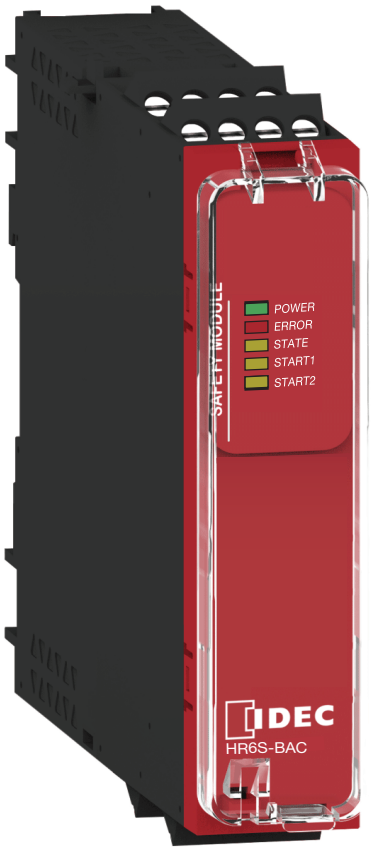
HR9Z-B2387(0)

HR6S-BAC

Safety Module

Original instructions



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Legal Information

Publication History

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Safety Information

Important Information

NOTICE

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 IDEC CORPRATION 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 HR6S-BAC.

Validity Note

The present document is valid for the products listed in the Chappter 1 "Type Code" *on page 14*.

Related Documents

Title of documentation	Reference number
HR6S-BAC User Guide	HR9Z-B2387 (ENG) HR9Z-B2388 (JPN)
HR6S-BAC Instruction Sheet	B-2386 (JPN, ENG, CHI)

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.

⚠ WARNING

INSUFFICIENTAND/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.

*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.

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.

Chapter 1
Introduction

What Is in This Chapter?

This chapter contains the following topics:

Device Overview

Outline

HR6S-BAC is a safety module for interruption of safety-related electrical circuits.

The safety module provides application functions used to monitor signals from different types of sensors/ devices.

The safety-related function is implemented by interrupting the power supply to the safety module. The equipment that can be connected to the safety-related supply inputs of the safety module must be able to interrupt the power supply to the safety module. It includes, for example:

- NO, NC, C/O, for example, Emergency Stop push-buttons, guard door switches.

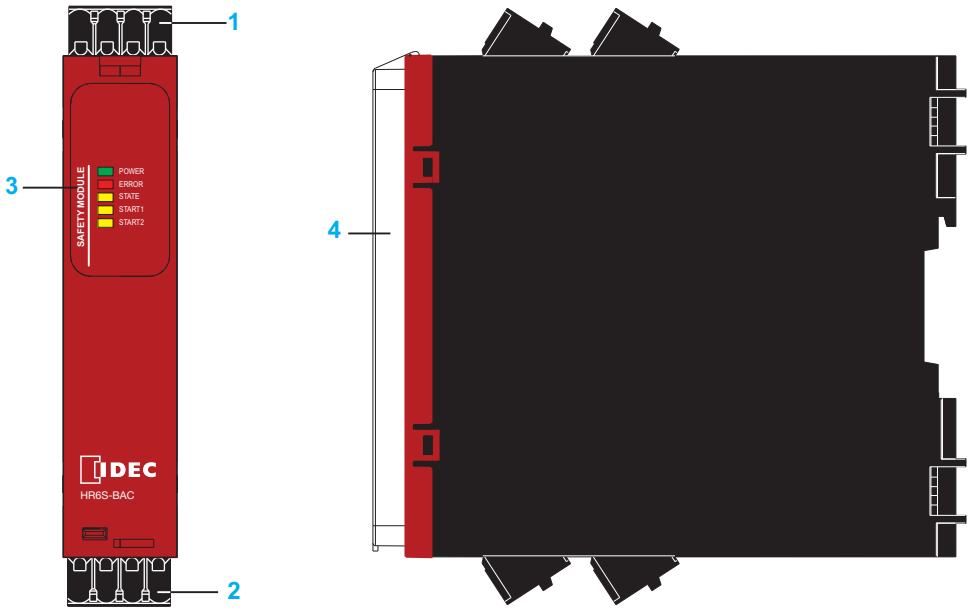
The safety module is available in two different types: either push-in terminals or screw terminals and either 24 V AC/DC supply voltage.

Feature summary:

- 2 applications
- 4 safety-related relay outputs (normally open (NO) relay contacts)
- 1 Auxiliary relay output (normally closed (NC) relay contacts)
- 3 start function

Front View and Side View

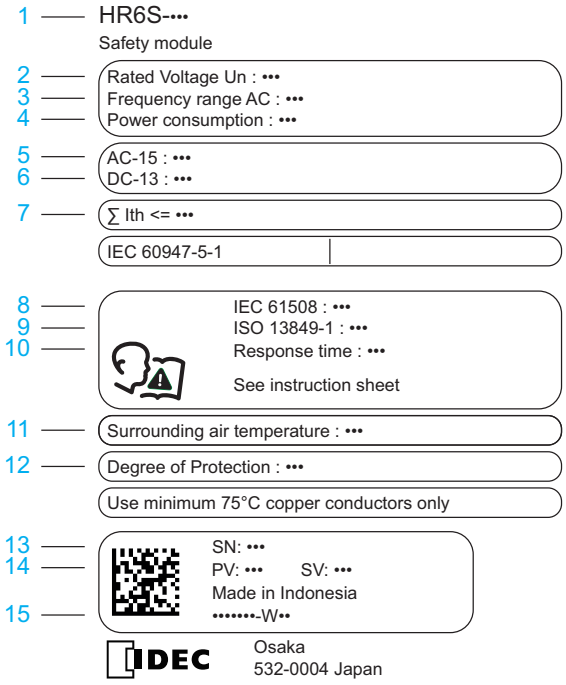
Front View and Side View



1	Removable terminal blocks, top
2	Removable terminal blocks, bottom
3	LED indicators
4	Sealable transparent cover

Nameplate

Nameplate



The nameplate contains the following data:

1 Device type (refer to this chappter "Type Code" *on page 14*)

2 Nominal voltage

3 Frequency range VAC supply

4 Input power

5 Maximum current of safety-related outputs with utilization category AC-15 (250 VAC)

6 Maximum current of safety-related outputs with utilization category DC-13 (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), 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
Type code (example)	H	R	6	S	-	B	A	C	1	C

Item	Meaning
1 ... 4	**Product range** HR6S: HR6S safety module
5 ... 7	**Product version** BAC
8	**Supply voltage** 1 = 24 V AC/DC
9	**Terminal type** C = Push-in terminals, removable P = Screw terminals, removable

If you have questions concerning the type code, contact your IDEC ORPORATION service representative.

Chapter 2
Technical Data

What Is in This Chapter?

This chapter contains the following topics:

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*1
Rate of change of temperature	0.5 °C/min (0.9 °F/min)
Ambient humidity	5 ... 95 % relative humidity, no condensation

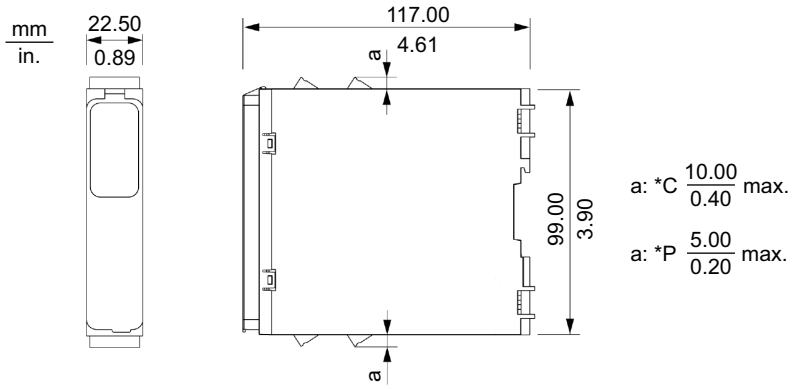
Mechanical conditions:

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

*1 Refer to this chappter "Safety-Related Outputs" *on page 23* for derating information.

Mechanical Characteristics

Dimensions



Characteristic	Value	
	HR6S-BAC1C	HR6S-BAC1P
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

Characteristic	Value
Stripping length for Push-in terminals	12 mm (0.47 in)
Stripping length for screw terminals	7 ... 8 mm (0.28 ... 0.31 in)
Wire cross section, single wire without wire ferrule*1	0.2 ... 2.5 mm^2 (24 ... 12 AWG)
Wire cross section, single wire with wire ferrule	0.25 ... 2.5 mm^2 (24 ... 12 AWG)
Wire cross section, two wires without wire ferrule*1	0.2 ... 1.5 mm^2 (24 ... 16 AWG)
Wire cross section, two wires with uninsulated wire ferrule	0.25 ... 1 mm^2 (24 ... 18 AWG)
Wire cross section, two wires with insulated wire ferrule	0.5 ... 1.5 mm^2 (20 ... 16 AWG)
Tightening torque for screw terminals	0.5 N m (4.4 lb in)

*1 Stranded or solid

Electrical Characteristics

Safety-Related Supply Input

The safety module implements the safety-related function by interrupting the power supply via the terminals A1 and A2.

Characteristic	Value
Supply voltage AC	24 VAC (-15 ... 10 %)
Supply voltage DC	24 VDC (-20 ... 20 %)
Nominal input power AC*1	3.5 VA (24 VAC)
Nominal input power DC	1.5 W (24 VDC)
Frequency range AC	50 ... 60 Hz
Overvoltage category	II
Pollution degree	2
Insulation voltage	300 V
Impulse withstand voltage	4 kV

Electromagnetic Compatibility (EMC)

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

Start/Restart Input

Characteristic	Value
Output voltage at Y1	>15 VDC
Input voltage at Y2, Y3	0 ... 24 VDC (+20 %)
Switching voltage to activate Y2, Y3	>15 VDC
Switching voltage to deactivate Y2, Y3	<5 VDC
Input current	5 mA
Maximum wire resistance	500 Ω

*1 with transformer

Classification of Start/Restart Input as per ZVEI CB24I

Representation and values as per identifying key, ZVEI CB24I:

Source/sink	Interface type	Additional measure	Source/sink	Interface type
Sink	A	M	Source	C0

Interface type A: Sink		
Parameter	**Minimum value**	**Maximum value**
Input current Ii (in the ON state)	3 mA	5 mA
Output voltage Ui	15 V	24 V (+20 %)
Additional measure M	The inputs are not types as per IEC 61131-2. TG is Y1 for Y2	>15 VDC

Refer to Chappter 3 "Dynamization" *on page 33*.

Safety-Related Outputs

Characteristic	Value
Number of safety-related outputs, consisting of two normally open relay contacts each	4
Number of safety-related outputs, consisting of two normally closed relay contacts each	1
Maximum short circuit current IK	1 kA
Maximum continuous current, normally open relay contacts	6 A
Maximum continuous current, normally closed relay contacts	3 A
Maximum total thermal current ΣIth	16 A
Minimum load	10 mA / 5 V
Utilization category as per UL 60947-5-1	B300 and R300 for normally open contacts D300 and R300 for normally closed contacts
Utilization category as per IEC 60947-4-1 and IEC 60947-5-1)	AC-1: 250 V AC-15: 250 V DC-1: 24 V DC-13: 24 V
Maximum current, normally open relay contacts	AC-1: 5 A AC-15: 3 A DC-1: 5 A DC-13: 3 A
Maximum current, normally closed relay contacts	DC-1: 3 A DC-13: 1 A AC-1: 3 A AC-15: 1 A
External fusing	10 A, category gG, for normally open relay contact 4 A, category gG, for normally closed relay contact

Timing Data

Maximum Response Times

Characteristic	Value
Maximum response time to request at safety-related supply input, and after power outage AC	150 ms
Maximum response time to request at safety-related supply input, and after power outage DC	80 ms

Switch-On and Activation Delays

Characteristic	Value
Switch on delay after power on and automatic start/restart	1500 ms
Delay after valid start/restart condition	100 ms

Monitored Start/Restart

Characteristic	Value
Waiting time after power on via safety-related supply input and beginning of monitored start	1500 ms
Minimum duration of start/restart pulse for monitored start/restart	80 ms

Dynamization of Start/Restart Input

Characteristic	Value
Test pulse duration (input must be activated for longer than duration of test pulse)	2 ms
Test pulse interval	500 ms
Maximum delay of test pulse	40 ms

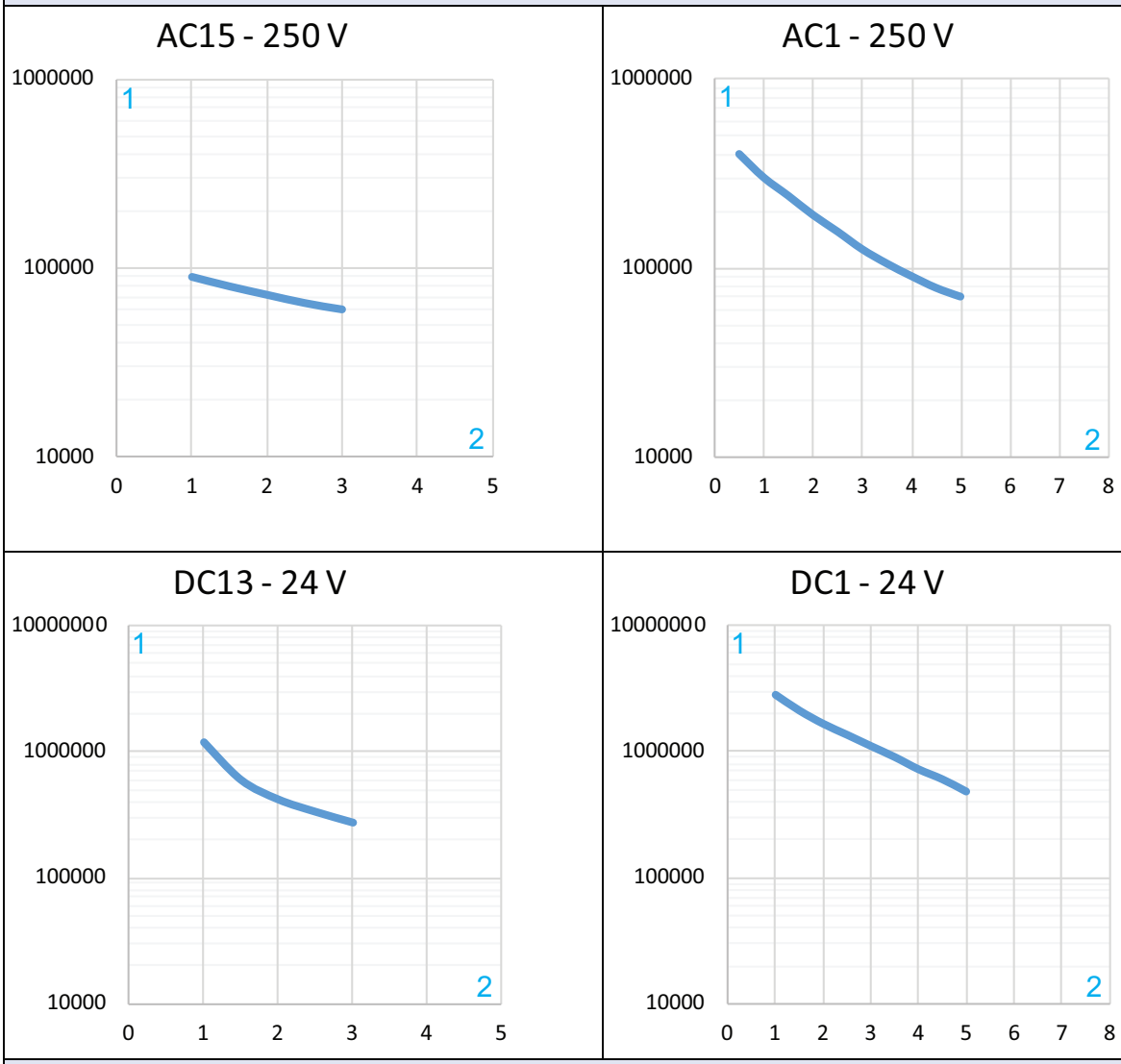
Data Functional Safety

Data Functional Safety

Characteristic	Value
Defined safe state	Safety-related outputs are de-energized Normally open relay contacts: open Normally closed relay contacts: closed
Maximum Performance Level (PL), Category (as per ISO 13849-1:2015)*1	Normally open relay contacts: PL e, Category 3 Normally closed relay contacts: PL c, Category 1
Maximum Safety Integrity Level (SIL) (as per IEC 61508-1:2010)*2	Normally open relay contacts: 3 Normally closed relay contacts: 1
Safety Integrity Level Claim Limit (SILCL) (as per IEC 62061:2005+AMD1:2012+AMD2:2015)*3	Normally open relay contacts: 3 Normally closed relay contacts: 1
Type (as per IEC 61508-2)	B
Hardware Fault Tolerance (HFT) (as per IEC 61508 and IEC 62061)	1
Stop Category for Emergency Stops (as per ISO 13850 and IEC 60204-1)	0
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 (PFH_D) in 1/h (as per IEC 61508 and ISO 13849-1)	0.95×10^{-9}
Mean Time To Dangerous Failure ($MTTF_D$) in years (high as per ISO 13849-1)	>30
Average Diagnostic Coverage (DC_{avg}) (high as per ISO 13849-1)	≥99 %
Demand mode of operation (as per IEC-61508-1, IEC-62061)	High / continuous
Maximum number of cycles over lifetime	DC-13, 24VDC 1A: 1,200,000 DC-13, 24VDC 3A: 275,000 AC-1, 250VAC 4A: 90,000 AC-15, 250VAC 1A: 90,000 AC-15, 250VAC 3A: 70,000

*1 Actual PL and category depend on application.
*2 Actual SIL depends on application.
*3 Actual SILCL depends on application.

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 this chappter "Timing Data" *on page 24* for additional technical data that may affect your functional safety calculations.

Chapter 3
Engineering

What Is in This Chapter?

This chapter contains the following topics:

Electromagnetic Compatibility (EMC)

Conducted and Radiated Electromagnetic Emissions

⚠ 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.
- 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, device type HR6S-BAC1* is a group 1, class B device. Class B as per IEC CISPR 11 corresponds to environment B as per IEC 60947-1.

Principles of Operation

Introduction

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

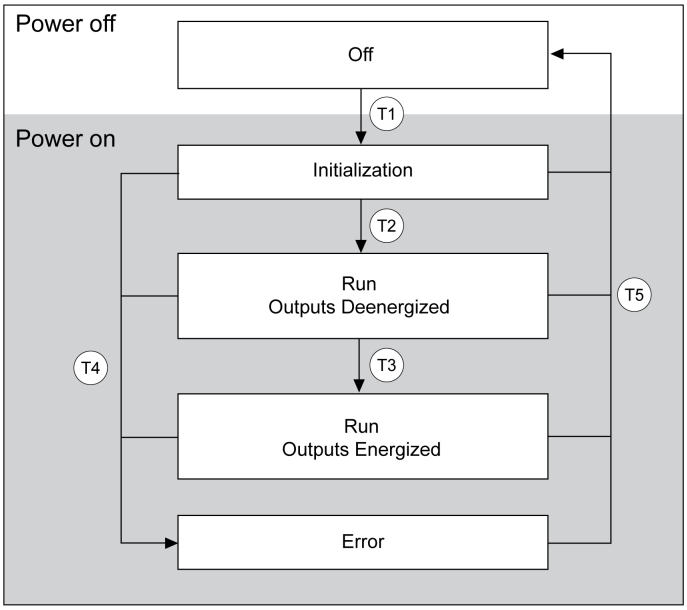
General Information on Activation and Deactivation of Safety-Related Supply Inputs and Safety-Related Outputs

In the present document, “activation” of a safety-related supply input means that a safety-related supply 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 supply input means that a safety-related supply 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	-	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 Chappter 2 "Data Functional Safety" *on page 25* for the defined safe state of the safety module.

State Transitions

State transition	Condition
T1	Power on
T2	Initialization successful
T3	Start/restart condition fulfilled (for example, automatic start/restart or manual start/restart with start/restart pushbutton pressed) Safety-related supply inputs activated
T4	Error detected
T5	Power off

NOTE: Refer to this chappter "General Information on Activation and Deactivation of Safety-Related Supply Inputs and Safety-Related Outputs" *on page 30* for details on the use of the terms “activated” and “deactivated” in the present document.

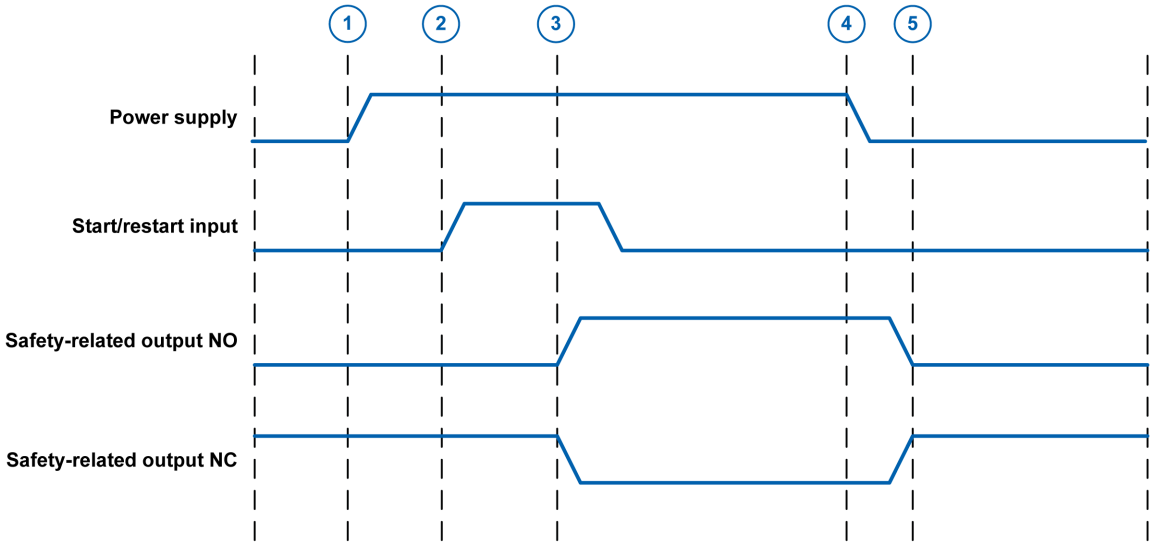
Example with Emergency Stop

The following example uses a machine with an Emergency Stop pushbutton, a start/restart pushbutton for manual start/restart, and a motor to demonstrate the individual operating states and state transitions. The selected application function is Chappter 5 "Application Function Emergency Stop" *on page 43*. The selected start/restart function is Chappter 5 "Manual Start/Restart" *on page 46*.

- After power is supplied to the safety-related supply input (Emergency Stop pushbutton not engaged), the safety module 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 (T4).
- If the start/restart pushbutton is not engaged, the safety module remains in the operating state Run: Outputs Deenergized. The motor is at a standstill.
  Detailed information on the start/restart functions and the timing can be found in Chappter 5 "Start/Restart Functions" *on page 45*.
- If the start/restart pushbutton is pressed, the start/restart input is activated, that is, the start/restart condition is fulfilled and the safety module transitions to the operating state Run: Outputs Energized. This operating state corresponds to regular operation of the machine.
- If the Emergency Stop pushbutton is engaged (power supply to the safety-related supply input removed), the safety-related output is deactivated within the response time (transition T5 to operating state Power off). The safety module is in the defined safe state. The motor is stopped.
  This corresponds to the Emergency Stop condition of the machine.
- To return to the operating state Run: Outputs Energized, power needs to be supplied to the safety-related supply input (Emergency Stop pushbutton rearmed (pulled out)) and the start/restart input needs to be activated again (start/restart pushbutton pressed).

Timing Diagram for Example with Emergency Stop

The following timing diagram provides an overview of the example with Emergency Stop.



Legend

Item	Description
1	Power is applied to the safety-related supply input (Emergency Stop pushbutton not engaged). The start/restart pushbutton has not yet been pressed so the start/restart condition is not fulfilled and the safety module remains in the defined safe state.
2	The start/restart pushbutton is pressed. The start/restart condition is fulfilled. Refer to Chappter 5 "Start/Restart Functions" *on page 45* for detailed information on the start/restart functions.
3	The safety-related output is activated within Chappter 2 "Switch-On and Activation Delays" *on page 24*. The motor runs. The safety module is not in the defined safe state.
4	The power supply to the safety-related power supply input is removed (Emergency Stop pushbutton engaged).
5	The safety-related output is deactivated within Chappter 2 "Maximum Response Times" *on page 24*. The Emergency Stop is active. The safety module is in the defined safe state.

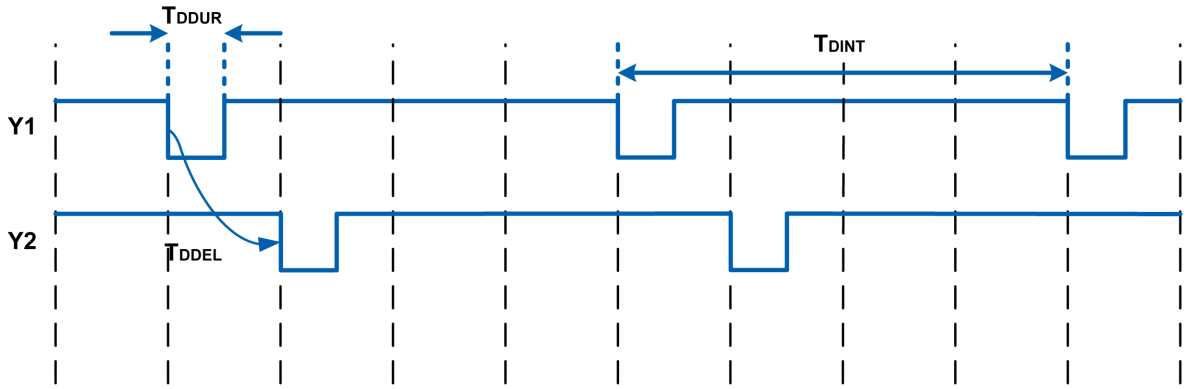
Dynamization

Dynamization of Inputs

Dynamization is used for cross circuit detection between the start/restart input to an external power supply unit or to ground. Dynamization is implemented by means of periodically generated test pulses at Y1 of the start/restart input.

Whether dynamization of the start/restart input is used depends on the start/ restart function configured by wiring of Chappter 4 "Start/Restart Input" *on page 40*. Dynamization is only used if terminals Y1 and Y2 are wired.

The following diagram illustrates the dynamization principle and timing of channels Y1 and Y2 of the start/restart input:



Designation	Value	Explanation
TDDUR	2 ms	Duration of the test pulse. The duration of the test pulse is the time between the start of the test pulse and the end of the test pulse.
TDINT	500 ms	Interval between test pulses. This interval is the time between the start of a test pulse and the start of the next test pulse.
TDDEL	40 ms	Maximum delay of test pulse. This delay is the maximum time between the start of the test pulse at the control output and the associated input channel, that is, the maximum time during which the input expects to “see” dynamization.

Chapter 4
Installation

What Is in This Chapter?

This chapter contains the following topics:

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 Chappter 1 "Type Code" *on page 14* 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.

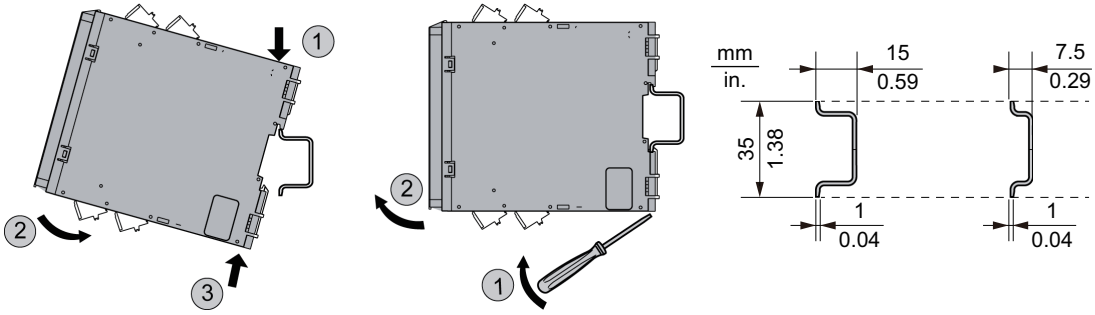
The ventilation of the control cabinet/enclosure must be sufficient to comply with the specified ambient conditions for the safety module and the other components operated in the control cabinet/enclosure.

Mechanical Installation

Mounting to DIN Rail

The device 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)



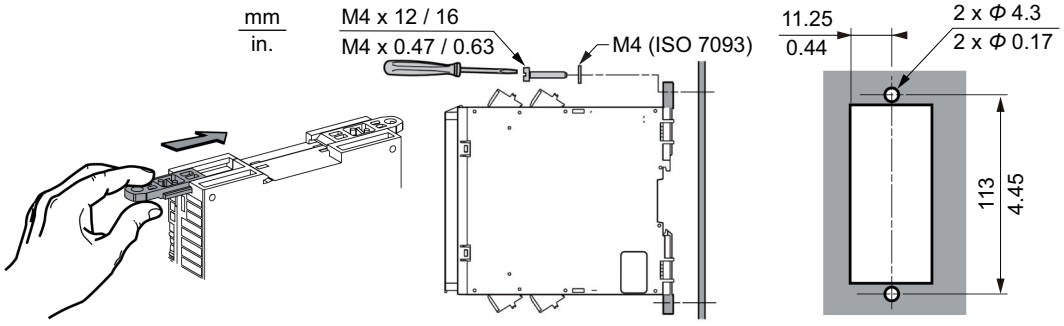
Mounting procedure (left illustration)

Step	Action
1	Slightly tilt the device and hook it onto the DIN rail.
2	Push the lower part of the device 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 device away from the DIN rail and lift the device 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 device.
2	Prepare the holes on the mounting surface.
3	Screw the device 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 device depends on the safety-related function to be implemented. Before wiring the device, engineer the safety-related function, perform a risk assessment with regard to your machine/process, and determine the suitability of the device as well as the connected equipment.
You can wire the device with the terminal blocks in the device or you can remove the terminal blocks. For the latter, pull the terminal blocks out of the device, connect the individual terminals and push the terminal blocks back into the device.
Use 75 °C (167 °F) copper conductors to wire the device.

Wire Cross Sections, Stripping Lengths, and Tightening Torques

Characteristic	Value
Stripping length for Push-in terminals	12 mm (0.47 in)
Stripping length for screw terminals	7 ... 8 mm (0.28 ... 0.31 in)
Wire cross section, single wire without wire ferrule*1	0.2 ... 2.5 mm^2 (24 ... 12AWG)
Wire cross section, single wire with wire ferrule	0.25 ... 2.5 mm^2 (24 ... 12AWG)
Wire cross section, two wires without wire ferrule*1	0.2 ... 1.5 mm^2 (24 ... 16AWG)
Wire cross section, two wires with uninsulated wire ferrule	0.25 ... 1 mm^2 (24 ... 18AWG)
Wire cross section, two wires with insulated wire ferrule	0.5 ... 1.5 mm^2 (20 ... 16AWG)
Tightening torque for screw terminals	0.5 N m (4.4 lb in)

*1 Stranded or solid

Block Diagram and Terminals

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

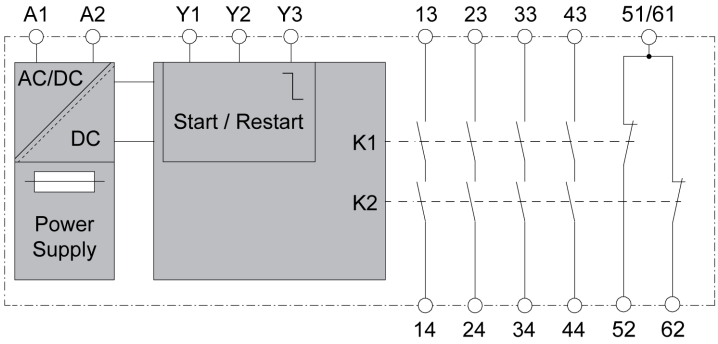
The push-in terminals are designed for the connection of only a single wire if you do not use wire ferrules. A maximum of two wires may be connected to a push-in terminal if the wires are installed with a twin wire ferrule.

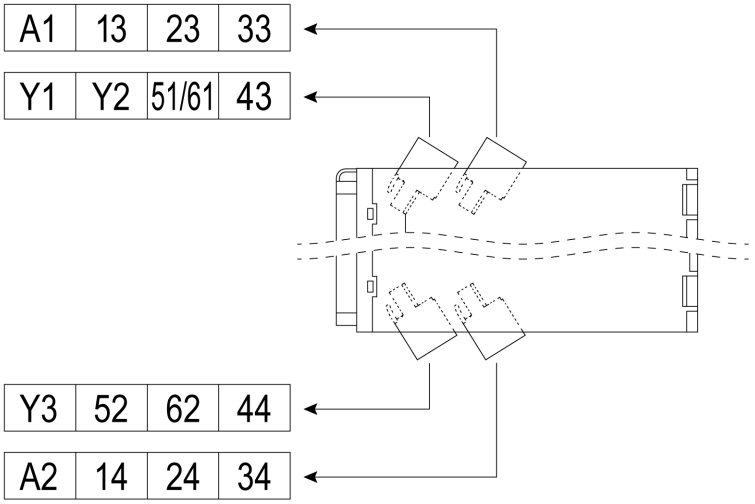
⚠ ⚠ DANGER

LOOSE WIRING CAUSES ELECTRIC SHOCK

Do not connect more than one wire to a push-in 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.





Terminal Designation	Explanation
A1, A2	Power supply
Y1	Control output of Start/Restart input
Y2	Input channel for automatic/manual start/restart
Y3	Input channel for monitored start/restart with falling edge
13, 14, 23, 24, 33, 34, 43, 44, 51/61, 52, 62	Terminals of the safety-related outputs

Safety-Related Supply Input and Power Supply

⚠ WARNING

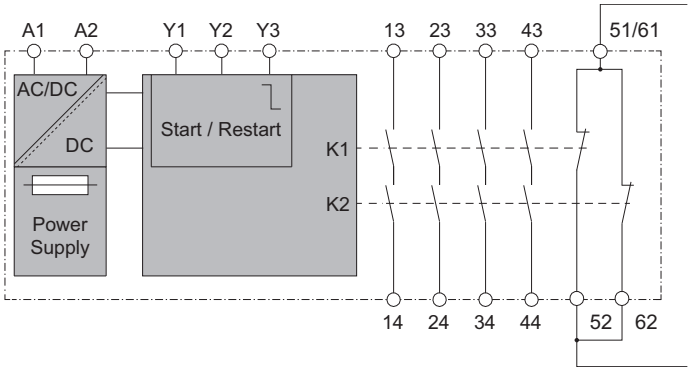
INSUFFICIENTAND/OR INEFFECTIVE SAFETY-RELATED FUNCTIONS
Only connect a sensor/device to a safety-related input that meets all requirements as per your risk assessment and that complies with all regulations, standards, and process definitions applicable to your machine/ process.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

The safety module implements the safety-related function by interrupting the power supply via the terminals A1 and A2.

Connect the terminals A1 and A2 to a power supply providing the supply voltage specified for the safety module in Chappter 2 "Environmental Conditions" *on page 17*. Connect the sensor/input device in such a way that it can interrupt the power supply to the two terminals A1 and A2 of the safety-related supply input. Refer to Chappter 5 "Application Functions" *on page 43*. for additional wiring information.

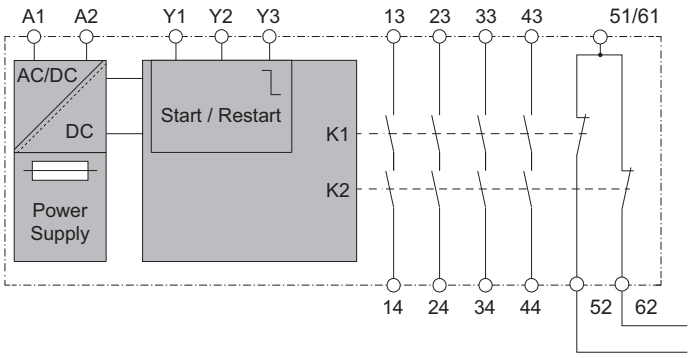
Safety-Related Outputs

The wiring of the safety-related outputs depends on the safety-related function to be implemented.
Install fuses with the rating specified in Chappter 2 "Environmental Conditions" *on page 17*.
The two normally closed relay contacts (terminals 51/61, 52, 62) can be connected in series or in parallel.
For connection in parallel, bridge terminals 52 and 62. Connect the supply of your connected equipment to terminal 51/61 and the output to one of the bridged terminals 52 or 62 as shown in the following figure:



A connection in parallel can be used, for example, for controlling an actuator.

For connection in series, leave terminal 51/61 unconnected. Connect the supply of your connected equipment to terminal 52 and the output to terminal 62 or vice versa as shown in the following figure:



A connection in series can be used, for example, to implement a non-safety-related diagnostics function that provides feedback to other equipment while the safety-related function uses one or several of the normally open relay contacts.

Start/Restart Input

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Do not use the Start/Restart function for safety-related purposes.
- Use Monitored Start/Restart if unintended restart is a hazard according to your risk assessment.

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

The start/restart input consists of one control output (terminal Y1) and two input channels (terminals Y2 and Y3).

The control output provides a nominal voltage of 24 VDC to the connected sensor/ device. It is also used for Chappter 3 "Dynamization" *on page 33*.

The wiring of the start/restart input depends on Chappter 5 "Start/Restart Functions" *on page 45* to be implemented.

Automatic start/restart:
Bridge terminals Y1 and Y2 and leave terminal Y3 unconnected.

Manual start/restart:
Connect terminals Y1 and Y2 to the device providing the start/restart signal, such as a push-button. Leave terminal Y3 unconnected.

Monitored start/restart and if the control output Y1 is to be used:
Connect terminals Y1 and Y3 to the device providing the start/restart signal, such as a push-button. Leave terminal Y2 unconnected.

Monitored start/restart and if the control output Y1 is not to be used:
Connect terminal Y3 to the device providing the start/restart signal, such as a logic controller. Leave terminals Y1 and Y2 unconnected. In this case, terminal A2 is the common reference potential for terminal Y3.

Respect the maximum wire resistance of 500 Ω when determining the cable length. The maximum wire length between the start/restart input and a sensor/ device is 30 m (98.43 ft) if the supply via the control output (terminal Y1) of the start/restart input is not used.

Chapter 5
Functions

What Is in This Chapter?

This chapter contains the following topics:

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.

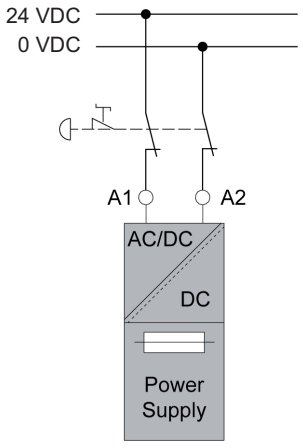
Overview of Application Functions

Typical applications	Type of outputs of sensor/device providing the input signal for application function
 Monitoring of Emergency Stop circuits as per ISO 13850 and IEC 60204-1, stop category 0 Refer to this chappter "Application Function Emergency Stop" *on page 43*.	Normally open, normally closed and/or changeover outputs
 Monitoring of guards as per ISO 14119/ 14120 with electrical switches Refer to this chappter "Application Function Guards" *on page 44*.	

Application Function Emergency Stop

Characteristic	Value/Description
Typical applications	 Monitoring of Emergency Stop circuits as per ISO 13850 and IEC 60204-1, stop category 0
Type of outputs of sensor/device providing the input signal for application function	Normally open, normally closed and/or changeover outputs

Wiring of the safety-related supply inputs for Emergency Stop, with 24 VDC supply:

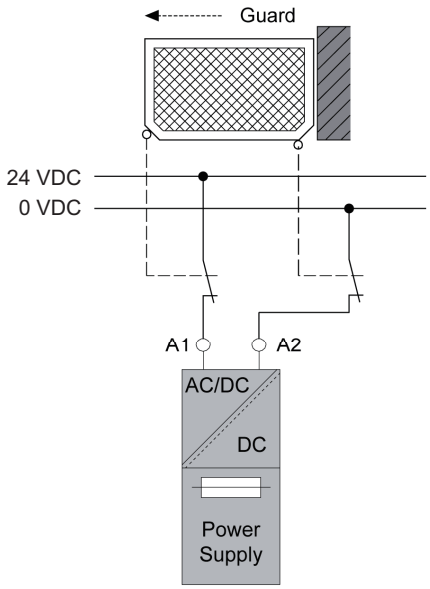


Use the same wiring logic for 24 VAC supply.

Application Function Guards

Characteristic	Value/Description
Typical applications	 Monitoring of guards as per ISO 14119/14120 with electrical switches
Type of outputs of sensor/device providing the input signal for application function	Normally open, normally closed and/or changeover outputs

Wiring of the safety-related supply inputs for guards, with 24 VDC supply:



Use the same wiring logic for 24 VAC supply.

Start/Restart Functions

Overview

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Do not use the Start/Restart function for safety-related purposes.
- Use Monitored Start/Restart if unintended restart is a hazard according to your risk assessment.

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

The safety module provides several start/restart functions which are selected by means of the wiring. The start/restart function determines the start/restart behavior of the safety module after power-on and the transition from the operating state Run: Outputs Deenergized (defined safe state) to the operating state Run: Outputs Energized.

The start /restart behavior is configured using the following characteristics:

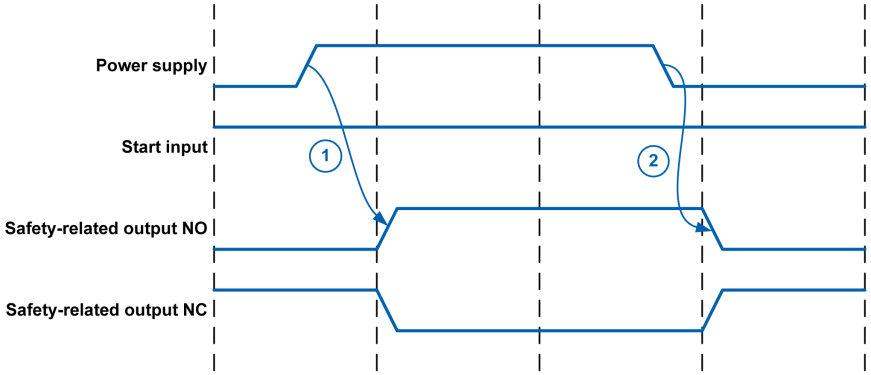
- Automatic start/restart
- Manual start/restart
- Monitored start/restart with falling edge

Refer to Chappter 4 "Start/Restart Input" *on page 40* for additional information on wiring the start/restart input.

Automatic Start/Restart

With automatic start/restart, the start/restart input is permanently active.

The following timing diagram illustrates the automatic start/restart:



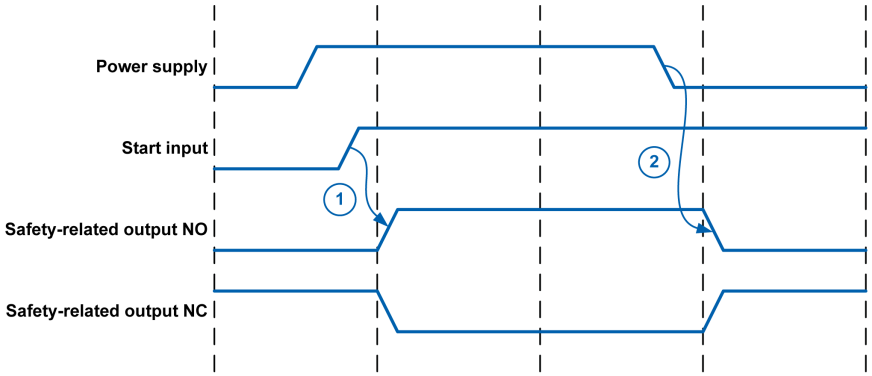
1 Activation delay (1500 ms): maximum time between activation of safety-related supply input and activation of safety-related output

2 Response time (150 ms): maximum time between deactivation of safety-related supply input (power to the safety-module removed) and deactivation of safety-related output

Manual Start/Restart

A manual start/restart requires the start/restart input to be activated. The safetyr-elated output is activated after the start/restart input has been activated.

The following timing diagram illustrates the manual start/restart:



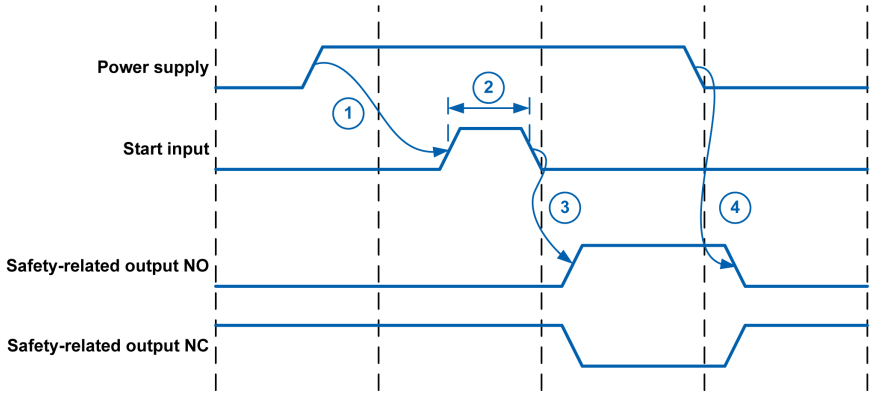
1 Activation delay (100 ms): maximum time between activation of start/restart input and activation of safety-related output

2 Response time (150 ms): maximum time between deactivation of safety-related supply input and deactivation of safety-related output

The signal required for activation of the start/restart input can be provided, for example, via a push-button, or a logic controller.

Monitored Start/Restart with Falling Edge

In the case of a monitored start/restart with falling edge, the start input must be activated and remain active for a duration of 80 ms. The safety-related outputs are activated with a falling edge of the start/restart input.



1 Waiting time after power-on (1500 ms): time that must pass between power-on and activation of the start/restart input

2 Minimum duration of start/restart pulse (80 ms): time for which the start/restart input must be activated before the falling edge at the start/restart input

3 Activation delay (100 ms): maximum time between deactivation of start/restart input and activation of safety-related output

4 Response time (150 ms): maximum time between deactivation of safety-related supply input and deactivation of safety-related output

The signal required for activation of the start/restart input can be provided, for example, via a push-button connected to Y1 or an external 24 VDC supply, or a logic controller.

Chapter 6
Configuration and Commissioning

What Is in This Chapter?

This chapter contains the following topics:

Configuration

Overview

The configuration is determined by the type of wiring of the start function and the application function. Additional configuration is not required.

Go through this chappter "Commissioning" *on page 49* after having modified the configuration by modifying the wiring.

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	Check Chappter 4 "Installation" *on page 34* according to the intended application.
2	Verify that there are no persons or obstructions in the zone of operation.
3	Apply power and start the machine/process.
4	Perform comprehensive tests for all operating states, the defined safe state, and all potential error situations.
5	Close the transparent cover of the safety module.
6	Document all modifications and the results of the commissioning procedure.

Chapter 7
Diagnostics

What Is in This Chapter?

This chapter contains the following topics:

Diagnostics via LED

Overview

The safety module features various LEDs, refer to Chappter 1 "Front View and Side View" *on page 12* that provide status information and information on detected errors.

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

POWER

State	Meaning
Off	No power supply
On	Power supply on

STATE

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

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

START1 and START2

These LEDs provide information on the start/restart condition and the type of start/ restart. Refer to Chappter 5 "Start/Restart Functions" *on page 45* for detailed information on the conditions and timing of the selected start/restart function.

State*1	Meaning
Off	Start/restart condition not fulfilled
On	Start/restart condition fulfilled
Flashing	Waiting for start/restart condition to be fulfilled

*1 LED START1 = Safety module is wired for manual/automatic start/restart.
LED START2 = Safety module is wired for monitored start/restart.

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 IDEC CORPRATION service representative if the condition persists.

State	In conjunction with additional LEDs		Meaning	Remedy
	Additional LEDs	State of additional LEDs		
On	STATE, START1 and START2	Flashing synchronously	General error detected.	Verify correct wiring.
On	POWER	Flashing	Power supply error detected.	Verify correct wiring. Use a suitable power supply.
On	START1	Flashing	Cross circuit detected at start/ restart input.	Verify correct wiring.
On	START1 and START2	Flashing synchronously	Safety module wired for both start/restart functions automatic/manual and monitored.	Wire the safety module for either automatic/manual start/ restart or for monitored start/ restart.
On	STATE	Flashing	Error detected at safety-related output.	Perform a power cycle.

Chapter 8
Accessories, Service, Maintenance, and Disposal

What Is in This Chapter?

This chapter contains the following topics:

Accessories

Accessories

Accessories

The following accessories are available for the device:

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 device. 30 pieces per packaging unit	HR9Z-EC
Sealing strips The uniquely numbered sealing strips are used to seal the transparent front cover of the device to help prevent unauthorized access to the configuration selectors. 10 pieces per packaging unit	HR9Z-ES

Maintenance

Service and Repairs

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

Maintenance Plan

Maintenance plan:

- Ensure that a safety-related function implemented with the device 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 device is not used beyond the specified lifetime (refer to Chappter 2 "Data Functional Safety" *on page 25*).
  To determine the end of the lifetime, add the specified lifetime to the date of manufacture indicated on the nameplate (refer to Chappter 1 "Nameplate" *on page 13*) of the device.
  Example: If the date of manufacture indicated on the nameplate is 2019-W10, do not use the device after week 10, 2039.

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

Transportation, Storage, and Disposal

Transportation and Storage

Ensure that the environmental conditions (refer to Chappter 2 "Environmental Conditions" *on page 17*) specified for transportation and storage are respected.

Disposal

Dispose of the product in accordance with all applicable regulations.

Service Addresses

If service support is required, please contact:

APEM SAS

55, Avenue Edouard Herriot BP1, 82303 Caussade Cedex, France
http://eu.idec.com

APEM COMPONENTS LIMITED.

Drakes Drive, Long Crendon, Buckinghamshire, HP18 9BA, UK

Additional Contact Addresses

See the homepage for additional contact addresses:
http://www.idec.com

HR6S Series Safety module
HR6S-BAC

- B-2387(0)
- November 2022
- 2-6-64 Nishimiyahara, Yodogawa-ku, Osaka, 532-0004 Japan

IDEC CORPORATION

IDEC CORPORATION

Head Office 6-64, Nishi-Miyahara-2-Chome, Yodogawa-ku, Osaka 532-0004, Japan

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		India	IDEC Controls India Private Ltd.	**Taiwan**	IDEC Taiwan Corporation		

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