

Modicon M221 Logic Controller Hardware Guide

12/2017



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.

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All pertinent state, regional, and local safety regulations must be observed when installing and using this product. For reasons of safety and to help ensure compliance with documented system data, only the manufacturer should perform repairs to components.

When devices are used for applications with technical safety requirements, the relevant instructions must be followed.

Failure to use Schneider Electric software or approved software with our hardware products may result in injury, harm, or improper operating results.

Failure to observe this information can result in injury or equipment damage.

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Safety Information



Important Information

NOTICE

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



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



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

DANGER

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

WARNING

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

CAUTION

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

NOTICE

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

PLEASE NOTE

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

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 programmable logic controllers (referred to herein as “logic controllers”), 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

Use this document to:

- Install and operate your M221 Logic Controller.
- Connect the M221 Logic Controller to a programming device equipped with SoMachine Basic software.
- Interface the M221 Logic Controller with I/O expansion modules, HMI and other devices.
- Familiarize yourself with the M221 Logic Controller features.

NOTE: Read and understand this document and all related documents (*see page 9*) before installing, operating, or maintaining your controller.

Validity Note

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

The technical characteristics of the devices described in this manual also appear online.

The characteristics that are presented in this manual 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 manual and online information, use the online information as your reference.

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

Related Documents

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

| Title of Documentation | Reference Number |
|---|--|
| Modicon TMH2GDB Remote Graphic Display - User Guide | EIO0000002063 (ENG) EIO0000002064 (FRE) EIO0000002065 (GER) EIO0000002066 (SPA) EIO0000002067 (ITA) EIO0000002068 (CHS) EIO0000002070 (TUR) EIO0000002069 (POR) |
| Modicon TMC2 Cartridges - Hardware Guide | EIO0000001768 (ENG) EIO0000001769 (FRE) EIO0000001770 (GER) EIO0000001771 (SPA) EIO0000001772 (ITA) EIO0000001773 (CHS) EIO0000001775 (TUR) EIO0000001774 (POR) |
| Modicon TM3 Digital I/O Modules - Hardware Guide | EIO0000001408 (ENG) EIO0000001409 (FRE) EIO0000001410 (GER) EIO0000001411 (SPA) EIO0000001412 (ITA) EIO0000001413 (CHS) EIO0000001377 (TUR) EIO0000001376(POR) |
| Modicon TM3 Analog I/O Modules - Hardware Guide | EIO0000001414 (ENG) EIO0000001415 (FRE) EIO0000001416 (GER) EIO0000001417 (SPA) EIO0000001418 (ITA) EIO0000001419 (CHS) EIO0000001379 (TUR) EIO0000001378 (POR) |
| Modicon TM3 Expert I/O Modules - Hardware Guide | EIO0000001420 (ENG) EIO0000001421 (FRE) EIO0000001422 (GER) EIO0000001423 (SPA) EIO0000001424 (ITA) EIO0000001425 (CHS) EIO0000001381 (TUR) EIO0000001380 (POR) |

| Title of Documentation | Reference Number |
|---|--|
| Modicon TM3 Safety Modules - Hardware Guide | EIO0000001831 (ENG) EIO0000001832 (FRE) EIO0000001833 (GER) EIO0000001834 (SPA) EIO0000001835 (ITA) EIO0000001836 (CHS) EIO0000001838 (TUR) EIO0000001837 (POR) |
| Modicon TM3 Transmitter and Receiver Modules - Hardware Guide | EIO0000001426 (ENG) EIO0000001427 (FRE) EIO0000001428 (GER) EIO0000001429 (SPA) EIO0000001430 (ITA) EIO0000001431 (CHS) EIO0000001383 (TUR) EIO0000001382 (POR) |
| TM221C DC Logic Controller - Instruction Sheet | EAV48550 |
| TM221C AC Logic Controller - Instruction Sheet | EAV58623 |
| TM221M Logic Controller - Instruction Sheet | HRB59602 |

You can download these technical publications and other technical information from our website at <http://www.schneider-electric.com/en/download>

Product Related Information


DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

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

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

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 |
|--------------------------------|---|
| EN 61131-2:2007 | Programmable controllers, part 2: Equipment requirements and tests. |
| ISO 13849-1:2008 | Safety of machinery: Safety related parts of control systems. General principles for design. |
| EN 61496-1:2013 | Safety of machinery: Electro-sensitive protective equipment. Part 1: General requirements and tests. |
| ISO 12100:2010 | Safety of machinery - General principles for design - Risk assessment and risk reduction |
| EN 60204-1:2006 | Safety of machinery - Electrical equipment of machines - Part 1: General requirements |
| EN 1088:2008 ISO 14119:2013 | Safety of machinery - Interlocking devices associated with guards - Principles for design and selection |
| ISO 13850:2006 | Safety of machinery - Emergency stop - Principles for design |
| EN/IEC 62061:2005 | Safety of machinery - Functional safety of safety-related electrical, electronic, and electronic programmable control systems |
| IEC 61508-1:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems: General requirements. |
| IEC 61508-2:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems: Requirements for electrical/electronic/programmable electronic safety-related systems. |
| IEC 61508-3:2010 | Functional safety of electrical/electronic/programmable electronic safety-related systems: Software requirements. |
| IEC 61784-3:2008 | Digital data communication for measurement and control: Functional safety field buses. |
| 2006/42/EC | Machinery Directive |
| 2014/30/EU | Electromagnetic Compatibility Directive |
| 2014/35/EU | Low Voltage Directive |

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

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

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

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

Part I

Modicon M221 Logic Controller Introduction

What Is in This Part?

This part contains the following chapters:

| Chapter | Chapter Name | Page |
|---------|-----------------------|------|
| 1 | M221 General Overview | 17 |
| 2 | M221 Features | 51 |
| 3 | M221 Installation | 75 |

Chapter 1

M221 General Overview

Overview

This chapter provides general information about the M221 Logic Controller system architecture and its components.

What Is in This Chapter?

This chapter contains the following topics:

| Topic | Page |
|-------------------------------------|------|
| TM221C Logic Controller Description | 18 |
| TM221M Logic Controller Description | 23 |
| Maximum Hardware Configuration | 28 |
| TMC2 Cartridges | 32 |
| TM3 Expansion Modules | 34 |
| TM2 Expansion Modules | 43 |
| Accessories | 47 |

TM221C Logic Controller Description

Overview

The TM221C Logic Controller has various powerful features and can service a wide range of applications.

Software configuration, programming, and commissioning are accomplished with the SoMachine Basic software described in the SoMachine Basic Operating Guide (*see SoMachine Basic, Operating Guide*) and the M221 Logic Controller - Programming Guide (*see Modicon M221, Logic Controller, Programming Guide*).

Programming Languages

The M221 Logic Controller is configured and programmed with the SoMachine Basic software, which supports the following IEC 61131-3 programming languages:

- IL: Instruction List
- LD: Ladder Diagram
- Grafcet (List)
- Grafcet (SFC)

Power Supply

The power supply of the TM221C Logic Controller is 24 Vdc (*see page 106*) or 100...240 Vac (*see page 110*).

Real Time Clock

The M221 Logic Controller includes a Real Time Clock (RTC) system (*see page 52*).

Run/Stop

The M221 Logic Controller can be operated externally by the following:

- a hardware Run/Stop switch (*see page 67*)
- a Run/Stop (*see page 67*) operation by a dedicated digital input, defined in the software configuration (for more information, refer to Configuring Digital Inputs (*see Modicon M221, Logic Controller, Programming Guide*)).
- SoMachine Basic software (for more information, refer to Toolbar (*see SoMachine Basic, Operating Guide*)).
- a TMH2GDB Remote Graphic Display (for more information, refer to Controller State Menu (*see Modicon TMH2GDB, Remote Graphic Display, User Guide*)).

Memory

This table describes the different types of memory:

| Memory Type | Size | Used to |
|--------------|--|--|
| RAM | 512 Kbytes of RAM memory: 256 Kbytes for internal variables and 256 Kbytes for application and data. | execute the application and contain data |
| Non-volatile | 1.5 Mbytes, of which 256 Kbytes is used to back up the application and data in case of power outage. | save the application |

Embedded Inputs/Outputs

The following embedded I/O types are available, depending on the controller reference:

- Regular inputs
- Fast inputs associated with counters
- Regular sink/source transistor outputs
- Fast sink/source transistor outputs associated with pulse generators
- Relay outputs
- Analog inputs

Removable Storage

The M221 Logic Controllers include an embedded SD card slot (*see page 70*).

The Modicon M221 Logic Controller allows the following types of file management with an SD card:

- Clone management (*see Modicon M221, Logic Controller, Programming Guide*): back up the application, firmware, and post configuration (if it exists) of the logic controller
- Firmware management (*see Modicon M221, Logic Controller, Programming Guide*): download firmware to the logic controller, to a TMH2GDB Remote Graphic Display , or to TM3 expansion modules
- Application management (*see Modicon M221, Logic Controller, Programming Guide*): back up and restore the logic controller application, or copy it to another logic controller of the same reference
- Post configuration management (*see Modicon M221, Logic Controller, Programming Guide*): add, change, or delete the post configuration file of the logic controller
- Error log management (*see Modicon M221, Logic Controller, Programming Guide*): back up or delete the error log file of the logic controller
- Memory management: back up and restore memory bits and words from a controller

Embedded Communication Features

The following types of communication ports are available depending on the controller reference:

- Ethernet (*see page 374*)
- USB Mini-B (*see page 372*)
- Serial Line 1 (*see page 377*)

Remote Graphic Display

For more information, refer to the Modicon TMH2GDB Remote Graphic Display - User Guide.

TM221C Logic Controller

| Reference | Digital Inputs | Digital Outputs | Analog Inputs | Communication Ports | Power Supply |
|-------------------------------------|--|--|---------------|---|---------------|
| TM221C16R <i>(see page 119)</i> | 5 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | 7 relay outputs | Yes | 1 serial line port 1 USB programming port | 100...240 Vac |
| TM221CE16R <i>(see page 123)</i> | | | Yes | 1 serial line port 1 USB programming port 1 Ethernet port | |
| TM221C16T <i>(see page 127)</i> | 5 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | Source outputs 5 regular transistor outputs 2 fast outputs (PLS/PWM/PTO/FREQGEN) ⁽³⁾ | Yes | 1 serial line port 1 USB programming port | 24 Vdc |
| TM221CE16T <i>(see page 133)</i> | | | Yes | 1 serial line port 1 USB programming port 1 Ethernet port | |
| TM221C16U <i>(see page 139)</i> | 5 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | Sink outputs 5 regular transistor outputs 2 fast outputs (PLS/PWM/PTO/FREQGEN) ⁽³⁾ | Yes | 1 serial line port 1 USB programming port | 24 Vdc |
| TM221CE16U <i>(see page 143)</i> | | | | 1 serial line port 1 USB programming port 1 Ethernet port | |

NOTE: The TM221C Logic Controller uses removable screw terminal blocks.

(1) The regular inputs have a maximum frequency of 5 kHz.

(2) The fast inputs can be used either as regular inputs or as fast inputs for counting or event functions.

(3) The fast transistor outputs can be used either as regular transistor outputs, for PLS, PWM, PTO, or FREQGEN functions, or reflex outputs for HSC.

| Reference | Digital Inputs | Digital Outputs | Analog Inputs | Communication Ports | Power Supply |
|-------------------------------------|---|---|---------------|---|---------------|
| TM221C24R <i>(see page 149)</i> | 10 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | 10 relay outputs | Yes | 1 serial line port 1 USB programming port | 100...240 Vac |
| TM221CE24R <i>(see page 153)</i> | | | Yes | 1 serial line port 1 USB programming port 1 Ethernet port | |
| TM221C24T <i>(see page 157)</i> | | Source outputs 8 regular transistor outputs 2 fast outputs (PLS/PWM/PTO/FREQGEN) ⁽³⁾ | Yes | 1 serial line port 1 USB programming port | 24 Vdc |
| TM221CE24T <i>(see page 161)</i> | | | Yes | 1 serial line port 1 USB programming port 1 Ethernet port | |
| TM221C24U <i>(see page 167)</i> | 10 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | Sink outputs 8 regular transistor outputs 2 fast outputs (PLS/PWM/PTO/FREQGEN) ⁽³⁾ | Yes | 1 serial line port 1 USB programming port | 24 Vdc |
| TM221CE24U <i>(see page 173)</i> | | | Yes | 1 serial line port 1 USB programming port 1 Ethernet port | |
| TM221C40R <i>(see page 179)</i> | 20 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | 16 relay outputs | Yes | 1 serial line port 1 USB programming port | 100...240 Vac |
| TM221CE40R <i>(see page 185)</i> | | | Yes | 1 serial line port 1 USB programming port 1 Ethernet port | |
| TM221C40T <i>(see page 191)</i> | | Source outputs 14 regular transistor outputs 2 fast outputs (PLS/PWM/PTO/FREQGEN) ⁽³⁾ | Yes | 1 serial line port 1 USB programming port | 24 Vdc |
| TM221CE40T <i>(see page 197)</i> | | | Yes | 1 serial line port 1 USB programming port 1 Ethernet port | |

NOTE: The TM221C Logic Controller uses removable screw terminal blocks.

(1) The regular inputs have a maximum frequency of 5 kHz.

(2) The fast inputs can be used either as regular inputs or as fast inputs for counting or event functions.

(3) The fast transistor outputs can be used either as regular transistor outputs, for PLS, PWM, PTO, or FREQGEN functions, or reflex outputs for HSC.

| Reference | Digital Inputs | Digital Outputs | Analog Inputs | Communication Ports | Power Supply |
|------------------------------|---|---|---------------|---|--------------|
| TM221C40U (see page 203) | 20 regular inputs ⁽¹⁾ 4 fast inputs | Sink outputs 12 regular transistor outputs 4 fast outputs | Yes | 1 serial line port 1 USB programming port | 24 Vdc |
| TM221CE40U (see page 209) | (HSC) ⁽²⁾ | (PLS/PWM/PTO/FREQEN) ⁽³⁾ | Yes | 1 serial line port 1 USB programming port 1 Ethernet port | |

NOTE: The TM221C Logic Controller uses removable screw terminal blocks.

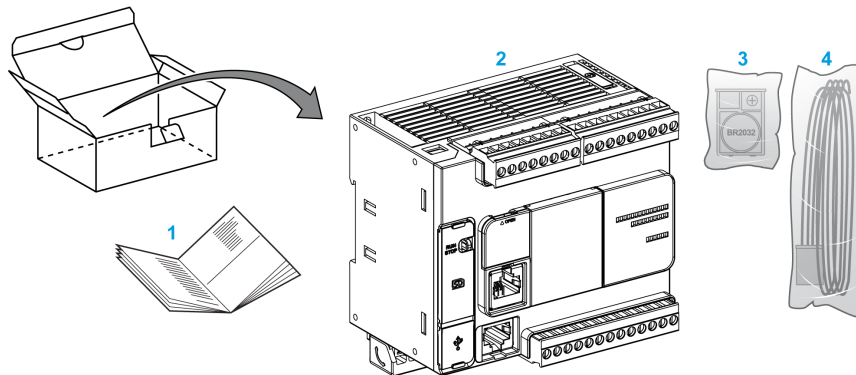
(1) The regular inputs have a maximum frequency of 5 kHz.

(2) The fast inputs can be used either as regular inputs or as fast inputs for counting or event functions.

(3) The fast transistor outputs can be used either as regular transistor outputs, for PLS, PWM, PTO, or FREQEN functions, or reflex outputs for HSC.

Delivery Content

The following figure presents the content of the delivery for a TM221C Logic Controller:



- 1 TM221C Logic Controller Instruction Sheet
- 2 TM221C Logic Controller
- 3 Battery holder with lithium carbon monofluoride battery, type Panasonic BR2032.
- 4 Analog cable

TM221M Logic Controller Description

Overview

The TM221M Logic Controller has various powerful features and can service a wide range of applications.

Software configuration, programming, and commissioning are accomplished with the SoMachine Basic software described in the SoMachine Basic Operating Guide (*see SoMachine Basic, Operating Guide*) and the M221 Logic Controller - Programming Guide (*see Modicon M221, Logic Controller, Programming Guide*).

Programming Languages

The M221 Logic Controller is configured and programmed with the SoMachine Basic software, which supports the following IEC 61131-3 programming languages:

- IL: Instruction List
- LD: Ladder Diagram
- Grafset (List)
- Grafset (SFC)

Power Supply

The power supply of the TM221M Logic Controller is 24 Vdc (*see page 106*).

Real Time Clock

The M221 Logic Controller includes a Real Time Clock (RTC) system (*see page 52*).

Run/Stop

The M221 Logic Controller can be operated externally by the following:

- a hardware Run/Stop switch (*see page 67*)
- a Run/Stop (*see page 67*) operation by a dedicated digital input, defined in the software configuration (for more information, refer to Configuring Digital Inputs (*see Modicon M221, Logic Controller, Programming Guide*))
- SoMachine Basic software (for more information, refer to Toolbar (*see SoMachine Basic, Operating Guide*)).
- a TMH2GDB Remote Graphic Display (for more information, refer to Controller State Menu (*see Modicon TMH2GDB, Remote Graphic Display, User Guide*)).

Memory

This table describes the different types of memory:

| Memory Type | Size | Used to |
|--------------|--|---|
| RAM | 512 Kbytes of RAM memory: 256 Kbytes for internal variables and 256 Kbytes for application and data. | execute the application and contains data |
| Non-volatile | 1.5 Mbytes, of which 256 Kbytes is used to back up the application and data in case of power outage. | save the application |

Embedded Inputs/Outputs

The following embedded I/O types are available, depending on the controller reference:

- Regular inputs
- Fast inputs (HSC)
- Regular transistor outputs
- Fast transistor outputs (PLS/PWM/PTO/FREQGEN)
- Relay outputs
- Analog inputs

Removable Storage

The M221 Logic Controllers include an embedded SD card slot (*see page 70*).

The Modicon M221 Logic Controller allows the following types of file management with an SD card:

- Clone management (*see Modicon M221, Logic Controller, Programming Guide*): back up the application, firmware, and post configuration (if it exists) of the logic controller
- Firmware management (*see Modicon M221, Logic Controller, Programming Guide*): download firmware updates directly to the logic controller, and download firmware to a TMH2GDB Remote Graphic Display
- Application management (*see Modicon M221, Logic Controller, Programming Guide*): back up and restore the logic controller application, or copy it to another logic controller of the same reference
- Post configuration management (*see Modicon M221, Logic Controller, Programming Guide*): add, change, or delete the post configuration file of the logic controller
- Error log management (*see Modicon M221, Logic Controller, Programming Guide*): back up or delete the error log file of the logic controller
- Memory management: backup/restore of memory bits and words from a controller

Embedded Communication Features

The following communication ports are available on the front panel of the controller, depending on the controller reference:

- Ethernet (*see page 374*)
- USB Mini-B (*see page 372*)
- SD Card (*see page 70*)
- Serial Line 1 (*see page 377*)
- Serial Line 2 (*see page 381*)

Remote Graphic Display

For more information, refer to the Modicon TMH2GDB Remote Graphic Display - User Guide.

TM221M Logic Controller

| Reference | Digital Input | Digital Output | Analog Input | Communication Ports | Terminal Type |
|--|--|---|--------------|---|----------------------------------|
| TM221M16R (<i>see page 253</i>) | 4 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | 8 relay outputs | Yes | 2 serial line ports 1 USB programming port | Removable screw terminal blocks |
| TM221M16RG (<i>see page 253</i>) | 4 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | 8 relay outputs | Yes | 2 serial line ports 1 USB programming port | Removable spring terminal blocks |
| TM221ME16R (<i>see page 271</i>) | 4 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | 8 relay outputs | Yes | 1 serial line port 1 USB programming port 1 Ethernet port | Removable screw terminal blocks |
| TM221ME16RG (<i>see page 271</i>) | 4 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | 8 relay outputs | Yes | 1 serial line port 1 USB programming port 1 Ethernet port | Removable spring terminal blocks |
| TM221M16T (<i>see page 289</i>) | 4 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | 6 regular transistor outputs 2 fast transistor outputs (PLS/PWM/PTO/FREQGEN) ⁽³⁾ | Yes | 2 serial line ports 1 USB programming port | Removable screw terminal blocks |

NOTE: The TM221M Logic Controller uses a 24 Vdc power supply (*see page 106*).

(1) The regular inputs I2, I3, I4, and I5 have a maximum frequency of 5 kHz.

The other regular inputs have a maximum frequency of 100 Hz.

(2) The fast inputs can be used either as regular inputs or as fast inputs for counting or event functions.

(3) The fast transistor outputs can be used as regular transistor outputs, for PLS, PWM, PTO or FREQGEN functions, or reflex outputs for HSC.

| Reference | Digital Input | Digital Output | Analog Input | Communication Ports | Terminal Type |
|-------------------------------|---|---|--------------|---|----------------------------------|
| TM221M16TG (see page 289) | 4 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | 6 regular transistor outputs 2 fast transistor outputs (PLS/PWM/PTO/FREQGEN) ⁽³⁾ | Yes | 2 serial line ports 1 USB programming port | Removable spring terminal blocks |
| TM221ME16T (see page 309) | 4 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | 6 regular transistor outputs 2 fast transistor outputs (PLS/PWM/PTO/FREQGEN) ⁽³⁾ | Yes | 1 serial line port 1 USB programming port 1 Ethernet port | Removable screw terminal blocks |
| TM221ME16TG (see page 309) | 4 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | 6 regular transistor outputs 2 fast transistor outputs (PLS/PWM/PTO/FREQGEN) ⁽³⁾ | Yes | 1 serial line port USB programming port 1 Ethernet port | Removable spring terminal blocks |
| TM221M32TK (see page 329) | 12 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | 14 regular transistor outputs 2 fast outputs (PLS/PWM/PTO/FREQGEN) ⁽³⁾ | Yes | 2 serial line ports 1 USB programming port | HE10 (MIL 20) connectors |
| TM221ME32TK (see page 329) | 12 regular inputs ⁽¹⁾ 4 fast inputs (HSC) ⁽²⁾ | 14 regular outputs 2 fast outputs (PLS/PWM/PTO/FREQGEN) ⁽³⁾ | Yes | 1 serial line port 1 USB programming port 1 Ethernet port | HE10 (MIL 20) connectors |

NOTE: The TM221M Logic Controller uses a 24 Vdc power supply (see page 106).

(1) The regular inputs I2, I3, I4, and I5 have a maximum frequency of 5 kHz.

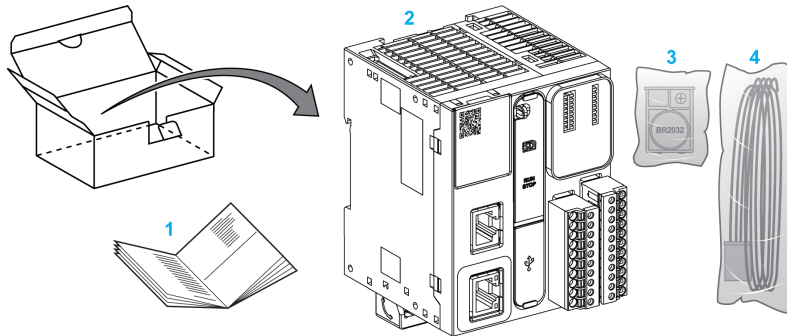
The other regular inputs have a maximum frequency of 100 Hz.

(2) The fast inputs can be used either as regular inputs or as fast inputs for counting or event functions.

(3) The fast transistor outputs can be used as regular transistor outputs, for PLS, PWM, PTO or FREQGEN functions, or reflex outputs for HSC.

Delivery Content

The following figure presents the content of the delivery for a TM221M Logic Controller:



- 1 TM221M Logic Controller Instruction Sheet
- 2 TM221M Logic Controller
- 3 Battery holder with lithium carbon monofluoride battery, type Panasonic BR2032.
- 4 Analog cable

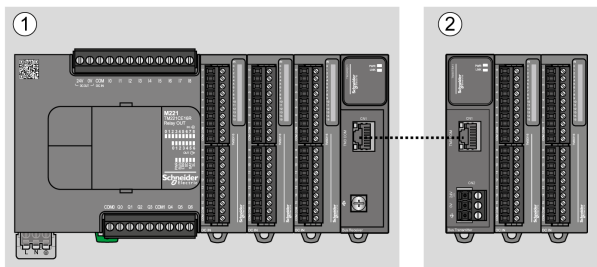
Maximum Hardware Configuration

Introduction

The M221 Logic Controller is a control system that offers an all-in-one solution with optimized configurations and an expandable architecture.

Local and Remote Configuration Principle

The following figure defines the local and remote configurations:



- (1) Local configuration
- (2) Remote configuration

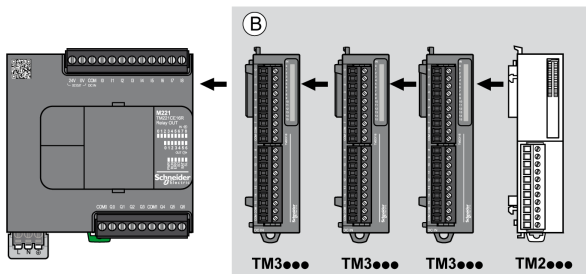
M221 Logic Controller Local Configuration Architecture

Optimized local configuration and flexibility are provided by the association of:

- M221 Logic Controller
- TM3 expansion modules
- TM2 expansion modules

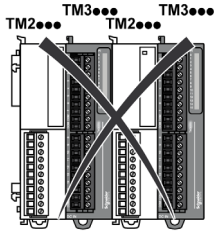
Application requirements determine the architecture of your M221 Logic Controller configuration.

The following figure represents the components of a local configuration:



- (B) Expansion modules (see maximum number of modules)

NOTE: You cannot mount a TM2 module before any TM3 module as indicated in the following figure:



M221 Logic Controller Remote Configuration Architecture

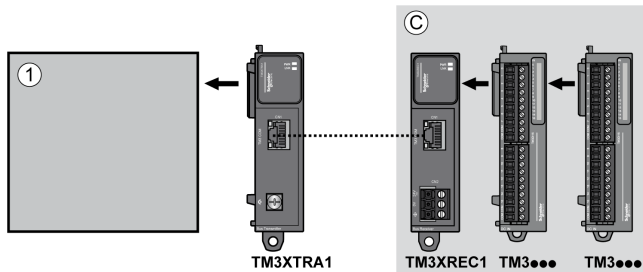
Optimized remote configuration and flexibility are provided by the association of:

- M221 Logic Controller
- TM3 expansion modules
- TM3 transmitter and receiver modules

Application requirements determine the architecture of your M221 Logic Controller configuration.

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

The following figure represents the components of a remote configuration:



- (1) Logic controller and modules
 (C) Expansion modules (7 maximum)

Maximum Number of Modules

The following table shows the maximum configuration supported:

| References | Maximum | Type of Configuration |
|--|-------------------------------|-----------------------|
| TM221C16• TM221CE16• TM221C24• TM221CE24• TM221C40• TM221CE40• TM221M16R• TM221ME16R• TM221M16T• TM221ME16T• TM221M32TK TM221ME32TK | 7 TM3 / TM2 expansion modules | Local |
| TM3XREC1 | 7 TM3 expansion modules | Remote |
| NOTE: TM3 transmitter and receiver modules are not included in a count of the maximum number of expansion modules. | | |

NOTE: The configuration with its TM3 and TM2 expansion modules is validated by SoMachine Basic software in the **Configuration** window taking into account the total power consumption of the installed modules.

NOTE: In some environments, the maximum configuration populated by high consumption modules, coupled with the maximum distance allowable between the TM3 transmitter and receiver modules, may present bus communication issues although the SoMachine Basic software allows for the configuration. In such a case you will need to analyze the consumption of the modules chosen for your configuration, as well as the minimum cable distance required by your application, and possibly seek to optimize your choices.

Current Supplied to the I/O Bus

The following table shows the maximum current supplied by the controllers to the I/O Bus:

| Reference | IO Bus 5 Vdc | IO Bus 24 Vdc |
|-------------------------|--------------|---------------|
| TM221C16R TM221CE16R | 325 mA | 120 mA |
| TM221C16T TM221CE16T | 325 mA | 148 mA |
| TM221C16U TM221CE16U | 325 mA | 148 mA |
| TM221C24R TM221CE24R | 520 mA | 160 mA |

| Reference | IO Bus 5 Vdc | IO Bus 24 Vdc |
|---------------------------|--------------|---------------|
| TM221C24T TM221CE24T | 520 mA | 200 mA |
| TM221C24U TM221CE24U | 520 mA | 200 mA |
| TM221C40R TM221CE40R | 520 mA | 240 mA |
| TM221C40T TM221CE40T | 520 mA | 304 mA |
| TM221C40U TM221CE40U | 520 mA | 304 mA |
| TM221M16R• TM221ME16R• | 520 mA | 460 mA |
| TM221M16T• TM221ME16T• | 520 mA | 492 mA |
| TM221M32TK TM221ME32TK | 520 mA | 484 mA |

NOTE: Expansion modules consume current from the 5 Vdc and 24 Vdc supplied to the I/O Bus. Therefore, the current delivered by the logic controller to the I/O Bus defines the maximum number of expansion modules that can be connected to the I/O Bus (validated by SoMachine Basic software in the **Configuration** window).

TMC2 Cartridges

Overview

You can expand the number of I/Os or communication options of your Modicon TM221C Logic Controller by adding TMC2 cartridges.

For more information, refer to the TMC2 Cartridges Hardware Guide.

TMC2 Standard Cartridges

The following table presents the general-purpose TMC2 cartridges with the corresponding channel type, voltage/current range, and terminal type:

| Reference | Channels | Channel Type | Voltage Current | Terminal Type |
|---|----------|------------------------------------|---|--|
| TMC2AI2 | 2 | Analog inputs (voltage or current) | 0...10 Vdc 0...20 mA or 4...20 mA | 3.81 mm (0.15 in.) pitch, non-removable screw terminal block |
| TMC2TI2 | 2 | Analog temperature inputs | Thermocouple type K, J, R, S, B, E, T, N,C 3 wires RTD type Pt100, Pt1000, Ni100, Ni1000 | 3.81 mm (0.15 in.) pitch, non-removable screw terminal block |
| TMC2AQ2V | 2 | Analog voltage outputs | 0...10 Vdc | 3.81 mm (0.15 in.) pitch, non-removable screw terminal block |
| TMC2AQ2C | 2 | Analog current outputs | 4...20 mA | 3.81 mm (0.15 in.) pitch, non-removable screw terminal block |
| TMC2SL1 ⁽¹⁾ | 1 | Serial line | RS232 or RS485 | 3.81 mm (0.15 in.) pitch, non-removable screw terminal block |
| (1) Only one serial line cartridge (TMC2SL1, TMC2CONV01) may be added to a logic controller. | | | | |

TMC2 Application Cartridges

The following table presents the applicative TMC2 cartridges with the corresponding channel type, voltage/current range, and terminal type:

| Reference | Channels | Channel Type | Voltage Current | Terminal Type |
|---|----------|---------------------------------------|--------------------------------------|--|
| TMC2HOIS01 | 2 | Analog inputs (voltage or current) | 0...10 Vdc 0...20 mA or 4...20 mA | 3.81 mm (0.15 in.) pitch, non-removable screw terminal block |
| TMC2PACK01 | 2 | Analog inputs (voltage or current) | 0...10 Vdc 0...20 mA or 4...20 mA | 3.81 mm (0.15 in.) pitch, non-removable screw terminal block |
| TMC2CONV01 ⁽¹⁾ | 1 | Serial line | RS232 or RS485 | 3.81 mm (0.15 in.) pitch, non-removable screw terminal block |
| (1) Only one serial line cartridge (TMC2SL1, TMC2CONV01) may be added to a logic controller. | | | | |

TM3 Expansion Modules

Introduction

The range of TM3 expansion modules includes:

- Digital modules, classified as follows:
 - Input modules (*see page 34*)
 - Output modules (*see page 35*)
 - Mixed input/output modules (*see page 37*)
- Analog modules, classified as follows:
 - Input modules (*see page 38*)
 - Output modules (*see page 39*)
 - Mixed input/output modules (*see page 40*)
- Expert modules (*see page 40*)
- Safety modules (*see page 41*)
- Transmitter and Receiver modules (*see page 42*)

For more information, refer to the following documents:

- TM3 Digital I/O Modules Hardware Guide
- TM3 Analog I/O Modules Hardware Guide
- TM3 Expert I/O Modules Hardware Guide
- TM3 Safety Modules Hardware Guide
- TM3 Transmitter and Receiver Modules Hardware Guide

TM3 Digital Input Modules

The following table shows the TM3 digital input expansion modules, with corresponding channel type, nominal voltage/current, and terminal type:

| Reference | Channels | Channel Type | Voltage Current | Terminal Type / Pitch |
|-----------|----------|----------------|-------------------|---|
| TM3DI8A | 8 | Regular inputs | 120 Vac 7.5 mA | Removable screw terminal block / 5.08 mm |
| TM3DI8 | 8 | Regular inputs | 24 Vdc 7 mA | Removable screw terminal block / 5.08 mm |
| TM3DI8G | 8 | Regular inputs | 24 Vdc 7 mA | Removable spring terminal block / 5.08 mm |
| TM3DI16 | 16 | Regular inputs | 24 Vdc 7 mA | Removable screw terminal blocks / 3.81 mm |

| Reference | Channels | Channel Type | Voltage Current | Terminal Type / Pitch |
|-----------|----------|----------------|-----------------|--|
| TM3DI16G | 16 | Regular inputs | 24 Vdc 7 mA | Removable spring terminal blocks / 3.81 mm |
| TM3DI16K | 16 | Regular inputs | 24 Vdc 5 mA | HE10 (MIL 20) connector |
| TM3DI32K | 32 | Regular inputs | 24 Vdc 5 mA | HE10 (MIL 20) connector |

TM3 Digital Output Modules

The following table shows the TM3 digital output expansion modules, with corresponding channel type, nominal voltage/current, and terminal type:

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

| Reference | Channels | Channel Type | Voltage Current | Terminal Type / Pitch |
|-----------|----------|-------------------------------------|--|--|
| TM3DQ16RG | 16 | Relay outputs | 24 Vdc / 240 Vac 8 A maximum per common line / 2 A maximum per output | Removable spring terminal blocks / 3.81 mm |
| TM3DQ16T | 16 | Regular transistor outputs (source) | 24 Vdc 8 A maximum per common line / 0.5 A maximum per output | Removable screw terminal blocks / 3.81 mm |
| TM3DQ16TG | 16 | Regular transistor outputs (source) | 24 Vdc 8 A maximum per common line / 0.5 A maximum per output | Removable spring terminal blocks / 3.81 mm |
| TM3DQ16U | 16 | Regular transistor outputs (sink) | 24 Vdc 8 A maximum per common line / 0.5 A maximum per output | Removable screw terminal blocks / 3.81 mm |
| TM3DQ16UG | 16 | Regular transistor outputs (sink) | 24 Vdc 8 A maximum per common line / 0.5 A maximum per output | Removable spring terminal blocks / 3.81 mm |
| TM3DQ16TK | 16 | Regular transistor outputs (source) | 24 Vdc 2 A maximum per common line / 0.1 A maximum per output | HE10 (MIL 20) connector |
| TM3DQ16UK | 16 | Regular transistor outputs (sink) | 24 Vdc 2 A maximum per common line / 0.1 A maximum per output | HE10 (MIL 20) connector |
| TM3DQ32TK | 32 | Regular transistor outputs (source) | 24 Vdc 2 A maximum per common line / 0.1 A maximum per output | HE10 (MIL 20) connectors |
| TM3DQ32UK | 32 | Regular transistor outputs (sink) | 24 Vdc 2 A maximum per common line / 0.1 A maximum per output | HE10 (MIL 20) connectors |

TM3 Digital Mixed Input/Output Modules

The following table shows the TM3 mixed I/O modules, with corresponding channel type, nominal voltage/current, and terminal type:

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

TM3 Analog Input Modules

The following table shows the TM3 analog input expansion modules, with corresponding resolution, channel type, nominal voltage/current, and terminal type:

| Reference | Resolution | Channels | Channel Type | Mode | Terminal Type / Pitch |
|-----------|-----------------------------|----------|--------------|---|--|
| TM3AI2H | 16 bit, or 15 bit + sign | 2 | inputs | 0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA | Removable screw terminal block / 5.08 mm |
| TM3AI2HG | 16 bit, or 15 bit + sign | 2 | inputs | 0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA | Removable spring terminal block / 5.08 mm |
| TM3AI4 | 12 bit, or 11 bit + sign | 4 | inputs | 0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA | Removable screw terminal block / 3.81 mm |
| TM3AI4G | 12 bit, or 11 bit + sign | 4 | inputs | 0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA | Removable spring terminal blocks / 3.81 mm |
| TM3AI8 | 12 bit, or 11 bit + sign | 8 | inputs | 0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA 0...20 mA extended 4...20 mA extended | Removable screw terminal block / 3.81 mm |
| TM3AI8G | 12 bit, or 11 bit + sign | 8 | inputs | 0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA 0...20 mA extended 4...20 mA extended | Removable spring terminal blocks / 3.81 mm |
| TM3TI4 | 16 bit, or 15 bit + sign | 4 | inputs | 0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA Thermocouple PT100/1000 NI100/1000 | Removable screw terminal block / 3.81 mm |

| Reference | Resolution | Channels | Channel Type | Mode | Terminal Type / Pitch |
|-----------|-----------------------------|----------|--------------|---|--|
| TM3TI4G | 16 bit, or 15 bit + sign | 4 | inputs | 0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA Thermocouple PT100/1000 NI100/1000 | Removable spring terminal blocks / 3.81 mm |
| TM3TI8T | 16 bit, or 15 bit + sign | 8 | inputs | Thermocouple NTC/PTC Ohmmeter | Removable screw terminal block / 3.81 mm |
| TM3TI8TG | 16 bit, or 15 bit + sign | 8 | inputs | Thermocouple NTC/PTC Ohmmeter | Removable spring terminal blocks / 3.81 mm |

TM3 Analog Output Modules

The following table shows the TM3 analog output modules, with corresponding resolution, channel type, nominal voltage/current, and terminal type:

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

TM3 Analog Mixed Input/Output Modules

This following table shows the TM3 analog mixed I/O modules, with corresponding resolution, channel type, nominal voltage/current, and terminal type:

| Reference | Resolution | Channels | Channel Type | Mode | Terminal Type / Pitch |
|-----------|-----------------------------|----------|--------------|---|---|
| TM3AM6 | 12 bit, or 11 bit + sign | 4 | inputs | 0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA | Removable spring terminal block / 3.81 mm |
| | | 2 | outputs | | |
| TM3AM6G | 12 bit, or 11 bit + sign | 4 | inputs | 0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA | Removable spring terminal block / 3.81 mm |
| | | 2 | outputs | | |
| TM3TM3 | 16 bit, or 15 bit + sign | 2 | inputs | 0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA Thermocouple PT100/1000 NI100/1000 | Removable screw terminal block / 5.08 mm |
| | | | 1 | outputs | |
| TM3TM3G | 16 bit, or 15 bit + sign | 2 | inputs | 0...10 Vdc -10...+10 Vdc 0...20 mA 4...20 mA Thermocouple PT100/1000 NI100/1000 | Removable spring terminal block / 5.08 mm |
| | | | 1 | outputs | |

TM3 Expert Module

The following table shows the TM3 expert expansion module, with corresponding terminal type:

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

TM3 Safety Modules

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

| Reference | Function Category | Channels | Channel type | Voltage Current | Terminal type |
|---|-------------------------------|-----------------------|--------------------------------|--|--|
| TM3SAC5R | 1 function, up to category 3 | 1 or 2 ⁽¹⁾ | Safety input | 24 Vdc 100 mA maximum | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable screw terminal block |
| | | Start ⁽²⁾ | Input | | |
| | | 3 in parallel | Relay outputs Normally open | 24 Vdc / 230 Vac 6 A maximum per output | |
| TM3SAC5RG | 1 function, up to category 3 | 1 or 2 ⁽¹⁾ | Safety input | 24 Vdc 100 mA maximum | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable spring terminal block |
| | | Start ⁽²⁾ | Input | | |
| | | 3 in parallel | Relay outputs Normally open | 24 Vdc / 230 Vac 6 A maximum per output | |
| TM3SAF5R | 1 function, up to category 4 | 2 ⁽¹⁾ | Safety inputs | 24 Vdc 100 mA maximum | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable screw terminal block |
| | | Start | Input | | |
| | | 3 in parallel | Relay outputs Normally open | 24 Vdc / 230 Vac 6 A maximum per output | |
| TM3SAF5RG | 1 function, up to category 4 | 2 ⁽¹⁾ | Safety inputs | 24 Vdc 100 mA maximum | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable spring terminal block |
| | | Start | Input | | |
| | | 3 in parallel | Relay outputs Normally open | 24 Vdc / 230 Vac 6 A maximum per output | |
| TM3SAFL5R | 2 functions, up to category 3 | 2 ⁽¹⁾ | Safety inputs | 24 Vdc 100 mA maximum | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable screw terminal block |
| | | Start | Input | | |
| | | 3 in parallel | Relay outputs Normally open | 24 Vdc / 230 Vac 6 A maximum per output | |
| TM3SAFL5RG | 2 functions, up to category 3 | 2 ⁽¹⁾ | Safety inputs | 24 Vdc 100 mA maximum | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable spring terminal block |
| | | Start | Input | | |
| | | 3 in parallel | Relay outputs Normally open | 24 Vdc / 230 Vac 6 A maximum per output | |
| TM3SAK6R | 3 functions, up to category 4 | 1 or 2 ⁽¹⁾ | Safety inputs | 24 Vdc 100 mA maximum | 3.81 mm (0.15 in.) and 5.08 mm (0.20 in.), removable screw terminal block |
| | | Start | Input | | |
| | | 3 in parallel | Relay outputs Normally open | 24 Vdc / 230 Vac 6 A maximum per output | |
| ⁽¹⁾ Depending on external wiring ⁽²⁾ Non-monitored start | | | | | |

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

TM3 Transmitter and Receiver Modules

The following table shows the TM3 transmitter and receiver expansion modules:

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

TM2 Expansion Modules

Overview

You can expand the number of I/Os of your M221 Logic Controller by adding TM2 I/O expansion modules.

The following types of electronic modules are supported:

- TM2 digital I/O expansion modules
- TM2 analog I/O expansion modules

For more information, refer to the following documents:

- TM2 Digital I/O Expansion Modules Hardware Guide
- TM2 Analog I/O Expansion Modules Hardware Guide

NOTE: TM2 modules can only be used in the local configuration, and only if there is no TM3 transmitter and receiver modules present in the configuration.

NOTE: It is prohibited to mount a TM2 module before any TM3 module. The TM2 modules must be mounted and configured at the end of the local configuration.

TM2 Digital Input Expansion Modules

The following table shows the compatible TM2 digital input expansion modules with the corresponding channel type, nominal voltage/current, and terminal type:

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

TM2 Digital Output Expansion Modules

The following table shows the compatible TM2 digital output expansion modules with the corresponding channel type, nominal voltage/current, and terminal type:

| Reference | Channels | Channel type | Voltage Current | Terminal type |
|------------|----------|-------------------------------------|--------------------------------|--------------------------------|
| TM2DRA8RT | 8 | Relay outputs | 30 Vdc / 240 Vac 2 A max | Removable screw terminal block |
| TM2DRA16RT | 16 | Relay outputs | 30 Vdc / 240 Vac 2 A max | Removable screw terminal block |
| TM2DDO8UT | 8 | Regular transistor outputs (sink) | 24 Vdc 0.3 A max per output | Removable screw terminal block |
| TM2DDO8TT | 8 | Regular transistor outputs (source) | 24 Vdc 0.5 A max per output | Removable screw terminal block |
| TM2DDO16UK | 16 | Regular transistor outputs (sink) | 24 Vdc 0.1 A max per output | HE10 (MIL 20) connector |
| TM2DDO16TK | 16 | Regular transistor outputs (source) | 24 Vdc 0.4 A max per output | HE10 (MIL 20) connector |
| TM2DDO32UK | 32 | Regular transistor outputs (sink) | 24 Vdc 0.1 A max per output | HE10 (MIL 20) connector |
| TM2DDO32TK | 32 | Regular transistor outputs (source) | 24 Vdc 0.4 A max per output | HE10 (MIL 20) connector |

TM2 Digital Mixed Input/Output Expansion Modules

The following table shows the compatible TM2 digital mixed I/O expansion modules with the corresponding channel type, nominal voltage/current, and terminal type:

| Reference | Channels | Channel type | Voltage Current | Terminal type |
|-------------|----------|----------------|--|-------------------------------------|
| TM2DMM8DRT | 4 | Regular inputs | 24 Vdc 7 mA | Removable screw terminal block |
| | 4 | Relay outputs | 24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output | |
| TM2DMM24DRF | 16 | Regular inputs | 24 Vdc 7 mA | Non-removable spring terminal block |
| | 8 | Relay outputs | 24 Vdc / 240 Vac 7 A maximum per common line / 2 A maximum per output | |

TM2 Analog Input Expansion Modules

The following table shows the compatible TM2 analog input expansion modules with the corresponding channel type, nominal voltage/current, and terminal type:

| Reference | Channels | Channel type | Voltage Current | Terminal Type |
|------------|----------|-------------------|---|--------------------------------|
| TM2AMI2HT | 2 | High-level inputs | 0...10 Vdc 4...20 mA | Removable screw terminal block |
| TM2AMI2LT | 2 | Low-level inputs | Thermocouple type J,K,T | Removable screw terminal block |
| TM2AMI4LT | 4 | Analog inputs | 0...10 Vdc 0...20 mA PT100/1000 Ni100/1000 | Removable screw terminal block |
| TM2AMI8HT | 8 | Analog inputs | 0...20 mA 0...10 Vdc | Removable screw terminal block |
| TM2ARI8HT | 8 | Analog inputs | NTC / PTC | Removable screw terminal block |
| TM2ARI8LRJ | 8 | Analog inputs | PT100/1000 | RJ11 connector |
| TM2ARI8LT | 8 | Analog inputs | PT100/1000 | Removable screw terminal block |

TM2 Analog Output Expansion Modules

The following table shows the compatible TM2 analog output expansion modules with the corresponding channel type, nominal voltage/current, and terminal type:

| Reference | Channels | Channel type | Voltage Current | Terminal Type |
|-----------|----------|----------------|-------------------------|--------------------------------|
| TM2AMO1HT | 1 | Analog outputs | 0...10 Vdc 4...20 mA | Removable screw terminal block |
| TM2AVO2HT | 2 | Analog outputs | +/- 10 Vdc | Removable screw terminal block |

TM2 Analog Mixed Input/Output Expansion Modules

The following table shows the compatible TM2 analog mixed I/O expansion modules with the corresponding channel type, nominal voltage/current, and terminal type:

| Reference | Channels | Channel type | Voltage Current | Terminal Type |
|-----------|----------|------------------|----------------------|--------------------------------|
| TM2AMM3HT | 2 | Analog inputs | 0...10 Vdc 4...20 mA | Removable screw terminal block |
| | 1 | Analog outputs | 0...10 Vdc 4...20 mA | |
| TM2AMM6HT | 4 | Analog inputs | 0...10 Vdc 4...20 mA | Removable screw terminal block |
| | 2 | Analog outputs | 0...10 Vdc 4...20 mA | |
| TM2ALM3LT | 2 | Low-level inputs | Thermo J,K,T, PT100 | Removable screw terminal block |
| | 1 | Analog outputs | 0...10 Vdc 4...20 mA | |

Accessories

Overview

This section describes the accessories, cables, and Telefast.

Accessories

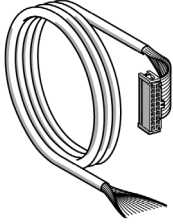
| Reference | Description | Use | Quantity |
|--------------|---|---|----------|
| TMASD1 | SD Card (<i>see page 70</i>) | Use to update the controller firmware, initialize a controller with a new application or clone a controller. | 1 |
| TMAT2MSET | Set of 8 removable screw terminal blocks: <ul style="list-style-type: none"> ● 4 x Removable screw terminal blocks (pitch 3.81 mm) with 11 terminals for inputs/outputs ● 4 x Removable screw terminal blocks (pitch 3.81 mm) with 10 terminals for inputs/outputs | Connects M221 Logic Controller embedded I/Os. | 1 |
| TMAT2MSETG | Set of 8 removable spring terminal blocks: <ul style="list-style-type: none"> ● 4 x Removable spring terminal blocks (pitch 3.81 mm) with 11 terminals for inputs/outputs ● 4 x Removable spring terminal blocks (pitch 3.81 mm) with 10 terminals for inputs/outputs | Connects M221 Logic Controller embedded I/Os. | 1 |
| TMAT2PSET | Set of 5 removable screw terminal block | Connects 24 Vdc power supply. | 1 |
| AB1AB8P35 | End brackets | Help secure the logic controller or receiver module and their expansion modules on a top hat section rail (DIN rail). | 1 |
| TM2XMTGB | Grounding Bar | Connects the cable shield and the module to the functional ground. | 1 |
| TM200RSRCEMC | Shielding take-up clip | Mounts and connects the ground to the cable shielding. | 25 pack |
| TMAM2 | Mounting Kit | Mounts the controller and I/O modules directly to a flat, vertical panel. | 1 |

Cables

| Reference | Description | Details | Length |
|---------------|--|--|--------------------|
| BMXXCAUSBH018 | Terminal port/USB port cordset | From the USB mini-B port on the TM221C Logic Controller to USB port on the PC terminal. NOTE: Grounded and shielded, this USB cable is suitable for long duration connections. | 1.8 m (5.9 ft) |
| BMXXCAUSBH045 | Terminal port/USB port cordset | From the USB mini-B port on the TM221M Logic Controller to USB port on the PC terminal. NOTE: Grounded and shielded, this USB cable is suitable for long duration connections. | 4.5 m (14.8 ft) |
| TMACBL1 | Analog cables | Cable equipped with a connector | 1 m (3.28 ft) |
| TCSMCN3M4F3C2 | RS-232 serial link cordset 1 RJ45 connector and 1 SUB-D 9 connector | For DTE terminal (printer) | 3 m (9.84 ft) |
| TCSMCN3M4M3S2 | RS-232 serial link cordset 1 RJ45 connector and 1 SUB-D 9 connector | For DCE terminal (modem, converter) | 3 m (9.84 ft) |
| TWDFCW30K | Digital I/O cables with free wires for 20-pin Modular controller | Cable equipped at a one end with an HE10 connector. (AWG 22 / 0.34 mm ²) | 3 m (9.84 ft) |
| TWDFCW50K | | Cable equipped at a one end with an HE10 connector. (AWG 22 / 0.34 mm ²) | 5 m (16.4 ft) |

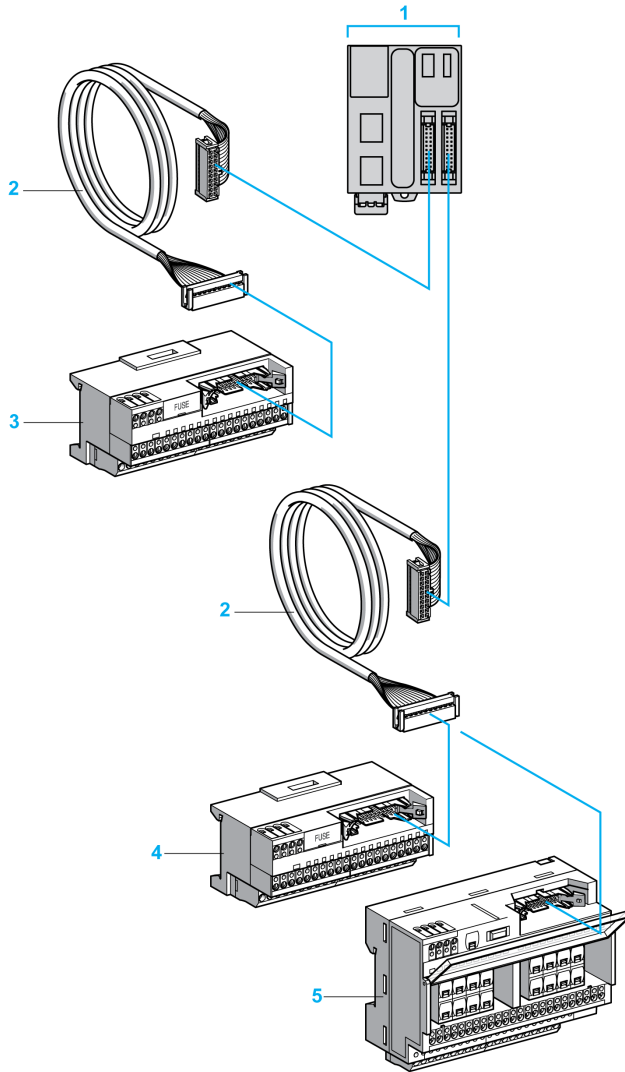
TWDFCW••K Cable Description

The following table provides specifications for the TWDFCW30K/50K with free wires for 20-pin connectors (HE10 or MIL20):

| Cable illustration | Pin Connector | Wire Color |
|---|---------------|------------------|
|  | 1 | White |
| | 2 | Brown |
| | 3 | Green |
| | 4 | Yellow |
| | 5 | Grey |
| | 6 | Pink |
| | 7 | Blue |
| | 8 | Red |
| | 9 | Black |
| | 10 | Violet |
| | 11 | Grey and pink |
| | 12 | Red and blue |
| | 13 | White and green |
| | 14 | Brown and green |
| | 15 | White and yellow |
| | 16 | Yellow and brown |
| | 17 | White and grey |
| | 18 | Grey and brown |
| | 19 | White and pink |
| | 20 | Pink and brown |

Telefast Pre-Wiring Sub-bases

The following illustration shows the Telefast system:



- 1 TM221M32TK / TM221ME32TK
- 2 Cable equipped with a 20-way HE 10 connector at each end.)
- 3 16 channel sub-base for input extension modules.
- 4 16 channel sub-base for output extension modules.
- 5 16 channel sub-base for output extension modules.

Refer to [*TM221M Logic Controller Instruction Sheet*](#).

Chapter 2

M221 Features

Overview

This chapter describes the Modicon M221 Logic Controller features.

What Is in This Chapter?

This chapter contains the following topics:

| Topic | Page |
|-----------------------|------|
| Real Time Clock (RTC) | 52 |
| Input Management | 59 |
| Output Management | 63 |
| Run/Stop | 67 |
| SD Card | 70 |

Real Time Clock (RTC)

Overview

The M221 Logic Controller includes an RTC to provide system date and time information, and to support related functions requiring a real-time clock. To continue keeping time when power is off, a non-rechargeable battery is required (see reference below). A battery LED on the front panel of the controller indicates if the battery is depleted or absent.

This table shows how RTC drift is managed:

| RTC Characteristics | Description |
|---------------------|---|
| RTC drift | Less than 30 seconds per month at 25 °C (77 °F) |

Battery

The controller has one backup battery.

In the event of a power interruption, the backup battery maintains user data and the RTC for the controller.

This table shows the characteristics of the battery:

| Characteristics | Description |
|--------------------------------|---|
| Use | In the event of a transient power outage, the battery powers the RTC and user data. |
| Backup life | At least 1 year at 25 °C max (77 °F). At higher temperatures, the time is reduced. |
| Battery monitoring | Yes |
| Replaceable | Yes |
| Battery life | 4 years at 25 °C max (77 °F). At higher temperatures, the time is reduced. |
| Controller battery type | Lithium carbon monofluoride, type Panasonic BR2032 |

Installing and Replacing the Battery

While lithium batteries are preferred due to their slow discharge and long life, they can present hazards to personnel, equipment and the environment and must be handled properly.

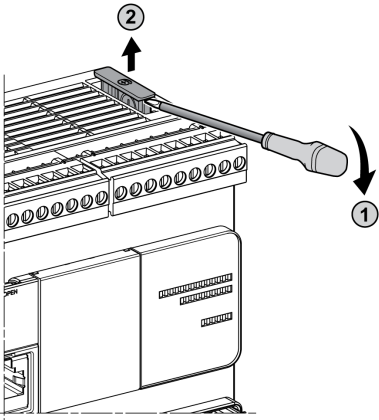
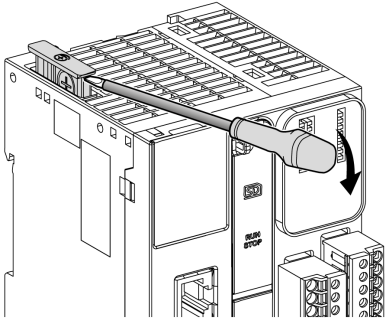
DANGER

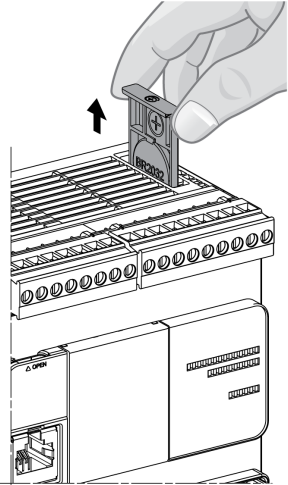
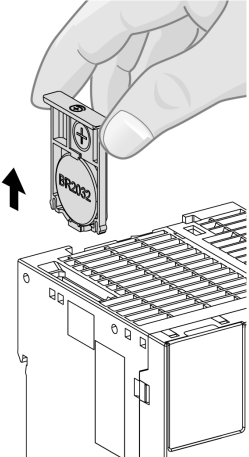
EXPLOSION, FIRE, OR CHEMICAL BURNS

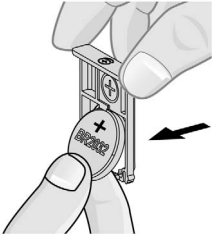
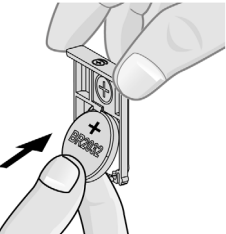
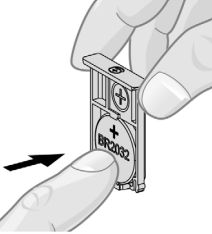
- Replace with identical battery type.
- Follow all the instructions of the battery manufacturer.
- Remove all replaceable batteries before discarding unit.
- Recycle or properly dispose of used batteries.
- Protect battery from any potential short-circuit.
- Do not recharge, disassemble, heat above 100 °C (212 °F), or incinerate.
- Use your hands or insulated tools to remove or replace the battery.
- Maintain proper polarity when inserting and connecting a new battery.

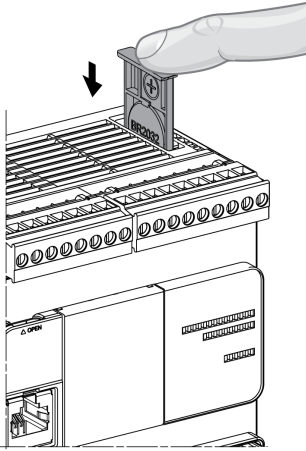
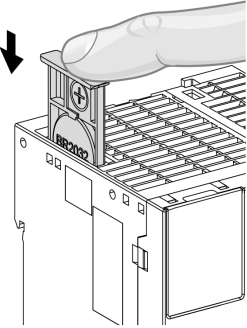
Failure to follow these instructions will result in death or serious injury.

To install or replace the battery, follow these steps:

| Step | Action |
|------|--|
| 1 | Remove power from your controller. |
| 2 | <p data-bbox="289 277 1227 315">Use an insulated screw-driver to pull out the battery holder from the TM221C Logic Controller.</p>  <p data-bbox="289 787 1227 824">Use an insulated screw-driver to pull out the battery holder from the TM221M Logic Controller.</p>  |

| Step | Action |
|------|--|
| 3 | <p data-bbox="326 203 891 227">Slide out the battery holder of the TM221C Logic Controller.</p>  <p data-bbox="326 779 891 803">Slide out the battery holder of the TM221M Logic Controller.</p>  |

| Step | Action |
|------|---|
| 4 | <p data-bbox="296 201 710 227">Remove the battery from the battery holder.</p>  |
| 5 | <p data-bbox="296 522 1171 574">Insert the new battery into the battery holder in accordance with the polarity markings on the battery.</p>  |
| 6 | <p data-bbox="296 872 1097 898">Replace the battery holder on the controller and verify that the latch clicks into place.</p>  |

| Step | Action |
|------|--|
| 7 | <p data-bbox="326 201 879 225">Slide in the battery holder of the TM221C Logic Controller.</p>  <p data-bbox="326 743 879 768">Slide in the battery holder of the TM221M Logic Controller.</p>  |
| 8 | Power up your M221 Logic Controller. |
| 9 | Set the internal clock. For further details on the internal clock, refer to SoMachine Basic Operating Guide (<i>see SoMachine Basic, Generic Functions Library Guide</i>). |

NOTE: Replacement of the battery in the controllers other than with the type specified in this documentation may present a risk of fire or explosion.

 **WARNING**

IMPROPER BATTERY CAN PROVOKE FIRE OR EXPLOSION

Replace battery only with identical type: Panasonic Type BR2032.

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

Input Management

Overview

The M221 Logic Controller features digital inputs, including 4 fast inputs.

The following functions are configurable:

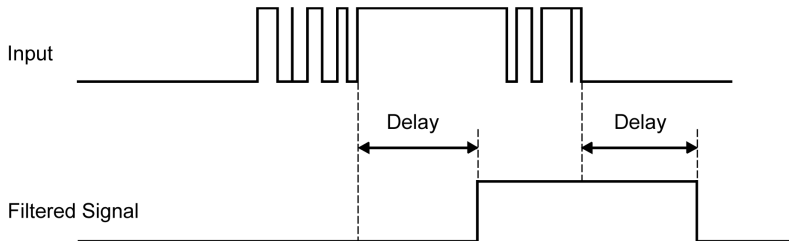
- Filters (depends on the function associated with the input).
- **I0..I15** inputs can be used for the Run/Stop function.
- Four fast inputs can be either latched or used for events (rising edge, falling edge, or both) and thus be linked to an external task.

NOTE: All inputs can be used as regular inputs.

Integrator Filter Principle

The filter is designed to reduce the bouncing effect at the inputs. Setting a filter value helps the controller to ignore sudden changes of input levels caused by induction of electromagnetic interference.

The following timing diagram illustrates the filter effects:



Bounce Filter Availability

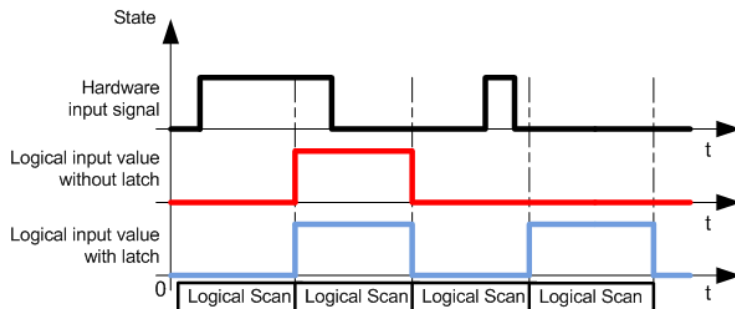
The bounce filter can be used on a fast input when:

- Using a latch or event
- HSC is enabled

Latching

Latching is a function that can be assigned to the M221 Logic Controller fast inputs. This function is used to memorize (or latch) any pulse with a duration that is less than the M221 Logic Controller scan time. When a pulse is shorter than one scan, the controller latches the pulse, which is then updated in the next scan. This latching mechanism only recognizes rising edges. Falling edges cannot be latched. Assigning inputs to be latched is done in the **Configuration** tab in SoMachine Basic.

The following timing diagram illustrates the latching effects:



Event

An input configured for Event can be associated with an External Task.

Run/Stop

The Run/Stop function is used to start or stop an application program using an input. In addition to the embedded Run/Stop switch, you can configure one (and only one) input as an additional Run/Stop command.

For more information, refer to the Run/Stop ([see page 67](#)).

⚠ WARNING

UNINTENDED MACHINE OR PROCESS START-UP

- Verify the state of security of your machine or process environment before applying power to the Run/Stop input.
- Use the Run/Stop input to help prevent the unintentional start-up from a remote location.

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

Input Management Functions Availability

Embedded digital inputs can be assigned to functions (Run/Stop, Latch, Event, Fast Counter, HSC, PTO). Inputs not assigned to functions are used as regular inputs. The following table presents the possible assignments of the embedded M221 Logic Controller digital inputs:

| Function | | Simple Input Function | | | Advanced Input Function | | |
|---|-------|-----------------------|-------|-------|-------------------------|-------------------------------|---------------------------------|
| | | Run/Stop | Latch | Event | Fast Counter | HSC | PTO ⁽³⁾ |
| Fast Input | %I0.0 | X | – | – | – | %HSC0 | – |
| | %I0.1 | X | – | – | – | %HSC0 or %HSC2 ⁽¹⁾ | – |
| Regular Input | %I0.2 | X | X | X | %FC0 | Preset for %HSC0 | Ref or probe for %PTO0 to %PTO3 |
| | %I0.3 | X | X | X | %FC1 | Catch for %HSC0 | |
| | %I0.4 | X | X | X | %FC2 | Catch for %HSC1 | |
| | %I0.5 | X | X | X | %FC3 | Preset for %HSC1 | |
| Fast Input | %I0.6 | X | – | – | – | %HSC1 | – |
| | %I0.7 | X | – | – | – | %HSC1 or %HSC3 ⁽²⁾ | – |
| X Yes – No (1) %HSC2 is available when %HSC0 is configured as Single Phase or Not Configured. (2) %HSC3 is available when %HSC1 is configured as Single Phase or Not Configured. (3) PTO function is available on controller references that contain transistor outputs. | | | | | | | |

| Function | | Simple Input Function | | | Advanced Input Function | | |
|--|--------|-----------------------|-------|-------|-------------------------|-----|---|
| | | Run/Stop | Latch | Event | Fast Counter | HSC | PTO ⁽³⁾ |
| Regular Input (depending on the controller reference) | %I0.8 | X | - | - | - | - | Ref or probe for %PTO0 to %PTO3 on TM221C40U and TM221CE40U controllers |
| | %I0.9 | X | - | - | - | - | |
| | %I0.10 | X | - | - | - | - | - |
| | %I0.11 | X | - | - | - | - | - |
| | %I0.12 | X | - | - | - | - | - |
| | %I0.13 | X | - | - | - | - | - |
| | %I0.14 | X | - | - | - | - | - |
| | %I0.15 | X | - | - | - | - | - |
| | %I0.16 | X | - | - | - | - | - |
| | %I0.17 | X | - | - | - | - | - |
| | %I0.18 | X | - | - | - | - | - |
| | %I0.19 | X | - | - | - | - | - |
| | %I0.20 | X | - | - | - | - | - |
| | %I0.21 | X | - | - | - | - | - |
| | %I0.22 | X | - | - | - | - | - |
| %I0.23 | X | - | - | - | - | - | |

X Yes
- No
(1) %HSC2 is available when %HSC0 is configured as Single Phase or Not Configured.
(2) %HSC3 is available when %HSC1 is configured as Single Phase or Not Configured.
(3) PTO function is available on controller references that contain transistor outputs.

Output Management

Introduction

The M221 Logic Controller features both regular and fast transistor outputs (PLS/PWM/PTO/FREQGEN).

The following output functions are configurable on the transistor outputs:

- Alarm output
- HSC (reflex features on HSC threshold)
- PLS
- PTO
- PWM
- FREQGEN

NOTE: All outputs can be used as regular outputs.

Output Management Availability

The information below refers to regular and fast transistor outputs on the M221 Logic Controller:

| Function | | Alarm Output | HSC | PLS / PWM / PTO / FREQGEN |
|---|-------|--------------|-----|---|
| Fast Output ⁽¹⁾ | %Q0.0 | X | – | <ul style="list-style-type: none"> • %PLS0 • %PWM0 • %PTO0 • %FREQGEN0 |
| | %Q0.1 | X | – | <ul style="list-style-type: none"> • %PLS1 • %PWM1 • %PTO⁽²⁾ • %FREQGEN1 |
| <p>(1) Fast output functions are only available on controller references that contain transistor outputs.</p> <p>(2) %PTO0 direction in CW/CCW output mode, or %PTO1 (not available when %PTO0 is configured in CW/CCW output mode), or %PTOx direction in other cases.</p> <p>(3) %Q0.2 and %Q0.3 are fast outputs on TM221C40U and TM221CE40U controllers</p> <p>(4) %PTO2 on TM221C40U and TM221CE40U controllers, or %PTOx direction in other cases.</p> <p>(5) %PTO2 direction in CW/CCW output mode on TM221C40U and TM221CE40U controllers, or %PTO3 (not available when %PTO2 is configured in CW/CCW output mode) on TM221C40U and TM221CE40U controllers, or %PTOx direction in other cases.</p> | | | | |

| Function | | Alarm Output | HSC | PLS / PWM / PTO / FREQGEN |
|--|--------|--------------|------------------------------------|---|
| Regular Output ⁽³⁾ (depending on the controller reference) | %Q0.2 | X | Reflex output 0 for %HSC0 or %HSC2 | <ul style="list-style-type: none"> • %PTO⁽⁴⁾ • %FREQGEN2 |
| | %Q0.3 | X | Reflex output 1 for %HSC0 or %HSC2 | <ul style="list-style-type: none"> • %PTO⁽⁵⁾ • %FREQGEN3 |
| | %Q0.4 | X | Reflex output 0 for %HSC1 or %HSC3 | %PTOx direction |
| | %Q0.5 | X | Reflex output 1 for %HSC1 or %HSC3 | %PTOx direction |
| | %Q0.6 | X | – | %PTOx direction |
| | %Q0.7 | X | – | %PTOx direction |
| | %Q0.8 | – | – | %PTOx direction |
| | %Q0.9 | – | – | %PTOx direction |
| | %Q0.10 | – | – | %PTOx direction |
| | %Q0.11 | – | – | %PTOx direction |
| | %Q0.12 | – | – | %PTOx direction |
| | %Q0.13 | – | – | %PTOx direction |
| | %Q0.14 | – | – | %PTOx direction |
| | %Q0.15 | – | – | %PTOx direction |

(1) Fast output functions are only available on controller references that contain transistor outputs.

(2) %PTO0 direction in CW/CCW output mode, or %PTO1 (not available when %PTO0 is configured in CW/CCW output mode), or %PTOx direction in other cases.

(3) %Q0.2 and %Q0.3 are fast outputs on TM221C40U and TM221CE40U controllers

(4) %PTO2 on TM221C40U and TM221CE40U controllers, or %PTOx direction in other cases.

(5) %PTO2 direction in CW/CCW output mode on TM221C40U and TM221CE40U controllers, or %PTO3 (not available when %PTO2 is configured in CW/CCW output mode) on TM221C40U and TM221CE40U controllers, or %PTOx direction in other cases.

Fallback Modes (Behavior for Outputs in Stop)

When the controller enters the STOPPED or one of the exception states for any reason, the local (embedded and expansion) outputs are set to **Default Value** defined in the application.

In case of PTO outputs, the fallback values are forced to 0 logic (0 Vdc) and these values cannot be modified.

Short-circuit or Over-current on Source Transistor Outputs

Outputs are clustered in packs of 4 outputs maximum (less when the total number of outputs of the controller is not a multiple of 4):

- Q0...Q3
- Q4...Q7
- Q8...Q11
- Q12...Q15

When a short-circuit or overload is detected and the system bit %S49 is set to 1, the cluster of 4 outputs is set to 0. An automatic rearming is done periodically (about 1 s). Only the short-circuit between an output set to 1 and 0 V is detected. The short-circuit between an output set to 0 and 24 V is not detected.

NOTE: By default, %S49 is set to 0.

The following table describes the actions taken on short-circuits or overload of transistor outputs from Q0 to Q3:

| If... | then... |
|--|---|
| If you have short-circuit at 0 V on transistor outputs | Transistor outputs automatically go into over-current protection or thermal protection mode. For more information, refer to transistor output wiring diagrams. |

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

WARNING

UNINTENDED MACHINE START-UP

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

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

NOTE: The automatic rearming feature can be disabled with the system bit %S49. Refer to the Programming Guide of your controller for more information.

Short-circuit or Over-Current on Sink Transistor Outputs

Sink transistor outputs are not internally protected against overloads or short-circuits.

The following table describes the actions taken on overloads or short-circuits on sink transistor outputs:

| if... | then ... |
|--|--|
| If you have short-circuit or overload at 0 V, or 24 V on sink transistor outputs | no action is taken and no error is detectable. |

For more information, refer to Sink Transistor Outputs Wiring Diagrams (*see page 244*).

Short-circuit or Over-Current on Relay Outputs

Relay outputs are not internally protected against overloads or short-circuits.

The following table describes the actions taken on overloads or short-circuits on relay outputs:

| if... | then... |
|---|--|
| If you have short-circuit or overload at 0 V or 24 V on relay outputs | No action is taken and no error is detectable. For more information, refer to relay output wiring diagrams. |

Relay outputs are electromechanical switches capable of carrying significant levels of current and voltage. All electromechanical devices have a limited operational life and must be installed so as to minimize the potential for unintended consequences.

WARNING

INOPERABLE OUTPUTS

Use appropriate, external safety interlocks on outputs where personnel and/or equipment hazards exist.

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

Run/Stop

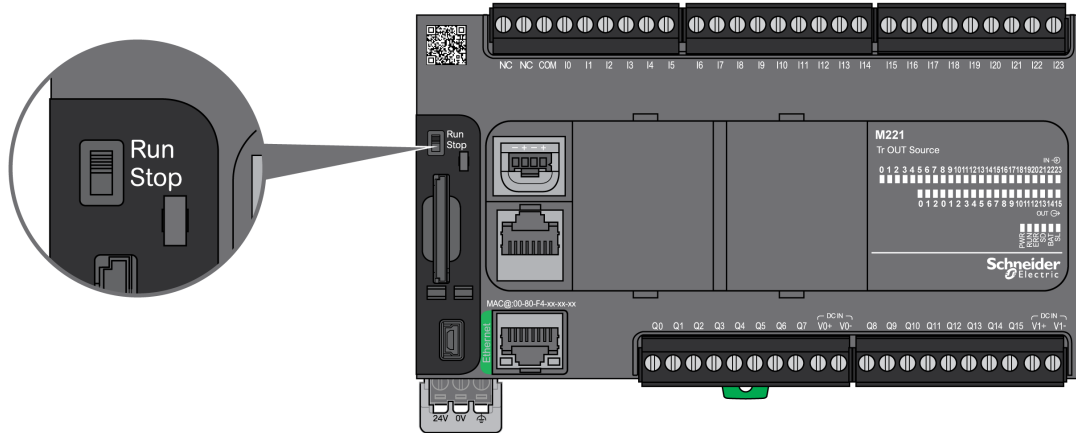
Run/Stop

The M221 Logic Controller can be operated externally by the following:

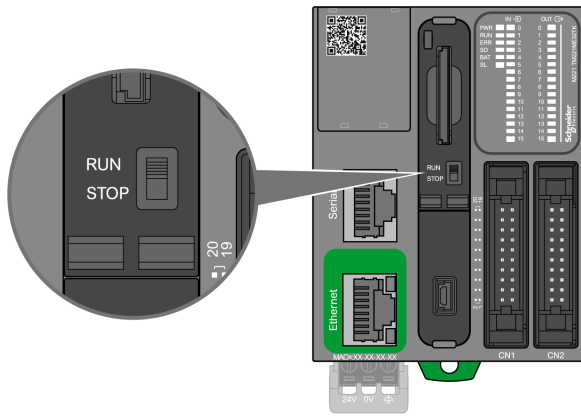
- a hardware Run/Stop switch
- a Run/Stop (*see page 60*) operation by a dedicated digital input, defined in the software configuration. For more information, refer to *Configuring Digital Inputs (see Modicon M221, Logic Controller, Programming Guide)*.
- a SoMachine Basic software command.
- a Remote Graphic Display (*see Modicon TMH2GDB, Remote Graphic Display, User Guide*).

The M221 Logic Controller has a Run/Stop hardware switch, which puts the controller in a RUN or STOP state.

The following figure shows the location of the Run/Stop switch on the TM221C Logic Controller:



The following figure shows the location of the Run/Stop switch on the TM221M Logic Controller:



The interaction of the different operators on the controller state behavior is summarized in the table below:

| | | Embedded Run/Stop hardware switch | | |
|--|-------------|---|---|---|
| | | Switch on Stop | Stop to Run transition | Switch on Run |
| Software configurable Run/Stop digital input | None | STOP Ignores external Run/Stop commands ² . | Commands a transition to RUN state ¹ . | Allows external Run/Stop commands ² . |
| | State 0 | STOP Ignores external Run/Stop commands ² . | STOP Ignores external Run/Stop commands ² . | STOP Ignores external Run/Stop commands ² . |
| | Rising edge | STOP Ignores external Run/Stop commands ² . | Commands a transition to RUN state ¹ . | Commands a transition to RUN state ¹ . |
| | State 1 | STOP Ignores external Run/Stop commands ² . | Commands a transition to RUN state ¹ . | Allows external Run/Stop commands ² . |

¹ For more information, refer to the Controller States and Behaviors (see *Modicon M221, Logic Controller, Programming Guide*).

² External Run/Stop commands sent by the SoMachine Basic online button or a Remote Graphic Display.

 **WARNING****UNINTENDED MACHINE OR PROCESS START-UP**

- Verify the state of security of your machine or process environment before applying power to the Run/Stop input or engaging the Run/Stop switch.
- Use the Run/Stop input to help prevent the unintentional start-up from a remote location, or from accidentally engaging the Run/Stop switch.

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

SD Card

Overview

When handling the SD card, follow the instructions below to help prevent internal data on the SD card from being corrupted or lost or a SD card malfunction from occurring:

NOTICE

LOSS OF APPLICATION DATA

- Do not store the SD card where there is static electricity or probable electromagnetic fields.
- Do not store the SD card in direct sunlight, near a heater, or other locations where high temperatures can occur.
- Do not bend the SD card.
- Do not drop or strike the SD card against another object.
- Keep the SD card dry.
- Do not touch the SD card connectors.
- Do not disassemble or modify the SD card.
- Use only SD cards formatted using FAT or FAT32.

Failure to follow these instructions can result in equipment damage.

The M221 Logic Controller does not recognize NTFS formatted SD cards. Format the SD card on your computer using FAT or FAT32.

When using the M221 Logic Controller and a SD card, observe the following to avoid losing valuable data:

- Accidental data loss can occur at any time. Once data is lost it cannot be recovered.
- If you forcibly extract the SD card, data on the SD card may become corrupted.
- Removing an SD card that is being accessed could damage the SD card, or corrupt its data.
- If the SD card is not positioned correctly when inserted into the controller, the data on the card and the controller could become damaged.

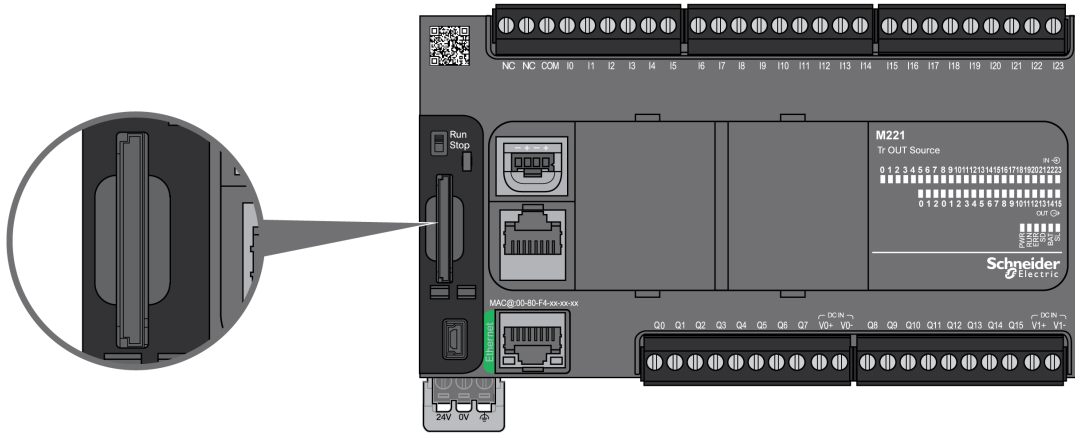
NOTICE

LOSS OF APPLICATION DATA

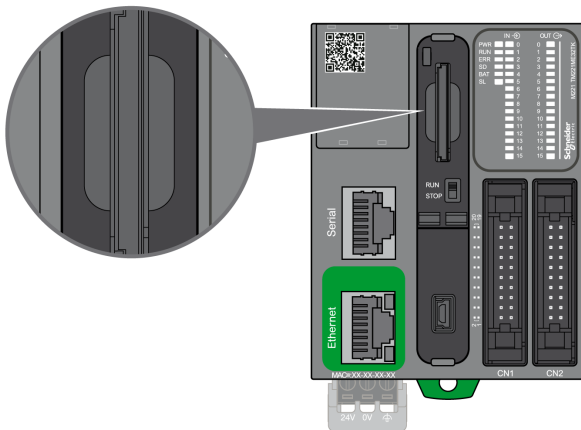
- Backup SD card data regularly.
- Do not remove power or reset the controller, and do not insert or remove the SD card while it is being accessed.
- Become familiar with the proper orientation of the SD card when inserting it into the controller.

Failure to follow these instructions can result in equipment damage.

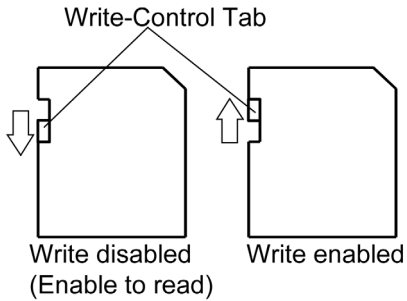
The following figure shows the SD card slot of the TM221C Logic Controller:

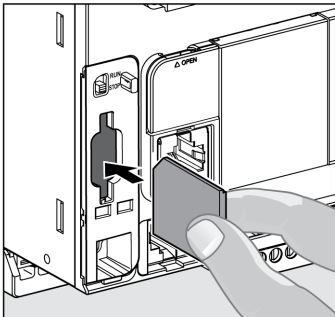
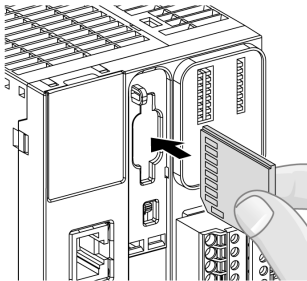


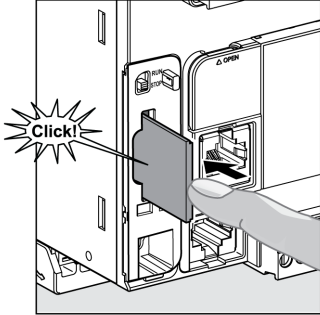
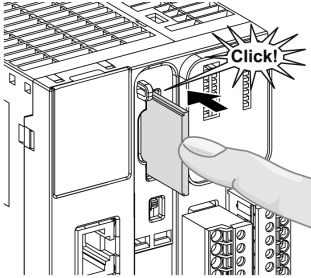
The following figure shows the SD card slot of the TM221M Logic Controller:



It is possible to set the Write-Control Tab to prevent write operations to the SD card. Push the tab up, as shown in the example on the right-hand side, to release the lock and enable writing to the SD card. Before using an SD card, read the manufacturer's instructions.



| Step | Action |
|------|---|
| 1 | <p>Insert the SD card into the SD card slot of the TM221C Logic Controller:</p>  <p>Insert the SD card into the SD card slot of the TM221M Logic Controller:</p>  |

| Step | Action |
|------|---|
| 2 | <p>Push until you hear it “click” (TM221C Logic Controller):</p>  <p>Push until you hear it “click” (TM221M Logic Controller):</p>  |

SD Card Slot Characteristics

| Topic | Characteristics | Description |
|---------------------|------------------------------|------------------------------|
| Supported type | Standard Capacity | SD (SDSC) |
| | High Capacity | SDHC |
| Global memory | Size | 32 GB max. |
| Memory organization | Application backup size | 64 MB |
| | Data storage size | 1.93 GB |
| Robustness | Write/erase cycles (typical) | 100,000 |
| | Temperature operating range | -40...+85 °C (-40...+185 °F) |
| | File retention time | 10 years |

TMASD1 Characteristics

| Characteristics | Description |
|-------------------------------|------------------------------|
| Card removal durability | Minimum 1000 times |
| File retention time | 10 years @ 25 °C (77 °F) |
| Flash type | SLC NAND |
| Memory size | 256 MB |
| Ambient operation temperature | -10 ... +85°C (14...185 °F) |
| Storage temperature | -25 ... +85°C (-13...185 °F) |
| Relative humidity | 95% max. non-condensing |
| Write/Erase cycles | 3,000,000 (approximately) |

NOTE: The TMASD1 has been rigorously tested in association with the logic controller. For other commercially available cards, consult your local sales representative.

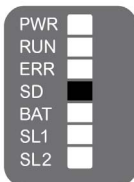
NOTE: The SD card can be used directly on your PC.

Status LED

The following figure shows the status LEDs of the TM221C Logic Controller:



The following figure shows the status LEDs of the TM221M Logic Controller:



The following table describes the SD card status LED:

| Label | Description | LED | | |
|-------|-------------|-------|----------|--|
| | | Color | Status | Description |
| SD | SD card | Green | On | Indicates that the SD card is being accessed. |
| | | | Off | Indicates no access. |
| | | | Flashing | Indicates that an error was detected during the SD card operation. |

Chapter 3

M221 Installation

Overview

This chapter provides installation safety guidelines, device dimensions, mounting instructions, and environmental specifications.

What Is in This Chapter?

This chapter contains the following sections:

| Section | Topic | Page |
|---------|--|------|
| 3.1 | M221 Logic Controller General Rules for Implementing | 76 |
| 3.2 | M221 Logic Controller Installation | 81 |
| 3.3 | M221 Electrical Requirements | 98 |

Section 3.1

M221 Logic Controller General Rules for Implementing

What Is in This Section?

This section contains the following topics:

| Topic | Page |
|-------------------------------|------|
| Environmental Characteristics | 77 |
| Certifications and Standards | 80 |

Environmental Characteristics


Enclosure Requirements

M221 Logic Controller system 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, the ability to meet electromagnetic compatibility requirements in the presence of conducted and/or radiated interference may be reduced.

All M221 Logic Controller system components meet European Community (CE) requirements for open equipment as defined by IEC/EN 61131-2. You must install them in an enclosure designed for the specific environmental conditions and to minimize the possibility of unintended contact with hazardous voltages. Use metal enclosures to improve the electromagnetic immunity of your M221 Logic Controller system. Use enclosures with a keyed locking mechanism to minimize unauthorized access.

Environmental Characteristics

All the M221 Logic Controller module components are electrically isolated between the internal electronic circuit and the input/output channels within the limits set forth and described by these environmental characteristics. For more information on electrical isolation, see the technical specifications of your particular controller found later in the current document. This equipment meets CE requirements as indicated in the table below. This equipment is intended for use in a Pollution Degree 2 industrial environment.

| |
|---|
|  WARNING |
| UNINTENDED EQUIPMENT OPERATION |
| Do not exceed any of the rated values specified in the environmental and electrical characteristics tables. |
| Failure to follow these instructions can result in death, serious injury, or equipment damage. |

The following table shows the general environmental characteristics:

| Characteristic | | Specification |
|-------------------------------|--------------------------------------|----------------------------|
| Standard compliance | IEC/EN 61131-2 IEC/EN 61010-2-201 | |
| Ambient operating temperature | Horizontal installation | -10...55 °C (14...131 °F) |
| | Vertical installation | -10...35 °C (14...95 °F) |
| Storage temperature | -25...70 °C (-13...158 °F) | |
| Relative humidity | Transport and storage | 10...95 % (non-condensing) |
| | Operation | 10...95 % (non-condensing) |

| Characteristic | | Specification |
|-----------------------------|--|---|
| Degree of pollution | IEC/EN 60664-1 | 2 |
| Degree of protection | IEC/EN 61131-2 | IP20 with protective covers in place |
| Machine Safety conformance | IEC/EN 61010-2-201 | Yes |
| Corrosion immunity | | Atmosphere free from corrosive gases |
| Operating altitude | | 0...2000 m (0...6560 ft) |
| Storage altitude | | 0...3000 m (0...9843 ft) |
| Vibration resistance | IEC/EN 61131-2 Panel mounting or mounted on a top hat section rail (DIN rail) | 3.5 mm (0.13 in) fixed amplitude from 5...8.5 Hz 29.4 m/s ² or 96.45 ft/s ² (3 g _n) fixed acceleration from 8.7...150 Hz |
| Mechanical shock resistance | | 147 m/s ² or 482.28 ft/s ² (15 g _n) for a duration of 11 ms 98 m/s ² or 32.15 ft/s ² (10 g _n) for a duration of 11 ms (for M221 Logic Controller with relay outputs) |

Electromagnetic Susceptibility

The M221 Logic Controller system meets electromagnetic susceptibility specifications as indicated in the following table:

| Characteristic | Designed to specification | Range | |
|--------------------------------|---------------------------|--|-------------------------------------|
| Electrostatic discharge | IEC/EN 61000-4-2 | 8 kV (air discharge) 4 kV (contact discharge) | |
| Radiated electromagnetic field | IEC/EN 61000-4-3 | 10 V/m (80...1000 MHz) 3 V/m (1.4...2 GHz) 1 V/m (2...3 GHz) | |
| Magnetic field | IEC/EN 61000-4-8 | 30 A/m 50 Hz, 60 Hz | |
| Fast transients burst | IEC/EN 61000-4-4 | – | CM ¹ and DM ² |
| | | AC/DC Power lines | 2 kV |
| | | Relay Outputs | 2 kV |
| | | 24 Vdc I/Os | 1 kV |
| | | Analog I/Os | 1 kV |
| | | Communication line | 1 kV |

| Characteristic | Designed to specification | Range | | |
|--|--|--|-----------------|-----------------|
| Surge immunity | IEC/EN 61000-4-5 IEC/EN 61131-2 | – | CM ¹ | DM ² |
| | | DC Power lines | 1 kV | 0.5 kV |
| | | AC Power lines | 2 kV | 1 kV |
| | | Relay Outputs | 2 kV | 1 kV |
| | | 24 Vdc I/Os | 1 kV | – |
| | | Shielded cable (between shield and ground) | 1 kV | – |
| Induced electromagnetic field | IEC/EN 61000-4-6 | 10 Vrms (0.15...80 MHz) | | |
| Conducted emission | IEC/EN 55011 (IEC/CISPR Publication 11) | AC power line: | | |
| | | <ul style="list-style-type: none"> ● 0.15...0.5 MHz: 79 dBμV/m QP / 66 dBμV/m AV ● 0.5...300 MHz: 73 dBμV/m QP / 60 dBμV/m AV | | |
| Radiated emission | IEC/EN 55011 (IEC/CISPR Publication 11) | AC/DC power line: | | |
| | | <ul style="list-style-type: none"> ● 10...150 kHz: 120...69 dBμV/m QP ● 150...1500 kHz: 79...63 dBμV/m QP ● 1.5...30 MHz: 63 dBμV/m QP | | |
| | | Class A, 10 m distance: | | |
| | | <ul style="list-style-type: none"> ● 30...230 MHz: 40 dBμV/m QP ● 230...1000 MHz: 47 dBμV/m QP | | |
| 1 Common Mode 2 Differential Mode | | | | |

Certifications and Standards

Introduction

The M221 Logic Controllers are designed to conform to the main national and international standards concerning electronic industrial control devices:

- IEC/EN 61131-2
- UL 508

The M221 Logic Controllers have obtained the following conformity marks:

- CE
- CSA (not for TM221C***U)
- EAC
- RCM
- UL
- cCSAus Hazardous Location (not for TM221C***U)

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

Section 3.2

M221 Logic Controller Installation

What Is in This Section?

This section contains the following topics:

| Topic | Page |
|---|------|
| Installation and Maintenance Requirements | 82 |
| TM221C Logic Controller Mounting Positions and Clearances | 84 |
| TM221M Logic Controller Mounting Positions and Clearances | 87 |
| Top Hat Section Rail (DIN rail) | 90 |
| Installing and Removing the Controller with Expansions | 93 |
| Direct Mounting on a Panel Surface | 96 |

Installation and Maintenance Requirements

Before Starting

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

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

In addition to the **Environmental Characteristics**, refer to **Product Related Information** in the beginning of the present document for important information regarding installation in hazardous locations for this specific equipment.

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.

TM221C Logic Controller Mounting Positions and Clearances

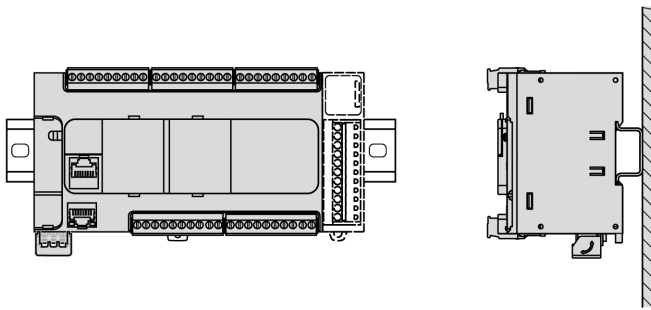
Introduction

This section describes the mounting positions for the TM221C Logic Controller .

NOTE: Keep adequate spacing for proper ventilation and to maintain the operating temperature specified in the Environmental Characteristics (*see page 77*).

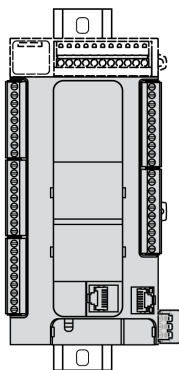
Correct Mounting Position

Whenever possible, the TM221C Logic Controller should be mounted horizontally on a vertical plane as shown in the figure below:



Acceptable Mounting Positions

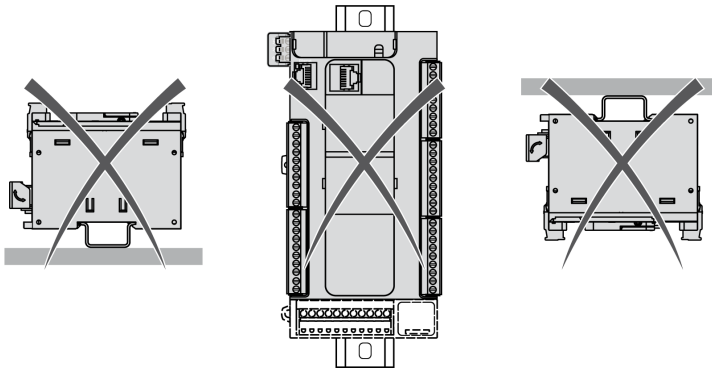
The TM221C Logic Controller can also be mounted vertically with a temperature derating on a vertical plane as shown below.



NOTE: Expansion modules must be mounted above the logic controller.

Incorrect Mounting Position

The TM221C Logic Controller should only be positioned as shown in Correct Mounting Position (*see page 84*) figure. The figures below show the incorrect mounting positions.



Minimum Clearances

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Place devices dissipating the most heat at the top of the cabinet and ensure adequate ventilation.
- Avoid placing this equipment next to or above devices that might cause overheating.
- Install the equipment in a location providing the minimum clearances from all adjacent structures and equipment as directed in this document.
- Install all equipment in accordance with the specifications in the related documentation.

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

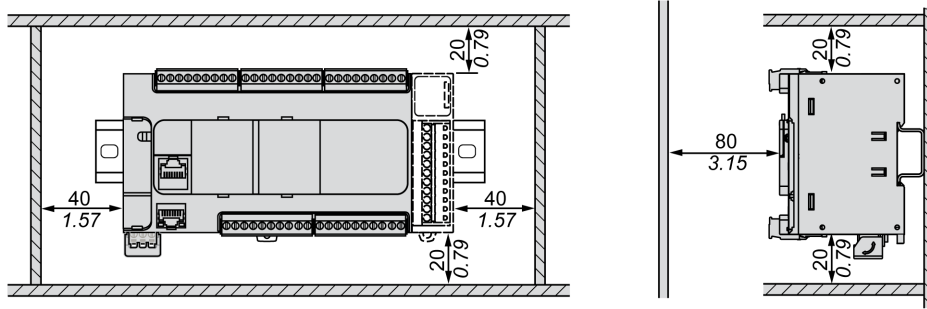
The M221 Logic Controller has been designed as an IP20 product and must be installed in an enclosure. Clearances must be respected when installing the product.

There are 3 types of clearances between:

- The M221 Logic Controller and all sides of the cabinet (including the panel door).
- The M221 Logic Controller terminal blocks and the wiring ducts. This distance reduces electromagnetic interference between the controller and the wiring ducts.
- The M221 Logic Controller and other heat generating devices installed in the same cabinet.

The following figure shows the minimum clearances that apply to all TM221C Logic Controller references:

$\frac{\text{mm}}{\text{in.}}$



TM221M Logic Controller Mounting Positions and Clearances

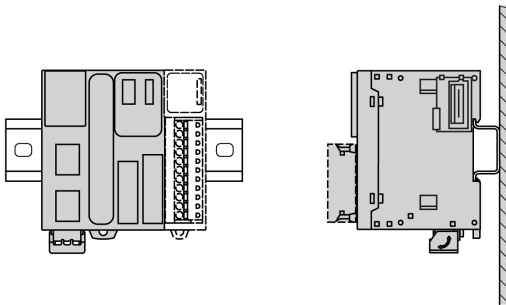
Introduction

This section describes the mounting positions for the M221 Logic Controller.

NOTE: Keep adequate spacing for proper ventilation and to maintain the operating temperature specified in the Environmental Characteristics (*see page 77*).

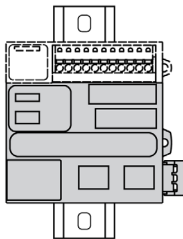
Correct Mounting Position

To obtain optimal operating characteristics, the M221 Logic Controller should be mounted horizontally on a vertical plane as shown in the figure below:



Acceptable Mounting Positions

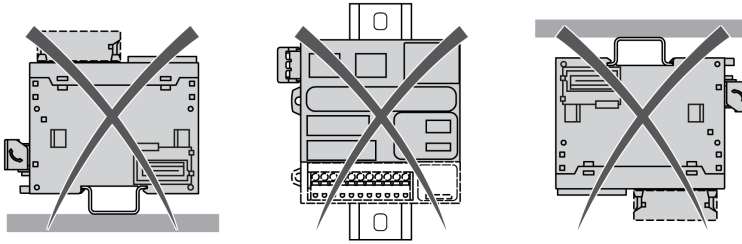
The M221 Logic Controller can also be mounted vertically on a vertical plane as shown below.



NOTE: Expansion modules must be mounted above the controller.

Incorrect Mounting Position

The M221 Logic Controller should only be positioned as shown in the Correct Mounting Position (see page 87) figure. The figures below show the incorrect mounting positions.



Minimum Clearances

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

- Place devices dissipating the most heat at the top of the cabinet and ensure adequate ventilation.
- Avoid placing this equipment next to or above devices that might cause overheating.
- Install the equipment in a location providing the minimum clearances from all adjacent structures and equipment as directed in this document.
- Install all equipment in accordance with the specifications in the related documentation.

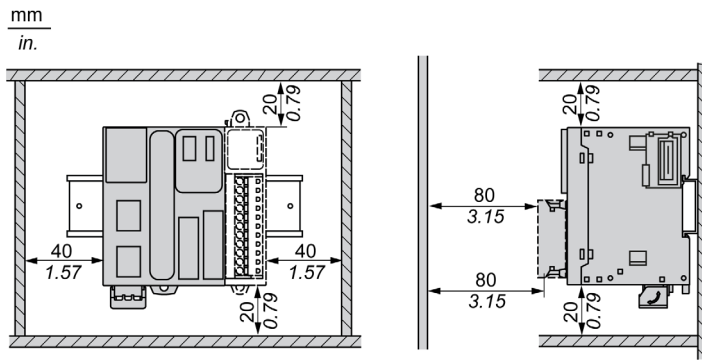
Failure to follow these instructions can result in death, serious injury, or equipment damage.

The M221 Logic Controller has been designed as an IP20 product and must be installed in an enclosure. Clearances must be respected when installing the product.

There are 3 types of clearances to consider:

- The M221 Logic Controller and all sides of the cabinet (including the panel door).
- The M221 Logic Controller terminal blocks and the wiring ducts to help reduce potential electromagnetic interference between the controller and the duct wiring.
- The M221 Logic Controller and other heat generating devices installed in the same cabinet.

The following figure shows the minimum clearances that apply to all M221 Logic Controller references:



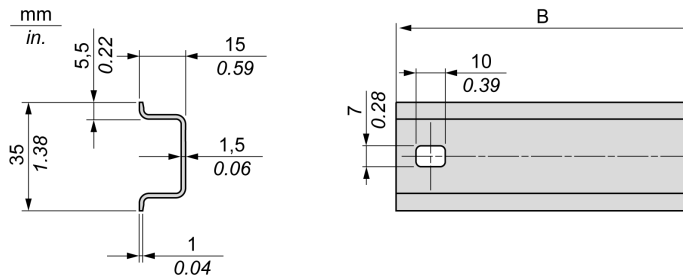
Top Hat Section Rail (DIN rail)

Dimensions of Top Hat Section Rail DIN Rail

You can mount the controller or receiver and its expansions on a 35 mm (1.38 in.) top hat section rail (DIN rail). It can be attached to a smooth mounting surface or suspended from a EIA rack or mounted in a NEMA cabinet.

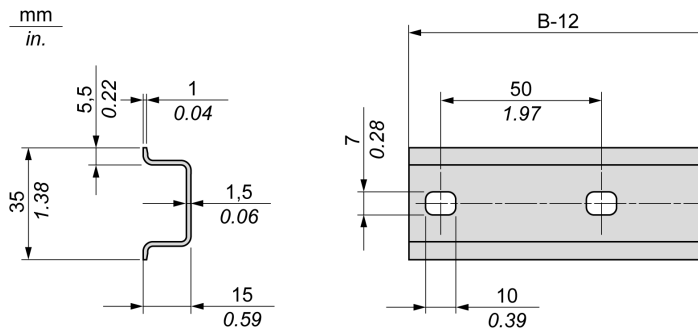
Symmetric Top Hat Section Rails (DIN Rail)

The following illustration and table show the references of the top hat section rails (DIN rail) for the wall-mounting range:



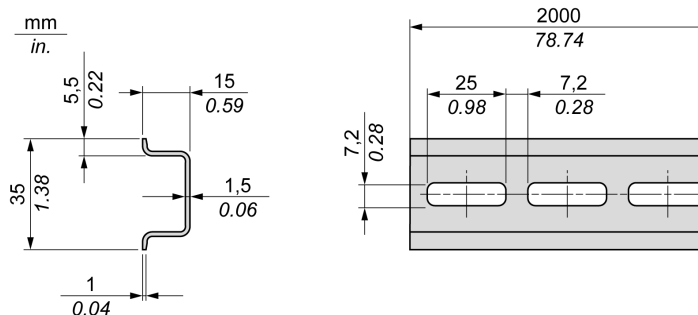
| Reference | Type | Rail Length (B) |
|------------|------|--------------------|
| NSYSDR50A | A | 450 mm (17.71 in.) |
| NSYSDR60A | A | 550 mm (21.65 in.) |
| NSYSDR80A | A | 750 mm (29.52 in.) |
| NSYSDR100A | A | 950 mm (37.40 in.) |

The following illustration and table show the references of the symmetric top hat section rails (DIN rail) for the metal enclosure range:



| Reference | Type | Rail Length (B-12 mm) |
|-----------|------|-----------------------|
| NSYSDR60 | A | 588 mm (23.15 in.) |
| NSYSDR80 | A | 788 mm (31.02 in.) |
| NSYSDR100 | A | 988 mm (38.89 in.) |
| NSYSDR120 | A | 1188 mm (46.77 in.) |

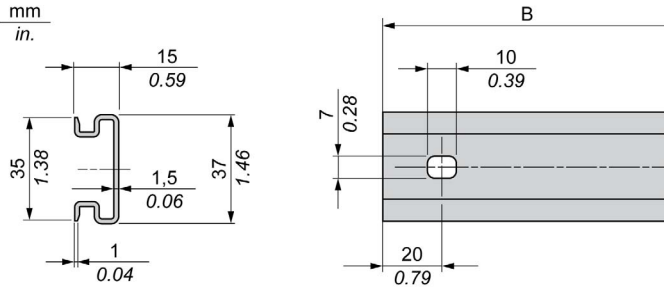
The following illustration and table shows the references of the symmetric top hat section rails (DIN rail) of 2000 mm (78.74 in.):



| Reference | Type | Rail Length |
|--|------|---------------------|
| NSYSDR200 ¹ | A | 2000 mm (78.74 in.) |
| NSYSDR200D ² | A | |
| 1 Unperforated galvanized steel 2 Perforated galvanized steel | | |

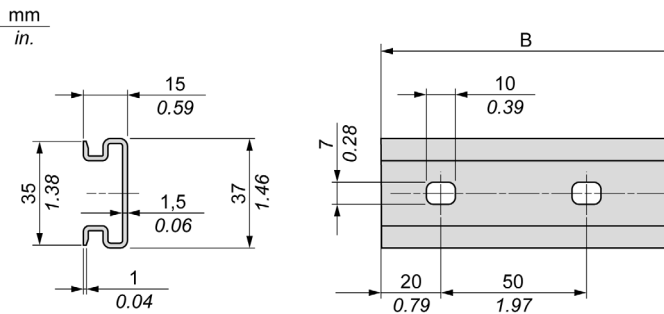
Double-Profile Top Hat Section Rails (DIN rail)

The following illustration and table show the references of the double-profile top hat section rails (DIN rails) for the wall-mounting range:



| Reference | Type | Rail Length (B) |
|-----------|------|--------------------|
| NSYDPR25 | W | 250 mm (9.84 in.) |
| NSYDPR35 | W | 350 mm (13.77 in.) |
| NSYDPR45 | W | 450 mm (17.71 in.) |
| NSYDPR55 | W | 550 mm (21.65 in.) |
| NSYDPR65 | W | 650 mm (25.60 in.) |
| NSYDPR75 | W | 750 mm (29.52 in.) |

The following illustration and table show the references of the double-profile top hat section rails (DIN rail) for the floor-standing range:



| Reference | Type | Rail Length (B) |
|-----------|------|---------------------|
| NSYDPR60 | F | 588 mm (23.15 in.) |
| NSYDPR80 | F | 788 mm (31.02 in.) |
| NSYDPR100 | F | 988 mm (38.89 in.) |
| NSYDPR120 | F | 1188 mm (46.77 in.) |

Installing and Removing the Controller with Expansions

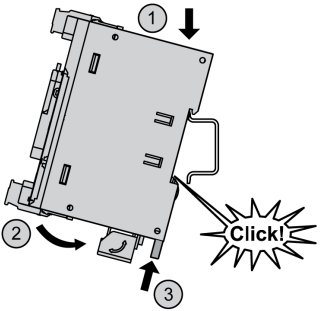
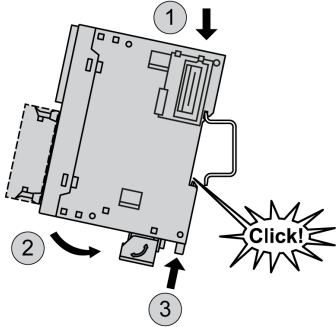
Overview

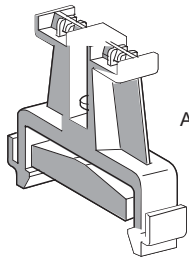
This section describes how to install and remove the controller with its expansion modules from a top hat section rail (DIN rail).

To assemble expansion modules to a controller or receiver module, or to other modules, refer to the respective expansion modules hardware guide(s).

Installing a Controller with its Expansions on a DIN Rail

The following procedure describes how to install a controller with its expansion modules on a top hat section rail (DIN rail):

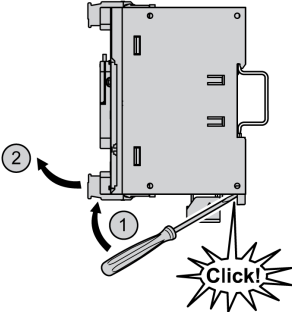
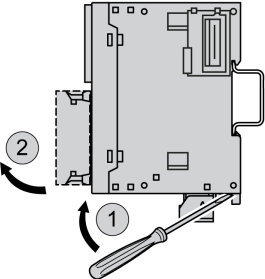
| Step | Action |
|------|---|
| 1 | Fasten the top hat section rail (DIN rail) to a panel surface using screws. |
| 2 | <p>Position the top groove of the controller and its expansion modules on the top edge of the DIN rail and press the assembly against the top hat section rail (DIN rail) until you hear the top hat section rail (DIN rail) clip snap into place.</p> <p>On TM221C Logic Controller:</p>  <p>On TM221M Logic Controller:</p>  |

| Step | Action |
|------|--|
| 3 | <p>Place 2 terminal block end clamps on both sides of the controller and expansion module assembly.</p>  <p style="text-align: center;">AB1AB8P35</p> <p>NOTE: Type ABB8P35 or equivalent terminal block end clamps help minimize sideways movement and improve the shock and vibration characteristics of the controller and expansion module assembly.</p> |

Removing a Controller with its Expansions from a Top Hat Section Rail (DIN Rail)

The following procedure describes how to remove a controller with its expansion modules from a top hat section rail (DIN rail):

| Step | Action |
|------|--|
| 1 | Remove all power from your controller and expansion modules. |

| Step | Action |
|------|---|
| 2 | <p data-bbox="353 203 1067 253">Insert a flat screwdriver into the slot of the top hat section rail (DIN rail) clip. On TM221C Logic Controller:</p>  <p data-bbox="353 592 637 613">On TM221M Logic Controller:</p>  |
| 3 | Pull down the DIN rail clip. |
| 4 | Pull the controller and its expansion modules from the top hat section rail (DIN rail) from the bottom. |

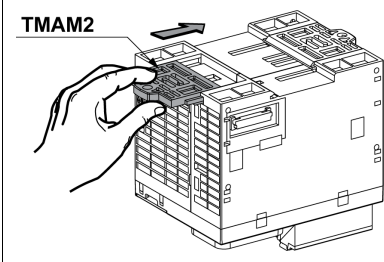
Direct Mounting on a Panel Surface

Overview

This section shows how to install M221 Logic Controller using the Panel Mounting Kit. This section also provides mounting hole layout for all modules.

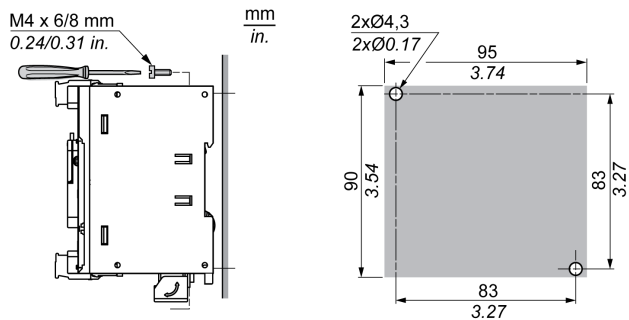
Installing the Panel Mount Kit

The following procedure shows how to install a mounting strip:

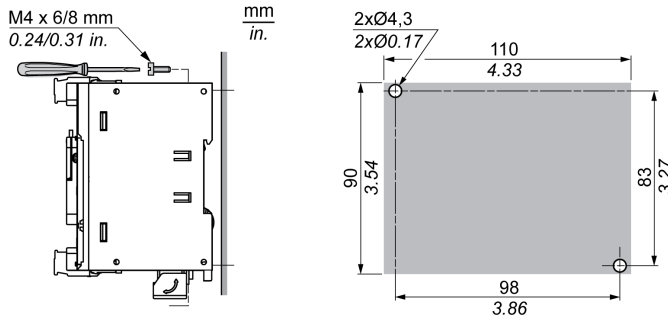
| Step | Action |
|------|--|
| 1 | Insert the mounting strip TMAM2 into the slot at the top of the module.  |

Mounting Hole Layout

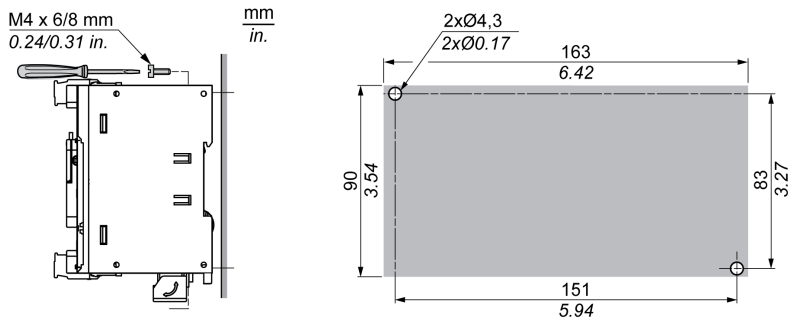
The following diagram shows the mounting hole layout for TM221C Logic Controller with 16 I/O channels:



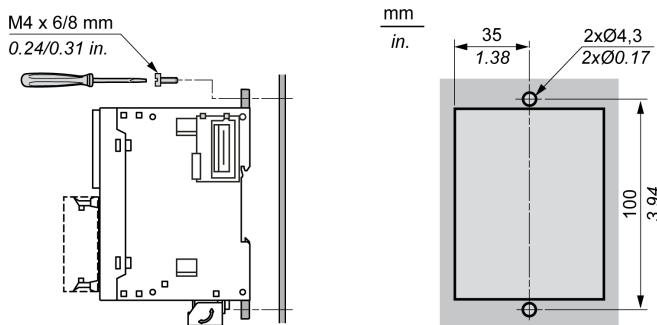
The following diagram shows the mounting hole layout for TM221C Logic Controller with 24 I/O channels:



The following diagram shows the mounting hole layout for TM221C Logic Controller with 40 I/O channels:



The following diagram shows the mounting hole layout for TM221M Logic Controller:



Section 3.3

M221 Electrical Requirements

What Is in This Section?

This section contains the following topics:

| Topic | Page |
|--|------|
| Wiring Best Practices | 99 |
| DC Power Supply Characteristics and Wiring | 106 |
| AC Power Supply Characteristics and Wiring | 110 |
| Grounding the M221 System | 113 |

Wiring Best Practices

Overview

This section describes the wiring guidelines and associated best practices to be respected when using the M221 Logic Controller system.

DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION OR ARC FLASH

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

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

WARNING

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.

Wiring Guidelines

The following rules must be applied when wiring a M221 Logic Controller 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 (required).
- Use twisted pair, shielded cables for analog, and/or fast I/O.
- Use twisted pair, shielded cables for networks, and fieldbus.

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 point¹.
- Route communication and I/O cables separately from power cables.

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

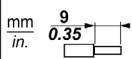








¹Multipoint grounding is permissible if connections are made to an equipotential ground plane dimensioned to help avoid cable shield damage in the event of power system short-circuit currents.


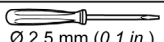
For more details, refer to Grounding Shielded Cables (*see page 113*).

NOTE: Surface temperatures may exceed 60 °C (140 °F). To conform to IEC 61010 standards, route primary wiring (wires connected to power mains) separately and apart from secondary wiring (extra low voltage wiring coming from intervening power sources). If that is not possible, double insulation is required such as conduit or cable gains.

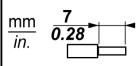








Rules for Removable Screw Terminal Block



The following tables show the cable types and wire sizes for a **3.81 pitch** removable screw terminal block (I/Os and power supply):

| | | | | | | | | |
|---|---|---|---|---|---|---|---|--|
|  |  |  |  |  |  |  |  |  |
| mm ² | 0.14...1.5 | 0.14...1.5 | 0.25...1.5 | 0.25...0.5 | 2 x 0.14...0.5 | 2 x 0.14...0.75 | 2 x 0.25...0.34 | 2 x 0.5 |
| AWG | 26...16 | 26...16 | 22...16 | 22...20 | 2 x 26...20 | 2 x 26...20 | 2 x 24...22 | 2 x 20 |

| | | |
|---|---|------------------------------|
|  Ø 2,5 mm (0.1 in.) |  | N•m 0.28 lb-in 2.48 |
|---|---|------------------------------|

The following tables show the cable types and wire sizes for a **5.08 pitch** removable screw terminal block (I/Os and power supply):

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |  |  |
| mm ² | 0.2...2.5 | 0.2...2.5 | 0.25...2.5 | 0.25...2.5 | 2 x 0.2...1 | 2 x 0.2...1.5 | 2 x 0.25...1 | 2 x 0.5...1.5 |
| AWG | 24...14 | 24...14 | 22...14 | 22...14 | 2 x 24...18 | 2 x 24...16 | 2 x 22...18 | 2 x 20...16 |

| | | | |
|---|---|-------|------|
|  |  | N•m | 0.51 |
| Ø 3,5 mm (0.14 in.) | | lb-in | 4.5 |

The use of copper conductors is required.

DANGER

LOOSE WIRING CAUSES ELECTRIC SHOCK

- Tighten connections in conformance with the torque specifications.
- Do not insert more than one wire per connector of the terminal block unless using the cable ends (ferrules) specified above.

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

DANGER





FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).






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

Rules for Removable Spring Terminal Block

The following tables show the cable types and wire sizes for a **3.81 pitch** removable spring terminal block (I/Os and power supply):

| | | | | |
|---|---|---|---|---|
| $\frac{\text{mm}}{\text{in.}}$ 9 0.35 |  |  |  |  |
| mm ² | 0.2...1.5 | 0.2...1.5 | 0.25...1.0 | 0.25...0.5 |
| AWG | 24...16 | 24...16 | 23...18 | 23...21 |

The following tables show the cable types and wire sizes for a **5.08 pitch** removable spring terminal block (I/Os and power supply):

| | | | | | |
|--|---|---|---|---|---|
| $\frac{\text{mm}}{\text{in.}}$ 10 0.39 |  |  |  |  |  |
| mm ² | 0.2...2.5 | 0.2...2.5 | 0.25...2.5 | 0.25...2.5 | 2 x 0.5...1 |
| AWG | 24...14 | 24...14 | 23...14 | 23...14 | 2 x 20...17 |

The use of copper conductors is required.

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

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

DANGER

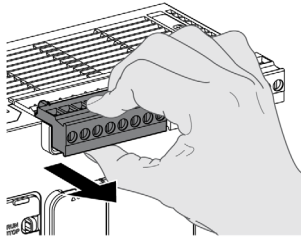
LOOSE WIRING CAUSES ELECTRIC SHOCK

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

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

Removing the I/O Terminal Block

The following figure shows the removal of the I/O terminal block from the TM221C Logic Controller:



Protecting Outputs from Inductive Load Damage

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

⚠ CAUTION

OUTPUT CIRCUIT DAMAGE DUE TO INDUCTIVE LOADS

Use an appropriate external protective circuit or device to reduce the risk of inductive direct current load damage.

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

If your controller or module contains relay outputs, these types of outputs can support up to 240 Vac. Inductive damage to these types of outputs can result in welded contacts and loss of control. Each inductive load must include a protection device such as a peak limiter, RC circuit or flyback diode. Capacitive loads are not supported by these relays.

⚠ WARNING

RELAY OUTPUTS WELDED CLOSED

- Always protect relay outputs from inductive alternating current load damage using an appropriate external protective circuit or device.
- Do not connect relay outputs to capacitive loads.

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

AC-driven contactor coils are, under certain circumstances, inductive loads that generate pronounced high-frequency interference and electrical transients when the contactor coil is de-energized. This interference may cause the logic controller to detect an I/O bus error.

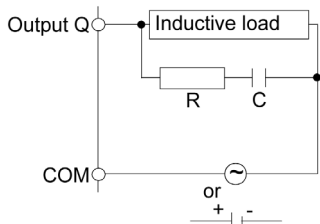
⚠ WARNING

CONSEQUENTIAL LOSS OF CONTROL

Install an RC surge suppressor or similar means, such as an interposing relay, on each TM3 expansion module relay output when connecting to AC-driven contactors or other forms of inductive loads.

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

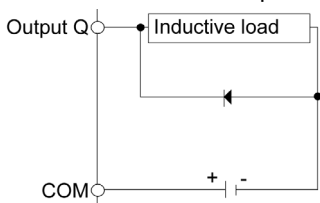
Protective circuit A: this protection circuit can be used for both AC and DC load power circuits.



C Value from 0.1 to 1 μF

R Resistor of approximately the same resistance value as the load

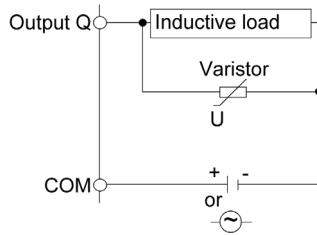
Protective circuit B: this protection circuit can be used for DC load power circuits.



Use a diode with the following ratings:

- Reverse withstand voltage: power voltage of the load circuit x 10.
- Forward current: more than the load current.

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



In applications where the inductive load is switched on and off frequently and/or rapidly, ensure that the continuous energy rating (J) of the varistor exceeds the peak load energy by 20 % or more.

DC Power Supply Characteristics and Wiring

Overview

This section provides the characteristics and the wiring diagrams of the DC power supply.

DC Power Supply Voltage Range

If the specified voltage range is not maintained, outputs may not switch as expected. Use appropriate safety interlocks and voltage monitoring circuits.

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

DC Power Supply Requirements

The M221 Logic Controller and associated I/O (TM2, TM3 and embedded I/O) require power supplies with a nominal voltage of 24 Vdc. The 24 Vdc power supplies must be rated Safety Extra Low Voltage (SELV) or Protective Extra Low Voltage (PELV) according to IEC 61140. These power supplies are isolated between the electrical input and output circuits of the power supply.

WARNING

POTENTIAL OF OVERHEATING AND FIRE

- Do not connect the equipment directly to line voltage.
- Use only isolating PELV or SELV power supplies to supply power to the equipment¹.

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

¹For compliance to UL (Underwriters Laboratories) requirements, the power supply must also be of a type Class 2 with a maximum power output availability of less than 100 VA (approximately 4 A at nominal voltage). A Class 2 circuit requires dry indoor use only in non-hazardous locations, and must be grounded. You must separate Class 2 circuits from other circuits. If a non-Class 2 power source is used, either power supply or transformer, you must impose a current limiting device such as a fuse or a circuit breaker with a maximum rating of 4 A, but never exceeding the limits indicated in the electric characteristics and wiring diagrams for this equipment. If the indicated rating of the electrical characteristics or wiring diagrams are greater than 4 A, multiple Class 2 power supplies may be used.

Controller DC Characteristics

The following table shows the DC power supply characteristics:

| Characteristic | | Value | |
|----------------------------|------------|--------------------------|------|
| Rated voltage | | 24 Vdc | |
| Power supply voltage range | | 20.4...28.8 Vdc | |
| Power interruption time | | 10 ms at 24 Vdc | |
| Maximum inrush current | | 35 A | |
| Maximum power consumption | TM221C16T | with 4 expansion modules | 10 W |
| | TM221CE16T | | 11 W |
| | TM221C16U | | 10 W |
| | TM221CE16U | | 11 W |
| | TM221C24T | with 7 expansion modules | 13 W |
| | TM221CE24T | | 14 W |
| | TM221C24U | | 13 W |
| | TM221CE24U | | 14 W |
| | TM221C40T | | 16 W |
| | TM221CE40T | | 17 W |
| | TM221C40U | | 16 W |
| | TM221CE40U | | 17 W |

| Characteristic | | | Value |
|---------------------------|--|--------------------------|--------------|
| Maximum power consumption | TM221M16R• | with 7 expansion modules | 22.5 W |
| | TM221ME16R• | | 23.3 W |
| | TM221M16T• | | 22 W |
| | TM221ME16T• | | 22.9 W |
| | TM221M32TK | | 22.3 W |
| | TM221ME32TK | | 23.2 W |
| Isolation | between DC power supply and internal logic | TM221C Logic Controller | 500 Vac |
| | | TM221M Logic Controller | Not isolated |
| | between DC power supply and protective earth ground (PE) | | 500 Vac |

Power interruption

The TM221M Logic Controller must be supplied by an external 24 V power supply equipment. During power interruptions, the TM221M Logic Controller, associated to the suitable power supply, is able to continue normal operation for a minimum of 10 ms as specified by IEC standards.

When planning the management of the power supplied to the controller, you must consider the power interruption duration due to the fast cycle time of the controller.

There could potentially be many scans of the logic and consequential updates to the I/O image table during the power interruption, while there is no external power supplied to the inputs, the outputs or both depending on the power system architecture and power interruption circumstances.

WARNING

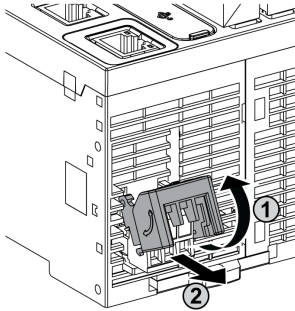
UNINTENDED EQUIPMENT OPERATION

- Individually monitor each source of power used in the controller system including input power supplies, output power supplies and the power supply to the controller to allow appropriate system shutdown during power system interruptions.
- The inputs monitoring each of the power supply sources must be unfiltered inputs.

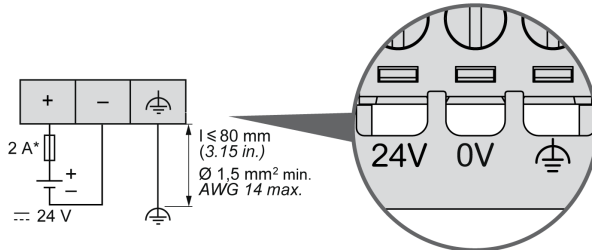
Failure to follow these instructions can result in death, serious injury, or equipment damage.

DC Power Supply Wiring Diagram

The following figure shows the power supply terminal block removal procedure:



The following figure shows the wiring of the DC power supply:



* Type T fuse

For more information, refer to the 5.08 pitch Rules for Removable Screw Terminal block (*see page 100*).

AC Power Supply Characteristics and Wiring

Overview

This section provides the wiring diagrams and the characteristics of the AC power supply.

AC Power Supply Voltage Range

If the specified voltage range is not maintained, outputs may not switch as expected. Use appropriate safety interlocks and voltage monitoring circuits.

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Controller AC Characteristics

The following table shows the AC power supply characteristics:

| Characteristic | | Value |
|-------------------------|--------------------------|------------------|
| Voltage | rated | 100...240 Vac |
| | limit (including ripple) | 85...264 Vac |
| Frequency | rated | 50/60 Hz |
| | limit | 45/66 Hz |
| Power interruption time | | 10 ms at 100 Vac |
| Maximum inrush current | at 240 Vac | 40 A |

| Characteristic | | | Value |
|--|--|--------------------------|----------|
| Maximum power consumption at 100...240 Vac | TM221C16R | with 4 expansion modules | 46 VA |
| | TM221CE16R | | 49 VA |
| | TM221C24R | with 7 expansion modules | 55 VA |
| | TM221CE24R | | 58 VA |
| | TM221C40R | | 67 VA |
| | TM221CE40R | | 70 VA |
| Isolation | between AC power supply and internal logic | | 2300 Vac |
| | between AC power supply and protective earth ground (PE) | | 1500 Vac |

Power interruption

The duration of power interruptions where the M221 Logic Controller is able to continue normal operation varies depending upon the load to the power supply of the controller, but generally a minimum of 10 ms is maintained as specified by IEC standards.

If there is a minimum load on the controller power supply, the interruption can be as long as 400 ms.

When planning the management of the power supplied to the controller, you must consider the duration due to the fast cycle time.

There could potentially be many scans of the logic and consequential updates to the I/O image table during the power interruption, while there is no external power supplied to the inputs, the outputs or both depending on the power system architecture and power interruption circumstances.

WARNING

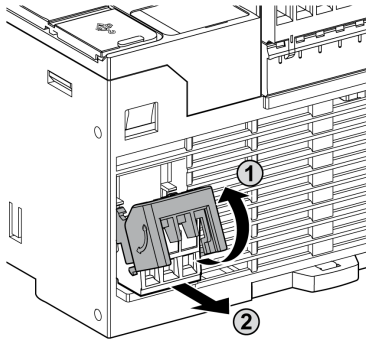
UNINTENDED EQUIPMENT OPERATION

- Individually monitor each source of power used in the Modicon M221 Logic Controller system including input power supplies, output power supplies and the power supply to the controller to allow appropriate system shutdown during power system interruptions.
- The inputs monitoring each of the power supply sources must be unfiltered inputs.

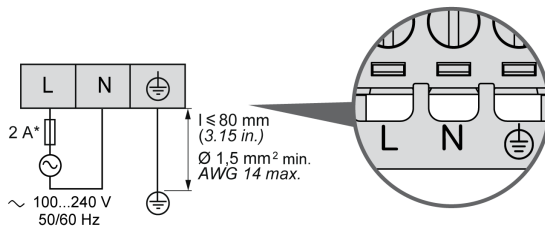
Failure to follow these instructions can result in death, serious injury, or equipment damage.

AC Power Supply Wiring Diagram

The following figure shows the power supply terminal block removal procedure:



The following figure shows the wiring of the AC power supply:



* Use an external, slow-blow, type T fuse.

Grounding the M221 System

Overview

To help minimize the effects of electromagnetic interference, cables carrying the fast I/O, analog I/O, and field bus communication signals must be shielded.

WARNING

UNINTENDED EQUIPMENT OPERATION

- Use shielded cables for all fast I/O, analog I/O, and communication signals.
- Ground cable shields for all fast I/O, analog I/O, and communication signals at a single point¹.
- Route communications and I/O cables separately from power cables.

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

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

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

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

Protective Ground (PE) on the Backplane

The protective ground (PE) is connected to the conductive backplane by a heavy-duty wire, usually a braided copper cable with the maximum allowable cable section.

Shielded Cables Connections

Cables carrying the fast I/O, analog I/O, and field bus communication signals must be shielded. The shielding must be securely connected to ground. The fast I/O and analog I/O shields may be connected either to the functional ground (FE) or to the protective ground (PE) of your M221 Logic Controller. The field bus communication cable shields must be connected to the protective ground (PE) with a connecting clamp secured to the conductive backplane of your installation.

⚠ 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.

The shielding of the Modbus cable must be connected to the protective ground (PE).

⚡ ⚠ DANGER

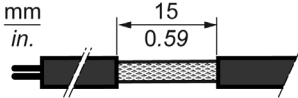
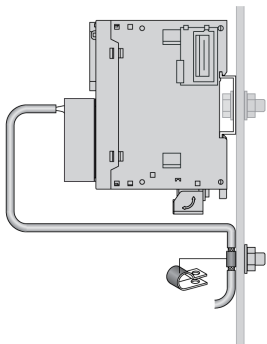
ELECTRIC SHOCK

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

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

Protective Ground (PE) Cable Shielding

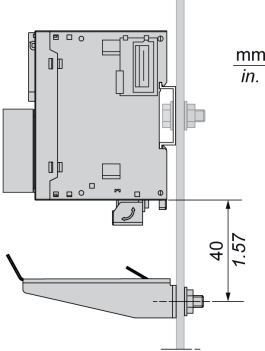
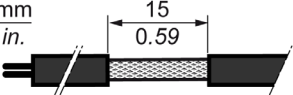
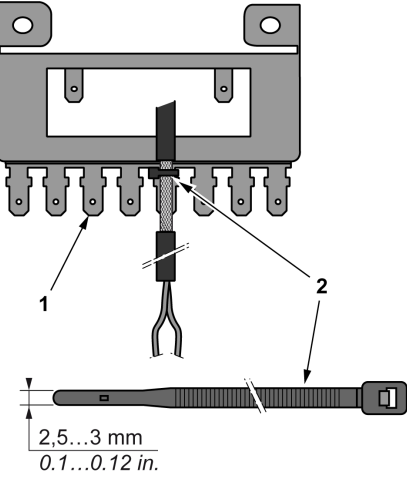
To ground the shield of a cable through a grounding clamp:

| Step | Description | |
|------|--|--|
| 1 | Strip the shielding for a length of 15 mm (0.59 in.) |  |
| 2 | Attach the cable to the conductive backplane plate by attaching the grounding clamp to the stripped part of the shielding as close as possible to the M221 Logic Controller system base. |  |

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

Functional Ground (FE) Cable Shielding

To connect the shield of a cable through the Grounding Bar:

| Step | Description | |
|------|---|--|
| 1 | Install the Grounding Bar directly on the conductive backplane below the M221 Logic Controller system as illustrated. |  |
| 2 | Strip the shielding for a length of 15 mm (0.59 in.). |  |
| 3 | Tightly clamp on the blade connector (1) using nylon fastener (2) (width 2.5...3 mm (0.1...0.12 in.)) and appropriate tool. |  |

NOTE: Use the TM2XMTGB Grounding Bar for Functional Ground (FE) connections.

Part II

Modicon TM221C Logic Controller

What Is in This Part?

This part contains the following chapters:

| Chapter | Chapter Name | Page |
|---------|-----------------------|------|
| 4 | TM221C16R | 119 |
| 5 | TM221CE16R | 123 |
| 6 | TM221C16T | 127 |
| 7 | TM221CE16T | 133 |
| 8 | TM221C16U | 139 |
| 9 | TM221CE16U | 143 |
| 10 | TM221C24R | 149 |
| 11 | TM221CE24R | 153 |
| 12 | TM221C24T | 157 |
| 13 | TM221CE24T | 161 |
| 14 | TM221C24U | 167 |
| 15 | TM221CE24U | 173 |
| 16 | TM221C40R | 179 |
| 17 | TM221CE40R | 185 |
| 18 | TM221C40T | 191 |
| 19 | TM221CE40T | 197 |
| 20 | TM221C40U | 203 |
| 21 | TM221CE40U | 209 |
| 22 | Embedded I/O Channels | 215 |

Chapter 4

TM221C16R

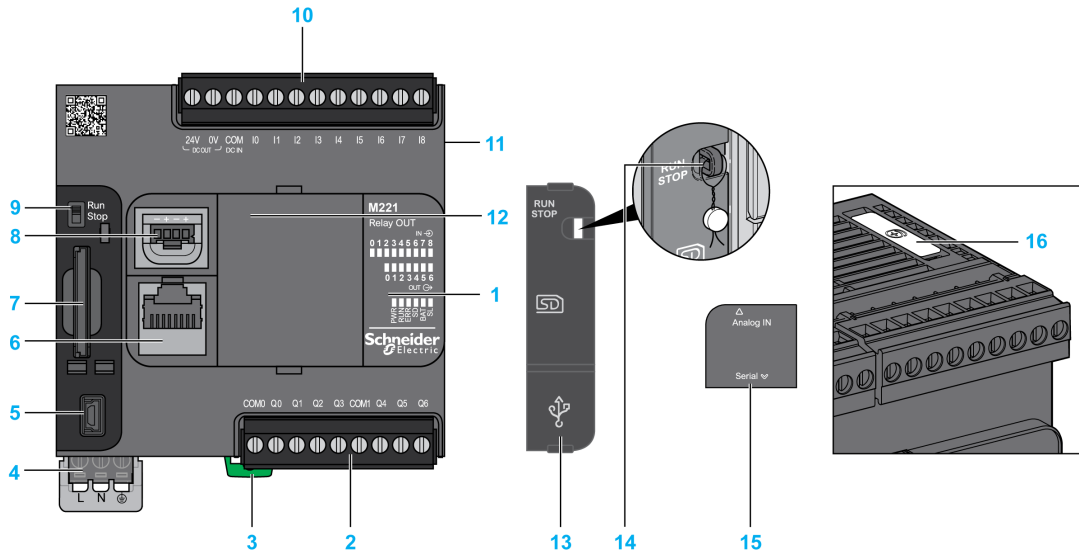
TM221C16R Presentation

Overview

The following features are integrated into the TM221C16R logic controller:

- 9 digital inputs
 - 4 fast inputs (HSC)
 - 5 regular inputs
- 7 digital outputs
 - 7 relay outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port

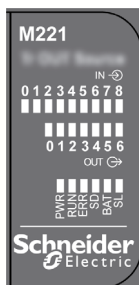
The following figure shows the different components of the logic controllers:



| N° | Description | Refer to |
|--|--|---|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (see page 90) |
| 4 | 100...240 Vac power supply | Power supply (see page 112) |
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (see page 372) |
| 6 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (see page 377) |
| 7 | SD Card slot | SD Card Slot (see page 70) |
| 8 | 2 analog inputs | Analog Inputs (see page 246) |
| 9 | Run/Stop switch | Run/Stop switch (see page 67) |
| 10 | Input removable terminal block and embedded power supply used for connecting sensors to the inputs. ⁽¹⁾ | Rules for Removable Screw Terminal Block (see page 100) |
| 11 | I/O expansion connector | – |
| 12 | Cartridge slot | – |
| 13 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 14 | Locking hook | – |
| 15 | Removable analog inputs cover | – |
| 16 | Battery holder | Installing and Replacing the Battery (see page 53) |
| <p>⁽¹⁾ Embedded power supply characteristics:</p> <ul style="list-style-type: none"> ● Voltage: 24 V -15%...+10% isolated ● I_{max}: 250 mA ● No protection and no overload detection <p>Refer to Embedded I/O Channels (see page 215).</p> | | |

Status LEDs

The following figure shows the status LEDs:



The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|-------|----------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |

* ERR LED is also On during booting process.

NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs ([see page 376](#))

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide ([see Modicon M221, Logic Controller, Programming Guide](#)).

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

| Label | Function Type | Color | Status | Description | | |
|-------|--|-------|----------|--|------------------------|-----------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| SD | SD Card Access <i>(see page 70)</i> | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery <i>(see page 52)</i> | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 <i>(see page 377)</i> | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |

* ERR LED is also On during booting process.

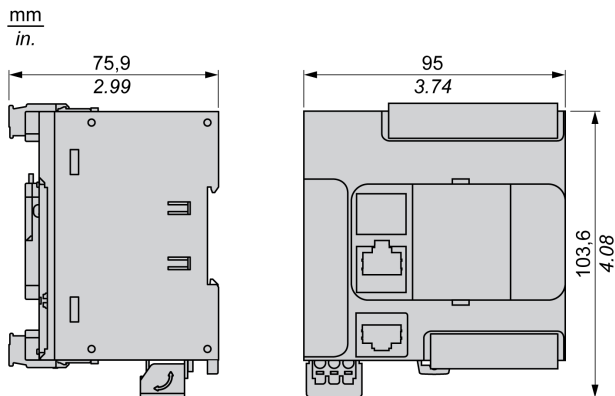
NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs *(see page 376)*

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide *(see Modicon M221, Logic Controller, Programming Guide)*.

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

Dimensions

The following figure show the external dimensions of the logic controller:



Chapter 5

TM221CE16R

TM221CE16R Presentation

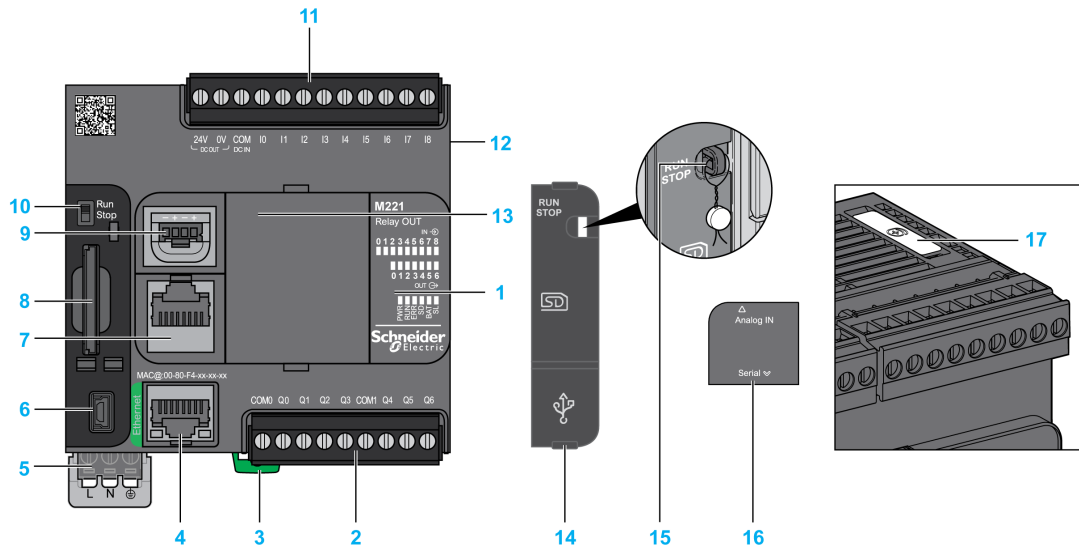
Overview

The following features are integrated into the TM221CE16R logic controller:

- 9 digital inputs
 - 4 fast inputs (HSC)
 - 5 regular inputs
- 7 digital outputs
 - 7 relay outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port
 - 1 Ethernet port

Description

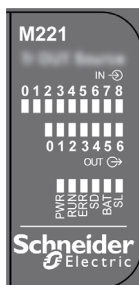
The following figure shows the different components of the logic controller:



| N° | Description | Refer to |
|--|--|--|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (<i>see page 90</i>) |
| 4 | Ethernet port / RJ45 connector | Ethernet port (<i>see page 374</i>) |
| 5 | 100...240 Vac power supply | Power supply (<i>see page 112</i>) |
| 6 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (<i>see page 372</i>) |
| 7 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (<i>see page 377</i>) |
| 8 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 9 | 2 analog inputs | Analog Inputs (<i>see page 246</i>) |
| 10 | Run/Stop switch | Run/Stop switch (<i>see page 67</i>) |
| 11 | Input removable terminal block and embedded power supply used for connecting sensors to the inputs. ⁽¹⁾ | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 12 | I/O expansion connector | – |
| 13 | Cartridge slot | – |
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Removable analog inputs cover | – |
| 17 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |
| <p>⁽¹⁾ Embedded power supply characteristics:</p> <ul style="list-style-type: none"> ● Voltage: 24 V -15%...+10% isolated ● I_{max}: 250 mA ● No protection and no overload detection <p>Refer to Embedded I/O Channels (<i>see page 215</i>).</p> | | |

Status LEDs

The following figure shows the status LEDs:



The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|-------|----------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |

* ERR LED is also On during booting process.

NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs ([see page 376](#))

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide ([see Modicon M221, Logic Controller, Programming Guide](#)).

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

| Label | Function Type | Color | Status | Description | | |
|-------|--|-------|----------|--|------------------------|-----------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| SD | SD Card Access <i>(see page 70)</i> | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery <i>(see page 52)</i> | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 <i>(see page 377)</i> | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |

* ERR LED is also On during booting process.

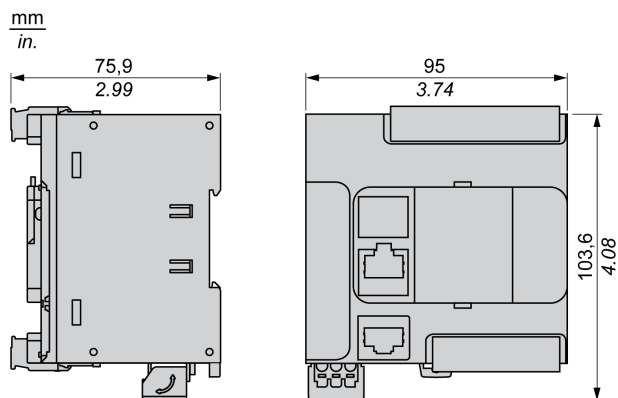
NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs *(see page 376)*

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide *(see Modicon M221, Logic Controller, Programming Guide)*.

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 6

TM221C16T

TM221C16T Presentation

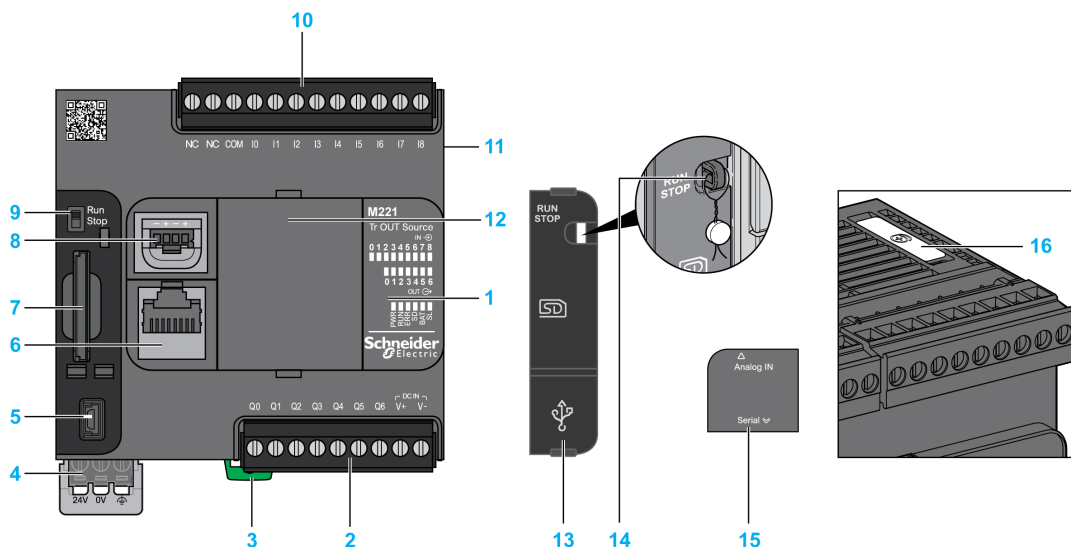
Overview

The following features are integrated into the TM221C16T logic controller:

- 9 digital inputs
 - 4 fast inputs (HSC)
 - 5 regular inputs
- 7 digital outputs
 - 2 fast source transistor outputs
 - 5 regular source transistor outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port

Description

The following figure shows the different components of the logic controllers:

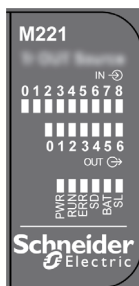


| N° | Description | Refer to |
|----|---|---|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (see page 90) |
| 4 | 24 Vdc power supply | Power supply (see page 106) |
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (see page 372) |
| 6 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (see page 377) |
| 7 | SD Card slot | SD Card Slot (see page 70) |
| 8 | 2 analog inputs | Analog Inputs (see page 246) |
| 9 | Run/Stop switch | Run/Stop switch (see page 67) |
| 10 | Input removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 11 | I/O expansion connector | – |
| 12 | Cartridge slot | – |
| 13 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |

| N° | Description | Refer to |
|----|-------------------------------|---|
| 14 | Locking hook | – |
| 15 | Removable analog inputs cover | – |
| 16 | Battery holder | Installing and Replacing the Battery (see page 53) |

Status LEDs

The following figure shows the status LEDs:



The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|-------|----------------|-------|----------|--|------------------------|-----------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |

* ERR LED is also On during booting process.

NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)

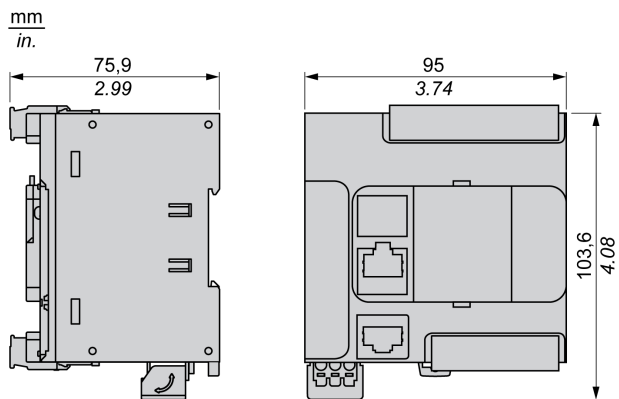
(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide).

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

| Label | Function Type | Color | Status | Description | | |
|--|---------------------------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access (see page 70) | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery (see page 52) | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 (see page 377) | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |
| <p>* ERR LED is also On during booting process.</p> <p>NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)</p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide).</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 7

TM221CE16T

TM221CE16T Presentation

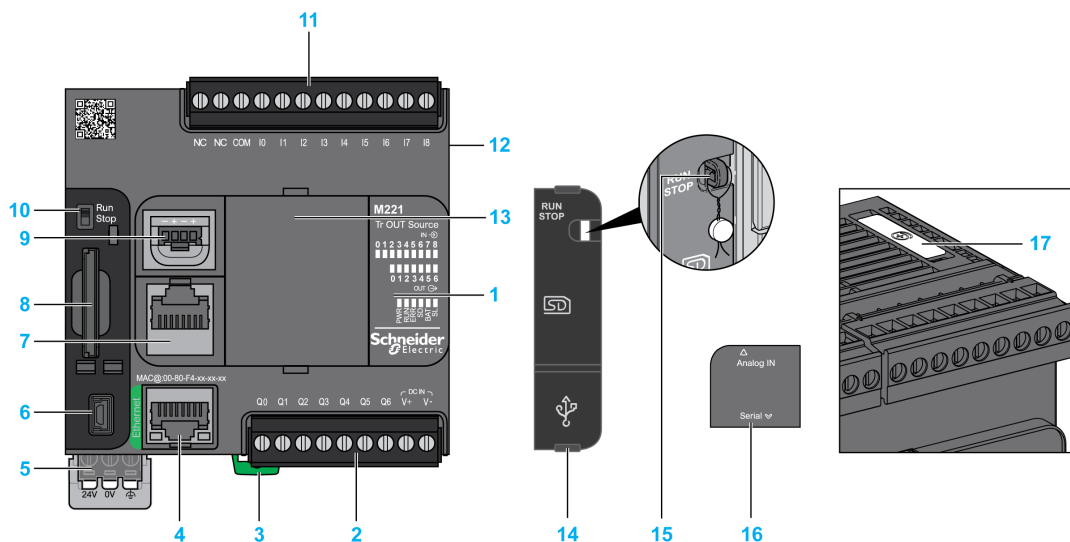
Overview

The following features are integrated into the TM221CE16T logic controller:

- 9 digital inputs
 - 4 fast inputs (HSC)
 - 5 regular inputs
- 7 digital outputs
 - 2 fast source transistor outputs
 - 5 regular source transistor outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port
 - 1 Ethernet port

Description

The following figure shows the different components of the logic controllers:

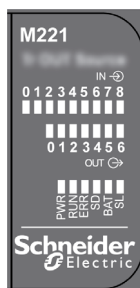


| N° | Description | Refer to |
|----|---|---|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (see page 90) |
| 4 | Ethernet port / RJ45 connector | Ethernet port (see page 374) |
| 5 | 24 Vdc power supply | Power supply (see page 106) |
| 6 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (see page 372) |
| 7 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (see page 377) |
| 8 | SD Card slot | SD Card Slot (see page 70) |
| 9 | 2 analog inputs | Analog Inputs (see page 246) |
| 10 | Run/Stop switch | Run/Stop switch (see page 67) |
| 11 | Input removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 12 | I/O expansion connector | – |
| 13 | Cartridge slot | – |

| N° | Description | Refer to |
|----|--|---|
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Removable analog inputs cover | – |
| 17 | Battery holder | Installing and Replacing the Battery (see page 53) |

Status LEDs

The following figure shows the status LEDs:



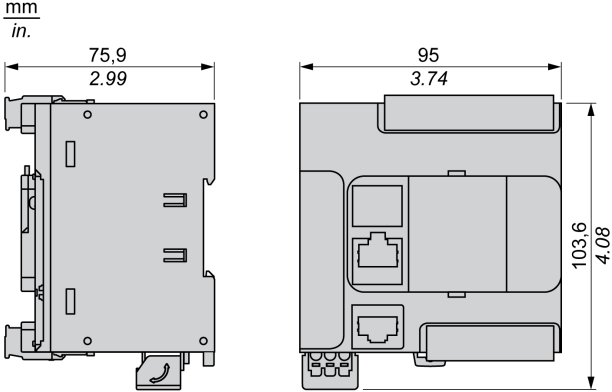
The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|--|----------------|-------|----------|--|------------------------|-----------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| <p>* ERR LED is also On during booting process.</p> <p>NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)</p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide).</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

| Label | Function Type | Color | Status | Description | | |
|--|---------------------------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access (see page 70) | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery (see page 52) | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 (see page 377) | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |
| <p>* ERR LED is also On during booting process.</p> <p>NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)</p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide).</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 8

TM221C16U

TM221C16U Presentation

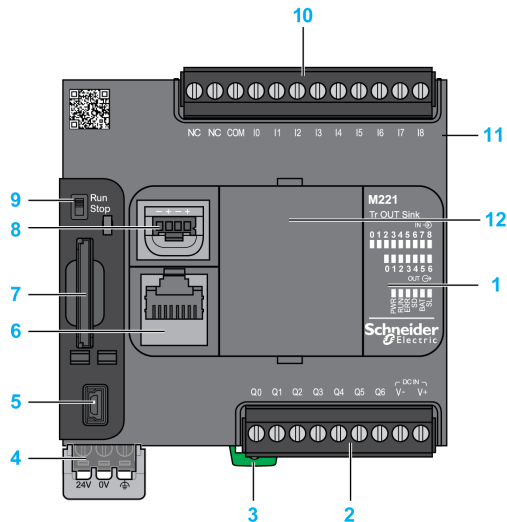
Overview

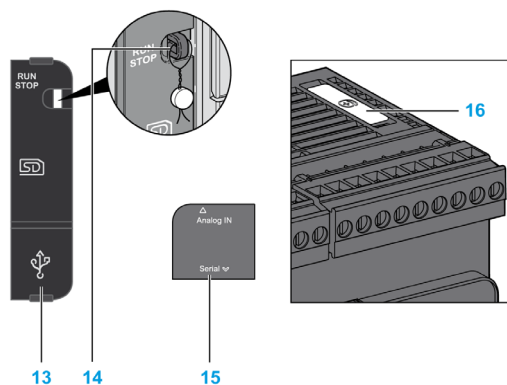
The following features are integrated into the TM221C16U logic controller:

- 9 digital inputs
 - 4 fast inputs (HSC)
 - 5 regular inputs
- 7 digital outputs
 - 2 fast sink transistor outputs
 - 5 regular sink transistor outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port

Description

The following figure shows the different components of the logic controllers:

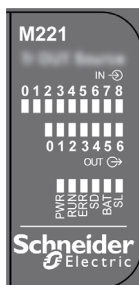




| N° | Description | Refer to |
|----|---|---|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (see page 90) |
| 4 | 24 Vdc power supply | Power supply (see page 106) |
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (see page 372) |
| 6 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (see page 377) |
| 7 | SD Card slot | SD Card Slot (see page 70) |
| 8 | 2 analog inputs | Analog Inputs (see page 246) |
| 9 | Run/Stop switch | Run/Stop switch (see page 67) |
| 10 | Input removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 11 | I/O expansion connector | – |
| 12 | Cartridge slot | – |
| 13 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 14 | Locking hook | – |
| 15 | Removable analog inputs cover | – |
| 16 | Battery holder | Installing and Replacing the Battery (see page 53) |

Status LEDs

The following figure shows the status LEDs:



The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|-------|----------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |

* ERR LED is also On during booting process.

NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs ([see page 376](#))

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide ([see Modicon M221, Logic Controller, Programming Guide](#)).

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

| Label | Function Type | Color | Status | Description | | |
|-------|--|-------|----------|--|------------------------|-----------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| SD | SD Card Access <i>(see page 70)</i> | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery <i>(see page 52)</i> | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 <i>(see page 377)</i> | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |

* ERR LED is also On during booting process.

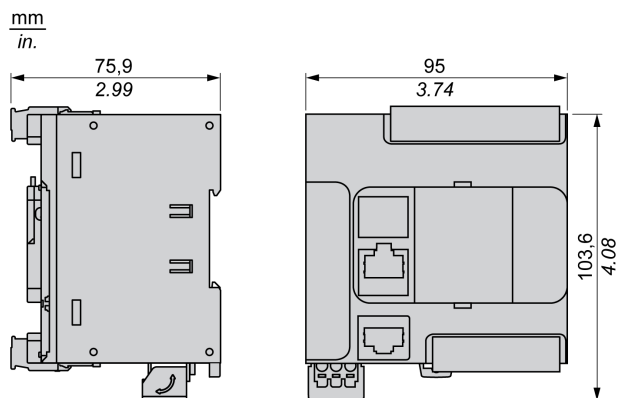
NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs *(see page 376)*

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide *(see Modicon M221, Logic Controller, Programming Guide)*.

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 9

TM221CE16U

TM221CE16U Presentation

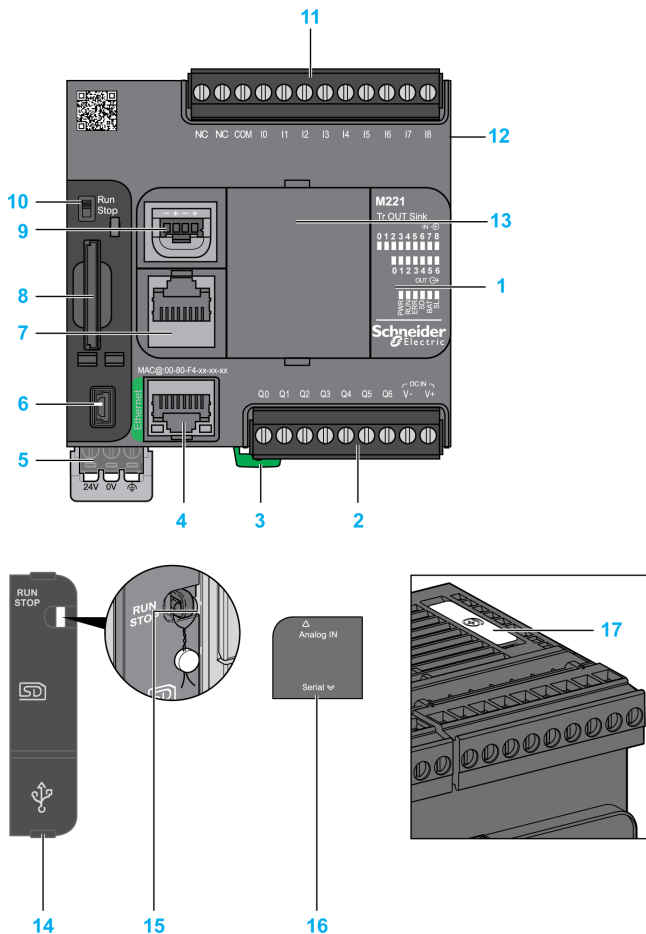
Overview

The following features are integrated into the TM221CE16U logic controller:

- 9 digital inputs
 - 4 fast inputs (HSC)
 - 5 regular inputs
- 7 digital outputs
 - 2 fast sink transistor outputs
 - 5 regular sink transistor outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port
 - 1 Ethernet port

Description

The following figure shows the different components of the logic controllers:

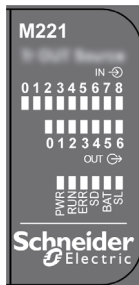


| N° | Description | Refer to |
|----|---|--|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (<i>see page 90</i>) |
| 4 | Ethernet port / RJ45 connector | Ethernet port (<i>see page 374</i>) |

| N° | Description | Refer to |
|----|---|--|
| 5 | 24 Vdc power supply | Power supply (<i>see page 106</i>) |
| 6 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (<i>see page 372</i>) |
| 7 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (<i>see page 377</i>) |
| 8 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 9 | 2 analog inputs | Analog Inputs (<i>see page 246</i>) |
| 10 | Run/Stop switch | Run/Stop switch (<i>see page 67</i>) |
| 11 | Input removable terminal block | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 12 | I/O expansion connector | – |
| 13 | Cartridge slot | – |
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Removable analog inputs cover | – |
| 17 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |

Status LEDs

The following figure shows the status LEDs:



The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|-------|---------------------------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access (see page 70) | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery (see page 52) | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 (see page 377) | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |

* ERR LED is also On during booting process.

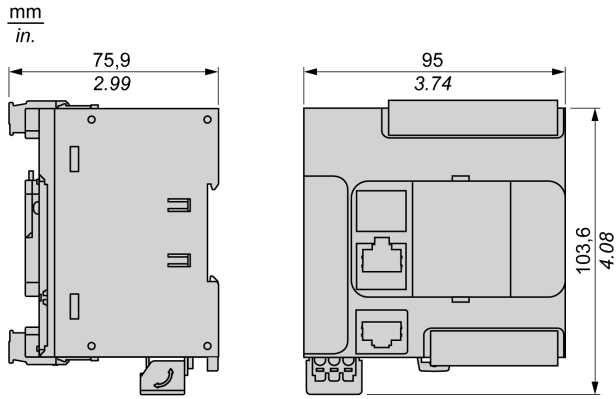
NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide).

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 10

TM221C24R

TM221C24R Presentation

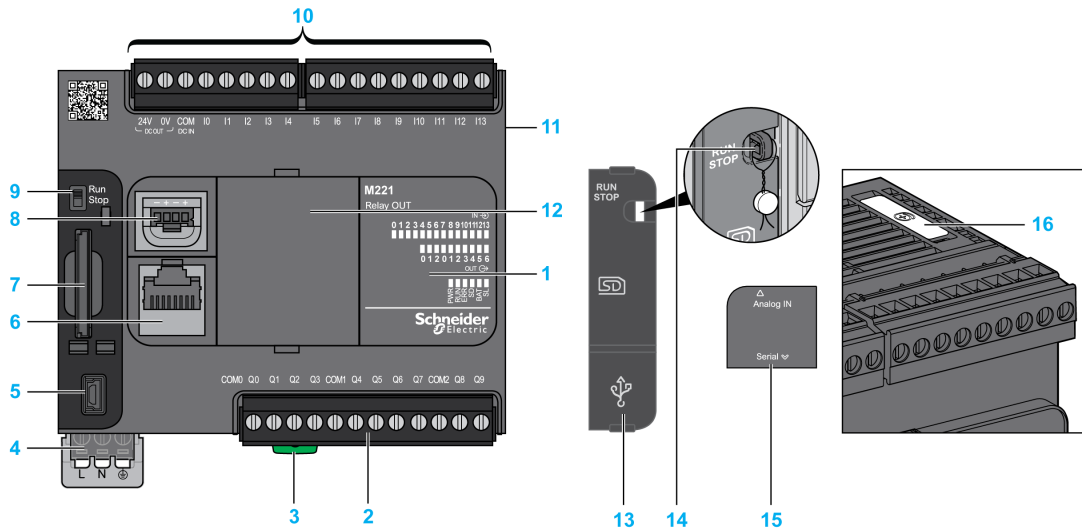
Overview

The following features are integrated into the TM221C24R logic controller:

- 14 digital inputs
 - 4 fast inputs (HSC)
 - 10 regular inputs
- 10 digital outputs
 - 10 relay outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port

Description

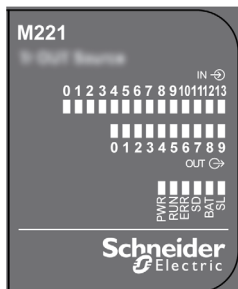
The following figure shows the different components of the logic controller:



| N° | Description | Refer to |
|--|--|---|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (see page 90) |
| 4 | 100...240 Vac power supply | Power supply (see page 112) |
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (see page 372) |
| 6 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (see page 377) |
| 7 | SD Card slot | SD Card Slot (see page 70) |
| 8 | 2 analog inputs | Analog Inputs (see page 246) |
| 9 | Run/Stop switch | Run/Stop switch (see page 67) |
| 10 | Input removable terminal block and embedded power supply used for connecting sensors to the inputs. ⁽¹⁾ | Rules for Removable Screw Terminal Block (see page 100) |
| 11 | I/O expansion connector | – |
| 12 | Cartridge slot | – |
| 13 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 14 | Locking hook | – |
| 15 | Removable analog inputs cover | – |
| 16 | Battery holder | Installing and Replacing the Battery (see page 53) |
| <p>⁽¹⁾ Embedded power supply characteristics:</p> <ul style="list-style-type: none"> ● Voltage: 24 V -15%...+10% isolated ● I_{max}: 250 mA ● No protection and no overload detection <p>Refer to Embedded I/O Channels (see page 215).</p> | | |

Status LEDs

The following figure shows the status LEDs:



The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|-------|----------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |

* ERR LED is also On during booting process.

NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs ([see page 376](#))

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide ([see Modicon M221, Logic Controller, Programming Guide](#)).

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

| Label | Function Type | Color | Status | Description | | |
|-------|--|-------|----------|--|------------------------|-----------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| SD | SD Card Access <i>(see page 70)</i> | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery <i>(see page 52)</i> | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 <i>(see page 377)</i> | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |

* ERR LED is also On during booting process.

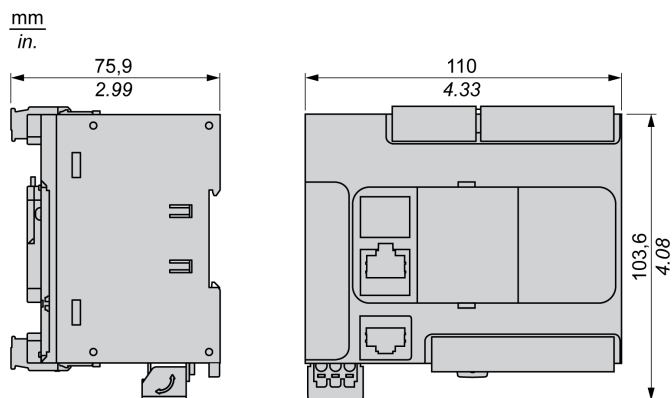
NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs *(see page 376)*

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide *(see Modicon M221, Logic Controller, Programming Guide)*.

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 11

TM221CE24R

TM221CE24R Presentation

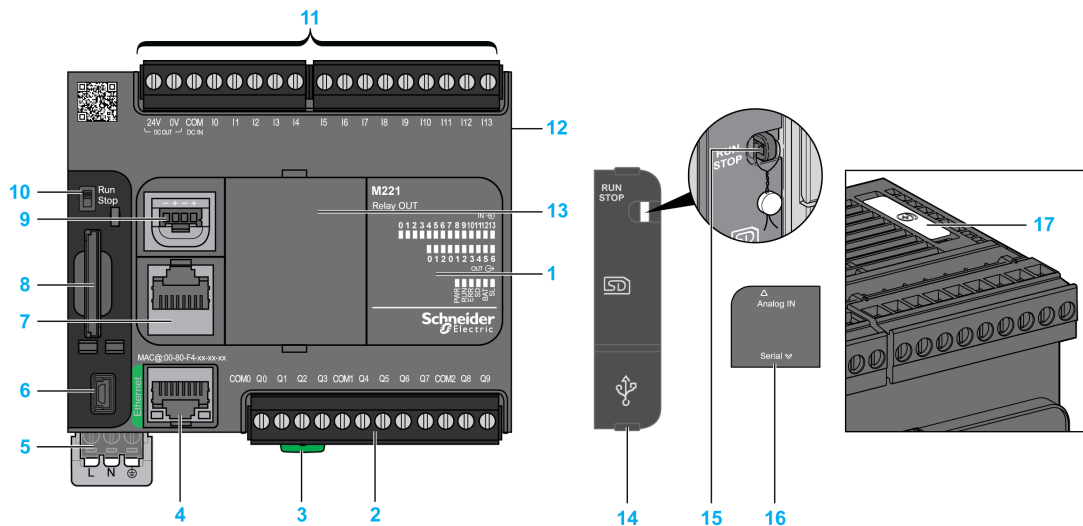
Overview

The following features are integrated into the TM221CE24R logic controller:

- 14 digital inputs
 - 4 fast inputs (HSC)
 - 10 regular inputs
- 10 digital outputs
 - 10 relay outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port
 - 1 Ethernet port

Description

The following figure shows the different components of the logic controllers:



| N° | Description | Refer to |
|---|--|---|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (see page 90) |
| 4 | Ethernet port / RJ45 connector | Ethernet port (see page 374) |
| 5 | 100...240 Vac power supply | Power supply (see page 112) |
| 6 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (see page 372) |
| 7 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (see page 377) |
| 8 | SD Card slot | SD Card Slot (see page 70) |
| 9 | 2 analog inputs | Analog Inputs (see page 246) |
| 10 | Run/Stop switch | Run/Stop switch (see page 67) |
| 11 | Input removable terminal block and embedded power supply used for connecting sensors to the inputs. ⁽¹⁾ | Rules for Removable Screw Terminal Block (see page 100) |
| 12 | I/O expansion connector | – |
| 13 | Cartridge slot | – |
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Removable analog inputs cover | – |
| 17 | Battery holder | Installing and Replacing the Battery (see page 53) |
| <p>⁽¹⁾ Embedded power supply characteristics:</p> <ul style="list-style-type: none"> ● Voltage: 24 V -15%...+10% isolated ● I_{max}: 250 mA ● No protection and no overload detection <p>Refer to Embedded I/O Channels (see page 215).</p> | | |

Status LEDs

The following figure shows the status LEDs:



The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|-------|----------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |

* ERR LED is also On during booting process.

NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs ([see page 376](#))

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide ([see Modicon M221, Logic Controller, Programming Guide](#)).

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

| Label | Function Type | Color | Status | Description | | |
|-------|--|-------|----------|--|------------------------|-----------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| SD | SD Card Access <i>(see page 70)</i> | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery <i>(see page 52)</i> | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 <i>(see page 377)</i> | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |

* ERR LED is also On during booting process.

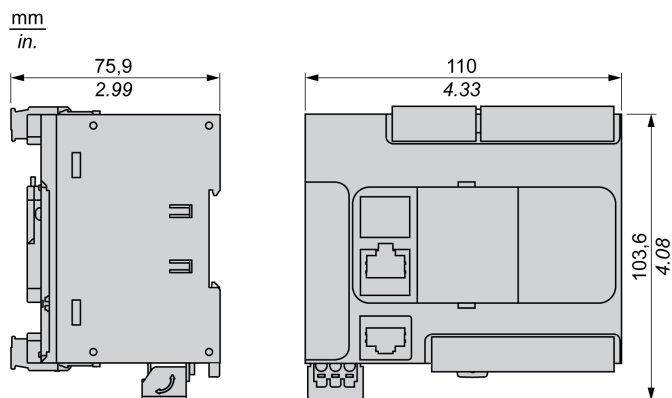
NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs *(see page 376)*

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide *(see Modicon M221, Logic Controller, Programming Guide)*.

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 12

TM221C24T

TM221C24T Presentation

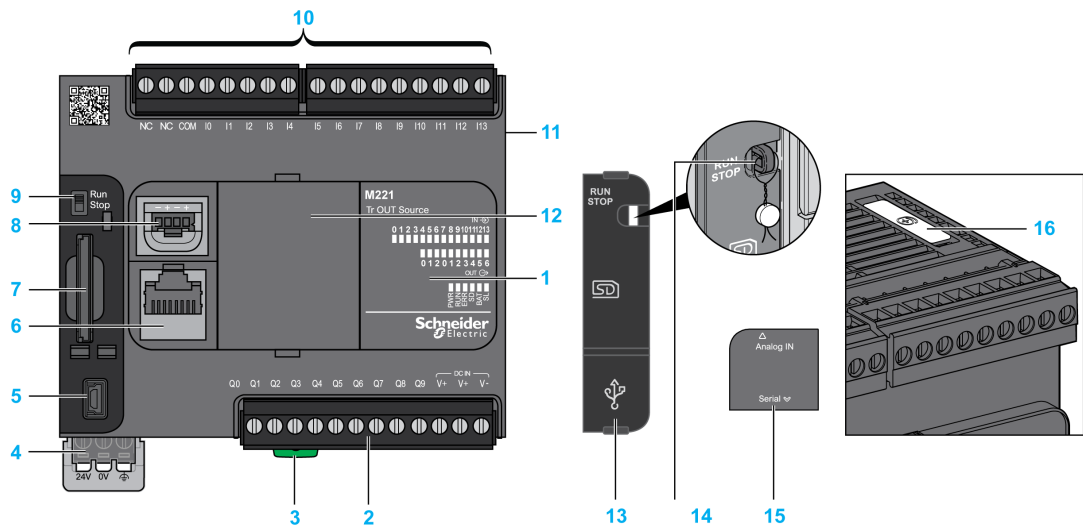
Overview

The following features are integrated into the TM221C24T logic controller:

- 14 digital inputs
 - 4 fast inputs (HSC)
 - 10 regular inputs
- 10 digital outputs
 - 2 fast source transistor outputs
 - 8 regular source transistor outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port

Description

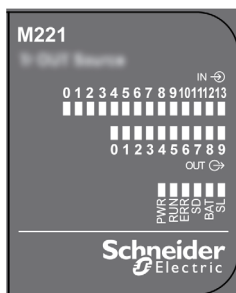
The following figure shows the different components of the logic controllers:



| N° | Description | Refer to |
|----|---|---|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (see page 90) |
| 4 | 24 Vdc power supply | Power supply (see page 106) |
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (see page 372) |
| 6 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (see page 377) |
| 7 | SD Card slot | SD Card Slot (see page 70) |
| 8 | 2 analog inputs | Analog Inputs (see page 246) |
| 9 | Run/Stop switch | Run/Stop switch (see page 67) |
| 10 | Input removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 11 | I/O expansion connector | – |
| 12 | Cartridge slot | – |
| 13 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 14 | Locking hook | – |
| 15 | Removable analog inputs cover | – |
| 16 | Battery holder | Installing and Replacing the Battery (see page 53) |

Status LEDs

The following figure shows the status LEDs:

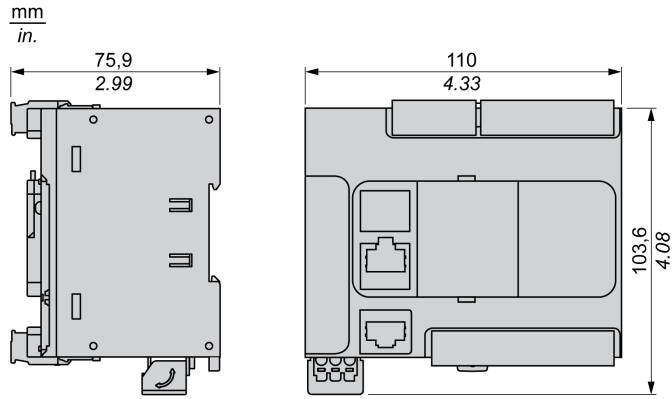


The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|--|---------------------------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access (see page 70) | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery (see page 52) | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 (see page 377) | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |
| <p>* ERR LED is also On during booting process.</p> <p>NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)</p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide).</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 13

TM221CE24T

TM221CE24T Presentation

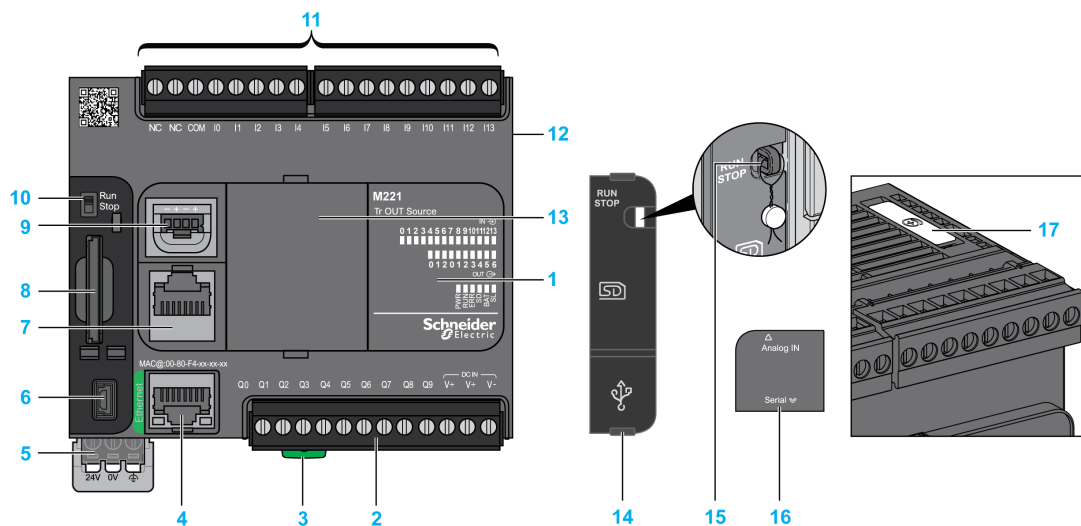
Overview

The following features are integrated into the TM221CE24T logic controller:

- 14 digital inputs
 - 4 fast inputs (HSC)
 - 10 regular inputs
- 10 digital outputs
 - 2 fast source transistor outputs
 - 8 regular source transistor outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port
 - 1 Ethernet port

Description

The following figure shows the different components of the logic controllers:

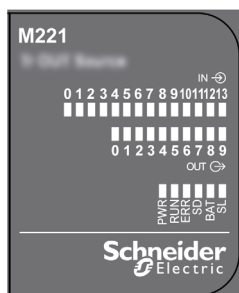


| N° | Description | Refer to |
|----|---|---|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (see page 90) |
| 4 | Ethernet port / RJ45 connector | Ethernet port (see page 374) |
| 5 | 24 Vdc power supply | Power supply (see page 106) |
| 6 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (see page 372) |
| 7 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (see page 377) |
| 8 | SD Card slot | SD Card Slot (see page 70) |
| 9 | 2 analog inputs | Analog Inputs (see page 246) |
| 10 | Run/Stop switch | Run/Stop switch (see page 67) |
| 11 | Input removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 12 | I/O expansion connector | – |
| 13 | Cartridge slot | – |

| N° | Description | Refer to |
|----|--|---|
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Removable analog inputs cover | – |
| 17 | Battery holder | Installing and Replacing the Battery (see page 53) |

Status LEDs

The following figure shows the status LEDs:



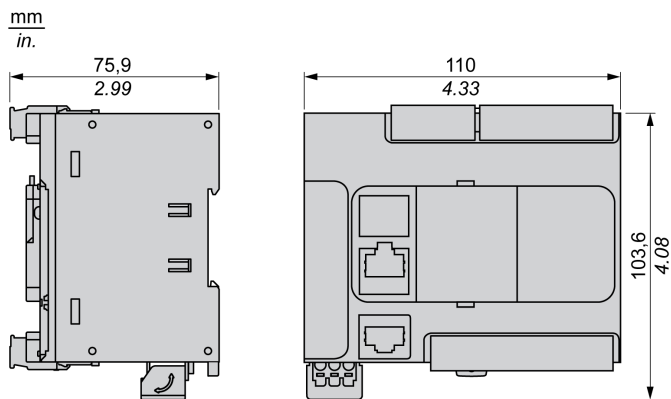
The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|--|----------------|-------|----------|--|------------------------|-----------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| * ERR LED is also On during booting process. | | | | | | |
| NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376) | | | | | | |
| (1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide). | | | | | | |
| (2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide. | | | | | | |

| Label | Function Type | Color | Status | Description | | |
|--|---------------------------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access (see page 70) | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery (see page 52) | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 (see page 377) | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |
| <p>* ERR LED is also On during booting process.</p> <p>NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)</p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide).</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 14

TM221C24U

TM221C24U Presentation

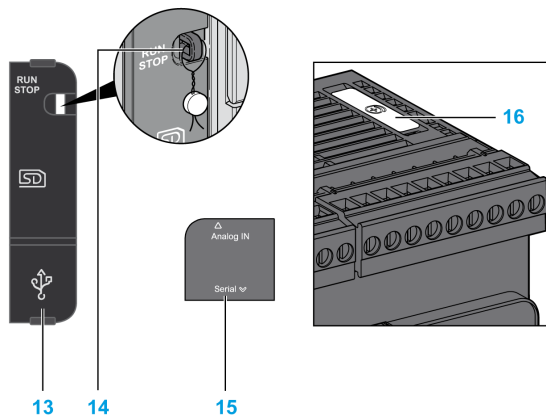
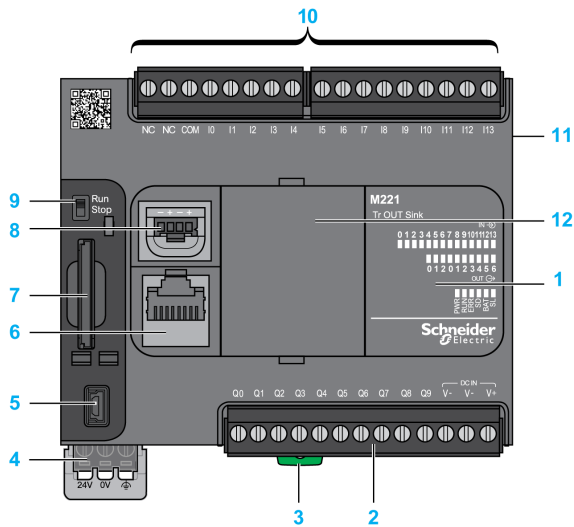
Overview

The following features are integrated into the TM221C24U logic controller:

- 14 digital inputs
 - 4 fast inputs (HSC)
 - 10 regular inputs
- 10 digital outputs
 - 2 fast sink transistor outputs
 - 8 regular sink transistor outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port

Description

The following figure shows the different components of the logic controllers:

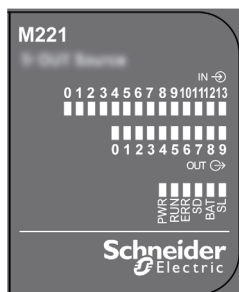


| N° | Description | Refer to |
|----|---|---|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (see page 90) |
| 4 | 24 Vdc power supply | Power supply (see page 106) |

| N° | Description | Refer to |
|----|---|---|
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (see page 372) |
| 6 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (see page 377) |
| 7 | SD Card slot | SD Card Slot (see page 70) |
| 8 | 2 analog inputs | Analog Inputs (see page 246) |
| 9 | Run/Stop switch | Run/Stop switch (see page 67) |
| 10 | Input removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 11 | I/O expansion connector | – |
| 12 | Cartridge slot | – |
| 13 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 14 | Locking hook | – |
| 15 | Removable analog inputs cover | – |
| 16 | Battery holder | Installing and Replacing the Battery (see page 53) |

Status LEDs

The following figure shows the status LEDs:

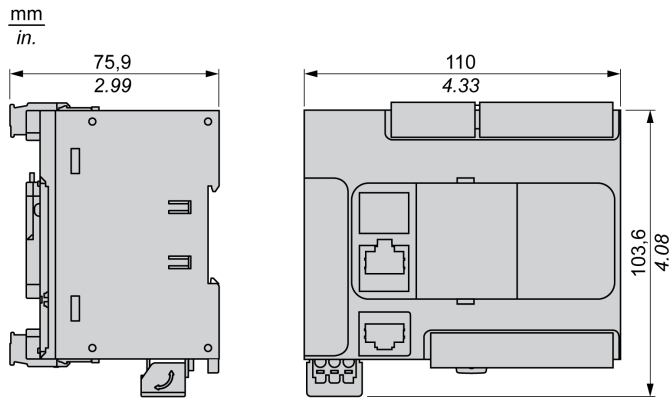


The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|--|---------------------------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access (see page 70) | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery (see page 52) | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 (see page 377) | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |
| <p>* ERR LED is also On during booting process.</p> <p>NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)</p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide).</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 15

TM221CE24U

TM221CE24U Presentation

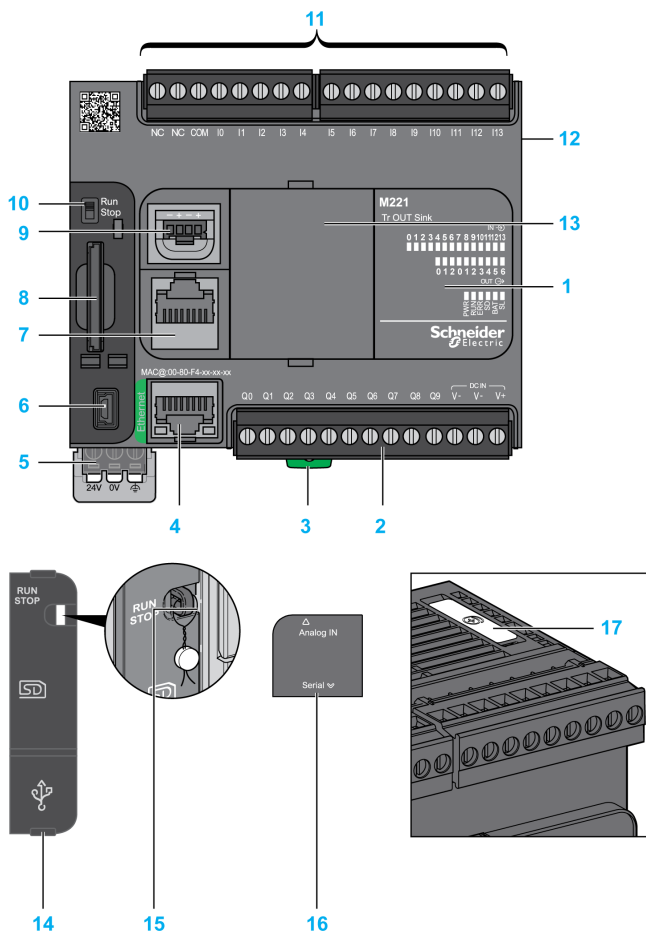
Overview

The following features are integrated into the TM221CE24U logic controller:

- 14 digital inputs
 - 4 fast inputs (HSC)
 - 10 regular inputs
- 10 digital outputs
 - 2 fast sink transistor outputs
 - 8 regular sink transistor outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port
 - 1 Ethernet port

Description

The following figure shows the different components of the logic controllers:

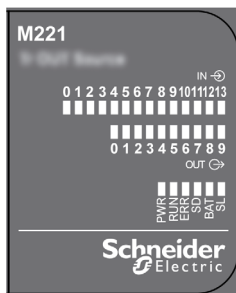


| N° | Description | Refer to |
|----|---|---|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (see page 90) |
| 4 | Ethernet port / RJ45 connector | Ethernet port (see page 374) |
| 5 | 24 Vdc power supply | Power supply (see page 106) |

| N° | Description | Refer to |
|----|---|--|
| 6 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (<i>see page 372</i>) |
| 7 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (<i>see page 377</i>) |
| 8 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 9 | 2 analog inputs | Analog Inputs (<i>see page 246</i>) |
| 10 | Run/Stop switch | Run/Stop switch (<i>see page 67</i>) |
| 11 | Input removable terminal block | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 12 | I/O expansion connector | – |
| 13 | Cartridge slot | – |
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Removable analog inputs cover | – |
| 17 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |

Status LEDs

The following figure shows the status LEDs:



The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|-------|---------------------------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access (see page 70) | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery (see page 52) | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 (see page 377) | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |

* ERR LED is also On during booting process.

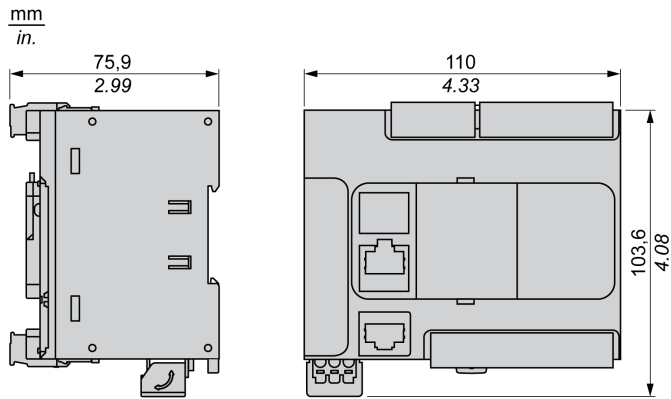
NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide).

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 16

TM221C40R

TM221C40R Presentation

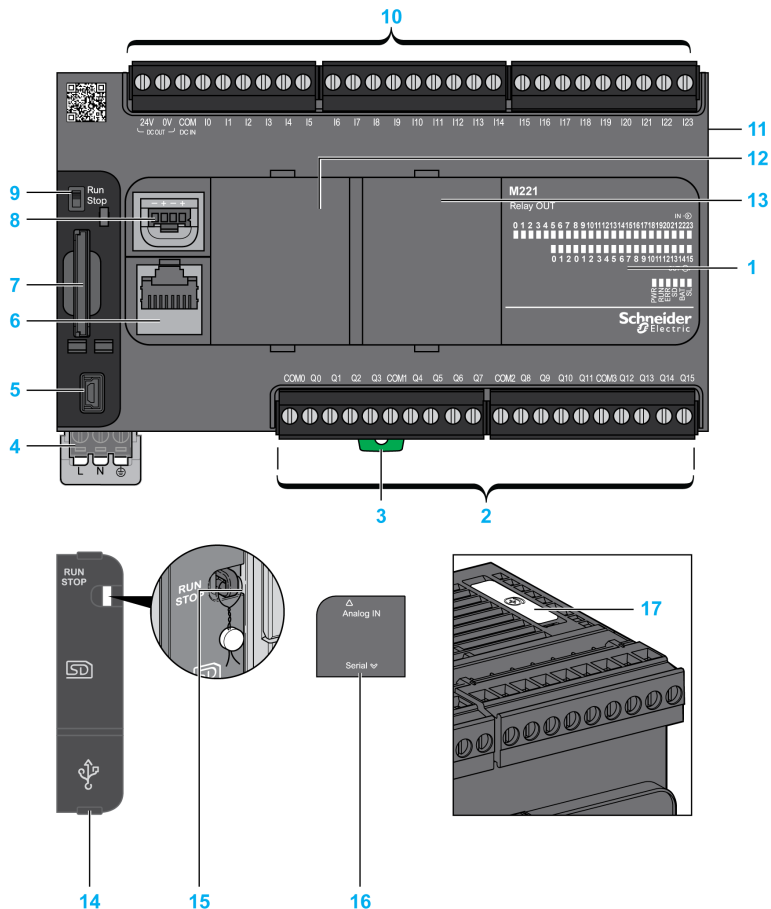
Overview

The following features are integrated into the TM221C40R logic controllers:

- 24 digital inputs
 - 4 fast inputs (HSC)
 - 20 regular inputs
- 16 digital outputs
 - 16 relay outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port

Description

The following figure shows the different components of the logic controllers:



| N° | Description | Refer to |
|--|---------------------------------|--|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| <p>(1) Embedded power supply characteristics:</p> <ul style="list-style-type: none"> ● Voltage: 24 V -15%...+10% isolated ● I_{max}: 250 mA ● No protection and no overload detection <p>Refer to Embedded I/O Channels (<i>see page 215</i>).</p> | | |

| N° | Description | Refer to |
|----|--|--|
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (<i>see page 90</i>) |
| 4 | 100...240 Vac power supply | Power supply (<i>see page 112</i>) |
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (<i>see page 372</i>) |
| 6 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (<i>see page 377</i>) |
| 7 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 8 | 2 analog inputs | Analog Inputs (<i>see page 246</i>) |
| 9 | Run/Stop switch | Run/Stop switch (<i>see page 67</i>) |
| 10 | Input removable terminal block and embedded power supply used for connecting sensors to the inputs. ⁽¹⁾ | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 11 | I/O expansion connector | – |
| 12 | Cartridge slot 1 | – |
| 13 | Cartridge slot 2 | – |
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Removable analog inputs cover | – |
| 17 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |

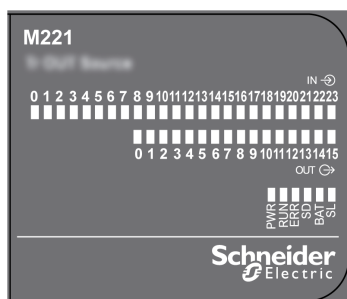
⁽¹⁾ Embedded power supply characteristics:

- Voltage: 24 V -15%...+10% isolated
- I_{max}: 250 mA
- No protection and no overload detection

Refer to Embedded I/O Channels (*see page 215*).

Status LEDs

The following figure shows the status LEDs:

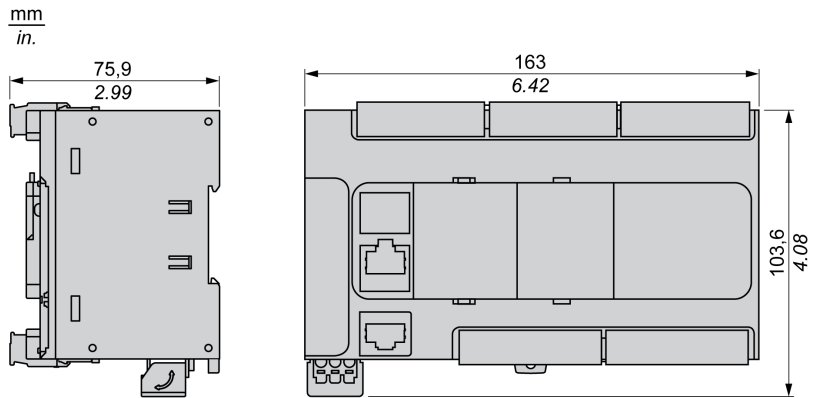


The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|--|---------------------------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access (see page 70) | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery (see page 52) | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 (see page 377) | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |
| <p>* ERR LED is also On during booting process.</p> <p>NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)</p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide).</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 17

TM221CE40R

TM221CE40R Presentation

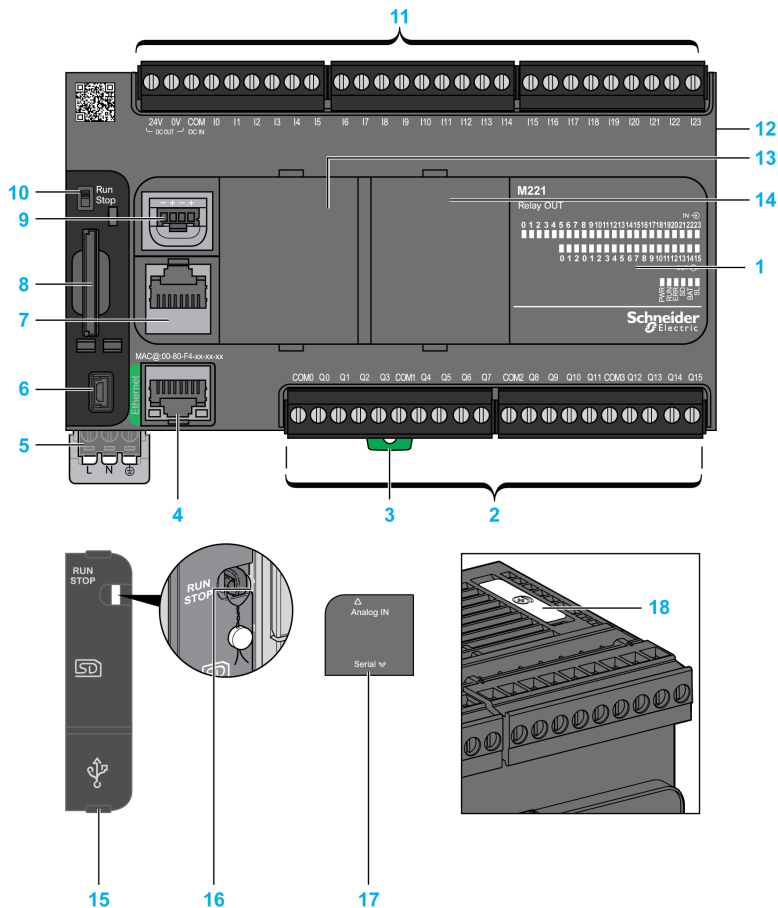
Overview

The following features are integrated into the TM221CE40R logic controllers:

- 24 digital inputs
 - 4 fast inputs (HSC)
 - 20 regular inputs
- 16 digital outputs
 - 16 relay outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port
 - 1 Ethernet port

Description

The following figure shows the different components of the logic controllers:

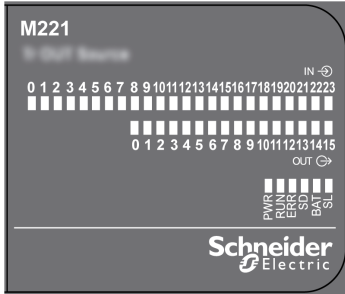


| N° | Description | Refer to |
|--|---------------------------------|--|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| <p>(1) Embedded power supply characteristics:</p> <ul style="list-style-type: none"> ● Voltage: 24 V -15%...+10% isolated ● I_{max}: 250 mA ● No protection and no overload detection <p>Refer to Embedded I/O Channels (<i>see page 215</i>).</p> | | |

| N° | Description | Refer to |
|--|--|--|
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (<i>see page 90</i>) |
| 4 | Ethernet port / RJ45 connector | Ethernet port (<i>see page 374</i>) |
| 5 | 100...240 Vac power supply | Power supply (<i>see page 112</i>) |
| 6 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (<i>see page 372</i>) |
| 7 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (<i>see page 377</i>) |
| 8 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 9 | 2 analog inputs | Analog Inputs (<i>see page 246</i>) |
| 10 | Run/Stop switch | Run/Stop switch (<i>see page 67</i>) |
| 11 | Input removable terminal block and embedded power supply used for connecting sensors to the inputs. ⁽¹⁾ | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 12 | I/O expansion connector | – |
| 13 | Cartridge slot 1 | – |
| 14 | Cartridge slot 2 | – |
| 15 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 16 | Locking hook | – |
| 17 | Removable analog inputs cover | – |
| 18 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |
| <p>⁽¹⁾ Embedded power supply characteristics:</p> <ul style="list-style-type: none"> ● Voltage: 24 V -15%...+10% isolated ● I_{max}: 250 mA ● No protection and no overload detection <p>Refer to Embedded I/O Channels (<i>see page 215</i>).</p> | | |

Status LEDs

The following figure shows the status LEDs:



The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|-------|----------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |

* ERR LED is also On during booting process.

NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide).

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

| Label | Function Type | Color | Status | Description | | |
|-------|---------------------------------|-------|----------|--|------------------------|-----------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| SD | SD Card Access (see page 70) | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery (see page 52) | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 (see page 377) | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |

* ERR LED is also On during booting process.

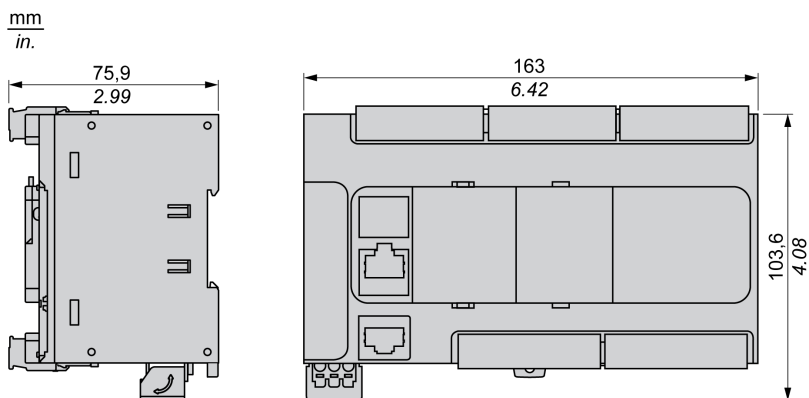
NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see *Modicon M221, Logic Controller, Programming Guide*).

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 18

TM221C40T

TM221C40T Presentation

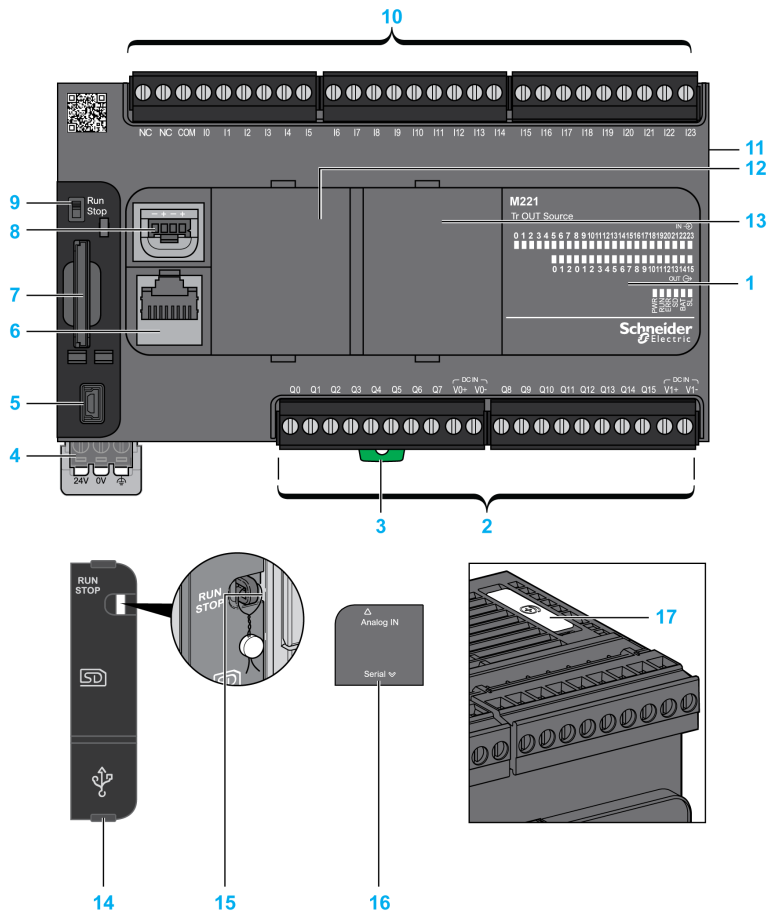
Overview

The following features are integrated into the TM221C40T logic controller:

- 24 digital inputs
 - 4 fast inputs (HSC)
 - 20 regular inputs
- 16 digital outputs
 - 2 fast source transistor outputs
 - 14 regular source transistor outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port

Description

The following figure shows the different components of the logic controllers:

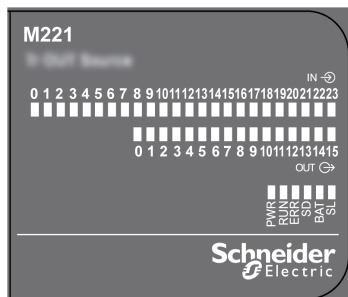


| N° | Description | Refer to |
|----|---|--|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (<i>see page 90</i>) |
| 4 | 24 Vdc power supply | Power supply (<i>see page 106</i>) |
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (<i>see page 372</i>) |

| N° | Description | Refer to |
|----|--|--|
| 6 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (<i>see page 377</i>) |
| 7 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 8 | 2 analog inputs | Analog Inputs (<i>see page 246</i>) |
| 9 | Run/Stop switch | Run/Stop switch (<i>see page 67</i>) |
| 10 | Input removable terminal block | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 11 | I/O expansion connector | – |
| 12 | Cartridge slot 1 | – |
| 13 | Cartridge slot 2 | – |
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Removable analog inputs cover | – |
| 17 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |

Status LEDs

The following figure shows the status LEDs:



The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|-------|--|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access <i>(see page 70)</i> | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery <i>(see page 52)</i> | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 <i>(see page 377)</i> | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |

* ERR LED is also On during booting process.

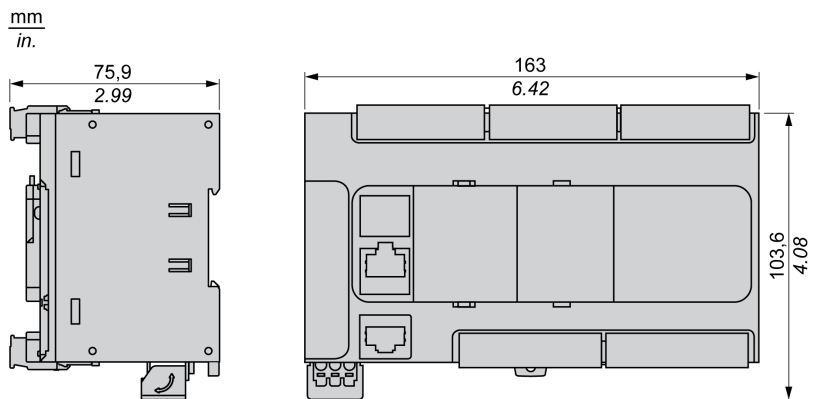
NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs *(see page 376)*

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide *(see Modicon M221, Logic Controller, Programming Guide)*.

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 19

TM221CE40T

TM221CE40T Presentation

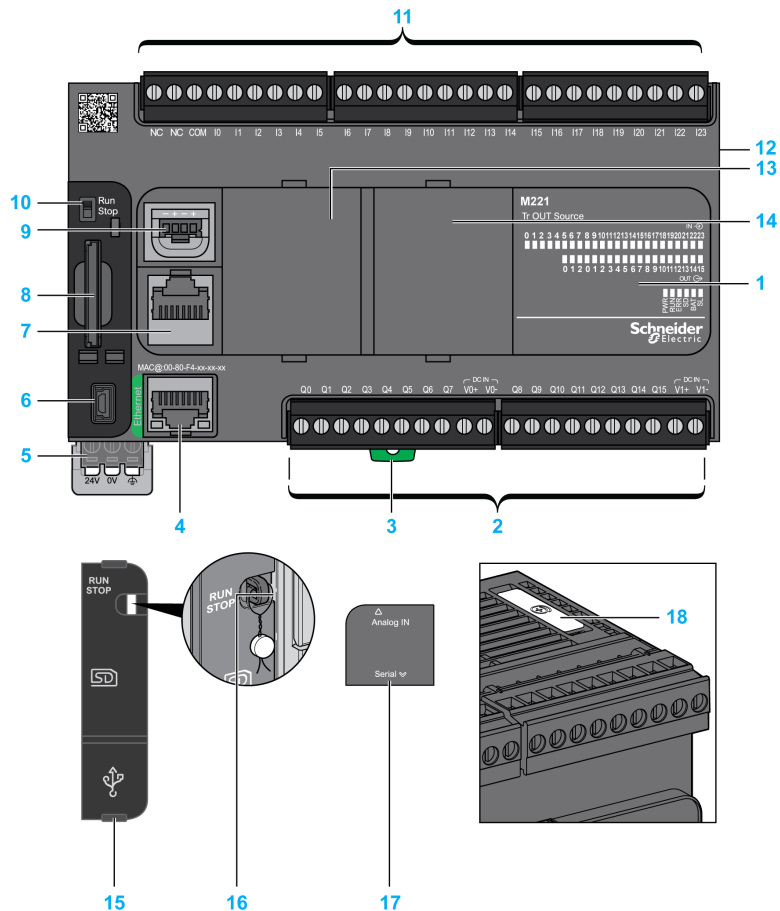
Overview

The following features are integrated into the TM221CE40T logic controllers:

- 24 digital inputs
 - 4 fast inputs (HSC)
 - 20 regular inputs
- 16 digital outputs
 - 2 fast source transistor outputs
 - 14 regular source transistor outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port
 - 1 Ethernet port

Description

The following figure shows the different components of the logic controllers:

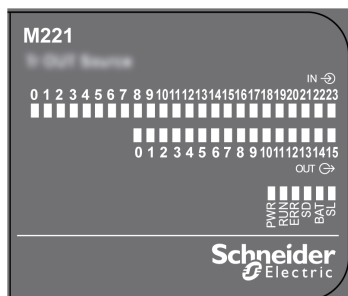


| N° | Description | Refer to |
|----|---|---|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (see page 90) |
| 4 | Ethernet port / RJ45 connector | Ethernet port (see page 374) |
| 5 | 24 Vdc power supply | Power supply (see page 106) |

| N° | Description | Refer to |
|----|---|--|
| 6 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (<i>see page 372</i>) |
| 7 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (<i>see page 377</i>) |
| 8 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 9 | 2 analog inputs | Analog Inputs (<i>see page 246</i>) |
| 10 | Run/Stop switch | Run/Stop switch (<i>see page 67</i>) |
| 11 | Input removable terminal block | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 12 | I/O expansion connector | – |
| 13 | Cartridge slot 1 | – |
| 14 | Cartridge slot 2 | – |
| 15 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 16 | Locking hook | – |
| 17 | Removable analog inputs cover | – |
| 18 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |

Status LEDs

The following figure shows the status LEDs:



The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|-------|---------------------------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access (see page 70) | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery (see page 52) | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 (see page 377) | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |

* ERR LED is also On during booting process.

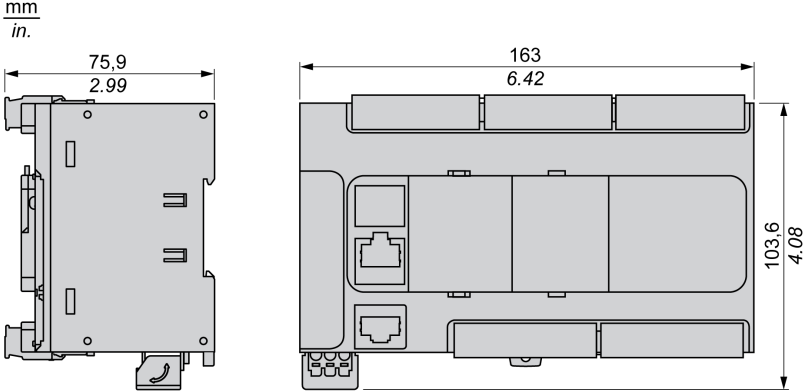
NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see *Modicon M221, Logic Controller, Programming Guide*).

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 20

TM221C40U

TM221C40U Presentation

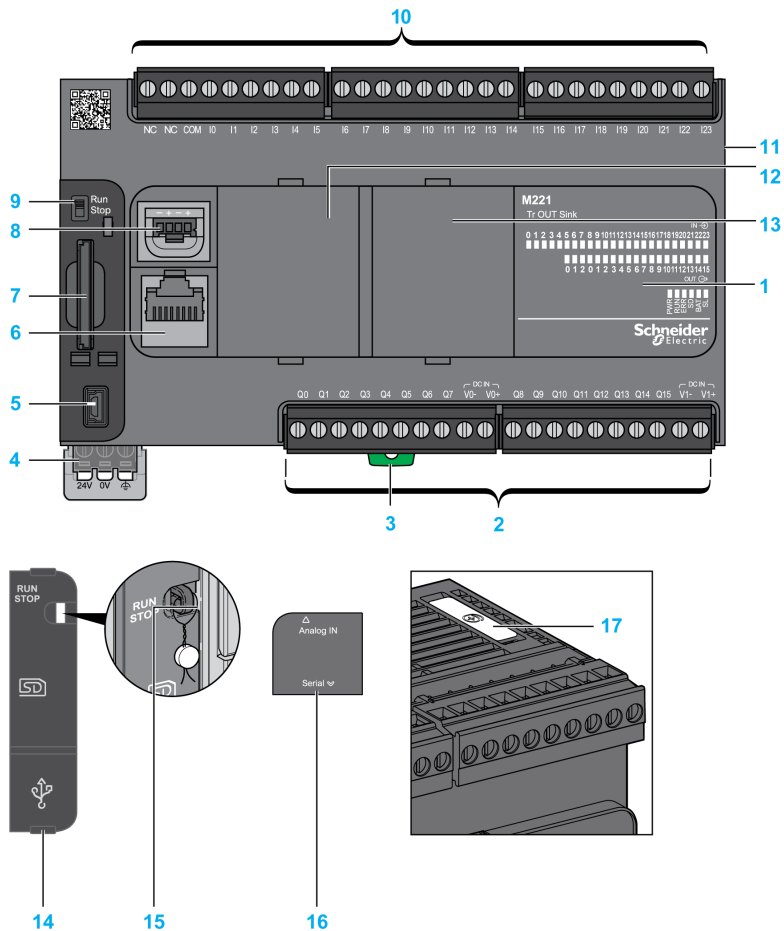
Overview

The following features are integrated into the TM221C40U logic controller:

- 24 digital inputs
 - 4 fast inputs (HSC)
 - 20 regular inputs
- 16 digital outputs
 - 4 fast sink transistor outputs
 - 12 regular sink transistor outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port

Description

The following figure shows the different components of the logic controllers:

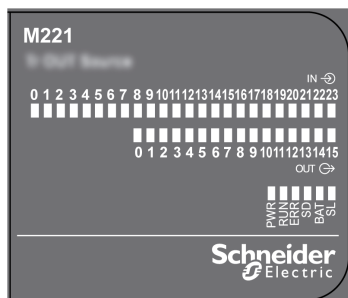


| N° | Description | Refer to |
|----|---|--|
| 1 | Status LEDs | - |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (<i>see page 90</i>) |
| 4 | 24 Vdc power supply | Power supply (<i>see page 106</i>) |

| N° | Description | Refer to |
|----|---|--|
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (<i>see page 372</i>) |
| 6 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (<i>see page 377</i>) |
| 7 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 8 | 2 analog inputs | Analog Inputs (<i>see page 246</i>) |
| 9 | Run/Stop switch | Run/Stop switch (<i>see page 67</i>) |
| 10 | Input removable terminal block | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 11 | I/O expansion connector | – |
| 12 | Cartridge slot 1 | – |
| 13 | Cartridge slot 2 | – |
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Removable analog inputs cover | – |
| 17 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |

Status LEDs

The following figure shows the status LEDs:

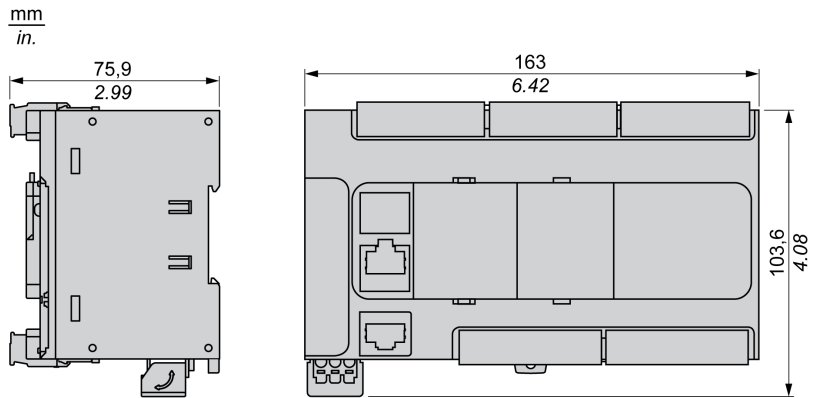


The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|--|--|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access <i>(see page 70)</i> | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery <i>(see page 52)</i> | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 <i>(see page 377)</i> | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |
| <p>* ERR LED is also On during booting process.</p> <p>NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs <i>(see page 376)</i></p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide <i>(see Modicon M221, Logic Controller, Programming Guide)</i>.</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 21

TM221CE40U

TM221CE40U Presentation

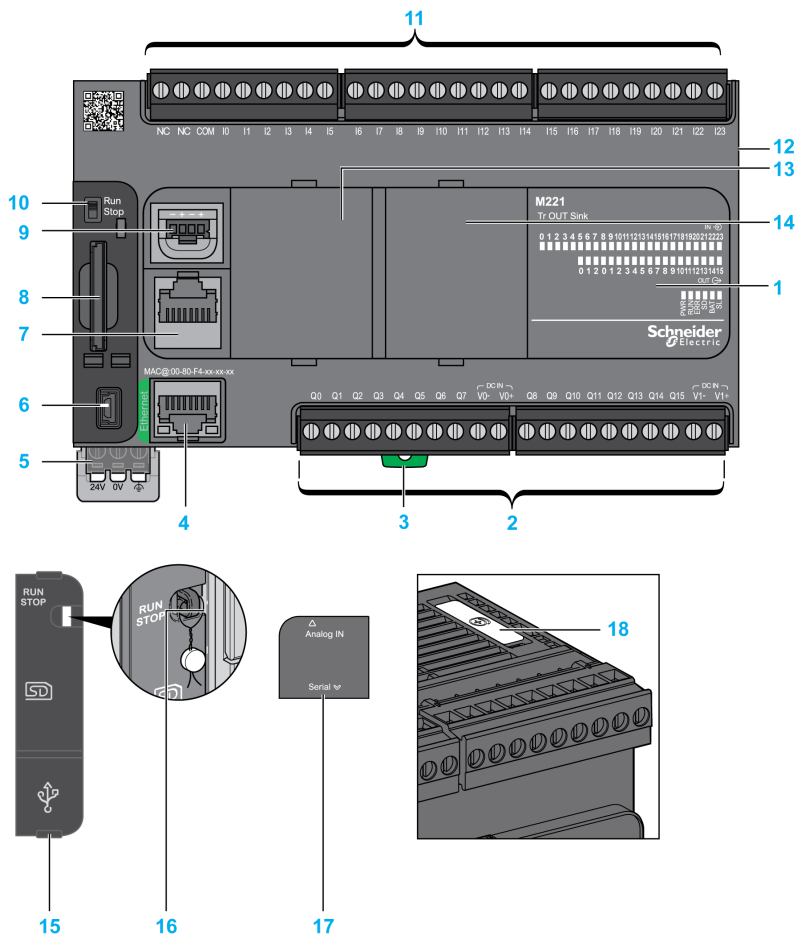
Overview

The following features are integrated into the TM221CE40U logic controller:

- 24 digital inputs
 - 4 fast inputs (HSC)
 - 20 regular inputs
- 16 digital outputs
 - 4 fast sink transistor outputs
 - 12 regular sink transistor outputs
- 2 analog inputs
- Communication ports
 - 1 serial line port
 - 1 USB mini-B programming port
 - 1 Ethernet port

Description

The following figure shows the different components of the logic controllers:

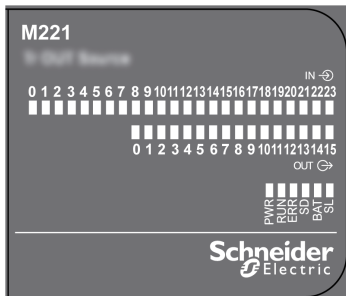


| N° | Description | Refer to |
|----|---|---|
| 1 | Status LEDs | – |
| 2 | Output removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 3 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (see page 90) |
| 4 | Ethernet port / RJ45 connector | Ethernet port (see page 374) |
| 5 | 24 Vdc power supply | Power supply (see page 106) |

| N° | Description | Refer to |
|----|---|--|
| 6 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (<i>see page 372</i>) |
| 7 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (<i>see page 377</i>) |
| 8 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 9 | 2 analog inputs | Analog Inputs (<i>see page 246</i>) |
| 10 | Run/Stop switch | Run/Stop switch (<i>see page 67</i>) |
| 11 | Input removable terminal block | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 12 | I/O expansion connector | – |
| 13 | Cartridge slot 1 | – |
| 14 | Cartridge slot 2 | – |
| 15 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 16 | Locking hook | – |
| 17 | Removable analog inputs cover | – |
| 18 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |

Status LEDs

The following figure shows the status LEDs:

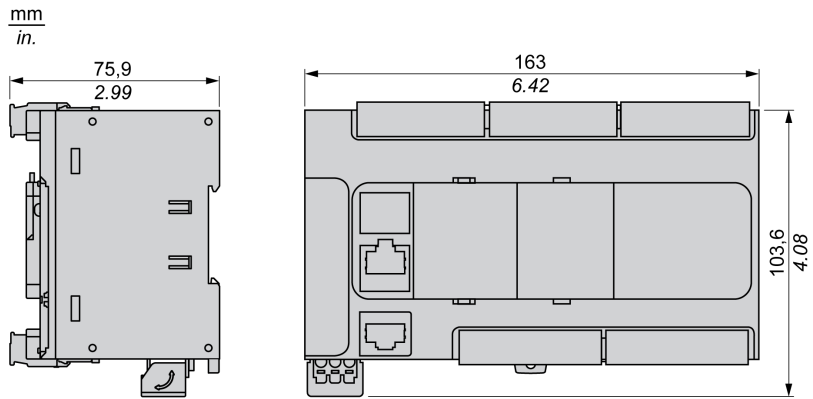


The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|--|---------------------------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access (see page 70) | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery (see page 52) | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 (see page 377) | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |
| <p>* ERR LED is also On during booting process.</p> <p>NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)</p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide).</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

Dimensions

The following figure shows the external dimensions of the logic controllers:



Chapter 22

Embedded I/O Channels

Overview

This chapter describes the embedded I/O channels.

What Is in This Chapter?

This chapter contains the following topics:

| Topic | Page |
|-------------------------------------|------|
| Digital Inputs | 216 |
| Relay Outputs | 231 |
| Regular and Fast Transistor Outputs | 237 |
| Analog Inputs | 246 |

Digital Inputs

Overview

The Modicon TM221C Logic Controller has digital inputs embedded:

| Reference | Total number of digital inputs | Fast inputs which can be used as 100 kHz HSC inputs | Regular inputs |
|-------------------------|--------------------------------|---|----------------|
| TM221C16• TM221CE16• | 9 | 4 | 5 |
| TM221C24• TM221CE24• | 14 | 4 | 10 |
| TM221C40• TM221CE40• | 24 | 4 | 20 |

For more information, refer to Input Management ([see page 59](#)).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Regular Input Characteristics

The following table describes the characteristics of the TM221C Logic Controller regular inputs:

| Characteristic | | Value | | |
|--|----------------------------------|---|-------------------------------|-------------------------------|
| | | TM221C16• TM221CE16• | TM221C24• TM221CE24• | TM221C40• TM221CE40• |
| Number of regular inputs | | 5 inputs (I2, I3, I4, I5, I8) | 10 inputs (I2...I5, I8...I13) | 20 inputs (I2...I5, I8...I23) |
| Number of channel groups | | 1 common line for I0...I8 | 1 common line for I0...I13 | 1 common line for I0...I23 |
| Input type | | Type 1 (IEC/EN 61131-2) | | |
| Logic type | | Sink/Source | | |
| Input voltage range | | 24 Vdc | | |
| Rated input voltage | | 19.2...28.8 Vdc | | |
| Rated input current | | 7 mA | | |
| Input impedance | | 3.4 kΩ | | |
| Input limit values | Voltage at state 1 | > 15 Vdc (15...28.8 Vdc) | | |
| | Voltage at state 0 | < 5 Vdc (0...5 Vdc) | | |
| | Current at state 1 | > 2.5 mA | | |
| | Current at state 0 | < 1.0 mA | | |
| Derating | | See derating curves (<i>see page 219</i>) | | |
| Turn on time | I2, I3, I4, I5 | 35 μs + filter value ¹ | | |
| | I8...I23 | 100 μs + filter value ¹ | | |
| Turn off time | I2, I3, I4, I5 | 35 μs + filter value ¹ | | |
| | I8...I23 | 100 μs + filter value ¹ | | |
| Isolation | Between input and internal logic | 500 Vac | | |
| Connection type | | Removable screw terminal blocks | | |
| Connector insertion/removal durability | | Over 100 times | | |
| Cable | Type | Unshielded | | |
| | Length | Maximum 30 m (98 ft) | | |
| ¹ For more information, refer to Integrator Filter Principle (<i>see page 59</i>) | | | | |

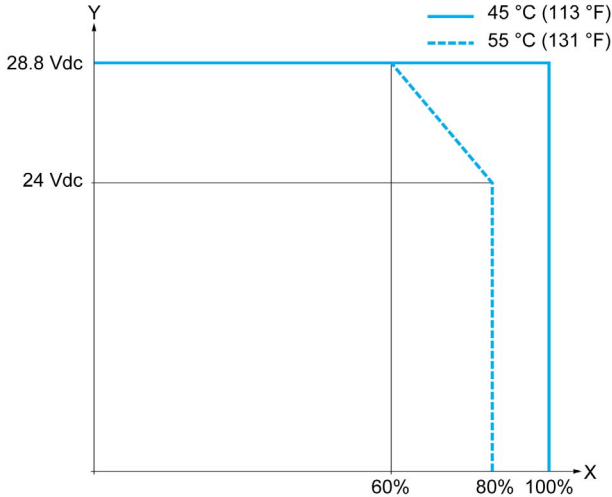
Fast Input Characteristics

The following table describes the characteristics of the TM221C Logic Controller fast inputs:

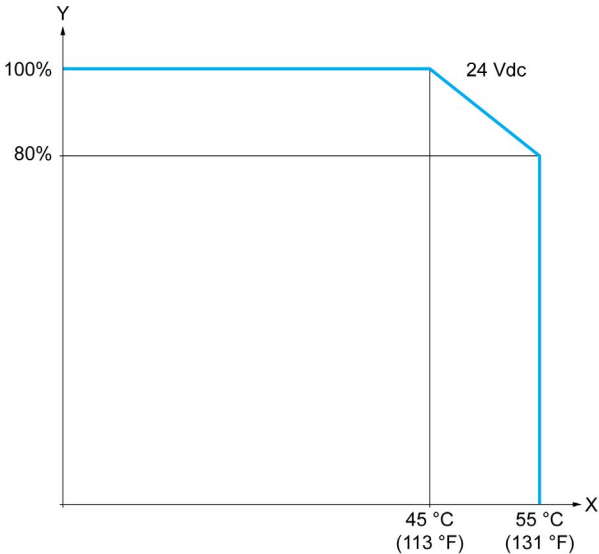
| Characteristic | | Value |
|---|----------------------------------|---|
| Number of fast inputs | | 4 inputs (I0, I1, I6, I7) |
| Number of channel groups | | 1 common line |
| Input type | | Type 1 (IEC/EN 61131-2) |
| Logic type | | Sink/Source |
| Rated input voltage | | 24 Vdc |
| Input voltage range | | 19.2...28.8 Vdc |
| Rated input current | | 5 mA |
| Input impedance | | 4.9 kΩ |
| Input limit values | Voltage at state 1 | > 15 Vdc (15...28.8 Vdc) |
| | Voltage at state 0 | < 5 Vdc (0...5 Vdc) |
| | Current at state 1 | > 2.6 mA |
| | Current at state 0 | < 0.6 mA |
| Derating | | See derating curves (see page 219) |
| Turn on time | | 5 μs + filter value ¹ |
| Turn off time | | 5 μs + filter value ¹ |
| HSC maximum frequency | Dual Phase | 100 kHz |
| | Single phase | 100 kHz |
| | Frequency Meter | 100 kHz |
| Supported HSC operation mode | | <ul style="list-style-type: none"> ● Dual Phase [Pulse / Direction] ● Dual Phase [Quadrature X1] ● Dual Phase [Quadrature X2] ● Dual Phase [Quadrature X4] ● Single Phase ● Frequency Meter |
| Isolation | Between input and internal logic | 500 Vac |
| | Between channel groups | 500 Vac |
| Connection type | | Removable screw terminal block |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Shielded, including the 24 Vdc power supply |
| | Length | Maximum 10 m (32.8 ft) |
| ¹ For more information, refer to Integrator Filter Principle (see page 59) | | |

Derating Curves (No Cartridge)

The following figures show the derating curves of the embedded digital inputs for a configuration without cartridge:



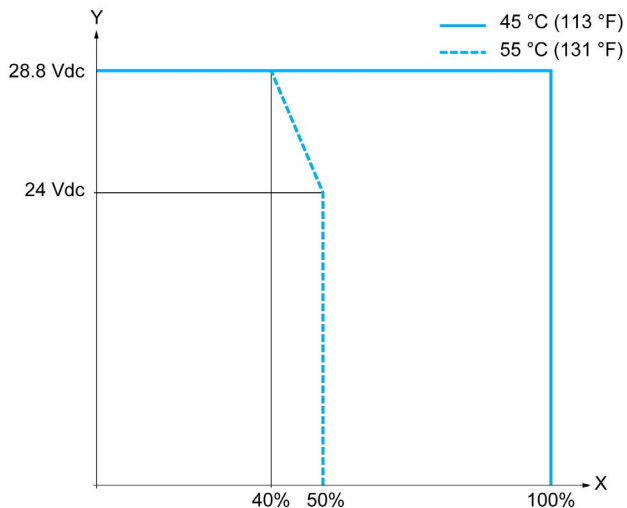
X Input simultaneous ON ratio
Y Input voltage



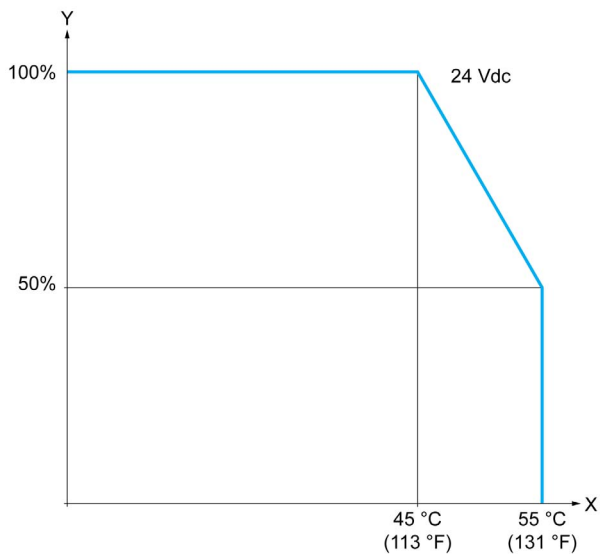
X Ambient temperature
Y Input simultaneous ON ratio

Derating Curves (with Cartridge)

The following figures show the derating curves of the embedded digital inputs for a configuration with cartridge:



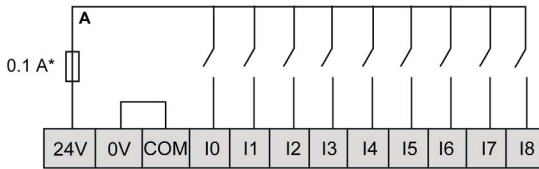
X Input simultaneous ON ratio
 Y Input voltage



X Ambient temperature
 Y Input simultaneous ON ratio

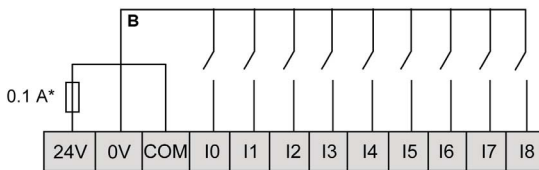
TM221C16R / TM221CE16R Wiring Diagrams

The following figure presents the sink wiring diagram (positive logic) of the inputs to the sensors for TM221C16R and TM221CE16R:



* Type T fuse

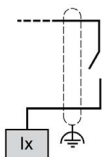
The following figure presents the source wiring diagram (negative logic) of the inputs to the sensors for TM221C16R and TM221CE16R:



* Type T fuse

NOTE: The TM221C Logic Controller provides a 24 Vdc supply to the inputs.

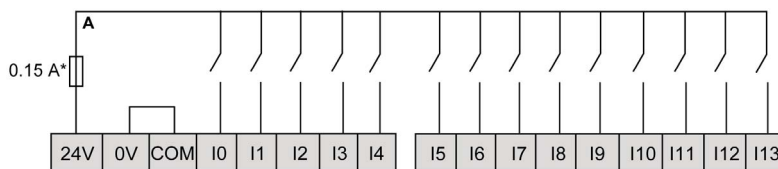
The following figure presents the connection of the fast inputs:



Ix I0, I1, I6, I7

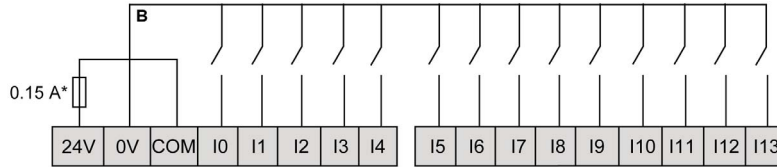
TM221C24R / TM221CE24R Wiring Diagrams

The following figure presents the sink wiring diagram (positive logic) of the inputs to the sensors for TM221C24R and TM221CE24R:



* Type T fuse

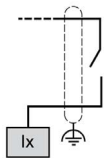
The following figure presents the source wiring diagram (negative logic) of the inputs to the sensors for TM221C24R and TM221CE24R:



* Type T fuse

NOTE: The TM221C Logic Controller provides a 24 Vdc supply to the inputs.

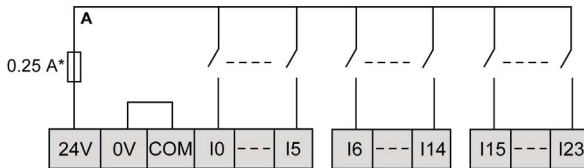
The following figure presents the connection of the fast inputs:



Ix I0, I1, I6, I7

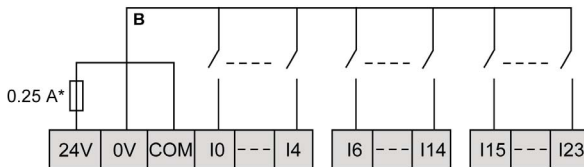
TM221C40R / TM221CE40R Wiring Diagrams

The following figure presents the sink wiring diagram (positive logic) of the inputs to the sensors for TM221C40R and TM221CE40R:



* Type T fuse

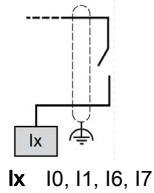
The following figure presents the source wiring diagram (negative logic) of the inputs to the sensors for TM221C40R and TM221CE40R:



* Type T fuse

NOTE: The TM221C Logic Controller provides a 24 Vdc supply to the inputs.

The following figure presents the connection of the fast inputs:

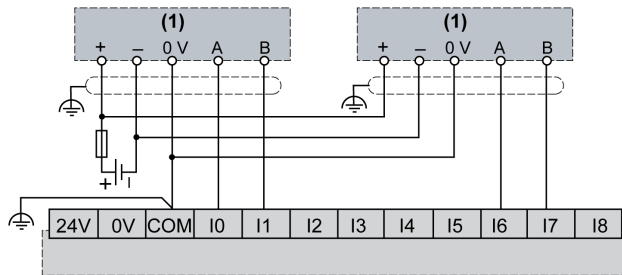


TM221C••R / TM221CE••R Encoder Examples Wiring Diagrams

The following figures show four wiring examples for TM221C••R and TM221CE••R:

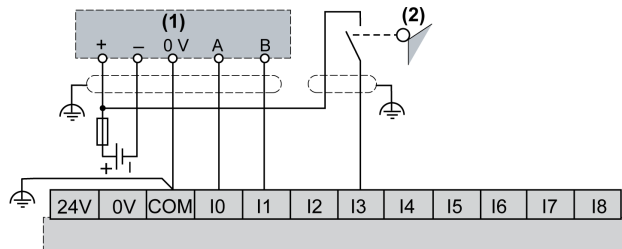
- dual-phase encoder without index
- dual-phase encoder with a limit switch and no index
- dual-phase encoder with index
- dual-phase encoder with index and PNP sensor

TM221C••R / TM221CE••R with a dual-phase encoder without index:



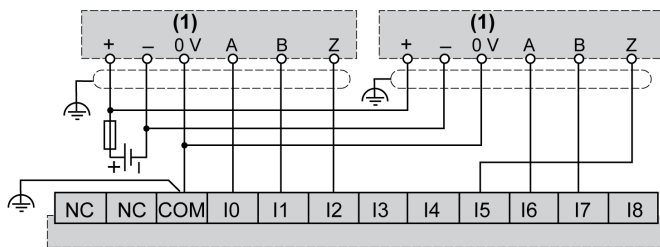
(1) Dual phase encoder without index

TM221C••R / TM221CE••R with a dual-phase encoder with a limit switch and no index:



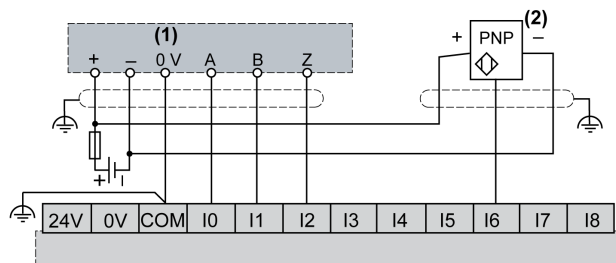
(1) Dual phase encoder without index
(2) Limit switch

TM221C••R / TM221CE••R with a dual-phase encoder with index:



(1) Dual phase encoder with index

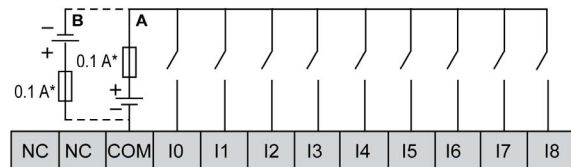
TM221C••R / TM221CE••R with a dual-phase encoder with index and PNP sensor:



(1) Dual phase encoder with index
(2) PNP sensor

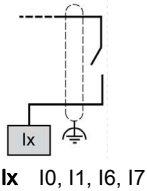
TM221C16T / TM221CE16T Wiring Diagrams

The following figure presents the connection of the inputs to the sensors for TM221C16T and TM221CE16T:



- * Type T fuse
- A Sink wiring (positive logic).
- B Source wiring (negative logic).

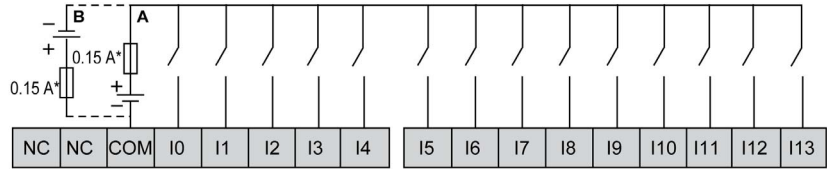
The following figure presents the connection of the fast inputs:



| |
|---|
| ⚠ 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. |

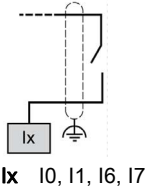
TM221C24T / TM221CE24T Wiring Diagrams

The following figure presents the connection of the inputs to the sensors for TM221C24T and TM221CE24T:



- * Type T fuse
- A Sink wiring (positive logic).
- B Source wiring (negative logic).

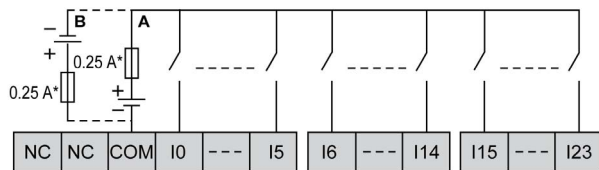
The following figure presents the connection of the fast inputs:



| |
|---|
| ⚠ 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. |

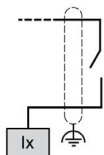
TM221C40T / TM221CE40T Wiring Diagrams

The following figure presents the connection of the inputs to the sensors for TM221C40T and TM221CE40T:



- * Type T fuse
- A Sink wiring (positive logic).
- B Source wiring (negative logic).

The following figure presents the connection of the fast inputs:



Ix I0, I1, I6, I7

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

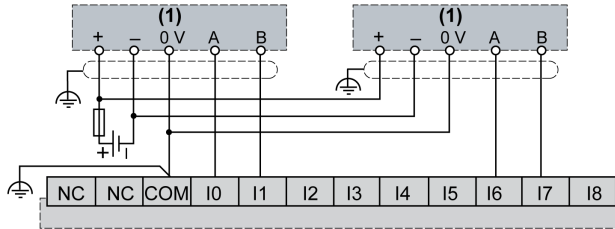
Failure to follow these instructions can result in death, serious injury, or equipment damage.

TM221C••T / TM221CE••T Encoder Examples Wiring Diagrams

The following figures show four wiring examples for TM221C••T and TM221CE••T:

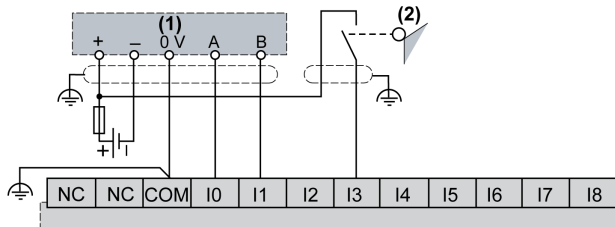
- dual-phase encoder without index
- dual-phase encoder with a limit switch and no index
- dual-phase encoder with index
- dual-phase encoder with index and PNP sensor

TM221C••T / TM221CE••T with a dual-phase encoder without index:



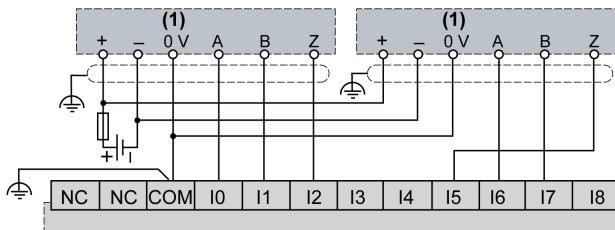
(1) Dual phase encoder without index

TM221C••T / TM221CE••T with a dual-phase encoder with a limit switch and no index:



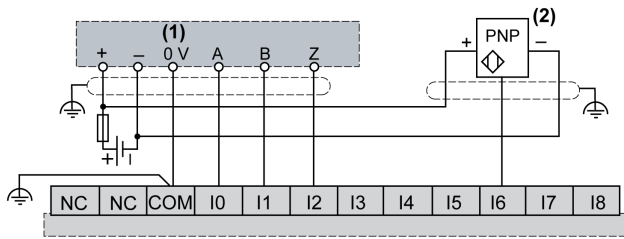
(1) Dual phase encoder without index
(2) Limit switch

TM221C••T / TM221CE••T with a dual-phase encoder with index:



(1) Dual phase encoder with index

TM221C••T / TM221CE••T with a dual-phase encoder with index and PNP sensor:



- (1) Dual phase encoder with index
- (2) PNP sensor

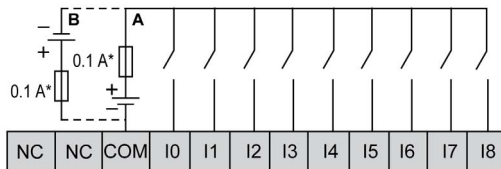
⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Do not connect wires to unused terminals and/or terminals indicated as “No Connection (N.C.)”.
Failure to follow these instructions can result in death, serious injury, or equipment damage.

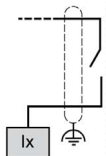
TM221C16U / TM221CE16U Wiring Diagrams

The following figure presents the connection of the inputs to the sensors for TM221C16U and TM221CE16U:



- * Type T fuse
- A** Sink wiring (positive logic).
- B** Source wiring (negative logic).

The following figure presents the connection of the fast inputs:



Ix I0, I1, I6, I7

⚠ WARNING

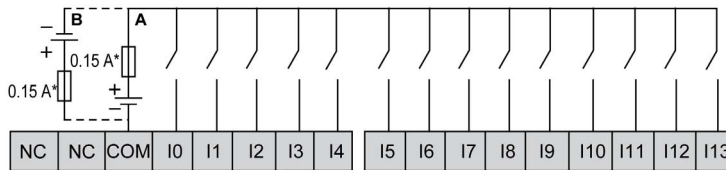
UNINTENDED EQUIPMENT OPERATION

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.

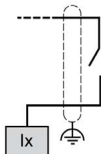
TM221C24U / TM221CE24U Wiring Diagrams

The following figure presents the connection of the inputs to the sensors for TM221C24U and TM221CE24U:



- * Type T fuse
- A** Sink wiring (positive logic).
- B** Source wiring (negative logic).

The following figure presents the connection of the fast inputs:



Ix I0, I1, I6, I7

⚠ WARNING

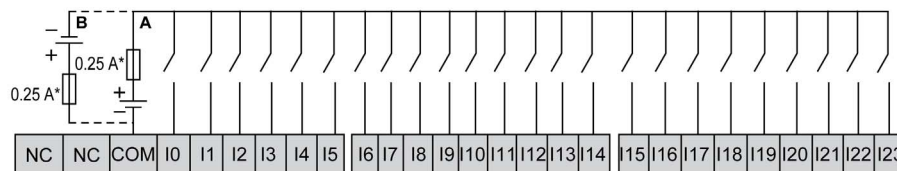
UNINTENDED EQUIPMENT OPERATION

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.

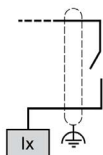
TM221C40U / TM221CE40U Wiring Diagrams

The following figure presents the connection of the inputs to the sensors for TM221C40U and TM221CE40U:



- * Type T fuse
- A Sink wiring (positive logic).
- B Source wiring (negative logic).

The following figure presents the connection of the fast inputs:



Ix 10, 11, 16, 17

⚠ 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.

Relay Outputs

Overview

The Modicon TM221C Logic Controller has 7, 10 or 16 relay outputs embedded:

| Reference | Number of relay outputs |
|------------------------|-------------------------|
| TM221C16R / TM221CE16R | 7 |
| TM221C24R / TM221CE24R | 10 |
| TM221C40R / TM221CE40R | 16 |

For more information, refer to Output Management (*see page 63*).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Relay Output Characteristics

The following table describes the characteristics of the TM221C Logic Controller with relay outputs:


| Characteristic | Value | | |
|--|--|---|---|
| | TM221C16R / TM221CE16R | TM221C24R / TM221CE24R | TM221C40R / TM221CE40R |
| Number of relay outputs | 7 outputs | 10 outputs | 16 outputs |
| Number of channel groups | 1 common line for Q0...Q3 1 common line for Q4...Q6 | 1 common line for Q0...Q3 1 common line for Q4...Q7 1 common line for Q8, Q9 | 1 common line for Q0...Q3 1 common line for Q4...Q7 1 common line for Q8...Q11 1 common line for Q12...Q15 |
| Output type | Relay | | |
| Contact type | NO (Normally Open) | | |
| Rated output voltage | 24 Vdc, 240 Vac | | |
| Maximum voltage at 2 A | 30 Vdc, 264 Vac | | |
| Minimum switching load | 5 Vdc at 10 mA | | |
| Rated output current | 2 A | | |
| Maximum output current | 2 A per output | | |
| | 7 A for common 0 (Q0...Q3) 6 A for common 1 (Q4...Q6) | 7 A for common 0 (Q0...Q3) 7 A for common 1 (Q4...Q7) 4 A for common 2 (Q8, Q9) | 7 A per common |
| Maximum output frequency with maximum load | 20 operations per minute | | |
| Derating | No derating | | |
| Turn on time | Max. 10 ms | | |
| Turn off time | Max. 10 ms | | |
| Contact resistance | 30 mΩ max | | |
| Mechanical life | 20 million operations | | |
| Electrical life | Under resistive load | See power limitation (<i>see page 233</i>) | |
| | Under inductive load | | |
| Protection against short circuit | No | | |

| Characteristic | | Value | | |
|--|-----------------------------------|---------------------------------|---------------------------|---------------------------|
| | | TM221C16R / TM221CE16R | TM221C24R / TM221CE24R | TM221C40R / TM221CE40R |
| Isolation | Between output and internal logic | 500 Vac | | |
| | Between channel groups | 500 Vac | | |
| Connection type | | Removable screw terminal blocks | | |
| Connector insertion/removal durability | | Over 100 times | | |
| Cable | Type | Unshielded | | |
| | Length | Max. 30 m (98 ft) | | |
| NOTE: Refer to Protecting Outputs from Inductive Load Damage (<i>see page 103</i>) for additional information concerning output protection. | | | | |

Power Limitation

The following table describes the power limitation of the relay outputs depending on the voltage, the type of load, and the number of operations required.

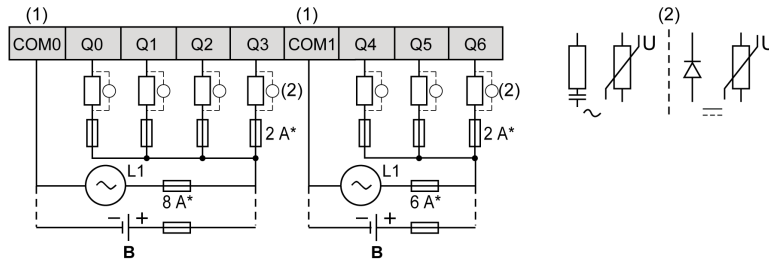
These controllers do not support capacitive loads.

|  WARNING |
|--|
| RELAY OUTPUTS WELDED CLOSED |
| <ul style="list-style-type: none"> • Always protect relay outputs from inductive alternating current load damage using an appropriate external protective circuit or device. • Do not connect relay outputs to capacitive loads. |
| Failure to follow these instructions can result in death, serious injury, or equipment damage. |

| Power Limitations | | | | |
|--|---------------|-----------------|------------------|----------------------|
| Voltage | 24 Vdc | 120 Vac | 240 Vac | Number of operations |
| Power of resistive loads AC-12 | – | 240 VA 80 VA | 480 VA 160 VA | 100,000 300,000 |
| Power of inductive loads AC-15 ($\cos \phi = 0.35$) | – | 60 VA 18 VA | 120 VA 36 VA | 100,000 300,000 |
| Power of inductive loads AC-14 ($\cos \phi = 0.7$) | – | 120 VA 36 VA | 240 VA 72 VA | 100,000 300,000 |
| Power of resistive loads DC-12 | 48 W 16 W | – | – | 100,000 300,000 |
| Power of inductive loads DC-13 L/R = 7 ms | 24 W 7.2 W | – | – | 100,000 300,000 |

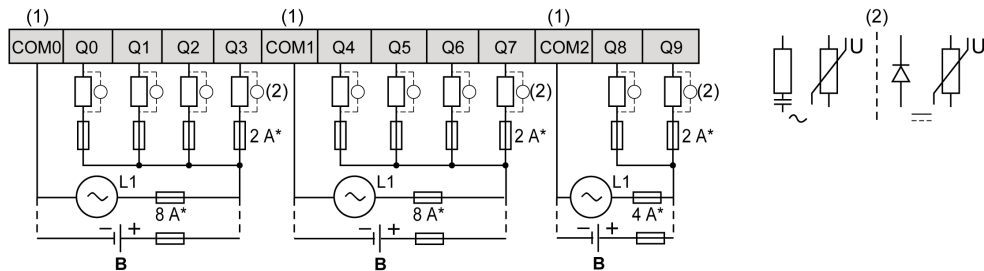
Relay Outputs Wiring Diagrams - Negative Logic (Sink)

The following figure presents the sink wiring diagram (negative logic) of the outputs to the load for the TM221C16R / TM221CE16R:



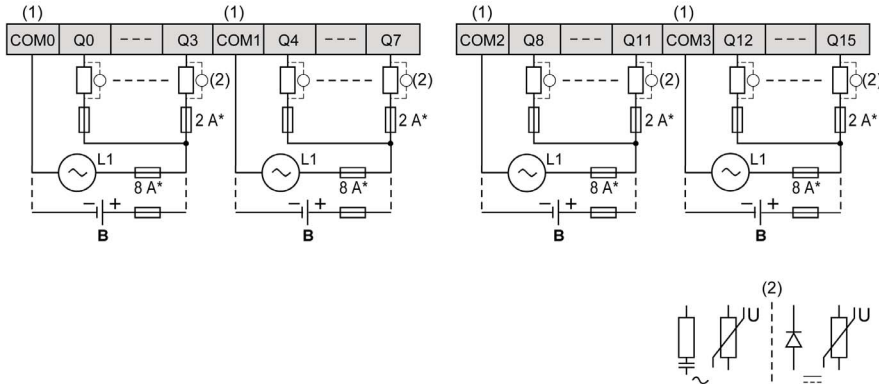
- * Type T fuse
- (1) The COM1 and COM2 terminals are **not** connected internally.
- (2) To improve the life time of the contacts, and to protect from potential inductive load damage, you must connect a free wheeling diode in parallel to each inductive DC load or an RC snubber in parallel of each inductive AC load
- B** Sink wiring (negative logic)

The following figure presents the sink wiring diagram (negative logic) of the outputs to the load for the TM221C24R / TM221CE24R:



- * Type T fuse
- (1) The COM0, COM1 and COM2 terminals are **not** connected internally.
- (2) To improve the life time of the contacts, and to protect from potential inductive load damage, you must connect a free wheeling diode in parallel to each inductive DC load or an RC snubber in parallel of each inductive AC load
- B** Sink wiring (negative logic)

The following figure presents the sink wiring diagram (negative logic) of the outputs to the load for the TM221C40R / TM221CE40R:



* Type T fuse

(1) The COM0, COM1, COM2 and COM3 terminals are **not** connected internally.

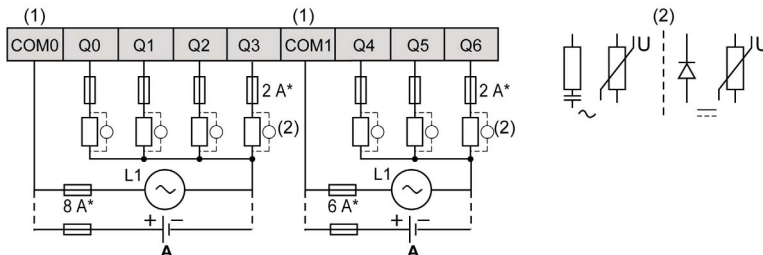
(2) To improve the life time of the contacts, and to protect from potential inductive load damage, you must connect a free wheeling diode in parallel to each inductive DC load or an RC snubber in parallel of each inductive AC load

B Sink wiring (negative logic)

NOTE: The assigned fuse values have been specified for the maximum current characteristics of the controller I/O and associated commons. You may have other considerations that are applicable based on the unique types of input and output devices you connect, and you should size your fuses accordingly.

Relay Outputs Wiring Diagrams - Positive Logic (Source)

The following figure presents the source wiring diagram (positive logic) of the outputs to the load for the TM221C16R / TM221CE16R:



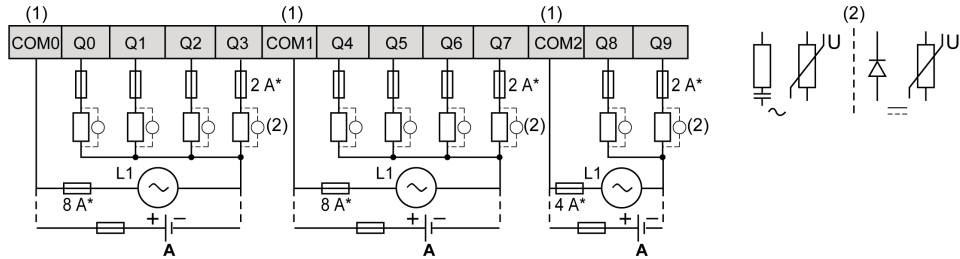
* Type T fuse

(1) The COM1 and COM2 terminals are **not** connected internally.

(2) To improve the life time of the contacts, and to protect from potential inductive load damage, you must connect a free wheeling diode in parallel to each inductive DC load or an RC snubber in parallel of each inductive AC load

A Source wiring (positive logic)

The following figure presents the source wiring diagram (positive logic) of the outputs to the load for the TM221C24R / TM221CE24R:



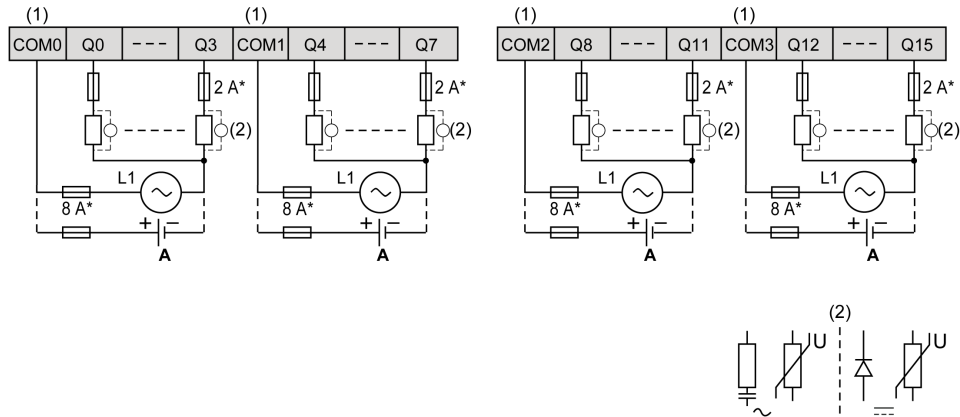
* Type T fuse

(1) The COM0, COM1 and COM2 terminals are **not** connected internally.

(2) To improve the life time of the contacts, and to protect from potential inductive load damage, you must connect a free wheeling diode in parallel to each inductive DC load or an RC snubber in parallel of each inductive AC load

A Source wiring (positive logic)

The following figure presents the source wiring diagram (positive logic) of the outputs to the load for the TM221C40R / TM221CE40R:



* Type T fuse

(1) The COM0, COM1, COM2 and COM3 terminals are **not** connected internally.

(2) To improve the life time of the contacts, and to protect from potential inductive load damage, you must connect a free wheeling diode in parallel to each inductive DC load or an RC snubber in parallel of each inductive AC load

A Source wiring (positive logic)

NOTE: The assigned fuse values have been specified for the maximum current characteristics of the controller I/O and associated commons. You may have other considerations that are applicable based on the unique types of input and output devices you connect, and you should size your fuses accordingly.

Regular and Fast Transistor Outputs

Overview

The Modicon TM221C Logic Controller has regular and fast transistor outputs embedded:

| Reference | Total number of digital outputs | Transistor outputs | Fast outputs |
|------------------------|---------------------------------|--------------------|--------------|
| TM221C16T / TM221CE16T | 7 | 5 | 2 |
| TM221C16U / TM221CE16U | 7 | 5 | 2 |
| TM221C24T / TM221CE24T | 10 | 8 | 2 |
| TM221C24U / TM221CE24U | 10 | 8 | 2 |
| TM221C40T / TM221CE40T | 16 | 14 | 2 |
| TM221C40U / TM221CE40U | 16 | 12 | 4 |

For more information, refer to Output Management (*see page 63*).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Regular Transistor Output Characteristics

The following table describes the characteristics of the TM221C Logic Controller regular transistor outputs:

| Characteristic | Value | | |
|--|--|--|--|
| | TM221C16T / TM221CE16T / TM221C16U / TM221CE16U | TM221C24T / TM221CE24T / TM221C24U / TM221CE24U | TM221C40T / TM221CE40T / TM221C40U / TM221CE40U |
| Number of regular transistor outputs | 5 outputs (Q2...Q6) | 8 outputs (Q2...Q9) | 14 outputs (Q2...Q15) (TM221C40T / TM221CE40T) 12 outputs (Q4...Q15) (TM221C40U / TM221CE40U) |
| Number of channel groups | 1 common line for Q0...Q6 | 1 common line for Q0...Q9 | 1 common line for Q0...Q7 1 common line for Q8...Q15 |
| Output type | Transistor | | |
| Logic type | Source for TM221...T Sink for TM221...U | | |
| Rated output voltage | 24 Vdc | | |
| Output voltage range | 19.2...28.8 Vdc | | |
| Rated output current | 0.5 A | | |
| Total output current | 3.5 A for channel group Q0...Q6 | 5 A for channel group Q0...Q9 | 4 A for channel group Q0...Q7 4 A for channel group Q8...Q15 |
| Voltage drop | 1 Vdc max | | |
| Leakage current when switched off | 0.1 mA | | |
| Maximum power of filament lamp | 12 W max | | |
| Derating | See derating curves (<i>see page 241</i>) | | |
| Turn on time | Q2, Q3 | Max. 50 µs | |
| | Other regular outputs | Max. 300 µs | |
| Turn off time | Q2, Q3 | Max. 50 µs | |
| | Other regular outputs | Max. 300 µs | |
| Protection against short circuit | Yes (TM221C...T only) | | |
| Short circuit output peak current | 1.3 A | | |
| Automatic rearming after short circuit or overload | Yes, every 1 s | | |

| Characteristic | | Value | | |
|--|-----------------------------------|--|--|--|
| | | TM221C16T / TM221CE16T / TM221C16U / TM221CE16U | TM221C24T / TM221CE24T / TM221C24U / TM221CE24U | TM221C40T / TM221CE40T / TM221C40U / TM221CE40U |
| Clamping voltage | | Max. 39 Vdc \pm 1 Vdc | | |
| Switching frequency | Under resistive load | 100 Hz max. | | |
| Isolation | Between output and internal logic | 500 Vac | | |
| Connection type | | Removable screw terminal blocks | | |
| Connector insertion/removal durability | | Over 100 times | | |
| Cable | Type | Unshielded | | |
| | Length | Max 30 m (98 ft) | | |
| NOTE: Refer to Protecting Outputs from Inductive Load Damage (<i>see page 103</i>) for additional information concerning output protection. | | | | |

Fast Transistor Output Characteristics

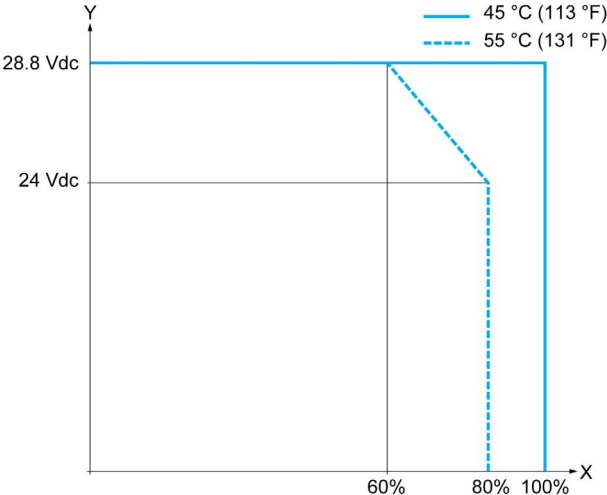
The following table describes the characteristics of the TM221C Logic Controller fast transistor outputs:

| Characteristic | | Value |
|-----------------------------------|--|---|
| Number of fast transistor outputs | | 2 fast outputs (Q0, Q1) 4 fast outputs (Q0, Q1, Q2 and Q3) for TM221...40U |
| Number of channel groups | | 1 common line |
| Output type | | Transistor |
| Logic type | | Source for TM221...T Sink for TM221...U |
| Rated output voltage | | 24 Vdc |
| Output voltage range | | 19.2...28.8 Vdc |
| Rated output current | | 0.5 A |
| Total output current | TM221C16T / TM221CE16T TM221C16U / TM221CE16U | 3.5 A for channel group Q0...Q6 |
| | TM221C24T / TM221CE24T TM221C24U / TM221CE24U | 5 A for channel group Q0...Q9 |
| | TM221C40T / TM221CE40T TM221C40U / TM221CE40U | 4 A for channel group Q0...Q7 4 A for channel group Q8...Q15 |
| Maximum power of filament lamp | | 12 W max |

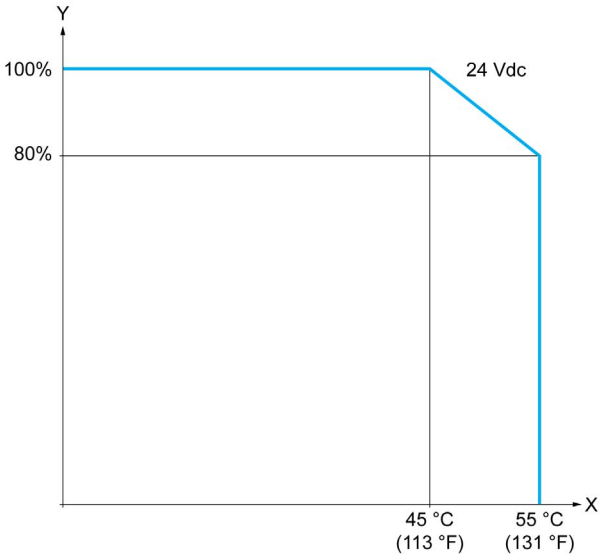
| Characteristic | | Value |
|---|-----------------------------------|---|
| Derating | | See derating curves (<i>see page 241</i>) |
| Turn on time (10 mA < output current < 100 mA) | | Max. 5 µs |
| Turn off time (10 mA < output current < 100 mA) | | Max. 5 µs |
| Protection against short circuit | | Yes (TM221C•••T only) |
| Short circuit output peak current | | 1.3 A max. |
| Automatic rearming after short circuit or overload | | Yes, every 1 s |
| Protection against reverse polarity | | Yes |
| Clamping voltage | | Typ. 39 Vdc +/- 1 Vdc |
| Maximum output frequency | PLS/PWM/PTO/FREQGEN | 100 kHz |
| Isolation | Between output and internal logic | 500 Vac |
| Connection type | | Removable screw terminal blocks |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Shielded, including 24 Vdc power supply |
| | Length | Maximum 3 m (9.84 ft) |
| <p>NOTE: Refer to Protecting Outputs from Inductive Load Damage (<i>see page 103</i>) for additional information concerning output protection.</p> | | |

Derating Curves (No Cartridge)

The following figures show the derating curves of the embedded digital outputs for a configuration without cartridge:



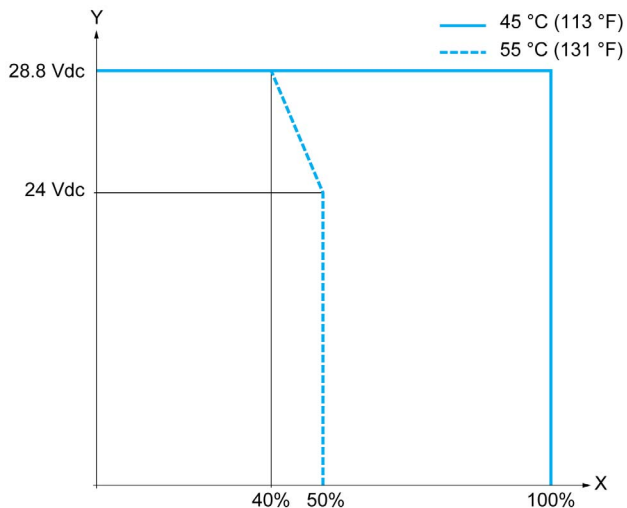
X Output simultaneous ON ratio
Y Output voltage



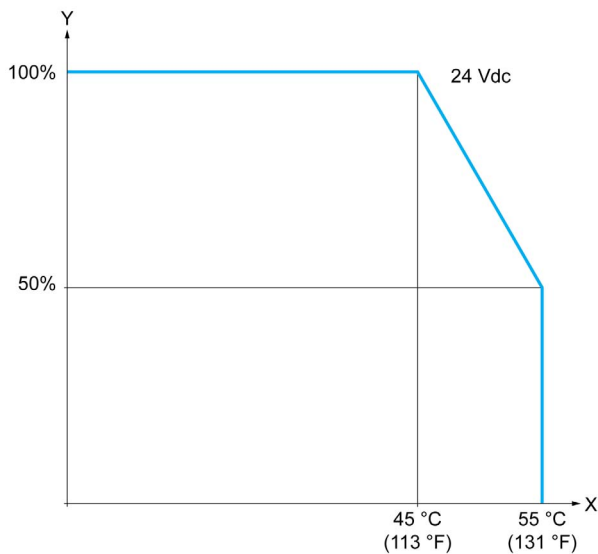
X Ambient temperature
Y Output simultaneous ON ratio

Derating Curves (with Cartridge)

The following figures show the derating curves of the embedded digital outputs for a configuration with cartridge:



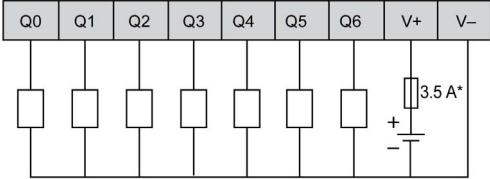
X Output simultaneous ON ratio
 Y Output voltage



X Ambient temperature
 Y Output simultaneous ON ratio

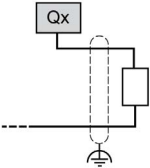
Transistor Outputs Wiring Diagrams

The following figure presents the connection of the outputs to the load for the TM221C16T / TM221CE16T:



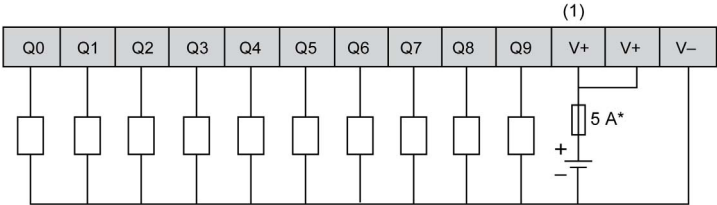
* Type T fuse

The following figure presents the connection of the fast outputs:



Qx Q0, Q1

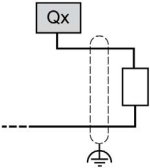
The following figure presents the connection of the outputs to the load for the TM221C24T / TM221CE24T:



* Type T fuse

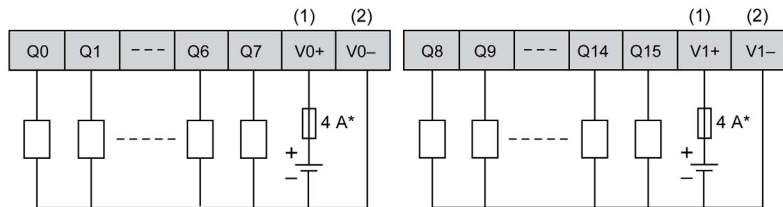
(1) The V+ terminals are connected internally.

The following figure presents the connection of the fast outputs:



Qx Q0, Q1

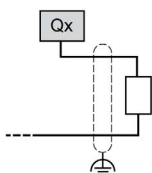
The following figure presents the connection of the outputs to the load for the TM221C40T / TM221CE40T:



* Type T fuse

- (1) The V0+ and V1+ terminals are **not** connected internally.
- (2) The V0- and V1- terminals are **not** connected internally.

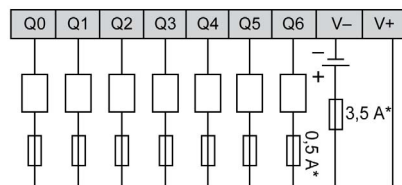
The following figure presents the connection of the fast outputs:



Qx Q0, Q1

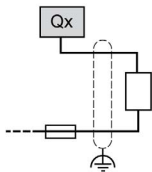
Sink Transistor Outputs Wiring Diagrams

The following figure presents the connection of the outputs to the load for the TM221C16U / TM221CE16U:



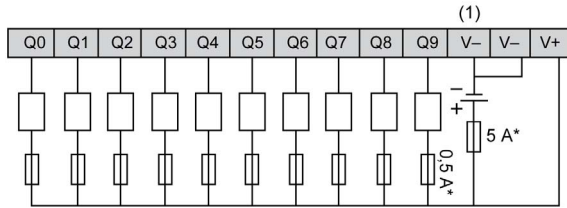
* Type T fuse

The following figure presents the connection of the fast outputs:



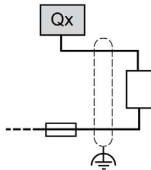
Qx Q0, Q1

The following figure presents the connection of the outputs to the load for the TM221C24U / TM221CE24U:



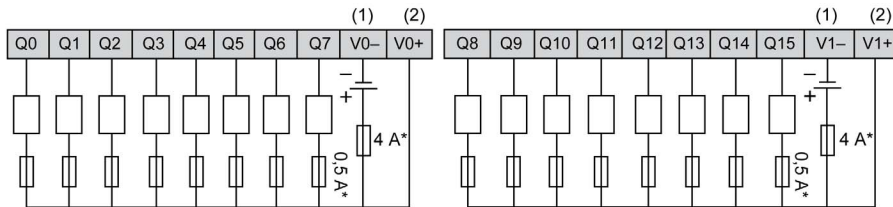
- * Type T fuse
- (1) The V- terminals are connected internally.

The following figure presents the connection of the fast outputs:



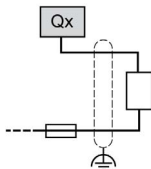
Qx Q0, Q1

The following figure presents the connection of the outputs to the load for the TM221C40U / TM221CE40U:



- * Type T fuse
- (1) The V0- and V1- terminals are **not** connected internally.
- (2) The V0+ and V1+ terminals are **not** connected internally.

The following figure presents the connection of the fast outputs:



Qx Q0, Q1, Q2, Q3

Analog Inputs

Overview

The Modicon M221 Logic Controller has 2 analog inputs embedded.

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

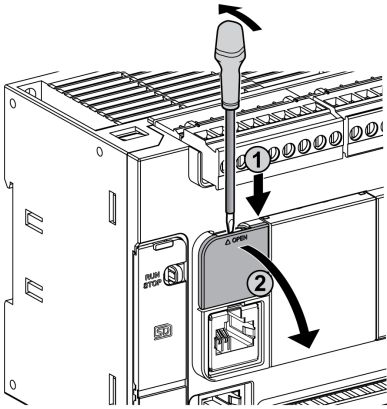
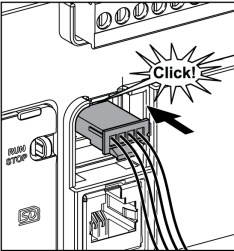
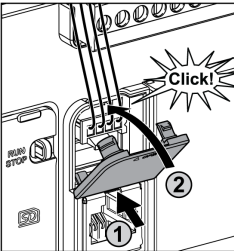
UNINTENDED EQUIPMENT OPERATION

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

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

Mounting the Analog Cables

The following procedure describes how to mount the analog cables:

| Step | Action |
|------|---|
| 1 | <p>Use a screw-driver to remove the protective cover.</p>  |
| 2 | <p>Push until you hear it "click".</p>  |
| 3 | <p>Replace the protective cover.</p>  |

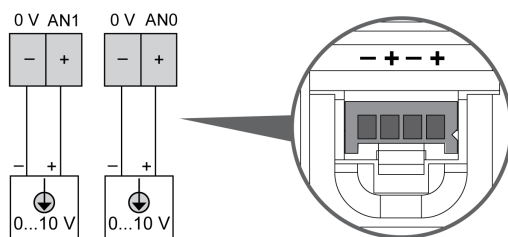
Analog Input Characteristics

The following table describes the characteristics of the M221 Logic Controller with analog inputs:

| Characteristic | | Voltage Input |
|---|----------------------------------|--|
| Number of maximum inputs | | 2 inputs |
| Input type | | Single-ended |
| Rated input range | | 0...+10 Vdc |
| Digital resolution | | 10 bits |
| Input value of LSB | | 10 mV |
| Input impedance | | 100 kΩ |
| Input delay time | | 12 ms |
| Sample duration time | | 1 ms per channel + 1 scan time |
| Accuracy | | ± 1 % of the full scale |
| Noise resistance - maximum temporary deviation during perturbations | | ± 5 % maximum of the full scale when EMC perturbation is applied to the power and I/O wiring |
| Isolation | Between input and internal logic | Not isolated |
| Connection type | | Specific connector and cable (supplied) |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Proprietary (supplied) |
| | Length | 1 m (3.3 ft) |

Analog Inputs Wiring Diagram

The following figure shows the wiring diagram of the M221 Logic Controller analog inputs:



The (-) poles are connected internally.

| Pin | Wire Color |
|-----|------------|
| 0 V | Black |
| AN1 | Red |

| Pin | Wire Color |
|-----|------------|
| 0 V | Black |
| AN0 | Red |

For more information, refer to the Wiring Best Practices ([see page 99](#)).

Part III

Modicon TM221M Logic Controller

What Is in This Part?

This part contains the following chapters:

| Chapter | Chapter Name | Page |
|---------|--------------------------|------|
| 23 | TM221M16R / TM221M16RG | 253 |
| 24 | TM221ME16R / TM221ME16RG | 271 |
| 25 | TM221M16T / TM221M16TG | 289 |
| 26 | TM221ME16T / TM221ME16TG | 309 |
| 27 | TM221M32TK | 329 |
| 28 | TM221ME32TK | 349 |

Chapter 23

TM221M16R / TM221M16RG

Overview

This chapter describes the TM221M16R / TM221M16RG controllers.

What Is in This Chapter?

This chapter contains the following topics:

| Topic | Page |
|--|------|
| TM221M16R / TM221M16RG Presentation | 254 |
| TM221M16R / TM221M16RG Digital Inputs | 259 |
| TM221M16R / TM221M16RG Digital Outputs | 263 |
| TM221M16R / TM221M16RG Analog Inputs | 267 |

TM221M16R / TM221M16RG Presentation

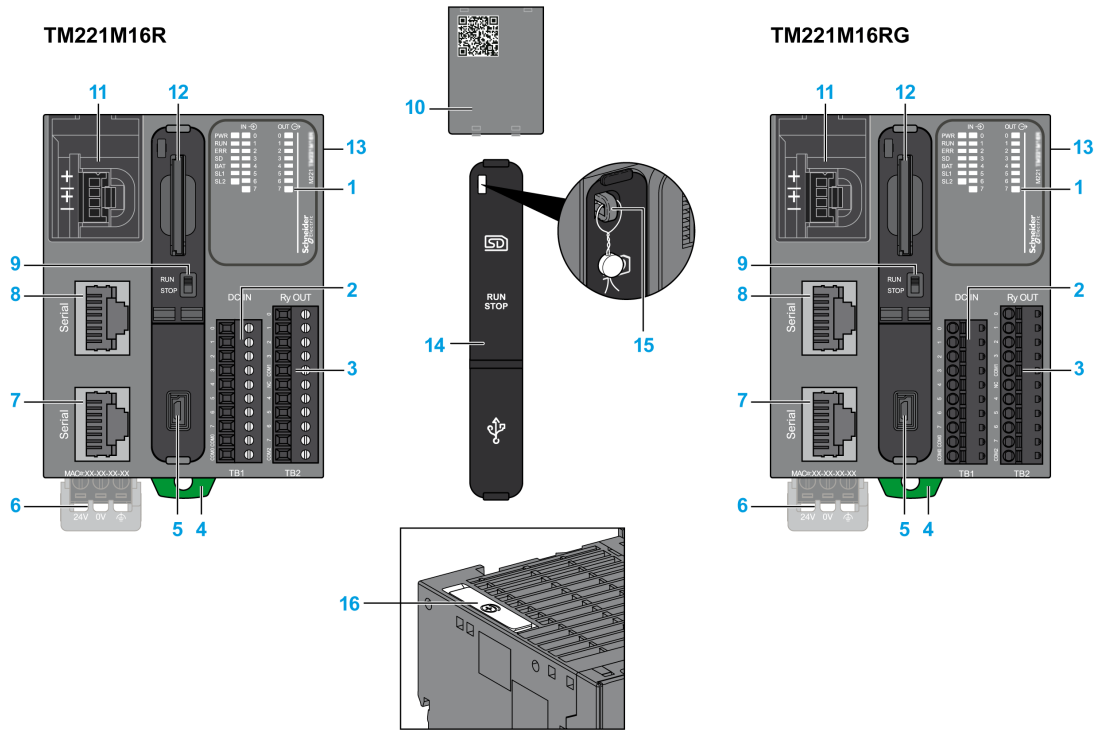
Overview

The following features are integrated into the TM221M16R (screw) and TM221M16RG (spring) controllers:

- 8 digital inputs
 - 4 regular inputs
 - 4 fast inputs (HSC)
- 8 digital outputs
 - 8 relay outputs
- 2 analog inputs
- Communication port
 - 2 serial line ports
 - 1 USB mini-B programming port

Description

The following figure shows the different components of the controllers:

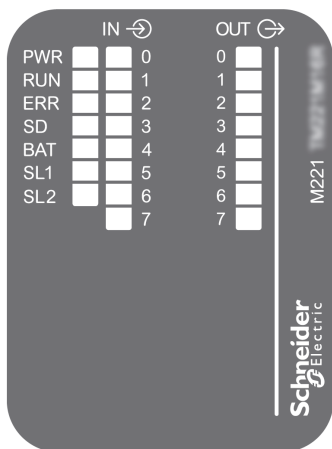


| N° | Description | Refer to |
|----|---|--|
| 1 | Status LEDs | – |
| 2 | Input removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 3 | Output removable terminal block | Rules for Removable Spring Terminal Block (see page 102) |
| 4 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (see page 90) |
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (see page 372) |
| 6 | 24 Vdc power supply | Power supply (see page 106) |
| 7 | Serial line port 2 / RJ45 connector (RS-485) | Serial line 2 (see page 381) |
| 8 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (see page 377) |
| 9 | Run/Stop switch | Run/Stop switch (see page 67) |

| N° | Description | Refer to |
|----|--|---|
| 10 | Removable analog inputs cover | – |
| 11 | 2 analog inputs | Analog Inputs (<i>see page 267</i>) |
| 12 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 13 | I/O expansion connector | – |
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |

Status LEDs

The following figure shows the status LEDs:



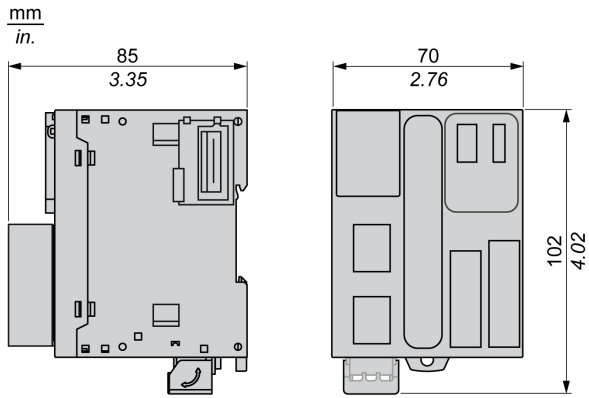
The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|---|---------------|-------|--------|----------------------------------|------------------------|-----------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| <p>* ERR LED is also On during booting process.</p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (<i>see Modicon M221, Logic Controller, Programming Guide</i>).</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

| Label | Function Type | Color | Status | Description | | |
|--|---------------------------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flashing | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access (see page 70) | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery (see page 52) | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL1 | Serial line 1 (see page 377) | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |
| SL2 | Serial line 2 (see page 381) | Green | On | Indicates the status of Serial line 2. | | |
| | | | Flashing | Indicates activity on Serial line 2. | | |
| | | | Off | Indicates no serial communication. | | |
| <p>* ERR LED is also On during booting process.</p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide).</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

Dimensions

The following figure shows the external dimensions of the controllers:



TM221M16R / TM221M16RG Digital Inputs

Overview

This M221 Logic Controller has embedded digital inputs:

- 4 regular inputs
- 4 fast inputs which can be used as 100 kHz HSC inputs

For more information, refer to Input Management (*see page 59*).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Regular Input Characteristics

The following table describes the characteristics of the TM221M Logic Controller regular inputs:

| Characteristic | Value |
|--------------------------|---------------------------|
| Number of regular inputs | 4 inputs (I2, I3, I4, I5) |
| Number of channel groups | 1 common line for I0...I7 |
| Input type | Type 1 (IEC/EN 61131-2) |
| Logic type | Sink/Source |
| Input voltage range | 24 Vdc |
| Rated input voltage | 19.2...28.8 Vdc |
| Rated input current | 7 mA |
| Input impedance | 3.4 kΩ |

| Characteristic | | Value |
|---|----------------------------------|--|
| Input limit values | Voltage at state 1 | > 15 Vdc (15...28.8 Vdc) |
| | Voltage at state 0 | < 5 Vdc (0...5 Vdc) |
| | Current at state 1 | > 2.5 mA |
| | Current at state 0 | < 1.0 mA |
| Derating | | No derating |
| Turn on time | | 35 μ s + filter value ¹ |
| Turn off time | | 35 μ s + filter value ¹ |
| Isolation | Between input and internal logic | 500 Vac |
| Connection type | TM221M16R | Removable screw terminal blocks |
| | TM221M16RG | Removable spring terminal blocks |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Unshielded |
| | Length | Maximum 30 m (98 ft) |
| ¹ For more information, refer to Integrator Filter Principle (see page 59) | | |

Fast Input Characteristics

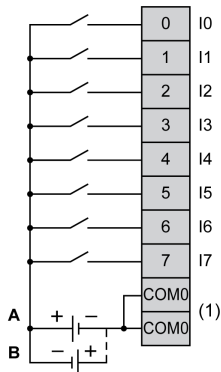
The following table describes the characteristics of the TM221M Logic Controller fast inputs:

| Characteristic | | Value |
|--------------------------|--------------------|---------------------------------------|
| Number of fast inputs | | 4 inputs (I0, I1, I6, I7) |
| Number of channel groups | | 1 common line for I0...I7 |
| Input type | | Type 1 (IEC/EN 61131-2) |
| Logic type | | Sink/Source |
| Rated input voltage | | 24 Vdc |
| Input voltage range | | 19.2...28.8 Vdc |
| Rated input current | | 4.5 mA |
| Input impedance | | 4.9 k Ω |
| Input limit values | Voltage at state 1 | > 15 Vdc (15...28.8 Vdc) |
| | Voltage at state 0 | < 5 Vdc (0...5 Vdc) |
| | Current at state 1 | > 2.5 mA |
| | Current at state 0 | < 1.0 mA |
| Derating | | No derating |
| Turn on time | | 5 μ s + filter value ¹ |
| Turn off time | | 5 μ s + filter value ¹ |

| Characteristic | | Value |
|---|----------------------------------|---|
| HSC maximum frequency | Dual Phase | 100 kHz |
| | Single phase | 100 kHz |
| | Frequency Meter | 100 kHz |
| HSC supported operation mode | | <ul style="list-style-type: none"> ● Dual Phase [Pulse / Direction] ● Dual Phase [Quadrature X1] ● Dual Phase [Quadrature X2] ● Dual Phase [Quadrature X4] ● Single Phase ● Frequency Meter |
| Isolation | Between input and internal logic | 500 Vac |
| Connection type | TM221M16R | Removable screw terminal block |
| | TM221M16RG | Removable spring terminal block |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Shielded, including the 24 Vdc power supply |
| | Length | Maximum 10 m (32.8 ft) |
| ¹ For more information, refer to Integrator Filter Principle (see page 59) | | |

Wiring Diagram

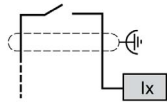
The following figure presents the connection of the inputs to the sensors:



(1) The COM0 terminals are connected internally.

A Sink wiring (positive logic).

B Source wiring (negative logic).



Ix I0, I1, I6, I7

TM221M16R / TM221M16RG Digital Outputs

Overview

M221 Logic Controller with 8 relay outputs embedded.

For more information on Output Management (*see page 63*).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Relay Output Characteristics

The following table describes the characteristics of the TM221M Logic Controller with relay outputs:

| Characteristic | Value |
|--------------------------|--|
| Number of relay outputs | 8 outputs |
| Number of channel groups | 1 common line for Q0...Q3 1 common line for Q4...Q7 |
| Output type | Relay |
| Contact type | NO (Normally Open) |
| Rated output voltage | 24 Vdc, 240 Vac |
| Maximum voltage at 2 A | 30 Vdc, 264 Vac |
| Minimum switching load | 5 Vdc at 10 mA |
| Rated output current | 2 A |

| Characteristic | | Value |
|---|-----------------------------------|--|
| Maximum output current | | 2 A per output |
| | | 7 A per common |
| Maximum output frequency with maximum load | | 20 operations per minute |
| Derating | | No derating |
| Turn on time | | Max. 10 ms |
| Turn off time | | Max. 10 ms |
| Contact resistance | | 30 mΩ max |
| Mechanical life | | 20 million operations |
| Electrical life | Under resistive load | See power limitation (<i>see page 264</i>) |
| | Under inductive load | |
| Protection against short circuit | | No |
| Isolation | Between output and internal logic | 500 Vac |
| | Between channel groups | 500 Vac |
| Connection type | TM221M16R | Removable screw terminal blocks |
| | TM221M16RG | Removable spring terminal blocks |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Unshielded |
| | Length | Max. 30 m (98 ft) |
| <p>NOTE: Refer to Protecting Outputs from Inductive Load Damage (<i>see page 103</i>) for additional information concerning output protection.</p> | | |

Power Limitation

The following table describes the power limitation of the TM221M16R / TM221M16RG relay outputs depending on the voltage, the type of load, and the number of operations required.

These controllers do not support capacitive loads.

WARNING

RELAY OUTPUTS WELDED CLOSED

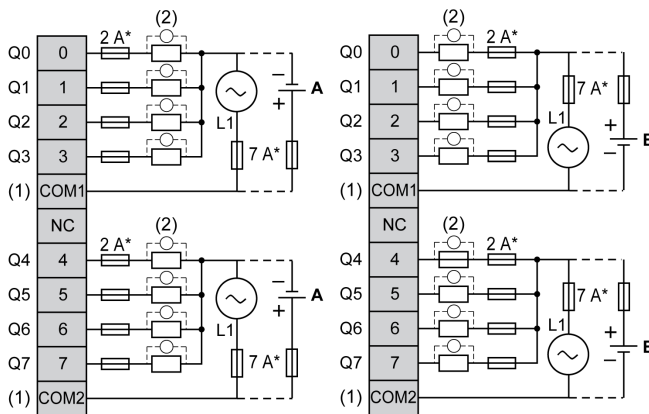
- Always protect relay outputs from inductive alternating current load damage using an appropriate external protective circuit or device.
- Do not connect relay outputs to capacitive loads.

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

| Power Limitations | | | | |
|--|---------------|-----------------|------------------|----------------------|
| Voltage | 24 Vdc | 120 Vac | 240 Vac | Number of operations |
| Power of resistive loads AC-12 | – | 240 VA 80 VA | 480 VA 160 VA | 100,000 300,000 |
| Power of inductive loads AC-15 (cos φ = 0.35) | – | 60 VA 18 VA | 120 VA 36 VA | 100,000 300,000 |
| Power of inductive loads AC-14 (cos φ = 0.7) | – | 120 VA 36 VA | 240 VA 72 VA | 100,000 300,000 |
| Power of resistive loads DC-12 | 48 W 16 W | – | – | 100,000 300,000 |
| Power of inductive loads DC-13 L/R = 7 ms | 24 W 7.2 W | – | – | 100,000 300,000 |

Wiring Diagram

The following figure presents the connection of the outputs to the load:



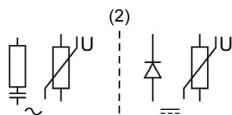
* Type T fuse

(1) The COM1 and COM2 terminals are **not** connected internally.

(2) To improve the life time of the contacts, and to protect from potential inductive load damage, you must connect a free wheeling diode in parallel to each inductive DC load or an RC snubber in parallel of each inductive AC load

A Source wiring (positive logic).

B Sink wiring (negative logic).



NOTE: The assigned fuse values have been specified for the maximum current characteristics of the controller I/O and associated commons. You may have other considerations that are applicable based on the unique types of input and output devices you connect, or conformance to local, national or applicable certification regulations and standards, and you should size your fuses accordingly.

 **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.

TM221M16R / TM221M16RG Analog Inputs

Overview

The M221 Logic Controllers have 2 analog inputs embedded.

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

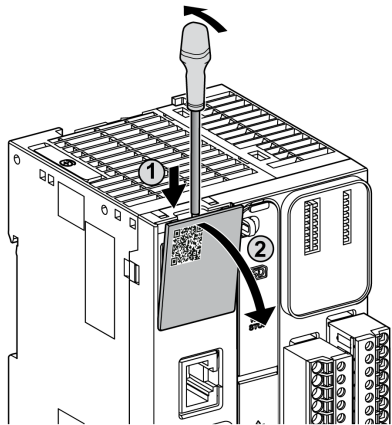
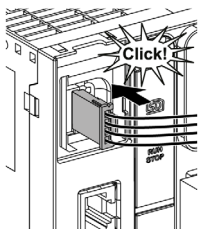
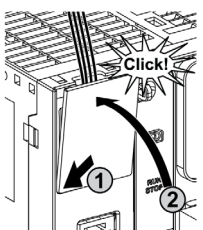
WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

The following procedure describes how to mount the analog cables:

| Step | Action |
|------|---|
| 1 | <p>Use a screw-driver to remove the protective cover.</p>  |
| 2 | <p>Push until you hear it "click".</p>  |
| 3 | <p>Replace the protective cover.</p>  |

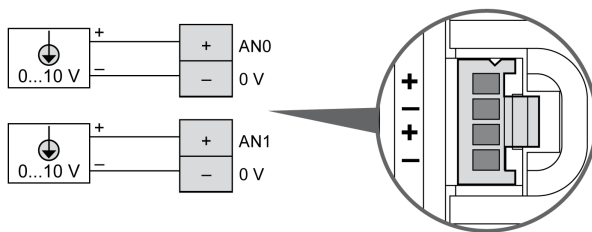
Analog Input Characteristics

The following table describes the characteristics of the M221 Logic Controller with analog inputs:

| Characteristic | | Voltage Input |
|---|----------------------------------|--|
| Number of maximum inputs | | 2 inputs |
| Input type | | Single-ended |
| Rated input range | | 0...+10 Vdc |
| Digital resolution | | 10 bits |
| Input value of LSB | | 10 mV |
| Input impedance | | 100 kΩ |
| Input delay time | | 12 ms |
| Sample duration time | | 1 ms per channel + 1 scan time |
| Accuracy | | ± 1 % of the full scale |
| Noise resistance - maximum temporary deviation during perturbations | | ± 5 % maximum of the full scale when EMC perturbation is applied to the power and I/O wiring |
| Isolation | Between input and internal logic | Not isolated |
| Connection type | | Specific connector and cable (supplied) |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Proprietary (supplied) |
| | Length | 1 m (3.3 ft) |

Wiring Diagram

The following figure shows the wiring diagram of the M221 Logic Controller analog inputs:



The (-) poles are connected internally.

| Pin | Wire Color |
|-----|------------|
| AN0 | Red |
| 0 V | Black |
| AN1 | Red |

| Pin | Wire Color |
|-----|------------|
| 0 V | Black |

For more information, refer to the Wiring Best Practices ([see page 99](#)).

Chapter 24

TM221ME16R / TM221ME16RG

Overview

This chapter describes the TM221ME16R / TM221ME16RG controllers.

What Is in This Chapter?

This chapter contains the following topics:

| Topic | Page |
|--|------|
| TM221ME16R / TM221ME16RG Presentation | 272 |
| TM221ME16R / TM221ME16RG Digital Inputs | 277 |
| TM221ME16R / TM221ME16RG Digital Outputs | 281 |
| TM221ME16R / TM221ME16RG Analog Inputs | 285 |

TM221ME16R / TM221ME16RG Presentation

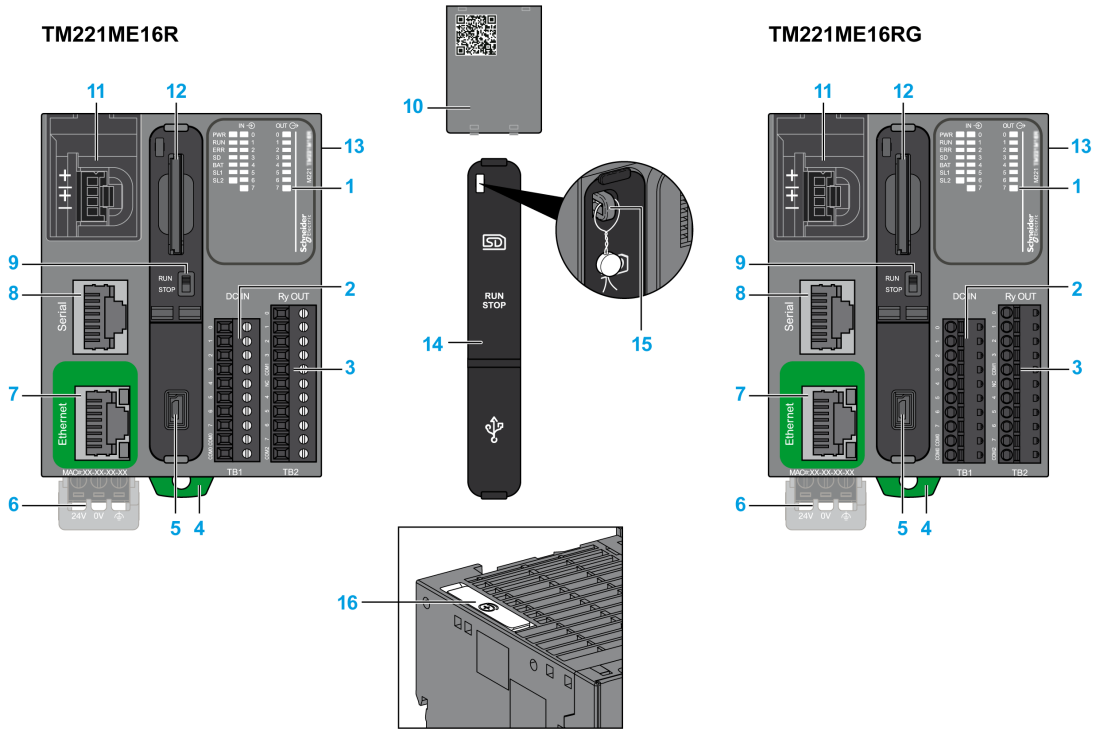
Overview

The following features are integrated into the TM221ME16R (screw) and TM221ME16RG (spring) controllers:

- 8 digital inputs
 - 4 regular inputs
 - 4 fast inputs (HSC)
- 8 digital outputs
 - 8 relay outputs
- 2 analog inputs
- Communication port
 - 1 serial line port
 - 1 USB mini-B programming port
 - 1 Ethernet port

Description

The following figure shows the different components of the controllers:

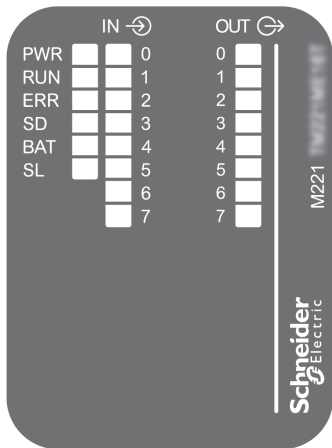


| N° | Description | Refer to |
|----|---|---|
| 1 | Status LEDs | – |
| 2 | Input removable terminal block | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 3 | Output removable terminal block | Rules for Removable Spring Terminal Block (<i>see page 102</i>) |
| 4 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (<i>see page 90</i>) |
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (<i>see page 372</i>) |
| 6 | 24 Vdc power supply | Power supply (<i>see page 106</i>) |
| 7 | Ethernet port / RJ45 connector | Ethernet port (<i>see page 374</i>) |
| 8 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (<i>see page 377</i>) |
| 9 | Run/Stop switch | Run/Stop switch (<i>see page 67</i>) |

| N° | Description | Refer to |
|----|--|---|
| 10 | Removable analog inputs cover | – |
| 11 | 2 analog inputs | Analog Inputs (<i>see page 285</i>) |
| 12 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 13 | I/O expansion connector | – |
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |

Status LEDs

The following figure shows the status LEDs:



The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|-------|---------------------------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access (see page 70) | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery (see page 52) | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 (see page 377) | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |

* ERR LED is also On during booting process.

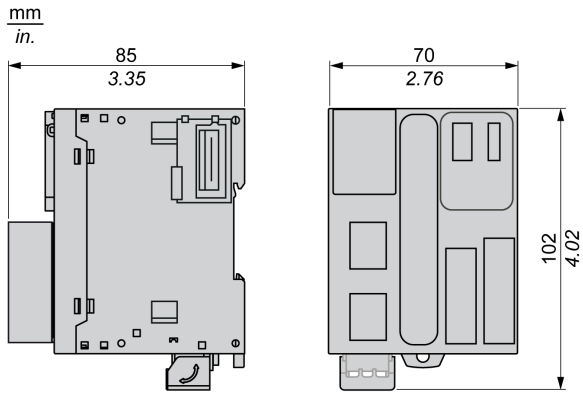
NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs (see page 376)

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see Modicon M221, Logic Controller, Programming Guide).

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

Dimensions

The following figure shows the external dimensions of the controllers:



TM221ME16R / TM221ME16RG Digital Inputs

Overview

This M221 Logic Controller has embedded digital inputs:

- 4 regular inputs
- 4 fast inputs which can be used as 100 kHz HSC inputs

For more information, refer to Input Management (*see page 59*).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Regular Input Characteristics

The following table describes the characteristics of the TM221M Logic Controller regular inputs:

| Characteristic | Value |
|--------------------------|---------------------------|
| Number of regular inputs | 4 inputs (I2, I3, I4, I5) |
| Number of channel groups | 1 common line for I0...I7 |
| Input type | Type 1 (IEC/EN 61131-2) |
| Logic type | Sink/Source |
| Input voltage range | 24 Vdc |
| Rated input voltage | 19.2...28.8 Vdc |
| Rated input current | 7 mA |
| Input impedance | 3.4 kΩ |

| Characteristic | | Value |
|---|----------------------------------|--|
| Input limit values | Voltage at state 1 | > 15 Vdc (15...28.8 Vdc) |
| | Voltage at state 0 | < 5 Vdc (0...5 Vdc) |
| | Current at state 1 | > 2.5 mA |
| | Current at state 0 | < 1.0 mA |
| Derating | | No derating |
| Turn on time | | 35 μ s + filter value ¹ |
| Turn off time | | 35 μ s + filter value ¹ |
| Isolation | Between input and internal logic | 500 Vac |
| Connection type | TM221ME16R | Removable screw terminal blocks |
| | TM221ME16RG | Removable spring terminal blocks |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Unshielded |
| | Length | Maximum 30 m (98 ft) |
| ¹ For more information, refer to Integrator Filter Principle (see page 59) | | |

Fast Input Characteristics

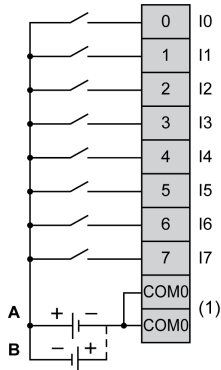
The following table describes the characteristics of the TM221M Logic Controller fast inputs:

| Characteristic | | Value |
|--------------------------|--------------------|---------------------------------------|
| Number of fast inputs | | 4 inputs (I0, I1, I6, I7) |
| Number of channel groups | | 1 common line for I0...I7 |
| Input type | | Type 1 (IEC/EN 61131-2) |
| Logic type | | Sink/Source |
| Rated input voltage | | 24 Vdc |
| Input voltage range | | 19.2...28.8 Vdc |
| Rated input current | | 4.5 mA |
| Input impedance | | 4.9 k Ω |
| Input limit values | Voltage at state 1 | > 15 Vdc (15...28.8 Vdc) |
| | Voltage at state 0 | < 5 Vdc (0...5 Vdc) |
| | Current at state 1 | > 2.5 mA |
| | Current at state 0 | < 1.0 mA |
| Derating | | No derating |
| Turn on time | | 5 μ s + filter value ¹ |
| Turn off time | | 5 μ s + filter value ¹ |

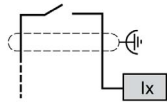
| Characteristic | | Value |
|---|----------------------------------|---|
| HSC maximum frequency | Dual Phase | 100 kHz |
| | Single phase | 100 kHz |
| | Frequency Meter | 100 kHz |
| HSC supported operation mode | | <ul style="list-style-type: none"> ● Dual Phase [Pulse / Direction] ● Dual Phase [Quadrature X1] ● Dual Phase [Quadrature X2] ● Dual Phase [Quadrature X4] ● Single Phase ● Frequency Meter |
| Isolation | Between input and internal logic | 500 Vac |
| | Between channel groups | 500 Vac |
| Connection type | TM221ME16R | Removable screw terminal block |
| | TM221ME16RG | Removable spring terminal block |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Shielded, including the 24 Vdc power supply |
| | Length | Maximum 10 m (32.8 ft) |
| ¹ For more information, refer to Integrator Filter Principle (see page 59) | | |

Wiring Diagram

The following figure presents the connection of the inputs to the sensors:



- (1) The COM0 terminals are connected internally.
- A Sink wiring (positive logic).
- B Source wiring (negative logic).



Ix I0, I1, I6, I7

TM221ME16R / TM221ME16RG Digital Outputs

Overview

M221 Logic Controller with 8 relay outputs embedded.

For more information on Output Management (*see page 63*).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Relay Output Characteristics

The following table describes the characteristics of the TM221M Logic Controller with relay outputs:

| Characteristic | Value |
|--------------------------|--|
| Number of relay outputs | 8 outputs |
| Number of channel groups | 1 common line for Q0...Q3 1 common line for Q4...Q7 |
| Output type | Relay |
| Contact type | NO (Normally Open) |
| Rated output voltage | 24 Vdc, 240 Vac |
| Maximum voltage at 2 A | 30 Vdc, 264 Vac |
| Minimum switching load | 5 Vdc at 1 mA |
| Rated output current | 2 A |

| Characteristic | | Value |
|---|-----------------------------------|--|
| Maximum output current | | 2 A per output |
| | | 7 A per common |
| Maximum output frequency with maximum load | | 20 operations per minute |
| Derating | | No derating |
| Turn on time | | Max. 10 ms |
| Turn off time | | Max. 10 ms |
| Contact resistance | | 30 mΩ max |
| Mechanical life | | 20 million operations |
| Electrical life | Under resistive load | See power limitation (<i>see page 282</i>) |
| | Under inductive load | |
| Protection against short circuit | | No |
| Isolation | Between output and internal logic | 500 Vac |
| | Between channel groups | 500 Vac |
| Connection type | TM221ME16R | Removable screw terminal blocks |
| | TM221ME16RG | Removable spring terminal blocks |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Unshielded |
| | Length | Max. 30 m (98 ft) |
| <p>NOTE: Refer to Protecting Outputs from Inductive Load Damage (<i>see page 103</i>) for additional information concerning output protection.</p> | | |

Power Limitation

The following table describes the power limitation of the TM221ME16R / TM221ME16RG relay outputs controllers depending on the voltage, the type of load, and the number of operations required.

These controllers do not support capacitive loads.

WARNING

RELAY OUTPUTS WELDED CLOSED

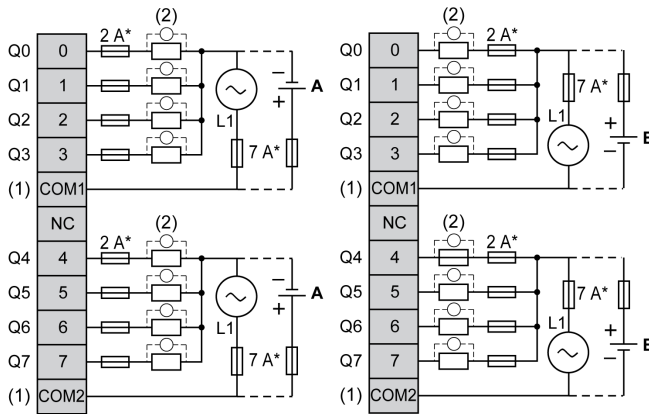
- Always protect relay outputs from inductive alternating current load damage using an appropriate external protective circuit or device.
- Do not connect relay outputs to capacitive loads.

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

| Power Limitations | | | | |
|--|---------------|-----------------|------------------|----------------------|
| Voltage | 24 Vdc | 120 Vac | 240 Vac | Number of operations |
| Power of resistive loads AC-12 | – | 240 VA 80 VA | 480 VA 160 VA | 100,000 300,000 |
| Power of inductive loads AC-15 (cos φ = 0.35) | – | 60 VA 18 VA | 120 VA 36 VA | 100,000 300,000 |
| Power of inductive loads AC-14 (cos φ = 0.7) | – | 120 VA 36 VA | 240 VA 72 VA | 100,000 300,000 |
| Power of resistive loads DC-12 | 48 W 16 W | – | – | 100,000 300,000 |
| Power of inductive loads DC-13 L/R = 7 ms | 24 W 7.2 W | – | – | 100,000 300,000 |

Wiring Diagram

The following figure presents the connection of the outputs to the load:



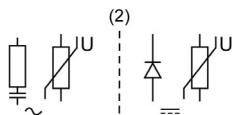
* Type T fuse

(1) The COM1 and COM2 terminals are **not** connected internally.

(2) To improve the life time of the contacts, and to protect from potential inductive load damage, you must connect a free wheeling diode in parallel to each inductive DC load or an RC snubber in parallel of each inductive AC load

A Source wiring (positive logic).

B Sink wiring (negative logic).



NOTE: The assigned fuse values have been specified for the maximum current characteristics of the controller I/O and associated commons. You may have other considerations that are applicable based on the unique types of input and output devices you connect, or conformance to local, national or applicable certification regulations and standards, and you should size your fuses accordingly.

 **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.

TM221ME16R / TM221ME16RG Analog Inputs

Overview

The M221 Logic Controllers have 2 analog inputs embedded.

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

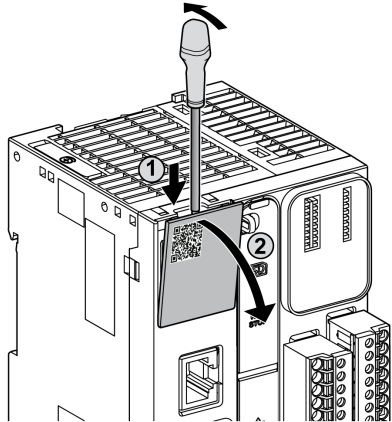
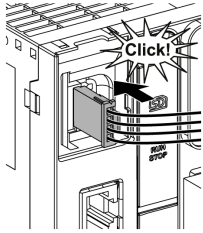
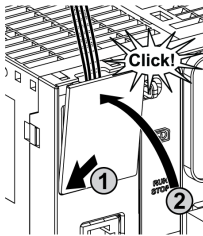
WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

The following procedure describes how to mount the analog cables:

| Step | Action |
|------|---|
| 1 | <p>Use a screw-driver to remove the protective cover.</p>  |
| 2 | <p>Push until you hear it "click".</p>  |
| 3 | <p>Replace the protective cover.</p>  |

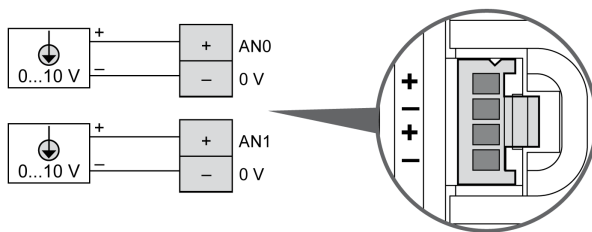
Analog Input Characteristics

The following table describes the characteristics of the M221 Logic Controller with analog inputs:

| Characteristic | | Voltage Input |
|---|----------------------------------|--|
| Number of maximum inputs | | 2 inputs |
| Input type | | Single-ended |
| Rated input range | | 0...+10 Vdc |
| Digital resolution | | 10 bits |
| Input value of LSB | | 10 mV |
| Input impedance | | 100 kΩ |
| Input delay time | | 12 ms |
| Sample duration time | | 1 ms per channel + 1 scan time |
| Accuracy | | ± 1 % of the full scale |
| Noise resistance - maximum temporary deviation during perturbations | | ± 5 % maximum of the full scale when EMC perturbation is applied to the power and I/O wiring |
| Isolation | Between input and internal logic | Not isolated |
| Connection type | | Specific connector and cable (supplied) |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Proprietary (supplied) |
| | Length | 1 m (3.3 ft) |

Wiring Diagram

The following figure shows the wiring diagram of the Modicon M221 Logic Controller analog inputs:



The (-) poles are connected internally.

| Pin | Wire Color |
|-----|------------|
| AN0 | Red |
| 0 V | Black |
| AN1 | Red |

| Pin | Wire Color |
|-----|------------|
| 0 V | Black |

For more information, refer to the Wiring Best Practices ([see page 99](#)).

Chapter 25

TM221M16T / TM221M16TG

Overview

This chapter describes the TM221M16T / TM221M16TG controllers.

What Is in This Chapter?

This chapter contains the following topics:

| Topic | Page |
|--|------|
| TM221M16T / TM221M16TG Presentation | 290 |
| TM221M16T / TM221M16TG Digital Inputs | 295 |
| TM221M16T / TM221M16TG Digital Outputs | 300 |
| TM221M16T / TM221M16TG Analog Inputs | 305 |

TM221M16T / TM221M16TG Presentation

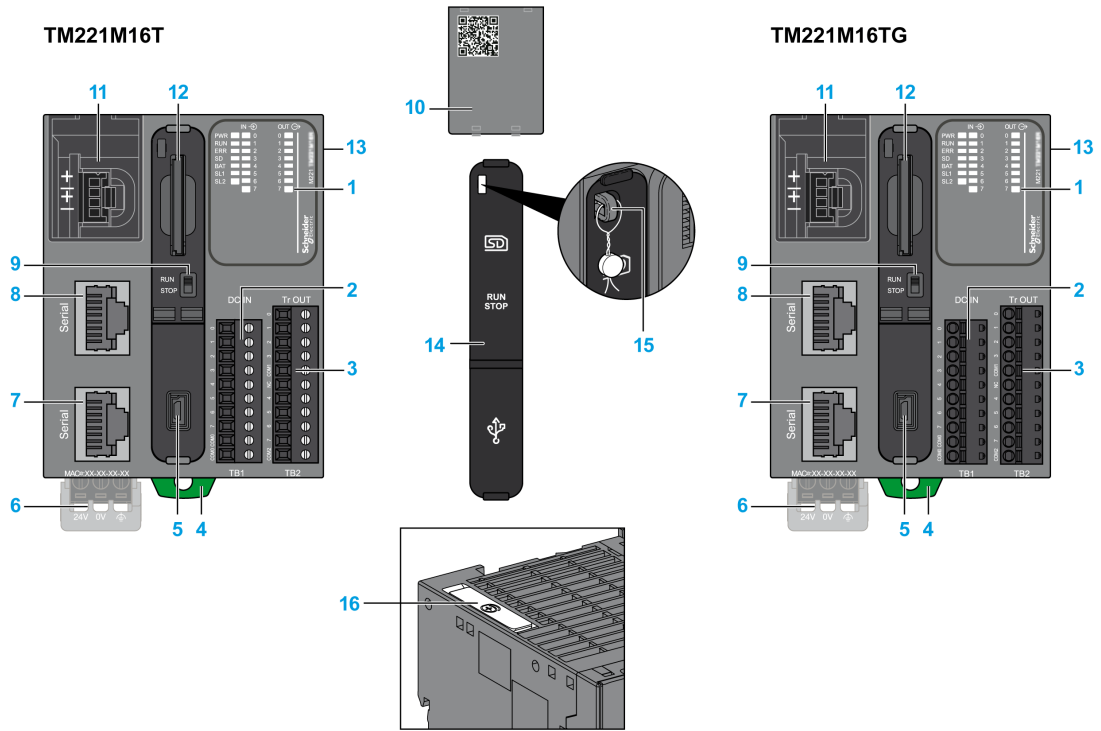
Overview

The following features are integrated into the TM221M16T (screw) and TM221M16TG (spring) controllers:

- 8 digital inputs
 - 4 regular inputs
 - 4 fast inputs (HSC)
- 8 digital outputs
 - 6 regular transistor outputs
 - 2 fast transistor outputs
- 2 analog inputs
- Communication port
 - 2 serial line ports
 - 1 USB mini-B programming port

Description

The following figure shows the different components of the controllers:

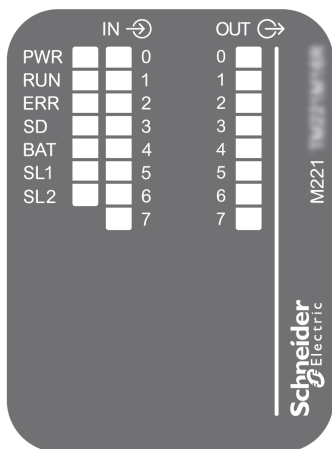


| N° | Description | Refer to |
|----|---|--|
| 1 | Status LEDs | – |
| 2 | Input removable terminal block | Rules for Removable Screw Terminal Block (see page 100) |
| 3 | Output removable terminal block | Rules for Removable Spring Terminal Block (see page 102) |
| 4 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (see page 90) |
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (see page 372) |
| 6 | 24 Vdc power supply | Power supply (see page 106) |
| 7 | Serial line port 2 / RJ45 connector (RS-485) | Serial line 2 (see page 381) |
| 8 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (see page 377) |
| 9 | Run/Stop switch | Run/Stop switch (see page 67) |

| N° | Description | Refer to |
|----|--|---|
| 10 | Removable analog inputs cover | – |
| 11 | 2 analog inputs | Analog Inputs (<i>see page 305</i>) |
| 12 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 13 | I/O expansion connector | – |
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |

Status LEDs

The following figure shows the status LEDs:



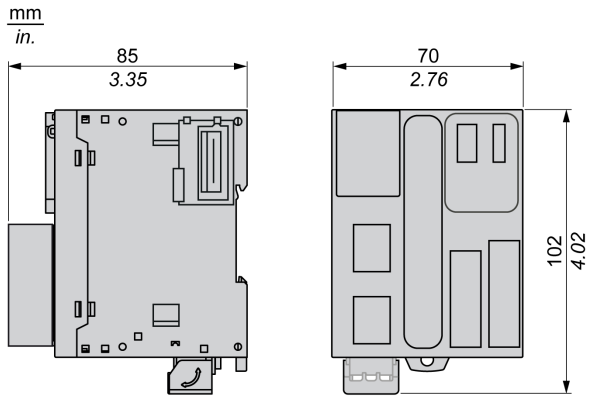
The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|---|---------------|-------|--------|----------------------------------|------------------------|-----------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| <p>* ERR LED is also On during booting process.</p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (<i>see Modicon M221, Logic Controller, Programming Guide</i>).</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

| Label | Function Type | Color | Status | Description | | |
|---|---------------------------------|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flashing | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access (see page 70) | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery (see page 52) | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL1 | Serial line 1 (see page 377) | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |
| SL2 | Serial line 2 (see page 381) | Green | On | Indicates the status of Serial line 2. | | |
| | | | Flashing | Indicates activity on Serial line 2. | | |
| | | | Off | Indicates no serial communication. | | |
| <p>* ERR LED is also On during booting process.</p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide (see <i>Modicon M221, Logic Controller, Programming Guide</i>).</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

Dimensions

The following figure shows the external dimensions of the controllers:



TM221M16T / TM221M16TG Digital Inputs

Overview

This M221 Logic Controller has embedded digital inputs:

- 4 regular inputs
- 4 fast inputs which can be used as 100 kHz HSC inputs

For more information, refer to Input Management (*see page 59*).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Regular Input Characteristics

The following table describes the characteristics of the TM221M Logic Controller regular inputs:

| Characteristic | Value |
|--------------------------|---------------------------|
| Number of regular inputs | 4 inputs (I2, I3, I4, I5) |
| Number of channel groups | 1 common line for I0...I7 |
| Input type | Type 1 (IEC/EN 61131-2) |
| Logic type | Sink/Source |
| Input voltage range | 24 Vdc |
| Rated input voltage | 19.2...28.8 Vdc |
| Rated input current | 7 mA |
| Input impedance | 3.4 kΩ |

| Characteristic | | Value |
|--|----------------------------------|--|
| Input limit values | Voltage at state 1 | > 15 Vdc (15...28.8 Vdc) |
| | Voltage at state 0 | < 5 Vdc (0...5 Vdc) |
| | Current at state 1 | > 2.5 mA |
| | Current at state 0 | < 1.0 mA |
| Derating | | see Derating Curve (<i>see page 298</i>) |
| Turn on time | | 35 μ s + filter value ¹ |
| Turn off time | | 35 μ s + filter value ¹ |
| Isolation | Between input and internal logic | 500 Vac |
| Connection type | TM221M16T | Removable screw terminal blocks |
| | TM221M16TG | Removable spring terminal blocks |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Unshielded |
| | Length | Maximum 30 m (98 ft) |
| ¹ For more information, refer to Integrator Filter Principle (<i>see page 59</i>) | | |

Fast Input Characteristics

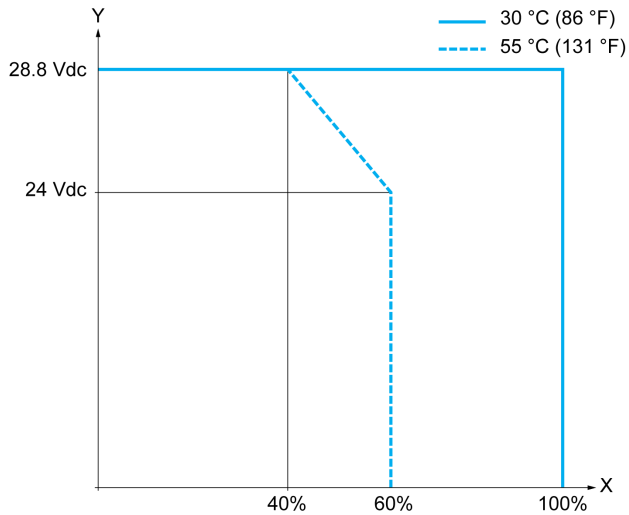
The following table describes the characteristics of the TM221M Logic Controller fast inputs:

| Characteristic | | Value |
|--------------------------|--------------------|--|
| Number of fast inputs | | 4 inputs (I0, I1, I6, I7) |
| Number of channel groups | | 1 common line for I0...I7 |
| Input type | | Type 1 (IEC/EN 61131-2) |
| Logic type | | Sink/Source |
| Rated input voltage | | 24 Vdc |
| Input voltage range | | 19.2...28.8 Vdc |
| Rated input current | | 4.5 mA |
| Input impedance | | 4.9 k Ω |
| Input limit values | Voltage at state 1 | > 15 Vdc (15...28.8 Vdc) |
| | Voltage at state 0 | < 5 Vdc (0...5 Vdc) |
| | Current at state 1 | 2.6 mA |
| | Current at state 0 | < 1.0 mA |
| Derating | | see Derating Curve (<i>see page 298</i>) |
| Turn on time | | 5 μ s + filter value ¹ |
| Turn off time | | 5 μ s + filter value ¹ |

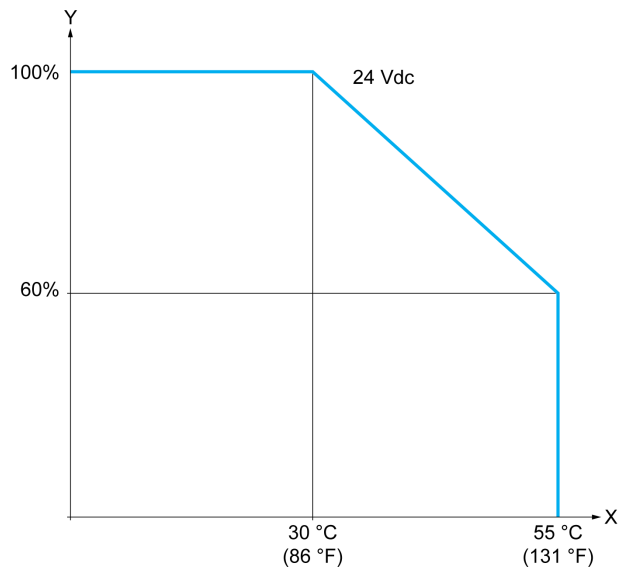
| Characteristic | | Value |
|---|----------------------------------|---|
| HSC maximum frequency | Dual Phase | 100 kHz |
| | Single phase | 100 kHz |
| | Frequency Meter | 100 kHz |
| HSC supported operation mode | | <ul style="list-style-type: none"> ● Dual Phase [Pulse / Direction] ● Dual Phase [Quadrature X1] ● Dual Phase [Quadrature X2] ● Dual Phase [Quadrature X4] ● Single Phase ● Frequency Meter |
| Isolation | Between input and internal logic | 500 Vac |
| | Between channel groups | 500 Vac |
| Connection type | TM221M16T | Removable screw terminal block |
| | TM221M16TG | Removable spring terminal block |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Shielded, including the 24 Vdc power supply |
| | Length | Maximum 10 m (32.8 ft) |
| ¹ For more information, refer to Integrator Filter Principle (see page 59) | | |

Derating Curves

The following figures show the derating curves of the embedded digital inputs:



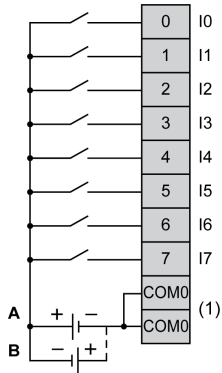
X Input simultaneous ON ratio
Y Input voltage



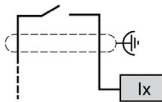
X Ambient temperature
Y Input simultaneous ON ratio

Wiring Diagram

The following figure presents the connection of the inputs to the sensors:



- (1) The COM0 terminals are connected internally.
- A Sink wiring (positive logic).
- B Source wiring (negative logic).



Ix I0, I1, I6, I7

TM221M16T / TM221M16TG Digital Outputs

Overview

The TM221M16T and TM221M16TG have digital outputs embedded:

- 6 regular transistor outputs
- 2 fast transistor outputs

For more information, refer to Output Management (*see page 63*).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Regular Transistor Output Characteristics

The following table describes the characteristics of the TM221M Logic Controller regular transistor outputs:

| Characteristic | Value |
|--------------------------------------|-----------------------------|
| Number of regular transistor outputs | 6 regular outputs (Q2...Q7) |
| Number of channel groups | 1 common line for Q0...Q7 |
| Output type | Transistor |
| Logic type | Source |
| Rated output voltage | 24 Vdc |
| Output voltage range | 19.2...28.8 Vdc |
| Rated output current | 0.5 A |

| Characteristic | | Value |
|--|-----------------------------------|--|
| Total output current | | 4 A |
| Voltage drop | | 1 Vdc max |
| Leakage current when switched off | | 0.1 mA |
| Maximum power of filament lamp | | 12 W max |
| Derating | | see Derating Curve (<i>see page 303</i>) |
| Turn on time | Q2...Q3 | Max. 50 μ s |
| | Q4...Q7 | Max. 300 μ s |
| Turn off time | Q2...Q3 | Max. 50 μ s |
| | Q4...Q7 | Max. 300 μ s |
| Protection against short circuit | | Yes |
| Short circuit output peak current | | 1.3 A |
| Automatic rearming after short circuit or overload | | Yes, every 1 s |
| Clamping voltage | | Max. 39 Vdc \pm 1 Vdc |
| Switching frequency | Under resistive load | 100 Hz max. |
| Isolation | Between output and internal logic | 500 Vac |
| Connection type | TM221M16T | Removable screw terminal blocks |
| | TM221M16TG | Removable spring terminal blocks |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Unshielded |
| | Length | Max 30 m (98 ft) |
| NOTE: Refer to Protecting Outputs from Inductive Load Damage (<i>see page 103</i>) for additional information concerning output protection. | | |

Fast Transistor Output Characteristics

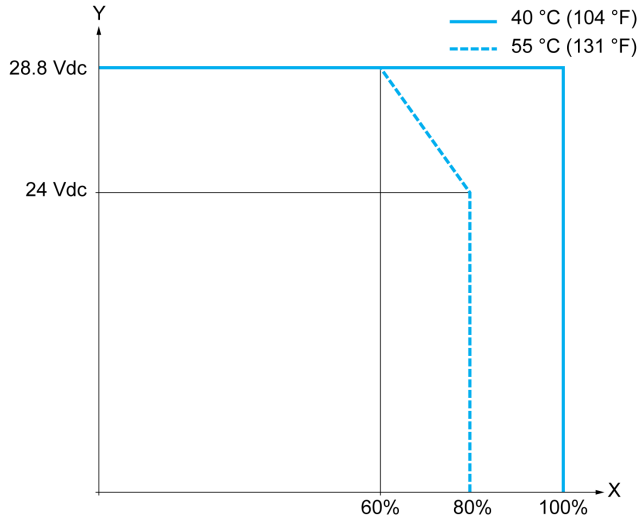
The following table describes the characteristics of the TM221M Logic Controller fast transistor outputs:

| Characteristic | Value |
|-----------------------------------|---------------------------|
| Number of fast transistor outputs | 2 outputs (Q0, Q1) |
| Number of channel groups | 1 common line for Q0...Q7 |
| Output type | Transistor |
| Logic type | Source |
| Rated output voltage | 24 Vdc |
| Output voltage range | 19.2...28.8 Vdc |
| Rated output current | 0.5 A |

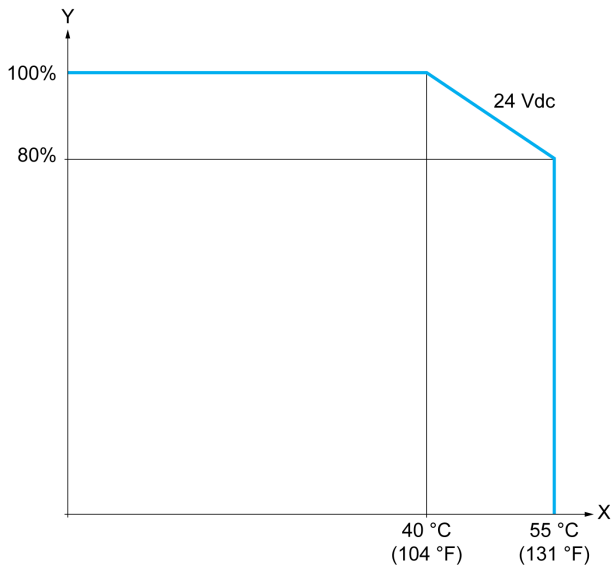
| Characteristic | | Value |
|---|-----------------------------------|--|
| Total output current | | 4 A |
| Maximum power of filament lamp | | 12 W max |
| Derating | | see Derating Curve (<i>see page 303</i>) |
| Turn on time (10 mA < output current < 100 mA) | | Max. 5 μ s |
| Turn off time (10 mA < output current < 100 mA) | | Max. 5 μ s |
| Protection against short circuit | | Yes |
| Short circuit output peak current | | 1.3 A max. |
| Automatic rearming after short circuit or overload | | Yes, every 1 s |
| Protection against reverse polarity | | Yes |
| Clamping voltage | | Typ. 39 Vdc +/- 1 Vdc |
| Maximum output frequency | PLS/PWM/PTO/FREQGEN | 100 kHz |
| Isolation | Between output and internal logic | 500 Vac |
| Connection type | TM221M16T | Removable screw terminal blocks |
| | TM221M16TG | Removable spring terminal blocks |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Shielded, including 24 Vdc power supply |
| | Length | Maximum 3 m (9.84 ft) |
| <p>NOTE: Refer to Protecting Outputs from Inductive Load Damage (<i>see page 103</i>) for additional information concerning output protection.</p> | | |

Derating Curves

The following figures show the derating curves of the embedded digital outputs:



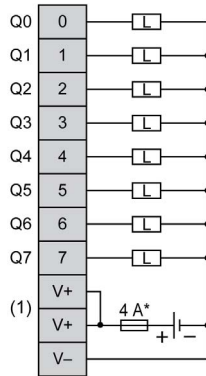
X Output simultaneous ON ratio
Y Output voltage



X Ambient temperature
Y Output simultaneous ON ratio

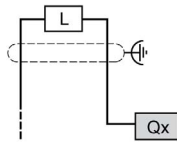
Wiring Diagram

The following figure presents the connection of the outputs to the load:



* Type T fuse

(1) The V+ terminals are connected internally.



Qx Q0, Q1

TM221M16T / TM221M16TG Analog Inputs

Overview

The M221 Logic Controllers have 2 analog inputs embedded.

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

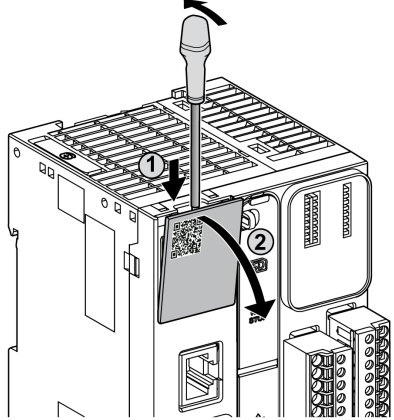
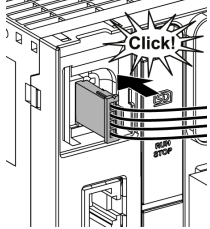
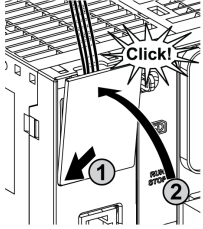
WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

The following procedure describes how to mount the analog cables:

| Step | Action |
|------|---|
| 1 | <p>Use a screw-driver to remove the protective cover.</p>  |
| 2 | <p>Push until you hear it “click”.</p>  |
| 3 | <p>Replace the protective cover.</p>  |

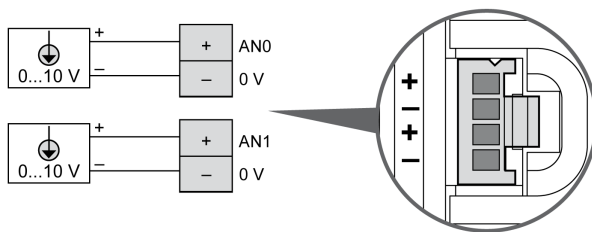
Analog Input Characteristics

The following table describes the characteristics of the M221 Logic Controller with analog inputs:

| Characteristic | | Voltage Input |
|---|----------------------------------|--|
| Number of maximum inputs | | 2 inputs |
| Input type | | Single-ended |
| Rated input range | | 0...+10 Vdc |
| Digital resolution | | 10 bits |
| Input value of LSB | | 10 mV |
| Input impedance | | 100 kΩ |
| Input delay time | | 12 ms |
| Sample duration time | | 1 ms per channel + 1 scan time |
| Accuracy | | ± 1 % of the full scale |
| Noise resistance - maximum temporary deviation during perturbations | | ± 5 % maximum of the full scale when EMC perturbation is applied to the power and I/O wiring |
| Isolation | Between input and internal logic | Not isolated |
| Connection type | | Specific connector and cable (supplied) |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Proprietary (supplied) |
| | Length | 1 m (3.3 ft) |

Wiring Diagram

The following figure shows the wiring diagram of the Modicon M221 Logic Controller analog inputs:



The (-) poles are connected internally.

| Pin | Wire Color |
|-----|------------|
| AN0 | Red |
| 0 V | Black |

| Pin | Wire Color |
|-----|------------|
| AN1 | Red |
| 0 V | Black |

For more information, refer to the Wiring Best Practices ([see page 99](#)).

Chapter 26

TM221ME16T / TM221ME16TG

Overview

This chapter describes the TM221ME16T / TM221ME16TG controllers.

What Is in This Chapter?

This chapter contains the following topics:

| Topic | Page |
|--|------|
| TM221ME16T / TM221ME16TG Presentation | 310 |
| TM221ME16T / TM221ME16TG Digital Inputs | 315 |
| TM221ME16T / TM221ME16TG Digital Outputs | 320 |
| TM221ME16T / TM221ME16TG Analog Inputs | 325 |

TM221ME16T / TM221ME16TG Presentation

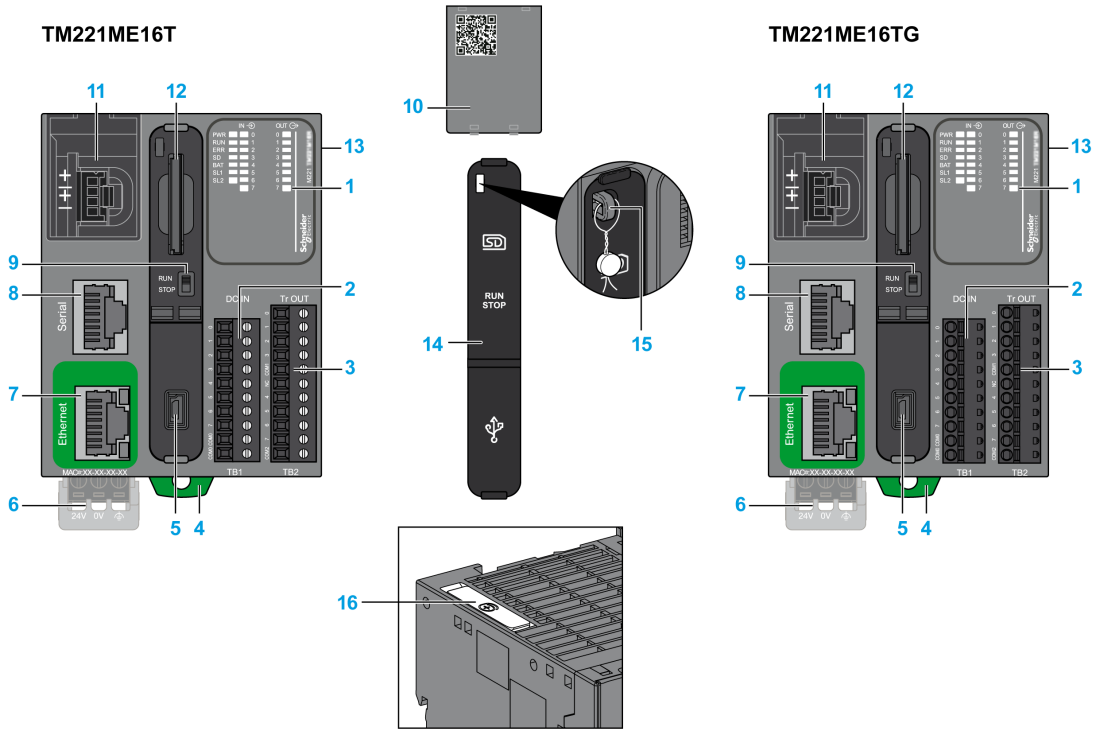
Overview

The following features are integrated into the TM221ME16T (screw) and TM221ME16TG (spring) controllers:

- 8 digital inputs
 - 4 regular inputs
 - 4 fast inputs (HSC)
- 8 digital outputs
 - 6 regular transistor outputs
 - 2 fast transistor outputs
- 2 analog inputs
- Communication port
 - 1 serial line port
 - 1 USB mini-B programming port
 - 1 Ethernet port

Description

The following figure shows the different components of the controllers:

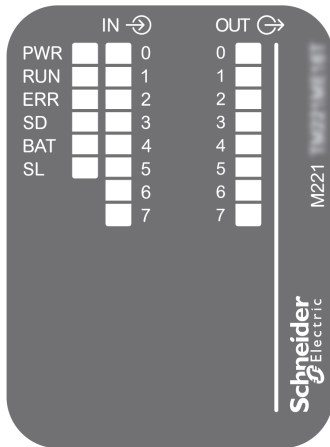


| N° | Description | Refer to |
|----|---|---|
| 1 | Status LEDs | – |
| 2 | Input removable terminal block | Rules for Removable Screw Terminal Block (<i>see page 100</i>) |
| 3 | Output removable terminal block | Rules for Removable Spring Terminal Block (<i>see page 102</i>) |
| 4 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (<i>see page 90</i>) |
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (<i>see page 372</i>) |
| 6 | 24 Vdc power supply | Power supply (<i>see page 106</i>) |
| 7 | Ethernet port / RJ45 connector | Ethernet port (<i>see page 374</i>) |
| 8 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (<i>see page 377</i>) |
| 9 | Run/Stop switch | Run/Stop switch (<i>see page 67</i>) |

| N° | Description | Refer to |
|----|--|---|
| 10 | Removable analog inputs cover | – |
| 11 | 2 analog inputs | Analog Inputs (<i>see page 325</i>) |
| 12 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 13 | I/O expansion connector | – |
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |

Status LEDs

The following figure shows the status LEDs:

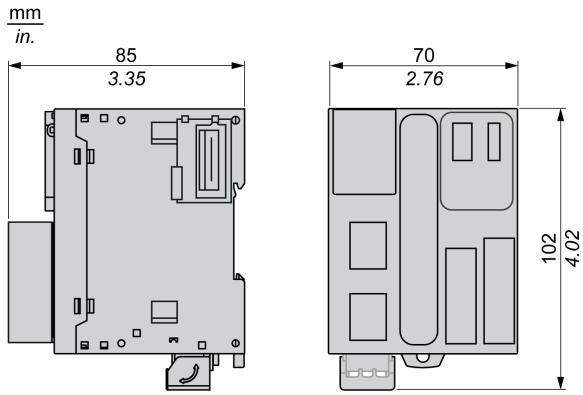


The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|--|--|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access <i>(see page 70)</i> | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery <i>(see page 52)</i> | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 <i>(see page 377)</i> | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |
| <p>* ERR LED is also On during booting process.</p> <p>NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs <i>(see page 376)</i></p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide <i>(see Modicon M221, Logic Controller, Programming Guide)</i>.</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

Dimensions

The following figure shows the external dimensions of the controllers:



TM221ME16T / TM221ME16TG Digital Inputs

Overview

This M221 Logic Controller has embedded digital inputs:

- 4 regular inputs
- 4 fast inputs which can be used as 100 kHz HSC inputs

For more information, refer to Input Management (*see page 59*).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Regular Input Characteristics

The following table describes the characteristics of the TM221M Logic Controller with transistor regular inputs:

| Characteristic | Value |
|--------------------------|---------------------------|
| Number of regular inputs | 4 inputs (I2, I3, I4, I5) |
| Number of channel groups | 1 common line for I0...I7 |
| Input type | Type 1 (IEC/EN 61131-2) |
| Logic type | Sink/Source |
| Rated input voltage | 24 Vdc |
| Input voltage range | 19.2...28.8 Vdc |
| Rated input current | 7 mA |

| Characteristic | | Value |
|--|----------------------------------|--|
| Input impedance | | 3.4 kΩ |
| Input limit values | Voltage at state 1 | > 15 Vdc (15...28.8 Vdc) |
| | Voltage at state 0 | < 5 Vdc (0...5 Vdc) |
| | Current at state 1 | > 2.5 mA |
| | Current at state 0 | < 1.0 mA |
| Derating | | see Derating Curve (<i>see page 318</i>) |
| Turn on time | | 35 μs + filter value ¹ |
| Turn off time | | 35 μs + filter value ¹ |
| Isolation | Between input and internal logic | 500 Vac |
| Connection type | TM221ME16T | Removable screw terminal blocks |
| | TM221ME16TG | Removable spring terminal blocks |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Unshielded |
| | Length | Maximum 30 m (98 ft) |
| ¹ For more information, refer to Integrator Filter Principle (<i>see page 59</i>) | | |

Fast Input Characteristics

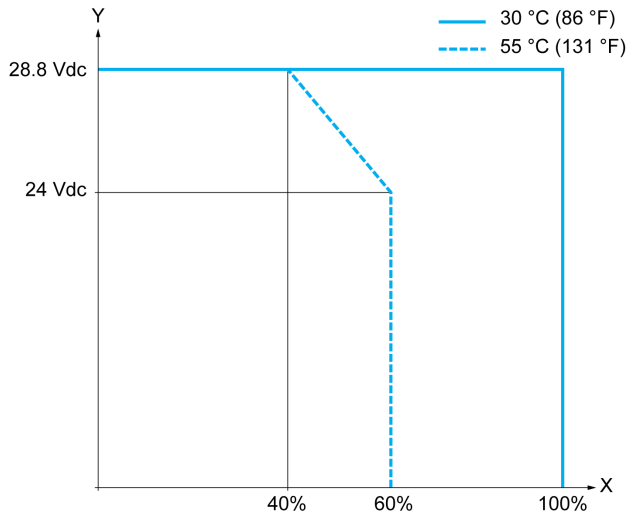
The following table describes the characteristics of the TM221M Logic Controller fast inputs:

| Characteristic | | Value |
|--------------------------|--------------------|--|
| Number of fast inputs | | 4 inputs (I0, I1, I6, I7) |
| Number of channel groups | | 1 common line for I0...I7 |
| Input type | | Type 1 (IEC/EN 61131-2) |
| Logic type | | Sink/Source |
| Rated input voltage | | 24 Vdc |
| Input voltage range | | 19.2...28.8 Vdc |
| Rated input current | | 4.5 mA |
| Input impedance | | 4.9 kΩ |
| Input limit values | Voltage at state 1 | > 15 Vdc (15...28.8 Vdc) |
| | Voltage at state 0 | < 5 Vdc (0...5 Vdc) |
| | Current at state 1 | > 2.5 mA |
| | Current at state 0 | < 1.0 mA |
| Derating | | see Derating Curve (<i>see page 318</i>) |
| Turn on time | | 5 μs + filter value ¹ |

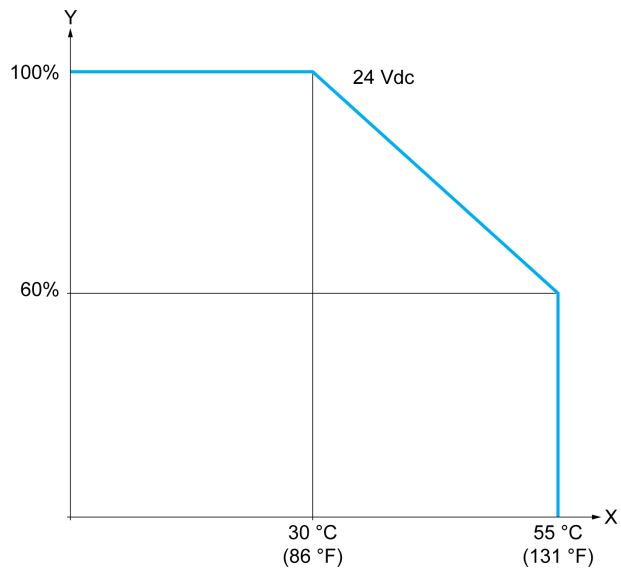
| Characteristic | | Value |
|---|----------------------------------|---|
| Turn off time | | 5 μ s + filter value ¹ |
| HSC maximum frequency | Dual Phase | 100 kHz |
| | Single phase | 100 kHz |
| | Frequency Meter | 100 kHz |
| HSC supported operation mode | | <ul style="list-style-type: none"> ● Dual Phase [Pulse / Direction] ● Dual Phase [Quadrature X1] ● Dual Phase [Quadrature X2] ● Dual Phase [Quadrature X4] ● Single Phase ● Frequency Meter |
| Isolation | Between input and internal logic | 500 Vac |
| | Between channel groups | 500 Vac |
| Connection type | TM221ME16T | Removable screw terminal block |
| | TM221ME16TG | Removable spring terminal block |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Shielded, including the 24 Vdc power supply |
| | Length | Maximum 10 m (32.8 ft) |
| ¹ For more information, refer to Integrator Filter Principle (see page 59) | | |

Derating Curves

The following figures show the derating curves of the embedded digital inputs:



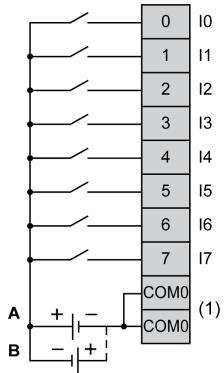
X Input simultaneous ON ratio
Y Input voltage



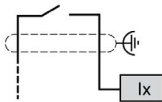
X Ambient temperature
Y Input simultaneous ON ratio

Wiring Diagram

The following figure presents the connection of the inputs to the sensors:



- (1) The COM0 terminals are connected internally.
- A Sink wiring (positive logic).
- B Source wiring (negative logic).



Ix I0, I1, I6, I7

TM221ME16T / TM221ME16TG Digital Outputs

Overview

The TM221ME16T and TM221ME16TG have 8 digital outputs embedded:

- 6 regular transistor outputs
- 2 fast transistor outputs

For more information, refer to Output Management (*see page 63*).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Regular Transistor Output Characteristics

The following table describes the characteristics of the TM221M Logic Controller regular transistor outputs:

| Characteristic | Value |
|--------------------------------------|-----------------------------|
| Number of regular transistor outputs | 6 regular outputs (Q2...Q7) |
| Number of channel groups | 1 common line for Q0...Q7 |
| Output type | Transistor |
| Logic type | Source |
| Rated output voltage | 24 Vdc |
| Output voltage range | 19.2...28.8 Vdc |
| Rated output current | 0.5 A |

| Characteristic | | Value |
|---|-----------------------------------|---|
| Total output current | | 3 A |
| Voltage drop | | 1 Vdc max |
| Leakage current when switched off | | 0.1 mA |
| Maximum power of filament lamp | | 12 W max |
| Derating | | see Derating Curve (see page 323) |
| Turn on time | Q2...Q3 | Max. 50 μ s |
| | Q4...Q7 | Max. 300 μ s |
| Turn off time | Q2...Q3 | Max. 50 μ s |
| | Q4...Q7 | Max. 300 μ s |
| Protection against short circuit | | Yes |
| Short circuit output peak current | | 1.3 A |
| Automatic rearming after short circuit or overload | | Yes, every 1 s |
| Clamping voltage | | Max. 39 Vdc \pm 1 Vdc |
| Switching frequency | Under resistive load | 100 Hz max. |
| Isolation | Between output and internal logic | 500 Vac |
| Connection type | TM221ME16T | Removable screw terminal blocks |
| | TM221ME16TG | Removable spring terminal blocks |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Unshielded |
| | Length | Max 30 m (98 ft) |
| NOTE: Refer to Protecting Outputs from Inductive Load Damage (see page 103) for additional information concerning output protection. | | |

Fast Transistor Output Characteristics

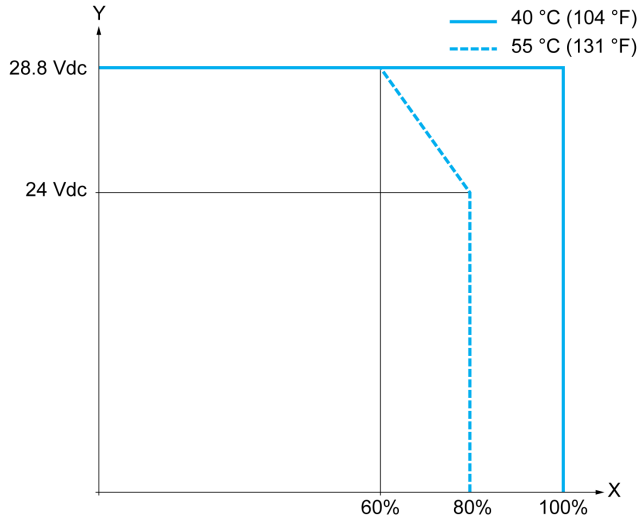
The following table describes the characteristics of the TM221M Logic Controller fast transistor outputs:

| Characteristic | Value |
|-----------------------------------|---------------------------|
| Number of fast transistor outputs | 2 outputs (Q0, Q1) |
| Number of channel groups | 1 common line for Q0...Q7 |
| Output type | Transistor |
| Logic type | Source |
| Rated output voltage | 24 Vdc |
| Output voltage range | 19.2...28.8 Vdc |
| Rated output current | 0.5 A |

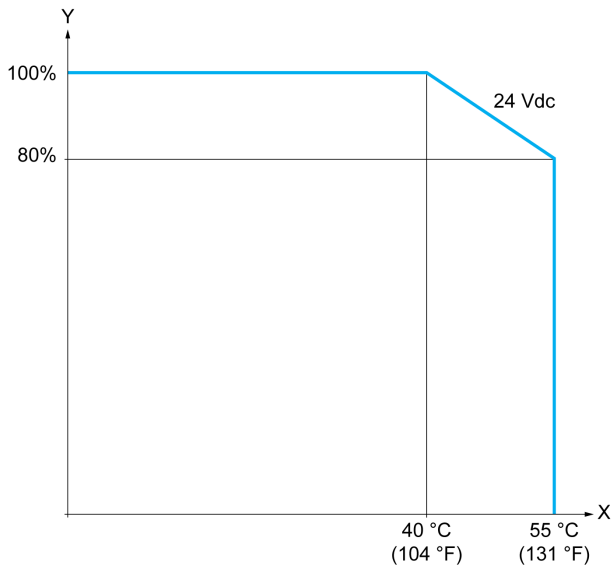
| Characteristic | | Value |
|--|--------------------------------------|--|
| Total output current | | 4 A |
| Maximum power of filament lamp | | 12 W max |
| Derating | | see Derating Curve (<i>see page 323</i>) |
| Turn on time (10 mA < output current < 100 mA) | | Max. 5 μ s |
| Turn off time (10 mA < output current < 100 mA) | | Max. 5 μ s |
| Protection against short circuit | | Yes |
| Short circuit output peak current | | 1.3 A max. |
| Automatic rearming after short circuit or overload | | Yes, every 1 s |
| Protection against reverse polarity | | Yes |
| Clamping voltage | | Typ. 39 Vdc +/- 1 Vdc |
| Maximum output frequency | PLS/PWM/PTO/ FREQGEN | 100 kHz |
| Isolation | Between output and internal logic | 500 Vac |
| Connection type | TM221ME16T | Removable screw terminal blocks |
| | TM221ME16TG | Removable spring terminal blocks |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Shielded, including 24 Vdc power supply |
| | Length | Maximum 3 m (9.84 ft) |
| NOTE: Refer to Protecting Outputs from Inductive Load Damage (<i>see page 103</i>) for additional information concerning output protection. | | |

Derating Curves

The following figures show the derating curves of the embedded digital outputs:



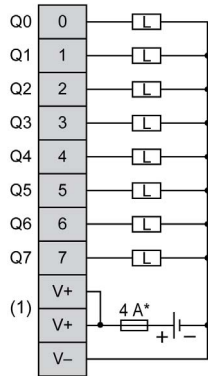
- X Output simultaneous ON ratio
- Y Output voltage



- X Ambient temperature
- Y Output simultaneous ON ratio

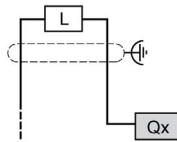
Wiring Diagram

The following figure presents the connection of the outputs to the load:



* Type T fuse

(1) The V+ terminals are connected internally.



Qx Q0, Q1

TM221ME16T / TM221ME16TG Analog Inputs

Overview

The M221 Logic Controllers have 2 analog inputs embedded.

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

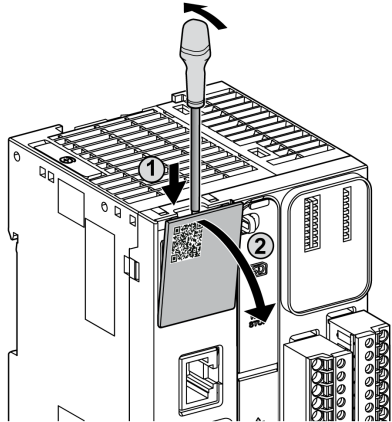
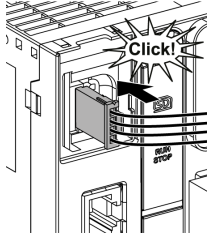
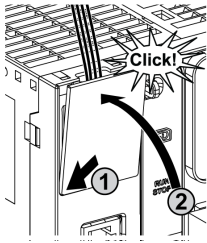
WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

The following procedure describes how to mount the analog cables:

| Step | Action |
|------|---|
| 1 | <p>Use a screw-driver to remove the protective cover.</p>  |
| 2 | <p>Push until you hear it "click".</p>  |
| 3 | <p>Replace the protective cover.</p>  |

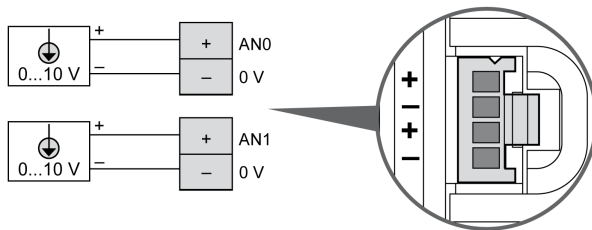
Analog Input Characteristics

The following table describes the characteristics of the M221 Logic Controller with analog inputs:

| Characteristic | | Voltage Input |
|---|----------------------------------|--|
| Number of maximum inputs | | 2 inputs |
| Input type | | Single-ended |
| Rated input range | | 0...+10 Vdc |
| Digital resolution | | 10 bits |
| Input value of LSB | | 10 mV |
| Input impedance | | 100 kΩ |
| Input delay time | | 12 ms |
| Sample duration time | | 1 ms per channel + 1 scan time |
| Accuracy | | ± 1 % of the full scale |
| Noise resistance - maximum temporary deviation during perturbations | | ± 5 % maximum of the full scale when EMC perturbation is applied to the power and I/O wiring |
| Isolation | Between input and internal logic | Not isolated |
| Connection type | | Specific connector and cable (supplied) |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Proprietary (supplied) |
| | Length | 1 m (3.3 ft) |

Wiring Diagram

The following figure shows the wiring diagram of the Modicon M221 Logic Controller analog inputs:



The (-) poles are connected internally.

| Pin | Wire Color |
|-----|------------|
| AN0 | Red |
| 0 V | Black |

| Pin | Wire Color |
|-----|------------|
| AN1 | Red |
| 0 V | Black |

For more information, refer to the Wiring Best Practices ([see page 99](#)).

Chapter 27

TM221M32TK

Overview

This chapter describes the TM221M32TK controllers.

What Is in This Chapter?

This chapter contains the following topics:

| Topic | Page |
|----------------------------|------|
| TM221M32TK Presentation | 330 |
| TM221M32TK Digital Inputs | 334 |
| TM221M32TK Digital Outputs | 339 |
| TM221M32TK Analog Inputs | 344 |

TM221M32TK Presentation

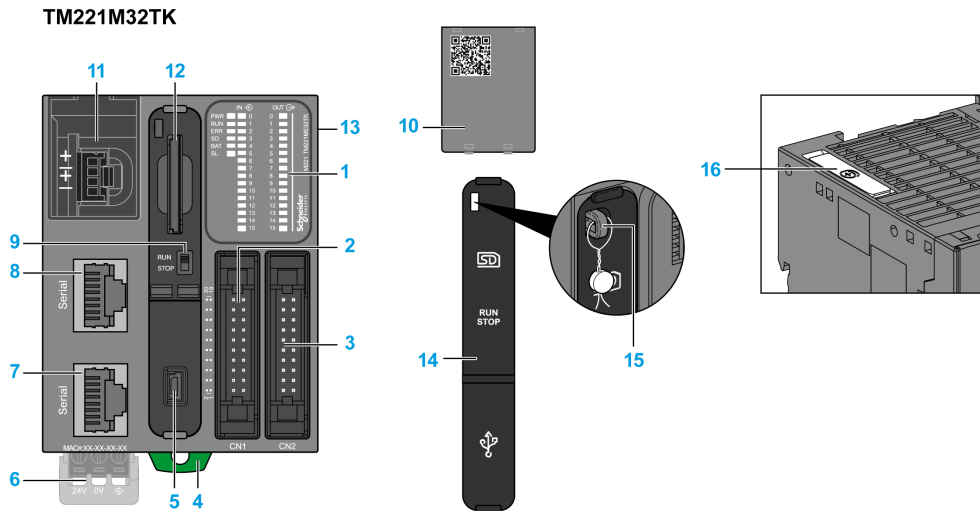
Overview

The following features are integrated into the TM221M32TK (HE10) controllers:

- 16 digital inputs
 - 12 regular inputs
 - 4 fast inputs (HSC)
- 16 digital outputs
 - 14 regular transistor outputs
 - 2 fast transistor outputs
- 2 analog inputs
- Communication port
 - 2 serial line ports
 - 1 USB mini-B programming port

Description

The following figure shows the different components of the controller:

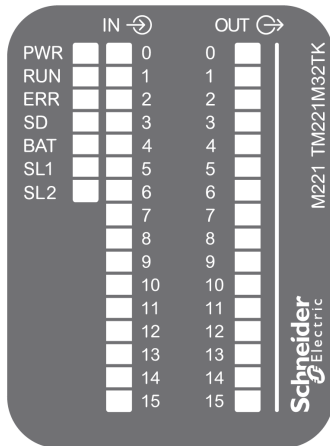


| N° | Description | Refer to |
|----|-------------------------------|------------------------------------|
| 1 | Status LEDs | – |
| 2 | Input HE10 (MIL20) connector | HE10 (MIL 20) connector cable list |
| 3 | Output HE10 (MIL20) connector | |

| N° | Description | Refer to |
|----|---|---|
| 4 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (<i>see page 90</i>) |
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (<i>see page 372</i>) |
| 6 | 24 Vdc power supply | Power supply (<i>see page 106</i>) |
| 7 | Serial line port 2 / RJ45 connector (RS-485) | Serial line 2 (<i>see page 381</i>) |
| 8 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (<i>see page 377</i>) |
| 9 | Run/Stop switch | Run/Stop switch (<i>see page 67</i>) |
| 10 | Removable analog inputs cover | – |
| 11 | 2 analog inputs | Analog Inputs (<i>see page 344</i>) |
| 12 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 13 | I/O expansion connector | – |
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |

Status LEDs

The following figure shows the status LEDs:



The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|-------|--|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flashing | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access <i>(see page 70)</i> | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery <i>(see page 52)</i> | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL1 | Serial line 1 <i>(see page 377)</i> | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |
| SL2 | Serial line 2 <i>(see page 381)</i> | Green | On | Indicates the status of Serial line 2. | | |
| | | | Flashing | Indicates activity on Serial line 2. | | |
| | | | Off | Indicates no serial communication. | | |

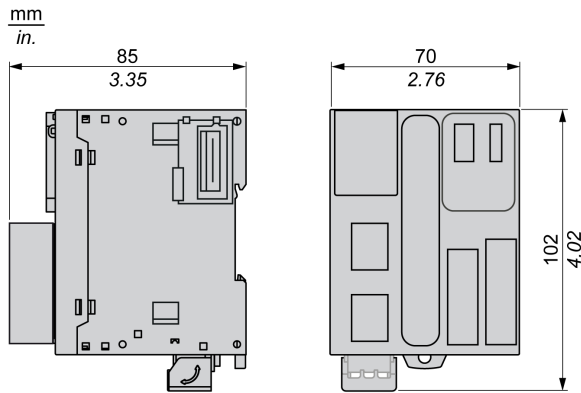
* ERR LED is also On during booting process.

(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide *(see Modicon M221, Logic Controller, Programming Guide)*.

(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.

Dimensions

The following figure shows the external dimensions of the controller:



TM221M32TK Digital Inputs

Overview

This M221 Logic Controller has embedded digital inputs:

- 12 regular inputs
- 4 fast inputs which can be used as 100 kHz HSC inputs

For more information, refer to Input Management (*see page 59*).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Regular Input Characteristics

The following table describes the characteristics of the TM221M Logic Controller regular inputs:

| Characteristic | Value |
|--------------------------|---|
| Number of regular inputs | 12 inputs |
| Number of channel groups | 1 common line for I0...I7 1 common line for I8...I15 |
| Input type | Type 1 (IEC/EN 61131-2) |
| Logic type | Sink/Source |
| Rated input voltage | 24 Vdc |
| Input voltage range | 19.2...28.8 Vdc |
| Rated input current | 7 mA |

| Characteristic | | Value |
|--|----------------------------------|--|
| Input impedance | | 3.4 k Ω |
| Input limit values | Voltage at state 1 | > 15 Vdc (15...28.8 Vdc) |
| | Voltage at state 0 | < 5 Vdc (0...5 Vdc) |
| | Current at state 1 | > 2.5 mA |
| | Current at state 0 | < 1.0 mA |
| Derating | | see Derating Curve (<i>see page 336</i>) |
| Turn on time | | 35 μ s + filter value ¹ |
| Turn off time | | 35 μ s + filter value ¹ |
| Isolation | Between input and internal logic | 500 Vac |
| Connection type | | HE10 (MIL 20) connectors |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Unshielded |
| | Length | Maximum 30 m (98 ft) |
| ¹ For more information, refer to Integrator Filter Principle (<i>see page 59</i>) | | |

Fast Input Characteristics

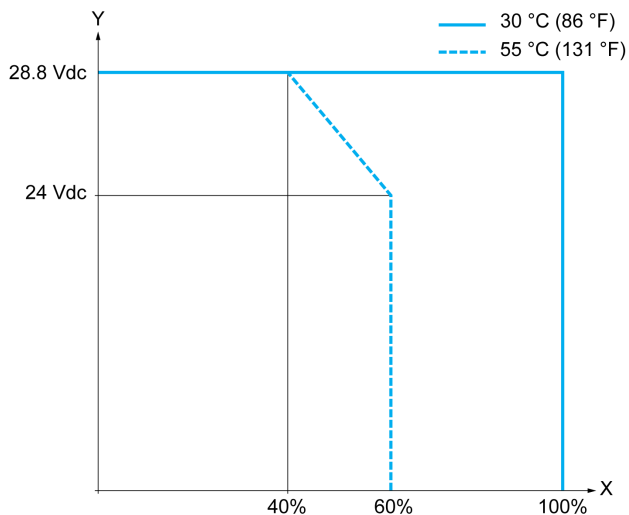
The following table describes the characteristics of the TM221M Logic Controller fast inputs:

| Characteristic | | Value |
|--------------------------|--------------------|--|
| Number of fast inputs | | 4 inputs (I0, I1, I6, I7) |
| Number of channel groups | | 1 common line for I0...I7 |
| Input type | | Type 1 (IEC/EN 61131-2) |
| Logic type | | Sink/Source |
| Rated input voltage | | 24 Vdc |
| Input voltage range | | 19.2...28.8 Vdc |
| Rated input current | | 4.5 mA |
| Input impedance | | 4.9 k Ω |
| Input limit values | Voltage at state 1 | > 15 Vdc (15...28.8 Vdc) |
| | Voltage at state 0 | < 5 Vdc (0...5 Vdc) |
| | Current at state 1 | > 2.5 mA |
| | Current at state 0 | < 1.0 mA |
| Derating | | see Derating Curve (<i>see page 336</i>) |
| Turn on time | | 5 μ s + filter value ¹ |
| Turn off time | | 5 μ s + filter value ¹ |

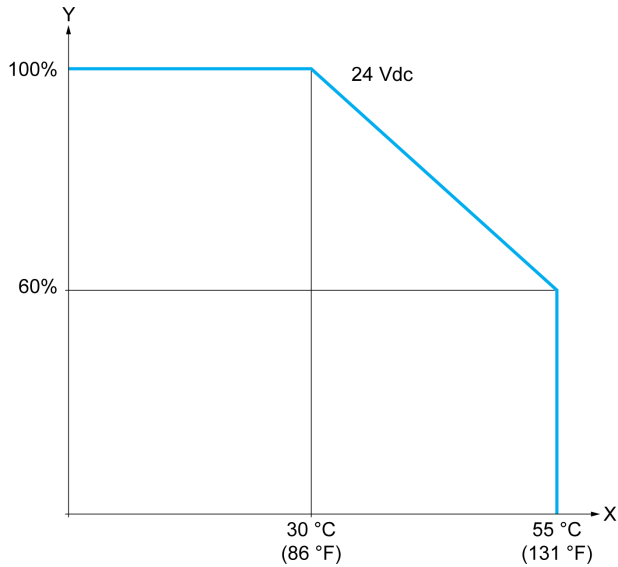
| Characteristic | | Value |
|---|----------------------------------|---|
| HSC maximum frequency | Dual Phase | 100 kHz |
| | Single phase | 100 kHz |
| | Frequency Meter | 100 kHz |
| HSC supported operation mode | | <ul style="list-style-type: none"> ● Dual Phase [Pulse / Direction] ● Dual Phase [Quadrature X1] ● Dual Phase [Quadrature X2] ● Dual Phase [Quadrature X4] ● Single Phase ● Frequency Meter |
| Isolation | Between input and internal logic | 500 Vac |
| | Between channel groups | 500 Vac |
| Connection type | TM221M32TK | HE10 (MIL 20) connector |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Shielded, including the 24 Vdc power supply |
| | Length | Maximum 10 m (32.8 ft) |
| ¹ For more information, refer to Integrator Filter Principle (see page 59) | | |

Derating Curves

The following figures show the derating curves of the embedded digital inputs:



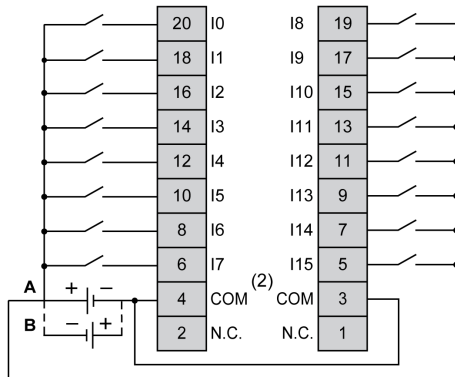
X Input simultaneous ON ratio
Y Input voltage



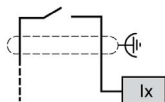
X Ambient temperature
 Y Input simultaneous ON ratio

Wiring Diagram with Free-Wire Cable

The following figure presents the connection of the inputs to the sensors:



- (1) The COM terminals are **not** connected internally.
- A Sink wiring (positive logic).
- B Source wiring (negative logic).



Ix I0, I1, I6, I7

For more information on the cable color for TWDFCW30K/TWDFCW50K, refer to TWDFCW••K Cable Description ([see page 49](#)).

TM221M32TK Digital Outputs

Overview

The TM221M32TK has 16 digital outputs embedded:

- 14 regular transistor outputs
- 2 fast transistor outputs

For more information, refer to Output Management (*see page 63*).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Regular Transistor Output Characteristics

The following table describes the characteristics of the TM221M Logic Controller regular transistor outputs:

| Characteristic | Value |
|--------------------------------------|-------------------------------|
| Number of regular transistor outputs | 14 regular outputs (Q2...Q15) |
| Number of channel groups | 1 common line for Q0...Q15 |
| Output type | Transistor |
| Logic type | Source |
| Rated output voltage | 24 Vdc |
| Output voltage range | 19.2...28.8 Vdc |
| Rated output current | 0.1 A |

| Characteristic | | Value |
|---|-----------------------------------|--|
| Total output current (Q0...Q15) | | 1.6 A |
| Voltage drop | | 1 Vdc max |
| Leakage current when switched off | | 0.1 mA |
| Maximum power of filament lamp | | 2.4 W max |
| Derating | | See Derating Curves (see page 342) |
| Turn on time | Q2...Q3 | Max. 50 μ s |
| | Q4...Q15 | Max. 300 μ s |
| Turn off time | Q2...Q3 | Max. 50 μ s |
| | Q4...Q15 | Max. 300 μ s |
| Protection against short circuit | | Yes |
| Short circuit output peak current | | 0.25 A |
| Automatic rearming after short circuit or overload | | Yes, every 1 s |
| Clamping voltage | | Max. 39 Vdc \pm 1 Vdc |
| Switching frequency | Under resistive load | 100 Hz max. |
| Isolation | Between output and internal logic | 500 Vac |
| Connection type | TM221M32TK | HE10 (MIL 20) connectors |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Unshielded |
| | Length | Max 30 m (98 ft) |
| NOTE: Refer to Protecting Outputs from Inductive Load Damage (see page 103) for additional information concerning output protection. | | |

Fast Transistor Output Characteristics

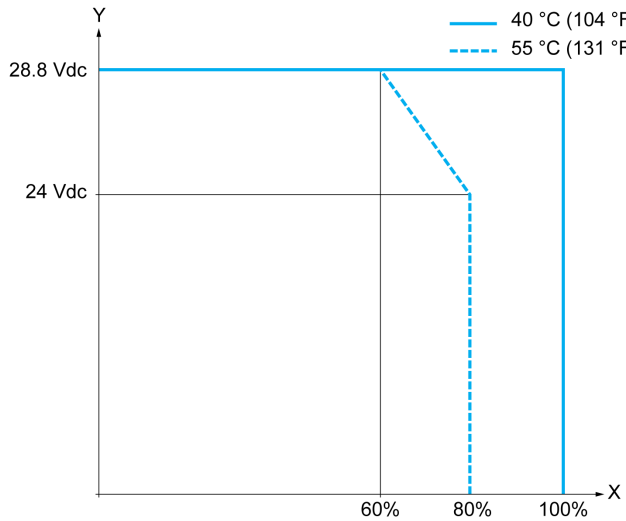
The following table describes the characteristics of the TM221M Logic Controller fast transistor outputs:

| Characteristic | Value |
|-----------------------------------|----------------------------|
| Number of fast transistor outputs | 2 outputs (Q0, Q1) |
| Number of channel groups | 1 common line for Q0...Q15 |
| Output type | Transistor |
| Logic type | Source |
| Rated output voltage | 24 Vdc |
| Output voltage range | 19.2...28.8 Vdc |
| Rated output current | 0.1 A |
| Total output current (Q0...Q15) | 1.6 A |

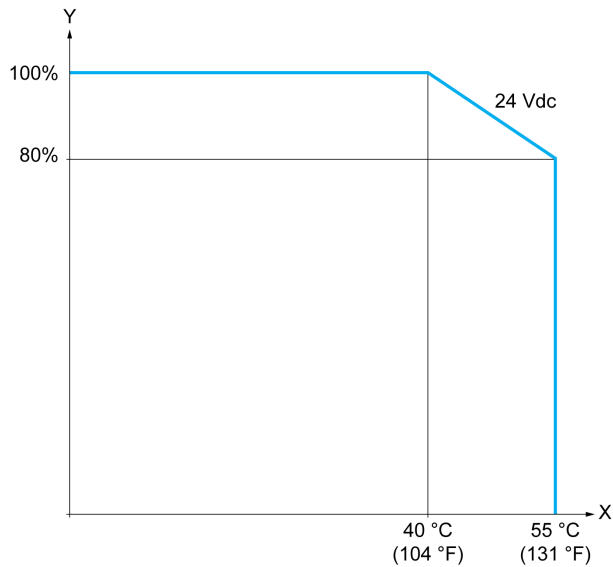
| Characteristic | | Value |
|---|-----------------------------------|---|
| Maximum power of filament lamp | | 2.4 W max |
| Derating | | See Derating Curves (<i>see page 342</i>) |
| Turn on time (10 mA < output current < 100 mA) | | Max. 5 μ s |
| Turn off time (10 mA < output current < 100 mA) | | Max. 5 μ s |
| Protection against short circuit | | Yes |
| Short circuit output peak current | | 1.3 A max. |
| Automatic rearming after short circuit or overload | | Yes, every 1 s |
| Protection against reverse polarity | | Yes |
| Clamping voltage | | Typ. 39 Vdc +/- 1 Vdc |
| Maximum output frequency | PWM | 100 kHz |
| | PLS | 100 kHz |
| Isolation | Between output and internal logic | 500 Vac |
| Connection type | TM221M32TK | HE10 (MIL 20) connectors |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Shielded, including 24 Vdc power supply |
| | Length | Maximum 3 m (9.84 ft) |
| <p>NOTE: Refer to Protecting Outputs from Inductive Load Damage (<i>see page 103</i>) for additional information concerning output protection.</p> | | |

Derating Curves

The following figures show the derating curves of the embedded digital outputs:



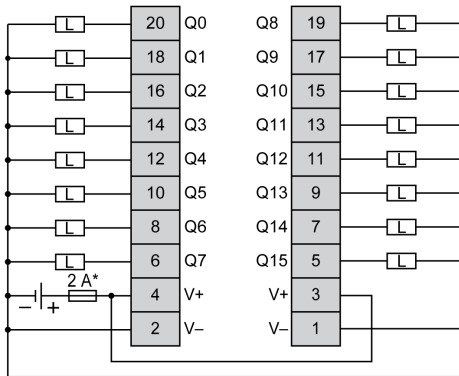
X Output simultaneous ON ratio
Y Output voltage



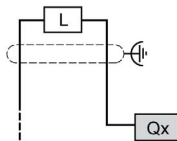
X Ambient temperature
Y Output simultaneous ON ratio

Wiring Diagram with Free-Wire Cable

The following figure presents the connection of the outputs to the load:



* Type T fuse



Qx Q0, Q1

For more information on the cable color for TWDFCW30K/TWDFCW50K, refer to TWDFCW••K Cable Description ([see page 49](#)).

TM221M32TK Analog Inputs

Overview

The M221 Logic Controllers have 2 analog inputs embedded.

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

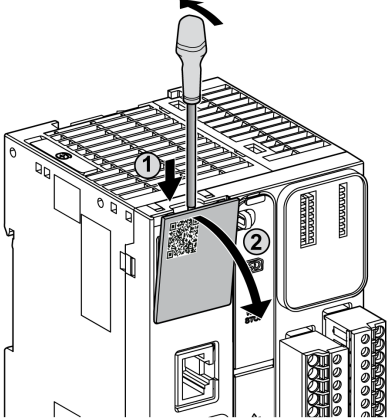
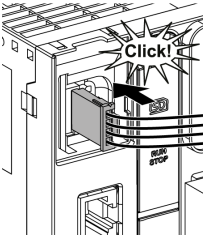
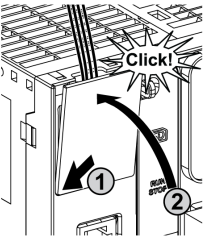
WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

The following procedure describes how to mount the analog cables:

| Step | Action |
|------|---|
| 1 | <p data-bbox="353 248 834 272">Use a screw-driver to remove the protective cover.</p>  |
| 2 | <p data-bbox="353 751 622 776">Push until you hear it “click”.</p>  |
| 3 | <p data-bbox="353 1065 632 1089">Replace the protective cover.</p>  |

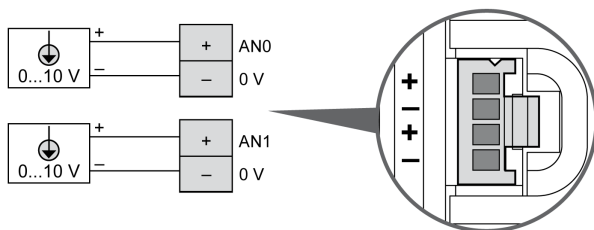
Analog Input Characteristics

The following table describes the characteristics of the M221 Logic Controller with analog inputs:

| Characteristic | | Voltage Input |
|---|----------------------------------|--|
| Number of maximum inputs | | 2 inputs |
| Input type | | Single-ended |
| Rated input range | | 0...+10 Vdc |
| Digital resolution | | 10 bits |
| Input value of LSB | | 10 mV |
| Input impedance | | 100 kΩ |
| Input delay time | | 12 ms |
| Sample duration time | | 1 ms per channel + 1 scan time |
| Accuracy | | ± 1 % of the full scale |
| Noise resistance - maximum temporary deviation during perturbations | | ± 5 % maximum of the full scale when EMC perturbation is applied to the power and I/O wiring |
| Isolation | Between input and internal logic | Not isolated |
| Connection type | | Specific connector and cable (supplied) |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Proprietary (supplied) |
| | Length | 1 m (3.3 ft) |

Wiring Diagram

The following figure shows the wiring diagram of the Modicon M221 Logic Controller analog inputs:



The (-) poles are connected internally.

| Pin | Wire Color |
|-----|------------|
| AN0 | Red |
| 0 V | Black |

| Pin | Wire Color |
|-----|------------|
| AN1 | Red |
| 0 V | Black |

For more information, refer to the Wiring Best Practices ([see page 99](#)).

Chapter 28

TM221ME32TK

Overview

This chapter describes the TM221ME32TK controller.

What Is in This Chapter?

This chapter contains the following topics:

| Topic | Page |
|-----------------------------|------|
| TM221ME32TK Presentation | 350 |
| TM221ME32TK Digital Inputs | 354 |
| TM221ME32TK Digital Outputs | 359 |
| TM221ME32TK Analog Inputs | 364 |

TM221ME32TK Presentation

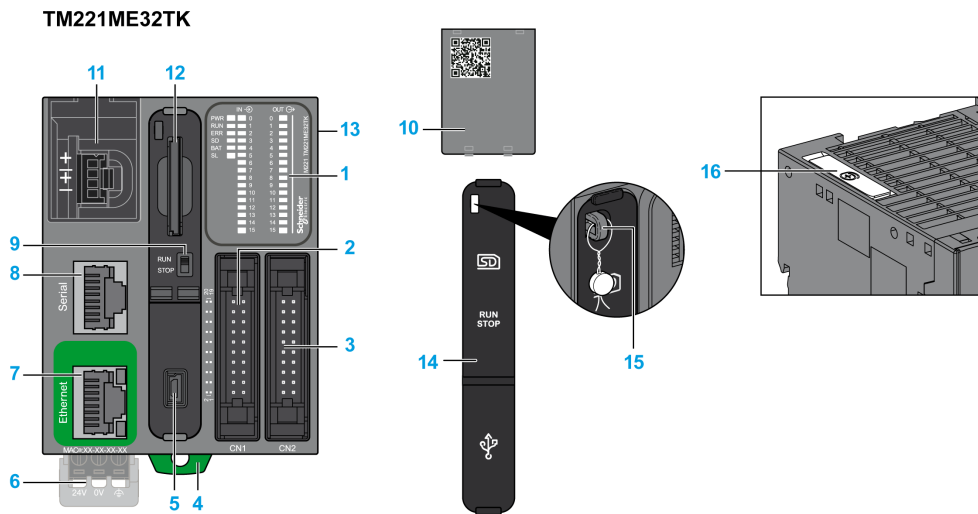
Overview

The following features are integrated into the TM221ME32TK (HE10) controllers:

- 16 digital inputs
 - 12 regular inputs
 - 4 fast inputs (HSC)
- 16 digital outputs
 - 14 regular transistor outputs
 - 2 fast transistor outputs
- 2 analog inputs
- Communication port
 - 1 serial line port
 - 1 USB mini-B programming port
 - 1 Ethernet port

Description

The following figure shows the different components of the controller:

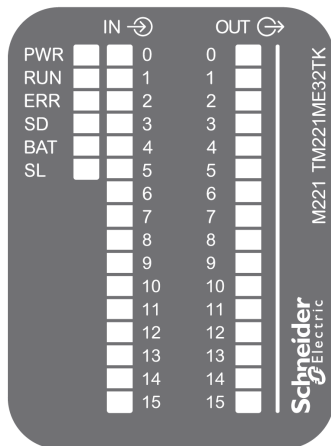


| N° | Description | Refer to |
|----|-------------------------------|------------------------------------|
| 1 | Status LEDs | - |
| 2 | Input HE10 (MIL20) connector | HE10 (MIL 20) connector cable list |
| 3 | Output HE10 (MIL20) connector | |

| N° | Description | Refer to |
|----|---|---|
| 4 | Clip-on lock for 35 mm (1.38 in.) top hat section rail (DIN-rail) | DIN Rail (<i>see page 90</i>) |
| 5 | USB mini-B programming port / For terminal connection to a programming PC (SoMachine Basic) | USB mini-B programming port (<i>see page 372</i>) |
| 6 | 24 Vdc power supply | Power supply (<i>see page 106</i>) |
| 7 | Ethernet port / RJ45 connector | Ethernet port (<i>see page 374</i>) |
| 8 | Serial line port 1 / RJ45 connector (RS-232 or RS-485) | Serial line 1 (<i>see page 377</i>) |
| 9 | Run/Stop switch | Run/Stop switch (<i>see page 67</i>) |
| 10 | Removable analog inputs cover | – |
| 11 | 2 analog inputs | Analog Inputs (<i>see page 364</i>) |
| 12 | SD Card slot | SD Card Slot (<i>see page 70</i>) |
| 13 | I/O expansion connector | – |
| 14 | Protective cover (SD Card slot, Run/Stop switch and USB mini-B programming port) | – |
| 15 | Locking hook | – |
| 16 | Battery holder | Installing and Replacing the Battery (<i>see page 53</i>) |

Status LEDs

The following figure shows the status LEDs:

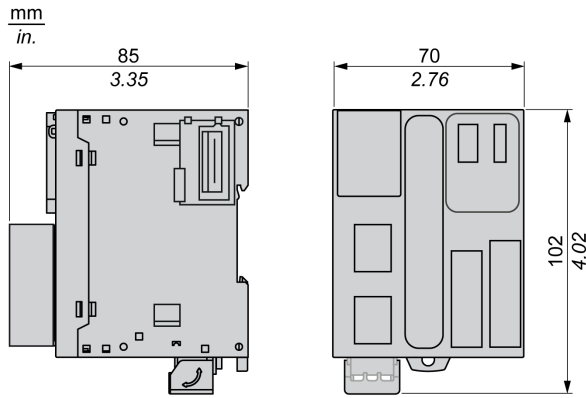


The following table describes the status LEDs:

| Label | Function Type | Color | Status | Description | | |
|--|--|-------|------------------------------------|--|------------------------|-------------------------------|
| | | | | Controller States ⁽¹⁾ | Prg Port Communication | Application Execution |
| PWR | Power | Green | On | Indicates that power is applied. | | |
| | | | Off | Indicates that power is removed. | | |
| RUN | Machine Status | Green | On | Indicates that the controller is running a valid application. | | |
| | | | Flashing | Indicates that the controller has a valid application that is stopped. | | |
| | | | Off | Indicates that the controller is not programmed. | | |
| ERR | Error | Red | On* | EXCEPTION | Restricted | NO |
| | | | Flashing (with RUN status LED Off) | INTERNAL ERROR | Restricted | NO |
| | | | Slow flash | Minor error detected ⁽²⁾ | Yes | Depends on the RUN status LED |
| | | | 1 single flash | No application | Yes | Yes |
| SD | SD Card Access <i>(see page 70)</i> | Green | On | Indicates that the SD card is being accessed. | | |
| | | | Flashing | Indicates that an error was detected during the SD card operation. | | |
| | | | Off | Indicates no access (idle) or no card is present. | | |
| BAT | Battery <i>(see page 52)</i> | Red | On | Indicates that the battery needs to be replaced. | | |
| | | | Flashing | Indicates that the battery charge is low. | | |
| | | | Off | Indicates that the battery is OK. | | |
| SL | Serial line 1 <i>(see page 377)</i> | Green | On | Indicates the status of Serial line 1. | | |
| | | | Flashing | Indicates activity on Serial line 1. | | |
| | | | Off | Indicates no serial communication. | | |
| <p>* ERR LED is also On during booting process.</p> <p>NOTE: For information about the LEDs integrated into the Ethernet connector, refer to Ethernet Status LEDs <i>(see page 376)</i></p> <p>(1) For more information about the controller state description, refer to the M221 Logic Controller - Programming Guide <i>(see Modicon M221, Logic Controller, Programming Guide)</i>.</p> <p>(2) The controller detected an error but remains in RUNNING state. The ERR LED on the controller flashes. For more information, refer to M221 Logic Controller - Programming Guide.</p> | | | | | | |

Dimensions

The following figure shows the external dimension controller:



TM221ME32TK Digital Inputs

Overview

This M221 Logic Controller has embedded digital inputs:

- 12 regular inputs
- 4 fast inputs which can be used as 100 kHz HSC inputs

For more information, refer to Input Management (*see page 59*).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Regular Input Characteristics

The following table describes the characteristics of the TM221M Logic Controller regular inputs:

| Characteristic | Value |
|--------------------------|---|
| Number of regular inputs | 12 inputs |
| Number of channel groups | 1 common line for I0...I7 1 common line for I8...I15 |
| Input type | Type 1 (IEC/EN 61131-2) |
| Logic type | Sink/Source |
| Rated input voltage | 24 Vdc |
| Input voltage range | 19.2...28.8 Vdc |
| Rated input current | 7 mA |

| Characteristic | | Value |
|--|----------------------------------|--|
| Input impedance | | 3.4 k Ω |
| Input limit values | Voltage at state 1 | > 15 Vdc (15...28.8 Vdc) |
| | Voltage at state 0 | < 5 Vdc (0...5 Vdc) |
| | Current at state 1 | > 2.5 mA |
| | Current at state 0 | < 1.0 mA |
| Derating | | see Derating Curve (<i>see page 355</i>) |
| Turn on time | | 35 μ s + filter value ¹ |
| Turn off time | | I2...I5: 35 μ s ¹ I8...I15: 100 μ s ¹ |
| Isolation | Between input and internal logic | 500 Vac |
| Connection type | | HE10 (MIL 20) connectors |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Unshielded |
| | Length | Maximum 30 m (98 ft) |
| ¹ For more information, refer to Integrator Filter Principle (<i>see page 59</i>) | | |

Fast Input Characteristics

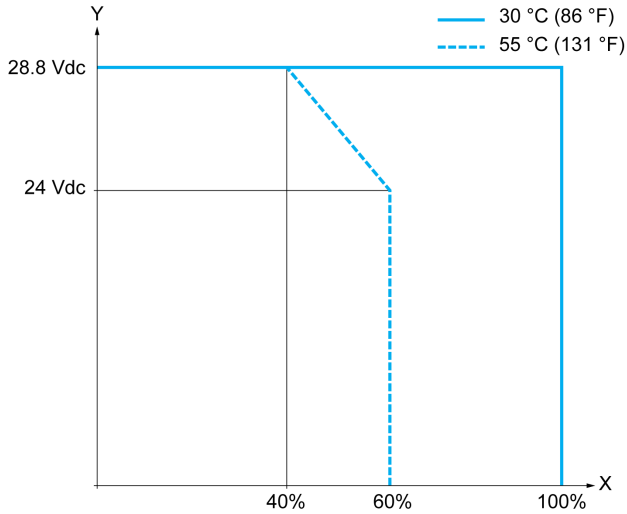
The following table describes the characteristics of the TM221M Logic Controller fast inputs:

| Characteristic | | Value |
|--------------------------|--------------------|--|
| Number of fast inputs | | 4 inputs (I0, I1, I6, I7) |
| Number of channel groups | | 1 common line for I0...I7 |
| Input type | | Type 1 (IEC/EN 61131-2) |
| Logic type | | Sink/Source |
| Rated input voltage | | 24 Vdc |
| Input voltage range | | 19.2...28.8 Vdc |
| Rated input current | | 4.5 mA |
| Input impedance | | 4.9 k Ω |
| Input limit values | Voltage at state 1 | > 15 Vdc (15...28.8 Vdc) |
| | Voltage at state 0 | < 5 Vdc (0...5 Vdc) |
| | Current at state 1 | > 2.5 mA |
| | Current at state 0 | < 1.0 mA |
| Derating | | see Derating Curve (<i>see page 357</i>) |
| Turn on time | | 5 μ s + filter value ¹ |

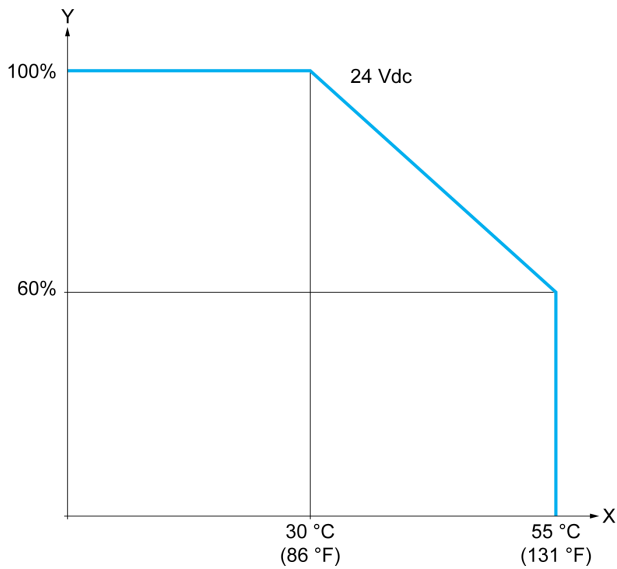
| Characteristic | | Value |
|---|----------------------------------|---|
| Turn off time | | 5 μ s + filter value ¹ |
| HSC maximum frequency | Dual Phase | 100 kHz |
| | Single phase | 100 kHz |
| | Frequency Meter | 100 kHz |
| HSC supported operation mode | | <ul style="list-style-type: none"> ● Dual Phase [Pulse / Direction] ● Dual Phase [Quadrature X1] ● Dual Phase [Quadrature X2] ● Dual Phase [Quadrature X4] ● Single Phase ● Frequency Meter |
| Isolation | Between input and internal logic | 500 Vac |
| | Between channel groups | 500 Vac |
| Connection type | TM221ME32TK | HE10 (MIL 20) connector |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Shielded, including the 24 Vdc power supply |
| | Length | Maximum 10 m (32.8 ft) |
| ¹ For more information, refer to Integrator Filter Principle (see page 59) | | |

Derating Curves

The following figures show the derating curves of the embedded digital inputs:



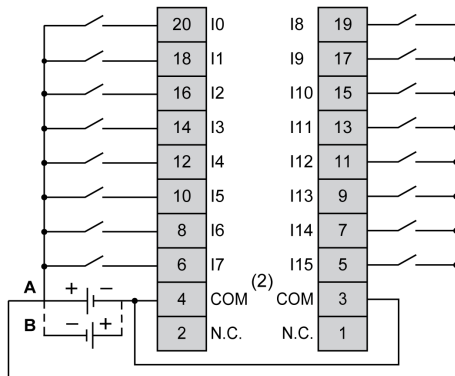
X Input simultaneous ON ratio
Y Input voltage



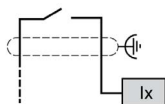
X Ambient temperature
Y Input simultaneous ON ratio

Wiring Diagram with Free-Wire Cable

The following figure presents the connection of the inputs to the sensors:



- (1) The COM terminals are **not** connected internally.
- A Sink wiring (positive logic).
- B Source wiring (negative logic).



Ix I0, I1, I6, I7

For more information on the cable color for TWDFCW30K/TWDFCW50K, refer to TWDFCW••K Cable Description ([see page 50](#)).

TM221ME32TK Digital Outputs

Overview

The TM221ME32TK has 16 digital outputs embedded:

- 14 regular transistor outputs
- 2 fast transistor outputs

For more information, refer to Output Management (*see page 63*).

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

Regular Transistor Output Characteristics

The following table describes the characteristics of the TM221M Logic Controller regular transistor outputs:

| Characteristic | Value |
|--------------------------------------|-------------------------------|
| Number of regular transistor outputs | 14 regular outputs (Q2...Q15) |
| Number of channel groups | 1 common line for Q0...Q15 |
| Output type | Transistor |
| Logic type | Source |
| Rated output voltage | 24 Vdc |
| Output voltage range | 19.2...28.8 Vdc |
| Rated output current | 0.1 A |

| Characteristic | | Value |
|---|-----------------------------------|--|
| Total output current (Q0...Q15) | | 1.6 A |
| Voltage drop | | 1 Vdc max |
| Leakage current when switched off | | 0.1 mA |
| Maximum power of filament lamp | | 2.4 W max |
| Derating | | See Derating Curves (see page 362) |
| Turn on time | Q2...Q3 | Max. 50 μ s |
| | Q4...Q15 | Max. 300 μ s |
| Turn off time | Q2...Q3 | Max. 50 μ s |
| | Q4...Q15 | Max. 300 μ s |
| Protection against short circuit | | Yes |
| Short circuit output peak current | | 0.25 A |
| Automatic rearming after short circuit or overload | | Yes, every 1 s |
| Clamping voltage | | Max. 39 Vdc \pm 1 Vdc |
| Switching frequency | Under resistive load | 100 Hz max. |
| Isolation | Between output and internal logic | 500 Vac |
| Connection type | TM221ME32TK | HE10 (MIL 20) connectors |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Unshielded |
| | Length | Max 30 m (98 ft) |
| NOTE: Refer to Protecting Outputs from Inductive Load Damage (see page 103) for additional information concerning output protection. | | |

Fast Transistor Output Characteristics

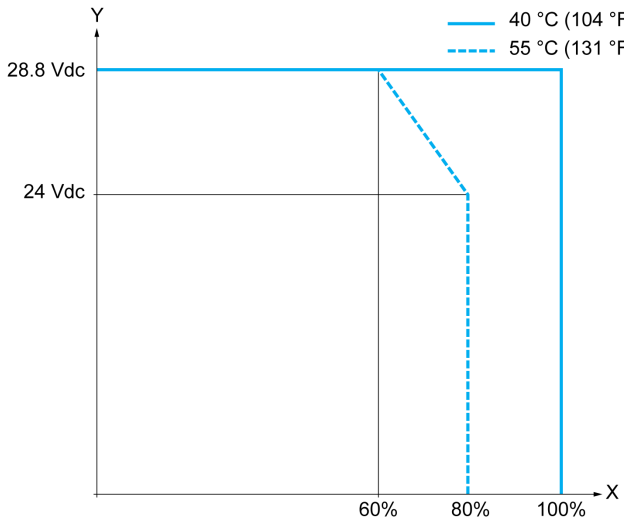
The following table describes the characteristics of the TM221M Logic Controller fast transistor outputs:

| Characteristic | Value |
|-----------------------------------|----------------------------|
| Number of fast transistor outputs | 2 outputs (Q0, Q1) |
| Number of channel groups | 1 common line for Q0...Q15 |
| Output type | Transistor |
| Logic type | Source |
| Rated output voltage | 24 Vdc |
| Output voltage range | 19.2...28.8 Vdc |
| Rated output current | 0.1 A |
| Total output current (Q0...Q15) | 1.6 A |

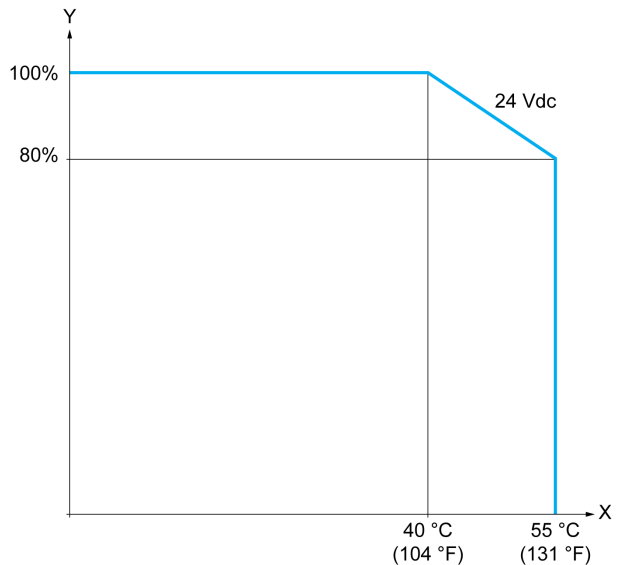
| Characteristic | | Value |
|--|--------------------------------------|---|
| Maximum power of filament lamp | | 2.4 W max |
| Derating | | See Derating Curves (<i>see page 362</i>) |
| Turn on time (10 mA < output current < 100 mA) | | Max. 5 μ s |
| Turn off time (10 mA < output current < 100 mA) | | Max. 5 μ s |
| Protection against short circuit | | Yes |
| Short circuit output peak current | | 1.3 A max. |
| Automatic rearming after short circuit or overload | | Yes, every 1 s |
| Protection against reverse polarity | | Yes |
| Clamping voltage | | Typ. 39 Vdc +/- 1 Vdc |
| Maximum output frequency | PLS/PWM/PTO/ FREQGEN | 100 kHz |
| Isolation | Between output and internal logic | 500 Vac |
| Connection type | TM221ME32TK | HE10 (MIL 20) connectors |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Shielded, including 24 Vdc power supply |
| | Length | Maximum 3 m (9.84 ft) |
| NOTE: Refer to Protecting Outputs from Inductive Load Damage (<i>see page 103</i>) for additional information concerning output protection. | | |

Derating Curves

The following figures show the derating curves of the embedded digital outputs:



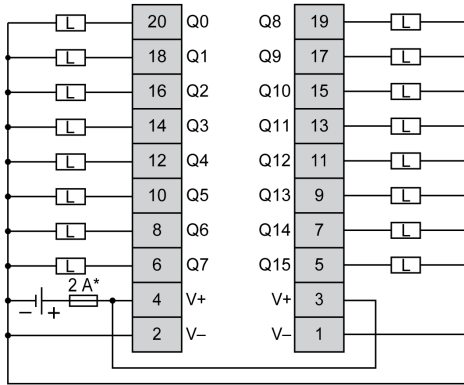
X Output simultaneous ON ratio
Y Output voltage



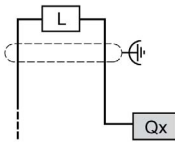
X Ambient temperature
Y Output simultaneous ON ratio

Wiring Diagram with Free-Wire Cable

The following figure presents the connection of the outputs to the load:



* Type T fuse



Qx Q0, Q1

For more information on the cable color for TWDFCW30K/TWDFCW50K, refer to TWDFCW••K Cable Description ([see page 49](#)).

TM221ME32TK Analog Inputs

Overview

The M221 Logic Controllers have 2 analog inputs embedded.

DANGER

FIRE HAZARD

- Use only the correct wire sizes for the current capacity of the I/O channels and power supplies.
- For relay output (2 A) wiring, use conductors of at least 0.5 mm² (AWG 20) with a temperature rating of at least 80 °C (176 °F).
- For common conductors of relay output wiring (7 A), or relay output wiring greater than 2 A, use conductors of at least 1.0 mm² (AWG 16) with a temperature rating of at least 80 °C (176 °F).

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

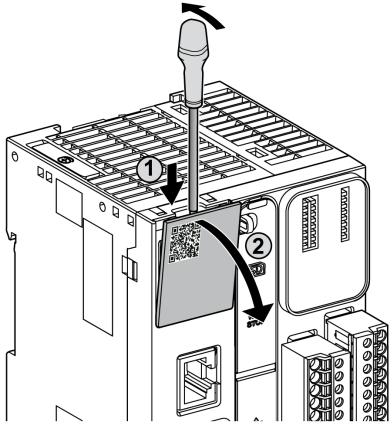
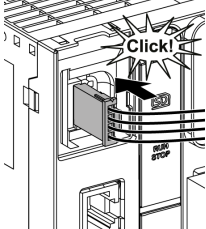
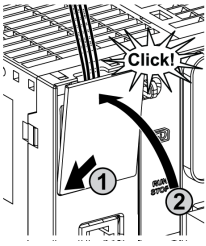
WARNING

UNINTENDED EQUIPMENT OPERATION

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

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

The following procedure describes how to mount the analog cables:

| Step | Action |
|------|---|
| 1 | <p>Use a screw-driver to remove the protective cover.</p>  |
| 2 | <p>Push until you hear it "click".</p>  |
| 3 | <p>Replace the protective cover.</p>  |

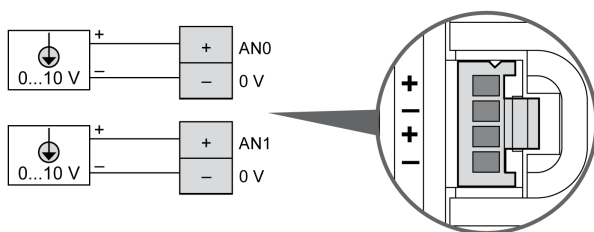
Analog Input Characteristics

The following table describes the characteristics of the M221 Logic Controller with analog inputs:

| Characteristic | | Voltage Input |
|---|----------------------------------|--|
| Number of maximum inputs | | 2 inputs |
| Input type | | Single-ended |
| Rated input range | | 0...+10 Vdc |
| Digital resolution | | 10 bits |
| Input value of LSB | | 10 mV |
| Input impedance | | 100 kΩ |
| Input delay time | | 12 ms |
| Sample duration time | | 1 ms per channel + 1 scan time |
| Accuracy | | ± 1 % of the full scale |
| Noise resistance - maximum temporary deviation during perturbations | | ± 5 % maximum of the full scale when EMC perturbation is applied to the power and I/O wiring |
| Isolation | Between input and internal logic | Not isolated |
| Connection type | | Specific connector and cable (supplied) |
| Connector insertion/removal durability | | Over 100 times |
| Cable | Type | Proprietary (supplied) |
| | Length | 1 m (3.3 ft) |

Wiring Diagram

The following figure shows the wiring diagram of the Modicon M221 Logic Controller analog inputs:



The (-) poles are connected internally.

| Pin | Wire Color |
|-----|------------|
| AN0 | Red |
| 0 V | Black |

| Pin | Wire Color |
|-----|------------|
| AN1 | Red |
| 0 V | Black |

For more information, refer to the Wiring Best Practices ([see page 99](#)).

Part IV

Modicon M221 Logic Controller Communication

What Is in This Part?

This part contains the following chapters:

| Chapter | Chapter Name | Page |
|---------|--|------|
| 29 | Integrated Communication Ports | 371 |
| 30 | Connecting the M221 Logic Controller to a PC | 385 |

Chapter 29

Integrated Communication Ports

What Is in This Chapter?

This chapter contains the following topics:

| Topic | Page |
|-----------------------------|------|
| USB Mini-B Programming Port | 372 |
| Ethernet Port | 374 |
| Serial Line 1 | 377 |
| Serial Line 2 | 381 |

USB Mini-B Programming Port

Overview

The USB Mini-B Port is the programming port you can use to connect a PC with a USB host port using SoMachine Basic software. Using a typical USB cable, this connection is suitable for quick updates of the program or short duration connections to perform maintenance and inspect data values. It is not suitable for long-term connections such as commissioning or monitoring without the use of specially adapted cables to help minimize electromagnetic interference.

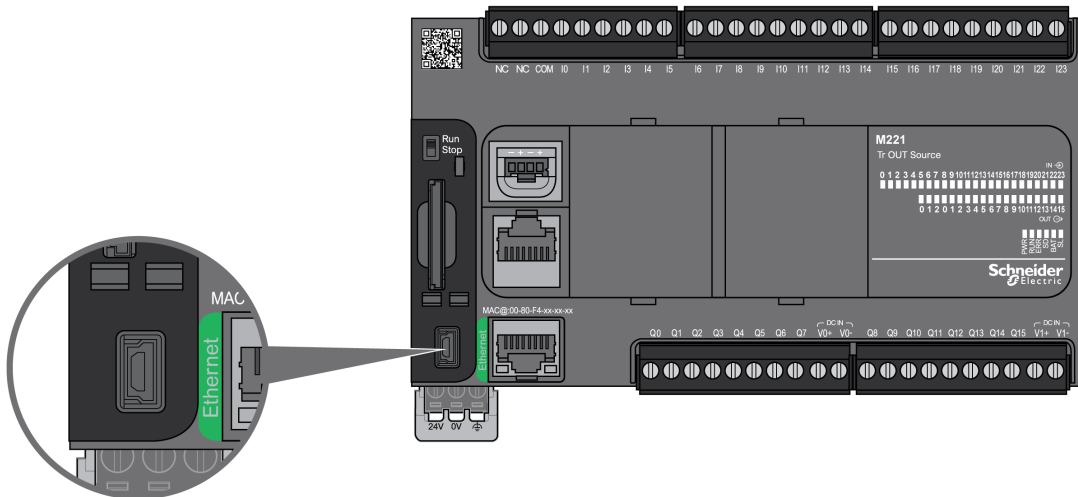
⚠ WARNING

UNINTENDED EQUIPMENT OPERATION OR INOPERABLE EQUIPMENT

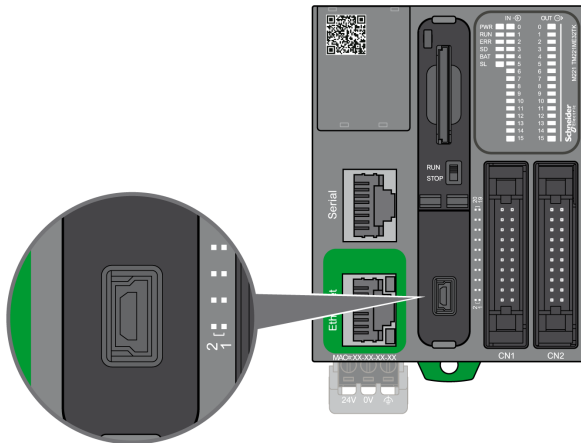
- You must use a shielded USB cable such as a BMX XCAUSBH0** secured to the functional ground (FE) of the system for any long-term connection.
- Do not connect more than one controller at a time using USB connections.
- Do not use the USB port(s), if so equipped, unless the location is known to be non-hazardous.

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

The following figure shows the location of the USB Mini-B programming port on the TM221C Logic Controller:



The following figure shows the location of the USB Mini-B programming port on the TM221M Logic Controller:



Characteristics

This table describes the characteristics of the USB Mini-B programming port:

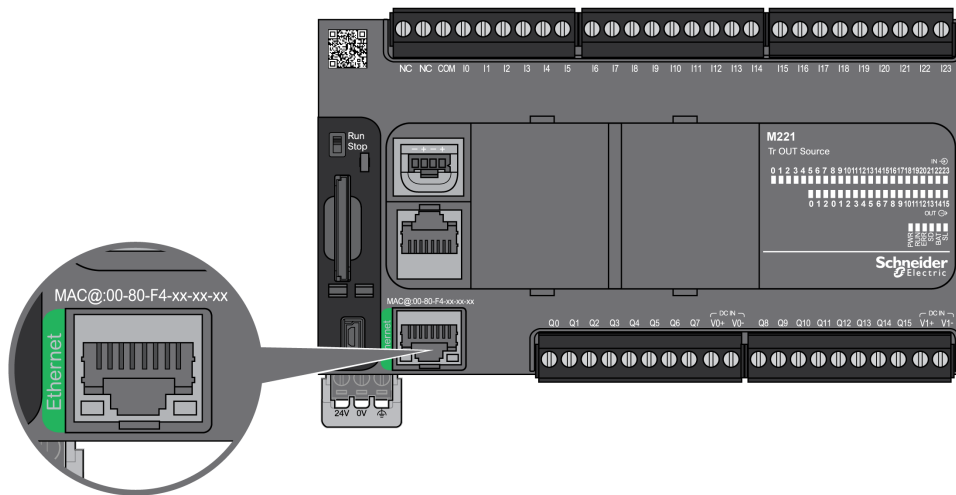
| Parameter | USB Programming Port |
|----------------|-------------------------|
| Function | Compatible with USB 2.0 |
| Connector type | Mini-B |
| Isolation | None |
| Cable type | Shielded |

Ethernet Port

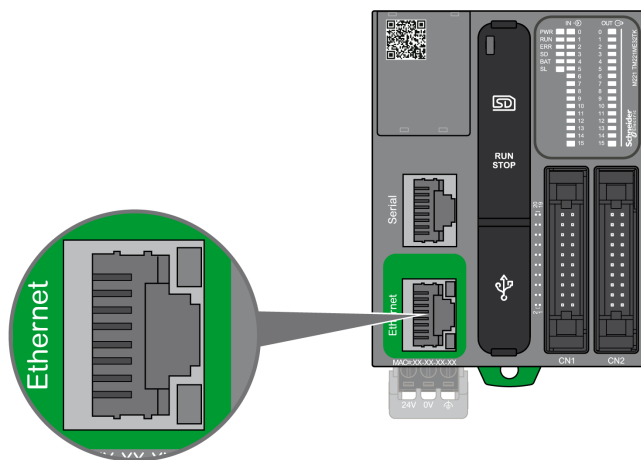
Overview

The TM221•E... are equipped with an Ethernet communication port.

The following figure presents the location of the Ethernet port on the TM221C Logic Controller:



The following figure presents the location of the Ethernet port on the TM221M Logic Controller:



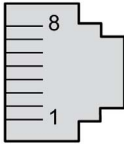
Characteristics

The following table describes Ethernet characteristics:

| Characteristic | Description |
|--------------------------------|---|
| Function | Modbus TCP/IP |
| Connector type | RJ45 |
| Driver | <ul style="list-style-type: none"> • 10 M half duplex (auto negotiation) • 100 M full duplex (auto negotiation) |
| Cable type | Shielded |
| Automatic cross-over detection | Yes |

Pin Assignment

The following figure presents the RJ45 Ethernet connector pin assignment:



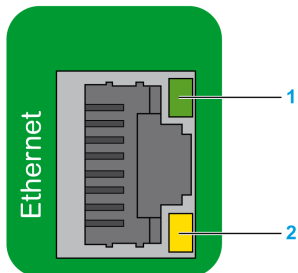
The following table describes the RJ45 Ethernet connector pins:

| Pin N° | Signal |
|--------|--------|
| 1 | TD+ |
| 2 | TD- |
| 3 | RD+ |
| 4 | - |
| 5 | - |
| 6 | RD- |
| 7 | - |
| 8 | - |

NOTE: The controller supports the MDI/MDIX auto-crossover cable function. It is not necessary to use special Ethernet crossover cables to connect devices directly to this port (connections without an Ethernet hub or switch).

Status LED

The following figures show the RJ45 connector status LED:



The following table describes the Ethernet status LEDs:

| Label | Description | LED | | |
|---------|-------------------|--------|----------|---|
| | | Color | Status | Description |
| 1: ACT | Ethernet activity | Green | Off | No activity, or logic controller is connected to a hub. |
| | | | Flashing | Activity |
| 2: LINK | Ethernet link | Yellow | Off | No link |
| | | | On | Link |

A change in the value of system bits %S34, %S35, or %S36 may provoke a reinitialization of the Ethernet channel. As a consequence, the Ethernet channel may not be available for several seconds after a change in the values of these System Bits.

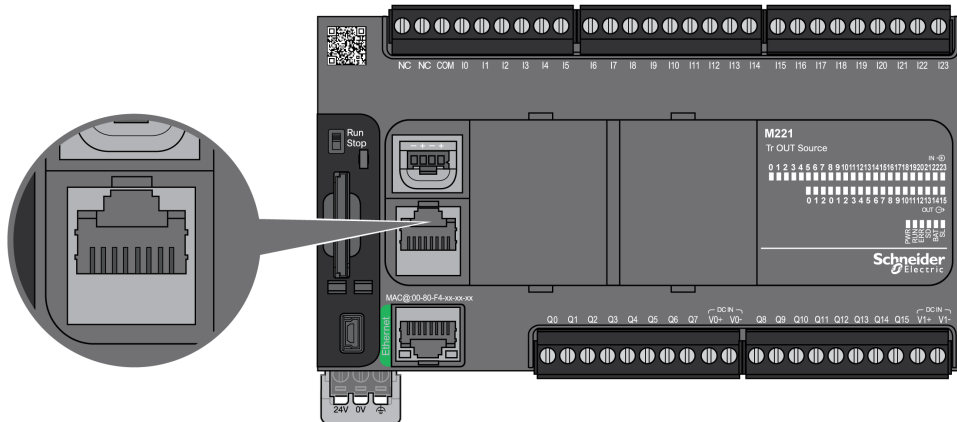
Serial Line 1

Overview

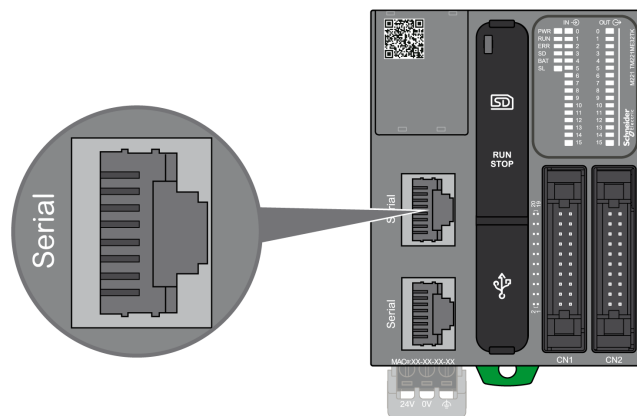
The serial line 1:

- can be used to communicate with devices supporting the Modbus protocol as either master or slave, ASCII protocol (printer, modem...) and SoMachine Basic Protocol (HMI,...).
- provides a 5 Vdc power distribution.

The following figure shows the location of the serial line 1 port on the TM221C Logic Controller:



The following figure shows the location of the serial line 1 port on the TM221M Logic Controller:



Characteristics

| Characteristic | | Description |
|------------------------------|--|---|
| Function | | RS485 or RS232 software configured |
| Connector type | | RJ45 |
| Isolation | | Non-isolated |
| Maximum baud rate | | 1200 up to 115 200 bps |
| Cable | Type | Shielded |
| | Maximum length (between the controller and an isolated junction box) | 15 m (49 ft) for RS485 3 m (9.84 ft) for RS232 |
| Polarization | | No |
| 5 Vdc power supply for RS485 | | Yes |

NOTE: Some devices provide voltage on RS485 serial connections. Do not connect these voltage lines to your controller as they may damage the controller serial port electronics and render the serial port inoperable.

NOTICE

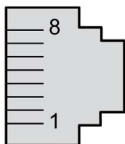
INOPERABLE EQUIPMENT

Use only the VW3A8306R** serial cable to connect RS485 devices to your controller.

Failure to follow these instructions can result in equipment damage.

Pin Assignment

The following figure shows the pins of the RJ45 connector:



The table below describes the pin assignment of the RJ45 connector:

| Pin | RS232 | RS485 |
|--|-------|-------|
| 1 | RxD | N.C. |
| 2 | TxD | N.C. |
| 3 | RTS | N.C. |
| 4 | N.C. | D1 |
| * 5 Vdc delivered by the controller. Do not connect. | | |

| Pin | RS232 | RS485 |
|-----|--------|--------|
| 5 | N.C. | D0 |
| 6 | CTS | N.C. |
| 7 | N.C.* | 5 Vdc |
| 8 | Common | Common |

* 5 Vdc delivered by the controller. Do not connect.

CTS: Clear To Send

N.C.: No Connection

RTS: Ready To Send

RxD: Received Data

TxD: Transmitted Data

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

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

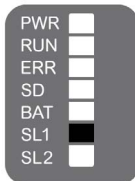
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Status LED

The following figure shows the serial line 1 status LED of the TM221C Logic Controller:



The following figure shows the serial line 1 status LED of the TM221M Logic Controller:



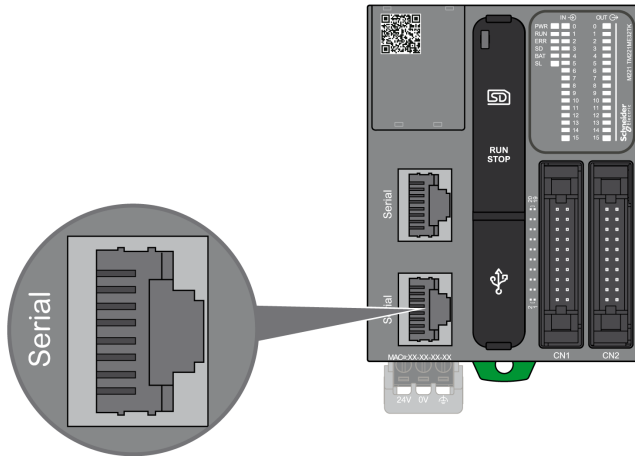
The table below describes the status LED of the serial line 1:

| Label | Description | LED | | |
|-------|---------------|-------|--------|---|
| | | Color | Status | Description |
| SL1 | Serial Line 1 | Green | On | Indicates the activity of the serial line 1 |
| | | | Off | Indicates no serial communication |

Serial Line 2

Overview

The serial line 2 is used to communicate with devices supporting the Modbus protocol as either a master or slave and ASCII Protocol (printer, modem...) and supports RS485 and terminal block.

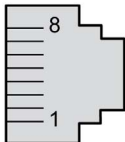


Characteristics

| Characteristic | | Description |
|------------------------------|----------------|---------------------------|
| Function | | RS485 software configured |
| Connector type | | RJ45 |
| Isolation | | Non-isolated |
| Maximum baud rate | | 1200 up to 115 200 bps |
| Cable | Type | Shielded |
| | Maximum length | 15 m (49 ft) for RS485 |
| Polarization | | No |
| 5 Vdc power supply for RS485 | | No |

Pin Assignment

The following figure presents the pins of the RJ45 connector:



The table below describes the pin assignment for RS485:

| Pin | RS485 | Description |
|-----|--------|-----------------------------------|
| 1 | N.C. | No connection |
| 2 | N.C. | No connection |
| 3 | N.C. | No connection |
| 4 | D1 | Modbus SL: D1 (+/B) RS-485 2-wire |
| 5 | D0 | Modbus SL: D0 (-/A) RS-485 2-wire |
| 6 | N.C. | No connection |
| 7 | N.C. | No connection |
| 8 | Common | Common |

⚠ WARNING

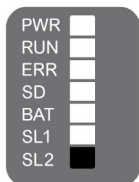
UNINTENDED EQUIPMENT OPERATION

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.

Status LED

The following graphic presents the status LED:



The table below describes the serial line 2 status LED:

| Label | Description | LED | | |
|-------|---------------|-------|--------|--|
| | | Color | Status | Description |
| SL2 | Serial Line 2 | Green | On | Indicates the activity of the serial line 2. |
| | | | Off | Indicates no serial communication. |

Chapter 30

Connecting the M221 Logic Controller to a PC

Connecting the Controller to a PC

Overview

To transfer, run, and monitor the applications, connect the controller to a computer, that has SoMachine Basic 1.0 or later installed, using either a USB cable or an Ethernet connection (for those references that support an Ethernet port).

NOTICE

INOPERABLE EQUIPMENT

Always connect the communication cable to the PC before connecting it to the controller.

Failure to follow these instructions can result in equipment damage.

USB Mini-B Port Connection

TCSXCNAMUM3P: This USB cable is suitable for short duration connections such as quick updates or retrieving data values.

BMXXCAUSBH018: Grounded and shielded, this USB cable is suitable for long duration connections on a TM221C Logic Controller.

BMXXCAUSBH045: Grounded and shielded, this USB cable is suitable for long duration connections on a TM221M Logic Controller.

NOTE: You can only connect 1 controller or any other device associated with SoMachine Basic and its component to the PC at any one time.

WARNING

INSUFFICIENT POWER FOR USB DOWNLOAD

Do not use a USB cable longer than 3m (9.8 ft) for USB powered download.

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

The USB Mini-B Port is the programming port you can use to connect a PC with a USB host port using SoMachine Basic software. Using a typical USB cable, this connection is suitable for quick updates of the program or short duration connections to perform maintenance and inspect data values. It is not suitable for long-term connections such as commissioning or monitoring without the use of specially adapted cables to help minimize electromagnetic interference.

⚠ WARNING

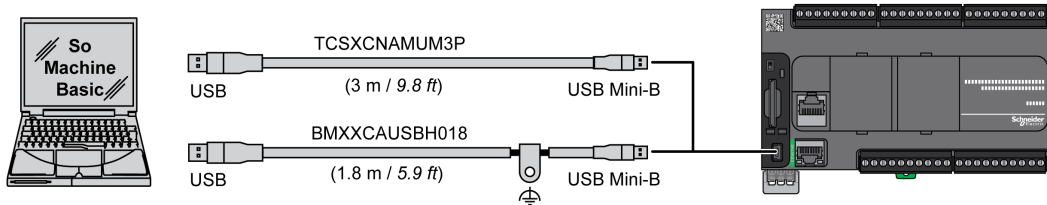
UNINTENDED EQUIPMENT OPERATION OR INOPERABLE EQUIPMENT

- You must use a shielded USB cable such as a BMX XCAUSBH0** secured to the functional ground (FE) of the system for any long-term connection.
- Do not connect more than one controller at a time using USB connections.
- Do not use the USB port(s), if so equipped, unless the location is known to be non-hazardous.

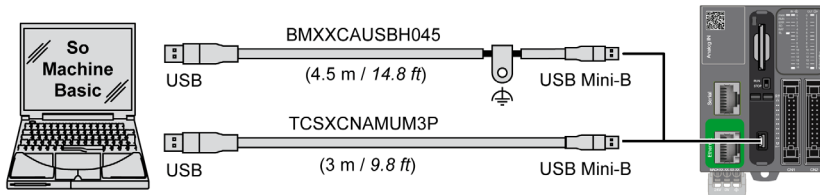
Failure to follow these instructions can result in death, serious injury, or equipment damage.

The communication cable should be connected to the PC first to minimize the possibility of electrostatic discharge affecting the controller.

The following illustration shows the USB connection to a PC on a TM221C Logic Controller:



The following illustration shows the USB connection to a PC on a TM221M Logic Controller:



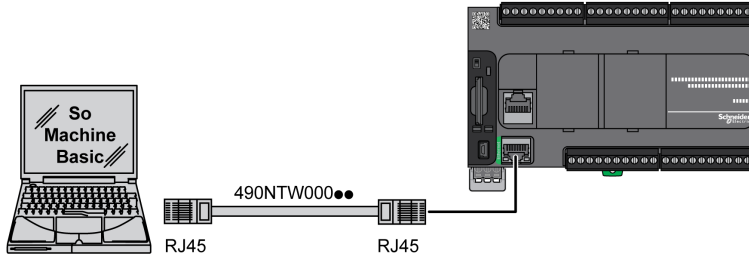
To connect the USB cable to your controller, follow the steps below:

| Step | Action |
|------|--|
| 1 | <p>1a If making a long-term connection using the cable BMXXCAUSBH045, or other cable with a ground shield connection, be sure to securely connect the shield connector to the functional ground (FE) or protective ground (PE) of your system before connecting the cable to your controller and your PC.</p> <p>1b If making a short-term connection using the cable TCSXCNAMUM3P or other non-grounded USB cable, proceed to step 2.</p> |
| 2 | Connect your USB cable to the computer. |
| 3 | Open the hinged access cover. |
| 4 | Connect the Mini connector of your USB cable to the controller USB connector. |

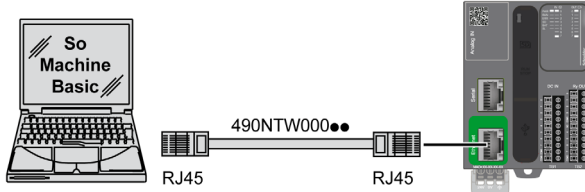
Ethernet Port Connection

You can also connect the controller to a PC using an Ethernet cable.

The following illustration shows the Ethernet connection to a PC on a TM221C Logic Controller:



The following illustration shows the Ethernet connection to a PC on a TM221M Logic Controller:



To connect the controller to the PC, do the following:

| Step | Action |
|------|---|
| 1 | Connect your Ethernet cable to the PC. |
| 2 | Connect your Ethernet cable to the Ethernet port on the controller. |

Glossary



A

analog input

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

application

A program including configuration data, symbols, and documentation.

ASCII

(American standard code for Information Interchange) A protocol for representing alphanumeric characters (letters, numbers, certain graphics, and control characters).

B

bps

(bit per second) A definition of transmission rate, also given in conjunction with multiplier kilo (kbps) and mega (mbps).

C

configuration

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

controller

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

CTS

(clear to send) A data transmission signal and acknowledges the RDS signal from the transmitting station.

CW/CCW

ClockWise / Counter ClockWise

D

DIN

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

E

EIA rack

(*electronic industries alliance rack*) A standardized (EIA 310-D, IEC 60297, and DIN 41494 SC48D) system for mounting various electronic modules in a stack or rack that is 19 inches (482.6 mm) wide.

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*).

expansion bus

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

F

FE

(*functional Earth*) A common grounding connection to enhance or otherwise allow normal operation of electrically sensitive equipment (also referred to as functional ground in North America).

In contrast to a protective Earth (protective ground), a functional earth connection serves a purpose other than shock protection, and may normally carry current. Examples of devices that use functional earth connections include surge suppressors and electromagnetic interference filters, certain antennas, and measurement instruments.

FreqGen

(*frequency generator*) A function that generates a square wave signal with programmable frequency.

G

GRAFCET

The functioning of a sequential operation in a structured and graphic form.

This is an analytical method that divides any sequential control system into a series of steps, with which actions, transitions, and conditions are associated.

H

HE10

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

HSC

(*high-speed counter*) A function that counts pulses on the controller or on expansion module inputs.

I**I/O**

(*input/output*)

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.

IEC 61131-3

Part 3 of a 3-part IEC standard for industrial automation equipment. IEC 61131-3 is concerned with controller programming languages and defines 2 graphical and 2 textual programming language standards. The graphical programming languages are ladder diagram and function block diagram. The textual programming languages include structured text and instruction list.

IL

(*instruction list*) A program written in the language that is composed of a series of text-based instructions executed sequentially by the controller. Each instruction includes a line number, an instruction code, and an operand (refer to IEC 61131-3).

instruction list language

A program written in the instruction list language that is composed of a series of text-based instructions executed sequentially by the controller. Each instruction includes a line number, an instruction code, and an operand (see IEC 61131-3).

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.

L**ladder diagram language**

A graphical representation of the instructions of a controller program with symbols for contacts, coils, and blocks in a series of rungs executed sequentially by a controller (see IEC 61131-3).

LD

(*ladder diagram*) A graphical representation of the instructions of a controller program with symbols for contacts, coils, and blocks in a series of rungs executed sequentially by a controller (refer to IEC 61131-3).

M

Modbus

The protocol that allows communications between many devices connected to the same network.

N

NEMA

(*national electrical manufacturers association*) The standard for the performance of various classes of electrical enclosures. The NEMA standards cover corrosion resistance, ability to help protect from rain, submersion, and so on. For IEC member countries, the IEC 60529 standard classifies the ingress protection rating for enclosures.

P

PE

(*Protective Earth*) A common grounding connection to help avoid the hazard of electric shock by keeping any exposed conductive surface of a device at earth potential. To avoid possible voltage drop, no current is allowed to flow in this conductor (also referred to as *protective ground* in North America or as an equipment grounding conductor in the US national electrical code).

program

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

PTO

(*pulse train outputs*) A fast output that oscillates between off and on in a fixed 50-50 duty cycle, producing a square wave form. PTO is especially well suited for applications such as stepper motors, frequency converters, and servo motor control, among others.

PWM

(*pulse width modulation*) A fast output that oscillates between off and on in an adjustable duty cycle, producing a rectangular wave form (though you can adjust it to produce a square wave).

R

RJ45

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

RS-232

A standard type of serial communication bus, based on 3 wires (also known as EIA RS-232C or V.24).

RS-485

A standard type of serial communication bus, based on 2 wires (also known as EIA RS-485).

RTS

(*request to send*) A data transmission signal and CTS signal that acknowledges the RTS from the destination node.

RxD

The line that receives data from one source to another.

S**SFC**

(*sequential function chart*) A language that is composed of steps with associated actions, transitions with associated logic condition, and directed links between steps and transitions. (The SFC standard is defined in IEC 848. It is IEC 61131-3 compliant.)

T**terminal block**

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

TxD

The line that sends data from one source to another.



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