Modicon TM3 (SoMachine Basic)

Expansion Modules Configuration 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 SoMachine Basic. For further information, refer to the separate documents provided in the SoMachine Basic online help.

Validity Note

This document has been updated for the release of SoMachine Basic V1.6 SP1.

Related Documents

Title of Documentation	Reference Number
SoMachine Basic - Operating Guide	*EIO0000001354 (ENG)* *EIO0000001355 (FRA)* *EIO0000001356 (GER)* *EIO0000001357 (SPA)* *EIO0000001358 (ITA)* *EIO0000001359 (CHS)* *EIO0000001366 (POR)* *EIO0000001367 (TUR)*
Modicon TM3 Digital I/O Modules - Hardware Guide	*EIO0000001408 (ENG)* *EIO0000001409 (FRE)* *EIO0000001410 (GER)* *EIO0000001411 (SPA)* *EIO0000001412 (ITA)* *EIO0000001413 (CHS)* *EIO0000001376 (POR)* *EIO0000001377 (TUR)*
Modicon TM3 Analog I/O Modules - Hardware Guide	*EIO0000001414 (ENG)* *EIO0000001415 (FRE)* *EIO0000001416 (GER)* *EIO0000001417 (SPA)* *EIO0000001418 (ITA)* *EIO0000001419 (CHS)* *EIO0000001378 (POR)* *EIO0000001379 (TUR)*

Title of Documentation	Reference Number
Modicon TM3 Expert Modules - Hardware Guide	*EIO0000001420 (ENG)* *EIO0000001421 (FRE)* *EIO0000001422 (GER)* *EIO0000001423 (SPA)* *EIO0000001424 (ITA)* *EIO0000001425 (CHS)* *EIO0000001380 (POR)* *EIO0000001381 (TUR)*
Modicon TM3 Safety Modules - Hardware Guide	*EIO0000001831 (ENG)* *EIO0000001832 (FRE)* *EIO0000001833 (GER)* *EIO0000001834 (SPA)* *EIO0000001835 (ITA)* *EIO0000001836 (CHS)* *EIO0000001837 (POR)* *EIO0000001838 (TUR)*
Modicon TM3 Transmitter and Receiver Modules - Hardware Guide	*EIO0000001426 (ENG)* *EIO0000001427 (FRE)* *EIO0000001428 (GER)* *EIO0000001429 (SPA)* *EIO0000001430 (ITA)* *EIO0000001431 (CHS)* *EIO0000001382 (POR)* *EIO0000001383 (TUR)*
Modicon M221 Logic Controller - Programming Guide	*EIO0000001360 (ENG)* *EIO0000001361 (FRE)* *EIO0000001362 (GER)* *EIO0000001363 (SPA)* *EIO0000001364 (ITA)* *EIO0000001365 (CHS)* *EIO0000001368 (POR)* *EIO0000001369 (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
EN 61131-2:2007	Programmable controllers, part 2: Equipment requirements and tests.
ISO 13849-1:2008	Safety of machinery: Safety related parts of control systems. 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
EN 1088:2008 ISO 14119:2013	Safety of machinery - Interlocking devices associated with guards - Principles for design and selection
ISO 13850:2006	Safety of machinery - Emergency stop - Principles for design
EN/IEC 62061:2005	Safety of machinery - Functional safety of safety-related electrical, electronic, and electronic programmable control systems
IEC 61508-1:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems: General requirements.
IEC 61508-2:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems: Requirements for electrical/electronic/programmable electronic safety-related systems.
IEC 61508-3:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems: Software requirements.
IEC 61784-3:2008	Digital data communication for measurement and control: Functional safety field buses.
2006/42/EC	Machinery Directive
2014/30/EU	Electromagnetic Compatibility Directive
2014/35/EU	Low Voltage Directive

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

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

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

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

Chapter 1
I/O Configuration General Information

Introduction

This chapter provides general information to help you configure TM3 expansion modules for SoMachine Basic.

What Is in This Chapter?

This chapter contains the following topics:

I/O Configuration General Description

Introduction

In your project, you can add I/O expansion modules to your M221 Logic Controller to increase the number of digital and analog inputs and outputs over those native to the logic controller itself (embedded I/O).

You can add either TM3 or TM2 I/O expansion modules to the logic controller, and further expand the number of I/O via TM3 transmitter and receiver modules to create remote I/O configurations. Special rules apply in all cases when creating local and remote I/O expansions, and when mixing TM2 and TM3 I/O expansion modules (refer to Maximum Hardware Configuration).

The I/O expansion bus of the M221 Logic Controller is created when you assemble the I/O expansion modules to the logic controller. I/O expansion modules are considered as external devices in the logic controller architecture and are treated, as such, differently than the embedded I/Os of the logic controller.

I/O Expansion Bus Errors

If the logic controller cannot communicate with one or more I/O expansion modules that is (are) contained in the program configuration and those modules are not configured as optional modules (refer to Optional I/O Expansion Modules *(see page 30)*), the logic controller considers it as an I/O expansion bus error. The unsuccessful communication may be detected during the startup of the logic controller or during runtime, and there may be any number of causes. Causes of communication exception on the I/O expansion bus include, among other things, disconnection of or physically missing I/O modules, electromagnetic radiation beyond published environmental specifications, or otherwise, inoperative modules.

During runtime, if an I/O expansion bus error is detected, the diagnostic information is contained in `%SW118` and `%SW120` system words, and the red LED indicator labeled **ERR** flashes.

Active I/O Expansion Bus Error Handling

System bit %S106 is set to 0 by default to specify the use of active I/O error handling. The application can set this bit to 1 to use passive I/O error handling instead.

By default, when the logic controller detects a TM3 module in bus communication error, it sets the bus to a "bus off" condition whereby the TM3 expansion module outputs, the input image and the output image are set to 0. A TM3 expansion module is considered to be in bus communication error when an I/O exchange with the expansion module has been unsuccessful for at least two consecutive bus task cycles. When a bus communication error occurs, bit n of %SW120 is set to 1, where n is the expansion module number, and %SW118 bit 14 is set to 0.

Normal I/O expansion bus operation can only be restored after eliminating the source of the error and performing one of the following:

- Power cycle
- New application download
- Application request through a rising edge on bit %S107
- With SoMachine Basic by selection of the **Initialize Controller** command

Passive I/O Expansion Bus Error Handling

The application can set system bit %S106 to 1 to use passive I/O error handling. This error handling is provided to afford compatibility with previous firmware versions and previous controllers that the M221 Logic Controller replaces.

When passive I/O error handling is in use, the controller attempts to continue data bus exchanges with the modules during bus communication errors. While the expansion bus error persists, the logic controller attempts to re-establish communication on the bus with incommunicative modules, depending on the type of I/O expansion module, TM3 or TM2:

- For TM3 I/O expansion modules, the value of the I/O channels is maintained (**Maintain values**) for approximately 10 seconds while the logic controller attempts to re-establish communication. If the logic controller cannot re-establish communications within that time, all affected TM3 I/O expansion outputs are set to 0.
- For the TM2 I/O expansion modules that may be part of the configuration, the value of the I/O channels is maintained indefinitely. That is to say, the outputs of the TM2 I/O expansion modules are set to **Maintain values** until either power is cycled on the logic controller system, or you issue an **Initialize Controller** command with SoMachine Basic.

In either case, the logic controller continues to solve logic and the embedded I/O continues to be managed by the application (Managed by application) while it attempts to re-establish communication with the incommunicative I/O expansion modules. If the communication is successful, the I/O expansion modules resume to be managed by the application. If communication with the I/O expansion modules is unsuccessful, you must resolve the reason for the unsuccessful communication, and then cycle power on the logic controller system, or issue an **Initialize Controller** command with SoMachine Basic.

The value of the incommunicative I/O expansion modules input image is maintained and the output image value is set by the application.

Further, if the incommunicative I/O module(s) disturb the communication with unaffected modules, the unaffected modules will also be considered in error and their corresponding bit in %SW120 will be set to 1. However, with the ongoing data exchanges that characterize the Passive I/O Expansion Bus Error Handling, the unaffected modules will nonetheless apply the data sent, and will not apply the fallback values as for the incommunicative module.

Therefore, you must monitor within your application the state of the bus and the error state of the module(s) on the bus, and to take the appropriate action necessary given your particular application.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Include in your risk assessment the possibility of unsuccessful communication between the logic controller and any I/O expansion modules.
- If the “Maintain values” option deployed during an I/O expansion bus error is incompatible with your application, use alternate means to control your application for such an event.
- Monitor the state of the I/O expansion bus using the dedicated system words and take appropriate actions as determined by your risk assessment.

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

For more information on the actions taken upon start-up of the logic controller when an I/O expansion bus error is detected, refer to Optional I/O Expansion Modules *(see page 30)*.

Restarting the I/O Expansion Bus

When active I/O error handling is being applied, that is, TM3 outputs set to 0 when a bus communication error is detected, the application can request a restart of the I/O expansion bus while the logic controller is still running (without the need for a Cold Start, Warm Start, power cycle, or application download).

System bit %S107 is available to request restarts of the I/O expansion bus.The default value of this bit is 0. The application can set %S107 to 1 to request a restart of the I/O expansion bus. On detection of a rising edge of this bit, the logic controller reconfigures and restarts the I/O expansion bus if all of the following conditions are met:

- %S106 is set to 0 (that is, I/O expansion bus activity is stopped)
- %SW118 bit 14 is set to 0 (I/O expansion bus is in error)
- At least one bit of %SW120 is set to 1 (at least one expansion module is in bus communication error)

If %S107 is set to 1 and any of the above conditions is not met, the logic controller takes no action.

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 will no longer function while the embedded I/O that may be present in your controller will continue 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.

Presentation of 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 logic 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 30)*.

General Description

Introduction

The range of TM3 expansion modules includes:

- Digital modules, classified as follows:
  - Input modules *(see page 18)*
  - Output modules *(see page 19)*
  - Mixed input/output modules *(see page 20)*
- Analog modules, classified as follows:
  - Input modules *(see page 21)*
  - Output modules *(see page 23)*
  - Mixed input/output modules *(see page 23)*
- Expert modules *(see page 24)*
- Safety modules *(see page 25)*
- Transmitter and receiver modules *(see page 26)*

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 41)* 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 41)* 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 41)* 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	

Reference	Channels	Channel Type	Voltage Current	Terminal Type / Pitch
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 44)* 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
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

Reference	Resolution	Channels	Channel Type	Mode	Terminal Type / Pitch
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 67)* 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 72)* 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 83)* section.

Reference	Description	Terminal Type / Pitch
TM3XTYS4	TeSys module	4 front connectors RJ-45 1 removable power supply connector / 5.08 mm

TM3 Safety Modules

This table contains the TM3 safety modules, 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	
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	

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

Reference	Function Category	Channels	Channel type	Voltage Current	Terminal type
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 87)* and TM3 Safety Operation Modes *(see page 95)*.

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 105)* 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

Using I/O Modules in a Configuration

Adding a Module

The following steps explain how to add an expansion module to the logic controller in a SoMachine Basic project:

Step	Action
1	Click the **Configuration** tab in the SoMachine Basic window.
2	In the catalog area, click one of the following module types to expand the list of expansion modules: • **TM3 Digital I/O Modules** • **TM3 Analog I/O Modules** • **TM3 Expert I/O Modules** • **TM2 Digital I/O Modules** • **TM2 Analog I/O Modules**
3	Select an expansion module from the list to add. **Result**: The description of the physical characteristics of the selected expansion module appears in the bottom of the catalog area.
4	Drag the selected expansion module to the editor area and drop the module on the right-hand side of the controller or the last expansion module in the configuration. **Result**: The module is added under the **My Controller → I/O Bus** branch of the hardware tree and the description of the physical characteristics of the selected module appears in the bottom of the editor area.

Inserting a Module Between two Existing Modules

Drag the module between two modules, or between the controller and the first module until a vertical green bar appears and then drop the module.

NOTE: The addresses change when you change the position of modules by inserting a new module. For example, if you move an input module from position 4 to position 2, the addresses change from `I4.x` to `I2.x`, and all corresponding addresses in the program are automatically renamed.

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 will no longer function while the embedded I/O that may be present in your controller will continue 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.

Replacing an Existing Expansion Module

You can replace an existing module with a new module by dragging the new module and dropping it onto the module to be replaced.

A message appears asking you to confirm the operation. Click **Yes** to continue.

Removing a Module

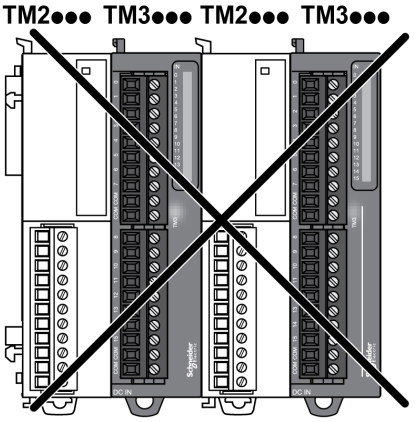
You can remove an expansion module by pressing the **Delete** key or by right-clicking the module and clicking **Remove** on the contextual menu that appears.

If the expansion module contains at least one address being used in a program, a message appears asking you to confirm the operation. Click **Yes** to continue.

Mixing Expansion Module Types

You can mix different I/O module types on the same logic controller (for example, TM2 and TM3 modules).

Place any TM2 module(s) at the end of your configuration after any TM3 module(s):



In this case, however, the I/O bus of the logic controller operates at the speed of the slower module type. For example, when both TM2 and TM3 modules are used, the I/O bus of the logic controller operates at the speed of the TM2 modules.

Maximum Hardware Configuration

SoMachine Basic displays a message when:

- The maximum number of modules supported by the logic controller is exceeded.
- The total power consumption of all expansion modules directly connected to the logic controller exceeds the maximum current delivered by the logic controller.

Refer to the hardware guide of your controller for more information on the maximum supported configuration.

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 logic 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 logic 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 logic 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 logic controller ignores the absent I/O expansion modules that you have marked as optional, which then allows the logic controller to start the I/O expansion bus.

The logic 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 logic 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 (TM3XTRA1 and the TM3XREC1) and TMC2 cartridges cannot be marked as optional.

The application must be configured with a functional level of at least **Level 3.2** for modules marked as optional to be recognized as such by the logic controller.

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

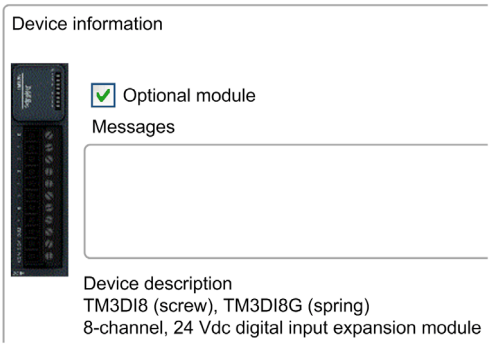
UNINTENDED EQUIPMENT OPERATION

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 in Offline Mode

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

Step	Action
1	Drag-and-drop the I/O expansion module from the catalog to the editor.
2	In the **Device information** area, select the **Optional module** check box: 

To mark an existing I/O expansion module as optional in the configuration:

Step	Action
1	Select the I/O expansion module in the editor.
2	In the **Device information** area, select the **Optional module** check box.

Optional I/O Expansion Modules in Online Mode

SoMachine Basic operates in online mode when a physical connection to a logic controller has been established.

When in SoMachine Basic online mode, the modification of the **Optional module** feature is disabled. You can visualize the downloaded configuration in the application:

- An I/O expansion module represented in yellow is marked as optional and not physically connected to the logic controller at start-up. An information message to that effect is displayed in the **Device information** area.
- An I/O expansion module represented in red is not marked as optional and not detected at start-up. An information message to that effect is displayed in the **Device information** area.

The selection of the **Optional module** feature is used by the logic controller to start the I/O bus. The following system words are updated to indicate the status of the physical I/O bus configuration:

System Word	Comment
%SW118 Logic controller status word	Bits 13 and 14 are pertinent to the I/O module status relative to the I/O bus. Bit 13, if FALSE, indicates that there are mandatory modules as defined by the I/O expansion bus configuration that are absent or otherwise inoperative when the logic controller attempts to start the I/O expansion bus. In this case, the I/O bus does not start. Bit 14, if FALSE, indicates that one or more modules have ceased communication with the logic controller after the I/O expansion bus is started. This is the case whether an I/O expansion module is defined as mandatory or as an optional module but present at start-up.
%SW119 I/O expansion module configuration	Each bit, starting with bit 1 (bit 0 is reserved), is dedicated to a configured I/O expansion module and indicates whether the module is optional (TRUE) or mandatory (FALSE) when the controller attempts to start the I/O bus.
%SW120 I/O expansion module status	Each bit, starting with bit 1 (bit 0 is reserved), is dedicated to a configured I/O expansion module and indicates the status of the module. When the logic controller attempts to start the I/O bus, if the value of %SW120 is non-zero (indicating that an error is detected for at least one of the modules), the I/O expansion bus does not start unless the corresponding bit in %SW119 is set to TRUE (indicating the module is marked as an optional module). When the I/O bus is started, if the value of %SW120 is modified by the system, it indicates that an error is detected on one or more I/O expansion modules (regardless of the **Optional module** feature).

For more information, refer to System Words *(see Modicon M221, Logic Controller, Programming Guide)*.

Shared Internal ID Codes

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

If you declare two modules with the same internal ID code next to each other in the configuration and both are declared as optional, a message appears at the bottom of the **Configuration** window. There must be at least one non-optional module between two optional modules.

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
TM3DI16K, TM3DI16/G
TM3DQ16R/G, TM3DQ16T/G, TM3DQ16TK, TM3DQ16U, TM3DQ16UG, TM3DQ16UK
TM3DQ32TK, TM3DQ32UK
TM3DI8/G, TM3DI8A
TM3DQ8R/G, TM3DQ8T/G, TM3DQ8U, TM3DQ8UG
TM3DM8R/G
TM3DM24R/G
TM3SAK6R/G
TM3SAF5R/G
TM3SAC5R/G
TM3SAFL5R/G
TM3AI2H/G
TM3AI4/G
TM3AI8/G
TM3AQ2/G
TM3AQ4/G
TM3AM6/G
TM3TM3/G
TM3TI4/G
TM3TI4D/G
TM3TI8T/G

Configuring Digital I/Os

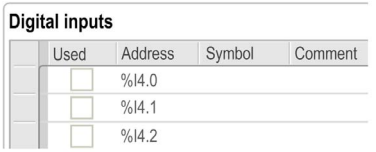
Overview

You can configure digital I/Os of your expansion module using:

- **Configuration** tab:
  - Digital inputs *(see page 34)*
  - Digital outputs *(see page 35)*
- **Programming** tab *(see page 36)*.

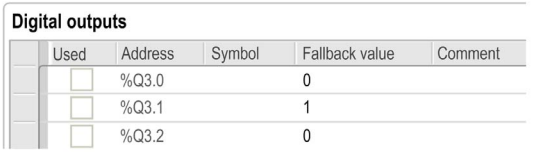
Configuring Digital Inputs in the Configuration Tab

Follow these steps to display and configure the digital input properties in the **Configuration** tab:

Step	Description
1	Click the **Configuration** tab in the SoMachine Basic window.
2	In the hardware tree, click **MyController → IO Bus → Module x → Digital inputs**, where x is the expansion module number on the controller. **Result**: The digital input properties of the selected module are displayed in the editor area, for example: 
3	Edit the properties to configure the digital inputs: ● **Used**: Indicates whether the corresponding address is being used in the program or not. ● **Address**: Displays the address of the digital input on the expansion module. For details on addressing I/O objects, refer to I/O Addressing *(see SoMachine Basic, Generic Functions Library Guide)*. ● **Symbol**: Allows you to specify a symbol to associate with the corresponding digital input object to be used in the program. Double-click in the **Symbol** column, type the symbol name of the corresponding object, and press **Enter**. ● **Comment**: Allows you to specify a comment to associate with the corresponding digital input object. Double-click in the **Comment** column, type a comment for the corresponding object, and press **Enter**.
4	Click **Apply** to save the changes.

Configuring Digital Outputs in the Configuration Tab

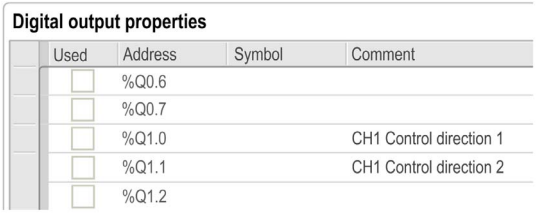
Follow these steps to display and configure the digital output properties in the **Configuration** tab:

Step	Description
1	Click the **Configuration** tab in the SoMachine Basic window.
2	In the hardware tree, click **MyController → IO Bus → Module x → Digital outputs**, where x is the expansion module number on the controller. **Result**: The digital output properties of the selected module are displayed in the editor area, for example:  Digital outputs Used | Address | Symbol | Fallback value | Comment %Q3.0 0 %Q3.1 1 %Q3.2 0
3	Edit the properties to configure the digital outputs: ● **Used**: Indicates whether the corresponding address is being used in the program or not. ● **Address**: Displays the address of the digital output on the expansion module. For details on addressing I/O objects, refer to I/O Addressing *(see SoMachine Basic, Generic Functions Library Guide)*. ● **Symbol**: Allows you to specify a symbol to associate with the corresponding digital output object to be used in the program. Double-click in the **Symbol** column, type the symbol name of the corresponding object, and press **Enter**. ● **Fallback value**. Allows you to specify the value to apply to the corresponding output (fallback to 0 or fallback to 1) when the logic controller enters the STOPPED or an exception state. The default value is 0. If **Maintain values** fallback mode is configured, the output retains its current value when the logic controller enters the STOPPED or an exception state. For more details on maintaining output values, refer to Fallback Behavior *(see SoMachine Basic, Operating Guide)*. ● **Comment**: Allows you to specify a comment to associate with the corresponding digital output object. Double-click in the **Comment** column, type a comment for the corresponding object, and press **Enter**.
4	Click **Apply** to save the changes.

Displaying Configuration Details in the Programming Tab

The **Programming** tab displays configuration details of all inputs/outputs and allows you to update programming-related properties such as symbols and comments.

Follow these steps to view and update details of I/O modules in the **Programming** tab:

Step	Description
1	Click the **Programming** tab in the SoMachine Basic window.
2	In the left-hand area of the **Programming** tab, click on the **Tools** tab and from the **I/O objects** branch, select one of the following I/O types to display the properties: • **Digital inputs** • **Digital outputs** • **Analog inputs** • **Analog outputs** **Result**: A list of all embedded and expansion module I/O addresses appears in the lower central area of the SoMachine Basic window, for example: 
3	Scroll down to the range of addresses corresponding to the expansion module you are configuring. The following properties are displayed: • **Used**: Indicates whether the corresponding address is being used in the program or not. • **Address**: Displays the address of the digital output on the expansion module. For details on addressing I/O objects, refer to I/O Addressing *(see SoMachine Basic, Generic Functions Library Guide)*. • **Symbol**: Allows you to specify a symbol to associate with the corresponding I/O object to be used in the program. Double-click in the **Symbol** column, type the symbol name of the corresponding object, and press **Enter**. If a symbol already exists, right-click in the **Symbol** column and choose **Search and Replace** to find and replace occurrences of this symbol throughout the program and/or program comments. • **Comment**: Allows you to specify a comment to associate with the corresponding I/O object. Double-click in the **Comment** column, type a comment for the corresponding object, and press **Enter**.
4	Click **Apply** to save the changes.

Filtering of Analog Input Channels

Presentation

Sampling and filtering can be applied to the signal received on analog input channels:

1. **Sampling**
   The sampling filter first calculates a moving average of the input values to remove random variations and highlight cyclic components.
   The sampling period used can be 1 ms, 10 ms or 100 ms, depending on the type of TM3 analog I/O module used.
   In the **Configuration** tab, you can choose between two sampling period values for some TM3 analog I/O modules:
   - a lower value (fast)
   - a higher value (slow)
2. **Filter** (Optional)
   A first-order filter is then applied to the values generated by the sampling filter. Specify the time constant to use, in units of 10 ms. If 0 is specified, no filtering is applied and the values calculated by the Sampling filter are available in the application.

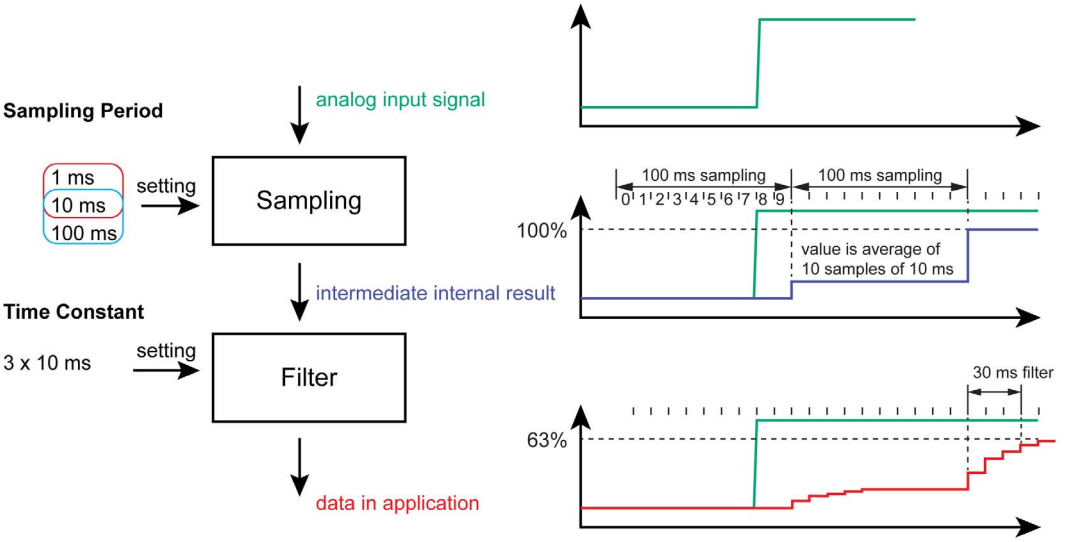
You configure sampling and filtering in the Configuration properties of TM3 Analog expansion modules:

Analog inputs

Used	Address	Sym...	Type	Scope	Min...	Max...	Filter	Filter Unit	Sampling	Units	Comment
☐	%IW1.0		Not...	Not...	0	0	0	x 10 ms	1 ms/Channel		
☐	%IW1.1		Not...	Not...	0	0	0	x 10 ms	1 ms/Channel		
☐	%IW1.2		Not...	Not...	0	0	0	x 10 ms	1 ms/Channel		
☐	%IW1.3		Not...	Not...	0	0	0	x 10 ms	1 ms/Channel		

Example of Sampling and Filter

The following illustration shows an example of the application of sampling and filter:



Adding Transmitter and Receiver Modules

Overview

TM3 Transmitter and Receiver modules increase the maximum number of I/O modules in a configuration and allow expansion modules to be installed in a remote location. For details, refer to the *TM3 Transmitter and Receiver Modules - Hardware Guide*.

Procedure

Before adding the Transmitter and Receiver modules, create a SoMachine Basic project and add a logic controller as described in the *SoMachine Basic Operating Guide*.

In SoMachine Basic, the Transmitter and Receiver modules are paired together as a single reference. To add the Transmitter and Receiver module pair to a configuration:

Step	Description
1	Click the **Configuration** tab in the SoMachine Basic window.
2	In the catalog area, click **TM3 Expert I/O Modules** to expand the list of expansion modules.
3	Select **TM3_XTRA1_XREC1** from the list. **Result**: The description of the physical characteristics of the Transmitter and Receiver module appears in the bottom of the catalog area.
4	Drag the selected Transmitter and Receiver module to the editor area and drop the module on the right-hand side of the controller or the last expansion module in the configuration. **Result**: The Transmitter and Receiver module is added under the **My Controller → I/O Bus** branch of the hardware tree and the description of the physical characteristics of the Transmitter and Receiver module appears in the bottom of the editor area.
5	Add further expansion modules to the right of the Transmitter and Receiver module pair, up to the maximum number of modules allowed. **NOTE:** Only one Transmitter and Receiver module pair can be added to a configuration.

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 18)*
- TM3 Digital Output Modules *(see page 19)*
- TM3 Digital Mixed Input/Output Modules *(see page 20)*

Configuring the Modules

Configuration tab: Displaying Configuration Details in the Configuration Tab *(see page 34)* describes how to view the configuration of these modules.

Programming tab: Displaying Configuration Details in the Programming Tab *(see page 36)* describes how to view and update programming-related properties of these modules.

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 21)*
- TM3 Analog Output Modules *(see page 23)*
- TM3 Analog Mixed Input/Output Modules *(see page 23)*

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 80)*.

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 SoMachine Basic, 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
Used		True/False	False	Indicates whether the address is being used in a program.
Address		`%IWx.0...%IWx.1`	`%IWx.y`	The address of the input channel, where *x* is the module number and *y* is the channel number.
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA**	**Not used**	Choose the mode of the channel.
Scope		**Normal**	**Normal**	The range of values for a 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	
Filter (x 10ms)		0...1000	0	Specifies the first order filter time constant (0...10 s) in increments of 10 ms *(see page 37)*.
Sampling		**1ms/Channel**	**1ms/Channel**	Specifies the sampling period of the channel *(see page 37)*.

Programming tab: Displaying Configuration Details in the Programming Tab *(see page 36)* describes how to view and update programming-related properties of these modules.

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 80)*.

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 SoMachine Basic, 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
Used	True/False	False	Indicates whether the address is being used in a program.
Address	`%IWx.0...%IWx.3`	`%IWx.y`	The address of the input channel, where *x* is the module number and *y* is the channel number.
Type	**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA**	**Not used**	Choose the mode of the channel.
Scope	**Normal**	**Normal**	The range of values for a channel.

Parameter		Value	Default Value	Description
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	
Filter (x 10ms)		0...1000	0	Specifies the filtering time *(see page 37)* (0...10 s) in increments of 10 ms.
Sampling		**1ms/Channel** **10ms/Channel**	**1ms/Channel**	Specifies the sampling period *(see page 37)* of the channel. If an input filter is active, the sampling period is set internally to 10 ms.

[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.

Programming tab: Displaying Configuration Details in the Programming Tab *(see page 36)* describes how to view and update programming-related properties of these modules.

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 80)*.

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 SoMachine Basic, 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
Used		True/False	False	Indicates whether the address is being used in a program.
Address		%IWx.0...%IWx.7	%IWx.y	The address of the input channel, where *x* is the module number and *y* is the channel number.
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA** **0 - 20 mA extended**[2] **4 - 20 mA extended**[2]	**Not used**	Choose the mode of the channel.
Scope		**Normal**	**Normal**	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	
	0 - 20 mA extended[2]		0	
	4 - 20 mA extended[2]		1200	
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	
	4 - 20 mA extended[2]		23170	

Parameter	Value	Default Value	Description
Filter (x 10ms)	0...1000	0	Specifies the first order filter time *(see page 37)* constant (0...10 s) in increments of 10 ms.
Sampling	**1ms/Channel** **10ms/Channel**	**1ms/Channel**	Specifies the sampling period *(see page 37)* of the channel. If an input filter is active, the sampling period is set internally to 10 ms.

[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 hardware version 03, firmware version (SV) 1.4 and SoMachine Basic V1.5.

The firmware version of TM3 expansion modules is displayed in the Commissioning window *(see SoMachine Basic, Operating Guide)*.

NOTE: The application must be configured with a functional level *(see SoMachine Basic, Operating Guide)* of at least Level 5.0 to be able to use the extended ranges.

Programming tab: Displaying Configuration Details in the Programming Tab *(see page 36)* describes how to view and update programming-related properties of these modules.

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 80)*.

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 SoMachine Basic, 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
Used		True/False	False	Indicates whether the address is being used in a program.
Address		%IWx.0...%IWx.3	%IWx.y	The address of the input channel, where *x* is the module number and *y* is the channel number.
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		**Normal** **Celsius (0.1°C)** **Fahrenheit (0.1°F)** **Fahrenheit (0.2°F)***	**Normal**	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		

Parameter	Value	Default Value	Description
Filter (x 10ms)	0...1000	0	Specifies the first order filter time *(see page 37)* constant (0...10 s) in increments of 10 ms.
Sampling	**10ms/Channel** **100ms/Channel**	**100ms/Channel**	Specifies the sampling period *(see page 37)* of the channel. If an input filter is active, the sampling period is set internally to 10 ms.
Units	**–** **0.1 °C** **0.1 °F** **0.2 °F**	**–**	Indicates the temperature unit.

Type	Normal		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

Programming tab: Displaying Configuration Details in the Programming Tab *(see page 36)* describes how to view and update programming-related properties of these modules.

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 80)*.

For further hardware information, refer to TM3TI4D / TM3TI4DG.

Configuring the Module

For each input, you can define:

Parameter	Value	Default Value	Description
Used	True/False	False	Indicates whether the address is being used in a program.
Address	`%IWx.0...%IWx.3`	`%IWx.y`	The address of the input channel, where *x* is the module number and *y* is the channel number.
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	**Normal** **Celsius (0.1°C)** **Fahrenheit (0.1°F)** **Fahrenheit (0.2°F)***	**Normal**	The range of values for a channel. * Only for B and C thermocouples.

Parameter		Value	Default Value	Description
Min.	**Temperature**	See the table below		Specifies the lower measurement limit.
Max.	**Temperature**	See the table below		Specifies the upper measurement limit.
Filter (x 10ms)		0...1000	0	Specifies the first order filter time *(see page 37)* constant (0...10 s) in increments of 10 ms.
Sampling		**10ms/Channel** **100ms/Channel**	**100ms/Channel**	Specifies the sampling period *(see page 37)* of the channel. If an input filter is active, the sampling period is set internally to 10 ms.
Units		**–** **0.1 °C** **0.1 °F** **0.2 °F**	**–**	Indicates the temperature unit.

Type	Normal		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

Programming tab: Displaying Configuration Details in the Programming Tab *(see page 36)* describes how to view and update programming-related properties of these modules.

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 80)*.

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 SoMachine Basic, 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.**

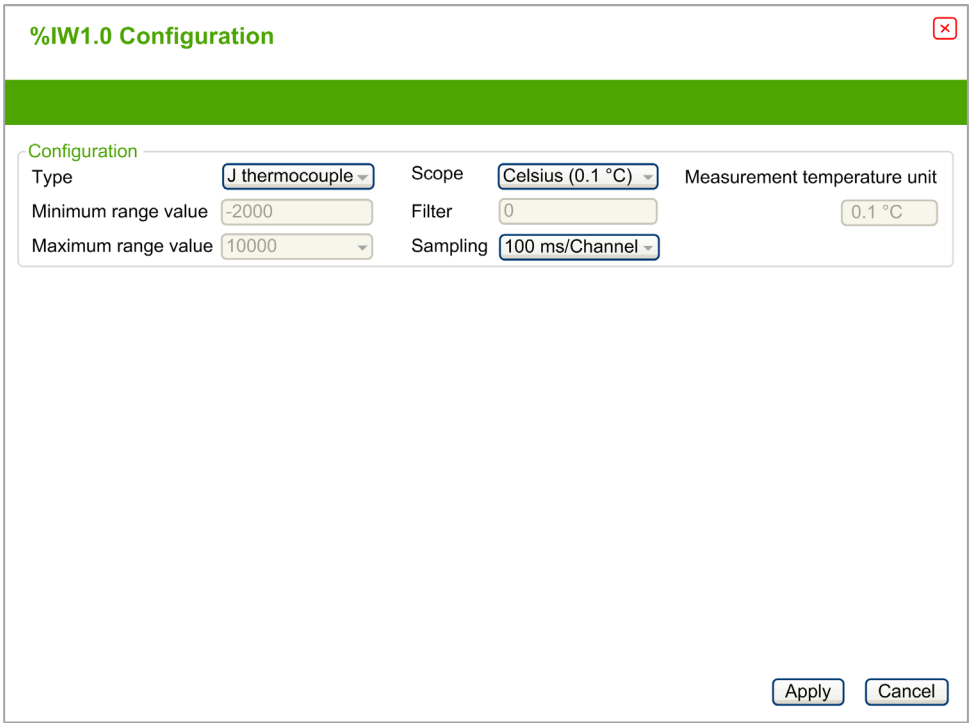
Configuring Analog Inputs in the Configuration Tab

Follow these steps to display and configure the analog input properties in the **Configuration** tab:

Step	Description
1	Click the **Configuration** tab in the SoMachine Basic window.
2	In the hardware tree, click **MyController → IO Bus → Module x → Analog inputs**, where x is the expansion module number on the controller. **Result**: The analog input properties of the selected module are displayed in the editor area.
3	Edit the properties to configure the analog inputs: ● **Used**: Indicates whether the corresponding address is being used in the program or not. ● **Address**: Displays the address of the analog input on the expansion module. For details on addressing I/O objects, refer to I/O Addressing *(see SoMachine Basic, Generic Functions Library Guide)*. ● **Symbol**: Allows you to specify a symbol to associate with the corresponding analog input object to be used in the program. Double-click in the **Symbol** column, type the symbol name of the corresponding object, and press **Enter**. ● **Type**: Displays the type of the analog input on the expansion module. ● **Configuration**: Click the **...** button to display the Input Assistant. ● **Comment**: Allows you to specify a comment to associate with the corresponding analog input object. Double-click in the **Comment** column, type a comment for the corresponding object, and press **Enter**.
4	Click **Apply** to save the changes.

Thermocouple Type

This figure represents the analog input assistant for the thermocouple configuration:



You can define the following parameters:

Parameter	Value	Description
Type	• **K Thermocouple** • **J Thermocouple** • **R Thermocouple** • **S Thermocouple** • **E Thermocouple** • **T Thermocouple** • **N Thermocouple** • **B Thermocouple** • **C Thermocouple**	Choose the parameter type for the channel.
Scope	• **Customized** • **Celsius (0.1 °C)** • **Fahrenheit (0.1 °F)** • **Fahrenheit (0.2 °F)**	Choose the parameter scope for the channel.

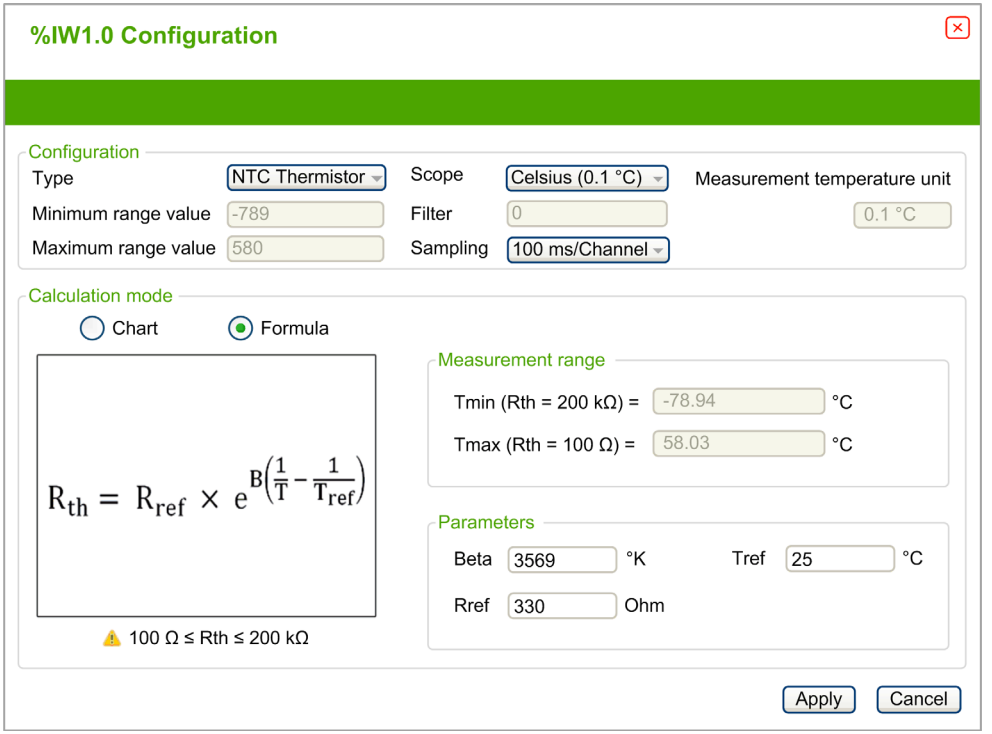
Parameter	Value	Description
Minimum range value	See the following table	Specifies the measurement limits (modifiable in **Customized** scope only).
Maximum range value		
Filter	0...1000	Specifies the first order filter time *(see page 37)* constant (0...10 s) in increments of 10 ms.
Sampling	**100 ms/Channel**	Specifies the sampling period *(see page 37)* of the channel.
Measurement temperature unit	–	Indicates the temperature unit.

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 Type

This figure represents the analog input assistant for the **NTC Thermistor** configuration with **Formula** calculation mode selected (default choice):



You can define the following parameters:

Parameter	Value	Description
Scope	• **Customized** • **Celsius (0.1 °C)** • **Fahrenheit (0.1 °F)**	Choose the parameter scope for the channel.
Minimum range value	**-32768...32767**	Specifies the measurement limit (modifiable in **Customized** scope only).
Maximum range value		
Filter	0...1000	Specifies the filtering time (0...10 s) in units of 10 ms.
Sampling	**100 ms/Channel**	Specifies the sampling period of the channel.
Measurement temperature unit	–	Indicates the temperature unit.

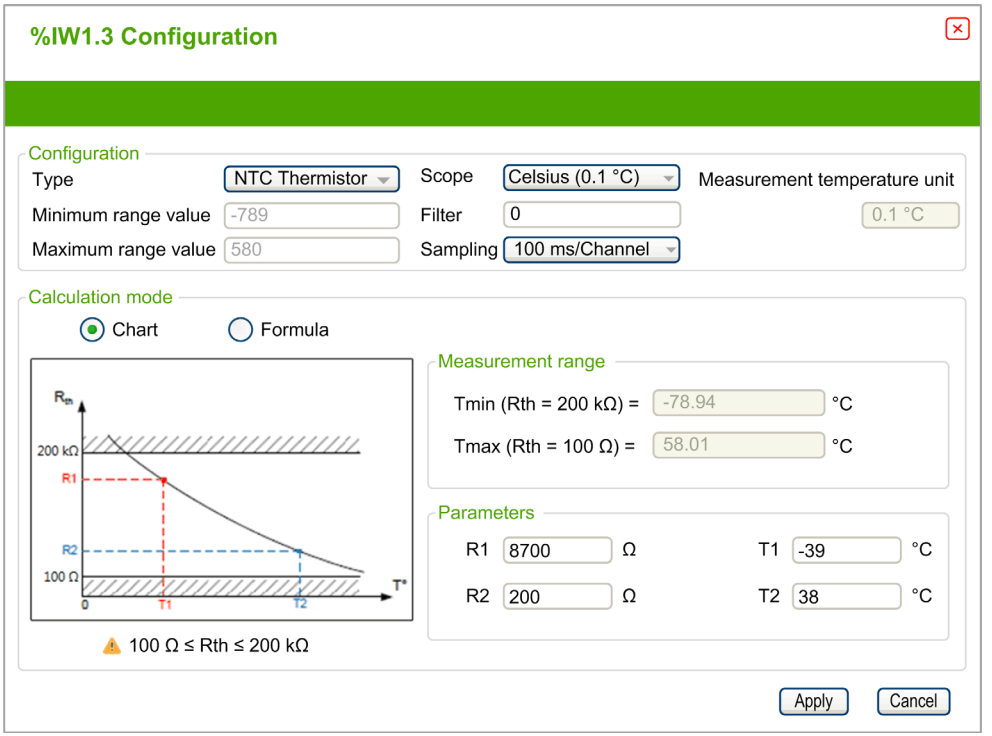
You can use a formula-based or chart-based calculation mode to estimate the measurement range.

NOTE: When changing the calculation mode from **Chart** to **Formula** and conversely, all parameters are reset to their default values.

The following table indicates the range and parameters available for the **Formula** calculation mode:

Parameter	Value	Description
Measurement range		
Tmin (Rth = 200 KΩ)	–	The estimated minimum temperature (calculated using the parameter values).
Tmax (Rth = 100 Ω)	–	The estimated maximum temperature (calculated using the parameter values).
Parameters		
Tref	1...1000 °C (33.8...1832 °F) -273...1000 °C (-459.4...710.33 °F) (1)	Specifies the temperature value.
Rref	1...65535 Ω	Specifies the resistance value in Ohms.
Beta	1...32767	Specifies the sensitivity of NTC probe.
(1) When the application is configured with a functional level of at least **Level 6.0**.		

This figure represents the analog input assistant for the **NTC Thermistor** configuration with **Chart** calculation mode selected:



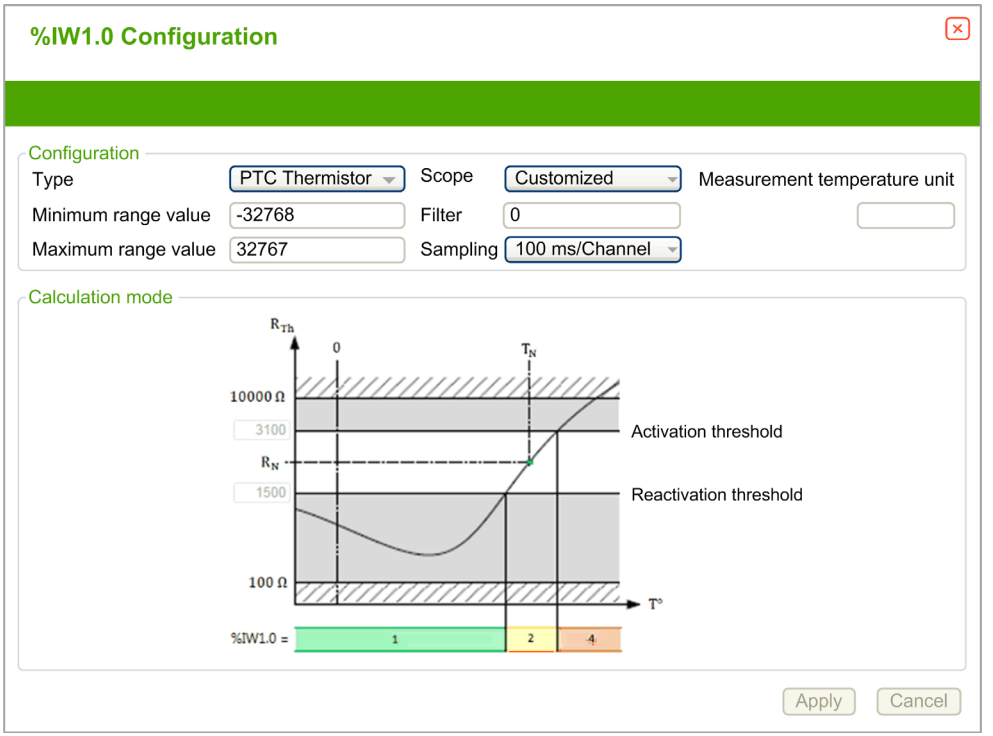
The following table indicates the range and parameters available for the **Chart** calculation mode:

Parameter	Value	Description
Measurement range		
Tmin (Rth = 200 KΩ)	–	The estimated minimum temperature (calculated using the parameter values).
Tmax (Rth = 100 Ω)	–	The estimated maximum temperature (calculated using the parameter values).
Parameters		
R1	100 Ω...200 KΩ	Specifies the resistance 1 in Ohms at temperature T1.
R2	100 Ω...200 KΩ	Specifies the resistance 2 in Ohms at temperature T2.
T1	-272.15...376.85 °C (-458.87...710.33 °F)	Specifies the temperature 1.
(1) Only when the application is configured with a functional level of at least **Level 6.0**		

Parameter	Value	Description
T2	0...376.85 °C (32...710.33 °F) -272.15...376.85°C (-457.87...710.33 °F) (1)	Specifies the temperature 2.
(1) Only when the application is configured with a functional level of at least **Level 6.0**		

PTC Thermistor Type

This figure represents the analog input assistant for the **PTC Thermistor** configuration:



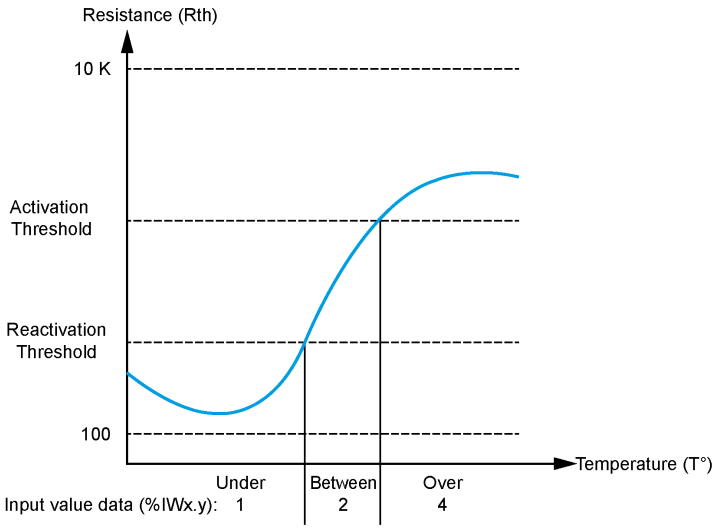
You can define the following parameters:

Parameter	Value	Description
Scope	• **Customized** • **Threshold**	Choose the parameter scope for the channel.
Minimum range value	**-32768...32767**	Specifies the measurement limits (modifiable in **Customized** scope only).
Maximum range value		
Filter	0...1000	Specifies the filtering time (0...10 s) in units of 10 ms.
Sampling	**100 ms/Channel**	Specifies the sampling period of the channel.
Measurement temperature unit	–	Indicates the temperature unit.
Activation Threshold	100...3100	Specifies the thresholds (modifiable in **Threshold** scope only).
Reactivation Threshold		

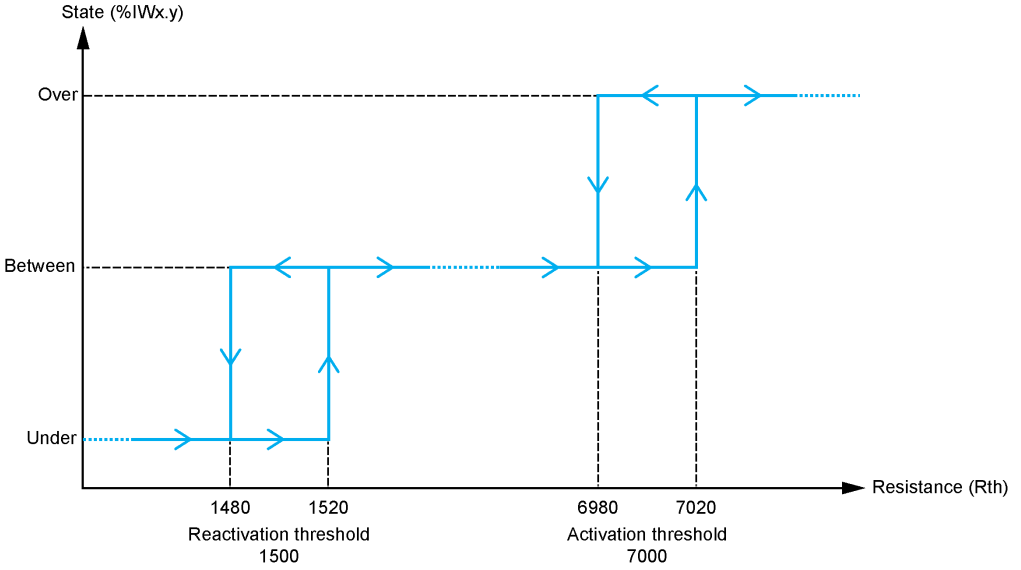
This table describes the read value according to the resistance:

Resistance Value	Read Value
Under the **Reactivation Threshold**	1
Between thresholds	2
Over the **Activation Threshold**	4

This figure represents the threshold operation:

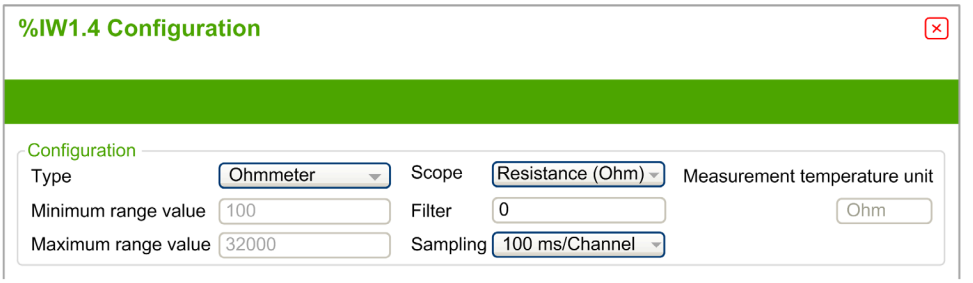


This figure represents an example hysteresis curve:



Ohmmeter Type

This figure represents the analog input assistant for the **Ohmmeter** configuration:



You can define the following parameters:

Parameter	Value	Description
Scope	**Resistance (Ohm)**	Choose the parameter scope for the channel.
Minimum range value	100	Specifies the low measurement limit.
Maximum range value	32000	Specifies the high measurement limit.
Filter	0...1000	Specifies the filtering time (0...10 s) in units of 10 ms.
Sampling	**100 ms/Channel**	Specifies the sampling period of the channel.

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 SoMachine Basic, 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
Used		True/False	False	Indicates whether the address is being used in a program.
Address		%QWx.0...%QWx.1	%QWx.y	Shows the address of the output channel, where *x* is the module number and *y* is the channel number.
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA**	**Not used**	Choose the mode of the channel.
Scope		**Normal**	**Normal**	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	
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	
Fallback value		**Min.**...**Max.**	If **Min.** value ≤ 0: 0 If **Min.** value > 0: **Min.** value	Specifies the fallback value of the output channel.

[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.

Programming tab: Displaying Configuration Details in the Programming Tab *(see page 36)* describes how to view and update programming-related properties of these modules.

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 SoMachine Basic, 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
Used		True/False	False	Indicates whether the address is being used in a program.
Address		%QWx.0...%QWx.3	%QWx.y	Shows the address of the output channel, where *x* is the module number and *y* is the channel number.
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA**	**Not used**	Choose the mode of the channel.
Scope		**Normal**	**Normal**	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	
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	
Fallback value		**Min.**...**Max.**	If **Min.** value ≤ 0: 0 If **Min.** value > 0: **Min.** value	Specifies the fallback value of the output channel.

[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.

Programming tab: Displaying Configuration Details in the Programming Tab *(see page 36)* describes how to view and update programming-related properties of these modules.

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 80)*.

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 SoMachine Basic, 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
Used		True/False	False	Indicates whether the address is being used in a program.
Address		`%IWx.0...%IWx.3`	`%IWx.y`	The address of the input channel, where *x* is the module number and *y* is the channel number.
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA**	**Not used**	Choose the mode of the channel.
Scope		**Normal**	**Normal**	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	
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	
Filter (x 10ms)		0...1000	0	Specifies the first order filter time constant (0...10 s) in increments of 10 ms *(see page 37)*.
Sampling		**1ms/Channel** **10ms/Channel**	**1ms/Channel**	Specifies the sampling period of the channel. If an input filter is active, the sampling period is set internally to 10 ms *(see page 37)*.

[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
Used		True/False	False	Indicates whether the address is being used in a program.
Address		%QWx.0...%QWx.1	%QWx.y	Shows the address of the output channel, where *x* is the module number and *y* is the channel number.
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA**	**Not used**	Choose the mode of the channel.
Scope		**Normal**	**Normal**	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	
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	
Fallback value		**Min.**...**Max.**	If **Min.** value ≤ 0: 0 If **Min.** value > 0: **Min.** value	Specifies the fallback value of the output channel.

[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.

Programming tab: Displaying Configuration Details in the Programming Tab *(see page 36)* describes how to view and update programming-related properties of these modules.

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 80)*.

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 SoMachine Basic, 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
Used	True/False	False	Indicates whether the address is being used in a program.
Address	`%IWx.0...%IWx.1`	`%IWx.y`	The address of the input channel, where *x* is the module number and *y* is the channel number.
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	**Normal** **Celsius (0.1°C)** **Fahrenheit (0.1°F)** **Fahrenheit (0.2°F)***	**Normal**	The range of values for a channel. * Only for B and C thermocouples.

Parameter		Value	Default Value	Description
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		
Filter (x 10ms)		0...1000	0	Specifies the first order filter time constant (0...10 s) in increments of 10 ms *(see page 37)*.
Sampling		**10ms/Channel** **100ms/Channel**	**100ms/Channel**	Specifies the sampling period of the channel. If an input filter is active, the sampling period is set internally to 10 ms *(see page 37)*.
Units		**–** **0.1 °C** **0.1 °F** **0.2 °F**	**–**	Indicates the temperature unit.

Type	Normal		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

Type	Normal		Celsius (0.1 °C)		Fahrenheit		
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Unit
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
Used		True/False	False	Indicates whether the address is being used in a program.
Address		%QWx.0	%QWx.0	Shows the address of the output channel, where *x* is the module number.
Type		**Not used** **0 - 10 V** **-10 - +10 V** **0 - 20 mA** **4 - 20 mA**	**Not used**	Choose the mode of the channel.
Scope		**Normal**	**Normal**	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	
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	
Fallback value		**Min.**...**Max.**	If **Min.** value ≤ 0: 0 If **Min.** value > 0: **Min.** value	Specifies the fallback value of the output channel.

[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.

Programming tab: Displaying Configuration Details in the Programming Tab *(see page 36)* describes how to view and update programming-related properties of these modules.

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 objects:

- %IWSx.y for input channel y of module x
- %QWSx.y for output channel y of module x

Input Channel Status Byte Description

This table describes the %IWS input channel status bytes

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 Channel Status Byte Description

This table describes the %QWS output channel status byte:

Byte value	Description
0	Normal
1	Undefined
2	Undefined
3	Configuration error detected
4	External power supply voltage limits exceeded

Byte value	Description
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 80)* 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

TM3XTYS4 Module Configuration

Introduction

This chapter describes how to configure the TM3 expert I/O modules *(see page 24)*.

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	%Ix.0	Input active if the selector of TeSys is in the ON position.
CH1_Run	%Ix.1	Input active if the power contacts of TeSys are closed.
CH1_Trip	%Ix.2	Input active if the selector of TeSys is in the TRIP position.
CH2_Ready	%Ix.3	Input active if the selector of TeSys is in the ON position.
CH2_Run	%Ix.4	Input active if the power contacts of TeSys are closed.
CH2_Trip	%Ix.5	Input active if the selector of TeSys is in the TRIP position.
CH3_Ready	%Ix.6	Active if the selector of TeSys is in the ON position.
CH3_Run	%Ix.7	Input active if the power contacts of TeSys are closed.
CH3_Trip	%Ix.8	Input active if the selector of TeSys is in the TRIP position.
CH4_Ready	%Ix.9	Input active if the selector of TeSys is in the ON position.
CH4_Run	%Ix.10	Input active if the power contacts of TeSys are closed.
CH4_Trip	%Ix.11	Input active if the selector of TeSys is in the TRIP position.
Error	%Ix.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	%Qx.0	This 24 V output drives the direct (forward) command of the motor.
CH1_Dir2Control	%Qx.1	This 24 V output drives the reverse (backward) command of the motor.
CH2_Dir1Control	%Qx.2	This 24 V output drives the direct (forward) command of the motor.
CH2_Dir2Control	%Qx.3	This 24 V output drives the reverse (backward) command of the motor.
CH3_Dir1Control	%Qx.4	This 24 V output drives the direct (forward) command of the motor.
CH3_Dir2Control	%Qx.5	This 24 V output drives the reverse (backward) command of the motor.
CH4_Dir1Control	%Qx.6	This 24 V output drives the direct (forward) command of the motor.
CH4_Dir2Control	%Qx.7	This 24 V output drives the reverse (backward) command of the motor.

Configuring the Modules

Configuration tab: Displaying Configuration Details in the Configuration Tab *(see page 34)* describes how to view the configuration of these modules.

Programming tab: Displaying Configuration Details in the Programming Tab *(see page 36)* describes how to view and update programming-related properties of these modules.

Chapter 5
TM3 Safety Modules Configuration

Introduction

This chapter describes how to configure the TM3 Safety Modules *(see page 25)*.

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

Configuration tab: Displaying Configuration Details in the Configuration Tab *(see page 34)* describes how to view the configuration of these modules.

Programming tab: Displaying Configuration Details in the Programming Tab *(see page 36)* describes how to view and update programming-related properties of these modules.

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 logic 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

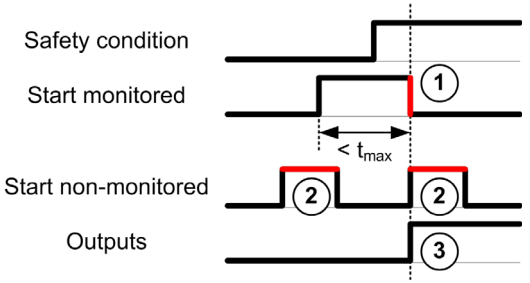
Two modes are available for the start functionality:

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.

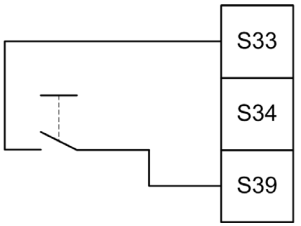
Both the safety conditions and the start conditions must be valid before allowing the activation of outputs.

⚠ 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

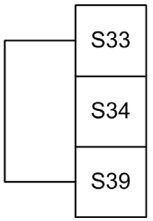
UNINTENDED EQUIPMENT OPERATION

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.

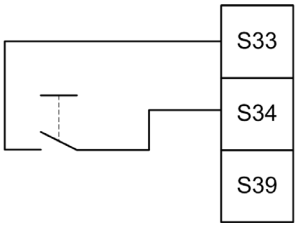
Monitored Start

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.

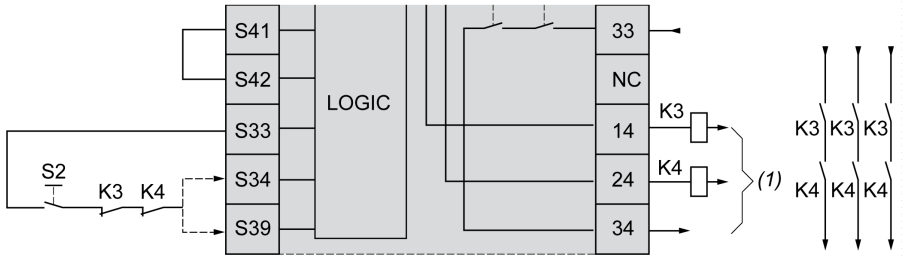
External device monitoring can be performed on:

- 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

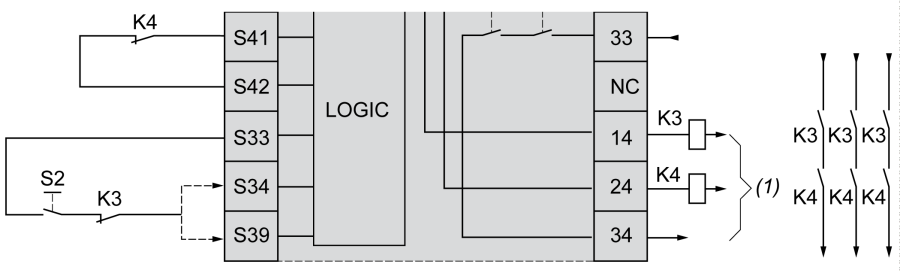
This figure shows an example of 1 channel EDM with the external feedback (**K3** and **K4**) added to the start condition, and **S41** directly connected to **S42**:



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

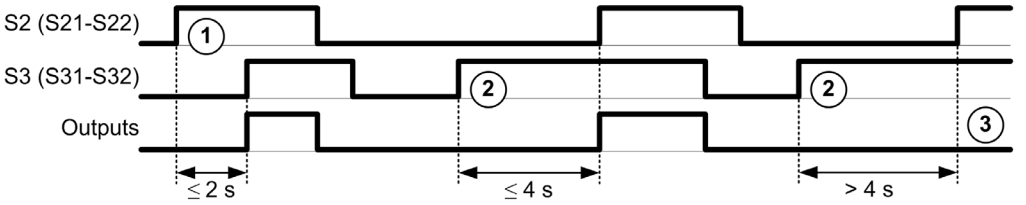
Synchronization Time Monitoring for TM3SAK6R / TM3SAK6RG

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 logic 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 89)* is valid.
- The safety conditions (safety-related inputs) indicate to activate the outputs.
- The internal enable *(see page 97)* 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 89)* 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 logic 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 logic controller through a communication on the TM3 Bus.

The enable condition is disabled by:

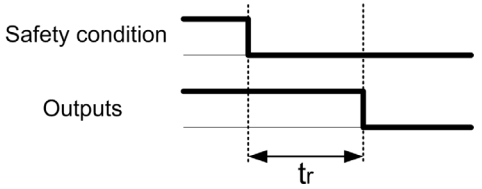
- The system logic controller through a communication on the TM3 Bus.
- The module internal safety-related microcontroller when:
  - The synchronization time *(see page 94)* is enabled and a time-out occurs.
  - The TM3 Bus time-out occurs.

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

TM3 Safety Modules I/O Mapping

Overview

The diagnostic is not safety-related and provides information on:
- Power supply voltage (in or out voltage tolerance)
- TM3 Bus communication status
- Relays state (energized or not)
- Inputs state (open or closed)

Diagnostic information is provided by using:
- TM3 Bus communication status
- Safety modules LED

TM3SAC5R / TM3SAC5RG Diagnostic Inputs

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

This table describes the diagnostic data transferred by the TM3SAC5R• module on the TM3 Bus:

Bit	Description
%Ix.0	Safety outputs active (on)
%Ix.1	Power supply available
%Ix.2	Power supply out of voltage tolerance
%Ix.3	Not applicable
%Ix.4	Not applicable
%Ix.5	Start active
%Ix.6	Relay **K1** activated
%Ix.7	Relay **K2** activated
%Ix.8	Reserved
%Ix.9	Reserved

Bit	Description
%Ix.10	Reserved
%Ix.11	Reserved
%Ix.12	Waiting for start condition *(see page 89)*
%Ix.13	Not applicable
%Ix.14	Reserved
%Ix.15	Reserved

TM3SAC5R / TM3SAC5RG Outputs

This table describes the outputs transferred on the TM3 Bus to the TM3 safety modules:

Bit	Description
%Qx.0	`TRUE` enables the activation of safety outputs.
%Qx.1	`TRUE` resets the module: current source switched off, outputs deactivated, and interlock reset.
%Qx.2	`TRUE` defines that the safety function remains active even when a TM3 Bus time-out occurs.

TM3SAF5R / TM3SAF5RG Diagnostic Inputs

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

This table describes the diagnostic data transferred by the TM3SAF5R• module on the TM3 Bus:

Bit	Description
%Ix.0	Safety outputs active (on)
%Ix.1	Power supply available
%Ix.2	Power supply out of voltage tolerance
%Ix.3	Channel 1 active
%Ix.4	Channel 2 active
%Ix.5	Start active
%Ix.6	Relay **K1** activated
%Ix.7	Relay **K2** activated
%Ix.8	Reserved

Bit	Description
%Ix.9	S11-S12 input active
%Ix.10	S21-S22 input active
%Ix.11	S31-S32 input active
%Ix.12	Waiting for start condition *(see page 89)*
%Ix.13	Not applicable
%Ix.14	Reserved
%Ix.15	Reserved

TM3SAF5R / TM3SAF5RG Outputs

This table describes the outputs transferred on the TM3 Bus to the TM3 safety modules:

Bit	Description
%Qx.0	`TRUE` enables the activation of safety outputs.
%Qx.1	`TRUE` resets the module: current source switched off, outputs deactivated, and interlock reset.
%Qx.2	`TRUE` defines that the safety function remains active even when a TM3 Bus time-out occurs.

TM3SAFL5R / TM3SAFL5RG Diagnostic Inputs

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

This table describes the diagnostic data transferred by the TM3SAFL5R• module on the TM3 Bus:

Bit	Description
%Ix.0	Safety outputs active (on)
%Ix.1	Power supply available
%Ix.2	Power supply out of voltage tolerance
%Ix.3	Channel 1 active
%Ix.4	Channel 2 active
%Ix.5	Start active
%Ix.6	Relay **K1** activated
%Ix.7	Relay **K2** activated

Bit	Description
%Ix.8	S11-S12 input active
%Ix.9	Reserved
%Ix.10	S21-S22 input active
%Ix.11	S31-S32 input active
%Ix.12	Waiting for start condition *(see page 89)*
%Ix.13	Not applicable
%Ix.14	Reserved
%Ix.15	Reserved

TM3SAFL5R / TM3SAFL5RG Outputs

This table describes the outputs transferred on the TM3 Bus to the TM3 safety modules:

Bit	Description
%Qx.0	`TRUE` enables the activation of safety outputs.
%Qx.1	`TRUE` resets the module: current source switched off, outputs deactivated, and interlock reset.
%Qx.2	`TRUE` defines that the safety function remains active even when a TM3 Bus time-out occurs.

TM3SAK6R / TM3SAK6RG Diagnostic Inputs

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

This table describes the diagnostic data transferred by each TM3SAK6R• module on the TM3 Bus:

Bit	Description
%Ix.0	Safety outputs active (on)
%Ix.1	Power supply available
%Ix.2	Power supply out of voltage tolerance
%Ix.3	Channel 1 active
%Ix.4	Channel 2 active
%Ix.5	Start active
%Ix.6	Relay **K1** activated

Bit	Description
%Ix.7	Relay **K2** activated
%Ix.8	S11-S12 input active
%Ix.9	S21-S22 input active
%Ix.10	S31-S32 input active
%Ix.11	S41-S42 input active
%Ix.12	Waiting for start condition *(see page 89)*
%Ix.13	Synchronization time expired *(see page 94)*
%Ix.14	Reserved
%Ix.15	Reserved

TM3SAK6R / TM3SAK6RG Outputs

This table describes the outputs transferred on the TM3 Bus to the TM3 safety modules:

Bit	Description
%Qx.0	`TRUE` enables the activation of safety outputs.
%Qx.1	`TRUE` resets the module: current source switched off, outputs deactivated, and interlock reset.
%Qx.2	`TRUE` defines that the safety function remains active even when a TM3 Bus time-out occurs.
%Qx.3	`TRUE` enables the synchronization time monitoring of **S21-S22** and **S31-S32** inputs.

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 26)*.

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 logic controller through the TM3 bus.The transmitter must be the last physical module directly connected to the logic 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 SoMachine Basic.

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 will no longer function while the embedded I/O that may be present in your controller will continue 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 logic 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.
- ERR LED is flashing, and bit 14 of TM3 status word (`%SW118`) is set to 0.
- Diagnostic information for the remote modules is available in the system word `%SW120`.
- In the SoMachine Basic configuration screen, all TM3 modules attached to the receiver module are red.

Reconnecting the cable does not restore normal operation. Only a logic 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.
- ERR LED is flashing, and bit 14 of TM3 status word (`%SW118`) is set to 0.
- Diagnostic information for the remote modules is available in the system word `%SW120`.
- In the SoMachine Basic configuration screen, all TM3 modules attached to the receiver module are red.

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

Receiver Module Disconnected During Start-up

If the receiver module was not connected at logic 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 logic controller are supplied by the same power supply, the whole configuration starts operating.

If only the receiver module is powered (logic controller not supplied), the TM3 modules after the receiver module are in **Reset** state (all outputs are forced to 0).

Chapter 7
Firmware Management

Firmware Management

Downloading Firmware to TM3 Analog Expansion Modules

The firmware can be updated in TM3 analog expansion modules that have a firmware version greater than or equal to 26. If necessary, the version of firmware can be confirmed using SoMachine Basic.

Firmware updates are performed using a script file on an SD card. When the SD card is inserted in the SD card slot of the M221 Logic Controller, the logic controller updates the firmware of the TM3 analog expansion modules on the I/O bus, including those that are:

- Connected remotely, using a TM3 Transmitter/Receiver module
- In configurations comprising a mix of TM3 and TM2 expansion modules.

This table describes how to download a firmware to one or more TM3 analog expansion modules using an SD card:

Step	Action
1	Apply power to the logic controller.

2	Ensure that the logic controller is in the `EMPTY` state by deleting the application in the logic controller. You can do this with SoMachine Basic by using one of the following script commands:
	`Delete "usr/*"`
	`Delete "usr/app"`
	Refer to File Management Operations *(see Modicon M221, Logic Controller, Programming Guide)* for details.

3	Insert an empty SD card into the PC.
4	Create a file called `script.cmd` in the SD card root directory.

5	Edit the file and insert the following command:
	`Download "/TM3/<filename>/*"`
	NOTE: `<filename>` is the file name of the firmware you wish to update. The asterisk signifies that all analog modules will be updated.
	To download the firmware to one specific TM3 analog expansion module, replace the asterisk with the position of the expansion module in the configuration. For example, to specify the module at position 4:
	`Download "/TM3/<filename>/4"`

Step	Action
6	Create the folder path `/TM3/` in the SD card root directory and copy the firmware file to the `TM3` folder. **NOTE:** A firmware file (the firmware file valid at the time of the installation of SoMachine Basic) and an example script are available in the folder `Firmwares & PostConfiguration\TM3\` of the SoMachine Basic installation folder.
7	Remove the SD card from the PC and insert it into the SD card slot of the M221 Logic Controller. **Result:** The logic controller begins transferring the firmware file from the SD card to the updatable TM3 analog expansion modules or to the one module specified in step 5. During this operation, the **SD** system LED on the M221 Logic Controller is illuminated. **NOTE:** The firmware update takes 10 to 15 seconds for each expansion module being updated. Do not remove power from the M221 Logic Controller, or remove the SD card, while the operation is in progress. Otherwise, the firmware update may be unsuccessful and the modules may no longer function correctly. In this case, run the Recovery Procedure *(see page 111)* to reinitialize the firmware on the modules.
8	Wait until the end of the operation (until the **SD** LED is off or flashing). If an error is detected, the **SD** and **ERR** LEDs flash and the detected error is logged in `Script.log` file.

If you remove power to the device, or there is a power outage or communication interruption during the transfer of the application, your device may become inoperative. If a communication interruption or a power outage occurs, reattempt the transfer. If there is a power outage or communication interruption during a firmware update, or if an invalid firmware is used, your device will become inoperative. In this case, use a valid firmware and reattempt the firmware update.

NOTICE

INOPERABLE EQUIPMENT

- Do not interrupt the transfer of the application program or a firmware change once the transfer has begun.
- Re-initiate the transfer if the transfer is interrupted for any reason.
- Do not attempt to place the device (logic controller, motion controller, HMI controller or drive) into service until the file transfer has completed successfully.

Failure to follow these instructions can result in equipment damage.

Example

Assume the configuration shown in the following table:

Slot Number	Reference	Description
0	TM3AI2H	TM3 Analog module with firmware version 26
1	TM3AI8G	TM3 Analog module with firmware version 24
2	TM3DI16	TM3 Digital expansion module
...	TM3XTRA1/TM3XREC1	TM3 Transmitter/Receiver modules
3	TM3TI4G	TM3 Analog module with firmware version 26

The modules must have a minimum version of 26 in order to receive a firmware update. In this example, a firmware update to version 27 can only be performed on the modules in slot numbers 0 and 3.

Recovery Procedure

This table describes how to reinitialize the firmware on TM3 analog expansion modules:

Step	Action

1	Ensure that the logic controller is in the `EMPTY` state by deleting the application in the logic controller. You can do this with SoMachine Basic by using one of the following script commands:
	`Delete "usr/*"`
	`Delete "usr/app"`
	For details, refer to File Management Operations *(see Modicon M221, Logic Controller, Programming Guide)*.

2	Disassemble *(see Modicon TM3, Analog I/O Modules, Hardware Guide)* from the logic controller all TM3 expansion modules that are functioning normally, and all TM3 analog modules except for the first module to recover.
3	Apply power to the logic controller.
4	Insert the SD card containing the firmware update into the logic controller. **Result:** The logic controller begins transferring the firmware file from the SD card to the module.
5	Wait until the **SD** LED is off or flashing). If an error is detected, the **SD** and **ERR** LEDs flash and the detected error is logged in `Script.log` file.
6	Disassemble *(see Modicon TM3, Analog I/O Modules, Hardware Guide)* the recovered TM3 expansion module.
7	Assemble *(see Modicon TM3, Analog I/O Modules, Hardware Guide)* the next expansion module to recover.
8	Repeat steps 3 to 7 for the other expansion modules to recover.

Glossary

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.

H

HE10

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

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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