Modicon TM5

Analog I/O Modules Hardware Guide

09/2020

EIO0000003203.01

www.schneider-electric.com

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

You agree not to reproduce, other than for your own personal, noncommercial use, all or part of this document on any medium whatsoever without permission of Schneider Electric, given in writing. You also agree not to establish any hypertext links to this document or its content. Schneider Electric does not grant any right or license for the personal and noncommercial use of the document or its content, except for a non-exclusive license to consult it on an "as is" basis, at your own risk. All other rights are reserved.

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.

© 2020 Schneider Electric. All rights reserved.

Table of Contents

Safety Information 7
About the Book 9
Part I TM5 Analog I/O General Overview 15
Chapter 1 TM5 System General Rules for Implementing 17
Installation and Maintenance Requirements 18
Wiring Best Practices 21
TM5 Environmental Characteristics 25
Installation Guidelines 27
Hot Swapping Electronic Modules 28
Chapter 2 TM5 Analog I/O General Overview 31
General Description 32
Physical Description 35
Part II TM5 System Analog Input Electronic Modules 39
Chapter 3 TM5SAI•L Analog 12 Bits Input Electronic Module 41
3.1 TM5SAI2L Electronic Module 2AI ±10V/0-20mA/4-20mA 12 Bits 42
TM5SAI2L Presentation 43
TM5SAI2L Characteristics 45
TM5SAI2L Wiring Diagram 47
3.2 TM5SAI4L Electronic Module 4AI ±10V/0-20mA/4-20mA 12 Bits 49
TM5SAI4L Presentation 50
TM5SAI4L Characteristics 52
TM5SAI4L Wiring Diagram 54
Chapter 4 TM5SAI•H Analog 16 Bits Input Electronic Module 57
4.1 TM5SAI2H Electronic Module 2AI ±10V/0-20mA 16 Bits 58
TM5SAI2H Presentation 59
TM5SAI2H Characteristics 61
TM5SAI2H Wiring Diagram 63
4.2 TM5SAI4H Electronic Module 4AI ±10V/0-20mA 16 Bits 66
TM5SAI4H Presentation 67
TM5SAI4H Characteristics 69
TM5SAI4H Wiring Diagram 72

Chapter 5 TM5SAI•PH Analog 16 Bits Temperature Input Electronic Module PT100/PT1000 75
5.1 TM5SAI2PH Electronic Module 2AI PT100/PT1000 16 Bits 76
TM5SAI2PH Presentation 77
TM5SAI2PH Characteristics 79
TM5SAI2PH Wiring Diagram 82
5.2 TM5SAI4PH Electronic Module 4AI PT100/PT1000 16 Bits 85
TM5SAI4PH Presentation 86
TM5SAI4PH Characteristics 88
TM5SAI4PH Wiring Diagram 91
Chapter 6 TM5SAI•TH Analog 16 Bits Temperature Input Electronic Module Thermocouple J/K/N/S. 95
6.1 TM5SAI2TH Electronic Module 2AI Thermocouple J/K/N/S 16 Bits . . 96
TM5SAI2TH Presentation 97
TM5SAI2TH Characteristics. 100
TM5SAI2TH Wiring Diagram 103
6.2 TM5SAI6TH Electronic Module 6AI Thermocouple J/K/N/S 16 Bits . . 106
TM5SAI6TH Presentation 107
TM5SAI6TH Characteristics. 110
TM5SAI6TH Wiring Diagram 113
Chapter 7 TM5SEAISG Analog Strain Gauge Input Electronic Module 117
TM5SEAISG Presentation 118
TM5SEAISG Characteristics 120
TM5SEAISG Wiring Diagram. 123
Part III TM5 System Analog Output Electronic Modules . . . 127
Chapter 8 TM5SAO•• Analog Output Electronic Module. 129
8.1 TM5SAO2L Electronic Module 2AO ±10V/0-20mA 12 Bits 130
TM5SAO2L Presentation 131
TM5SAO2L Characteristics 133
TM5SAO2L Wiring Diagram. 135
8.2 TM5SAO4L Electronic Module 4AO ±10V/0-20mA 12 Bits 137
TM5SAO4L Presentation 138
TM5SAO4L Characteristics 140
TM5SAO4L Wiring Diagram. 144

8.3 TM5SAO2H Electronic Module 2AO ±10V/0-20mA 16 Bits 146
TM5SAO2H Presentation 147
TM5SAO2H Characteristics 149
TM5SAO2H Wiring Diagram 151
8.4 TM5SAO4H Electronic Module 4AO ±10V/0-20mA 16 Bits 153
TM5SAO4H Presentation 154
TM5SAO4H Characteristics 156
TM5SAO4H Wiring Diagram 160
Glossary 163
Index 167

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.

QUALIFICATION OF PERSONNEL

Only appropriately trained persons who are familiar with and understand the contents of this manual and all other pertinent product documentation are authorized to work on and with this product.

The qualified person must be able to detect possible hazards that may arise from parameterization, modifying parameter values and generally from mechanical, electrical, or electronic equipment. The qualified person must be familiar with the standards, provisions, and regulations for the prevention of industrial accidents, which they must observe when designing and implementing the system.

INTENDED USE

The products described or affected by this document, together with software, accessories, and options, are expansion modules, intended for industrial use according to the instructions, directions, examples, and safety information contained in the present document and other supporting documentation.

The product may only be used in compliance with all applicable safety regulations and directives, the specified requirements, and the technical data.

Prior to using the product, you must perform a risk assessment in view of the planned application. Based on the results, the appropriate safety-related measures must be implemented.

Since the product is used as a component in an overall machine or process, you must ensure the safety of persons by means of the design of this overall system.

Operate the product only with the specified cables and accessories. Use only genuine accessories and spare parts.

Any use other than the use explicitly permitted is prohibited and can result in unanticipated hazards.

About the Book

At a Glance

Document Scope

This manual describes the hardware implementation of the ModiconTM5 Analog I/O modules. It provides parts descriptions, specifications, wiring diagrams, installation and setup for Modicon TM5 Analog I/O modules.

Validity Note

This document has been updated for the release of EcoStruxure™ Machine Expert V1.2.5.

For product compliance and environmental information (RoHS, REACH, PEP, EOLI, etc.), go to *www.schneider-electric.com/green-premium*.

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

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

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

Related Documents

Title of Documentation	Reference Number
Modicon TM5 Expansion Modules Configuration Programming Guide	EIO0000003179 (ENG) EIO0000003180 (FRE) EIO0000003181 (GER) EIO0000003182 (SPA) EIO0000003183 (ITA) EIO0000003184 (CHS)
Modicon TM5 Strain Gauge IoDrvTM5SEAISG Library Guide	EIO0000003185 (ENG) EIO0000003186 (FRE) EIO0000003187 (GER) EIO0000003188 (SPA) EIO0000003189 (ITA) EIO0000003190 (CHS)
Modicon TM5 / TM7 Flexible System - System Planning and Installation Guide	EIO0000003161 (ENG) EIO0000003162 (FRE) EIO0000003163 (GER) EIO0000003164 (SPA) EIO0000003165 (ITA) EIO0000003166 (CHS)
TM5 AIO Modules Instruction Sheet	BBV56047 (ENG)

You can download these technical publications and other technical information from our website at https://www.se.com/ww/en/download/ .

Product Related Information

DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Disconnect all power from all equipment including connected devices prior to removing any covers or doors, or installing or removing any accessories, hardware, cables, or wires except under the specific conditions specified in the appropriate hardware guide for this equipment.
- Always use a properly rated voltage sensing device to confirm the power is off where and when indicated.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- Use only the specified voltage when operating this equipment and any associated products.

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

DANGER

POTENTIAL FOR EXPLOSION

- Only use this equipment in non-hazardous locations, or in locations that comply with Class I, Division 2, Groups A, B, C and D.
- Do not substitute components which would impair compliance to Class I, Division 2.
- Do not connect or disconnect equipment unless power has been removed or the location is known to be non-hazardous.
- Do not use the USB port(s), if so equipped, unless the location is known to be non-hazardous.

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

⚠ WARNING

LOSS OF CONTROL

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

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

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Terminology Derived from Standards

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

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

Among others, these standards include:

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

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

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

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

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

Part I
TM5 Analog I/O General Overview

What Is in This Part?

This part contains the following chapters:

Chapter	Chapter Name	Page
1	TM5 System General Rules for Implementing	17
2	TM5 Analog I/O General Overview	31

Chapter 1
TM5 System General Rules for Implementing

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
Installation and Maintenance Requirements	18
Wiring Best Practices	21
TM5 Environmental Characteristics	25
Installation Guidelines	27
Hot Swapping Electronic Modules	28

Installation and Maintenance Requirements

Before Starting

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

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

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

NOTICE

ELECTROSTATIC DISCHARGE

- Store all components in their protective packaging until immediately before assembly.
- Never touch exposed conductive parts such as contacts or terminals.

Failure to follow these instructions can result in equipment damage.

Disconnecting Power

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

DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Disconnect all power from all equipment including connected devices prior to removing any covers or doors, or installing or removing any accessories, hardware, cables, or wires except under the specific conditions specified in the appropriate hardware guide for this equipment.
- Always use a properly rated voltage sensing device to confirm the power is off where and when indicated.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- Use only the specified voltage when operating this equipment and any associated products.

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

Programming Considerations

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Operating Environment

⚠ DANGER

POTENTIAL FOR EXPLOSION

- Only use this equipment in non-hazardous locations, or in locations that comply with Class I, Division 2, Groups A, B, C and D.
- Do not substitute components which would impair compliance to Class I, Division 2.
- Do not connect or disconnect equipment unless power has been removed or the location is known to be non-hazardous.
- Do not use the USB port(s), if so equipped, unless the location is known to be non-hazardous.

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Installation Considerations

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Use appropriate safety interlocks where personnel and/or equipment hazards exist.
- Install and operate this equipment in an enclosure appropriately rated for its intended environment and secured by a keyed or tooled locking mechanism.
- Use the sensor and actuator power supplies only for supplying power to the sensors or actuators connected to the module.
- Power line and output circuits must be wired and fused in compliance with local and national regulatory requirements for the rated current and voltage of the particular equipment.
- Do not use this equipment in safety-critical machine functions unless the equipment is otherwise designated as functional safety equipment and conforming to applicable regulations and standards.
- Do not disassemble, repair, or modify this equipment.
- Do not connect any wiring to reserved, unused connections, or to connections designated as No Connection (N.C.).

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

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

Wiring Best Practices

Introduction

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

Wiring Rules

DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

- Disconnect all power from all equipment including connected devices prior to removing any covers or doors, or installing or removing any accessories, hardware, cables, or wires except under the specific conditions specified in the appropriate hardware guide for this equipment.
- Always use a properly rated voltage sensing device to confirm the power is off where and when indicated.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- Use only the specified voltage when operating this equipment and any associated products.

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

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

- I/O and communication wiring must be kept separate from the power wiring. Route these 2 types of wiring in separate cable ducting.
- Verify that the operating conditions and environment are within the specification values.
- Use proper wire sizes to meet voltage and current requirements.
- Use copper conductors only.
- Use twisted pair, shielded cables for analog, expert, or fast I/O and TM5 bus signals.
- Use twisted pair, shielded cables for encoder, networks and fieldbus (CAN, serial, Ethernet).

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

Refer to the section Grounding the TM5 System to ground the shielded cables.

This table provides the wire sizes to use with the removable spring terminal blocks (TM5ACTB06, TM5ACTB12, TM5ACTB12, TM5ACTB12PS, TM5ACTB32):

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

This table provides the wire sizes to use with the TM5ACTB16 terminal blocks:

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

⚠ DANGER

FIRE HAZARD

Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.

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

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

DANGER

LOOSE WIRING CAUSES ELECTRIC SHOCK

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

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

TM5 Terminal Block

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

DANGER

ELECTRIC SHOCK OR UNINTENDED EQUIPMENT OPERATION

Connect the terminal blocks to their designated location.

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

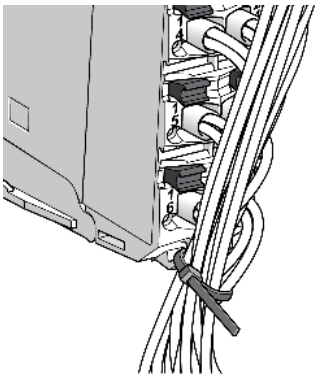
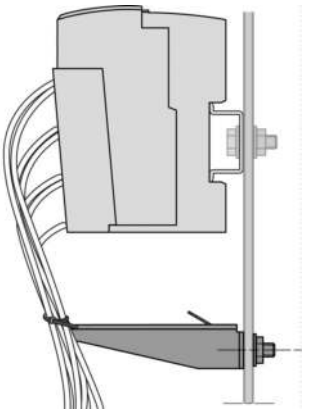
NOTE: To help prevent a terminal block from being inserted incorrectly, ensure that each terminal block and electronic module is clearly and uniquely coded.

TM5 Strain Relief Using Cable Tie

There are 2 methods to reduce the stress on cables:

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

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

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

⚠ WARNING

ACCIDENTAL DISCONNECTION FROM PROTECTIVE GROUND (PE)

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

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

TM5 Environmental Characteristics

Enclosure Requirements

TM5 components are designed as Zone B, Class A industrial equipment according to IEC/CISPR Publication 11. If they are used in environments other than those described in the standard, or in environments that do not meet the specifications in this manual, your ability to meet electromagnetic compatibility requirements in the presence of conducted and/or radiated interference may be reduced.

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

Environmental Characteristics

This equipment meets UL and CSA standards and, for the majority of the modules, carry both certification marks. In addition, all modules are certified as CE compliant. This equipment is intended for use in a Pollution Degree 2 industrial environment.

NOTE: Some module characteristics may differ from those presented in the following tables. Refer to the chapter concerning your specific module for more information.

The table below provides the general environmental characteristics:

Characteristic	Minimum Specification	Tested Range	
Standard	IEC61131-2	–	
Agency Standards	UL 508 CSA 22.2 No. 142-M1987 CSA 22.2 No. 213-M1987	–	
Ambient operating temperature	–	Horizontal installation	0...55 °C (32...131 °F)
	–	Vertical installation	0...50 °C (32...122 °F)
Storage temperature	–	-25...70 °C (-13...158 °F)	
Relative humidity	–	5...95% (non-condensing)	
Degree of pollution	IEC60664	2	
Degree of protection	IEC61131-2	IP20	
Corrosion immunity	None	–	
Operating altitude	–	0...2000 m (0...6.560 ft.)	
Storage altitude	–	0...3000 m (0...9.842 ft.)	
NOTE: The tested ranges may indicate values beyond that of the IEC Standard. However, our internal standards define what is necessary for industrial environments. In all cases, we uphold the minimum specification if indicated.			

Characteristic		Minimum Specification	Tested Range	
Vibration resistance		–	Mounted on a DIN rail	3.5 mm (0.138 in.) fixed amplitude from 5...8.4 Hz 9.8 m/s^2 (1 g_n) fixed acceleration from 8.4...150 Hz
Mechanical shock resistance		–	147 m/s^2 (15 g_n) for a duration of 11 ms	
Connection type	Removable spring terminal block	–	–	
Connector insertion/removal cycles		–	50	
NOTE: The tested ranges may indicate values beyond that of the IEC Standard. However, our internal standards define what is necessary for industrial environments. In all cases, we uphold the minimum specification if indicated.				

Electromagnetic Susceptibility

The following table provides the TM5 System electromagnetic susceptibility specifications:

Characteristic	Minimum Specification	Tested Range
Electrostatic discharge	IEC/EN 61000-4-2	8 kV (air discharge), criteria B 4 kV (contact discharge), criteria B
Electromagnetic fields	IEC/EN 61000-4-3	10 V/m (80 MHz...2 GHz), criteria A 10 V/m (80 MHz...2.7 GHz)(1)
Fast transients burst	IEC/EN 61000-4-4	Power lines: 2 kV, criteria B I/O: 1 kV, criteria B Shielded cable: 1 kV, criteria B Repetition rate: 5 and 100 KHz
Surge immunity 24 Vdc circuit	IEC/EN 61000-4-5	1 kV in common mode, criteria B 0.5 kV in differential mode, criteria B
Surge immunity 230 Vac circuit	IEC/EN 61000-4-5	2 kV in common mode, criteria B 1 kV in differential mode, criteria B
Induced electromagnetic field	IEC/EN 61000-4-6	10 V_{eff} (0.15...80 MHz), criteria A
Conducted emission	EN 55011 (IEC/CISPR11)	150...500 kHz, quasi peak 79 dB (µV) 500 kHz...30 MHz, quasi peak 73 dB (µV)
Radiated emission	EN 55011 (IEC/CISPR11)	30...230 MHz, 10 m@40 dB (µV/m) 230 MHz...1 GHz, 10 m@47 dB (µV/m)

Criteria A Uninterrupted operation during test.
Criteria B Brief interruption during the test allowed.
(1) Applies for TM5SE1IC20005 and TM5SE1MISC20005.

NOTE: The tested ranges may indicate values beyond that of the IEC Standard. However, our internal standards define what is necessary for industrial environments. In all cases, we uphold the minimum specification if indicated.

Installation Guidelines

Installation

The following table provides documentation references for spacing requirements and installation of electronic modules and accessories:

Spacing requirement	For mounting positions and minimum clearances, the electronic modules are mounted according to the rules defined for the controllers. Refer to the *Enclosing the TM5 System*.
Electronic modules installation	Refer to: ● *TM5 Association Table*. ● *Expanding the TM5 System*.
Accessories installation	Refer to the *Installation of Accessories*.

Hot Swapping Electronic Modules

Definition

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

Hot Swapping Considerations

Before initiating a hot swap operation, confirm that the electronic module type is approved for hot swapping *(see page 30)*.

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

DANGER

EXPLOSION OR ELECTRIC SHOCK

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

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

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

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

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

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

⚠ WARNING

LOSS OF CONTROL

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

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

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

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

Modules that are not Hot Swap-able

Electronic modules that can not be hot swapped under any circumstances include:

TM5	Electronic Modules Type	Reasons
Controller	PCI communication	The replacement of the PCI communication module requires a power cycle before it will recognized by the controller.
	Controller Power Distribution Module	These modules are not removable.
	Embedded I/O Modules	
Field bus interface	CANopen interface module	The replacement of the CANopen interface module depends on CANopen master architecture. Refer to the Generic CANopen Implementation Guide and documentation associated with the CANopen master.
Compact I/O	I/O modules	These modules are not removable.

Chapter 2
TM5 Analog I/O General Overview

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
General Description	32
Physical Description	35

General Description

Introduction

The range of analog electronic modules includes:

• Analog input electronic modules

• Analog temperature input electronic modules

• Analog output electronic modules

The TM5 analog I/O electronic modules need to be associated with a bus base and a terminal block. Every analog electronic module channel has a status LED.

Analog Input Electronic Module Features

Analog input electronic modules convert measured values (voltages, currents) into numeric values, which can be processed by the controller.

Each channel in an electronic module is capable of converting either current or voltage signals. There are different terminal connection points for each type of signal. Since current and voltage require different adjustment values, it is also necessary to configure the desired type of input signal:

- -10...+10 Vdc voltage signal (default).
- 0...20 mA current signal.
- 4...20 mA current signal.

The following table shows the analog input electronic modules features:

Reference	Number of Channels	Digital Converter Resolution	Voltage/Current
TM5SAI2L *(see page 43)*	2	12 bit + sign 12 bit	-10...+10 Vdc 0...20 mA/4...20 mA
TM5SAI4L *(see page 50)*	4	12 bit + sign 12 bit	-10...+10 Vdc 0...20 mA/4...20 mA
TM5SAI2H *(see page 59)*	2	15 bit + sign 15 bit	-10...+10 Vdc 0...20 mA
TM5SAI4H *(see page 67)*	4	15 bit + sign 15 bit	-10...+10 Vdc 0...20 mA

Analog Temperature Electronic Module Features

Temperature measurement values are converted into numeric values which can be processed by the controller using temperature electronic modules. For temperature measurements, the temperature electronic module returns the measured value in 0.1°C steps.

The step value 0.1°C *(0.18°F)* is supported as standard by all temperature electronic modules.

The following table shows the analog temperature input electronic modules features:

Reference	Number of Channels	Digital Converter Resolution	Sonde Type
TM5SAI2PH *(see page 77)*	2	16 bit	PT100/1000
TM5SAI4PH *(see page 86)*	4	16 bit	PT100/1000
TM5SAI2TH *(see page 97)*	2	16 bit	Thermocouple J, K, N, S, B, R and 1 µV/bit, 2 µV/bit
TM5SAI6TH *(see page 107)*	6	16 bit	Thermocouple J, K, N, S, B, R and 1 µV/bit, 2 µV/bit

Analog Strain Gauge Input Electronic Module Features

The TM5SEAISG is an analog module which allows to convert the output of a 4-wire or 6-wire full-bridge strain gauge to a numeric value.

The following table shows the strain gauge input electronic module features:

Reference	Number of Channels	Digital Converter Resolution	Sensor Type
TM5SEAISG *(see page 118)*	1	24 bit	Full-bridge strain gauge

Analog Output Electronic Module Features

Analog output electronic modules convert controller internal numeric values into voltages or currents.

The following table shows the analog output electronic modules features:

Reference	Number of Channels	Digital Converter Resolution	Voltage/Current
TM5SAO2L *(see page 131)*	2	12 bit + sign 12 bit	-10...+10 Vdc 0...20 mA
TM5SAO4L *(see page 138)*	4	12 bit + sign 12 bit	-10...+10 Vdc 0...20 mA
TM5SAO2H *(see page 147)*	2	15 bit + sign 15 bit	-10...+10 Vdc 0...20 mA
TM5SAO4H *(see page 154)*	4	15 bit + sign 15 bit	-10...+10 Vdc 0...20 mA

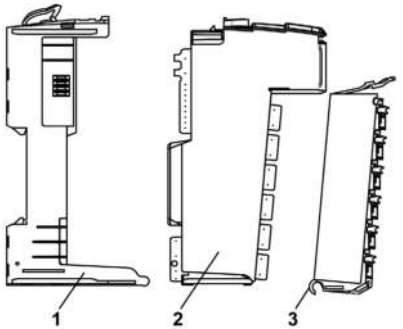
Physical Description

Introduction

Each slice consists of three elements. These elements are the bus base, the electronic module and the terminal block.

Elements

The following illustration shows the elements of a slice.



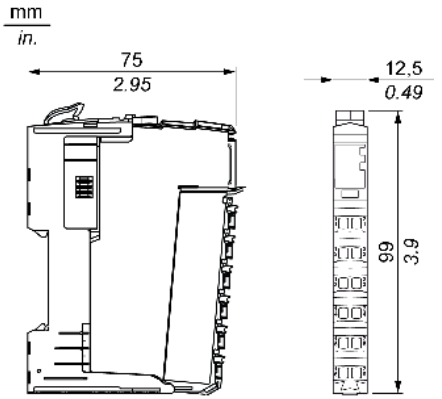
1 Bus base
2 Electronic module
3 Terminal block

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

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

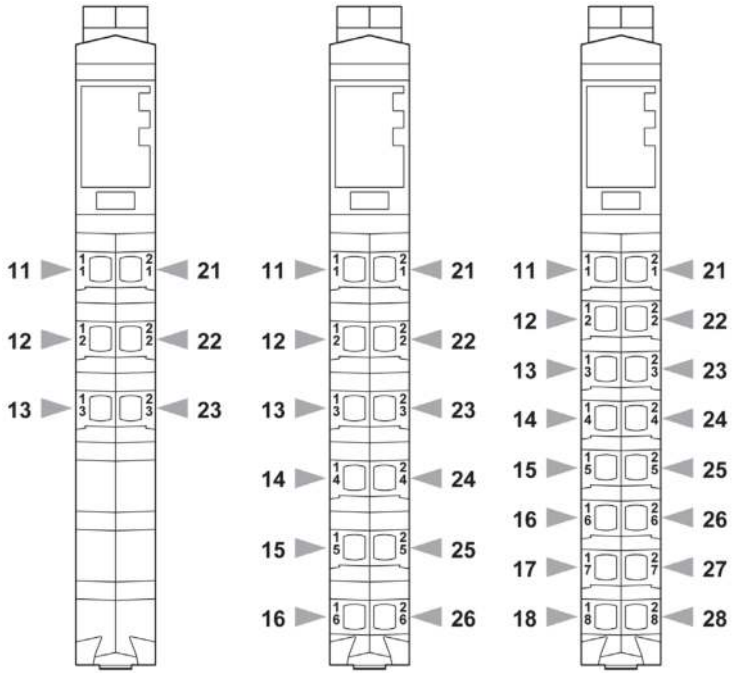
Dimensions

The following illustration shows the dimensions of a slice:



Pin Assignment

The following illustration shows the pin assignments respectively for the 6-pin, 12-pin and the 16-pin terminal blocks:



Accessories

Refer to the *Installation of Accessories*.

Labeling

Refer to the *Labeling the* TM5 System.

Part II
TM5 System Analog Input Electronic Modules

What Is in This Part?

This part contains the following chapters:

Chapter	Chapter Name	Page
3	TM5SAI•L Analog 12 Bits Input Electronic Module	41
4	TM5SAI•H Analog 16 Bits Input Electronic Module	57
5	TM5SAI•PH Analog 16 Bits Temperature Input Electronic Module PT100/PT1000	75
6	TM5SAI•TH Analog 16 Bits Temperature Input Electronic Module Thermocouple J/K/N/S	95
7	TM5SEAISG Analog Strain Gauge Input Electronic Module	117

Chapter 3
TM5SAI•L Analog 12 Bits Input Electronic Module

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
3.1	TM5SAI2L Electronic Module 2AI ±10V/0-20mA/4-20mA 12 Bits	42
3.2	TM5SAI4L Electronic Module 4AI ±10V/0-20mA/4-20mA 12 Bits	49

Section 3.1
TM5SAI2L Electronic Module 2AI ±10V/0-20mA/4-20mA 12 Bits

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SAI2L Presentation	43
TM5SAI2L Characteristics	45
TM5SAI2L Wiring Diagram	47

TM5SAI2L Presentation

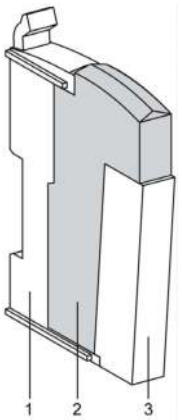
Main Characteristics

The table below describes the main characteristics of the TM5SAI2L electronic module:

Main Characteristics		
Number of input channels	2	
Signal type	Voltage	Current
Input range	-10...+10 Vdc	0...20 mA / 4...20 mA
Resolution	12 bits + sign	12 bits

Ordering Information

The following figure shows the slice with a TM5SAI2L:



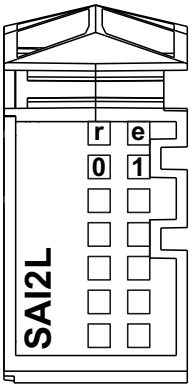
The table below shows the model numbers for the terminal block and bus base associated to TM5SAI2L:

Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White
2	TM5ASAI2L	Electronic module	White
3	TM5ACTB06 or TM5ACTB12	Terminal block, 6 pins Terminal block, 12 pins	White White

NOTE: For more information, refer to *TM5 bus bases and terminal blocks*

Status LEDs

The following figure shows the TM5SAI2L status LEDs:



The table below shows the TM5SAI2L status LEDs:

LED	Color	Status	Description
r	Green	Off	No power supply
		Single Flash	Reset state
		Flashing	Preoperational state
		On	Normal operation
e	Red	Off	OK or no power supply
		On	Detected error or reset state
		Double Flash	System detected error: ● Scan time overrun ● Synchronization detected error
0-1	Green	Off	Channel not configured
		Flashing	Overflow or underflow of the input signal
		On	The analog/digital converter is running, value is available

TM5SAI2L Characteristics

Introduction

This is the description characteristics for **TM5SAI2L** electronic module.

See also Environmental Characteristics *(see page 25)*.

⚠ DANGER

FIRE HAZARD

Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

General Characteristics

The table below describes the general characteristics of the TM5SAI2L electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to the 24 Vdc I/O power segment
Power supply range	20.4...28.8 Vdc
24 Vdc I/O segment current draw	33 mA
TM5 Bus 5 Vdc current draw	2 mA
Power dissipation	0.81 W max.
Weight	25 g (0.9 oz)
Id code for firmware update	7070 dec

Input Characteristics

The table below describes the input characteristics of the TM5SAI2L electronic module:

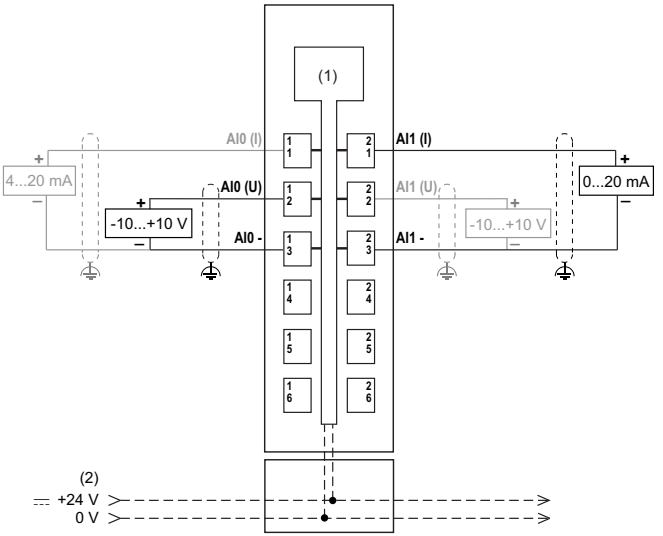
Input Characteristics	Voltage Input	Current Input
Input range	-10...+10 Vdc	0...20 mA / 4...20 mA
Input impedance	20 MΩ min.	-
Load impedance	-	400 Ω max.
Sample duration time	300 µs for all inputs without filtering 1 ms for all inputs with filtering	
Input type	Differential	
Conversion mode	Successive Approximative Register	
Input filter	Low pass 3rd order / cut-off frequency 1 kHz	
Input tolerance - maximum deviation at ambient 25° C (77°F)	< 0.08% of the measurement	< 0.08% of the measurement
Input tolerance - temperature drift	0.006% / °C of the measurement	0.009% / °C of the measurement
Input tolerance - non linearity	< 0.025% of the full scale (20 Vdc)	< 0.05% of the full scale (20 mA)
Digital resolution	12 bits + sign	12 bits
Resolution value	2.441 mV	4.883 µA
Common mode rejection	DC	70 dB min.
	50 Hz	70 dB min.
Noise resistance - cable	Shielded cable is necessary	
Crosstalk rejection between channels	70 dB min.	
Isolation between channels	Not isolated	
Isolation between channels and bus	See note [1].	
Permitted input signal	±30 Vdc max.	±50 mA max.
Input protection	Protection against wiring with 24 Vdc supply voltage	
Common mode voltage allowable between channels	±12 Vdc max.	

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

TM5SAI2L Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for TM5SAI2L:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(I): Current
(U): Voltage

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

NOTICE

INOPERABLE EQUIPMENT

Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel.

Failure to follow these instructions can result in equipment damage.

Section 3.2
TM5SAI4L Electronic Module 4AI ±10V/0-20mA/4-20mA 12 Bits

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SAI4L Presentation	50
TM5SAI4L Characteristics	52
TM5SAI4L Wiring Diagram	54

TM5SAI4L Presentation

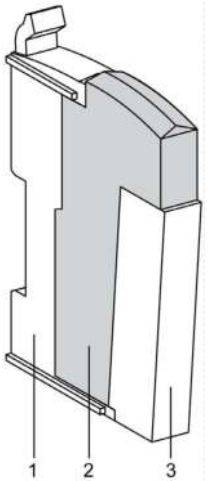
Main Characteristics

The table below describes the main characteristics of the TM5SAI4L electronic module:

Main Characteristics		
Number of input channels	4	
Signal type	Voltage	Current
Input range	-10...+10 Vdc	0...20 mA / 4...20 mA
Resolution	12 bits + sign	12 bits

Ordering Information

The following figure shows the slice with a TM5SAI4L:



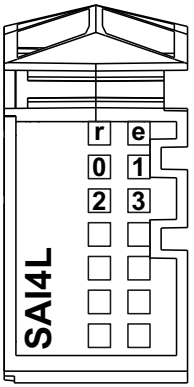
The table below shows the model numbers for the terminal block and bus base associated to TM5SAI4L:

Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White
2	TM5ASAI4L	Electronic module	White
3	TM5ACTB12	Terminal block, 12 pins	White

NOTE: For more information, refer to *TM5 bus bases and terminal blocks*

Status LEDs

The following figure shows the TM5SAI4L status LEDs:



The table below shows the TM5SAI4L status LEDs:

LEDs	Color	Status	Description
r	Green	Off	No power supply
		Single Flash	Reset state
		Flashing	Preoperational state
		On	Normal operation
e	Red	Off	OK or no power supply
		On	Detected error or reset state
		Double Flash	System detected error: ● Scan time overrun ● Synchronization detected error
0-3	Green	Off	Channel not configured
		Flashing	Overflow or underflow of the input signal
		On	The analog/digital converter is running, value is available

TM5SAI4L Characteristics

Introduction

This is the description characteristics for TM5SAI4L electronic module.

See also Environmental Characteristics *(see page 25)*.

⚠ DANGER

FIRE HAZARD

Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

General Characteristics

The table below describes the general characteristics of the TM5SAI4L electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to the 24 Vdc I/O power segment
Power supply range	20.4...28.8 Vdc
24 Vdc I/O segment current draw	46 mA
TM5 Bus 5 Vdc current draw	2 mA
Power dissipation	1.11 W max.
Weight	25 g (0.9 oz)
Id code for firmware update	7082 dec

Input Characteristics

The table below describes the input characteristics of the TM5SAI4L electronic module:

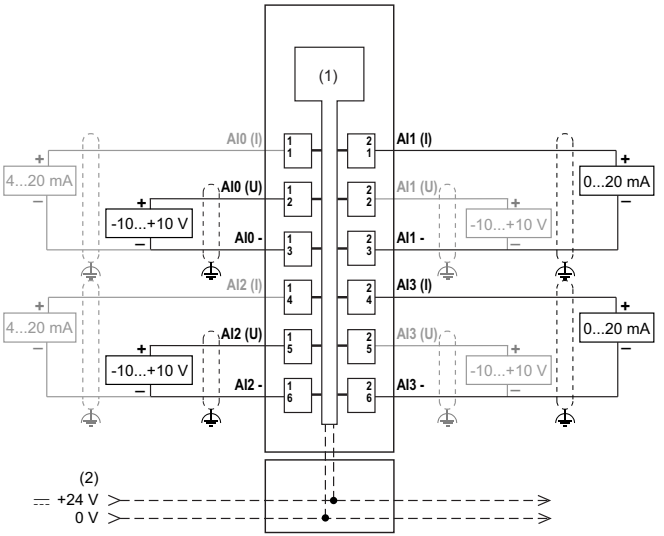
Input Characteristics	Voltage Input	Current Input
Input range	-10...+10 Vdc	0...20 mA / 4...20 mA
Input impedance	20 MΩ min.	-
Load impedance	-	400 Ω max.
Sample duration time	400 µs for all inputs without filtering 1 ms for all inputs with filtering	
Input type	Differential	
Conversion mode	Successive Approximative Register	
Input filter	Low pass 3rd order / cut-off frequency 1 kHz	
Input tolerance - maximum deviation at ambient 25° C (77°F)	< 0.08% of the measurement	< 0.08% of the measurement
Input tolerance - temperature drift	0.006% / °C of the measurement	0.009% / °C of the measurement
Input tolerance - non linearity	< 0.025% of the full scale (20 Vdc)	< 0.05% of the full scale (20 mA)
Digital resolution	12 bits + sign	12 bits
Resolution value	2.441 mV	4.883 µA
Common mode rejection	DC	70 dB min.
	50 Hz	70 dB min.
Noise resistance - cable	Shielded cable is necessary	
Crosstalk rejection between channels	70 dB min.	
Isolation between channels	Not isolated	
Isolation between channels and bus	See note [1].	
Permitted input signal	±30 Vdc max.	±50 mA max.
Input protection	Protection against wiring with 24 Vdc supply voltage	
Common mode voltage allowable between channels	±12 Vdc max.	

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

TM5SAI4L Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for TM5SAI4L:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(I): Current
(U): Voltage

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

NOTICE

INOPERABLE EQUIPMENT

Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel.

Failure to follow these instructions can result in equipment damage.

Chapter 4
TM5SAI•H Analog 16 Bits Input Electronic Module

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
4.1	TM5SAI2H Electronic Module 2AI ±10V/0-20mA 16 Bits	58
4.2	TM5SAI4H Electronic Module 4AI ±10V/0-20mA 16 Bits	66

Section 4.1
TM5SAI2H Electronic Module 2AI ±10V/0-20mA 16 Bits

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SAI2H Presentation	59
TM5SAI2H Characteristics	61
TM5SAI2H Wiring Diagram	63

TM5SAI2H Presentation

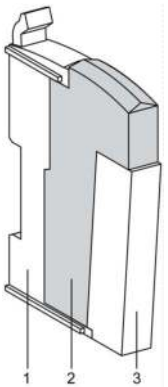
Main Characteristics

The table below describes the main characteristics of the TM5SAI2H electronic module:

Main Characteristics		
Number of input channels	2	
Signal type	Voltage	Current
Input range	-10...+10 Vdc	0...20 mA
Resolution	15 bits + sign	15 bits

Ordering Information

The following figure shows the slice with a TM5SAI2H:



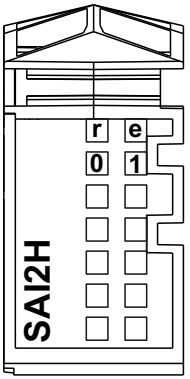
The table below shows the model numbers for the terminal block and bus base associated to TM5SAI2H:

Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White
2	TM5ASAI2H	Electronic module	White
3	TM5ACTB06 or TM5ACTB12	Terminal block, 6 pins Terminal block, 12 pins	White White

NOTE: For more information, refer to *TM5 bus bases and terminal blocks (see Modicon TM5 / TM7 Flexible System, System Planning and Installation Guide)*

Status LEDs

The following figure shows theTM5SAI2H status LEDs:



The table below shows theTM5SAI2H status LEDs:

LEDs	Color	Status	Description
r	Green	Off	No power supply
		Single Flash	Reset state
		Flashing	Preoperational state
		On	Normal operation
e	Red	Off	OK or no power supply
		On	Detected error or reset state
		Double Flash	System detected error: ● Scan time overrun ● Synchronization detected error
0-1	Green	Off	Channel not configured
		On	The analog/digital converter is running, value is available

TM5SAI2H Characteristics

Introduction

This is the description characteristics for **TM5SAI2H** electronic module.

See also Environmental Characteristics *(see page 25)*.

⚠ DANGER

FIRE HAZARD

Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

General Characteristics

The table below describes the general characteristics of the TM5SAI2H electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to the 24 Vdc I/O power segment
Power supply range	20.4...28.8 Vdc
24 Vdc I/O segment current draw	50 mA
TM5 Bus 5 Vdc current draw	2 mA
Power dissipation	1.21 W max.
Weight	25 g (0.9 oz)
Id code for firmware update	7072 dec

Input Characteristics

The table below describes the input characteristics of the TM5SAI2H electronic module:

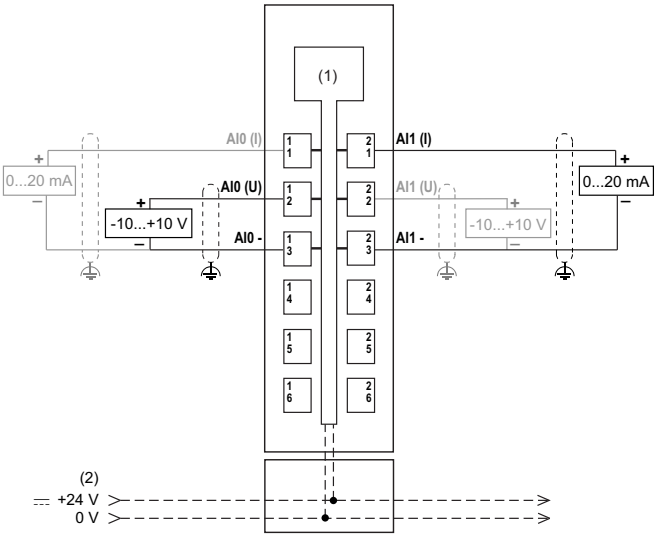
Input Characteristics	Voltage Input	Current Input
Input range	-10...+10 Vdc	0...20 mA
Input impedance	20 MΩ min.	-
Load impedance	-	400 Ω max.
Sample duration time	50 µs for all inputs	
Input type	Differential	
Conversion mode	Successive Approximative Register	
Input filter	Low pass 3rd order / cut-off frequency 10 kHz	
Input tolerance - maximum deviation at ambient 25°C (77°F)	< 0.08% of the measurement	
Input tolerance - temperature drift	0.01% / °C of the measurement	
Input tolerance - non linearity	< 0.01% of the full scale (20 Vdc)	< 0.015% of the full scale (20 mA)
Digital resolution	15 bits + sign	15 bits
Resolution value	305.176 µV	610.352 nA
Common mode rejection	DC	70 dB min.
	50 Hz	70 dB min.
Noise resistance - cable	Shielded cable is necessary	
Crosstalk rejection between channels	70 dB min.	
Isolation between channels	Not isolated	
Isolation between channels and bus	See note [1].	
Permitted input signal	±30 Vdc max.	±50 mA max.
Input protection	Protection against wiring with 24 Vdc supply voltage	
Common mode voltage allowable between channels	±12 Vdc max.	

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

TM5SAI2H Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for TM5SAI2H:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(I): Current
(U): Voltage

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

NOTICE

INOPERABLE EQUIPMENT

Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel.

Failure to follow these instructions can result in equipment damage.

Condition of Installation

Do not place 16-bit analog input modules side-by-side because their electromagnetic characteristics may lead to mutual interference and possible unintended equipment operation. Further, other types of equipments can generate similar electromagnetic interference affecting the conversion accuracy of the modules. In the physical configuration, a single slice of non-interfering equipment is sufficent to avoid this type of disturbance. Separate the 16-bit analog modules from each other and from the following equipment:

- TM5SBER2 Bus receiver
- TM5SPS2 and TM5SPS2F Power Distribution Modules
- TM258••• and LMC058••• Controllers

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Do not place 16_bit analog input modules next to each other.
- Do not place 16_bit analog input modules in direct proximity to equipment that generates electromagnetic interference.
- Insert at least one none interfering slice between any 16-bit analog input modules and any interference generating equipment.

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

Section 4.2
TM5SAI4H Electronic Module 4AI ±10V/0-20mA 16 Bits

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SAI4H Presentation	67
TM5SAI4H Characteristics	69
TM5SAI4H Wiring Diagram	72

TM5SAI4H Presentation

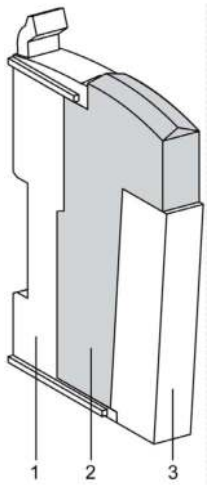
Main Characteristics

The table below describes the main characteristics of the TM5SAI4H electronic module:

Main Characteristics		
Number of input channels	4	
Signal type	Voltage	Current
Input range	-10...+10 Vdc	0...20 mA
Resolution	15 bits + sign	15 bits

Ordering Information

The following figure shows the slice with a TM5SAI4H:



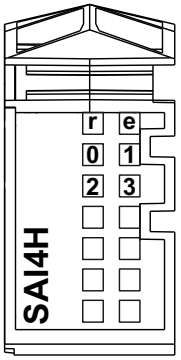
The table below shows the model numbers for the terminal block and bus base associated to TM5SAI4H:

Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White
2	TM5ASAI4H	Electronic module	White
3	TM5ACTB12	Terminal block, 12 pins	White

NOTE: For more information, refer to *TM5 bus bases and terminal blocks*

Status LEDs

The following figure shows the LEDs for TM5SAI4H:



The table below shows the TM5SAI4H status LEDs:

LEDs	Color	Status	Description
r	Green	Off	No power supply
		Single Flash	Reset state
		Flashing	Preoperational state
		On	Normal operation
e	Red	Off	OK or no power supply
		On	Detected error or reset state
		Double Flash	System detected error: ● Scan time overrun ● Synchronization detected error
0-3	Green	Off	Channel not configured
		On	The analog/digital converter is running, value is available

TM5SAI4H Characteristics

Introduction

This is the description characteristics for **TM5SAI4H** electronic module.

See also Environmental Characteristics *(see page 25)*.

⚠ DANGER

FIRE HAZARD

Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

General Characteristics

The table below describes the general characteristics of the TM5SAI4H electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to the 24 Vdc I/O power segment
Power supply range	20.4...28.8 Vdc
24 Vdc I/O segment current draw	63 mA
TM5 Bus 5 Vdc current draw	2 mA
Power dissipation	1.51 W max.
Weight	25 g (0.9 oz)
Id code for firmware update	7073 dec.

Input Characteristics

The table below describes the input characteristics of the TM5SAI4H electronic module:

Input Characteristics	Voltage Input	Current Input
Input range	-10...+10 Vdc	0...20 mA
Input impedance	20 MΩ min.	-
Load impedance	-	400 Ω max.
Sample duration time	50 µs for all inputs	
Input type	Differential	
Conversion mode	Successive Approximative Register	
Input filter	Low pass 3rd order / cut-off frequency 10 kHz	
Input tolerance - maximum deviation at ambient 25°C (77°F)	< 0.08% of the measurement	
Input tolerance - temperature drift	0.01% / °C of the measurement	
Input tolerance - non linearity	< 0.01% of the full scale (20 Vdc)	< 0.015% of the full scale (20 mA)
De-rating *	See note *	
Digital resolution	15 bits + sign	15 bits
Resolution value	305.176 µV	610.352 nA
Common mode rejection	DC	70 dB min.
	50 Hz	70 dB min.
Noise resistance - cable	Shielded cable is necessary	
Crosstalk rejection between channels	70 dB min.	
Isolation between channels	Not isolated	

* Note: These analog electronic modules are subject to operating temperature restrictions between 55 and 60 °C (131 and 140 °F). If the ambiant temperature of your installation may exceed 55 °C (131 °F), do not install the TM5SAI•H modules adjacent to other devices capable of dissipating more than 1.15 W. For more information refer to *Enclosing the TM5 System*.

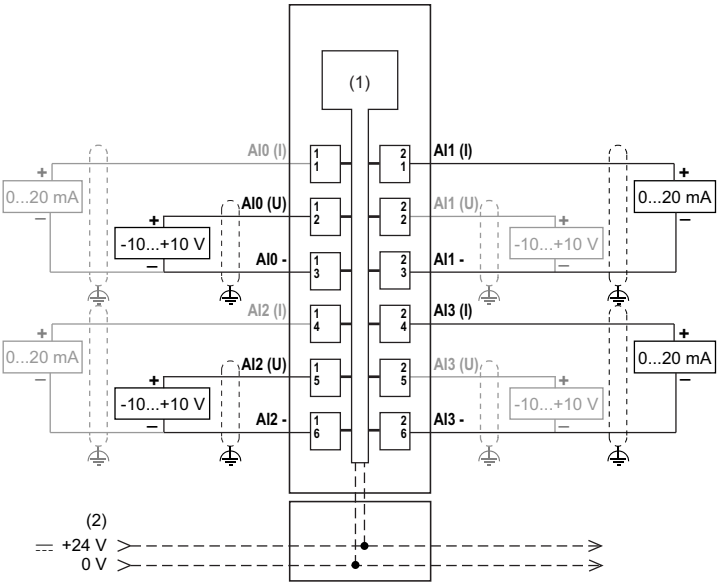
Input Characteristics	Voltage Input	Current Input
Isolation between channels and bus	See note [1].	
Permitted input signal	±30 Vdc max.	±50 mA max.
Input protection	Protection against wiring with 24 Vdc supply voltage	
Common mode voltage allowable between channels	±12 Vdc max.	
[*] Note: These analog electronic modules are subject to operating temperature restrictions between 55 and 60 °C (131 and 140 °F). If the ambiant temperature of your installation may exceed 55 °C (131 °F), do not install the TM5SAI•H modules adjacent to other devices capable of dissipating more than 1.15 W. For more information refer to *Enclosing the TM5 System*.		

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

TM5SAI4H Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for the TM5SAI4H:



1 Internal electronics
2 24 Vdc I/O power segment integrated into the bus bases
I Current
U Voltage

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

NOTICE

INOPERABLE EQUIPMENT

Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel.

Failure to follow these instructions can result in equipment damage.

Condition of Installation

Do not place 16-bit analog input modules side-by-side because their electromagnetic characteristics may lead to mutual interference and possible unintended equipment operation. Further, other types of equipments can generate similar electromagnetic interference affecting the conversion accuracy of the modules. In the physical configuration, a single slice of non-interfering equipment is sufficient to avoid this type of disturbance. Separate the 16-bit analog modules from each other and from the following equipment:

- TM5SBER2 Bus receiver
- TM5SPS2 and TM5SPS2F Power Distribution Modules
- TM258••• and LMC058••• Controllers:

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Do not place 16-bit analog input modules next to each other.
- Do not place 16-bit analog input modules in direct proximity to equipment that generate electromagnetic interference.
- Insert at least one non-interfering slice between any 16-bit analog input module and any interference generating equipment.

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

Chapter 5
TM5SAI•PH Analog 16 Bits Temperature Input Electronic Module PT100/PT1000

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
5.1	TM5SAI2PH Electronic Module 2AI PT100/PT1000 16 Bits	76
5.2	TM5SAI4PH Electronic Module 4AI PT100/PT1000 16 Bits	85

Section 5.1
TM5SAI2PH Electronic Module 2AI PT100/PT1000 16 Bits

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SAI2PH Presentation	77
TM5SAI2PH Characteristics	79
TM5SAI2PH Wiring Diagram	82

TM5SAI2PH Presentation

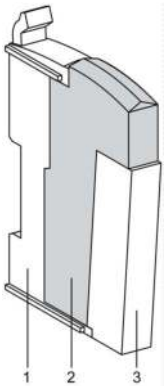
Main Characteristics

The table below describes the main characteristics of the TM5SAI2PH electronic module:

Main Characteristics		
Number of input channels	2	
Measurement type	Temperature	Resistance
Input sensor type	PT100 or PT1000	-
Input range	-200°C...850°C	0.1 Ω...4500 Ω / 0.05 Ω...2250 Ω
Resolution	16-bit	

Ordering Information

The following figure shows the slice with a TM5SAI2PH:



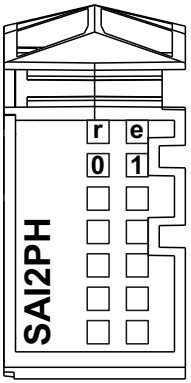
The table below shows the model numbers for the terminal block and bus base associated to TM5SAI2PH:

Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White
2	TM5ASAI2PH	Electronic module	White
3	TM5ACTB06 or TM5ACTB12	Terminal block, 6 pins Terminal block, 12 pins	White White

NOTE: For more information, refer to *TM5 bus bases and terminal blocks*

Status LEDs

The following figure shows the LEDs for TM5SAI2PH:



The table below shows the TM5SAI2PH status LEDs:

LEDs	Color	Status	Description
r	Green	Off	No power supply
		Single Flash	Reset state
		Flashing	Preoperational state
		On	Normal operation
e	Red	Off	OK or no power supply
		On	Detected error or reset state
		Single Flash	Detected error for an I/O channel.
e+r	Steady Red / Single Green Flash		Invalid firmware
0-1	Green	Off	Channel not configured
		Flashing	Overflow, underflow or broken wire detected
		On	The analog/digital converter is running, value is available

TM5SAI2PH Characteristics

Introduction

This is the description characteristics for **TM5SAI2PH** electronic module.

See also **Environmental Specifications** *(see page 25)*.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

General Characteristics

The table below describes the general characteristics of the TM5SAI2PH electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to the 24 Vdc I/O power segment
Power supply range	20.4...28.8 Vdc
24 Vdc I/O segment current draw	46 mA
TM5 Bus 5 Vdc current draw	2 mA
Power dissipation	1.11 W max.
Weight	25 g (0.9 oz)
Id code for firmware update	7078 dec

Input Characteristics

The table below describes the input characteristics of the TM5SAI2PH electronic module:

Input Characteristics		
Input sensor type		PT100/PT1000
Input temperature range		PT100: -200...850°C *(-328...1562°F)* PT1000: -200...850°C *(-328...1562°F)*
Resistance measurement range		1st mode: 0.1...4500 Ω 2nd mode: 0.05...2250 Ω
Measuring current		250 µA ± 1.25%
Sample duration time		See Cycle Time and I/O Update Time
Wiring type		2-wire or 3-wire connection configured by software for all inputs
Conversion mode		Sigma delta type
Input filter		Low pass 1st order / cut-off frequency 500 Hz
Input tolerance - maximum deviation at ambient 25°C (77°F)		0.037% of the measurement
Input tolerance - temperature drift		0.004% / °C of the measurement
Input tolerance - non linearity		0.0010% of the entire resistance range
Digital resolution		16-bit
Resolution temperature value		PT1000: 0.1°C *(0.18°F)*
		PT100: 0.1°C *(0.18°F)*
Resolution resistance value		1st mode: 0.1 Ω 2nd mode: 0.05 Ω
Common mode rejection	DC	95 dB min.
	50 Hz	80 dB min.
Noise resistance - cable		Shielded cable is necessary
Crosstalk rejection between channels		93 dB min.
Isolation between channels		Not isolated

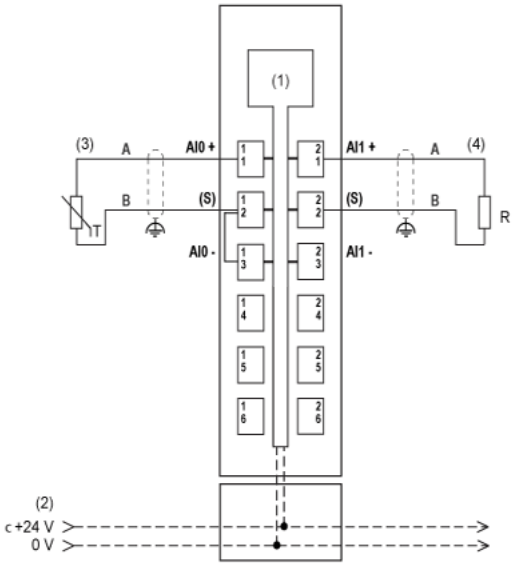
Input Characteristics	
Isolation between channels and bus	See note [1].
Permitted input signal	±30 Vdc max.
Input protection	Protection against wiring with 24 Vdc supply voltage
Common mode voltage allowable between channels	2 Vdc max.

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

TM5SAI2PH Wiring Diagram

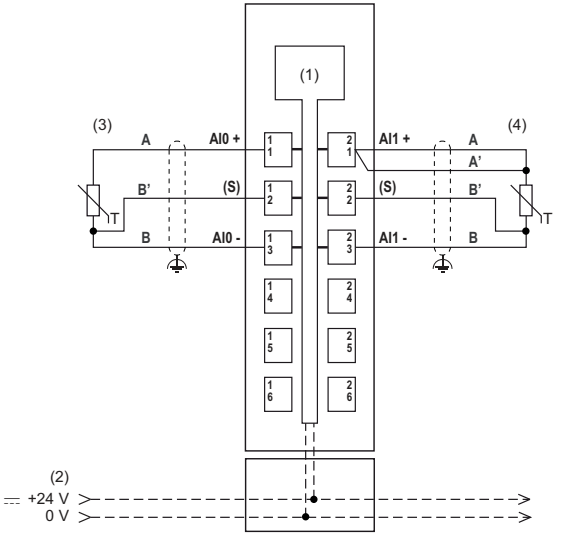
Wiring Diagram

The following figure shows the 2-wire wiring diagram of TM5SAI2PH:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(3): 2-wire sensor
(S): Sensor
(4): Resistor

The following figure shows the 3-wire and 4-wire wiring diagram for TM5SAI2PH:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(3): 3-wire sensor
(4): 4-wire sensor
(S): Sensor

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

NOTICE

INOPERABLE EQUIPMENT

Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel.

Failure to follow these instructions can result in equipment damage.

Section 5.2
TM5SAI4PH Electronic Module 4AI PT100/PT1000 16 Bits

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SAI4PH Presentation	86
TM5SAI4PH Characteristics	88
TM5SAI4PH Wiring Diagram	91

TM5SAI4PH Presentation

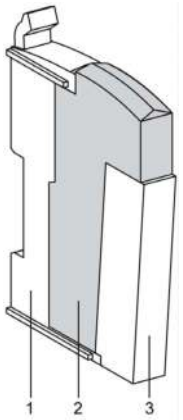
Main Characteristics

The table below describes the main characteristics of the TM5SAI4PH electronic module:

Main Characteristics		
Number of input channels	4	
Measurement type	Temperature	Resistance
Input sensor type	PT100 or PT1000	-
Input range	-200.0°C...850.0°C	0.1 Ω...4500.0 Ω / 0.05 Ω...2250.0 Ω
Resolution	16-bit	

Ordering Information

The following figure shows the slice with a TM5SAI4PH:



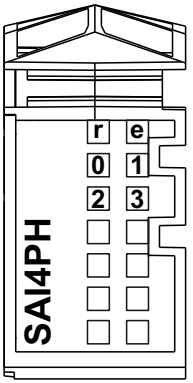
The table below shows the model numbers for the terminal block and bus base associated to TM5SAI4PH:

Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White
2	TM5ASAI4PH	Electronic module	White
3	TM5ACTB12	Terminal block, 12 pins	White

NOTE: For more information, refer to *TM5 bus bases and terminal blocks*

Status LEDs

The following figure shows the TM5SAI4PH status LEDs:



The table below shows the TM5SAI4PH status LEDs:

LEDs	Color	Status	Description
r	Green	Off	No power supply
		Single Flash	Reset state
		Flashing	Preoperational state
		On	Normal operation
e	Red	Off	OK or no power supply
		On	Detected error or reset state
		Single Flash	Detected error for an I/O channel.
e+r	Steady Red / Single Green Flash		Invalid firmware
0-3	Green	Off	Channel not configured
		Flashing	Overflow, underflow or broken wire detected
		On	The analog/digital converter is running, value is available

TM5SAI4PH Characteristics

Introduction

This is the description characteristics for **TM5SAI4PH** electronic module.

See also **Environmental Specifications** *(see page 25)*.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

General Characteristics

The table below describes the general characteristics of the TM5SAI4PH electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to the 24 Vdc I/O power segment
Power supply range	20.4...28.8 Vdc
24 Vdc I/O segment current draw	46 mA
TM5 Bus 5 Vdc current draw	2 mA
Power dissipation	1.11 W max.
Weight	25 g (0.9 oz)
Id code for firmware update	7079 dec

Input Characteristics

The table below describes the input characteristics of the TM5SAI4PH electronic module:

Input Characteristics		
Input sensor type		PT100/PT1000
Input temperature range		PT100: -200...850°C *(-328...1562°F)* PT1000: -200...850°C *(-328...1562°F)*
Resistance measurement range		1st mode: 0.1...4500 Ω 2nd mode: 0.05...2250 Ω
Measuring current		250 µA ± 1.25%
Sample duration time		See Cycle Time and I/O Update Time
Wiring type		2-wire or 3-wire connection configured by software for all inputs
Conversion mode		Sigma delta type
Input filter		Low pass 1st order / cut-off frequency 500 Hz
Input tolerance - maximum deviation at ambient 25°C (77°F)		0.037% of the measurement
Input tolerance - temperature drift		0.004% / °C of the measurement
Input tolerance - non linearity		0.001% of the entire resistance range
Digital resolution		16-bit
Resolution temperature value		PT1000: 0.1°C *(0.18°F)*
		PT100: 0.1°C *(0.18°F)*
Resolution resistance value		1st mode: 0.1 Ω 2nd mode: 0.05 Ω
Common mode rejection	DC	95 dB min.
	50 Hz	80 dB min.
Noise resistance - cable		Shielded cable is necessary
Crosstalk rejection between channels		93 dB min.
Isolation between channels		Not isolated

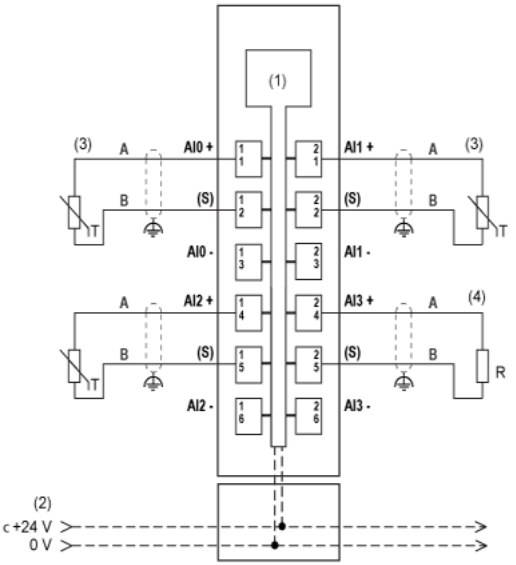
Input Characteristics	
Isolation between channels and bus	See note [1].
Permitted input signal	±30 Vdc max.
Input protection	Protection against wiring with 24 Vdc supply voltage
Common mode voltage allowable between channels	2 Vdc max.

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

TM5SAI4PH Wiring Diagram

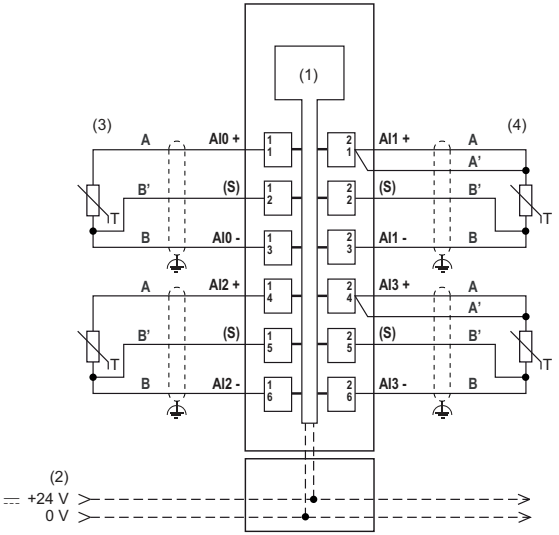
Wiring Diagram

The following figure shows the 2-wire wiring diagram of TM5SAI4PH:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(3): 2-wire sensor
(S): Sensor
(4): Resistor

The following figure shows the 3-wire and 4-wire wiring diagram of TM5SAI4PH:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(3): 3-wire sensor
(4): 4-wire sensor
(S): Sensor

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

NOTICE

INOPERABLE EQUIPMENT

Verify that the physical wiring of the analog circuit is compatible with the software configuration for the analog channel.

Failure to follow these instructions can result in equipment damage.

Chapter 6
TM5SAI•TH Analog 16 Bits Temperature Input Electronic Module Thermocouple J/K/N/S

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
6.1	TM5SAI2TH Electronic Module 2AI Thermocouple J/K/N/S 16 Bits	96
6.2	TM5SAI6TH Electronic Module 6AI Thermocouple J/K/N/S 16 Bits	106

Section 6.1
TM5SAI2TH Electronic Module 2AI Thermocouple J/K/N/S 16 Bits

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SAI2TH Presentation	97
TM5SAI2TH Characteristics	100
TM5SAI2TH Wiring Diagram	103

TM5SAI2TH Presentation

Main Characteristics

The table below describes the main characteristics of the TM5SAI2TH module:

Main Characteristics		
Number of input channels	2	
Measurement type	Temperature	Voltage
Input sensor type	J, K, N, S, B and R thermocouple sensors	
Input range	Type J: -210...1200°C *(-346...2192°F)* Type K: -270...1372°C *(-454...2501°F)* Type N: -270...1300°C *(-454...2372°F)* Type S: -50...1768°C *(-58...3214°F)* Type B: 0...1820°C *(32...3308°F)* Type R: -50...1768°C *(-58...3214°F)* 1 µV per bit 2 µV per bit	± 65.534 mV
Resolution	16-bit	

The thermocouple modules are configured as a whole for the same type of thermocouple sensor. You cannot mix thermocouple sensor types on the same module, otherwise the temperature readings will not be correct.

⚠ WARNING

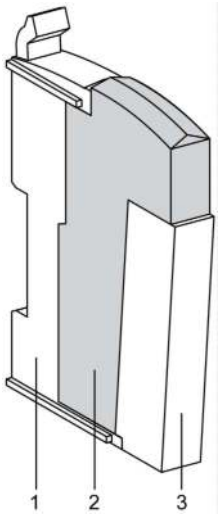
UNINTENDED EQUIPMENT OPERATION

- Only connect thermocouple sensors of the same type to the temperature module.
- Configure the module for the correct type of thermocouple.

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

Ordering Information

The following figure shows the slice with a TM5SAI2TH:



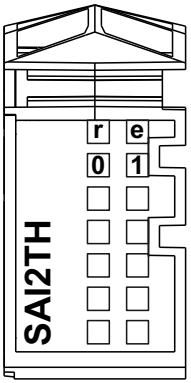
The table below shows the model numbers for the terminal block and bus base associated to TM5SAI2TH:

Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White
2	TM5ASAI2TH	Electronic module	White
3	TM5ACTB06 or TM5ACTB12	Terminal block, 6 pins Terminal block, 12 pins	White White

NOTE: For more information, refer to *TM5 bus bases and terminal blocks*

Status LEDs

The following figure shows theTM5SAI2TH status LEDs:



The table below shows theTM5SAI2TH status LEDs:

LEDs	Color	Status	Description
r	Green	Off	No power supply
		Single Flash	Reset state
		Flashing	Preoperational state
		On	Normal operation
e	Red	Off	OK or no power supply
		On	Detected error or reset state
		Single Flash	Detected error for an I/O channel.
e+r	Steady Red / Single Green Flash		Invalid firmware
0-1	Green	Off	Channel not configured
		Flashing	Overflow, underflow or broken wire detected
		On	The analog/digital converter is running, value is available

TM5SAI2TH Characteristics

Introduction

This is the description characteristics for **TM5SAI2TH** electronic module.

See also Environmental Characteristics *(see page 25)*.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

General Characteristics

The table below describes the general characteristics of the TM5SAI2TH electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to the 24 Vdc I/O power segment
Power supply range	20.4...28.8 Vdc
24 Vdc I/O segment current draw	30 mA
TM5 Bus 5 Vdc current draw	2 mA
Power dissipation	0.73 W max.
Weight	25 g (0.9 oz)
Id code for firmware update	7080 dec

Input Characteristics

The table below describes the input characteristics of the TM5SAI2TH electronic module:

Input Characteristics		
Input sensor type		Thermocouple
Input temperature range		Type J: -210...1200°C *(-346...2192°F)* Type K: -270...1372°C *(-454...2501°F)* Type N: -270...1300°C *(-454...2372°F)* Type S: -50...1768°C *(-58...3214°F)* Type B: 0...1820°C *(32...3308°F)*[2] Type R: -50...1768°C *(-58...3214°F)*[2] 1 µV per bit[2] 2 µV per bit[2]
Input voltage range		± 65.534 mV
Sample duration time		See Cycle Time and I/O Update Time
Conversion mode		Sigma delta type
Input filter		Low pass 1st order / cut-off frequency 500 Hz
Input time		1...66.7 ms configurable by software
Input tolerance - maximum deviation at ambient 25°C (77°F)		Type J: ± 0.10% of the measurement Type K: ± 0.11% of the measurement Type N: ± 0.11% of the measurement Type S: ± 0.17% of the measurement
Input tolerance - temperature drift		0.01% / °C of the measurement
Input tolerance - non linearity		± 0.001% of the entire measurement range
Input tolerance - terminal temperature compensation		± 5°C after 10 min
Digital resolution		16-bit
Resolution temperature value		0.1°C *(0.18°F)*
Common mode rejection	DC	70 dB min.
	50 Hz	70 dB min.
Noise resistance - cable		Shielded cable is necessary
Crosstalk rejection between channels		70 dB min.

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

[2] Designed for use with Sercos III (TM5NS31) and EtherNet/IP (TM5NEIP1).

Input Characteristics	
Isolation between channels	Not isolated
Isolation between channels and bus	See note [1].
Permitted input signal	± 5 Vdc max.
Input protection	Protection against wiring with 24 Vdc supply voltage
Common mode voltage allowable between channels	± 15 Vdc max.

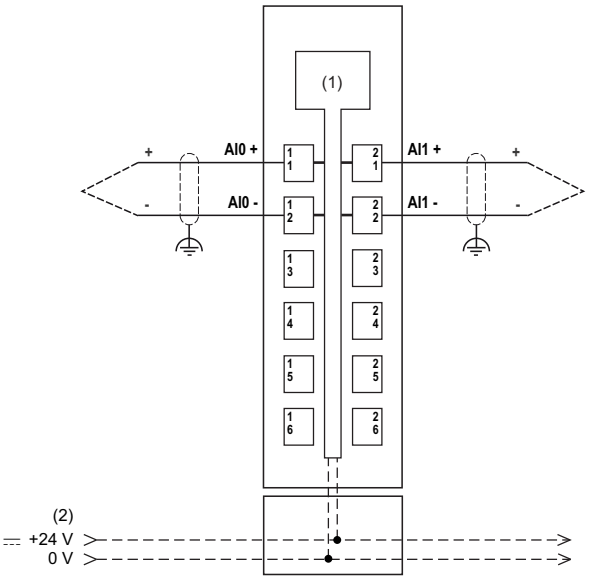
[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

[2] Designed for use with Sercos III (TM5NS31) and EtherNet/IP (TM5NEIP1).

TM5SAI2TH Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for TM5SAI2TH:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Ceramic Heating Element with Integrated Thermo Elements

Ripple voltage effects can potentially cause measurement errors.

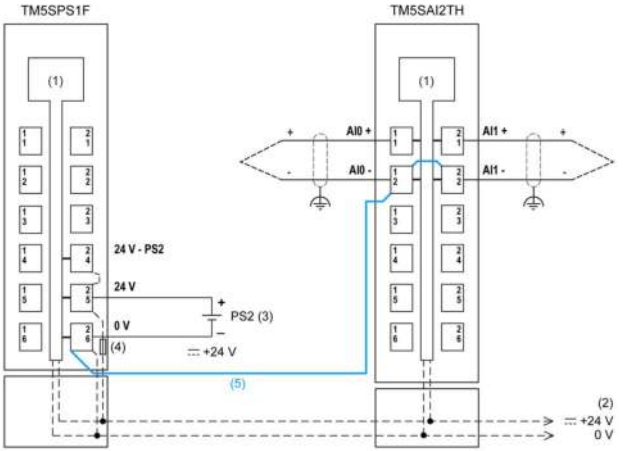
⚠ WARNING

RIPPLE VOLTAGE CAN CAUSE UNINTENDED EQUIPMENT OPERATION

Connect the negative input of the thermocouple element to the negative input of the power module that is supplying the thermocouple.

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

The following figure shows the wiring diagram for TM5SAI2TH with a PDM:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(3): PS2: External isolated power supply 24 Vdc
(4): Integrated fuse type T slow-blow 6.3 A 250 V exchangeable
(5): Connection of the negative inputs of the thermocouple module with negative input of PDM

Section 6.2
TM5SAI6TH Electronic Module 6AI Thermocouple J/K/N/S 16 Bits

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SAI6TH Presentation	107
TM5SAI6TH Characteristics	110
TM5SAI6TH Wiring Diagram	113

TM5SAI6TH Presentation

Main Characteristics

The table below describes the main characteristics of the TM5SAI6TH module:

Main Characteristics		
Number of input channels	6	
Measurement type	Temperature	Voltage
Input sensor type	J, K, N and S thermocouple sensors	
Input range	Type J: -210...1200°C *(-346...2192°F)* Type K: -270...1372°C *(-454...2501°F)* Type N: -270...1300°C *(-454...2372°F)* Type S: -50...1768°C *(-58...3214°F)* 1 µV per bit(1) 2 µV per bit(1) Sensor type R(1) Sensor type B(1)	± 65.534 mV
Resolution	16-bit	
(1) Designed for use with Sercos III (TM5NS31) and EtherNet/IP (TM5NEIP1).		

The thermocouple modules are configured as a whole for the same type of thermocouple sensor. You cannot mix thermocouple sensor types on the same module, otherwise the temperature readings will not be correct.

⚠ WARNING

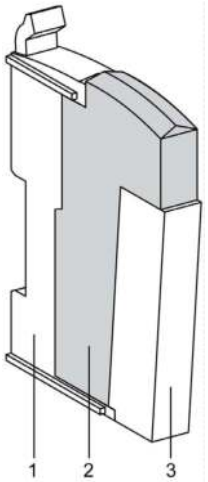
UNINTENDED EQUIPMENT OPERATION

- Only connect thermocouple sensors of the same type to the temperature module.
- Configure the module for the correct type of thermocouple.

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

Ordering Information

The following figure shows the slice with a TM5SAI6TH:



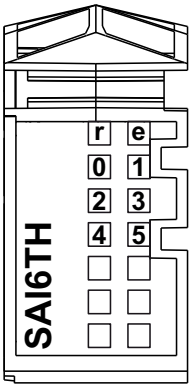
The table below shows the model numbers for the terminal block and bus base associated to TM5SAI6TH:

Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White
2	TM5ASAI6TH	Electronic module	White
3	TM5ACTB12	Terminal block, 12 pins	White

NOTE: For more information, refer to *TM5 bus bases and terminal blocks (see Modicon TM5 / TM7 Flexible System, System Planning and Installation Guide)*

Status LEDs

The following figure shows the TM5SAI6TH status LEDs:



The table below shows the TM5SAI6TH status LEDs:

LEDs	Color	Status	Description
r	Green	Off	No power supply
		Single Flash	Reset state
		Flashing	Preoperational state
		On	Normal operation
e	Red	Off	OK or no power supply
		On	Detected error or reset state
		Single Flash	Detected error for an I/O channel.
e+r	Steady Red / Single Green Flash		Invalid firmware
0-5	Green	Off	Channel not configured
		Flashing	Overflow, underflow or broken wire detected
		On	The analog/digital converter is running, value is available

TM5SAI6TH Characteristics

Introduction

This is the description characteristics for **TM5SA6TH** electronic module.

See also Environmental Characteristics *(see page 25)*.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

General Characteristics

The table below describes the general characteristics of the TM5SAI6TH electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to the 24 Vdc I/O power segment
Power supply range	20.4...28.8 Vdc
24 Vdc I/O segment current draw	38 mA
TM5 Bus 5 Vdc current draw	2 mA
Power dissipation	0.92 W max.
Weight	25 g (0.9 oz)
Id code for firmware update	7081 dec

Input Characteristics

The table below describes the input characteristics of the TM5SAI6TH electronic module:

Input Characteristics		
Input sensor type		Thermocouple
Input temperature range		Type J: -210...1200°C *(-346...2192°F)* Type K: -270...1372°C *(-454...2501°F)* Type N: -270...1300°C *(-454...2372°F)* Type S: -50...1768°C *(-58...3214°F)* 1 µV per bit[2] 2 µV per bit[2] Sensor type R[2] Sensor type B[2]
Input voltage range		± 65.534 mV
Sample duration time		See Cycle Time and I/O Update Time
Conversion mode		Sigma delta type
Input filter		Low pass 1st order / cut-off frequency 500 Hz
Input time		1...66.7 ms configurable by software
Input tolerance - maximum deviation at ambient 25° C (77°F)		Type J: ± 0.10% of the measurement Type K: ± 0.11% of the measurement Type N: ± 0.11% of the measurement Type S: ± 0.17% of the measurement
Input tolerance - temperature drift		0.01% / °C of the measurement
Input tolerance - non linearity		± 0.001% of the entire measurement range
Input tolerance - terminal temperature compensation		± 5°C after 10 min
Digital resolution		16-bit
Resolution temperature value		0.1°C *(0.18°F)*
Common mode rejection	DC	70 dB min.
	50 Hz	70 dB min.
Noise resistance - cable		Shielded cable is necessary
Crosstalk rejection between channels		70 dB min.

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

[2] Designed for use with Sercos III (TM5NS31) and EtherNet/IP (TM5NEIP1).

Input Characteristics	
Isolation between channels	Not isolated
Isolation between channels and bus	See note [1].
Permitted input signal	± 5 Vdc max.
Input protection	Protection against wiring with 24 Vdc supply voltage.
Common mode voltage allowable between channels	± 15 Vdc max.

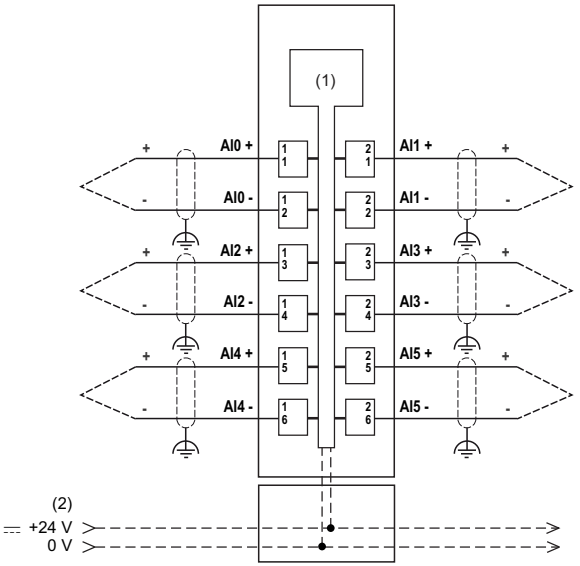
[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

[2] Designed for use with Sercos III (TM5NS31) and EtherNet/IP (TM5NEIP1).

TM5SAI6TH Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for TM5SAI6TH:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

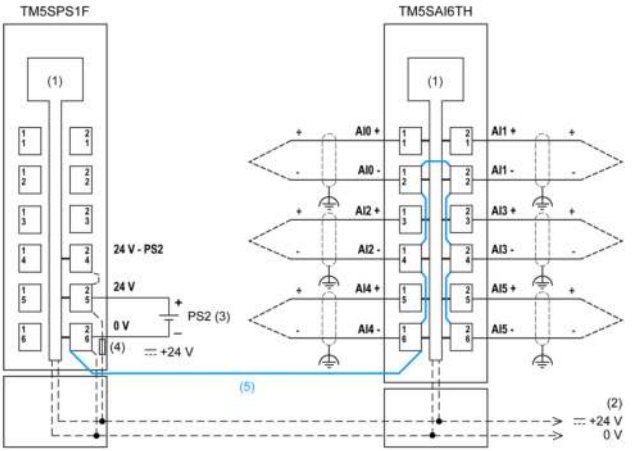
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Ceramic Heating Element with Integrated Thermo Elements

Ripple voltage effects can potentially cause measurement errors.

⚠ WARNING
RIPPLE VOLTAGE CAN CAUSE UNINTENDED EQUIPMENT OPERATION Connect the negative input of the thermocouple element to the negative input of the power module that is supplying the thermocouple. **Failure to follow these instructions can result in death, serious injury, or equipment damage.**

The following figure shows the wiring diagram for TM5SAI6TH with a PDM:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(3): PS2: External isolated power supply 24 Vdc
(4): Integrated fuse type T slow-blow 6.3 A 250 V exchangeable
(5): Connection of the negative inputs of the thermocouple module with negative input of PDM

Chapter 7
TM5SEAISG Analog Strain Gauge Input Electronic Module

What Is in This Chapter?

This chapter contains the following topics:

Topic	Page
TM5SEAISG Presentation	118
TM5SEAISG Characteristics	120
TM5SEAISG Wiring Diagram	123

TM5SEAISG Presentation

Main Characteristics

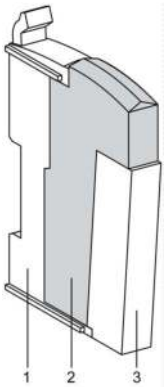
The table below describes the main characteristics of the TM5SEAISG module:

Main Characteristics	
Number of input channels	1
Measurement type	Full-bridge strain gauge
Sensor operating range	85...5000 Ω
Resolution	24-bit

For configuring and programming your TM5SEAISG electronic module, refer to IoDrvTM5SEAISG Strain Gauge Library Guide.

Ordering Information

The following figure shows the slice with a TM5SEAISG:



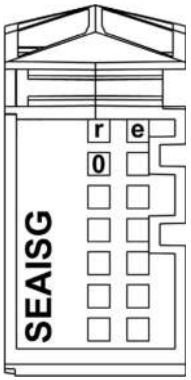
The table below shows the model numbers for the terminal block and bus base associated to TM5SEAISG:

Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White
2	TM5SEAISG	Electronic module	White
3	TM5ACTB12	Terminal block, 12 pins	White

NOTE: For more information, refer to *TM5 bus bases and terminal blocks*

Status LEDs

The following figure shows theTM5SEAISG status LEDs:



The table below shows theTM5SEAISG status LEDs:

LEDs	Color	Status	Description
r	Green	Off	No power supply
		Single Flash	Reset state
		Flashing	Preoperational state
		On	Normal operation
e	Red	Off	OK or no power supply
		On	Detected error or reset state
0	Green	Off	Broken wire detected The analog/digital converter is busy
		On	The analog/digital converter is running, value is available

TM5SEAISG Characteristics

Introduction

This is the description characteristics for the TM5SEAISG electronic module. See also Environmental Characteristics *(see page 25)*

⚠ DANGER

FIRE HAZARD

Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

General Characteristics

The table below describes the general characteristics of the TM5SEAISG electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to the 24 Vdc I/O power segment
Power supply range	20.4...28.8 Vdc
24 Vdc I/O segment current draw	52 mA
TM5 Bus 5 Vdc current draw	2 mA
Power dissipation	1.25 W max.
Weight	25 g (0.9 oz)
ID code for firmware update	7390 dec

Input Characteristics of Analog Channels

The table describes the input characteristics of analog channels of the TM5SEAISG electronic module:

Input Characteristics	Full-bridge Strain Gauge
Number of inputs	1
Bridge factor	+/- 2...+/- 256 mV/Vdc configurable using `ConfigOutput00` ADC configuration register. Refer to Expansion Bus I/O Mapping Tab.
Input type	Differential
Input current	690 nA
Sensor operating range	85...5000 Ω
Conversion time	Depends on the data output rate
Data output rate	2.5...7500 samples per second, configured by software
Conversion mode	Sigma delta type
Input filter	Third order / attenuation 60 dB / cut-off frequency 5 kHz
Input tolerance - temperature drift	10 ppm
Digital resolution	24 bits
Resolution	Refer to effective resolution of the strain gauge value in bits
Wire	Shielded, twisted pair cable length < 30 m (98.42 ft)[1]
Input protection	Protection against wiring with 24 Vdc supply voltage
(1) The shielded, twisted pair cable should be as short as possible and run separately to the sensor (isolated from load circuit) without intermediate terminals.	

Full-bridge Strain Gauge Supply Characteristics

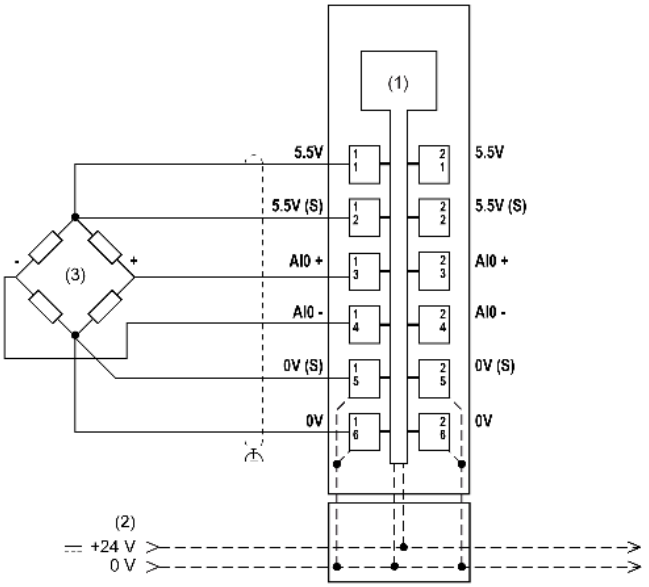
Full-bridge Supply Characteristics		
Number of full-bridge		4 max.
Wiring type		4 or 6 wires
Supply voltage		5.5 Vdc
Supply current		65 mA max.
Voltage drop		0.2 Vdc max. at 65 mA
Supply protection		Overload short-circuit
Isolation	Between input and internal bus	See note [1]
	Between supply and internal bus	See note [1]

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

TM5SEAISG Wiring Diagram

Wiring Diagram

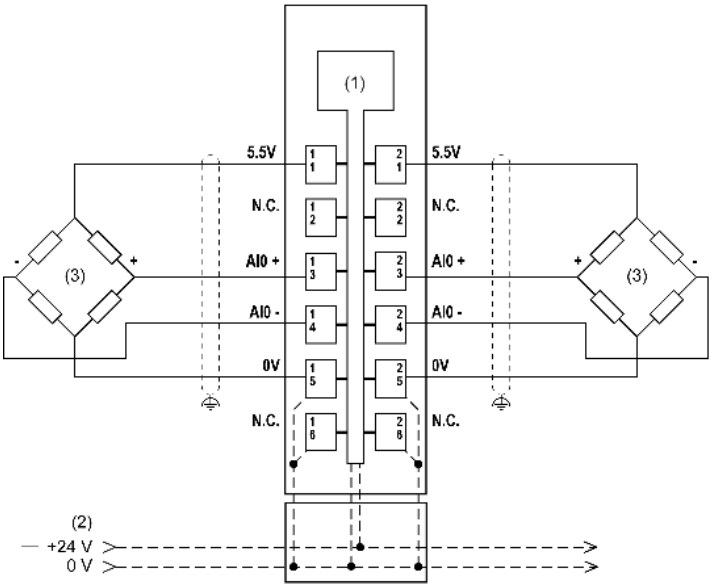
The following figure shows the wiring diagram for TM5SEAISG with a 6-wire full-bridge strain gauge:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(3): 6-wire full-bridge strain gauge
(S): Sensor

NOTE: For parallel connection of full-bridge strain gauges, refer to the guidelines of the sensor manufacturer.

The following figure shows the wiring diagram for TM5SEAISG with two 4-wire full-bridge strain gauges:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(3): 4-wire full-bridge strain gauge

NOTE: For parallel connection of full-bridge strain gauges, refer to the guidelines of the sensor manufacturer.

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Part III
TM5 System Analog Output Electronic Modules

Chapter 8
TM5SAO•• Analog Output Electronic Module

What Is in This Chapter?

This chapter contains the following sections:

Section	Topic	Page
8.1	TM5SAO2L Electronic Module 2AO ±10V/0-20mA 12 Bits	130
8.2	TM5SAO4L Electronic Module 4AO ±10V/0-20mA 12 Bits	137
8.3	TM5SAO2H Electronic Module 2AO ±10V/0-20mA 16 Bits	146
8.4	TM5SAO4H Electronic Module 4AO ±10V/0-20mA 16 Bits	153

Section 8.1
TM5SAO2L Electronic Module 2AO ±10V/0-20mA 12 Bits

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SAO2L Presentation	131
TM5SAO2L Characteristics	133
TM5SAO2L Wiring Diagram	135

TM5SAO2L Presentation

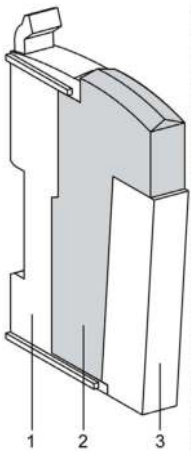
Main Characteristics

The table below describes the main characteristics of the TM5SAO2L electronic module:

Main Characteristics		
Number of output channels	2	
Signal type	Voltage	Current
Output range	-10...+10 Vdc	0...20 mA
Resolution	12 bits + sign	12 bits

Ordering Information

The following figure shows the slice with a TM5SAO2L:



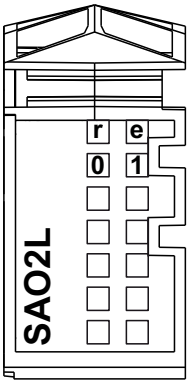
The table below shows the model numbers for the terminal block and bus base associated to TM5SAO2L:

Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White
2	TM5ASAO2L	Electronic module	White
3	TM5ACTB06 or TM5ACTB12	Terminal block, 6 pins Terminal block, 12 pins	White White

NOTE: For more information, refer to *TM5 bus bases and terminal blocks*

Status LEDs

The following figure shows the TM5SAO2L status LEDs:



The table below shows the TM5SAO2L status LEDs:

LEDs	Color	Status	Description
r	Green	Off	No power supply
		Single Flash	Reset state
		Flashing	Preoperational state
		On	Normal operation
e	Red	Off	OK or no power supply
		On	Detected error or reset state
0-1	Yellow	Off	Value = 0
		On	Value ≠ 0

TM5SAO2L Characteristics

Introduction

This is the description characteristics for the **TM5SAO2L** electronic module.

See also Environmental Characteristics *(see page 25)*.

⚠ DANGER

FIRE HAZARD

Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

General Characteristics

The table below describes the general characteristics of the TM5SA02L electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to the 24 Vdc I/O power segment
Power supply range	20.4...28.8 Vdc
24 Vdc I/O segment current draw	46 mA
TM5 Bus 5 Vdc current draw	2 mA
Power dissipation	1.11 W max.
Weight	25 g (0.9 oz)
ID code for firmware update	7074 dec

Output Characteristics

The table below describes the output characteristics of the TM5SA02L electronic module:

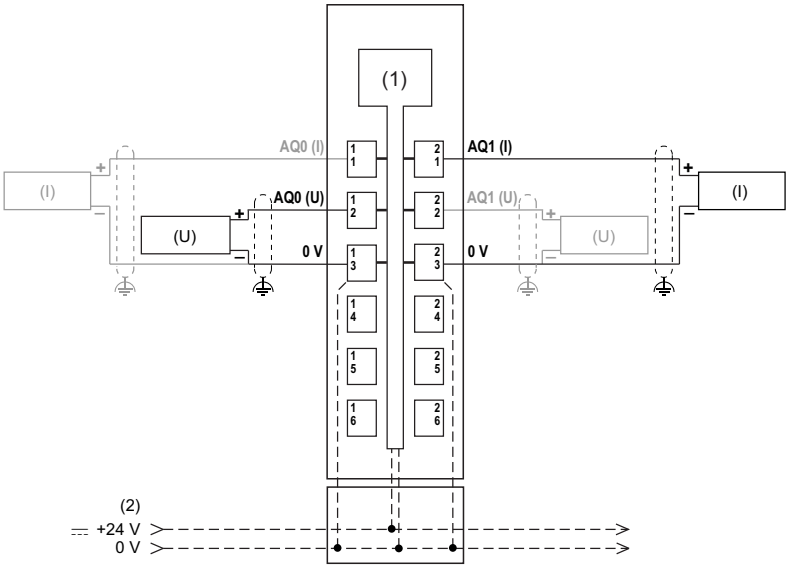
Characteristic	Voltage Output	Current Output
Output range	-10...+10 Vdc	0...20 mA
Output impedance	1 kΩ min.	-
Load impedance	-	500 Ω max.
Sample duration time	200 µs for all outputs	
Output type	Differential	
Response time for output change	1 ms max.	
Output tolerance - maximum deviation at ambient 25° C (77° F)	< 0.15% of the measurement	
Output tolerance - temperature drift	0.02% / °C of the measurement	
Output tolerance - non linearity	< 0.007% of the full scale (20 Vdc)	< 0.007% of the full scale (20 mA)
Output tolerance - maximum deviation caused by load change	0.02% from 10 MΩ to 1 kΩ, resistive	0.5% from 1 Ω to 500 Ω, resistive
Digital resolution	12 bits + sign	12 bits
Resolution value	4.882 mV	9.766 µA
Noise resistance - cable	Shielded cable is necessary	
Isolation between channels	Not isolated	
Isolation between channels and bus	See note [1].	
Output protection	Short circuit protection: current limitation is 40 mA	

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

TM5SAO2L Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for TM5SAO2L:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(I): Current
(U): Voltage

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Section 8.2
TM5SAO4L Electronic Module 4AO ±10V/0-20mA 12 Bits

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SAO4L Presentation	138
TM5SAO4L Characteristics	140
TM5SAO4L Wiring Diagram	144

TM5SAO4L Presentation

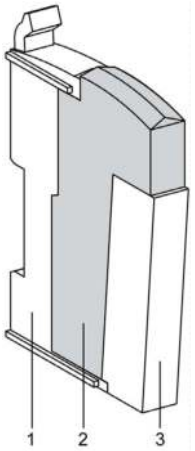
Main Characteristics

The table below describes the main characteristics of the TM5SAO4L electronic module:

Main Characteristics		
Number of output channels	4	
Signal type	Voltage	Current
Output range	-10...+10 Vdc	0...20 mA
Resolution	12 bits + sign	12 bits

Ordering Information

The following figure shows the slice with a TM5SAO4L:



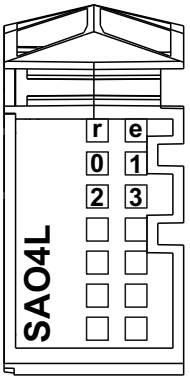
The table below shows the model numbers for the terminal block and bus base associated to TM5SAO4L:

Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White
2	TM5ASAO4L	Electronic module	White
3	TM5ACTB12	Terminal block, 12 pins	White

NOTE: For more information, refer to *TM5 bus bases and terminal blocks*

Status LEDs

The following figure shows the TM5SAO4L status LEDs:



The table below shows the TM5SAO4L status LEDs:

LEDs	Color	Status	Description
r	Green	Off	No power supply
		Single Flash	Reset state
		Flashing	Preoperational state
		On	Normal operation
e	Red	Off	OK or no power supply
		On	Detected error or reset state
0-3	Yellow	Off	Value = 0
		On	Value ≠ 0

TM5SAO4L Characteristics

Introduction

This is the description characteristics for the **TM5SAO4L** electronic module.

See also Environmental Characteristics *(see page 25)*.

⚠ DANGER

FIRE HAZARD

Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

General Characteristics

The table below describes the general characteristics of the TM5SA04L electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to the 24 Vdc I/O power segment
Power supply range	20.4...28.8 Vdc
24 Vdc I/O segment current draw	63 mA
TM5 Bus 5 Vdc current draw	2 mA
Power dissipation	1.51 W max.
Weight	25 g (0.9 oz)
ID code for firmware update	7075 dec

Output Characteristics

The table below describes the output characteristics of the TM5SA04L electronic module:

Characteristic	Voltage Output	Current Output
Output range	-10...+10 Vdc	0...20 mA
Output impedance	1 kΩ min.	-
Load impedance	-	200 Ω min. 500 Ω max.
Sample duration time	300 µs for all outputs	
Output type	Differential	
Response time for output change	1 ms max.	
Output tolerance - maximum deviation at ambient 25° C (77° F)	< 0.08% of the measurement	
Output tolerance - temperature drift	0.015% / °C of the measurement	
Output tolerance - non linearity	< 0.005% of the full scale (20 Vdc)	< 0.005% of the full scale (20 mA)
De-rating *	See note *	
Output tolerance - maximum deviation caused by load change	0.02% from 10 MΩ to 1 kΩ, resistive	0.5% from 1 Ω to 500 Ω, resistive
Digital resolution	12 bits + sign	12 bits
Resolution value	4.882 mV	9.766 µA
Noise resistance - cable	Shielded cable is necessary	
Isolation between channels	Not isolated	
Isolation between channels and bus	See note 1.	
Output protection	Short circuit protection: current limitation is 40 mA	
* Note: These analog electronic modules are subject to operating temperature restrictions between 55 and 60 °C (131 and 140 °F). If the ambiant temperature of your installation may exceed 55 °C (131 °F), do not install the TM5SAI•H modules adjacent to other devices capable of dissipating more than 1.15 W. For more information refer to *Enclosing the TM5 System*.		

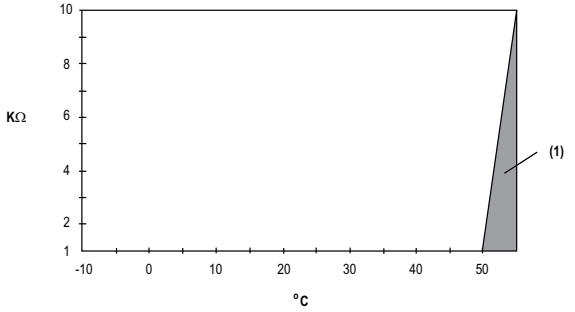
[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

De-rating the output load

The analog output modules can be configured as voltage outputs, current outputs, or a mix of voltage and current outputs. In the case of a mixed configuration, you must adjust the following de-rating information.

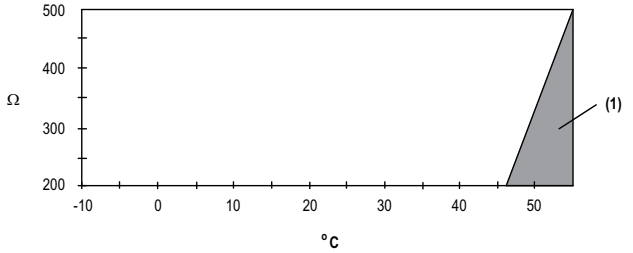
If only one of the outputs in the mix is configured as a current output, use the mean between the current and voltage curves. If more than one output in the mix is configured as a current output, use the current output de-rating curve. Otherwise, use the appropriate de-rating information as follows:

De-rating the voltage output load in a horizontal installation:



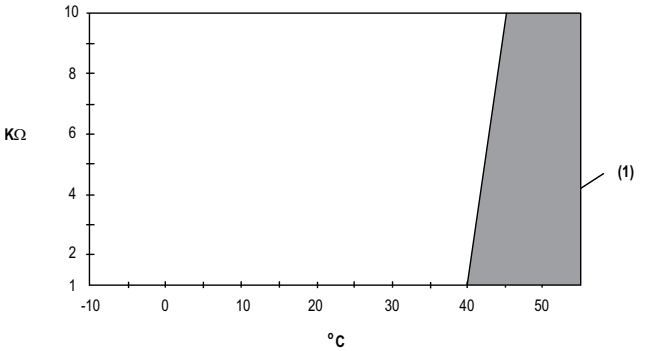
1 Invalid area

De-rating the current output load in a horizontal installation:



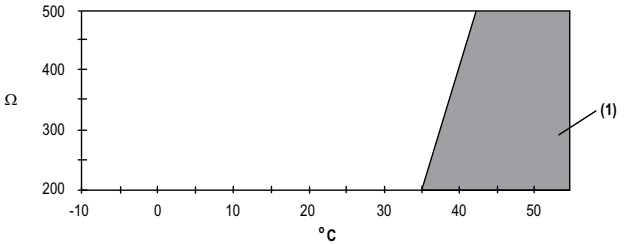
1 Invalid area

De-rating the voltage output load in a vertical installation:



1 Invalid area

De-rating the current output load in a vertical installation:

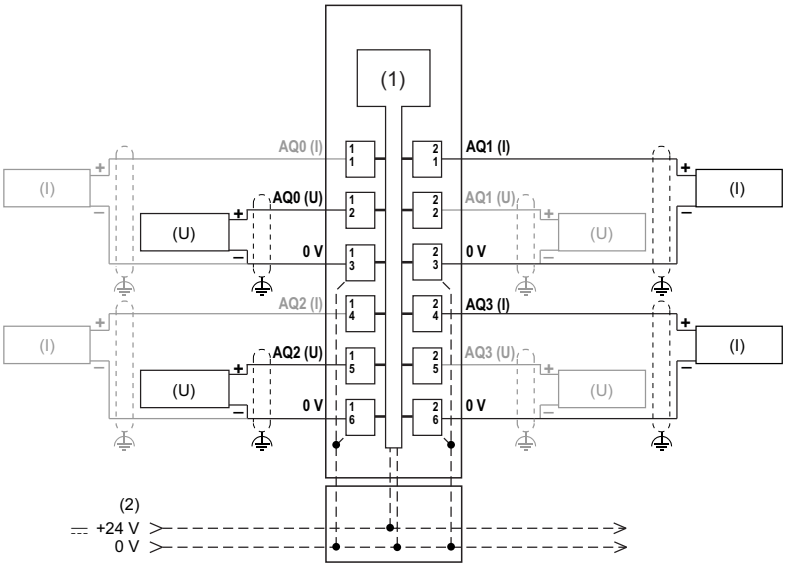


1 Invalid area

TM5SAO4L Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for TM5SAO4L:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(I): Current
(U): Voltage

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Section 8.3
TM5SAO2H Electronic Module 2AO ±10V/0-20mA 16 Bits

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SAO2H Presentation	147
TM5SAO2H Characteristics	149
TM5SAO2H Wiring Diagram	151

TM5SAO2H Presentation

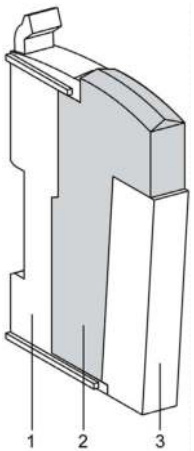
Main Characteristics

The table below describes the main characteristics of the TM5SAO2H electronic module:

Main Characteristics		
Number of output channels	2	
Signal type	Voltage	Current
Output range	-10...+10 Vdc	0...20 mA
Resolution	15 bits + sign	15 bits

Ordering Information

The following figure shows the slice with a TM5SAO2H:



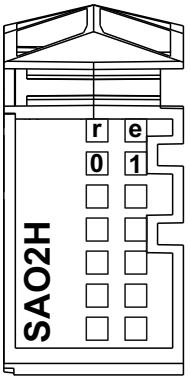
The table below shows the model numbers for the terminal block and bus base associated to TM5SAO2H:

Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White
2	TM5ASAO2H	Electronic module	White
3	TM5ACTB06 or TM5ACTB12	Terminal block, 6 pins Terminal block, 12 pins	White White

NOTE: For more information, refer to *TM5 bus bases and terminal blocks*

Status LEDs

The following figure shows the TM5SAO2H status LEDs:



The table below shows the TM5SAO2H status LEDs:

LEDs	Color	Status	Description
r	Green	Off	No power supply
		Single Flash	Reset state
		Flashing	Preoperational state
		On	Normal operation
e	Red	Off	OK or no power supply
		On	Detected error or reset state
0-1	Yellow	Off	Value = 0
		On	Value ≠ 0

TM5SAO2H Characteristics

Introduction

This is the description characteristics for the **TM5SAO2H** electronic module.

See also Environmental Characteristics *(see page 25)*.

⚠ DANGER

FIRE HAZARD

Use only the correct wire sizes for the maximum current capacity of the I/O channels and power supplies.

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

General Characteristics

The table below describes the general characteristics of the TM5SA02H electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to the 24 Vdc I/O power segment
Power supply range	20.4...28.8 Vdc
24 Vdc I/O segment current draw	50 mA
TM5 Bus 5 Vdc current draw	2 mA
Power dissipation	1.21 W max.
Weight	25 g (0.9 oz)
ID code for firmware update	7076 dec

Output Characteristics

The table below describes the output characteristics of the TM5SA02H electronic module:

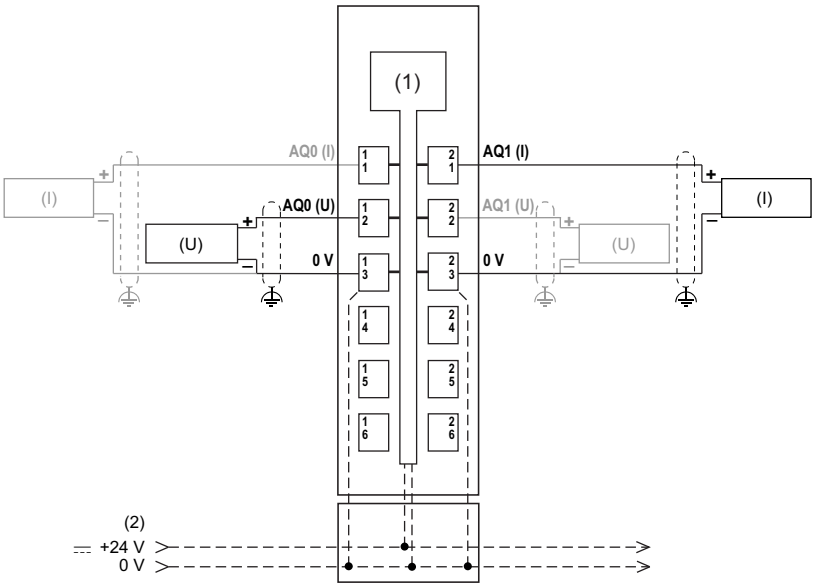
Characteristic	Voltage Output	Current Output
Output range	-10...+10 Vdc	0...20 mA
Output impedance	1 kΩ min.	-
Load impedance	+/- 10 mA max	500 Ω max.
Sample duration time	50 µs for all outputs	
Output type	Differential	
Response time for output change	1 ms max.	
Output tolerance - maximum deviation at ambient 25° C (77° F)	< 0.045% of the measurement	
Output tolerance - temperature drift	0.015% / °C of the measurement	
Output tolerance - non linearity	< 0.007% of the full scale (20 Vdc)	< 0.007% of the full scale (20 mA)
Output tolerance - maximum deviation caused by load change	0.02% from 10 MΩ to 1 kΩ, resistive	0.5% from 1 Ω to 500 Ω, resistive
Digital resolution	15 bits + sign	15 bits
Resolution value	305.176 µV	610.352 nA
Noise resistance - cable	Shielded cable is necessary	
Isolation between channels	Not isolated	
Isolation between channels and bus	See note [1].	
Output protection	Short circuit protection: current limitation is 40 mA	

[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

TM5SAO2H Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for TM5SAO2H:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(I): Current
(U): Voltage

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Section 8.4
TM5SAO4H Electronic Module 4AO ±10V/0-20mA 16 Bits

What Is in This Section?

This section contains the following topics:

Topic	Page
TM5SAO4H Presentation	154
TM5SAO4H Characteristics	156
TM5SAO4H Wiring Diagram	160

TM5SAO4H Presentation

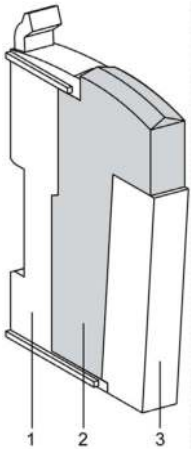
Main Characteristics

The table below describes the main characteristics of the TM5SAO4H electronic module:

Main Characteristics		
Number of output channels	4	
Signal type	Voltage	Current
Output range	-10...+10 Vdc	0...20 mA
Resolution	15 bits + sign	15 bits

Ordering Information

The following figure shows the slice with a TM5SAO4H:



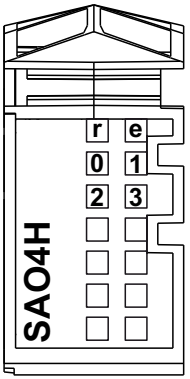
The table below shows the model numbers for the terminal block and bus base associated to TM5SAO4H:

Number	Model Number	Description	Color
1	TM5ACBM11 or TM5ACBM15	Bus base Bus base with address setting	White White
2	TM5ASAO4H	Electronic module	White
3	TM5ACTB12	Terminal block, 12 pins	White

NOTE: For more information, refer to *TM5 bus bases and terminal blocks*

Status LEDs

The following figure shows the TM5SAO4H status LEDs:



The table below shows the TM5SAO4H status LEDs:

LEDs	Color	Status	Description
r	Green	Off	No power supply
		Single Flash	Reset state
		Flashing	Preoperational state
		On	Normal operation
e	Red	Off	OK or no power supply
		On	Detected error or reset state
0-3	Yellow	Off	Value = 0
		On	Value ≠ 0

TM5SAO4H Characteristics

Introduction

This is the description characteristics for the **TM5SAO4H** electronic module.

See also Environmental Characteristics *(see page 25)*.

DANGER

FIRE HAZARD

Use only the correct wire sizes for the maximum current capacity of the power supplies.

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

General Characteristics

The table below describes the general characteristics of the TM5SA04H electronic module:

General Characteristics	
Rated power supply voltage Power supply source	24 Vdc Connected to the 24 Vdc I/O power segment
Power supply range	20.4...28.8 Vdc
24 Vdc I/O segment current draw	63 mA
TM5 Bus 5 Vdc current draw	2 mA
Power dissipation	1.51 W max.
Weight	25 g (0.9 oz)
ID code for firmware update	7077 dec

Output Characteristics

The table below describes the output characteristics of the TM5SA04H electronic module:

Characteristic	Voltage Output	Current Output
Output range	-10...+10 Vdc	0...20 mA
Output impedance	1 kΩ min.	-
Load impedance	+/- 10 mA max	200 Ω min. 500 Ω max.
Sample duration time	50 µs for all outputs	
Output type	Differential	
Response time for output change	1 ms max.	
Over voltage before output change (Response time)	+/- 15% of the Full scale (20V)	-
Over current before output change (Response time)	-	+/- 10% of the Full scale (20mA)
Output tolerance - maximum deviation at ambient 25° C (77° F)	< 0.04% of the measurement	
Output tolerance - temperature drift	0.01% / °C of the measurement	
Output tolerance - non linearity	< 0.005% of the full scale (20 Vdc)	< 0.005% of the full scale (20 mA)
De-rating *	See note *	
Output tolerance - maximum deviation caused by load change	0.02% from 10 MΩ to 1 kΩ, resistive	0.5% from 1 Ω to 500 Ω, resistive
Digital resolution	15 bits + sign	15 bits
Resolution value	305.176 µV	610.352 nA
Noise resistance - cable	Shielded cable is necessary	
Isolation between channels	Not isolated	
Isolation between channels and bus	See note [1].	
Output protection	Short circuit protection: current limitation is 40 mA	

* Note: These analog electronic modules are subject to operating temperature restrictions between 55 and 60 °C (131 and 140 °F). If the ambiant temperature of your installation may exceed 55 °C (131 °F), do not install the TM5SAI•H modules adjacent to other devices capable of dissipating more than 1.15 W. For more information refer to *Enclosing the TM5 System (see Modicon TM5 / TM7 Flexible System, System Planning and Installation Guide)*.

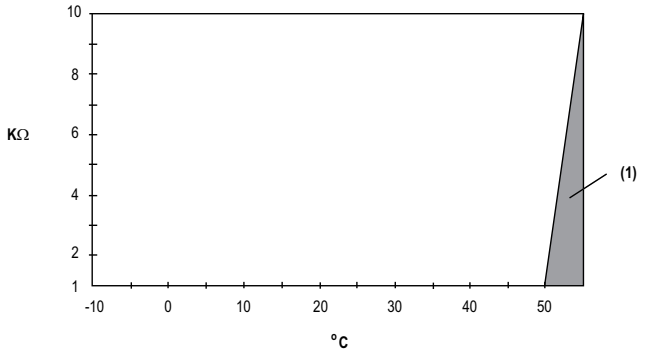
[1] The isolation of the electronic module is 500 Vac RMS between the electronics powered by the TM5 bus and those powered by 24 Vdc I/O power segment connected to the module. In practice, the TM5 electronic module is installed in the bus base, and there is a bridge between the TM5 power bus and the 24 Vdc I/O power segment. The two power circuits reference the same functional ground (FE) through specific components designed to reduce effects of electromagnetic interference. These components are rated at 30 Vdc or 60 Vdc. This effectively reduces isolation of the entire system from the 500 Vac RMS.

De-rating the output load

The analog output modules can be configured as voltage outputs, current outputs, or a mix of voltage and current outputs. In the case of a mixed configuration, you must adjust the following de-rating information.

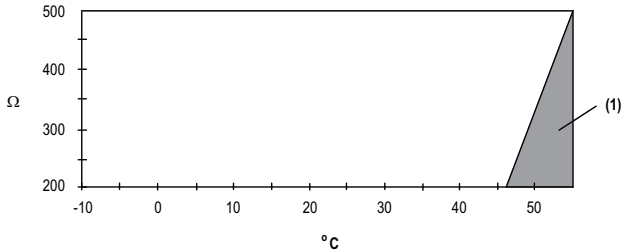
If only one of the outputs in the mix is configured as a current output, use the mean between the current and voltage curves. If more than one output in the mix is configured as a current output, use the current output de-rating curve. Otherwise, use the appropriate de-rating information as follows:

De-rating the voltage output load in a horizontal installation:



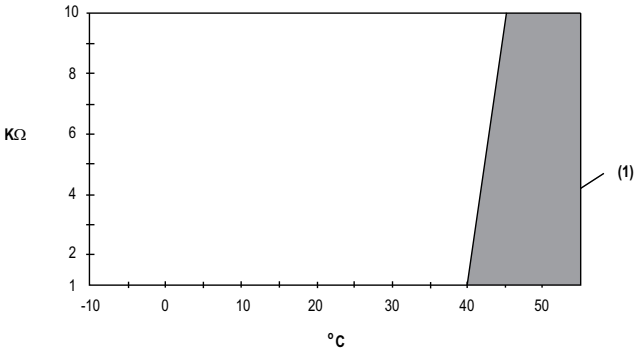
1 Invalid area

De-rating the current output load in a horizontal installation:



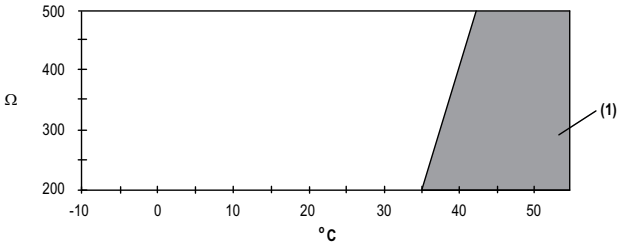
1 Invalid area

De-rating the voltage output load in a vertical installation:



1 Invalid area

De-rating the current output load in a vertical installation:

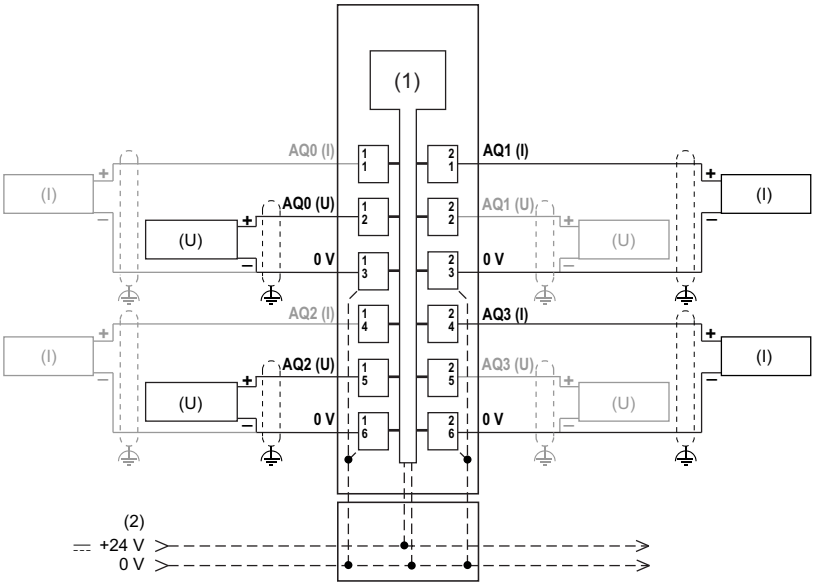


1 Invalid area

TM5SAO4H Wiring Diagram

Wiring Diagram

The following figure shows the wiring diagram for TM5SAO4H:



(1): Internal electronics
(2): 24 Vdc I/O power segment integrated into the bus bases
(I): Current
(U): Voltage

U11se shielded, properly grounded cables for all analog and high-speed inputs or outputs and communication connections. If you do not use shielded cable for these connections, electromagnetic interference can cause signal degradation. Degraded signals can cause the controller or attached modules and equipment to perform in an unintended manner.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

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

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Glossary

!

%

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.

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.

C

CAN

(*controller area network*) A protocol (ISO 11898) for serial bus networks, designed for the interconnection of smart devices (from multiple manufacturers) in smart systems and for real-time industrial applications. Originally developed for use in automobiles, CAN is now used in a variety of industrial automation control environments.

CANopen

An open industry-standard communication protocol and device profile specification (EN 50325-4).

control network

A network containing logic controllers, SCADA systems, PCs, HMI, switches, ...

Two kinds of topologies are supported:

- flat: all modules and devices in this network belong to same subnet.
- 2 levels: the network is split into an operation network and an inter-controller network.

These two networks can be physically independent, but are generally linked by a routing device.

controller

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

CSA

(*Canadian standards association*) The Canadian standard for industrial electronic equipment in hazardous environments.

D

DIN

(*Deutsches Institut für Normung*) A German institution that sets engineering and dimensional standards.

E

electronic module

In a programmable controller system, most electronic modules directly interface to the sensors, actuators, and external devices of the machine/process. This electronic module is the component that mounts in a bus base and provides electrical connections between the controller and the field devices. Electronic modules are offered in a variety of signal levels and capacities. (Some electronic modules are not I/O interfaces, including power distribution modules and transmitter/receiver modules.)

element

The short name of the ARRAY element.

EN

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

encoder

A device for length or angular measurement (linear or rotary encoders).

equipment

A part of a machine including sub-assemblies such as conveyors, turntables, and so on.

Ethernet

A physical and data link layer technology for LANs, also known as IEEE 802.3.

F

FAST I/O

FAST input/output Specific I/O modules with some electrical features (for example, response time) while the treatment of these channels are done directly by the controller

firmware

Represents the BIOS, data parameters, and programming instructions that constitute the operating system on a controller. The firmware is stored in non-volatile memory within the controller.

H

hot swapping

The replacement of a component with a like component while the system remains under power and operational. The replacement component begins to function automatically after it is installed.

I

IEC

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

input filter

A special function that helps reject extraneous signals on input lines due to such things as contact bounce and inducted electrical transients. Inputs provide a level of input filtering using the hardware. Additional filtering with software is also configurable through the programing or the configuration software.

IP 20

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

IP 67

(*ingress protection*) The protection classification according to IEC 60529. IP 67 modules are protected against ingress of dust, contact, and water up to an immersion depth of 1 m.

L

LED

(*light emitting diode*) An indicator that illuminates under a low-level electrical charge.

M

machine

Consists of several *functions* and/or *equipment*.

ms

(*millisecond*)

N

network

A system of interconnected devices that share a common data path and protocol for communications.

P

PCI

(*peripheral component interconnect*) An industry-standard bus for attaching peripherals.

PDM

(*power distribution module*) A module that distributes either AC or DC field power to a cluster of I/O modules.

Pt100/Pt1000

(*platinum 100/1000*) Resistance thermometers, also referred to as resistance temperature detectors, are sensors used to measure temperature by correlating electrical resistance with temperature. As the temperature changes, the resistance to an electrical current passing through them predictably changes likewise. They are characterized by their nominal resistance R0 at a temperature of 0 °C.

- Pt100 (R0 = 100 Ω)
- Pt1000 (R0 = 1 kΩ)

T

terminal block

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

U

UL

(*underwriters laboratories*) A US organization for product testing and safety certification.

Index

E

Electronic modules
    documentation references, *27*
    installation, *27*
environmental characteristics, *25*

G

General characteristics
    TM5SAI2H, *61*
    TM5SAI2L, *45*
    TM5SAI2PH, *79*
    TM5SAI2TH, *100*
    TM5SAI4H, *69*
    TM5SAI4L, *52*
    TM5SAI4PH, *88*
    TM5SAI6TH, *110*
    TM5SAO2H, *149*
    TM5SAO2L, *133*
    TM5SAO4H, *156*
    TM5SAO4L, *140*
    TM5SEAISG, *120*

H

hot swapping, *28*

I

installation and Maintenance
    installation and Maintenance require-
    ments, *18*
intended use, *8*

P

Presentation
    TM5SAI2H, *59*
    TM5SAI2L, *43*
    TM5SAI2PH, *77*
    TM5SAI2TH, *97*
    TM5SAI4H, *67*
    TM5SAI4L, *50*
    TM5SAI4PH, *86*
    TM5SAI6TH, *107*
    TM5SAO2H, *147*
    TM5SAO2L, *131*
    TM5SAO4H, *154*
    TM5SAO4L, *138*
    TM5SEAISG, *118*

Q

qualification of personnel, *8*

T

TM5 analog
    TM5SAI2H, *58*
    TM5SAI2L, *42*
    TM5SAI2PH, *76*
    TM5SAI2TH, *96*
    TM5SAI4H, *66*
    TM5SAI4L, *49*
    TM5SAI4PH, *85*
    TM5SAI6TH, *106*
    TM5SAO2H, *146*
    TM5SAO2L, *130*
    TM5SAO4H, *153*
    TM5SAO4L, *137*
    TM5SEAISG, *117*
TM5SAI2H, *58*
TM5SAI2L, *42*
TM5SAI2PH, *76*
TM5SAI2TH, *96*

TM5SAI4H, *66*
TM5SAI4L, *49*
TM5SAI4PH, *85*
TM5SAI6TH, *106*
TM5SAO2H, *146*
TM5SAO2L, *130*
TM5SAO4H, *153*
TM5SAO4L, *137*
TM5SEAISG, *117*

W

Wiring Diagram
    TM5SAI2H, *63*
    TM5SAI2L, *47*
    TM5SAI2PH, *82*
    TM5SAI2TH, *103*
    TM5SAI4H, *72*
    TM5SAI4L, *54*
    TM5SAI4PH, *91*
    TM5SAI6TH, *113*
    TM5SAO2H, *151*
    TM5SAO2L, *135*
    TM5SAO4H, *160*
    TM5SAO4L, *144*
    TM5SEAISG, *123*
wiring rules, *21*