



This manual links to Armor PowerFlex AC Drive Fault Codes Reference Data, publication [35-RD002](#) and to Armor PowerFlex AC Drive CIP Objects and Attributes Reference Data, publication [35-RD001](#); download the spreadsheet now for offline access.



Armor PowerFlex AC Drives

Bulletins 35E, 35S



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.

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

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



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



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

IMPORTANT

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

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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About This Publication

This manual describes Armor™ PowerFlex® AC drives with EtherNet/IP® and Armor PowerFlex drives with Integrated Safety via EtherNet/IP. It includes information on installation, configuration, programming, and use.

This manual is intended for engineers or technicians that are directly involved in the installation, wiring, programming, operation, and maintenance of the Armor PowerFlex drive.

Rockwell Automation recognizes that some of the terms that are currently used in our industry and in this publication are not in alignment with the movement toward inclusive language in technology. We are proactively collaborating with industry peers to find alternatives to such terms and making changes to our products and content. Please excuse the use of such terms in our content while we implement these changes.

Conventions

In this manual, we use the term GuardLogix® controller to collectively refer to all of the following safety programmable controllers: GuardLogix, Compact GuardLogix, Armor GuardLogix, and Armor Compact GuardLogix controllers. We use the term Logix controller to collectively refer to all compatible programmable controllers. See [Integrated Safety Functions and Compatible Controllers on page 91](#) for more information.

Access Fault Code and CIP Object and Attribute Data



This manual links to Armor PowerFlex AC Drive Fault Codes Reference Data, publication [35-RD002](#) and to Armor PowerFlex AC Drive CIP Objects and Attributes Reference Data, publication [35-RD001](#). Download the spreadsheets from Literature Library.

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.

Summary of Changes

This publication contains the following new or updated information. This list includes substantive updates only and is not intended to reflect all changes.

Topic	Page
Added IMPORTANT notes about dynamic brake function being available for frame size B drives (5...10 Hp), only when firmware revision is 2.002 or higher.	27, 181
Added how to change an IP address after a Safety device is configured.	77
Added step to check DC bus voltage after fuse replacement.	234

Terminology

This table defines the abbreviations that are used in this manual.

Abbreviations and Definitions

Abbreviation	Full Term	Definition
1oo2	One out of Two	Refers to the behavioral design of a dual-channel safety system.
CAT	Category	Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection, and/or by their reliability (source ISO 13849).
CL	Claim Limit	The maximum Safety Integrity Level (SIL) rating that can be claimed for a safety-related electrical control system subsystem in relation to architectural constraints and systematic safety integrity (source IEC 62061).
DC	Diagnostic Coverage	The ratio of the detected failure rate to the total failure rate.
DeviceID	Device ID	A unique identifier, which is comprised of the module number and Safety Network Number (SNN), to make sure that duplicate module numbers do not compromise communication between the correct safety devices.
EN	European Norm	The official European Standard.
ESD	Emergency Shutdown Systems	A system, usually independent of the main control system, which is designed to safely shut down an operating system.
ESPE	Electro-sensitive Protective Equipment	An assembly of devices and/or components working together for protective tripping or presence-sensing purposes and includes as a minimum: <ul style="list-style-type: none"> • A sensing device. • Controlling/monitoring devices. • Output signal-switching devices (OSSD).
HFT	Hardware Fault Tolerance	The Hardware Fault Tolerance (HFT) equals n , where $n+1$ faults could cause the loss of the safety function. An HFT of one means that two faults are required before safety is lost.
IEC	International Electrotechnical Commission	The International Electrotechnical Commission (IEC) is the organization that prepares and publishes international standards for all electrical, electronic, and related technologies.
IGBT	Insulated Gate Bipolar Transistors	Typical power switch that is used to control main current.
ISO	International Organization for Standardization	The International Organization for Standardization (ISO) is an international standard-setting body that is composed of representatives from various national standards organizations.
MTTF	Mean Time to Failure	The length of time that a device or other product is expected to remain reliable in operation.
PELV	Protective Extra Low Voltage	An electrical system where the voltage cannot exceed ELV under normal conditions, and under single-fault conditions, except earth faults in other circuits.
PFD	Average Probability of a Dangerous Failure on Demand	The average probability of a system to fail to perform its design function on demand.
PFH	Average Frequency of a Dangerous Failure per hour	The average frequency of a system to have a dangerous failure per hour.
PL	Performance Level	EN ISO 13849-1 safety rating
PM	Permanent Magnet	In permanent magnet (PM) motors, magnets mounted on or embedded in the rotor, couple with the current-induced internal magnetic fields of the motor generated by electrical input to the stator.
SELV	Safety Extra Low Voltage Circuit	A secondary circuit that is designed and protected so that, under normal and single fault conditions, its voltages do not exceed a safe value.
SIL	Safety Integrity Level	A measure of a products ability to lower the risk that a dangerous failure could occur.
SSN	Safety Network Number	A unique number that identifies a section of a safety network.
STR	Spurious Trip Rate	That part of the overall failure rate that does not lead to a dangerous undetected failure.
STO	Safe Torque Off	The Safe Torque Off (STO) function is used to help prevent unexpected motor rotation during an emergency while the drive remains connected to the power supply. When STO is activated, the torque power cannot reach the drive, which stops and helps prevent any motor shaft rotation.

Additional Resources

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

Resource	Description
Armor PowerFlex AC Drives Fault Codes Reference Data, publication 35-RD002	Provides a list of Armor PowerFlex drive fault codes.
Armor PowerFlex AC Drives CIP Objects and Attributes Reference Data, publication 35-RD001	Provides a list of Armor PowerFlex drive CIP® objects and attributes.
Armor PowerFlex Drives Specifications Technical Data, publication 35-TD001	Provides information on product specifications, ratings, certifications, system interface, and wiring diagrams to aid in product selection.
Armor PowerFlex Motor Controller Product Information, publication 35-PC001	Provides basic information on how to install, configure, and program the Armor PowerFlex controllers.

Resource	Description
On-Machine Media for Armor PowerFlex, ArmorStart, and ArmorConnect Products Selection Guide, publication 280PWR-SG001	Provides information on product specifications, ratings, certifications, system interface, wiring diagrams, and dimensions to aid in On-Machine™ media product selection.
EtherNet/IP Device Level Ring Application Technique, publication ENET-AT007	Describes Device Level Ring (DLR) topologies, configuration considerations, and diagnostic methods.
EtherNet/IP Network Devices User Manual, publication ENET-UM006	Describes how to configure and use EtherNet/IP devices with a Logix 5000® controller and communicate with various devices on the Ethernet network.
Group Installation Listing Requirements for Drives and Contactor-based Motor Controllers White Paper, publication 280-WP001	Describes the importance of drives and motor controllers being Listed for group installations and how to verify if they have been Listed for group installations.
Armor PowerFlex Fan Replacement Kit Installation Instructions, publication 35-IN008	Provides instructions on how to replace the Armor PowerFlex fan.
Armor PowerFlex Electronic Motor Disconnect Whitepaper, publication 35-WP001	Provides information about motor protection using the electronic motor disconnect.
PowerFlex AC Drive Performance Specifications per Ecodesign Regulation (EU) 2019/1781 and UK SI 2021 No. 745, publication PFLEX-TD003	Provides specifications per EU and UK Ecodesign, including efficiency class.
Logix5000 Controllers Common Procedures Programming Manual, publication 1756-PM001	Provides access to the Logix 5000 Controllers set of programming manuals. The manuals cover such topics as how to manage project files, organize tags, program logic, test routines, handle faults, and more.
Logix5000 Controllers General Instructions Reference Manual, publication 1756-RM003	Provides information on the programming instructions available to use in Logix Designer application projects.
GuardLogix Safety Application Instruction Set Reference Manual, publication 1756-RM095	Provides information on the GuardLogix Safety application instruction set.
GuardLogix 5570 and Compact GuardLogix 5370 Controller Systems Safety Reference Manual, publication 1756-RM099	Provides information on safety application requirements for GuardLogix 5570 and Compact GuardLogix 5370 controllers in Studio 5000 Logix Designer® applications.
GuardLogix 5580 and Compact GuardLogix 5380 Controller Systems Safety Reference, publication 1756-RM012	Provides information on safety application requirements for GuardLogix 5580 and Compact GuardLogix 5380 controllers in Studio 5000 Logix Designer applications.
GuardLogix 5570 Controllers User Manual, publication 1756-UM022	Provides information on how to use standard Guard Logix 5570 controllers.
ControlLogix 5580 and GuardLogix 5580 Controllers User Manual, publication 1756-UM543	Provides information on how to use standard ControlLogix® 5580 controllers.
Compact GuardLogix 5370 Controllers User Manual, publication 1769-UM022	Provides information on how to use Compact GuardLogix 5370 controllers.
CompactLogix 5380 and Compact GuardLogix 5380 Controllers User Manual, publication 5069-UM001	Provides information on how to use CompactLogix™ 5380 and Compact GuardLogix 5380 controllers.
Wiring and Grounding Guidelines for Pulse-width Modulated (PWM) AC Drives, publication DRIVES-IN001	Provides information to install, protect, wire, and ground pulse-width modulated (PWM) AC drives.
System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001	Information, examples, and techniques that are designed to minimize system failures caused by electrical noise.
Safety Automation Builder and SISTEMA Library	Download Safety Automation Builder® software to help simplify machine safety design and validation, and reduce time and costs. The SISTEMA tool, also available for download from the Safety Automation Builder page, automates calculation of the attained Performance Level from the safety-related parts of a machine's control system to (EN) ISO 13849-1.
Ethernet Reference Manual publication, 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 publication, 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.
American Standards, Configurations, and Ratings: Introduction to Motor Circuit Design, publication IC-AT001	Provides an overview of American motor circuit design based on methods that are outlined in the NEC®.
Industrial Components Preventive Maintenance, Enclosures, and Contact Ratings Specifications, publication IC-TD002	Provides a quick reference tool for Allen-Bradley® industrial automation controls and assemblies.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
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.
Product Certifications website, rok.auto/certifications .	Provides declarations of conformity, certificates, and other certification details.

You can view or download publications at [rok.auto/literature](#).

CE and UKCA Conformity

CE and UKCA Declarations of Conformity are available online at: rok.auto/certifications.

The Armor PowerFlex drive when installed and maintained in accordance with the instructions in this document, is in conformity with the essential requirements of these directives/regulations:

- 2006/42/EC Machinery Directive/2008 No. 1597 Supply of Machinery (Safety) Regulations (MD)
- 2014/30/EU EMC Directive/2016 No. 1091 Electromagnetic Compatibility Regulations (EMC)
- 2014/35/EU Low Voltage Directive /2016 No. 1101 Electrical Equipment (Safety) Regulations (LV)
- 2011/65/EU RoHS Directive/2012 No. 3032 RoHS Regulations (RoHS)
- 2009/125/EC Ecodesign Directive/2021 No. 745 Ecodesign for Energy-Related Products Regulations (Eco)

The following standards have been applied to demonstrate conformity.

Machinery Directive (2006/42/EC)/2008 No. 1597 Supply of Machinery (Safety) Regulations (MD)

- EN ISO 13849-1 Safety of machinery - Safety related parts of control systems - Part 1: General principles for design
- EN 60204-1 Safety of machinery - Electrical equipment of machines - Part 1: General requirements
- EN 62061 Safety of machinery - Functional safety of safety-related electrical, electronic, and programmable electronic control systems
- EN 61800-5-2 Adjustable speed electrical power drive systems - Part 5- 2: Safety requirement - Functional
- IEC 61508 Part 1...7 Functional safety of electrical/electronic/ programmable electronic safety-related systems

EMC Directive (2014/30/EU)/2016 No. 1091 Electromagnetic Compatibility Regulations (EMC)

- EN 61800-3 Adjustable speed electric power drive systems - Part 3: EMC requirements and specific test methods

LVD Directive (2014/35/EU)/2016 No. 1101 Electrical Equipment (Safety) Regulations (LV)

- EN 61800-5 -1 Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy (LVD)

RoHS Directive (2011/65/EU)/2012 No. 3032 RoHS Regulations (RoHS)

- EN 63000 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Ecodesign Directive (2019/1781/EU)/2021 No. 745 Ecodesign for Energy-Related Products Regulations (Eco)

Armor PowerFlex Variable Frequency Drives Overview

Description

The Armor™ PowerFlex® unit is a variable frequency drive (VFD) and is suited for variable frequency applications where more precise motor control is needed. The Armor PowerFlex drives are available in integrated safety (Bulletin 35S) and standard (Bulletin 35E) versions.

All Armor PowerFlex drives feature an embedded dual-port EtherNet/IP™ switch, which supports star, linear, and DLR topologies.

The Armor PowerFlex drive provides an IP54/66, UL Type 4/12, and NEMA 4/12 enclosure design, which is suitable for water wash down environments, when appropriate cables are attached or sealing caps are in place. For details, see Armor PowerFlex AC Drives Specifications, publication [35-TD001](#) and the On-Machine Media for Armor PowerFlex, ArmorStart, and ArmorConnect Products Selection Guide, publication [280PWR-SG001](#).

IMPORTANT To ensure that Armor PowerFlex system, which includes the attached cables and sealing caps, meet the application requirement, see the *Armor PowerFlex Enclosure Ratings when used with Cable Assemblies and Sealing Caps* table located in the On-Machine Media for Armor PowerFlex, ArmorStart, and ArmorConnect Products Selection Guide, publication [280PWR-SG001](#).

IMPORTANT The Armor PowerFlex drive ships with a screw-in cap which is required to be installed when the power OUT connection is not in use. (This scenario could apply when daisy chaining is not in use or when the drive is the last unit in the daisy chain). When installed, this screw-in cap provides an IP54 rating to the power OUT connection. If a greater IP rating is required, for example IP66, appropriately rated sealing caps are required to be installed. For selection information, see Accessories in the On-Machine Media for Armor PowerFlex, ArmorStart, and ArmorConnect Products Selection Guide, publication [280PWR-SG001](#).

Fault diagnostic capabilities, including status indicators, are built in to the Armor PowerFlex drive to help you pinpoint a problem for easy troubleshooting and quick restarting.

Input and Outputs

All Armor PowerFlex drives include four standard inputs and two standard configurable I/Os.

The Armor PowerFlex safety drive includes: two test outputs, four safety inputs, and one bipolar safety output.

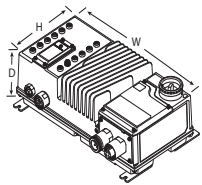
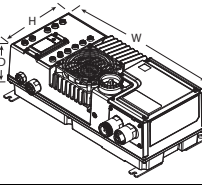
Table 1 - Product Overview

Type	Bulletin	Inputs and Outputs	On-board Safety Inputs and Outputs
Armor PowerFlex with integrated safety on EtherNet/IP network	35S	4 inputs 2 configurable I/Os	1 bipolar safety output 4 safety inputs
Armor PowerFlex on EtherNet/IP network	35E		—

Frame Size

The Armor PowerFlex drive is available in Frame sizes A and B.

Table 2 - Frame Sizes

Frame		Output Current	Input Voltage	Approximate Dimensions			
Size	Rating			Diagram	Width (W), max.	Depth (D), max.	Height (H), max.
A	1 Hp (0.75 kW)	2.3 A	380...480V AC		16.0 in. (40.6 cm)	5.67 in. (14.4 cm)	8.0 in. (20.3 cm)
	2 Hp (1.5 kW)	4.0 A					
	3 Hp (2.2 kW)	6.0 A					
B	5 Hp (3.7 kW)	10.5 A	380...480V AC		18.3 in. (46.5 cm)	7.2 in. (18.2 cm)	8.0 in. (20.3 cm)
	7.5 Hp (5.6 kW)	13 A					
	10 Hp (7.5 kW)	17 A					

For additional specifications see Armor PowerFlex AC Drives Specifications Technical Data, publication [35-TD001](#).



We recommend that the drive rating should be no more than two times the motor rating. Example: For a 1 Hp drive, the motor should be 0.5 Hp or larger.

Safety Functions

The Armor PowerFlex safety version (35S) is capable of hard-wired and integrated safety. In hardwired mode, Safe Torque Off (STO) can be used. Integrated safety supports STO, integrated drive-based Safe Stop functions and integrated controller-based Safe Monitor functions. See [Chapter 6](#), for details.

Location of Features

Figure 1 - Bulletin 35E Armor PowerFlex Standard VFD (Frame Size A)

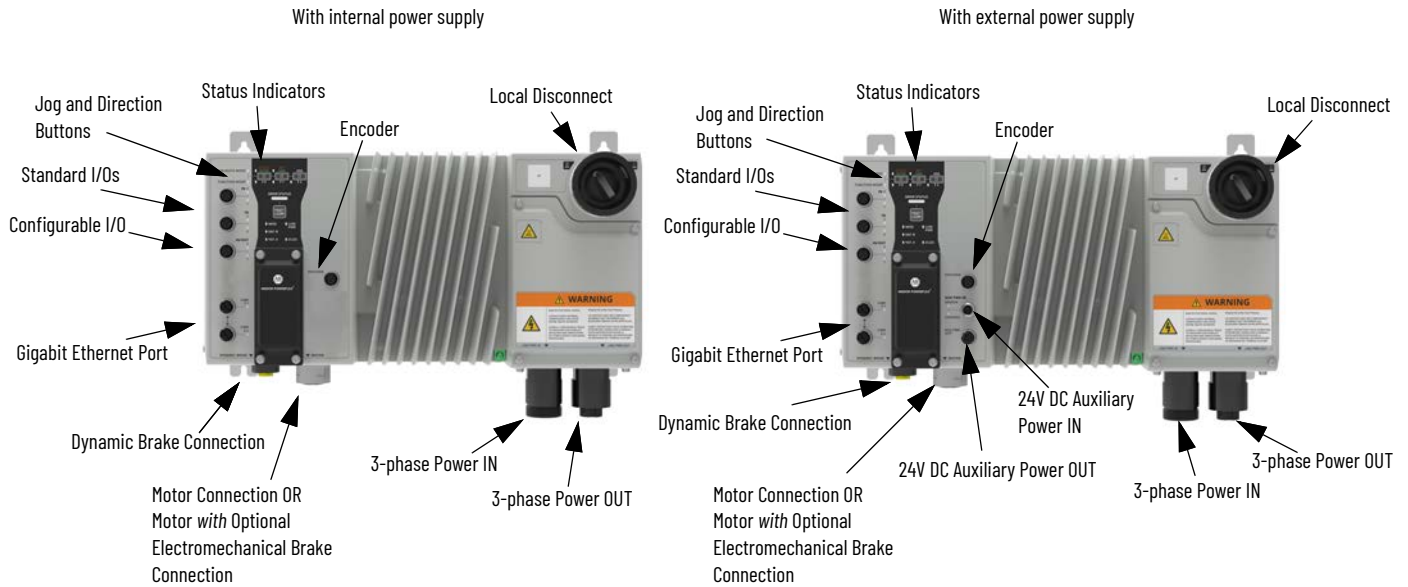


Figure 2 - Bulletin 35S Armor PowerFlex with Integrated Safety VFD (Frame Size A)

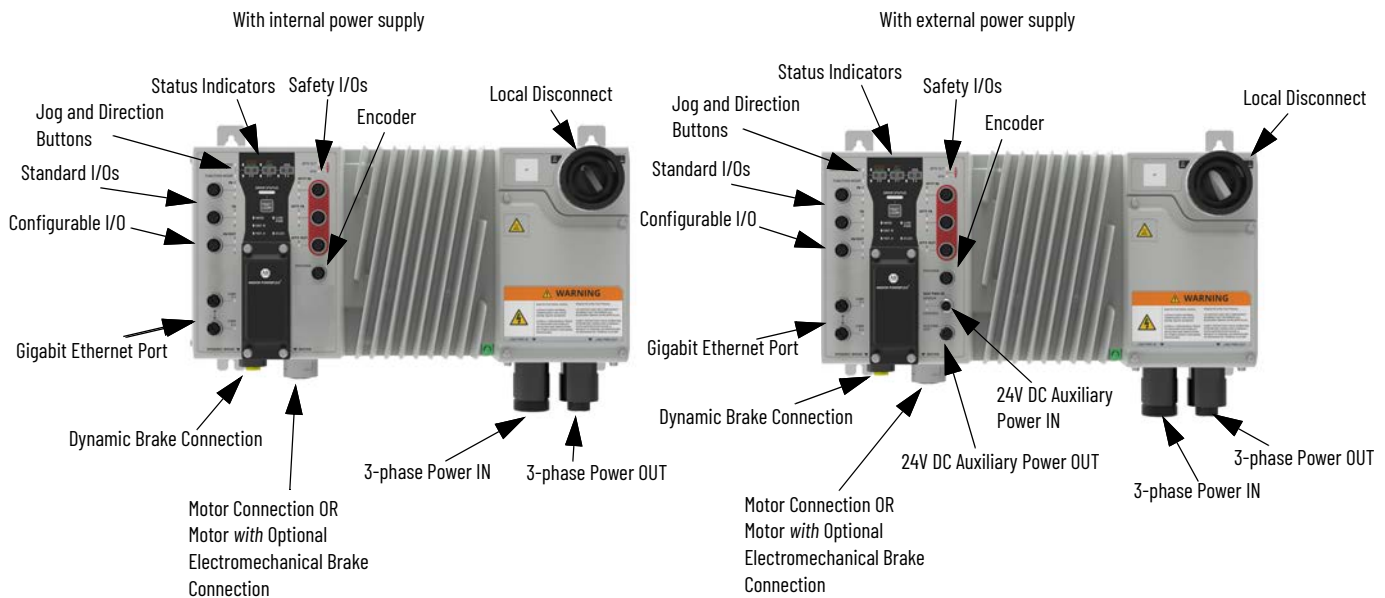


Figure 3 - Bulletin 35E Armor PowerFlex Standard VFD (Frame Size B)

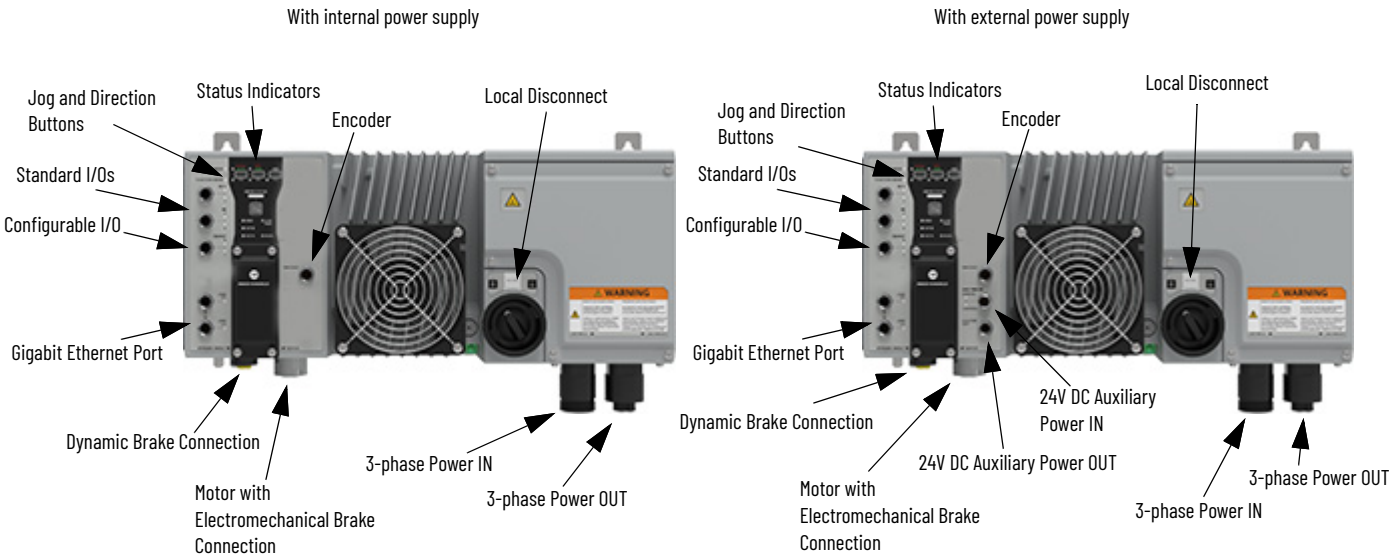
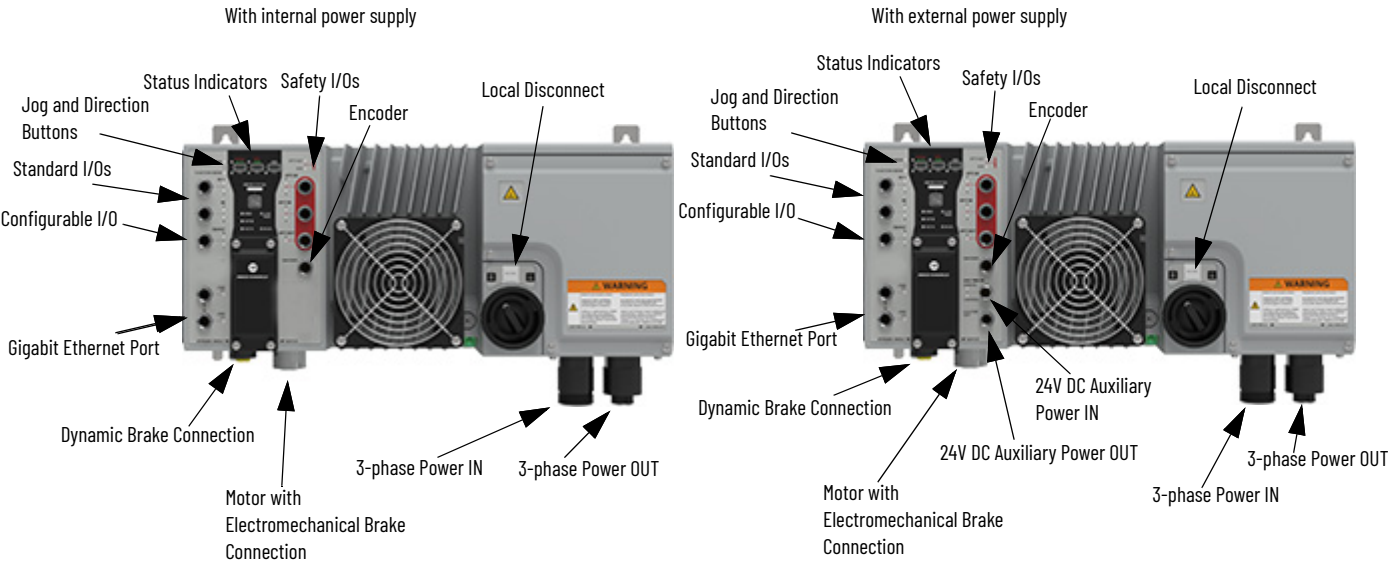


Figure 4 - Bulletin 35S Armor PowerFlex with Integrated Safety VFD (Frame Size B)



Catalog Number Explanation

Examples that are given in this section are not intended to be used for product selection. Not all combinations produce a valid catalog number. Use ProposalWorks™ software to configure the Armor PowerFlex Drive. ProposalWorks software is available from rok.auto/systemtools.

Catalog Number Explanation for Bulletin 35 Armor PowerFlex Drives

35 **S** - **6** **D** **1** - **L** **1** **1**
a **b** **c** **d** **e** **f** **g** **h** **i**

a	
Bulletin Number	
Code	Description
35	Armor PowerFlex Drive

b	
Type	
Code	Description
S	Integrated Safety
E	Standard with EtherNet/IP

c	
Enclosure Type	
Code	Description
6	IP54/66, NEMA Type 1/4/12 ⁽¹⁾

d	
Line Voltage	
Code	Description
D	480Y/277V AC, 50/60 Hz

e	
Motor Power Output Rating	
Code	Description
1	Frame A: 1 Hp, 0.75 kW, 2.3 A
2	Frame A: 2 Hp, 1.5 kW, 4.0 A
3	Frame A: 3 Hp, 2.2 kW, 6.0 A
4	Frame B: 5 Hp, 3.7 kW, 10.5 A
5	Frame B: 7.5 Hp, 5.6 kW, 13 A
6	Frame B: 10 Hp, 7.5 kW, 17 A

f	
24V DC Auxiliary Power Source	
Code	Description
L	External
P	Internal

g	
Power-in Gland	
Code	Description
0 ⁽²⁾	Cord/conduit
1 ⁽³⁾	Round Quick Connect
2	Square Quick Connect

h	
EM Brake⁽⁴⁾	
Code	Description
0	None
1	Included

i	
EMI Filter	
Code	Description
1	Included

(1) Enclosure ratings vary depending on the catalog number configuration, for details see Armor PowerFlex AC Drives Specifications, publication [35-TD001](#).

(2) UL Listing is pending. Contact your local Allen-Bradley distributor for details.

(3) You must select Round Quick Connect power-in gland to qualify for UL Listing.

(4) If you choose a drive without an EM brake (Code 0), then a 4-pin motor cable is required. If you choose a drive with an EM brake (Code 1), then a 7-pin motor cable is required. Example: Cat. No. 35S-6D3-**P101** requires a 4-pin cable (Cat. No. 280-PWRM29-Mxx or 284-PWRM29-Mxx). Cat. No. 35S-6D3-**P111** requires a 7-pin cable (Cat. No. 357-PWRM29-Mxx). For details, see the On-Machine Media for Armor PowerFlex, ArmorStart, and ArmorConnect Products Selection Guide, publication [280PWR-S6001](#). The EM Brake is standard (included) for Frame B sizes (5, 7.5, and 10 Hp).

Required Software

[Table 3](#) lists the software that is required to operate Armor PowerFlex drives.

Table 3 - Armor PowerFlex Drives Required Software

Network		Software ⁽¹⁾	Version
EtherNet/IP		FactoryTalk® Linx ⁽²⁾	6.20 or later
		Studio 5000®	32.00...35.xx
		Add-on Profile	Download the most current version from the Product Compatibility and Download Center at rok.auto/pcdc
		BOOTP/DHCP Utility	Version 2.3 or later (BOOTP is not supported.)
Programmable Controller			Firmware Version
Armor PowerFlex 35S and 35E versions	GuardLogix and Compact GuardLogix controllers (see page 91 for the listing of compatible controllers)		32.00...35.xx
Armor PowerFlex 35E version	ControlLogix and CompactLogix controllers (see page 91 for the listing of compatible controllers)		32.00...35.xx

(1) We recommend using a Windows® 10 operating system or higher, to achieve full software functionality.

(2) The RSLinx® application is **not** supported.

Studio 5000 Logix Designer® application is the single software that is used for setup and commissioning. It's accomplished through the installation and use of an Add-on Profile (AOP) downloaded from Product Compatibility and Download Center (PCDC). See [page 11](#) for more information.

Motor Control

Armor PowerFlex drives provide you with selectable choices for accurate motor control.

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

Figure 5 - IEEE per Phase Motor Model

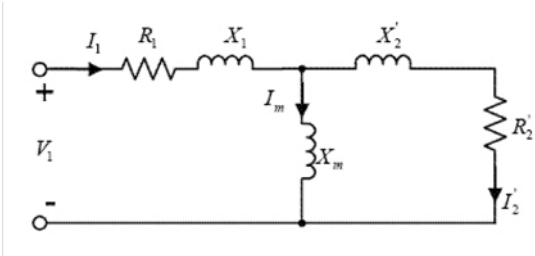


Table 4 - IEEE Phase Motor Model Diagram Designations

I_1	Stator current [Amps]
I_2	Rotor current [Amps]
R_1	Stator circuit resistance [Ohms]
R_2	Rotor circuit resistance [Ohms]
X_1	Stator leakage reactance [Ohms]
X_2	Rotor circuit reactance [Ohms]
I_w	Magnetizing current [Amps]
X_w	Magnetizing reactance [Ohms]
V_1	Applied stator voltage [Volts]

Control Modes

Velocity control is accomplished via three options for control mode:

- Volts/Hertz (V/Hz)
- Sensorless Vector (SVC)
- Velocity Vector (VVC)
- Sensorless Vector (SVC) Economizer

Volts/Hertz

Volts/Hz (V/Hz) control is a simple, low-cost method for controlling variable frequency drives (VFDs), and is generally regarded as the most common VFD control scheme. It's suitable for both constant torque and variable torque applications and can provide up to 150% of the rated torque at zero speed for startup and peak loads. The magnetic field strength is proportional to the ratio of voltage (V) to frequency (Hz), or V/Hz. The VFD controls the motor speed by varying the frequency of the applied voltage, according to the synchronous speed equation.

Operation in this mode, 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.

Sensorless Vector

Sensorless vector control (SVC) provides better torque production and a wider speed range than V/Hz. However, it may not be appropriate when more than one motor is connected to the same drive.

SVC does not have an external sensor to obtain feedback from a motor. SVC mode monitors the voltage and current of the motor via the already-connected power leads, and then mathematically determines the motor speed with optimum accuracy. This is a simpler and less costly solution than installing and connecting an encoder. While not as good as a dedicated sensor, SVC provides sufficient feedback in most applications to enable pseudo closed-loop operation.

SVC uses a V/Hz core that is enhanced by current resolution, a slip estimator, a high-performance current limiter, and the vector algorithms. The algorithms operate on the knowledge that motor current is the vector sum of the torque and flux producing components.

Values can be entered to identify the motor values or an autotune routine can be run to identify the motor values (see [Run Autotune on page 169](#)). For improved SVC performance, we recommend that an autotune is performed with the motor connected.

Velocity Vector

In Velocity Vector Control (VVC), a high bandwidth regulator that separates and controls the components of stator current, replaces the volts/hertz core used in V/Hz and SVC control modes. The high bandwidth characteristics of this control help eliminate nuisance trips due to shock-loads and will continuously adapt to changes in the motor and load characteristics.

A separate adaptive controller uses information gained during auto tuning; actual reference information and motor feedback information, to give independent torque and flux control. This allows continuous regulation of the motor speed and improved overall control. For the Armor PowerFlex drive, this mode should be operated with feedback to provide the fastest response to load changes.



A rotate tune must be done in order to provide the optimal motor velocity control using vector mode (see [Run Autotune on page 169](#)).

Sensorless Vector Economizer

SVC Economizer mode consists of the sensorless vector control with an additional energy savings function. For details, see [Configure Motor Control Mode on page 163](#).

Velocity Control

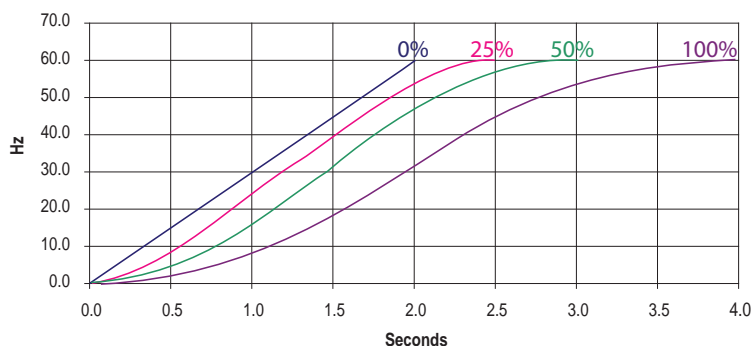
Velocity control refers to controlling the speed of a connected motor. Acceleration and deceleration times can be specified, which indicate the time it should take the velocity to go from zero to the configured maximum velocity (or vice versa). From these times, actual acceleration/deceleration values (rates) can be calculated and the motor output controlled to meet these desired values.

Example: If Acceleration Time is 10 s, it means that the motor should go from a standstill to maximum velocity in 10 s. Maximum velocity can be lower or higher than rated speed.

Velocity control also allows the rate of change of acceleration and deceleration (also known as "jerk") to be adjusted. This control function is known as S-Curve. By enabling/configuring the S-Curve function, the transition between velocities can be made smoother by not immediately applying or removing the desired acceleration/deceleration rate.

When S Curve is enabled, it adds time to the overall acceleration by a percentage of the programmed acceleration time. This is shown in the curve in [Figure 6](#) which represents 0%, 25%, 50%, and 100% S Curve. Note that half of the “S” is added to the beginning and half is added to the end of the ramp.

Figure 6 - S Curve Example



Flying Start

The flying start feature lets you start a motor that is already in motion. Flying start is used to start a rotating motor, as quick as possible, and resume normal operation with a minimal impact on load or speed. When a drive is started in its normal mode, it initially applies a frequency of 0 Hz and ramps to the desired frequency. If the drive is started in this mode with the motor already spinning, large currents will be generated. An overcurrent trip may result if the current limiter cannot react quickly enough. The likelihood of an overcurrent trip is further increased if there is a residual electro-magnetic flux (back EMF) on the spinning motor when the drive starts. In addition, larger mechanical stress is placed on the application.

In Flying Start mode, the drive's response to a start command is to synchronize with the motor's speed (frequency and phase) and voltage. The motor will then accelerate to the desired frequency. This process helps prevent an overcurrent trip and significantly reduces the time for the motor to reach its desired frequency. Since the drive synchronizes with the motor at its rotating speed and ramps to the proper speed, little or no mechanical stress is present.

With flying start enabled, the drive may cause the motor shaft to slightly rotate forward and/or reverse, when the drive is started in a condition where the motor is not rotating. This motion may occur because the drive performs a sweep of the motor to find its current speed. This sweep produces a small amount of EMF which in turn causes the motor to move. A generic application example for flying start, would be a high inertia load where the rotating load is coasting to a stop and the process requires a re-start of the drive before the rotating load/motor is at rest. Depending on the system design, even with flying start enabled, some applications may require additional hardware to control regenerative energy and prevent an overcurrent or overvoltage fault.



ATTENTION: When flying start is enabled and the motor is starting from zero speed, the motor shaft can turn forward or reverse while the algorithm attempts to detect current speed.

When flying start is disabled and the drive receives a start command while the motor is in motion, the drive performs a ramp from zero speed (no output frequency) to the commanded speed. Performing this ramp from zero on a running motor can cause an overcurrent condition which may result in damage to the motor or load.

Load Monitor

This feature monitors the drive for conditions where more or less power than expected is being provided to or provided by the motor to drive a particular load. Two types of monitoring can be performed: shear pin and load loss.

- Shear pin monitors for power greater than the configured level, which may indicate a stuck load. This feature can cause a fault and stop the motor to help prevent damage to the motor or load device.
- Load loss monitors for power less than the configured level, which may indicate that the load is no longer connected to the motor. This feature can stop the motor or trigger an alarm.

You can configure the power level as an absolute amount of output current being supplied to the motor.

Motor Thermal Overload

Motor thermal overload protection helps to prevent overheating and possible damage to the connected motor. When the drive detects that the motor is too hot, a thermal overload condition is declared. Power to the motor is removed to allow the motor to cool and the overload condition to clear. When the overload condition is cleared, the motor can be restarted. You can define the behavior of the motor thermal overload feature (erase thermal memory or allow cool down) when the device powers up. See [Configure Motor Protection on page 168](#).

A motor thermal model calculates thermal capacity utilization to estimate the actual heating of the connected motor based on:

- Configured motor overload current, which is the level at which the motor is considered to be in an overload condition
- Actual product output current (all three phases are measured)
- Time over which the output current is delivered

The protection feature lets the motor operate at a power level above its overload rating for short periods of time while starting or accelerating to help prevent faults from occurring.

When excessive current flows through the motor circuit, there is increased motor temperature sensed which will result in a Drive fault after a specified delay, defined as Class 10. This overheating generally occurs when the motor is overloaded, when a bearing seizes up, when something locks the motor shaft and prevents it from turning, or when the motor simply fails to start properly. A failure to start may be caused by faulty start windings in the motor.

See Armor PowerFlex AC Drives Specifications, publication [35-TD001](#), for overload trip curves specifications.

Fault Auto Reset

The fault auto reset and run (auto restart) feature lets certain faults be cleared and the product be commanded back into the running state.

The Auto Restart feature provides the ability for the drive to automatically perform a fault reset followed by a start attempt without user or application intervention. This allows remote or “unattended” operation. Only certain faults are allowed to be reset. Certain faults that indicate possible drive component malfunction are not resettable. Caution should be used when enabling this feature, since the drive will attempt to issue its own start command based on user selected programming.

List of resettable faults:

- Inverter - Ground Fault (event code 0x04250002)
- Motor Thermal Overload - Overload, Hard (event code 0x04320001)
- Load Monitor - Above Level (Shear Pin) (event code 0x04340001)
- Load Monitor - Below Level (Load Loss) (event code 0x04340002)
- Temperature Sensor - Overtemperature, Hard (event code 0x04230002)

IMPORTANT Multiple simultaneous faults of any type will prevent a restart.

Safe Torque Off and Safe Monitor Functions

The hardwired and integrated safety features are available on the Armor PowerFlex safety drive (35S).

Hardwired Safe Torque Off

When the Armor PowerFlex safety drive is in its out-of-box state, it operates in hardwired Safe Torque Off (STO) mode. The STO function is controlled by either dual channel safety input; either safety input 0 (S0) and safety input 1 (S1), or safety input 2 (S2) and safety input 3 (S3).

IMPORTANT

The Armor PowerFlex safety drive (35S) includes functional safety. If during the initial out-of-box setup a local jog is required, install the red (M12) safety bypass plug onto one of the two safety inputs. This plug is used to enable torque in the out-of-box hardwired mode, during setup. After a safety connection is made with the safety drive, a reset ownership must be performed to enter the out-of-box, hardwired state again. For details, see [STO Bypass Operation on page 100](#).

Use only the S0 and S1 connector when the hardwired safety device that controls when safety is demanded, requires pulse testing per the risk assessment. If pulse testing is not required, then either the S2 and S3 connector or the S0 and S1 connector can be used, but not both.

IMPORTANT

In hardwired safety mode, only one of the two safety input connectors can be used. Connecting a cable and safety device to both safety inputs' connectors, in hardwired safety mode, will cause an STO Both Pairs Used fault. See section *Hardwired STO Operation* For information on resetting this fault, see [Hardwired STO Operation on page 100](#).

Torque is permitted when one input pair on one of the two safety input connectors is energized and disabled when either input is de-energized. Choose the desired safety input connector for hardwired STO mode. See [Hardwired Safe Torque Off Function on page 100](#) for details.

Integrated Safety Functions

When the Armor PowerFlex is applied with a suitable safety programmable controller, additional functionality is available. This functionality includes network safety functions such as STO, timed SS1, SBC, and Safety I/O. When adding a suitable safety encoder to the Armor PowerFlex drive, it can support additional safe speed monitoring functions, such as SLS, SLP, SDI, and SS1 ramp.

In addition to safety I/O features, the drive supports these functions: integrated STO, timed SS1, Safe Brake control (SBC), and monitored SS1 when a safety encoder is used.

See [Chapter 6](#) for details on integrated safety I/O and safety functions.

Standard Encoder Operation and Diagnostics

The Armor PowerFlex drive has a feedback interface that allows an external feedback device (encoder) to be connected to the product. An encoder can provide more accurate velocity control by providing an indication of the actual speed of the motor/load.

Supported standard encoder types:

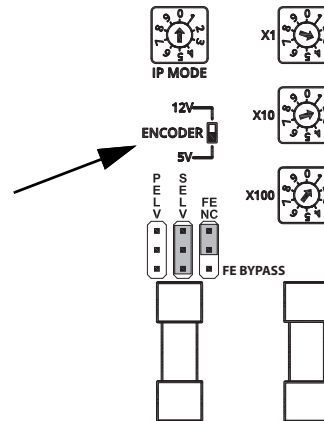
- Digital Incremental, Single Channel, Single Ended
- Digital Incremental, Single Channel, Differential
- Digital Incremental, Dual Channel, Single Ended
- Digital Incremental, Dual Channel, Differential

The encoder signals are connected in parallel for both safety and standard drive control. Standard control can use single-ended encoder signals, but differential signals are required for safety functions. The standard and safety feedback must be configured separately. If the feedback device uses safe speed monitor functions, additional diagnostics and configuration values must be considered.

See [Safety Feedback Interface Instruction Operation on page 125](#) for more information on the controller-based safety encoder support and diagnostics. See [Configure Encoder Feedback on page 173](#) for information on how to configure the standard and safety encoders.

The Armor PowerFlex can supply either 5V or 12V to the encoder, through the encoder output. The encoder supply voltage switch must be set to the proper supply voltage (5V or 12V) for your connected encoder. The encoder supply voltage switch is on the I/O board, next to the IP address switches (see [Figure 7](#)). See [Remove Front Logic Cover on page 70](#) for information on how to gain access to the I/O board.

Figure 7 - Encoder Supply Voltage Switch



The safety feedback configuration allows for the voltage supply to be monitored, see [Encoder Voltage Monitoring on page 121](#) for more details.

IMPORTANT For fault-free operation of the encoder, the cable shield of the connecting cable must be grounded on both sides (encoder and control) using large area connections. On the encoder side, this is typically done in the plug connector or via the connecting cable.

IMPORTANT For proper operation of the Armor PowerFlex drive, the maximum total encoder cable length is 20 m (65.6 ft).

Supported Standard Encoder Diagnostics:

- Wire Error Detection
- Velocity Comparison

The standard encoder diagnostics support basic wire error checking and velocity comparison. The standard encoder diagnostics check for wiring errors and reports them to the user. The diagnostics detect when 1 of the 4 encoder signals is open, shorted to ground, or shorted to encoder power. The velocity comparison diagnostic detects when the measured velocity from the encoder is outside of the expected velocity value.

For more information, see [Configure Encoder Feedback on page 173](#).

Group Motor Application

IMPORTANT The Armor PowerFlex drives and their mating cable assemblies can be applied using NFPA 70 (NEC), NFPA 79, and specific local electrical code as required.

The Armor PowerFlex drive integrates the motor branch short circuit and ground fault protection devices. Therefore, no additional motor control branch circuit protection is required. Multiple Armor PowerFlex drives can be applied in a group application if you follow the local electrical codes for the protection of the feeder conductors using recommended Branch Circuit Protection device.

Local Disconnect

The Armor PowerFlex drive has a local, at-motor disconnect switch which is positioned on the front of the unit. The local disconnect removes power from the motor terminals and outputs when in the Off position. The local disconnect does not remove safety output power. A lock can be applied to the local disconnect when in the Off position. For additional information, see [Local Disconnect Behavior on page 66](#).

If a motor over-current fault should occur, the integrated branch protection may trip. This may cause the drive to fault if the bus voltage falls below minimum threshold. If a fault occurs, the disconnect switch (On/Off) position will not change state. For diagnostic help and trouble shooting, see [System Status Indicator on page 215](#).

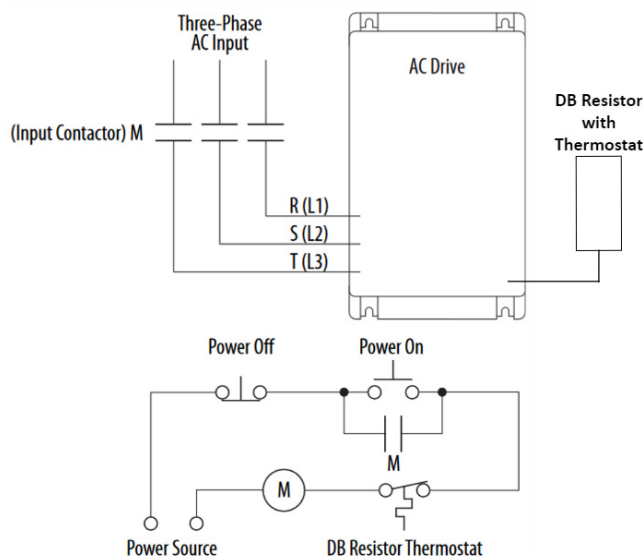
EMI Filter

The EMI filter is required to be CE compliant. The filter must only be used in installations with solidly grounded Wye AC supply distribution and must be bonded to the power distribution ground. The shielded motor cable is ordered separately. Use the Rockwell Automation® power media and cable assemblies that are specified by the selection guide or instructions for the controller, to comply with the UL Listing of the controller. See the Armor PowerFlex AC Drives Specifications Technical Data, publication [35-TD001](#) and the On-Machine Media for Armor PowerFlex, ArmorStart, and ArmorConnect Products Selection Guide, publication, [280PWR-SG001](#), for available catalog numbers.

Dynamic Brake Resistor

Dynamic braking (DB) allows excess electrical energy to be dissipated as thermal energy by directing it through a large resistor. When the dynamic braking feature is enabled, the brake resistor is activated (current is allowed to flow through it) when the bus voltage exceeds a user-defined threshold. This is primarily useful when stopping, allowing a faster stop without causing a DC bus overvoltage.

Typically, AC drives do not offer protection for externally mounted dynamic brake resistors. A risk of fire exists if external braking resistors are not protected from drive component failure, for example, failure of the brake IGBT. In this case, external resistor packages must be protected from over-temperature condition using a protective circuit, or equivalent, as the example shown.



The Armor PowerFlex frame size A (1...3 Hp) and frame size B^(a) (5...10 Hp) have the internal ability to detect a thermal event on the dynamic brake resistor and shut down the Electronic Motor Disconnect which eliminates the need for the upstream control devices. See [Electronic Motor Disconnect on page 67](#), for more information.

The dynamic brake resistor kit is available for light-duty applications (mountable, does not take extra space) or standard duty applications (larger footprint, with more capability). The dynamic brake resistor kit can be factory-ordered separately. See the Armor PowerFlex AC Drive Specifications Technical Data, publication [35-TD001](#), for available catalog numbers.

(a) Frame size B must have firmware revision 2.002 or higher.

IMPORTANT Frame size A drives (1...3 Hp) support the dynamic brake function. **Do not** use any type of brake resistor with frame size B drives (5...10 Hp) with firmware revision 2.001. You must update the firmware to revision 2.002 or higher, to enable an enhanced level of dynamic brake resistor protection.

IMPORTANT We recommend that you apply only light-duty or standard-duty dynamic braking resistors, based on your application needs. If you require a deviation from the Rockwell Automation recommended resistors, it is your responsibility to ensure it is suitable to be used with the Armor PowerFlex drive and will meet the application's needs. As a precaution, you should review these changes with your UL representative or Authority Having Jurisdiction (AHJ).

The dynamic brake connector is provided standard with the Armor PowerFlex drive.

Power Input Gland

The Armor PowerFlex drive offers several methods to connect 3-phase power to the unit. You can select one of the three offered connectivity options via the catalog number configuration.

Conduit/cord allows you to apply conduit or cord to manually terminate each conductor.

Factory-installed receptacles can be selected to provide connectivity to three-phase quick-connections. You can select the round M35 ArmorConnect® quick-connect power media, or you can select the square quick-connect that offers connectivity to DESINA Q4/2 connectors, such as HARTING® power cable assembly solutions. For selection information, see the On-Machine Media for Armor PowerFlex, ArmorStart, and ArmorConnect Products Selection Guide, publication, [280PWR-SG001](#).

Factory-installed Options

You must select factory-installed options and add them to the catalog number selection before ordering. Options are not modular and you cannot install them on site.

Internal Power Supply

When you select your Armor PowerFlex drive catalog number, you can choose for it to be configured with an internal 24V DC auxiliary power supply (50 W) or you can choose to have an external power supply. Your power supply choice is made by catalog number selection and cannot be changed in the field. The internal power supply provides all control and I/O power and is sourced from the incoming three-phase power. This eliminates the need to run separate control power to each unit, reducing installation time and cost.

The internal power supply (IPS) connects to the line side of the local disconnect. This means that when the local disconnect is Off, the IPS will continue to provide 24V DC to the Armor PowerFlex. Only when the machine level (main) disconnect is Off, removing all three-phase power, does the IPS shutdown and the Armor PowerFlex drive turns Off.

The Armor PowerFlex drive can source a class 2 circuit according to the NEC 725.60 standard, which covers unswitched power (for sensors) and/or switched power (for actuators). For more information, see the Armor PowerFlex AC Drive Specifications Technical Data, publication [35-TD001](#).

Electromechanical Brake

The Armor PowerFlex Drive frame size A, supports an optional electromechanical brake (EMB or EM brake) function. Internally controlled (On/Off) mechanical contacts apply source (line) voltage to the external motor mechanical brake solenoid when it is demanded. This releases the motor brake to allow motion.

Both Automatic and Manual brake control are available with the Armor PowerFlex drive. For details, see [Configure Electromechanical Brake on page 182](#).

A customer-accessible, 3 A fuse is provided to help protect the brake cable from over-current. The brake and motor conductors are integrated into a single cable assembly and ordered separately. Use the Rockwell Automation power media and cable assemblies that are specified in the selection guide or instructions for the drive, to comply with the UL Listing of the drive. See the On-Machine Media for Armor PowerFlex, ArmorStart, and ArmorConnect Products Selection Guide, publication, [280PWR-SG001](#).

The EM brake current is a calculated AC RMS value based on peak averages, and not a “true RMS” value. If the brake output is nonsinusoidal (such as a half wave rectifier), the calculated RMS current will be incorrect and potentially cause a fault.

The EM brake fault can be disabled if the brake being used has a low current draw.

IMPORTANT	For proper operation, the minimum EM brake current required is 100 mA. Current draw less than 70 mA _{rms} will cause EM brake not connected/broken wire or undercurrent fault.
IMPORTANT	The EM brake feedback current must be sinusoidal or an EM brake current fault may occur.

Standard Configuration

Figure 8 - Standard Drives Configuration



The Armor PowerFlex drive internally integrates motor branch short circuit and ground fault protection devices. No additional motor control branch circuit protection is required and the drive can be installed in a group application. For upstream group protection, it is possible to use one branch circuit protection device. Though not related to NFPA 70 Emergency Stop, the following example will show the calculations for sizing the branch circuit protection device.

Many applications require the use of an Emergency Stop device using NFPA 79 regulations. The following example achieves NFPA 79 status by using a method of relay-controlled removal of power from the Armor PowerFlex 35E standard drive, to the motors. The wiring example demonstrates how to achieve a Category 0, NFPA 70 Emergency Stop status, in which the motor will coast to stop, based on friction and losses. This example can be used on any non-safety drive, as a means to remove power to the motors and achieve a Category 0, stop.

Hardware used for the example:

- (3) Armor PowerFlex 35E-6D1-P001
- (3) AC motors 2.3 FLA
- Power and motor cables. To comply with UL Listing of drive, use Rockwell Automation cable assemblies see publication 280PWR-SG001)
- Safety Relay; 440R-D2252
- Bulletin 100S safety rated contactors; 100S-C09EJ23C MCS 100S-C, 9amp, 24V DC-2
- Bussmann Fuses; LPJ-9SP
- 800F E-Stop Push Button; 800FM-G611MX11

Calculation of fuse and contactor sizing:

$2.3 \text{ A Motor FLA} \times 3 \times 1.25 = 8.625 \text{ A}$. A 9 A rating fuse and contactor was chosen. In this example, the fuse is sized to NEC code or the sum of motor minimum: $\text{FLA} \times 1.25$.

IMPORTANT Follow local code for sizing based on your equipment

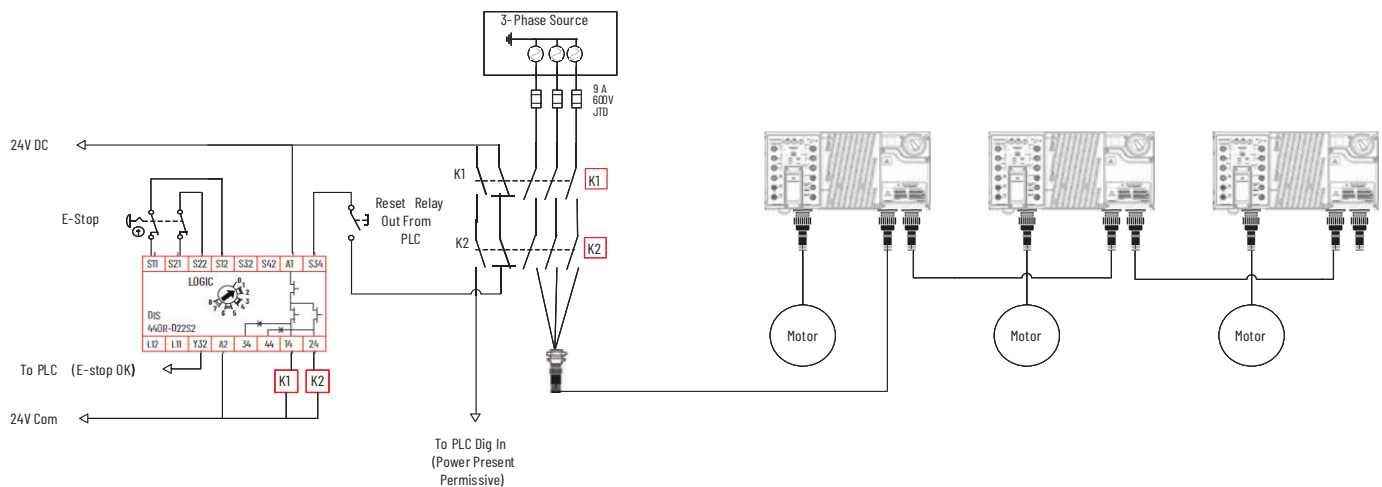
Wiring Instructions

Use the NO contact on the 100S contactor as a permissive, for the drive to indicate that line power is present to the drive (*Power Present Permissive*). The contact will close when line power is present. A digital input on the PLC can be programmed as the ready input. When the input is closed, the drive is ready to run.

Use the NC contact on the 100S contactor as a reset for the 440R-D2252 safety relay. Use both NC contacts on the 100S in a relay string, wired in series. Wired in this string is a digital output on the PLC which will be programmed as a reset, when the 440R-D2252 needs to be reset.

Wire the Y32 output on the 440R-D2252 relay, to a PLC digital input to indicate the Armor PowerFlex drive is not in an Emergency Stop condition (*Estop OK*). See [Figure 9](#).

Figure 9 - Standard Drive with E-Stop



Safety Drives Configuration

Armor PowerFlex safety drives (35S) are capable of Safe Torque Off (STO) via hardwired STO connections and integrated drive-based STO and SS1, and integrated controller-based safety functions like Safely Limited Speed (SLS). These examples illustrate some of the functional safety configuration options.

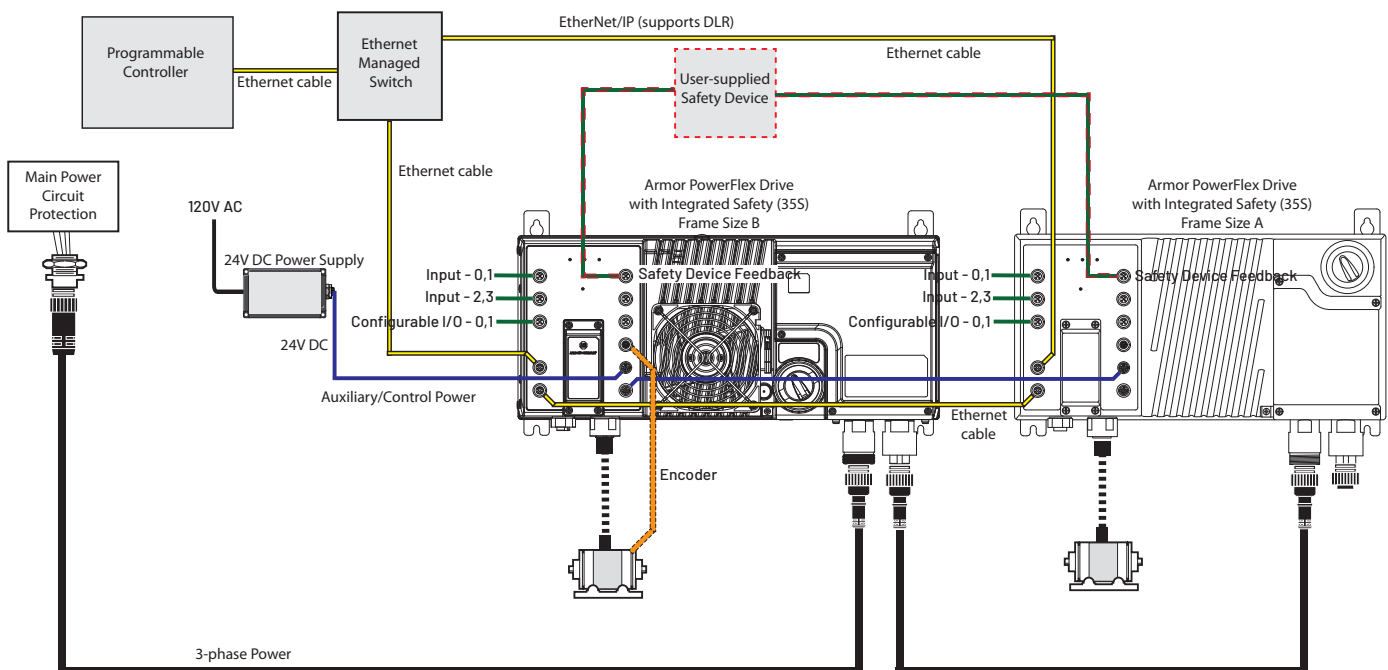
Hardwired STO

Armor PowerFlex safety drives use the STO connector for wiring external safety-devices and cascading hardwired safety-connections from one drive to another (see [Figure 10](#)).

IMPORTANT Safety inputs 0 and 1 support safety pulse test in hardwired safety operation. Safety inputs 2 and 3 do NOT support pulse test in hardwired mode.

IMPORTANT In hardwired safety mode only, one of the two safety input connectors can be used (either safety input 0 and 1 or safety input 2 and 3). Connecting a cable and safety device to both safety inputs connectors, in hardwired safety mode, will cause a safety fault that cannot be reset.

Figure 10 - Hardwired Safe Torque Off

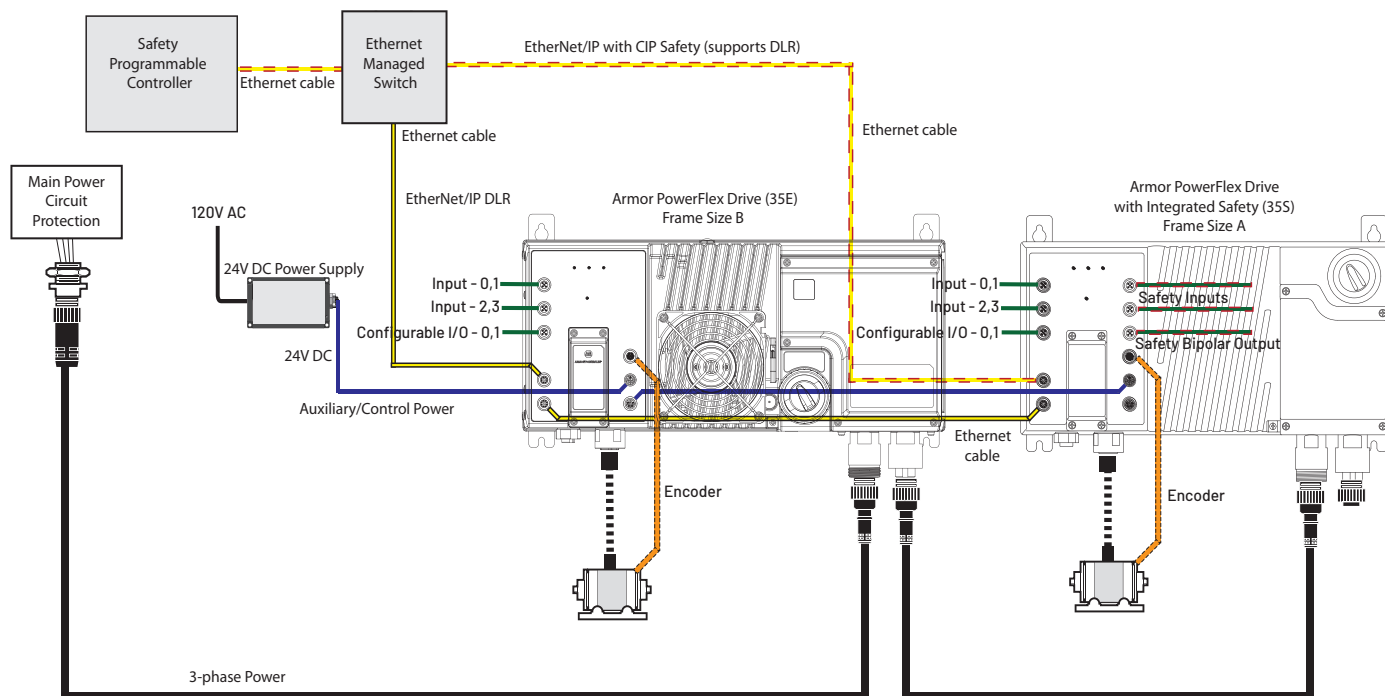


Integrated STO

The GuardLogix or Compact GuardLogix safety controller issues the STO or SS1 command over the EtherNet/IP network and the Armor PowerFlex drive executes the command.

In the example shown in [Figure 11 on page 32](#), a drive without the safety configuration (35E) makes the standard I/O connection and a separate Armor PowerFlex safety drive (35S) makes the safety-only I/O connection.

Figure 11 - Integrated Safe Torque Off (STO) or Timed Safe Stop (SS1)

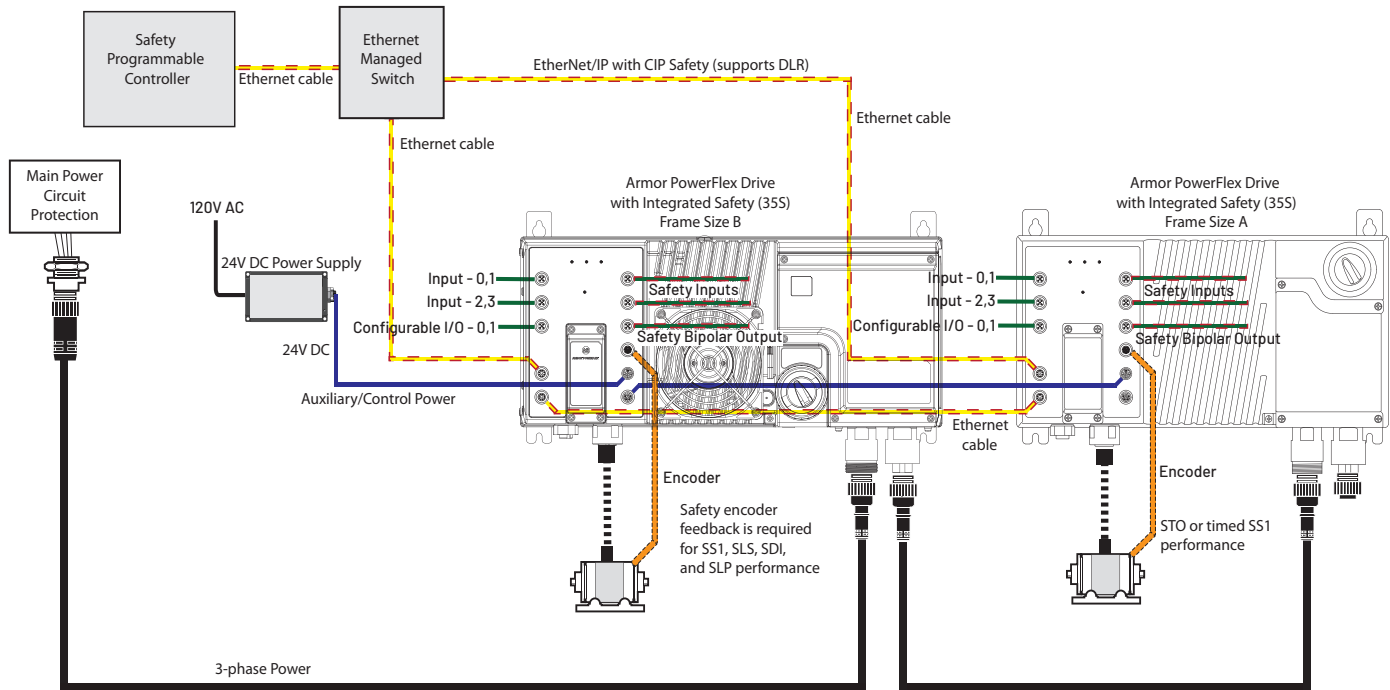


Integrated Safe Speed Monitoring

Armor PowerFlex drives are capable of safe stop and safe speed monitor functions via drive-based and controller-based integrated safety over the EtherNet/IP network (see [Figure 12](#)).

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

Figure 12 - Integrated Safe Speed Monitored



Notes:

Install the Armor PowerFlex Drive

This chapter provides installation information.

Unpack and Inspect

The installer/customer is responsible for thoroughly inspecting the equipment before accepting the shipment from the freight company. Check the items that are received against the purchase order. If any items are damaged, it is your responsibility not to accept delivery until the freight agent has noted the damage on the freight bill. If any concealed damage is found during unpacking, it is again your responsibility to notify the freight agent. Leave the shipping container intact and request the freight agent to make a visual inspection of the equipment.

Follow these steps to unpack and inspect the unit:

- Remove all packing material, wedges, or braces from within and around the Armor PowerFlex controller.
- Remove all packing material from the device or devices.
- Check the items nameplate numbers against the purchase order. See [Catalog Number Explanation on page 19](#) and for an explanation of the catalog number system that aids in nameplate interpretation.
- Contact your local Allen-Bradley distributor if any items are missing.

IMPORTANT	Before the installation and startup of the drive, you must perform a general inspection of mechanical integrity (for example: loose parts, wires, connections, packing materials, and so on).
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IMPORTANT	Locate and retain the red STO bypass plug that ships with the product. It can be used for product commissioning. See STO Bypass Operation on page 100 .
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Storage

The drive must remain in its shipping container before installation. If the equipment will not be used for some time, it must be stored according to the following instructions to maintain warranty coverage.

- Store in a clean, dry location.
- Store within an ambient temperature range of -25...+70 °C (-13...+158 °F).
- Store within a relative humidity range of 5...95%, noncondensing.
- Do not store equipment where it can be exposed to a corrosive atmosphere.
- Do not store equipment in a construction area.

Personal and Electrical Safety Precautions

In addition to the precautions listed throughout this manual, the following statements, which are general to the system, must be read and understood.



ATTENTION: Only trained and qualified personnel familiar with the controller and associated machinery can plan or implement the installation, startup, adjustment, and subsequent maintenance or repair of the system. You must have previous experience with and a basic understanding of electrical terminology, configuration procedures, required equipment, and safety precautions.



ATTENTION: An incorrectly applied or installed drive can damage components or reduce product life. Wiring or application errors, such as undersizing the motor, incorrect or inadequate AC supply, or excessive ambient temperatures, can result in malfunction of the system.



ATTENTION: If this equipment is used in a manner not specified by the manufacturer, the protection that is provided by the equipment, could be impaired.



ATTENTION: If a malfunction or damage occurs, make no attempt to repair. Return the module to the manufacturer for repair. Do not dismantle the module.



ATTENTION: The National Electrical Code® (NEC®), NFPA®79, and any other governing regional or local code overrules the information in this manual. Rockwell Automation cannot assume responsibility for the compliance or proper installation of the Armor PowerFlex drive or associated equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.



ATTENTION: This unit has remote sources of power. Disconnect all power sources before the cover is removed. Failure to comply could result in death or serious injury.
ATTENTION: Do not attempt to service internal components when the unit is energized. Complete lock out / tag out procedures for all input power sources.



ATTENTION: The drive contains high-voltage capacitors. After removal of the main power supply, the capacitor discharge process can take 30 seconds to several minutes before a safe voltage is reached. Before working on the drive, or before servicing any device on the motor side, follow the procedure [Test for Hazardous Voltage](#), starting on page 231, to verify that power is isolated and to verify that there are no hazardous voltages present. Use the test points under the power section door to confirm there are no hazardous AC line voltages (Test points: D1, D2, D3), and to confirm that the DC Bus capacitor bank voltage is at a safe level (Test points: DC+, DC-). After confirming no hazardous voltages are present at the test points under the power section door, open the power section cover to access the terminal block. Measure the input power on the L1, L2, and L3 of the exposed terminal block to verify that the power has been removed and that no hazardous voltage is present. Failure to verify that power is removed before working on the drive, or failure to verify that no hazardous voltages are present before working on the drive can result in personal injury or death. Darkened display light-emitting diode (LED) status indicators are not an indication that capacitors have discharged to safe voltage levels.



SHOCK HAZARD: To avoid electrical shock, open the appropriate upstream protection (disconnect switch or branch circuit protection) before connecting and disconnecting cables. Risk of shock exists. Unused receptacles must be capped, the environmental rating might not be maintained with uncapped receptacles. Do not operate controls or open covers without appropriate personal protective equipment. Failure to comply can result in serious injury or death.



WARNING: Circumstances that can cause an explosion could exist, which could lead to personal injury or death, property damage, or economic loss. Tripping of the instantaneous-trip circuit breaker is an indication that a fault current has been interrupted. Current-carrying components of a drive must be examined and replaced if they are damaged, to reduce the risk of fire or electrical shock.



ATTENTION: Solid-state equipment has operational characteristics that differ from the characteristics of electromechanical equipment. Safety Guidelines for the Application, Installation, and Maintenance of Solid-state Controls, publication [SGI-1.1](#), available from your local Rockwell Automation sales office or online at rok.auto/literature, describes some important differences between solid-state equipment and hard-wired electromechanical devices.

Precautions for Cold Temperature Conditions



ATTENTION: To make sure that the cables and the Armor PowerFlex connection points are at the same temperature within specifications at the time of installation, place the Armor PowerFlex and cables in an environment warmer than -25°C (-13°F) for a minimum of 1 hour, before connecting the cables to the Armor PowerFlex.



ATTENTION: Before operating a motor with the Armor PowerFlex in a $-25\text{...}-30^{\circ}\text{C}$ ($-13\text{...}-22^{\circ}\text{F}$) environment, power up the Armor PowerFlex for approximately 45 minutes, to allow the internal temperature to stabilize.

Precautions for Motor Start/Stop



ATTENTION: A contactor or other device that routinely disconnects and reapplies the AC line to the drive to start and stop the motor can cause drive hardware damage. The drive is designed to use start/stop command signals that start and stop the motor. When the start/stop command signal will also apply line side AC power concurrently, do not exceed one start/stop command signal per minute.

Avoid Electrostatic Discharge



ATTENTION: This Armor PowerFlex drive contains Electrostatic Discharge (ESD) sensitive parts and assemblies. Static control precautions are required when you install, test, service, or repair this assembly. Component damage can result if ESD control procedures are not followed. If you are not familiar with static control procedures, see an applicable ESD protection handbook.

Environmental Considerations



At the end of its life, this equipment must be collected separately from any unsorted municipal waste.

Lift Instructions

If you have a Frame B drive, you must perform the following lift procedure.



ATTENTION: All equipment and hardware that is used to lift the Armor PowerFlex drive must be properly sized and rated to lift and hold the weight of the drive safely. To guard against possible personal injury or equipment damage:

- Inspect all hardware for proper attachment before the drive is lifted.
- Do not allow any part of the drive or lift equipment to contact electrically charged conductors or components.
- Do not subject the drive to high rates of acceleration or deceleration during a lift or transportation.
- Do not allow personnel or their limbs directly beneath the drive during a lift.

Lift and Mount the Drive

Follow these steps to lift and mount the drive:

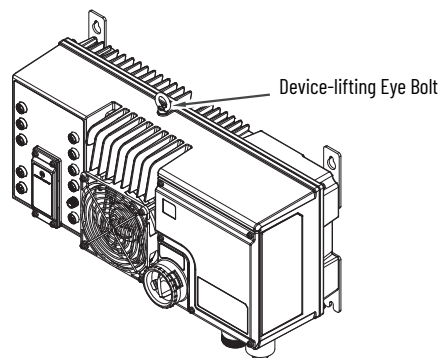
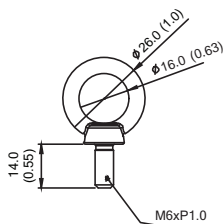
1. Remove the plug that covers the lifting hole, located on the top of the drive.
2. Tightly screw in the device-lifting metal eye bolt that is shipped with the drive.



ATTENTION: The eye bolt must be fully screwed in place before proceeding.

3. Insert and secure the appropriately-rated lifting hardware to the eye bolt.

Metal Eye Bolt Dimensions — mm (in)



ATTENTION: To guard against equipment damage, verify that the hardware is securely connected to the correct lifting hole in the drive as shown. Do NOT use connectors or splash shield to lift the drive.

4. Slowly lift the drive to an upright position and carefully transport it to the installation location.
5. Install the drive using one of the specified orientations as described in [Mounting Orientation](#).
6. After the drive is secured in place, remove the eye bolt and re-insert the plug.

Mounting Orientation

Standard orientation is with the X-axis horizontal (left-right), Y-axis vertically aligned with gravity, and the Z-axis out from a standard panel orientation; this results in the high-voltage connectors pointing toward the earth.

Acceptable limits of deviation from the standard orientation are as follows:

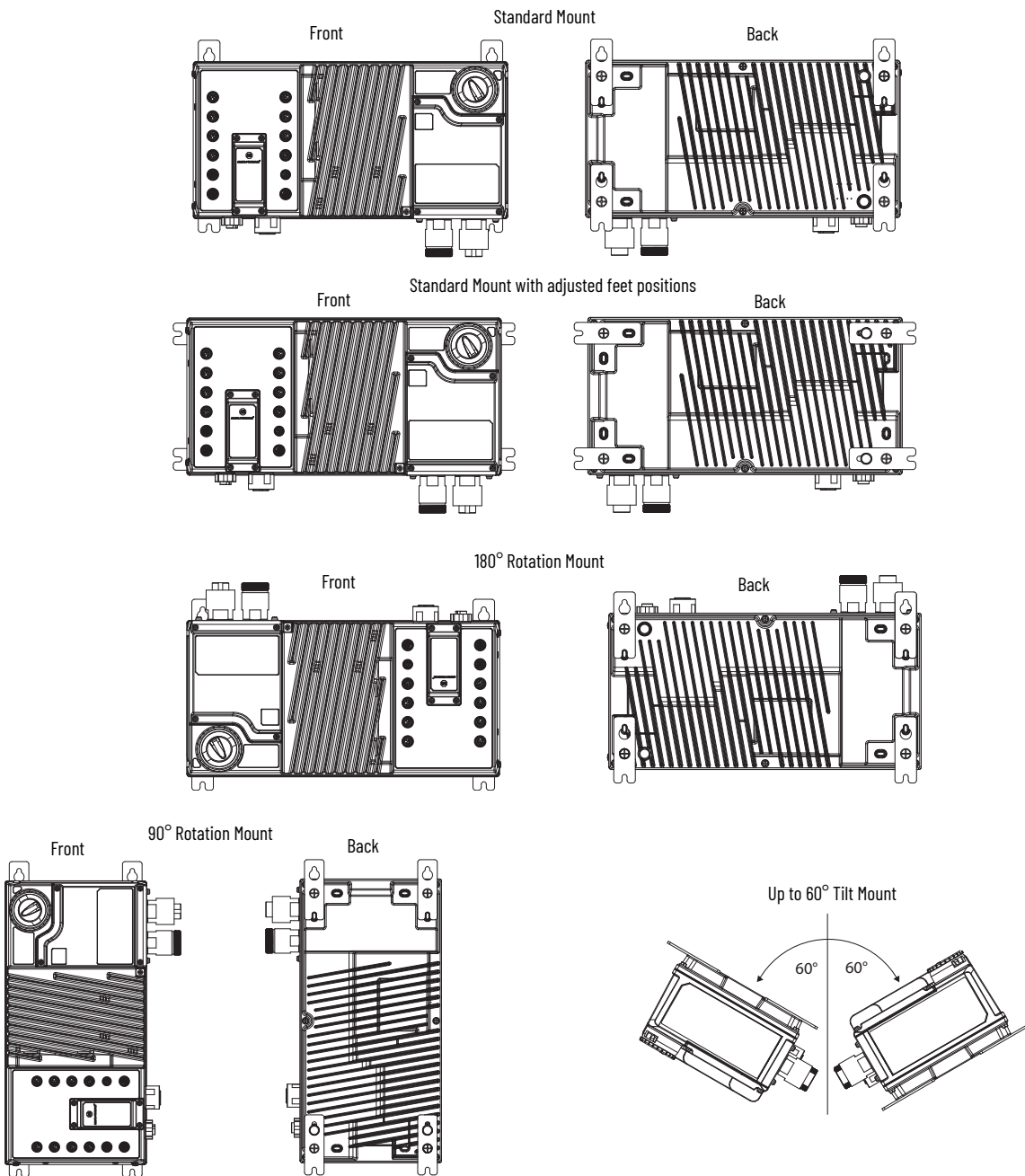
- Up to 60° tilt about the vertical axis (forward or back)
- 90° rotation (with local disconnect pointing up)
- 180° rotation (with high-voltage connectors pointing up)



ATTENTION: For proper heat dissipation and product operation, mount in one of the orientations shown in [Figure 13](#).

These deviations from the standard orientation may result in thermal or power derating. For additional details, see [Configure Motor Protection on page 168](#).

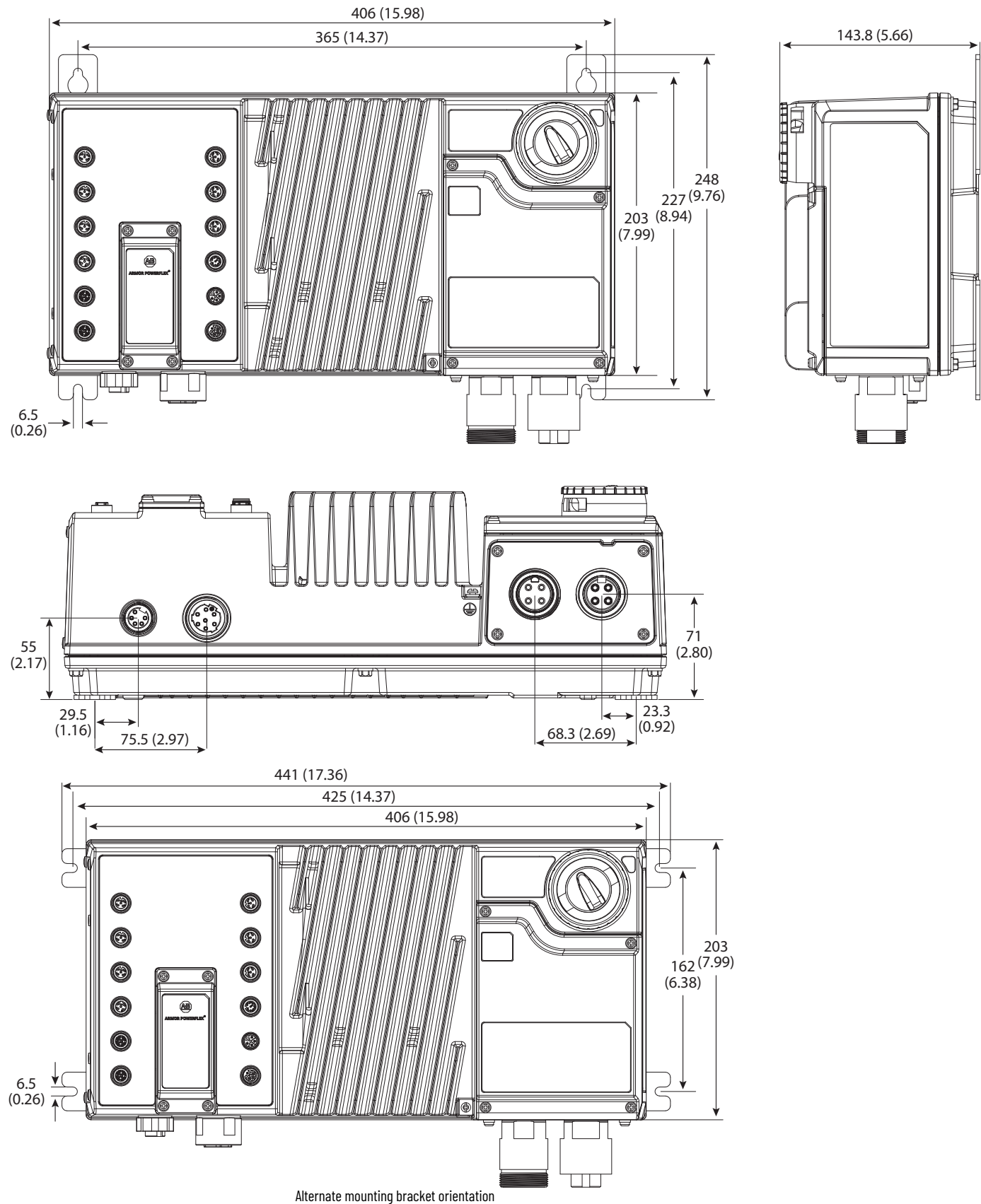
Figure 13 - Mount Positions with Mounting Feet Shown (Frame Size A shown in examples)



Armor PowerFlex Drive Dimensions

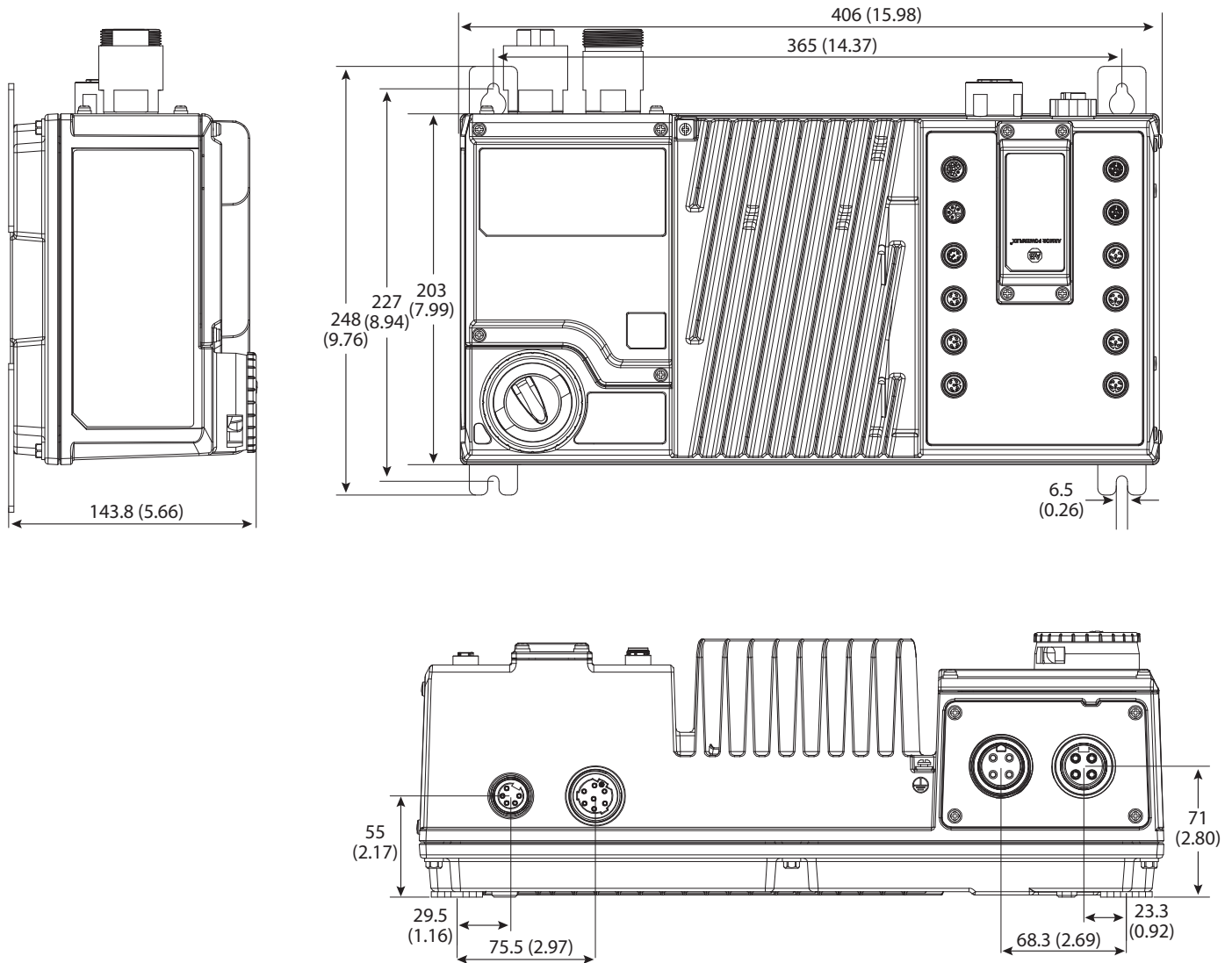
Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.

Figure 14 – Armor PowerFlex Frame Size A: Standard Mounting Position



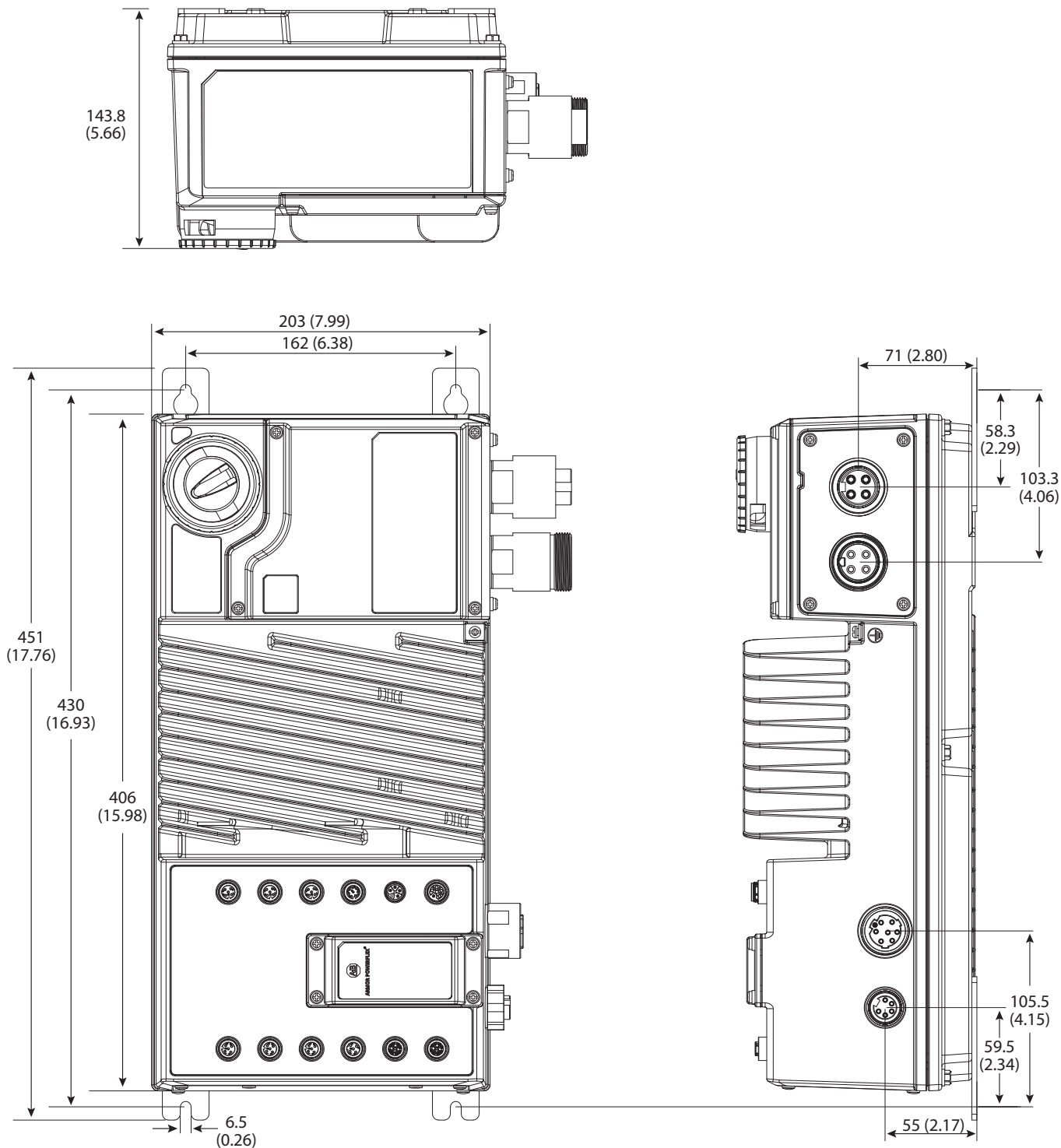
Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.

Figure 15 - Armor PowerFlex Frame Size A: 180° Mount Position



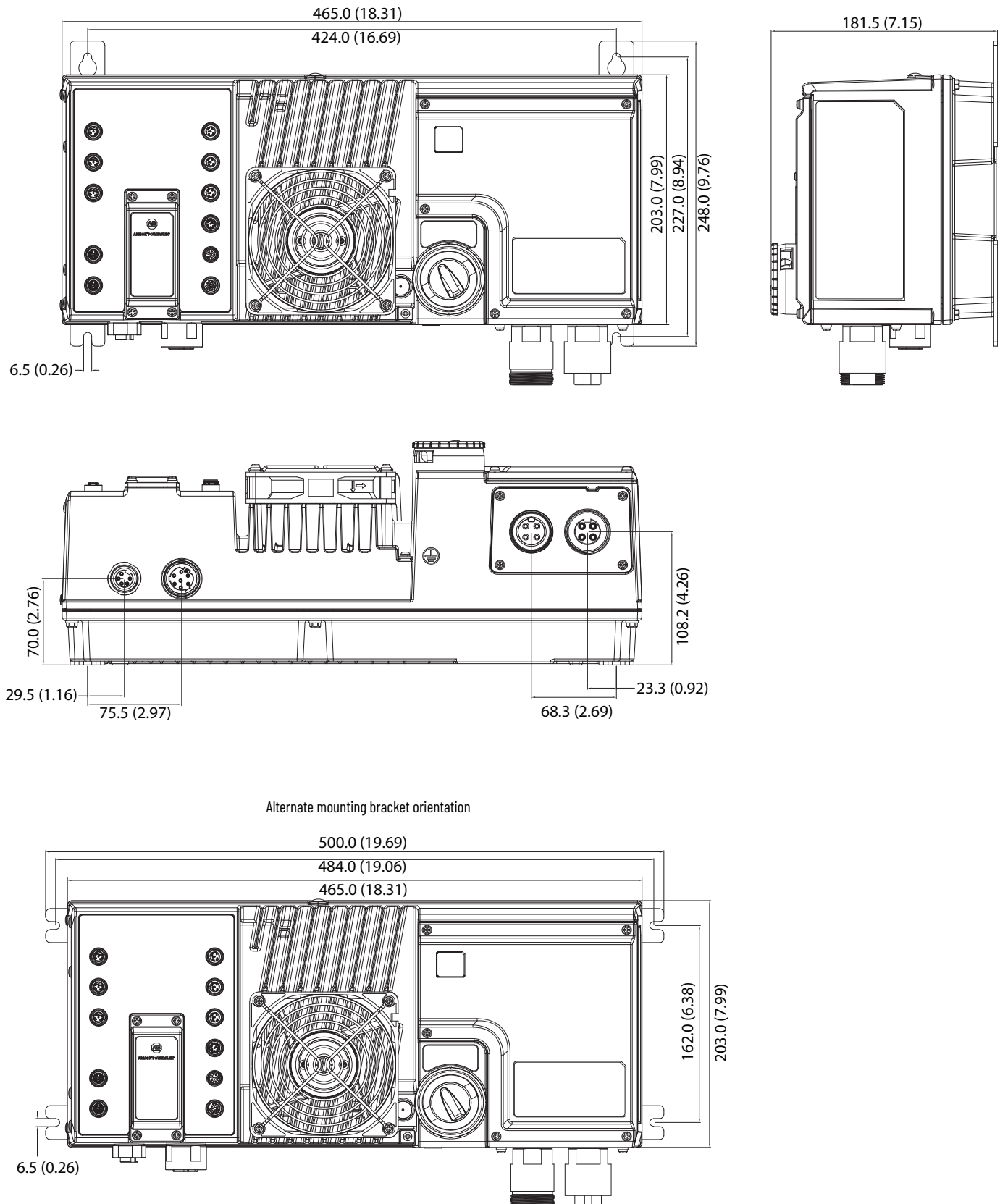
Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.

Figure 16 - Armor PowerFlex Frame Size A: 90° Mount Position



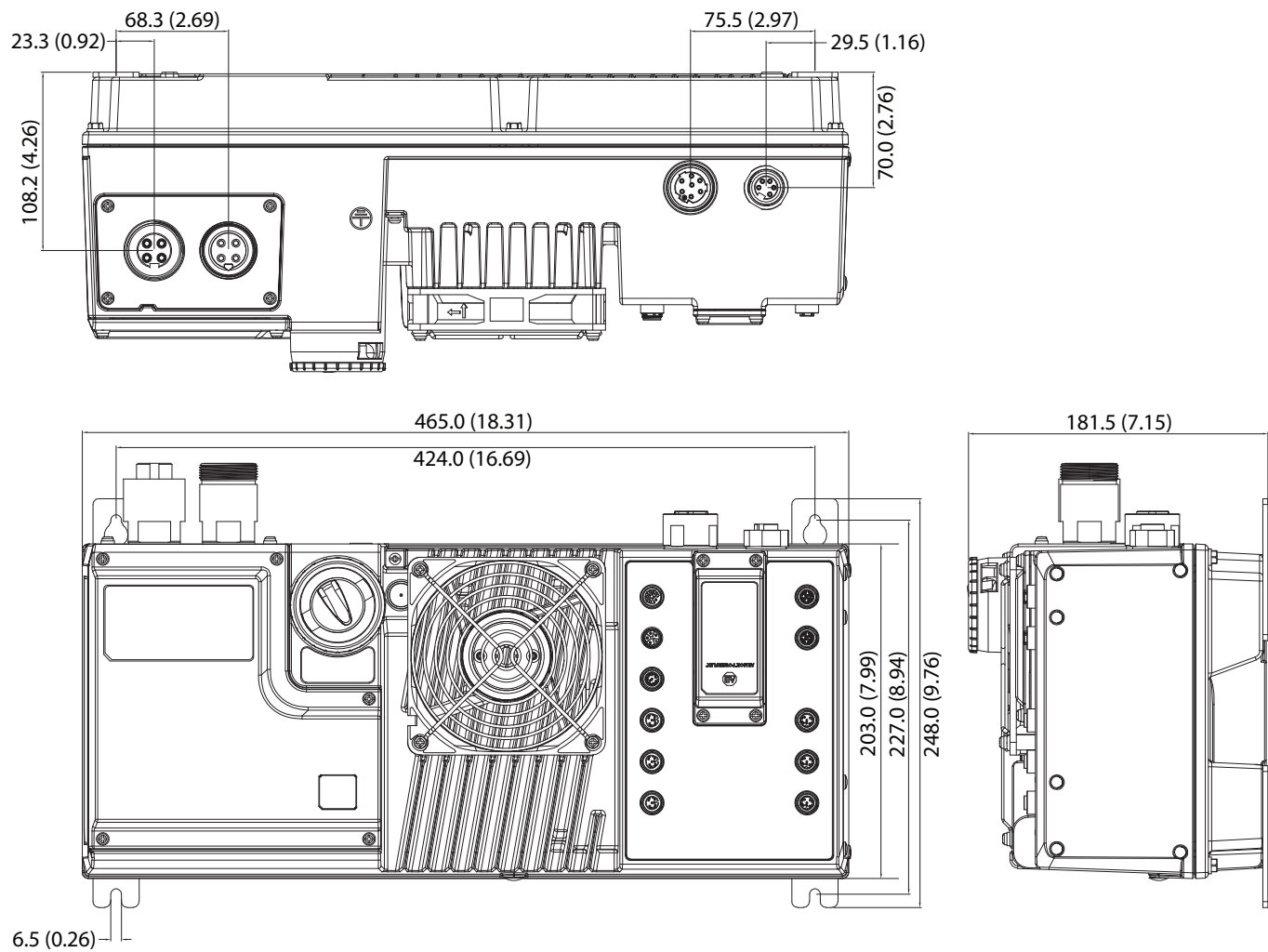
Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.

Figure 17 - Armor PowerFlex Frame Size B: Standard Mounting Position



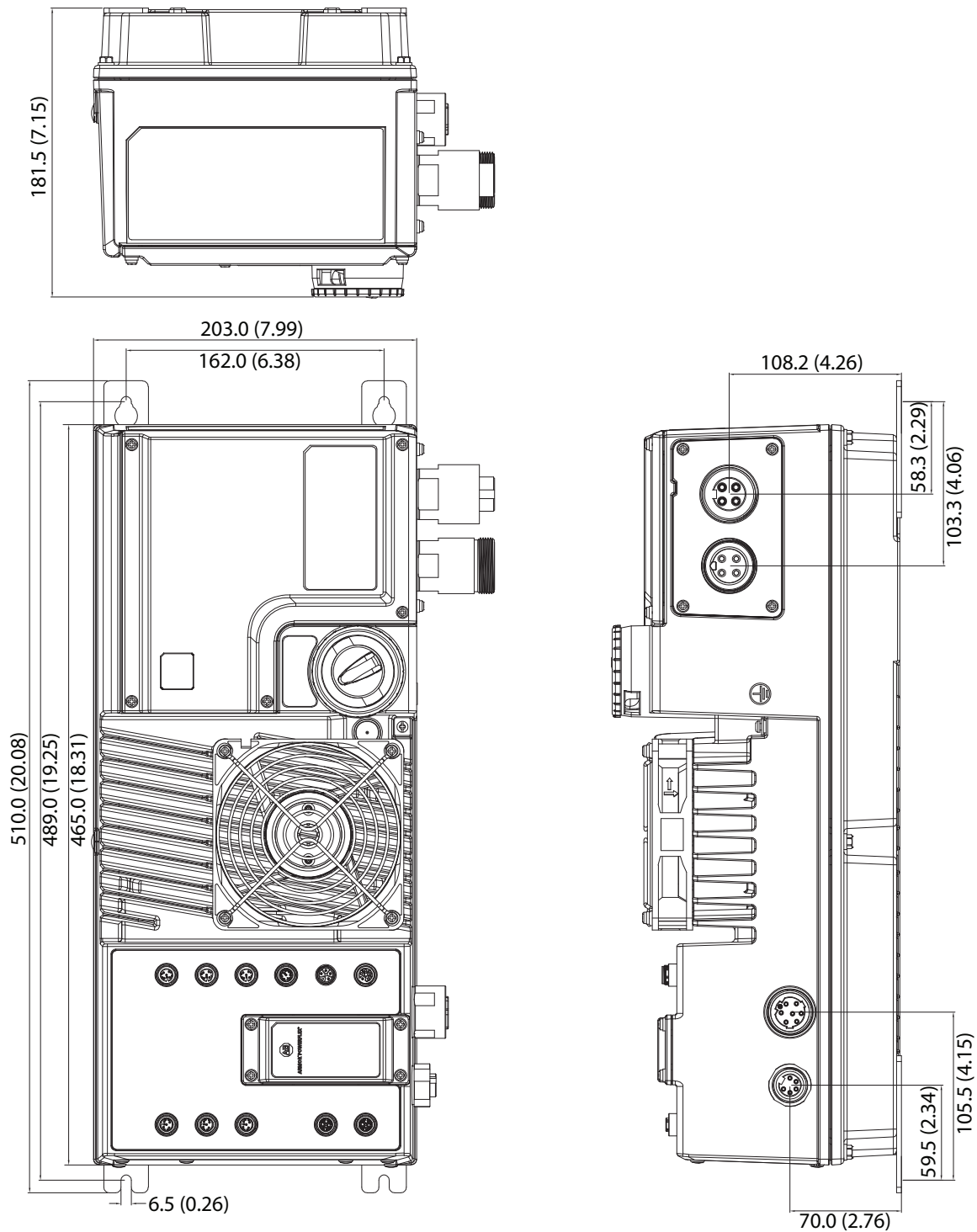
Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.

Figure 18 - Armor PowerFlex Frame Size B: 180° Mount Position



Dimensions are shown in millimeters (inches). Dimensions are not intended to be used for manufacturing purposes. All dimensions are subject to change.

Figure 19 - Armor PowerFlex Frame Size B: 90° Mount Position



Wiring and Workmanship Guidelines

In addition to conduit and seal-tite raceway, it is acceptable to use cable that is rated Tray Cable Exposed Runs (TC-ER), for power and control wiring on Armor PowerFlex installations. The National Electrical Code (NEC) and NFPA 79 outline the following guidance for installations in the USA and Canada.

In industrial establishments where the conditions of maintenance and supervision verify that only qualified persons service the installation, and where the exposed cable is continuously supported and protected against physical damage, by using mechanical protection, such as struts, angles, or channels, Type TC tray cable that complies with the crush and impact requirements of Type MC (Metal Clad) cable and is identified for such use with the marking Type TC-ER (Exposed Run) shall be permitted between a cable tray and the utilization equipment or device as open wiring. The cable shall be secured at intervals not exceeding 1.8 m (6 ft) and installed in a good workmanlike manner. Equipment grounding for the utilization equipment shall be provided by an equipment grounding conductor within the cable.

While the Armor PowerFlex drive is intended for installation in factory floor environments of industrial establishments, the following must be considered when locating the Armor PowerFlex drive in the application:

- Cables that include control voltage cables, for example, 24V DC and communications, are not to be exposed to operator or building traffic on a continuous basis.
- Location of the Armor PowerFlex drive to minimize exposure to continual traffic is recommended. If location to minimize traffic flow is unavoidable, other barriers to minimize inadvertent exposure to the cabling must be considered.
- Cables must be routed to minimize inadvertent exposure and/or damage.
- If conduit or other raceways are not used, we recommend that strain relief fittings be used when installing the cables for the control and power wiring through the conduit openings.
- Power cabling, such as three-phase, source brake, and dynamic brake, must be kept at least 150 mm (6 in.) away from the EtherNet/IP network and I/O cables to avoid noise issues.

See [Wiring on page 47](#) for additional cable location requirements.

Electromagnetic Compatibility

The following guidelines are provided for Electromagnetic Compatibility (EMC) installation compliance.

Cabling and Grounding

IMPORTANT	<p>For EMC, the motor cable connector that is selected must provide good 360° contact and low transfer impedance from the shield or armor of the cable to the conduit entry plate at both the motor and the Armor PowerFlex drive, for electrical bonding.</p> <p>The motor cable must be kept as short as possible to avoid electromagnetic emissions and capacitive currents. CE conformity of Armor PowerFlex drive with EMC Directive does not confirm that the entire machine installation complies with CE EMC requirements.</p>
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The Electromagnetic Interference (EMI) filter can achieve relatively high ground leakage currents. Therefore, the filter must only be used in installations that are solidly grounded (bonded) to the building power distribution ground. Grounding must not rely on flexible cables and must exclude any form of plug or socket that would permit inadvertent disconnection. Some local codes can require redundant ground connections. The integrity of all connections must be periodically checked.

Wiring

Wire in an industrial control application can be divided into three groups: power, control, and signal. The following recommendations for physical separation between these groups, are provided to reduce the coupling effect:

- Minimum spacing between different wire groups in the same tray must be 16 cm (6 in.).
- Wire runs outside an enclosure must be run in conduit or have shielding/armor with equivalent attenuation.
- Different wire groups must be run in separate conduits.
- Minimum spacing between conduits that contain different wire groups must be 8 cm (3 in.).

Install Ethernet Cable Ferrite Cores

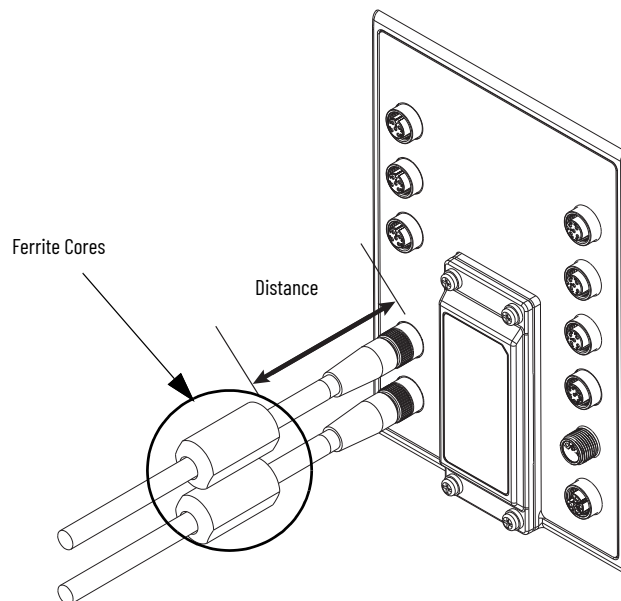
Ferrite core installation is required for series A, Armor PowerFlex drives.

Two ferrite cores are provided with each Armor PowerFlex (series A) drive.
Rockwell Automation part number: PN-699379
(Fair-Rite part number: 0431164281)

To maintain EMC compliance, the ferrite cores must be installed on each Ethernet cable, close to the connector. The distance from the end of the ferrite core to the end of the cable connector, should be approximately 13.5...14 mm (0.53...0.55 in.) See [Figure 20](#).

IMPORTANT Do not install the ferrite cores over any cable labels.

Figure 20 - Ethernet Cable Ferrite Cores



Product Grounding

Grounding is done for two basic reasons: safety, and noise containment or reduction. While the safety ground scheme and the noise current return circuit can sometimes share the same path and components, they must be considered different circuits with different requirements.

The objective of grounding is to verify that all metal work is at the same ground (or Earth) potential at power frequencies. Impedance between the drive and the building scheme ground, must conform to the requirements of national and local industrial safety regulations or electrical codes. These requirements vary based on country, type of distribution system, and other factors. Periodically check the integrity of all ground connections.

General safety dictates that all metal parts are connected to earth with separate copper wire or wires of the appropriate gauge. To determine the proper conductor size, see the NEC table 250.122 or your local electrical code. Most equipment has specific provisions to connect a ground and PE (protective earth) directly to it.

The following considerations apply to ungrounded and high resistive distribution systems:



ATTENTION: The Armor PowerFlex drive contains protective Metal Oxide Varistors (MOVs) that are referenced to a ground. These devices must not be disconnected or installed on an ungrounded and high resistive distribution system.



ATTENTION: Do not apply the EMI filter to grounded or ungrounded delta power source. The EMI requires a solidly grounded wye (Y) power source (for example, 480/277 or 400/230V AC, 3-phase power source). If applied to a grounded or ungrounded 480V AC delta power source, the EMI filter maybe damaged.

The installer can connect the product ground in two different ways.

- The first method is to use the conduit/cord gland plate or the factory installed quick connect power connectors.
- The second method is to connect the device's external ground to a solid earth ground connection.



ATTENTION: The Armor PowerFlex drive must be installed in a solidly-grounded (Delta/Wye with Grounded Wye Neutral) system.

The Armor PowerFlex requires a solidly-grounded system because it provides added protection and safety to the system. A solidly grounded system provides the following protection and safety features:

- Controlled path for common mode noise current produced by VFD
- Consistent line-to-ground voltage reference that minimizes insulation stress
- Accommodation for system surge protection schemes

For additional information, see Wiring and Grounding Guidelines for Pulse-width Modulated (PWM) AC Drives, publication [DRIVES-IN001](#).

Armor PowerFlex External Ground



If the product is mounted to a non-grounded surface, the installer must use a second ground that uses the external ground point.

The ground wire is sized according to the application needs and your local electrical code.

See the National Electrical Code (NEC) NFPA 70 and/or the Electrical Standard for Industrial Machinery, NFPA 79 for proper installation details.

The ground must be connected to earth ground. This ground point must be connected to adjacent building ground (girder, joist), a floor ground rod, busbar, or building ground grid. Grounding points must comply with national and local industrial safety regulations or electrical codes. Some codes can require redundant ground paths and periodic examination of connection integrity.



ATTENTION: To avoid electrolytic corrosion on the external earth terminal, avoid the spraying of moisture directly on the terminal. When used in washdown environments apply a sealant or other corrosion inhibitor on the external ground terminal to minimize any negative effects of galvanic or electro-chemical corrosion. Ground connections must be inspected regularly.

Shielding and Grounding of Motors and Motor Cables

The motor frame or stator core must be connected directly to the protective earth (PE) connection with a separate ground conductor. We recommend that each motor frame is grounded to building ground at the motor.

Motor Cable Considerations

Most recommendations about motor cable address issues come from the nature of the drive output. A pulse width modulation (PWM) drive creates AC motor current by sending DC voltage pulses to the motor in a specific pattern. These pulses affect the wire insulation and can be a source of electrical noise. The rise time, amplitude, and frequency of these pulses must be considered when choosing a wire/cable type. The choice of cable must consider:

1. The effects of the drive output after the cable is installed
2. The need for the cable to contain drive output noise
3. The amount of cable-charging current available from the drive
4. Possible voltage drop (and subsequent loss of torque) for long wire runs

Keep the motor cable lengths less than 14 m (45.9 ft) unless otherwise noted in the device specifications.

Unshielded Motor Cable

An unshielded motor cable is allowed for installations that do not require EMC compliance. The use of cables without shielding is generally acceptable for installations where drive electrical noise does not interfere with the operation of other devices such as: communication cards, photoelectric switches, weigh scales, and others. Be certain the installation does not require shielded cable to meet specific EMC standards for CE, RCM, FCC and any other applicable standards. The type of installation determines the cable specifications.



ATTENTION: Shielded motor cable is mandatory for EMC emission compliant installations.

Power Considerations

The following items should be considered for the power circuit design.



ATTENTION: As a standalone unit, this product does not comply with the harmonic emission and harmonic immunity requirements per EN 61000-3-2 and EN 61000-4-13, as referenced in EN 61800-3. It is thus only intended for use within a system which has been verified by the end user to meet these requirements. The system may use a 5%- line reactor for achieving compliance to these limits.
Cat. No. 1321-3R18-C line reactor is an available option.

Add Line Reactor

To minimize harmonics, we recommend adding a line reactor to the Armor PowerFlex input power using these guidelines.

- Rated voltage: 480V AC, minimum
- Rated current: The line reactor rated current should be based on the real current, not on the output rating of the Armor PowerFlex drive. For example, you could have an Armor PowerFlex Frame B drive rated at 17 A, but your application has a motor that draws only 10 A, then 10 A should be used as the criteria to select the line reactor rated current.
- Impedance: 5%

For additional information on selecting line reactors, see Line Reactors and AC Drives White Paper, publication [DRIVES-WP016](#).

Branch Circuit Protection Requirements

When using ArmorConnect three-phase power media or fixed wire (such as cord or conduit), with the Armor PowerFlex drive, protective devices that meet local applicable electrical codes can be used for the feeder branch circuit protection. The feeder protective device is intended to protect the line-side power conductors.



ATTENTION: Select the branch circuit protection that complies with NFPA 79 or NFPA 70 (NEC) and any other governing regional or local codes.



WARNING: If the branch circuit protective device trips, you must verify that the Source Brake function is still operational before putting the equipment back in service. If the source brake function is not working properly, loss of brake function or motor damage can occur.



WARNING: Do not install the Armor PowerFlex drive where the maximum available fault current exceeds the product rating.

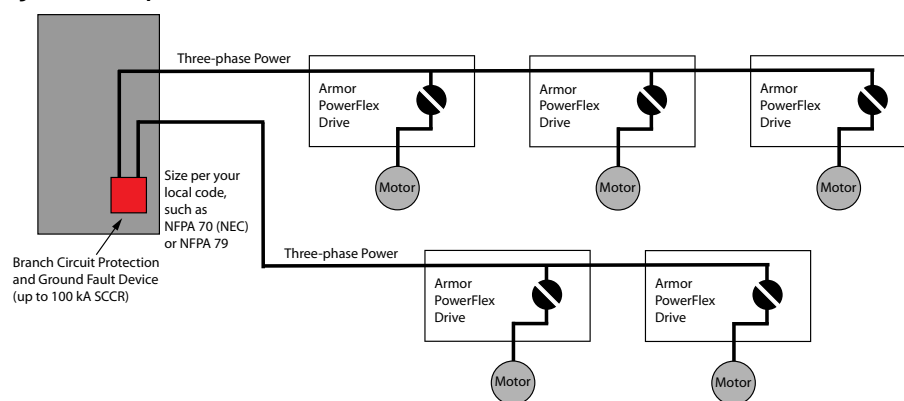
Group Motor Installations for USA and Canada Markets

The Armor PowerFlex drive integrates the motor branch short circuit and ground fault protection devices and it is considered self-protected. Therefore, no additional motor control branch circuit protection is required. Multiple Armor PowerFlex drives can be applied in a group application; as each Armor PowerFlex is self-protected. The installer must follow the local electrical codes for the protection of the feeder conductors using recommended branch circuit protection devices.

Motor cable assemblies are not supplied and have to be ordered separately. To comply with the UL Listing of the drive, use the Rockwell Automation® motor cable assembly that is specified by the instructions for the drive. See the On-Machine Media for Armor PowerFlex, ArmorStart, and ArmorConnect Products Selection Guide, publication, [280PWR-SG001](#).

[Figure 21 on page 51](#) shows an example that illustrates installations involving multiple motors with a single Branch Circuit Protection Device (BCPD) protecting the entire “Group”.

Figure 21 - Group Motor Installation



Rockwell Automation offers a wide range of branch circuit protection that will protect your branch circuit conductors that feed power to your Armor PowerFlex drive group.

Our molded case circuit breakers have multiple frame sizes to accommodate your required current ratings and breaking capabilities. These breakers provide protection of circuits against overload, short circuit, and ground fault. For more information, see [Molded Case Circuit Breakers](#).

Our disconnect switches are available in both fixed- and variable-depth styles with flange- or door-mounting styles. Our switches are NEMA, IEC, and UL rated. We offer a variety of fused and non-fused versions from 20...1250 A, in both open and enclosed configurations. For more information, see [Fusible Disconnect Switches](#).

Auxiliary Power Connections

The 24V DC auxiliary power is supplied by one or two external power supplies or by the optional internal power supply (IPS). If you choose an external power supply configuration, our current offering of auxiliary power cables and receptacles have an IP66, UL Type 1/12 rating. You must confirm that this rating is acceptable for the intended application.

Auxiliary power provides:

- Input/sensor power — sourced from unswitched 24V DC
- Output power — sourced from switched 24V DC
- Communications power — sourced from unswitched 24V DC

Power Supply Requirements

You can apply the Armor PowerFlex drive with an external 24V DC auxiliary power supply. The external auxiliary power supply will power up communication, inputs, and outputs. The external power supply provides unswitched and switched 24V DC to the Armor PowerFlex drive.



You can install, configure, and operate the I/O without three-phase power connected, if you order an Armor PowerFlex drive with the external power supply configuration and if you provide external unswitched 24V DC to the product.

To use Armor PowerFlex, you must choose a power supply that is suitable for your application and field I/O requirements. The Armor PowerFlex drive can source a class 2 circuit according to the NEC 725.60 standard, which covers unswitched power (for sensors) and/or switched power (for actuators).

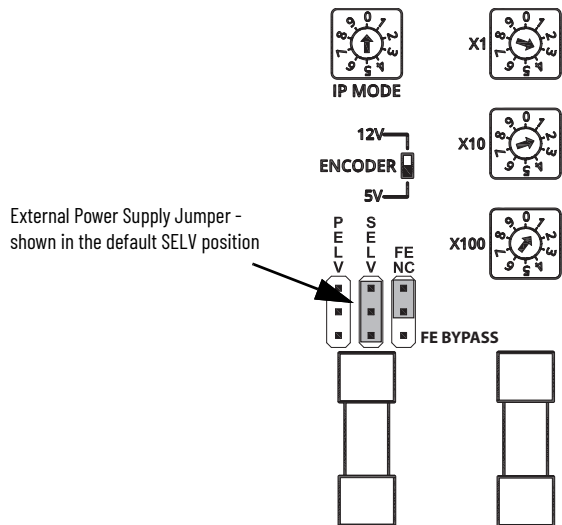
These are the requirements for an external auxiliary power supply:

- Rated for 24V DC nominal (tolerance 24V DC $\pm 15\%$)
- The supply should be PELV or SELV type
- The supply must be capable of 150% current boost power for at least one second

If you choose an external power supply, you must set the external power supply jumper to the type of your power supply (either PELV or SELV). The external power supply jumper is on the

I/O board, below the encoder power supply switch (see [Figure 22](#)). See [Remove Front Logic Cover on page 70](#) for information on how to gain access to the I/O board.

Figure 22 - External Power Supply Jumper



As an option, you can select an internal power supply (IPS). With this option selected, you do not require an external power supply. The Armor PowerFlex drive will internally source the 24V DC power for communications, inputs, and outputs.

The 24V DC IPS is sourced from the three-phase power coming into the Armor PowerFlex drive. The IPS circuitry connects to the line side of the local disconnect, which means that when the local disconnect on the Armor PowerFlex drive is in the Off position, the IPS will continue to provide 24V DC power. To shutdown the IPS output power, the main disconnect must be set to the Off position, to remove all three-phase power coming into the Armor PowerFlex drive.

When selecting the internal power supply option for the Armor PowerFlex (see [Internal Power Supply Wiring and Local Disconnect Behavior on page 54](#)), it can be considered a class 2 circuit as per the NEC 725.60 standard. This class covers unswitched power (for sensors) and/or switched power (for actuators). For more details, see the Armor PowerFlex AC Drives Specifications, publication [35-TD001](#).

IMPORTANT	There is an instantaneous inrush of 6.5 A for 15 milliseconds. The external 24V DC power supply must be able to support this demand when multiple Armor PowerFlex drives are turned ON simultaneously. For supplies without this capacity, we recommend applying unswitched power first and after a 2...4 second delay, apply switched power. If auxiliary power falls below 20.4V DC, there is a higher risk of communications issues or device faults.
IMPORTANT	Both a switched and unswitched 24V supply from this source are provided to the safety subsystem. The installer is responsible for providing safety power that is PELV or SELV rated.
IMPORTANT	To comply with the CE Low Voltage Directive (LVD), all connections to this equipment must be powered from a source compliant with the following: <ul style="list-style-type: none">• Safety extra low voltage (SELV) Supply• Protected extra low voltage (PELV) Supply• To comply with UL/cUL requirements, this equipment must be powered from a source compliant with the following: IEC 60950-1 Ed. 2.1, Clause 2.2 - SELV Circuits

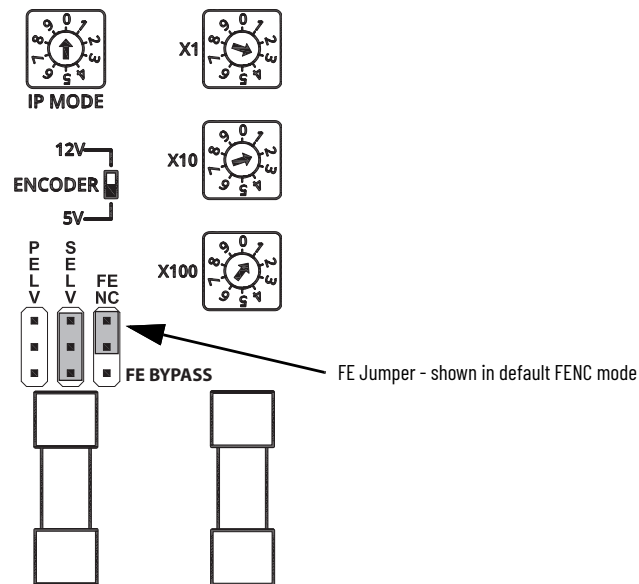
IMPORTANT The switched and unswitched circuits are Limited Voltage/Limited Current (LV/LC) according to UL 61800-5-1, which is equivalent to Limited-power circuits per 725.60 (A)(4) - Power Sources for Class 2 and Class 3 Circuits.

Field Earth Jumper

There is a “Field Earth” (FE) jumper that is located on the I/O board. The purpose of the FE jumper is to filter the noise on the auxiliary (AUX) power rail.

- Connect the FE jumper to pin 1 and pin 2 of the B17 connector to configure the drive into the Field Earth Not Connected (FENC) mode.
- Connect the FE jumper to pin 2 and pin 3 of the B17 connector to configure the drive into the Field Earth (bypass) mode.

Figure 23 - FE Jumper



The default position of the FE jumper is in the FENC mode. Do **not** change this position if there are other Armor PowerFlex drives that are not daisy-chained with AUX 24V power, because the Field Earth pin on the AUX POWER IN connector is connected to field earth irrespective of FE jumper position.

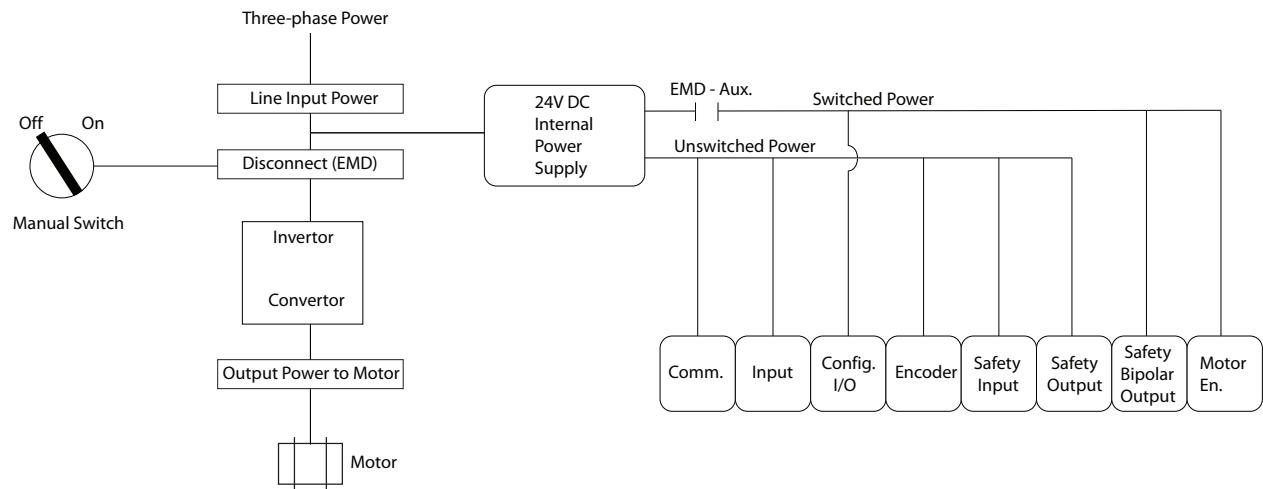
Change the jumper position to the Field Earth mode when there are other Armor PowerFlex drives that are daisy chained with AUX 24V power. This helps to filter the noise on the AUX 24V power cable in this daisy-chained drive configuration. See [Table 5](#).

Table 5 - Field Earth Jumper Configuration

Field Earth Jumper Position	Description
Pin 1 to Pin 2 (default)	Field Earth Not Connected (FENC) mode: For multiple drives that are not daisy chained with 24V auxiliary power.
Pin 2 to Pin 3	Field Earth mode: For multiple drives that are daisy chained with 24V auxiliary power.

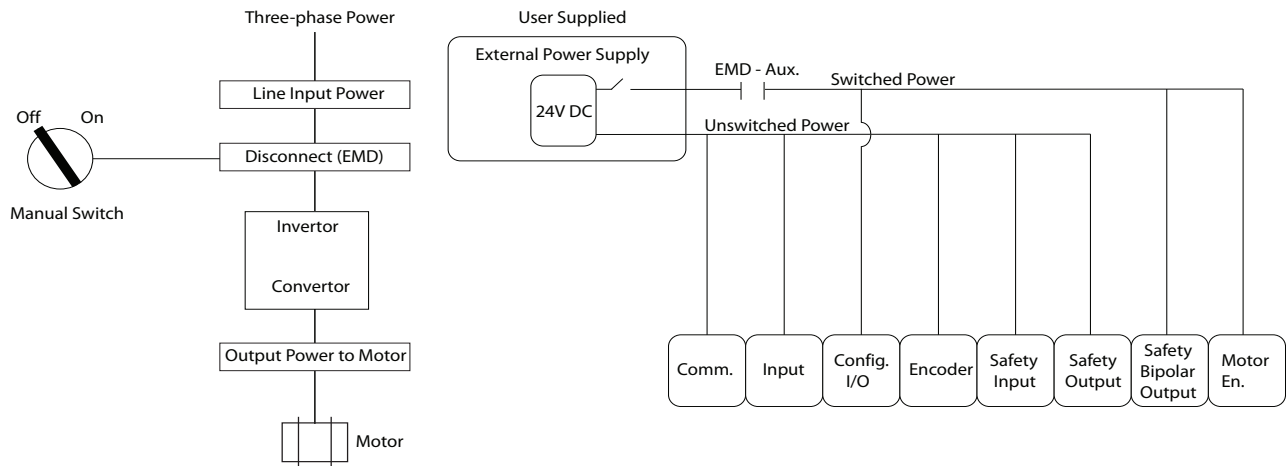
Internal Power Supply Wiring and Local Disconnect Behavior

Figure 24 - Internal Power Supply (optional)



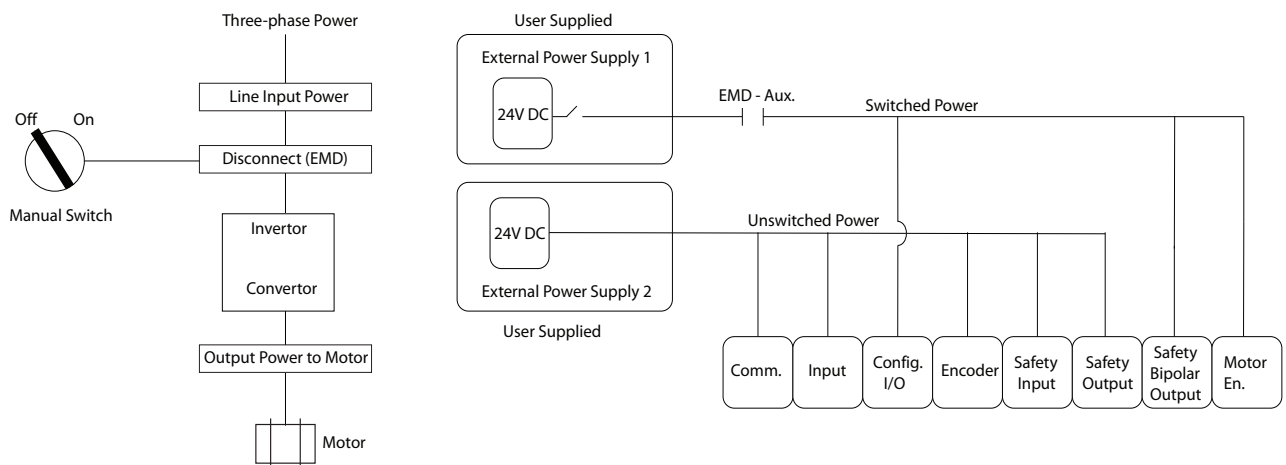
Single External Power Supply Wiring and Local Disconnect Behavior

Figure 25 - Single External Power Supply



Multiple External Power Supply Wiring and Local Disconnect Behavior

Figure 26 - Multiple External Power Supplies



Power Terminal Location and Internal Wiring

Figure 27 - Armor PowerFlex Safety Drive Terminals

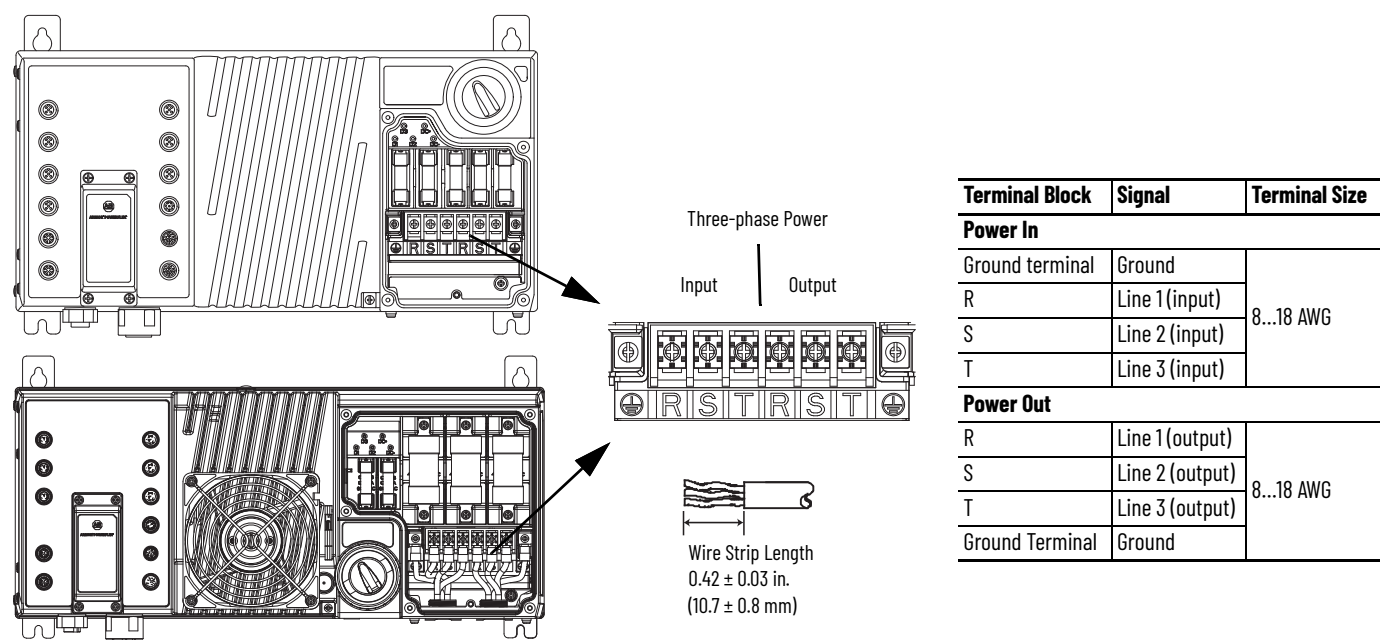
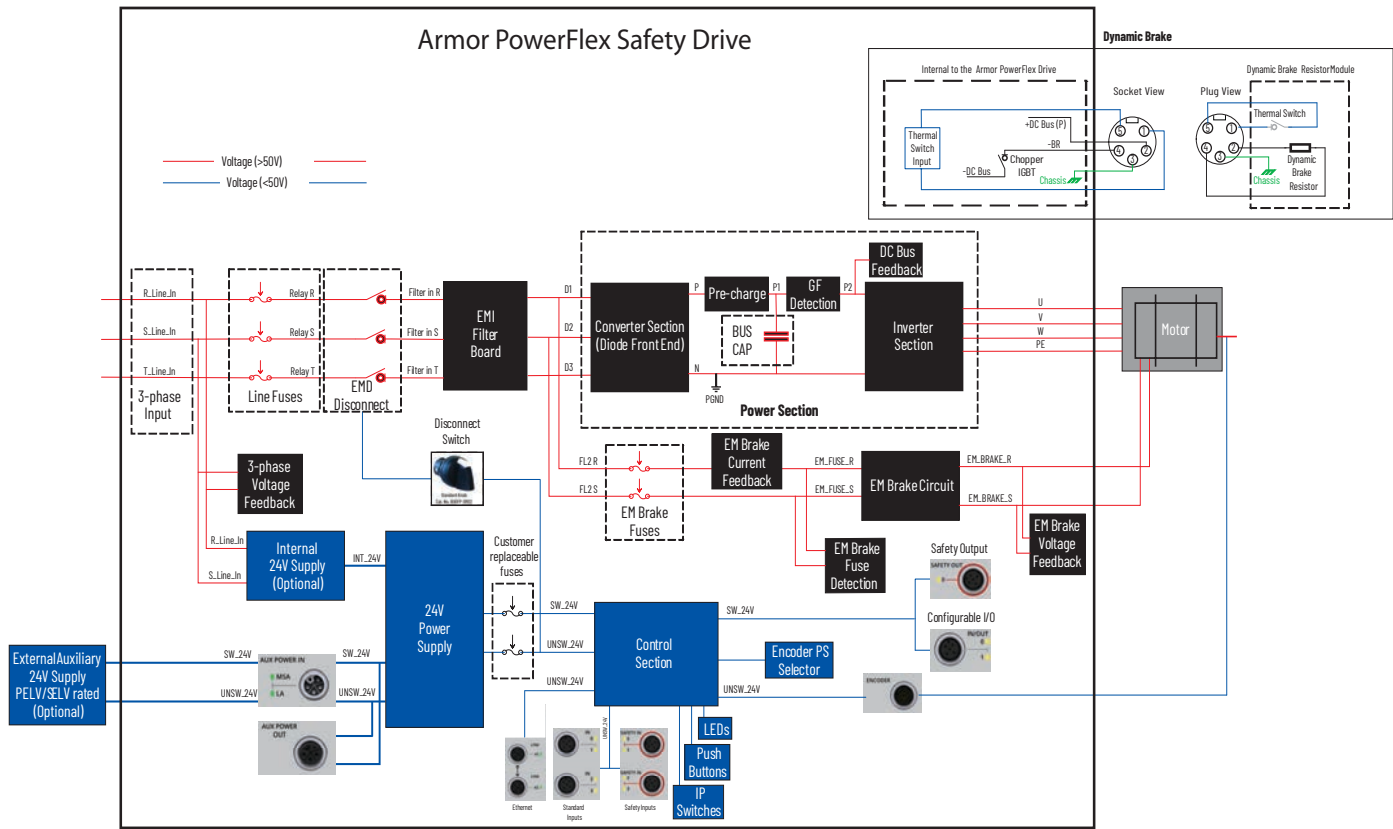


Figure 28 - Bulletin 35S — Integrated Safety Version Armor PowerFlex Drive Internal Wiring



IMPORTANT The Electronic Motor Disconnect (EMD) board monitors when the Armor PowerFlex gets a fault. The CPU (Armor PowerFlex firmware) provides a signal to the EMD indicating if a fault is present. When a fault is present, the EMD disconnect opens. When a Dynamic Brake is used, this functionality will serve as an isolating contactor. For additional information about the EMD, see the [Local Disconnect Behavior on page 66](#). For details about not using an isolating contactor, see [Configure Dynamic Brake on page 181](#).

Figure 29 - Bulletin 35E – Armor PowerFlex Standard Drive Terminals

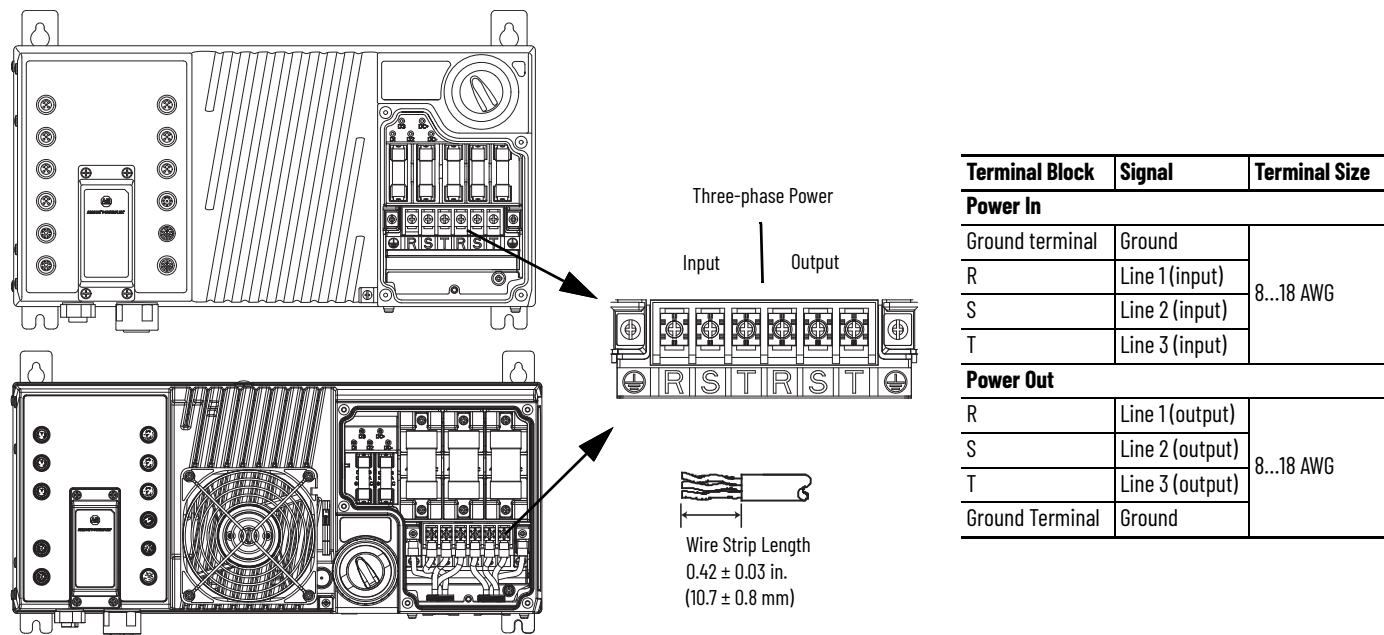
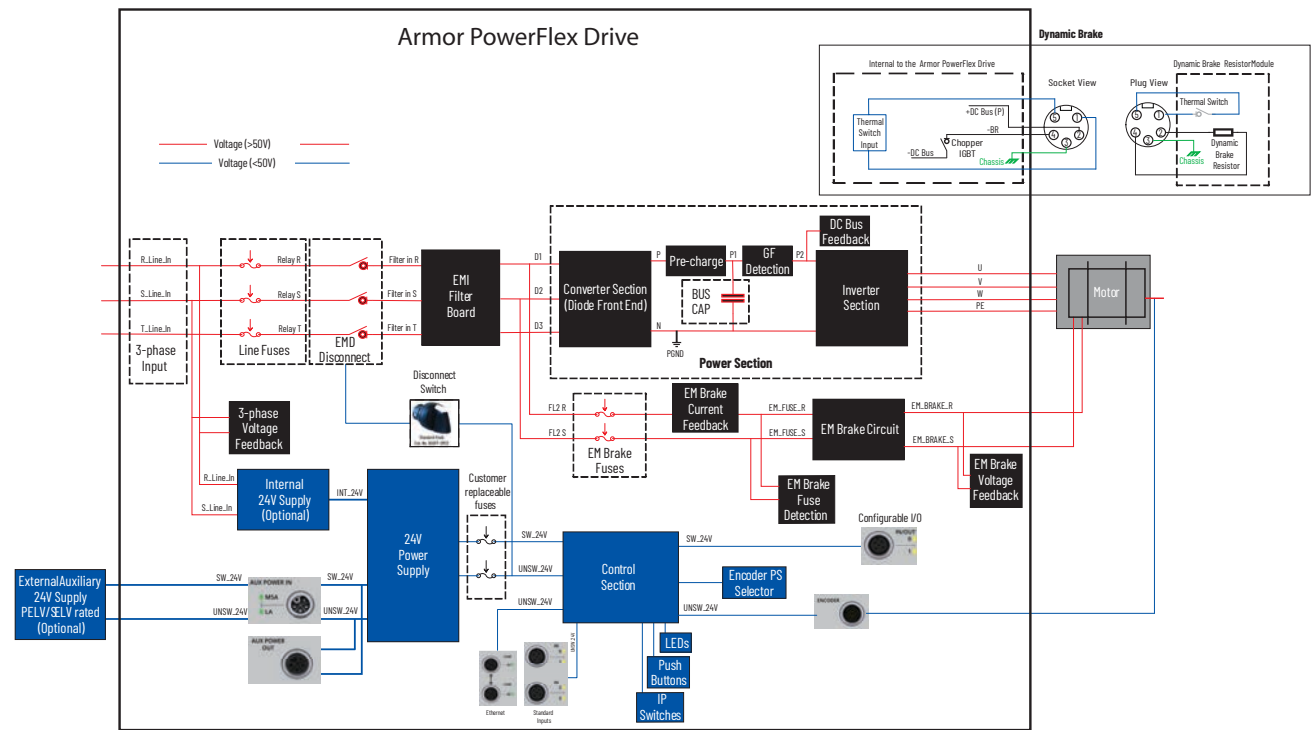


Figure 30 - Bulletin 35E – Standard Version Armor PowerFlex VFD Internal Wiring



IMPORTANT The Electronic Motor Disconnect (EMD) board monitors when the Armor PowerFlex gets a fault. The CPU (Armor PowerFlex firmware) provides a signal to the EMD indicating if a fault is present. When a fault is present, the EMD disconnect opens. When a Dynamic Brake is used, this functionality will serve as an isolating contactor. For additional information about the EMD, see the [Local Disconnect Behavior on page 66](#). For details about not using an isolating contactor, see [Configure Dynamic Brake on page 181](#).

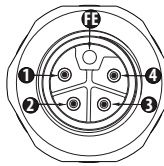
Connector Pinouts and Cable Torques

IMPORTANT You must connect cables properly and use sealing caps or dust covers as needed, to achieve specified enclosure ratings.

Power and Motor Connector Pinouts and Cable Torques

IMPORTANT The Armor PowerFlex drive includes a rubber sealing boot which is required to be installed when the drive's 3-phase power out circuit is not in use. This condition can apply when Armor PowerFlex drives are **not** daisy chained together or when the drive is the last unit in a daisy chain configuration.

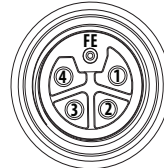
Auxiliary Power IN (M12, plug) ^(a)



Pin 1: +24V unswitched power (sensor power) (brown)
 Pin 2: Switched power ground (white)
 Pin 3: Unswitched power ground (blue)
 Pin 4: +24V switched power (black)
 FE: FE pass-through jumper (gray)

Cable Connector Torque
 0.6...0.65 N•m (5.3...5.8 lb•in)

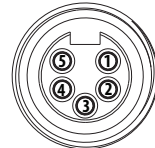
Auxiliary Power OUT (M12, socket)



Pin 1: +24V unswitched power (sensor power) (brown)
 Pin 2: Switched power ground (white)
 Pin 3: Unswitched power ground (blue)
 Pin 4: +24V switched power (black)
 FE: FE pass-through jumper (gray)

Cable Connector Torque
 0.6...0.65 N•m (5.3...5.8 lb•in)

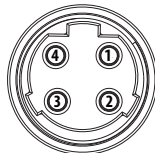
Dynamic Brake Connection (M22, socket)



Pin 1: DB temp SW-
 Pin 2: DB resistor T1
 Pin 3: Chassis (PE)
 Pin 4: DB resistor T2
 Pin 5: DB temp SW+

Cable Connector Torque
 1.69 N•m (15 lb•in)

Motor without EM brake (M29, socket)



Pin 1: Motor T1 (black)
 Pin 2: Motor T2 (white)
 Pin 3: Motor T3 (red)
 Pin 4: Ground (green/yellow)

Cable Connector Torque
 2.26 N•m (20 lb•in)

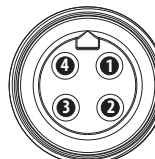
Motor with EM brake (M29, socket)



Pin 1: Motor T1 (black)
 Pin 2: Motor T2 (white)
 Pin 3: Motor T3 (red)
 Pin 4: Ground (green/yellow)
 Pin 5: EM brake T1
 Pin 6: EM brake T2
 Pin 7: Drain wire

Cable Connector Torque
 2.26 N•m (20 lb•in)

Three-Phase Power IN with Round Connector (M35, plug)



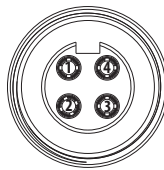
Pin 1: L1 (black)
 Pin 2: Ground (green/yellow)
 Pin 3: L3 (red)
 Pin 4: L2 (white)

Use when application requires UL or CE compliance as standard

Cable Connector Torque
 4.52 N•m (40 lb•in)

(a) The maximum Auxiliary Power IN cable length is 20 m (65.6 ft). A maximum of two cables can be connected in series to achieve the desired overall length – not to exceed 20 m (65.6 ft).

Three-Phase Power OUT with Round Connector (M35, socket)

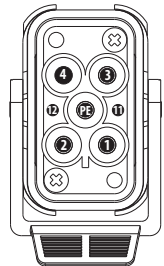


- Pin 1: L1 (black)
- Pin 2: Ground (green/yellow)
- Pin 3: L3 (red)
- Pin 4: L2 (white)

Use when application requires UL or CE compliance as standard

Cable Connector Torque
4.52 N•m (40 lb•in)

Three-Phase Power IN with Square Connector – plug

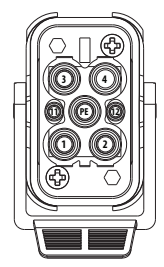


- Pin 1: Line input 1
- Pin 2: Line input 2
- Pin 3: Line input 3
- Pin 4: not used
- Pin 11: not used
- Pin 12: not used
- Center Pin: Chassis (PE)

Use when application requires CE compliance as standard

Cable Connector Torque
Snap in place (no torque)

Three-Phase Power OUT with Square Connector – socket



- Pin 1: Line input 1
- Pin 2: Line input 2
- Pin 3: Line input 3
- Pin 4: not used
- Pin 11: not used
- Pin 12: not used
- Center Pin: Chassis (PE)

Use when application requires CE compliance as standard

Cable Connector Torque
Snap in place (no torque)

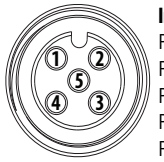
Standard I/O Connector Pinouts and Cable Torques

ATTENTION: No power should be applied to the input connectors. The 24V and Chassis (PE) terminals are only meant to supply power from the Armor PowerFlex drive to external sensor devices (power output). If the drive is powered via the input connectors, there is no fuse protection on the 24V supply and an input power overcurrent fault will occur, that cannot be cleared.

The following characteristics are common to the I/O connections for Armor PowerFlex standard versions:

- 5-pin female connectors (M12)
- Four fixed inputs (two per connector)
- Two configurable points on one connector

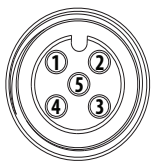
I/O Standard Input (M12, socket)



- Input**
- Pin 1: +24V unswitched (sensor) power
 - Pin 2: Input n+1
 - Pin 3: Input Common
 - Pin 4: Input n
 - Pin 5: Chassis (PE)

Cable Connector Torque
0.5...0.6 N•m (4.4...5.3 lb•in)
(hand tight)

I/O Configurable Input or Output (M12, socket)



- Input**
- Pin 1: +24V switched power
 - Pin 2: Input 1
 - Pin 3: I/O Common
 - Pin 4: Input 0
 - Pin 5: Chassis (PE)

- Output**
- Pin 1: Not used (+24V)
 - Pin 2: Output 1
 - Pin 3: I/O Common
 - Pin 4: Output 0
 - Pin 5: Chassis (PE)

Cable Connector Torque
0.5...0.6 N•m (4.4...5.3 lb•in)
(hand tight)

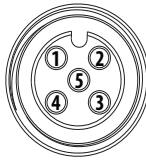
Safety I/O Connector Pinouts and Cable Torques

The following input and output characteristics are common to the I/O connections for Armor PowerFlex safety versions:

- Four single-channel or two dual-channel 24V DC safety input
- Two single-channel 24V DC test output
- One bipolar 24V DC safety output

For specific user safety I/O wiring examples, see [Safety Drives Configuration on page 31](#).

I/O Safety: Configurable 2-channel safety input with test outputs (M12, socket)



Pin 1: Test Output 1
Pin 2: Safety Input n+1
Pin 3: Common
Pin 4: Safety Input n
Pin 5: Test Output 0

Cable Connector Torque
0.5...0.6 N•m (4.4...5.3 lb•in)
(hand tight)

I/O Safety: Configurable bipolar output (M12, socket)

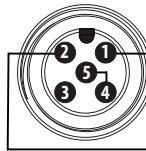


Pin 1: NC (no connection)
Pin 2: Output n (N) sinking
Pin 3: Output Power Common
Pin 4: Output n (P) sourcing
Pin 5: Output Power Common

Cable Connector Torque
0.5...0.6 N•m (4.4...5.3 lb•in)
(hand tight)

I/O Safety: Jumper Bypass Plug

Used when no cables are connected to the safety inputs. Only one jumper is required and can be attached to Safety In 0/1 or Safety In 2/3 (but not both), to enable torque in hardwired mode.



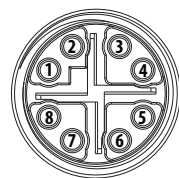
Pin 1: connect to Pin 2
Pin 2: connect to Pin 1
Pin 3: NC (no connection)
Pin 4: connect to Pin 5
Pin 5: connect to Pin 4

Cable Connector Torque
0.5...0.6 N•m (4.4...5.3 lb•in)
(hand tight)

Ethernet Connector Pinouts and Cable Torque

The Armor PowerFlex drive uses a sealed X-coded M12 (micro) style Ethernet connector.

EtherNet 1 GB (M12, socket)



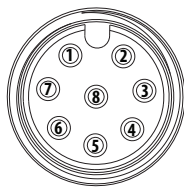
Pin 1: D1+ (white/orange)
Pin 2: D1- (orange)
Pin 3: D2+ (white/green)
Pin 4: D2- (green)
Pin 5: D4+ (white/brown)
Pin 6: D4- (brown)
Pin 7: D3- (blue)
Pin 8: D3+ (white/blue)

Cable Connector Torque
0.5...0.6 N•m (4.4...5.3 lb•in)
(hand tight)

Encoder Connector Pinouts and Cable Torque

Encoder systems are sensors that are mounted on the rotor shaft that can record information about the instantaneous rotor position and speed.

Encoder (M12, socket)^(a)

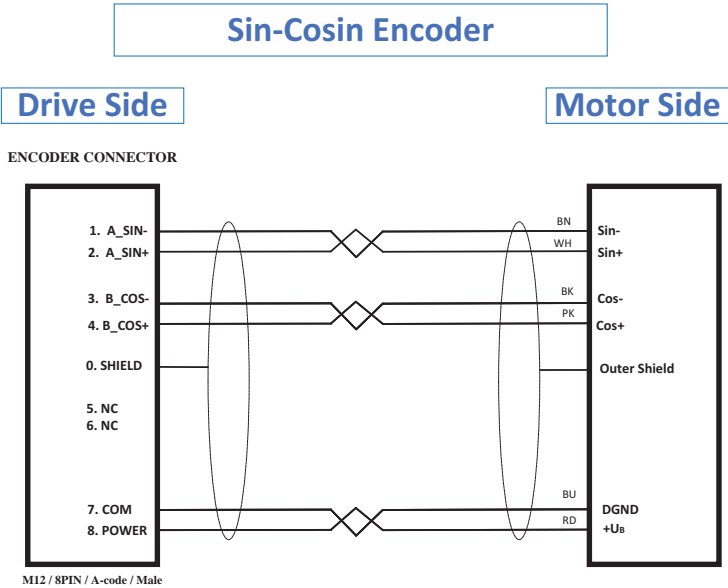


- Pin 1: Output A, SIN- (white)
- Pin 2: Output A, SIN+ (brown)
- Pin 3: Output B, COS- (green)
- Pin 4: Output B, COS+ (yellow)
- Pin 5: not used (grey)
- Pin 6: not used (pink)
- Pin 7: Encoder supply ground (blue)
- Pin 8: Encoder supply power (5V or 12V) (red)

Cable Connector Torque
0.5...0.6 N•m (4.4...5.3 lb•in)
(hand tight)

Encoder Wiring Examples

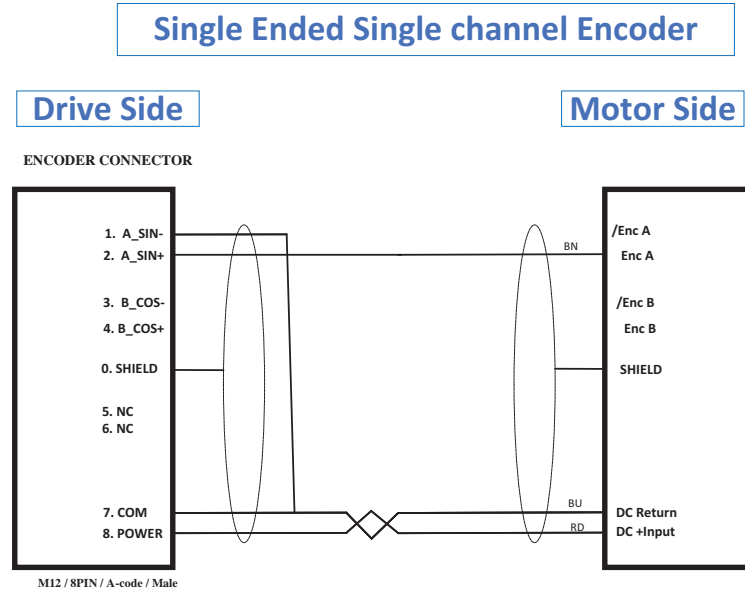
Sin-Cosin Encoder Wiring Example



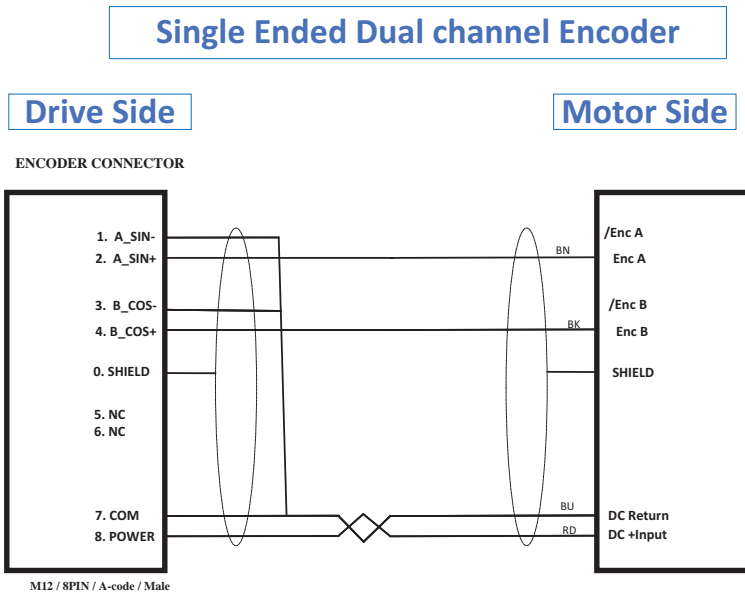
When using a safety sine/cosine encoder, the cable shield must be connected to ground on both sides to ensure fault-free operation. (On the Armor PowerFlex side it is done by M12 connector, on the encoder side it can be typically done by connecting the shield of the cable with the connector housing.) If you use an encoder without cable shield connection capability, it is acceptable to leave the shielding grounded only on the Armor PowerFlex side.

(a) The maximum Encoder cable length is 20 m (65.6 ft). A maximum of two cables can be connected in series to achieve the desired overall length — not to exceed 20 m (65.6 ft).

Single-ended, Single-channel Encoder Wiring Example



Single-ended, Dual-channel Encoder Wiring Example

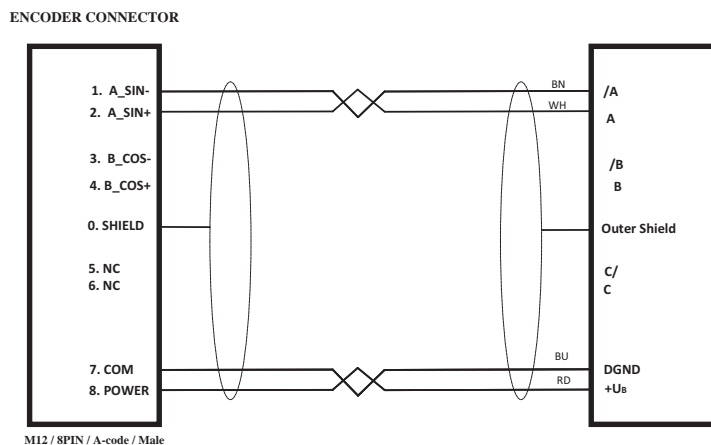


Differential (AqB) Single-channel Encoder Wiring Example

Differential (AgB), Single Channel Differential Encoder

Drive Side

Motor Side



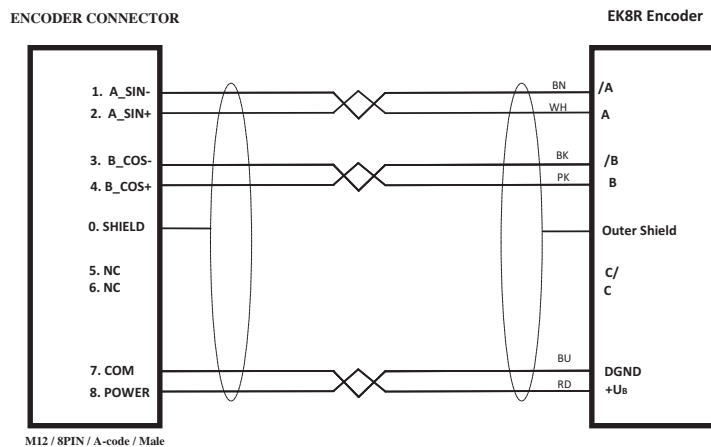
M12 / 8PIN / A-code / Male

Differential (AqB) Dual-channel Encoder Wiring Example

Differential (AqB), Dual Channel Differential Encoder

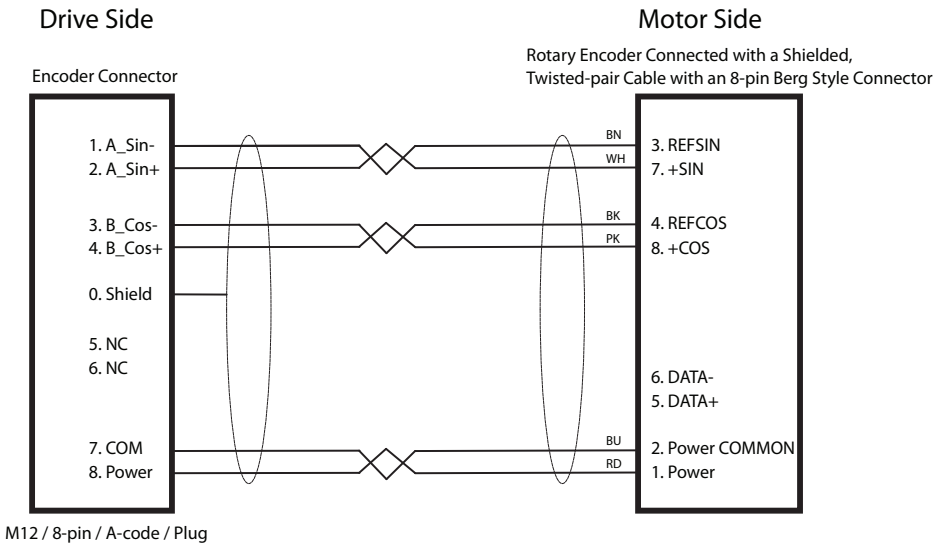
Drive Side

Motor Side



M12 / 8PIN / A-code / Male

Hiperface (analog only) Encoder Wiring Example



ArmorConnect Media

Details of ArmorConnect power media are described in the On-Machine Media for Armor PowerFlex, ArmorStart, and ArmorConnect Products Selection Guide, publication [280PWR-SG001](#).

The ArmorConnect power media offers both three-phase and auxiliary power cable cord set systems, including patchcords, receptacles, tees, reducers and accessories, to be used with the Armor PowerFlex drive. These cable system components facilitate quick connection of Armor PowerFlex drives, reducing installation time. They allow repeatable, consistent connection of the three-phase and auxiliary power to the Armor PowerFlex drive and motor by providing a plug and play environment that also avoids system mis-wiring.

IMPORTANT

We do not recommend using a tool to tighten the connectors. The connectors should be hand tightened and verified by a torque measurement tool. See the ArmorConnect instructions for the recommended tightening torque.

IMPORTANT

The UL Listing of the Armor PowerFlex drive requires its mating output motor and input power cable assemblies to be only those assemblies that are specified by the instructions for the controller. By using other cable assemblies, you violate the Listing of the controller, which NFPA 79 prohibits (see 1.5 of NFPA 79 and 110.3(B) of NFPA 70 (NEC)).

IMPORTANT

For proper operation of the Armor PowerFlex drive, the maximum total encoder cable length is 20 m (65.6 ft).

IMPORTANT

For proper operation of the Armor PowerFlex drive, the maximum total cable length for 24V Auxiliary Power IN, is 20 m (65.6 ft).



SHOCK HAZARD: Risk of electrical shock. Do not disconnect or connect power cables under load.



ATTENTION: ArmorConnect cables are not intended to be connected or disconnected under load. Connecting or disconnecting ArmorConnect cables under load can result in physical injury or equipment damage, as a result of high make and break currents and potential fault currents.



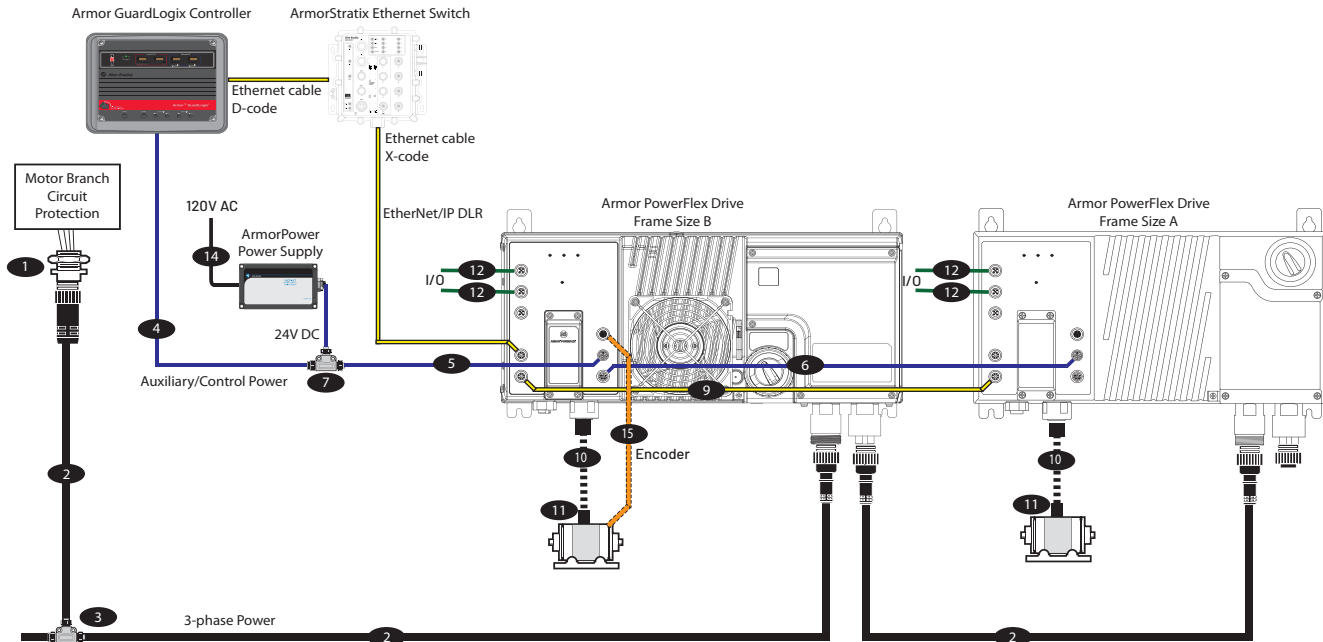
ATTENTION: If you choose to purchase your own cables without connectors and terminate them on site, Rockwell Automation cannot be responsible for failure of the published environmental ratings.



ATTENTION: If you install a motor cable that has a connector on one end and floating leads for a field-attachable connector on the other end, use the connector end to attach to the Armor PowerFlex drive.

Figure 31 shows example configurations for power, control, and communication media.

Figure 31 - Cable System Overview (Armor PowerFlex Drive Standard Version shown)



Item	Description	Example Cat. No.
1	Three-phase power receptacle, round or Three-phase power receptacle, square	280-M35F-Mxx ⁽¹⁾ or HARTING® 61 04 201 2753
2	Three-phase power cable, round or Three-phase power cable, square	280-PWRM35A-Mxx ⁽¹⁾ or HARTING 61 04 202 2953 Lxxx ⁽¹⁾
3	Three-phase power t-port, round or Three-phase power t-port, square	280-T35 or HARTING 09 12 008 4720
4	Auxiliary/Control power cable, 4-pin	889N-F4AFNM-xx ⁽¹⁾
5	Auxiliary/Control power cable, 4 to 5-pin	889L-R5JFN4M-xx ⁽¹⁾⁽²⁾
6	Auxiliary/Control power cable, 5-pin	889L-R5JFLE-xx ⁽¹⁾⁽²⁾
7	Auxiliary/Control power t-port, 4-pin	898N-43PB-N4KF
not shown	Auxiliary/Control power receptacle, 4-pin	888N-D4AF1-xx ⁽¹⁾
8	Ethernet patchcord 10/100 MB, D-code to D-code	1585D-M4TBDM-xx ⁽¹⁾
9	Ethernet patchcord 10/100 MB, X-code to D-code	1585D-E8TG04E-xx ⁽¹⁾
10	Ethernet patchcord 1 GB, X-code to X-code	1585D-E8TGDE-xx ⁽¹⁾
11	Motor cable (with EM brake), 7-pin or Motor cable (without EM brake), 4-pin	357-PWRM29A-Mxx ⁽¹⁾ or 280-PWRM29A-Mxx ⁽¹⁾ 284-PWRM29A-Mxx ⁽¹⁾
12	Motor receptacle (with EM brake), 7-pin or Motor receptacle (without EM brake), 4-pin	357-M29M-M05 or 284-M29M-M03
13	I/O cables, standard	889D-R5ACDE-xx ⁽¹⁾
14	120V AC line in cable	889N-F3AFC-F-xx ⁽¹⁾
15	Encoder cable	889D-R8FBDE-xx ⁽¹⁾
16	Encoder receptacle	888D-F8AB3-xx ⁽¹⁾

(1) xx specifies the available cable lengths.

(2) Our current offering of 5-pin, auxiliary power cables and receptacles have an IP66, UL Type 1/12 rating. You must confirm that this rating is acceptable for the intended application.

For details, see On-Machine Media for Armor PowerFlex, ArmorStart, and ArmorConnect Products Selection Guide, publication [280PWR-SG001](#).

Local Disconnect Behavior

The Armor PowerFlex drive has a local, at-motor disconnect switch that is positioned on the front of the unit. The disconnect is a two position maintained switch. Turn right for the On position and turn left for the Off position.

The local disconnect removes power from the motor terminals and outputs when in the Off condition. The disconnect switch does not remove the test output power for the safety inputs, but it does remove output power for the bi-polar safety output.

When the disconnect switch is in the On position and a short circuit or ground fault event occurs, the Armor PowerFlex drive will fault but the switch handle will **NOT** change state to a fault position. In this case, you need to manually turn the disconnect switch to the Off position.

When the switch is in the Off position, it can be locked in place to act as a lockable maintenance switch.



ATTENTION: You must verify that hazardous voltages have dissipated before servicing the equipment. For details, see [Predictive Maintenance on page 229](#).

Figure 32 - Local Disconnect in OFF Position



Electronic Motor Disconnect

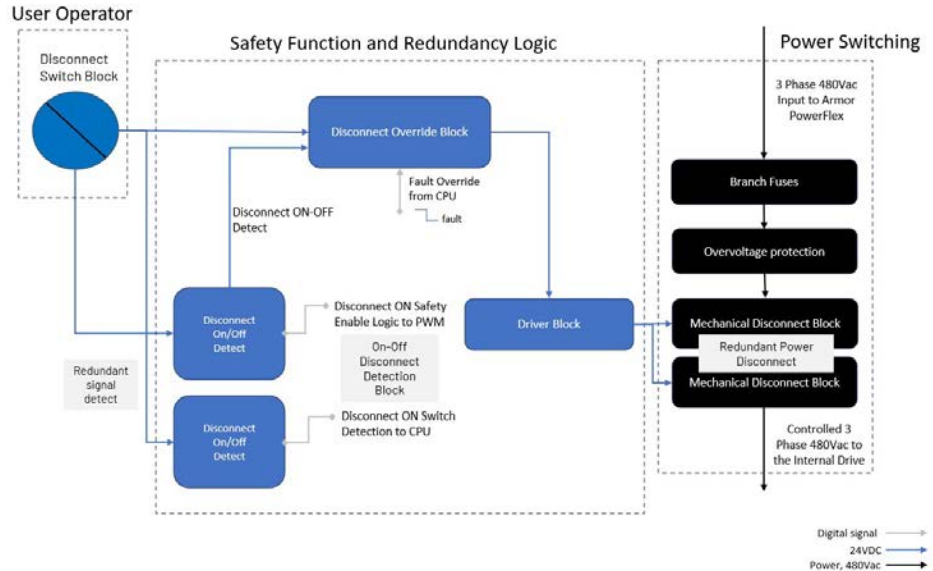
The Armor PowerFlex local, at-motor disconnect switch uses a patented design for Electronic Motor Disconnect (EMD). The EMD design provides a reliable means for automatically or manually, disconnecting the motor and Armor PowerFlex drive, from the three-phase power supply. The EMD design can disconnect power in case of fault conditions, device failures, for maintenance, or other shutdown reasons.



See [TechConnect Document ID 0A67224](#), for information about Armor PowerFlex lockout/tagout.

[Figure 33](#) shows a high-level schematic of the EMD control blocks, followed by an explanation of each control block functionality.

Figure 33 – EMD Circuit



Control Block Explanations

- **Disconnect Switch** – A low voltage (24V DC) Double Pole Single Throw (DPST) switch that provides manual switching control from the three-phase supply.
- **3-phase Dual Form A Contact Mechanical Relays** (wired in series) – The physical means to disconnect the motor and Armor PowerFlex drive from three-phase power. The relays are controlled by the Driver Control block.
- **Driver** – Circuit that controls the Mechanical Relays of each phase independently to open or close. The Drive Control Block commands come from the Disconnect Override Control block.
- **Disconnect Override** – This circuit controls the Driver Block which commands the relays to open or close. The Disconnect Override Control Block will command the Driver Block to close the Mechanical Relays only if the following conditions are met:
 - The first contact of the Disconnect Switch is on, providing 24V DC to the Disconnect Override Control Block
 - The Fault Override Logical Signal from the CPU (Armor PowerFlex firmware) is off (24V signal is high)
 - The Override Signal from the EnB On-Off Disconnect Detection circuit is off (24V signal is high)

The EMD Disconnect Override Block gets a Fault Signal from the CPU indicating that the Armor PowerFlex drive is faulted. When this occurs, the EMD will open. So if the drive sensed a DB Resistor Thermal event, a fault will be created and the EMD will open, which is what an isolating contactor would be used for.

- **On-Off Disconnect Detection** – Circuit that monitors the state of each of the contacts of the DPST Disconnect Switch. Each contact is monitored independently by the On-Off Disconnect Detection Block to provide redundant feedback of the state of the Disconnect Switch to the CPU (Armor PowerFlex firmware). If either of the feedback signals detects an open contact in the Disconnect Switch, the PWM Driver will be commanded to disable the gate firing of the Inverter Insulated Gate Bipolar Transistors (IGBTs) so power is cut off to the motor connector.

EtherNet/IP Operation

Armor PowerFlex drives incorporate the advantages of EtherNet/IP communication for access to configuration, status, and diagnostics. These controllers feature:

- Dual-port embedded switch with 1 GB performance^(a)
- Star Linear and Device Level Ring topologies

For more information on EtherNet/IP light-emitting diode (LED) indication status, see [EtherNet/IP Status Indicators on page 216](#).

The Armor PowerFlex drive supports:

- Ten connected messaging connections
- One exclusive owner standard I/O connection
- Input and output safety connections for Armor PowerFlex safety drive (35S)

IMPORTANT

When applying an Armor PowerFlex drive with a two programmable controller architecture; one for standard connection and the other for safety connection, the safety connection must be made before the standard connection or there will be a connection fault. If the standard connection is made first, the drive enters protected mode and will reject the safety connection causing a fault.

Set the IP Address

There are different methods available for setting the IP address of the Armor PowerFlex drive. You can choose from the following:

- [Set the IP Address using Rotary Switches](#)
- [Set the IP Address using the BOOTP/DHCP Server Utility](#)
- [Set the IP Address using the FactoryTalk Linx Application](#)

Set the IP Address using Rotary Switches

Use this procedure if you cannot or do not want to use the BOOTP/DHCP tool.

There are four rotary switches that are used to set the IP address; one Mode switch and three address switches. The Mode switch is used to set one of the five predefined private IP addresses, except for the last octet. The last octet is set by the three address switches. The Armor PowerFlex drive ships with the Mode switch set to 0 and the three address switches set to 999. This configuration has no IP address set for the drive and DHCP is enabled.

(a) Products with EtherNet/IP embedded switch technology have two ports to connect to a linear or DLR network in a single subnet. You cannot use these ports as two Network Interface Cards (NICs) connected to two different subnets.

Remove Front Logic Cover

The IP address rotary switches are located under the front logic cover of the Armor PowerFlex drive. With unswitched auxiliary power removed, remove the four screws of the logic cover, then lift it off to access the switches. See [Figure 34](#) and [Figure 35](#).

Figure 34 - Logic Cover Removal

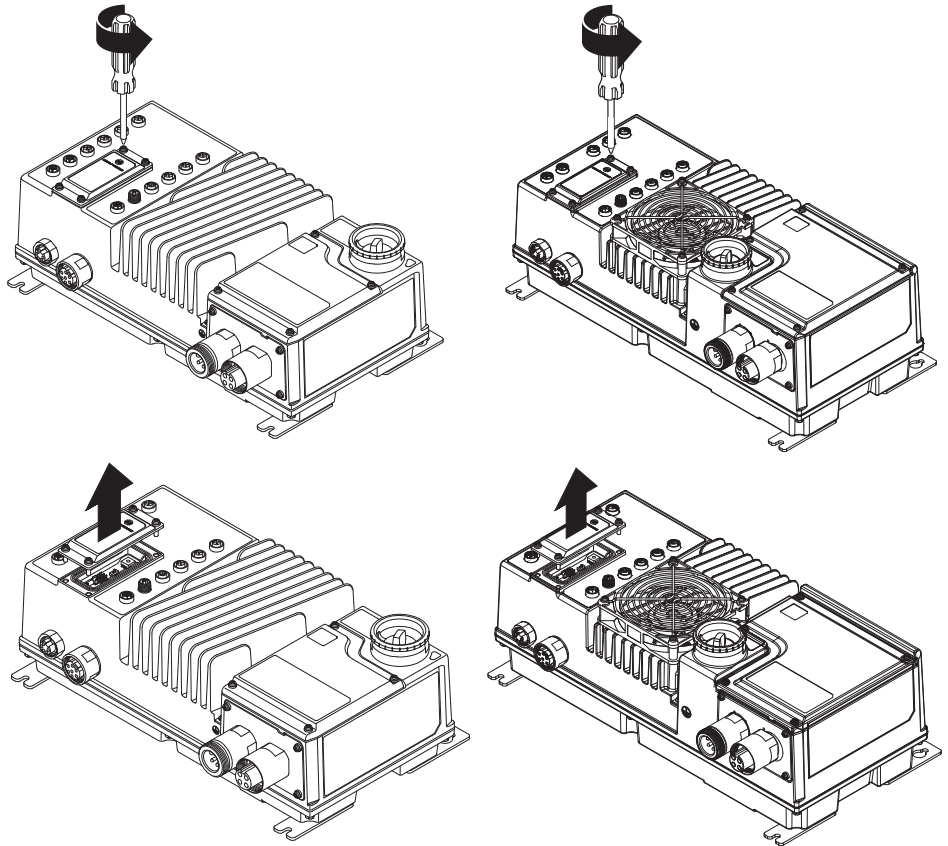
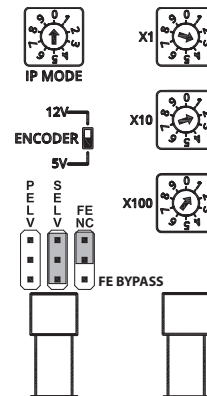


Figure 35 - IP Address Switches



This example shows the rotary address switches set to 123 for an IP Address of 192.168.1.123

The Mode switch operates as follows:

- The Mode switch is read and latched on power-up.
- The drive must have power cycled or reset for any Mode switch changes to be recognized.
- The Mode switch setting is ignored if the rotary switches address is not within the range of 1...254.

[Table 6](#) describes the Mode switch settings when the rotary address switches are set to 1...254.

Set the Mode switch to one of the predefined IP Address types and then, set the rotary address switches to a value that completes the IP address.

Table 6 - IP Address Mode Switch Settings

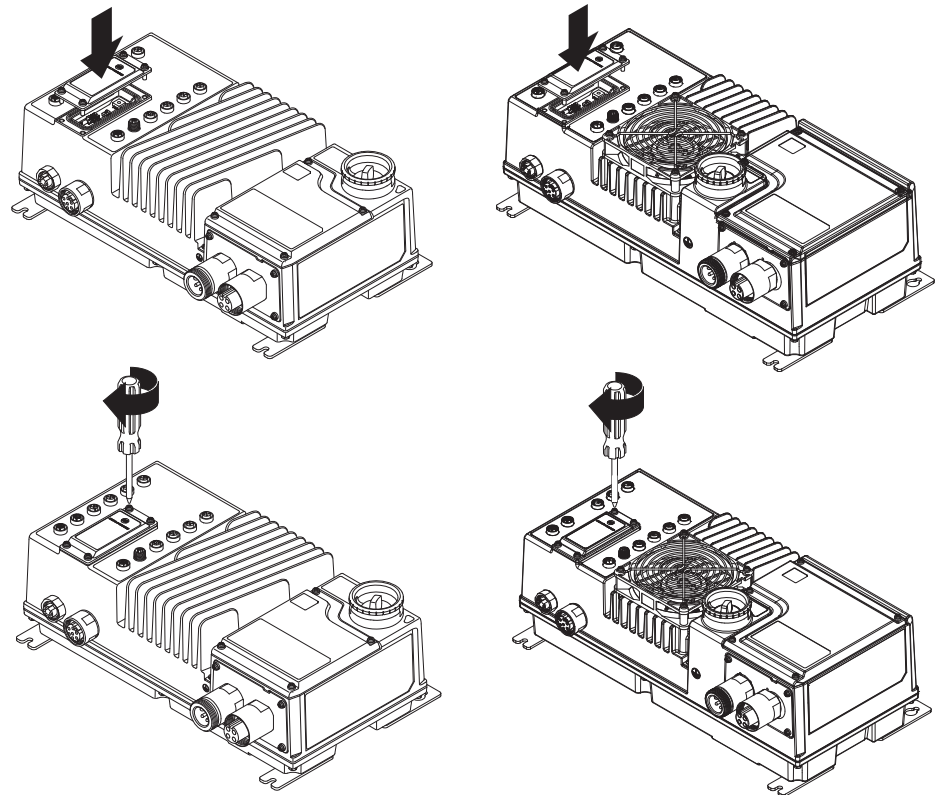
Mode Switch Setting	IP Address Type	Subnet Mask	Rotary Switches Address	Gateway Address
0 (default)	Class C private IP address = 192.168.1.x ⁽¹⁾	255.255.255.0	1	0.0.0.0
			2...254	192.168.1.1
1	Class C private IP address = 192.168.6.x ⁽¹⁾	255.255.255.0	1	0.0.0.0
			2...254	192.168.6.1
2	Class A private IP address = 10.0.11.x ⁽¹⁾	255.255.255.0	1	0.0.0.0
			2...254	10.0.11.1
3	IP address = 136.129.6.x ⁽¹⁾	255.255.0.0	100	0.0.0.0
			2...99 or 101...254	136.129.6.100
4	IP address = 11.200.0.x ⁽¹⁾	255.255.0.0	1	0.0.0.0
			2...254	11.200.0.1
5	IP address = 11.200.1.x ⁽¹⁾	255.255.0.0	1	0.0.0.0
			2...254	11.200.1.1
6...9	The network interface is disabled so the drive cannot communicate on the network.			

(1) x = Address switches value.

Replace Front Logic Cover

After the switches are set, replace the logic cover and tighten the screws 1.37...1.57 N•m (12.13...13.90 lb•in).

Figure 36 - Logic Cover Replacement



Example of How to Set the IP Address Switches

This is a step-by-step example of how to set the IP address to 192.168.1.123, using the rotary switches:

1. Remove unswitched auxiliary power to the Armor PowerFlex drive. For details, see [Auxiliary Power Connections on page 51](#).
2. Remove the Armor PowerFlex drive's logic cover. See [Figure 34](#).
3. Set the Mode switch to 0, to select the 192.168.1.x private IP address, as indicated in [Table 6](#).
4. Set the rotary address switches to 123. See [Figure 35](#).

IMPORTANT

When the switches are set to 192.168.1.1, the subnet mask is set to 255.255.255.0 and the gateway address is set to 0.0.0.0. Switch settings 000 and 255...998 are reserved and cannot be used.

5. Replace the Armor PowerFlex drive's logic cover. See [Figure 36](#).
6. Re-apply unswitched auxiliary power to the Armor PowerFlex drive.

After the Armor PowerFlex drive goes through its boot-up sequence, the IP address is set to 192.168.1.123.

Set the IP Address using the BOOTP/DHCP Server Utility

If the network does not use one of the five private IP addresses that can be set with the Mode switch, the Rockwell Automation BOOTP/DHCP Server Utility (or a third-party DHCP Server) can be used to set the Armor PowerFlex IP address. Before you set the IP address using DHCP, make sure that you have the following information:

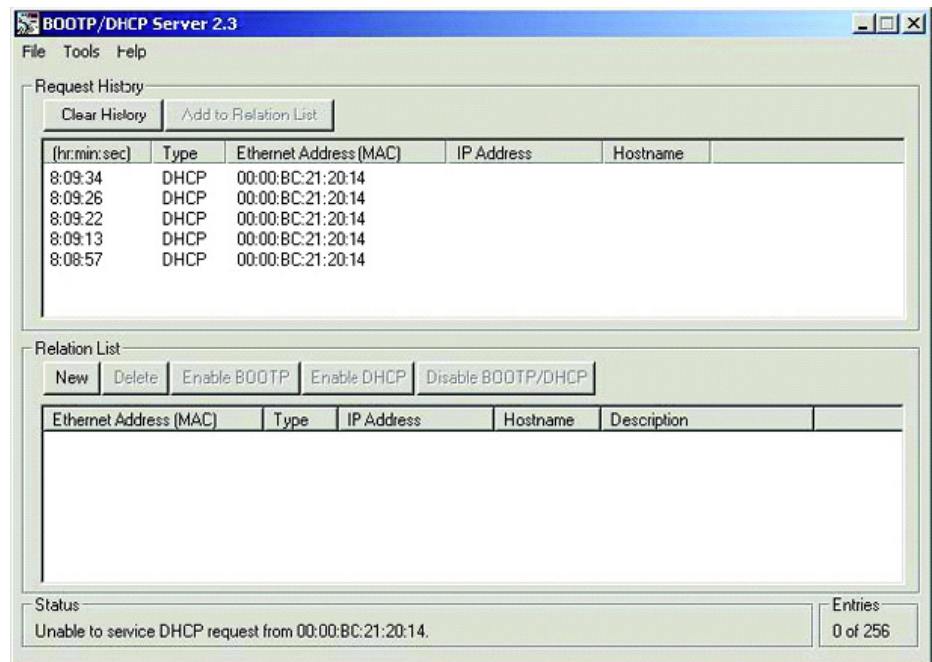
- MAC ID for the device
- Desired IP address for the Armor PowerFlex drive

To configure the Armor PowerFlex IP Address using the BOOTP/DHCP utility, after you install and power up the drive, perform the following steps:

1. Run the BOOTP/DHCP software.

In the BOOTP/DHCP Request History panel, the hardware (MAC ID) addresses of the devices that are issuing BOOTP/DHCP requests are shown.

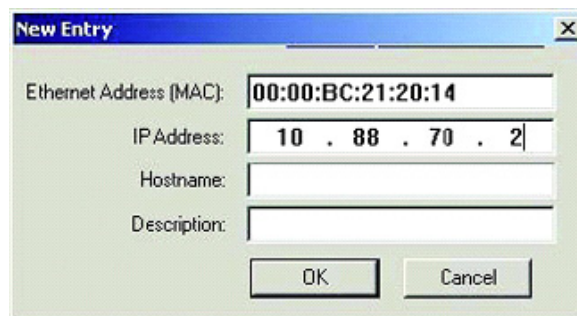
Figure 37 - BOOTP/DHCP Request History Panel



2. Double-click the hardware (MAC ID) address of the Armor PowerFlex drive that you want to configure.

The New Entry dialog box with the Ethernet Address (MAC) of the device is shown.

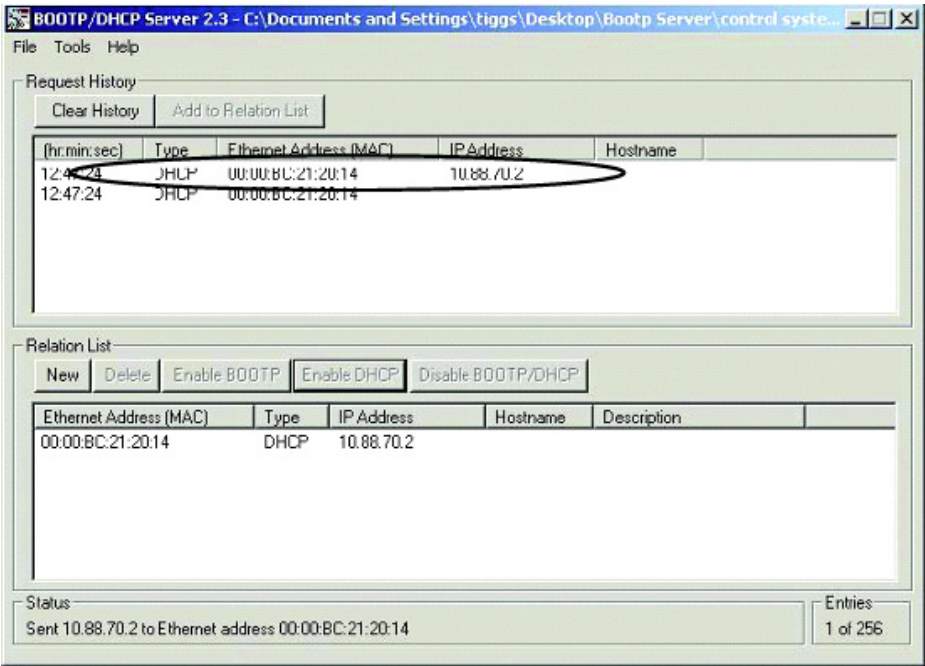
Figure 38 - New Entry Dialog Box



3. Enter the IP address that you want to assign to the device, and click OK.

The device is added to the Relation List, which displays the Ethernet Address (MAC) and the corresponding IP address, host name, and Description (if applicable).

Figure 39 - Relation List



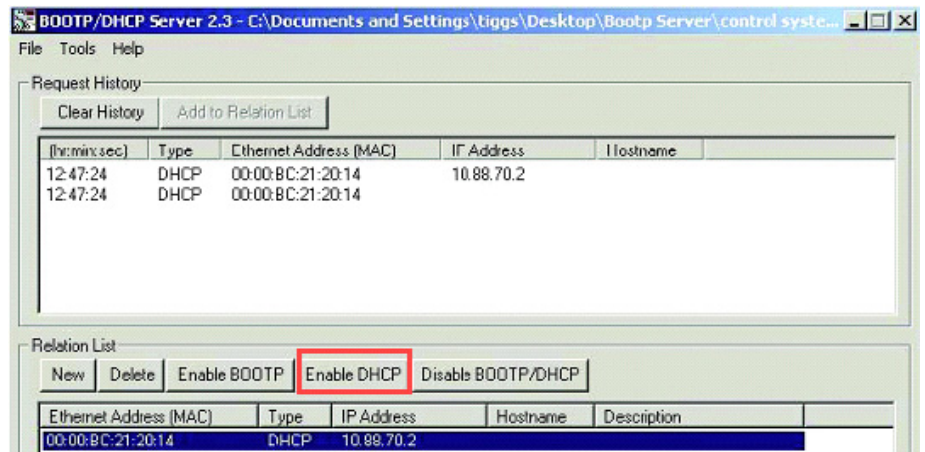
When the address is displayed in the IP address column in the Request History section, it signifies that the IP address assignment has been made.

- 4. To assign this configuration to the device: highlight the device in the Relation List panel, and click the Disable BOOTP/DHCP button.

When power is cycled to the Armor PowerFlex, it uses the IP Address assigned and will not issue a DHCP request anymore.

- 5. If desired, DHCP can be enabled using the BOOTP/DHCP Server Utility. To enable DHCP for a device with DHCP disabled: highlight the device in the Relation List, and click the Enable DHCP button. You must have an entry for the device in the Relation List panel to re-enable DHCP.

Figure 40 - Enable DHCP Button



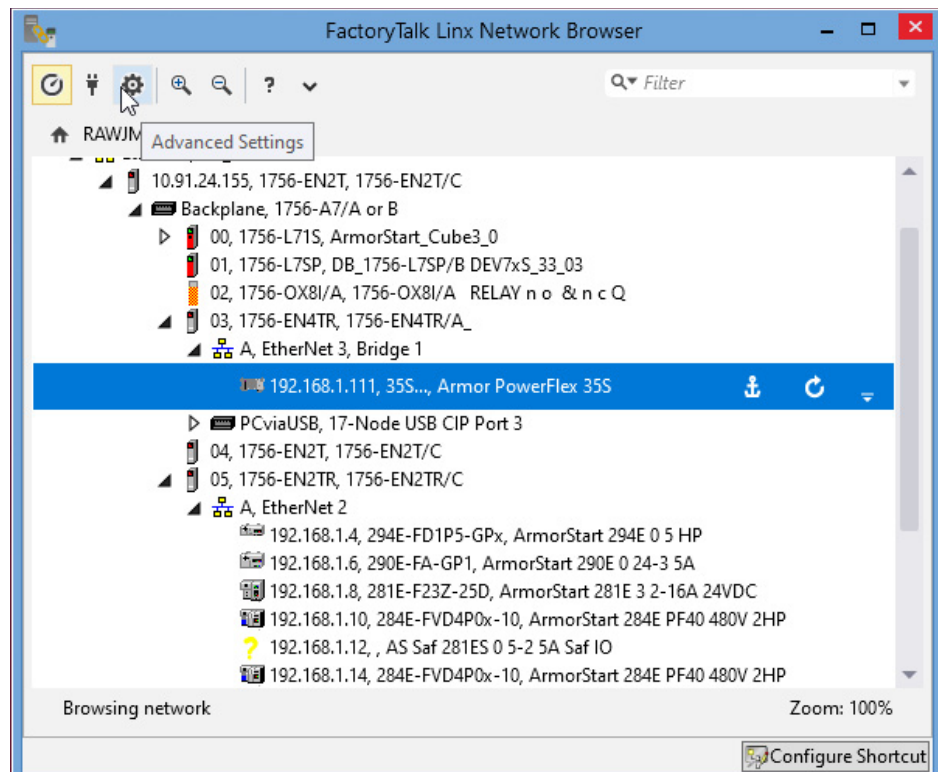
Set the IP Address using the FactoryTalk Linx Application

This procedure can only be used when a static IP address for the Armor PowerFlex drive has already been set using a BootP/DHCP server and needs to be changed to a different IP address.

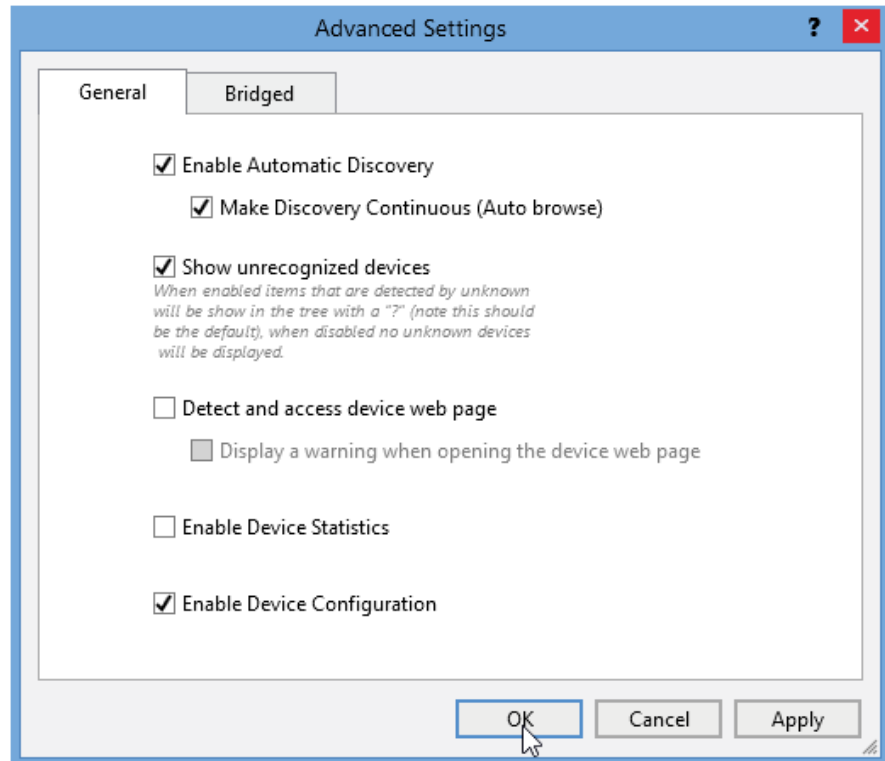
IMPORTANT This method cannot be used if the static IP address of the Armor PowerFlex drive has been set using the rotary switches.

To change the static IP address of the Armor PowerFlex drive, perform these steps:

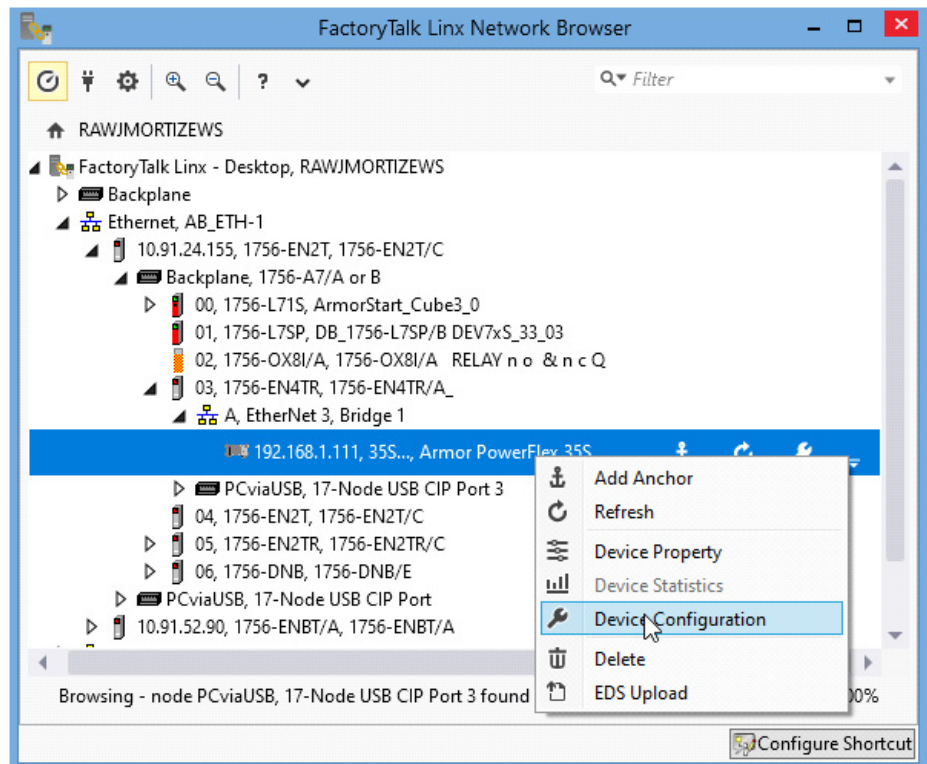
1. Launch FactoryTalk Linx and make sure that the IP Address of the Armor PowerFlex drive can be seen. The proper EtherNet driver must have been setup.
2. Once the IP address of the Armor PowerFlex drive appears in the FactoryTalk Linx EtherNet driver, open the advance settings as shown.



3. In Advanced Settings, check Enable Device Configuration under the General tab and click OK. This allows changing the IP address using FactoryTalk Linx.



4. Right-click the device and choose Device Configuration.



- After the Device Configuration dialog box appears, select the Internet Protocol tab.

- Click Manually Configure IP Settings (if not already checked) and change the appropriate fields to configure the new IP address.
- Click Apply to make the changes.
- Cycle power or reset the device.

For more information on how to configure the adapter with the BOOTP/DHCP and FactoryTalk Linx tools, see online help or the EtherNet/IP Network Devices User Manual, publication [ENET-UM006](#).

Change IP Address after Safety Device is Configured

If you have a safety device configured and want to change the IP address, you need to Reset Ownership. See [Reset Ownership on page 97](#).

If you have a running I/O connection (safety or standard), you have to inhibit module in order to perform soft restart via a MSG instruction. See [Standard Connection Settings on page 183](#).

Example scenarios:

- Safety configuration is not deployed.
 - Power is not removed.
 - Switches are changed to desired IP address.
 - Reset command is sent via MSG instruction (CIP Identity reset 0) -> **Successful**.
 - The drive boots with IP address set in [step b](#).
- Safety configuration is deployed.
 - Power is not removed.
 - Switches are change to desired IP address.
 - Reset command is sent via MSG instruction (CIP Identity reset 0) -> **Successful**.

- d. The drive boots with new IP address but the drive will be in a FAULTED state (Safety recoverable fault).
- 3. If a safety I/O or standard I/O is running.
 - a. Power is not removed.
 - b. Switches are change to desired IP address.
 - c. Reset command is sent via MSG instruction (CIP Identity reset 0) -> **Unsuccessful as there is a running I/O connection.**

Device Level Ring

Device Level Ring (DLR) is an EtherNet/IP protocol that is defined by the Open DeviceNet Vendors Association (ODVA). DLR provides a means to detect, manage, and recover from single faults in a ring-based network.

A DLR network includes the following types of ring nodes.

Table 7 - DLR Nodes

Node	Description
Ring supervisor	A ring supervisor provides these functions: <ul style="list-style-type: none">• Manages traffic on the DLR network• Collects diagnostic information for the network A DLR network requires at least one node to be configured as ring supervisor. By default, the supervisor function is disabled on supervisor-capable devices.
Ring participants	Ring participants provide these functions: <ul style="list-style-type: none">• Process data that is transmitted over the network.• Pass on the data to the next node on the network.• Report fault locations to the active ring supervisor. When a fault occurs on the DLR network, ring participants reconfigure themselves and relearn the network topology.
Redundant gateways (optional)	Redundant gateways are multiple switches that are connected to a single DLR network and also connected together through the rest of the network. Redundant gateways provide DLR network resiliency to the rest of the network.

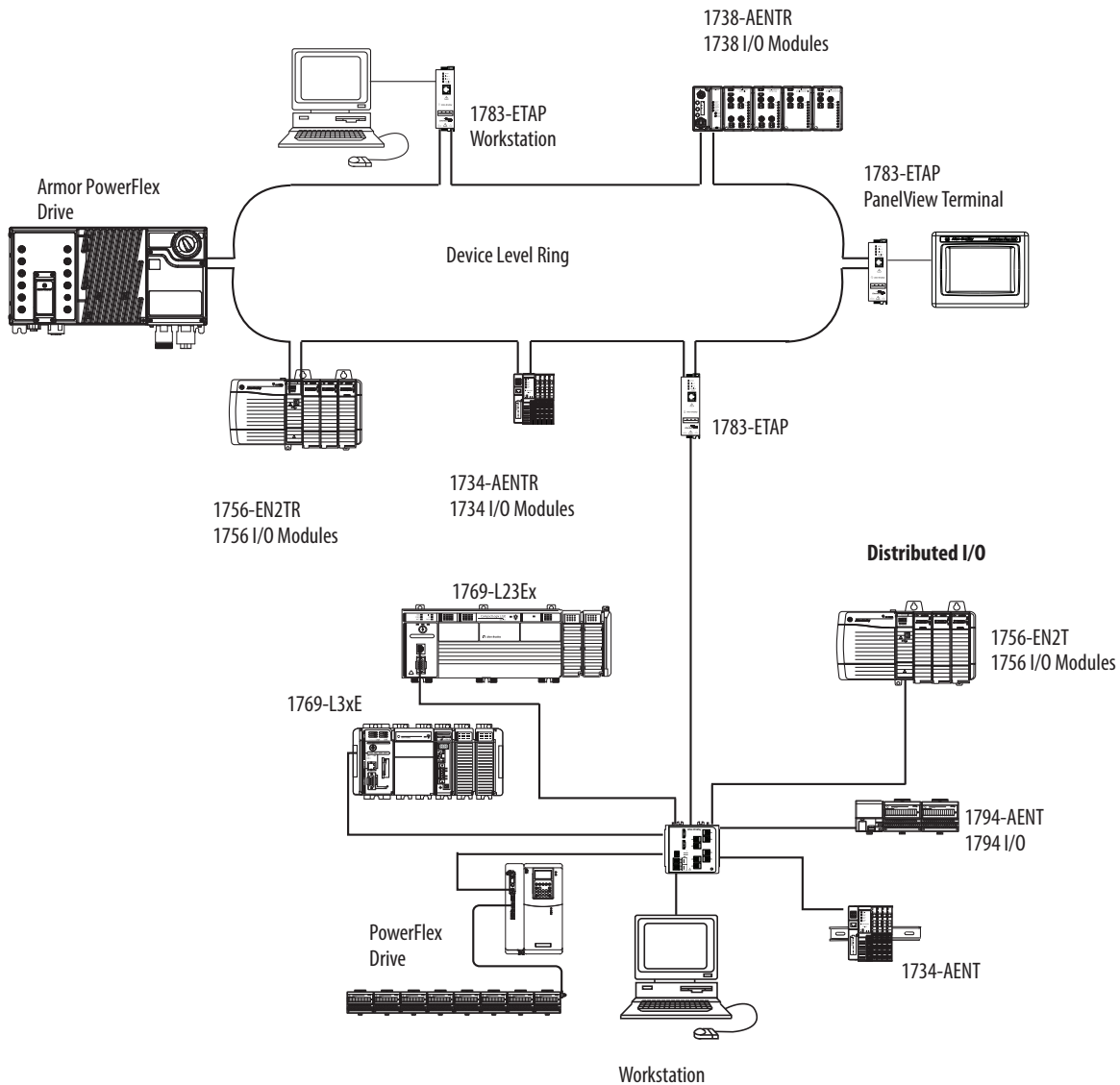
Depending on their firmware capabilities, both devices and switches can operate as supervisors or ring nodes on a DLR network. Only switches can operate as redundant gateways.

See [Figure 41 on page 79](#) for an example of a DLR network.

IMPORTANT	The Armor PowerFlex drive cannot be configured as a ring supervisor.
------------------	--

For more information about DLR, see the EtherNet/IP Device Level Ring Application Technique, publication [ENET-AT007](#).

Figure 41 - Armor PowerFlex Drive in a DLR Configuration



It is recommended that no more than 50 nodes are on a single DLR. If your application requires more than 50 nodes, it is recommended that the DLR networks be segmented.

With smaller networks:

- There is better management of traffic on the network.
- The networks are easier to maintain.
- There is a lower likelihood of multiple faults.

Protected Operations Mode

To maintain the secure operation of your drive, operations that can disrupt drive operation are restricted based on its operating mode.

This drive is in protected mode when: there are standard or safety I/O connections, the drive is running.

The screenshot displays the Rockwell Automation ArmorPowerFlex software interface. The left-hand pane shows a hierarchical tree view of the drive's configuration, including sections like 'Controller', 'Tasks', 'Motion Groups', 'Assets', 'Data Types', 'Logical Model', and 'I/O Configuration'. The central pane has tabs for 'INFORMATION', 'MONITOR', and 'FAULTS AND ALARMS'. The 'FAULTS AND ALARMS' tab is active, showing a table of faults and alarms. The table has columns for 'Code', 'Name', 'Timestamp', 'Type', and 'Details'. The right-hand pane shows the 'Faults and Alarms' section with a list of events and a 'Clear Faults' button. The status bar at the bottom indicates 'Drive State: Stopped' and 'Torque: Enabled'.

Code	Name	Timestamp	Type	Details
0x041c0009	Source Active	2023-08-30 06:43:28.585	Information	
0x043a0001	Torque Enabled	2023-08-30 06:43:28.585	Information	
0x041c0009	Source Active	2023-08-30 06:43:15.055	Information	
0x043a0003	STO Reaction	2023-08-30 06:43:15.055	Information	
0x043a0002	Torque Disabled	2023-08-30 06:43:15.055	Information	
0x04190002	Configuration Operation Apply Success	2023-08-30 06:43:14.745	Information	
0x00f60001	Link Up	2023-08-24 11:01:40.759	Information	
0x00f60002	Link Down	2023-08-24 11:01:14.841	Information	
0x043a0001	Torque Enabled	2023-08-24 11:01:11.865	Information	
0x041c0009	Source Active	2023-08-24 11:01:10.865	Information	

When there is a Standard I/O connection, or the drive is running, the following features are disabled:

- Configuration of standard control attributes
- Configuration of Network Attributes
- Enabling/Disabling Physical Ports
- Remote Resets
- Security Configurations (except to preexisting configuration over previously made secure connection)
- Firmware Updates

When there is a Safety I/O connection, remote reset and firmware updates are disabled, along with reconfiguration of safety parameters. Safety configurations are allowed when there is a standard I/O connection to support commissioning efforts.

If an attempt is made, a device state conflict error is reported.

Ethernet Communication Troubleshooting

The EtherNet/IP communication module can experience intermittent network connectivity due to these conditions:

- Duplex mismatch
- Electrical noise that is induced into a cable or results from a Logix/switch ground potential difference
- Bad hardware, such as a cable or switch port

To help troubleshoot the EtherNet/IP network, you must use a managed switch.

Here are the important features in a managed switch:

- Internet Group Multicast Protocol (IGMP) snooping
- Support for Virtual Local Area Networks (VLAN)
- Port mirroring

IMPORTANT

Use a switch that is equipped with wire-speed switching fabric. The switch fabric is a measure of the maximum traffic that a switch can handle without dropping a packet and without storing a packet in memory. Wire-speed switching fabric refers to a switch that can handle the maximum data rate of the network on each of its ports.

Switches are typically rated in Gbps. For a 10-port switch connected to EtherNet/IP products, the maximum data rate that is needed, is typically 100...200 MB/s. Therefore, a 10-port-switch that is rated at least 1 GB/s is adequate for an EtherNet/IP application.

For more information on EtherNet/IP networks, see these resources:

Table 8 - Resources for EtherNet/IP Network Information

Publication	Description
Troubleshoot EtherNet/IP Networks Application Technique, publication ENET-AT003	Describes troubleshooting techniques for Integrated Architecture products on EtherNet/IP networks.
EtherNet/IP Device Level Ring Application Technique, publication ENET-AT007	Describes DLR topologies, configuration considerations, and diagnostic methods, including how to monitor your EtherNet/IP network.
Ethernet Design Considerations Reference Manual, publication ENET-RM002	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.

Notes:

Keypad Operation

The Armor PowerFlex drive has a front panel keypad with four buttons to allow user input.

- LOCAL/AUTO, F0
- FWD/REV, F1
- JOG, F2
- FAULT CLEAR

The keypad also has status indicator LEDs, which indicate the mode that the keypad is in and the status of the buttons.

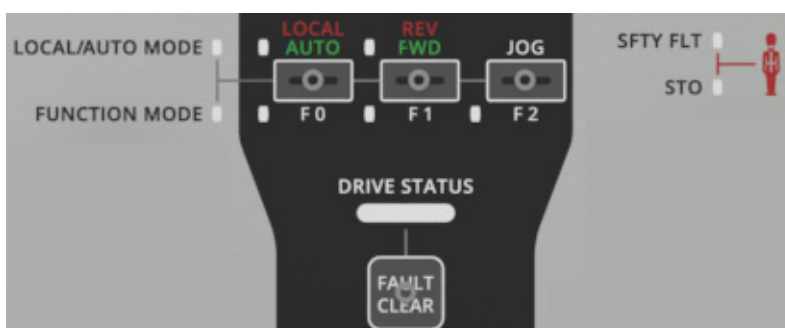


Table 9 - Keypad Button Operation

Button	Description	Status Indicator	Mode
Fault Clear	<ul style="list-style-type: none"> Pressing Fault Clear can clear all existing non-critical standard faults. (Clearing all faults might require additional actions, such as cycling main input power.) It does not clear any alarms. 	—	—
Local/Auto	<ul style="list-style-type: none"> Press this button to toggle between Local and Auto modes. The default mode is Auto. Local is a manual override mode that provides local control via the Forward/Reverse and Jog keypad buttons. Auto is for control of the drive where all reference and sequencing commands come from a network connection. When in Auto mode, the Forward/Reverse and Jog keypad buttons are not operational. 	Local/Auto— Red	Local
		Local/Auto— Green	Auto
Forward/Reverse	<ul style="list-style-type: none"> When in Local mode, press this button to toggle between forward and reverse direction for running the motor. Forward is the default direction, which is set at power-up. Direction is maintained when switching between Local and Auto modes. 	Fwd/Rev — Steady green	Local mode forward direction
		Fwd/Rev — Steady red	Local mode - reverse direction
		Fwd/Rev — Blink	Local mode - Jog button pressed
		Fwd/Rev — Off	Auto mode
Jog	<ul style="list-style-type: none"> When in Local mode, pressing and holding the Jog button jogs the motor. The Fwd/Rev blinks when the drive is modulating. 	Fwd/Rev — Blink green	Jog forward direction
		Fwd/Rev — Blink red	Jog reverse direction
Function Mode (F0, F1, F2)	<ul style="list-style-type: none"> To enable Function mode, see Temporarily Disable Keypad Motor Control on page 85. In Function mode, the three buttons provide generic inputs whose function can be set by using program logic. Pressing the F0, F1, or F2 button has no direct effect on product behavior. The button state is reported to let user-defined logic take action based on the state of the button. The buttons are momentary, meaning that they are active when pressed and de-activated when released. When pressed, the button state reported to the network is 1. When released, the button state reported to the network is 0. 	Function Mode — Steady amber	Function mode
		F0, F1, F2 — Steady amber	F0key is pressed or, F1 key is pressed or, F2 key is pressed
		F0, F1, F2 — Off	F0key is not pressed or, F1 key is not pressed or, F2 key is not pressed

IMPORTANT

You cannot use the LOCAL/AUTO button to change the mode while the drive is running.

One button press is recognized at a time. To switch from jogging forward to jogging reverse, first remove the jog, press reverse, and then reassert the jog. This does not mean that the motor must be at rest.

Keypad Modes

The keypad operates in three different modes: Auto, Local, and Function. The keypad is used for motor control and will only block network motor control commands, while in Local mode.

- Auto – Motor control via the keypad is enabled, but not active. Local control from the embedded keypad is ignored. The Armor PowerFlex drive is only controlled via the EtherNet network.
- Local – Motor control via the keypad is enabled and it is active. The Armor PowerFlex drive is controlled from the embedded keypad only. If the unit is connected to a network, most commands are ignored.



A network stop command will take precedence over the keypad when set to local mode. The network stop command will prevent local jog via the keypad.

- Function – Motor control via the keypad is disabled, the keypad button state is still reported. The F0, F1, and F2 buttons are used as inputs and not for control.

Local/Auto (Local Motor Control) Modes Operation

Local and Auto modes are used when the keypad is enabled for motor control operation. In these modes, the three keypad buttons have a specific function:

- LOCAL/AUTO toggles between Auto or Local modes with the status indicator displaying the current mode (local is default). The drive must not be running to use the button to switch modes in Auto mode, the Forward/Reverse and Jog buttons don't do anything
- Forward/Reverse toggles between directions in Local mode. The indicator displays the current direction (forward is default). At power-up, the keypad direction is set to forward. The direction is maintained when switching between LOCAL/AUTO mode.
- Pressing Jog causes the motor to move at the jog reference velocity, in Local mode. The default jog velocity is 10 rev/s (20 Hz).

Function Mode Operation

When Function mode is selected (see [Temporarily Disable Keypad Motor Control on page 85](#)), all three buttons become generic inputs whose function can be set by using programmable controller logic.

When the keypad mode is Function, pressing the keypad buttons F0, F1, and F2 have no direct impact on product behavior. In this mode, the button state is reported to allow user-defined logic to take action based on the button state.

The F0, F1, and F2 LEDs indicate if a button is being pressed.

Fault Clear Button Operation

When the Fault Clear button is pressed, any faults currently unacknowledged in the product are acknowledged. You cannot disable or change the function of the Clear Faults button.

Temporarily Disable Keypad Motor Control

Keypad motor control operation can be temporarily disabled by two different methods.

- Datalink
- Message Instruction

Datalink

The keypad can be disabled by using the output datalink, Disable predefined Keypad Functions. For datalink configuration details, see [Configure Datalinks on page 156](#).

Message Instruction

To temporarily disable the keypad motor control operation, a MSG instruction targeting attribute 2, (Inhibit) of the Motor Control Source object, can be used. Set this attribute to 1 (true) to disable keypad motor control operation. [Table 10](#) shows the message instruction parameter needed to temporarily disable the keypad control.

Table 10 - Keypad Control: MSG

Parameter	Value	Description
Service Code	0x10	Set attribute single
Class	0x41c	Motor control source
Instance	1	Keypad
Attribute	2	Inhibit
Value	BOOL	0 = Source not inhibited (Keypad active) 1 = Source inhibited (Keypad disabled)

This configuration allows you to temporarily use Local mode of the keypad to perform maintenance tasks when needed, while disabling use of the keypad for motor control during normal operation.

IMPORTANT

The value of the Inhibit attribute is reset to 0 (not inhibited, keypad can be used for motor control) when the drive has power cycled. If it is important that the keypad be inhibited in the application, logic should be added to resend the inhibit message instruction after a power cycle, or simply resend the inhibit message instruction, periodically.

Keypad Actions in Local and Function Modes

Table 11 and Table 12 show what actions occur for Local and Function modes and list what LEDs are illuminated, including their color. In Disabled mode, no buttons are active and all LEDs are Off.

Table 11 – Local Mode Keypad Actions

LOCAL Mode	LOCAL/AUTO Button	
	AUTO selected	LOCAL selected
Mode LEDs Top: Green Bottom: Off	Drive is remotely controlled. Keypad F/R and JOG buttons are not active. All reference and sequencing commands come from a network connection / logic controller.	Drive is in local control. Allows use of the JOG and F/R buttons
LOCAL/AUTO LED	Red	Green
Fwd/Rev LED	Off	Fwd – Green Rev – Red
Fwd/Rev Button	Not active	Selects JOG direction
JOG Button pressed	Not active	Fwd/Rev LED – Blinks while JOG is pressed Green – Forward JOG Red – Reverse JOG (the drive jogs while the JOG button is pressed)
JOG Button not selected	Not active	Fwd/Rev LED – Steady (no blink) based on selected direction color
F0 LED	Amber LED – Off	Amber LED – Off
F1 LED	Amber LED – Off	Amber LED – Off
F2 LED	Amber LED – Off	Amber LED – Off

Table 12 – Function Mode Keypad Actions and Status Indicators

FUNCTION mode	LOCAL/AUTO – F0 Button		Fwd/Rev – F1 Button		JOG – F2 Button	
	F0 selected	F0 unselected	F1 selected	F1 unselected	F2 selected	F2 unselected
Mode LEDs Top: Off Bottom: Amber	Network reads F0 state = '1' All reference and commands come from the network.	Network reads F0 state = '0' All reference and commands come from the network.	Network reads F1 state = '1' All reference and commands come from the network.	Network reads F1 state = '0' All reference and commands come from the network.	Network reads F2 state = '1' All reference and commands come from the network.	Network reads F2 state = '0' All reference and commands come from the network.
LOCAL/AUTO Mode LED	Off	Off	Off	Off	Off	Off
Fwd/Rev LED	Off	Off	Off	Off	Off	Off
F0 LED	Amber LED – On	Amber LED – Off	Amber LED – Off	Amber LED – Off	Amber LED – Off	Amber LED – Off
F1 LED	Amber LED – Off	Amber LED – Off	Amber LED – On	Amber LED – Off	Amber LED – Off	Amber LED – Off
F2 LED	Amber LED – Off	Amber LED – Off	Amber LED – Off	Amber LED – Off	Amber LED – On	Amber LED – Off

Standard and Configurable I/O Operation

All Armor PowerFlex drives include four standard inputs and two standard configurable I/Os. These inputs and outputs are used with sensors and actuators respectively, for monitoring and controlling the application process.

The Armor PowerFlex safety drive (35S) includes safety I/Os: two test outputs, four safety inputs, and one bipolar safety output. The four safety inputs share the two test outputs (two safety inputs per test output). See [Chapter 6](#) for safety I/O details.

Standard I/O Operation

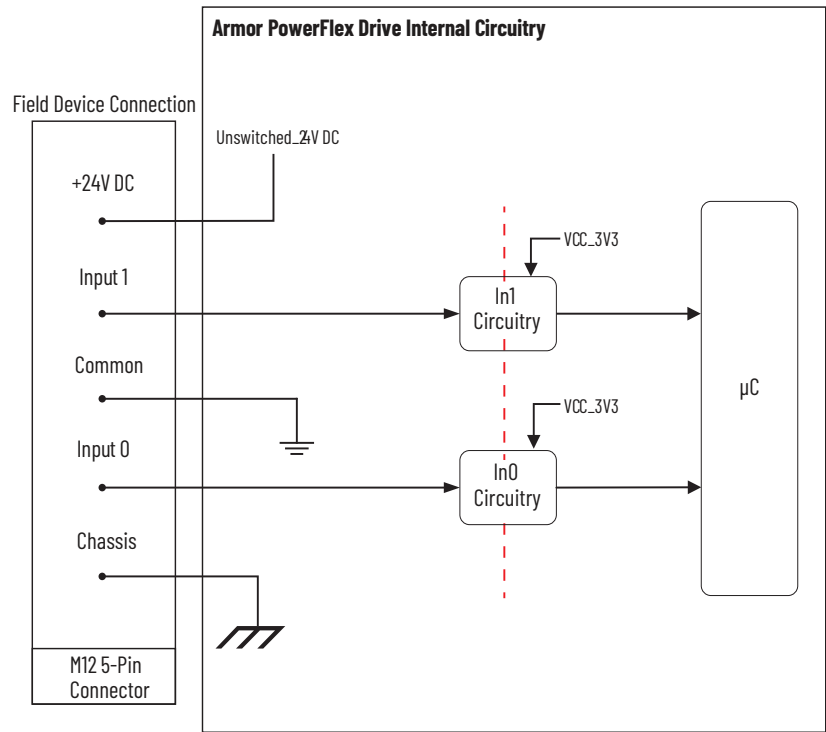
The Armor PowerFlex drives include four inputs that are single keyed (two inputs per connector) and sourced from control power. The inputs use two M12 connectors. Each input has an light-emitting diode (LED) status indication (See [I/O Status Indicators on page 215](#) for details). They are configurable as sinking or sourcing (See [Configure Safety Inputs on page 193](#) for configuration details).

Short-circuit protection: The maximum sourcing sensor power is 300 mA for all discrete inputs. Therefore if all six are inputs, a maximum of 50 mA is allowed per input. Or for any single input, the full 300 mA can be sourced. If maximum sourcing power is exceeded, a fault is generated.

You can set an On to Off and Off to On, filter time in the programming software. This setting helps prevent rapid changes of input data due to contact bounce.

Each I/O point has a status LED see [I/O Status Indicators on page 215](#) for details.

Standard Input Internal Wiring Diagram



Standard Input Wiring Examples

Connected Devices	Connection	Schematic Diagram
Reset switch	Connect the reset switch between +24V Unswitched Sensor Power and Input 1	<p>Pin 1:+24V unswitched (sensor) power Pin 2: Input 1 Pin 3: Input Common Pin 4: Input 0 Pin 5: Chassis (PE)</p>
Dual input configuration	Connect the LED between 24V and Input 1 and connect the reset switch between 24V and Input 0	<p>Pin 1:+24V unswitched (sensor) power Pin 2: Input 1 Pin 3: Input Common Pin 4: Input 0 Pin 5: Chassis (PE)</p>

Configurable I/O Operation

The Armor PowerFlex drives have two configurable I/O points that are self-configurable as either an input or output, based on the electrical connection used. By default, the I/O points are configured as inputs.

The two I/O points are sourced from switched auxiliary power. The two I/O points use one single-keyed two M12 connector. Each I/O has an LED status indication (See [I/O Status Indicators on page 215](#) for details).

The self-configuring I/O points are named I/00 and I/01.

Turning a self-configuring I/O point ON via the Output Tag *devicename.O.I0_0* or *devicename.O.I0_1*, makes it behave as an output. See [Table 78 on page 201](#).

IMPORTANT

To operate properly, standard outputs require a minimum load of 10 mA, otherwise an over/under current error will occur.

The Input Tag *devicename.I.I0_0* or *devicename.I.I0_1* value reflects the state of a connected input device, if one is connected, or the output state, if the point is being used to drive an output device. You must confirm that the Discrete Output Point output value is not accidentally set to 1 if the point is being used as an input.

- If an I/O point is to be an output, dedicate that point as an output with a wired load and energize it through a control program.
- Energized outputs show an associated active input that can be used as a feedback mechanism to verify that the output is on.
- If an I/O point is to be an input, wire the input device as normal and leave the associated output de-energized at all times.

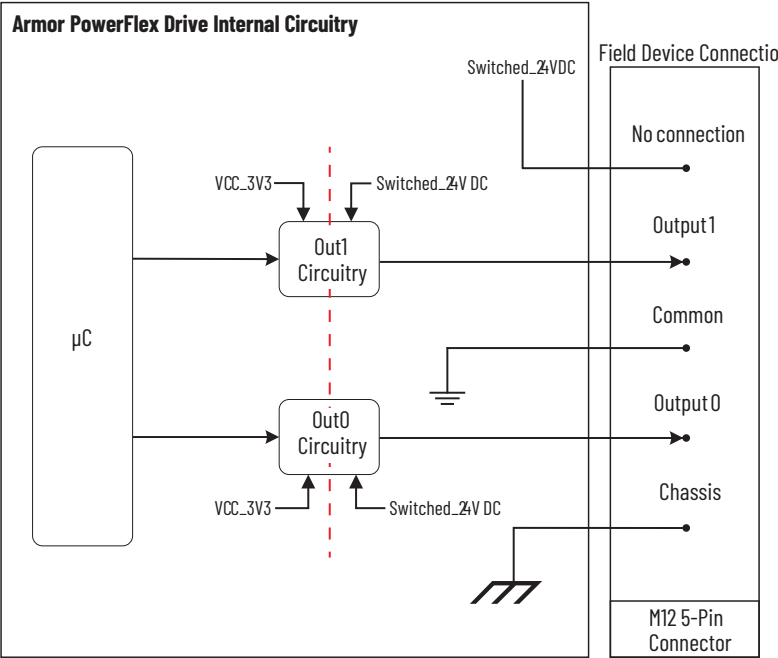
When a fault occurs, standard outputs (the self-configuring I/O points) will be set to a known state based on their configured fault action.

Configured Fault Actions

- Connection Idle (Controller Run -> Program Transition) Action
- Connection Fault Action
- Product Fault Action

To configure the fault action for the configurable I/O, see [Configure Standard I/O Points on page 185](#).

Configurable I/O Internal Wiring Diagram (Output)



Standard Output Wiring Examples

Connected Devices	Connection	Schematic Diagram
Output drives LED (I/O configured as output)	Connect the LED between Input/Output 1 and Common	<p>Pin 1: +24V unswitched (sensor) power Pin 2: Input/Output 1 Pin 3: Input Common Pin 4: Input/Output 0 Pin 5: Chassis (PE)</p>
Outputs drive LEDs (Both of the I/Os are configured as outputs)	Connect the first LED between Input/Output 1 and Common Connect the second LED between Input/Output 0 and Common	<p>Pin 1: +24V unswitched (sensor) power Pin 2: Input/Output 1 Pin 3: Input Common Pin 4: Input/Output 0 Pin 5: Chassis (PE)</p>

Standard I/O Wiring Example

Connected Devices	Connection	Schematic Diagram
Output drives LED and Input as reset switch	Output: Connect the LED between Input/Output 1 and Common Connect the reset switch between Input/Output 0 and +24V Unswitched Sensor Power	<p>Pin 1: +24V unswitched (sensor) power Pin 2: Input/Output 1 Pin 3: Input Common Pin 4: Input/Output 0 Pin 5: Chassis (PE)</p>

Safety Functions

This chapter only applies to the Armor PowerFlex safety version (35S) used in a safety application. If you are using an Armor PowerFlex standard version (35E), this chapter does not apply to you.

The Armor PowerFlex safety version provides hard-wired Safe Torque Off (STO), integrated Safe Torque Off (STO), integrated drive-based Safe Stop 1 functions, Safe Brake Control (SBC), and integrated controller-based Safe Monitor functions, capability.

Table 13 - Integrated Safety Functions and Compatible Controllers

Integrated Safety Over the EtherNet/IP Network		
	Safety Function	Minimum Controller Required (Firmware Version 32.00...35.xx)
Drive-based stop functions	<ul style="list-style-type: none"> Timed Safe Stop 1 (SS1) Monitored Safe Stop 1 (SS1)⁽¹⁾ Safe Brake Control (SBC) 	<ul style="list-style-type: none"> GuardLogix 5580 Compact GuardLogix 5380
Controller-based stop functions	<ul style="list-style-type: none"> Monitored Safe Stop 1 (SS1)⁽¹⁾ Safe Brake Control (SBC) 	
Controller-based monitor functions	<ul style="list-style-type: none"> Safely Limited Speed (SLS)⁽¹⁾ Safely Limited Position (SLP)⁽¹⁾ Safe Direction (SDI)⁽¹⁾ 	
Safety feedback function	Safety Feedback Interface (SFX) ⁽¹⁾	
Integrated STO mode	Safe Torque Off (STO)	

(1) Monitored safety functions require an encoder to be configured in the safety configuration.

Table 14 - Hardwired Safety Functions and Compatible Controllers

Hardwired Safety – No Safety Connection		
	Safety Function	Minimum Controller Required for Standard Connection (Firmware Version 32.00...35.xx)
Hardwired STO mode	Safe Torque Off (STO)	<ul style="list-style-type: none"> ControlLogix 5570 or 5580 Armor ControlLogix 5570 GuardLogix 5570 or 5580 Armor GuardLogix 5370 CompactLogix 5370 or 5580 Armor CompactLogix 5370 includes GuardLogix variants Compact GuardLogix 5370 or 5580

IMPORTANT

The functional safety part of the product does not need any maintenance (apart from proof testing, if applicable). For the functional safety part of the product, no spare parts are available and no repair is possible or intended by the user. If there is a permanent fault, the device has to be taken out of use and replaced by another device.

Safety Considerations



ATTENTION: The drive is suitable for performing mechanical work on the drive train or affected area of a machine only. It does not provide electrical safety.



ATTENTION: The drive does not remove dangerous voltages at the drive output. Before performing any electrical work on the drive or motor, turn off the input power to the drive, and follow all safety procedures.



ATTENTION: Failure to maintain the specified ambient temperature can result in a failure of the safety function.



ATTENTION: Personnel responsible for the application of safety-related programmable electronic systems (PES) must be aware of the safety requirements in the application of the system and must be trained in use of the system.



ATTENTION: When designing your system, consider how various personnel can interact with the machine. Additional safeguard devices can be required for your specific application.



ATTENTION: In circumstances where external influences (for example, suspended loads that can fall) are present, additional measures (for example, mechanical brakes) can be necessary to help prevent any hazard.

The system operator is responsible for the following:

- Setup, safety rating, and validation of any sensors or actuators connected to the system
- Completion of a machine-level risk assessment and reassess the system anytime a change is made
- Certification of the machine to the desired ISO 13849-1 performance level or EN/IEC 62061 SIL CL level
- Project management and proof testing in accordance with ISO 13849-1
- Programming the application software and the drive configurations in accordance with the information in this manual
- Access control to the system
- Analyzing all configuration settings and choosing the proper setting to achieve the required safety rating
- Validation and documentation of all safety functions used
- Performance of necessary proof tests and periodic safety checks

Stop Category Definitions

There are two stop categories that apply to Armor PowerFlex drives:

- Stop Category 0 is achieved with immediate removal of power to the machine actuators, which results in an uncontrolled coast-to-stop. An STO accomplishes a Stop Category 0 stop.
- Stop Category 1 is achieved with a Ramp to Stop followed with immediate removal of power to the machine actuators. An SS1 with STO accomplishes a Stop Category 1 stop.

IMPORTANT

When designing the machine application, consider the timing and distance for a coast-to-stop (Stop Category 0 or Safe Torque Off). For more information on stop categories and Safe Torque Off, see EN 6204-1 and EN/IEC 61800-5-2.

Performance Level and Safety Integrity Level

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

See the ISO 13849-1, IEC 61508, and IEC 62061 standards for complete information on requirements for PL and SIL determination. See rok.auto/certifications for product certifications.

Proof Tests

IEC 61508 requires you to perform various proof tests of the equipment that issued in the system. Proof tests are performed at user-defined times. For example, proof tests can be once a year, once every 15 years, or whatever time frame is appropriate.

The Armor PowerFlex drive has a useful life of 20 years; no proof test is required. Other components of the system, such as safety I/O devices, sensors, and actuators, can have different useful life times.

IMPORTANT	The time frame for the proof test interval depends on the specific application.
------------------	---

PFD and PFH Definitions

Safety-related systems can be classified as operating in either a Low Demand mode, or in a High Demand/Continuous mode.

- Low Demand mode: where the frequency of demands for operation, made on a safety-related system, is no greater than one per year, or no greater than twice the proof test frequency.
- High Demand/Continuous mode: where the frequency of demands for operation, made on a safety-related system, is greater than once per year, or greater than twice the proof test interval.

The SIL value for a low-demand safety-related system is directly related to the order-of-magnitude ranges of its average probability of failure to perform its safety function on demand or, simply, the average probability of a dangerous failure on demand (PFD_{avg}).

The SIL value for a High Demand/Continuous mode safety-related system is directly related to the average frequency of a dangerous failure (PFH) per hour.

For redundant parts of a PDS (SR) which cannot be tested without disrupting the application in which the PDS (SR) is used (machine or plant) and where no justifiable technical solution can be implemented, the following maximum diagnostic test intervals can be considered as acceptable. See [Table 15](#).

Table 15 - Maximum Diagnostic Test Intervals

To achieve the listed safety rating	Maximum STO demand interval
SIL 3/Category 4, PL _e	one STO operation per day
SIL 3/Category 3, PL _e	one STO operation per three months
SIL 2/Category 3, PL _d	one STO operation per year

Safety Data for Armor PowerFlex Drives

The following sections list safety data for Hardwired STO and Integrated STO and Safety Functions.

Table 16 - PFD and PFH for Armor PowerFlex Drives Hardwired STO

Attribute	Value
PFD _(average)	2.65 E-04
PFH (1/hour)	3.04 E-09
SIL	3
PL	e
Category	4
MTTFd years	139.7 (high)
DC _{avg} %	97.2% (medium)
HFT (hardware fault tolerance)	1
Mission time	20 years

Safety Data for Integrated STO and Integrated Safety Functions

These PFH calculations are based on the equations from Part 6 of EN 61508 and show worst-case values.

Table 17 - PFD and PFH for Armor PowerFlex Drives Integrated STO and Timed SS1

Attribute	Value
PFD _(average)	1.56 E-4
PFH (1/hour)	1.76 E-9
SIL	3
PL	e
Category	4
MTTFd years	171.3 (high)
DC _{avg} %	97.7% (medium)
HFT	1
Mission time	20 years

[Table 18](#) provides PFH values to add for safety functions that use the safety I/O provided on the Armor PowerFlex drive.

Table 18 - PFD or PFH to Add When Safety Functions Use Safety I/O

Attribute	Single Channel Safety I/O	Dual Channel Safety I/O
PFD _(average)	6.64 E-4	1.12 E-4
PFH (1/hour)	7.58 E-9	1.28 E-9
SIL	2	3
PL	d	e
Category	2	4
MTTFd years	760.3	757.6
DC _{avg} %	95%	95%
HFT	0	1
Mission time	20 years	20 years

IMPORTANT

Single channel safety I/O is only certified for use in functional safety applications with process safety times greater than or equal to 300 ms; or applications with demand rates for both input and output, less than or equal to 1 demand per 30 s.

IMPORTANT If single channel safety I/O is used, pulse testing (external pulse testing for safety inputs, pulse testing for safety outputs) MUST be enabled on the single channel I/O points.

Safety Data for Safety Functions with Safety Feedback

[Table 19](#) provides PFD_{avg} and PFH values to add to the PFD_{avg} and PFH values from [Table 17](#) or [Table 18](#) for safety functions that require safe encoder feedback. Safety functions that use safe encoder feedback include: drive based Monitored Safe Stop 1 and controller-based safety functions SS1, SLS, SLP, and SDI.

In general, the PFD_{avg} and PFH values from [Table 19](#) should be added to [Table 17](#) and [Table 18](#) when Safety Instance is set to 'Single Feedback Monitoring'.

Table 19 - PFD or PFH to Add When Safety Functions Use Safety Feedback

Attribute	Single Encoder Feedback
PFD (average)	2.88 E-5
PFH (1/hour)	3.29 E-10
SIL	2
PL	d
Category	3
MTTFd years	2154.3
DCavg%	97.3%
HFT	1
Mission time	20 years

IMPORTANT Achievable safety rating depends on each system component. For Safe Feedback, the safety rating of the selected encoders could limit the safety rating of the system.

Safety Reaction Time

The safety reaction time is the length of time from a safety-related event as input to the system until the system is in the safe state. [Table 20](#) shows the safety reaction time from an input signal condition that triggers a safe stop, to the initiation of the configured Stop Type. For details on how to calculate system reaction times with GuardLogix controllers, see the GuardLogix Controller Systems Safety Reference Manuals that are listed in the [Additional Resources on page 12](#).

Table 20 - Safety Reaction Time

Function	Reaction Time
Hardwired STO	12 ms
Integrated STO	10 ms
Safety Output	10 ms

IMPORTANT The safety reaction time that was previously listed, excludes the connection reaction time.

A number of factors influence the safety reaction time, including the configuration of the safety I/O on your device and the configuration of your safety controller. These factors include:

- Safety Input On to Off and Off to On delay settings, if applicable
- Safety Input Connection Reaction Time Limit settings
- Safety controller Safety Task Period and Watchdog settings
- Produced and consumed safety Connection Reaction Time Limit settings

- Safety Output Connection Reaction Time Limit settings

See [Safety Input and Output Connection Settings \(safety variants only\) on page 184](#), for information on how to configure these settings.

For details on reaction time calculation of your safety system, see Reaction Times in the GuardLogix Controller Systems Safety Reference Manual, for your safety programmable controller. These manuals are listed in the [Additional Resources on page 12](#).

Spurious Trip Rate

[Table 21](#) shows the Spurious Trip Rate (STR) and Mean Time to Failure Spurious (MTTF_{Spurious}) values, calculated according to the ISA TR-84 method.

Table 21 - STR and MTTF Spurious Rates

Attribute	Value
Spurious Trip Rate (per hour)	6.61 E-6
MTTF Spurious (years)	1.73 E+1

Contact Information If Safety Failure Occurs

If you experience a failure with any safety-certified device, contact your local Allen-Bradley distributor to request any of these actions:

- Return the device to Rockwell Automation so the failure is appropriately logged for the catalog number that is affected and a record is made of the failure.
- Request a failure analysis (if necessary) to determine the probable cause of the failure.


Safe Torque Off Function

The TÜV Rheinland group has approved Armor PowerFlex drives with hardwired and integrated Safe Torque Off (STO) for use in safety-related applications up to ISO 13849-1 Performance Level e (PLe), SIL CL 3 per IEC 61508, IEC 61800-5-2, and EN/IEC 62061, in which removing the motion-producing power is considered to be the safe state.


For product certifications currently available from Rockwell Automation, go to [rok.auto/certifications](#). All components in the system must be chosen and applied correctly to achieve the desired level of operator safeguarding.

Description of Operation

The Armor PowerFlex STO circuit is designed to turn off all output-power transistors when the STO function is requested. You can use the Armor PowerFlex STO circuit in combination with other safety devices to achieve a Stop Category 0 stop as described in [Stop Category Definition for STO on page 97](#), and protection-against-restart as specified in IEC 60204-1.



ATTENTION: When designing your system, consider how various personnel can interact with the machine. Additional safeguard devices can be required for your specific application.



ATTENTION: If there is a failure of two output IGBTs in the Armor PowerFlex drive, the Armor PowerFlex drive can provide energy for up to 180° of rotation in a 2-pole motor before torque production in the motor ceases.

The STO feature provides a method, with sufficiently low probability of failure, to force the power-transistor control signals to a disabled state. When disabled, or anytime power is removed from the safety enable inputs, all drive output-power transistors are released from the On state. This results in a condition where the drive performs a Category 0 Stop (see [Stop Category Definition for STO on page 97](#)). Disabling the power transistor output does not provide physical isolation of the electrical output that is required for some applications.

See [Safe Brake Control Function on page 115](#) for information on how to use a mechanical brake with the drive.



ATTENTION: When STO is demanded, the motor output provides mechanical isolation of the electrical output that is required for some applications.



ATTENTION: In circumstances where external influences (for example, falling of suspended loads) are present, additional measures (for example, mechanical brakes) may be necessary to help prevent any hazard.

Stop Category Definition for STO

Stop Category 0 as defined in IEC 60204 or Safe Torque Off as defined by IEC 61800-5-2 is achieved with immediate removal of motion-producing power to the actuator.

IMPORTANT

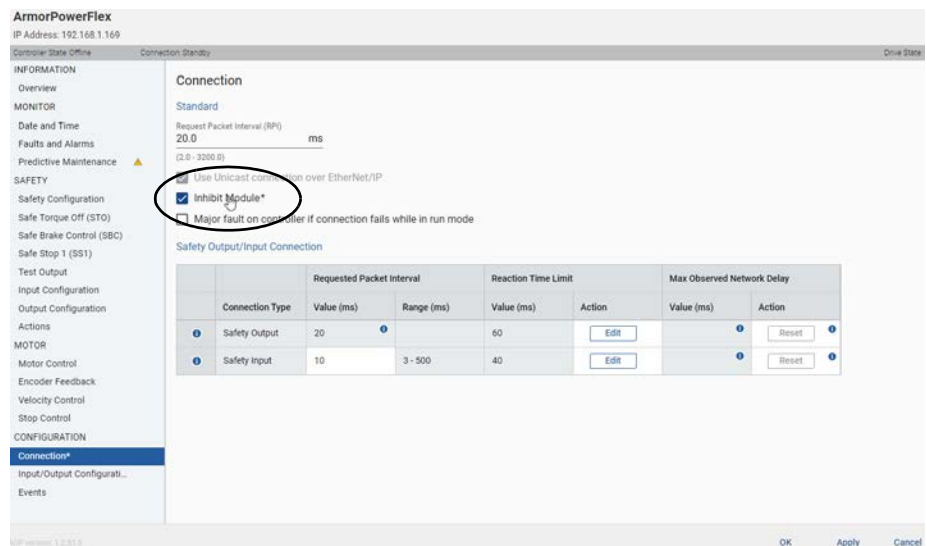
If there is a malfunction, the most likely stop category is Stop Category 0. When designing the machine application, timing and distance must be considered for a coast-to-stop. For more information regarding stop categories, see IEC 60204-1.

Reset Ownership

After the integrated safety connection configuration is applied to the drive at least once, you can restore the Armor PowerFlex drive to the out-of-box state by resetting ownership in the Logix Designer application, while online. When you reset the Armor PowerFlex drive, all configuration settings, including standard and safety I/O configurations are returned to their out-of-box settings. Resetting Ownership using the Logix Designer application, requires that the Module Connection is inhibited.

Follow these steps to inhibit the module connection:

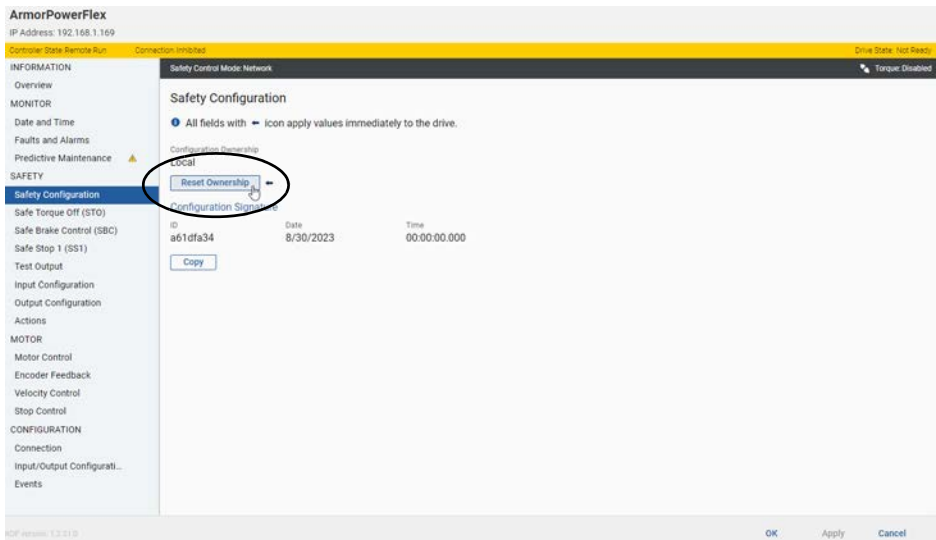
1. Right-click the device and click Properties.
2. Click Connection.
3. Check the Inhibit Module checkbox.



4. Click Apply and then OK.

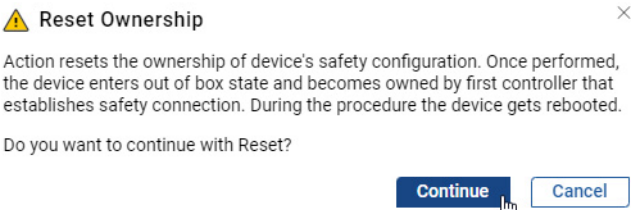
Follow these steps to reset the device to its out-of-box configuration when online.

- 1. Right-click the module and choose Properties.
- 2. Click Safety Configuration.
- 3. Click Reset Ownership.

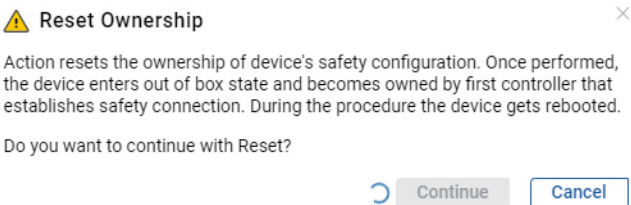


IMPORTANT During Reset Ownership, the Logix Designer application is locked and you cannot perform any other actions.

- 4. Click Continue.



The Logix Designer application is locked until the reset is completed.



Out-of-Box State

Out-of-Box is the state in which the Armor PowerFlex drive is delivered from the factory. All configuration settings including standard and safety I/O configurations, are returned to factory default values.

In the Out-of-Box state, the drive is in Hardwired STO mode, which means it is ready for hardwired connections to the safety I/O. See [Description of Operation on page 96](#).

Reset to Out-of-box State

You can reset the Armor PowerFlex drive to the out-of box state in two ways:

- By resetting ownership via the Logix Designer application. See [Reset Ownership](#)
- By setting the IP address switches to 888 using the following procedure:
 - a. Remove power from the product. Wait for it to power down.
 - b. Set the network address switches to 888. [See Set the IP Address on page 69](#) for instructions on how to set the IP address. The IP Mode switch is ignored because the network address switch setting of 888 is not within the range of 1...254.
 - c. Apply power to the product.
 - d. Wait for 60 seconds.
 - e. Remove power from the product. Wait for it to power down.
 - f. Set the network address switches to 1 to 254 or 999.
 - g. Re-apply power to the product. The product's configuration settings have been restored to their factory default values.

IMPORTANT Only authorized personnel should attempt to reset ownership. The safety connection must be inhibited before the reset is attempted. If any active connection is detected, the safety reset is rejected.

Recognize Out-of-box State Using a Message Instruction

A message instruction can be used to query the Safety Supervisor Object to determine if the device is in the out-of-box state.

The safety supervisor state provides information on the state of the integrated safety connection and the mode of operation. There is only one safety supervisor object per drive module.

[Table 22](#) shows the message instruction parameter needed to query the Safety Supervisor Object. [Table 23](#) shows the possible response values and their relation to the safety connection. For a message instruction example, see [Appendix B on page 245](#).

Table 22 - Safety Supervisor State: MSG

Parameter	Value	Description
Service Code	0x0E	Get attribute single
Class	0x39	Safety supervisor
Instance	1	Revision
Attribute	0x0B 11 (decimal)	Device status
Data Type	SINT	Short integer

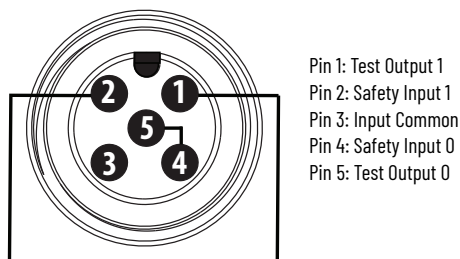
Table 23 - Safety Supervisor States

Value	Display Text	Definition
1	Testing	Device is performing test diagnostics
2	Idle	No active connections
3	Test Flt	A fault has occurred while executing test diagnostics
4	Executing	Normal running state
5	Abort	A major recoverable fault has occurred
6	Critical Flt	A critical fault has occurred
7	Configuring	Transition state
8	Waiting	Out-of-box state
51	Wait w Trq	Out-of-box state
52	Exec w Trq	STO bypass state

STO Bypass Operation

To support commissioning of the product, a STO bypass plug may be used to enable torque. The STO bypass plug can be used on either pair of inputs to enable torque.

Figure 42 - Hardwired STO - Safety Bypass Plug



IMPORTANT

To use the 35S drive in an application without safety or to bypass the STO feature while commissioning or testing the drive, the drive must be in Hardwired mode and either safety input pair must be wired to enable torque. The safety bypass jumper plug can be used for this purpose.



ATTENTION: If you bypass the STO feature, the safety system permits motor torque that could result in unintended motion. Use additional preventive measures to maintain the safety integrity of the machinery.

Hardwired Safe Torque Off Function

Armor PowerFlex safety drives (35S) are configured for Hardwired Safe Torque Off (STO) mode when the Connection is set to Standard in the Device Definition dialog box of the Logix Designer application (see [Configure the Device Definition on page 154](#) for details). To be configured for Hardwired STO mode, it is also required that no Network Safety connection has been made.

Hardwired STO Operation

If the Safety Supervisor state is waiting (8) or waiting with torque permitted (51), then the safety control is in the out-of-box state. See [Table 23 on page 99](#).

For hardwired control of the STO:

- The STO function must be in Hardwired STO mode.
- The safety inputs must be wired appropriately.

Two of the four 24V DC discrete safety inputs control the STO function. Safety Input 0 and 1 along with Test Output 0 and 1 are intended to interface to dual-channel equivalent safety devices. Safety Inputs 2 and 3 are intended to interface to Output Solid State Devices (OSSD). Only one pair of inputs can be used at a time. See [Safety I/O Operation on page 129](#) for additional information.

If either pair of safety inputs are energized (SI0 and SI1, or SI2 and SI3), the output power transistors will turn on. If either of the safety enable inputs are de-energized, then all output power transistors turn off. The hardwired STO response time is less than 12 ms. [Figure 45](#) shows the timing diagram of the hardwired STO in normal operation. [Figure 46](#) shows the timing diagram of the hardwired STO function while Safety Inputs are discrepant.

All safety inputs in hardwired mode are configured for 100 ms Off to On delay, and 1 ms On to Off delay, to reject pulse testing. Both pairs are also configured for a 0.9 s discrepancy time. In hardwired mode, safety inputs 0 and 1 are configured for pulse testing. Safety inputs 2 and 3 are not configured for pulse testing. Torque is enabled when either safety input pair is enabled.

[Figure 43](#) and [Figure 44](#) show wiring examples for both hardwired input pair.

Figure 43 - Hardwired STO - Dual Channel Device

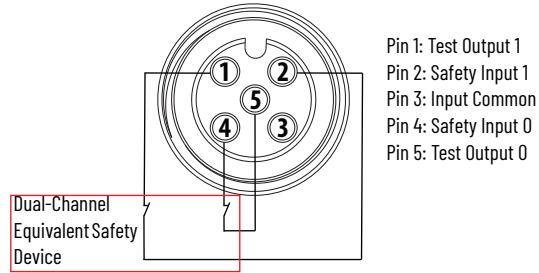


Figure 44 - Hardwired STO - Signal Switching Device using External Power Supply

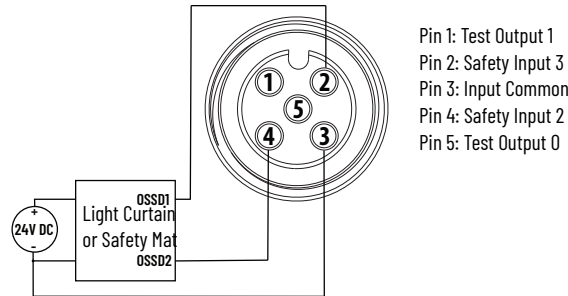
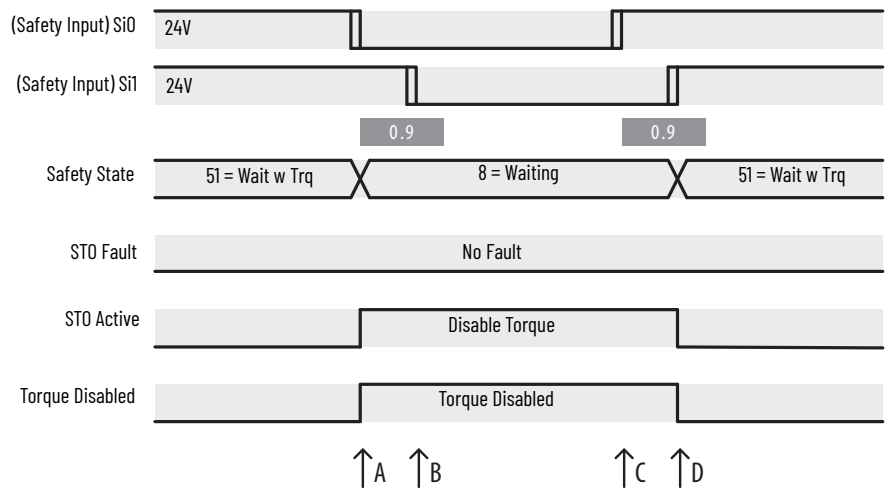


Figure 45 - Normal Operation



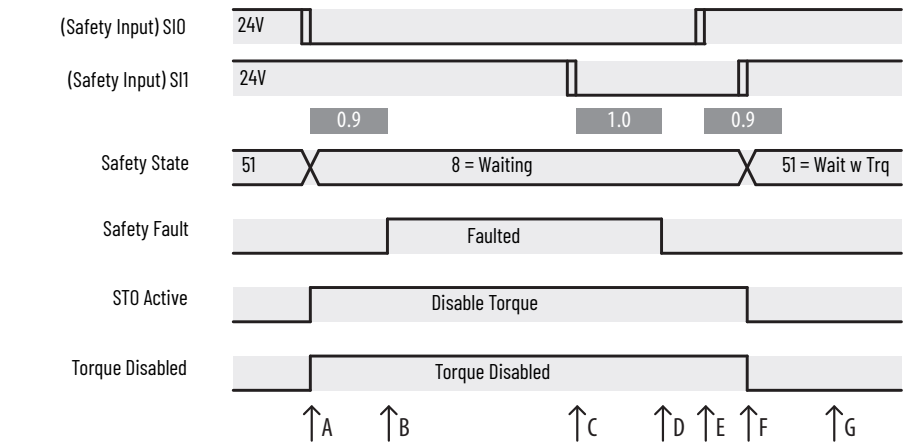
Letter	Description
A	Set Safety Input SIO = 0 volts
B	Set Safety Input SI1 = 0 volts within 0.9 seconds
C	Set Safety Input SIO = 24 volts
D	Set Safety Input SI1 = 24 volts within 0.9 seconds

Hardwired STO Fault Operation

Both STO safety inputs must turn off together, otherwise a Hardwired Discrepancy (102) STO fault occurs, even if the first safety input gets turned on again. All hardwired inputs must be set to zero for 1 ms, for the fault to be cleared. [Figure 46](#) and [Figure 47](#) describe this operation.

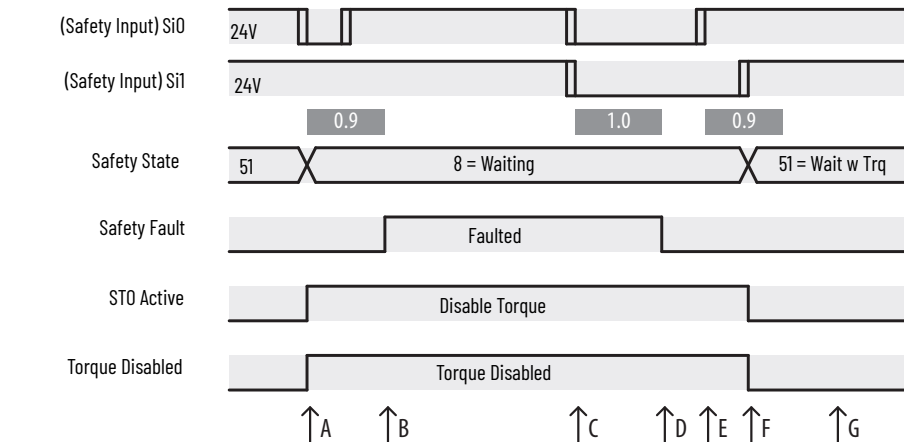
If both input pairs become energized (SIO or SI1, and SI2 or SI3), a Both Pairs Active (105) STO Fault type will occur. All inputs must be set to zero for 1 ms for the fault to be cleared.

Figure 46 – System Operation when Safety Enable Inputs Mismatch Occurs



Letter	Description
A	Set Safety Input SIO = 0 volts
B	Discrepancy fault after 0.9 seconds
C	Set Safety Input SI1 = 0 volts
D	Discrepancy fault cleared after 1.0 seconds
E	Set Safety Input SIO = 24 volts
F	Set Safety Input SI1 = 24 volts
G	Clear Armor PowerFlex Fault

Figure 47 – System Operation in the Event That the Safety Enable Inputs Mismatch Momentarily



Letter	Description
A	Set Safety Input SIO = 0 volts
B	Discrepancy fault after 0.9 seconds
C	Set Safety Input SI1 = 0 volts
D	Discrepancy fault cleared after 1.0 seconds
E	Set Safety Input SIO = 24 volts
F	Set Safety Input SI1 = 24 volts
G	Clear Armor PowerFlex Fault



ATTENTION: The STO fault is detected upon demand of the STO function. After troubleshooting, a safety function must be executed to verify correct operation.

IMPORTANT	A Hardwired Input Discrepancy fault (102) and both pairs active fault (105), can be reset by placing all inputs in the off state for more than 1 second. Any other STO fault types can only be cleared in hardwired STO mode by power cycling or resetting the device.
------------------	--

Integrated Safety Features

The Armor PowerFlex drive is suitable for use in a safety-control network that meets the requirements up to and including the following:

- SIL CL 3 according to IEC 62061 and IEC 61508
- Category 4, PLe as defined in ISO 13849-1

The TÜV Rheinland group has approved Armor PowerFlex drives with integrated Safe Torque Off (STO) and Safe Stop 1 functions (Timed SS1 and Monitored SS1 and SBC) for use in safety-related applications up to ISO 13849-1 Performance Level e (PLe), SIL CL 3 per IEC 61508, IEC 61800-5-2, and IEC 62061, in which removing the motion-producing power is considered to be the safe state. See the GuardLogix Safety Application Instruction Set Reference Manual, publication [1756-RM095](#), for more information on the Drive Safety instructions and TÜV Rheinland certification.

Integrated Safety Applications

Armor PowerFlex 35S drives feature integrated safety I/O (4 safety inputs, 2 test outputs, and 1 bipolar safety output) as well as integrated Safe Stop and Safe Monitor functions.

A safety input only connection can be used to monitor the safety status of the Armor PowerFlex device in another safety controller. See [Configure Safety Listen Only Connection on page 195](#), for instructions how to configure this connection and for more information.

Drive-based safe stop functions that are built in to the Armor PowerFlex 35S drives are:

- Safe Torque Off
- Timed Safe Stop 1
- Monitored Safe Stop 1
- Safe Brake Control, stop functions

Controller-based safety functions operate in GuardLogix 5580 or Compact GuardLogix 5380 controllers and use the EtherNet/IP network to communicate with the safety I/O. Drive Safety instructions use safety feedback, provided by the Armor PowerFlex drive to the safety task of the controller, to perform safe monitor functions.

The supported Drive Safety instructions are:

- Safety Feedback Interface (SFX)
- Safe Stop 1 Monitored (SS1)
- Safely limited Speed (SLS)
- Safely limited Position (SLP)
- Safe Direction (SDI)
- Safe Brake Control (SBC)

When used for safe speed monitoring, the drive is configured for single-feedback to achieve the following safety rating:

Single-feedback configurations using safety encoders provide up to SIL 2 PLd capability.

IMPORTANT	Drive Safety instructions are only available in Logix Designer version 32.00...35.xx and can only be used with Compact GuardLogix 5380 and GuardLogix 5580 controllers.
------------------	---

Integrated Safety System Application Requirements

Safety application requirements include evaluating average frequency of dangerous failure rates (PFH), system reaction time settings, and functional verification tests that fulfill the SIL criteria. Create, record, and verify the safety signature as part of the required safety application development process. The safety controller creates the safety signature. The safety signature consists of an identification number, date, and time that uniquely identifies the safety portion of a project. This signature covers 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, see the GuardLogix Controller Systems Safety Reference Manuals. See [Additional Resources on page 12](#).

IMPORTANT

You must read, understand, and fulfill the requirements that are detailed in the appropriate GuardLogix controller systems safety reference manual before operating a safety system that uses a GuardLogix controller and an Armor PowerFlex drive. See [Additional Resources on page 12](#).

Drive-based Integrated Safe Stop Functions

IMPORTANT

Safety Output Monitor Value is not safety data and has no defined safe state. Use Output Monitor Value for diagnostic purposes only.

The information in this section describes information that is common to the integrated Safe Torque Off, Timed Safe Stop 1, Monitored Safe Stop 1, and Safe Brake Control stop functions that are built into the drive. Detailed information for each function follows this topic.

- Safe Torque Off [page 105](#)
- Timed Safe Stop 1 [page 112](#)
- Monitored Safe Stop 1 [page 113](#)
- Safe Brake Control [page 115](#)

Safety Output Assembly Safe Stop Function Tags

The safety output controller for Integrated Safe Speed consists of different Logix tags:

- Pass thru status and faults
- Safety stop function commands
- Safety I/O commands

See [Safety Output Tags on page 203](#) for a list of Safety Output Assembly Tags.

Safety Input Assembly Safe Stop Function Tags

The safety input assembly for Integrated Safe Speed consists of different Logix tags:

- Connection status
- Safety feedback and stop function status
- Safety I/O status

See [Safety Input Tags on page 201](#) for a list of Safety Input Assembly Tags.



ATTENTION: Safety I/O connections and produced/consumed connections cannot be automatically configured to fault the controller if a connection is lost and the system transitions to the safe state. If you must detect a device fault so that the system maintains the required SIL level, you must monitor the Safety I/O CONNECTION_STATUS bits and initiate the fault via program logic.

Safety Function in Response to Connection Event

The drive allows for a safety function to be executed when the safety connection to the drive is lost or the connection enters the idle state. This operation is referred to as the connection action. There are two configurable connection actions that are defined as follows:

- Connection Loss Action - The safety function to be executed if the network connection from the drive to the safety controller is lost or closed.
- Connection Idle Action - The safety function to be executed if the safety controller that is connected to the drive enters program mode.

In both of these cases, the safety function must be executed by the drive. Therefore, only the drive-based safety functions are used in these cases.

The following drive-based safety functions are supported as a connection loss action and connection idle action:

- STO
- SS1

The action can be configured in the Logix Designer application on the Actions page. See [Configure Safety Actions on page 198](#), for more information.

Integrated Safe Torque Off Function

The Safe Torque Off (STO) feature provides a method, with sufficiently low probability of failure, to force the output power to a disabled state. When the command to execute the STO function is received by the Armor PowerFlex drive, the output power device transitions to an Off state, which results in a condition where the motor is coasting.

The Integrated STO response time is less than 10 ms.



ATTENTION: Safe Torque Off (STO) will prevent the motor from applying torque to a system but in some systems torque is also applied to the mechanical system by a suspended load, unbalanced load, back pressure, and so on. In such a system, application of a mechanical brake is required to hold the load while motor torque is disabled by STO.

You can use the STO circuit in combination with other safety devices to achieve the stop and protection-against-restart as specified in IEC 60204-1. These conditions must be met for integrated control of the STO function:

- You must have a GuardLogix family of safety controllers project with an EtherNet/IP network connection configured.
- You must add the drive to the Ethernet network connection in the safety controller I/O tree.

IMPORTANT

Integrated STO will not work unless an IP address has been configured for the drive. See [Set the IP Address on page 69](#).

The safety reaction time is the time from when the Armor PowerFlex drive STO command receives the CIP Safety™ packet that triggers a safe stop to the initiation of the configured Stop Type. See [Safety Data for Safety Functions with Safety Feedback on page 95](#), for details.

Safe Torque Off Activation

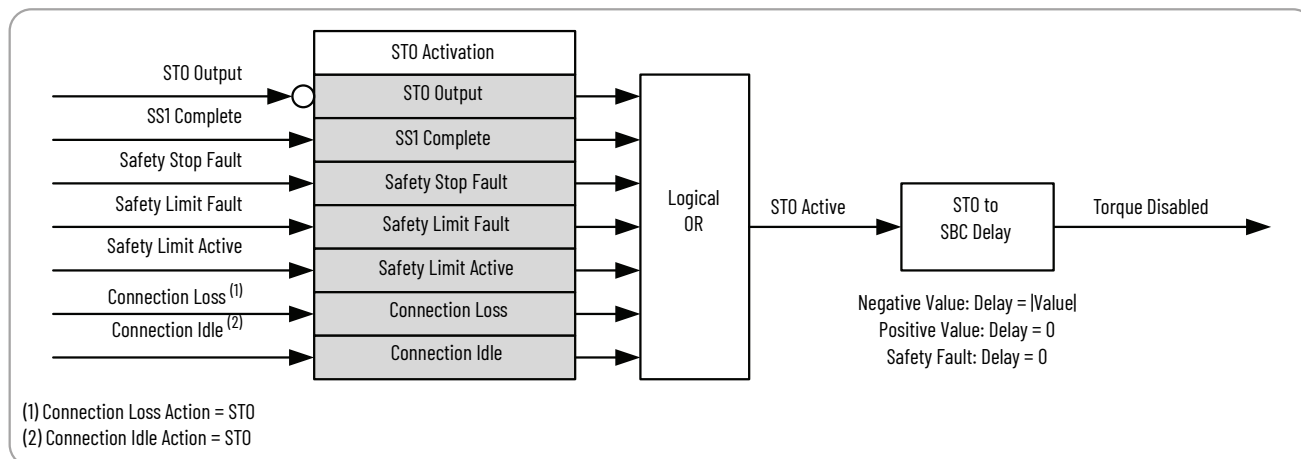
Safe Torque Off can be initiated by one or more sources:

- STO Output - Setting the Safety Output Assembly Tag (*devicename:SO.STOOutput1* = 0)
- SS1 Complete - Completion of a Safe Stop 1
- Stop Fault - Any Safety Fault
- Connection Loss - Loss of connection to the safety controller

- Connection Idle – Safety controller in program mode

When STO is activated, all sources of activation are stored in an attribute as a bit mask. The attribute can then be read to determine the causes of a STO activation. [Figure 48](#) shows the operation of the STO activation attribute. The STO Activation attribute can be read with a Message (MSG) Instruction (see attribute 265 in Armor PowerFlex AC Drives CIP Objects and Attributes Reference Data, publication [35-RD001](#)).

Figure 48 - Safe Torque Off Activation



Safe Torque Off Reset

After torque is disabled due to a STO activation, the STO function must be reset to enable torque. When the STO function must be reset, the following attribute values are set:

- `devicename:SI.STOActive = 1`
- `devicename:SI.RestartRequired = 1`

The steps to reset the STO function depend on the cause of STO activation and the Restart/ Cold Start Type configured in the module.

- Safety Fault STO Activation Reset

IMPORTANT

When a Safety Fault activates the STO function, the cause of the safety fault must be removed before STO can be reset, regardless of the configured restart type.

Once the cause of the fault is removed, a 0 to 1 transition on the `devicename:SO.ResetRequest` tag resets the STO function to the Torque Enabled state.

- Connection Loss/Idle STO Activation Reset

If a connection loss/idle event activates the STO function, the connection must be re-established and running before the STO function can be reset. The function must be reset based on the configured Cold Start type.

- Automatic Cold Start/Restart Type Operation

If there are no Safety Faults and no safety demands, the STO function can be reset.

- Manual Cold Start/Restart Type Operation

If there are no Safety Faults and no safety demands present in the module, the STO function can be reset by a 1 to 0 transition on the `devicename:SO.STOOutput` tag then a 0 to 1 transition on `devicename:SO.ResetRequest` tag.



Setting `devicename:SO.STOOutput = 1` and `devicename:SO.RequestReset = 1` in the same program scan, enables torque.

Safe Torque Off Delay

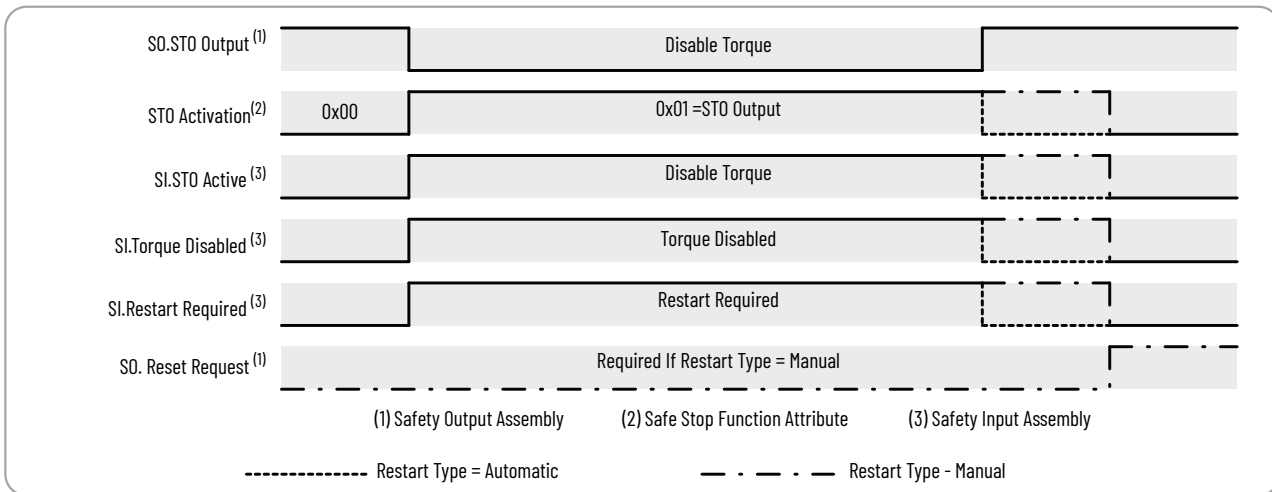
A delay to provide time for the drive to stop the load in response to STO Active can be programmed. This delay time is referred to as STO Delay. If no delay is desired, set the STO Delay to zero. The STO Delay must be a positive integer value.

If Safe Brake Control is being used, the STO delay must be zero. If an STO delay is desired with the use of the Safe Brake Control function, see [Safe Brake Control Function](#) on page 115 for information on how to configure STO to SBC delay. If STO is activated by a safety fault, any configured delay is ignored, and torque is disabled instantly.

Safe Torque Off Operation

The operation of the STO function and its attributes is dependent on the configuration of the STO function and the activation reason. For all STO activations besides safety fault, the operation of STO is dependent on STO Delay. For STO activations caused by a safety fault, the operation ignores STO Delay. See the following sections for more information.

Figure 49 - STO Without Delay

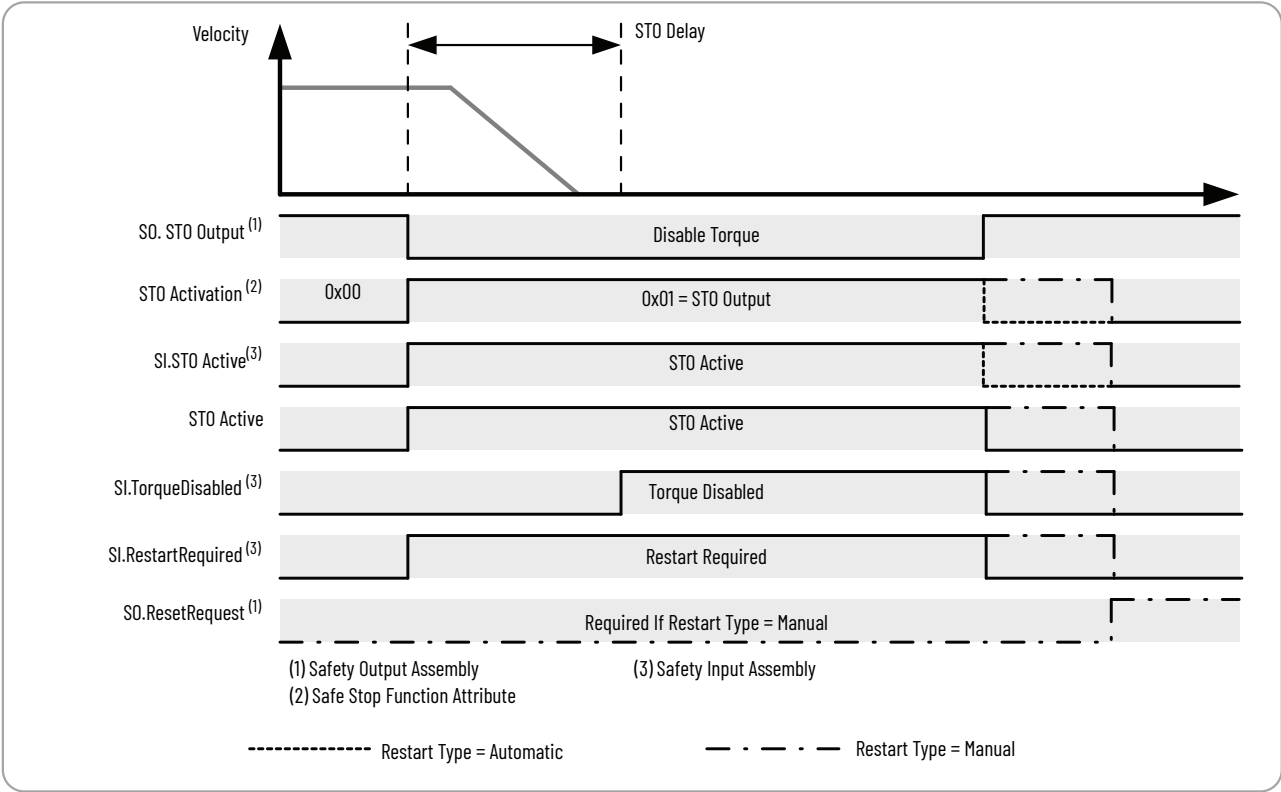


Safe Torque Off With Delay Operation

When the STO Delay is configured for a positive nonzero value, the delay is inserted between STO Active and Torque Disabled. The STO Delay is meant to serve as a delay between the configured STO drive stop action and when torque is disabled. The delay allows the drive to complete the stop before torque is disabled. This operation is effectively a Timed Safe Stop 1 function. See [Safe Stop 1 Function](#) on page 110 for information on how to configure a drive stop type in response to a STO activation.

[Figure 50](#) shows the timing of STO status and torque attributes in response to a STO activation, along with the restart type behavior, when STO Delay is configured.

Figure 50 - STO with Delay



IMPORTANT The Safe Brake Control (SBC) Mode must be set to 'Not Used' to permit STO Delay. If Mode is not set to 'Not Used', Delay is set to zero.

Safe Torque Off Safety Fault

When the Armor PowerFlex drive experiences a STO Fault, the Armor PowerFlex drive is placed in the safe state and the cause of the fault is recorded. If the STO function detects a fault, it sets the following attributes:

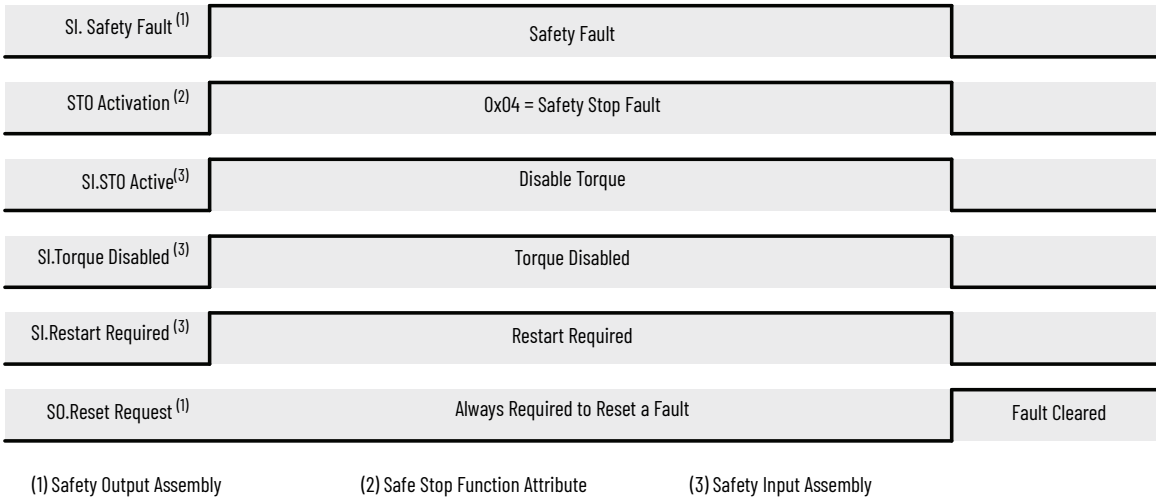
- *devicename:Sl.SafetyFault* = 1
- *devicename:Sl.RestartRequired* = 1
- STO Fault Type, see [Safe Torque Off Fault on page 126](#)

For more information on STO Fault Types and troubleshooting methods, see [Monitor Safety Status and Faults via a Message Instruction on page 125](#).

When a safety fault occurs in the module, the STO function is forced to the Safe State, which is the Torque Disabled state. In this case, the configured STO Delay value is bypassed and torque is immediately disabled. [Figure 51](#) shows the timing of STO and torque attributes in response to STO activation by a Safety Fault.

Clearing a Safety Fault requires correcting the fault condition, then a 0 to 1 transition on Request Reset.

Figure 51 – STO with Safety Fault



ATTENTION: If STO activation by a safety fault occurs, the configured STO Delay time is ignored, and torque is immediately disabled.

Safe Stop 1 Function

The Safe Stop 1 (SS1) function signals the configured SS1 Stop Action Source to initiate a stopping action, then the safety module monitors the stop. When the Safe Stop 1 is complete, STO is activated and torque is disabled. If the drive does not complete the stop within the limits that are configured in the Safe Stop 1 function, an SS1 Fault is annunciated.

Safe Stop 1 Activation

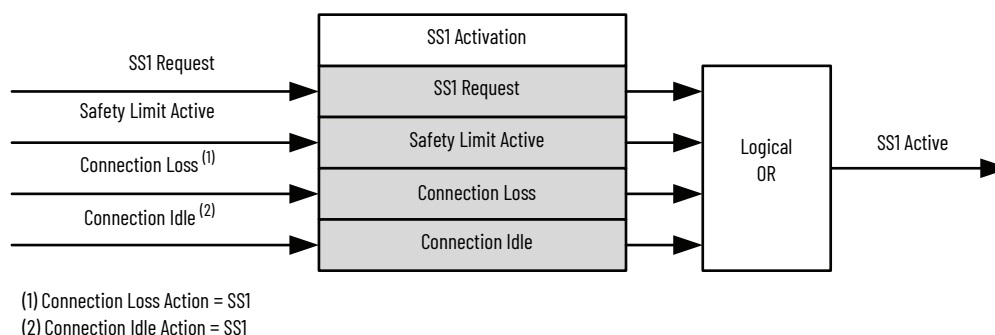
Safe Stop 1 can be initiated by one or more sources:

- SS1 Request – Setting the Safety Output Assembly Tag (*devicename:S0.SS1Request1* = 1)
- Limit Active – Reserved for future use
- Connection Loss – Loss of connection to the safety controller
- Connection Idle – Safety controller in program mode

When SS1 is activated, all sources of activation are stored in an attribute as a bit mask and the attribute can then be read to determine the causes of an SS1 activation. [Figure 52](#) shows the operation of the SS1 activation attribute. The SS1 Activation attribute can be read with a message instruction (see attribute 289 in Armor PowerFlex AC Drives CIP Objects and Attributes Reference Data, publication [35-RD001](#)).

Unlike the STO function, SS1 does not get activated by a safety fault.

Figure 52 – Safe Stop 1 Activation



Safe Stop 1 Reset

After an SS1 action is complete, the SS1 function must be reset to enable torque. When the SS1 Function needs to be reset, the following attribute values are set:

- *devicename:SI.SS1Active* = 1
- *devicename:SI.RestartRequired* = 1

The steps to reset the SS1 function depend on the cause of SS1 activation and the Restart/Cold Start Type configured in the module.

- Connection Loss/Idle SS1 Activation Reset
If a connection loss/idle event activates the SS1 function, the connection must be re-established and running before the SS1 function can be reset. The function must be reset based on the configured Cold Start type.
- Automatic Cold Start/Restart Type Operation
If there are no Safety Faults present in the module, the SS1 function can be reset by a 1 to 0 transition on the *devicename:S0.SS1Request1* tag.
- Manual Cold Start/Restart Type Operation
If there are no Safety Faults in the module, the SS1 function can be reset by a 1 to 0 transition on the *devicename:S0.SS1Request1* tag then a 0 to 1 transition on *devicename:S0.ResetRequest* tag.

SS1 Safety Fault

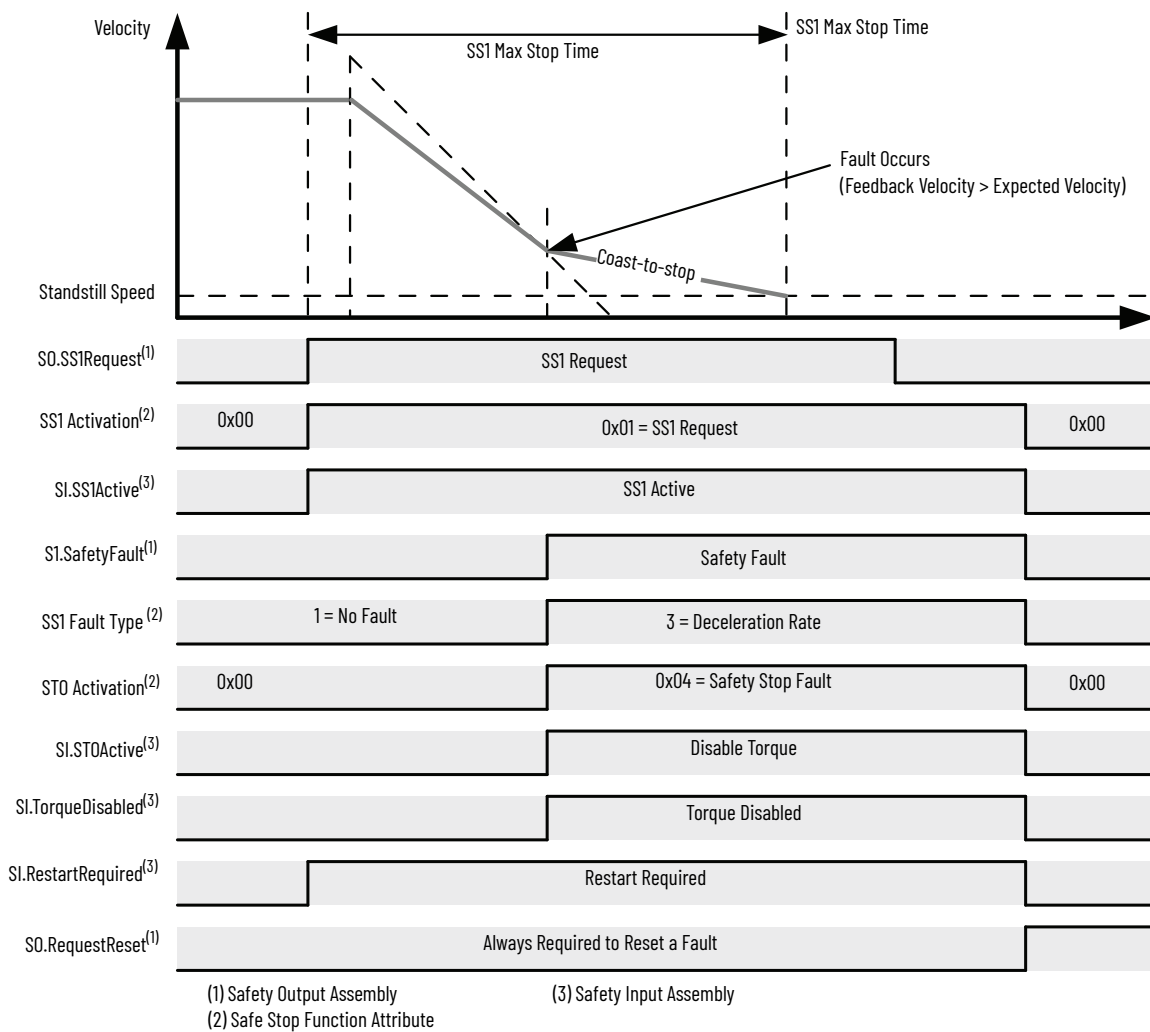
When an SS1 Safety Fault occurs, the STO function is activated immediately and torque is disabled. [Figure 53](#) describes the operation of SS1 when an SS1 fault is detected.

The 'Safe State' of the SS1 function is the Torque Disabled state. If the SS1 function detects a fault, it sets:

- `devicename:SI.SafetyFault = 1`
- `devicename:SI.RestartRequired = 1`
- SS1 Fault Type, see [Safe Stop 1 Fault on page 127](#)

Clearing a Safety Fault requires correcting the fault condition and a 0 to 1 transition on Request Reset. For more information on SS1 Safety Faults, see [Monitor Safety Status and Faults via a Message Instruction on page 125](#).

Figure 53 – Safe Stop 1 Fault Operation



Timed Safe Stop 1

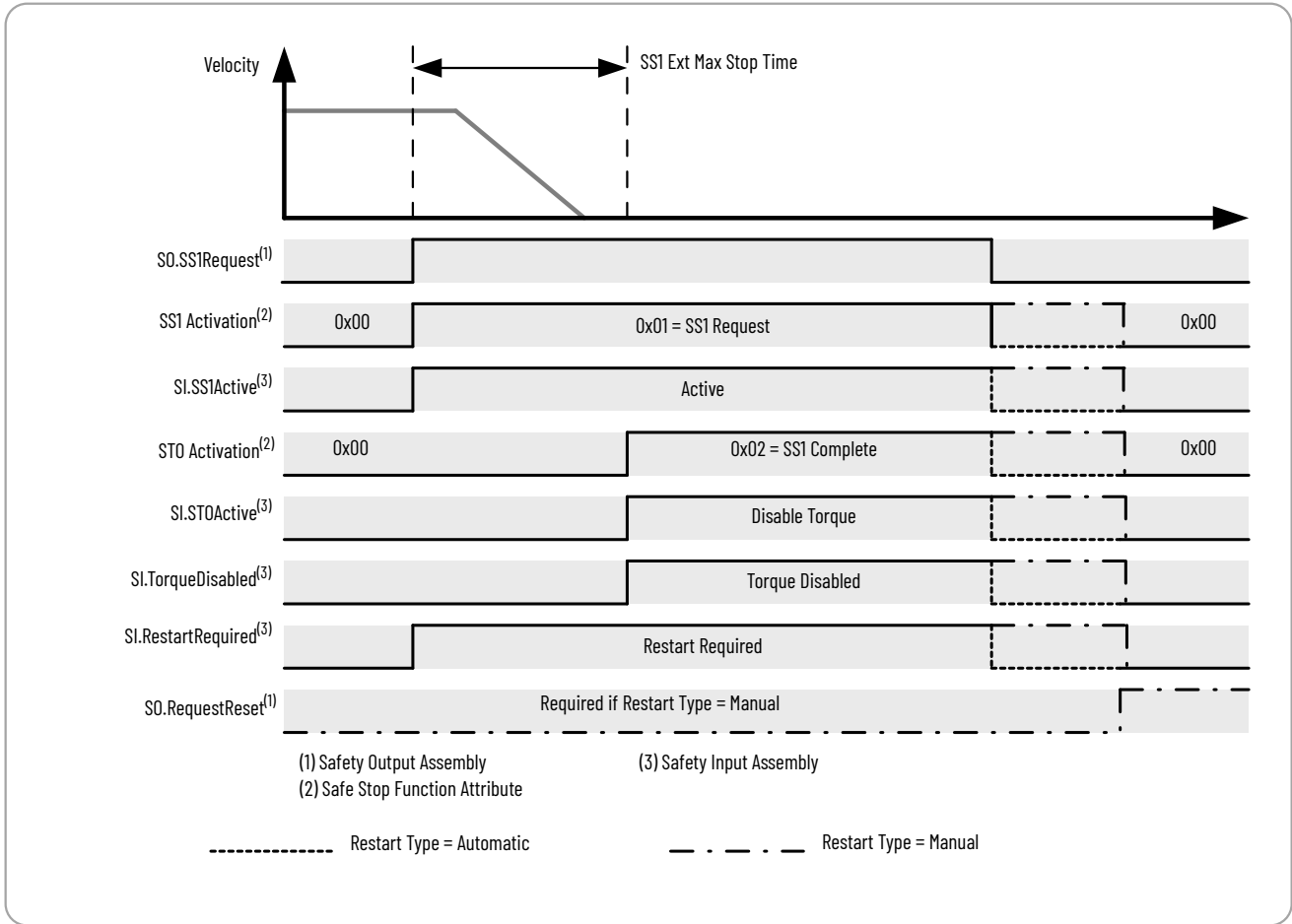
A Timed Safe Stop 1 involves initiating motor deceleration and initiating the STO function after the configured time delay.

Timed Safe Stop 1 Operation

When the Armor PowerFlex drive is configured for Timed Safe Stop 1 Mode, the Safe Stop 1 function is initiated by setting the *devicename*:S0.SS1Request1 safety output tag. This sets the 'SS1 Request' bit in the SS1 Activation attribute and sets the *devicename*:SI.SS1Active safety input tag.

The SS1 function waits for the configured SS1 Max Stop Time, then sets the SS1 Complete flag in the STO Activation attribute, which sets STO Active to Disable Torque. In Timed Safe Stop 1 mode, speed and deceleration are not monitored so this mode does not require Safety Feedback. [Figure 54](#) shows the timing of SS1 status and torque attributes in response to an SS1 activation, along with the restart behavior.

Figure 54 - Timed Safe Stop 1



Monitored Safe Stop 1

A Monitored Safe Stop 1 involves monitoring the motor feedback deceleration rate and time, then initiating an STO activation when the motor feedback speed is below a specified limit.

Monitored Safe Stop 1 Operation

When the Armor PowerFlex drive is configured for Monitored Safe Stop 1 Mode, the Safe Stop 1 function is initiated by setting the *devicename*:S0.SS1Request1 safety output tag. This sets the 'SS1 Request' bit in the SS1 Activation attribute, and also sets the *devicename*:S1.SS1Active safety input tag.

After the SS1 Active bit is set, the configured SS1 Decel Monitor Delay timer begins. After the configured Decel Monitor Delay expires, an internal speed ramp value is computed every time that the encoder is sampled. If the magnitude of *devicename*:S1.FeedbackVelocity exceeds the sum of the internal ramp plus Decel Speed Tolerance, the SS1 Fault Type attribute is set to 'Deceleration Rate' and the SS1 Fault attribute is set to Faulted.

[Figure 55](#) describes the equations that are used for computing the deceleration (decel) reference rate and tolerance.

Figure 55 - SS1 Deceleration Reference Rate and Tolerance Calculation

$$\text{Decel Reference Rate} = \frac{\text{Decel Reference Speed}}{1000 \times \text{Stop Delay}}$$

If Time Units = Seconds,

$$\text{SS1 Decel Ref Rate} = -\frac{\text{Decel Reference Rate} \times \text{Position Scaling}}{\text{Feedback Resolution}}$$

$$\text{SS1 Decel Tolerance} = \frac{\text{Decel Reference Tolerance} \times \text{Position Scaling}}{\text{Feedback Resolution}}$$

If Time Units = Minutes,

$$\text{SS1 Decel Ref Rate} = -\frac{\text{Decel Reference Rate} \times \text{Position Scaling}}{\text{Feedback Resolution} \times 60}$$



A Configured Decel Reference Rate of 0 disables the ramp check. SS1 faults if the drive does not slow to less than the Standstill Speed.

If the magnitude of *devicename*:S1.FeedbackVelocity is not less than the configured Standstill Speed before Max Stop Time expires, the SS1 Fault Type is set to 'Maximum Time' and the SS1 Fault attribute is set to 'Faulted'. [Figure 56](#) describes the equations that are used for computing the standstill speed.

Figure 56 - SS1 Standstill Speed Calculation

If Time Units = Seconds,

$$\text{SS1 Standstill Speed} = \frac{\text{Standstill Speed} \times \text{Position Scaling}}{\text{Feedback Resolution}}$$

If Time Units = Minutes,

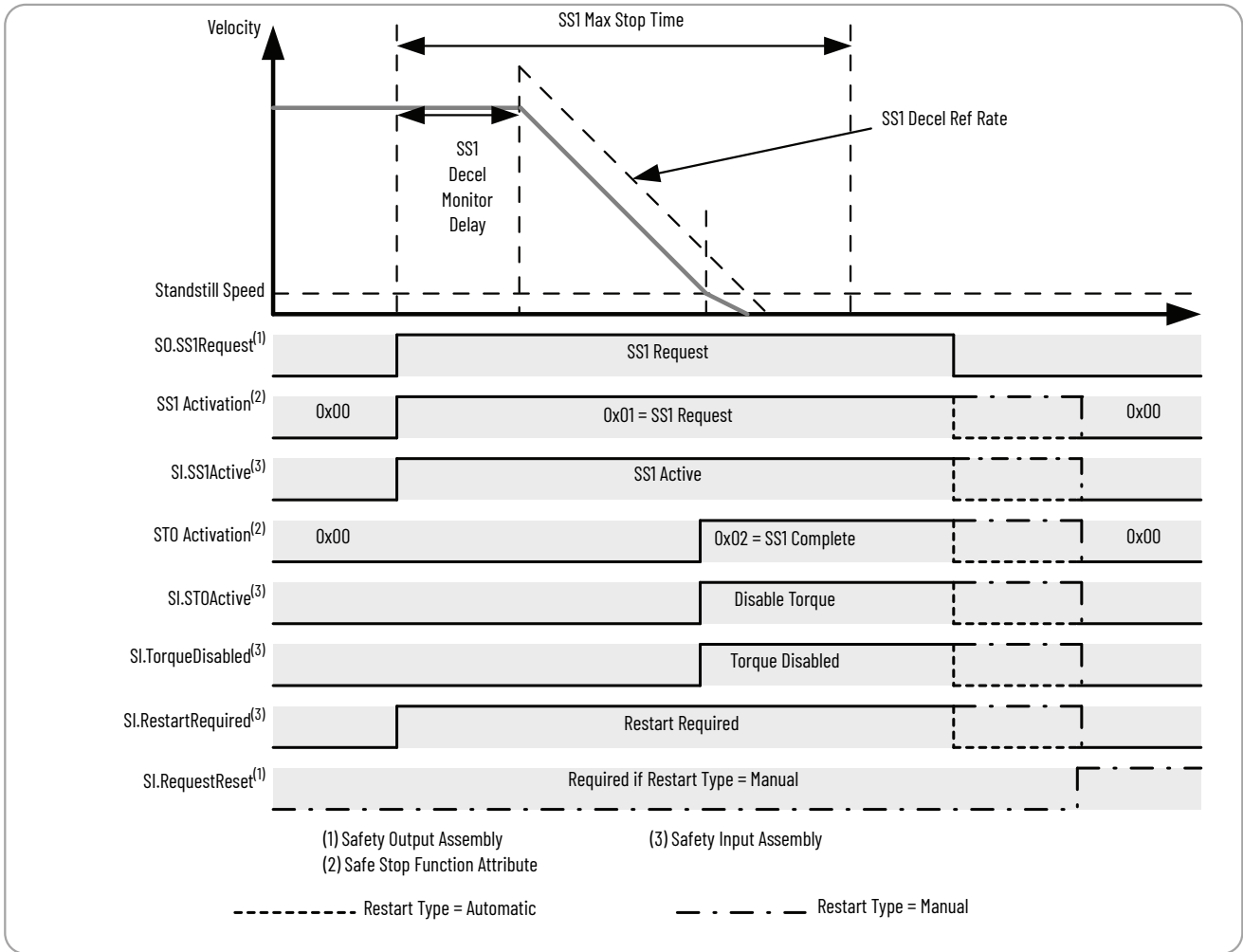
$$\text{SS1 Standstill Speed} = \frac{\text{Standstill Speed} \times \text{Position Scaling}}{\text{Feedback Resolution} \times 60}$$

Where *Standstill Speed*, *Position Scaling*, and *Feedback Resolution* are user-configured values.

When the magnitude of *devicename*:SI.FeedbackVelocity is less than the Standstill Speed, the SS1 Complete flag in the STO Activation attribute is set, and STO Active is set. If STO Delay is positive (and SBC Mode = Not Used) or if STO to SBC Delay is negative (and STO Activates SBC = Linked), then the Torque Disabled attribute is set after the configured time delay. Otherwise, the Torque Disabled attribute is set immediately.

Figure 57 shows the timing of the Monitored SS1 operation, along with the restart type behavior.

Figure 57 - Monitored Safe Stop 1



Speed units are configured by the 'Position Units' and 'Time Units' Add-on Profile Controls on the Scaling page.



A Configured Decel Reference Rate of 0 disables the ramp check. SS1 will fault if the drive does not slow to less than the Standstill Speed within Max Stop Time.

Safe Brake Control Function

The Safe Brake Control (SBC) function uses the module's safety outputs to control an electromechanical brake that is attached to the motor. The SBC function releases the brake to allow motion or engages the brake to prevent motion.

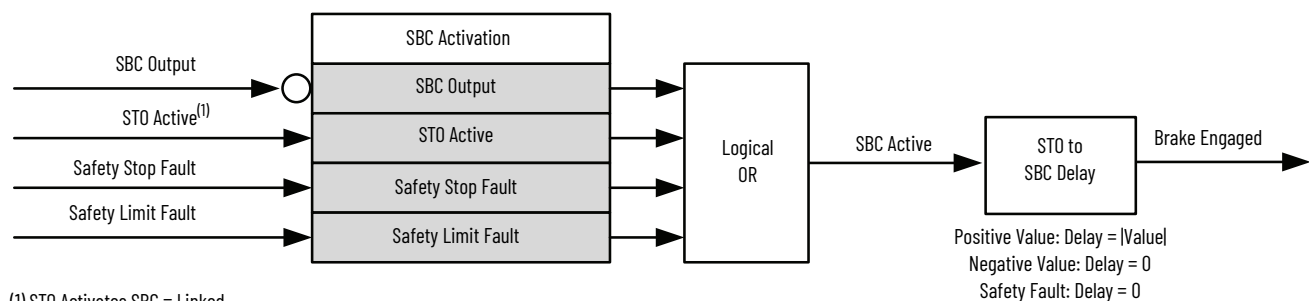
Safe Brake Control Activation

Safe Brake Control can be initiated by one or more sources:

- SBC Output – Clearing the Safety Output Assembly Tag (*devicename*:S0.SBCOutput1 = 0)
- STO Active – SBC is configured as 'Linked'
- Safety Stop Fault – Any Safety Fault
- Safe Limit Fault – Reserved for future use

When SBC is activated, all sources of activation are stored in an attribute as a bit mask, and the attribute can then be read to determine the causes of an SBC activation. Figure 58 shows the operation of the SBC activation attribute. The SBC Activation attribute can be read with a message instruction (see attribute 365 in Armor PowerFlex AC Drives CIP Objects and Attributes Reference Data, publication [35-RD001](#)).

Figure 58 – Safe Brake Control Activation



If the SBC Activation bit mask indicates that only STO Active is the source of activation, then the STO to SBC Delay is executed. If the activation is not by STO Active, or other activation bits are also set, the STO to SBC Delay is not executed and the brake is immediately engaged.

Safe Brake Control Reset

After the brake is engaged due to an SBC activation, the SBC function must be reset to release the brake. When the SBC function must be reset, the following attribute values are set:

- *devicename*:SI.SBCActive = 1
- *devicename*:SI.RestartRequired = 1

The steps to reset the SBC function depend on the cause of SBC activation and the Restart/Cold Start Type configured in the module.

IMPORTANT

When the SBC function is activated by a Safety Fault, the cause of the safety fault must be removed before the SBC function can be reset, regardless of the configured restart type.

- **Safety Fault SBC Activation Reset**
Once the fault is removed, a 0 to 1 transition on *devicename*:S0.ResetRequest tag resets the SBC function to the Brake Released state.
- **Automatic Cold Start/Restart Type Operation**
If there are no Safety Faults in the module, the STO function can be reset by a 0 to 1 transition on the *devicename*:S0.SBCOutput tag.
- **Manual Cold Start/Restart Type Operation**

If Restart Type is set to 'Manual' and there are no Safety Faults in the module, the SBC function can be reset by a 0 to 1 transition on the *devicename:SO.SBCOutput* tag, then a 0 to 1 transition on *devicename:SO.ResetRequest* tag.



Setting *devicename:SO.SBCOutput* = 1 and *devicename:SO.RequestReset* = 1 in the same scan enables torque.

Safe Brake Control Modes

SBC Mode specifies if the SBC functionality is used and how the safety outputs controlling the brake operate. The mode also changes the instances of the CIP objects controlling the safety outputs. The module supports the following modes.

Not Used

In 'Not Used' mode, the SBC function is not used by the application. The associated safety outputs are not under SBC control, and can be configured independently. The safety outputs are mapped to the following CIP objects:

- So0: Safety Discrete Output Point Object Instance 1
- So1: Safety Discrete Output Point Object Instance 2
- Safety Dual Channel Output Object Instance 1

IMPORTANT	If the Safe Brake Mode is set to 'Not Used', then the state of the two safety outputs So0 and So1 is controlled by the Safety Output Assembly tags; otherwise, the two Safety Outputs are controlled by the Safe Brake Function.
------------------	--

IMPORTANT	If the Safe Brake Mode is set to 'Not Used', then setting the Safety Output tag <i>devicename:SO.SBCOutput1</i> = 1 sets the SBC Fault and sets the SBC Fault Type to 'Config'.
------------------	---

Used, No Test Pulses

In 'Used, No Test Pulses' mode, the associated safety outputs are not pulse tested. The associated safety outputs are under SBC control and cannot be configured independently. The safety outputs are mapped to the following CIP objects:

- So0: Safety Discrete Output Point Object Instance 3
- So1: Safety Discrete Output Point Object Instance 4
- Safety Dual Channel Output Object Instance 2

Used, Test Pulses

In the 'Used, Test Pulses' mode, the safety outputs are under SBC control and cannot be configured independently. The safety outputs are mapped to the same CIP objects as the 'Used, No Test Pulses' mode.

There is no difference in implementation of Safety Outputs pulse testing in SBC control versus direct control. See [Safety I/O Operation on page 129](#) for pulse test behavior.SBC Operation when Activated by Safety Output Assembly.

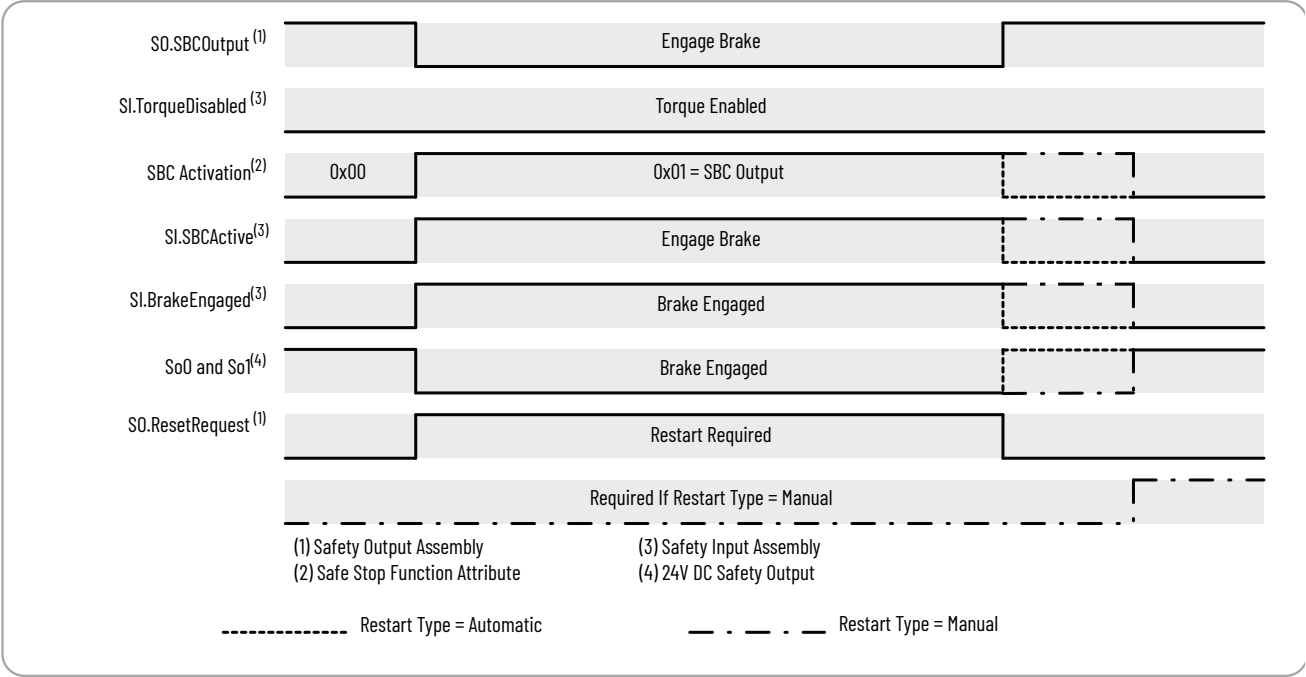
IMPORTANT	When pulse testing is used to achieve the maximum safety rating (SIL 3 Category 4, PLe), the safety output wiring must be protected against external damage by cable ducting, conduit, armored cable, or other means. See ISO 13849-2:Table D.4, for additional information.
------------------	--

IMPORTANT If the Safe Brake Mode is set to 'Used', then the Safety Input Assembly tags associated with safety outputs will be forced to:

devicename:Sl.Out00Monitor = 0
devicename:Sl.Out01Monitor = 0
devicename:Sl.Out00Status = 0
devicename:Sl.Out01Status = 0
devicename:Sl.Out00Ready = 0
devicename:Sl.Out01Ready = 0

When the SBC function is activated by clearing the *devicename:SO.SBCOutput* tag, the associated safety outputs are de-energized, which forces the brake to engage, and torque is still enabled. [Figure 59](#) shows the timing of SBC attributes when the SBC function is executed independently.

Figure 59 - SBC Operation by Safety Output Assembly



STO Activates SBC Operation

If the SBC function is configured to link STO and SBC activation, any STO activation will cause the SBC function to be activated as well. The brake is engaged (de-energized) by the SBC function when torque is disabled by the STO function.

If the SBC function is configured to link STO activation to SBC activation, you can configure an STO to SBC Delay time where:

- STO to SBC Delay > 0 configures a delay between when STO is activated and the brake is engaged. [Figure 60](#) describes this operation.
- STO to SBC Delay < 0 configures the brake to engage when STO is activated and delays disabling torque. [Figure 61](#) describes this operation.

Figure 60 - SBC Linked to STO with Positive Delay

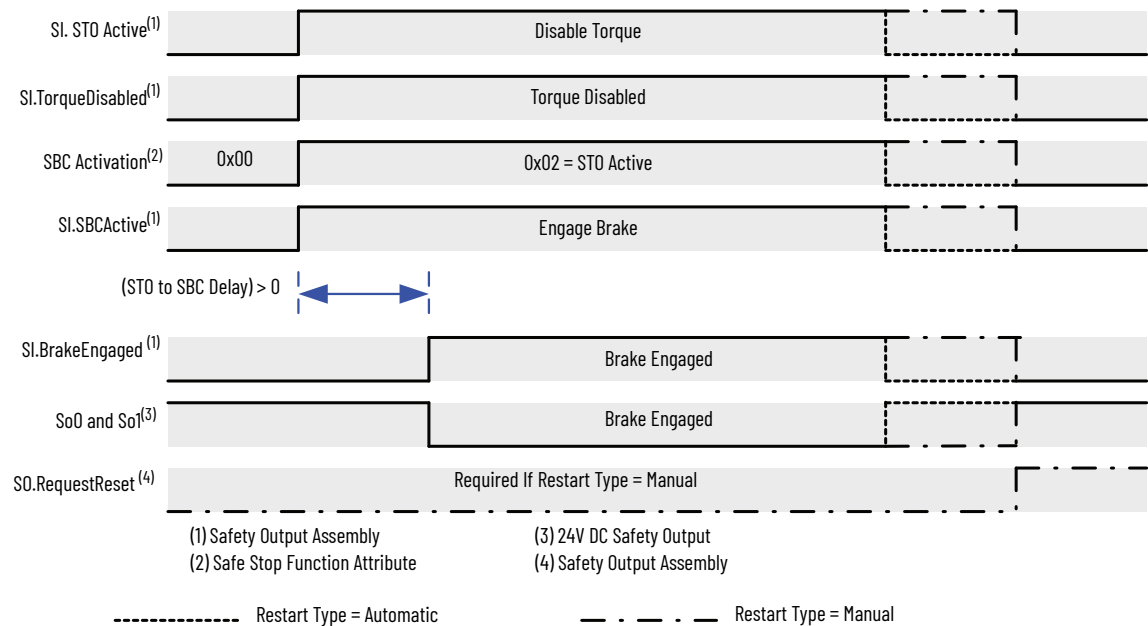
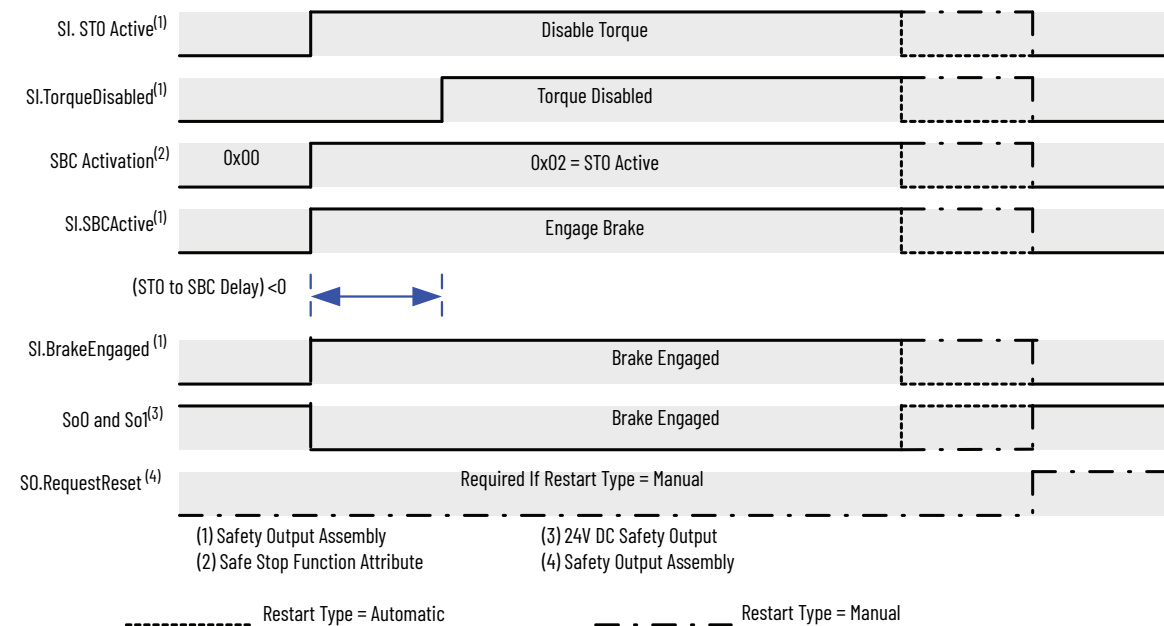


Figure 61 - SBC Linked to STO with Negative Delay



SBC Safety Fault

When the module experiences an SBC Fault, the device is placed in the safe state and the cause of the fault is recorded.

If SBC function detects a fault, it sets:

- `devicename:Sl.SafetyFault = 1`
- `devicename:Sl.RestartRequired = 1`
- `devicename:Sl.SBCReady = 0`

For more information on SBC fault types and troubleshooting methods, see [Monitor Safety Status and Faults via a Message Instruction on page 125](#).

Connecting a Safety Brake

IMPORTANT

If you want a specific system safety rating, you need a safety brake that is rated at least to your desired system safety rating. In a safety chain, the lowest safety rated component limits the overall system safety rating.

The safety brake control function uses the bipolar safety outputs So0 and So1 to control a safety brake.

The design of a safety brake circuit is application-dependent and is based on the following factors:

- Choice of safety brake for the application
- If the brake provides feedback in the application
- If the application uses single or dual channel

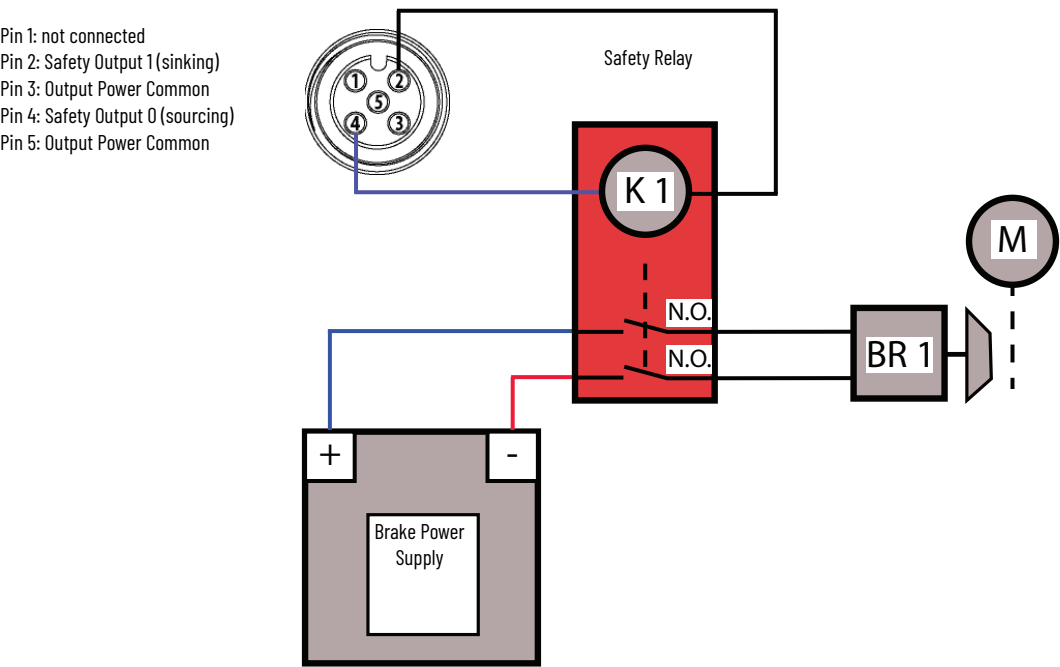
The safety brake function interfaces to the safety brake through the safety outputs So0 and So1. [Figure 62](#) shows a wiring example for connecting a brake to the module.

Usually the voltage and current rating of the safety brake is much higher than the safety outputs can directly control. To support brakes with that require higher voltage and higher current, an interposing safety relay such as the 700S-CF Safety Control Relay is required.

Safety brakes typically require a voltage suppression device. Most safety brakes provide a suppression device as an option or they specify a diode or MOV to use. Use the recommended suppression devices.

The drive-based SBC function does not implement checking of brake feedback; however, the available safety inputs can be used to send the status of brake feedback to the safety controller that is programmed with a diagnostic check.

Figure 62 - Safety Brake Wiring Example



Safety Feedback

- IMPORTANT**

For fault-free operation of the encoder, the cable shield of the connecting cable must be grounded on both sides (encoder and control) using large area connections. On the encoder side, this is typically done in the plug connector or via the connecting cable.
- IMPORTANT**

Achievable safety rating depends on each system component. If you want SIL 2 PLd safe feedback, you need an encoder that is rated at SIL 2 PLd or greater. In a safety chain, the lowest safety rated component limits the overall system safety rating.

The Armor PowerFlex product supports encoder feedback for safe speed monitor functions. [Table 24](#) describes the supported encoder types and achievable safety ratings.

Table 24 - Supported Encoder Types with Safety Ratings

Encoder Type	Achievable System Safety Rating
Sine/Cosine	<ul style="list-style-type: none">SIL 2 PLd with safety-rated encoderorPLd with standard encoder⁽¹⁾
Digital AqB	SIL 2 PLd with safety-rated encoder

(1) When using a standard sine/cosine encoder, safety relevant data (MTTF) and safety diagnostic measures to achieve the required diagnostic coverage, must be considered. Encoder diagnostics for sine/cosine encoders that are provided by the Armor PowerFlex drive, include: encoder voltage monitoring, $\sin^2 + \cos^2$ vector length monitoring, zero crossing detection, and signal offset. Additional (customer supplied) diagnostics may be required. You must determine the suitability of the encoder and the system safety rating.

You can achieve a PLd rating if using a standard, (not certified) sine/cosine encoder and you can get the relevant failure rate data from the manufacturer and do the calculations to show that this is acceptable for your application.

Rockwell Automation offers the Bulletin 843ES CIP Safety encoders, which provide safety feedback directly to a safety programmable controller via the EtherNet/IP network.

Safety Encoder Diagnostics

The following encoder diagnostics are available for all supported encoder types:

- Encoder Voltage Monitoring (Configurable)
- Maximum Speed Limit (Configurable)
- Maximum Acceleration (Configurable)
- Maximum Encoder Input Frequency

See [Chapter 7](#), for information on how to configure the diagnostics.

IMPORTANT

These diagnostics are based on the capability of the chosen encoder and its rated limits. They do not provide a safety-rated safety function.

Encoder Voltage Monitoring

The voltage monitoring diagnostic samples the voltage being supplied to the encoder to confirm that its level is within its configured range. If the voltage monitoring diagnostic detects a voltage that is out of the configured range, the safety feedback instance reports a voltage monitoring fault and causes the module to enter the safe state.

The following voltage monitoring ranges are supported:

- 4.75...5.25V
- 11.4...12.6V

If a voltage range is not specified, then the voltage monitoring diagnostic is not performed.

Maximum Speed Limit

The maximum speed limit diagnostic detects when encoder speed is above a configured limit. If the speed of the encoder is greater than the configured max speed limit, an exceeded max speed fault is reported by the safety feedback instance. This causes the module to enter the safe state.

If the encoder being used specifies a maximum speed, set the maximum speed limit configuration value to this value or lower. If the limit is configured as 0, this diagnostic is not performed.

Maximum Acceleration

The maximum acceleration diagnostic detects when encoder acceleration is above a configured limit. If the module detects that the acceleration of the encoder has exceeded the configured limit, a max acceleration fault is reported by the safety feedback instance. This causes the module to enter the safe state.

If the encoder being used specifies a maximum acceleration, set the maximum acceleration configuration value to this value or lower. If the maximum acceleration is configured as 0, this diagnostic is not performed.

Maximum Encoder Input Frequency

The maximum encoder input frequency diagnostic confirms that the safety feedback signals do not exceed the maximum frequency (encoder counts per second) supported by the module. This value is not configurable and has fixed values based on the encoder type. [Table 25](#) shows the maximum frequency based on encoder type.

Table 25 - Encoder Maximum Frequency

Encoder Type	Maximum Frequency
Digital AqB	250 kHz
Sine/Cosine and Hiperface	163.8 kHz

If the module detects an encoder input frequency above the limit, a max frequency fault is reported in the safety feedback instance and the module enters the safe state.

Digital AqB Diagnostics

The following non-configurable diagnostic functions are implemented in the module to perform diagnostics for digital AqB encoders:

- Inverse Signal Monitoring
- Quadrature Error Detection

Inverse Signal Monitoring

The inverse signal monitoring diagnostic confirms that the inverted and noninverted signals are always at opposite signal levels. If the module detects that the Digital AqB Encoder signals are not inverse, a feedback signal lost fault is reported in the safety feedback instance and the module enters the safe state. This diagnostic is meant to detect encoder wiring errors, such as open, short, or short to power.

Quadrature Error Detection

The quadrature error detection confirms that the A and B signals from the digital AqB encoder do not change simultaneously. This diagnostic is also referred to as an exclusive bit check. If the module detects a quadrature error, the safety feedback instance reports a quadrature error fault and enters the safe state. A simultaneous change indicates an error with the encoder wiring or an issue with the encoder itself.

Sine/Cosine and Hiperface Diagnostics

The following non-configurable diagnostic functions are implemented in the module to perform diagnostics on Hiperface and or Sine/Cosine type encoders:

- Sin² + Cos² Vector Length Monitoring
- Zero-crossing Detection
- Signal Offset (Sine/Cosine Encoder Type Only)

IMPORTANT

The digital feedback is not compatible with Armor PowerFlex drives and should not be used. Only the analog signals should be used.

Sin² + Cos² Vector Length Monitoring

The Sin² + Cos² vector length monitoring diagnostic confirms that the sine and cosine signals are sinusoidal and 90° apart. This diagnostic is meant to detect errors in the wiring of the encoder and problems within the encoder itself. [Table 26](#) describes the tolerance of encoder output signal amplitudes for this diagnostic. [Table 27](#) describes the phase tolerance of the diagnostic. If the module detects that the amplitude and or phase of the signals is out of range, the safety feedback instance reports a Sin² + Cos² fault and the module is placed in the safe state.

Table 26 - Sin² + Cos² Vector Length Monitoring Amplitude Range

Maximum	Minimum
1.3V p-p	0.7V p-p

Table 27 - Sin² + Cos² Vector Length Monitoring Phase Tolerance

Tolerance
90° ± 20°

Zero-crossing Detection

The zero-crossing detection diagnostic confirms that the sine and cosine signals have a similar offset to ground. The offset tripping point is ± 50 mV. If the offset of the sine and cosine signals is greater than the tripping point, the zero-crossing detection diagnostic fails, a signal lost fault is reported in the safety feedback instance, and the module is placed in the safe state.

Signal Offset

The signal offset diagnostic confirms that a Sine/Cosine type encoder is producing the proper offset on the Sine and Cosine signals. This diagnostic is not performed when the feedback device type is configured as Hiperface. [Table 28](#) describes the offset tolerance of the diagnostic. If the offset of the Sine and or Cosine signals are outside the tolerance range, the safety feedback instance reports a signal offset fault and the module is placed in the safe state.

Table 28 - Signal Offset Tolerance

Maximum	Minimum
3.0V	2.0V

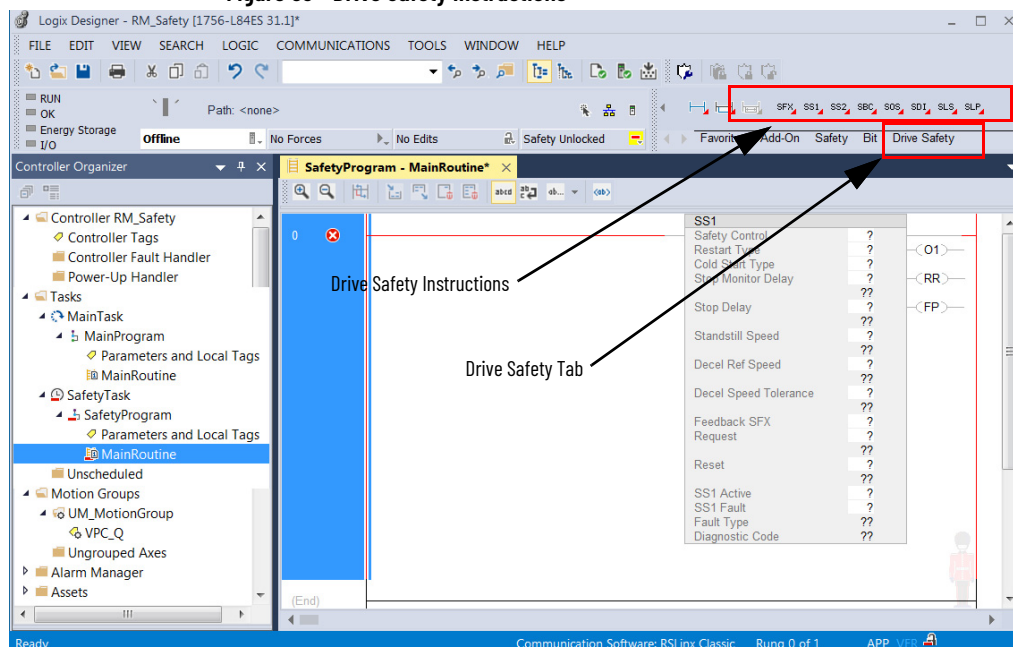
Controller-based Safe Monitor Functions

The Drive Safety instructions (see [Table 29 on page 123](#)) are available in the Studio 5000 Logix Designer application, version 32.00...35.xx, in the Drive Safety instruction element group that is enabled when the Safety Program - MainRoutine is open (see [Figure 63 on page 123](#)).

Table 29 - Safety Instructions

Safety Instruction	Description
Safety Feedback Interface	SFX The SFX function scales feedback position into position units and feedback velocity into position units per time unit. SFX is used with other Drive Safety instructions. SFX also provides unwind for rotary applications and position homing.
Safe Stop 1	SS1 The SS1 function monitors the motor deceleration rate within set limits during motor stopping and provides an indication to initiate Safe Torque Off (STO) function when the motor speed is below the specified limit.
Safely-limited Speed	SLS The SLS function prevents the motor from exceeding the specified speed limit.
Safely-limited Position	SLP The SLP function prevents the motor shaft from exceeding the specified position limits.
Safe Direction	SDI The SDI function prevents the motor shaft from moving in the unintended direction.
Safe Brake Control	SBC The SBC function provides safe output signals to control an external brake.

Figure 63 - Drive Safety Instructions



Before Adding the Safety Instructions

Before adding Drive Safety instructions to your Logix Designer application, you must:

- Add the Armor PowerFlex drive to your safety controller project.
- Configure a safety instance of Single Feedback Monitoring.

Drive Safety Instruction Example

Drive Safety instructions provide the following information. In this example, the Safely-limited Speed (SLS) instruction is shown.

Figure 64 - SLS Drive Safety Instruction

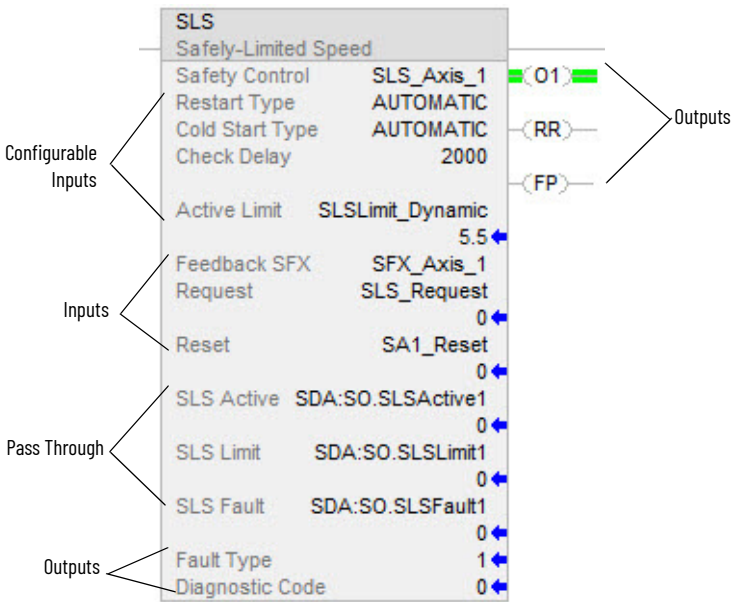


Table 30 - Drive Safety Instruction Definitions

Instruction Information	Description
Configurable Inputs	Safety function parameters that are used to define how the safety function operates.
Inputs	<ul style="list-style-type: none">• Feedback SFX is the link to the SFX instruction for a safety drive.• Request initiates the safe monitoring function.• Reset initiates a safety instruction reset.
Pass Through	Safety Output Assembly Object tags pass safety function status information from the Safety Task of the safety controller to the safety instance of the drive module. In standard I/O mode, datalinks must also be configured to provide status information to the standard controller.
Outputs	<ul style="list-style-type: none">• Fault Type is the instruction fault code that indicates the type of fault that occurred.• Diagnostic Code provides additional details on the fault.• O1 - Output 1 indicates the status of the instruction. When ON (1), it indicates that the input conditions are satisfied.• RR - Reset Required indicates when a reset is needed to restart the instruction or to clear faults.• FP - Fault Present indicates whether a fault is present in the instruction.

Safety Feedback Interface Instruction Operation

Although the Safety Feedback Interface (SFX) instruction is a safety instruction, it alone does not perform a safety function.

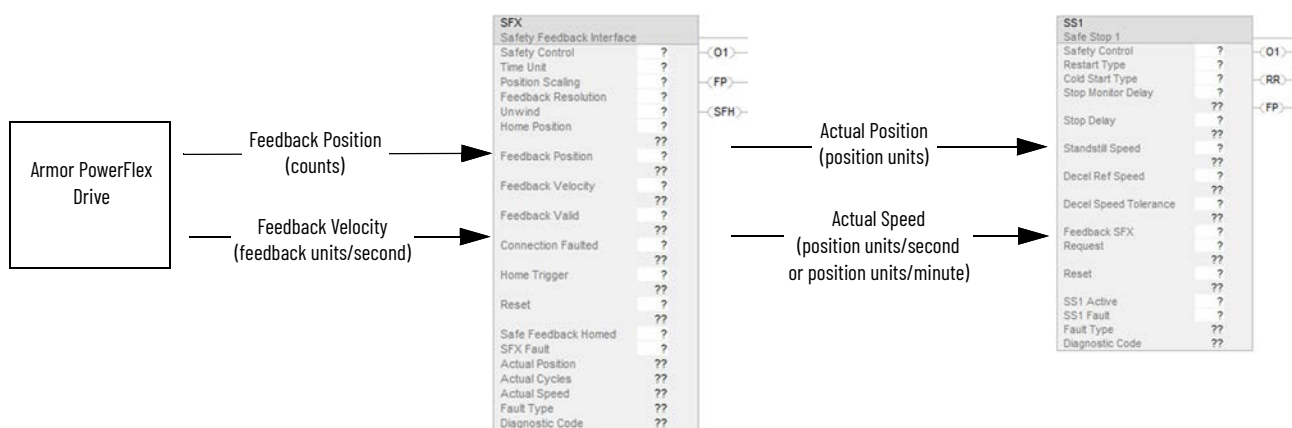
The Safety Feedback Interface (SFX) instruction scales feedback position into position units and feedback velocity into speed units per unit of time. Feedback position and velocity are read from the safety input assembly and become inputs to the instruction. The SFX instruction also sets a reference position from a home input and performs position unwind in rotary applications. Typically, one SFX instruction is used per safety drive. This instruction provides the position and velocity feedback that is used by other safety instructions, also used by the same safety drive.

The drive provides safe position and velocity feedback.

The outputs of the SFX instruction are used as inputs to other Drive safety instructions. For any drive to execute a controller-based safety function, an SFX instruction is required.

In [Figure 65](#), the SS1 instruction uses the Actual Speed output from the SFX instruction during execution of the SS1 safety function.

Figure 65 - SS1 Instruction



Monitor Safety Status and Faults via a Message Instruction

To obtain more detailed information about any faults that are detected in the drive, most faults have a corresponding fault-type attribute. Use an MSG instruction in the ladder program to read the specific attribute information. Details of the various fault-type attributes are described in the following sections.

See [Example: Read SS1 Fault Type on page 247](#) on for an example of using the MSG instruction to read status.

Safety Supervisor State

The Safety Supervisor State provides information on the state of the safety connection and the mode of operation. It can be read in the user's Logix program using an MSG instruction.

Table 31 - Safety Supervisor State: MSG

Parameter	Value	Description
Service Code	0x0E	Get Attribute Single
Class	0x39	Safety Supervisor
Instance	1	-
Attribute	0x0B 11 (decimal)	Device Status
Data Type	SINT	Unsigned Short Integer

Table 32 - Device Status

Value	Description
1	Device is performing test diagnostics
2	No active connections
3	A fault has occurred while executing test diagnostics
4	Normal running state
5	A major recoverable fault has occurred
6	A critical fault has occurred
7	Transition state (configuring)
8	Out-of-box state: waiting
51	Out-of-box state: waiting with torque permitted
52	STO bypass state: executing with torque permitted

Safety Core Fault

The Safety instance has detected a nonrecoverable fault or internal error. When this detection happens, the Safety instance reboots itself and attempts to re-establish normal operation.

If this fault persists through power cycles, return the drive for repair. If malfunction or damage occurs, no attempts at repair should be made.

Safe Torque Off Fault

The Safe Torque Off (STO) function detected a fault. The safe stop function records the specific fault type in the STO Fault Type attribute. [Table 33](#) describes the parameters for an MSG instruction. [Table 34](#) describes the fault types.

Table 33 - Safe Torque Off Fault Type: MSG

Parameter	Value	Description
Service Code	0x0E	Get attribute single
Class	0x5A	Safety stop functions
Instance	1	Drive-module safety instance
Attribute	0x108	STO fault type
Data Type	SINT	Short integer

Table 34 - STO Fault Types

STO Fault Type Value	STO Fault Type Name	Description
1	No Fault	No fault is present
3	Circuit Error	Internal STO diagnostics has found an issue with STO circuitry.
4	Stuck Low Internal STO health and/or power input stuck low	Internal STO diagnostics indicate an STO signal is stuck low
5	Stuck High Internal STO health and/or power input stuck high	Internal STO diagnostics indicate an STO signal is stuck high
102	Hardwired Input Discrepancy	Hardwired input pair are not matching.
104	Hardwired Input Active in Integrated Mode	A hardwired input is being used while in integrated mode
105	Both Pairs Active	(Both Safety Input pairs are active, only one can be active for hardwired STO control)

Safe Stop 1 Fault

The Safe Stop 1 (SS1) function detected a fault. The safe stop function records the specific fault type in the Safe Stop Fault attribute. [Table 35](#) describes the parameters for an MSG instruction. The drive immediately disables torque, ignoring STO delay, if an SS1 fault is detected. If the SS1 Fault Type is reported as 1 (no fault), the SS1 fault was generated by the connected safety controller and reported to the drive over the safety connection. [Table 36](#) describes the SS1 fault types.

Table 35 - Safe Stop 1 Fault Type: MSG

Parameter	Value	Description
Service Code	0x0E	Get attribute single
Class	0x5A	Safety stop functions
Instance	1	Drive-module safety instance
Attribute	0x11c 284 (decimal)	SS1 fault type
Data Type	SINT	Short integer

Table 36 - SS1 Fault Types

SS1 Fault Type Value	SS1 Fault Type Name	Description
1	No Fault	No Fault is present
2	Invalid Configuration	The drive-based SS1 function has been requested when it has been configured as 'not used'.
3	Deceleration Rate	Applies only when SS1 is configured for Monitored SS1 mode. The SS1 function has detected that the feedback speed is not decelerating as fast as expected.
4	Maximum Time	Applies only when SS1 is configured for Monitored SS1 mode. The SS1 function has detected that the device has not reached standstill speed within the maximum stopping time.

Safe Brake Control Fault

The Safe Brake Control (SBC) function detected a fault. The safe stop function records the specific fault type in the SBC Fault Type attribute. The SBC fault type is also recorded in [SBC Fault Type], attribute 364. [Table 37](#) describes the parameters for an MSG instruction. [Table 38](#) describes the fault types.

Table 37 - SBC Fault Type: MSG

Parameter	Value	Description
Service Code	0x0E	Get attribute single
Class	0x5A	Safety stop functions
Instance	1	Drive-module safety instance
Attribute	0x16C 364 (decimal)	SBC fault type
Data Type	SINT	Short integer

Table 38 - SBC Fault Types

STO Fault Type Value	STO Fault Type Name	Description
1	No Fault	No Fault is present.
2	Invalid Configuration	The drive-based SBC function has been requested when it has been configured as 'not used'.

SLS, SLP, and SDI Faults

The drive does not support drive-based SS2, SOS, SLS, SLP, and SDI safe stop/safety limit functions. The safety controller supports the SLS, SLP, and SDI safety function instructions. If the drive reports one of these faults, either the safety controller detected the fault and reported to the drive over the safety output connection, or the request tag was set through the safety output assembly. Additional information for these faults must be obtained from the safety controller that is associated with the drive. In addition, the safety controller is responsible for issuing a torque disable request.

Safety Feedback Faults

When configured for safety feedback, the drive performs periodic diagnostics to make sure that the feedback device is operating correctly. Use an explicit message to read the fault type information from the drive. For example, if an error is detected, the Safe Feedback object (class code 0x58) updates the Feedback Fault Reason attribute (attribute ID 0x09) with the reason for the fault.

Table 39 - Safety Feedback Faults

Safety Feedback Fault Reason Value	Safety Feedback Fault Reason Name	Description
1	No Fault	No Fault is present.
2	Invalid Configuration	The encoder's configuration is invalid.
3	Exceeded Max Speed	The encoder speed has exceeded the configured maximum speed.
4	Exceeded Max Acceleration	The encoder acceleration has exceeded the configured maximum acceleration.
5	$\sin^2 + \cos^2$ Error	The encoder has failed the vector length or aspect ratio checks.
6	Quadrature Error	The encoder has exceeded the maximum number of quadrature signal errors.
9	Supply Voltage Error	The associated dual channel feedback instance has detected a fault in the other encoder
11	Feedback Signal Loss	A feedback signal is missing, shorted, or open.
107	Max input frequency	Max Frequency of the configured encoder has been exceeded.
109	Position Rollover	Position has exceeded the maximum value supported by this product. Please reset the device

Safety Fault Reset

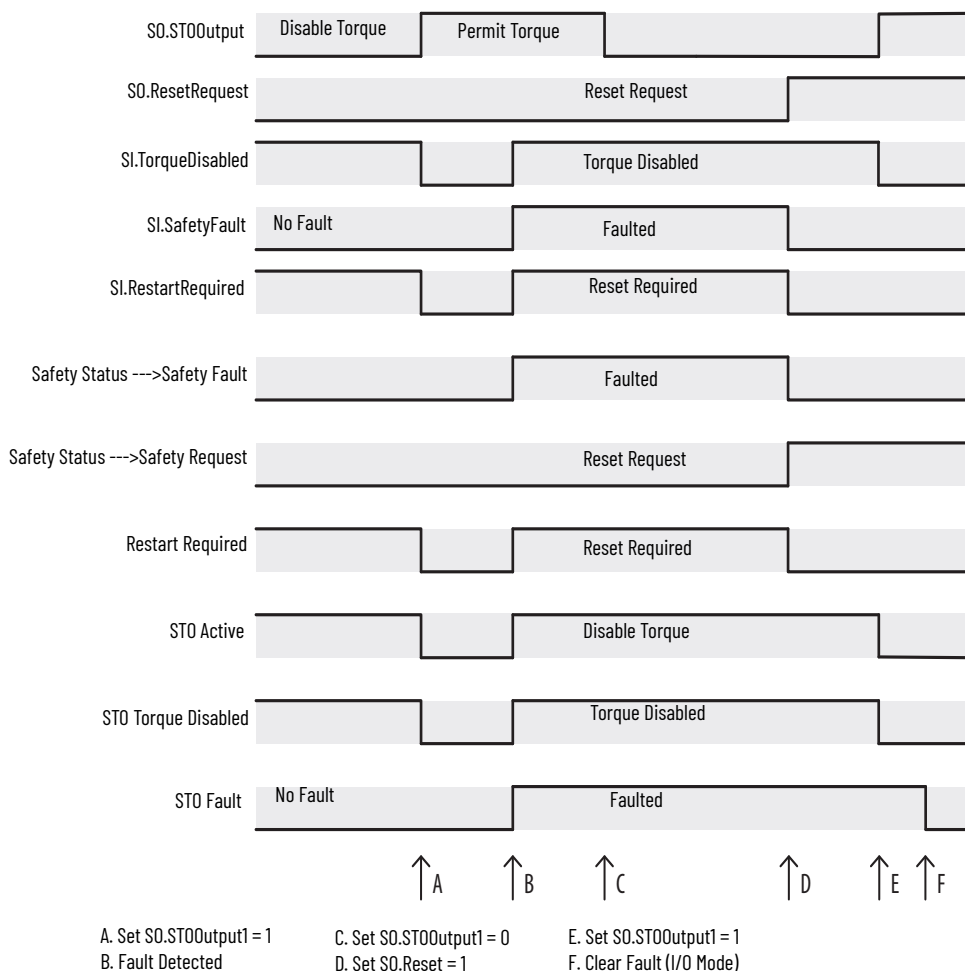
If the drive detects a fault, the input assembly tag `device:SI.SafetyFault` is set to one.

A Safety Fault can result from the SS1 stopping function, STO function, safety feedback, SBC function, or other safety diagnostics.

To acknowledge or clear this fault, remove the source of the safety fault and send a fault reset to the safety logic.

See [Figure 66 on page 129](#) for more information about the Integrated Safety Functions option module, state restart functionality.

Figure 66 - Reset Safe Stop Fault Diagram



Safety I/O Operation

24V DC safety inputs and outputs:

- 4 safety inputs; 2 test outputs; 1 bipolar safety output
- Single channel safety inputs up to SIL 2, Category 2, PLd
- Dual channel safety inputs and bipolar output up to SIL 3, Category 4, PLe
- Safety output can be configured for SBC or control via the safety output assembly
- Communication for safety I/O data is performed through safety connections that support CIP Safety protocol over an EtherNet/IP network.

There are status indicators for each I/O point, see [View Status Indicators on page 215](#).

IMPORTANT

The Allen-Bradley® Lifeline™ 5 cable pull switches are not currently compatible with the Armor PowerFlex safety inputs. As an alternative, see the Lifeline 4 cable pull switches with the 5-pin, M12 option. To achieve the same safety ratings as the Lifeline 5 switches, the Armor PowerFlex safety input configuration requires both pulse test outputs to be configured as Pulse Test, and both inputs to be configured as Pulse Test, when using Lifeline 4 switches.

Safe State

The following are the safe states of the Armor PowerFlex safety I/O:

- Safety outputs from network data: OFF (single channel and dual channel equivalent)
- Safety input data to network: OFF (single channel and dual-channel equivalent)
- Safety input data to network: OFF/ON for input channels n/n+1 (dual-channel complimentary, See [Dual Channels, Complementary on page 133](#) for additional details)

The safety I/O is designed for use in applications where the safe state is the off state.

Safety Input Features

- Safety devices, such as emergency stop push buttons, gate switches, and safety light curtains, can be connected.
- Dual-channel mode evaluates consistency between two input signals (channels), which allows use of the module for safety Category 3 and 4 and in applications that are rated up to and including Performance Level e/SIL 3 when both channels' Point Mode configurations are set to Safety Pulse Test.
- Single-channel mode evaluates one input signal (channel), which allows use of the module for safety Category 2 and in applications that are rated up to and including Performance Level d/SIL 2 when the channel's Point Mode configuration is set to Safety Pulse Test.
- You can configure a discrepancy time to control how long two channels are allowed to be discrepant before a fault is declared.
- An external wiring short-circuit check is possible when inputs are wired in combination with test outputs. The drive must be wired in combination with test outputs when this function is used.
- Independently adjustable on- and off-delays are available per channel.
- Separate test outputs are provided for short-circuit detection of a safety input or inputs.
 - Power (24V) can be supplied to devices, such as safety sensors.
 - Test outputs can be configured as standard outputs.
- A test output can optionally be used in combination with a safety input for short-circuit detection. To make use of this feature, configure the test output as a pulse test source and configure the safety input as 'Used with Test Output'. Test Output 0 is associated with safety inputs 0 and 2. Test Output 1 is associated with safety inputs 1 and 3.

Safety Input Operation

Safety inputs are used to monitor a safety input device and can be configured as single or dual channel inputs. They also support configuration of on- and off-delay times. A configurable latch error time allows you to specify the minimum amount of time that a safety input alarm is reported.

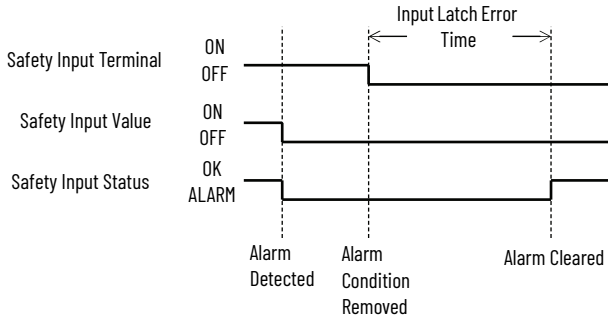
Single-channel Mode (Safety Inputs)

The next paragraph describes the status and value that the I/O subsystem reports for normal and alarm states. In normal operation, the I/O value that is reported is the value being read on the input terminal. The I/O status is on. When a fault is detected, the Safety Input value and status are forced Off.

The safety input subsystem allows for a configurable time for which an alarm state is held, which is referred to as Input Latch Error Time. In single channel mode, the input latch error time describes the period between when the alarm condition is removed and when the safety input stops reporting the alarm.

[Figure 67](#) shows the operation of input latch error time in single channel mode. See [Safety Input or Output Fault Recovery on page 145](#) for information on how to remove an alarm.

Figure 67 - Single-channel Mode



Dual-channel Mode and Discrepancy Time (Safety Inputs)

To support redundant safety devices, the consistency between signals on two input points can be evaluated, which is referred to as dual-channel operation. Two modes are available when using dual-channel inputs: equivalent and complementary.

When using either dual-channel input mode, the time from when a discrepancy is created and when the discrepancy is reported can be configured, which is referred to as Discrepancy Time. The configured discrepancy time is 0 (deactivated)...65,535 ms in increments of 1 ms.

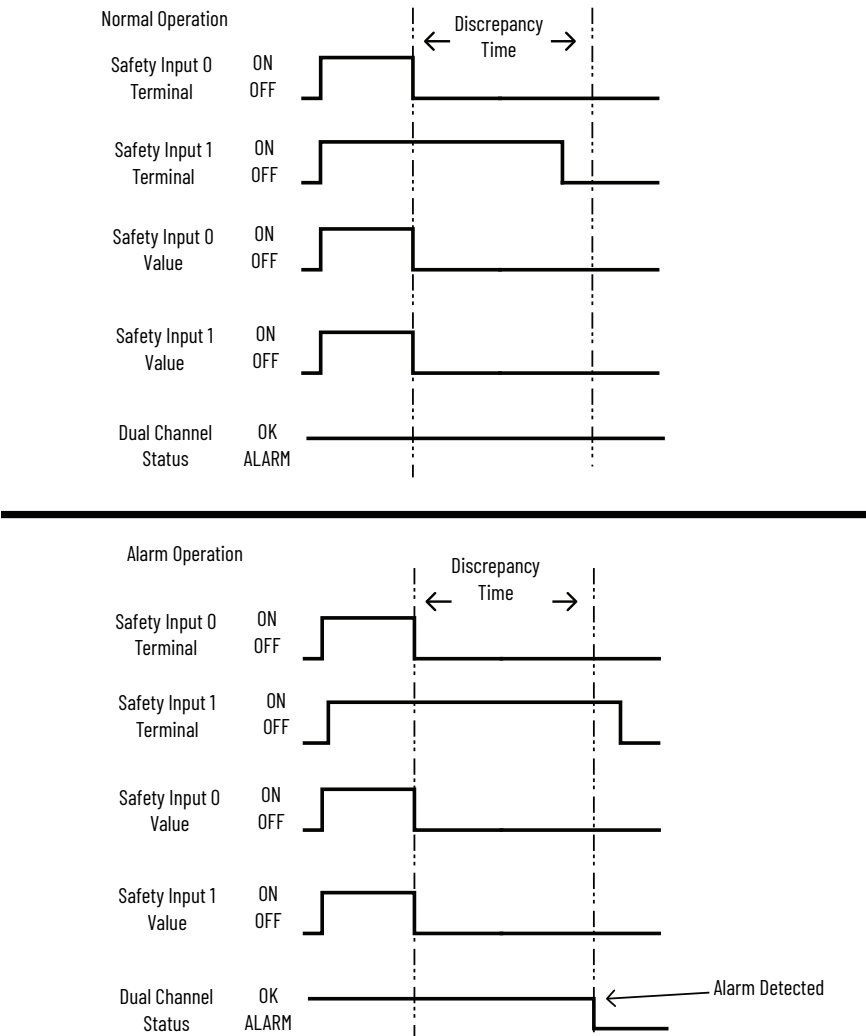
IMPORTANT The dual-channel function is used with two consecutive inputs that are paired together, this process starts at an even input number, such as inputs 0 and 1; 2 and 3; and so on.

IMPORTANT Do not set the discrepancy time longer than necessary. The purpose of the discrepancy time is to allow for normal differences between contact switching when demands are placed on safety inputs. For discrepancy checking to operate correctly, only one demand on the safety input is expected during the discrepancy time. If the discrepancy time is set too high, and multiple demands occur during this time, then both safety input channels will alarm.

Dual-channel, Equivalent

In Equivalent mode, both inputs of a pair must be in the same (equivalent) state. When a transition occurs in one channel of the pair before the transition of the second channel of the pair, a discrepancy occurs. If the second channel transitions to the appropriate state before the discrepancy time elapses, the inputs are considered equivalent. If the second transition does not occur before the discrepancy time elapses, the channels transition to the alarm state. In the fault state, the input and status for both channels are set low (Off). When configured as an equivalent dual pair, the data bits for both channels are sent to the controller as equivalent, both high or both low.

Figure 68 - Equivalent, Normal Operation and Fault Detection (Not to Scale)

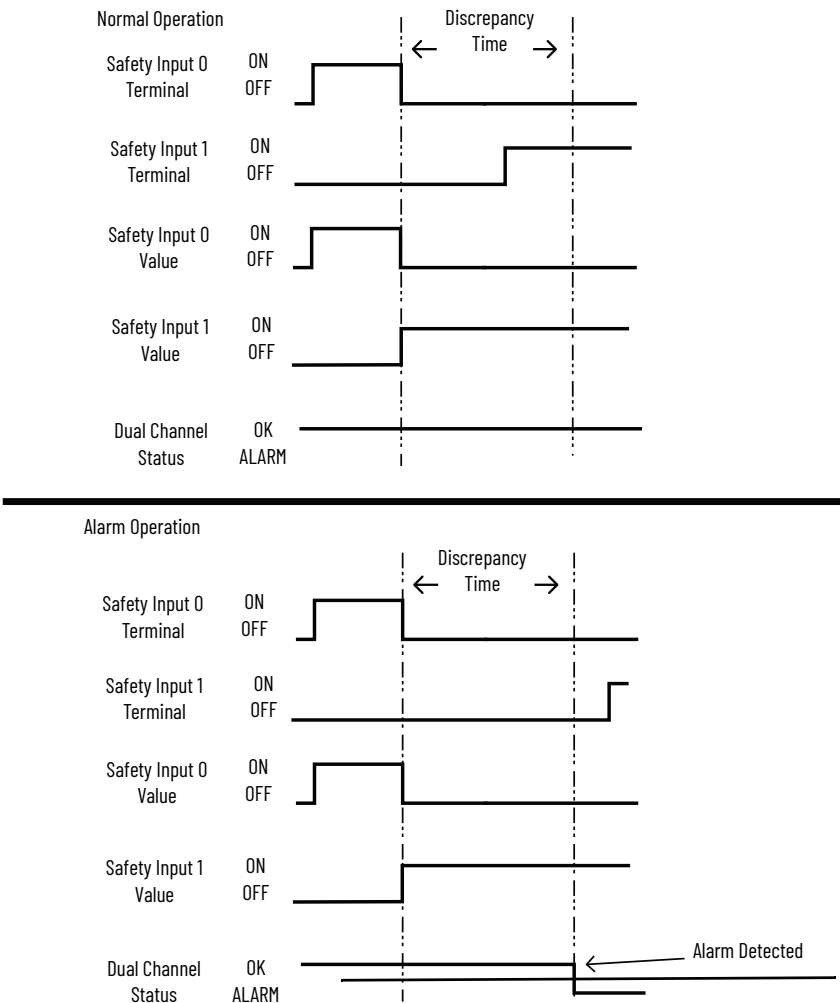


Dual Channels, Complementary

In Complementary mode, the inputs of a pair must be in the opposite (complementary) state. When a transition occurs in one channel of the pair before the transition of the second channel of the pair, a discrepancy occurs. If the second channel transitions to the appropriate state before the discrepancy time elapses, the inputs are considered complementary.

If the second transition does not occur before the discrepancy time elapses, the channels transition to the alarm state. The alarm state of complementary inputs is the even-numbered input that is turned Off and the odd-numbered input turned On. Note that if faulted, both channel status bits are set low. When configured as a complementary dual-channel pair, the data bits for both channels are sent to the controller in complementary, or opposite states.

Figure 69 - Complementary, Normal Operation and Fault Detection (not to scale)



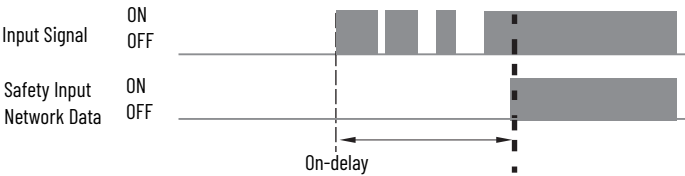
Input Delays

Each safety input has a configurable filter time for sampling the input. Both the on→off and off→on filter values can be configured.

Off to On Delay

On-delay—An input signal is treated as Logic 0 during the on-delay time (0...65,535 ms, in increments of 1 ms) after the rising edge of the input contact. The input turns on only if the input contact remains on after the on delay time has elapsed. This setting helps prevent rapid changes of the input data due to contact bounce.

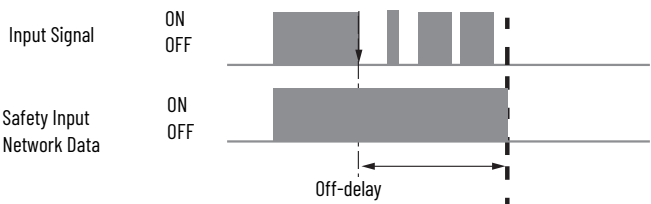
Figure 70 - On-delay



On to Off Delay

Off-delay—An input signal is treated as Logic 1 during the off-delay time (0...65,535 ms, in increments of 1 ms) after the falling edge of the input contact. The input turns off only if the input contact remains off after the off delay time has elapsed. This setting helps prevent rapid changes of the input data due to contact bounce.

Figure 71 - Off-delay



Using a Test Output with a Safety Input

A test output can be used in combination with a safety input for short circuit, cross-channel, and open-circuit fault detection. Configure the test output as a pulse test source and associate it to a specific safety input.

Figure 72 - Test Output Wiring Example

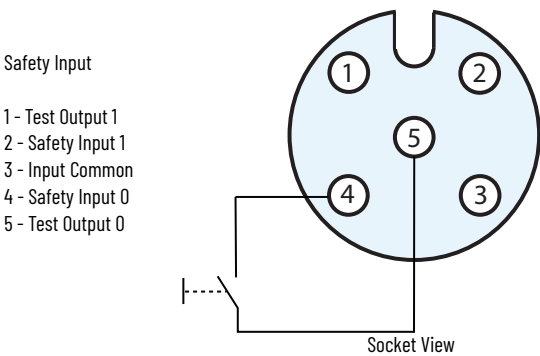
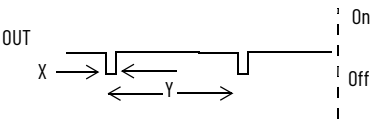


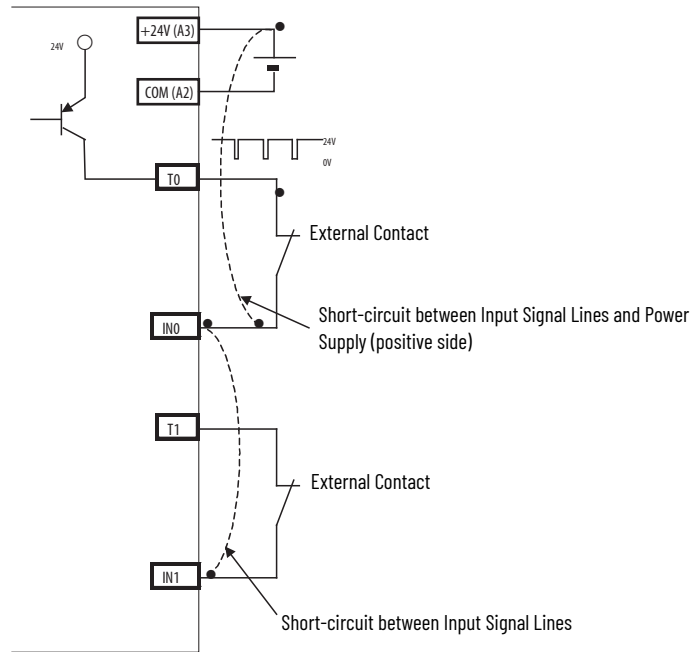
Figure 73 - Test Pulse in a Cycle



The pulse width (X) is typically 500 μ s. The pulse period (Y) is typically 300 ms. The relation between pulse period and width is fixed.

When the external input contact is closed, a test pulse is output from the test output terminal to diagnose the field wiring and input circuitry. By using this function, short-circuits between inputs and 24V power, and between input signal lines and open circuits can be detected. See [Figure 74](#).

Figure 74 - Short-circuit between Input Signal Lines



IMPORTANT Depending on the targeted SIL, Category/PL and the safety application, fault exclusions for short circuits between any two conductors/cables may be necessary. See ISO 13849-2, Annex D for additional information.

Safety Input Status Data

The Safety Input data can be monitored through:

- Safety Input Assembly
- Message Instruction

IMPORTANT Only the Safety Input Value and Status in the Safety Input Assembly can be considered safety data. Input values that are read through CIP messages are not safety data. Do not use standard inputs for safety purposes.

The following Safety Input data is available:

- Safety Input Status
- Safety Input Value (Data)
- Safety Input Valid

Each safety input point reports its own status, value, and valid attributes.

[Table 40](#) shows the relation between physical Safety Input terminal states, and the data and status reported by the Safety Input subsystem.

Table 40 - Terminal Safety Input Status and Controller I/O Data

Dual-channel Mode	Input Terminal		Controller Input Data and Status				Dual-channel Resultant Data	Dual-channel Resultant
	IN0	IN1	Safety Input 0 Data	Safety Input 1 Data	Safety Input 0 Status	Safety Input 1 Status		
Dual-channels, Equivalent	OFF	OFF	OFF	OFF	ON	ON	OFF	Normal
	OFF	ON	OFF	OFF	OFF	OFF	OFF	Alarm
	ON	OFF	OFF	OFF	OFF	OFF	OFF	Alarm
	ON	ON	ON	ON	ON	ON	ON	Normal
Dual-channels, Complementary	OFF	OFF	OFF	OFF	OFF	OFF	OFF	Alarm
	OFF	ON	OFF	ON	ON	ON	ON	Normal
	ON	OFF	ON	OFF	ON	ON	ON	Normal
	ON	ON	OFF	OFF	OFF	OFF	OFF	Alarm

Safety Input Status

The safety input status indicates whether an alarm is present in the safety input point. The safety input status is provided in the safety input assembly, as shown in [Table 41](#). [Table 42](#) describes the attributes for reading the safety status via CIP messaging.

Table 41 - Safety Input Assembly Tags for Safety Input Status

Safety Input Assembly Tag Name (safety controller)	Type/[bit]	Description
<i>devicename:SI.InputStatus</i>	SINT	A collection of safety input values and status for each safety input
<i>devicename:SI.In00Status</i>	[4]	Status of Safety Input 0 0 = Alarm 1 = OK
<i>devicename:SI.In01Status</i>	[5]	Status of Safety Input 1 0 = Alarm 1 = OK
<i>devicename:SI.In02Status</i>	[6]	Status of Safety Input 2 0 = Alarm 1 = OK
<i>devicename:SI.In03Status</i>	[7]	Status of Safety Input 3 0 = Alarm 1 = OK

Table 42 - MSG Configuration for Safety Input Status

Service Code	0x0E	Get attribute single
Class	0x3D	Safety Discrete Input Point Object
Instance	i + 1	Where i is the number of the safety input
Data Type	USINT	
Attribute	0x4 4 (decimal)	Safety Status 0 = Alarm 1 = OK

Safety Input Value

The safety input value is the value of the input after safety and on/off delay evaluations when the safety input is not in the alarm state. If the safety input is in the alarm state, this value will always be 0.

The safety input value is provided in the safety input assembly, as shown in [Table 43](#). [Table 44](#) describes the attributes for reading the safety value via CIP™ messaging.

Table 43 - Safety Input Assembly Tags for Safety Input Values

Safety Input Assembly Tag Name (safety controller)	Type/[bit]	Description
<i>devicename</i> :SI.InputStatus	SINT	A collection of safety input values and status for each safety input
<i>devicename</i> :SI.In00Data	[0]	Value of Safety Input 0 0 = OFF 1 = ON
<i>devicename</i> :SI.In01Data	[1]	Value of Safety Input 1 0 = OFF 1 = ON
<i>devicename</i> :SI.In02Data	[2]	Value of Safety Input 2 0 = OFF 1 = ON
<i>devicename</i> :SI.In03Data	[3]	Value of Safety Input 3 0 = OFF 1 = ON

Table 44 - MSG Configuration for Safety Input Value

Service Code	0x0E	Get attribute single
Class	0x3D	Safety Discrete Input Point Object
Instance	$i + 1$	Where i is the number of the safety input
Data Type	USINT	
Attribute	0x7 7 (decimal)	Safety Input Logical Value 0 = OFF 1 = ON

Safety Input Valid

When set, the safety input valid attribute indicates that the safety input is configured for safety use and producing valid data. If this value is not set, the data that is associated with the safety input is no longer valid safety data.

IMPORTANT	The Safety Input Valid attribute should be checked before using safety input data in a safety application.
------------------	--

The safety input valid attribute is provided in the safety input assembly, as shown in [Table 45](#). [Table 46](#) describes the attributes for reading the safety value via CIP messaging.

Table 45 - Safety Input Assembly Tags for Safety Input Valid

Safety Input Assembly Tag Name (safety controller)	Type/[bit]	Description
<i>devicename</i> :SI.IOSupport	SINT	A collection of bits that describe safety IO functionality
<i>devicename</i> :SI.In00Valid	[0]	Safety Input 0 Valid 0 = Data invalid 1 = Data valid
<i>devicename</i> :SI.In01 Valid	[1]	Safety Input 1 Valid 0 = Data invalid 1 = Data valid
<i>devicename</i> :SI.In02 Valid	[2]	Safety Input 2 Valid 0 = Data invalid 1 = Data valid
<i>devicename</i> :SI.In03 Valid	[3]	Safety Input 3 Valid 0 = Data invalid 1 = Data valid

Table 46 - MSG Configuration for Safety Input Valid

Service Code	0x0E	Get attribute single
Class	0x3D	Safety Discrete Input Point Object
Instance	<i>i</i> + 1	Where <i>i</i> is the number of the safety input
Data Type	USINT	
Attribute	0x64 100 (decimal)	Safety Input Valid 0 = Data invalid 1 = Data Valid

Table 47 - Safety Input Specifications

Input Type	Current Sinking
IEC 61131-2 (input type)	Type 3
Voltage, on-state	11...30V DC
Voltage, off-state	~3...5V DC
Current, on-state, minimum	2 mA
Current, off-state, maximum	1.5 mA

Safety Input Alarms

The safety input logic can detect configuration, circuit, and discrepancy errors for each safety input. When an error is detected, the associated safety input data is put into the safe state, and the alarm type attribute is set.

Configuration Error

A configuration error occurs when a safety input's configuration data is invalid. If this error occurs, check to make sure that the configuration attributes for the safety input are valid. A configuration error can also occur if the safety input is selected for external pulse testing and the associated test output's configuration is not valid for this mode.

Circuit Error

A circuit error occurs in a safety input when a pulse test fails. There are two types of circuit errors that can be reported:

- Internal Circuit Error
 - An internal circuit error occurs when an internal pulse test fails. This means that circuitry inside the module has failed. An internal circuit error may not be recoverable; replacing the module may be required.
- External Circuit Error
 - An external circuit error occurs when pulse testing by the safety input's associated test output fails. This error indicates the input circuitry external to the card has failed.

Discrepancy and Dual Channel Errors

The discrepancy and dual channel errors are related, as a discrepancy can only occur when the safety input is in dual channel mode. A discrepancy error occurs when one of the dual channel safety inputs is not reporting the expected safety input value. The safety input with the unexpected value reports the discrepancy error. The other associated safety input will also be put in the safe state and report a dual channel error alarm.

Determining Safety Input Alarm Type

To determine if a safety input is reporting an alarm, examine the safety input's input status attribute (see [Safety Input Status on page 136](#) for information on accessing this attribute). If the input is reporting an alarm, the alarm type can be accessed through CIP messaging.

The safety input alarm type can be read via CIP messaging. See [Table 48](#) for the attributes that are required to read the alarm type.

Table 48 - MSG Configuration for Safety Input Alarm Type

Parameter	Value	Description
Service Code	0x0E	Get attribute single
Class	0x3D	Safety Discrete Input Point Object
Instance	$i + 1$	Where i is the number of the safety input
Data Type	USINT	Unsigned integer value
Attribute	0x6E 110	Safety Input Alarm Type 0 = No Alarm 1 = Configuration Error 2 = External Circuit Error 3 = Internal Circuit Error 4 = Discrepancy Error 5 = Dual Channel error

Safety Input Alarm Recovery

If an error is detected, the safety input data remains in the off state. Follow this procedure to activate the safety input data.

1. Remove the cause of the error.
2. Place the safety input (or safety inputs if in dual channel mode) into the safe state.
The safety input status turns on (alarm cleared) after the input-error latch time has elapsed.



If the latch error time has expired, but the safety input is not yet in the safe state, the alarm will not be cleared. Once the safety input is in the safe state, the alarm will clear immediately.

Safety Output Operation

The safety outputs can operate only in dual channel bipolar mode. The safety output can also be configured to run pulse test diagnostics.

The safety output assembly controls the bipolar output only when the drive is not using the SBC function. If the SBC function is used, it controls the output.

Safety Output Features

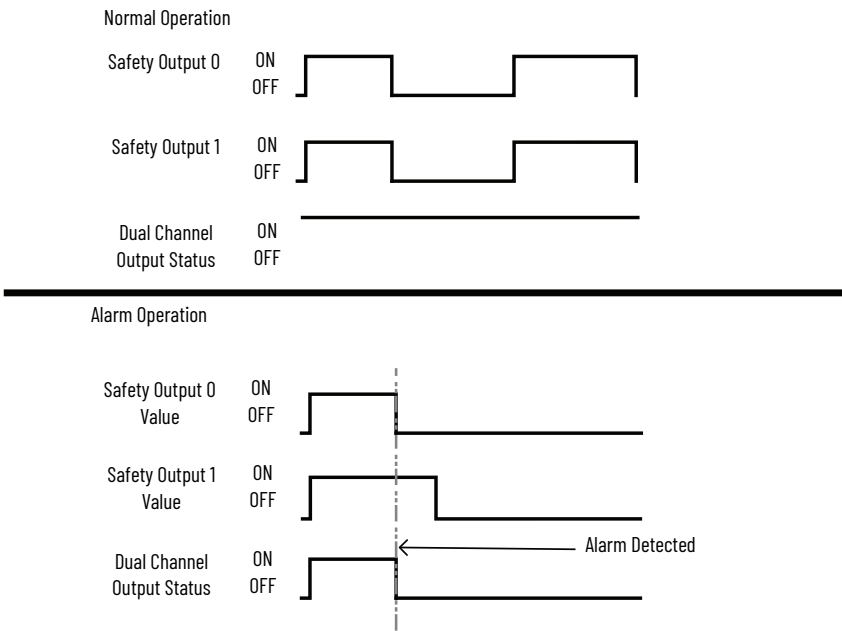
- Current sourcing/current sinking-bipolar pair
- Dual-channel mode provides redundant control by using two output signals (channels), which allows use of the module for safety Category 4, and applications that are rated up to and including Performance Level e/SIL 3 when both channels' Point Mode configurations are set to Safety Pulse Test.
- Safety output can be pulse tested to detect field wiring short circuits to 24V DC.
- Safety output can be configured for SBC or control via the safety output assembly

Dual-channel Mode (Safety Outputs)

When the data of both channels is in the on state, and neither channel has an alarm, the outputs are turned on. The status is normal. If an alarm is detected on one channel, the safety output data and individual safety output status turn off for both channels.

[Figure 75](#) shows the operation of dual channel outputs under normal and alarm conditions.

Figure 75 - Dual-channel Setting (Not to Scale)



In dual-channel mode, the output latch error time describes the period between when the alarm condition is removed and when the dual channel safety output stops reporting the alarm. [Figure 76](#) shows the normal operation of output latch error time in dual channel mode. When one or both of the associated output points have an alarm (such as a Pulse Test Failure), and there is a discrepancy between the two channels, the alarm and discrepancy must be cleared before the latch error timer begins counting. [Figure 77](#) shows this special case operation. See [Safety Input or Output Fault Recovery on page 145](#) for information on how to remove an alarm.

Figure 76 - Dual Channel Output Latch Error Behavior

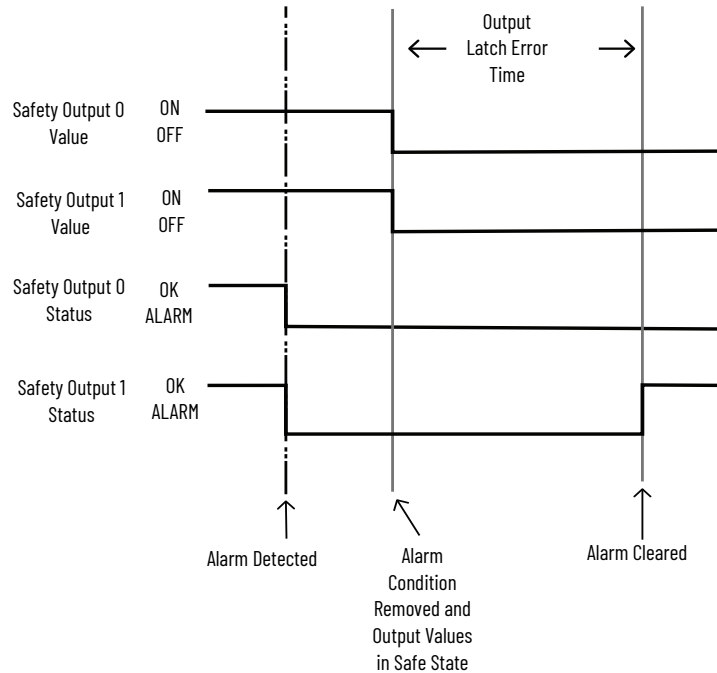
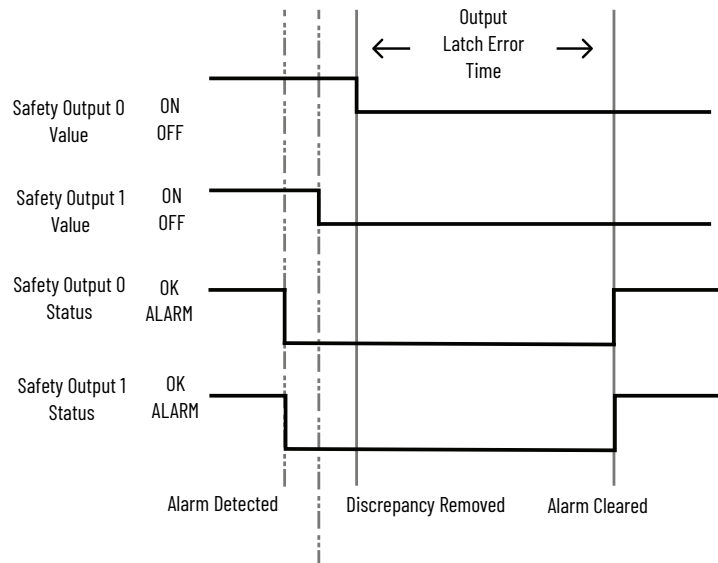


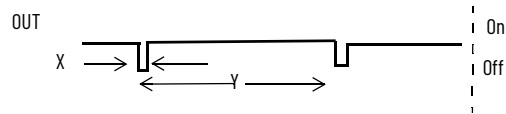
Figure 77 - Dual Channel Output Latch Error Behavior With Alarm and Discrepancy



Safety Output with Test Pulse

When the safety output is on, the safety output can be configured to pulse test the safety output channel. By using this function, you can continuously test the ability of the safety output to remove power from the output terminals of the module. If an error is detected, the safety output data and individual safety output status turn Off.

Figure 78 - Test Pulse in a Cycle



For the Armor PowerFlex drives, the pulse width (X) is typically 500 μ s; the pulse period (Y) is typically 300 ms.

IMPORTANT To help prevent the test pulse from causing the connected device to malfunction, pay careful attention to the input response time of the output device.

Safety Output Data

The safety output data can be monitored through:

- Safety input assembly
- Message Instruction

The following safety output data is available:

- Safety output status
- Safety output ready
- Output monitor value

Each safety output point reports its own status, monitor value, and ready attributes.

Safety Output Status

The safety output status indicates whether an alarm is present in the safety output point. The safety output status is provided in the safety input assembly, as shown in [Table 49](#). [Table 50](#) describes the attributes for reading the safety status via CIP messaging.

Table 49 - Safety Input Assembly Tags for Safety Output Status

Safety Input Assembly Tag Name (safety controller)	Type / [bit]	Description
devicename:SI.OutputStatus	SINT	A collection of safety output status, safety output monitor values, and test output status
devicename:SI.Out00Status	[2]	Status of Safety Output 0 0 = Alarm 1 = OK
devicename:SI.Out01Status	[3]	Status of Safety Output 1 0 = Alarm 1 = OK

Table 50 - MSG Configuration for Safety Output Status

Service Code	0x0E	Get attribute single
Class	0x3B	Safety Discrete Output Point Object
Instance	i + 1	Where i is the number of the safety output
Data Type		USINT
Attribute	0x5 5 (decimal)	Safety Status 0 = Alarm 1 = OK

Table 51 - Safety Output Specifications

Attribute	Value
Output type	Bipolar output
Output current	1 A
Test Pulse width	500 μ s
Test Pulse period	300 ms

Safety Output Ready

When set, the safety output ready attribute indicates that the safety output is configured for safety use and ready to be commanded.

IMPORTANT Check the Safety Output Ready attribute before commanding the safety output.

The safety output ready attribute is provided in the safety input assembly, as shown in [Table 52](#). [Table 53](#) describes the attributes for the Safety Output Ready attribute via CIP messaging.

Table 52 - Safety Input Assembly Tags for Safety Output Ready

Safety Input Assembly Tag Name (safety controller)	Type/[bit]	Description
devicename:SI.IOSupport	SINT	A collection of bits describing safety IO functionality
devicename:SI.Out00Ready	[4]	Safety Output 0 Ready 0 = Not Ready 1 = Ready
devicename:SI.Out01Ready	[5]	Safety Output 1 Ready 0 = Not Ready 1 = Ready

Table 53 - MSG Configuration for Safety Output Ready

Service Code	0x0E	Get attribute single
Class	0x3B	Safety Discrete Output Point Object
Instance	i + 1	Where i is the number of the safety output
Data Type	USINT	
Attribute	0x64 100 (decimal)	Safety Status 0 = Not Ready 1 = Ready

Safety Output Monitor Value

IMPORTANT Safety Output Monitor Value is not safety data and has no defined safe state. Use Output Monitor Value for diagnostic purposes only.

The output monitor value of a safety output is the value of the output that is read by the module. It is expected that the output monitor value is the same as the commanded safety output value in normal operation. The output monitor value can be used to diagnose output alarms.

The output monitor value is provided in the safety input assembly, as shown in [Table 54](#). [Table 55](#) describes the attributes for reading the output monitor value via CIP messaging.

Table 54 - Safety Input Assembly Tags for Safety Output Monitor Value

Safety Input Assembly Tag Name (safety controller)	Type/[bit]	Description
<i>devicename</i> :SI.OutputStatus	SINT	A collection of safety output status, safety output monitor values, and test output status
<i>devicename</i> :SI.Out00Monitor	[0]	Output Monitor Value of Safety Output 0 0 = OFF 1 = ON
<i>devicename</i> :SI.Out01Monitor	[1]	Output Monitor Value of Safety Output 1 0 = OFF 1 = ON

Table 55 - MSG Configuration for Safety Output Monitor Value

Service Code	0x0E	Get attribute single
Class	0x3B	Safety Discrete Output Point Object
Instance	$i + 1$	Where i is the number of the safety output
Data Type	USINT	Unsigned integer value
Attribute	0x4 4 (decimal)	Output Monitor Value 0 = OFF 1 = ON

Test Output Operation

The test outputs of the Integrated Safety Function module can be configured in the following modes:

- Test pulse output. When in test output mode, the test output point operates with a safety input to perform pulse testing on the external safety input circuitry.
- Power supply output. In power supply output mode, the output point is forced on, and only shuts off for a critical fault. For safety input and output specifications, see Armor PowerFlex AC Drives Specifications Technical Data, publication [35-TD001](#).



ATTENTION: As soon as the firmware boots and power is supplied to the I/O, the test outputs will turn on if they configured for either Pulse Test or Power Supply. These configured functions are independent of the I/O connections to the module.



ATTENTION: If a module with Test Outputs configured as Pulse Test or Power Supply is incorrectly installed in an application where actuators are connected to these Test Output points, the actuators are activated as soon as the firmware boots and power is supplied to the I/O.

To help prevent this possibility, follow these procedures.

- When installing or replacing a module, be sure that the module is correctly configured for the application or in the out-of-box condition before you apply input power.
- Reset modules to their out-of-box condition when removing them from an application.
- Be sure that all modules in the replacement stock are in their out-of-box condition.



ATTENTION: Do not use test outputs as safety outputs. Test outputs do not function as safety outputs.

Test Output Specifications

Output Type	Bipolar
Output current	1 A
Test pulse width	500 μ s
Test Pulse Period	300 ms
Field capacitance, maximum	950 nF
Residual voltage, maximum	0.3V
Leakage current, maximum	0.1 mA
Short circuit protection	yes
Reaction time from message to Output safe, maximum	<10 ms

Safety Input or Output Fault Recovery

If an error is detected, the safety data remains in the Off state. Follow this procedure to activate the safety data again.

1. Remove the cause of the error.
2. Place the safety input or safety output into the safe state.
3. Allow the input- or output-error latch time to elapse.

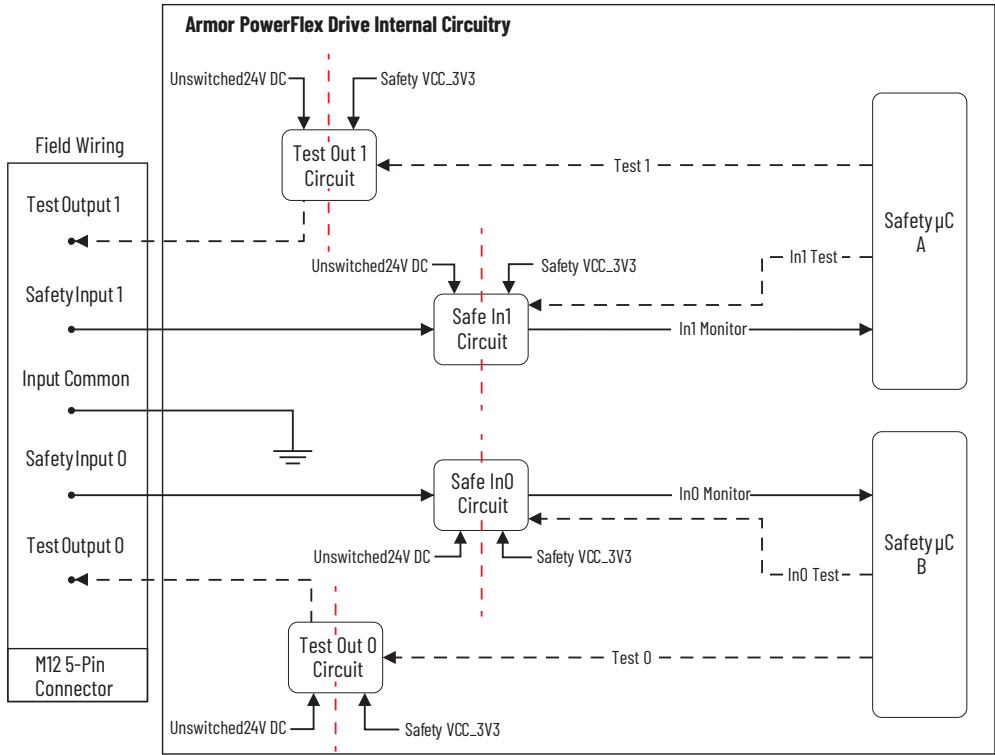
After these steps are completed, the I/O indicator (red) turns Off. The safety input or output data is now active.

IMPORTANT	Stuck high faults on safety outputs require a power reset to clear the error.
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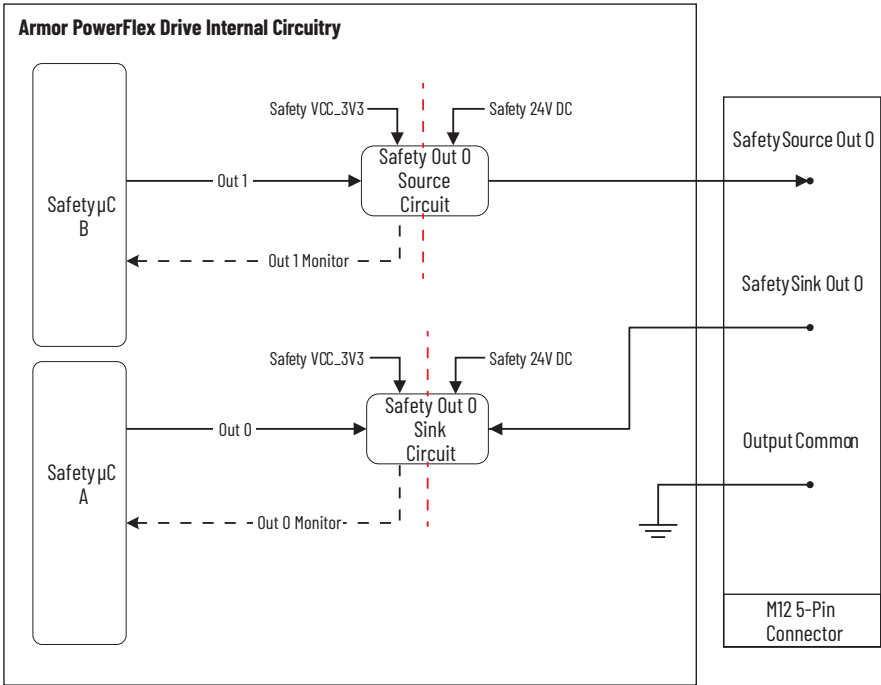
Safety I/O Wiring

IMPORTANT The wiring examples that are shown here are not a guarantee of Safety Category and Performance Level ratings. You must perform your own risk assessment to validate the requirements of your system.

Safety Input Internal Wiring Diagram Example



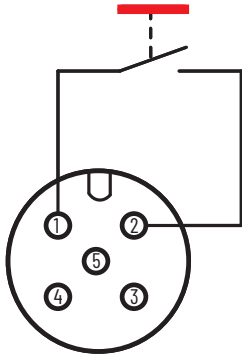
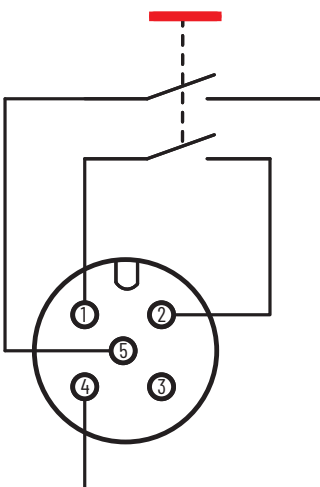
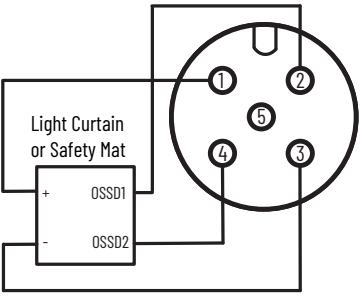
Safety Output Internal Wiring Diagram Example



Status and Faults

Each Safety I/O point has a status LED see [I/O Status Indicators on page 215](#) for details.

Safety Input Wiring Examples

Connected Devices	Output Pulse from Output Test	Connection	Schematic Diagram	Up to Safety Category	Up to Performance Level
Reset switch	No	Connect the switch between Test Output 1 and Input 1	<p>Pin 1: Test Output 1 Pin 2: Input 1 Pin 3: Input Common Pin 4: Input 0 Pin 5: Test Output 0</p> 	2	PLc
Emergency stop switch Door monitor	Yes	Connect the switch between Test Output 1 and Input 1 and between Test Output 0 and Input 0	<p>Pin 1: Test Output 1 Pin 2: Input 1 Pin 3: Input Common Pin 4: Input 0 Pin 5: Test Output 0</p> 	4	PLe
OSSD Safety Device Light Curtain or Safety Mat	No	Connect Test Output 1 to Device Power and connect Safety Inputs to OSSD device outputs	<p>Pin 1: Test Output 1 - configured as Power Supply^(a) Pin 2: Input 1 Pin 3: Input Common Pin 4: Input 0 Pin 5: Test Output 0 - not connected</p>  <p>(a) You cannot use other Safety Inputs in Test Pulse configuration, when a Test Output is configured for Power Supply.</p>	4	PLe

Safety Output Wiring Examples

Connected Devices	Output Pulse from Output Test	Connection	Schematic Diagram	Up to Safety Category	Up to Performance Level
Drive inductive load	Yes - see pulse testing IMPORTANT note	Connect the switch between Output 0 (sink) and Output 0 (source)	<p>Pin 1: No connection Pin 2: Output 0 (sink) Pin 3: Output Power Common Pin 4: Output 0 (source) Pin 5: Output Power Common</p>	4	PLe

IMPORTANT Depending on the targeted SIL, Category/PL and the safety application, fault exclusions for short circuits between any two conductors/cables may be necessary. See ISO 13849-2, Annex D for additional information.

IMPORTANT When pulse testing is used to achieve the maximum safety rating (SIL 3 Category 4, PLe) the safety output wiring must be protected against external damage by cable ducting, conduit, armored cable, or other means. See ISO 13849-2:Table D.4, for additional information.

Replacing an Armor PowerFlex Drive on a Safety Network

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

IMPORTANT If the Armor PowerFlex drive was used previously, clear the existing configuration before installing it on a safety network by resetting the device to out-of-box condition. See [Reset Ownership on page 97](#).

Replacing an Armor PowerFlex drive 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 constitute 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 device.

Replace an Armor PowerFlex drive in a GuardLogix System

When you replace an Armor PowerFlex drive, the replacement device must be configured properly and the replacement Armor PowerFlex drive's operation be user-verified.

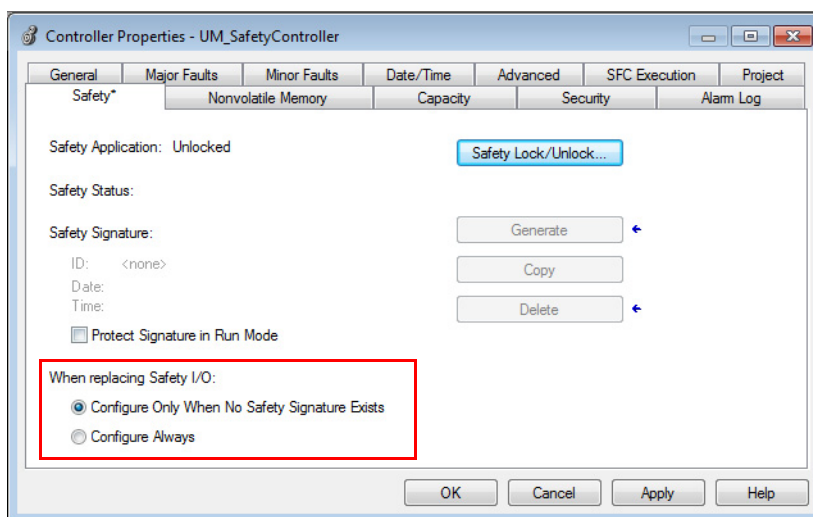


ATTENTION: During an Armor PowerFlex drive replacement or functional test, the safety of the system must not rely on any portion of the affected Armor PowerFlex drive.

There are two options for Armor PowerFlex drive replacement available on the Safety page of the Controller Properties dialog box in the Logix Designer application:

- Configure Only When No Safety Signature Exists
- Configure Always

Figure 79 - Armor PowerFlex Drive Replacement Options



Configure Only When No Safety Signature Exists

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

Configure Always

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

- The controller has configuration data for a compatible Armor PowerFlex drive at that network address
- The Armor PowerFlex drive is in out-of-box condition mode or 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 2/PLd or SIL 3/PLe behavior during the replacement and functional testing of the product. If other parts of the integrated safety control system are being relied upon to maintain SIL 2/PLd or SIL 3/PLe, 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 in safety control systems that are not being relied upon for SIL 2/PLd or SIL 3/PLe. See the GuardLogix user manual appropriate for your Logix 5000 controller:

- ControlLogix 5580 and GuardLogix 5580 Controllers User Manual, publication [1756-UM543](#)
- CompactLogix 5380 and Compact GuardLogix 5380 Controllers User Manual, publication [5069-UM001](#)

Configure the Armor PowerFlex Drive

The Armor PowerFlex drive is configured by using the Studio 5000 Logix Designer application. The drive's operation is based on the settings that are defined in a set of CIP objects and attributes, which you can configure via the user interface in the Logix Designer application.



For the list of CIP objects and attributes, see Armor PowerFlex AC Drive CIP Objects and Attributes Reference Data, publication [35-RD001](#).

Install Armor PowerFlex Add-on Profile

Download and install the Add-on Profile (AOP) for the Armor PowerFlex drive so that the Studio 5000 Logix Designer application can fully support the features of the Armor PowerFlex drive. Download AOPs from the Product Compatibility Download Center (PCDC) website at rok.auto/pcdc.

Create a Logix Designer Project

Before you can add the Armor PowerFlex drive, you must create a Logix Designer project that includes a Logix 5000 controller with a connection to the EtherNet/IP network. The Armor PowerFlex has an embedded dual port EtherNet module so there is no need for an optional EtherNet communication module.

If you are using integrated Safe Torque Off (STO), drive-based, or controller-based safety functions or the Armor PowerFlex drive's safety I/O, your system must include an integrated safety controller, see [Integrated Safety Functions and Compatible Controllers on page 91](#). See [Additional Resources on page 12](#), for a listing of integrated safety controller user manuals.

Select FactoryTalk Linx Communication

The Armor PowerFlex drive requires FactoryTalk® Linx communication. This is selected in the Studio 5000 Logix Designer application.

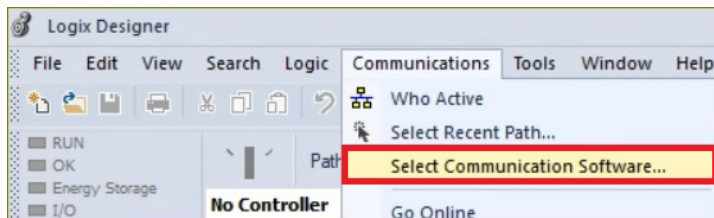


Starting with Studio 5000 Version 33.00, the default communication software is set to **FactoryTalk Linx**.

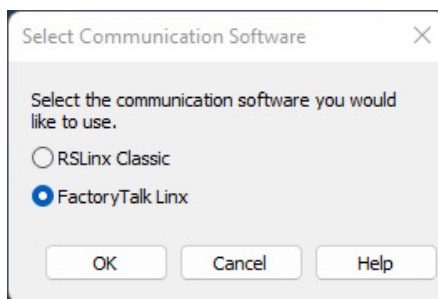
IMPORTANT

The current project file must be closed first in the Logix Designer application before changing to FactoryTalk Linx communication, or an error message will pop up that indicates it cannot change communication software.

1. To choose FactoryTalk Linx in Studio 5000 Logix Designer application, click on Communications.
2. Click on Select Communications Software.



3. Click on FactoryTalk Linx.



4. Click OK.
5. Re-open your project.

The pages of configuration dialog boxes that are available in the Logix Designer application vary depending on which version of Armor PowerFlex drive you have and also on the configuration choices you make when you set up your drive. See [Table 56](#).

Table 56 - Pages Available Based on the Configured Variant Type

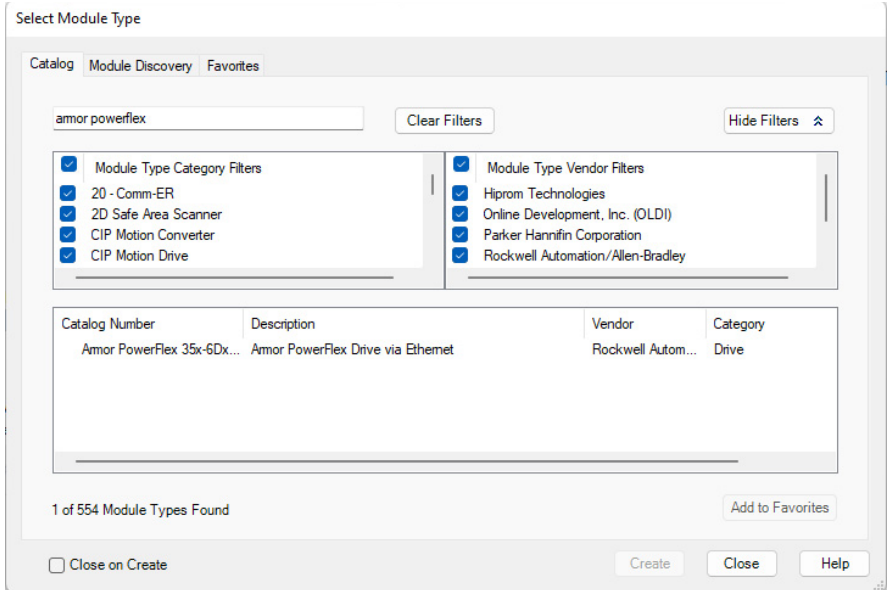
Configured Connection Type	Page
Standard Only	Overview
	Device Definition
	Datalinks Input
	Datalinks Output
	Quick Start
	Date and Time
	Faults and Alarms
	Predictive Maintenance
	Motor Control
	Autotune
	Encoder Feedback
	Velocity Control
	Stop Control
	Connection
Standard and Safety	Input/Output Configuration
	Events
	Overview
	Device Definition
	Datalinks Input
	Datalinks Output
	Quick Start
	Date and Time
	Faults and Alarms
	Predictive Maintenance
	Safety Configuration
	Safety Feedback
	Scaling
	Safe Torque Off (STO)
	Safe Brake Control (SBC)
	Safe Stop 1 (SS1)
	Test Output
	Input Configuration
	Output Configuration
Safety Only	Actions
	Motor Control
	Autotune
	Encoder Feedback
	Velocity Control
	Stop Control
	Connection
	Input/Output Configuration
	Events
	Overview
	Device Definition
	Datalinks Input
	Datalinks Output
	Date and Time
	Faults and Alarms
	Predictive Maintenance
	Safety Configuration
	Safety Feedback
	Scaling
	Safe Torque Off (STO)
	Safe Brake Control (SBC)
	Safe Stop 1 (SS1)
	Test Output
	Input Configuration
	Output Configuration
	Actions
	Connection
	Input/Output Configuration
	Events

IMPORTANT

For any new entires or modifications that you make to a page, you must click Apply or OK when finished, to save the entered values.

Add an Armor PowerFlex Drive to the Project

1. Right-click the Ethernet network and choose New Module.
2. Select the appropriate Armor PowerFlex option and click Create.



Configure the Device Definition

When the Armor PowerFlex module is first created, the software automatically launches the Device Definition window since the Name and IP Address of the module is the minimal configuration that is needed to create the module. To make any changes to the Device Definition at a later time, you will need to launch Device Definition from the Overview page.

Device Definition

Datalinks Input

Datalinks Output

Type

Armor PowerFlex

Catalog Number

35S-6D4-PX11

Revision

2

(001 - 255)

Name

New_APF

Electronic Keying

Compatible Keying

Product

Armor PowerFlex

Connection

Standard and Safety

Description

Max. 50 characters

Safety Instance

Single Feedback Monitoring

Variant

Safety (S)

Drive Rating

5 HP (4.0 kW)

Ethernet Address

Private Network

Power Supply

Internal 24 V...

EM Brake

Equipped

192 . 168 . 1 . 88

Safety

Safety Application

Networked

Safety Network Number (S_

48DA_038F_266C

Edit

Perform the following steps to enter your device details.

1. Enter values and use pull-down menus to configure the device definition. See [Table 57](#).



As you enter values, the Catalog Number field will update accordingly. An “X” will be displayed in the Catalog Number field for values that are irrelevant to the drive configuration.

Table 57 - Device Definition Settings


Field	Description	
Name	Name for your Armor PowerFlex drive, which also defines how Control Tags that are associated with the drive, are named in the Logix Designer application.	
Revision	<p>Firmware revision for the drive, including major and minor revision levels – The available major firmware revisions in the pull-down menu are dependent on the AOP version that is installed. (See the left-hand side footer of the Logix Designer screen.) Selecting revision 2 or later allows access to:</p> <ul style="list-style-type: none"> • Datalinks feature, see Configure Datalinks on page 156 • Frame size B support • Events configuration, see Configure Events on page 186 • Automatic or Manual EM Brake control, see Configure Electromechanical Brake on page 182 	
Description	Optionally add a description of your Armor PowerFlex drive	
Electronic Keying	Exact Match	Indicates that all keying attributes must match to establish communication. If any attribute does not match precisely, communication with the device does not occur.
	Compatible Module (default)	<p>Lets the installed device accept the key of the device that is defined in the project, when the installed device can emulate the defined device. With Compatible Module, you can typically replace a device with another device that has the following characteristics:</p> <ul style="list-style-type: none"> • Same catalog number • Same or higher Major Revision • Minor Revision as follows: <ul style="list-style-type: none"> – If the Major Revision is the same, the Minor Revision must be the same or higher. – If the Major Revision is higher, the Minor Revision can be any number.
	Disable Keying 	<p>Indicates that the keying attributes are not considered when attempting to communicate with a device. With Disable Keying, communication can occur with a device other than the type specified in the project.</p> <p>ATTENTION: Be cautious when using Disable Keying; if used incorrectly, this option can lead to personal injury or death, property damage, or economic loss. We strongly recommend that you do not use Disable Keying.</p> <p>If you use Disable Keying, you must take full responsibility for understanding whether the device being used can fulfill the functional requirements of the application.</p>
	IMPORTANT	Changing Electronic Keying attributes online interrupts connections to the device and any devices that are connected through the device. Connections from other controllers can also be broken. If an I/O connection to a device is interrupted, the result can be a loss of data.
Connection	Standard Only (35E or 35S)	An exclusive standard I/O connection that lets the standard input and standard output connections be configured for Data or Listen Only connections. The safety input and output connections are set to None.
	Safety Only (35S)	An exclusive safety I/O connection where a programmable controller owns the communication channel and provides safety data and configuration from the safety I/O. The standard input and output connections, if available on the drive, are set to None.
	Standard and Safety (35S)	There is a data connection and separate safety connection that provides an exclusive communication channel for standard I/O and safety I/O data.

Table 57 - Device Definition Settings

Field	Description	
Ethernet Address	Type the IP address. This setting must match the IP address that you set on the Armor PowerFlex drive by using one of the methods that are outlined in Set the IP Address on page 69 . IP Address - Enter an IP address, subnet mask, and gateway address for the drive. This is the IP address that the controller uses to communicate with the drive. Private Network - Type or select the desired address. This is the IP address that the controller uses to communicate with the drive. Host Name - Type the host name of the host Ethernet drive. Host Name is only active for Standard Only connection.	
Safety Instance	Not Used	No safety application — default for standard variant
	Safe Stop Only ⁽¹⁾	STO function and Timed SS1 Safe Stop functions are available.
	Single Feedback Monitoring ⁽¹⁾	Primary feedback is used in the safety object for safe monitoring.
Variant	Standard (E)	Standard drive
	Safety (S)	Integrated Safety drive
Drive Rating	1 HP (0.75 kW)	Power rating for drive
	2 HP (1.5 kW)	
	3 HP (2.2 kW)	
	5 HP (4 kW) ⁽²⁾	
	7.5 HP (5.5 kW) ⁽²⁾	
	10 HP (7.5 kW) ⁽²⁾	
Power Supply	Internal 24V DC	Auxiliary/control power is supplied by the drive.
	External 24V DC	You are supplying the power supply for the auxiliary/control power
EM Brake	Not Equipped	The drive does not have a mechanical brake option
	Equipped	The drive has the mechanical brake control option

(1) Only available when Connection type is Safety Only or Safety and Standard.

(2) Only available when the Revision is set to 2.0 or higher.

IMPORTANT

For an Armor PowerFlex drive with safety (35S), the safety and standard connections can both be managed by one Safety controller, or the safety connection can be managed by a Safety controller and the standard connection managed by a second controller. For example, a GuardLogix controller manages the safety connection and a CompactLogix controller manages the standard connection.

In the case that one Safety Controller will manage the safety connection and another controller will manage the standard connection, the safety connection must be done first and then, the standard connection. If the standard connection from a controller is done first, the safety connection from the different Safety Controller will be rejected.

2. After the values are entered, click OK.

Configure Datalinks

A datalink is a custom controller's tag that can be assigned to a user-defined attribute. Once created, it is added to the tag database and automatically transferred between the controller and the drive. It allows the specified attribute value to be read or written without using explicit message instructions.

Armor PowerFlex drives use datalinks to transfer data, to and from the controller. When an I/O connection that includes datalinks is active, the datalinks being used are locked and cannot be changed until the I/O connection becomes idle or inactive.

Use datalinks when you need to change a value of a parameter frequently. Because when you use a datalink to change a value, the value is not written to the Non-Volatile Storage (NVS). Instead, the value is stored in volatile memory and lost when the drive loses power.

IMPORTANT Datalinks are only available if you select drive firmware revision 2.00 or higher.

Input datalink stores the current value of user-defined drive's status attribute. Data is produced by the drive and consumed by the controller (data is sent from the drive to the controller).

Output datalink modifies the value of user-defined drive's control attribute. Data is produced by the controller and consumed by the drive (data is sent from the controller to the drive).

Datalink names are predefined and can be changed using Logix Designer's aliasing feature.

Requested Packet Interval value specifies the period at which the data is updated.

Available Datalinks are as follows:

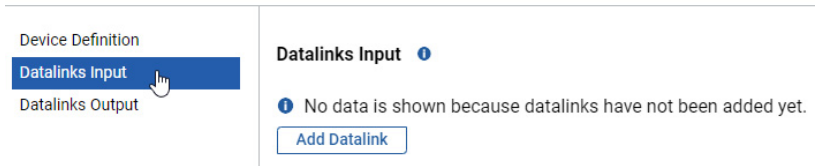
- 8 configurable boolean datalinks for standard inputs
- 4 configurable real floating-point datalinks for standard inputs
- 8 configurable boolean datalinks for standard outputs
- 4 configurable real floating-point datalinks for standard outputs

For details about the Armor PowerFlex attributes, see the Armor PowerFlex AC Drives CIP Objects and Attributes Reference Data, publication [35-RD001](#).

Perform the following steps to set up datalinks.

1. Click Datalinks Input or Datalinks Output.

Device Definition



2. Click Add Datalink to select a specific datalink. See [Table 58](#) for a listing of datalinks.

Table 58 - Datalinks

Datalinks Input	Datalinks Output
DC injection braking is on	Acceleration / Deceleration Control Switch
Encoder Feedback Data is Valid	Switch between Current Limit 1 and 2 values
Motor current exceeds overload current limit	Disable predefined Keypad Functions
Motor thermal capacity is utilized above safe limit	Dynamic Acceleration Time Reference [s]
Actual Acceleration Time Reference used by the drive [s]	Dynamic Deceleration Time Reference [s]
Actual Deceleration Time Reference used by the drive [s]	Dynamic S-Curve Reference [%]
Actual S-Curve Reference used by the drive [%]	
Minimum measured temperature of motor output heatsink [°C]	
Maximum measured temperature of motor output heatsink [°C]	
Dynamic Brake is active	
Encoder Feedback is Faulted	
Flying start is currently active	
Output Point 0 Status	
Output Point 1 Status	
Input Point 0 Status	
Input Point 1 Status	
Input Point 2 Status	
Input Point 3 Status	
IO Point 0 Status	
IO Point 1 Status	

Your configured datalinks are displayed in a table that is located below the Add Datalink button. You can remove or rearrange datalinks by following the listed instructions.



The Logix Designer application calculates in real time, the remaining slots available for datalinks.

Datalinks Input ⓘ

Remaining REAL Data Type Remaining BOOL Data Type
4 7

ⓘ To remove an attribute, click then apply changes. To change the order of the items press then drag and drop the item.

[Add Datalink](#)

	Actions	Description	Data Type	Controller Tag Name
*		DC injection braking is on	BOOL	DCBrakingOn

Once profile configuration is applied, the datalinks are created in Logix Designer's Controller Tag section. For more information, see [Auto-generated Tags on page 199](#).

View or Generate a Safety Network Number

The Logix Designer application automatically assigns a Safety Network Number (SNN) to each Armor PowerFlex safety drive as it is added to the project. The SNN is a time-based number that uniquely identifies subnets across all networks in the safety system. All Armor PowerFlex safety drives in a same system use the same SNN by default.

Manual manipulation of an SNN is required in the following situations:

- If safety consumed tags are used
- If the project consumes safety input data from a device whose configuration is owned by some other device
- If a safety project is copied to another hardware installation within the same routable safety system

If an SNN is assigned manually, the SNN has to be unique.

IMPORTANT

If you assign an SNN manually, make sure that the system expansion does not result in duplication of SNN and node address combinations. An alert message appears if your project contains duplicate SNN and node address combinations. You can still verify the project, but we recommend that you resolve the duplicate combinations.

To edit the SNN, follow these steps.

1. To open the Safety Network Number dialog box, click Edit, (to the right of the Safety Network Number), in the Device Definition dialog box.

Safety Network Number

Format

☒ Time-based

☐ Number-based

3/21/2022 12:21:26.222 PM

1
(1 - 9999)

Safety Network Number (SNN)
47A6_03B9_76CE

HEX

[Set](#)

[OK](#) [Cancel](#)

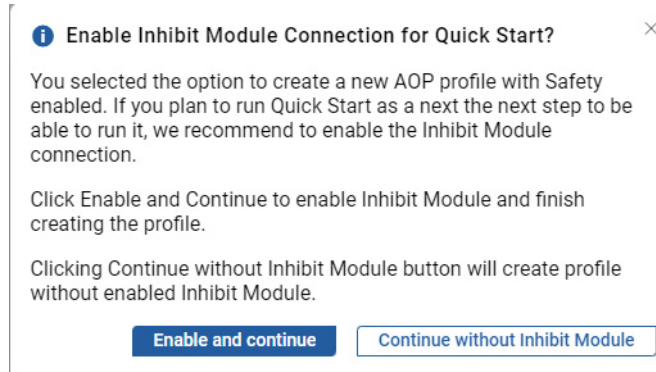
2. Select either Time-based or Number-based.

3. If you select Number-based, enter a value from 1...9999 decimal.
4. Click Set.
5. Click OK to close the Safety Network Number dialog box.
6. Click OK again, to close the Device Definition dialog box.

If needed, the Device Definition dialog box can be reaccessed via the Overview page.

Enable Inhibit Module Connection for Quick Start

Once you create a new module and click OK on the Device Definition page, the Logix Designer application will prompt you to inhibit the connection. This is a requirement if you are planning to run Quick Start.



Quick Start

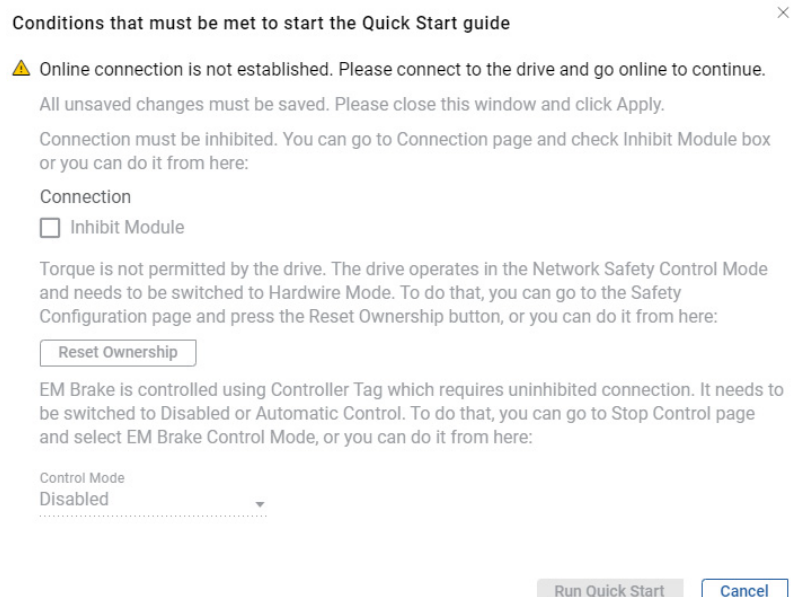
Quick Start is an optional wizard that allows you to quickly set up the drive and test the motor. Quick Start is only available if you are online and a connection between the Armor PowerFlex drive and the programmable controller is inhibited.

Perform the following steps to run Quick Start.

1. Click Quick Start.

Certain conditions must be met before you can run Quick Start. The following message will pop up, indicating what conditions still need to be met before the Quick Start can be run. In this example, the project is offline. One of the required conditions is to be online with the project.


Quick Start Offline Message




After you are online, the following message is displayed. You must meet the remaining conditions to enable the Run Quick Start button.

Quick Start Online Message

Conditions that must be met to start the Quick Start guide

- ① All fields with  icon apply values immediately to the drive.
- ✔ Online connection is established
- ✔ No unsaved changes detected
- ⚠ Connection must be inhibited. You can go to Connection page and check Inhibit Module box or you can do it from here:

Connection 

☐ Inhibit Module 

Torque is not permitted by the drive. The drive operates in the Network Safety Control Mode and needs to be switched to Hardwire Mode. To do that, you can go to the Safety Configuration page and press the Reset Ownership button, or you can do it from here:

Reset Ownership 

EM Brake is controlled using Controller Tag which requires uninhibited connection. It needs to be switched to Disabled or Automatic Control. To do that, you can go to Stop Control page and select EM Brake Control Mode, or you can do it from here:

Control Mode 

Automatic or Manual Co... 

Run Quick Start

Cancel

2. Click Run Quick Start.



Data that is written during the Quick Start procedure is immediately saved to the Armor PowerFlex drive.

3. The Quick Start consists of three pages:
 - Motor Data
 - Direction Test
 - Autotune

Follow the prompts of each of the pages sequentially, to complete the Quick Start.

Motor Data Page

4. Starting with the Motor Data page, enter input data from the motor nameplate.

The motor nameplate data is immediately applied to the drive and saved to the project. This means that once you do direction tests, the drive uses the actual provided motor data instead of default values

- Click Next, when finished. This will open the Direction Test page.

Direction Test Page


Direction Test



Rotation of the motor in an undesired direction can occur during this procedure. To guard against possible injury, load before proceeding.

Jog Reference 	Commanded Direction	Motor Polarity 
0.0 Rev/s	Forward	Normal
(0.0 - 400.0)		

Velocity Feedback	Actual Direction
0.000 Rev/s	Forward

 Select and hold Jog to determine the forward direction of motor rotation.

☐ The direction of motor rotation is correct

- As prompted, enter a Jog Reference (preferably a slow speed) and click the Jog button to confirm that the motor is moving in the correct direction. Adjust if necessary.
- If necessary, adjust the Motor Polarity field, or swap two of the motor cables to change the motor rotation direction.

Both Jog Reference and Motor Polarity are applied to the drive immediately. You do not need to apply it manually (by pressing OK or Apply).



WARNING: Before swapping motor cables, take appropriate precautions to remove power to the motor.

- Once the motor is rotating in the correct direction, click Next to access the Autotune page. See [Run Autotune on page 169](#).

Configure Motor Control

Motor control configuration is concerned with the configuration of the control mode and control method.

Basic motor control involves the control of the state of a connected motor. The state can either be stopped (no power applied to motor) or running (power applied to motor). Basic motor control also allows the direction of motion of the motor to be controlled.

When the Armor PowerFlex drive is configured for standard and safety or standard only connections, the following categories are available in the Module Properties window, for motor configuring operation:

- Motor Control
- Encoder Feedback
- Velocity Control
- Stop Control

Click Motor Control.

Motor Control

Motor Polarity Normal	Full Load Slip / Droop 0.00	RPM	Maximum PWM Frequency 4000.00	Hz
	(-600.00 - 600.00)		(2,000.00 - 16,000.00)	

❗ If Drive Rating is higher than 3 HP (2.2 kW), Maximum PWM Frequency must be limited to 4000.00 Hz.

Frequency Control

Curve Type
Constant Torque

❗ Drive uses predefined V/Hz curve that is suitable for constant torque application (conveyor, turntable, lifter, etc.). Provides high starting torque.

Start Boost Voltage 11.50	V	Break Voltage 115.00	V	Break Frequency 15.00	Hz
(0.00 - 115.00)		(0.00 - 460.00)		(0.00 - 500.00)	

Motor Nameplate

Type
AC Rotary Induction

Rated Voltage 460.00	Volts (RMS)	Rated Frequency 60.00	Hz	Rated Speed 1750.00	RPM
(20.00 - 460.00)		(0.00 - 500.00)		(0.00 - 24,000.00)	
Rated Power 1.50	kW	Full Load Amps 2.90	Amps (RMS)	Pole Count 4	
(0.00 - 1.50)		(0.08 - 8.00)		(2 - 40)	

Motor Protection

❗ For Motor Cooling Model to work correctly, go to Date and Time page and synchronize data with your workstation (Set from Workstation button)

Thermal Overload Power Up Behaviour
Assume Motor Cold

Overload Current 2.30	A	Derate Frequency 0.00	Hz
(0.00 - 4.60)		(0.00 - 60.00)	
Current Limit 1 3.45	A	Current Limit 2 3.45	A
(0.00 - 4.14)		(0.00 - 4.14)	

Flying Start

☐ Enable Flying Start

Auto Restart

☐ Enable Auto Restart

Auto Restart Retries 1	Auto Restart Delay 1.00	s
(1 - 9)	(1.00 - 120.00)	

Autotune

Configure Motor Control Mode

Control mode specifies what parameters the motor control in the device is controlling. Basically it indicates the property or properties of the motor output that are being actively managed by the motor control algorithms. Armor PowerFlex drives use velocity control.

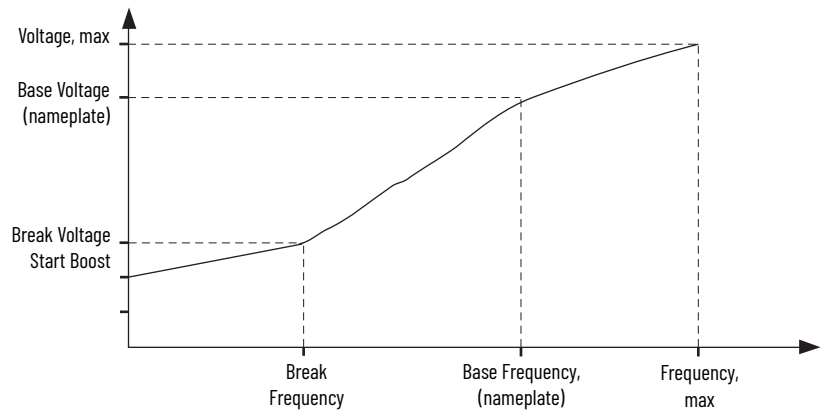
1. On the Motor Control page, choose a Motor Control Mode.

Motor Control Mode	Description
Volts/Hertz (V/Hz)	If you choose this mode, you can adjust the Frequency control settings as described in Voltz/Hertz Control Mode See Volts/Hertz Control Mode .
Sensorless Vector (SVC)	The motor is controlled using current feedback, assuming that the total current is the vector sum of the torque- and flux-producing components. In this mode, you cannot adjust the Frequency Control settings. See Configure Full Load Slip/Droop and Maximum PWM Frequency , for the next steps.
Velocity Vector (VVC)	A high-speed bandwidth regulator and adaptive controller are used to provide continuous regulation of the motor speed and improved overall control. It is recommended to use an encoder when using VVC mode. In this mode, you cannot adjust the Frequency Control settings. See Configure Full Load Slip/Droop and Maximum PWM Frequency , for next steps.
Sensorless Vector (SVC) Economizer	In this mode, when steady state speed is achieved, the economizer becomes active and automatically adjusts the drive output voltage based on the applied load. By matching output voltage to applied load, the motor efficiency is optimized. Reduced load commands a reduction in motor flux current. The feature is inactive during acceleration, deceleration or any load changes. Applications using a PID control scheme, where the speed of the motor may continuously vary according to the output of the PID, will not benefit from this feature. We also do not recommended to use the Economizer on highly dynamic applications, as it may cause delays in motor (torque) reaction. In this mode, Frequency Control settings cannot be adjusted.

Volts/Hertz Control Mode

The Volts/Hertz Control Mode uses a fixed relationship between frequency and voltage, forming what is known as a "Volts per Hertz" curve. When you select Volts/Hertz mode, you can adjust the Frequency Control settings to influence the curve.

Figure 80 - Volts per Hertz Curve Example



2. On the Motor Control page, choose a Boost Select method.

Boost Select Types	Description
Custom V/Hz	Custom V/Hz allows a wide variety of patterns for the V/Hz ratio. The default configuration is a straight line from zero to rated voltage and frequency. The volts/hertz ratio can be changed to provide increased torque performance when required. See Figure 80 .
Variable Torque	Variable frequency control selects a curve suitable for variable torque loads such as fans and pumps. This type of curve has no starting / acceleration boost. See Figure 81 on page 164 .
Constant Torque	Constant frequency control selects a curve suitable for constant torque loads such as conveyors and compressors. See Figure 82 on page 164 .

Figure 81 - Variable Frequency Example

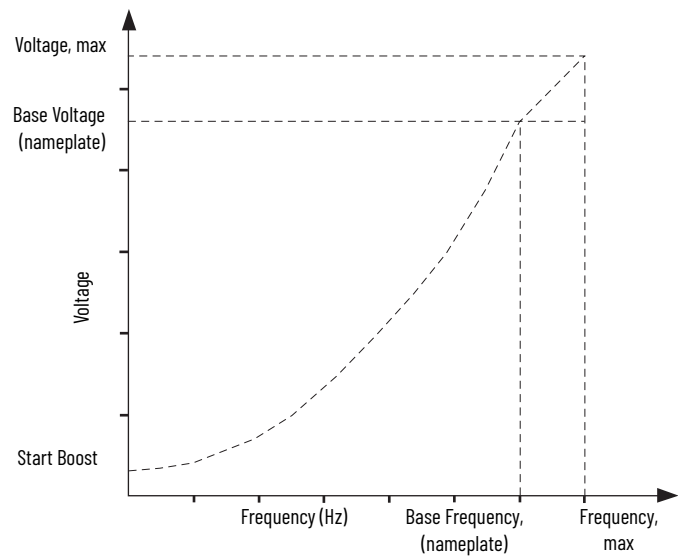
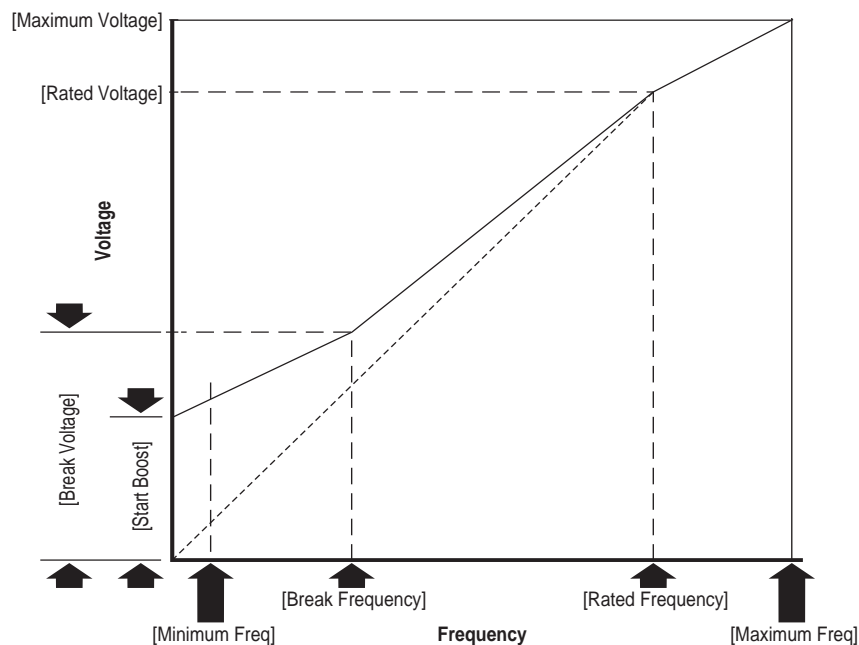


Figure 82 - Constant Frequency Example



Frequency control parameters are only enabled if you select Custom V/Hz Boost Select type, otherwise, they are disabled. See [Table 59 on page 165](#) to help you set the frequency control values.

Table 59 - Frequency Control Parameters

Frequency Control Value	Description
Start Boost Voltage	This setting redefines the Volts/Hz curve. It is used to create additional torque for breakaway from zero speed and acceleration of heavy loads at lower speeds. The boost voltage is only applied until the specified break voltage/frequency point on the curve is reached. The range is 0...115 V, with a default setting of 11.5V.
Break Voltage	Type a value to set the output voltage of the drive at the Break Frequency where boost ends. This setting is used to increase the slope of the lower portion of the Volts / hertz curve, providing additional torque. The range is 0...460 V, with a default setting of 115V.
Break Frequency	Type a value to set the output frequency of the drive device at the Break Voltage where boost ends. Used to increase the slope of the lower portion of the Volts / hertz curve, providing additional torque. The range is 0.0...500.0 Hz, with a default setting of 15.0 Hz.

Autotune

The Armor PowerFlex drive provides an Autotune feature to obtain proper motor tuning data to provide optimal velocity control performance for Sensorless Vector or Velocity Vector control modes. Autotune does not adjust the performance of V/Hz control, so do not run it for this motor control mode. See [Run Autotune on page 169](#) for instructions on performing the Autotune application. The motor tuning data can also be entered manually with values that are available from the motor manufacturer.

Configure Motor Polarity

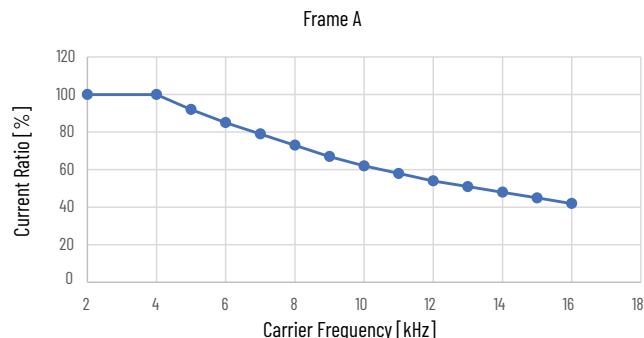
Choose either Normal or Inverted motor polarity.

Configure Full Load Slip/Droop and Maximum PWM Frequency

Enter your desired values for these two attributes:

Attribute	Range	Description
Full Load Slip/Droop	-600...+600 RPM	This setting compensates for the inherent slip in an induction motor. This speed is added to the commanded output frequency based on motor current. Positive values indicate slip compensation, negative values indicate droop compensation.
Maximum PWM Frequency	2000...16,000 Hz	Frame A — This setting limits the carrier frequency of the PWM output waveform. Figure 83 on page 165 provides derating guidelines that are based on the PWM frequency setting. Frame B — The only carrier frequency currently allowed is 4000 Hz. Additional carrier frequency selections are in development.

Figure 83 - Maximum PWM



Configure Motor Nameplate

IMPORTANT This section is for offline entry of Motor Nameplate Data. If you already entered Motor Nameplate Data via Quick Start, it is already saved and you do not need to re-enter it.

From the Motor Control page, enter Motor Nameplate values based on your system configuration.

Motor Nameplate

Type
AC Rotary Induction

Rated Voltage
460.00
(20.00 - 460.00)

Volts (RMS)

Rated Frequency
60.00
(0.00 - 500.00)

Hz

Rated Speed
1750.00
(0.00 - 24,000.00)

RPM

Rated Power
0.75
(0.00 - 0.75)

kW

Full Load Amps
1.50
(0.07 - 4.60)

Amps (RMS)

Pole Count
4
(2 - 40)

Enter motor nameplate data for Voltage, Frequency, and Full Load Current.

IMPORTANT The motor nameplate values entered must match the actual characteristics of the connected motor. Do not use the default values if they do not match. If these values are incorrect, poor motor control performance, faults, and other undesired behavior can result.

Size: 1 Hp (35S-6D1-*, 35E-6D1-*)

Motor Nameplate	Minimum	Maximum	Default
Voltage	20V AC	460V AC	460V AC
Frequency	0 Hz	500 Hz	60 Hz
Rated Speed	0 RPM	24,000 RPM	1750 RPM
Rated Power	0 kW	0.75 kW	0.75 kW
Pole Count	2	N/A	4
Full Load Amps rms	0.0652 A	2.3 A	2.3 A

Size: 2 Hp (35S-6D2-*, 35E-6D2-*)

Motor Nameplate	Minimum	Maximum	Default
Voltage	20V AC	460V AC	460V AC
Frequency	0 Hz	500 Hz	60 Hz
Rated Speed	0 RPM	24,000 RPM	1750 RPM
Rated Power	0 kW	1.5 kW	1.5 kW
Pole Count	2	N/A	4
Full Load Amps rms	0.0652 A	4.0 A	4.2 A

Size: 3 Hp (35S-6D3-*, 35E-6D3-*)

Motor Nameplate	Minimum	Maximum	Default
Voltage	20V AC	460V AC	460V AC
Frequency	0 Hz	500 Hz	60 Hz
Rated Speed	0 RPM	24,000 RPM	1750 RPM
Rated Power	0 kW	2.2 kW	2.2 kW
Pole Count	2	N/A	4
Full Load Amps rms	0.0652 A	6.0 A	6.0 A

Size: 5 Hp (35S-6D4-*, 35E-6D4-*)

Motor Nameplate	Minimum	Maximum	Default
Voltage	20V AC	460V AC	460V AC
Frequency	0 Hz	500 Hz	60 Hz
Rated Speed	0 RPM	24,000 RPM	1750 RPM
Rated Power	0 kW	3.7 kW	3.7 kW
Pole Count	2	N/A	4
Full Load Amps rms	0.0652 A	2.3 A	10.5 A

Size: 7.5 Hp (35S-6D5-*, 35E-6D5-*)

Motor Nameplate	Minimum	Maximum	Default
Voltage	20V AC	460V AC	460V AC
Frequency	0 Hz	500 Hz	60 Hz
Rated Speed	0 RPM	24,000 RPM	1750 RPM
Rated Power	0 kW	5.6 kW	5.6 kW
Pole Count	2	N/A	4
Full Load Amps rms	0.0652 A	4.0 A	13 A

Size: 10 Hp (35S-6D6-*, 35E-6D6-*)

Motor Nameplate	Minimum	Maximum	Default
Voltage	20V AC	460V AC	460V AC
Frequency	0 Hz	500 Hz	60 Hz
Rated Speed	0 RPM	24,000 RPM	1750 RPM
Rated Power	0 kW	7.5 kW	7.5 kW
Pole Count	2	N/A	4
Full Load Amps rms	0.0652 A	6.0 A	17 A

Configure Motor Protection

1. From the Motor Control page, enter the values for Motor Protection.
See [Set Date and Time on page 221](#), for synchronization procedure.

Motor Protection

❗ For the cooling model to work correctly, go to the Date and Time page and synchronize data with your workstation (Set from Workstation button).

☐ Enable Motor Overload Retention

Overload Current		Current Limit		Derate Frequency	
2.30	A	3.45	A	0.00	Hz
(0.00 - 4.60)		(0.00 - 4.14)		(0.00 - 60.00)	

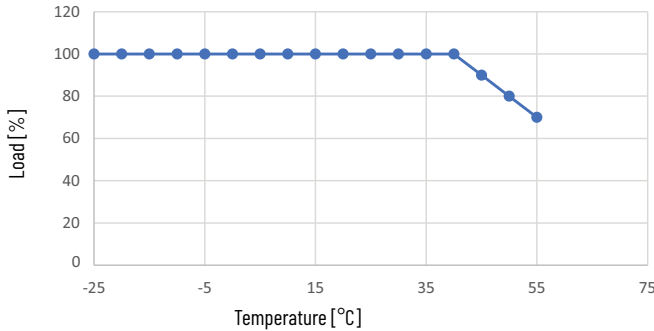
Attribute	Range	Description
Overload Current	0...34.0 ⁽¹⁾ A	Set the overload current to the maximum allowable current.
Current Limit 1 Current Limit 2	0.00...25.5 ⁽¹⁾ A	Configure the Current Limit, which sets the maximum motor output current that is allowed before current limiting occurs. The drive uses Current Limit 1 as default and ignores Current Limit 2. However, you can switch between them by using a Message Instruction or by using the datalink: Switch Between Current Limit 1 and Current Limit 2 (See Configure Datalinks on page 156).
Derate Frequency	0...60 Hz	Set the Derate Frequency, which lets the thermal capacity be reduced when the frequency being output to the motor is below this value.

(1) The maximum range value will vary based on the Drive Rating that is selected in the Device Definition.

Derating

Use the Load vs. Temperature graph, [Figure 84](#), to derate for altitudes from 0...1000 m (0...3300 ft).

Figure 84 - Load vs. Temperature Derating for 0...1000 m (0...3300 ft)

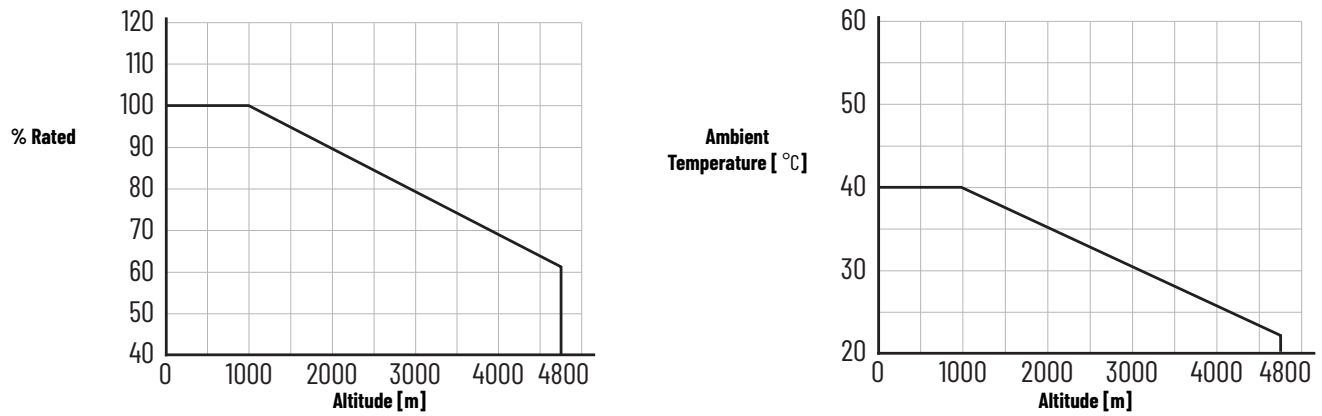


If the drive is used above 1000 m (3300 ft):

- Derate the maximum ambient temperature by 5 °C (9 °F) for every additional 1000 m (3300 ft), above the nominal 1000 m (3300 ft).
- Or
- Derate the output current by 10% for every additional 1000 m (3300 ft), above the nominal 1000 m (3300 ft).

See [Figure 85](#).

Figure 85 - Derating Curves for High Altitude



2. Choose a Motor Overload Retention setting. See [Table 60](#).

Table 60 - Motor Overload Retention

Attribute	Range	Description
Motor Overload	Enabled/Disabled	<p>This defines the behavior of the motor thermal overload feature when the device powers up.</p> <ul style="list-style-type: none"> Enabled (toggle switch left) - The value of the Thermal Capacity Utilized attribute is reset to 0 on power up. This assumes that the motor is fully cool. Disabled (toggle switch right) - The value of the Thermal Capacity Utilized attribute is saved at power down and restored on power up. This assumes that the motor has not cooled down at all while the product was off.

Run Autotune

The Autotune procedure can be run using the Quick Start procedure on the Overview page or it can be selected from the Motor Control page.

Autotune provides an automatic method for determining various motor tuning attribute values, by measuring physical attributes of the motor that is connected to the Armor PowerFlex drive. By actually measuring these motor characteristics for the specific motor that is being used (instead of relying on default values, typical values for the motor type and size, or nominal values provided by a motor manufacturer), motor control performance is improved.

The Autotune routine also uses the motor Name Plate Data values that are entered in the Motor Control page. It is important that you entered the Name Plate Data values for the motor, correctly.

The drive can perform static and rotate Autotune operations.

Perform these steps to run Autotune.

1. Click Autotune.

You must be online with the programmable controller. If not, you will see the following offline message after clicking Autotune.

Autotune Offline Error Message

Conditions that must be met to start Autotune
×

⚠ Online connection is not established. Please connect to the drive and go online to continue.

All unsaved changes must be saved. Please close this window and click Apply.

Connection must be inhibited. You can go to Connection page and check Inhibit Module box or you can do it from here:

Connection

☐ Inhibit Module

Torque is not permitted by the drive. The drive operates in the Network Safety Control Mode and needs to be switched to Hardwire Mode. To do that, you can go to the Safety Configuration page and press the Reset Ownership button, or you can do it from here:

EM Brake is controlled using Controller Tag which requires uninhibited connection. It needs to be switched to Disabled or Automatic Control. To do that, you can go to Stop Control page and select EM Brake Control Mode, or you can do it from here:

Control Mode
Disabled

After clicking Autotune when online, the Autotune online request message is displayed.

Autotune Online Message Example – Module Not Inhibited

Conditions that must be met to start Autotune
×

① All fields with ➡ icon apply values immediately to the drive.

✔ Online connection is established

✔ No unsaved changes detected

⚠ Connection must be inhibited. You can go to Connection page and check Inhibit Module box or you can do it from here:

Connection ➡

☐ Inhibit Module

Torque is not permitted by the drive. The drive operates in the Network Safety Control Mode and needs to be switched to Hardwire Mode. To do that, you can go to the Safety Configuration page and press the Reset Ownership button, or you can do it from here:

➡

EM Brake is controlled using Controller Tag which requires uninhibited connection. It needs to be switched to Disabled or Automatic Control. To do that, you can go to Stop Control page and select EM Brake Control Mode, or you can do it from here:

Control Mode ➡
Automatic or Manual Co...

2. Follow all the prompts to put the drive in a ready to run state. This example has a Safety Connection and EM Brake Control (The prompts listed are based on the Armor PowerFlex configuration in the Device Definition page, therefore, the prompts that you see might differ from the ones shown in this example). For this example:
 - Connection — Check Inhibit Module box (The drive must be inhibited.)
 - Click Reset Ownership (The drive will default to hardwired Safety which allows torque to be permitted, so the drive is in a ready run state.)

- Install the STO bypass plug (see [STO Bypass Operation on page 100](#))
- EM Brake Control Mode — When the EM Braked is properly connected, select “Automatic Control” or “Automatic or Manual Control” (see [Configure Electromechanical Brake on page 182](#)). If the EM Brake is not connected, select “Disabled”.

IMPORTANT

If motor control performance is important when using Sensorless Vector or Velocity Vector control, the Autotune function should be performed. If the performance does not improve after the Autotune function is completed, contact the motor manufacturer for the optimal motor characteristic references and overwrite the values that are identified in the Autotune step.

IMPORTANT

Autotune cannot be performed when torque is disabled in an Armor PowerFlex safety drive (35S). Install the safety bypass jumper (hardwired STO mode), see [Hardwired STO Operation on page 100](#), or enable torque via a separate safety controller (network STO mode), see [Integrated Safe Torque Off Function on page 105](#).

Autotune cannot be performed when a safety connection has been configured.



ATTENTION: Rotation of the motor in an undesired direction can occur during this procedure. To guard against possible injury and/or equipment damage, we recommend disconnecting the motor from the load before you continue.

3. Click Run Autotune.

Autotune page

Autotune ⓘ

⚠ Rotation of the motor in an undesired direction can occur during this procedure. To guard against possible injury and/or equipment damage, it is recommended that the motor be disconnected from the load before proceeding.

ⓘ All fields with ⓘ icon apply values immediately to the drive.

☐ I acknowledge that I understand the risk.

Test Method
Static Tune ▾

Start Test ⓘ Accept Test Results Accept Default Values Clear Faults ➡

ⓘ	Name	Value	Units	Test Results	ⓘ	Default Value (Calculated)
	Motor Stator Resistance (0.00 - 100.00)	5.8	Ohm			5
	Motor Rotor Resistance (0.00 - 100.00)	11.2	Ohm			11
	Motor Flux Current (0.00 - 100.00)	14.1	A			14
	Motor Total Leakage Inductance (0.00 - 100.00)	4.4	H			4
	Motor Mutual Inductance (0.00 - 100.00)	7.9	H			7

Back Finish ➡ Exit

4. From the Autotune dialog box, choose an option. See [Table 61](#).

Different quantities are measured based on the Autotune option that is selected and based on the type of motor that is connected to the drive.

Table 61 - Autotune Options

Options	Description
1 "Static Tune"	<p>A static Autotune operation performs measurements of physical attributes of the attached motor without causing movement of the motor. Some electrical energy is output to the motor, but it is not driven in a way to cause movement.</p> <p>The number of physical quantities that can be measured during a static tune are limited. For induction motors, the following are measured during a static Autotune:</p> <ul style="list-style-type: none"> • Induction Motor Stator Resistance • Induction Motor Rotor Resistance <p>Use this Autotune operation when no motor movement is allowed or when the motor cannot be uncoupled from the load.</p>
2 "Rotate Tune"	<p>A rotate Autotune operation performs measurements of physical attributes of the attached motor while the motor is moved. Moving the motor allows more physical quantities to be made and in some cases, more accurate measurements can be made.</p> <p>For induction motors, the following are measured during a rotate Autotune:</p> <ul style="list-style-type: none"> • Induction Motor Stator Resistance • Induction Motor Rotor Resistance • Induction Motor Flux Current • Induction Motor Total Leakage Inductance • Induction Motor Mutual Inductance <p>Use this Autotune operation when motor movement is allowed and the load can be uncoupled from the motor. The LOAD MUST BE DISCONNECTED / UNCOUPLED or the measurements will not be accurate.</p>

IMPORTANT For Velocity Vector Control (VVC), the recommended tune method is Rotate tune and not Static tune. If Static tune is used, the precision of motor control will be diminished.



ATTENTION: Autotune cannot be performed when a safety connection has been configured.

ATTENTION: Rotation of the motor in an undesired direction can occur during this procedure. To guard against possible injury and/or equipment damage, we recommend disconnecting the motor from the load before you continue.

- When the autotune procedure is done, you can choose to enter tuning values manually, accept test results, or acknowledge default values.
- To use the measured quantities, click Accept Test Results.
- Click Finish, when complete.

The Autotune process inhibits the Armor PowerFlex connection without exiting the Autotune window. Once the Autotune process is completed, you must uninhibit the connection.

- See [Standard Connection Settings on page 183](#) to uninhibit the connection.

If Autotune was run from the Quick Start application, continue with [Configure Motor Control on page 162](#).

Configure Flying Start

Enabling Flying Start lets the drive reconnect to a spinning motor at actual RPM. For details, see [Flying Start on page 22](#).

- Choose to enable or disable Flying Start by checking or unchecking the check box, respectively.



ATTENTION: When flying start is enabled and the motor is starting from zero speed, the motor shaft can turn forward or reverse while the algorithm attempts to detect current speed.

Configure Auto Restart

The auto restart feature provides the ability for the drive to automatically perform a fault reset followed by a start attempt without any user intervention.

1. From the Motor Control pull-down menu, click Auto Restart.

If Auto Restart is enabled, it can be configured to perform multiple fault clear/start attempt cycles in response to a single start request.

2. Choose the number of Auto Restart Tries (up to 9), which sets the maximum number of times the drive attempts to reset a fault and restart.

IMPORTANT

The Auto Restart feature only clears a limited number of the following motor control related faults. Any other faults will not be cleared and the drive will not restart. The drive will also not restart after multiple simultaneous faults of any type occur.

- Inverter - Ground Fault (event code 0x04250002)
- Motor Thermal Overload - Overload, Hard (event code 0x04320001)
- Load Monitor - Above Level (Shear Pin) (event code 0x04340001)
- Load Monitor - Below Level (Load Loss) (event code 0x04340002)
- Temperature Sensor - Overtemperature, Hard (event code 0x04230002)

3. Choose an Auto Restart Delay time (up to 120 s), which defines the time between restart attempts if Auto Restart Tries is set to a value greater than zero.



ATTENTION: Equipment damage and/or personal injury can result if this function is used in an inappropriate application. Do not use this function without review of applicable local, national, and international codes, standards, regulations, or industry guidelines.

Configure Encoder Feedback

The default setting for Encoder Feedback is Disable Encoder Feedback, which is selected when no encoder is used.

When an encoder is being used in the system configuration, you must adjust the Encoder Feedback parameters for the type of encoder that is used.

To achieve speed range/accuracy for SVC and VVC closed loop control, a minimum of 1024 PPR encoder is recommended. The encoder pulse is approximately 250 kHz. See [Table 62](#) for encoder specifications.

Table 62 - Encoder Specifications

Type	Incremental
Supply	User-selectable 5V or 12V, 250 mA
Quadrature Phasing	90 ± 27° @ 25° C (77° F)
Duty Cycle	50%, +10%
Requirements	Encoders must be line driver type, quadrature (dual channel) or pulse (single channel) output, single-ended or differential and capable of supplying a minimum of 10 mA per channel. Allowable input is DC up to a maximum frequency of 250 kHz. The encoder inputs automatically scale to allow 5V, 12V DC nominal input signal voltages.

1. If you are using an encoder, click Encoder Feedback.

Encoder Feedback

All fields are disabled because Electrical Interface Type is set to Disabled Encoder Feedback.

Electrical Interface Type*

Disabled Encoder Feedback

Polarity

Normal

Cycle Resolution

1024

Cycles/Rev

Cycle Interpolation*

1

Counts/Cycle

Effective Resolution*

1024

Counts/Rev

(1 - 20000)

☒

Enable Velocity Comparison Diagnostic

2. Choose the Electrical Interface Type:

- Digital Incremental, Single Channel, Single Ended
- Digital Incremental, Single Channel, Differential
- Digital Incremental, Dual Channel, Single Ended
- Digital Incremental, Dual Channel, Differential
- Generic Sine/Cosine

3. From the Encoder Feedback page, select the encoder parameters. See [Table 63 on page 174](#).

Table 63 - Encoder Feedback Parameters

Attribute	Range	Description
Polarity	Normal/Inverted	Choose between Normal (default) or Inverted as appropriate for your application. This is based on encoder rotation and evaluation requirements.
Cycle Resolution	1...20,000 cycles/rev	This setting is used in the Effective Resolution calculation. The actual motor encoder cycle resolution. This is the raw encoder cycle resolution of the motor or encoder device type.
Cycle Interpolation	4 (default)	This is used in the Effective Resolution calculation. The safety primary-feedback interpolated counts as oppose to the motion axis-feedback interpolated counts. For the Integrated Safety Functions module, this value is 4 and cannot be changed.
Effective Resolution	1...80,000 cycles/rev	This calculated value is the product of cycle resolution and cycle interpolation for the primary safety function evaluation.
Enable Velocity Comparison Diagnostic	Enable/disable	When enabled, this diagnostic compares the velocity that is determined by the encoder and the predicted or estimated velocity based on the motor control model. If the difference is too large, a Feedback Velocity Comparison Failure fault occurs.

Configure Velocity Control

Velocity control refers to controlling of the speed of a connected motor. A speed is commanded by the user, and the motor control algorithms determine the output to the motor necessary to achieve this speed.

Additionally, the motor control method and optional feedback device determine how accurately the commanded speed can be met (closed loop control versus open loop control).

The Velocity Control settings include: setting the velocity limits, enabling or disabling the dynamic acceleration control, entering up to four preset values for velocities, acceleration times, deceleration times, and s-curves, and setting the minimum and maximum output frequencies.

Follow these steps to configure the Velocity Control settings.

1. Click Velocity Control.

Velocity Control

Velocity Limits & Ramp Rates

Minimum Velocity
0.00 Rev/s
(0.00 - 400.00)

Maximum Velocity
30.00 Rev/s
(0.00 - 400.00)

Dynamic Acceleration Control

☐ Disabled

Presets

	Preset	Velocity (Rev/s)		Acceleration Time (s)		Deceleration Time (s)		S-Curve (%)	
		Value	Range	Value	Range	Value	Range	Value	Range
	1	0	0 - 400	2	0 - 600	2	0 - 600	0	0 - 100
	2	0	0 - 400	10	0 - 600	10	0 - 600	0	0 - 100
	3	0	0 - 400	10	0 - 600	10	0 - 600	0	0 - 100
	4	0	0 - 400	10	0 - 600	10	0 - 600	0	0 - 100

Output Frequency

Minimum Output Frequency
0.00 Hz
(0.00 - 500.00)

Maximum Output Frequency
60.00 Hz
(0.00 - 500.00)

Velocity Limits

2. Enter the Velocity Limits (Minimum Velocity and Maximum Velocity). See [Table 64](#).

Table 64 - Velocity Limits

Attribute	Range	Description
Minimum Velocity	0...400 Rev/s	Sets the minimum velocity for the drive.
Maximum Velocity	0...400 Rev/s	Sets the maximum velocity for the drive. IMPORTANT Stop the drive before changing this setting.

Dynamic Acceleration Control

The Dynamic Acceleration Control setting applies only to Acceleration Time, Deceleration Time and S-Curve attributes. See [Preset Velocity, Acceleration Time, Deceleration Time, S-Curve on page 176](#).

3. Click On or Off for the Dynamic Acceleration Control. See [Table 65](#).

Table 65 - Dynamic Acceleration Control

Attribute	Description
On	When On is selected, you can change the values of Acceleration and Deceleration Times currently being used and the changes are implemented in real time, even if the drive is running. Make real-time changes using a Message Instruction or datalink.
Off	When Off is selected, you must wait for the drive to stop before any changes made to the Acceleration and Deceleration Times, will take effect.

Preset Velocity, Acceleration Time, Deceleration Time, S-Curve

Enter a value for each attribute on a preset row: Velocity, Acceleration Time, Deceleration Time, and S-Curve. Enter up to four total presets.

4. The Preset Velocity to be used, is selected using the output tags *devicename.O.VelocityRefSelect_x* (where x can be 0, 1, or 2). [Table 66](#) and [Table 67](#) show the bit definitions to select the Preset Velocities, Acceleration Times, Deceleration Times, and S-curves.

Table 66 - Preset Velocity Output Tag Bit Configuration

VelocityRefSelect_2	VelocityRefSelect_1	VelocityRefSelect_0	Preset Velocity to be used
0	0	0	User velocity reference in output tag (CommandedVelocity)
0	0	1	Preset 1
0	1	0	Preset 2
0	1	1	Preset 3
1	0	0	Preset 4

IMPORTANT If an illegal value is entered (a value that is not defined in the table) for the Velocity Output Tag, the CommandVelocity output tag is used.

Table 67 - Preset Acceleration/Deceleration/S-Curve Output Tag Bit Configuration

AccelRefSelect_2	AccelRefSelect_1	AccelRefSelect_0	Preset Acceleration Time, Deceleration Time, S-Curve to be used
0	0	0	Preset 1
0	0	1	Preset 1
0	1	0	Preset 2
0	1	1	Preset 3
1	0	0	Preset 4

IMPORTANT If an illegal value (a value that is not defined in the table) is entered for the Preset Acceleration/Deceleration/S-Curve Output Tag, Preset 1 is used.



You can change Acceleration Time, Deceleration Time, and S-curve in real time by using a Message Instruction or datalink (for details, see [Configure Datalinks on page 156](#)).

Output Datalinks required for dynamic acceleration control (see [Datalinks Output for Dynamic Acceleration Control](#)):

- Acceleration/Deceleration Control Switch
 - If 0, acceleration presets are used. You select which preset defined on Velocity Control is used, by setting bits AccelRefSelect_0...2.
 - If 1, then you enter the required values in the custom controller tags added to the end of devicename.0 structure in the Controller Tag tree, in the Logix Designer application.
- Dynamic Acceleration Time Reference [s]
- Dynamic Deceleration Time Reference [s]
- Dynamic S-Curve Reference [%]

Datalinks Output for Dynamic Acceleration Control

Datalinks Output

Data Type: AB:35_APF_Drive_36639:O:1 Remaining REAL Data Type: 1 Remaining BOOL Data Type: 7

To remove an attribute, click then apply changes. To change the order of the items press then drag and drop the item.

[Add Datalink](#)

Actions	Description	Data Type	Controller Tag Name
	Acceleration / Deceleration Control Switch	BOOL	EnableDynamicRampControl
	Dynamic Acceleration Time Reference [s]	REAL	DynamicAccelTime
	Dynamic Deceleration Time Reference [s]	REAL	DynamicDecelTime
	Dynamic S-Curve Reference [%]	REAL	DynamicSCurve

Optionally, you can go to the Datalinks Input tab and add input datalinks that can be used as feedback (values are actually used by the drive) (see [Datalinks Input for Dynamic Acceleration Control](#)):

- Actual Acceleration Time Reference used by drive [s]
- Actual Deceleration Time Reference used by drive [s]
- Actual S-Curve Reference used by drive [%]

Datalinks Input for Dynamic Acceleration Control

Datalinks Input

Data Type: AB:35_APF_Drive_36983:I:1 Remaining REAL Data Type: 1 Remaining BOOL Data Type: 8

To remove an attribute, click then apply changes. To change the order of the items press then drag and drop the item.

[Add Datalink](#)

Actions	Description	Data Type	Controller Tag Name
	Actual Acceleration Time Reference used by drive [s]	REAL	AccelTime
	Actual Deceleration Time Reference used by drive [s]	REAL	DecelTime
	Actual S-Curve Reference used by drive [%]	REAL	SCurve

Attribute	Description
Velocity	Sets the target velocity.
Acceleration Time	Sets the rate of acceleration for all speed increases except during a jog function. See Figure 86 for a graphic example.
Deceleration Time	Sets the rate of deceleration for all speed decreases except during a jog function. See Figure 86 for a graphic example.
S Curve	Sets the percentage of acceleration or deceleration time that is applied to ramp as an S curve. Half of the time is added at the beginning and half at the end of the ramp. See Figure 87 for a graphic example.

Figure 86 - Ramp Acceleration and Deceleration

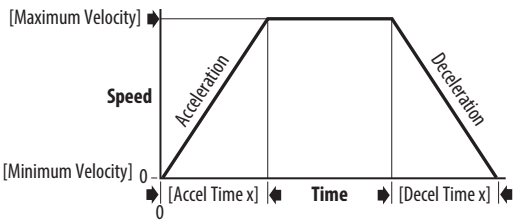
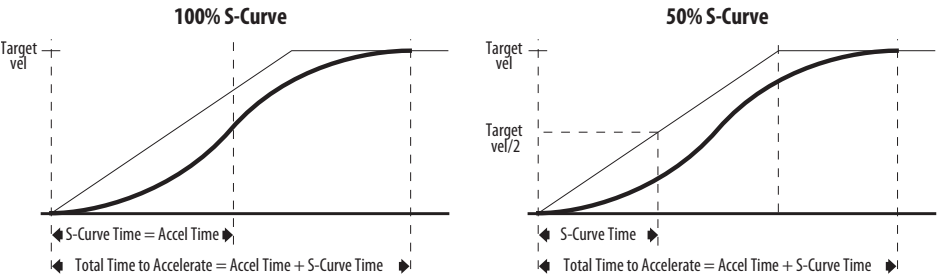


Figure 87 - S-Curve Examples



Output Frequency

- 5. Enter your minimum and maximum Output Frequency settings.

Output Frequency

Minimum Output Frequency

0.00

Hz

(0.00 - 500.00)

Maximum Output Frequency

60.00

Hz

(0.00 - 500.00)

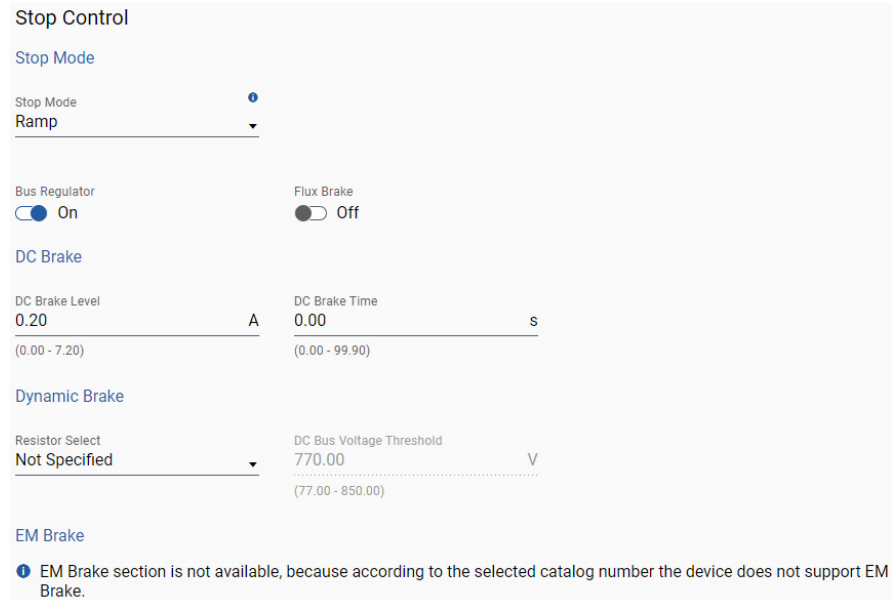


The values are actual frequency in Hz, not 100X the value.

Configure Stop Control

The Stop Control page includes attributes related to the stop control of the motor.

1. Click Stop Control.



Stop Control

Stop Mode

Stop Mode
Ramp

Bus Regulator
On

Flux Brake
Off

DC Brake

DC Brake Level
0.20 A
(0.00 - 7.20)

DC Brake Time
0.00 s
(0.00 - 99.90)

Dynamic Brake

Resistor Select
Not Specified

DC Bus Voltage Threshold
770.00 V
(77.00 - 850.00)

EM Brake

EM Brake section is not available, because according to the selected catalog number the device does not support EM Brake.

2. Choose a Stop Mode from the pull-down menu. See [Table 68](#). Your choice of Stop Mode can be also applied to different events, see [Configure Events on page 186](#).

Table 68 - Motor Stop Modes

Modes	Description
Coast	When a stop is initiated, power to the motor is immediately removed resulting in an uncontrolled stop.
Ramp (default)	When a stop is initiated, power to the motor is not interrupted, but the velocity is reduced to zero at a rate defined by the Deceleration Time. Power to the motor is not removed until zero velocity is achieved. This is a controlled stop.
DC Brake	When a stop is initiated, power to the motor is not interrupted, but a user configured amount of DC current is injected into the motor to produce a more rapid stop. After either a fixed period or when the velocity reaches zero, power to the motor is removed.

3. Enable or disable the Bus Regulator function.

The Bus Regulator reduces the Decel Rate as required to help prevent the DC Bus Voltage from increasing to the trip limit.



ATTENTION: The bus regulator function is useful to help prevent nuisance overvoltage faults that result from aggressive decelerations, overhauling loads, and eccentric loads. However, it can also cause either of the following two conditions to occur.

- Fast positive changes in input voltage or imbalanced input voltages can cause uncommanded positive speed changes
- Actual deceleration times can be longer than commanded deceleration times — (However, a Stall Fault is generated if the drive remains in this state for 1 minute. If this condition is unacceptable, Bus Regulator must be disabled. In addition, installing a properly sized dynamic brake resistor provides equal or better performance in most cases.)

4. Enable or disable the Flux Brake function.

The flux brake can be enabled for Ramp stop mode. It only applies to certain motor types, such as AC induction.

Flux Braking causes over fluxing of the motor which reduces the motor speed faster than just the decel ramp alone. This feature is not intended for high inertia loads because over fluxing can cause excessive heat in the motor. Very long decel times can create heat.

Configure DC Brake

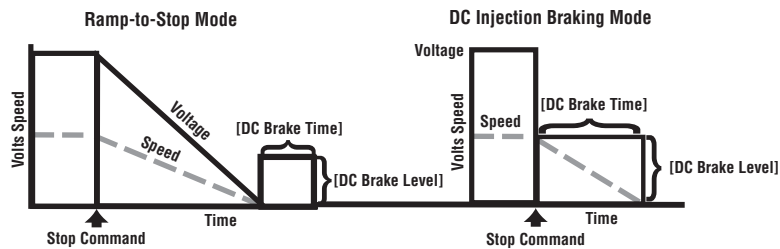
DC Brake attributes need to be adjusted when DC Brake is set for the Stop Mode or when the stop mode is Ramp to stop and DC Brake Injection is desired to hold the load in place for certain period of time after a ramped stop.

Attribute	Range	Description
DC Brake Level	0...30.6 ⁽¹⁾ A	This setting defines the maximum DC brake current, in Amps, applied to the motor when Stop Mode is set to Ramp to Stop or DC Brake Stop. See Figure 88 on page 180 .
DC Brake Time	0...99.9 s	This setting specifies the length of time that DC brake current is injected into the motor. See Figure 88 on page 180 .

(1) The maximum range value will vary based on the Drive Rating that is selected in the Device Definition.

Default values are drive rating dependent and listed in the Armor PowerFlex AC Drives CIP Objects and Attributes Reference Data, publication [35-RD001](#).

Figure 88 - DC Brake Example



ATTENTION: If a hazard of injury due to movement of equipment or material exists, a mechanical braking device must be used. This feature must not be used with synchronous or permanent magnet motors. Motors can be demagnetized during braking.




ATTENTION: Excess motor current and/or applied duration, could cause motor damage. Motor voltage can exist long after the Stop command is issued. The right combination of DC Brake Level and DC Brake Time must be determined to provide the safest, most efficient stop.

Configure Dynamic Brake

IMPORTANT Stop the drive before changing this setting.

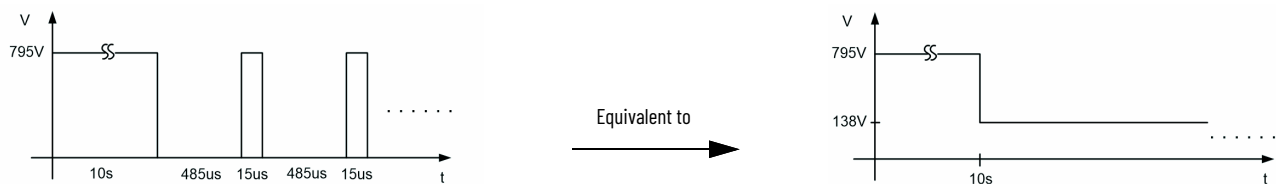
Choose a Resistor option that matches the physical Dynamic Brake connected to the Armor PowerFlex. When the External Light Duty or External Normal duty options are selected, the dynamic brake feature is enabled. Then, set the DC Bus Threshold Voltage.

IMPORTANT Frame size A drives (1...3 Hp) support the dynamic brake function. **Do not** use any type of brake resistor with frame size B drives (5...10 Hp) with firmware revision 2.001. You must update the firmware to revision 2.002 or higher, to enable an enhanced level of dynamic brake resistor protection.

	Value	Description
Dynamic Brake Resistor	Not Specified	Not used; no dynamic brake
	External Light Duty	3% duty cycle, for details see Light Duty Dynamic Brake Resistor Operation on page 181
	External Normal Duty	5% duty cycle, for details see Standard Duty Dynamic Brake Resistor Operation on page 181
DC Bus Voltage Threshold	77...850V DC 	If the DC bus voltage falls below the value set in this parameter, the Dynamic Brake does not turn on. Lower values make the Dynamic Braking function more responsive, but can result in nuisance Dynamic Brake activation. ATTENTION: Equipment damage can result if this parameter is set to a value that causes the dynamic braking resistor to dissipate excessive power. Parameter settings less than 770V DC should be carefully evaluated to confirm that the dynamic brake resistor's wattage rating is not exceeded. In general, values less than 700V DC are not needed. Do not set the parameter above 810V DC because it will cause a DC Bus Overvoltage error.

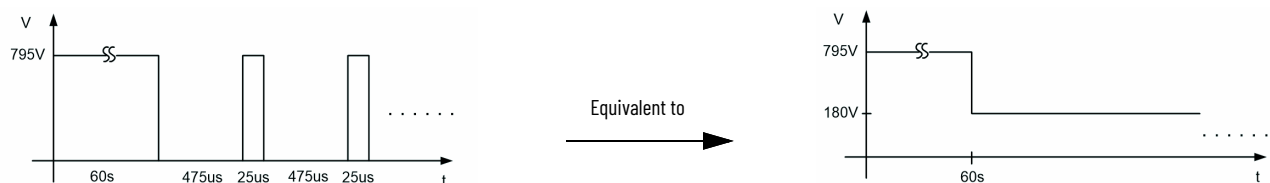
Light Duty Dynamic Brake Resistor Operation

When the light duty dynamic brake resistor is applied, the braking operation applies 100% duty cycle up to 10 seconds, followed by 3% duty cycle.




Standard Duty Dynamic Brake Resistor Operation

When the standard duty dynamic brake resistor is applied, the braking operation applies 100% duty cycle up to 60 seconds, followed by 5% duty cycle.



Configure Electromechanical Brake

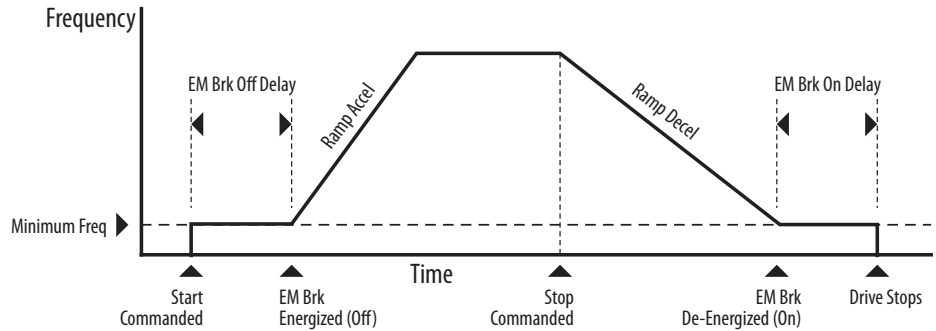
To configure the control setting of the Electromechanical brake (EMB or EM brake), choose a Control Mode for the EM brake from the pull-down menu. If choosing Automatic Control or Automatic or Manual Control, also set the Off Delay and On Delay, see [Figure 89](#).

Control Mode	Description																											
Disabled	The integrated EM brake contactor does not energize. Therefore, if the Armor PowerFlex drive is connected to a motor with an EM brake, it never releases.																											
Automatic Control (default)	The EM brake releases automatically, once the drive starts and the Brake Off Delay timer is satisfied. It engages automatically once the drive stops and the Brake On Delay timer is satisfied (see Figure 89). When the delay is set to 0, the brake releases once a valid start is detected by the drive and engages once a valid stop condition has been detected. If Source Brake Release Mode is set to Automatic, then the Stop Mode must be set to Ramp.																											
Automatic or Manual Control ⁽¹⁾	EM brake operation is based on the settings of output tag bits <i>devicename:0.EMBrakeAutoManCtrl</i> and <i>devicename:0.EMBrakeRelease</i> . The following table explains the bit settings and the EM brake state. For application examples, see Automatic or Manual Application Examples .																											
	<table><tr><th colspan="2">Device Output Tag Bit</th><th colspan="3">EM Brake State</th></tr><tr><th>EMBrakeAutoManCtrl</th><th>EMBrakeRelease</th><th>Manual Control Mode</th><th>Automatic Control Mode</th><th>Automatic or Manual Control Mode</th></tr><tr><td>1</td><td>1</td><td>Released</td><td rowspan="4">Engaged – when the motor control is stopped Released – when the motor control is started</td><td>Released</td></tr><tr><td>1</td><td>0</td><td>Engaged</td><td>Engaged</td></tr><tr><td>0</td><td>1</td><td>Engaged</td><td>Engaged – when the motor control is stopped Released – when the motor control is started</td></tr><tr><td>0</td><td>0</td><td>Engaged</td><td>Released – when the motor control is started</td></tr></table>	Device Output Tag Bit		EM Brake State			EMBrakeAutoManCtrl	EMBrakeRelease	Manual Control Mode	Automatic Control Mode	Automatic or Manual Control Mode	1	1	Released	Engaged – when the motor control is stopped Released – when the motor control is started	Released	1	0	Engaged	Engaged	0	1	Engaged	Engaged – when the motor control is stopped Released – when the motor control is started	0	0	Engaged	Released – when the motor control is started
	Device Output Tag Bit		EM Brake State																									
	EMBrakeAutoManCtrl	EMBrakeRelease	Manual Control Mode	Automatic Control Mode	Automatic or Manual Control Mode																							
	1	1	Released	Engaged – when the motor control is stopped Released – when the motor control is started	Released																							
	1	0	Engaged		Engaged																							
	0	1	Engaged		Engaged – when the motor control is stopped Released – when the motor control is started																							
	0	0	Engaged		Released – when the motor control is started																							
IMPORTANT	Ensure that <i>devicename:0.EMBrakeRelease</i> is in the correct state <i>BEFORE</i> the <i>devicename:0.EMBrakeAutoManCtrl</i> transitions from 0 to 1. A brake status bit is accessible for diagnostic purposes over the network.																											
You control if the EM brake is released or engaged based on the state of output bit <i>devicename:0>manualEMBrakeRelease</i> .																												
	ATTENTION: The Armor PowerFlex drive has no control over the EM brake in Controller Tag configuration. In Controller Tag mode, the programmable controller will control the EM brake. Precautions are required to ensure the EM brake is in the correct state at all times																											

(1) Requires drive firmware revision 2.00 or higher.

IMPORTANT Cycling the Logix Designer configuration from Automatic to Manual to Automatic, the bit state must be in a known state *BEFORE* a subsequent change to Manual.

Figure 89 - EM Brake Delay Timer Example



Automatic or Manual Application Examples

Example 1

- EM Brake Mode: Automatic or Manual
- EMBrakeAutoManCtrl = 0 [mode = automatic which is under drive control]
- Drive Run commanded 0 to 1
- EMBrakeRelease = 0 (brake engaged by default), the motor starts and the brake is disengaged automatically because of the mode setting
- Then, EMBrakeAutoManCtrl bit changes from 0 to 1 (Manual), motor still moves

- EMBrakeRelease bit changes from 0 to 1 [brake disengaged] brake engaged but drive is still running. The brake will cause excess current to generate which will like cause a fault which is logged on Faults & Alarms page.

Example 2

- EM Brake Mode: Automatic or Manual
- EMBrakeAutoManCtrl = 1 [mode = manual]
- Drive Run commanded 0 to 1
- EMBrakeRelease = 0 (default), the motor starts but the brake is still engaged
- The brake will cause excess current to generate which will like cause a fault which is logged on Faults & Alarms page

Click OK to exit the Stop Control page.

Configure Connections

Perform the steps in the following sections to configure your standard and safety output and input connections.

Standard Connection Settings

For standard connections, the drive uses unicast connections. With unicast, data is sent to one network device. For more information on unicast connections, see the Ethernet Reference Manual, publication [ENET-RM002](#).

1. To open the Connection page, click Connection in the Module Properties window of the Armor PowerFlex drive.

Connection

Standard

Request Packet Interv...
20.0 ms

(2.0 - 3200.0)

- ☒ Use Unicast connection over EtherNet/IP
- ☐ Inhibit Module*
- ☐ Major fault on controller if connection fails while in run mode*

2. Enter a value for the RPI rate for the Standard Connection.

	Default Setting	Range	Description
RPI Rate	20.0 ms	2...3200 ms	The RPI defines the slowest rate at which the drive produces input data to and consumes output data from the controller.

3. To Inhibit the connection check the check-box and click on the Apply or OK button. To Un-Inhibit the connection, uncheck the check-box and click on the Apply or OK button. The Inhibit Module check-box is unchecked by default.

The Inhibit Module check-box allows you to indefinitely suspend a connection, including Listen Only connections, between an owner-controller and a digital I/O module without removing the module from the configuration.

This process lets you temporarily disable a module, to perform maintenance.

IMPORTANT

You cannot inhibit a connection when the drive is safety-locked or a safety signature exists for the drive. This means that you cannot use the QuickStart procedure for editing the Armor PowerFlex drive.

4. Configure whether a drive connection failure, while the programmable controller is in Run mode, causes a major fault in the controller. Minor fault is the default.



The Module Fault area of the Connection page provides a fault description and error code for troubleshooting.

The connection between the owner and the Armor PowerFlex drive is based on the following:

- Armor PowerFlex drive safety network number (when there is a safety connection)
- Controller slot number

- GuardLogix safety controller safety network number (when there is a safety connection)
- Path from the controller to the Armor PowerFlex drive
- Armor PowerFlex drive configuration signature

If any differences are detected, the connection between the GuardLogix safety controller and the Armor PowerFlex drive is lost, and the yellow yield icon appears in the controller project tree after you download the program.

Safety Input and Output Connection Settings (safety variants only)

Safety I/O connections are unicast only.

Safety Output/Input Connection

		Requested Packet Interval		Reaction Time Limit		Max Observed Network Delay	
	Connection Type	Value (ms)	Range (ms)	Value (ms)	Action	Value (ms)	Action
	Safety Output	20		60	Edit		Reset
	Safety Input	10	3 - 500	40	Edit		Reset

On the connections page, follow these steps:

1. The RPI (Requested Packet Interval) for the Safety Input connection can be adjusted for the application. See the following table for additional information. The RPI for the Safety Output connection is a fixed value based on the period set for the safety task in the controller.

	Default Setting	Range	Description
RPI Rate	10.0 ms	3...500 ms	The RPI defines the slowest rate at which a module sends its data to the owner-controller. The time is sent to the module with all other configuration parameters. When the specified time frame elapses, the module sends data.

2. The Reaction Time Limit for the Safety Input and the Safety Output can be adjusted for the application. Click Edit to open the Connection Reaction Time Limit window.

Connection Reaction Time Limit ✕

Safety Output Connection Reaction Time Limit

Requested Packet Int...
20 ms
Set by Safety Task

×

Timeout Multiplier
2
(1 - 4)

+

Network Delay Multiplier
200 %
(10 - 600)

- 1

= 60 ms

[OK](#) [Cancel](#)

3. Enter values for the Timeout Multiplier and Network Delay Multiplier for both the Safety Output and Safety Input. These values are combined in a formula with the RPI, to calculate the Connection Reaction Time Limit. When you select appropriate RPIs, the system has maximum performance.

	Default Setting	Range	Description
Timeout Multiplier	2	1...4	To determine what is appropriate, analyze each safety channel. The default Timeout Multiplier of 2 and Network Delay Multiplier of 200 creates a worst-case input connection-reaction time limit of 4 times the RPI, and an output connection-reaction time limit of 3 times the RPI.
Network Delay Multiplier	200%	10...600%	The Connection Reaction Time Limit sets the maximum age of safety packets on the associated connection. If the age of the data that is used by the consuming device exceeds the connection reaction time limit, a connection fault occurs.

IMPORTANT Changes to these settings must be approved only after a thorough review by a safety administrator.

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- After the values are entered, click OK to close the Connection Reaction Time Limit window.

A connection status tag, called `ConnectionFaulted`, exists for every connection. If the RPI and connection reaction time limit for the network are set appropriately, then this status tag must always remain low. Monitor all connection status bits to verify that they are not going high intermittently due to timeouts. This could be caused by a network issue and could be used as an Ethernet troubleshooting diagnostic.

For more information about the Connection Reaction Time Limit, see the user manual for your safety controller.

Configure Standard I/O Points

Follow these steps to configure the standard I/O points.

- From the Configuration menu, choose Input/Output Configuration.

Input/Output Configuration

Input Configuration

		Input Delay Time (ms)		
	Point	Off → On	On → Off	Range
	0	5	5	0 - 65535
	1	5	5	0 - 65535
	2	5	5	0 - 65535
	3	5	5	0 - 65535

Input/Output Configuration ⓘ

		Input Configuration			Output Configuration		
		Delay Time (ms)			Connection		Product
	Point	Off → On	On → Off	Range	Idle Action	Fault Action	Fault Action
	0	5	5	0 - 65535	On ▼	On ▼	On ▼
	1	5	5	0 - 65535	On ▼	On ▼	On ▼

- Assign the Input Delay Time, Off→On (0...65,535 ms). The default value is zero.
Delay time is for Off to On transition. Input must be high after input delay has elapsed before it is set logic 1. This delay time is configured per channel with each channel tuned to match the characteristics of the field device, for maximum performance.
- Assign the Input Delay Time, On→Off (0...65,535 ms). The default value is zero.
Delay time is On to Off transition. Input must be low after input delay has elapsed before it is set logic 0. This delay time is configured per channel with each channel tuned to match the characteristics of the field device, for maximum performance.

If using the configurable I/O points as inputs, define an Off→On and On→Off delay time as described previously in [step 2](#) and [step 3](#).

If using the configurable I/O points as outputs, the action that the output should take when one of the conditions listed below is detected, can be configured to On, Off, or Hold.

- Idle Action - Idle Network Connection to the Armor PowerFlex drive
 - Fault Action - Fault Network Connection to the Armor PowerFlex drive
 - Product Fault Action - Armor PowerFlex Fault
- Click OK to close the Connection page.

IMPORTANT

To operate properly, standard outputs require a minimum load of 10 mA, otherwise an over/under current error will occur.

Configure Events

Events configuration allows you to choose a result for a specific event. Your available events to configure will vary, depending on which firmware revision is selected, see [Configure the Device Definition on page 154](#).

Events

Name – Firmware Revision 1	Name – Firmware Revision 2
Output Phase Loss	Output Phase Loss
Brake Undercurrent, Hard	Brake Undercurrent, Hard
Load Monitor, Above Level (Shear Pin)	Load Monitor, Above Level (Shear Pin)
Load Monitor, Below Level (Load Loss)	Load Monitor, Below Level (Load Loss)
Underspeed, Hard ⁽¹⁾	
Overspeed, Hard ⁽¹⁾	
State Discrepancy ⁽¹⁾	

(1) This event applies to the fan.

Choose from the available Type selections in [Table 69](#), to configure each event.

Table 69 - Event Type Configuration

Type	Description
Fault	Fault may cause immediate damage and always stops the motor. It must be cleared, otherwise the motor cannot be restarted. If the event type is set to Fault, then you must configure how the drive stops the motor. You can either specify a Stop Mode for each event (see Table 70) or use the same Stop Mode that is used when the drive receives a stop command from the controller (Active Stop Mode option, see Configure Stop Control on page 179).
Alarm - start inhibit	Alarm - start inhibit does not stop the motor. The condition that triggered the alarm must be resolved, otherwise the motor cannot be restarted.
Alarm - inform	Alarm - inform does not stop the motor. It may cause long term damage if the alarm condition is not resolved.
Information	Information notifies you about state of the drive.
Disabled	Disables the event. There is no corresponding event that is visible on the Faults and Alarms page.

If the event type is Fault, choose from the available Stop Mode selections in [Table 70](#), to configure each stop mode.

Table 70 - Motor Stop Configuration

Stop Mode	Description
Coast	The motor comes to rest on its own; it is not a controlled stop.
Ramp	Ramp stops the motor after specified time.
DC Brake	DC Brake provides rapid motor stop by DC current injection.
Activate Stop Mode	Active Stop Mode stops the motor using the mode specified on the Stop Control page. See Configure Stop Control on page 179 .



Stop mode is used only when event type is set to Fault. Otherwise the configuration is ignored by the drive.

Configure Safety Functions (safety version)

Safety configuration includes the following pages:

- Safety Configuration
- Safety Feedback – (only available with an encoder)
- Scaling – (only available with an encoder)
- Safe Torque Off (STO)
- Safe Brake Control (SBC)
- Safe Stop 1 (SS1)
- Test Output

- Input Configuration
- Output Configuration
- Actions

Safety Configuration Reset Ownership

For information, see [Reset Ownership on page 97](#).

Configure Safety Feedback

Configure feedback if you intend to use any drive-based or controller-based safety function that monitors motion. There are many different combinations of feedback for velocity control and safety that can be configured.



Safety Feedback only appears when Single Feedback Monitoring is selected as the Safety Instance in the Device Definition.

Follow these steps to configure the Primary Feedback.

1. Select the Safety Feedback page.

Safety Feedback

Electrical Interface Type*
Digital Incremental, Dual Cha... ▾

Polarity Normal ▾	Voltage Monitor Not Monitored ▾
----------------------	------------------------------------

Cycle Resolution 0 Cycles/Rev (0 - 999999999)	Cycle Interpolation* 4 Counts/Cycle	Effective Resolution 0 Counts/Rev
---	--	--------------------------------------

Velocity Average Time 0 ms (0 - 65535)	Maximum Speed 0.000 Rev/s (0 - 999999999.000)	Standstill Speed 0.000 Rev/s (0 - 999999999.000)
--	---	--

Acceleration Average Time 0 ms (0 - 65535)	Maximum Acceleration 0.000 Rev/s² (0 - 999999999.000)
--	---

2. Enter your Safety Feedback attributes.

Attribute	Description	Value
Electrical Interface Type	Select your type of feedback device.	Disabled safety feedback - not specified (default)
		Digital Incremental - Sine/Cosine
		Dual Channel, Differential {aka. Digital AqB}
		Generic Sine Cosine Hiperface
Polarity	Defines the direction of counting versus the direction of motion. <ul style="list-style-type: none">Normal means counts increase when motion is in the positive direction.Inverted means that counts decrease when motion is in the positive direction.	Normal (default)
		Inverted
Voltage Monitor	Selects monitoring of voltage that is supplied to power the feedback.	Not Monitored (default)
		4.75...5.25V
		11.4...12.6V
Cycle Resolution	Defines the number of Cycles per Unit. The unit is typically meters for linear devices and revolutions for rotary devices.	cycles/rev
Cycle Interpolation	Defines the number of position Counts per Cycle.	counts/cycle
Effective Resolution	Defines the number of position Counts per Unit.	counts/rev
Velocity Average Time	Specifies the time period over which to average Feedback Velocity. Select 0 to disable averaging.	0 ms (default)
		0...1000 ms
Maximum Speed	Defines the maximum allowable speed. Exceeding this speed causes a fault. Select 0 to set no maximum speed.	0 rev/s (default)
		# rev/s
Standstill Speed	Defines the speed below which motion is considered stopped. Feedback Velocity above standstill speed will set either Motion Negative or Motion Positive attributes to 1.	0 rev/s (default)
		# rev/s
Acceleration Average Time	Specifies the time period over which to average Feedback Acceleration. Select 0 to disable averaging.	0 ms (default)
		0...1000 ms
Maximum Acceleration	Defines the maximum allowable acceleration. Exceeding this acceleration causes a fault. Select 0 to set no maximum acceleration.	0 rev/s ² (default)
		# rev/s ²

Configure Scaling

The scaling page lets you configure the position and time to be used in terms of counts per position unit (defined by the user) in the safe monitoring functions. It defines “Actual Speed” and “Actual Position” that is used to match the velocity controller.

Scaling

Effective Resoluti...

0

Counts/Rev

Position Units

Position Units

Max. 30 characters

Time Units

Seconds

Position Scaling

1.000

Counts/1.0 Position Units

(0.000 - 999999999.000)

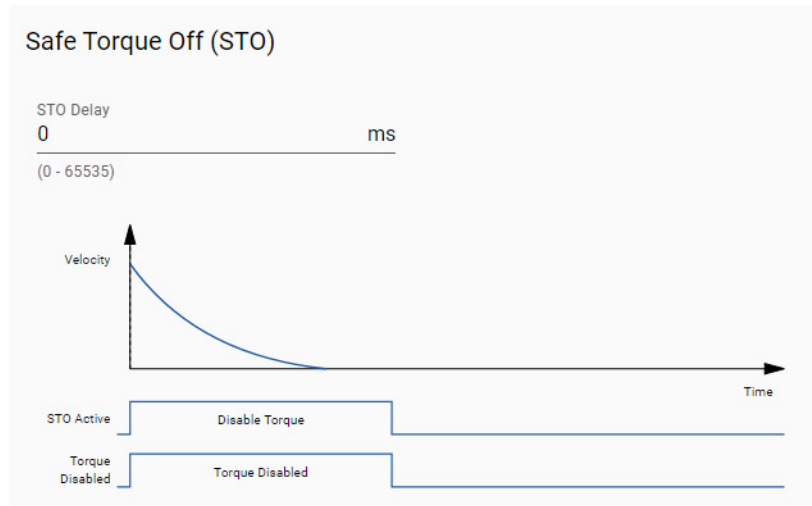
Select Scaling and enter the safety scaling attributes per the following table.

Attribute	Description
Effective Resolution	The number of counts per motor revolution, which is determined by the Primary Feedback category.
Position Units	The position units for this safety application. Enter text for the name of your units.
Time Units	The evaluation of position per unit of time for a velocity evaluation. Choose between Seconds (default) and Minutes, as appropriate for your application.
Position Scaling	The conversion constant showing the counts per position units. This is the number of counts for one of your position units.

Configure Safe Torque Off

From the Safety Configuration menu, choose Safe Torque Off (STO).

The STO function can be configured to delay when torque is disabled, by entering an STO Delay value. To see how STO Delay affects operation, see [Safe Torque Off Delay](#) and [Safe Torque Off Operation on page 107](#).



STO Active command becomes active if any of the following inputs to STO are asserted:

- STO Output = 0
- Safety Connection is Loss and Connection Loss Action = STO
- Safety Connection is Idle and Connection Idle Action = STO
- Drive-based SS1 Function is Complete (= 1)
- Safety Stop Fault = 1
- Critical Safety fault occurs

STO Output is a tag in the safety output assembly of the Armor PowerFlex drive that is used to activate the STO function for the drive. When any source for STO is asserted, the STO Active bit becomes high to indicate that the STO function is operating.

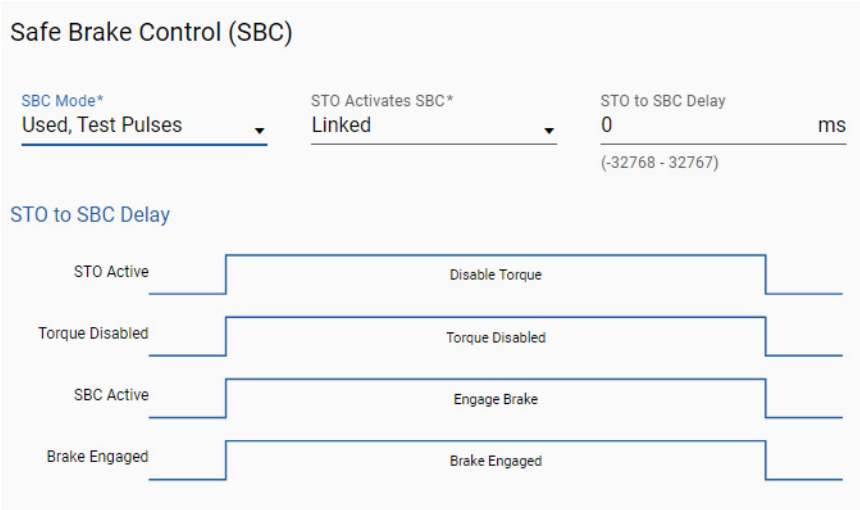
STO Delay follows this sequence of events.

1. STO becomes active and the STO delay timer begins.
2. The STO delay timer expires.
3. Torque producing power is removed from the inverter output.
 - If STO is activated by a Safety Stop fault or Critical Safety fault, torque is removed immediately without the STO delay.
 - If STO is reset by removing all inputs that cause the STO Active command to be true, torque is immediately permitted without delay.

Configure Safe Brake Control (SBC)

From the Safety Configuration menu, choose Safe Brake Control (SBC).

SBC is configured when Safe Brake Control functionality is desired in an application.



The default mode for SBC is 'Not Used'. If the SBC functionality is desired, setting the mode to 'Used', 'Test Pulses', or setting the mode to 'Used, No Test Pulses', will enable the SBC function. When configured for 'Used, Test Pulses mode', pulse testing of the physical brake outputs are performed. For more information on the drive-based SBC function, see [Safe Brake Control Function on page 115](#).

See [Table 71](#) for descriptions of the SBC attributes.

Table 71 - SBC Attributes

Attribute	Description
STO Activates SBC	Determines if an STO event engages the brake. If set to 'Not Linked', an STO event does not engage the brake. If set to 'Linked', the brake is engaged during an STO event based on the 'STO to SBC Delay' attribute. This attribute is only valid when the 'Mode' is set to one of the two 'Used' options.
STO to SBC Delay	The delay of brake engagement in milliseconds. If the value is a positive number, the delay specifies the time between when STO is activated and the brake is engaged. If the value is a negative number, the brake is engaged immediately after STO is activated, and the delay specifies the time between STO activation and when torque is actually disabled. This attribute is only valid when 'STO Activates SBC' is set to 'Linked'.

IMPORTANT Safety Output is used for SBC control. To configure the SBC, the Safety Bipolar Outputs need to be set to Not Used in the Configure Safety Output. See [Configure Safety Outputs on page 194](#).

Configure Safe Stop 1

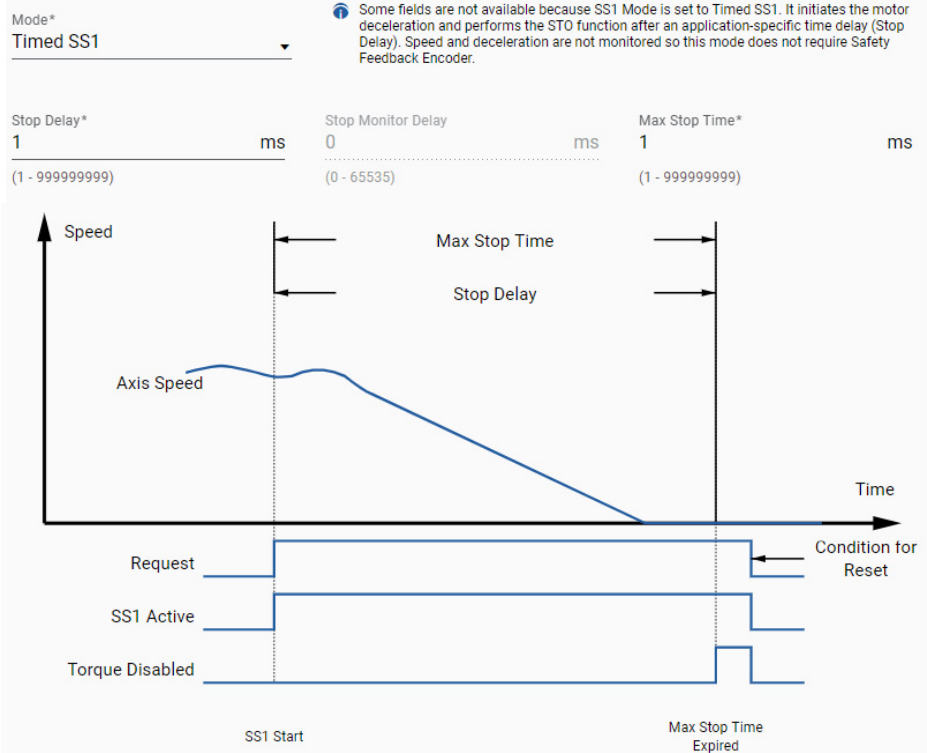
From the Safety Configuration menu choose Safe Stop 1 (SS1).

SS1 is configured when a Timed or Monitored Safe Stop 1 condition is desired.

'Timed SS1' mode is available when the module is configured with or without safety feedback monitoring. The 'Monitored SS1' mode is only available when the module Safety Instance in the Device Definition is configured for single feedback monitoring (for more information on the drive-based Safe Stop 1 function, see [Safe Stop 1 Function on page 110](#).)

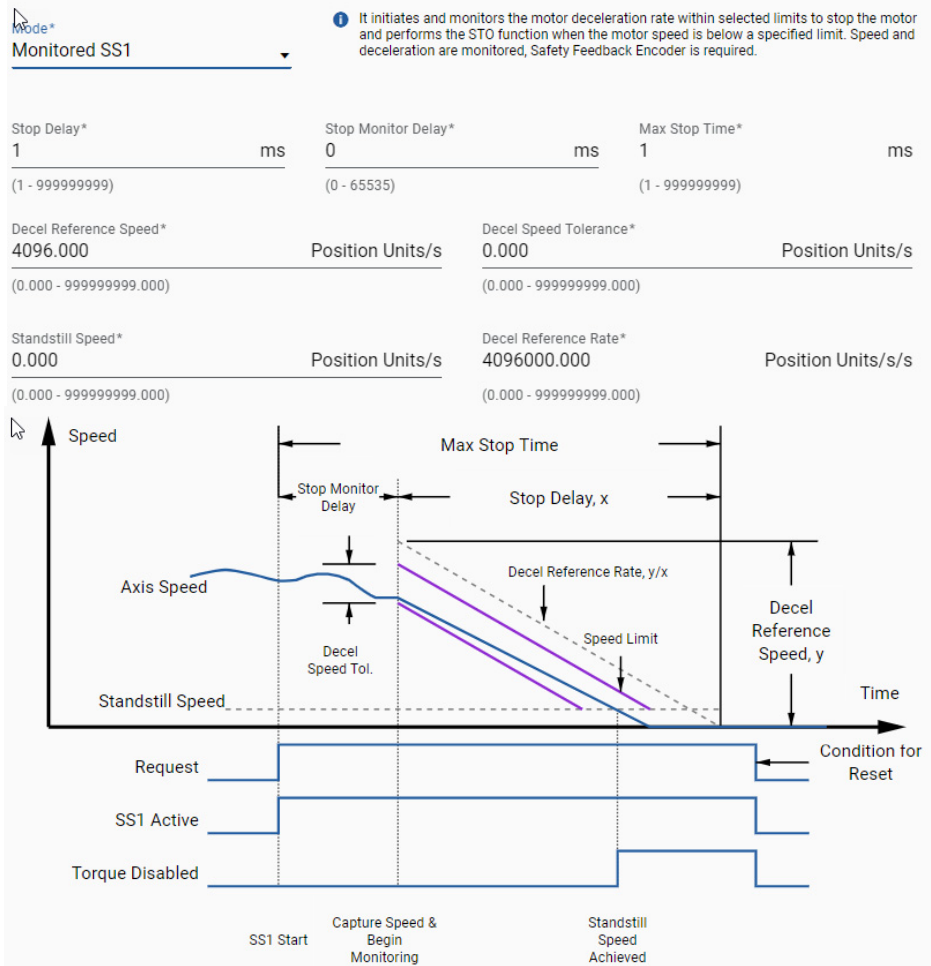
Timed SS1 is a fixed time for the motor to stop before removing torque. Motor feedback is not monitored. 'Stop Delay' is the only parameter that is used for 'Timed SS1' and determines the 'Max Stop Time'.

Safe Stop 1 (SS1)



Monitored SS1 is a ramped safe-stop where the motion safety instance monitors the speed ramp to standstill speed, while the drive controls the deceleration to standstill speed. When standstill is reached, the motion safety instance removes torque from the motor.

Safe Stop 1 (SS1)



Configure these settings:

Property	Description
Mode	Specifies the mode of the SS1 function. The Mode selection determines which attributes on the tab are available to configure. The available options are: <ul style="list-style-type: none"> Not Used Timed SS1 Monitored SS1 Monitored SS1 is unavailable when the Safety Instance on the Device Definition window is set to 'Safe Stop, Only'.
Stop Monitor Delay	The delay time before deceleration is monitored. Valid values are 0...65535. This option is not available when 'Mode' is 'Timed SS1'.
Stop Delay	The stop delay time used when the SS1 function is initiated by a stop type condition.
Max Stop Time	Displays the SS1 maximum stop time. This value is the sum of 'Stop Delay' and 'Stop Monitor Delay'.
Decel Reference Speed	Specifies the deceleration speed to monitor for SS1. This parameter is unavailable when 'Mode' is 'Timed SS1'.
Decel Reference Rate	The minimum rate of deceleration while stopping. Changing the Stop Delay value recalculates the Decel Reference Rate. This parameter is unavailable when 'Mode' is 'Timed SS1'.
Decel Speed Tolerance	The speed tolerance that is applied to the deceleration ramp check.
Standstill Speed	The speed limit that is used to declare motion as stopped.

Configure Safety Inputs

Follow these steps to configure the safety inputs.

1. From the Safety Configuration menu, choose Input Configuration.

Input Configuration

		Point Operation					Input Delay Time (ms)		
	Point	Type	Discrepancy Time (ms)	Range	Point Mode	Test Source	Off → On	On → Off	Range
❶	0	Single Channel ▼	100	0 - 65535	Not Used	None	0	0	0 - 65535
❷	1				Not Used	None	0	0	0 - 65535
❸	2	Single Channel ▼	100	0 - 65535	Not Used	None	0	0	0 - 65535
❹	3				Not Used	None	0	0	0 - 65535

❶ Test Source value corresponds to the Point value on Test Output page.

Input Error Latch Time
1000 ms
(0 - 65535)

2. In the Input Configuration dialog box, assign the Point Operation Type. See [Table 72](#).

Table 72 - Point Operation Types

Type	Description
Single Channel	Inputs are treated as single channels. Dual-channel safety inputs can be configured as two individual single channels. This configuration does not affect pulse tests because it is handled on an individual channel basis. IMPORTANT: Use single-channel mode when you intend to use the GuardLogix safety application instructions.
Dual Channel Equivalent	Inputs are treated as a dual-channel pair. The channels must match within the discrepancy time or an error is generated.
Dual Channel Complementary	Inputs are treated as a dual-channel pair. They must be in opposite states within the discrepancy time or an error is generated.

3. When you choose Dual Channel Equivalent or Dual Channel Complementary, you must also consider the Discrepancy Time. A Discrepancy Time of 0 ms disables the discrepancy check. The Discrepancy Time accepts values of 0...65535 in increments of 1 ms.

IMPORTANT Configuring discrepancy time on Armor PowerFlex safety inputs masks input discrepancies that are detected by the controller safety instructions. The controller reads status to obtain this fault information.

4. Assign the Point Mode. See [Table 73](#).

Table 73 - Input Point Modes

Point Mode	Description
Not Used	The input is disabled. If 24V is applied to the input terminal, it remains logic 0.
Used as Standard Input	The input point is enabled and performs as a Standard Input. The associated Test Output can be used to provide 24V DC power supply but it has to be configured for Power Supply.
Used with Test Output	The input point is enabled and performs a pulse test on the input. When the input is energized, the input pulses low briefly. The pulse test detects whether the input is functioning properly. Verify that the associated Test Output is set to Pulse Test.
Used without Test Output	The input point is enabled and does not perform a pulse test on the input.

When the input Point Mode is Used With Test Output:

- Test Output 0 is associated with safety inputs 0 and 2.
- Test Output 1 is associated with safety inputs 1 and 3.

5. Assign the Input Delay Time, Off to On (0...65,535 ms, in increments of 1 ms). The default is 0 ms.
Filter time is for Off to On transition. Input must be high after input delay has elapsed before it is set logic 1. This delay time is configured per channel with each channel tuned to match the characteristics of the field device, for maximum performance.
6. Assign the Input Delay Time, On to Off (0...65,535 ms, in increments of 1 ms). The default is 0 ms.
Filter time is On to Off transition. Input must be low after input delay has elapsed before it is set logic 0. This delay time is configured per channel with each channel tuned to match the characteristics of the field device, for maximum performance.
7. From the Input Error Latch Time field, enter the time that the module holds an error to make sure that the controller can detect it (0...65,535 ms, in increments of 1 ms - default 1000 ms).
This setting provides more accurate diagnostics. The purpose for latching input errors is to make sure that intermittent faults that can exist only for a few milliseconds are latched long enough for the controller to read. The amount of time to latch the errors are based on the RPI, the safety task watchdog, and other application-specific variables.
8. Click Apply.

Configure Test Outputs

If you have configured safety inputs to use a test output, follow these steps to configure the test outputs:

1. From the Safety Configuration menu, choose Test Output.

Test Output		
	Point	Point Mode
	0	Not Used ▼
	1	Not Used ▼

2. In the Test Output dialog box, assign a point mode. See [Table 74](#).

Table 74 - Test Output Configuration

Point Mode	Description
Not Used	The test output is disabled.
Test Pulse Output	Used to test a safety input for short circuit detection.
Power Supply Output	Test output is configured for power supply.

For test output specifications, see [Test Output Specifications on page 145](#).

Configure Safety Outputs

The dual channel mode features bipolar safety outputs which must be configured the same. The Armor PowerFlex drive treats the outputs as a pair and sets them high (1) or low (0), as a matched pair.



Output configuration is not available when Safe Brake Control (SBC) is enabled.

Safety logic must set both of these outputs On or Off simultaneously or the module declares a channel fault.

Follow these steps to configure the safety outputs.

1. From the Safety Configuration menu, choose Output Configuration.

Output Configuration

i Output Configuration is not available when Safe Brake Control is enabled.

	Point	Point Operation Type	Point Mode
i	0	Dual Channel	Not Used
i	1		

Output Error Latch Time
1000 ms
(0 - 65535)

2. Assign the Point Mode. See [Table 75](#).

Table 75 - Safety Output Point Mode

Point Mode	Description
Not Used	The output is disabled.
Used without Test Pulses	The output point is enabled and does not perform a pulse test on the output.
Used with Test Pulses	The output point is enabled and performs a pulse test on the output. When the output is energized, the output pulses low briefly. The pulse test detects whether the output is functioning properly.

3. Enter the Output Error Latch Time.

Attribute	Description
Output Error Latch Time	Specifies the amount of time in milliseconds an Output error will be latched. If the error is no longer present after this time, the error condition can be reset.

Configure Safety Listen Only Connection

The Armor PowerFlex drive supports an additional safety input, listen only connection, which allows for a separate safety controller to be configured to receive the safety input assembly data from the Armor PowerFlex drive. This can be used to receive safety status data to coordinate between safety systems.

See [Table on page 203](#) for information on mapping the listen only connection input data tags to the safety input data tags.

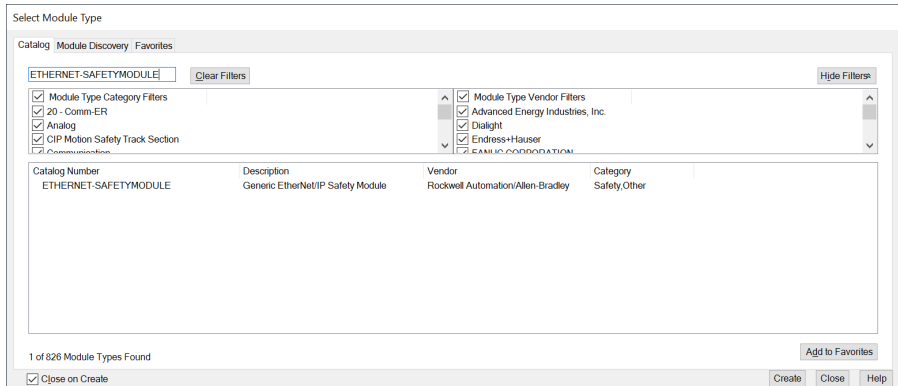
IMPORTANT

The listen only connection requires that the safety device has initially been configured through the Armor PowerFlex Add on Profile configuration for a standard and safety or safety only connection. The configuring connection and listen only connection must be in separate controllers.

Add Safety Listen Only Connection

The safety listen only connection is configured through the Generic EtherNet/IP Safety page in Studio 5000.

1. In the New Module Menu, select the ETHERNET-SAFETYMODULE profile and click Create.

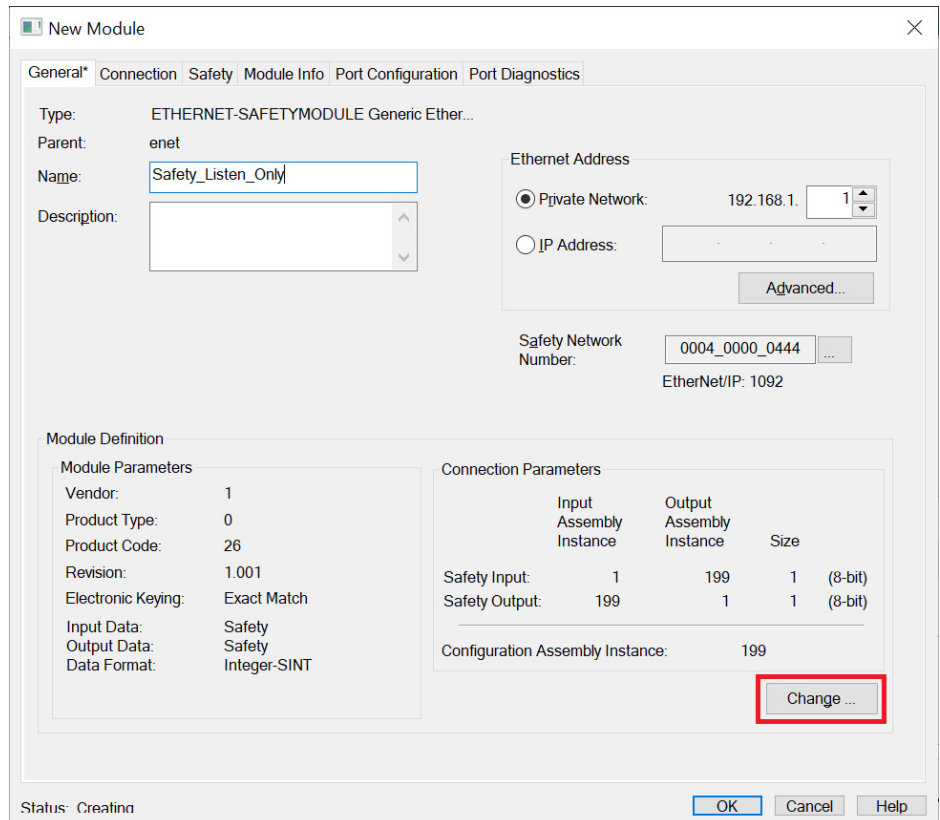


2. Enter the Name and Ethernet Address fields in the New Module creation page. The Ethernet Address should match the address of the desired Armor PowerFlex device that you want to receive safety status information from.
3. Enter the Safety Network Number (SNN). The SNN field needs to match the SNN set by the controller which owns the safety connection. You can determine this from the Armor PowerFlex Device Definition page. See [Configure the Device Definition on page 154](#) for more information.



The safety network number can also be determined by a get attribute single CIP message to class 0xF5, instance 1, attribute 7.

4. Click Change, under the Connection Parameter fields.



5. Configure the following values in the Module tab in the Module Definition page, as shown.

Module Definition

Module Connection

Vendor:	1
Product Type:	170
Product Code:	2
Major Revision:	2
Minor Revision:	1

Electronic Keying: Exact Match

Input Data:	Safety
Output Data:	None
Data Format:	Integer-SINT

The disabled controls cannot be changed while online.

OK Cancel Help

6. Click the Connection tab in the Module Definition page and configure the information as shown.

Module Definition

Module Connection

	Input Assembly Instance	Output Assembly Instance	Size (8-bit)
Safety Input:	1024	199	15

Configuration Assembly Instance: 100

OK Cancel Help

7. Click OK on the Module Definition page, then click OK on the New Module page, to finish creating the safety listen only connection profile.

Configure Safety Actions

Use the settings on the Actions page to:

- Define the action to take when the safety connection is lost.
- Define the action to take when the safety connection goes idle.
- Define the restart and cold start behavior.

Restart is the restart behavior while operating. A cold start is the restart behavior when applying controller power or controller mode changes to 'Run'.

Follow these steps to configure the safety actions.

1. From the Safety Configuration menu, choose Actions

Actions to Take Upon Conditions

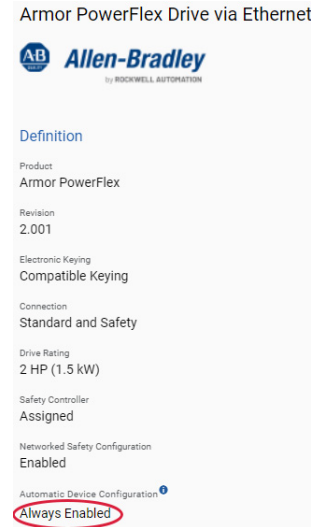
2. Choose the safety action values. See [Table 76](#).

Table 76 - Safety Action Value Descriptions

Attribute	Description	Values	Description
Connection Loss Action	<ul style="list-style-type: none"> • Connection loss is caused by removal of the Ethernet cable from the drive. • The loss could also be an indication of excessive traffic, causing the drive to lose synchronization to the grandmaster clock controller. 	SS1	Drive-based Safe Stop 1 function is initiated and operates according to the SS1 configuration.
		STO	Torque is removed according to the STO configuration.
Connection Idle Action	Connection idle is caused by the safety output task becoming disabled because the controller goes from run to Remote Program mode.	SS1	Drive-based Safe Stop 1 function is initiated and operates according to the SS1 configuration.
		STO	Torque is removed according to the STO configuration.
Restart Type	Restart type means that the safety function resets and will be ready for subsequent operation when the reset conditions are met. See specific function for more detail.	Automatic	Restart automatically allowed after safety function completes and function request is removed. If restart is required due to a fault, a manual restart must be performed.
		Manual	Restart is allowed after removing any faults if present, disabling the safety function request tag, and a 0->1 transition of S0.ResetRequest bit.
Cold Start Type	Cold start type means that the configured safety function is ready for operation immediately after the controller enters run mode.	Automatic	Restart allowed after safety function completes and function request is removed. If restart is required due to a fault, the fault condition must also be removed.
		Manual	Restart is allowed after a 0->1 transition of S0.ResetRequest bit.

Using Automatic Device Configuration

Automatic Device Configuration (ADC) supports the automatic download of drive configuration data. It is always active in the drive and cannot be disabled.



Drive configuration settings are stored in the Logix controller. With ADC, the Logix controller automatically downloads the configuration settings for a particular drive each time the Logix controller connects to the Armor PowerFlex drive.



ATTENTION: Logix holds the Master copy of the drive configuration.

ADC is triggered any time the Armor PowerFlex drive detects a configuration signature mismatch when establishing an EtherNet/IP network I/O connection.

No other configuration tools are supported. Any Armor PowerFlex drive configuration changes must be made by editing the Module Properties in the Logix Designer project.

Auto-generated Tags

After you configure the Armor PowerFlex drive, the drive tags are generated for standard and safety inputs and outputs. The data from the input (produced) and output (consumed) assemblies is used as descriptive tag names to simplify programming.

To find the status of the configurable I/O, see [Configurable I/O Operation on page 89](#).

IMPORTANT

Review the CONNECTION_STATUS Data section of the GuardLogix 5580 and Compact GuardLogix 5380 Controller Systems Safety Reference Manual, publication [1756-RM012](#), for information on how to use the connection status tags.

Table 77 - Standard Input Tags

Input Tag	Function
DeviceName.I.DriveStatus	Bitmask of status bits below
DeviceName.I.Ready	0 = Motor control is not ready to run (see run inhibits for details) 1 = Motor control is ready to run, there is nothing blocking a run request
DeviceName.I.Running	0 = Motor control is not running, no power output to motor 1 = Motor control is running, power is being output to the motor
DeviceName.I.CommandedDirection	0 = Current commanded direction is reverse 1 = Current commanded direction is forward
DeviceName.I.ActualDirection	Indicates the actual direction of motion when Running = 1, not valid if Running = 0 0 = Actual direction of motion is reverse 1 = Actual direction of motion is forward

Table 77 - Standard Input Tags

Input Tag	Function
DeviceName.I.Accelerating	Set to 1 if motor control is accelerating (increasing velocity) to achieve velocity reference
DeviceName.I.Decelerating	Set to 1 if motor control is decelerating (decreasing velocity) due to a stop or to achieve velocity reference
DeviceName.I.AtReferenceSpeed	Set to 1 if motor control is running and the current velocity is the velocity reference
DeviceName.I.Fault	Set to 1 if there is an unacknowledged fault present
DeviceName.I.SafetyIn0Monitor	Safety input 0 state, 0 = off, 1 = on (35S only)
DeviceName.I.SafetyIn1Monitor	Safety input 1 state, 0 = off, 1 = on (35S only)
DeviceName.I.SafetyIn2Monitor	Safety input 2 state, 0 = off, 1 = on (35S only)
DeviceName.I.SafetyIn3Monitor	Safety input 3 state, 0 = off, 1 = on (35S only)
DeviceName.I.SafetyOutMonitor	Safety output 0 (bipolar output) state, 0 = off, 1 = on (35S only)
DeviceName.I.SafeTorqueEnabled	Set to 1 if the safety logic is permitting torque (power output to motor), else 0 (35S only)
DeviceName.I.SafetyFault	Set to 1 if there is a safety specific fault present (35S only)
DeviceName.I.In_0	Standard input 0 state, 0 = off, 1 = on
DeviceName.I.In_1	Standard input 1 state, 0 = off, 1 = on
DeviceName.I.In_2	Standard input 2 state, 0 = off, 1 = on
DeviceName.I.In_3	Standard input 3 state, 0 = off, 1 = on
DeviceName.I.IO_0	Self-configuring I/O point 0 state when used as an input, 0 = off, 1 = on
DeviceName.I.IO_1	Self-configuring I/O point 1 state when used as an input, 0 = off, 1 = on
DeviceName.I.KeypadButtonF0	State of front panel keypad button F0 (Local/Auto), 0 = not pressed, 1 = pressed
DeviceName.I.KeypadButtonF1	State of front panel keypad button F1 (Forward/Reverse), 0 = not pressed, 1 = pressed
DeviceName.I.KeypadButtonF2	State of front panel keypad button F2 (Jog), 0 = not pressed, 1 = pressed
DeviceName.I.KeypadHandMode	Set to 1 if the front panel keypad is in the local state (it is in control of the motor)
DeviceName.I.ThreePhaseACPowerPresent	Set to 1 if there is 3-phase AC power detected on the power input connector
DeviceName.I.DisconnectClosed	State of the AC power disconnect switch, 0 = open/off, 1 = closed/on
DeviceName.I.EMBrakeReleased	Set to 1 if the EM brake is released (energized), else 0
DeviceName.I.Alarm	Set to 1 if there is an active alarm condition present
DeviceName.I.OutputFrequency	Frequency of the output to the motor, in hertz
DeviceName.I.OutputVoltage	Voltage of the output to the motor, in volts, AC
DeviceName.I.OutputCurrent	Current being output to the motor, in amps
DeviceName.I.OutputPower	Power being output to the motor, in kilowatts
DeviceName.I.DCBusVoltage	Voltage of the internal DC bus, in volts, DC
DeviceName.I.DriveHeatsinkTemperature	Temperature of the motor output heatsink, degrees Celsius
DeviceName.I.EncoderCounts	Raw encoder (feedback device) counts ⁽¹⁾
DeviceName.I.MotorOverloadLevel	Motor thermal overload level as a percentage (0% to 100%)
DeviceName.I.TripFaultCode	Fault / event code of the first fault that caused the device to enter the faulted state, 0 if no unacknowledged faults present
DeviceName.I.CurrentVelocity	Current estimated or measured velocity of the motor, valid if Running = 1

(1) An incremental encoder is supported so the maximum count is 2^{30} . Once the maximum is reached, the count value will rollover to a negative number (-2^{30}).

Table 78 - Standard Output Tags

Output Tag	Function
DeviceName.O.LogicCommand	Bitmask of command bits below
DeviceName.O.Stop	A 0 to 1 transition will cause motor control to perform a stop Motor control is blocked from running if set to 1
DeviceName.O.Start	A 0 to 1 transition will cause motor control to attempt to run
DeviceName.O.Run	Motor control will attempt to run when set to 1, and remain running until set back to 0
DeviceName.O.Jog	Motor control will attempt to jog (run with preset speed) when set to 1, and remain jogging until set back to 0
DeviceName.O.DirectionCmd_0 DeviceName.O.DirectionCmd_1	0,0 or 1,1 = No direction commanded, current direction is maintained 1,0 = Forward direction commanded 0,1 = Reverse direction commanded
DeviceName.O.ClearFault	A 0 to 1 transition will acknowledge or clear all active faults
DeviceName.O.AccelRefSelect_0 DeviceName.O.AccelRefSelect_1 DeviceName.O.AccelRefSelect_2	0,0,0 = Use default acceleration reference (Acceleration Preset 1) For configuration, see Table 67 on page 176 . 0,0,1 = Use Acceleration Preset 1 0,1,0 = Use Acceleration Preset 2 0,1,1 = Use Acceleration Preset 3 1,0,0 = Use Acceleration Preset 4
DeviceName.O.VelocityRefSelect_0 DeviceName.O.VelocityRefSelect_1 DeviceName.O.VelocityRefSelect_2	0,0,0 = Use velocity reference in output tag (CommandedVelocity) For configuration, see Table 66 on page 176 . 1,0,0 = Use Velocity Preset 1 0,1,0 = Use Velocity Preset 2 1,1,0 = Use Velocity Preset 3 0,0,1 = Use Velocity Preset 4
DeviceName.O.IO_0	Controls the state of the self-configuring I/O point 0 0 = output off / input mode, 1 = output on If using this I/O point as an input, this should remain 0
DeviceName.O.IO_1	Controls the state of the self-configuring I/O point 1 0 = output off / input mode, 1 = output on If using this I/O point as an input, this should remain 0
DeviceName.O.EMBrakeAutoManCtrl ⁽¹⁾	Controls whether manual EM brake control via the DeviceName.O.EMBrakeRelease bit is enabled. 0 = Manual brake control is disabled, DeviceName.O.EMBrakeRelease bit ignored 1 = Manual brake control is enabled, DeviceName.O.EMBrakeRelease determines EM brake state in modes "Automatic or Manual Control" or "Manual Control"
DeviceName.O.EMBrakeRelease	1 = Manually release (energize) the EM brake (This tag member is ignored on units without EM brake control circuitry)
DeviceName.O.CommandedVelocity	Dynamic velocity reference value, used if DeviceName.O.VelocityRefSelect = 0,0,0

(1) Only available if firmware revision 2 or higher is selected and if you configure EM Brake to Automatic or Manual Control.

Table 79 - Safety Input Tags

Safety Input Tags	Function
DeviceName.SI.ConnectionStatus	Bitmask of status bits below
DeviceName.SI.RunMode	Safety Connection: 0 = Idle 1 = Run
DeviceName.SI.ConnectionFaulted	Safety Connection: 0 = Normal 1 = Faulted
DeviceName.SI.FeedbackPosition	Indicates the actual position of the feedback device.

Table 79 - Safety Input Tags

Safety Input Tags	Function
DeviceName.SI.FeedbackVelocity	Indicates the Feedback velocity, the actual velocity of the feedback device.
DeviceName.SI.StopStatus	A collection of the following bits.
DeviceName.SI.STOActive	Safe Torque Off (STO) function status 0 = Permit Torque 1 = Disable Torque
DeviceName.SI.SBCActive	Safe Brake Control (SBC) function status 0 = Release Brake 1 = Engage Brake
DeviceName.SI.SS1Active	Safe Stop 1 (SS1) function status: 0 = Not Active 1 = Active
DeviceName.SI.SafetyFault	1 = Safe Stop Fault present
DeviceName.SI.RestartRequired	1 = Fault Reset or Stop Restart is required
DeviceName.SI.SafeStatus	A collection of the following bits.
DeviceName.SI.TorqueDisabled	0 = Torque Permitted 1 = Torque Disabled
DeviceName.SI.BrakeEngaged	Indicates the status of SBC function: 0 = Brake Released 1 = Brake Engaged
DeviceName.SI.MotionStatus	Reserved for future use; always 0.
DeviceName.SI.MotionPositive	Indicates positive motion: 0 = No Positive Motion 1 = Positive Motion
DeviceName.SI.MotionNegative	Indicates negative motion: 0 = No Negative Motion 1 = Negative Motion
DeviceName.SI.FunctionSupport	Reserved for future use; always 0.
DeviceName.SI.PrimaryFeedbackValid	Indicates that valid feedback is being produced by a connected feedback device: 0 = Feedback Invalid 1 = Feedback Valid
DeviceName.SI.SBCReady	Indicates whether SBC function is ready for operation: 0 = Not Ready 1 = Ready
DeviceName.SI.SS1Ready	Indicates whether SS1 function is ready for operation: 0 = Not Ready 1 = Ready
DeviceName.SI.OutputStatus	A collection of safety output status, safety output monitor values, and test output status
DeviceName.SI.Out00Monitor	Output Monitor Value of Safety Output 0 0 = OFF 1 = ON
DeviceName.SI.Out01Monitor	Output Monitor Value of Safety Output 1 0 = OFF 1 = ON
DeviceName.SI.Out00Status	Status of Safety Output 0 0 = Alarm 1 = OK
DeviceName.SI.Out01Status	Status of Safety Output 1 0 = Alarm 1 = OK
DeviceName.SI.Test00Status	Status of Test Output 0 0 = Alarm 1 = OK
DeviceName.SI.Test01Status	Status of Test Output 1 0 = Alarm 1 = OK
DeviceName.SI.InputStatus	A collection of safety input values and status for each safety input
DeviceName.SI.In00Data	Value of Safety Input 0 0 = OFF 1 = ON

Table 79 - Safety Input Tags

Safety Input Tags	Function
DeviceName.SI.In01Data	Value of Safety Input 1 0 = OFF 1 = ON
DeviceName.SI.In02Data	Value of Safety Input 2 0 = OFF 1 = ON
DeviceName.SI.In03Data	Value of Safety Input 13 0 = OFF 1 = ON
DeviceName.SI.In00Status	Status of Safety Input 0 0 = Alarm 1 = OK
DeviceName.SI.In01Status	Status of Safety Input 1 0 = Alarm 1 = OK
DeviceName.SI.In02Status	Status of Safety Input 2 0 = Alarm 1 = OK
DeviceName.SI.In03Status	Status of Safety Input 3 0 = Alarm 1 = OK
DeviceName.SI.IOSupport	A collection of bits describing safety IO functionality
DeviceName.SI.In00Valid	Safety Input 0 Valid 0 = Data invalid 1 = Data valid
DeviceName.SI.In01Valid	Safety Input 1 Valid 0 = Data invalid 1 = Data valid
DeviceName.SI.In02Valid	Safety Input 2 Valid 0 = Data invalid 1 = Data valid
DeviceName.SI.In03Valid	Safety Input 3 Valid 0 = Data invalid 1 = Data valid
DeviceName.SI.Out00Ready	Safety Output 0 Ready 0 = Not Ready 1 = Ready
DeviceName.SI.Out01Ready	Safety Output 1 Ready 0 = Not Ready 1 = Ready

Table 80 - Safety Output Tags

Safety Output Tags	Function
DeviceName.S0.PassThruDataA1	32-bit data container holding general-purpose safety data passed from the safety controller.
DeviceName.S0.PassThruDataB1	32-bit data container holding general-purpose safety data passed from the safety controller.
DeviceName.S0.PassThruStopStatus	See the following descriptions of Safe Stop Function Status bits.
DeviceName.S0.SBCIntegrity	Status of an external Safety Brake controlled by SBC function. 0 = SBC fault. The brake status, released or engaged, is undetermined. 1 = No faults detected.
DeviceName.S0.SBCActive	Indicates that the SBC function is active and the sequence to set the Safety Brake has started. This function is only available as a controller-based function. 0 = SBC Function is not Active 1 = SBC Function is Active
DeviceName.S0.SBCBrakeEngaged	Indicates that the External Safety Brake is engaged by the controller-based SBC function. 0 = Brake is Engaged 1 = Brake is Released

Table 80 - Safety Output Tags

Safety Output Tags	Function
DeviceName.SO.SS1Active	Indicates that the controller-based SS1 function is active. 0 = SS1 Function is not Active 1 = SS1 Function is Active
DeviceName.SO.SS2Active	Indicated that the controller-based SS2 function is active. 0 = SS2 Function is not Active 1 = SS2 Function is Active
DeviceName.SO.SOSActive	Indicates that the controller-based SOS function is active. 0 = SOS Function is not Active 1 = SOS Function is Active
DeviceName.SO.SOSStandstill	Indicates that the controller-based SOS function has detected Standstill according to the function configuration. 0 = Monitored axis is not at Standstill 1 = Monitored axis is at Standstill
DeviceName.SO.PassThruSpeedLimitStatus1	See the following descriptions of Limit Function Status bits.
DeviceName.SO.SSMActive	For use with a controller-based SSM function.
DeviceName.SO.SSMStatus	For use with a controller-based SSM function.
DeviceName.SO.SLSActive	Indicates that the controller-based SLS function is active. 0 = SLS Function is not active 1 = SLS Function is active
DeviceName.SO.SLSLimit	Indicates that the controller-based SLS function has detected the monitored axis speed above the limit setpoint. 0 = axis is below setpoint speed 1 = axis is greater than or equal to the setpoint speed
DeviceName.SO.SDIActive	Indicates that the controller-based SDI function is active. 0 = SDI Function is not active 1 = SDI Function is active
DeviceName.SO.SDILimit	Indicates that the controller-based SDI function detected motion greater than the limit in the unintended direction. 0 = Limit not reached 1 = Unintended motion
DeviceName.SO.PassThruPositionLimitStatus	See the following descriptions of individual bits, indicating the Monitoring Function Limit status of controller-based functions.
DeviceName.SO.SCAActive	For use with a controller-based SCA function.
DeviceName.SO.SCAStatus	For use with a controller-based SCA function.
DeviceName.SO.SLPActive	Indicates that the controller-based SLP function is active. 0 = SLP Function is not active 1 = SLP Function is active
DeviceName.SO.SLPLimit	Indicates that the controller-based SLP function has detected the monitored axis position outside of the setpoint limits. 0 = axis position is within the limits 1 = axis position is outside of the limits
DeviceName.SO.SFHomed	Status of the controller-based SFX position homing function. 1 = SFX Homed
DeviceName.SO.PassThruStopFaults	See the following descriptions of individual bits, indicating the Safety Fault status of controller-based safety functions.
DeviceName.SO.SFXFault	Indicates that a fault occurred with the controller-based SFX function. 0 = Normal Operation 1 = Fault
DeviceName.SO.SBCFault	Indicates that a fault occurred with the controller-based SBC function. 0 = Normal Operation 1 = Fault
DeviceName.SO.SS1Fault	Indicates that a fault occurred with the controller-based SS1 function. 0 = Normal Operation 1 = Fault
DeviceName.SO.SS2Fault	Indicates that a fault occurred with the controller-based SS2 function. 0 = Normal Operation 1 = Fault
DeviceName.SO.SOSFault	Not available, always 0.

Table 80 - Safety Output Tags

Safety Output Tags	Function
DeviceName.SO.PassThruLimitFaults	See the following descriptions of individual bits, indicating the Safety Fault status of controller-based safety functions.
DeviceName.SO.SLSFault	Controller-based SLS fault. 0 = Normal Operation 1 = Fault
DeviceName.SO.SDIFault	Controller-based SDI fault. 0 = Normal Operation 1 = Fault
DeviceName.SO.SLPFault	Controller-based SLP fault. 0 = Normal Operation 1 = Fault
DeviceName.SO.SafetyStopFunctions	A collection of bits used to activate (request) safety functions as described in this table.
DeviceName.SO.STOOutput	Control Safe Torque Off (STO): 0 = Disable Torque 1 = Enable Torque
DeviceName.SO.SBCOutput	If Safe Brake Control (SBC) is configured: 0 = Engage Brake (So0 and So1 OFF) 1 = Release Brake (So0 and So1 ON) If Safe Brake Control is not configured, this tag must be set to 0. If set to 1, will cause SBC fault.
DeviceName.SO.SS1Request	If Safe Stop 1 (SS1) is configured: 0 = No Request 1 = Request Safe Stop 1 If Safe Stop 1 is not configured, this tag must be set to 0. If set to 1, will cause SS1 fault.
DeviceName.SO.ResetRequest	A 0 to 1 transition is required to reset Safety Faults. If Restart Type is 'Manual', a 0 to 1 transition is required to restart a Safety Stop Functions.
DeviceName.SO.SafetyIOCommands	See the following descriptions of individual bits.
DeviceName.SO.Out00Output	Command Safety Output 0
DeviceName.SO.Out01Output	Command Safety Output 1

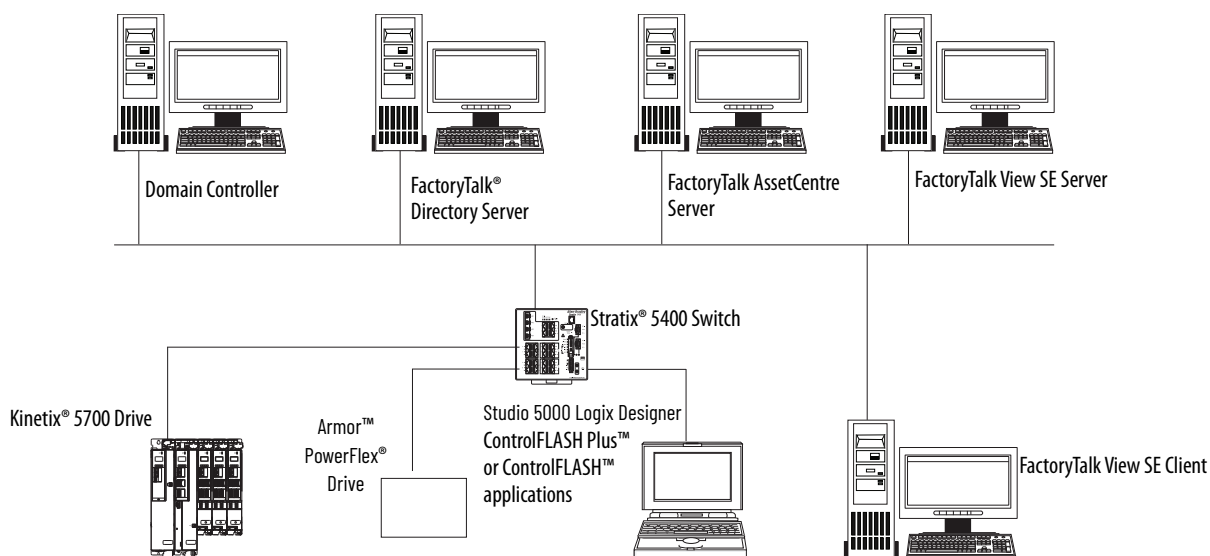
Table 81 - Safety Listen Only Tags

Safety Listen Only Tags	Safety Input Tags	Function
DeviceName.I.Data[0]	DeviceName.SI.FeedbackPosition	Indicates the actual position of the feedback device.
DeviceName.I.Data[1]		
DeviceName.I.Data[2]		
DeviceName.I.Data[3]		
DeviceName.I.Data[4]	DeviceName.SI.FeedbackVelocity	Indicates the Feedback velocity, the actual velocity of the feedback device.
DeviceName.I.Data[5]		
DeviceName.I.Data[6]		
DeviceName.I.Data[7]		
DeviceName.I.Data[8]	DeviceName.SI.StopStatus	A collection of the following bits.
DeviceName.I.Data[9]	DeviceName.SI.SafeStatus	A collection of the following bits.
DeviceName.I.Data[10]	DeviceName.SI.MotionStatus	Reserved for future use; always 0.
DeviceName.I.Data[11]	DeviceName.SI.FunctionSupport	Reserved for future use; always 0.
DeviceName.I.Data[12]	DeviceName.SI.OutputStatus	A collection of safety output status, safety output monitor values, and test output status
DeviceName.I.Data[13]	DeviceName.SI.InputStatus	A collection of safety input values and status for each safety input
DeviceName.I.Data[14]	DeviceName.SI.IOSupport	A collection of bits describing safety IO functionality

Notes:

Develop Secure Applications

To enhance overall security, integrate your drive with these system components.



FactoryTalk® Security and FactoryTalk® Directory applications let you:

- Manage user accounts and configure user groups to support the separation of duties and least privileged
- Identify, authenticate, and authorize users
- Configure strong password requirements

FactoryTalk® AssetCentre application allows you:

- Inventory assets
- Configure and use auditable events
- Manage audit storage capacity
- Manage a diagnostics and health log
- Manage change detection and reporting
- Schedule backups
- Recover from disruptions if they occur

We recommend using a Windows® 10 operating system or higher, to achieve full software functionality.

For additional information to help you develop secure applications, reference these publications:

Topic	Publication
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.	System Security Design Guidelines Reference Manual, SECURE-RM001
Network architecture recommendations	Converged Plantwide Ethernet (CPwE) Design and Implementation Guide, publication ENET-TD001
Windows® infrastructure recommendations (domain controller) How to configure and use these Rockwell Automation products: <ul style="list-style-type: none">• FactoryTalk® Directory• FactoryTalk® Activation Manager• FactoryTalk® Security• FactoryTalk® AssetCentre	Security Configuration User Manual, publication SECURE-UM001 .
How to configure and use CIP Security™ with Rockwell Automation products to improve the security of your industrial automation system, including the use of FactoryTalk® Policy Manager to define communication between zones.	CIP Security™ with Rockwell Automation Products Application Technique, publication SECURE-AT001

CIP Security

CIP Security is a standard, open-source communication mechanism that helps to provide a secure data transport across an EtherNet/IP network. CIP Security lets CIP-connected devices authenticate each other before transmitting and receiving data.

CIP Security uses the following security properties to help devices protect themselves from malicious communication:

- Device Identity and Authentication
- Data Integrity and Authentication
- Data Confidentiality

Rockwell Automation uses the following products to implement CIP Security:

- FactoryTalk® Policy Manager application (includes FactoryTalk System Services, version 6.20 or later)
- FactoryTalk® Linx application, version 6.11 or later (lets workstation applications communicate securely using CIP Security)
- Studio 5000 Logix Designer® application, version 32.00...35.xx

This application is required to interface with CIP Security-enabled Logix controllers. The minimum application version varies by controller product family.

For more information on CIP Security, for example, a list of CIP Security capable products and publications that describe how to use the products, including limitations and considerations, see the following:

- [Rockwell Automation - CIP Security](#)
- CIP Security with Rockwell Automation Products Application Technique, publication [SECURE-AT001](#)

Automatic Device Configuration

Automatic Device Configuration supports control system backup and provides a means for the system to recover to a know secure state if a disruption occurs. See [Using Automatic Device Configuration on page 199](#).

The controller maintains a copy (backup) of the drive's configuration data.

Before establishing a controlling connection, the controller compares its copy of the product's configuration data to the product's actual configuration and updates the product's configuration data if they are different.

Security configuration and network configuration settings are not included when using ADC. To use ADC:

1. Configure the drive's IP address so that it can connect to your network.
See [Set the IP Address on page 69](#).
2. Make security configuration settings using FactoryTalk Policy Manager.
3. Connect to your controller to download configuration data.

Syslog Event Logging

The Armor PowerFlex drive supports syslog event logging for security-related events. Choose a syslog collector that supports the following:

- RFC-5424 syslog protocol
- Ability to receive messages from the drive

To set the IP address of the syslog collector, use FactoryTalk Policy Manager software. For more information, see CIP Security with Rockwell Automation Products Application Technique, publication [SECURE-AT001](#).

Reset to Out-of-Box for Secure Erase

A power-up with rotary address switches set to 888 triggers a factory reset to out-of-box configuration.

A factory reset clears user-configurable settings such that the data cannot be retrieved with commercially available tools.

It does not erase the following types of data:

- Diagnostic data like, power on time
- Security log data
- Elapsed and remaining life data for components that are monitored for predictive maintenance

Start is inhibited during a reset operation. For the reset procedure details, see [Reset to Out-of-box State on page 99](#).

Disable Ethernet Ports

Restrict the use of unnecessary ports, for example disable communication on network port 2 if only network port 1 is needed for application.

IMPORTANT	Remember the following: <ul style="list-style-type: none"> • Once a port is disabled, you lose any connection that is established through the controller Ethernet port. • You cannot disable Ethernet ports if the controller keyswitch is in Run mode or if the FactoryTalk Security settings deny this editing option.
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There are two ways to disable the Ethernet port:

- [Disable the Ethernet Port on the FactoryTalk Linx Configuration Tab on page 209](#)
- [Disable the Ethernet Port with a MSG Instruction on page 212](#)

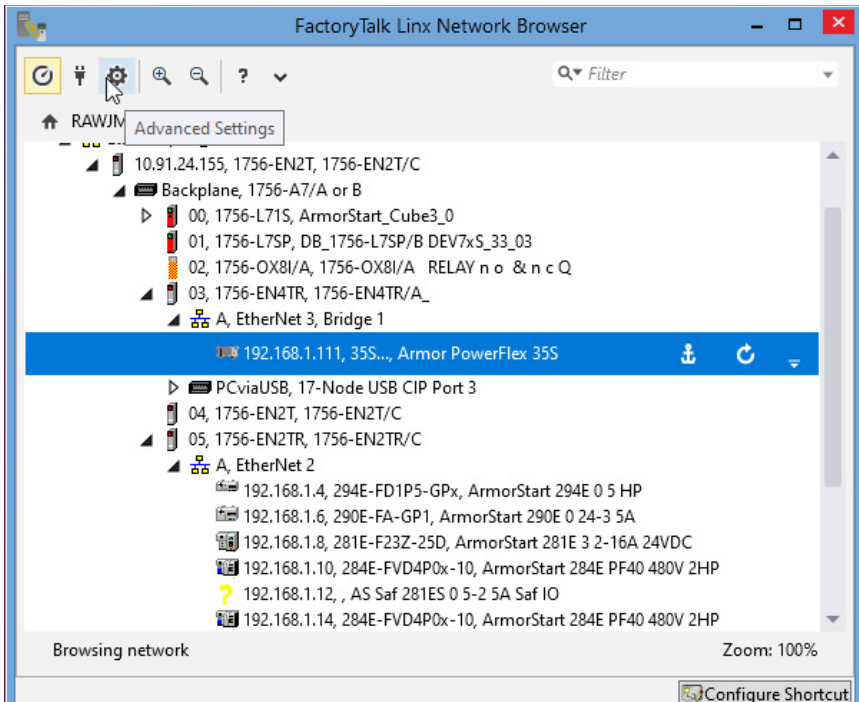
Disable the Ethernet Port on the FactoryTalk Linx Configuration Tab

You can disable the Ethernet ports on the Armor PowerFlex drive using FactoryTalk Linx.

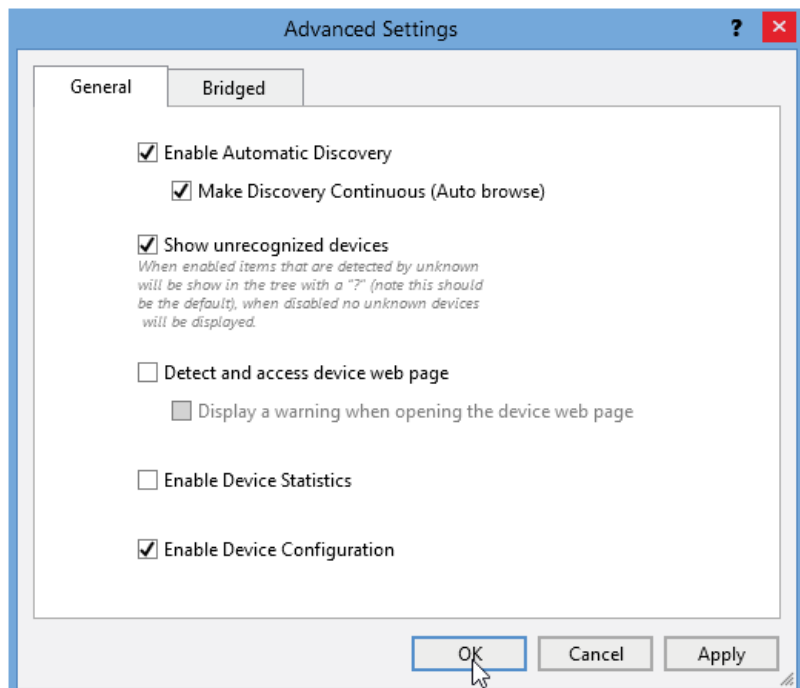
IMPORTANT	Once a port is disabled, it cannot be used with FactoryTalk Linx. So if both ports are disabled, FactoryTalk Linx will not be able to communicate with the unit. The Armor PowerFlex will have to be reset to factory default to enable communication again, see Reset to Out-of-box State on page 99 .
------------------	--

Perform the following steps to disable a port of the Armor PowerFlex drive, using FactoryTalk Linx.

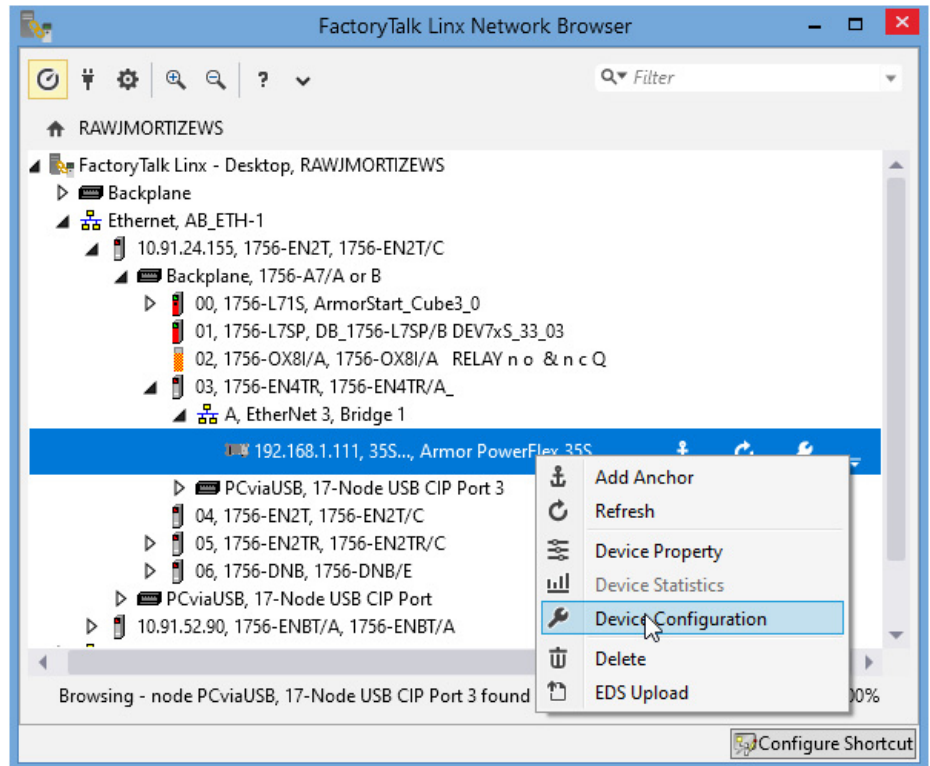
1. Launch the FactoryTalk Linx and create the appropriate EtherNet driver if needed.
2. Once you see the Armor PowerFlex IP Address listed under the EtherNet Driver, go to the advance settings as shown.



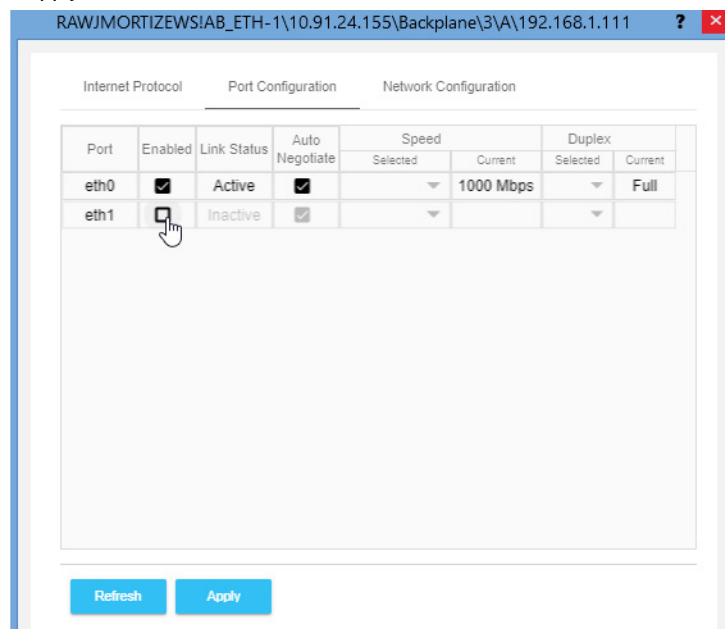
3. In Advanced Settings, check Enable Device Configuration under the General tab and click OK. This allows the IP Address to be changed using FactoryTalk Linx.



4. Right-click the device and choose Device Configuration.



5. Click on the Port Configuration tab.
6. Under the Enable column, uncheck the check box of the port that you want to disable.
7. Click Apply.



8. The port unchecked port is now disabled
9. To re-enable a port, repeat steps 1...7, but in step 6 check the check box of the port that you want to enable.

Disable the Ethernet Port with a MSG Instruction

You can use a CIP Generic MSG to the drive, to disable one of the Ethernet ports. Follow these steps:

1. Add a MSG instruction to your program.
This message only has to execute once, it does not need to execute with every program scan.

IMPORTANT You cannot add a MSG instruction to your program if the controller keyswitch is in Run mode, or if the FactoryTalk Security settings deny this editing option.

2. In the Configuration tab, set the Message Type as CIP Generic.
3. Enter the remaining fields using the parameters in [Table 82](#).

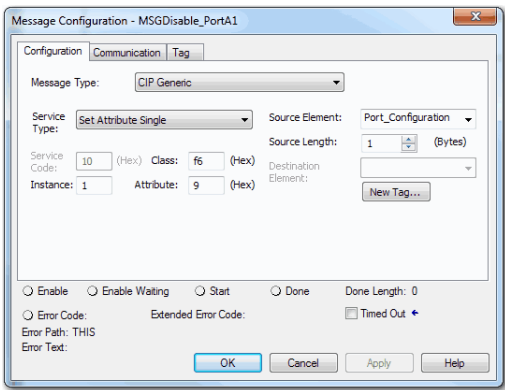
Table 82 - Port Configuration Tab: MSG

Parameter	Value	Description
Service Code	0x10	Set Attribute Single
Class	0x00F6	Motor Control Source
Instance	1	EtherNet Port 1
	2	EtherNet Port 2
Attribute	9	Admin
Data Type	USINT	0 = Reserve 1 = Enable Interface 2 = Disable Interface

IMPORTANT These values are stored to NVS memory in such a way that the MSG instruction is not required to execute each time the controller powers up.

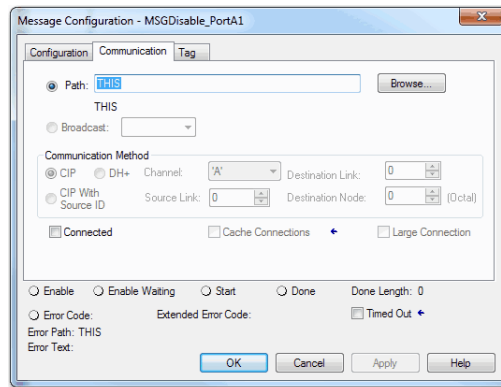
In this example, the controller tag is named Port_Configuration.

- Source Length - 1



4. Configure the Communication tab to use a Path of THIS. (THIS is the name of the Armor PowerFlex drive used in the example.)

IMPORTANT Messages to THIS must be unconnected messages.



5. Before you enable the MSG instruction, make sure that the Source Element tag value is 2.

IMPORTANT You can re-enable an Ethernet port after it is disabled. To re-enable the port, complete the steps that are described in this section. Before you enable the MSG instructions, however, make sure that the Source Element tag value is 1.

Notes:

Diagnostics, Status, and Troubleshooting

View Status Indicators

The Armor PowerFlex drive has several groups of light-emitting diode (LED) status indicators, including system status, I/O status, EtherNet/IP status, power status, and keypad status, as described in this section.



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

System Status Indicator

The system status LED (STATUS) indicates the overall state or status of the Armor PowerFlex drive. The STATUS LED operates the same for the Armor PowerFlex standard drive (35E) and the Armor PowerFlex safety drive (35S). See [Table 83](#).



Table 83 - STATUS LED

State	LED Indicator Status	Description
Drive is ready to run	Flashing green	Drive is ready to run but is not running, no faults or alarms
Drive is running	Steady green	Drive is running, no faults or alarms
Drive is not ready to run	Flashing amber	Drive is not ready to run, motor control cannot be started OR an alarm is present, device is not running
Drive is running with alarm	Steady amber	Drive is running, alarm is present OR Drive is not ready to restart because a run inhibit condition is preventing a restart
Fault is present	Flashing red	Fault is present, must be acknowledged by user before a motor control start can be accepted
Major (nonrecoverable) fault is present	Steady red	Drive has a major non-recoverable fault, power cycle or replace unit
Firmware update mode	Flashing green/red	Drive is in firmware update mode / firmware update in progress

I/O Status Indicators

The standard I/O LEDs consist of:

- IN0: input
- IN1: input
- IN2: input
- IN3: input
- IN/OUT0: configurable I/O
- IN/OUT1: configurable I/O



[Table 84](#) and [Table 85](#) describe the I/O status indicator state and status.

Table 84 - Standard Input LEDs: IN0...IN3

State	LED Indicator Status	Description
Input off	Off	Input is off, no fault
Input on	Steady green	Input is on, no fault
Input fault	Steady red	Input is faulted

Table 85 - Configurable I/O LEDs: IN/OUT0...IN/OUT1

State	LED Indicator Status	Description
I/O off	Off	Input or output is off, no fault
Input on	Steady green	Input is on, no fault
Output on	Steady amber	Output is on, no fault
I/O fault	Steady red	I/O point is faulted

The safety I/O LEDs consist of:

- SAFETY IN0: safety input
- SAFETY IN1: safety input
- SAFETY IN2: safety input
- SAFETY IN3: safety input
- SAFETY OUT0: safety output



[Table 86](#) and [Table 87](#) describe the safety I/O status indicator state and status.



ATTENTION: Do not use light-emitting diode (LED) status indicators on the safety I/O for safety operations. Do not use the colors as indication of safe or unsafe states.

Table 86 - Safety Input LEDs: SAFETY IN0...SAFETY IN3

State	LED Indicator Status	Description
Safety input off	Off	Input is off or not configured, no fault
Safety input on	Steady green	Input is on, no fault
Safety input fault	Steady red	Input is faulted, due to wiring or input circuit fault
Partner fault	Flashing red	Partner input circuit of a dual-input configuration is faulted

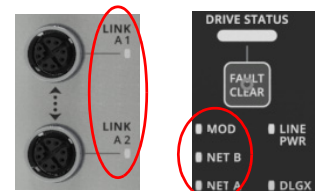
Table 87 - Safety Output LED: SAFETY OUT0

State	LED Indicator Status	Description
Safety output off	Off	Output is off or not configured, no fault
Safety output on	Steady green	Output is on, no fault
Safety output fault	Steady red	Output is faulted, due to wiring or output circuit fault

EtherNet/IP Status Indicators

The EtherNet/IP LEDs consist of:

- LINK A1: link activity
- LINK A2: link activity
- NET A: network status
- MOD: EtherNet/IP module status



[Table 88](#), [Table 89](#), and [Table 90](#) describe the EtherNet/IP state and status.

Table 88 - Ethernet Link Activity Status LEDs: LINK A1, LINK A2

State	LED Indicator Status	Description
No link	Off	No link
Link, no activity	Steady green	Link is established, no activity
Link, with activity	Flashing green	Link, with activity - flash rate is dependent on level of traffic on port, maximum flash rate of 100 ms on/100 ms off

Table 89 - Ethernet Network Status LED: NET A

State	LED Indicator Status	Description
Not powered, no IP address	Off	If the device does not have an IP address (or is powered Off), the network status indicator is steady Off.
Connected	Steady green	If the device has at least one established connection (even to the Message Router), the network status indicator is steady green.
No connections	Flashing green	If the device has no established connections, but has obtained an IP address, the network status indicator is flashing green.
Duplicate IP address	Steady red	If the device has detected that the IP address is already in use, the network status indicator is steady red.
Connection timeout	Flashing red	If one or more of the connections in which this device is the target has timed out, the network status indicator is flashing red. This indicator is turned Off only when all timeout connections are re-established or if the device is reset.
Self test	Flashing red/green	While the device is performing its power-up test, the network status indicator is flashing green/red.

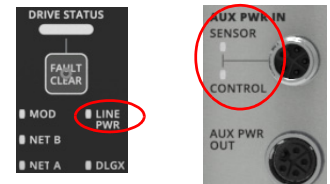
Table 90 - Ethernet Module Status LED: MOD

State	LED Indicator Status	Description
No power	Off	If no power is supplied to the device, the module status indicator is steady Off.
Device operational	Steady green	If the device is operating correctly and the programmable controller is in Run mode, the module status indicator is steady green.
Standby	Flashing green	If the device has not been configured or the programmable controller is not in Run mode, the module status indicator is flashing green.
Unrecoverable major fault	Steady red	If the device has detected a nonrecoverable major fault, see Monitor Faults, Alarms, and Events .
Recoverable major fault	Flashing red	If the device has detected a recoverable major fault, the module status indicator is flashing red. Note: An incorrect or inconsistent configuration is considered a minor fault.
Self test	Flashing red/green	While the device is performing its power-up test, the module status indicator is flashing green/red.
Waiting for TUNID or Configuring	Flashing red/green	For Armor PowerFlex safety drive (35S), if there is no safety configuration and torque is not enabled via the hardwired inputs, or the safety configuration process is occurring, the module status indicator is flashing red/green.

Power Status Indicators

The power status LEDs consist of:

- LINE PWR: 3-phase AC power
- SENSOR: indicates switched auxiliary/control 24V power (output power)
 - SENSOR refers to external power for items (sensors, output devices) connected to the product. This supply powers the user output circuits in the product.
- CONTROL: indicates unswitched auxiliary 24V power (sensor power)
 - CONTROL refers to local power for the module itself. This supply powers the logic and user input circuits in the product.



[Table 91](#), [Table 92](#), and [Table 93](#) describe the power status indicator state and status.

Table 91 - 3-phase Power LED: LINE PWR

State	LED Indicator Status	Description
3-phase input power not present	Off	3-phase AC input power is not present, motor output is not possible.
3-phase input power present, drive On	Steady green	3-phase AC input power is present, the local disconnect switch is On
3-phase input power present, drive Off	Flashing green	3-phase AC power is present and the local disconnect switch is Off

Table 92 - SENSOR - Switched Auxiliary/Control 24V Power (Output Power)

State	LED Indicator Status	Description
Switched 24V power not present	Off	Switched 24V input power not present, user outputs on the drive are not operational
Switched 24V power present	Steady green	Switched 24V input power is present and above the minimum required voltage
Switched 24V power present	Flashing red	Switched 24V input power is present but below the minimum required voltage

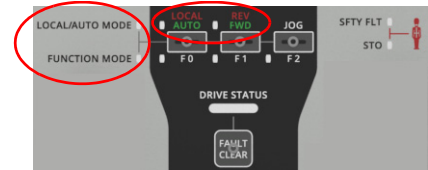
Table 93 - CONTROL - Unswitched Auxiliary/Control 24V Power (Sensor Power)

State	LED Indicator Status	Description
Unswitched 24V power not present	Off	Unswitched 24V input power not present, drive is not operational
Unswitched 24V power present	Steady green	Unswitched 24V input power is present and within operating voltage range
Unswitched 24V power present	Flashing red	Unswitched 24V input power is present but not within operating voltage range

Keypad Status Indicators

The keypad LEDs consist of:

- **LOCAL/AUTO MODE:** The keypad LOCAL/AUTO mode LEDs indicate if the Local/Auto commands for the keypad buttons are active or not.
- **FUNCTION MODE:** The keypad Function mode LED indicates whether the keypad is in Function mode.
- **LOCAL/AUTO:** The keypad auto/local state LED indicates whether the keypad mode is auto mode, local mode, or another mode.
- **FWD/REV:** The keypad forward/reverse LED indicates the selected direction of motion and whether there is motion when in the local keypad mode.
- **F0...F2:** The keypad user function key LEDs (F0...F2) indicate that a keypad key is being pressed when the keypad mode is in user mode.



[Table 94](#), [Table 95](#), [Table 96](#), [Table 97](#), and [Table 98](#) describe the keypad status indicator state and status.

Table 94 - LOCAL/AUTO MODE

State	LED Indicator Status	Description
LOCAL/AUTO keypad mode is not available	Off	LOCAL/AUTO keypad mode is not available, keypad has been configured for user mode
LOCAL/AUTO keypad mode is available	Steady green	LOCAL/AUTO keypad mode is available

Table 95 - LOCAL/AUTO

State	LED Indicator Status	Description
Keypad is in another mode	Off	Keypad is in Function mode or it has been disabled
Keypad is in auto mode	Steady green	Keypad is in auto mode
Keypad is in local mode	Steady red	Keypad is in local mode



An event named SourceActive (OX041C0009) will be logged whenever the Keypad is changed to Local mode.

Table 96 - FWD/REV

State	LED Indicator Status	Description
Keypad mode is not local	Off	No Keypad control
Keypad mode is local	Steady green	Keypad mode is local, direction that is selected is forward, no motion
Keypad mode is local	Flashing green	Keypad mode is local, direction that is selected is forward, motion commanded (jogging, jog key pressed)
Keypad mode is local	Steady red	Keypad mode is local, direction that is selected is reverse, no motion
Keypad mode is local	Flashing red	Keypad mode is local, direction that is selected is reverse, motion commanded (jogging, jog key pressed)

Table 97 - FUNCTION MODE

State	LED Indicator Status	Description
Keypad mode is something other than Function mode	Off	Keypad is in Local/Auto mode
Unswitched 24V power present	Steady amber	Keypad has been configured for Function mode, local and auto modes are unavailable

Table 98 - Function Keys F0...F2

State	LED Indicator Status	Description
No key is being pressed OR keypad is not in Function mode	Off	Key is not being pressed in Function mode, or keypad mode is not user mode
Key is pressed while in Function mode	Steady amber	Key is being pressed while in Function mode

Safety Function Status Indicator



The safety function LEDs consist of:

- STO: Safe Torque Off
- SAFETY FAULT:

Table 99 - STO

State	LED Indicator Status	Description
Torque disabled	Off	Torque is disabled (STO active = 1/Disable Torque). Device may not be powered, check Module Status LED
Torque permitted	Steady green	The STO circuit is permitting torque (Torque Disabled = 0/Torque Permitted)
Torque inhibited	Flashing green	Torque is enabled but the STO circuit is not permitting torque (STO Active = 0/Permit Torque, Torque Disabled = 1/Torque Disabled)
Circuit fault	Flashing red	The STO circuit is faulted
Nonrecoverable fault	Steady red	A nonrecoverable fault has occurred

Table 100 - SAFETY FLT

State	LED Indicator Status	Description
Normal operation	Steady green	Normal operation
Recoverable fault	Flashing red	A recoverable fault has occurred
Nonrecoverable fault	Steady red	A nonrecoverable fault has occurred

Monitor Faults, Alarms, and Events

The Armor PowerFlex drive provides notification of critical faults, major faults, major alarms, and events.



ATTENTION: Do not attempt to defeat or override fault circuits. Determine the cause of the fault indication and correct it before an operation attempt. Failure to correct a control system or mechanical malfunction can result in personal injury and /or equipment damage due to uncontrolled machine system operation.

- When a critical fault occurs, all motor control operations stop. Motor power is immediately removed, which causes the attached motor to coast to a stop.
- A major fault stops the drive with a stop mode of coast.
- A major alarm notifies you of a condition that exists, but does not stop motor control operations, if the drive is already in a run condition. If the alarm occurs while the drive is in a stop condition, the alarm must be cleared for a run condition to be accepted. Alarms are cleared automatically when the condition that caused the alarm is no longer present for at least one second.
- An event occurs during normal operation of the product and can help you monitor status or troubleshoot problems.

The Armor PowerFlex drive's fault log, accessible from the Faults and Alarms page, displays the fault code, name of the fault, timestamp, and type of fault (Event, Alarm, Fault) and details about the fault.

Faults and Alarms Page – Online

ArmorPowerFlex
IP Address: 192.168.1.169

Controller State: Remote Run Connection: Running Drive State: Stopped
Torque: Enabled

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Overview
MONITOR
Date and Time
Faults and Alarms
Predictive Maintenance
SAFETY
Safety Configuration
Safe Torque Off (STO)
Safe Brake Control (SBC)
Safe Stop 1 (SS1)
Test Output
Input Configuration
Output Configuration
Actions
MOTOR
Motor Control
Encoder Feedback
Velocity Control
Stop Control
CONFIGURATION
Connection
Input/Output Configurati...
Events

Safety Control Mode: Network

Faults and Alarms

i Data is shown in UTC time zone.
Event type can be changed on Events page under Configuration section.

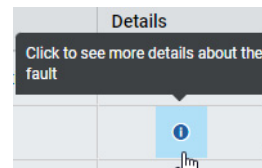
i All fields with **←** icon apply values immediately to the drive.

Code	Name	Timestamp	Type	Details
0x043a0001	Torque Enabled	2023-08-30 07:19:37.295	Information	
0x041c0009	Source Active	2023-08-30 07:19:26.516	Information	
0x04190002	Configuration Operation Apply Success	2023-08-30 07:18:23.315	Information	
0x043f0001	Source Data Invalid	2023-08-30 07:17:59.859	Information	
0x043f0001	Source Data Invalid	2023-08-30 07:17:59.859	Information	
0x041c0001	Source Data Invalid	2023-08-30 07:17:59.859	Information	
0x041c0009	Source Active	2023-08-30 07:08:29.452	Information	
0x04190002	Configuration Operation Apply Success	2023-08-30 07:08:27.235	Information	
0x041c0009	Source Active	2023-08-30 06:51:15.385	Information	
0x043a0003	STO Reaction	2023-08-30 06:51:15.385	Information	

Reset Module Clear Log ← Clear Faults ←

Additional fault details are available for high severity faults. To access these details, click on the blue **i** logo that appears in the Details column.

Fault Details Access



Fault Details Example**Fault's Details - Code 0x043a0008**

Queue #	Instance Name	Code
58	Safety	0x043a0008
Timestamp (UTC)	Name	
2023-08-30 07:35:53.055	Safe Stop 1 Fault	

Data at Time of Occurrence

Name	Value
Motor is Ready	False
Motor is Running	False
Direction	Forward
Output Frequency	0 Hz
Output Voltage	0 V
Output Current	0 A
DC Bus Measured Voltage	647 V
IGBT Heatsink Temperature	9 °C

Close


Set Date and Time

For an accurate fault timestamp, you must synchronize the drive's Real Time Clock (RTC) with your workstation.


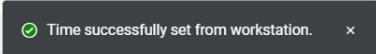
Set the time and date in the Logix Designer application using the following steps.

1. Click Date and Time.
2. On the Date and Time page, click Set from Workstation.

Date and Time

i All fields with  icon apply values immediately to the drive.

Date	Time	Time Zone
2023-08-30	07:44:53.000	Coordinated Universal Time (UTC)

A confirmation message will appear that indicates the date and time have been synchronized with your workstation.

Saving Fault History

If you go offline and do not close the Logix Designer application, events are cached until the Logix Designer application, is closed or you go online again.

Faults and Alarms Page – Offline

ArmorPowerFlex

IP Address: 192.168.1.169

Controller State: Offline Connection: Standby Drive State: Offline

INFORMATION

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Faults and Alarms

Predictive Maintenance

SAFETY

Safety Configuration

Safe Torque Off (STO)

Safe Brake Control (SBC)

Safe Stop 1 (SS1)

Test Output

Input Configuration

Output Configuration

Actions

MOTOR

Motor Control

Encoder Feedback

Velocity Control

Stop Control

CONFIGURATION

Connection

Input/Output Configurati...

Events

Faults and Alarms

The device is offline. Last data update: 2023-08-30 06:48:21 (UTC). After closing the profile, data will be deleted.

Code	Name	Timestamp	Type	Details
0x041c0009	Source Active	2023-08-30 06:43:28.585	Information	
0x043a0001	Torque Enabled	2023-08-30 06:43:28.585	Information	
0x041c0009	Source Active	2023-08-30 06:43:15.055	Information	
0x043a0003	STO Reaction	2023-08-30 06:43:15.055	Information	
0x043a0002	Torque Disabled	2023-08-30 06:43:15.055	Information	
0x04190002	Configuration Operation Apply Success	2023-08-30 06:43:14.745	Information	
0x00f60001	Link Up	2023-08-24 11:01:40.759	Information	
0x00f60002	Link Down	2023-08-24 11:01:14.841	Information	
0x043a0001	Torque Enabled	2023-08-24 11:01:11.865	Information	
0x041c0009	Source Active	2023-08-24 11:01:10.865	Information	
0x043a0003	STO Reaction	2023-08-24 11:01:10.865	Information	
0x043a0002	Torque Disabled	2023-08-24 11:01:10.865	Information	

Reset Module

Clear Log

Clear Faults

The log stores the 100 most recent entries in nonvolatile memory.

The Clear Faults button, clears unacknowledged faults. The Clear log button, clears the fault log data. The Reset Module button cycles power to the drive. See [Clearing Faults](#), for details.


Exporting Faults

Faults can be exported to a file while offline (cached data) or while online.

Exporting Faults While Offline

ArmorPowerFlex
IP Address: 192.168.1.169

Controller State: Offline Connection: Standby Drive State: Offline

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MONITOR
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Faults and Alarms
Predictive Maintenance 
SAFETY
Safety Configuration
Safe Torque Off (STO)
Safe Brake Control (SBC)
Safe Stop 1 (SS1)
Test Output
Input Configuration
Output Configuration
Actions
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Connection
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Events

Faults and Alarms

The device is offline. Last data update: 2023-08-30 07:33:40 (UTC). After closing the profile, data will be deleted.

Code	Name	Timestamp	Type	Details
0x00f60001	Link Up	2023-08-30 07:28:56.010	Information	
0x041c0009	Source Active	1970-01-01 00:00:06.894	Information	
0x043a0003	STO Reaction	1970-01-01 00:00:06.893	Information	
0x043a0002	Torque Disabled	1970-01-01 00:00:06.893	Information	
0x043a0001	Torque Enabled	1970-01-01 00:00:06.783	Information	
0x00010003	User Initiated Device Reset	1970-01-01 00:00:05.864	Information	
0x041c0009	Source Active	2023-08-30 07:24:33.324	Information	
0x043a0003	STO Reaction	2023-08-30 07:24:33.323	Information	
0x043a0002	Torque Disabled	2023-08-30 07:24:33.323	Information	
0x043a0001	Torque Enabled	2023-08-30 07:19:37.295	Information	
0x041c0009	Source Active	2023-08-30 07:19:26.516	Information	
0x04190002	Configuration Operation Apply Success	2023-08-30 07:18:23.315	Information	


Reset Module Clear Log Clear Faults

When exporting faults while online, you will also be prompted for a location of where to save the file.

Exporting Faults While Online


ArmorPowerFlex
IP Address: 192.168.1.169

Controller State: Remote Run Connection: Inhibited Drive State: Not Ready




INFORMATION
Overview
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Safe Torque Off (STO)
Safe Brake Control (SBC)
Safe Stop 1 (SS1)
Test Output
Input Configuration
Output Configuration
Actions
MOTOR
Motor Control
Encoder Feedback
Velocity Control
Stop Control
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Connection
Input/Output Configurati...
Events

Faults and Alarms

Data is shown in UTC time zone.
Event type can be changed on Events page under Configuration section.

All fields with  icon apply values immediately to the drive.

Code	Name	Timestamp	Type	Details
0x00f60001	Link Up	2023-08-30 07:28:56.010	Information	
0x041c0009	Source Active	1970-01-01 00:00:06.894	Information	
0x043a0003	STO Reaction	1970-01-01 00:00:06.893	Information	
0x043a0002	Torque Disabled	1970-01-01 00:00:06.893	Information	
0x043a0001	Torque Enabled	1970-01-01 00:00:06.783	Information	
0x00010003	User Initiated Device Reset	1970-01-01 00:00:05.864	Information	
0x041c0009	Source Active	2023-08-30 07:24:33.324	Information	
0x043a0003	STO Reaction	2023-08-30 07:24:33.323	Information	
0x043a0002	Torque Disabled	2023-08-30 07:24:33.323	Information	
0x043a0001	Torque Enabled	2023-08-30 07:19:37.295	Information	

Reset Module  Clear Log  Clear Faults 

Access Fault, Alarm, and Event Codes



This manual links to Armor PowerFlex AC Drive Fault Codes Reference Data, publication [35-RD002](#), for a list of fault codes; download the spreadsheets now for offline access.

Clearing Faults

There are two types of faults that can occur on the drive; standard and safety. They are indicated by the following status bar descriptions:

- Drive State: Faulted (standard fault)
- Drive State: Safety Faulted (safety fault)

Standard Fault

When a standard fault occurs, there are three ways to clear it, if the condition that is causing the fault has been resolved:

1. Use the *DeviceName.O.ClearFault* tag. A 0 to 1 transition will acknowledge or clear all active non-Safety faults. If the tag already has a value of 1 and then a non-safety fault occurs, the fault will not be cleared. The 0 to 1 transition is required to acknowledge or clear all active non-safety faults. Connection must not be inhibited for this command to work. See [Chapter 7](#) for additional information.
2. Use the Fault Clear button on the drive's keypad. See [Chapter 4](#) for additional information.
3. Use the Clear Faults or Clear Log button in the Fault and Alarms page of the Logix Designer application. Pressing these buttons will acknowledge or clear all active non-safety faults.

The Clear Log button will also clear the fault memory. Connection must not be inhibited for this command to work. (Clearing all faults might require additional actions, such as cycling main input power). See [Chapter 4](#) for additional information.

Clear Log and Clear Faults Buttons

ArmorPowerFlex
IP Address: 192.168.1.169

Controller State: Remote Run Connection: Running Drive State: Stopped
Torque: Enabled

INFORMATION
Safety Control Mode: Network

MONITOR
Date and Time
Faults and Alarms
Predictive Maintenance ⚠

SAFETY
Safety Configuration
Safe Torque Off (STO)
Safe Brake Control (SBC)
Safe Stop 1 (SS1)
Test Output
Input Configuration
Output Configuration
Actions

MOTOR
Motor Control
Encoder Feedback
Velocity Control
Stop Control

CONFIGURATION
Connection
Input/Output Configurati...
Events

Faults and Alarms

1 Data is shown in UTC time zone.
Event type can be changed on Events page under Configuration section.

1 All fields with ← icon apply values immediately to the drive.

Code	Name	Timestamp	Type	Details
0x043a0001	Torque Enabled	2023-08-30 07:19:37.295	Information	
0x041c0009	Source Active	2023-08-30 07:19:26.516	Information	
0x04190002	Configuration Operation Apply Success	2023-08-30 07:18:23.315	Information	
0x043f0001	Source Data Invalid	2023-08-30 07:17:59.859	Information	
0x043f0001	Source Data Invalid	2023-08-30 07:17:59.859	Information	
0x041c0001	Source Data Invalid	2023-08-30 07:17:59.859	Information	
0x041c0009	Source Active	2023-08-30 07:08:29.452	Information	
0x04190002	Configuration Operation Apply Success	2023-08-30 07:08:27.235	Information	
0x041c0009	Source Active	2023-08-30 06:51:15.385	Information	
0x043a0003	STC	2023-08-30 06:51:15.385	Information	

This action clears only standard faults. To clear safety faults use safety Controller Tag named ResetRequest.

Reset Module Clear Log ← Clear Faults →

4. The Reset Module button cycles power to the drive. It is not the typical method of clearing faults. For the typical method, using Clear Log and Clear Faults buttons, see [step 3](#).

To continue with the Reset Module button, you must be online and have selected Inhibit Module on the Connections page. For details, see [Standard Connection Settings](#).

IMPORTANT

During Reset Module, the Logix Designer application is locked and you cannot perform any other actions until the reset is completed.

Reset Module

ArmorPowerFlex
IP Address: 192.168.1.169

Controller State: Remote Run Connection: Inhibited Drive State: Not Ready Torque: Disabled

INFORMATION

- Overview
- MONITOR
- Date and Time
- Faults and Alarms**
- Predictive Maintenance
- SAFETY
- Safety Configuration
- Safe Torque Off (STO)
- Safe Brake Control (SBC)
- Safe Stop 1 (SS1)
- Test Output
- Input Configuration
- Output Configuration
- Actions
- MOTOR
- Motor Control
- Encoder Feedback
- Velocity Control
- Stop Control
- CONFIGURATION
- Connection
- Input/Output Configurati...
- Events

Safety Control Mode: Network

Faults and Alarms

❗ Data is shown in UTC time zone.
Event type can be changed on Events page under Configuration section.

❗ All fields with ➡ icon apply values immediately to the drive.

Code	Name	Timestamp	Type	Details
0x041c0009	Source Active	2023-08-30 07:24:33.324	Information	
0x043a0003	STO React	2023-08-30 07:24:33.323	Information	
0x043a0002	Torque Dis	2023-08-30 07:24:33.323	Information	
0x043a0001	Torque En	2023-08-30 07:19:37.295	Information	
0x041c0009	Source Active	2023-08-30 07:19:26.516	Information	
0x04190002	Configuration Operation Apply Success	2023-08-30 07:18:23.315	Information	
0x043f0001	Source Data Invalid	2023-08-30 07:17:59.859	Information	
0x043f0001	Source Data Invalid	2023-08-30 07:17:59.859	Information	
0x041c0001	Source Data Invalid	2023-08-30 07:17:59.859	Information	
0x041c0009	Source Active	2023-08-30 07:08:29.452	Information	

Reset Module

The typical way to clear logs and faults is by using Clear Log and Clear Faults buttons. Resetting Module will result in rebooting the device.

Do you want to continue with Reset?

Yes, reset now Cancel

Reset Module ➡ Clear Log ➡ Clear Faults ➡

Safety Fault

ArmorPowerFlex

IP Address: 192.168.1.169

Controller State: Remote Run Connection: Running Drive State: Safety Faulted

INFORMATION

Overview

MONITOR

Date and Time

Faults and Alarms

Predictive Maintenance

SAFETY

Safety Configuration

Safe Torque Off (STO)

Safe Brake Control (SBC)

Safe Stop 1 (SS1)

Test Output

Input Configuration

Output Configuration

Actions

MOTOR

Motor Control

Encoder Feedback

Velocity Control

Stop Control

CONFIGURATION

Connection

Input/Output Configurati...

Events

Safety Control Mode: Network

Torque: Enabled

Faults and Alarms

Data is shown in UTC time zone.
Event type can be changed on Events page under Configuration section.


All fields with icon apply values immediately to the drive.

Code	Name	Timestamp	Type	Details
0x041c0009	Source Active	2023-08-30 07:35:53.092	Information	
0x043a0008	Safe Stop 1 Fault	2023-08-30 07:35:53.055	Fault	
0x043a0001	Torque Enabled	2023-08-30 07:35:53.055	Information	
0x04190002	Configuration Operation Apply Success	2023-08-30 07:35:52.515	Information	
0x00f60001	Link Up	2023-08-30 07:28:56.010	Information	
0x041c0009	Source Active	1970-01-01 00:00:06.894	Information	
0x043a0003	STO Reaction	1970-01-01 00:00:06.893	Information	
0x043a0002	Torque Disabled	1970-01-01 00:00:06.893	Information	
0x043a0001	Torque Enabled	1970-01-01 00:00:06.783	Information	
0x00010003	User Initiated Device Reset	1970-01-01 00:00:05.864	Information	

Reset Module

Clear Log

Clear Faults

- When a Safety Fault occurs, this is the sequence of steps to clear it (if the condition that created the fault has been resolved):
1. Make sure that there is a running connection between the programmable controller and Armor PowerFlex. The connection must not be inhibited.
- 

When the Armor PowerFlex connection is inhibited, controller tags are not exchanged between the programmable controller and the drive, therefore updates are not possible (e.g. this is similar to putting the programmable controller in Program Mode).
2. Use the *DeviceName:SO.ResetRequest* tag. A 0 to 1 transition will clear all active Safety faults. If the tag already has a value of 1 and then a Safety fault occurs, the fault will not be cleared. The 0 to 1 transition is required to clear all active Safety faults. See [Chapter 6](#) for details on Safety Functions and Safety Faults.

Condition Monitoring

The drive monitors the condition of the following physical components:

- Power supply
- Temperature

When these components operate outside their limits, a fault or alarm can be triggered. See Armor PowerFlex AC Drives Fault Codes Reference Data, publication [35-RD002](#).

You can use a message instruction to get status information about these physical components of the drive. See Armor PowerFlex AC Drives CIP Objects and Attributes Reference Data, publication [35-RD001](#) and the example in [Power Supply on page 227](#).

Power Supply

The voltage of internal and external power supplies is monitored and a fault occurs if they are outside the valid range (20.4 ...26.4V):

- 0x04260001 Undervoltage, Hard
- 0x04260002 Overvoltage, Hard

You can use a message instruction to get the status of the internal or external power supplies (active or inactive), the nominal and measured voltage and more. For message instruction information, see Armor PowerFlex AC Drives CIP Objects and Attributes Reference Data, publication [35-RD001](#).

You can also use a message instruction to get the state of the front panel disconnect switch (on/off) used to interrupt 3-phase AC power to the drive.

Service Code	0X0E	Get attribute single
Class	0X0426	Power supply object
Instance	4	3-phase AC power (for motor)
Data Type	BOOL	—
Attribute	8	Physical switch state 0 = The physical switch is in the off position. Power is not being supplied to the end device. 1 = The physical switch is in the on position. Power is being supplied to the end device.

Temperature Sensor

The drive monitors the temperature of system and power boards, the IGBT heatsink, and the system processor. A fault (0x04230002 Overtemperature, Hard) occurs if the measured temperature of any of these components exceeds the predefined, fixed level at which damage may occur.

Fan

For Frame B, the fan will turn OFF either instantly or when a pre-determined time or condition requires it.

Fan Diagnostics include:

1. Alarm that fan has reached its useful life.
 - a. The user can enable or disable this. The default is enabled.
 - b. The user may decide to replace the fan or not
 - c. The user may elect to reset the alarm and continue
 - d. The product is not expected to detect if the fan was actually replaced.
 - e. The act of resetting should be added to the event log
2. Alarm that fan is not operating within its design specification.
 - a. The default is Disable
 - b. When the alarm is enabled, and the condition improves it should automatically clear
3. Fault if the fan has stopped or is well below minimum RPM and must be replaced.
 - a. Fault can be changed to an Alarm. Fan underspeed fault can be configured as an alarm to allow continued operation with reduced performance if the fan is not operational.
 - b. When a fault occurs, the unit will stop.
If the fan recovers before the fault is annunciated, then the drive will continue operation as normal and reset the timer and stop timing.

A fan fault requires you to acknowledge the fault by pressing the clear button locally or remotely, to resume operation. Until you replace the fan or the fan returns to normal operation, there will be a persistent alarm. When the fan issue is corrected, then the alarm will turn off.

Maintenance and Repair

The Armor PowerFlex drive does not require regular maintenance. We recommend that you check that the heatsink has good airflow and that the fan is not obstructed. Also inspect quick connections as needed, to ensure connections remain tight where exposed to shock and vibration.

IMPORTANT

The functional safety part of the product does not need any maintenance (apart from proof testing, if applicable). For the functional safety part of the product, no spare parts are available and no repair is possible or intended by the user. In case of permanent fault, the device has to be taken out of order and replaced by another one.

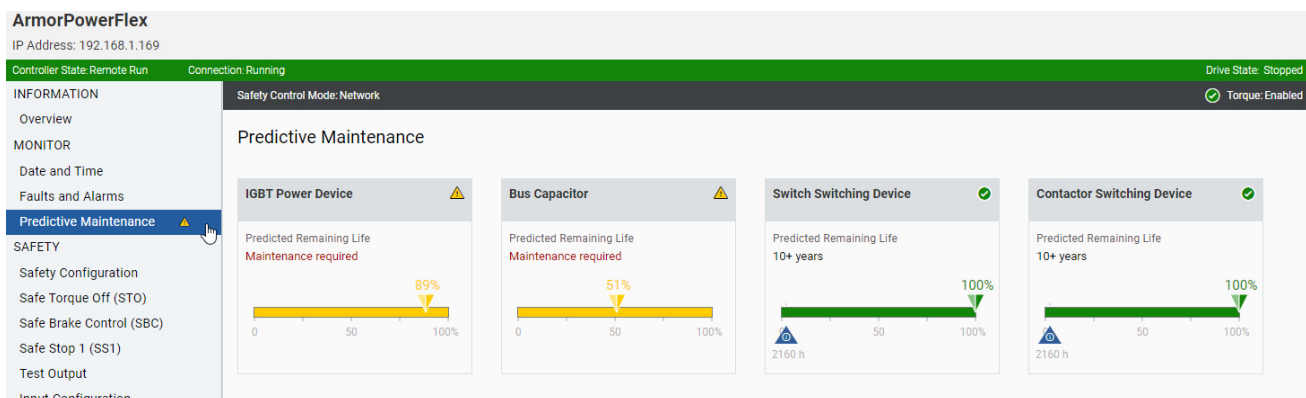
Predictive Maintenance

By using the Predictive Maintenance Component object (class 0x0414), the drive tracks the usage of and calculates the estimated remaining life of these drive components:

Instance	Drive Component
1	IGBT
2	DC bus capacitor
3	Heatsink fan
4	Disconnect switch
5	EM brake

The Predictive Maintenance page displays the Elapsed and predicted Remaining Life of the components, the consumed life as a percentage of the components total life, and indicates whether the component is currently operational.

Predictive Maintenance Page Example



After the Logix Designer application reads the Predictive Maintenance data, the data is cached.

IMPORTANT

The Total Life value might not equal the sum of the Elapsed Life and Remaining Life values because the predictive maintenance process also accounts for environmental or load conditions.

Only the heatsink fan predictive maintenance data can be reset after replacement of a heatsink fan. Click the Reset button to reset the heatsink fan predictive maintenance data.

Remove Power Before Servicing the Armor PowerFlex Drive

Be aware of the following precautions while servicing the Armor PowerFlex drive.

Precautions



ATTENTION: Before replacing a component in a safety system, see [Safety I/O Wiring on page 146](#).



ATTENTION: The service of energized industrial control equipment can be hazardous. Electrical shock, burns, or unintentional actuation of controlled industrial equipment can cause death or serious injury. For safety of maintenance personnel and others who can be exposed to electrical hazards associated with maintenance activities, follow the local safety-related work practices (for example, the NFPA 70E, Part II in the United States). Maintenance personnel must be trained in the safety practices, procedures, and requirements that pertain to their respective job assignments.



ATTENTION: Only qualified personnel familiar with adjustable frequency AC drives and associated machinery must plan or implement the installation, startup, and subsequent maintenance of the system. Failure to comply can result in personal injury and/or equipment damage.



ATTENTION: This drive contains electrostatic discharge (ESD) – sensitive parts and assemblies. Static control precautions are required during installation, test, service, or repair of this assembly. Component damage can result if ESD control procedures are not followed. If you are not familiar with static control procedures, see Guarding against Electrostatic Damage, publication [8000-4.5.2](#), or any other applicable ESD protection handbook.



ATTENTION: The drive contains high-voltage capacitors. After removal of the main power supply, the capacitor discharge process can take 30 seconds to several minutes before a safe voltage is reached. Before working on the drive, or before servicing any device on the motor side, follow the procedure [Test for Hazardous Voltage](#), starting on page [231](#), to verify that power is isolated and to verify that there are no hazardous voltages present. Use the test points under the power section door to confirm there are no hazardous AC line voltages (Test points: D1, D2, D3), and to confirm that the DC Bus capacitor bank voltage is at a safe level (Test points: DC+, DC-). After confirming no hazardous voltages are present at the test points under the power section door, open the power section cover to access the terminal block. Measure the input power on the L1, L2, and L3 of the exposed terminal block to verify that the power has been removed and that no hazardous voltage is present. Failure to verify that power is removed before working on the drive, or failure to verify that no hazardous voltages are present before working on the drive can result in personal injury or death. Darkened display light-emitting diode (LED) status indicators are not an indication that capacitors have discharged to safe voltage levels.



ATTENTION: An incorrectly applied or installed drive can result in component damage or a reduction in product life. Wiring or application errors, such as undersized motor, incorrect or inadequate AC supply, or excessive ambient temperatures can result in malfunction of the system.



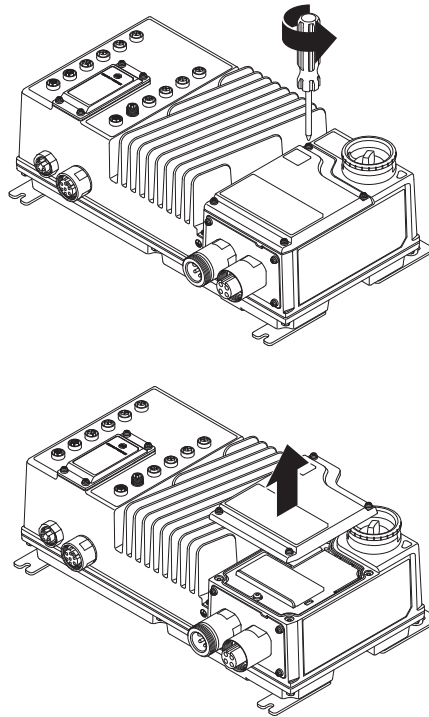
ATTENTION: The Armor PowerFlex drive is meant to be disconnected and replaced, only after proper lockout/tagout procedures have been employed. See [TechConnect Document ID 0A67224](#), for information about Armor PowerFlex lockout/tagout.

Test for Hazardous Voltage

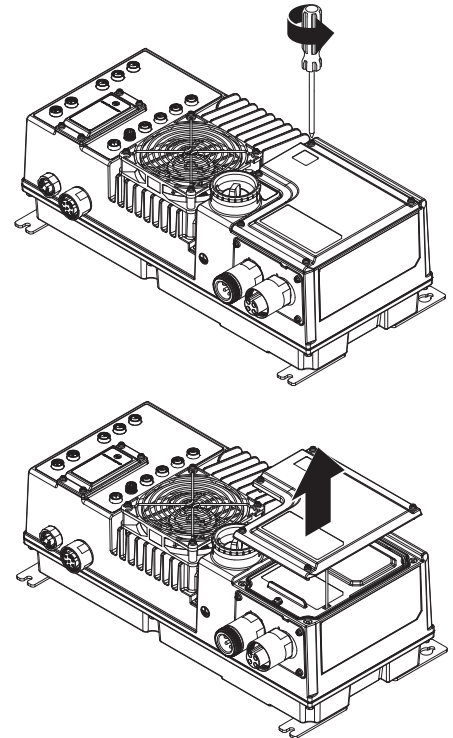
Before servicing the Armor PowerFlex drive or any device in the motor side (motor, motor cables, motor brake, and so on), you must follow these steps to remove power from the Armor PowerFlex, verify power is removed, and test for hazardous voltage:

1. Remove power from the drive by removing the three-phase power using the isolating device upstream (system circuit breaker, for example).
After removal of the main power supply, the capacitor discharge process can take 30 seconds to several minutes before a safe voltage is reached.
2. Loosen the screws to remove the power section door to gain access to the voltage test points: D1, D2, D3, DC-, and DC+.

Frame A



Frame B



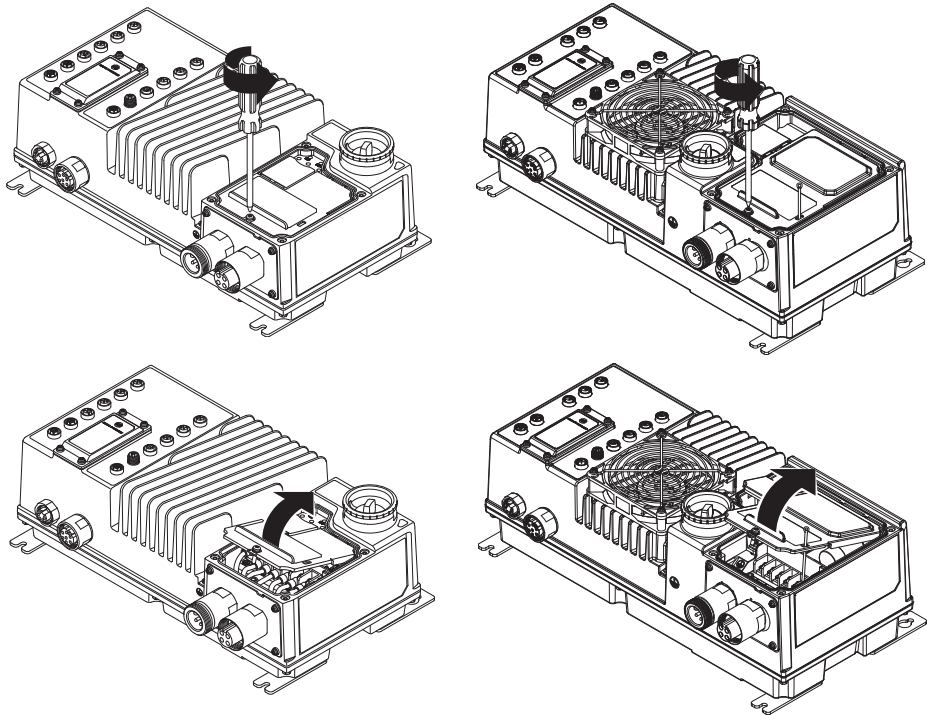
3. Measure the AC line voltage test points D1, D2, D3 (line-to-line and line-to-ground) to verify that main power has been disconnected.
4. Measure DC voltage across DC- and DC+ test points to verify that the DC bus has discharged to zero volts.



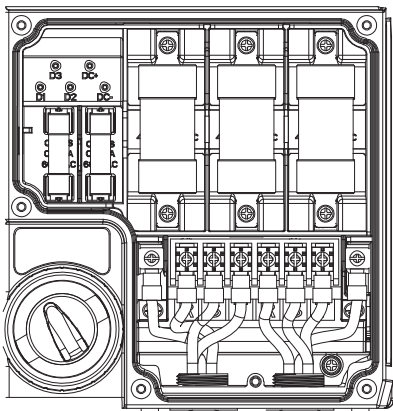
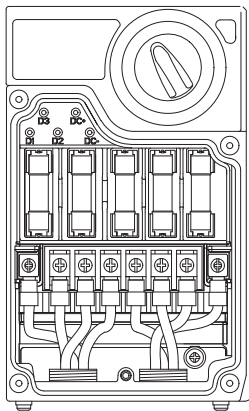
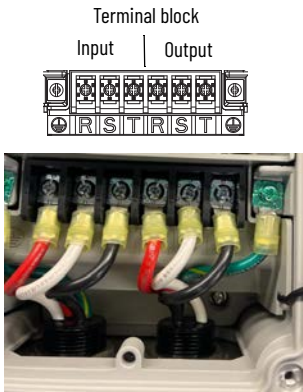
5. After verifying that there are no hazardous voltages present on test points: D1, D2, D3, DC-, or DC+, loosen the screws and remove the internal power section cover.

Frame A

Frame B



6. To verify that power has been removed and hazardous voltage is no longer present, take measurements on the exposed terminal block. Measure **input** power on L1, L2, and L3 (line-to-line and line-to-ground).



Input				Output			
Terminal	Terminal R	Terminal S	Terminal T	Terminal R	Terminal S	Terminal T	Terminal
ground	Line 1	Line 2	Line 3	Line 1	Line 2	Line 3	ground

7. You can now proceed with [Fuse Replacement](#) or other service to the device.

Fuse Replacement

The following fuses can be replaced on the Armor PowerFlex drive:

- Three 3-phase input line fuses
- Two EM brake fuses
- One fuse for Switched +24V power and one fuse for Unswitched +24V power

3-phase AC Power and EM Brake Fuse Replacement

Table 101 - 3-phase Input Power and EM Brake Fuse Specifications

Specification	3-phase AC Line Power Fuses		EM Brake Fuses
	Frame A	Frame B	
Part No.	KTK-20	LPJ-45SP	KTK-6
Description	20 A, 600V AC, UL Listed Class CC, Std. 248-14	45 A, 600V AC, UL Listed Class J, Std. 248-14	6 A, 600V AC, UL Listed Class CC, Std. 248-14
Current	20 A	45 A	6 A
Interrupting Capacity	100 kA rms	300 kA rms	100 kA rms
Voltage Rating	600V AC	600V AC	600V AC
Manufacturer	Bussmann	Bussmann	Bussmann
Dimension mm (in.):	38.1 (1.5) x 10.3 (0.41)	60.4 (2.38) x 26.9 (1.06)	38.1 (1.5) x 10.3 (0.41)

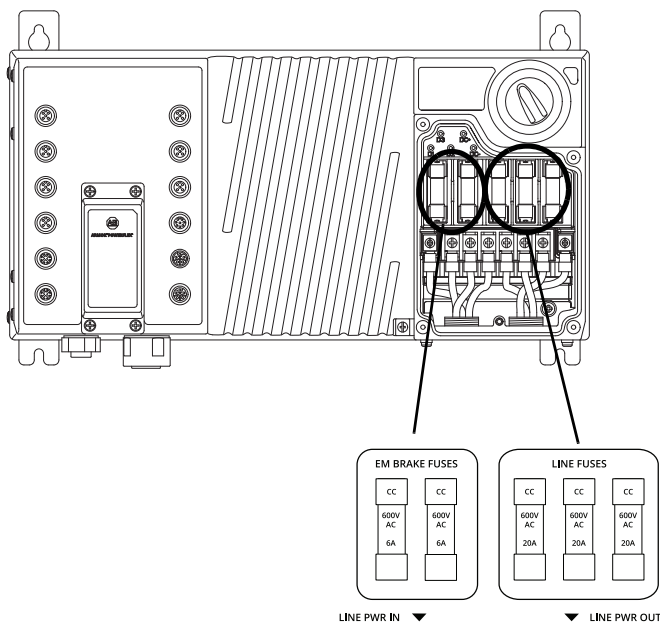
1. Loosen the screws and remove the power section door. See [step 2](#) on [page 231](#).
2. Loosen the screws and remove the internal power section cover. See [step 5](#) on [page 232](#).
3. Remove fuses from holding. We recommend using fuse puller FP-3 from Eaton/Bussmann.



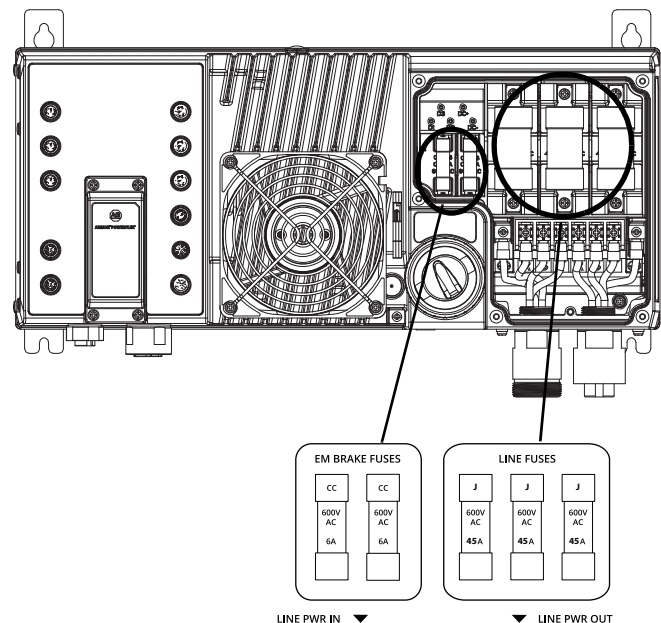
When removing line power fuses, we recommend starting with the middle one, for ease of access.

4. Check each fuse with a multimeter to see if they are in good condition. If damaged, replace the fuses.

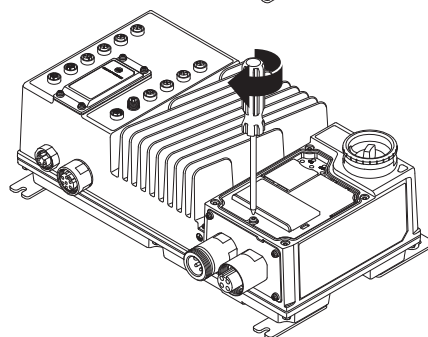
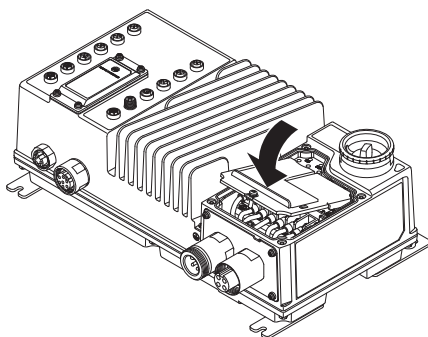
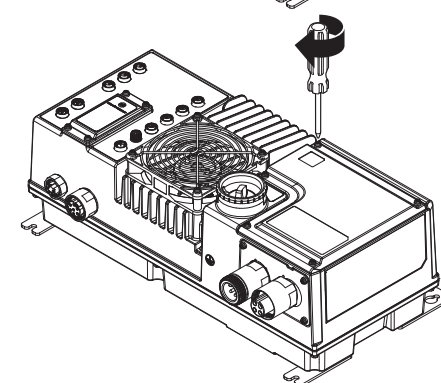
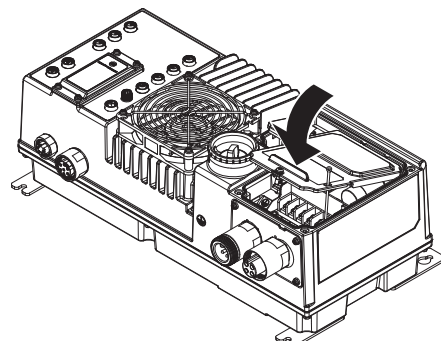
Frame A



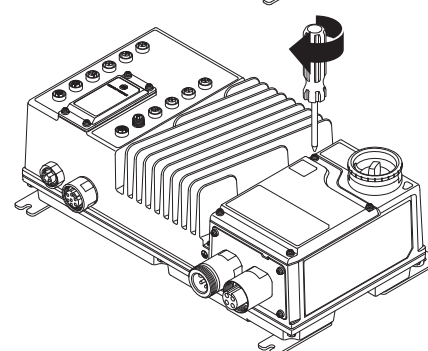
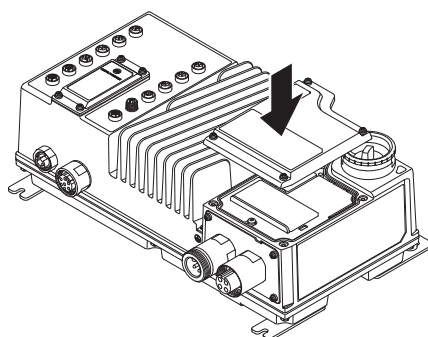
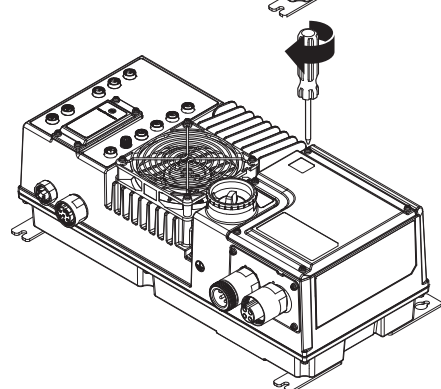
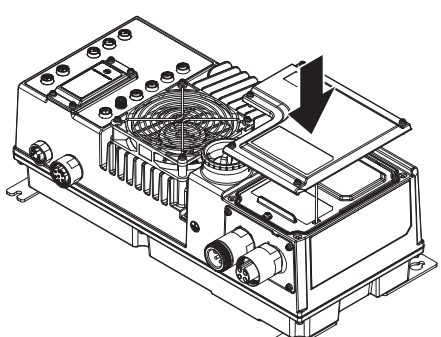
Frame B



5. Replace the internal power section cover. Tighten the screws. 1.37...1.57 N•m (12.1...13.9 lb•in).

Frame A**Frame B**

6. Before replacing the power section door, re-apply power and measure DC voltage across DC- and DC+ test points to verify that the DC bus is re-energized.
7. Replace the power section door. Tighten the screws. 1.37...1.57 N•m (12.1...13.9 lb•in).

Frame A**Frame B**

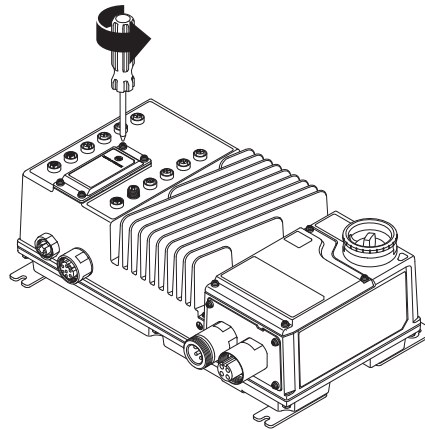
Switched and Unswitched +24V DC Power Fuse Replacement

Table 102 - 24V Fuse Specifications

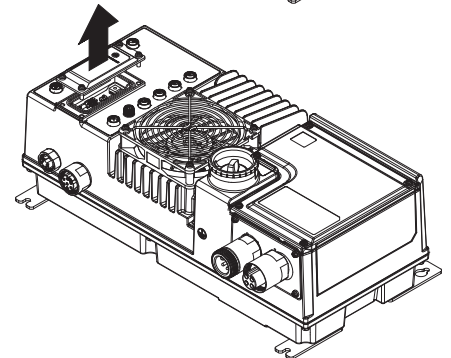
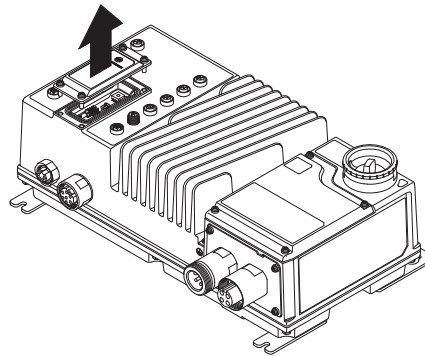
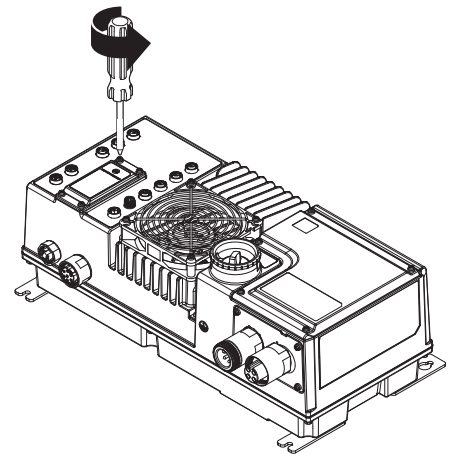
Specification	Unswitched (Control) 24V DC Power Fuses	Switched (Sensor) 24V DC Power Fuses
Part No.	21502.5MXP	215004.MXP
Description	Fuse T C, 2.5 A, 250V, H CLIP	Fuse T C, 4 A, 250V, H CLIP
Current	2.5 A	4 A
Interrupting Capacity	1500 A @ 250V AC	1500 A @ 250V AC
Voltage Rating	250V DC	250V DC
Manufacturer	Littlefuse	Littlefuse
Dimension mm (in.):	20 (0.78) x 5.2 (0.20)	21.5 (0.84) x 5.5 (0.21)

1. Loosen the screws and remove the logic section door screws.

Frame A

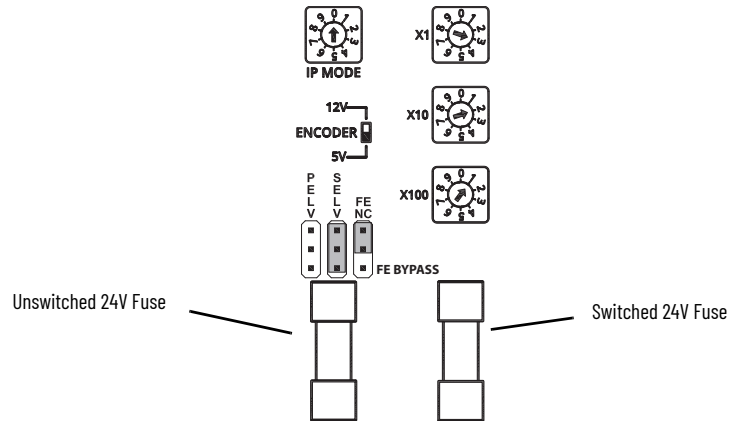


Frame B



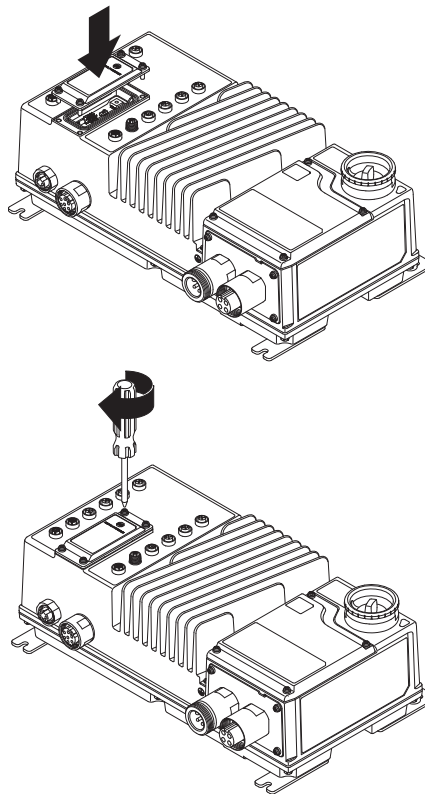
2. Remove fuses from holding. We recommend using fuse puller FP-3 from Eaton/Bussmann.

3. Check each fuse with a multimeter to see if they are in good condition. If damaged, replace the fuses.

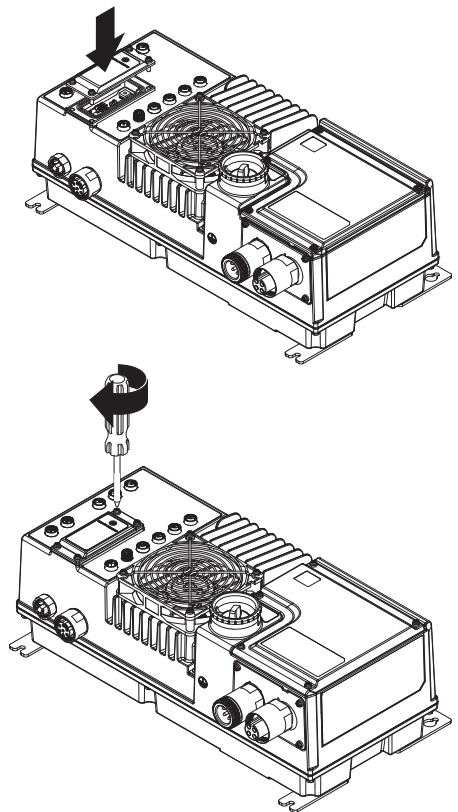


4. Replace the logic section door. Tighten the screws. 1.37...1.57 N•m (12.1...13.9 lb•in).

Frame A



Frame B



Fan Replacement

For instructions on how to replace the fan, see the Armor PowerFlex Fan Replacement Kit Installation Instructions, publication [35-IN008](#).

Integrated Safety Instruction Validation Checklist

IMPORTANT

The validation tests in this appendix only apply to these integrated safety functions:

- Monitored Safe Stop 1 (SS1)
- Safely Limited Speed (SLS)
- Safely Limited Position (SLP)
- Safe Direction (SDI)
- Safety Feedback Interface (SFX)
- Safe Brake Control (SBC)

Use this appendix to validate your integrated safety instructions. Each instruction has a checklist with test commands and results to verify for normal operation and abnormal operation scenarios.

For additional information on the safety instructions see the Drive Safety Chapter of GuardLogix Safety Application Instruction Set Reference Manual, publication [1756-RM095](#).

Safe Stop 1

Use the Safe Stop 1 (SS1) instruction checklist in [Table 103](#) to verify normal operation and the abnormal operation scenarios.

IMPORTANT

Perform I/O verification and validation before validating your safety ladder program. SFX instruction must be verified within your application.

When possible, use immediate operands for instructions to reduce the possibility of systematic errors in your ladder program.

Instruction operands must be verified for your safety ladder program.

Table 103 - SS1 Instruction Checklist

Test Type	Test Description	Test Status
Normal Operation	Initiate a Start command.	
	<ul style="list-style-type: none"> Verify that the machine is in a normal machine run condition Verify proper machine status and safety application program status 	
	Operate the machine at the desired operating system speed.	
	Set up a trend with expected time scale and the following tags to graphically capture this information: <ul style="list-style-type: none"> SFX_Name.ActualSpeed SS1_Name.SpeedLimit SS1_Name.DecelerationRamp SS1_Name.O1 	
	Initiate SS1 demand.	
	Make sure that the instruction output SS1_Name.O1 turns off without generating a fault and that the drive initiates an STO instruction. <ul style="list-style-type: none"> Verify that the STO instruction de-energizes the motor for a normal safe condition. 	
	While the system is stopped with the sensor subsystems in a safe state, initiate a Start command. <ul style="list-style-type: none"> Verify that the STO instruction remains de-energized for a normal safe condition Verify proper machine status and safety application program status 	
	While the system is stopped with the SS1 demand removed, initiate a Reset command of the STO and SS1 instructions. <ul style="list-style-type: none"> Verify that the STO instruction remains de-energized Verify proper machine status and safety application program status 	

Table 103 - SS1 Instruction Checklist (Continued)

Test Type	Test Description	Test Status
Abnormal Operation 1	Change the actual motion deceleration rate within the motion task that is associated with this SS1 function so that it is slower than the calculated speed limit used by the SS1 instruction.	
	Initiate a Start command. • Verify that the machine is in a normal machine run condition • Verify proper machine status and safety application program status	
	Operate the machine at the desired operating system speed.	
	Set up a trend with expected time scale and the following tags to graphically capture this information: • SFX_Name.ActualSpeed • SS1_Name.SpeedLimit • SS1_Name.DecelerationRamp • SS1_Name.O1	
	Initiate SS1 demand.	
	Make sure that the instruction generates a deceleration fault and that the drive initiates an STO instruction. • Verify that the STO instruction de-energizes the motor for a normal safe condition	
	While the system is stopped with the sensor subsystems in a safe state, initiate a Start command. • Verify that the STO instruction remains de-energized for a normal safe condition • Verify proper machine status and safety application program status	
	While the system is stopped with the SS1 demand removed, initiate a Reset command of the STO and SS1 instructions. • Verify that the STO instruction remains de-energized • Verify proper machine status and safety application program status	
Abnormal Operation 2	Change the motion deceleration rate within the motion task that is associated with this SS1 function so that the stop delay time is exceeded without triggering a deceleration fault.	
	Initiate a Start command. • Verify that the machine is in a normal machine run condition • Verify proper machine status and safety application program status	
	Operate machine at desired operating system speed.	
	Set up a trend with expected time scale and the following tags to graphically capture this information: • SFX_Name.ActualSpeed • SS1_Name.SpeedLimit • SS1_Name.DecelerationRamp • SS1_Name.O1	
	Initiate SS1 demand.	
	Make sure that the instruction generates a maximum time fault and that the drive initiates an STO instruction. • Verify that the STO instruction de-energizes the motor for a normal safe condition	
	While the system is stopped with the sensor subsystems in a safe state, initiate a Start command. • Verify that the STO instruction remains de-energized for a normal safe condition • Verify proper machine status and safety application program status	
	While the system is stopped with the SS1 demand removed, initiate a Reset command of the STO and SS1 instructions. • Verify that the STO instruction remains de-energized • Verify proper machine status and safety application program status	

Safely-limited Speed

Use the Safety-limited Speed (SLS) instruction checklist in [Table 104](#) to verify normal operation and the abnormal operation scenarios.

IMPORTANT

Perform I/O verification and validation before validating your safety ladder program. SFX instruction must be verified within your application.

When possible, use immediate operands for instructions to reduce the possibility of systematic errors in your ladder program.

Instruction operands must be verified for your safety ladder program.

Table 104 - SLS Instruction Checklist

Test Type	Test Description	Test Status
Normal Operation	Initiate a Start command. <ul style="list-style-type: none"> Verify that the machine is in a normal machine run condition Verify proper machine status and safety application program status 	
	Operate the machine within the desired speed range.	
	Set up a trend with expected time scale and the following tags to graphically capture this information: SFX_Name.ActualSpeed SLS_Name.SLSLimit SLS_Name.ActiveLimit SLS_Name.Output 1	
	Initiate SLS demand.	
	Verify that the drive achieves the speed below the SLS_Name.ActiveLimit without asserting the SLS_Name.SLSLimit output.	
	While the system is in SLS monitoring state and with the sensor subsystems in a safe state, remove the SLS demand. <ul style="list-style-type: none"> Verify proper machine status and safety application program status 	
	Resume normal machine operation. <ul style="list-style-type: none"> Verify proper machine status and safety application program status 	
Abnormal Operation 1	Initiate a Start command. <ul style="list-style-type: none"> Verify that the machine is in a normal machine run condition Verify proper machine status and safety application program status 	
	Operate the machine within the normal speed range.	
	Set up a trend with expected time scale and the following tags to graphically capture this information: SFX_Name.ActualSpeed SLS_Name.SLSLimit SLS_Name.ActiveLimit SLS_Name.Output 1	
	Initiate SLS demand.	
	Verify that the drive achieves the speed below the SLS_Name.ActiveLimit without asserting the SLS_Name.SLSLimit output.	
	While the system is in the SLS monitoring state, initiate a motion command that violates the SLS_Name.ActiveLimit. <ul style="list-style-type: none"> Verify that the SLS_Name.SLSLimit output is asserted and the programmed stop action is initiated 	
	While the system is stopped with the sensor subsystems in a safe state, initiate a Start command. <ul style="list-style-type: none"> Verify proper machine status and safety application program status 	
	While the system is stopped, initiate a Reset command. <ul style="list-style-type: none"> Verify proper machine status and safety application program status 	

Safely-limited Position

Use the Safely-limited Position (SLP) instruction checklist in [Table 105](#) to verify normal operation and the abnormal operation scenarios.

IMPORTANT

Perform I/O verification and validation before validating your safety ladder program. SFX instruction must be verified within your application.

When possible, use immediate operands for instructions to reduce the possibility of systematic errors in your ladder program.

Instruction operands must be verified for your safety ladder program.

Table 105 - SLP Instruction Checklist

Test Type	Test Description	Test Status
Normal Operation	Initiate a Start command. <ul style="list-style-type: none"> Verify that the machine is in a normal machine run condition Verify proper machine status and safety application program status 	
	Operate the machine within the desired position range.	
	Set up a trend with expected time scale and the following tags to graphically capture this information: <ul style="list-style-type: none"> SFX_Name.ActualPosition SLP_Name.SLPLimit SLP_Name.PositiveTravelLimit SLP_Name.NegativeTravelLimit SLP_Name.Output 1 	
	Initiate SLP demand.	
	Verify that the drive achieves and maintains a position between the SLP_Name.PositiveTravelLimit and the SLP_Name.NegativeTravelLimit without asserting the SLP_Name.SLPLimit output.	
	While the system is in SLP monitoring state and with the sensor subsystems in a safe state, remove the SLP demand. <ul style="list-style-type: none"> Verify proper machine status and safety application program status 	
	Resume normal machine operation. <ul style="list-style-type: none"> Verify proper machine status and safety application program status 	
Abnormal Operation 1	Initiate a Start command. <ul style="list-style-type: none"> Verify that the machine is in a normal machine run condition Verify proper machine status and safety application program status 	
	Operate the machine within the desired position range.	
	Set up a trend with expected time scale and the following tags to graphically capture this information: <ul style="list-style-type: none"> SFX_Name.ActualPosition SLP_Name.SLPLimit SLP_Name.PositiveTravelLimit SLP_Name.NegativeTravelLimit SLP_Name.Output 1 	
	Initiate SLP demand.	
	Verify that the drive achieves and maintains a position between the SLP_Name.PositiveTravelLimit and the SLP_Name.NegativeTravelLimit without asserting the SLP_Name.SLPLimit output.	
	While the system is in the SLP monitoring state, initiate a motion command that violates the SLP_Name.PositiveTravelLimit. <ul style="list-style-type: none"> Verify that SLP_Name.SLPLimit output is asserted and the programmed stop action is initiated 	
	While the system is stopped with the sensor subsystems in a safe state, initiate a Start command. <ul style="list-style-type: none"> Verify proper machine status and safety application program status 	
	While the system is stopped, initiate a Reset command. <ul style="list-style-type: none"> Verify proper machine status and safety application program status 	
Abnormal Operation 2	Initiate a Start command. <ul style="list-style-type: none"> Verify that the machine is in a normal machine run condition Verify proper machine status and safety application program status 	
	Operate the machine within the desired position range.	
	Set up a trend with expected time scale and the following tags to graphically capture this information: <ul style="list-style-type: none"> SFX_Name.ActualPosition SLP_Name.SLPLimit SLP_Name.PositiveTravelLimit SLP_Name.NegativeTravelLimit SLP_Name.Output 1 	
	Initiate SLP demand.	
	Verify that the drive achieves and maintains a position between the SLP_Name.PositiveTravelLimit and the SLP_Name.NegativeTravelLimit without asserting the SLP_Name.SLPLimit output.	
	While the system is in the SLP monitoring state, initiate a motion command that violates the SLP_Name.NegativeTravelLimit. <ul style="list-style-type: none"> Verify that SLP_Name.SLPLimit output is asserted and the programmed stop action is initiated 	
	While the system is stopped with the sensor subsystems in a safe state, initiate a Start command. <ul style="list-style-type: none"> Verify proper machine status and safety application program status 	
	While the system is stopped, initiate a Reset command. <ul style="list-style-type: none"> Verify proper machine status and safety application program status 	

Safe Direction

Use the Safe Direction (SDI) instruction checklist in [Table 106](#) to verify normal operation and the abnormal operation scenarios.

IMPORTANT

Perform I/O verification and validation before validating your safety ladder program. SFX instruction must be verified within your application.

When possible, use immediate operands for instructions to reduce the possibility of systematic errors in your ladder program.

Instruction operands must be verified for your safety ladder program.

Table 106 - SDI Instruction Checklist

Test Type	Test Description	Test Status
Normal Operation	Initiate a Start command. • Verify that the machine is in a normal machine run condition • Verify proper machine status and safety application program status	
	Operate the machine within the desired operating range.	
	Set up a trend with expected time scale and the following tags to graphically capture this information: • <i>SFX_Name.ActualPosition</i> • <i>SDI_Name.SDILimit</i> • <i>SDI_Name.PositionWindow</i> • <i>SDI_Name.Output 1</i>	
	Initiate SDI demand.	
	Verify that motion is in the intended direction and the <i>SDI_Name.SDILimit</i> output is not asserted.	
	While the system is in SDI monitoring state and with the sensor subsystems in a safe state, remove the SDI demand. • Verify proper machine status and safety application program status	
	Resume normal machine operation. • Verify proper machine status and safety application program status	
Abnormal Operation 1	Initiate a Start command. • Verify that the machine is in a normal machine run condition • Verify proper machine status and safety application program status	
	Operate the machine within the desired operating range.	
	Set up a trend with expected time scale and the following tags to graphically capture this information: • <i>SFX_Name.ActualPosition</i> • <i>SDI_Name.SDILimit</i> • <i>SDI_Name.PositionWindow</i> • <i>SDI_Name.Output 1</i>	
	Initiate SDI demand.	
	Verify that motion is in the intended direction and the <i>SDI_Name.SDILimit</i> output is not asserted.	
	While the system is in the SDI monitoring state, initiate a motion command that violates the <i>SDI_Name.PositionWindow</i> in the unintended direction. • Verify that <i>SDI_Name.SDILimit</i> output is asserted and the programmed stop action is initiated	
	While the system is stopped with the sensor subsystems in a safe state, initiate a Start command. • Verify proper machine status and safety application program status	
	While the system is stopped, initiate a Reset command. • Verify proper machine status and safety application program status	

Safe Feedback Interface

Use the Safe Feedback Interface (SFX) instruction checklist in [Table 107](#) to verify normal operation and the abnormal operation scenarios.

IMPORTANT

Perform I/O verification and validation before validating your safety ladder program. SFX instruction must be verified within your application.

When possible, use immediate operands for instructions to reduce the possibility of systematic errors in your ladder program.

Instruction operands must be verified for your safety ladder program.

Table 107 - SFX Instruction Checklist

Test Type	Test Description	Test Status
Normal Scaling Operation	Initiate a Start command. <ul style="list-style-type: none"> Verify that the machine is in a normal machine run condition Verify proper machine status and safety application program status 	
	Operate the machine within the normal operating range.	
	Set up a trend with the expected time scale and the following tags to graphically compare the motion position and speed from the Main task to the scaled position and speed in the Safety task. <ul style="list-style-type: none"> Axis_Name.ActualPosition Axis_Name.ActualSpeed SFX_Name.ActualPosition SFX_Name.ActualSpeed 	
	Verify that the standard and safety position and speed are correlated as expected.	
Normal Homing Operation	Initiate a Start command.	
	Initiate a Homing procedure. <ul style="list-style-type: none"> Verify that the Home Position in the SFX instruction is set 	
	Set up a trend with the expected time scale and the following tags to graphically compare the motion position and speed from the Main task to the scaled position and speed in the Safety task. <ul style="list-style-type: none"> Axis_Name.ActualPosition SFX_Name.ActualPosition 	
	Verify that the standard and safety position are correlated as expected.	
Abnormal Operation 1	Initiate a Start command. <ul style="list-style-type: none"> Verify that the machine is in a normal machine run condition Verify proper machine status and safety application program status 	
	Operate the machine within the normal operating range.	
	Set up a trend with the expected time scale and the following tags to graphically compare the motion position and speed from the Main task to the scaled position and speed in the Safety task. <ul style="list-style-type: none"> Axis_Name.ActualPosition Axis_Name.ActualSpeed SFX_Name.ActualPosition SFX_Name.ActualSpeed 	
	Verify that the standard and safety position and speed are correlated as expected.	
	Disconnect the feedback between the motor/encoder and drive.	
	Verify the generation of a Fault Type: 100 Feedback Invalid by checking Device_Name.SI.PrimaryFeedbackValid tag.	
	Verify that the system fault action takes place as configured.	
	While the system is stopped with the sensor subsystems in a safe state, initiate a Start command. <ul style="list-style-type: none"> Verify proper machine status and safety application program status 	
	While the system is stopped, initiate a Reset command. <ul style="list-style-type: none"> Verify proper machine status and safety application program status 	
Abnormal Operation 2	Initiate a Start command. <ul style="list-style-type: none"> Verify that the machine is in a normal machine run condition Verify proper machine status and safety application program status 	
	Operate the machine within the normal operating range.	
	Set up a trend with the expected time scale and the following tags to graphically compare the motion position and speed from the Main task to the scaled position and speed in the Safety task. <ul style="list-style-type: none"> Axis_Name.ActualPosition Axis_Name.ActualSpeed SFX_Name.ActualPosition SFX_Name.ActualSpeed 	
	Verify that the standard and safety position and speed are correlated as expected.	
	Disconnect the Ethernet cable between the controller and the drive.	
	Verify the generation of a Fault Type: 101 Connection Fault by checking the Device_Name.SI.ConnectionFaulted tag.	
	Verify that the system fault action takes place as configured	
	While the system is stopped with the sensor subsystems in a safe state, initiate a Start command. <ul style="list-style-type: none"> Verify proper machine status and safety application program status 	
	While the system is stopped, initiate a Reset command. <ul style="list-style-type: none"> Verify proper machine status and safety application program status 	

Safe Brake Control

Use the Safe Brake Control (SBC) instruction checklist in [Table 108](#) to verify normal operation and the abnormal operation scenarios.

IMPORTANT

Perform I/O verification and validation before validating your safety ladder program.

When possible, use immediate operands for instructions to reduce the possibility of systematic errors in your ladder program.

Instruction operands must be verified for your safety ladder program.

Table 108 - SBC Instruction Checklist

Test Type	Test Description	Test Status
Normal Operation	Verify that the brake feedback is properly wired to the input module as documented.	
	Initiate a Start command. • Verify that the machine is in a normal machine run condition • Verify proper machine status and safety application program status	
	Set up a trend with expected time scale and the following tags to graphically capture this information: • <i>SBC_Name.B01</i> • <i>SBC_Name.B02</i> • <i>SBC_Name.TOR</i> • <i>Device_Name.STOOutput</i>	
	Initiate an SBC request and initiate the STO event. • Verify the expected coordination of the STO output initiation and the <i>SBC_Name.B01</i> and <i>SBC_Name.B02</i> outputs • Verify proper machine status and safety application program status	
	While the system is stopped, initiate a Start command. • Verify that the system remains de-energized for a normal safe condition • Verify proper machine status and safety application program status	
	While the system is stopped, initiate a Reset command. • Verify that the system remains de-energized for a normal safe condition • Verify proper machine status and safety application program status	
Abnormal Operation	Verify that brake feedback is properly wired to the input module as documented.	
	Initiate a Start command. • Verify that the machine is in a normal machine run condition • Verify proper machine status and safety application program status	
	Initiate machine function to make sure that the brake is released.	
	Set up a trend with expected time scale and the following tags to graphically capture this information: • <i>SBC_Name.B01</i> • <i>SBC_Name.B02</i> • <i>SBC_Name.TOR</i> • <i>Device_Name.STOOutput</i>	
	Remove brake feedback wires from the input module.	
	• Verify that the appropriate diagnostic code is generated • Verify that the brake output <i>SBC_Name.B01</i> and <i>SBC_Name.B02</i> bits clear • Verify the external brake engagement	
	While the system is stopped with the sensor subsystems in a safe state, initiate a Start command. • Verify proper machine status and safety application program status	
	While the system is stopped, initiate a Reset command. • Verify proper machine status and safety application program status	

Notes:

Configure a Message Instruction

Overview

A message instruction (MSG) is used to transfer data that does not require continuous updates. You can use it to configure and monitor the parameters/attributes of a dependent device on the network.

IMPORTANT A message instruction must not be used for any safety-related function.

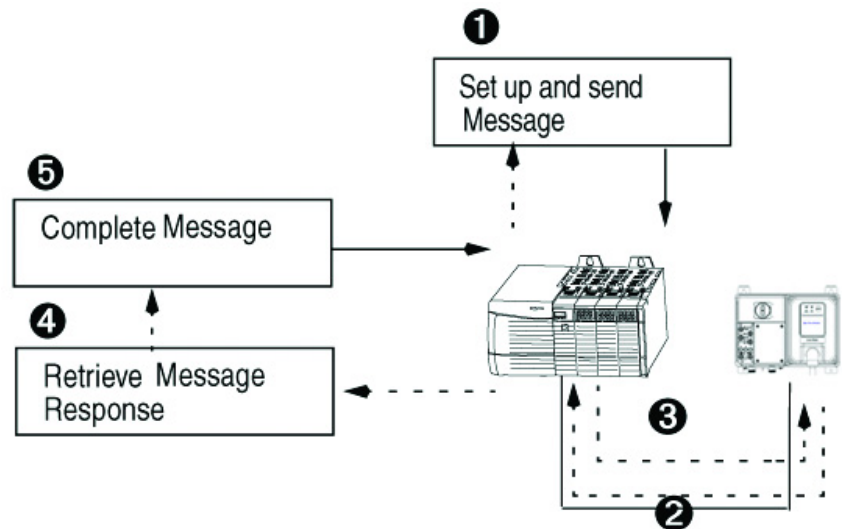
Before you can configure an MSG instruction, you must create a tag with the MESSAGE data type to use in your logic program.

The MSG (message) instruction handles all messaging that is initiated by a Logix Designer program. It automatically creates and manages TCP connections and CIP encapsulation sessions.

For details on how to use MSG instructions, see Logix 5000 Controllers Messages Programming Manual, publication [1756-PM012](#).

Message Process

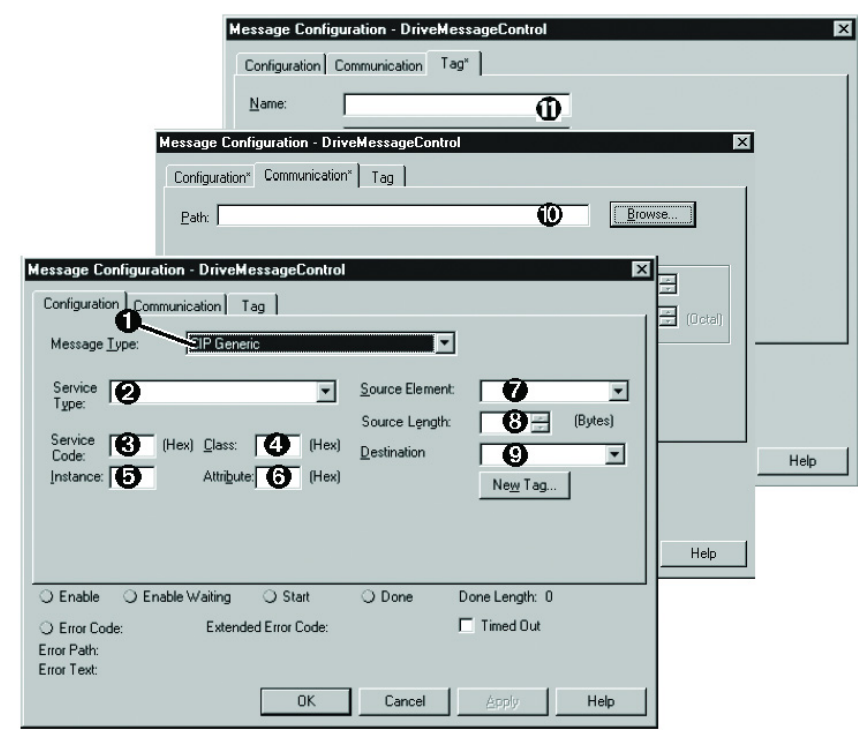
Figure 90 - Message Process



Box	Description
1	Format the required data and configure the ladder logic program to send a Message Request to the scanner or bridge module (download).
2	The scanner or bridge module transmits the Message Request to the dependent device over the EtherNet/IP network.
3	The dependent device transmits the Message Response back to the scanner. The data is stored in the scanner buffer.
4	The controller retrieves the Message Response from the buffer of the scanner (upload).
5	The Message is complete.

The details of each step vary depending on the controller. See the product documentation for your controller.

Figure 91 - ControlLogix Message Format in Studio 5000



For supported classes, instances, and attributes, see Armor PowerFlex AC Drives CIP Objects and Attributes Reference Data, publication [35-RD001](#).

Box	Description
1	Message Type The message type is usually CIP Generic.
2	Service Type The service type indicates the service (for example, Get Attribute Single or Set Attribute Single) that you want to perform.
3	Service Code The service code is the code for the requested EtherNet/IP service. This value changes based on the Service Type that has been selected. In most cases, this is a read-only box. If you select "Custom" in the Service Type box, then you must specify a service code in this box (for example, 4B for a Get Attributes Scattered service or 4C for a Set Attributes Scattered service).
4	Class The class is an EtherNet/IP class.
5	Instance The instance is an instance (or object) of an EtherNet/IP class.
6	Attribute The attribute is a class or instance attribute.
7	Source Element This box contains the name of the tag for any service data to be sent from the scanner or bridge to the module and drive.
8	Source Length This box contains the number of bytes of service data to be sent in the message.
9	Destination This box contains the name of the tag that receives service response data from the module and drive.
10	Path The path is the route that the message follows. Note: Click Browse to find the path or type in the name of a module that you previously mapped.
11	Name The name for the message.

Example: Read SS1 Fault Type

In the drive module, the connection to the safety instance or instances is controlled by a safety supervisor. The supervisor status is read by the safety controller through the Safety Input Assembly or by an explicit message.

Table 109 - Safe Stop 1 Fault Type: MSG

Parameter	Value	Description
Service Code	0x0E	Get attribute single
Class	0x5A	Safety Stop Functions Object
Instance	1	
Attribute	0x11C	SS1 Fault Type
Data Type	USINT	Unsigned short integer



The screenshot shows the 'Message Configuration - MSG1' dialog box. The 'Configuration' tab is selected. The 'Message Type' is set to 'CIP Generic'. The 'Service Type' is 'Get Attribute Single'. The 'Service Code' is 'e' (Hex), 'Class' is '5a' (Hex), 'Instance' is '1', and 'Attribute' is '11c' (Hex). The 'Source Element' is empty, 'Source Length' is '0' (Bytes), and 'Destination Element' is 'SS1_Fault_Type'. The 'New Tag...' button is visible. At the bottom, there are radio buttons for 'Enable', 'Enable Waiting', 'Start', and 'Done', with 'Done Length' set to '0'. There are also checkboxes for 'Error Code', 'Extended Error Code', and 'Timed Out'.

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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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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.

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Publication 35-UM001E-EN-P - February 2024

Supersedes Publication 35-UM001D-EN-P - October 2023

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