Modicon TM3
Expansion Modules Programming 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.

About the Book

At a Glance

Document Scope

This document describes the configuration of the TM3 expansion modules for EcoStruxure Machine Expert. For further information, refer to the separate documents provided in the EcoStruxure Machine Expert online help.

Validity Note

This document has been updated for the release of EcoStruxure™ Machine Expert V1.1.

Related Documents

Title of Documentation	Reference Number
TM3 Digital I/O Modules - Hardware Guide	*EIO0000003125 (ENG)* *EIO0000003126 (FRE)* *EIO0000003127 (GER)* *EIO0000003128 (SPA)* *EIO0000003129 (ITA)* *EIO0000003130 (CHS)* *EIO0000003424 (POR)* *EIO0000003425(TUR)*
TM3 Analog I/O Modules - Hardware Guide	*EIO0000003131 (ENG)* *EIO0000003132 (FRE)* *EIO0000003133 (GER)* *EIO0000003134 (SPA)* *EIO0000003135 (ITA)* *EIO0000003136 (CHS)* *EIO0000003426 (POR)* *EIO0000003427 (TUR)*
TM3 Expert Modules - Hardware Guide	*EIO0000003137 (ENG)* *EIO0000003138 (FRE)* *EIO0000003139 (GER)* *EIO0000003140 (SPA)* *EIO0000003141 (ITA)* *EIO0000003142 (CHS)* *EIO0000003428 (POR)* *EIO0000003429 (TUR)*

Title of Documentation	Reference Number
TM3 Safety Modules - Hardware Guide	*EIO0000003353 (ENG)* *EIO0000003354 (FRE)* *EIO0000003355 (GER)* *EIO0000003356 (SPA)* *EIO0000003357 (ITA)* *EIO0000003358 (CHS)* *EIO0000003359 (POR)* *EIO0000003360 (TUR)*
TM3 Transmitter and Receiver Modules - Hardware Guide	*EIO0000003143 (ENG)* *EIO0000003144 (FRE)* *EIO0000003145 (GER)* *EIO0000003146 (SPA)* *EIO0000003147 (ITA)* *EIO0000003148 (CHS)* *EIO0000003430 (POR)* *EIO0000003431 (TUR)*
TM3 Expert I/O Modules - HSC Library Guide	*EIO0000003683 (ENG)* *EIO0000003684 (FRE)* *EIO0000003685 (GER)* *EIO0000003686 (SPA)* *EIO0000003687 (ITA)* *EIO0000003688 (CHS)* *EIO0000003689 (POR)* *EIO0000003690 (TUR)*

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Product Related Information

⚠ 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.

Terminology Derived from Standards

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

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

Among others, these standards include:

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

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

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

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

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

Chapter 1
I/O Configuration General Information

Introduction

This chapter provides general information to help you configure TM3 expansion modules for EcoStruxure Machine Expert.

What Is in This Chapter?

This chapter contains the following topics:

I/O Configuration General Practices

Match Software and Hardware Configuration

The I/O that may be embedded in your controller is independent of the I/O that you may have added in the form of I/O expansion. It is important that the logical I/O configuration within your program matches the physical I/O configuration of your installation. If you add or remove any physical I/O to or from the I/O expansion bus or, depending on the controller reference, to or from the controller (in the form of cartridges), then you must update your application configuration. This is also true for any field bus devices you may have in your installation. Otherwise, there is the potential that the expansion bus or field bus no longer function while the embedded I/O that may be present in your controller continues to operate.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Update the configuration of your program each time you add or delete any type of I/O expansions on your I/O bus, or you add or delete any devices on your field bus.

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

Use the `GetRightBusStatus` function regularly to monitor the expansion bus status.

The Optional Feature for I/O Expansion Modules

I/O expansion modules can be marked as optional in the configuration. The **Optional module** feature provides a more flexible configuration by the acceptance of the definition of modules that are not physically attached to the controller. Therefore, a single application can support multiple physical configurations of I/O expansion modules, allowing a greater degree of scalability without the necessity of maintaining multiple application files for the same application.

You must be fully aware of the implications and impacts of marking I/O modules as optional in your application, both when those modules are physically absent and present when running your machine or process. Be sure to include this feature in your risk analysis.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Include in your risk analysis each of the variations of I/O configurations that can be realized marking I/O expansion modules as optional, and in particular the establishment of TM3 Safety modules (TM3S…) as optional I/O modules, and make a determination whether it is acceptable as it relates to your application.

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

NOTE: For more details about this feature, refer to Optional I/O Expansion Modules *(see page 29)*.

General Description

Introduction

The range of TM3 expansion modules includes:

- Digital modules, classified as follows:
  - Input modules *(see page 15)*
  - Output modules *(see page 16)*
  - Mixed input/output modules *(see page 18)*
- Analog modules, classified as follows:
  - Input modules *(see page 18)*
  - Output modules *(see page 20)*
  - Mixed input/output modules *(see page 20)*
- Expert modules *(see page 21)*
- Safety modules *(see page 22)*
- Transmitter and receiver modules *(see page 23)*

TM3 Digital Input Modules

The following table shows the TM3 digital input expansion modules, with corresponding channel type, nominal voltage/current, and terminal type. For information on configuration of these modules, refer to the TM3 Digital I/O Modules Configuration *(see page 33)* section.

Reference	Channels	Channel Type	Voltage Current	Terminal Type / Pitch
TM3DI8A	8	Regular inputs	120 Vac 7.5 mA	Removable screw terminal block / 5.08 mm
TM3DI8	8	Regular inputs	24 Vdc 7 mA	Removable screw terminal block / 5.08 mm
TM3DI8G	8	Regular inputs	24 Vdc 7 mA	Removable spring terminal block / 5.08 mm
TM3DI16	16	Regular inputs	24 Vdc 7 mA	Removable screw terminal block / 3.81 mm
TM3DI16G	16	Regular inputs	24 Vdc 7 mA	Removable spring terminal block / 3.81 mm
TM3DI16K	16	Regular inputs	24 Vdc 5 mA	HE10 (MIL 20) connector
TM3DI32K	32	Regular inputs	24 Vdc 5 mA	HE10 (MIL 20) connector

TM3 Digital Output Modules

The following table shows the TM3 digital output modules, with corresponding channel type, nominal voltage/current, and terminal type. For information on configuration of these modules, refer to the TM3 Digital I/O Modules Configuration *(see page 33)* section.

Reference	Channels	Channel Type	Voltage Current	Terminal Type / Pitch
TM3DQ8R	8	Relay outputs	24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output	Removable screw terminal block / 5.08 mm
TM3DQ8RG	8	Relay outputs	24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output	Removable spring terminal block / 5.08 mm
TM3DQ8T	8	Regular transistor outputs (source)	24 Vdc 4 A maximum per common line/0.5 A maximum per output	Removable screw terminal block / 5.08 mm
TM3DQ8TG	8	Regular transistor outputs (source)	24 Vdc 4 A maximum per common line/0.5 A maximum per output	Removable spring terminal block / 5.08 mm
TM3DQ8U	8	Regular transistor outputs (sink)	24 Vdc 4 A maximum per common line/0.5 A maximum per output	Removable screw terminal block / 5.08 mm
TM3DQ8UG	8	Regular transistor outputs (sink)	24 Vdc 4 A maximum per common line/0.5 A maximum per output	Removable spring terminal block / 5.08 mm
TM3DQ16R	16	Relay outputs	24 Vdc / 240 Vac 8 A maximum per common line / 2 A maximum per output	Removable screw terminal block / 3.81 mm
TM3DQ16RG	16	Relay outputs	24 Vdc / 240 Vac 8 A maximum per common line / 2 A maximum per output	Removable spring terminal block / 3.81 mm
TM3DQ16T	16	Regular transistor outputs (source)	24 Vdc 4 A maximum per common line / 0.5 A maximum per output	Removable screw terminal block / 3.81 mm

Reference	Channels	Channel Type	Voltage Current	Terminal Type / Pitch
TM3DQ16TG	16	Regular transistor outputs (source)	24 Vdc 4 A maximum per common line / 0.5 A maximum per output	Removable spring terminal block / 3.81 mm
TM3DQ16U	16	Regular transistor outputs (sink)	24 Vdc 2 A maximum per common line / 0.3 A maximum per output	Removable screw terminal block / 3.81 mm
TM3DQ16UG	16	Regular transistor outputs (sink)	24 Vdc 2 A maximum per common line / 0.3 A maximum per output	Removable spring terminal block / 3.81 mm
TM3DQ16TK	16	Regular transistor outputs (source)	24 Vdc 2 A maximum per common line / 0.1 A maximum per output	HE10 (MIL 20) connector
TM3DQ16UK	16	Regular transistor outputs (sink)	24 Vdc 2 A maximum per common line / 0.1 A maximum per output	HE10 (MIL 20) connector
TM3DQ32TK	32	Regular transistor outputs (source)	24 Vdc 2 A maximum per common line / 0.1 A maximum per output	HE10 (MIL 20) connector
TM3DQ32UK	32	Regular transistor outputs (sink)	24 Vdc 2 A maximum per common line / 0.1 A maximum per output	HE10 (MIL 20) connector

TM3 Digital Mixed Input/Output Modules

This following table shows the TM3 mixed I/O modules, with corresponding channel type, nominal voltage/current, and terminal type. For information on configuration of these modules, refer to the TM3 Digital I/O Modules Configuration *(see page 33)* section.

Reference	Channels	Channel Type	Voltage Current	Terminal Type / Pitch
TM3DM8R	4	Regular inputs	24 Vdc 7 mA	Removable screw terminal block / 5.08 mm
	4	Relay outputs	24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output	
TM3DM8RG	4	Regular inputs	24 Vdc 7 mA	Removable spring terminal block /5.08 mm
	4	Relay outputs	24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output	
TM3DM24R	16	Regular inputs	24 Vdc 7 mA	Removable screw terminal block / 3.81 mm
	8	Relay outputs	24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output	
TM3DM24RG	16	Regular inputs	24 Vdc 7 mA	Removable spring terminal block / 3.81 mm
	8	Relay outputs	24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output	

TM3 Analog Input Modules

The following table shows the TM3 analog input expansion modules, with corresponding channel type, nominal voltage/current, and terminal type. For information on configuration of these modules, refer to the TM3 Analog Input Modules Configuration *(see page 36)* section.

Reference	Resolution	Channels	Channel Type	Mode	Terminal Type / Pitch
TM3AI2H	16 bit, or 15 bit + sign	2	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable screw terminal block / 5.08 mm
TM3AI2HG	16 bit, or 15 bit + sign	2	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable spring terminal block / 5.08 mm

Reference	Resolution	Channels	Channel Type	Mode	Terminal Type / Pitch
TM3AI4	12 bit, or 11 bit + sign	4	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable screw terminal block / 3.81 mm
TM3AI4G	12 bit, or 11 bit + sign	4	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable spring terminal blocks / 3.81 mm
TM3AI8	12 bit, or 11 bit + sign	8	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA 0...20 mA extended 4...20 mA extended	Removable screw terminal block / 3.81 mm
TM3AI8G	12 bit, or 11 bit + sign	8	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA 0...20 mA extended 4...20 mA extended	Removable spring terminal blocks / 3.81 mm
TM3TI4	16 bit, or 15 bit + sign	4	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA Thermocouple PT100/1000 NI100/1000	Removable screw terminal block / 3.81 mm
TM3TI4G	16 bit, or 15 bit + sign	4	inputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA Thermocouple PT100/1000 NI100/1000	Removable spring terminal blocks / 3.81 mm
TM3TI4D	16 bit, or 15 bit + sign	4	inputs	Thermocouple	Removable screw terminal block / 3.81 mm
TM3TI4DG	16 bit, or 15 bit + sign	4	inputs	Thermocouple	Removable spring terminal blocks / 3.81 mm
TM3TI8T	16 bit, or 15 bit + sign	8	inputs	Thermocouple NTC/PTC	Removable screw terminal block / 3.81 mm
TM3TI8TG	16 bit, or 15 bit + sign	8	inputs	Thermocouple NTC/PTC	Removable spring terminal blocks / 3.81 mm

TM3 Analog Output Modules

The following table shows the TM3 analog output modules, with corresponding channel type, nominal voltage/current, and terminal type. For information on configuration of these modules, refer to the TM3 Analog Output Modules Configuration *(see page 56)* section.

Reference	Resolution	Channels	Channel Type	Mode	Terminal Type / Pitch
TM3AQ2	12 bit, or 11 bit + sign	2	outputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable screw terminal block / 5.08 mm
TM3AQ2G	12 bit, or 11 bit + sign	2	outputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable spring terminal block / 5.08 mm
TM3AQ4	12 bit, or 11 bit + sign	4	outputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable screw terminal block / 5.08 mm
TM3AQ4G	12 bit, or 11 bit + sign	4	outputs	0...10 Vdc -10…+10 Vdc 0...20 mA 4...20 mA	Removable spring terminal block / 5.08 mm

TM3 Analog Mixed Input/Output Modules

This following table shows the TM3 analog mixed I/O modules, with corresponding channel type, nominal voltage/current, and terminal type. For information on configuration of these modules, refer to the TM3 Analog Mixed I/O Modules Configuration *(see page 61)* section.

Reference	Resolution	Channels	Channel Type	Mode	Terminal Type / Pitch
TM3AM6	12 bit, or 11 bit + sign	4	inputs	0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA	Removable screw terminal block / 3.81 mm
		2	outputs		
TM3AM6G	12 bit, or 11 bit + sign	4	inputs	0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA	Removable spring terminal block / 3.81 mm
		2	outputs		

Reference	Resolution	Channels	Channel Type	Mode	Terminal Type / Pitch
TM3TM3	16 bit, or 15 bit + sign	2	inputs	0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA Thermocouple PT100/1000 NI100/1000	Removable screw terminal block / 5.08 mm
	12 bit, or 11 bit + sign	1	output	0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA	
TM3TM3G	16 bit, or 15 bit + sign	2	inputs	0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA Thermocouple PT100/1000 NI100/1000	Removable spring terminal block / 5.08 mm
	12 bit, or 11 bit + sign	1	output	0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA	

TM3 Expert Modules

The following table shows the TM3 expert expansion modules, with corresponding terminal type. For information on configuration of these modules, refer to the TM3 Expert I/O Modules Configuration *(see page 73)* section.

Reference	Description	Terminal Type / Pitch
TM3XTYS4	TeSys module	4 front connectors RJ-45 1 removable power supply connector / 5.08 mm
TM3XFHSC202	High Speed Counting (HSC) module with events	Removable screw terminal blocks / 3.81 mm
TM3XFHSC202G	High Speed Counting (HSC) module with events	Removable spring terminal blocks / 3.81 mm
TM3XHSC202	High Speed Counting (HSC) module	Removable screw terminal blocks / 3.81 mm
TM3XHSC202G	High Speed Counting (HSC) module	Removable spring terminal blocks / 3.81 mm

TM3 Safety Modules

This table contains the TM3 safety modules *(see Modicon TM3, Safety Modules, Hardware Guide)*, with the corresponding channel type, nominal voltage/current, and terminal type:

Reference	Function Category	Channels	Channel type	Voltage Current	Terminal type
TM3SAC5R	1 function, up to category 3	1 or 2 (1)	Safety input	24 Vdc 100 mA maximum	3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable screw terminal block
		Start (2)	Input		
		3 in parallel	Relay outputs Normally open	24 Vdc / 230 Vac 6 A maximum per output	
TM3SAC5RG	1 function, up to category 3	1 or 2 (1)	Safety input	24 Vdc 100 mA maximum	3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable spring terminal block
		Start (2)	Input		
		3 in parallel	Relay outputs Normally open	24 Vdc / 230 Vac 6 A maximum per output	
TM3SAF5R	1 function, up to category 4	2 (1)	Safety inputs	24 Vdc 100 mA maximum	3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable screw terminal block
		Start	Input		
		3 in parallel	Relay outputs Normally open	24 Vdc / 230 Vac 6 A maximum per output	
TM3SAF5RG	1 function, up to category 4	2 (1)	Safety inputs	24 Vdc 100 mA maximum	3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable spring terminal block
		Start	Input		
		3 in parallel	Relay outputs Normally open	24 Vdc / 230 Vac 6 A maximum per output	
TM3SAFL5R	2 functions, up to category 3	2 (1)	Safety inputs	24 Vdc 100 mA maximum	3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable screw terminal block
		Start	Input		
		3 in parallel	Relay outputs Normally open	24 Vdc / 230 Vac 6 A maximum per output	
TM3SAFL5RG	2 functions, up to category 3	2 (1)	Safety inputs	24 Vdc 100 mA maximum	3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable spring terminal block
		Start	Input		
		3 in parallel	Relay outputs Normally open	24 Vdc / 230 Vac 6 A maximum per output	

(1) Depending on external wiring
(2) Non-monitored start

Reference	Function Category	Channels	Channel type	Voltage Current	Terminal type
TM3SAK6R	3 functions, up to category 4	1 or 2 (1)	Safety inputs	24 Vdc 100 mA maximum	3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable screw terminal block
		Start	Input		
		3 in parallel	Relay outputs Normally open	24 Vdc / 230 Vac 6 A maximum per output	
TM3SAK6RG	3 functions, up to category 4	1 or 2 (1)	Safety inputs	24 Vdc 100 mA maximum	3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable spring terminal block
		Start	Input		
		3 in parallel	Relay outputs Normally open	24 Vdc / 230 Vac 6 A maximum per output	
(1) Depending on external wiring (2) Non-monitored start					

For more information on the terms methods used concerning functional safety as they apply to the TM3 Safety Modules, refer to the sections TM3 Safety Functionality modes *(see page 93)* and TM3 Safety Operation Modes *(see page 102)*.

TM3 Transmitter and Receiver Modules

The following table shows the TM3 transmitter and receiver expansion modules, with corresponding terminal type. For information on configuration of these modules, refer to the TM3 Transmitter and Receiver I/O Modules Configuration *(see page 117)* section.

Reference	Description	Terminal Type / Pitch
TM3XTRA1	Data transmitter module for remote I/O	1 front connector RJ-45 1 screw for functional ground connection
TM3XREC1	Data receiver module for remote I/O	1 front connector RJ-45 1 removable power supply connector / 5.08 mm

Adding an Expansion Module

Adding a Module

To add an expansion module to your controller, select the expansion module in the **Hardware Catalog**, drag it to the **Devices tree**, and drop it on one of the highlighted nodes.

For more information on adding a device to your project, refer to:

• Using the Drag-and-drop Method *(see EcoStruxure Machine Expert, Programming Guide)*

• Using the Contextual Menu or Plus Button *(see EcoStruxure Machine Expert, Programming Guide)*

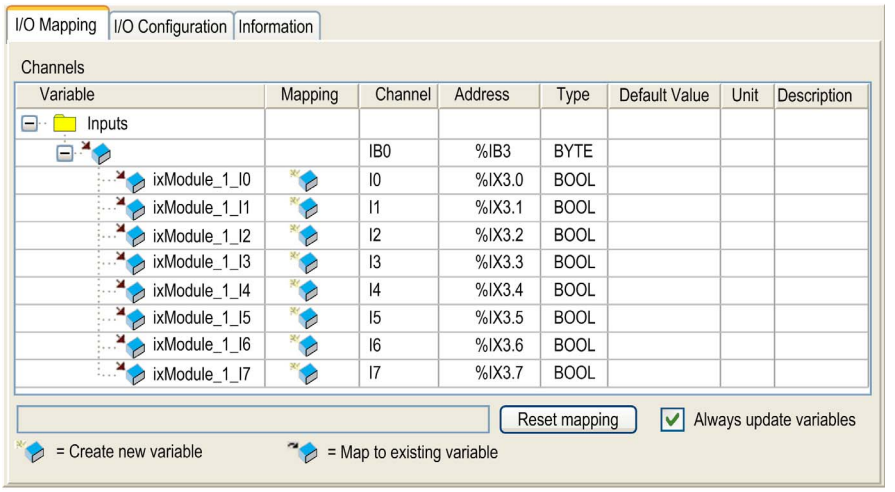
I/O Mapping Tab

The I/O mapping of an expansion module is carried out through the **I/O Mapping** tab of the expansion module configuration.

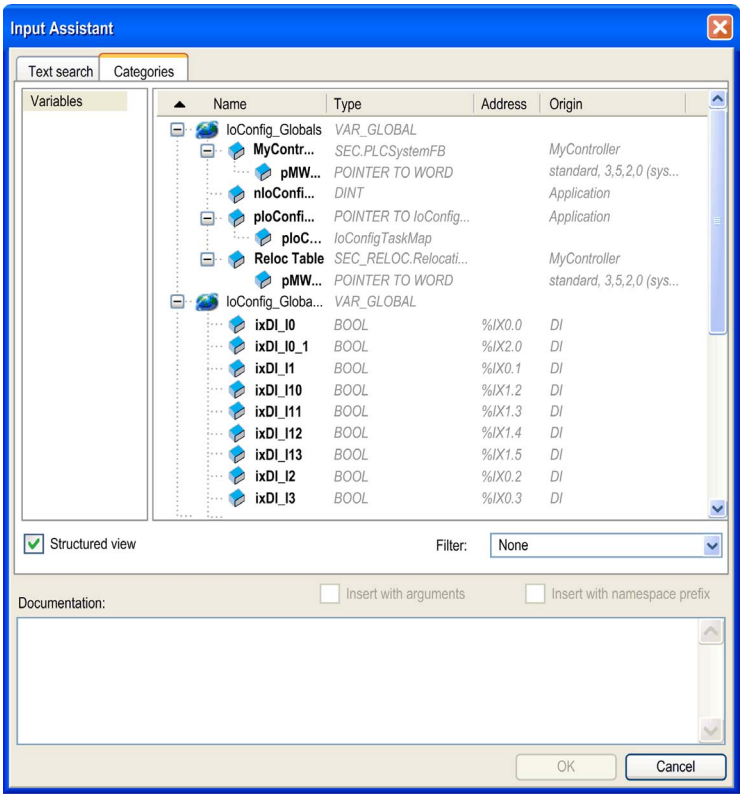
This table describes how to configure an expansion module:

Step	Action
1	Double-click the expansion module node in the **Devices tree** to display the **I/O Mapping** tab.
2	Edit the parameters of the **I/O Mapping** tab to configure the expansion module.

This figure shows the **I/O Mapping** tab:



This table describes each parameter of the **I/O Mapping** tab:

Parameter	Description
Variable	Allows you to map the channel on a variable. **NOTE:** Expand the list of variables from the category **Inputs** or **Outputs**. You can map a channel by either creating a new variable or mapping to an existing variable. **Create new variable**: Double-click the variable to enter the new variable name. A new variable is created if the variable does not already exist. **Map to existing variable**: Double-click the variable and click **[...]** to open the **Input Assistant** window. Select the variable from the list and press **OK**. This figure shows the **Input Assistant** window: 
Mapping	Indicates whether the channel is mapped on a new variable or an existing variable.
Channel	Displays the channel name of the device.

Parameter	Description
Address	Displays the address of the channel. **NOTE:** If the channel is mapped to an existing variable, corresponding address appears as strikethrough text in the table.
Type	Displays the data type of the channel.
Default Value	Indicates the value taken by the output when the controller is in a **STOPPED** or **HALT** state. Double-click the cell to change the default value. You can toggle between the following values: ● No value (*empty cell*) ● `TRUE` ● `FALSE`
Unit	Displays the unit of the channel value.
Description	Allows you to enter a short description of the channel.
Bus cycle options	Depending on the controller reference, you can configure the **Bus cycle options**. This configuration setting is the parent for all **Bus cycle task** parameters used in the application device tree. Some devices with cyclic calls, such as a **CANopen manager**, can be attached to a specific task. In the device, when this setting is set to **Use parent bus cycle setting**, the setting set for the controller is used. The selection list offers all tasks currently defined in the active application. The default setting is **Use parent bus cycle setting**.

I/O Configuration Tab

This tab allows you to configure the I/O module:

Parameter	Type	Value	Default Value	Unit	Description
Optional module	Enumeration of BYTE	No	No		
Functional Mode	Enumeration of BYTE	1	1		1 = Normal Mode 2 = Latch Filter Fallback Mode(TM3 DIO module with SV >=2.0)

NOTE: To configure the module as an optional module, refer to Optional I/O Expansion Modules *(see page 29)*.

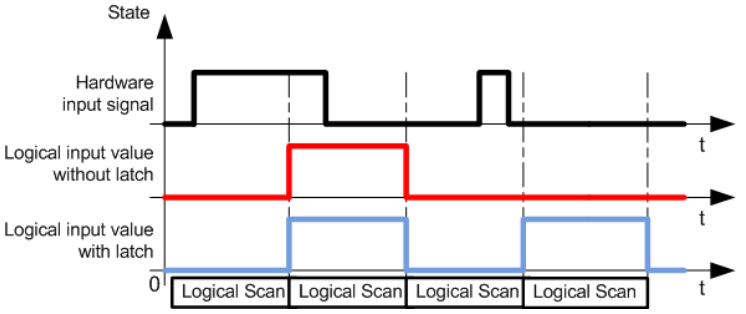
Configuring the Latch and Filter Parameters

The latch parameter allows incoming pulses with amplitude widths shorter than the controller scan time to be captured and recorded. You can select the type of edge (rising, falling, both or none).

The filter parameter reduces the effect of bounce on a controller digital input.

NOTE: The more the filter value is low, the more the effects of electromagnetic interference are maximized.

The following timing diagram illustrates the latching effects:



NOTE: You can configure these parameters on the following modules:

- TM3DI16
- TM3DI16G
- TM3DI16K
- TM3XHSC202 / TM3XHSC202G

This table describes how to configure the latch and filter parameters.

Step	Action
1	Click the module node → **I/O Configuration** tab.
2	Select **2** as **Value** for **Functional Mode**.
3	Select an input.
4	Configure the parameters.

This table describes the latch and filter parameters:

Parameter	Type	Value	Default Value	Unit	Description
Fonctional Mode	Enumeration of BYTE	1 2	1	–	**Fonctional Mode 2** allows you to configure latch and filter parameters.
Inputs					
Latch	Enumeration of BYTE	No Both edges Rising edge Falling edge	No	–	Latching allows incoming pulses with amplitude widths shorter than controller scan time to be captured and recorded.
Filter	Enumeration of BYTE	0 0.1 0.2 0.3 0.5 1 2 4 12	4	ms	Integrator filtering value reduces the effect of bounce on a controller input.

Optional I/O Expansion Modules

Presentation

I/O expansion modules can be marked as optional in the configuration. The **Optional module** feature provides a more flexible configuration by the acceptance of the definition of modules that are not physically attached to the controller. Therefore, a single application can support multiple physical configurations of I/O expansion modules, allowing a greater degree of scalability without the necessity of maintaining multiple application files for the same application.

Without the **Optional module** feature, when the controller starts up the I/O expansion bus (following a power cycle, application download or initialization command), it compares the configuration defined in the application with the physical I/O modules attached to the I/O bus. Among other diagnostics made, if the controller determines that there are I/O modules defined in the configuration that are not physically present on the I/O bus, an error is detected and the I/O bus does not start.

With the **Optional module** feature, the controller ignores the absent I/O expansion modules that you have marked as optional, which then allows the controller to start the I/O expansion bus.

The controller starts the I/O expansion bus at configuration time (following a power cycle, application download, or initialization command) even if optional expansion modules are not physically connected to the controller.

The following module types can be marked as optional:

- TM3 I/O expansion modules
- TM2 I/O expansion modules

NOTE: TM3 Transmitter/Receiver modules (the TM3XTRA1 and the TM3XREC1) and TMC4 cartridges cannot be marked as optional.

You must be fully aware of the implications and impacts of marking I/O modules as optional in your application, both when those modules are physically absent and present when running your machine or process. Be sure to include this feature in your risk analysis.

⚠ WARNING

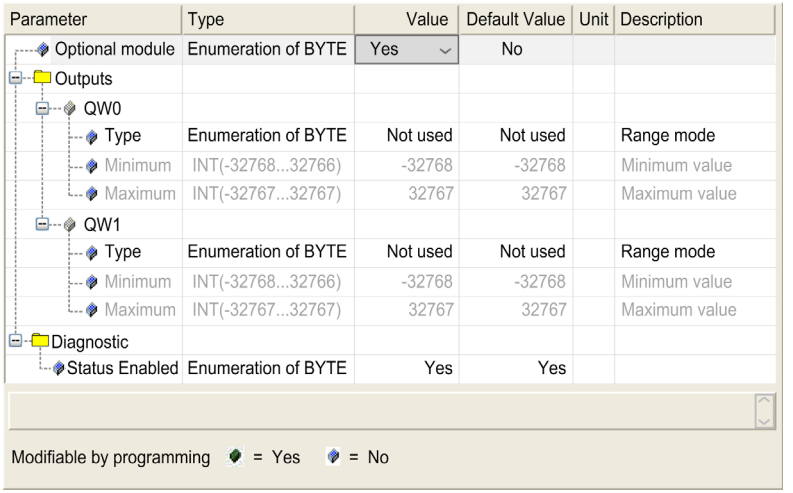
UNINTENDED EQUIPMENT OPERATION

Include in your risk analysis each of the variations of I/O configurations that can be realized marking I/O expansion modules as optional, and in particular the establishment of TM3 Safety modules (TM3S…) as optional I/O modules, and make a determination whether it is acceptable as it relates to your application.

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

Marking an I/O Expansion Module as Optional

To add an expansion module and mark it as optional in the configuration:

Step	Action
1	Add the expansion module to your controller .
2	In the **Devices tree**, double-click the expansion module.
3	Select the **I/O Configuration** tab.
4	In the **Optional module** line, select **Yes** in the **Value** column: 

Shared Internal ID Codes

Controllers and bus couplers identify expansion modules by a simple internal ID code. This ID code is not specific to each reference, but identifies the logical structure of the expansion module. Therefore, different references can share the same ID code.

You cannot have two modules with the same internal ID code declared as optional without at least one mandatory module placed between them.

This table groups the module references sharing the same internal ID code:

Modules sharing the same internal ID code
TM2DDI16DT, TM2DDI16DK
TM2DRA16RT, TM2DDO16UK, TM2DDO16TK
TM2DDI8DT, TM2DAI8DT
TM2DRA8RT, TM2DDO8UT, TM2DDO8TT
TM2DDO32TK, TM2DDO32UK

Modules sharing the same internal ID code
TM3DI16K, TM3DI16, TM3DI16G
TM3DQ16R, TM3DQ16RG, TM3DQ16T, TM3DQ16TG, TM3DQ16TK, TM3DQ16U, TM3DQ16UG, TM3DQ16UK
TM3DQ32TK, TM3DQ32UK
TM3DI8, TM3DI8G, TM3DI8A
TM3DQ8R, TM3DQ8RG, TM3DQ8T, TM3DQ8TG, TM3DQ8U, TM3DQ8UG
TM3DM8R, TM3DM8RG
TM3DM24R, TM3DM24RG
TM3SAK6R, TM3SAK6RG
TM3SAF5R, TM3SAF5RG
TM3SAC5R, TM3SAC5RG
TM3SAFL5R, TM3SAFL5RG
TM3AI2H, TM3AI2HG
TM3AI4, TM3AI4G
TM3AI8, TM3AI8G
TM3AQ2, TM3AQ2G
TM3AQ4, TM3AQ4G
TM3AM6, TM3AM6G
TM3TM3, TM3TM3G
TM3TI4, TM3TI4G
TM3TI4D, TM3TI4DG
TM3TI8T, TM3TI8TG
TM3XFHSC202, TM3XFHSC202G
TM3XHSC202, TM3XHSC202G

Chapter 2
TM3 Digital I/O Modules Configuration

Configuring the TM3 Digital I/O Modules

Introduction

The range of TM3 digital I/O expansion modules includes:

- TM3 Digital Input Modules *(see page 15)*
- TM3 Digital Output Modules *(see page 16)*
- TM3 Digital Mixed Input/Output Modules *(see page 18)*

Configuring the Modules

Refer to the I/O Configuration *(see page 26)* for detailed information on the configuration of the digital I/O expansion modules in EcoStruxure Machine Expert.

Updating the Firmware Version

To update the firmware version of the TM3DI16, TM3DI16G and TM3DI16K modules, refer to the programming guide of your controller.

Chapter 3
TM3 Analog I/O Modules Configuration

Introduction

This chapter describes how to configure the TM3 analog I/O modules.

The range of TM3 analog I/O expansion modules includes:

- TM3 Analog Input Modules *(see page 18)*
- TM3 Analog Output Modules *(see page 20)*
- TM3 Analog Mixed Input/Output Modules *(see page 20)*

What Is in This Chapter?

This chapter contains the following sections:

Section 3.1
TM3 Analog Input Modules

What Is in This Section?

This section contains the following topics:

TM3AI2H / TM3AI2HG

Introduction

The TM3AI2H (screw terminal block) / TM3AI2HG (spring terminal block) expansion module feature 2 analog input channels with 16-bit resolution.

The channel input types are:

- 0...10 V
- -10...+10 V
- 0...20 mA
- 4...20 mA

For information on the diagnostic codes produced by each input type, refer to Analog I/0 Modules Diagnostics *(see page 70)*.

For further hardware information, refer to TM3AI2H / TM3AI2HG *(see Modicon TM3, Analog I/O Modules, Hardware Guide)*.

NOTE: If you have physically wired the analog channel for a voltage signal and you configure the channel for a current signal in EcoStruxure Machine Expert, you may damage the analog circuit.

NOTICE
INOPERABLE EQUIPMENT Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel. **Failure to follow these instructions can result in equipment damage.**

Configuring the Module

For each input, you can define:

Parameter		Value	Default Value	Description
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA**	**Not used**	Choose the mode of the channel.
Min.	**0 - 10 V**	-32768...32767	0	Specifies the lower measurement limit.
	-10 - +10 V		-10000	
	0 - 20 mA		0	
	4 - 20 mA		4000	
Max.	**0 - 10 V**	-32768...32767	10000	Specifies the upper measurement limit.
	-10 - +10 V		10000	
	0 - 20 mA		20000	
	4 - 20 mA		20000	
Input Filter		0...1000	0	Specifies the first order filter time constant (0...10 s) in increments of 10 ms.
Sampling		**1ms/Channel**	**1ms/Channel**	Specifies the sampling period of the channel.
Status Enabled		**Yes** **No**	**Yes**	Enables the diagnostic byte of each channel. If the status is disabled (value = No), the status bytes `IBStatusIW0` and `IBStatusIW1` do not contain relevant information.

I/O Mapping Tab

Variables can be defined and named in the **I/O Mapping** tab. Additional information such as topological addressing is also provided in this tab.

This table describes the **I/O Mapping** tab:

Variable	Channel	Type	Description
Inputs	IW0	INT	Current value of the input 0
	IW1	INT	Current value of the input 1
Diagnostic	IBStatusIW0	BYTE	Status of input 0 *(see page 70)*
	IBStatusIW1	BYTE	Status of input 1 *(see page 70)*

For further generic descriptions, refer to I/O Mapping Tab Description *(see page 24)*.

TM3AI4 / TM3AI4G

Introduction

The TM3AI4 (screw terminal block) / TM3AI4G (spring terminal block) expansion module feature 4 analog input channels with 12-bit resolution.

The channel input types are:

- 0...10 V
- -10...+10 V
- 0...20 mA
- 4...20 mA

For information on the diagnostic codes produced by each input type, refer to Analog I/0 Modules Diagnostics *(see page 70)*.

For further hardware information, refer to TM3AI4 / TM3AI4G *(see Modicon TM3, Analog I/O Modules, Hardware Guide)*.

NOTE: If you have physically wired the analog channel for a voltage signal and you configure the channel for a current signal in EcoStruxure Machine Expert, you may damage the analog circuit.

NOTICE
INOPERABLE EQUIPMENT Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel. **Failure to follow these instructions can result in equipment damage.**

Configuring the Module

For each input, you can define:

Parameter		Value	Default Value	Description
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA**	**Not used**	Choose the mode of the channel.
Min.	**0 - 10 V**	-32768...32767[1]	0	Specifies the lower measurement limit.
	-10 - +10 V		-10000	
	0 - 20 mA		0	
	4 - 20 mA		4000	

Parameter		Value	Default Value	Description
Max.	**0 - 10 V**	-32768...32767[1]	10000	Specifies the upper measurement limit.
	-10 - +10 V		10000	
	0 - 20 mA		20000	
	4 - 20 mA		20000	
Input Filter		0...1000	0	Specifies the first order filter time constant (0...10 s) in increments of 10 ms.
Sampling		**1ms/Channel** **10ms/Channel**	**1ms/Channel**	Specifies the sampling period of the channel. If an input filter is active, sampling is set internally to 1 ms.
Status Enabled		**Yes** **No**	**Yes**	Enables the diagnostic byte of each channel. If the status is disabled (value = No), the status bytes `IBStatusIWx` do not contain relevant information.

[1] The 12-bit data (0 to 4095) processed in the analog I/O module can be linear-converted to a value between -32768 and 32767.

I/O Mapping Tab

Variables can be defined and named in the **I/O Mapping** tab. Additional information such as topological addressing is also provided in this tab.

This table describes the **I/O Mapping** tab:

Variable	Channel	Type	Description
Inputs	IW0	INT	Current value of the input 0
	IW1	INT	Current value of the input 1
	IW2	INT	Current value of the input 2
	IW3	INT	Current value of the input 3
Diagnostic	IBStatusIW0	BYTE	Status of input 0 *(see page 70)*
	IBStatusIW1	BYTE	Status of input 1 *(see page 70)*
	IBStatusIW2	BYTE	Status of input 2 *(see page 70)*
	IBStatusIW3	BYTE	Status of input 3 *(see page 70)*

For further generic descriptions, refer to I/O Mapping Tab Description *(see page 24)*.

TM3AI8 / TM3AI8G

Introduction

The TM3AI8 (screw terminal block) / TM3AI8G (spring terminal block) expansion module feature 8 analog input channels with 12-bit resolution.

The channel input types are:

- 0...10 V
- -10...+10 V
- 0...20 mA
- 4...20 mA
- 0...20 mA extended
- 4...20 mA extended

For information on the diagnostic codes produced by each input type, refer to Analog I/0 Modules Diagnostics *(see page 70)*.

For further hardware information, refer to TM3AI8 / TM3AI8G *(see Modicon TM3, Analog I/O Modules, Hardware Guide)*.

NOTE: If you have physically wired the analog channel for a voltage signal and you configure the channel for a current signal in EcoStruxure Machine Expert, you may damage the analog circuit.

NOTICE
INOPERABLE EQUIPMENT Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel. **Failure to follow these instructions can result in equipment damage.**

Configuring the Module

For each input, you can define:

Parameter		Value	Default Value	Description
Type		**Not used**, **0 - 10 V**, **-10 - +10 V**, **0 - 20 mA**, **4 - 20 mA**, **0 - 20 mA extended**, **4 - 20 mA extended**.	**Not used**	Choose the mode of the channel.
Min.	**0 - 10 V**	-32768...32767[1]	0	Specifies the lower measurement limit.
	-10 - +10 V		-10000	
	0 - 20 mA		0	
	4 - 20 mA		4000	
	0 - 20 mA extended[2]		0	Not editable.
	4 - 20 mA extended[2]		1200	Not editable.
Max.	**0 - 10 V**	-32768...32767[1]	10000	Specifies the upper measurement limit.
	-10 - +10 V		10000	
	0 - 20 mA		20000	
	4 - 20 mA		20000	
	0 - 20 mA extended[2]		23540	Not editable.
	4 - 20 mA extended[2]		23170	Not editable.
Input Filter		0...1000	0	Specifies the first order filter time constant (0...10 s) in increments of 10 ms.
Sampling		**1ms/Channel** **10ms/Channel**	**1ms/Channel**	Specifies the sampling period of the channel. If an input filter is active, sampling is set internally to 1 ms.
Status Enabled		**Yes** **No**	**Yes**	Enables the diagnostic byte of each channel. If the status is disabled (value = No), the status bytes `IBStatusIWx` do not contain relevant information.

[1] The 12-bit data (0 to 4095) processed in the analog I/O module can be linear-converted to a value between -32768 and 32767.

[2] The extended ranges are supported by modules from product version (PV) 03, firmware version (SV) 1.4.

I/O Mapping Tab

Variables can be defined and named in the **I/O Mapping** tab. Additional information such as topological addressing is also provided in this tab.

This table describes the **I/O Mapping** tab:

Variable	Channel	Type	Description
Inputs	IW0	INT	Current value of the input 0
	IW1	INT	Current value of the input 1
	IW2	INT	Current value of the input 2
	IW3	INT	Current value of the input 3
	IW4	INT	Current value of the input 4
	IW5	INT	Current value of the input 5
	IW6	INT	Current value of the input 6
	IW7	INT	Current value of the input 7
Diagnostic	IBStatusIW0	BYTE	Status of input 0 *(see page 70)*
	IBStatusIW1	BYTE	Status of input 1 *(see page 70)*
	IBStatusIW2	BYTE	Status of input 2 *(see page 70)*
	IBStatusIW3	BYTE	Status of input 3 *(see page 70)*
	IBStatusIW4	BYTE	Status of input 4 *(see page 70)*
	IBStatusIW5	BYTE	Status of input 5 *(see page 70)*
	IBStatusIW6	BYTE	Status of input 6 *(see page 70)*
	IBStatusIW7	BYTE	Status of input 7 *(see page 70)*

For further generic descriptions, refer to I/O Mapping Tab Description *(see page 24)*.

TM3TI4 / TM3TI4G

Introduction

The TM3TI4 (screw terminal block) / TM3TI4G (spring terminal block) expansion module feature 4 analog input channels with 16-bit resolution.

The channel input types are:

- 0...10 V
- -10...+10 V
- 0...20 mA
- 4...20 mA
- K thermocouple
- J thermocouple
- R thermocouple
- S thermocouple
- B thermocouple
- E thermocouple
- T thermocouple
- N thermocouple
- C thermocouple
- PT100
- PT1000
- NI100
- NI1000

For information on the diagnostic codes produced by each input type, refer to Analog I/0 Modules Diagnostics *(see page 70)*.

For further hardware information, refer to TM3TI4 / TM3TI4G *(see Modicon TM3, Analog I/O Modules, Hardware Guide)*.

NOTE: If you have physically wired the analog channel for a voltage signal and you configure the channel for a current signal in EcoStruxure Machine Expert, you may damage the analog circuit.

NOTICE
INOPERABLE EQUIPMENT Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel. **Failure to follow these instructions can result in equipment damage.**

Configuring the Module

For each input, you can define:

Parameter		Value	Default Value	Description
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA** **K Thermocouple** **J Thermocouple** **R Thermocouple** **S Thermocouple** **B Thermocouple** **E Thermocouple** **T Thermocouple** **N Thermocouple** **C Thermocouple** **PT100** **PT1000** **NI100** **NI1000**	**Not used**	Choose the mode of the channel.
Scope		**Customized** **Celsius (0.1°C)** **Fahrenheit (0.1°F)** **Fahrenheit (0.2°F)***	**Customized**	The range of values for a channel. * Only for B and C thermocouples.
Min.	**0 - 10 V**	-32768...32767	0	Specifies the lower measurement limit.
	-10 - +10 V		-10000	
	0 - 20 mA		0	
	4 - 20 mA		4000	
	Temperature	See the table below		
Max.	**0 - 10 V**	-32768...32767	10000	Specifies the upper measurement limit.
	-10 - +10 V		10000	
	0 - 20 mA		20000	
	4 - 20 mA		20000	
	Temperature	See the table below		
Input Filter		0...1000	0	Specifies the first order filter time constant (0...10 s) in increments of 10 ms.

Parameter	Value	Default Value	Description
Sampling	**10ms/Channel** **100ms/Channel**	**100ms/Channel**	Specifies the sampling period of the channel. If an input filter is active, sampling is set internally to 10 ms.
Status Enabled	**Yes** **No**	**Yes**	Enables the diagnostic byte of each channel. If the status is disabled (value = No), the status bytes `IBStatusIWx` do not contain relevant information.

Type	Customized		Celsius (0.1 °C)		Fahrenheit		
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Unit
K Thermocouple	-32768	32767	-2000	13000	-3280	23720	0.1 °F
J Thermocouple	-32768	32767	-2000	10000	-3280	18320	0.1 °F
R Thermocouple	-32768	32767	0	17600	320	32000	0.1 °F
S Thermocouple	-32768	32767	0	17600	320	32000	0.1 °F
B Thermocouple	-32768	32767	0	18200	160	16540	0.2 °F
E Thermocouple	-32768	32767	-2000	8000	-3280	14720	0.1 °F
T Thermocouple	-32768	32767	-2000	4000	-3280	7520	0.1 °F
N Thermocouple	-32768	32767	-2000	13000	-3280	23720	0.1 °F
C Thermocouple	-32768	32767	0	23150	160	20995	0.2 °F
PT100	-32768	32767	-2000	8500	-3280	15620	0.1 °F
PT1000	-32768	32767	-2000	6000	-3280	11120	0.1 °F
NI100	-32768	32767	-600	1800	-760	3560	0.1 °F
NI1000	-32768	32767	-600	1800	-760	3560	0.1 °F

I/O Mapping Tab

Variables can be defined and named in the **I/O Mapping** tab. Additional information such as topological addressing is also provided in this tab.

This table describes the **I/O Mapping** tab:

Variable	Channel	Type	Description
Inputs	IW0	INT	Current value of the input 0
	IW1	INT	Current value of the input 1
	IW2	INT	Current value of the input 2
	IW3	INT	Current value of the input 3
Diagnostic	IBStatusIW0	BYTE	Status of input 0 *(see page 70)*
	IBStatusIW1	BYTE	Status of input 1 *(see page 70)*
	IBStatusIW2	BYTE	Status of input 2 *(see page 70)*
	IBStatusIW3	BYTE	Status of input 3 *(see page 70)*

For further generic descriptions, refer to I/O Mapping Tab Description *(see page 24)*.

TM3TI4D / TM3TI4DG

Introduction

The TM3TI4D (screw terminal block) / TM3TI4DG (spring terminal block) expansion module feature 4 analog input channels with 16-bit resolution.

The channel input types are:
- K thermocouple
- J thermocouple
- R thermocouple
- S thermocouple
- B thermocouple
- E thermocouple
- T thermocouple
- N thermocouple
- C thermocouple

For information on the diagnostic codes produced by each input type, refer to Analog I/0 Modules Diagnostics *(see page 70)*.

For further hardware information, refer to TM3TI4D / TM3TI4DG.

Configuring the Module

For each input, you can define:

Parameter		Value	Default Value	Description
Type		**Not used** **K Thermocouple** **J Thermocouple** **R Thermocouple** **S Thermocouple** **B Thermocouple** **E Thermocouple** **T Thermocouple** **N Thermocouple** **C Thermocouple**	**Not used**	Choose the mode of the channel.
Scope		**Customized** **Celsius (0.1°C)** **Fahrenheit (0.1°F)** **Fahrenheit (0.2°F)***	**Customized**	The range of values for a channel. * Only for B and C thermocouples.
Min.	**Temperature**	See the table below		Specifies the lower measurement limit.
Max.	**Temperature**	See the table below		Specifies the upper measurement limit.
Input Filter		0...1000	0	Specifies the first order filter time constant (0...10 s) in increments of 10 ms.

Parameter	Value	Default Value	Description
Sampling	**10ms/Channel** **100ms/Channel**	**100ms/Channel**	Specifies the sampling period of the channel. If an input filter is active, sampling is set internally to 10 ms.
Status Enabled	**Yes** **No**	**Yes**	Enables the diagnostic byte of each channel. If the status is disabled (value = No), the status bytes `IBStatusIWx` do not contain relevant information.

Type	Customized		Celsius (0.1 °C)		Fahrenheit		
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Unit
K Thermocouple	-32768	32767	-2000	13000	-3280	23720	0.1 °F
J Thermocouple	-32768	32767	-2000	10000	-3280	18320	0.1 °F
R Thermocouple	-32768	32767	0	17600	320	32000	0.1 °F
S Thermocouple	-32768	32767	0	17600	320	32000	0.1 °F
B Thermocouple	-32768	32767	0	18200	160	16540	0.2 °F
E Thermocouple	-32768	32767	-2000	8000	-3280	14720	0.1 °F
T Thermocouple	-32768	32767	-2000	4000	-3280	7520	0.1 °F
N Thermocouple	-32768	32767	-2000	13000	-3280	23720	0.1 °F
C Thermocouple	-32768	32767	0	23150	160	20995	0.2 °F

I/O Mapping Tab

Variables can be defined and named in the **I/O Mapping** tab. Additional information such as topological addressing is also provided in this tab.

This table describes the **I/O Mapping** tab:

Variable	Channel	Type	Description
Inputs	IW0	INT	Value of the input 0
	IW1	INT	Value of the input 1
	IW2	INT	Value of the input 2
	IW3	INT	Value of the input 3
Diagnostic	IBStatusIW0	BYTE	Status of input 0 *(see page 70)*
	IBStatusIW1	BYTE	Status of input 1 *(see page 70)*
	IBStatusIW2	BYTE	Status of input 2 *(see page 70)*
	IBStatusIW3	BYTE	Status of input 3 *(see page 70)*

For further generic descriptions, refer to I/O Mapping Tab Description *(see page 24)*.

TM3TI8T / TM3TI8TG

Introduction

The TM3TI8T (screw terminal block) / TM3TI8TG (spring terminal block) expansion module feature 8 analog input channels with 16-bit resolution.

The channel input types are:

- K thermocouple
- J thermocouple
- R thermocouple
- S thermocouple
- B thermocouple
- E thermocouple
- T thermocouple
- N thermocouple
- C thermocouple
- NTC thermistor
- PTC thermistor
- Ohmmeter

For information on the diagnostic codes produced by each input type, refer to Analog I/0 Modules Diagnostics *(see page 70)*.

For further hardware information, refer to TM3TI8T / TM3TI8TG *(see Modicon TM3, Analog I/O Modules, Hardware Guide)*.

NOTE: If you have physically wired the analog channel for a voltage signal and you configure the channel for a current signal in EcoStruxure Machine Expert, you may damage the analog circuit.

NOTICE
INOPERABLE EQUIPMENT Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel. **Failure to follow these instructions can result in equipment damage.**

Configuring the Module

For each input, you can define the following parameters:

Parameter	Value	Default Value	Description
Type • **Not used**	-	**Not used**	Choose the parameter type and scope for the channel.
Type • **K Thermocouple** • **J Thermocouple** • **R Thermocouple** • **S Thermocouple** • **E Thermocouple** • **T Thermocouple** • **N Thermocouple** • **NTC Thermistor**	**Scope** • **Customized** • **Celsius (0.1 °C)** • **Fahrenheit (0.1 °F)**	**Celsius (0.1 °C)**	
Type • **B Thermocouple** • **C Thermocouple**	**Scope** • **Customized** • **Celsius (0.1 °C)** • **Fahrenheit (0.2 °F)**	**Celsius (0.1 °C)**	
Type • **PTC Thermistor**	**Scope** • **Customized** • **Threshold**	**Threshold**	
Type • **Ohmmeter**	**Scope** • **Resistance (Ω)**	**Resistance**	
Minimum	See the table below		Specifies the low measurement limit.
Maximum	See the table below		Specifies the high measurement limit.
Rref (used only with NTC probe *(see page 52)*)	1...65535	330	Reference resistance in Ohm at temperature Tref.
Tref (used only with NTC probe)	1...1000	25	Reference temperature value in Celsius.
Beta (used only with NTC probe)	1...32767	3569	Sensitivity of NTC probe in Kelvin.
Input Filter	0...1000	0	Specifies the first order filter time constant (0...10 s) in increments of 10 ms.
Sampling	**100ms/Channel**	**100ms/Channel**	Specifies the sampling period of the channel.
Status Enabled	**Yes** **No**	**Yes**	Enables the diagnostic byte of each channel. If the status is disabled (value = No), the status bytes `IBStatusIWx` do not contain relevant information.

Parameter	Value	Default Value	Description
High Threshold (used only with PTC probe *(see page 53)*)	100...10000	3100	Activation threshold
Low Threshold (used only with PTC probe)	100...10000	1500	Reactivation threshold

The following table indicates the possible range values for the selected type of thermocouple:

Type	Customized	Range in Celsius	Range in Fahrenheit
K Thermocouple	-32768...32767	-2000...13000 (0.1°C)	-3280...23720 (0.1°F)
J Thermocouple		-2000...10000 (0.1°C)	-3280...18320 (0.1°F)
R Thermocouple		0...17600 (0.1°C)	320...32000 (0.1°F)
S Thermocouple		0...17600 (0.1°C)	320...32000 (0.1°F)
B Thermocouple		0...18200 (0.1°C)	160...16540 (0.2°F)
E Thermocouple		-2000...8000 (0.1°C)	-3280...14720 (0.1°F)
T Thermocouple		-2000...4000 (0.1°C)	-3280...7520 (0.1°F)
N Thermocouple		-2000...13000 (0.1°C)	-3280...23720 (0.1°F)
C Thermocouple		0...23150 (0.1°C)	160...20995 (0.2°F)
NTC Thermistor		-900...1500 (0.1°C)	-1300...3020 (0.1°F)
PTC Thermistor		–	–

NTC Thermistor

The temperature (Tm) varies in relation to the resistance (r) following the equation below:

$$Tm(r) = \frac{1}{\frac{1}{T} + \frac{1}{B}\ln\left[\frac{r}{R}\right]}$$

Where:

- Tm = temperature measured by the probe, in Kelvin
- r = physical value of the resistance in Ohm
- R = reference resistance in Ohm at temperature T
- T = reference temperature in Kelvin
- B = sensitivity of the NTC probe in Kelvin

R,T, and B must be greater or equal to 1.

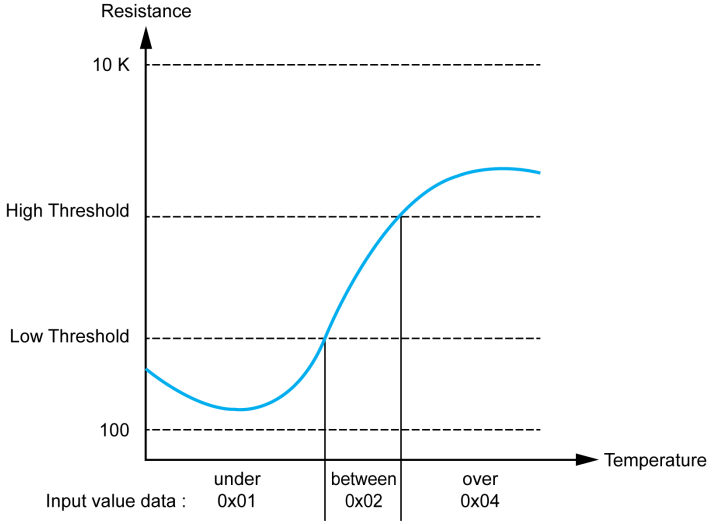
NOTE: 25 °C = 77 °F = 298.15 K

PTC Thermistor

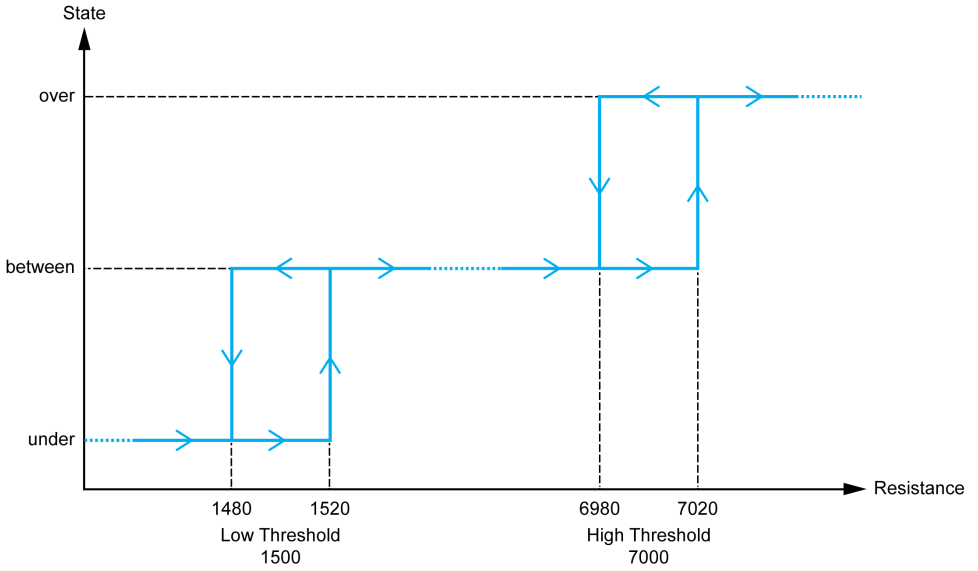
This table describes the read value according to the resistance:

Resistance Value	Read Value
Under the low threshold	1
Between thresholds	2
Over the high threshold	4

This figure represents the threshold operation:



This figure represents an example hysteresis curve:



Ohmmeter

This table describes the minimum and maximum values:

Parameter	Value
Minimum	100 Ω
Maximum	32 kΩ

I/O Mapping Tab

Variables can be defined and named in the **I/O Mapping** tab. Additional information such as topological addressing is also provided in this tab.

This table describes the **I/O Mapping** tab:

Variable	Channel	Type	Description
Inputs	IW0	INT	Current value of the input 0
	IW1	INT	Current value of the input 1
	IW2	INT	Current value of the input 2
	IW3	INT	Current value of the input 3
	IW4	INT	Current value of the input 4
	IW5	INT	Current value of the input 5
	IW6	INT	Current value of the input 6
	IW7	INT	Current value of the input 7
Diagnostic	IBStatusIW0	BYTE	Status of input 0 *(see page 70)*
	IBStatusIW1	BYTE	Status of input 1 *(see page 70)*
	IBStatusIW2	BYTE	Status of input 2 *(see page 70)*
	IBStatusIW3	BYTE	Status of input 3 *(see page 70)*
	IBStatusIW4	BYTE	Status of input 4 *(see page 70)*
	IBStatusIW5	BYTE	Status of input 5 *(see page 70)*
	IBStatusIW6	BYTE	Status of input 6 *(see page 70)*
	IBStatusIW7	BYTE	Status of input 7 *(see page 70)*

For further generic descriptions, refer to I/O Mapping Tab Description *(see page 24)*.

Section 3.2
TM3 Analog Output Modules

What Is in This Section?

This section contains the following topics:

TM3AQ2 / TM3AQ2G

Introduction

The TM3AQ2 (screw terminal block) / TM3AQ2G (spring terminal block) expansion module feature 2 analog output channels with 12-bit resolution.

The channel output types are:

- 0...10 V
- -10...+10 V
- 0...20 mA
- 4...20 mA

For further hardware information, refer to TM3AQ2 / TM3AQ2G *(see Modicon TM3, Analog I/O Modules, Hardware Guide)*.

NOTE: If you have physically wired the analog channel for a voltage signal and you configure the channel for a current signal in EcoStruxure Machine Expert, you may damage the analog circuit.

NOTICE
INOPERABLE EQUIPMENT Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel. **Failure to follow these instructions can result in equipment damage.**

Configuring the Module

For each output, you can define:

Parameter		Value	Default Value	Description
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA**	**Not used**	Choose the mode of the channel.
Min.	**0 - 10 V**	-32768...32767[1]	0	Specifies the lower measurement limit.
	-10 - +10 V		-10000	
	0 - 20 mA		0	
	4 - 20 mA		4000	
Max.	**0 - 10 V**	-32768...32767[1]	10000	Specifies the upper measurement limit.
	-10 - +10 V		10000	
	0 - 20 mA		20000	
	4 - 20 mA		20000	
Status Enabled		**Yes** **No**	**Yes**	Enables the diagnostic byte of each channel. If the status is disabled (value = No), the status bytes `IBStatusQWx` do not contain relevant information.

[1] The 12-bit data (0 to 4095) processed in the analog I/O module can be linear-converted to a value between -32768 and 32767.

I/O Mapping Tab

Variables can be defined and named in the **I/O Mapping** tab. Additional information such as topological addressing is also provided in this tab.

This table describes the **I/O Mapping** tab:

Variable	Channel	Type	Default Value	Description
Outputs	QW0	INT	-32768...32767	Command word of the output 0
	QW1	INT	-32768...32767	Command word of the output 1
Diagnostic	IBStatusQW0	BYTE	-	Status of output 0 *(see page 71)*
	IBStatusQW1	BYTE	-	Status of output 1 *(see page 71)*

For further generic descriptions, refer to I/O Mapping Tab Description *(see page 24)*.

TM3AQ4 / TM3AQ4G

Introduction

The TM3AQ4 (screw terminal block) / TM3AQ4G (spring terminal block) expansion module feature 4 analog output channels with 12-bit resolution.

The channel output types are:

- 0...10 V
- -10...+10 V
- 0...20 mA
- 4...20 mA

For further hardware information, refer to TM3AQ4 / TM3AQ4G *(see Modicon TM3, Analog I/O Modules, Hardware Guide)*.

NOTE: If you have physically wired the analog channel for a voltage signal and you configure the channel for a current signal in EcoStruxure Machine Expert, you may damage the analog circuit.

NOTICE
INOPERABLE EQUIPMENT Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel. **Failure to follow these instructions can result in equipment damage.**

Configuring the Module

For each output, you can define:

Parameter		Value	Default Value	Description
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA**	**Not used**	Choose the mode of the channel.
Scope		**Customized**	**Customized**	The range of values for a channel.
Min.	**0 - 10 V**	-32768...32767[1]	0	Specifies the lower measurement limit.
	-10 - +10 V		-10000	
	0 - 20 mA		0	
	4 - 20 mA		4000	

Parameter		Value	Default Value	Description
Max.	**0 - 10 V**	-32768...32767[1]	10000	Specifies the upper measurement limit.
	-10 - +10 V		10000	
	0 - 20 mA		20000	
	4 - 20 mA		20000	
Status Enabled		**Yes** **No**	**Yes**	Enables the diagnostic byte of each channel. If the status is disabled (value = No), the status bytes `IBStatusQWx` do not contain relevant information.

[1] The 12-bit data (0 to 4095) processed in the analog I/O module can be linear-converted to a value between -32768 and 32767.

I/O Mapping Tab

Variables can be defined and named in the **I/O Mapping** tab. Additional information such as topological addressing is also provided in this tab.

This table describes the **I/O Mapping** tab:

Variable	Channel	Type	Default Value	Description
Outputs	QW0	INT	-32768...32767	Command word of the output 0
	QW1	INT	-32768...32767	Command word of the output 1
	QW2	INT	-32768...32767	Command word of the output 2
	QW3	INT	-32768...32767	Command word of the output 3
Diagnostic	IBStatusQW0	BYTE	-	Status of output 0 *(see page 71)*
	IBStatusQW1	BYTE	-	Status of output 1 *(see page 71)*
	IBStatusQW2	BYTE	-	Status of output 2 *(see page 71)*
	IBStatusQW3	BYTE	-	Status of output 3 *(see page 71)*

For further generic descriptions, refer to I/O Mapping Tab Description *(see page 24)*.

Section 3.3
TM3 Analog Mixed Input/Output Modules

What Is in This Section?

This section contains the following topics:

TM3AM6 / TM3AM6G

Introduction

The TM3AM6 (screw terminal block) / TM3AM6G (spring terminal block) expansion module feature 4 analog input channels and 2 analog output channels with 12-bit resolution.

The channel input types are:
- 0...10 V
- -10...+10 V
- 0...20 mA
- 4...20 mA

For information on the diagnostic codes produced by each input type, refer to Analog I/0 Modules Diagnostics *(see page 70)*.

The channel output types are:
- 0...10 V
- -10...+10 V
- 0...20 mA
- 4...20 mA

For further hardware information, refer to TM3AM6 / TM3AM6G *(see Modicon TM3, Analog I/O Modules, Hardware Guide)*.

NOTE: If you have physically wired the analog channel for a voltage signal and you configure the channel for a current signal in EcoStruxure Machine Expert, you may damage the analog circuit.

NOTICE
INOPERABLE EQUIPMENT Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel. **Failure to follow these instructions can result in equipment damage.**

Configuring the Module

For each input, you can define:

Parameter		Value	Default Value	Description
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA**	**Not used**	Choose the mode of the channel.
Min.	**0 - 10 V**	-32768...32767[1]	0	Specifies the lower measurement limit.
	-10 - +10 V		-10000	
	0 - 20 mA		0	
	4 - 20 mA		4000	
Max.	**0 - 10 V**	-32768...32767[1]	10000	Specifies the upper measurement limit.
	-10 - +10 V		10000	
	0 - 20 mA		20000	
	4 - 20 mA		20000	
Input Filter		0...1000	0	Specifies the first order filter time constant (0...10 s) in increments of 10 ms.
Sampling		**1ms/Channel** **10ms/Channel**	**1ms/Channel**	Specifies the sampling period of the channel. If an input filter is active, sampling is set internally to 1 ms.
Status Enabled		**Yes** **No**	**Yes**	Enables the diagnostic byte of each channel. If the status is disabled (value = No), the status bytes `IBStatusIWx` do not contain relevant information.

[1] The 12-bit data (0 to 4095) processed in the analog I/O module can be linear-converted to a value between -32768 and 32767.

For each output, you can define:

Parameter		Value	Default Value	Description
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA**	**Not used**	Choose the mode of the channel.
Min.	**0 - 10 V**	-32768...32767[1]	0	Specifies the lower measurement limit.
	-10 - +10 V		-10000	
	0 - 20 mA		0	
	4 - 20 mA		4000	
Max.	**0 - 10 V**	-32768...32767[1]	10000	Specifies the upper measurement limit.
	-10 - +10 V		10000	
	0 - 20 mA		20000	
	4 - 20 mA		20000	
Status Enabled		**Yes** **No**	**Yes**	Enables the diagnostic byte of each channel. If the status is disabled (value = No), the status bytes `IBStatusQWx` do not contain relevant information.

[1] The 12-bit data (0 to 4095) processed in the analog I/O module can be linear-converted to a value between -32768 and 32767.

I/O Mapping Tab

Variables can be defined and named in the **I/O Mapping** tab. Additional information such as topological addressing is also provided in this tab.

This table describes the **I/O Mapping** tab:

Variable	Channel	Type	Default Value	Description
Inputs	IW0	INT	-	Current value of the input 0
	IW1	INT	-	Current value of the input 1
	IW2	INT	-	Current value of the input 2
	IW3	INT	-	Current value of the input 3
Outputs	QW0	INT	-32768...32767	Command word of the output 0
	QW1	INT	-32768...32767	Command word of the output 1
Diagnostic	IBStatusIW0	BYTE	-	Status of input 0 *(see page 70)*
	IBStatusIW1	BYTE	-	Status of input 1 *(see page 70)*
	IBStatusIW2	BYTE	-	Status of input 2 *(see page 70)*
	IBStatusIW3	BYTE	-	Status of input 3 *(see page 70)*
	IBStatusQW0	BYTE	-	Status of output 0 *(see page 71)*
	IBStatusQW1	BYTE	-	Status of output 1 *(see page 71)*

For further generic descriptions, refer to I/O Mapping Tab Description *(see page 24)*.

TM3TM3 / TM3TM3G

Introduction

The TM3TM3 (screw terminal block) / TM3TM3G (spring terminal block) expansion module feature 2 analog input channels with 16-bit resolution and 1 analog output with 12-bit resolution.

The channel input types are:

- 0...10 V
- -10...+10 V
- 0...20 mA
- 4...20 mA
- K thermocouple
- J thermocouple
- R thermocouple
- S thermocouple
- B thermocouple
- E thermocouple
- T thermocouple
- N thermocouple
- C thermocouple
- PT100
- PT1000
- NI100
- NI1000

For information on the diagnostic codes produced by each input type, refer to Analog I/0 Modules Diagnostics *(see page 70)*.

The channel output types are:

- 0...10 V
- -10...+10 V
- 0...20 mA
- 4...20 mA

For further hardware information, refer to TM3TM3 / TM3TM3G *(see Modicon TM3, Analog I/O Modules, Hardware Guide)*.

NOTE: If you have physically wired the analog channel for a voltage signal and you configure the channel for a current signal in EcoStruxure Machine Expert, you may damage the analog circuit.

NOTICE
INOPERABLE EQUIPMENT Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel. **Failure to follow these instructions can result in equipment damage.**

Configuring the Module

For each input, you can define:

Parameter		Value	Default Value	Description
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA** **K Thermocouple** **J Thermocouple** **R Thermocouple** **S Thermocouple** **B Thermocouple** **E Thermocouple** **T Thermocouple** **N Thermocouple** **C Thermocouple** **PT100** **PT1000** **NI100** **NI1000**	**Not used**	Choose the mode of the channel.
Scope		**Customized** **Celsius (0.1°C)** **Fahrenheit (0.1°F)** **Fahrenheit (0.2°F)***	**Customized**	The range of values for a channel. * Only for B and C thermocouples.
Min.	**0 - 10 V**	-32768...32767	0	Specifies the lower measurement limit.
	-10 - +10 V		-10000	
	0 - 20 mA		0	
	4 - 20 mA		4000	
	Temperature	See the table below		

Parameter		Value	Default Value	Description
Max.	**0 - 10 V**	-32768...32767	10000	Specifies the upper measurement limit.
	-10 - +10 V		10000	
	0 - 20 mA		20000	
	4 - 20 mA		20000	
	Temperature	See the table below		
Input Filter		0...1000	0	Specifies the first order filter time constant (0...10 s) in increments of 10 ms.
Sampling		**10ms/Channel** **100ms/Channel**	**100ms/Channel**	Specifies the sampling period of the channel. If an input filter is active, sampling is set internally to 10 ms.
Status Enabled		**Yes** **No**	**Yes**	Enables the diagnostic byte of each channel. If the status is disabled (value = No), the status bytes `IBStatusIWx` do not contain relevant information.

Type	Customized		Celsius (0.1 °C)		Fahrenheit		
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Unit
K Thermocouple	-32768	32767	-2000	13000	-3280	23720	0.1 °F
J Thermocouple	-32768	32767	-2000	10000	-3280	18320	0.1 °F
R Thermocouple	-32768	32767	0	17600	320	32000	0.1 °F
S Thermocouple	-32768	32767	0	17600	320	32000	0.1 °F
B Thermocouple	-32768	32767	0	18200	160	16540	0.2 °F
E Thermocouple	-32768	32767	-2000	8000	-3280	14720	0.1 °F
T Thermocouple	-32768	32767	-2000	4000	-3280	7520	0.1 °F
N Thermocouple	-32768	32767	-2000	13000	-3280	23720	0.1 °F
C Thermocouple	-32768	32767	0	23150	160	20995	0.2 °F
PT100	-32768	32767	-2000	8500	-3280	15620	0.1 °F
PT1000	-32768	32767	-2000	6000	-3280	11120	0.1 °F
NI100	-32768	32767	-600	1800	-760	3560	0.1 °F
NI1000	-32768	32767	-600	1800	-760	3560	0.1 °F

For the output, you can define:

Parameter		Value	Default Value	Description
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA**	**Not used**	Choose the mode of the channel.
Min.	**0 - 10 V**	-32768...32767[1]	0	Specifies the lower measurement limit.
	-10 - +10 V		-10000	
	0 - 20 mA		0	
	4 - 20 mA		4000	
Max.	**0 - 10 V**	-32768...32767[1]	10000	Specifies the upper measurement limit.
	-10 - +10 V		10000	
	0 - 20 mA		20000	
	4 - 20 mA		20000	
Status Enabled		**Yes** **No**	**Yes**	Enables the diagnostic byte of each channel. If the status is disabled (value = No), the status byte `IBStatusQW0` does not contain relevant information.

[1] The 12-bit data (0 to 4095) processed in the analog I/O module can be linear-converted to a value between -32768 and 32767.

I/O Mapping Tab

Variables can be defined and named in the **I/O Mapping** tab. Additional information such as topological addressing is also provided in this tab.

This table describes the **I/O Mapping** tab:

Variable	Channel	Type	Default Value	Description
Inputs	IW0	INT	-	Current value of the input 0
	IW1	INT	-	Current value of the input 1
Outputs	QW0	INT	-32768...32767	Command word of the output 0
Diagnostic	IBStatusIW0	BYTE	-	Status of input 0 *(see page 70)*
	IBStatusIW1	BYTE	-	Status of input 1 *(see page 70)*
	IBStatusQW0	BYTE	-	Status of output 0 *(see page 71)*

For further generic descriptions, refer to I/O Mapping Tab Description *(see page 24)*.

Section 3.4
TM3 Analog I/O Modules Diagnostic

Analog I/O Modules Diagnostics

Introduction

The operating status of each I/O channel is given by the diagnostic bytes in the **I/O Mapping** tab:

- IBStatusIWx for input channel x
- IBStatusQWx for output channel x

NOTE: If the **Status Enabled** parameter in the **I/O Configuration** tab is deactivated, it is possible to update the value of the diagnostic bytes by calling the `TM3_GetModuleInternalStatus` function.

For more information about `TM3_GetModuleInternalStatus` function:

- Refer to *M241 Controller PLCSystem Library Guide* for Modicon M241 Logic Controller.
- Refer to *M251 Controller PLCSystem Library Guide* for Modicon M251 Logic Controller.
- Refer to *M262 Controller System Library Guide* for Modicon M262 Logic/Motion Controller.

Input Diagnostic Byte Description

This table describes the IBStatusIWx diagnostic byte:

Byte value	Description
0	Normal
1	Undefined
2	Undefined
3	Configuration error detected.
4	External power supply error detected.
5	Wiring error detected (input voltage/current high limit exceeded).
6	Wiring error detected (input voltage/current low limit exceeded).
7	Hardware error detected.
8	The measured value is in the High extended zone.
9	The measured value is in the Low extended zone.
10...255	Undefined

Output Diagnostic Byte Description

This table describes the IBStatusQWx diagnostic byte:

Byte value	Description
0	Normal
1	Undefined
2	Undefined
3	Configuration error detected
4	External power supply voltage limits exceeded
5	Undefined
6	Undefined
7	Hardware error detected
8...255	Undefined

Status Byte Values Produced By Channel Input Types

The following tables shows the Input Channel Status Byte *(see page 70)* values generated by different channel input types of the TM3 Analog expansion modules.

0...10 V channel input type:

Input voltage	Status Code Generated
≤ -0.20 V	6
-0.19 V...10.19 V	0
≥ 10.20 V	5

-10...+10 V input channel type:

Input voltage	Status Code Generated
≤ -10.40 V	6
-10.39 V...10.39 V	0
≥ 10.40 V	5

0...20 mA input channel type:

Input voltage	Status Code Generated
≤ -0.40 mA	6
-0.39 mA...20.39 mA	0
≥ 20.40 mA	5

4...20 mA input channel type:

Input voltage	Status Code Generated
≤ 3.68 mA	6
3.69 mA...20.31 mA	0
≥ 20.32 mA	5

0...20 mA extended mode of the TM3AI8 / TM3AI8G expansion modules:

Input voltage	Status Code Generated
≤ -0.40 mA	6
-0.39 mA...20.00 mA	0
20.01 mA...23.54 mA	8
≥ 23.55 mA	5

4...20 mA extended mode of the TM3AI8 / TM3AI8G expansion modules:

Input voltage	Status Code Generated
< 1.19 mA	6
1.20 mA...3.99 mA	9
4.00 mA...20.00 mA	0
20.01 mA...23.17 mA	8
≥ 23.18 mA	5

Chapter 4
TM3 Expert I/O Modules Configuration

Introduction

This chapter describes how to configure the TM3 expert I/O modules *(see page 21)*.

What Is in This Chapter?

This chapter contains the following sections:

Section 4.1
TM3XTYS4 Module

What Is in This Section?

This section contains the following topics:

TM3XTYS4 Module Overview

Introduction

The TeSys expansion module TM3XTYS4 is equipped with:

- 4 RJ-45 connectors to connect to Tesys motor starter devices
- 2 digital inputs for each channel:
  - Forward
  - Reverse
- 3 digital outputs for each channel:
  - Ready
  - Run
  - Trip
- Removable 24 Vdc power supply

The TeSys expansion module is connected to the controller through the TM3 bus. TM3XTYS4 expansion modules can be connected to the controller in any order.

Adding and Configuring the TM3XTYS4 Module

To add a TM3XTYS4 module to a project:

1. Add the expansion module *(see page 24)* to your controller.
2. Configure the expansion module *(see page 76)* inputs and outputs.
3. Insert a channel *(see page 77)* that is connected to the device.
4. Select the device type *(see page 77)* that is associated with the channel.
5. Add the FB_TeSysU function block *(see page 78)* to your application and configure it in order to control the device directly from the application.

TM3XTYS4 Module Configuration

Introduction

This chapter describes how to configure the TM3XTYS4 expert I/O module *(see page 21)*.

Configuring the Module

Configuration of the TM3XTYS4 module is carried out through the **I/O Mapping** tab of the module.

In the **Devices tree**, double-click the **Module_***n* subnode of the module, where *n* is the unique identifier of the module. The **I/O Mapping** tab appears.

The digital inputs of this module are:

Channel	Address	Description
CH1_Ready	%IXx.0	Input active if the selector of TeSys is in the ON position.
CH1_Run	%IXx.1	Input active if the power contacts of TeSys are closed.
CH1_Trip	%IXx.2	Input active if the selector of TeSys is in the TRIP position.
CH2_Ready	%IXx.3	Input active if the selector of TeSys is in the ON position.
CH2_Run	%IXx.4	Input active if the power contacts of TeSys are closed.
CH2_Trip	%IXx.5	Input active if the selector of TeSys is in the TRIP position.
CH3_Ready	%IXx.6	Active if the selector of TeSys is in the ON position.
CH3_Run	%IXx.7	Input active if the power contacts of TeSys are closed.
CH3_Trip	%IXx.8	Input active if the selector of TeSys is in the TRIP position.
CH4_Ready	%IXx.9	Input active if the selector of TeSys is in the ON position.
CH4_Run	%IXx.10	Input active if the power contacts of TeSys are closed.
CH4_Trip	%IXx.11	Input active if the selector of TeSys is in the TRIP position.
Error	%IXx.12	Over current error flag of protect source outputs (0:Error, 1:Normal).

The digital outputs of this module are:

Tesys	Address	Description
CH1_Dir1Control	%QXx.0	This 24 V output drives the direct (forward) command of the motor.
CH1_Dir2Control	%QXx.1	This 24 V output drives the reverse (backward) command of the motor.
CH2_Dir1Control	%QXx.2	This 24 V output drives the direct (forward) command of the motor.
CH2_Dir2Control	%QXx.3	This 24 V output drives the reverse (backward) command of the motor.
CH3_Dir1Control	%QXx.4	This 24 V output drives the direct (forward) command of the motor.
CH3_Dir2Control	%QXx.5	This 24 V output drives the reverse (backward) command of the motor.
CH4_Dir1Control	%QXx.6	This 24 V output drives the direct (forward) command of the motor.
CH4_Dir2Control	%QXx.7	This 24 V output drives the reverse (backward) command of the motor.

Inserting a Channel

Each channel connected to a device can be separately configured.

To add channels to the configuration:

Step	Action
1	Select the **Module_**x node in the **Devices tree** and click  , or right-click the module node and select **Add Device** from the context menu. **Result:** The **Add Device** dialog box is displayed.
2	Select the channel to insert in the **Name** list.
3	Click **Add Device**. **Result:** The selected channel is added to the project and displayed in the **Devices tree** as a new **Tesys_Channel_***x* subnode of the expansion module. The **Add Device** dialog box remains open. You can do the following: ● Add another channel by repeating step 2 of this procedure. ● Or, click the **Close** button.

Selecting the Associated Device Type

To configure the type of device associated with a channel:

Step	Action
1	Double-click the **Tesys_Channel_***x* node in the **Devices tree**.
2	On the **I/O Configuration** tab, double-click in the **Value** column and select the type of Tesys motor starter connected to the channel.

FB_TesysU: Control the TM3 Expert I/O Module

Overview

The `FB_TeSysU` function block is included in the TM3 library.

Graphical Representation

I/O Variable Description

This table describes the input variables:

Input	Type	Comment
`xRev`	BOOL	State determines the direction command: ● FALSE: forward direction (DIR1) ● TRUE: reverse direction (DIR2)
`xRun`	BOOL	Activates/deactivates the direction command to the associated motor starter: ● FALSE: no direction command is activated (neither DIR1 nor DIR2) ● TRUE: depending on the state of the xRev input, the corresponding command (DIR1 or DIR2) is activated
`xEnable`	BOOL	True enables the function block.

This table describes the output variables:

Output	Type	Comment
xDiag	TU_CONSTANTS	The current status when q_xError is set to True: • TU_STDBY. Tesys: off, xRun: on • TU_OFF. Tesys: off, xRun: off • TU_RUN. Tesys: on, xRun: on • TU_RDY. Tesys: on, xRun: off • TU_TRIP. Tesys: on, xRun: on • TU_ERR_REV_ON_DOL. Tesys: on, xRun: on • TU_ERR_REV_AT_RUN. Tesys: on, xRun: on • TU_ERR_OVERCURRENT. Tesys: on, xRun: on • FB_DISABLED. Tesys: on, xRun: on
q_xReady	BOOL	True sets the selector of the module to the ON position
q_xRun	BOOL	True closes the power contacts of the module.
q_xTrip	BOOL	True sets the selector of the module to the TRIP position
q_xError	BOOL	True retrieves the current detected error status.

Section 4.2
TM3XHSC202 / TM3XHSC202G Modules

What Is in This Section?

This section contains the following topics:

TM3XHSC202 / TM3XHSC202G Module Overview

Introduction

The TM3XHSC202 (screw) / TM3XHSC202G (spring) expansion modules are equipped with:

- 10 inputs for each channel
- 8 outputs for each channel
- 24 Vdc power supply

TM3XHSC202 / TM3XHSC202G expansion modules can be connected to the controller in any order. They support advanced counting functions. For more information, refer to the TM3 Expert I/O Modules - HSC Library Guide.

Adding and Configuring the TM3XHSC202 / TM3XHSC202G Modules

To add a TM3XHSC202 / TM3XHSC202G module to a project:

Step	Action
1	Add the expansion module to your controller.
2	Configure the expansion module inputs and outputs.
3	Double click **Counters** node.
4	Configure the counting function. For more information, refer to the TM3 Expert I/O Modules - HSC Library Guide

TM3XHSC202 / TM3XHSC202G Module Configuration

Overview

The embedded I/O function allows configuration of the inputs and outputs.

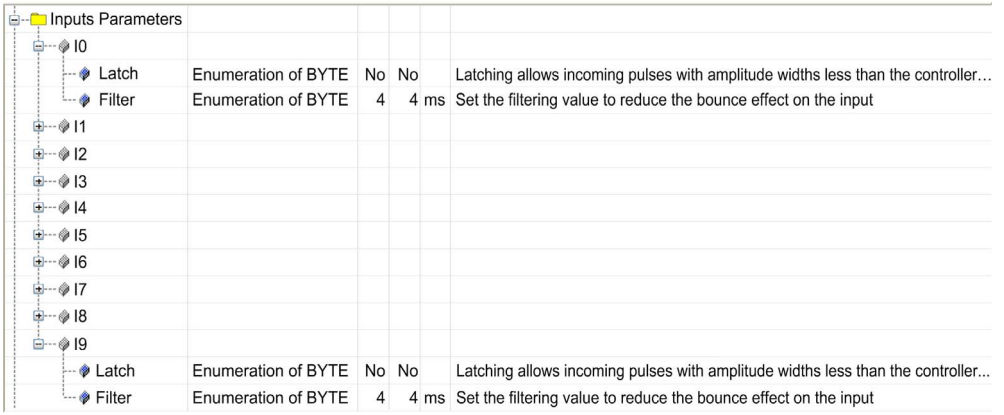
Accessing the I/O Configuration Window

Follow these steps to access the I/O configuration window:

Step	Description
1	In the Devices tree, under the **IO_Bus** node, double-click the module name.
2	Select the **I/O Configuration** tab.

Configuration of Inputs

This figure shows the **I/O Configuration** tab for inputs:



For each input not used by a counting function, you can configure the following parameters:

Parameter	Value	Description	Constraint
Latch	No* Yes	Allows incoming pulses with amplitude widths shorter than the controller scan time to be captured and recorded.	Use latch inputs in the task configured in the Bus cycle task *(see page 24)*.
Filter	0.000 ms 0.001 ms 0.002 ms 0.005 ms 0.01 ms 0.05 ms 0.08 ms 0.5 ms 1 ms 4 ms* 12 ms	Reduces the effect of noise, such as contact bounce or other transient interference, on a controller input.	Increased filter times reduce the effective speed of the high speed counter.
* Parameter default value			

Configuration of Outputs

This figure shows the **I/O Configuration** tab for outputs:

Outputs Parameters					
Q0					
Fallback mode	Enumeration of BYTE	Fallback value	Fallback value		Fallback mode
Fallback value	Enumeration of BYTE	0	0		Fallback value
Q1					
Q2					
Q3					
Q4					
Q5					
Q6					
Q7					
Fallback mode	Enumeration of BYTE	Fallback value	Fallback value		Fallback mode
Fallback value	Enumeration of BYTE	0	0		Fallback value
Rearming Output Mode	Enumeration of BYTE	Auto	Auto		

This table presents the function of the different parameters:

Parameter	Value	Description	
Fallback mode	**Maintain** **Fallback Value***	**Reflex Output** configured	**Reflex Output** not configured
		Allows you to set the fallback mode when: • The controller is in `STOPPED` state. • The connection between the controller and the module is lost. **NOTE:** **Maintain** is disabled.	Allows you to set the fallback mode when the connection between the controller and the module is lost. **NOTE:** When the controller is in `STOPPED` state, the fallback behavior is defined in **PLC Settings** tab.
Fallback value	0* 1	Allows you to set the fallback value. Available if **Fallback mode** set to **Fallback Value**.	
Rearming Output Mode	**Auto*** **Manual**	Select the rearming output mode: • **Automatic rearming**: as soon as the detected error is corrected, the output is set again according to the current value assigned to it and the diagnostic value is reset. • **Manual rearming**: when an error is detected, the status is memorized and the output is forced to tri-state until user manually clears the status (see I/O mapping channel).	
* Parameter default value			

In the case of a short-circuit or current overload, the common group of outputs automatically enters into thermal protection mode (all outputs in the group are set to 0), and are then periodically rearmed (each 10 seconds) to test the connection state. However, you must be aware of the effect of this rearming on the machine or process being controlled.

⚠ WARNING

UNINTENDED MACHINE START-UP

Inhibit the automatic rearming of outputs if this feature is an undesirable behavior for your machine or process.

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

I/O Mapping Tab

For more information on the **I/O Mapping** tab, refer to the EcoStruxure Machine Expert Programming Guide.

Section 4.3
TM3XFHSC202 / TM3XFHSC202G Modules

What Is in This Section?

This section contains the following topics:

TM3XFHSC202 / TM3XFHSC202G Module Overview

Introduction

The TM3XFHSC202 (screw) / TM3XFHSC202G (spring) expansion modules are equipped with:

- 10 inputs for each channel
- 8 outputs for each channel
- 24 Vdc power supply

TM3XFHSC202 / TM3XFHSC202G expansion modules can be connected to the controller in any order. They support advanced counting and event functions. For more information, refer to the TM3 Expert I/O Modules - HSC Library Guide *(see Modicon TM3 Expert I/O Modules, HSC Library Guide)*.

Adding and Configuring the TM3XFHSC202 / TM3XFHSC202G Modules

To add a TM3XFHSC202 / TM3XFHSC202G module to a project:

Step	Action
1	Add the expansion module to your controller.
2	Configure the expansion module inputs and outputs.
3	Double click **Counters** node.
4	Configure the counting function. For more information, refer to the TM3 Expert I/O Modules - HSC Library Guide

TM3XFHSC202 / TM3XFHSC202G Module Configuration

Overview

The embedded I/O function allows configuration of the inputs and outputs.

Accessing the I/O Configuration Window

Follow these steps to access the I/O configuration window:

Step	Description
1	In the Devices tree, under the **IO_Bus** node, double-click the module name.
2	Select the **I/O Configuration** tab.

Configuration of Inputs

This figure shows the **I/O Configuration** tab for inputs:

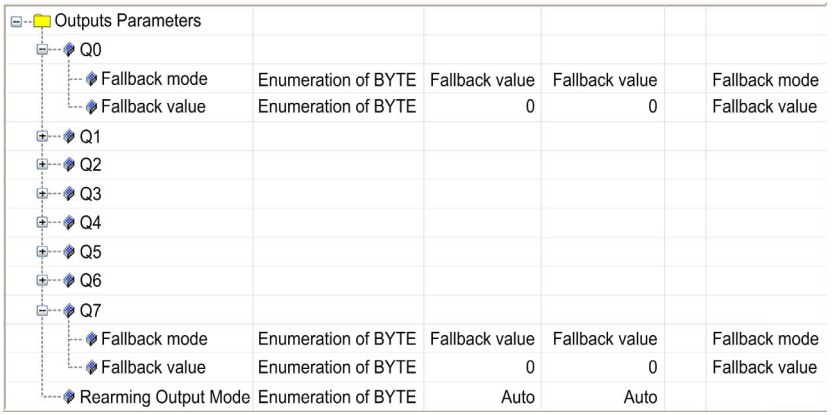
Inputs Parameters					
I0					
Latch	Enumeration of BYTE	No	No		Latching allows incoming pulses with amplitude widths less than the controller...
Event	Enumeration of BYTE	No	No		Event detection
Filter	Enumeration of BYTE	4	4	ms	Set the filtering value to reduce the bounce effect on the input
I1					
I2					
I3					
I4					
I5					
I6					
I7					
I8					
I9					
Latch	Enumeration of BYTE	No	No		Latching allows incoming pulses with amplitude widths less than the controller...
Event	Enumeration of BYTE	No	No		Event detection
Filter	Enumeration of BYTE	4	4	ms	Set the filtering value to reduce the bounce effect on the input

For each input not used by a counting function, you can configure the following parameters:

Parameter	Value	Description	Constraint
Latch	No* Yes	Allows incoming pulses with amplitude widths shorter than the controller scan time to be captured and recorded.	Available if **Event** disabled. Use latch inputs in MAST task only.
Event	No* **Rising edge** **Falling edge** **Both edges**	Event detection	Available if: ● **Latch** disabled and ● The module is one of the two first TM3XFHSC202 / TM3XFHSC202G modules on the bus *(see Modicon TM3, Expert I/O Modules, Hardware Guide)*.
Event Name	–	Allows you to name the external event to reference in a task to use the input event.	Available if **Event** different than no. 49 characters maximum. To use this event you must create an **External Event** task and give it the same name than the event.
Filter	0.000 ms 0.001 ms 0.002 ms 0.005 ms 0.01 ms 0.05 ms 0.08 ms 0.5 ms 1 ms 4 ms* 12 ms	Reduces the effect of noise on a controller input.	–
* Parameter default value			

Configuration of Outputs

This figure shows the **I/O Configuration** tab for outputs:



Outputs Parameters					
Q0					
Fallback mode	Enumeration of BYTE	Fallback value	Fallback value		Fallback mode
Fallback value	Enumeration of BYTE	0	0		Fallback value
Q1					
Q2					
Q3					
Q4					
Q5					
Q6					
Q7					
Fallback mode	Enumeration of BYTE	Fallback value	Fallback value		Fallback mode
Fallback value	Enumeration of BYTE	0	0		Fallback value
Rearming Output Mode	Enumeration of BYTE	Auto	Auto		

This table presents the function of the different parameters:

Parameter	Value	Description	
Fallback mode	**Maintain Fallback Value***	**Reflex Output** configured	**Reflex Output** not configured
		Allows you to set the fallback mode when: ● The controller is in `STOPPED` state. ● The connection between the controller and the module is lost. **NOTE: Maintain** is disabled.	Allows you to set the fallback mode when the connection between the controller and the module is lost. **NOTE:** When the controller is in `STOPPED` state, the fallback behavior is defined in **PLC Settings** tab.
Fallback value	0* 1	Allows you to set the fallback value. Available if **Fallback mode** set to **Fallback Value**.	
Rearming Output Mode	**Auto*** **Manual**	Select the rearming output mode: ● **Automatic rearming**: as soon as the detected error is corrected, the output is set again according to the current value assigned to it and the diagnostic value is reset. ● **Manual rearming**: when an error is detected, the status is memorized and the output is forced to tri-state until user manually clears the status (see I/O mapping channel).	
* Parameter default value			

In the case of a short-circuit or current overload, the common group of outputs automatically enters into thermal protection mode (all outputs in the group are set to 0), and are then periodically rearmed (each 10 seconds) to test the connection state. However, you must be aware of the effect of this rearming on the machine or process being controlled.

⚠ WARNING

UNINTENDED MACHINE START-UP

Inhibit the automatic rearming of outputs if this feature is an undesirable behavior for your machine or process.

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

I/O Mapping Tab

For more information on the **I/O Mapping** tab, refer to the EcoStruxure Machine Expert Programming Guide.

Chapter 5
TM3 Safety Modules Configuration

Introduction

This chapter describes how to configure the TM3 Safety Modules *(see page 22)*.

What Is in This Chapter?

This chapter contains the following sections:

Section 5.1
Configuration: TM3 Safety Modules

Configuring the TM3 Safety Modules

Introduction

For more information on the terms methods used concerning functional safety as they apply to the TM3 Safety Modules, refer to the TM3 Safety Modules Hardware Guide *(see Modicon TM3, Safety Modules, Hardware Guide)*.

Configuring the Modules

Refer to the I/O Mapping and Configuration tabs *(see page 24)* for detailed information on the configuration of the safety expansion modules in EcoStruxure Machine Expert.

Section 5.2
General Principles: TM3 Safety Functionality Modes

What Is in This Section?

This section contains the following topics:

Interlock

Description

In 2 channel operation, both inputs related to both channels must be seen open before a safety cycle can be started and the output can be closed. This functionality ensures that the output circuit cannot be activated if one of the input channels is not able to be open (for example in case of contact malfunction or short circuit).

The interlock function checks if both **K1** and **K2** relays are open before the safety cycle. In case of short power-supply interruption, one of the relays may be off while the other remains on. To allow the operation of the module on power return, the power-supply interruption should be at least 100 ms in duration.

Power Cycle

The interlock condition is reset by a power cycle. Information about a possible malfunction detected, provided by the interlock, is interrupted and not recovered before the next safety cycle.

Reset

The controller can request to reset the safety module by communicating with the safety module on the TM3 Bus.

When the reset signal is active, both safety module internal relays are deactivated.

The reset signal can be used to reset the module after the activation of the interlock function.

NOTE: The reset signal overwrites an activated interlock function. Information about a possible malfunction detected, provided by the interlock, is interrupted and not recovered before the next safety cyle.

The interruption of the interlock function could lead to the degradation of the safety level of the system. The reset of this function should only be done manually after verification of the intended functionality.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Do not use the reset function to reset an interlock programmatically.
- Always verify the interlock notification before using the reset function.

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

Start

Description

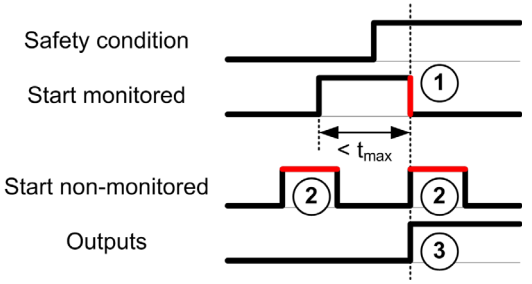
Two modes are available for the start functionality:

Non-monitored start: When non-monitored, the start mode can be:

- Manually controlled (conditioned by the input state)
- Automatic (hardwired)

Monitored start: When monitored, the start mode is manually controlled (conditioned by the input edge).

This figure represents the events sequence for the two start modes available:



Events description:

1. Monitored start condition is triggered by a falling edge on the **start** input.
2. Non-monitored start condition is available as long as the **start** input is on. The start condition can be valid before the safety-related input.
3. The outputs get activated only if start + safety-related input conditions are valid.

NOTE: For a monitored start, the falling edge on the **start** input must appear within 20 seconds (± 5 seconds) after activation of the start input at nominal supply voltage.

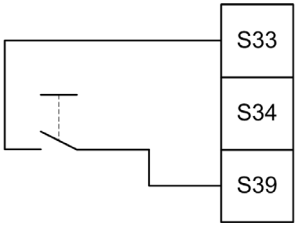
Both the safety conditions and the start conditions must be valid before allowing the activation of outputs.

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

Manual Non-Monitored Start

The start condition is valid when the **start** input is closed (start switch is pressed).

This figure represents how to connect a switch on a TM3 safety module to configure a manual non-monitored start:



Automatic Start

There is no start interlock when automatic start is used. After a power cycle, the output behavior depends solely on the state of the inputs.

⚠ WARNING

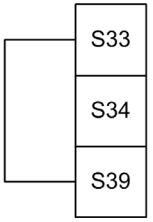
UNINTENDED EQUIPMENT OPERATION

Do not use automatic start if a start interlock is required in your application after a power cycle.

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

The module is in automatic start mode if the **start** input is permanently closed (hardwired).

This figure represents how to connect a switch on a TM3 safety module to configure an automatic start:



NOTE: There is no start interlock in automatic start after a power cycle.

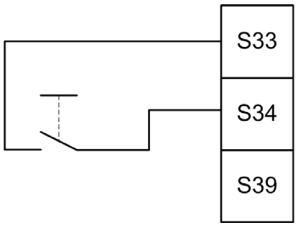
Monitored Start

In monitored start mode, the outputs are activated when:

- All required inputs are closed
- A falling edge is applied to the **start** input. A falling edge means that the start switch is pressed and released again.

At nominal supply voltage, the start switch must be released within 20 seconds (± 5 seconds) after it has been closed. The exact delay depends on supply voltage and ambient temperature.

This figure represents how to connect a switch on a TM3 safety module to configure a monitored start (when available on the module):



External Device Monitoring (EDM)

Description

External device monitoring functionality is used to ensure that external contactors controlled by the safety module outputs are able to interrupt the safety circuit. This functionality is implemented by adding the external contactor feedback to the start condition of the safety module.

The external contactor must provide a feedback through a normally closed auxiliary contact forcibly guided by its normally open safety contact. The start condition is valid only when the external feedback (normally closed) is closed.

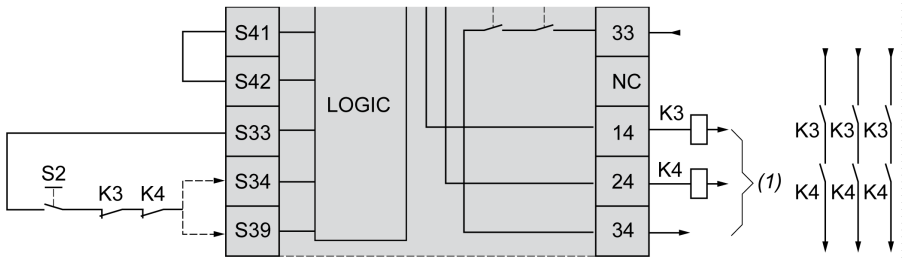
External device monitoring can be performed on:

- 1 channel.
  External feedback is provided to the start condition.
- 2 channels for short circuit detection.
  External feedback is provided to the start condition and to the **S4** input.

NOTE: The state of the external device is only monitored when the safety module is analyzing the start condition validity. When outputs are activated, the external device is not monitored.

EDM Configuration With One Channel

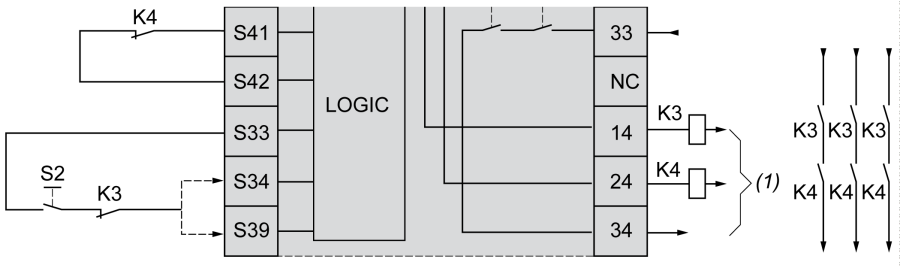
This figure shows an example of 1 channel EDM with the external feedback (**K3** and **K4**) added to the start condition, and **S41** directly connected to **S42**:



K3 External contactor with a normally closed feedback and normally open safety contact
K4 External contactor with a normally closed feedback and normally open safety contact
S2 Start switch
(1) Safety outputs

EDM Configuration With Two Channels

This figure shows an example of 2 channels EDM with one external feedback added to the start condition (**K3**), and the other feedback (**K4**) connected to **S41** and **S42**:



K3 External contactor with a normally closed feedback and normally open safety contact
K4 External contactor with a normally closed feedback and normally open safety contact
S2 Start switch
(1) Safety outputs

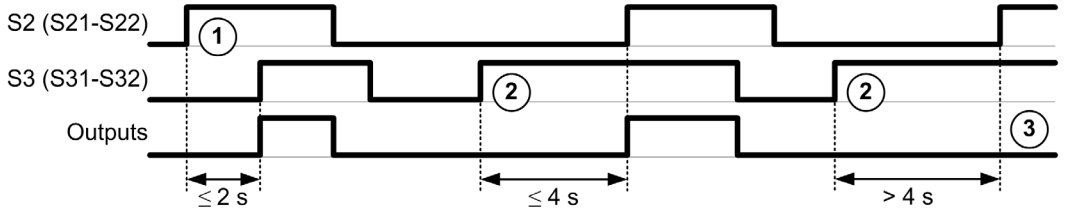
Synchronization Time Monitoring for TM3SAK6R / TM3SAK6RG

Description

The synchronization time monitoring is relevant for 2-channel applications. It monitors both inputs to determine that they are activated simultaneously (within a defined time). The synchronization time monitoring allows to detect a contact error (short-circuit) before the activation of the other input.

When the synchronization time monitoring is enabled, the outputs are allowed to be activated if both input S21-S22 and input S31-S32 are activated within 2 or 4 seconds. The defined time depends on which input is activated first as explained in the following figure. The outputs are not activated if the synchronization time is expired.

This figure represents the synchronization time monitoring chronogram on a TM3SAK6R• module in a 2-channel application:



Events description:

1. **S21-S22** operated before **S31-S32**
2. **S31-S32** operated before **S21-S22**
3. Outputs are not activated because the synchronization time is expired.

Synchronization Time Monitoring Control

The synchronization time monitoring is enabled or disabled by the system controller through a communication with the safety module on the TM3 Bus.

The synchronization time monitoring is an additional feature that contributes to the safety system, but cannot itself provide for functional safety.

⚠ WARNING

INCORRECT USE OF THE INTERNAL SYNCHRONIZATION TIME CONDITION

Do not use the synchronization time monitoring to control safety-related operations.

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

When enabled, the synchronization time is monitored by the module internal safety-related microcontroller.

In a 2-channel application, **S21-S22** and **S31-S32** simultaneous activation is monitored if `SyncOn` bit is set to 1.

Section 5.3
General Principles: TM3 Safety Operation Modes

What Is in This Section?

This section contains the following topics:

Power-On Condition

Description

When applying power to the safety module, the outputs are activated only if these four conditions are fulfilled:

- The start condition *(see page 95)* is valid.
- The safety conditions (safety-related inputs) indicate to activate the outputs.
- The internal enable *(see page 104)* condition is valid.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Do not use automatic start if a start interlock is required in your application after a power cycle.

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

Enable Condition

Description

The enable condition is a module internal control required to allow the internal relay **K2** to be closed. The internal relays can only be closed if the following conditions are fulfilled:

- The start condition *(see page 95)* is valid.
- The safety conditions (safety-related inputs) indicate to authorize activation of the outputs.
- The internal enable condition is valid for **K2**.

The safety outputs are deactivated:

- if the enable condition is not valid, or
- if the safety conditions are no longer valid.

Enable Condition

The enable condition is set by the controller through a communication with the safety module on the TM3 Bus.

⚠ WARNING

INCORRECT USE OF THE INTERNAL ENABLE CONDITION

Do not use the internal enable condition to control safety-related operations.

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

The enable condition is enabled by the system controller through a communication on the TM3 Bus.

The enable condition is disabled by:

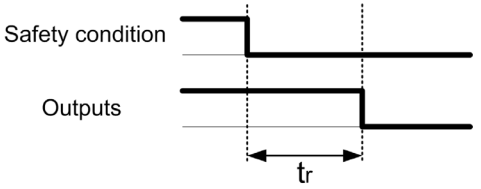
- The system controller through a communication on the TM3 Bus.
- The module internal safety-related microcontroller when:
  - The synchronization time *(see page 100)* is enabled and a time-out occurs.
  - The TM3 Bus time-out occurs.

NOTE: The enable condition only affects to internal relay **K2**. Internal relay **K1** may be active even when the enable condition is not valid.

Output Response Time

Description

This figure represents the response time (t_r) between the opening of one input (safety condition invalid) and all outputs deactivation:



NOTE: $t_r \leq 20$ ms

On Delay and Restart Delay

On Delay Description

On delay represents the time elapsed between the enabling of the condition for activation and the activation of the outputs.

NOTE: On delay ≤ 100 ms

Restart Delay Description

Restart delay represents the time required to reactivate internal relays after their deactivation.

NOTE: Restart delay ≤ 300 ms

Section 5.4
I/O Mapping: TM3 Safety Modules

What Is in This Section?

This section contains the following topics:

TM3SAC5R / TM3SAC5RG I/O Mapping

I/O Mapping Tab

Variables are defined and named in the **I/O Mapping** tab. Additional information such as topological addressing is also provided in this tab.

This table describes the **I/O Mapping** tab:

Variable	Channel		Type	Description
Diagnostics	IW0		WORD	-
ixModule_x_OutputOn	Bit 0	OutputOn	BOOL	Safety output on
ixModule_x_Supply	Bit 1	Supply	BOOL	Supply available (A1/A2)
ixModule_x_SupplyFail	Bit 2	SupplyFail	BOOL	Supply out of tolerance Acceptable range: 20.4...28.8 Vdc
-	Bit 3	Not applicable	BOOL	Not valid as a TM3 safety function block output
-	Bit 4	Not applicable	BOOL	Not valid as a TM3 safety function block output
ixModule_x_Start	Bit 5	Start	BOOL	Start active
ixModule_x_K1	Bit 6	K1	BOOL	Relay K1 activated
ixModule_x_K2	Bit 7	K2	BOOL	Relay K2 activated
-	Bit 8...11	Not applicable	BOOL	Not valid as a TM3 safety function block outputs
ixModule_x_WaitingForStart	Bit 12	WaitingForStart	BOOL	Waiting for start condition *(see page 95)*
-	Bit 13	Not applicable	BOOL	Not valid as a TM3 safety function block output
-	Bit 14, bit 15	Reserved	BOOL	-
Outputs	QB0		BYTE	-
qxModule_x_Enable	Bit 0	Enable	BOOL	TRUE enables the activation of safety outputs.
qxModule_x_ResetModule	Bit 1	ResetModule	BOOL	TRUE resets the module: current source switched off, outputs deactivated, and interlock reset.
qxModule_x_KeepAlive	Bit 2	KeepAlive	BOOL	TRUE defines the safety function remains active even when a TM3 Bus time-out occurs.

For further generic descriptions, refer to I/O Configuration Tab Description *(see page 24)*.

TM3SAF5R / TM3SAF5RG I/O Mapping

I/O Mapping Tab

Variables are defined and named in the **I/O Mapping** tab. Additional information such as topological addressing is also provided in this tab.

This table describes the **I/O Mapping** tab:

Variable	Channel		Type	Description
Diagnostics	IW0		WORD	-
ixModule_x_OutputOn	Bit 0	OutputOn	BOOL	Safety output on
ixModule_x_Supply	Bit 1	Supply	BOOL	Supply available (A1/A2)
ixModule_x_SupplyFail	Bit 2	SupplyFail	BOOL	Supply out of tolerance Acceptable range: 20.4...28.8 Vdc
ixModule_x_CH1	Bit 3	CH1	BOOL	Channel 1 active
ixModule_x_CH2	Bit 4	CH2	BOOL	Channel 2 active
ixModule_x_Start	Bit 5	Start	BOOL	Start active
ixModule_x_K1	Bit 6	K1	BOOL	Relay K1 activated
ixModule_x_K2	Bit 7	K2	BOOL	Relay K2 activated
-	Bit 8	Not applicable	BOOL	Not valid as a TM3 safety function block output
ixModule_x_S1	Bit 9	S1	BOOL	S1 active
ixModule_x_S2	Bit 10	S2	BOOL	S2 active
ixModule_x_S4	Bit 11	S4	BOOL	S4 active
ixModule_x_WaitingForStart	Bit 12	WaitingForStart	BOOL	Waiting for start condition *(see page 95)*
-	Bit 13	Not applicable	BOOL	Not valid as a TM3 safety function block output
-	Bit 14, bit 15	Reserved	BOOL	-
Outputs	QB0		BYTE	-
qxModule_x_Enable	Bit 0	Enable	BOOL	TRUE enables the activation of safety outputs.
qxModule_x_ResetModule	Bit 1	ResetModule	BOOL	TRUE resets the module: current source switched off, outputs deactivated, and interlock reset.
qxModule_x_KeepAlive	Bit 2	KeepAlive	BOOL	TRUE defines the safety function remains active even when a TM3 Bus time-out occurs.

For further generic descriptions, refer to I/O Configuration Tab Description *(see page 24)*.

TM3SAFL5R / TM3SAFL5RG I/O Mapping

I/O Mapping Tab

Variables are defined and named in the **I/O Mapping** tab. Additional information such as topological addressing is also provided in this tab.

This table describes the **I/O Mapping** tab:

Variable	Channel		Type	Description
Diagnostics	IW0		WORD	-
ixModule_x_OutputOn	Bit 0	OutputOn	BOOL	Safety output on
ixModule_x_Supply	Bit 1	Supply	BOOL	Supply available (A1/A2)
ixModule_x_SupplyFail	Bit 2	SupplyFail	BOOL	Supply out of tolerance Acceptable range: 20.4...28.8 Vdc
ixModule_x_CH1	Bit 3	CH1	BOOL	Channel 1 active
ixModule_x_CH2	Bit 4	CH2	BOOL	Channel 2 active
ixModule_x_Start	Bit 5	Start	BOOL	Start active
ixModule_x_K1	Bit 6	K1	BOOL	Relay K1 activated
ixModule_x_K2	Bit 7	K2	BOOL	Relay K2 activated
ixModule_x_S1	Bit 8	S1	BOOL	S1 active
-	Bit 9	Not applicable	BOOL	Not valid as a TM3 safety function block output
ixModule_x_S2	Bit 10	S2	BOOL	S2 active
ixModule_x_S4	Bit 11	S4	BOOL	S4 active
ixModule_x_WaitingForStart	Bit 12	WaitingForStart	BOOL	Waiting for start condition *(see page 95)*
-	Bit 13	Not applicable	BOOL	Not valid as a TM3 safety function block output
-	Bit 14, bit 15	Reserved	BOOL	-
Outputs	QB0		BYTE	-
qxModule_x_Enable	Bit 0	Enable	BOOL	TRUE enables the activation of safety outputs.
qxModule_x_ResetModule	Bit 1	ResetModule	BOOL	TRUE resets the module: current source switched off, outputs deactivated, and interlock reset.
qxModule_x_KeepAlive	Bit 2	KeepAlive	BOOL	TRUE defines the safety function remains active even when a TM3 Bus time-out occurs.

For further generic descriptions, refer to I/O Configuration Tab Description *(see page 24)*.

TM3SAK6R / TM3SAK6RG I/O Mapping

I/O Mapping Tab

Variables are defined and named in the **I/O Mapping** tab. Additional information such as topological addressing is also provided in this tab.

This table describes the **I/O Mapping** tab:

Variable	Channel		Type	Description
Diagnostics	IW0		WORD	-
ixModule_x_OutputOn	Bit 0	OutputOn	BOOL	Safety output on
ixModule_x_Supply	Bit 1	Supply	BOOL	Supply available (A1/A2)
ixModule_x_SupplyFail	Bit 2	SupplyFail	BOOL	Supply out of tolerance Acceptable range: 20.4...28.8 Vdc
ixModule_x_CH1	Bit 3	CH1	BOOL	Channel 1 active
ixModule_x_CH2	Bit 4	CH2	BOOL	Channel 2 active
ixModule_x_Start	Bit 5	Start	BOOL	Start active
ixModule_x_K1	Bit 6	K1	BOOL	Relay K1 activated
ixModule_x_K2	Bit 7	K2	BOOL	Relay K2 activated
ixModule_x_S1	Bit 8	S1	BOOL	S1 active
ixModule_x_S2	Bit 9	S2	BOOL	S2 active
ixModule_x_S3	Bit 10	S3	BOOL	S3 active
ixModule_x_S4	Bit 11	S4	BOOL	S4 active
ixModule_x_WaitingForStart	Bit 12	WaitingForStart	BOOL	Waiting for start condition *(see page 95)*
ixModule_x_SyncFailure	Bit 13	SyncFailure	BOOL	Synchronization time expired *(see page 100)*
Outputs	QB0		BYTE	-
qxModule_x_Enable	Bit 0	Enable	BOOL	TRUE enables the activation of safety outputs.
qxModule_x_ResetModule	Bit 1	ResetModule	BOOL	TRUE resets the module: current source switched off, outputs deactivated, and interlock reset.
qxModule_x_KeepAlive	Bit 2	KeepAlive	BOOL	TRUE defines the safety function remains active even when a TM3 Bus time-out occurs.
qxModule_x_SyncOn	Bit 3	SyncOn	BOOL	TRUE enables the synchronization time monitoring of S2 and S3 inputs.

For further generic descriptions, refer to I/O Configuration Tab Description *(see page 24)*.

Section 5.5
Function Blocks: TM3 Safety Modules

What Is in This Section?

This section contains the following topics:

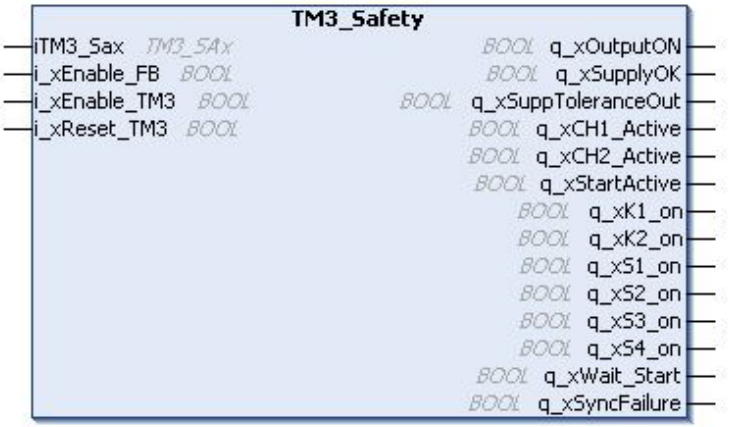
TM3_Safety: Control the TM3 Safety Module

Overview

The `TM3_Safety` function block is included in the TM3 Safety library.

The **IEC Objects** tab is only available if a function block instance of a device has been created, which can be accessed by the application. To access the IEC objects, double click the module node → **I/O Mapping** tab.

Graphical Representation



I/O Variable Description

This table describes the input variables:

Input	Type	Comment
iTM3_Sax	TM3_SAx	Reference to the local TM3 safety modules.
i_xEnable_FB	BOOL	TRUE enables the function block.
i_xEnable_TM3	BOOL	TRUE enables the activation of the hardware module outputs. **NOTE:** Enable/disable **i_xEnable_FB** before enabling/disabling **i_xEnable_TM3**.
i_xReset_TM3	BOOL	TRUE deactivates the module: the current source is switched off, the outputs are deactivated, and the interlock is reset.

NOTE:

This table describes the output variables:

Output	Type	Comment
q_xOutputON	BOOL	0: safety output is off. 1: safety output is on.
q_xSupplyOK	BOOL	Supply is available.
q_xSuppToleranceOut	BOOL	Supply is out of tolerance.
q_xCH1_Active	BOOL	Channel 1 is active.
q_xCH2_Active	BOOL	Channel 2 is active.
q_xStartActive	BOOL	Start is active.
q_xK1_on	BOOL	Relay K1 is activated.
q_xK2_on	BOOL	Relay K2 is activated.
q_xS1_on	BOOL	S1 is active.
q_xS2_on	BOOL	S2 is active.
q_xS3_on	BOOL	S3 is active.
q_xS4_on	BOOL	S4 is active.
q_xWait_Start	BOOL	Waiting for start condition *(see page 95)*.
q_xSyncFailure	BOOL	Synchronization time expired *(see page 100)*.

NOTE: Not all outputs are valid for all TM3 safety module references. To determine which outputs are valid for which TM3 safety module references, see the I/O mapping for the individual references *(see page 107)*.

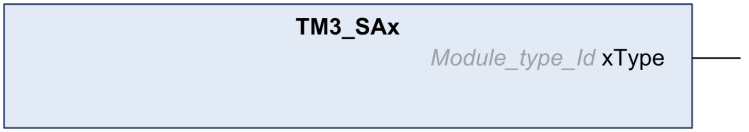
TM3_SAx: Get the name of the I/O

Function Block Description

The TM3_SAx function block gets the name of the I/O.

After you get the name of the I/O, TM3_SAx becomes an input parameter of the TM3_Safety function block.

Graphical Representation



Chapter 6
TM3 Transmitter and Receiver I/O Modules Configuration

Introduction

This chapter describes how to configure the TM3 transmitter and receiver I/O modules *(see page 23)*.

What Is in This Chapter?

This chapter contains the following topics:

Configuring the TM3 Transmitter and Receiver I/O Modules

Introduction

The TM3XTRA1 transmitter module is equipped with:

- 1 RJ-45 connector
- 1 functional ground screw
- 2 status LEDs (link and power)

The TM3XREC1 receiver module is equipped with:

- 1 RJ-45 connector
- 2 status LEDs (link and power)
- Removable 24 Vdc power supply

The transmitter expansion module is connected to the controller through the TM3 bus.The transmitter must be the last physical module directly connected to the controller.

The receiver module is connected to the transmitter module using a specific cable (VDIP1845460••).

Additional TM3 modules can then be connected to the receiver module through the extended TM3 bus.

NOTE: You cannot use TM2 expansion modules in configurations that include the TM3 transmitter/receiver modules.

Configuring the Modules

The TM3XTRA1 and TM3XREC1 expansion modules have no configurable properties in EcoStruxure Machine Expert.

Behavior of the TM3 Transmitter and Receiver Modules

Overview

The following exceptional behaviors can occur with TM3 transmitter and receiver modules:

- Transmitter/receiver cable disconnected or broken during operation
- Removing receiver module power during operation
- Receiver module disconnected during startup
- Receiver module powered on after the controller

The TM3 modules before the transmitter module are called "Local", and those after the receiver module are called "Remote".

The I/O that may be embedded in your controller is independent of the I/O that you may have added in the form of I/O expansion. It is important that the logical I/O configuration within your program matches the physical I/O configuration of your installation. If you add or remove any physical I/O to or from the I/O expansion bus or, depending on the controller reference, to or from the controller (in the form of cartridges), then you must update your application configuration. This is also true for any field bus devices you may have in your installation. Otherwise, there is the potential that the expansion bus or field bus no longer function while the embedded I/O that may be present in your controller continues to operate.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Update the configuration of your program each time you add or delete any type of I/O expansions on your I/O bus, or you add or delete any devices on your field bus.

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

Transmitter/Receiver Cable Disconnected or Broken During Operation

The controller continuously retries to access the modules attached to the receiver module.

When the receiver module detects cable disconnection:

- All local modules continue operating.
- All remote modules are put into the **Reset** state.
- I/O LED is on, and TM3 status bit (`plc_r.i_lwSystemFault_1.1)` is set to 0.
- Diagnostic information for the remote modules is available in the `TM3_MODULE_R` array.
- In EcoStruxure Machine Expert a red sign appears in front of the TM3 module with detected errors.

Reconnecting the cable does not restore normal operation. Only a controller power cycle or reset restores normal operation after disconnecting and then reconnecting the cable.

Removing Receiver Module Power During Operation

When the receiver module detects cable disconnection:

- All local modules continue operating.
- I/O LED is on, and TM3 status bit (`plc_r.i_lwSystemFault_1.1)` is set to 0.
- Diagnostic information for the remote modules is available in the `TM3_MODULE_R` array.
- In EcoStruxure Machine Expert a red sign appears in front of the TM3 module with detected errors.

Restoring power results in the TM3 modules attached to the receiver module assuming a **Reset** state. Only a controller power cycle or reset restores normal operation.

Receiver Module Disconnected During Start-up

If the receiver module was not connected at controller start-up, nothing happens because the TM3 bus is not started.

Receiver Module Powered on After the Controller

If two separate power supplies are used for the receiver module and the controller, the power supply of the receiver module must be switched on before the controller power supply. The TM3 bus does not start if the correct order of power application is not respected, and all modules are in **Reset** state (all outputs are forced to 0).

If the receiver module and the controller are supplied by the same power supply, the whole configuration starts operating.

If only the receiver module is powered (controller not supplied):

- The TM3 modules after the receiver module are in **Reset** state (all outputs are forced to 0).
- The TM3XFHSC202 / TM3XHSC202 and TM3XFHSC202G / TM3XHSC202G modules after the receiver module are in **Fallback mode** (all outputs forced to the configured values).

Glossary

A

application

A program including configuration data, symbols, and documentation.

C

configuration

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

controller

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

D

digital I/O

(*digital input/output*) An individual circuit connection at the electronic module that corresponds directly to a data table bit. The data table bit holds the value of the signal at the I/O circuit. It gives the control logic digital access to I/O values.

E

expansion bus

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

F

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)

H

HE10

Rectangular connector for electrical signals with frequencies below 3 MHz, complying with IEC 60807-2.

I

I/O

(*input/output*)

R

RJ45

A standard type of 8-pin connector for network cables defined for Ethernet.

T

terminal block

(*terminal block*) The component that mounts in an electronic module and provides electrical connections between the controller and the field devices.

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S

T