

# Modicon TM3

## Safety Modules

### Hardware Guide

12/2017



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The information provided in this documentation contains general descriptions and/or technical characteristics of the performance of the products contained herein. This documentation is not intended as a substitute for and is not to be used for determining suitability or reliability of these products for specific user applications. It is the duty of any such user or integrator to perform the appropriate and complete risk analysis, evaluation and testing of the products with respect to the relevant specific application or use thereof. Neither Schneider Electric nor any of its affiliates or subsidiaries shall be responsible or liable for misuse of the information contained herein. If you have any suggestions for improvements or amendments or have found errors in this publication, please notify us.

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All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this information can result in injury or equipment damage.

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# Safety Information

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## 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.

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## 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.

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# About the Book

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## At a Glance

### Document Scope

This guide describes the hardware implementation of TM3 safety modules. It provides the parts description, characteristics, wiring diagrams, and installation details for TM3 safety modules.

### Validity Note

The information in this manual is applicable **only** for TM3 safety modules.

This document has been updated for the release of TM3TI4D Add-on for SoMachine V4.3.

This document has been updated for the release of SoMachine Basic V1.6.

The technical characteristics of the devices described in this document also appear online. To access this information online:

| Step | Action   |
|------|--|
| 1    | Go to the Schneider Electric home page <a href="http://www.schneider-electric.com">www.schneider-electric.com</a> .  |
| 2    | In the <b>Search</b> box type the reference of a product or the name of a product range. <ul style="list-style-type: none"><li>• Do not include blank spaces in the reference or product range.</li><li>• To get information on grouping similar modules, use asterisks (*).</li></ul> |
| 3    | If you entered a reference, go to the <b>Product Datasheets</b> search results and click on the reference that interests you.<br>If you entered the name of a product range, go to the <b>Product Ranges</b> search results and click on the product range that interests you.         |
| 4    | If more than one reference appears in the <b>Products</b> search results, click on the reference that interests you.   |
| 5    | Depending on the size of your screen, you may need to scroll down to see the data sheet.   |
| 6    | To save or print a data sheet as a .pdf file, click <b>Download XXX product datasheet</b> .  |

The characteristics that are presented in this manual 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 manual and online information, use the online information as your reference.

## Related Documents


| Title of Documentation  | Reference Number   |
|---|--|
| Modicon TM3 Modules Configuration - Programming Guide (SoMachine)       | <a href="#">EIO0000001402 (ENG)</a><br><a href="#">EIO0000001403 (FRA)</a><br><a href="#">EIO0000001404 (GER)</a><br><a href="#">EIO0000001405 (SPA)</a><br><a href="#">EIO0000001406 (ITA)</a><br><a href="#">EIO0000001407 (CHS)</a>   |
| Modicon TM3 Modules Configuration - Programming Guide (SoMachine Basic) | <a href="#">EIO0000001396 (ENG)</a><br><a href="#">EIO0000001397 (FRA)</a><br><a href="#">EIO0000001398 (GER)</a><br><a href="#">EIO0000001399 (SPA)</a><br><a href="#">EIO0000001400 (ITA)</a><br><a href="#">EIO0000001401 (CHS)</a><br><a href="#">EIO0000001374 (POR)</a><br><a href="#">EIO0000001375 (TUR)</a> |
| Modicon M221 Logic Controller - Hardware Guide                          | <a href="#">EIO0000001384 (ENG)</a><br><a href="#">EIO0000001385 (FRA)</a><br><a href="#">EIO0000001386 (GER)</a><br><a href="#">EIO0000001387 (SPA)</a><br><a href="#">EIO0000001388 (ITA)</a><br><a href="#">EIO0000001389 (CHS)</a><br><a href="#">EIO0000001370 (POR)</a><br><a href="#">EIO0000001371 (TUR)</a> |
| Modicon M241 Logic Controller - Hardware Guide                          | <a href="#">EIO0000001456 (ENG)</a><br><a href="#">EIO0000001457 (FRA)</a><br><a href="#">EIO0000001458 (GER)</a><br><a href="#">EIO0000001459 (SPA)</a><br><a href="#">EIO0000001460 (ITA)</a><br><a href="#">EIO0000001461 (CHS)</a>   |
| Modicon M251 Logic Controller - Hardware Guide                          | <a href="#">EIO0000001486 (ENG)</a><br><a href="#">EIO0000001487 (FRA)</a><br><a href="#">EIO0000001488 (GER)</a><br><a href="#">EIO0000001489 (SPA)</a><br><a href="#">EIO0000001490 (ITA)</a><br><a href="#">EIO0000001491 (CHS)</a>   |
| TM3SAC5R TM3 Safety Module Instruction Sheet                            | <a href="#">EAV48222</a>   |
| TM3SAF5R TM3 Safety Module Instruction Sheet                            | <a href="#">EAV48224</a>   |



| Title of Documentation                        | Reference Number         |
|---|--------------------------|
| TM3SAFL5R TM3 Safety Module Instruction Sheet | <a href="#">EAV48225</a> |
| TM3SAK6R TM3 Safety Module Instruction Sheet  | <a href="#">EAV48226</a> |

You can download these technical publications and other technical information from our website at <http://www.schneider-electric.com/en/download>

## 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.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- 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.<sup>1</sup>
- 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.**

<sup>1</sup> 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

### UNINTENDED EQUIPMENT OPERATION

- Only use software approved by Schneider Electric for use with this equipment.
- Update your application program every time you change the physical hardware configuration.

**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   |
|------------------|---|
| EN 61131-2:2007  | Programmable controllers, part 2: Equipment requirements and tests.                             |
| ISO 13849-1:2008 | Safety of machinery: Safety related parts of control systems.<br>General principles for design. |

| Standard                       | Description   |
|--------------------------------|---|
| 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   |
| EN 1088:2008<br>ISO 14119:2013 | Safety of machinery - Interlocking devices associated with guards - Principles for design and selection   |
| ISO 13850:2006                 | Safety of machinery - Emergency stop - Principles for design  |
| EN/IEC 62061:2005              | 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 61784-3:2008               | Digital data communication for measurement and control: Functional safety field buses.  |
| 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.



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# Part I

## TM3 Safety General Overview

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### What Is in This Part?

This part contains the following chapters:

| Chapter | Chapter Name                    | Page |
|---------|---------------------------------|------|
| 1       | TM3 Safety Modules Description  | 15   |
| 2       | TM3 Safety Modules Installation | 33   |



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# Chapter 1

## TM3 Safety Modules Description

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### What Is in This Chapter?

This chapter contains the following sections:

| Section | Topic                                   | Page |
|---------|---|------|
| 1.1     | Modules and Accessories                 | 16   |
| 1.2     | Safety Applications Sequential Behavior | 22   |

# Section 1.1

## Modules and Accessories

---

### What Is in This Section?

This section contains the following topics:

| Topic                | Page |
|----------------------|------|
| General Description  | 17   |
| Physical Description | 20   |




## General Description

### Introduction

The TM3 safety modules are digital I/O functional safety modules and they can be used to incorporate machine safety into the overall machine control.

The TM3 safety modules are designed to be connected to the M221, M241, M251 logic controllers.

The safety-related functions are managed uniquely by the safety module, independent from the rest of the system. Any communication dependant function is not considered as safety-related.

|  |
|--|
|  <b>WARNING</b>   |
| <p><b>UNINTENDED EQUIPMENT OPERATION</b></p> <p>Do not use the data transferred over the TM3 Bus for any functional safety-related task(s).</p> <p><b>Failure to follow these instructions can result in death, serious injury, or equipment damage.</b></p> |

### TM3 Safety Terminology

This table lists the technical terms, acronyms, abbreviations, and their respective description:

| Term used | Description  |
|-----------|--|
| EDM       | External Device Monitoring   |
| ESPE      | Electro-Sensitive Protective Equipment   |
| K         | Refers to: <ul style="list-style-type: none"> <li>● K1: internal relay</li> <li>● K2: internal relay</li> <li>● K3: external contactor</li> <li>● K4: external contactor</li> </ul>  |
| PL        | Performance Level  |
| SIL       | Safety Integrity Level   |
| S         | Refers to safety inputs: <ul style="list-style-type: none"> <li>● Safety or start inputs:                             <ul style="list-style-type: none"> <li>○ S11-S12</li> <li>○ S21-S22</li> <li>○ S31-S32</li> <li>○ S41-S42</li> </ul> </li> <li>● External switches <b>S1</b>, <b>S2</b>, <b>S3</b>, and so on.</li> </ul> <p><b>NOTE:</b> The function depends on the module type.</p> |
| Start     | Refers to: <ul style="list-style-type: none"> <li>● Non-monitored: may be manual or automatic mode. Start button must be closed for valid start condition.</li> <li>● Monitored: start button must be pressed and then released for valid start condition.</li> </ul>  |

## Application

Safety systems comprise many components. A single safety component in and of its own does not constitute the safety system. The design of the entire safety system must be considered before attempting to install, operate, or maintain it. The applicable safety standards must be followed when installing and wiring the system components. For more information, refer to the Document Scope (*see page 7*).

## Safe State

The TM3 safety modules are operationally defined to be in a safe state when their outputs are off. To exit the safe state condition, a combination of hardware inputs and enabling TM3 Bus communications are required.

The information transacted on the TM3 Bus is not considered part of the safety-related functionality.

## WARNING

### UNINTENDED EQUIPMENT OPERATION

Do not use the data transferred over the TM3 Bus for any functional safety-related task(s).

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

## TM3 Safety Modules

This table contains the TM3 safety modules (*see page 61*), with the corresponding channel type, nominal voltage/current, and terminal type:

| Reference   | Function Category            | Channels              | Channel type                   | Voltage Current                            | Terminal type  |
|---|------------------------------|-----------------------|--------------------------------|--|--|
| TM3SAC5R<br><i>(see page 63)</i>  | 1 function, up to category 3 | 1 or 2 <sup>(1)</sup> | Safety input                   | 24 Vdc<br>100 mA maximum                   | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable screw terminal block  |
|   |                              | Start <sup>(2)</sup>  | Input                          |  |  |
|   |                              | 3 in parallel         | Relay outputs<br>Normally open | 24 Vdc / 230 Vac<br>6 A maximum per output |  |
| TM3SAC5RG<br><i>(see page 63)</i>   | 1 function, up to category 3 | 1 or 2 <sup>(1)</sup> | Safety input                   | 24 Vdc<br>100 mA maximum                   | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable spring terminal block |
|   |                              | Start <sup>(2)</sup>  | Input                          |  |  |
|   |                              | 3 in parallel         | Relay outputs<br>Normally open | 24 Vdc / 230 Vac<br>6 A maximum per output |  |
| <sup>(1)</sup> Depending on external wiring<br><sup>(2)</sup> Non-monitored start |                              |                       |                                |  |  |

| Reference  | Function Category             | Channels              | Channel type                   | Voltage Current                            | Terminal type  |
|--|-------------------------------|-----------------------|--------------------------------|--|--|
| TM3SAF5R<br><i>(see page 73)</i>   | 1 function, up to category 4  | 2 <sup>(1)</sup>      | Safety inputs                  | 24 Vdc<br>100 mA maximum                   | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable screw terminal block  |
|  |                               | Start                 | Input                          |  |  |
|  |                               | 3 in parallel         | Relay outputs<br>Normally open | 24 Vdc / 230 Vac<br>6 A maximum per output |  |
| TM3SAF5RG<br><i>(see page 73)</i>  | 1 function, up to category 4  | 2 <sup>(1)</sup>      | Safety inputs                  | 24 Vdc<br>100 mA maximum                   | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable spring terminal block |
|  |                               | Start                 | Input                          |  |  |
|  |                               | 3 in parallel         | Relay outputs<br>Normally open | 24 Vdc / 230 Vac<br>6 A maximum per output |  |
| TM3SAFL5R<br><i>(see page 83)</i>  | 2 functions, up to category 3 | 2 <sup>(1)</sup>      | Safety inputs                  | 24 Vdc<br>100 mA maximum                   | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable screw terminal block  |
|  |                               | Start                 | Input                          |  |  |
|  |                               | 3 in parallel         | Relay outputs<br>Normally open | 24 Vdc / 230 Vac<br>6 A maximum per output |  |
| TM3SAFL5RG<br><i>(see page 83)</i>   | 2 functions, up to category 3 | 2 <sup>(1)</sup>      | Safety inputs                  | 24 Vdc<br>100 mA maximum                   | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable spring terminal block |
|  |                               | Start                 | Input                          |  |  |
|  |                               | 3 in parallel         | Relay outputs<br>Normally open | 24 Vdc / 230 Vac<br>6 A maximum per output |  |
| TM3SAK6R<br><i>(see page 95)</i>   | 3 functions, up to category 4 | 1 or 2 <sup>(1)</sup> | Safety inputs                  | 24 Vdc<br>100 mA maximum                   | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable screw terminal block  |
|  |                               | Start                 | Input                          |  |  |
|  |                               | 3 in parallel         | Relay outputs<br>Normally open | 24 Vdc / 230 Vac<br>6 A maximum per output |  |
| TM3SAK6RG<br><i>(see page 95)</i>  | 3 functions, up to category 4 | 1 or 2 <sup>(1)</sup> | Safety inputs                  | 24 Vdc<br>100 mA maximum                   | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable spring terminal block |
|  |                               | Start                 | Input                          |  |  |
|  |                               | 3 in parallel         | Relay outputs<br>Normally open | 24 Vdc / 230 Vac<br>6 A maximum per output |  |
| <p><sup>(1)</sup> Depending on external wiring</p> <p><sup>(2)</sup> Non-monitored start</p> |                               |                       |                                |  |  |

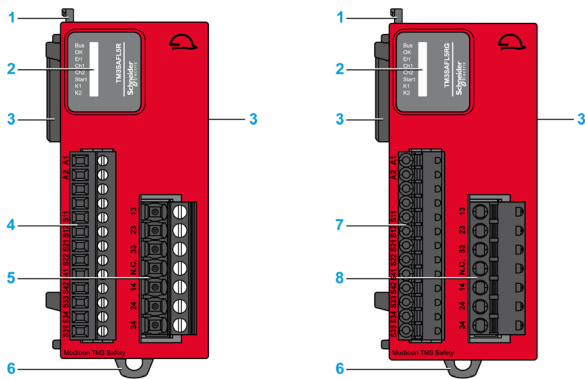
## Physical Description

### Introduction

This section describes the physical characteristics of the TM3 safety modules.

### TM3 Safety Module with Removable Screw or Spring Terminal Block


This figure illustrates the main elements of a TM3 safety module with removable screw or spring terminal blocks:



This table describes the main elements of the TM3 safety modules:

| Label | Elements   |   |
|-------|--|---|
| 1     | Locking device for attachment to the previous module.                                  |   |
| 2     | Status LED indicators  |   |
| 3     | Expansion connector for TM3 Bus (one on each side).                                    |   |
| 4     | Power supply and input removable screw terminal block with a 3.81 mm (0.15 in) pitch.  | Rules for removable screw terminal block ( <a href="#">see page 55</a> )  |
| 5     | Relay output removable screw terminal block with a 5.08 mm (0.20 in) pitch.            |   |
| 6     | Clip-on lock for 35 mm (1.38 in.) DIN-rail.  | Top hat section rail (DIN rail) ( <a href="#">see page 44</a> )           |
| 7     | Power supply and input removable spring terminal block with a 3.81 mm (0.15 in) pitch. | Rules for removable spring terminal block ( <a href="#">see page 56</a> ) |
| 8     | Relay output removable spring terminal block with a 5.08 mm (0.20 in) pitch.           |   |

This table presents the symbols printed on the product:

| Symbol  | Reference      | Title                    |
|---|----------------|--------------------------|
| ~   | IEC 60417-5032 | Alternating current (ac) |
| ≡   | IEC 60417-5031 | Direct current (dc)      |
|  | ISO 7000-0434A | Caution                  |

## Section 1.2

### Safety Applications Sequential Behavior

---

#### What Is in This Section?

This section contains the following topics:

| Topic                   | Page |
|-------------------------|------|
| One Channel Application | 23   |
| Two Channel Application | 26   |
| Safety-Mat Application  | 30   |

## One Channel Application




### Performance and Safety Integrity Levels

This table describes the performance and safety integrity levels associated to the 1 channel application:

| Application type      | Performance Level (PL) and maximum category (IEC/ISO 13849-1) | Maximum Safety Integrity Level (SIL) (IEC/EN 62061) |
|-----------------------|---|---|
| 1 channel application | PL c, category 2  | SIL 1   |


### Chronogram Convention

The inputs and outputs behavior description may be based on chronograms. In those chronograms, the following convention on signals status applies:

| I/O behavior  | Status   |
|---|----------|
|  | On       |
|  | Off      |
|  | Optional |

### Output Activation

Both the safety conditions and the start conditions must be valid before allowing the activation of outputs.

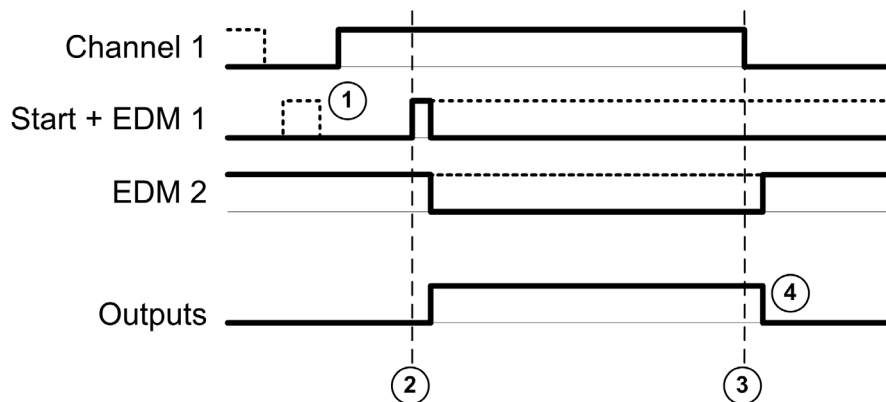
|   |
|---|
|  <b>WARNING</b>    |
| <b>UNINTENDED EQUIPMENT OPERATION</b>   |
| Do not use either the monitored start or the non-monitored start as a safety function.                |
| <b>Failure to follow these instructions can result in death, serious injury, or equipment damage.</b> |

### Non-Monitored Start

This table presents the module types available in a 1 channel application with a non-monitored start:

| Reference | Channel 1    | Start + EDM 1 | EDM 2   | Outputs        |
|-----------|--------------|---------------|---------|----------------|
| TM3SAC5R  | +24 Vdc - A1 | Y1-Y2         | -       | 13-14          |
| TM3SAK6R  | S11-S12      | S33-S39       | S41-S42 | 23-24<br>33-34 |

This figure represents the output activation management in a 1 channel application with a non-monitored start:



Events description:

1. Non-monitored start condition is available as long as the **start** input is on.  
The start condition can be valid before the safety input.  
The outputs are on only if start + safety input conditions are valid.
2. Safety inputs + start conditions are valid
3. Safety inputs condition invalid
4. The outputs react to the safety input and start conditions with a delay given by system constraints.

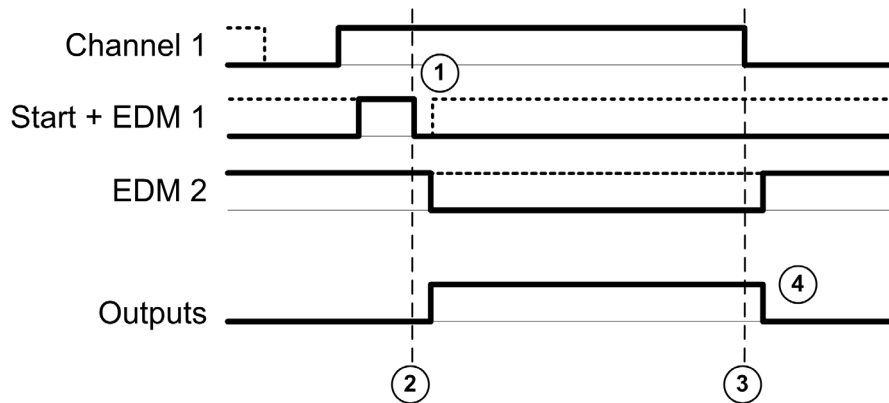


### Monitored Start

This table presents the module type available in a 1 channel application with a monitored start:

| Reference | Channel 1 | Start + EDM 1 | EDM 2   | Outputs                 |
|-----------|-----------|---------------|---------|-------------------------|
| TM3SAK6R  | S11-S12   | S33-S34       | S41-S42 | 13-14<br>23-24<br>33-34 |

This figure represents the output activation management in a 1 channel application with a monitored start:



Events description:

1. Monitored start condition is triggered by a falling edge on the **start** input.
2. Safety inputs + start conditions are valid
3. Safety inputs condition invalid
4. The outputs react to the safety input and start conditions with a delay given by system constraints.

## Two Channel Application




### Performance and Safety Integrity Levels

This table describes the performance and safety integrity levels associated to the 2 channel application:

| Application type   | Performance Level (PL) and maximum category (IEC/ISO 13849-1) | Maximum Safety Integrity Level (SIL) (IEC/EN 62061) |
|--|---|---|
| 2 channel application without short-circuit detection                                | PL d, category 3  | SIL 2   |
| 2 channel application (2 * PNP sensors) without short-circuit detection              | PL d, category 3  | SIL 2   |
| 2 channel application with short-circuit detection                                   | PL e, category 4  | SIL 3   |
| 2 channel application (PNP + NPN complementary sensors) with short-circuit detection | PL e, category 4  | SIL 3   |

### Chronogram Convention

The inputs and outputs behavior description may be based on chronograms. In those chronograms, the following convention on signals status applies:

| I/O behavior  | Status   |
|---|----------|
|    | On       |
|  | Off      |
|  | Optional |

### Output Activation

Both the safety conditions and the start conditions must be valid before allowing the activation of outputs.

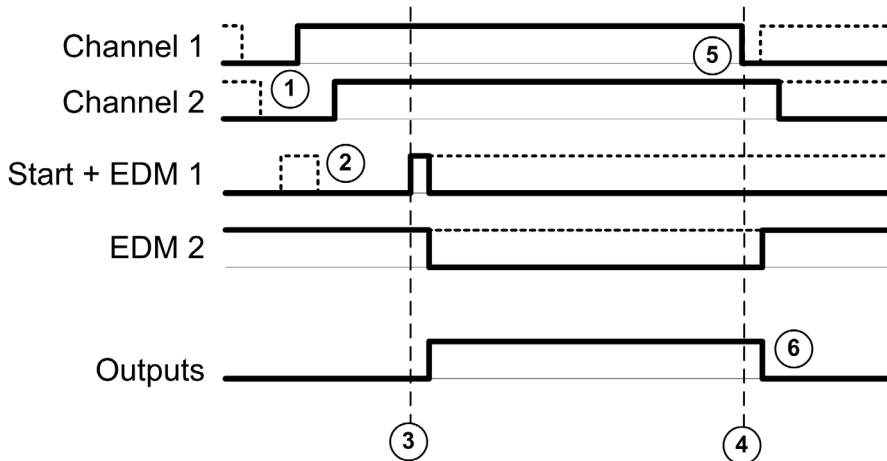
|   |
|---|
| ⚠ WARNING   |
| UNINTENDED EQUIPMENT OPERATION  |
| Do not use either the monitored start or the non-monitored start as a safety function.                |
| <b>Failure to follow these instructions can result in death, serious injury, or equipment damage.</b> |

### Non-Monitored Start

This table presents the module types available in a 2 channel application with a non-monitored start:

| Reference | Channel 1    | Channel 2 | Start + EDM 1 | EDM 2   | Outputs |
|-----------|--------------|-----------|---------------|---------|---------|
| TM3SAC5R  | +24 Vdc - A1 | A2-GND    | Y1-Y2         | –       | 13-14   |
| TM3SAF5R  | S11-S12      | S21-S22   | S33-S39       | S41-S42 | 23-24   |
| TM3SAFL5R |              |           |               |         | 33-34   |
| TM3SAK6R  | S21-S22      | S31-S32   |               |         |         |

This figure represents the output activation management in a 2 channel application with a non-monitored start:



Events description:

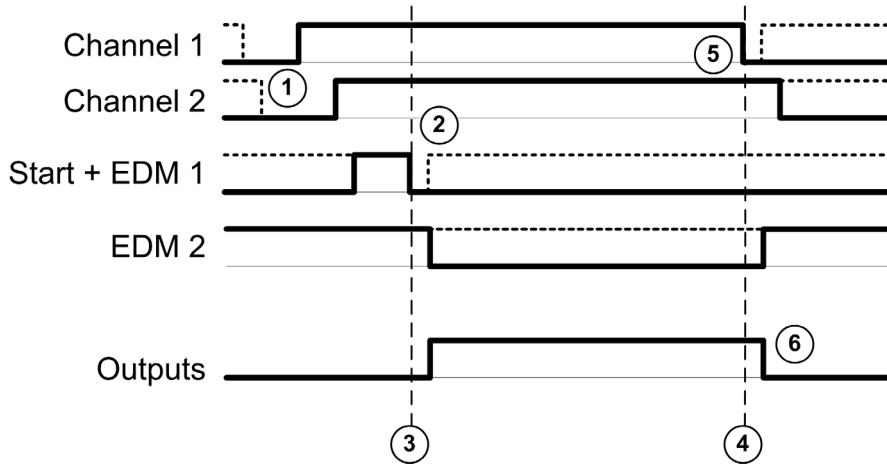
1. Both **S2** and **S3** inputs must be set to off before the outputs can be activated. This condition is called interlock. For more information, refer to the TM3 Expansion Modules Programming Guide for your software platform.
2. Non-monitored start condition is available as long as the **start** input is on.  
The start condition can be valid before the safety inputs.  
The outputs are on only if start + safety inputs conditions are valid.
3. Safety inputs + start conditions are valid
4. Safety inputs condition invalid
5. At least 1 input is off
6. The outputs react to the safety inputs and start conditions with a delay given by system constraints.

### Monitored Start

This table presents the module types available in a 2 channel application with a monitored start:

| Reference | Channel 1 | Channel 2 | Start + EDM 1 | EDM 2   | Outputs |
|-----------|-----------|-----------|---------------|---------|---------|
| TM3SAF5R  | S11-S12   | S21-S22   | S33-S34       | S41-S42 | 13-14   |
| TM3SAFL5R |           |           |               |         | 23-24   |
| TM3SAK6R  | S21-S22   | S31-S32   |               |         | 33-34   |

This figure represents the output activation management in a 2 channel application with a monitored start:



Events description:

- Both **S2** and **S3** inputs must be set to off before the outputs can be activated. This condition is called interlock. For more information, refer to the TM3 Expansion Modules Programming Guide for your software platform.
- Monitored start condition is triggered by a falling edge on the **start** input.
- Safety inputs + start conditions are valid
- Safety inputs condition invalid
- At least 1 input is off
- The outputs react to the safety inputs and start conditions with a delay given by system constraints.

## Safety-Mat Application

### Performance and Safety Integrity Levels

This table describes the performance and safety integrity levels associated to the safety-mat application:

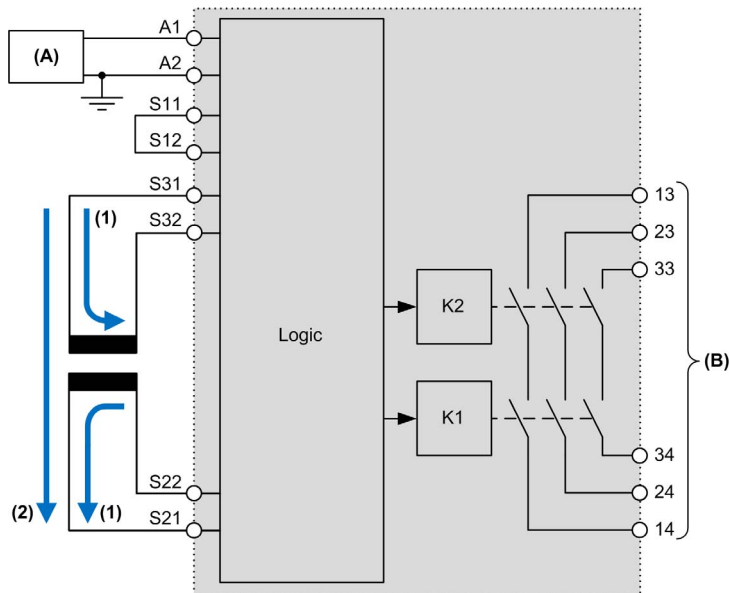
| Application type                        | Performance Level (PL) and maximum category (IEC/ISO 13849-1) | Maximum Safety Integrity Level (SIL) (IEC/EN 62061) |
|---|---|---|
| Safety-mat application (current source) | PL d, category 3  | SIL 2   |

### Description

This table presents the module type available in a safety-mat application:

| Reference | Channel 1 | Channel 2 | Start + EDM 1 | EDM 2   | Outputs                 |
|-----------|-----------|-----------|---------------|---------|-------------------------|
| TM3SAK6R  | S21-S22   | S31-S32   | S33-S34       | S41-S42 | 13-14<br>23-24<br>33-34 |

This figure represents the current flow in a safety-mat connected to safety inputs:



(A): Current source  
(A1): 24 Vdc

**(A2):** GND pin out

**(B):** Outputs

**(1):** Current flow when the mat is released, relays K1 and K2 are supplied.

**(2):** Current flow when the mat is under pressure (mat is stepped on), relays K1 and K2 are not supplied (the mat provides a short circuit path).





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# Chapter 2

## TM3 Safety Modules Installation

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### What Is in This Chapter?

This chapter contains the following sections:

| Section | Topic                                     | Page |
|---------|---|------|
| 2.1     | TM3 Safety General Rules for Implementing | 34   |
| 2.2     | TM3 Safety Module Installation            | 39   |
| 2.3     | TM3 Safety Electrical Requirements        | 52   |

# Section 2.1

## TM3 Safety General Rules for Implementing

---

### What Is in This Section?

This section contains the following topics:

| Topic                         | Page |
|-------------------------------|------|
| Environmental Characteristics | 35   |
| Certifications and Standards  | 38   |

## Environmental Characteristics

### Enclosure Requirements

TM3 safety module components are designed as Zone B, Class A industrial equipment according to IEC/CISPR Publication 11. If they are used in environments other than those described in these standards, or in environments that do not meet the specifications in this manual the ability to meet electromagnetic compatibility requirements in the presence of conducted and/or radiated interference may be reduced.

All TM3 safety module components meet European Community (CE) requirements for open equipment as defined by IEC/EN 61131-2. You must install them in an enclosure designed for the specific environmental conditions and to minimize the possibility of unintended contact with hazardous voltages. Use metal enclosures to improve the electromagnetic immunity of your TM3 safety module components. Use enclosures with a keyed locking mechanism to minimize unauthorized access.

The TM3 safety module environment must be designed to improve the durability of the equipment.

### WARNING

#### UNINTENDED EQUIPMENT OPERATION

Install and use the module in a cabinet with an IP54 rating.

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

### Environmental Characteristics

All the TM3 safety module components are electrically isolated between the internal electronic circuit and the input/output channels.

This equipment meets CE requirements as indicated in the following table. This equipment is intended for use in a Pollution Degree 2 industrial environment.

### WARNING

#### UNINTENDED EQUIPMENT OPERATION

Do not exceed any of the rated values specified in the environmental and electrical characteristics tables.

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

| Characteristic                |  | Specification   |
|-------------------------------|--|---|
| Standard compliance           | IEC/EN 61131-2<br>IEC/EN 61010-2-201                           |   |
| Ambient operating temperature | Horizontal installation  | -10...55 °C (14...131 °F)   |
|                               | Vertical installation  | -10...35 °C (14...95 °F)  |
| Storage temperature           |  | -40...70 °C (-40...158 °F)  |
| Relative humidity             | Transport and storage  | 10...95 % (non-condensing)  |
|                               | Operation  |   |
| Pollution degree              | IEC/EN 60664-1   | 2   |
| Degree of protection          | IEC/EN 60529   | IP20  |
| Overvoltage category          |  | III (4 kV)  |
| Rated insulation voltage      | IEC/EN 60664-1   | 300 Vac   |
| Corrosion immunity            |  | Atmosphere free from corrosive gases  |
| Operating altitude            |  | 0...2000 m (0...6560 ft)  |
| Storage altitude              |  | 0...3000 m (0...9840 ft)  |
| Vibration resistance          | Panel mounting or mounted on a top hat section rail (DIN rail) | 3.5 mm (0.04 in.) fixed amplitude from 5...8.4 Hz<br>9.8 m/s <sup>2</sup> or 32.15 ft/s <sup>2</sup> (1 g <sub>n</sub> ) fixed acceleration from 8.4...150 Hz |
| Mechanical shock resistance   |  | 147 m/s <sup>2</sup> or 482.285 ft/s <sup>2</sup> (15 g) for 11 ms duration   |

### Electromagnetic Susceptibility

The TM3 safety module components meet electromagnetic susceptibility specifications as indicated in the table:

| Characteristic   | Range  |                   |                   | Designed to specification               |
|--|--|-------------------|-------------------|---|
| Electrostatic discharge                                | 8 kV (air discharge)<br>4 kV (contact discharge)   |                   |                   | IEC/EN 61000-4-2                        |
| Radiated electromagnetic field                         | 10 V/m (80 MHz...1 GHz)<br>3 V/m (1.4 GHz...2 GHz)<br>1 V/m (2...3 GHz)  |                   |                   | IEC/EN 61000-4-3                        |
| Fast transient burst                                   | AC/DC Power lines  | 2 kV              |                   | IEC/EN 61000-4-4                        |
|  | Relay outputs  | 2 kV              |                   |   |
|  | 24 Vdc I/Os  | 1 kV              |                   |   |
| Surge immunity   | –  | CM <sup>(1)</sup> | DM <sup>(2)</sup> | IEC/EN 61000-4-5<br>IEC/EN 61131-2      |
|  | DC Power lines   | 0.5 kV            | 0.5 kV            |   |
|  | Relay outputs  | 2 kV              | 1 kV              |   |
|  | 24 Vdc I/Os  | 0.5 kV            | 0.5 kV            |   |
|  | Shielded cable (between shield and ground)   | 1 kV              | –                 |   |
| Induced electromagnetic field                          | 10 Vrms (0.15...80 MHz)  |                   |                   | IEC/EN 61000-4-6                        |
| Radiated emission                                      | Class A, 10 m distance:<br><ul style="list-style-type: none"> <li>● 30...230 MHz: 40 dB<math>\mu</math>V/m QP</li> <li>● 230 MHz...1 GHz: 47 dB<math>\mu</math>V/m QP</li> </ul> |                   |                   | IEC/EN 55011 (IEC/CISPR Publication 11) |
| <b>(1)</b> Common mode<br><b>(2)</b> Differential mode |  |                   |                   |   |

## Certifications and Standards

### Introduction

The TM3 safety modules are designed to conform to the main national and international standards concerning electronic industrial control devices:

- EN 62061
- EN ISO 13849-1
- IEC/EN 61131-2

The TM3 safety modules have obtained the following conformity marks:

- UL
- CSA
- CE
- RCM
- EAC
- CCC

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## Section 2.2

### TM3 Safety Module Installation

---

#### What Is in This Section?

This section contains the following topics:

| Topic   | Page |
|---|------|
| Installation and Maintenance Requirements                   | 40   |
| Installation Guidelines                                     | 43   |
| Top Hat Section Rail (DIN rail)                             | 44   |
| Assembling a Module to a Controller or Receiver Module      | 48   |
| Disassembling a Module from a Controller or Receiver Module | 50   |
| Mounting a TM3 Safety Module Directly on a Panel Surface    | 51   |

## Installation and Maintenance Requirements

### Before Starting

Read and understand this chapter before beginning the installation of your system.

The use and application of the information contained herein require expertise in the design and programming of automated control systems. Only you, the user, machine builder or integrator, can be aware of all the conditions and factors present during installation and setup, operation, and maintenance of the machine or process, and can therefore determine the automation and associated equipment and the related safeties and interlocks which can be effectively and properly used. When selecting automation and control equipment, and any other related equipment or software, for a particular application, you must also consider any applicable local, regional or national standards and/or regulations.

Pay particular attention in conforming to any safety information, different electrical requirements, and normative standards that would apply to your machine or process in the use of this equipment.

### Disconnecting Power

All options and modules should be assembled and installed before installing the control system on a mounting rail, onto a mounting plate or in a panel. Remove the control system from its mounting rail, mounting plate or panel before disassembling the equipment.

## 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.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- 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.**



## Programming Considerations

### WARNING

#### UNINTENDED EQUIPMENT OPERATION

- Only use software approved by Schneider Electric for use with this equipment.
- Update your application program every time you change the physical hardware configuration.

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

## Operating Environment

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

#### UNINTENDED EQUIPMENT OPERATION

Install and operate this equipment according to the conditions described in the Environmental Characteristics.

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

## Installation Considerations

### **WARNING**

#### **UNINTENDED EQUIPMENT OPERATION**

- Use appropriate safety interlocks where personnel and/or equipment hazards exist.
- Install and operate this equipment in an enclosure appropriately rated for its intended environment.
- Use the sensor and actuator power supplies only for supplying power to the sensors or actuators connected to the module.
- Power line and output circuits must be wired and fused in compliance with local and national regulatory requirements for the rated current and voltage of the particular equipment.
- Do not disassemble, repair, or modify this equipment.
- 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.**

**NOTE:** JDYX2 or JDYX8 fuse types are UL-recognized and CSA approved.

## Installation Guidelines

### Introduction

TM3 expansion modules are assembled by connecting them to a logic controller or receiver module.

The logic controller or receiver module and their expansion modules can be installed on a top hat section rail (DIN rail).

### Mounting Position and Minimum Clearances

The mounting position and minimum clearances of the expansion modules must conform with the rules defined for the appropriate hardware system. Refer to the *Installation chapter* in the *Controller Hardware* documentation for your specific controller.

## WARNING

### UNINTENDED EQUIPMENT OPERATION

- Place devices dissipating the most heat at the top of the cabinet and ensure adequate ventilation.
- Avoid placing this equipment next to or above devices that might cause overheating.
- Install the equipment in a location providing the minimum clearances from all adjacent structures and equipment as directed in this document.
- Install all equipment in accordance with the specifications in the related documentation.

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

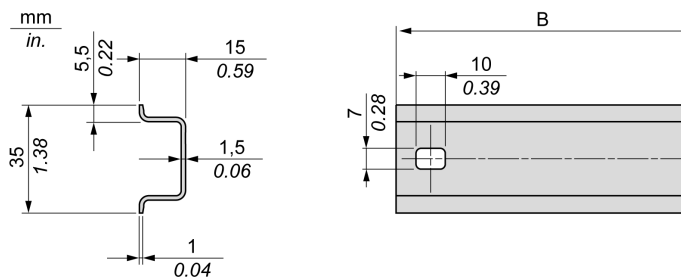
## Top Hat Section Rail (DIN rail)

### Dimensions of Top Hat Section Rail DIN Rail

You can mount the controller or receiver and its expansions on a 35 mm (1.38 in.) top hat section rail (DIN rail). It can be attached to a smooth mounting surface or suspended from a EIA rack or mounted in a NEMA cabinet.

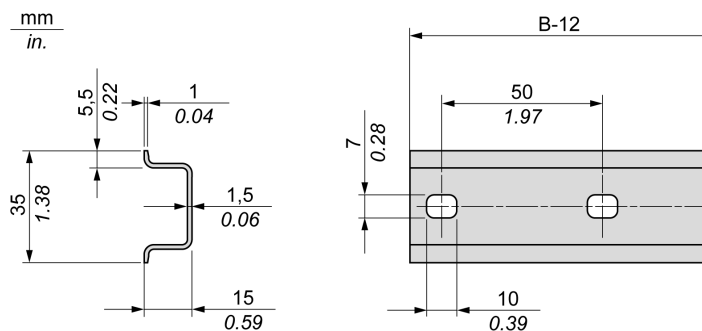
### Symmetric Top Hat Section Rails (DIN Rail)

The following illustration and table show the references of the top hat section rails (DIN rail) for the wall-mounting range:



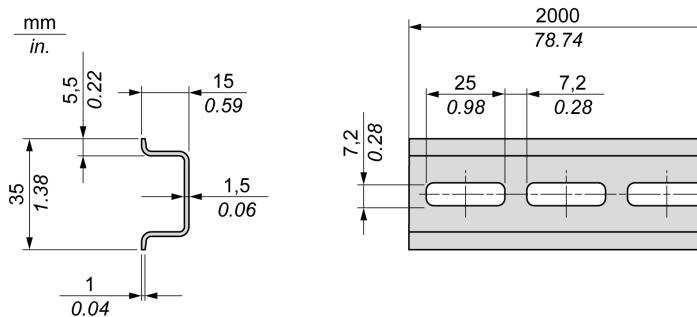
| Reference  | Type | Rail Length (B)    |
|------------|------|--------------------|
| NSYSDR50A  | A    | 450 mm (17.71 in.) |
| NSYSDR60A  | A    | 550 mm (21.65 in.) |
| NSYSDR80A  | A    | 750 mm (29.52 in.) |
| NSYSDR100A | A    | 950 mm (37.40 in.) |

The following illustration and table show the references of the symmetric top hat section rails (DIN rail) for the metal enclosure range:



| Reference  | Type | Rail Length (B-12 mm) |
|------------|------|-----------------------|
| NSYS DR60  | A    | 588 mm (23.15 in.)    |
| NSYS DR80  | A    | 788 mm (31.02 in.)    |
| NSYS DR100 | A    | 988 mm (38.89 in.)    |
| NSYS DR120 | A    | 1188 mm (46.77 in.)   |

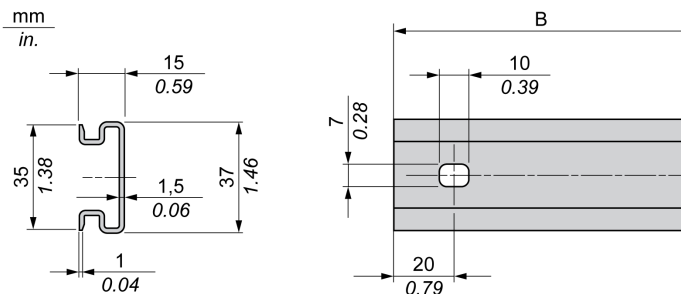
The following illustration and table shows the references of the symmetric top hat section rails (DIN rail) of 2000 mm (78.74 in.):



| Reference  | Type | Rail Length         |
|--|------|---------------------|
| NSYS DR200 <sup>1</sup>  | A    | 2000 mm (78.74 in.) |
| NSYS DR200D <sup>2</sup>   | A    |                     |
| <b>1</b> Unperforated galvanized steel<br><b>2</b> Perforated galvanized steel |      |                     |

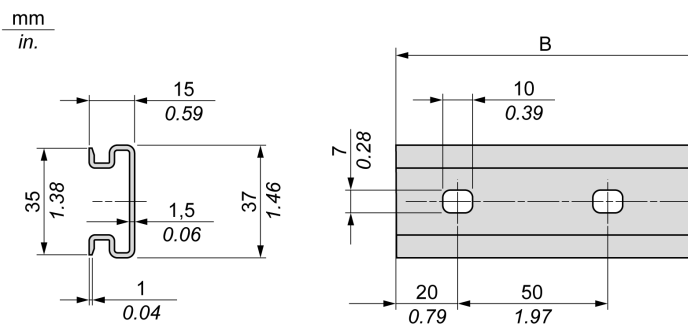
### Double-Profile Top Hat Section Rails (DIN rail)

The following illustration and table show the references of the double-profile top hat section rails (DIN rails) for the wall-mounting range:



| Reference | Type | Rail Length (B)    |
|-----------|------|--------------------|
| NSYDPR25  | W    | 250 mm (9.84 in.)  |
| NSYDPR35  | W    | 350 mm (13.77 in.) |
| NSYDPR45  | W    | 450 mm (17.71 in.) |
| NSYDPR55  | W    | 550 mm (21.65 in.) |
| NSYDPR65  | W    | 650 mm (25.60 in.) |
| NSYDPR75  | W    | 750 mm (29.52 in.) |

The following illustration and table show the references of the double-profile top hat section rails (DIN rail) for the floor-standing range:



| <b>Reference</b> | <b>Type</b> | <b>Rail Length (B)</b> |
|------------------|-------------|------------------------|
| NSYDPR60         | F           | 588 mm (23.15 in.)     |
| NSYDPR80         | F           | 788 mm (31.02 in.)     |
| NSYDPR100        | F           | 988 mm (38.89 in.)     |
| NSYDPR120        | F           | 1188 mm (46.77 in.)    |

## Assembling a Module to a Controller or Receiver Module

### Introduction

This section describes how to assemble an expansion module to a controller, Receiver module or other modules.

### 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.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- 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.**

After connecting new modules to the controller, either directly or through a transmitter/receiver, update and reupload your application program before placing the system back in service. If you do not revise your application program to reflect the addition of new modules, I/O located on the expansion bus may no longer operate normally.

### WARNING

#### UNINTENDED EQUIPMENT OPERATION

- Only use software approved by Schneider Electric for use with this equipment.
- Update your application program every time you change the physical hardware configuration.

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



### Assembling a Module to a Controller or Receiver Module


The following procedure shows how to assemble a controller or receiver module and a module together.

| Step | Action   |
|------|--|
| 1    | Remove all power and dismount any existing controller I/O assembly from its DIN mounting.  |
| 2    | Remove the expansion connector sticker from the controller or the outermost installed expansion module.  |
| 3    | Verify that the locking device ( <i>see Modicon TM3, Transmitter and Receiver Modules, Hardware Guide</i> ) on the new module is in the upper position.  |
| 4    | Align the internal bus connector on the left side of the module with the internal bus connector on the right side of the controller, Receiver module or expansion module.  |
| 5    | Press the new module towards the controller, Receiver module or expansion module until it is securely in place.  |
| 6    | Push down the locking device ( <i>see Modicon TM3, Transmitter and Receiver Modules, Hardware Guide</i> ) on the top of the new module to lock it to the controller, Receiver module or previously installed expansion module. |

## Disassembling a Module from a Controller or Receiver Module

### Introduction

This section describes how to disassemble a module from a controller or receiver module.


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.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- 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.**

### Disassembling a Module from a Controller or Receiver Module

The following procedure describes how to disassemble a module from a controller or receiver module.

| Step | Action   |
|------|--|
| 1    | Remove all power from the control system.  |
| 2    | Dismount the assembled controller and modules from the mounting rail.  |
| 3    | Push up the locking device ( <i>see Modicon TM3, Digital I/O Modules, Hardware Guide</i> ) from the bottom of the module to disengage it from the controller or receiver module. |
| 4    | Pull apart module from the controller or receiver module.  |

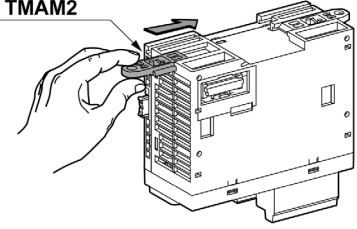
## Mounting a TM3 Safety Module Directly on a Panel Surface

### Overview

This section shows how to install a TM3 safety module using the panel mounting kit and the module mounting holes layout.

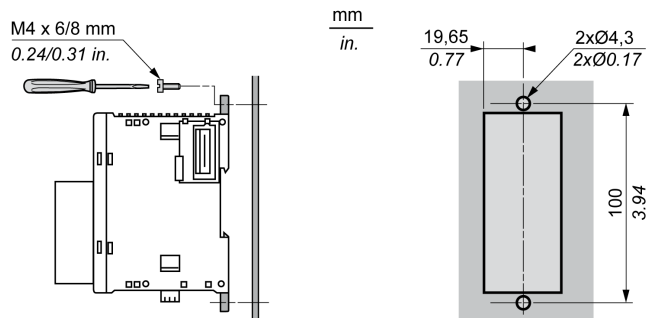
### Installing the Panel Mount Kit

The following procedure shows how to install a mounting strip:

| Step | Action  |
|------|---|
| 1    | <p>Insert the mounting strip TMAM2 into the slot at the top of the TM3 safety module.</p>  |

### Mounting Hole Layout

The following diagram shows the mounting holes for a TM3 safety module:



## Section 2.3

### TM3 Safety Electrical Requirements

---

#### What Is in This Section?

This section contains the following topics:

| Topic                           | Page |
|---------------------------------|------|
| Wiring Best Practices           | 53   |
| DC Power Supply Characteristics | 59   |

## Wiring Best Practices

### Overview

This section describes the wiring guidelines and associated best practices to be respected when using TM3 safety modules.

### 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.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- 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.**

### 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.<sup>1</sup>
- 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.**

<sup>1</sup> 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.

### Functional Ground (FE) on a Top Hat Section Rail (DIN Rail)

The top hat section rail (DIN Rail) for your system is common with the functional ground (FE) plane and must be mounted on a conductive backplane.

|  |
|--|
|  <b>WARNING</b> |
|--|

|                                       |
|---------------------------------------|
| <b>UNINTENDED EQUIPMENT OPERATION</b> |
|---------------------------------------|

|  |
|--|
| Connect the DIN rail to the functional ground (FE) of your installation. |
|--|

|   |
|---|
| <b>Failure to follow these instructions can result in death, serious injury, or equipment damage.</b> |
|---|

### Wiring Guidelines

The following rules must be applied when wiring a TM3 safety module:

- I/O and communication wiring must be kept separate from the power wiring. Route these 2 types of wiring in separate cable ducting.
- Verify that the operating conditions and environment are within the specification values.
- Use proper wire sizes to meet voltage and current requirements.
- Use copper conductors.
- Use twisted pair, shielded cables for I/O.
- Use twisted pair, shielded cables for networks, and fieldbus.

|  |
|--|
|  <b>WARNING</b> |
|--|

|                                       |
|---------------------------------------|
| <b>UNINTENDED EQUIPMENT OPERATION</b> |
|---------------------------------------|

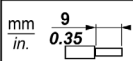










- |  |
|--|
| <ul style="list-style-type: none"><li>● Use shielded cables for all fast I/O, analog I/O, and communication signals.</li><li>● Ground cable shields for all fast I/O, analog I/O, and communication signals at a single point<sup>1</sup>.</li><li>● Route communications and I/O cables separately from power cables.</li></ul> |
|--|

|   |
|---|
| <b>Failure to follow these instructions can result in death, serious injury, or equipment damage.</b> |
|---|

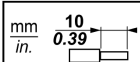










<sup>1</sup>Multipoint grounding is permissible if connections are made to an equipotential ground plane dimensioned to help avoid cable shield damage in the event of power system short-circuit currents.

### Rules for Removable Screw Terminal Block

The following tables show the cable types and wire sizes for a **3.81 mm (0.15 in.)** pitch removable screw terminal block (I/Os and power supply):

|   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|
|                        |  |  |  |  |  |  |  |  |
| mm <sup>2</sup>   | 0,14...1,5  | 0,14...1,5  | 0,25...0,5  | 0,25...1,5  | 2 x 0,14...0,5  | 2 x 0,14...0,75   | 2 x 0,25...0,34   | 2 x 0,5   |
| AWG   | 26...16   | 26...16   | 24...20   | 24...16   | 2 x 26...20   | 2 x 26...18   | 2 x 24...22   | 2 x 20  |
| <br>Ø 2,5 mm (0.1 in.) |  | N•m 0,22  |   | lb-in 2.0   |   |   |   |   |

The following tables show the cable types and wire sizes for a **5.08 mm (0.20 in.)** pitch removable screw terminal block (outputs):

|  |   |   |   |   |   |   |  |   |
|--|---|---|---|---|---|---|--|---|
|                         |  |  |  |  |  |  |  |  |
| mm <sup>2</sup>  | 0,2...2,5   | 0,2...2,5   | 0,25...2,5  | 0,25...2,5  | 2 x 0,2...1,5   | 2 x 0,2...1,5   | 2 x 0,25...1,0   | 2 x 0,5...1,5   |
| AWG  | 24...12   | 24...12   | 24...12   | 24...12   | 2 x 24...16   | 2 x 24...16   | 2 x 24...18  | 2 x 20...16   |
| <br>Ø 3,5 mm (0.14 in.) |  | N•m 0,51  |   | lb-in 4.5   |   |   |  |   |

The use of copper conductors is required.

## ⚠ DANGER

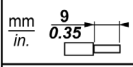




**FIRE HAZARD**

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm<sup>2</sup> (AWG 20) with a temperature rating of at least 90 °C (194 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm<sup>2</sup> (AWG 16) with a temperature rating of at least 90 °C (194 °F).

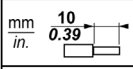





**Failure to follow these instructions will result in death or serious injury.**

### Rules for Removable Spring Terminal Block

The following tables show the cable types and wire sizes for a **3.81 mm (0.15 in.)** pitch removable spring terminal block (I/Os and power supply):

|   |   |   |   |   |            |
|---|---|---|---|---|------------|
|  |  |  |  |  |            |
|   | mm <sup>2</sup>   | 0.2...1.5   | 0.2...1.5   | 0.25...1.0  | 0.25...0.5 |
|   | AWG   | 24...16   | 24...16   | 23...18   | 23...21    |

The following tables show the cable types and wire sizes for a **5.08 mm (0.20 in.)** pitch removable spring terminal block (outputs):

|   |   |   |   |   |   |             |
|---|---|---|---|---|---|-------------|
|  |  |  |  |  |  |             |
|   | mm <sup>2</sup>   | 0.2...2.5   | 0.2...2.5   | 0.25...2.5  | 0.25...2.5  | 2 x 0.5...1 |
|   | AWG   | 24...12   | 24...12   | 24...12   | 24...12   | 2 x 20...18 |

The use of copper conductors is required.

## ⚠ DANGER

### FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm<sup>2</sup> (AWG 20) with a temperature rating of at least 90 °C (194 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm<sup>2</sup> (AWG 16) with a temperature rating of at least 90 °C (194 °F).

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

The spring clamp connectors of the terminal block are designed for only one wire or one cable end. Two wires to the same connector must be installed with a double wire cable end to help prevent loosening.

## ⚡ ⚠ DANGER

### LOOSE WIRING CAUSES ELECTRIC SHOCK

Do not insert more than one wire per connector of the terminal block unless using a double wire cable end (ferrule).

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



### Protecting Outputs from Inductive Load Damage

Depending on the load, a protection circuit may be needed for the outputs on the controllers and certain modules. Inductive loads using DC voltages may create voltage reflections resulting in overshoot that will damage or shorten the life of output devices.

## ⚠ CAUTION

### OUTPUT CIRCUIT DAMAGE DUE TO INDUCTIVE LOADS

Use an appropriate external protective circuit or device to reduce the risk of inductive direct current load damage.

**Failure to follow these instructions can result in injury or equipment damage.**

If your controller or module contains relay outputs, these types of outputs can support up to 240 Vac. Inductive damage to these types of outputs can result in welded contacts and loss of control. Each inductive load must include a protection device such as a peak limiter, RC circuit or flyback diode. Capacitive loads are not supported by these relays.

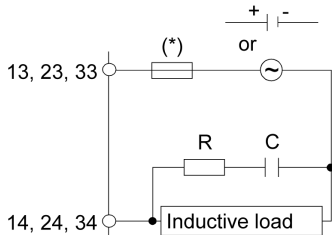
## ⚠ WARNING

### RELAY OUTPUTS WELDED CLOSED

- Always protect relay outputs from inductive alternating current load damage using an appropriate external protective circuit or device.
- Do not connect relay outputs to capacitive loads.

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

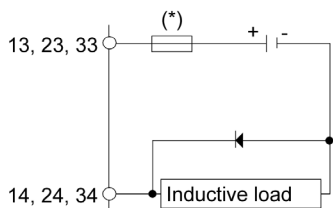
Protective circuit A: this protection circuit can be used for both AC and DC load power circuits.



(\*) Fuses. Refer to electrical characteristics for fuse values.

- C represents a value from 0.1 to 1  $\mu\text{F}$ .
- R represents a resistor of approximately the same resistance value as the load.

Protective circuit B: this protection circuit can be used for DC load power circuits.

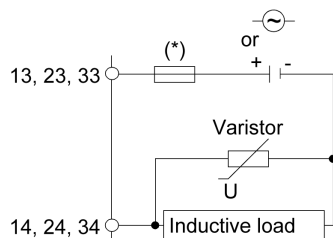


(\*) Fuses. Refer to electrical characteristics for fuse values.

Use a diode with the following ratings:

- Reverse withstand voltage: power voltage of the load circuit x 10.
- Forward current: more than the load current.

Protective circuit C: this protection circuit can be used for both AC and DC load power circuits.



(\*) Fuses. Refer to electrical characteristics for fuse values.

- In applications where the inductive load is switched on and off frequently and/or rapidly, ensure that the continuous energy rating (J) of the varistor exceeds the peak load energy by 20 % or more.

## DC Power Supply Characteristics

### Overview

This section provides the characteristics of the DC power supply.

### Power Supply Voltage Range

If the specified voltage range is not maintained, outputs may not switch as expected. Use appropriate safety interlocks and voltage monitoring circuits.

## DANGER

### FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm<sup>2</sup> (AWG 20) with a temperature rating of at least 90 °C (194 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm<sup>2</sup> (AWG 16) with a temperature rating of at least 90 °C (194 °F).

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

## WARNING

### UNINTENDED EQUIPMENT OPERATION

Do not exceed any of the rated values specified in the environmental and electrical characteristics tables.

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

### DC Power Supply Characteristics

The 24 Vdc power supply must meet the regulations for extra low voltages with safe separation:

- Protective Extra Low Voltage (PELV) according to IEC/EN 60950-1 or
- Safety Extra Low Voltage (SELV) according to IEC/EN 60204-1, EN 50178/IEC 62103, and IEC 60364-4-4.

These power supplies are isolated between the electrical input and output circuits of the power supply.

|   |
|---|
|  <b>WARNING</b>  |
| <b>POTENTIAL OF OVERHEATING AND FIRE</b>  |
| <ul style="list-style-type: none"><li>● Do not connect the equipment directly to line voltage.</li><li>● Use only isolating PELV or SELV power supplies to supply power to the equipment.</li></ul> |
| <b>Failure to follow these instructions can result in death, serious injury, or equipment damage.</b>   |

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## Part II

### TM3 Safety Modules

---

#### What Is in This Part?

This part contains the following chapters:

| Chapter | Chapter Name                                    | Page |
|---------|---|------|
| 3       | TM3SAC5R / TM3SAC5RG Module, 1 Function Cat3    | 63   |
| 4       | TM3SAF5R / TM3SAF5RG Module, 1 Function Cat4    | 73   |
| 5       | TM3SAFL5R / TM3SAFL5RG Module, 2 Functions Cat3 | 83   |
| 6       | TM3SAK6R / TM3SAK6RG Module, 3 Functions Cat4   | 95   |



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# Chapter 3

## TM3SAC5R / TM3SAC5RG Module, 1 Function Cat3

---

### Overview

This chapter describes the TM3SAC5R• module, its characteristics, and its connection.

### What Is in This Chapter?

This chapter contains the following topics:

| Topic                                | Page |
|--------------------------------------|------|
| TM3SAC5R / TM3SAC5RG Presentation    | 64   |
| TM3SAC5R / TM3SAC5RG Characteristics | 66   |
| TM3SAC5R / TM3SAC5RG Wiring Diagram  | 69   |

## TM3SAC5R / TM3SAC5RG Presentation

### Overview

The main characteristics of the TM3SAC5R (screw) and TM3SAC5RG (spring) modules are:

- 1 channel or 2 channels
- 24 Vdc
- Removable screw or spring terminal

### Main Characteristics

This table describes the main characteristics of the TM3SAC5R• module:

| Characteristic                  |           | Value   |
|---------------------------------|-----------|---|
| Number of safety input channels |           | 2   |
| Start mode                      |           | Non-monitored                                   |
| Supply voltage                  |           | 24 Vdc -15...+20 %                              |
| Number of outputs               |           | 3 parallel relay outputs, stop category 0       |
| Rated output voltage            |           | 24 Vdc / 230 Vac<br>6 A maximum per output path |
| Connection type                 | TM3SAC5R  | Removable screw terminal block                  |
|                                 | TM3SAC5RG | Removable spring terminal block                 |
| Weight                          |           | 190 g (6.70 oz)                                 |

### Associated Applications

This table defines the type and example of applications that can be associated to the TM3SAC5R• module:

| Application type   | Application example  |
|--|--|
| 1 channel application ( <i>see page 23</i> )                                 | <ul style="list-style-type: none"> <li>• Monitoring 1 channel emergency stop circuits</li> <li>• Monitoring 1 channel limit switches on protective guards</li> </ul>   |
| 2 channel application without short-circuit detection ( <i>see page 26</i> ) | <ul style="list-style-type: none"> <li>• Monitoring 2 channel emergency stop circuits without short-circuit detection</li> <li>• Monitoring 2 channel limit switches on protective guards without short-circuit detection</li> </ul> |



## Status LED

This figure shows the status LEDs:



This table provides the TM3SAC5R• module status LED indicators description:

| LED          | Color | Status   | Description   |
|--------------|-------|----------|---|
| <b>Bus</b>   | Green | Flashing | The module is receiving the 5 Vdc power supply from the TM3 Bus and the TM3 Bus is functioning. |
| <b>A1/A2</b> | Green | On       | +24 Vdc power supply provided to the module is in the voltage tolerance.                        |
|              |       | Flashing | TM3 Bus time-out: the safety operation is maintained.   |
| <b>Err</b>   | Red   | On       | +24 Vdc power supply provided to the module is out of the voltage tolerance.                    |
|              |       | Flashing | TM3 Bus time-out: the safety output is deactivated (off).                                       |
| <b>Start</b> | Green | On       | Start condition valid (The circuit between Y1-Y2 is closed).                                    |
| <b>K1</b>    | Green | On       | K1 relay energized (closed)   |
|              |       | Flashing | Waiting for start condition   |
| <b>K2</b>    | Green | On       | K2 relay energized (closed)   |
|              |       | Flashing | Waiting for start condition   |

## TM3SAC5R / TM3SAC5RG Characteristics

### Introduction

This section provides a description of the characteristics of TM3SAC5R / TM3SAC5RG safety modules.

See also Environmental Characteristics (*see page 35*).

### WARNING

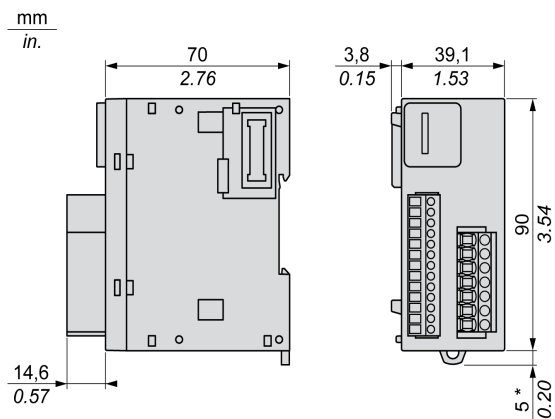
#### UNINTENDED EQUIPMENT OPERATION

Do not exceed any of the rated values specified in the environmental and electrical characteristics tables.

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

### Dimensions

This diagram shows the external dimensions of the TM3SAC5R / TM3SAC5RG safety modules:



\* 8.5 mm (0.33 in.) when the clamp is pulled out.

## Safety-related

The TM3SAC5R• module is a safety module for monitoring emergency stop and limit switches on protective guards according to ISO/EN 13849, IEC/EN 62061, IEC/EN 61058. The module has these safety-related characteristics:

| Characteristic   | Value   | Designed to specification |
|--|---|---------------------------|
| Safety integrity level (SIL)   | 2   | IEC/EN 61508-1:2010       |
| Safety integrity level claim limit (SILCL)   | 2   | IEC/EN 62061:2005         |
| Safe failure fraction (SFF)  | 95 %  | IEC/EN 61508-1:2010       |
| Hardware fault tolerance (HFT)   | 1   | IEC/EN 61508-1:2010       |
| Type   | A   | IEC/EN 61508-1:2010       |
| Mode of operation  | High demand mode  | IEC/EN 61508-1:2010       |
| Probability of dangerous failures per hour (PFHd)  | $30 * 10^{-9} / \text{h}^{(1)}$   | IEC/EN 61508-1:2010       |
|  | $5 * 10^{-9} / \text{h}^{(2)}$  |                           |
| Mean time to dangerous failure (MTTFd)   | 85 years <sup>(1)</sup>   | ISO/EN 13849-1:2008       |
|  | 500 years <sup>(2)</sup>  |                           |
| Performance level (PL) category (cat.)   | PL d. cat. 3  | ISO/EN 13849-1:2008       |
| Diagnostic coverage (DC)   | 95 %  | ISO/EN 13849-1:2008       |
| Lifetime   | 20 years  | –                         |
| Response time  | 20 ms   | –                         |
| Proof test interval (PTI)  | None  | –                         |
| Stop category  | 0   | IEC/EN 60204-1            |
| Start  | Manual or automatic   | –                         |
| Paths  | <ul style="list-style-type: none"> <li>• 3 enabling paths</li> <li>• 1 signaling path</li> </ul>  | –                         |
| Feedback   | Feedback loop to monitor external contactors.   | –                         |
| Defined safe state   | The TM3 safety modules are in the defined safe state when their outputs are off (internal relays are not energized; output path is open). | –                         |
| <p><b>NOTE:</b> These modules contain electromechanical relays, so actual MTTFd and PFHd values vary depending on the application load and duty cycle.</p> <p>(1) 60 operation cycles per hour at DC-13 24 Vdc 1 A<br/> (2) 1 operation cycle per hour at DC-13 24 Vdc 4 A</p> |   |                           |

## Power Supply

This table describes the power supply characteristics of the TM3 safety module:

| Characteristic                     |                       | Value                    |
|------------------------------------|-----------------------|--------------------------|
| Supply voltage                     | IEC 60038             | 24 Vdc -15...+20 %       |
| External fuse protection (maximum) |                       | 4 A slow blow (class gG) |
| Power consumption                  | 24 Vdc supply voltage | 3.6 W                    |
|                                    | TM3 Bus (5 Vdc)       | 0.2 W                    |

## Control Circuit

This table describes the control circuit characteristics of the TM3 safety module:

| Characteristic       |         | Value    |
|----------------------|---------|----------|
| Input voltage (high) | Minimum | 20.4 Vdc |
|                      | Nominal | 24 Vdc   |
|                      | Maximum | 28.8 Vdc |
| Input voltage (low)  | Nominal | 0 Vdc    |
| Input current (high) | Nominal | 70 mA    |
|                      | Maximum | 150 mA   |
| Input current (low)  | Nominal | 0 mA     |
| Response time        |         | ≤ 20 ms  |
| Delay                | On      | ≤ 100 ms |
|                      | Restart | ≤ 300 ms |

## Output Circuit

This table describes the output circuit characteristics of the TM3 safety module:

| Characteristic   |                                    | Value           |
|--|------------------------------------|-----------------|
| Maximum switching current of each output   | AC-15: 230 Vac                     | 5 A             |
|  | DC-13: 24 Vdc                      | 4 A             |
| Minimum switching voltage and current (new contact never used with higher loads) |                                    | 17 V, 10 mA     |
| Maximum current  | Per output path                    | 6 A             |
|  | Sum of current in all output paths | ≤ 18 A          |
| External fuse protection (maximum)   | Slow blow (class gG) fuse          | 4 A             |
|  | Fast blow fuse                     | 6 A             |
| Maximum switching operations   |                                    | 10 <sup>7</sup> |

## TM3SAC5R / TM3SAC5RG Wiring Diagram

### Introduction

These safety modules have a built-in removable screw or spring terminal block for the connection of inputs and outputs.

### Wiring Rules

See Wiring Best Practices (*see page 53*).

The 24 Vdc power supply must be rated Protective Extra Low Voltage (PELV) or Safety Extra Low Voltage (SELV) and fulfill the IEC/EN 60204-1 requirements. These power supplies are isolated between the electrical input and output circuits of the power supply.

### WARNING

#### POTENTIAL OF OVERHEATING AND FIRE

- Do not connect the equipment directly to line voltage.
- Use only isolating PELV or SELV power supplies to supply power to the equipment.

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

### WARNING

#### LOSS OF CONTROL

Place a properly rated fuse on the primary input power line and on the outputs, as described in the related documentation.

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

### Emergency Stop Wiring Diagram

Both the safety conditions and the start conditions must be valid before allowing the activation of outputs.

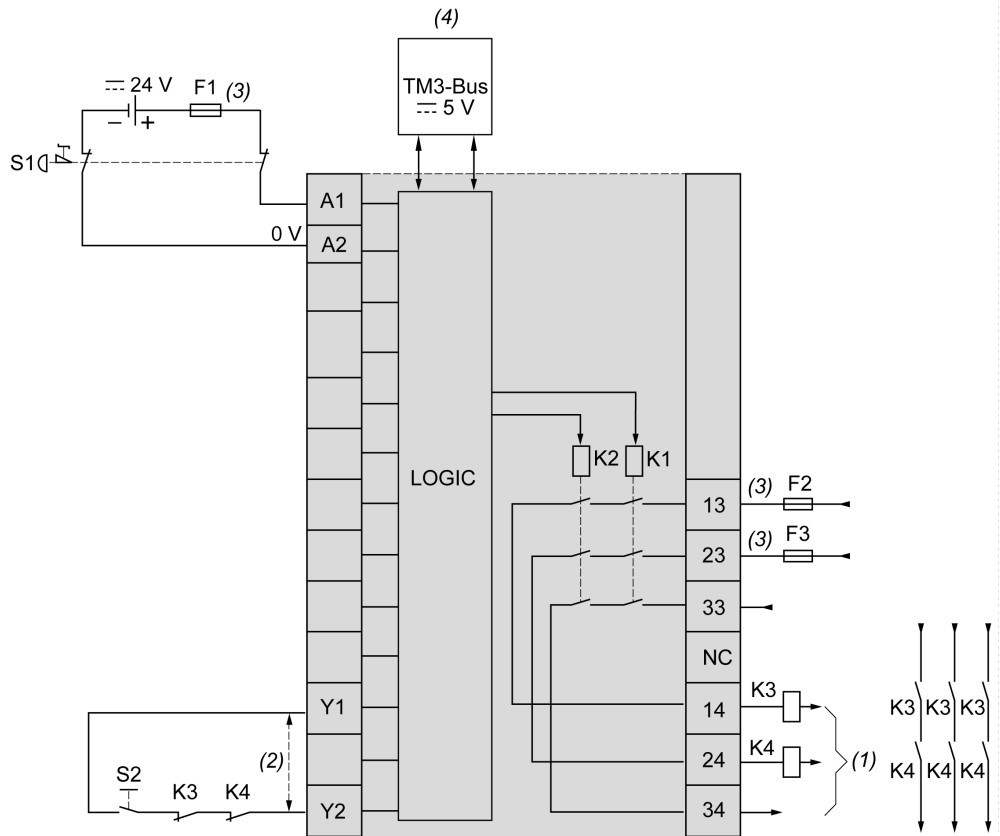
### WARNING

#### UNINTENDED EQUIPMENT OPERATION

Do not use either the monitored start or the non-monitored start as a safety function.

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

This figure shows an example of emergency stop wiring to a TM3SAC5R• module:



**S1:** Emergency stop switch

**S2:** Start switch

(1): Safety outputs

(2): For automatic start, directly connect [Y1] and [Y2] terminals. For more information, refer to the TM3 Expansion Modules Programming Guide for your software platform.

(3): Fuses. Refer to electrical characteristics for fuse values.

(4): Non-safety related TM3 Bus communication with logic controller

## ⚠ WARNING

### UNINTENDED EQUIPMENT OPERATION

Do not use the data transferred over the TM3 Bus for any functional safety-related task(s).

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

 **WARNING**

**UNINTENDED EQUIPMENT OPERATION**

Do not connect wires to unused terminals and/or terminals indicated as “No Connection (N.C.)”.

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





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# Chapter 4

## TM3SAF5R / TM3SAF5RG Module, 1 Function Cat4

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### Overview

This chapter describes the TM3SAF5R• module, its characteristics, and its connection.

### What Is in This Chapter?

This chapter contains the following topics:

| Topic                                | Page |
|--------------------------------------|------|
| TM3SAF5R / TM3SAF5RG Presentation    | 74   |
| TM3SAF5R / TM3SAF5RG Characteristics | 76   |
| TM3SAF5R / TM3SAF5RG Wiring Diagram  | 79   |

## TM3SAF5R / TM3SAF5RG Presentation

### Overview

The main characteristics of the TM3SAF5R (screw) and TM3SAF5RG (spring) modules are:

- 2 channels
- 24 Vdc
- Removable screw or spring terminal

### Main Characteristics

This table describes the main characteristics of the TM3SAF5R• module:

| Characteristic                  |           | Value   |
|---------------------------------|-----------|---|
| Number of safety input channels |           | 2   |
| Start mode                      |           | Monitored / Non-monitored start                 |
| Supply voltage                  |           | 24 Vdc -15...+20 %                              |
| Number of outputs               |           | 3 parallel relay outputs, stop category 0       |
| Rated output voltage            |           | 24 Vdc / 230 Vac<br>6 A maximum per output path |
| Connection type                 | TM3SAF5R  | Removable screw terminal block                  |
|                                 | TM3SAF5RG | Removable spring terminal block                 |
| Weight                          |           | 190 g (6.70 oz)                                 |

### Associated Applications

This table defines the type and example of applications that can be associated to the TM3SAF5R• module:

| Application type  | Application example   |
|---|---|
| 2 channel application ( <i>see page 26</i> ) with short-circuit detection | <ul style="list-style-type: none"> <li>• Monitoring 2 channel emergency stop circuits with short-circuits detection</li> <li>• Monitoring 2 channel limit switches on protective guards with short-circuit detection</li> </ul> |

**Status LED**

This figure shows the status LEDs:



This table provides the TM3SAF5R• module status LED indicators description:

| LED          | Color | Status   | Description  |
|--------------|-------|----------|--|
| <b>Bus</b>   | Green | Flashing | The module is receiving the 5 Vdc power supply from the TM3 Bus and the TM3 Bus is functioning.                              |
| <b>OK</b>    | Green | On       | +24 Vdc power supply provided to the module is in the voltage tolerance.   |
|              |       | Flashing | TM3 Bus time-out: the functional safety operation is maintained.   |
| <b>Err</b>   | Red   | On       | +24 Vdc power supply provided to the module is out of the voltage tolerance.   |
|              |       | Flashing | TM3 Bus time-out: the safety output is deactivated (off).  |
| <b>Ch1</b>   | Green | On       | Channel 1 is active: The circuit between S21-S22 is closed.  |
| <b>Ch2</b>   | Green | On       | Channel 2 is active: The circuit between S11-S12 is closed. See note below.  |
| <b>Start</b> | Green | On       | Start condition valid: inputs S11-S12, S21-S22, and S41-S42 (EDM 2) closed, and S34 or S39 connected to S33. See note below. |
| <b>K1</b>    | Green | On       | K1 relay energized (closed)  |
|              |       | Flashing | Waiting for start condition  |
| <b>K2</b>    | Green | On       | K2 relay energized (closed)  |
|              |       | Flashing | Waiting for start condition  |


**NOTE:** While waiting for Start there is no indication of **Ch2** if S41-S42 (EDM 2) is open (by feedback of external device (NC contact)).

## TM3SAF5R / TM3SAF5RG Characteristics

### Introduction

This section provides a description of the characteristics of TM3SAF5R / TM3SAF5RG safety modules.

See also Environmental Characteristics (*see page 35*).

 **WARNING**

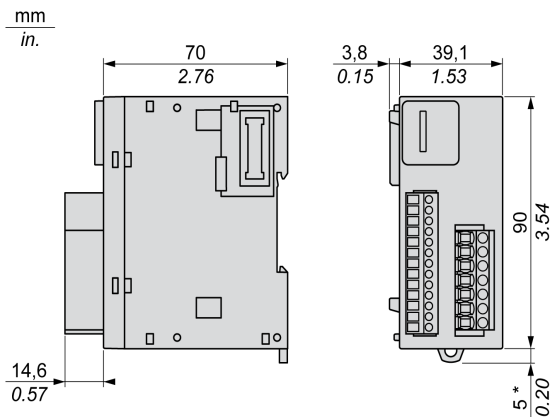
**UNINTENDED EQUIPMENT OPERATION**

Do not exceed any of the rated values specified in the environmental and electrical characteristics tables.

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

### Dimensions

This diagram shows the external dimensions of the TM3SAF5R / TM3SAF5RG safety modules:



\* 8.5 mm (0.33 in.) when the clamp is pulled out.

## Safety-related

The TM3SAF5R• module is a safety module for monitoring emergency stop and limit switches on protective guards according to ISO/EN 13849, IEC/EN 62061, IEC/EN 61058. The module has these safety-related characteristics:

| Characteristic   | Value   | Designed to specification |
|--|---|---------------------------|
| Safety integrity level (SIL)   | 3   | IEC/EN 61508-1:2010       |
| Safety integrity level claim limit (SILCL)   | 3   | IEC/EN 62061:2005         |
| Safe failure fraction (SFF)  | 95 %  | IEC/EN 61508-1:2010       |
| Hardware fault tolerance (HFT)   | 1   | IEC/EN 61508-1:2010       |
| Type   | A   | IEC/EN 61508-1:2010       |
| Mode of operation  | High demand mode  | IEC/EN 61508-1:2010       |
| Probability of dangerous failures per hour (PFHd)  | $30 * 10^{-9} / h^{(1)}$  | IEC/EN 61508-1:2010       |
|  | $5 * 10^{-9} / h^{(2)}$   |                           |
| Mean time to dangerous failure (MTTFd)   | 85 years <sup>(1)</sup>   | ISO/EN 13849-1:2008       |
|  | 500 years <sup>(2)</sup>  |                           |
| Performance level (PL) category (cat.)   | PL e. cat. 4  | ISO/EN 13849-1:2008       |
| Diagnostic coverage (DC)   | 95 %  | ISO/EN 13849-1:2008       |
| Lifetime   | 20 years  | –                         |
| Response time  | 20 ms   | –                         |
| Proof test interval (PTI)  | None  | –                         |
| Stop category  | 0   | IEC/EN 60204-1            |
| Start  | Manual or automatic   | –                         |
| Paths  | <ul style="list-style-type: none"> <li>• 3 enabling paths</li> <li>• 1 signaling path</li> </ul>  | –                         |
| Feedback   | Feedback loop to monitor external contactors.   | –                         |
| Defined safe state   | The TM3 safety modules are in the defined safe state when their outputs are off (internal relays are not energized; output path is open). | –                         |
| <p><b>NOTE:</b> These modules contain electromechanical relays, so actual MTTFd and PFHd values vary depending on the application load and duty cycle.</p> <p>(1) 60 operation cycles per hour at DC-13 24 Vdc 1 A<br/> (2) 1 operation cycle per hour at DC-13 24 Vdc 4 A</p> |   |                           |

## Power Supply

This table describes the power supply characteristics of the TM3 safety module:

| Characteristic                     |                       | Value                    |
|------------------------------------|-----------------------|--------------------------|
| Supply voltage                     | IEC 60038             | 24 Vdc -15...+20 %       |
| External fuse protection (maximum) |                       | 4 A slow blow (class gG) |
| Power consumption                  | 24 Vdc supply voltage | 3.6 W                    |
|                                    | TM3 Bus (5 Vdc)       | 0.2 W                    |

## Control Circuit

This table describes the control circuit characteristics of the TM3 safety module:

| Characteristic  |         | Value    |
|-----------------|---------|----------|
| Contact voltage | Nominal | 24 Vdc   |
| Contact current | Nominal | 35 mA    |
|                 | Maximum | 100 mA   |
| Response time   |         | ≤ 20 ms  |
| Delay           | On      | ≤ 100 ms |
|                 | Restart | ≤ 300 ms |

## Output Circuit

This table describes the output circuit characteristics of the TM3 safety module:

| Characteristic   |                                    | Value           |
|--|------------------------------------|-----------------|
| Maximum switching current of each output   | AC-15: 230 Vac                     | 5 A             |
|  | DC-13: 24 Vdc                      | 4 A             |
| Minimum switching voltage and current (new contact never used with higher loads) |                                    | 17 V, 10 mA     |
| Maximum current  | Per output path                    | 6 A             |
|  | Sum of current in all output paths | ≤ 18 A          |
| External fuse protection (maximum)   | Slow blow (class gG) fuse          | 4 A             |
|  | Fast blow fuse                     | 6 A             |
| Maximum switching operations   |                                    | 10 <sup>7</sup> |

## TM3SAF5R / TM3SAF5RG Wiring Diagram

### Introduction

These safety modules have a built-in removable screw or spring terminal block for the connection of inputs and outputs.

### Wiring Rules

See Wiring Best Practices (*see page 53*).

The 24 Vdc power supply must be rated Protective Extra Low Voltage (PELV) or Safety Extra Low Voltage (SELV) and fulfill the IEC/EN 60204-1 requirements. These power supplies are isolated between the electrical input and output circuits of the power supply.

### WARNING

#### POTENTIAL OF OVERHEATING AND FIRE

- Do not connect the equipment directly to line voltage.
- Use only isolating PELV or SELV power supplies to supply power to the equipment.

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

### WARNING

#### LOSS OF CONTROL

Place a properly rated fuse on the primary input power line and on the outputs, as described in the related documentation.

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

### Emergency Stop Wiring Diagram

Both the safety conditions and the start conditions must be valid before allowing the activation of outputs.

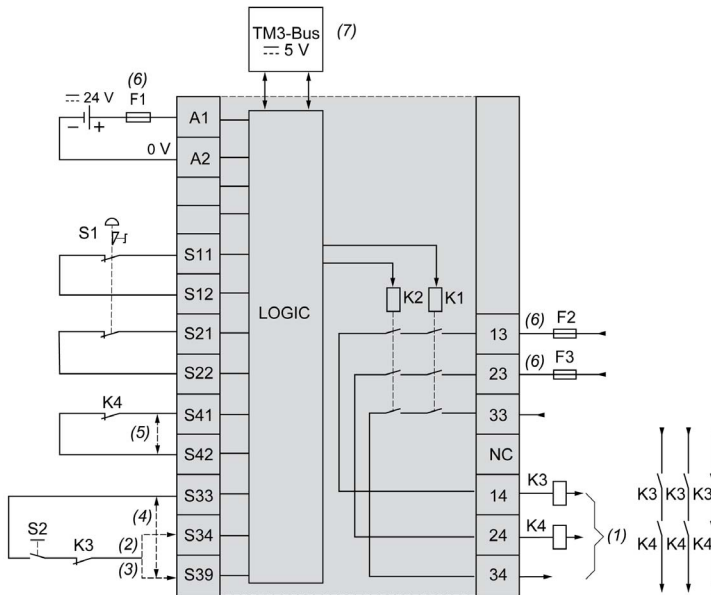
⚠ WARNING

**UNINTENDED EQUIPMENT OPERATION**

Do not use either the monitored start or the non-monitored start as a safety function.

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

This figure shows an example of emergency stop wiring to a TM3SAF5R• module:



**S1:** Emergency stop switch

**S2:** Start switch

**(1):** Safety outputs

**(2):** Monitored start<sup>1</sup>

**(3):** Non-monitored start<sup>1</sup>

**(4):** For automatic start<sup>1</sup>, directly connect **[S33]** and **[S39]** terminals

**(5):** Second external device monitoring<sup>1</sup> channel. Connect **[S41]** and **[S42]** terminals if not used.

**(6):** Fuses. Refer to electrical characteristics for fuse values.

**(7):** Non-safety related TM3 Bus communication with logic controller

<sup>1</sup> For more information, refer to the TM3 Expansion Modules Programming Guide for your software platform.



**⚠ WARNING**

**UNINTENDED EQUIPMENT OPERATION**

Do not use the data transferred over the TM3 Bus for any functional safety-related task(s).

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

**⚠ WARNING**

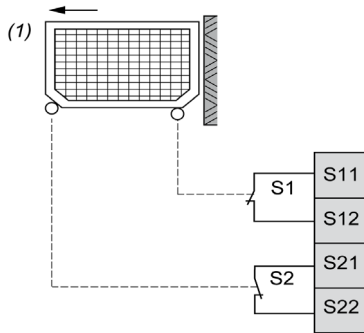
**UNINTENDED EQUIPMENT OPERATION**

Do not connect wires to unused terminals and/or terminals indicated as “No Connection (N.C.)”.

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

**Protective Guard Wiring**

This figure shows an example of 2 channel protective guard wiring to the safety module inputs:



(1): Protective guard



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# Chapter 5

## TM3SAFL5R / TM3SAFL5RG Module, 2 Functions Cat3

---

### Overview

This chapter describes the TM3SAFL5R• module, its characteristics, and its connection.

### What Is in This Chapter?

This chapter contains the following topics:

| Topic                                  | Page |
|--|------|
| TM3SAFL5R / TM3SAFL5RG Presentation    | 84   |
| TM3SAFL5R / TM3SAFL5RG Characteristics | 86   |
| TM3SAFL5R / TM3SAFL5RG Wiring Diagram  | 90   |

## TM3SAFL5R / TM3SAFL5RG Presentation

### Overview

The main characteristics of the TM3SAFL5R (screw) and TM3SAFL5RG (spring) modules are:

- 2 channels
- 24 Vdc
- Removable screw or spring terminal

### Main Characteristics

This table describes the main characteristics of the TM3SAFL5R• module:

| Characteristic                  |            | Value   |
|---------------------------------|------------|---|
| Number of safety input channels |            | 2   |
| Start mode                      |            | Monitored / Non-monitored start                 |
| Supply voltage                  |            | 24 Vdc -15...+20 %                              |
| Number of outputs               |            | 3 parallel relay outputs, stop category 0       |
| Rated output voltage            |            | 24 Vdc / 230 Vac<br>6 A maximum per output path |
| Connection type                 | TM3SAFL5R  | Removable screw terminal block                  |
|                                 | TM3SAFL5RG | Removable spring terminal block                 |
| Weight                          |            | 190 g (6.70 oz)                                 |

### Associated Applications

This table defines the type and example of applications that can be associated to the TM3SAFL5R• module:

| Application type   | Application example   |
|--|---|
| 2 channel application without short-circuit detection ( <i>see page 26</i> ) | <ul style="list-style-type: none"> <li>• Monitoring 2 channel emergency stop circuits without short-circuit detection</li> <li>• Monitoring 2 channel limit switches on protective guards without short-circuit detection</li> <li>• Monitoring output signal switching devices of safety light curtains (type 4 according to IEC/EN 61496-1) with 2 * PNP transistors</li> <li>• Monitoring 2 * PNP transistors sensors output (proximity switches)</li> </ul> |

**Status LED**

This figure shows the status LEDs:



This table provides the TM3SAFL5R• module status LED indicators description:

| LED          | Color | Status   | Description   |
|--------------|-------|----------|---|
| <b>Bus</b>   | Green | Flashing | The module is receiving the 5 Vdc power supply from the TM3 Bus and the TM3 Bus is functioning.                       |
| <b>OK</b>    | Green | On       | +24 Vdc power supply provided to the module is in the voltage tolerance.  |
|              |       | Flashing | TM3 Bus time-out: the functional safety operation is maintained.  |
| <b>Err</b>   | Red   | On       | +24 Vdc power supply provided to the module is out of the voltage tolerance.  |
|              |       | Flashing | TM3 Bus time-out: the safety output is deactivated (off).   |
| <b>Ch1</b>   | Green | On       | Channel 1 is active: The circuit between S11-S12 is closed or supplied from OSSD output from sensor (PNP).            |
| <b>Ch2</b>   | Green | On       | Channel 2 is active: The circuit between S21-S22 is closed or supplied from OSSD output from sensor (PNP).            |
| <b>Start</b> | Green | On       | Start condition valid: inputs S11-S12, S21-S22, and S41-S42 (EDM 2) closed/supplied, and S34 or S39 connected to S33. |
| <b>K1</b>    | Green | On       | K1 relay energized (closed)   |
|              |       | Flashing | Waiting for start condition   |
| <b>K2</b>    | Green | On       | K2 relay energized (closed)   |
|              |       | Flashing | Waiting for start condition   |

## TM3SAFL5R / TM3SAFL5RG Characteristics

### Introduction

This section provides a description of the characteristics of TM3SAFL5R / TM3SAFL5RG safety modules.

See also Environmental Characteristics (*see page 35*).

### ⚠ WARNING

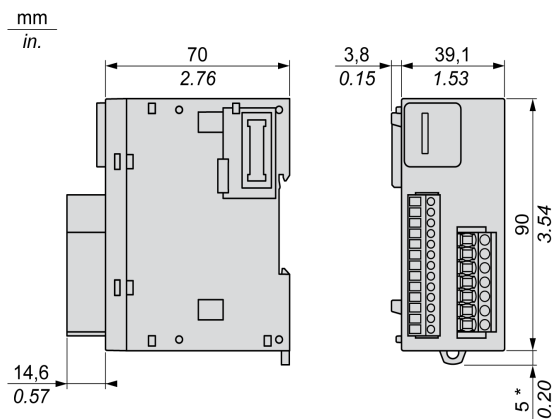
#### UNINTENDED EQUIPMENT OPERATION

Do not exceed any of the rated values specified in the environmental and electrical characteristics tables.

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

### Dimensions

This diagram shows the external dimensions of the TM3SAFL5R / TM3SAFL5RG safety modules:



\* 8.5 mm (0.33 in.) when the clamp is pulled out.

## Safety-related

The TM3SAFL5R• module is a safety module for monitoring emergency stop and limit switches on protective guards and safety light curtains according to ISO/EN 13849, IEC/EN 62061, IEC/EN 61058. The module has these safety-related characteristics:

| Characteristic   | Value   | Designed to specification |
|--|---|---------------------------|
| Safety integrity level (SIL)   | 2   | IEC/EN 61508-1:2010       |
| Safety integrity level claim limit (SILCL)   | 2   | IEC/EN 62061:2005         |
| Safe failure fraction (SFF)  | 95 %  | IEC/EN 61508-1:2010       |
| Hardware fault tolerance (HFT)   | 1   | IEC/EN 61508-1:2010       |
| Type   | A   | IEC/EN 61508-1:2010       |
| Mode of operation  | High demand mode  | IEC/EN 61508-1:2010       |
| Probability of dangerous failures per hour (PFHd)  | $30 * 10^{-9} / h^{(1)}$  | IEC/EN 61508-1:2010       |
|  | $5 * 10^{-9} / h^{(2)}$   |                           |
| Mean time to dangerous failure (MTTFd)   | 85 years <sup>(1)</sup>   | ISO/EN 13849-1:2008       |
|  | 500 years <sup>(2)</sup>  |                           |
| Performance level (PL) category (cat.)   | PL d. cat. 3  | ISO/EN 13849-1:2008       |
| Diagnostic coverage (DC)   | 95 %  | ISO/EN 13849-1:2008       |
| Lifetime   | 20 years  | –                         |
| Response time  | 20 ms   | –                         |
| Proof test interval (PTI)  | None  | –                         |
| Stop category  | 0   | IEC/EN 60204-1            |
| Start  | Manual or automatic   | –                         |
| Paths  | <ul style="list-style-type: none"> <li>• 3 enabling paths</li> <li>• 1 signaling path</li> </ul>  | –                         |
| Feedback   | Feedback loop to monitor external contactors.   | –                         |
| Defined safe state   | The TM3 safety modules are in the defined safe state when their outputs are off (internal relays are not energized; output path is open). | –                         |
| <p><b>NOTE:</b> These modules contain electromechanical relays, so actual MTTFd and PFHd values vary depending on the application load and duty cycle.</p> <p>(1) 60 operation cycles per hour at DC-13 24 Vdc 1 A<br/> (2) 1 operation cycle per hour at DC-13 24 Vdc 4 A</p> |   |                           |

## Power Supply

This table describes the power supply characteristics of the TM3 safety module:

| Characteristic                     |                       | Value                    |
|------------------------------------|-----------------------|--------------------------|
| Supply voltage                     | IEC 60038             | 24 Vdc -15...+20 %       |
| External fuse protection (maximum) |                       | 4 A slow blow (class gG) |
| Power consumption                  | 24 Vdc supply voltage | 3.6 W                    |
|                                    | TM3 Bus (5 Vdc)       | 0.2 W                    |

## Control Circuit

This table describes the control circuit characteristics of the TM3 safety module:

| Characteristic  |         | Value    |
|---|---------|----------|
| Input voltage (high) <sup>(1)</sup>   | Minimum | 19.6 Vdc |
|   | Nominal | 24 Vdc   |
|   | Maximum | 28.8 Vdc |
| Input voltage (low) <sup>(1)</sup>  | Minimum | 0 Vdc    |
|   | Nominal | 0 Vdc    |
|   | Maximum | 2 Vdc    |
| Input current (high) <sup>(1)</sup>   | Nominal | 35 mA    |
|   | Maximum | 80 mA    |
| Input current (low) <sup>(1)</sup>  | Nominal | 0 mA     |
| Maximum output current from control circuit terminals: S11, S22<br><i>(see page 17)</i> |         | 100 mA   |
| Nominal voltage at the pins   |         | 24 Vdc   |
| Response time   |         | ≤ 20 ms  |
| Delay   | On      | ≤ 100 ms |
|   | Restart | ≤ 300 ms |
| <b>(1)</b> At terminal S12, S22 when externally supplied                                |         |          |



## Output Circuit

This table describes the output circuit characteristics of the TM3 safety module:

| Characteristic   |                                    | Value           |
|--|------------------------------------|-----------------|
| Maximum switching current of each output   | AC-15: 230 Vac                     | 5 A             |
|  | DC-13: 24 Vdc                      | 4 A             |
| Minimum switching voltage and current (new contact never used with higher loads) |                                    | 17 V, 10 mA     |
| Maximum current  | Per output path                    | 6 A             |
|  | Sum of current in all output paths | ≤ 18 A          |
| External fuse protection (maximum)   | Slow blow (class gG) fuse          | 4 A             |
|  | Fast blow fuse                     | 6 A             |
| Maximum switching operations   |                                    | 10 <sup>7</sup> |

## TM3SAFL5R / TM3SAFL5RG Wiring Diagram

### Introduction

These safety modules have a built-in removable screw or spring terminal block for the connection of inputs and outputs.

### Wiring Rules

See Wiring Best Practices (*see page 53*).

The 24 Vdc power supply must be rated Protective Extra Low Voltage (PELV) or Safety Extra Low Voltage (SELV) and fulfill the IEC/EN 60204-1 requirements. These power supplies are isolated between the electrical input and output circuits of the power supply.

### WARNING

#### POTENTIAL OF OVERHEATING AND FIRE

- Do not connect the equipment directly to line voltage.
- Use only isolating PELV or SELV power supplies to supply power to the equipment.

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

### WARNING

#### LOSS OF CONTROL

Place a properly rated fuse on the primary input power line and on the outputs, as described in the related documentation.

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

### Emergency Stop Wiring Diagram

Both the safety conditions and the start conditions must be valid before allowing the activation of outputs.

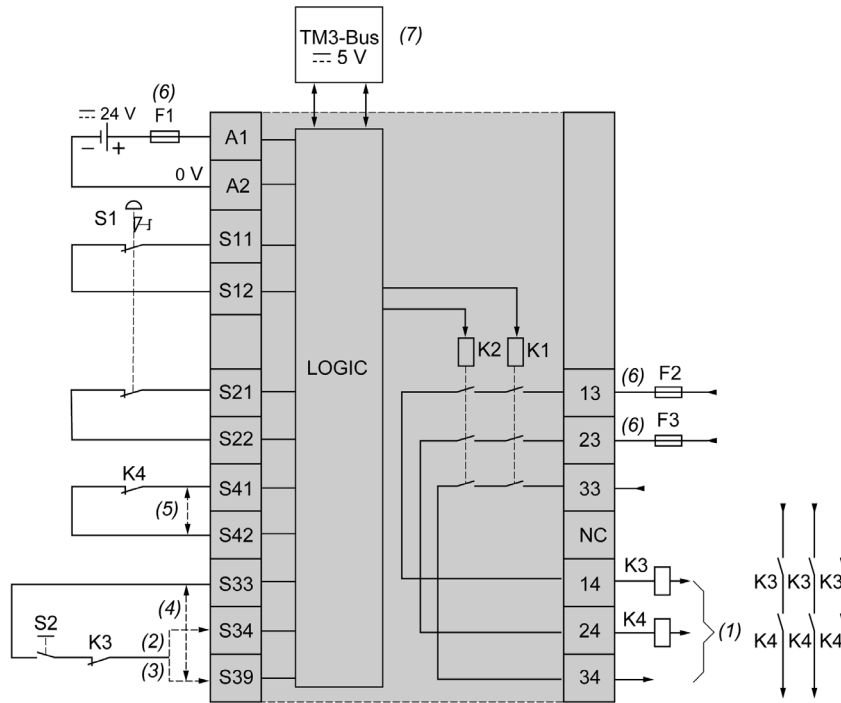
### WARNING

#### UNINTENDED EQUIPMENT OPERATION

Do not use either the monitored start or the non-monitored start as a safety function.

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

This figure shows an example of emergency stop wiring to a TM3SAFL5R• module:



**S1:** Emergency stop switch

**S2:** Start switch

(1): Safety outputs

(2): Monitored start<sup>1</sup>

(3): Non-monitored start<sup>1</sup>

(4): For automatic start<sup>1</sup>, directly connect [S33] and [S39] terminals

(5): Second external device monitoring<sup>1</sup> channel. Connect [S41] and [S42] terminals if not used.

(6): Fuses. Refer to electrical characteristics for fuse values.

(7): Non-safety related TM3 Bus communication with logic controller

<sup>1</sup> For more information, refer to the TM3 Expansion Modules Programming Guide for your software platform.

## ⚠ WARNING

### UNINTENDED EQUIPMENT OPERATION

Do not use the data transferred over the TM3 Bus for any functional safety-related task(s).

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

## WARNING

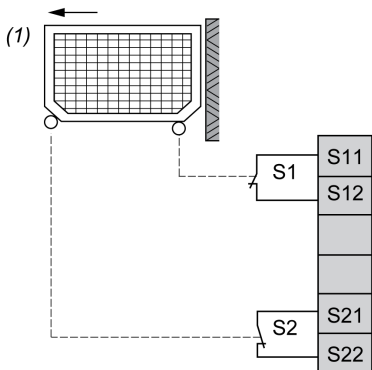
### UNINTENDED EQUIPMENT OPERATION

Do not connect wires to unused terminals and/or terminals indicated as “No Connection (N.C.)”.

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

### Protective Guard Wiring

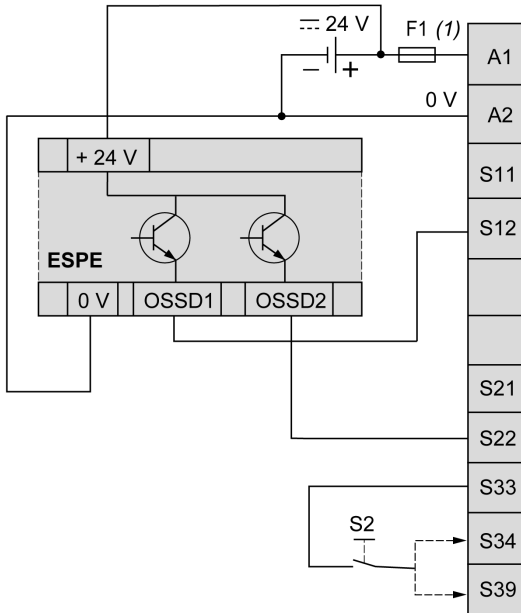
This figure shows an example of 2 channel protective guard wiring to the safety module inputs:



(1): Protective guard

### Electro-Sensitive Protective Equipment (ESPE) Wiring

This figure shows an example of ESPE (type 4 outputs, IEC/EN 61496-1) wiring to the safety module inputs:



(1): Fuses. Refer to electrical characteristics for fuse values.

S2: Start switch

**NOTE:** The ESPE must be supplied by the same PELV/SELV power supply as the safety module.



---

# Chapter 6

## TM3SAK6R / TM3SAK6RG Module, 3 Functions Cat4

---

### Overview

This chapter describes the TM3SAK6R• module, its characteristics, and its connection.

### What Is in This Chapter?

This chapter contains the following topics:

| Topic                                | Page |
|--------------------------------------|------|
| TM3SAK6R / TM3SAK6RG Presentation    | 96   |
| TM3SAK6R / TM3SAK6RG Characteristics | 99   |
| TM3SAK6R / TM3SAK6RG Wiring Diagram  | 103  |

## TM3SAK6R / TM3SAK6RG Presentation

### Overview

The main characteristics of the TM3SAK6R (screw) and TM3SAK6RG (spring) modules are:

- 2 channels
- 24 Vdc
- Removable screw or spring terminal

### Main Characteristics

This table describes the main characteristics of the TM3SAK6R• module:

| Characteristic                  |           | Value   |
|---------------------------------|-----------|---|
| Number of safety input channels |           | 2   |
| Start mode                      |           | Monitored / Non-monitored start                 |
| Supply voltage                  |           | 24 Vdc -15...+20 %                              |
| Number of outputs               |           | 3 parallel relay outputs, stop category 0       |
| Rated output voltage            |           | 24 Vdc / 230 Vac<br>6 A maximum per output path |
| Connection type                 | TM3SAK6R  | Removable screw terminal block                  |
|                                 | TM3SAK6RG | Removable spring terminal block                 |
| Weight                          |           | 190 g (6.70 oz)                                 |

### Associated Applications

This table defines the type and example of applications that can be associated to the TM3SAK6R• module:

| Application type   | Application example   |
|--|---|
| 1 channel application ( <i>see page 23</i> )                                 | <ul style="list-style-type: none"> <li>• Monitoring 1 channel emergency stop circuits</li> <li>• Monitoring 1 channel limit switches on protective guards</li> </ul>  |
| 2 channel application ( <i>see page 26</i> ) without short-circuit detection | <ul style="list-style-type: none"> <li>• Monitoring 2 channel emergency stop circuits without short-circuit detection</li> <li>• Monitoring 2 channel limit switches on protective guards without short-circuit detection</li> <li>• Monitoring output signal switching devices of safety light curtains (type 4 according to IEC/EN 61496-1) with 2 * PNP transistors</li> <li>• Monitoring 2 * PNP transistors sensors output (proximity switches)</li> </ul> |



| Application type  | Application example  |
|---|--|
| 2 channel application ( <i>see page 26</i> ) with short-circuit detection | <ul style="list-style-type: none"> <li>Monitoring 2 channel emergency stop circuits with short-circuits detection</li> <li>Monitoring 2 channel limit switches on protective guards with short-circuit detection</li> <li>Monitoring output signal switching devices of safety light curtains (type 4 according to IEC/EN 61496-1) with 1 PNP + 1 NPN transistors</li> <li>Monitoring 1 PNP + 1 NPN transistors sensors output (proximity switches)</li> </ul> |
| Safety-mat application ( <i>see page 30</i> ) (current source)            | <ul style="list-style-type: none"> <li>Monitoring short-circuit generating safety-mats or pressure sensitive rails</li> </ul>  |

### Synchronization Time Monitoring

Synchronization time between activation of inputs S21-S22 and S31-S32 can be monitored either within 2 or 4 seconds.

For additional information, refer to the TM3 Expansion Modules Programming Guide for your software platform.

### Status LED

This figure shows the status LEDs:



This table provides the TM3SAK6R• module status LED indicators description:

| LED        | Color | Status   | Description   |
|------------|-------|----------|---|
| <b>Bus</b> | Green | Flashing | The module is receiving the 5 Vdc power supply from the TM3 Bus and the TM3 Bus is functioning. |
| <b>OK</b>  | Green | On       | +24 Vdc power supply provided to the module is in the voltage tolerance.                        |
|            |       | Flashing | TM3 Bus time-out: the functional safety operation is maintained.                                |
| <b>Err</b> | Red   | On       | +24 Vdc power supply provided to the module is out of the voltage tolerance.                    |
|            |       | Flashing | TM3 Bus time-out: the safety output is deactivated (off).                                       |

| LED          | Color | Status   | Description  |
|--------------|-------|----------|--|
| <b>Ch1</b>   | Green | On       | Depending on the application. See next table.  |
|              |       | Flashing | Synchronization time monitoring detected an error: input S21-S22 closed too late after input S31-S32.  |
| <b>Ch2</b>   | Green | On       | Depending on the application. See next table.  |
|              |       | Flashing | Synchronization time monitoring detected an error: input S31-S32 closed too late after input S21-S22. See note below.                          |
| <b>Start</b> | Green | On       | Start condition valid: inputs S11-S12, S21-S22, S31-S32, and S41-S42 (EDM 2) closed/supplied, and S34 or S39 connected to S33. See note below. |
| <b>K1</b>    | Green | On       | K1 relay energized (closed)  |
|              |       | Flashing | Waiting for start condition  |
| <b>K2</b>    | Green | On       | K2 relay energized (closed)  |
|              |       | Flashing | Waiting for start condition  |

This table gives information on **Ch1** and **Ch2** status:

| Use case  | Channel    | Condition   |
|---|------------|---|
| 1-channel application (cat. 1)  | <b>Ch1</b> | Input S11-S12 closed and input S31-S32 closed with a jumper.                        |
|   | <b>Ch2</b> | Input S21-S22 closed with a jumper.   |
| 2-channel application (cat. 3 - w/o short-circuit monitoring)   | <b>Ch1</b> | Input S11-S12 and input S31-S32 closed.   |
|   | <b>Ch2</b> | Input S21-S22 closed with a jumper.   |
| 2-channel application (cat. 4)  | <b>Ch1</b> | Input S11-S12 closed and input S31-S32 closed with a jumper.                        |
|   | <b>Ch2</b> | Input S21-S22 closed.   |
| 2-channel application (cat. 3 - if the sensor device can detect short-circuit, then cat. 4)<br>Solid state: PNP + PNP | <b>Ch1</b> | Input S12 and input S32 supplied with PNP 24 V connection.                          |
|   | <b>Ch2</b> | Input S21-S22 closed with a jumper.   |
| 2-channel application (cat. 4)<br>Solid state: PNP + NPN  | <b>Ch1</b> | Input S11-S12 closed with a jumper and input S32 supplied with PNP 24 V connection. |
|   | <b>Ch2</b> | Input S22 connected to external NPN 0 V.  |
| Safety mat application  | <b>Ch1</b> | Input S11-S12 closed by jumper, with safety mat connected to input S31-S32.         |
|   | <b>Ch2</b> | Safety mat connected to input S21-S22.  |

**NOTE:** While waiting for Start there is no indication of **Ch2** if S41-S42 (EDM 2) is open (by feedback of external device (NC contact)).

## TM3SAK6R / TM3SAK6RG Characteristics

### Introduction

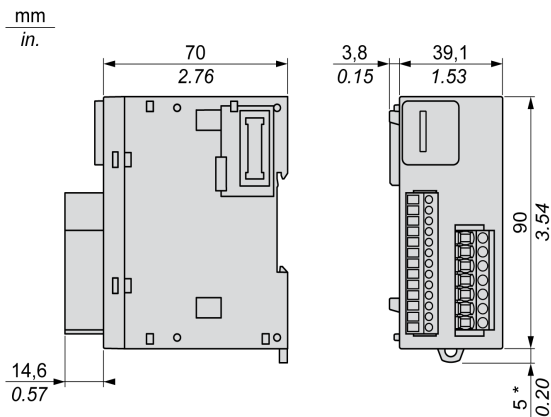
This section provides a description of the characteristics of TM3SAK6R / TM3SAK6RG safety modules.

See also Environmental Characteristics (*see page 35*).

|   |
|---|
| <b>⚠ WARNING</b>  |
| <b>UNINTENDED EQUIPMENT OPERATION</b>   |
| Do not exceed any of the rated values specified in the environmental and electrical characteristics tables. |
| <b>Failure to follow these instructions can result in death, serious injury, or equipment damage.</b>       |

### Dimensions

This diagram shows the external dimensions of the TM3SAK6R / TM3SAK6RG safety modules:



\* 8.5 mm (0.33 in.) when the clamp is pulled out.

### Safety-related

The TM3SAK6R• module is a safety module for monitoring emergency stop and limit switches on protective guards, safety light curtains, and safety-mats according to ISO/EN 13849, IEC/EN 62061, IEC/EN 61058. The module has these safety-related characteristics:

| Characteristic   | Value   | Designed to specification |
|--|---|---------------------------|
| Safety integrity level (SIL)   | 3   | IEC/EN 61508-1:2010       |
| Safety integrity level claim limit (SILCL)   | 3   | IEC/EN 62061:2005         |
| Safe failure fraction (SFF)  | 95 %  | IEC/EN 61508-1:2010       |
| Hardware fault tolerance (HFT)   | 1   | IEC/EN 61508-1:2010       |
| Type   | A   | IEC/EN 61508-1:2010       |
| Mode of operation  | High demand mode  | IEC/EN 61508-1:2010       |
| Probability of dangerous failures per hour (PFHd)  | $30 * 10^{-9} / h^{(1)}$  | IEC/EN 61508-1:2010       |
|  | $5 * 10^{-9} / h^{(2)}$   |                           |
| Mean time to dangerous failure (MTTFd)   | 85 years <sup>(1)</sup>   | ISO/EN 13849-1:2008       |
|  | 500 years <sup>(2)</sup>  |                           |
| Performance level (PL) category (cat.)   | PL e. cat. 4  | ISO/EN 13849-1:2008       |
| Diagnostic coverage (DC)   | 95 %  | ISO/EN 13849-1:2008       |
| Lifetime   | 20 years  | –                         |
| Response time  | 20 ms   | –                         |
| Proof test interval (PTI)  | None  | –                         |
| Stop category  | 0   | IEC/EN 60204-1            |
| Start  | Manual or automatic   | –                         |
| Paths  | <ul style="list-style-type: none"> <li>• 3 enabling paths</li> <li>• 1 signaling path</li> </ul>  | –                         |
| Feedback   | Feedback loop to monitor external contactors.   | –                         |
| Defined safe state   | The TM3 safety modules are in the defined safe state when their outputs are off (internal relays are not energized; output path is open). | –                         |
| <p><b>NOTE:</b> These modules contain electromechanical relays, so actual MTTFd and PFHd values vary depending on the application load and duty cycle.</p> <p>(1) 60 operation cycles per hour at DC-13 24 Vdc 1 A<br/>                 (2) 1 operation cycle per hour at DC-13 24 Vdc 4 A</p> |   |                           |

## Power Supply

This table describes the power supply characteristics of the TM3 safety module:

| Characteristic                     |                       | Value                    |
|------------------------------------|-----------------------|--------------------------|
| Supply voltage                     | IEC 60038             | 24 Vdc -15...+20 %       |
| External fuse protection (maximum) |                       | 4 A slow blow (class gG) |
| Power consumption                  | 24 Vdc supply voltage | 3.6 W                    |
|                                    | TM3 Bus (5 Vdc)       | 0.2 W                    |

## Control Circuit

This table describes the control circuit characteristics of the TM3 safety module:

| Characteristic  |         | Value    |
|---|---------|----------|
| Input voltage (high) <sup>(1)</sup>   | Minimum | 19.6 Vdc |
|   | Nominal | 24 Vdc   |
|   | Maximum | 28.8 Vdc |
| Input voltage (low) <sup>(1)</sup>  | Minimum | 0 Vdc    |
|   | Nominal | 0 Vdc    |
|   | Maximum | 2 Vdc    |
| Input current (high) <sup>(1)</sup>   | Nominal | 35 mA    |
|   | Maximum | 80 mA    |
| Input current (low) <sup>(1)</sup>  | Nominal | 0 mA     |
| Maximum output current from control circuit terminals: S11, S31, S22 ( <i>see page 17</i> ) |         | 100 mA   |
| Nominal voltage at the pins   |         | 24 Vdc   |
| Response time   |         | ≤ 20 ms  |
| Delay   | On      | ≤ 100 ms |
|   | Restart | ≤ 300 ms |
| <b>(1)</b> At terminal S12, S32 when externally supplied                                    |         |          |

### Output Circuit

This table describes the output circuit characteristics of the TM3 safety module:

| Characteristic   |                                    | Value           |
|--|------------------------------------|-----------------|
| Maximum switching current of each output   | AC-15: 230 Vac                     | 5 A             |
|  | DC-13: 24 Vdc                      | 4 A             |
| Minimum switching voltage and current (new contact never used with higher loads) |                                    | 17 V, 10 mA     |
| Maximum current  | Per output path                    | 6 A             |
|  | Sum of current in all output paths | ≤ 18 A          |
| External fuse protection (maximum)   | Slow blow (class gG) fuse          | 4 A             |
|  | Fast blow fuse                     | 6 A             |
| Maximum switching operations   |                                    | 10 <sup>7</sup> |

## TM3SAK6R / TM3SAK6RG Wiring Diagram

### Introduction

These safety modules have a built-in removable screw or spring terminal block for the connection of inputs and outputs.

### Wiring Rules

See Wiring Best Practices (*see page 53*).

The 24 Vdc power supply must be rated Protective Extra Low Voltage (PELV) or Safety Extra Low Voltage (SELV) and fulfill the IEC/EN 60204-1 requirements. These power supplies are isolated between the electrical input and output circuits of the power supply.

### WARNING

#### POTENTIAL OF OVERHEATING AND FIRE

- Do not connect the equipment directly to line voltage.
- Use only isolating PELV or SELV power supplies to supply power to the equipment.

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

### WARNING

#### LOSS OF CONTROL

Place a properly rated fuse on the primary input power line and on the outputs, as described in the related documentation.

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

### Emergency Stop Wiring Diagram

Both the safety conditions and the start conditions must be valid before allowing the activation of outputs.

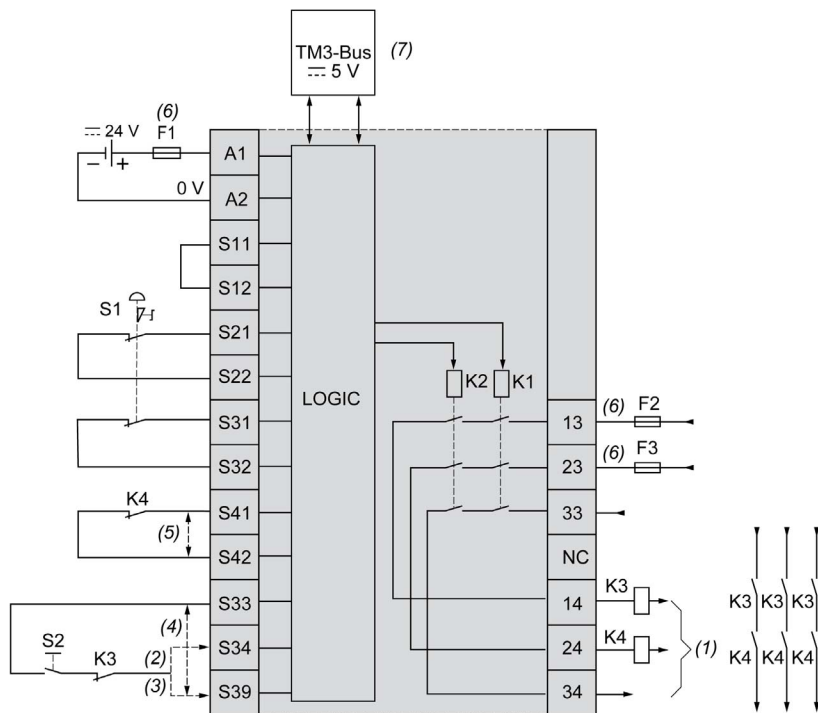
### WARNING

#### UNINTENDED EQUIPMENT OPERATION

Do not use either the monitored start or the non-monitored start as a safety function.

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

This figure shows an example of emergency stop wiring to a TM3SAK6R• module:



**S1:** Emergency stop switch

**S2:** Start switch

(1): Safety outputs

(2): Monitored start<sup>1</sup>

(3): Non-monitored start<sup>1</sup>

(4): For automatic start<sup>1</sup>, directly connect [S33] and [S39] terminals

(5): Second external device monitoring<sup>1</sup> channel. Connect [S41] and [S42] terminals if not used.

(6): Fuses. Refer to electrical characteristics for fuse values.

(7): Non-safety related TM3 Bus communication with logic controller

<sup>1</sup> For more information, refer to the TM3 Expansion Modules Programming Guide for your software platform.

## ⚠ WARNING

### UNINTENDED EQUIPMENT OPERATION

Do not use the data transferred over the TM3 Bus for any functional safety-related task(s).

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



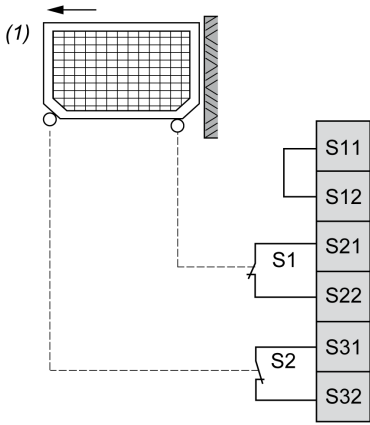
**⚠ WARNING**

**UNINTENDED EQUIPMENT OPERATION**

Do not connect wires to unused terminals and/or terminals indicated as “No Connection (N.C.)”.  
**Failure to follow these instructions can result in death, serious injury, or equipment damage.**

**Protective Guard Wiring**

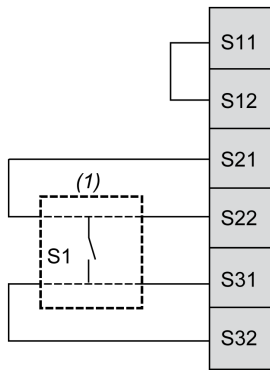
This figure shows an example of 2 channel protective guard wiring to the safety module inputs:



(1): Protective guard


**Safety-Mat Wiring**

This figure shows an example of safety-mat (pressure sensitive, short circuit generating) wiring to the safety module inputs:



(1): Safety-mat

**NOTE:** Normally, most safety-mats are maladapted for use in combination with the automatic start mode. In addition, if you use the safety-mat in your application which includes the automatic start mode, you should consider this in your risk analysis.

 **WARNING**

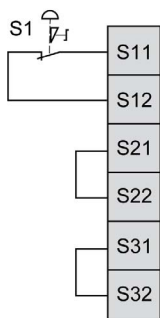
**UNINTENDED EQUIPMENT OPERATION**

Only use short-circuit generating pressure sensitive devices according to ISO/EN 13856-1:2013 for the safety-mat function.

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

### One Channel Emergency Stop Wiring

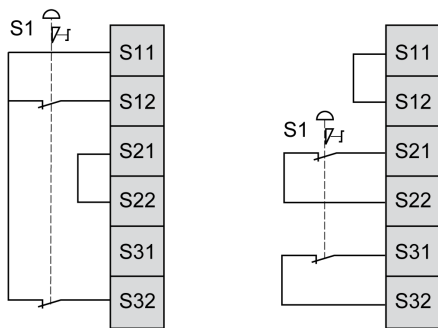
This figure illustrates an example of 1 channel emergency stop wiring to the safety module inputs:



**S1:** Emergency stop switch

### Two Channel Emergency Stop Wiring

This figure illustrates two examples of 2 channel emergency stop wiring to the safety module inputs:



**S1:** Emergency stop switch

**NOTE:** Inputs **S11** and **S12** are not intended for the monitoring of short-circuits in external wiring.

## ⚠ WARNING

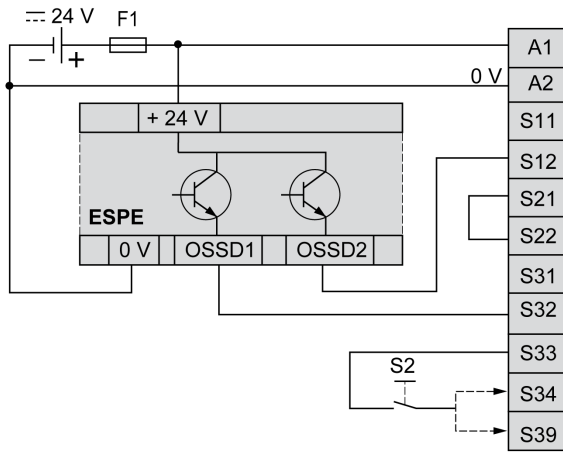
**UNINTENDED EQUIPMENT OPERATION**

Do not use the **S11** and **S12** inputs to build SIL 3 applications unless you exclude the possibility of short-circuits by external measures.

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

### Electro-Sensitive Protective Equipment (ESPE) Wiring

This figure shows an example of ESPE (type 4 outputs, IEC/EN 61496-1) wiring to the safety module inputs:

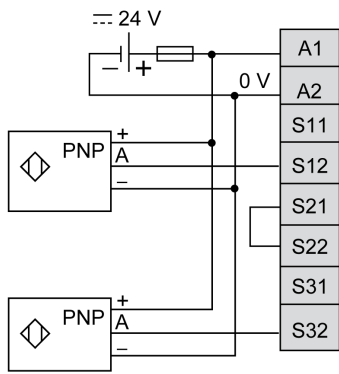


**S2:** Start switch

**NOTE:** The ESPE must be supplied by the same PELV/SELV power supply as the safety module.

### Proximity Sensors Without Short Circuit Detection Wiring

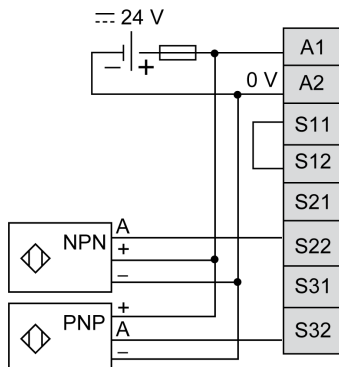
This figure shows an example of a 2 channel application (2 \* PNP sensors) wiring to the safety module inputs:



**NOTE:** The sensors must be supplied by the same PELV/SELV power supply as the safety module.

### Proximity Sensors with Short Circuit Detection Wiring

This figure shows an example of a 2 channel application (PNP + NPN complementary sensors) wiring to the safety module inputs:



**NOTE:** The sensors must be supplied by the same PELV/SELV power supply as the safety module.



## A

### **application**

A program including configuration data, symbols, and documentation.

## C

### **configuration**

The arrangement and interconnection of hardware components within a system and the hardware and software parameters that determine the operating characteristics of the system.

### **controller**

Automates industrial processes (also known as programmable logic controller or programmable controller).

## E

### **EIA rack**

(*electronic industries alliance rack*) A standardized (EIA 310-D, IEC 60297, and DIN 41494 SC48D) system for mounting various electronic modules in a stack or rack that is 19 inches (482.6 mm) wide.

### **EN**

EN identifies one of many European standards maintained by CEN (*European Committee for Standardization*), CENELEC (*European Committee for Electrotechnical Standardization*), or ETSI (*European Telecommunications Standards Institute*).

### **expansion bus**

An electronic communication bus between expansion I/O modules and a controller.

### **expansion connector**

A connector to attach expansion I/O modules.

## F

### FE

*(functional Earth)* A common grounding connection to enhance or otherwise allow normal operation of electrically sensitive equipment (also referred to as functional ground in North America).

In contrast to a protective Earth (protective ground), a functional earth connection serves a purpose other than shock protection, and may normally carry current. Examples of devices that use functional earth connections include surge suppressors and electromagnetic interference filters, certain antennas, and measurement instruments.

## I

### I/O

*(input/output)*

### IEC

*(international electrotechnical commission)* A non-profit and non-governmental international standards organization that prepares and publishes international standards for electrical, electronic, and related technologies.

### IP 20

*(ingress protection)* The protection classification according to IEC 60529 offered by an enclosure, shown by the letter IP and 2 digits. The first digit indicates 2 factors: helping protect persons and for equipment. The second digit indicates helping protect against water. IP 20 devices help protect against electric contact of objects larger than 12.5 mm, but not against water.

## N

### NEMA

*(national electrical manufacturers association)* The standard for the performance of various classes of electrical enclosures. The NEMA standards cover corrosion resistance, ability to help protect from rain, submersion, and so on. For IEC member countries, the IEC 60529 standard classifies the ingress protection rating for enclosures.

## P

### program

The component of an application that consists of compiled source code capable of being installed in the memory of a logic controller.



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