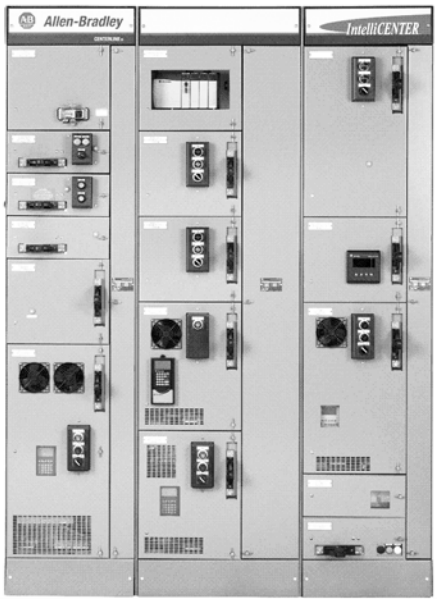
Application Technique

Original Instructions

CENTERLINE Low Voltage Motor Control Centers Functional Safety

Bulletin Numbers 2100 and 2500



Important User Information

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

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

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

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

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

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

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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 publication describes a standardized implementation of safety functions that combine CENTERLINE® Low Voltage Motor Control Centers (LVMCC) with a variety of safety-related products.

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. Changes beyond the substantive updates listed are identified by change bars.

Topic	Page
Added Safety Automation Builder statement to section "IMPORTANT"	12

Download Files and Software

Before you can download files from the Product Compatibility and Download Center (PCDC) at rok.auto/pcdc, you must be registered with the website and accept the User Agreement.

Access Components of the Safety Function

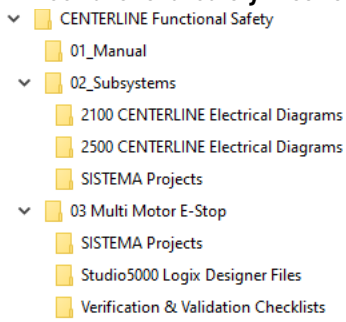
The component files (Studio 5000 Logix Designer® files, SISTEMA, electrical schematics, and verification and validation checklist) help you implement the safety functions shown in this document. 'LVMCC Functional Safety Application Guide Content' files are available to download from the Product Compatibility and Download Center (PCDC) at rok.auto/pcdc.

Download Safety Files

Download CENTERLINE LVMCC Functional Safety Files

1. Navigate to the Product Compatibility and Download Center (PCDC) at rok.auto/pcdc.
2. Search for "LVMCC Functional Safety Application Guide Content"
3. Download this release package to your personal computer (PC).
4. Extract the zip file to a a desirable location on your PC. The folder structure appears as shown in Figure 1.

Figure 1 - LVMCC Functional Safety Files Folder Organization



For more information on using additional content, view the following videos:
Introduction to Functional Safety for CENTERLINE Low Voltage Motor Control Centers
Access Functional Safety Component Files for CENTERLINE LVMCC
CENTERLINE Low Voltage Motor Control Center Safety Function with Safety Relay and Motor Starter
CENTERLINE LVMCC Safety Function with GuardLogix and PowerFlex Drives

About the SISTEMA Software Utility

SISTEMA (Safety Integrated Software Tool for the Evaluation of Machine Applications) is a free software utility for safety function evaluation per ISO13849-1. For more information on SISTEMA, visit the DGUV website and the Rockwell Automation SISTEMA Library.

Related Safety Standards

Table 1 - Related Safety Standards

Standard	Description
ANSI B11.19-2010	American National Standard for Machines – Performance Criteria for Safeguarding
ANSI B11.20–2017	Safety Requirements for Integrated Manufacturing Systems
ANSI/ASSE Z244.1 – 2016	The Control of Hazardous Energy Lockout, Tag Out, and Alternative Methods
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 ISO 13849-1	Safety of machinery – Safety-related parts of control systems — Part 1: General principles for design
EN ISO 13849-2	Safety of machinery — Safety-related parts of control systems — Part 2: Validation
IEC 61508 Part 1-7	Functional safety of electrical/electronic/programmable electronic safety-related systems
ISO 12100	Safety of machinery – General principles for design – Risk assessment and risk reduction
NFPA 79 - 2018	Electrical Standard for Industrial Machinery

General Safety Information

IMPORTANT These application examples are for advanced users and assume that you are trained and experienced in safety system requirements.

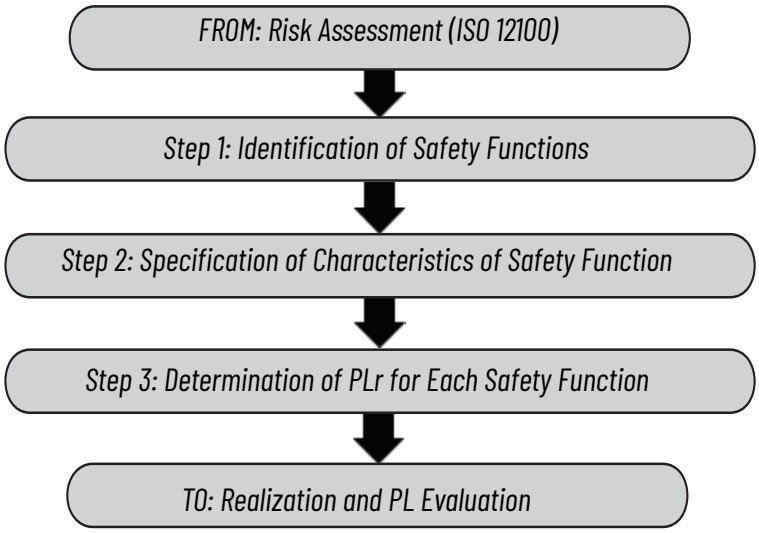
Risk Assessments

ATTENTION: A risk assessment should be performed to make sure that all task and hazard combinations have been identified and addressed.
The risk assessment can require additional circuitry to reduce the risk to a tolerable level. Safety circuits must consider safety distance calculations which beyond the scope of this document.

Learn more about our safety-risk assessment services at rok.auto/safetyservices.

The required performance level (PLr) is the result of a risk assessment and refers to the amount of the risk reduction to be carried out by the safety-related parts of the control system. Part of the risk reduction process is to determine the safety functions of the machine. For example, the PLr by the risk assessment for one of the required safety functions could be Category 3, Performance Level d (Cat. 3, PLd). A safety system that achieves Cat. 3, PLd or higher can be considered control reliable. Each safety product has its own rating and can be combined to create a safety function that meets or exceeds the PLr.

Figure 2 - Safety Function Flow



Safety Distance Calculations

ATTENTION: While safety distance or access time calculations are beyond the scope of this document, compliant safety circuits must often consider a safety distance or access time calculation.

Non-separating Safeguards

Non-separating safeguards provide no physical barrier to help prevent access to a hazard. Publications that offer guidance for calculating compliant safety distances for safety systems that use non-separating safeguards, such as light curtains, scanners, two-hand controls, or safety mats, include the following:

Table 2 - Non-separating Safeguards: Publications

Publication Number	Title	Description
EN ISO 13855:2010	Safety of Machinery	Positioning of safeguards with respect to the approach speeds of parts of the human body
EN ISO 13857:2008	Safety of Machinery	Safety distances to help prevent hazardous zones being reached by upper and lower limbs
ANSI B11:19 2010	Machines	Performance Criteria for Safeguarding

In addition to this publication guidance, consult relevant national or local safety standards to assure compliance.

Separating Safeguards

Separating safeguards monitor a movable, physical barrier that guard access to a hazard. Publications that offer guidance for calculating compliant access times for safety systems that use separating safeguards, such as gates with limit switches or interlocks (including SensaGuard™ switches), include the following:

Table 3 - Separating Safeguards: Publications

Publication Number	Title	Description
EN ISO 14119:2013	Safety of Machinery	Interlocking devices associated with guards - Principles for design and selection
EN ISO 13855:2010	Safety of Machinery	Positioning of safeguards with respect to the approach speeds of parts of the human body
EN ISO 13857:2008	Safety of Machinery	Safety distances to help prevent hazardous zones being reached by upper and lower limbs
ANSI B11:19 2010	Machines	Performance Criteria for Safeguarding

In addition to this publication guidance, consult relevant national or local safety standards to assure compliance.

Considerations for Safety Distance and Stopping Performance

Based on the selection of a sensor subsystem, the risk assessment determines if a safety distance calculation is required. Typically, a safety distance calculation is required if a non-separating sensor subsystem (such as a light curtain) is selected for the safety function. If a safety distance calculation is required for this safety function, the following publications can be referenced:

Table 4 - Safety Distance Calculation Publications

Publication Number	Title
440L-UM003	GuardShield™ Micro 400 Safety Light Curtains User Manual
1756-RM012	GuardLogix® 5580 and Compact GuardLogix 5380 Controller Systems Safety Reference
SAFEBK-RM002	SafeBook 5 - Safety related control systems for machinery

Safe Stop Safety Function

This document includes partial safety functions (subsystems) and complete safety functions. The complete safety function covered in this document includes the stopping of a motor when the safety system detects one or more sensor subsystems have placed a demand on the safety function. The stopping of the motor removes the hazard.

- Stop Category 0 - coast-to-stop
- Stop Category 1 - controlled stop

In these applications, the removal of motion-producing power is the safe state. All components in the system must be chosen and applied correctly to achieve the desired level of operator safeguarding.

Introduction

About this Application Technique

This Application Technique describes a standardized implementation of safety functions that combine CENTERLINE® Low Voltage Motor Control Centers (LVMCCs) with a variety of safety-related products.

Components included in the safety function include drawings, SISTEMA files, and Studio 5000 Logix Designer® files. The safety function can provide the following:

- Help minimize delivery times of safety CENTERLINE LVMCC units.
- Help decrease overall cost of acquisition of safety CENTERLINE LVMCC units.
- Enable you to maximize operational safety and productivity by selecting motor controller units (MCUs) as safety function subsystems.
- Enable you to minimize personal and enterprise risk when engineering safety functions that use safety MCUs as safety function subsystems.

Both CENTERLINE 2100 and CENTERLINE 2500 LVMCCs are covered in this Application Technique and the following products are included as safety subsystems:

- MCUs (hardwired and integrated safety options)
- Safety control relay distribution units
- Safety monitoring relay distribution units
- Bulletin 1734 safety I/O remote distribution unit

IMPORTANT This Application Technique does not cover the safety soft starter unit option. Consider alternate MCU options when the application requires the safety circuit to meet a specified safety level per ISO 13849-1 or ISO 62061. See the Rockwell Automation Knowledgebase article, Example Safety Circuits Categories for the SMC™ soft starters, which show examples of safety circuit categories for soft starters.

This Application Technique focuses on an emergency-stop (E-stop), typically triggered by push button or pull-cord mechanism, because it is the most common safety function that is implemented in machines and equipment. Safety relays, contactors, and variable frequency drives (VFDs) are part of the safety function and are commonly located inside of an LVMCC.

When applying a safety function to an LVMCC, it is common to define a safety zone where one motor or multiple motors must stop if an E-stop push button is actuated. This Application Technique covers both situations. In this Application Technique, the MCU is considered a safety function subsystem.

A subsystem is a part of the safety function and in an LVMCC is usually a unit or a combination of units responsible for the output (contactor or drive) and possibly the logic solver (safety controller or safety relay) of the safety function.

Typically, a safety function includes three subsystems:

- input (sensor),
- logic solver (controller or monitoring relay), and
- output (actuator).

In this Application Technique, the term 'subsystem' is being applied to an LVMCC unit. As an example, a subsystem can contain an actuator (such as a drive or a contactor), a logic solver (such as a safety monitoring relay), or both.

A SISTEMA (Safety Integrated Software Tool for the Evaluation of Machine Applications) file is available for each subsystem that is listed in this Application Technique. The SISTEMA file provides justification for the safety level that is achieved by the subsystem. The justification is based on the safety product certificates or in concepts such as well-tried components or well-tried safety principles that require products to meet specific standards. When applicable, a SISTEMA file also contains an evaluation against CCF (Common Cause Failure) for the subsystem.

The SISTEMA file facilitates the integration of the subsystem into a safety function application.

This Application Technique considers both an Ethernet/IP™ and IntelliCENTER® LVMCC, capable of connecting to a safety controller for integrated network safety, and a hardwired functional safety solution.

The following chapters describe three different subsystems that are covered by this Application Technique:

- Safety Variable-frequency Drives Subsystems, Chapter 3
- Safety Starters Subsystems, Chapter 4
- Safety Distribution Subsystems, Chapter 5

A description, set of electrical schematics, and configuration information is provided for subsystems of each type. Chapter 6 provides examples for how to use the components that are shown in this Application Technique to build a safety function application. Verification and validation checklists are provided for example applications. For information on how to download the complete set of electrical schematic examples, see Access Components of the Safety Function on page 7.

IMPORTANT You are responsible for these system safety considerations:

- Set-up, safety rating, and validation of any sensors or actuators connected to the system.
- Completion of a system-level risk assessment and reassess the system anytime that a change is made.
- Certification of the system to the desired safety performance level/safety integrity level.
- Project management and proof testing.
- Programming the application software and the safety option module configurations in accordance with the information in the product manual.
- Access control to the system.
- Analyzing all configuration settings and choose the proper setting to achieve the required safety rating.
- Validation and documentation of all safety functions used.
- Modification to the SISTEMA subsystems with the correct number of operations of the electromechanical components (E-stop push buttons, contactors, and relays). The following number of operations were used in the SISTEMA files available in the 'LVMCC Functional Safety Application Guide Content':
  - Safety actuation that is driven by E-stop push buttons that drive operations of safety relays (700-HPS) and contactors: 100 operations/year.
  - Standard operations that are driven by normal motor start and stop commands that affects contactors: Every 10 minutes (52,560 operations per year considering 365 days per year, 24 hours per day and 600 seconds between operations).
  - The number of operations of electromechanical devices affect the results of the SISTEMA calculation and a final performance of the safety function. Adjust the SISTEMA files with the number of operations used in your machine to obtain the correct results.
  - This Application Technique uses Rockwell SISTEMA Library-VDMA66413_2_08_20220201_Rockwell_Automation.xml. When using the LVMCC SISTEMA project files downloaded from PCDC, you are responsible for download the latest Rockwell Automation SISTEMA library. When documenting your safety function, always give preference to use the Rockwell Automation safety product information from the latest Rockwell Automation SISTEMA Library. Download Rockwell Automation SISTEMA Library from https://www.rockwellautomation.com/en-us/capabilities/industrial-safety-solutions/safety-automation-builder.html

Safety VFD Subsystems

Safety variable-frequency drives (VFD) subsystems use a variable-frequency drive unit as the output device. The safety VFD eliminates a hazard by removing torque from the motor, executing a controlled stop of the motor, or executing another safety function (such as safe limited speed). Safety commands are received by the safety VFD through either the safety network or the hardwired safety inputs. The subsystem can contain a safety monitoring relay as the logic solver when used for single motor applications.

Safety VFD Safety Certification

This safety certification section applies to the safety VFDs used in the subsystem. A SISTEMA (Safety Integrated Software Tool for the Evaluation of Machine Applications) file is available for each subsystem that is listed in this Application Technique. The SISTEMA file provides justification for the safety level that is achieved by the subsystem. The justification is based on the safety product certificates. See the Product Certifications website, rok.auto/certifications for more information.

The TÜV Rheinland group has approved the PowerFlex® 520-series drives and PowerFlex 750-series safety option modules (Cat. No. 20-750-S, 20-750-S1, 20-750-S3 and 20-750-S4) as suitable for use in hardwired or integrated safety applications up to the safety levels listed in the product manuals listed in Additional Resources on page 109.

PowerFlex 750-series Drive Units

The functional safety ratings of the subsystems listed in this section are suitable for use in hardwired or integrated safety applications up to and including the Safety Integrity Level (SIL), Claim Limit (CL), and Performance Level (PL) safety levels listed in Appendix A on page 83.

NEMA wiring diagram examples are available for download. See Access Components of the Safety Function on page 7.

The options that include the MSR138DP safety monitoring relay are intended for single motor applications where the user wires the input safety device (such as an E-stop push button or E-stop pull-cord) directly to the unit terminals.

Available Unit Options

The following unit options are available for the CENTERLINE® 2100 and 2500 LVMCCs.

Table 5 - Available Unit Options for CENTERLINE 2100 and 2500 LVMCCs

PowerFlex 750-Series	Frame	with Option Module	
CENTERLINE 2100 and 2500 LVMCCs			
753	1...7	20-750-S	Hardwired Safety Torque Off (STO) wired to terminals
755	1...7	20-750-S	Hardwired STO wired to terminals
755 (1)	1...7	20-750-S1	Hardwired Safety Speed Monitor
755	1...7	20-750-S3	Integrated Safety STO
755	1...7	20-750-S4	Integrated Safety Functions
753 (2)	1...7	20-750-S, MSR138DP	Using Time-delay Outputs
755 (2)	1...7	20-750-S, MSR138DP	Using Time-delay Outputs
753 (2)	1...7	20-750-S, MSR127	Safety Monitoring Relay
755 (2)	1...7	20-750-S, MSR127	Safety Monitoring Relay
CENTERLINE 2100 LVMCCs Only			
753	1...7	20-750-S and MSR138DP	Safety Monitoring Relay
755	1...7	20-750-S and MSR138DP	Safety Monitoring Relay

(1) Not in standard 2500 offering.
(2) Not in standard 2100 offering.

The following unit options are available only for the CENTERLINE 2500 LVMCCs:

- PowerFlex 753 Frame 1...7 with 20-750-S and GSR-DI safety monitoring relay
- PowerFlex 753 Frame 1...7 with 20-750-S, GSR-DI and GSR-EMD using time-delayed outputs
- PowerFlex 755 Frame 1...7 with 20-750-S and GSR-DI safety monitoring relay
- PowerFlex 755 Frame 1...7 with 20-750-S, GSR-DI and GSR-EMD using time-delayed outputs

If a safety option failure occurs, see the product manuals for the PowerFlex drive safety options that are listed in the Additional Resources on page 109. These product manuals contain the following information:

- safety certification,
- proof tests,
- probability of a dangerous failure on demand (PFD) and average frequency of a dangerous failure per hour (PFH) definitions,
- safety data,
- safe state,
- safety reaction time,
- considerations for safety ratings,
- requirements for single and dual encoder systems, and
- contact information.

Safety Ratings

For safety rating values, see the tables in Appendix A on page 83.

Electrical Schematics Examples

This section shows four examples of PowerFlex 750 Series safety subsystems electrical schematics. For information on how to download the complete set of electrical schematic examples, see Access Components of the Safety Function on page 7.

Example 1: PowerFlex 750 with 20-750-S - Hardwired STO

For the CENTERLINE 2100 LVMCC, the unit catalog number 216xU/VB-...-14SRR includes the 20-750-S safety option module. See the CENTERLINE 2100 LVMCC Program Guide, publication 2100-CA004 for more information.

Figure 3 shows the PowerFlex 750 unit with the 20-750-S option interfacing with three different types of distribution units:

- Safety Relay Unit - Category 1
- Safety Monitoring Relay Unit - Category 3
- Safety Remote I/O - Category 3

Figure 3 - PowerFlex 750 Units with Distribution Units Interface Diagram

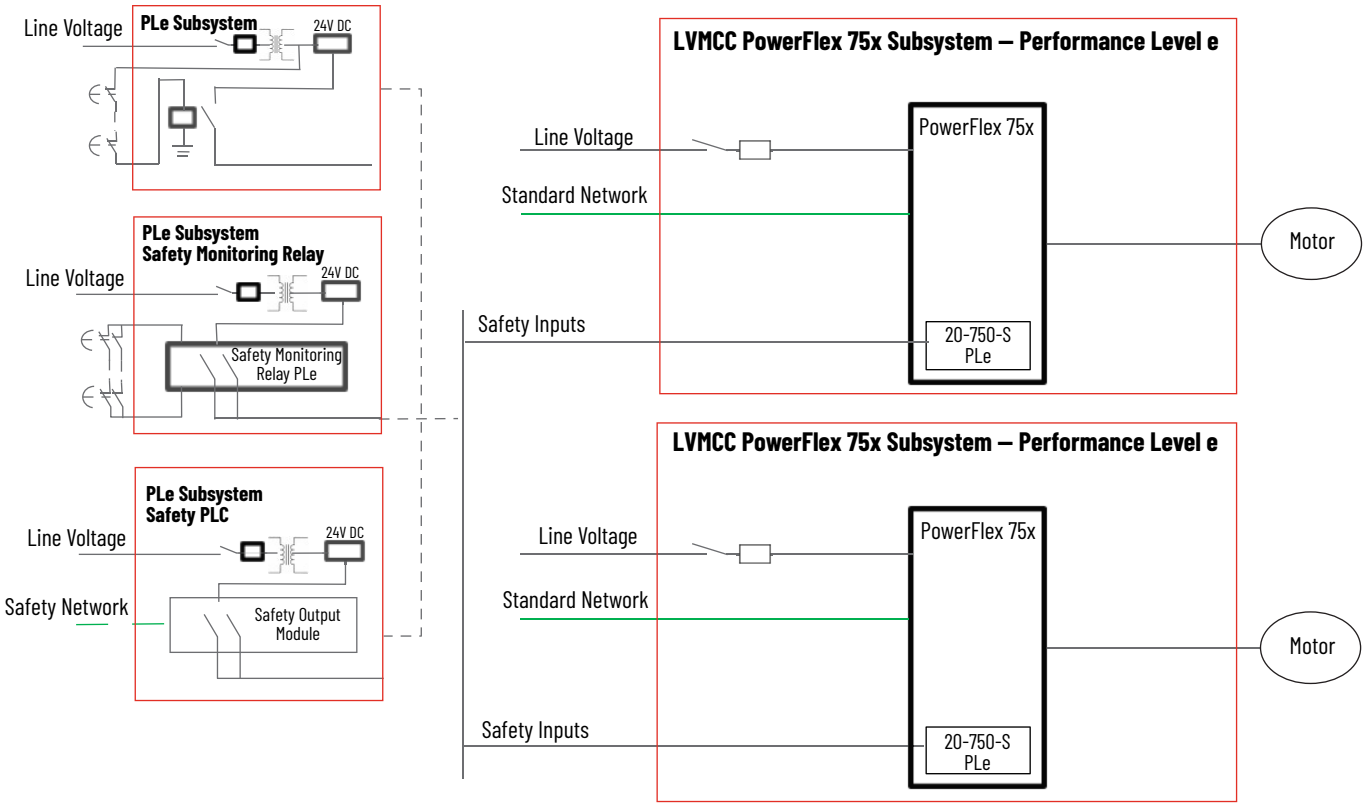


Figure 4 shows the 20-750-S option wiring. It uses shielded cable from the VFD safety inputs terminals to the unit terminals. The 20-750-S option module receives the safety input signals (+24V DC) from the safety distribution unit.

IMPORTANT The external power supply must conform to the Directive 2014/35/EU Low Voltage, the safety distribution unit contains a power supply that conforms with that directive.

Figure 4 - PowerFlex 750 Unit Safety Input Wiring

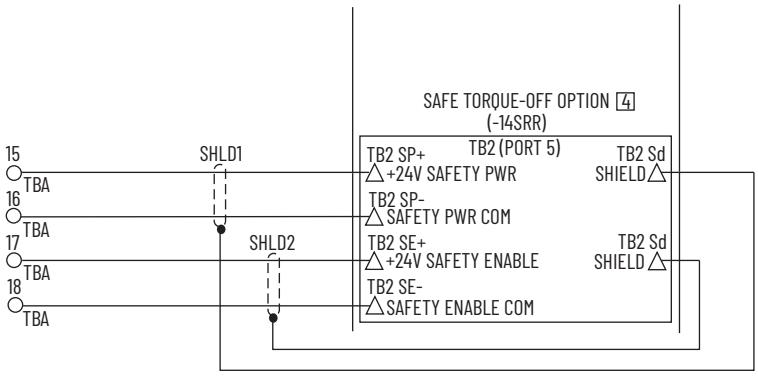


Figure 5 shows one option of local control for the PowerFlex 753 drive.

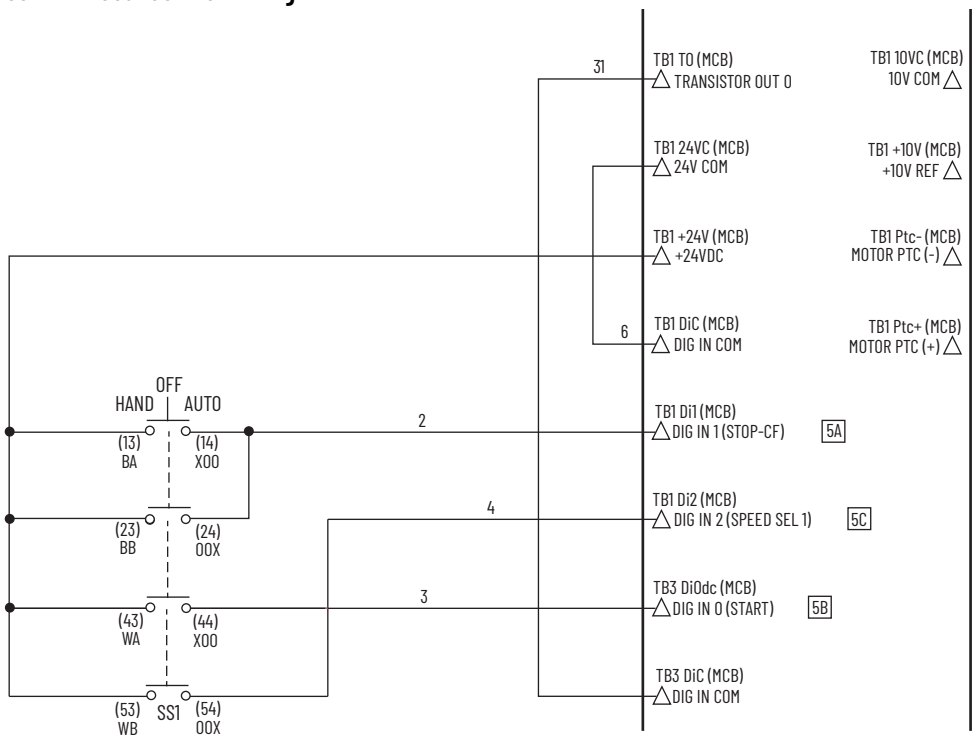
If the selector is placed in 'HAND' position, the drive receives the start command.

PowerFlex 750 drive does **not** restart automatically if the selector remains on the 'HAND' position during a restart of the safety function. Rather, the PowerFlex 750 drive waits for a transition of the selector to the 'HAND' position.

The verification and validation plan includes these scenarios:

- The safety circuit is actuated when the drive is running and the safety circuit is reset; the drive waits for a cycle of the HAND selector before it starts.
- The safety circuit is actuated when the drive is ready and the safety circuit is reset; the drive waits for a cycle of the HAND selector before it starts.

Figure 5 - PowerFlex 753 with Local Control Wiring



Example 2: PowerFlex 750 with 20-750-S and MSR138DP Safety Monitoring Relay

Figure 6 shows the PowerFlex 750 drive with the 20-750-S module and the MSR138DP relay interfacing with E-stop signals. The E-stop effects only the motor controlled by the unit.

For the CENTERLINE 2100 LVMCC, the unit catalog number 216xU/VB-...-14SFRx includes the 20-750-S safety option module and the MSR138DP relay.

Figure 6 - PowerFlex 750 with MSR138DP Diagram

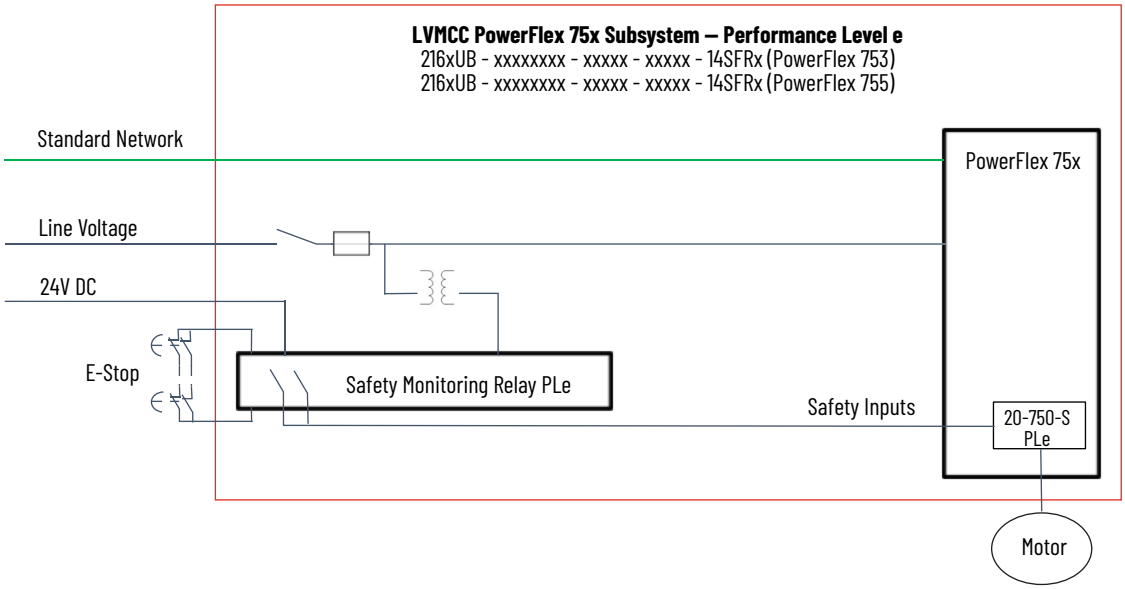


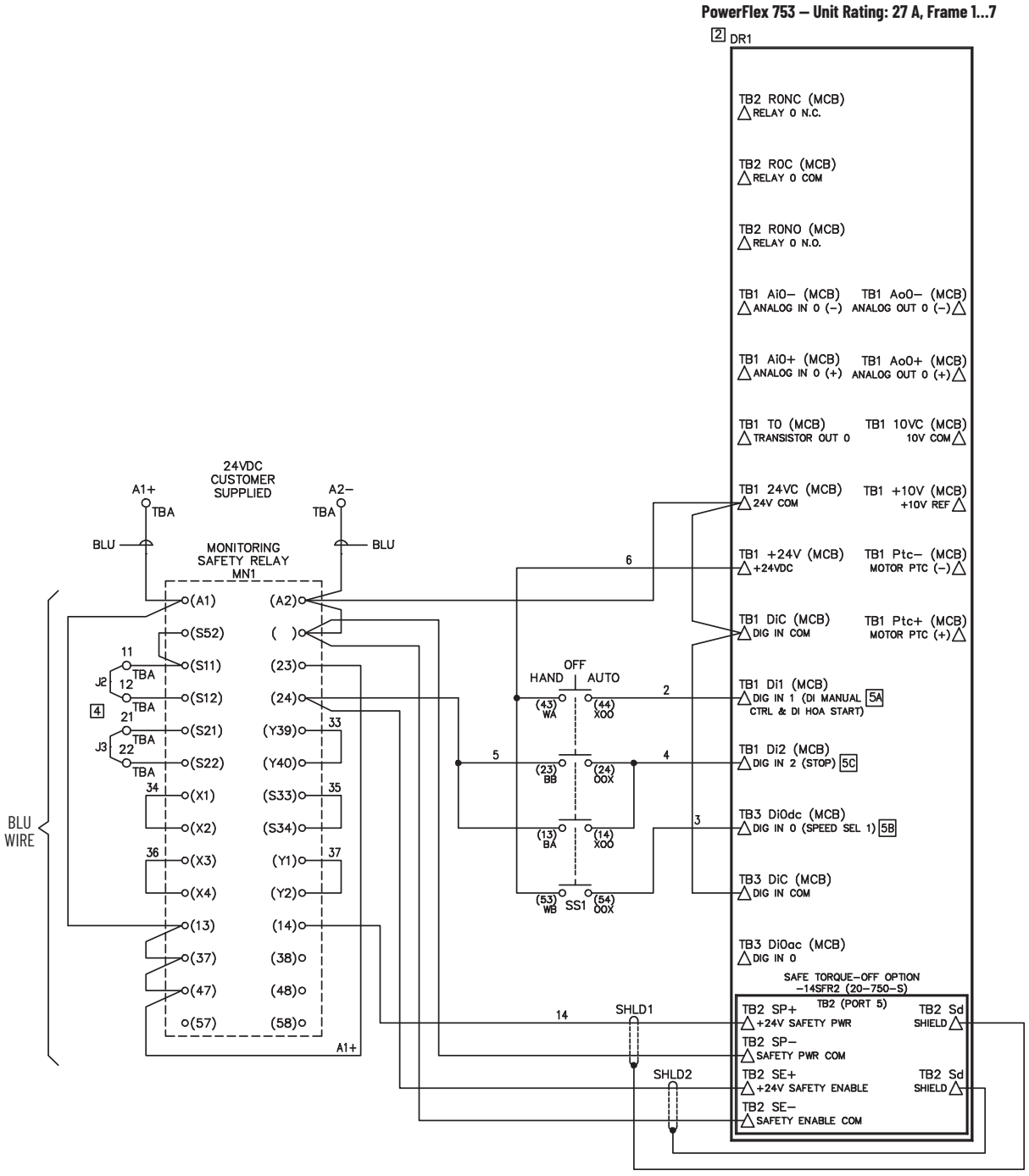
Figure 7 shows the wiring for one of the available unit configurations. The 24V DC must be externally supplied to the unit. This option uses the MSR138DP module immediate safety output terminals 14 and 24. The time-delay safety output wiring option uses the MSR138DP module terminals 38 and 48.

For the CENTERLINE 2100 LVMCC, the unit catalog number 216xU/VB-...-14SFRx has a factory-installed MSR138DP safety relay. The relay uses a removable terminal block and accepts one N.C. or two N.C. inputs or a light curtain, provides two N.O. safety outputs and three N.O. delayed safety outputs with 0.5...10 s delay.

- Unit catalog number 216xWx-...-14SFR1 relay control power is 115V AC.
- Unit catalog number 216xWx-...-14SFR2 relay control power is 24V DC.

IMPORTANT The external power supply must conform to the Directive 2014/35/EU Low Voltage, the safety distribution unit contains a power supply that conforms with that directive.

Figure 7 - PowerFlex 753 Unit with 20-750-S Module, MSR138DP Relay, and Local Operation (PlantPAx®) Sample Wiring Diagram



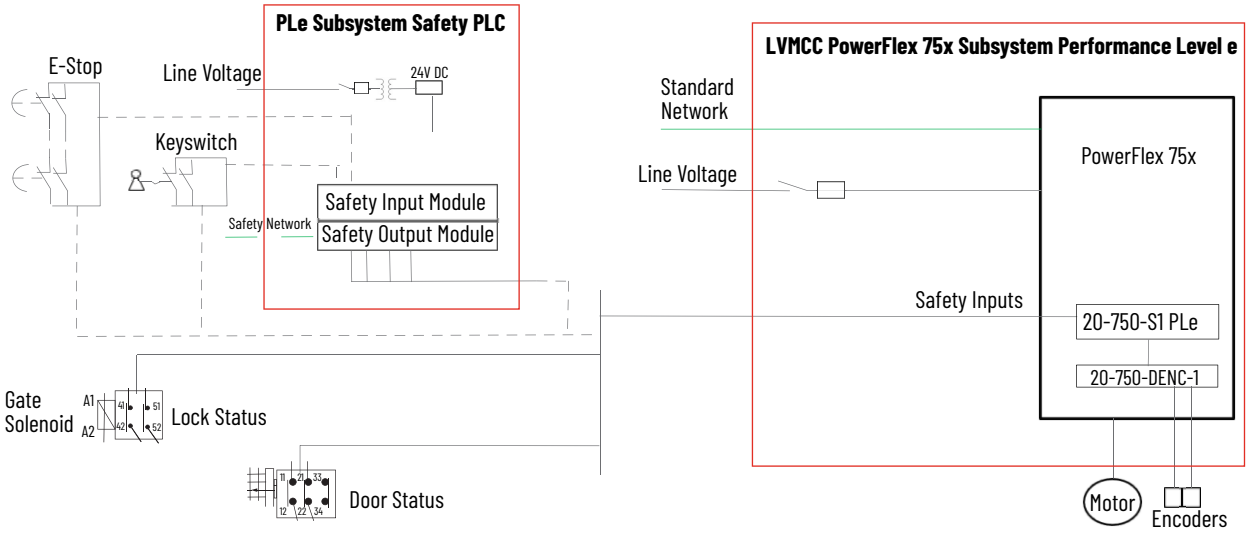
Example 3: PowerFlex 755 with 20-750-S1 - Hardwired Safe Speed Monitor Module

Figure 8 shows the PowerFlex 750 unit with the 20-750-S1 module interfacing with these items:

- E-stop
- Gate solenoid
- Door status
- Lock status
- Safety I/O

For CENTERLINE 2100 LVMCC, the unit catalog number 216xU/V-...-14S1-14DENC1 includes the 20-750-S1 safety speed monitor option module and 20-750-DENC-1 dual incremental encoder option card.

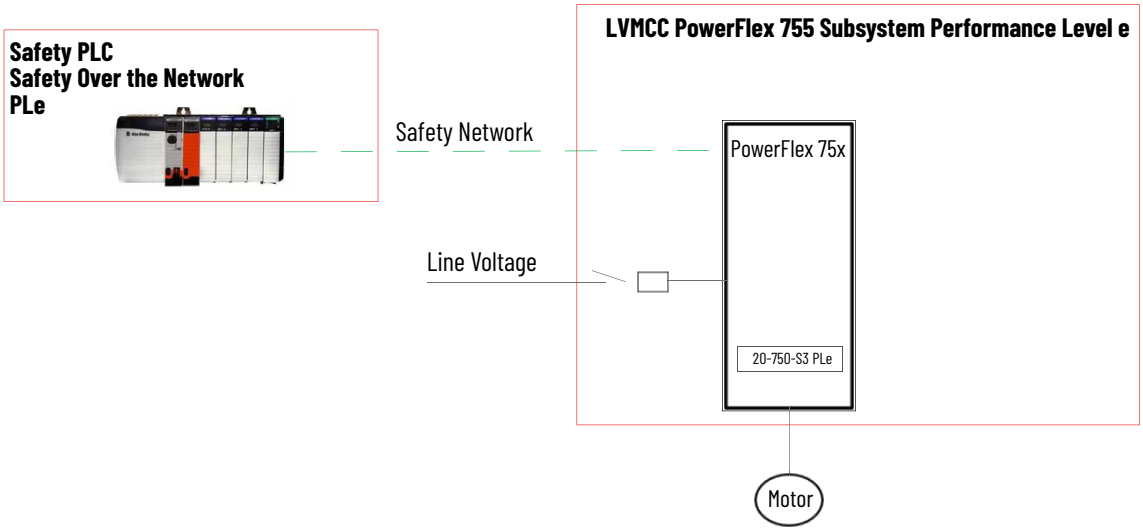
Figure 8 - PowerFlex 750 Hardwired Safe Speed Diagram



Example 4: PowerFlex 755 with 20-750-S3 - Integrated Safety - Safe Torque Off

For CENTERLINE 2100 LVMCC, the unit catalog number 216xU/V-...-14SRR2 includes the 20-750-S3 integrated safety module, which is capable of STO (Safe Torque Off) over an EtherNet/IP™ network.

Figure 9 - PowerFlex 750 Networked Safety Diagram



Configuration

PowerFlex 750 drive units come with different types of safety option modules (Cat. No. 20-750-S, 20-750-S1, 20-750-S3, or 20-750-S4). In addition to the safety option modules, you can configure the drive to accept different local operation devices such as a Hand-Off-Auto (HOA) selector, Start-Stop push button, and others. The drive must be properly configured to match the application requirements.

PowerFlex 750 Drive using Local Operation Station

The PowerFlex 750 series is configured by using the Studio 5000 Logix Designer® application, Connected Components Workbench™ software, or a local Human Interface Module (HIM). See the PowerFlex 750-Series AC Drives Reference Manual, publication 750-RM002, and PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001, for a detailed description of how to configure the PowerFlex 750 series drive.

See the notes in the electrical schematics examples for drive parametrization that is related to the local operation of the drive.
See Access Components of the Safety Function on page 7 for information on how to download the complete set of electrical schematic examples.

IMPORTANT
- The safety jumper is removed at the factory. The 20-750-S module ships with the safe torque off (STO) feature enabled.
- The hardware-enable jumper remains in place. Both jumpers are located on the main control board.
- The safety-enable (SAFETY) J2 jumper must be removed when using the STO option module, else a Safety Jumper In fault (F213) will occur.
- The hardware-enable jumper J1 must remain installed when using a Safety Option Module, else a Safety Board Fault (F211) will occur.

PowerFlex 755 with 20-750-S3 - Integrated Safety - STO Module

The PowerFlex 755 drive is configured using the Studio 5000 Logix Designer® application. See the PowerFlex 755/755T Integrated Safety - Safe Torque Off Option Module User Manual, publication 750-UM004, or the PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001, for a detailed description of how to configure the 20-750-S3 module.

IMPORTANT
- The safety jumper is removed at the factory. The 20-750-S3 module ships with the STO feature enabled.
- The hardware-enable jumper remains in place. Both jumpers are located on the main control board.
- The safety-enable (SAFETY) J2 jumper must be removed when using the STO option module, else a Safety Jumper In fault (F213) will occur.
- The hardware-enable jumper J1 must remain installed when using a Safety Option Module, else a Safety Board Fault (F211) will occur.

The safety controller is configured by using the Studio 5000 Logix Designer application. Studio 5000 Logix Designer application file examples are available for download. See Access Components of the Safety Function on page 7 for information. One of the safety function examples uses a PowerFlex 755 integrated STO.

PowerFlex 520-series Units

The following unit options are available for the CENTERLINE 2100 AND 2500 LVMCCs.

Table 6 - PowerFlex 520-series Units: Available Unit Options for CENTERLINE 2100 and 2500 LVMCCs

PowerFlex 520-Series	with Option Module
CENTERLINE 2100 and 2500 LVMCCs	
525	Hardwired STO wired to terminals (1)
527	Integrated safety STO (2)
525	with MSR138DP using time-delay outputs (1)
525	with MSR127 safety monitoring relay (1)
CENTERLINE 2100 LVMCCs Only	
525	with MSR138DP safety monitoring relay
525	with MSR138DP safety monitoring relay with time-delay outputs (1)
CENTERLINE 2500 LVMCCs Only	
525	with GSR-DI safety monitoring relay
525	with GSR-DI and GSR-EMD using time-delayed outputs

(1) Not in standard 2100 offering.
(2) Not in standard offering.

NEMA wiring diagram examples are available for download. See Access Components of the Safety Function on page 7.

See the 'Safe Torque Off function' section in the PowerFlex 520-Series Adjustable Frequency AC Drive User Manual, publication 520-UM001 for PowerFlex 525 drives safety information. See the 'Integrated Safe Torque Off' section in the PowerFlex 527 Adjustable Frequency AC Drive User Manual, publication 520-UM002, for PowerFlex 527 drive safety information.

The PowerFlex 525 STO function is intended to be part of the safety-related control system of a machine. Before use, perform a risk assessment that compares the PowerFlex 525 STO function specifications and all foreseeable operational and environmental characteristics of the machine to which it is to be fitted.

A safety analysis of the machine section that is controlled by the drive is required to determine how often to test the safety function for proper operation during the life of the machine.

ATTENTION: The following information is merely a guide for proper installation. Rockwell Automation cannot assume responsibility for the compliance or the noncompliance to any code, national, local, or otherwise for the proper installation of this equipment.
A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.
In STO mode, hazardous voltages might be present at the motor. To avoid an electric shock hazard, disconnect power to the motor and verify that the voltage is zero before performing any work on the motor.
If there is a failure of two output insulated gate bi-polar transitions (IGBTs) the drive:

- When the PowerFlex 525 STO has controlled the drive outputs to the off state, the drive can provide energy for up to 180° of rotation in a 2-pole motor before torque production in the motor ceases.

Safety Ratings

For safety rating values, see the tables in Appendix A on page 83.

Electrical Schematics Examples

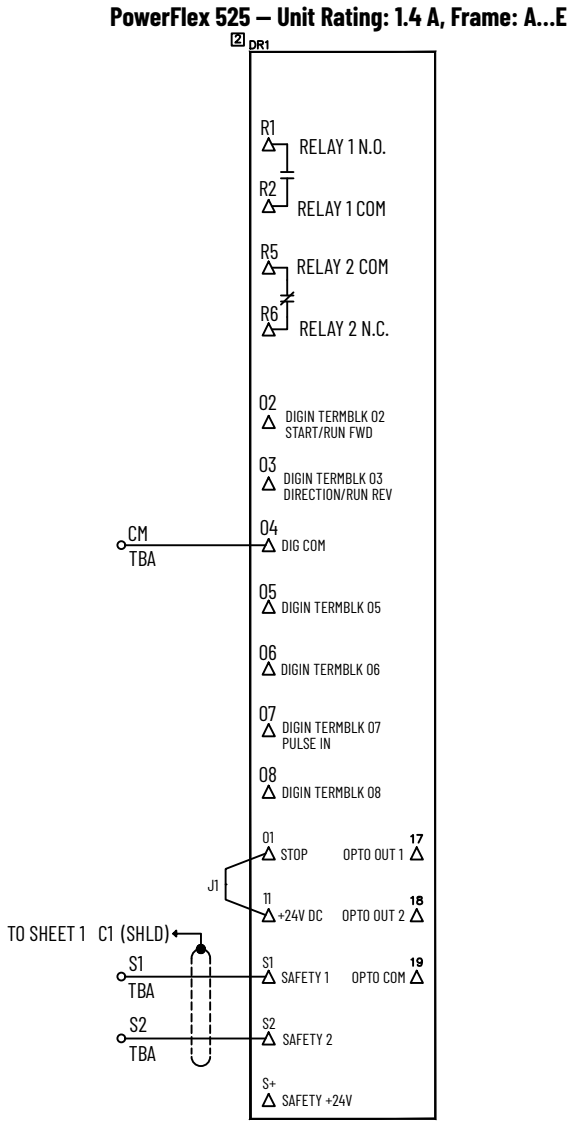
This section shows two examples of PowerFlex 520-series safety subsystems electrical schematics. For information on how to download the complete set of electrical schematic examples, see Access Components of the Safety Function on page 7.

Example 1: PowerFlex 525 – Hardwired STO

Figure 10 shows the PowerFlex 525 hardwired STO option wiring for the CENTERLINE 2100. It uses shield cable from the VFD safety inputs terminals to the unit terminals. The PowerFlex 525 drive receives the safety input signals (+24V DC) from the safety distribution unit.

IMPORTANT The external power supply must conform to the Directive 2014/35/EU Low Voltage. The safety distribution unit contains a power supply that conforms with that directive.

Figure 10 - PowerFlex 525 Safety Input Wiring



If the application requires a local operation station, verify that the drive does NOT start as soon as safety circuit is reset. Figure 11 on page 23 shows one of the options for local control of the PowerFlex 525 drive. If the selector is placed in the 'HAND' position, the drive receives the start command.

The PowerFlex 525 drive does not restart automatically if selector is in the 'HAND' position during a restart of the safety function.
The PowerFlex 525 drive waits for a transition of the selector to the 'HAND' position.

IMPORTANT Auto Restart (A541) must not be enabled. Parameters t105, t106, and A541 must be set to their default values:

- t105 [Safety Open En] = 0 'FaultEnable' (Default)
- t106 [SafetyFltRstCfg] = 0 'PwrCycleRset' (Default)
- A541 [Auto Rstrt Tries] = 0 (Default)

The verification and validation plan includes these scenarios:

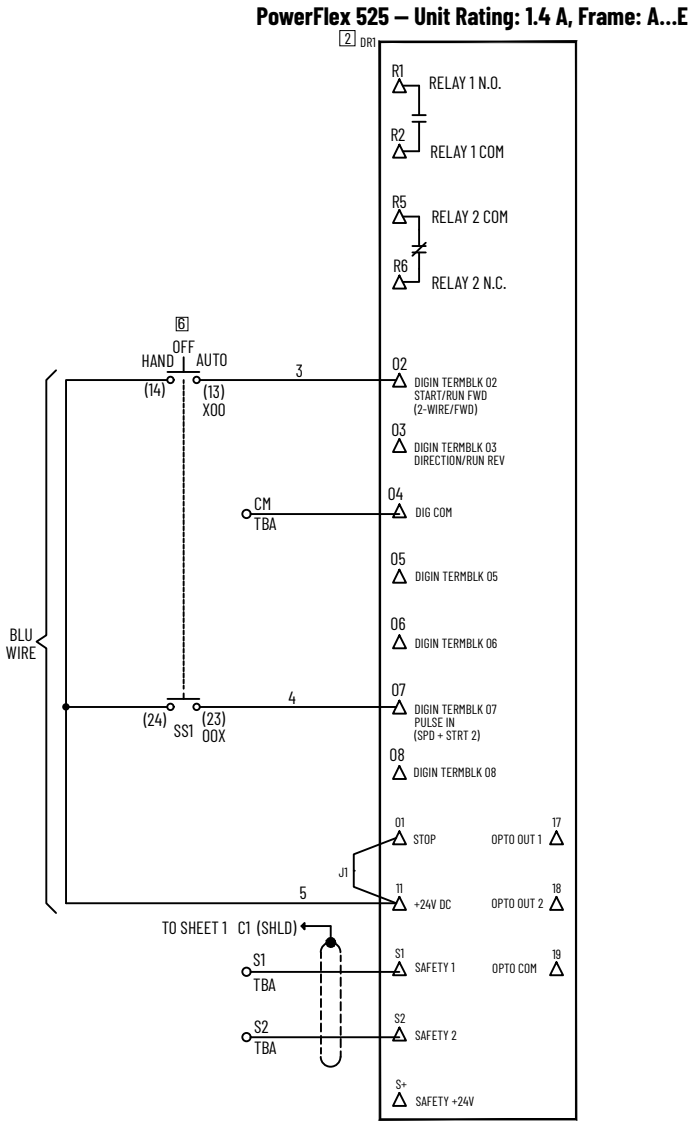
- The safety circuit is actuated when drive is running, safety circuit is reset, and drive fault is reset (over the network or locally).
- The safety circuit is actuated when drive is ready and the safety circuit is reset.

In addition to the above scenario, when using the HOA selector, the 2-wire mode must be set to edge trigger mode (CENTERLINE 2100 terminal block parameter configuration is done at the factory and it is available in the wiring diagram).

- t062 [DIGIN TERMBLK 02] = 48 '2-WIRE FWD' (Default)
- t064 [2-WIRE MODE] = 0 'Edge Trigger' (Default)

IMPORTANT The external power supply must conform to the Directive 2014/35/EU Low Voltage, the safety distribution unit contains a power supply that conforms with that directive.

Figure 11 - PowerFlex 525 Drive with Local Control Wiring



Example 2: PowerFlex 525 Drive with MSR138DP Safety Monitoring Relay

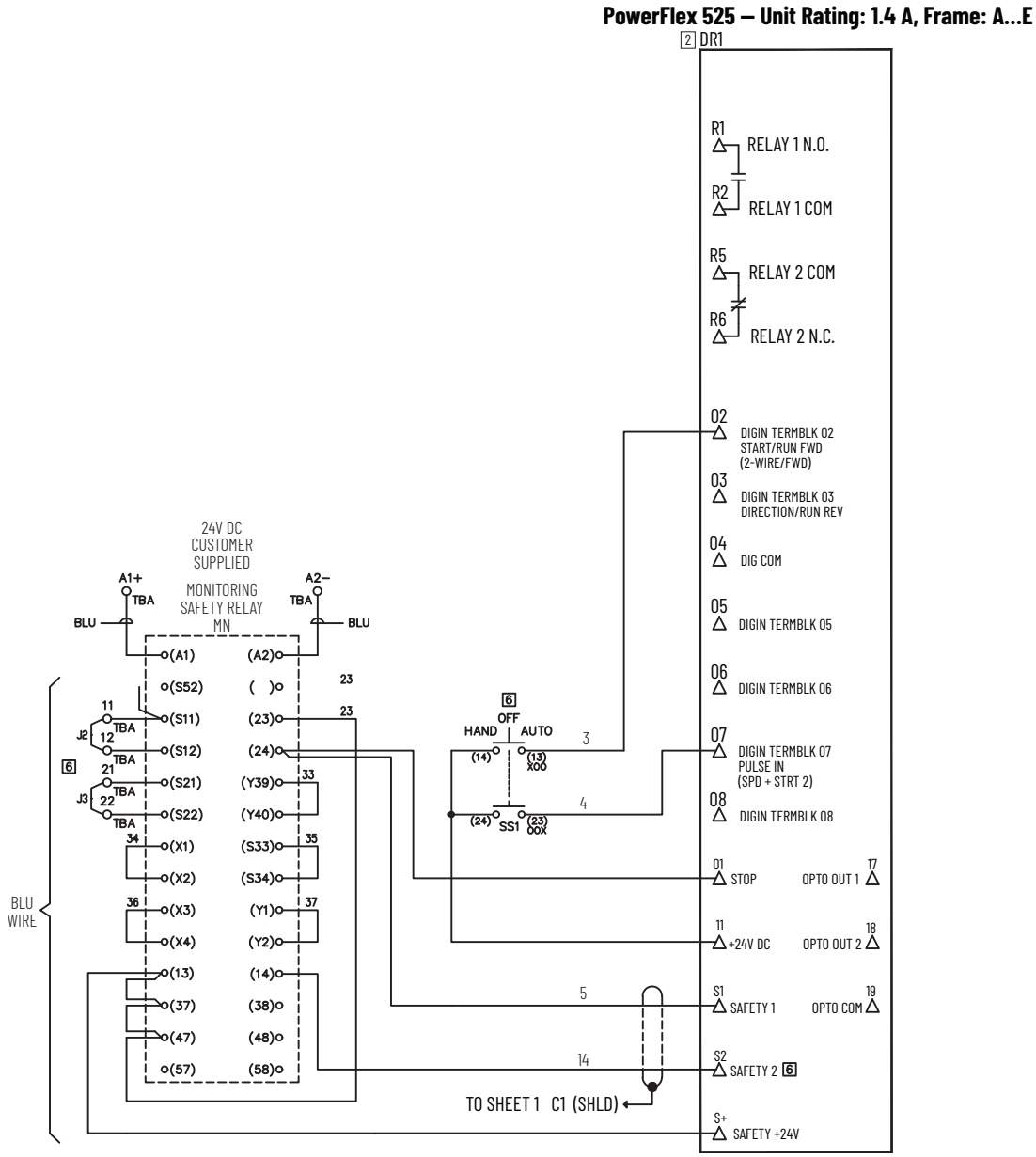
The MSR138DP safety monitoring relay option is intended for single motor applications, where the input safety device (for example, an E-stop push button or E-stop pull-cord) is wired directly to the unit terminals. See the electrical schematic examples for more information. For information on how to download the complete set of electrical schematic examples, see Access Components of the Safety Function on page 7.

For CENTERLINE 2100 MCCs, the unit Cat. No. 216xWx-...-14FRx has a factory-installed MSR138DP safety relay. The relay uses a removable terminal block and accepts one normally closed (N.C.) input, or two N.C. inputs, or a light curtain which provides two N.O. safety outputs and three N.O. delayed safety outputs with 0.5...10 second delay.

- Unit catalog number 216xWx-...-14FR1 relay control power is 115V AC.
- Unit catalog number 216xWx-...-14FR2 relay control power is 24V DC.

Figure 12 shows the wiring for one of the available unit configurations. The 24V DC must be externally supplied to the unit. This option uses the MSR138DP immediate safety outputs (terminals 14 and 24). The time-delay safety output wiring option uses MSR138DP terminals 38 and 48.

Figure 12 - PowerFlex 525 Drive with MSR138DP Relay Electrical Schematic



Configuration

PowerFlex 525 drive units can be configured to accept different local operation devices such as a HOA selector, start-stop push buttons, and others. The drive must be properly configured to match application requirements.

PowerFlex 525 using Local Operation Station

The PowerFlex 525 drive is configured by using the local keypad, a connected Human Interface Module (HIM), Studio 5000 Logix Designer application, or Connected Components Workbench software version 7 or later. See the PowerFlex 520-Series Adjustable Frequency AC Drive User Manual, publication 520-UM001, for more information about how to configure the PowerFlex 525 drive.

IMPORTANT The PowerFlex 525 drive unit ships with a safety bypass jumper in place. The jumper is installed between terminal S+ and the safety input terminals S1 and S2. The safety bypass jumper must be removed for the drive to accept the safety signals coming from the safety distribution unit.

See the notes in the electrical schematic examples for drive parametrization that is related to the local operation of the drive in CENTERLINE 2100 MCCs. For information on how to download the complete set of electrical schematic examples, see Access Components of the Safety Function on page 7.

PowerFlex 527 Drive using Integrated STO over the EtherNet/IP™ Network

The PowerFlex 527 drive is configured by using the Studio 5000 Logix Designer application. See the PowerFlex 527 Adjustable Frequency AC Drive User Manual, publication 520-UM002 for more information about this drive.

IMPORTANT The PowerFlex 527 drive unit ships with a safety bypass jumper in place. The jumper is installed between terminal S+ and the safety input terminals S1 and S2. Remove the jumper so the drive can accept the safety commands from the network.

Notes:

Safety Starters Subsystems

Safety starters subsystems use contactors as the output device that minimizes the hazard by removing torque from the motor. Safety commands remove power from the contactor coil. Mirror auxiliary contacts provide contactor diagnostic of a faulted state. The subsystem can contain a safety monitoring relay as the logic solver when used for single motor applications.

Full-voltage Non-reversing Starter Subsystem – Category 1/PLc

The following options are available for CENTERLINE® 2100 Motor Control Centers (MCCs) and CENTERLINE 2500 MCCs:

Starter	Contactors	Relay
CENTERLINE 2100 MCCs as Non-standard Offering		
Full-voltage non-reversing starter	one NEMA Bulletin 500 Contactors	with interposing relay
		without interposing relay
CENTERLINE 2500 MCCs as Standard Offering		
Direct-on-line (DOL) starter	one IEC Bulletin 100S Contactors	with interposing relay
		without interposing relay

NEMA and IEC wiring diagram examples are available for download. See Download Files and Software on page 7.

Safety Rating

For safety rating values, see the tables in Quick Reference - Functional Safety Ratings on page 83.

- Category 1 (Cat. 1), up to Performance Level C (PLc) according to ISO 13849-1:2015
- Up to SIL CL1 according to IEC 62061:2005

A Cat. 1 circuit does not require fault detection, but does require well-tried components and well-tried safety principles (see ISO 13849-2:2012). The ISO 13849-2:2012 standard, Table D.3, considers contactors 'well-tried component' that comply with standard IEC 60947-4-1. To follow well-tried safety principals (Table D.2 from ISO 13849-2:2012), the CENTERLINE 2500 starter design oversizes the contactor by 50% and the 2100 starter design uses the Bulletin 500 contactor as a proven design component.

Electrical Schematic Example using Interposing Relay

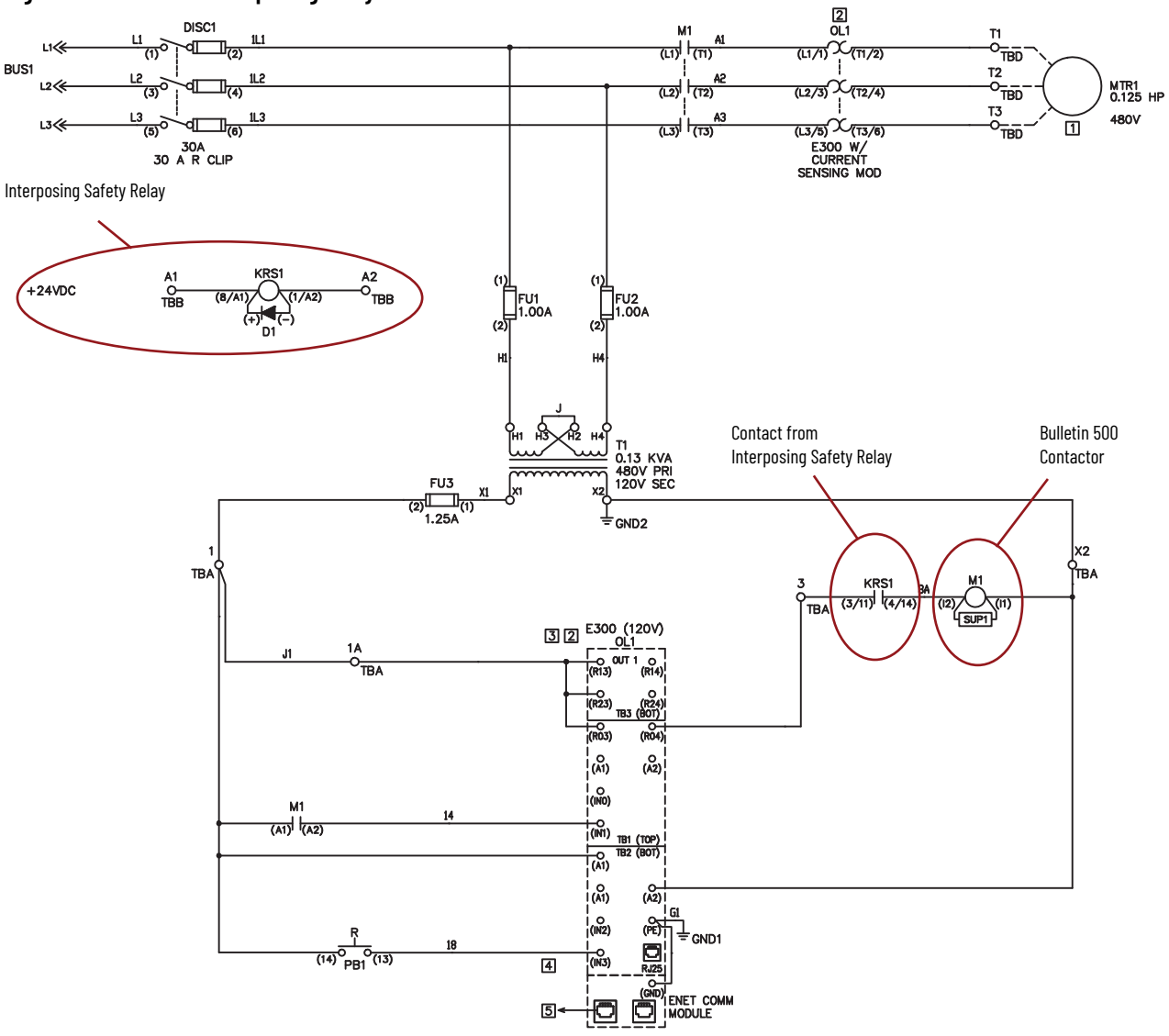
Figure 13 shows the Cat. 1 - full voltage non-reversing (FVNR) wiring for the CENTERLINE 2100 MCC with interposing relay. This option receives the safety input signal (+24V DC) from the safety distribution unit.

The same contact from the safety distribution unit interfaces with up to eight MCC units (drive or starter). This option optimizes the use of contacts of the safety relay distribution unit.

The contactor is used for both the safety function and normal operation that includes both safety and standard operations in the number of operations when calculating mean time to dangerous failure (MTTFd) based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

The interposing relay de-energizes only when the safety function is actuated, which includes only the safety operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

Figure 13 - FVNR with Interposing Relay Cat. 1 Electrical Schematic



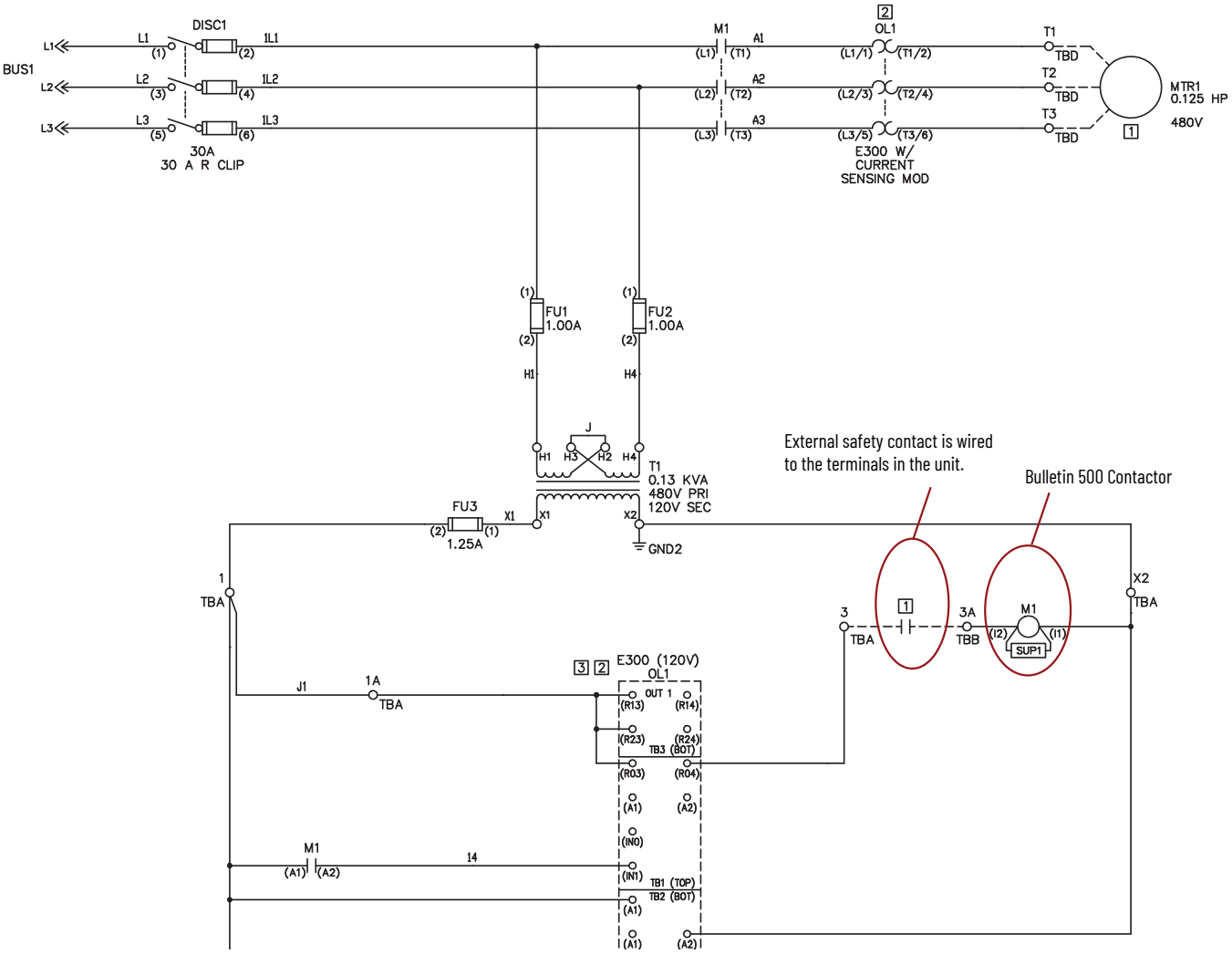
Electrical Schematic Example without Interposing Relay

Figure 14 shows the Cat. 1 - FVNR wiring for the CENTERLINE 2100 MCC without interposing relay. This option receives one dedicated contact from the safety distribution unit. The relay distribution unit contact is wired to terminals in the unit.

The contactor is used for both the safety function and normal operation, which includes both safety and standard operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

A dedicated contact from the relay distribution unit de-energizes the contactor coil when the safety function is actuated.

Figure 14 - FVNR without Interposing Relay Cat. 1 Electrical Schematic



Configuration

The subsystem configuration is shown in the wiring diagram. The CENTERLINE 2100 MCC wiring diagram notes parameter settings for the E300™ Electronic Overload Relay. Independent of the starter mode (remote or local operation), the E300 relay output that commands the M1 contactor must only be allowed to close after the safety circuit is properly reset.

Direct On-line Starter Subsystem - Category 2/PLd

The following options are available only in CENTERLINE® 2500 MCCs. IEC wiring diagram examples are available for download.
See Access Components of the Safety Function on page 7

- Direct on-line (DOL) starter with IEC Bulletin 100S contactor with MSR138DP

Safety Rating

For safety rating values, see the tables in Quick Reference - Functional Safety Ratings on page 83

- Cat. 2, up to PLd according to ISO 13849-1:2015
- Up to SIL CL2 according to IEC 62061:2005

Category 2 (Cat. 2) requires basic and well-tried safety principles (see ISO 13849-2). The ISO 13849-2:2012 standard, Table D.3 considers contactors 'well-tried component' that comply with standard IEC 60947-4-1. Additionally, they shall be designed in a way that their function is checked at the machine startup and before the initiation of any hazardous situation. Occurring failure shall generate output that starts proper action to mitigate the risk.

ISO 13849-2:2012 Standard, Table D.3 considers contactors 'well-tried component' that comply with standard IEC60947-4-1.

ISO 13849-2:2012 Standard, Table D.2 considers contactors 'well-tried safety principles' that comply with the use of positively mechanically linked contacts. For example, monitoring the safety function in Cat. 2, 3, and 4 systems. See EN 50205, IEC 60947-4-1:2001, Annex F, IEC 60947-5-1:2003 + A1:2009, Annex L.

To follow well-tried safety principals (Table D.2 from ISO 13849-2:2012), the 2500 design oversized contactors by 50%.

ISO 13849-1:2015 Standard, states that Performance Level d (PLd) shall initiate safe state that is maintained until fault is cleared.

Bulletin 100S and the selected auxiliary contacts comply with the standards that are mentioned above.

The contactor diagnostic is achieved with normally closed (N.C.) auxiliary feedback contacts connected in series that must be connected to a logic solver, such as a safety Performance Level c (PLc) or a safety monitoring relay. Typically, the auxiliary feedback signal is sent to the safety distribution unit.

Additional diagnostic is achieved with normally open (N.O.) auxiliary feedback contacts connected to E300 relay inputs.

The Bulletin 100S contactors auxiliary contacts that are used comply with mirror contacts (IEC 60947-4-1 Draft Annex F) and therefore can be considered as well-tried components per Table D.3 of IEC 13849-2:2012 and as using well-tried safety principles per Table D.2 of IEC 13849-2:2012.

The MSR138DP has three input wiring options: one N.C. two N.C., and two output signal switching device (OSSD). When connected in to the two N.C. fashion, the MSR138DP checks for cross faults across two inputs. When connected to light curtains, the light curtain must perform the cross fault detection. The MSR138DP has output monitoring that can accommodate either automatic/manual reset or a monitored manual reset. When configured with automatic/manual reset (jumpers on X1-X2 and X3-X4), the MSR138DP can have reset terminals S33-S34 jumped or can be converted to an unmonitored manual reset by adding a N.O. switch in the monitoring loop (S33-S34). When configured to monitored manual reset, the MSR138DP checks the output monitoring circuit through the manual application of the reset switch. The unit cannot be reset until the timing function has completed.

The outputs of the MSR138DP include two N.O. immediate safety outputs and three N.O. delayed safety outputs. The safety outputs have independent and redundant internal contacts to support the safety function. If a reset request is made during the time cycle, it causes a lockout condition. Cycle inputs after timing has a completed and rest reset after the delay time has expired to clear lockout.

Electrical Schematic Example

Figure 15 on page 31 shows the Cat. 2 - DOL wiring for the CENTERLINE 2500 MCC MSR138DP Safety Relay. This option receives the safety input signal (+24V DC) from the safety distribution unit.

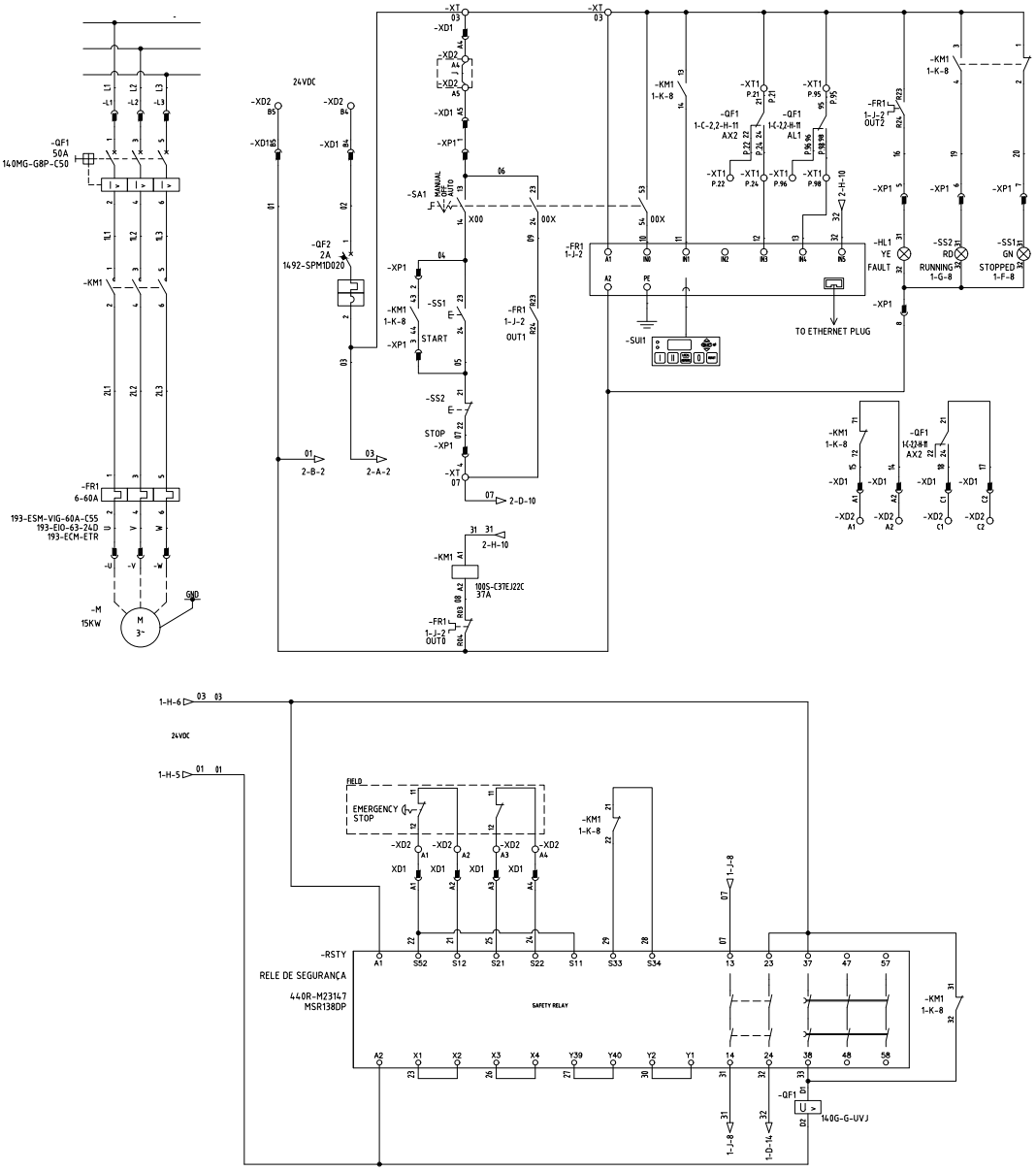
This option receives the safety input signal (+24V DC) from the safety distribution unit.

Bulletin 100S (CENTERLINE 2500 IEC MCC) contactors are used for both the safety function and normal operation, which includes both safety and standard operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

MSR138DP is delivered configured with automatic/manual reset.

If the contactor does not open (KM1 N.C. auxiliary stays open) after pressing E-stop, then the MSR138DP time delay output opens and the shunt trip (140G-G-UVJ circuit breaker accessory) is activated and the circuit breaker trips helping prevent hazardous situation. This circuit design allows you to maintain safe state until the fault is cleared to meet PLd requirement.

Figure 15 - Cat. 2 - DOL Wiring for DOL with Safety Relay MSR138



Configuration

The subsystem configuration is shown in the wiring diagram. The CENTERLINE 2500 MCC wiring diagram describes parameterization for the E300 relay. For the starter units, use one contactor to execute both safety and standard operations in remote or in local operation. The E300 is not part of the safety circuit, but it commands the contactor for standard operation and it is aware of MSR138DP status by monitoring one of its safety outputs. The user should create proper logic to control the relay output that commands this contactor to assure it closes only after the safety circuit is properly reset. The MSR138DP relay, which is used by the CENTERLINE 2500 MCC, is configured through wiring.

Full-voltage Non-reversing Starter Subsystem - Category 3/PLe

Starters with a Safety Monitoring Relay

MSR127TP Safety Monitoring Relay

The MSR127TP safety monitoring relay is recommended as the preferred solution due to its flexibility. It can be used where single or multiple motors are required to stop in response to a demand from the same safety input signal. The MSR127 accepts the wiring directly from the contacts of a safety device (such as an E-stop push button) or can be wired to receive the 24V DC signals from the safety distribution system.

The MSR127TP safety monitoring relay can be connected in three different input wiring configurations: one N.C., two N.C., or with two positive-negative-positive (PNP) connections from a light curtain. When connected in the two N.C. wiring configuration, the MSR127TP safety monitoring relay checks cross fault across two inputs. When connected with two PNP connections from a light curtain, the light curtain must perform the cross fault detection. The MSR127TP safety monitoring relay has an automatic/manual reset.

Starters with a MSR127TP safety monitoring relay installed are designed for applications where single or multiple motors are required to stop in response to a demand from the same safety input signal.

MSR131RTP Safety Monitoring Relay

The MSR131RTP safety monitoring relay is a versatile monitoring safety relay. It can be connected in four different input wiring configurations: one N.C., two N.C., two PNP connections from a light curtain, or a four-wire safety mat.

When connected in the two N.C. wiring configuration, the MSR131RTP safety monitoring relay checks for cross faults across the two inputs. When connected as two PNP connections from a light curtain, the light curtain must perform the cross fault detection. The MSR131RTP safety monitoring relay has output monitoring that can accommodate either automatic/manual reset or a monitored manual reset. When configured with automatic/manual reset (jumpers on X1-X2 and X3-X4), the MSR131RTP safety monitoring relay can have the reset terminals S33-S34 jumped or can be converted to an unmonitored manual reset by adding a N.O. switch in the monitoring loop (S33-S34). When configured for monitored manual reset, the MSR131RTP safety monitoring relay checks the output monitoring circuit through the manual application of the reset switch. The outputs include three N.O. safety rated outputs, two N.C. auxiliary outputs, and two solid-state outputs. One solid-state output indicates that the inputs are closed. The second solid-state output indicates that the safety outputs are active.

The safety outputs have independent and redundant internal contacts to confirm the safety function. The auxiliary output is a standard output that is intended to provide an external signal that indicates the status of the safety outputs. The input power entry is 24V AC/DC, 115V AC, or 230V AC.

Starters with a MSR131RTP safety monitoring relay installed are designed for applications where single or multiple motors are required to stop in response to a demand from the same safety input signal.

Guardmaster Safety Relay GSR-DI Safety Monitoring Relay

The Guardmaster® safety relay, dual input (GSR-DI) safety monitoring relay (Cat. No. 440R-D22R2) safety relay has two dual-channel inputs and two electromechanical relay outputs. In addition, the dual-input (DI) safety relay has a single wire safety (SWS) circuit input and output. The DI safety relay can be set for automatic or monitored manual reset by adjusting the switch on the front panel.

Starters with a GSR-DI safety monitoring relay installed are designed for applications where a single motor is required to stop in response to a demand from the same safety input signal.

Starters without a Safety Monitoring Relay

Starters without a safety monitoring relay installed is designed for applications where multiple motors are required to stop in response to a demand from the same safety input signal. The interposing relay allows the unit to receive the safety interlock signal from the safety distribution system (where the same contact stops multiple units). If an interposing relay is not used, the unit must receive a dedicated contact as the safety interlock for each unit.

The following options are available for the CENTERLINE 2100 MCCs and 2500 MCCs as non-standard options..

Starter	Contactors	Relay
CENTERLINE 2100 MCCs as Non-standard Options		
FVNR Starter	two NEMA Bulletin 300 Contactors	with interposing relay
		without interposing relay
	one NEMA Bulletin 500 Contactor and two IEC Bulletin 100S Contactors	with interposing relay
		without interposing relay
	two NEMA Bulletin 300 Contactors	and MSR127TP relay
	one NEMA Bulletin 500 Contactor and two IEC Bulletin 100S Contactors	
	two NEMA Bulletin 300 Contactors	and MSR131RTP relay
	one NEMA Bulletin 500 Contactor and two IEC Bulletin 100S Contactors	
CENTERLINE 2500 MCCs as Standard Offering		
DOL Starter	two IEC Bulletin 100S Contactors	with interposing relay
		without interposing relay
		and GSR-DI relay
		and MSR127TP relay

Safety Rating

For safety rating values, see the tables in Quick Reference - Functional Safety Ratings on page 83.

- Cat. 3, PLe according to ISO 13849-1:2015
- SIL CL3 according to IEC 62061:2005

For use in safety-related subsystems up to SIL3/PLe/Cat. 3 with safety logic monitoring unit.

A Cat. 3 circuit requires fault detection, well-tried components, well-tried safety principles (see ISO 13849-2) and two separate channels to avoid a single fault that leads to the loss of the safety function.

ISO 13849-2:2012 Standard, Table D.3 considers contactors 'well-tried component' that comply with standard IEC60947-4-1.

ISO 13849-2:2012 Standard, Table D.2 considers contactors 'well-tried safety principles' that comply with the use of positively mechanically linked contacts. For example, for monitoring the safety function in Cat. 2, 3, and 4 systems (see EN 50205, IEC 60947-4-1:2001, Annex F, IEC 60947-5-1:2003 + A1:2009, Annex L).

Bulletin 100S and Bulletin 300 and the selected auxiliary contacts comply with the standards that are mentioned above.

The contactor diagnostic is achieved with N.C. auxiliary feedback contacts connected in series that must be connected to a logic solver, such as a safety PLc or a safety monitoring relay. Typically, the auxiliary feedback signal is sent to the safety distribution unit. Additional diagnostic is achieved with N.O. auxiliary feedback contacts connected to E300 relay inputs.

The Bulletin 300 and Bulletin 100S contactor auxiliary contacts that are used comply with mirror contacts (IEC 60947-4-1 Draft Annex F) and therefore can be considered as well-tried components per Table D.3 of IEC 13849-2:2012 and as using well-tried safety principles per Table D.2 of IEC 13849-2:2012.

The MSR131RTP safety monitoring relay is a versatile monitoring safety relay. It can be connected in four different input wiring configurations: one N.C., two N.C., two PNP connections from a light curtain, or a four-wire safety mat. When connected in the two N.C. fashion, the MSR131RTP safety monitoring relay checks for cross faults across the two inputs. When connected to light curtains, the light curtain must perform the cross fault detection. The MSR131RTP safety monitoring relay has output monitoring that can accommodate either automatic/manual reset, or a monitored manual reset. When configured with automatic/manual reset (jumpers on X1-X2 and X3-X4), the MSR131RTP safety monitoring relay can have the reset terminals S33-S34 jumped or can be converted to an unmonitored manual reset by adding a N.O. switch in the monitoring loop (S33-S34). When configured for monitored manual reset, the MSR131RTP safety monitoring relay checks the output monitoring circuit through the manual application of the reset switch. The outputs include three N.O. safety rated outputs, two N.C. auxiliary outputs, and two solid-state outputs. One solid-state output indicates that the inputs are closed. The second solid-state output indicates that the safety outputs are active.

The safety outputs have independent and redundant internal contacts to confirm the safety function. The auxiliary output is a standard output that is intended to provide an external signal that indicates the status of the safety outputs. The input power entry is 24V AC/DC, 115V AC, or 230V AC.

The GSR-DI (Cat. No. 440R-D22R2) safety relay has two dual-channel inputs and two electromechanical relay outputs. In addition, the DI safety relay has a SWS circuit input and output. The DI safety relay can be set for automatic or monitored manual reset by adjusting the switch on the front panel. The configuration switch also sets the and/or logic that is applied to the inputs.

The MSR127TP safety monitoring relay can be connected in three different input wiring configurations: one N.C., two N.C., or with two PNP connections from a light curtain. When connected in two N.C. fashion, the MSR127TP safety monitoring relay checks cross fault across two inputs. When connected to light curtains, the light curtain must perform the cross fault detection. The MSR127TP safety monitoring relay has an automatic/manual reset.

Electrical Schematic Examples

This section shows five examples of starter safety subsystems electrical schematics. To download the complete set of electrical schematic examples, see Access Components of the Safety Function on page 7.

FVNR/DOL Category 3 using Two Contactors with Interposing Relay

Figure 16 on page 35 shows the Cat. 3 - FVNR electrical schematic for the CENTERLINE 2100 MCC (NEMA) FVNR starter with two Bulletin 300 contactors with interposing relay.

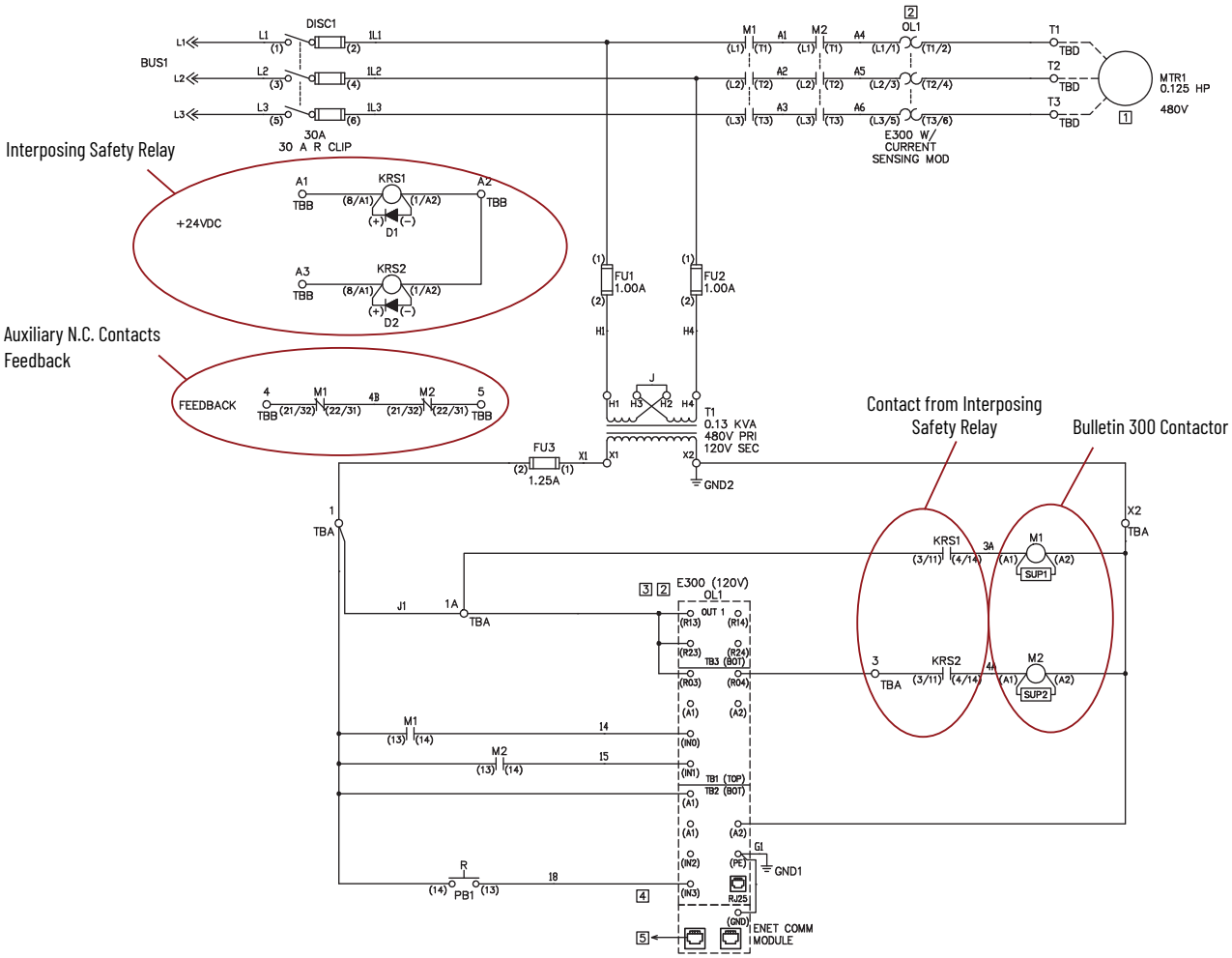
This option receives the safety input signal (+24V DC) from the safety distribution unit.

The same contact from the safety distribution unit interfaces with up to eight MCC units (drive or starter). This option optimizes the use of safety outputs from the safety distribution unit.

One of the Bulletin 300 (CENTERLINE 2100 NEMA MCC) or Bulletin 100S (CENTERLINE 2500 IEC MCC) contactors are used for both the safety function and normal operation, which includes both safety and standard operations in the number of operations when calculating MTTFd based on B10d of the components (see the SISTEMA CENTERLINE file projects for more information).

The second contactor and the interposing relay de-energize only when the safety function is actuated, which includes only the safety operations in the number of operations when calculating MTTFd based on B10d of the components (see the SISTEMA CENTERLINE file projects for more information).

Figure 16 - FVNR Cat. 3 with Interposing Relay Electrical Schematic



FVNR using One Bulletin 500 and Two 100S Contactors without Interposing Relay

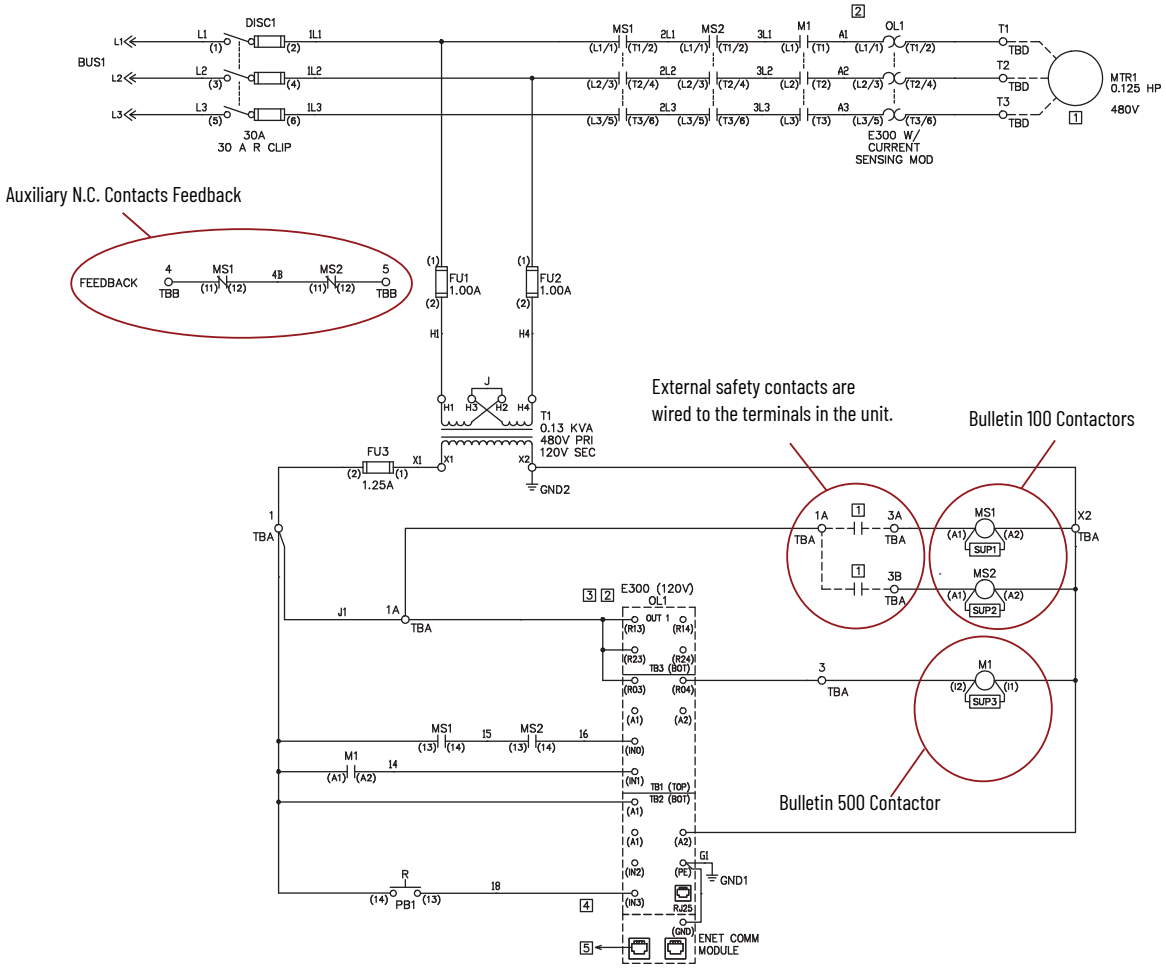
Figure 17 shows the Cat. 3 - FVNR electrical schematic for the CENTERLINE 2100 MCC using one Bulletin 500 contactor and two IEC Bulletin 100S contactors without an interposing relay.

Bulletin 500 contactors are used for normal operation only and are not part of the safety circuit.

Bulletin 100S contactors are used for the safety function only, which includes only the safety operations in the number of operations when calculating MTTFd based on B10d of the components (see the SISTEMA CENTERLINE file projects for more information).

The unit receives two contacts from relay distribution that de-energize the contactor coil when the safety function is actuated. The relay distribution unit must reserve two unique contacts for each starter unit.

Figure 17 - FVNR Cat. 3 with one Bulletin 500 and two 100S Contactors without Interposing Relay



FVNR using Two Contactors without Interposing Relay

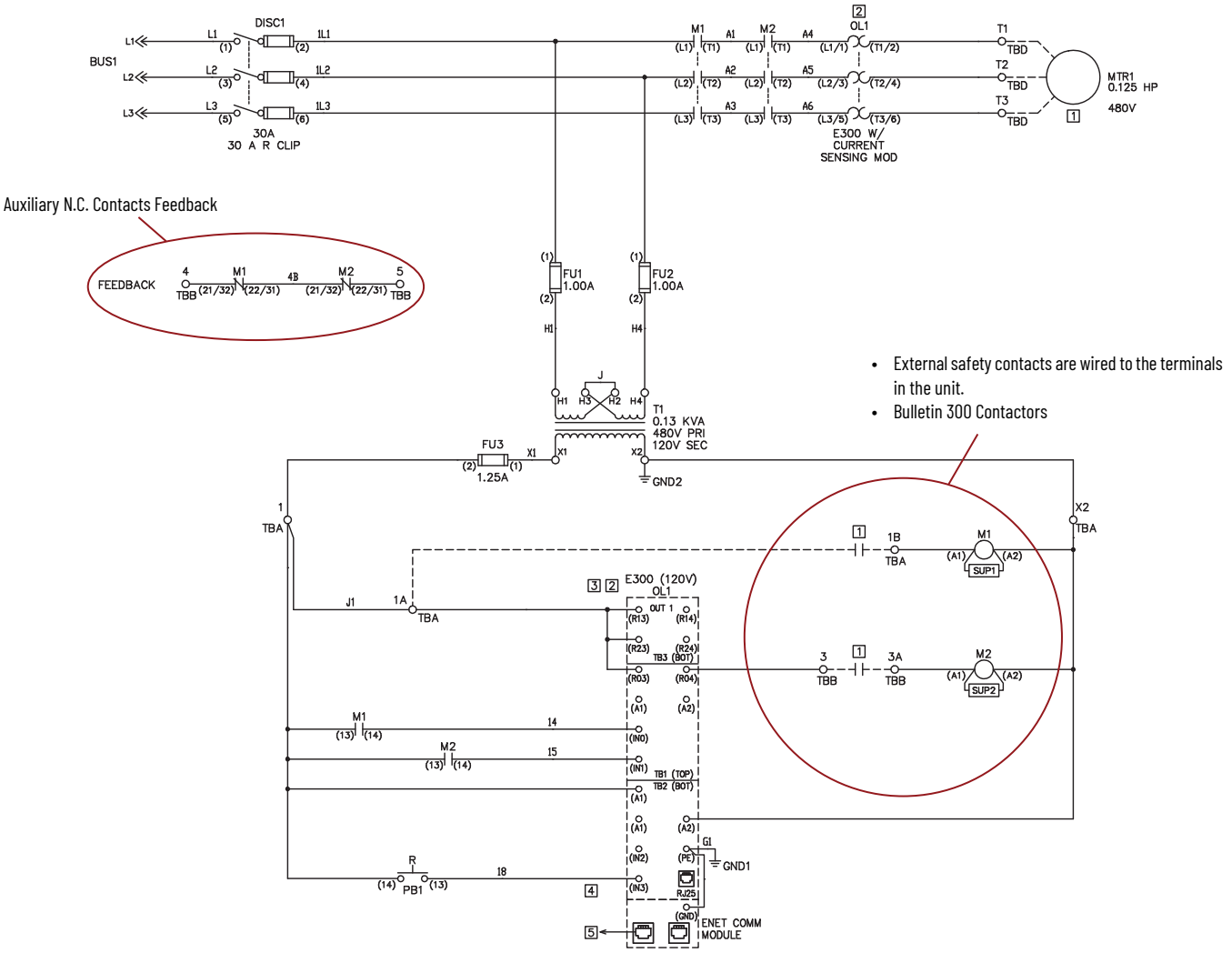
Figure 18 shows the Cat. 3 - FVNR electrical schematic for the CENTERLINE 2100 MCC using two Bulletin 300 NEMA contactors without interposing relay.

One of the Bulletin 300 (CENTERLINE 2100 NEMA MCC) contactors is used for both the safety function and normal operation, which includes both safety and standard operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

The other Bulletin 300 contactor is used for the safety function only, which includes only the safety operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

The unit receives two contacts from the relay distribution that de-energize the contactor coil when the safety function is actuated. The relay distribution unit must reserve two unique contacts for each unit with this option.

Figure 18 - FVNR Cat. 3 with Two Bulletin 300 Contactors without Interposing Relay Electrical Schematic



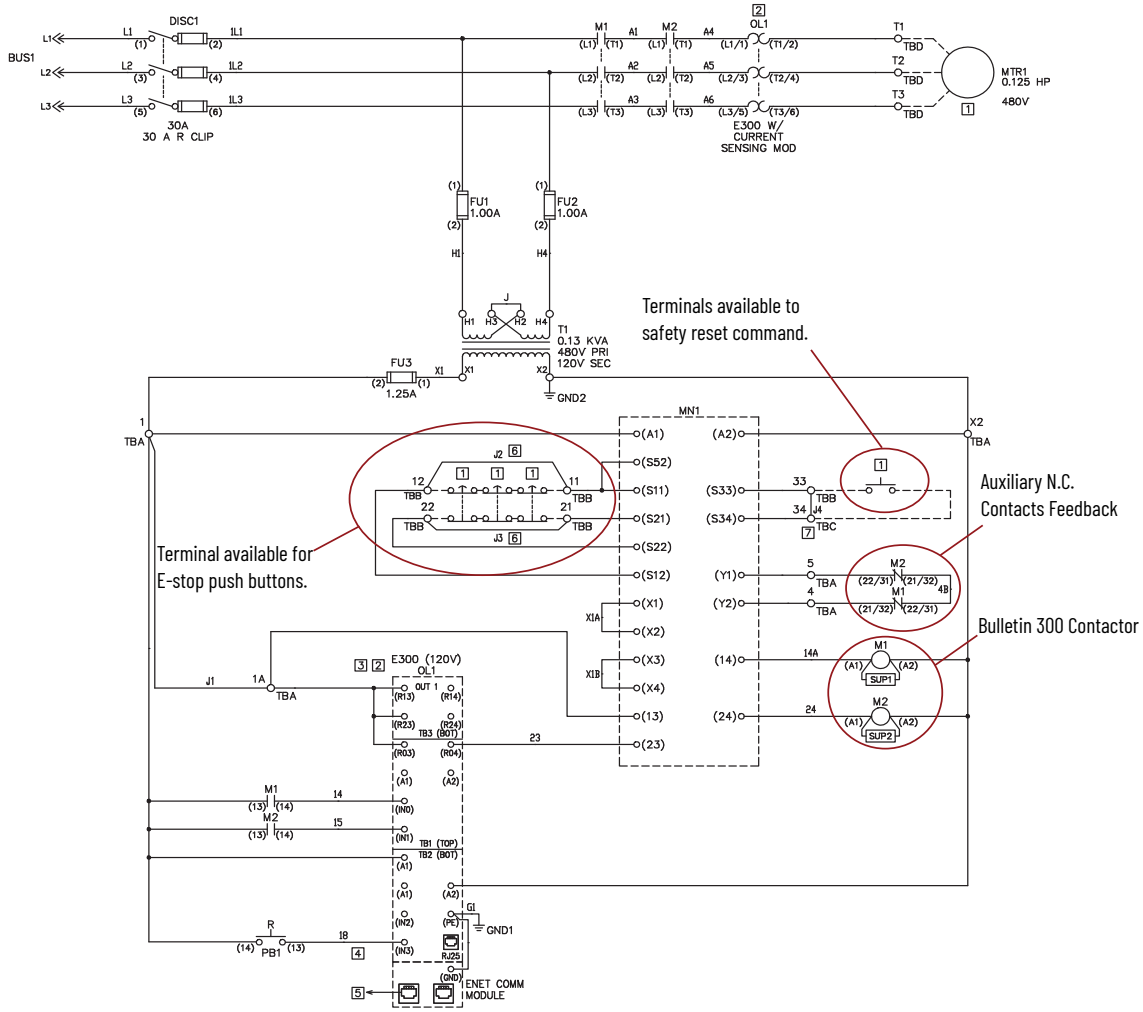
FVNR using MSR131RTP Safety Monitoring Relay and two Contactors

Figure 19 shows the Cat. 3 - FVNR electrical schematic for the CENTERLINE 2100 MCC (NEMA) FVNR starter with two Bulletin 300 contactors and MSR131RTP safety monitoring relay.

One of the Bulletin 300 (CENTERLINE 2100 NEMA MCC) contactors is used for both the safety function and normal operation, which includes both safety and standard operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

The second contactor and the interposing relay de-energize only when the safety function is actuated which includes only the safety operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

Figure 19 - FVNR Cat. 3 with two Contactors and MSR131RTP Safety Monitoring Relay Electrical Schematic



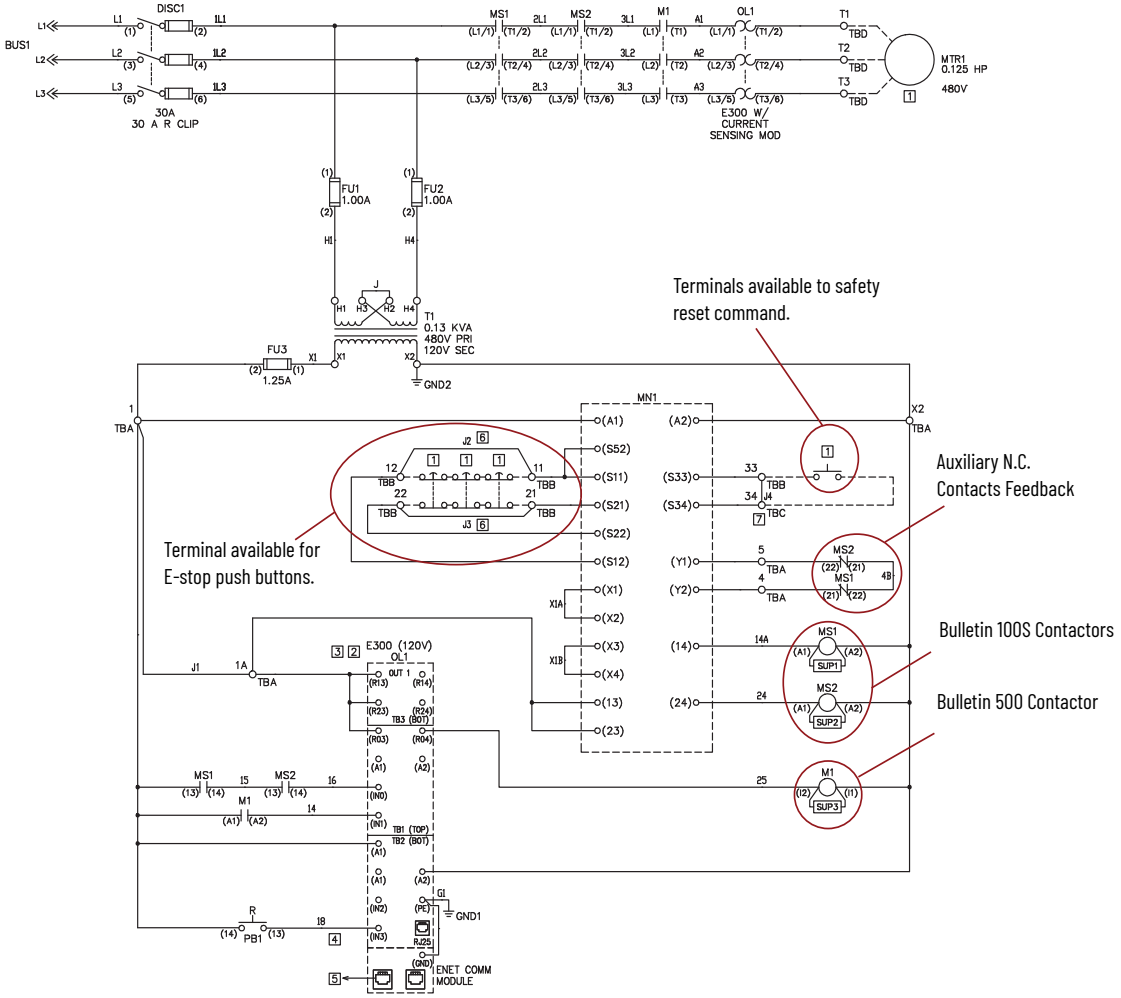
FVNR using one MSR131RTP Safety Monitoring Relay, one Bulletin 500 Contactor, and two IEC Bulletin 100S Contactors

Figure 20 shows the Cat. 3 - FVNR electrical schematic for the CENTERLINE 2100 MCC using one Bulletin 500 contactor and two IEC Bulletin 100S contactors and MSR131RTP safety monitoring relay.

Bulletin 500 contactors are used for normal operation only and are not part of the safety circuit.

Bulletin 100S contactors are used for the safety function only, which includes only the safety operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

Figure 20 - FVNR Cat. 3 with one Bulletin 500, two Bulletin 100S Contactors, and MSR131RTP Safety Monitoring Relay Schematic



Configuration

Subsystem configuration is shown in the wiring diagram. The CENTERLINE 2100 MCC wiring diagram describes parameterization for the E300 relay. For the starter units using one contactor to execute both safety and standard operations in remote or in local operation, the E300 relay output that commands this contactor must only be allowed to close after the safety circuit is properly reset. The MSR131RTP safety monitoring relay, which is used by the CENTERLINE 2100 MCC, is configured through wiring. The GSR-DI safety relay, which is used by the CENTERLINE 2500 MCC, requires rotary switch setting. See the Guardmaster Safety Relays User Manual, publication 440R-UM013 for information.

Full-voltage Reversing Starter Subsystem – Category 1/PLc

The following options are available for the CENTERLINE 2100 MCCs and the CENTERLINE 2500 MCCs. NEMA and IEC wiring diagram examples are available for download. See Access Components of the Safety Function on page 7.

Starter	Contactors	Relay
Full-voltage Reversing starter	NEMA Bulletin 500 Contactors	with interposing relay
		without interposing relay
DOL Reversing Starter	IEC Bulletin 100S Contactors	with interposing relay
		without interposing relay

Safety Rating

For safety rating values, see the tables in Quick Reference - Functional Safety Ratings on page 83.

- Cat. 1, PLc according to ISO 13849-1:2015
- SIL CL 1 according to IEC 62061:2005

A Cat. 1 circuit does not require fault detection, but it does require well-tried components and well-tried safety principles (see ISO 13849-2). ISO 13849-2:2012 Standard, Table D.3 considers contactors 'well-tried component' that comply with standard IEC60947-4-1.

To follow well-tried safety principals (Table D.2 from ISO 13849-2:2012), the 2500 design oversized contactors by 50% and the 2100 design uses Bulletin 500 contactors (proven design component).

Electrical Schematic using Interposing Relay

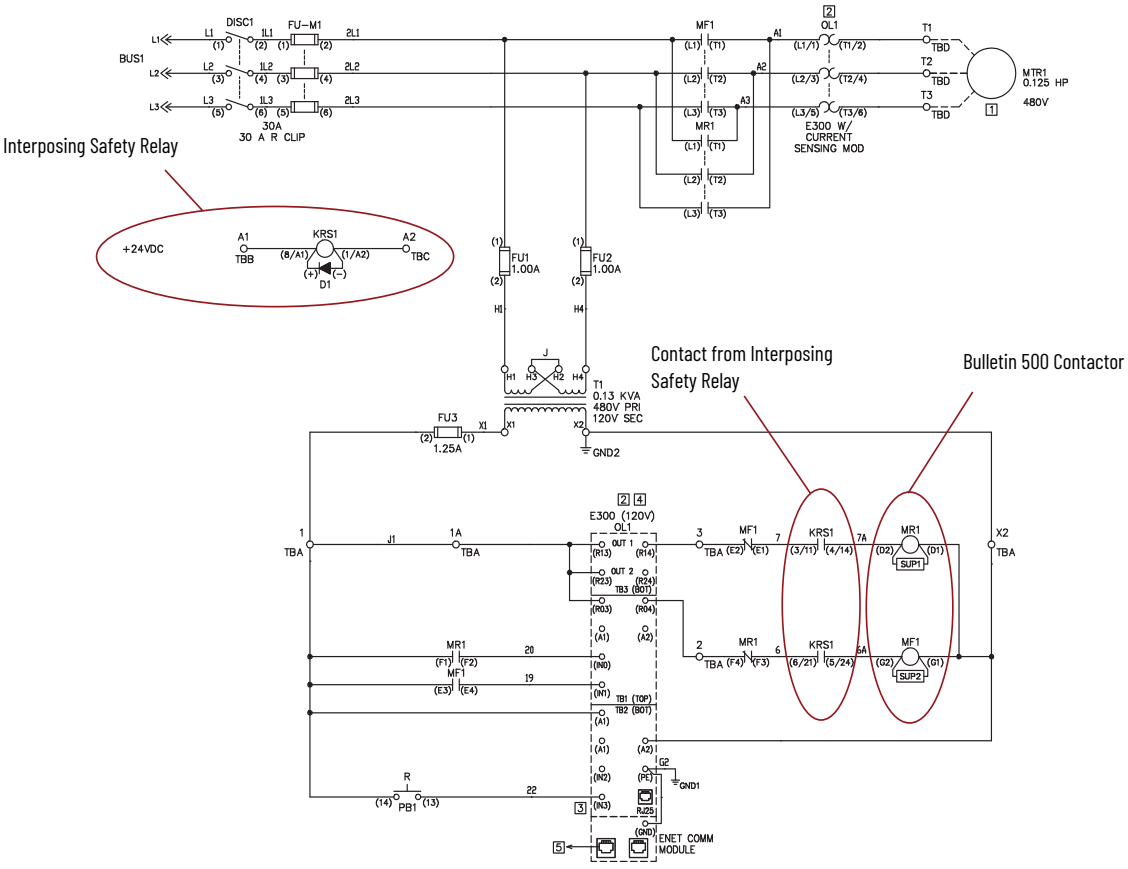
Figure 21 on page 41 shows the Cat. 1 - FVR wiring for the CENTERLINE 2100 MCC with interposing relay. This option receives the safety input signal (+24V DC) from the safety distribution unit.

The same contact from the safety distribution unit interfaces with up to eight MCC units (drive or starter). This option optimizes the use of contacts of the safety relay distribution unit.

The contactor is used for both the safety function and normal operation, which includes both safety and standard operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

The interposing relay de-energizes only when the safety function is actuated, which includes only the safety operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

Figure 21 - FVR Cat. 1 using Interposing Relay Electrical Schematic



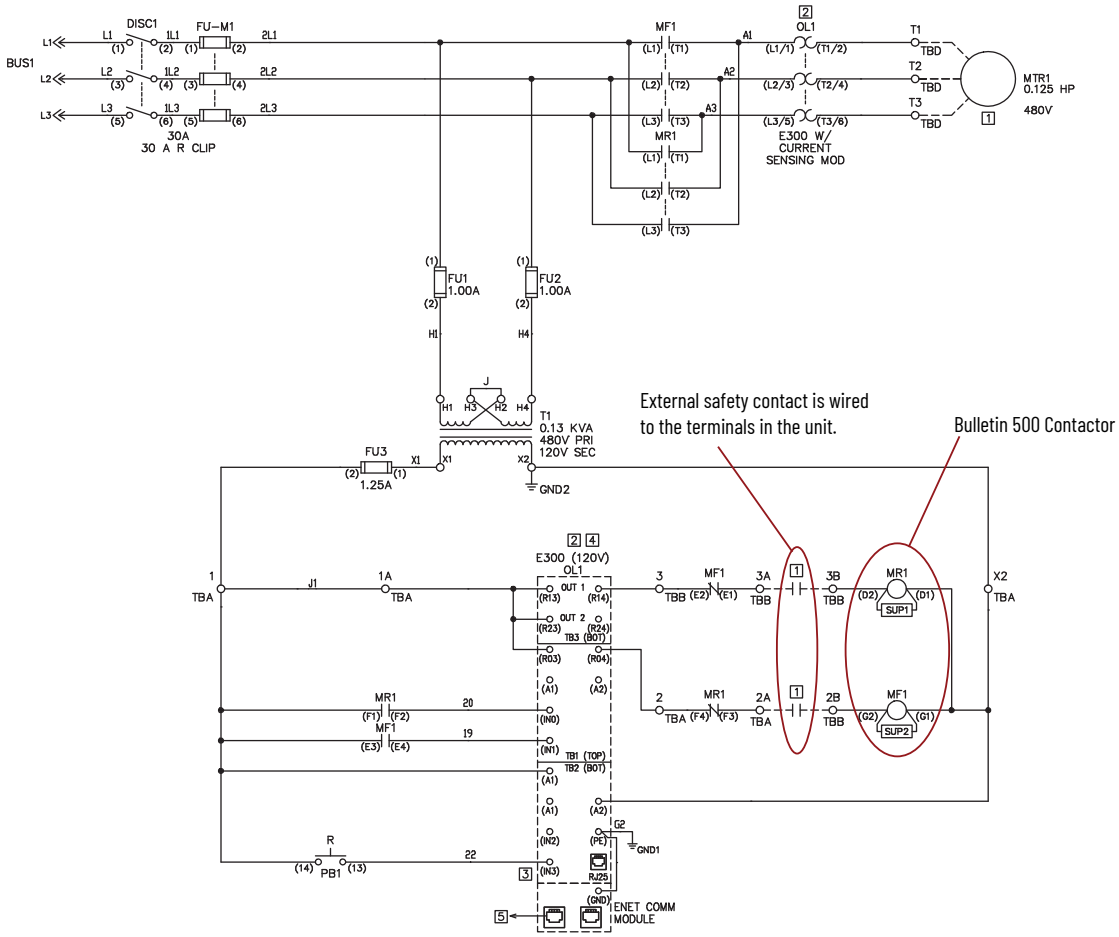
Electrical Schematic without Interposing Relay

Figure 22 shows the Cat. 1 - FVNR wiring for the CENTERLINE 2100 MCC without interposing relay. This option receives one dedicated contact from the safety distribution unit. The relay distribution unit contacts are wired to terminals in the unit.

The contactors are used for both the safety function and normal operation, which includes both safety and standard operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

A dedicated contact from the relay distribution unit de-energizes the contactor coil when the safety function is actuated.

Figure 22 - FVR Cat. 1 without Interposing Relay Schematic



Configuration

Subsystem configuration is shown in the wiring diagram. The CENTERLINE 2100 MCC wiring diagram describes parameterization for the E300 relay; it does not affect the safety function unless there is local operation input devices.

Direct-on-line Reversing Starter Subsystem – Category 2/PLd

The following options are available only in CENTERLINE® 2500 MCCs.
IEC wiring diagram examples are available for download. See Access Components of the Safety Function on page 7.

- Direct-on-line reversing (DOLR) Starter with IEC Bulletin 100S contactor with MSR138DP

Safety Rating

For safety rating values, see the tables in Quick Reference - Functional Safety Ratings on page 83.

- Cat. 2, up to PLd according to ISO 13849-1:2015
- Up to SIL CL2 according to IEC 62061:2005

Cat. 2 requires basic and well-tried safety principles (see ISO 13849-2). The ISO 13849-2:2012 standard, Table D.3 considers contactors 'well-tried component' that comply with standard IEC 60947-4-1. Additionally, this shall be designed in a way that their function is checked at the machine startup and before the initiation of any hazardous situation. Occurring failure shall generate output that starts proper action to mitigate the risk.

ISO 13849-2:2012 Standard, Table D.3 considers contactors 'well-tried component' that comply with standard IEC60947-4-1.

ISO 13849-2:2012 Standard, Table D.2 considers contactors 'well-tried safety principles' that comply with the use of positively mechanically linked contacts. For example, for monitoring the safety function in Cat. 2, 3, and 4 systems see EN 50205, IEC 60947-4-1:2001,Annex F, IEC 60947-5-1:2003 + A1:2009, Annex L.

To follow well-tried safety principals (Table D.2 from ISO 13849-2:2012) for 2500, we are oversizing contactors by 50%.

ISO 13849-1:2015 Standard states that the PLd shall initiate safe state that is maintained until fault is cleared.

Bulletin 100S and the selected auxiliary contacts comply with the standards that are mentioned above.

The contactor diagnostic is achieved with N.C. auxiliary feedback contacts connected in series that must be connected to a logic solver, such as a safety PLc or a safety monitoring relay. Typically, the auxiliary feedback signal is sent to the safety distribution unit.

Additional diagnostic is achieved with N.O. auxiliary feedback contacts connected to E300 relay inputs.

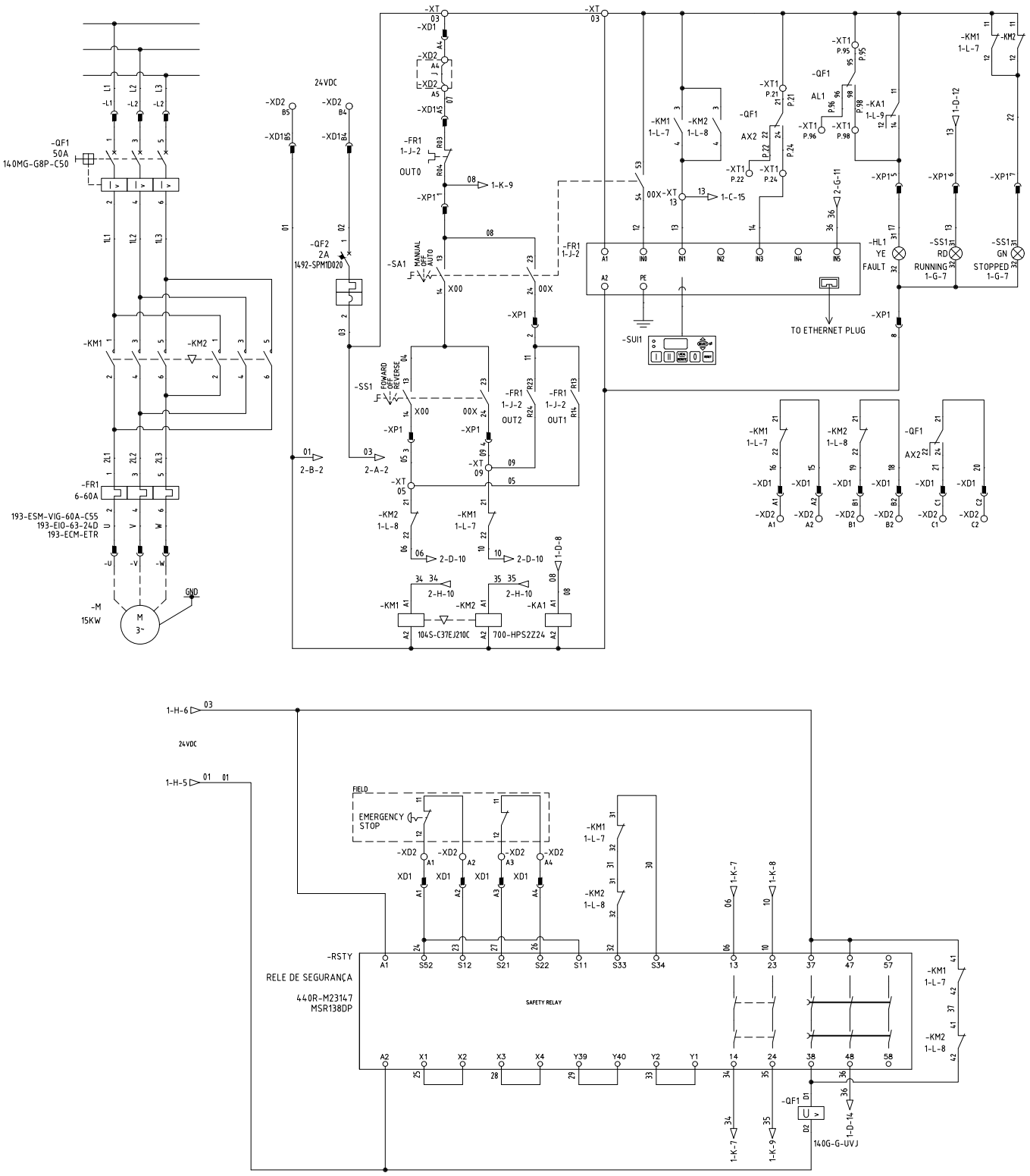
The Bulletin 100S contactor auxiliary contacts that are used comply with mirror contacts (IEC 60947-4-1 Draft Annex F). Therefore, these contactors can be considered as well-tried components per Table D.3 of IEC 13849-2:2012 and as using well-tried safety principles per Table D.2 of IEC 13849-2:2012.

The MSR138DP relay has three input wiring options: 1 N.C., 2 N.C., or 2 OSSD. When connected in to the two N.C. fashion, the MSR138DP checks for cross faults across two inputs. When connected to light curtains, the light curtain must perform the cross fault detection. The MSR138DP has output monitoring that can accommodate either automatic/manual reset or a monitored manual reset. When configured with automatic/manual reset (jumpers on X1-X2 and X3-X4), the MSR138DP can have reset terminals S33-S34 jumped or can be converted to an unmonitored manual reset by adding a N.O. switch in the monitoring loop (S33-S34). When configured to monitored manual reset, the MSR138DP checks the output monitoring circuit through the manual application of the reset switch. The unit cannot be reset until the timing function has completed.

The outputs of the MSR138DP include two N.O. immediate safety outputs and three N.O. delayed safety outputs. The safety outputs have independent and redundant internal contacts to support the safety function. If a reset request is made during the time cycle, it causes a lockout condition. Cycle inputs after timing has a completed and rest reset after the delay time has expired to clear the lockout.

Electrical Schematic

Figure 23 - DOLR Starter Subsystem — Cat. 2/PLd



The subsystem configuration is shown in the wiring diagram. The CENTERLINE 2500 MCC wiring diagram describes parameterization for the E300 relay. For the starter units, use one contactor to execute both safety and standard operations in remote or in local operation. The E300 is not part of the safety circuit, but it commands the contactor for standard operation and it is aware of MSR138DP status by monitoring one of its safety outputs. You should create proper logic to control the relay output that commands this contactor to insure it closes only after the safety circuit is properly reset. The MSR138DP relay, which is used by the CENTERLINE 2500 MCC, is configured through wiring.

FVR Starter Subsystem - Category 3/PLe

To download the complete set of electrical schematic examples, see Access Components of the Safety Function on page 7.

The MSR127 safety monitoring relay is recommended as the prefer solution due to its flexibility. It can be used where single or multiple motors are required to stop in response to a demand from the same safety input signal. The MSR127 accepts the wiring directly from the contacts of a safety device, such as an E-stop push button, or it can be wired to receive the 24V DC signals from the safety distribution system.

Starters with an MSR127 or a MSR131RTP safety monitoring relay installed in the unit are designed for applications where single or multiple motors are required to stop in response to a demand from the same safety input signal.

Starters with a GSR-DI safety monitoring relay installed in the unit are designed for applications where a single motor is required to stop in response to a demand from the same safety input signal.

Starters without a safety monitoring relay installed in the unit are designed for applications where multiple motors are required to stop in response to a demand from the same safety input signal. The interposing relay allows the unit to receive the safety interlock signal from the safety distribution system; the same contact stops multiple units.

If an interposing relay is not used, then the unit must receive a dedicated contact as the safety interlock for each unit.

The following options are available for the CENTERLINE 2100 MCCs as non-standard offering:

Starter	Contactors	Relay
FVR Starter	three NEMA Bulletin 300 Contactors	with interposing relay
		without interposing relay
	two NEMA Bulletin 500 Contactors and two IEC Bulletin 100S Contactors	with interposing relay
		without interposing relay
	three NEMA Bulletin 300 Contactors	MSR127TP
		MSR131RTP
	two NEMA Bulletin 500 Contactors and two IEC Bulletin 100S Contactors	MSR127TP
		MSR131RTP

The following options are available for the CENTERLINE 2500 Motor Control Centers as standard offering:

Starter	Contactors	Relay
DOLR Starter	three IEC Bulletin 100S Contactors	with interposing relay
		without interposing relay
		GSR-DI
		MSR127TP

Safety Rating

For safety rating values, see the tables in Quick Reference - Functional Safety Ratings on page 83.

- Cat. 3, PLe according to ISO 13849-1:2015
- SIL CL3 according to IEC 62061:2005

The Cat. 3 circuit requires fault detection, well-tried components, well-tried safety principles (see ISO 13849-2), and irequires two separate channels to avoid a single fault that leads to the loss of the safety function.

ISO 13849-2:2012 Standard, Table D.3 considers contactors 'well-tried component' that comply with standard IEC60947-4-1.

ISO 13849-2:2012 Standard, Table D.2 considers contactors 'well-tried safety principles' that comply with the use of positively mechanically linked contacts. For example, for the monitoring function in Cat. 2, 3, and 4 systems (see EN 50205, IEC 60947-4-1:2001,Annex F, IEC 60947-5-1:2003 + A1:2009, Annex L).

Bulletin 100S and Bulletin 300 and the selected auxiliary contacts comply with the standards mentioned.

The diagnostic for the contactor is achieved with N.C. auxiliary feedback contacts connected in series that must be connected to a logic solver such as a safety PLc or a safety monitoring relay. Typically, the auxiliary feedback signal is sent to the safety distribution unit. Additional diagnostic is achieved with N.O. auxiliary feedback contacts connected to E300 relay inputs.

Bulletin 300 and Bulletin 100S contactor auxiliary contacts that are used comply with mirror contacts (IEC 60947-4-1 Draft Annex F) and, therefore can be considered as well-tried components per Table D.3 of IEC 13849-2:2012 and as using well-tried safety principles per Table D.2 of IEC 13849-2:2012.

The MSR131RTP safety monitoring relay is a versatile monitoring safety relay. It can be connected in four different input wiring configurations: one N.C., two N.C., two PNP connections from a light curtain, or a four-wire safety mat. When connected in the two N.C. fashion, the MSR131RTP safety monitoring relay checks for cross faults across the two inputs. When connected to light curtains, the light curtain must perform the cross fault detection. The MSR131RTP safety monitoring relay has output monitoring that can accommodate either automatic/manual reset or a monitored manual reset. When configured with automatic/manual reset (jumpers on X1-X2 and X3-X4), the MSR131RTP safety monitoring relay can have the reset terminals S33-S34 jumpered or can be converted to an unmonitored manual reset by adding a N.O. switch in the monitoring loop (S33-S34). When configured for monitored manual reset, the MSR131RTP safety monitoring relay checks the output monitoring circuit through the manual application of the reset switch. The outputs include three N.O. safety-rated outputs, two N.C. auxiliary outputs, and two solid-state outputs. One solid-state output indicates that the inputs are closed. The second solid-state output indicates that the safety outputs are active.

The safety outputs have independent and redundant internal contacts to confirm the safety function. The auxiliary output is a standard output that is intended to provide an external signal, which indicates the status of the safety outputs. The input power entry is 24V AC/DC, 115V AC, or 230V AC.

The GSR-DI (Cat. No. 440R-D22R2) safety relay has two dual-channel inputs and two electromechanical relay outputs. In addition, the DI safety relay has a SWS circuit input and output. The DI safety relay can be set for automatic or monitored manual reset by adjusting the switch on the front panel. The configuration switch also sets the and/or logic that is applied to the inputs.

Electrical Schematic Examples

This section shows six examples of electrical schematics for the starter safety subsystems. To download the complete set of electrical schematic examples, see Access Components of the Safety Function on page 7.

FVR/DOLR using Three Contactors with Interposing Relay

Figure 24 on page 47 shows the Cat. 3 - FVR electrical schematic for the CENTERLINE 2100 MCC (NEMA) FVR starter with three Bulletin 300 contactors with interposing relay.

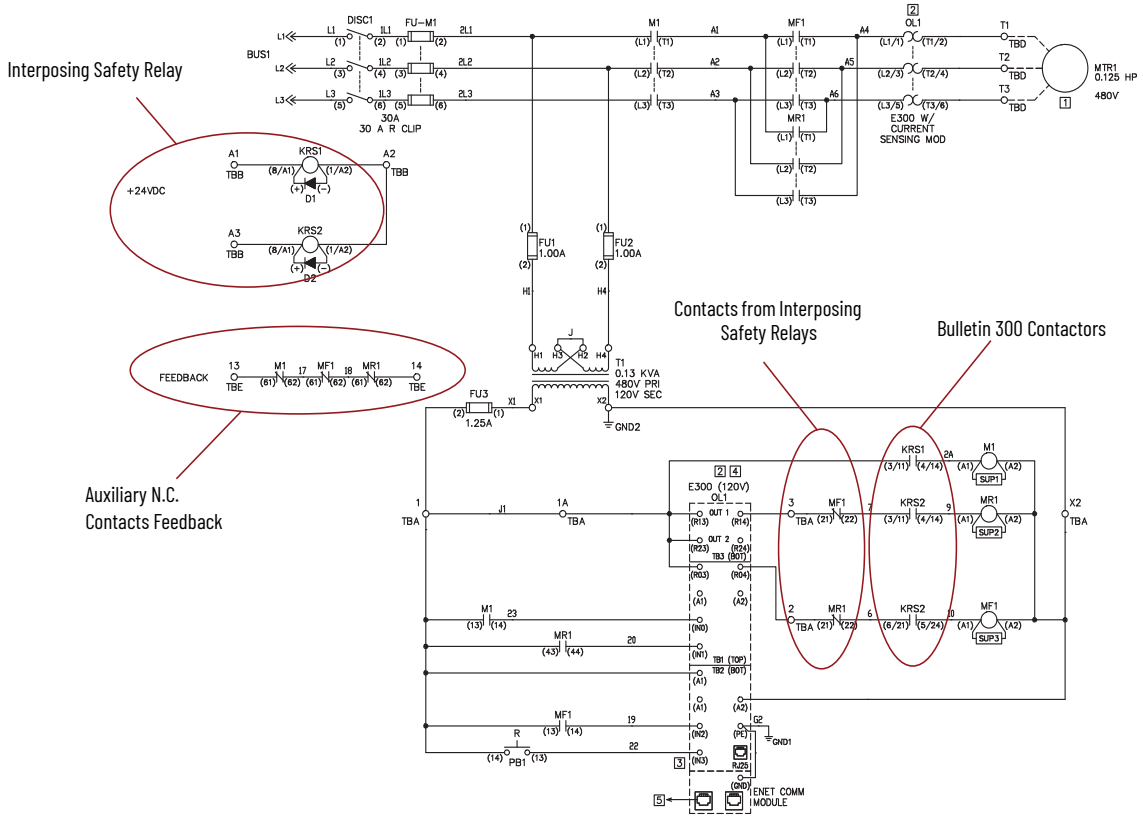
This option receives the safety input signal (+24V DC) from the safety distribution unit.

The same contact from the safety distribution unit interfaces with up to eight motor control units (MCUs) (drive or starter). This option optimizes the use of safety outputs from the safety distribution unit.

Two Bulletin 300 (CENTERLINE 2100 NEMA MCC) or two Bulletin 100S (CENTERLINE 2500 IEC MCC) contactors are used for both the safety function and normal operation, which includes both safety and standard operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

The third contactor and the interposing relay de-energize only when the safety function is actuated, which includes only the safety operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

Figure 24 - FVR Cat. 3 with three Contactors and Interposing Relay Electrical Schematic



FVR using two Bulletin 500 and two 100S Contactors without Interposing Relay

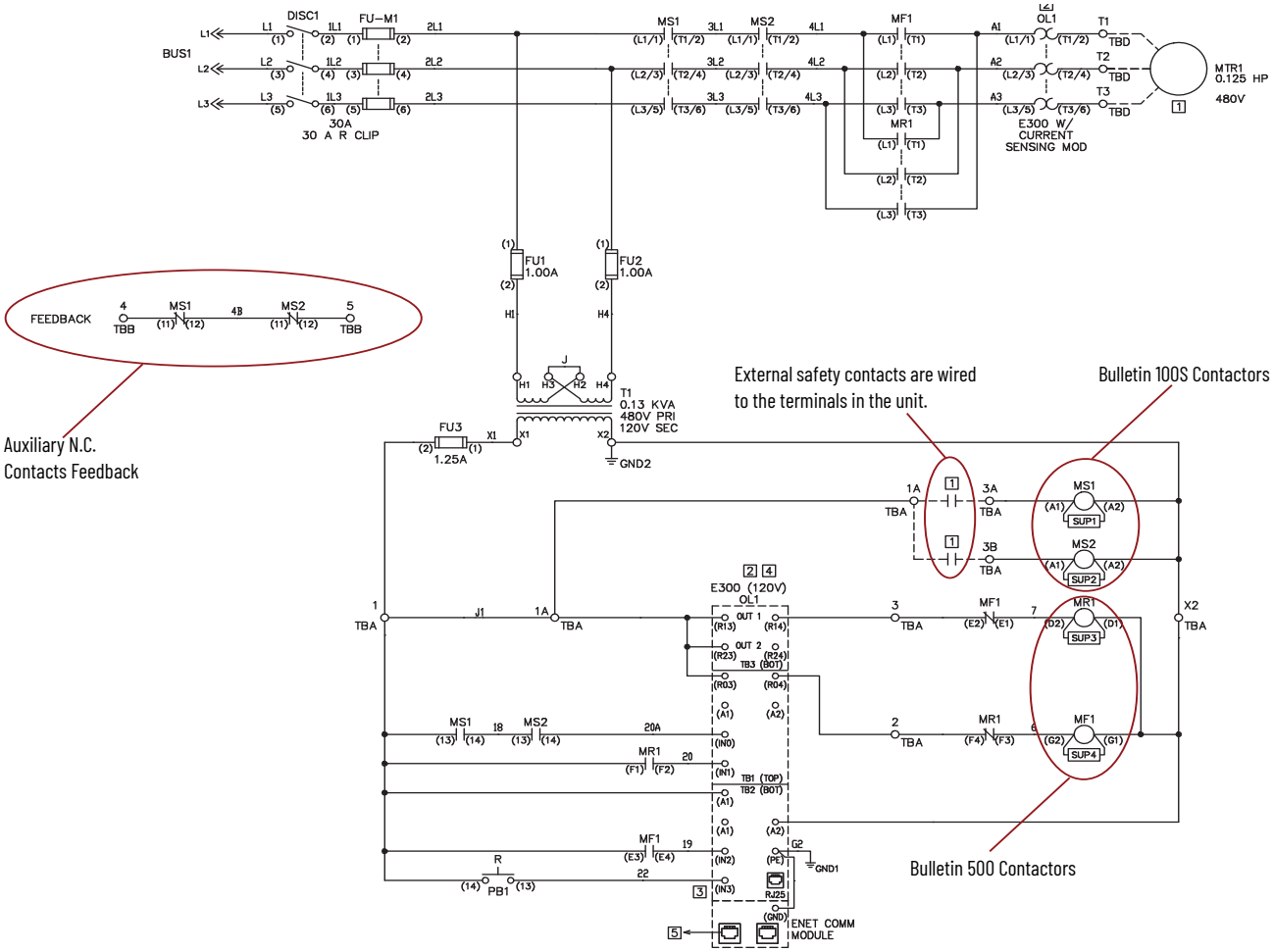
Figure 25 shows the Cat. 3 - FVR electrical schematic for the CENTERLINE 2100 MCC using two Bulletin 500 Contactors and two IEC Bulletin 100S Contactors without interposing relay

Bulletin 500 contactors are used for normal operation only and are not part of the safety circuit.

Bulletin 100S contactors are used for the safety function only, which includes only the safety operations in the number of operations when calculating MTTFd based on B10d of the components (see the SISTEMA CENTERLINE file projects for more information).

The unit receives two contacts from the relay distribution that de-energize the contactor coils when the safety function is actuated. The relay distribution unit must reserve two unique contacts for each starter unit.

Figure 25 - FVR Cat. 3 with two Bulletin 500 Contactors and two Bulletin 100S Contactors without Interposing Relay Electrical Schematic



FVR/DOLR using three Contactors without Interposing Relay

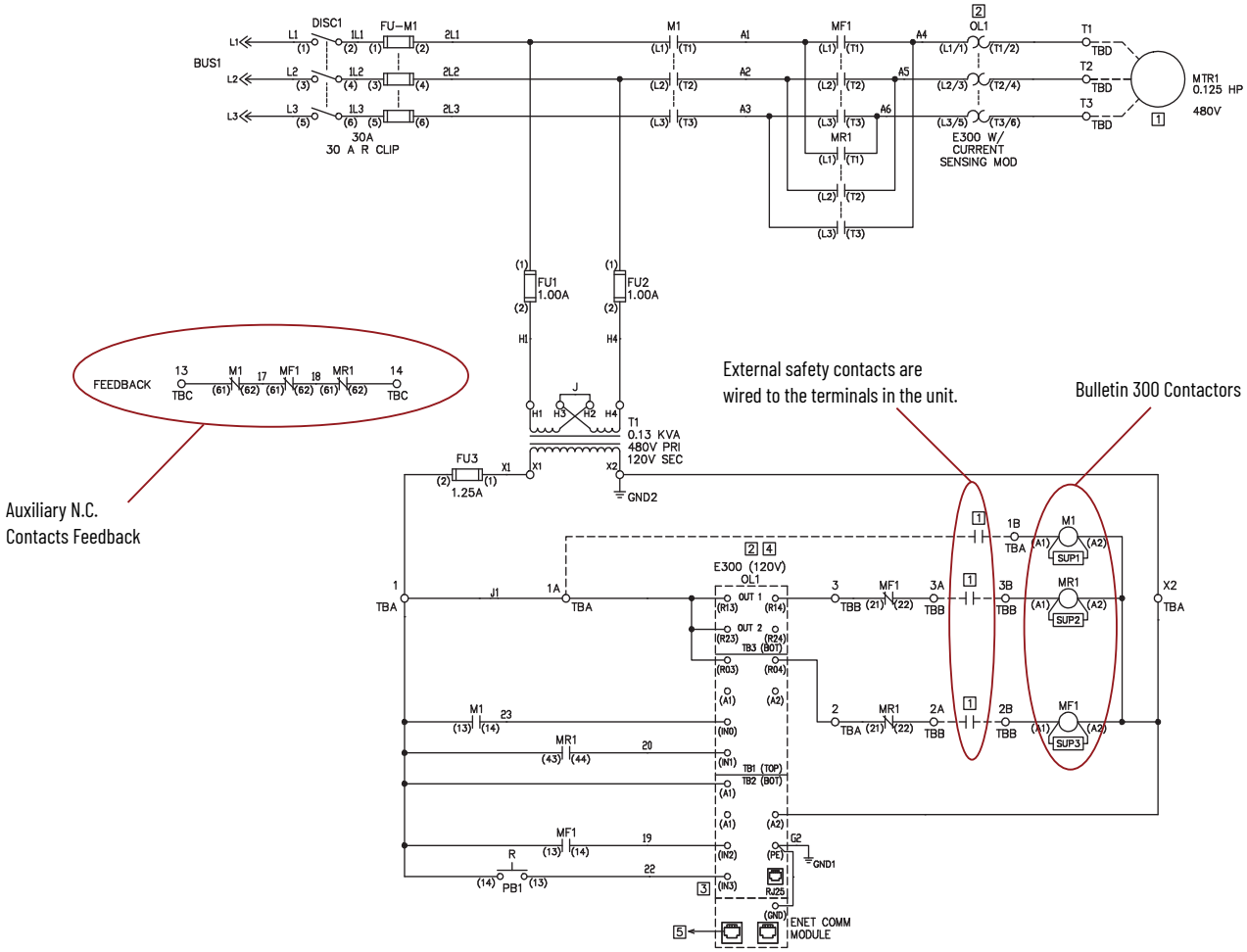
Figure 26 shows the Cat. 3 - FVR electrical schematic for the CENTERLINE 2100 MCC (NEMA) FVR starter with three Bulletin 300 contactors without interposing relay.

Two Bulletin 300 (CENTERLINE 2100 NEMA MCC) or two Bulletin 100S (CENTERLINE 2500 IEC MCC) contactors are used for both the safety function and normal operation, which includes both safety and standard operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

The third contactor and the Interposing relay de-energize only when the safety function is actuated which includes only the safety operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

The unit receives three contacts from the relay distribution that de-energize the contactor coils when the safety function is actuated. The relay distribution unit must reserve three unique contacts for each unit with this option.

Figure 26 - FVR Cat. 3 with three Contactors without Interposing Relay Electrical Schematic



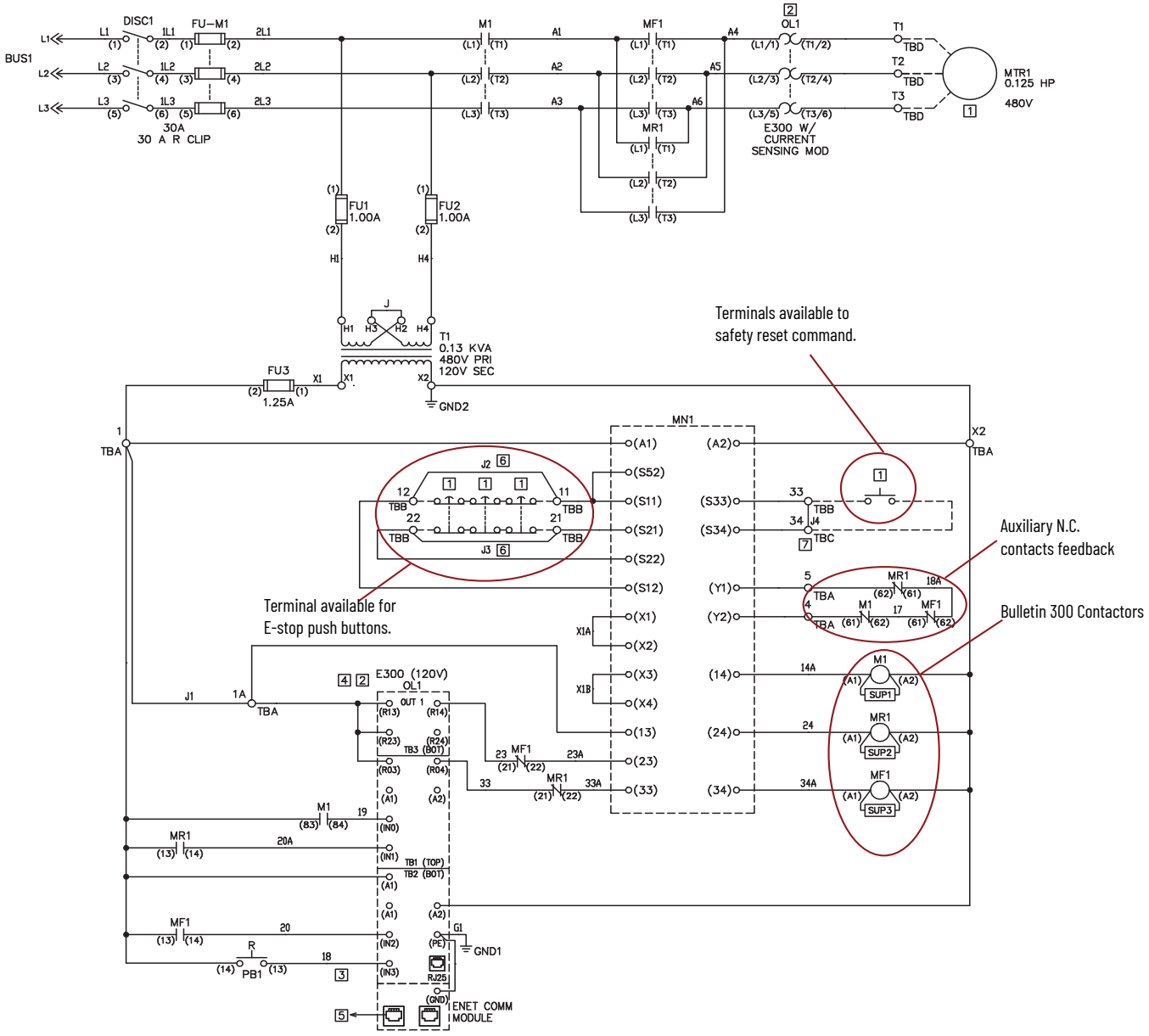
FVR using MSR131RTP Safety Monitoring Relay and three Contactors

Figure 27 shows the Cat. 3 - FVR electrical schematic for the CENTERLINE 2100 MCC (NEMA) FVR starter with three Bulletin 300 contactors and MSR131RTP safety monitoring relay.

Two of the Bulletin 300 (CENTERLINE 2100 NEMA MCC) contactors are used for both the safety function and normal operation, which includes both safety and standard operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

The third contactor (M1) de-energizes only when the safety function is actuated, which includes only the safety operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

Figure 27 - FVR Cat. 3 with three Contactors and MSR131RTP Safety Monitoring Relay Electrical Schematic

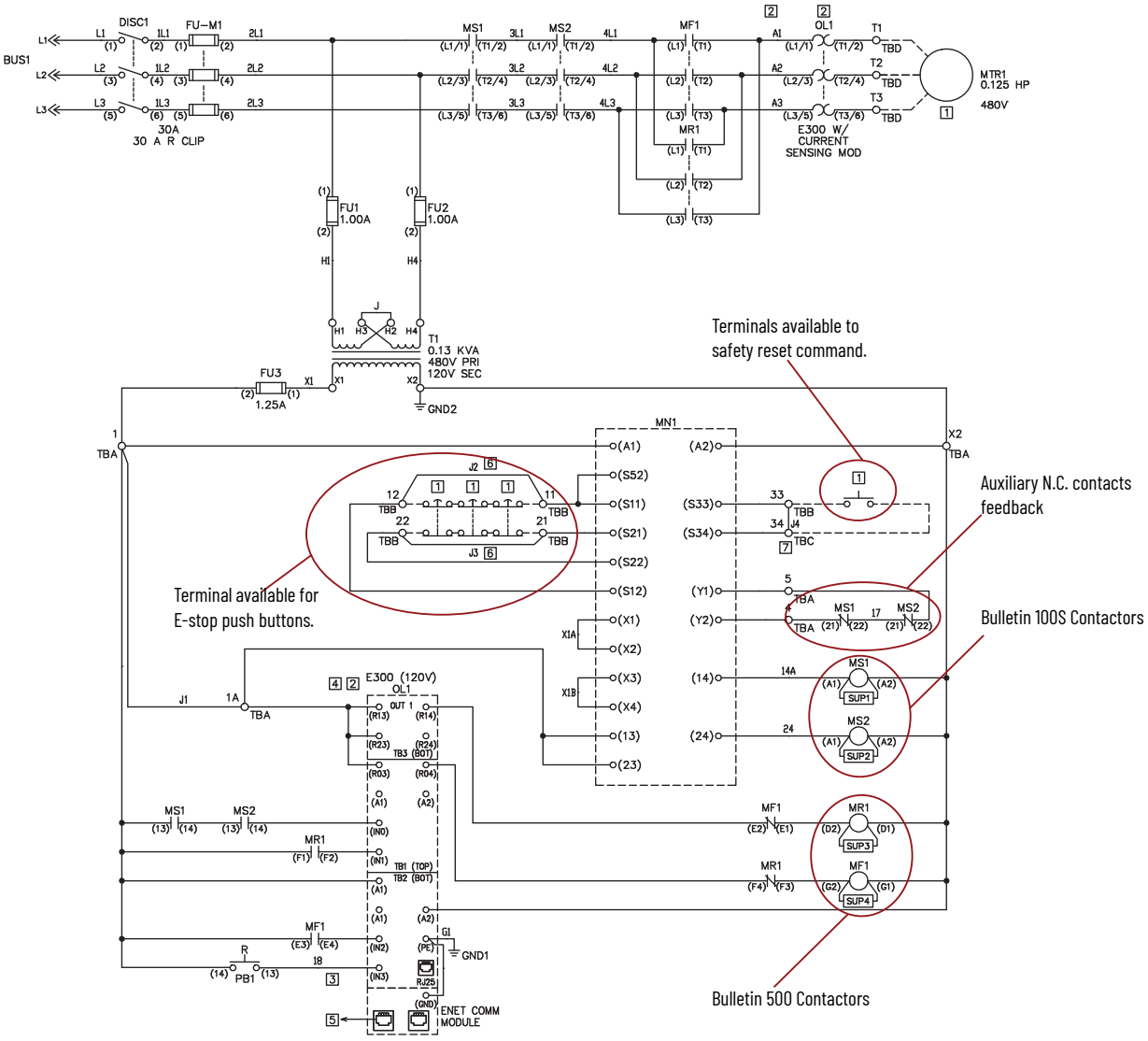


FVR using one MSR131RTP Safety Monitoring Relay, two Bulletin 500 Contactor, and two Bulletin IEC Bulletin 100S Contactors

Figure 28 shows the Cat. 3 - FVR electrical schematic for the CENTERLINE 2100 MCC using two Bulletin 500 contactor and two Bulletin IEC Bulletin 100S contactors and MSR131RTP safety monitoring relay.

- Bulletin 500 contactors are used for normal operation only and are not part of the safety circuit.
- Bulletin 100S contactors are used for the safety function only, which includes only the safety operations in the number of operations when calculating MTTFd based on B10d of the components. See the SISTEMA CENTERLINE file projects for more information.

Figure 28 - FVR Cat. 3 with two Bulletin 500 Contactors, two Bulletin IEC Bulletin 100S Contactors, and MSR131RTP Relay Schematic



Configuration

Subsystem configuration is shown in the wiring diagram. The CENTERLINE 2100 MCC wiring diagram describes parameterization for the E300 relay. For the starter units using contactors to execute both safety and standard operations, in remote or in local operation, the E300 relay output that commands these contactors must only be allowed to close after the safety circuit is properly reset. The MSR131RTP safety monitoring relay, which is used by the CENTERLINE 2100 MCC, is configured through wiring. The GSR-DI, which is used by the CENTERLINE 2500 MCC, requires rotary switch setting. See the Guardmaster Safety Relays User Manual, publication 440R-UM013 for information.

Notes:

Safety Distribution Subsystems

Safety distribution subsystems receive the safety inputs, such as E-stop signals, and distribute hardwired safety signals to the safety units (starters or drives). The subsystem contains safety monitoring relays as the logic solver or Bulletin 1734 POINT I/O™ safety modules.

Safety Relay Subsystem – Category 1

The following options are available in both CENTERLINE® 2100 motor control centers (MCCs) and CENTERLINE 2500 MCCs.

- CENTERLINE 2100 Category 1 (Cat. 1) safety relay distribution subsystem (stop category 0) - C1_SRDS
- CENTERLINE 2500 Cat. 1 safety relay distribution subsystem (stop category 0) - C1_SRDS

NEMA wiring diagram examples are available for download. See Access Components of the Safety Function on page 7.

Safety Rating

For safety rating values, see the tables in Quick Reference - Functional Safety Ratings on page 83.

- Cat. 1, PLc according to ISO 13849-1:2015
- SIL CL 1 according to IEC 62061:2005

CENTERLINE 2100 Circuit Description

The CENTERLINE 2100 MCC uses the 700S heavy-duty safety control relay. The CENTERLINE 2500 MCC uses the 700S-CF safety control relay. This circuit description applies only for the CENTERLINE 2100 MCC.

The circuit supports only stop category 0 (coast-to-stop). The unit comes with circuit protection (120V AC/60 Hz). The unit comes with a 24V DC power supply to command the drive safety inputs or the 700-HPS interposing relays of the safety starter units.
The CENTERLINE 2100 MCC unit can be ordered with or without a disconnect switch and the associated control transformer. See the diagram examples, which can be downloaded, for more information.

Cat. 1 safety distribution is available with up to three safety zones. Each individual safety zone commands the safety circuit of up to 72 MCCs:

- safety starters with interposing relays or variable frequency drives (VFDs), where 9 x 8 = 72, considering eight MCCs being commanded by each normally open (N.O.) contact available for the safety zone or
- up to nine safety starter units without interposing relays (9 x 1 = 9, considering one MCC unit being commanded by each N.O. contact available for the safety zone).

Each safety zone circuit is composed of:

- One 700S-P1020A1 NEMA heavy-duty safety control relay – 10 A - 120V/60 Hz – 10 N.O./2 normally closed (N.C.)
  - Bulletin 700S-P safety control relays are designed to meet worldwide safety standards. These relays have mechanically linked contacts and tamper-resistant covers.
  - 10 N.O. contacts available per relay
  - One N.O. contact that is reserved to the reset command circuit
  - Nine N.O. contacts available to the motor controller unit safety circuit
- One pair of terminals to receive one E-stop string (safety zone)
- One pair of terminals to indicate the status of one E-stop string (safety zone)
  - Can be connected to light indicators or to Performance Level C (PLc) inputs
- One pair of terminals for the reset command of the E-stop string (safety zone)
  - Can be connected to reset buttons or to PLc outputs
- Two pairs of terminals to receive +24V DC external power

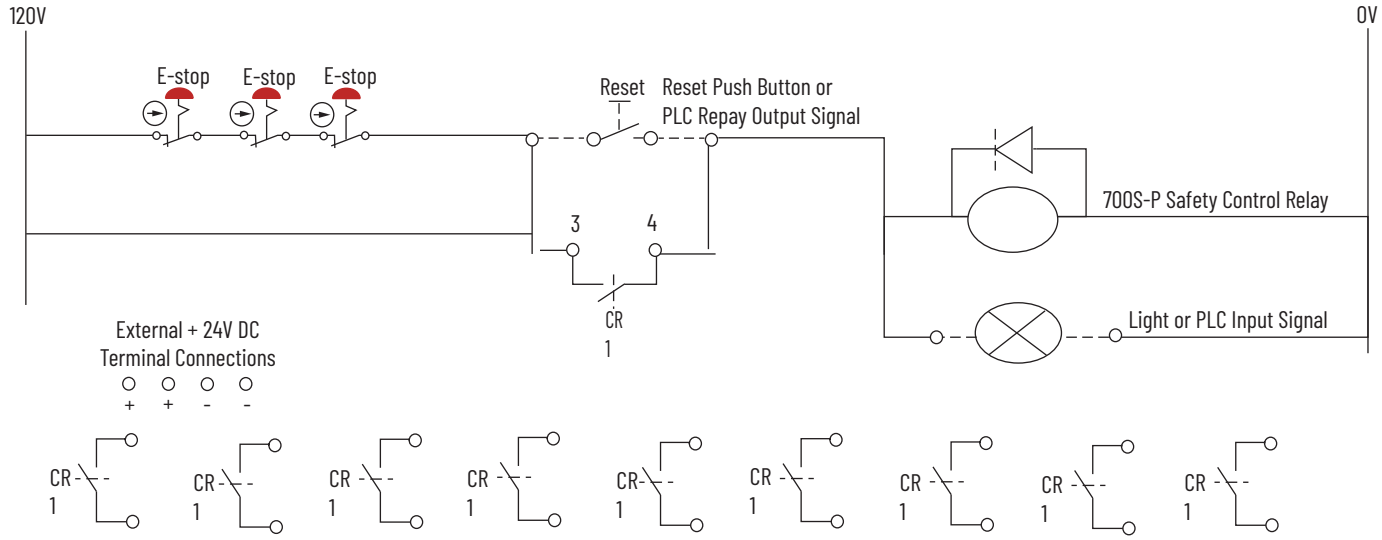
The safety zone circuit can be expanded if the application requires more than 72 motor controller units per E-stop string. In this scenario, order a unit with two safety zones and use one N.O. contact from the first 700S-P safety relay to energize the coil of the second 700S-P safety control relay.

Electrical Schematic Example

This section shows one example of a safety relay subsystem electrical schematic.
To download the complete set of electrical schematic examples, see Access Components of the Safety Function on page 7.

Figure 29 shows the wiring for one safety zone.

Figure 29 - Cat. 1 Relay Distribution Unit Electrical Schematic



- If the safety starter is using interposing relays, one contact commands up to eight motor controller units (starters or VFDs units - 24V DC safety circuit).
- If the safety starter is not using interposing relays, one contact must be sent to a unique safety starter.

Safety Monitoring Relay Distribution Subsystem – Category 3

The following unit options are available as standard offerings for the CENTERLINE 2100 and CENTERLINE 2500 LVMCCs.

- CENTERLINE 2100 Cat. 3 safety monitoring relay distribution subsystem using two immediate safety outputs (stop category 0) and three time-delayed safety outputs (stop category 1) with interposing relays (two 700-HPS per immediate safety output and one 700-HPS per time-delayed safety output) - C3_SMRDSTD_WIR.
  - SISTEMA Identifier '2100_Cat3_SMRDS_with 700HPS' has PLe since MSR139DP Immediate Outputs have this PL.
  - SISTEMA Identifier '2100_Cat3_SMRDSTD_with 700HPS' has PLd because the MSR139DP time-delay outputs have this PL.
- CENTERLINE 2500 Cat. 3 safety monitoring relay distribution subsystem using GSR-DI relay with interposing relays - C3_SMRDS_WIR.
- CENTERLINE 2500 Cat. 3 safety monitoring relay distribution subsystem using GSR-DI and GSR-EMD (expansion module time-delayed) safety relays with interposing relays - C3_SMRDSTD_WIR.
- CENTERLINE 2100 Cat. 3 safety monitoring relay distribution subsystem using two immediate safety outputs (stop category 0) and three time-delayed safety outputs (stop category 1) without interposing relays (no 700-HPS, safety outputs go directly to motion control units (MCUs)) - C3_SMRDSTD.
  - SISTEMA Identifier '2100_Cat3_SMRDS' has PLe since MSR139DP immediate outputs have this PL.
  - SISTEMA Identifier '2100_Cat3_SMRDSTD' has PLd since MSR139DP time-delay outputs have this PL.
- CENTERLINE 2500 Cat. 3 safety monitoring relay distribution subsystem using GSR-DI relay without interposing relays - C3_SMRDS.
- CENTERLINE 2500 Cat. 3 safety monitoring relay distribution subsystem using GSR-DI and GSR-EMD relays without interposing relays - C3_SMRDSTD.

Safety Rating

For safety rating values, see the tables in Appendix A on page 83.

- Cat. 3, PLe according to ISO 13849-1:2015
- SIL CL3 according to IEC 62061:2005

CENTERLINE 2100 Circuit Description

NEMA wiring diagram examples are available for download. See Access Components of the Safety Function on page 7.

The CENTERLINE 2100 MCC uses the MSR138DP safety monitoring relay. The CENTERLINE 2500 MCC uses the GSR-DI and GSR-EMD safety monitoring relay. This circuit description applies only for the CENTERLINE 2100 MCC.

The circuit supports stop category 0 (coast-to-stop) and stop category 1 (controlled stop) when using variable frequency drives (VFDs). The unit comes with circuit protection and a +24V DC power supply.

Cat. 3 requires two separate safety channels in the safety circuit. Therefore, each motor controller must receive separate safety circuit commands from two different safety relay outputs.

A Cat. 3 safety monitoring distribution unit is available with up to three safety zones. Each safety zone has one safety monitoring relay.

When using the option with a Bulletin 700-HPS interposing relay and considering only the immediate safety outputs, each individual safety zone commands the safety circuit of up to:

- 32 motor controller units (VFDs or safety starters with interposing relays)
- Four safety starters without interposing relays, assuming one pair of contacts to each starter

Justification for 32 motor controller units maximum per safety zone is as follows:

- Each motor controller unit receives one pair of contacts.
  - each contact comes from a different safety relay output
- Four pairs of contacts are available in each safety zone.
  - each 700-HPS has two N.O. contacts
- A limit of eight MCUs commanded by each pair of N.O. contacts.
  - 4 pairs of contacts x 8 MCUs per pair of contacts = 32 MCUs

Justification for four safety starters without interposing relays maximum per safety zone are as follows:

- Each MCU receives one pair of contacts.
  - each contact comes from a different safety relay output
- Four pairs of contacts are available in each safety zone.
  - each 700-HPS has two N.O. contacts
- A limit of one safety starter without interposing relays commanded by each pair of N.O. contacts.
  - four pairs of contacts x 1 safety starter per pair of contacts = 4 safety starters

Each safety zone is composed of the following:

- One 440R-MSR138DP monitoring safety relay, 440R-M23147.
  - two immediate safety relay outputs
  - three time-delayed safety relay outputs
- Four 700-HPS safety relays per safety zone when counting only the relays that are dedicated to the immediate safety outputs.
  - two contacts per 700-HPS safety relay
- One pair of terminals to receive one E-stop string (safety zone).
- One pair of terminals to indicate the status of one E-stop string (safety zone).
  - can be connected to light indicators or to PLc inputs
- One pair of terminals for the reset command for the E-stop string (safety zone).
  - can be connected to reset buttons or to PLc outputs

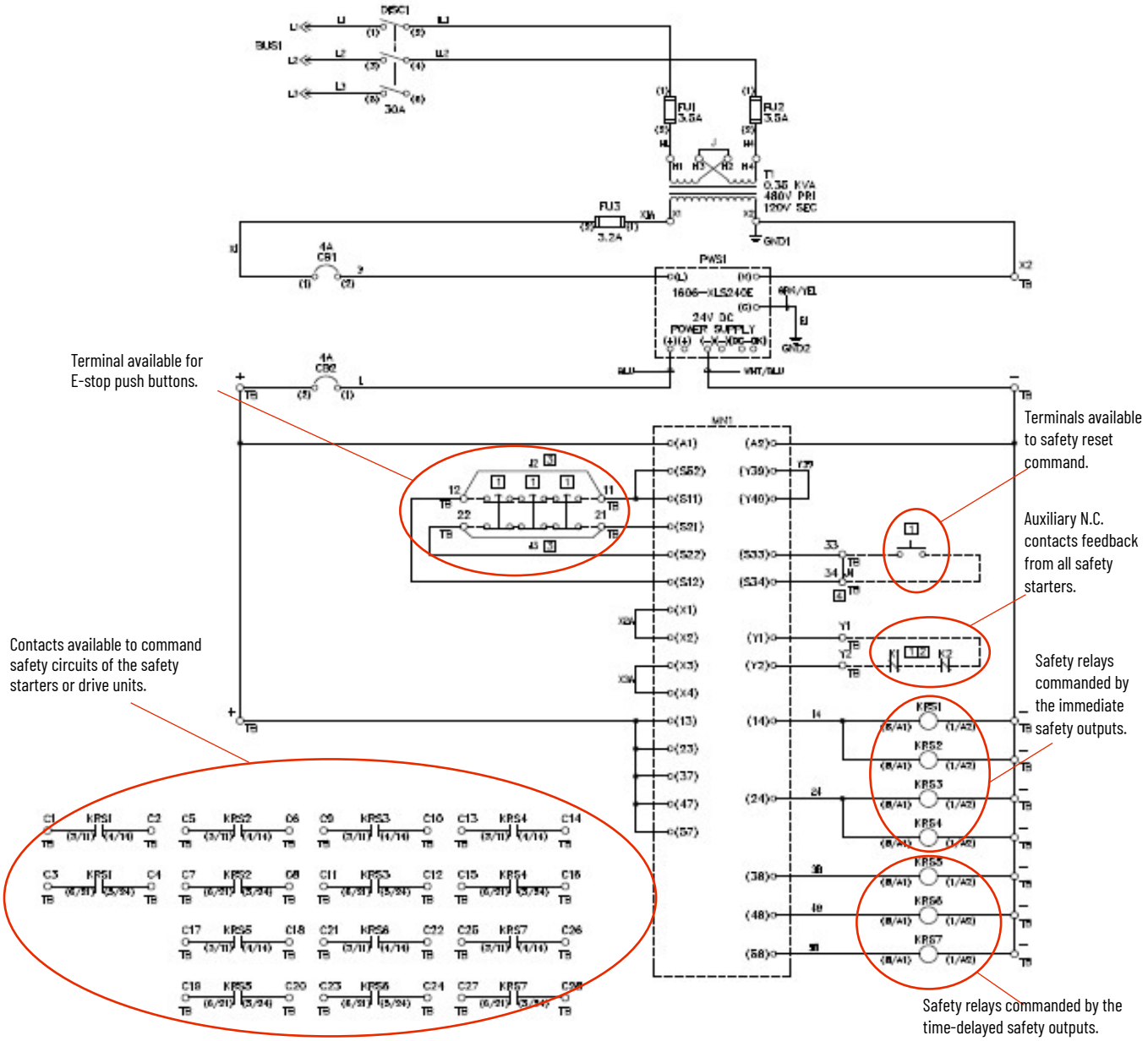
You can expand the safety zone circuit if the application requires more than 32 MCUs per E-stop string. In this scenario, order a unit with two safety zones and use a pair of 700-HPS contacts, where each contact must come from a different safety relay output, to actuate the safety input signals of the second safety monitoring relay.

Electrical Schematic Example

Figure 30 shows the wiring of a Cat. 3 relay distribution unit with interposing relays for one safety zone, capable of commanding the safety circuit of 32 MCUs without considering the time-delayed safety outputs.

Immediate safety outputs use terminal 14 and 24 from the safety monitoring relay as seen in Figure 30. Time-delayed safety outputs use terminals 38, 48, and 58 from the safety monitoring relay.

Figure 30 - Cat. 3 Relay Distribution Unit with Interposing Relays Electrical Schematic



- If the safety starter is using interposing relays, one pair of contacts commands up to eight motor controller units (starters or VFD units - 24V DC safety circuit).
- If the safety starter is not using interposing relays, at least one pair of contacts must be sent to a unique safety starter.
- Each unit must receive at least one contact from KRS1 or KRS2 and one contact from KRS3 or KRS4.

Configuration

MSR138DP monitoring safety relay configuration is done through wiring. See Figure 30 on page 56 for the electrical schematic.

The relay is configured for manual reset and cross-loop monitoring of the safety inputs. The MSR138DP monitoring safety relay has an adjustable rotary switch to set the timer for delayed safety outputs, which can be used when the application requires a stop category 1 for the drives.

See the Bulletin 440R — Guardmaster Safety Relays Selection Guide, publication 440R-SG001 for the configuration of the switch position for GSR-DI and GSR-EMD relays. For more information about how to configure the GSR-DI relay, refer to Guardmaster Safety Relay DI Installation Instructions, publication 440r-in063.

Safety Remote I/O Distribution Subsystem – Category 3

This unit is capable of being configured from one to a maximum of four safety zones. NEMA wiring diagram examples are available for download. See Access Components of the Safety Function on page 7.

Safety Rating

For safety rating values, see the tables in Appendix A on page 83.

- Cat. 3, PLe according to ISO 13849-1:2015
- SIL CL3 according to IEC 62061:2005

Standard Options

The following unit options are available for the CENTERLINE 2100 and CENTERLINE 2500 LVMCCs:

- CENTERLINE 2100 Cat. 3 safety remote I/O distribution subsystem (stop category 0/1) with interposing relays
  - one to four configurable safety zones
  - one 1734-OB8S (one 700-HPS per safety output) and
  - three 1734-IB8S (auxiliary contactor feedback in series, reset signal, E-stop string channel) - C3SRIODS_WIR.

  This first option is the standard option that is described in this section.
- CENTERLINE 2100 Cat. 3 safety remote I/O distribution subsystem (stop category 0/1) without interposing relays
  - one to four configurable safety zones
  - one 1734-OB8S (No 700-HPS) and
  - three 1734-IB8S (auxiliary contactor feedback in series, reset signal, E-stop string channel) - C3SRIODS.
- CENTERLINE 2500 Cat. 3 safety remote I/O distribution subsystem (stop category 0/1) with interposing relays
  - one to four configurable safety zones
  - one 1734-OB8S (one 700-HPS per safety output) and
  - three 1734-IB8S (auxiliary contactor feedback in series, reset signal, E-stop string channel) - C3SRIODS_WIR.
- CENTERLINE 2500 Cat. 3 safety remote I/O distribution subsystem (stop category 0/1) without interposing relays
  - one to four configurable safety zones
  - one 1734-OB8S (No 700-HPS) and
  - three 1734-IB8S (auxiliary contactor feedback in series, reset signal, E-stop string channel) - C3SRIODS.

Circuit Components for the Option with Interposing Relays

- Circuit protection
- 24V DC+ power supply
- One 1734-AENTR
- One 1734-OB8S
  - Eight safety outputs serving four safety zones maximum
- Two safety outputs for each safety zone
- Three 1734-IB8S – 24 safety inputs, 12 safety modules test outputs serving four safety zones maximum
  - Four safety inputs for auxiliary feedback from safety starters from each safety zone
    It uses four safety test outputs
  - Eight safety inputs for dual channel E-stop signals from each safety zone
    It uses eight safety test outputs
  - Four safety inputs for reset signals for each safety zone
- Four terminals to receive two E-stop strings from each safety zone
  - Available to be connected from the E-stop strings to safety inputs
- Two terminals for the reset command for each safety zone
  - Available to be connected from the reset buttons to safety inputs
- Eight 700-HPS safety relays
  - One 700-HPS per safety output
  - Two contacts per 700-HPS safety relay
  - Just one contact is used if safety starter has interposing relays
  - More than one contact can be required if the safety starter is not using an interposing relay
  - 16 pairs of terminals are available for the 16 contacts from the 700-HPS relays
  - Eight motor controller units are commanded per each contact
- Two terminals to receive auxiliary contact feedback string from each safety zone
  - Two terminals are available for each safety zone (all auxiliary contact feedback safety from the starters of that safety zone should be connected in series by using a daisy chain connection from one unit to the next unit)
  - Four safety inputs are available to receive the auxiliary feedback contacts
    Eight safety starters maximum per safety input
- Approximate total number of terminals required: 67

Circuit Description for the Option with Interposing Relays

This circuit supports stop category 0 (coast-to-stop) and stop category 1 (controlled stop) when using VFDs. The unit comes with circuit protection, +24V DC power supply and a 1734-AENTR module.

Cat. 3 requires two separate safety channels in the safety circuit, so each motor controller must receive separate safety circuit commands from two different safety outputs.

A Cat. 3 safety remote I/O distribution unit can command the safety circuit of a maximum of 32 MCUs.

A Cat. 3 safety remote I/O distribution unit can be configured from one to a maximum of four safety zones.

Each pair of safety outputs commands the safety circuit of up to either:

- Eight motor controller units (VFDs or safety starters with interposing relays) or
- One safety starter without interposing relays (two contacts from one 700-HPS available for each channel)

The unit comes with three 1734-IB8S modules (24 safety inputs serving four safety zones maximum):

- Four safety inputs for auxiliary feedback from safety starters in each safety zone
- Eight safety inputs for dual channel E-stop signals in each safety zone
- Four safety inputs for reset signals in each safety zone

Justification for 32 MCUs maximum per Cat. 3 safety remote I/O distribution unit:

- Each pair of safety outputs can command up to eight MCUs
- Each distribution unit comes with four pairs of safety outputs
- Four pairs of safety outputs x 8 MCUs per pair of safety outputs = 32 MCUs

Justification for four MCUs maximum per Cat. 3 safety remote I/O distribution unit when using safety starters without interposing relays:

- Each pair of safety outputs can command only one MCU when the safety starter does not use interposing relays. The motor controller must receive individual contacts. A Cat. 3 safety starter without interposing relay can require from a minimum of two to a maximum of three contacts.
- Each distribution unit comes with four pairs of safety outputs
- Four pairs of safety outputs x 1 MCUs per pair of safety outputs = 4 MCUs

Configuration

Studio 5000 Logix Designer® files examples are available for download. One of the safety function examples uses a Safety Distribution Unit using 1734 safety I/O modules. See Download Files and Software on page 7.

Electrical Schematic Example

This section shows an electrical schematic for one example of a safety remote I/O distribution subsystem. To download the complete set of electrical schematic examples, see Download Files and Software on page 7.

Figure 31...Figure 34 show the wiring of the distribution unit.

Figure 31 - Remote I/O Distribution Unit - Reset and E-stop Inputs Electrical Schematic

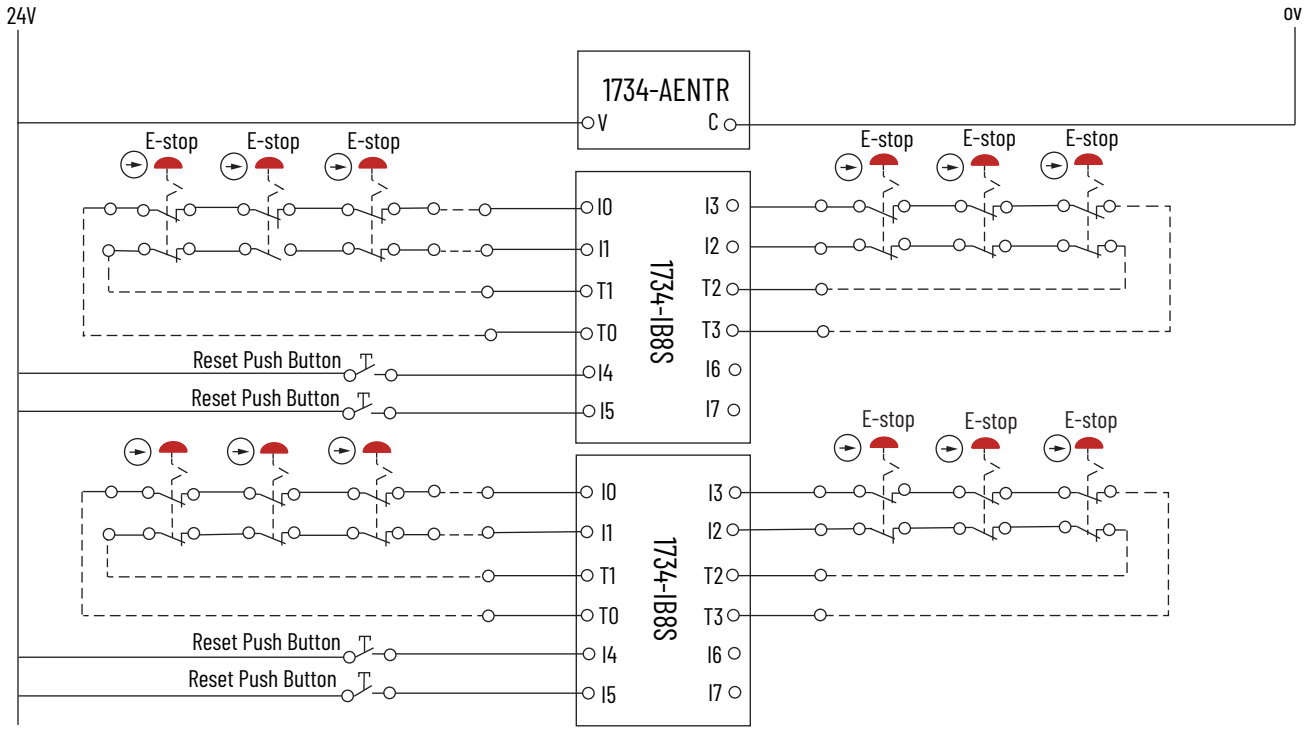


Figure 32 - Remote I/O Distribution Unit - Auxiliary Contact Feedback Inputs Electrical Schematic

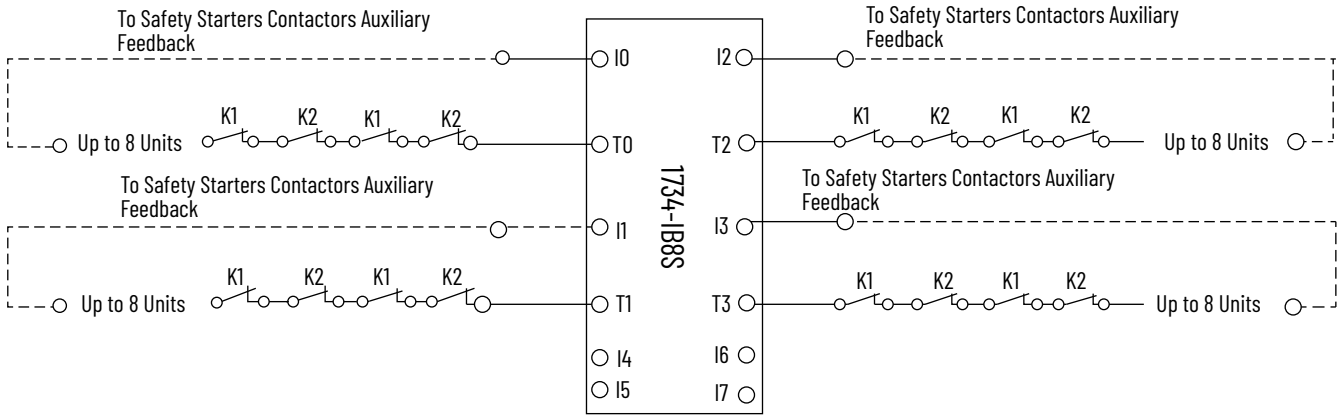


Figure 33 - Remote I/O Distribution Unit - Safety Outputs Electrical Schematic

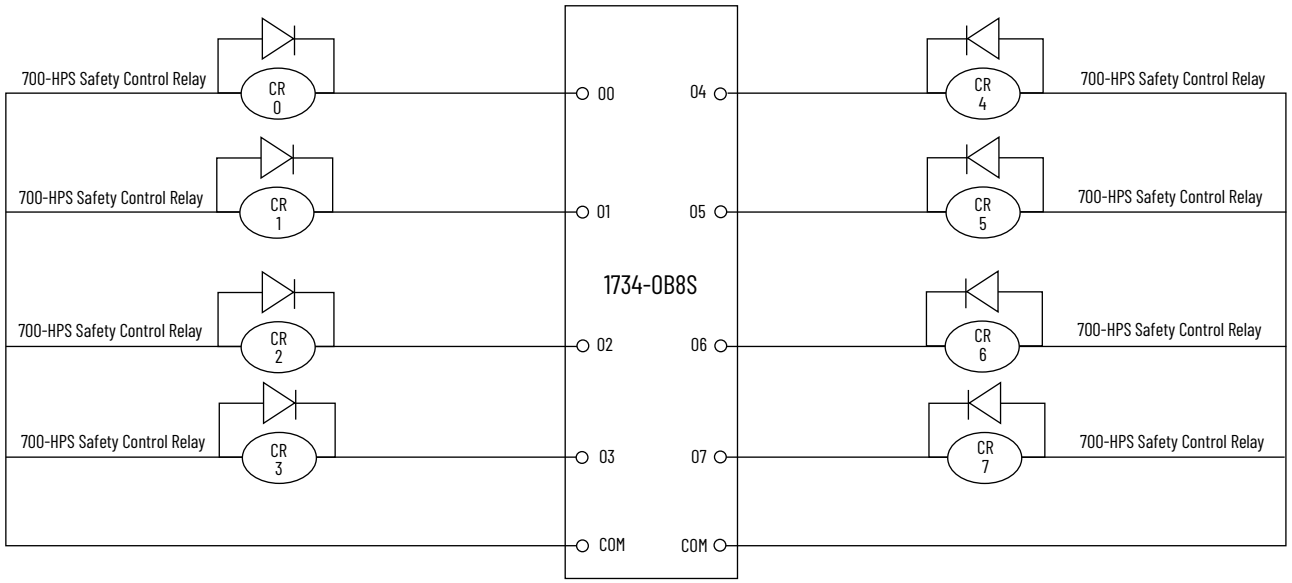
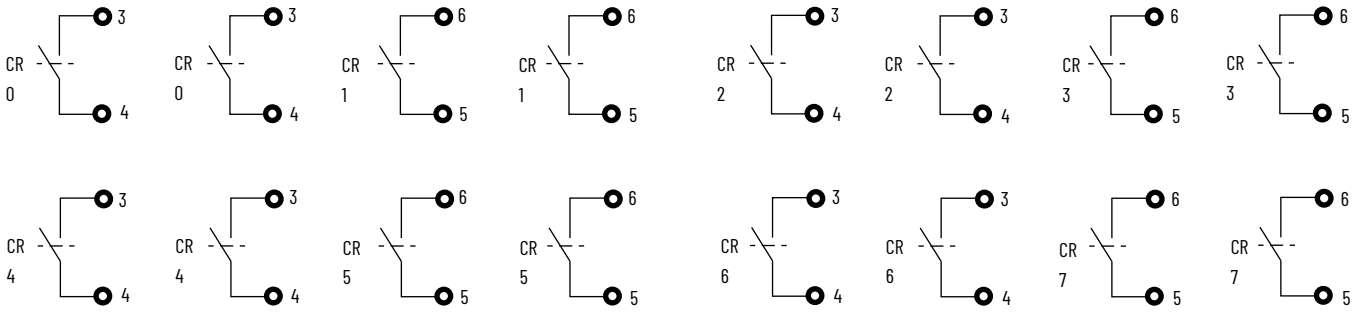


Figure 34 - Remote I/O Distribution Unit – 700-HPS Contacts Electrical Schematic



700-HPS contacts wiring information:

- If the safety starter is using interposing relays, one pair of contacts from two different safety outputs commands up to eight motor controller units (starters or VFDs units - 24V DC safety circuit).
- If the safety starter is not using interposing relays, at least one pair of contacts must be sent to a unique safety starter.
- Each unit must receive at least one contact from two different 700-HPS relays.

Multi-motor E-stop Safety Function Examples

This chapter describes four multi-motor safety function examples with safety starter and drive units as the output devices responsible for removing torque from two motors when the E-stop push buttons are actuated. The hardwired safety commands to the safety starters and drive units come from the safety distribution unit or from a safety programmable logic controller (PLC) through the network to the PowerFlex® 527 and PowerFlex 755 drives.

Safety Function: Multi-motor E-stop - Category 1

This example describes how power is removed from a hazard when a safety system detects that an E-stop push button has been actuated.

The logic solver that is used by this safety function is the Category 1 (Cat. 1) safety relay distribution unit.

This example considers that two output subsystems are actuated simultaneously when E-stop is pressed. Both output subsystem safety functions are evaluated in the same safety function.

The output subsystems that are used in this example are:

- PowerFlex 750-series frame 1...7 with 20-750-S
- CENTERLINE® 2100 full voltage non-reversing (FVNR) starter Cat. 1 with one Bulletin 500 contactor NEMA size 0...3 at AC3 with interposing safety relay

Safety Function Realization: Risk Assessment

The required Performance Level (PL) is the result of a risk assessment and refers to the amount of the risk reduction to be carried out by the safety-related parts of the control system. Part of the risk reduction process is to determine the safety functions of the machine. In this application, the Performance Level required (PLr) by the risk assessment is Cat. 1, PLb for the safety function. Each safety product or subsystem has its own rating and can be combined to create a safety function that meets or exceeds the PLr.

Safety Function Requirements

When you press the E-stop, this action stops and helps prevent hazardous motion by removal of power to the motor. When you reset the E-stop button, hazardous motion and power to the motor do not resume until a secondary action (pressing the start button) occurs. Faults at the E-stop button, wiring terminals, or safety relay are not detected. The emergency stop functions are complementary to any other safeguards on the machine and do not reduce the performance of other safety-related functions. The safety function in this example can connect and interrupt power to motors rated up to the low voltage motor control center (LVMCC) subsystem rating.

The safety function in this example meets or exceeds the requirements for Cat. 1, PLc.

Functional Safety Description

The safety relay subsystem has a safety control relay that receives wires coming from the E-stop push button. There is just one channel with no diagnostics. When you press the E-stop push button, the circuit is interrupted. The relay responds to this interruption by opening its contacts, which de-energizes the coil of starter contactor in the FVNR starter and the safety inputs of the PowerFlex drive.

See the following sections for details on the wiring:

- Safety Relay Subsystem – Category 1 on page 53
- PowerFlex 750-series Drive Units on page 13
- Full-voltage Non-reversing Starter Subsystem – Category 1/PLc on page 27

With power removed, the relay opens and the hazardous motion coasts to a stop (stop category 0). This example covers only stop category 0. Hazardous motion cannot be started until the E-stop is released, and the reset button is pressed and released.

In the FVNR unit, a contact from the safety control relay distribution unit energizes the interposing relay (see Figure 13 on page 28).

The PowerFlex drive monitors its safe torque off (STO) inputs for valid status and faults. The drive monitors its internal safety circuits for valid status and faults. The drive monitors its output power transistors for valid status and faults. When the safety relay de-energizes the drive STO inputs, the drive STO feature forces the drive output power transistors to a disabled state. The hazardous motion that is controlled by the drive coasts to a stop. This feature does not provide electrical power isolation. The PowerFlex 750-series drive using the 20-750-S safety option module is a Cat. 3/PLe/SIL3 device and the separate wiring of SP+ and SE+ is what makes this a Cat. 3 (dual channel) circuit. The drive STO input checks that both SP+ and SE+ switch at the same time.

Bill of Materials

The safety function that is shown in this section uses these products or subsystems.

Figure 35 - Multi-motor E-stop - Cat. 1 Bill of Materials

Catalog Number	Description	Quantity
Contact Rockwell Automation 216xU/VB-...-14SRR-ENG	SISTEMA Identifier: 2x00_PF750_S0 PowerFlex 750-series Frame 1...7 with 20-750-S – hardwired STO (shielded cable to terminals)	1
Contact Rockwell Automation	SISTEMA Identifier: 2100_FVNR_Cat1_B500_Size03_with 700HPS 2100 FVNR starter Cat. 1 with interposing relays using Bulletin 500 NEMA size 0...3 at AC3	1
Contact Rockwell Automation	SISTEMA Identifier: 2100_Cat1_SRDS 2100 Cat. 1 safety relay distribution subsystem (stop category 0) - C1_SRDS	1
800T-1TYM	800T push button, 30 mm (1.18 in.) push-button station, Type 4/13, 1 Push Button, emergency stop, Push-Pull/Twist release, no conduit, no locking attachment	1
800TC-TFXLT6A5S	800T non-illuminated trigger action two position maintained, twist release, red 63 mm (2.48 in.) metal head, with no legend on cap, finger guards on terminals, traditional contact block code: 2-NCLB self-monitoring contact	1

Setup and Wiring

For detailed information on how to install and wire these products, see the publications that are listed in Additional Resources on page 107.

System Overview

E-stop contact is connected to the coil of the 700S safety relay.

When the E-stop is released and the reset is pressed, the relay is energized and the contacts of the relay allow energization of the contactor starter and the drive safety input. The starter only closes the contactor when the E300 relay receives the start command from the network (AUTO mode) or when a local start command is issued (MANUAL mode).

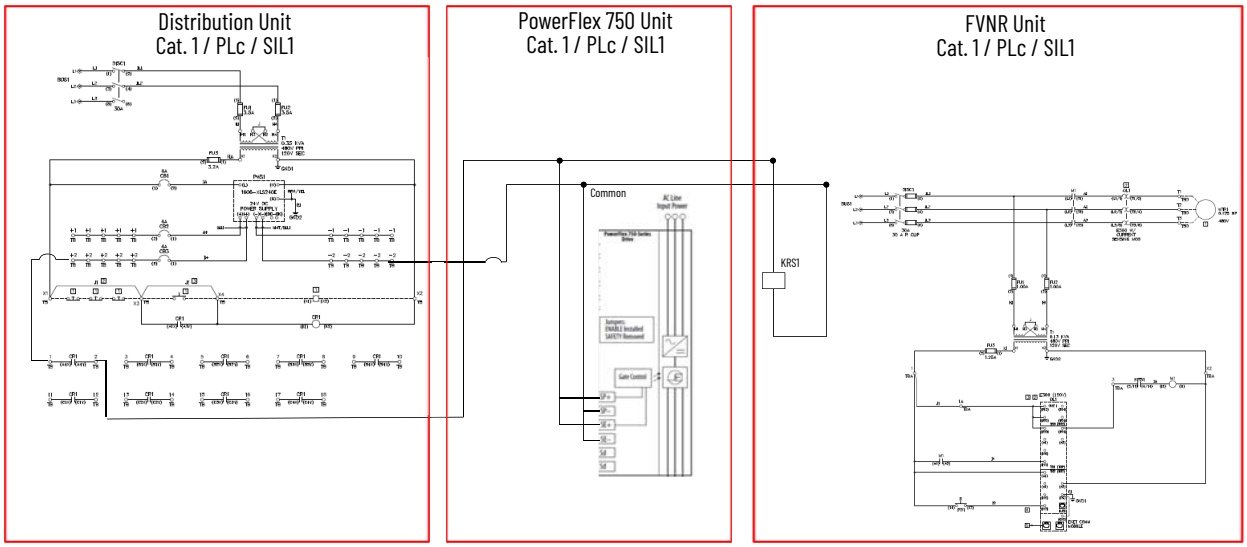
When the E-stop is pressed, the safety relay is de-energized and the contacts of the safety relay de-energize the contactor starter and the drive safety input. The relay cannot be reset until the E-stop is released. There is no diagnostic and just one channel for the safety circuit.

Electrical Schematic

Figure 36 gives an overview of the subsystems that compose this system. It shows an example of an LVMCC unit that receives an E-stop contact (single channel) that energizes the safety control relay.

The safety control relay unit distributes one safety contact from the 700S safety control relay to a maximum of eight MCC units within the same line-up. Because the safety function is a Cat. 1 circuit, it is a single channel circuit with no fault diagnostic.
The PowerFlex 750-series subsystem still has internal diagnostics but it is being considered a Cat. 1 subsystem because it receives only one contact for both channels.

Figure 36 - Multi-motor E-stop Cat. 1 Electrical Schematic Overview



Configuration

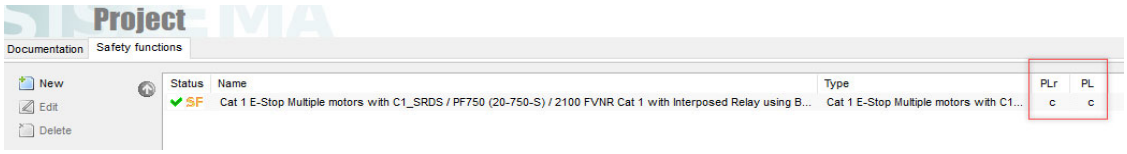
See the respective subsystem section for configuration information.

Calculation of the PL

When properly implemented, the E-stop safety function for a multi-motor application can achieve a safety rating of Cat. 1 PLc according to ISO 13849-1: 2015, as calculated by using the Safety Integrity Software Tool for the Evaluation of Machine Applications (SISTEMA).

The SISTEMA file that is referenced in this safety function is available for download. See Access Components of the Safety Function on page 7.

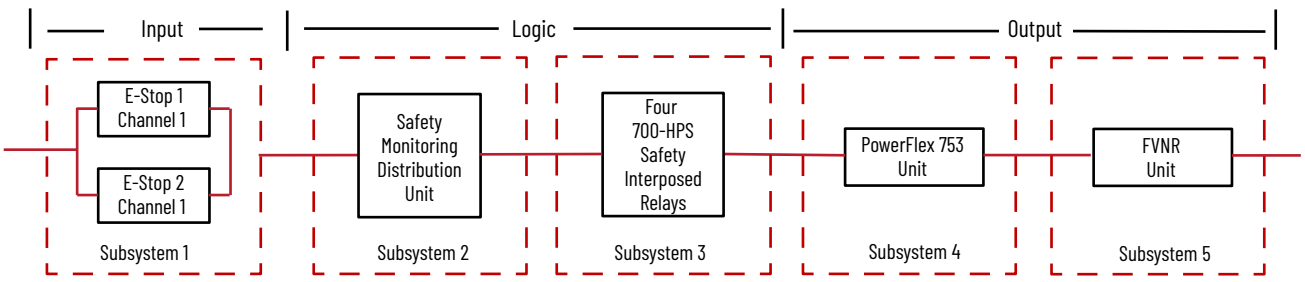
Figure 37 - SISTEMA Multi-motor E-stop Cat. 1 Safety Function



Complete Safety Function PL Calculation Example

When modeled in SISTEMA, the multi-motor E-stop safety function is treated as an individual safety function and can be modeled as follows.

Figure 38 - Multi-motor E-stop Cat. 1 Safety Function Model



The E-stop function is a complementary protective measure that is intended to be used with other safeguarding measures and protective devices to reduce risk sufficiently. The emergency stop function shall be designed not to impair the effectiveness of the other protective devices or safety functions.

Subsystem 3 and Subsystem 4 are included in the same safety function for simplification. The fact that Subsystem 3 and Subsystem 4 are included in the same safety function affects the Performance Level and the final PFHD value that is achieved by the safety function.

If Subsystem 3 and Subsystem 4 are separated in two different safety functions them both safety functions would be able to achieve a lower PFHD value as individual safety functions.

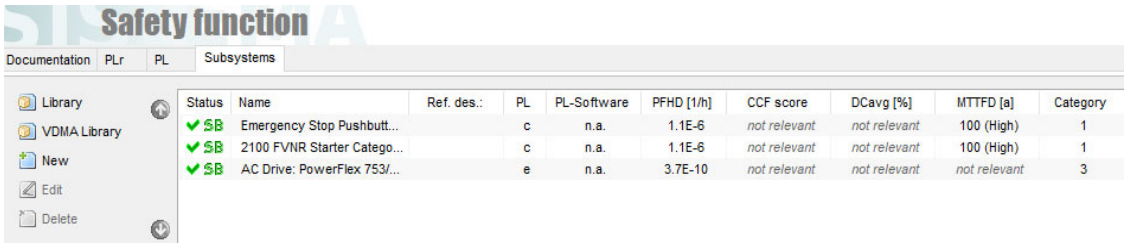
The separation of the subsystems in different safety functions depends on the definition of the hazards during the risk assessment evaluation. If there is a unique hazard that is being addressed by the safety function, then it makes sense to include both subsystems in the same safety function. On the other hand, if there are two different hazards that need to be addressed then it makes sense to separate it in two safety functions.

This safety function includes the following subsystems:

- Emergency stop push button and control relay: 700S-CF
  - Cat. 1 / PLc
- PowerFlex 750-series frame 1...7 with 20-750-S – hardwired STO module (shielded cable to terminals)
  - Cat. 3 / PLe
- 2100 FVNR starter Cat. 1 with one Bulletin 500 contactor NEMA size 0...3 at AC3 and one interposing safety relay (700-HPS) as output subsystem
  - Cat. 1 / PLc

Figure 39 shows the multi-motor E-stop safety function subsystems as modeled in the SISTEMA file example.

Figure 39 - SISTEMA Cat. 1 E-stop Function 1 Subsystems



Functional Safety Data Required for Determining the PL of Electromechanical Devices

Relays, push buttons, and contactors are electromechanical devices, the functional safety data that is required for PL calculation includes the following:

- Mean Time to Failure, dangerous (MTTFd) – Required for Cat. 1 circuits and up
- Diagnostic Coverage (DCavg) - Required for Cat. 2 circuits and up
- Common Cause Failure (CCF) - Required for Cat. 2 circuits and up

The functional safety evaluations of the electromechanical devices include the following:

- How frequently they are operated – required for Cat. B circuits and up
- Whether they are effectively monitored for faults - required for Cat. 2 circuits and up
- Whether they are properly specified and installed - required for Cat. B circuits and up

SISTEMA calculates the MTTFd by using B10d data that are provided for the safety relay, E-stop push buttons, and contactors along with the estimated frequency of use, entered during the creation of the SISTEMA project. Download the SISTEMA file for this example to see the maximum frequency operation for each subsystem. See Access Components of the Safety Function on page 7 for details on how to download the SISTEMA files.

Verification and Validation Plan

Verification and validation play important roles in the avoidance of faults throughout the safety system design and development process. ISO 13849-2 sets the requirements for verification and validation. The standard calls for a documented plan to confirm that all safety functional requirements have been met.

Verification is an analysis of the resulting safety control system. The PL of the safety control system is calculated to confirm that the system meets the PLr specified. The SISTEMA software is typically used to perform the calculations and assist with satisfying the requirements of ISO 13849-1.

Validation is a functional test of the safety control system to demonstrate that the system meets the specified requirements of the safety function. The safety control system is tested to confirm that all safety-related outputs respond appropriately to their corresponding safety-related inputs. The functional test includes normal operating conditions and potential fault injection of failure modes. A checklist is typically used to document the validation of the safety control system.

Verification and validation checklist examples are available for download. See Access Components of the Safety Function on page 7.

Safety Function: Multi-motor E-stop using a Monitoring Safety Relay - Cat. 3

This safety function describes how power is removed from a motor when a safety system detects that an E-stop has been actuated.

The logic solver that is used by this safety function is the C3_SMRDSTD_WIR - Cat. 3 safety monitoring relay distribution subsystem using two immediate safety outputs (stop category 0) with interposing relays (two 700 HPS per safety output).

This safety function considers that two output subsystems are actuated simultaneously when one of the E-stops is pressed.
Both output subsystem safety functions are evaluated in the same safety function.

The output subsystems that are used in this example are:

- PowerFlex 750-series Frame 1...7 with 20-750-S – hardwired STO module (shielded cable to terminals)
- CENTERLINE 2100 FVNR starters Cat. 3 with two Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) and two interposing safety relays (700-HPS)

Safety Function Realization: Risk Assessment

The required PL is the result of a risk assessment and refers to the amount of the risk reduction to be carried out by the safety-related parts of the control system. Part of the risk reduction process is to determine the safety functions of the machine. In this application, the PLr by the risk assessment is Cat. 3, PLd, for the safety function. A safety system that achieves Cat. 3, PLd or higher can be considered control reliable. Each safety product or subsystem has its own rating and can be combined to create a safety function that meets or exceeds the PLr.

Safety Function Requirements

When you press the E-stop button, this action stops and helps prevent hazardous motion by removal of power to the motor. When you reset the E-stop button, hazardous motion and power to the motor do not resume until a secondary action (such as, pressing the start button) occurs. Faults at the E-stop button, wiring terminals, or safety relay are detected before the next safety demand. The emergency stop functions are complementary to any other safeguards on the machine and do not reduce the performance of other safety-related functions. The safety function in this example can connect and interrupt power to motors rated up to the LVMCC unit rating.

The safety function in this example meets or exceeds the requirements for Cat. 3, PLd per ISO 13849-1 and control reliable operation per ANSI B11.19.

Functional Safety Description

An E-stop button is connected to the safety monitoring relay. One channel runs through the E-stop contact between pulsed output S11 and input S12, and the other channel runs between pulsed output S21 and input S22. The safety relay monitors the pulse stream at each input to confirm that each E-stop channel is in a proper state. When you press the E-stop button, these two circuits are interrupted. The safety monitoring relay responds to this interruption by opening its safety contacts (13...14 and 23...24), and time-delayed safety output contacts (37...38, 47...48, 57...58) which de-energizes the coils of contactors in the starters and the safety inputs of the PowerFlex drives.

See the following sections for details on the wiring:

- Safety Monitoring Relay Distribution Subsystem – Category 3 on page 54
- PowerFlex 750 with 20-750-S – hardwired STO module - electrical schematic, Figure 4 on page 16
- FVNR starter subsystem – Cat. 3 / PLd - electrical schematic, Figure 13 on page 28

With power removed, if outputs are connected to the safety contacts (13...14 and 23...24), the hazardous motion coasts to a stop (stop category 0). This example covers only stop category 0.

The distribution unit uses the safety outputs (terminals 14 and 24) to command a motor coast stop (stop category 0). If stop Cat. 1 is required for the drive units, use the time-delayed safety output terminals 38 and 48 coils. Power to the motor is eliminated after a delay, while the drive units execute a controlled stop (stop category 1).

The hazardous motion cannot be started until the E-stop is released, and the reset button is pressed and released.

The FVNR unit receives two contacts from the safety monitoring relay distribution that energizes the two interposing safety relays (see the FVNR wiring diagram, Figure 16 on page 35). The contacts from the interposing safety relay must be closed to allow the energization of the contactor coils.

To achieve the safety function described in this example, confirm the state of the contactors before permitting a reset of the safety circuit by checking the status of the N.C. auxiliary contact feedback from the contactors available in the starter unit terminals. Those must be connected in series with other starter units and wired back to the safety monitoring relay (terminals Y1 and Y2). If a safety contact of one or both contactors is welded closed, the corresponding auxiliary N.C. contact is held open, which interrupts the signal between Y1 and Y2 (see Figure 30 on page 56).

The PowerFlex drive monitors its STO inputs for valid status and faults. The drive monitors its internal safety circuits for valid status and faults. The drive monitors its output power transistors for valid status and faults. When the safety relay de-energizes the drive STO inputs, the drive STO feature forces the drive output power transistors to a disabled state. The hazardous motion that is controlled by the drive coasts to a stop. This feature does not provide electrical power isolation.

The safety monitoring relay in this application example is configured for manual reset (S33...S34 – see Figure 30 on page 56). When the E-stop inputs are in the proper state and the contactors are properly de-energized, pressing, and releasing the reset button results in the safety monitoring relay energizing its safety outputs. The energization of the safety outputs closes one of the contactors. The status of the second contactor depends on the state of the E300 relay output.

Bill of Materials

The safety function that is shown in this document use these products or subsystems.

Table 7 - Multi-motor E-stop using a Monitoring Safety Relay - Cat. 3 Bill of Materials

Catalog Number	Description	Quantity
Contact Rockwell Automation 216xU/VB-...-14SRR	SISTEMA Identifier: 2x00_PF750_S0 PowerFlex 750-series Frame 1...7 with 20-750-S – hardwired STO (shielded cable to terminals) Add option for HAND/OFF/AUTO selector	1
Contact Rockwell Automation	SISTEMA Identifier: 2100_FVNR_Cat3_B300_Size03_with 700HPS 2100 FVNR starters Cat. 3 with two Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) and two interposing safety relay (700-HPS)	1
Contact Rockwell Automation	SISTEMA Identifier: 2100_Cat3_SMRDSTD_with 700HPS 2100 Cat. 3 safety monitoring relay distribution subsystem using two immediate safety outputs (stop category 0) with interposing relays (two 700 HPS per safety output) - C3_SMRDSTD_WIR.	1
800T-1TYM	800T push button, 30 mm push-button station, Type 4/13, 1 Push Button, emergency stop, Push-Pull/Twist release, no conduit, no locking attachment	1
800TC-TFXLT6A5S	800T non-illuminated trigger action two position that is maintained, twist release, red 63 mm (2.48 in.) metal head, with no legend on cap, finger guards on terminals, traditional contact block code: 2-NCLB self-monitoring contact	1

Setup and Wiring

For detailed information on how to install and wire these products, see the publications that are listed in Additional Resources on page 107.

System Overview

The pulsed outputs of the safety monitoring relay (terminals S11 and S21) are run separately through the E-stop contact. This configuration enables the safety monitoring relay to detect a loose wire, a short to 24V, a short to GND, and cross-channel faults.

The safety monitoring relay responds to E-stop inputs and detected E-stop circuit faults by opening its safety contacts (13...14 and 23...24) and time-delayed safety output contacts (37...38, 47...48, 57...58). This action de-energizes the coils of the starter contactors and the safety inputs of the VFDs that are commanded by those safety outputs. The Guardmaster® single input safety relay cannot be reset until the E-stop is released, or the fault is corrected. In some cases, the E-stop must be pressed and released before the Guardmaster® single input safety relay can be reset. After some faults, the safety relay must be power cycled. Once the fault is cleared, the safety relay can be reset.

The safety monitoring relay monitors itself for any internal faults. When a fault is detected, the safety monitoring relay responds by opening its safety contacts (13...14 and 23...24) and time-delayed safety output contacts (37...38, 47...48, 57...58). This action de-energizes the coils of the starter contactors and the safety inputs of the VFDs that are commanded by those safety outputs. Some internal faults can be cleared by power-cycling the safety monitoring relay. In other cases, the safety monitoring relay safety relay must be replaced.

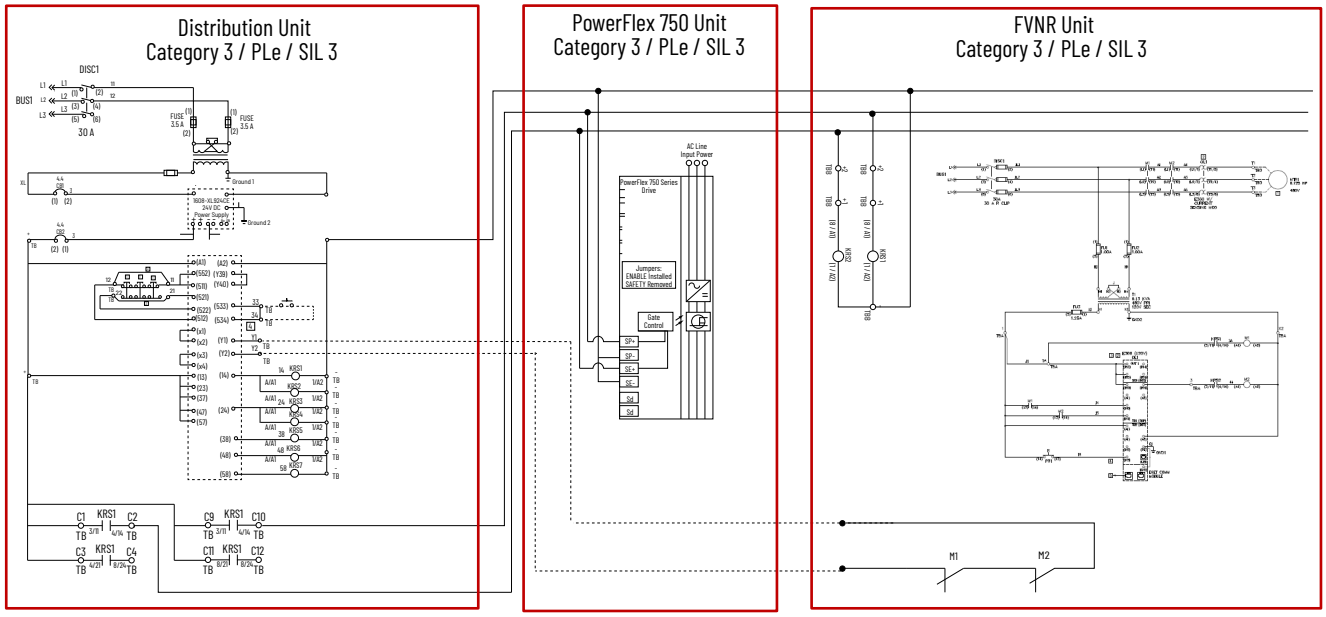
The safety monitoring relay monitors the contactors for welded contacts via feedback from two N.C. contacts in a series from the starter unit. If a contact is welded, the N.C. contact is held open, which helps prevent the reset of the safety monitoring relay.

Electrical Schematic

Figure 40 gives an overview of the subsystems that compose this system. The safety monitoring relay distribution unit receives inputs from a dual channel E-stop string. The distribution unit distributes two safety contacts from two separate safety control relays to a maximum of eight MCC units within the same line-up.

This Cat. 3 circuit uses dual channel circuits and a safety-monitoring relay to diagnose faults.

Figure 40 - Multi-motor E-stop using a Monitoring Safety Relay Cat. 3 Electrical Schematic Overview



Configuration

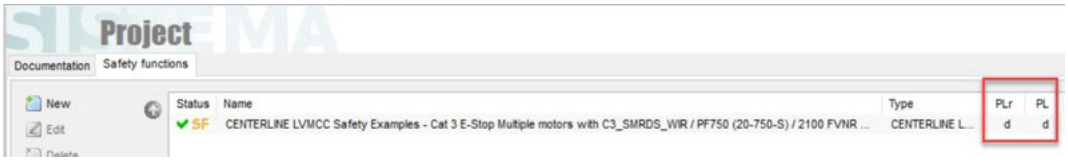
See the respective subsystem section for configuration information.

Calculation of the PL

When properly implemented, the multi-motor E-stop safety function can achieve a safety rating of Cat. 3, PLd, according to ISO 13849-1: 2015, as calculated by using the SISTEMA.

The SISTEMA file that is referenced in this safety function is available for download.
See Access Components of the Safety Function on page 7.

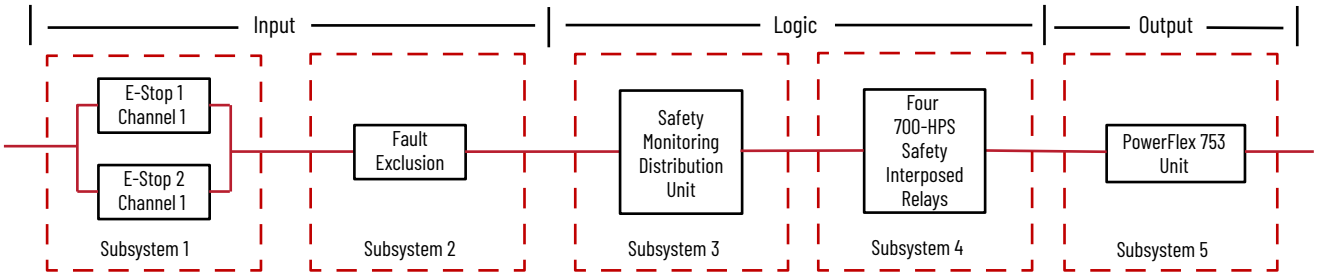
Figure 41 - SISTEMA Multi-motor E-stop using a Monitoring Safety Relay Cat. 3 Safety Function



Complete Safety Function PL Calculation Example

When modeled in SISTEMA, the multi-motor E-stop safety function is treated as an individual safety function and can be modeled as follows.

Figure 42 - Multi-motor E-stop using a Monitoring Safety Relay Cat. 3 Safety Function Model



Subsystem 4 and Subsystem 5 are included in the same safety function for simplification. The fact that Subsystem 4 and Subsystem 5 are included in the same safety function affects the Performance Level and the final PFHD value that is achieved by the safety function.

If Subsystem 4 and Subsystem 5 are separated in two different safety functions them both safety functions would be able to achieve a lower PFHD value as individual safety functions.

The separation of the subsystems in different safety functions depends on the definition of the hazards during the risk assessment evaluation. If there is a unique hazard that is being addressed by the safety function, then it makes sense to include both subsystems in the same safety function. On the other hand, if there are two different hazards that must be addressed then it makes sense to separate it in two safety functions.

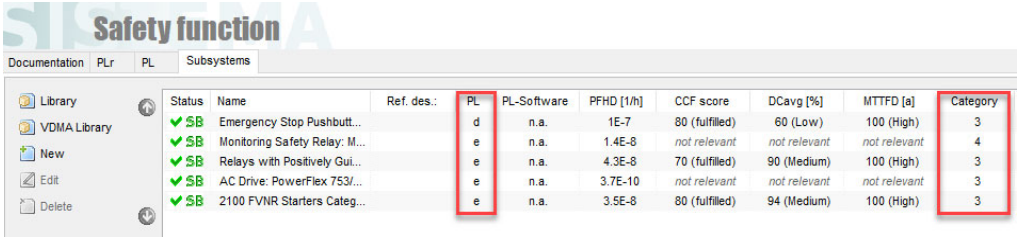
The E-stop function is a complementary protective measure that is intended to be used with other safeguarding measures and protective devices to reduce risk sufficiently. The emergency stop function shall be designed not to impair the effectiveness of the other protective devices or safety functions.

This safety function includes the following subsystems:

- Emergency stop push buttons
  - Cat. 3 / PLd
- Monitoring safety relay: MSR138 - immediate action contact
  - Cat. 4 / PLe
- Relays with positively guided contacts: four 700-HPS (two for each immediate safety output)
  - Cat. 3 / PLe
- AC Drive: PowerFlex 753/755 with 20-750-S hardwired STO
  - Cat. 3 / PLe
- 2100 FVNR starters Cat. 3 with two Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) and two interposing safety relay (700-HPS)
  - Cat. 3 / PLe

Figure 43 shows the multi-motor E-stop safety function subsystems as modeled in the SISTEMA file example.

Figure 43 - Multi-motor E-stop using a Monitoring Safety Relay Cat. 3 – SISTEMA Subsystems



Functional Safety Data Required for Determining the PL of Electromechanical Devices

Relays, push button, and contactors are electromechanical devices, the functional safety data that is required for PL calculation includes the following:

- Mean Time to Failure, dangerous (MTTFd) – Required for Cat. 1 circuits and up
- Diagnostic Coverage (DCavg) - Required for Cat. 2 circuits and up
- Common Cause Failure (CCF) - Required for Cat. 2 circuits and up

The functional safety evaluations of the electromechanical devices include the following:

- How frequently they are operated – Required for Cat. B circuits and up
- Whether they are effectively monitored for faults - Required for Cat. 2 circuits and up
- Whether they are properly specified and installed - Required for Cat. B circuits and up

SISTEMA calculates the MTTFd by using B10d data that are provided for the safety relay, E-stop push buttons, and contactors along with the estimated frequency of use, entered during the creation of the SISTEMA project. Download the SISTEMA file for this example to see the maximum frequency operation for each subsystem. The interposing safety relays in the distribution unit and in the starter are actuated only when the E-stop is actuated, not during a normal start and stop cycles of the motor.

For details on how to download the SISTEMA files, see Access Components of the Safety Function on page 7.

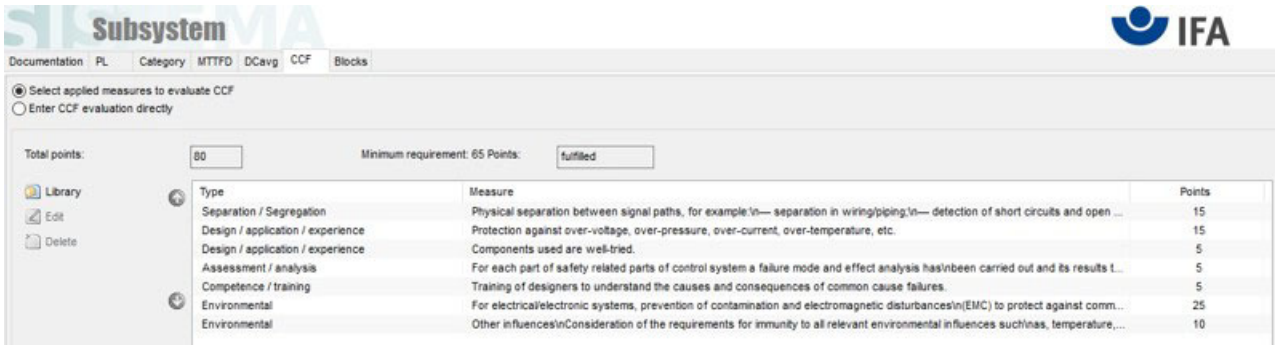
The DCavg (99%) for the contactors is selected from the Output Device table of ISO 13849-1 Annex E, Direct Monitoring.

The DCavg (99%) for the E-stop is selected from the Input Device table of ISO 13849-1 Annex E, Direct Monitoring.

The CCF value is generated by using the scoring process that is outlined in Annex F of ISO 13849-1. The complete CCF scoring process must be performed when implementing an application. A minimum score of 65 must be achieved. The safety starters units have a CCF greater than 65. See the SISTEMA file for details.

Figure 44 shows the CCF measures assumed in the design of the safety function.

Figure 44 - CCF Measures Assumed (Multi-motor E-stop using a Monitoring Safety Relay Cat. 3)



Verification and Validation Plan

Verification and validation play important roles in the avoidance of faults throughout the safety system design and development process. ISO 13849-2 sets the requirements for verification and validation. The standard calls for a documented plan to confirm that all safety functional requirements have been met.

Verification is an analysis of the resulting safety control system. The PL of the safety control system is calculated to confirm that the system meets the PLr specified. The SISTEMA software is typically used to perform the calculations and assist with satisfying the requirements of ISO 13849-1.

Validation is a functional test of the safety control system to demonstrate that the system meets the specified requirements of the safety function. The safety control system is tested to confirm that all safety-related outputs respond appropriately to their corresponding safety-related inputs. The functional test includes normal operating conditions and potential fault injection of failure modes. A checklist is typically used to document the validation of the safety control system.

Verification and validation checklist examples are available for download. See Access Components of the Safety Function on page 7.

Safety Function: Multi-motor E-stop using 1734 Remote I/O – Cat. 3

This safety function describes how power is removed from a hazard when a safety system detects that an E-stop has been actuated.

The logic solver that is used by this safety function is a safety PLc that controls a Cat. 3 safety remote I/O distribution subsystem without interposing relays (C3SRIODS_WIR).

This example considers that two output subsystems are actuated simultaneously when one of the E-stops is pressed.
Both output subsystem safety functions are evaluated in the same safety function.

The output subsystems that are used in this example are:

- PowerFlex 525 with embedded STO (shielded cable to terminals)
- CENTERLINE 2100 full voltage reversing (FVR) starters Cat. 3 with three Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) and two interposing safety relays (700-HPS)

Safety Function Realization: Risk Assessment

The required PL is the result of a risk assessment and refers to the amount of the risk reduction to be carried out by the safety-related parts of the control system. Part of the risk reduction process is to determine the safety functions of the machine. In this application, the PLr by the risk assessment is Cat. 3, PLd for the safety function. A safety system that achieves Cat. 3, PLd or higher can be considered control reliable. Each safety product or subsystem has its own rating and can be combined to create a safety function that meets or exceeds the PLr.

Safety Function Requirements

When you press the E-stop, this action stops and helps prevent hazardous motion by removal of power to the motor. When you release the E-stop button, hazardous motion and power to the motor do not resume until a secondary action (such as, pressing the start button) occurs. Faults at the E-stop button, wiring terminals, or safety relay are detected before the next safety demand. The emergency stop functions are complementary to any other safeguards on the machine and do not reduce the performance of other safety-related functions. The safety function in this example can connect and interrupt power to motors rated up to the LVMCC unit rating.

The safety function in this example meets or exceeds the requirements for Cat. 3, PLd per ISO 13849-1 and control reliable operation per ANSI B11.19.

Functional Safety Description

Hazardous motion is interrupted or prevented by actuation of any E-stop button. The E-stop contacts are connected to a pair of safety inputs of a safety input module (DI-0/1, Module 1). The contactor coils and drive safety inputs are connected to a pair of safety outputs of a safety output module (DO-0/1, Module 4). The normally closed auxiliary contacts of the contactors are wired in series to a single safety input of a safety input module (DI-0, Module 3). The I/O modules are connected via CIP Safety™ over an EtherNet/IP™ network to the GuardLogix®

controller. The safety code in the safety controller monitors the status of the E-stop buttons by using a pre-certified safety instruction named Dual Channel Input Stop (DCS). When all conditions are satisfied, no faults are detected on the input modules, and the reset button is pressed, a second certified function block called Configurable Redundant Output (CROUT) checks the status of the feedback from the contactors. The controller then issues an output signal to the safety output module (DO-0/1, Module 4) to switch ON a pair of outputs to energize the M1 contactor coil and the drive safety inputs.

Only the M1 contactor energizes after the safety circuit is reset. The MR1 (reverse contactor) or MF1 (forward contact) energizes only when commanded by the application software that controls the E300 relay outputs. To avoid the automatic start of the motors when the safety circuit is reset, the application software must interlock the start command with the safety circuit ready status. Once the safety circuit is open, the start command for the motor must drop and remain off until the safety circuit is reset, and a new start command is issued. An example of an application software that matches this description is available for download (the example is in the 'Studio 5000 Logix Designer® Files' folder); see Access Components of the Safety Function on page 7.

See the following sections for details on the wiring:

- Cat. 3 safety remote I/O distribution unit - electrical schematic on Figure 31 on page 59
- PowerFlex 525 – hardwired STO drive - electrical schematic on Figure 10 on page 22
- Cat. 3 FVR unit with interposing relays - electrical schematic on Figure 24 on page 47

This example covers only stop category 0 (coast-to-stop). Stop Cat. 1 removes power to the motor after a delay while drive units execute a controlled stop.

The safety remote I/O distribution unit has four pairs of safety outputs. Each safety output pair energizes an interposing safety relay (see Figure 31...Figure 34 on page 60). If stop Cat. 1 is required for the drive units, use a dedicated pair of safety outputs to energize the safety circuit of those units with a delay. An example of stop Cat. 1 logic is available for download; see Access Components of the Safety Function on page 7.

The hazardous motion cannot be started until the E-stop is released, and then the reset button is pressed and released. Drive faults must be reset before a start command.

The FVR unit receives two contacts from the safety remote I/O distribution unit that energizes the two interposing safety relays (see FVR wiring diagram, Figure 24 on page 47). The contacts from the interposing safety must be closed to allow the energization of the contactor coils.

The E300 relay outputs control the contactor coils energization. One output controls the movement forward and another controls the reverse movement. Auxiliary normally open (N.O.) contacts from the contactors are wired to E300 relay inputs to allow the controller to confirm the direction of rotation of the motor based on contactor feedback.

Only the M1 contactor energizes after the safety circuit is reset. The MR1 (reverse contactor) or MF1 (forward contact) energizes only when commanded by the application software that controls the E300 relay outputs. To avoid the automatic start of the motors when the safety circuit is reset, the application software must interlock the start command with the safety circuit ready status. Once the safety circuit is open, the start command for the motor must drop and remain off until the safety circuit is reset, and a new start command is issued. An example of an application software that matches this description is available for download, the example is in the 'Studio 5000 Logix Designer® Files' folder; see Access Components of the Safety Function on page 7.

These N.O. auxiliary contacts let you create an application logic to diagnose which individual contactor has failed. An example of an application software that matches this description is available for download, the example is in the 'Studio5000 Logix Designer Files' folder; see Access Components of the Safety Function on page 7. An overload protection trip de-energizes both E300 relay outputs.

The N.O. auxiliary contacts from M1, MR1, and MF1 are wired to E300 relay inputs 0, 1, and 2. Contactor M1 N.O. auxiliary feedback contact indicates the SAFETY CIRCUIT status for that starter and contactor. The M2 N.O. auxiliary contact indicates the RUNNING/STOPPED status of the starter. The safety monitoring relay prevents the safety circuit from being reset if there is an open circuit of the contactor normally closed (N.C.) auxiliary feedback contacts. Only if the contactors N.C. auxiliary feedback contacts are closed, then it is possible to reset the safety monitoring relay. Once the safety relay resets, then both safety outputs of the relay energize but only contactor M1 will close. MR1 and MF1 remain to wait for the E300 output contact to close. If the E-stop is pressed, the safety monitoring relay opens its safety outputs and M1, MR1, and MF1 contactors open. If a contactor remains closed, it is possible to detect which contactor has failed by examining the N.O. auxiliary contacts status from M1, MR1, and MF1 in the application software.

To achieve the safety function of this example, N.C. auxiliary contacts from the contactors are wired to a safety input. If a contact of one or both contactors is welded closed, the corresponding auxiliary N.C. contact is held open, which is monitored by the by CROUT instruction.

The PowerFlex drive monitors its STO inputs for valid status and faults. The drive monitors its internal safety circuits for valid status and faults. The drive monitors its output power transistors for valid status and faults. When the safety relay de-energizes the drive STO inputs,

the drive STO feature forces the drive output power transistors to a disabled state. The hazardous motion that is controlled by the drive coasts to a stop. This feature does not provide electrical power isolation.

When the E-stop inputs are in the proper state and the contactors and drive safety inputs are properly de-energized, pressing and releasing the reset button energizes in the safety outputs. The energization of the safety outputs closes one of the contactors. The state of forward and reverse contactors depend on the state of the E300 relay outputs. The motor that is controlled by the drive starts only after its faults are reset and after it receives a start command.

Bill of Materials

The safety function that is shown in this document uses these products or subsystems.

Figure 45 - Multi-motor E-stop using 1734 Remote I/O – Cat. 3 Bill of Materials

Catalog Number	Description	Quantity
Contact Rockwell Automation	SISTEMA Identifier: 2x00_PF525 PowerFlex 525 with 20-750-S – hardwired STO (shielded cable to terminals)	1
Contact Rockwell Automation	2100_FVR_Cat3_B300_Size03_with 700HPS 2100 FVR starters Cat. 3 with three Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) and two interposing safety relay (700-HPS)	1
Contact Rockwell Automation	SISTEMA Identifier: 2100_Cat3_SRIODS_with 700HPS 2100 Cat. 3 safety remote I/O distribution subsystem (stop category 0/1) with interposing relays - 1 safety zone – one 1734-OB8S (one 700-HPS per safety output) and one 1734-IB8S (auxiliary contactor feedback in series, reset signal, E-stop string channel) - C3SRIODS_WIR.	1
1756-L8xES	Safety controller: GuardLogix® controller 1756-L8xES	1
1756-L8SP	Safety controller Partner: GuardLogix safety partner 1756-L8SP	1
800T-1TYM	800T push button, 30 mm push-button station, Type 4/13, 1 push button, emergency stop, push-pull/twist release, no conduit, no locking attachment	1
800TC-TFXLT6A5S	800T non-illuminated trigger action two position that is maintained, twist release, red 63 mm (2.48 in.) metal head, with no legend on cap, finger guards on terminals, traditional contact block code: 2-NCLB self-monitoring contact	1

Setup and Wiring

For detailed information on how to install and wire these products, see the publications that are listed in Additional Resources on page 107.

System Overview

The 1734-IB8S input module monitors the inputs from the E-stop contacts. See ISO 13850 Safety of machinery - Emergency stop function - Principles for design, for more information on the use of E-stops. An E-stop is a complementary safety device. E-stop devices are typically used to stop unintended motion.

The circuit is tested by using test pulses (T0 and T1) on the inputs, I0 and I1. These test pulses source the 24V DC for the circuit. By periodically dropping the 24V DC to 0V DC, it is possible to detect cross-channel faults and shorts to an external 24V DC. Shorts to 0V DC are an open circuit by the input and are detected by either the hardware, if configured to detect discrepancy errors, or by the appropriate safety function block in the application code.

The final control devices, in this case, are the safety contactors in the FVNR starter and the safety inputs of the STO circuit of the PowerFlex 525 drive.

The contactors are controlled by a 1734-OB8S safety output module. Two outputs from this module energize two separate interposing relays. A contact from each interposing relay energizes an interposing relay that is located at the starter unit. A contact from one of the interposing relays energizes one of the contactors in the starter. The forward and the reverse contactors are not energized because it remains to wait for a command from the E300 relay forward or reverse output. The contactors are wired in a redundant configuration and are tested for faults. The test is accomplished by using a CROUT instruction to monitor the status of the N.C. auxiliary feedback contacts from the contactors. The N.C. auxiliary contacts are wired in series to a safety input. If safety input is ON, it means that all contactors are opened. If safety input is OFF, it means that at least one contactor remains closed.

The PowerFlex 525 drive is hardwired with STO and it is intended for use in safety-related applications where the de-energized state is the safe state. The hardwired STO signals are controlled by the 1734-OBS safety output module. Two outputs from this module energize two separate interposing relays. These outputs are wired in a redundant configuration and are pulse that is tested to detect wiring faults.

The system is reset with a momentary push button.

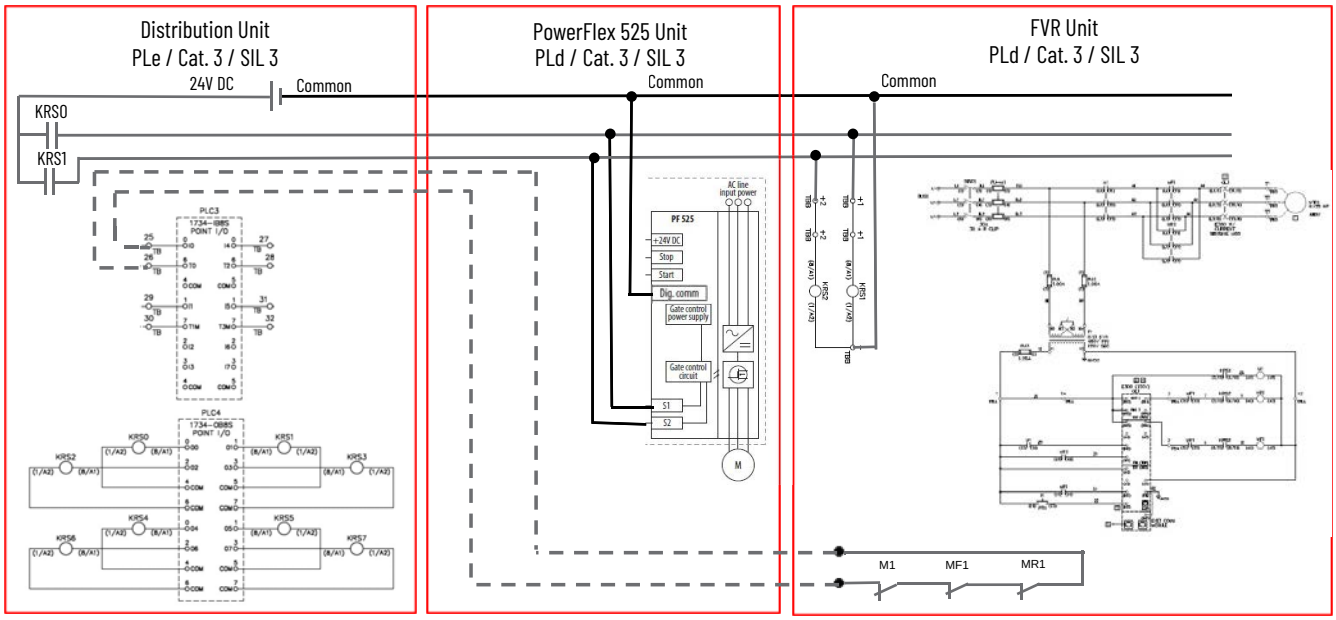
Electrical Schematic

Figure 46 shows an overview of the subsystems that compose this system.

The safety remote I/O distribution unit receives inputs from a dual channel E-stop string. It contains a remote safety I/O module (1734-OB8S) that distributes two safety contacts from two separate safety control relays to a maximum of eight MCC units within the same line-up.

This Cat. 3 circuit uses dual channel circuit and remote safety I/O.

Figure 46 - Multi-motor E-stop using 1734 Remote I/O Cat. 3 Electrical Schematic Overview



Configuration

For the following items, see the Configuration section in Actuator Subsystems – Stop Cat. 0 or 1 via an Integrated Safety Controller and PowerFlex 525 Drive with Hardwired STO Function, publication SAFETY-AT149, and Emergency Stop Products: Integrated Safety Controller Connected to a Series of Dual-channel E-stop Buttons Safety Function, publication SAFETY-AT036:

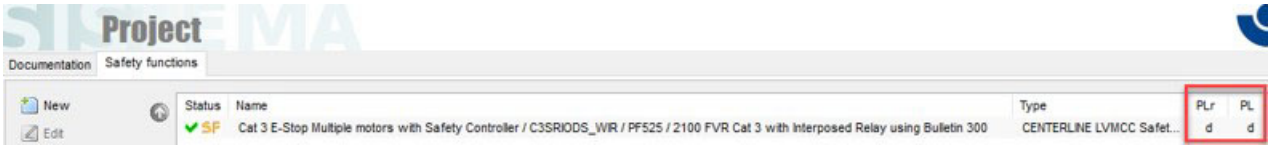
- Configure the controller and add I/O modules
- Configure the I/O modules
- Program the E-stop logic (DCS instruction)
- Program contactor safety logic (CROUT instruction)
- Program PowerFlex 525 safety logic (stop category 0 and stop category 1)
- Falling edge reset

Calculation of the PL

When properly implemented, the multi-motor E-stop safety function can achieve a safety rating of Cat. 3, PLd according to ISO 13849-1: 2015, as calculated by using the SISTEMA.

The SISTEMA file referenced in this safety function is available for download. See Access Components of the Safety Function on page 7.

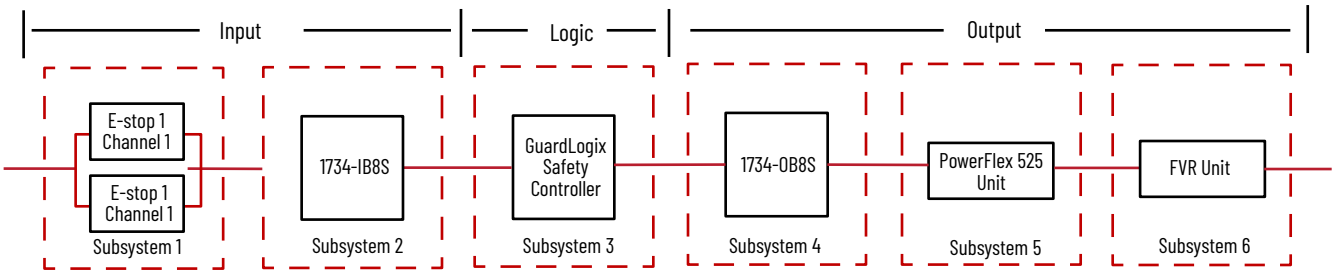
Figure 47 - SISTEMA Multi-motor E-stop using 1734 Remote I/O Cat. 3 Safety Function



Complete Safety Function PL Calculation Example

When modeled in SISTEMA, the multi-motor E-stop safety function is treated as an individual safety function and can be modeled as follows.

Figure 48 - Multi-motor E-stop using 1734 Remote I/O Cat. 3 Model



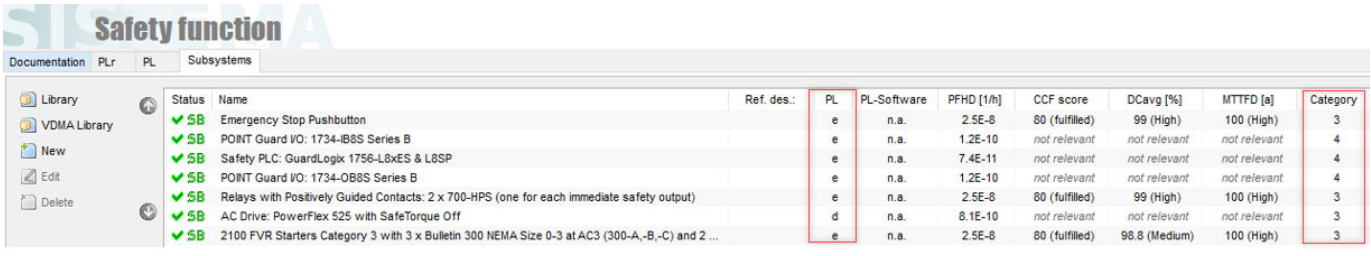
The E-stop function is a complementary protective measure that is intended to be used with other safeguarding measures and protective devices to reduce risk sufficiently. The E-stop function shall be designed not to impair the effectiveness of the other protective devices or safety functions.

This safety function includes the following subsystems:

- Emergency stop push button
  - Cat. 3 / PLd
- POINT Guard I/O™: 1734-IB8S Series B
  - Cat. 4 / PLe
- Safety controller: GuardLogix 1756-L8xES and L8SP
  - Cat. 4 / PLe
- POINT Guard I/O™: 1734-OB8S Series B
  - Cat. 4 / PLe
- Relays with positively guided contacts: two 700-HPS (one for each immediate safety output)
  - Cat. 3 / PLe
- AC Drive: PowerFlex 525 with STO
  - Cat. 3 / PLd
- CENTERLINE 2100 FVR starters Cat. 3 with three Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) and two interposing safety relays (700-HPS)
  - Cat. 3 / PLe

This diagram shows the multi-motor E-stop safety function subsystem as modeled in the SISTEMA file example and assumes the use of a specific safety controller. If you use another controller, you must redo the calculation with the controller you chose.

Figure 49 - Multi-motor E-stop using 1734 Remote I/O Cat. 3 - SISTEMA Subsystems



Status	Name	Ref. des.:	PL	PL-Software	PFHD [1/h]	CCF score	DCavg [%]	MTTFD [a]	Category
SB	Emergency Stop Pushbutton		e	n.a.	2.5E-8	80 (fulfilled)	99 (High)	100 (High)	3
SB	POINT Guard I/O: 1734-IB8S Series B		e	n.a.	1.2E-10	not relevant	not relevant	not relevant	4
SB	Safety PLC: GuardLogix 1756-L8xES & L8SP		e	n.a.	7.4E-11	not relevant	not relevant	not relevant	4
SB	POINT Guard I/O: 1734-OB8S Series B		e	n.a.	1.2E-10	not relevant	not relevant	not relevant	4
SB	Relays with Positively Guided Contacts: 2 x 700-HPS (one for each immediate safety output)		e	n.a.	2.5E-8	80 (fulfilled)	99 (High)	100 (High)	3
SB	AC Drive: PowerFlex 525 with SafeTorque Off		d	n.a.	8.1E-10	not relevant	not relevant	not relevant	3
SB	2100 FVR Starters Category 3 with 3 x Bulletin 300 NEMA Size 0-3 at AC3 (300-A,-B,-C) and 2 ...		e	n.a.	2.5E-8	80 (fulfilled)	98.8 (Medium)	100 (High)	3

Functional Safety Data Required for Determining the PL of Electromechanical Devices

Relays, push buttons, and contactors are electromechanical devices.
The functional safety data that are required for PL calculation includes the following:

- Mean Time to Failure, dangerous (MTTFd) – Required for Cat. 1 circuits and up
- Diagnostic Coverage (DCavg) - Required for Cat. 2 circuits and up

- Common Cause Failure (CCF) - Required for Cat. 2 circuits and up

The functional safety evaluations of the electromechanical devices include the following:

- How frequently they are operated – Required for Cat. B circuits and up
- Whether they are effectively monitored for faults - Required for Cat. 2 circuits and up
- Whether they are properly specified and installed - Required for Cat. B circuits and up

SISTEMA calculates the MTTFd by using B10d data that are provided for the safety relay, E-stop push buttons and contactors along with the estimated frequency of use, entered during the creation of the SISTEMA project. Download the SISTEMA file for this example to see the maximum frequency operation for each subsystem. The interposing safety relays in the distribution unit and in the starter are actuated only when the E-stop is actuated, not during a normal start and stop cycles of the motor. For details on how to download the SISTEMA files, see Access Components of the Safety Function on page 7.

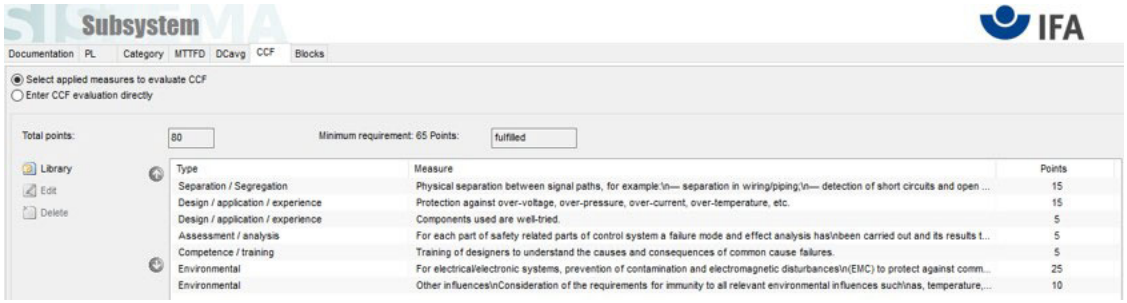
The DCavg (99%) for the contactors is selected from the Output Device table of ISO 13849-1 Annex E, Direct Monitoring.

The DCavg (99%) for the E-Stop is selected from the Input Device table of ISO 13849-1 Annex E, Direct Monitoring.

The CCF value is generated by using the scoring process that is outlined in Annex F of ISO 13849-1. The complete CCF scoring process must be performed when implementing an application. A minimum score of 65 must be achieved. The safety starter units have a CCF greater than 65. See SISTEMA file for details.

Figure 50 shows the CCF measures assumed in the design of the safety function.

Figure 50 - CCF measures assumed (Multi-motor E-stop using 1734 Remote I/O Cat. 3)



Verification and Validation Plan

Verification and validation play important roles in the avoidance of faults throughout the safety system design and development process. ISO 13849-2 sets the requirements for verification and validation. The standard calls for a documented plan to confirm that all safety functional requirements have been met.

Verification is an analysis of the resulting safety control system. The PL of the safety control system is calculated to confirm that the system meets the PLr specified. The SISTEMA software is typically used to perform the calculations and assist with satisfying the requirements of ISO 13849-1.

Validation is a functional test of the safety control system to demonstrate that the system meets the specified requirements of the safety function. The safety control system is tested to confirm that all safety-related outputs respond appropriately to their corresponding safety-related inputs. The functional test includes normal operating conditions and potential fault injection of failure modes. A checklist is typically used to document the validation of the safety control system.

Before validating the GuardLogix safety system, confirm that the safety system and safety application program have been designed in accordance with the controller safety reference manuals that are listed in page 107, and the GuardLogix Safety Application Instruction Set Reference Manual, publication 1756-RM095.

A validation checklist is available for download. See Access Components of the Safety Function on page 7.

Safety Function: Multi-motor E-stop using Integrated Safety – Cat. 3

This safety function describes how power is removed from a hazard when a safety system detects that an E-stop has been actuated.

The logic solver that is used by this safety function is a safety PLc that uses safety instructions to stop the drives over the safety network.

This safety function considers that two output subsystems are actuated simultaneously when one of the E-stop buttons is pressed. Both output subsystem safety functions are evaluated in the same safety function.

The output subsystems that are used in this example are:

- PowerFlex 755 with 20-750-S3 - integrated STO using standard I/O
- PowerFlex 527 - integrated STO using integrated motion on the EtherNet/IP network and the PowerFlex 525/PowerFlex 527 Add-On Instruction (AOI)

Safety Function Realization: Risk Assessment

The required PL is the result of a risk assessment and refers to the amount of the risk reduction to be carried out by the safety-related parts of the control system. Part of the risk reduction process is to determine the safety functions of the machine. In this application, the PLr by the risk assessment is Cat. 3, PLd, for the safety function. A safety system that achieves Cat. 3, PLd or higher can be considered control reliable. Each safety product or subsystem has its own rating and can be combined to create a safety function that meets or exceeds the PLr.

Safety Function Requirements

When you press the E-stop, this action stops and prevents hazardous motion by removal of power to the motor. When you reset the E-stop button, hazardous motion and power to the motor do not resume until a secondary action occurs (such as, pressing the start button). Faults at the E-stop button, wiring terminals, or safety relay are detected before the next safety demand. The emergency stop functions are complementary to any other safeguards on the machine and do not reduce the performance of other safety-related functions. The safety functions in this example can connect and interrupt power to motors rated up to the LVMCC unit rating.

The safety functions in this section each meet or exceed the requirements for Cat. 3, PLd, per ISO 13849-1 and control reliable operation per ANSI B11.19.

Functional Safety Description

Hazardous motion is interrupted or prevented by actuation of the E-stop button. Each E-stop is considered a separate safety function. The E-stop contacts are connected to a pair of safety inputs of a safety input module (DI-0/1, module 1). The I/O module is connected via CIP (Common Industrial Protocol) Safety™ over an EtherNet/IP™ network to the safety controller. The safety code in the safety controller monitors the status of theE-stop buttons by using a pre-certified safety instruction named Dual Channel Input Stop (DCS). When all conditions are satisfied, no faults are detected on the input modules, and the reset button is pressed, the controller then enables the safety inputs assembly over the CIP Safety network for both drives. Once the safety input assembly is enabled, the drives are in a ready state waiting for the start command.

This safety function covers only stop category 0 (coast-to-stop). Stop category 1 removes power to the motor after a delay while drive units executes a controlled stop.

The hazardous motion cannot be started until the E-stop is released, and then the reset button is pressed and released. Drive faults must be reset before a start command.

The PowerFlex drive monitors its STO network inputs for valid status and faults. The drive monitors its internal safety circuits for valid status and faults. The drive monitors its output power transistors for valid status and faults. When STO network inputs are disabled, the drive STO feature forces the drive output power transistors to a disabled state. The hazardous motion that is controlled by the drive coasts to a stop. This feature does not provide electrical power isolation.

When the E-stop contacts are in the proper state and drive STO network inputs are enabled, pressing and releasing the reset button energizes the drive STO network output. The motor that is controlled by the drive only starts after its faults are reset and after it receives a start command.

Bill of Materials

The safety function that is shown in this document uses these products or subsystems.

Table 8 - Multi-motor E-stop using Integrated Safety – Cat. 3 Bill of Materials

Catalog Number	Description	Quantity
Contact Rockwell Automation 216xU/V-...-14SRR2	SISTEMA Identifier: 2x00_PF750_S3 PowerFlex 755 Frames 1...7 with 20-750-S3 – integrated STO	1
Contact Rockwell Automation	SISTEMA Identifier: 2x00_PF527 PowerFlex 527 – integrated STO (with Integrated Motion on the EtherNet/IP™ network)	1
1756-L8xES	GuardLogix safety controller 1756-L8xES	1
1756-L8SP	GuardLogix safety partner 1756-L8SP	1
1734-AENTR	1734 Remote I/O Adapter	1
1734-IB8S	1734 Safety Input Module	1
800T-1TYM	800T push button, 30 mm push-button station, Type 4/13, 1 push button, emergency stop, push-pull/twist release, no conduit, no locking attachment	1
800TC-TFXLT6A5S	800T non-illuminated trigger action two position that is maintained, twist release, red 63 mm (2.48 in.) metal head, with no legend on cap, finger guards on terminals, traditional contact block code: 2-NCLB self-monitoring contact	1

Setup and Wiring

For detailed information on how to install and wire these products see the publications that are listed in Additional Resources on page 107.

System Overview

The 1734-IB8S input module monitors the contacts from the E-stop.

See ISO 13850 Safety of machinery - Emergency stop function - Principles for design, for more information on the use of E-stops.
An E-stop is a complementary safety device for an emergency situation.

The circuit is tested by using test pulses (T0 and T1) on the inputs, I0 and I1. These test pulses source the 24V DC for the circuit. By periodically dropping the 24V DC...0V DC, it is possible to detect cross-channel faults and shorts to an external 24V DC. Shorts to 0V DC are an open circuit by the input and are detected by either the hardware, if configured to detect discrepancy errors, or by the appropriate safety function block in the application code.

The final control devices, in this case, are the networked STO safety inputs on the PowerFlex 527 and PowerFlex 755 (20-750-S3) drive. The system is reset with a momentary push button.

Electrical Schematic

Figure 46 on page 73 and Figure 52 on page 78 show an overview of the subsystems that compose this system. The safety remote I/O distribution unit receives inputs from a dual channel E-stop string. This Cat. 3 circuit uses dual channel circuit and remote safety I/O.

Figure 51 - Multi-motor E-stop using Integrated Safety Cat. 3 Electrical Schematic Overview

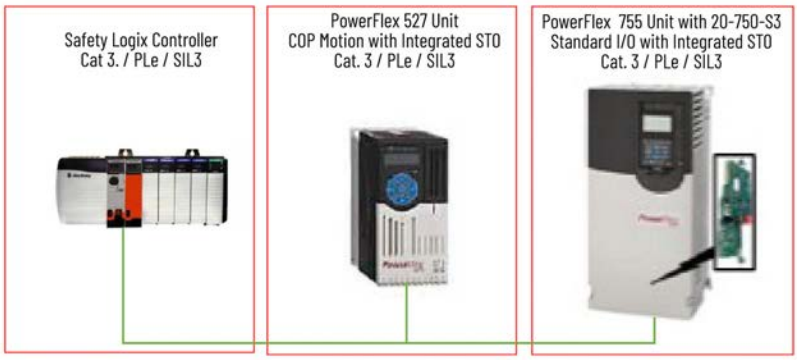
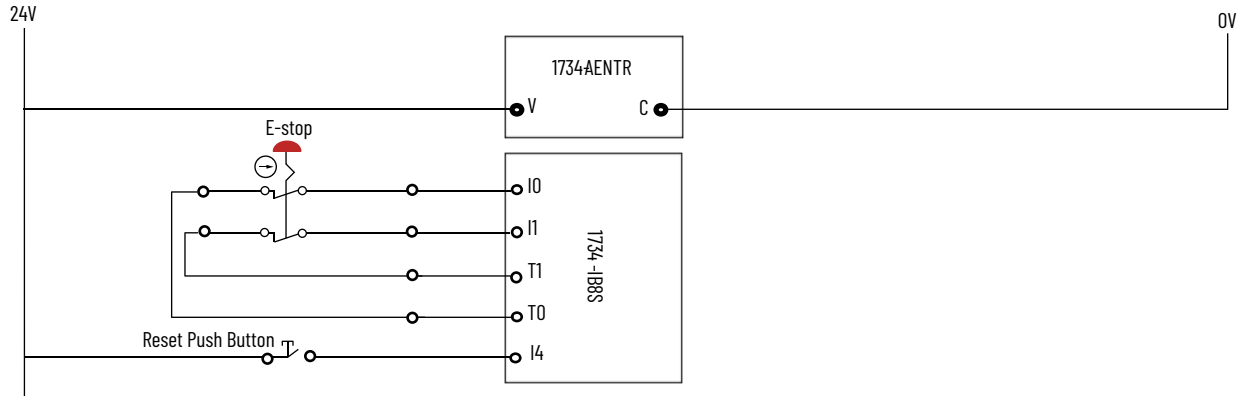


Figure 52 - 1734-IB8S Push Buttons Electrical Schematic



Configuration

For the following items, see the configuration section of the Actuator Subsystems – Stop Category 0 or 1 via an Integrated Safety Controller and PowerFlex 525 Drive with Hardwired STO Safety Function, publication SAFETY-AT149, and the Emergency Stop Products: Integrated Safety Controller Connected to a Series of Dual-channel E-stop Buttons Safety Function, publication SAFETY-AT036:

- Configure the controller and add I/O modules
- Configure the 1734-IB8S module
- Program the E-stop logic (DCS instruction)

For the following items, see the configuration section of the Actuator Subsystems - Stop Cat. 0 or 1 via a PowerFlex Drive with Integrated STO Safety Function, publication SAFETY-AT141:

- Configure the GuardLogix controller and PowerFlex drives
- Programming
  - Safety program logic – stop category 0
  - Safety program logic – stop category 1
  - Falling edge reset

For Logix Designer application file examples see Access Components of the Safety Function on page 7.

Calculation of the PL

When properly implemented, each of the two E-stop safety functions can achieve a safety rating of Cat. 3, PLd, according to ISO 13849-1: 2008, as calculated by using the SISTEMA.

The SISTEMA file that is referenced in this safety function is available for download.
See Access Components of the Safety Function on page 7.

Figure 53 - SISTEMA Multi-motor E-stop using Integrated Safety Cat. 3 Safety Function

The functional safety specifications of the project call for a PL of PLd (minimum) and a structure of Cat. 3 (minimum).
A PFHD of less than 1.0 E-06 for the overall safety function is required for PLd.

When properly implemented, the PowerFlex 527 subsystem can be used in a safety function that achieves a safety rating of Cat. 3, PLe according to ISO 13849-1: 2015, as calculated by using the SISTEMA software PL calculation tool.

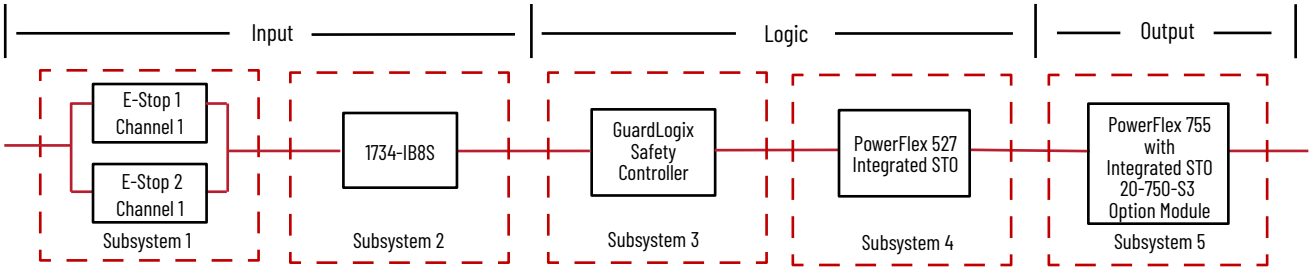
When properly implemented, the PowerFlex 755 drive or the PowerFlex 755T drive product with the 20-750-S3 module subsystem can be used in a safety function that achieves a safety rating of Cat. 3, PLe according to ISO 13849-1: 2015, as calculated by using the SISTEMA software PL calculation tool.

The category and PL of the safety controller and PowerFlex drives subsystems are shown in the graphics.

Complete Safety Function PL Calculation Example

When modeled in SISTEMA, the multi-motor E-stop safety function is treated as an individual safety function and can be modeled as follows.

Figure 54 - Motor E-stop using Integrated Safety Cat. 3 Model



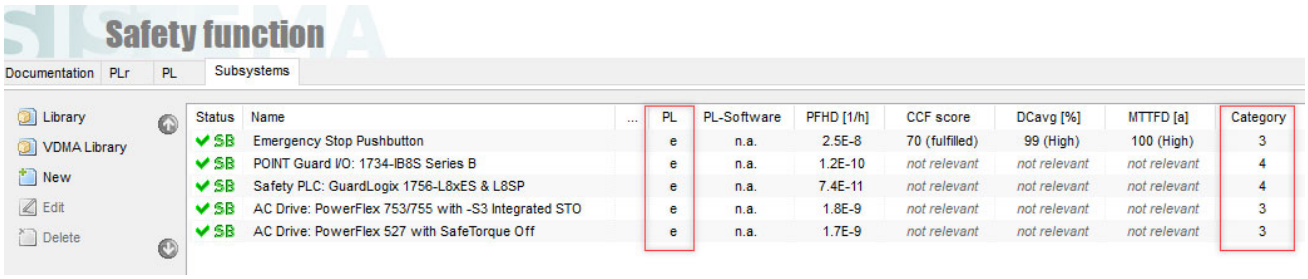
The E-stop function is a complementary protective measure that is intended to be used with other safeguarding measures and protective devices to reduce risk sufficiently. The emergency stop function shall be designed not to impair the effectiveness of the other protective devices or safety functions. Per EN ISO 13849-2 2012, Annex D, for emergency stop devices in accordance with IEC 60947-5-5, a fault exclusion for mechanical aspects is allowed up to PLe if the maximum number of operations is considered. However, the actual number of operations (NOP) is used for the purposes of the MTTFd calculation in this document. Subsystem 2 is included in each safety function to make clear that while the E-stops have a single mechanical actuator, a fault exclusion is allowed. The fault exclusion is assigned a PLe so that it does not unnecessarily affect the calculations.

This safety function includes the following subsystems:

- Emergency stop push buttons
  - Cat. 3 / PLd
- POINT Guard I/O: 1734-IB8S Series B
  - Cat. 4 / PLe
- Safety controller: GuardLogix 1756-L8xES and 1756-L8SP
  - Cat. 4 / PLe
- PowerFlex 755 with 20-750-S3 - integrated STO using standard I/O
  - Cat. 3 / PLe
- PowerFlex 527 - integrated STO using integrated motion on the EtherNet/IP network and PowerFlex 525/PowerFlex 527 Add-On Instruction
  - Cat. 3 / PLe

Figure 55 shows the multi-motor E-stop safety function subsystem as modeled in the SISTEMA file example and assumes the use of a specific safety controller. If you use another controller, you must redo the calculations with the controller you chose.

Figure 55 - Multi-motor E-stop using Integrated Safety Cat. 3 – SISTEMA Subsystems



Functional Safety Data Required for Determining the PL of Electromechanical Devices

The CCF value is generated by using the scoring process that is outlined in Annex F of ISO 13849-1. The complete CCF scoring process must be performed when implementing an application. A minimum score of 65 must be achieved. The safety starter units have a CCF greater than 65. See SISTEMA file for details.

Push buttons are electromechanical devices. The functional safety data that is required for PL calculation includes the following:

- Mean Time to Failure, dangerous (MTTFd) – Required for Cat. 1 circuits and up
- Diagnostic Coverage (DCavg) - Required for Cat. 2 circuits and up
- Common Cause Failure (CCF) - Required for Cat. 2 circuits and up

The functional safety evaluations of the electromechanical devices include the following:

- How frequently they are operated – Required for Cat. B circuits and up
- Whether they are effectively monitored for faults - Required for Cat. 2 circuits and up
- Whether they are properly specified and installed - Required for Cat. B circuits and up

SISTEMA calculates the MTTFd by using B10d data that are provided for the E-stop push buttons along with the estimated frequency of use, entered during the creation of the SISTEMA project. Download the SISTEMA file for this example to see the maximum frequency operation for each subsystem.

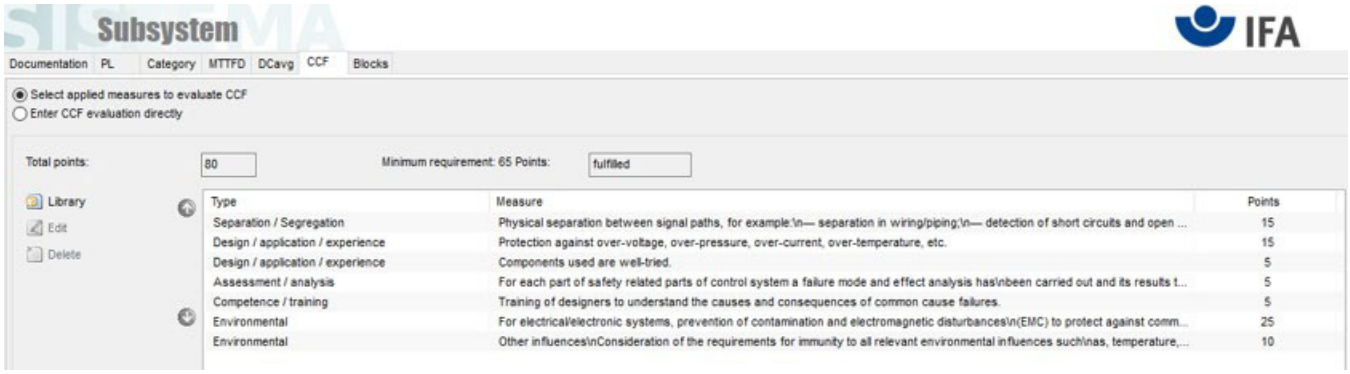
For details on how to download the SISTEMA files see Access Components of the Safety Function on page 7.

The DCavg (60%) for the E-stop was entered manually to consider that the E-stops are connected in series.
Masking, due to series connection, reduces the ability of the system to detect faults.

The CCF value is generated by using the scoring process that is outlined in Annex F of ISO 13849-1. The complete CCF scoring process must be performed when implementing an application. A minimum score of 65 must be achieved. See SISTEMA file for details.

Figure 56 shows the CCF measures assumed in the design of the safety function.

Figure 56 - CCF measures assumed (Multi-motor E-stop using Integrated Safety Cat. 3)



Verification and Validation Plan

Verification and validation play important roles in the avoidance of faults throughout the safety system design and development process. ISO 13849-2 sets the requirements for verification and validation. The standard calls for a documented plan to confirm that all safety functional requirements have been met.

Verification is an analysis of the resulting safety control system. The PL of the safety control system is calculated to confirm that the system meets the PLr specified. The SISTEMA software is typically used to perform the calculations and assist with satisfying the requirements of ISO 13849-1.

Validation is a functional test of the safety control system to demonstrate that the system meets the specified requirements of the safety function. The safety control system is tested to confirm that all safety-related outputs respond appropriately to their corresponding safety-related inputs. The functional test includes normal operating conditions and potential fault injection of failure modes. A checklist is typically used to document the validation of the safety control system.

Before validating the GuardLogix safety system, confirm that the safety system and safety application program are designed in accordance with the controller safety reference manuals that are listed in Additional Resources on page 107, and the GuardLogix Safety Application Instruction Set Reference Manual, publication 1756-RM095.

A validation checklist is available for download. See Access Components of the Safety Function on page 7.

Notes:

Quick Reference - Functional Safety Ratings

The functional safety rating of the subsystems listed in the tables is suitable for use in hardwired or integrated safety applications up to and including the safety integrity level (SIL), claim limit (CL), and Performance Level (PL) safety levels listed in the table.

The following functional safety rating tables are shown in Appendix A:

Subsystems with PowerFlex®
CENTERLINE® MCC Subsystems with PowerFlex® 520-Series Drives
CENTERLINE MCC Subsystems with PowerFlex 750-Series Drives
Direct-on-line (DOL) Subsystems
2500 CENTERLINE MCC DOL Subsystems - Category 1
2500 CENTERLINE MCC DOL Subsystems - Category 2
2500 CENTERLINE MCC DOL Subsystems - Category 3
2500 CENTERLINE MCC DOL Subsystems with GSR-DI Relay - Category 3
2500 CENTERLINE MCC DOL Subsystems with MSR127TP Relay - Category 3
Direct-on-line Reversing (DOLR) Subsystems
2500 CENTERLINE MCC DOLR Subsystems - Category 1
2500 CENTERLINE MCC DOLR Subsystems - Category 2
2500 CENTERLINE MCC DOLR Subsystems - Category 3
2500 CENTERLINE MCC DOLR Subsystems with GSR-DI and 700-HPS - Category 3
2500 CENTERLINE MCC DOLR Subsystems with MSR127TP-Category 3

Full-voltage Non-reversing (FVNR) Subsystems
2100 CENTERLINE MCC FVNR Subsystems - Category 1
2100 CENTERLINE MCC FVNR Subsystems - Category 3
2100 CENTERLINE MCC FVNR Subsystems with MSR127TP - Category 3
2100 CENTERLINE MCC FVNR Subsystems with MSR131RTP - Category 3
Full-voltage Reversing (FVR) Subsystems
2100 CENTERLINE MCC FVR Subsystems - Category 1
2100 CENTERLINE MCC FVR Subsystems - Category 3
2100 CENTERLINE MCC FVR Subsystems with MSR127TP - Category 3
2100 CENTERLINE MCC FVR Subsystems with MSR131RTP - Category 3
Safety Distribution Subsystems
2100 CENTERLINE MCC Safety Distribution Subsystems
2500 CENTERLINE MCC Safety Distribution Subsystems
Safety Subsystems
Multiple Motors E-stop Safety Functions Examples using CENTERLINE MCC Subsystems

Subsystems with PowerFlex

Table 9 - CENTERLINE® MCC Subsystems with PowerFlex® 520-Series Drives

SISTEMA Identifier	SISTEMA Description (1)	HFT per IEC 62061: 2005	Claim Limit (CL) up to and including:			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
2100_PF525_MSR138DP	2100 PowerFlex 525 with MSR138DP safety monitoring relay-hardwired STO - stop category 0	HFT 1	SIL CL 2	PLd	Cat. 3	0
2500_PF525_GSRDI	2500 PowerFlex 525 with GSR-DI safety monitoring relay - hardwired STO - stop category 0					
2x00_PF525_MSR138DP_TD	2x00 PowerFlex 525 with MSR138DP safety monitoring relay using time-delayed outputs - hardwired STO - stop category 1	HFT 1	SIL CL 2	PLd	Cat. 3	1
2500_PF525_GSRDI_TD	2500 PowerFlex 525 with GSR-DI and GSR-EMD safety monitoring relay using time-delayed outputs - hardwired STO - stop category 1					
2x00_PF525_S0_MSR127	PowerFlex 525 with MSR127 Safety Monitoring Relay – hardwired STO – stop category 0	HFT 1	SIL CL 3	PLe	Cat. 3	1
2x00_PF525	PowerFlex 525 - hardwired STO (shielded cable to terminals)	HFT 1	SIL CL 2	PLd	Cat. 3	0/1
2x00_PF527	PowerFlex 527 - integrated STO (Integrated Motion on EtherNet/IP™ networks)	HFT 1	SIL CL 3	PLe	Cat. 3	0/1

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).

Table 10 - CENTERLINE MCC Subsystems with PowerFlex 750-Series Drives

SISTEMA Identifier	SISTEMA Description (1)	HFT per IEC 62061: 2005	CL			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			up to and including:			
2100_PF750_S0_MSR138DP	2100 PowerFlex 750-series Frame 1...7 with 20-750-S and MSR138DP safety monitoring relay - hardwired STO - stop category 0	HFT 1	SIL CL 3	PLe	Cat. 3	0
2500_PF750_S0_GSRDI	2500 PowerFlex 750-series Frame 1...7 with 20-750-S and GSR-DI safety monitoring relay - hardwired STO - stop category 0					
2x00_PF750_S0_MSR138DP_TD	2x00 PowerFlex 750-series Frames 1...7 with 20-750-S and MSR138DP safety monitoring relay using time-delayed outputs - hardwired STO - stop category 1	HFT 1	SIL CL 2	PLd	Cat. 3	1
2500_PF750_S0_GSRDI_TD	2500 PowerFlex 750-series Frames 1...7 with 20-750-S, GSR-DI and GSR-EMD safety monitoring relays using time-delayed outputs - hardwired STO - stop category 1	HFT 1	SIL CL 3	PLe	Cat. 3	1
2x00_PF750_S0	PowerFlex 750-series Frame 1...7 with 20-750-S - hardwired STO (shielded cable to terminals)					0/1
2x00_PF750_S0_MSR127	PowerFlex 750-series Frames 1...7 with MSR127 safety monitoring relay – hardwired STO – stop category 0					1
2x00_PF750_S1_PTON	PowerFlex 750-series Frames 1...7 with 20-750-S1 - hardwired safe speed monitoring - dual encoder and pulse test ON	HFT 1	SIL CL 3	PLe	Cat. 4	0/1
2x00_PF750_S1_PTOFF	PowerFlex 750-series Frames 1...7 with 20-750-S1 - hardwired safe speed monitoring - dual encoder and pulse test OFF	HFT 1	SIL CL 2	PLd	Cat. 3	
2x00_PF750_S3	PowerFlex 755 Frames 1...7 with 20-750-S3 - integrated STO	HFT 1	SIL CL 3	PLe	Cat. 3	
2x00_PF750_S4	PowerFlex 755 Frames 1...7 with 20-750-S4 - integrated STO and timed SS1	HFT 1	SIL CL 3	PLe	Cat. 4	

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).

Direct-on-line (DOL) Subsystems

Table 11 - 2500 CENTERLINE MCC DOL Subsystems - Category 1

SISTEMA Identifier	SISTEMA Description (1)	HFT per IEC 62061: 2005	Claim Limit (CL)			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			up to and including:			
2500_DOL_Cat1_100SC09C97_ with 700HPS	2500 DOL starter category 1 with 1 x Bulletin 100S-C09 to C97 contactor at AC3 and 1 x interposing safety relay (700-HPS)	HFT 0	SIL CL 1 (2)	PLc (2)	Cat. 1	0
2500_DOL_Cat1_100SE116E370_ with 700HPS	2500 DOL starter category 1 with 1 x Bulletin 100S-E116 to E370 at AC3 at AC3 and 1 x interposing safety relay (700-HPS)					
2500_DOL_Cat1_100SC09C97	2500 DOL starter category 1 without interposing relay using Bulletin 100S-C09 to C97 at AC3					
2500_DOL_Cat1_100SE116E370	2500 DOL starter category 1 without interposing relay using Bulletin 100S-E116 to E370 at AC3					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).
(2) The number of operations effect Claim Limits (see SISTEMA files).

Table 12 - 2500 CENTERLINE MCC DOL Subsystems - Category 2

SISTEMA Identifier	SISTEMA Description (1)	HFT per IEC 62061: 2005	CL			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			up to and including:			
2500_DOL_Cat2_100SC09C97_ MSR138DP	2500 DOL starter category 2 with 2 x Bulletin 100S-C09 to C97 contactor at AC3 and 1 x Minotaur™ Safety Monitoring Relay (MSR 138 DP)	HFT 0	SIL CL 2 (2)	PLd (2)	Cat. 2	0
2500_DOL_Cat2_100E116E370_ MSR138DP	2500 DOL starter category 2 with 2 x Bulletin 100-E116 to E370 at AC3 and 1 x Minotaur Safety Monitoring Relay (MSR 138 DP)					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).
(2) Depends upon the number of operations.

Table 13 - 2500 CENTERLINE MCC DOL Subsystems - Category 3

SISTEMA Identifier	SISTEMA Description [1]	HFT per IEC 62061: 2005	CL			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			up to and including:			
2500_DOL_Cat3_100SC09C97_ with 700HPS	2500 DOL starter category 3 with 2 x Bulletin 100S-C09 to C97 contactor at AC3 and 2 x interposing safety relay (700-HPS)	HFT 1	SIL CL 3 [2] [3]	PLe [2] [3]	Cat. 3 [3]	0
2500_DOL_Cat3_100SE116E305_ with 700HPS	2500 DOL starter category 3 with 2 x Bulletin 100S-E116 to E305 at AC3 and 2 x interposing safety relay (700-HPS)					
2500_DOL_Cat3_100SC09C97	2500 DOL starter category 3 without interposing relay using 2 x Bulletin 100S-C09 to C97 at AC3					
2500_DOL_Cat3_100SE116E305	2500 DOL starter category 3 without interposing relay using 2 x Bulletin 100S-E116 to E305 at AC3					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).
(2) Depends on the number of operations.
(3) For use in safety-related subsystems up to and including SIL 3 / PLe / Cat. 3 with safety logic monitoring unit.

Table 14 - 2500 CENTERLINE MCC DOL Subsystems with GSR-DI Relay - Category 3

SISTEMA Identifier	SISTEMA Description [1]	HFT per IEC 62061: 2005	CL			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			up to and including:			
2500_DOL_Cat3_100SC09C97_GSRDI	2500 DOL starter category 3 with 2 x Bulletin 100S-C09 to C97 at AC3 and GSR-DI relay	HFT 1	SIL CL 3 [2]	PLe [2]	Cat. 3	0
2500_DOL_Cat3_100SE116E305_GSRDI	2500 DOL starter category 3 with 2 x Bulletin 100S-E116 to E305 at AC3 and GSR-DI relay					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).
(2) Depends on the number of operations.

Table 15 - 2500 CENTERLINE MCC DOL Subsystems with MSR127TP Relay - Category 3

SISTEMA Identifier	SISTEMA Description [1]	HFT per IEC 62061: 2005	CL			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			up to and including:			
2500_DOL_Cat3_100SC09C97_MSR127TP	2500 DOL starter category 3 with 2 x Bulletin 100S-C09 to C97 at AC3 and MSR127TP relay	HFT 1	SIL 3 [2]	PLe [2]	Cat. 3	0
2500_DOL_Cat3_100SE116E305_MSR127TP	2500 DOL starter category 3 with 2 x Bulletin 100S-E116 to E305 at AC3 and MSR127TP relay					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).
(2) Depends on the number of operations.

Direct-on-line Reversing (DOLR) Subsystems

Table 16 - 2500 CENTERLINE MCC DOLR Subsystems - Category 1

SISTEMA Identifier	SISTEMA Description [1]	HFT per IEC 62061: 2005	CL			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			Up to and including			
2500_DOLR_Cat1_100SC09C97_ with 700HPS	2500 DOLR starter category 1 with 2 x Bulletin 100S-C09 to C97 contactor at AC3 and 1 x interposing safety relay (700-HPS)	HFT 0	SIL CL 1 [2]	PLc [2]	Cat. 1	0
2500_DOLR_Cat1_100E116E370_ with 700HPS	2500 DOLR Starter category 1 with 2 x Bulletin 100-E116 to E370 at AC3 and 1 x interposing safety relay (700-HPS)					
2500_DOLR_Cat1_100SC09C97	2500 DOLR starter category 1 without interposing relay using 2 x Bulletin 100S-C09 to C97 at AC3					
2500_DOLR_Cat1_100E116E370	2500 DOLR starter category 1 without interposing relay using 2 x Bulletin 100-E116 to E370 at AC3					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).
(2) Depends on the number of operations.

Table 17 - 2500 CENTERLINE MCC DOLR Subsystems - Category 2

SISTEMA Identifier	SISTEMA Description [1]	HFT per IEC 62061: 2005	CL			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			Up to and including			
2500_DOLR_Cat1_100E116E305_ MSR138DP	2500 DOLR Starter category 1 with 2 x Bulletin 100-E116 to E305 at AC3 and 1 x Minotaur Safety Monitoring Relay (MSR 138 DP)	HFT 0	SIL CL 2 [2]	PLd [2]	Cat. 2	0
2500_DOLR_Cat1_100SC09C97_ MSR138DP	2500 DOLR starter category 1 with 2 x Bulletin 100S-C09 to C97 contactor at AC3 and 1 x Minotaur Safety Monitoring Relay (MSR 138 DP)					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).
(2) Depends on the number of operations.

Table 18 - 2500 CENTERLINE MCC DOLR Subsystems - Category 3

SISTEMA Identifier	SISTEMA Description [1]	HFT per IEC 62061: 2005	CL			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			Up to and including			
2500_DOLR_Cat3_100SC09C97_ with 700HPS	2500 DOLR starter category 3 with 1 x Bulletin 100S-C09 to C97 contactor at AC3 and 2 x interposing safety relay (700-HPS)	HFT 1	SIL CL 3 [2] [3]	PLe [2] [3]	Cat. 3 [3]	0
2500_DOLR_Cat3_100SE116E305_ with 700HPS	2500 DOLR starter category 3 with 2 x Bulletin 100S-E116 to E305 at AC3 and 2 x interposing safety relay (700-HPS)					
2500_DOLR_Cat3_100SC09C97	2500 DOLR starter category 3 without interposing relay using 3 x Bulletin 100S-C09 to C97 at AC3					
2500_DOLR_Cat3_100SE116E305	2500 DOLR starter category 3 without interposing relay using 1 x Bulletin 100S-E116 to E305 at AC3					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).
(2) Depends on the number of operations.
(3) For use in safety-related subsystems up to and including SIL 3 / PLe / Cat. 3 with safety logic monitoring unit.

Table 19 - 2500 CENTERLINE MCC DOLR Subsystems with GSR-DI and 700-HPS - Category 3

SISTEMA Identifier	SISTEMA Description [1]	HFT per IEC 62061: 2005	Claim Limit			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			Up to and including			
2500_DOLR_Cat3_100SC09C97_ GSRDI700HPS	2500 DOLR starter category 3 with 3 x Bulletin 100S-C09 to C97 at AC3, GSR-DI and 700-HPS relay	HFT 1	SIL CL 3 [2]	PLe [2]	Cat. 3	0
2500_DOLR_Cat3_100SE116E305_ GSRDI700HPS	2500 DOLR starter category 3 with 1 x Bulletin 100S-E116 to E305 at AC3, GSR-DI, and 700-HPS relay					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93)
(2) Depends on the number of operations.

Table 20 - 2500 CENTERLINE MCC DOLR Subsystems with MSR127TP-Category 3

SISTEMA Identifier	SISTEMA Description (1)	HFT per IEC 62061: 2005	Claim Limit			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			Up to and including			
2500_DOLR_Cat3_100SC09C97_MSR127TP	2500 DOLR starter category 3 with 3 x Bulletin 100S-C09 to C97 at AC3 and MSR127TP relay	HFT 1	SIL CL 3 (2)	PLe (2)	Cat. 3	0
2500_DOLR_Cat3_100SE116E05_MSR127TP	2500 DOLR starter category 3 with 1 x Bulletin 100S-E116 to E305 at AC3 and MSR127TP relay					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93)
(2) Depends on the number of operations.

Full-voltage Non-reversing (FVNR) Subsystems

Table 21 - 2100 CENTERLINE MCC FVNR Subsystems - Category 1

SISTEMA Identifier	SISTEMA Description (1)	HFT per IEC 62061: 2005	Claim Limit			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			up to and including:			
2100_FVNR_Cat1_B500_Size03_ with 700HPS	2100 FVNR starter category 1 with 1 x Bulletin 500 contactor NEMA size 0...3 at AC3 and 1 x interposing safety relay (700-HPS)	HFT 0	SIL CL 1 (2)	PLc (2)	Cat. 1	0
2100_FVNR_Cat1_B500_Size4_ with 700HPS	2100 FVNR starter category 1 with 1 x Bulletin 500 contactor NEMA size 4 at AC3 and 1 x interposing safety relay (700-HPS)					
2100_FVNR_Cat1_B500_ Size03	2100 FVNR starter category 1 without interposing relays using Bulletin 500 NEMA size 0...3 at AC3					
2100_FVNR_Cat1_B500_Size4	2100 FVNR starter category 1 without interposing relays using Bulletin 500 NEMA size 4 at AC3					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).
(2) The number of operations effect Claim Limits (see SISTEMA files).

Table 22 - 2100 CENTERLINE MCC FVNR Subsystems - Category 3

SISTEMA Identifier	SISTEMA Description (1)	HFT per IEC 62061: 2005	Claim Limit (CL)			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			up to and including:			
2100_FVNR_Cat3_B300_Size03_ with 700HPS	2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) and 2 x interposing safety relay (700-HPS)	HFT 1	SIL CL 3 (2) (3)	PLe (2) (3)	Cat. 3 (3)	0
2100_FVNR_Cat3_B300_Size4_ with 700HPS	2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 4 at AC3 and 2 x interposing safety relay (700-HPS)					
2100_FVxR_Cat3_B500B100S_ Size03_with 700HPS	2100 FVNR or FVR category 3 with 2 x 100S/104S-C09 to C97 at AC3 and 2 x interposing safety relay (700-HPS). Bulletin 500 NEMA size 0...3 contactors are not part of the safety circuit. (4)					
2100_FVxR_Cat3_B500B300S_ Size4_with 700HPS	2100 FVNR or FVR category 3 with 2 x 300S at AC3 and 2 x interposing safety relay (700-HPS). Bulletin 500 NEMA size 4 contactors are not part of the safety circuit. (4)					
2100_FVNR_Cat3_B300_Size03	2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) without interposing relays.					
2100_FVNR_Cat3_B300_Size4	2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 4 at AC3 without interposing relays. (4)					
2100_FVxR_Cat3_B500B100S_ Size03	2100 FVNR or FVR category 3 with 2 x 100S/104S-C09 to C97 at AC3 without interposing relays. Bulletin 500 NEMA size 0...3 contactors are not part of the safety circuit. (4)					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).
(2) The number of operations effect Claim Limits (see SISTEMA files).
(3) For use in safety-related subsystems up to and including SIL 3 / PLe / Cat. 3 with Safety Logic Monitoring Unit.
(4) Since the starter includes both Bulletin 500 and Bulletin 100S, it requires at least a 0.5 space factor more when compared with an equivalent starter using Bulletin 300 contactors.

Table 23 - 2100 CENTERLINE MCC FVNR Subsystems with MSR127TP - Category 3

SISTEMA Identifier	SISTEMA Description [1]	HFT per IEC 62061: 2005	CL			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			up to and including:			
2100_FVNR_Cat3_B300_Size03_MSR127TP	2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) with MSR127TP relay.	HFT 1	SIL CL 3 [2]	PLe [2]	Cat. 3	0
2100_FVNR_Cat3_B300_Size4_MSR127TP	2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 4 at AC3 with MSR127TP relay.					
2100_FVxR_Cat3_B500B100S_Size03_MSR127TP [3]	2100 FVNR or FVR category 3 with 2 x 100S/104S-C09 to C97 at AC3 with MSR127TP relay. Bulletin 500 NEMA size 0...3 contactors are not part of the safety circuit.					
2100_FVxR_Cat3_B500B300S_Size4_MSR127TP [3]	2100 FVNR or FVR category 3 with 2 x 300S at AC3 with MSR127TP relay. Bulletin 500 NEMA size 4 contactors are not part of the safety circuit.					

(1) The SISTEMA safety function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).
(2) The number of operations effects claim limits; see SISTEMA files.
(3) Since the starter includes both Bulletin 500 and Bulletin 100S, it requires at least more 0.5 space factor when compared with an equivalent starter using only Bulletin 300 contactors.

Table 24 - 2100 CENTERLINE MCC FVNR Subsystems with MSR131RTP - Category 3

SISTEMA Identifier	SISTEMA Description [1]	HFT per IEC 62061: 2005	Claim Limit (CL)			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			Up to and including			
2100_FVNR_Cat3_B300_Size03_MSR131RTP	2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) with MSR131RTP relay.	HFT 1	SIL CL 3 [2]	PLe [2]	Cat. 3	0
2100_FVNR_Cat3_B300_Size4_MSR131RTP	2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 4 at AC3 with MSR131RTP relay.					
2100_FVxR_Cat3_B500B100S_Size03_MSR131RTP [3]	2100 FVNR or FVR category 3 with 2 x 100S/104S-C09 to C97 at AC3 with MSR131RTP relay. Bulletin 500 NEMA size 0...3 contactors are not part of the safety circuit.					
2100_FVxR_Cat3_B500B300S_Size4_MSR131RTP [3]	2100 FVNR or FVR category 3 with 2 x 300S at AC3 with MSR131RTP relay. Bulletin 500 NEMA size 4 contactors are not part of the safety circuit.					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93)
(2) The number of operations effect Claim Limits (see SISTEMA files).
(3) Since the starter includes both Bulletin 500 and Bulletin 100S, it requires at least a 0.5 space factor more when compared with an equivalent starter using Bulletin 300 contactors.

Full-voltage Reversing (FVR) Subsystems

Table 25 - 2100 CENTERLINE MCC FVR Subsystems - Category 1

SISTEMA Identifier	SISTEMA Description [1]	HFT per IEC 62061: 2005	Claim Limit (CL)			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			Up to and including			
2100_FVR_Cat1_B500_Size03_with 700HPS	2100 FVR starter category 1 with 2 x Bulletin 500 contactor NEMA size 0...3 at AC3 and 1 x interposing safety relay (700-HPS)	HFT 0	SIL CL 1 [2]	PLc [2]	Cat. 3	0
2100_FVR_Cat1_B500_Size4_with 700HPS	2100 FVR starter category 1 with 2 x Bulletin 500 contactor NEMA size 4 at AC3 and 1 x interposing safety relay (700-HPS)					
2100_FVR_Cat1_B500_Size03	2100 FVR starter category 1 without interposing relays using 2 x Bulletin 500 NEMA size 0...3 at AC3					
2100_FVR_Cat1_B500_Size4	2100 FVR starter category 1 without interposing relays using 2 x Bulletin 500 NEMA size 4 at AC3					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93)
(2) Depends upon the number of operations.

Table 26 - 2100 CENTERLINE MCC FVR Subsystems - Category 3

SISTEMA Identifier	SISTEMA Description [1]	HFT per IEC 62061: 2005	Claim Limit (CL)			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			Up to and including			
2100_FVR_Cat3_B300_Size03_with 700HPS	2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) and 2 x interposing safety relay (700-HPS)	HFT 0	SIL CL 3 (2) (3)	PLe (2) (3)	Cat. 3 (3)	0
2100_FVR_Cat3_B300_Size4_with 700HPS	2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 4 at AC3 and 2 x interposing safety relay (700-HPS)					
2100_FVxR_Cat3_B500B100S_Size03_with 700HPS [4]	2100 FVNR or FVR category 3 with 2 x 100S/104S-C09 to C97 at AC3 and 2 x interposing safety relay (700-HPS). Bulletin 500 NEMA size 0...3 contactors are not part of the safety circuit.					
2100_FVxR_Cat3_B500B300S_Size4_with 700HPS [4]	2100 FVR or FVR category 3 with 2 x 300S at AC3 and 2 x interposing safety relay (700-HPS). Bulletin 500 NEMA size 4 contactors are not part of the safety circuit.					
2100_FVR_Cat3_B300_Size03	2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) without interposing relays					
2100_FVR_Cat3_B300_Size4	2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 4 at AC3 without interposing relays					
2100_FVxR_Cat3_B500B100S_Size03 [4]	2100 FVNR or FVR category 3 with 2 x 100S/104S-C09 to C97 at AC3 without interposing relays. Bulletin 500 NEMA size 0...3 contactors are not part of the safety circuit.					
2100_FVxR_Cat3_B500B300S_Size4 [4]	2100 FVNR or FVR category 3 with 2 x 300S at AC3 without interposing relays. Bulletin 500 NEMA size 4 contactors are not part of the safety circuit.					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93)
(2) The number of operations effects claim limit; see SISTEMA files.
(3) For use in safety-related subsystems up to and including SIL 3 / PLe / Cat 3 with safety logic monitoring unit.
(4) Since the starter includes both Bulletin 500 and Bulletin 100S, it requires at least more 0.5 space factor when compared with an equivalent starter using only Bulletin 300 contactors.

Table 27 - 2100 CENTERLINE MCC FVR Subsystems with MSR127TP - Category 3

SISTEMA Identifier	SISTEMA Description [1]	HFT per IEC 62061: 2005	Claim Limit (CL)			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			Up to and including			
2100_FVR_Cat3_B300_Size03_MSR127TP	2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) with MSR127TP relay	HFT 1	SIL CL 3 [2]	PLe [2]	Cat. 3	0
2100_FVR_Cat3_B300_Size4_ MSR127TP	2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 4 at AC3 with MSR127TP relay					
2100_FVxR_Cat3_B500B100S_Size03_ MSR127TP [3]	2100 FVNR or FVR category 3 with 2 x 100S/104S-C09 to C97 at AC3 with MSR127TP relay. Bulletin 500 NEMA size 0...3 contactors are not part of the safety circuit.					
2100_FVxR_Cat3_B500B300S Size4_ MSR127TP [3]	2100 FVNR or FVR category 3 with 2 x 300S at AC3 with MSR127TP relay. Bulletin 500 NEMA size 4 contactors are not part of the safety circuit.					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).
(2) The number of operations effects claim limits; see SISTEMA files.
(3) Since the starter includes both Bulletin 500 and Bulletin 100S, it requires at least a 0.5 space factor more when compared with equivalent starter using only Bulletin 300 contactors.

Table 28 - 2100 CENTERLINE MCC FVR Subsystems with MSR131RTP - Category 3

SISTEMA Identifier	SISTEMA Description [1]	HFT per IEC 62061: 2005	CL			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			Up to and including			
2100_FVR_Cat3_B300_Size03_MSR131RTP	2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) with MSR131RTP relay.	HFT 1	SIL CL 3 [2]	PLe [2]	Cat. 3	0
2100_FVR_Cat3_B300_Size4_MSR131RTP	2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 4 at AC3 with MSR131RTP relay.					
2100_FVxR_Cat3_B500B100S_Size03_MSR131RTP [3]	2100 FVNR or FVR category 3 with 2 x 100S/104S-C09 to C97 at AC3 with MSR131RTP relay. Bulletin 500 NEMA size 0...3 contactors are not part of the safety circuit.					
2100_FVxR_Cat3_B500B300S_Size4_MSR131RTP [3]	2100 FVNR or FVR category 3 with 2 x 300S at AC3 with MSR131RTP relay. Bulletin 500 NEMA size 4 contactors are not part of the safety circuit.					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).
(2) The number of operations effects claim limits; see SISTEMA files.
(3) Since the starter includes both Bulletin 500 and Bulletin 100S, it requires at least a 0.5 space factor more when compared with an equivalent starter using only Bulletin 300 contactors.

Safety Distribution Subsystems

Table 29 - 2100 CENTERLINE MCC Safety Distribution Subsystems

SISTEMA Identifier	SISTEMA Description (1)	HFT per IEC 62061: 2005	CL			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			Up to and including			
2100_Cat1_SRDS	2100 category 1 safety relay distribution subsystem (stop category 0) - C1_SRDS	HFT 0	SIL CL 1	PLc	Cat. 1	0
2100_Cat3_SMRDS_ with 700HPS	2100 category 3 safety monitoring relay distribution subsystem using two immediate safety outputs (stop category 0) with interposing relays (2 x 700 HPS per safety output) - C3_SMRDS_WIR.	HFT 1	SIL CL 3	PLe	Cat. 4	0
2100_Cat3_SMRDS	2100 category 3 safety monitoring relay distribution subsystem using two immediate safety outputs (stop category 0) without interposing relays (No 700 HPS, safety outputs go directly to MCUs) - C3_SMRDS.					
2100_Cat3_SMRDSTD_ with 700HPS	2100 category 3 safety monitoring relay distribution subsystem using two time-delayed safety outputs (stop category 1) with interposing relays (1 x 700 HPS per safety output) - C3_SMRDSTD_WIR.	HFT 1	SIL CL 2	PLd	Cat. 3	1
2100_Cat3_SMRDSTD	2100 category 3 safety monitoring relay distribution subsystem using two time-delayed safety outputs (stop category 1) without interposing relays (No 700 HPS, safety outputs go directly to MCUs) - C3_SMRDSTD.					
2100_Cat3_SRIODS_ with 700HPS	2100 category 3 safety remote I/O distribution subsystem (stop category 0/1) with interposing relays - 1 x 1734-OB8S (one 700-HPS per safety output) and 1 x 1734-IB8S (auxiliary contactor feedback in series, reset signal, E-stop string channel) - C3SRIODS_WIR.	HFT 1	SIL CL 3	PLe	Cat. 4	0/1
2100_Cat3_SRIODS	2100 category 3 safety remote I/O distribution subsystem (stop category 0/1) without interposing relays - 1 x 1734-OB8S (No 700-HPS) and 1 x 1734-IB8S (auxiliary contactor feedback in series, reset signal, E-stop string channel) - C3SRIODS.					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).

Table 30 - 2500 CENTERLINE MCC Safety Distribution Subsystems

SISTEMA Identifier	SISTEMA Description (1)	HFT per IEC 62061: 2005	CL			Stop Cat. Capability per IEC 60204-1: 2018
			SIL per IEC 62061: 2005	PL per ISO 13849-1: 2015	Cat. per ISO 13849-1: 2015	
			Up to and including			
2500_Cat1_SRDS	2500 cat 1 safety relay distribution subsystem (stop category 0) - C1_SRDS	HFT 0	SIL 1	PLc	Cat. 1	0
2500_Cat3_SMRDS_ with 700HPS	2500 category 3 safety monitoring relay distribution subsystem using two immediate safety outputs (stop category 0) with interposing relays (2 x 700 HPS per safety output) - C3_SMRDS_WIR.	HFT 1	SIL 3	PLe	Cat. 4	0
2500_Cat3_SMRDS	2500 cat 3 safety monitoring relay distribution subsystem using two immediate safety outputs (stop category 0) without interposing relays (No 700 HPS, safety outputs go directly to MCUs) - C3_SMRDS					
2500_Cat3_SMRDSTD_ with 700HPS	2500 category 3 safety monitoring relay distribution subsystem using two time-delayed safety outputs (stop category 1) with interposing relays (1 x 700 HPS per safety output) - C3_SMRDSTD_WIR	HFT 1	SIL 3	PLe	Cat. 3	1
2500_Cat3_SMRDSTD	2500 category 3 safety monitoring relay distribution subsystem using two immediate safety outputs (stop category 0) without interposing relays (No 700 HPS, safety outputs go directly to MCUs) - C3_SMRDSTD					
2500_Cat3_SRIODS_ with 700HPS	2500 category 3 safety remote I/O distribution subsystem (stop category 0/1) with interposing relays - 1 x 1734-OB8S (one 700-HPS per safety output) and 1 x 1734-IB8S (auxiliary contactor feedback in series, reset signal, E-stop string channel) - C3SRIODS_WIR	HFT 1	SIL 3	PLe	Cat. 4	0/1
2500_Cat3_SRIODS	2500 category 3 safety remote I/O distribution subsystem (stop category 0/1) without interposing relays - 1 x 1734-OB8S (No 700-HPS) and 1 x 1734-IB8S (auxiliary contactor feedback in series, reset signal, E-stop string channel) - C3SRIODS					

(1) The SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description (see Appendix B on page 93).

Multiple Motors E-stop Safety Functions

Table 31 - Multiple Motors E-stop Safety Functions Examples using CENTERLINE MCC Subsystems

Multiple motors E-stop Safety Function Examples	HFT IEC 62061:2005	CL			Stop Cat. IEC 60204-1:2018
		SIL CL IEC 62061:2005	PL ISO 13849-1:2015	Cat. ISO 13849-1:2015	
		Up to and including			
Cat. 1 E-stop multiple motors with the following subsystems: • E-stop push button • C1_SRDS - Cat. 1 safety relay distribution subsystem (stop category 0) • PowerFlex 750 (20-750-S) - hardwired STO module • 2100 FVNR Cat. 1 with interposing relay using Bulletin 500	HFT 0	SIL 1	PL b	Cat. 1	0
Cat. 3 E-stop multiple motors with the following subsystems: • E-stop push button • C3_SMRDS_WIR - Cat. 3 safety monitoring relay distribution subsystem using immediate safety outputs (stop category 0) with interposing relays • PowerFlex 750 (20-750-S) - hardwired STO module • 2100 FVNR Cat. 3 with interposing relay using Bulletin 300	HFT 1	SIL CL 3	PLd	Cat. 3	0
Cat. 3 E-stop multiple motors with the following subsystems: • E-stop push button • Safety controller • C3SRIODS_WIR - Cat. 3 safety remote I/O distribution subsystem (stop category 0) with interposing relays. • PowerFlex 525 - hardwired STO module • 2100 FVR Cat. 3 with interposing relay using Bulletin 300					
Cat. 3 E-stop multiple motors with the following subsystems: • E-stop push button • 1734-IB8S • Safety controller • PowerFlex 750 (20-750-S3) - integrated STO module • PowerFlex 527 - integrated STO	HFT 1	SIL CL 3	PLd	Cat. 3	0/1

SISTEMA CENTERLINE File Organization

The SISTEMA (Safety Integrated Software Tool for the Evaluation of Machine Applications) tool automates calculation of the attained Performance Level (PL) from the safety-related parts of a machine control system. Data for our machine safety products is available in the form of a library file to be used with the SISTEMA calculation tool. The combination of the two saves time and provides comprehensive support for safety evaluation to (EN) ISO 13849-1 for machine and system designers. You can also download SISTEMA and the Rockwell Automation library from the SISTEMA Performance Level Calculator site.

Other manufacturers also offer product libraries files that contain the calculated Performance Levels for their products. Locked libraries of safety-related components or parts of control systems that inform relevant data (characteristic values) for the safety-related devices or subsystems are available for download and use in designing/verifying your safety system. Project files are open files that are provided by manufacturers as examples of typical subsystem or safety function configurations.

To learn more about SISTEMA software, visit the DGUV website here.

SISTEMA uses the following hierarchy:

- Project
    - Safety Function
        - Subsystem
            - Channel
                - Block

The MCC projects that are shown in this publication are configured in a similar manner:

- Project: Functional Safety CENTERLINE® MCC...
    - Safety Function: Description of the subsystem

The project container for all safety motor controller subsystems is named 'Functional Safety CENTERLINE MCC'.
The safety function level is the container for the description of the subsystems.

The following functional safety rating tables are shown in Appendix B:

Subsystems with PowerFlex® Drives
CENTERLINE MCC Subsystems with PowerFlex 520-Series Drives
CENTERLINE MCC Subsystems with PowerFlex 750-Series Drives
Direct-on-line (DOL) Subsystems
2500 CENTERLINE MCC DOL Subsystems - Category 1
2500 CENTERLINE MCC DOL Subsystems - Category 2
2500 CENTERLINE MCC DOL Subsystems - Category 3
2500 CENTERLINE MCC DOL Subsystems with GSR-DI - Category 3
2500 CENTERLINE MCC DOL Subsystems with MSR127TP Relay - Category 3
Direct-on-line Reversing (DOLR) Subsystems
2500 CENTERLINE MCC DOL Reversing Subsystems - Category 1
2500 CENTERLINE MCC DOL Reversing Subsystems - Category 2
2500 CENTERLINE MCC DOL Reversing Subsystems - Category 3
2500 CENTERLINE MCC DOL Reversing Subsystems with GSR-DI and 700-HPS - Category 3
2500 CENTERLINE MCC DOL Reversing Subsystems with MSR127TP Relay - Category 3

Full-voltage Non-reversing (FVNR) Starters
2100 CENTERLINE MCC FVNR Starter - Category 1
2100 CENTERLINE MCC FVNR Starter - Category 3
2100 CENTERLINE MCC FVNR Starter with MSR131RTP - Category 3
Full-voltage Non-reversing (FVNR) Subsystems
2100 CENTERLINE MCC FVNR Subsystems with MSR127TP - Category 3
Full-voltage Reversing Subsystems
2100 CENTERLINE MCC FVR Subsystems - Category 1
2100 CENTERLINE MCC FVR Subsystems - Category 3
2100 CENTERLINE MCC FVR Subsystems with MSR127TP - Category 3
2100 CENTERLINE MCC FVR Subsystems with MSR131RTP - Category 3
Safety Distribution Subsystems
2100 CENTERLINE MCC Safety Distribution Subsystems
2500 CENTERLINE MCC Safety Distribution Subsystems
Multiple Motors E-stop Safety Functions
Multiple Motors E-stop Safety Functions Examples using CENTERLINE MCC Subsystems

Functional Safety

The following tables list the functional safety for CENTERLINE 2100 Catalog Number (Cat. No.) and CENTERLINE 2500 Cat. No. unit designs that correspond to the SISTEMA Safety Function Container with Subsystems folder.

Subsystems with PowerFlex Drives

Table 32 - CENTERLINE MCC Subsystems with PowerFlex 520-Series Drives

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description	CENTERLINE Ordering Information
2100_PF525_MSR138DP	2100 PowerFlex 525 with MSR138DP safety monitoring relay – hardwired safety torque off (STO) – stop category 0 • AC Drive: PowerFlex 525 with STO • Monitoring safety relay: MSR138 - immediate action contact	2100: Cat. No. 216_W-14SFR1 - MSR138DP (120VAC) 2100: Cat. No. 216_W-14SFR2 - MSR138DP (24V DC)
2500_PF525_GSRDI	2500 PowerFlex 525 with GSR-DI safety monitoring relay – hardwired STO – stop category 0 • AC Drive: PowerFlex 525 with STO • Monitoring safety relay: GSR-DI	2500: Contact Rockwell Automation
2100_PF525_MSR138DP_TD	2100 PowerFlex 525 with MSR138DP safety monitoring relay using time-delayed outputs - hardwired STO – stop category 1 • AC Drive: PowerFlex 525 with STO • MSR138DP as a Subsystem using time-delayed outputs	2100: Contact Rockwell Automation MSR138DP - 120VAC and 24V DC options available
2500_PF525_GSRDI_TD	2500 PowerFlex 525 with GSR-DI and GSR-EMD safety monitoring relays using time-delayed outputs - hardwired STO – stop category 1 • AC Drive: PowerFlex 525 with STO • Monitoring safety relay: GSR-DI • Monitoring safety relay: GSR-EMD	2500: Contact Rockwell Automation
2x00_PF520_S0_MSR127	PowerFlex 525 with MSR127 Safety Monitoring Relay – hardwired STO – stop category 0 • AC Drive: PowerFlex 525 with STO • Monitoring safety relay: MSR127	2100 and 2500: Contact Rockwell Automation
2x00_PF525_	PowerFlex 525 with 20-750-S – hardwired STO (shielded cable to terminals) • AC Drive: PowerFlex 525 with STO	
2x00_PF527	PowerFlex 527 – integrated STO (Integrated Motion on EtherNet/IP™ networks) • AC Drive: PowerFlex 527 with STO	

Table 33 - CENTERLINE MCC Subsystems with PowerFlex 750-Series Drives

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description	CENTERLINE Ordering Information
2100_PF750_S0_MSR138DP	2100 PowerFlex 750-series Frame 1...7 with 20-750-S and MSR138DP safety monitoring relay - hardwired STO - stop category 0 • AC Drive: PowerFlex 753/755 with -S hardwired STO • Monitoring safety relay: MSR138 - immediate action contact	2100: Cat. No. 216_U/V-14SFR1 - MSR138DP (120V AC) 2100: Cat. No. 216_U/V-14SFR2 - MSR138DP (24V DC)
2500_PF750_S0_GSRDI	2500 PowerFlex 750-series Frames 1...7 with 20-750-S and GSR-DI safety monitoring relay - hardwired STO - stop category 0 • AC Drive: PowerFlex 753/755 with -S hardwired STO • Monitoring safety relay: GSR-DI	2500: Contact Rockwell Automation
2x00_PF750_S0_MSR138DP_TD	2x00 PowerFlex 750-series Frames 1...7 with 20-750-S and MSR138DP safety monitoring relay using time-delayed outputs - hardwired STO - stop category 1 • AC Drive: PowerFlex 753/755 with -S hardwired STO • Monitoring safety relay: MSR138 - time-delayed acting contact	2100: Contact Rockwell Automation MSR138DP - 120V AC and 24V DC options available
2500_PF750_S0_GSRDI_TD	2500 PowerFlex 750-series Frames 1...7 with 20-750-S, GSR-DI and GSR-EMD safety monitoring relays using time-delayed outputs - hardwired STO - stop category 1 • AC Drive: PowerFlex 753/755 with -S hardwired STO • Monitoring safety relay: GSR-DI • Monitoring safety relay: GSR-EMD	2500: Contact Rockwell Automation
2x00_PF750_S0	PowerFlex 750-series Frame 1...7 with 20-750-S - hardwired STO (shielded cable to terminals) • AC Drive: PowerFlex 753/755 with -S hardwired STO	2500: Contact Rockwell Automation 2100: Cat. No. 216_U/V-14SRR

Table 33 - CENTERLINE MCC Subsystems with PowerFlex 750-Series Drives (Continued)

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description	CENTERLINE Ordering Information
2x00_PF750_S0_MSR127	PowerFlex 750-series Frames 1...7 with MSR127 Safety Monitoring Relay – hardwired STO – stop category 0 • AC Drive: PowerFlex 753/755 with -S hardwired STO • Monitoring safety relay: MSR127	100 and 2500: Contact Rockwell Automation
2x00_PF750_S1_PTON	PowerFlex 750-series Frames 1...7 with 20-750-S1 - hardwired safe speed monitoring - dual encoder and pulse test ON • AC Drive: PowerFlex 753/755 with -S1 Safe Speed Monitor - dual encoder - pulse test ON	2500: Contact Rockwell Automation 2100: Cat. No. 216_U/V-14S1-14DENC1-14DA2R2
2x00_PF750_S1_PTOFF	PowerFlex 750-series Frames 1...7 with 20-750-S1 - hardwired safe speed monitoring - dual encoder and pulse test OFF • AC Drive: PowerFlex 753/755 with -S1 Safe Speed Monitor - dual encoder - pulse test OFF	2500: Contact Rockwell Automation 2100: Cat. No. 216_U/V-14S1-14DENC1-14DA2R2
2x00_PF750_S3	PowerFlex 755 Frames 1...7 with 20-750-S3 - integrated STO • AC Drive: PowerFlex 753/755 with -S3 integrated STO	100 and 2500: Contact Rockwell Automation
2x00_PF750_S4	PowerFlex 755 Frames 1...7 with 20-750-S4 - integrated STO and Timed SS1 • AC Drive: PowerFlex 755 with -S4 Drive STO/Timed SS1	100 and 2500: Contact Rockwell Automation

Direct-on-line (DOL) Subsystems

For CENTERLINE 2500 ordering information, contact Rockwell Automation.

Table 34 - 2500 CENTERLINE MCC DOL Subsystems - Category 1

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2500_DOL_Cat1_100SC09C97_with 700HPS	2500 DOL starter Cat. 1 with 1 x Bulletin 100S-C09 to C97 contactor at AC3 and 1 x interposing safety relay (700-HPS) • Channel 1 Block 1 – output contactor: 100S-C09 to C97 at AC3 • Channel 1 Block 2 – relay with positively guided contacts: 700-HPS
2500_DOL_Cat1_100SE116E370_with 700HPS	2500 DOL starter Cat. 1 with 1 x Bulletin 100S-E116 to E370 at AC3 and 1 x interposing safety relay (700-HPS) • Channel 1 Block 1 – contactors 100S-E116 to E370 at AC3 • Channel 1 Block 2 – relay with positively guided contacts: 700-HPS
2500_DOL_Cat1_100SC09C97	2500 DOL starter Cat. 1 without interposing relay using Bulletin 100S-C09 to C97 at AC3 • Channel 1 Block 1 – output contactor: 100S-C09 to C97 at AC3
2500_DOL_Cat1_100SE116E370	2500 DOL starter Cat. 1 without interposing relay using Bulletin 100S-E116 to E370 at AC3 • Channel 1 Block 1 – contactors 100S-E116 to E370 at AC3 - without electronic coil interface

Table 35 - 2500 CENTERLINE MCC DOL Subsystems - Category 2

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2500_DOL_Cat2_100SC09C97_MSR138DP	2500 DOL starter category 2 with 2 x Bulletin 100S-C09 to C97 contactor at AC3 and 1 x Minotaur™ Safety Monitoring Relay (MSR 138 DP) • Channel 1 Block 1 – Output Contactor: 100S-C09 to C97 at AC3 • Test Channel Block 1 – NC Auxiliary Contact: 100S-C09 to C97 at AC3 • Test Channel Block 2 – Circuit breaker shunt/under voltage relay (Test Output Device) • Monitoring safety relay: MSR-138 – Immediate acting contacts • Monitoring safety relay: MSR-138 – Delayed acting contacts
2500_DOL_Cat2_100SE116E370_MSR138DP	2500 DOL starter category 3 without interposing relay using 2 x Bulletin 100S-E116 to E370 at AC3 • Channel 1 Block 1 – Output Contactor: 100S-E116 to E370: 50% maximum AC3 Load • Test Channel Block 1 – NC Auxiliary Contact: 100S-E116 to E370: 50% maximum AC3 Load • Test Channel Block 2 – Circuit breaker shunt/under voltage relay (Test Output Device) • Monitoring safety relay: MSR-138 – Immediate acting contacts • Monitoring safety relay: MSR-138 – Delayed acting contacts

Table 36 - 2500 CENTERLINE MCC DOL Subsystems - Category 3

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2500_DOL_Cat3_100SC09C97_with 700HPS	2500 DOL starter category 3 with 2 x Bulletin 100S-C09 to C97 contactor at AC3 and 2 x interposing safety relay (700-HPS) • Channel 1/2 Block 1 – output contactor: 100S-C09 to C97 at AC3 • Channel 1/2 Block 2 – relay with positively guided contacts: 700-HPS
2500_DOL_Cat3_100SE116E305_with 700HPS	2500 DOL starter category 3 with 2 x Bulletin 100S-E116 to E305 at AC3 and 2 x interposing safety relay (700-HPS) • Channel 1/2 Block 1 – contactors 100S-E116 to E305 at AC3 • Channel 1/2 Block 2 – relay with positively guided contacts: 700-HPS
2500_DOL_Cat3_100SC09C97	2500 DOL starter category 3 without interposing relay using 2 x Bulletin 100S-C09 to C97 at AC3 • Channel 1/2 Block 1 – output contactor: 100S-C09 to C97 at AC3
2500_DOL_Cat3_100SE116E305	2500 DOL starter category 3 without interposing relay using 2 x Bulletin 100S-E116 to E305at AC3 • Channel 1/2 Block 1 – contactors 100S-E116 to E305 at AC3

Table 37 - 2500 CENTERLINE MCC DOL Subsystems with GSR-DI - Category 3

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2500_DOL_Cat3_100SC09C97_GSRDI	2500 DOL starter category 3 without interposing relay using 2 x Bulletin 100S-C09 to C97 at AC3 • Channel 1/2 Block 1 – output contactor: 100S-C09 to C97 at AC3 • Monitoring safety relay: GSR-DI
2500_DOL_Cat3_100SE116E305_GSRDI	2500 DOL starter category 3 without interposing relay using 2 x Bulletin 100S-E116 to E305 at AC3 • Channel 1/2 Block 1 – contactors 100S-E116 to E305 at AC3 • Monitoring safety relay: GSR-DI

Table 38 - 2500 CENTERLINE MCC DOL Subsystems with MSR127TP Relay - Category 3

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2500_DOL_Cat3_100SC09C97_MSR127	2500 DOL starter category 3 without interposing relay using 2 x Bulletin 100S-C09 to C97 at AC3 • Channel 1/2 Block 1 – output contactor: 100S-C09 to C97 at AC3 • Monitoring safety relay: MSR-127
2500_DOL_Cat3_100SE116E305_MSR127	2500 DOL starter category 3 without interposing relay using 2 x Bulletin 100S-E116 to E305 at AC3 • Channel 1/2 Block 1 – contactors 100S-E116 to E305 at AC3 • Monitoring safety relay: MSR-127

Direct-on-line (DOL) Reversing Subsystems

For CENTERLINE 2500 ordering information, contact Rockwell Automation.

Table 39 - 2500 CENTERLINE MCC DOL Reversing Subsystems - Category 1

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2500_DOLR_Cat1_100SC09C97_ with 700HPS	2500 DOLR starter category 1 with 2 x Bulletin 100S-C09 to C97 contactor at AC3 and 1 x interposing safety relay (700-HPS) • Channel 1 Block 1 – output contactor: 100S-C09 to C97 at AC3 • Channel 1 Block 2 – output contactor: 100S-C09 to C97 at AC3 • Channel 1 Block 3 – relay with positively guided contacts: 700-HPS
2500_DOLR_Cat1_100E116E370_ with 700HPS	2500 DOLR starter category 1 with 2 x Bulletin 100 E116 to E370 at AC3 and 1 x interposing safety relay (700-HPS) • Channel 1 Block 1 – output Contactor: 100S-E116 to E370: 50% maximum AC3 Load • Channel 1 Block 2 – output Contactor: 100S-E116 to E370: 50% maximum AC3 Load • Channel 1 Block 3 – relay with positively guided contacts: 700-HPS
2500_DOLR_Cat1_100SC09C97	2500 DOLR starter category 1 without interposing relay using 2 x Bulletin 100S-C09 to C97 at AC3 • Channel 1 Block 1 – output contactor: 100S-C09 to C97 at AC3 • Channel 1 Block 2 – output contactor: 100S-C09 to C97 at AC3
2500_DOLR_Cat1_100E116E370	2500 DOLR starter category 1 without interposing relay using 2 x Bulletin 100S-E116 to E370 at AC3 • Channel 1 Block 1 – output Contactor: 100S-E116 to E370: 50% maximum AC3 Load • Channel 1 Block 2 – output Contactor: 100S-E116 to E370: 50% maximum AC3 Load

Table 40 - 2500 CENTERLINE MCC DOL Reversing Subsystems - Category 2

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2500_DOLR_Cat2_100SC09C97_ MSR138DP	2500 DOLR starter category 2 with 2 x Bulletin 100S-C09 to C97 contactor at AC3 and 1 x Minotaur Safety Monitoring Relay (MSR 138 DP) • Channel 1 Block 1 – Output Contactor: 100S-C09 to C97 at AC3 • Channel 1 Block 2 – Output Contactor: 100S-C09 to C97 at AC3 • Test Channel Block 1 – NC Auxiliary Contact: 100S-C09 to C97 at AC3 • Test Channel Block 2 – Circuit breaker shunt/under voltage relay (Test Output Device) • Monitoring safety relay: MSR-138 – Immediate acting contacts • Monitoring safety relay: MSR-138 – Delayed acting contacts
2500_DOLR_Cat2_100SE116E370_ MSR138DP	2500 DOLR starter category 3 without interposing relay using 2 x Bulletin 100S-E116 to E370 at AC3 • Channel 1 Block 1 – Output Contactor: 100S-E116 to E370: 50% maximum AC3 Load • Channel 1 Block 2 – Output Contactor: 100S-E116 to E370: 50% maximum AC3 Load • Test Channel Block 1 – NC Auxiliary Contact: 100S-E116 to E370: 50% maximum AC3 Load • Test Channel Block 2 – Circuit breaker shunt/under voltage relay (Test Output Device) • Monitoring safety relay: MSR-138 – Immediate acting contacts • Monitoring safety relay: MSR-138 – Delayed acting contacts

Table 41 - 2500 CENTERLINE MCC DOL Reversing Subsystems - Category 3

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2500_DOLR_Cat3_100SC09C97_ with 700HPS	2500 DOLR starter category 3 with 3 x Bulletin 100S-C09 to C97 contactor at AC3 and 2 x interposing safety relay (700-HPS) • Channel 1 Block 1 – output contactor: 100S-C09 to C97 at AC3 • Channel 1 Block 2 – relay with positively guided contacts: 700-HPS • Channel 2 Block 1/2 – output contactor: 100S-C09 to C97 at AC3 • Channel 2 Block 3 – relay with positively guided contacts: 700-HPS
2500_DOLR_Cat3_100SE116 to E370_ with 700HPS	2500 DOLR starter category 3 with 1 x Bulletin 100S-E116 to E305 at AC3 and 2 x interposing safety relay (700-HPS) • Channel 1 Block 1 – contactor 100S-E116 to E305at AC3 • Channel 1 Block 2 – relay with positively guided contacts: 700-HPS • Channel 2 Block 1/2 – contactors 100 E116 to E305 at AC3 • Channel 2 Block 3 – relay with positively guided contacts: 700-HPS
2500_DOLR_Cat3_100SC09C97	2500 DOLR starter category 3 without interposing relay using 3 x Bulletin 100S-C09 to C97 at AC3 • Channel 1 Block 1 – output contactor: 100S-C09 to C97 at AC3 • Channel 2 – output contactor: 100S-C09 to C97 at AC3
2500_DOLR_Cat3_100SE116E370	2500 DOLR starter category 3 without interposing relay using 1 x Bulletin 100S-E116 to E305 at AC3 • Channel 1 Block 1 – contactor 100S-E116 to E305 at AC3 • Channel 2 – contactors 100 E116 to E305 at AC3

Table 42 - 2500 CENTERLINE MCC DOL Reversing Subsystems with GSR-DI and 700-HPS - Category 3

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2500_DOLR_Cat3_100SC09C97_ GSRDI700HPS	2500 DOLR starter category 3 without interposing relay using 3 x Bulletin 100S-C09 to C97 at AC3 • Channel 1 Block 1 – output contactor: 100S-C09 to C97 at AC3 • Channel 2 Block 1/2 – output contactor: 100S-C09 to C97 at AC3 • Channel 2 Block 3 - 700-HPS • Monitoring safety relay: GSR-DI
2500_DOLR_Cat3_100SE116E370_ GSRDI700HPS	2500 DOLR starter category 3 without interposing relay using 1 x Bulletin 100S-E116 to E305 at AC3 • Channel 1 Block 1 – contactor 100S-E116 to E305 at AC3 • Channel 2 Block 1/2 – contactors 100 E116 to E305 at AC3 • Channel 2 Block 3 - 700-HPS • Monitoring safety relay: GSR-DI

Table 43 - 2500 CENTERLINE MCC DOL Reversing Subsystems with MSR127TP Relay - Category 3

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2500_DOLR_Cat3_100SC09C97_MSR127	2500 DOLR starter category 3 without interposing relay using 2 x Bulletin 100S-C09 to C97 at AC3 • Channel 1/2 Block 1 – Output contactor: 100S-C09 to C97 at AC3 • Channel 2 Block 2 – Output contactor: 100S-C09 to C97 at AC3 • Monitoring safety relay: MSR-127
2500_DOLR_Cat3_100SE116E305_MSR127	2500 DOLR starter category 3 without interposing relay using 2 x Bulletin 100S-E116 to E305 at AC3 • Channel 1/2 Block 1 – Output Contactor: Bulletin 100-E116 to E305 at AC3 • Channel 2 Block 2 – Output Contactor: Bulletin 100-E116 to E305 at AC3 • Monitoring safety relay: MSR-127

Full-voltage Non-reversing (FVNR) Subsystems

For CENTERLINE 2100 ordering information, contact Rockwell Automation..

Table 44 - 2100 CENTERLINE MCC FVNR Starter - Category 1

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2100_FVNR_Cat1_B500_Size03_ with 700HPS	2100 FVNR Starter with 1 x Bulletin 500 contactor NEMA size 0...3 at AC3 and 1 x interposing safety relay (700-HPS) • Channel 1 Block 1 – output contactor: Bulletin 500 contactor NEMA size 0...3 at AC3 • Channel 1 Block 2 – relay with positively guided contacts: 700-HPS
2100_FVNR_Cat1_B500_Size4_ with 700HPS	2100 FVNR Starter with 1 x Bulletin 500 contactor NEMA size 4 at AC3 and 1 x interposing safety relay (700-HPS) • Channel 1 Block 1 – output contactor: Bulletin 500 contactor NEMA size 4 at AC3 • Channel 1 Block 2 – relay with positively guided contacts: 700-HPS
2100_FVNR_Cat1_B500_Size03	2100 FVNR starter category 1 without interposing relays using Bulletin 500 NEMA size 0...3 at AC3 • Channel 1 Block 1 – output contactor: Bulletin 500 contactor NEMA size 0...3 at AC3
2100_FVNR_Cat1_B500_Size4	2100 FVNR starter category 1 without interposing relays using Bulletin 500 NEMA size 4 at AC3 • Channel 1 Block 1 – output contactor: Bulletin 500 contactor NEMA size 4 at AC3

Table 45 - 2100 CENTERLINE MCC FVNR Starter - Category 3

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2100_FVNR_Cat3_B300_Size03_ with 700HPS	2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) and 2 x interposing safety relay (700-HPS) • Channel 1/2 Block 1 – output contactor: Bulletin 300 contactor NEMA size 0...3 at AC3 • Channel 1/2 Block 2 – relay with positively guided contacts: 700-HPS
2100_FVNR_Cat3_B300_Size4_ with 700HPS	2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 4 at AC3 and 2 x interposing safety relay (700-HPS) • Channel 1/2 Block 1 – output contactor: Bulletin 300 contactor NEMA size 4 at AC3 • Channel 1/2 Block 2 – relay with positively guided contacts: 700-HPS
2100_FVxR_Cat3_B500B100S_Size03 with 700HPS	2100 FVNR or FVR category 3 with 2 x 100S/104S-C09 to C97 at AC3 and 2 x interposing safety relay (700-HPS). Starter includes Bulletin 500 NEMA size 0...3 contactors, but it is/are not part of the safety circuit. • Channel 1/2 Block 1 – output contactor: 100S-C09 to C97 at AC3 • Channel 1/2 Block 2 – relay with positively guided contacts: 700-HPS
2100_FVxR_Cat3_B500B300S_Size4_ with 700HPS	2100 FVNR or FVR category 3 with 2 x 300S at AC3 and 2 x interposing safety relay (700-HPS). Bulletin 500 NEMA size 4 contactors are not part of the safety circuit. • Channel 1/2 Block 1 – contactor 300S at AC3 • Channel 1/2 Block 2 – relay with positively guided contacts: 700-HPS
2100_FVNR_Cat3_B300_Size03	2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) without interposing safety relays • Channel 1/2 Block 1 – output contactor: Bulletin 300 contactor NEMA size 0, 1, 2, and 3 at AC3
2100_FVNR_Cat3_B300_Size4	2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 4 at AC3 without interposing safety relays • Channel 1/2 Block 1 – output contactor: Bulletin 300 contactor NEMA size 4 at AC3
2100_FVxR_Cat3_B500B100S_Size03	2100 FVNR or FVR category 3 with 2 x 100S/104S-C09 to C97 at AC3 without interposing safety relays. Starter includes Bulletin 500 NEMA size 0...3 contactors, but it is/are not part of the safety circuit. • Channel 1/2 Block 1 – output contactor: 100S-C09 to C97 at AC3
2100_FVxR_Cat3_B500B300S_Size4	2100 FVNR or FVR category 3 with 2 x 300S at AC3 and without interposing safety relays. Bulletin 500 NEMA size 4 contactors are not part of the safety circuit. • Channel 1/2 Block 1 – contactor 300S at AC3

Table 46 - 2100 CENTERLINE MCC FVNR Starter with MSR131RTP - Category 3

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for theSafety Motor Controller Subsystem Description
2100_FVNR_Cat3_B300_Size03_ MSR131RTP	2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) with MSR131RTP relay • Channel 1/2 Block 1 – output contactor: Bulletin 300 contactor NEMA size 0, 1, 2, and 3 at AC3 • Monitoring safety relay: MSR131
2100_FVNR_Cat3_B300_Size4_ MSR131RTP	2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 4 at AC3 with MSR131RTP relay • Channel 1/2 Block 1 – output contactor: Bulletin 300 contactor NEMA size 4 at AC3 • Monitoring safety relay: MSR131
2100_FVxR_Cat3_B500B100S_Size03_ MSR131RTP	2100 FVNR or FVR category 3 with 2 x 100S/104S-C09 to C97 at AC3 with MSR131RTP relay. Starter includes Bulletin 500 NEMA size 0...3 contactors, but it is/are not part of the safety circuit. • Channel 1/2 Block 1 – output contactor: 100S-C09 to C97 at AC3 • Monitoring safety relay: MSR131
2100_FVxR_Cat3_B500B300S_Size4_ MSR131RTP	2100 FVNR or FVR category 3 with 2 x 300S at AC3 with MSR131RTP relay. Bulletin 500 NEMA size 4 contactors are not part of the safety circuit. • Channel 1/2 Block 1 - output contactor: Bulletin 300S contactor NEMA size 4 at AC3 • Monitoring safety relay: MSR131

Table 47 - 2100 CENTERLINE MCC FVNR Subsystems with MSR127TP - Category 3

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2100_FVNR_Cat3_B300_Size03_ MSR127TP	2100 FVNR Starters Category 3 with 2 x Bulletin 300 NEMA Size 0...3 at AC3 (300-A,-B,-C) with MSR127TP relay. • Channel 1/2 Block 1 – Output Contactor: Bulletin 300 Contactor NEMA Sizes 0, 1, 2 and 3 at AC3 • Monitoring safety relay: MSR-127
2100_FVNR_Cat3_B300_Size4_ MSR127TP	2100 FVNR Starters Category 3 with 2 x Bulletin 300 NEMA Size 4 at AC3 (300-D) with MSR127TP relay. • Channel 1/2 Block 1 – Output Contactor: Bulletin 300 Contactor NEMA Size 4 at AC3 • Monitoring safety relay: MSR-127
2100_FVxR_Cat3_B500B100S_Size03 _ MSR127TP	2100 FVNR or FVR Category 3 with 2 x 100S/104S-C09 to C97 at AC3 with MSR127TP relay. Bulletin 500 NEMA Size 0...3 Contactors are not part of the safety circuit. • Channel 1/2 Block 1 – Output Contactor: 100S-C09 to C97 at AC3 • Monitoring safety relay: MSR-127
2100_FVxR_Cat3_B500B300S_Size4_ MSR127TP	2100 FVNR or FVR Category 3 with 2 x 300S at AC3 with MSR127TP relay. Bulletin 500 NEMA Size 4 Contactors are not part of the safety circuit. • Channel 1/2 Block 1 – Output Contactor: Bulletin 300S Contactor NEMA Size 4 at AC3 for the safety circuit • Monitoring safety relay: MSR-127

Full-voltage Reversing (FVR) Subsystems

For CENTERLINE 2100 ordering information, contact Rockwell Automation..

Table 48 - 2100 CENTERLINE MCC FVR Subsystems - Category 1

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2100_FVR_Cat1_B500_Size03_ with 700HPS	2100 FVR Starter with 2 x Bulletin 500 contactor NEMA size 0...3 at AC3 and 1 x interposing safety relay (700-HPS) • Channel 1 Block 1 – output contactor: Bulletin 500 contactor NEMA size 0...3 at AC3 • Channel 1 Block 2 – output contactor: Bulletin 500 contactor NEMA size 0...3 at AC3 • Channel 1 Block 3 – relay with positively guided contacts: 700-HPS
2100_FVR_Cat1_B500_Size4_ with 700HPS	2100 FVR Starter with 2 x Bulletin 500 contactor NEMA size 4 at AC3 1 x interposing safety relay (700-HPS) • Channel 1 Block 1 – output contactor: Bulletin 500 contactor NEMA size 4 at AC3 • Channel 1 Block 2 – output contactor: Bulletin 500 contactor NEMA size 4 at AC3 • Channel 1 Block 3 – relay with positively guided contacts: 700-HPS
2100_FVR_Cat1_B500_Size03	2100 FVR starter category 1 without interposing relays using 2 x Bulletin 500 NEMA size 0...3 at AC3 • Channel 1 Block 1 – output contactor: Bulletin 500 contactor NEMA size 0...3 at AC3 • Channel 1 Block 2 – output contactor: Bulletin 500 contactor NEMA size 0...3 at AC3
2100_FVR_Cat1_B500_Size4	2100 FVR starter category 1 without interposing relays using 2 x Bulletin 500 NEMA size 4 at AC3 • Channel 1 Block 1 – output contactor: Bulletin 500 contactor NEMA size 4 at AC3 • Channel 1 Block 2 – output contactor: Bulletin 500 contactor NEMA size 4 at AC3

Table 49 - 2100 CENTERLINE MCC FVR Subsystems - Category 3

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2100_FVR_Cat3_B300_Size03_ with 700HPS	2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) and 2 x interposing safety relay (700-HPS) • Channel 1 Block 1 – output contactor: Bulletin 300 contactor NEMA size 0...3 at AC3 • Channel 1 Block 2 – relay with positively guided contacts: 700-HPS • Channel 2 Block 1/2 – output contactor: Bulletin 300 contactor NEMA size 0...3 at AC3 • Channel 2 Block 3 – relay with positively guided contacts: 700-HPS
2100_FVR_Cat3_B300_Size4_ with 700HPS	2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 4 at AC3 and 2 x interposing safety relay (700-HPS) • Channel 1 Block 1 – output contactor: Bulletin 300 contactor NEMA size 4 at AC3 • Channel 1 Block 2 – relay with positively guided contacts: 700-HPS • Channel 2 Block 1/2 – output contactor: Bulletin 300 contactor NEMA size 4 at AC3 • Channel 2 Block 3 – relay with positively guided contacts: 700-HPS
2100_FVxR_Cat3_B500B100S_ Size03_with 700HPS	2100 FVNR or FVR category 3 with 2 x 100S/104S-C09 to C97 at AC3 and 2 x interposing safety relay (700-HPS). Starter includes Bulletin 500 NEMA size 0...3 contactors, but it is/are not part of the safety circuit. • Channel 1/2 Block 1 – output contactor: 100S-C09 to C97 at AC3 • Channel 1/2 Block 2 – relay with positively guided contacts: 700-HPS
2100_FVxR_Cat3_B500B300S_ Size4_with 700HPS	2100 FVNR or FVR category 3 with 2 x 300S at AC3 - 2 x interposing safety relay (700-HPS). Bulletin 500 NEMA size 4 contactors are not part of the safety circuit. • Channel 1/2 Block 1 – Output Contactor: Bulletin 300S Contactor NEMA Size 4 at AC3 for the safety circuit • Channel 1/2 Block 2 – relay with positively guided contacts: 700-HPS
2100_FVR_Cat3_B300_Size03	2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) without interposing safety relays • Channel 1 Block 1 – output contactor: Bulletin 300 contactor NEMA size 0, 1, 2 and 3 at AC3 • Channel 2 Block 1/2 – output contactor: Bulletin 300 contactor NEMA size 0, 1, 2 and 3 at AC3
2100_FVR_Cat3_B300_Size4	2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 4 at AC3 without interposing safety relays • Channel 1 Block 1 – output contactor: Bulletin 300 contactor NEMA size 4 at AC3 • Channel 2 Block 1/2 – output contactor: Bulletin 300 contactor NEMA size 4 at AC3
2100_FVxR_Cat3_B500B100S_ Size03	2100 FVNR or FVR category 3 with 2 x 100S/104S-C09 to C97 at AC3 without interposing safety relays. Starter includes Bulletin 500 NEMA size 0...3 contactors, but it is/are not part of the safety circuit. • Channel 1/2 Block 1 – output contactor: 100S-C09 to C97 at AC3
2100_FVxR_Cat3_B500B300S_ Size4	2100 FVNR or FVR category 3 with 2 x 300S at AC3 - without interposing safety relays. Bulletin 500 NEMA size 4 contactors are not part of the safety circuit. • Channel 1/2 Block 1 – output Contactor: Bulletin 300S Contactor NEMA Size 4 at AC3 for the safety circuit

Table 50 - 2100 CENTERLINE MCC FVR Subsystems with MSR127TP - Category 3

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2100_FVR_Cat3_B300_Size03_ MSR127TP	2100 FVR Starters Category 3 with 2 x Bulletin 300 NEMA Size 0...3 at AC3 (300-A,-B,-C) with MSR127TP relay. • Channel 1/2 Block 1 – Output Contactor: Bulletin 300 Contactor NEMA Sizes 0...3 at AC3 • Channel 2 Block 2 – Output Contactor: Bulletin 300 Contactor NEMA Sizes 0...3 at AC3 • Monitoring safety relay: MSR-127
2100_FVR_Cat3_B300_Size4_ MSR127TP	2100 FVR Starters Category 3 with 2 x Bulletin 300 NEMA Size 4 at AC3 (300-D) with MSR127TP relay. • Channel 1/2 Block 1 – Output Contactor: Bulletin 300 Contactor NEMA Size 4 at AC3 • Channel 2 Block 2 – Output Contactor: Bulletin 300 Contactor NEMA Size 4 at AC3 • Monitoring safety relay: MSR-127
2100_FVxR_Cat3_B500B100S_Size03_ MSR127TP	2100 FVNR or FVR Category 3 with 2 x 100S/104S-C09 to C97 at AC3 with MSR127TP relay. Bulletin 500 NEMA Size 0...3 Contactors are not part of the safety circuit. • Channel 1/2 Block 1 – Output Contactor: 100S-C09 to C97 at AC3 • Monitoring safety relay: MSR-127
2100_FVxR_Cat3_B500B300S_Size4_ MSR127TP	2100 FVNR or FVR Category 3 with 2 x 300S at AC3 with MSR127TP relay. Bulletin 500 NEMA Size 4 Contactors are not part of the safety circuit. • Channel 1/2 Block 1 – Output Contactor: Bulletin 300S Contactor NEMA Size 4 at AC3 for the safety circuit • Monitoring safety relay: MSR-127

Table 51 - 2100 CENTERLINE MCC FVR Subsystems with MSR131RTP - Category 3

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2100_FVR_Cat3_B300_Size03_ MSR131RTP	2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) with MSR131RTP relay • Channel 1 Block 1 – output contactor: Bulletin 300 contactor NEMA size 0, 1, 2, and 3 at AC3 • Channel 2 Block 1/2 – output contactor: Bulletin 300 contactor NEMA size 0, 1, 2, and 3 at AC3 • Monitoring safety relay: MSR131
2100_FVR_Cat3_B300_Size4_ MSR131RTP	2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 4 at AC3 (300-D) with MSR131RTP relay • Channel 1 Block 1 – output contactor: Bulletin 300 contactor NEMA size 4 at AC3 • Channel 2 Block 1/2 – output contactor: Bulletin 300 contactor NEMA size 4 at AC3 • Monitoring safety relay: MSR131
2100_FVxR_Cat3_B500B100S_Size03_ MSR131RTP	2100 FVNR or FVR category 3 with 2 x 100S/104S-C09 to C97 at AC3 with MSR131RTP relay. Starter includes Bulletin 500 NEMA size 0...3 contactors, but it is/are not part of the safety circuit. • Channel 1/2 Block 1 – output contactor: 100S-C09 to C97 at AC3 • Monitoring safety relay: MSR131
2100_FVxR_Cat3_B500B300S_Size4_ MSR131RTP	2100 FVNR or FVR category 3 with 2 x 300S at AC3 - with MSR131RTP relay. Bulletin 500 NEMA size 4 contactors are not part of the safety circuit. • Channel 1/2 Block 1 – output contactor: Bulletin 300S Contactor NEMA Size 4 at AC3 for the safety circuit • Monitoring safety relay: MSR131

Safety Distribution Subsystems

For CENTERLINE 2100 ordering information, contact Rockwell Automation.

Table 52 - 2100 CENTERLINE MCC Safety Distribution Subsystems

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2100_Cat1_SRDS	2100 category 1 safety relay distribution subsystem (stop category 0) - C1_SRDS 1 safety zone: – 10 MCUs if each contact goes to one MCU without interposing relays or – 80 MCUs if each contact goes to 8 MCUs with interposing relays – 700S-P1020A1 (120 VAC- 10 N.O. and 2 NC contacts – 10 Amps/contact) • Channel 1 - Block 1 – Control Relay: 700S NEMA Heavy-Duty Safety Control Relay
2100_Cat3_SMRDS_ with 700HPS	2100 category 3 safety monitoring relay distribution subsystem using two immediate safety outputs (stop category 0) with interposing relays (2 x 700 HPS per safety output) - C3_SMRDS_WIR.1 safety zone: – 4 MCUs if one contact from each 700-HPS commanded by a safety output goes to one MCU without interposing relays or – 32 (4 x 8) MCUs if one contact from each 700-HPS commanded by a safety output goes to 8 x MCUs with interposing relays – 32 MCUs maximum consumption is 70 mA * 32 = 2.24 Amps (700-HPS contact rating: DC-1 - 8 Amps @ 30V DC). • Monitoring safety relay: MSR138 - immediate action contact • Channel 1/2 – Block 1/2 – relay with positively guided contacts: 700-HP
2100_Cat3_SMRDS	2100 category 3 safety monitoring relay distribution subsystem using two immediate safety outputs (stop category 0) without interposing relays (No 700 HPS, safety outputs go directly to MCUs) - C3_SMRDS.1 safety zone: – 1 MCU if one contact from each safety output goes to one MCU without interposing relays or – 8 (1 x 8) MCUs if one contact from each safety output goes to one MCU with interposing relays – 8 MCUs maximum consumption is 70 mA * 8 = 0.56 Amps (MSR138DP - DC13: 2 A / 24V DC). • Monitoring safety relay: MSR138 - time-delayed acting contact
2100_Cat3_SMRDSTD_ with 700HPS	2100 category 3 safety monitoring relay distribution subsystem using two time-delayed safety outputs (stop category 1) with interposing relays (1 x 700 HPS per safety output) - C3_SMRDSTD_WIR.1 safety zone: – 2 MCUs if one contact from each 700-HPS commanded by a safety output goes to one MCU without interposing relays or – 16 (2 x 8) MCUs if one contact from each 700-HPS commanded by a safety output goes to 8 x MCUs with interposing relays – 16 MCUs maximum consumption is 70 mA * 16 = 1.12 Amps (700-HPS contact rating: DC-1 - 8 Amps @ 30V DC). • Monitoring safety relay: MSR138 - time-delayed acting contact • Channel 1/2 – Block 1 – relay with positively guided contacts: 700-HPS
2100_Cat3_SMRDSTD	2100 category 3 safety monitoring relay distribution subsystem using two time-delayed safety output(stop category 1) without interposing relays (No 700 HPS, safety outputs go directly to MCUs) - C3_SMRDSTD.1 safety zone: – 1 MCU if one contact from each safety output goes to one MCU without interposing relays or – 8 (1 x 8) MCUs if one contact from each safety output goes to one MCU with interposing relays • 8 MCUs maximum consumption is 70 mA * 8 = 0.56 Amps (MSR138DP - DC13: 2 A / 24V DC). • Monitoring safety relay: MSR138 - time-delayed acting contact
2100_Cat3_SRIODS_ with 700HPS	2100 category 3 safety remote I/O distribution subsystem (stop category 0/1) with interposing relays - 4 safety zones: – 1 x 1734-OB8S (one 700-HPS per safety output) and 1 x 1734-IB8S (auxiliary contactor feedback in series, reset signal, E-stop string channel) - C3SRIODS_WIR. – 4 x safety zones maximum (4 pairs of safety outputs available in one 1734-OB8S): – 4 (4 x 1) MCUs - one pair of safety outputs commands 1 x MCU without interposing relays or – 32 (4 x 8) MCUs - one pair of safety outputs commands 8 x MCUs with interposing relays – 32 MCUs maximum consumption is 70 mA * 32 = 2.24 Amps (700-HPS contact rating: DC-1 - 8 Amps @ 30V DC). 1734 I/O modules receive power from adapter 1734-AENTR. • Subsystem – 1 x POINT Guard I/O: 1734-IB8S Series B • Subsystem – 1 x POINT Guard I/O: 1734-OB8S Series B • Channel 1/2 – Block 1 – relay with positively guided contacts: 700-HPS
2100_Cat3_SRIODS	2100 category 3 safety remote I/O distribution subsystem (stop category 0/1) without interposing relays - 4 safety zones – 1 x 1734-OB8S (No 700-HPS) and 1 x 1734-IB8S (auxiliary contactor feedback in series, reset signal, E-stop string channel) - C3SRIODS. – 4 x safety zones maximum (4 pairs of safety outputs available in one 1734-OB8S): – 32 (4 x 8) MCUs - one pair of safety outputs commands 8 x MCUs with interposing relays – 32 MCUs maximum consumption is 70 mA * 32 = 2.24 Amps (1734-OB8S: 1 Amp max per safety output). – 1734 I/O modules receive power from adapter 1734-AENTR. • Subsystem – 1 x POINT Guard I/O: 1734-IB8S Series B • Subsystem – 1 x POINT Guard I/O: 1734-OB8S Series B

For CENTERLINE 2500 ordering information, contact Rockwell Automation.

Table 53 - 2500 CENTERLINE MCC Safety Distribution Subsystems

SISTEMA Identifier	Description SISTEMA Safety Function hierarchy level is being used as a container for the Safety Motor Controller Subsystem Description
2500_Cat1_SRDS	2500 Cat. 1 safety relay distribution subsystem (stop category 0) - C1_SRDS 1 safety zone: – 10 MCUs if each contact goes to one MCU without interposing relays or – 80 MCUs if each contact goes to 8 MCUs with interposing relays – 700S-CF • Channel 1 Block 1 – Control Relay: 700S-CFB
2500_Cat3_SMRDS_ with 700HPS	2500 category 3 safety monitoring relay distribution subsystem using two immediate safety outputs (stop category 0) with interposing relays (2 x 700 HPS per safety output) - C3_SMRDS_WIR 1 safety zone: – 4 MCUs if one contact from each 700-HPS commanded by a safety output goes to one MCU without interposing relays or – 32 (4 x 8) MCUs if one contact from each 700-HPS commanded by a safety output goes to 8 x MCUs with interposing relays – 32 MCUs maximum consumption is 70 mA * 32 = 2.24 Amps (700-HPS contact rating: DC-1 - 8 Amps @ 30V DC). • Monitoring safety relay: GSR-DI • Channel 1/2 – Block 1/2 – relay with positively guided contacts: 700-HPS
2500_Cat3_SMRDS	2500 Cat. 3 safety monitoring relay distribution subsystem using two immediate safety outputs (stop category 0) without interposing relays (No 700 HPS, safety outputs go directly to MCUs) - C3_SMRDS 1 safety zone: – 1 MCU if one contact from each safety output goes to one MCU without interposing relays or – 8 (1 x 8) MCUs if one contact from each safety output goes to one MCU with interposing relays • 8 MCUs maximum consumption is 70 mA * 8 = 0.56 Amps (GSR-DI/440R-D22R2 - DC13: 2 A / 24V DC). • Monitoring safety relay: GSR-DI
2500_Cat3_SMRDSTD_ with 700HPS	2500 category 3 safety monitoring relay distribution subsystem using two time-delayed safety outputs (stop category 1) with interposing relays (1 x 700 HPS per safety output) - C3_SMRDSTD_WIR 1 safety zone: – 2 MCUs if one contact from each 700-HPS commanded by a safety output goes to one MCU without interposing relays or – 16 (2 x 8) MCUs if one contact from each 700-HPS commanded by a safety output goes to 8 x MCUs with interposing relays 32 MCUs maximum consumption is 70 mA * 16 = 1.12 Amps (700-HPS contact rating: DC-1 - 8 A @ 30V DC). • Monitoring safety relay: GSR-DI (2 immediate safety outputs) • Channel 1/2 – Block 1 – relay with positively guided contacts: 700-HPS • Monitoring safety relay: GSR-EM4R2D (4 time delayed safety outputs)
2500_Cat3_SMRDSTD	2500 category 3 safety monitoring relay distribution subsystem using two immediate safety outputs (stop category 0) without interposing relays (No 700 HPS, safety outputs go directly to MCUs) - C3_SMRDSTD 1 safety zone: – 1 MCU if one contact from each safety output goes to one MCU without interposing relays or – 8 (1 x 8) MCUs if one contact from each safety output goes to one MCU with interposing relays • 16 MCUs maximum consumption is 70 mA * 8 = 0.56 Amps (GSR-DI/440R-D22R2 - DC13: 2 A / 24V DC). • Monitoring safety relay: GSR-DI (2 immediate safety outputs) • Monitoring safety relay: GSR-EM4R2D (4 time delayed safety outputs)
2500_Cat3_SRIODS_ with 700HPS	2500 category 3 safety remote I/O distribution subsystem (stop category 0/1) with interposing relays - 4 safety zones – 1 x 1734-OB8S (one 700-HPS per safety output) and 1 x 1734-IB8S (auxiliary contactor feedback in series, reset signal, E-stop string channel) - C3SRIODS_WIR 4 x safety zones maximum (4 pairs of safety outputs available in one 1734-OB8S): – 4 (4 x 1) MCUs- one pair of safety outputs commands 1 x MCU without interposing relays or – 32 (4 x 8) MCUs - one pair of safety outputs commands 8 x MCUs with interposing relays 32 MCUs maximum consumption is 70 mA * 32 = 2.24 Amps (700-HPS contact rating: DC-1 - 8 Amps @ 30V DC). 1734 I/O modules receive power from adapter 1734-AENTR. • Subsystem – 1 x POINT Guard I/O™: 1734-IB8S Series B • Subsystem – 1 x POINT Guard I/O: 1734-OB8S Series B • Channel 1/2 – Block 1 – relay with positively guided contacts: 700-HPS
2500_Cat3_SRIODS	2500 category 3 safety remote I/O distribution subsystem (stop category 0/1) without interposing relays - 4 safety zones – 1 x 1734-OB8S (No 700-HPS) and 1 x 1734-IB8S (auxiliary contactor feedback in series, reset signal, E-stop string channel) - C3SRIODS 4 x safety zones maximum (4 pairs of safety outputs available in one 1734-OB8S): – 32 (4 x 8) MCUs - one pair of safety outputs commands 8 x MCUs with interposing relays 32 MCUs maximum consumption is 70 mA * 32 = 2.24 Amps (1734-OB8S: 1 A maximum per safety output). 1734 I/O modules receive power from adapter 1734-AENTR. • Subsystem – 1 x POINT Guard I/O: 1734-IB8S Series B • Subsystem – 1 x POINT Guard I/O: 1734-OB8S Series B

Multiple Motors E-stop Safety Functions

Table 54 - Multiple Motors E-stop Safety Functions Examples using CENTERLINE MCC Subsystems

SISTEMA Project Library File	SISTEMA Safety Function Container with Subsystems	
CENTERLINE LVMCC Safety Examples Cat. 1 E-stop Multiple motors with C1_SRDS / PowerFlex 750 (20-750-S) / 2100 FVNR Cat. 1 with interposing relay using Bulletin 500	**Cat. 1 E-stop Multiple Motors with C1_SRDS / PF750 (20-750-S) / 2100 FVNR Cat. 1 with interposing relay using Bulletin 500**	
	• Emergency Stop push buttons and 700S-CFB Control Relay – Channel 1 Block 1 - E-stop Switch: 800T-FX, 800TC-FX - twist-to-release • Block 2 - Control Relay: 700S-CFB – Align Block 2 with Block 1	• AC Drive: PowerFlex 753/755 with -S Hardwired STO • SB: 2100 FVNR starter category 1 with 1 x Bulletin 500 contactor NEMA size 0...3 at AC3 and 1 x interposing safety relay (700-HPS) – Channel 1 Block 1 - Output Contactor: Bulletin 500 Contactor NEMA Sizes 0, 1, 2 and 3 at AC3 Block 2 - relay with positively guided contacts: 700-HPS
CENTERLINE LVMCC Safety Examples Cat. 3 E-stop Multiple motors with C3_SMRDS_WIR / PowerFlex 750 (20-750-S) / 2100 FVNR Cat. 3 with interposing relay using Bulletin 300	**Cat. 3 E-stop Multiple Motors with C3_SMRDS_WIR / PF750 (20-750-S) / 2100 FVNR Cat. 3 with interposing relay using Bulletin 300**	
	• SB: Emergency stop push button – Channel 1 Block 1 - E-stop Switch: 800T-FX, 800TC-FX - twist-to-release – Channel 2 Block 1 - E-stop switch: 800T-FX, 800TC-FX - twist-to-release • C3_SMRDS_WIR - SB: Monitoring safety relay: MSR138 - immediate action contact • C3_SMRDS_WIR - SB: Relays with positively guided contacts: 4 x 700-HPS (two for each immediate safety output) – Channel 1 Block 1 - relay with positively guided contacts: 700-HPS Block 2 - relay with positively guided contacts: 700-HPS – Channel 2 Block 1 - relay with positively guided contacts: 700-HPS Block 2 - relay with positively guided contacts: 700-HPS	• SB: AC Drive: PowerFlex 753/755 with -S hardwired STO • SB: 2100 FVNR starters category 3 with 2 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) and 2 x interposing safety relays (700-HPS) – Channel 1 Block 1 - Output Contactor: Bulletin 300 Contactor NEMA Sizes 0, 1, 2 and 3 at AC3 Block 2 - relay with positively guided contacts: 700-HPS – Channel 2 Block 1 - Output Contactor: Bulletin 300 Contactor NEMA Sizes 0, 1, 2 and 3 at AC3 Block 2 - relay with positively guided contacts: 700-HPS
CENTERLINE LVMCC Safety Examples Cat. 3 E-stop Multiple motors with safety controller / C3SRIODS_WIR / PF525 / 2100 FVR Cat. 3 with interposing relay using Bulletin 300	**Cat. 3 E-stop Multiple Motors with Safety Controller / C3SRIODS_WIR / PF525 / 2100 FVR Cat. 3 wIth interposing relay using Bulletin 300**	
	• SB: Emergency stop push button – Channel 1 Block 1 - E-stop Switch: 800T-FX, 800TC-FX - twist-to-release – Channel 2 Block 1 - E-stop Switch: 800T-FX, 800TC-FX - twist-to-release • SB: POINT Guard I/O: 1734-IB8S Series B • SB: Safety controller: GuardLogix® 1756-L8xES and L8SP • SB: POINT Guard I/O: 1734-OB8S Series B • SB: Relays with positively guided contacts: 2 x 700-HPS (one for each immediate safety output) - C3SRIODS_WIR – Channel 1 Block 1 - relay with positively guided contacts: 700-HPS – Channel 2 Block 1 - relay with positively guided contacts: 700-HPS	• SB: AC Drive: PowerFlex 525 with Safe Torque Off • SB: 2100 FVR starters category 3 with 3 x Bulletin 300 NEMA size 0...3 at AC3 (300-A,-B,-C) and 2 x interposing safety relays (700-HPS) – Channel 1 Block 1 - Output Contactor: Bulletin 300 Contactor NEMA Sizes 0, 1, 2 and 3 at AC3 Block 2 - relay with positively guided contacts: 700-HPS – Channel 2 Block 1 - Output Contactor: Bulletin 300 Contactor NEMA Sizes 0, 1, 2 and 3 at AC3 Block 2 - Output Contactor: Bulletin 300 Contactor NEMA Sizes 0, 1, 2 and 3 at AC3 Block 3 - relay with positively guided contacts: 700-HPS
CENTERLINE LVMCC Safety Examples Cat. 3 E-stop Multiple motors with safety controller / PowerFlex 750 (20-750-S3) / PowerFlex 527	**Cat. 3 E-stop Multiple Motors with Safety Controller / PF750 (20-750-S3) / PF527**	
	• SB: Emergency stop push button – Channel 1 Block 1 - E-stop Switch: 800T-FX, 800TC-FX - twist-to-release – Channel 2 Block 1 - E-stop Switch: 800T-FX, 800TC-FX - twist-to-release • SB: POINT Guard I/O: 1734-IB8S Series B	• SB: Safety controller: GuardLogix 1756-L8xES and L8SP • SB: AC Drive: PowerFlex 753/755 with -S3 integrated STO • SB: AC Drive: PowerFlex 527 with STO

Terms and Abbreviations

The following terms and abbreviations are used throughout this manual.
For definitions of terms not listed here, see the Allen-Bradley® Industrial Automation Glossary, publication AG-7.1.

1oo2 One out of Two - Refers to the behavioral design of a dual-channel safety system.

Cat. Category - See standard EN ISO 1384901 for the definition of category.

CL Claim Limit - See standard IEC 62061 for the definition of claim limit.

DCavg% Diagnostic Coverage - See standard IEC 61508 for the definition of diagnostic coverage.

E-stop Emergency stop - Emergency stop systems are more reactive safety systems. Emergency stop systems are used by personnel to shut down equipment after a condition is recognized that could cause damage to personnel, or equipment. These systems typically utilize large red mushroom head push buttons with yellow background or red pull-cords that are located near operator areas to signal the control system that an emergency condition has been recognized. The control system must then shut down the equipment safely.

ESD Emergency Shutdown Systems - A system, usually independent of the main control system, that is designed to shut down an operating system safely.

HFT Hardware Fault Tolerance - The HFT equals n, where n+1 fault could cause the loss of the safety function. An HFT of 1 means that two faults are required before safety is lost.

MTTFd Mean Time to Failure Dangerously - The average length of time before a device has a dangerous failure.

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. PELV is defined in IEC 61131-2.

PFD Probability of 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 occur per hour.

PL Performance Level per ISO 13849-1 Standard.

Safety Zone Any space within and/or around machinery in which a person can be exposed to a hazard where all of the machinery hazards are eliminated in a determinate amount of time after the actuation of the safety inputs.

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. SELV is defined in IEC 61010-2-201.

SIL Safety Integrity Level - A measure of a products ability to lower the risk that a dangerous failure could occur.

SISTEMA Safety-Integrated Software Tool for the Evaluation - a free software utility for safety function evaluation per ISO13849-1. For more information on SISTEMA, visit the DGUV website and the Rockwell Automation SISTEMA Library.

STO Safe Torque Off - The Safe Torque Off (STO) function is used to prevent unexpected motor rotation if there is an emergency while the drive remains connected to the power supply. When STO is activated, the torque power cannot reach the motor.

Additional Resources

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

Resource	Description
Actuator Subsystems – Stop Cat. 0 or 1 via an Integrated Safety Controller and PowerFlex 525 Drive with Hardwired Safe Torque Off Safety Function, publication SAFETY-AT149	Provides information for how to program the logic and configure the actuator subsystems of a safety function.
Actuator Subsystems - Stop Cat. 0 or 1 via a PowerFlex Drive with Integrated Safe Torque Off Safety Function, publication SAFETY-AT141	Provides information for how to program the logic and configure the actuator subsystems of a safety function.
CENTERLINE 2100 Motor Control Centers Selection Guide, publication 2100-SG003	Provides selection information for the CENTERLINE® 2100 motor control centers (MCCs).
CENTERLINE 2500 Low-voltage Motor Control Centers and Switchgear Assemblies Selection Guide, publication 2500-SG001	Provides selection information for the CENTERLINE 2500 MCCs.
Emergency Stop Products: Integrated Safety Controller Connected to a Series of Dual-channel E-stop Buttons Safety Function, publication SAFETY-AT036	Provides information for how to wire, configure, and program a Compact GuardLogix® Controller and POINT Guard I/O module to monitor a series of dual-channel safety E-stop devices.
EtherNet/IP™ Network Devices User Manual, publication ENET-UM006	Describes how to configure and use EtherNet/IP devices to communicate on the EtherNet/IP network.
Ethernet Reference Manual, publication ENET-RM002	Describes basic Ethernet concepts, infrastructure components, and infrastructure features.
GuardLogix 5570 and Compact GuardLogix 5370 Controller Systems Safety Reference Manual, publication 1756-RM099	Describes the GuardLogix 5570 and Compact GuardLogix 5370 controller systems, which are type-approved and certified for use in safety applications.
GuardLogix 5580 and Compact GuardLogix 5380 Controller Systems Safety Reference Manual, publication 1756-RM012	Describes the GuardLogix 5580 and Compact GuardLogix 5380 controller systems, which are type-approved and certified for use in safety applications.
GuardLogix Safety Application Instruction Set Reference Manual, publication 1756-RM095	Provides GuardLogix Safety Application Instruction Set, which is type-approved and certified for safety-related function in applications up to and including Safety Integrity Level (SIL) 3 according to IEC61508, and Performance Level, PLe (Cat.4), according to ISO13849-1.
Guardmaster® Safety Relays (DI, DIS, SI, CI, GLP, EM, and EMD) for Bulletin 440R Selection Guide, publication 440R-SG001	Provides selection information for Guardmaster® safety relays.
GuardShield™ Micro 400 Safety Light Curtains User Manual, publication 445L-IN005	Provides examples of how to convert existing light curtain applications to safety light curtains with the latest technologies.
IEC Contactor Specifications Technical Data, publication 100-TD013	Provides specifications and selection information for Bulletin Numbers 100/104-K, 100/104-C, 100/104S-C, 100/104-E, and 100S-E.
Minotaur MSR124RT Monitoring Safety Relay Installation Instructions, publication 440R-IN082	Provides installation and wiring information for the Minotaur MSR124RT monitoring safety relay.
Minotaur MSR131RTP Monitoring Safety Relay Installation Instructions, publication, 440R-IN087A	Provides installation and wiring information for the Minotaur MSR131RTP monitoring safety relay.
PowerFlex 520-Series Adjustable Frequency AC Drive User Manual, publication 520-UM001	Provides information for the use of the PowerFlex® 520 drives.
PowerFlex 527 AC Drive Specifications Technical Data, publication 520-TD002	Provides specifications for the PowerFlex 527 drives.
PowerFlex 527 Adjustable Frequency AC Drive User Manual, publication 520-UM002	Provides information for the use of the PowerFlex 527 drives.
PowerFlex 750-Series AC Drives Programming Manual, publication 750-PM001	Provides the basic information that is required to install, startup, and troubleshoot PowerFlex 750-series Adjustable Frequency AC Drives.
PowerFlex 750-Series AC Drives Reference Manual, publication 750-RM002	Provides detailed information including operation, parameter descriptions, and programming.
PowerFlex 750-Series Safe Torque Off Option Module User Manual, publication 750-UM002	Provides information for how to use the PowerFlex 750-series Safe Torque Off (STO) option module in Safety Integrity Level (SIL) 3, Performance Level [PLe], or category (Cat.) 3 applications.
PowerFlex 755/755T Integrated Safety Functions Option Module User Manual, publication 750-UM005	Provides information for how to use PowerFlex 755 drives and PowerFlex 755T drive products in safety applications up to SIL 3, PLe, Cat. 4.
PowerFlex 755/755T Integrated Safety - Safe Torque Off User Manual, publication 750-UM004	Provides information for how to use PowerFlex 755 drives and PowerFlex 755T drive products in SIL 3, PLe, and Cat. 3 applications.
Rockwell Automation Functional Safety Data Sheet, publication SAFETY-SR001	Provides functional safety data for Rockwell Automation products.
Safe Speed Monitor Option Module for PowerFlex 750-Series AC Drives, publication 750-RM001	Provides information for how to use the PowerFlex 750-series Safe Speed Monitor option module in SIL 3, PLe, or Cat. 4 applications.
SafeBook 5 - Safety-related control systems for machinery, publication SAFEBK-RM002	Provides information about safety distance calculations.
Safety Function: E-stop String Safety Function, publication SAFETY-AT059	Describes how power is removed from a hazard when a safety system detects that an E-stop has been actuated.
Safety Function: Light Curtain Products: Light Curtain GuardLogix Controller, publication SAFETY-AT056	Provides information for how to wire, configure, and program a Compact GuardLogix controller and POINT Guard I/O module to monitor a 440L GuardShield light curtain.

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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