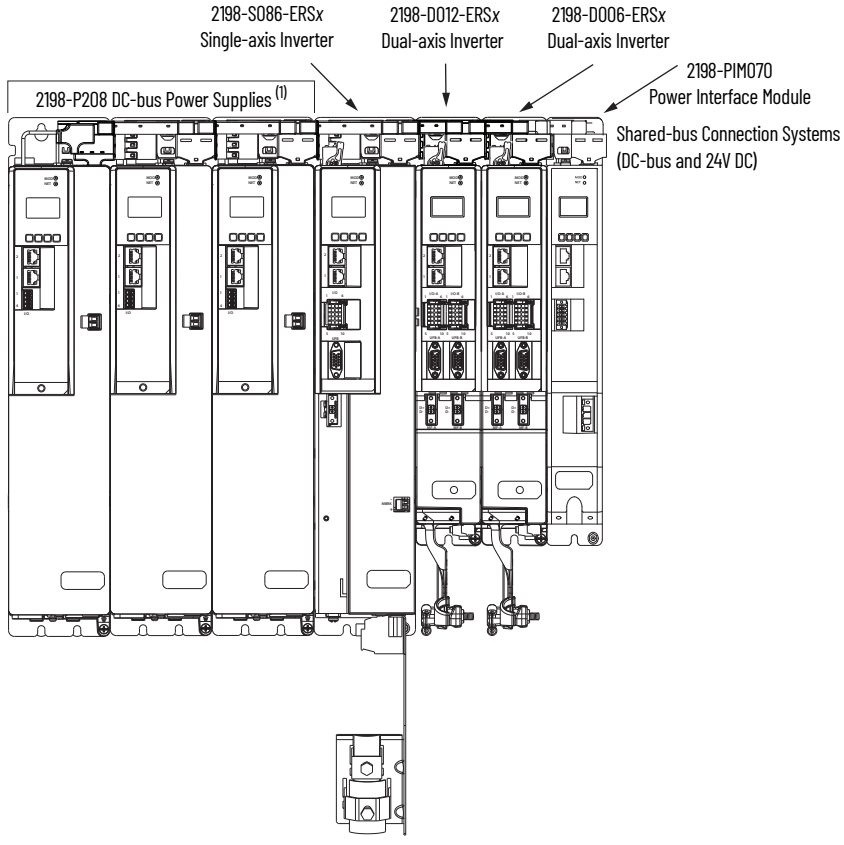
Figure 17 - System Mounting Order Example (single DC-bus power supply)



IMPORTANT The maximum number of inverter modules depends on the maximum system capacitance precharge capability of the power supplies and the total system capacitance. When there are two or three DC-bus power supplies, they must be catalog number 2198-P208.

Refer to Appendix B on page 189 for more system sizing information.

Figure 18 - System Mounting Order Example (multiple DC-bus power supplies)



(1) The DC-bus power supplies can be left or right of the inverters.

IMPORTANT The maximum number of in-cabinet inverter modules depends on the maximum system capacitance precharge capability of the power supply and the total system capacitance.

Refer to Appendix B on page 189 for more system sizing information.

Mount Capacitor Modules

Mount the 2198-CAPMOD-2240 capacitor module on the far right or far left of any system cluster, depending on the input power configuration. A capacitor module is required in the following situations:

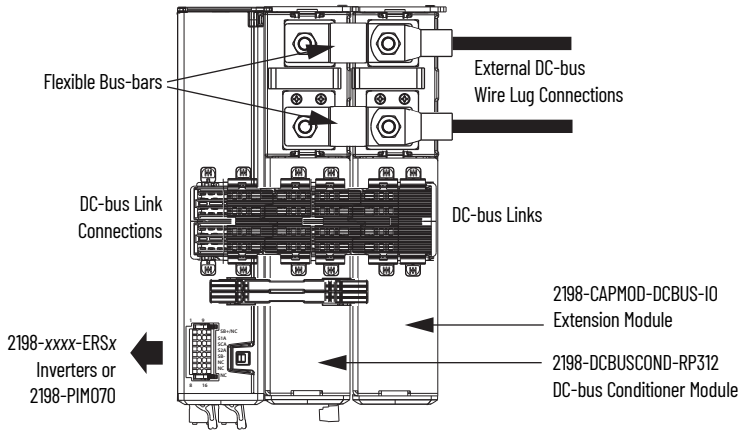
- Required in each cluster of a multi-cluster system
- More than one capacitor module can be used in a cluster, if needed

IMPORTANT Each additional capacitor module adds to the total system capacitance and increased energy storage.

The 2198-CAPMOD-DCBUS-IO extension module is always mounted next to a capacitor module or DC-bus conditioner module and always positioned on the outside of the system cluster (either first or last). The extension module can be paired with another accessory module and flexible bus-bars if external DC-bus current is ≥104 A up to a maximum of 208 A.

IMPORTANT When the extension module is mounted next to another accessory module, they must be connected by flexible bus-bars.

Figure 19 - Flexible Bus Bar Example



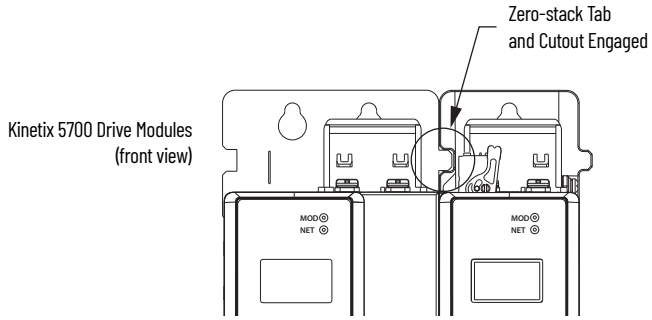
IMPORTANT In a multi-cluster system with a power supply rated ≥104 A, two accessory modules connected by flexible bus-bars must be used to create a 208 A extended cluster system.

Zero-stack Tab and Cutout

Engaging the zero-stack tab and cutout from one drive module to another makes efficient use of panel space, especially for high axis-count installations.

IMPORTANT Engaging the zero-stack tab and cutout from module-to-module is required for any input power configuration. This is done to make sure that the DC-bus connectors are spaced properly to accept the shared-bus connection system.

Figure 20 - Zero-stack Tab and Cutout Example



For ArmorKinetix system sizing examples, refer to Appendix B on page 189.

Drill-hole Patterns for In-cabinet Modules

This section provides drill-hole patterns for Kinetix 5700 drive modules that are mounted in zero-stack (shared-bus) configurations. Properly spaced drill-holes are essential for engaging the zero-stack tab and cutout from module-to-module so that the DC-bus connectors are spaced properly to accept the DC-bus links.

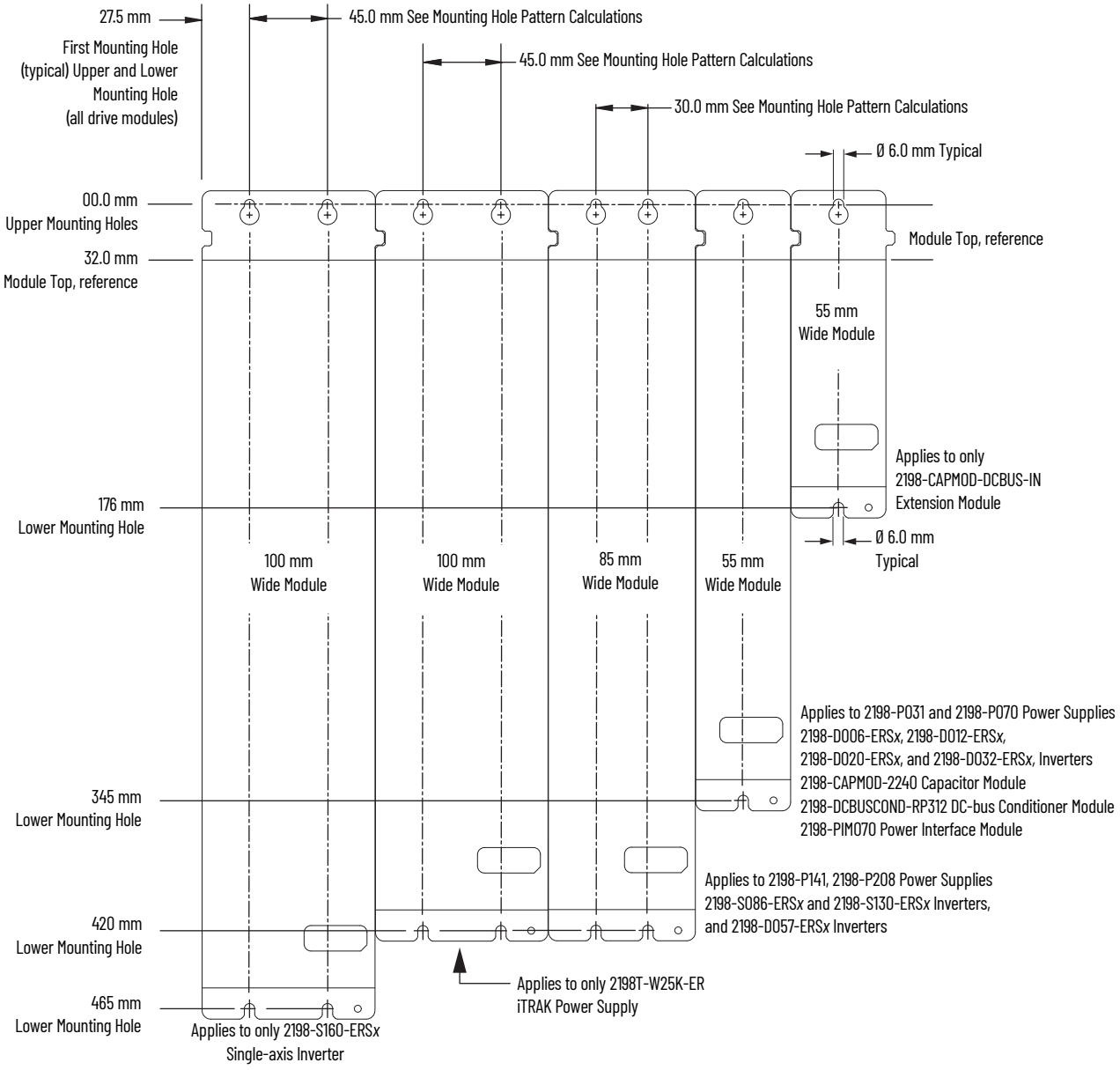
The DC-bus power supply can be mounted on the far right, far left, or anywhere in between. However, the far left position is preferred to accommodate the 24V shared bus.

Also available to assist you in mounting PIM modules is the 2198-K5700-MOUNTKIT system mounting toolkit.

Use Figure 21 to calculate the left-to-right hole pattern for Kinetix 5700 drive system configurations that include the 2198-P*xxx* DC-bus power supply and PIM modules.

1. The first hole location is zero.
2. The second hole location is module width minus 55 mm (2.16 in.).
3. The next hole location is 55 mm (2.16 in.).
4. Repeat step 2 and step 3 for the remaining holes.

Figure 21 - DC-bus Power Supply Mounting Hole Patterns

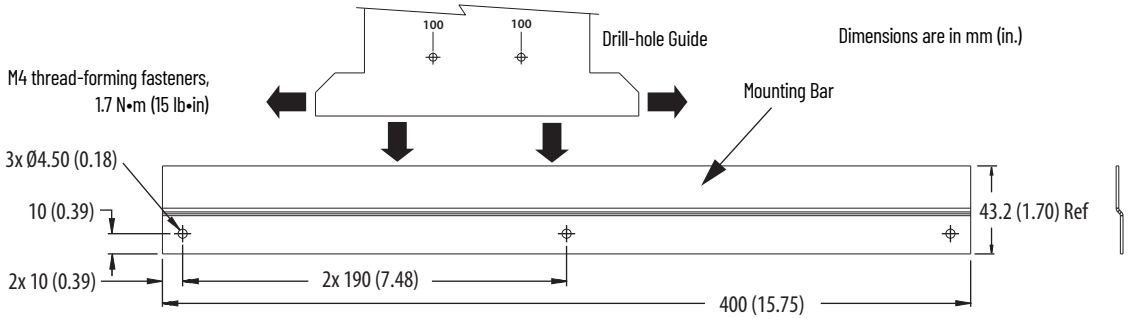


IMPORTANT Hole spacing is measured in millimeters and not converted to inches to avoid errors due to rounding.

Drill-hole Patterns by Using the System Mounting Toolkit

The mounting bar must be mounted horizontally on the system panel. The drill-hole guide inserts behind the mounting bar and slides left and right. Holes and slots in the drill-hole guide let you establish the location of each ArmorKinetix PIM module.

Figure 22 - Mounting Bar



For step-by-step instructions on how to use the system mounting toolkit, see the Kinetix 5700 System Mounting Toolkit Installation Instructions, publication 2198-IN012.

Mount the In-cabinet Modules

This procedure assumes that you have prepared your panel and understand how to bond your system. For installation instructions regarding Kinetix 5700 units, see publication 2198-UM002. For other equipment and accessories, refer to the instructions that came with those products.

Follow these steps to mount your ArmorKinetix PIM modules to the panel.

1. Lay out the hole pattern for each module in the enclosure.

   See Establish Noise Zones on page 37 for panel layout recommendations.

   IMPORTANT To improve the bond between the drive modules and subpanel, construct your subpanel out of zinc plated (paint-free) steel.

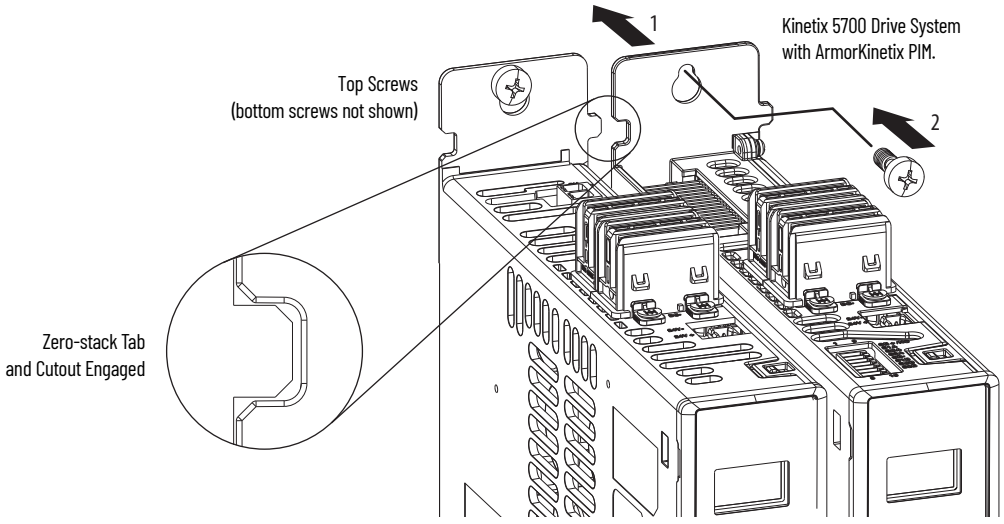
2. Drill holes in the panel for mounting your drive system.

   Refer to Drill-hole Patterns for In-cabinet Modules beginning on page 42.

3. Loosely attach the mounting hardware to the panel.

   The recommended mounting hardware is M5 (#10-32) steel bolts. Observe bonding techniques as described in HF Bond for Modules on page 34.

4. Attach the DC-bus supply (or supplies) or the regenerative bus supply to the cabinet panel.



5. Attach additional drive modules to the right or left of the previous module by using the same method, but also making sure that the zero-stack tabs and cutouts are engaged.

   Zero-stack mounting is required for all configurations. See the Zero-stack Tab and Cutout Example on page 42.

6. Tighten all mounting fasteners.

   Apply 4.0 N•m (35.4 lb•in) maximum torque to each fastener.

Install Shared-bus Connection Systems

The shared-bus connection system is used to extend the DC-bus power and 24V control power from one drive module to another.

IMPORTANT The zero-stack tab and cutout must be engaged between adjacent drive modules for the shared-bus connection system to fit properly.

DC-bus Connection System

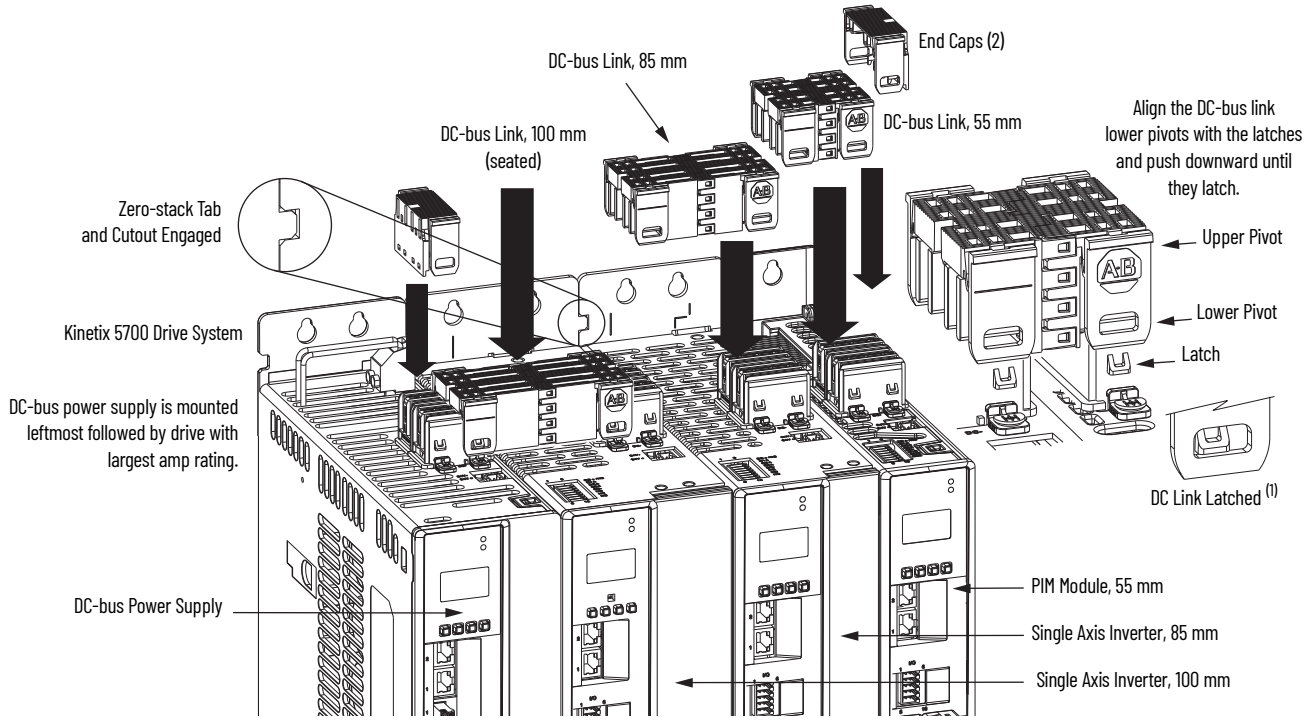
The DC-bus connection system is required and comprised of these two components:

- DC-bus links that are inserted between drive modules to extend the DC-bus from one drive module to another.

  IMPORTANT DC-bus links are included with inverter and accessory modules, so when two or three 2198-P208 DC-bus power supplies are connected in parallel, order extra 2198-BARCON-85DC200 DC-bus links.

- DC-bus end-caps that are inserted into the first and last drive modules to cover the exposed DC-bus connector on both ends of the bus.

Figure 23 - DC-bus Connector Example



(1) DC-bus links latch on both sides when inserted into the DC-bus connectors. To remove the DC-bus link, depress both sets of upper pivots to unlatch the lower pivots and hold the DC-bus link firmly while pulling upward.

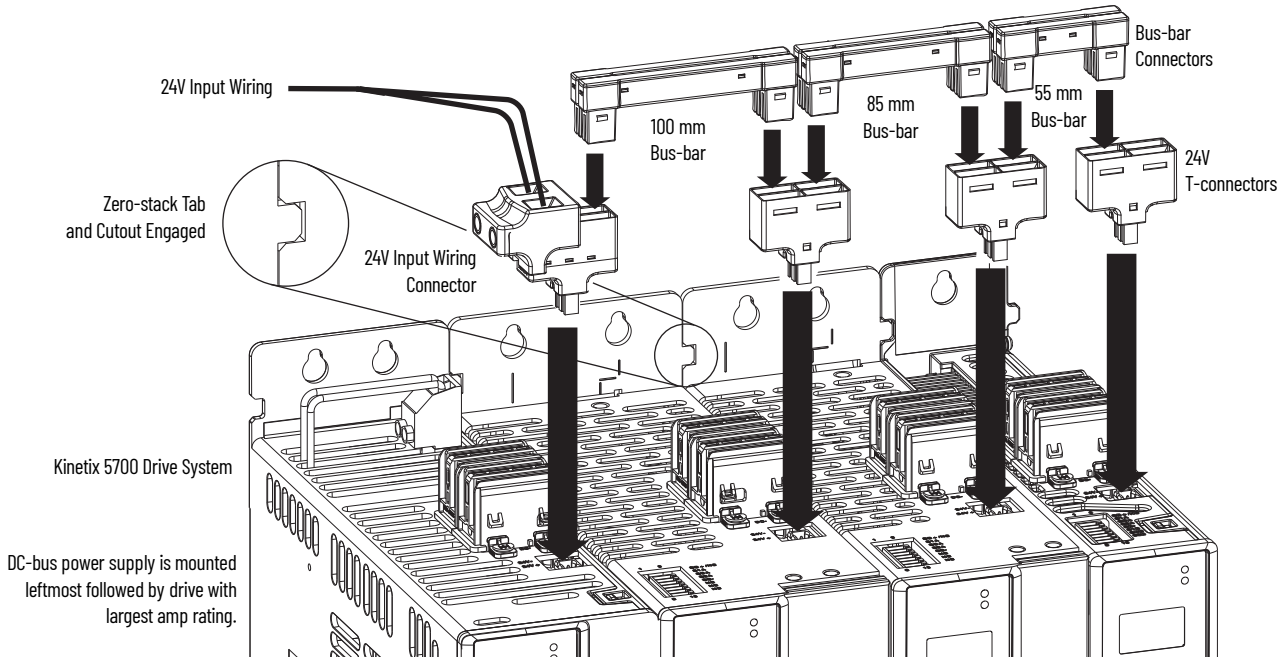
24V Input Power Connection System

The optional 24V input power connection system always feeds 24V DC from left to right and is comprised of three components:

- The 24V input wiring connector that plugs into the DC-bus power supply or first module supplied by the 24V external power receives 24V DC input wiring.
- 24V DC T-connectors that plug into the drive modules downstream from the power supply or first module supplied by the 24V external power where the 24V control power is shared.
- Bus bars that connect between drive modules to extend the 24V control power from one drive module to another.

Multiple 24V shared-bus input wiring connectors can be used in a high axis-count system. If the 40 A shared-bus current rating is exceeded, you can add another connector at any point in the cluster. PIM modules use the 2198-TCON-24VDCIN36 input wiring connector and accept up to 10 mm^2 (6 AWG) wire. The CP connectors that are included with each module accept up to 10 mm^2 (12 AWG) or 6 mm^2 (10 AWG), so the shared-bus input wiring connectors can provide the means to use larger gauge conductors for reduced voltage drop on long wire runs.

Figure 24 - 24V Connector Example



The three 24V input power components must assemble from left to right across the drive system.

1. Attach wiring to 24V input wiring connector.
2. Insert input wiring connector and T-connectors into the appropriate drive module connectors.
3. Insert bus-bars to connect between wiring connector and T-connectors.

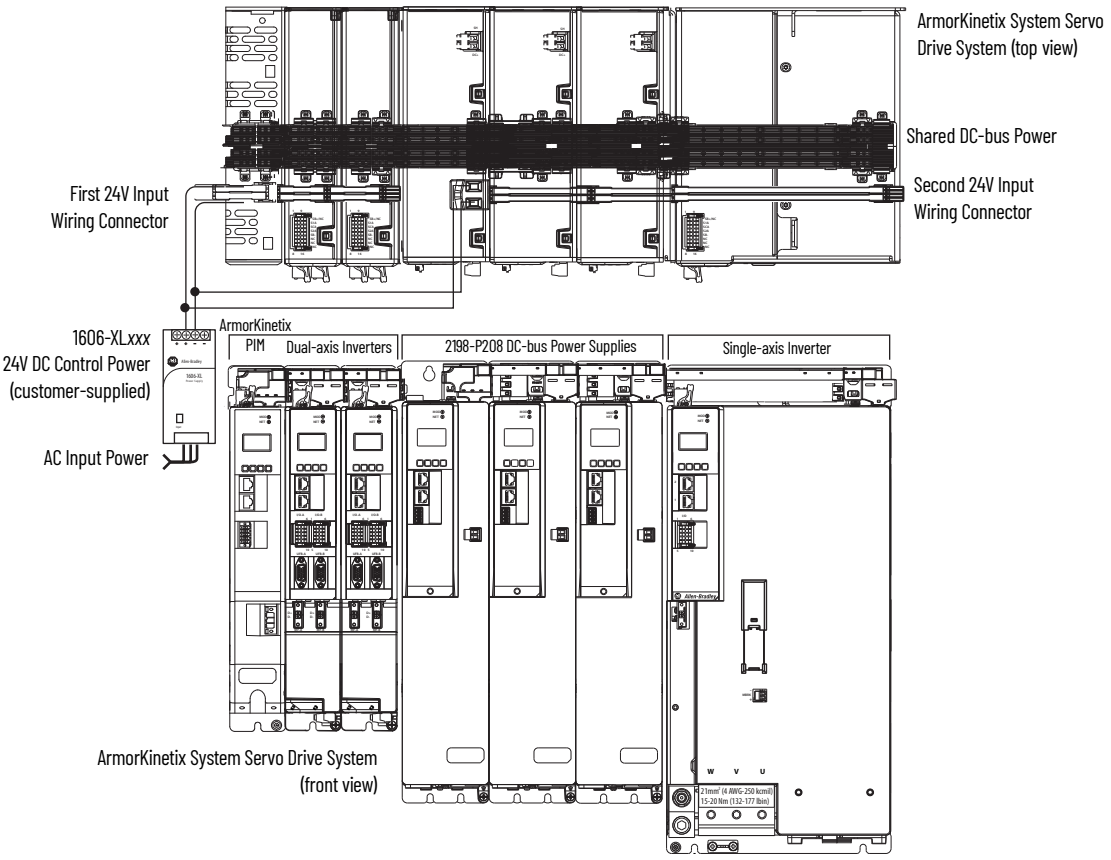
IMPORTANT The input wiring connector can be inserted into any drive module (mid-stream in the drive system) to begin a new 24V control bus when the maximum current value is reached. However, the input connector must always extend the 24V DC-bus from left to right.

IMPORTANT Mount the 24V power supply as close to the drive system as possible to minimize voltage drop on the 24V input power wiring.

If the maximum current rating exceeds 40 A, the configurations requires more than one 24V input wiring connector:

In this example, one 24V connection system spans (left to right) across the PIM module and dual-axis inverters only. In the other 24V input connection system, the 2198-S312-P-T control power T-connector and bus-bar connects the bus supply and single-axis inverter only.

Figure 25 - Multiple 24V Input Wiring Connector Example



On-machine Modules

ATTENTION: Do not attempt to open or modify the ArmorKinetix DS*x* module. This manual describes modifications that you can perform in the field. Do not attempt other changes. Only a qualified Allen-Bradley® employee can service a DS*x* module.
Failure to observe these safety procedures could result in personal injury or damage to equipment.

ATTENTION: Damage can occur to the bearings and the feedback device if a sharp impact is applied to the shaft during installation of couplings and pulleys, or to remove the shaft key. Damage to the feedback device can also result from applying leverage from the faceplate to remove devices mounted on the shaft. Do not strike the shaft, key, couplings, or pulleys with tools during installation or removal. Use a wheel puller to apply pressure from the user end of the shaft to remove any friction fit or stuck device from the shaft.

Failure to observe these safety procedures could result in damage to the DS*x* module.

ATTENTION: Unmounted DS*x* modules, disconnected mechanical couplings, loose shaft keys, and disconnected cables are dangerous, if power is applied. Disassembled equipment should be appropriately identified (tagged-out) and access to electrical power restricted (locked-out).

Before applying power, remove the shaft key and other mechanical couplings that could be thrown from the shaft.

Failure to observe these safety procedures could result in personal injury or damage to equipment.

Preferred fasteners are stainless steel. The installation must comply with all local regulations. The installer also must use equipment and installation practices that promote electromagnetic compatibility and safety.

Precautions for Mounting ArmorKinetix DSD and DSM Modules

ATTENTION: Arcing or unexpected motion can occur if cables are connected or disconnected while power is applied to the DS*x* module. Before working on the system, disconnect power and wait the full time interval indicated on the PIM module warning label or verify the DC bus voltage at the PIM module measures less than 60V DC.
Failure to observe this precaution could result in severe bodily injury or loss of life, and damage to the product will occur.

ATTENTION: Do not strike the shaft, couplings, or pulleys with tools during installation or removal.
Damage can occur to the motor bearings and the feedback device if you apply a sharp impact to the shaft during installation of couplings and pulleys, or a shaft key.

Failure to observe these safety procedures could result in damage to the motor and its components.

ATTENTION: The DS*x* module is not for direct connection to an AC power line. DS*x* modules are designed for connection to a PIM module that controls the application of power.

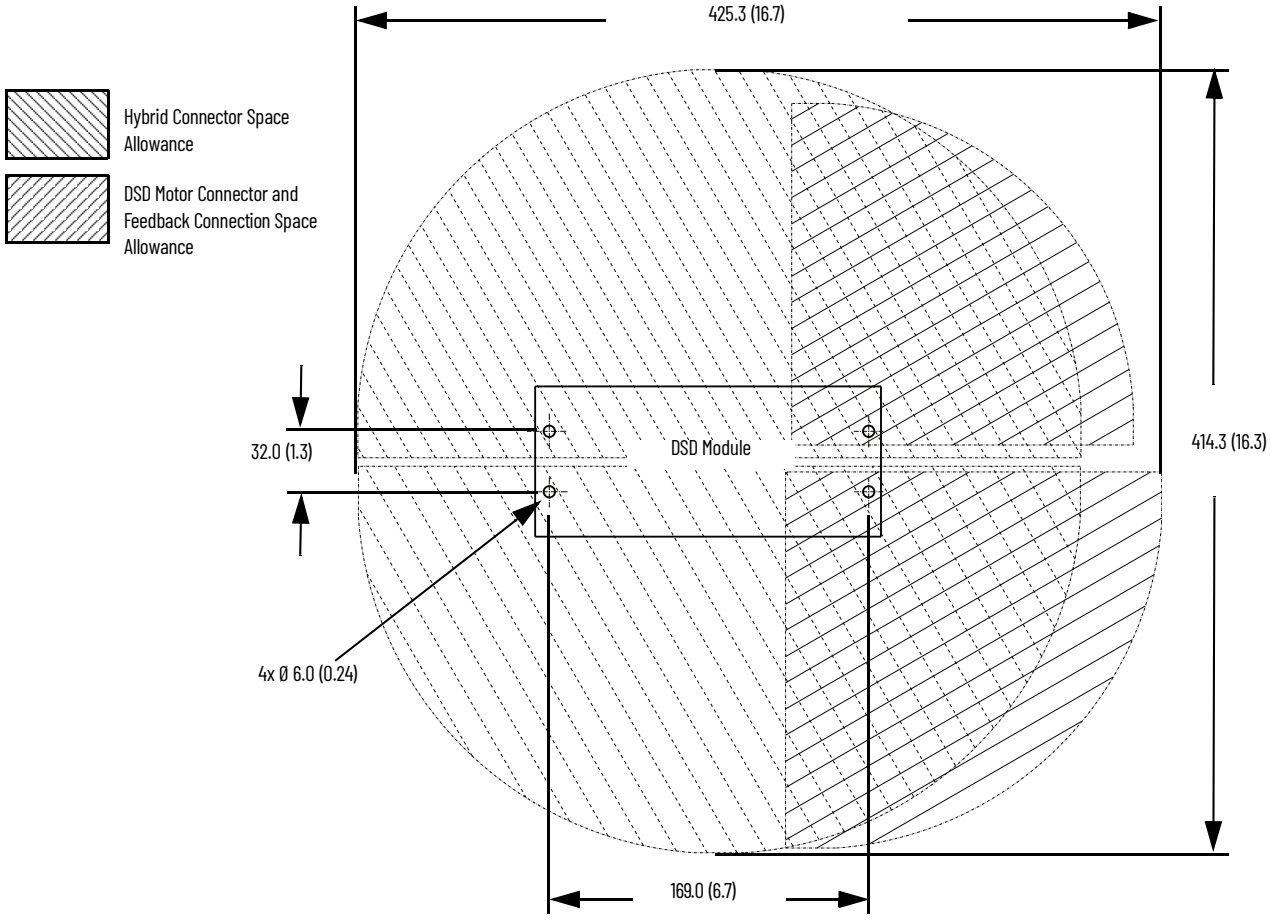
Failure to observe these safety precautions could result in damage to the motor and equipment.

Drill Hole Patterns for ArmorKinetix DSD Modules

This diagram shows the location of the mounting holes on the DSD module and the connector space allowance.

IMPORTANT The mounting template is not to scale. Dimensions are in mm (in.).

Figure 26 - DSD Mounting Template



Mount the DSD Module

ArmorKinetix DSD module installation must comply with all local regulations and use of equipment and installation practices that promote safety and electromagnetic compatibility:

- All DSD modules include a mounting pilot holes for aligning the module on a machine.
- Recommended mounting screws are stainless steel, size M5.
  Tighten the mounting screws to 6.4 N•m (57 lb•in).

Mount the DSD module on any surface and in any orientation.

ATTENTION: Unmounted motors, disconnected mechanical couplings, loose shaft keys, and disconnected cables are dangerous if power is applied. Identify (tag-out) disassembled equipment and restrict access to (lock-out) the electrical power.
Before applying power to the motor, remove the shaft key and other mechanical couplings that could be thrown from the shaft.

ATTENTION: Verify that cables are installed and restrained to prevent uneven tension or flexing at the connector. Provide support at 3 m (10 ft) intervals throughout the cable run.
Excessive and uneven lateral force at the cable connector can result in the connector's environmental seal opening and closing as the cable flexes.

ATTENTION: Connectors are designed to be rotated into a fixed position during motor installation, and remain in that position without further adjustment. Strictly limit the applied forces and the number of times the connector is rotated to make sure that connectors meet the specified IP ratings.
Apply force only to the connector and cable plug. Do not apply force to the cable extending from the cable plug. No tools, for example pliers or vise-grips, should be used to assist with the rotation of the connector.

Failure to observe safety precautions could result in damage to the DSD module and its components.

1. Position the DSD module on the machine in any position.
2. Properly mount and align the DSD module using stainless steel bolts.

Drill Hole Patterns for ArmorKinetix DSM Modules

This diagram shows the location and size of the mounting holes on the DSM module.

Figure 27 - DSM Dimensions, 75 mm Frame Size

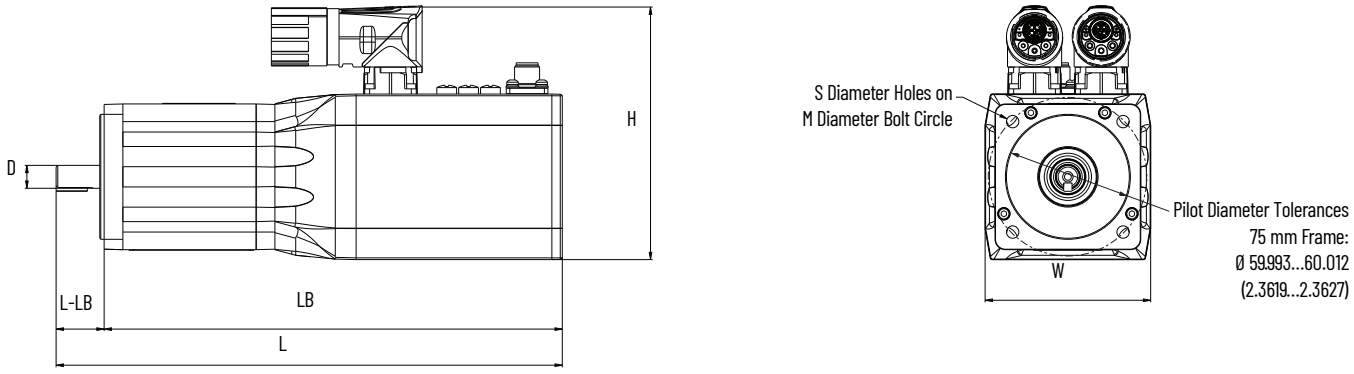


Table 13 - DSM Dimensions Table, 75 mm Frame Size

Cat. No.	L mm (in.)	LB mm (in.)	L-LB mm (in.)	H mm (in.)	W mm (in.)	D mm (in.)	M mm (in.)	S mm (in.)
2198-DSM*xxx*-ERS*x*-x0751 without brake	244.8 (9.64)	221.8 (8.73)	23.0 (0.91)	121.9 (4.80)	79.5 (3.13)	11.0 (0.43)	75.0 (2.953)	5.95 (0.23)
2198-DSM*xxx*-ERS*x*-x0751 with brake	275.4 (10.84)	252.4 (9.94)						
2198-DSM*xxx*-ERS*x*-x0752 without brake	269.8 (10.62)	246.8 (9.72)						
2198-DSM*xxx*-ERS*x*-x0752 with brake	300.4 (11.83)	277.4 (10.92)						
2198-DSM*xxx*-ERS*x*-x0753 without brake	294.8 (11.61)	271.8 (10.70)						
2198-DSM*xxx*-ERS*x*-x0753 with brake	325.4 (12.81)	302.4 (11.91)						

Figure 28 - DSM Dimensions, 100 mm Frame Size

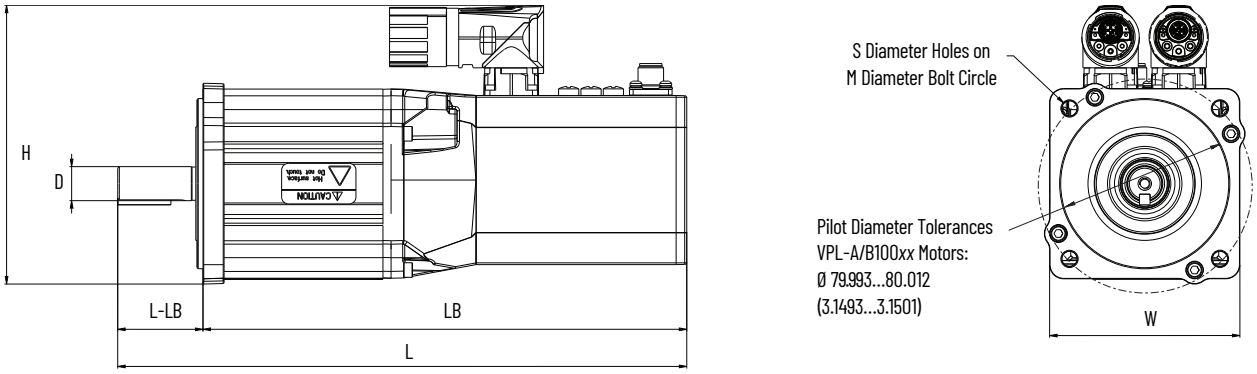


Table 14 - DSM Dimensions Table, 100 mm Frame Size

STACK SIZE	L mm (in.)	LB mm (in.)	L-LB mm (in.)	H mm (in.)	W mm (in.)	D mm (in.)	M mm (in.)	S mm (in.)
2198-DSM*xxx*-ERS*x*-x1001 without brake	269.7 (10.62)	229.7 (9.04)	40.0 (1.57)	126.4 (4.98)	89.4 (3.52)	16.0 (0.63)	100.0 (3.937)	7.2 (0.28)
2198-DSM*xxx*-ERS*x*-x1001 with brake	304.2 (11.98)	264.2 (10.40)						
2198-DSM*xxx*-ERS*x*-x1002 without brake	295.1 (11.62)	255.1 (10.04)						
2198-DSM*xxx*-ERS*x*-x1002 with brake	329.6 (12.98)	289.6 (11.40)						
2198-DSM*xxx*-ERS*x*-x1003 without brake	320.5 (12.62)	280.5 (11.04)						
2198-DSM*xxx*-ERS*x*-x1003 with brake	355.0 (13.98)	315.0 (12.40)						

Figure 29 - DSM Dimensions, 115 mm Frame Size

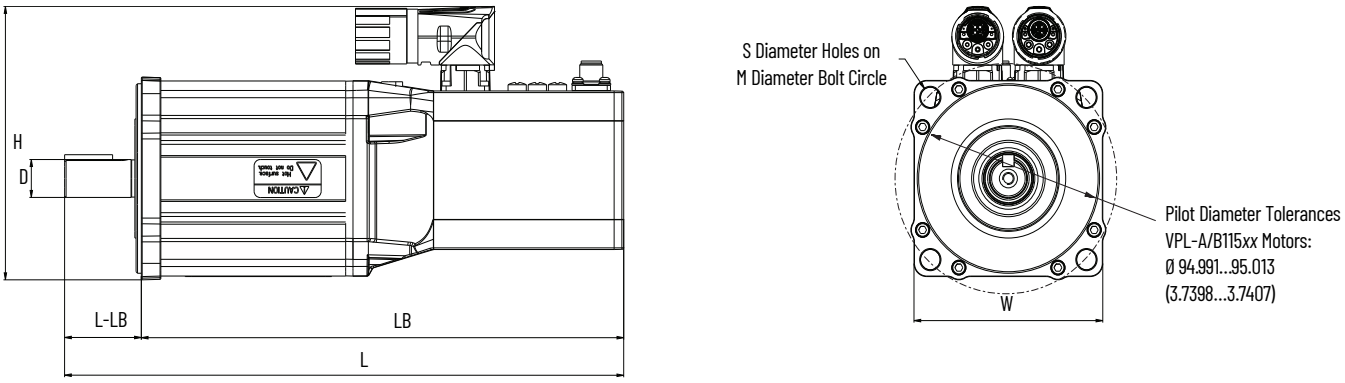


Table 15 - DSM Dimensions Table, 115 mm Frame Size

STACK SIZE	L mm (in.)	LB mm (in.)	L-LB mm (in.)	H mm (in.)	W mm (in.)	D mm (in.)	M mm (in.)	S mm (in.)
2198-DSM*xxx*-ERS*x*-x1152 without brake	291.5 (11.48)	251.5 (9.90)	40.0 (1.57)	137.1 (5.40)	98.3 (3.87)	19.0 (0.75)	115.0 (4.528)	10.2 (0.40)
2198-DSM*xxx*-ERS*x*-x1152 with brake	340.0 (13.39)	300.0 (11.81)						
2198-DSM*xxx*-ERS*x*-x1153 without brake	316.9 (12.48)	276.9 (10.90)						
2198-DSM*xxx*-ERS*x*-x1153 with brake	365.4 (14.39)	325.4 (12.81)						

Figure 30 - DSM Dimensions, 130 mm Frame Size

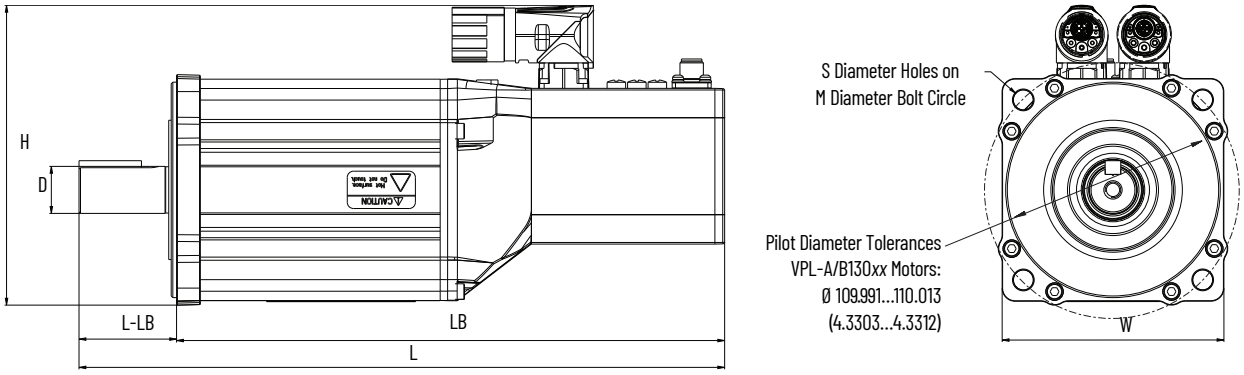


Table 16 - DSM Dimensions Table, 130 mm Frame Size

STACK SIZE	L mm (in.)	LB mm (in.)	L-LB mm (in.)	H mm (in.)	W mm (in.)	D mm (in.)	M mm (in.)	S mm (in.)
2198-DSM*xxx*-ERS*x*-x1303 without brake	330.2 (13.00)	280.2 (11.03)	50.0 (1.97)	153.1 (6.03)	113.7 (4.48)	24.0 (0.94)	130.0 (5.118)	10.2 (0.40)
2198-DSM*xxx*-ERS*x*-x1303 with brake	378.7 (14.91)	328.7 (12.94)						
2198-DSM*xxx*-ERS*x*-x1304 without brake	355.6 (14.00)	305.6 (12.03)						
2198-DSM*xxx*-ERS*x*-x1304 with brake	404.1 (15.91)	354.1 (13.94)						
2198-DSM*xxx*-ERS*x*-x1306 without brake	406.4 (16.00)	356.4 (14.03)						
2198-DSM*xxx*-ERS*x*-x1306 with brake	454.9 (17.91)	404.9 (15.94)						

Mount the DSM Module

Motor installation must comply with all local regulations and use of equipment and installation practices that promote safety and electromagnetic compatibility:

- All DSM modules include a mounting pilot for aligning the DSM module on a machine.
- Preferred fasteners are stainless steel.

ATTENTION: Unmounted DSM modules, disconnected mechanical couplings, loose shaft keys, and disconnected cables are dangerous if power is applied. Identify (tag-out) disassembled equipment and restrict access to (lock-out) the electrical power.
Before applying power to the DSM modules, remove the shaft key and other mechanical couplings that could be thrown from the shaft.

ATTENTION: Verify that cables are installed and restrained to prevent uneven tension or flexing at the connector. Provide support at 3 m (10 ft) intervals throughout the cable run.
Excessive and uneven lateral force at the cable connector can result in the connector environmental seal opening and closing as the cable flexes.

Change Connector Orientation

DSM modules use a connector style that integrates the power, and feedback signals within a single connector. You can rotate the connector 325°. The rotatable connector housing lets you move the connector into a position that best protects the connection from environmental contaminates and provides easy access.

ATTENTION: Connectors are designed to be rotated into a fixed position during motor installation, and remain in that position without further adjustment. Strictly limit the applied forces and the number of times the connector is rotated to make sure that connectors meet the International Protection (IP) rating as outlined in the Kinetix 5700, 5500, 5300, and 5100 Servo Drives Specifications Technical Data, publication KNX-TD003.

ATTENTION: Excessive force can damage the connector. Do not pull on the cable and do not use tools, such as pliers or vise-grips, to rotate the connector. Use your hands to rotate the connector.

1. Mount and fully seat a mating cable on the DSM module connector.
   This provides a larger area to grasp and extends the leverage force.
2. Grasp the mated connector and cable plug with your hands and slowly rotate the DSM module connector into the new position.
3. Remove the cable plug after the connector is aligned.

Install the DSM

ATTENTION: Damage can occur to the DSM module bearings and the feedback device if sharp impact is applied to the shaft during installation of couplings and pulleys. Damage to the feedback device can result from applying leverage to the DSM module mounting face when removing devices mounted on the shaft.
Do not strike the shaft, couplings, or pulleys with tools during installation or removal. Use a wheel puller, to apply pressure from the user end of the shaft, when attempting to remove any device from the shaft.

1. Leave enough space around the DSM module so it can dissipate heat and stay within its specified operating temperature range.
2. Determine the radial and axial shaft load limitations of your DSM module.

   See Load Force Ratings in the Kinetix 5700, 5500, 5300, and 5100 Servo Drives Specifications Technical Data, publication KNX-TD003.
3. Install the DSM module with the connector positioned in your preferred orientation.
4. Mount and align the DSM module.
5. Attach the cable.
   a. Carefully align the cable connector with the DSM module connector.

      The flat surface on the top of the motor connector and the flat surfaces on the cable connector must align for the cable connector to mate with the DSM module connector.

      When there is no hybrid cable or no connection to Studio 5000 Logix Designer application available, DSM modules with a brake may require the release of the brake prior to rotating the shaft so the DSM module aligns with the machine mounts. See DSM Brake Override Input Specifications on page 64 for more information.

      ATTENTION: Keyed connectors must be properly aligned and hand-tightened.
      Do not use tools, or apply excessive force, when mating the cable to the motor connector. If the connectors do not go together with light hand force, realign and try again.

   b. Hand-tighten the knurled collar one-quarter turn to fully seat the cable connector.

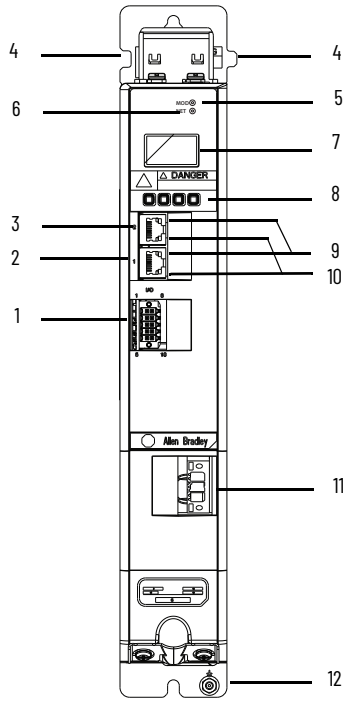
ArmorKinetix Modules Connector Data and Feature Descriptions

Connectors and Indicators

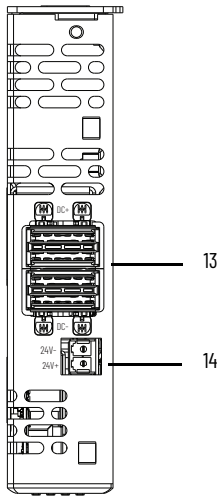
This chapter illustrates connectors and indicators for the ArmorKinetix® system components (PIM, DSD, and DSM modules), including the DC-bus power supply, and accessory modules. Also included in this chapter are connector pinouts and descriptions for ArmorKinetix system modules.

Use these illustrations to identify the connectors and indicators for the ArmorKinetix modules.

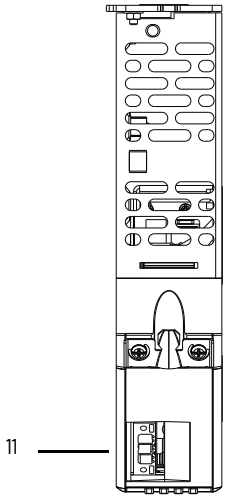
Figure 31 - ArmorKinetix Power Interface Module (PIM) Features and Indicators



ArmorKinetix PIM, Front View



ArmorKinetix PIM, Top View

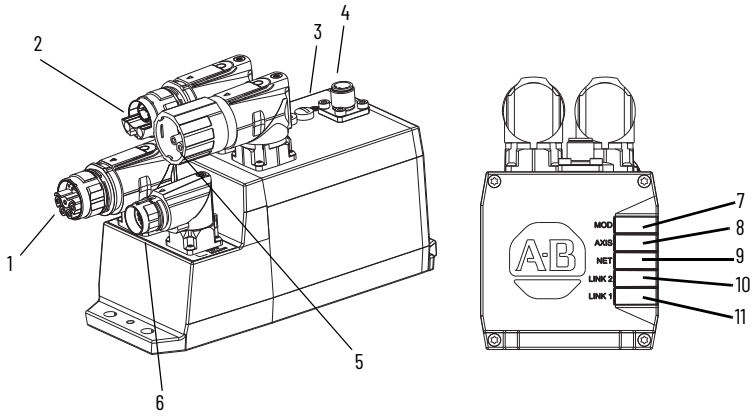


ArmorKinetix PIM, Bottom View

Item	Description
1	Digital inputs connector
2	Ethernet (PORT1) RJ45 connector
3	Ethernet (PORT2) RJ45 connector
4	Zero-stack mounting tab/cutout
5	Module status indicator
6	Network status indicator
7	LCD display

Item	Description
8	Navigation pushbuttons
9	Link speed status indicators
10	Link/Activity status indicators
11	Hybrid Cable Power Connector
12	Ground terminal
13	DC bus (DC) connector
14	24V control input power (CP) connector

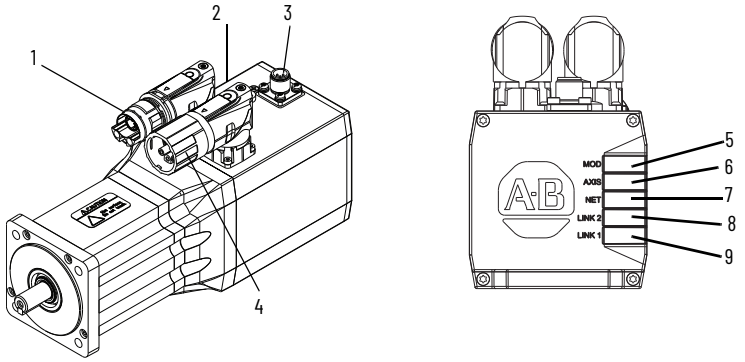
Figure 32 - ArmorKinetix Distributed Servo Drive Module (DSD) Features and Indicators



Item	Description
1	Motor power and feedback connector
2	Hybrid cable input connector
3	IP Address rotary switches
4	Digital Input connector
5	Hybrid cable output connector
6	Motor feedback connector

Item	Description
7	MOD - module status indicator
8	Axis status indicator
9	Network status indicator
10	Link 2 status indicator
11	Link 1 status indicator

Figure 33 - ArmorKinetix Distributed Servo Motor Module (DSM) Features and Indicators



Item	Description
1	Hybrid cable input connector
2	IP Address rotary switches
3	Digital Input Connector
4	Hybrid cable output connector
5	MOD - module status indicator

Item	Description
6	Axis status indicator
7	Network status indicator
8	Link 2 status indicator
9	Link 1 status indicator

Connectors Signal Descriptions (PIM)

Use these descriptions to identify the connectors and indicators for the ArmorKinetix PIM modules.

24V DC Control Power Input Connector

The ArmorKinetix system requires 24V DC (21.6...26.4V) input power for control circuitry.

IMPORTANT SELV or PELV rated power supplies must be used.
The National Electrical Code and local electrical codes take precedence over the values and methods provided. Implementation of these codes is the responsibility of the machine builder.

Table 17 - Control Power Current Specifications

Attribute	Value
Control power DC input voltage	24V DC ±10%
Control power DC input current	12 A max
Max Control power inrush current	13.2 A max (1)
Control power DC output voltage to DSM/DSD	58V (2)
Control power DC output current to DSM/DSD	4 A max
Control Power Output Short-circuit protection	Yes

(1) Values are with no capacitor modules. For Inrush current with capacitor modules, see PIM Module 24V DC Power Supply Current Demand (Inrush), Table 74.

(2) The PIM module output is always 58V. At the end of 140 m (459 ft) of cable, output voltage is 40V.

DC Bus Connector

The 2198-P*xxx* DC-bus power supply RC connector wires to an external passive shunt when the internal shunt capacity is exceeded.

Table 18 - DC Bus Power Connector

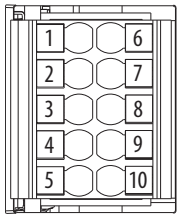
DC Pin	Description	Signal	Module
Bus bar	DC bus connections	DC–	• DC-bus power supply • Inverters • Accessory modules • iTRAK® power supply
		DC+	

Digital Inputs Connector Pinouts

The ArmorKinetix PIM module has four configurable digital inputs and four configurable functions to choose from in the Studio 5000 Logix Designer® application.

Table 19 - PIM Module Digital Input Pinouts

Pin	Description	Signal
1	24V current sinking fast input No. 1	IN1
2	I/O common for customer-supplied 24V supply	COM
3	24V current sinking fast input No. 2	IN2
4	I/O common for customer-supplied 24V supply	COM
5	Chassis ground	SHLD
6	24V current sinking fast input No. 3	IN3
7	I/O common for customer-supplied 24V supply	COM
8	24V current sinking fast input No. 4	IN4
9	I/O common for customer-supplied 24V supply	COM
10	Chassis ground	SHLD



Pin Orientation for 10-pin Digital Inputs (IOD) Connector

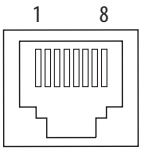
Table 20 - Configurable Functions

Default Configuration	Description
Digital input1 = Unassigned Digital input2 = Unassigned Digital input3 = Unassigned Digital input4 = Unassigned	Unassigned
	Bus Capacitor OK
	Shunt Thermal Switch OK
	Bus Conditioner OK

Ethernet Connector

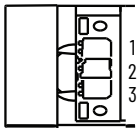
The PORT1 and PORT2 (RJ45) Ethernet connectors provide communication with the Logix 5000® controller.

Pin	Description	Signal	Module
1	Transmit+	TD+	• Power Interface Module
2	Transmit–	TD–	
3	Receive+	RD+	
4	Reserved	–	
5	Reserved	–	
6	Receive–	RD–	
7	Reserved	–	
8	Reserved	–	



Hybrid Cable Power Connector

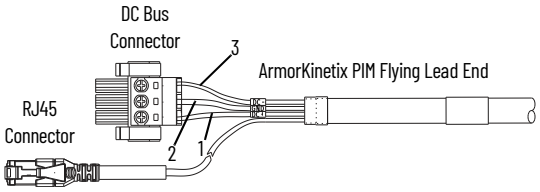
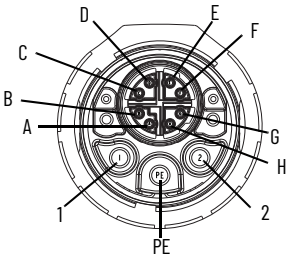
Pin	Description	Signal	Module
1	DC+	DC+	• Power Interface Module
2	Ground	GND	
3	DC-	DC-	



Connector Signal Descriptions (DSD and DSM)

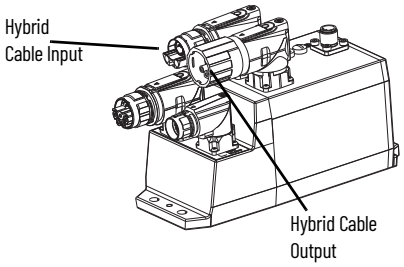
Use these descriptions to identify the connectors for the ArmorKinetix DSx modules.

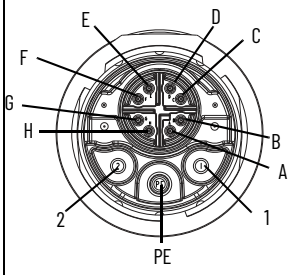
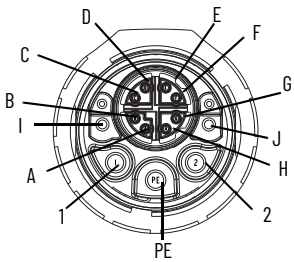
Hybrid Connector (PIM to DSD or DSM)

PIM Module End	DSx Module Input
	

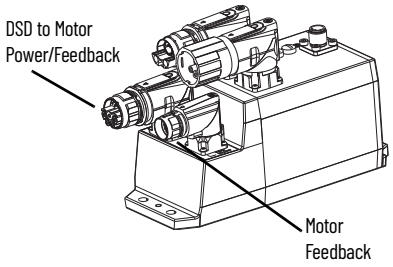
Pin	Signal Name		Pin	Signal Name
–	Ethernet 1	RJ45 Connector	A	Ethernet 1
–	Ethernet 2		B	Ethernet 2
–	Ethernet 3		C	Ethernet 3
–	Ethernet 4		D	Ethernet 4
–	Ethernet 5		E	Ethernet 5
–	Ethernet 6		F	Ethernet 6
–	Ethernet 7		G	Ethernet 7
–	Ethernet 8		H	Ethernet 8
–	Not populated		9	Not populated
–	Not populated		10	Not populated
1	DC +	DC Bus Connector	2	DC +
2	Ground		PE	Ground
3	DC -		1	DC -

DSx Hybrid Connector (DSx to or from DSx)

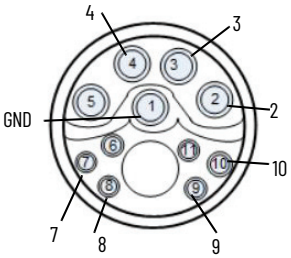


	Input Connector Device End	Output Connector Cable Side
		
Pin	**Signal Name**	**Signal Name**
A	Ethernet 1	Ethernet 1
B	Ethernet 2	Ethernet 2
C	Ethernet 3	Ethernet 3
D	Ethernet 4	Ethernet 4
E	Ethernet 5	Ethernet 5
F	Ethernet 6	Ethernet 6
G	Ethernet 7	Ethernet 7
H	Ethernet 8	Ethernet 8
I	Brake 24V	Not populated
J	Brake return	Not populated
1	DC -	DC -
PE	Ground	Ground
2	DC +	DC +

DSD Module to Motor Connectors (motor power/feedback and feedback connectors)

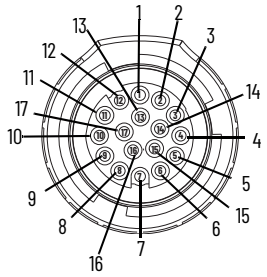


DSD to Motor Power/Feedback



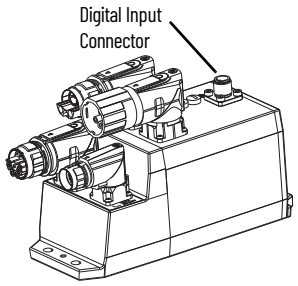
Pin	Signal Name
1	Ground
2	U
3	V
4	W
7	DSL +
8	DSL -
9	Brake +
10	Brake -

DSD Motor Feedback Connector

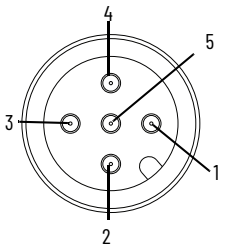


Pin	Pin Signal Name
1	SIN +
2	SIN -
3	COS +
4	COS -
5	DATA +
6	DATA -
7	Reserved
8	Reserved
9	EPWR 5V
10	ECOM (N/C)
11	EPWR 9V
12	ECOM
13	TS +
14	TS - (N/C)
15	S1
16	S2
17	S3

Digital Input Connector



Digital input Connector



Pin	Signal Name
1	IN 1
2	IN 2
3	24V COM
4	IN 3
5	IN 4

Control Signal Specifications

This section provides a description of the digital inputs, Ethernet communication, power and relay specifications, encoder feedback specifications, and safe torque-off features.

Digital Input Functions

Digital inputs are available for the machine interface on the on the PIM module (Digital Inputs Connector Pinouts on page 57) and on the DSx module (Digital Input Connector on page 62). There are four possible input functions for the PIM module and nine possible input functions for the DSx module. Digital inputs require a 24V DC @ 15 mA supply. These are sinking inputs that require a sourcing device. A common connection is provided on the digital input connector for each of the digital inputs.

IMPORTANT To improve registration input EMC performance, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

Table 21 - Understand Digital Input Functions

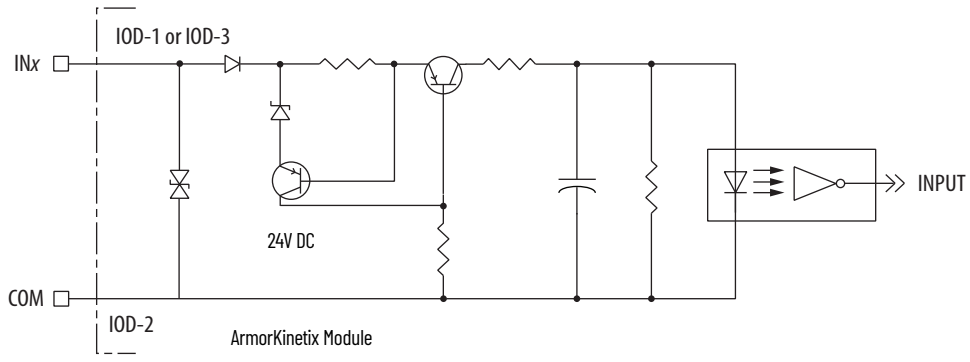
Functions	Description (1)	2198-PIM	2198-DSx-ERSx
Unassigned	Unassigned	X	X
Enable	A 24V DC input is applied to this terminal as a condition to enable each module.	–	X
Home	An active state indicates to a homing sequence that the referencing sensor has been seen. Typically, a transition of this signal is used to establish a reference position for the machine axis.	–	X
Registration 1	An inactive-to-active transition (also known as a positive transition) or active-to-inactive transition (also known as a negative transition) is used to latch position values for use in registration moves.	–	X
Registration 2		–	X
Positive Overtravel Negative Overtravel	The positive/negative limit switch (normally closed contact) inputs for each axis require 24V DC (nominal).	–	X
Shunt Thermal Switch OK	When the 2198-R014, 2198-R031, or 2198-R127 external shunt resistor is wired to the DC-bus power supply, this input must be configured in the Studio 5000 Logix Designer application to monitor the status of the external shunt module thermal switch and assigned to Shunt thermal switch OK. This function does not apply to the 2198-R004 shunt resistor. You can also use this input to monitor the status of an active shunt module in DC-bus power supply systems that are connected via the capacitor module or extension module, or in regenerative bus supply systems that are connected via the RC connector or an accessory module.	X	–
Bus Capacitor OK	You can configure this input in the Studio 5000 Logix Designer application and wire the module status (MS) output from the 2198-CAPMOD-2240 capacitor module to indicate to the DC-bus power supply, regenerative bus supply, or inverters that a major fault is present on the capacitor module.	X	X
Bus Conditioner OK	You can configure this input in the Studio 5000 Logix Designer application and wire the module status (MS) output from the 2198-DCBUSCOND-RP312 DC-bus conditioner module to indicate to the DC-bus power supply, regenerative bus supply, or inverters that a major fault is present on the DC-bus conditioner module.	X	X

(1) The function is always inactive unless assigned to a digital input in the Studio 5000 Logix Designer application. To configure your DC-bus power supply digital input for Shunt Thermal Switch OK or Bus capacitor OK, see Configure the Kinetix 5700 Drive Modules in the Kinetix 5700 Servo Drives UserManual, publication 2198-UM002.

Table 22 - Digital Input Specifications

Attribute	Value	2198-PIM	2198-DSx-ERSx
Digital input type	Optically isolated, active high, single-ended, current sinking (EN 61131-2 Type 1)	X	X
Input current (with 24V applied)	12 mA, typical	X	X
On-state input voltage	15...30V @ 15 mA, max	X	X
Off-state input voltage	-1.0...5.0V	X	X
Pulse reject filtering (applies to registration function only)	12.0 µs	-	X
Pulse reject filtering (debounce filter) Applies to all other input functions, Home, for example.	20 ms, nom	X	X
Propagation delay (registration functions, inverters only)	0 (delay compensated)	-	X
Registration accuracy (inverters only)	±3 µs	-	X
Registration repeatability (inverters only)	700 ns	-	X
Windowed registration invalid-to-valid event delay (inverters only)	125 µs, min	-	X

Figure 34 - Digital Input Circuitry



Ethernet Communication Specifications

The PORT1 and PORT2 (RJ45) Ethernet connectors on the PIM provide communication with the DS*x* module and the Logix 5000 controller.

Attribute	PIM Value	DSx Value
Communication	10BASE-TX Full Duplex, 100BASE-TX Half/Full Duplex (1)	100/1000BASE-TX Half/Full Duplex
Cyclic update period (2)	1.0 ms, min	1.0 ms, min
Embedded switch features	Three-port, cut-through, time correction on IEEE-1588 packets, limited filtering, quality of service with four priority levels	Three-port, cut-through, time correction on IEEE-1588 packets, limited filtering, quality of service with four priority levels
Auto MDI/MDIX crossover detection/correction	Yes	Yes
Port-to-port time synchronization variation	100 ns, max	100 ns, max
Cabling	• CAT5E or CAT6, Shielded, 50 m (164 ft) max when not using hybrid cable	• CAT5E or CAT6, Shielded, 30 m (98 ft) max when not using hybrid cable

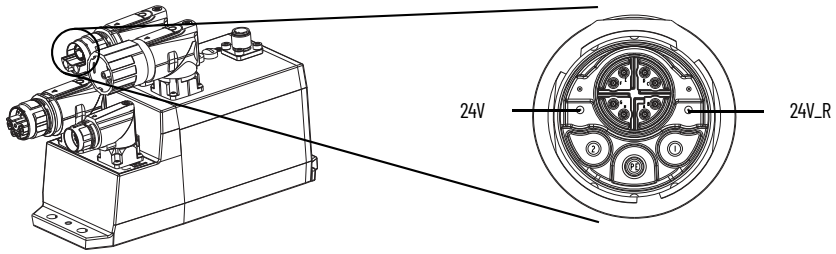
(1) 10 MB half duplex not support for the PIM module.
(2) With CIP Security™ enabled on the 2198-P*xxx* DC-bus power supply, the cyclic update period cannot be faster than 4.0 ms.

DSM Brake Override Input Specifications

When there is no hybrid cable or no connection to Studio 5000 Logix Designer application available, DSM modules with a brake may require the release of the brake prior to rotating the shaft so the DSM module aligns with the machine mounts. The brake override connection is made on two dedicated pins of the hybrid input connector. The hybrid cable has no connection on those pins.

The brake override may only be activated when the hybrid input cable is not connected. A brake override is attached at the location where the hybrid input cable would normally be attached and an external 24V power supply can be connected to these pins on the hybrid connector to release the motor parking brake.

Figure 35 - Input Hybrid Cable - Brake Connection



Polarity of the two pins is not important, the brake override works regardless of the connection.

Two connections are required for the motor/brake override input power. Connections are rated for +24V and current as shown in the following table. An active signal releases the motor brake.

Table 23 - Brake Specification

Specification	Value
Nominal brake voltage	24V DC
Minimum voltage	21.6V DC
Maximum voltage	27.6V DC
Maximum brake current	450 mA

The brake option is a spring-set holding brake that releases when voltage is applied to the brake coil in the motor.

DSM Brake Input Specifications

For a detailed information on vertical loads and how the servo motor holding-brake option can be used to help keep a load from falling, see the Vertical Load and Holding Brake Management Application Technique, publication MOTION-AT003.

Control of the solid-state relay to release the motor brake is configurable in the Studio 5000 Logix Designer application (refer to Configure SPM Motor Closed-loop Control Axis Properties on page 112). An active signal releases the motor brake. Turn-on and turn-off delays are specified by the MechanicalBrakeEngageDelay and MechanicalBrakeReleaseDelay settings.

IMPORTANT Holding brakes that are available on Allen-Bradley® rotary motors are designed to hold a motor shaft at 0 rpm for up to the rated brake-holding torque, not to stop the rotation of the motor shaft, or be used as a safety device.

You must command the servo drive to 0 rpm and engage the brake only after verifying that the motor shaft is at 0 rpm.

These steps provide one method you can use to control a brake.

1. Connect the hybrid cable according to the appropriate interconnect diagram in Appendix A beginning on page 169.
2. Enter the MechanicalBrakeEngageDelay and Mechanical BrakeReleaseDelay times in the Studio 5000 Logix Designer application.

   Refer to Axis Properties>Parameter List. The delay times must be from the appropriate motor family brake specifications table in the Kinetix Rotary Motion Specifications Technical Data, publication KNX-TD001.
3. Use the drive stop-action default setting (Current Decel & Disable).

   Refer to Axis Properties>Actions>Stop Action in the Studio 5000 Logix Designer application.
4. Use the motion instruction Motion Axis Stop (MAS) to decelerate the servo motor to 0 rpm.
5. Use the motion instruction Motion Servo Off (MSF) to engage the brake and disable drive.

Feedback Specifications

The ArmorKinetix DSD module accepts motor feedback signals from Hiperface digital-servo-link (DSL) encoders on the motor/power feedback (M23 type) connector and Hiperface, and incremental encoders on the motor feedback (M17 type) connector.

IMPORTANT Auto-configuration in the Studio 5000 Logix Designer application of intelligent absolute, high-resolution encoders, and incremental encoders is possible with only Allen-Bradley motors.

The motor power/feedback and motor feedback connectors can be used in the following applications:

- Motor feedback
- Auxiliary feedback-only axis
- Dual-loop control applications

Encoder Feedback Supported on the DSD Module Motor Power/ Feedback Connector

The ArmorKinetix system supports Kinetix VPL, VPF, VPH, and VPS servo motors with Hiperface digital-servo-link (DSL) encoders by using the 2090-CSBM1P7-14AF*xx* motor power/feedback cable connected to the motor power/feedback (M23 type) connector on the DSD module.

Other Allen-Bradley motors and actuators with Hiperface single-turn or multi-turn high-resolution absolute encoders are also accepted, but you must connect to the motor feedback (M17 type) connector on the DSD module.

Encoder Feedback Supported on the DSD Module Motor Feedback Connector

The ArmorKinetix system also supports multiple types of feedback devices by using the 17-pin motor feedback connector on the DSD module and sharing connector pins in many cases.

Table 24 - Motor Feedback (M17 Connector) General Specifications - ArmorKinetix DSD Module

Attribute	Motor and Auxiliary Feedback
Feedback device support	• Hiperface Sine/Cosine • Generic TTL Incremental (1) • Generic Sine/Cosine Incremental (1)
Power supply voltage (MTR_EPWR5V) Power supply current (MTR_EPWR5V)	5.27...5.50V (2) 300 mA, max
Power supply voltage (MTR_EPWR9V) Power supply current (MTR_EPWR9V)	8.30...9.90V (2) 150 mA, max
Thermostat	• Single-ended, under 500 Ω = no fault • Single-ended, over 10 kΩ = fault

(1) These could be with or without HALL effects (UVW).
(2) These motor feedback voltage and current ratings are per axis.

Table 25 - Feedback General Specifications - ArmorKinetix DSM Module

Attribute	Motor Feedback
Feedback device support	• Hiperface digital-servo-link (DSL)

Table 26 - Motor Feedback Signals by Device Type

Pin	DSD Module Motor Feedback Connector (M17 type)	Wire	Hiperface SIN/COS	Generic TTL Incremental	Generic Sine/Cosine Incremental
1	SIN+	Black	MTR_SIN	MTR_AM	MTR_SIN
2	SIN-	White/Black	MTR_SIN-	MTR_AM-	MTR_SIN-
3	COS+	Red	MTR_COS+	MTR_BM+	MTR_COS+
4	COS-	White/Red	MTR_COS-	MTR_BM-	MTR_COS-
5	DATA+	Green	MTR_DATA+	MTR_IM+	MTR_IM+
6	DATA-	White/Green	MTR_DATA-	MTR_IM-	MTR_IM-
7	CLK+	Brown	Reserved	—	—
8	CLK-	White/Brown	Reserved	—	—
9	EPWR5V	Gray	MTR_EPWR5V (1)	MTR_EPWR5V (1)	MTR_EPWR5V (1)
10	ECOM	White/Gray	MTR_ECOM	MTR_ECOM	MTR_ECOM
11	EPWR9V	Orange	MTR_EPWR9V (1)	MTR_EPWR9V (1)	MTR_EPWR9V (1)
12	ECOM	(N/C)	(N/C)	(N/C)	(N/C)
13	TS+	White/Orange	MTR_TS+	MTR_TS+	MTR_TS+
14	TS-	Blue	(N/C)	(N/C)	(N/C)
15	S1 (c)	WhiteBlue	—	S1	S1
16	S2 (c)	Yellow	—	S2	S2
17	S3 (c	White/Yellow	—	S3	S3

(1) Determine which power supply your encoder requires and connect to only the specified supply. Do not make connections to both supplies.

Table 27 - Hiperface Specifications

Attribute	Value
Memory support	Not programmed, or programmed with Allen-Bradley motor data
Hiperface data communication	9600 baud, 8 data bits, no parity
Sine/cosine interpolation	4096 counts/sine period
Input frequency (AM/BM)	250 kHz, max
Input voltage (AM/BM)	0.6...1.2V, peak to peak, measured at the drive inputs
Line loss detection (AM/BM)	Average (sin^2 + cos^2) > constant
Noise filtering (AM and BM)	Two-stage coarse count pulse reject filter with rejected pulse tally
Incremental position verification	Position compare between incremental accumulator and serial data performed every 50 ms or less

Table 28 - Generic TTL Incremental Specifications

Attribute	Value
TTL incremental encoder support	5V, differential A quad B
Quadrature interpolation	4 counts / square wave period
Differential input voltage (MTR_AM, MTR_BM, and MTR_IM)	5V DC, differential line driver (DLD) output compatible
DC current draw (MTR_AM, MTR_BM, and MTR_IM)	30 mA, max
Input signal frequency (MTR_AM, MTR_BM, and MTR_IM)	5.0 MHz, max
Edge separation (MTR_AM and MTR_BM)	42 ns min, between any two edges
Commutation verification (1)	Commutation angle verification performed at the first Hall signal transition and periodically verifies thereafter
Hall inputs (MTR_S1, MTR_S2, and MTR_S3)	Single-ended, TTL, open collector, or none

(1) These could be with or without HALL effects (UVW). Refer to Commutation Self-sensing Startup on page 233.

Table 29 - Generic Sine/Cosine Incremental Specifications

Attribute	Value
Sine/Cosine interpolation	2048 counts/sine wave period
Input frequency (MTR_SIN and MTR_COS)	250 kHz, max
Differential input voltage (MTR_SIN and MTR_COS)	0.6...1.2V, p-p
Commutation verification (1)	Commutation angle verification performed at the first Hall signal transition and periodically verifies thereafter
Hall inputs (MTR_S1, MTR_S2, and MTR_S3)	Single-ended, TTL, open collector, or none

(1) These could be with or without HALL effects (UVW). Refer to Commutation Self-sensing Startup on page 233.

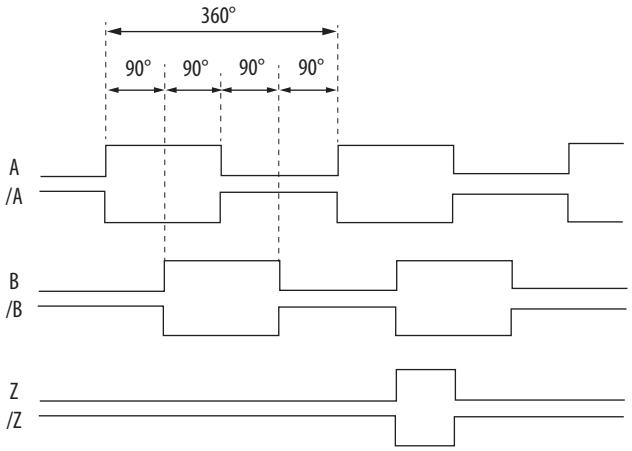
Refer to Encoder Phasing Definitions on page 68 for encoder phasing alignment diagrams.

IMPORTANT Unprogrammed Smart feedback devices (Hiperface Sin/Cos, Hiperface DSL) are not supported. Unprogrammed as load or feedback-only feedback types are supported, except unprogrammed Hiperface DSL encoders. Contact your local distributor or Rockwell Automation representative for support options.

Encoder Phasing Definitions

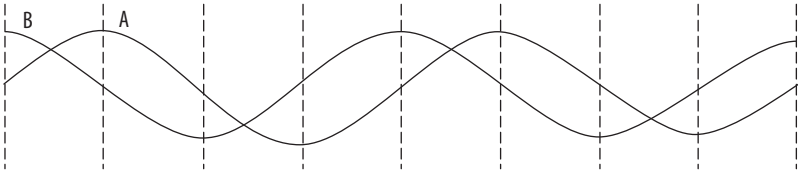
For TTL encoders, the drive position increases when A leads B. Clockwise motor rotation is assumed, when looking at the shaft.

Figure 36 - TTL Encoder Phasing



For Sin/Cos encoders (Hiperface), the drive position increases when Cosine (B) leads Sine (A). Clockwise motor rotation is assumed, when looking at the shaft.

Figure 37 - Sine/Cosine Encoder Phasing



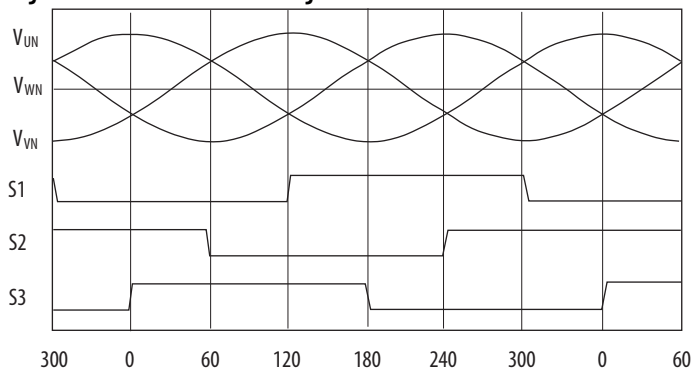
IMPORTANT The Sine/Cosine encoder signal phasing is different than the TTL encoder signal phasing.

IMPORTANT When using an incremental Sine/Cosine feedback device, the drive cannot synthesize a marker signal, so a physical marker signal is required for the home-to-marker sequence (and the marker hookup test) to complete.

When using absolute feedback devices (for example, Hiperface) the drive synthesizes a marker signal because these devices don't have a marker signal required for the home-to-marker sequence (and the marker hookup test) to complete.

The drive Motor Feedback (M17 connector) connector uses Hall signals to initialize the commutation angle for permanent magnet motor commutation. The commutation self-sensing feature initializes the commutation angle for motors that do not have the Hall effect sensors.

Figure 38 - Hall Encoder Phasing



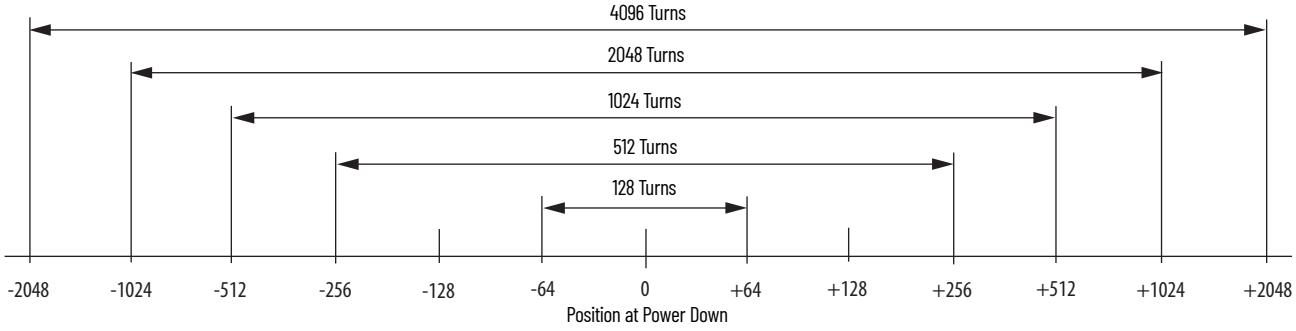
Absolute Position Feature

The absolute position feature tracks the position of the motor, within the multi-turn retention limits, while the drive is powered off. The absolute position feature is available with only multi-turn encoders.

Table 30 - Absolute Position Retention Limits

Encoder Type	Cat. No. Designator	Rotary Motor Cat. No.	Linear Actuator Cat. No.	Retention Limits	
				Turns (rotary)	mm (linear)
Hiperface DSL	-P	VPL-A/B*xxxxx*-P VPF-A/B*xxxxx*-P VPS-B*xxxxx*-P 2198-DSM0*xx*-ERS*x*-*xxxxxx*-P	VPAR-A/B*xxxxx*-P	4096 (±2048)	–
	-W	VPL-A/B*xxxxx*-W, VPF-A/B*xxxxx*-W VPH-A/B*xxxxx*-W 2198-DSM0*xx*-ERS*x*-x075*xx*-W	VPAR-B*xxxxx*-W	4096 (±2048)	–
	-Q	VPL-A/B*xxxxx*-Q VPF-A/B*xxxxx*-Q VPH-A/B*xxxxx*-Q	VPAR-B*xxxxx*-Q	512 (±256)	–
	-T	2198-DSM0*xx*-ERS*x*-x1xxxx-T	VPAR-B*xxxxx*-W	4096 (±2048)	
Hiperface	-M	MPL-A/B*xxxxx*-M MPM-A/B*xxxxx*-M MPF-A/B*xxxxx*-M MPS-A/B*xxxxx*-M	MPAR-A/B3*xxxx*-M	2048 (±1024)	–
	-V	MPL-A/B*xxxxx*-V	MPAR-A/B1*xxxx*-V, MPAR-A/B2*xxxx*-V	4096 (±2048)	–
Hiperface (magnetic scale)	-xD*x*	–	LDAT-S*xxxxxx*-xD*x*	–	960 (37.8)

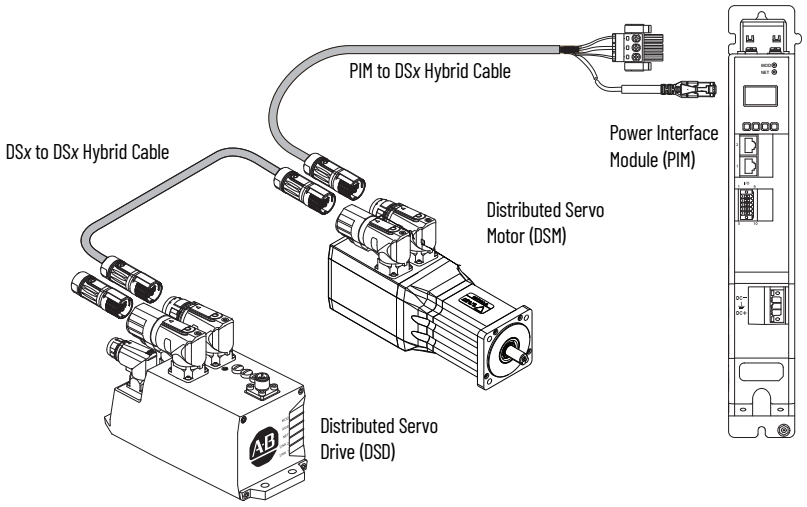
Figure 39 - Absolute Position Limits (measured in turns)



Notes:

Connect the ArmorKinetix System

This chapter provides procedures for wiring your ArmorKinetix® system components and making cable connections.



Basic Wiring Requirements

This section contains basic wiring information for the ArmorKinetix system power supplies, servo drives, and accessories.

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

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

IMPORTANT This section contains common PWM servo system wiring configurations, size, and practices that can be used in a majority of applications. National Electrical Code, local electrical codes, special operating temperatures, duty cycles, or system configurations take precedence over the values and methods provided.

Bypass a ArmorKinetix DSD or DSM Module

You can bypass a non-functioning module. The length of the cables that are connected between modules cannot exceed the 30 m (98 ft) maximum distance.

Determine Input Power Configurations

The ArmorKinetix system power supply can be either the 2198-P*xxx* DC-bus power supply.

DC-bus Power Supply

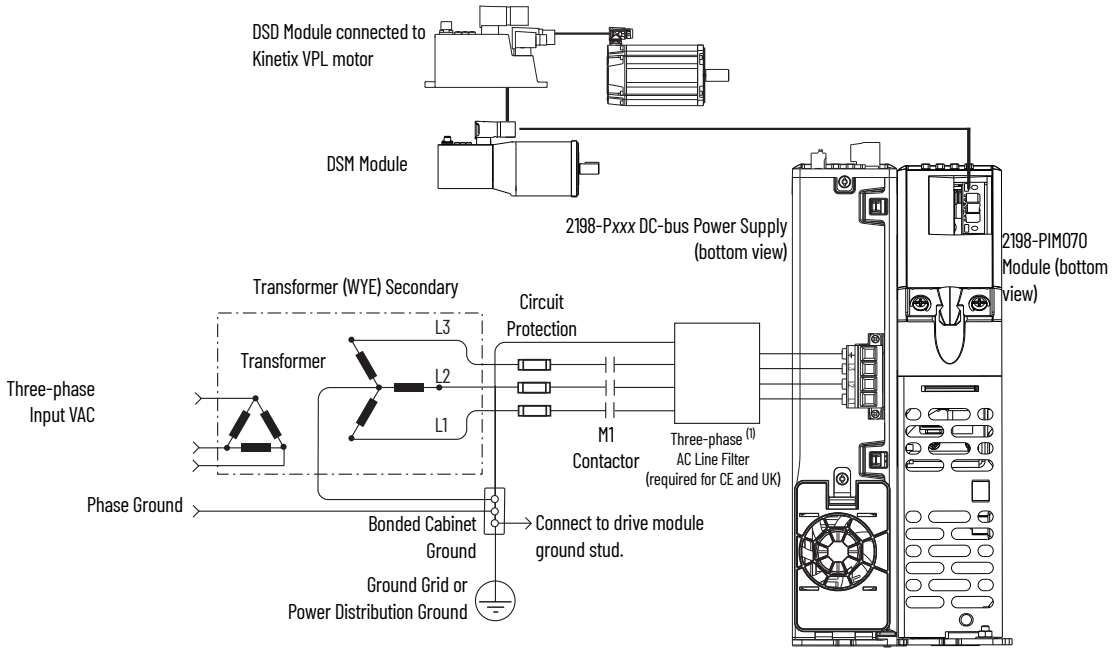
Before wiring input power to your 2198-P*xxx* DC-bus power supply, you must determine the type of input power within your facility. The modules are designed to operate in both grounded and ungrounded environments.

IMPORTANT For EN/IEC 61800-3 category C3 compliance, use the appropriate 2198-DBR*xx*-F line filter with a grounded WYE configuration. The use of a line filter in an ungrounded, corner-grounded, or impedance-grounded configuration can affect the line filter components and result in equipment damage.

Grounded Power Configurations

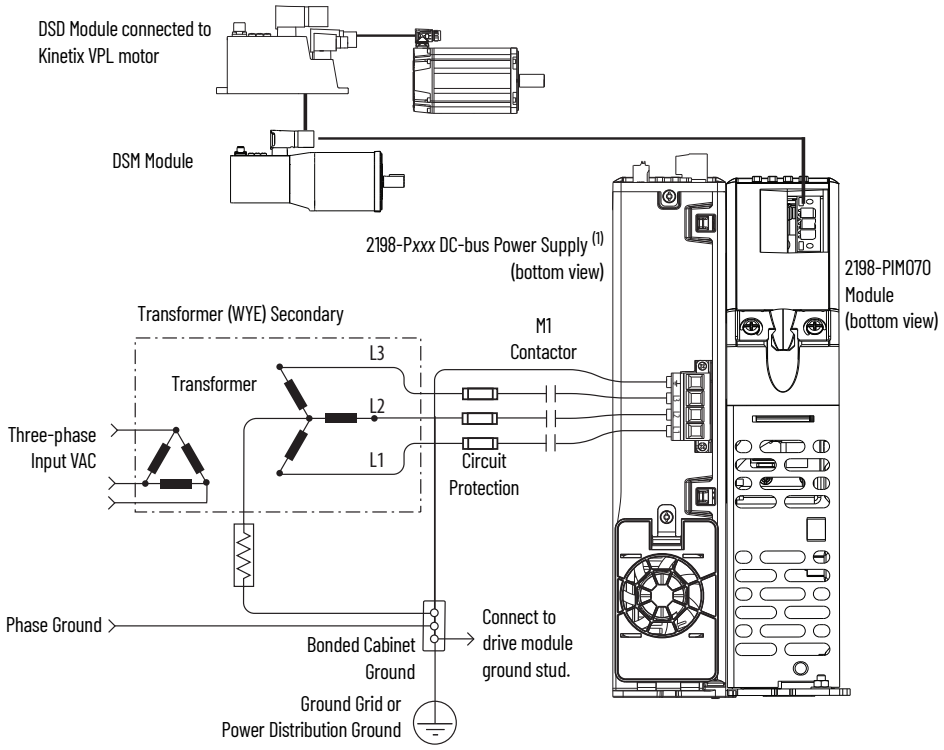
The grounded (WYE) power configuration grounds your three-phase power at a neutral point. This type of grounded power configuration is preferred.

Figure 40 - Grounded Power Configuration (WYE Secondary)



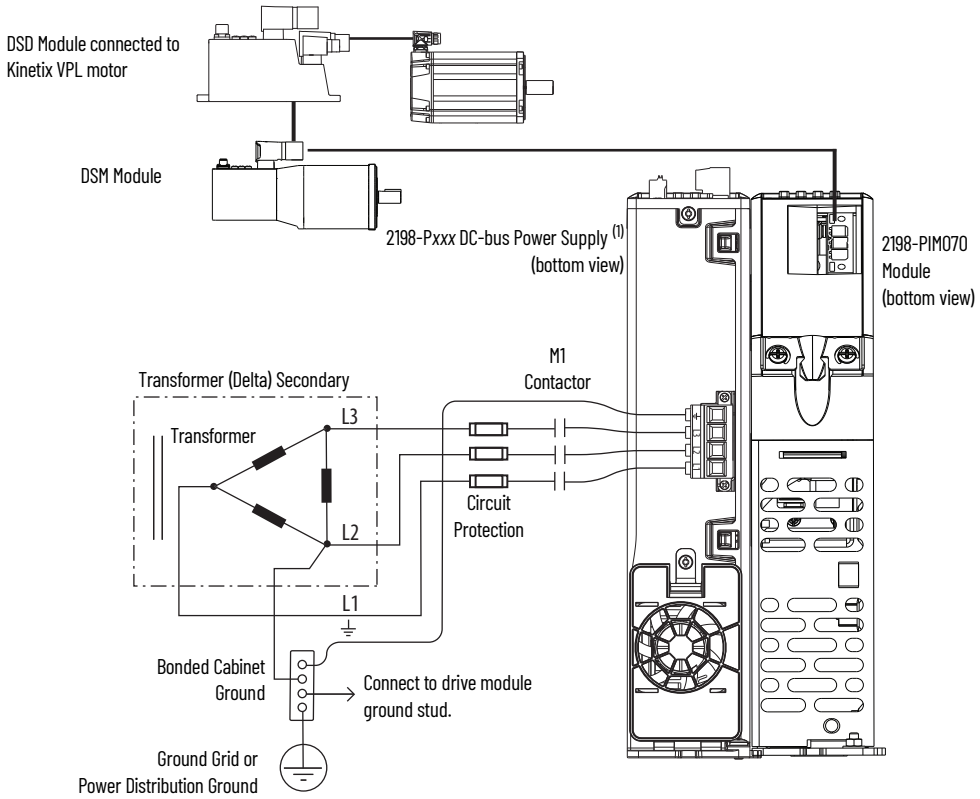
(1) When using 2198-DBR*xx*-F line filter, 2198-P*xxx* power supply has the ground jumper installed. To configure ground jumpers, see the Kinetix 5700 Servo Drives User Manual, publication 2198-UM002. The PIM, DSD, or DSM modules do not have ground jumpers.

Figure 41 - Impedance-grounded Power Configuration (WYE secondary)



(1) 2198-P*xxx* power supply has the ground jumper removed. To configure ground jumpers, see the Kinetix 5700 Servo Drives User Manual, publication 2198-UM002. The PIM, DSD, or DSM modules do not have ground jumpers.

Figure 42 - Corner-grounded Power Configuration (Delta secondary)



(1) 2198-P*xxx* power supply has the ground jumper removed. To configure ground jumpers, see the Kinetix 5700 Servo Drives User Manual, publication 2198-UM002. The PIM, DSD, or DSM modules do not have ground jumpers.

Refer to Power Wiring Examples beginning on page 169 for input power interconnect diagrams.

Ungrounded Power Configurations

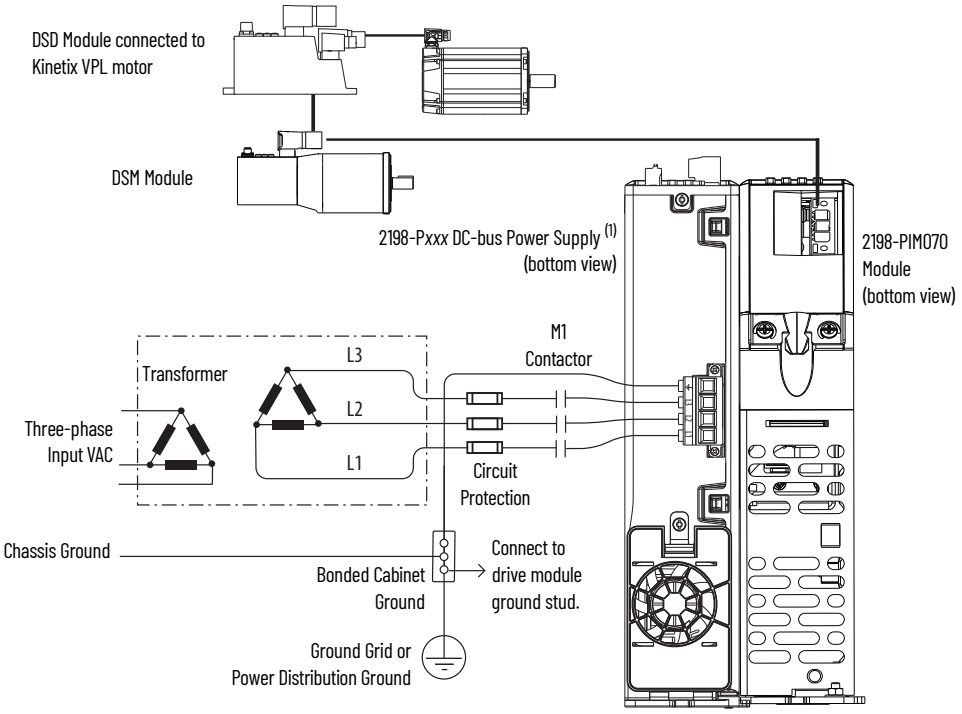
The ungrounded power configuration (Figure 43), corner-grounded (Figure 42), and impedance-grounded (Figure 41) power configurations do not provide a neutral ground point.

IMPORTANT If you determine that you have ungrounded, corner-grounded, or impedance-grounded power distribution in your facility, you must remove the ground screw in each of your DC-bus power supplies, dual-axis inverters (if present), and the ground jumper in each of your single-axis inverters (if present).

The PIM modules, DSD modules, and DSM modules do not have these ground jumpers.

Refer to Ground the System on page 75 for more information.

Figure 43 - Ungrounded Power Configuration



(1) 2198-P*xxx* power supply has the ground jumper removed. To configure ground jumpers, see the Kinetix 5700 Servo Drives User Manual, publication 2198-UM002. The PIM, DSD, or DSM modules do not have ground jumpers.

ATTENTION: Ungrounded and corner-grounded systems do not reference each phase potential to a power distribution ground. This can result in an unknown potential to earth ground. Drive-to-motor cable lengths are limited with these AC power source types. See Appendix C, beginning on page 201, for more information.

Refer to Power Wiring Examples beginning on page 169 for input power interconnect diagrams.

Ground the System

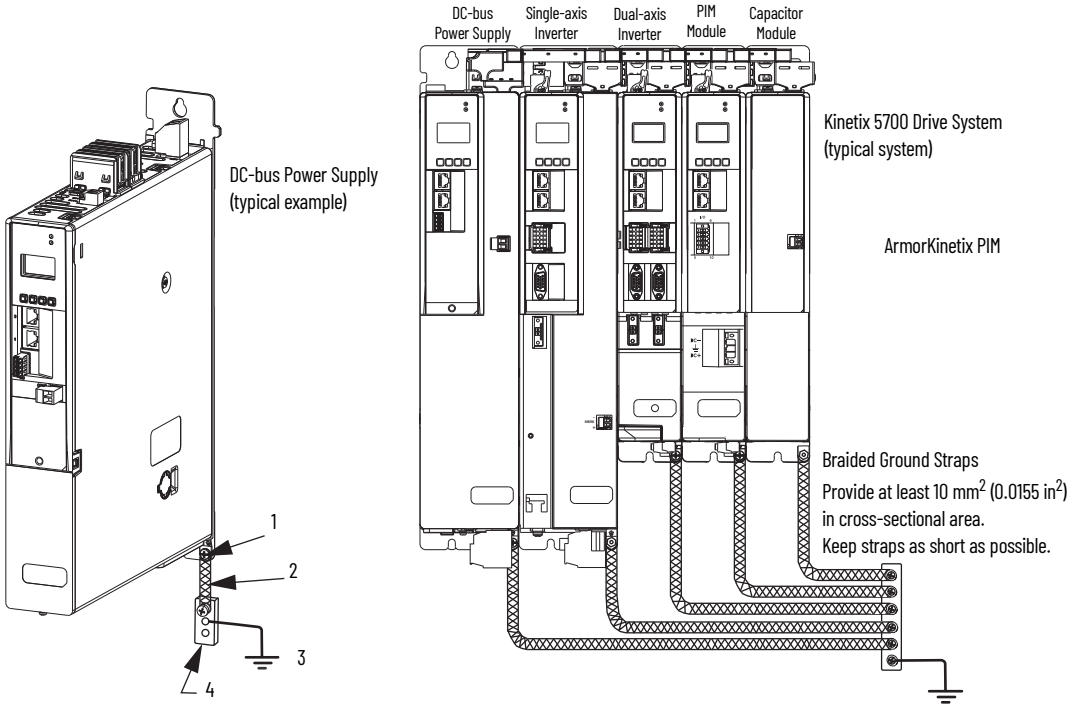
All equipment and components of a machine or process system should have a common earth ground point connected to chassis. A grounded system provides a ground path for short circuit protection. Grounding your modules and panels minimize shock hazard to personnel and damage to equipment caused by short circuits, transient overvoltages, and accidental connection of energized conductors to the equipment chassis.

ATTENTION: The National Electrical Code contains grounding requirements, conventions, and definitions. Follow all applicable local codes and regulations to safely ground your system
For CE and UK grounding requirements, refer to Agency Compliance on page 27.

ATTENTION: High voltage can build up on the shields of a hybrid cable, if the shield is not grounded. Verify that there is a connection to ground for all shields in the hybrid cable. Failure to observe these safety procedures could result in personal injury or damage to equipment.

Ground the Kinetix 5700 power supplies, inverters, ArmorKinetix PIM, and accessory modules to a bonded cabinet ground bus with a braided of at least 10 mm^2 (0.0155 in^2) in cross-sectional area. Keep the braided ground strap as short as possible for optimum bonding.

Figure 44 - Connect the Ground Terminal



Item	Description
1	Ground screw (green) 2.0 N•m (17.7 lb•in), max
2	Braided ground strap (customer supplied)
3	Ground grid or power distribution ground
4	Bonded cabinet ground bus (customer supplied)

Refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001, for more information.

ArmorKinetix PIM Wiring

The hybrid cables include connectors on both ends.

Refer to Power Wiring Examples on page 169 for interconnect diagrams.

IMPORTANT The National Electrical Code and local electrical codes take precedence over the values and methods provided.

Use these guidelines as a reference when wiring the power connectors on your ArmorKinetix modules.

IMPORTANT For connector locations of the ArmorKinetix System drive modules, refer to DC Bus Connector on page 57.

IMPORTANT To improve system performance, run wires and cables in the wireways as established in Establish Noise Zones on page 37.

Insert the connector plug into the drive module connector.

Wire the 24V Control Power Input Connector

The 24V power (CP) connector requires 24V DC input for the control circuitry. The connector plug ships with the module and shared-bus connector kits are purchased separately.

IMPORTANT Mount the 24V power supply as close to the drive system as possible to minimize voltage drop on the 24V input power wiring.

Figure 45 - CP Connector Wiring - Connector Plug

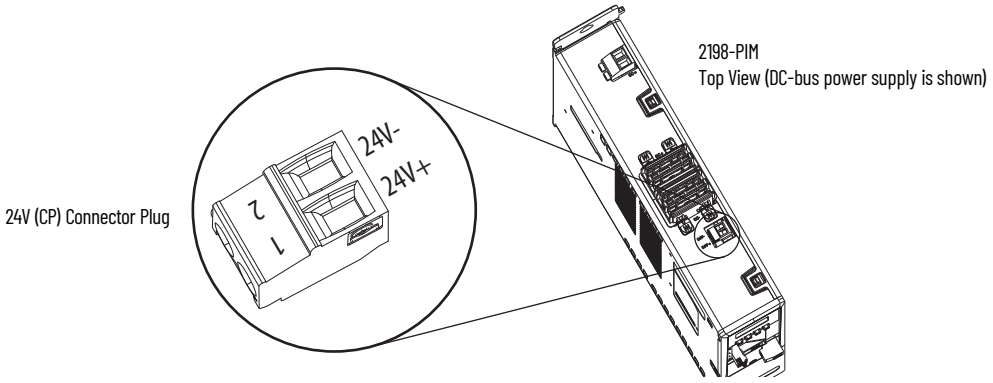


Table 31 - CP Connector Plug Wiring Specifications

Drive Module Cat. No.	CP Pin	Signal	Recommended Wire Size mm^2 (AWG)	Strip Length mm (in.)	Torque Value N•m (lb•in)
2198-PIM070	CP-1 CP-2	24V+ 24V-	0.5...4 (1) (20...12)	7.0 (0.28)	0.22...0.25 (1.9...2.2)

(1) Use sufficient wire size to support the complete control power load, including the Kinetix 5700 drive modules, ArmorKinetix modules, and pass-through current for the attached motor modules.

The ArmorKinetix PIM uses the 2198-H040-D-T connector, see publication 2198-IN005 for more information.

Figure 46 - CP Connector Wiring - Shared Bus

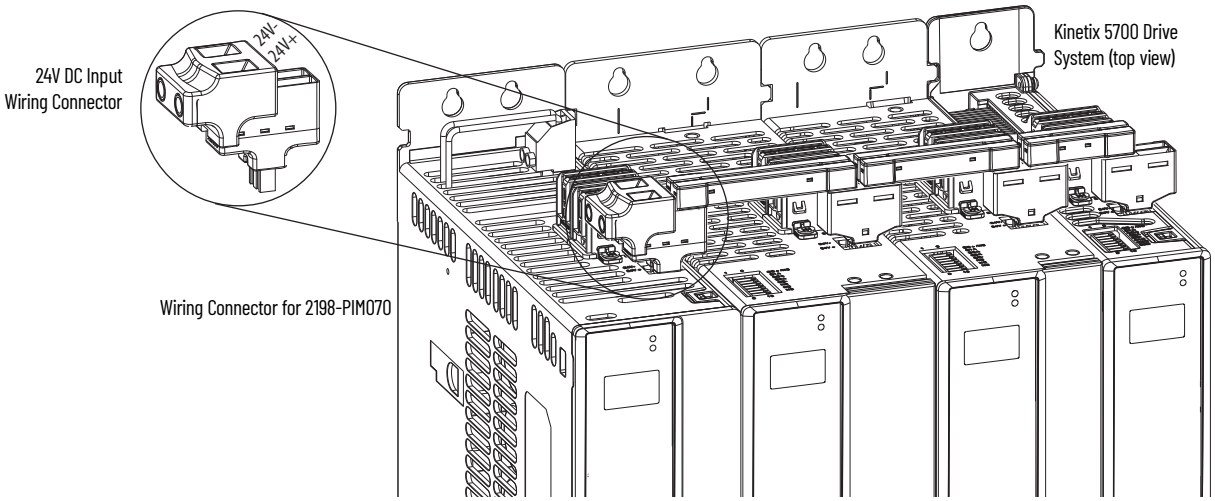


Table 32 - CP Shared-bus Wiring Specifications

Drive Module (1) (2) Cat. No.	**CP Pin**	**Signal**	**Input Current, max** A rms, max.	**Recommended Wire Size** mm^2 (AWG)	**Strip Length** mm (in.)	**Torque Value** N•m (lb•in)
2198-PIM070	CP-1 CP-2	24V+ 24V-	12	1.6 (14)	11.0 (0.43)	1.7...1.8 (15.0...15.9)

(1) Catalog numbers 2198T-W25K-ER, 2198-RP263, 2198-RP312, 2198-S263-ERSx, and 2198-S312-ERSx, use a slightly larger input wiring connector than the other Kinetix 5700 drive modules.
(2) Bus-bars and T-connectors can be added only to the right of the 24V DC input wiring connector.

Wire the Digital Inputs Connector

The digital inputs connector applies to the ArmorKinetx PIM module and use spring tension to hold wires in place.

Figure 47 - Digital Input Connector Wiring

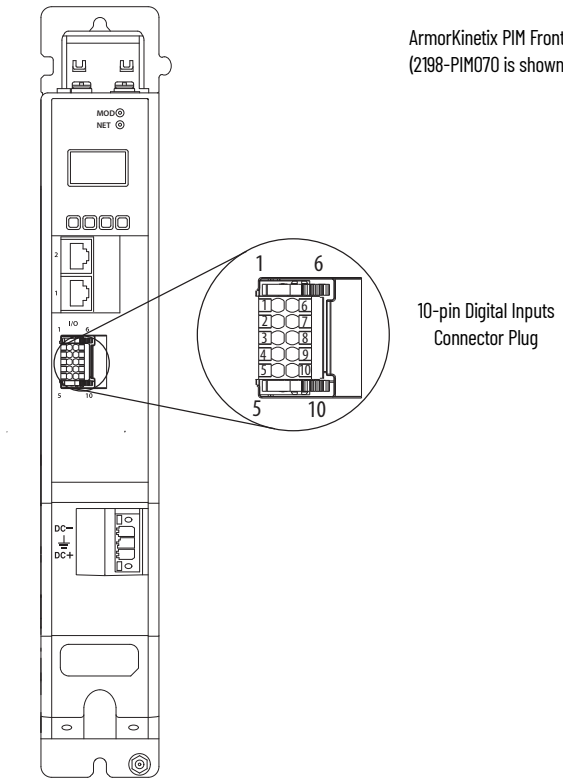


Table 33 - Digital Inputs Connector Specifications

Drive Module Cat. No.	Connector Pin	Signal	Recommended Wire Size mm^2 (AWG)	Strip Length mm (in.)	Torque Value N•m (lb•in)
2198-PIM	IOD-1 IOD-2 IOD-3 IOD-4 IOD-5 IOD-6 IOD-7 IOD-8 IOD-9 IOD-10	IN1 COM IN2 COM SHLD IN3 COM IN4 COM SHLD	0.14…1.5 (26…16)	10.0 (0.39)	N/A (1)

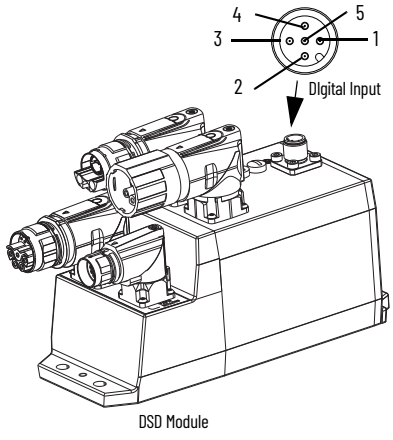
(1) This connector uses spring tension to hold wires in place.

Connect the Hybrid Cable and Make Ethernet Connections

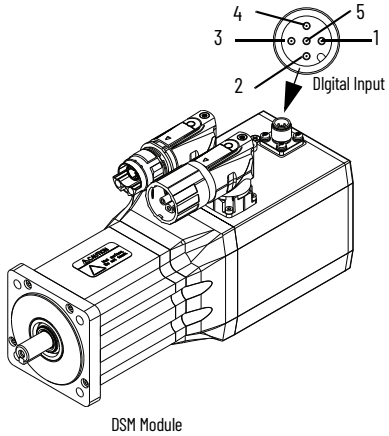
1. Route the ArmorKinetix PIM to DS*x* Hybrid cable to the PIM module.
2. Connect the Ethernet RJ45 connector to the Ethernet port on the PIM module.
3. Connect the DC bus connector from the cable to the power connector on the PIM module.
4. Insert the connector plug into the DS*x* module connector.

Connect Digital Inputs on ArmorKinetix DSD and DSM Modules

There are four configurable inputs available.



DSD Module



DSM Module

Table 34 - Digital Input Information

No. of Pins	Signal Name	Shield	Wire Size [AWG]	Cat. No. (1)	
				Straight Concave	Right-angle Concave
5-pin	1 - IN 1 2 - IN 2 3 - 24V COM 4 - IN 3 5 - IN 4	Unshielded (Yellow)	22	889D-F5AC-2	889D-R5AC-2
		Unshielded (Black)		889D-F5BC-2	889D-R5BC-2
5-pin		Shielded	22	889D-F5EC-2	889D-R5EC-2
5-pin		Braided shield	22	889D-F5ECDM-2	889D-F5ECDE-2

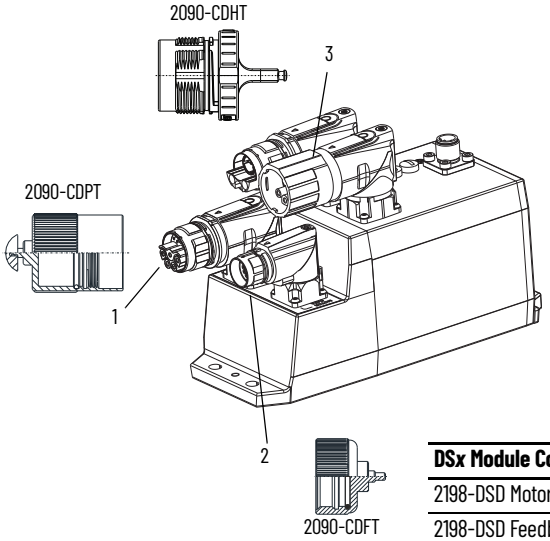
(1) The 2 at the end of the catalog number is for 2 m (6.6 ft) cable length. Replace the 2 with 5 (5 m [16.4 ft]) or 10 (10 m[32.8 ft]) for standard cable lengths.

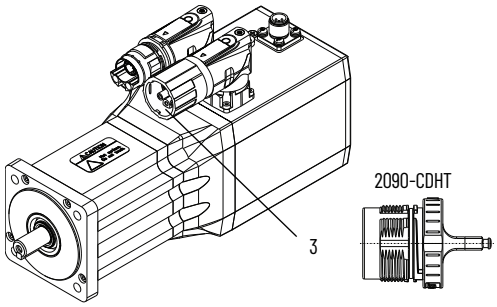
Connect Cables and Terminators to DSx Modules

Connect the motor power/feedback cable to the motor power/feedback connector (1) on the DSD module. When not using a cable, use a connector terminator (2090-CDPT) to cover the connector.

Connect the motor feedback cable to the motor feedback connector (2) on the DSD module. When not using a cable, use a connector terminator (2090-CDFT) to cover the connector.

Connect the ArmorKinetix hybrid cable to the hybrid connectors (3) on the DSx module When not using a cable, use a connector terminator (2090-CDHT) to cover the connector.





DSx Module Connector	2090-CDHT	2090-CDFT	2090-CDPT
2198-DSD Motor Power/Feedback Connector	–	–	x
2198-DSD Feedback Connector	–	x	–
2198-DSD/DSM Hybrid Connector	x	–	–

Notes:

Configure and Start the ArmorKinetix System

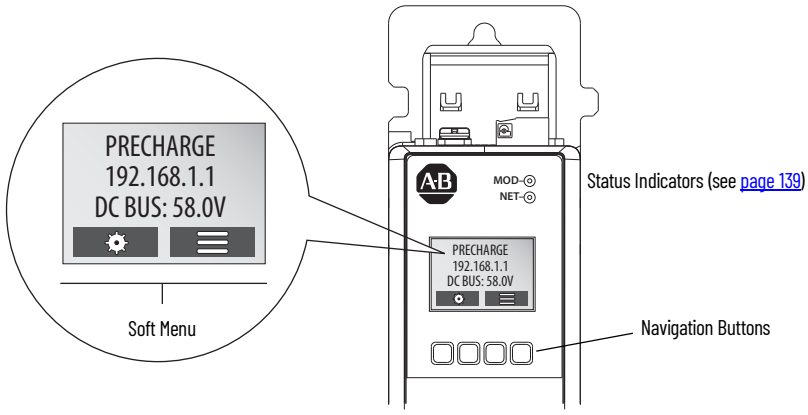
This chapter provides procedures for configuring your ArmorKinetix® system with a Logix 5000® controller by using the Studio 5000 Logix Designer® application.

Before you begin, make sure that you know the catalog number for each drive module, the Logix module and /or controller, and the motor used in your motion control application.

Power Interface Module (PIM) Display

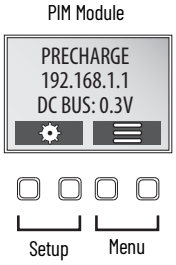
The ArmorKinetix Power Interface Module (PIM) has two status indicators and an LCD status display. The indicators and display are used to monitor the system status, set network parameters, and troubleshoot faults. Four navigation buttons, directly below the display, are used to select items from a soft menu.

Figure 48 - ArmorKinetix PIM LCD Display and Status Indicators



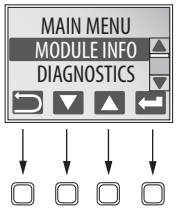
This is the Home screen.

- The setup selections are tied to the Setup (left-side) buttons and the menu selections are tied to the Menu (right-side) buttons.



The soft menu provides a changing selection that corresponds to the current screen. Use the navigation buttons to perform the following.

Each soft menu item is executed by pressing the navigation button directly below the item, as shown in this example.



	Press to go back. Pressing enough times results in the Home screen.
	Pressing either arrow moves the selection to the next (or previous) item. When changing values, pressing the up arrow increments the highlighted value. Values rollover after reaching the end of the list.
	Press to select values to change, moving from right to left. Values rollover when reaching the end of the list.
	Press to select a menu item.
	Press to return to the Home screen.
	Press to display the fault help (possible solutions in troubleshooting tables). For ArmorKinetix System fault code descriptions and possible solutions, see Kinetix 5700 System Fault Codes, publication 2198-RD003.

Menu Screens

The menu screens provide information about the drives, motors, diagnostics, and the fault log. Parameters cannot be updated in the menu screens. Press one of the menu buttons to access the menu.

You can use the soft menu items and navigation buttons to view the information.

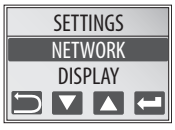
Table 35 - Navigating the ArmorKinetix PIM Menu

Menu/Sub Menu Selections	Attributes	Description	Example Values
Module Info	Catalog number		2198-PIM070
	Firmware revision		FW REV: 14.1.*xxx*
	Hardware revision		HW REV: 1.1
	Serial number		SERIAL#: xxxxxxxxxx
Diagnostics> Converter Diagnostics	Converter diagnostics		CONV UTIL: 0.7%
			DC BUS: 0.0V
			IBUS: 0.0A
			CONV UTIL: 0.0%
			PWR OUT: 0.0kW
	Digital Inputs		IN1: OFF
			IN2: OFF
			IN3: OFF
			IN4: OFF
Fault Log	Fault text	For ArmorKinetix system fault code descriptions and possible solutions, see ArmorKinetix System Fault Codes, publication 2198-RD004.	FLT S15 - CONVERTER OVERCURRENT
	Fault details		The measured converter current has exceeded the factory set current limit.
	Fault help		Reduce bus current load, check wiring for shorts

Setup Screens

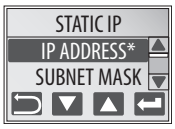
The setup screens provide the means of changing drive settings, for example, the IP address. Press one of the setup buttons to access the setup screens.

You can use the soft menu items and navigation buttons to view the information and make changes.



Press to validate your changes:

- If the change is invalid, the value doesn't change.
- If the change is valid, an asterisk appears next to the changed attribute.



IMPORTANT You must cycle control power to make network configuration changes persistent. In this example, the IP address was changed. The change takes affect and the asterisk disappears after control power is cycled.
Display configuration changes take effect immediately.

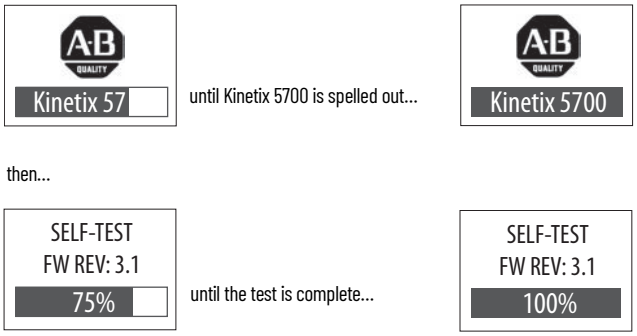
Table 36 - Navigating the PIM Settings Menu

Settings Menu Selections	Sub Menu Selections	Attributes	Default	Description
Protected Mode	Reset	ENABLED DISABLED	ENABLED	When Enabled (default), identity object or safety resets are not possible when a controller connection is open.
	Network Config	ENABLED DISABLED	ENABLED	When Enabled (default), network configuration changes are not possible when a controller connection is open.
	Flash Update	ENABLED DISABLED	ENABLED	When Enabled (default), firmware updates are not possible when a controller connection is open.
	Device Config	ENABLED DISABLED	ENABLED	When Enabled (default), only attribute writes are possible when a controller connection is open.
Network	->Static IP (1)	IP address	192.168.1.1	Indicates current IP address
		Subnet mask	255.255.255.000	Indicates current subnet mask
		Gateway	192.168.001.001	Indicates current gateway
	DHCP	On		Turns DHCP on
		Off		Turns DHCP off
Display	Backlight Timeout	30 sec ... NEVER (NEVER = no timeout period, the backlight is always on)	-> 3 min (1)	Sets backlight timeout period of the display
	Cyclic Data Select (2)	-> DC BUS		DC bus voltage
		CONV UTIL		Converter utilization in % Rated
		CONV TEMP		Converter temperature in °C
		PWR OUT		Output power in Watts
		IBUS		Output current in Amps
	Set Contrast	-10...+10	0	Contrast setting of the display
Web		ENABLED DISABLED	DISABLED	When Enabled, the drive's diagnostic webpage is accessible.

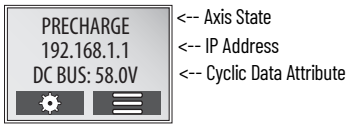
(1) An arrow (->) appears in front of the chosen attribute indicating that this attribute is currently configured. This is also the factory default setting.
(2) The DC bus voltage is one of several cyclic data attributes. You can select any of the Cyclic Data Select attributes to be displayed on the Home screen.

Startup Sequence

On initial powerup, the drive performs a self test. Upon successful completion, the drive firmware revision is displayed.



Next, the CIP axis state, the IP address, and the default cyclic data attribute (in this example DC-bus voltage) appears. In addition, the setup and menu soft keys are displayed. This is the Home screen.



In this example PRECHARGE is the axis state attribute. Table 37 lists the other axis states and their descriptions.

Table 37 - CIP Axis States on the Home Screen

Axis State	Description
STANDBY	The drive is waiting to receive configuration information from the controller.
CONNECTING	The drive is trying to establish communication with the EtherNet/IP controller.
CONFIGURING	The drive is receiving configuration information from the controller.
SYNCING	The drive is waiting for a successful Group Sync service.
PRECHARGE	The drive is ready for mains input power.
RUNNING	The drive is configured for No Control and is fully operational.
MAJOR FAULTED	The drive is faulted due to an existing or past fault condition.
START INHIBITED	The drive has an active condition that inhibits it from being enabled.
SHUTDOWN	The drive has been shut down.

Set Network Parameters for the PIM Module

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

You must program network parameters by using the LCD display.

1. From the LCD display, select SETUP>NETWORK and choose between STATIC IP and DHCP. The default setting is STATIC IP.
2. If STATIC IP, then press ↵ to configure the following parameters:
   - IP address
   - Gateway
   - Subnet mask

Settings are stored in nonvolatile memory. IP addressing can also be changed through the Module Configuration dialog box in RSLinx® software. Changes to the IP addressing take effect after power is cycled. The module is factory programmed to static IP address of 192.168.1.1.

Refer to Setup Screens on page 82 for help setting the network parameters.

Set Network Parameters for the DSD and DSM Modules

Use the rotary switches on the module to set the IP address, 192.168.1.*xxx*, where you set the last octet *xxx*. You can set the IP address when there is no power applied to the module. IP addressing can also be changed through the Module Configuration dialog box in RSLinx software. Changes to the IP addressing, protected mode enabled/disabled settings, and restoring factory defaults take effect after power is cycled. The DS*x* module is factory programmed to '999', which puts the module in BOOTP/DHCP mode.

Rotary switches are housed under removable caps and are NOT accessible during normal operation. Remove a cover to gain access. Use a screw driver to turn the switches to the appropriate setting.

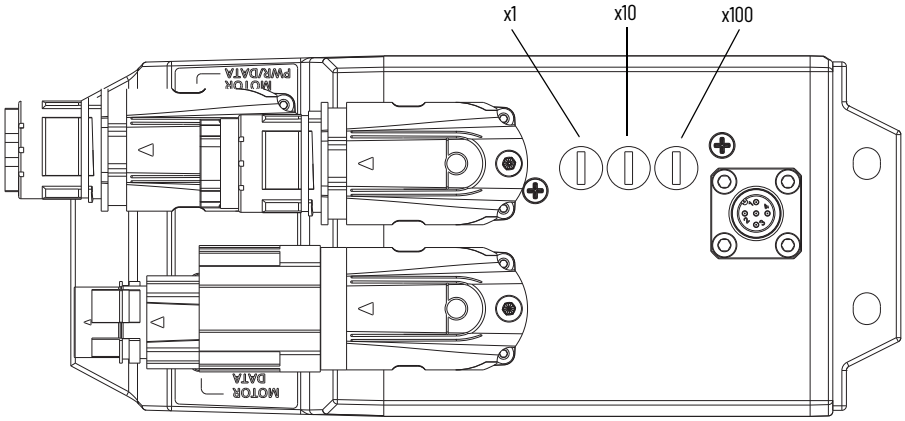


Table 38 - EtherNet/IP Rotary Switch Settings

Switch Setting	Function
000	Disable Protected Mode. A power cycle after the switches are set to 000 disables Protected Mode.
001...254	Sets the last octet of the IP address to the value indicated (xxx in 192.168.1.xxx) on the module.
888	A power cycle after the switches are set to 888 restores all factory default settings. Before you use this setting, read the **Important** statement after this table.
900	Enable Protected Mode. A power cycle after the switches are set to 900 enables Protected Mode. When the system is in Protected Mode, the module does not allow any configuration changes, resets, or firmware updates when a controller connection is open. Protected Mode is enabled by default.
999	Sets the IP address to a value determined by DHCP or an address that is stored in non-volatile memory. IP addresses can be changed through the Module Configuration dialog box in RSLinx software. '999' is the default setting.
All other values	Reserved.

IMPORTANT Before changing the EtherNet/IP address rotary switch settings to 888, consider the following:

- Restoring the factory default settings clears all functional safety configurations, resets safety ownership, and returns the motor module to the out-of-box-state.
- Only authorized personnel should attempt to reset the safety ownership.
- When the motor module returns to the out-of-box state, Safe Torque Off (STO) safety integrity is lost.

Install the Add-on Profile for the Studio 5000 Environment

For help using the Studio 5000 Logix Designer application as it applies to configuring the ControlLogix® or CompactLogix™ controllers and the GuardLogix® 5580 safety controller and Compact GuardLogix 5380 controller, refer to Additional Resources on page 9.

Each release of the Studio 5000 Logix Designer application makes possible the configuration of additional Allen-Bradley® motors, actuators, power supplies, and drive features not available in previous versions.

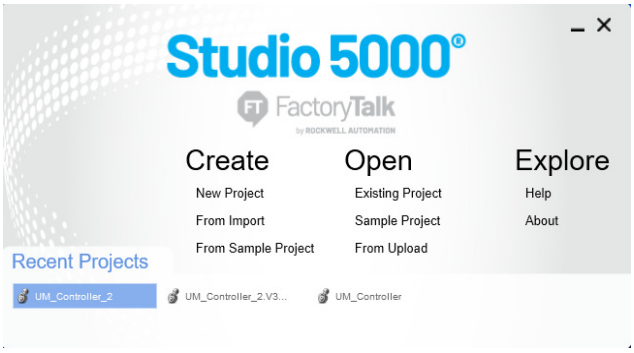
Download Add-On profiles (AOP) from the Product Compatibility Download Center (PCDC) website: at rok.auto/pcdc.

Configure the Logix 5000 Controller

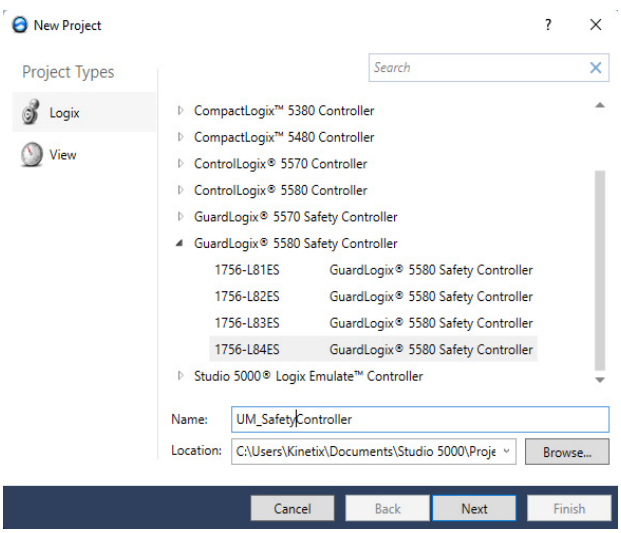
These procedures assume that you have wired your ArmorKinetix System drive system. In this example, the GuardLogix 5580 safety controller and Compact GuardLogix 5380 controller dialog boxes are shown.

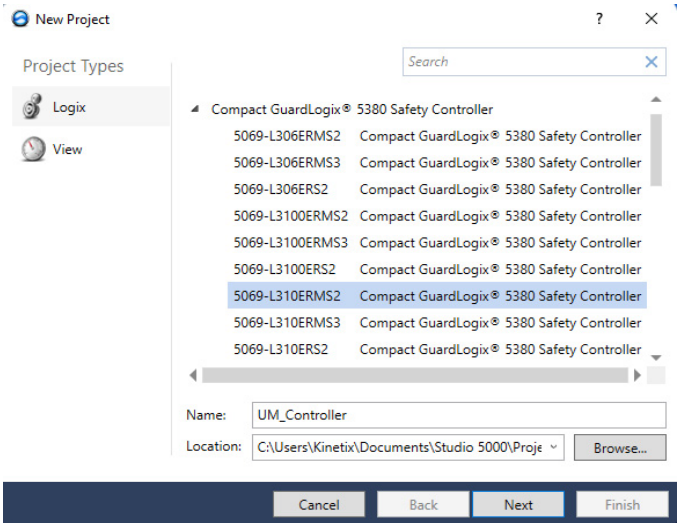
Follow these steps to configure the controller.

1. Apply power to your controller and open your Studio 5000 Logix Designer application



2. From the Create menu, choose New Project.
   The New Project dialog box appears.





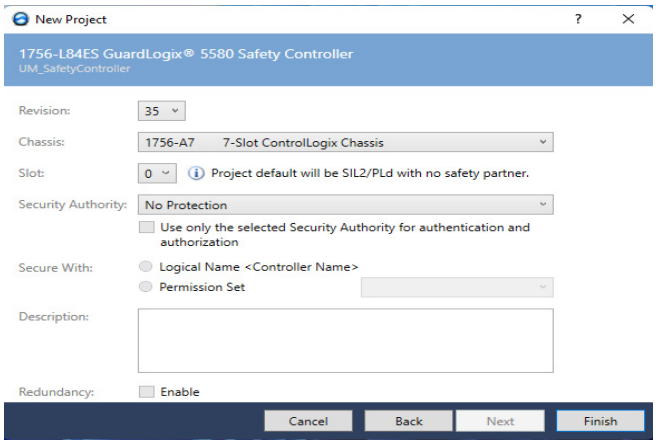
IMPORTANT If you are configuring a safety application, you must use a GuardLogix or Compact GuardLogix safety controller.

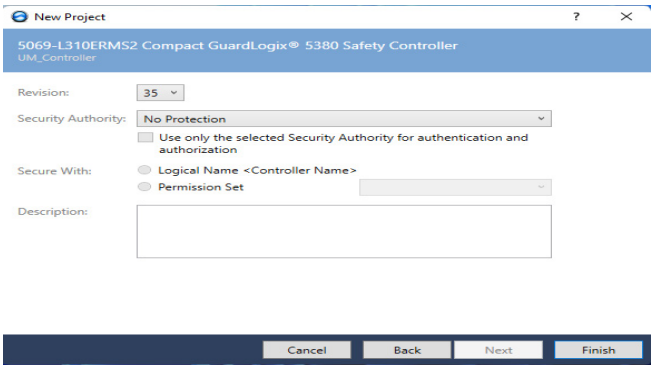
See Integrated Functional Safety Support on page 20 for a table of minimum controller requirements.

In this example, the typical dialog boxes for ControlLogix and GuardLogix 5580 controllers and CompactLogix 5380 controllers with embedded Ethernet are shown.

Follow these steps to configure your Logix 5000 controller.

1. Expand the Logix 5000 controller family and select your controller.
2. Type the file Name.
3. Click Next.
   The New Project dialog box appears.





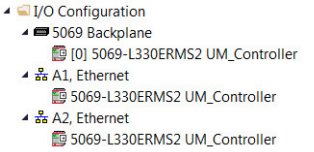
4. From the Revision dropdown menu, choose your software revision.

IMPORTANT To configure ArmorKinetix systems, you must be using the Studio 5000 Logix Designer application, version 35.00.00 or later (with a user-installed Add-On Profile).

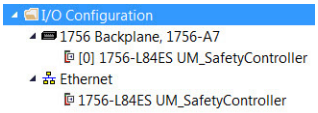
5. Click Finish.

   The new controller appears in the Controller Organizer under the I/O Configuration folder.

   Controller Organizer with Compact GuardLogix 5380 controller.



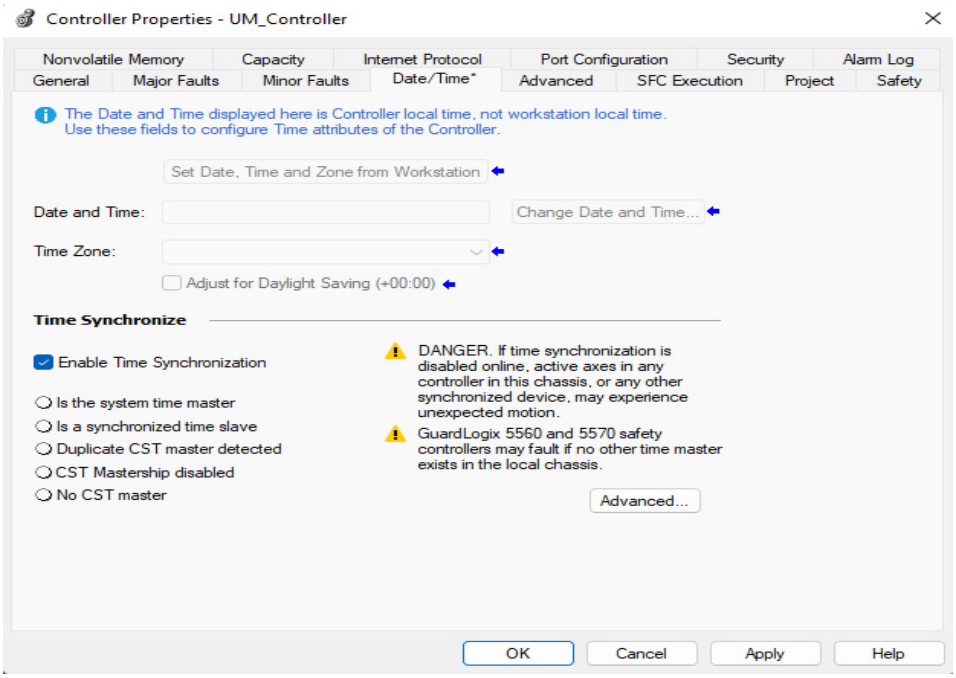
   Controller Organizer with GuardLogix 5580 controller.



6. From the Edit menu, choose Controller Properties.

   The Controller Properties dialog box appears.

7. Click the Date/Time tab.



8. Check Enable Time Synchronization.

   The motion modules set their clocks to the module you assign as the Grandmaster.

IMPORTANT Check Enable Time Synchronization for all controllers that participate in CIP Sync™. The overall CIP Sync network automatically promotes a Grandmaster clock, unless the priority is set in Advanced.

9. Click OK.

Add and Configure a Kinetix 5700 DC-bus Power Supply

Add the DC-bus Power Supply to the Controller organizer, see the Kinetix 5700 Servo Drives User Manual, publication 2198-UM002.

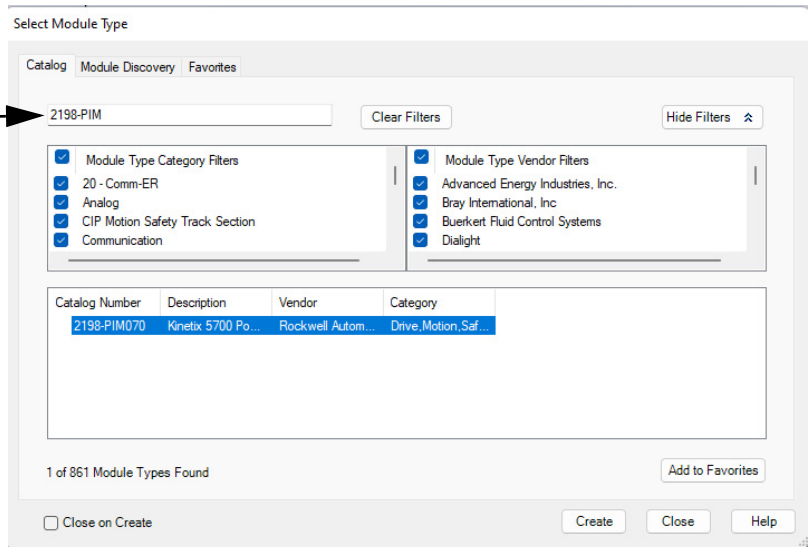
IMPORTANT When adding the power supply to the controller organizer, on the Power page, verify that the voltage and the Primary Bus sharing group match the PIM module.

Add and Configure the ArmorKinetix PIM Module

Follow these steps to configure the ArmorKinetix PIM module.

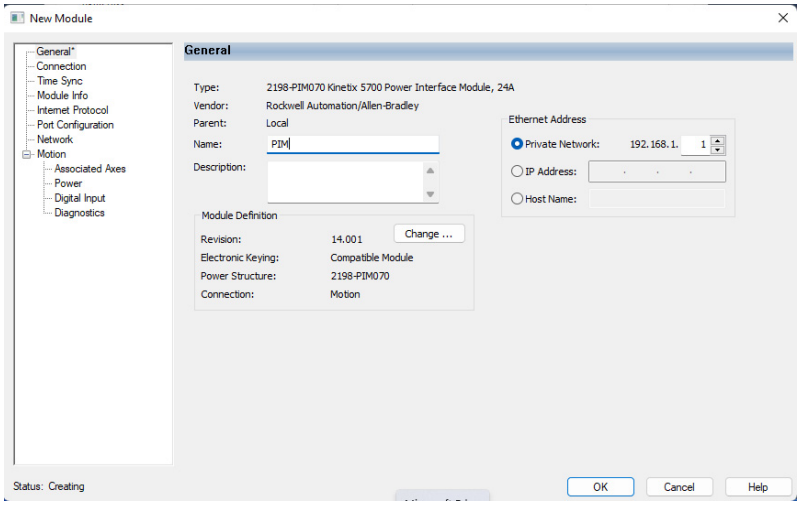
1. Below the controller you just created, right-click Ethernet and choose New Module.

   The Select Module Type dialog box appears.

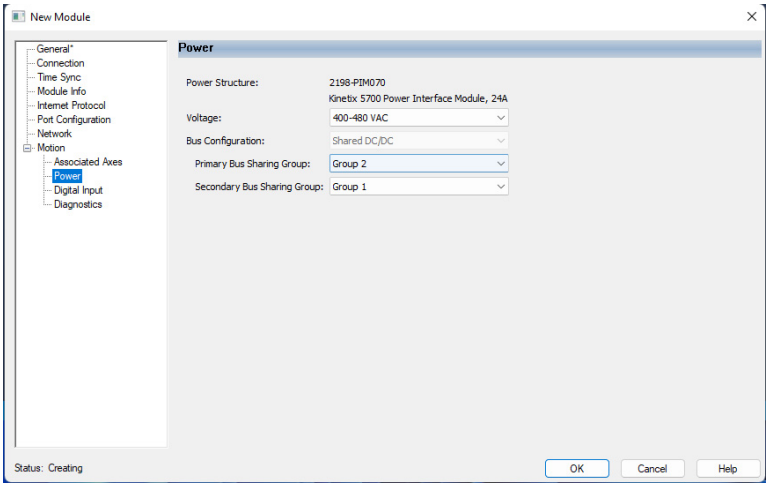


2. By using the filters, check Motion and Allen-Bradley, and select your 2198-PIM module as appropriate for your hardware configuration.
3. Click Create.

   The New Module dialog box appears.



4. Configure the new module.
   a. Type the module Name.
   b. Select an Ethernet Address option.
      In this example, the Private Network address is selected.
   c. Enter the address of your 2198-PIM070 module.
      In this example, the last octet of the address is 1.
5. Click the Power category.



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

6. From the dropdown menus, choose the power options appropriate for your hardware configuration.

Attribute	Menu	Description
Bus Configuration	Shared DC/DC (1)	Applies to PIM modules.
Primary Bus-sharing Group (2)	• Group1 • Group2 • Group3...	Selects the Bus Sharing Group shared with the AC/DC converter suppling DC voltage to the PIM power supply.
Secondary Bus-sharing Group		Selects the Bus Sharing Group shared with the DSx modules connected to the PIM module power supply output.
Voltage	• 200...240V AC • 400...480V AC	Select 200V Class or 400V Class.

(1) Shared DC/DC bus configuration is the only option for the PIM module and the selection cannot be changed.
(2) For more information on bus-sharing groups, refer to Understand Bus-sharing Group Configuration on page 128. For more information on primary and secondary bus-sharing groups, see Kinetix 5700 Servo Drives User Manual, publication 2198-UM002.

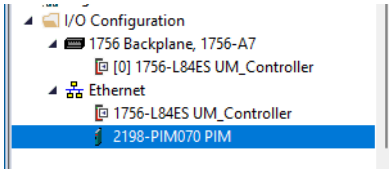
ATTENTION: To avoid damage to equipment all modules physically connected to the same shared-bus connection system must be part of the same Bus Sharing Group in the Studio 5000 Logix Designer application.

7. Click OK to close the New Module dialog box.

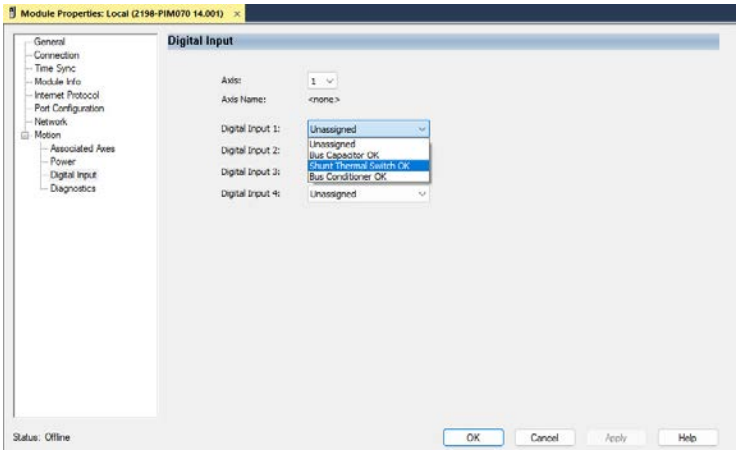
To configure the remaining PIM properties, you must close the New Module dialog box and reopen it as the Module Properties dialog box.

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

9. To open the Module Properties dialog box, right-click the PIM module you just created in the Controller Organizer and choose Properties.

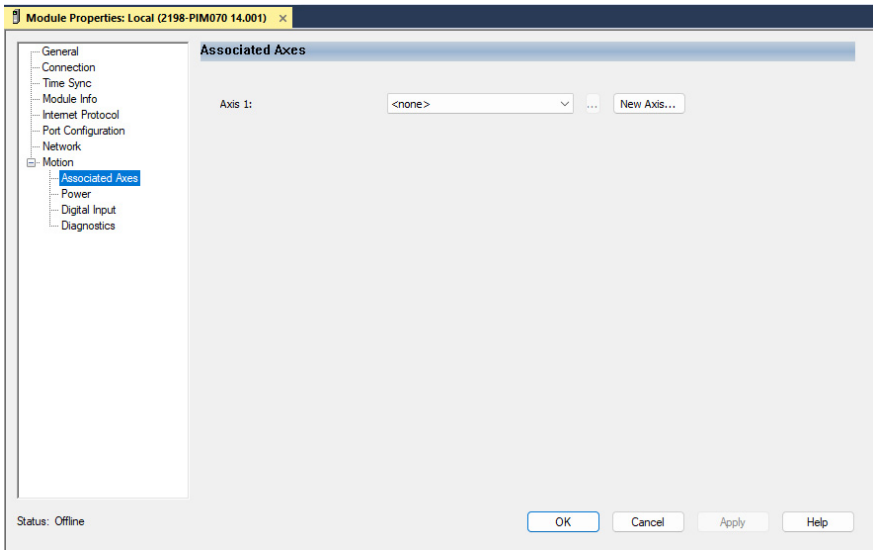


10. Click the Digital Input category.



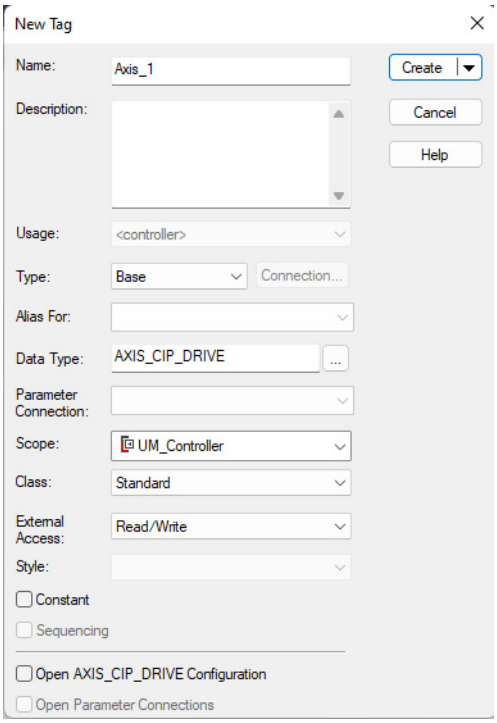
11. From the Digital Input dropdown menu choose from these options:
    - Bus Capacitor OK
    - Bus Conditioner OK
    - Shunt Thermal Switch OK.

    See Digital Input Functions on page 62 for option definitions.
12. Click the Associated Axes category.



13. Click New Axis.

    The New Tag dialog box appears.



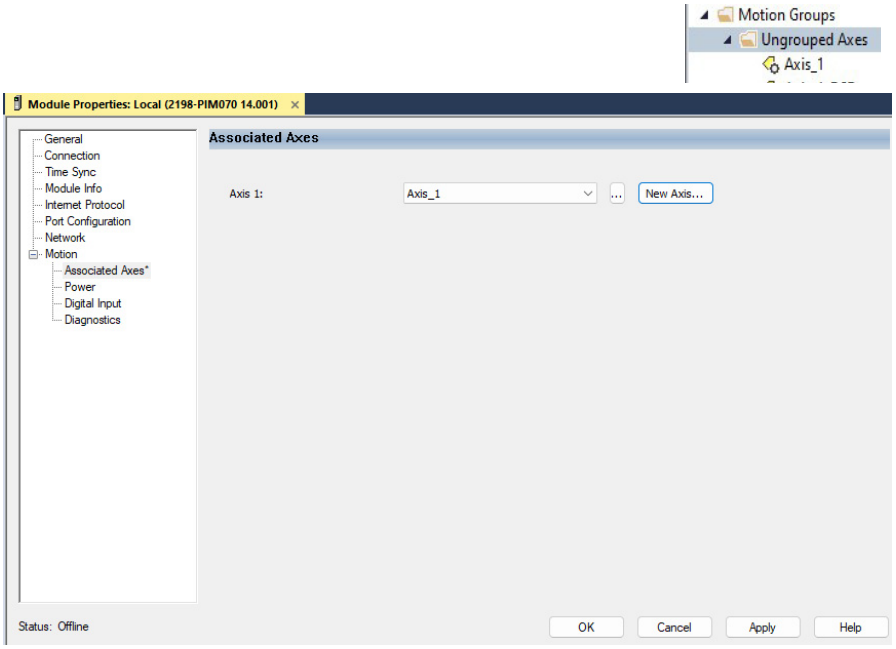
14. Type the axis Name.

    AXIS_CIP_DRIVE is the default Data Type.

    Class is Standard or Safety.

15. Click Create.

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



16. Click Apply.
17. Repeat step 1 through step 16 if you have more than one 2198-PIM070 module.

Add and Configure the DSD or DSM Module

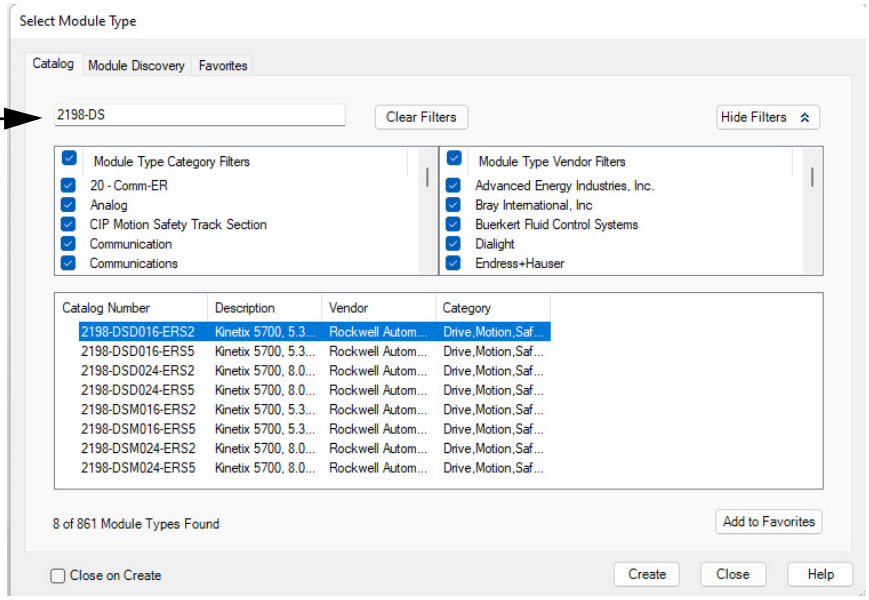
This procedure applies to single-axis inverters with integrated safety connections. In this example, a 2198-DSx-ERSx module is configured.

Follow these steps to configure the ArmorKinetix DSD or DSM module.

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

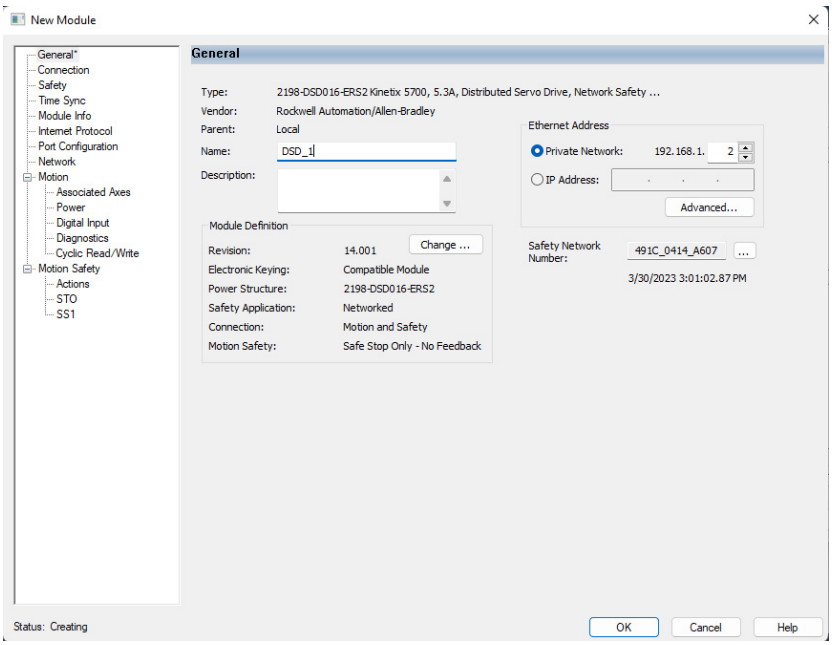
   The Select Module Type dialog box appears.

Enter 2198-DS here to further limit your search.



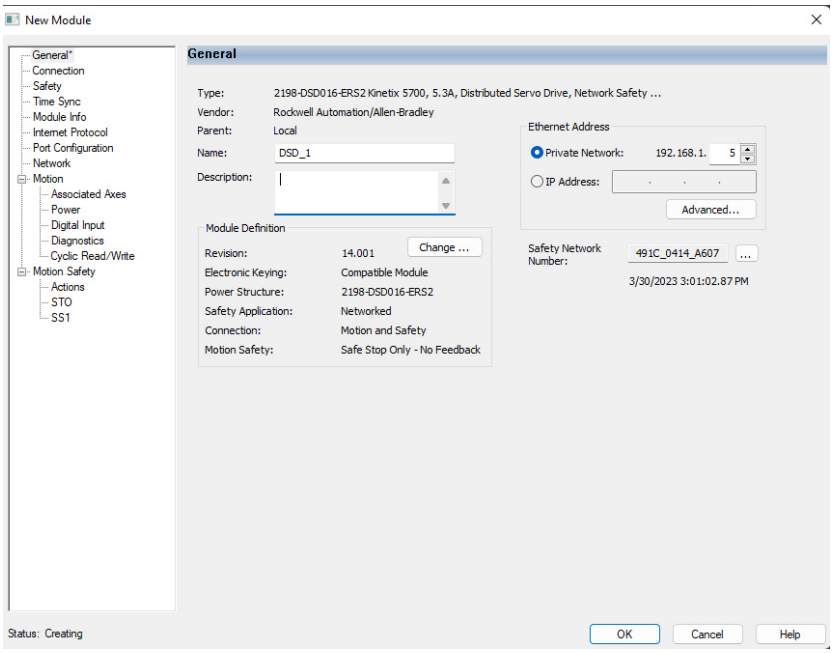
2. By using the filters, check Motion and Allen-Bradley, and select your 2198-DSx module as appropriate for your hardware configuration.
3. Click Create.

   The New Module dialog box appears.



4. Add the DSD/DSM module to the controller organizer and click create.

   The New Module dialog box appears.



5. Configure the new drive.
   a. Type the drive Name.
   b. Select an Ethernet Address option.
   c. Enter the address of your 2198-DS*x*-ERS*x* module.
   d. Click Advanced if using network address translation with safety connection to add drive module configured IP address.

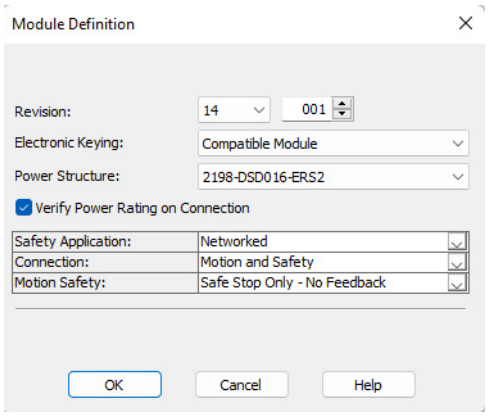
      The Safety Network Number (SNN) field populates automatically when the Connection mode on the Module Definition dialog box includes an integrated Motion and Safety or Safety-only connection. For a detailed explanation of the safety network number, refer to the appropriate GuardLogix controller publication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

Configure Module Definition

Follow these steps to configure 2198-DSx-ERS2 and 2198-DSx-ERS5 modules.

1. To open Module Definition dialog box, click Change.

   The Module Definition dialog box appears.



   Depending on the Module Definition revision selection, alternate product features and feedback types can be selected.

2. From the Safety Application dropdown menu, choose between Safety Off or Networked for an integrated safety application (see Table 39 on page 94 for definitions).

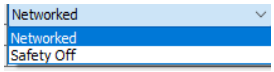


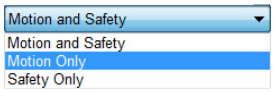
Table 39 - Safety Application Definitions

Safety Application Mode	Safety Functions	Minimum Drive Module Required	Drive Module Connection Options	Minimum Controller Required (1)
Safety off	None	2198-DSx-ERS2 or -ERS5	• Motion Only	• ControlLogix 5570 • CompactLogix 5370
Networked (integrated)	Safe Torque-off (STO)	2198-DSx-ERS2 or -ERS5	• Motion and Safety • Safety Only • Safety Networked (Integrated) • Motion Only • Networked (Integrated) and select Safety Only	• GuardLogix 5570 • Compact GuardLogix 5370
	Timed SS1	2198-DSx-ERS2 or -ERS5	• Motion and Safety • Safety Only	
	• Timed SS1 • Monitored SS1 • Controller-based safety functions (2)	2198-DSx-ERS5	• Motion and Safety • Safety Only	• GuardLogix 5580 • Compact GuardLogix 5380

(1) Where a ControlLogix or CompactLogix (non-safety) controller is specified, a GuardLogix or Compact GuardLogix controller is backwards compatible. Also, GuardLogix 5580 and Compact GuardLogix 5380 controllers are backwards compatible with GuardLogix 5570 and Compact GuardLogix 5370 controllers.

(2) See the Kinetix 5700 Safe Monitor Functions Safety Reference Manual, publication 2198-RM001, for more information on these Drive Safety instructions.

3. From the Connection dropdown menu, choose the Connection mode for your motion application (see Table 40 for definitions).



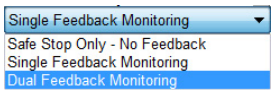
When 'Safety' appears in the Connection mode, integrated safety is implied.

Table 40 - Module Connection Definitions

Connection Mode	Safety Options	Description
Motion and Safety	• Integrated mode	• Motion connections and Integrated Safety are managed by this controller.
Motion Only	• Integrated mode if there is a secondary safety controller	• Motion connections are managed by this controller.
Safety Only	• Integrated mode	• Integrated Safety is managed by this controller. • Motion connections are managed by another controller that has a Motion-only connection to the drive.

4. From the Motion Safety *x* dropdown menu, choose the integrated safety type (see Table 41 on page 95 for definitions).

   Motion Safety aligns with Axis 1 configured in Associated Axes.



Dual Feedback Monitoring is only available on DSD modules, not on DSM modules.

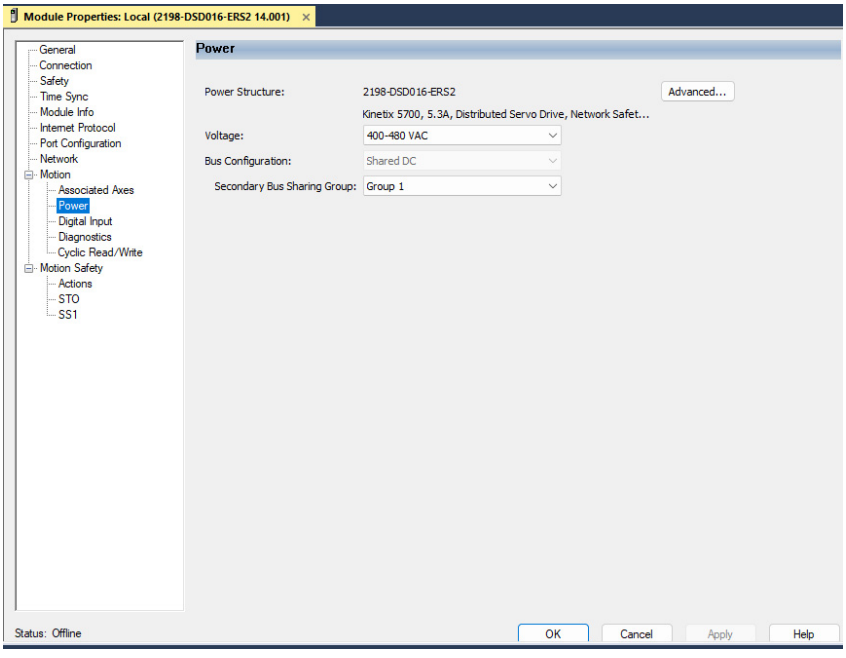
Table 41 - Motion Safety Definitions

Motion Safety Mode	Module Connection Options	Description
Safe Stop Only - No Feedback	• Motion and Safety • Safety Only	• 2198-DSx-ERS5: STO function and Timed SS1 Safe Stop functions are available. • 2198-DSx-ERS2 STO function and Timed SS1 Safe Stop functions are available.
Single Feedback Monitoring	• Motion and Safety • Safety Only	• 2198-DSx-ERS5: STO function and Timed SS1 Safe Stop functions are available. • 2198-DSD-ERS5: Primary feedback is used in the safety object for safe monitoring. The feedback can be a SIL rated Hiperface DSL encoder, for example, a VPL-B1003P-Q or W motor used in the Motor Power/Feedback connector. This can also be a Sine/Cosine device, for example, an MPL-B310P-M motor used in the Motor Feedback connector. See the Kinetix 5700 Safe Monitor Functions Safety Reference Manual, publication 2198-RM001, to evaluate SIL levels possible with a single feedback device. • 2198-DSx-ERS5: Drive-based Monitored SS1 and other controller-based monitoring functions.
Dual Feedback Monitoring	• Motion and Safety • Safety Only	• 2198-DSD-ERS5: STO function and Timed SS1 Safe Stop functions are available. • 2198-DSD-ERS5: Safety feedback which can be used for SS1 (monitored) safety function functionality. • 2198-DSD-ERS5: Safe dual channel feedback is available.

5. Click OK to close the Module Definition dialog box.
6. Click Apply.

Configure the Power and Safety Categories

1. Click the Power category.



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

2. From the dropdown menus, choose the power options appropriate for your hardware configuration.

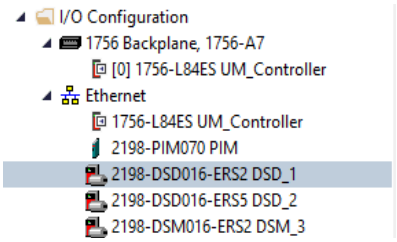
Attribute	Menu	Description
Voltage	• 200...240V AC • 400...480V AC	Select 200V Class or 400V Class.
Bus Configuration	Shared DC	Applies to 2198-DSx-ERSx modules.
Secondary Bus Sharing Group (1)	• Group1 • Group2 • Group3...	Applies to any bus-sharing configuration.

(1) For more information on bus-sharing groups, refer to Understand Bus-sharing Group Configuration on page 128.

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

3. Click OK to close the Module Properties dialog box.
4. Click Close to close the Select Module Type dialog box.

   Your 2198-DSx-ERSx module appears in the Controller Organizer under the Ethernet network in the I/O Configuration folder.



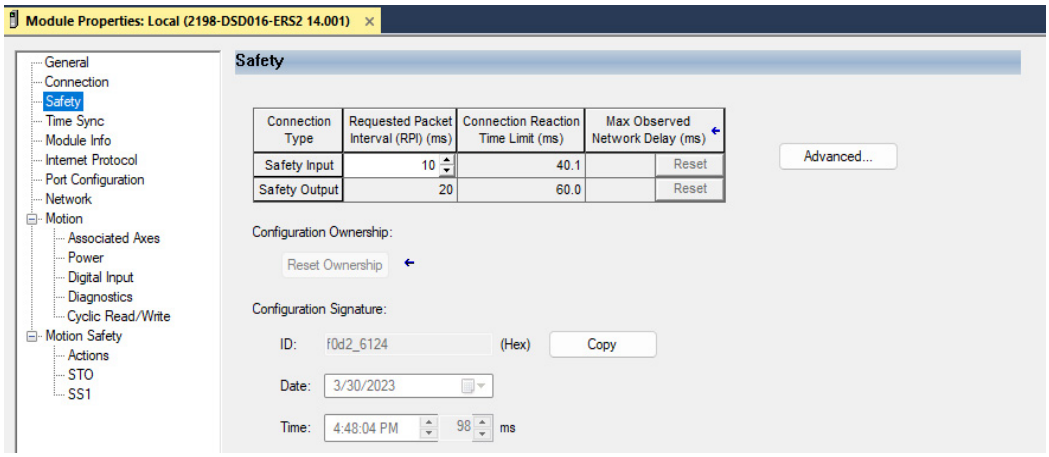
5. Right-click the drive you just created in the Controller Organizer and choose Properties.

   The Module Properties dialog box appears.

To configure the remaining inverter properties, you must close the New Module dialog box and reopen it as the Module Properties dialog box.

If	Then
Your application includes integrated safety	Go to step 6 on page 96.
Your application has no safety connections	Go to Add an Associated Axis on page 97.

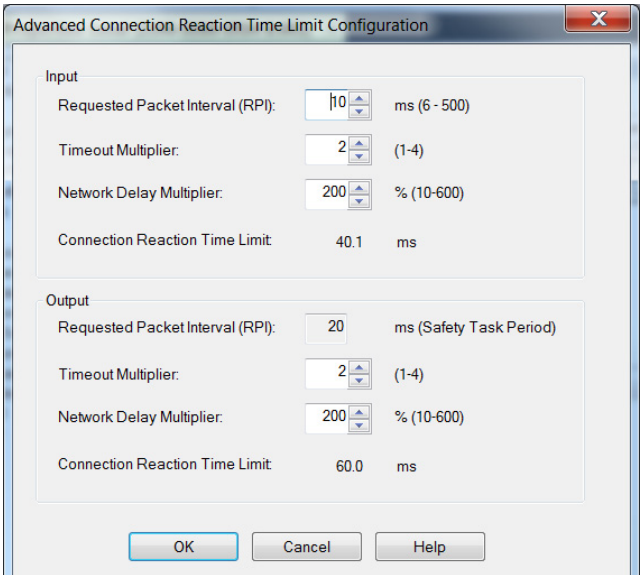
6. Click the Safety category.



7. The connection between the owner and the 2198-DSx-ERSx module is based on the following:
   - Servo drive safety network number
   - GuardLogix slot number
   - GuardLogix safety network number
   - Path from the GuardLogix controller to the 2198-DSx-ERSx drive
   - Configuration signature

   If any differences are detected, the connection between the GuardLogix controller and the 2198-DSx-ERSx module is lost, and the yellow yield icon appears in the controller project tree after you download the program.
8. Click Advanced.

   The Advanced Connection Reaction Time Limit Configuration dialog box appears.



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

   For more information about the Advanced Connection Reaction Time Limit Configuration, refer to Additional Resources on page 9 for the appropriate user manual for your GuardLogix or Compact GuardLogix controller.
9. Click OK to close the Advanced dialog box.
10. Click Apply to save the Safety category parameters.

Add an Associated Axis

After you've established your ArmorKinetix modules in the Studio 5000 Logix Designer application, the feedback options need to be defined for each axis. Each physical axis supports motor and auxiliary feedback.

Table 42 - ArmorKinetix Feedback Axis Summary

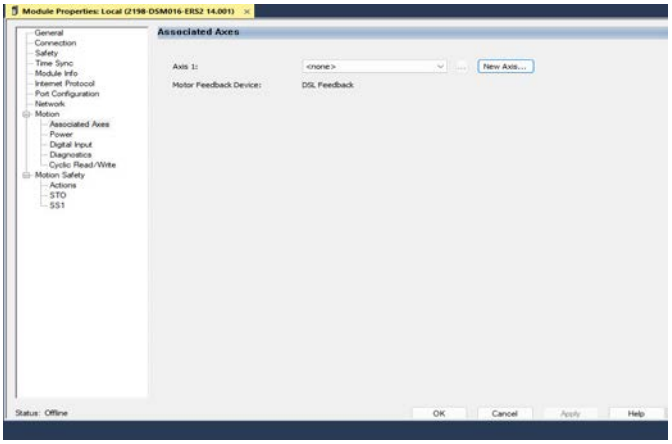
Module	Inverter Cat. No.	Motor Feedback	Auxiliary Feedback
ArmorKinetix DSD	2198-DSD-ERS2 or 2198-DSD-ERS5	1 (axis 1)	1 (axis 2)
ArmorKinetix DSM	2198-DSM-ERS2 or 2198-DSM-ERS5	1 (axis 1)	–

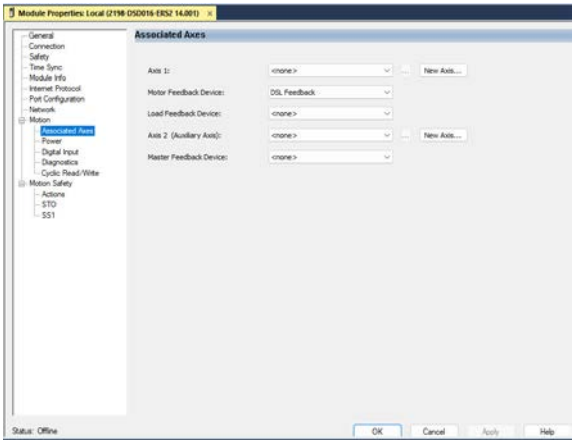
Table 43 - Motor Feedback Compatibility

Module	Motor Feedback Device Option	Feedback Type		Description
DSD	Motor Feedback Connector	• Digital AqB • Digital AqB with UVW • Sine/Cosine • Sine/Cosine with UVW	Incremental	Applies to Kinetix MPL (-H) rotary motors, Kinetix MPAS (direct-drive) linear actuators, Kinetix LDAT (-xBx) linear thrusters, and Kinetix LDC linear motors.
		Hiperface Sine/Cosine	High-resolution, absolute, single-turn and multi-turn	Applies to Kinetix MPL, MPM, MPF, MPS (-M/S or -V/E) rotary motors; Kinetix MPAS (ballscrew), MPAR linear actuators; ; and Kinetix LDAT (-xDx) linear thrusters by using the motor feedback cable.
	Motor Power/Feedback Connector	Hiperface DSL	High-resolution, absolute, single-turn and multi-turn	VPx family (VPL, VPF, VPS, and VPH), 63...130mm Frames, Kinetix VPAR electric cylinders.
DSM	DSL Feedback (internal connection)	Hiperface DSL	High-resolution, absolute, single-turn and multi-turn	Applies to ArmorKinetix DSM modules.

Follow these steps to configure the axes for your ArmorKinetix System.

1. Right-click the 2198-DSx-ERSx module you just created and choose Properties.
   The Module Properties dialog box appears.
2. Select the Associated Axes category.



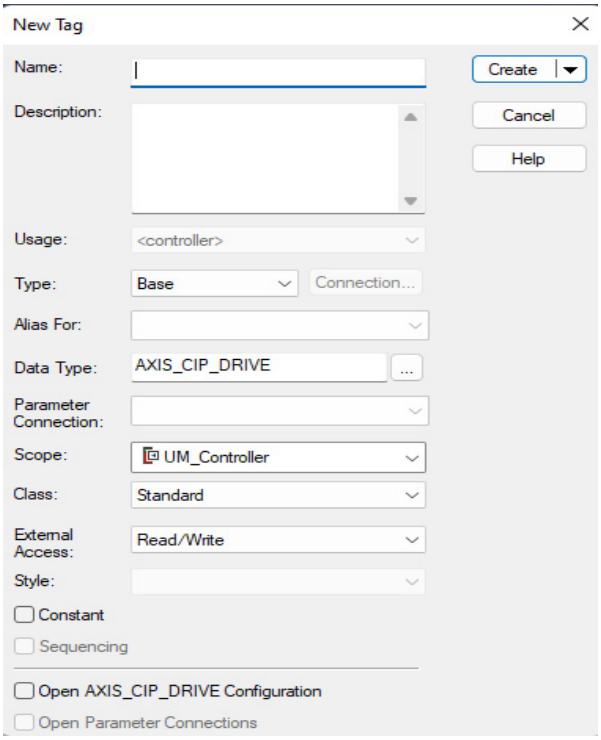


In this example, DSM modules support one axis and DSL feedback only. The DSD modules support up to two axes and either Auxiliary or DSL feedback.

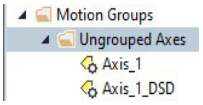
Motor Feedback Options	Description
DSL Feedback (M23 type connector)	The DSD module motor power and feedback connector includes power and DSL feedback when connected to a Kinetix VPx motor by using 2090-CSBM1P7-14AFxx cables.
Motor Feedback (M17 type connector)	The DSD module motor feedback connector includes other feedback types, but not DSL, when connected to other motors by using 2090-CFBM7S7-CDAFxx cables.

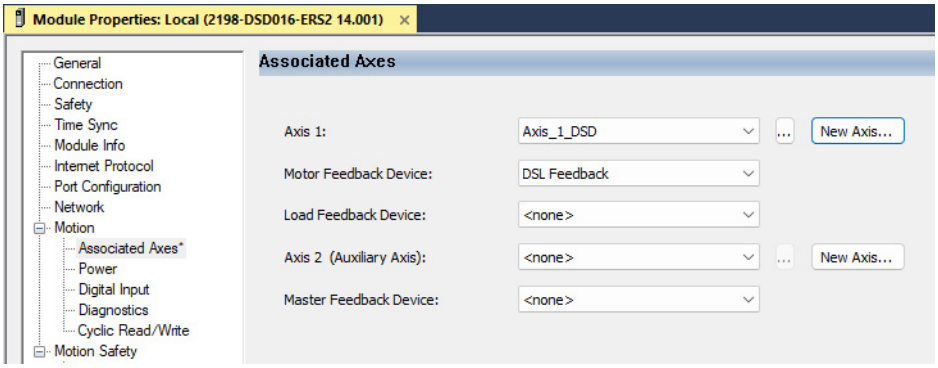
3. From the Axis *x* dropdown menu, choose an axis to assign to that motor feedback or auxiliary feedback device.
4. From the Feedback Device dropdown menu, choose either DSL Feedback or Auxiliary Feedback to associate with each axis.

5. Click New Axis.
   The New Tag dialog box appears.



6. Type the axis Name.
   AXIS_CIP_DRIVE is the default Data Type.
7. Click Create.
   The axis (Axis_1 in this example) appears in the Controller Organizer under Motion Groups> Ungrouped Axes and is assigned as Axis 1.





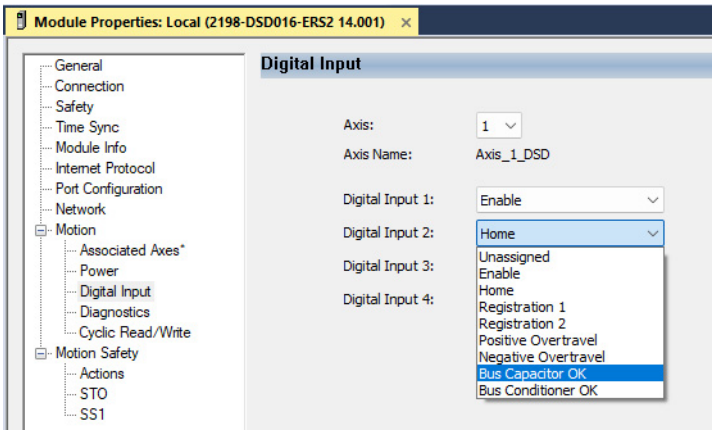
You can configure an axis as Feedback Only. Refer to Configure Feedback-only Axis Properties on page 104 for more information.

Refer to Configure Motor Feedback Properties on page 123 for configuring motor feedback, load feedback, and master feedback devices.

8. Click Apply.

Configure Digital Inputs

1. Click the Digital Input category.



2. From the Digital Input dropdown menus choose the functions appropriate for your application.

   See Digital Input Functions on page 62 for definitions of the functions.

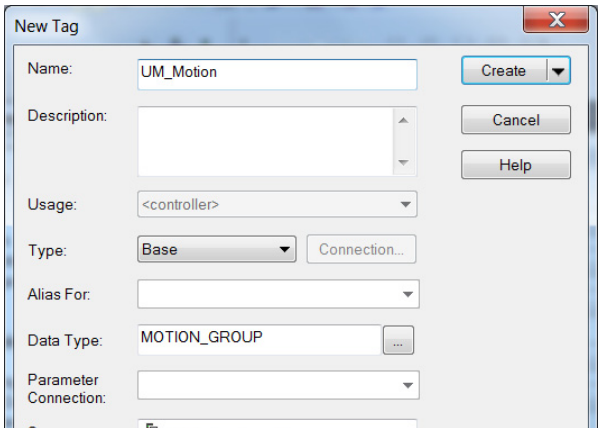
3. Click OK.
4. Repeat step 1 through step 3 for each ArmorKinetix DSx module.

Configure a Motion Group

Follow these steps to configure the motion group.

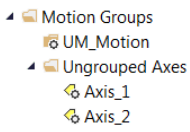
1. In the Controller Organizer, right-click Motion Groups and choose New Motion Group.

   The New Tag dialog box appears.

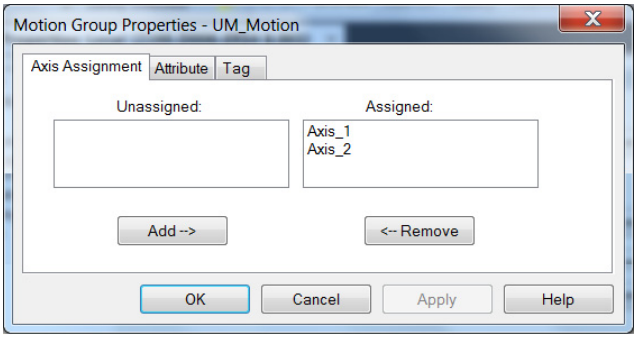


2. Type the new motion group Name.
3. Click Create.

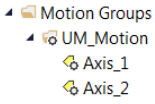
   Your new motion group appears in the Controller Organizer under the Motion Groups folder.



4. Right-click the new motion group and choose Properties.
   The Motion Group Properties dialog box appears.



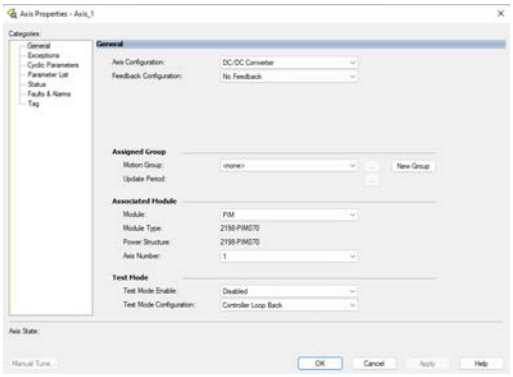
5. Click the Axis Assignment tab and move your axes (created earlier) from Unassigned to Assigned.
6. Click the Attribute tab and edit the default values as appropriate for your application.
7. Click OK.
   Your axes moves to the new motion group.



Configure Axis Properties for the PIM Module

When an axis is associated to the ArmorKinetix PIM module, the Axis Configuration is set to DC/DC Converter and the Feedback Configuration is set to No Feedback.

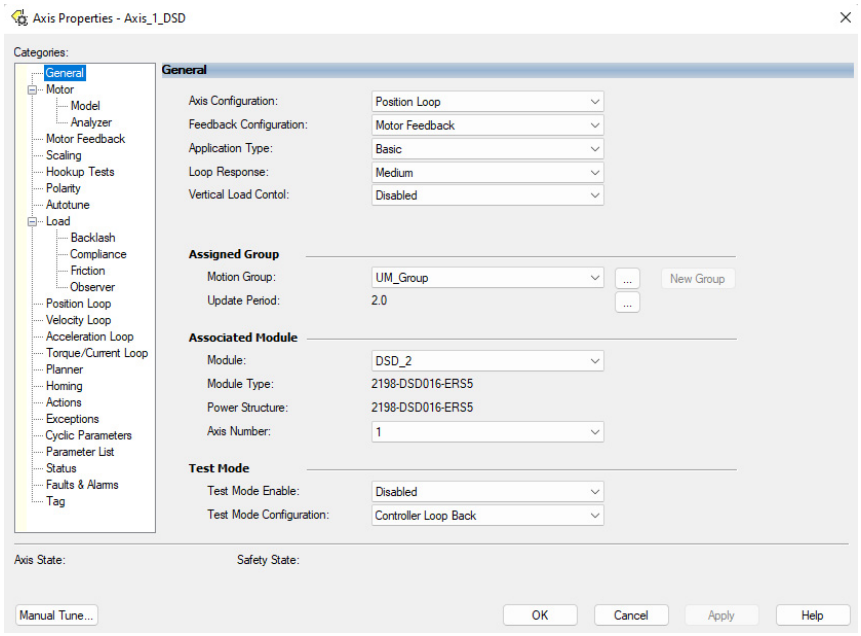
You can choose the Motion Group or create a New Group.



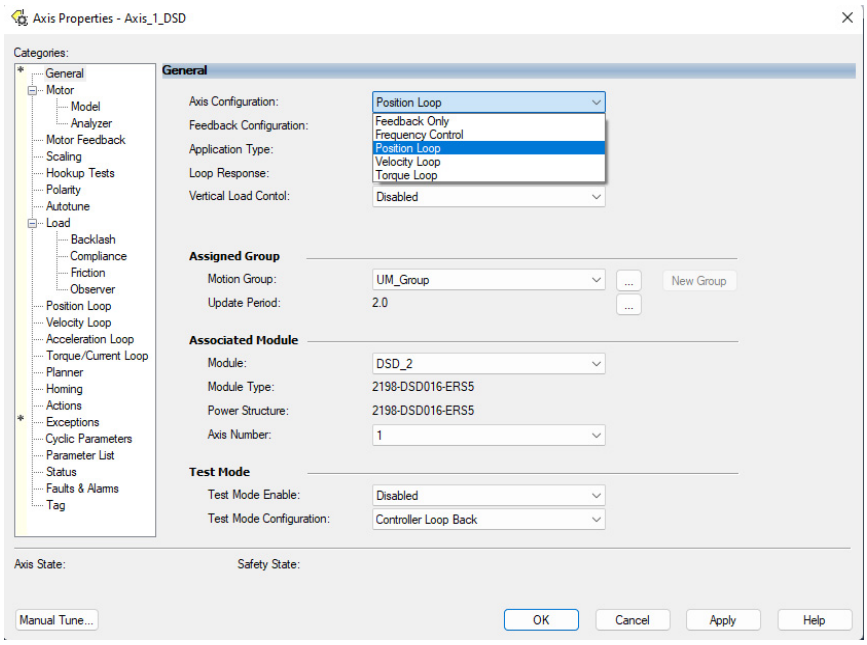
Configure Axis Properties for ArmorKinetix DSD and DSM Modules

Follow these steps to configure Axis Properties for your 2198-DSx-ERSx module.

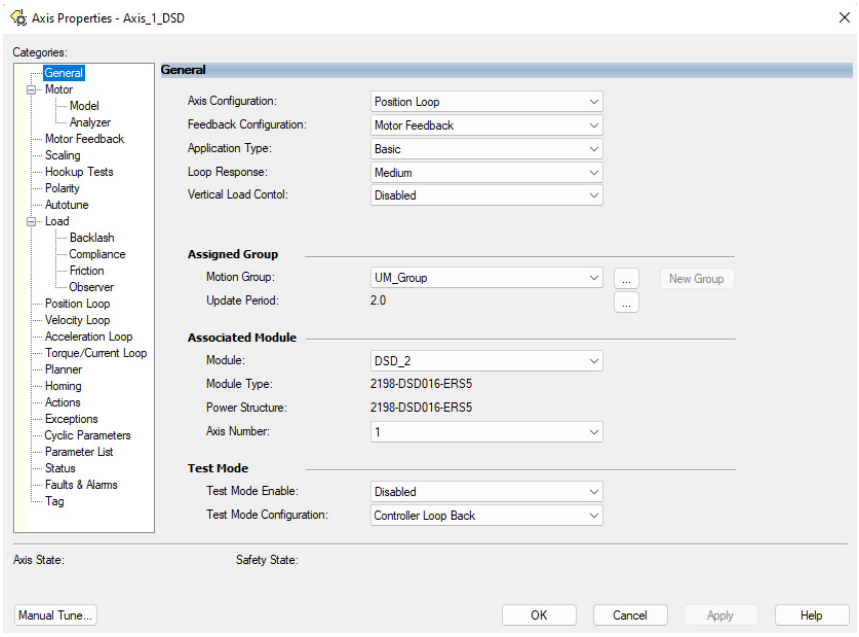
1. In the Controller Organizer, right-click the DSx module axis and choose Properties.
2. Select the General category.
   The General dialog box appears.



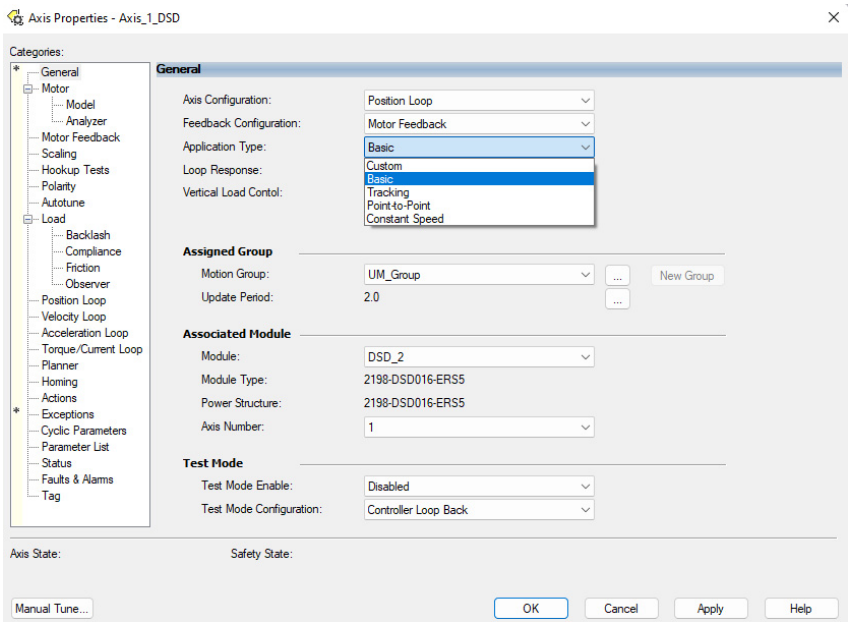
3. From the Axis Configuration dropdown menu, choose your configuration.
   This example is for the DSD module. The DSM module does not have Frequency Control.



4. From the Feedback Configuration dropdown menu, choose your configuration, if applicable.



5. From the Application Type dropdown menu, choose your type if applicable.



6. From the Loop Response dropdown menu choose Medium (default).
   The default setting is appropriate for most applications.

Loop Response Setting	Impact
High	Under-damped voltage set-point step response (Z = 0.8)
Medium	Critically-damped voltage set-point step response (Z = 1.0)
Low	Over-damped voltage set-point step response (Z = 1.5)

7. Click Apply.
8. Review other categories for the axis and make changes as needed for your application.
9. Click OK.

Configure Vertical Load Control Axis Properties

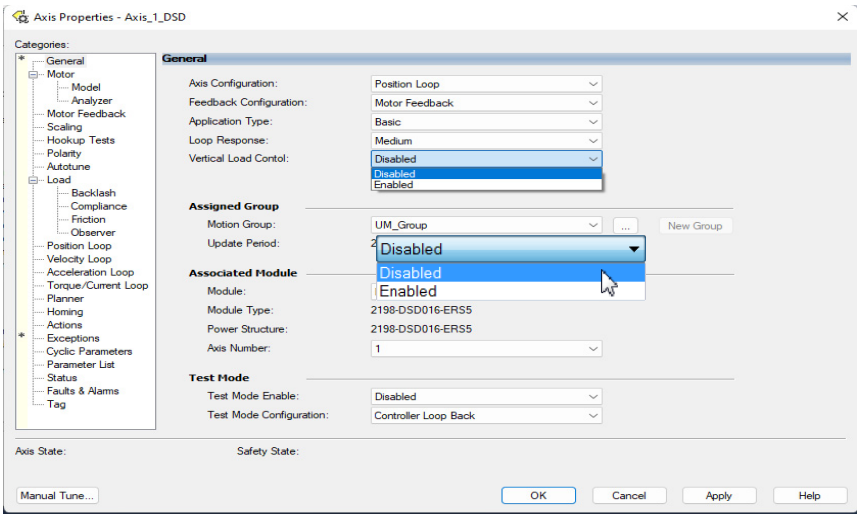
The 2198-DSx-ERSx modules support the Vertical Load Control feature. A vertical load is an axis that can move due to stored potential energy. Some examples include a robot arm, lift, or compressed spring. When set to Enabled, rather than applying Stop Category 0 stopping actions in response to most Major fault conditions, when possible, the drive brings the motor to a controlled stop and engages the holding brake prior to disabling the power structure.

When Vertical Load Control is enabled and the drive supports Torque Proving and Brake Proving functionality, the controller sets the associated Proving Configuration attribute default value to enable.

IMPORTANT Brake proving functionality is applicable only to drive control modes that are capable of generating holding torque based on a feedback device. Therefore, Brake Proving is not applicable to Frequency Control mode with Sensorless Vector control method.

For more information on controlling vertical loads, see the Vertical Load and Holding Brake Management Application Technique, publication MOTION-AT003.

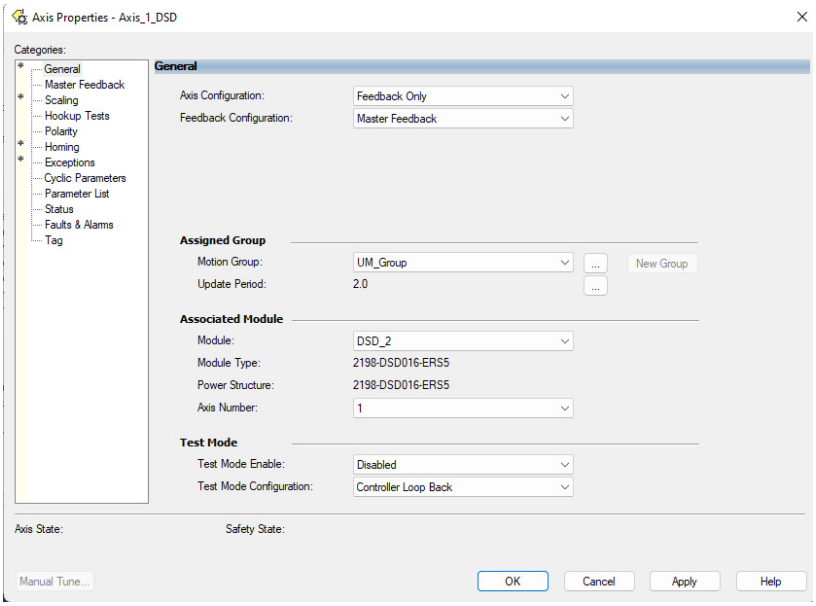
Figure 49 - Configure Vertical Load Control



Configure Feedback-only Axis Properties

Follow these steps to configure feedback-only axis properties.

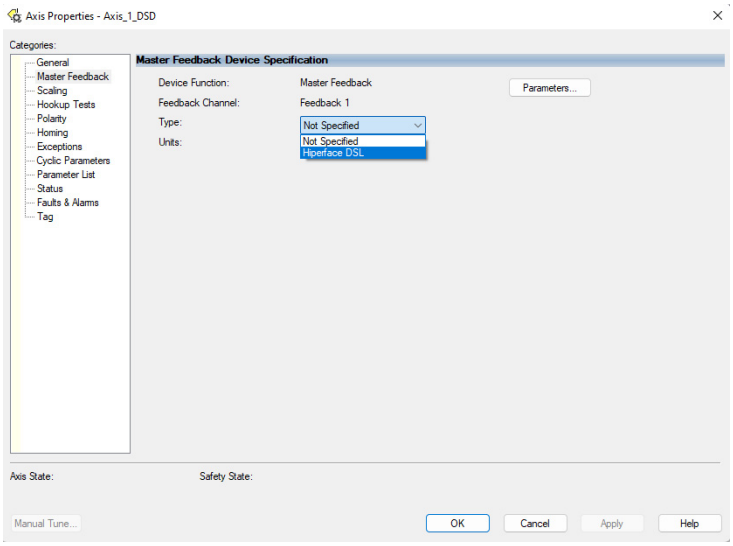
1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the General category.
   The General dialog box appears.



3. From the Axis Configuration dropdown menu, choose Feedback Only.
4. From the Feedback Configuration dropdown menu, choose Master Feedback.
5. From the Module dropdown menu, choose the drive to associate with your Feedback Only axis.

   The Module Type and Power Structure fields populate with the chosen drive catalog number.
6. Click Apply.
7. Configure module properties for your module for Master Feedback.
8. Select the Master Feedback Category.

   The Master Feedback Device Specification appears.



9. From the Type dropdown menu, choose a feedback device type.
10. Review other categories in the Controller Organizer and make changes as needed for your application.
11. Click OK.

See Feedback Specifications on page 65 for more information on auxiliary feedback signals and Allen-Bradley auxiliary feedback encoders available for use.

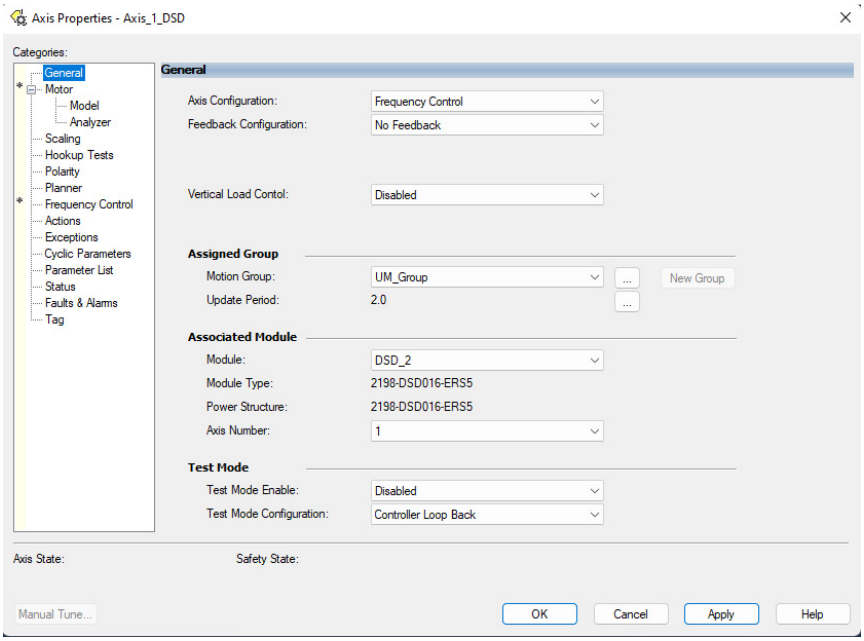
Configure Induction-motor Frequency-control Axis Properties

Follow these steps to configure induction-motor axis properties for various frequency control methods. Induction motors are only compatible with the ArmorKinetix DSD module and not the DSM module.

General and Motor Categories

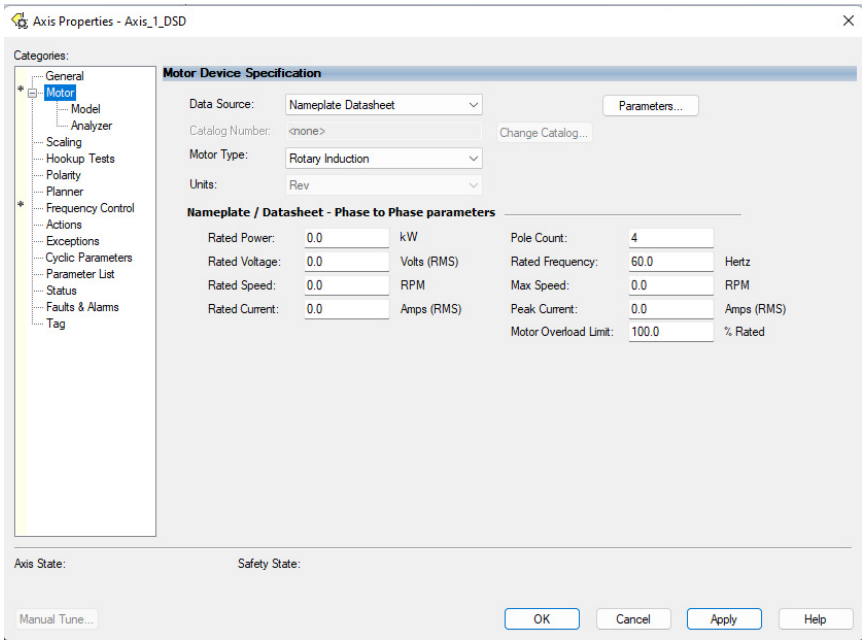
1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the General category.

   The General dialog box appears.



3. From the Axis Configuration dropdown menu, choose Frequency Control.
4. From the Feedback Configuration dropdown menu, choose No Feedback.
5. From the Module dropdown menu, choose the drive to associate with your Frequency Control (induction motor) axis.

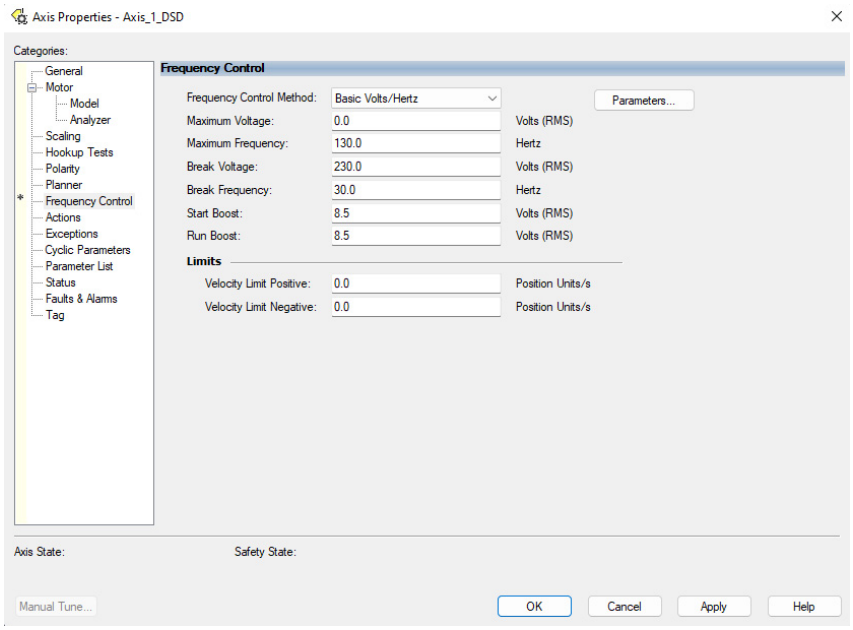
   The Module Type and Power Structure fields populate with the chosen drive catalog number.
6. Click Apply.
7. Select the Motor category.



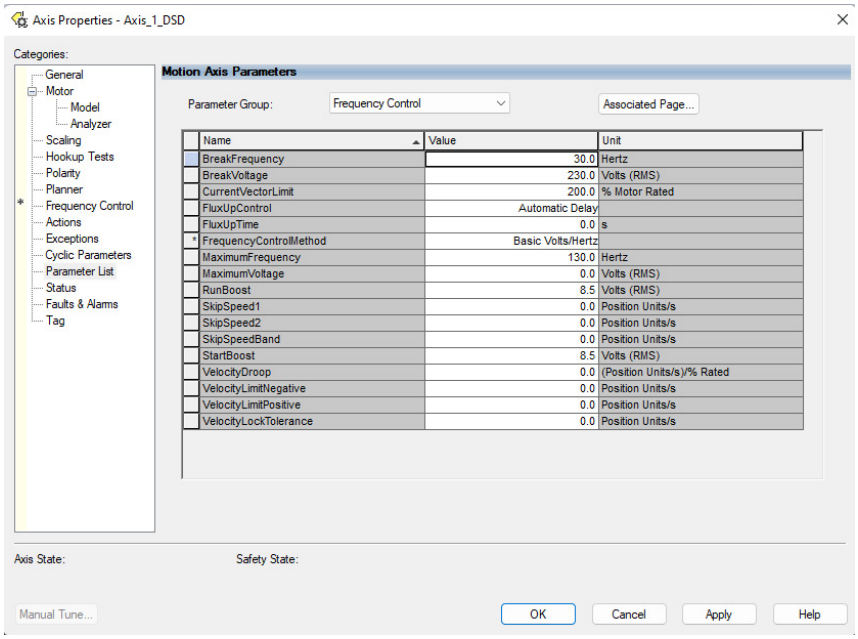
8. From the Data Source dropdown menu, choose Nameplate Datasheet.
   This is the default setting.
9. From the Motor Type dropdown menu, choose Rotary Induction.
10. From the motor nameplate or datasheet, enter the phase-to-phase values for your motor.
    See Motor Category on page 213 for a motor performance datasheet example. Also, see Motor Nameplate Datasheet Entry for Custom Motor Applications, publication 2198-AT002.
11. Click Apply.

Basic Volts/Hertz Method

1. Configure the General category and Motor category as shown in General and Motor Categories on page 106.
2. Select the Frequency Control category.
3. From the Frequency Control Method dropdown menu, select Basic Volts/Hertz.



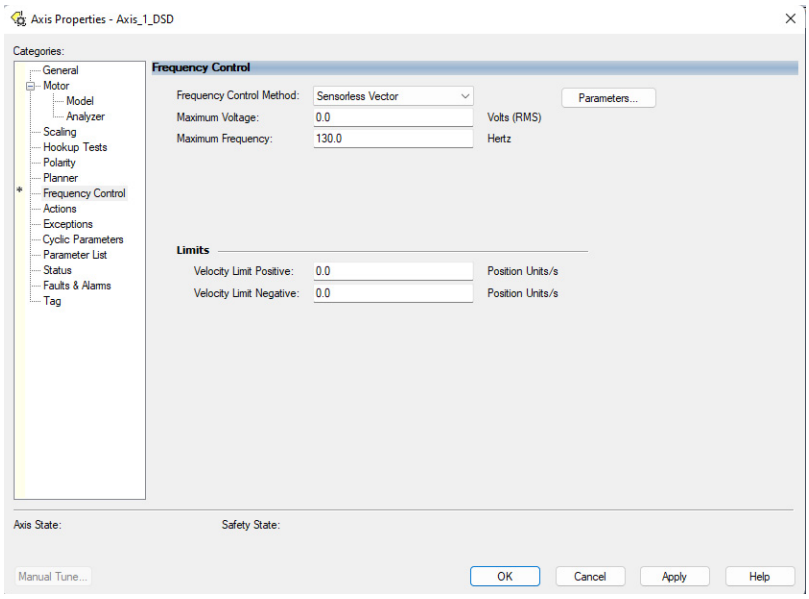
4. Enter the Basic Volts/Hertz attribute values appropriate for your application.
   Default values are shown.
5. Click Apply.
6. Select the Parameter List category.
   The Motion Axis Parameters dialog box appears.



7. From the Parameter Group dropdown menu, choose Frequency Control.
8. Set the FluxUp, SkipSpeed, VelocityDroop, and CurrentVectorLimit attributes appropriate for your application.
   See the corresponding section in Appendix D, beginning on page 201, for information and configuration examples regarding all of these topics.
9. Click OK.

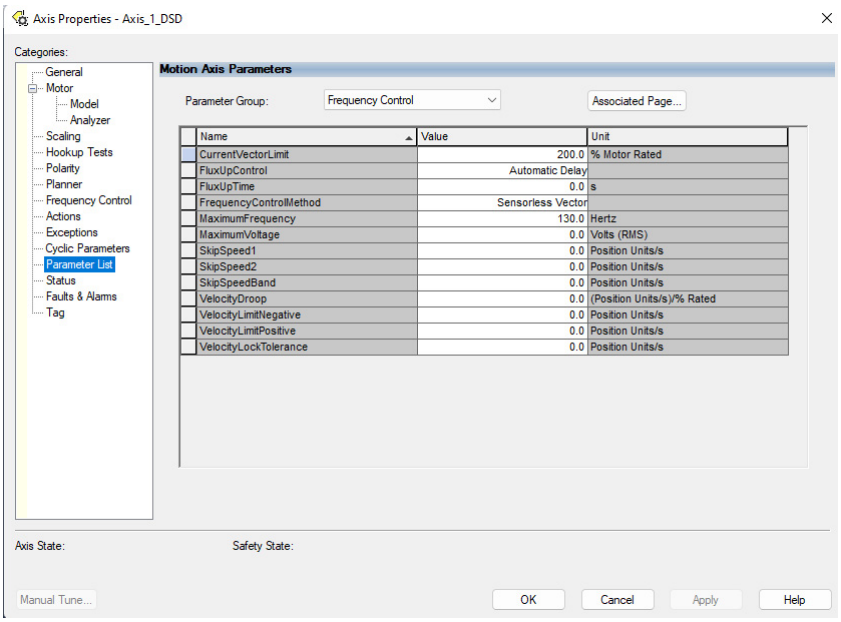
Sensorless Vector Method

1. Configure the General category and Motor category as shown in General and Motor Categories on page 106.
2. Select the Frequency Control category.
3. From the Frequency Control Method dropdown menu, choose Sensorless Vector.



4. Enter the Basic Volts/Hertz values appropriate for your application.

   Default values are shown.
5. Click Apply.
6. Select the Parameter List category.
7. The Motion Axis Parameters dialog box appears.

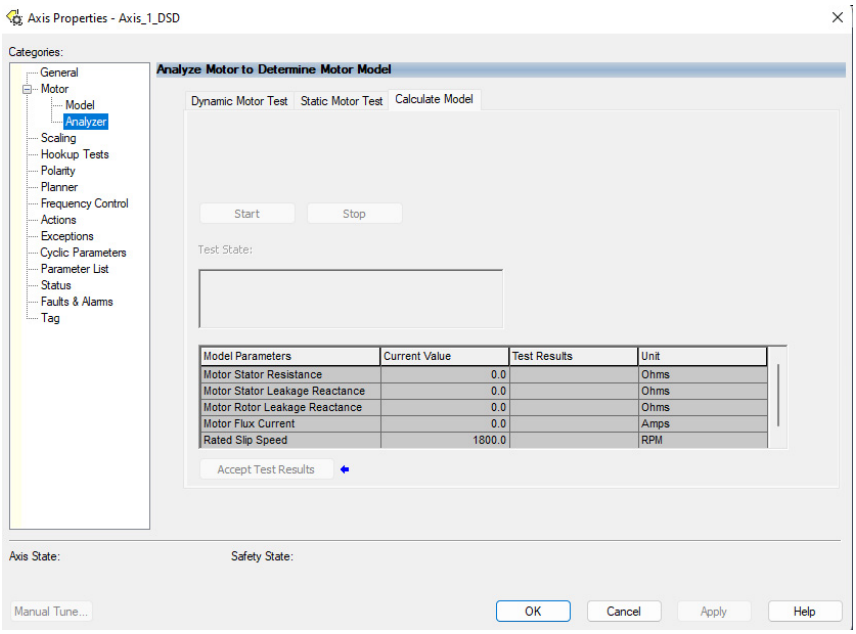


8. From the Parameter Group dropdown menu, choose Frequency Control.
9. Set the FluxUp, SkipSpeed, VelocityDroop, MaximumFrequency, MaximumVoltage, and CurrentVectorLimit attributes appropriate for your application.

   See the corresponding section in Appendix D, beginning on page 201, for information and configuration examples regarding all of these topics.
10. Click Apply.
11. Select the Motor>Model category.

    Motor model attributes are automatically estimated from the Nameplate/Datasheet parameters. For improved performance, motor tests can be run.

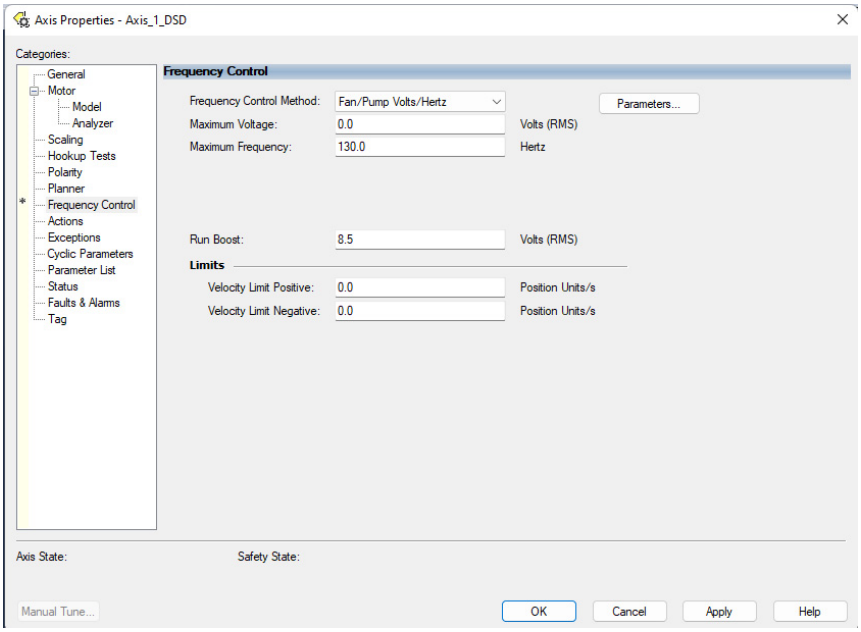
12. Select the Motor>Analyzer category.
    The Analyze Motor to Determine Motor Model dialog box opens.



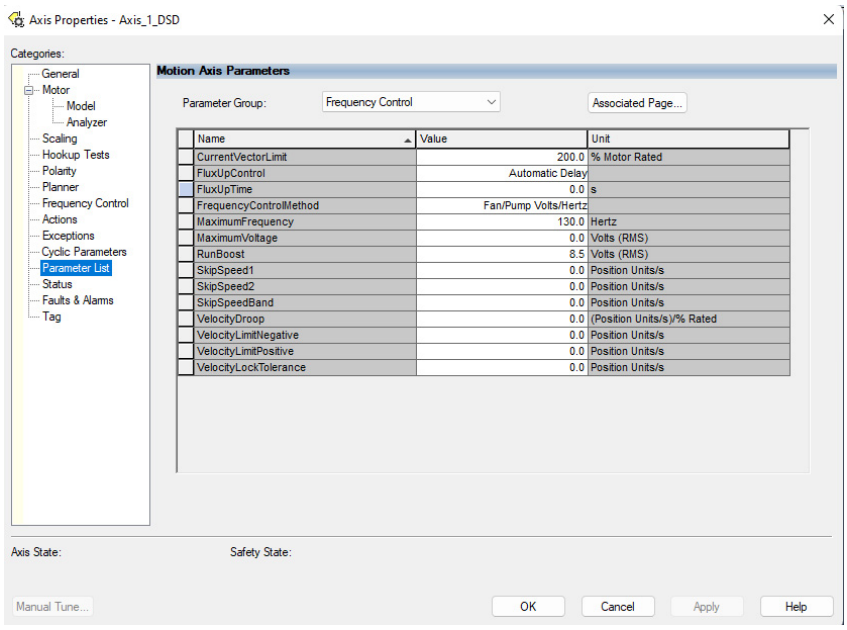
13. Click one of the motor test tabs.
    In this example, Calculate Model is chosen. See Motor Tests and Autotune Procedure on page 215 for information about each of the tests.
14. Click Start.
15. Click Accept Test Results.
16. Click OK.

Fan/Pump Volts/Hertz Method

1. Configure the General category and Motor category as shown in General and Motor Categories on page 106.
2. Select the Frequency Control category.
3. From the Frequency Control Method dropdown menu, select Fan/Pump Volts/Hertz.



4. Enter the Basic Volts/Hertz attribute values appropriate for your application.
   Default values are shown.
5. Click Apply.
6. Select the Parameter List category.
   The Motion Axis Parameters dialog box appears.



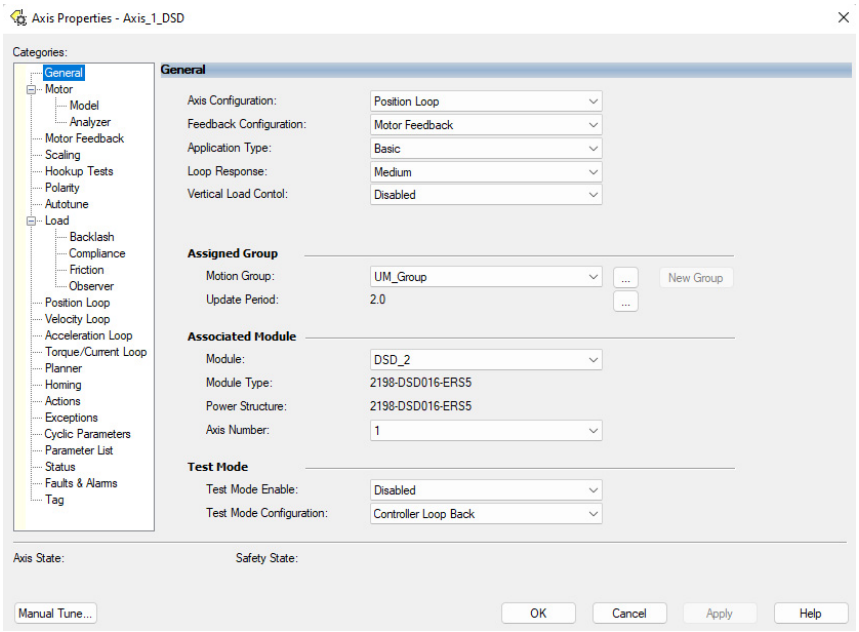
7. From the Parameter Group dropdown menu, choose Frequency Control.
8. Set the FluxUp, SkipSpeed, VelocityDroop, RunBoost, MaximumFrequency, MaximumVoltage and CurrentVectorLimit attributes appropriate for your application.
   See the corresponding section in Appendix D, beginning on page 201, for information and configuration examples regarding all of these topics.
9. Click OK.

Configure SPM Motor Closed-loop Control Axis Properties

Follow these steps to configure surface permanent-magnet (SPM) motor closed-loop axis properties. These steps apply to the DSD and DSM modules.

1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the General category.

   The General and Associated Module dialog box appears.



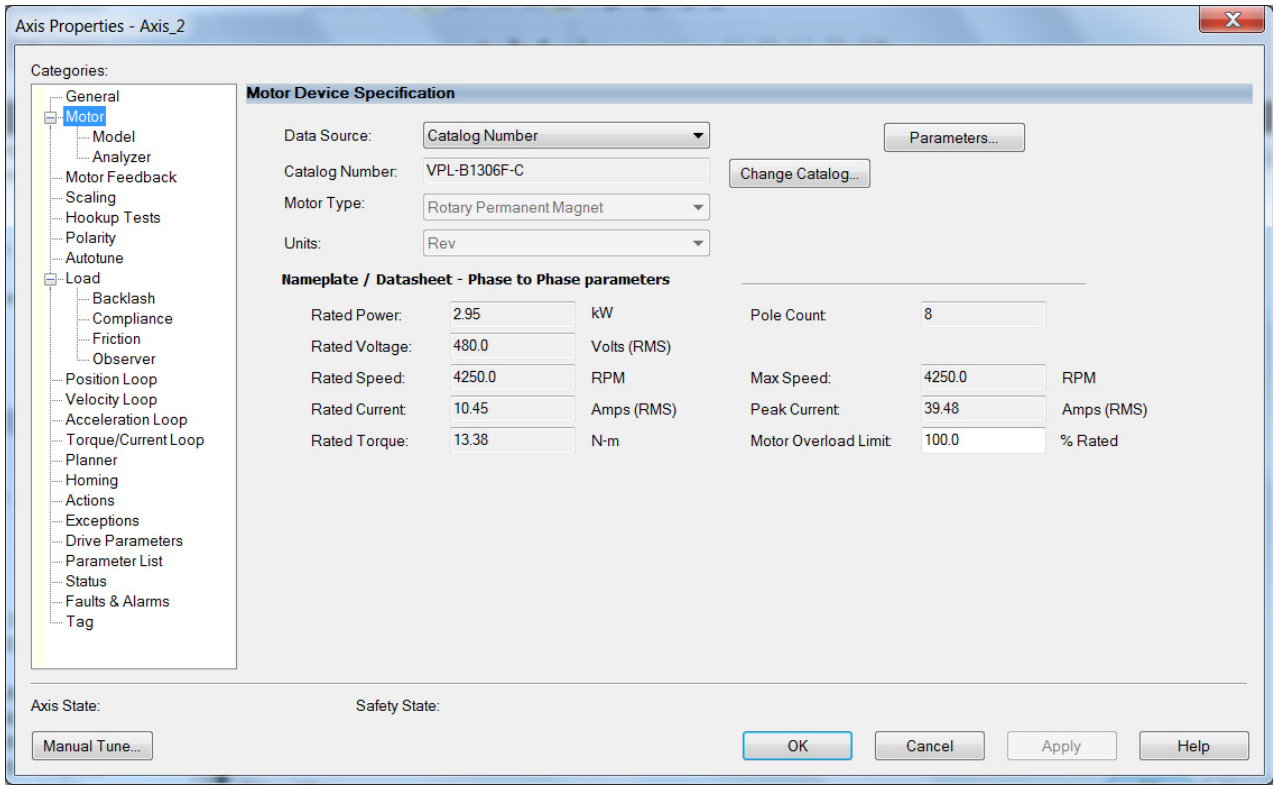
3. From the General dropdown menus, change configuration settings as needed for your application.

IMPORTANT Frequency Control is not supported for permanent magnet motors.

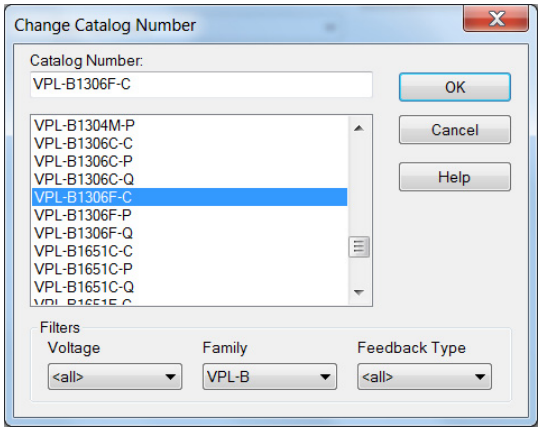
4. From the Associated Module>Module dropdown menu, choose your ArmorKinetix DSD module.

   The catalog number populates the Module Type and Power Structure fields.
5. Click Apply.

6. Select the Motor category.
   The Motor Device Specification dialog box appears.

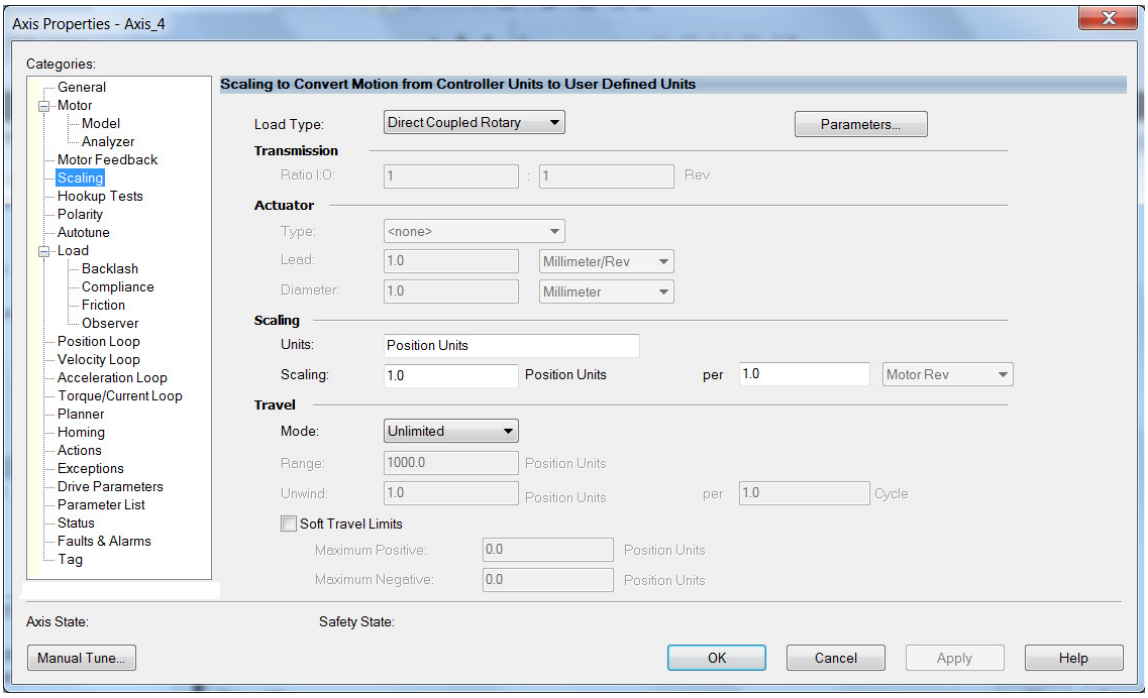


7. From the Data Source dropdown menu, choose Catalog Number.
8. Click Change Catalog.
   The Change Catalog Number dialog box appears.

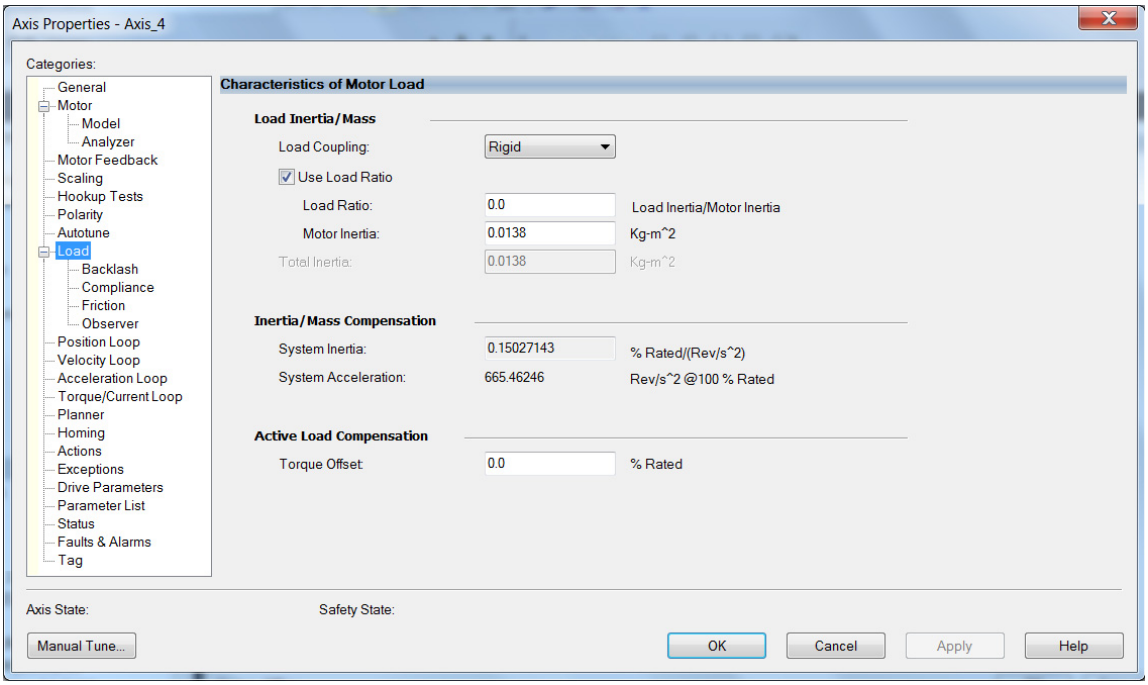


9. Select the motor catalog number appropriate for your application.
   To verify the motor catalog number, refer to the motor name plate.
10. Click OK to close the Change Catalog Number dialog box.
11. Click Apply.
    Motor data specific to your motor appears in the Nameplate / Datasheet - Phase to Phase parameters field.

12. Select the Scaling category and edit the default values as appropriate for your application.



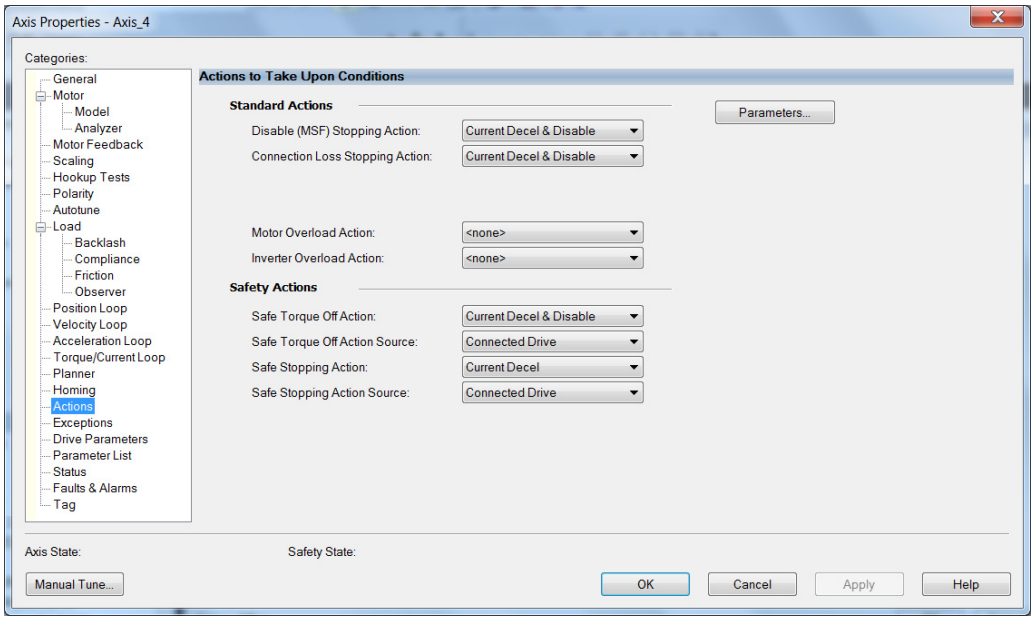
13. Click Apply, if you make changes.
14. Select the Load category and edit the default values as appropriate for your application.



15. Click Apply, if you make changes.

16. Select the Actions category.

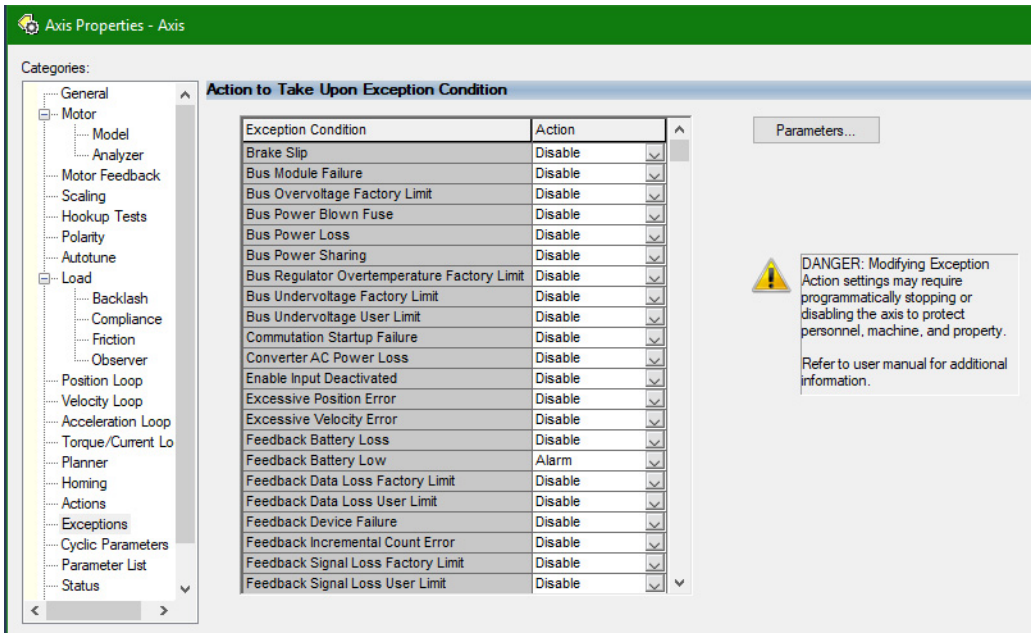
    The Actions to Take Upon Conditions dialog box appears.



From this dialog box you can program actions for the drive module to take. Refer to Logix 5000 Controller and Drive Module Behavior on page 142 for more information.

17. Select the Exceptions category.

    The Action to Take Upon Exception Condition dialog box appears.

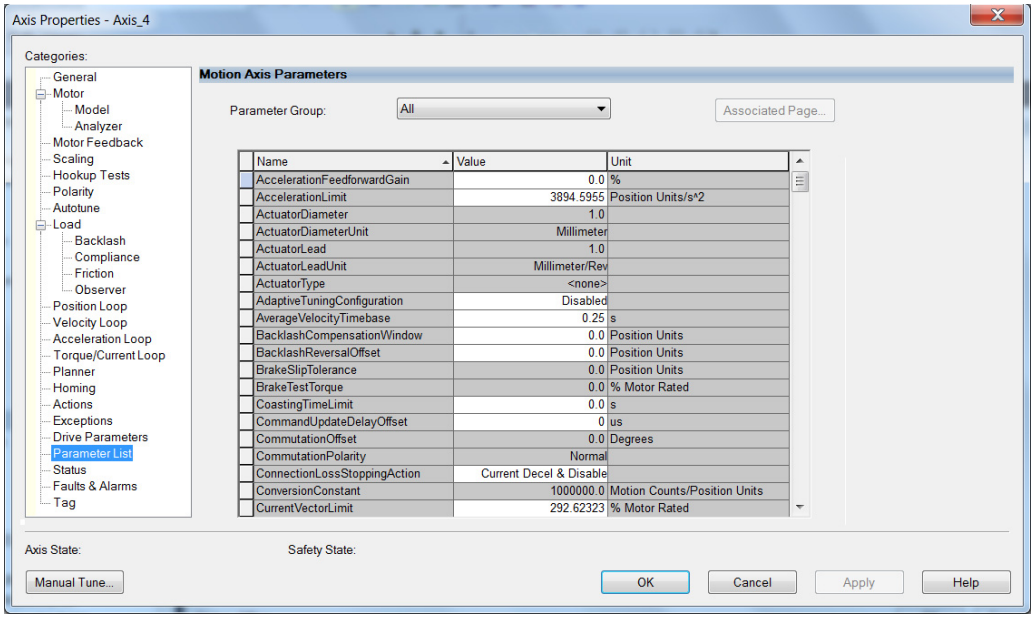


From this dialog box you can change the action for exceptions (faults). Refer to Logix 5000 Controller and Drive Module Behavior on page 142 for more information.

In the Studio 5000 Logix Designer application, Disable replaced StopDrive as the default Action.

18. Select the Parameter List category.

    The Motion Axis Parameters dialog box appears.



    From this dialog box you can set brake engage and release delay times for servo motors. The parameter names for the brake delay are MechanicalBrakeEngageDelay and MechanicalBrakeReleaseDelay. For recommended motor brake delay times, refer to the Kinetix Rotary Motion Specifications Technical Data, publication KNX-TD001.

19. Click OK.

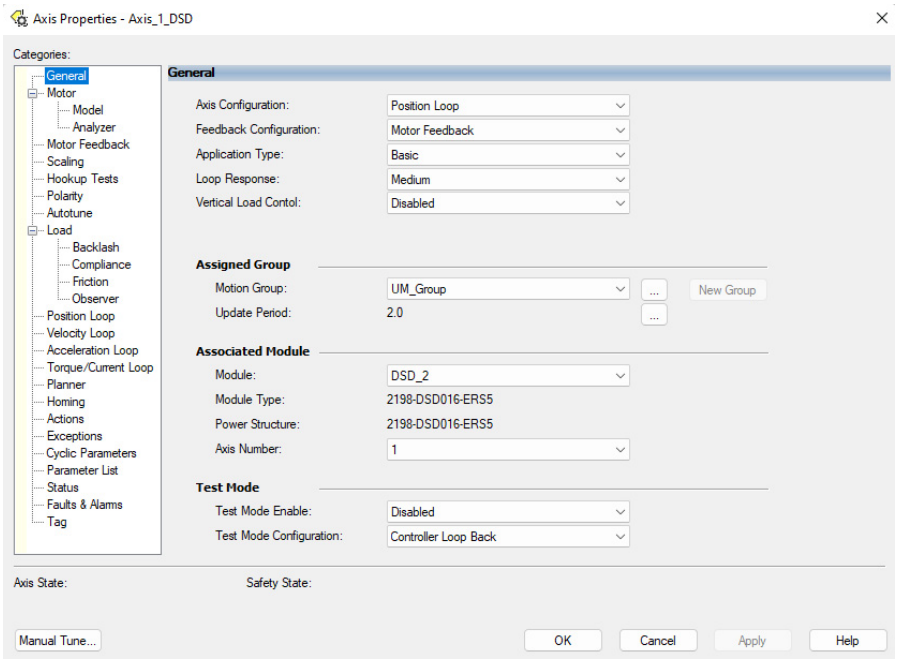
20. Repeat step 1 through step 19 for each servo motor axis.

Configure Induction-motor Closed-loop Control Axis Properties

Follow these steps to configure induction-motor closed-loop control axis properties. These steps apply to the ArmorKinetix DSD module only.

1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the General category.

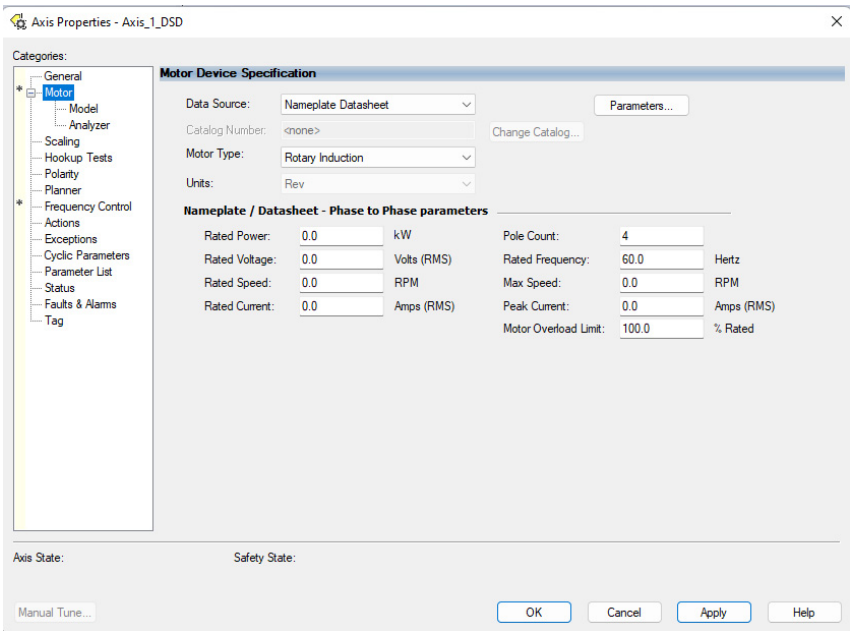
   The General and Associated Module dialog box appears.



3. From the General dropdown menus, change configuration settings as needed for your application.
4. From the Associated Module>Module dropdown menu, choose your DSD module.

   The catalog number populates the Module Type and Power Structure fields.
5. Click Apply.

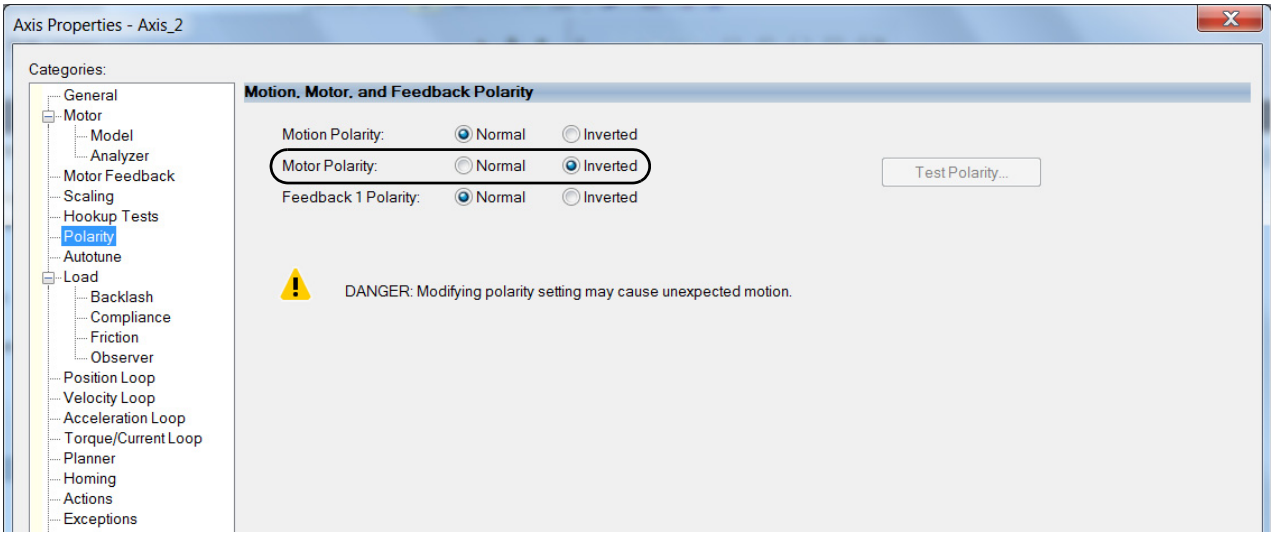
6. Select the Motor category.
   The Motor Device Specification dialog box appears.



7. From the Data Source dropdown menu, choose Nameplate Datasheet.
   This is the default setting.

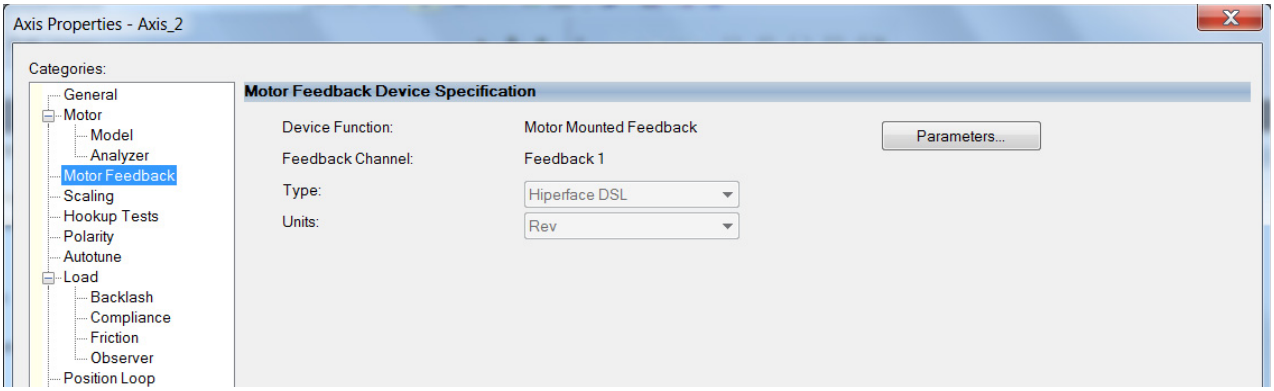
IMPORTANT Motor NV is not a supported data source in the Studio 5000 Logix Designer application for axes configured as Induction-motor closed-loop.

   a. Select the Polarity category.
   b. For Motor Polarity, click Inverted (default is Normal).

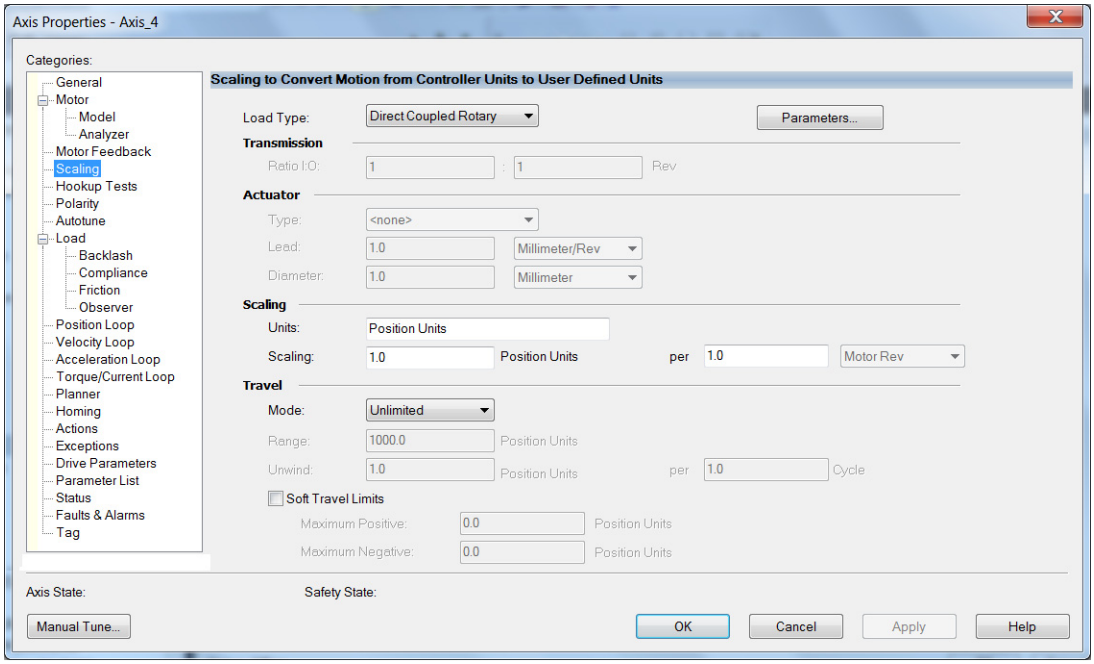


   c. Click Apply and return to the Motor category.
8. From the Motor Type dropdown menu, choose Rotary Induction.
9. From the motor nameplate or datasheet, enter the phase-to-phase values for your motor.
   See Motor Category on page 213 for a motor performance datasheet example. Also see Motor Nameplate Datasheet Entry for Custom Motor Applications, publication 2198-AT002.
10. Click Apply.

11. Select the Motor Feedback category.
    The Motor Feedback Device Specification dialog box appears.



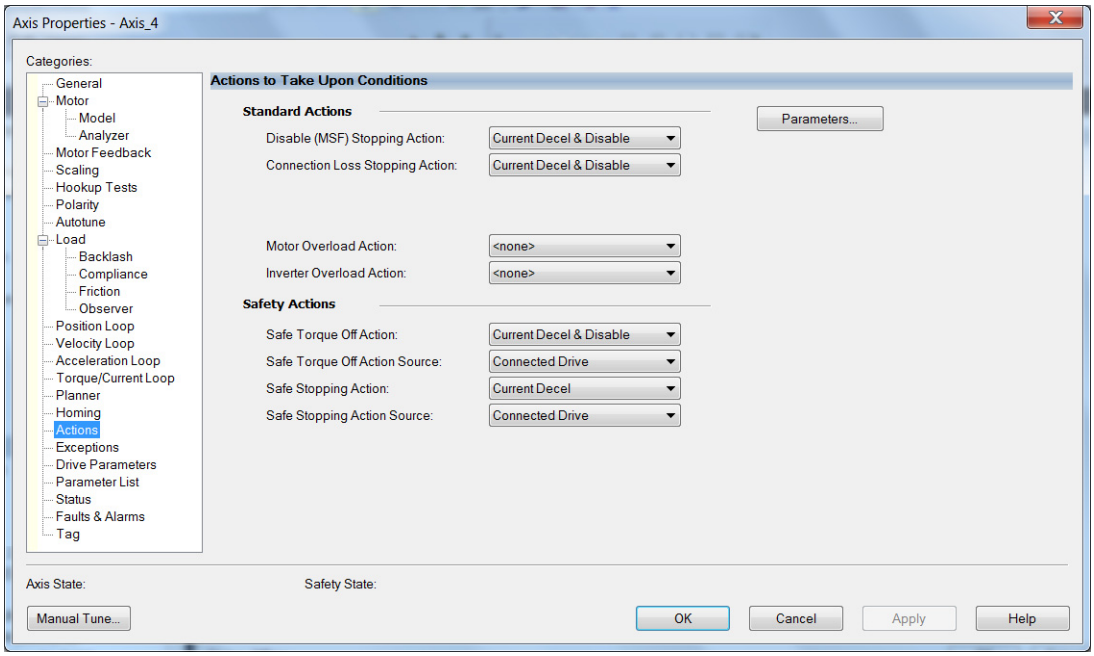
12. From the Type dropdown menu, choose the feedback type appropriate for your application.
    See Configure Motor Feedback Properties on page 123 for feedback configuration examples.
13. Click Apply.
14. Select the Scaling category and edit the default values as appropriate for your application.



15. Click Apply, if you make changes.

16. Select the Actions category.

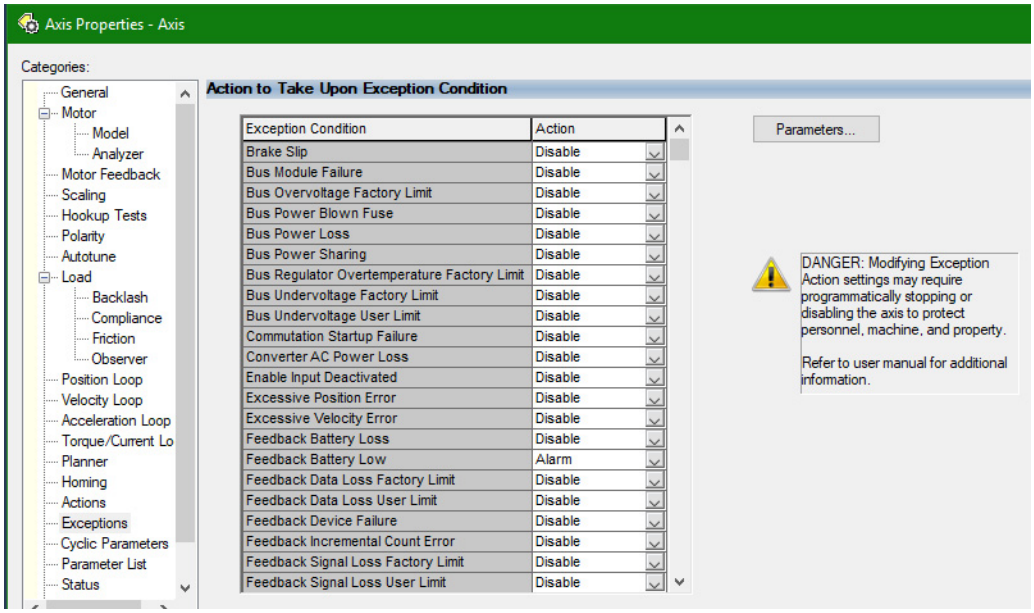
    The Actions to Take Upon Conditions dialog box appears.



From this dialog box you can program actions for the drive module to take. Refer to Logix 5000 Controller and Drive Module Behavior on page 142 for more information.

17. Select the Exceptions category.

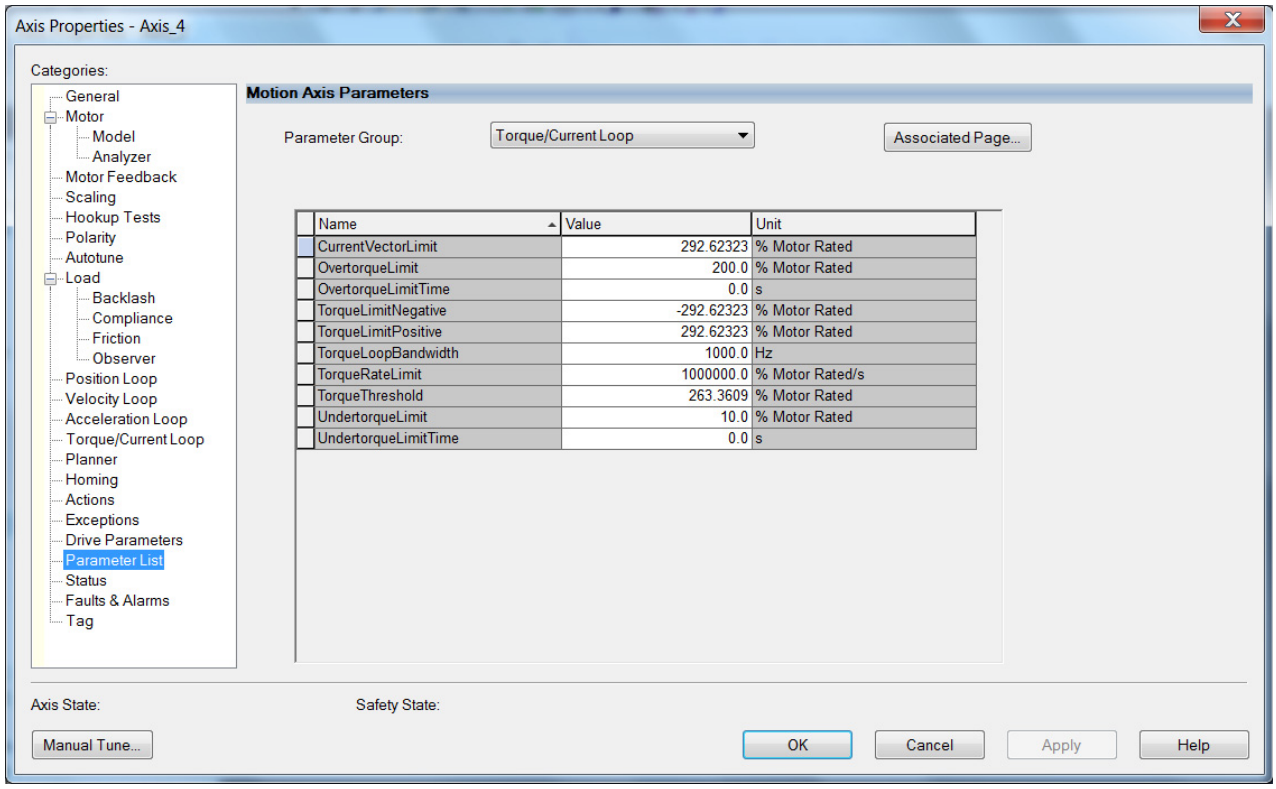
    The Action to Take Upon Exception Condition dialog box appears.



From this dialog box you can change the action for exceptions (faults). Refer to Logix 5000 Controller and Drive Module Behavior on page 142 for more information.

In the Studio 5000 Logix Designer application, Disable replaced StopDrive as the default Action.

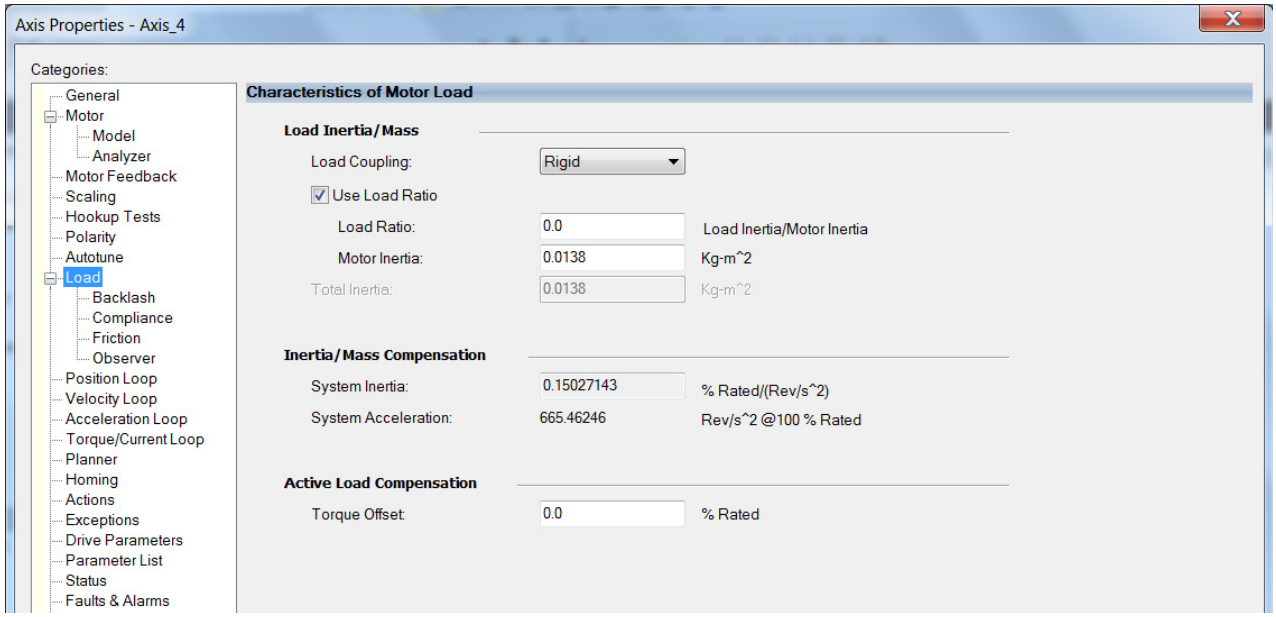
18. Select the Parameter List category.
    The Motion Axis Parameters dialog box appears.



19. From the Parameter Group dropdown menu, choose Torque/Current Loop.
20. Set the FluxUp attributes appropriate for your application.
    See the corresponding section in Appendix D, beginning on page 201, for information and configuration examples regarding this topic.

IMPORTANT The Automatic FluxUpControl setting is recommended for best autotune results.

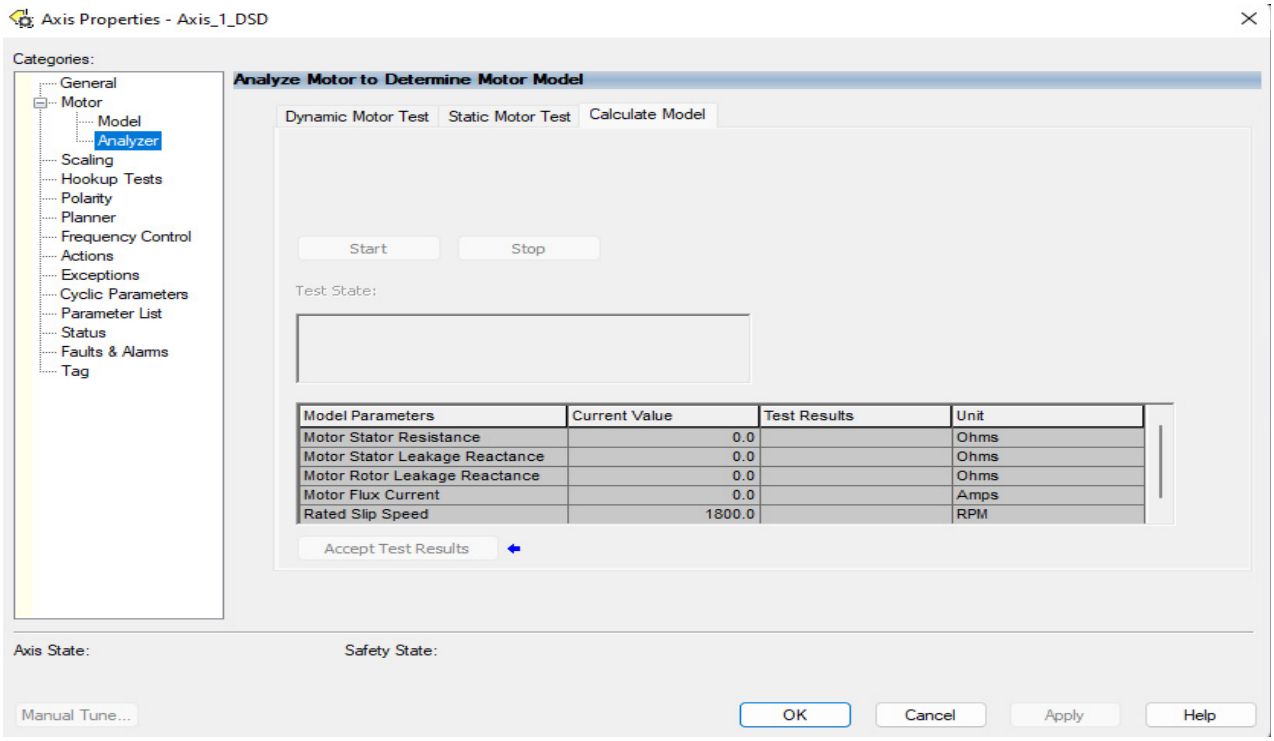
21. Click Apply.
22. Select the Load category and edit the default values as appropriate for your application.



23. Click Apply, if you make changes.
24. Click OK.
25. Select the Motor>Model category.

    Motor model attributes are automatically estimated from the Nameplate/Datasheet parameters. For improved performance, motor tests can be run.
26. Select the Motor>Analyzer category.

    The Analyze Motor to Determine Motor Model dialog box opens.



IMPORTANT The Dynamic motor test cannot be run without a non-zero motor inertia.

27. Click the tab corresponding to the Motor Test you want to run.

    See Motor Tests and Autotune Procedure on page 215 for information about each of the tests.
28. Click Start.
29. Click Accept Test Results.
30. Click Apply.
31. Select the Autotune category.
32. Repeat step 1 through step 31 for each induction motor axis.

Configure Motor Feedback Properties

This section provides more configuration detail for module properties and axis properties when incremental feedback types are used in your application.

Depending on the Motion Safety selection you made when you configured the module definition (see Add and Configure the DSD or DSM Module > Configure Module Definition on page 94) and the choices you made when configuring the Associated Axes for your device (see Add an Associated Axis on page 97)

In this section you configure the axis properties of your ArmorKinetix DS*x* module for the type of feedback you intend use in your application.

IMPORTANT The DSM module is only compatible with DSL feedback type.

Table 44 defines valid feedback assignments for each feedback type.

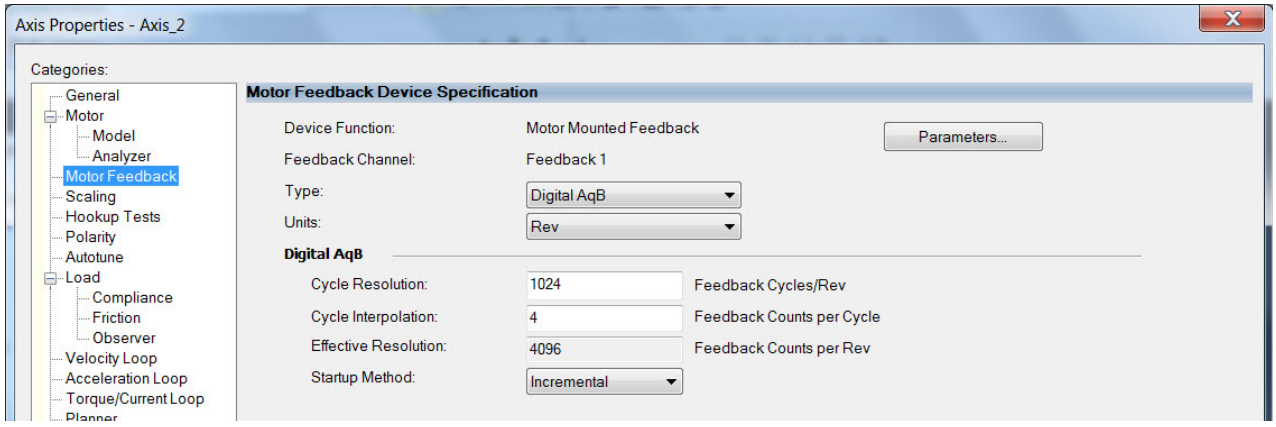
Table 44 - Valid Feedback Assignments

Feedback Type		Permanent Magnet Motors	Induction Motors	Feedback Only
Hiperface DSL	High-resolution single-turn and multi-turn, absolute	Motor feedback Load feedback		Master feedback
Hiperface				
Digital AqB	Incremental			
Digital AqB with UVW				
Sine/Cosine				
Sine/Cosine with UVW				

Digital AqB (TTL) Feedback

In this example, a motor feedback device is configured for Digital AqB feedback.

1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the Motor Feedback category.
   The Motor Feedback Device Specification dialog box appears.



3. Configure the device function and type.
   In this example, Motor Feedback is the device function and Digital AqB is the feedback type.
4. Enter values for the Digital AqB specification fields.
   The only valid value for Cycle Interpolation is 4.
5. From the Startup Method dropdown menu, choose Incremental.
6. Click Apply.

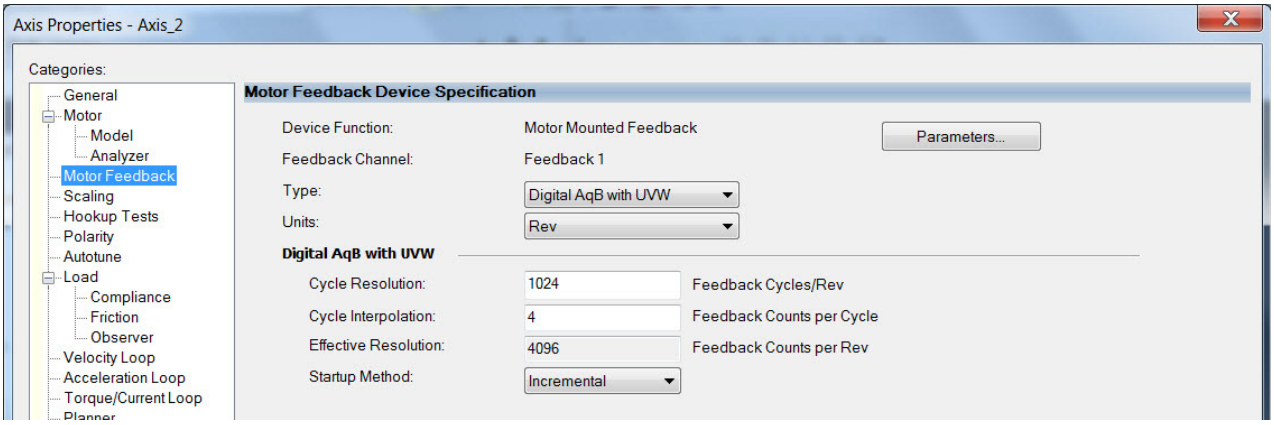
When the Device Function is Load-Side Feedback or Master Feedback, configuration is identical to Motor Mounted Feedback.

Digital AqB with UVW (TTL w/Hall) Feedback

In this example, a motor feedback device is configured for Digital AqB with UVW feedback.

1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the Motor Feedback category.

   The Motor Feedback Device Specification dialog box appears.



3. Configure the device function and type.

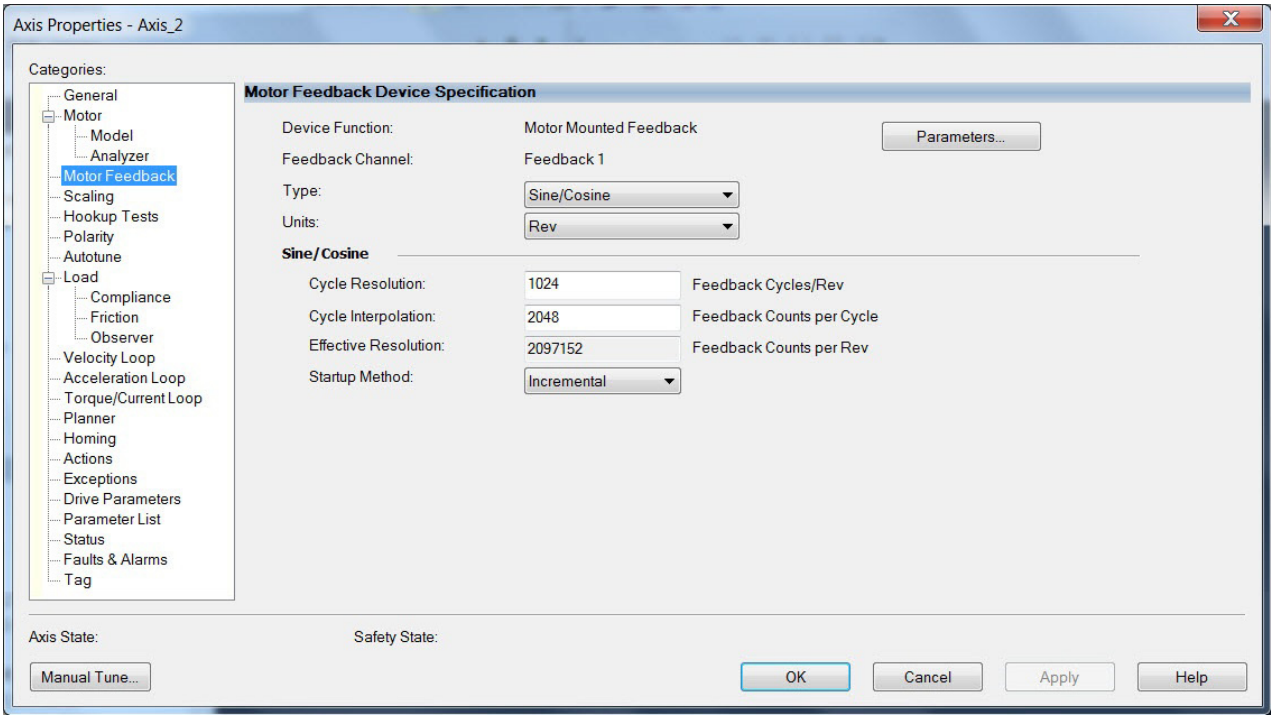
   In this example, Motor Feedback is the device function and Digital AqB with UVW is the feedback type.
4. Enter values for the Digital AqB with UVW specification fields.

   The only valid value for Cycle Interpolation is 4.
5. From the Startup Method dropdown menu, choose Incremental.
6. From the Alignment dropdown menu, choose Not Aligned.
7. Click Apply.

Sine/Cosine Feedback

In this example, a motor feedback device is configured for Sine/Cosine feedback.

1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the Motor Feedback category.
   The Motor Feedback Device Specification dialog box appears.



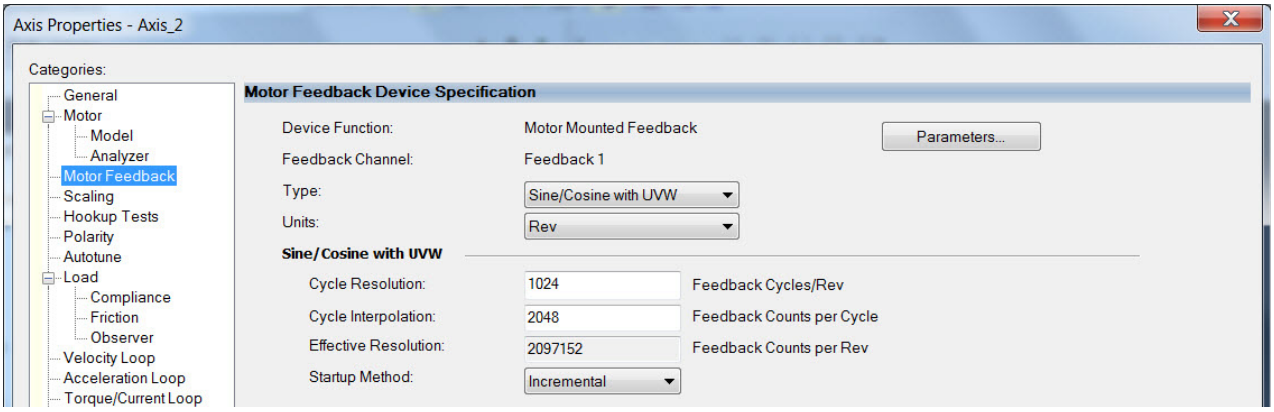
3. Configure the device function and type.
   In this example, Motor Feedback is the device function and Sine/Cosine is the feedback type.
4. Enter values for the Sine/Cosine specification fields.
   The only valid values for Cycle Interpolation are powers of 2 from 4 through 65536.
5. From the Startup Method dropdown menu, choose Incremental.
6. Click Apply.

When the Device Function is Load-Side Feedback or Master Feedback, configuration is identical to Motor Mounted Feedback.

Sine/Cosine with Hall Feedback

In this example, a motor feedback device is configured for Sine/Cosine with UVW feedback.

1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the Motor Feedback category.
   The Motor Feedback Device Specification dialog box appears.

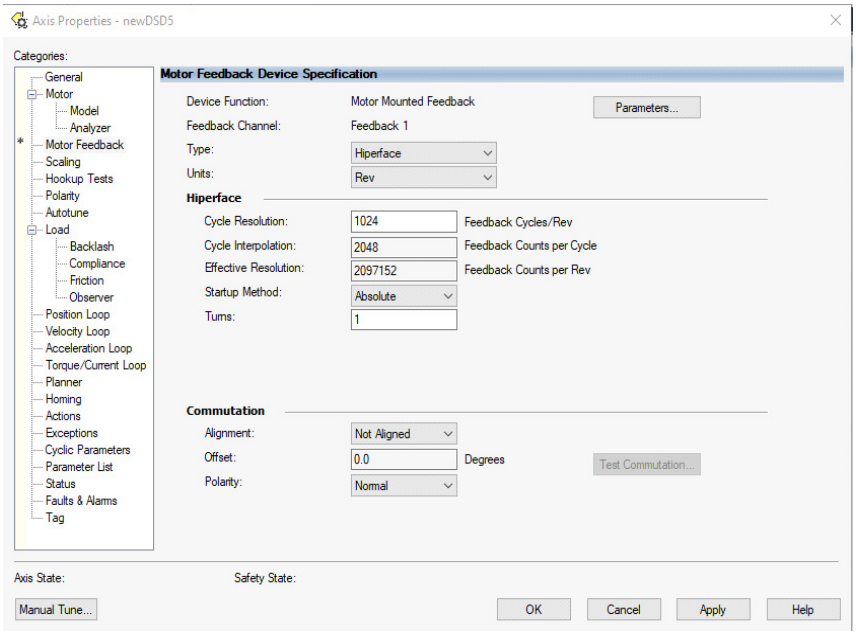


3. Configure the device function and type.
   In this example, Motor Feedback is the device function and Sine/Cosine with UVW is the feedback type.
4. Enter values for the Sine/Cosine with UVW specification fields.
   The only valid values for Cycle Interpolation are powers of 2 from 4 through 65536.
5. From the Startup Method dropdown menu, choose Incremental.
6. From the Alignment dropdown menu, choose Not Aligned.
7. Click OK.

Hiperface DSL

In this example, a motor feedback device is configured for Hiperface DSL feedback.

1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the Motor Feedback category.
   The Motor Feedback Device Specification dialog box appears.



3. Configure the device function and type.

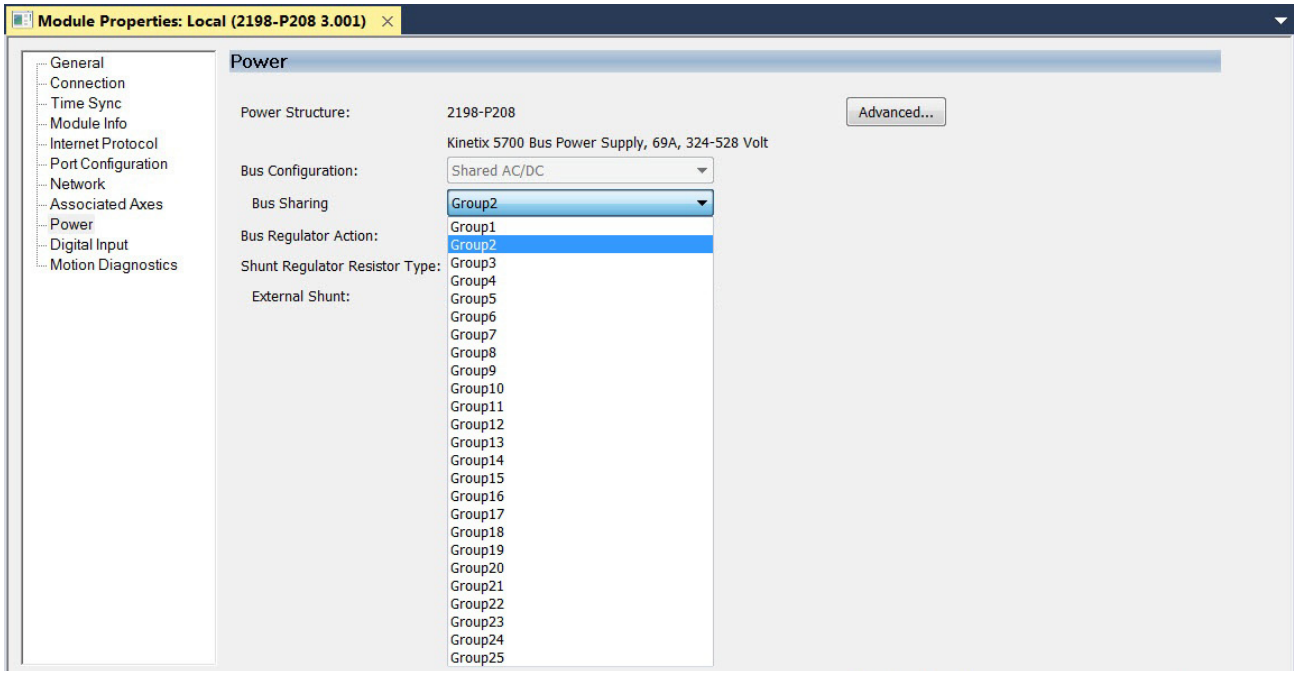
   In this example, Motor Feedback is the device function and Hiperface DSL is the feedback type.
4. Enter values for the Hiperface DSL specification fields.
5. From the Startup Method dropdown menu, choose Absolute.
6. From the Alignment dropdown menu, choose Not Aligned.
7. Click OK.

Understand Bus-sharing Group Configuration

When configuring Module Properties>Power category for each ArmorKinetix module, you can breakout modules from one or more servo systems into multiple bus-sharing (power) groups.

Kinetix 5700 DC Bus supply and a PIM module let you configure a Primary bus-sharing group. The PIM module also allows a Secondary bus-sharing group. A DSD module or a DSM module let you configure only a Secondary group.

Figure 50 - Bus-sharing Group Configuration



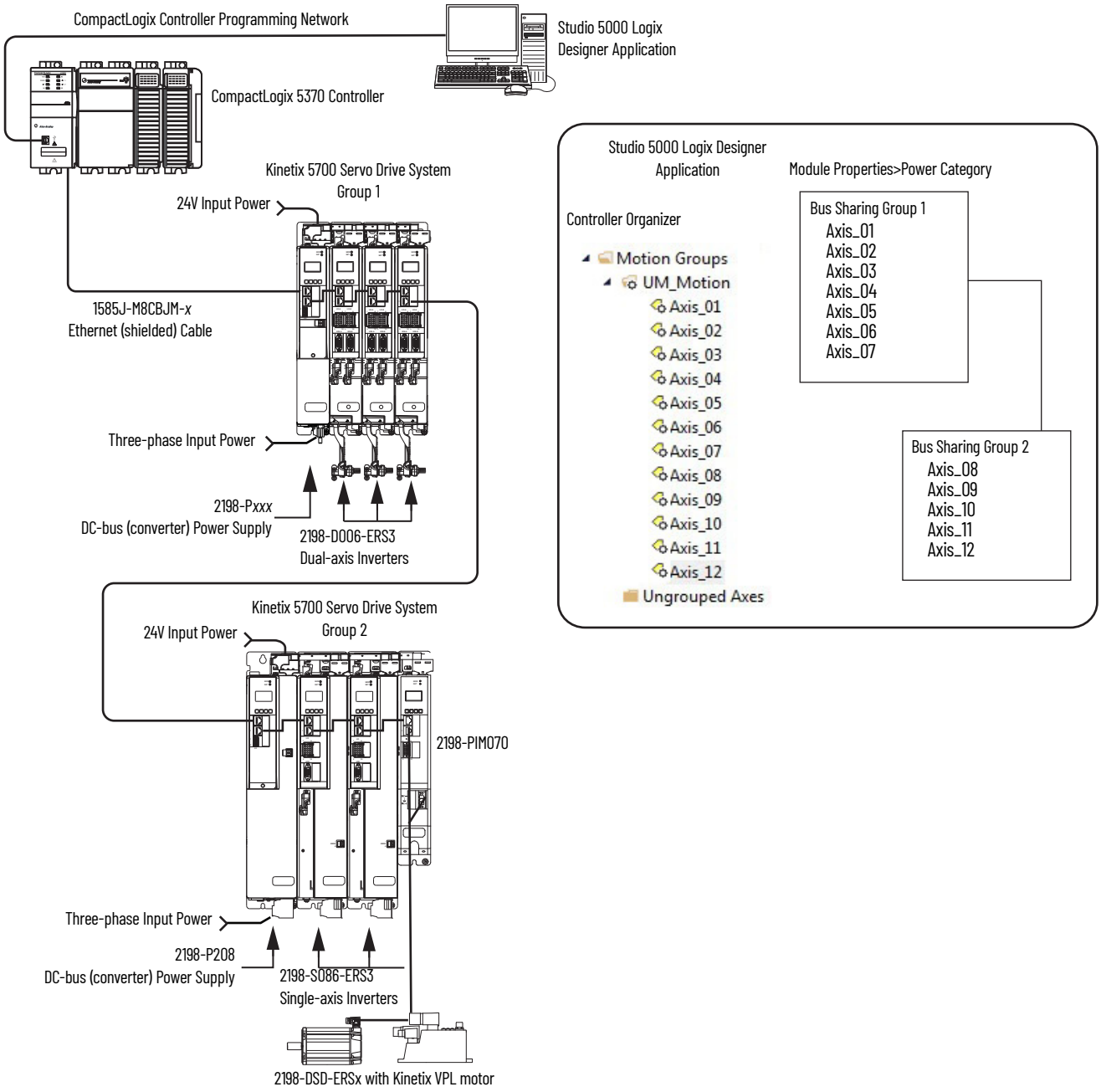
Bus-sharing Group Example

In Figure 51, twelve axes are needed to support the motion application. All twelve axes are configured in the same Motion group in the Studio 5000 Logix Designer application.

However, the twelve axes of motion are also configured as two bus-sharing groups in Module Properties>Power category. By creating two bus-sharing groups, a converter drive that faults in Group 1 only disables Group 1 drives, and has no effect on the drive operation of Group 2 drive.

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

Figure 51 - Bus-sharing Group Example



Configure Bus-sharing Groups

In both groups, the Bus Configuration for the converter drive is Shared AC/DC and the Bus Configuration for the inverter drives is Shared DC.

Figure 52 - Group 1 DC-bus Power Supply (converter) Configuration

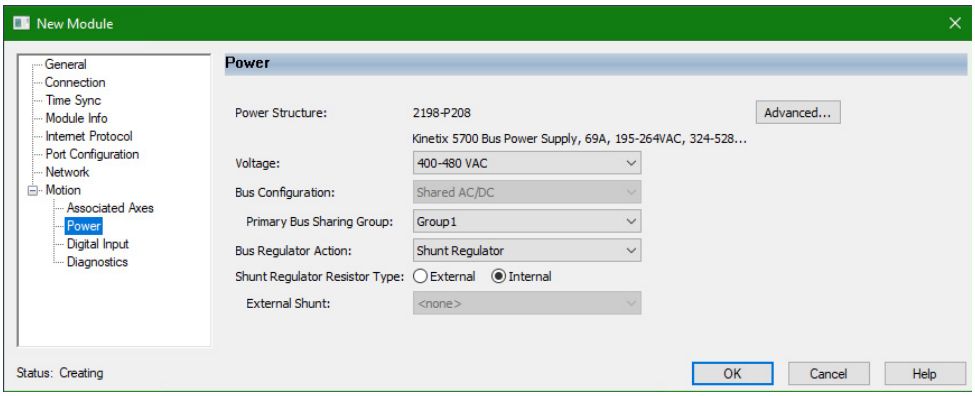


Figure 53 - Group 1 Dual-axis Inverter Configuration

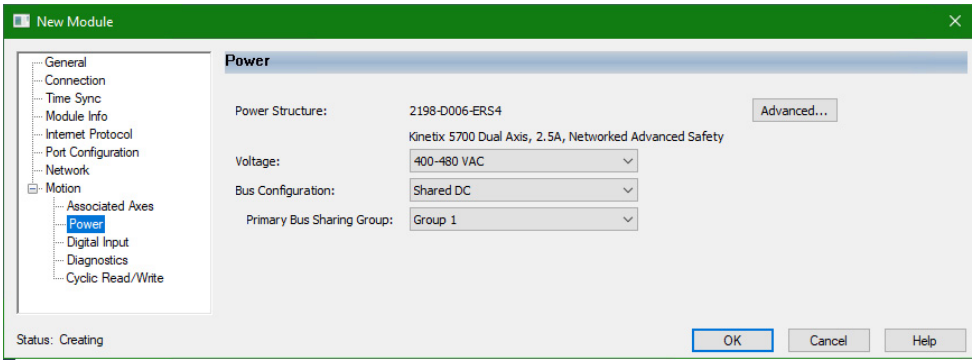


Figure 54 - Group 2 DC-bus Power Supply (converter) Configuration

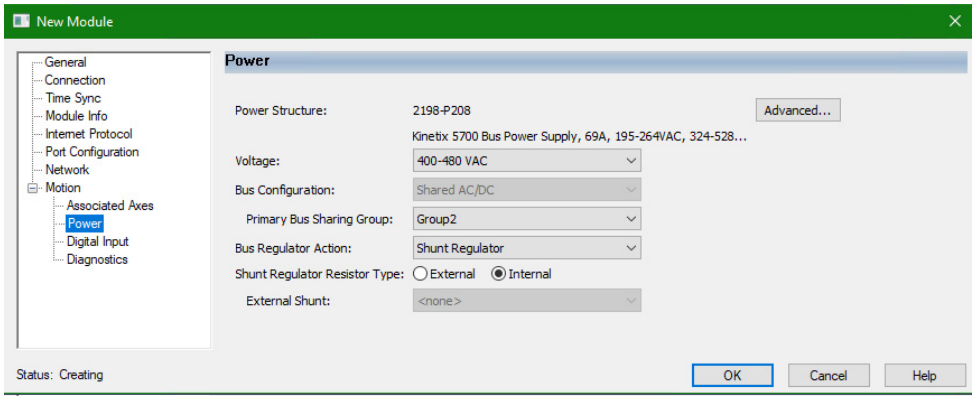


Figure 55 - Group 2 Single-axis Inverter Configuration

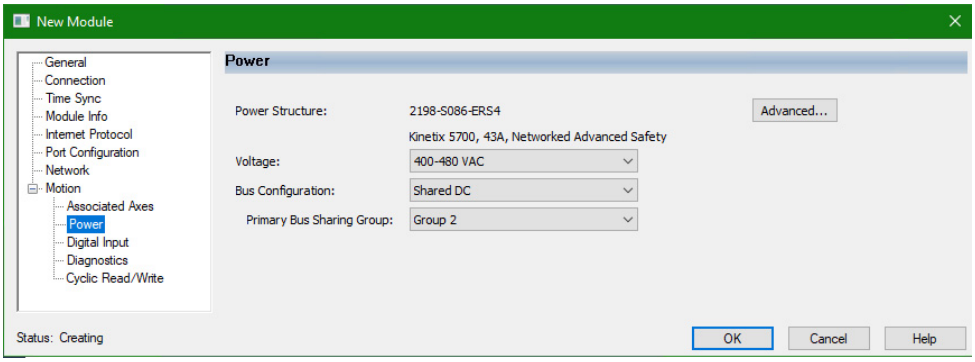
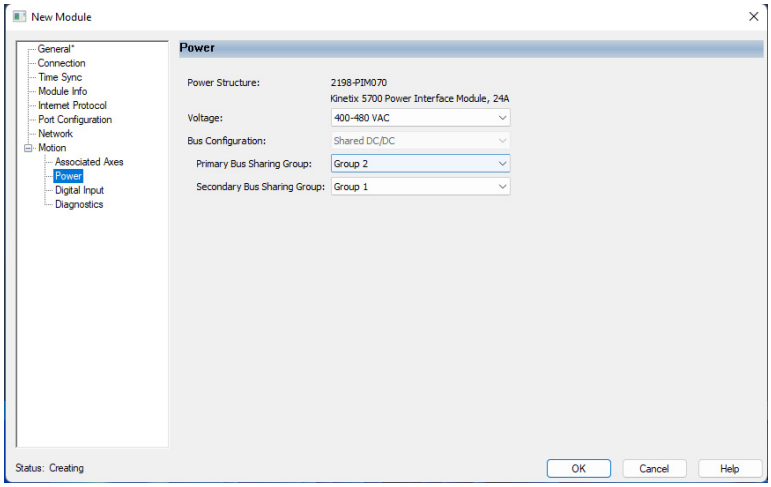


Figure 56 - Group 2 PIM Module Configuration



Download the Program

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

Apply Power to the System

This procedure assumes that you have wired and configured your ArmorKinetix system and your Logix 5000 controller.

SHOCK HAZARD: To avoid hazard of electrical shock, perform all mounting and wiring of the 2198 servo drives prior to applying power. Once power is applied, connector terminals can have voltage present even when not in use.

Follow these steps to apply power to the ArmorKinetix System system.

1. Disconnect the load to the motor.

   ATTENTION: To avoid personal injury or damage to equipment, disconnect the load to the motor. Make sure each motor is free of all linkages when initially applying power to the system.

2. Apply 24V DC control power.

   The PIM module LCD display begins the startup sequence. Refer to Startup Sequence on page 84. If the startup sequence does not begin, check the 24V control power connections.

3. When the startup sequence completes, verify the following:
   a. DC-bus power supply NET status indicators are steady green.
   b. DC-bus power supply MOD status indicators are flashing.
   c. DC-bus power supply axis-state is PRECHARGE.

If the DC-bus power supply does not reach the specified axis state and the two status indicators are not as specified, refer to Status Indicators on page 139.

IMPORTANT Apply control power before applying three-phase AC power. This makes sure the shunt is enabled, which can prevent nuisance faults or Bus Overvoltage faults.

4. Apply mains input power and monitor the DC BUS voltage on the LCD display.

   If the DC BUS does not reach the expected voltage level, check the three-phase input power connections.

   It can take as long as 1.8 seconds after input power is applied before the module can accept motion commands.

   a. Verify that all NET and MOD status indicators are steady green.

   b. Verify that the DC-bus power supply axis-state is RUNNING.

   If the DC-bus power supply does not reach the specified axis state, refer to Fault Code Overview on page 138.

Test and Tune the Axes

This procedure assumes that you have configured your ArmorKinetix System drive, your Logix 5000 controller, and applied power to the system.

IMPORTANT Before proceeding with testing and tuning your axes, verify that the MOD and NET status indicators are operating as described in Status Indicators on page 139.

For help using the Studio 5000 Logix Designer application as it applies to testing and tuning your axes with ControlLogix EtherNet/IP modules or CompactLogix 5370 controllers, refer to Additional Resources on page 9.

Also, see Motor Nameplate Datasheet Entry for Custom Motor Applications, publication 2198-AT002, for detailed information on testing and tuning custom motors.

Test the Axes

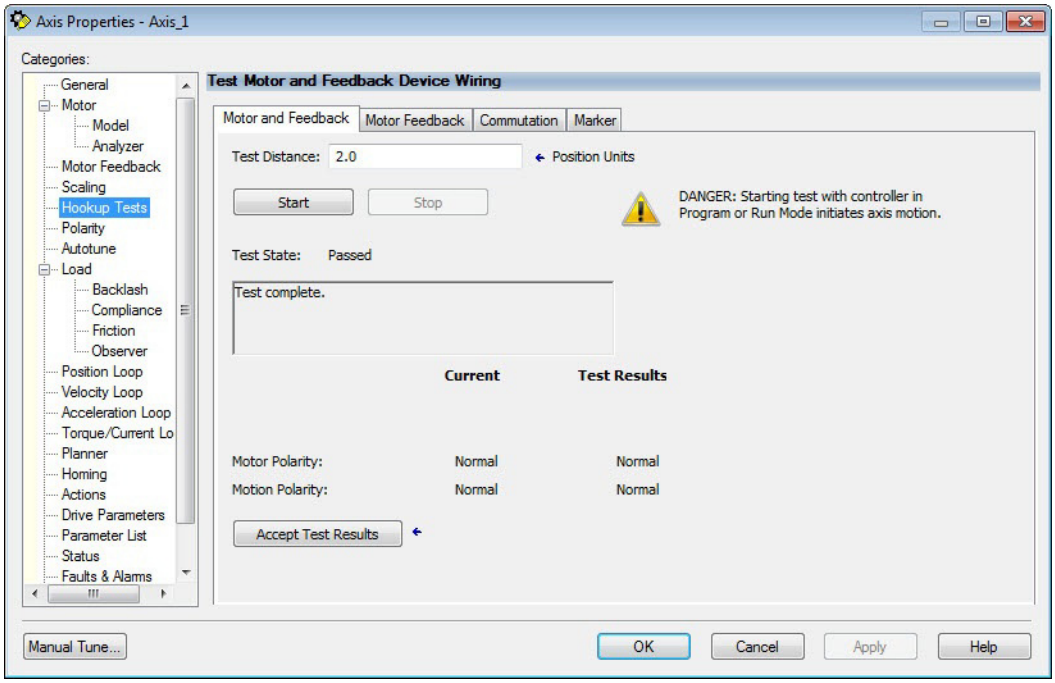
Follow these steps to test the axes.

1. Verify the load was removed from each axis.

ATTENTION: To avoid personal injury or damage to equipment, you must remove the load from each axis as uncontrolled motion can occur when an axis with an integral motor brake is released during the test.

2. In your Motion Group folder, right-click an axis and choose Properties.

   The Axis Properties dialog box appears.



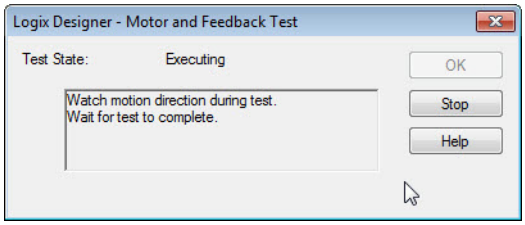
3. Select the Hookup Tests category.
4. In the Test Distance field, enter the desired test distance.

   The Position Units are defined in Axis Properties>Scaling category.

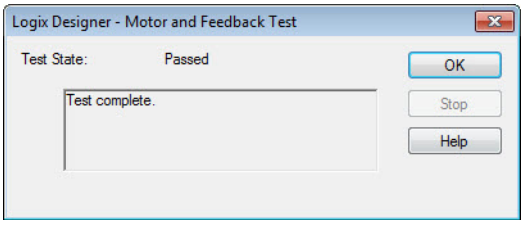
Hookup Test	Definitions
Marker	Verifies marker detection capability as you manually rotate the motor shaft. The test completes when the drive either detects the marker or when the motor moves the distance specified in the Test Distance field. If the marker remains undetected and the test completes successfully, it means the motor moved the full test distance. If the marker remains undetected and the test fails, the motor did not move the full test distance. Run this test after running the Motor Feedback and Motor and Feedback tests.
Commutation	Verifies the commutation offset and commutation polarity of the motor. This test applies to third-party or custom permanent-magnet motors equipped with (TTL with Hall and Sine/Cosine with Hall) incremental encoders that are not available as a catalog number in the Motion Database. See Commutation Test on page page 235.
Motor Feedback	Verifies feedback connections are wired correctly as you manually rotate the motor shaft. The test completes when the drive determines that the motor moved the full distance specified in the Test Distance field. Run this test before the Motor and Feedback Test to verify that the feedback can be read properly.
Motor and Feedback	Verifies motor power and feedback connections are wired correctly as the drive commands the motor to rotate. Because the drive is rotating the motor, this test requires full bus power to run. Run the Motor Feedback test before running this test to verify that the feedback is being read correctly.

5. Click the desired test to verify connections.
6. Click Start.

   The Studio 5000 Logix Designer - Motor and Feedback Test dialog box appears. The Test State is Executing.

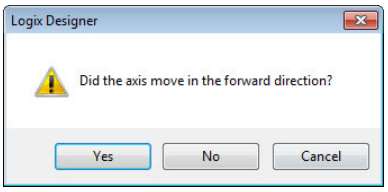


   When the test completes successfully, the Test State changes from Executing to Passed.

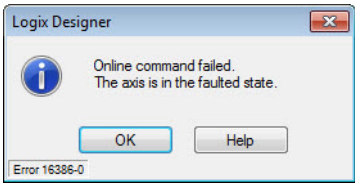


7. Click OK.

   This dialog box appears asking if the axis moved in the forward direction.



8. Click Yes if you agree.
9. Click Accept Test Results.
10. If the test fails, this dialog box appears.



    a. Click OK.
    b. Verify the DC bus voltage.
    c. Verify unit values entered in the Scaling category.
    d. Verify the motor power and feedback wiring.
    e. Return to step 5 and run the test again.

Tune the Axes

With Studio 5000 Logix Designer application, the load observer and adaptive tuning (tuningless) features are enabled by default, so configuration is not required for tuningless operation.

If additional tuning is required, see the Motion System Tuning Application Technique, publication MOTION-AT005, for more information.

Notes:

Troubleshoot the ArmorKinetix System

This chapter provides troubleshooting tables and related information for your ArmorKinetix® system.

Safety Precautions

Observe the following safety precautions when troubleshooting your ArmorKinetix system.

ATTENTION: Capacitors on the DC bus can retain hazardous voltages after input power has been removed. Before working on the drive module, measure the DC bus voltage to verify it has reached a safe level or wait the full time interval as indicated in the warning on the front of the module. Failure to observe this precaution could result in severe bodily injury or loss of life.

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

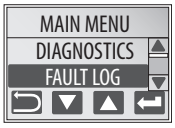
ATTENTION: Provide an earth ground for test equipment (oscilloscope) used in troubleshooting. Failure to ground the test equipment could result in personal injury.

Interpret Status Indicators

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

Display Interface

The PIM LCD display provides fault messages and troubleshooting information by using the soft menu items and navigation buttons.



Under the Main Menu, select FAULT LOG by using the up/down arrows.

	Press to display the list of active fault codes.
	Press again to display the fault details (the problem in troubleshooting tables).
	Press to display the fault help (possible solutions in troubleshooting tables).

Refer to Power Interface Module (PIM) Display on page 81 for more information on navigating the LCD display menu.

Fault Code Overview

The fault code tables are designed to help you determine the source of the fault or exception. When a fault condition is detected, the drive module performs the appropriate fault action, the fault is displayed, and the fault is added to a persistent fault log (along with diagnostics data). The earlier faults have priority to be displayed.

The drive module removes the fault text from the display when a Fault Reset service is sent from the controller and the fault is no longer active. If a fault condition is still active following a Fault Reset service, the fault is again posted to the display and written to the fault log.

However, there can be a delay before the fault is posted again. In a Studio 5000 Logix Designer® application, this delay results as the AxisFault tag on the drive axis being cleared until the fault is posted again. During this delay, the AxisState tag continues to indicate that the axis is faulted. Use the AxisState tag on the axis object only to determine if an axis is faulted.

Although software overtravel fault codes do not exist, software overtravel detection for the AXIS_CIP_DRIVE axis type is determined in the Logix 5000® controller. For more information, see Integrated Motion on the EtherNet/IP™ Network Reference Manual, publication MOTION-RM003.

The PIM, DSD, and DSM modules maintain a fault log of the last 128 faults. The fault log includes time stamps and is stored in persistent memory. However, the fault log cannot be cleared on the module. The DSD and DSM modules default to web enable so you can use an internet browser on the same subnet to access the fault log.

Table 45 - Fault Code Summary

Fault Code Type (1) (2)	Description
FLT S*xx*	Standard runtime axis exceptions. The exception can apply to an individual axis or to all axes.
FLT M*xx*	Manufacturer-specific runtime axis exception. The exception can apply to an individual axis or to all axes.
INIT FLT S*xx*	Exceptions that prevent normal operation and occur during the initialization process.
INIT FLT M*xx*	
NODE FLT*xx*	Exceptions that can prevent normal operation of the drive module and apply to the entire module and affect all axes.
NODE ALARM *xx*	Exceptions that can prevent normal operation of the drive module, but do not result in any action other than reporting the alarm to the controller.
INHIBIT S*xx*	Conditions that prevent normal operation and indicate the drive module is prevented from being enabled.
INHIBIT M*xx*	
ALARM S*xx*	An underlying exception condition that does not result in any action other than reporting the alarm to the controller.
ALARM M*xx*	
SAFE FLT*xx* (3)	Exception generated by a fault condition detected in the safety function. See SAFE FLT Fault Codes on page 139 for more information.

(1) S*xx* refers to Standard exceptions.
(2) M*xx* refers to Manufacturer-specific exceptions.
(3) For troubleshooting 2198-*xxxx*-ERS5 inverter SAFE FLT fault codes, refer to the ArmorKinetix System Safe Monitor Functions Safety Reference Manual, publication 2198-RM007.

Fault codes triggered by conditions that fall outside factory set limits are identified by FL at the end of the display message.
For example, FLT S07 – MTR OVERLOAD FL. Factory limits are set in the firmware and are not changeable.

Fault codes triggered by conditions that fall outside user set limits are identified by UL at the end of the display message.
For example, FLT S08 – MTR OVERLOAD UL. Some UL limits are changeable in the parameter list. You can change UL limits with Explicit MSG. We do not recommend altering UL limits without technical analysis or discussion with OEM machine builder.

Fault Codes

For ArmorKinetix module fault code descriptions and possible solutions, see Kinetix 5700 System Fault Codes, publication 2198-RD003; download the spreadsheet for offline access.

SAFE FLT Fault Codes

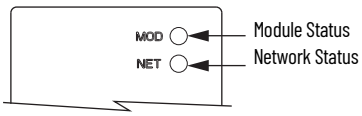
For troubleshooting 2198-DSx-ERS2 module and 2198-DSx-ERS5 module SAFE FLT fault codes, see the ArmorKinetix System Safe Monitor Functions Safety Reference Manual, publication 2198-RM007.

Status Indicators

These status indicators apply to the ArmorKinetix PIM and DSx modules. The module status and network status indicators are just above the LCD status display.

IMPORTANT Status indicators are not reliable for safety functions. Use them only for general diagnostics during commissioning or troubleshooting. Do not attempt to use status indicators to determine operational status.

ArmorKinetix PIM Modules



ArmorKinetix DSx Modules

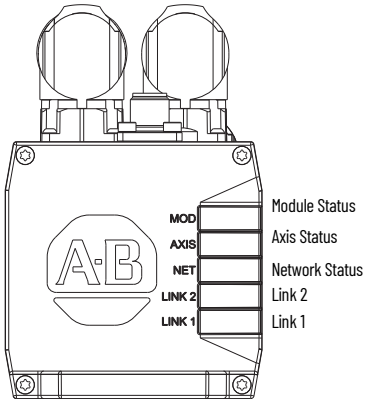


Table 46 - Module Status Indicator

Condition	Status
Steady Off	No power applied to the drive.
Steady Green	Drive is operational. No faults or failures.
Flashing Green	Standby (drive not configured) and Precharge (drive is configured).
Flashing Red	Major recoverable fault. The drive detected a recoverable fault, for example, an incorrect or inconsistent configuration.
Steady Red	Major fault. The drive detected a non-recoverable fault.
Flashing Green/Red	Self-test. The drive performs self-test during powerup. Once self-test is complete, Flashing Green/Red condition continues if drive is waiting for: • Safety configuration when in Integrated STO mode • Safety inputs when in Hardwired STO mode

Table 47 - Axis Status - DSx Module

Identity Object State	Module Status LED	Motion Device Axis Object State	Axis Status LED
Nonexistent - Power Off	Off	Off	Off
Device Self-testing	Flashing Red/Green	Self-test	Flashing Red/Green
Standby	Flashing Green	Initialization - Bus not Up	Off
		Initialization - Bus Up	Flashing Green
		Shutdown - Bus not Up	Off
		Shutdown - Bus Up	Flashing Amber
		Pre-charge - Bus not Up	Off
		Start Inhibit	Flashing Amber
Operational	Solid Green	Stopped	Flashing Green
		Stopping	Solid Green
		Starting	Solid Green
		Running	Solid Green
		Testing	Solid Green
Major Recoverable Fault	Flashing Red	Aborting	Flashing Red
		Major Faulted	Flashing Red
Major Unrecoverable Fault	Solid Red	Aborting	Solid Red
		Major Faulted	Solid Red

Ethernet RJ45 Connectors - PIM Module

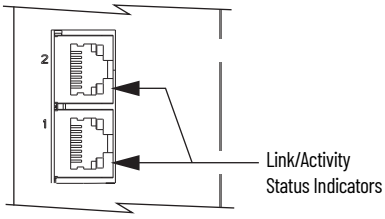


Table 48 - Network Status Indicator (Link 1 and Link 2) - DSx Module

Condition	Status
Steady Off	No power applied to the drive or IP address is not configured.
Flashing Green	No Motion or Safety connection is established, but drive has obtained an IP address.
Steady Green	Motion or Safety connection is established and no timeout has occurred. Normal operation.
Flashing Red	Connection timeout. One or more of the connections, for which this drive is the target, has timed out.
Steady Red	Duplicate IP address. IP address specified is already in use.
Flashing Green/Red	Self-test. The drive performs self-test during powerup. Once self-test is complete, Flashing Green/Red condition continues if drive is processing a safety device ID proposal.

Table 49 - Ethernet Link/Activity Status Indicator - PIM Module

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

General Troubleshooting

These conditions do not always result in a fault code, but can require troubleshooting to improve servo drive performance.

Table 50 - General Troubleshooting

Condition	Potential Cause	Possible Resolution
Axis or system is unstable.	The position feedback device is incorrect or open.	Check wiring.
	Unintentionally in Torque mode.	Check to see what primary operation mode was programmed.
	Motor tuning limits are set too high.	Run Tune in the Studio 5000 Logix Designer application.
	Position loop gain or position controller accel/decel rate is improperly set.	Run Tune in the Studio 5000 Logix Designer application.
	Improper grounding or shielding techniques are causing noise to be transmitted into the position feedback or velocity command lines, causing erratic axis movement.	Check wiring and ground.
	Motor Select limit is incorrectly set (servo motor is not matched to axis module).	• Check setups. • Run Tune in the Studio 5000 Logix Designer application.
	Mechanical resonance.	• Notch filter or output filter can be required (refer to Axis Properties dialog box, Compliance tab in the Studio 5000 Logix Designer application). • Enable adaptive tuning. See Adaptive Tuning on page 239 for more notch filter information.
You cannot obtain the motor acceleration/deceleration that you want.	Torque Limit limits are set too low.	Verify that torque limits are set properly.
	Incorrect motor selected in configuration.	Select the correct motor and run Tune in the Studio 5000 Logix Designer application again.
	The system inertia is excessive.	• Check motor size versus application need. • Review servo system sizing.
	The system friction torque is excessive.	Check motor size versus application need.
	Available current is insufficient to supply the correct accel/decel rate.	• Check motor size versus application need. • Review servo system sizing.
	Acceleration limit is incorrect.	Verify limit settings and correct them, as necessary.
	Velocity Limit limits are incorrect.	Verify limit settings and correct them, as necessary.
	The motor is operating in the field-weakening range of operation.	Reduce the commanded acceleration or deceleration.

Table 50 - General Troubleshooting (Continued)

Condition	Potential Cause	Possible Resolution
Motor does not respond to a command.	The axis cannot be enabled until stopping time has expired.	Disable the axis, wait the configured stopping time, and enable the axis.
	The motor wiring is open.	Check the wiring.
	The motor cable shield connection is improper.	• Check feedback connections. • Check cable shield connections.
	The motor has malfunctioned.	Repair or replace the motor.
	The coupling between motor and machine has broken (for example, the motor moves, but the load/machine does not).	Check and correct the mechanics.
	Primary operation mode is set incorrectly.	Check to see what primary operation mode was programmed.
	Velocity or torque limits are set incorrectly.	Check and properly set the limits.
	Brake connector not wired	Check brake wiring
Presence of noise on command or motor feedback signal wires.	Recommended grounding per installation instructions have not been followed.	• Verify grounding. • Route wire away from noise sources. • Refer to System Design for Control of Electrical Noise, publication GMC-RM001.
	Line frequency can be present.	• Verify grounding. • Route wire away from noise sources.
	Variable frequency can be velocity feedback ripple or a disturbance caused by gear teeth or ballscrew, and so forth. The frequency can be a multiple of the motor power transmission components or ballscrew speeds resulting in velocity disturbance.	• Decouple the motor for verification. • Check and improve mechanical performance, for example, the gearbox or ballscrew mechanism.
No rotation	The motor connections are loose or open.	Check motor wiring and connections.
	Foreign matter is lodged in the motor.	Remove foreign matter.
	The motor load is excessive.	Verify the servo system sizing.
	The bearings are worn.	Return the motor for repair.
	The motor brake is engaged (if supplied).	• Check brake wiring and function. • Return the motor for repair.
	The motor is not connect to the load.	Check coupling.
Motor overheating	The duty cycle is excessive.	Change the command profile to reduce accel/decel or increase time.
	The rotor is partially demagnetized causing excessive motor current.	Return the motor for repair.
Abnormal noise	Motor tuning limits are set too high.	Run Tune in the Studio 5000 Logix Designer application.
	Loose parts are present in the motor.	• Remove the loose parts. • Return motor for repair. • Replace motor.
	Through bolts or coupling is loose.	Tighten bolts.
	The bearings are worn.	Return motor for repair.
	Mechanical resonance.	Notch filter can be required (refer to Axis Properties dialog box, Compliance tab in the Studio 5000 Logix Designer application).
Erratic operation - Motor locks into position, runs without control or with reduced torque.	Motor power phases U and V, U and W, or V and W reversed.	Check and correct motor power wiring.
AC Contactor won't close	Stuck in configuring.	Check for messages on quick view pane of the controller organizer in the Studio 5000 Logix Designer application.
	Contactor enable unplugged on DFE module.	Plug in the contactor enable.
	AC contactor coil failure.	Replace contactor.

These conditions do not always result in a fault code, but can require troubleshooting to improve bus supply performance.

Table 51 - PIM Module Troubleshooting

Condition	Potential Cause	Possible Solution
Absence of (or fluctuations on) the PIM module output voltage under control power only (No 58V)	DC Control input Voltage to the PIM module is out of range of operation.	PIM module Input Voltage should be within the range of 21.6…26.4V.
	The 24V supply current capability is not enough to supply the PIM module load.	Size the 24V supply properly.
	External bus capacitance exceeds the maximum limit.	Do not exceed the maximum allowed external bus capacitance. See Calculate System and External-bus Capacitance on page 191.
	One or both PIM module DC Bus fuses are open.	Replace fuses.
	PIM module Load current exceeds the limits.	Do not connect more than 24 axes to one PIM module. See Calculate 24V DC Control Power Current Demand on page 193.

Logix 5000 Controller and Drive Module Behavior

By using the Studio 5000 Logix Designer application, you can configure how the ArmorKinetix system responds when a module fault/exception occurs.

The INIT FLT *xxx* faults are always generated after powerup, but before the drive is enabled, so the stopping behavior does not apply.

NODE ALARM *xxx* faults do not apply because they do not trigger stopping behavior.

For troubleshooting SAFE FLT fault codes, refer to Chapter 9 on page 268 (integrated safety).

The DC-bus power supplies and servo drives support fault actions for Ignore, Alarm, Minor Fault, and Major Fault as defined in Table 52. The drives also support five configurable stopping actions as defined in Table 56.

Table 52 - ArmorKinetix Module Exception Action Definitions

Exception Action	Definition
Ignore	The drive module completely ignores the exception condition. For some exceptions that are fundamental to the operation of the planner, Ignore is not an available option.
Alarm	The drive module sets the associated bit in the Motion Alarm Status word, but does not otherwise affect axis behavior. Like Ignore, if the exception is so fundamental to the drive, Alarm is not an available option. When an exception action is set to Alarm, the Alarm goes away by itself when the exceptional condition has cleared.
Minor Fault	The drive module latches the exception condition, but the drive does not execute any exception action.
Major Fault	The drive module latches the exception condition and executes the configured exception action.

You can configure exception behavior in the Studio 5000 Logix Designer application from the Axis Properties dialog box, Actions category. These controller exception actions are mapped to the drive exception actions.

Table 53 - Studio 5000 Logix Designer Exception Action Definitions

Exception Action	Definition
Ignore	The controller completely ignores the exception condition. For some exceptions that are fundamental to the operation of the planner, Ignore is not an available option.
Alarm	The controller sets the associated bit in the Motion Alarm Status word, but does not otherwise affect axis behavior. Like Ignore, if the exception is so fundamental to the drive, Alarm is not an available option. When an exception action is set to Alarm, the Alarm goes away by itself when the exceptional condition has cleared.
Fault Status Only	Like Alarm, Fault Status Only instructs the controller to set the associated bit in the Motion Fault Status word, but does not otherwise affect axis behavior. However, unlike Alarm an explicit Fault Reset is required to clear the fault once the exceptional condition has cleared. Like Ignore and Alarm, if the exception is so fundamental to the drive, Fault Status Only is not an available option.
Stop Planner	The controller sets 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 maximum deceleration rate. An explicit Fault Reset is required to clear the fault once the exceptional condition has cleared. If the exception is so fundamental to the drive, Stop Planner is not an available option.
Disable	When the exception occurs, the associated bit in the Fault Status word is set and the axis comes to a stop by using the stopping action defined by the drive for the particular exception that occurred. In the event of a fault, there is no controller-based configuration to specify what the stopping action is. The stopping action is device dependent.
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 power structure of the drive. 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 power structure of the drive. An explicit Shutdown Reset is required to restore the drive to an operational state.

PIM Module Behavior

Stopping action for exception fault codes does not apply to the PIM module. The Disable exception action for a PIM module means the module enters into a Major Fault state. The Shutdown exception action exhibits the same behavior as Disable, except the PIM module enters into Shutdown as the final state and requires a Shutdown Reset to recover.

Fault actions are shown in Table 54 and Table 55.

Figure 57 - Studio 5000 Logix Designer Axis Properties - Exceptions Tab

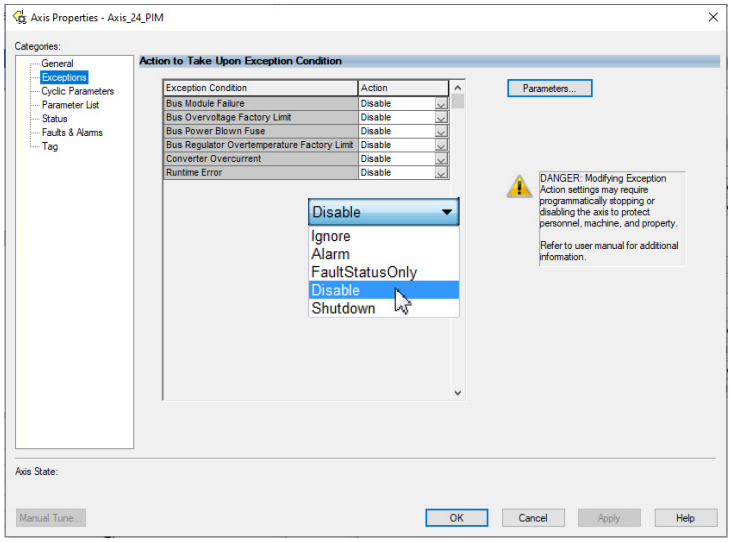


Table 54 - PIM Module Behavior, FLT S*xx* Fault Codes

Exception Fault Code	Exception Text	Fault Action				Best Available Stopping Action (applies to major faults)
		Ignore	Alarm	Minor Fault	Major Fault	
FLT S15 CONVERTER OVERCURRENT	Converter Overcurrent Fault	–	–	–	X	The PIM module does not perform stopping actions.
FLT S27 – BUS REG OVERTEMP FL (1)	Bus Regulator Overtemperature Factory Limit Fault	–	–	–	X	
FLT S32 – BUS CAPACITOR MODULE FAILURE	Bus Capacitor Module Failure	X	X	X	X	
FLT S35 BUS OVERVOLTAGE FL	Bus Overvoltage Factory Limit	–	–	–	X	
FLT S38 – BUS POWER FUSE BLOWN FAULT	Bus Power Fuse Blown Fault	–	–	–	X	

(1) Supported when shunt thermal switch is connected to the power supply digital input and configured in the Studio 5000 Logix Designer application.

Table 55 - PIM Module Behavior, FLT M*xx* Fault Codes

Exception Fault Code	Exception Text	Fault Action				Best Available Stopping Action (applies to major faults)
		Ignore	Alarm	Minor Fault	Major Fault	
FLT M26 – RUNTIME ERROR	Runtime Error	–	–	–	X	The PIM module does not perform stopping actions.

ArmorKinetix Behavior

For the ArmorKinetix modules, only selected exceptions are configurable. In the drive behavior tables, the controlling attribute is given for programmable fault actions.

Table 56 - Configurable Stopping Actions

Stopping Action	Description	
Ramped Decel & Hold (1)	Most control	The best available stopping action is the one that maintains the most control over the motor. However, not all faults support every stopping action.
Current Decel & Hold	Most control	
Ramped Decel & Disable (1)	Less control	
Current Decel & Disable	Less control	
Disable & Coast (2)	Least control	

(1) Ramped Decel is available only when General>Axis Configuration is set to Velocity Loop or Frequency Control.
(2) When configured for Frequency Control (induction motors only), select Decel & Disable only when the Current Limiting feature is enabled. For more information on this feature, see Current Limiting for Frequency Control on page 208.

Actions define the drive behavior in response to specific conditions. The Actions category includes Standard Actions and Safety Actions.

Table 57 - Actions Definitions

Action Category	Action Name	Action Trigger Condition	Available Actions
Standard	Disable (MSF) Stopping Action	Execution of an MSF motion instruction.	• Ramped Decel & Hold • Current Decel & Hold • Ramped Decel & Disable • Current Decel & Disable • Disable & Coast
	Connection Loss Stopping Action	Loss of the motion connection (for example, inhibiting the module or a network cable disconnect).	• Ramped Decel & Disable • Current Decel & Disable • Disable & Coast
	Motor Overload Action	Receiving MTR OVERLOAD fault.	• Current Foldback • None
	Inverter Overload Action	Receiving INV OVERLOAD fault.	• Current Foldback • None
Safety	Safe Torque Off Action	Transition from logic 0 to 1 of the SafeTorqueOffActiveStatus axis tag, which indicates a safe torque-off action was commanded (STO). (1)	• Ramped Decel & Disable • Current Decel & Disable • Disable & Coast
	Safe Stopping Action	Transition from logic 0 to 1 of the SS1ActiveStatus or SS2ActiveStatus axis tag which indicates a safe stopping action was commanded (SS1, SS2). (2)	• Ramped Decel (3) • Current Decel

(1) This action is executed only if the axis tag transitions due to a requested STO, not if it was triggered by another safe-stop function (SS1, for example).
(2) See Knowledgebase Technote: Kinetix 5700 ERS4 Drive based SS1 monitored - Stopping method for more information.
(3) Applies to only Velocity Control mode.

Standard Actions

When a control connection update fault (NODE FLT 01) occurs or a controller connection loss fault (NODE FLT 06) occurs, that other node faults can occur first, which triggers a fault action of Current Decel & Disable. Without knowing if NODE FLT 01 or NODE FLT 06 will occur first on a connection loss fault, we recommend that you do not change the default connection loss setting of Current Decel & Disable.

Use DLR ring topology (see Ring Topology on page 15) for applications where the possibility of connection loss must be minimized.

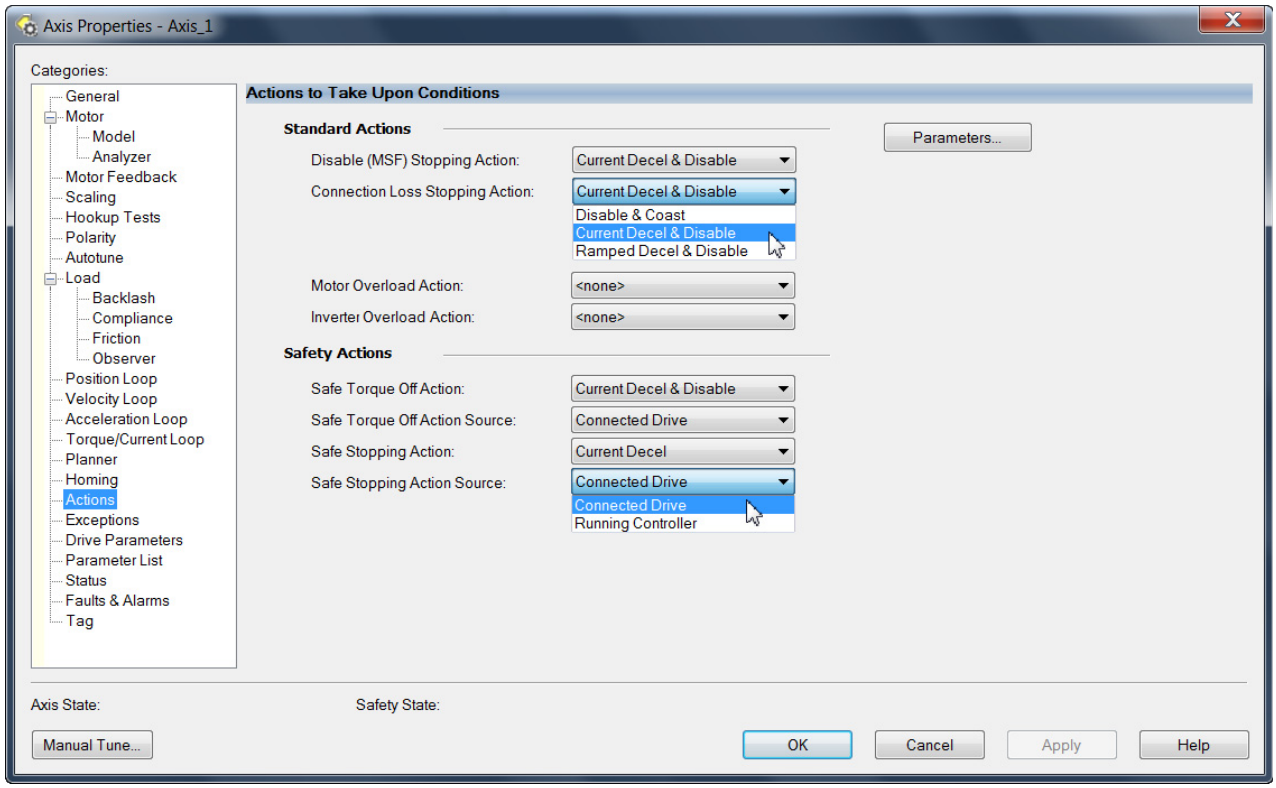
Safety Actions

The Action Source dropdown menus include Connected Drive mode and Running Controller mode.

When configured for Connected Drive (default), the drive initiates the stopping sequence according to the selected stopping action. However, the drive must have an open connection to the motion controller for the configured stopping action to occur.

When configured for Running Controller and the controller is in Run mode, the stopping sequence is controlled by your application program in the motion controller. This provides flexibility based on your application and requires that your program provide the desired action in response to the safety function active status. If no logic is created, no stopping action occurs. If the motion controller is in Program mode (not actively running the application program), the drive ignores the Action Source and initiates the configured stopping sequence according to the corresponding Action selected in the dropdown menu.

Figure 58 - Studio 5000 Logix Designer Axis Properties - Actions Category



Behavior and Exception Fault Codes

Table 58...Table 60 provide module behavior and the exception fault codes.

Table 58 - Drive Behavior, FLT S*xx* Fault Codes

Exception Fault Code	Exception Text	Permanent Magnet Motor	Induction Motor	Fault Action				Best Available Stopping Action (applies to major faults)
				Ignore	Alarm	Minor Fault	Major Fault	
FLT S04 – MTR OVERSPEED UL	Motor Overspeed User Limit Fault	X	X	X	X	X	X	Ramped Decel (1)/Hold
FLT S05 – MTR OVERTEMP FL	Motor Overtemperature Factory Limit Fault (If #589 vertical load control)	X	X	–	–	–	–	Current Decel/Disable
	Motor Overtemperature Factory Limit Fault (If not #589 vertical load control)			–	–	–	–	Disable/Coast
FLT S07 – MTR OVERLOAD FL	Motor Thermal Overload Factory Limit Fault	X	X	–	–	–	X	Ramped Decel (1)/ Disable
FLT S08 – MTR OVERLOAD UL	Motor Thermal OverLoad User Limit Fault	X	X	X	X	X	X	Ramped Decel (1)/Hold
FLT S11 – INV OVERTEMP FL	Inverter Overtemperature Factory Limit Fault (If #589 vertical load control)	X	X	–	–	–	X	Current Decel/Disable
	Inverter Overtemperature Factory Limit Fault (If not #589 vertical load control)			–	–	–		Disable/Coast
FLT S13 – INV OVERLOAD FL	Inverter Thermal Overload Factory Limit Fault	X	X	–	–	–	X	Current Decel/Disable
FLT S14 – INV OVERLOAD UL	Inverter Thermal Overload User Limit Fault	X	X	X	X	X	X	Ramped Decel (1)/Hold
FLT S22 – AC POWER LOSS	Converter AC Power Loss Fault	X	X	X	X	X	X	Ramped Decel (1)/ Disable
FLT S32 – BUS CAPACITOR MODULE FAILURE	Bus Capacitor Module Failure	X	X	X	X	X	X	Ramped Decel (1)/Hold
FLT S33 – BUS UNDERVOLT FL	Bus Undervoltage Factory Limit Fault	X	X	–	–	–	X	Disable/Coast
FLT S34 – BUS UNDERVOLT UL	Bus Undervoltage User Limit Fault	X	X	X	X	X	X	Ramped Decel (1)/Hold
FLT S35 – BUS OVERVOLT FL	Bus Overvoltage Factory Limit Fault	X	X	–	–	–	X	Disable/Coast
FLT S37 – BUS POWER LOSS	Bus Power Loss	X	X	X	X	X	X	Ramped Decel (1)/ Disable
FLT S40 – BUS POWER SHARING FAULT	Bus Power Sharing Fault	X	X	X	X	X	X	Ramped Decel (1)/ Disable
FLT S44 – FDBK LOSS UL (2)	Feedback Signal Loss UL	X	X	X	X	X	X	Ramped Decel (1)/Hold
FLT S46 – FDBK COMM UL (2)	Motor Feedback Data Loss User Limit Fault	X	X	X	X	X	X	Ramped Decel (1)/Hold
FLT S49 – BRAKE SLIP FLT	Brake Slip Exception	X	X	X	X	X	X	Ramped Decel (1)/Hold
FLT S50 – POS HW OTRAVEL	Hardware Overtravel - Positive	X	X	X	X	X	X	Ramped Decel (1)/Hold
FLT S51 – NEG HW OTRAVEL	Hardware Overtravel - Negative	X	X	X	X	X	X	Ramped Decel (1)/Hold
FLT S54 – POSN ERROR (2)	Excessive Position Error Fault (If #589 vertical load control)	X	X	X	X	X	X	Current Decel/Disable
	Excessive Position Error Fault (If not #589 vertical load control)							Disable/Coast
FLT S55 – VEL ERROR (2)	Excessive Velocity Error Fault (If #589 vertical load control)	X	X	X	X	X	X	Current Decel/Disable
	Excessive Velocity Error Fault (If not #589 vertical load control)							Disable/Coast
FLT S56 – OVERTORQUE LIMIT (2)	Overtorque Limit Fault	X	X	X	X	X	X	Ramped Decel (1)/Hold
FLT S57 – UNDERTORQUE LIMIT (2)	Undertorque Limit Fault	X	X	X	X	X	X	Ramped Decel (1)/Hold
FLT S61 – ENABLE INPUT	Enable Input Deactivated	X	X	X	X	X	X	Ramped Decel (1)/ Disable

(1) Available only in Velocity Control mode. Available stopping action is Current Decel in Position Control mode.
(2) Does not apply to induction motors in frequency control mode.

Table 59 - Drive Behavior, FLT Mxx Fault Codes

Exception Fault Code	Exception Text	Permanent Magnet Motor	Induction Motor	Fault Action				Best Available Stopping Action DSD/ DSM [1] (applies to major faults)
				Ignore	Alarm	Minor Fault	Major Fault	
FLT M02 – MOTOR VOLTAGE [2]	Motor Voltage Mismatch Fault	X	X	X	X	X	X	Disable/Coast
FLT M05 – FDBK BATTERY LOSS	Feedback Battery Loss Fault	X	–	–	–	–	X	Disable/Coast
FLT M06 – FDBK BATTERY LOW	Feedback Battery Low Fault	X	–	X	X	X	X	Disable/Coast
FLT M07 – FEEDBACK INCREMENTAL COUNT ERROR FAULT	Feedback Incremental Count Error Fault	X	X	X	X	X	X	Disable/Coast
FLT M26 – RUNTIME ERROR	Runtime Error	X	X	–	–	–	X	Disable/Coast
FLT M28 – SAFETY COMM [3]	Safety Module Communication Error	X	X	–	–	–	X	Disable/Coast

(1) The PIM module does not have Stopping Action.
(2) Does not apply to induction motors in frequency control mode.
(3) Applies to drives in Integrated STO mode.

Table 60 - Drive Behavior, NODE FLT Fault Codes

Exception Fault Code	Exception Text	Permanent Magnet Motor	Induction Motor	Fault Action				Best Available Stopping Action (applies to major faults)
				Ignore	Alarm	Minor Fault	Major Fault	
NODE FLT 01 – LATE CTRL UPDATE	Control Connection Update Fault	X	X	–	–	–	X	Ramped Decel [1]/Disable
NODE FLT 05 – CLOCK SKEW FLT	Clock Skew Fault	X	X	–	–	–	X	Ramped Decel [1]/Disable
NODE FLT 06 – LOST CTRL CONN	Lost Controller Connection Fault	X	X	–	–	–	X	Programmable per [2] Connection Loss Stopping Action (see Table 57 on page 144).
NODE FLT 07 – CLOCK SYNC	Clock Sync Fault	X	X	–	–	–	X	Ramped Decel[1]/Disable

(1) Available only in Velocity Control mode. Available stopping action is Current Decel in Position Control mode.
(2) Do not change the default stopping action.

Notes:

Remove and Replace PIM and DSx Modules

This chapter provides remove and replace procedures for ArmorKinetix® system modules.

ATTENTION: This drive contains electrostatic discharge (ESD) sensitive parts and assemblies. You are required to follow static-control precautions when you install, test, service, or repair this assembly. If you do not follow ESD control procedures, components can be damaged. If you are not familiar with static control procedures, refer to Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD awareness handbook.

Before You Begin

When each in-cabinet drive module is installed, network settings are configured from the setup screens. Before removing the module, revisit the Network menu and make note of the static IP or DHCP settings. Refer to Set Network Parameters for the PIM Module on page 84 to access those settings.

IMPORTANT If you intend to use the same Studio 5000 Logix Designer application after replacing your module, the new module must be the same catalog number as the old module.

IMPORTANT If replacing a drive module that was configured for integrated safety, see Understand Integrated Safety Drive Replacement on page 161.

You also need these tools available before you begin removal and replacement procedures:

- Screwdrivers (to loosen/remove screws)
- Voltmeter (to make sure that no voltage exists on drive connectors)

Remove Power and All Connections

Follow these steps to remove power from all power supplies and drives in the system. See Kinetix 5700 Servo Drives User Manual, publication 2198-UM002, to remove power from the drives, and DC Bus.

1. Verify that all control and input power has been removed from the system.

   ATTENTION: To avoid shock hazard or personal injury, make sure that all power has been removed before proceeding. This system can have multiple sources of power. More than one disconnect switch can be required to de-energize the system.

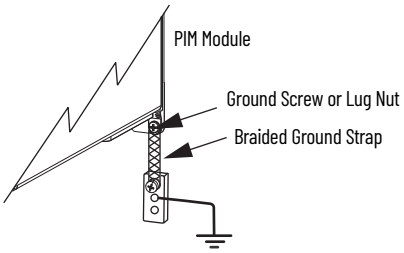
2. Wait 5 minutes for the DC bus to discharge completely before proceeding.

   SHOCK HAZARD: This product contains stored energy devices. To avoid the hazard of electrical shock, verify that voltage on capacitors has been discharged before attempting to service, repair, or remove this unit. Do not attempt the procedures in this document unless you are qualified to do so and are familiar with solid-state control equipment and the safety procedures in publication NFPA 70E.

3. Using a voltmeter, verify that the DC-bus voltage has discharged.
4. Label and remove all wiring connectors from the module that you are removing.

To identify each connector, refer to DC Bus Connector on page 57.

5. Unplug the DC-bus links and end caps from on top of the power supply, inverters, PIM module, and accessory modules you are removing.
6. Unplug the shared-bus 24V input wiring connector, T-connectors, and bus-bars from on top of the PIM module that you are removing (if applicable).
7. For 2198-DS*x*-ERS*x* modules, unplug the hybrid cables, motor power and feedback cable, and digital input cable.
8. For ArmorKinetix PIM modules, unplug the DC Power Connector and the Ethernet network connector.
9. Remove the ground screw or lug nut and braided ground strap.



Remove the PIM Module

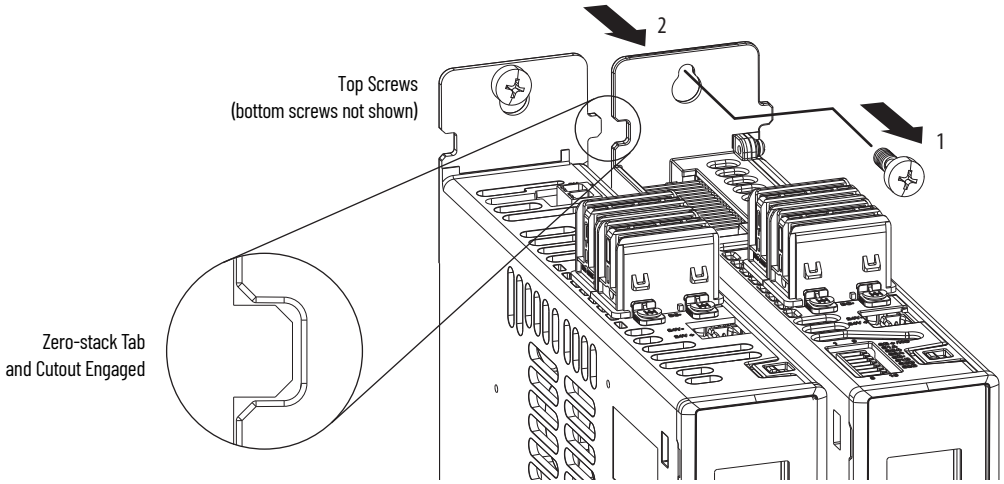
You can remove DC-bus power supplies, PIM modules, or accessory modules from the panel in any configuration by using the same procedure.

IMPORTANT This procedure applies to any ArmorKinetix PIM module in any configuration.

Follow these steps to remove ArmorKinetix PIM modules from the panel.

1. Loosen the top and bottom screws of the module you are removing.

   Modules with 55 mm width have one top and bottom screw.
2. For the ArmorKinetix PIM modules, grasp the top and bottom of the module with both hands and pull the module straight out and away from the panel, clearing the zero-stack mounting tabs and cutouts.



Replace the PIM Module

To replace the PIM module, reverse the steps that are shown above or refer to Mount the In-cabinet Modules on page 44.

Table 61 - Drive Module Torque Values

Kinetix 5700 Drive Module Cat. No.	Fasteners	Torque Value N•m (lb•in)
All Kinetix 5700 and ArmorKinetix modules	Module mounting screws	4.0 (35.4)
	Module ground lug	
2198-P*xxx*	Input power connector screws	0.8 (7.1)

Start and Configure the Drive Module

Follow these steps to configure the replacement module.

IMPORTANT If you intend to use the same Studio 5000 Logix Designer application after replacing your drive module, the new module must be the same catalog number as the old module.

IMPORTANT If a servo drive was previously configured by a safety controller, reset the drive to the Out of Box state. Refer to Out-of-Box State on page 159.

1. Reapply power to the drive system.

   Refer to Apply Power to the System on page 131 for the procedure.
2. Configure the network settings for the module.

   For example, if your old module was configured as Static IP, you must set the IP address, gateway, and subnet mask in the new module identical to the old module.

   Refer to Set Network Parameters for the PIM Module on page 84 to access those settings.
3. Download the Studio 5000 Logix Designer application to the controller.
4. Verify that the drive system is working properly.

Notes:

ArmorKinetix System Safety Features

Use this chapter to become familiar with the safe torque-off functionality built into ArmorKinetix® system.

Overview

This chapter covers integrated STO and SS1 timed on 2198-DSx-ERS2 and safe monitor functions on 2198-DSx-ERS5, see the ArmorKinetix System Safe Monitor Functions Safety Reference Manual, publication 2198-RM007. The ArmorKinetix DSD and DSM have both ERS2 and ERS5 implementations.

The 2198-DSx-ERS2 supports:

- Integrated STO
- Timed Safe Stop (SS1-t)

The 2198-DSx-ERS5 supports:

- Integrated STO
- Timed Safe Stop (SS1-t)
- Monitored Safe Stop (SS1-r)
- Safe Stop (SS2)(1)
- Safe Operational Stop (SOS)(1)
- Safely-limited Speed (SLS)(1)
- Safe Direction (SDI)(1)

In Integrated STO mode, the GuardLogix® safety controller issues the STO command over the EtherNet/IP™ network and the 2198-DSx-ERS2 and 2198-DSx-ERS5 inverters execute the STO command.

For integrated Monitored SS1 and Timed SS1 stopping function operations, see the ArmorKinetix System Safe Monitor Functions Safety Reference Manual, publication 2198-RM007.

Table 62 - ArmorKinetix Functional Safety Mode Support

Safety Mode	DSD or DSM Module Cat. No.
Integrated STO mode	2198-DSx-ERS2
	2198-DSx-ERS5
Monitored SS1 stopping function	2198-DSx-ERS5
Timed SS1 stopping function	2198-DSx-ERS2
	2198-DSx-ERS5

(1) These functions are available through the safety controller.

Certification

For product certifications currently available from Rockwell Automation, go to rok.auto/certifications.

Distributed Servo Drive (DSD)

The TÜV Rheinland group has approved 2198-DSD modules with integrated safe torque-off for use in safety-related applications up to SIL CL3, according to EN/IEC 61800-5-2, IEC 61508, and EN/IEC 62061; up to Performance Level PLe and Category 3, according to EN/ISO 13849-1; when used as described in the ArmorKinetix System Safe Monitor Functions Safety Reference Manual, publication 2198-RM007.

Distributed Servo Motor (DSM)

For STO and SS1:

The TÜV Rheinland group has approved 2198-DSM modules with integrated safe torque-off for use in safety-related applications up to SIL CL3, according to EN/IEC 61800-5-2, IEC 61508, and EN/IEC 62061; up to Performance Level PLe and Category 3, according to EN/ISO 13849-1; when used as described in the AmorKinetix System Safe Monitor Functions Safety Reference Manual, publication 2198-RM007.

For Monitoring Function:

The TÜV Rheinland group has approved 2198-DSM modules with integrated safe torque-off for use in safety-related applications up to SIL CL2, according to EN/IEC 61800-5-2, IEC 61508, and EN/IEC 62061; up to Performance Level PLd and Category 3, according to EN/ISO 13849-1; when used as described in the ArmorKinetix System Safe Monitor Functions Safety Reference Manual, publication 2198-RM007.

Important Safety Considerations

The system user is responsible for the following:

- Validation of any sensors or actuators connected to the system
- Completing a machine-level risk assessment
- Certification of the machine to the desired EN/ISO 13849-1 performance level or EN/IEC 62061 SIL level
- Project management and proof testing in accordance with EN/ISO 13849-1

Stop Category Definition

Stop Category 0 as defined in EN/IEC 60204-1 or safe torque-off as defined by EN/IEC 61800-5-2 is achieved with immediate removal of motion producing power to the actuator.

IMPORTANT In the event of a malfunction, the most likely stop category is Stop Category 0. When designing the machine application, timing and distance must be considered for a coast to stop. For more information regarding stop categories, refer to EN/IEC 60204-1.

Performance Level (PL) and Safety Integrity Level (SIL)

For safety-related control systems, Performance Level (PL), according to EN/ISO 13849-1, and SIL levels, according to IEC 61508 and EN/IEC 62061, include a rating of the systems ability to perform its safety functions. All of the safety-related components of the control system must be included in both a risk assessment and the determination of the achieved levels.

Refer to the EN/ISO 13849-1, IEC 61508, and EN/IEC 62061 standards for complete information on requirements for PL and SIL determination.

Average Frequency of a Dangerous Failure

Safety-related systems are classified as operating in a High-demand/continuous mode. The SIL value for a High-demand/continuous mode safety-related system is directly related to the probability of a dangerous failure per hour (PFH).

PFH calculation is based on the equations from IEC 61508 and show worst-case values. Table 63 and Table 64 provide data for a 20-year proof test interval and demonstrates the worst-case effect of various configuration changes on the data.

IMPORTANT Determination of safety parameters is based on the assumptions that the system operates in High-demand mode and that the safety function is requested at least once every three months.

Table 63 - PFH for 20-year Proof Test Interval - DSD Modules

Attribute	2198-DSD-ERS2 Single-axis Inverters	2198-DSD-ERS5 Single-axis Inverters
PFH (1e-9) (under worst case conditions)	3.38	3.38
HFT (hardware fault tolerance) (1)	1	1
Proof test (years)	20	20
MTTFd (Mean Time to Failure) years	128	128
DC avg (Diagnostic Coverage) %	90	90
Category	3	3
PL (Performance Level)	e - for support of the safety stopping functions d - for support of monitoring functions	e - for support of the safety stopping functions
SIL (Safety Integrity Level)	3 - for support of the stopping functions 2 - for support of monitoring functions	up to 3
SFF (Safe Failure Fraction) %	95	95

(1) A hardware fault tolerance of N means that N+1 is the minimum number of faults that can cause a loss of the safety function as defined by IEC 61508-2.

The DSM module is equipped with a Hiperface DSL functional safety-rated feedback sensor, which is designed to maintain the functional safety rating of the feedback sensor attached.

Table 64 - PFH for 20-year Proof Test Interval - DSM Module Encoder Reliability Data

Attribute	2198-DSM0*xx*-ERS*x*-x075*xx*-W	2198-DSM0*xx*-ERS*x*-x1*xxxx*-T
Probability of a Dangerous Failure per Hour (PFH)	350.0 x 10^{-9} at 115 °C (239 °F) ambient temperature	370.0 x 10^{-9} at 115 °C (239 °F) ambient temperature

Compatible Safety Controllers

A GuardLogix 5580 or Compact GuardLogix 5380 safety controller is required for integrated safety control of the ArmorKinetix safe torque-off function.

The Studio 5000 Logix Designer® application, version 35.00.00 or later, provides support for programming, commissioning, and maintaining Logix 5000® safety controllers with ArmorKinetix systems.

The safety connection can originate from either of these controller configurations:

- Single safety controller that provides both safety and motion control
- Safety controller that controls only the safety, with a separate ControlLogix® 5570, ControlLogix 5580, CompactLogix™ 5370, or CompactLogix 5380 controller that controls motion

Table 65 - Studio 5000 Logix Designer Requirements

Studio 5000 Logix Designer Application	ArmorKinetix Modules Cat. No.
Version 35.00.00 or later	2198-DSx-ERS2 2198-DSx-ERS5

Safety Application Requirements

Safety application requirements include evaluating probability of failure rates (PFH), system reaction time settings, and functional validation tests that fulfill SIL 3 criteria. Refer to Average Frequency of a Dangerous Failure on page 155 for more PFH information.

Creating, recording, and verifying the safety signature is also a required part of the safety application development process. Safety signatures are created by the safety controller. The safety signature consists of an identification number, date, and time that uniquely identifies the safety portion of a project. This includes all safety logic, data, and safety I/O configuration.

For safety system requirements, including information on the safety network number (SNN), verifying the safety signature, and functional verification tests refer to the appropriate GuardLogix controller publication as defined in Additional Resources on page 9.

IMPORTANT You must read, understand, and fulfill the requirements detailed in the GuardLogix controller systems safety reference manual prior to operating a safety system that uses a GuardLogix controller and ArmorKinetix DSD and DSM modules.

Description of Operation

The safe torque-off (STO) feature provides a method, with sufficiently low probability of failure, to force the power-transistor control signals to a disabled state. When the command to execute the STO function is received from the GuardLogix controller, all of the drive output-power transistors are released from the ON-state. This results in a condition where the drive IGBT disables and the motor coasts. Disabling the power transistor output does not provide isolation of the electrical output that is required for some applications.

These conditions must be met for integrated control of the STO function:

- The module must be configured for **Safety Only** or **Motion and Safety** connections

The ArmorKinetix system STO function response time is less than 10 ms. Response time for the drive is the delay between the time the drive receives the CIP Safety™ packet with an STO request and the time when motion producing power is removed from the motor.

Table 66 - Safe Torque-off Network Specifications

Attribute	2198-DSx-ERS2	2198-DSx-ERS5
STO function response time	10 ms, max	
Safety connection RPI, min	6 ms	
Input assembly connections (1)	3 (Drv:SI)	1 (Drv:SI)
Output assembly connections (1)	1 (Drv:SO)	
Integrated safety open request support	Type 1 and Type 2 requests	

(1) Motion and Safety and Safety Only connections with the inverter uses 1 input assembly connection and 1 output assembly connection.

Safe Torque-off Assembly Tags

In Integrated safe torque-off (STO) mode, a GuardLogix 5580 or Compact GuardLogix 5380 safety controller commands the ArmorKinetix system safe torque-off function through the appropriate tag in the safety output assembly.

The SO.Command tags are sent from the GuardLogix safety output assembly to the ArmorKinetix system safety output assembly to control the safe torque-off function.

The SI.Status tags are sent from the ArmorKinetix DS*x* module to the GuardLogix safety input assembly and indicate the ArmorKinetix system safety control status.

The SI.ConnectionStatus tags indicate the safety input connection status.

Table 67 lists the Integrated STO safety tags added to the controller tags when an ArmorKinetix DS*x* module is added to a GuardLogix I/O Configuration and the connection is configured for Motion and Safety or Safety Only. The full list can be found in the Kinetix 5700 Safe Monitor Functions Safety Reference Manual, publication 2198-RM001.

The attribute values listed are the Assembly Object attribute values.

Table 67 - DS*x* Inverter Integrated STO Specifications

Studio 5000 Logix Designer Tag Name	Attribute [bit]	Type	Description
SI.ConnectionStatus (1) (2)		DINT	
SI.RunMode	[0]	BOOL	Combinations of the RunMode and ConnectionFaulted states
SI.ConnectionFault	[1]	BOOL	
SI.Status (1) (3)		SINT	
SI.TorqueDisabled	[0]	BOOL	0 = Torque Permitted 1 = Torque Disabled
SI.SafetyFault	[6]	BOOL	1 = STO fault present
SI.RestartRequired	[7]	BOOL	1 = Restart is required
SO.Command (1) (4)		SINT	
SO.STOOutput	[0]	BOOL	0 = Disable Permit 1 = Permit Torque
SO.ResetRequest	[7]	BOOL	0 --> 1 = Reset STO fault

(1) Bits not listed are always zero.
(2) ConnectionStatus is determined by the Safety Validator in the GuardLogix controller.
(3) Status is sent from the drive to the controller using integrated safety protocol.
(4) Commands are sent from the controller to the drive using integrated safety protocol.

IMPORTANT Only the data listed in Table 67 is communicated with SIL 3 integrity.

In these examples, the appropriate STO bit permits torque when the bit is high.

Figure 59 - STO Function with Safe Stop Only-No Feedback (Logix Designer, version 35 or later)

STO Fault Reset

To clear the STO Fault condition, a transition from logic 0 to 1 of the SO.ResetRequest tag is required after the SO.STOOutput tag has transitioned from logic 0 to 1 (see Table 67 on page 157 for changes in STO tag names).

If the ArmorKinetix DS*x* module safety controller detects a fault, the input assembly tag SI.SafetyFault is set to 1.

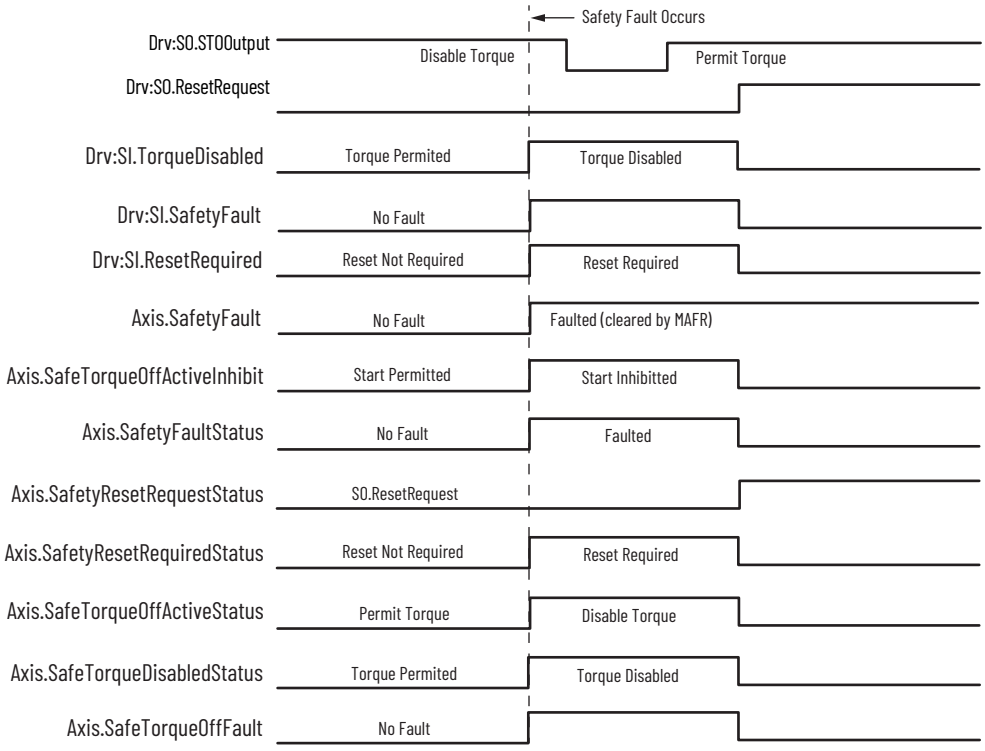
To reset Axis.SafetyFault, an MAFR command must be issued.

IMPORTANT Transition of the S0.STOOutput tag to logic 1 must always be executed prior to transition of the S0.ResetRequest tag to logic 1.

IMPORTANT All ArmorKinetix inverter axes enter the faulted state if any STO function fault is detected. Refer to Understand Integrated Safety Drive Replacement on page 161 for integrated safety troubleshooting.

Refer to Figure 60 for an understanding of the ArmorKinetix system STO state restart functionality.

Figure 60 - Reset Safe Torque-off Fault Diagram



Standard Data for Safe Torque Off Status

This section describes the safety related status data that is available to the motion controller.

IMPORTANT The status data described in this section is STANDARD data (not SAFETY data) and cannot be used as part of a safety function.

When an ArmorKinetix module is added to a Logix Designer application I/O tree and a motion axis (AXIS_CIP_DRIVE) is created and associated with it, axis tags are added to the controller tags.

This table lists the safety related STANDARD tags that are added when a new AXIS_CIP_DRIVE axis is defined.

Table 68 - Safety Related Axis Tags

Studio 5000 Logix Designer Tag Name	Attribute [bit]	Type	Description
AxisFaults	34	DINT	
ModuleFaults	163	DINT	
GuardStatus	980	DINT	
GuardFault	981	DINT	
CIPAxisFaultsRA	903	DINT	
SafetyModuleCommunicationErrorFault	[28]	BOOL	Loss of communication to safety control
CIPAxisAlarmsRA	904	DINT	
SafetyModuleCommunicationErrorAlarm	[28]	BOOL	Loss of communication to safety control
CIPInitializationFaultsRA	910	DINT	
InvalidSafetyFirmwareFault	[14]	BOOL	Invalid safety control firmware
CIPStartInhibits	676	DINT	
SafeTorqueOffActiveInhibit	[5]	BOOL	Torque disabled - Integrated
CIPStartInhibitsRA	912	DINT	
AxisSafetyState	760	DINT	Safety supervisor state
AxisSafetyStatus (1)	761	DINT	
SafetyFaultStatus	[0]	BOOL	Status of SI.SafetyFault
SafetyResetRequestStatus	[1]	BOOL	Status of SO.ResetRequest
SafetyResetRequiredStatus	[2]	BOOL	Status of SI.ResetRequired
SafeTorqueOffActiveStatus	[3]	BOOL	Status of SO.STOOutput
SafeTorqueDisabledStatus	[4]	BOOL	Status of SI.TorqueDisabled
SafetyOutputConnectionClosedStatus	[30]	BOOL	1 if all output connections are closed
SafetyOutputConnectionIdleStatus	[31]	BOOL	1 if safety controller is in program mode
AxisSafetyFaults	763	DINT	
SafetyCoreFault	[1]	BOOL	Loss of communications to safety control
SafetyTorqueOffFault	[3]	BOOL	Status of SI.SafetyFault

(1) Bits not shown are always zero.

Out-of-Box State

The 2198-DS*x*-ERS*x* modules ship in the out-of-box state.

ATTENTION: In the out-of-box state, motion producing power is allowed by the safe torque-off (STO) function unless an integrated safety connection configuration has been applied to the drive at least once.

In the out-of-box state, you can configure 2198-DS*x*-ERS*x* modules:

- Without a GuardLogix 5580 safety controller for a non-safety application.
- With a GuardLogix 5580 safety controller when the Connection type is configured for Motion Only.

Restore Out-of-Box State

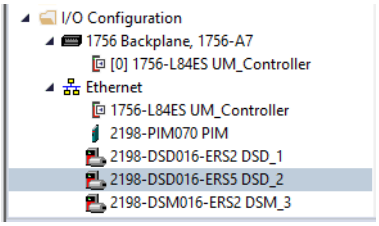
After the integrated safety connection configuration is applied to the 2198-DS*x*-ERS*x* modules at least once, you can restore the drive to the out-of-box state.

IMPORTANT This procedure is only valid when online with the controller and no Safety Lock or Safety Signature is applies to the controller.

To restore the module to out-of-box state, see Set Network Parameters for the DSD and DSM Modules on page 85.

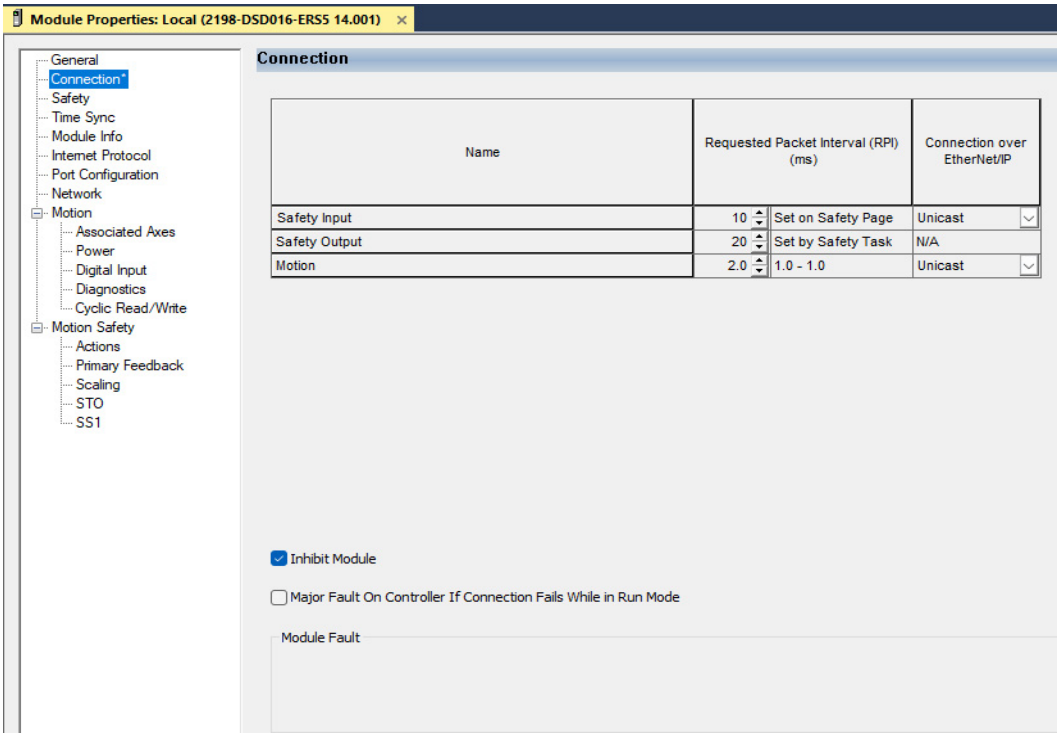
Follow these steps to restore your 2198-DS*x*-ERS*x* module to the out-of-box state.

1. Right-click the 2198-DS*x*-ERS*x* module you created and choose Properties.



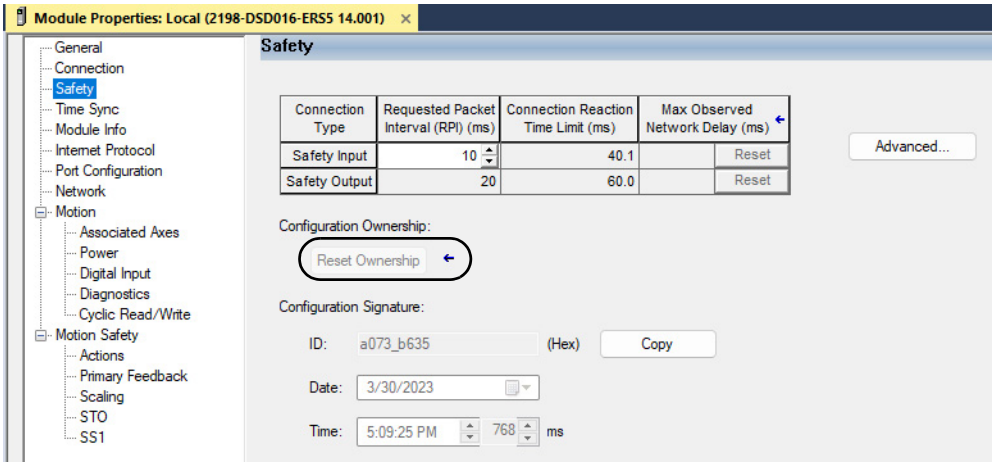
2. Click the Connection tab.

   The Connection tab appears.



3. Check Inhibit Module.
4. Click Apply and click the Safety tab.

   The Safety tab appears.



5. In the Configuration Ownership field, click Reset Ownership.

IMPORTANT	Only authorized personnel should attempt Reset Ownership.

If any active connection is detected, the reset is rejected.

6. Cycle drive power.

The drive is in the out-of-box state.

IMPORTANT	If power to the drive is not cycled after step 5, the drive does not transition to the out-of-box state and maintains STO function.

IMPORTANT	When the drive returns to the out-of-box state, STO safety integrity is lost.

Understand Integrated Safety Drive Replacement

GuardLogix controllers retain I/O device configuration on-board and are able to download the configuration to the replacement device.

IMPORTANT	If a 2198-DSx-ERSx module was used previously, clear the existing configuration before installing it on a safety network by resetting the drive to its out-of-box condition. To see how this is done, refer to Restore Out-of-Box State on page 160.

Replacing a 2198-DSx-ERSx module that sits on an integrated safety network is more complicated than replacing standard devices because of the safety network number (SNN).

The device number and SNN make up the safety device's DeviceID. Safety devices require this more complex identifier to make sure that duplicate device numbers do not compromise communication between the correct safety devices. The SNN is also used to provide integrity on the initial download to the 2198-DSx-ERSx module.

When the Studio 5000 Logix Designer application is online, the Safety tab of the Module Properties dialog box displays the current configuration ownership. When the opened project owns the configuration, Local is displayed.

Communication error is displayed if the module read fails. Refer to Replace an Integrated Safety Drive in a GuardLogix System on page 162 for integrated safety drive replacement information.

Replace an Integrated Safety Drive in a GuardLogix System

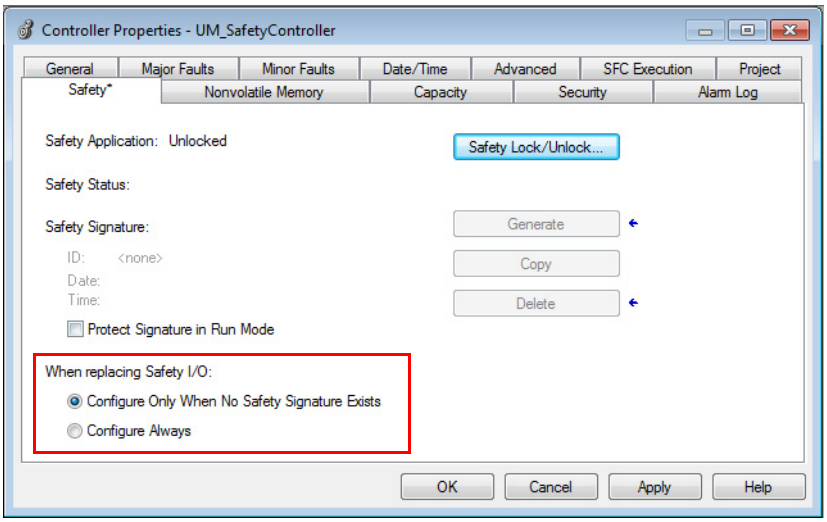
When you replace an integrated safety drive, the replacement device must be configured properly and the replacement drives operation be user-verified.

ATTENTION: During drive replacement or functional test, the safety of the system must not rely on any portion of the affected drive.

Two options for safety drive replacement are available on the Safety tab of the Controller Properties dialog box in the Studio 5000 Logix Designer application:

- Configure Only When No Safety Signature Exists
- Configure Always

Figure 61 - Safety Drive Replacement Options



Configure Only When No Safety Signature Exists

This setting instructs the GuardLogix controller to automatically configure a safety drive only when the safety task does not have a safety task signature, and the replacement drive is in an out-of-box condition, meaning that a safety network number does not exist in the safety drive.

If the safety task has a safety task signature, the GuardLogix controller automatically configures the replacement CIP Safety I/O device only if the following is true:

- The device already has the correct safety network number.
- The device electronic keying is correct.
- The node or IP address is correct.

For detailed information, see the ControlLogix 5580 and GuardLogix 5580 Controllers User Manual, publication 1756-UM543 or CompactLogix 5380 and Compact GuardLogix 5380 Controllers User Manual, publication 5069-UM001.

Configure Always

When the Configure Always feature is enabled, the controller automatically checks for and connects to a replacement drive that meets all of the following requirements:

- The controller has configuration data for a compatible drive at that network address
- The drive has an SNN that matches the configuration

ATTENTION: Enable the Configure Always feature only if the entire integrated safety control system is not being relied on to maintain SIL 3 behavior during the replacement and functional testing of an ArmorKinetix system.
If other parts of the integrated safety control system are being relied upon to maintain SIL 3, make sure that the controller's Configure Always feature is disabled.

It is your responsibility to implement a process to make sure proper safety functionality is maintained during device replacement.

ATTENTION: Do not place any devices in the out-of-box condition on any integrated safety network when the Configure Always feature is enabled, except while following the device replacement procedure in the GuardLogix user manual appropriate for your Logix 5000 controller:
- GuardLogix 5580 Controllers User Manual, publication 1756-UM543
- Compact GuardLogix 5380 Controllers User Manual, publication 5069-UM001

Motion Direct Commands in Motion Control Systems

You can use the Motion Direct Command (MDC) feature to initiate motion while the controller is in Program mode, independent of application code that is executed in Run mode. These commands let you do a variety of functions, for example, move an axis, jog an axis, or home an axis.

A typical use might involve a machine integrator testing different parts of the motion system while the machine is being commissioned or a maintenance engineer, under certain restricted scenarios in accordance with safe machine operating procedures, wanting to move an axis (like a conveyor) to clear a jam before resuming normal operation.

ATTENTION: To avoid personal injury or damage to equipment, follow these rules regarding Run mode and Program mode.
- Only authorized, trained personnel with knowledge of safe machine operation should be allowed to use Motion Direct Commands
- Additional supervisory methods, like removing the controller key switch, should be used to maintain the safety integrity of the system after returning the safety controller to RUN mode

Understand STO Bypass When Using Motion Direct Commands

If a Safety-only connection between the GuardLogix safety controller and the 2198-DS*x*-ERS*x* module was established at least once after the drive was received from the factory, the drive does not allow motion while the safety controller is in Program mode by default.

This is because the safety task is not executed while the GuardLogix safety controller is in Program mode. This applies to applications running in a single-safety controller (with Motion and Safety connections). When an integrated safety drive has a Motion connection to a standard controller and a separate Safety connection to a dual-safety controller, the standard controller can transition to Program mode while the safety controller stays in Run mode and continues to execute the safety task.

However, 2198-DS*x*-ERS*x* systems are designed with a bypass feature for the STO function in single-safety controller configurations. You can use the MDC feature to allow motion while following all the necessary and prescribed steps per machine safety operating procedures.

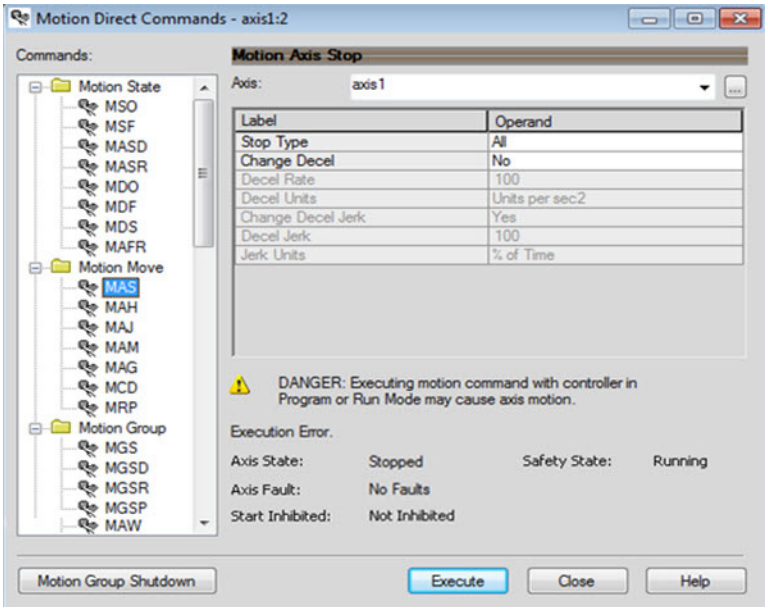
ATTENTION: Consider the consequences of allowing motion through the use of MDC when the controller is in Program mode. You must acknowledge warning messages in the Studio 5000 Logix Designer application that warn of the drive bypassing the STO function and unintended motion can occur. The integrated safety drive does not respond to the request of STO function if MDC mode is entered.

ATTENTION: It is your responsibility to maintain machine safety integrity while executing motion direct commands. One alternative is to provide ladder logic for Machine Maintenance mode that leaves the controller in Run mode with safety functions executing.

Studio 5000 Logix Designer Application Warning Messages

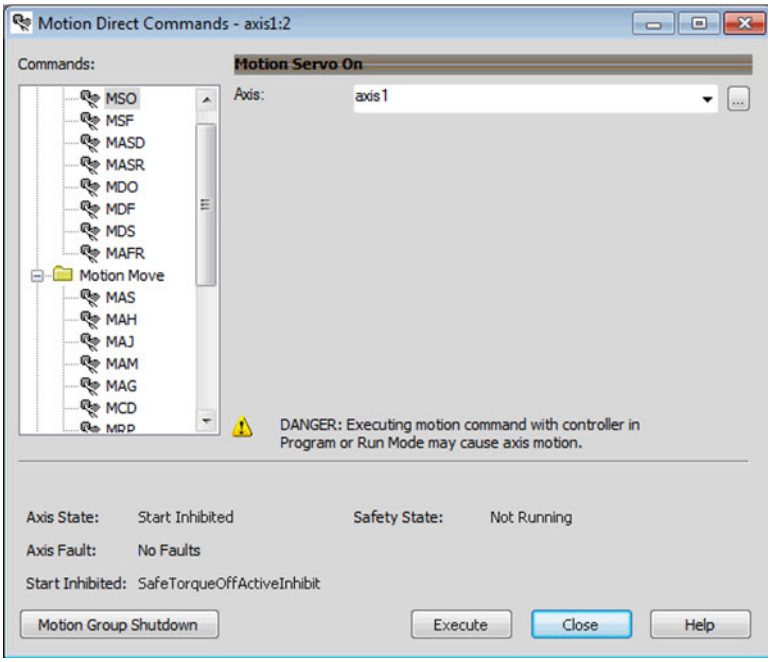
When the controller is in Run mode, executing safety functions, the 2198-DSx-ERSx drive follows the commands that it receives from the safety controller. Safety state = Running, Axis state = Stopped/Running, as shown in Figure 62.

Figure 62 - Safety State Indications When Controller is in Run Mode (safety task executing)



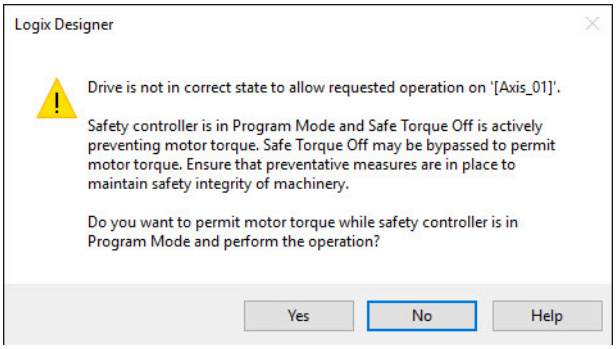
When the controller transitions to Program mode, the integrated safety drive is in the safe state (torque not permitted). Safety state = Not Running, Axis state = Start Inhibited, as shown in Figure 63).

Figure 63 - Safety State Indications After Controller Transitions to Program Mode



When you issue a motion direct command to an axis to produce torque in Program mode, for example MSO or MDS, with the safety connection present to the drive, a warning message is presented before the motion direct command is executed, as shown in Figure 64.

Figure 64 - STO Bypass Prompt When the Safety Controller is in Program Mode

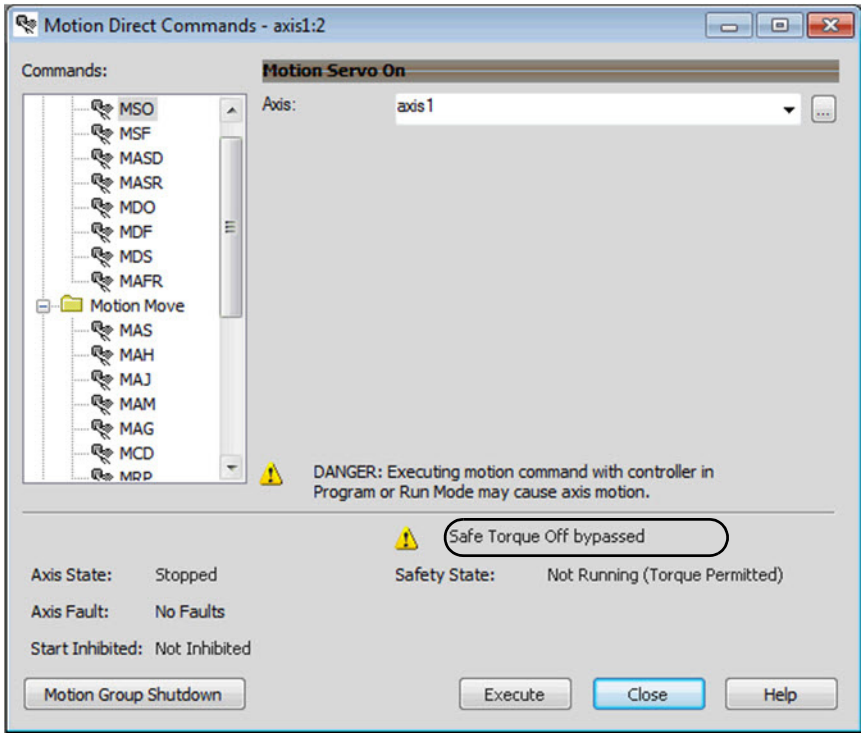


The warning in Figure 64 is displayed the first time a motion direct command is issued.

After you acknowledge the warning message by clicking Yes, torque is permitted by the drive and a warning message is indicated in the software as shown in Figure 65. Safety state = Not Running (torque permitted), Axis state = Stopped/Running, Persistent Warning = Safe Torque Off Bypassed.

IMPORTANT Switch the controller to Run mode to exit Motion Direct Command mode with STO function bypassed.

Figure 65 - Safety State Indications After Controller Transitions to Program Mode (MDC executing)



IMPORTANT The persistent warning message text 'Safe Torque Off bypassed' appears when a motion direct command is executed.

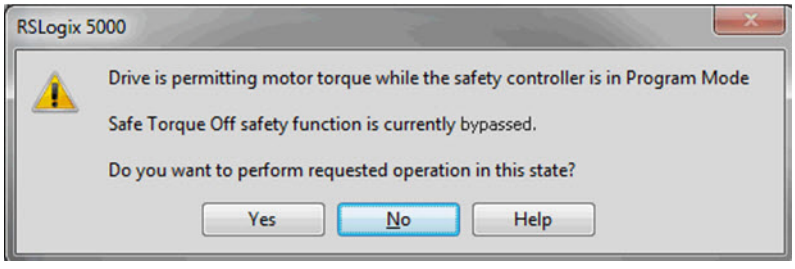
Warning message persists even after the dialog is closed and reopened as long as the integrated safety drive is in STO Bypass mode.

The persistent warning message is removed only after the integrated safety drive is restored to the Safe state.

Torque Permitted in a Multi-workstation Environment

The warning in Figure 66 is displayed to notify a second user working in a multi-workstation environment that the first user has placed the integrated safety drive in the STO state and that the current action is about to bypass the STO state and permit torque.

Figure 66 - STO Bypass Prompt When MDC is Issued in Multi-workstation Environment



Warning Icon and Text in Axis Properties

In addition to the other warnings that require your acknowledgment, the Studio 5000 Logix Designer application also provides warning icons and persistent warning messages in other Axis Properties dialog boxes when the integrated safety drive is in STO Bypass mode.

Figure 67 - Axis and Safe State Indications on the Hookup Services Dialog Box

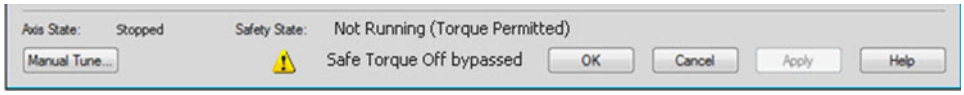


Figure 68 - Axis and Safe State Indications on Motion Direct Commands Dialog Box

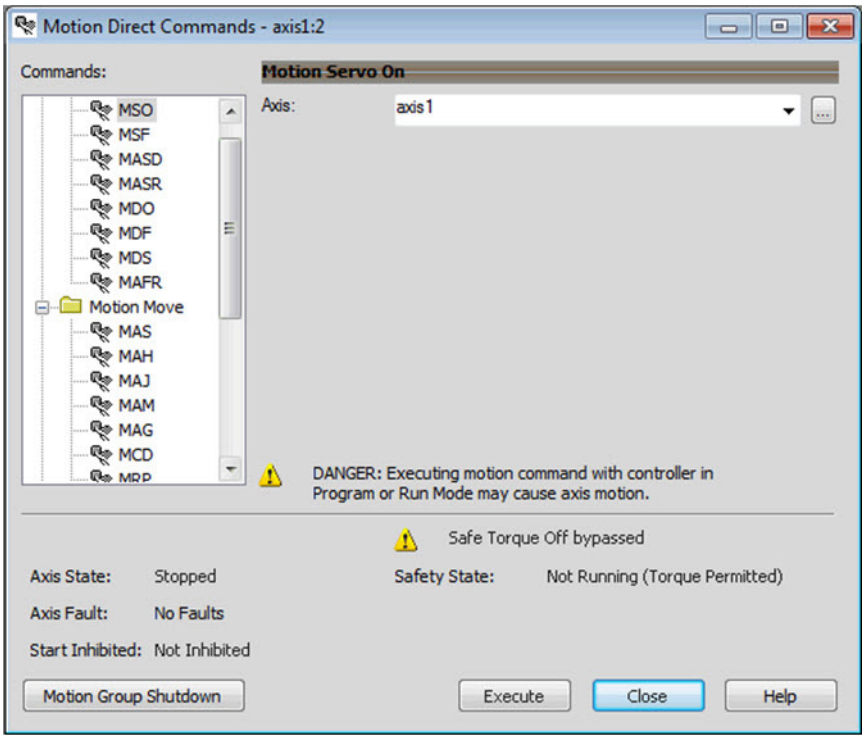
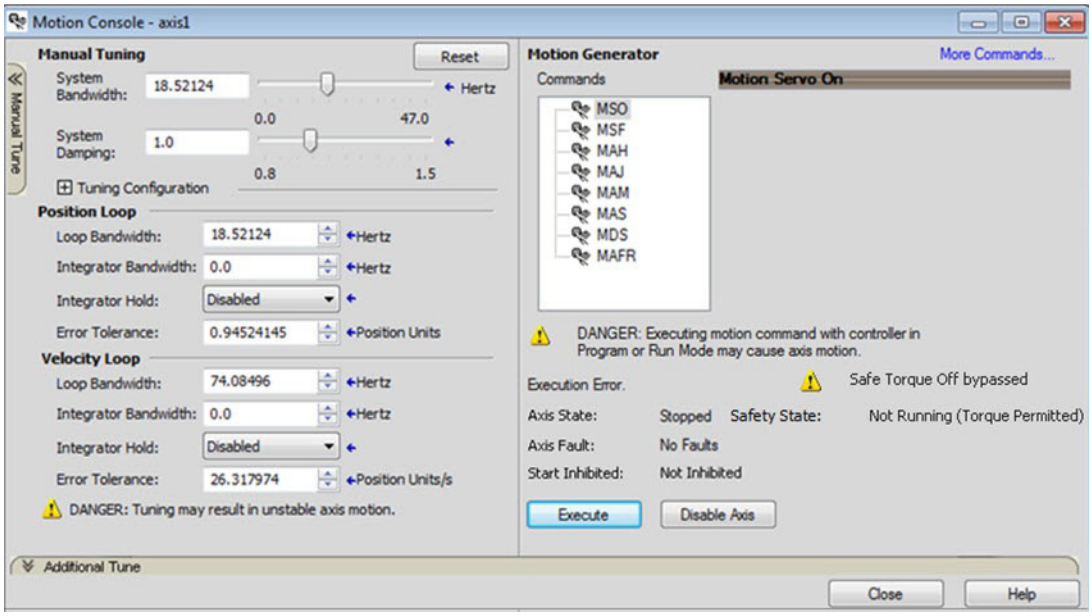


Figure 69 - Axis and Safe State Indications on the Motion Console Dialog Box



Functional Safety Considerations

ATTENTION: Before maintenance work can be performed in Program mode, the developer of the application must consider the implications of allowing motion through motion direct commands and should consider developing logic for run-time maintenance operations to meet the requirements of machine safety operating procedures.

ATTENTION: Motion is allowed when motion direct commands are used in Program mode and STO function is not available.
Motion direct commands issued when the controller is in Program mode causes the drive to bypass the STO Active condition.
It is your responsibility to implement additional preventive measures to maintain safety integrity of the machinery during execution of motion direct commands in Program mode.

ATTENTION: To avoid personal injury and damage to equipment in the event of unauthorized access or unexpected motion during authorized access, return the controller to RUN mode and remove the key before leaving the machine unattended.

Interconnect Diagrams

Interconnect Diagram Notes

This appendix provides wiring examples and system block diagrams for your ArmorKinetix® system components. These notes apply to the Studio 5000 Logix Designer® application wiring examples on the following pages.

Table 69 - Interconnect Diagram Notes

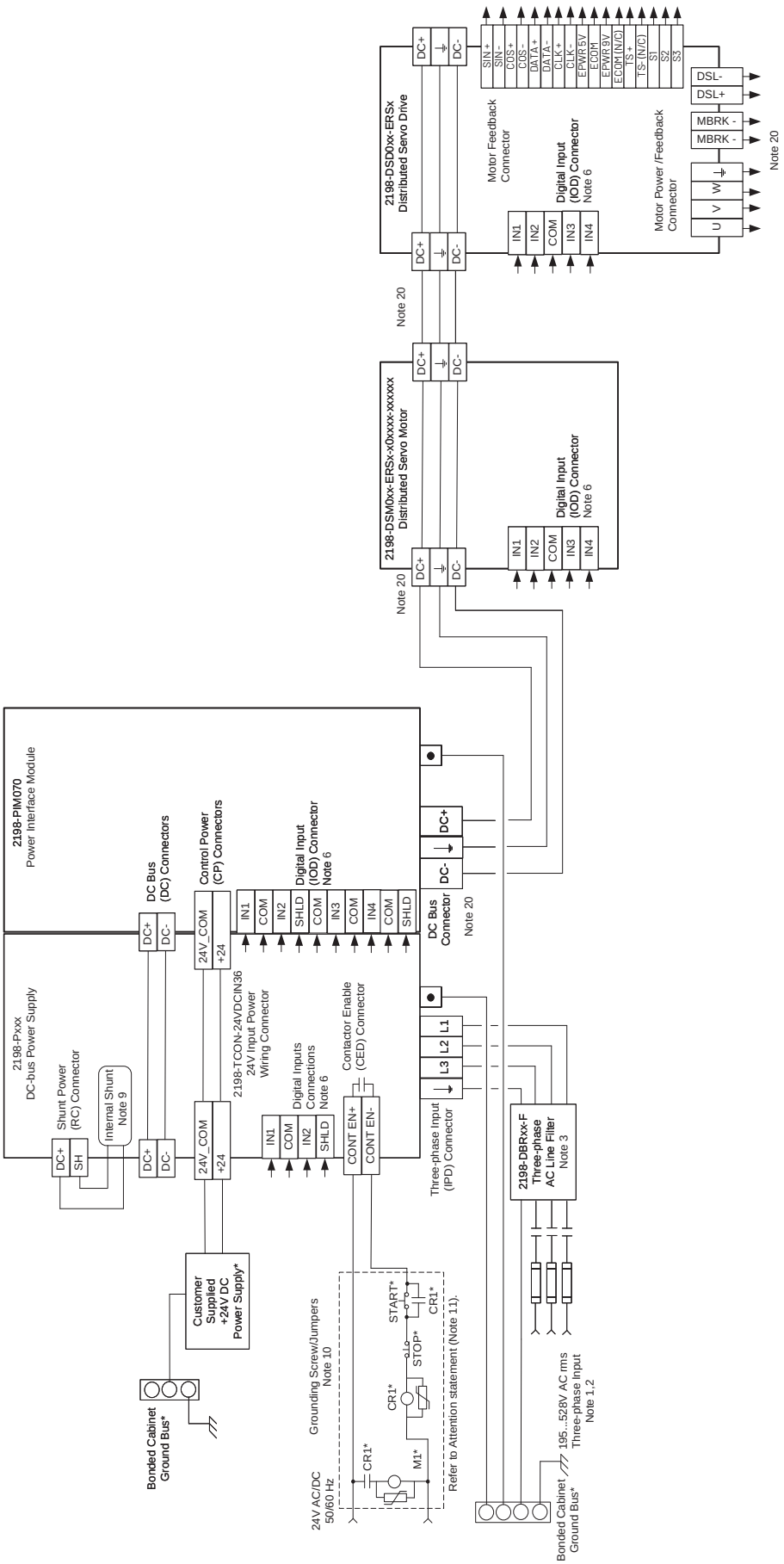
Note	Information
1	For power wiring specifications, refer to ArmorKinetix PIM Wiring on page 76.
2	For fuse replacement see Kinetix 5700, 5500, 5300, and 5100 Servo Drives Specifications Technical Data, publication KNX-TD003.
3	AC (EMC) line filter is required for CE and UK compliance. Mount the line filter with 50 mm (1.97 in.) minimum clearance between the drive and filter. If routing in wireway is unavoidable, use shielded cable with shields grounded to the drive chassis and filter case. For AC line filter specifications, refer to Kinetix 5700, 5500, 5300, and 5100 Servo Drives Specifications Technical Data, publication KNX-TD003. 2198-DBR*xx*-F line filters are preferred.
4	Cable shield clamp must be used to meet CE and UK requirements with Kinetix 2090 power cables 2 AWG and smaller.
5	2198-Dxxx -ERSx dual-axis inverters include separate digital inputs, DSL feedback, universal feedback, motor power, and motor brake wiring plugs for each axis.
6	Digital inputs are available for the machine interface on the on the PIM module, see page 57, and on the DSx modules, see page 62.
7	PE ground connection bonded to the panel must be used to meet CE and UK requirements. See Ground the System on page 75.
8	For M1 contactor selection and specifications, refer to Kinetix 5700, 5500, 5300, and 5100 Servo Drives Specifications Technical Data, publication KNX-TD003.
9	Internal shunt wired to the RC connector is default configuration. Remove internal shunt wires to attach external shunt wires.
10	Default configuration for ground screws or jumper is for grounded power at customer site. For impedance-grounded power configurations, remove the screws/jumper. Refer to Determine Input Power Configurations on page 72 for more information.
11	**ATTENTION:** Implementation of control circuits and risk assessment is the responsibility of the machine builder. Reference international standards EN/IEC 62061 and EN/ISO 13849-1 estimation and safety performance categories.
12	**ATTENTION:** An AC three-phase mains contactor must be wired in series between the branch circuit protection and the Kinetix 5700 system power supply. In addition, the AC three-phase contactor control string must be wired in series with the contactor-enable relay at the CED connector. The recommended minimum wire size for wiring the circuitry to the contactor-enable connector is 1.5 mm^2 (16 AWG).
13	For motor cable specifications, refer to Kinetix Rotary and Linear Motion Cable Specifications Technical Data, publication KNX-TD004.
14	Brake connector pins are labeled plus (+) and minus (-) or F and G respectively. Power connector pins are labeled U, V, W, and ⏚ (GND) or A, B, C, and ⏚ (D) respectively.
15	Kinetix LDAT linear thrusters do not have a brake option, so only the 2090-CPWM7DF-*xx*AA*xx* or 2090-CPWM7DF-*xx*AF*xx* motor power cables apply.
16	Kinetix MPAS-B*xxxxx*-VxxSxA (ballscrew) linear stages use the 9V supply. MPAS-B*xxxxx*-ALMx2C (direct-drive) linear stages use the 5V supply.
17	Kinetix MPL-A/B15*xx*-H...MPL-A/B45*xx*-H, MPL-A15*xx*-V/E...MPL-A2*xx*-V/E, MPL-A3*xx*-S/M...MPL-A45*xx*-S/M, MPM-A115*xx*...MPM-A130*xx*, MPF-A3*xx*...MPF-A45*xx*, MPS-A*xxx*, MPAS-B*xxx* (direct drive), and encoders use the +5V DC supply.
18	Kinetix MPL-B15*xx*-V/E...MPL-B2*xx*-V/E, MPL-B3*xx*-S/M...MPL-B6*xx*-S/M, MPL-A5*xx*, MPM-B*xx*, MPM-A165*xx*...MPM-A215*xx*, MPF-B*xx*, MPF-A5*xx*, MPS-B*xxx*, MPAR-B*xxx*, and MPAS-B*xxx* (ballscrew) encoders use the +9V DC supply.
19	The 2198-CAPMOD-2240 capacitor module is used in applications with up to 104 A maximum external DC-bus current. You can add the 2198-DCBUSCOND-RP312 DC-bus conditioner module to the left or right of the capacitor module when the external DC-bus current exceeds 104 A, up to a maximum of 208 A.
20	See ArmorKinetix 2090 Cables and Connectors, publication 2090-IN053, for information on cables to use when connecting ArmorKinetix PIM, DSD, and DSM modules.

Power Wiring Examples

You must supply input power components. The three-phase line filter is wired downstream of the circuit protection devices. Each drive module includes the appropriate DC-bus link and connector set. The 24V supply can be jumpered from drive-to-drive by using discrete wires or the shared-bus connection system.

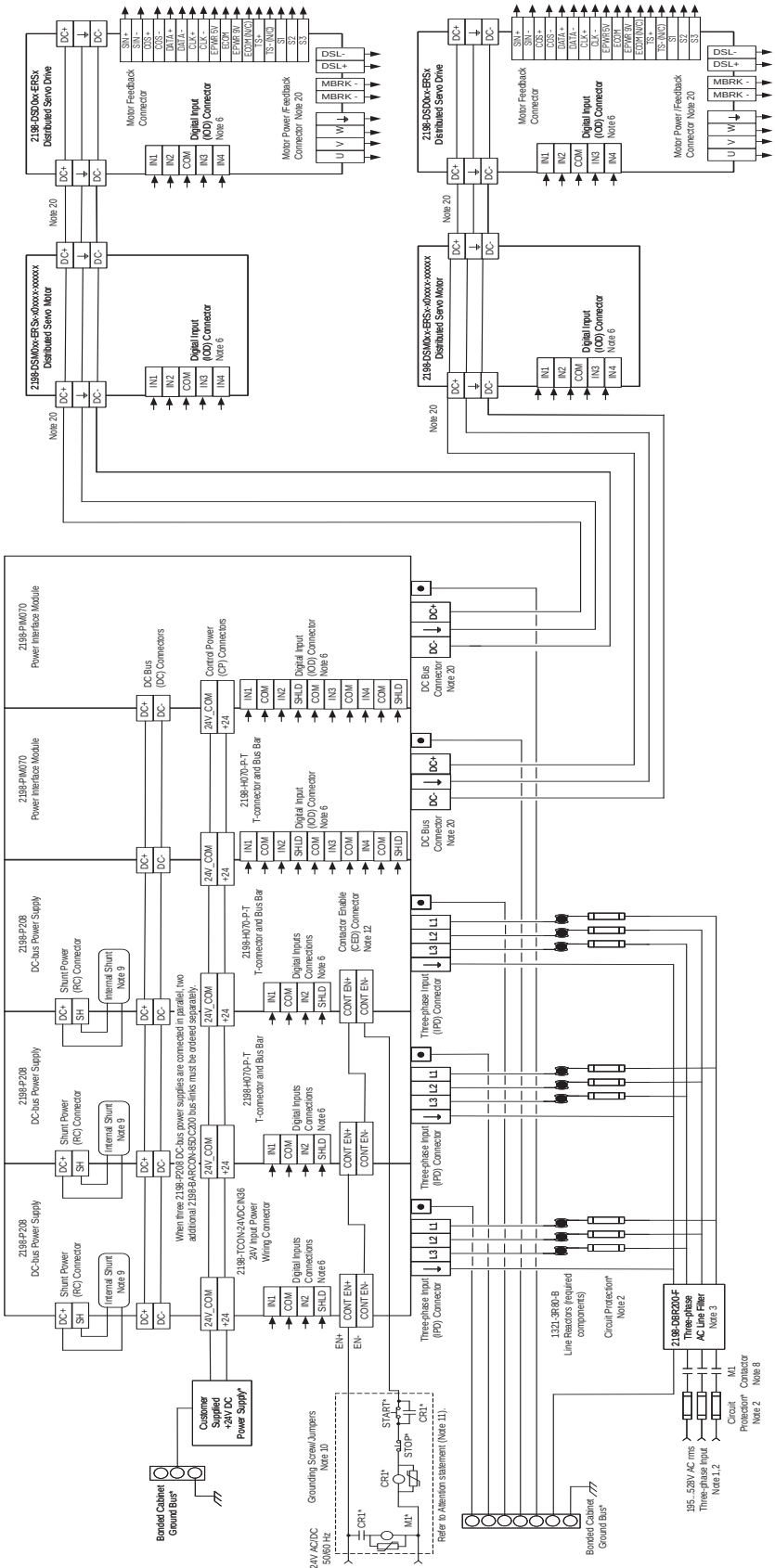
In this example, the ArmorKinetix DSx modules and optional accessory modules are downstream of a single 2198-P*xxx* DC-bus power supply and the 2198-PIM070 power interface module.

Figure 70 - DC-bus Power Supply (single converter) Configuration



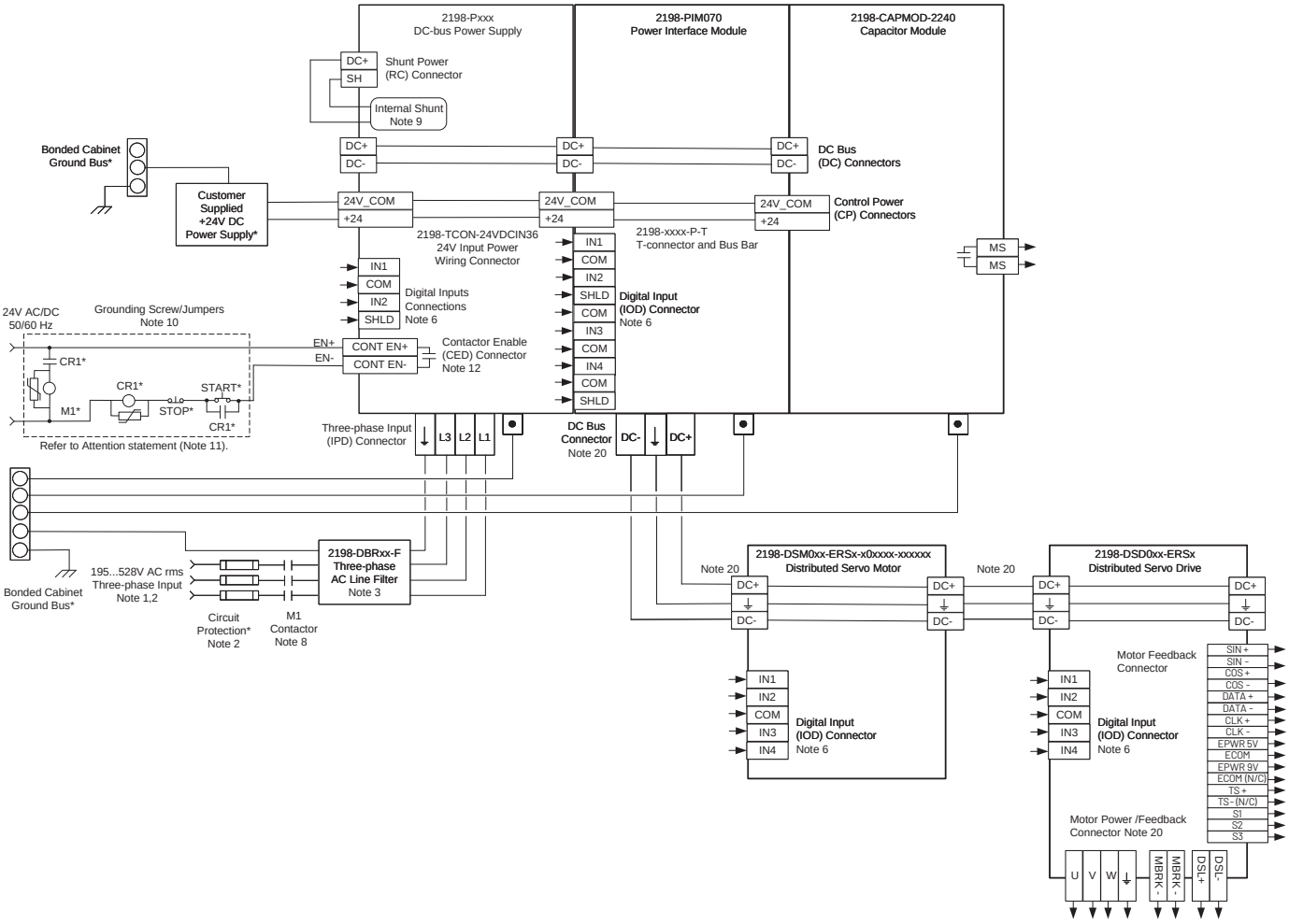
In this example, the inverter drives and optional capacitor modules are downstream of three DC-bus (converter) power supplies. When two or three DC-bus power supplies are used, they must be catalog number 2198-P208. This configuration provides more power (kW) to the drive system.

Figure 71 - DC-bus Power Supply (multiple converters) Configuration



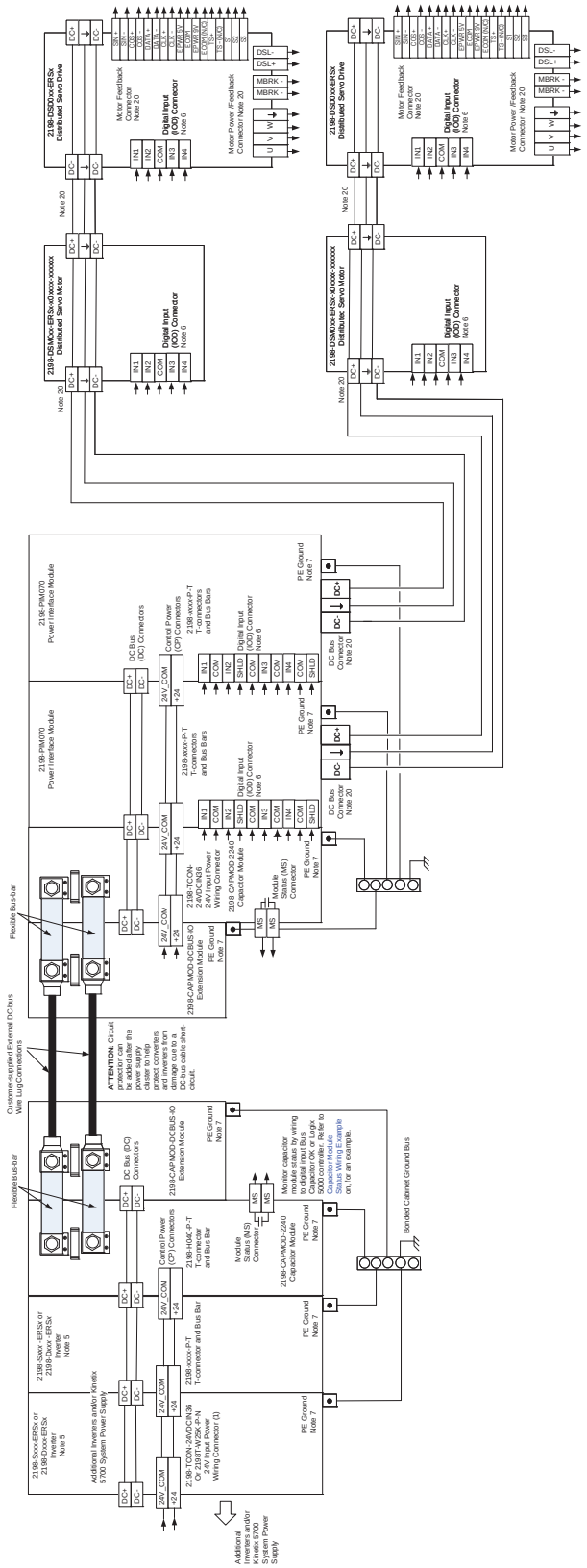
In this example, the 2198-CAPMOD-2240 capacitor module is included for energy storage and to improve dynamic performance.

Figure 72 - DC-bus Power Supply with Capacitor Module



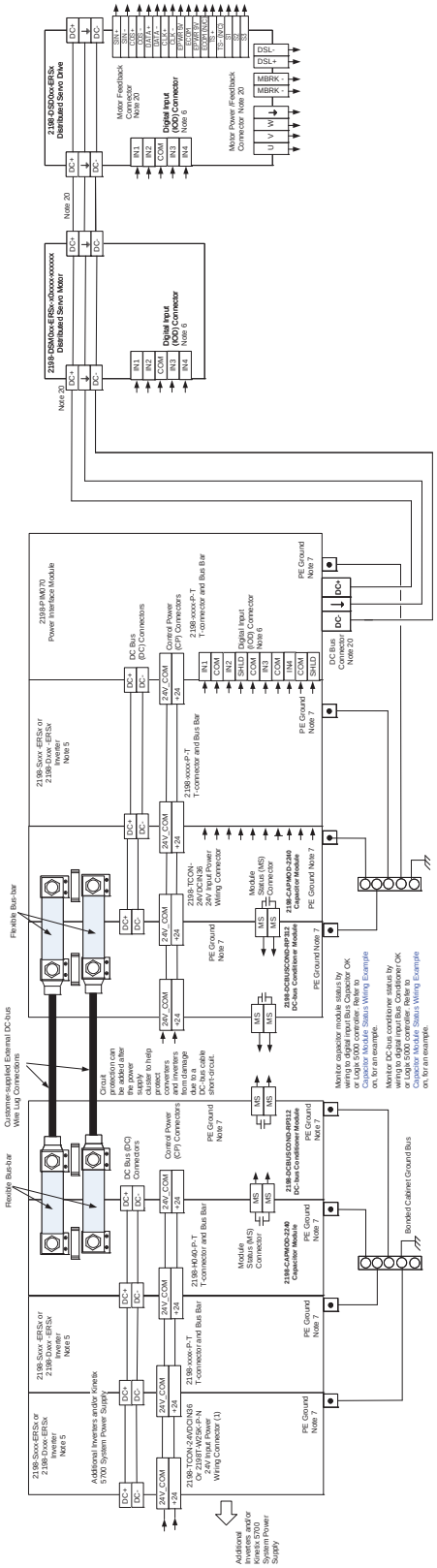
In this example, the 2198-CAPMOD-2240 capacitor module and 2198-CAPMOD-DCBUS-IO extension module are used for energy storage and to extend the DC-bus voltage to another inverter cluster. The capacitor modules are used alone when the external DC-bus current is ≤104 A. The extension module (or any combination of two accessory modules) is needed when the external DC-bus current is >104 A, up to a maximum 208 A.

Figure 73 - ArmorKinetix System Extended Drive System Example (extension module)



In this example, the 2198-CAPMOD-2240 capacitor module and 2198-DCBUSCOND-RP312 DC-bus conditioner module are used for energy storage and to extend the DC-bus voltage to another inverter cluster. The capacitor modules are used alone when the external DC-bus current is ≤104 A. The DC-bus conditioner module (or any combination of two accessory modules) is needed when the external DC-bus current is >104 A, up to a maximum 208 A.

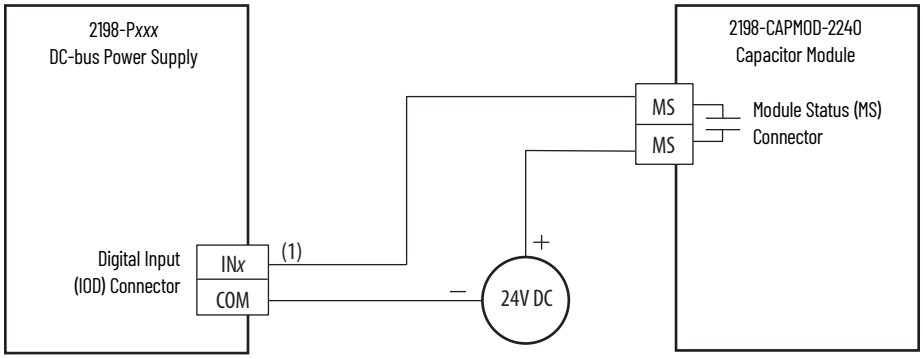
Figure 74 - ArmorKinetix System Extended Drive System Example (DC-bus conditioner module)



Capacitor Module Status Wiring Example

You can configure either of the DC-bus power supply digital inputs as Bus Capacitor OK in the Studio 5000 Logix Designer application to monitor the Module Status output. See the Kinetix 5700 Servo Drives User Manual, publication 2198-UM002 for how the DC-bus power supply Digital Inputs category is configured.

Figure 75 - DC-bus Power Supply with Capacitor Module



(1) Configure either of two digital inputs as Bus Capacitor OK.

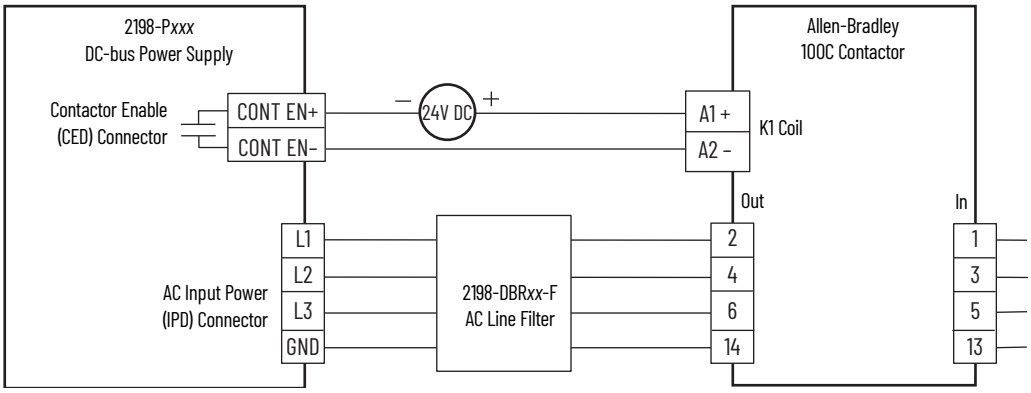
Refer to the Kinetix 5700 Capacitor Modules Installation Instructions, publication 2198-IN008, for additional installation information.

Contactor Wiring Examples

We recommend that you wire an Allen-Bradley® (Bulletin 100) auxiliary contactor to the bus supply digital input (IOD connector) and configure AC Line Contactor OK to monitor three-phase input power. Use the Normally Open (N.O.) auxiliary contact, if more than one auxiliary contact is available.

IMPORTANT 2198-P141 and 2198-P208 power supplies require an additional intermediate relay that is used with the contactor.

Figure 76 - Contactor Wiring for DC-bus Power Supply



Refer to IEC Contactor Specifications Technical Data, publication 100-TD013, for additional contactor related information.

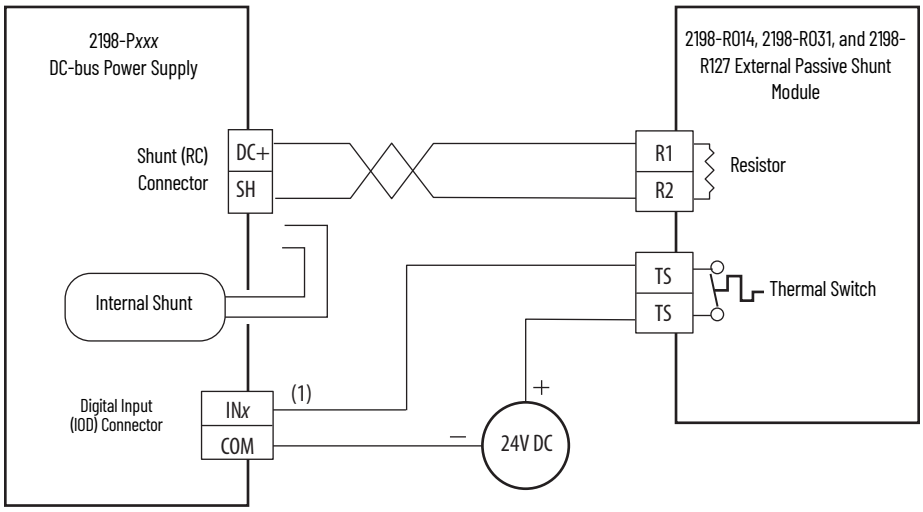
Passive Shunt Wiring Examples

Wiring from the 2198 shunt modules and resistor are made directly to the shunt (RC) connector. You can configure either of the DC-bus power supply digital inputs as Shunt Thermal Switch OK in the Studio 5000 Logix Designer application. See the Kinetix 5700 Servo Drives User Manual, publication 2198-UM002 for how the DC-bus power supply Digital Inputs category is configured.

IMPORTANT Passive shunts attach to only 2198-Pxxx DC-bus power supplies. Before wiring the 2198 external shunt to the RC connector, remove the wires from the internal servo-drive shunt. Do not connect both internal and external shunt resistors to the DC-bus power supply.

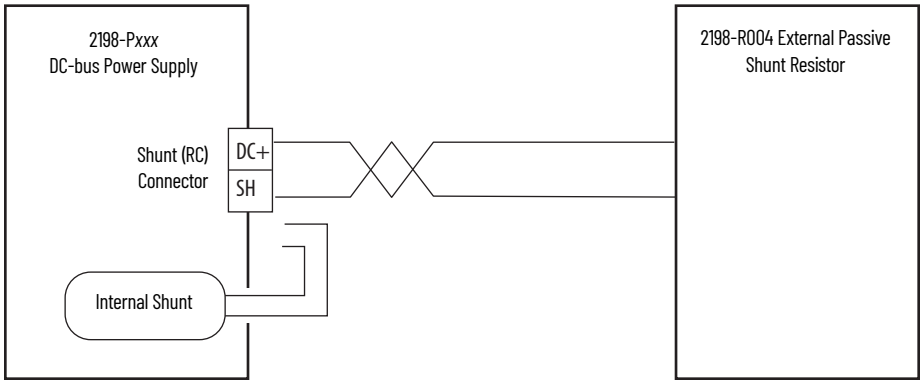
ATTENTION: To avoid damage to the ArmorKinetix system, wire the 2198-R031, or 2198-R127 shunt thermal switch to a digital input on the DC-bus power supply and configure the Shunt Thermal Switch OK function in the Studio 5000 Logix Designer application.

Figure 77 - DC-bus Power Supply with External Passive Shunt Module



(1) Configure either of two digital inputs as Shunt Thermal Switch OK.

Figure 78 - DC-bus Power Supply with External Passive Shunt Resistor



Refer to the Kinetix 5700 Passive Shunt Module Installation Instructions, publication 2198-IN011, for additional installation information.

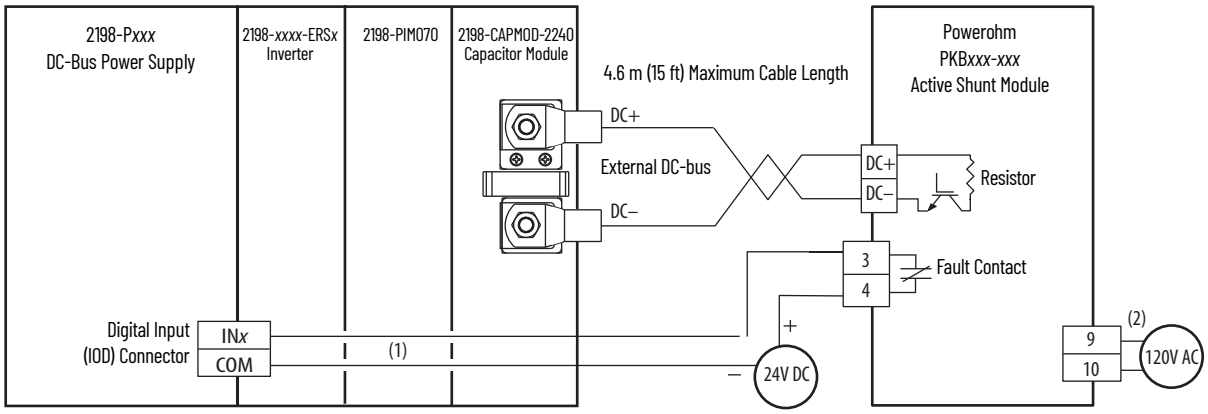
Active Shunt Wiring Examples

Active shunts are available from the Rockwell Automation Encompass™ partners Powerohm Resistors, Inc. (https://www.hubbell.com/powerohm/en) or Bonitron, Inc. (https//:www.bonitron.com).

IMPORTANT Powerohm Bulletin PKBxxx active shunt modules use built-in internal brake resistors. Bulletin PWBxxx active shunt modules require appropriately sized external brake resistors.

ATTENTION: To avoid damage to the ArmorKinetix system, wire the active shunt thermal switch to a digital input on the power supply and configure the Shunt Thermal Switch OK function in the Studio 5000 Logix Designer application.

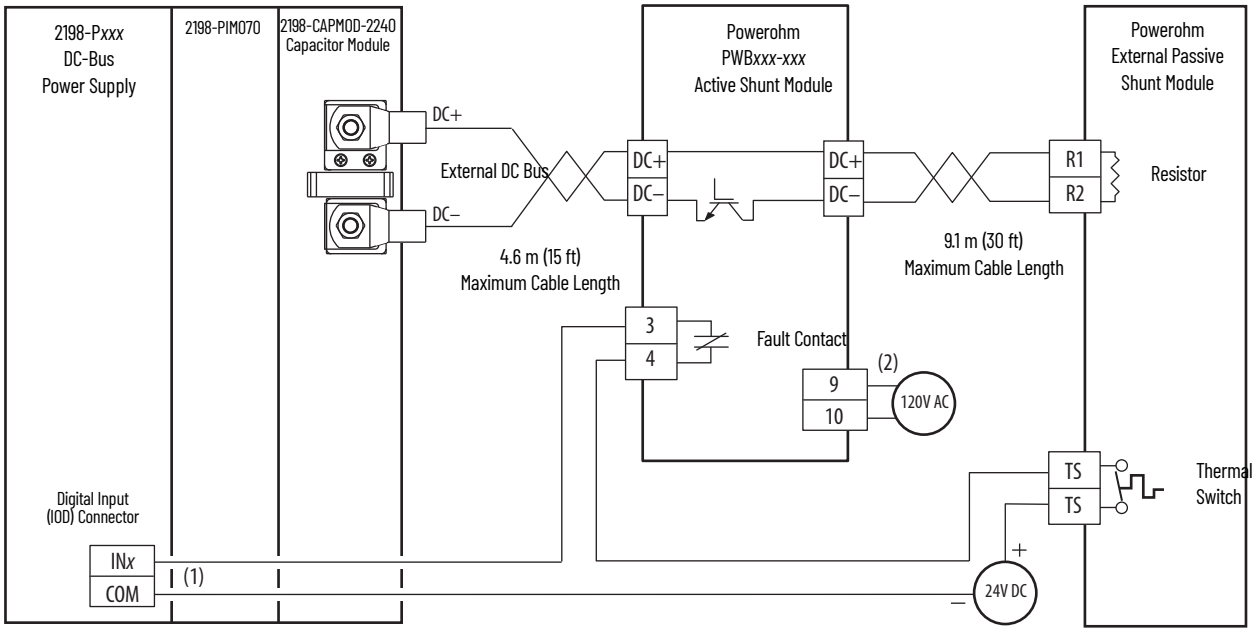
Figure 79 - 2198 Power Supply with External Active Shunt (built-in brake resistor)



(1) Configure any available digital input as Shunt Thermal Switch OK. See the Digital Inputs Connector Pinouts on page 55.
(2) Powerohm PKB050 and PKB050-800 shunts require 120V AC between pins 9 and 10 to supply power to the cooling fans.

See Knowledgebase Technote: Using PKB external active shunt with Kinetix 5700 for more information on wiring to these Powerohm Bulletin PKB*xxx* active shunts.

Figure 80 - 2198 Power Supply with External Active Shunt (external brake resistor)



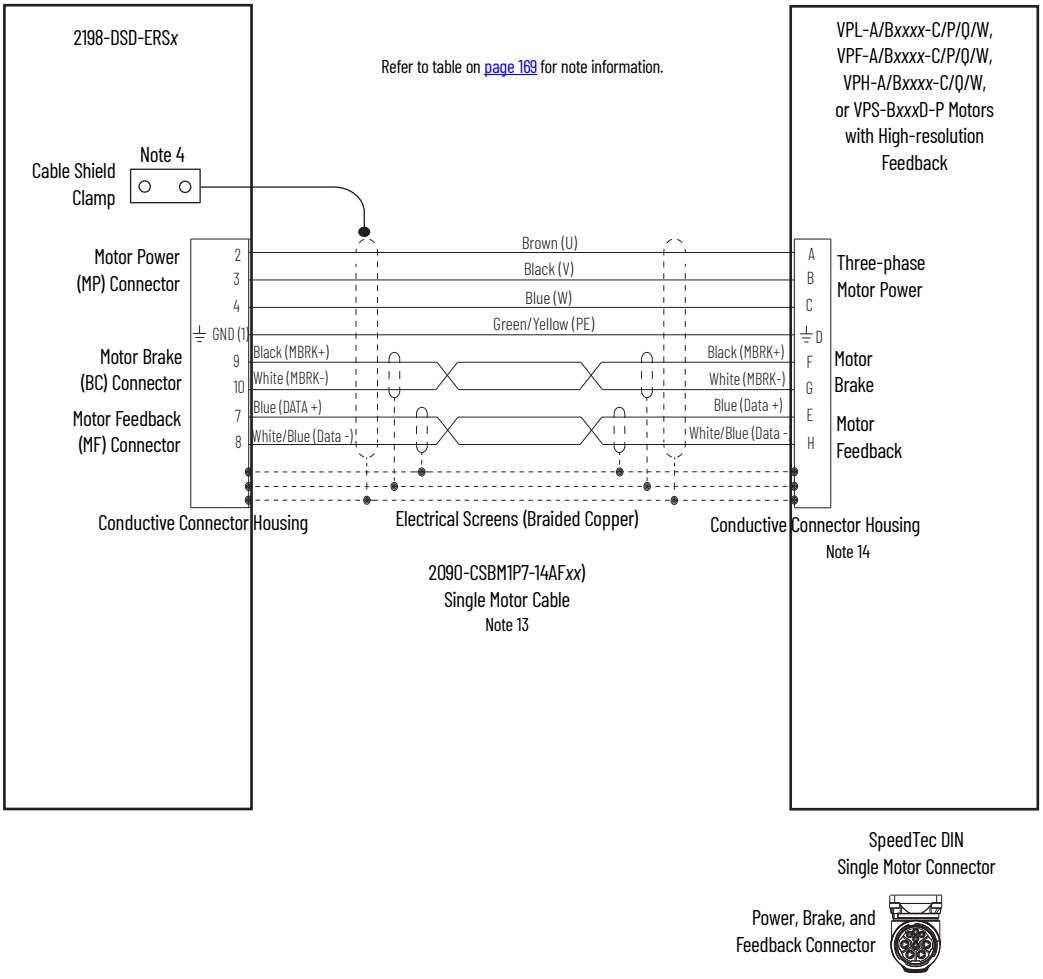
(1) Configure any available digital input as Shunt Thermal Switch OK. See the Digital Inputs Connector Pinouts on page 55.
(2) Powerohm PWB050 and PWB050-800 shunts require 120V AC between pins 9 and 10 to supply power to the cooling fans.

See Knowledgebase Technote: Using PWB external active shunt with Kinetix 5700 for more information on wiring to these Powerohm Bulletin PWB*xxx* active shunts.

ArmorKinetix Module and Rotary Motor Wiring Examples

These Kinetix rotary motors use single cable technology. The 2090-CSBM1P7-14AF*xx* motor power/feedback cable provides power from the DSD module and the Kinetix VPL motor and provides feedback from the Kinetix VPL motor. See the ArmorKinetix 2090 Cables and Connectors installation instructions, publication 2090-IN053 for more cable information.

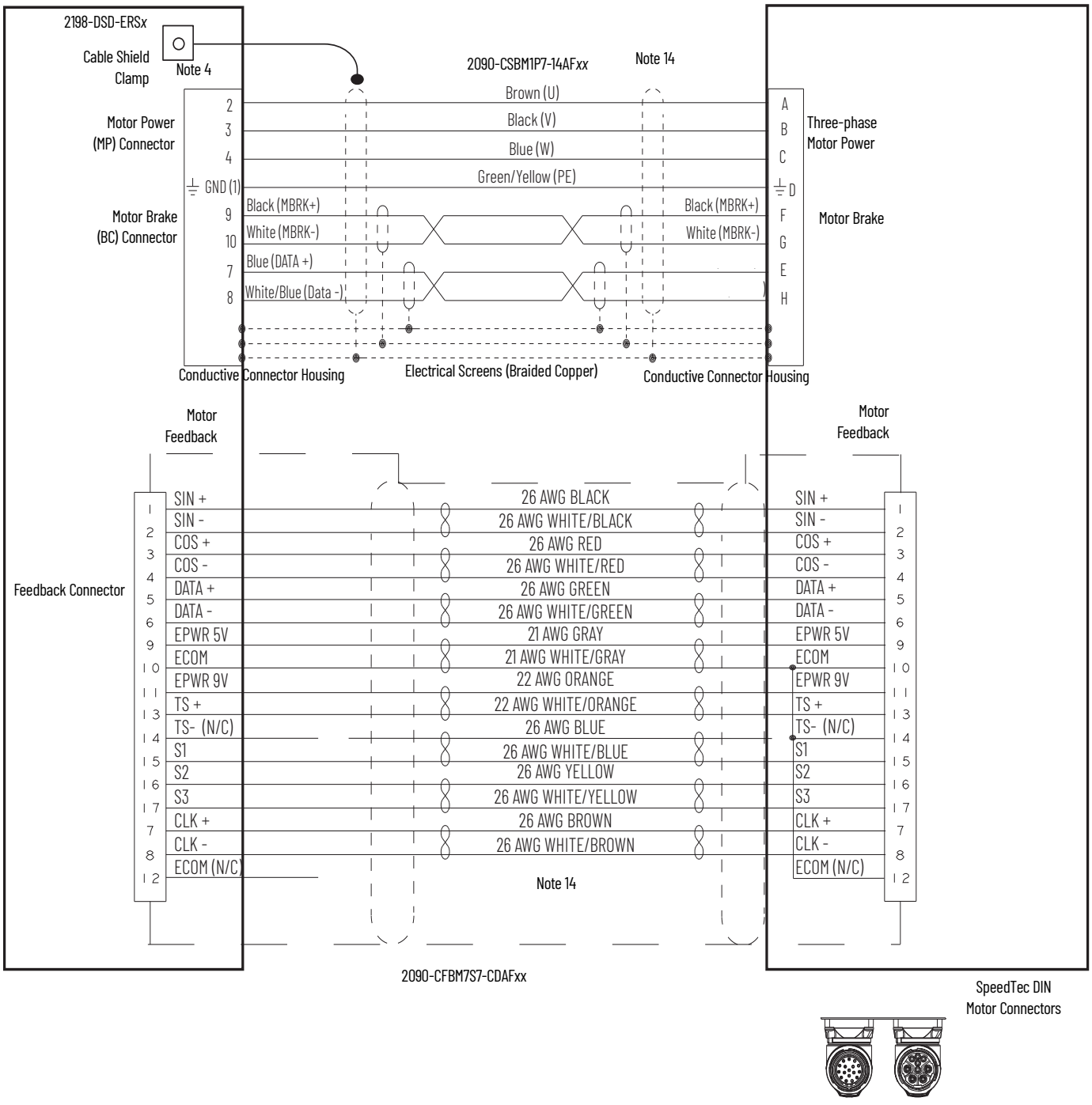
Figure 81 - ArmorKinetix DSD Module with Kinetix VPL, VPF, VPH, and VPS Motors (Frames 63 mm, 75 mm, 100 mm, 115 mm, and 130 mm)



These compatible Allen-Bradley rotary motors have separate cables for motor power/brake and feedback connections. See the ArmorKinetix 2090 Cables and Connectors installation instructions, publication 2090-IN053 for more cable information.

Figure 82 - ArmorKinetix DSD Module with Kinetix MPL, MPM, MPF, and MPS (Frames 100 mm, 115 mm, and 130 mm)

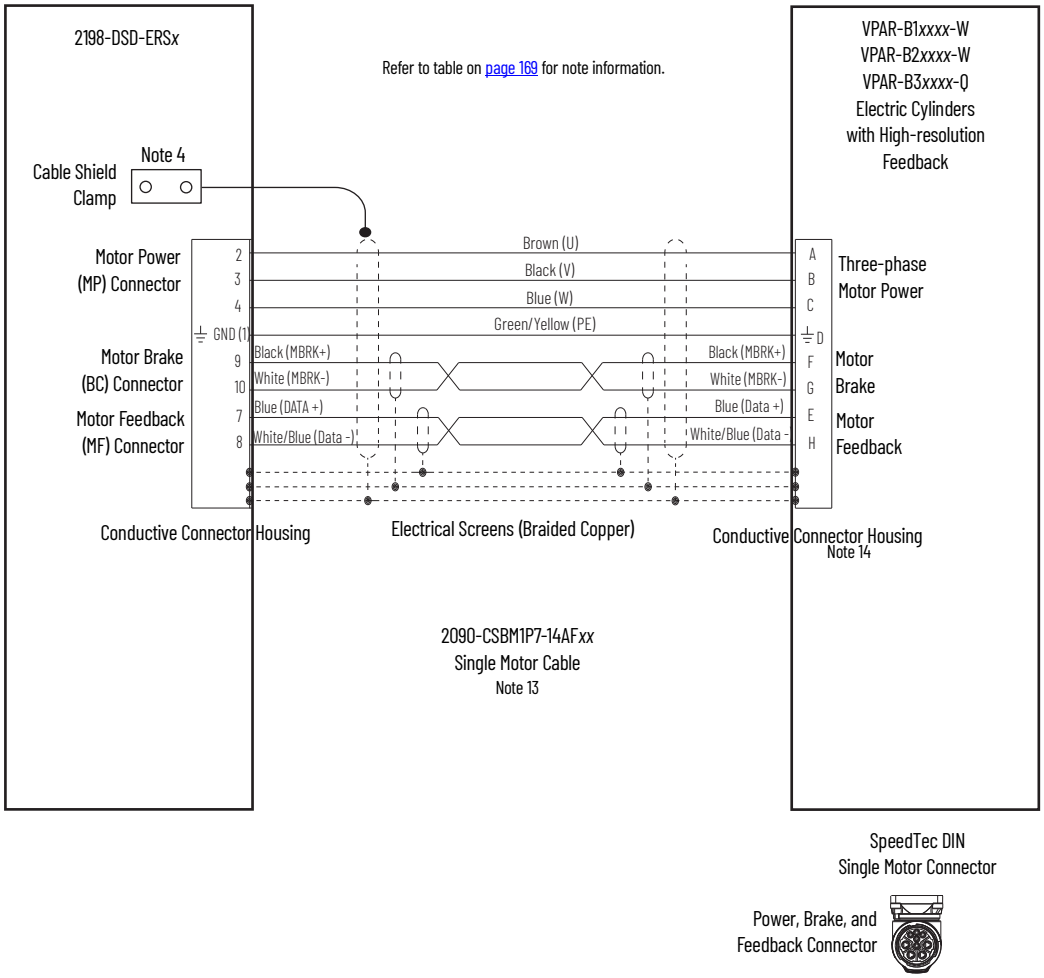
Refer to table on page 169 for note information.



ArmorKinetix System and Linear Actuator Wiring Examples

These Kinetix linear actuators use single cable technology. The 2090-CSBM1P7-14AF*xx* motor power/feedback cable provides power from the DSD module and the Kinetix VPAR motor and provides feedback from the Kinetix VPAR motor. See the ArmorKinetix 2090 Cables and Connectors installation instructions, publication 2090-IN053 for more cable information.

Figure 83 - ArmorKinetix DSD Module with Kinetix VPAR Electric Cylinders



These compatible linear actuators have separate connectors and cables for power/brake and feedback connections.

Figure 84 - ArmorKinetix DSD Module with Kinetix LDAT Linear Thrusters

Refer to table on page 169 for note information.

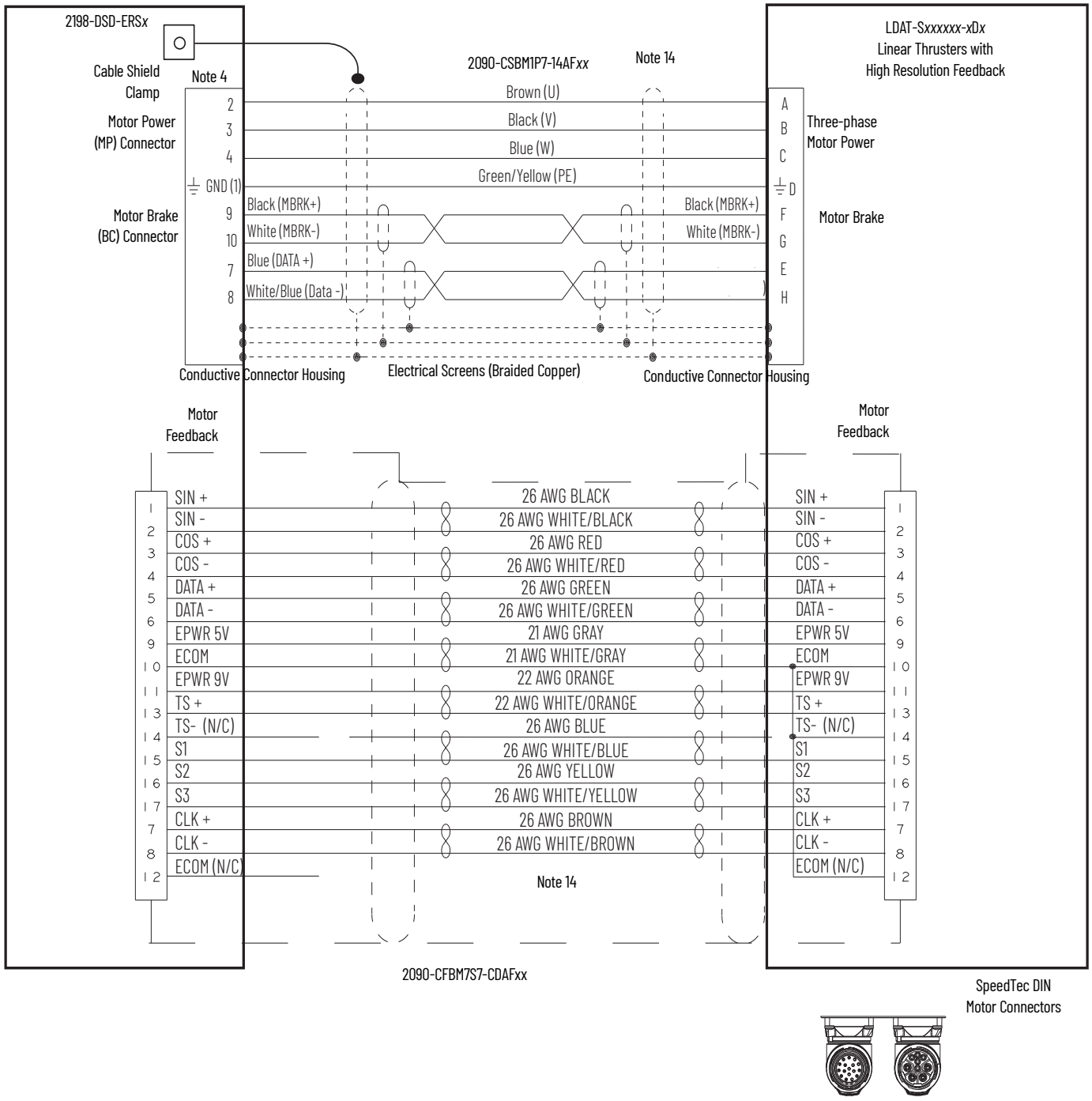


Figure 85 - ArmorKinetix DSD Module with Kinetix MPAR Electric Cylinders

Refer to table on page 169 for note information.

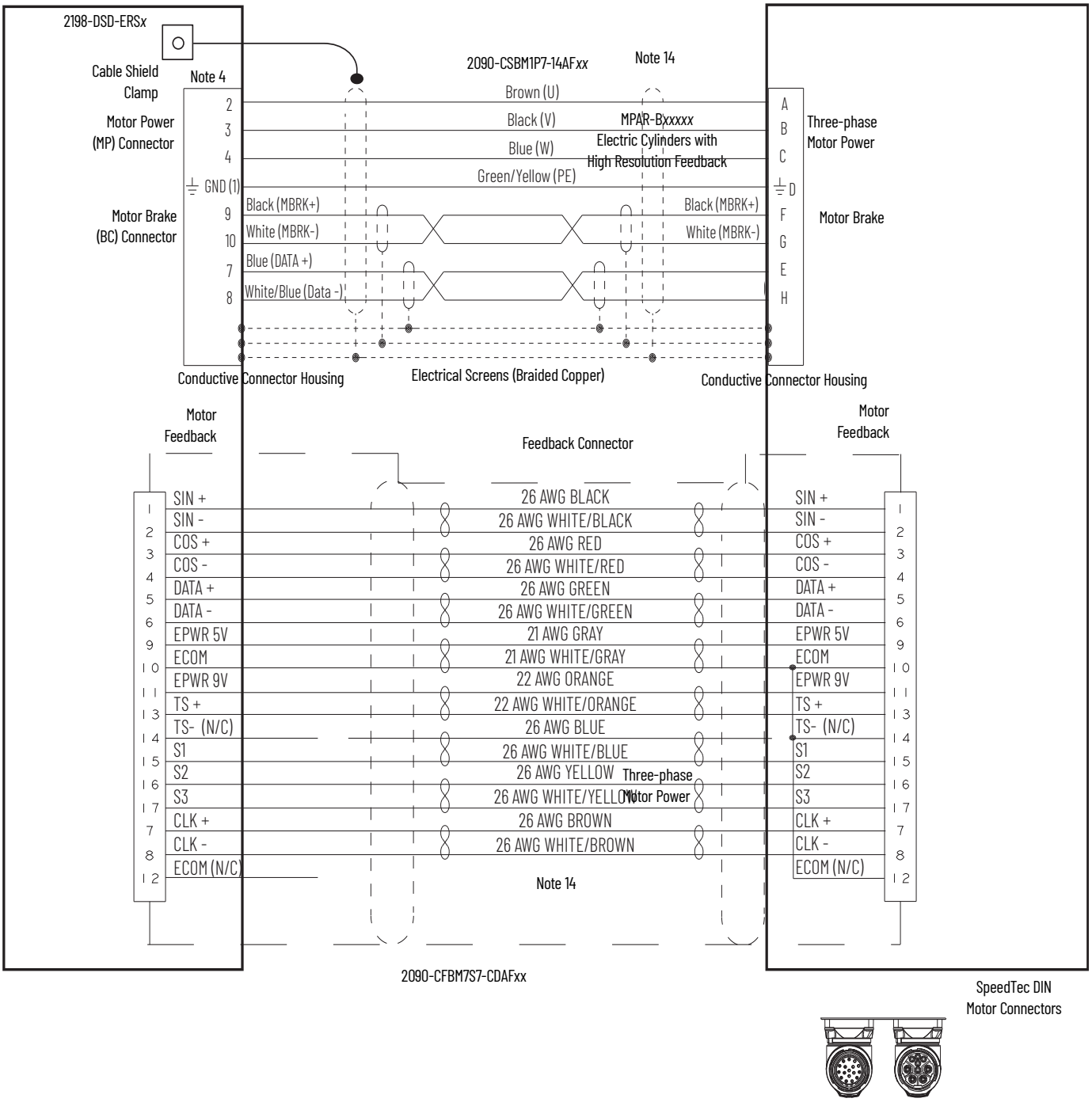


Figure 86 - ArmorKinetix DSD Module with Kinetix LDC Linear Motors (cable connectors)

Refer to table on page 169 for note information.

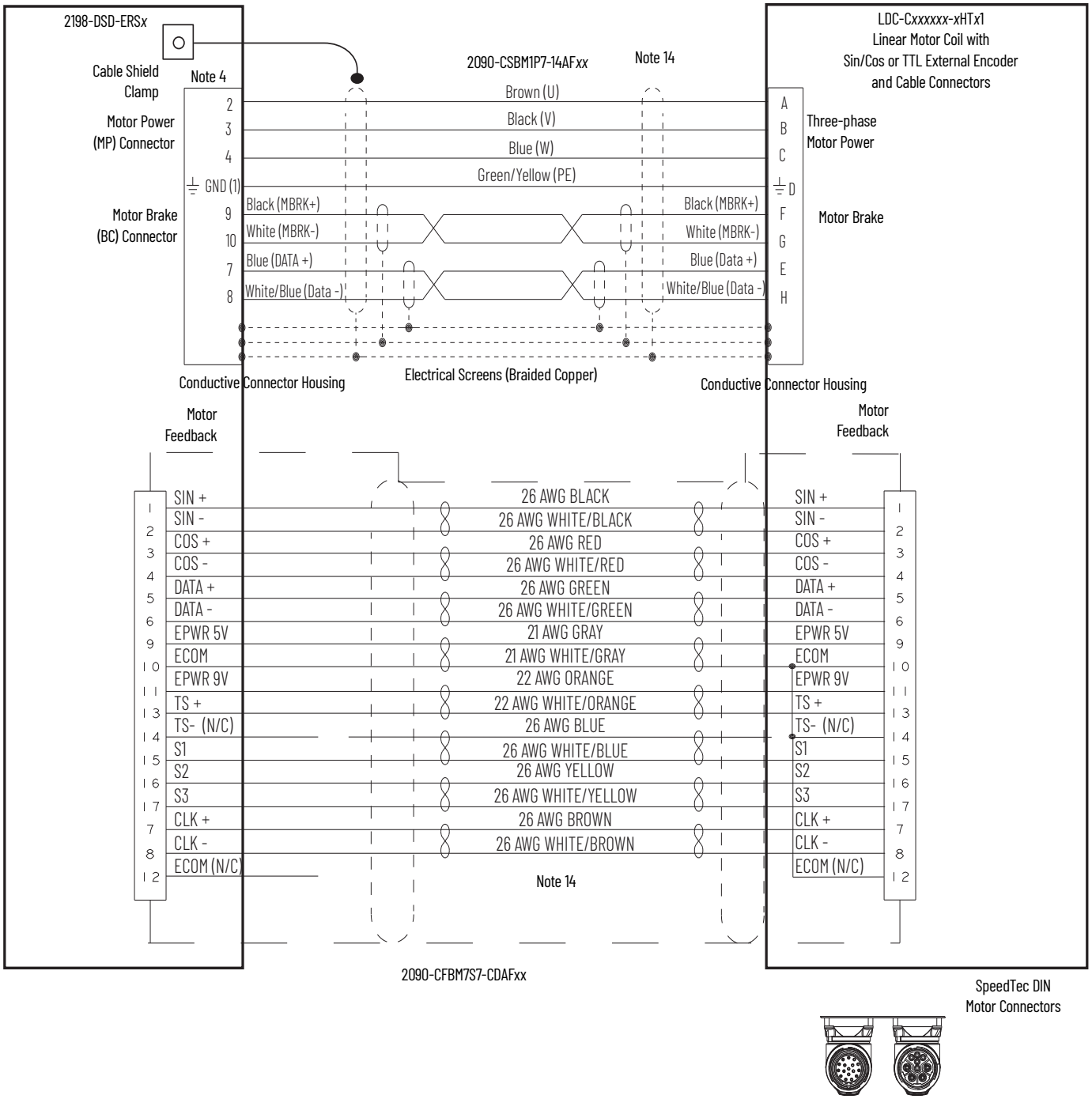
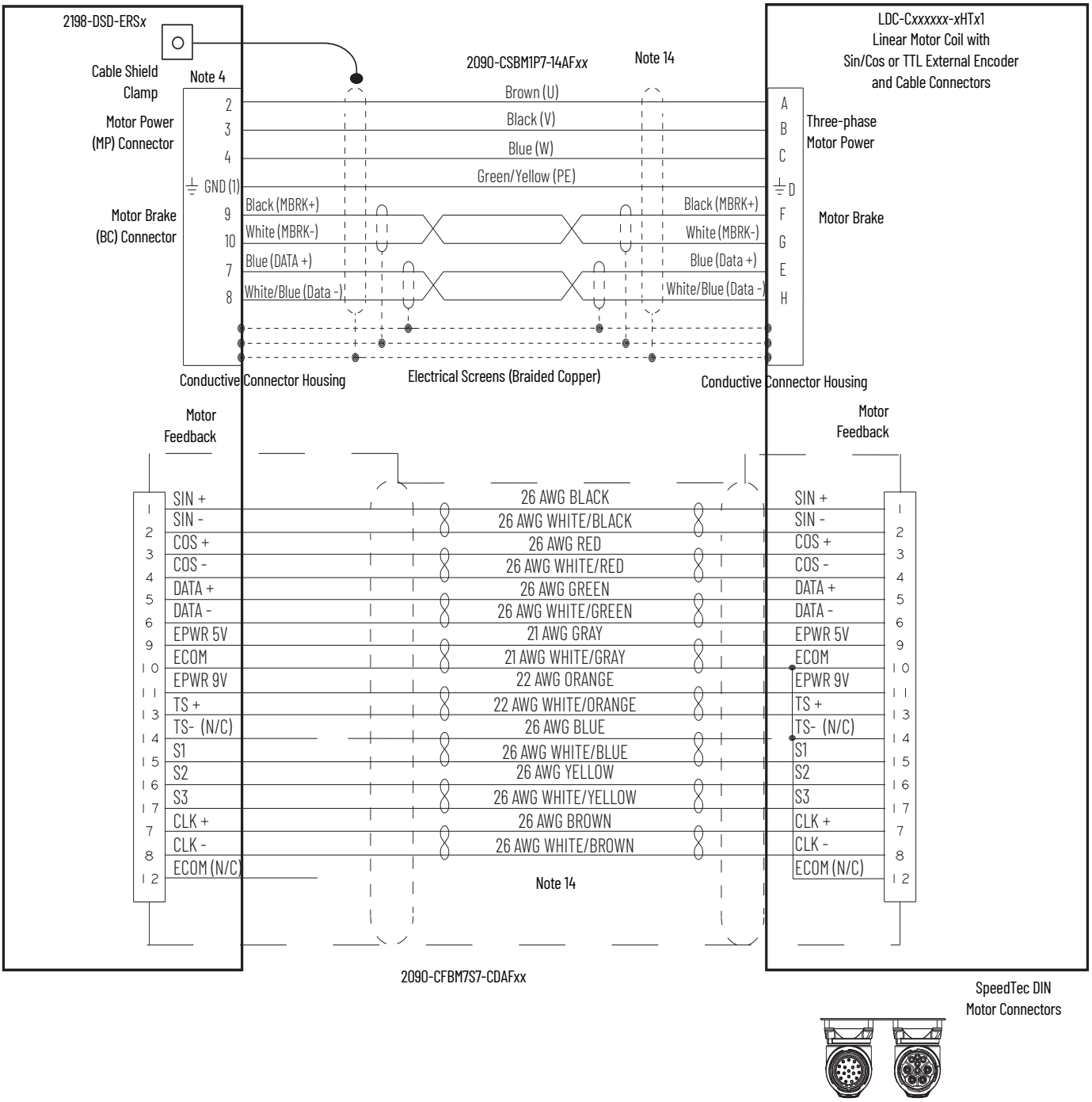


Figure 87 - ArmorKinetix DSx Modules with Kinetix LDC Linear Motors (flying-lead cables)

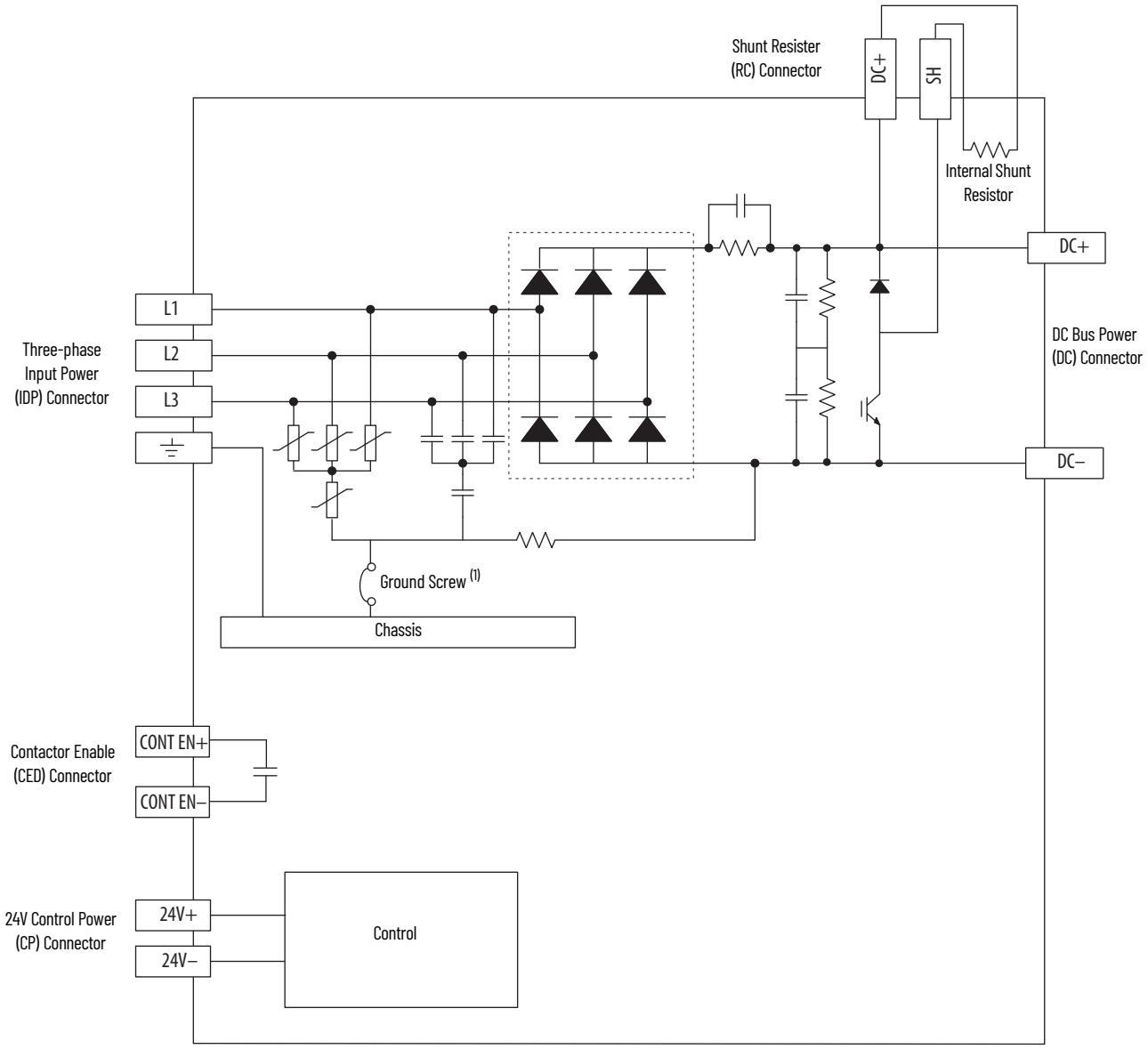
Refer to table on page 169 for note information.



System Block Diagrams

This section provides block diagrams of the ArmorKinetix system.

Figure 88 - DC-bus Power Supply Block Diagram



(1) Ground screw in the installed (default) configuration.

Figure 89 - Capacitor Module Block Diagram

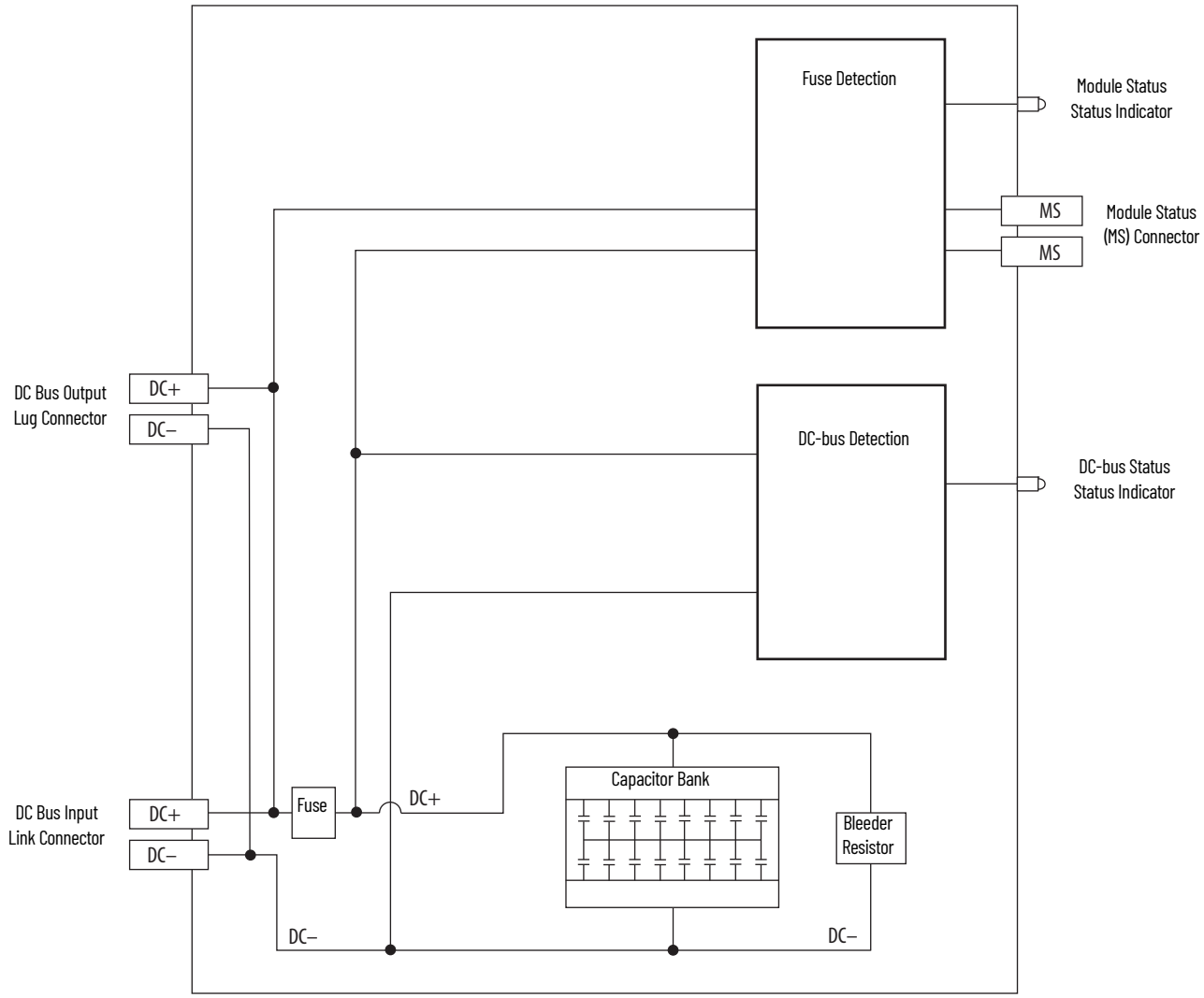


Figure 90 - DC-bus Conditioner Module Block Diagram

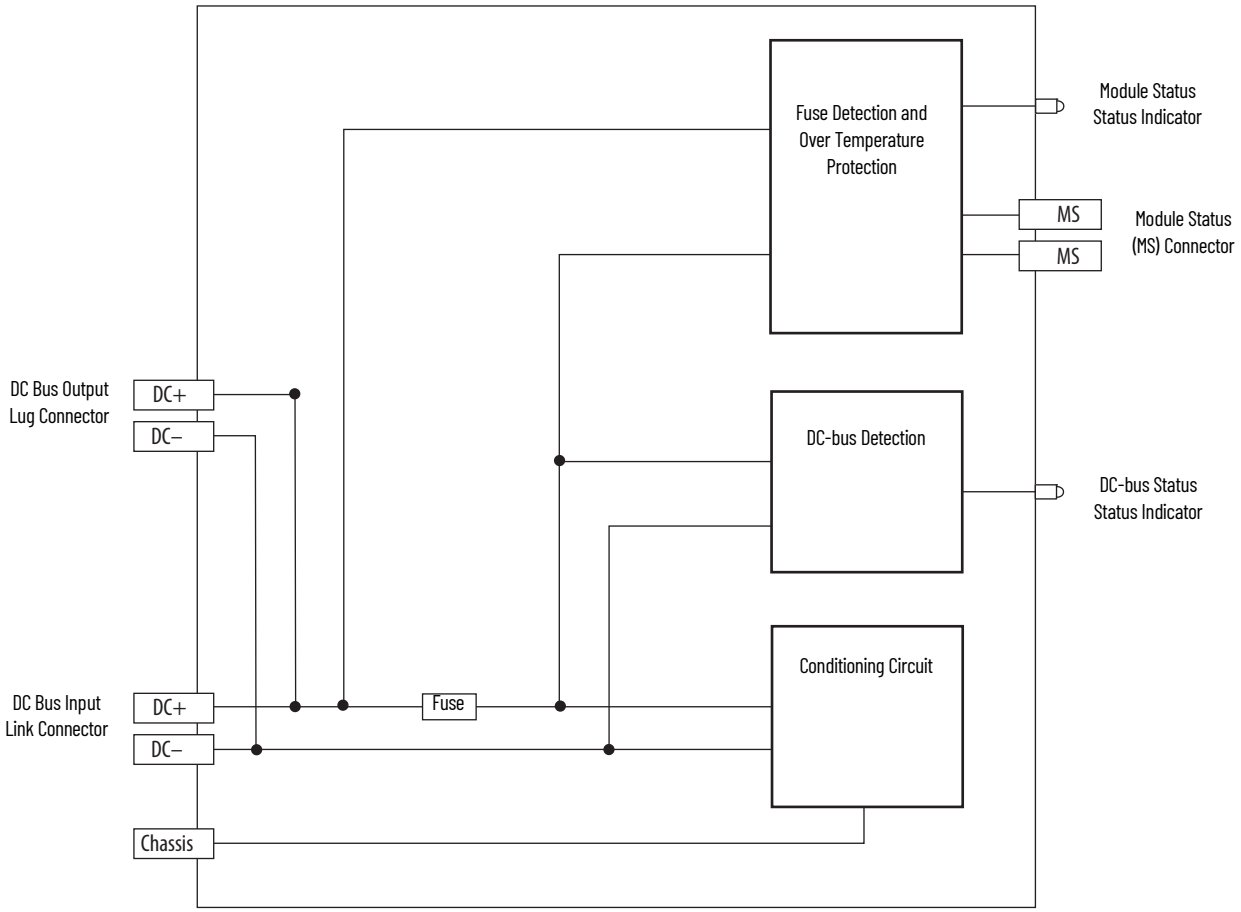


Figure 91 - ArmorKinetix PIM Module Block Diagram

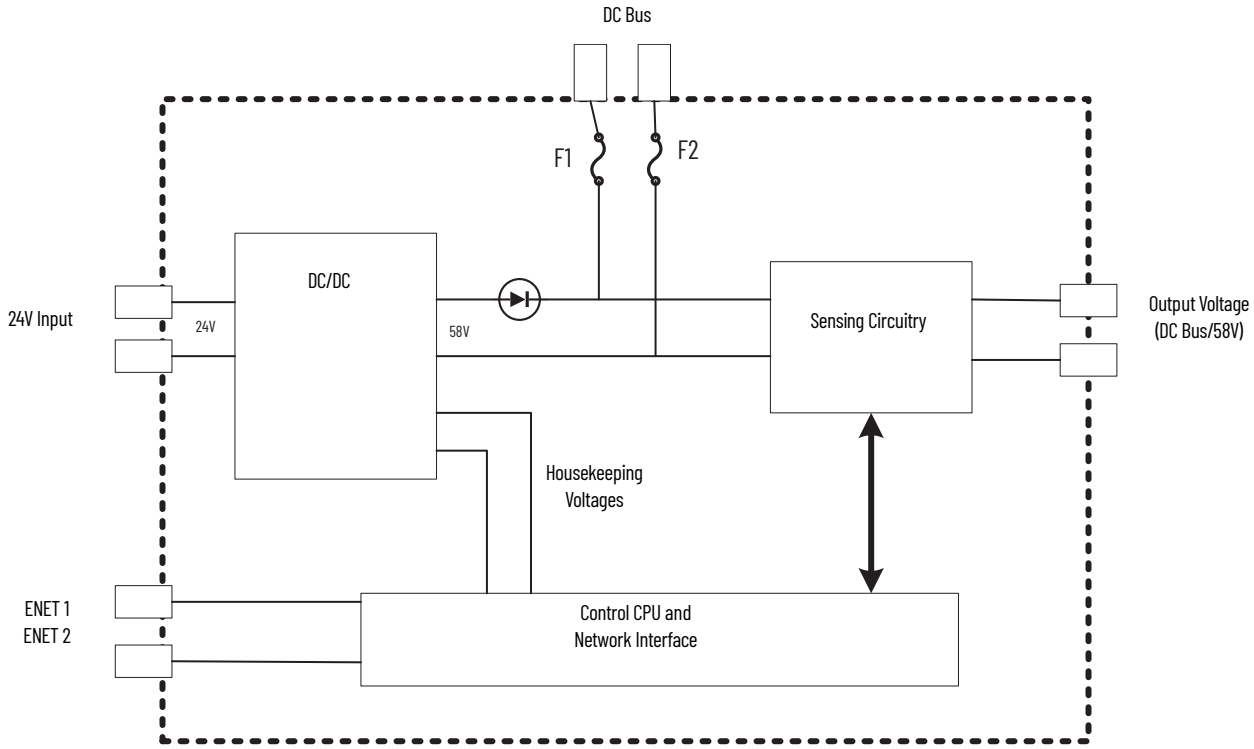


Figure 92 - ArmorKinetix DSD Inverter Module Block Diagram

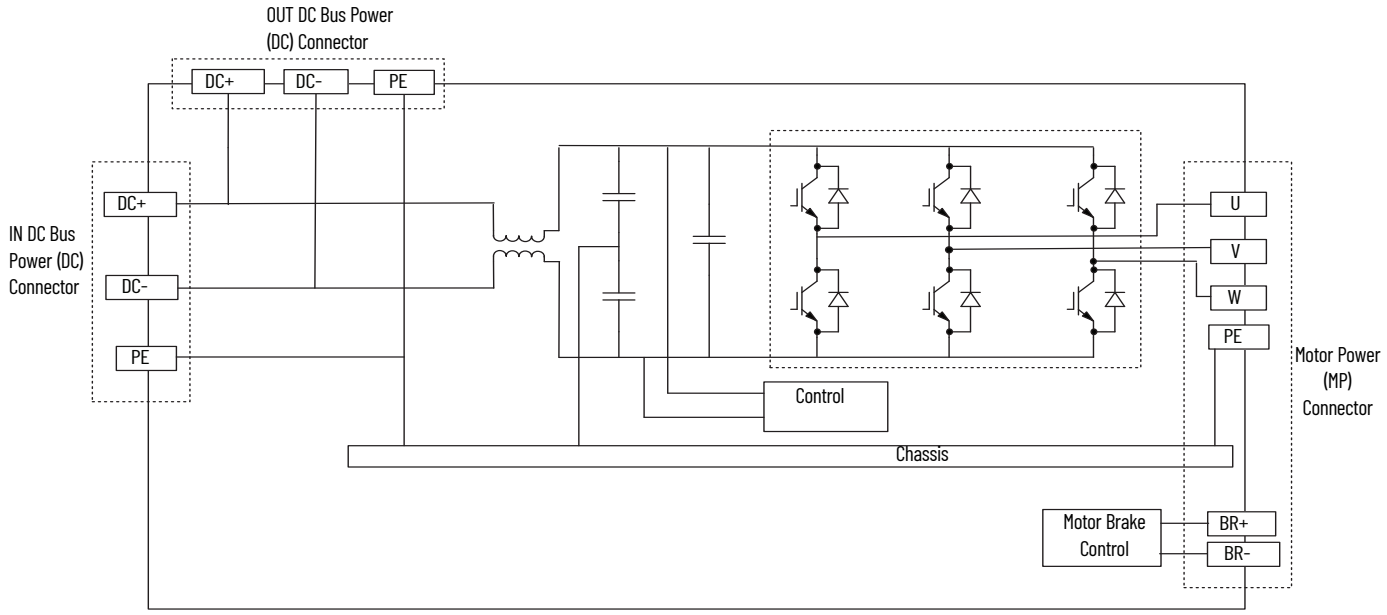
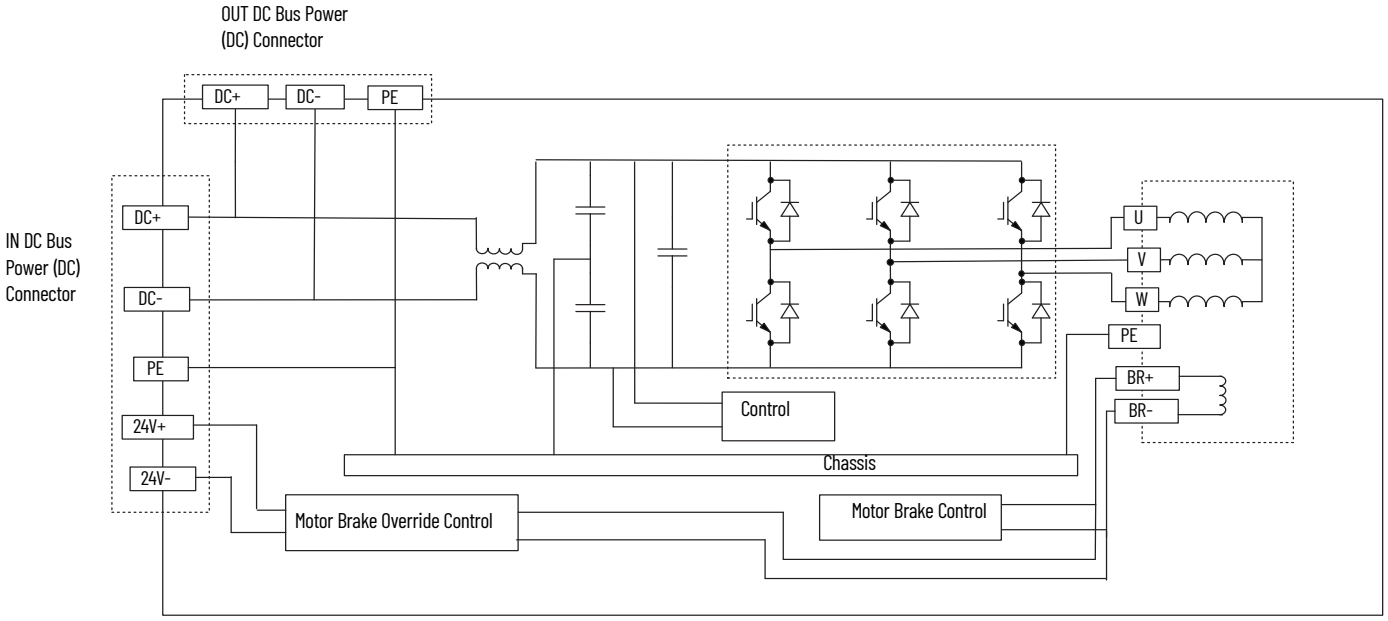


Figure 93 - ArmorKinetix DSM Inverter/Motor Module Block Diagram



Size Multi-axis Shared-bus Configurations

This appendix provides information and examples for sizing your ArmorKinetix® system power supplies and inverters in multi-axis shared-bus configurations.

Shared DC-bus Configurations

You can supply power to your Kinetix® 5700 shared DC-bus system configuration from following sources:

- Single 2198-P*xxx* DC-bus power supply
- Multiple 2198-P208 DC-bus power supplies (up to three are possible)

Shared DC-bus Definitions

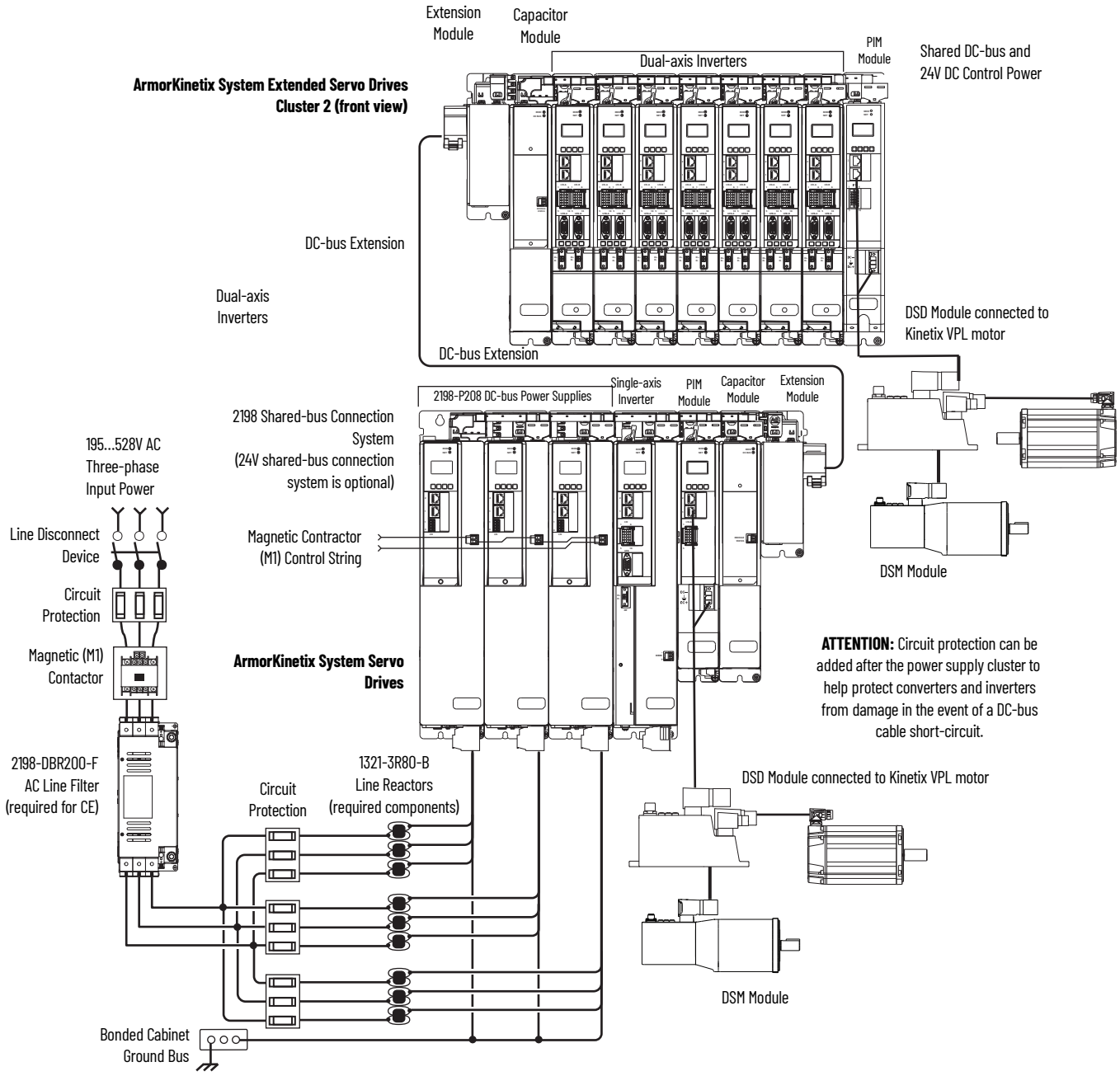
Throughout this manual, these terms are used to describe how modules are grouped together.

Table 70 - Shared-bus Terminology

Term	Definition
DC-bus group	Drive modules that are all connected to the same DC bus.
Cluster	Group of power supply and/or drive modules that are directly connected together via Kinetix 5700 DC bus-bars only.
Extended cluster	Group of drive modules that are directly connected together via Kinetix 5700 DC bus-bars and connected to the power supply cluster via customer-supplied DC-bus cable.
Power supply cluster	The cluster that contains the AC to DC converter (power supply).
Extended DC-bus	When 2 drive clusters are part of the same DC-bus group joined by the DC bus-bars and customer-supplied DC-bus cable.

In this example, two drive clusters in the same cabinet are connected by the same 276...747V DC-bus voltage. Kinetix 5700 capacitor modules provide connection points for the DC bus. The extension module is needed only when the DC-bus system current exceeds 104 A, and can support up to 208 A maximum external DC-bus current.

Figure 94 - Extended DC-bus Installation



IMPORTANT When two or three DC-bus power supplies are wired together in the same drive cluster, they must all be catalog number 2198-P208.

General Sizing Guidelines

These limitations apply to Kinetix 5700 servo drive systems supplied by a single 2198-P*xxx* or multiple 2198-P208 DC-bus power supplies:

- The sum of the inverter motor-power cable lengths for all inverters on the same DC bus-sharing group must not exceed 1200 m (3937 ft) to comply with CE and UK requirements when used with 2198-DBR*xx*-F line filters. See Cable Length Restrictions and System Sizing on page 29 for additional motor power cable-length limitations.
- The total system capacitance limit is based on the power supply catalog number. DC-bus groups must not exceed the limits as defined in Table 71.
- No more than three 2198-P208 DC-bus power supplies can be used to increase the converter power.
- If using the 24V DC shared-bus connection system to distribute control input power to a cluster of drive modules, current from the 24V power supply must not exceed 40 A.
- The Kinetix 5700 system can have multiple drive clusters in a single DC-bus group. See the Kinetix 5700 Servo Drives User Manual, publication 2198-UM002 for more information on extended clusters.

System Sizing Guidelines

You begin the process by selecting the motor for your application and sizing the drive and power supply combinations. Next, calculate whether the hybrid cable, motor power cable length, total system capacitance, and 24V current demand are within specifications.

Select Drive/Motor Combinations

The motor required for a particular application determines the servo drive required for full motor performance.

For best results, use the FactoryTalk® Motion Analyzer™ system sizing and selection tool, available at: rok.auto/motion-analyzer.

Drive/motor performance specifications and torque/speed curves are also available in the Kinetix 5700 Drive Systems Design Guide, publication KNX-RM010.

Select the Power Supply and Define the DC-bus Groups

- Determine the converter DC-bus motoring and bus-regulation power requirements based on the load profile.
- Estimate the net converter and inverter power and bus-regulator capacity, based on the load profiles.
- Determine if 2198-CAPMOD-2240 capacitor modules are required.
- Determine if 2198-DCBUSCOND-RP312 DC-bus conditioner modules are required.

For best results, use the FactoryTalk Motion Analyzer system sizing and selection tool, available at: rok.auto/motion-analyzer.

Calculate System and External-bus Capacitance

Total system capacitance is the sum of all internal capacitance values from each of the DSD modules, DSM modules, single-axis inverters, dual-axis inverters, power supplies, and capacitor modules in the same DC-bus group.

The total system capacitance must be less than the maximum supported DC-bus capacitance value of the power supply, see Table 71.

IMPORTANT If your total system capacitance value exceeds the maximum supported capacitance value of the DC-bus power supply, perform one of the following:

- Increase the size of the 2198-P*xxx* DC-bus power supply
- Use multiple DC-bus power supplies (1…3 power supplies are possible)

Decrease the total system capacitance by removing inverters or capacitor modules from the DC-bus group.

External bus capacitance is the total system capacitance minus the power supply capacitance. The external bus capacitance must be entered into the Studio 5000 Logix Designer® application for a regenerative power supply to maintain proper control.

Table 71 - Power Supply Capacitance

Power Supply	DC-bus Power Supply Cat. No.	Supported Capacitance, max μF	Internal Capacitance μF
Single DC-bus Power Supply	2198-P031	8,000	585
	2198-P070		780
	2198-P141	13,000	1640
	2198-P208		2050
Multiple DC-bus Power Supplies	2198-P208 x 2	26,000	4100
	2198-P208 x 3	39,000	6150
iTRAK® Power Supply	2198T-W25K-ER	390	0

Table 72 - Internal Inverter and Accessory Module Capacitance

Drive Module	Drive Module Cat. No.	Internal Capacitance μF
Dual-axis Inverters	2198-D006-ERS*x*	165
	2198-D012-ERS*x*	
	2198-D020-ERS*x*	330
	2198-D032-ERS*x*	390
	2198-D057-ERS*x*	705
Single-axis Inverters	2198-S086-ERS*x*	560
	2198-S130-ERS*x*	840
	2198-S160-ERS*x*	1120
	2198-S263-ERS*x*	2050
	2198-S312-ERS*x*	
Capacitor Module	2198-CAPMOD-2240	2240
Extension Module	2198-CAPMOD-DCBUS-IO	0
DC-bus Conditioner Module	2198-DCBUSCOND-RP312	0
Distributed Servo Drive (DSD)	2198-DSD0*xx*-ERS*x*	5.2
Distributed Servo Motor (DSM)	2198-DSM0*xx*-ERS*x*	5.2

Calculate the Total Motor Power Cable Length

To meet CE and UK requirements, the sum of all motor power cable lengths from the same DC-bus group must not exceed 1200 m (3937 ft) when 2198-DBR*xx*-F line filters are used. See Cable Length Restrictions and System Sizing on page 29 for additional motor power cable-length limitations.

Calculate 24V DC Control Power Current Demand

If using the 24V DC shared-bus connection system to distribute control input power to a drive cluster, output current from the 24V power supply must not exceed 40 A.

Table 73 - Control Power Current Specifications

Drive Module	Module Cat. No.	24V Current Per Module (non-brake motor) (1) A_{DC}	24V Inrush Current (2) A
DC-bus Power Supplies	2198-P031	0.8	4.0
	2198-P070		
	2198-P141	1.9	
	2198-P208		
Dual-axis Inverters	2198-D006-ERS*x*	1.4 (3)	4.0
	2198-D012-ERS*x*		
	2198-D020-ERS*x*		
	2198-D032-ERS*x*	1.7 (3)	
	2198-D057-ERS*x*	2.3 (3)	
Single-axis Inverters	2198-S086-ERS*x*	4.6	4.0
	2198-S130-ERS*x*		
	2198-S160-ERS*x*		
	2198-S263-ERS*x*		
	2198-S312-ERS*x*		
PIM Module	2198-PIM070	12	13.2(4)
iTRAK Power Supply (5)	2198T-W25K-ER	1.3	2.2
Capacitor Module	2198-CAPMOD-2240	0.1	7.0
Extension Module	2198-CAPMOD-DCBUS-IO	–	–
DC-bus Conditioner Module	2198-DCBUSCOND-RP312	0.1	7.0

(1) For motor-brake current values, see to the Kinetix Rotary Motion Specifications Technical Data, publication KNX-TD001.
(2) Inrush current duration is less than 30 ms.
(3) Values are base current per module.
(4) Values are with no capacitor modules. For Inrush current with capacitor modules, see Table 74.
(5) These values represent only the iTRAK power supply. They do not include the iTRAK motor modules that are connected to the iTRAK power supply and also draw current from this 24V control power input. For more information regarding 24V control power requirements, see iTRAK System with TriMax Bearings User Manual, publication 2198T-UM002, or iTRAK 5730 System User Manual, publication 2198T-UM003.

IMPORTANT If the 24V control-power output current (based on your system calculation) exceeds 40 A, you can insert another control-power input wiring connector at any point in your drive cluster. However, the input connector must always extend the 24V DC-bus from left to right.

Table 74 - PIM Module 24V DC Power Supply Current Demand (Inrush)

	4 Axes(1)	8 Axes(1)	12 Axes(1)	16 Axes(1)	20 Axes(1)	24 Axes(1)
1 Capacitor Module(2)	7 A	8.5 A	10 A	11.3 A	13 A	14.3 A
6 Capacitor Modules	30.3 A	31.6 A	32.5 A	33.4 A	32.2 A	32 A
11 Capacitor Modules	32.8 A	33.2 A	33.5 A	34 A	34.4 A	35 A

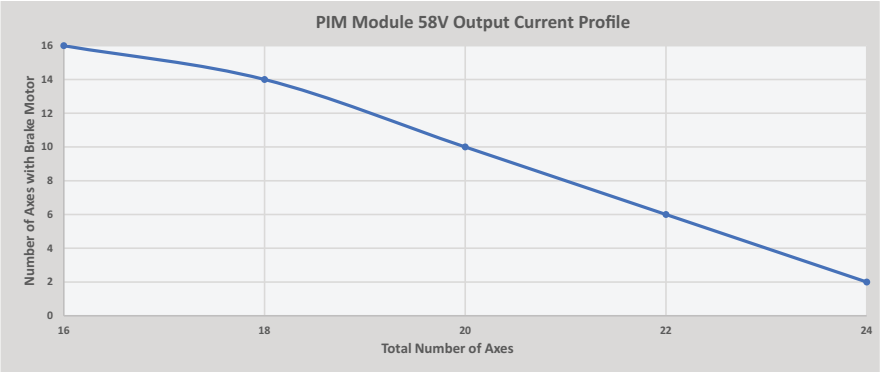
(1) Including 2 brake motors out of the total number.
(2) One capacitor module is 2.24 mF

Table 75 - PIM Module 24V DC Power Supply Current Demand (Continuous)

	4 Axes(1)	8 Axes(1)	12 Axes(1)	16 Axes(1)	20 Axes(1)	24 Axes(1)
58V Continuous Output Current	0.5 A	1.3 A	1.9 A	2.6 A	3.3 A	4.0 A
24V Continuous Input Current	2.5 A	4.5 A	6.0 A	8.0 A	9.8 A	12.0 A

(1) Including 2 brake motors out of the total number.

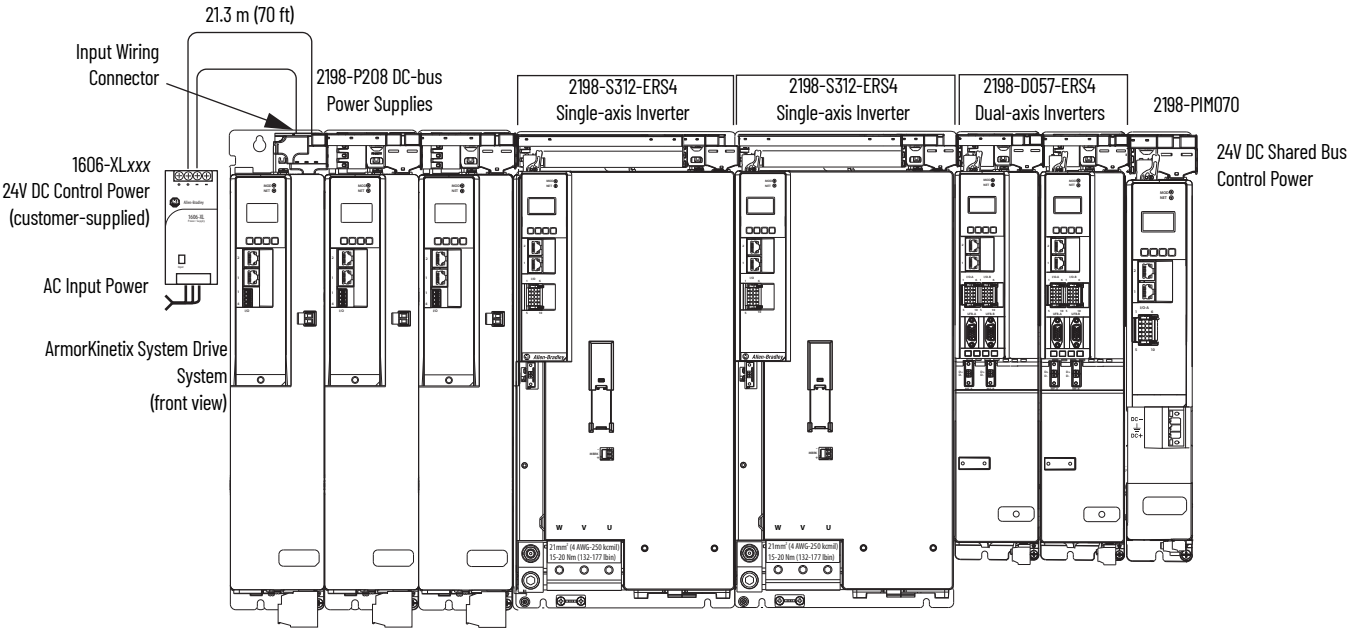
Figure 95 - PIM Module Power Output Specification



24V DC Voltage Drop Calculation Example

In this example, the 24V DC power supply is 21.3 m (70 ft) away from the Kinetix 5700 drive system. The drive system includes one bus supply, two 2198-S312-ERS4 single-axis inverters, two 2198-D057-ERS4 dual-axis inverters, and one 2198-PIM070 module. The inverters supply power to seven non-brake motors.

Figure 96 - 24V DC Voltage Drop Example System



Follow these steps to calculate the voltage drop for your drive system. The system conditions remain the same, but the wire gauge (AWG) is increased to reduce the voltage drop.

1. Determine the 24V DC control power current demand.

   In this example, the total current demand is 22.9 A. See Calculate 24V DC Control Power Current Demand on page 193 for current values.

Module	Quantity	Current Demand
2198-P208	1	9.1 A
2198-PIM070	1	12 A
2198-S312-ERS4	2	4.6 • 2 = 9.2 A
2198-D057-ERS4	2	2.3 • 2 = 4.6 A
Total current demand		34.9 A

2. Determine the voltage drop across the wire that is used to supply 24V power to the drive system (voltage drop = current draw • resistance of the wire).

   You must obtain the wire resistance value from the wire manufacturer. Resistance values used below are only examples.

Wire Length	Wire Gauge mm^2 (AWG)	Calculation	Voltage Drop
21.3 m (70 ft)	1.5 (16)	34.9 A • 0.281 Ω	9.80V
	4.0 (12)	34.9 A • 0.111 Ω	3.87V
	6.0 (10)	34.9 A • 0.070 Ω	2.44V

3. Determine if the voltage supplied to the drive system is within its required input-voltage range; 24V ±10% (21.6...26.4V DC).

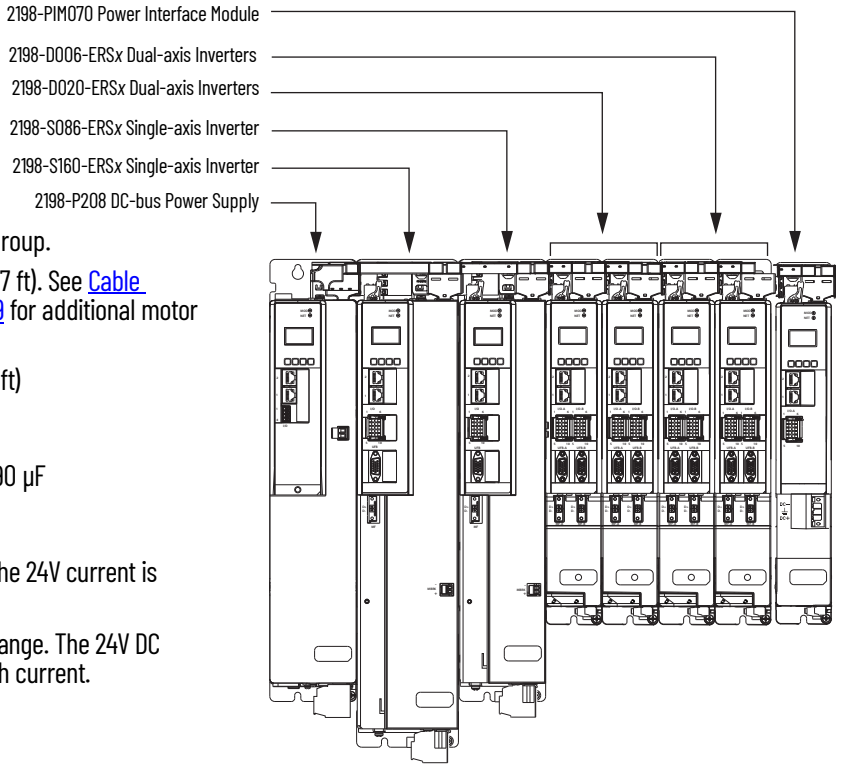
Wire Length	Wire Gauge mm^2 (AWG)	Calculation	Applied Voltage
21.3 m (70 ft)	1.5 (16)	24V – 6.43V	17.57V (insufficient)
	4.0 (12)	24V – 2.54V	21.46V (insufficient)
	6.0 (10)	24V – 1.60V	22.40V (acceptable)

   In this example, increasing the wire gauge to 6 mm^2 (10 AWG) is one way to lower the voltage drop.

System Sizing Example

This example shows how a single Kinetix 5700 drive cluster meets the total bus capacitance, power cable length, and 24V DC current limitations.

Figure 97 - Example DC-bus Group (single drive cluster)



In this example, only 1 drive cluster defines the DC-bus group.

- Maximum motor power cable length: 1200 m (3937 ft). See Cable Length Restrictions and System Sizing on page 29 for additional motor power cable-length limitations.
  - Total motor power cable length is 337 m (1106 ft)
- Maximum supported capacitance: 13,000 µF
  - Total system capacitance is 4840 µF
  - External bus capacitance is 4840 - 2050 = 2790 µF
- Maximum 24V DC control power current: 40 A
  - Total 24V DC control power current is 20.3 A
  - The Coil Current column shows how much of the 24V current is consumed by the motor brake circuit.

All of the total system values are within the acceptable range. The 24V DC power supply should be rated to greater than 28 A inrush current.

Table 76 - System Sizing Example Data

DC-bus Group Cat. No.	Axis	Internal Capacitance µF	Cable Length m (ft)	Servo Motor		24V DC Control Power Current Calculations			
				Servo Motor Cat. No.	Brake Option Yes/No	Brake Current @ 24V DC A	24V Current (non-brake motor) A_{DC}	Total Current A	24V Inrush Current A_{DC}
2198-P208	–	2050	–	–	–	–	1.9	1.9	4.0
2198-S160-ERSx	–	1120	50 (164)	MPL-B980E	No	–	4.6	4.6	4.0
2198-S086-ERSx	–	560	90 (295)	MPL-B660F	Yes	2.10	4.6	6.7	4.0
2198-DSM016-ERSx-B0752M	–	5.2	50 (164)	2198-DSM016-ERSx-B0752M	Yes	–	–	–	–
2198-DSD016-ERSx	A	5.2	4 (13)	VPL-B1003C	Yes	–	–	–	–
2198-D020-ERSx	A	390	20 (66)	VPL-B1152F	No	-	1.4	1.4	4.0
	B		15 (49)	VPL-B1152F	No	-			
2198-D020-ERSx	A	390	9 (30)	VPL-B1003C	Yes	0.50	1.4	2.4	4.0
	B		90 (295)	VPL-B1003C	Yes	0.50			
2198-D006-ERSx	A	165	9 (30)	MPL-B310P	Yes	0.50	1.4	1.9	4.0
	B		9 (30)	MPL-B310P	No	-			
2198-D006-ERSx	A	165	15 (49)	MPL-B310P	No	-	1.4	1.4	4.0
	B		30 (98)	MPL-B310P	No	-			
Totals		**4850.4**	**391 (1283)**			**3.6**	**16.7**	**20.3**	**28.0**

For more information on motor and motor-brake specifications, refer to the Kinetix Rotary Motion Specifications Technical Data, publication KNX-TD001.

System Sizing Application Example

This example shows how to size the DC-bus power supply for your multi-axis system by using the motor output power (kW). Sizing is based on the largest motor kW value in your drive system.

The Kinetix 5700 drive modules and ArmorKinetix PIM modules are zero-stacked and use the shared-bus connection system to extend power from the 2198-P*xxx* DC-bus power supply to multiple drive modules.

For best results, use the FactoryTalk Motion Analyzer system sizing and selection tool, available at: rok.auto/motion-analyzer.

Table 77 - Kinetix 5700 System Power Supply Continuous Output Power

DC-Bus Power Supply Cat. No.	Continuous Output Power kW
2198-P031	7
2198-P070	17
2198-P141	31
2198-P208	46

In this typical system, all axes are running in an asynchronous rapid acceleration/deceleration motion profile. Use this formula to calculate the minimum continuous output-power (kW) for your Kinetix 5700 drive system:

2198-P*xxx* = Largest motor-rated kW x (axis-count x 0.6) + (axis-count x 0.2)

Table 78 - Motor/Drive System Example

Motor Quantity	Motor Cat. No.	Motor Rated Output (1) kW	Drive Cat. No.
1	MPM-B2153F	7.2	2198-S086-ERS*x*
1			2198-S086-ERS*x*
1	MPL-B660F	6.1	2198-S086-ERS*x*
1			2198-S086-ERS*x*
1	2198-DSM024-ERSx-B0753M	0.78(2)	2198-DSM024-ERSx-B0753M
2	VPL-B0753	0.82	2198-D020-ERS*x*
2			2198-D020-ERS*x*
9 = axis count			

(1) For more motor specifications, see the Kinetix Rotary Motion Specifications Technical Data, publication KNX-TD001.
(2) For more DSM module specifications, see Kinetix 5700, 5500, 5300, and 5100 Servo Drives Specifications Technical Data, publication KNX-TD003.

Continuous Output Power, min (kW) = 7.2 x (8 x 0.6) + (8 x 0.2)
kW = 7.2 x 4.8 + 1.6
kW = 36.16

In this example, the MPM-B2153F motor has the largest motor-rated output. As a result, the minimum continuous output-power = 36.16 kW, and the 2198-P208 DC-bus power supply is required for the 8-axis system example.

Notes:

Maximum Motor Cable Lengths for Kinetix 5700 Power Supplies

This appendix provides information on maximum motor cable length limitations for ArmorKinetix® systems.

Maximum motor cable lengths for the following configurations are dependent on these configuration variables:

- Kinetix® 5700 power supply
  - 2198-P*xxx* DC-bus power supply
- AC input power type
  - WYE grounded
  - WYE impedance grounded
  - WYE/Delta corner grounded or ungrounded
- AC input voltage
  - 240V AC
  - 480V AC
  - 400V AC
- Whether the drive cluster includes a DC-bus conditioner module
- Allen-Bradley® servo motor or actuator connected to the inverter

Table 79 - Drive-to-Motor Feedback Cable Length

Feedback Type	Cable Length, max (1)(2) m (ft)
Single-turn or multi-turn absolute	up to 90 (295) (in-cabinet drive)
	up to 4 (13.1) (DSD module)
Incremental	up to 30 (98) (in-cabinet drive)
	up to 4 (13.1) (DSD module)

(1) See DC-bus Power Supply Configurations on page 200 for the maximum motor-to-drive cable length for specific motor and actuator families.
(2) Cable length is not affected by use of the 2198-H2DCK converter kit on the Kinetix 5700 drive.

DC-bus Power Supply Configurations

Cable length maximums for 2198-P*xxx* DC-bus power supplies when they operate with DC-bus regulation disabled.

Table 80 - DC-bus Power Supply - DFE (480V AC input)

AC Input Power Source Type	Motor/Actuator Cat. No.	DSD-to-Motor Cable Length, max m (ft)
WYE Grounded	• LDAT-S*xxxxxx* • LDC-C*xxxxxx*	3 (9.8)
	• VP*x*-B*xxxxx*, MP*x*-B*xxxxx* • VPAR-B1*xxxx*, VPAR-B2*xxxx* • Third-party Motor (1000V min. rated)	4 (13.1)
Delta Corner Grounded	• VP*x*-B*xxxxx*, MP*x*-B*xxxxx* • Third-party Motor (1200V min)	4 (13.1)
• WYE Impedance Grounded (1) • WYE Ungrounded (2) • Delta Ungrounded (2)	• LDAT-S*xxxxxx* • LDC-C*xxxxxx*	3 (9.8)
	• VP*x*-B*xxxxx*, MP*x*-B*xxxxx* • VPAR-B1*xxxx*, VPAR-B2*xxxx* • Third-party Motor (1000V min. rated)	4 (13.1)

(1) Impedance grounded systems running in ground fault conditions, for prolonged periods of time, cause additional stress to the motor insulation and can cause premature motor failure.
(2) Unbalanced, floating, ungrounded systems can cause additional stress to the motor.

Table 81 - DC-bus Power Supply - DFE (400V AC input)

AC Input Power Source Type	Motor/Actuator Cat. No.	DSD-to-Motor Cable Length, max m (ft)
WYE Grounded	• LDAT-S*xxxxxx* • LDC-C*xxxxxx*	4 (13.1)
	• VP*x*-B*xxxxx*, MP*x*-B*xxxxx* • VPAR-B1*xxxx*, VPAR-B2*xxxx* • Third-party Motor (1000V min. rated)	
Delta Corner Grounded	• VP*x*-B*xxxxx*, MP*x*-B*xxxxx* • Third-party Motor (1200V min)	
• WYE Impedance Grounded (1) • WYE Ungrounded (2) • Delta Ungrounded (2)	• LDAT-S*xxxxxx* • LDC-C*xxxxxx*	
	• VP*x*-B*xxxxx*, MP*x*-B*xxxxx* • VPAR-B1*xxxx*, VPAR-B2*xxxx* • Third-party Motor (1000V min. rated)	

(1) Impedance grounded systems running in ground fault conditions, for prolonged periods of time, cause additional stress to the motor insulation and can cause premature motor failure.
(2) Unbalanced, floating, ungrounded systems can cause additional stress to the motor.

Table 82 - DC-bus Power Supply - DFE (200V AC input)

AC Input Power Source Type	Motor/Actuator Cat. No.	DSD-to-Motor Cable Length, max m (ft)
WYE Grounded	• LDAT-S*xxxxxx* • LDC-C*xxxxxx*	4 (13.1)
	• VP*x*-A*xxxxx*, MP*x*-B*xxxxx* • VPAR-A1*xxxx*, VPAR-B2*xxxx* • Third-party Motor (1000V min. rated)	
Delta Corner Grounded	• VP*x*-A1*xxxx*, MP*x*-B1*xxxx* • Third-party Motor (1200V min)	
• WYE Impedance Grounded (1) • WYE Ungrounded (2) • Delta Ungrounded (2)	• LDAT-S*xxxxxx* • LDC-C*xxxxxx*	
	• VP*x*-B*xxxxx*, MP*x*-B*xxxxx* • VPAR-B1*xxxx*, VPAR-B2*xxxx* • Third-party Motor (1000V min. rated)	

(1) Impedance grounded systems running in ground fault conditions, for prolonged periods of time, cause additional stress to the motor insulation and can cause premature motor failure.
(2) Unbalanced, floating, ungrounded systems can cause additional stress to the motor.

Motor Control Feature Support

This appendix provides feature descriptions for the induction motors and permanent-magnet motors that are supported by ArmorKinetix® DSx modules.

Frequency Control Methods

The ArmorKinetix DSD modules support three open-loop frequency control methods. These are the choices:

- **Basic Volts/Hertz** - This method is used in single asynchronous-motor applications
- **Basic Volts/Hertz - Fan Pump** - This method is similar to Basic Volts/Hertz, but is specifically tailored for fan/pump applications
- **Sensorless Vector with Slip Compensation** - This method is used for most constant torque applications. Provides excellent starting, acceleration, and running torque

To configure your induction motor in the Studio 5000 Logix Designer application, refer to Configure Induction-motor Frequency-control Axis Properties on page 106.

Open-loop frequency control is suitable in applications such as conveyors, pumps, and fans. Features include the following:

- Start Boost and Run Boost
- Electronic motor thermal-overload protection per Class 10 requirements
- Two skip frequencies, in which the drive does not operate
- All three-phase induction motors, suitable for variable speed drive (VFD) operation, are supported

Table 83 - Motor Specifications

Attribute	Value
Output frequency, max	590 Hz
Pole pairs, max	50
Motor cable length, max	4 m (13 ft) (1)

(1) Applies to all ArmorKinetix modules and compatible motors/actuators.

Basic Volts/Hertz

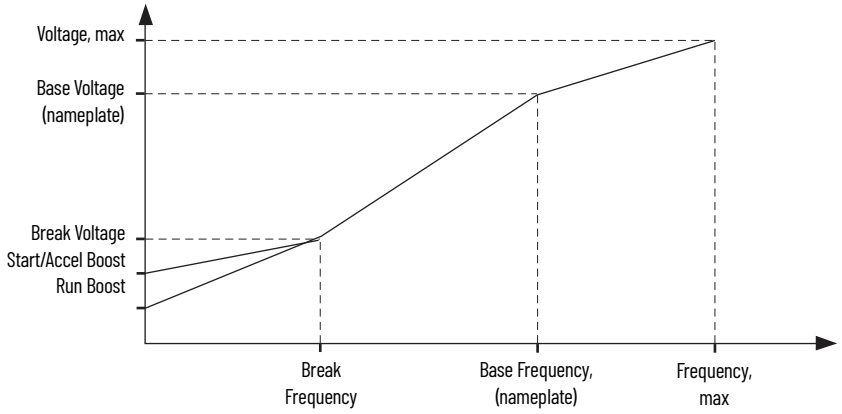
Volts/hertz operation creates a fixed relationship between output voltage and output frequency. Voltage is applied to the motor, which is based on the operating frequency command at a fixed volts/hertz ratio. The ratio is calculated from the motor nameplate data and entered into the Studio 5000 Logix Designer application > Axis Properties > Frequency Control category.

The Basic Volts/Hertz method provides various patterns. The default configuration is a straight line from zero to rated voltage and frequency. As seen in Figure 98, you can change the volts/hertz ratio to provide increased torque performance when required by programming five distinct points on the curve.

Table 84 - Basic Volts/Hertz Definitions

Curve Feature	Definition
Start boost	Used to create additional torque for breakaway from zero speed and acceleration of heavy loads at lower speeds.
Run boost	Used to create additional running torque at low speeds. The value is typically less than the required acceleration torque. The drive lowers the boost voltage to this level when running at low speeds (not accelerating). This reduces excess motor heating that could result if the higher start/accel boost level were used.
Break voltage/frequency	Used to increase the slope of the lower portion of the Volts/Hertz curve, providing additional torque.
Motor nameplate voltage/ frequency	Sets the upper portion of the curve to match the motor design. Marks the beginning of the constant power region.
Maximum voltage/frequency	Slopes the portion of the curve that is used above base speed.

Figure 98 - Basic Volts/Hertz Method



Basic Volts/Hertz for Fan/Pump Applications

The Basic Volts/Hertz Fan/Pump (fan/pump) method is based on the Basic Volts/Hertz (V/Hz) method, but is specifically tailored for fan/pump applications.

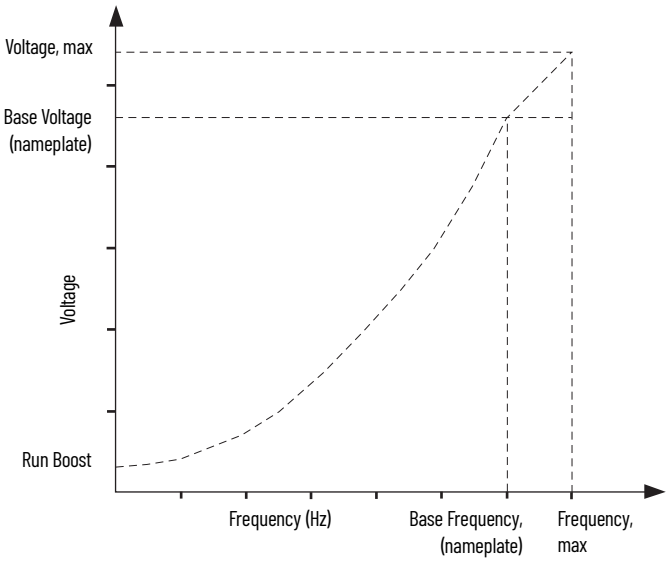
Figure 99 - Output Voltage Equation

$$V_x = \left(\frac{f_x}{f_n}\right)^2 \left(V_n - V_{boost}\right) + V_{boost}$$

Where:
V_x = Output voltage
f_x = Output frequency
V_n = Rated voltage
F_n = Rated frequency
V_{boost} = Run boost voltage

For maximum system efficiency, fan/pump loads use variable frequency drives that are equipped with a specific V/Hz curve where voltage is proportional to square of the frequency.

Figure 100 - Basic Volts/Hertz Fan/Pump Method

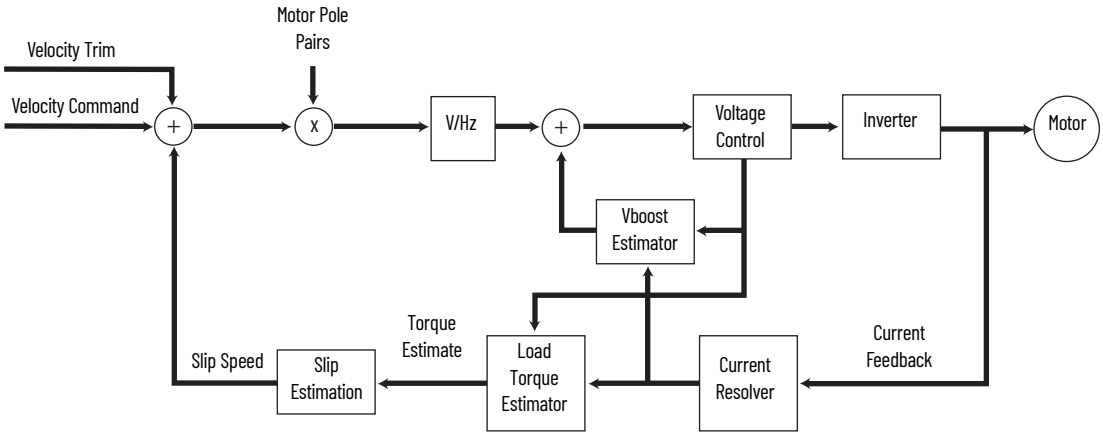


The Fan/Pump control method supports the run-boost attribute, but does not support break-voltage, break-frequency, or start-boost.

Sensorless Vector

The Sensorless Vector method uses a volts/hertz core enhanced by a current resolver, slip estimator, and a voltage-boost compensator based on the operating conditions of the motor.

Figure 101 - Sensorless Vector Method

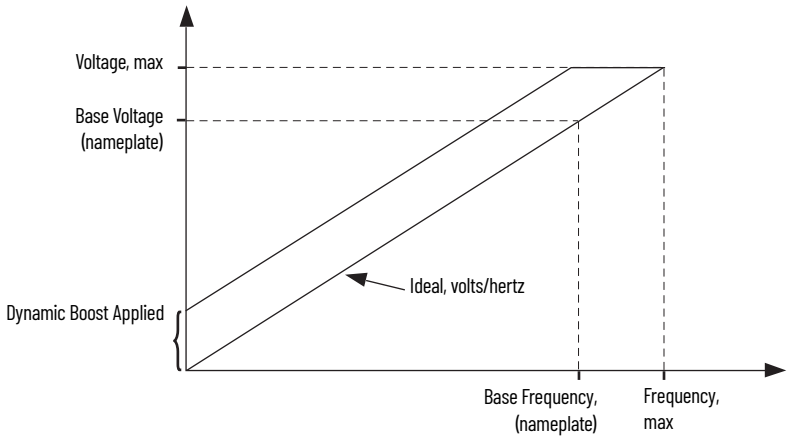


The algorithms operate on the knowledge of the relationship between the rated slip and torque of the motor. The drive uses applied voltages and measured currents to estimate operating slip-frequency. You can enter values to identify the motor resistance value or you can run a motor test to identify the motor resistance value (see Motor Tests and Autotune Procedure on page 215). Motor nameplate data and test results are ways to accurately estimate the required boost voltage.

The sensorless vector method offers better torque production and speed regulation over a wider speed range than basic volts/hertz.

Dynamic boost is applied internally to compensate voltage drop and improve starting torque.

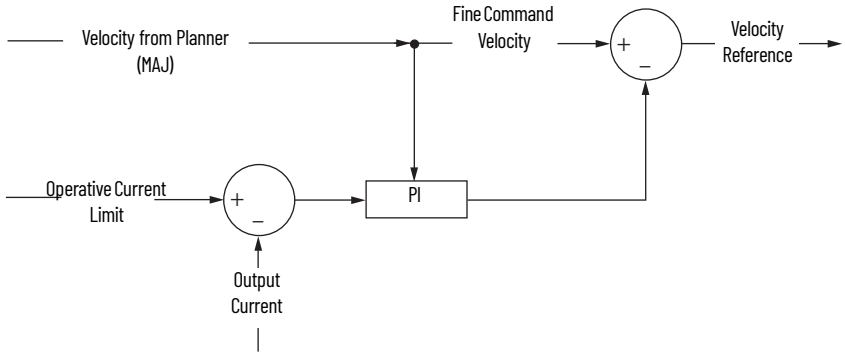
Figure 102 - Approximate Load Curve



Current Limiting for Frequency Control

The current limiting module prevents the OutputCurrent value from exceeding the OperativeCurrentLimit value when the drive is configured in Frequency Control mode.

Figure 103 - Current Limiting Module



In Frequency Control mode, OperativeCurrentLimit is the minimum value of the motor-thermal current limit, inverter-thermal current limit, motor-peak current limit, drive-peak current limit, and the CurrentVectorLimit value.

The Effects of Current Limiting

Indirect current limiting is available for induction motors configured for frequency control. You can use this feature to help prevent overcurrent faults due to aggressive acceleration/deceleration profiles or impact loads. The Current Limiting attribute uses a PI regulator to control the OutputCurrent by adjusting the velocity reference.

IMPORTANT	When configured for Frequency Control (induction motors only), select the Decel and disable stopping action only when the Current Limiting feature is enabled.

Figure 104 - Effects of Current Limiting on an Aggressive Acceleration

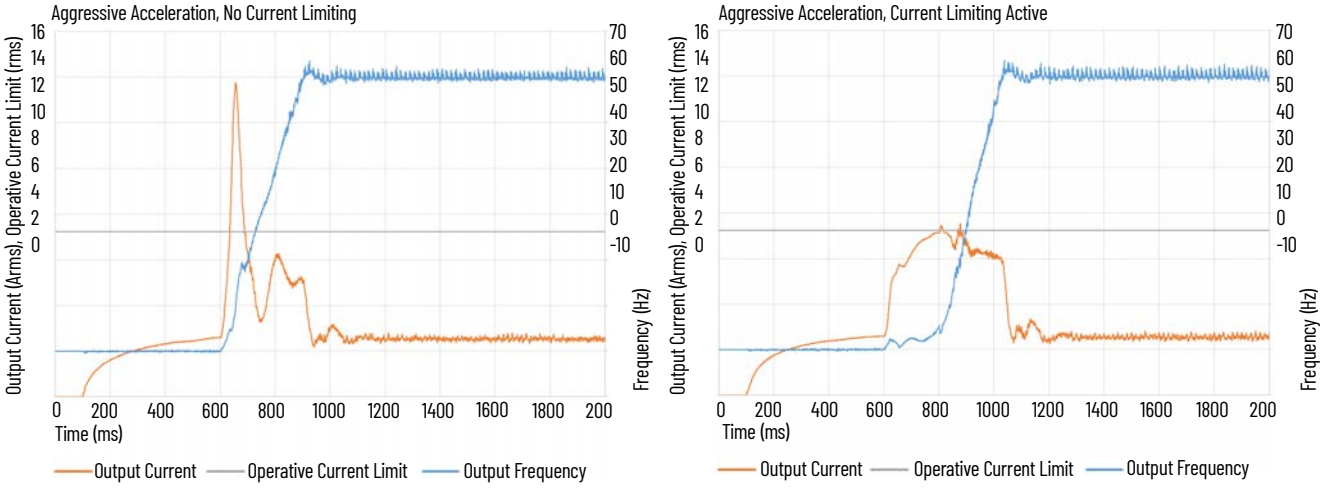
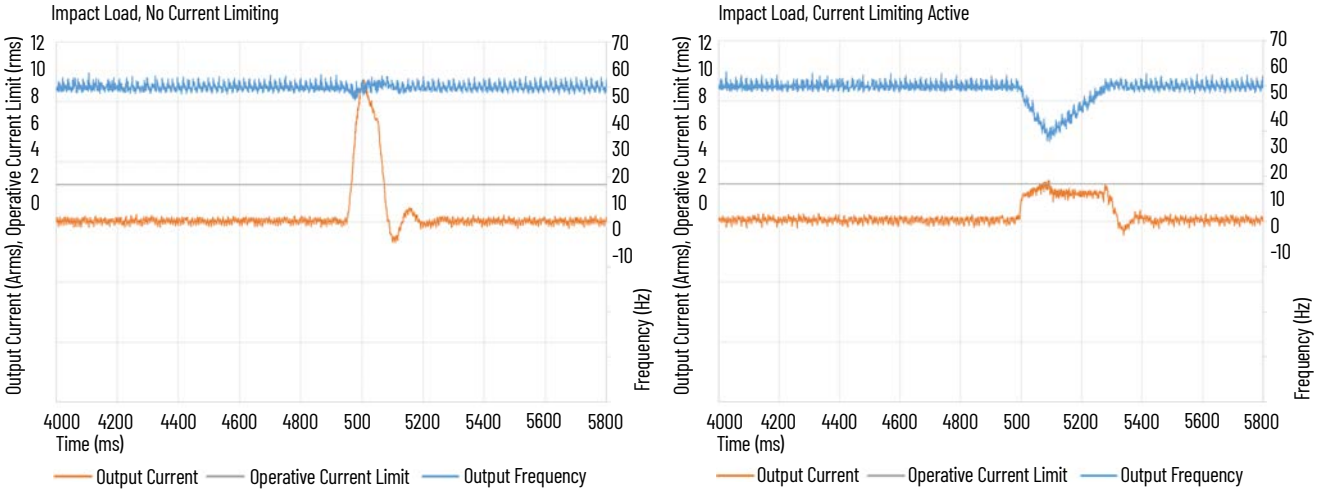


Figure 105 - Effects of Current Limiting on an Impact Load



Current limiting for frequency control is not enabled by default. You can enable via messaging by using the following device-specific attributes.

We recommend you leave the Kp, Ki, Kd gains at the default values.

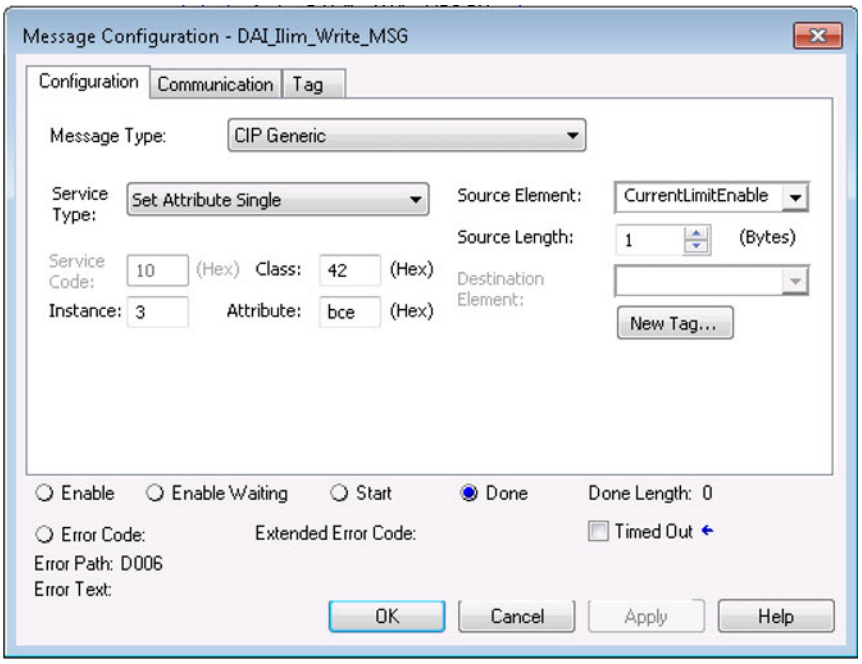
Table 85 - Enable Current Limiting via Messaging

Attribute Offset	Type	Attribute Name	Conditional Implementation	Description
3022	SINT	Current Limiting Enable	Frequency Control Induction Motor only	When enabled, limits the rate of change to the velocity reference during high-current situations for improved current limiting. This feature is only active when executing an MDS command and when configured for Frequency Control. 0 = Current Limiting is disabled 1 = Current Limiting is enabled
3023	REAL	Current Limiting Kd		Derivative gain for the current limiting function. Only functional when configured for Frequency Control and when executing an MDS command. Units of seconds.
3024	REAL	Current Limiting Ki		Integral gain for the current limiting function. Only functional when configured for Frequency Control and when executing an MDS command. Units of feedback counts / (Amp, inst* Seconds).
3025	REAL	Current Limiting Kp		Proportional gain for the current limiting function. Only functional when configured for Frequency Control and when executing an MDS command. Units of feedback counts / Amp, inst.

IMPORTANT For induction motors greater than 5 Hp, it is recommended that the Stability Control feature also be enabled when Current Limiting is enabled.

Enable the Current Limiting Feature

In this example, a Message Configuration (MSG) instruction is configured to set the CurrentLimitingEnable attribute for axis 3 of a dual-axis inverter. The Instance field is used to direct the message to the proper axis. For single-axis inverters the value of 1 is used for Instance.



Set the CurrentVectorLimit Attribute Value

For current limiting, the CurrentVectorLimit attribute is used to help determine the OperativeCurrentLimit of the drive. Set the CurrentVectorLimit value to artificially lower OperativeCurrentLimit below the drive or motor peak current limits.

1. Select the Parameter List category and scroll to CurrentVectorLimit.

CoastingTimeLimit	0.0	s
ConversionConstant	1000000.0	Motion Counts/Position Units
CurrentVectorLimit	100.0	% Motor Rated
FluxUpControl	No Delay	
FluxUpTime	0.0	s

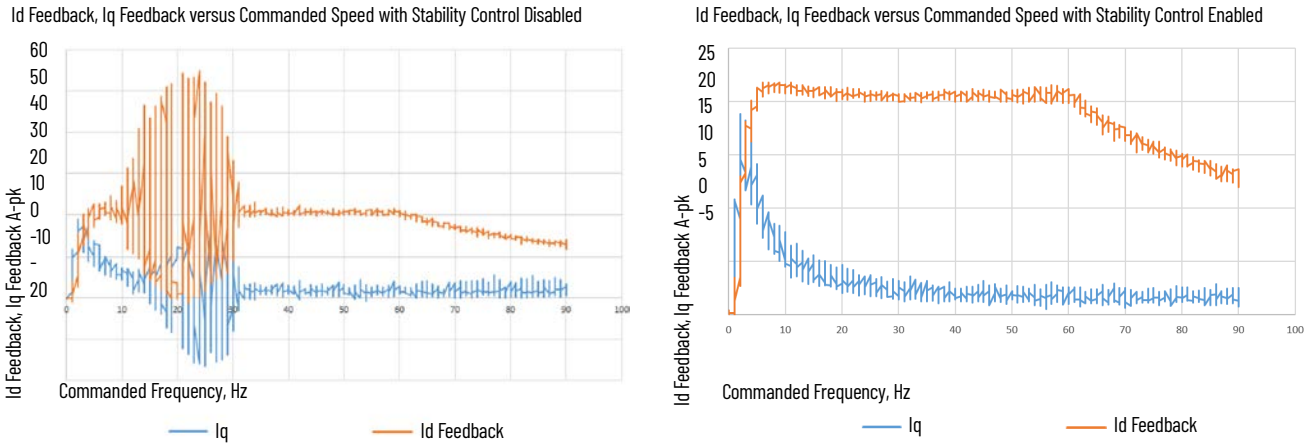
2. Set the CurrentVectorLimit value appropriate for your application.

IMPORTANT The CurrentVectorLimit attribute appears in the Parameter List of the Studio

Stability Control for Frequency Control

Stability control is available for induction motors configured for frequency control. This feature can be used to help remove resonances that are sometimes seen on larger motors. The stability control feature adjusts the OutputFrequency and OutputVoltage commands to stabilize the OutputCurrent.

Figure 106 - Effects of Stability Control



Stability control for frequency control is not enabled by default. You can enable via messaging by using the following device-specific attributes.

We recommend you leave the angle, voltage gains, and filter bandwidth at the default values.

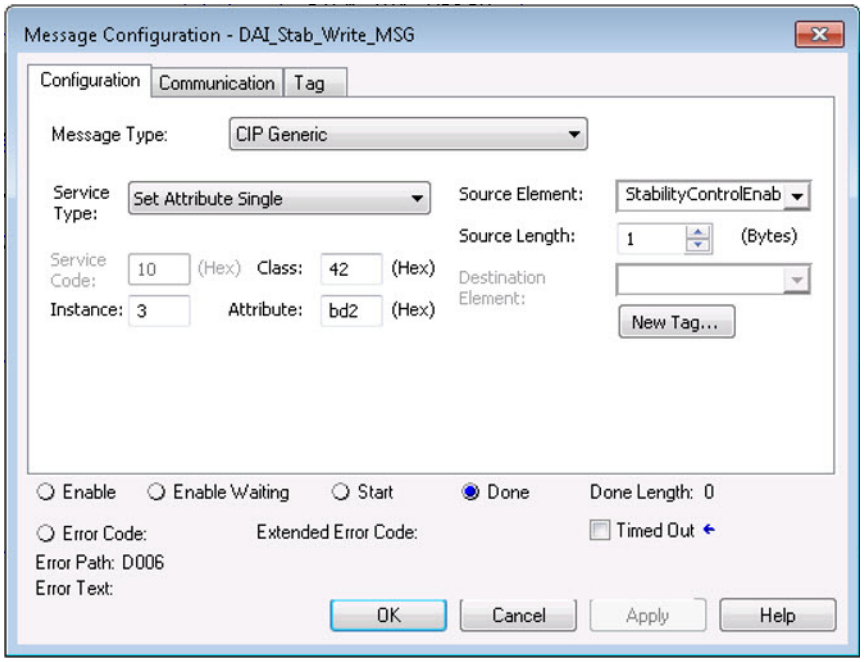
Table 86 - Enable Current Limiting via Messaging

Attribute Offset	Type	Attribute Name	Conditional Implementation	Description
3026	SINT	Stability Control Enable	Frequency Control Induction Motor only	Enables stability control when configured for frequency control. 0 = Stability Control is disabled 1 = Stability Control is enabled
3027	REAL	Stability Filter Bandwidth		Sets the bandwidth of the low-pass filter applied to the current feedback signal. This bandwidth is common to both the angle and voltage stability control algorithms. Units of radians/second.
3028	REAL	Stability Voltage Gain		The gain of the voltage stability control function. Only active when configured for frequency control. Units of Volt (inst,p-n)/Amp (inst).
3029	REAL	Stability Angle Gain		The gain of the electrical angle stability control function. Only active when configured for frequency control. Units of radians/Amp (inst).

IMPORTANT Because the stability control feature works by manipulating the OutputVoltage and OutputFrequency signals, these signals may appear 'noisy' when the feature is enabled.

Enable the Stability Control Feature

In this example, a Message Configuration (MSG) instruction is configured to enable the StabilityControl attribute for axis 3 of a dual-axis inverter. The Instance field is used to direct the message to the proper axis. For single-axis inverters the value of 1 is used for Instance.

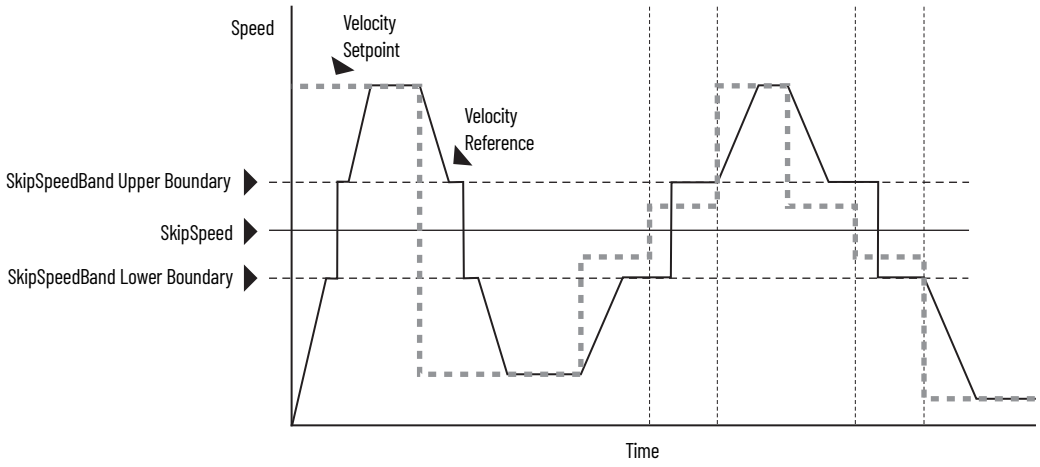


Skip Speeds

Some machines have a resonant operating frequency (vibration speed) that is undesirable or could cause equipment damage. To guard against continuous operation at one or more resonant points, you can configure the skip-speed attributes in the Studio 5000 Logix Designer application>Axis Properties>Parameter List category.

The value that is programmed into the SkipSpeed1 or SkipSpeed2 attribute sets the central speed of a skip-speed band within which the drive does not operate. The width of the band is determined by the SkipSpeedBand attribute. The range is split, half above and half below the SkipSpeed*x* attribute. Any command set-point within this band is adjusted by the skip-speed feature to fall at either the upper or lower skip-speed band boundary value. The skip-speed feature contains hysteresis (25% of the SkipSpeedBand value) to prevent frequent switching of VelocityReference.

Figure 107 - Single Skip Speed Example



A SkipSpeedBand value of 0 disables the skip-speed feature.

IMPORTANT When a single SkipSpeed value is desired, the SkipSpeed1 and SkipSpeed2 settings must be the same.

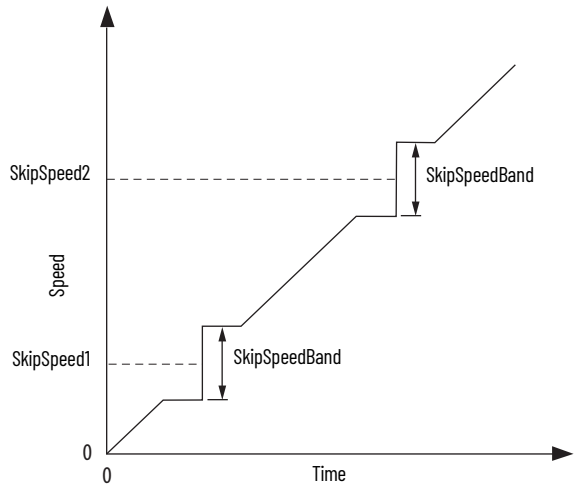
IMPORTANT Acceleration and deceleration are affected by the skip-speed feature. Too large of a SkipSpeedBand value can result in an overcurrent drive fault.

IMPORTANT The MaximumFrequency attribute is always enforced. Skip-speed band boundary values beyond the MaximumFrequency value do not apply.

Multiple Skip Speeds

The ArmorKinetix DS*x* modules feature two independent skip-speed attributes (SkipSpeed1 and SkipSpeed2) that use the same SkipSpeedBand.

Figure 108 - Multiple Skip Speed Example

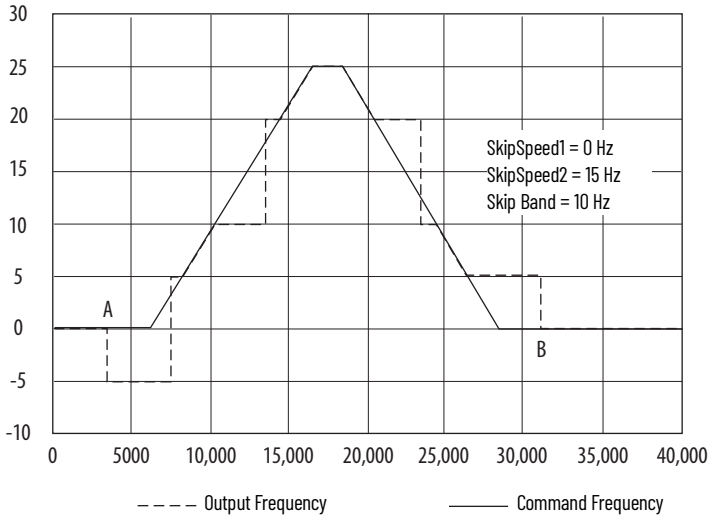


When skip-speed band boundaries of SkipSpeed1 and SkipSpeed2 overlap, the skip-speed hysteresis is calculated using the effective skip band.

In Figure 109, SkipSpeed1 is set to 0 and SkipSpeed2 is set to 15 hz. The skip band is 10 Hz wide.

At point A the axis is enabled, and the motor begins to rotate at -5 Hz even though the command is 0 Hz. As the command reaches hysteresis point the output frequency begins to follow the command. During deceleration, when the command decreases to 0 Hz, the output frequency continues at 5 Hz until the axis is disabled (point B), or the command is changed outside of the skip band.

Figure 109 - Zero-speed Skip Frequency

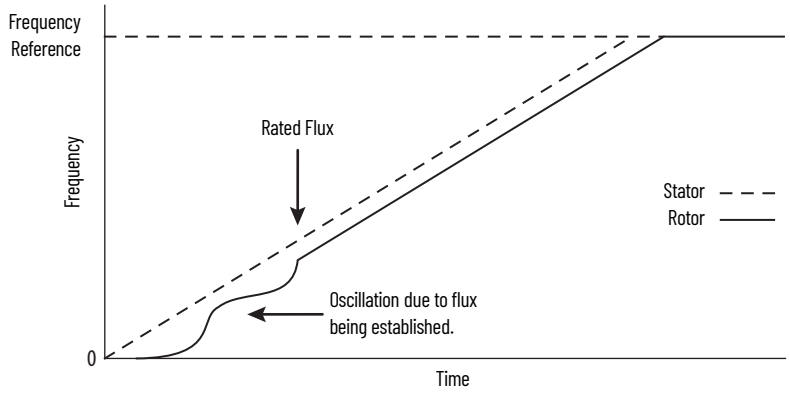


Flux Up

AC induction motors require that flux builds in the motor stator before controlled torque can develop. To build flux, voltage is applied. There are two methods to flux the motor and three configurable FluxUpControl settings.

With the No Delay setting (normal start), flux is established when the output voltage and frequency are applied to the motor. While flux is building, the unpredictable nature of the developed torque can cause the rotor to oscillate even though acceleration of the load can occur. In the motor, the acceleration profile does not follow the commanded acceleration profile due to the lack of developed torque.

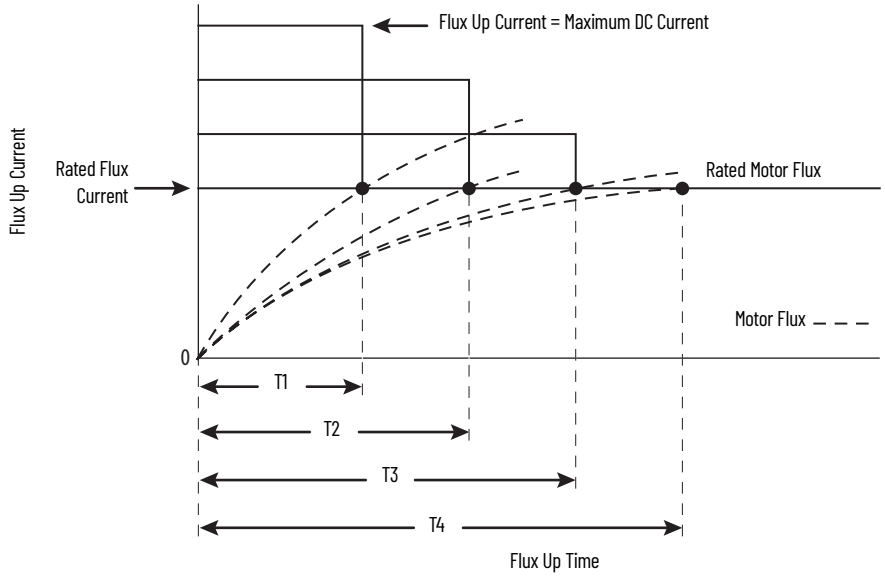
Figure 110 - Acceleration Profile during Normal Start - No Flux Up



With the Automatic setting (default) DC current is applied to the motor so that flux builds before rotation. The flux-up time period is based on the level of flux-up current and the rotor time constant of the motor. The flux-up current is not adjustable.

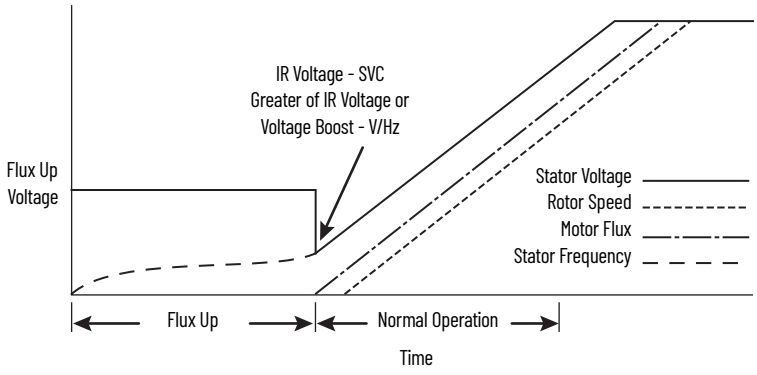
In the Manual setting, DC current is applied to the motor so that flux builds before rotation. The flux-up time period is determined by the FluxUpTime attribute. The flux-up current is not adjustable.

Figure 111 - Flux Up Current versus Flux Up Time



Once rated flux is reached in the motor, normal operation can begin and the desired acceleration profile achieved.

Figure 112 - Rated Flux Reached



Flux Up Attributes

ID	Access	Attribute	Conditional Implementation
558	Set	Flux Up Control	Ind Motor only 0 = No Delay 1 = Manual Delay 2 = Automatic Delay
559	Set	Flux Up Time (1)	Ind Motor only Units: Seconds Default: 0.0000 Min/Max: 0.0000 / 1000.00

(1) This is the time designated for the Manual Delay setting. This attribute is not supported by the Automatic delay method. The flux-up feature is disabled if FluxUpControl is set to Manual Delay and FluxUpTime is set to 0.

FluxUpControl Attribute

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.

Table 87 - FluxUp Control Delay Methods

Delay Method	Description
No delay	The axis transitions immediately to the Running state while the motor flux is building.
Manual delay	The axis remains in the Starting state while the motor stator flux is building according to the Flux Up Time attribute.
Automatic delay	The drive determines the amount of delay time to fully flux the motor based on the motor configuration attribute data or measurements.

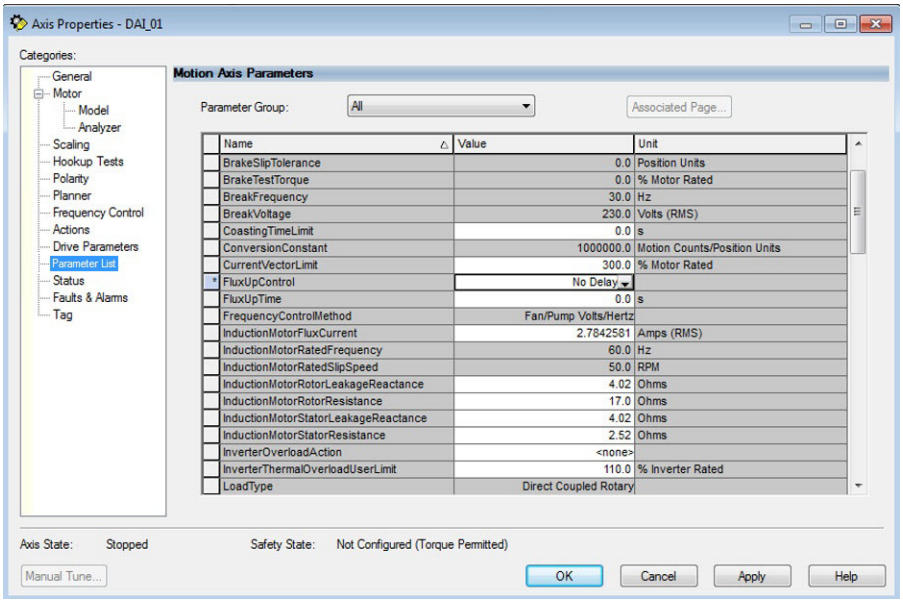
FluxUpTime Attribute

When FluxUpControl is configured for Manual Delay, this attribute sets the length of delay time to fully flux the motor before transitioning to the Running state.

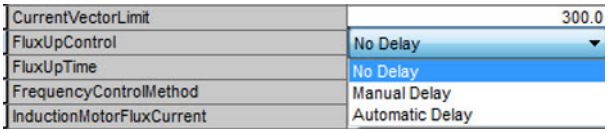
Configure the Flux Up Attributes

Follow these steps to configure the flux-up attributes.

1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the Parameter List category and scroll to FluxUpControl.



3. From the FluxUpControl dropdown menu, choose the proper delay value appropriate for your application.



4. If you chose Manual Delay in step 3, enter a value in the FluxUpTime attribute appropriate for your application.

   If you chose No Delay or Automatic Delay in step 3, the FluxUpTime attribute does not apply.

Current Regulator Loop Settings

Current loop bandwidth is set differently based on the selected motor type.

Table 88 - Current Regulator Loop Settings

Motor Type	Default Torque/Current Loop Bandwidth Hz
Rotary permanent magnet	1000
Rotary interior permanent magnet	
Linear permanent magnet	
Rotary induction	400

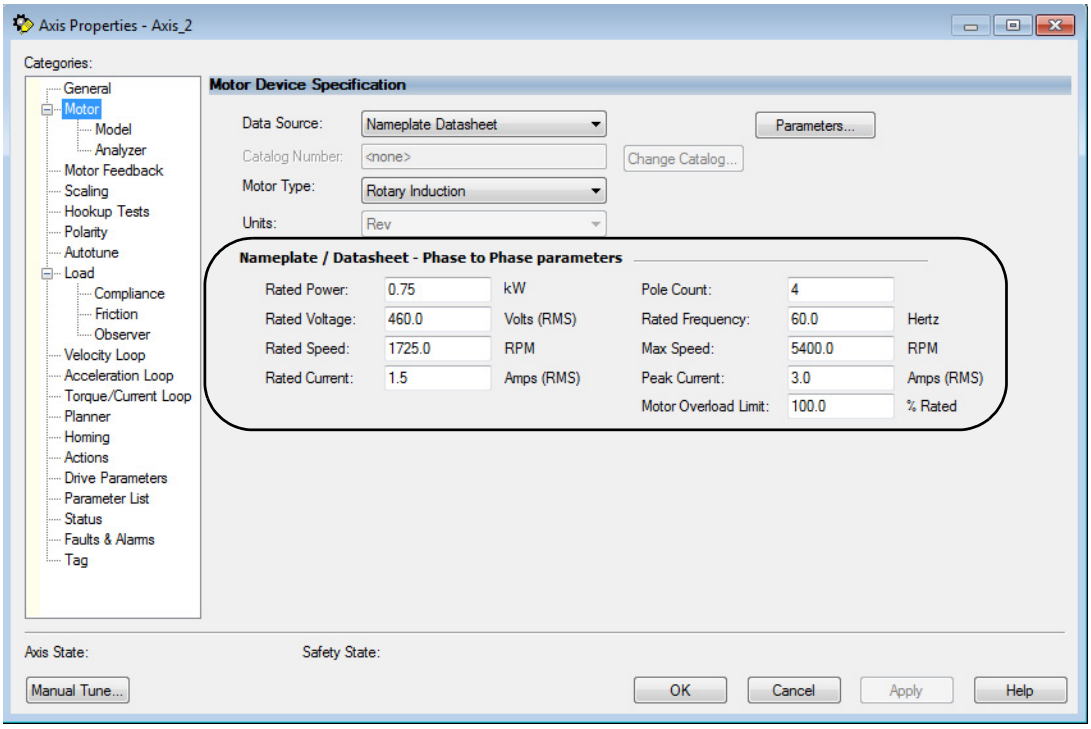
IMPORTANT The Studio 5000 Logix Designer application does not perform calculations when the Torque/Current Loop Bandwidth attribute is updated. This bandwidth affects many other gains and limits. Changing, (lowering) the torque loop bandwidth without updating all the dependent attributes can result in drive/motor instability.

Motor Category

From the Motor category you can enter motor nameplate or datasheet values (phase-to-phase parameters) for rotary induction motors.

In this example, the Motor category>Nameplate / Datasheet parameters, were taken from a typical motor performance datasheet. Max Speed and Peak Current values are typically application dependent.

Figure 113 - Motor Nameplate / Datasheet Example



See Figure 114 for motor manufacturer performance data sheet example.

Figure 114 - Motor Manufacturer Performance Data Sheet

CERTIFICATION DATA SHEET

TYPICAL MOTOR PERFORMANCE DATA

HP	kW	SYNC. RPM	F.L. RPM	FRAME	ENCLOSURE	KVA CODE	DESIGN
1	.75	1800	1725	56C	TENV	P	A

PH	Hz	VOLTS	FL AMPS	START TYPE	DUTY	INSL	S.F.	AMB°C	ELEVATION
3	60	460	1.5	INVERTER ONLY	CONTINUOUS	F3	1.0	40	3300

FULL LOAD EFF: 84	3/4 LOAD EFF: 82.5	1/2 LOAD EFF: 78.5	GTD. EFF	ELEC. TYPE	NO LOAD AMPS
FULL LOAD PF: 75	3/4 LOAD PF: 65.5	1/2 LOAD PF: 51	81.5	SQ CAGE INV DUTY	1

F.L. TORQUE	LOCKED ROTOR AMPS	L.R. TORQUE	B.D. TORQUE	F.L. RISE°C
3 LB-FT	30 / 15	10.8 LB-FT 360%	15 LB-FT 500%	65

SOUND PRESSURE @ 3 FT.	SOUND POWER	ROTOR WK ^2	MAX. WK ^2	SAFE STALL TIME	STARTS / HOUR	APPROX. MOTOR WGT
62 dBA	72 dBA	0.11 LB-FT^2	0 LB-FT^2	0 SEC.	0	42 LBS.

EQUIVALENT WYE CKT.PARAMETERS (OHMS PER PHASE)

R1	R2	X1	X2	XM
8.378	5.6232	10.7068	9.9116	278.036

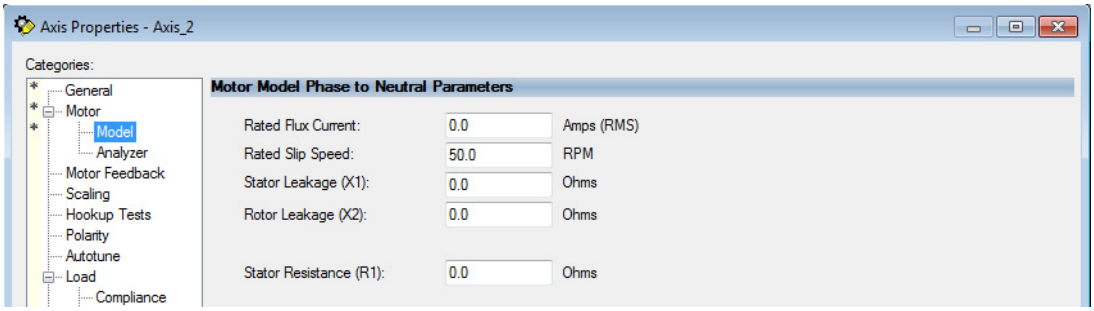
RM	ZREF	XR	TD	TD0
11132.8	284	1.7	0.0071	0.136

Motor > Model Category

From the Motor > Model category you can enter additional motor nameplate or datasheet values (phase-to-neutral parameters) for induction motors.

The Motor > Model parameters are used in closed-loop induction-motor control mode, sensorless vector control mode, and when FluxUp is enabled, and are estimated automatically by the Logix Designer application based on the motor nameplate data. You can also enter these parameter values directly from the motor nameplate/datasheet or indirectly by running a Motor > Analyzer test.

Figure 115 - Phase-to-Neutral Parameters



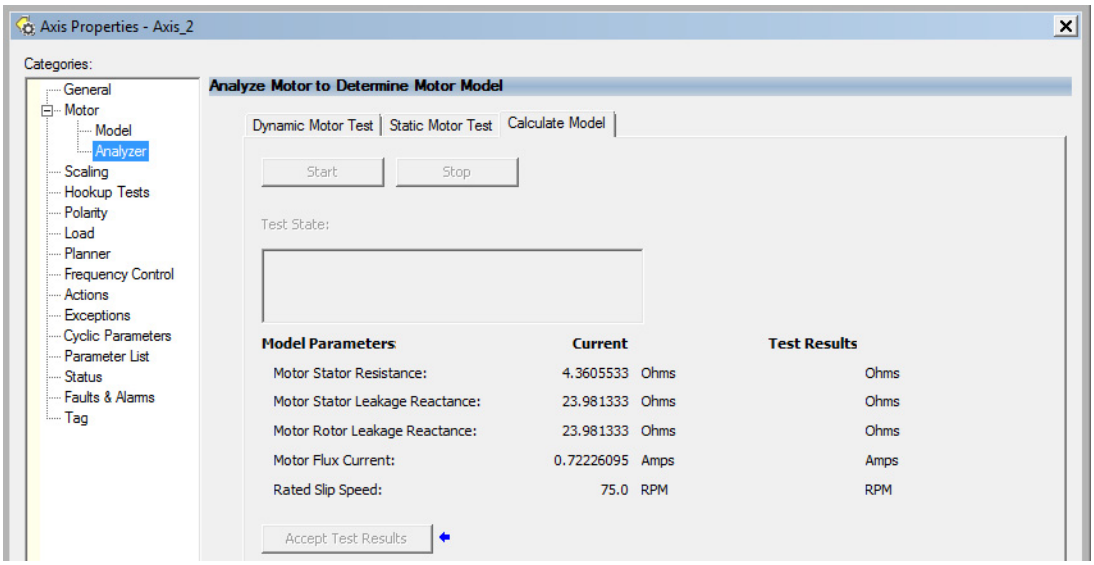
IMPORTANT If you do not know the Stator Leakage, Rotor Leakage, Stator Resistance, Rated Flux Current, and system inertia, you can run the static motor test and Autotune procedure to determine the parameter values.

Motor > Analyzer Category

From the Motor > Analyzer category you can perform three types of tests to identify motor parameters.

In this example, the Calculate Model test was run. If the Motor>Analyzer test executes successfully, and you accept the test values, they populate the Model Parameter attributes.

Figure 116 - Motor Analyzer Category



Motor Tests and Autotune Procedure

You can perform three types of tests to identify motor parameters and one test for motor/system inertia. These parameters are used by sensorless-vector frequency-control and induction motor closed-loop modes. Table 89 recommends which test to use based on the control mode and application.

Table 89 - Motor Tests and Autotune Matrix

Control Mode	Description	Calculate	Static	Dynamic	Autotune (inertia test)
Induction motor - Frequency control	Basic volts/hertz	Not required	Not required	Not required	Not required
	Basic volts/hertz for Fan/Pump	Not required	Not required	Not required	Not required
	Sensorless vector	Required	Preferred	Not required	Not required
Induction motor - Closed-loop control		Required	Preferred (1)	Preferred	Required (2)

(1) If it is not desired to rotate the motor (due to coupled load) you can perform this test for induction motor closed-loop mode and skip the Dynamic test. The dynamic test provides the best results for induction motor closed-loop mode.

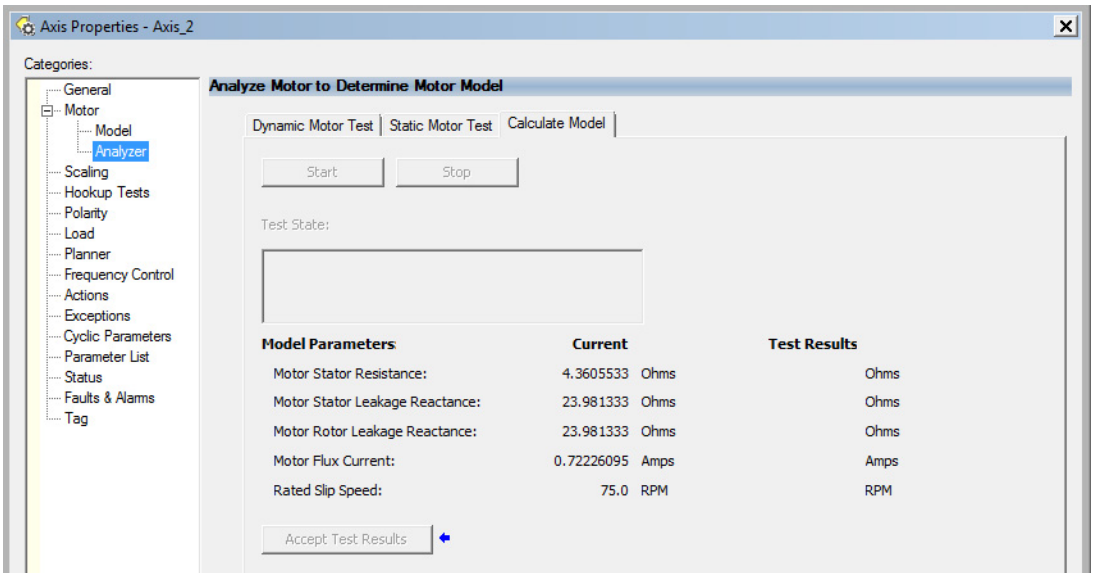
(2) The motor inertia value must be non-zero prior to running a dynamic test. The motor inertia value is estimated automatically based upon the Motor Nameplate data in the Studio 5000 Logix Designer application.

The Motor > Analyzer category offers three choices for calculating or measuring electrical motor data.

Follow these steps to run motor tests and identify motor parameters.

1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the Motor>Analyzer category.

   Nameplate data was entered on page 213. The nameplate data must be entered before running the Calculate test.



3. Click Start to run the test.
4. Click Accept Test Results to save the values.
5. Click OK.

Motor Analyzer Category Troubleshooting

Calculate Model

When a Calculate test is run, the drive uses motor nameplate data to estimate the motor's Rated Flux Current, Stator Resistance (Rs), Stator Leakage Reactance (X1) and Rotor Leakage Reactance (X2). The drive also calculates the rated slip speed based on rated speed and rated frequency. No measurements are taken when using the Calculate test.

Static Motor Test

Use the Static test if the motor shaft cannot rotate or if it is already coupled to the load. Only tests that do not create motor movement are run. During this test, the Stator Resistance (Rs), Stator Leakage Reactance (X1), and Rotor Leakage Reactance (X2) values are measured during a series of static tests. The Rated Flux Current is estimated, since measurement of this value requires motor movement. The drive also calculates the rated slip speed based on rated speed and rated frequency.

The Static test requires that you enter initial estimates for Rated Flux Current, Rated Slip Speed, Stator Resistance (Rs), Stator Leakage Reactance (X1), and Rotor Leakage Reactance (X2) into the Motor Model fields.

- For the Studio 5000 Logix Designer application, version 35.00 or later, initial estimates are populated by the controller.

Dynamic Motor Test

Dynamic tests are run with the motor disconnected from the load because the motor shaft turns and there are no travel limits. This is often the most accurate test method. During this test, the Stator Resistance (Rs), Stator Leakage Reactance (X1) and Rotor Leakage Reactance (X2) values are measured in a series of static tests. The Rated Flux Current is measured during a rotational test, in which the drive commands 75% of the motor rated speed.

The rated slip speed is measured during a second rotational test, in which the drive commands a speed (default of 100% of the motor rated speed) and set a torque limit (default of 50% of the motor rated torque). This quickly accelerates the motor to rated speed and then decelerates back to zero speed.

IMPORTANT The Dynamic test does not support travel limits.

The Dynamic test also requires that you enter initial estimates for Rated Flux Current, Rated Slip Speed, Stator Resistance (Rs), Stator Leakage Reactance (X1), and Rotor Leakage Reactance (X2) into the Motor Model fields.

- For the Studio 5000 Logix Designer application, version 35.00 or later, initial estimates are automatically populated by the controller.

The Dynamic test uses the Ramp Acceleration and Ramp Deceleration attributes to set the rotational test ramp-up and ramp-down times. If the resulting acceleration/deceleration times are less than 10 seconds, 10 seconds is used. If these attributes are not supported, 10 seconds is also used.

The Dynamic test also uses the IM Slip Test Velocity Command (percent of rated speed) and IM Slip Test Torque Limit (percent of rated torque) attributes to define the motion profile for the slip measurement. The default values are 100.0 and 50.0 respectively. The speed command dictates the speed that the motor spins up to and the torque dictates how quickly the motor reaches that speed. In general, A higher speed and lower torque results in a longer acceleration and a more accurate rated slip speed.

However, be aware that the dynamic test will not return expected results if the torque limit is set below 30.0.

Table 90 - Slip Test via Messaging

Attribute Offset	Type	Attribute Name	Conditional Implementation	Description
3095	REAL	IM Slip Test Torque Limit	Closed loop induction motor only	Sets positive and negative torque limits for the slip test within the Dynamic motor test (similar to the torque limits in the inertia test). Units are in percent of rated torque.
3096	REAL	IM Slip Test Velocity Command		Sets the velocity command for the slip test within the Dynamic motor test, (similar to the velocity command in the inertia test). Units are in percent of motor rated speed.

The Dynamic test requires the Positive and Negative Torque Limits for said axis are not over-written while the test is in progress. This can be satisfied by making sure that (1) these cyclic attributes are not checked as writable within the Drive Parameters tab of the axis properties and (2) these parameters are not being messaged via an MSG instruction.

When configured for closed-loop control, the Dynamic test requires that an accurate system inertia is set in the Studio 5000 Logix Designer application. A default value is automatically populated by the controller.

When configured for closed-loop control, the Dynamic test uses the velocity regulator tuning as entered into the Studio 5000 Logix Designer application. If the motor is coupled to a load, the velocity regulator tuning may need to be adjusted to make sure the velocity response is well controlled. The Dynamic test fails if the steady-state velocity feedback is not within a ±30% tolerance of the commanded velocity.

IMPORTANT The Dynamic test is not supported in closed-loop Torque Control.

If using the Dynamic test in Frequency Control mode, uncouple the motor from any load or results may not be valid. In closed-loop control, either a coupled or uncoupled load produces valid results.

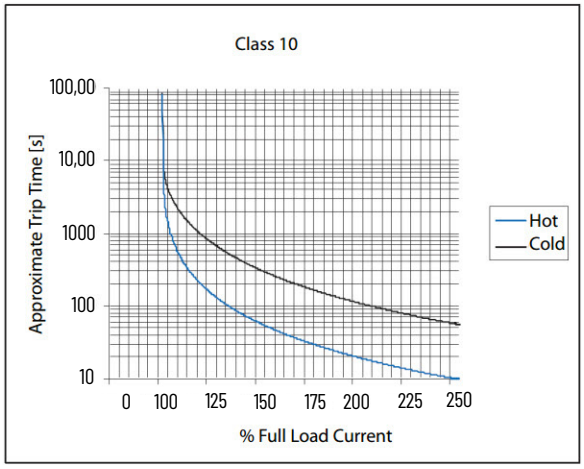
Selection of Motor Thermal Models

The ArmorKinetix modules contain two motor thermal-overload protection algorithms that you can use to prevent the motor from overheating.

Generic Motors

The default thermal model is a generic I^2T Class 10 overload protection algorithm. This model is active if the MotorWindingToAmbientResistance or the MotorWindingToAmbientCapacitance values are 0.0. The purpose of this algorithm is to limit the time a motor is operating with excessive levels of current. The relationship between Motor Overload Factory Limit trip-time and motor output current is shown in Figure 117.

Figure 117 - Motor Overload Curve



You can use the MotorOverloadLimit attribute (default of 100%, max of 200%) to increase the motor overload trip-time by artificially increasing the motor rated current (for thermal protection only). MotorOverloadLimit should only be increased above 100% if cooling options are applied. Increasing MotorOverloadLimit causes MotorCapacity to increase more slowly.

The generic motor thermal model also derates the motor rated current (for thermal protection only) when operating at low speeds. The derating factor is 30% at 0 Hz and 0% at 20 Hz, with linear interpolation between. Operating at output frequencies less than 20 Hz causes MotorCapacity to increase more quickly.

When the generic motor thermal-model is active, the MotorCapacity attribute increases only if the motor output current is greater than the effective motor rated current (taking into account the MotorOverloadLimit and low speed derating factor). The default MotorThermalOverloadFactoryLimit and MotorThermalOverloadUserLimit values for this thermal model are both 100%.

IMPORTANT The generic motor-thermal model does not support Current Foldback as a Motor Overload Action.

Rotary Motor Fan Cooling Attribute Information

For motors that are thermally uncharacterized (for example, many third party motors), the drive utilizes a generic I^2T thermal model for motor thermal protection. When using the generic thermal model, the motor's continuous output capacity at low speeds is de-rated to account for an assumed reduction in cooling ability. Motors equipped with forced ventilation may not require the de-rated overload protection at low speeds. For this application type, messageable attributes have been added to firmware versions 13.5 and later. With these attributes, you can adjust the speed threshold at which derating begins and the amount of derating to be applied at zero speed. See Table 91 for attribute information.

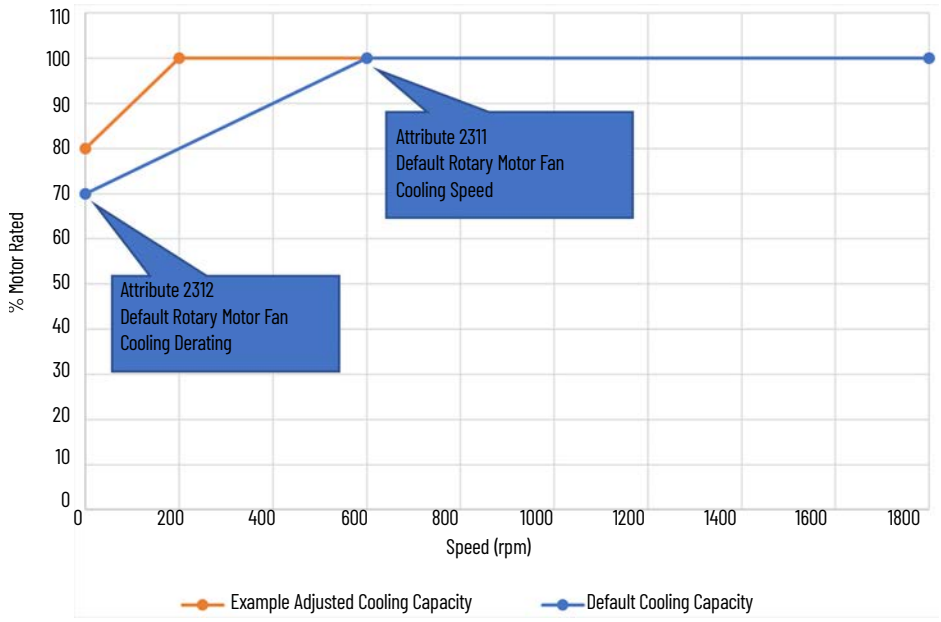
Table 91 - Rotary Motor Fan Cooling Attributes

Attribute ID	Access	Attribute Name	Data Type	Description	Default Value	Units
2311	Set	Rotary Motor Fan Cooling Speed	REAL	Selects the output speed of the motor below which the motor thermal protection method reduces the threshold used to detect an overload condition due to the reduced effectiveness of an integral fan cooling system. A value of zero disables the effect of the attribute. This attribute is only applicable when using the I^2T motor thermal protection method.	600	rpm
2312	Set	Rotary Motor Fan Cooling Derating	REAL	The attribute value indicates the level of the overload detection threshold at zero speed as a percentage of rated continuous motor current. This attribute is only applicable when using the I^2T motor thermal protection method.	70	% Motor Rated

Motor Thermal Overload Plot

Figure 118 shows the default values of the attributes 2311 and 2312 and an example with attributes changed to 200 rpm and 80% respectively.

Figure 118 - Motor Thermal Overload Threshold Versus Motor Speed



Thermally Characterized Motors

If the MotorWindingToAmbientResistance and MotorWindingToAmbientCapacitance attribute values are both non-zero, the motor is considered thermally characterized and an alternate motor thermal model is run. The purpose of this algorithm is to limit the time a motor is operating with excessive levels of current. This thermal model uses the first-order time constant determined from the MotorWindingToAmbientResistance and MotorWindingToAmbientCapacitance values to estimate the motor thermal capacity based on the motor output current.

The MotorOverloadLimit attribute (default of 100%, max of 200%) can be used to increase the motor overload trip-time by increasing the MotorThermalOverloadFactoryLimit value. The MotorOverloadLimit should be increased above 100% only if cooling options are applied. Increasing MotorOverloadLimit does not change the behavior of MotorCapacity.

This thermal model supports setting the MotorOverloadAction attribute as Current Foldback. Selecting the Current Foldback action results in a reduction in the current reference via the MotorThermalCurrentLimit attribute value that is reduced in proportion the percentage difference between the MotorCapacity and the MotorOverloadLimit values.

When this thermal model is active, the MotorCapacity attribute is non-zero if the motor output current is non-zero. The default MotorThermalOverloadFactoryLimit and MotorThermalOverloadUserLimit values for this thermal model are both 110%.

IMPORTANT This thermal model does not derate the motor-rated current when operating at low speeds. Operating at low output frequencies does not cause the MotorCapacity behavior to change.

Speed Limited Adjustable Torque (SLAT)

Speed limited adjustable torque (SLAT) is a special mode of operation used primarily in web handling applications. While configured for SLAT, the drive typically operates as a torque regulator. The drive can automatically enter velocity regulation based on conditions within the velocity regulator and the magnitude of the velocity regulator's output, relative to the applied TorqueTrim attribute.

A torque regulated application can be described as any process requiring tension control. For example, a winder or unwinder with material being drawn or pulled with a specific tension required. The process also requires that another element set the speed.

When operating as a torque regulator, the motor current is adjusted to achieve the desired torque. If the material being wound or unwound breaks, the load decreases dramatically and the motor can potentially go into a runaway condition.

The SLAT feature is used to support applications that require a robust transition from torque regulation to velocity regulation (and vice versa). The SLAT feature can be configured via the SLATConfiguration attribute as:

Table 92 - SLAT Configuration Descriptions

Name	Description
SLAT Disable	SLAT function is disabled. Normal Velocity Loop operation.
SLAT Min Speed/Torque	Drive automatically switches from Torque regulation to Velocity regulation if VelocityError < 0 and switches back to Torque regulation if VelocityError > SLATSetPoint for SLATTimeDelay.
SLAT Max Speed/Torque	Drive automatically switches from Torque regulation to Velocity regulation if VelocityError > 0 and switches back to Torque regulation if VelocityError < SLATSetPoint for SLATTimeDelay.

Direction of the applied torque and direction of the material movement determine whether SLAT minimum or SLAT maximum mode should be used.

Motion Polarity Setting

The Motion Polarity setting in the Studio 5000 Logix Designer application > Axis Properties > Polarity does not affect SLAT behavior, however, you may require clarification on whether to use the SLAT Min Speed/Torque or SLAT Max Speed/Torque configuration when Motion Polarity is set to Inverted. In this case, the velocity error displayed in the Studio 5000 Logix Designer application is inverted compared to what is actually used by the axis to control the SLAT function. So, if the SLAT configuration is set to Min and then Motion Polarity is switched to Inverted, change the SLAT configuration to Max.

Table 93 - SLAT Operation When Motion Polarity Is Inverted

Velocity Command	Motion Polarity	SLAT Configuration
Positive (clockwise)	Normal	Min
	Inverted	Max
Negative (CCW)	Normal	Min
	Inverted	Max

SLAT Min Speed/Torque

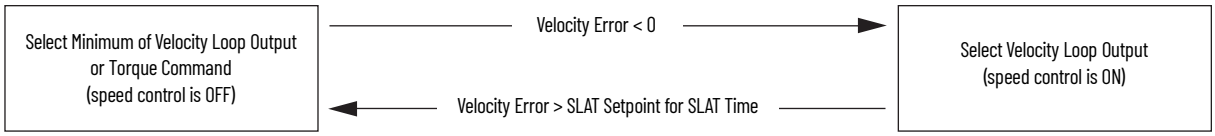
SLAT Min Speed/Torque is a special mode of operation primarily used in web handling applications. The drive typically operates as a torque regulator, provided that the TorqueTrim attribute is less than the torque output due to the velocity regulator's control effort. The drive can automatically enter velocity regulation based on conditions within the velocity regulator and the magnitude of the velocity regulator's output relative to the torque reference.

When used for SLAT control, an application dependent VelocityCommand value is applied to the drive via an MAJ instruction or MDS instruction. An application dependent TorqueTrim value is also applied via cyclic write. Under normal operation, VelocityCommand is set to a level that results in the velocity regulator's control effort becoming saturated when the motor's speed is mechanically limited. The TorqueReference value equals the TorqueTrim value, resulting in a positive VelocityError value.

Should the mechanical speed limitation be removed (example: web break), the motor accelerates and VelocityError becomes negative. At this time, a forced transition to velocity regulation occurs, and the motor's speed is regulated to the VelocityCommand attribute.

The axis remains in velocity regulation until VelocityError exceeds SLATSetPoint for a time specified by SLATTimeDelay. At this point, the axis returns to operating as a torque regulator.

Figure 119 - SLAT Min Speed/Torque



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

SLAT Max Speed/Torque

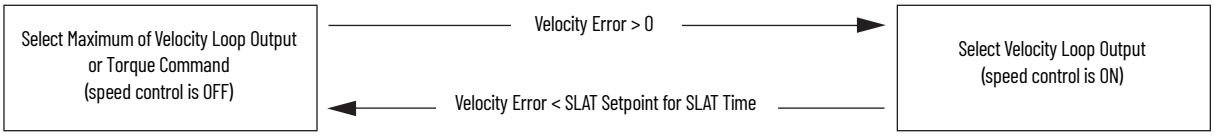
SLAT Max Speed/Torque is a special mode of operation primarily used in web handling applications. The drive typically operates as a torque regulator, provided that the TorqueTrim attribute is greater than the torque output due to the velocity regulator's control effort. The drive can automatically enter velocity regulation based on conditions within the velocity regulator and the magnitude of the velocity regulator's output relative to the torque reference.

When used for SLAT control, an application dependent VelocityCommand value is applied to the drive via an MAJ instruction or MDS instruction. An application dependent TorqueTrim value is also applied via cyclic write. Under normal operation, VelocityCommand is set to a level that results in the velocity regulator's control effort becoming saturated when the motor's speed is mechanically limited. The TorqueReference value equals the TorqueTrim value, resulting in a negative VelocityError value.

Should the mechanical speed limitation be removed (example: web break), the motor accelerates and VelocityError becomes positive. At this time, a forced transition to velocity regulation occurs, and the motor's speed is regulated to the VelocityCommand attribute.

The axis remains in velocity regulation until VelocityError is less than SLATSetPoint for a time specified by SLATTimeDelay. At this point, the axis returns to operating as a torque regulator.

Figure 120 - SLAT Max Speed/Torque



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

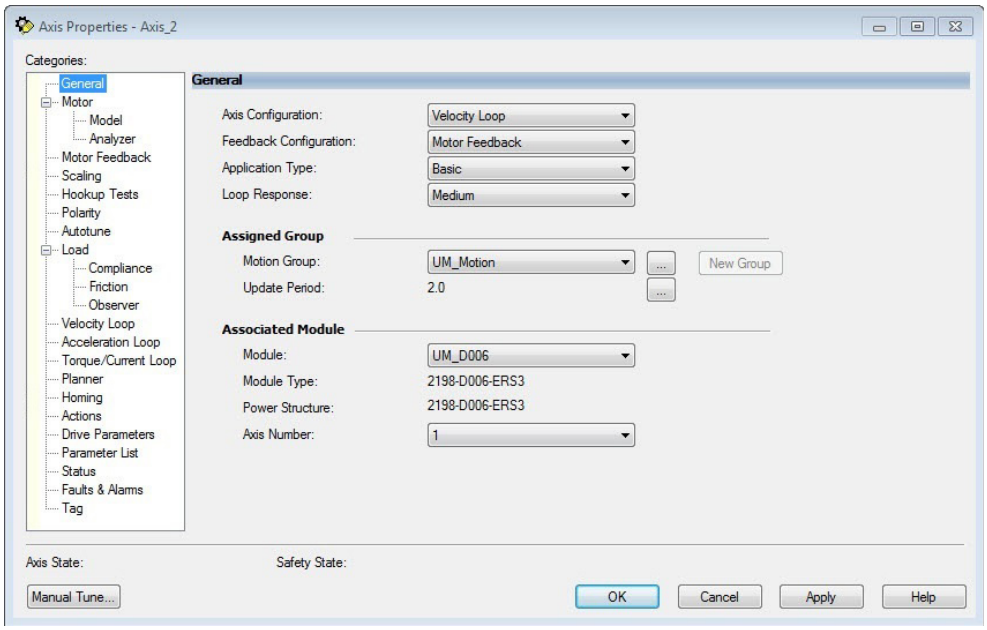
SLAT Attributes

ID	Access	Attribute	Conditional Implementation
833	Set	SLAT Configuration	0 = SLAT Disable 1 = SLAT Min Speed/Torque 2 = SLAT Max Speed/Torque
834	Set	SLAT Set Point	Velocity Units
835	Set	SLAT Time Delay	Seconds

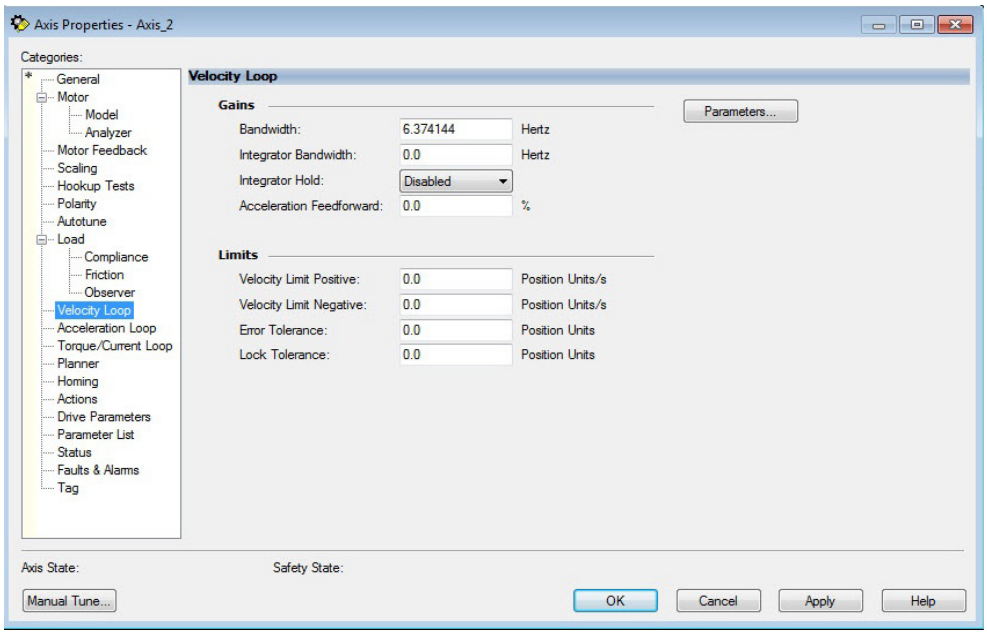
Configure the Axis for SLAT

Follow these steps to configure the SLAT attributes.

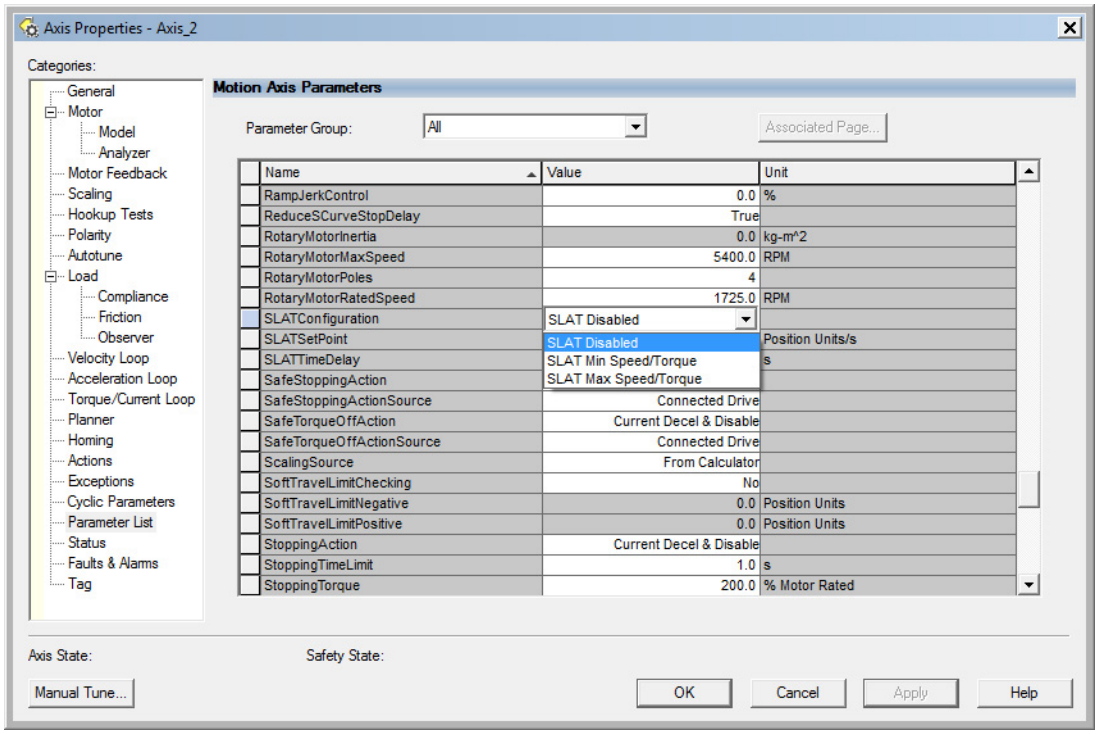
1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the General category.
   The General dialog box appears.



3. From the Axis Configuration dropdown menu, choose Velocity Loop.
   The Velocity Loop dialog box appears.



4. Enter values for the Velocity Loop attributes appropriate for your application.
5. Click Apply.
6. Select the Parameters List category.
   The Motion Axis Parameters dialog box appears.



7. From the SLATConfiguration dropdown menu, choose the SLAT configuration appropriate for your application.

IMPORTANT SLAT parameters are configurable only when Velocity Loop is chosen from the General category, Axis Configuration dropdown menu.

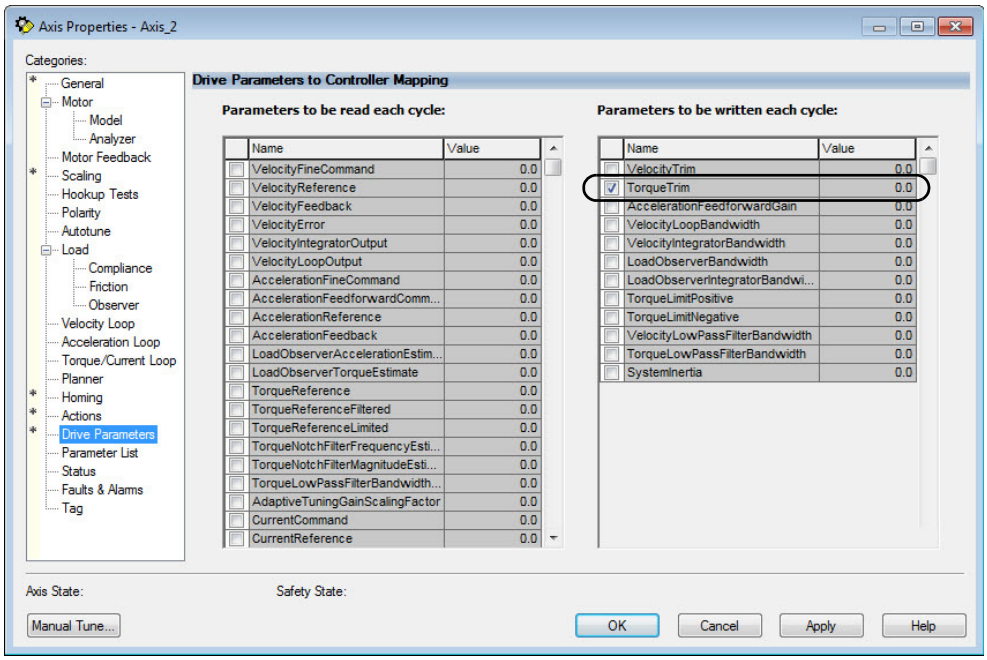
8. Click Apply.

9. Enter values for SLATSetPoint and SLATTimeDelay attributes appropriate for your application.

	SLATConfiguration	SLAT Max Speed/Torque	
	SLATSetPoint	0.0	Position Units/s
	SLATTimeDelay	0.0	s

10. Click OK.
11. Select the Drive Parameters category.

    The Drive Parameters to Controller Mapping dialog box appears.



When using SLAT with ArmorKinetix modules, the velocity command is sent to the drive via an MAJ instruction or MDS instruction. The torque command is sent via the cyclic write TorqueTrim attribute. See the Integrated Motion on the EtherNet/IP Network Reference Manual, publication MOTION-RM003, for more information on cyclic read and cyclic write.

For MAJ instructions:

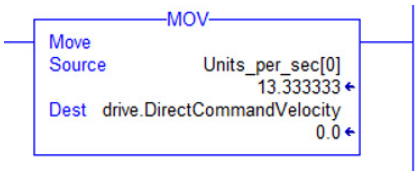
- When using SLAT, start the axis with the MSO instruction.
- The VelocityCommand is sent via the MAJ instruction.
- The TorqueCommand is sent to AxisTag.TorqueTrim.
- To make changes to the VelocityCommand, you must re-trigger the MAJ with the Speed value or use a MCD (motion change dynamics) instruction.
- To stop the axis use a MAS instruction.
- The axis accelerates and decelerates at the MAJ instruction programmed Acceleration and Deceleration rates.
- You can also change the rates using the MCD instruction.

For MDS instruction:

- When using SLAT, start the axis with an MDS instruction.
- The MDS instruction turns on the power structure enable and tracking command status and also executes the velocity command.

  See sample code in Motion Drive Start (MDS) Instruction.
- The acceleration and deceleration rate is controlled by Ramped Acceleration and Ramped Deceleration by using the SSV instruction.
- The Torque Command is set to Axis Tag.Torque Trim. Make sure the Torque Trim Write is checked in the drive parameter (see Drive Parameters dialog box above). The value can be changed.

- Alternatively, you can use the Axis Tag.DirectCommandVelocity to alter the Velocity Command when the existing MDS instruction is being executed.



- To stop the axis, use MAS instructions, keeping the Change Decel to NO and by using an SSV instruction to change Ramped Deceleration for the desired rate.

Motion Drive Start (MDS) Instruction

ArmorKinetix modules provide access to the Motion Drive Start (MDS) instruction. Use the MDS instruction to activate the drive control loops for the specified axis and run the motor at the specified speed.

For information regarding the MDS instruction, refer to the Logix 5000® Controllers Motion Instructions Reference Manual, publication MOTION-RM002.

The MDS instruction is valid only when the axis configuration is set to one of these control modes:

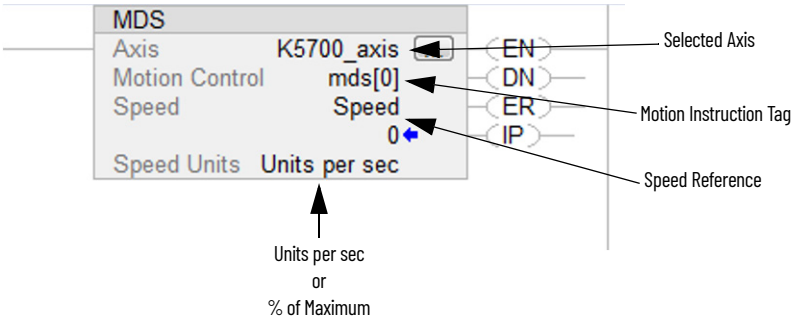
- Frequency Control
- Velocity Loop
- Torque Loop

IMPORTANT The MDS instruction is not valid when the axis configuration is set to Position Loop.

Motion Drive Start Instruction Configuration

The MDS instruction is configured in a similar fashion to most motion instructions, as seen in this example.

Figure 121 - Typical MDS Instruction

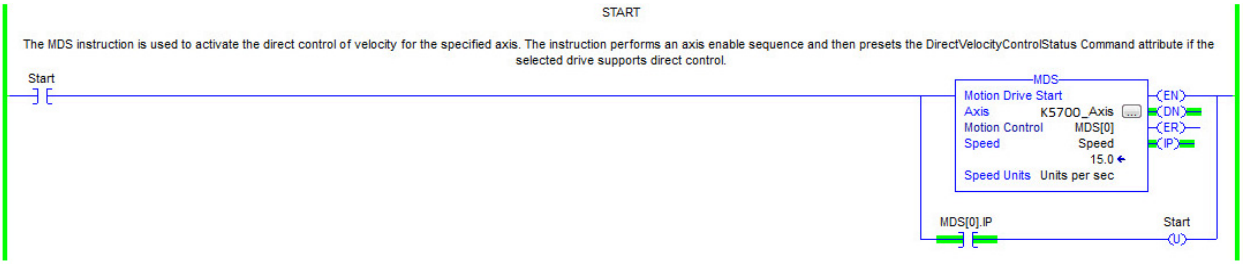


The MDS instruction is similar to a Motion Axis Jog (MAJ) instruction, however, the MDS instruction does not set the acceleration/deceleration rates. The acceleration rate is dynamically set by the ramp attributes configured in a Set System Value (SSV) instruction. See Ramp Attributes on page 227.

The K5700_Axis was configured for revolutions. Therefore, the Speed Units are revolutions per second (rev/s).

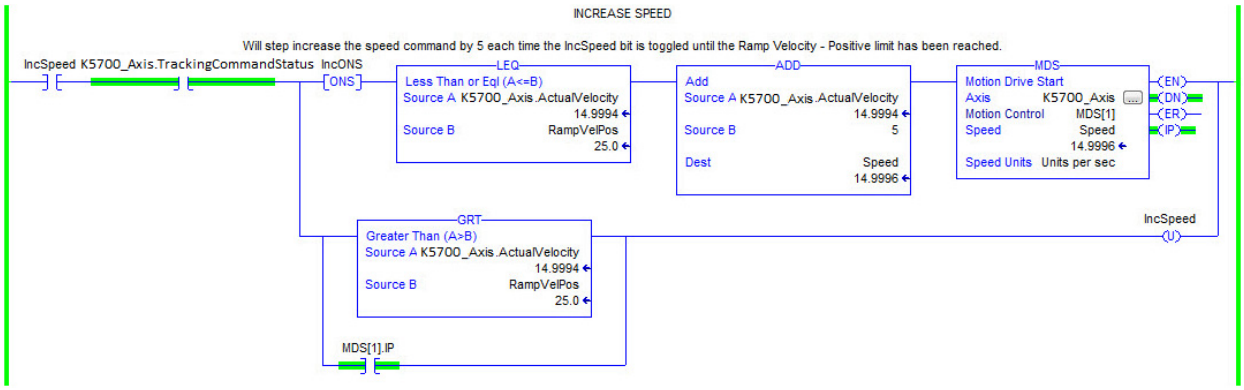
Motion Drive Start (MDS) Sample Code

Figure 122 - Start



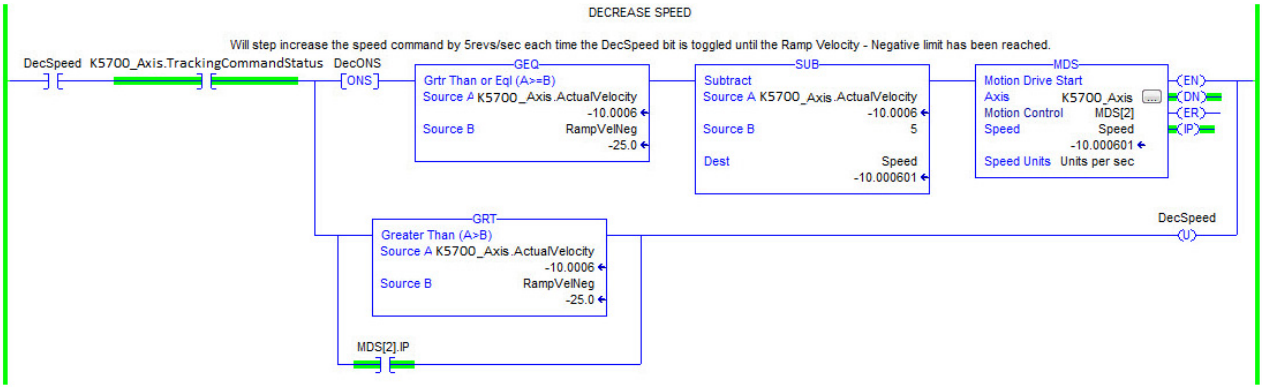
The speed is increased by updating the speed reference and then re-executing the MDS instruction.

Figure 123 - Increase Speed



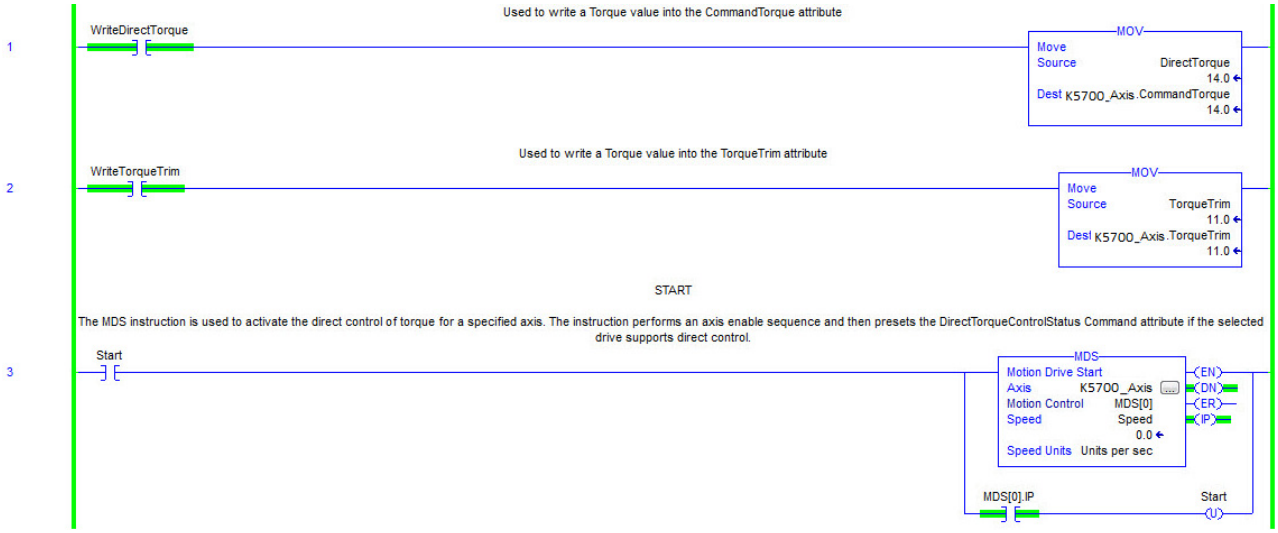
The speed is decreased by updating the speed reference and then re-executing the MDS instruction.

Figure 124 - Decrease Speed



When the axis configuration is in Torque Loop, the Speed attribute within the MDS instruction is not used to command the speed of the drive. The speed is determined by the amount of torque specified in the CommandTorque and/or TorqueTrim attributes.

Figure 125 - Torque Mode



IMPORTANT You must command zero torque in the CommandTorque and TorqueTrim attributes before you can use the Motion Axis Stop (MAS) instruction to stop a specific motion process on an axis or to stop the axis completely. To use the MAS instruction, you must set Change Decel to No. Otherwise, an instruction error can occur. The deceleration rate is set based on the Ramp Deceleration attribute. The Motion Servo Off (MSF) instruction is used to deactivate the drive output for the specified axis and to deactivate the axis' servo loop. If you execute an MSF instruction while the axis is moving, the axis coasts to an uncontrolled stop.

Ramp Attributes

The MDS instruction is validated if the Integrated Motion on EtherNet/IP drive device supports the following five ramp attributes:

- RampAcceleration
- RampDeceleration
- RampVelocity - Positive
- RampVelocity - Negative
- RampJerk - Control

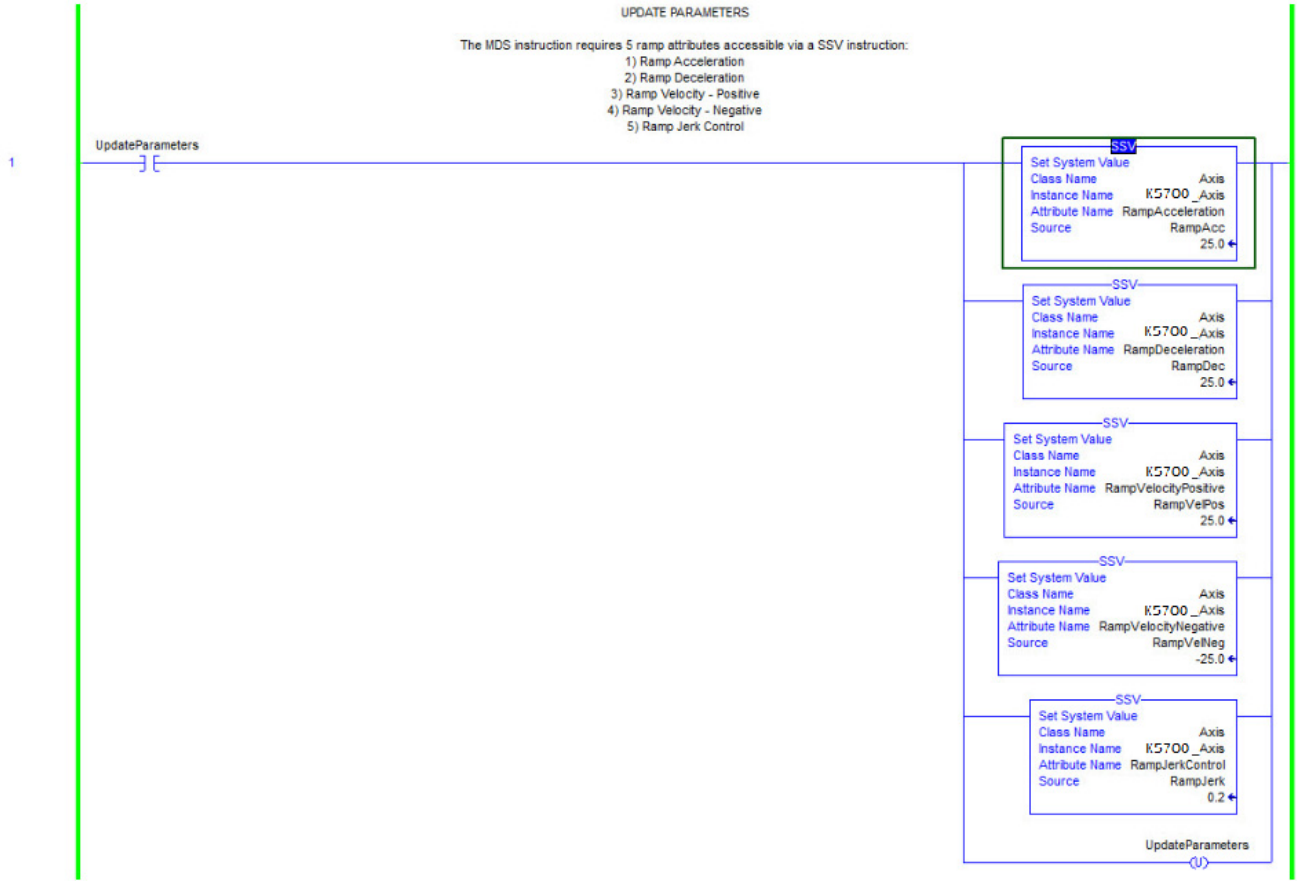
IMPORTANT Ramp attributes are available only when the ArmorKinetix DS*x* axis configuration is set to Frequency Control or Velocity Loop. Ramp attributes are not available when the axis configuration is set to Torque Loop or Position Loop.

Table 94 - Ramp Attributes

Ramp Attribute	Access	ID	Description
RampVelocity - Positive	Set	374	Ramp Velocity - Positive attribute is a positive value that defines the maximum positive velocity command output of the Ramp Generator.
RampVelocity - Negative	Set	375	Ramp Velocity - Negative attribute is a negative value that defines the maximum negative velocity command output of the Ramp Generator.
RampAcceleration	Set	376	The Ramp Acceleration attribute is a positive value that defines the maximum acceleration (increasing speed) of the velocity command output by the Ramp Generator.
RampDeceleration	Set	377	The Ramp Deceleration attribute is a positive value that defines the maximum deceleration (decreasing speed) of the velocity command output by the Ramp Generator.
RampJerk - Control	Set	379	The Ramp Jerk Control attribute sets the percentage of acceleration or deceleration 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.

IMPORTANT The Ramp attributes can be viewed and set with only an SSV or GSV instruction.

Figure 126 - Ramp Attribute Sample Code



Motor Overload Retention

The motor overload retention feature protects the motor in the event of a drive power-cycle, in which the motor thermal state is lost.

With motor overload retention, upon drive power-up the MotorCapacity attribute initially reads:

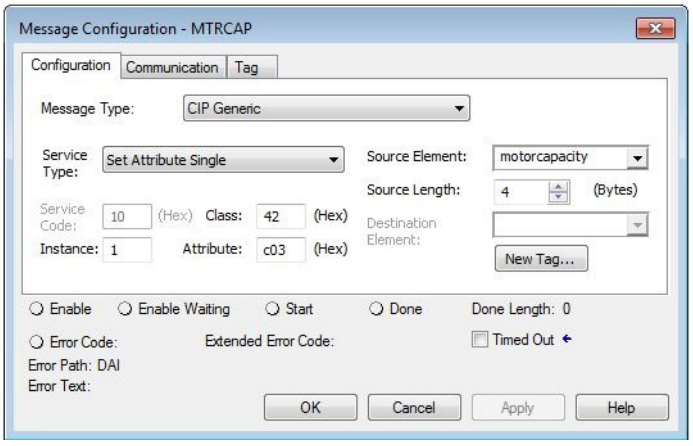
- 20% if the motor is configured to use an integral thermal switch or an integral motor winding temperature is available
- 50% if the motor is not configured to use an integral thermal switch or an integral motor winding temperature is not available

If you have a separate monitoring algorithm within your Logix 5000 controller, you can use the InitialMotorCapacity attribute $(3075)_{10}$ or $(C03)_{16}$ to change the initial MotorCapacity value that the motor overload retention feature populates.

- You can write to the InitialMotorCapacity attribute only in the Stopped state after power-up
- You cannot write to the InitialMotorCapacity attribute after the first time the axis is enabled following a power cycle.

Use a message instruction to write to the InitialMotorCapacity value.

In this example, the source element tag motorcapacity is a REAL Data type.



Phase Loss Detection

The phase-loss detection feature is designed to determine if motor power wiring is electrically connected to a motor and that reasonable current control exists. This attribute enables the operation of the drive's torque proving functions that work in conjunction with mechanical brake control.

When the ProvingConfiguration attribute is 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. If the torque prove test fails, the motor brake stays engaged and a FLT-S09 Motor Phase Loss exception (fault) is generated.

IMPORTANT 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.

Table 95 - Phase-loss Detection Startup Sequence

Startup Phase	Description
Phase 1	When the drive receives an enable request, the Starting state begins execution and torque proving starts.
Phase 2	The torque proving feature ramps current to the motor-phase output connector and verifies that the current feedback circuitry detects current on each of the phases.
Phase 3	Once motor-current feedback has been verified in each motor phase, the drive attempts to enable the current control loop at a user-specified current level, and verifies that the current-loop error tolerance is within range.

Torque proving is available for all motoring configurations including closed-loop servo control and induction motors.

For permanent magnet (PM) motors, the drive attempts to apply current to the motor phases such that all current through the motor is flux current. However, due to the electrical angle of the motor at the time of the MSO instruction, it may not be possible to verify the motor phase wiring with only flux current. Therefore, with a PM motor it is possible that the motor shaft can move slightly during torque proving if no motor brake exists to hold the load.

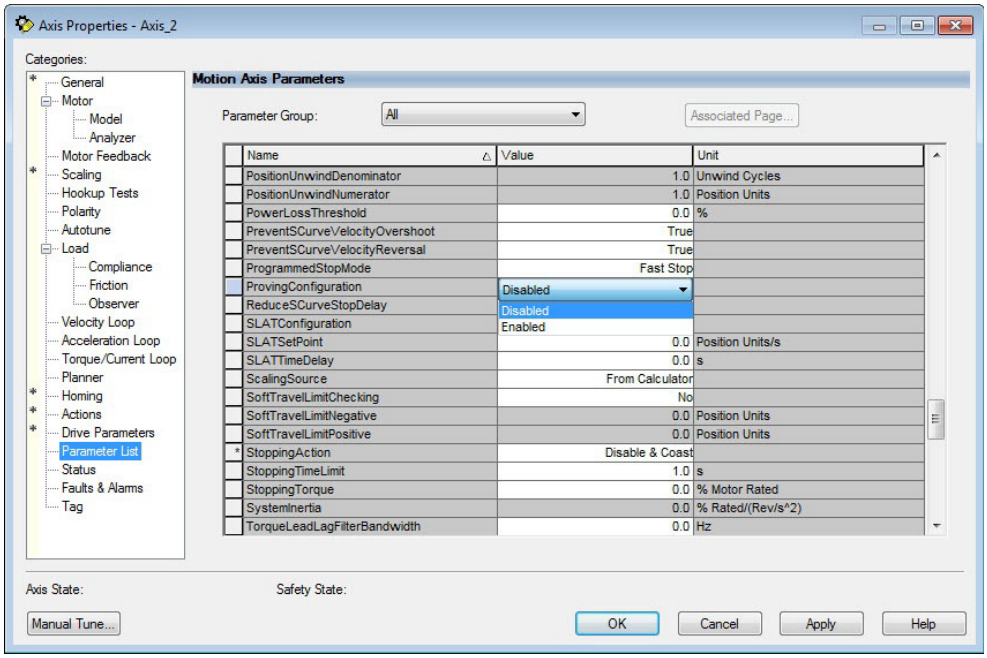
Phase-loss Detection Attributes

ID	Access	Attribute	Conditional Implementation
590	SSV	ProvingConfiguration	0 = Disabled 1 = Enabled
591	SSV	TorqueProveCurrent	% Motor Rated Units: Amps Default: 0.000 Min/Max: 0/10,000

Phase-loss Detection Configuration

Follow these steps to configure the phase-loss detection attributes.

1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the Parameter List category and scroll to ProvingConfiguration.



3. From the ProvingConfiguration dropdown menu, choose Enabled to enable the torque proving feature.

	TorqueOffset	0.0	% Motor Rated
	TorqueProveCurrent	0.0	% Motor Rated
	TorqueRateLimit	1000000.0	% Motor Rated/s

4. Enter a value in the TorqueProveCurrent attribute appropriate for your application.
5. Click OK.

The TorqueProveCurrent attribute is active only if ProvingConfiguration is set to Enabled. TorqueProveCurrent lets you specify the amount of current that is used during the torque proving test and calculated as a percentage of motor rating. The higher the TorqueProveCurrent value the more current the drive delivers to the motor to verify that the motor phase wiring is available and capable of that current level. High current levels conversely cause more thermal stress and (potentially) can cause more torque to be driven against the motor brake during the test. If the TorqueProveCurrent level selected is too small, the drive cannot distinguish the proving current from noise, and in this case the drive posts an INHIBIT M04 torque-proving configuration fault code. The minimum amount of torque proving current depends on catalog number of the drive.

Phase Loss Detection Current Example

In this example, a 2198-D032-ERS3 dual-axis inverter is paired with a VPL-B1003T-C motor with 9.58 A rms rated current. Use the phase-loss detection equation and table to calculate the initial minimum torque-proving current as a percentage of motor rated current. Depending on the unique characteristics of your application, the required torque-proving current value can be larger than the initial recommended value.

Figure 127 - Phase-loss Detection Equation

$$\left(\frac{\textit{Rating From Table}}{\textit{Motor Rated Current}}\right) = \frac{0.9337\ \text{A}}{9.58\ \text{A}} = 9.75\%\ \text{motor rated current.}$$

Table 96 - Recommended Phase-loss Detection Current

Drive Cat. No.	**Phase-loss Detection Current, min** A, rms
2198-S086-ERS*x*	7.183
2198-S130-ERS*x*	9.337
2198-S160-ERS*x*	12.21
2198-S263-ERS*x*	21.492
2198-S312-ERS*x*	27.436
2198-D006-ERS*x*	0.1796
2198-D012-ERS*x*	0.3591
2198-D020-ERS*x*	0.5746
2198-D032-ERS*x*	0.9337
2198-D057-ERS*x*	1.6520

Velocity Droop

The velocity droop function can be useful when some level of compliance is required due to rigid mechanical coupling between two motors. The feature is supported when the axis is configured for Frequency Control, Velocity Control, or Position Control.

Closed Loop Control

The closed-loop velocity droop function is supported when configured for either Velocity or Position control. The velocity error input to the integral term is reduced by a fraction of the velocity regulator's output, as controlled by the VelocityDroop attribute. Therefore, 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.

IMPORTANT The closed-loop velocity droop function acts to reduce the velocity error input to the integral term, but never changes the polarity of the velocity error.

IMPORTANT When configured for closed-loop control, the units of the VelocityDroop attribute are Velocity Control Units / Sec / % Rated Torque.

Frequency Control

The velocity droop function is also supported when configured for Frequency Control. As the estimated Iq current within the motor increases, the velocity reference is reduced in proportion to the VelocityDroop attribute. Therefore, 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.

IMPORTANT The frequency-control velocity droop function acts to reduce the velocity reference, but never changes the direction of the velocity reference.

IMPORTANT When configured for frequency control, the units of the VelocityDroop attribute are Velocity Control Units / Sec / % Rated Iq Current.

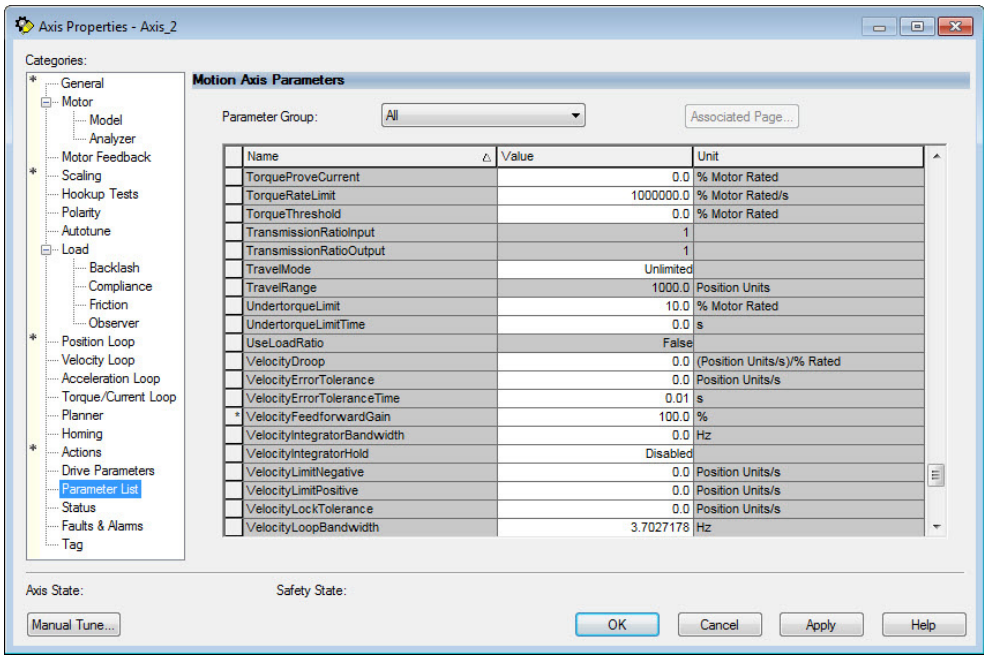
Table 97 - Velocity Droop Attribute

ID	Access	Attribute	Conditional Implementation
464/321	SSV	Velocity Droop	Velocity Units / Sec / % Rated

Velocity Droop Configuration

Follow these steps to configure the velocity droop attribute.

1. In the Controller Organizer, right-click an axis and choose Properties.
2. Select the Parameter List category and scroll to VelocityDroop.



3. Enter a value in the Velocity Droop attribute appropriate for your application.
4. Click OK.

Commutation Self-sensing Startup

The commutation self-sensing feature is used to determine the initial electrical angle for permanent magnet (PM) motors with an incremental encoder that do not have Hall effect sensors. For PM motors that use encoders with Hall sensors, the drive can still be configured to use this feature, however, the Hall effect signals are ignored. When enabled, this feature is executed automatically at powerup and when the system is enabled.

IMPORTANT Following a connection loss to the controller after the initial power-up, the commutation self-sense feature is run again when connection is re-established and motion is commanded.

The self-sense feature takes approximately 5 seconds to execute. Five seconds is the default amount time assuming no retries are required. The axis stays in the Starting state while self-sense executes.

The sequencing of events is as follows.

1. One-second current ramp time
2. One second delay
3. One-second move time
4. One second delay
5. One-second current ramp time

IMPORTANT Self-sensing startup is not commutation diagnostics. You can perform commutation diagnostics on Hall effect or self-sensing motors at any time.

To use the self-sense feature, select the Motor Feedback category and from the Commutation Alignment dropdown menu, choose Self-Sense.

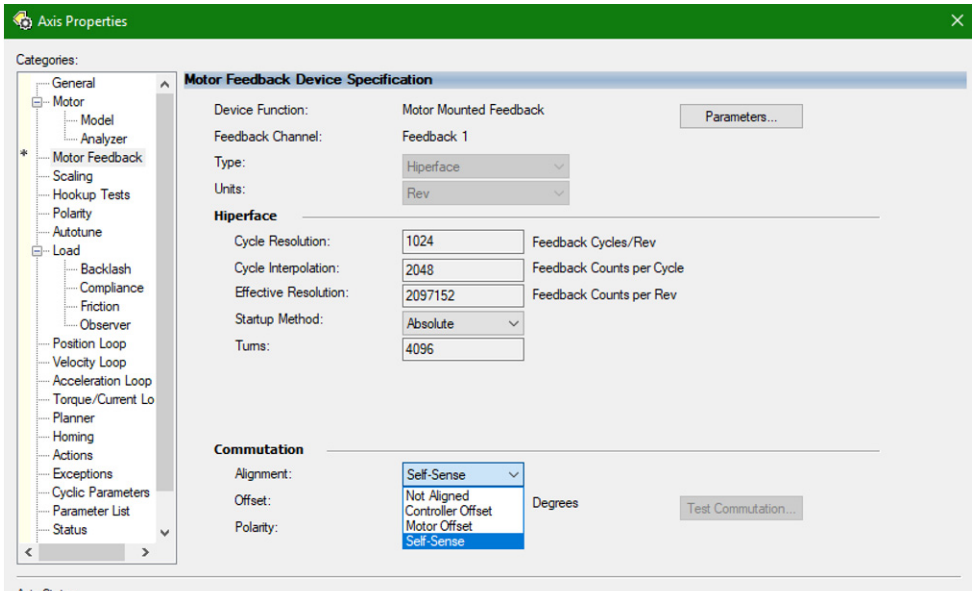


Table 98 - Self-sense Feature Attributes

CIP™ Attribute Number	CIP Attribute Name	Data Type	Description	Semantics of Values
562	Commutation Self-Sensing Current	REAL	The percent of the motors rated peak current to use for self-sensing startup. This value can be adjusted when the motor is moving a high inertia load.	% Motor Rated Peak Current [default = 100]
3102	Self-Sense Direction	USINT	• Forward – indicates the motor moves in only the positive direction during self-sensing startup. • Negative – indicates the motor moves in only the negative direction during self-sensing startup.	0 = Forward - CW (rotary) or Positive (linear) [default] 1 = Reverse - CCW (rotary) or Negative (linear)
3103	Self-Sense Lock Time	REAL	The amount of time the drive uses to build up current to the Self-Sensing Current level specified above.	Seconds [default = 1.0]
3104	Self-Sense Lock Delay	REAL	The amount of time the motor must be in the locked position after reaching the full Self-Sensing Current.	Seconds [default = 1.0]
3105	Self-Sense Move Time	REAL	The amount of time the drive uses for the verification move during self-sensing startup. Applies only to motors with self-sensing startup.	Seconds [default = 1.0]
3106	Self-Sense Move Delay	REAL	The amount of time the drive holds the final position after the verification move during self-sensing startup.	Seconds [default = 1.0]

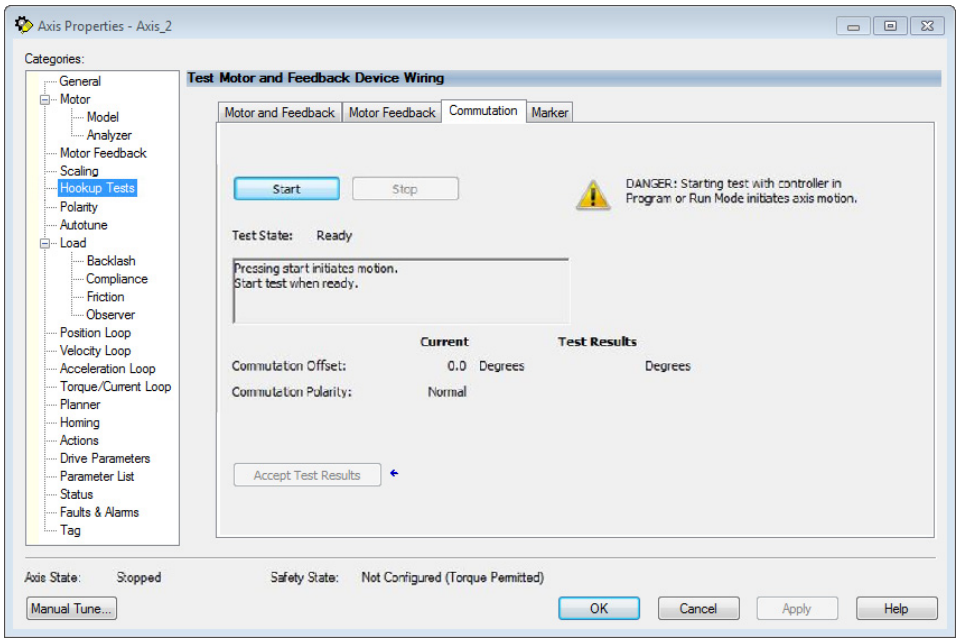
Commutation Test

The commutation test determines an unknown commutation offset and can also be used to determine the unknown polarity of the start-up commutation wiring. You can also use the commutation test to verify a known commutation offset and the polarity start-up commutation wiring.

IMPORTANT This test applies to third-party or custom permanent-magnet motors equipped with (TTL with Hall and Sine/Cosine with Hall) incremental encoders that are not available as a catalog number in the Motion Database.

IMPORTANT When motors have an unknown commutation offset and are not listed in the Motion Database by catalog number, you cannot enable the axis, unless you enable the communication self-sensing feature.

Figure 128 - Hookup Tests - Commutation Tab



To run the commutation test, see Test the Axes on page 133.

Adaptive Tuning

The adaptive tuning feature is an algorithm inside the ArmorKinetix DSx modules. The algorithm continuously monitors and, if necessary, adjusts or adapts various filter parameters and, in some cases, control-loop gains to compensate for unknown and changing load conditions while the drive is running. Its primary function is to:

- Automatically adjust torque-loop notch and low-pass filter parameters to suppress resonances
- Automatically adjust control-loop gains to avoid instability when detected

See Motion System Tuning Application Techniques, publication MOTION-AT005, for more information on the AdaptiveTuningConfiguration attribute.

Virtual Torque Sensor

The virtual torque sensor feature provides an estimate of the motor torque without having a physical torque sensor. The virtual torque sensor can be leveraged to improve the commissioning and maintenance experience with mechanical systems and to optimize production quality. Some examples of how the feature can be applied include the following:

- Indication of shaft misalignment during commissioning
- Verification of appropriate mechanical belt tensioning during maintenance
- Detection of a material jam during operation

The feature provides an estimate of the motor air-gap torque under dynamic and steady state operating conditions. The air-gap torque is the torque that includes the load torque, motor torque losses, and rotor acceleration torque. The estimated torque does not affect motion control or drive performance.

The virtual torque sensor is available with the following hardware and software:

- Studio 5000 Logix Designer® version 35 and later
- ArmorKinetix DS*x* modules with firmware revision 14.000 or later

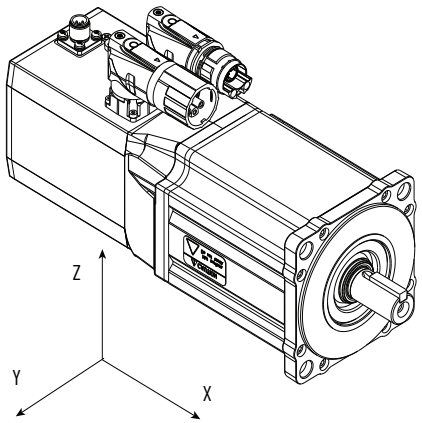
For more information on how to apply the virtual torque sensor feature, see Virtual Torque Sensor Application Technique, publication 2198-AT003.

Accelerometer Support

The ArmorKinetix DS*x* modules include a built-in 3-axis accelerometer and can provide real-time vibration data. The X/Y/Z raw and RMS accelerometer feedback data are accessible in the Studio 5000 Logix Designer application via cyclic read attributes. For more information, see Knowledgebase Technote *ArmorKinetix DSD/DSM Frequently Asked Questions*.

	Name	Value
☑	AccelerometerFeedbackDeviceX	0.0
☑	AccelerometerFeedbackDeviceY	0.0936
☑	AccelerometerFeedbackDeviceZ	0.9984
☑	AccelerometerFeedbackDeviceXRMS	0.015833221
☑	AccelerometerFeedbackDeviceYRMS	0.07101931
☑	AccelerometerFeedbackDeviceZRMS	1.0407315

- X - Direction: Axial direction
- Y – Direction: Rotational direction
- Z - Direction: Radial direction



Slip-ring Support

A slip-ring is an electromechanical device that allows the transmission of power and electrical signals from a stationary to a rotating structure. You can use a slip-ring in any electromechanical system that requires rotation while transmitting power, control circuits, or digital signals including data. For more information, see Knowledgebase Technote *ArmorKinetix DSD/DSM Frequently Asked Questions*.

There are two variants of the slip-ring, 24 and 48 axes. For 24 axes, one PIM module is required and for 48 axes, two PIM modules are required. Each variant has two options for how the slip-ring is mounted, see Table 100 and Table 101 for option specifications. The slip-ring is connected between DSx modules. See Figure 129, Figure 130, Figure 131, and Figure 132.

Table 99 - Slip-ring Specifications

Slip-ring Connector	Description/Specification
Hybrid (Brush/Ring Side)	Power Signal (3 wires). 800V, 75 A
	1 Gigabit Ethernet Signal Wires (8 wires), 1 A
Ethernet (Brush/Ring Side)	1 Gigabit Ethernet Signal Wires (8 wires), 1 A
Aux (Brush/Ring Side)	See vendor specification

24 Axes Support

IMPORTANT Depending on your slip-ring connections (whether the brush side or the ring side is connected to the DSx module), there are two options for the connector type on the slip-ring module. The slip-ring module mounts vertically with the rotational side on the top and the stationary side on the bottom.

Table 100 - Slip-ring Module Options

Slip-ring Connector	Slip-ring Connector - 24 Axes (Option 1)	Slip-ring Connector -24 Axes (Option 2)
Hybrid (brush side)	Plug	Socket
Ethernet (brush side)	Socket	Plug
Aux (brush side)	–	–
Hybrid (ring side)	Socket	Plug
Ethernet (ring side)	Plug	Socket
Aux (ring side)	–	–

24 Axes Support - Option 1

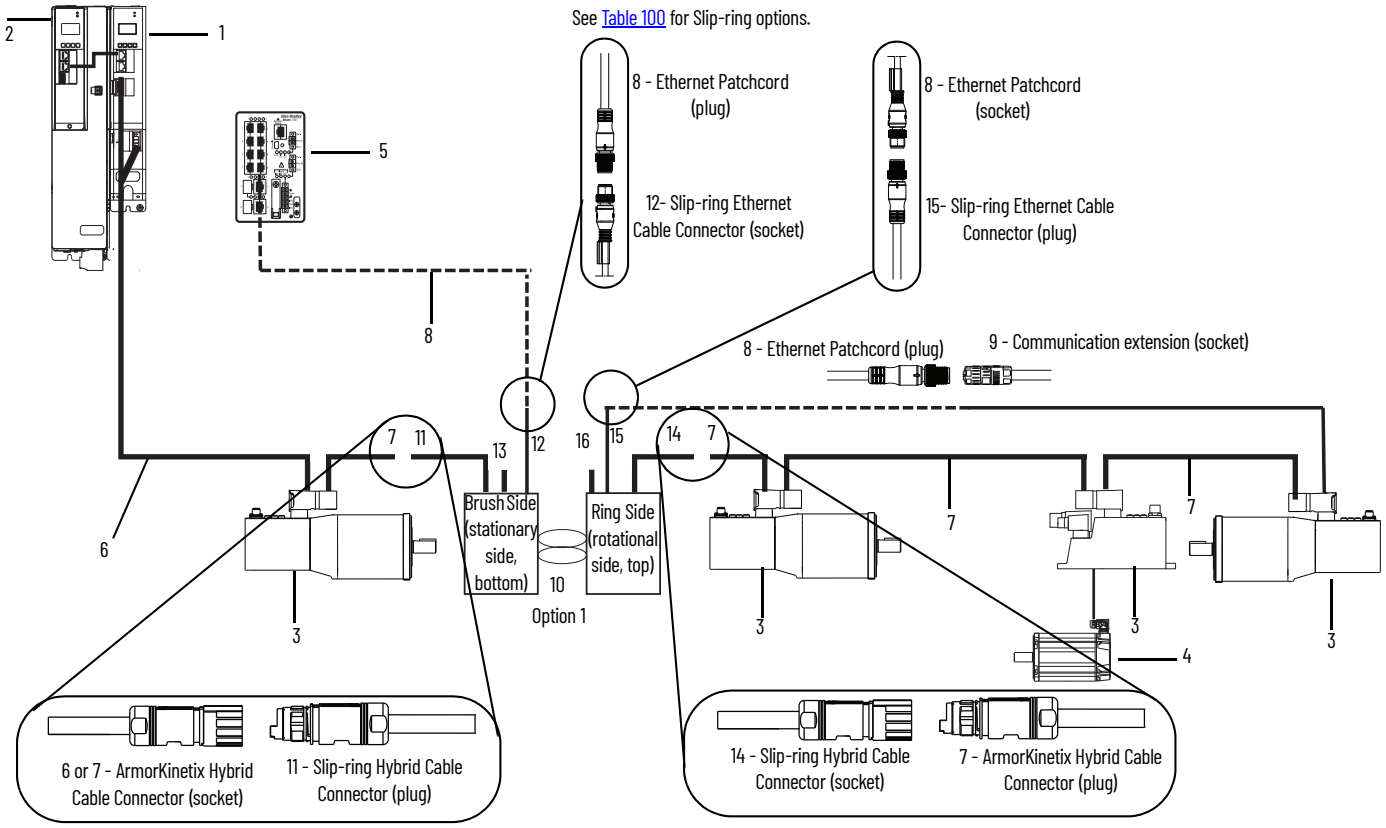
For 24 axes support, option 1, the brush side is stationary.

1. Connect the PIM module (1) to the DSx module (3) by using the ArmorKinetix PIM to DSx hybrid cable (6).
2. Connect the DSx module (3) to the slip-ring (10) hybrid connector (11) by using the ArmorKinetix DSx to DSx hybrid cable (7).

IMPORTANT The hybrid cable (7) connector that connects to the slip-ring stationary side is always the socket side of the cable. Therefore, the slip-ring side connecting to the DSx module must have a plug connector.

3. If DLR topology is required, connect an Ethernet cable (8) to the Ethernet connector (12) on the brush side of the slip-ring to an Ethernet switch (5).
4. Connect the other side of the slip-ring (14) to a DSx module by using a ArmorKinetix hybrid cable (7).
5. If DLR topology is required, connect the Ethernet connector (15) on the ring side of the slip-ring to an Ethernet patchcord (8) to connect the communication extension jumper cable (9).
6. Connect the communication extension cable to the last DSx module.

Figure 129 - One PIM Module with Slip-ring (24 axes support)



Item	Description	Item	Description
1	ArmorKinetix PIM modules	9	Communication extension jumper cable (2090-CDET)
2	Kinetix® 5700 power supply	10	Slip-ring module
3	ArmorKinetix DSD or DSM module	11	Slip-ring hybrid cable connector (plug connector) brush side
4	Kinetix VPL motor	12	Ethernet connection (brush side)
5	Ethernet switch	13	Aux connection (brush side)
6	ArmorKinetix PIM to DSx hybrid cable (2090-CDHIFS-12AF*xxxx*)	14	Slip-ring hybrid cable connector (socket connector) ring side
7	ArmorKinetix DSx to DSx hybrid cable (2090-CDHP1S-12AF*xxxx*)	15	Ethernet connection (ring side)
8	Ethernet patchcord, 1 Gigabit with hybrid connector to connect to communication extension 85 m (278 ft) max. (1585D-M8UGDM, 1585D-M8TGDE, or 1585D-E8TGDE)	16	Aux connection (ring side)

24 Axes Support - Option 2

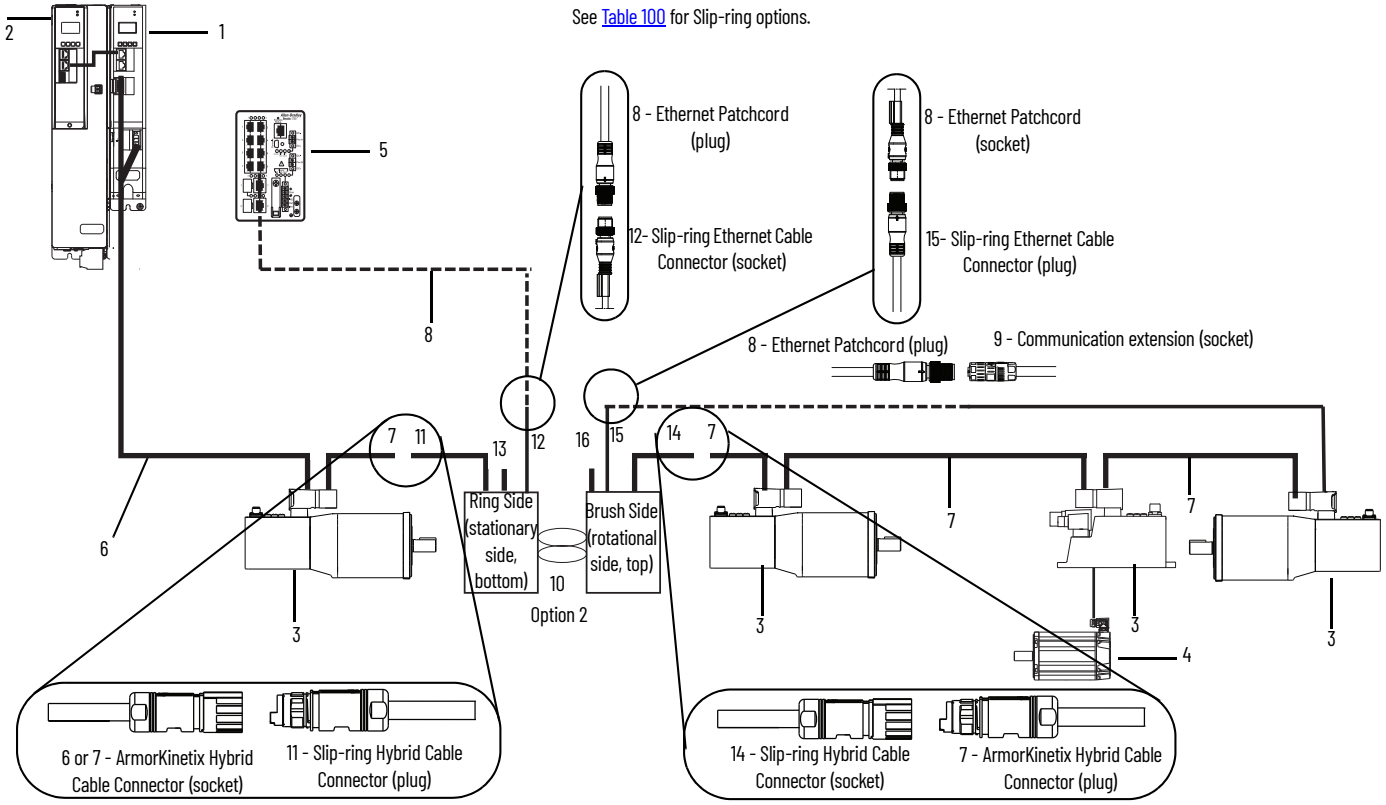
For 24 axes support, option 2, the ring side is stationary.

1. Connect the PIM module (1) to the DSx module (3) by using the ArmorKinetix PIM to DS*x* hybrid cable (6).
2. Connect the DS*x* module (3) to the slip-ring (10) hybrid connector (11) by using the ArmorKinetix DS*x* to DS*x* hybrid cable (7).

IMPORTANT The hybrid cable (7) connector that connects to the slip-ring stationary side is always the socket side of the cable. Therefore, the slip-ring side connecting to the DS*x* module must have a plug connector.

3. If DLR topology is required, connect an Ethernet cable (8) to the Ethernet connector (12) on the ring side of the slip-ring to an Ethernet switch (5).
4. Connect the other side of the slip-ring (14) to a DS*x* module by using a ArmorKinetix hybrid cable (7).
5. If DLR topology is required, connect the Ethernet connector (15) on the brush side of the slip-ring to an Ethernet patchcord (8) to connect the communication extension jumper cable (9).
6. Connect the communication extension cable to the last DS*x* module.

Figure 130 - One PIM Module with Slip-ring (24 axes support)



Item	Description	Item	Description
1	ArmorKinetix PIM modules	9	Communication extension jumper cable (2090-CDET)
2	Kinetix 5700 power supply	10	Slip-ring module
3	ArmorKinetix DSD or DSM module	11	Slip-ring hybrid connector (plug connector) ring side
4	Kinetix VPL motor	12	Ethernet connection (ring side)
5	Ethernet switch	13	Aux connection (ring side)
6	ArmorKinetix PIM to DS*x* hybrid cable (2090-CDHIFS-12AF*xxxx*)	14	Slip-ring hybrid connector (socket connector) brush side
7	ArmorKinetix DS*x* to DS*x* hybrid cable (2090-CDHP1S-12AF*xxxx*)	15	Ethernet connection (brush side)
8	Ethernet patchcord, 1 Gigabit with hybrid connector to connect to communication extension 85 m (278 ft) max. (1585D-M8UGDM, 1585D-M8TGDE, or 1585D-E8TGDE)	16	Aux connection (brush side)

48 Axes Support

IMPORTANT Depending on your slip-ring connections (whether the brush side or the ring side is connected to the DS*x* module), there are two options for the connector type on the slip-ring module. The slip-ring module mounts vertically with the rotational side on the top and the stationary side on the bottom.

Table 101 - Slip-ring Module Options

Slip-ring Connector	Slip-ring Connector - 48 Axes (Option 1)	Slip-ring Connector - 48 Axes (Option 2)
Hybrid B1 (brush side)	Plug	Socket
Hybrid B2 (brush side)	Plug	Socket
Aux B1 (brush side)	–	–
Hybrid R1 (ring side)	Socket	Plug
Hybrid R2 (ring side)	Socket	Plug
Aux B1 (ring side)	–	–

48 Axes Support - Option 1

For 48 axes support, option 1, the brush side is stationary.

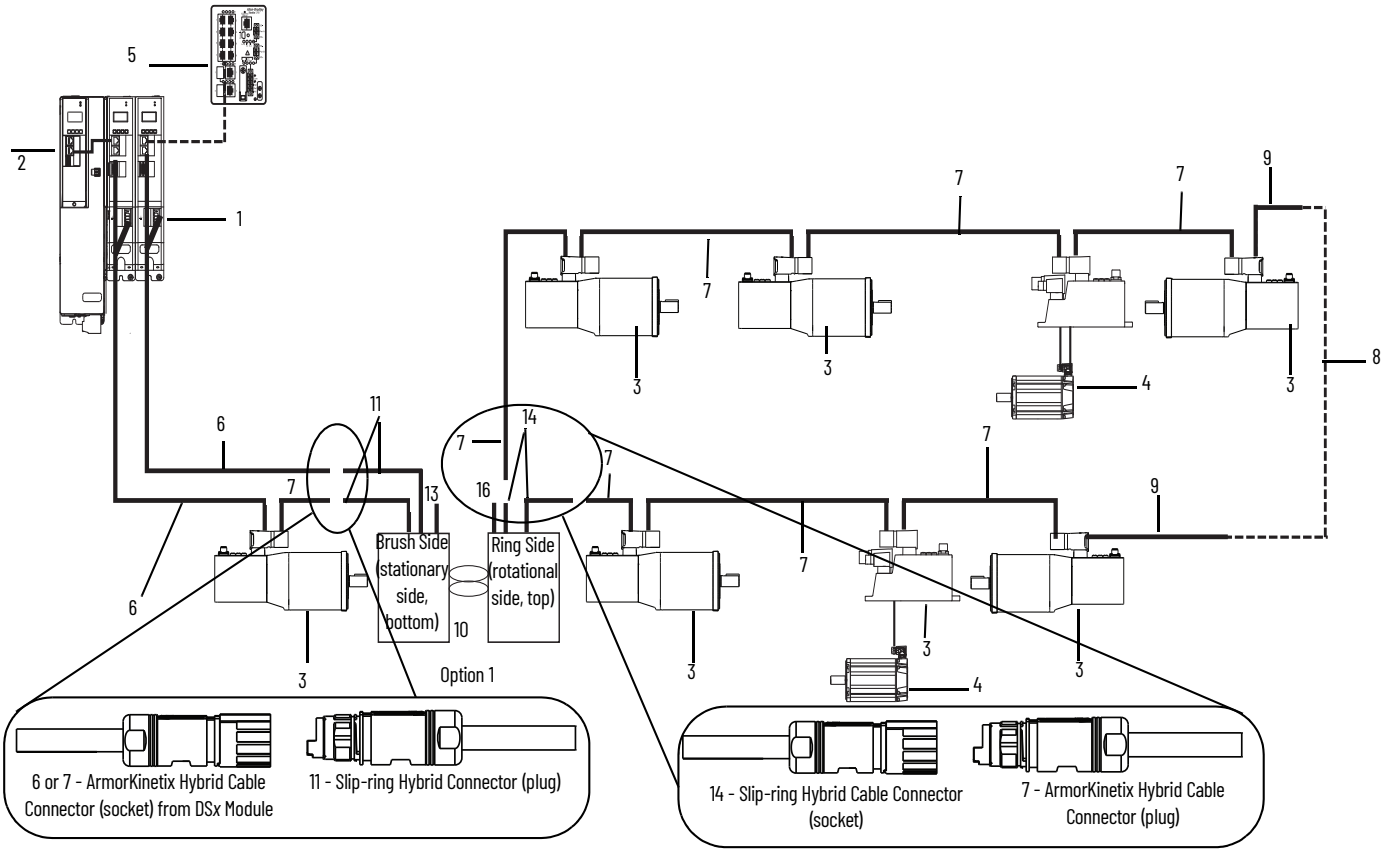
1. Connect the PIM module (1) to the DS*x* module (3) by using the ArmorKinetix PIM to DS*x* hybrid cable (6).
2. Connect the DS*x* module (3) to the slip-ring (10) hybrid connector (11) by using the ArmorKinetix DS*x* to DS*x* hybrid cable (7).

IMPORTANT The hybrid cable (7) connector that connects to the slip-ring stationary side is always the socket side of the cable. Therefore, the slip-ring side connecting to the DS*x* module must have a plug connector.

3. Connect the other side of the slip-ring (14) to a DS*x* module by using a ArmorKinetix hybrid cable (7).
4. If DLR topology is required, use the communication extension cable (9) and an Ethernet patchcord (8) to connect to the last DS*x* module.

Figure 131 - Two PIM Modules with Slip-ring (48 axes support)

See Table 101 for Slip-ring options.



Item	Description	Item	Description
1	ArmorKinetix PIM modules	8	Ethernet patchcord, 1 Gigabit with hybrid connector to connect to communication extension 85 m (278 ft) max. (1585D-M8UGDM, 1585D-M8TGDE, or 1585D-E8TGDE)
2	Kinetix 5700 power supply	9	Communication extension jumper cable (2090-CDET)
3	ArmorKinetix DSD or DSM module	10	Slip-ring module
4	Kinetix VPL motor	11	Slip-ring hybrid connector (plug connector) brush side
5	Ethernet switch	13	Aux connection (brush side)
6	ArmorKinetix PIM to DSx hybrid cable (2090-CDHIFS-12AF*xxxx*)	14	Slip-ring hybrid connector (socket connector) ring side
7	ArmorKinetix DSx to DSx hybrid cable (2090-CDHP1S-12AF*xxxx*)	16	Aux connection (ring side)

48 Axes Support - Option 2

For 48 axes support, option 2, the ring side is stationary.

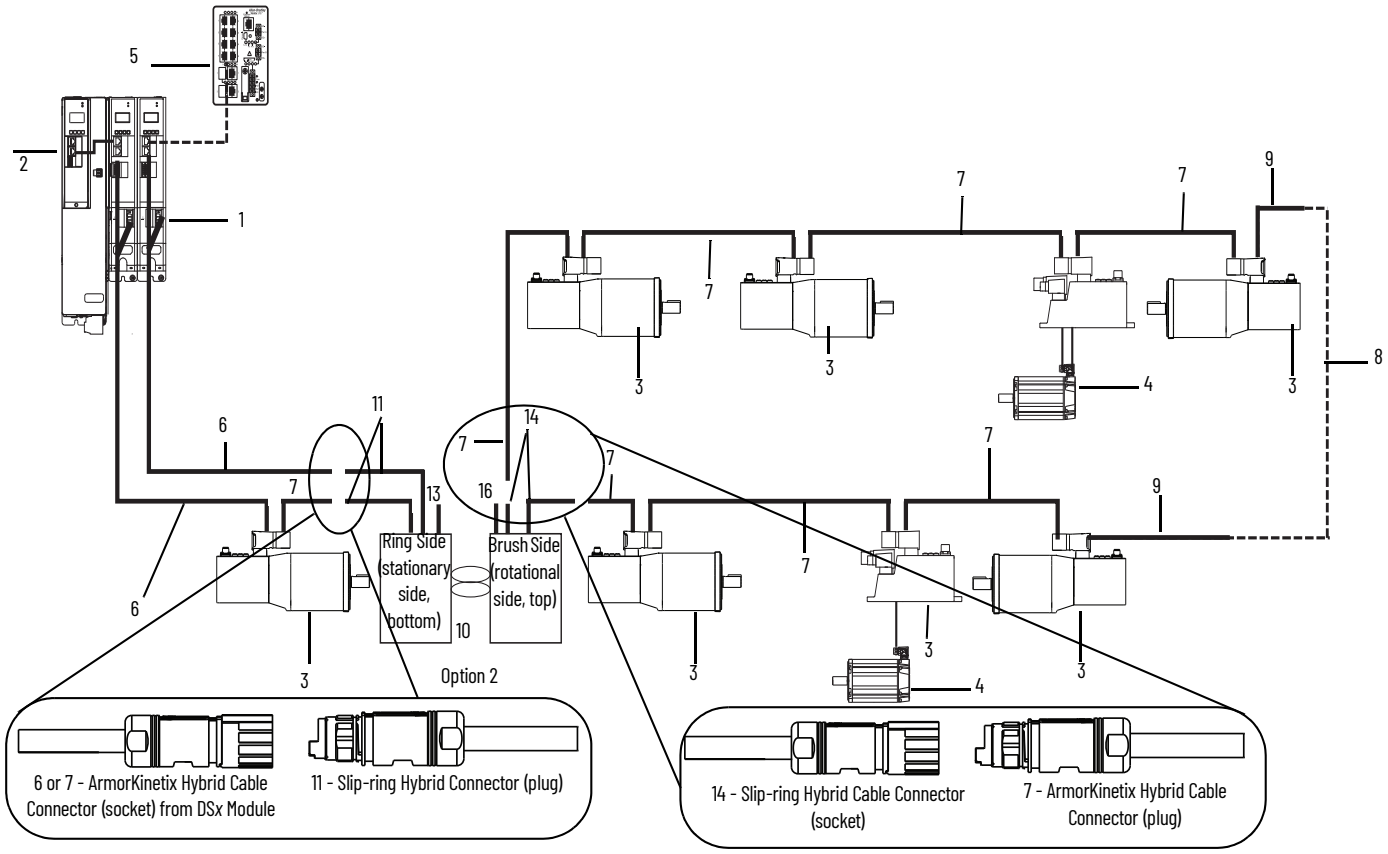
1. Connect the PIM module (1) to the DSx module (3) by using the ArmorKinetix PIM to DS*x* hybrid cable (6).
2. Connect the DS*x* module (3) to the slip-ring (10) hybrid connector (11) by using the ArmorKinetix DS*x* to DS*x* hybrid cable (7).

IMPORTANT The hybrid cable (7) connector that connects to the slip-ring stationary side is always the socket side of the cable. Therefore, the slip-ring side connecting to the DS*x* module must have a plug connector.

3. Connect the other side of the slip-ring (14) to a DS*x* module by using a ArmorKinetix hybrid cable (7).
4. If DLR topology is required, use the communication extension cable (9) and an Ethernet patchcord (8) to connect to the last DS*x* module.

Figure 132 - Two PIM Modules with Slip-ring (48 axes support)

See Table 101 for Slip-ring options.



Item	Description	Item	Description
1	ArmorKinetix PIM modules	8	Ethernet patchcord, 1 Gigabit with hybrid connector to connect to communication extension 85 m (278 ft) max. (1585D-M8UGDM, 1585D-M8TGDE, or 1585D-E8TGDE)
2	Kinetix 5700 power supply	9	Communication extension jumper cable (2090-CDET)
3	ArmorKinetix DSD or DSM module	10	Slip-ring module
4	Kinetix VPL motor	11	Slip-ring hybrid connector (plug connector) ring side
5	Ethernet switch	13	Aux connection (ring side)
6	ArmorKinetix PIM to DS*x* hybrid cable (2090-CDHIFS-12AF*xxxx*)	14	Slip-ring hybrid connector (socket connector) brush side
7	ArmorKinetix DS*x* to DS*x* hybrid cable (2090-CDHP1S-12AF*xxxx*)	16	Aux connection (brush side)

Numerics

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Rockwell Automation Support

Use these resources to access support information.

Technical Support Center	Find help with how-to videos, FAQs, chat, user forums, Knowledgebase, and product notification updates.	rok.auto/support
Local Technical Support Phone Numbers	Locate the telephone number for your country.	rok.auto/phonesupport
Technical Documentation Center	Quickly access and download technical specifications, installation instructions, and user manuals.	rok.auto/techdocs
Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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Waste Electrical and Electronic Equipment (WEEE)

At the end of life, this equipment should be collected separately from any unsorted municipal waste.

Rockwell Automation maintains current product environmental compliance information on its website at rok.auto/pec.

Rockwell Otomasyon Ticaret A.Ş. Kar Plaza İş Merkezi E Blok Kat:6 34752, İçerenköy, İstanbul, Tel: +90 (216) 5698400 EEE Yönetmeliğine Uygundur

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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
UNITED KINGDOM: Rockwell Automation Ltd. Pitfield, Kiln Farm Milton Keynes, MK11 3DR, United Kingdom, Tel: (44)(1908) 838-800, Fax: (44)(1908) 261-917

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