

Modicon TM2 (SoMachine Basic)

Expansion Modules Configuration Programming Guide

06/2016

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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 TM2 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 V1.4 SP1.

Related Documents

Title of Documentation	Reference Number
SoMachine Basic - Operating Guide	<i>EIO0000001354 (ENG)</i> <i>EIO0000001355 (FRA)</i> <i>EIO0000001356 (GER)</i> <i>EIO0000001357 (SPA)</i> <i>EIO0000001358 (ITA)</i> <i>EIO0000001359 (CHS)</i> <i>EIO0000001366 (POR)</i> <i>EIO0000001367 (TUR)</i>
TM2 Digital I/O Modules - Hardware Guide	<i>EIO0000000028 (ENG)</i> <i>EIO0000000029 (FRE)</i> <i>EIO0000000030 (GER)</i> <i>EIO0000000031 (SPA)</i> <i>EIO0000000032 (ITA)</i> <i>EIO0000000033 (CHS)</i>
TM2 Analog I/O Modules - Hardware Guide	<i>EIO0000000034 (ENG)</i> <i>EIO0000000035 (FRE)</i> <i>EIO0000000036 (GER)</i> <i>EIO0000000037 (SPA)</i> <i>EIO0000000038 (ITA)</i> <i>EIO0000000039 (CHS)</i>

Title of Documentation	Reference Number
Modicon M221 Logic Controller - Programming Guide	<i>EIO0000001360 (ENG)</i> <i>EIO0000001361 (FRE)</i> <i>EIO0000001362 (GER)</i> <i>EIO0000001363 (SPA)</i> <i>EIO0000001364 (ITA)</i> <i>EIO0000001365 (CHS)</i> <i>EIO0000001369 (TUR)</i> <i>EIO0000001368 (POR)</i>

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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
2004/108/EC	Electromagnetic Compatibility Directive
2006/95/EC	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 TM2 digital and analog expansion I/O modules for SoMachine Basic.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
I/O Configuration General Description	12
TM2 Expansion Modules	15
Using I/O Modules in a Configuration	19
Optional I/O Expansion Modules	22
Configuring Digital I/Os	26
I/O Objects	29

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 Error

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 22](#))), 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 %S118 and %SW120 system words, and the red LED indicator labeled **ERR** flashes. While the I/O expansion bus error is active, 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 the TM3 I/O expansion modules, the values 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 zero.
- For the TM2 I/O expansion modules that may be part of the configuration, the values 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 I/O expansion modules. If the communication is successful, the I/O expansion modules will 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.

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” 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 22](#)).

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 22](#)).

TM2 Expansion Modules

Introduction

The range of TM2 expansion modules includes:

- Digital expansion modules
- Analog expansion modules

Both digital and analog expansion modules have:

- Input modules
- Output modules
- Mixed input/output modules

TM2 Digital Input Modules

The table shows the TM2 digital input expansion modules with corresponding channel type, voltage/current, and terminal type. These modules require no configuration in SoMachine Basic. For further information on configuration, refer to the Configuring I/O Modules ([see page 26](#)) section.

Reference	Channels	Channel Type	Voltage/Current	Terminal Type
TM2DAI8DT	8	Regular inputs	120 Vac 7.5 mA	Removable screw terminal block
TM2DDI8DT	8	Regular inputs	24 Vdc 7 mA	Removable screw terminal block
TM2DDI16DT	16	Regular inputs	24 Vdc 7 mA	Removable screw terminal block
TM2DDI16DK	16	Regular inputs	24 Vdc 5 mA	HE10 (MIL 20) connector
TM2DDI32DK	32	Regular inputs	24 Vdc 5 mA	HE10 (MIL 20) connector

TM2 Digital Output Modules

The table shows the TM2 digital output expansion modules with corresponding channel type, voltage/current, and terminal type. These modules require no configuration in SoMachine Basic. For further information on configuration, refer to the Configuring I/O Modules ([see page 26](#)) section.

Reference	Channels	Channel Type	Voltage/Current	Terminal Type
TM2DRA8RT	8	Relay outputs	30 Vdc/230 Vac 2 A max.	Removable screw terminal block
TM2DRA16RT	16	Relay outputs	30 Vdc/230 Vac 2 A max.	Removable screw terminal block

Reference	Channels	Channel Type	Voltage/Current	Terminal Type
TM2DDO8UT	8	Regular transistor outputs (sink)	24 Vdc 0.3 A max. per output	Removable screw terminal block
TM2DDO8TT	8	Regular transistor outputs (source)	24 Vdc 0.3 A max. per output	Removable screw terminal block
TM2DDO16UK	16	Regular transistor outputs (sink)	24 Vdc 0.1 A max. per output	HE10 (MIL 20) connector
TM2DDO16TK	16	Regular transistor outputs (source)	24 Vdc 0.1 A max. per output	HE10 (MIL 20) connector
TM2DDO32UK	32	Regular transistor outputs (sink)	24 Vdc 0.1 A max. per output	HE10 (MIL 20) connector
TM2DDO32TK	32	Regular transistor outputs (source)	24 Vdc 0.1 A max. per output	HE10 (MIL 20) connector

TM2 Digital Mixed Input/Output Modules

The table shows the TM2 digital mixed input/output expansion modules with corresponding channel type, voltage/current, and terminal type. These modules require no configuration in SoMachine Basic. For further information on configuration, refer to the Configuring I/O Modules (*see page 26*) section.

Reference	Channels	Channel Type	Voltage/Current	Terminal Type
TM2DMM8DRT	4 4	Regular inputs Relay outputs	24 Vdc/7 mA 30 Vdc/230 Vac 2 A max.	Removable screw terminal block
TM2DMM24DRF	16 8	Regular inputs Relay outputs	24 Vdc/7 mA 30 Vdc/230 Vac 2 A max.	Non-removable wire clamp terminal

TM2 Analog Input Modules

The table shows the TM2 analog input expansion modules with corresponding channel type, voltage/current, and sensor type:

Reference	Channels	Channel Type	Voltage/Current	Sensor Type
TM2AMI2HT (see page 39)	2	High-level inputs	0...10 Vdc 4...20 mA	–
TM2AMI2LT (see page 40)	2	Low-level inputs	–	Thermocouple type J,K,T
TM2AMI4LT (see page 42)	4	Inputs	0...10 Vdc 0...20 mA	PT100/1000 Ni100/1000
TM2AMI8HT (see page 44)	8	Inputs	0...10 Vdc 0...20 mA	–
TM2ARI8HT (see page 52)	8	Inputs	–	NTC/PTC
TM2ARI8LRJ (see page 59)	8	Inputs	–	PT100/1000
TM2ARI8LT (see page 61)	8	Inputs	–	PT100/1000

TM2 Analog Output Modules

The table shows the TM2 analog output expansion modules with corresponding channel type and voltage/current:

Reference	Channels	Channel Type	Voltage/Current
TM2AMO1HT (see page 50)	1	Outputs	0...10 Vdc 4...20 mA
TM2AVO2HT (see page 63)	2	Outputs	± 10 Vdc

TM2 Analog Mixed Input/Output Modules

The table shows the TM2 analog mixed input/output expansion modules with corresponding channel type, voltage/current, and sensor type:

Reference	Channels	Channel Type	Voltage/Current	Sensor Type
TM2AMM3HT (see page 46)	2	Inputs	0...10 Vdc 4...20 mA	–
	1	Outputs	0...10 Vdc 4...20 mA	

Reference	Channels	Channel Type	Voltage/Current	Sensor Type
TM2AMM6HT (<i>see page 48</i>)	4	Inputs	0...10 Vdc 4...20 mA	–
	2	Outputs	0...10 Vdc 4...20 mA	
TM2ALM3LT (<i>see page 36</i>)	2	Low-level inputs	–	Thermocouple type J,K,T, PT100
	1	Outputs	0...10 Vdc 4...20 mA	–

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 ● TM2 Digital I/O Modules ● TM2 Analog I/O Modules ● TM3 Expert 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

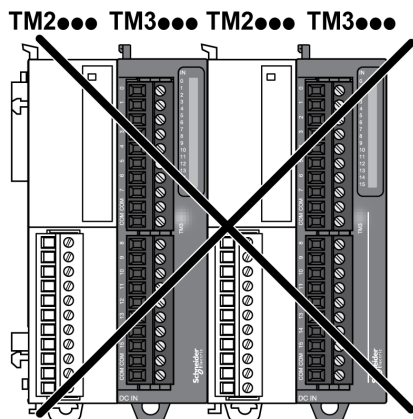
You can remove an expansion module by pressing the **Delete** key or by right-clicking the module and clicking **Remove** on the contextual menu that appears.

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

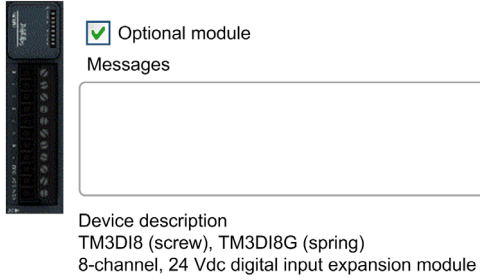
UNINTENDED EQUIPMENT OPERATION

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.

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

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

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

Modules sharing the same internal ID code
TM3DI16K, TM3DI16/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
TM3TI8T/G

Configuring Digital I/Os

Overview

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

- **Configuration tab:**
 - Digital inputs (*see page 26*)
 - Digital outputs (*see page 27*)
- Programming tab (*see page 28*).

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: Digital inputs <table><tr><th></th><th>Used</th><th>Address</th><th>Symbol</th><th>Comment</th></tr><tr><td></td><td>☐</td><td>%I4.0</td><td></td><td></td></tr><tr><td></td><td>☐</td><td>%I4.1</td><td></td><td></td></tr><tr><td></td><td>☐</td><td>%I4.2</td><td></td><td></td></tr></table>		Used	Address	Symbol	Comment		☐	%I4.0				☐	%I4.1				☐	%I4.2		
	Used	Address	Symbol	Comment																	
	☐	%I4.0																			
	☐	%I4.1																			
	☐	%I4.2																			
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 (<i>see page 29</i>). ● 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 <table><tr><th></th><th>Used</th><th>Address</th><th>Symbol</th><th>Fallback value</th><th>Comment</th></tr><tr><td>☐</td><td></td><td>%Q3.0</td><td></td><td>0</td><td></td></tr><tr><td>☐</td><td></td><td>%Q3.1</td><td></td><td>1</td><td></td></tr><tr><td>☐</td><td></td><td>%Q3.2</td><td></td><td>0</td><td></td></tr></table>		Used	Address	Symbol	Fallback value	Comment	☐		%Q3.0		0		☐		%Q3.1		1		☐		%Q3.2		0	
	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 (<i>see page 29</i>). ● 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. ● 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: Digital output properties <table><tr><th></th><th>Used</th><th>Address</th><th>Symbol</th><th>Comment</th></tr><tr><td></td><td>☐</td><td>%Q0.6</td><td></td><td></td></tr><tr><td></td><td>☐</td><td>%Q0.7</td><td></td><td></td></tr><tr><td></td><td>☐</td><td>%Q1.0</td><td></td><td>CH1 Control direction 1</td></tr><tr><td></td><td>☐</td><td>%Q1.1</td><td></td><td>CH1 Control direction 2</td></tr><tr><td></td><td>☐</td><td>%Q1.2</td><td></td><td></td></tr></table>		Used	Address	Symbol	Comment		☐	%Q0.6				☐	%Q0.7				☐	%Q1.0		CH1 Control direction 1		☐	%Q1.1		CH1 Control direction 2		☐	%Q1.2		
	Used	Address	Symbol	Comment																											
	☐	%Q0.6																													
	☐	%Q0.7																													
	☐	%Q1.0		CH1 Control direction 1																											
	☐	%Q1.1		CH1 Control direction 2																											
	☐	%Q1.2																													
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 (<i>see page 29</i>). ● 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.																														

I/O Objects

Introduction

I/O objects include both bits and words. Each physical input and output is mapped to these objects in internal memory. I/O bit objects can be used as operands and tested by Boolean instructions. I/O word objects can be used in most non-Boolean instructions such as functions and instructions containing arithmetic operators.

Examples of I/O objects:

- Digital inputs
- Digital outputs
- Analog inputs
- Analog outputs
- Communication inputs and outputs

The range of valid objects is from 0 to the maximum configured and supported for your controller (see the Hardware Guide and Programming Guide for your logic controller).

Syntax

This figure shows the input/output address format:

%	I, Q, IW, QW, IWS, or QWS	y	.	z
Symbol	Object type	Module number	point	Channel number

This table describes the components of the addressing format:

Component	Item	Value	Description
Symbol	%	–	The percent symbol always precedes an internal address.
Object type	I	–	Digital input (bit object)
	Q	–	Digital output (bit object)
	IW	–	Analog input value (word object)
	QW	–	Analog output value (word object)
	IWS	–	Analog input channel status (word object)
	QWS	–	Analog output channel status (word object)
(1) <i>m</i> is the number of local modules configured (maximum 7). (2) <i>n</i> is the number of remote modules configured (maximum <i>n</i>+7). The maximum position number is 14. (3) <i>p</i> is the number of the cartridge in the controller. <i>q</i> is the channel number on the cartridge.			

Component	Item	Value	Description
Module number	y	0	Embedded I/O channel on the logic controller, or on a cartridge inserted in the logic controller.
		1...m ⁽¹⁾	I/O channel on an expansion module directly connected to the controller.
		m+1...n ⁽²⁾	I/O channel on an expansion module connected using the TM3 Transmitter/Receiver modules.
Channel number	z	0...31	I/O channel number on the logic controller or expansion module. The number of available channels depends on the logic controller model or expansion module type.
		p0q ⁽³⁾	I/O channel on a cartridge inserted in the logic controller. The number of available channels depends on the cartridge type.

(1) m is the number of local modules configured (maximum 7).

(2) n is the number of remote modules configured (maximum n+7). The maximum position number is 14.

(3) p is the number of the cartridge in the controller. q is the channel number on the cartridge.

Description

This table lists and describes all I/O objects that are used as operands in instructions:

Type	Address or Value	Write Access ⁽¹⁾	Description
Input bits	%I _y .z ⁽²⁾	No ⁽³⁾	These bits are the logical images of the electrical states of the physical digital I/O. They are stored in data memory and updated between each scan of the program logic.
Output bits	%Q _y .z ⁽²⁾	Yes	
Input word	%IW _y .z ⁽²⁾	No	These word objects contain the analog value of the corresponding channel.
Output word	%QW _y .z ⁽²⁾	Yes	
Input word status	%IWS _y .z ⁽²⁾	No	These word objects contain the status of the corresponding analog channel.
Output word status	%QWS _y .z ⁽²⁾	No	

(1) Written by the program or by using an animation table.

(2) y is the module number and z is the channel number. Refer to addressing syntax of I/Os ([see page 29](#)) for descriptions of y and z.

(3) Although you cannot write to input bits, they can be forced.

Examples

This table shows some examples of I/O addressing:

I/O Object	Description
%I0.5	Digital input channel number 5 on the controller (embedded I/O are module number 0).
%Q3.4	Digital output channel number 4 on the expansion module at address 3 (expansion module I/O).
%IW0.1	Analog input 1 on the controller (embedded I/O).
%QW2.1	Analog output 1 on the expansion module at address 2 (expansion module I/O).
%IWS0.101	Analog input channel status of input channel 1 on the first cartridge in the logic controller).
%QWS1.1	Analog output channel status of output channel 1 on the expansion module at address 1 (expansion module I/O).

Chapter 2

TM2 Digital I/O Modules

TM2 Digital I/O Modules

Introduction

The range of TM2 digital I/O expansion modules includes:

- TM2 Digital Input Modules (*see page 15*)
- TM2 Digital Output Modules (*see page 15*)
- TM2 Digital Mixed Input/Output Modules (*see page 16*)

Configuring the Modules

Configuration tab: Displaying Configuration Details in the Configuration Tab (*see page 26*) describes how to view the configuration of these modules.

Programming tab: Displaying Configuration Details in the Programming Tab (*see page 28*) describes how to view and update programming-related properties of these modules.

Chapter 3

TM2 Analog I/O Modules

Introduction

This chapter describes how to view the configuration of analog I/O modules.

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
TM2ALM3LT	36
TM2AMI2HT	39
TM2AMI2LT	40
TM2AMI4LT	42
TM2AMI8HT	44
TM2AMM3HT	46
TM2AMM6HT	48
TM2AMO1HT	50
TM2ARI8HT	52
TM2ARI8LRJ	59
TM2ARI8LT	61
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TM2ALM3LT

Introduction

The TM2ALM3LT expansion module features 2 analog input and 1 analog output channels, K, J, and T thermocouple and PT100 input types, 0...10 Vdc and 4...20 mA output types, 12-bit resolution, and removable screw terminal block.

For further hardware information, refer to TM2ALM3LT (see *Modicon TM2, Analog I/O Modules, Hardware Guide*).

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.

<i>NOTICE</i>			
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.y	%IWx...%IWy	The address of the input channel, where <i>x</i> is the module number and <i>y</i> is the channel number
Type	Not used Thermocouple K Thermocouple J Thermocouple T PT100	Not used	The channel mode.
Scope	Normal Customized Celsius (0.1°C) Fahrenheit (0.1°F)	Normal	The range of values for a channel.

Parameter		Value	Default Value	Description
Min.	Normal	0	0	Specifies the lower measurement limit.
	Customized	-32768...32767	-32768	
	Celsius (0.1°C)	See the table below	See the table below	
	Fahrenheit (0.1°F)			
Max.	Normal	4095	4095	Specifies the upper measurement limit.
	Customized	-32768...32767	32767	
	Celsius (0.1°C)	See the table below	See the table below	
	Fahrenheit (0.1°F)			

Type	Normal		Celsius (0.1°C)		Fahrenheit (0.1°F)	
	Min.	Max.	Min.	Max.	Min.	Max.
Thermocouple K	0	4095	0	13000	320	23720
Thermocouple J	0	4095	0	12000	320	21920
Thermocouple T	0	4095	0	4000	320	7520
PT100	0	4095	-1000	5000	-1480	9320

For each output, you can define:

Parameter		Value	Default Value	Description
Type		Not used 0...10 V 4...20 mA	Not used	This identifies the mode of a channel.
Scope		Normal Customized	Normal	This identifies the range of values for a channel.
Min.	Normal	0	0	Specifies the lower measurement limit.
	Customized	-32768...32767	-32768	
Max.	Normal	4095	4095	Specifies the upper measurement limit.
	Customized	-32768...32767	32767	
Fallback value		Minimum...Maximum	0	The value to apply to this output if the logic controller enters fallback mode. If fallback mode is not configured, the output maintains its current value. Refer to Fallback Behaviour (<i>see SoMachine Basic, Operating Guide</i>) for details.

Programming tab: Displaying Configuration Details in the Programming Tab (*see page 28*) describes how to view and update programming-related properties of these modules.

TM2AMI2HT

Introduction

The TM2AMI2HT expansion module features 2 analog input channels, 0...10 V and 4...20 mA input types, 12-bit resolution, and removable screw terminal block.

For further hardware information, refer to TM2AMI2HT (*see Modicon TM2, Analog I/O Modules, Hardware Guide*).

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.y	%IWx...%IWy	The address of the input channel, where <i>x</i> is the module number and <i>y</i> is the channel number
Type		Not used 0...10 V 4...20 mA	Not used	Choose the mode of the channel.
Scope		Normal Customized	Normal	The range of values for a channel.
Min.	Normal	0	0	Specifies the lower measurement limit.
	Customized	-32768...32767	-32768	
Max.	Normal	4095	4095	Specifies the upper measurement limit.
	Customized	-32768...32767	32767	

Programming tab: Displaying Configuration Details in the Programming Tab (*see page 28*) describes how to view and update programming-related properties of these modules.

TM2AMI2LT

Introduction

The TM2AMI2LT expansion module features 2 analog input channels, K, J, and T thermocouple input types, 12-bit resolution, and removable screw terminal block.

For further hardware information, refer to TM2AMI2LT (see *Modicon TM2, Analog I/O Modules, Hardware Guide*).

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.y	%IWx...%IWy	Shows the address of the input channel, where <i>x</i> is the module number and <i>y</i> is the channel number
Type		Not used Thermocouple K Thermocouple J Thermocouple T	Not used	This identifies the mode of a channel.
Scope		Normal Customized Celsius (0.1°C) Fahrenheit (0.1°F)	Normal	This identifies the range of values for a channel.
Min.	Normal	0	0	Specifies the lower measurement limit.
	Customized	-32768...32767	-32768	
	Celsius (0.1°C)	See the table below	See the table below	
	Fahrenheit (0.1°F)			

Parameter		Value	Default Value	Description
Max.	Normal	4095	4095	Specifies the upper measurement limit.
	Customized	-32768...32767	32767	
	Celsius (0.1°C)	See the table below	See the table below	
	Fahrenheit (0.1°F)			

Type	Normal		Celsius (0.1°C)		Fahrenheit (0.1°F)	
	Min.	Max.	Min.	Max.	Min.	Max.
Thermocouple K	0	4095	-2700	13700	-4540	24980
Thermocouple J	0	4095	-2000	7600	-3280	14000
Thermocouple T	0	4095	-2700	4000	-4520	7520

Programming tab: Displaying Configuration Details in the Programming Tab ([see page 28](#)) describes how to view and update programming-related properties of these modules.

TM2AMI4LT

Introduction

The TM2AMI4LT expansion module features 4 analog input channels, 0...10 Vdc, 0...20 mA, PT100, PT1000, NI100, and NI1000 input types, 12-bit resolution, and removable screw terminal block.

NOTE: All inputs used must be of the same type (voltage, current, or temperature).

For further hardware information, refer to TM2AMI4LT (*see Modicon TM2, Analog I/O Modules, Hardware Guide*).

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

Input type. Select the operating mode for all input channels:

- **Voltage** (the default)
- **Current**
- **Temperature**

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.y	%IWx...%IWy	Shows the address of the input channel, where <i>x</i> is the module number and <i>y</i> is the channel number

Parameter		Value	Default Value	Description
Type		Not used 0...10 V 0...20 mA PT100 PT1000 NI100 NI1000	Not used	This identifies the type of a channel. If Voltage input type is enabled, then the type Not used and 0...10 V are available. If Current input type is enabled, then the type Not used and 0...20 mA are available. If Temperature input type is enabled, then the type Not used , PT100 , PT1000 , NI100 , and NI1000 are available.
Scope		Not used Normal Customized Resistance (Ohm) Celsius (0.1°C) Fahrenheit (0.1°F)	Not used	This identifies the range of values for a channel.
Min.	Normal	0	0	Specifies the lower measurement limit.
	Customized	-32768...32767	-32768	
	Resistance (Ohm)	See the table below	See the table below	
	Celsius (0.1°C)			
	Fahrenheit (0.1°F)			
Max.	Normal	4095	4095	Specifies the upper measurement limit.
	Customized	-32768...32767	32767	
	Resistance (Ohm)	See the table below	See the table below	
	Celsius (0.1°C)			
	Fahrenheit (0.1°F)			

Type	Normal		Resistance (Ohm)		Celsius (0.1°C)		Fahrenheit (0.1°F)	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
PT100	0	4095	18	314	-2000	6000	-3280	11120
PT1000	0	4095	184	3138	-2000	6000	-3280	11120
NI100	0	4095	74	199	-500	1500	-580	3020
NI1000	0	4095	742	1987	-500	1500	-580	3020

Programming tab: Displaying Configuration Details in the Programming Tab (*see page 28*) describes how to view and update programming-related properties of these modules.

TM2AMI8HT

Introduction

The TM2AMI8HT expansion module features 8 analog input channels, 0...10 Vdc and 0...20 mA signal types, 10-bit resolution, and removable screw terminal block.

NOTE: All inputs used must be the same type (voltage or current).

For further hardware information, refer to TM2AMI8HT (*see Modicon TM2, Analog I/O Modules, Hardware Guide*).

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

Input type. Select the operating mode for all input channels:

- **Voltage** (the default)
- **Current**

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.y	%IWx...%IWy	Shows the address of the input channel, where <i>x</i> is the module number and <i>y</i> is the channel number
Type	Not used 0...10 V 0...20 mA	Not used	This identifies the type of a channel. If Voltage input type is enabled, then the type Not used and 0...10 V are available. If Current input type is enabled, then the type Not used and 0...20 mA are available.
Scope	Not used Normal Customized	Not used	This identifies the range of values for a channel.

Parameter		Value	Default Value	Description
Min.	Normal	0	0	Specifies the lower measurement limit.
	Customized	-32768...32767	-32768	
Max.	Normal	1023	1023	Specifies the upper measurement limit.
	Customized	-32768...32767	32767	

Programming tab: Displaying Configuration Details in the Programming Tab ([see page 28](#)) describes how to view and update programming-related properties of these modules.

TM2AMM3HT

Introduction

The TM2AMM3HT expansion module features 2 analog input and 1 analog output channel, 0...10 Vdc and 4...20 mA input/output types, 12-bit resolution, and removable screw terminal block.

For further hardware information, refer to TM2AMM3HT (*see Modicon TM2, Analog I/O Modules, Hardware Guide*).

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.y	%IWx...%IWy	Shows the address of the input channel, where <i>x</i> is the module number and <i>y</i> is the channel number
Type		Not used 0...10 V 4...20 mA	Not used	This identifies the mode of a channel.
Scope		Normal Customized	Normal	This identifies the range of values for a channel.
Min.	Normal	0	0	Specifies the lower measurement limit.
	Customized	-32768...32767	-32768	
Max.	Normal	4095	4095	Specifies the upper measurement limit.
	Customized	-32768...32767	32767	

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.y	%QWx...%QWy	Shows the address of the output channel, where <i>x</i> is the module number and <i>y</i> is the channel number
Type		Not used 0...10 V 4...20 mA	Not used	This identifies the mode of a channel.
Scope		Normal Customized	Normal	This identifies the range of values for a channel.
Min.	Normal	0	0	Specifies the lower measurement limit.
	Customized	-32768...32767	-32768	
Max.	Normal	4095	4095	Specifies the upper measurement limit.
	Customized	-32768...32767	32767	
Fallback value		Minimum...Maximum	0	The value to apply to this output if the logic controller enters fallback mode. If fallback mode is not configured, the output maintains its current value. Refer to Fallback Behaviour for details.

Programming tab: Displaying Configuration Details in the Programming Tab (*see page 28*) describes how to view and update programming-related properties of these modules.

TM2AMM6HT

Introduction

The TM2AMM6HT expansion module features 4 analog input and 2 analog output channels, 0...10 V and 4...20 mA, each standard and fast input types, 0...10 V and 4...20 mA standard output types, 12-bit resolution, and removable screw terminal block.

For further hardware information, refer to TM2AMM6HT (*see Modicon TM2, Analog I/O Modules, Hardware Guide*).

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.

<i>NOTICE</i>			
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.y	%IWx...%IWy	Shows the address of the input channel, where <i>x</i> is the module number and <i>y</i> is the channel number
Type		Not used 0...10 V 4...20 mA 0...10 V - FAST 4...20 mA - FAST	Not used	This identifies the mode of a channel.
Scope		Normal Customized	Normal	This identifies the range of values for a channel.
Min.	Normal	0	0	Specifies the lower measurement limit.
	Customized	-32768...32767	-32768	
Max.	Normal	4095	4095	Specifies the upper measurement limit.
	Customized	-32768...32767	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.y	%QWx...%QWy	Shows the address of the output channel, where <i>x</i> is the module number and <i>y</i> is the channel number
Type		Not used 0...10 V 4...20 mA	Not used	This identifies the mode of a channel.
Scope		Normal Customized	Normal	This identifies the range of values for a channel.
Min.	Normal	0	0	Specifies the lower measurement limit.
	Customized	-32768...32767	-32768	
Max.	Normal	4095	4095	Specifies the upper measurement limit.
	Customized	-32768...32767	32767	

Programming tab: Displaying Configuration Details in the Programming Tab ([see page 28](#)) describes how to view and update programming-related properties of these modules.

TM2AMO1HT

Introduction

The TM2AMO1HT expansion module features 1 analog output channel, 0...10 Vdc and 4...20 mA output types, 12-bit resolution, and removable screw terminal block

For further hardware information, refer to TM2AMO1HT (*see Modicon TM2, Analog I/O Modules, Hardware Guide*).

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 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.y	%QWx...%QWy	Shows the address of the output channel, where <i>x</i> is the module number and <i>y</i> is the channel number
Type		Not used 0...10 V 4...20 mA	Not used	This identifies the mode of a channel.
Scope		Normal Customized	Normal	This identifies the range of values for a channel.
Min.	Normal	0	0	Specifies the lower measurement limit.
	Customized	-32768...32767	-32768	
Max.	Normal	4095	4095	Specifies the upper measurement limit.
	Customized	-32768...32767	32767	

Parameter	Value	Default Value	Description
Fallback value	Minimum...Maximum	0	The value to apply to this output if the logic controller enters fallback mode. If fallback mode is not configured, the output maintains its current value. Refer to Fallback Behaviour (<i>see SoMachine Basic, Operating Guide</i>) for details.

Programming tab: Displaying Configuration Details in the Programming Tab (*see page 28*) describes how to view and update programming-related properties of these modules.

TM2ARI8HT

Introduction

The TM2ARI8HT expansion module features 8 analog input channels, NTC/PTC signal type, 10-bit resolution, and removable screw terminal block.

For further hardware information, refer to TM2ARI8HT (*see Modicon TM2, Analog I/O Modules, Hardware Guide*).

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 (<i>see page 29</i>). ● 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.

NTC Thermistor Type

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

The screenshot shows the '%IW2.0 Configuration' dialog box. It has a green header bar. Below it, the 'Configuration' section includes:

- Type: NTC (dropdown)
- Scope: Normal (dropdown)
- Measurement temperature unit: (empty)
- Minimum range value: 0
- Filter: 0
- Maximum range value: 1023
- Sampling: (empty)

 The 'Calculation mode' section has two radio buttons: 'Chart' (unselected) and 'Formula' (selected). The 'Formula' mode displays the equation:

$$R_{th} = R_{ref} \times e^{B\left(\frac{1}{T} - \frac{1}{T_{ref}}\right)}$$
 Below the equation is a warning icon and text: '100 Ω ≤ Rth ≤ 200 kΩ'. To the right of the equation, the 'Measurement range' section shows:

- Tmin (Rth = 200 kΩ) = 194.21 K
- Tmax (Rth = 100 Ω) = 331.18 K

 The 'Parameters' section shows:

- Beta: 3569
- Tref: 29815 0.01 °K
- Rref: 330 Ohm

 At the bottom right are 'Apply' and 'Cancel' buttons.

You can define the following parameters:

Parameter	Value	Description
Scope	- Normal - Customized - Resistance (Ohm) - Celsius (0.1 °C) - Fahrenheit (0.1 °F)	Choose the parameter scope for the channel.
Minimum range value	-32768...32767	Specifies the measurement limits (modifiable in Customized scope only).
Maximum range value		
Measurement temperature unit	–	Indicates the temperature unit.

You can use an equation-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...60000	Reference temperature value, expressed in 0.01 °K units.
Rref	1...65500	Reference resistance value in Ohms.
Beta	1...32767	Sensitivity of NTC probe.

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

%IW2.0 Configuration ✕

Configuration

Type: **NTC** Scope: **Normal** Measurement temperature unit:

Minimum range value: 0 Filter: 0

Maximum range value: 1023 Sampling: -

Calculation mode

☒ Chart ☐ Formula

⚠ 100 Ω ≤ Rth ≤ 200 kΩ

Measurement range

Tmin (Rth = 200 kΩ) = 194.21 K

Tmax (Rth = 100 Ω) = 331.16 K

Parameters

R1 8700 Ω T1 234.15 K

R2 200 Ω T2 311.15 K

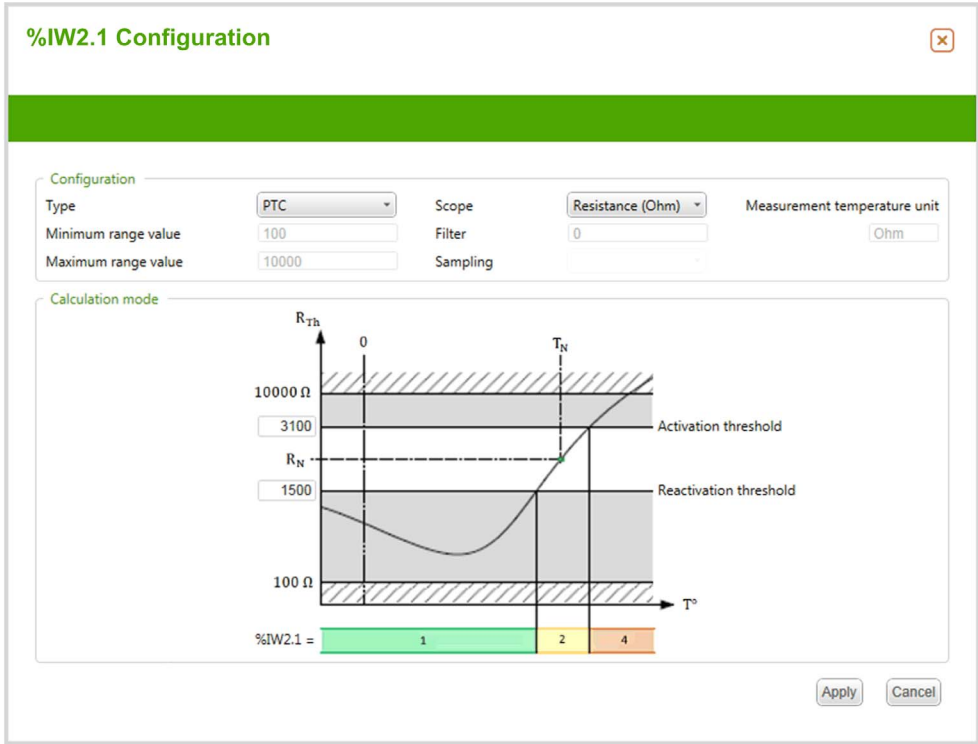
Apply Cancel

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	1...60000	Specifies the resistance 1 in Ohms at temperature T1.
R2	1...60000	Specifies the resistance 2 in Ohms at temperature T2.
T1	-900...1500	Specifies the temperature 1 in Kelvin.
T2	-900...1500	Specifies the temperature 2 in Kelvin.

PTC Thermistor Type

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



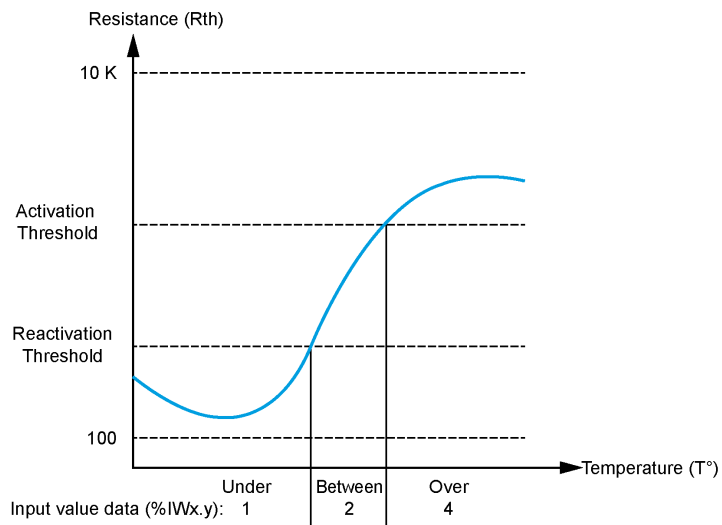
You can define the following parameters:

Parameter	Value	Description
Scope	Resistance (Ohm)	Choose the scope for the channel.
Minimum range value	100...10000	Specifies the measurement limits.
Maximum range value		
Measurement temperature unit	–	Indicates the temperature unit.
Activation Threshold	1000...10000	High threshold
Reactivation Threshold	100...999	Low threshold

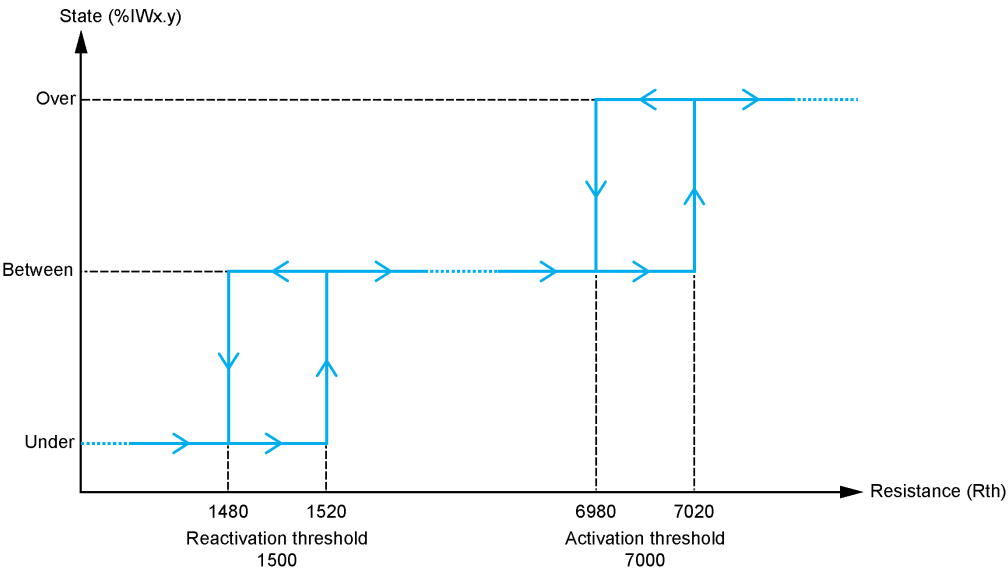
The table presents the read value according to the resistance value:

Resistance Value	Read Value
Under the low threshold (Reactivation Threshold)	1
Between thresholds	2
Over the high threshold (Activation Threshold)	4

This figure represents the threshold operation:



This figure represents an example hysteresis curve:



TM2ARI8LRJ

Introduction

The TM2ARI8LRJ expansion module features 8 analog input channels, PT100/1000 sensor type, 12-bit resolution, and RJ11 connector.

For further hardware information, refer to TM2ARI8LRJ (*see Modicon TM2, Analog I/O Modules, Hardware Guide*).

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.y	%IWx...%IWy	Shows the address of the input channel, where <i>x</i> is the module number and <i>y</i> is the channel number
Type		Not used PT100 PT1000	Not used	This identifies the type of a channel.
Scope		Not used Normal Customized Celsius (0.1 °C) Fahrenheit (0.1 °F)	Not used	This identifies the range of values for a channel.
Min.	Normal	0	0	Specifies the lower measurement limit.
	Customized	-32768...32767	-32768	
	Celsius (0.1°C)	See the table below	See the table below	
	Fahrenheit (0.1 °F)			

Parameter		Value	Default Value	Description
Max.	Normal	4095	4095	Specifies the upper measurement limit.
	Customized	-32768...32767	32767	
	Celsius (0.1 °C)	See the table below	See the table below	
	Fahrenheit (0.1 °F)			

Type	Normal		Celsius (0.1°C)		Fahrenheit (0.1 °F)	
	Min.	Max.	Min.	Max.	Min.	Max.
PT100	0	4095	-2000	6000	-3280	11120
PT1000	0	4095	-500	2000	-580	3920

Programming tab: Displaying Configuration Details in the Programming Tab (*see page 28*) describes how to view and update programming-related properties of these modules.

TM2ARI8LT

Introduction

The TM2ARI8LT expansion module features 8 analog input channels, PT100/1000 sensor type, 12 bits resolution, and 2 removable screw terminal blocks.

For further hardware information, refer to TM2ARI8LT (*see Modicon TM2, Analog I/O Modules, Hardware Guide*).

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.y	%IWx...%IWy	Shows the address of the input channel, where <i>x</i> is the module number and <i>y</i> is the channel number
Type		Not used	Not used	This identifies the type of a channel.
		PT100		
		PT1000		
Scope		Not used Normal Customized Celsius (0.1°C) Fahrenheit (0.1°F)	Not used	This identifies the range of values for a channel.
Min.	Normal	0	0	Specifies the lower measurement limit.
	Customized	-32768...32767	-32768	
	Celsius (0.1°C)	See the table below	See the table below	
	Fahrenheit (0.1°F)			

Parameter		Value	Default Value	Description
Max.	Normal	4095	4095	Specifies the upper measurement limit.
	Customized	-32768...32767	32767	
	Celsius (0.1°C)	See the table below	See the table below	
	Fahrenheit (0.1°F)			

Type	Normal		Celsius (0.1°C)		Fahrenheit (0.1°F)	
	Min.	Max.	Min.	Max.	Min.	Max.
PT100	0	4095	-2000	6000	-3280	11120
PT1000	0	4095	-500	2000	-580	3920

Programming tab: Displaying Configuration Details in the Programming Tab (*see page 28*) describes how to view and update programming-related properties of these modules.

TM2AVO2HT

Introduction

The TM2AVO2HT expansion module features 2 analog output channels, -10 V...+10 V output type, 11-bit resolution plus 1 sign bit, and 2 removable screw terminal blocks.

For further hardware information, refer to TM2AVO2HT (*see Modicon TM2, Analog I/O Modules, Hardware Guide*)

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 the outputs, 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.y	%QWx...%QWy	Shows the address of the output channel, where <i>x</i> is the module number and <i>y</i> is the channel number
Type		Not used	Not used	This identifies the mode of a channel.
		-10...10 V		
Scope		Normal	Normal	This identifies the range of values for a channel.
		Customized		
Min.	Normal	-2048	-2048	Specifies the lower measurement limit.
	Customized	-32768...32767	-32768	
Max.	Normal	2047	2047	Specifies the upper measurement limit.
	Customized	-32768...32767	32767	

Parameter	Value	Default Value	Description
Fallback value	Minimum...Maximum	0	The value that is applied to this output when the logic controller enters fallback mode. If fallback mode is not configured, the output maintains its current value. Refer to Fallback Behaviour (<i>see SoMachine Basic, Operating Guide</i>) for details.

Programming tab: Displaying Configuration Details in the Programming Tab (*see page 28*) describes how to view and update programming-related properties of these modules.

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*

Diagnostic bytes are available for the following modules:

- TM2AMM3HT
- TM2ALM3LT
- TM2AMI2HT
- TM2AMO1HT

Input Channel Status Byte Description

This table describes the %IWS input channel status byte:

Byte value	Description
0	Normal
1	Undefined
2	Undefined
3	Configuration error detected
4	External power supply error detected
5	Wiring error detected (high limit exceeded)
6	Wiring error detected (low limit exceeded)
7	General hardware error detected
8...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 error detected
5	Undefined

Byte value	Description
6	Undefined
7	General hardware error detected
8...255	Undefined



!

%

According to the IEC standard, % is a prefix that identifies internal memory addresses in the logic controller to store the value of program variables, constants, I/O, and so on.

%Q

According to the IEC standard, %Q represents an output bit (for example, a language object of type digital OUT).

A

analog input

Converts received voltage or current levels into numerical values. You can store and process these values within the logic controller.

analog output

Converts numerical values within the logic controller and sends out proportional voltage or current levels.

application

A program including configuration data, symbols, and documentation.

C

configuration

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

controller

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

E

expansion bus

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

expansion I/O module

(*expansion input/output module*) Either a digital or analog module that adds additional I/O to the base controller.

I

I/O

(input/output)

P

program

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



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