XPSUVN

Safety Module

User Guide
Original instructions

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www.se.com

Legal Information

Table of Contents

Safety Information 5
- Qualification of Personnel 5
- Intended Use 6

About the Book 7

Introduction 11
- Device Overview 11
- Front View and Side View 12
- Nameplate 13
- Type Code 13

Technical Data 15
- Environmental Conditions 15
- Mechanical Characteristics 16
- Electrical Characteristics 17
- Timing Data 19
- Data Functional Safety 19

Engineering 22
- Electromagnetic Compatibility (EMC) 22
- Principles of Operation 22
- Voltage Measurement 25
- Activation Delay and Voltage Threshold 29

Installation 32
- Prerequisites and Requirements 32
- Mechanical Installation 32
- Electrical Installation 34

Functions 38
- Application Functions 38

Configuration and Commissioning 42
- Configuration 42
- Commissioning 45

Diagnostics 47
- Diagnostics via LEDs 47
- Diagnostics via Status Output Z1 48

Accessories, Service, Maintenance, and Disposal 51
- Accessories 51
- Maintenance 51
- Transportation, Storage, and Disposal 51
- Service Addresses 52

Index 53

Safety Information

Important Information

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, **could result in** death or serious injury.

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, **could result** in minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

Please Note

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

Qualification of Personnel

Only appropriately trained persons who are familiar with and understand the contents of this manual and all other pertinent product documentation as well as all documentation of all components and equipment of the machine/process are authorized to work on and with this product.

The qualified person must be a certified expert in functional safety.

The qualified person must be able to detect possible hazards that may arise from parameterization, modifying configurations, settings, and wiring, and generally

from mechanical, electrical, or electronic equipment. The qualified person must be able to understand the effects that modifications to configurations, settings, and wiring may have on the safety of the machine/process.

The qualified person must be familiar with and understand the contents of the risk assessment as per ISO 12100-1 and/or any other equivalent assessment as well as all documents related to such risk assessment or equivalent assessments for the machine/process.

The qualified person must be familiar with the standards, provisions, and regulations for the prevention of industrial accidents, which they must observe when designing, implementing, and maintaining the machine/process.

The qualified person must be thoroughly familiar with the safety-related applications and the non-safety-related applications used to operate the machine/process.

Intended Use

This product described in the present document is a safety module intended to perform safety-related functions in a machine/process according to the present document, to the specified related documents, and to all other documentation of the components and equipment of the machine/process.

The product may only be used in compliance with all applicable safety regulations and directives, the specified requirements and the technical data.

Prior to using the product, you must perform a risk assessment as per ISO 12100-1 in view of the planned application. Based on the results of the risk assessment, the appropriate safety-related measures must be implemented.

Since the product is used as a component in an overall machine or process, you must ensure the safety of persons by means of the design of this overall machine or process.

Operate the product only with the specified cables and accessories. Use only genuine accessories.

Any use other than the use explicitly permitted is prohibited and can result in hazards.

About the Book

Document Scope

This manual describes technical characteristics, installation, commissioning, operation and maintenance of the safety module XPSUVN.

Validity Note

The present document is valid for the products listed in the Type Code, page 13.

For product compliance and environmental information (RoHS, REACH, PEP, EOLI, etc.), go to www.se.com/ww/en/work/support/green-premium/.

The characteristics that are described in the present document, as well as those described in the documents included in the Related Documents section below, can be found online. To access the information online, go to the Schneider Electric home page www.se.com/ww/en/download/.

The characteristics that are described in the present document should be the same as those characteristics that appear online. In line with our policy of constant improvement, we may revise content over time to improve clarity and accuracy. If you see a difference between the document and online information, use the online information as your reference.

Related Documents

Title of documentation	Reference number
XPSUVN User Guide	EIO0000004260 (eng) EIO0000004262 (fre) EIO0000004261 (ger) EIO0000004263 (spa) EIO0000004264 (ita) EIO0000004265 (chi)
XPSUVN Instruction Sheet	NNZ32597 (eng, fre, ger, ita, spa, chi) NNZ32602 (eng, jpn, kor, por, rus, tur)
XPSUEP User Guide	EIO0000003509 (eng) EIO0000003510 (fre) EIO0000003511 (ger) EIO0000003513 (spa) EIO0000003512 (ita) EIO0000003516 (chi)
XPSUEP Instruction Sheet	PHA71854 (eng, fre, ger, ita, spa, chi) PHA71855 (eng, jpn, kor, por, rus, tur)
XpsuSupport Library Guide	EIO0000004435 (eng) EIO0000004436 (ger)

Product Related Information

⚠DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Disconnect all power from all equipment including connected devices prior to removing any covers or doors, or installing or removing any accessories, hardware, cables, or wires except under the specific conditions specified in the appropriate hardware guide for this equipment.
- Always use a properly rated voltage sensing device to confirm the power is off where and when indicated.
- Where 24 Vdc or Vac is indicated, use PELV power supplies conforming to IEC 60204-1.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to this equipment.
- Use only the specified voltage when operating this equipment and any associated products.

Failure to follow these instructions will result in death or serious injury.

This equipment has been designed to operate outside of any hazardous location. Only install this equipment in zones known to be free of a hazardous atmosphere.

⚠DANGER

POTENTIAL FOR EXPLOSION

Install and use this equipment in non-hazardous locations only.

Failure to follow these instructions will result in death or serious injury.

⚠WARNING

LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths and, for certain critical control functions, provide a means to achieve a safe state during and after a path failure. Examples of critical control functions are emergency stop and overtravel stop, power outage and restart.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths may include communication links. Consideration must be given to the implications of unanticipated transmission delays or failures of the link.
- Observe all accident prevention regulations and local safety guidelines.[1]
- Each implementation of this equipment must be individually and thoroughly tested for proper operation before being placed into service.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

[1] For additional information, refer to NEMA ICS 1.1 (latest edition), "Safety Guidelines for the Application, Installation, and Maintenance of Solid State Control" and to NEMA ICS 7.1 (latest edition), "Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems" or their equivalent governing your particular location.

⚠WARNING

INSUFFICIENT AND/OR INEFFECTIVE SAFETY-RELATED FUNCTIONS

- Verify that a risk assessment as per ISO 12100 and/or other equivalent assessment has been performed before this product is used.
- Fully read and understand all pertinent manuals before performing any type of work on or with this product.
- Verify that modifications do not compromise or reduce the Safety Integrity Level (SIL), Performance Level (PL) and/or any other safety-related requirements and capabilities defined for your machine/process.
- After modifications of any type whatsoever, restart the machine/process and verify the correct operation and effectiveness of all functions by performing comprehensive tests for all operating states, the defined safe state, and all potential error situations.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Terminology Derived from Standards

The technical terms, terminology, symbols and the corresponding descriptions in this manual, or that appear in or on the products themselves, are generally derived from the terms or definitions of international standards.

In the area of functional safety systems, drives and general automation, this may include, but is not limited to, terms such as *safety*, *safety function*, *safe state*, *fault*, *fault reset*, *malfunction*, *failure*, *error*, *error message*, *dangerous*, etc.

Among others, these standards include:

Standard	Description
IEC 61131-2:2007	Programmable controllers, part 2: Equipment requirements and tests.
ISO 13849-1:2015	Safety of machinery: Safety related parts of control systems. General principles for design.
EN 61496-1:2013	Safety of machinery: Electro-sensitive protective equipment. Part 1: General requirements and tests.
ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk reduction
EN 60204-1:2006	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
ISO 14119:2013	Safety of machinery - Interlocking devices associated with guards - Principles for design and selection
ISO 13850:2015	Safety of machinery - Emergency stop - Principles for design
IEC 62061:2015	Safety of machinery - Functional safety of safety-related electrical, electronic, and electronic programmable control systems
IEC 61508-1:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems: General requirements.
IEC 61508-2:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems: Requirements for electrical/electronic/programmable electronic safety-related systems.
IEC 61508-3:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems: Software requirements.
IEC 61784-3:2016	Industrial communication networks - Profiles - Part 3: Functional safety fieldbuses - General rules and profile definitions.
2006/42/EC	Machinery Directive
2014/30/EU	Electromagnetic Compatibility Directive
2014/35/EU	Low Voltage Directive

In addition, terms used in the present document may tangentially be used as they are derived from other standards such as:

Standard	Description
IEC 60034 series	Rotating electrical machines
IEC 61800 series	Adjustable speed electrical power drive systems
IEC 61158 series	Digital data communications for measurement and control – Fieldbus for use in industrial control systems

Finally, the term *zone of operation* may be used in conjunction with the description of specific hazards, and is defined as it is for a *hazard zone* or *danger zone* in the *Machinery Directive* (*2006/42/EC*) and *ISO 12100:2010*.

NOTE: The aforementioned standards may or may not apply to the specific products cited in the present documentation. For more information concerning the individual standards applicable to the products described herein, see the characteristics tables for those product references.

Introduction

Device Overview

Outline

XPSUVN is a safety module for interruption of safety-related electrical circuits.

The safety module provides for sensorless standstill monitoring of a motor. The safety module measures the residual voltage that is generated by remanent magnetization after power to the motor is removed and while it coasts down. The voltage is measured via an analog voltage measuring input to determine when standstill has actually been reached. This can be used to implement a safety-related function such as controlling an interlocking device with guard locking.

The following types of motors which generate a measurable residual voltage when coasting down after power supply has been removed can be connected to the safety-related input of the device:

- Three-phase AC motors
- Single-phase AC motors
- DC motors
- Three-phase AC motors with star-delta wiring

The safety module can monitor motors that are operated via mains as well as motors that are controlled by electronic motor control equipment such as frequency inverters.

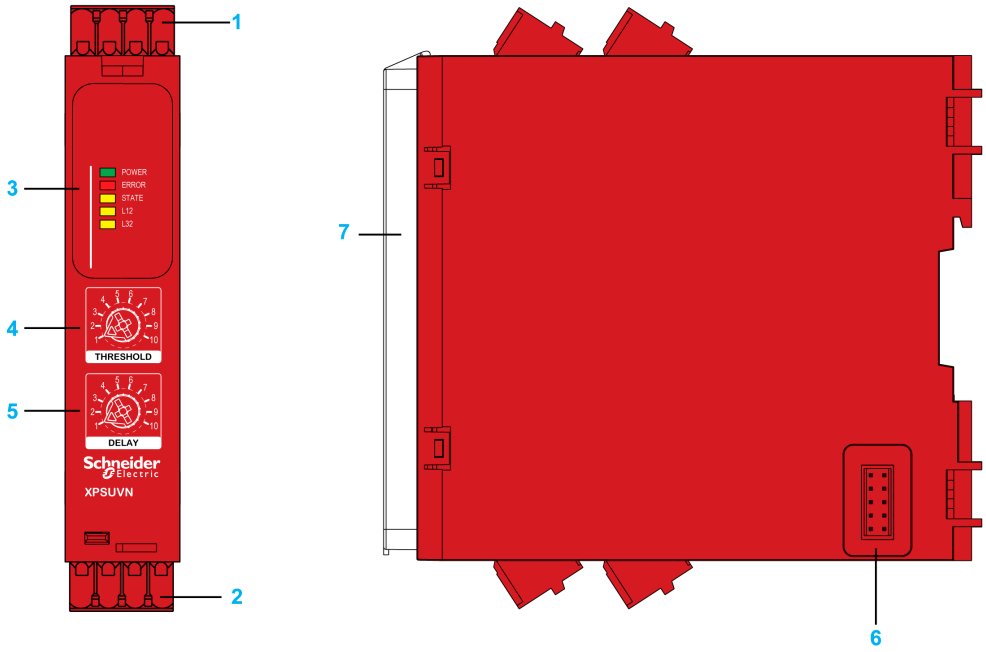
The safety module is available in four different types: either spring terminals or screw terminals and either 24 Vac/Vdc supply voltage or 48 … 240 Vac/Vdc supply voltage.

Feature summary:

- Standstill monitoring
- Safety-related analog measuring input
- Configurable voltage threshold
- Configurable activation delay for safety-related outputs
- Broken wire detection
- One safety-related output consisting of two normally open (NO) relay contacts
- One non-safety-related binary status output
- One non-safety-related pulsed diagnostics output
- Connector for connection of extension module XPSUEP to increase the number of safety-related outputs by six

Front View and Side View

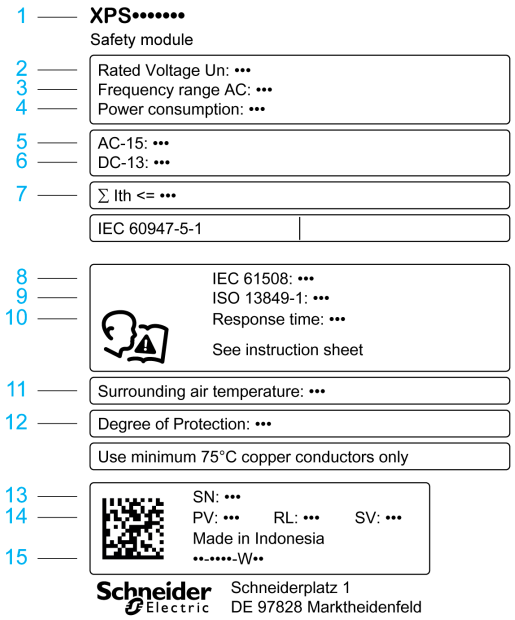
Front View and Side View



1	Removable terminal blocks, top
2	Removable terminal blocks, bottom
3	LED indicators
4	Voltage threshold selector
5	Activation delay selector
6	Connector for optional output extension module XPSUEP (lateral)
7	Sealable transparent cover

Nameplate

Nameplate



The nameplate contains the following data:

1	Device type (refer to chapter Type Code, page 13)
2	Nominal voltage
3	Frequency range Vac supply
4	Input power
5	Maximum current of safety-related outputs with utilization category AC15 (250 Vac)
6	Maximum current of safety-related outputs with utilization category DC13 (24 Vdc)
7	Maximum total thermal current
8	Maximum Safety Integrity Level (SIL) as per IEC 61508-1:2010
9	Maximum Performance Level and Category as per ISO 13849-1:2015
10	Maximum response time to request at safety-related input
11	Permissible ambient temperature range during operation
12	IP degree of protection
13	Serial number
14	Product version (PV), release (RL), software version (SV)
15	Plant code and date of manufacture (example: PP-2019-W10 means plant code PP, year of manufacture 2019, week of manufacture 10)

Type Code

Type Code

Item	1	2	3	4	5	6	7	8	9	10
Type code (example)	X	P	S	U	V	N	1	1	A	C

Item	Meaning
1 ... 4	**Product range** XPSU = Universal
5 ... 6	**Product version** VN
7	**Supply voltage** 1 = 24 Vac/Vdc 3 = 48 … 240 Vac/Vdc
8 ... 9	**Number of safety-related outputs** 1A = 1 normally open relay contact
10	**Terminal type** C = Spring terminals, removable P = Screw terminals, removable

If you have questions concerning the type code, contact your Schneider Electric service representative.

Technical Data

Environmental Conditions

Environmental Conditions For Storage

Environmental parameters:

Characteristic	Value
Ambient temperature	-40 ... 70 °C (-40 ... 158 °F)
Rate of change of temperature	1 °C/min (1.8 °F/min)
Ambient humidity	10 ... 100 % relative humidity

Mechanical conditions:

Characteristic	Value
Vibration, sinusoidal, displacement amplitude 2 ... 9 Hz	1.5 mm
Vibration, sinusoidal, acceleration amplitude 9 ... 200 Hz	5 m/s^2
Shock, shock response spectrum type L, peak acceleration	40 m/s^2

Environmental Conditions For Transportation

Environmental parameters:

Characteristic	Value
Ambient temperature	-25 ... 85 °C (-13 ... 185 °F)
Ambient humidity	5 ... 95 % relative humidity, no condensation

Mechanical conditions:

Characteristic	Value
Vibration, sinusoidal, displacement amplitude 2 ... 9 Hz	3.5 mm
Vibration, sinusoidal, acceleration amplitude 9 ... 200 Hz	10 m/s^2
Vibration, sinusoidal, acceleration amplitude 200 ... 500 Hz	15 m/s^2
Shock, shock response spectrum type I, peak acceleration	100 m/s^2
Shock, shock response spectrum type II, peak acceleration	300 m/s^2

Environmental Conditions For Operation

Characteristic	Value
Maximum installation altitude above mean sea level	2000 m (6562 ft)
Installation required in control cabinet/enclosure with degree of protection	IP54

Environmental parameters:

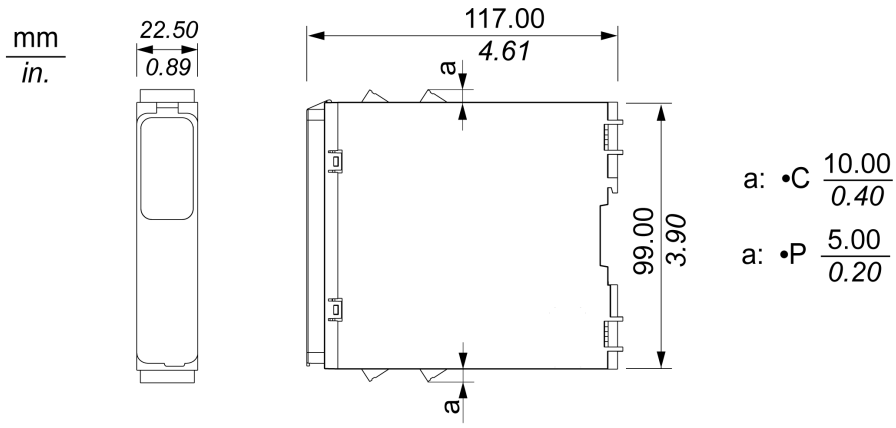
Characteristic	Value
Ambient temperature	-25 ... 55 °C (-13 ... 131 °F), no icing **NOTE:** Refer to Safety-Related Outputs, page 18 for derating information.
Rate of change of temperature	0.5 °C/min (0.9 °F/min)
Ambient humidity	5 ... 95 % relative humidity, no condensation

Mechanical conditions:

Characteristic	Value
Vibration, sinusoidal, displacement amplitude 2 ... 9 Hz	3 mm
Vibration, sinusoidal, acceleration amplitude 9 ... 200 Hz	10 m/s^2
Shock, shock pulse shape: half-sine, peak acceleration	150 m/s^2

Mechanical Characteristics

Dimensions



Characteristic	Value	
	XPSUVN•••C	**XPSUVN•••P**
Width	22.5 mm (0.89 in)	
Height without terminals	99 mm (3.90 in)	
Height with terminals	119 mm (4.70 in)	109 mm (4.30 in)
Depth	117 mm (4.61 in)	

Weight

Characteristic	Value
Weight	0.2 kg (0.44 lbs)

Degree Of Protection

Characteristic	Value
Housing	IP40
Terminals	IP20

Wire Cross Sections, Stripping Lengths, and Tightening Torques

Spring terminals

Characteristic	Value
Stripping length	12 mm (0.47 in)
Wire cross section, single wire (solid or stranded) without wire ferrule	0.2 ... 2.5 mm² (AWG 24 ... 12)
Wire cross section, single wire (stranded) with insulated or uninsulated wire ferrule	0.25 ... 2.5 mm² (AWG 24 ... 12)
Wire cross section, two wires (stranded) with insulated twin wire ferrule	0.5 ... 1.0 mm² (AWG 20 ... 18)

Screw terminals

Characteristic	Value
Stripping length	7 ... 8 mm (0.28 ... 0.31 in)
Tightening torque	0.5 Nm (4.4 lb-in)
Wire cross section, single wire (solid or stranded) without wire ferrule	0.2 ... 2.5 mm² (AWG 24 ... 12)
Wire cross section, single wire (stranded) with insulated or uninsulated wire ferrule	0.25 ... 2.5 mm² (AWG 24 ... 12)
Wire cross section, two wires (solid or stranded) without wire ferrule	0.2 ... 1.5 mm² (AWG 24 ... 16)
Wire cross section, two wires (stranded) with uninsulated wire ferrules	0.25 ... 0.75 mm² (AWG 24 ... 20)
Wire cross section, two wires (stranded) with insulated twin wire ferrule	0.5 ... 1.5 mm² (AWG 20 ... 16)

Electrical Characteristics

Supply

Characteristic	Value	
	XPSUVN1•••	**XPSUVN3•••**
Supply voltage AC	24 Vac (-15 ... 10 %)	48 ... 240 Vac (-10 ... 10 %)
Supply voltage DC	24 Vdc (-20 ... 20 %)	48 ... 240 Vdc (-10 ... 10 %)
Nominal input power AC	5.5 VA (24 Vac)	9 VA (240 Vac)
Nominal input power DC	2.0 W (24 Vdc)	2.5 W (48 Vdc)
Frequency range AC	50 ... 60 Hz	
Overvoltage category	II	
Pollution degree	2	
Rated insulation voltage (isolation) as per IEC 60947-5-1	300 V	
Impulse withstand voltage	4 kV	

Electromagnetic Compatibility (EMC)

Characteristic	Value	
	XPSUVN1•••	**XPSUVN3•••**
Conducted and radiated emissions as per IEC CISPR 11	Group 1/class B	Group 1/class A
Usage in environment as per IEC/UL 60947-1	Environment B	Environment A

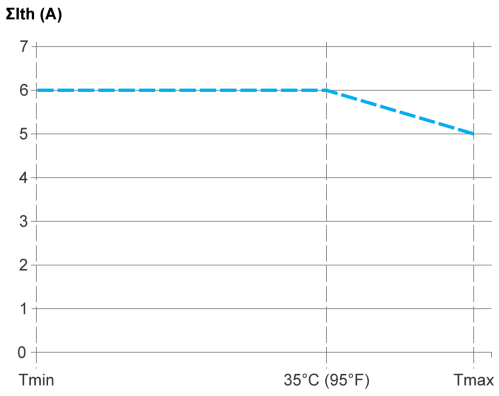
Common Reference Potential

Terminal B2 is provided to obtain a common reference potential for 24 Vdc signals.

Safety-Related Analog Input

Characteristic	Value
Frequency range of residual voltage for detection of motor standstill	0 ... 1 kHz
Overvoltage category	II
Pollution degree	2
Rated insulation voltage phase-to-ground (isolation) as per IEC 60947-5-1	400 V
Rated insulation voltage phase-to-phase (isolation) as per IEC 60947-5-1	690 V
Impulse withstand voltage	6 kV
Measured voltages	U12 between terminals L1 and L2 U32 between terminals L3 and L2
Adjustable voltage thresholds for detection of motor standstill (values are peak-to-peak for AC voltage)	50 mV, 65 mV, 85 mV, 110 mV, 140 mV, 180 mV, 230 mV, 300 mV, 400 mV, 500 mV
Hysteresis for adjustable voltage thresholds for detection of motor movement	100 %

Safety-Related Outputs

Characteristic	Value
Number of safety-related outputs, consisting of two normally open relay contacts each	1
Maximum short circuit current IK	0.6 kA
Maximum continuous current	6 A
Maximum total thermal current ΣIth in free air up to 55°C (131°F) and for side-by-side mounting up to 35°C (95°F)	6 A
Maximum total thermal current ΣIth for side-by-side mounting at 55° C (131°F)	5 A Derating curve (derating starting at 35 °C (95 °F)): 
Minimum load	10 mA / 5 V
Utilization category as per UL 60947-5-1	B300 and R300
Utilization category as per IEC 60947-4-1 and IEC 60947-5-1)	AC1: 250 V AC15: 250 V DC1: 24 V DC13: 24 V

Characteristic	Value
Maximum current, normally open relay contacts	AC1: 5 A AC15: 3 A DC1: 5 A DC13: 3 A
External fusing	6 A, category gG

Additional Non-Safety-Related Outputs Z1 and Z2

Characteristic	Value
Number of semiconductor pulsed outputs	1
Number of semiconductor binary status outputs	1
Output voltage	24 Vdc
Maximum current	20 mA

Timing Data

Maximum Response Times

Characteristic	Value	
	XPSUVN1•••	**XPSUVN3•••**
Maximum response time to request at safety-related input	20 ms	
Maximum response time after power outage AC	120 ms	80 ms
Maximum response time after power outage DC	80 ms	80 ms

Switch-On Delays

Characteristic	Value
Switch on delay after power on	2500 ms

Delay Times for Activation Delay for Safety-Related outputs (Delay Selector)

Characteristic	Value
Configurable values	0.5 s, 1 s, 2 s, 3 s, 5 s, 8 s, 12 s, 20 s, 35 s, 60 s

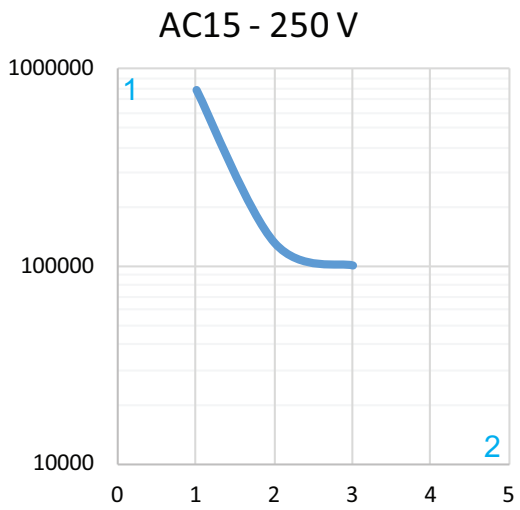
Data Functional Safety

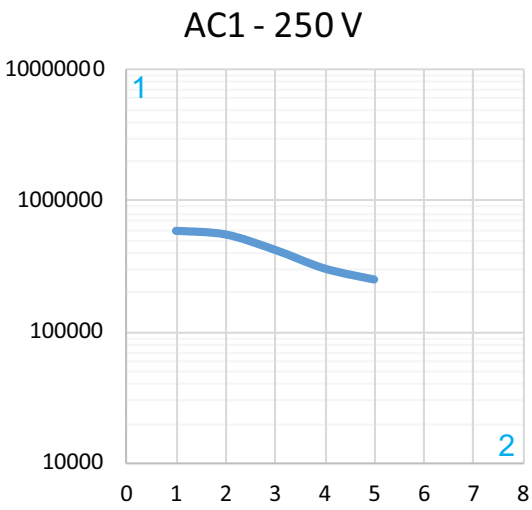
Data Functional Safety

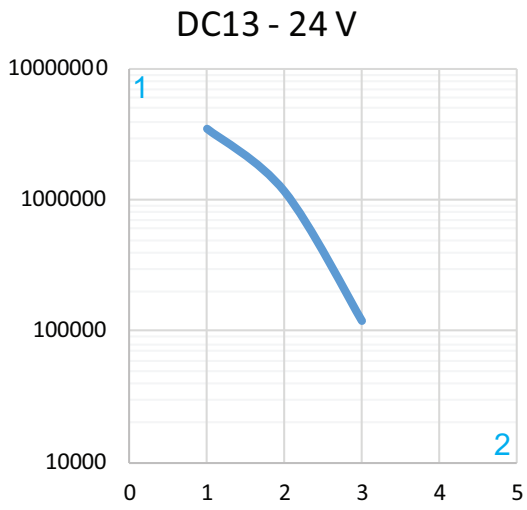
Characteristic	Value	
	XPSUVN1•••	**XPSUVN3•••**
Defined safe state	Safety-related outputs are de-energized Normally open relay contacts: open	
Maximum Performance Level (PL), Category (as per ISO 13849-1:2015)	PL e, Category 3 Actual PL and category depend on application.	

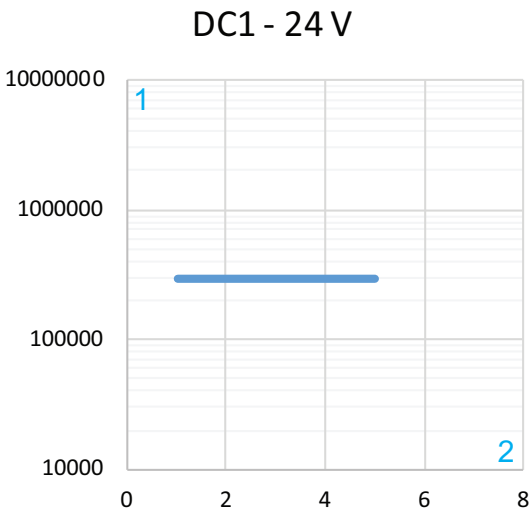
Characteristic	**Value**	
	XPSUVN1•••	**XPSUVN3•••**
Maximum Safety Integrity Level (SIL) (as per IEC 61508-1:2010)	3 Actual SIL depends on application.	
Safety Integrity Level Claim Limit (SILCL) (as per IEC 62061:2005+AMD1:2012+AMD2:2015)	3 Actual SILCL depends on application.	
Type (as per IEC 61508-2)	B	
Hardware Fault Tolerance (HFT) (as per IEC 61508 and IEC 62061)	1	
Lifetime in years at an ambient temperature of 55 °C (131 °F)	20	
Safe Failure Fraction (SFF) (as per IEC 61508 and IEC 62061)	>99 %	
Probability of Dangerous Failure per hour (PFHD) in 1/h (as per IEC 61508 and ISO 13849-1)	2.39×10^{-9}	2.44×10^{-9}
Mean Time To Dangerous Failure (MTTFd) in years (high as per ISO 13849-1)	>30	
Average Diagnostic Coverage (DC_{avg}) (medium as per ISO 13849-1)	98.8 %	98.9 %
Demand mode of operation (as per IEC-61508-1, IEC-62061)	High/continuous	
Maximum number of cycles over lifetime	DC13, 24 Vdc 1 A: 361000 DC13, 24 Vdc 3 A: 12000 AC1, 250 Vac 4 A: 303000 AC15, 250 Vac 1 A: 780000 AC15, 250 Vac 3 A: 100000	

Electrical durability of the safety-related output relay contacts as per IEC 60947-5-1









1 Operating cycles

2 Rated current in A

Refer to chapter Timing Data, page 19 for additional technical data that may affect your functional safety calculations.

Engineering

Electromagnetic Compatibility (EMC)

Conducted and Radiated Electromagnetic Emissions

Equipment of class A as per IEC CISPR 11 is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

⚠WARNING

INSUFFICIENT ELECTROMAGNETIC COMPATIBILITY

- Verify compliance with all EMC regulations and requirements applicable in the country in which the device is to be operated and with all EMC regulations and requirements applicable at the installation site.
- Do not install and operate devices of class A as per IEC CISPR 11 in residential environments.
- Implement all required radio interference suppression measures and verify their effectiveness.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

According to IEC CISPR 11, the safety module of type XPSUVN1••• is a group 1, class B device. Class B as per IEC CISPR 11 corresponds to environment B as per IEC 60947-1.

According to IEC CISPR 11, the safety module of type XPSUVN3••• is a group 1, class A device. Class A as per IEC CISPR 11 corresponds to environment A as per IEC 60947-1.

Principles of Operation

Introduction

The following sections provide basic information on the principles of operation of the safety module to assist you in engineering your application function.

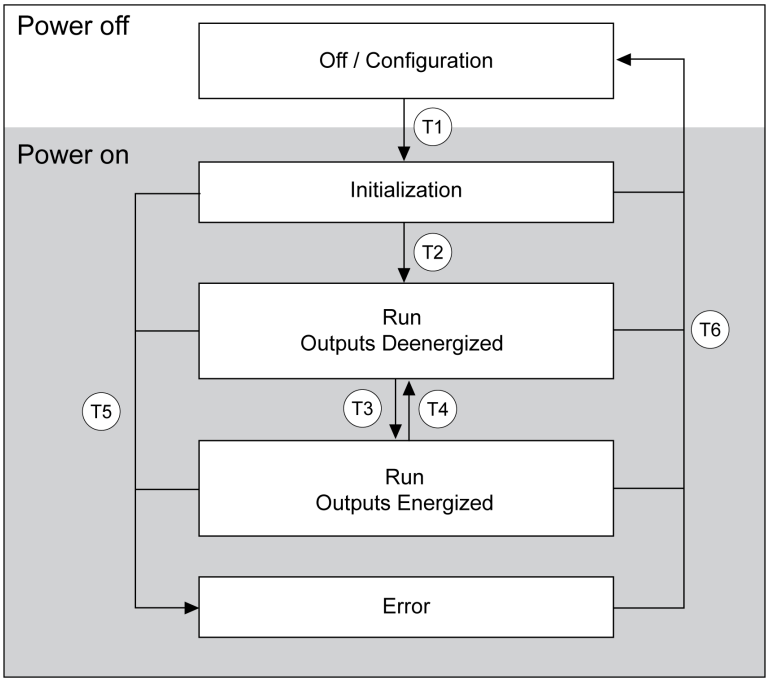
General Information on Activation and Deactivation of Safety-Related Inputs and Safety-Related Outputs

In the present document, “activation” of a safety-related input means that a safety-related input changes its state so that the safety module can enter the operating state Run: Outputs Energized. As a result, the safety-related outputs are “activated” (energized). In this condition, the safety module is not in the defined safe state.

The term “deactivation” of a safety-related input means that a safety-related input changes its state so that the safety module enters the operating state Run: Outputs Deenergized. As a result, the safety-related outputs are “deactivated” (deenergized). In this condition, the safety module is in the defined safe state.

Operating States

The following graphic illustrates the operating states and state transitions of the safety module:



Operating state	Description	In defined safe state
Off / Configuration	Configuration only possible in this operating state	Yes
Initialization	Self-tests	Yes
Run: Outputs Deenergized	Regular operation with safety-related function active	Yes
Run: Outputs Energized	Regular operation with safety-related function not active	No
Error	Error detected	Yes

NOTE: Refer to the chapter Data Functional Safety, page 19 for the defined safe state of the safety module.

State Transitions

State transition	Condition
T1	• Power on
T2	• Initialization successful • Switch on delay has passed
T3	• Safety-related inputs activated
T4	• Safety-related inputs deactivated (corresponds to triggering of the safety-related function)
T5	• Error detected
T6	• Power off

NOTE: Refer to the chapter General Information on Activation and Deactivation of Safety-Related Inputs and Safety-Related Outputs, page 22 for details on the use of the terms “activated” and “deactivated” in the present document.

Operating States and Timing - General Overview

The following description provides an overview of the operation of the safety module with the various operating states.

- After the safety module is powered on, it enters the operating state Initialization (T1).

- If the initialization is successful, the safety module enters the operating state Run: Outputs Deenergized (T2).

  If an error is detected, the safety module transitions to the operating state Error (T5).
- When entering the operating state Run: Outputs Deenergized, the safety module measures the voltage at the safety-related analog input.

  If the voltage at the safety-related analog input is above the adjusted threshold voltage , the motor is considered not to be at a standstill and the safety module remains in the operating state Run: Outputs Deenergized.

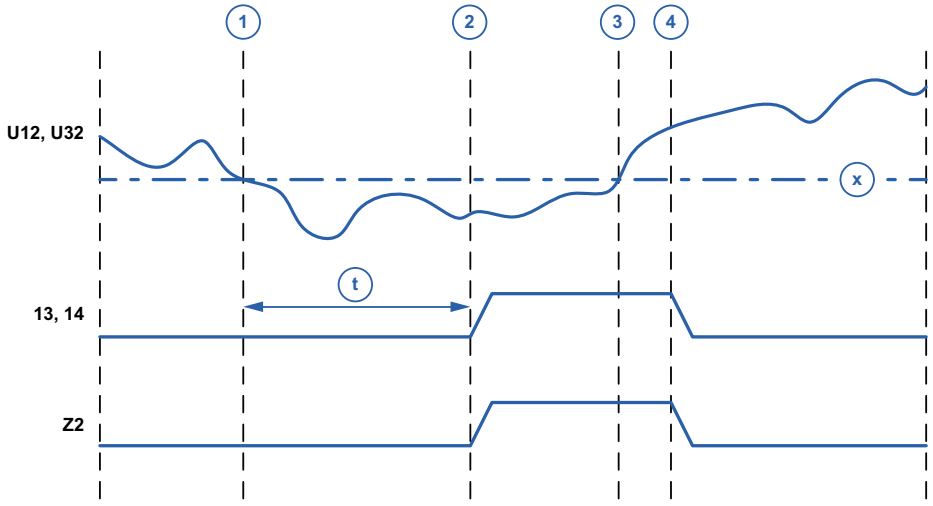
  If the voltage at the safety-related analog input is below the adjusted threshold voltage and remains below it for the adjusted activation delay, the motor is considered to be at a standstill and the safety module transitions to the operating state Run: Outputs Energized (T3).
- If the power to the motor is removed, the motor coasts down and the voltage drops.

  If the voltage drops below the adjusted voltage threshold, but does not stay below it for the adjusted activation delay, the motor is not considered to be at a standstill and the safety module remains in the operating state Run: Outputs Deenergized.

  If the voltage drops below the adjusted voltage threshold and remains below it for the adjusted activation delay, the motor is considered to be at a standstill and the safety module transitions to the operating state Run: Outputs Energized) (T3).
- To return to the operating state Run: Outputs Deenergized (T4), power needs to be applied to the motor and the voltage at the safety-related analog input needs to increase above the adjusted voltage threshold).

  NOTE: The safety module operates with automatic start/restart.

Timing Diagram - General Overview



Legend

Item	Description
1	• The motor is coasting down and the measured voltage drops below the adjusted voltage threshold (x). • The adjusted activation delay, page 19 (t) starts to elapse. The safety module remains in the defined safe state.
2	• The adjusted activation delay (t) has elapsed. The measured voltage has been below the adjusted voltage threshold (x) for the duration of the activation delay (t). • The safety-related outputs are energized. The safety module is not in the defined safe state. • The non-safety-related status output Z2 is activated.

Item	Description
3	• The measured voltage increases above the adjusted voltage threshold (x).
4	• The measured voltage increases above the adjusted voltage threshold including the hysteresis, page 29 for detection of motor movement. • The safety-related output is deactivated within the response time, page 19. • The safety module is in the defined safe state.

Refer to Timing with Activation Delay and Hysteresis, page 30 for further details on timing.

Voltage Measurement

General Information

The safety module allows for sensorless standstill monitoring of a motor by measuring the residual voltage that is generated by remanent magnetization after power to the motor is removed and the motor coasts down or has reached standstill. An adjustable voltage threshold is used to determine whether the motor is considered to be at a standstill:

- Residual voltage above voltage threshold: Motor is considered not to be at a standstill
- Residual voltage below voltage threshold: Motor is considered to be at a standstill if the adjustable activation delay has fully elapsed.

The safety module does not directly measure velocity or standstill like, for example, an encoder does. The safety module determines standstill as a condition derived from the measured residual voltage. The amount of residual voltage decreases proportionally to the speed of the motor. A variety of factors can affect the measurement of the residual voltage and, as a result, the conditions under which the safety module transitions from and to the defined safe state. Among others, these factors include:

- Changing load, inertia, and friction can influence the way the motor coasts down and, by implication, the residual voltage values measured at a given point in time.
- Changes in the voltage level below the adjusted voltage threshold can imply slight motor movements that are not detected by the safety module.
- External forces acting on the motor (such as suspended loads or movements of the mechanical system and the motor caused by persons) can cause voltage (motor as generator) above the voltage threshold and trigger a transition to the defined safe state.
- Radiated and/or conducted electromagnetic interference may affect the measurement.

⚠WARNING

INSUFFICIENT AND/OR INEFFECTIVE SAFETY-RELATED FUNCTION

- In your risk assessment, consider all factors that can have an impact on the residual voltage measured by the device.
- Take all measures required to ensure that any voltage value measured when the device is not in the defined safe state actually corresponds to a physical standstill of the motor, for example, by removing all power to the motor or by using properly rated mechanical brakes.
- Verify that radiated and/or conducted electromagnetic interference at the installation site does not affect the measurement.
- Verify correct operation and effectiveness of all functions by performing comprehensive tests for all operating states, the defined safe state, and all potential error situations under all load, inertia, and friction conditions that can occur in your machine/process.

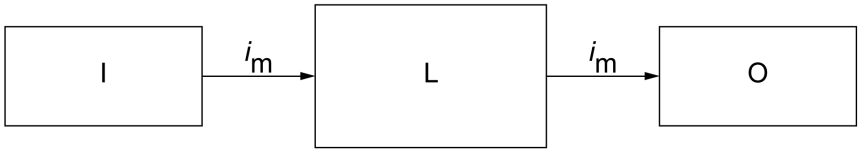
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Single-Channel Voltage Measurement and Dual-Channel Voltage Measurement

The safety module provides two measurement channels to the safety-related input which are implemented via terminals L1 and L2 (channel 1 for measurement of voltage U12) and terminals L3 and L2 (channel 2 for measurement of voltage U32).

The safety module itself provides the functional safety characteristics specified in the chapter Data Functional Safety, page 19. However, the actual functional safety data of the function you implement with the safety module depend on your application. The maximum functional safety characteristics specified can be reached if the safety module is used to measure the residual voltage of two separate motor phases of a motor via the two available measurement channels (dual-channel voltage measurement).

As defined by ISO 13849, a functional channel is a channel consisting of an input device I, a logic or processing device L and an output device O.



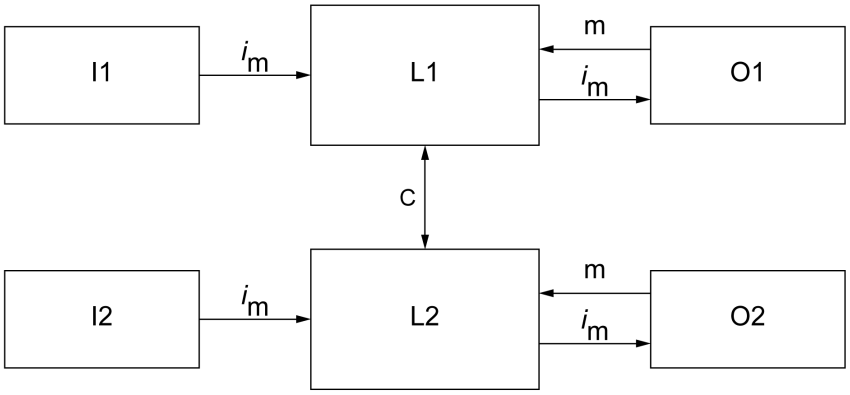
I = Input

***i*m** = Interconnecting means

L = Logic

O = Output

If both measurement channels of the safety module are used to measure the residual voltage U12 and U32 of two separate motor phases of a motor (dual-channel voltage measurement), this can be represented by the following structure in terms of ISO 13849:



I1, I2 = Inputs (correspond to motor windings/motor phases)

***i*m** = Interconnecting means

m = Monitoring

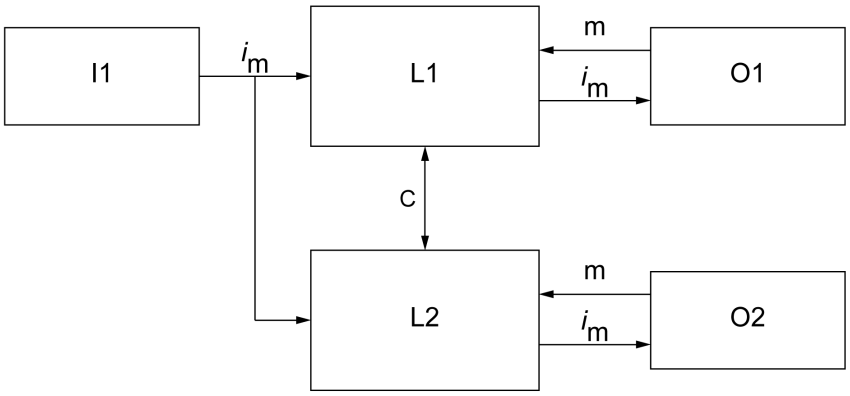
L1, L2 = Logic (corresponds to safety module)

O1, O2 = Outputs

c = Cross monitoring (corresponds to internal functions of the safety module)

I1 and I2 represent one motor phase each. They are connected to the safety module represented by L1 and L2 via two separate channels. In terms of ISO 13849, dual-channel voltage measurement corresponds to a designated architecture for up to category 4 which can reach a maximum Performance Level of e.

If the residual voltage U12 (or U32) of one motor phase of a motor is measured (single-channel voltage measurement), this can be represented by the following structure in terms of ISO 13849:



I1 = Inputs (correspond to motor winding/motor phase)

***i*m** = Interconnecting means

m = Monitoring

L1, L2 = Logic (corresponds to safety module)

O1, O2 = Outputs

c = Cross monitoring (corresponds to internal functions of the safety module)

In this case, the motor phase (I1) is connected to terminals L1 and L2 of the safety module. Terminals L1 and L3 are bridged. In terms of ISO 13849, single-channel voltage measurement corresponds to a designated architecture for category B and category 1. A category 1 architecture can reach a maximum Performance Level of c.

If the safety-related function to be implemented with the safety module is to reach the maximum functional safety values specified for the safety module in the chapter Data Functional Safety, page 19, you need to use dual-channel voltage measurement and meet all other requirements specified in the present document and resulting from your risk assessment.

Motor Types, Electronic Motor Control Equipment, Conditions, and Constraints

The following types of motors can be connected to the safety module, subject to the condition that the motors generate a residual voltage resulting from remanent magnetization that is measurable by the safety module:

- Three-phase AC motors
- Single-phase AC motors
- DC motors
- Three-phase AC motors with star-delta wiring

Terminals L1, L2, and L3 must be wired directly to the motor windings (for example, no transformers).

The state of the connection of the motor windings must remain identical at all velocities and at standstill (for example, no interruption, no short circuits).

If electronic motor control equipment such as frequency inverters or DC injection braking units are used, there must be no DC voltage at the analog safety-related input terminals of the safety module after the motor has reached a physical standstill.

If conducted or radiated interference is present in your application, use shielded wires to connect the motor to the safety-related analog input of the safety module. Connect the shield to the motor. Route the wires to the safety-related analog input separately from cables that may cause interference.

If multiple motors are connected, the total of the residual voltages of the connected motors must not be zero while the motors are still coasting down.

Electronic Motor Control Equipment

The safety module can be used with motors which are controlled by electronic motor control equipment such as variable speed drives (frequency inverters, servo drives), soft starters with soft stop, DC injection braking units, etc. under the following conditions:

- A residual voltage resulting from the remanent magnetization of the motor windings is available.
- This residual voltage can drop below the configurable voltage threshold that corresponds to motor standstill.
- At motor standstill, there is no DC voltage in addition to the residual voltage generated by the remanent magnetization of the motor windings.

If the safety module is in the defined safe state and DC voltage is detected at the safety-related analog input (for example, because a DC injection braking unit is used or a DC motor is connected), it can be detected as a broken wire condition, page 29 and the safety module does not exit the defined safe state. If there is no physical interruption of the circuit, this condition persists until the DC voltage is removed (for example, the DC injection braking unit is disabled).

Equipment or operating modes that do not remove the power to the motor when it is at a standstill (for example, certain types of position control) cannot be used with the safety module.

Wire Interruption

The safety module monitors the circuitry for the voltage between L1 and L2 (voltage U12) as well as between L3 and L2 (voltage U32) for wire interruption (also referred to as broken wire detection).

If one or more of the wires connected to L1 and/or L2 and/or L3 are interrupted, the safety module detects a broken wire condition.

When the motor is running (voltage above voltage threshold), a wire interruption at L2 is not indicated. In such a case, the safety module does not detect standstill (no transition from defined safe state).

A broken wire condition causes an alert. In the case of an alert, the safety module transitions to the defined safe state or remains in the defined safe state.

The safety module may detect a broken wire condition even if there is no physical interruption of the wire:

- Motor operated at very low velocity (at frequencies of less than 0.5 Hz)
- DC voltage detected

A broken wire condition can be detected if DC motors are connected or if DC voltage is introduced by electronic motor control equipment such as a variable speed drive or a DC injection braking unit.

The broken wire condition persists as long as this DC voltage is detected. Once the DC voltage is removed, the broken wire condition is cleared (no power cycle required) and the safety module can exit the defined safe state, provided the residual voltage is below the voltage threshold.

If you use a DC motor or electronic motor control equipment, you can ignore this condition if it does not persist beyond the removal of the DC voltage. If it persists, verify the integrity of the wiring to the safety module.

If you can exclude the presence of DC voltage, verify the integrity of the wiring to the safety module.

This condition is indicated by the LEDs, page 47 and available via status output Z1, page 48.

Activation Delay and Voltage Threshold

Overview

The measurement of the residual voltage resulting from the remanent magnetization of the motor windings uses an adjustable voltage threshold. When the measured voltage drops below this voltage threshold, the safety module considers the motor to be at a standstill. For detection of motor movement, the measured voltage must increase above the adjusted voltage threshold plus a hysteresis of 100 % of the adjusted voltage threshold value. The hysteresis is not used during coasting down of the motor for detection of motor standstill.

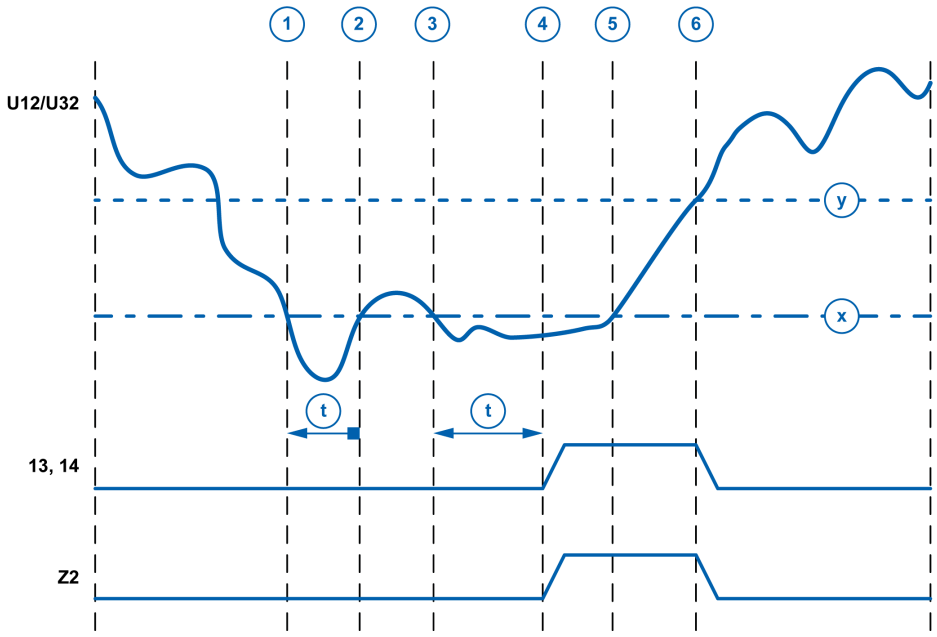
In addition, the safety module uses an adjustable activation delay. The activation delay is the period between the point in time at which the measured voltage drops below the adjusted voltage threshold and the point in time at which activation of the safety-related outputs is triggered. The activation delay must fully elapse

before the safety-related outputs are activated. If the measured voltage increases above the adjusted voltage threshold while the activation delay is running, the activation delay is reset to zero and the safety-related output remains deactivated.

The voltage threshold and the activation delay allow you to adapt the safety-related function to the motor used and to the specific conditions in your application that determine the way the motor coasts down (such as load, friction, and speed). In addition, the adjustable voltage threshold lets you compensate for constraints that may result from the EMC (Electromagnetic Compatibility) situation at the installation site of the machine/process.

Refer to the chapter Voltage Measurement, page 25 for information on the measuring principle.

Timing with Voltage Threshold, Activation Delay, and Hysteresis



x Voltage threshold

y Hysteresis

Timing

Item	Description
1	• The motor coasts down and the measured voltage drops below the voltage threshold (x). • The activation delay (t) starts to elapse. The safety module remains in the defined safe state.
2	• The measured voltage increases above the voltage threshold. The activation delay (t) has not fully elapsed and is, therefore, reset to 0. The safety module remains in the defined safe state.
3	• The measured voltage once again drops below the voltage threshold. The activation delay (t) restarts. The safety module remains in the defined safe state.
4	• The measured voltage has been below the adjusted voltage threshold (x) for the duration of the activation delay (t). • The safety-related outputs are energized. The safety module is not in the defined safe state. • Fluctuations in the measured voltage below the voltage threshold (x) up to line (5) must not correspond to physical movements of the motor (refer to General Information, page 25 for details).

Item	Description
5	• The motor restarts and the measured voltage increases above the voltage threshold (x). The safety module does not yet transition to the defined safe state.
6	• The measured voltage increases above the voltage threshold plus the hysteresis (y) of 100 % of the adjusted voltage threshold. • The safety-related output is deactivated within the response time. • The safety module is in the defined safe state.

Select the activation delay and the voltage threshold in such a way as to meet the requirements of your application.

For example, if the residual voltage values oscillate during coasting down as in the above diagram, you may want to increase the voltage threshold and the activation delay to cover the amplitude above the voltage threshold (after line 2). This keeps the safety module from restarting the activation delay and decreases the total time until the safety-related outputs are activated.

If, on the other hand, the residual voltage decreases monotonously and then remains at a constant value, you may use a lower voltage threshold value and/or a lower activation delay value.

Selectors for Activation Delay and Voltage Threshold

Refer to the chapter Front View and Side View, page 12 for the location of the selectors.

Activation delay selector:

Selector position	Value in s
1	0.5
2	1
3	2
4	3
5	5
6	8
7	12
8	20
9	35
10	60

Voltage threshold selector:

Selector position	Value in mV
1	50
2	65
3	85
4	110
5	140
6	180
7	230
8	300
9	400
10	500

Installation

Prerequisites and Requirements

Inspecting the Device

Damaged products may cause electric shock or unintended equipment operation.

⚠⚠DANGER

ELECTRIC SHOCK OR UNINTENDED EQUIPMENT OPERATION

- Do not use damaged products.
- Keep foreign objects (such as chips, screws or wire clippings) from getting into the product.

Failure to follow these instructions will result in death or serious injury.

Verify the product type by means of the type code, page 13 and the data printed on the device.

Control Cabinet/Enclosure

Install the safety module in a control cabinet or enclosure with degree of protection IP54 that is secured by a keyed or tooled locking mechanism.

The ventilation of the control cabinet/enclosure must be sufficient to comply with the specified ambient conditions for the safety module and the other components operated in the control cabinet/enclosure.

Label on Extension Module Connector

The connector for connection of the extension module XPSUEP is covered by a label. Do not remove the label from the connector unless you want to connect the extension module XPSUEP.

NOTICE

INOPERABLE EQUIPMENT

Do not remove the protective label from the extension connector unless you are immediately attaching an extension module.

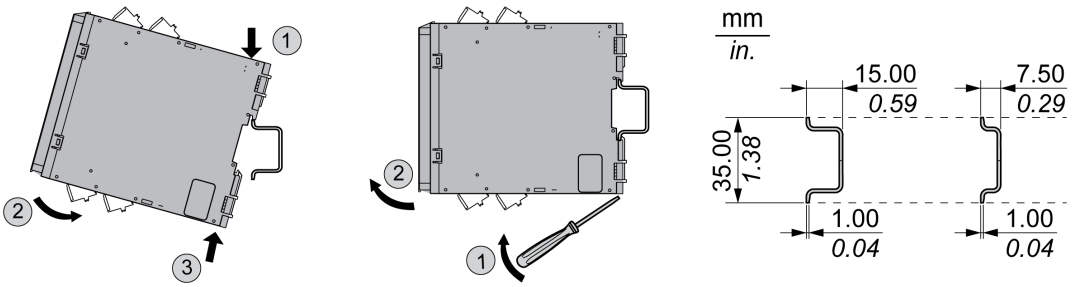
Failure to follow these instructions can result in equipment damage.

Mechanical Installation

Mounting to DIN Rail

The safety module can be mounted to the following DIN rails as per IEC 60715:

- 35 x 15 mm (1.38 x 0.59 in)
- 35 x 7.5 mm (1.38 x 0.29 in)



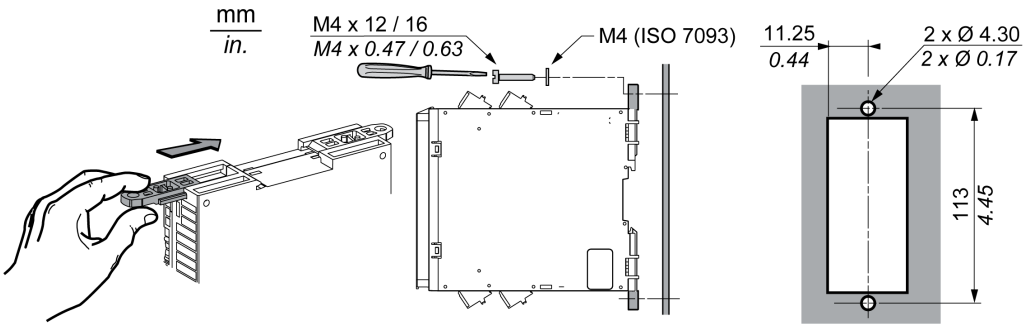
Mounting procedure (left illustration)

Step	Action
1	Slightly tilt the safety module and hook it onto the DIN rail.
2	Push the lower part of the safety module towards the DIN rail.
3	Snap in the DIN rail clip.

Dismounting procedure (center illustration)

Step	Action
1	Unlock the DIN rail clip using a screwdriver.
2	Pull the lower part of the safety module away from the DIN rail and lift the safety module towards the top to remove it from the DIN rail.

Screw-Mounting



Mounting procedure:

Step	Action
1	Push the additional fastener into the grooves at the safety module.
2	Prepare the holes.
3	Screw the safety module to the mounting surface using the specified screws and a washer M4 as per ISO 7093 for each screw.

Electrical Installation

General Information

⚠DANGER

FIRE, ELECTRIC SHOCK OR ARC FLASH

- Disconnect all power from all equipment of your machine/process prior to electrical installation of the device.
- Confirm the absence of power using a properly rated voltage sensing device.
- Place a "Do Not Turn On" or equivalent hazard label on all power switches and lock them in the non-energized position.

Failure to follow these instructions will result in death or serious injury.

Wiring of the safety module depends on the safety-related function to be implemented. Before wiring the safety module, engineer the safety-related function, perform a risk assessment with regard to your machine/process, and determine the suitability of the safety module as well as the connected equipment.

Refer to the Schneider Electric Safety Chain Solutions at https://www.se.com for examples of safety-related applications.

You can wire the safety module with the terminal blocks inserted, or you can remove the terminal blocks. For the latter, pull the terminal blocks out of the safety module, connect the individual terminals and push the terminal blocks back into the safety module.

Use 75 °C (167 °F) copper conductors to wire the safety module.

Wire Cross Sections, Stripping Lengths, and Tightening Torques

Spring terminals

Characteristic	Value
Stripping length	12 mm (0.47 in)
Wire cross section, single wire (solid or stranded) without wire ferrule	0.2 ... 2.5 mm^2 (AWG 24 ... 12)
Wire cross section, single wire (stranded) with insulated or uninsulated wire ferrule	0.25 ... 2.5 mm^2 (AWG 24 ... 12)
Wire cross section, two wires (stranded) with insulated twin wire ferrule	0.5 ... 1.0 mm^2 (AWG 20 ... 18)

Screw terminals

Characteristic	Value
Stripping length	7 ... 8 mm (0.28 ... 0.31 in)
Tightening torque	0.5 Nm (4.4 lb-in)
Wire cross section, single wire (solid or stranded) without wire ferrule	0.2 ... 2.5 mm^2 (AWG 24 ... 12)
Wire cross section, single wire (stranded) with insulated or uninsulated wire ferrule	0.25 ... 2.5 mm^2 (AWG 24 ... 12)
Wire cross section, two wires (solid or stranded) without wire ferrule	0.2 ... 1.5 mm^2 (AWG 24 ... 16)
Wire cross section, two wires (stranded) with uninsulated wire ferrules	0.25 ... 0.75 mm^2 (AWG 24 ... 20)
Wire cross section, two wires (stranded) with insulated twin wire ferrule	0.5 ... 1.5 mm^2 (AWG 20 ... 16)

Block Diagram and Terminals

The following drawings present the block diagram and the terminals with their designations in the removable terminal blocks.

The spring clamp terminals are designed for the connection of only a single wire if you do not use wire ferrules. A maximum of two wires may be connected to a spring clamp terminal if the wires are installed with a twin wire ferrule.

⚠⚠DANGER

LOOSE WIRING CAUSES ELECTRIC SHOCK

Do not connect more than one wire to a spring clamp terminal unless you use an approved twin wire ferrule and make the connection according to the specifications provided in the present document.

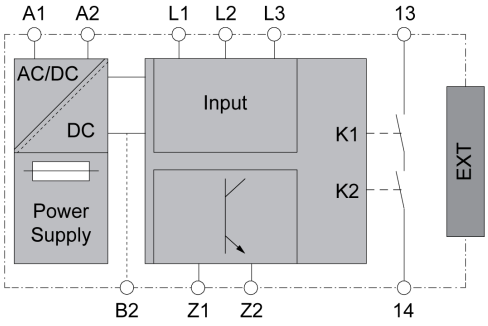
Failure to follow these instructions will result in death or serious injury.

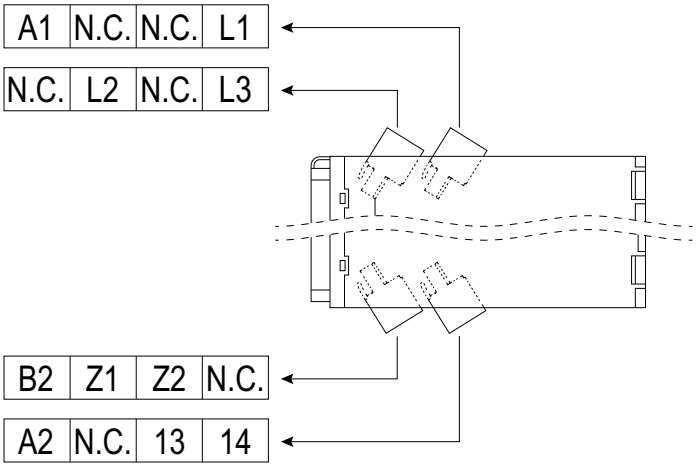
⚠WARNING

UNINTENDED EQUIPMENT OPERATION

Do not connect any wiring to reserved, unused connections, or to connections designated as No Connection (N.C.).

Failure to follow these instructions can result in death, serious injury, or equipment damage.





Terminal Designation	Explanation
A1, A2	Power supply
L1, L2, L3	Input channels of safety-related analog input
13, 14	Terminals of the safety-related outputs
B2	Terminal for common reference potential for 24 Vdc signals. The power supplies of the connected equipment must have a common

Terminal Designation	Explanation
	reference potential to be connected to this terminal. In the case of XPSUVN31A•, terminal B2 must be grounded. In the case of XPSUVN11A•, the safety module is already grounded via the PELV power supply unit connected to terminals A1 and A2.
Z1	Pulsed output for diagnostics, not safety-related
Z2	Solid state output, not safety-related
EXT	Connector for output extension module XPSUEP

Safety-Related Analog Input

⚠WARNING

INSUFFICIENT AND/OR INEFFECTIVE SAFETY-RELATED FUNCTIONS

- Verify that the motor to be connected to the safety-related input meets all requirements specified in the present document.
- Only connect a motor to the safety-related input that meets all requirements as per your risk assessment and that complies with all regulations, standards, and process definitions applicable to your machine/process.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The safety module provides a safety-related analog input with the terminals L1, L2, and L3. The safety module measures the voltage between L1 and L2 (U12) and between L3 and L2 (U32).

Refer to the chapter Engineering, page 22 for details on the measuring principle as well as conditions and constraints concerning motor. Refer to the chapter Application Functions, page 38 for details on wiring different types of motors.

Requirements:

- Directly connect the motor windings to the terminals of the safety-related analog input (not via transformers or similar equipment).
- Do not separate the motor windings from the wires connected to the terminals of the safety-related analog input by motor contactors or similar equipment.
- If conducted or radiated interference is present in your application, use shielded wires to connect the motor to the safety-related analog input of the safety module. Connect the shield to the motor. Route the wires to the safety-related analog input separately from cables that may cause interference.

Safety-Related Outputs

The wiring of the safety-related output depends on the safety-related function to be implemented.

Install fuses with the rating specified in the chapter Electrical Characteristics, page 18.

Additional, Non-Safety-Related Outputs Z1 and Z2

⚠WARNING

INCORRECT USE OF OUTPUT

Do not use the additional outputs Z1 and Z2 for safety-related purposes.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Connect the semiconductor pulsed output Z1 to a suitable input of the logic controller if you want to use the diagnostics pattern the output provides.

Connect the semiconductor binary status output Z2 to a suitable device for evaluation of the signal provided via this output. Output Z2 is activated when the safety-related outputs are activated.

The maximum wire length between the additional outputs Z1 or Z2 and connected equipment is 30 m (98.43 ft)

The common reference potential is established via terminal B2.

Power Supply

Connect the terminals A1 and A2 to a power supply providing the supply voltage specified for the safety module in the chapter Electrical Characteristics, page 17.

Common Reference Potential

Terminal B2 is provided to obtain a common reference potential for 24 Vdc signals.

The power supplies of the connected equipment must have a common reference potential.

In the case of XPSUVN31A•, terminal B2 must be grounded. In the case of XPSUVN11A•, the safety module is already grounded via the PELV power supply unit connected to terminals A1 and A2.

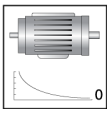
Functions

Application Functions

Introduction

The following sections provide an overview of the available application functions and a detailed listing of requirements and values as well as the wiring of the safety-related inputs for each of the application functions.

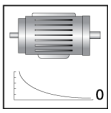
Overview of Application Functions

Typical applications	Type of motor
 Standstill monitoring	Three-phase AC motors Details, page 38
	Single-phase AC motors Details, page 39
	DC motors Details, page 40
	Three-phase AC motors (star-delta) Details, page 41

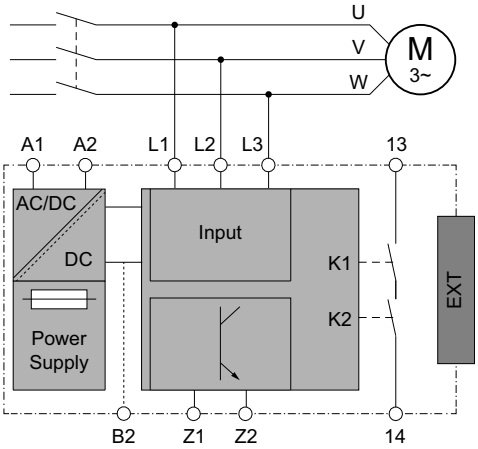
The wiring diagrams for the application functions present the wiring of the motor itself. The wiring of electronic motor control equipment such as variable speed drives (frequency inverters, servo drives), soft starters with soft stop, DC injection braking units, etc. you may use in your application depends on the equipment. Refer to the corresponding manuals for details on wiring such equipment.

The application function for standstill monitoring of three phase AC motors provides a wiring example with a frequency inverter and STO.

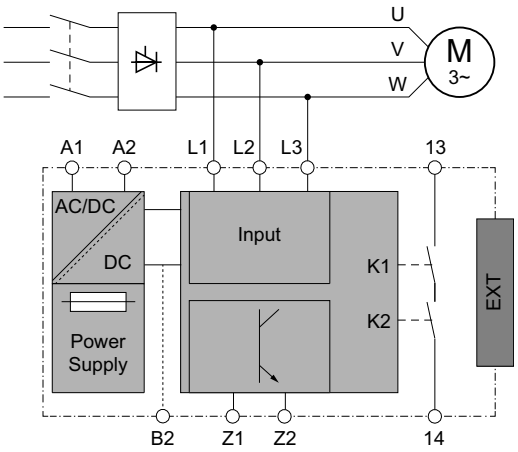
Standstill Monitoring of Three-Phase AC Motors

Characteristic	Value/Description
Application	 Standstill monitoring of three-phase motors
Terminals to be connected	Connect the motor phases to the terminals of the analog input: U to L1 V to L2 W to L3
Voltage threshold (configured via threshold selector, page 12)	50 mV, 65 mV, 85 mV, 110 mV, 140 mV, 180 mV, 230 mV, 300 mV, 400 mV, 500 mV
Activation delay (configured via delay selector, page 12)	0.5 s, 1 s, 2 s, 3 s, 5 s, 8 s, 12 s, 20 s, 35 s, 60 s
Single-channel/dual-channel voltage measurement, page 26	Dual-channel

Wiring of three-phase AC motor



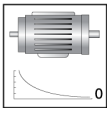
Wiring of three-phase AC motor with frequency inverter with STO (Safe Torque Off)



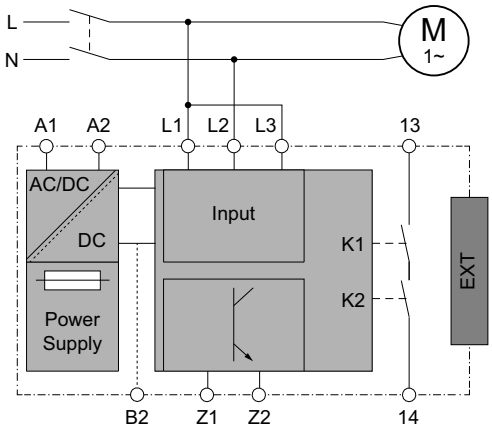
If the frequency inverter does not provide STO or if you do not want to use STO, you need to install a contactor between the frequency inverter and the motor.

If you want to monitor a three-phase motor via a single channel, you can, for example, connect U to L2, and V to L1 and L3. This type of wiring provides single-channel voltage measurement, page 26.

Standstill Monitoring of Single-Phase AC Motors

Characteristic	Value/Description
Application	 Standstill monitoring of single-phase motors
Terminals to be connected	Connect the motor phases to the terminals of the analog input: Phase to L1 and L3 Neutral to L2
Voltage threshold (configured via threshold selector, page 12)	50 mV, 65 mV, 85 mV, 110 mV, 140 mV, 180 mV, 230 mV, 300 mV, 400 mV, 500 mV
Activation delay (configured via delay selector, page 12)	0.5 s, 1 s, 2 s, 3 s, 5 s, 8 s, 12 s, 20 s, 35 s, 60 s
Single-channel/dual-channel voltage measurement, page 26	Single-channel

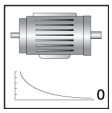
Wiring of single-phase AC motor



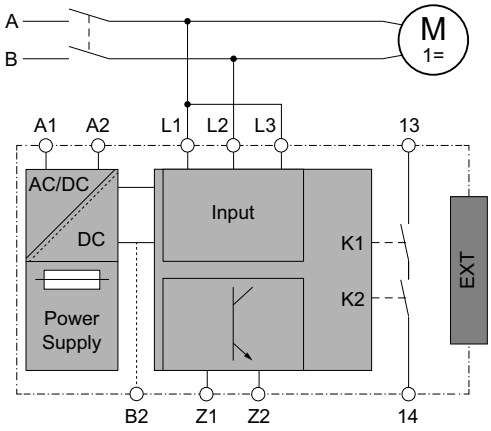
The wiring diagrams for the application functions present the wiring of the motor itself. The wiring of electronic motor control equipment such as variable speed drives (frequency inverters, servo drives), soft starters with soft stop, DC injection braking units, etc. you may use in your application depends on the equipment. Refer to the corresponding manuals for details on wiring such equipment.

The application function for standstill monitoring of three phase AC motors provides a wiring example with a frequency inverter and STO.

Standstill Monitoring of DC Motors

Characteristic	Value/Description
Application	 Standstill monitoring of DC motors
Terminals to be connected	Connect the motor to the terminals of the analog input: A to L1 and L3 B to L2
Voltage threshold (configured via threshold selector, page 12)	50 mV, 65 mV, 85 mV, 110 mV, 140 mV, 180 mV, 230 mV, 300 mV, 400 mV, 500 mV
Activation delay (configured via delay selector, page 12)	0.5 s, 1 s, 2 s, 3 s, 5 s, 8 s, 12 s, 20 s, 35 s, 60 s
Single-channel/dual-channel voltage measurement, page 26	Single-channel

Wiring of DC motor

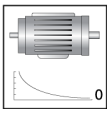


The wiring diagrams for the application functions present the wiring of the motor itself. The wiring of electronic motor control equipment such as variable speed drives (frequency inverters, servo drives), soft starters with soft stop, DC injection

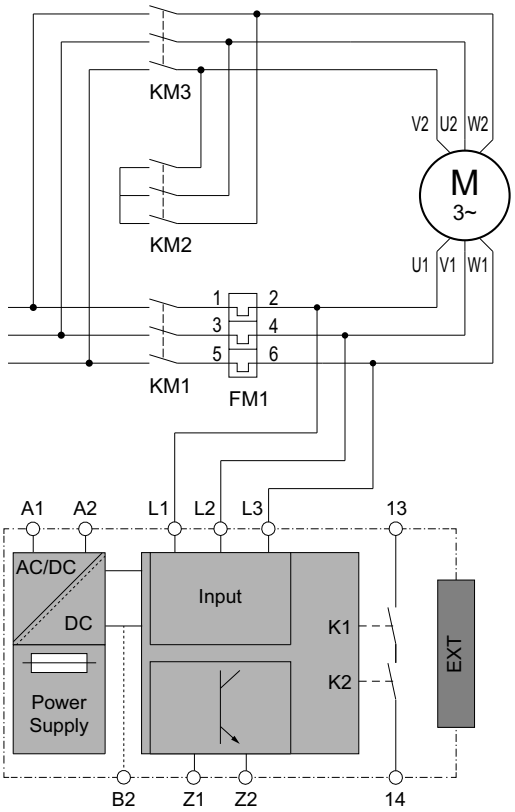
braking units, etc. you may use in your application depends on the equipment. Refer to the corresponding manuals for details on wiring such equipment.

The application function for standstill monitoring of three phase AC motors provides a wiring example with a frequency inverter and STO.

Standstill Monitoring of Three-Phase AC Motors with Star-Delta Wiring

Characteristic	Value/Description
Application	 Standstill monitoring of three-phase motors with star-delta wiring
Terminals to be connected	Connect the motor phases to the terminals of the analog input as shown in the wiring following diagram.
Voltage threshold (configured via threshold selector, page 12)	50 mV, 65 mV, 85 mV, 110 mV, 140 mV, 180 mV, 230 mV, 300 mV, 400 mV, 500 mV
Activation delay (configured via delay selector, page 12)	0.5 s, 1 s, 2 s, 3 s, 5 s, 8 s, 12 s, 20 s, 35 s, 60 s
Single-channel/dual-channel voltage measurement, page 26	Dual-channel

Wiring of three-phase motor, star-delta



After power has been removed from the motor, the star contactor (KM2) must be activated to allow for measurement of the residual voltage during coasting down.

The wiring diagrams for the application functions present the wiring of the motor itself. The wiring of electronic motor control equipment such as variable speed drives (frequency inverters, servo drives), soft starters with soft stop, DC injection braking units, etc. you may use in your application depends on the equipment. Refer to the corresponding manuals for details on wiring such equipment.

The application function for standstill monitoring of three phase AC motors provides a wiring example with a frequency inverter and STO.

Configuration and Commissioning

Configuration

Overview

⚠WARNING

INEFFECTIVE SAFETY-RELATED FUNCTION AND/OR UNINTENDED EQUIPMENT OPERATION

- Only modify the settings of the selectors of the device if you are fully aware of all effects of such modifications.
- Verify that the settings of the selectors match the intended safety-related function and the corresponding wiring of the device.
- Verify that modifications do not compromise or reduce the Safety Integrity Level (SIL), Performance Level (PL), and/or any other safety-related requirements and capabilities defined for your machine/process.
- Commission the device before it is used for the first time and after each configuration according to the instructions in the present manual and in compliance with all regulations, standards, and process definitions applicable to your machine/process

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The safety module does not directly measure velocity or standstill like, for example, an encoder does. The safety module determines standstill as a condition derived from the measured residual voltage. The amount of residual voltage decreases proportionally to the speed of the motor. A variety of factors can affect the measurement of the residual voltage and, as a result, the conditions under which the safety module transitions from and to the defined safe state. Among others, these factors include:

- Changing load, inertia, and friction can influence the way the motor coasts down and, by implication, the residual voltage values measured at a given point in time.
- Changes in the voltage level below the adjusted voltage threshold can imply slight motor movements that are not detected by the safety module.
- External forces acting on the motor (such as suspended loads or movements of the mechanical system and the motor caused by persons) can cause voltage (motor as generator) above the voltage threshold and trigger a transition to the defined safe state.
- Radiated and/or conducted electromagnetic interference may affect the measurement.

⚠WARNING

INSUFFICIENT AND/OR INEFFECTIVE SAFETY-RELATED FUNCTION

- In your risk assessment, consider all factors that can have an impact on the residual voltage measured by the device.
- Take all measures required to ensure that any voltage value measured when the device is not in the defined safe state actually corresponds to a physical standstill of the motor, for example, by removing all power to the motor or by using properly rated mechanical brakes.
- Verify that radiated and/or conducted electromagnetic interference at the installation site does not affect the measurement.
- Verify correct operation and effectiveness of all functions by performing comprehensive tests for all operating states, the defined safe state, and all potential error situations under all load, inertia, and friction conditions that can occur in your machine/process.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Part of the configuration of the safety module is determined by the type of wiring of the application function. In addition, you need to configure the voltage threshold for standstill detection and the delay for deactivation of the safety-related outputs.

The safety module must be installed and wired according to the requirements of the safety-related function to be implemented before you can configure it.

Modifications to the positions of the selectors only become effective after power-up. Remove power from the safety module before modifying the position of the selectors. If the positions of the selectors are modified while power is applied to the safety module, a configuration error is detected.

Go through the commissioning procedure, page 45 after having modified the positions of the selectors or the wiring.

Configuration Procedure

To prepare configuration and gain an idea of possible voltage threshold and activation delay values, you may want to determine the progression of the residual voltage during coasting down of the motor using suitable equipment such as an oscilloscope, provided your application so permits. However, you must go through the complete configuration and commissioning procedures for each individual safety module in its actual application and under real life operating conditions at the installation site.

Step	Action
1	Verify that the safety module has been wired according to the type of motor to be monitored for standstill, and that the wiring meets all safety-related requirements identified in your risk assessment.
2	Verify that the motor to be monitored has coasted down and is at a standstill.
3	Remove power from the safety module if the safety module is not powered off. If an extension module XPSUEP is connected, remove power from the extension module as well.
4	Open the transparent cover of the safety module.
5	Set the voltage threshold selector, page 31 to the minimum value (selector position 1 (50 mV). If you have performed preparatory measurements, you can also set the selector to a voltage threshold value determined as appropriate by means of such measurements.
6	Set the activation delay selector , page 31 to the minimum value (selector position 1 (0.5 s). If you have performed preparatory measurements, you can also set the selector to an activation delay time value determined as appropriate by means of such measurements.
7	Apply power to the safety module. The LED POWER illuminates. When the switch-on delay after power on, page 19 and the activation delay set via the activation delay selector have elapsed, the LEDs L12 and L32, page 47 illuminate to indicate that standstill has been detected. The LED STATE illuminates to indicate that the safety-related output has been activated.
8	If the LEDs L12 and L32 do not illuminate and if the LED ERROR, page 47 remains off (that is, no alerts, page 47 and no detected errors, page 48), the measured residual voltage is not below the adjusted voltage threshold: • Verify that the motor is at a physical standstill and that all power has been removed from the motor. If this does not remedy the condition, the motor may not be suitable for standstill monitoring with the safety module.
9	If the LEDs L12 and/or L32 start to flash synchronously in conjunction with the LED ERROR, the safety module has detected a broken wire condition, page 29: • Verify correct wiring. • If your application monitors a DC motor or if electronic motor control equipment is used to control the monitored AC or DC motor, verify that no DC voltage is present at the safety-related analog input when the motor is at a physical standstill (refer to the chapter Electronic Motor Control Equipment, page 28 for details). If this does not remedy the condition, the motor may not be suitable for standstill monitoring with the safety module.
10	Start the motor. When the measured residual voltage increases to a value above the voltage threshold, the LEDs STATE, L12 and L32 turn off. If the LEDs STATE, L12 and L32 remain lit, the measured residual voltage does not increase above the adjusted voltage threshold. This can be the case if the motor is operated at very low speeds: • Increase the speed of the motor. If the condition persists even at increased speed of the motor, the motor not may not be suitable for correct standstill detection.
11	Stop the motor. When the voltage drops below the adjusted voltage threshold and the activation delay time has fully passed, the LEDs L12, L32 and STATE illuminate to indicate that standstill has been detected and the safety-related output has been activated. Verify that the motor is at a physical standstill once the LEDs L12, L32 and STATE illuminate and the safety-related output is activated. If the LEDs L12, L32 and STATE illuminate and the safety-related output is activated, but the motor is not at a physical standstill at this point in time: • Remove power from the safety module. • Increase the activation delay time. • Apply power to the safety module.

Step	Action
	• Start and run the motor until the LEDs STATE, L12 and L32 turn off and the safety-related output is deactivated. • Stop the motor. If the condition persists even with the maximum activation delay, the motor not may not be suitable for correct standstill detection. If you use the safety module for monitoring of a DC motor or if the monitored motor is controlled by means of electronic motor control equipment (refer to the chapter Electronic Motor Control Equipment, page 28 for details), the safety module may detect a broken wire condition (LEDs L12 and/or L32 flashing synchronously, LED ERROR flashing) while the motor coasts down, even below the voltage threshold and even if the motor has reached a physical standstill. This condition is cleared as soon as no more DC voltage is measured. Verify that the motor remains at a physical standstill until it is restarted. If the motor does not remain at a physical standstill, the adjusted voltage threshold may be too high and movements may go undetected.
12	If the LEDs L12, L32 and STATE do not illuminate, the safety module does not detect standstill (even if there is a physical standstill of the motor). In such a case, the measurement of the residual voltage during coasting down may yield results that are different from the measurement at standstill as performed in step 7. The adjusted voltage threshold may be too high. • Verify that there is no broken wire condition. • Remove power from the safety module. • Adapt the voltage threshold and, if required, the activation delay values. • Apply power to the safety module. • Start and stop the motor. • Re-perform steps 11 and 12 until correct standstill detection is obtained.
13	Verify correct operation of your machine/process with the configured values for all operating states, the defined safe state, and all potential error situations under all load, inertia, and friction conditions that can occur in your machine/process.
14	Verify that the configured values coincide with the results of your risk assessment and your safety-related calculations. If they do not, re-perform your risk assessment and your safety-related calculations.

Commissioning

Overview

⚠WARNING

INEFFECTIVE SAFETY-RELATED FUNCTION AND/OR UNINTENDED EQUIPMENT OPERATION

- Commission the device before it is used for the first time and after each configuration.
- Commission or recommission the machine/process pursuant to all regulations, standards, and process definitions applicable to your machine/process.
- Only start the machine/process if there are no persons or obstructions in the zone of operation.
- Verify correct operation and effectiveness of all functions by performing comprehensive tests for all operating states, the defined safe state, and all potential error situations.
- Document all modifications and the results of the commissioning procedure in compliance with all regulations, standards, and process definitions applicable to your machine/process.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Commissioning Procedure

Step	Action
1	Verify correct mechanical and electrical installation, page 32 according to the intended application.
2	Verify correct configuration, page 42 according to the intended application.
3	Verify that there are no persons or obstructions in the zone of operation.
4	Apply power and start the machine/process. If an extension module XPSUEP is connected, apply power to the extension module at the same time as to the safety module.
5	Perform comprehensive tests for all operating states, the defined safe state, and all potential error situations.
6	Close the transparent cover of the safety module and seal it with the enclosed sealing strip. Additional sealing strips are available as an accessory. Refer to the chapter Accessories, page 51 for additional information.
7	Document all modifications and the results of the commissioning procedure.

Diagnostics

Diagnostics via LEDs

Overview

The safety module features various LEDs, page 12 that provide status information and information on alerts and detected errors.

Recommission the safety module if, during troubleshooting, you modify the wiring.

Recommission the safety module, page 45 if, during troubleshooting, you modify the position of the threshold selector or the delay selector.

POWER

State	Meaning
Off	No power supply
On	Power supply on

STATE

This LED provides information on the state of the safety-related output.

State	Meaning
Off	Safety-related output deactivated
On	Safety-related output activated

L12 and L32

These LEDs provide information on the voltage level at the safety-related analog input (motor running or motor standstill detected).

LED	State	Meaning
L12, L32	Off	No motor standstill detected. • L12: Voltage U12 between L1 and L2 is above adjusted voltage threshold, or voltage U12 is below adjusted voltage threshold, but activation delay time has not fully elapsed. • L32: Voltage U32 between L3 and L2 is above adjusted voltage threshold, or voltage U32 is below adjusted voltage threshold, but activation delay time has not fully elapsed. If only one motor phase is monitored (single-channel voltage measurement, page 26, terminals L1 and L3 bridged), the LEDs L12 and L32 behave identically.
L12, L32	On	Motor standstill detected. • L12: Voltage U12 between L1 and L2 is below adjusted voltage threshold and activation delay time has fully elapsed. • L32: Voltage U32 between L3 and L2 is below adjusted voltage threshold and activation delay time has fully elapsed. If only one motor phase is monitored (single-channel voltage measurement, page 26, terminals L1 and L3 bridged), the LEDs L12 and L32 behave identically.

ERROR - Alerts

This LED flashes in conjunction with additional L•• LEDs to indicate alerts.

In the case of an alert, the safety module transitions to the defined safe state. Remove the cause of the alert to be able to exit the defined safe state and resume operation. Contact your Schneider Electric service representative if the condition persists.

State	In conjunction with additional LEDs		Meaning	Remedy
	Additional LED (s)	State of additional LED(s)		
Flashing	L12	Flashing	Wiring in circuit for voltage U12 interrupted (between L1 and L2, broken wire).	• If DC voltage can be present, wait until the condition disappears. Refer to Wire Interruption, page 29 for details. • If the condition persists, verify correct wiring of L1.
Flashing	L32	Flashing	Wiring in circuit for voltage U32 interrupted (between L3 and L2, broken wire).	• If DC voltage can be present, wait until the condition disappears. Refer to Wire Interruption, page 29 for details. • If the condition persists, verify correct wiring of L3.
Flashing	L12 and L32	Flashing synchronously	Wiring in circuits for voltages U12 and U32 interrupted (between L1 and L2 as well as between L3 and L2, broken wire).	• If DC voltage can be present, wait until the condition disappears. Refer to Wire Interruption, page 29 for details. • If the condition persists, verify correct wiring of L1, L2, and L3.

ERROR - Detected Errors

This LED illuminates in conjunction with additional LEDs to indicate detected errors. In the case of a detected error, the safety module transitions to the defined safe state. Remove the cause of the detected error and perform a power cycle of the safety module to be able to exit the defined safe state and resume operation. Contact your Schneider Electric service representative if the condition persists.

State	In conjunction with additional LEDs		Meaning	Remedy
	Additional LEDs	State of additional LEDs		
On	STATE, L12 and L32	Flashing synchronously	General error detected.	• Verify correct wiring.
On	STATE, L12 and L32	On	Configuration error detected.	• Verify that the positions of the selectors are appropriate for the application to be implemented.
On	POWER	Flashing	Power supply error detected.	• Verify correct wiring. • Use a suitable power supply.
On	STATE	Flashing	Error detected at safety-related output.	• Perform a power cycle.
On	L12 and L32	Flashing synchronously	Error detected at safety-related output of extension module.	• Perform a power cycle.

Diagnostics via Status Output Z1

Overview

The pulsed output Z1 provides diagnostics information in the form of a bit pattern. If the output Z1 is connected to a logic controller, the XpsuSupport library can be used to evaluate the diagnostics information. The library consists of the function blocks *FB_XpsuDiag* and *FB_XpsuMain*. The function block *FB_XpsuDiag* converts the bit sequences into diagnostics codes for monitoring the status of the safety module. The function block *FB_XpsuMain* uses the diagnostics codes as input to perform calculations concerning, for example, maintenance tasks.

⚠WARNING

INCORRECT USE OF OUTPUT

Do not use the additional outputs Z1 and Z2 for safety-related purposes.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Refer to the XpsuSupport Library Guide, page 7 for details.

Diagnostics Codes

The safety module encodes diagnostics information into sequences of 10 bits with a total duration of 2 s (each bit 200 ms). The first four bits (0010) represent the beginning of a bit sequence. The next six bits contain the diagnostics code itself.

The following table lists the bit sequences of the diagnostics codes, the description of the corresponding status as well as correctives, if applicable.

Bit sequence	Description	Correctives	Type (1)
0010101101	Supply voltage out of tolerance.	Verify correct wiring. Use a suitable power supply.	E
0010000011	General error detected.	Verify correct wiring. Perform a power cycle. If the error persists, replace the safety module.	E
0010000110	General error detected in expansion module.	Verify correct wiring. Perform a power cycle of the base safety module and the connected extension module. If the error persists, replace the extension module.	E
0010000111	Configuration error detected. The position of at least one of the selectors has been modified during operation.	Verify that the position of the selectors is appropriate for the application to be implemented. Perform a power cycle. If the error persists, replace the safety module.	E
0010100110	Wiring in circuit for voltage U12 interrupted (between L1 and L2, broken wire).	If DC voltage can be present, wait until the condition disappears (refer to Wire Interruption, page 29 for details. If the condition persists, verify correct wiring of L1 and L2.	E
0010100000	Wiring in circuit for voltage U32 interrupted (between L3 and L2, broken wire).	If DC voltage can be present, wait until the condition disappears (refer to Wire Interruption, page 29 for details. If the condition persists, verify correct wiring of L3 and L2.	E
0010110111	Voltage at safety-related input is above the adjusted voltage threshold, safety module is in defined safe state.	-	S
0010110101	Voltage U12 does not meet the requirements for detected standstill while U32 already does.	-	S
0010111111	Voltage U32 does not meet the requirements for detected standstill	-	S

Bit sequence	Description	Correctives	Type (1)
	while U12 already does.		
0010101111	Safety module in operating state Run: Outputs Energized, safety-related outputs activated.	-	S

(1)	Type of message: E = Error detected, S = Status information

Accessories, Service, Maintenance, and Disposal

Accessories

Accessories

The following accessories are available for the safety module:

Description	Commercial Reference
Coding bits The coding bits are used if the terminal blocks are removed to help ensure correct insertion of the terminal blocks into the safety module. 30 pieces per packaging unit	XPSEC
Sealing strips The uniquely numbered sealing strips are used to seal the transparent front cover of the safety module to help prevent unauthorized access to the configuration selectors. 10 pieces per packaging unit	XPSES

Maintenance

Service and Repairs

The safety module contains no user-serviceable parts. Do not attempt to open, service, or repair the safety module.

Maintenance Plan

Maintenance plan:

- Ensure that a safety-related function implemented with the safety module is triggered at the minimum intervals required by the regulations, standards, and process definitions applicable to your machine/process.
- Inspect the wiring at regular intervals.
- Tighten the threaded connections at regular intervals.
- Verify that the safety module is not used beyond the specified lifetime, page 19.

  To determine the end of the lifetime, add the specified lifetime to the date of manufacture indicated on the nameplate, page 13 of the safety module.

  Example: If the date of manufacture indicated on the nameplate is 2019-W10, do not use the safety module after week 10, 2039.

As a machine designer or system integrator, include this information in the maintenance plan for your customer.

Transportation, Storage, and Disposal

Transportation and Storage

Ensure that the environmental conditions, page 15 specified for transportation and storage are respected.

Disposal

Dispose of the product in accordance with all applicable regulations.

Visit https://www.se.com/green-premium for information and documents on environmental protection as per ISO 14025 such as:

- EoLi (Product End-of-Life Instructions)
- PEP (Product Environmental Profile)

Service Addresses

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Additional Contact Addresses

See the homepage for additional contact addresses:

https://www.se.com

Index

A

accessories 51
activation delay
  timing diagram 30
activation, safety-related inputs 22
alerts 47
application functions
  configuration 42
application functions: see index entry functions 38

B

block diagram 35
broken wire detection 29

C

Category 19
commissioning 45
configuration
  application functions 42

D

DC injection braking units 28
DCavg 20
deactivation, safety-related inputs 22
degree of protection 16
Demand Mode of Operation 20
diagnostics 47
diagram, block 35
dimensions 16
drives 28
dual-channel 26

E

electrical characteristics 17
electrical durability 21
electromagnetic compatibility 22
EMC 22
environmental characteristics 15
errors, detected 47
example application
  overview 23
  timing diagram 24

F

frequency inverters 28
functional safety data 19
functions
  configuration of application functions 42
  overview application functions 38
  standstill monitoring DC motors 40
  standstill monitoring single-phase AC motors 39
  standstill monitoring three-phase AC motors 38
  standstill monitoring three-phase AC motors, star-delta 41

H

HFT 20

I

inputs, safety-related
  technical data 18
  wiring 36
installation 32, 34
  control cabinet 32
  enclosure 32
  mechanical 32
  prerequisites 32

L

L 19
LEDs 47
lifetime 20

M

maintenance 51
mechanical characteristics 16
monitoring of standstill
  DC motors 40
  single-phase AC motors 39
  three-phase AC motors, star-delta 41
monitoring of standstill,
  three-phase AC motors 38
mounting 32
  DIN rail 32
  screw mounting 33
MTTFd 20

N

nameplate 13

O

operating cycles over lifetime 20
operating state transitions 23
operating states 22
operation, environmental characteristics 15
output Z1
  diagnostics 48
  technical data 19
  wiring 37
output Z2
  technical data 19
  wiring 37
outputs, safety-related
  technical data 18
  wiring 36

P

Performance Level 19
PFHD 20
power supply
  technical data 17
  wiring 37

R

response times
technical data 19

S

safe state, defined 19
Safety Integrity Level 20
safety-related inputs
activation 22
deactivation 22
technical data 18
wiring 36
safety-related outputs
technical data 18
wiring 36
service addresses 52
servo drives 28
SFF 20
signal output Z2
technical data 19
wiring 37
SIL 20
SILCL 20
single-channel 26
standstill monitoring
DC motors 40
single-phase AC motors 39
three-phase AC motors 38
three-phase AC motors, star-delta 41
star-delta 41
state machine 22
state transitions 23
status output Z1
diagnostics 48
technical data 19
wiring 37
storage, environmental characteristics 15
stripping lengths 17
supply
technical data 17
wiring 37

T

technical data
degree of protection 16
dimensions 16
electrical characteristics 17
environmental characteristics 15
functional safety data 19
mechanical characteristics 16
operation 15
power supply 17
response times 19
safety-related inputs 18
safety-related outputs 18
signal output Z2 19
status output Z1 19
storage 15
stripping lengths 17
supply 17
tightening torques terminals 17
timing data 19
transportation 15
weight 16
wire cross sections 17
tightening torques terminals 17
timing data 19
timing diagram
activation delay 30
example application 24
hysteresis 30
transportation, environmental characteristics 15
troubleshooting 47
type code 13

V

variable speed drives 28
view
front view 12
side view 12

W

weight 16
wire cross sections 17
wire interruption 29
wiring 34
power supply 37
safety-related inputs 36
safety-related outputs 36
supply 37
Z2 37

Z

Z1 status output
diagnostics 48
technical data 19
wiring 37
Z2 signal output
technical data 19
wiring 37

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