PacDrive TM5 / TM7 Safety Flexible System

System Planning and Installation Guide

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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

Important Information

NOTICE

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

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

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by 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.

BEFORE YOU BEGIN

Do not use this product on machinery lacking effective point-of-operation guarding. Lack of effective point-of-operation guarding on a machine can result in serious injury to the operator of that machine.

⚠ WARNING

UNGUARDED EQUIPMENT

- Do not use this software and related automation equipment on equipment which does not have point-of-operation protection.
- Do not reach into machinery during operation.

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

This automation equipment and related software is used to control a variety of industrial processes. The type or model of automation equipment suitable for each application will vary depending on factors such as the control function required, degree of protection required, production methods, unusual conditions, government regulations, etc. In some applications, more than one processor may be required, as when backup redundancy is needed.

Only you, the user, machine builder or system integrator can be aware of all the conditions and factors present during setup, operation, and maintenance of the machine and, therefore, can determine the automation equipment and the related safeties and interlocks which can be properly used. When selecting automation and control equipment and related software for a particular application, you should refer to the applicable local and national standards and regulations. The National Safety Council's Accident Prevention Manual (nationally recognized in the United States of America) also provides much useful information.

In some applications, such as packaging machinery, additional operator protection such as point-of-operation guarding must be provided. This is necessary if the operator's hands and other parts of the body are free to enter the pinch points or other hazardous areas and serious injury can occur. Software products alone cannot protect an operator from injury. For this reason the software cannot be substituted for or take the place of point-of-operation protection.

Ensure that appropriate safeties and mechanical/electrical interlocks related to point-of-operation protection have been installed and are operational before placing the equipment into service. All interlocks and safeties related to point-of-operation protection must be coordinated with the related automation equipment and software programming.

NOTE: Coordination of safeties and mechanical/electrical interlocks for point-of-operation protection is outside the scope of the Function Block Library, System User Guide, or other implementation referenced in this documentation.

START-UP AND TEST

Before using electrical control and automation equipment for regular operation after installation, the system should be given a start-up test by qualified personnel to verify correct operation of the equipment. It is important that arrangements for such a check be made and that enough time is allowed to perform complete and satisfactory testing.

⚠ WARNING

EQUIPMENT OPERATION HAZARD

- Verify that all installation and set up procedures have been completed.
- Before operational tests are performed, remove all blocks or other temporary holding means used for shipment from all component devices.
- Remove tools, meters, and debris from equipment.

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

Follow all start-up tests recommended in the equipment documentation. Store all equipment documentation for future references.

Software testing must be done in both simulated and real environments.

Verify that the completed system is free from all short circuits and temporary grounds that are not installed according to local regulations (according to the National Electrical Code in the U.S.A, for instance). If high-potential voltage testing is necessary, follow recommendations in equipment documentation to prevent accidental equipment damage.

Before energizing equipment:

- Remove tools, meters, and debris from equipment.
- Close the equipment enclosure door.
- Remove all temporary grounds from incoming power lines.
- Perform all start-up tests recommended by the manufacturer.

OPERATION AND ADJUSTMENTS

The following precautions are from the NEMA Standards Publication ICS 7.1-1995 (English version prevails):

- Regardless of the care exercised in the design and manufacture of equipment or in the selection and ratings of components, there are hazards that can be encountered if such equipment is improperly operated.
- It is sometimes possible to misadjust the equipment and thus produce unsatisfactory or unsafe operation. Always use the manufacturer's instructions as a guide for functional adjustments. Personnel who have access to these adjustments should be familiar with the equipment manufacturer's instructions and the machinery used with the electrical equipment.
- Only those operational adjustments actually required by the operator should be accessible to the operator. Access to other controls should be restricted to prevent unauthorized changes in operating characteristics.

About the Book

At a Glance

Document Scope

This guide provides the information you will need in order to plan and install a safety-related TM5 / TM7 System.

This guide contains:

- an overview and description of the TM5 / TM7 Safety-Related System,
- information and requirements to plan your installation.

Validity Note

This document has been updated for the release of EcoStruxure™ Machine Expert V1.2.

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

Step	Action
1	Go to the Schneider Electric home page *www.schneider-electric.com*.
2	In the **Search** box type the reference of a product or the name of a product range. ● Do not include blank spaces in the reference or product range. ● To get information on grouping similar modules, use asterisks (*).
3	If you entered a reference, go to the **Product Datasheets** search results and click on the reference that interests you. If you entered the name of a product range, go to the **Product Ranges** search results and click on the product range that interests you.
4	If more than one reference appears in the **Products** 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 datasheet.
6	To save or print a datasheet as a .pdf file, click **Download XXX product datasheet**.

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

Related Documents

Document title	Reference
Modicon TM5 Compact I/O Modules Hardware Guide	*EIO0000000456 (Eng)*; *EIO0000000457 (Fre)*; *EIO0000000458 (Ger)*; *EIO0000000459 (Spa)*; *EIO0000000460 (Ita)*; *EIO0000000461 (Chs)*;
Modicon TM5 Digital I/O Modules Hardware Guide	*EIO0000000444 (Eng)* *EIO0000000445 (Fre)* *EIO0000000446 (Ger)* *EIO0000000447 (Spa)* *EIO0000000448 (Ita)* *EIO0000000449 (Chs)*
Modicon TM5 Analog I/O Modules Hardware Guide	*EIO0000000450 (Eng)* *EIO0000000451 (Fre)* *EIO0000000452 (Ger)* *EIO0000000453 (Spa)* *EIO0000000454 (Ita)* *EIO0000000455 (Chs)*
Modicon TM5 Expert (High Speed Counter) Modules Hardware Guide	*EIO0000000462 (Eng)* *EIO0000000463 (Fre)* *EIO0000000464 (Ger)* *EIO0000000465 (Spa)* *EIO0000000466 (Ita)* *EIO0000000467 (Chs)*
Modicon TM5 Transmitter and Receiver Modules Hardware Guide	*EIO0000000468 (Eng)* *EIO0000000469 (Fre)* *EIO0000000470 (Ger)* *EIO0000000471 (Spa)* *EIO0000000472 (Ita)* *EIO0000000473 (Chs)*
Modicon TM7 Digital I/O Blocks Hardware Guide	*EIO0000000703 (Eng)* *EIO0000000704 (Fre)* *EIO0000000705 (Ger)* *EIO0000000706 (Spa)* *EIO0000000707 (Ita)* *EIO0000000708 (Chs)*
Modicon TM5/TM7 I/O Safety Modules Hardware Guide	*EIO0000000861 (Eng)* *EIO0000000862 (Ger)*
Modicon TM5/TM7 Safety PLC SLC100/200 FS Hardware Guide	*EIO0000000889 (Eng)* *EIO0000000891 (Ger)*
TM5 Sercos III Bus Interface Operating Manual	–

Document title	Reference
PacDrive Logic Motion Controller LMC 101/201 C Operating Manual	–
PacDrive Logic Motion Controller LMC 300/400/600 C Operating Manual	–
PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide	*EIO0000001058 (Eng)* *EIO0000001060 (Ger)*

You can download these technical publications and other technical information from our website at *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.

For important hazardous location information, refer to the individual product descriptions contained in their hardware guides.

⚠ WARNING

LOSS OF CONTROL

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

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

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

⚠ WARNING

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.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Understand the requirements contained in IEC 61508, "Functional safety of electrical/electronic/programmable electronic safety-related systems" before applying the information contained in the present document.
- Completely understand the applications and environment defined by Safety Integrity Level (SIL) 3 within IEC 61508 Parts 1-7, First edition.
- Do not exceed SIL 3 ratings in the application of this product.

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

NOTE: SIL requirements referred to in the present document are based on the standards current at the time of TÜV certification.

Terminology Derived from Standard

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

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

Among others, these standards include:

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

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

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

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

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

Part I
Introduction to the TM5 / TM7 Safety-Related System

Overview

This manual provides an overview of the TM5 / TM7 Safety-Related System:

- The TM5 System is comprised of IP20-rated components with which you can create distributed and/or remote I/O architectures *(see page 79)*.
  A typical TM5 Safety-Related System includes a controller, a Safety Logic Controller (TM5CSLC100FS/TM5CSLC200FS), a Sercos III Bus Interface and safety-related modules *(see page 37)*. The components must be installed in enclosures appropriate to the intended operating environment and secured by a keyed or tool locking mechanism. You can also add non-safety-related modules and accessories to your Sercos bus. However, these non-safety-related components will not be a part of your safety-related system.
- The TM7 System is comprised of IP67-rated components with which you can create distributed and/or remote I/O architectures.
  A TM7 Safety-Related System can be expanded from the Sercos III Bus Interfaces through transmitter modules and including safety-related I/O blocks, non-safety-related expansion blocks and accessories which can be used in environments conforming to IP67 (splashing water, oil, dust, etc...).

What Is in This Part?

This part contains the following chapters:

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2	Basics of the TM5 / TM7 Safety-Related System	25
3	Description of the TM5 Safety-Related System	31
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Chapter 1
Functional Safety Information

What Is in This Chapter?

This chapter contains the following topics:

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IEC 61508 and Safety Integrity Level (SIL)

Introduction

The TM5/TM7 Safety-related I/O modules are a Safety-Related System certified according to IEC 61508 by TÜV Nord.

IEC 61508 Description

The IEC 61508 is a technical standard concerning the functional safety of electrical, electronic or programmable electronic safety-related systems.

A safety-related system is a system that is required to perform one or more specific functions to ensure that risks are kept at or below an acceptable level. Such functions are defined as safety functions.

A system is defined “functionally safe” when random, systematic, and common cause equipment or machine failures do not lead to malfunctioning of the system and do not result in injury or death of humans, spills to the environment, and loss of equipment and production.

Description of the Safety Integrity Level (SIL)

Safety-related functions are executed to achieve and maintain the defined safe state of a system. The IEC 61508 specifies four levels of safety performance for a safety-related function. These are called Safety Integrity Levels (SIL), ranging from 1 (the lowest) to 4 (the highest). The TM5/TM7 Safety-related I/O modules are certified for use in SIL 3 applications in which the de-energized state is the defined safe state.

Functional Safety Certification

Introduction

The TM5/TM7 Safety-related I/O modules are certified by TÜV Nord for use in applications up to SIL 3 according to IEC 61508 and IEC 62061.

This certification verifies that the TM5 and TM7 modules are compliant with the following standards:

- IEC 61508: Functional safety of electrical/electronic/programmable electronic safety-related systems, Parts 1 to 4, 2010, up to SIL 3
- ISO 13849-1: Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design, 2015, up to PL e (Category 4)
- IEC 62061: Safety of machinery - Functional safety of safety-related electrical, electronic, and programmable electronic control systems, 2005 (A1:2013), up to SILcl 3

NOTE: Using a Safety Logic Controller equipment is a necessary but not sufficient precondition for the certification of a SIL 3 application. A SIL 3 application must also fulfill the requirements of the IEC 61508, IEC 61511, IEC 61131-2, and other application standards.

Classification of the Schneider Electric Products

The safety-related modules allow to perform safety-related functions. However, they also support non-safety-related modules, enabling you to add non-safety parts to your SIL 3 project.

Therefore, the Schneider Electric products must be distinguished into:

- safety-related modules and
- non-safety-related modules

In contrast to the safety-modules, non-safety-related modules are not used to perform safety-related functions. They are designated as non-interfering modules for use with the Safety Logic Controller. A detected error in one of these modules does not detract the execution of the safety-related functions.

Functional Safety Parameters

The Functional Safety parameters according to EN ISO 13849 are as follows:

- Performance Level for
  - SDI (safety-related digital input) to SDO (safety-related digital output): up to PL e
  - SAI (safety-related analog input) to SAO (safety-related analog output): up to PL e
- Category: up to 4.

Available Safety-Related Controller

The following Schneider Electric safety-related controllers are available:

Module Type	Module Reference
Safety Logic Controller SLC 100 SERCOS III 20 nodes	TM5CSLC100FS
Safety Logic Controller SLC 200 SERCOS III 100 nodes	TM5CSLC200FS

NOTE: The safety-related modules must be connected by using an additional Sercos III Bus Interface TM5NS31 exclusively to the Safety Logic Controller. Mechanical, hardware, and firmware features are described in the Modicon TM5 Safety Logic Controller SLC100/200 FS Hardware Guide *(see Modicon TM5, Safety Logic Controller SLC100/200 FS, Hardware Guide)*.

Available Bus Interface

The following Schneider Electric bus interface is available:

Module Type	Module Reference
Sercos III Bus Interface	TM5NS31

NOTE: The Sercos III Bus Interface, required for communication with the Safety Logic Controller, is considered a non-interfering module and does not contribute nor detract from the safety-related function of the controller. The safety layer part of the Sercos III communication is managed inside the safety-related modules and not in the Sercos III Bus Interface.

⚠ DANGER

IMPROPER SAFETY-RELATED SYSTEM

- Use only modules designated as safety-related modules to perform safety-related functions.
- Make sure that neither inputs nor outputs of non-safety-related modules are used for safety-related functions.

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

Probabilities of Failure

For SIL 3 applications, IEC 61508 defines the following probabilities of failure on demand (PFD) and probabilities of failure per hour (PFH) depending on the mode of operation:

- PFD ≥ 10^{-4} to < 10^{-3} for low demand mode of operation
- PFH ≥ 10^{-8} to < 10^{-7} for high demand mode of operation

Training

Introduction

As stated in the IEC 61508, Part 1, App. B, all persons involved in a Safety Lifecycle activity must have the appropriate training, technical knowledge, experience, and qualifications relevant apply the products specified in the present document. Training, technical knowledge, experience, and qualifications should be assessed in relation to each particular application.

NOTE: Make sure you possess all information and skills required to install, run, and maintain Safety-Related Systems correctly.

Chapter 2
Basics of the TM5 / TM7 Safety-Related System

Overview

This chapter provides an overview of the TM5 / TM7 Safety-Related System architecture. Also, the color coding principle is described.

What Is in This Chapter?

This chapter contains the following topics:

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Color Coding of the TM5 Safety-Related System	27
Color Coding of the TM7 Safety-Related System	29

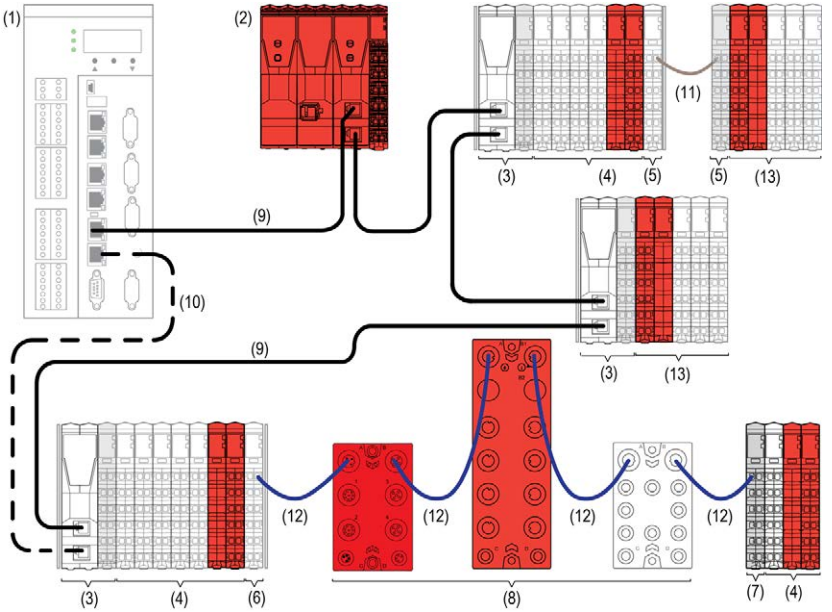
TM5 / TM7 Safety-Related System I/O Architecture

Introduction

The TM5 / TM7 Safety-Related System is an open system and can operate with Pacdrive via the Sercos III automation bus.

TM5 / TM7 Safety-Related System I/Os

The following figure represents TM5 / TM7 Safety-Related System I/Os connected via the Sercos III automation bus to a Logic Motion Controller:



1 Logic Motion Controller LMC •0• C
2 Safety Logic Controller TM5CSLC100FS/TM5CSLC200FS (red, for safety-related applications only)
3 Sercos III Bus Interface TM5NS31
4 TM5 Safety-Related System I/O Modules (red, for safety-related applications only) and non-safety-related TM5 System I/O Modules
5 Transmitter Module TM5SBET1 and Receiver Module TM5SBER2
6 Transmitter Module TM5SBET7
7 Receiver Module TM5SBER2
8 TM7 Safety-Related System I/O Modules (red, for safety-related applications only) and non-safety-related TM7 System I/O Module
9 Sercos III Ethernet Bus Cable
10 Sercos III Ethernet Bus Cable (optional)
11 TM5 Expansion bus cable TCSXCNNXNX100
12 TM7 Expansion Bus Cable
13 TM5 Safety Power Distribution module TM5SPS10FS, and non-safety-related TM5 System I/O Modules

Remote Configuration Architecture

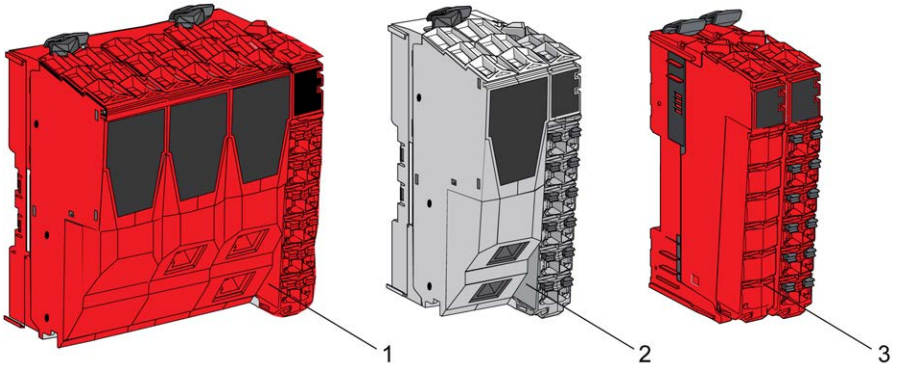
In addition to your distributed configuration you can place remote I/Os at a distance up to 100 m (328.1 ft) from the Sercos III Bus Interface.

NOTE: You can create remote I/Os with TM5 expansion modules and/or TM7 expansion blocks. Refer to *Modicon TM5 Transmitter and Receiver Modules Hardware Guide (see Modicon TM5, Transmitter and Receiver Modules, Hardware Guide)* to design remote configurations.

Color Coding of the TM5 Safety-Related System

Overview

The following figure shows colors of the TM5 Safety-Related System components:



1 Safety Logic Controller TM5CSLC100FS/TM5CSLC200FS
2 Non-safety-related Sercos III Bus Interface TM5NS31
3 TM5 Safety-Related System I/O Module

Safety Logic Controller Color Assignment

The Safety Logic Controller and its removable terminal block are colored in red.

Memory Key Color Assignment

The Memory Key of the Safety Logic Controller is gray and red.

For more information regarding the Memory Key, refer to Safety Logic Controller Memory Key *(see page 296)*.

Sercos III Bus Interface Color Assignment

Two colors are used for the four components of a Sercos III Bus Interface *(see page 43)*:

- White for the:
  - Sercos III Bus Interface bus base and,
  - Sercos III Bus Interface module.
- Gray for the:
  - Interface Power Distribution Module (IPDM) and,
  - associated terminal block.

Slice Color Assignment

The components of a TM5 Safety-Related System module are colored in red.

⚠ ⚠ DANGER

INCOMPATIBLE COMPONENTS CAUSE ELECTRIC SHOCK OR ARC FLASH

- Do not associate components of a slice that have different colors.
- Always confirm the compatibility of slice components and modules before installation using the association table in this manual.
- Verify that correct terminal blocks (minimally, matching colors and correct number of terminals) are installed on the appropriate electronic modules.

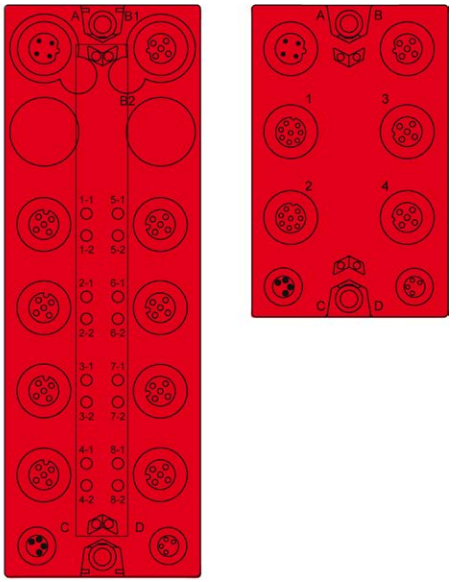
Failure to follow these instructions will result in death or serious injury.

NOTE: Verify the compatibility of components with the association table *(see page 210)* before installation.

Color Coding of the TM7 Safety-Related System

TM7 Safety-Related System Modules Color Assignment

The color of the TM7 Safety-Related System modules is red.



Chapter 3
Description of the TM5 Safety-Related System

Overview

This chapter provides a brief description of the constituent parts of the TM5 Safety-Related System. It describes the Safety Logic Controller, the safety-related modules , the non-safety related modules and the accessories.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
General Information on Safety Logic Controllers	32
Safety Logic Controller Presentation	33
Safety Logic Controller Description	35
Safety-Related Slice Description	37
Sercos III Bus Interface Description	41
Accessories for the TM5 System	46

General Information on Safety Logic Controllers

General Overview

Safety Logic Controllers manage the tasks within a safety-related application and provide the following functionalities:

- configuration management
- parameter management
- execution of the safety-related application program

NOTE: The safety-related modules must be connected through a Sercos III Bus Interface.

Configuration Management

The configuration management monitors the safety-related configuration of the application in the Safety Logic Controller and provides the following functions:

- Helps ensure a consistent, safety-related configuration.
- Verifies the module types, as well as the hardware and firmware versions, with those specified in the Safety Logic Controller application.
- Verifies the configuration at startup and periodically during operation.

Parameter Management

When replacements are needed, the parameter management system helps to ensure that newly installed modules are assigned correct parameters that apply to the application in the Safety Logic Controller.

The parameter management provides the following functions:

- Helps to ensure consistent parameters on the safety-related I/O modules.
- Verifies the parameters with those specified in the Safety Logic Controller application.
- Independently performs complete parameter downloads.

Memory Key

The memory key on the Safety Logic Controller supports the following features:

- holds the safety-related application that is loaded at boot-up.
- storage medium for the application, configuration, and parameters.
- application transfer of safety-related functions to another Safety Logic Controller.

NOTE: A memory key is required for operation of the Safety Logic Controller. For more information concerning the role of the memory key in the Safety Logic Controller system, refer to Safety Logic Controller Memory Key *(see page 296)*.

Safety Logic Controller Presentation

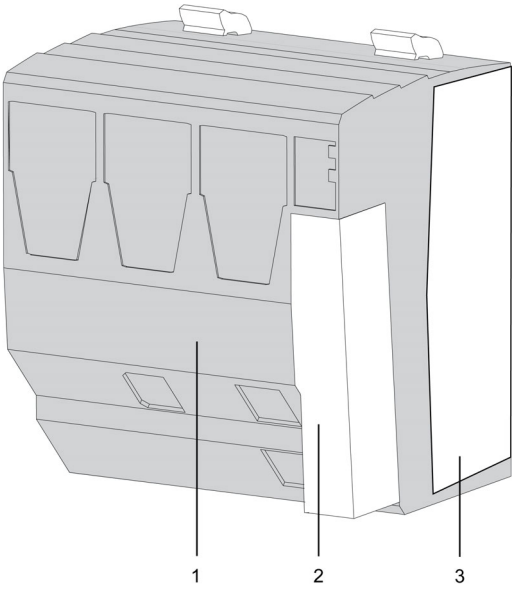
Features

The table below describes the features of TM5CSLC100FS and TM5CSLC200FS :

Feature	TM5CSLC100FS	TM5CSLC200FS
System module	Safety CPU Standard	Safety CPU Plus
Maximum I/O modules via Sercos III interface	20 safety-related modules	100 safety-related modules
Interfaces	Sercos III, controlled node, integrated 2x switch	
Application memory	exchangeable application memory: memory key	
Dimensions (W x H x D)	87.5 x 99 x 75 mm (3.44 x 3.89 x 2.92 inches)	

Ordering Information

The figure below presents TM5CSLC100FS and TM5CSLC200FS in combination with the required accessories:



The table below presents the references for the Safety Logic Controllers and the terminal block:

Number	Reference	Description	Color
1	TM5CSLC100FS	SLC 100 Sercos III	red
	TM5CSLC200FS	SLC 200 Sercos III	
2	TM5ACTB52FS *(see page 292)*(1)	TM5 terminal block, 12-pin, safety coded	red
3	TM5ACLPR10(1)	TM5 Locking plate	white
(1) Included in delivery of TM5CSLC100FS/TM5CSLC200FS			

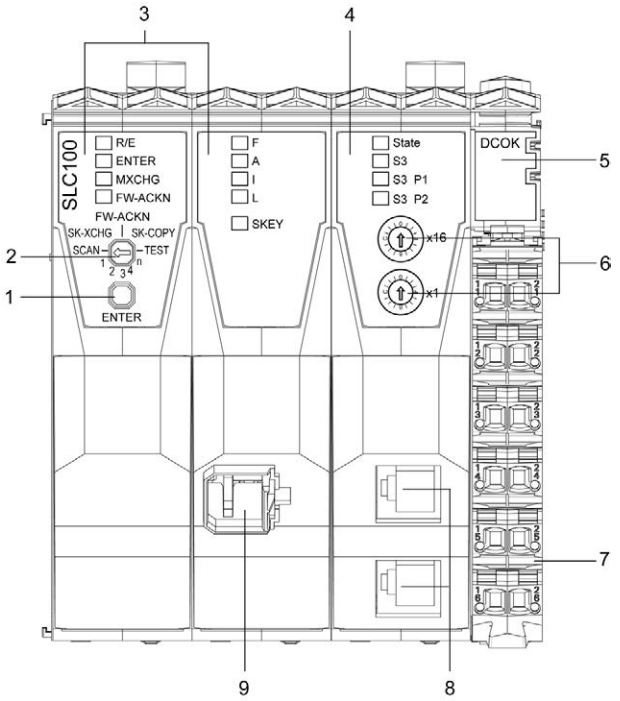
NOTE: A memory key is required for operation of the Safety Logic Controller, and is sold separately. For more information concerning the role of the memory key in the Safety Logic Controller system, refer to Safety Logic Controller Memory Key *(see page 296)*.

Safety Logic Controller Description

Description

The LED indicators, buttons and switches are integrated to operate the Safety Logic Controller.

The following figure presents the operating and connection elements:



N°	Description	Refer to
1	Confirmation button	Confirming a Function *(see Modicon TM5, Safety Logic Controller SLC100/200 FS, Hardware Guide)*
2	Selection switch	Description of the Selection Switch Functions *(see Modicon TM5, Safety Logic Controller SLC100/200 FS, Hardware Guide)*
3	Logic processor	Logic Processor LED indicators *(see Modicon TM5, Safety Logic Controller SLC100/200 FS, Hardware Guide)*
4	Sercos III interface	Sercos III interface *(see Modicon TM5, Safety Logic Controller SLC100/200 FS, Hardware Guide)*

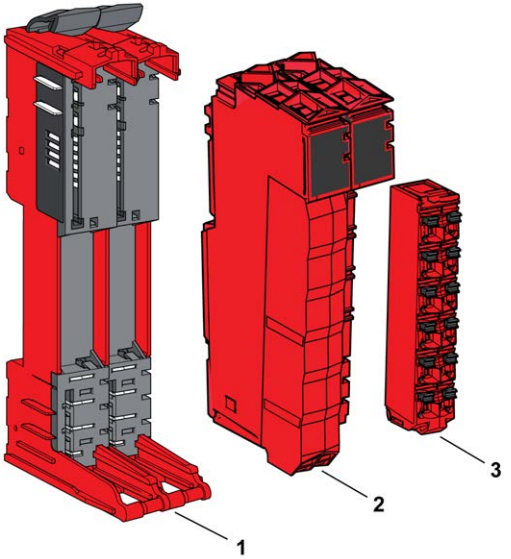
N°	Description	Refer to
5	Integrated power supply	Integrated Power Supply *(see Modicon TM5, Safety Logic Controller SLC100/200 FS, Hardware Guide)*
6	Sercos address switches	Sercos Address *(see Modicon TM5, Safety Logic Controller SLC100/200 FS, Hardware Guide)*
7	Terminal block for Safety Logic Controller power supply	Safety-Related Terminal Block Description *(see page 40)*
8	Sercos III connection with 2 x RJ45	Sercos III RJ45 Ports *(see Modicon TM5, Safety Logic Controller SLC100/200 FS, Hardware Guide)*
9	Memory key slot / slot cover	Safety Logic Controller Memory Key *(see page 296)*

These components enable you to perform the following operations:
- module replacement
- firmware update
- memory key replacement, including a possible transfer of module configuration from the previous memory key
- support for the replacement of Safety Logic Controller

Safety-Related Slice Description

Overview

The following figure shows the three components of a safety-related slice:



1 Safety-related bus base
2 Safety-related electronic module
3 Safety-related terminal block

⚠⚠ DANGER

INCOMPATIBLE COMPONENTS CAUSE ELECTRIC SHOCK OR ARC FLASH

- Do not associate components of a slice that have different colors.
- Always confirm the compatibility of slice components and modules before installation using the association table in this manual.
- Verify that correct terminal blocks (minimally, matching colors and correct number of terminals) are installed on the appropriate electronic modules.

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

The safety-related bus base and the safety-related terminal block for the safety-related electronic module, must be ordered separately. For the references see respective sections below.

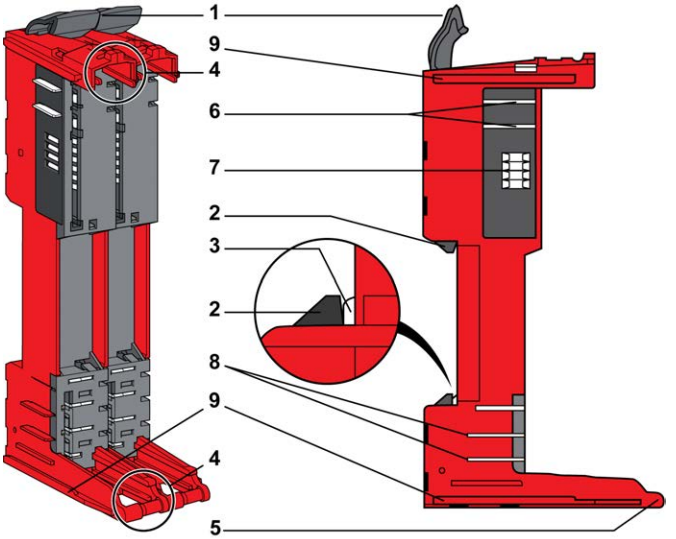
When assembled the three components form an integral unit that resists vibration and electrostatic discharge.

NOTICE
ELECTROSTATIC DISCHARGE • Never touch the contacts of the electronic module. • Always keep the connector in place during normal operation. **Failure to follow these instructions can result in equipment damage.**

The compatibility table gives the possible associations between components of a slice.

Safety-Related Bus Base Description

The following figures shows the different parts of the safety-related bus base:



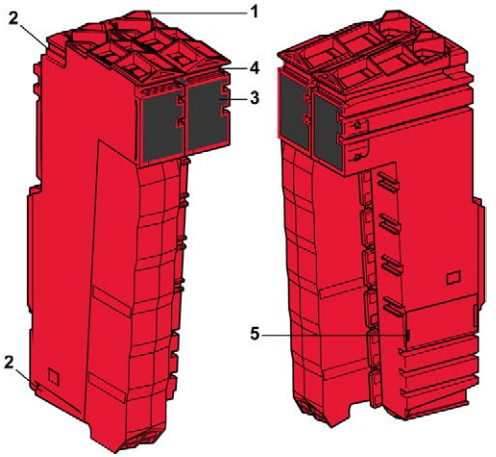
1 Locking lever
2 DIN rail locking mechanism
3 DIN rail contact
4 Guides for assembly of the safety-related electronic module
5 Rotation axle for safety-related terminal block
6 TM5 bus power contacts
7 TM5 bus data contacts
8 24 Vdc I/O power segment contacts
9 Interlocking guides

This table below presents the types of safety -related bus bases *(see page 290)* to be used in the safety-related slice:

Reference	Safety-Related Bus Base Description	Color
TM5ACBM3FS	Bus base 24 Vdc for safety-related modules, safety coded 24 Vdc I/O power segment pass-through	Red
TM5ACBM4FS	Bus base 24 Vdc for safety-related modules, safety coded 24 Vdc I/O power segment left isolated	Red

Safety-Related Electronic Module Description

The following figure presents the different parts of the safety-related electronic modules:



1 Locking lever
2 Guides for assembly
3 Display (LEDs)
4 Slot for labeling
5 Internal fuse exchangeable (depending on references)

This table presents the different types of safety-related electronic modules:

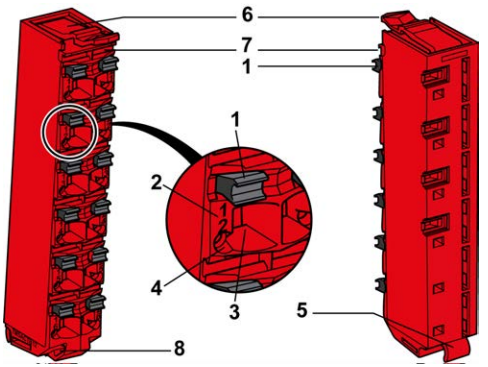
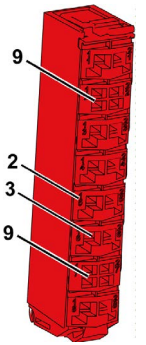
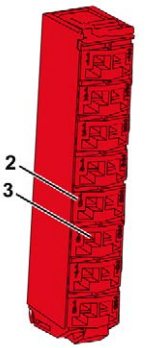
Reference	Safety-Related Electronic Module Description	Color	Refer to
TM5S•••FS	Safety-related modules	Red	Modicon TM5/TM7 I/O Safety Modules Hardware Guide

Safety-Related Terminal Block Description

The main features of the safety-related terminal block are:

- Tool-free wiring with spring clamp push-in technology
- Push-button wire release
- Ability to label *(see page 147)* each terminal
- Plain text labeling *(see page 155)* also possible
- Test access *(see page 158)* for standard probes

The following figures present the different parts of the safety-related terminal blocks:

TM5ACTB52FS	TM5ACTB5EFS	TM5ACTB5FFS
		

1 Wire release push-button
2 Pin assignment
3 Spring clamp connector
4 Test access point
5 Hinge for the axle on the safety-related bus base
6 Latch for the safety-related electronic module
7 Front slot for labeling
8 Slot for cable tie
9 Access point to terminal temperature compensation

This table presents the safety-related terminal blocks *(see page 292)*:

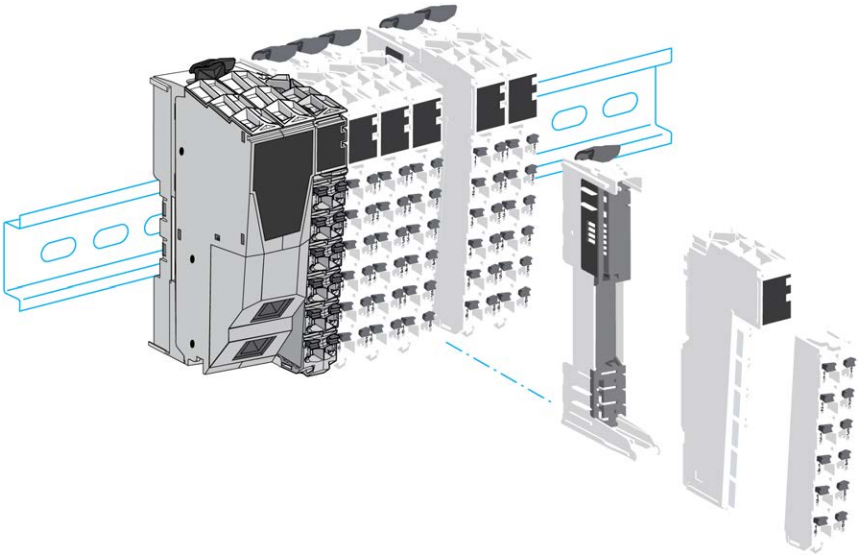
Reference	Safety-Related Terminal Block Description	Color
TM5ACTB52FS	24 Vdc / 230 Vac, 12-pin terminal block for safety-related modules and Safety Logic Controller, safety coded	Red
TM5ACTB5EFS	24 Vdc, 16-pin terminal block for safety-related modules, safety coded, 2x PT1000 integrated for terminal temperature compensation	Red
TM5ACTB5FFS	24 Vdc, 16-pin terminal block for safety-related modules, safety coded	Red

Sercos III Bus Interface Description

Introduction

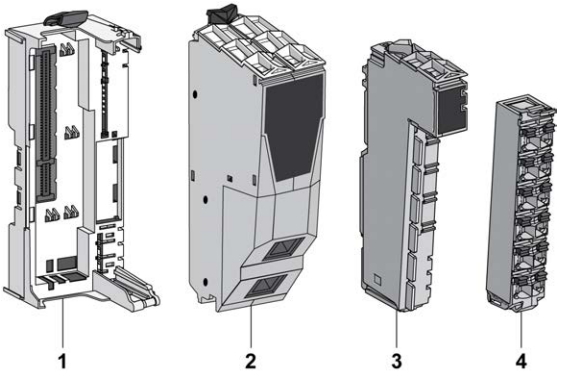
The TM5 Sercos III Bus Interface is the first element of the TM5 distributed I/O island *(see page 26)*.

The following figure shows the location of the TM5 Sercos III Bus Interface in a distributed I/O island:



Sercos III Bus Interface Overview

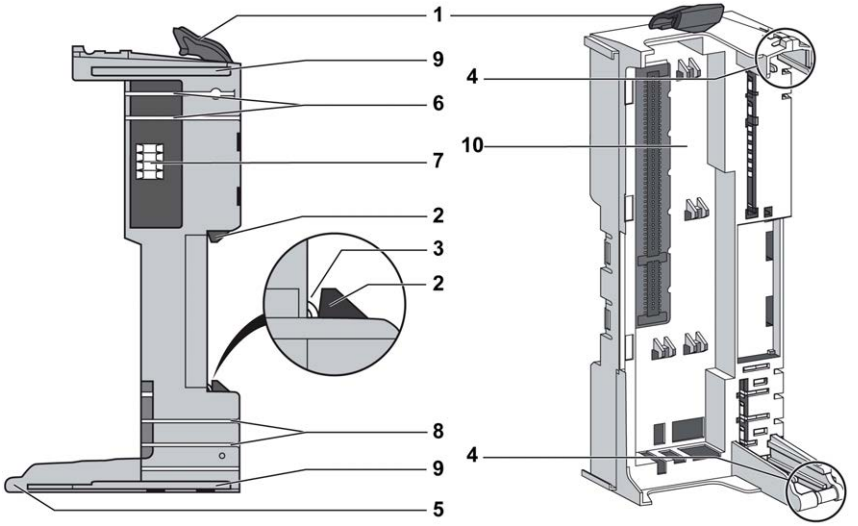
The TM5 Sercos III Bus Interface with built-in power distribution is composed of four different parts that can either be ordered together as a kit, or can be ordered separately as shown below:



Item	Description
1	Sercos III Bus Interface bus base *(see page 43)*
2	Sercos III Bus Interface *(see page 44)*
3	Interface Power Distribution Module (IPDM) *(see page 44)*
4	Terminal block *(see page 45)*

Sercos III Bus Interface Bus Base Description

The following figure shows the different parts of the Sercos III Bus Interface bus base:



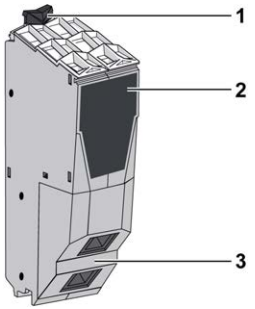
1 Locking lever
2 DIN rail locking mechanism
3 DIN rail contact
4 Guides for assembly of the IPDM
5 Rotation axle for terminal block
6 TM5 bus power contacts
7 TM5 bus data contacts
8 24 Vdc I/O power segment contacts
9 Interlocking guides
10 Slot for bus interface module

The following table gives the available reference:

Reference	Sercos III Bus Interface Bus Base Description	Color
TM5ACBN1	Bus base for Sercos III Bus Interface module and Interface Power Distribution Module (IPDM) *(see page 44)*	White

Sercos III Bus Interface Module Description

The following figure shows the front view of the Sercos III Bus Interface module:



1 Locking clip
2 Front view
3 Bus connector

The following table gives the available reference:

Reference	Bus Interface Module Description	Color
TM5NS31	Sercos III Bus Interface module	White

Interface Power Distribution Module (IPDM)

The following table gives the available reference:

Reference	IPDM Description *(see page 39)*	Color
TM5SPS3	Bus interface 24 Vdc power supply	Gray

The distribution of the power by the IPDM consists of two dedicated electrical circuits:

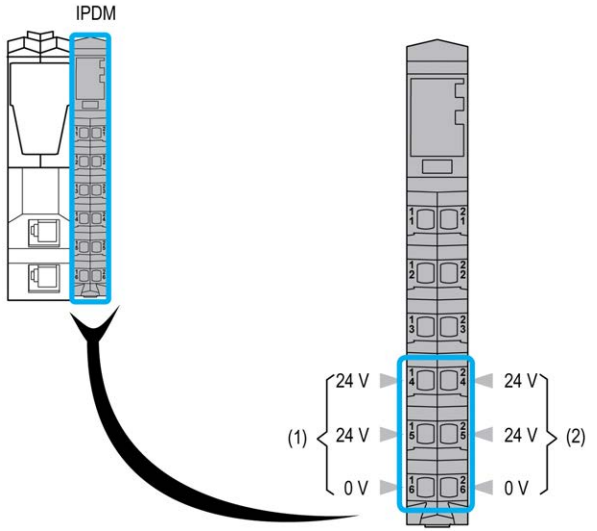
Designation:	Description:
24 Vdc Main power	24 Vdc power that serves the electronics of the bus Interface Module and generates independent power for the TM5 power bus that serves the expansion modules.
24 Vdc I/O power segment	The 24 Vdc power that serves: ● the expansion modules, ● the sensors and actuators connected to the expansion modules, ● the external devices connected to the Common Distribution Modules (CDM).

Terminal Block Description

The following table gives the available reference:

Reference	Terminal Block Description *(see page 40)*	Color
TM5ACTB12PS	24 Vdc, 12-pin terminal block for PDM, IPDM and Receiver electronic module *(see page 292)*	Gray

The following figure shows the terminal block assignments of the IPDM:

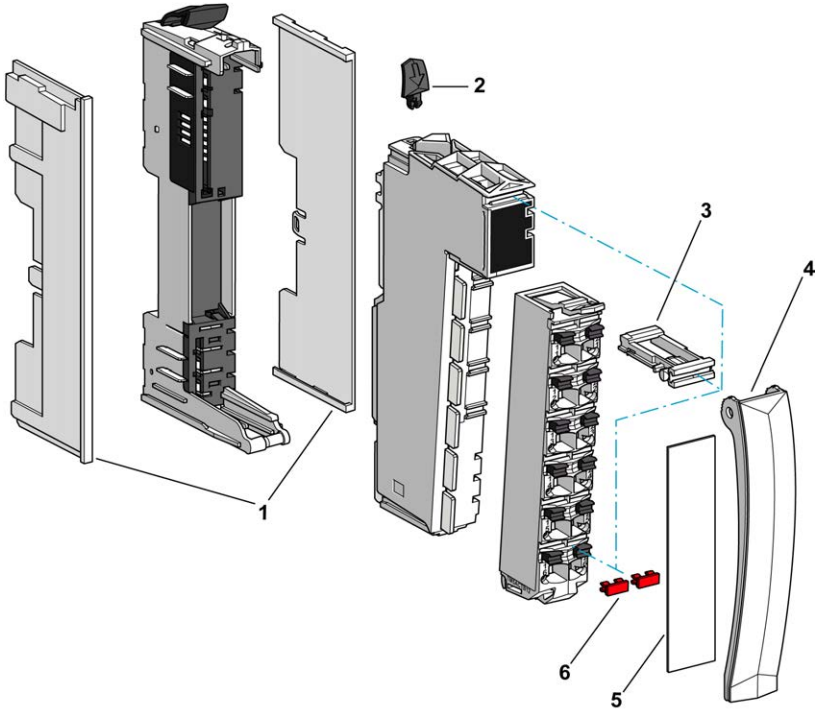


(1) 24 Vdc Main power
(2) 24 Vdc I/O power segment

Accessories for the TM5 System

Overview

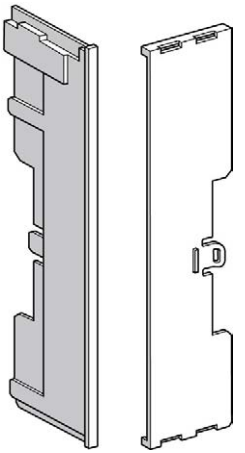
The TM5 accessories include the following:



1 Left and right bus base locking plates
2 Electronic module locking clip
3 Terminal locking clip
4 Plain text cover holder
5 Legend strips
6 Label tab

Bus Base Locking Plate

The bus base locking plate helps protect the TM5 bus exposed contacts on either the right and/or the left side of the TM5 system configuration:

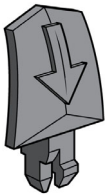
Reference	Description	
TM5ACLPL10	10 left bus base locking plates	
TM5ACLPR10	10 right bus base locking plates	

You must use the bus base locking plate to help avoid damage to the TM5 during installation from electrostatic discharge.

NOTICE
ELECTROSTATIC DISCHARGE ● Install a right bus base locking plate to the rightmost slice of all configurations. ● Install a left bus base locking plate to the first slice of all remote configurations. **Failure to follow these instructions can result in equipment damage.**

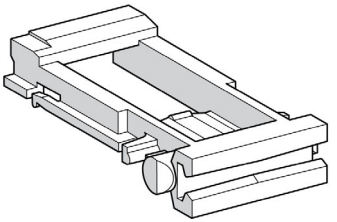
Electronic Module Locking Clip

The locking clip *(see page 151)* helps to securely lock the electronic module to the bus base:

Reference	Description
TM5ACADL100	Locking clip (x100) 

Terminal Locking Clip

The terminal locking clip *(see page 151)* helps to secure the terminal block to the electronic module:

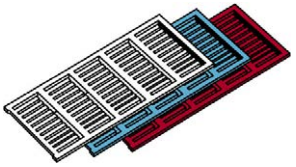
Reference	Description
TM5ACTLC100	Terminal locking clip (x100) 

Label Tabs and Labeling Tool

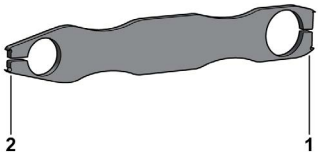
The label tabs are used for:

- labeling *(see page 146)*,
- coding *(see PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide)*.

The following table gives you the references of the three colored label tabs:

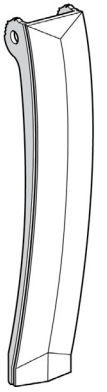
Reference	Description	
TM5ACLITW1	White label tabs, for 16 modules	
TM5ACLITR1	Red label tabs, for 16 modules	
TM5ACLITB1	Blue label tabs, for 16 modules	

The following labeling tool is needed for installing the label tabs, and the coding system between the connectors and the electronic modules:

Reference	Description
TM5ACLT1	Labeling insert tool for label tabs  **1** Double-width cutters **2** Single-width cutters

Plain Text Cover Holder

In addition to the label tabs, the cover holder allows plain text labeling. The plain text cover holder *(see page 155)* is attached to the terminal locking clip:

Reference	Description	
TM5ACTCH100	Plain text cover holder (x100)	
TM5ACTLS100	Legend strip for cover holder (x100)	

TM5 Bus Expansion Cable

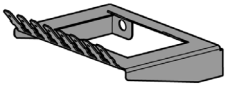
The TM5 bus expansion cable is used between Transmitter and Receiver modules for TM5 data bus:

Reference	Description
TCSXCNNXNX100	Expansion bus cable 100 m (328 ft)

Refer to *Modicon TM5 Transmitter and Receiver Modules Hardware Guide* for connections.

TM2XMTGB Grounding Plate

The TM2XMTGB Grounding Plate is an accessory used in the TM5 grounding step *(see page 106)* of the TM5 System installation:

Reference	Description
TM2XMTGB	Grounding Plate 

⚠ WARNING

ACCIDENTAL DISCONNECTION FROM PROTECTIVE GROUND (PE)

- Do not use the TM2XMTGB Grounding Plate to provide a protective ground (PE).
- Use the TM2XMTGB Grounding Plate only to provide a functional ground (FE).

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

Chapter 4
Description of the TM7 Safety-Related System

Overview

This chapter provides a brief description of the constituent parts of the TM7 Safety-Related System. It describes the expansion block and the accessories.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Expansion Blocks Description	54
Accessories for the TM7 System	56

Expansion Blocks Description

Introduction

There are two main types of TM7 expansion blocks:

- TM7 Power Distribution Block (PDB) *(see page 299)*
- TM7 Safety-Related System I/O block

Both the TM7 Power Distribution Blocks and TM7 Safety-Related System I/O blocks use two power buses and a data bus to perform their functions. These buses are organized as follows:

- **TM7 bus:** this bus includes one data bus and one power bus, named as follows:
  - **TM7 power bus:** distributes power to supply the electronics of the TM7 Safety-Related System I/O blocks. This bus receives its power from a TM5SBET7 Transmitter module. If necessary, the power on the TM7 power bus can be reinforced by adding a TM7 PDB.
  - **TM7 data bus:** passes data between the Sercos III Bus Interface and the TM7 expansion blocks.
- **24 Vdc I/O power segment:** distributes power to the inputs, outputs and the connected sensors and actuators of the TM7 Safety-Related System I/O blocks. Each TM5 / TM7 Safety-Related System can have multiple 24 Vdc I/O power segments, depending on considerations such as power consumption and separation of I/O types.

Ordering Information

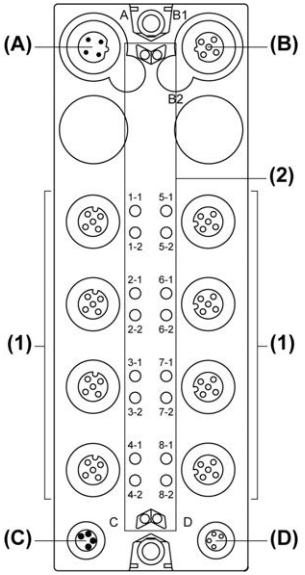
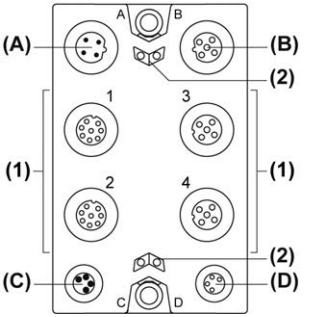
Each I/O block reference is distinguished by its type and number of I/O and its physical size. TM7 Safety-Related System I/O blocks come in two sizes *(see page 167)*.

Reference	Description	Refer to
TM7SDM12DTFS	Mixed input and output block for safety-related applications	Modicon TM5/TM7 Digital I/O Safety Modules Hardware Guide
TM7SDI8DFS	Digital input block for safety-related applications	

TM7 cables *(see page 305)* have to be ordered separately.

I/O Block Main Features

The following figure represents the main features of the I/O blocks:

Size 1	Size 2
	

(A) TM7 bus IN connector
(B) TM7 bus OUT connector
(C) 24 Vdc power IN connector
(D) 24 Vdc power OUT connector
(1) Input / Output connectors (depending on reference)
(2) Status LEDs

NOTE: For more information on the pinouts of these various connectors, see Modicon TM5/TM7 I/O Safety Modules Hardware Guide *(see Modicon TM5/TM7, I/O Safety Modules, Hardware Guide)*.

Accessories for the TM7 System

Overview

The TM7 accessories include the following:

- useable with all expansion blocks:
  - M8 and M12 sealing plugs,
  - support for block label,
  - expansion bus, power distribution and sensor cables,
  - torque wrench.
- useable with analog temperature input blocks only:
  - M12 thermocouple plug.
- useable with the smaller expansion block:
  - DIN rail mounting plate

DIN Rail Mounting Plate

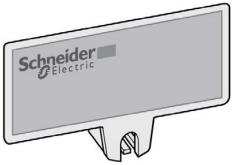
The following accessory is used to install blocks onto a 35 mm DIN Rail *(see page 197)*:

Reference	Description	Description
TM7ACMP	Mounting plate on DIN rail	

NOTE: Only small (Size 1) blocks can be installed on DIN rail with the TM7ACMP mounting plate.

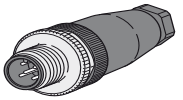
Support For Block Label

The support for block labels allows labeling the blocks *(see page 203)*:



M12 Thermocouple Plug

The M12 thermocouple plug *(see Modicon TM7, Analog I/O Blocks, Hardware Guide)* is used for compensation of the temperature at measurement points:

Reference	Description	
TM7ACTHA	M12 thermocouple plug	

M8 and M12 Sealing Plug

The following table presents the references of the sealing plugs for unused M8 and M12 connectors:

Reference	Description	
TM7ACCB	M8 Sealing plug	
TM7ACCA	M12 Sealing plug	

TM7 Cables

The connections for TM7 System are designed as circular plugs. The following types of pre-assembled cables are required to connect and build the TM7 System:

- Expansion bus cables *(see page 306)*
- Power cables *(see page 315)*
- Sensor cables *(see page 322)*

Torque Wrench

Two torque wrenches (M8 and M12) are available as accessories to help you mount and fasten the TM7 cables *(see page 201)*.

Each torque wrench has a screwdriver-type handle and a 4 mm (0.16 in.) hexagonal drive shaft. The torque of the drive shaft is preset and cannot be adjusted. The bit mounted on the drive shaft is appropriately sized for either an M8 or M12 plug:

Reference	Description	
TM7ACTW	Torque wrench with preset torque of 0.2 Nm (1.8 lbf-in) for M8 size plug	
	Torque wrench with preset torque of 0.4 Nm (3.5 lbf-in) for M12 size plug	

Part II
TM5 Safety-Related System

Overview

This part provides information to help you plan, install, commission, and maintain the TM5 Safety-Related System.

What Is in This Part?

This part contains the following chapters:

Chapter	Chapter Name	Page
5	Initial Planning Considerations	61
6	Installation Procedures	115
7	Commissioning and Maintaining	157

Chapter 5
Initial Planning Considerations

Overview

This chapter provides information that is helpful in the early planning stages for a TM5 Safety-Related System. It includes the requirements for enclosing the TM5 Safety-Related System in a protective housing and for determining the type of power supply source required for your configuration.

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
5.1	Operating Environment	62
5.2	Mechanical Requirements	66
5.3	TM5 Power System	76
5.4	Electrical Requirements	90
5.5	System Limits	112

Section 5.1
Operating Environment

TM5 Environmental Characteristics

Introduction

The following information describes the system-wide environmental requirements and characteristics for the TM5 Safety-Related System.

Enclosure Requirements

TM5 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 the standard, or in environments that do not meet the specifications in this manual, your ability to meet electromagnetic compatibility requirements in the presence of conducted and/or radiated interference may be reduced.

All TM5 components meet European Community (CE) requirements for open equipment as defined by EN61131-2. You must install them in an enclosure designed for the specific environmental conditions and to minimize the possibility of unintended contact with hazardous voltages. Your enclosure should be constructed of metal to improve the electromagnetic immunity of your TM5 System. Your enclosure should have a keyed locking mechanism to minimize unauthorized access.

Environmental Characteristics

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

The following table provides the general environmental characteristics:

Characteristic	Specification	Range
Standard	IEC61131-2	
Agencies	Consult the agency information in the specific hardware guide.	
Ambient operating temperature	Horizontal installation	0...55 °C (32...131 °F)(1)
	Vertical installation	0...50 °C (32...122 °F)(2)
Storage temperature		-25...70 °C (-13...158 °F)
Relative humidity		5...95 % (non-condensing)
Degree of pollution	IEC60664	2
Degree of protection	IEC61131-2	IP20
Corrosion immunity		No
Operating altitude		0...2000 m (0...6.560 ft.)
Storage altitude		0...3000 m (0...9.842 ft.)
Vibration resistance	Mounted on a DIN rail	3.5 mm (0.138 in.) fixed amplitude from 5...8.4 Hz 9.8 m/s^2 (1 gn) fixed acceleration from 8.4...150 Hz
Mechanical shock resistance		147 m/s^2 (482.28 ft/s^2) (15 gn) for a duration of 11 ms
Connection type		Removable spring terminal block
Connector insertion/removal cycles		50

(1) Some devices have temperature operating restrictions that require derating between 55 °C and 60 °C (131 °F and 140 °F), and may be subject to other possible restrictions.See the specific characteristics for your electronic module.

(2) For the Safety Logic Controller, this range is 0…+45 °C (32...113 °F).

Electromagnetic Susceptibility

The following table provides the TM5 System electromagnetic susceptibility specifications:

Characteristic	Specification	Range
Electrostatic discharge	IEC/EN 61000-4-2	8 kV (air discharge), criteria B 4 kV (contact discharge), criteria B
Electromagnetic fields	IEC/EN 61000-4-3	10 V/m (80 MHz...2 GHz), criteria A
Fast transients burst	IEC/EN 61000-4-4	Power lines: 2 kV, criteria B I/O: 1 kV, criteria B Shielded cable: 1 kV, criteria B Repetition rate: 5 KHz and 100 KHz
Surge immunity 24 Vdc circuit	IEC/EN 61000-4-5	1 kV in common mode, criteria B 0.5 kV in differential mode, criteria B
Surge immunity 230 Vac circuit		2 kV in common mode, criteria B 1 kV in differential mode, criteria B
Induced electromagnetic field	IEC/EN 61000-4-6	10 Veff (0.15...80 MHz), criteria A
Conducted emission	EN 55011 (IEC/CISPR11)	150...500 kHz, quasi peak 79 dB (µV)
		500 kHz...30 MHz, quasi peak 73 dB (µV)
Radiated emission	EN 55011 (IEC/CISPR11)	30...230 MHz, 10 m@40 dB (µV/m)
		230 MHz...1 GHz, 10 m@47 dB (µV/m)
Criteria A Uninterrupted operation during test. **Criteria B** Brief interruption during the test allowed.		

Electromagnetic Susceptibility according to IEC 62061

The following table provides the TM5 System electromagnetic susceptibility specifications (according to IEC 62061):

Connection	Characteristic	Specification	Range
Housing	Electrostatic discharge (ESD)(1)	IEC 61000-4-2	6 kV/ 8 kV (contact-/air discharge)
	High-frequency electromagnetic (EM) fields	IEC 61000-4-3	20 V/m (80 MHz...1 GHz) 6 V/m (1.4...2 GHz) 3 V/m (2...2.7 GHz)(2)
	Magnetic field with electrical frequency(3)	IEC 61000-4-8	30 A/m(4)
AC supply	Voltage dips / Short-term interruptions	IEC 61000-4-11	0.5 period 30% reduction(4)
	Voltage fluctuations /Interruptions	IEC 61000-4-11	250 periods, > 95% reduction(4)
	High-speed transient electrical disturbances (burst)	IEC 61000-4-4	4 kV
	Surges(5)	IEC 61000-4-5	2 kV line to line / 4 kV grounding line
	Line-conducted disturbances, induced by high-frequency fields	IEC 61000-4-6	10 V in the specified frequencies(2)
DC supply(6)	High-speed transient electrical disturbances (burst)	IEC 61000-4-4	4 kV
	Surges	IEC 61000-4-5	1 kV line to line / 2 kV grounding line(5)
	Line-conducted disturbances, induced by high-frequency fields	IEC 61000-4-6	10 V in the specified frequencies(2)
I/O signal control lines	High-speed transient electrical disturbances (burst)	IEC 61000-4-4	2 kV for > 3 m lines
	Surges	IEC 61000-4-5	2 kV grounding line(7)
	Line-conducted disturbances, induced by high-frequency fields	IEC 61000-4-6	10 V(2)
Functional ground (earth)	High-speed transient electrical disturbances (burst)	IEC 61000-4-4	2 kV

(1) Strict adherence to environmental conditions described in IEC 61000-4-2 is necessary for parts handled by persons other than operating personnel with specific ESD (electrostatic discharge) control operations. However, this is not valid for equipment with limited access by properly trained personal only.
(2) The increased values must be implemented in frequency areas generally used for digital radio transmission, excluding areas where reliable measures are taken to reduce the electromagnetic influence of such equipment. ISM frequencies must be individually observed.
(3) For magnetically sensitive equipment only.
(4) An increased value is not used on phenomena where it is not considered necessary for the functional safety.
(5) External protection devices are allowed in order to achieve immunity.
(6) DC connections between system/equipment parts that are not connected with a DC distributing network are handled as I/O signal/control connections.
(7) Only in the case of long lines.

Section 5.2
Mechanical Requirements

Introduction

This section provides information for enclosing the TM5 Safety-Related System in a protective housing.

What Is in This Section?

This section contains the following topics:

Topic	Page
Enclosing the TM5 Safety-Related System	67
Mounting Positions	73

Enclosing the TM5 Safety-Related System

Introduction

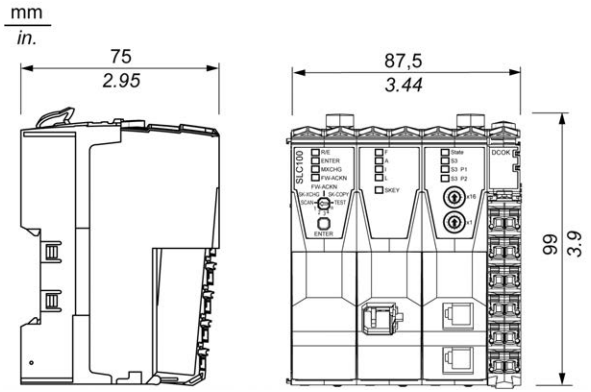
Components of the TM5 Safety-Related System are mounted "side by side". There is no space between the TM5 components.

The TM5 Safety-Related System components have an IP20 rating and must be enclosed. For optimal cooling and air circulation, an adequate clearance must be respected between your TM5 Safety-Related System (installed in the enclosure) and surrounding fixed objects (such as wire ducts and inside surfaces of the enclosure).

Size of the Enclosure

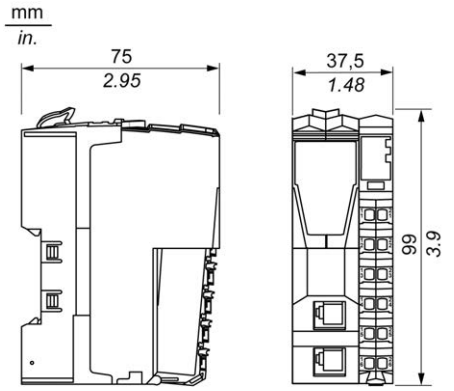
The size of the enclosure is determined by the number of expansion modules that are used with the Sercos III Bus Interface and any other auxiliary equipment. Spacing requirements *(see page 68)* must be included in determining the size of the enclosure.

Safety Logic Controller Dimensions



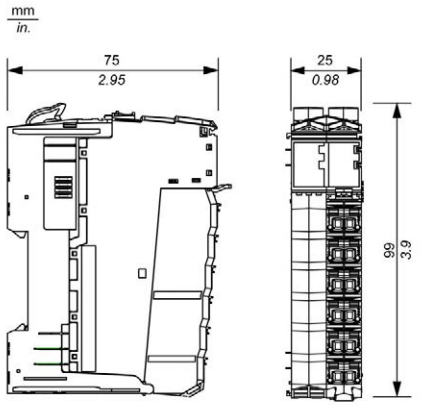
Sercos III Bus Interface Dimensions

The following figure gives the dimensions of the Sercos III Bus Interface:



Safety-Related Module Dimensions

The following figure gives the dimensions of the safety-related module:



Spacing Requirements

NOTE: Keep adequate spacing for proper ventilation and to maintain an ambient temperature as described in the environmental characteristics *(see page 62)*.

Clearances must be respected when installing the product.

There are 3 types of clearances:

- Between the TM5 Safety-Related System and the sides of the cabinet (including the panel door). This type of clearance allows proper circulation of air around the TM5 Safety-Related System.
- Between the TM5 Safety-Related System terminal blocks and the wiring ducts. This distance helps avoid electromagnetic interference between the terminal blocks and the wiring ducts.
- Between the TM5 Safety-Related System and other heat generating devices installed in the same cabinet.

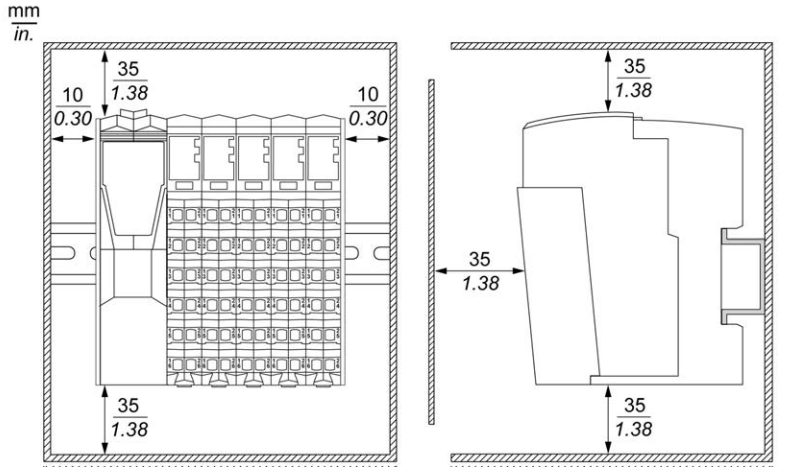
⚠ WARNING

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.

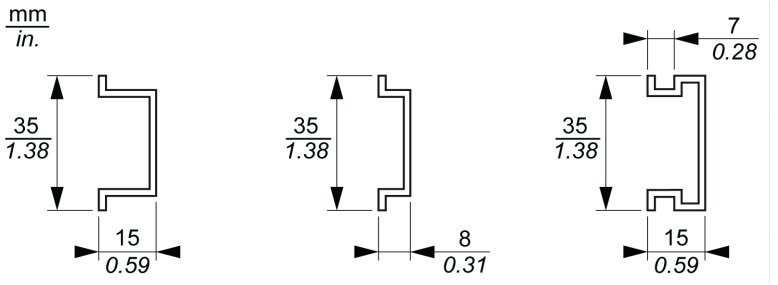
Failure to follow these instructions can result in death, serious injury, or equipment damage.

The following graphic represents the minimum clearance requirements for a TM5 Safety-Related System in a cabinet:



Mounting

You can mount the system on a DIN rail. For EMC (Electromagnetic Compatibility) compliance, a metal DIN rail must be attached to a flat metal mounting surface or mounted on an EIA (Electronic Industries Alliance) rack or in a NEMA (National Electrical Manufacturers Association) cabinet enclosure.



You can order a suitable DIN rail from Schneider Electric:

Rail Depth	Reference
15 mm (0.59 in.)	AM1DE200
8 mm (0.31 in.)	AM1DP200
15 mm (0.59 in.)	AM1ED200

Thermal Considerations

For proper heat dissipation, keep adequate spacing around your TM5 Safety-Related System. Mount the TM5 Safety-Related System in the coolest area possible, most often at the bottom of the enclosure.

The following tables list some maximum dissipation values for estimating the wattage dissipation when you plan the cooling for your TM5 Safety-Related System and enclosure:

Safety Logic Controller	Reference	Maximum Dissipation Value (W)	De-rating(1)
Modicon TM5 Safety Logic Controller	TM5CSLC100FS	5.1	No
	TM5CSLC200FS	5.1	No
(1) De-ratings are specific to each device. Refer to the expansion hardware guides for details.			

Bus Interface	Reference	Maximum Dissipation Value (W)	De-rating(1)
Sercos III Bus Interface	TM5NS31	1.72	No
Interface Power Distribution Module (IPDM)	TM5SPS3	1.82	Yes
(1) De-ratings are specific to each device. Refer to TM5SPS3 Characteristics *(see page 252)*.			

Type of Slice	Reference	Slice Maximum Dissipation Value (W)	De-rating (1)
Digital safety input	TM5SDI2DFS	1.38	No
	TM5SDI4DFS	1.7	No
	TM5SDI20DFS	2.13	Yes
Digital safety output	TM5SDO2TFS	1.36	Yes
	TM5SDO2TAFS	1.36	Yes
	TM5SDO2DTRFS	1.54	Yes
	TM5SDO4TFS	1.68	Yes
	TM5SDO4TAFS	1.68	Yes
	TM5SDO6TBFS	1.85	Yes
Digital safety mixed input/output	TM5SDM4DTRFS	1.54	Yes
	TM5SDM8TBFS	1.78	Yes
Analog safety input	TM5SAI4AFS	2.08	Yes
	TM5SAI4ATCFS	1.58	No
Safety counter	TM5SDC1FS	1.13	No
Safety Power Distribution Module (SPDM)	TM5SPS10FS	1.83	Yes
(1) De-ratings are specific to each device. Refer to the expansion hardware guides for details.			

The values above assume maximum bus voltage, maximum field-side voltage and maximum load currents. Typical values are often considerably lower.

⚠ 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.

NOTE: Keep adequate spacing for proper ventilation and to maintain an ambient temperature. Maximum ambient temperature depends on the mounting position.

Mounting Positions

Introduction

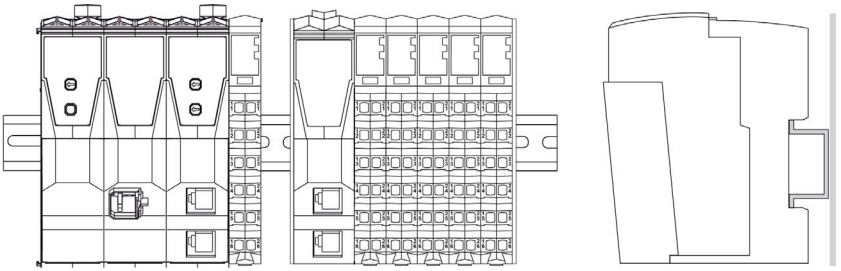
This section shows the correct mounting positions for the TM5 Safety-Related System.

Remote and distributed configurations follow the same rules.

The TM5 Safety-Related System should only be positioned as shown in the correct or acceptable mounting position figures below.

Correct Mounting Position

The TM5 Safety-Related System must be mounted horizontally on a vertical plane as shown in the figures below:



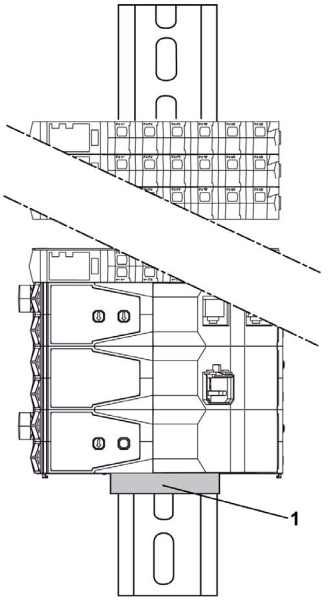
NOTE: The Safety Controller TM5CSLC100FS/TM5CSLC200FS can only be connected with the safety-related modules via the Sercos III Bus Interface TM5NS31. There is no electrical connection between Safety Controllers and the safety-related modules via the bus base.

NOTE: Keep adequate spacing for proper ventilation and to maintain an ambient temperature as described in the environmental characteristics *(see page 62)*.

Acceptable Mounting Positions

Whenever possible, the TM5 Safety-Related System should only be positioned in the horizontal mounting position. This position affords the best heat dissipation of the devices.

However, the TM5 Safety-Related System can also be mounted sideways on a vertical plane as shown below.



1 End bracket

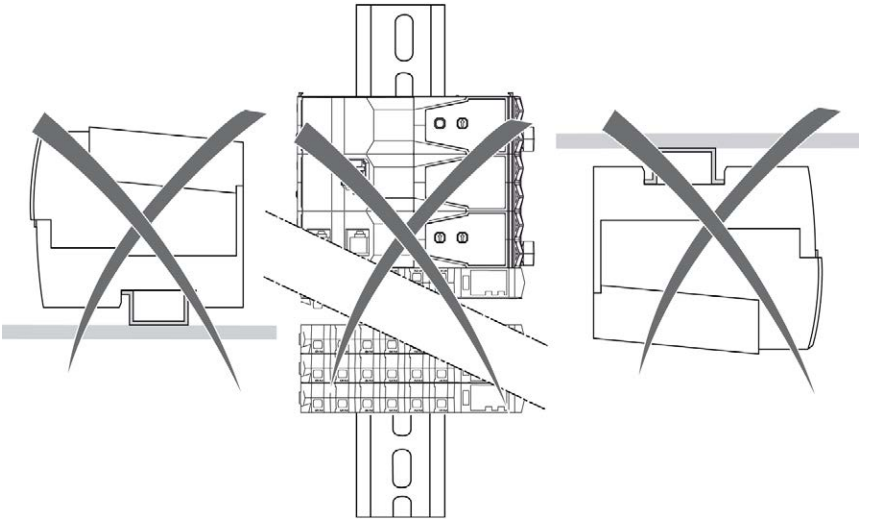
NOTICE
INOPERABLE EQUIPMENT ● Mount the expansion modules on top of the controller when mounting on a vertical plane. ● Secure the first element of the TM5 configuration (controller, receiver and any slices) against slipping. **Failure to follow these instructions can result in equipment damage.**

NOTE: Use an end bracket (reference AB1 AB8R35 for example) to help secure the configuration.

NOTE: The TM5 configuration is temperature de-rated when installed vertically. Refer to the specific characteristics for your devices.

Incorrect Mounting Position

The figures below show incorrect mounting positions:



Section 5.3
TM5 Power System

Introduction

In the planning phase, the type of expansion modules that you select for your TM5 Safety-Related System determines the required power distribution. The following section will help you establish a power budget and select the power and common distribution modules for your system.

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5 Power Distribution Description	77
TM5 Power Distribution Mounting Rules	84
TM5 Power Distribution System Implementation	86
Example: Current Consumed by a Remote Configuration	87

TM5 Power Distribution Description

Power Distribution Overview

Power distribution starts with the controller in the case of non-safety-related controllers, and otherwise starts with the remote/distributed interface modules in both safety-related and non-safety related systems.

The first (leftmost) component in the remote and distributed *(see page 26)* configurations of the TM5 System distributes power for the 24 Vdc I/O power segment and generates power for the TM5 power bus. There are other components that distribute power to create separate 24 Vdc I/O power segments, and others that distribute power and additionally generate supplemental power to the TM5 power bus.

The Interface Power Distribution Module (IPDM) of the Sercos III Bus Interface is the beginning of the power distribution for the distributed configuration.

NOTE:

- The TM5SBET7 Transmitter module *(see page 171)* is the beginning of the power distribution for the TM7 power bus.
- The TM5SBER2 Receiver module is the beginning of the power distribution for the remote configuration.

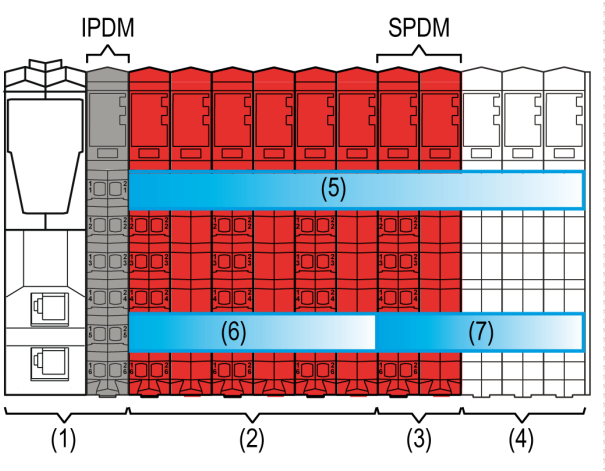
Where and when needed, Power Distribution Modules (PDM) could be added to:

- Divide the 24 Vdc I/O power segment into several separated 24 Vdc I/O power segments, or;
- Divide the 24 Vdc I/O power segment into several separated 24 Vdc I/O power segments and provide supplementary power to the TM5 power bus if required by your I/O configuration.

TM5SPS10FS Safety Power Distribution Module (SPDM)

Where and when needed, the TM5SPS10FS Safety Power Distribution Module (SPDM) can be added, in association with its dedicated, left-isolating TM5ACBM4FS *(see page 290)* safety-related bus base, and is a power source for specified non-safety-related I/O modules. The Safety Power Distribution Module (SPDM) supports the pre-defined safe state of poweroff (de-energized) to the I/O modules connected. As illustrated below, the TM5SPS10FS Safety Power Distribution Module (SPDM) is used to create an isolated group of non-safety related I/O modules.

NOTE: For the list of compatible non-safety-related I/O modules that you can connect to the TM5SPS10FS Safety Power Distribution Module (SPDM) and of the general rules/restrictions/limitations, refer to TM5SPS10FS Presentation *(see Modicon TM5/TM7, I/O Safety Modules, Hardware Guide)* and to the Modicon TM5/TM7 I/O Safety Modules Hardware Guide.



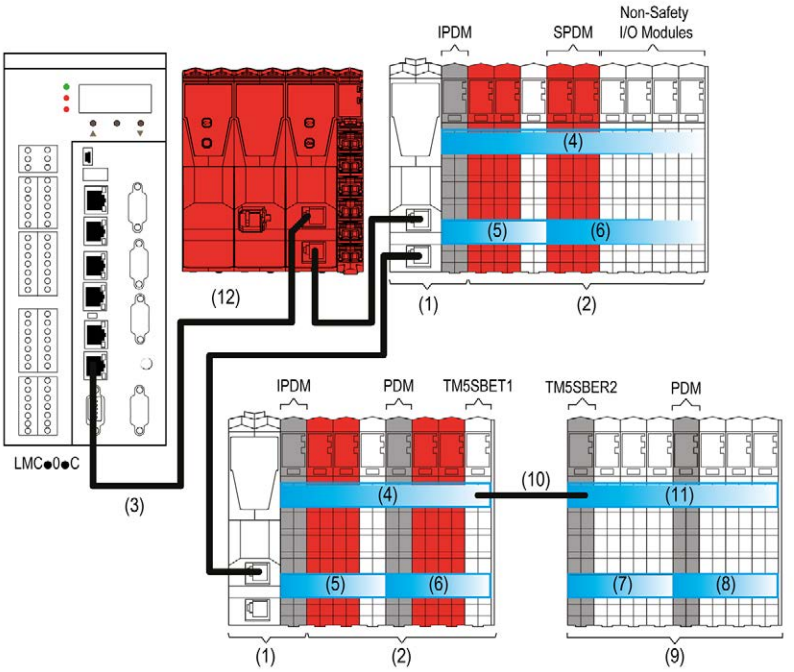
(1) Sercos III Bus Interface
(2) Safety-related I/O modules
(3) TM5SPS10FS Safety Power Distribution Module (SPDM)
(4) Non-safety-related I/O modules
(5) TM5 bus and electronic module power supply
(6) 24 Vdc I/O power segment of safety-related I/O modules
(7) 24 Vdc I/O power segment of non-safety-related I/O modules
IPDM Interface Power Distribution Module (IPDM)
SPDM Safety Power Distribution Module (SPDM): TM5SPS10FS

For more information on the wiring, refer to TM5SPS10FS Presentation *(see Modicon TM5/TM7, I/O Safety Modules, Hardware Guide)*.

For detailed information on the TM5ACBM4FS safety-related bus base, refer to TM5ACBM4FS Safety-Related System Bus Base *(see page 290)*.

Power Distribution of a Distributed/Remote Configuration

The figure shows the power distribution overview of a distributed/remote configuration:



(1) Sercos III Bus Interface
(2) Distributed expansions
(3) Sercos III bus cable
(4) TM5 power bus of the distributed configuration
(5...8) 24 Vdc I/O power segments
(9) Remote expansion
(10) Expansion bus cable (l <= 100 m / 328.1 ft)
(11) TM5 power bus of the remote configuration
(12) Safety Logic Controller TM5CSLC100FS/TM5CSLC200FS (red, for safety-related applications only)
IPDM Interface Power Distribution Module
PDM Power Distribution Module
SPDM Safety Power Distribution Module
TM5SBET1 Transmitter module
TM5SBER2 Receiver module

24 Vdc I/O Power Segment Description

Power is distributed to the inputs and outputs of the TM5 System through the 24 Vdc I/O power segment.

The following table gives the first and last devices of the 24 Vdc I/O power segment(s):

TM5 Configuration		Segment Begin	Segment End
Distributed *(see page 26)*	First 24 Vdc I/O power segment	The IPDM	The last remote expansion module or the first PDM/SPDM (from left to right) of the configuration
	Second 24 Vdc I/O power segment	The first PDM /SPDM (from left to right) of the configuration.	The last expansion module or the second PDM/SPDM (from left to right) of the configuration.
	...	...	...
Remote	First 24 Vdc I/O power segment	The Receiver module	The last remote expansion module or the first PDM/SPDM (from left to right) of the configuration
	Second 24 Vdc I/O power segment	The first PDM /SPDM (from left to right) of the configuration.	The last expansion module or the second PDM/SPDM (from left to right) of the configuration.
	...	...	...

A segment is a group of expansion modules that are supplied by the same power distribution module.

The power provided on the 24 Vdc I/O power segment is consumed by the 24 Vdc modules placed in this segment.

The reasons to build a new segment are:

- An SPDM is required to de-energize a segment.
- The first (leftmost) component in the remote and distributed configurations *(see page 26)* of theTM5 System distributes power for the 24 Vdc I/O power segment and generates power for the TM5 power bus.
- To separate groups of modules. For example, a group of inputs separated from a group of outputs.
- To provide power to the 24 Vdc I/O power segment (in the case that the power of the previous segment has been consumed by other I/O modules).
- To provide supplementary power to the TM5 power bus.

TM5 Power Bus Description

The TM5 bus consists in two parts:
- TM5 data bus
- TM5 power bus

The TM5 power bus distributes the power to supply the electronics of the expansion modules of a remote or distributed configuration. If needed the power on the TM5 bus can be reinforced by adding specific PDMs/SPDMs depending on the reference.

The following table gives the first and last devices of the TM5 power bus:

TM5 Configuration	Power Bus Begin	Power Bus End
Remote	The Receiver module	The last remote expansion I/O or Transmitter module
Distributed *(see page 26)*	The IPDM	The last distributed expansion I/O or Transmitter module

NOTE: The TM5SBET1 transmitter module must be the last electronic module in either the local or remote TM5 configuration that you intend to extend.

Interface Power Distribution Module (IPDM)

The Interface Power Distribution Module (IPDM *(see page 39)*) is the connection of the Sercos III Bus Interface to the external 24 Vdc power supplies.

Among other things, the IPDM connects:
- Directly the external power supply to the 24 Vdc I/O power segment.
- The external power supply to the internal power supply that generates the power distributed on the TM5 power bus, which is derived from the 24 Vdc Main power connection.

The following table describes the parts powered by the 24 Vdc I/O power segment and the TM5 power bus:

Designation	Description
24 Vdc I/O power segment	Serves: ● the distributed expansion modules, ● the sensors and actuators connected to the distributed expansion modules, ● the external devices connected to the Common Distribution Modules (CDM) of the distributed configuration.
TM5 power bus	Serves the electronic of the expansions (bus bases and electronic modules) of the distributed configuration.

Receiver Module (TM5SBER2)

The TM5SBER2 integrates an electronic power supply that generates the power distributed by the TM5 power bus.

It also connects the external 24 Vdc power supply to the 24 Vdc I/O power segment.

The following table describes the parts powered by the 24 Vdc I/O power segment and the TM5 power bus:

Designation	Description
24 Vdc I/O power segment	Serves: ● the remote expansion modules, ● the sensors and actuators connected to the remote expansion modules, ● the external devices connected to the Common Distribution Modules (CDM) of the remote configuration.
TM5 power bus	Serves the electronic of the expansions (bus bases and electronic modules).

Power Distribution Module (PDM)

Depending of the TM5 configuration and the current consumed on either the TM5 power bus or the 24 Vdc I/O power segment(s), you may need to add PDMs to create another 24 Vdc power segment and/or supplement power to the electronic of the expansions via the TM5 power bus.

For more information refer also to TM5 Power Distribution Modules *(see page 219)*.

The following table describes the parts powered by the 24 Vdc I/O power segment and the TM5 power bus:

Designation	Description
24 Vdc I/O power segment	Serves: ● the expansion modules of the segment determined by the PDM, ● the sensors and actuators connected to the expansion modules of the segment determined by the PDM, ● the external devices connected to the Common Distribution Modules (CDM) in the segment determined by the PDM.
TM5 power bus (depends on PDM references)	Serves the electronic of the expansions (bus bases and electronic modules) of the expanded configuration.

Safety Power Distribution Module (SPDM)

Depending of the TM5 configuration and the current consumed on either the TM5 power bus or the 24 Vdc I/O power segment(s), you may need to add SPDMs to create another 24 Vdc power segment and/or supplement power to the electronic of the expansions via the TM5 power bus.

The following table describes the parts powered by the 24 Vdc I/O power segment and the TM5 power bus:

Designation	Description
24 Vdc I/O power segment	Serves: ● the expansion modules of the segment determined by the PDM, ● the sensors and actuators connected to the expansion modules of the segment determined by the PDM, ● the external devices connected to the Common Distribution Modules (CDM) in the segment determined by the PDM. ● the SPDM provides the option to remove power for the segment.
TM5 power bus (depends on PDM references)	Serves the electronic of the expansions (bus bases and electronic modules) of the expanded configuration.

Supplying the 24 Vdc I/O Power Segment and the TM5 Power Bus

TM5 Power System, Power Distribution Description, Supplying the 24 Vdc I/O Power Segment and the TM5 Power Bus:

Equipment		Maximum Current Distributed on the 24 Vdc I/O Power Segment	Current Supplied to the TM5 Power Bus	
Function	Reference		0...55 °C (32...131 °F)	55...60 °C (131...140 °F)
Receiver module	TM5SBER2	10 A	1156 mA	750 mA
PDM	TM5SPS1	10 A	No	No
	TM5SPS1F	6.3 A	No	No
	TM5SPS2	10 A	1136 mA	740 mA
	TM5SPS2F	6.3 A	1136 mA	740 mA
SPDM	TM5SPS10FS	10 A	No	No
IPDM	TM5SPS3	10 A	750 mA	500 mA

Safety Logic Controller

The Safety Logic Controller TM5CSLC100FS/TM5CSLC200FS provides an integrated power supply.

TM5 Power Distribution Mounting Rules

PDMs Mounting Rules

Installing a PDM according to these rules automatically establishes a new 24 Vdc I/O power segment for I/O expansions to the right of the PDM.

The TM5SPS2• PDM can be placed at the end of the configuration. In this case, it supplies only the TM5 power bus.

Rules:

- Do not mount PDMs side by side
- Do not mount a PDM and a Transmitter or Receiver module side by side
- Do not mount a PDM and an Interface Power Distribution Module (IPDM) side by side
- Do not mount a PDM next to any of the following modules: TM5SAI2H, TM5SAI4H, TM5SAO4L or TM5SAO4H

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Do not mount a Power Distribution Module (PDM) next to any one of the following modules:

- Power Distribution Module (PDM)
- Transmitter module TM5SBET1 or TM5SBET7
- Receiver module TM5SBER2
- Interface Power Distribution Module TM5SPS3 (IPDM)
- Analog input module TM5SAI2H or TM5SAI4H
- Analog output module TM5SAO4L or TM5SAO4H

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

SPDMs Mounting Rules

Installing an SPDM according to these rules automatically establishes a new 24 Vdc I/O power segment for I/O expansions to the right of the SPDM.

Rules:

- Do not mount SPDMs side by side.
- Do not mount an SPDM next to any of the following modules:
  - TM5SAI2H
  - TM5SAI4H
  - TM5SAO4L
  - TM5SAO4H
- Only connect compatible modules *(see Modicon TM5/TM7, I/O Safety Modules, Hardware Guide)* to the SPDM.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Do not mount a Safety Power Distribution Module (SPDM) next to any one of the following modules:

- Another Safety Power Distribution Module (SPDM)
- Analog output module TM5SAO4L or TM5SAO4H
- Analog input module TM5SAI2H or TM5SAI4H

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

IPDM Mounting Rules

Rules:

- Do not mount a PDM next to an IPDM
- Do not mount a Transmitter or Receiver module next to an IPDM
- Do not mount any of the following modules: TM5SAI2H, TM5SAI4H, TM5SAO4L or TM5SAO4H next to an IPDM

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Do not mount any one of the following modules next to an Interface Power Distribution Module (IPDM):

- Power Distribution Module (PDM)
- Transmitter module TM5SBET1 or TM5SBET7
- Receiver module TM5SBER2
- Analog input module TM5SAI2H or TM5SAI4H
- Analog output module TM5SAO4L or TM5SAO4H

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

TM5 Power Distribution System Implementation

Power Distribution Planning

The power distribution system supplies the 24 Vdc I/O power segment and the TM5 power bus for local, remote and distributed configurations.

The planning of your TM5 power distribution system should follow this order:

Step	Description
1	Plan your TM5 System (controller and expansion modules, remote and distributed islands).
2	(Optionally) Create some 24 Vdc power segments by adding PDM type TM5SPS1•, for example, to separate the input slices from output slices. Another example is to separate the AC slices from DC slices.
3	Calculate the current consumed on each 24 Vdc I/O power and insert additional PDM type TM5SPS1• to create segments where and when needed.
4	Calculate the current consumed on the TM5 power bus segment(s) and replace PDM type TM5SPS1• with type TM5SPS2• or provide additional PDM type TM5SPS2• where and when needed.
5	For a defined safe state at power-off for the non-safety-related I/O modules connected to an SPDM (Safe Power Distribution Module *(see page 82)*), calculate the current consumed on each 24 Vdc I/O power segment and insert additional SPDM to create segments where and when needed.

To plan the power distribution of the TM5 System you must calculate the:

- Current consumption on the 24 Vdc I/O power segment(s)
- Current consumption on the TM5 power bus segment or segments in the case of remote configurations(s).

Current Consumed on the 24 Vdc I/O Power Segment

The current consumed on the 24 Vdc I/O power segment is composed of

- The current consumed by the electronic modules(1).
- The current consumed by the loads connected to the DC outputs of the modules supplied by the 24 Vdc I/O power segment.
- The current consumed to supply the sensors and actuators connected to the electronics modules.
- The current consumed to supply external devices connected to the Common Distribution Modules (CDM)

Note:

(1) For the electronics modules with 24 Vdc inputs, this current includes the input signal currents for all inputs in activated state.

Current Consumed on the TM5 Power Bus

The current consumed on the TM5 power bus is composed of:

- The current consumed by the bus bases
- The current consumed by the electronic modules.

Example: Current Consumed by a Remote Configuration

Introduction

This example is for a remote configuration (TM5 Receiver module and its expansion modules). From this example, you should be able to make the calculations necessary for your TM5 Safety-Related System.

In a remote configuration, the TM5SBER2 Receiver module connects:

- directly the external power supply to the 24 Vdc I/O power segment.
- the external power supply to the internal power supply that generates the power distributed on the TM5 power bus.

All current consumption values are documented in the TM5 Consumption Table *(see page 214)*.

Planning Example

This configuration example includes:

- The TM5SBER2 Receiver module.
- Some expansion slices:
  - TM5SDI20DFS
  - TM5SDI4DFS
  - TM5SDO4TFS
  - TM5SDO4TAFS
  - TM5SDO2TAFS
  - TM5SDM4DTRFS
- Assumptions used for the purposes of calculating the consumption of this example:

  TM5SBER2: The maximum current distributed on the 24 Vdc I/O power segment is limited by an external isolated power supply of 6300 mA.

  TM5SDI20DFS: The current to supply the electronic sensors of this example has been estimated at 50 mA per pulse, or 200 mA total for using all four pulses.

  TM5SDI4DFS; The current to supply the electronic sensors of this example has been estimated at 50 mA per pulse, or 200 mA total for using all four pulses.

  TM5SDO4TFS: The sum of the current draw for all outputs connected to the module is not more than 1500 mA at any given time. The maximum supplied current could be up to 2000 mA.

  TM5SDO2TFS: The sum of the current draw for all outputs connected to the module is not more than 300 mA at any given time. The maximum supplied current could be up to 1000 mA.

  TM5SDO4TAFS: The sum of the current draw for all outputs connected to the module is not more than 2000 mA at any given time. The maximum supplied current could be up to 5000 mA.

  TM5SDO2TAFS: The sum of the current draw for all outputs connected to the module is not more than 600 mA at any given time. The maximum supplied current could be up to 4000 mA.

  TM5SDM4DTRFS: The current to supply the electronic sensors of this example has been estimated at 50 mA per pulse, or 100 mA total for using both pulses.

The following table shows the current supplied and consumed in mA on the TM5 power bus and the 24 Vdc I/O power segment:

TM5SBER2	TM5SDI20DFS	TM5SDI4DFS	TM5SDO4TFS	TM5SDO2TFS	TM5SDO4TAFS	TM5SDO2TAFS	TM5SDM4DTRFS	Legend
1156								(1)
26	26	26	26	26	26	26	26	(2)
0	80	64	50	50	50	50	52	(3)
26	106	90	76	76	76	76	78	(4)
1130	1024	934	858	782	706	630	552	(5)
6300 maximum								(6)
25	67	52	54	41	54	41	48	(7)
0	0	0	1500	300	2000	600	0	(8)
0	200	200	0	0	0	0	50	(9)
25	267	252	1554	341	2054	641	98	(10)
6275	6008	5756	4202	3861	1807	1166	1068	(11)

Legend:
External isolated main power supply, 24 Vdc
(1) Current supplied on TM5 power bus, in mA
(2) Consumption of the bus base, in mA
(3) Consumption of the electronic module, in mA
(4) Sum of (2) and (3), in mA
(5) Remaining current available after slice consumption, in mA
External isolated I/O power supply, 24 Vdc
(6) Current supplied on the 24 Vdc I/O power segment, in mA
(7) Consumption of the electronic module, in mA
(8) Consumption of the loads of the output slices, in mA
(9) Consumption of the supply to sensors, actuators or external devices, in mA
(10) Sum of (7), (8) and (9), in mA
(11) Remaining current available after slice consumption, in mA

Current Consumed on the 24 Vdc I/O Power Segment

The 24 Vdc I/O power segment begins with the TM5SBER2 Receiver module and finishes with the TM5SDM4DTRFS expansion module. The capacity of this 24 Vdc I/O power segment is limited to 6300 mA in this example.

The total current consumed on the 24 Vdc I/O power segment is 5232 mA, and does not exceed the 6300 mA capacity of this segment.

The following step is to calculate the current consumed on the TM5 power bus to validate the configuration of the example.

Current Consumed on the TM5 Power Bus

The TM5SBER2 Receiver module generates 1156 mA on the TM5 power bus to supply remote expansion I/Os. The TM5 power bus begins with the TM5SBER2 Receiver module and terminates with the TM5SDM4DTRFS expansion module.

The total current consumed on the TM5 power bus is 604 mA, and does not exceed the 1156 mA capacity of the TM5 power bus.

Final Configuration of the Example

This configuration does not need an additional PDM for power distribution.

Depending on the application, a PDM can be inserted to create separated groups *(see page 80)*.

Section 5.4
Electrical Requirements

Introduction

The following section provides the general wiring rules for the TM5 Safety-Related System. Considerations and techniques for grounding the TM5 Safety-Related System are also presented.

What Is in This Section?

This section contains the following topics:

Topic	Page
Wiring Best Practices	91
Selecting an External 24 Vdc Power Supply	97
Wiring the Power Supply	98
Grounding the System	106

Wiring Best Practices

Introduction

There are several rules that must be followed when wiring the TM5 System.

Wiring Rules

⚠ 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.

The following rules must be applied when wiring the TM5 System:

- 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 only.
- In the case of TM5 Safety-related I/O modules:
  - Use twisted pair, shielded cables for analog, expert, or fast I/O and TM5 bus signals.
  - Use twisted pair, shielded cables for encoder, networks and Sercos III bus.

TM5 Safety I/O Wiring

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Use shielded cables for all fast I/O, analog I/O and communication signals.
- Ground cable shields for all analog I/O, fast I/O and communication signals at a single point[1].
- Route communication and I/O cables separately from power cables.

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

[1]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.

To ground the shielded cables, refer to the section Grounding the TM5 System *(see page 106)*.

This table provides the wire sizes to use with the removable terminal block TM5ACTB52FS:

mm / in. 9 / 0.35				
mm²	0,08…2,5	0,25…2,5	0,25…1,5	2 x 0,25...2 x 0,75
AWG	28…14	24…14	24…16	2 x 24…2 x 18

This table provides the wire sizes to use with the removable terminal blocks TM5ACTB5EFS and TM5ACTB5FFS:

mm / in. 9 / 0.35			
mm²	0,08…1,5	0,25…1,5	0,25…0,75
AWG	28…16	24...16	24...20

⚠ DANGER

FIRE HAZARD

- Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm^2 (AWG 20) with a temperature rating of at least 80 °C (176 °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^2 (AWG 16) with a temperature rating of at least 80 °C (176 °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 spring terminal blocks unless using a double wire cable end (ferrule).

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

TM5 Terminal Block

Inserting an incorrect terminal block into the electronic module can cause unintended operation of the application and/or damage the electronic module.

DANGER

ELECTRIC SHOCK OR UNINTENDED EQUIPMENT OPERATION

Connect the terminal blocks to their designated location.

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

NOTE: To help prevent a terminal block from being inserted incorrectly, ensure that each terminal block and electronic module is clearly and uniquely coded *(see PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide)*.

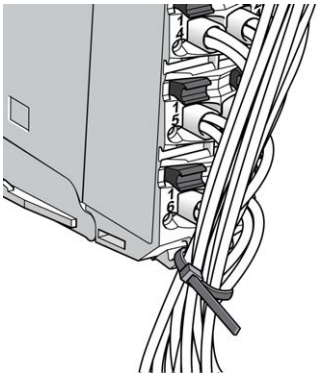
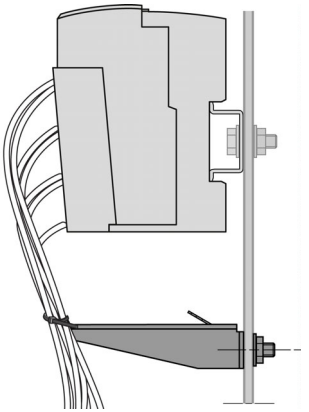
TM5 Strain Relief Using Cable Tie

There are 2 methods to reduce the stress on cables:

- The terminal blocks *(see page 40)* have slots to attach cable ties. A cable tie can be fed through this slot to secure cables and wires to reduce stress between them and the terminal block connections.
- After grounding the TM5 System by means of the grounding plate TM2XMTGB, wires can be bundled and affixed to the grounding plate tabs using wire ties to reduce stress on the cables.

The following table provides the size of the cable tie and presents the two methods to reduce the stress on the cables:

Cable Tie Size	Terminal Block	TM2XMTGB Grounding Plate
Thickness	1.2 mm (0.05 in.) maximum	1.2 mm (0.05 in.)
Width	4 mm (0.16 in.) maximum	2.5...3 mm (0.1...0.12 in.)

Cable Tie Size	Terminal Block	TM2XMTGB Grounding Plate
Mounting illustration		

⚠ WARNING

ACCIDENTAL DISCONNECTION FROM PROTECTIVE GROUND (PE)

- Do not use the TM2XMTGB Grounding Plate to provide a protective ground (PE).
- Use the TM2XMTGB Grounding Plate only to provide a functional ground (FE).

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

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.

⚠ WARNING

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 death, serious 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.

NOTE: In the TM5 Safety-Related System, relay outputs can support up to 48 Vac (TM5SDM4DTRFS) and up to 230 Vac (TM5SDO2DTRFS).

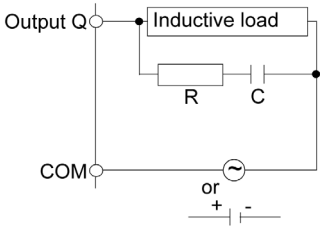
⚠ WARNING

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.

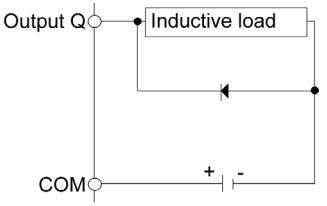
Failure to follow these instructions can result in death, serious injury, or equipment damage.

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



C Value from 0.1 to 1 µF
R Resistor of approximately the same resistance value as the load

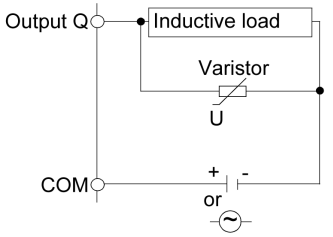
Protective circuit B: this protection circuit can be used for DC load power circuits.



Use a diode with the following ratings:

- Reverse withstand voltage: power voltage of the load circuit x10.
- Forward current: more than the load current.

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



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.

Selecting an External 24 Vdc Power Supply

Characteristics of the 24 Vdc Power Supply

The TM5 System requires power supplies with a nominal voltage of 24 Vdc. The 24 Vdc power supplies must be rated Protective Extra Low Voltage (PELV) according to IEC 61140. These power supplies are isolated between the electrical input and output circuits of the power supply.

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

Calculating the Power Supply Requirement

Refer to TM5 Power Distribution System Implementation *(see page 86)*.

Wiring the Power Supply

Overview

To distribute current for the 24 Vdc I/O power segment(s) and TM5 power bus according to the power distribution description *(see page 77)*, the following modules are connected to an external source:

- Safety Logic Controller
- Interface Power Distribution Module (IPDM)
- Receiver module (TM5SBER2)
- Power Distribution Module (PDM) TM5SPS1•
- Power Distribution Module (PDM) TM5SPS2•
- Safety Power Distribution Module (SPDM)TM5SPS10FS

Source power for these can come from one or more supplies. Your requirements are dictated by:

- voltage and current needs
- isolation requirements

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

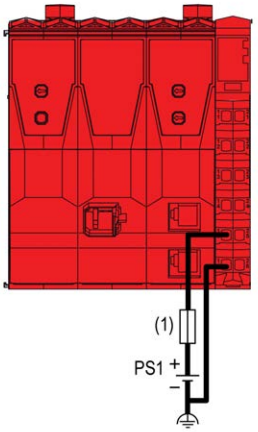
- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

Wiring the Safety Logic Controller

There is one power connection to be made to the Safety Logic Controller from your source power supplies:

Connections	Power Supply
24 Vdc Main power that generates power for TM5 power bus	PS1



(1) External fuse, Type T slow-blow, 1 A, 250 V
PS1 External isolated power supply 24 Vdc

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

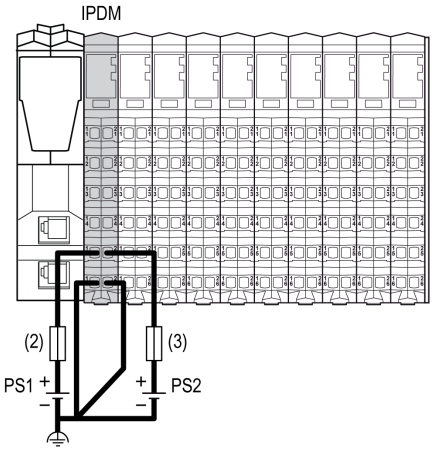
Failure to follow these instructions will result in death or serious injury.

Wiring the Interface Power Distribution Module (TM5SPS3)

The IPDM (TM5SPS3) *(see page 81)* is the first connection of the distributed configuration to the external 24 Vdc power supplies. Power is supplied by two external isolated power supplies.

There are two power connections to be made to the IPDM (IPDM TM5SPS3) from your source power supplies:

Connections	2 Power Supplies
24 Vdc Main power that generates power for TM5 power bus	PS1
24 Vdc I/O power segment	PS2



(2) External fuse, Type T slow-blow, 1 A, 250 V
(3) External fuse, Type T slow-blow, 10 A maximum, 250 V
PS1/PS2 External isolated power supply 24 Vdc

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

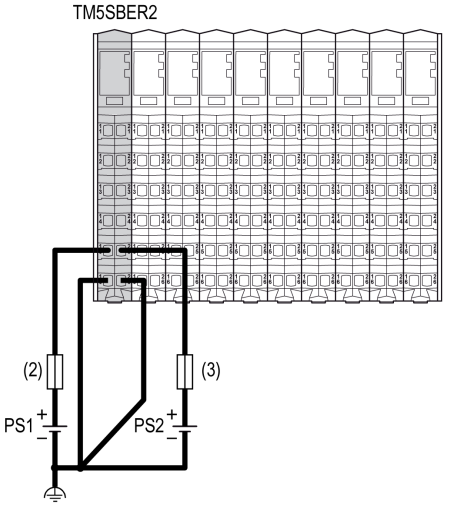
Failure to follow these instructions will result in death or serious injury.

Wiring the Receiver Module (TM5SBER2)

The receiver module (TM5SBER2) *(see page 81)* is the first connection of the remote configuration to the external 24 Vdc power supplies. Power is supplied by two external isolated power supplies.

There are two power connections to be made to the receiver module (TM5SBER2) from your source power supplies:

Connections	2 Power Supplies
24 Vdc Main power that generates power for TM5 power bus	PS1
24 Vdc I/O power segment	PS2



(2) External fuse, Type T slow-blow, 1 A, 250 V
(3) External fuse, Type T slow-blow, 10 A maximum, 250 V
PS1/PS2 External isolated power supply 24 Vdc

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

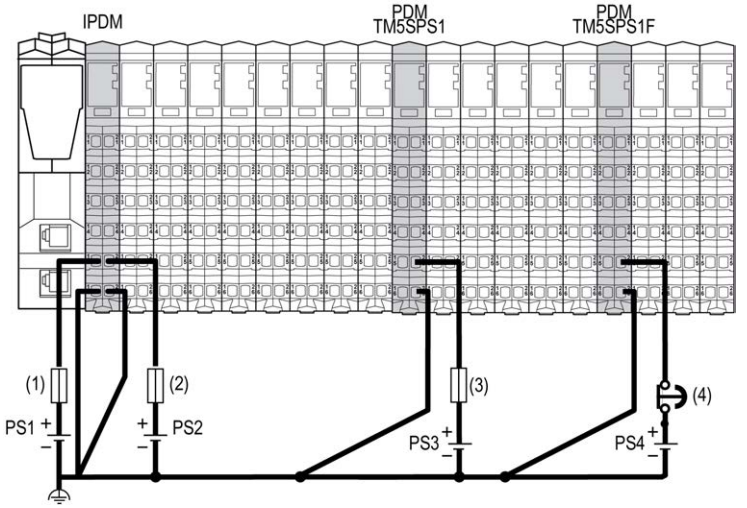
Wiring the Power Distribution Module TM5SPS1•

The TM5SPS1• (PDM) divides the 24 Vdc I/O power segment into several separated 24 Vdc I/O power segments *(see page 80)*. Each separated 24 Vdc I/O power segment is supplied by one external isolated power supply depending on current needs and capabilities.

There is one power connection to be made to each TM5SPS1• (PDM) from your source power supplies:

Segment Begin	Connection	Power Supplies
IPDM for the distributed configuration	24 Vdc Main power that generates power for TM5 power bus	PS1
	24 Vdc I/O power segment 1	PS2
First PDM (from left to right) of the configuration	24 Vdc I/O power segment 2	PS3
Second PDM (from left to right) of the configuration	24 Vdc I/O power segment 3	PS4
...	...	...

The following figure shows the wiring to supply the 24 Vdc I/O power segments:



1 External fuse, Type T slow-blow, 1 A, 250 V
2 External fuse, Type T slow-blow, 10 A, 250 V
3 External fuse, Type T slow-blow, 10 A maximum, 250 V
4 Approved emergency stop device
PS1/PS2/PS3/PS4 External isolated power supply 24 Vdc

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

NOTE: The requirements for the power supply are different for the input and the output slices. An emergency stop is generally used with the power supply providing power for output slices.

Wiring the Power Distribution Module TM5SPS2•

The TM5SPS2• (PDM) divides the 24 Vdc I/O power segment into several separated 24 Vdc I/O power segments *(see page 80)* and reinforces the TM5 power bus *(see page 81)*.

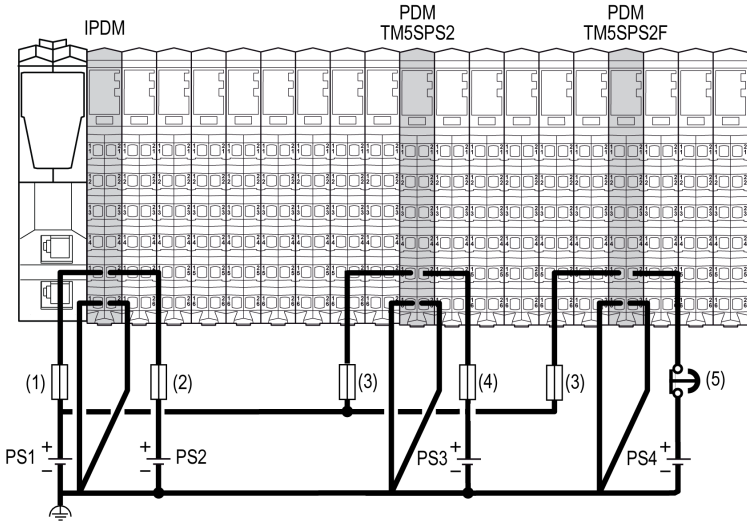
Selecting a 24 Vdc power supply *(see page 97)* should be based on current needs and capabilities.

Each separated 24 Vdc I/O power segment is supplied by one external isolated power supply depending on current needs and capabilities.

There are two power connections to be made to each TM5SPS2• (PDM) from your source power supplies:

Segment Begin	Connection	Power Supplies
IPDM for the distributed configuration	24 Vdc Main power that generates power for TM5 power bus	PS1
	24 Vdc I/O power segment 1	PS2
First PDM (from left to right) of the configuration	24 Vdc Main power that generates power to reinforce the TM5 power bus	PS1
	24 Vdc I/O power segment 2	PS3
Second PDM (from left to right) of the configuration	24 Vdc Main power that generates power to reinforce the TM5 power bus	PS1
	24 Vdc I/O power segment 3	PS4
...	...	...

In the following example, the PS1 is connected to the Main power. In this case the 2 TM5SPS2• PDMs are connected to PS1 to supply the TM5 power bus:



(1) External fuse, Type T slow-blow, 1 A, 250 V
(2) External fuse, Type T slow-blow, 10 A, 250 V
(3) External fuse, Type T slow-blow, 1 A, 250 V
(4) External fuse, Type T slow-blow, 10 A maximum, 250 V
(5) Approved emergency stop device
PS1/PS2/PS3/PS4 External isolated power supply 24 Vdc

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

NOTE: The requirements for the power supply are different for the input and the output slices. An emergency stop is generally used with the power supply providing power for output slices.

Wiring the Safety Power Distribution Module (SPDM) TM5SPS10FS

The TM5SPS10FS Safety Power Distribution Module (SPDM), in association with its dedicated, left-isolating TM5ACBM4FS safety bus base, is a power source for specified non-safety-related I/O modules. The Safety Power Distribution Module (SPDM) supports the pre-defined safe state of power-off (de-energized) to the I/O modules connected. For more information on the correct wiring, refer to TM5SPS10FS Presentation *(see Modicon TM5/TM7, I/O Safety Modules, Hardware Guide)*.

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

NOTE: The requirements for the power supply are different for the input and the output slices. An emergency stop is generally used with the power supply providing power for output slices.

Grounding the System

Introduction

Use shielded, properly grounded cables for all analog and high-speed inputs or outputs and communication connections. If you do not use shielded cable for these connections, electromagnetic interference can cause signal degradation. Degraded signals can cause the controller or attached modules and equipment to perform in an unintended manner.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Use shielded cables for all fast I/O, analog I/O and communication signals.
- Ground cable shields for all analog I/O, fast I/O and communication signals at a single point[1].
- Route communication and I/O cables separately from power cables.

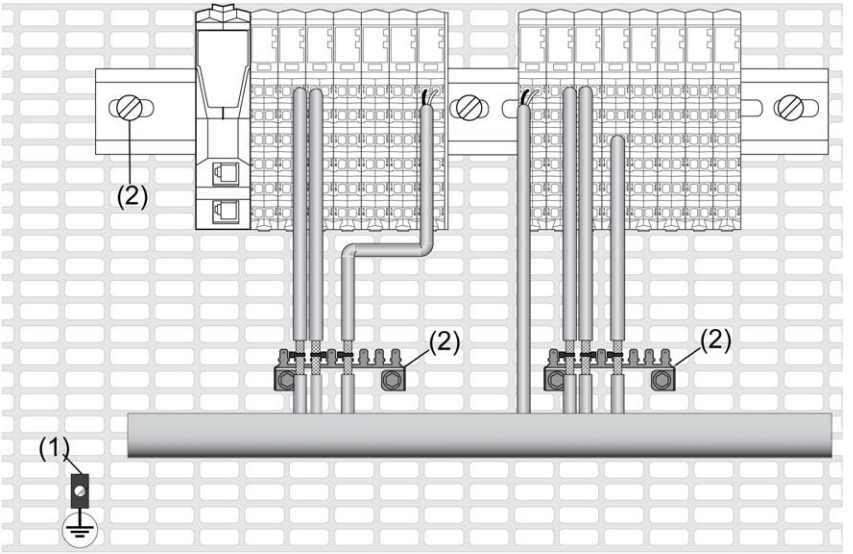
Failure to follow these instructions can result in death, serious injury, or equipment damage.

[1]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.

The use of shielded cables requires compliance with the following wiring rules:

- For protective ground connections (PE), metal conduit or ducting can be used for part of the shielding length, provided there is no break in the continuity of the ground connections. For functional ground (FE), the shielding is intended to attenuate electromagnetic interference and the shielding must be continuous for the length of the cable. If the purpose is both functional and protective, as is often the case for communication cables, the cable should have continuous shielding.
- Wherever possible, keep cables carrying one type of signal separate from the cables carrying other types of signals or power.

The figure below represents a TM5 System with shielded cables:



1 Protective ground (PE)
2 Functional ground (FE)

Protective Ground (PE) on the Backplane

The protective ground (PE) is connected to the conductive backplane by a heavy-duty wire, usually a braided copper cable with a cross-section of 6 mm^2 (AWG 10) or larger.

Functional Ground (FE) on the DIN Rail

The DIN Rail for your TM5 System is common with the functional ground (FE) plane and must be mounted on a conductive backplane.

⚠ WARNING
UNINTENDED EQUIPMENT OPERATION
Connect the DIN rail to the functional ground (FE) of your installation.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

The connection between the functional ground (FE) and your TM5 System is made by the DIN Rail contacts *(see page 38)* on the back of the controller and the bus base of the expansion modules.

Shielded Cables Connections

Cables carrying the fast I/O, analog I/O, network and Sercos III bus communication signals must be shielded. The shielding must be securely connected to ground. The fast I/O and analog I/O shields may be connected either to the functional ground (FE) of your system via the TM2XMTGB grounding plate or to the protective ground (PE). The Sercos III bus communication cable shields must be connected to the protective ground (PE) with a connecting clamp secured to the conductive backplane of your installation.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK

Make sure that CANopen and Modbus cables are securely connected to the protective ground (PE).

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

⚠ WARNING

ACCIDENTAL DISCONNECTION FROM PROTECTIVE GROUND (PE)

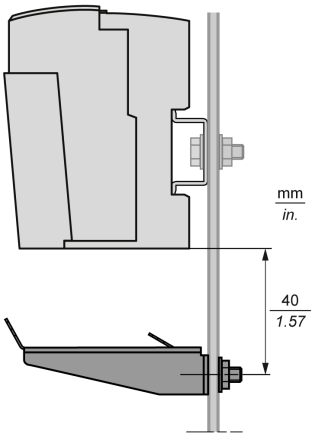
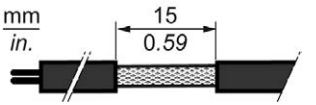
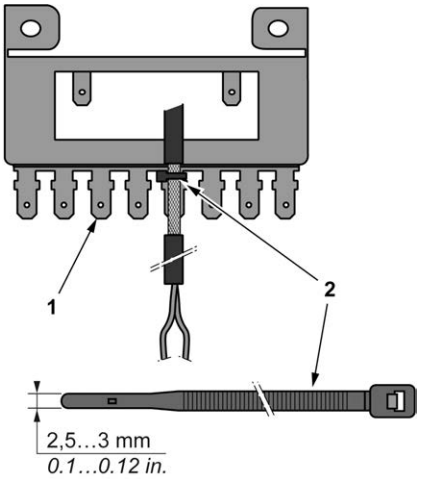
- Do not use the TM2XMTGB Grounding Plate to provide a protective ground (PE).
- Use the TM2XMTGB Grounding Plate only to provide a functional ground (FE).

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

NOTE: The functional ground of the Ethernet connection is internal.

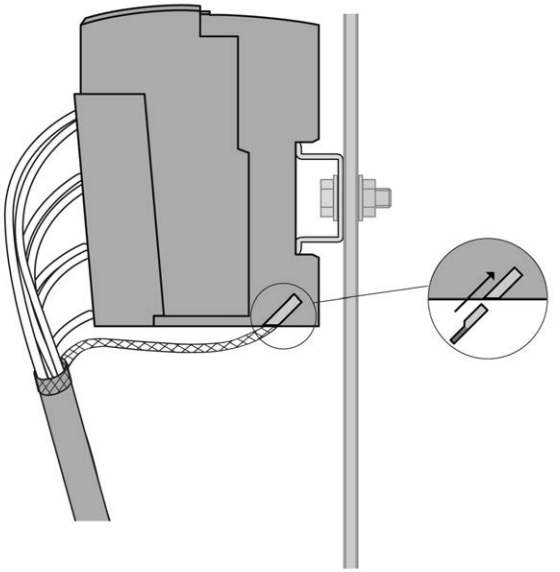
Functional Ground (FE) Cable Shielding

Alternative 1: Connect the shield of a cable via the Grounding Plate:

Step	Description	
1	Install the Grounding Plate *(see page 51)* directly on the conductive backplane below the TM5 System as illustrated.	
2	Strip the shielding for a length of 15 mm (0.59 in.)	
3	Tightly clamp on the blade connector **(1)** using nylon fastener **(2)**(width 2.5...3 mm (0.1...0.12 in.)) and appropriate tool.	

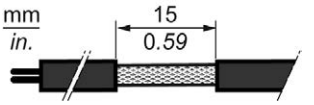
Alternative 2: Connect the shield of a cable via the grounding connector on the bus base of the TM5 I/O modules:

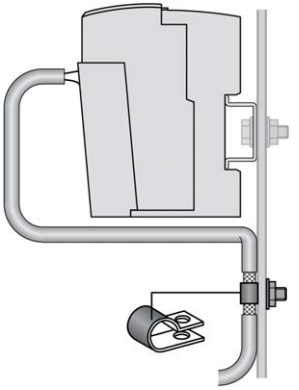
Twist the shield of all shielded cables of a module and connect them with a cable end (2.8 x 0.5 mm / 0.11 x 0.02 in) to the grounding connector of the TM5 I/O modules.



Protective Ground (PE) Cable Shielding

To ground the shield of a cable via a grounding clamp:

Step	Description	
1	Strip the shielding for a length of 15 mm (0.59 in.)	

Step	Description	
2	Attach the cable to the conductive backplane plate by attaching the grounding clamp to the stripped part of the shielding as close as possible to the TM5 System base.	

NOTE: The shielding must be clamped securely to the conductive backplane to help ensure good contact.

Section 5.5
System Limits

System Limits

Overview

The system limits are determined by several parameters as they relate to Sercos III nodes. Nodes are a logical construction; a single, physical device on the network may constitute one or more logical nodes, such as the Lexium 62 Double Drive. Further attention must be given to whether any given node contains a safety-related function. In addition, there are limits to the number of safety-related devices across all nodes attached to the Safety Logic Controller.

For example, the TM5NS31 Sercos III Bus Interface is a Sercos node. It counts as one node towards the maximum of 254. However, there are still other limits that must be respected in association of the Safety Logic Controller. If there are one or more TM5 or TM7 Safety-Related modules attached to the Sercos III Bus Interface, then it also counts towards the imposed Safety Logic Controller limits of the maximum number of Sercos nodes with integrated safety-related functions. Finally, the total number of safety-related devices must also be respected. For example, each TM5 or TM7 safety-related module is a safety-related device.

Exceeding the parametric limits results in the TM5 Safety-Related System assuming the defined safe state.

The table presents the relationship between device type, type of node or devices and the respective maximum number of nodes within the PacDrive3 system:

Device Type	Sercos III Nodes	Sercos III Nodes containing Safety-Related Functions	Safety-Related Devices
TM5/TM7 Safety-Related Module	–	–	1
Sercos III Bus Interface TM5NS31	1	1(1)	–
Lexium 62 Single Drive with integrated safety	1	1	1
Lexium 62 Double Drive with integrated safety(2)	2	2	2
Lexium 62 ILM with integrated safety	1	1	1
Safety Logic Controller TM5CSLC100FS / TM5CSLC200FS	1	1	–
Maximum number of nodes	**254**	**20(3) / 50(4)**	**20(3) / 100(4)**

(1) If one or more safety-related devices are attached.
(2) The Lexium 62 Double Drive counts as two.
(3) Maximum number of nodes for the TM5CSLC100FS (besides the 20 nodes of the TM5CSLC100FS)
(4) Maximum number of nodes for the TM5CSLC200FS (besides the 100 nodes of the TM5CSLC100FS)

Example for a System Configuration with Allocation of the Maximum Number of Safety-Related Nodes

The following represents a hypothetical example of a maximum system configuration:

- 26 TM5/TM7 safety-related modules per Sercos III Bus Interface TM5NS31
- 2 Sercos III Bus Interfaces TM5NS31
- 12 Lexium 62 Single Drives with integrated safety
- 12 Lexium 62 Double Drives with integrated safety
- 12 Lexium 62 ILMs with integrated safety
- 1 Safety Logic Controller TM5CSLC200FS

For this system configuration, the following number of nodes is allocated according to table above.

The table presents the counting communication participants:

Device Type	Sercos III Nodes	Sercos III Nodes containing Safety-Related Functions	Safety-Related Devices
26 TM5/TM7 Safety-Related Modules per Sercos III Bus Interface TM5NS31	-	-	52
2 Sercos III Bus Interfaces TM5NS31	2	2	-
12 Lexium 62 Single Drives with integrated safety	12	12	12
12 Lexium 62 Double Drives with integrated safety	24	24	24
12 Lexium 62 ILMs with integrated safety	12	12	12
1 Safety Logic Controller TM5CSLC200FS	1	-	-
Total number of nodes	51	50	100
Maximum number of nodes	**254**	**50**	**100**

Conclusion:

- This system configuration uses the maximum possible number of 100 safety-related devices and 50 Sercos III nodes containing safety-related functions together with a TM5CSLC200FS Safety Logic Controller.
- The two Sercos III Bus Interfaces TM5NS31 also counts as two Sercos III nodes containing safety-related functions as each of them has TM5 and/or TM7 Safety-Related Modules attached.

Chapter 6
Installation Procedures

Overview

This chapter focuses on procedures for construction of a TM5 System. The installation quick start guide summarizes the steps involved in the installation process.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Installation and Maintenance Requirements	116
Installation Quick Start Guide	119
The Layout of your TM5 System	121
DIN Rail Installation	122
Sercos III Bus Interface Installation	124
Compact I/O Installation	128
Slices Installation	130
Equipment Removal	137
Expanding the TM5 System	140
Addressing	142
Labeling the TM5 System	146
Installation of Accessories	151

Installation and Maintenance Requirements

Before Starting

Read and understand this chapter before beginning the installation of your TM5 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.

NOTICE
ELECTROSTATIC DISCHARGE ● Store all components in their protective packaging until immediately before assembly. ● Never touch exposed conductive parts such as contacts or terminals. **Failure to follow these instructions can result in equipment damage.**

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

For important hazardous location information, refer to the individual product descriptions contained in their hardware guides.

⚠ 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.

NOTE: Individual modules may differ in terms of operating temperature de-ratings or other important environmental characteristics. For the specific information, refer to the hardware guide for your particular module.

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 and secured by a keyed or tooled locking mechanism.
- 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 use this equipment in safety-critical machine functions unless the equipment is otherwise designated as functional safety equipment and conforming to applicable regulations and standards.
- 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 Quick Start Guide

Introduction

This section provides a summary of the installation process covered in detail throughout the rest of this chapter. The information is presented in generalized steps which convey each of the operations that are required in the installation process. Each step is accompanied by a reference that locates the detailed information associated with it.

The installation process is divided into three phases described below.

Installation-Phase 1

In the first phase of the installation, you install the DIN rail, the Sercos III Bus Interface and any bus bases for any expansion modules that may be part of your TM5 System configuration:

Step	Action	Refer to
1	Develop an installation plan that covers all aspects of the installation.	Making a Plan *(see page 121)*
2	Fasten the DIN rail to the mounting plate of the enclosure.	DIN Rail Installation *(see page 122)*
3	For distributed configuration install the Sercos III Bus Interface at the first (leftmost) location on the rail. **NOTE:** In case of vertical installation the Sercos III Bus Interface must be at the lowest location and secured. Refer to Acceptable Mounting positions *(see page 74)*. **NOTE:** Go to Installation-Phase 2 *(see page 120)* if there are no expansion modules.	Controller Installation or Sercos III Bus Interface Installation *(see page 124)*
4	Determine the left-to-right arrangement of the expansion modules on the rail.	–
5	Attach the bus base (for slices) and compact I/O to the DIN rail in accordance with your expansion modules layout, working left to right from the Sercos III Bus Interface.	Mounting the Bus Bases *(see page 131)* or Compact I/O Installation *(see page 128)*
6	Optional: Assign the module addresses in accordance with your expansion modules layout.	Addressing *(see page 142)*

Installation-Phase 2

In the second phase of the installation, you install the electronic modules and terminal blocks with or without coding:

Step	Action	For Details, see
1	Develop a coding scheme for the electronic modules that matches the expansion modules layout. **NOTE:** The safety-related I/O slices do not support the coding of the electronic modules.	Coding the TM5 System *(see PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide)*
2	Install the electronic modules in their bus bases in accordance with your slice layout. **NOTE:** To install a compact I/O block, remove the terminal block from the preceding device (controller, power distribution or I/O slice), then install the compact I/O block. Refer to Mounting positions *(see page 73)*.	Inserting the Electronic Module *(see page 132)*
3	Install a left bus base locking plate to the first slice of each remote configuration.	Mounting the Left Bus Base Locking Plate *(see page 136)*
4	Install a right bus base locking plate to the rightmost expansion module of each configuration.	Mounting the Right Bus Base Locking Plate *(see page 135)*
5	Mount the terminal blocks in accordance with your expansion modules layout.	Mounting the Terminal Blocks *(see page 133)*

Installation-Phase 3

In the final phase, you install cable ducts, connect all grounding points, make the necessary signal and power connections, and commission your TM5 System.

Step	Action	For Details, see
1	Install the TM2XMTGB grounding plate.	Grounding the TM5 System *(see page 106)*
2	Install cable ducts, conduits and any wiring harnesses.	–
3	Make Functional Ground (FE) connections.	Functional Ground (FE) Cable Shielding *(see page 109)*
4	Make Protective Ground (PE) connections.	Protective Ground (PE) Cable Shielding *(see page 110)*
5	Make the field wiring connections.	Specific Hardware Guides
6	Make the power connections.	Wiring the Power Supply *(see page 98)*
7	Reduce stress on the wires with adequate cable ties.	TM5 Strain Relief Using Cable Tie *(see page 93)*
8	Commission the TM5 System.	Configuring the TM5 System (refer to your controller programming guide)

The Layout of your TM5 System

Making a Plan

Before you begin to install your TM5 System, you need to establish a plan that identifies:

- the type of enclosure for the TM5 System
- the number and type of expansion modules on your TM5 System
- the order in which any TM5 expansion modules are assembled together to form the TM5 bus
- the power requirements of your TM5 System configuration
- a coding scheme that helps match the terminal blocks with their electronic modules
- a labeling plan

The local TM5 bus is constructed as a series of interconnected bus base units. The structure of the TM5 backplane is defined by the type and order of electronic modules that will reside in it. You will need to make these decisions in advance and the association table *(see page 210)* can help you. There is a color coding system *(see page 27)* in the TM5 System. In addition to labeling your TM5 System *(see page 146)*, you can also follow a coding system *(see PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide)* of the electronic modules and terminal blocks.

NOTE: The safety-related I/O slices do not support the coding of the electronic modules.

Selecting Expansion Modules

When you plan a TM5 System layout, you need to know the number and type of expansion electronic modules and their matching bus bases and terminal blocks.

NOTE: There are restrictions and regulations associated with certain module types. Refer to the hardware guides.

Once the number and type of modules has been established, it becomes possible to determine power distribution requirements *(see page 86)*, your external power source requirements *(see page 97)* and the overall hardware design.

DIN Rail Installation

Grounding Function

The DIN rail must be attached to a conductive backplane that itself is connected to a protective ground (PE) *(see page 107)*.

In the mounting channel of each piece of the TM5 equipment is a metal spring contact. When properly mounted on a metal DIN rail, these contacts provide connection to the functional ground (FE) *(see page 107)* for the entire TM5 System.

Mounting the DIN Rail

The TM5 System components are designed for mounting on rail conforming to IEC 60715.

To help achieve the stated TM5 System performance characteristics, the mounting hardware must be installed at the end positions and at 100 mm (3.94 in.) maximum increments along the length of the rail.

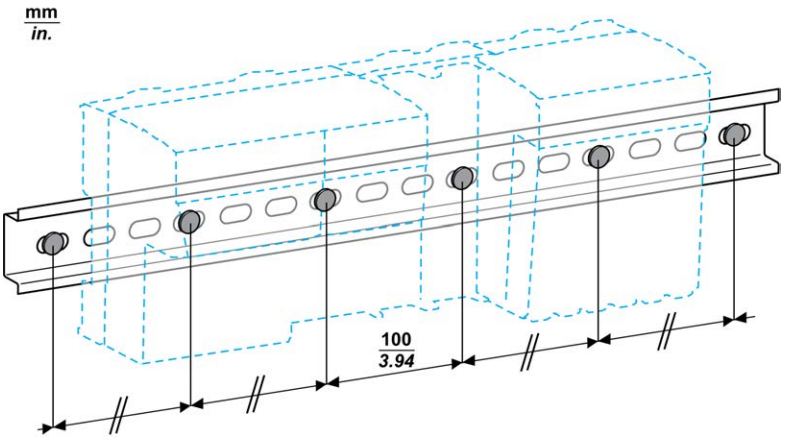
⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Verify that the DIN rail is securely installed with mounting hardware at the end positions and at 100 mm (3.94 in.) maximum increments along the length of the rail.
- Be sure that the DIN rail is firmly connected to a conductive backplane, and that the conductive backplane is secured to a protective ground as specified in this guide and in accordance with local regulations.

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

The following figure illustrates the mounting requirements for the DIN rail:



Low profile NSYSDR200D DIN rail may be used with low profile mounting hardware such as flat head screws with countersunk mounting holes.

NOTE: If you use NSYSDR200D DIN rail, ensure that the maximum fastener screw head protrusion does not exceed 1.0 mm (0.039 in.) above the inner surface of the DIN rail.

Sercos III Bus Interface Installation

Introduction

The installation procedure of the Sercos III Bus Interface is to assemble the 4 components and then install it directly on the DIN rail.

NOTE: If the Sercos III Bus Interface is already installed and wired, or the connectors are pre-wired, be sure to remove all power before attempting these procedures.

⚠ 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.

NOTICE

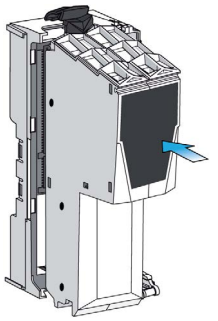
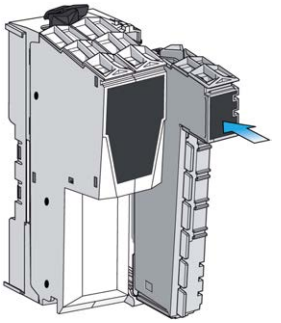
ELECTROSTATIC DISCHARGE

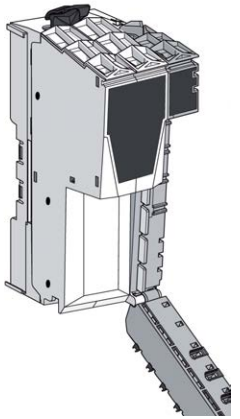
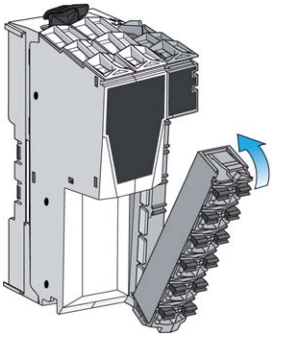
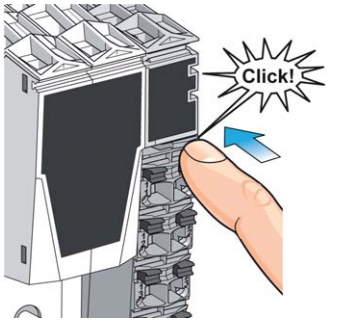
- Store electronic components in their protective packaging until immediately before assembly.
- Only touch modules on the housing.
- Take the necessary protective measures against electrostatic discharges.

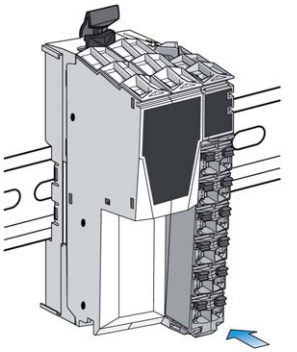
Failure to follow these instructions can result in equipment damage.

Sercos III Bus Interface Installation

The following procedure gives step by step instructions to assemble and install a Sercos III Bus Interface on a DIN rail:

Step	Action	
1	Remove bus base, the electronic modules and terminal block from protective packaging. Verify for visible mechanical damage.	
2	Insert interface electronic module in the slot of the bus base *(see page 43)*.	
3	Push the interface electronic module straight into the bus base until it clicks.	
4	Insert the IPDM electronic module in the guides of the bus base *(see page 43)*.	
5	Push the electronic module straight into the bus base until it clicks.	

Step	Action	
6	Hang the bottom edge of the terminal block in its hinge on the bus base *(see page 43)*.	
7	Rotate upward.	
8	Press the terminal block until it clicks in place.	

Step	Action	
9	Push the locking lever all the way up on all of the bus base. This opens the locking mechanism.	
10	Hang the Sercos III Bus Interface in the desired position on the mounting rail.	
11	Close the locking mechanism by pushing the lever down.	

Compact I/O Installation

Introduction

The compact I/O is always preceded by Sercos III Bus Interface or a slice. The installation procedure of the compact I/O is to install it directly on the DIN rail.

NOTE: If the Sercos III Bus Interface is already installed and wired, or the slice connectors are pre-wired, be sure to remove all power before attempting these procedures.

⚠ 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.

NOTICE

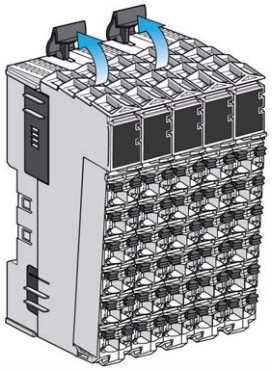
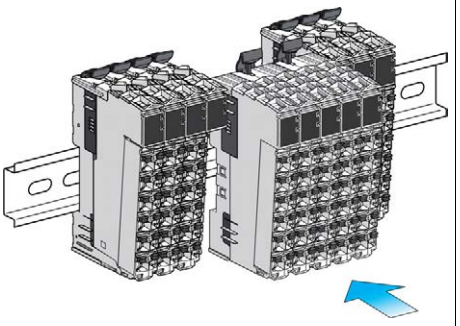
ELECTROSTATIC DISCHARGE

- Store electronic components in their protective packaging until immediately before assembly.
- Only touch modules on the housing.
- Take the necessary protective measures against electrostatic discharges.

Failure to follow these instructions can result in equipment damage.

Mounting the Compact I/O

The following procedure describes how to mount the compact I/O:

Step	Description	
1	Remove compact I/O from the protective packaging. Verify the compact I/O for visible mechanical damage.	
2	Push the locking levers all the way up. This opens the locking mechanism.	
3	Remove the terminal block of the preceding TM5 component (last embedded module of the controller or the last expansion module prior to the compact I/O). **NOTE:** Remember to reinstall the removed terminal block *(see page 133)* after installation of the slice. If already installed, remove the right locking plate *(see page 140)* of the preceding TM5 component.	
4	Insert the compact I/O in the guides of the preceding TM5 component, slide the compact I/O in against the mounting rail and secure it by pushing both locking levers down.	
5	Install the right locking plate *(see page 135)*.	

Slices Installation

Introduction

The installation procedure of the slices is to install and assemble them directly on the DIN rail:

1 Mount the bus bases.
2 Insert the electronic modules.
3 Mount the terminal blocks.

NOTE: If the Sercos III Bus Interface is already installed and wired, or the slice connectors are pre-wired, be sure to remove all power before attempting these procedures.

⚠ 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.

The installation procedure for the first bus base depends whether it is a local, remote or distributed configuration.

NOTICE

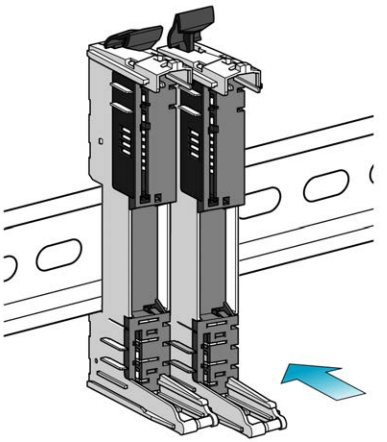
ELECTROSTATIC DISCHARGE

- Store electronic components in their protective packaging until immediately before assembly.
- Only touch modules on the housing.
- Take the necessary protective measures against electrostatic discharges.

Failure to follow these instructions can result in equipment damage.

Mounting the Bus Bases

The following procedure describes how to mount the bus bases:

Step	Description
1	Remove bus bases from protective packaging. Verify the bus bases for visible mechanical damage.
2	Push the locking lever all the way up on all of the bus bases. This opens the locking mechanism.
3	**Remote configuration:** Go to next step. **Distributed configuration:** Remove the terminal block of the IPDM of the Sercos III Bus Interface.
4	**Remote configuration:** Hang the first bus base in the desired position on the mounting rail and close the locking mechanism by pushing the lever down. **Distributed configuration:** Insert the first bus base in the guides of the Sercos III Bus Interface bus base, slide the bus base in against the mounting rail and secure it by pushing the lever down.
5	Insert the next bus base in the guides of the previously mounted bus base. 
6	Slide the bus base in against the mounting rail and secure it by pushing down the locking lever.
7	According to the installation plan, proceed like this with the rest of the bus bases.
8	If using bus bases with address setting, assign the bus base address *(see page 142)* at this step of the installation procedure of the slices.

NOTE: Remember to reinstall the removed terminal block *(see page 133)* after installation of the slice.

Inserting the Electronic Modules

A slice must only be composed of a single color. For example, a gray bus base should only be assembled with a gray electronic module and a gray terminal block. However, color alone is not sufficient for compatibility; always confirm that functionality of slice components matches as well.

⚠ ⚠ DANGER

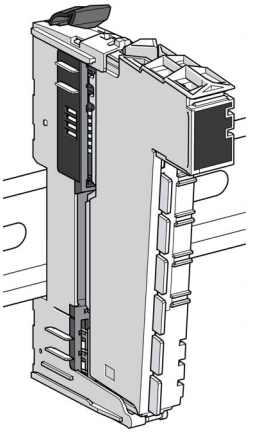
INCOMPATIBLE COMPONENTS CAUSE ELECTRIC SHOCK OR ARC FLASH

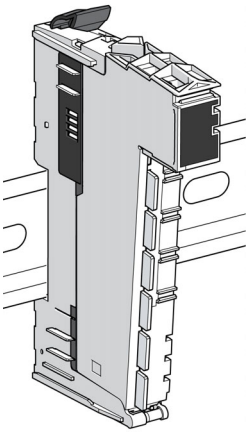
- Do not associate components of a slice that have different colors.
- Always confirm the compatibility of slice components and modules before installation using the association table in this manual.
- Verify that correct terminal blocks (minimally, matching colors and correct number of terminals) are installed on the appropriate electronic modules.

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

NOTE: If the Sercos III Bus Interface is already installed and wired and you are replacing an existing electronic module, be sure to follow the Hot-swap guidelines *(see page 159)* in association with the following procedures.

The following procedure describes how to mount the electronic modules:

Step	Action	
1	Remove electronic module from protective packaging. Verify the electronic module for visible mechanical damage.	
2	Insert electronic module in the guides of the bus base *(see page 38)*.	

Step	Action	
3	Push the electronic module straight into the bus base until it clicks.	
4	According to the installation plan, proceed like this with all the electronic modules.	

Mounting the Terminal Blocks

A slice must only be composed of a single color. For example, a gray bus base should only be assembled with a gray electronic module and a gray terminal block. However, color alone is not sufficient for compatibility; always confirm that functionality of slice components matches as well.

⚠ ⚠ DANGER

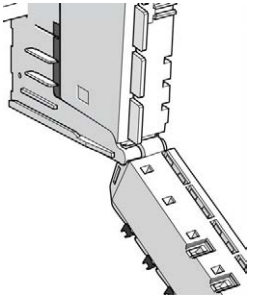
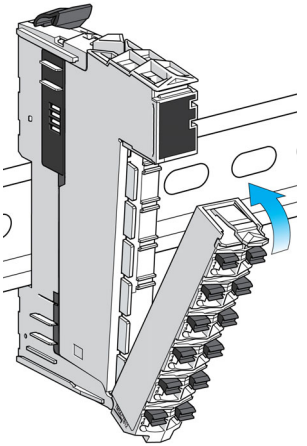
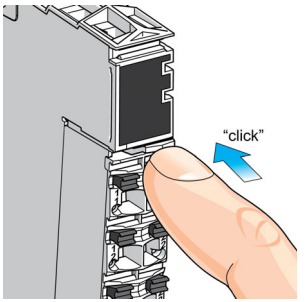
INCOMPATIBLE COMPONENTS CAUSE ELECTRIC SHOCK OR ARC FLASH

- Do not associate components of a slice that have different colors.
- Always confirm the compatibility of slice components and modules before installation using the association table in this manual.
- Verify that correct terminal blocks (minimally, matching colors and correct number of terminals) are installed on the appropriate electronic modules.

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

See Coding the TM5 System *(see PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide)* for assistance in labeling and associating components.

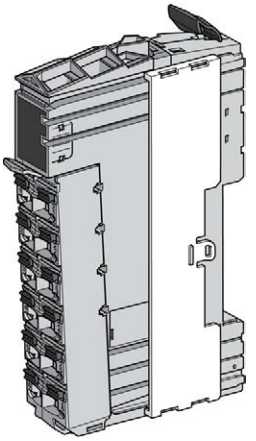
The following procedure describes how to mount the terminal block:

Step	Action	
1	Hang the bottom edge of the terminal block in its hinge on the bus base.	
2	Rotate upward.	
3	Press the terminal block until it clicks in place.	

Step	Action
4	According to the installation plan, proceed like this with all the terminal blocks.

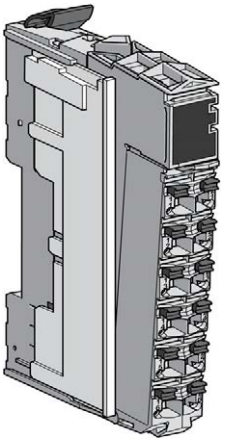
Right Bus Base Locking Plate

The right bus base locking plate must be attached to the rightmost slice of the Sercos III Bus Interface or the rightmost expansion module of the remote configuration, or distributed island:

Step	Action	
1	Remove the terminal block of the rightmost expansion module .	
2	From the front, insert the right bus base locking plate into the bus base interlocking guides *(see page 38)*.	
3	Push it in all the way.	
4	Replace the terminal block of the rightmost expansion module.	

Left Bus Base Locking Plate

The left bus base locking plate is attached to the first slice (receiver slice) of the remote islands:

Step	Action	
1	Place the left bus base locking plate on the left slice and insert it in the interlocking guides *(see page 38)* of the terminal block.	
2	Slide the bus base locking plate forward.	

Equipment Removal

Introduction

The following procedures describe how to remove a TM5 System or part of a system from the DIN rail.

NOTE: When replacing a controller, a Sercos III Bus Interface or expansion modules and their bus bases, be sure to remove all power before attempting these procedures.

⚠ DANGER

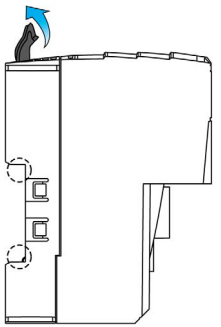
HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- 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.

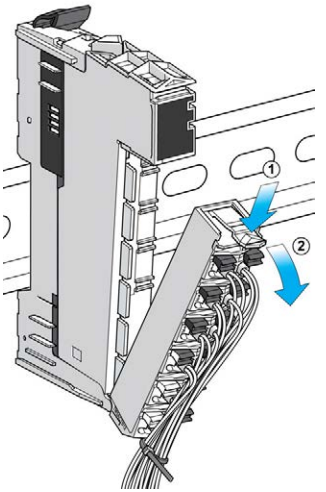
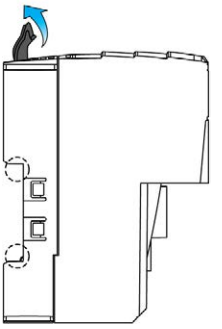
Failure to follow these instructions will result in death or serious injury.

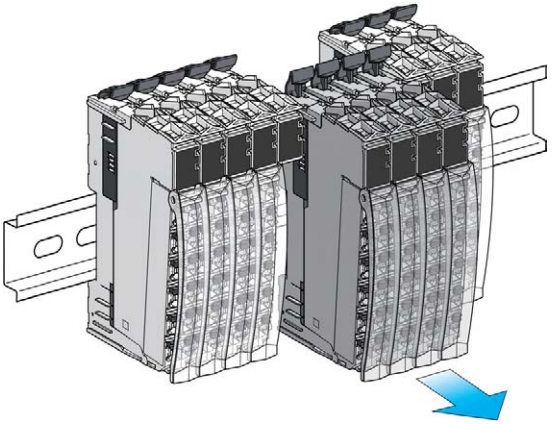
Complete Configuration Removal

The following procedure describes how to remove a complete configuration:

Step	Action	
1	Remove all power from all equipment.	
2	Push all the locking levers all the way up. This opens the locking mechanism for equipment installation.	
3	Remove the TM5 System configuration from the mounting rail.	

Partial Configuration Removal

Step	Action	
1	Remove all power from all equipment.	
2	For mechanical reasons, remove the terminal block of the electronic module at the left of the partial configuration to be removed. To do this: **1** push down on the locking lever on the terminal block **2** rotate the terminal block out and down	
3	Push the locking levers of the configuration to be removed all the way up. This opens the locking mechanism for equipment installation.	

Step	Action
4	Remove the partial configuration from the mounting rail. 
5	Put the removed terminal block *(see page 133)* back on the electronic module.

Expanding the TM5 System

How to Expand the TM5 System

When adding expansion modules be sure to remove all power before attempting these procedures.

⚠ 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.

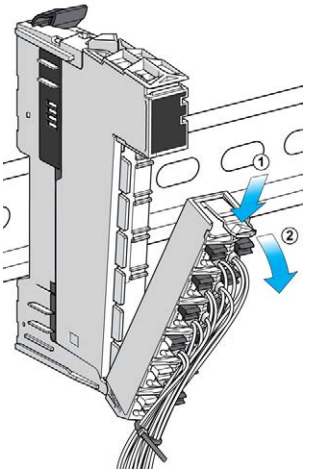
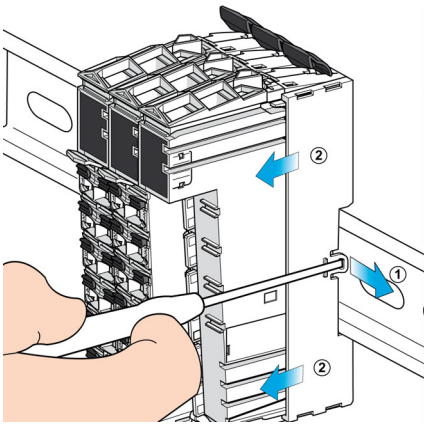
⚠ WARNING

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.

The following procedure describes how to expand the TM5 System:

Step	Action	
1	Remove all power from all equipment.	
2	Remove the terminal block from the rightmost slice: **1** Push down on the locking lever on the terminal block. **2** Rotate the terminal block out and down.	
3	Remove the locking plate from the rightmost slice: **1** Use a screwdriver to unhook the locking clip of the right locking plate. **2** Pull the locking plate off the bus base and electronic module.	
4	Install expansion modules according to your expansion layout as described in the slice *(see page 130)* or compact I/O *(see page 128)* installation procedures. Install the rightmost terminal block removed at the step 2.	
5	Install the right locking plate *(see page 135)* to the rightmost expansion module of your new configuration.	

Addressing

Introduction

The TM5 backplane of bus bases, which holds the individual I/O modules together, is auto-addressing. It is usually not necessary to set the address setting numbers.

However, in certain cases, it may be necessary to define specific slices or potential groups at fixed addresses, regardless of the preceding modules in the backplane. For this purpose, there are bus bases in the TM5 System with rotary switches, which allow you to set the address of an individual slice. All subsequent slices refer to this offset and are again automatically addressed from this point forward.

NOTE: Manual address setting is not supported with TM5NS31 and TM5NEIP1 fieldbus interfaces. In addition, manual address setting is not supported by EcoStruxure Machine Expert. Therefore, bus bases with rotary switches are unnecessary. However, if the fieldbus interfaces are used, the address setting of the switches must be 0.

Addressing Principle

In the TM5 System, the address setting number begins at 1 and is the address number of the Interface Power Distribution Module (IPDM) of the distributed configuration.

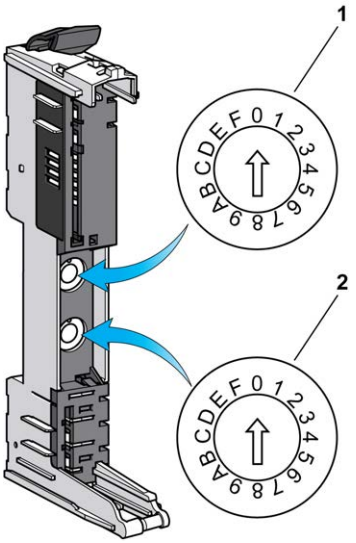
The following modules and expansion modules addresses are assigned according to their positions in the TM5 backplane (+1 regarding the left preceding module address).

Bus Bases with Address Setting

The following table gives you the references of the bus bases *(see page 290)* with address setting:

References	Description	Color
TM5ACBM05R	24 Vdc / 24 Vdc I/O power segment left isolated with address setting	Gray
TM5ACBM15	24 Vdc / 24 Vdc I/O power segment pass-through with address setting	White

Address Setting Rotary Switches



1 x16
2 x1

The address of the slice is set using the address setting rotary switches (01 - FD hex).

The address setting 00 hex causes automatic assignment of the address of the expansion module.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Verify that the addressing of the bus base modules is ordinal within the physical layout of the configuration from left to right.
- Verify that the physical configuration (order and references of the I/O modules and any addressed bus bases) corresponds exactly to that defined in the software configuration for your application.

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

Set the rotary switches before installing the bus base on the DIN rail and making a connection to the other components of your TM5 system. If the bus base is already installed before its address has been set, then remove all power to your TM5 system before setting the address.

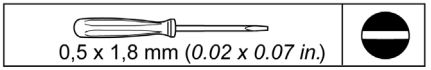
⚠ DANGER

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.

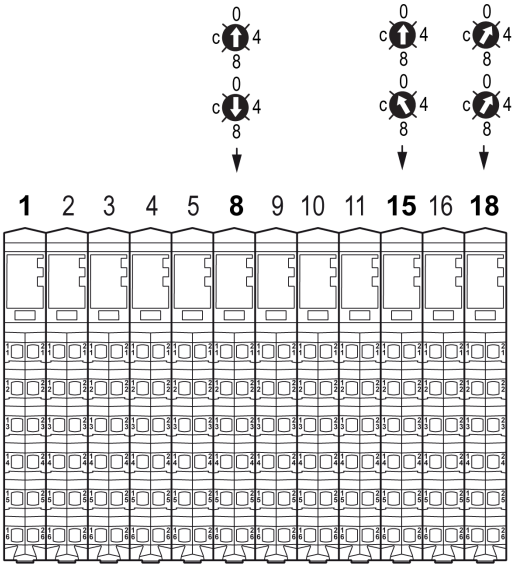
Failure to follow these instructions will result in death or serious injury.

You must use a flat-head screwdriver of the size noted below to turn the rotary address selection switches.



Example

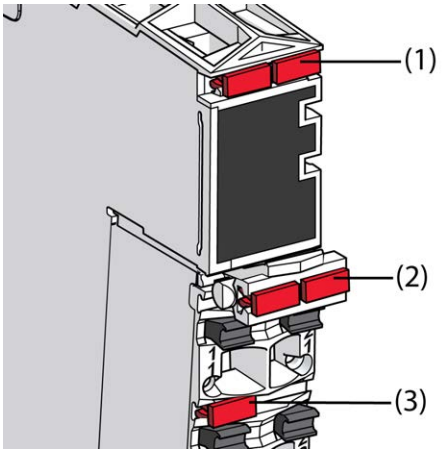
The example below demonstrates the automatic addressing of the slices up to the point of a bus base with an address setting rotary switch. This bus base forces the address for the slice, in the example, to 8. From that point, the automatic sequential addressing continues until the next bus base with an address setting rotary switch is encountered.



Labeling the TM5 System

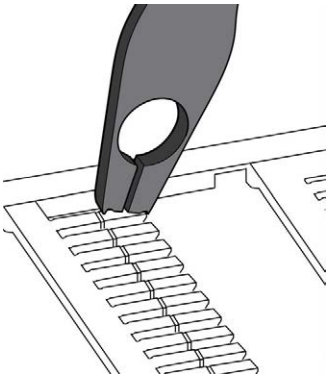
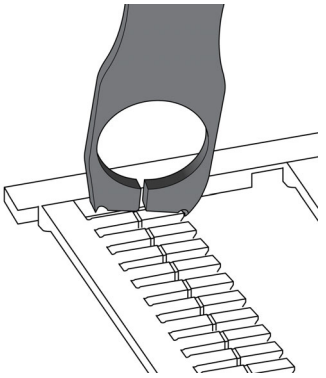
Introduction

This section explains how to label:



1 The electronic module.
2 The locking clip of the terminal block
3 The connectors of the terminal block

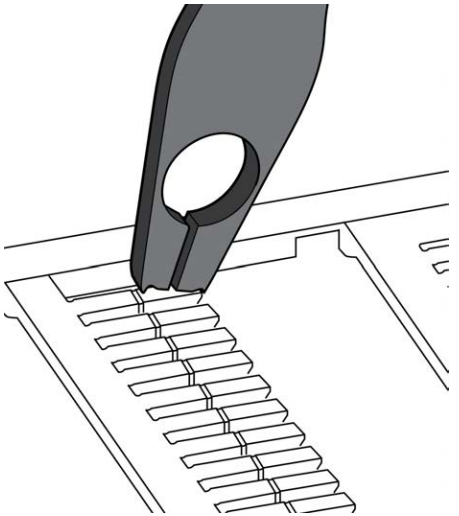
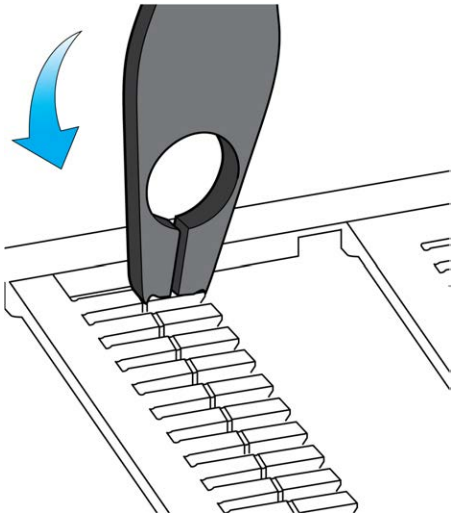
NOTE: The following procedure explains how to install one label tab by using the single-width cutters of the labeling tool. You can extrapolate with the double-width cutters of the labeling tool *(see page 48)* to install two label tabs in the same step.

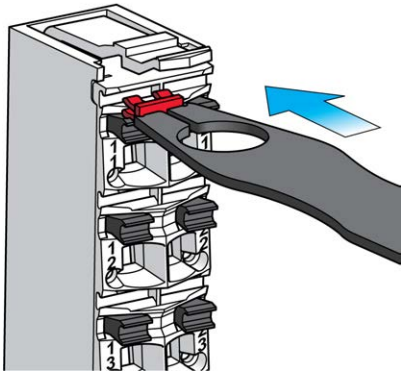
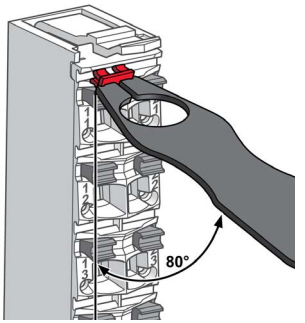
Single-width Cutters	Double-width Cutters
	

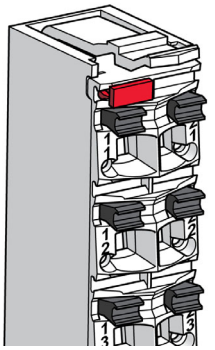
Labeling the Connectors of the Terminal Block

You can label the connectors of the terminal block as well as the locking clip of the terminal block itself.

The following table describes how to label the terminals of the terminal block:

Step	Action	
1	Grip the desired label tab with the single width cutters of the labeling tool.	
2	Press with the labeling tool to separate the label.	

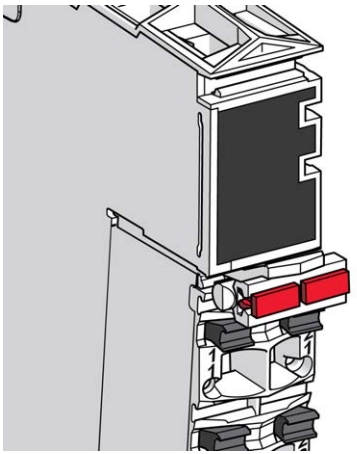
Step	Action	
3	Center the label tab over the slot on the terminal block.	
4	Hold the labeling tool at approximately an 80° angle to the terminal block.	

Step	Action	
5	Press with the labeling tool to insert the feet of the label tab into the slot. **Result**: Inserted label.	

Labeling the Terminal Locking Clip

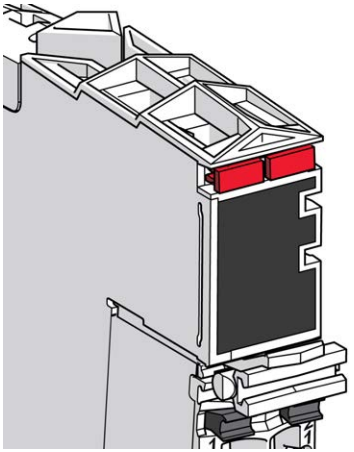
To label the terminal block itself, insert one or two label tabs in the terminal locking clip *(see page 48)* using the same procedure described above.

The following figure shows the labeled terminal locking clip:



Labeling the Electronic Module

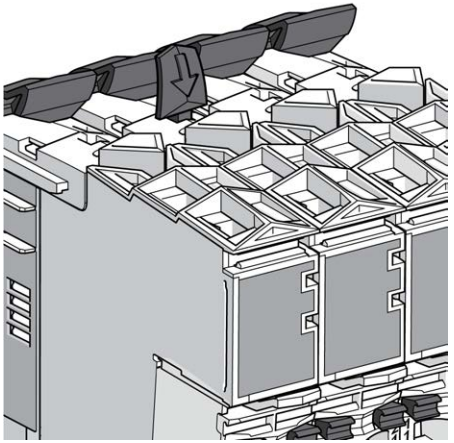
The electronic module is labeled in a manner similar to the terminal block:



Installation of Accessories

Locking Clip

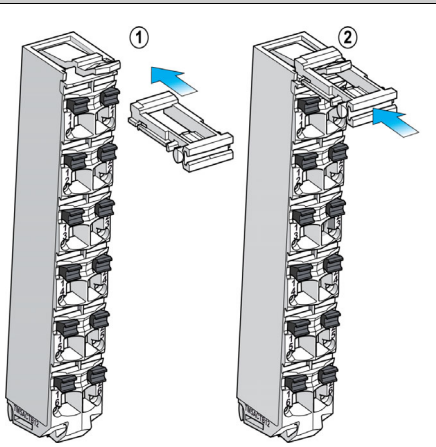
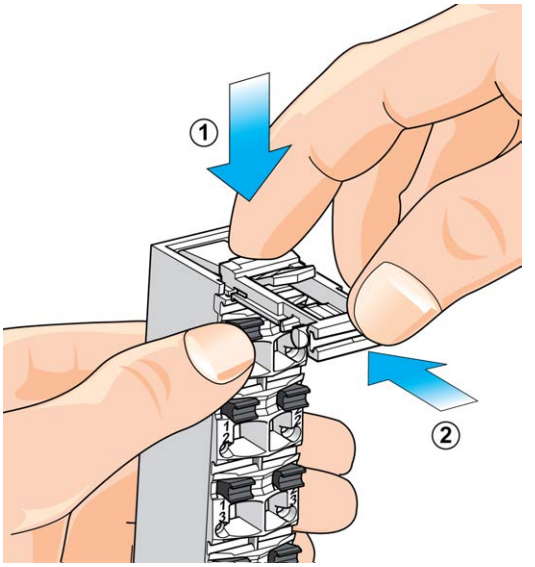
The locking clip attaches the electronic module to the bus base. The locking clip is inserted in the appropriate opening on the top of the slice and pushed down.

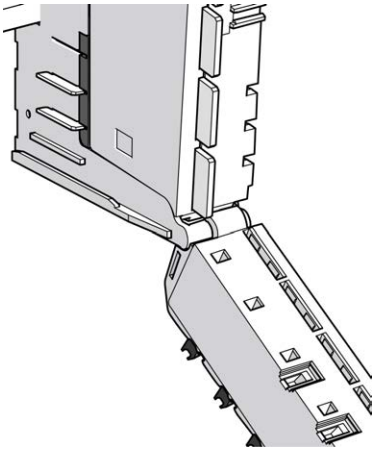
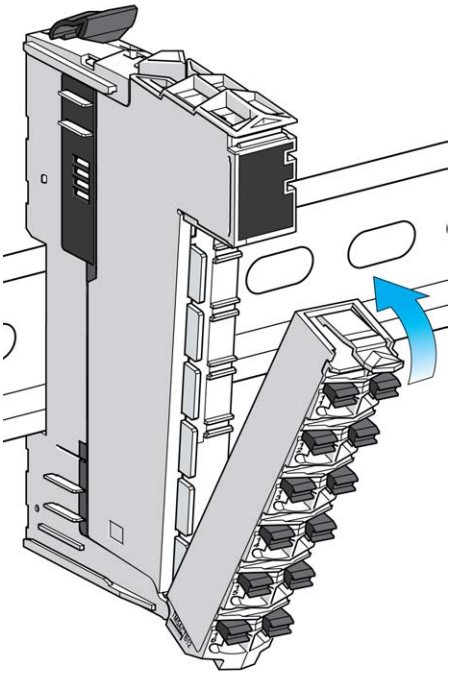


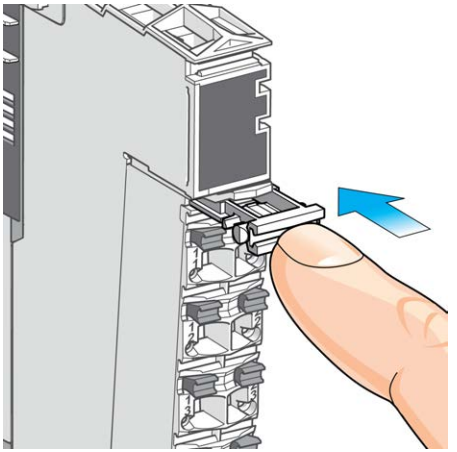
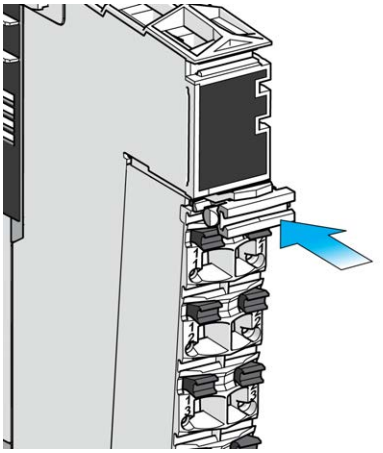
Terminal Locking Clip

The terminal locking clip attaches to the terminal block to help secure it to the electronic module.

The following table describes how to install the terminal locking clip:

Step	Action	
1	Set the terminal locking clip on the terminal block locking lever as shown.	
2	Push down and hold the terminal locking clip and the locking lever with your index finger. Slide the terminal locking clip forward with your thumb.	

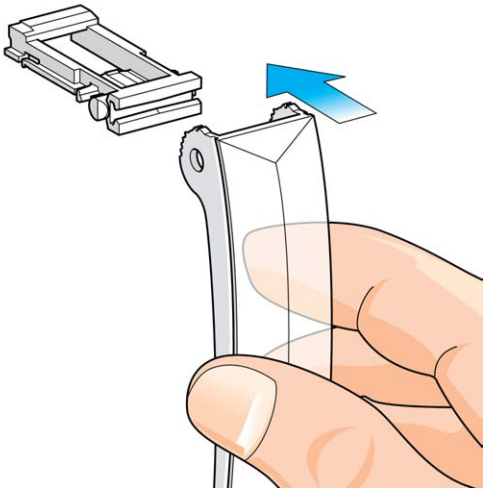
Step	Action	
3	Hang the bottom edge of the terminal block in its hinge on the bus module.	
4	Rotate the terminal block up into place.	

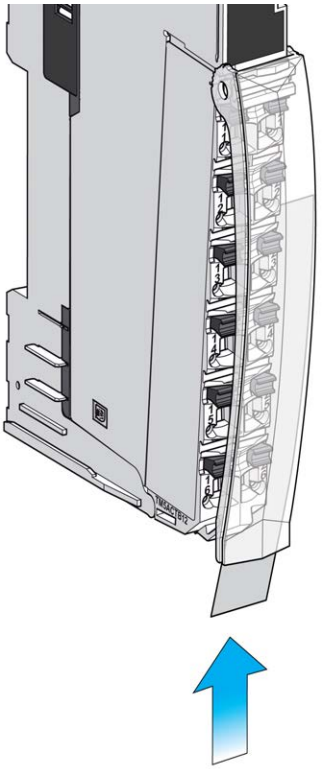
Step	Action	
5	Secure the terminal block in the electronic module by pushing in the terminal locking clip.	
6	Installed terminal locking clip.	

NOTE: To remove the terminal block, reverse Step 5 by pulling out the terminal locking clip.

Plain Text Cover

The covers are attached to the terminal locking clips:

Step	Action	
1	Hold the plain text cover at a 90° angle to the terminal locking clip.	
2	Push the plain text cover into the terminal locking clip until it clicks into the slot on the clip.	

Step	Action	
3	Insert the plain text legend *(see page 50)* strips.	

Chapter 7
Commissioning and Maintaining

Overview

Once your TM5 Safety-Related System has been installed and you have confirmed that the installation has been properly grounded and powered, you can follow the procedures in this chapter to commission and maintain your configuration.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Diagnostics	158
Hot Swapping Electronic Modules	159

Diagnostics

Introduction

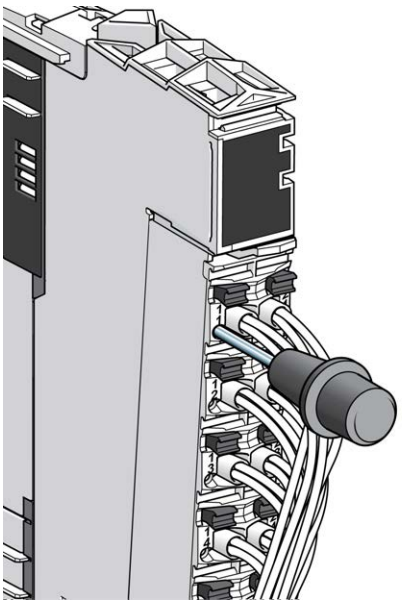
The TM5 System offer several levels of diagnostics:

- Test points on the terminal blocks
- Directly on the module using LED displays
- Via EcoStruxure Machine Expert software (Diagnostics, Message Logger, I/O Mapping, Safe Logger)

Test Points

Each terminal block *(see page 40)* has an access point for a test probe. You can measure the terminal potential without disconnecting the wire.

The following figure illustrates the use of the test probes:



Status LEDs

TM5 bus status, power, I/O status and channel states are displayed in direct relationship to the channels or the function. The different states are displayed differently, for example green for OK, red for detected error.

Refer to the hardware guides for the products of the TM5 System for status LEDs descriptions.

Hot Swapping Electronic Modules

Definition

Hot swapping is the ability to remove an I/O electronic module from its bus base and then replace it with an identical electronic module while the TM5 Safety-Related System is under power without disrupting the normal operations of the controller. When the electronic module is returned to its bus base or replaced with another electronic module with the same reference, it starts to operate again.

Hot Swapping Considerations

Before initiating a hot swap operation, confirm that the electronic module type is approved for hot swapping *(see page 160)*.

When removing or inserting an I/O module while power is applied, remove and insert the electronic module by hand. Do not use tools to hot swap modules because they may come into contact with hazardous voltages. Also, remove any locking clips and the terminal block before removing the electronic module from its bus base. Hot swapping is only allowed when replacing identical electronic modules.

⚠⚠ DANGER

EXPLOSION OR ELECTRIC SHOCK

- Only perform a hot swap operation in locations known and confirmed to be non-hazardous.
- Use only your hands.
- Do not use any metal tools.
- Do not disconnect any wires from the terminal block.
- Only replace an electronic module with an identical reference.

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

NOTE: Only the electronic module is hot swap-able. Do not attempt a hot swap operation on the bus base, or on electronic modules that are integrated with their bus bases such as the compact I/O.

You need to understand and plan for the effects of hot-swapping certain modules. Hot-swapping modules that control power distribution to other modules, for example, can impact your machine or process. Power Distribution Modules (PDM), Interface Power Distribution Modules (IPDM), Common Distribution modules, Sercos III Bus Interface Modules, and Transmitter and Receiver modules all either distribute power or communications to other electronic modules. Disconnecting the connector to these modules will interrupt power or communications to the modules they service.

For example, some Power Distribution Modules (PDMs) provide power to both the TM5 power bus and 24 Vdc I/O power segment. It is possible that you may need to replace the PDM because one service is inoperable, but not both. In this case, hot-swapping the PDM would interrupt the service that is still operating, and would interrupt power to the modules drawing power from that service.

I/O configuration that employ Common Distribution modules require careful consideration when wiring is restricted by short wire lengths. It may be the case that in order to hot-swap an electronic module that has become inoperable, you need to disconnect the connector of the Common module servicing it. Further, that same Common module may be connected to modules or devices other than the module you wish to hot-swap. Disconnecting the Common module in this case would necessarily interrupt the supply to the unaffected modules and/or devices. Be sure that you know what I/O slices or devices are connected to the Common module, and the impact that this disconnection would have on your machine or process before attempting a hot-swap operation.

⚠ WARNING

LOSS OF CONTROL

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

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

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

NOTE: Be sure you thoroughly understand the effects of a hot-swap operation on all modules and connected devices as they relate to your machine or process.

Modules that are not Hot Swap-able

Electronic modules that can not be hot swapped include:

TM5	Electronic Modules Type	Reasons
Safety Logic Controller	Controller	This module is not removable.
Bus interface	Sercos III Bus Interface module	This module is not removable.
I/O Modules	Safety-Related I/O Modules	This module is not removable.

Part III
TM7 Safety-Related System

Overview

This part provides information to help you plan, install, commission, and maintain your TM7 Safety-Related System.

What Is in This Part?

This part contains the following chapters:

Chapter	Chapter Name	Page
8	Initial Planning Considerations	163
9	Installation Procedures	193
10	Commissioning and Maintaining	205

Chapter 8
Initial Planning Considerations

Overview

This chapter provides information that is helpful in the early planning stages for a TM7 Safety-Related System. It includes the requirements for mounting and wiring the TM7 Safety-Related System and for determining the type of power supply source required for your configuration.

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
8.1	Operating Environment	164
8.2	Mechanical Requirements	167
8.3	TM7 Power System	169
8.4	Electrical Requirements	183
8.5	System Limits	192

Section 8.1
Operating Environment

TM7 Environmental Characteristics

Introduction

The following information describes the system-wide environmental requirements and characteristics for the TM7 Safety-Related System.

Environmental Characteristics

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

The table below provides the general environmental characteristics:

Characteristic	Specification	Range
Standard	IEC61131-2	
Agencies	UL 508 CSA 22.2 No. 142-M1987 CSA 22.2 No. 213-M1987	
Ambient operating temperature		0...60 °C (14...140 °F)
Storage temperature		-25...85 °C (-13...185 °F)
Relative humidity		5...95% (non-condensing)
Pollution degree	IEC60664	2 (non-conductive material)
Protection degree	EN/IEC60529	IP67
Operating altitude		0...2000 m (0...6560 ft.)
		2000...3000 m (6560...9842 ft.)(1)
Vibration resistance	IEC60721-3-5 Class 5M3	7.5 mm (0.295 in.) fixed amplitude from 2...8 Hz 20 m/s^2 (2 gn) fixed acceleration from 8...200 Hz 40 m/s^2 (4 gn) fixed acceleration from 200...500 Hz
Mechanical shock resistance	IEC60721-3-5 Class 5M3	300 m/s^2 (30 gn) for a duration of 11 ms, half sine wave, shock type 1
Connection type		M8 or M12 depending on the I/O block

(1) Reduction of ambient temperature by 0.5 °C (0.9 °F) for every additional 100 m (328 ft.) of altitude beyond 2000 m (6560 ft.).

Electromagnetic Susceptibility

The table below provides the TM7 System electromagnetic susceptibility specifications:

Characteristic	Specification	Range
Electrostatic discharge	EN/IEC 61000-4-2	± 8 kV, criteria B (air discharge) ± 6 kV, criteria B (contact discharge)
Electromagnetic fields	EN/IEC 61000-4-3	10 V/m, 80% amplitude modulation at 1 kHz (80 MHz...2 GHz) 1 V/m (2...2.7 GHz)
Fast transients burst	EN/IEC 61000-4-4	Power lines: 2 kV, criteria B I/O: 1 kV, criteria B Shielded cable: 1 kV, criteria B Repetition rate: 5 kHz and 100 kHz
Surge immunity 24 Vdc circuit	EN/IEC 61000-4-5	Power lines: 1 kV (12 Ω), criteria B in common mode 0.5 kV (2 Ω), criteria B in differential mode
		Unshielded lines: 0.5 kV (42 Ω), criteria B in common mode 1 kV (42 Ω), criteria B in differential mode
		Shielded lines: 1 kV (12 Ω), criteria B in common mode 0.5 kV (2 Ω), criteria B in differential mode
Induced electromagnetic field	EN/IEC 61000-4-6	Network, I/O signal connections > 10 m (32.8 ft.), functional ground connection: 10 Veff, criteria A, 80% amplitude modulation at 1 kHz (150...80 MHz)
Conducted emission	EN 55011 (IEC/CISPR11)	150...500 kHz quasi peak 79 dB µV
		500 kHz...30 MHz quasi peak 73 dB µV
Radiated emission	EN 55011 (IEC/CISPR11)	30...230 MHz 10 m (32.8 ft)@40 dB (µV/m)
		230 MHz...1 GHz 10 m (32.8 ft)@47 dB (µV/m)
Criteria A Uninterrupted operation during test. **Criteria B** Brief interruption during the test allowed.		

Conformity and Test Certification

These devices were developed and tested according to valid European guidelines and standards. Modules labeled ATEX meet the following EU guidelines:

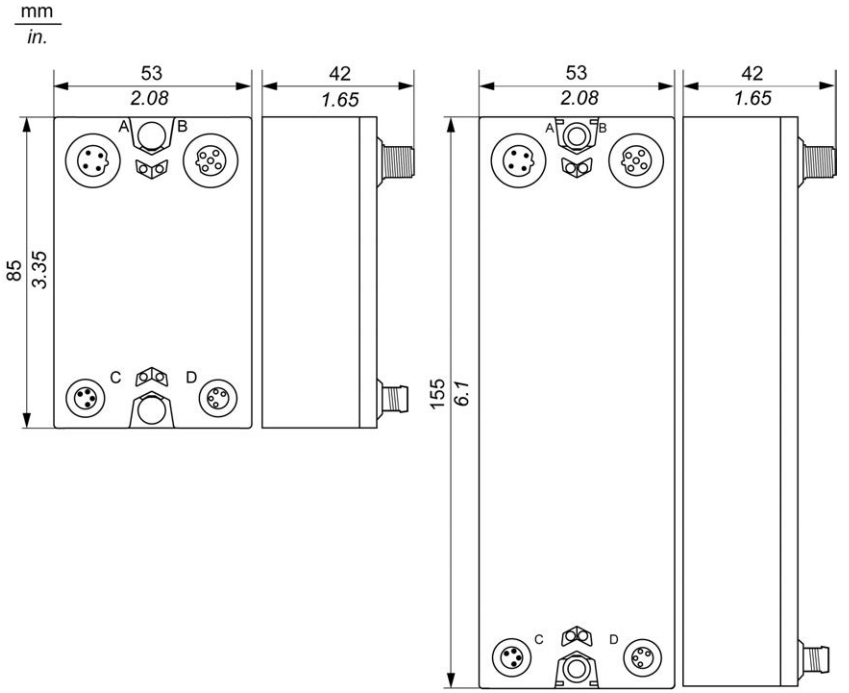
Characteristic	Specification
Electromagnetic compatibility (EMC)	2004/108/EC
Low voltage (LV)	2006/95/EC
Equipment explosive atmospheres (ATEX)	94/9/EC
Standards met	EN 61131-2, EN 61000-6-2, EN 61000-6-4, EN 60204-1, EN 50178, EN 60079-15
Device group II, Category 3, Zone 2 suitable for explosive gas	II 3G
Protection according to European standards	Ex
Ignition protection "n"	nA
Gas group	IIA
Temperature class	T5
Equipment protection level (EPL)	Gc
Maximum surface temperature	84 °C (183 °F)
Protection index according to EN/IEC 60529	IP67
Ambient temperature range	Ta = 0...60 °C (32...140 °F)
Certificate number	TÜV 10 ATEX 7939 X

Section 8.2
Mechanical Requirements

Mechanical Requirements

Dimensions

The following figure gives the dimensions of the TM7 Safety-Related System blocks size 1 (left) and size 2 (right):

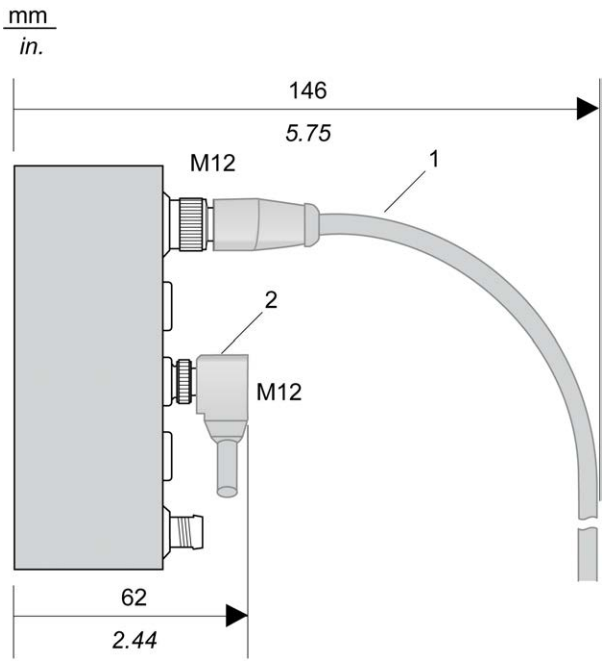


TM7 I/O Blocks		
Type of block	**Reference**	**Size**
Mixed input and output block for safety-related applications	TM7SDM12DTFS	2
Digital input block for safety-related applications	TM7SDI8DFS	1

Spacing Requirements

TM7 blocks can be installed side-by-side. However, you must observe the minimum spacings from the front face of each expansion block, based on cable connector type and cable bend radius *(see page 305)*.

The following figure shows an example of wire bending requirements for a block connected with pre-wired straight cables and elbowed cables:



1 Straight cable
2 Elbowed cable

Section 8.3
TM7 Power System

Introduction

In the planning phase, the number of I/O blocks that you select for your TM7 System, and the cable lengths between these blocks, determine the required power distribution. The following section helps you establish a power budget and select the power distribution and I/O blocks for your system.

What Is in This Section?

This section contains the following topics:

Topic	Page
TM7 Power Distribution Description	170
TM7 Power Distribution System Implementation	173
Example: Current Consumed by a Remote Configuration	174

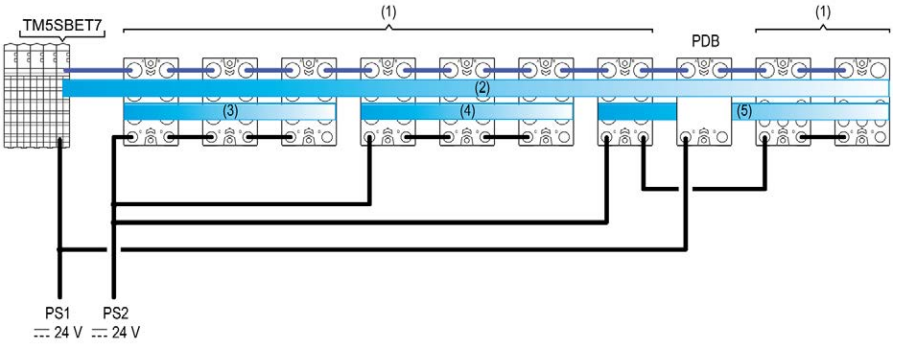
TM7 Power Distribution Description

Power Distribution Overview

In a remote configuration *(see page 27)*, the TM5SBET7 Transmitter module generates power for the TM7 power bus. The first I/O block of the remote configuration after a TM5SBET7 distributes power for the first 24 Vdc I/O power segment.

There are other components that generate supplemental power to the TM7 power bus, or distribute power to create separate 24 Vdc I/O power segments. For example, Power Distribution Blocks (PDB) can be added to provide supplementary power to the TM7 power bus if required by your I/O configuration. Another example, you connect a power supply to a I/O block to divide the 24 Vdc I/O power segment into several separated 24 Vdc I/O power segments.

The figure below shows a representation of the power distribution overview for a remote configuration. Refer to the section Wiring the Power Supply *(see page 188)* for details on connectors wiring:



(1) TM7 I/O blocks
(2) TM7 Power bus
(3...5) 24 Vdc I/O power segments
TM5SBET7 Transmitter module
PDB Power Distribution Block
PS1 External isolated main power supply, 24 Vdc
PS2 External isolated I/O power supply, 24 Vdc

TM7 Power Bus Description

The TM7 bus consists in two parts:

- TM7 data bus
- TM7 power bus

The TM7 power bus distributes the power to supply the electronics of the I/O blocks. If needed, the power on the TM7 bus can be reinforced by adding a PDB.

In a remote configuration, the TM7 data and power busses begin with a TM5SBET7 transmitter module.

NOTE: The TM5SBET7 transmitter module must be the last electronic module in the remote TM5 configuration that you intend to extend.

24 Vdc I/O Power Segment Description

Power is distributed to the inputs and outputs of the TM7 System through the 24 Vdc I/O power segment.

The 24 Vdc I/O power segment begins with the first TM7 component of the configuration and is terminated at the point where another I/O block is connected to a power supply or at the end of the configuration.

A segment is a group of I/O blocks connected to each other via the 24 Vdc power IN and 24 Vdc power OUT connectors.

The reasons to build a new segment are:

- To separate groups of I/O blocks. For example, a group of inputs separated from a group of outputs.
- Because the power supplied to the preceding 24 Vdc I/O power segment is fully consumed by the devices on that segment.

Transmitter Module (TM5SBET7)

The TM5SBET7 Transmitter Module supplies power to the TM7 power bus, and also relays data from the Sercos III Bus Interface to the remote expansion devices through the TM7 data bus.

Depending on the mounting position of the TM5SBET7 transmitter module, the number of TM7 expansion I/O blocks connected without a PDB is limited to:

TM5SBET7 Position	Maximum Number of TM7 I/O Blocks
Horizontal	8
Vertical	6

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Do not connect more than 8 blocks to a TM5SBET7 installed in a horizontal orientation.
- Do not connect more than 6 blocks to a TM5SBET7 installed in a vertical orientation.

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

NOTE: To install more than 6 or 8 blocks (according to the installation orientation of the TM5SBET7) of TM7 remote I/O, you will need to add a Power Distribution Block.

Power Distribution Block (PDB)

The Power Distribution Blocks (PDBs) are used to reinforce the voltages and currents distributed by the TM7 power bus. Any of the following may require you to add PDBs to reinforce the TM7 power bus:

- No PDBs have been installed, and the number of I/O blocks exceeds the maximum number that can be supported by the TM5SBET7 transmitter module based on installation orientation. For more information, refer to Transmitter Module *(see page 171)*.
- The installed transmitter module and PDBs are adequate to the I/O block current consumption and cable lengths, but you desire redundant power in the event a PDB becomes inoperative.
- The cumulative power consumption of the I/O block electronics exceeds the maximum output current available from the TM5SBET7 transmitter module and any PDBs already installed. For more information, refer to Current Supplied and Consumption Tables on the TM7 Power Bus *(see page 217)*.
- The maximum number of I/O blocks that can be powered by the existing transmitter module and PDBs has been installed, and the cable run from the first I/O block to the last exceeds 100 m (328 ft).

NOTE: If the distance from the first to the last I/O block on a fully populated TM7 power bus exceeds 100 m (328 ft), the voltage drop on the cable can reduce the maximum number of TM7 I/O blocks that can be powered. In these circumstances, add a PDB and verify that the supply voltage to each I/O block is within limits.

Supplying the TM7 Power Bus

The table below gives the maximum current supplied to the TM7 power bus:

Equipment	Current Supplied to the TM7 Power Bus in a Horizontal Mounting Orientation		Current Supplied to the TM7 Power Bus in a Vertical Mounting Orientation
	0...55 °C (32...131 °F)	55...60 °C (131...140 °F)	0...50 °C (32...122 °F)
TM5SBET7	304 mA	228 mA	228 mA
TM7SPS1A	750 mA		

Supplying the 24 Vdc I/O Power segment

The table below gives the maximum current distributed on the 24 Vdc I/O Power segment:

Equipment	Maximum Current
TM5SBET7	–
TM7SPS1A	–
TM7 I/O Block(1)	8 A
(1) When connecting the 24 Vdc I/O power IN connector to an external power supply	

TM7 Power Distribution System Implementation

Power Distribution Planning

The power distribution system supplies the 24 Vdc I/O power segment and the TM7 power bus for local and remote configurations.

The planning of your TM7 power distribution system should follow this order:

Step	Description
1	Select the combination of controllers, I/O, and accessories necessary for your application.
2	Create some 24 Vdc power segments by connecting the TM7 I/O blocks to power supplies.
3	Calculate the current consumed on the TM7 power bus and provide additional PDB where and when needed.
4	Identify any voltage drop considerations due to cable lengths in excess of 100 m (328 ft) and provide additional PDB where and when needed.
5	Calculate the current consumed on each 24 Vdc I/O power segment and connect TM7 I/O blocks to create segments where and when needed.

To plan the power distribution of the TM7 System you must calculate the:

- Current consumption on the TM7 power bus.
- Current consumption on the 24 Vdc I/O power segment(s)
  - The current consumed by the electronics of the block.
  - The current consumed by the loads connected to the DC outputs of the modules supplied by the 24 Vdc I/O power segment.
  - The current consumed to supply the sensors and actuators connected to the block.

Example: Current Consumed by a Remote Configuration

Introduction

This example is for a remote configuration *(see page 26)* (TM5 System Transmitter module and TM7 System expansion I/O blocks). From this example, you should be able to make the calculations necessary for your TM7 System.

All current consumption values are documented in the chapter TM7 Safety-Related System Power Consumption Tables *(see page 215)*.

Planning Example

This configuration example includes:

- The TM5SBET7 transmitter module.
- Some expansion blocks:
  - TM7BDI8B
  - TM7BDI16B
  - TM7SDM12DTFS
  - TM7BDM16B
  - TM7BDO8TAB
  - TM7SDI8DFS
  - TM7BAI4CLA
  - TM7BAO4CLA
- Assumptions used for the purposes of calculating the consumption of this example:

  TM7BDI8B: This block is connected to the power supply to distribute 8000 mA to the 24 Vdc I/O power segment.
  The current to supply the electronic sensors of this example has been estimated at 25 mA per sensor, or 200 mA total for the block.

  TM7BDI16B: The current to supply the electronic sensors of this example has been estimated at 37.5 mA per sensor, or 500 mA total for the block.

  TM7SDM12DTFS: The sum of the current draw for all outputs connected to the block is not more than 2500 mA at any given time.
  The current to supply the electronic sensors of this example has been estimated at 50 mA per sensor, or 400 mA total for the block.

  TM7BDM16B: The sum of the current draw for all outputs connected to the block is not more than 2000 mA at any given time.
  The current to supply the electronic sensors of this example has been estimated at 25 mA per sensor, or 200 mA total for the block.

  TM7BDO8TAB: This block is connected to the power supply to distribute 8000 mA to the 24 Vdc I/O power segment.
  Only 6 of the outputs are active at any given time, and that the maximum current draw of any given output is 1000 mA, or 6000 mA total for the block.

  TM7SDI8DFS: The consumption of the block is 150 mA (from main power supply). The consumption of the electronics of the block is 168 mA (from I/O power supply).

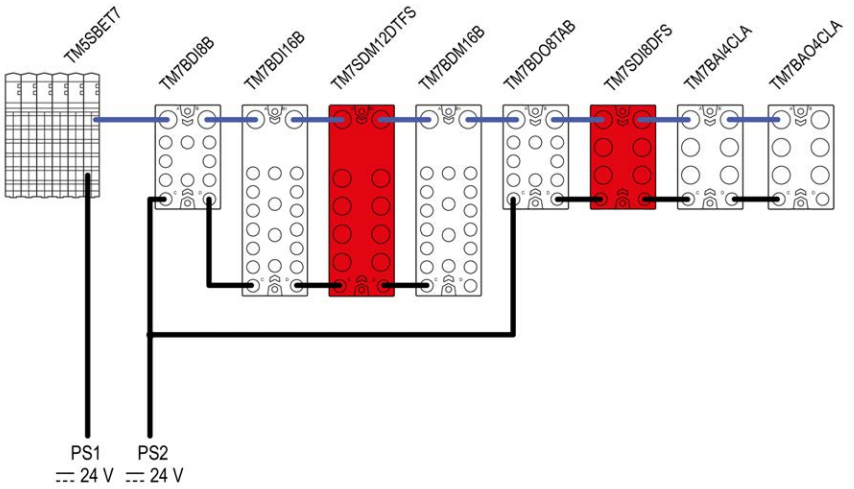
  TM7BAI4CLA: The consumption of the block is 38 mA (from main power supply).

The consumption of the electronics of the block is 125 mA (from I/O power supply).

TM7BAO4CLA: The consumption of the block is 38 mA (from main power supply).

The consumption of the electronics of the block is 188 mA (from I/O power supply).

The following graphic shows the example configuration connected to the power supplies PS1 and PS2:



PS1 External isolated main power supply, 24 Vdc
PS2 External isolated I/O power supply, 24 Vdc

The following table shows the current supplied and consumed in mA on the TM7 power bus and the 24 Vdc I/O power segment:

Type of power supply	Type of consumption (in mA)	TM5SBET7	TM7BDI8B	TM7BDI16B	TM7SDM12DTFS	TM7BDM16B	TM7BDO8TAB	TM7SDI8DFS	TM7BAI4CLA	TM7BAO4CLA
TM7 bus: External isolated main power supply, 24 Vdc	Current supplied on the TM7 power bus	304								
	Consumption of the TM7 System I/O block	0	38	38	160	38	38	150	38	38
	Remaining current available after block consumption	0	266	228	68	30	-8	-158	-196	–234

Type of power supply	Type of consumption (in mA)	TM5SBET7	TM7BDI8B	TM7BDI16B	TM7SDM12DTFS	TM7BDM16B	TM7BDO8TAB	TM7SDI8DFS	TM7BAI4CLA	TM7BAO4CLA
24 Vdc I/O power segment: External isolated I/O power supply, 24 Vdc	Current supplied on the 24 Vdc I/O power segment	8000	8000				8000			
	Consumption of the electronics of the TM7 I/O block	0	42	21	75	125	83.3	87.5	125	188
	Consumption of the loads of the output channels	0	0	0	2500	2000	6000	0	0	0
	Consumption of the supply to sensors, actuators or external devices	0	200	500	400	200	0	80	0	0
	Consumption of the supply to sensors, actuators or external devices	0	242	521	2975	2325	6083	168	125	188
	Remaining current available after block consumption	0	7758	7237	4262	1937	1917	1749	1624	1436

Current Consumed on the TM7 Power Bus

The TM5SBET7 generates 304 mA on the TM7 power bus to supply expansion blocks. The TM7 power bus begins with the TM7BDI8B block and terminates with the TM7BAO4CLA expansion block.

The total current consumed on the TM7 power bus is 538 mA and exceeds the 304 mA capacity of the segment.

Supplement the TM7 power bus by adding a TM7SPS1A between the TM7BDM16B and TM7BDO8TAB blocks.

NOTICE
EQUIPMENT DAMAGE Supplement the TM7 power bus by adding a Power Distribution Block (PDB) when the current consumption on the TM7 power bus exceeds the capacity of the segment. **Failure to follow these instructions can result in equipment damage.**

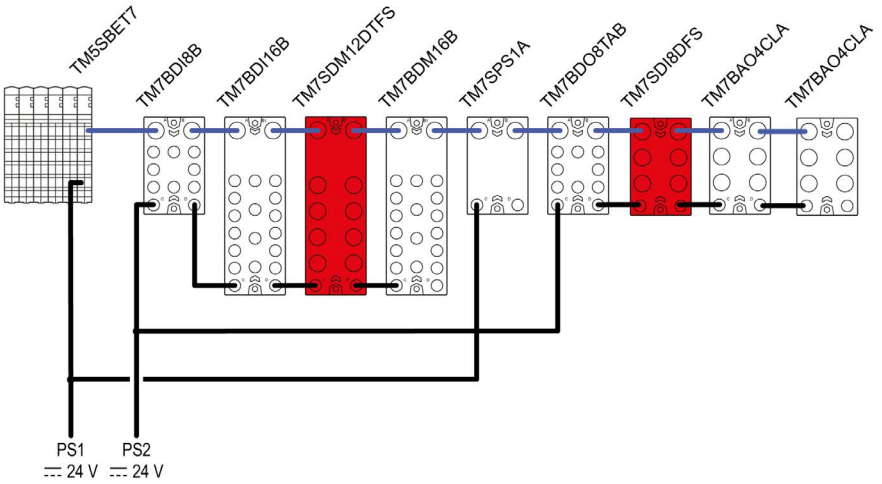
The following table shows the current supplied and consumed in mA on the TM7 power bus:

Type of power supply	Type of consumption (in mA)	TM5SBET7	TM7BDI8B	TM7BDI16B	TM7SDM12DTFS	TM7BDM16B	TM7SPS1A	TM7BDO8TAB	TM7BDI8DFS	TM7BAI4CLA	TM7BAO4CLA
TM7 bus: External isolated main power supply, 24 Vdc	Current supplied on the TM7 power bus	304					750				
	Consumption of the TM7 System I/O block	0	38	38	160	38	0	38	150	38	38
	Remaining current available after block consumption	0	266	228	68	30	780	742	592	554	516

Type of power supply	Type of consumption (in mA)	TM5SBET7	TM7BDI8B	TM7BDI16B	TM7SDM12DTFS	TM7BDM16B	TM7SPS1A	TM7BDO8TAB	TM7BDI8DFS	TM7BAI4CLA	TM7BAO4CLA
24 Vdc I/O power segment: External isolated I/O power supply, 24 Vdc	Current supplied on the 24 Vdc I/O power segment	8000									
	Consumption of the electronics of the TM7 I/O block	0	42	21	75	125	0	83.3	87.5	125	188
	Consumption of the loads of the output channels	0	0	0	2500	2000	0	6000	0	0	0
	Consumption of the supply to sensors, actuators or external devices	0	200	500	400	200	0	0	80	0	0
	Consumption of the supply to sensors, actuators or external devices	0	242	521	2975	2325	0	6083	168	125	188
	Remaining current available after block consumption	0	7758	7237	4262	1937	8000	1917	1749	1624	1436

The total current consumed on the TM7 power bus is 538 mA, and does not exceed the 1054 mA capacity of the TM7 power bus.

The following graphic shows the example configuration (with the PDB) connected to the power supplies PS1 and PS2:



PS1 External isolated main power supply, 24 Vdc
PS2 External isolated I/O power supply, 24 Vdc

For important information concerning power supply connections, TM5SBET7, PDB, I/O Block, refer to Wiring the Power Supply *(see page 188)*.

The next step is to calculate the current consumed on the 24 Vdc I/O power segment to validate the configuration of this example.

Current Consumed on the 24 Vdc I/O Power Segment

In this example,

- The first 24 Vdc I/O power segment begins with the TM7BDI8B and finishes with the TM7BDM16B. The capacity of this segment is limited to 8000 mA.
- The second 24 Vdc I/O power segment begins with the TM7BDO8TAB and finishes with the TM7BAO4CLA. The capacity of this segment is limited to 8000 mA.

The following table shows the current supplied and consumed in mA on the 24 Vdc I/O power segment:

Type of power supply	Type of consumption (in mA)	TM5SBET7	TM7BDI8B	TM7BDI16B	TM7SDM12DTFS	TM7BDM16B	TM7SPS1A	TM7BDO8TAB	TM7SDI8DFS	TM7BAI4CLA	TM7BAO4CLA
TM7 bus: External isolated main power supply, 24 Vdc	Current supplied on the TM7 power bus	304					750				
	Consumption of the TM7 System I/O block	0	38	38	160	38	0	38	150	38	38
	Remaining current available after block consumption	0	266	228	68	30	780	742	592	554	516

Type of power supply	Type of consumption (in mA)	TM5SBET7	TM7BDI8B	TM7BDI16B	TM7SDM12DTFS	TM7BDM16B	TM7SPS1A	TM7BDO8TAB	TM7SDI8DFS	TM7BAI4CLA	TM7BAO4CLA
24 Vdc I/O power segment: External isolated I/O power supply, 24 Vdc	Current supplied on the 24 Vdc I/O power segment	8000									
	Consumption of the electronics of the TM7 I/O block	0	42	21	75	125	0	83.3	87.5	125	188
	Consumption of the loads of the output channels	0	0	0	2500	2000	0	6000	0	0	0
	Consumption of the supply to sensors, actuators or external devices	0	200	500	400	200	0	0	80	0	0
	Consumption of the supply to sensors, actuators or external devices	0	242	521	2975	2325	0	6083	168	125	188
	Remaining current available after block consumption	0	7758	7237	4262	1937	8000	1917	1749	1624	1436

The total current consumed on the first 24 Vdc I/O power segment is 6063 mA and does not exceed the 8000 mA capacity of this segment.

The total current consumed on the second 24 Vdc I/O power segment is 6564 mA and does not exceed the 8000 mA capacity of that segment.

NOTICE
EQUIPMENT DAMAGE Create a new segment when the current consumption of the devices on a 24 Vdc I/O power segment exceeds the capacity of the segment. **Failure to follow these instructions can result in equipment damage.**

NOTE: To create a new segment, connect a separate external isolated power supply to 24 Vdc Power In connector of the block that would otherwise cause the current limitation to be exceeded.

Section 8.4
Electrical Requirements

Introduction

The following section provides the general wiring rules for the TM7 System. Considerations and techniques for grounding the TM7 System are also presented.

What Is in This Section?

This section contains the following topics:

Topic	Page
Wiring Best Practices	184
Selecting an External 24 Vdc Power Supply	187
Wiring the Power Supply	188

Wiring Best Practices

Introduction

There are several rules that must be followed when wiring a TM7 System. Refer to TM7 Cables *(see page 305)* for additional details.

Wiring Rules

⚠ 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.

The following rules must be applied when wiring the TM7 System:

- 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 only.
- In the case of TM7 Safety-related I/O modules, use only the expansion bus and I/O cables specifically designed for TM7 I/O.

TM7 Blocks Grounding

The TM7 System blocks, when using Schneider Electric IP67 pre-fabricated cables, incorporate a grounding system intrinsic to the mounting and connecting hardware. The TM7 System blocks must always be mounted on a conductive backplane. The backplane or object used for mounting the blocks (metal machine frame, mounting rail or mounting plate) must be grounded (PE) according to your local, regional and national requirements and regulations. Refer to grounding of your system blocks *(see page 106)*, for more important information.

NOTE: If you do not use Schneider Electric IP67 pre-fabricated cables, you must use shielded cables and conductive connectors (metal threads on the connector), and be sure to connect the cable shield to the metal sleeve of the connector.

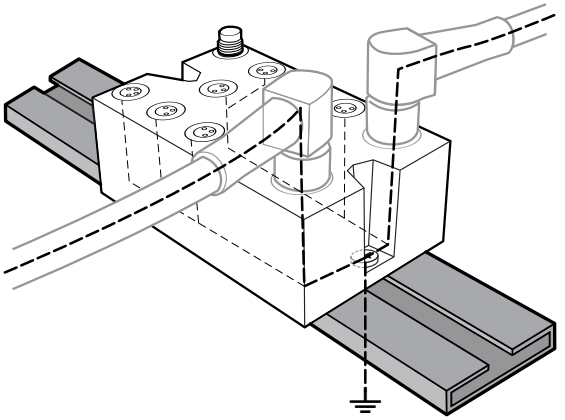
⚠ WARNING

IMPROPER GROUNDING CONTINUITY

- Use only cables with insulated, shielded jackets.
- Use only IP67 connectors with metal threads.
- Connect the cable shield to the metal threads of the connectors.
- Always comply with local, regional and/or national wiring requirements.

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

The following figure presents the grounding of the TM7 System:



Protecting Outputs from Inductive Load Damage

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

NOTICE

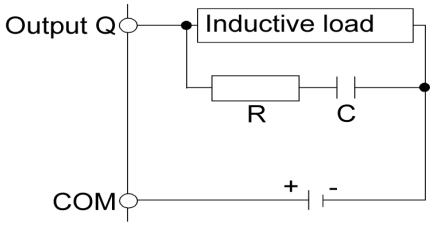
INOPERABLE EQUIPMENT

- Be sure that the actuators connected to the TM7 Digital I/O blocks have a built-in protective circuit to reduce the risk of inductive current load damage to the outputs.
- If the actuators do not have built-in protection, use an appropriate, IP67 rated external protective circuit to reduce the risk of inductive current load damage to the outputs.

Failure to follow these instructions can result in equipment damage.

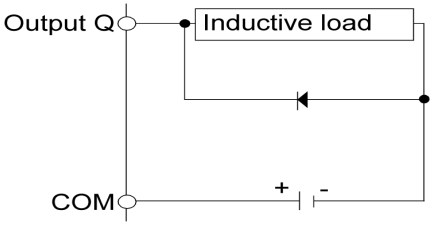
NOTE: The following wiring diagrams are conceptual and are provided as non-definitive guidance for selecting an appropriate IP67 protective device.

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



- C represents a value from 0.1 to 1 µF.
- R represents a resistor of approximately the same resistance value as the load.

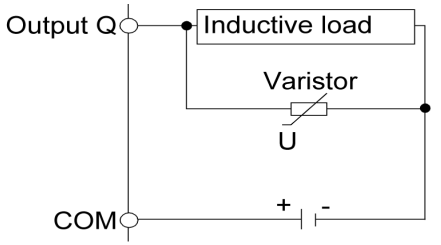
Protective circuit B: this protection circuit can be used for DC load power circuits.



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 DC load power circuits.



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.

Selecting an External 24 Vdc Power Supply

Characteristics of the 24 Vdc Power Supply

The TM7 System requires power supplies with a nominal voltage of 24 Vdc. The 24 Vdc power supplies must be rated Protective Extra Low Voltage (PELV) according to IEC 61140. These power supplies are isolated between the electrical input and output circuits of the power supply.

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

Calculating the Power Supply Requirement

Refer to TM7 Power Distribution System Implementation *(see page 173)*.

Wiring the Power Supply

Overview

To distribute current for the 24 Vdc I/O power segment(s) and TM7 power bus, and according to the power distribution description *(see page 170)*, the following modules and blocks are connected to an external power source:

- Transmitter module (TM5SBET7)
- Power Distribution Block (PDB)
- I/O blocks

Source power for these can come from one or more supplies. Your requirements are dictated by:

- voltage and current needs
- isolation requirements

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

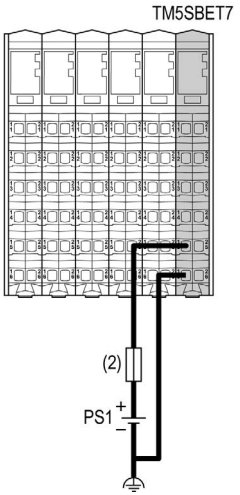
- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

Wiring the Transmitter Module (TM5SBET7)

The TM5SBET7 *(see page 171)* is the connection to the external 24 Vdc power supply and the beginning of the power distribution for the TM7 remote configuration. The power is supplied by one external isolated power supply depending on current needs and capabilities.

The following figure shows the wiring of the TM5SBET7 wired with one external 24 Vdc power supply:



(2) External fuse, Type T slow-blow, 1 A, 250 V
PS1 External isolated power supply, 24 Vdc

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system. If you do not interconnect the 0 Vdc circuits of the external power supplies, the status LEDs may not function correctly. In addition, there may potentially be more significant consequences such as an explosion and/or fire hazard.

⚠ DANGER

POTENTIAL EXPLOSION OR FIRE

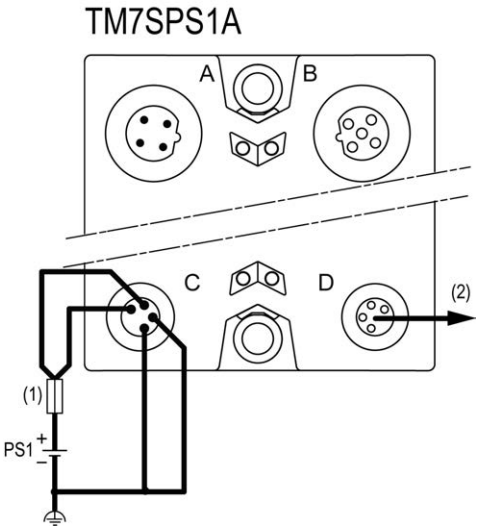
Always connect the 0 Vdc terminals of the external power supplies to the functional ground (FE) of your system.

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

Wiring the PDB

The TM7SPS1A (PDB) reinforces the TM7 power bus *(see page 170)*. Power is supplied by one external isolated power supply depending on current needs and capabilities.

The following figure shows the wiring of the PDB with one power supply:



(1) External fuse, Type T slow-blow, 1 A minimum, 4 A maximum, 250 V
(2) Maximum current 4 A
PS1 External isolated main power supply, 24 Vdc

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

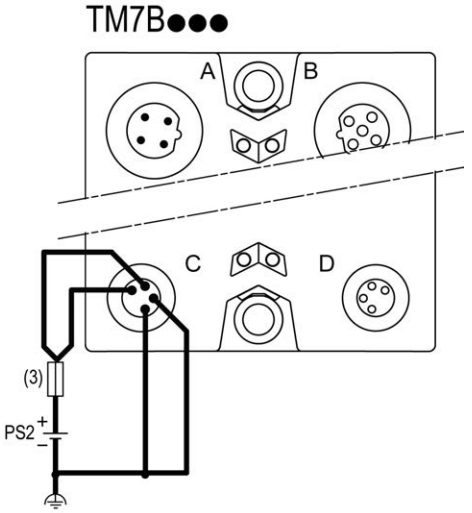
Failure to follow these instructions will result in death or serious injury.

Wiring the I/O Block

When you provide power to a TM7 I/O block using the 24 VDC Power OUT connector of the preceding I/O block, both blocks occupy the same 24 Vdc I/O power segment. However, if you connect an external isolated power supply to the 24 Vdc Power IN connector of a TM7 I/O block, you establish a new 24 Vdc I/O power segment beginning with that I/O block.

When beginning a new 24 Vdc I/O power segment, select an external isolated power supply sufficient to the power requirements of the I/O blocks planned for that segment. For more information, refer to 24 Vdc I/O Power Segment Description *(see page 170)*.

The following figure shows a I/O block wired with one external 24 Vdc power supply:



(3) External fuse, Type T slow-blow, 8 A maximum, 250 V
PS2 External isolated I/O power supply, 24 Vdc

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

Section 8.5
System Limits

System Limits

Introduction

For information on the safety-related TM7 System Limits, refer to the respective TM5 section System Limits *(see page 112)*.

Chapter 9
Installation Procedures

Overview

This chapter focuses on procedures for construction of a TM7 System. The installation guidelines summarize the steps involved in the installation process.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Installation Requirements	194
Installation Guidelines	197
Addressing	204

Installation Requirements

Before Starting

Read and understand this chapter before beginning the installation of your TM7 System.

⚠ DANGER

POTENTIAL FOR EXPLOSION

- Use devices with explosion protection as intended according to these operation instructions and corresponding documents.
- Conform to valid safety and accident prevention regulations and adhere to standards such as IEC/EN 60079-14.
- Be sure that all other associated equipment, such as cables and connectors, are also suitable for the operating location.
- Ground all devices, using a metal plate, terminal strip or mounting plate securely connected to the housing back plate, to an equalized potential.
- 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.
- Devices must remain voltage free until all installation or maintenance work is completed.
- Remove as necessary dust collecting on devices that can cause explosions.
- Be sure that all connectors and sealing plugs on the M8 and M12 connectors are in place and fastened with a torque between 0.2 and 0.4 Nm (1.8 and 3.5 lbf-in) before applying any power.
- Be sure that all connectors are firmly sealed with either properly wired connectors or sealing plugs before applying power during regular operation.

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

NOTICE

ELECTROSTATIC DISCHARGE

- Do not touch the pin connectors of the block.
- Keep the cables or sealing plugs in place during normal operation.

Failure to follow these instructions can result in equipment damage.

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

⚠ DANGER

POTENTIAL FOR EXPLOSION

- Only use this equipment in non-hazardous locations or in locations that comply either with the Class I, Division 2, Groups A, B, C and D, or with the ATEX Group II, Zone 2 specifications for hazardous locations, depending on your local and/or national regulations.
- Do not substitute components which would impair compliance to the hazardous location specifications of this equipment.
- Do not connect or disconnect equipment unless power has been removed or the location is known to be non-hazardous.

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

NOTE: Additional equipment used in conjunction with the equipment described herein must also be suitable for the operating location.

Requirements for use in ATEX Group II, Zone 2:

- Install and use the equipment strictly in accordance to the installation and operating instructions found here and in other related documentation.
- Respect and follow all valid safety and accident prevention regulations, as well as adhering to standards such as IEC/EN 60079-14 or those that govern the eventual locality of your application.
- All equipment must be grounded to an equipotential ground plane dimensioned to the power system of your application.
- Equipment must remain unpowered until installation work is completed, including all cable connections with the proper torque having been applied to all connector unions.
- Before applying power, be sure that all connectors that are not being used (open connectors with no cable attached) are capped with suitable sealing plugs.
- During service or maintenance, the equipment must be shut down and protected from being accidently restarted.
- Do not connect or disconnect cables or sealing plugs under power unless the equipment is in a known non-hazardous location.

⚠ 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.

NOTE: Individual modules may differ in terms of operating temperature de-ratings or other important environmental characteristics. For the specific information, refer to the hardware guide for your particular module.

Installation Considerations

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- 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 use this equipment in safety-critical machine functions unless the equipment is otherwise designated as functional safety equipment and conforming to applicable regulations and standards.
- 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: Use UL-recognized and CSA approved JDYX2 or JDYX8 fuse types.

Installation Guidelines

Introduction

The TM7 System can be mounted using:

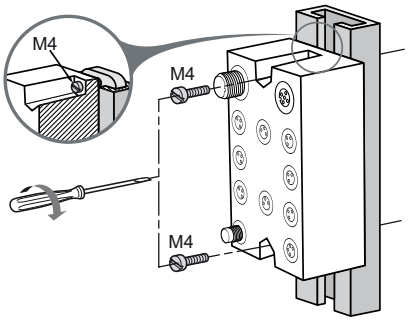
- An aluminium frame with two wedge nuts and M4 screws
- A DIN rail with TM7ACMP mounting plate
- Directly on the machine.

NOTE: Mounting on a DIN rail using the TM7ACMP mounting plate is only possible with the size 1 (smallest) block dimension *(see page 167)*.

NOTE: The TM7 System components must always be mounted to a conductive backplane.

TM7 Block on an Aluminium Frame

Blocks can be mounted on an aluminium frame with two wedge nuts and M4 screws:



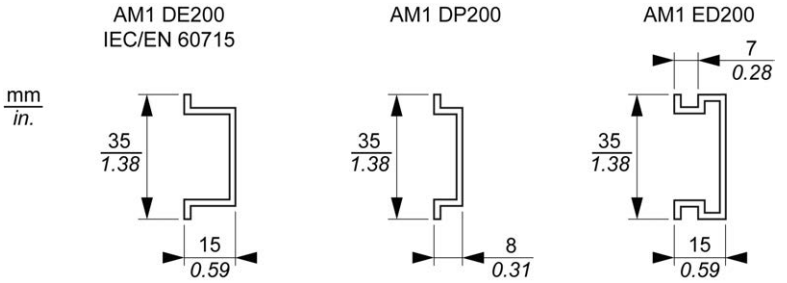
NOTE: Maximum torque to fasten the M4 screws is 0.6 N.m (5.3 lbf-in).

NOTICE
INOPERABLE EQUIPMENT • Ensure that the block is securely affixed to its mounting surface. • Do not tighten screws beyond the specified maximum torque. **Failure to follow these instructions can result in equipment damage.**

TM7 Block on a DIN Rail

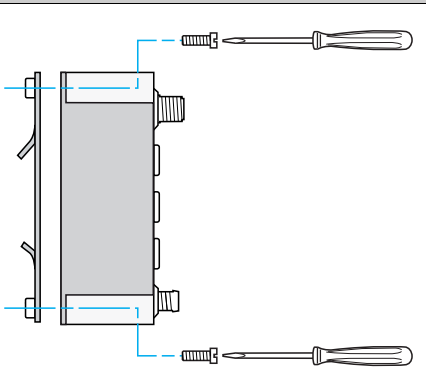
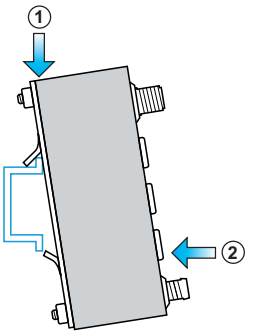
You can mount the size 1 blocks on a DIN rail with the TM7ACMP *(see page 56)* mounting plate. For EMC (Electromagnetic Compatibility) compliance, a metal DIN rail must be attached to a flat metal mounting surface or mounted on an EIA (Electronic Industries Alliance) rack or in a NEMA (National Electrical Manufacturers Association) enclosure. In all cases, the mounting surface must be properly grounded *(see page 106)*.

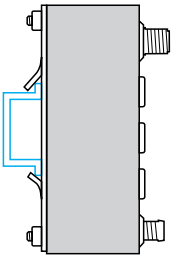
You can order a suitable DIN rail from Schneider Electric:



NOTE: Only size 1 (smallest) blocks can be installed on DIN rail with the mounting plate.

The following procedure gives step by step instructions to assemble and install a block on a DIN rail:

Step	Action	
1	Screw the block to the mounting plate. The required screws are supplied with the mounting plate. **NOTE:** Maximum torque to fasten the required screws is 0.6 Nm (5.3 lbf-in).	
2	Place the upper protruding catches of the mounting plate on the top edge of the DIN rail (1). Rotate the block to the DIN rail until it clicks (2).	

Step	Action	
3	The block is correctly installed to the DIN rail	

NOTICE

INOPERABLE EQUIPMENT

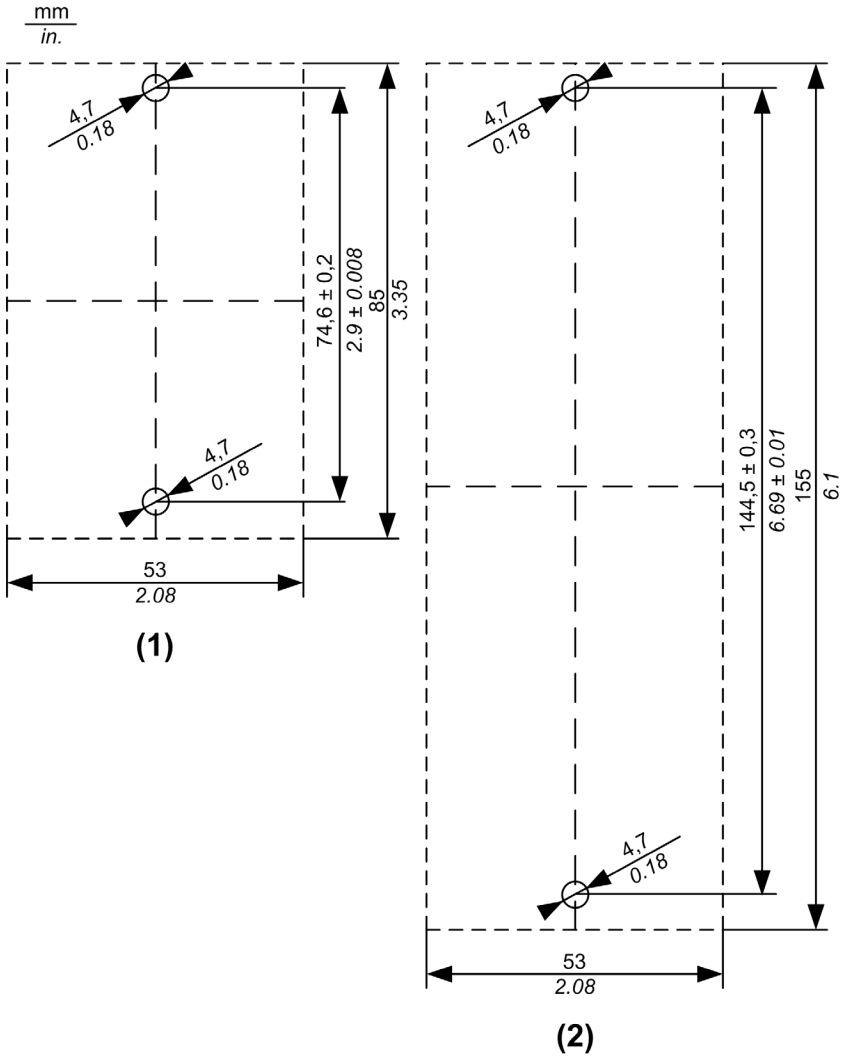
- Ensure that the block is securely affixed to its mounting surface.
- Do not tighten screws beyond the specified maximum torque.

Failure to follow these instructions can result in equipment damage.

For more information on mounting the DIN rail refer to the TM5 section DIN Rail Installation *(see page 122)*.

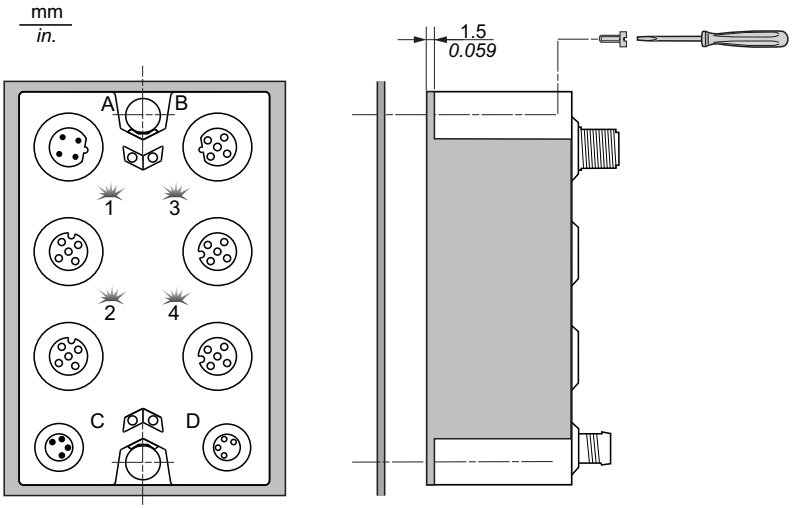
TM7 Block Directly on the Machine

The TM7 block can be mounted to any bare-metal surface of the machine, provided that the surface is properly grounded *(see page 106)*. To mount the block directly on the machine, the following figure gives the drilling template of the blocks:



(1) Size 1 block
(2) Size 2 block

The thickness of the base plate should be taken into consideration when defining the screw length.

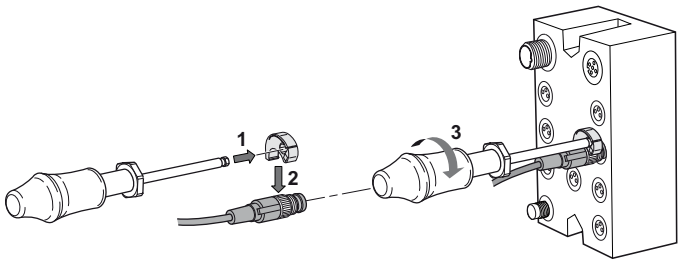


NOTE: Maximum torque to fasten the required M4 screws is 0.6 Nm (5.3 lbf-in).

NOTICE
INOPERABLE EQUIPMENT • Ensure that the block is securely affixed to its mounting surface. • Do not tighten screws beyond the specified maximum torque. **Failure to follow these instructions can result in equipment damage.**

TM7 Cable Installation

The plug connector of the TM7 cables *(see page 305)* is mounted by hand and then tightened to a defined force with the aid of the torque wrench *(see page 58)*:



Connector Size	Torque
M8	0.2 Nm (1.8 lbf-in)
M12	0.4 Nm (3.5 lbf-in)

⚠ WARNING

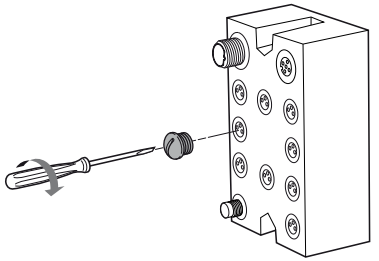
IP67 NON-CONFORMANCE

- Properly fit all connectors with cables or sealing plugs and tighten for IP67 conformance according to the torque values as specified in this document.
- Do not connect or disconnect cables or sealing plugs in the presence of water or moisture.

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

Sealing Plug Installation

Open connectors with no cable attached are capped with suitable sealing plugs *(see page 57)*:



Connector Size	Torque
M8	0.2 Nm (1.8 lbf-in)
M12	0.4 Nm (3.5 lbf-in)

⚠ WARNING

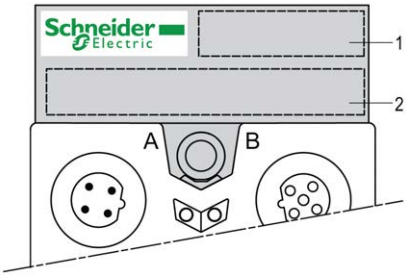
IP67 NON-CONFORMANCE

- Properly fit all connectors with cables or sealing plugs and tighten for IP67 conformance according to the torque values as specified in this document.
- Do not connect or disconnect cables or sealing plugs in the presence of water or moisture.

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

TM7 Block Labeling

The support for block label and its label are inserted in the appropriate opening in the top (the figure below) or in the bottom of the block:



1 Reference of the block
2 Area for customer

Addressing

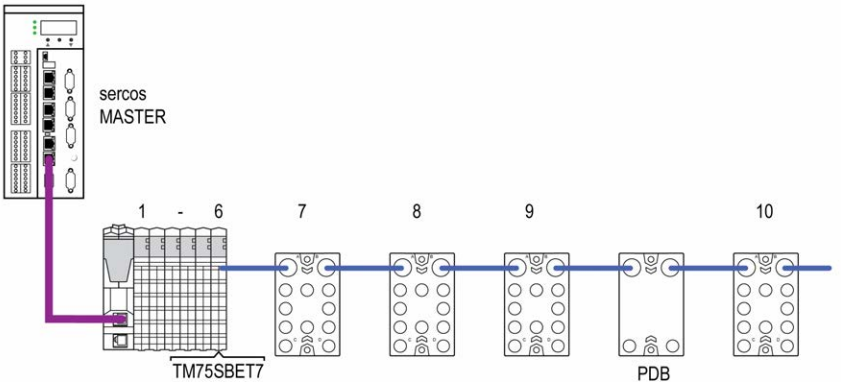
Addressing Principle

The TM7 bus is auto-addressing, and automatically increments by 1 starting with the first I/O block after the TM5SBET7 transmitter module. For example, if the address of the transmitter module is 6, the first TM7 I/O block will automatically be assigned an address of 7.

NOTE: The TM7 Power Distribution Block (PDB) does not have a physical address.

An Example of Addressing

The example below illustrates the addressing principle for the TM7 bus. As you can see, the TM7 System automatically addresses the I/O blocks from left to right:



TM5SBET7 Transmitter module
PDB Power Distribution Block

Chapter 10
Commissioning and Maintaining

Diagnostics

Diagnostics

The TM7 System offers several levels of diagnostics depending on the type of the block using LED displays.

Refer to *TM7 Digital I/O Blocks Hardware Guide* , *TM7 Analog I/O Blocks Hardware Guide* and/or *Modicon TM5/TM7 I/O Safety Modules Hardware Guide* for the products of the TM7 System for status LEDs descriptions.

Appendices

Overview

These appendices give the association and power consumption tables, the description of the power distribution and common distribution electronic modules, the bus bases and terminal blocks for designing your TM5 / TM7 Safety-Related System.

What Is in This Appendix?

The appendix contains the following chapters:

Chapter	Chapter Name	Page
A	Association and Power Consumption Tables	209
B	TM5 Power Distribution Modules (PDM)	219
C	TM5 Interface Power Distribution Module (IPDM)	249
D	TM5 Common Distribution Modules (CDM)	257
E	TM5 Accessories Modules	287
F	TM5 Safety-Related System Bus Bases, Terminal Blocks and Memory Keys	289
G	TM7 Power Distribution Block (PDB)	299
H	TM7 Cables	305

Appendix A
Association and Power Consumption Tables

Overview

This chapter gives the association table and power consumption tables that are useful for designing your TM5 Safety-Related System and TM7 Safety-Related System.

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
A.1	Association Table	210
A.2	TM5 Safety-Related System Power Consumption Tables	212
A.3	TM7 Safety-Related System Power Consumption Tables	215

Section A.1
Association Table

TM5 Safety-Related System Association Table

Association Table

One bus base, one electronic module and one terminal block compose a slice.

A slice must only be composed of a single color. For example, a gray bus base should only be assembled with a gray electronic module and a gray terminal block. However, color alone is not sufficient for compatibility; always confirm that functionality of slice components matches as well.

⚠ ⚠ DANGER

INCOMPATIBLE COMPONENTS CAUSE ELECTRIC SHOCK OR ARC FLASH

- Do not associate components of a slice that have different colors.
- Always confirm the compatibility of slice components and modules before installation using the association table in this manual.
- Verify that correct terminal blocks (minimally, matching colors and correct number of terminals) are installed on the appropriate electronic modules.

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

The following table provides information on the compatibility of the bus bases, electronic modules, and terminal blocks available in the TM5 Safety-Related System.

Reference		Bus Bases		Terminal Blocks		
		TM5ACBM3FS	TM5ACBM4FS	TM5ACTB52FS	TM5ACTB5EFS	TM5ACTB5FFS
Digital Safety Input Modules	TM5SDI2DFS	X	–	X	–	–
	TM5SDI4DFS	X	–	X	–	–
	TM5SDI20DFS	X	–	X	–	–

X Compatible
– Incompatible

Reference		Bus Bases		Terminal Blocks		
		TM5ACBM3FS	TM5ACBM4FS	TM5ACTB52FS	TM5ACTB5EFS	TM5ACTB5FFS
Digital Safety Output Modules	TM5SDO2TFS	X	–	X	–	–
	TM5SDO2TAFS	X	–	X	–	–
	TM5SDO2DTRFS	X	–	X	–	–
	TM5SDO4TFS	X	–	X	–	–
	TM5SDO4TAFS	X	–	X	–	–
	TM5SDO6TBFS	X	–	X	–	–
Digital Safety Mixed Input/Output Modules	TM5SDM4DTRFS	X	–	X	–	–
	TM5SDM8TBFS	X	–	–	–	X
Analog Safety Input Modules	TM5SAI4AFS	X	–	–	X	–
	TM5SAI4ATCFS	X	–	–	X	X
Digital Counter Safety Module	TM5SDC1FS	X	–	X	–	–
Safety Power Distribution Module	TM5SPS10FS	–	X	X	–	–
X Compatible **–** Incompatible						

Section A.2
TM5 Safety-Related System Power Consumption Tables

Introduction

This section gives the current supplied and consumption tables useful for designing your TM5 Safety-Related System.

What Is in This Section?

This section contains the following topics:

Topic	Page
Current Supplied and Consumption Tables on the 24 Vdc I/O Power Segment	213
Current Supplied and Consumption Tables on the TM5 Power Bus	214

Current Supplied and Consumption Tables on the 24 Vdc I/O Power Segment

Introduction

The following tables give a synthesis of the current supplied and current consumed on the 24 Vdc I/O power segment by the following TM5 Safety-Related System components:

- Electronic modules

The bus bases do not draw current from the 24 Vdc I/O power segment.

Electronic Modules

The following table gives the current consumed by the electronic modules on the 24 Vdc I/O power segment:

Reference		On the 24 Vdc I/O Power Segment			
		Current Consumed by the Electronic Module (mA)	Maximum Current Consumed by the Loads (mA) of the Module	Maximum Current Consumed by the Sensor/Actuator/ External Device (mA)	Maximum Measurement Range Evaluable by one Output
Digital Safety Input Modules	TM5SDI2DFS	41.7	-	-	2.48 mA
	TM5SDI4DFS	52.1	-	-	2.48 mA
	TM5SDI20DFS	66.7	-	-	2.48 mA
Digital Safety Output Modules	TM5SDO2TFS	40.8	1000	500	-
	TM5SDO2TAFS	40.8	4000	2000	-
	TM5SDO2DTRFS	47.9	5...6000	5...6000	-
	TM5SDO4TFS	54.2	2000	500	-
	TM5SDO4TAFS	54.2	5000	2000	-
	TM5SDO6TBFS	58.3	1200	200	-
Digital Safety Mixed Input/output Modules	TM5SDM4DTRFS	47.9	5...6000	5...6000	3.30 mA
	TM5SDM8TBFS	58.3	1000	500	2.48 mA
Analog Safety Input Modules	TM5SAI4AFS	70.8	-	-	0.5...25 mA
	TM5SAI4ATCFS	50.0	-	-	-65 mV... +65 mV
Digital Counter Safety Module	TM5SDC1FS	31.3	80	80	2.48 mA
Safety Power Distribution Module	TM5SPS10FS	62.5	10000	10000	-

Current Supplied and Consumption Tables on the TM5 Power Bus

Introduction

The following tables give a synthesis of the current supplied and current consumed on the TM5 power bus by the following TM5 Safety-Related System components:

- Electronic modules
- Bus bases

Electronic Modules

The following table gives the current consumed by the electronic modules on the TM5 power bus:

Reference		On the TM5 Power Bus
		Current Consumed (mA)
Digital Safety Input Modules	TM5SDI2DFS	50
	TM5SDI4DFS	64
	TM5SDI20DFS	80
Digital Safety Output Modules	TM5SDO2TFS	50
	TM5SDO2TAFS	50
	TM5SDO2DTRFS	52
	TM5SDO4TFS	50
	TM5SDO4TAFS	50
	TM5SDO6TBFS	64
Digital Safety Mixed Input/Output Module	TM5SDM4DTRFS	52
	TM5SDM8TBFS	50
Analog Safety Input Modules	TM5SAI4AFS	50
	TM5SAI4ATCFS	50
Digital Counter Safety Module	TM5SDC1FS	50
Safety Power Distribution Module	TM5SPS10FS	40
NOTE: The current consumption values of the electronic modules do not take into account the current consumption values of the associated bus bases *(see page 214)*.		

Bus Bases

The following table gives the current consumed by the bus base on the TM5 power bus:

Reference	On the TM5 Power Bus
	Current Consumed (mA)
TM5ACBM3FS	26
TM5ACBM4FS	26

Section A.3
TM7 Safety-Related System Power Consumption Tables

Introduction

This section gives the current supplied and consumption tables useful for designing your TM7 Safety-Related System.

What Is in This Section?

This section contains the following topics:

Topic	Page
Current Supplied and Consumption Tables on the 24 Vdc I/O Power Segment	216
Current Supplied and Consumption Tables on the TM7 Power Bus	217

Current Supplied and Consumption Tables on the 24 Vdc I/O Power Segment

Introduction

The following tables give a synthesis of the current supplied and current consumed on the 24 Vdc I/O power segment by the TM7 Safety-Related System blocks.

NOTE: There is no current supplied or consumed by the TM7 Power Distribution Block (PDB) on the 24 Vdc I/O power segment.

TM7 Safety-Related System Block

The following table gives the current supplied and consumed by the TM7 Safety-Related System block on the 24 Vdc I/O power segment:

Reference		On the 24 Vdc I/O Power Segment			
		Maximum Current Supplied(1) (mA)	Current Consumed by the Electronic (mA)	Maximum Current Consumed by the Loads (mA)	Maximum Current Consumed by the Sensor/Actuator (mA)
Digital safety mixed input/output	TM7SDM12DTFS	5000	75	5000	2000
Digital safety input	TM7SDI8DFS	1200	87.5	1200	600
(1) When connecting the 24 Vdc I/O power IN connector to an external power supply					

Current Supplied and Consumption Tables on the TM7 Power Bus

Introduction

The following table gives a synthesis of the current supplied and current consumed on the TM7 power bus by the following TM5 / TM7 System components:

- TM5SBET7 Transmitter module,
- TM7 Safety-Related System expansion block.

TM5SBET7 Transmitter Module

For information on the current supplied to the TM7 power bus, refer to Supplying the TM7 Power Bus *(see page 170)*.

Expansion Block

The following table gives the current consumed by the expansion block on the TM7 power bus:

Reference		On the TM7 Power Bus
		Current Consumed (mA)
Digital Safety mixed input/output	TM7SDM12DTFS	160
Digital Safety input	TM7SDI8DFS	150

Appendix B
TM5 Power Distribution Modules (PDM)

Overview

This chapter describes the Power Distribution Modules (PDM).

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
B.1	TM5SPS1 PDM Electronic Module 24 Vdc I/O	220
B.2	TM5SPS1F PDM Electronic Module 24 Vdc I/O Fuse 6.3 A	227
B.3	TM5SPS2 PDM Electronic Module 24 Vdc I/O and TM5 Power Bus	234
B.4	TM5SPS2F PDM Electronic Module 24 Vdc I/O Fuse 6.3 A and TM5 Power Bus	241

Section B.1
TM5SPS1 PDM Electronic Module 24 Vdc I/O

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SPS1 Presentation	221
TM5SPS1 Characteristics	223
TM5SPS1 Wiring Diagram	225

TM5SPS1 Presentation

Main Characteristics

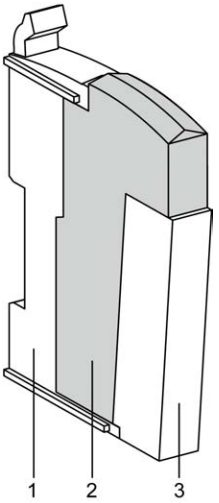
The TM5SPS1 Power Distribution Module (PDM) supplies the 24 Vdc I/O power segment.

The table below describes the main characteristics of the TM5SPS1 electronic module:

Main Characteristics	
Maximum current provided on 24 Vdc I/O power segment	10000 mA
TM5 power bus current generated	No

Ordering Information

The following figure and table gives the references to create a slice with the TM5SPS1 electronic module:

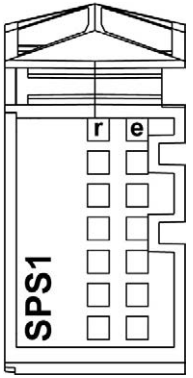


Number	Reference	Description	Color
1	TM5ACBM01R or TM5ACBM05R	Bus base 24 Vdc I/O power segment left isolated Bus base 24 Vdc I/O power segment left isolated with address setting	Gray Gray
2	TM5SPS1	Electronic module	Gray
3	TM5ACTBM12PS	Terminal block, 12-pin	Gray

NOTE: For more information, refer to TM5 Bus Bases and Terminal Blocks *(see PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide)*.

Status LEDs

The following figure shows the TM5SPS1 status LEDs:



The table below describes the TM5SPS1 status LEDs:

LED	Color	Status	Description
r	Green	Off	Power supply not connected
		Single flash	Reset state
		Flashing	Preoperational state
		On	RUN state
e	Red	Off	OK or module not connected
		Double flash	Indicates one of the following conditions: ● 24 Vdc I/O power segment, via the external power supply or supplies, is too low. ● TM5 power bus, via the external power supply or supplies, is too low.
e+r	Steady red/single green flash		Invalid firmware

TM5SPS1 Characteristics

Introduction

This section gives the TM5SPS1 electronic module characteristics.

See also Environmental Characteristics *(see page 62)*.

⚠ DANGER

FIRE HAZARD

- Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm^2 (AWG 20) with a temperature rating of at least 80 °C (176 °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^2 (AWG 16) with a temperature rating of at least 80 °C (176 °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.

General Characteristics

The following table shows the general characteristics of the TM5SPS1 electronic module:

General Characteristics	
Rated power supply voltage	24 Vdc
24 Vdc I/O power segment current draw	25 mA
TM5 power bus 5 Vdc current draw	40 mA
Power dissipation	0.8 W maximum
Weight	30 g (1.1 oz)
ID code	7103 dec

24 Vdc I/O Power Segment Characteristics

The following table shows the 24 Vdc I/O power segment characteristics of the TM5SPS1 electronic module:

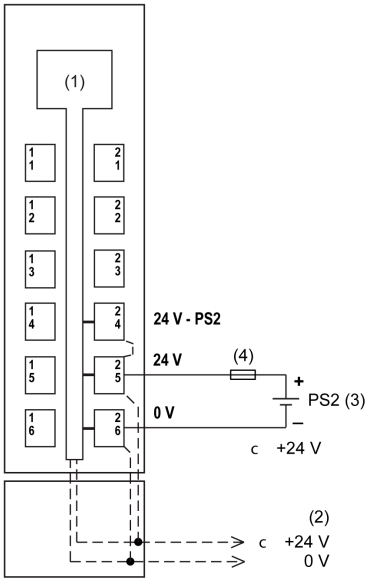
24 Vdc I/O Power Segment Characteristics	
Power supply range	20.4...28.8 Vdc
Rated voltage	24 Vdc
Maximum current provided	10000 mA
Reverse polarity protection	No
Short circuit protection	External fuse type T slow-blow 10 A maximum 250 V
Isolation between power segment and TM5 power and data buses	See note [1]

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by TM5 power bus and the part powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 module is installed in the bus base, and there is a bridge between TM5 power bus and 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce the effects of electromagnetic interference. These components are rated at 30 or 60 V. This effectively reduces isolation of the entire system from the 500 Vac RMS.

TM5SPS1 Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for the TM5SPS1:



1 Internal electronics
2 24 Vdc I/O power segment integrated into the bus bases
3 PS2: External isolated power supply 24 Vdc
4 External fuse type T slow-blow 10 A maximum 250 V

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

⚠ 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.

Section B.2
TM5SPS1F PDM Electronic Module 24 Vdc I/O Fuse 6.3 A

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SPS1F Presentation	228
TM5SPS1F Characteristics	230
TM5SPS1F Wiring Diagram	232

TM5SPS1F Presentation

Main Characteristics

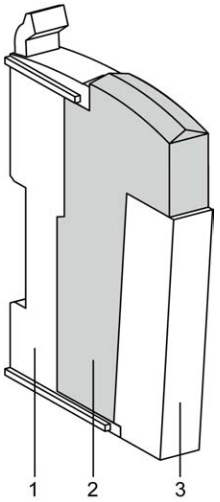
The TM5SPS1F Power Distribution Module (PDM) feeds the 24 Vdc I/O power segment through an exchangeable fuse.

The table below describes the main characteristics of the TM5SPS1F electronic module:

Main Characteristics	
Maximum current provided on 24 Vdc I/O power segment	6300 mA
TM5 power bus current generated	No

Ordering Information

The following figure and table gives the references to create a slice with the TM5SPS1F electronic module:

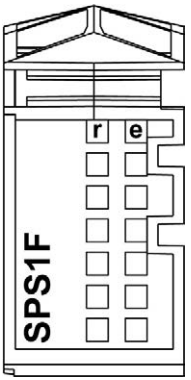


Number	Model Number	Description	Color
1	TM5ACBM01R or TM5ACBM05R	Bus base 24 Vdc I/O power segment left isolated Bus base 24 Vdc I/O power segment left isolated with address setting	Gray Gray
2	TM5SPS1F	Electronic module	Gray
3	TM5ACTBM12PS	Terminal block, 12-pin	Gray

NOTE: For more information, refer to TM5 Bus Bases and Terminal Blocks *(see PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide)*.

Status LEDs

The following figure shows the TM5SPS1F status LEDs:



The table below describes the TM5SPS1F status LEDs:

LED	Color	Status	Description
r	Green	Off	Power supply not connected
		Single flash	Reset state
		Flashing	Preoperational state
		On	RUN state
e	Red	Off	OK or module not connected
		Double flash	Indicates one of the following conditions: ● 24 Vdc I/O power segment, via the external power supply or supplies, is too low. ● TM5 power bus, via the external power supply or supplies, is too low.
e+r	Steady red/single green flash		Invalid firmware

TM5SPS1F Characteristics

Introduction

This section gives the TM5SPS1F electronic module characteristics.

See also Environmental Characteristics *(see page 62)*.

⚠ DANGER

FIRE HAZARD

- Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm^2 (AWG 20) with a temperature rating of at least 80 °C (176 °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^2 (AWG 16) with a temperature rating of at least 80 °C (176 °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.

General Characteristics

The following table shows the general characteristics of the TM5SPS1F electronic module:

General Characteristics	
Rated power supply voltage	24 Vdc
24 Vdc I/O power segment current draw	35 mA
TM5 power bus 5 Vdc current draw	40 mA
Power dissipation	1.02 W maximum
Weight	30 g (1.1 oz)
ID code	8214 dec

24 Vdc I/O Power Segment Characteristics

The following table shows the 24 Vdc I/O power segment characteristics of the TM5SPS1F electronic module:

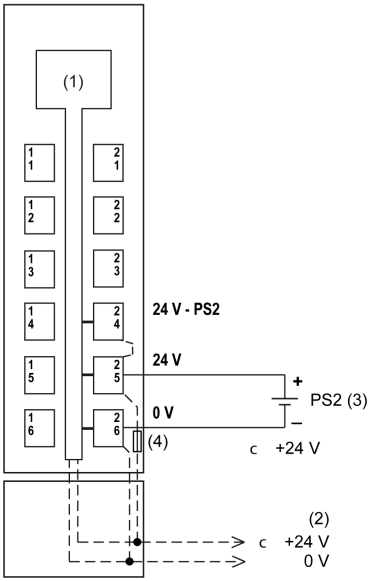
24 Vdc I/O Power Segment Characteristics	
Power supply range	20.4...28.8 Vdc
Rated power supply voltage	24 Vdc
Maximum current provided	6300 mA
Reverse polarity protection	No
Short circuit protection	Integrated fuse type T slow-blow 6.3 A 250 V exchangeable
Isolation between power segment and TM5 power and data buses	See note [1]

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by TM5 power bus and the part powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 module is installed in the bus base, and there is a bridge between TM5 power bus and 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce the effects of electromagnetic interference. These components are rated at 30 or 60 V. This effectively reduces isolation of the entire system from the 500 Vac RMS.

TM5SPS1F Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for TM5SPS1F:



1 Internal electronics
2 24 Vdc I/O power segment integrated into the bus bases
3 PS2: External isolated power supply 24 Vdc
4 Integrated fuse type T slow-blow 6.3 A 250 V exchangeable

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

⚠ 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.

Section B.3
TM5SPS2 PDM Electronic Module 24 Vdc I/O and TM5 Power Bus

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SPS2 Presentation	235
TM5SPS2 Characteristics	237
TM5SPS2 Wiring Diagram	239

TM5SPS2 Presentation

Main Characteristics

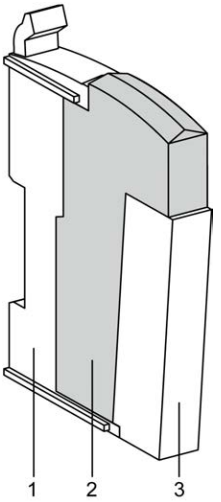
The Power Distribution Module (PDM) TM5SPS2 feeds the TM5 power bus as well as the 24 Vdc I/O power segment.

The table below describes the main characteristics of the TM5SPS2 electronic module:

Main characteristics	
Maximum current provided on 24 Vdc I/O power segment	10000 mA
TM5 power bus current generated	1136 mA

Ordering Information

The following figure and table gives the references to create a slice with the TM5SPS2 electronic module:

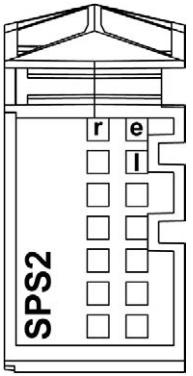


Number	Reference	Description	Color
1	TM5ACBM01R or TM5ACBM05R	Bus base 24 Vdc I/O power segment left isolated Bus base 24 Vdc I/O power segment left isolated with address setting	Gray Gray
2	TM5SPS2	Electronic module	Gray
3	TM5ACTBM12PS	Terminal block, 12-pin	Gray

NOTE: For more information, refer to TM5 Bus Bases and Terminal Blocks *(see PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide)*.

Status LEDs

The following figure shows the TM5SPS2 status LEDs:



The table below describes the TM5SPS2 status LEDs:

LED	Color	Status	Description
r	Green	Off	Power supply not connected
		Single flash	Reset state
		Flashing	Preoperational state
		On	RUN state
e	Red	Off	OK or module not connected
		Double flash	Indicates one of the following conditions: ● TM5 power bus is overloaded. ● 24 Vdc I/O power segment, via the external power supply or supplies, is too low. ● Input voltage for TM5 power bus, via the external power supply or supplies, is too low.
e+r	Steady red/single green flash		Invalid firmware
l	Red	Off	TM5 power bus in the acceptable range
		On	TM5 power bus is overloaded

TM5SPS2 Characteristics

Introduction

This section gives the TM5SPS2 electronic module characteristics.

See also Environmental Characteristics *(see page 62)*.

⚠ DANGER

FIRE HAZARD

- Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm^2 (AWG 20) with a temperature rating of at least 80 °C (176 °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^2 (AWG 16) with a temperature rating of at least 80 °C (176 °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.

General Characteristics

The following table shows the general characteristics of the TM5SPS2 electronic module:

General Characteristics	
Rated power supply voltage	24 Vdc
24 Vdc I/O power segment current draw	25 mA
Power dissipation	1.91 W maximum
Weight	30 g (1.1 oz)
ID code	7104 dec

TM5 Power Bus Characteristics

The following table shows the TM5 power bus characteristics of the TM5SPS2 electronic module:

TM5 Power Bus Characteristics	
Power supply range	20.4...28.8 Vdc
Rated input current	0.7 A maximum at 24 Vdc
Reverse polarity protection	Yes
Fuse	Integrated, can not be exchanged
Current generated	1136 mA
Parallel operation	Yes [2]
Electrical isolation	See note [1]

1 The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 or 60 V.
2 In parallel operation, only 75% of the rated power can be assumed. Ensure that all parallel operating power supplies are switched on and off simultaneously.

Temperature De-rating

These electronic modules are subject to temperature restrictions on TM5 power bus current generated

- 0...55 °C (32...131 °F): 1136 mA
- 55...60 °C (131...140 °F): 740 mA

24 Vdc I/O Power Segment Characteristics

The following table shows the 24 Vdc I/O power segment characteristics of the TM5SPS2 electronic module:

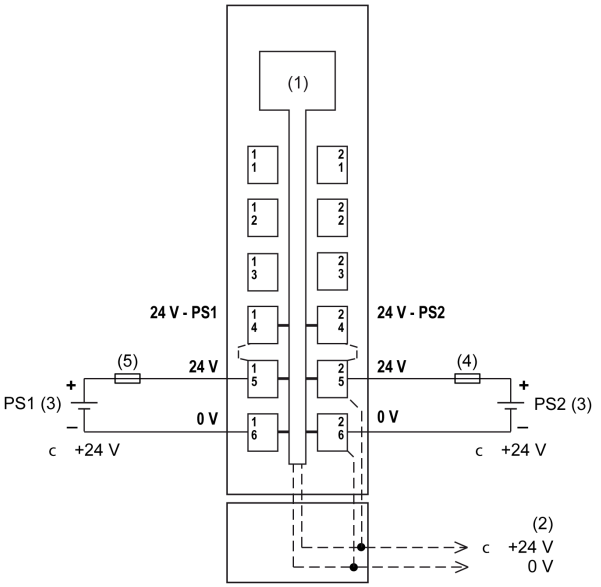
24 Vdc I/O Power Segment Characteristics	
Power supply range	20.4...28.8 Vdc
Rated power supply voltage	24 Vdc
Maximum current provided	10000 mA
Reverse polarity protection	No
Short circuit protection	External fuse type T slow-blow 10 A maximum 250 V
Isolation between power segment and TM5 power and data buses	See note [1]

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by TM5 power bus and the part powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 module is installed in the bus base, and there is a bridge between TM5 power bus and 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce the effects of electromagnetic interference. These components are rated at 30 or 60 V. This effectively reduces isolation of the entire system from the 500 Vac RMS.

TM5SPS2 Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for the TM5SPS2:



1 Internal electronics
2 24 Vdc I/O power segment integrated into the bus bases
3 PS1/PS2: External isolated power supplies 24 Vdc
4 External fuse type T slow-blow 10 A maximum 250 V
5 External fuse type T slow-blow 1 A 250 V

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

⚠ 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.

Section B.4
TM5SPS2F PDM Electronic Module 24 Vdc I/O Fuse 6.3 A and TM5 Power Bus

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SPS2F Presentation	242
TM5SPS2F Characteristics	244
TM5SPS2F Wiring Diagram	246

TM5SPS2F Presentation

Main Characteristics

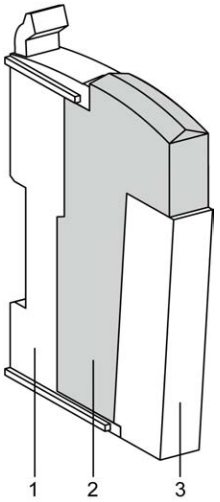
The TM5SPS2F Power Distribution Module feeds the TM5 power bus as well as the 24 Vdc I/O power segment through an integrated exchangeable fuse.

The table below describes the main characteristics of the TM5SPS2F electronic module:

Main Characteristics	
Maximum current provided on 24 Vdc I/O power segment	6300 mA
TM5 power bus current generated	1136 mA

Ordering Information

The following figure and table gives the references to create a slice with the TM5SPS2F electronic module:

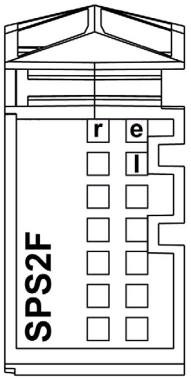


Number	Model Number	Description	Color
1	TM5ACBM01R or TM5ACBM05R	Bus base 24 Vdc I/O power segment left isolated Bus base 24 Vdc I/O power segment left isolated with address setting	Gray Gray
2	TM5SPS2F	Electronic module	Gray
3	TM5ACTBM12PS	Terminal block, 12-pin	Gray

NOTE: For more information, refer to TM5 Bus Bases and Terminal Blocks *(see PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide)*.

Status LEDs

The following figure shows the TM5SPS2F status LEDs:



The table below describes the TM5SPS2F status LEDs:

LED	Color	Status	Description
r	Green	Off	Power supply not connected
		Single flash	Reset state
		Flashing	Preoperational state
		On	RUN state
e	Red	Off	OK or module not connected
		Double flash	Indicates one of the following conditions: ● TM5 power bus is overloaded. ● 24 Vdc I/O power segment, via the external power supply or supplies, is too low. ● Input voltage for TM5 power bus, via the external power supply or supplies, is too low.
e+r	Steady red/single green flash		Invalid firmware
l	Red	Off	TM5 power bus in the acceptable range
		On	TM5 power bus is overloaded

TM5SPS2F Characteristics

Introduction

This section gives the TM5SPS2F electronic module characteristics.

See also Environmental Characteristics *(see page 62)*.

⚠ DANGER

FIRE HAZARD

- Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm^2 (AWG 20) with a temperature rating of at least 80 °C (176 °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^2 (AWG 16) with a temperature rating of at least 80 °C (176 °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.

General Characteristics

The following table shows the general characteristics of the TM5SPS2F electronic module:

General Characteristics	
Rated power supply voltage	24 Vdc
24 Vdc I/O power segment current draw	35 mA
Power dissipation	2.13 W maximum
Weight	30 g (1.1 oz)
ID code	8215 dec

TM5 Power Bus Characteristics

The following table shows the TM5 power bus characteristics of the TM5SPS2F electronic module:

TM5 Power Bus Characteristics	
Power supply range	20.4...28.8 Vdc
Rated input current	0.7 A maximum at 24 Vdc
Reverse polarity protection	Yes
Fuse	Integrated, can not be exchanged
Current generated	1136 mA
Parallel operation	Yes [2]
Electrical isolation	See note [1]

1 The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 or 60 V.
2 In parallel operation, only 75% of the rated power can be assumed. Please ensure that all parallel operating power supplies are switched on and off simultaneously.

Temperature De-rating

These electronic modules are subject to temperature restrictions on TM5 power bus current generated

- 0...55 °C (32...131 °F): 1136 mA
- 55...60 °C (131...140 °F): 740 mA

24 Vdc I/O Power Segment Characteristics

The following table shows the 24 Vdc I/O power segment characteristics of the TM5SPS1 electronic module:

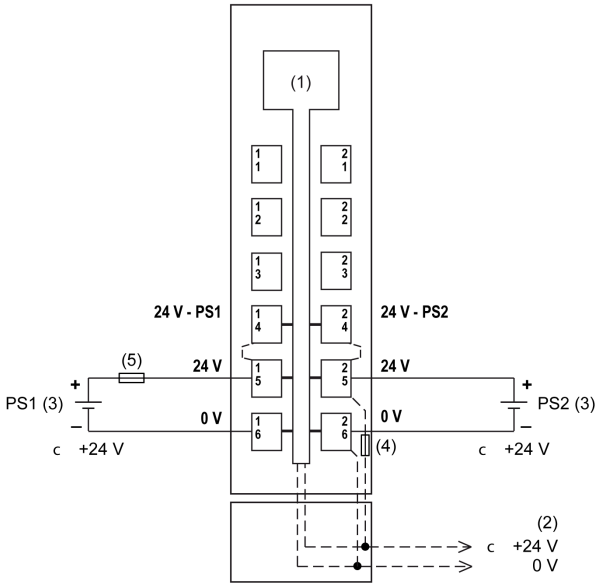
24 Vdc I/O Power Segment Characteristics	
Power supply range	20.4...28.8 Vdc
Rated power supply voltage	24 Vdc
Maximum current provided	6300 mA
Reverse polarity protection	No
Short circuit protection	Integrated fuse type T slow-blow 6.3 A 250 V exchangeable
Isolation between power segment and TM5 power and data buses	See note [1]

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by TM5 power bus and the part powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 module is installed in the bus base, and there is a bridge between TM5 power bus and 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce the effects of electromagnetic interference. These components are rated at 30 or 60 V. This effectively reduces isolation of the entire system from the 500 Vac RMS.

TM5SPS2F Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for the TM5SPS2F:



1 Internal electronics
2 24 Vdc I/O power segment integrated into the bus bases
3 PS2: External isolated power supply 24 Vdc
4 Integrated fuse type T slow-blow 6.3 A 250 V exchangeable
5 External fuse type T slow-blow 1 A 250 V

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

⚠ 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.

Appendix C
TM5 Interface Power Distribution Module (IPDM)

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
TM5SPS3 Presentation	250
TM5SPS3 Characteristics	252
TM5SPS3 Wiring Diagram	255

TM5SPS3 Presentation

Main Characteristics

The TM5SPS3 Interface Power Distribution Module (IPDM) consists of two dedicated electrical circuits:

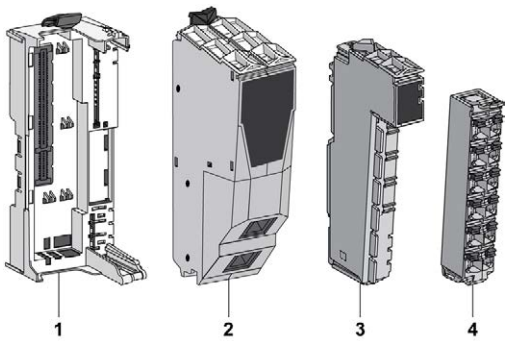
- a 24 Vdc main power that serves the electronics of the Sercos III Bus Interface module and generates independent power for the TM5 power bus that serves the expansion modules.
- a 24 Vdc I/O power segment that serves:
  - the expansion modules,
  - the sensors and actuators connected to the expansion modules,
  - the external devices connected to the Common Distribution Modules (CDM)

The table below provides the main characteristics of the TM5SPS3 Interface Power Distribution Module (IPDM):

Main Characteristics	
Maximum current provided on 24 Vdc I/O power segment	10000 mA
TM5 power bus generated	750 mA

Ordering Information

The following figure and table provide the references to create a TM5 Sercos III Bus Interface with the TM5SPS3 IPDM:

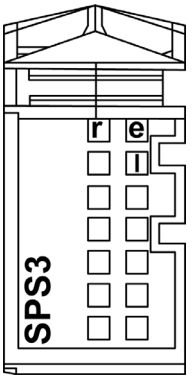


Number	Reference	Description	Color
1	TM5ACBN1	Bus base for Sercos III Bus Interface module and Interface Power Distribution Module (IPDM) *(see page 43)*	White
2	TM5NS31	Sercos III Bus Interface module *(see page 44)*	White
3	TM5SPS3	Interface Power Distribution Module (IPDM) *(see page 44)*	Grey
4	TM5ACTB12PS	Terminal block for PDM, IPDM and receiver electronic module *(see page 45)*	Grey

NOTE: For more information, refer to *TM5 Bus Bases and Terminal Blocks (see PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide)*.

Status LEDs

The following figure and table provide the TM5SPS3 IPDM status LEDs:



LED	Color	Status	Description
r	Green	Off	Power supply not connected
		Single flash	Reset status
		Flashing	TM5 expansion bus in preoperational status
		On	RUN status
e	Red	Off	OK or module not connected
		Double flash	Indicates one of the following conditions: ● 24 Vdc I/O power segment, via the external power supply or supplies, is too low. ● TM5 power bus, via the external power supply or supplies, is too low.
e+r	Steady red/single green flash		Invalid firmware
l	Red	Off	The TM5 Interface Power Distribution Module (IPDM) supply is within the acceptable range.
		On	The TM5 Interface Power Distribution Module (IPDM) supply is insufficient.

TM5SPS3 Characteristics

General Characteristics

⚠ DANGER

FIRE HAZARD

Use only the correct wire sizes for the maximum current capacity of the power supplies.

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.

The table below provides the general characteristics of the Interface Power Distribution Module (IPDM) TM5SPS3:

General Characteristics	
Rated power supply voltage	24 Vdc
24 Vdc I/O power segment current draw	25 mA
Power dissipation	1.82 W maximum
Weight	30 g (1.1 oz)
ID code	8076 dec

See also Environmental Characteristics *(see page 62)*.

TM5 Power Bus Characteristics

The table below provides the TM5 power bus characteristics of the Interface Power Distribution Module (IPDM) TM5SPS3:

TM5 Power Bus Characteristics	
Power supply range	20.4...28.8 Vdc
Rated input current	0.7 A at 24 Vdc
Reverse polarity protection	Yes
Fuse	Integrated, cannot be exchanged
Current generated	• On TM5 power bus: 750 mA • To supply the field bus interface module: 300 mA
Electrical isolation	See note [1]
Parallel operation	Yes [2]

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

[2] In parallel operation, only 75% of the rated power can be assumed. Ensure that all parallel operating power supplies are switched on and off simultaneously.

Temperature De-rating

The Interface Power Distribution Module (IPDM) TM5SPS3 is subject to temperature restrictions depending on the current consumption on the TM5 power bus:

- up to 500 mA: 0...60°C (32...140°F)
- over 500 mA: 0...55°C (32...131°F)

24 Vdc I/O Power Segment Characteristics

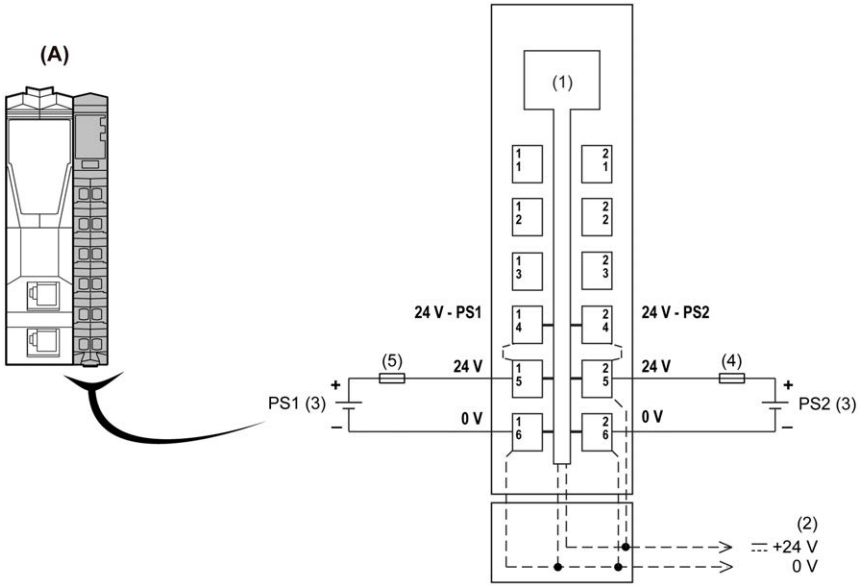
The table below provides the 24 Vdc I/O power segment characteristics of the Interface Power Distribution Module (IPDM) TM5SPS3:

24 Vdc I/O Power Segment Characteristics	
Power supply range	20.4...28.8 Vdc
Rated power supply voltage	24 Vdc
Maximum current provided	10 A
Reverse polarity protection	No
Short circuit protection	External fuse type T slow-blow 10 A maximum 250 V
Isolation between power segment and TM5 buses	See note [1]
[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.	

TM5SPS3 Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for the Interface Power Distribution Module (IPDM) TM5SPS3:



A Interface Power Distribution Module (IPDM)
1 Internal electronics
2 24 Vdc I/O power segment integrated in the bus bases
3 PS1/PS2: External isolated power supply 24 Vdc
4 External fuse, Type T slow blow, 10 A maximum, 250 V
5 External fuse, Type T slow blow, 1 A, 250 V

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

⚠ 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.

Appendix D
TM5 Common Distribution Modules (CDM)

Overview

This chapter describes TM5 Common Distribution Modules (CDM) for designing your TM5 System.

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
D.1	TM5SPDG12F Electronic Module 12 x 0 Vdc	258
D.2	TM5SPDD12F Electronic Module 12 x 24 Vdc	265
D.3	TM5SPDG5D4F Electronic Module 5 x 0 Vdc and 5 x 24 Vdc	272
D.4	TM5SPDG6D6F Electronic Module 6 x 0 Vdc and 6 x 24 Vdc	279

Section D.1
TM5SPDG12F Electronic Module 12 x 0 Vdc

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SPDG12F Presentation	259
TM5SPDG12F Characteristics	261
TM5SPDG12F Wiring Diagram	263

TM5SPDG12F Presentation

Main Characteristics

The TM5SPDG12F CDM provides 12 x 0 Vdc terminal connections from the 24 Vdc I/O power segment, which opens up additional wiring possibilities for sensors and actuators.

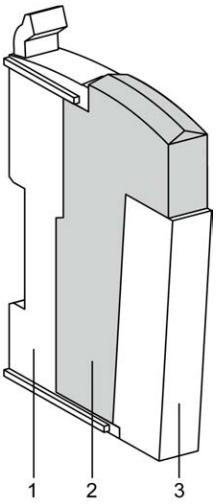
The module is equipped with an exchangeable fuse between the 0 Vdc potential on the terminal block and the 0 Vdc of the 24 Vdc I/O power segment. The status of the fuse is available with the status LEDs and in the I/O mapping tab *(see Modicon TM5, Expansion Modules Configuration, Programming Guide)* of the EcoStruxure Machine Expert software.

The table below gives you the main characteristics of the TM5SPDG12F electronic module:

Main Characteristics		
Power supply source	24 Vdc I/O power segment	
Type of common connections	0 Vdc	24 Vdc
Number of common connections	12	0

Ordering Information

The following figure and table gives the references to create a slice with the TM5SPDG12F:



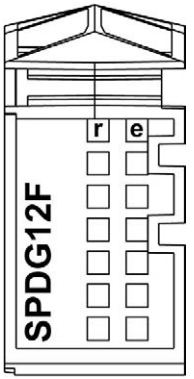
Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White

Number	Model Number	Description	Color
2	TM5SPDG12F	Electronic module	White
3	TM5ACTB12	Terminal block, 12-pin	White

NOTE: For more information, refer to TM5 Bus Bases and Terminal Blocks *(see PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide)*.

Status LEDs

The following figure shows the TM5SPDG12F status LEDs:



The table below describes the TM5SG12F status LEDs:

LEDs	Color	Status	Description
r	Green	Off	Module supply not connected
		Single flash	Reset state
		Flashing	Preoperational state
		On	RUN state
e	Red	Off	Ok or no power supply
		On	Detected error or reset state
		Single Flash	Fuse is blown or missing
e+r	Steady red / single green flash		Invalid firmware

TM5SPDG12F Characteristics

Introduction

This section gives the TM5SPDG12F electronic module characteristics.

See also **Environmental Characteristics** *(see page 62)*.

⚠ DANGER

FIRE HAZARD

- Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm^2 (AWG 20) with a temperature rating of at least 80 °C (176 °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^2 (AWG 16) with a temperature rating of at least 80 °C (176 °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.

General Characteristics

The following table shows the general characteristics of the TM5SPDG12F electronic module:

General Characteristics	
Rated power supply voltage Power supply source	0 Vdc Connected to the 0 Vdc of the 24 Vdc I/O power segment.
Status indicators	Operating state, module status
24 Vdc I/O power segment current draw	6300 mA maximum
TM5 power bus 5 Vdc current draw	24 mA
Power dissipation	1.12 W maximum
Weight	25 g (0.9 oz)
ID code	9853 dec

Common Characteristics

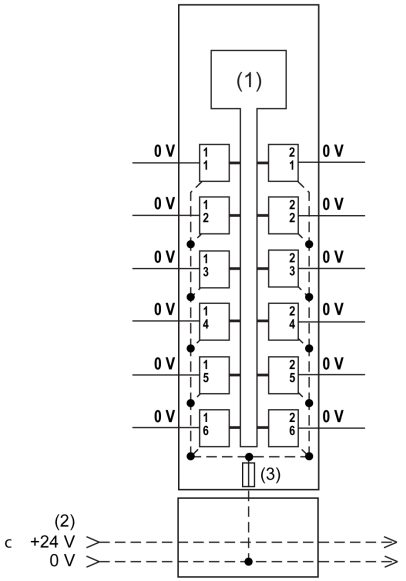
The following table shows the common characteristics of the TM5SPDG12F electronic module:

Common Characteristics	
Rated output voltage	0 Vdc from the 24 Vdc I/O power segment
Protection	Integrated fuse type T slow-blow 6.3 A 250 V exchangeable

TM5SPDG12F Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for the TM5SPDG12F:

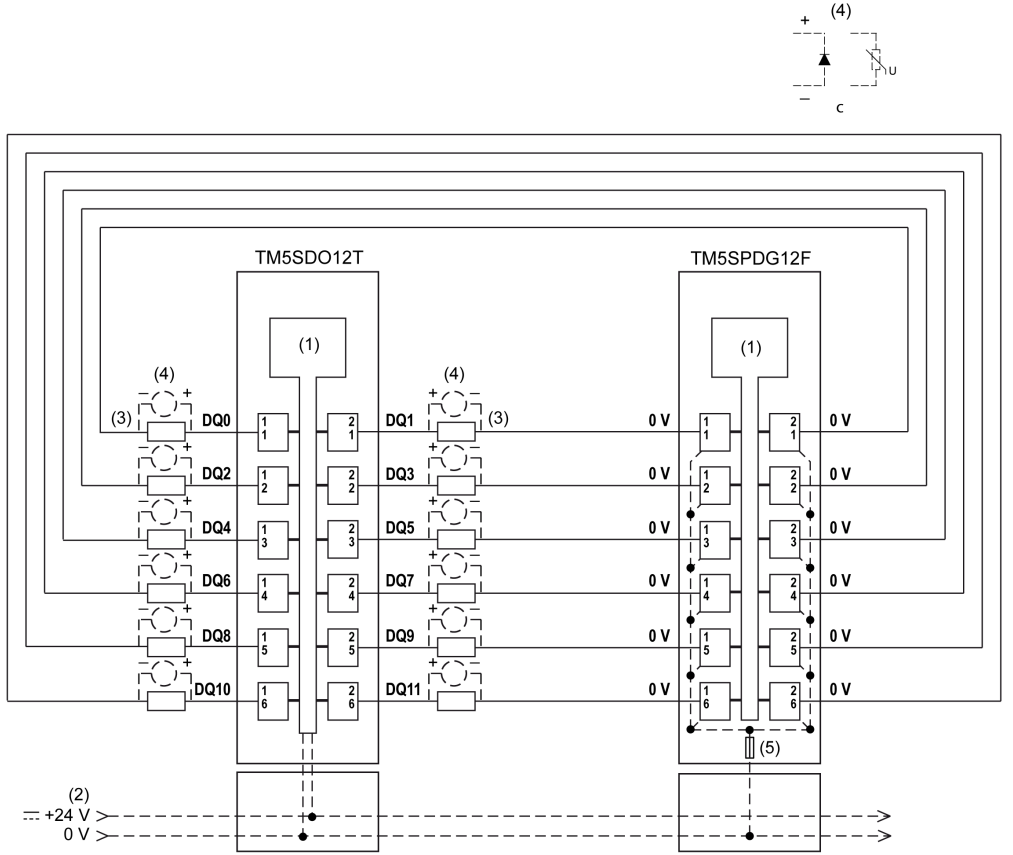


1 Internal electronics
2 24 Vdc I/O power segment integrated into the bus bases
3 Integrated fuse type T slow-blow 6.3 A 250 V exchangeable

NOTE: I/O electronic modules and the field devices connected to them must all reside on the same 24 Vdc I/O power segment. If not, the status LEDs may not function correctly. In addition, there may potentially be more significant consequences such as an explosion and/or fire hazard.

⚠ WARNING
POTENTIAL EXPLOSION OR FIRE
Connect the returns from the devices to the same power source as the 24 Vdc I/O power segment serving the module.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

The following figure shows the wiring diagram for the TM5SPDG12F with a TM5SDO12T:



1 Internal electronics
2 24 Vdc I/O power segment integrated into the bus bases
3 1-wire load
4 Inductive load protection
5 Integrated fuse type T slow-blow 6.3 A 250 V exchangeable

⚠ 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.

Section D.2
TM5SPDD12F Electronic Module 12 x 24 Vdc

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SPDD12F Presentation	266
TM5SPDD12F Characteristics	268
TM5SPDD12F Wiring Diagram	270

TM5SPDD12F Presentation

Main Characteristics

The TM5SPDD12F CDM provides 12 x 24 Vdc terminal connections from the 24 Vdc I/O power segment, which opens up additional wiring possibilities for sensors and actuators.

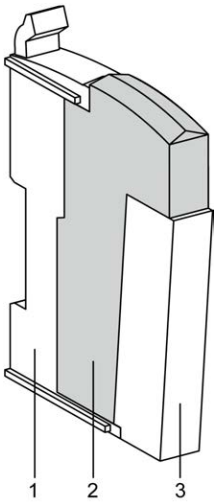
The module is equipped with an exchangeable fuse between the 24 Vdc potential on the terminal block and the 24 Vdc of the 24 Vdc I/O power segment. The status of the fuse is available with the status LEDs and in the I/O mapping tab *(see Modicon TM5, Expansion Modules Configuration, Programming Guide)* of the EcoStruxure Machine Expert software.

The table below gives you the main characteristics of the TM5SPDD12F electronic module:

Main Characteristics		
Power supply source	24 Vdc I/O power segment	
Type of common connections	0 Vdc	24 Vdc
Number of common connections	0	12

Ordering Information

The following figure shows a slice with the TM5SPDD12F:



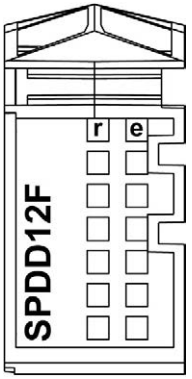
Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White

Number	Model Number	Description	Color
2	TM5SPDD12F	Electronic module	White
3	TM5ACTB12	Terminal block, 12-pin	White

NOTE: For more information, refer to TM5 Bus Bases and Terminal Blocks *(see PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide)*.

Status LEDs

The following figure shows the TM5SPDD12F status LEDs:



The table below describes the TM5SPDD12F status LEDs:

LEDs	Color	Status	Description
r	Green	Off	Module supply not connected
		Single flash	Reset state
		Flashing	Preoperational state
		On	RUN state
e	Red	Off	Ok or no power supply
		On	Detected error or reset state
		Single Flash	Fuse is blown or missing
e+r	Steady red / single green flash		Invalid firmware

TM5SPDD12F Characteristics

Introduction

This section gives the TM5SPDD12F module characteristics.

See also **Environmental Characteristics** *(see page 62)*.

⚠ DANGER

FIRE HAZARD

- Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm^2 (AWG 20) with a temperature rating of at least 80 °C (176 °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^2 (AWG 16) with a temperature rating of at least 80 °C (176 °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.

General Characteristics

The following table shows the general characteristics of the TM5SPDD12F electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to the 24 Vdc of the 24 Vdc I/O power segment.
Status indicators	Operating state, module status
24 Vdc I/O power segment current draw	6300 mA maximum
TM5 power bus 5 Vdc current draw	24 mA
Power dissipation	1.12 W maximum
Weight	25 g (0.9 oz)
ID code	9854 dec

Common Characteristics

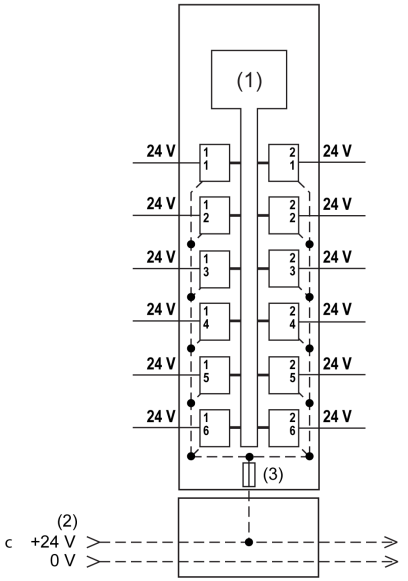
The following table shows the common characteristics of the TM5SPDD12F electronic module:

Common Characteristics	
Rated output voltage	24 Vdc from the 24 Vdc I/O power segment
Protection	Integrated fuse type T slow-blow 6.3 A 250 V exchangeable

TM5SPDD12F Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for the TM5SPDD12F:



1 Internal electronics
2 24 Vdc I/O power segment integrated into the bus bases
3 Integrated fuse type T slow-blow 6.3 A 250 V exchangeable

NOTE: I/O electronic modules and the field devices connected to them must all reside on the same 24 Vdc I/O power segment. If not, the status LEDs may not function correctly. In addition, there may potentially be more significant consequences such as an explosion and/or fire hazard.

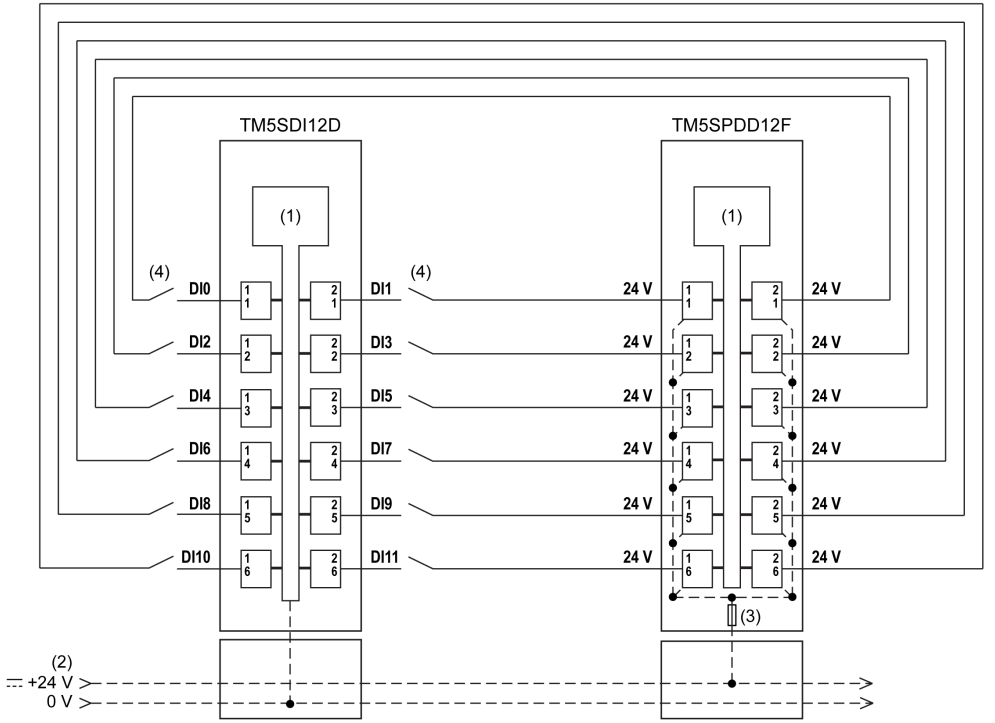
⚠ WARNING

POTENTIAL EXPLOSION OR FIRE

Connect the returns from the devices to the same power source as the 24 Vdc I/O power segment serving the module.

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

The following figure shows the wiring diagram for the TM5SPDD12F with a TM5SDI12D:



1 Internal electronics
2 24 Vdc I/O power segment integrated into the bus bases
3 Integrated fuse type T slow-blow 6.3 A 250 V exchangeable
4 1-wire sensor

⚠ 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.

Section D.3
TM5SPDG5D4F Electronic Module 5 x 0 Vdc and 5 x 24 Vdc

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SPDG5D4F Presentation	273
TM5SPDG5D4F Characteristics	275
TM5SPDG5D4F Wiring Diagram	277

TM5SPDG5D4F Presentation

Main Characteristics

The TM5SPDG5D4F CDM provides 5 x 0 Vdc and 5 x 24 Vdc terminal connections from an external 24 Vdc power source. There is no connection to the 24 Vdc I/O power segment.

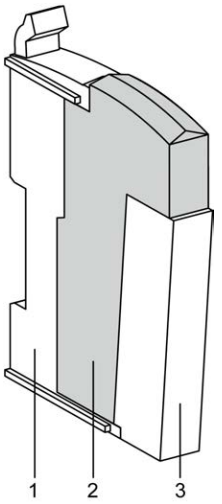
The module is equipped with an exchangeable fuse between the 24 Vdc potential on the terminal block and the external 24 Vdc power source. The status of the fuse is available with the status LEDs and in the I/O mapping tab *(see Modicon TM5, Expansion Modules Configuration, Programming Guide)* of the EcoStruxure Machine Expert software.

The table below gives you the main characteristics of the TM5SPDG5D4F electronic module:

Main Characteristics		
Power supply source	External 24 Vdc power source	
Type of common connections	0 Vdc	24 Vdc
Number of common connections	5	5

Ordering Information

The following figure shows a slice with the TM5SPDG5D4F electronic module:



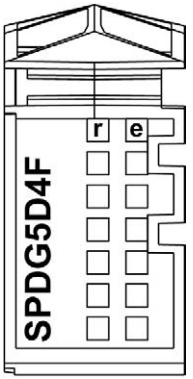
Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White

Number	Model Number	Description	Color
2	TM5SPDG5D4F	Electronic module	White
3	TM5ACTB12	Terminal block, 12-pin	White

NOTE: For more information, refer to TM5 Bus Bases and Terminal Blocks *(see PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide)*.

Status LEDs

The following figure shows the TM5SPDG5D4F status LEDs:



The table below describes the TM5SPDG5D4F status LEDs:

LEDs	Color	Status	Description
r	Green	Off	Module supply not connected
		Single flash	Reset state
		Flashing	Preoperational state
		On	RUN state
e	Red	Off	Ok or no power supply
		On	Detected error or reset state
		Single Flash	Fuse is blown or missing
		Double Flash	Feed voltage too low
e+r	Steady red / single green flash		Invalid firmware

TM5SPDG5D4F Characteristics

Introduction

This section gives the TM5SPDG5D4F module characteristics.

See also **Environmental Characteristics** *(see page 62)*.

⚠ DANGER

FIRE HAZARD

- Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm^2 (AWG 20) with a temperature rating of at least 80 °C (176 °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^2 (AWG 16) with a temperature rating of at least 80 °C (176 °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.

General Characteristics

The following table shows the general characteristics of the TM5SPDG5D4F electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to an external 24 Vdc power source
Power supply range	20.4...28.8 Vdc
Status indicators	Operating state, module status
24 Vdc I/O power segment current draw	Not connected
TM5 power bus 5 Vdc current draw	24 mA
Power dissipation	1.27 W maximum
Weight	25 g (0.9 oz)
ID code	9856 dec

Common Characteristics

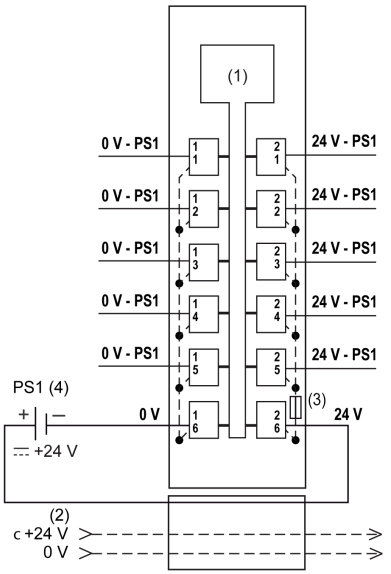
The following table shows the common characteristics of the TM5SPDG5D4F electronic module:

Common Characteristics	
Power supply range	20.4...28.8 Vdc
Rated output voltage	0 Vdc and 24 Vdc from the external 24 Vdc power source
Protection	Integrated fuse type T slow-blow 6.3 A 250 V exchangeable

TM5SPDG5D4F Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for the TM5SPDG5D4F:



1 Internal electronics
2 24 Vdc I/O power segment integrated into the bus bases
3 Integrated fuse type T slow-blow 6.3 A 250 V exchangeable
4 PS1: External isolated power supplies 24 Vdc

NOTE: Connect the 0 Vdc power circuits together and to the functional ground (FE) of your system to meet the EMC requirements.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OVERHEATING AND FIRE

- Do not connect the modules directly to line voltage.
- Use only isolating PELV systems according to IEC 61140 to supply power to the modules.
- Connect the 0 Vdc of the external power supplies to FE (Functional Earth/ground).

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

⚠ 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.**

Section D.4
TM5SPDG6D6F Electronic Module 6 x 0 Vdc and 6 x 24 Vdc

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SPDG6D6F Presentation	280
TM5SPDG6D6F Characteristics	282
TM5SPDG6D6F Wiring Diagram	284

TM5SPDG6D6F Presentation

Main Characteristics

The TM5SPDG6D6F CDM provides 6 x 0 Vdc and 6 x 24 Vdc terminal connections from the 24 Vdc I/O power segment.

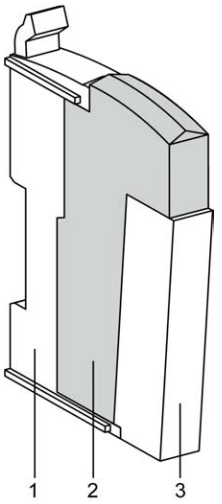
The module is equipped with an exchangeable fuse between the 24 Vdc potential on the terminal block and the 24 Vdc of the 24 Vdc I/O power segment. The status of the fuse is available with both the status LEDs and in the I/O mapping tab *(see Modicon TM5, Expansion Modules Configuration, Programming Guide)* of the EcoStruxure Machine Expert software.

The table below gives you the main characteristics of the TM5SPDG6D6F electronic module:

Main Characteristics		
Power supply source	24 Vdc I/O power segment	
Type of common connections	0 Vdc	24 Vdc
Number of common connections	6	6

Ordering Information

The following figure shows a slice with the TM5SPDG6D6F electronic module:



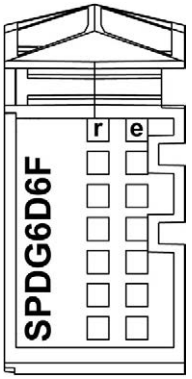
Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White

Number	Model Number	Description	Color
2	TM5SPDG6D6F	Electronic module	White
3	TM5ACTB12	Terminal block, 12-pin	White

NOTE: For more information, refer to TM5 Bus Bases and Terminal Blocks *(see PacDrive TM5 / TM7 Flexible System, System Planning and Installation Guide)*.

Status LEDs

The following figure shows the TM5SPDG6D6F status LEDs:



The table below describes the TM5SPDG6D6F status LEDs:

LEDs	Color	Status	Description
r	Green	Off	Module supply not connected
		Single flash	Reset state
		Flashing	Preoperational state
		On	RUN state
e	Red	Off	Ok or no power supply
		On	Detected error or reset state
		Single flash	Fuse is blown or missing
		Double flash	Feed voltage too low
		Triple flash	24 Vdc I/O power segment OK, fuse is blown and feed voltage is too low
e+r	Steady red / single green flash		Invalid firmware

TM5SPDG6D6F Characteristics

Introduction

This section gives the TM5SPDG6D6F module characteristics.

See also **Environmental Characteristics** *(see page 62)*.

⚠ DANGER

FIRE HAZARD

- Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm^2 (AWG 20) with a temperature rating of at least 80 °C (176 °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^2 (AWG 16) with a temperature rating of at least 80 °C (176 °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.

General Characteristics

The following table shows the general characteristics of the TM5SPDG6D6F electronic module:

General Characteristics	
Rated power supply voltage Power supply source	0 Vdc and 24 Vdc Connected to the 24 Vdc I/O power segment.
Status indicators	Operating state, module status
24 Vdc I/O power segment current draw	6300 mA maximum
TM5 power bus 5 Vdc current draw	24 mA
Power dissipation	1.27 W maximum
Weight	25 g (0.9 oz)
ID code	9855 dec

Common Characteristics

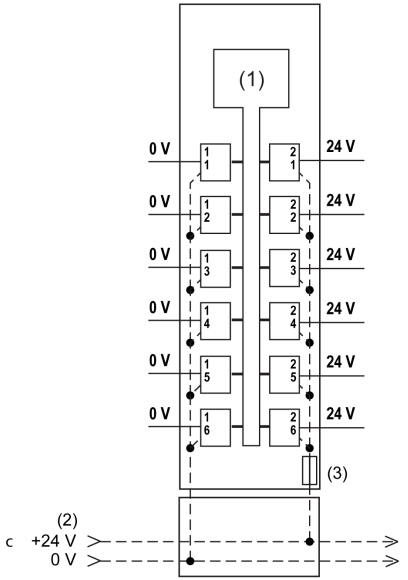
The following table shows the common characteristics of the TM5SPDG6D6F electronic module:

Common Characteristics	
Rated output voltage	0 Vdc and 24 Vdc from the 24 Vdc I/O power segment
Protection	Integrated fuse type T slow-blow 6.3 A 250 V exchangeable

TM5SPDG6D6F Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for the TM5SPDG6D6F:



1 Internal electronics
2 24 Vdc I/O power segment integrated into the bus bases
3 Integrated fuse type T slow-blow 6.3 A 250 V exchangeable

NOTE: I/O electronic modules and the field devices connected to them must all reside on the same 24 Vdc I/O power segment. If not, the status LEDs may not function correctly. In addition, there may potentially be more significant consequences such as an explosion and/or fire hazard.

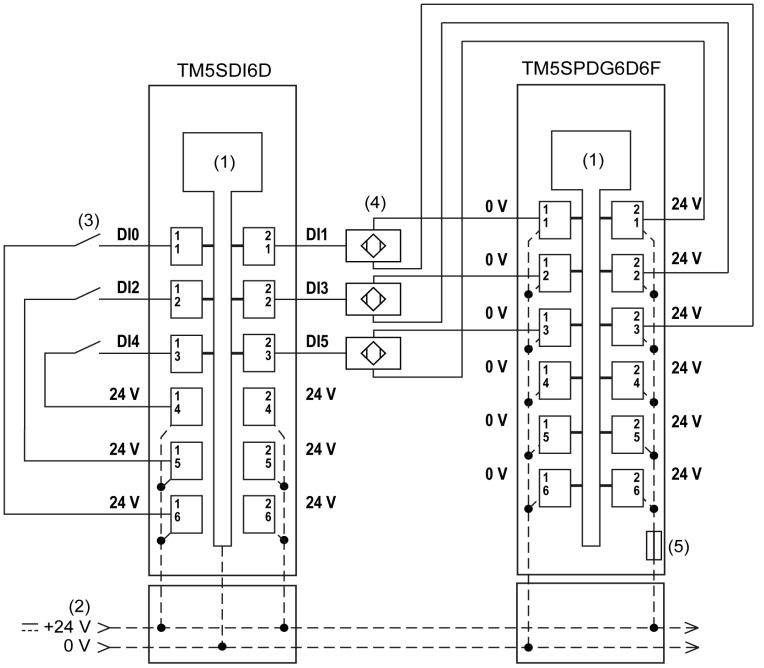
⚠ WARNING

POTENTIAL EXPLOSION OR FIRE

Connect the returns from the devices to the same power source as the 24 Vdc I/O power segment serving the module.

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

The following figure shows the wiring diagram for the TM5SPDG6D6F with a TM5SDI6D:



1 Internal electronics
2 24 Vdc I/O power segment integrated into the bus bases
3 2-wire sensor
4 3-wire sensor
5 Integrated fuse type T slow-blow 6.3 A 250 V exchangeable

⚠ 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.

Appendix E
TM5 Accessories Modules

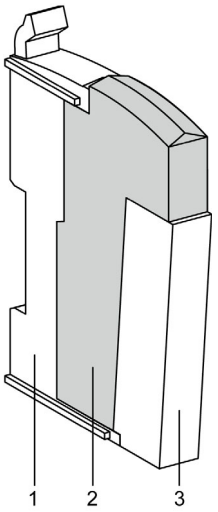
TM5SD000 Dummy Module

General Information

TM5SD000 dummy module is a non-functional module. This module is used as a place holder for later system expansion according to the TM5 association table *(see page 210)*.

Ordering Information

The following figure shows a slice with the TM5SD000 dummy module:

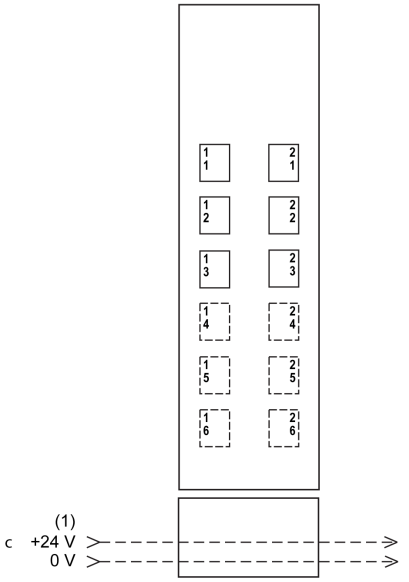


Number	Reference	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White
2	TM5DSD000	Dummy module	White
3	TM5ACTB06 or TM5ACTB12	Terminal block, 6-pin Terminal block, 12-pin	White White

General Characteristics

The characteristics of the TM5SD000 dummy module are described in environmental characteristics *(see page 62)*.

Wiring Diagram



1 24 Vdc I/O power segment integrated into the bus bases

Appendix F
TM5 Safety-Related System Bus Bases, Terminal Blocks and Memory Keys

Overview

This chapter describes the bus bases, terminal blocks and memory keys for designing your TM5 Safety-Related System.

What Is in This Chapter?

This chapter contains the following topics:

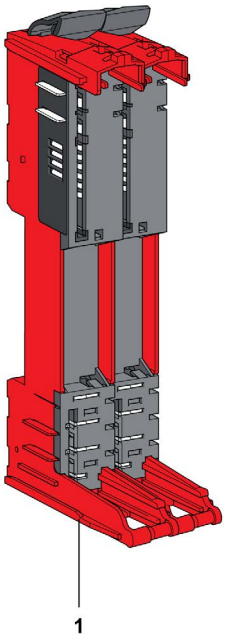
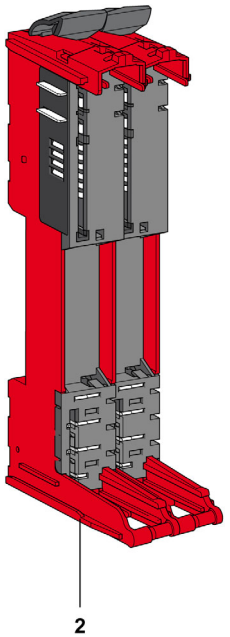
Topic	Page
TM5 Safety-Related System Bus Base	290
TM5 Safety-Related System Terminal Block	292
Safety Logic Controller Memory Key	296

TM5 Safety-Related System Bus Base

Overview

The TM5ACBM3FS red bus base is designed for 24 Vdc safety-related electronic modules.

The following figures show the TM5 Safety-Related System bus bases:

TM5ACBM3FS	TM5ACBM4FS
	

Number	Reference	Description	Color
1	TM5ACBM3FS	Bus base 24 Vdc for safety-related modules, safety coded 24 Vdc I/O power segment pass-through	Red
2	TM5ACBM4FS	Bus base 24 Vdc for safety-related modules, safety coded 24 Vdc I/O power segment left isolated	Red

A slice must only be composed of a single color. For example, a gray bus base should only be assembled with a gray electronic module and a gray terminal block. However, color alone is not sufficient for compatibility; always confirm that functionality of slice components matches as well.

⚠⚠ DANGER

INCOMPATIBLE COMPONENTS CAUSE ELECTRIC SHOCK OR ARC FLASH

- Do not associate components of a slice that have different colors.
- Always confirm the compatibility of slice components and modules before installation using the association table in this manual.
- Verify that correct terminal blocks (minimally, matching colors and correct number of terminals) are installed on the appropriate electronic modules.

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

General Characteristics

This section gives the TM5 System bus bases characteristics. See also environmental characteristics *(see page 62)*.

⚠ 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.

The following table shows the technical data for TM5 System bus bases:

General Characteristics	
TM5 power bus current draw	26 mA
Power dissipation	0.13 W maximum

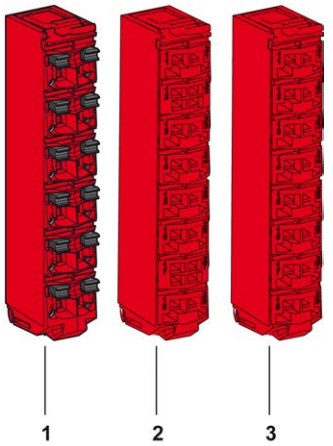
TM5 Safety-Related System Terminal Block

Overview

The main features of the terminal blocks are:

- Tool-free wiring *(see page 91)* with spring clamp push-in technology
- Simple push-button wire release
- Ability to label *(see page 147)* each terminal
- Plain text labeling *(see page 155)* also possible
- Test access *(see page 158)* for standard probes

The following figure shows the TM5 Safety-Related System terminal block:



Number	Reference	Description	Color
1	TM5ACTB52FS	24 Vdc / 230 Vac, 12-pin terminal block for safety-related modules and Safety Logic Controller, safety coded	Red
2	TM5ACTB5EFS	24 Vdc, 16-pin terminal block for safety-related modules, safety coded, 2x PT1000 integrated for terminal temperature compensation	Red
3	TM5ACTB5FFS	24 Vdc, 16-pin terminal block for safety-related modules, safety coded	Red

A slice must only be composed of a single color. For example, a gray bus base should only be assembled with a gray electronic module and a gray terminal block. However, color alone is not sufficient for compatibility; always confirm that functionality of slice components matches as well.

⚠⚠ DANGER

INCOMPATIBLE COMPONENTS CAUSE ELECTRIC SHOCK OR ARC FLASH

- Do not associate components of a slice that have different colors.
- Always confirm the compatibility of slice components and modules before installation using the association table in this manual.
- Verify that correct terminal blocks (minimally, matching colors and correct number of terminals) are installed on the appropriate electronic modules.

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

General Characteristics

⚠ DANGER

FIRE HAZARD

- Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm^2 (AWG 20) with a temperature rating of at least 80 °C (176 °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^2 (AWG 16) with a temperature rating of at least 80 °C (176 °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.

⚠ 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.

The following table shows the technical data for TM5 Safety-Related System terminal block, see also environmental characteristics *(see page 62)*:

General Characteristics		
Type of terminal		Spring-clamp push-in terminal
Contact resistance		≤ 5 mΩ
Maximum voltage(1)	TM5ACTB52FS	253 Vac
	TM5ACTB5EFS	50 Vdc
	TM5ACTB5FFS	
Current(1)	TM5ACTB52FS	10 A maximum per connector
	TM5ACTB5EFS	2 A maximum per connector
	TM5ACTB5FFS	
Weight	TM5ACTB52FS	20 g (0.7 oz)
	TM5ACTB5EFS	
	TM5ACTB5FFS	
Connection cross section	TM5ACTB52FS	
	Solid wire line Fine wire line With wire cable end With double wire cable end	0.08 mm²...2.5 mm² (AWG 28...14) 0.25 mm²...2.5 mm² (AWG 24...14) 0.25 mm²...1.5 mm² (AWG 24...16) 2 x 0.25...2 x 0.75 mm² (AWG 2 x 24...2 x 18)
	TM5ACTB5EFS TM5ACTB5FFS	
	Solid wire line Fine wire line With wire cable end With double wire cable end	0.08 mm²...1.5 mm² (AWG 28...16) 0.25 mm²...1.5 mm² (AWG 24...16) 0.25 mm²...0.75 mm² (AWG 24...20) -
Wire		Follow the wiring rules *(see page 91)*.
Note: **(1)** Connected voltage and current depends on I/O electronics modules associated.		

⚠ ⚠ DANGER

LOOSE WIRING CAUSES ELECTRIC SHOCK

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

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

Maximum Insertion/Removal Cycles

The TM5 System bus bases are designed to withstand up to 50 electronic module insertion/removal cycles.

NOTE: If electronic modules are inserted and removed from a bus base more than 50 times, the integrity of the electronic module-to-bus base contacts are subject to possible degradation. Be sure that the history of your electronic modules is known.

Safety Logic Controller Memory Key

Presentation

A memory key is required for operation of the Safety Logic Controller, and is sold separately.

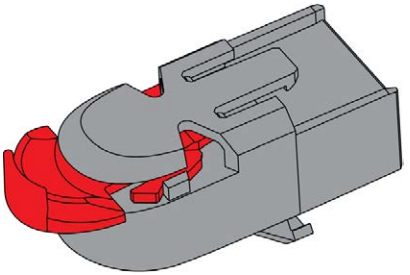
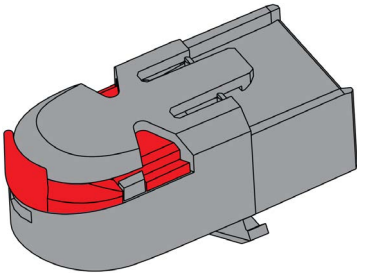
The table below presents the reference for the memory key:

Reference	Description	Color
TM5ACSLCM8FS	Safety Logic Controller memory key, 8 Mb	Gray and red

Functions of the Memory Key

The memory key is required to load the program, parameters and configuration into the Safety Logic Controller when it boots up. In addition, you can use the key to store the program, the parameters, and the system configuration and transfer the data to another Safety Logic Controller.

The memory key is equipped with a mechanical locking mechanism to help prevent removal during operation:

Locking mechanism	
Unlocked memory key:	Locked memory key:
	

Removing a Memory Key

Removing a memory key results in a boot status change (the LED indicators **F**, **I** and **L** illuminate) and a disabling of the safety-related functions. In addition, removing the memory key during operation can corrupt the data on the memory key.

⚠ WARNING

INTERRUPTION OF SAFETY-RELATED FUNCTION AND POSSIBLE LOSS OF MEMORY KEY DATA

- Do not remove the memory key when the Safety Logic Controller is in a RUN state.
- Engage the locking mechanism while the key is inserted in the Safety Logic Controller.

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

To remove the memory key, proceed as follows:

Step	Action
1	Ensure that the Safety Logic Controller is STOPPED or that power has been removed.
2	Disengage the mechanical locking mechanism.
3	Pull the memory key out of the Safety Logic Controller. **NOTE:** The Safety Logic Controller requires a valid memory key to operate.

Appendix G
TM7 Power Distribution Block (PDB)

Overview

This chapter describes the TM7SPS1A Power Distribution Block (PDB) for designing your TM7 System.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
TM7SPS1A Presentation	300
TM7SPS1A Characteristics	302
TM7SPS1A Wiring Diagram	303

TM7SPS1A Presentation

Main Characteristics

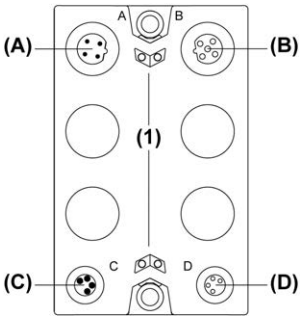
The TM7SPS1A PDB supplies the TM7 power bus.

The following table provides the main characteristics of the TM7SPS1A block:

Main Characteristics	
Rated output power	15 W
Rated input voltage	24 Vdc
Rated output voltage	20 Vdc
Rated output current	750 mA
TM7 bus connection type	M12, B coded, male and female connector types
Power supply connection type	M8, 4-pin, male and female connector types

Description

The following figure illustrates the TM7SPS1A block:

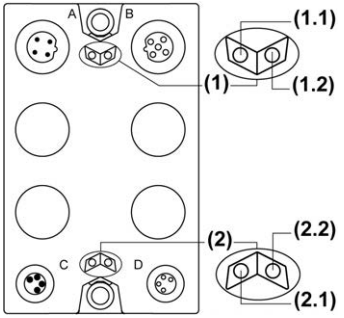


(A) TM7 bus IN connector
(B) TM7 bus OUT connector
(C) 24 Vdc power IN connector
(D) 24 Vdc power OUT connector
(1) Status LEDs

NOTE: Refer also to Status LEDs *(see page 301)*.

Status LEDs

The following figure illustrates the status LEDs of the TM7SPS1A block:



(1) TM7 power bus status LEDs, set of two LEDs: 1.1 (green) and 1.2 (green)
(2) Power status LEDs, set of two LEDs: 2.1 (orange) and 2.2 (orange)

The table below describes the TM7 power bus status LEDs of the TM7SPS1A block:

TM7 power bus status LEDs		Description
LED 1.1	LED 1.2	
OFF	OFF	No power supply on TM7 Bus, or detected error on TM7 Power bus
ON	ON	TM7 power supply is in valid range

The table below describes the power status LEDs of the TM7SPS1A block:

Power status LEDs		Description
LED 2.1	LED 2.2	
OFF	OFF	No power supply, or power supply below the lower limit value
ON	ON	Power block supply is in valid range

TM7SPS1A Characteristics

General Characteristics

⚠ DANGER

FIRE HAZARD

Use cable sizes that meet the I/O channel and power supply voltage and current ratings.

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.

The table below describes the general characteristics of the TM7SPS1A block:

General Characteristics	
Rated power supply voltage	24 Vdc
Power supply range	18...30 Vdc
Rated input current	750 mA
Protection	Internal fuse not replaceable
Power dissipation	3 W maximum
Weight	190 g (6.7 oz)

See also Environmental Characteristics *(see page 164)*.

Output Characteristics

The table below describes the output characteristics of the TM7SPS1A block:

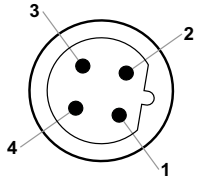
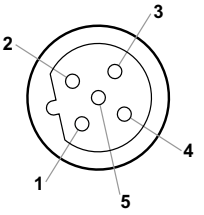
Output Characteristics	
Rated output power	15 W
Rated output voltage	20 Vdc
Output current	750 mA maximum
Internal protection	Overload and short circuit
Power Supply Outage	5 ms minimum at 24 Vdc input voltage and maximum output current

Output Characteristics	
Parallel operation	Yes, protection with redundancy during parallel operation of multiple PDBs
Redundant operation	Yes, if connected to the same input power supply

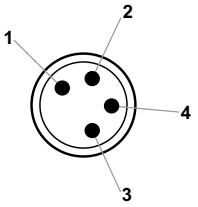
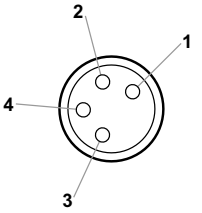
TM7SPS1A Wiring Diagram

Pin Assignments

The following figure shows the pin assignment of the TM7 bus IN (A) and OUT (B) connectors:

Connector (A)	Pin	Designation	Connector (B)
	1	TM7 V+	
	2	TM7 Bus Data	
	3	TM7 0V	
	4	TM7 Bus $\overline{\text{Data}}$	
	5	N.C.	

The following figure shows the pin assignment of the 24 Vdc power IN (C) and OUT (D) connectors:

Connector (C)	Pin	Designation	Connector (D)
	1	24 Vdc Main power	
	2	24 Vdc Main power	
	3	0 Vdc	
	4	0 Vdc	

⚠ DANGER

FIRE HAZARD

Use cable sizes that meet the I/O channel and power supply voltage and current ratings.

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

Use shielded, properly grounded cables for all analog and high-speed inputs or outputs and communication connections. If you do not use shielded cable for these connections, electromagnetic interference can cause signal degradation. Degraded signals can cause the controller or attached modules and equipment to perform in an unintended manner.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Use shielded cables for all fast I/O, analog I/O and communication signals.
- Ground cable shields for all analog I/O, fast I/O and communication signals at a single point[1].
- Route communication and I/O cables separately from power cables.

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

[1]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.

⚠ WARNING

ELECTROMAGNETIC INTERFERENCE

- Do not connect cables to connectors that are not properly wired to the sensor or actuator.
- Always use sealing plugs for any unused connectors.

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

⚠ WARNING

IP67 NON-CONFORMANCE

- Properly fit all connectors with cables or sealing plugs and tighten for IP67 conformance according to the torque values as specified in this document.
- Do not connect or disconnect cables or sealing plugs in the presence of water or moisture.

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.

Appendix H
TM7 Cables

Overview

This chapter describes the TM7 cables for wiring your TM7 System.

What Is in This Chapter?

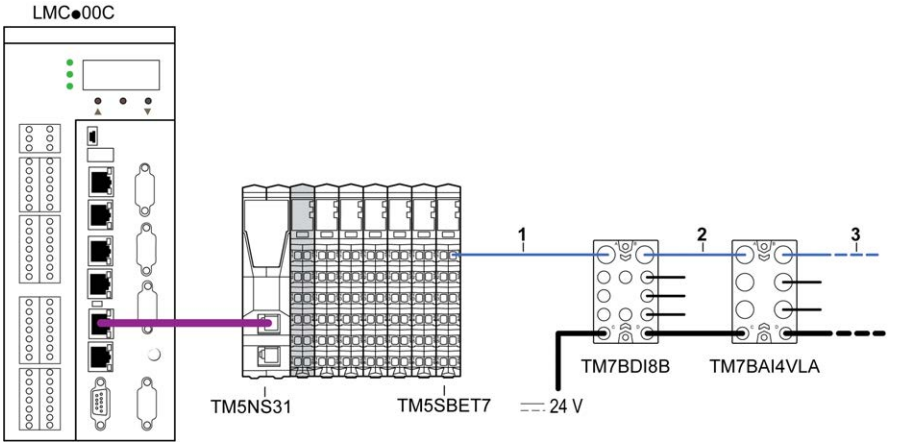
This chapter contains the following topics:

Topic	Page
Expansion Bus Cables	306
Power Cables	315
Sensor Cables	322

Expansion Bus Cables

Overview

The following figure shows expansion bus cables used in TM5/TM7 configurations:



1 Attachment IN cable: to connect a TM7 I/O block after a TM5 configuration using a TM5SBET7 transmitter module.
2 Drop cable: to build TM7 expansion bus between TM7 expansions blocks.
3 Attachment OUT cable: to connect a TM5 remote island after a TM7 I/O block using a TM5SBER2 receiver module.

Ordering Information

Length	Short Description, Reference					
	Drop Cable		Attachment IN Cable		Attachment OUT Cable	
0.3 m (1 ft)	TCSXCN2M2F03E	TCSXCN1M1F03E	–	–	–	–
1 m (3.3 ft)	TCSXCN2M2F1E	TCSXCN1M1F1E	TCSXCN2FNX1E	TCSXCN1FNX1E	TCSXCN2MNX1E	TCSXCN1MNX1E
2 m (6.6 ft)	TCSXCN2M2F2E	TCSXCN1M1F2E	–	–	–	–
3 m (9.8 ft)	–	–	TCSXCN2FNX3E	TCSXCN1FNX3E	TCSXCN2MNX3E	TCSXCN1MNX3E
5 m (16.4 ft)	TCSXCN2M2F5E	TCSXCN1M1F5E	–	–	–	–
10 m (32.8 ft)	TCSXCN2M2F10E	TCSXCN1M1F10E	TCSXCN2FNX10E	TCSXCN1FNX10E	TCSXCN2MNX10E	TCSXCN1MNX10E

Length	Short Description, Reference					
	Drop Cable		Attachment IN Cable		Attachment OUT Cable	
15 m (49.2 ft)	TCSXCN2M2F15E	TCSXCN1M1F15E	–	–	–	–
25 m (82 ft)	–	–	TCSXCN2FNX25E	TCSXCN1FNX25E	TCSXCN2MNX25E	TCSXCN1MNX25E
Dimensions and Pin Assignment	TCSXCN2M2F••E *(see page 309)*	TCSXCN1M1F••E *(see page 310)*	TCSXCN2FNX••E *(see page 311)*	TCSXCN1FNX••E *(see page 312)*	TCSXCN2MNX••E *(see page 313)*	TCSXCN1MNX••E *(see page 314)*

Cable Characteristics

The table below describes the characteristics of the individual wire pairs of the cable:

Wire	Characteristics	Value
Power pair	Conductor cross section (gauge)	0.34 mm^2 (AWG 22)
	Material insulation	Polyolefin
	Core diameter including insulation	1.40 mm (0.05 in.) ± 0.05 mm (0.002 in.)
	Electrical resistance (at 20 °C (68 °F))	≤ 0.052 Ω/m (0.016 Ω/ft)
	Insulation resistance (at 20 °C (68 °F))	≥ 100 MΩ*km (328 GΩ*ft)
	Nominal voltage	300 V
	Test voltage conductor	2000 Vdc x 1 s
Data pair	Conductor cross section (gauge)	0.2 mm^2 (AWG 24)
	Material insulation	Foam-skin PE
	Core diameter including insulation	2.05 mm (0.08 in.) ± 0.1 mm (0.004 in.)
	Electrical resistance (at 20 °C (68 °F))	≤ 0.078 Ω/m (0.024 Ω/ft)
	Insulation resistance (at 20 °C (68 °F))	≥ 5000 MΩ*km (16.4 TΩ*ft)
	Characteristic impedance (at 5 MHz)	120 Ω
	Nominal voltage	30 V
	Test voltage conductor	1500 Vdc x 1 s

The table below describes the general characteristics of the cable:

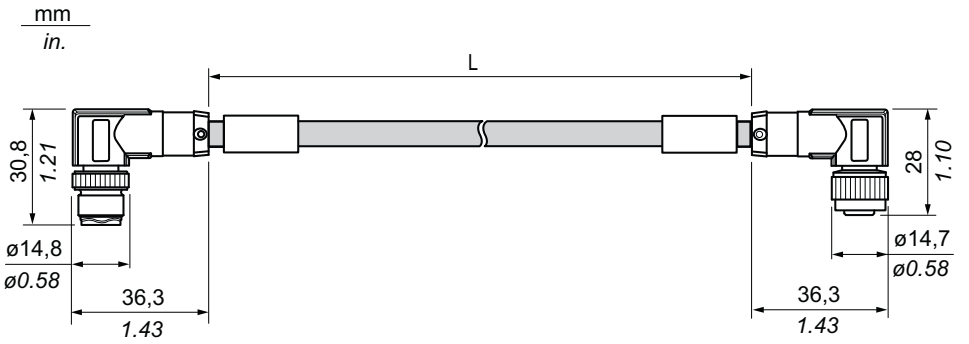
Characteristics		Specification
Cable type		Special PUR black shielded
Conductor material		Stranded tinned copper
Shield		Tinned copper foil and drain wire
External cable diameter		6.7 mm (0.26 in.) ± 0.3 mm (0.012 in.)
Minimum curve radius		67 mm (2.63 in.)
Maximum pulling strength	Static application	50 N/mm^2 (7252 lbf/in^2)
	Dynamic application	20 N/mm^2 (2901 lbf/in^2)
Wire colors	Power pair	Red, black
	Data pair	Blue, white
External sheath, color		Black-gray RAL 7021
Cable weight		54.8 kg/km (0.037 lb/ft)
Number of bending cycles		4 million
Traversing path		10 m (32.8 ft)
Traversing rate		3 m/s (9.8 ft/s)
Acceleration		10 m/s^2 (32.8 ft/s^2)
M12 fastening torque		Maximum 0.4 Nm (3.5 lbf-in)

The table below describes the environmental characteristics of the cable:

Characteristics	Specification
Operating temperature	–20...75 °C (–4...167 °F)
Storage temperature	–40...80 °C (–40...176 °F)
Special properties	Flexible cable conduit capable
	Silicone-free
Freedom from halogen	As per DIN VDE 0472 part 815
WEEE/RoHS	Compliant

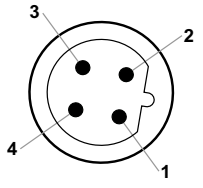
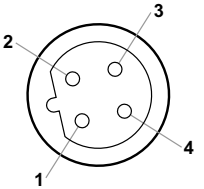
TCSXCN2M2F••E Dimensions and Pin Assignment

Dimensions



L length as a function of the particular reference

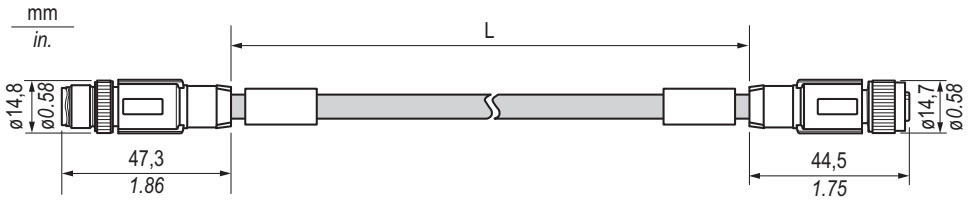
Pin Assignment

Male Connector	Pin	Designation	Wire Color	Female Connector
	1	TM7 V+	Red	
	2	TM7 Bus Data	White	
	3	TM7 OV	Black	
	4	TM7 Bus $\overline{\text{Data}}$	Blue	
	M12(1)	SHLD	Shield	

(1) Shielding 360 ° around M12 knurled screw.

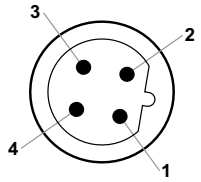
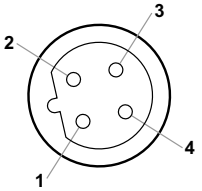
TCSXCN1M1F••E Dimensions and Pin Assignment

Dimensions



(L) length as a function of the particular reference

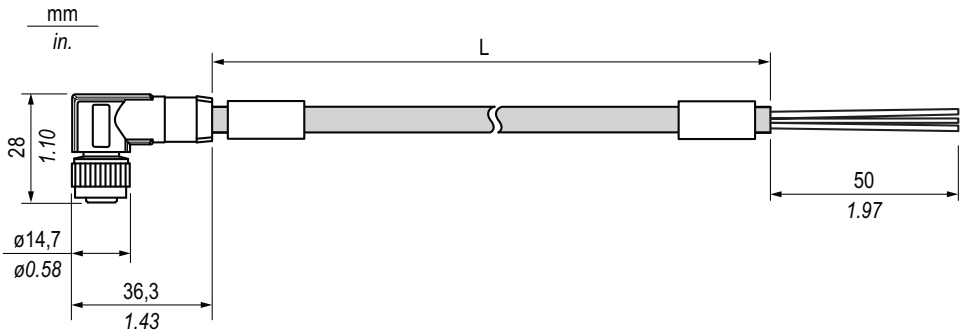
Pin Assignment

Male Connector	Pin	Designation	Wire Color	Female Connector
	1	TM7 V+	Red	
	2	TM7 Bus Data	White	
	3	TM7 OV	Black	
	4	TM7 Bus $\overline{\text{Data}}$	Blue	
	M12(1)	SHLD	Shield	

(1) Shielding 360 ° around M12 knurled screw.

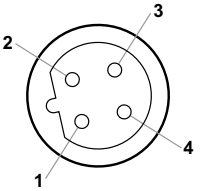
TCSXCN2FNX••E Dimensions and Pin Assignment

Dimensions



(L) length as a function of the particular reference

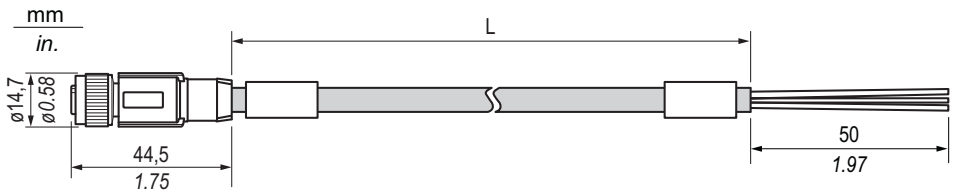
Pin Assignment

Female Connector	Pin	Designation	Wire Color	Open
	1	TM7 V+	Red	For custom wiring
	2	TM7 Bus Data	White	
	3	TM7 OV	Black	
	4	TM7 Bus $\overline{\text{Data}}$	Blue	
	M12(1)	SHLD	Shield	

(1) Shielding 360 ° around M12 knurled screw.

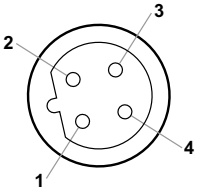
TCSXCN1FNX••E Dimensions and Pin Assignment

Dimensions



(L) length as a function of the particular reference

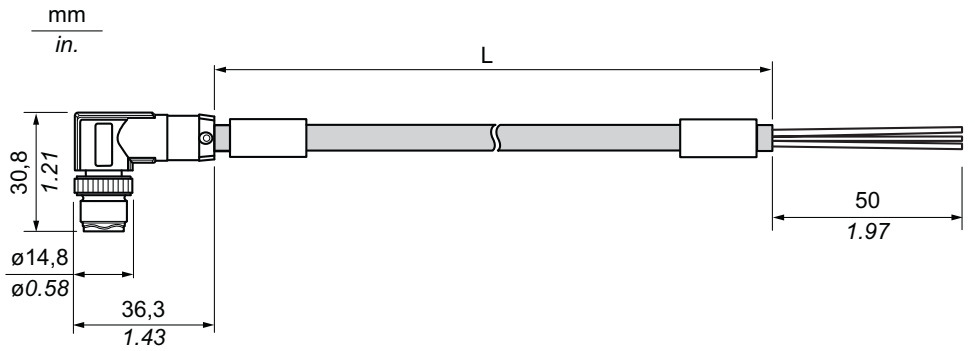
Pin Assignment

Female Connector	Pin	Designation	Wire Color	Open
	1	TM7 V+	Red	For custom wiring
	2	TM7 Bus Data	White	
	3	TM7 OV	Black	
	4	TM7 Bus $\overline{\text{Data}}$	Blue	
	M12(1)	SHLD	Shield	

(1) Shielding 360 ° around M12 knurled screw.

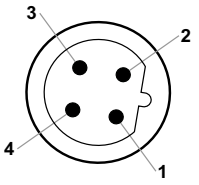
TCSXCN2MNX••E Dimensions and Pin Assignment

Dimensions



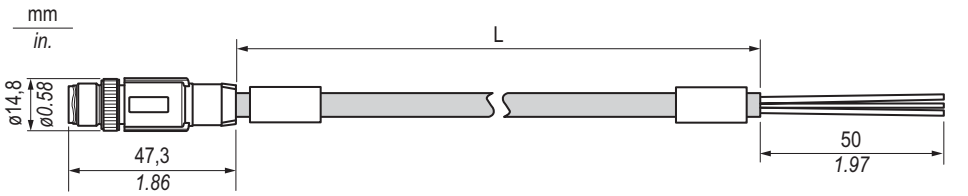
(L) length as a function of the particular reference

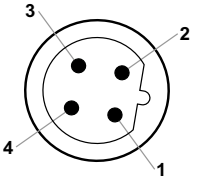
Pin Assignment

Male Connector	Pin	Designation	Wire Color	Open
	1	TM7 V+	Red	For custom wiring
	2	TM7 Bus Data	White	
	3	TM7 OV	Black	
	4	TM7 Bus $\overline{\text{Data}}$	Blue	
	M12(1)	SHLD	Shield	

(1) Shielding 360 ° around M12 knurled screw.

TCSXCN1MNX••E Dimensions and Pin Assignment

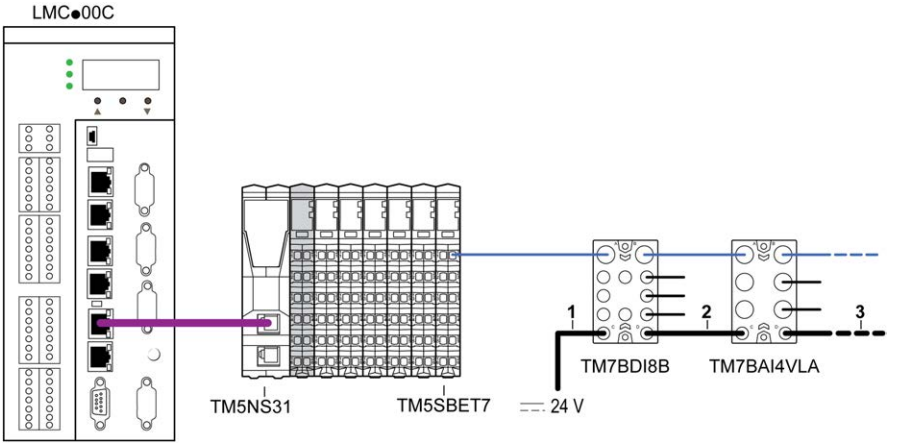
Dimensions

(L) length as a function of the particular reference

Pin Assignment				
Male Connector	**Pin**	**Designation**	**Wire Color**	**Open**
	1	TM7 V+	Red	For custom wiring
	2	TM7 Bus Data	White	
	3	TM7 OV	Black	
	4	TM7 Bus $\overline{\text{Data}}$	Blue	
	M12(1)	SHLD	Shield	
(1) Shielding 360 ° around M12 knurled screw.				

Power Cables

Overview

The following figure shows the power cables used in TM5/TM7 configurations:



1 Attachment IN cable: to connect an external power supply to a TM7 interface I/O block, a TM7 Power Distribution Block (PDB) or a TM7 I/O block.
2 Drop cable: to route 24 Vdc I/O power segment between two TM7 blocks.
3 Attachment OUT cable: to connect a TM7 block to another device.

Ordering Information

Length	Short Description, Reference					
	Drop Cable		Attachment IN Cable		Attachment OUT Cable	
0.3 m (1 ft)	TCSXCNEMEF03V	TCSXCNDMDF03V	–	–	–	–
1 m (3.3 ft)	TCSXCNEMEF1V	TCSXCNDMDF1V	TCSXCNEFNX1V	TCSXCNDFNX1V	TCSXCNEXNX1V	TCSXCNDMNX1V
2 m (6.6 ft)	TCSXCNEMEF2V	TCSXCNDMDF2V	–	–	–	–
3 m (9.8 ft)	–	–	TCSXCNEFNX3V	TCSXCNDFNX3V	TCSXCNEXNX3V	TCSXCNDMNX3V
5 m (16.4 ft)	TCSXCNEMEF5V	TCSXCNDMDF5V	–	–	–	–
10 m (32.8 ft)	TCSXCNEMEF10V	TCSXCNDMDF10V	TCSXCNEFNX10V	TCSXCNDFNX10V	TCSXCNEXNX10V	TCSXCNDMNX10V
15 m (49.2 ft)	TCSXCNEMEF15V	TCSXCNDMDF15V	–	–	–	–

Length	Short Description, Reference					
	Drop Cable		Attachment IN Cable		Attachment OUT Cable	
25 m (82 ft)	–	–	TCSXCNEFN X25V	TCSXCNDFN X25V	TCSXCNEXN X25V	TCSXCNDMN X25V
Dimensions and Pin Assignment	TCSXCNEME F••V *(see page 317)*	TCSXCNDMD F••V *(see page 318)*	TCSXCNEFN X••V *(see page 319)*	TCSXCNDFN X••V *(see page 319)*	TCSXCNEXN X••V *(see page 320)*	TCSXCNDMN X••V *(see page 321)*

Cable Characteristics

The table below describes the characteristics of the individual wire of the cable:

Characteristics	Specifications
Conductor cross section (gauge)	0.34 mm^2 (AWG 22)
Material insulation	Polypropylene (PP)
Core diameter including insulation	1.27 mm (0.05 in.) ± 0.02 mm (0.0008 in.)
Electrical resistance (at 20 °C (68 °F))	≤ 0.058 Ω/m (0.018 Ω/ft)
Insulation resistance (at 20 °C (68 °F))	≥ 100 MΩ*km (328 GΩ/ft)
Nominal voltage	300 V
Test voltage conductor	3000 Vdc x 1 s

The table below describes the general characteristics of the cable:

Characteristics	Specification
Cable type	PUR halogen-free black
Conductor material	Bare Cu litz wires
Shield	Braided copper wires
External cable diameter	4.7 mm (0.19 in.)
Minimum curve radius	47 mm (1.85 in.)
Wire colors	Black, brown, blue, white
External sheath, color	Black-gray RAL 7021
Cable weight	30 kg/km (0.02 lb/ft)
Number of bending cycles	4 million
Traversing path	10 m (32.8 ft)
Traversing rate	3 m/s (9.8 ft/s)
Acceleration	10 m/s^2 (32.8 ft/s^2)

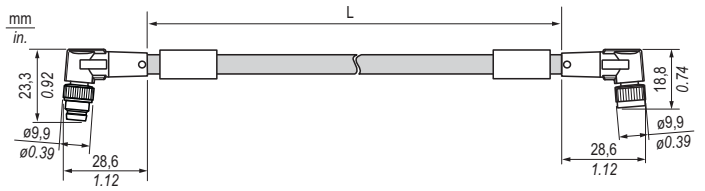
Characteristics	Specification
M8 fastening torque	Maximum 0.2 Nm (1.8 lbf-in)

The table below describes the environmental characteristics of the cable:

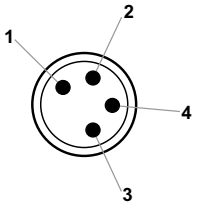
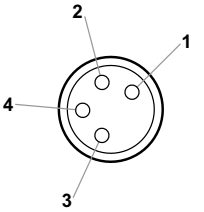
Characteristics	Specification
Operating temperature	–5...80 °C (23...176 °F)
Storage temperature	–40...80 °C (–40...176 °F)
Special properties	Flexible cable conduit capable
	Silicone-free
	Free of substances which would hinder coating with paint or varnish
Flame resistance	As per UL-Style 20549
Freedom from halogen	As per DIN VDE 0472 part 815
Resistance to oil	Complying with DIN EN 60811-2-1
Other resistance	Resistant to acids, alkaline solutions and solvents
	Hydrolysis and microbe resistant
WEEE/RoHS	Compliant

TCSXCNEMEF••V Dimensions and Pin Assignment

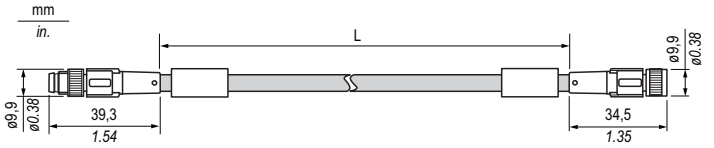
Dimensions

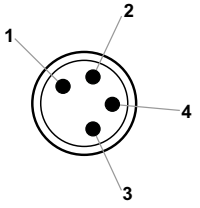
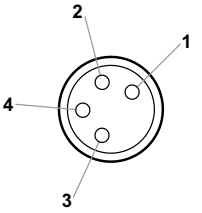


L length as a function of the particular reference

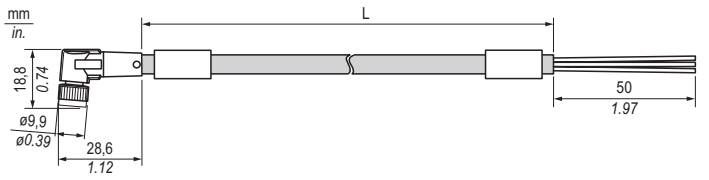
Pin Assignment				
Male Connector	**Pin**	**Designation**	**Wire Color**	**Female Connector**
	1	24 Vdc	White	
	2	24 Vdc	Brown	
	3	0 Vdc	Blue	
	4	0 Vdc	Black	

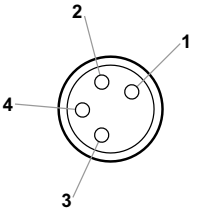
TCSXCNDMDF••V Dimensions and Pin Assignment

Dimensions

L length as a function of the particular reference

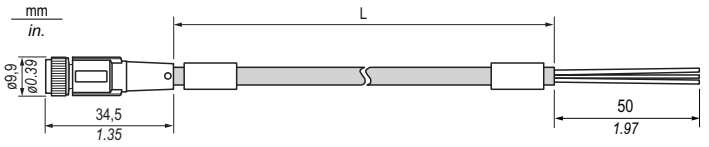
Pin Assignment				
Male Connector	**Pin**	**Designation**	**Wire Color**	**Female Connector**
	1	24 Vdc	White	
	2	24 Vdc	Brown	
	3	0 Vdc	Blue	
	4	0 Vdc	Black	

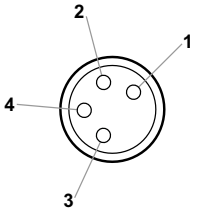
TCSXCNEFNX••V Dimensions and Pin Assignment

Dimensions

L length as a function of the particular reference

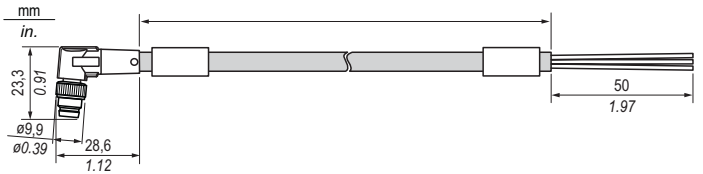
Pin Assignment				
Female Connector	**Pin**	**Designation**	**Wire Color**	**Open**
	1	24 Vdc	White	For custom wiring
	2	24 Vdc	Brown	
	3	0 Vdc	Blue	
	4	0 Vdc	Black	

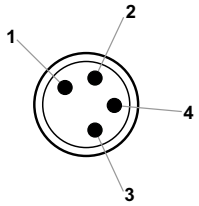
TCSXCNDFNX••V Dimensions and Pin Assignment

Dimensions

L length as a function of the particular reference

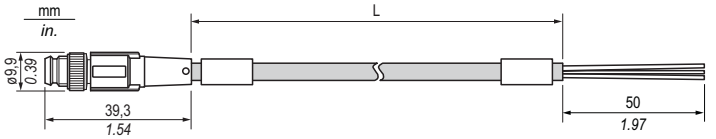
Pin Assignment				
Female Connector	**Pin**	**Designation**	**Wire Color**	**Open**
	1	24 Vdc	White	For custom wiring
	2	24 Vdc	Brown	
	3	0 Vdc	Blue	
	4	0 Vdc	Black	

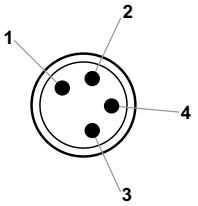
TCSXCNEXNX••V Dimensions and Pin Assignment

Dimensions

L length as a function of the particular reference

Pin Assignment				
Male Connector	**Pin**	**Designation**	**Wire Color**	**Open**
	1	24 Vdc	White	For custom wiring
	2	24 Vdc	Brown	
	3	0 Vdc	Blue	
	4	0 Vdc	Black	

TCSXCNDMNX••V Dimensions and Pin Assignment

Dimensions

L length as a function of the particular reference

Pin Assignment				
Male Connector	**Pin**	**Designation**	**Wire Color**	**Open**
	1	24 Vdc	White	For custom wiring
	2	24 Vdc	Brown	
	3	0 Vdc	Blue	
	4	0 Vdc	Black	

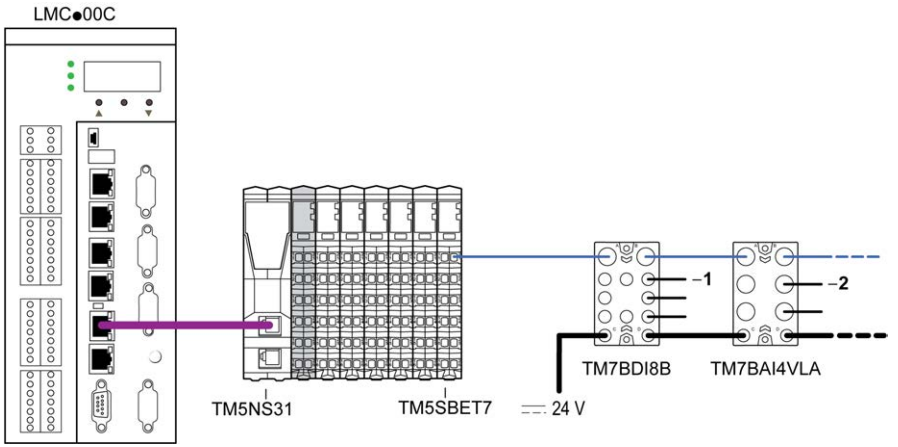
Sensor Cables

Overview

The sensor cables are used to:

- Connect the sensors to the analog inputs of the TM7 I/O blocks
- Connect the actuators to the analog outputs of the TM7 I/O blocks
- Connect the fast digital signals to the fast inputs or outputs of the TM7 I/O blocks

The following figure shows sensor cables used in TM5/TM7 configurations:



1 Sensor cable for TM7 Sercos III Bus Interface I/O block and TM7 digital I/O block
2 Sensor cable for TM7 analog I/O block

Ordering Information

Length	Short Description, Reference			
	M 12 Cable for Analog I/O		M 12 Cable for Digital I/O	M 8 Cable for Digital I/O
0.5 m (1.6 ft)	–	–	XZ CP1564L05	XZ CP2737L05
1 m (3.3 ft)	–	–	XZ CP1564L1	XZ CP2737L1
2 m (6.6 ft)	TCSXCN2M2SA	TCSXCN1M2SA	XZ CP1564L2	XZ CP2737L2
5 m (16.4 ft)	TCSXCN2M5SA	TCSXCN1M5SA	–	–
15 m (49.2 ft)	TCSXCN2M15SA	TCSXCN1M15SA	–	–
Dimensions and Pin Assignment	TCSXCN2M••SA *(see page 326)*	TCSXCN1M••SA *(see page 327)*	XZ CP1564L•• *(see page 328)*	XZ CP2737L•• *(see page 328)*

TCSXCN2M••SA and TCSXCN1M••SA Cable Characteristics

The table below describes the characteristics of the individual wire of the cable:

Characteristics	Specifications
Conductor cross section (gauge)	0.34 mm^2 (AWG 22)
Material insulation	Polypropylene (PP)
Material filler	Polyethylene (PE)
Core diameter including insulation	1.27 mm (0.05 in.) ± 0.02 mm (0.0008 in.)
Electrical resistance (at 20 °C (68 °F))	≤ 0.058 Ω/m (0.018 Ω/ft)
Insulation resistance (at 20 °C (68 °F))	≥ 100 GΩ*km (328 TΩ*ft)
Nominal voltage	300 V
Test voltage conductor	3000 Vdc x 1 s

The table below describes the general characteristics of the cable:

Characteristics	Specification
Cable type	Special PUR black shielded
Conductor material	Bare Cu litz wires
Shield	Braided copper wires
External cable diameter	5.9 mm (0.23 in.)
Minimum curve radius	59 mm (2.32 in.)
Wire colors	Brown, white, blue, black, gray
External sheath, color	Black-gray RAL 7021
Cable weight	48 kg/km (1.55 lb/ft)
Number of bending cycles	4 million
Traversing path	10 m (32.8 ft)
Traversing rate	3 m/s (9.8 ft/s)
Acceleration	10 m/s^2 (32.8 ft/s^2)
M12 fastening torque	Maximum 0.4 Nm (3.5 lbf-in)

The following table lists the environmental characteristics of the cable:

Characteristics	Specification
Operating temperature	– 5...80 °C (23...176 °F)
Storage temperature	– 40...80 °C (– 40...176 °F)

Characteristics	Specification
Special properties	Flexible cable conduit capable
	Silicone-free
	Free of substances which would hinder coating with paint or varnish
Flame resistance	As per UL-Style 20549
Freedom from halogen	As per DIN VDE 0472 part 815
Resistance to oil	Complying with DIN EN 60811-2-1
Other resistance	Resistant to acids, alkaline solutions and solvents
	Hydrolysis and microbe resistant
WEEE/RoHS	Compliant

XZ CP1564L•• Cable Characteristics

The following table describes the characteristics of the individual wire of the cable:

Characteristics	Specifications
Conductor cross section (gauge)	4 x 0.34 mm^2 (AWG 22) and 1 x 0.5 mm^2 (AWG 20)
Material insulation	PVC
Insulation resistance (at 20 °C (68 °F))	> 1 GΩ
Nominal current	4 A
Nominal voltage	30 Vac, 36 Vdc
Contact resistance	≤ 5 mΩ
Insulation voltage	2500 Vdc

The following table lists the general characteristics of the cable:

Characteristics		Specification
Cable type		Special PUR black shielded
External cable diameter		5.2 mm (0.20 in.)
Minimum curve radius		52 mm (2.05 in.)
Wire colors		Brown, black/white, blue, black, yellow/green
External sheath, color		Black
Cable weight	XZ CP1564L05	0.040 kg (0.09 lb)
	XZ CP1564L1	0.065 kg (0.14 lb)
	XZ CP1564L2	0.115 kg (0.25 lb)
Tensile strength		20...45 N/mm^2 (2901...6527 lbf/in^2)
M12 fastening torque		Maximum 0.4 Nm (3.5 lbf-in)

The following table lists the environmental characteristics of the cable:

Characteristics	Specification
Operating temperature	–5...90 °C (23...194 °F)
Storage temperature	–35...100 °C (–31...212 °F)
Special properties	Flexible cable conduit capable
	Silicone-free
	Without unmoulding agent
Flame resistance	C2 conforming to NF C 32-070
Freedom from halogen	As per DIN VDE 0472 part 815
Other resistance	Resistant to soluble, mineral or synthetic oil at 90 °C (194 °F)
WEEE/RoHS	Compliant

XZ CP2337L•• Cable Characteristics

The following table describes the characteristics of the individual wire of the cable:

Characteristics	Specifications
Conductor cross section (gauge)	0.34 mm^2 (AWG 22)
Material insulation	PVC
Insulation resistance (at 20 °C (68 °F))	> 1 GΩ
Nominal current	4 A
Nominal voltage	60 Vac, 75 Vdc
Contact resistance	≤ 5 mΩ
Insulation voltage	2500 Vdc

The following table lists the general characteristics of the cable:

Characteristics		Specification
Cable type		Special PUR black shielded
External cable diameter		5.2 mm (0.20 in.)
Minimum curve radius		52 mm (2.05 in.)
Wire colors		Brown, blue, black
External sheath, color		Black
Cable weight	XZ CP2737L05	0.030 kg (0.07 lb)
	XZ CP2737L1	0.050 kg (0.11 lb)
	XZ CP2737L2	0.080 kg (0.18 lb)
Tensile strength		20...45 N/mm^2 (2901...6527 $lbf.in^2$)

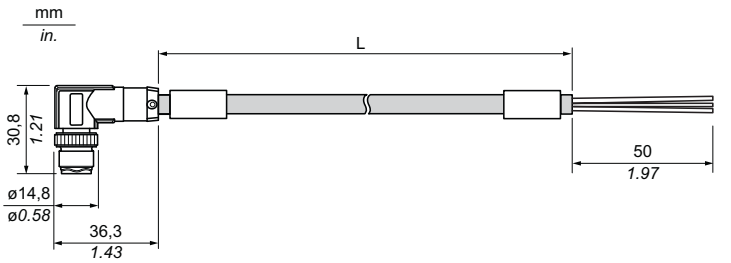
Characteristics	Specification
M8 fastening torque	Maximum 0.2 Nm (1.8 lbf-in)

The following table lists the environmental characteristics of the cable:

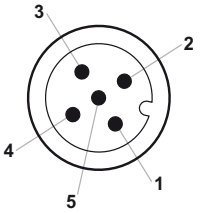
Characteristics	Specification
Operating temperature	–5...90 °C (23...194 °F)
Storage temperature	–35...100 °C (–31...212 °F)
Special properties	Flexible cable conduit capable
	Silicone-free
	Without unmoulding agent
Flame resistance	C2 conforming to NF C 32-070
Freedom from halogen	As per DIN VDE 0472 part 815
Other resistance	Resistant to soluble, mineral or synthetic oil at 90 °C (194 °F)
WEEE/RoHS	Compliant

TCSXCN2M••SA Dimensions and Pin Assignment

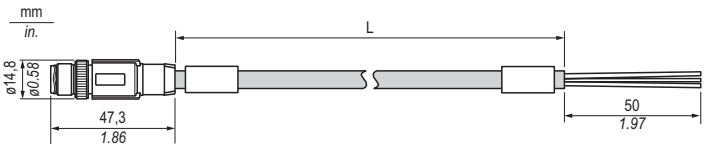
Dimensions



L length as a function of the particular reference

Pin Assignment			
Male Connector	**Pin**	**Designation**	**Wire Color**
	1	For pin assignment, refer to the wiring diagrams of the Modicon TM7 Analog I/O Blocks Hardware Guide.	Brown
	2		White
	3		Blue
	4		Black
	5		Gray
	M12[1]		SHLD
1 Shielding 360 ° around M12 knurled screw			

TCSXCN1M••SA Dimensions and Pin Assignment

Dimensions

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Pin Assignment			
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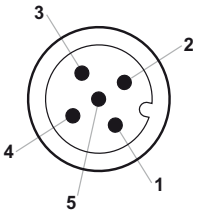
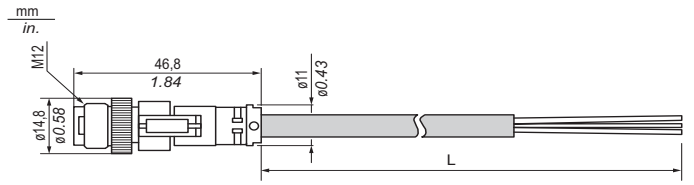
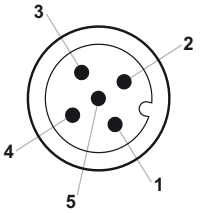
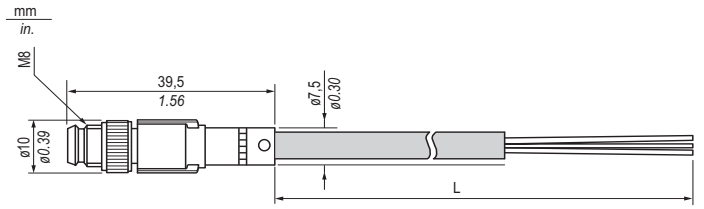
	1	For pin assignment, refer to the wiring diagrams of the Modicon TM7 Analog I/O Blocks Hardware Guide.	Brown
	2		White
	3		Blue
	4		Black
	5		Gray
	M12[1]		SHLD
1 Shielding 360 ° around M12 knurled screw			

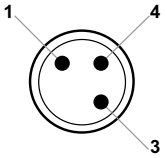
XZ CP1564L•• Dimensions and Pin Assignment

Dimensions

L length as a function of the particular reference

Pin Assignment			
Male Connector	**Pin**	**Designation**	**Wire Color**
	1	For pin assignment, refer to the wiring diagrams of the Modicon TM7 Digital I/O Blocks Hardware Guide.	Brown
	2		Black / White
	3		Blue
	4		Black
	5		Yellow / Green

XZ CP2737L•• Dimensions and Pin Assignment

Dimensions

L length as a function of the particular reference

Pin Assignment			
Male Connector	**Pin**	**Designation**	**Wire Color**
	1	For pin assignment, refer to the wiring diagrams of the Modicon TM7 Digital I/O Blocks Hardware Guide.	Brown
	3		Blue
	4		Black

Glossary

A

AWG

(*American wire gauge*) The standard that specifies wire section sizes in North America.

B

bus base

A mounting device that is designed to seat an electronic module on a DIN rail and connect it to the TM5 bus for M258 and LMC058 logic controllers. Each base bus extends the integrated TM5 data and electronic power buses as well as the 24 Vdc I/O power segment. The electronic modules are added to the TM5 system through their insertion on the base bus.

B coded

Connectors that have 1 raised key on the female connector and 1 mating slot on the male connector. These connectors (also called reverse keyed) are used for Sercos bus applications.

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.

CSA

(*Canadian standards association*) The Canadian standard for industrial electronic equipment in hazardous environments.

D

DIN

(*Deutsches Institut für Normung*) A German institution that sets engineering and dimensional standards.

E

EIA

(*electronic industries alliance*) The trade organization for establishing electrical/electronic and data communication standards (including RS-232 and RS-485) in the United States.

electronic module

In a programmable controller system, most electronic modules directly interface to the sensors, actuators, and external devices of the machine/process. This electronic module is the component that mounts in a bus base and provides electrical connections between the controller and the field devices. Electronic modules are offered in a variety of signal levels and capacities. (Some electronic modules are not I/O interfaces, including power distribution modules and transmitter/receiver modules.)

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*).

encoder

A device for length or angular measurement (linear or rotary encoders).

equipment

A part of a machine including sub-assemblies such as conveyors, turntables, and so on.

expansion bus

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

F

FAST I/O

FAST input/output Specific I/O modules with some electrical features (for example, response time) while the treatment of these channels are done directly by the controller

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.

firmware

Represents the BIOS, data parameters, and programming instructions that constitute the operating system on a controller. The firmware is stored in non-volatile memory within the controller.

function

A programming unit that has 1 input and returns 1 immediate result. However, unlike FBs, it is directly called with its name (as opposed to through an instance), has no persistent state from one call to the next and can be used as an operand in other programming expressions.

Examples: boolean (AND) operators, calculations, conversions (BYTE_TO_INT)

I

ID

(*identifier/identification*)

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

(*Internet protocol* Part of the TCP/IP protocol family that tracks the Internet addresses of devices, routes outgoing messages, and recognizes incoming messages.

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.

IP 67

(*ingress protection*) The protection classification according to IEC 60529. IP 67 modules are protected against ingress of dust, contact, and water up to an immersion depth of 1 m.

L

LED

(*light emitting diode*) An indicator that illuminates under a low-level electrical charge.

M

ms

(*millisecond*)

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.

network

A system of interconnected devices that share a common data path and protocol for communications.

P

PDM

(*power distribution module*) A module that distributes either AC or DC field power to a cluster of I/O modules.

PE

(*Protective Earth*) A common grounding connection to help avoid the hazard of electric shock by keeping any exposed conductive surface of a device at earth potential. To avoid possible voltage drop, no current is allowed to flow in this conductor (also referred to as *protective ground* in North America or as an equipment grounding conductor in the US national electrical code).

R

run

A command that causes the controller to scan the application program, read the physical inputs, and write to the physical outputs according to solution of the logic of the program.

S

Sercos

(*serial real-time communications system*) A digital control bus that interconnects, motion controls, drives, I/Os, sensors, and actuators for numerically controlled machines and systems. It is a standardized and open controller-to-intelligent digital device interface, designed for high-speed serial communication of standardized closed-loop real-time data.

STOP

A command that causes the controller to stop running an application program.

T

terminal block

(*terminal block*) The component that mounts in an electronic module and provides electrical connections between the controller and the field devices.

U

UL

(*underwriters laboratories*) A US organization for product testing and safety certification.

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