

SoHVAC

Modicon M168 Controller Hardware Guide

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

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

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

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

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Safety Information



Important Information

NOTICE

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, 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 an imminently hazardous situation which, if not avoided, **will result in** death or serious injury.

WARNING

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

CAUTION

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

CAUTION

CAUTION, used without the safety alert symbol, indicates a potentially hazardous situation which, if not avoided, **can result in** equipment damage.

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 the installation, and has received the safety training necessary to recognize and avoid the hazards involved.

About the Book



At a Glance

Document Scope

This document describes the M168 controller, expansions, and accessories including installation and wiring information.

Validity Note

This document is valid for SoHVAC V1.0.

Related Documents

Title of Documentation	Reference Number
Air Handling Units Parametric Controllers User Manual	TM168 UMAHU101
Single and Twin Circuit Scroll Compressors Chiller Parametric Controllers User Manual	TM168 UMCHL1
SoHVAC Development Environment for Programmable Controllers Introduction Manual for the C Programming Language	EIO0000000536
SoHVAC Software User Manual	EIO0000000537
SoHVAC Standard Library User Guide	EIO0000000538
TM16823● and TM168E17 Instruction sheet	S1A71258
TM168GD●● Instruction sheet	S1A78528
TM168DEVCM/TM168AVCM Instruction sheet	S1A78530
Network Connectivity Modules for M168 controllers	S1A42781

You can download these technical publications and other technical information from our website at www.schneider-electric.com.

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.
- Always use a properly rated voltage sensing device to confirm the power is removed.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- Use only the specified voltage when operating this equipment and any associated products.

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

The application of this product requires expertise in the design and programming of control systems. Only the user or integrator can be aware of all the conditions and factors present during installation and setup, operation, and maintenance of the application, 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, the user or integrator must also consider any applicable local, regional or national standards and/or regulations.

⚠ WARNING**REGULATORY INCOMPATIBILITY**

Be sure that all equipment applied and systems designed comply with all applicable local, regional and national regulations and standards.

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

This equipment has been designed to operate outside of any hazardous location. Only install this equipment in zones known to be free of hazardous atmosphere.

⚠ DANGER

EXPLOSION HAZARD

This equipment is suitable for use in non-hazardous locations only.

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.

User Comments

We welcome your comments about this document. You can reach us by e-mail at techcomm@schneider-electric.com.

1. M168 Offer Introduction

The **M168** controller family includes:

- Programmable Controllers and parametric controllers that are pre-programmed for specific machines and machine applications. The controllers are programmed with SoHVAC in a simple and intuitive way using the function blocks.
- I/O expansion module.
- Dedicated displays.
- Specific modules such as expansion valve control modules and other accessories.

1.1. Controllers

The M168 range includes programmable controllers with the following options:

- Built-in display
- Network connectivity slot
- The ability to execute solution-based application function blocks (AFB). This applies to S-Type controllers only--indicated by an 'S' at the end of the controller reference.



1.1.1. Main Features

Analog Inputs

The TM168●23 controller has 5 analog inputs that are configurable by software for the:

- NTC probes: -50...120 °C (-58...248 °F) (10 K Ω \pm 1% at 25 °C (77 °F))
- PTC probes: -50...150 °C (-58...302 °F) (990 Ω \pm 1% at 25 °C (77 °F))
- PT1000 probes: -100...200 °C (-148...392 °F)
- 0...5 Vdc ratiometric transducers
- 0...10 Vdc transducers
- 0...20 mA transducers
- 4...20 mA transducers

Digital Inputs

The TM168●23 is equipped with 7 isolated low-voltage digital inputs.

Digital Outputs

The TM168●23 is equipped with 8 digital outputs:

- 7 NO relays
- 1 CO relay

Analog Outputs

The TM168●23 is equipped with 3 analog outputs:

- 2 configurable:
 - 0...10 Vdc
 - 0...20 mA
 - 4...20 mA
- 1 output reserved for future expansions of functionality.

Serial Ports

The controllers have the following serial communication ports:

- 2 Modbus serial ports:
 - 1 RS-485 for use with the Modbus protocol (Slave only)
 - 1 RS-485 for use with the Modbus protocol (Master or Slave)
- 1 serial port for connecting expansion modules (ExpBus)
- 1 programming port

In addition the TM168●23C● controllers have:

- 1 network slot for Building Management System (BMS) connectivity

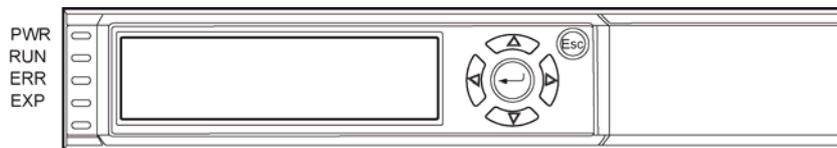
User Interface (Optional)

2 versions of controllers are available:

- TM168D23●● with built-in user interface
- TM168B23●● without built-in user interface

The built-in user interface has:

- 120*32 graphic LCD display with backlight
- keypad with 6 keys and 4 signal LEDs



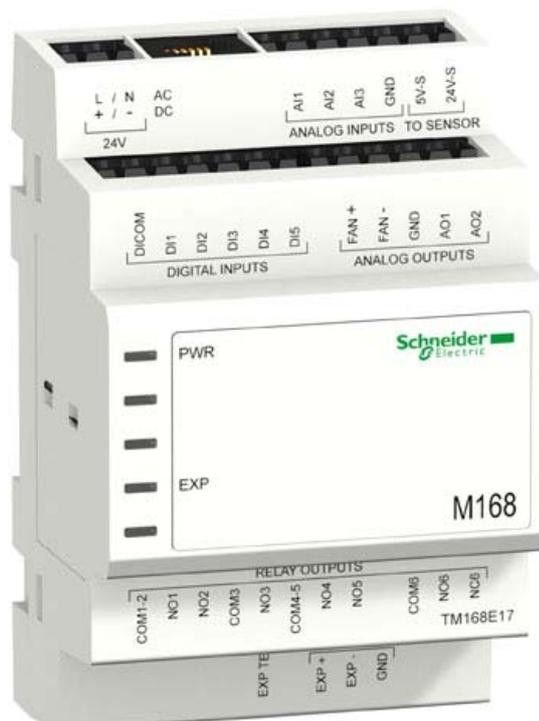
RTC

A Real Time Clock is embedded in the controller.

1.2. Expansions

The M168 controller expansions allow you to add a display module and/or increase the number of inputs and outputs available to your application.

NOTE: The TM168E17 I/O expansion module only operates when connected to the expansion bus of an M168 controller. It does not operate with other controllers.



1.2.1. Main Features

Analog Input

The TM168E17 expansion is equipped with 3 analog inputs that you can configure using the SoHVAC software:

- NTC probes: 50...120 °C (-58...248 °F) (10 K Ω ±1% at 25 °C (77 °F))
- PTC probes: -50...150 °C (-58...302 °F) (990 Ω ±1% at 25 °C (77 °F))
- 0...5 Vdc ratiometric transducers / 0...10 Vdc transducers
- 0...20 mA transducers / 4...20 mA transducers
- PT1000: -100...200 °C (-148...392 °F)

Digital Input

The TM168E17 expansion is equipped with 5 non-isolated dry contact digital inputs. The module supplies the dry contact inputs voltage.

Do not use an external power supply to provide power to devices connected to these inputs. The use of an external power supply with these inputs can damage your TM168E17 I/O Expansion Module.

CAUTION

INOPERABLE EQUIPMENT

Do not connect an external power supply to the dry contact inputs of the I/O Expansion Module.

Failure to follow these instructions can result in equipment damage.

Digital Output

The TM168E17 expansion is equipped with 6 digital outputs:

- 5 NO relays
- 1 CO relay

Analog Output

The TM168E17 expansion is equipped with 3 analog outputs:

- 2 configurable by software through SoHVAC for 0...10 Vdc, or 0...20 mA, or 4...20 mA
- 1 for PWM

Serial Ports

The expansions have the following serial communication ports:

- 1 serial port for connecting to the controller and additional I/O expansion modules (expansion bus)
- 1 port for firmware updates

Displays

The M168 range includes 2 external displays:

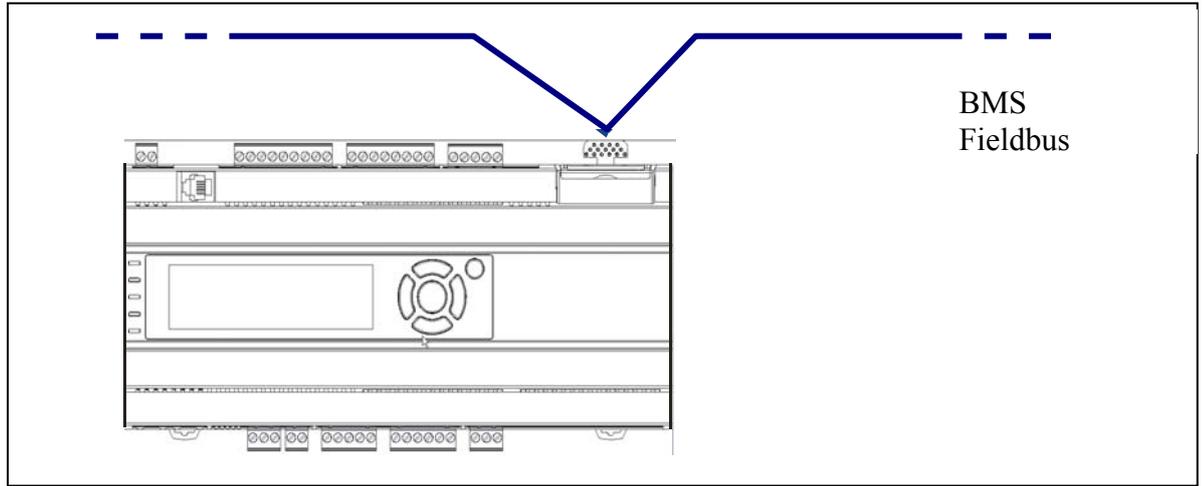
- TM168GDB and
- TM168GDTS



1.3. BMS Connectivity

The M168 **TM168•23C•** controllers include a network connectivity slot into which you can install a module supporting Building Management System (BMS) connections.

Controller with a BMS connectivity module installed:



BACnet MS/TP module example:



For more information on how to connect your module to the BMS network, see the Network Connectivity Modules for M168 Controllers User Guide.

1.4. Parameter key

The Parameter Key TM168APARAKEY allows you to transfer your controller configuration parameters rapidly to several machines:

- copy parameters and data from the controller to the Parameter Key (upload)
- copy parameters from Parameter Key to the controller (download)

NOTE: The download of parameters from the key to the controller is allowed only if data in the controller and the key match.

The controller needs to be connected to a power supply to use the Parameter Key.



NOTE: The copying of parameters from the key to the controller (download) is allowed only if data in the controller and the key match

A remote display is required for controllers that do not have a built-in display to use the Parameter Key.

You can perform upload/download operations using the standard upload/download page present on the main controller.

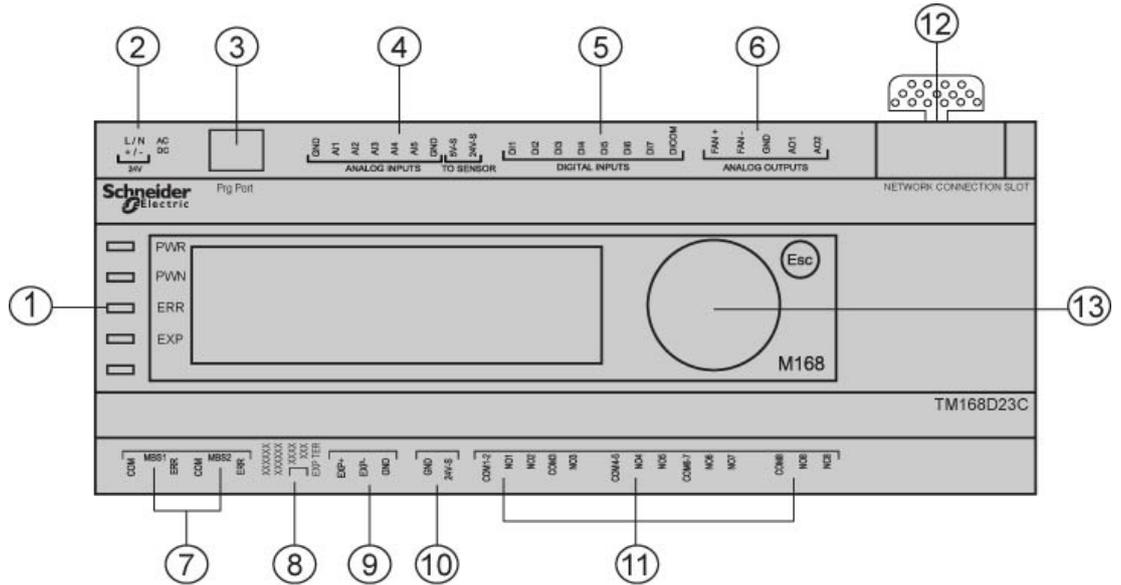
NOTE: Information of upload/download completed is available in the controller page.

2. Controllers and I/O Expansions

2.1. Controller and Expansion Range

Reference	Display	Analog Inputs	Analog Outputs	PWM Output	Low-Voltage Digital Input	High-Voltage Digital Input	Dry contact Input	Relay Outputs	Communication ports	Network connectivity slot
TM168B23/ TM168B23S	No	5	2	1	7	0	-	8	2 Modbus + ExpBus	No
TM168B23C/ TM168B23CS	No	5	2	1	7	0	-	8	2 Modbus + ExpBus	Yes
TM168D23/ TM168D23S	Yes	5	2	1	7	0	-	8	2 Modbus + ExpBus	No
TM168D23C/ TM168D23CS	Yes	5	2	1	7	0	-	8	2 Modbus + ExpBus	Yes
TM168E17	No	3	2	1	0	0	5	6	ExpBus	No

2.2. Physical Description of a Controller



Number	Description
1	LED Status
2	Power supply unit terminal block
3	Programming port
4	Analog inputs terminal block
5	Digital inputs terminal block
6	Analog outputs terminal block
7	2RJ45 connectors for MBS1 and MBS2 serial lines
8	Dip switches for termination and polarization (Modbus or ExpBUS)
9	ExpBUS terminal block
10	Auxiliary power supply for remote display
11	Relay outputs terminal block
12	Network connectivity slot
13	Built-in display

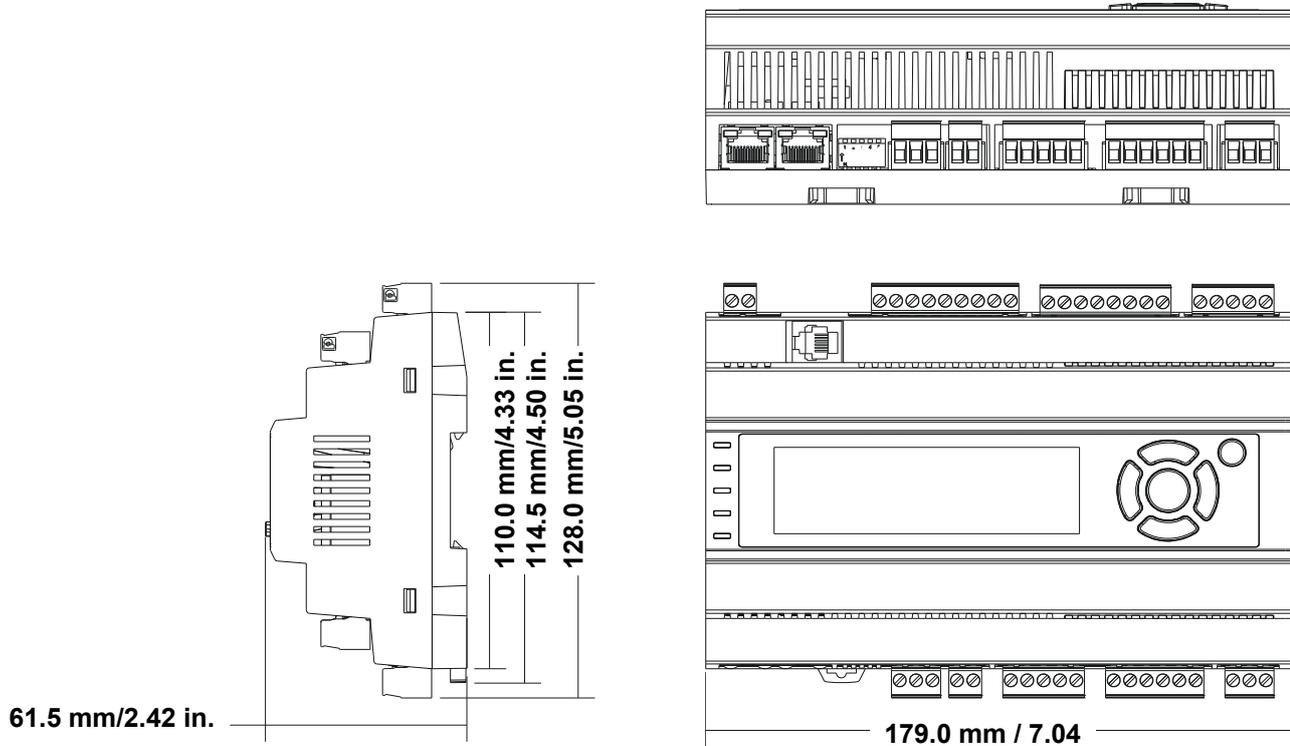
1.

The dimensions of the TM168●23 controllers are displayed below. All dimensions are in millimeters and equivalent inches.

Controllers without Communication Slot:

TM168B23/TM168B23S – Base without built-in display, programmable 23 I/O

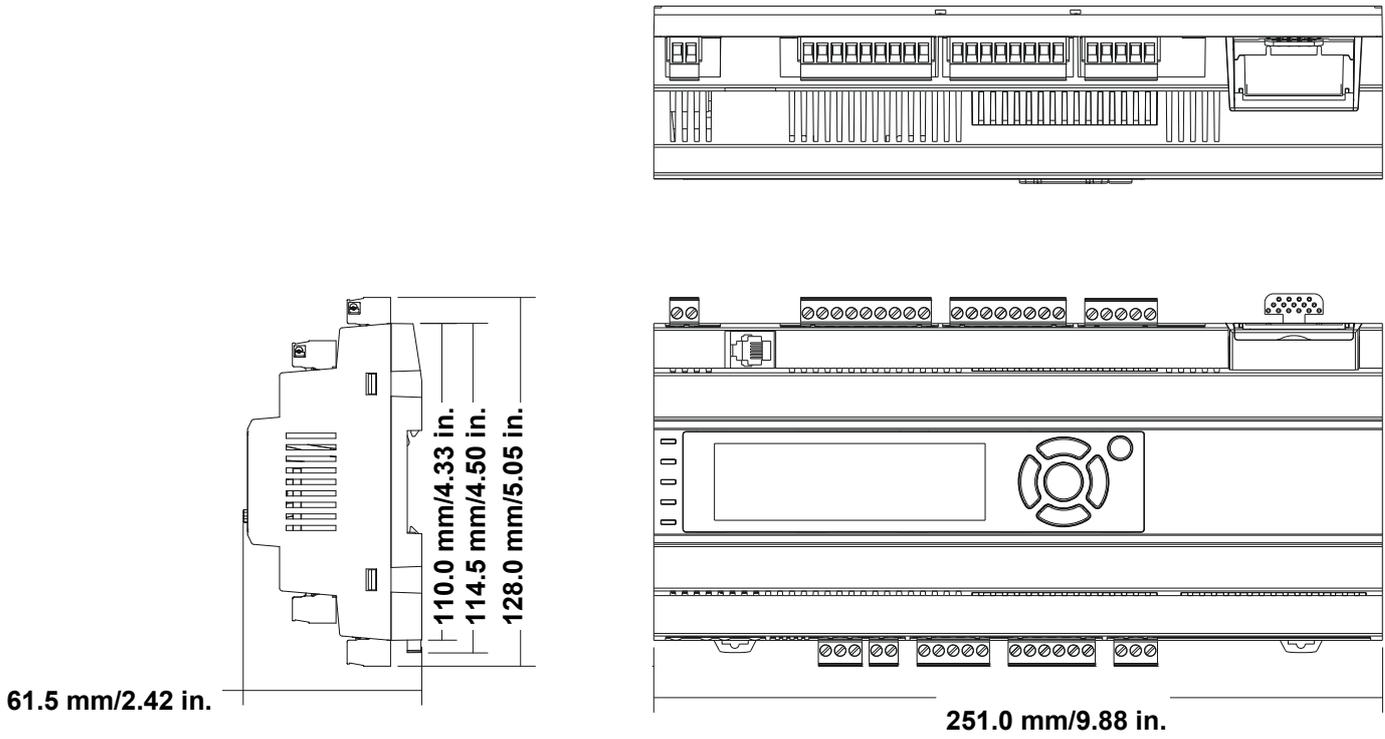
TM168D23/TM168D23S – Base with built-in display, programmable 23 I/O



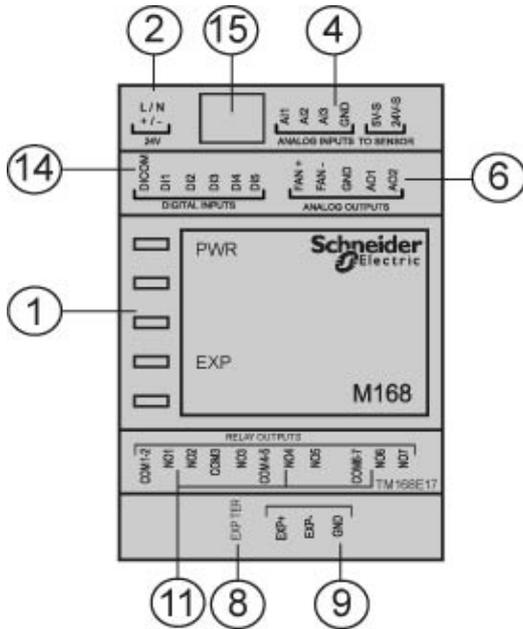
Controllers with communication slot :

TM168B23C/TM168B23CS - Base without built-in display, 23 I/O for BMS

TM168D23C/TM168D23CS - Base with built-in display, 23 I/O for BMS

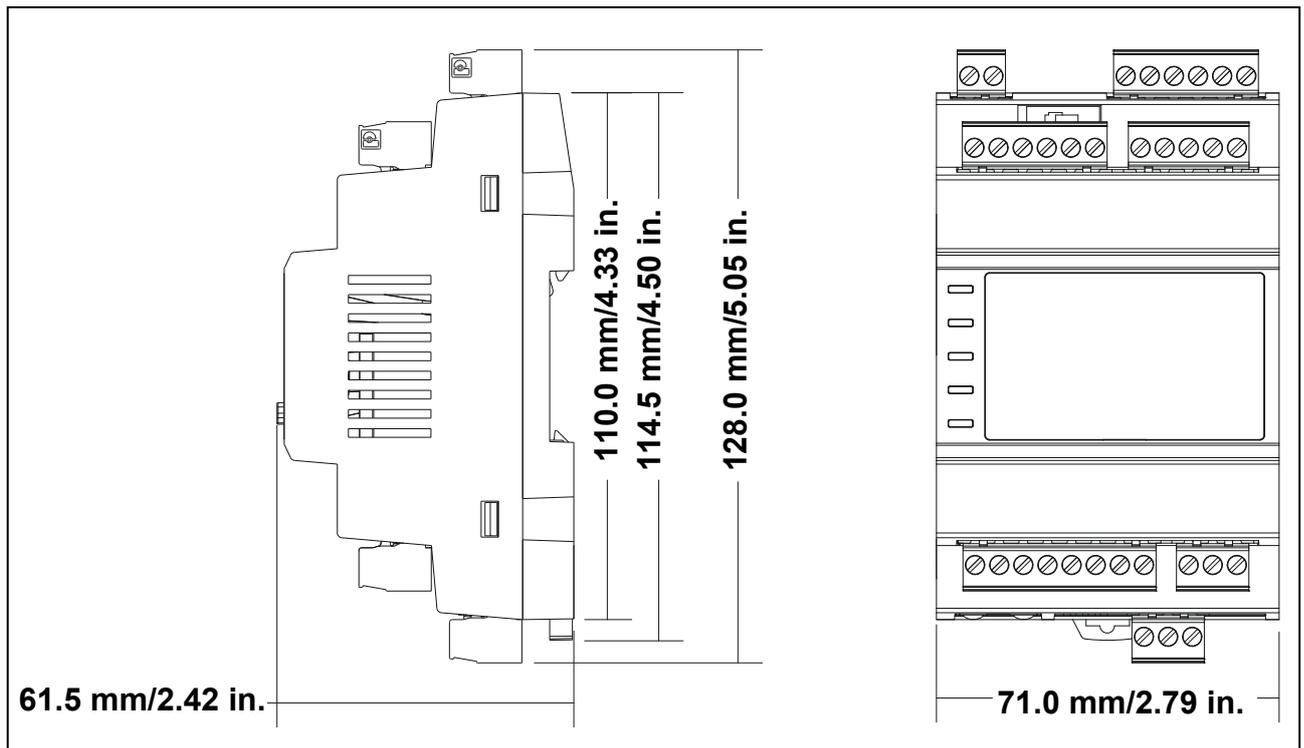


2.3. Physical Description of an I/O Expansion



Number	Description
1	LED Status
2	Power supply unit terminal block
4	Analog inputs terminal block
6	Analog outputs terminal block
8	Dip switches for termination and polarization (Modbus or ExpBUS)
9	ExpBUS terminal block
11	Relay outputs terminal block
14	Dry contact inputs terminal block
15	Programming port (firmware download only)

The TM168E17 – Expansion 17 I/O module dimensions :



2.4. Installation

2.4.1. Installation and Maintenance Requirements

Before Starting

Read and understand this manual before beginning the installation of your M168 Controller. All options and modules should be assembled and installed before installing the control system on a mounting rail. Remove the control system from its mounting rail before disassembling the equipment.

Disconnecting Power

⚠ 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.
- Always use a properly rated voltage sensing device to confirm the power is removed.
- 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

This equipment has been designed to operate outside of any hazardous location. Only install this equipment in zones known to be free of hazardous atmosphere.

⚠ DANGER

EXPLOSION HAZARD

This equipment is suitable for use in non-hazardous locations only.

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

- 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.
- 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.
- Do not disassemble, repair, or modify this equipment.
- Do not connect any wiring to unused connections, or to connections designated as Not Connected (N.C.).

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

▲ WARNING

UNINTENDED EQUIPMENT OPERATION

- Install and operate this equipment according to the environmental conditions described in the operating limits.

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

2.4.2. First Start-Up

Introduction

This procedure helps you through the first installation and start-up of your M168 Controller.

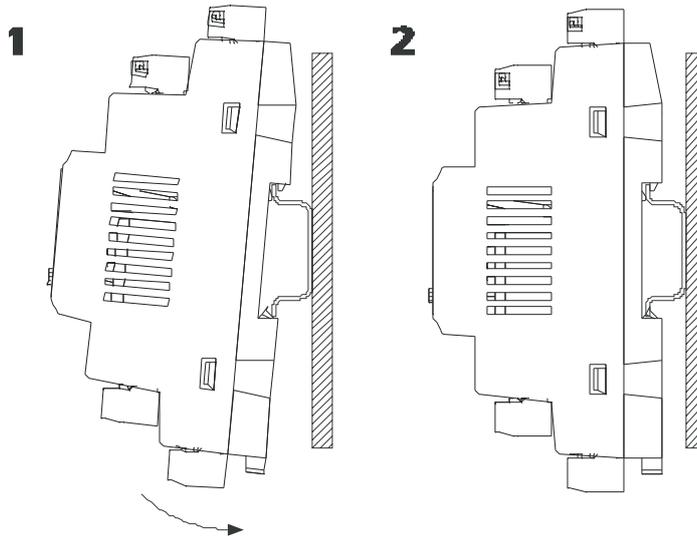
Startup Procedure

Step	Action	Comment
1	Unpack your M168 Controller and check the contents of the package.	Package contents
2	Mount your controller on DIN rail	Refer to Installation on a DIN rail
3	Connect your devices to the Inputs	Refer to the <i>Input Wiring chapter</i>
4	Connect your devices to the Outputs	Refer to the <i>Output Wiring chapter</i>
5	Connect your M168 Controller to the power supply.	Refer to Power Supply
6	Connect your M168 Controller to your PC.	SoHVAC must be installed on your PC.
7	Apply power	Refer to State Machine in the <i>SoHVAC Software User Manual</i> .
8	Create an application	Refer to the <i>SoHVAC Software User Manual</i> .
9	Download your application into the M168 Controller.	Refer to the <i>SoHVAC Software User Manual</i> .
10	Run the application to fully test the program and control system before commissioning	Refer to the <i>SoHVAC Software User Manual</i> .

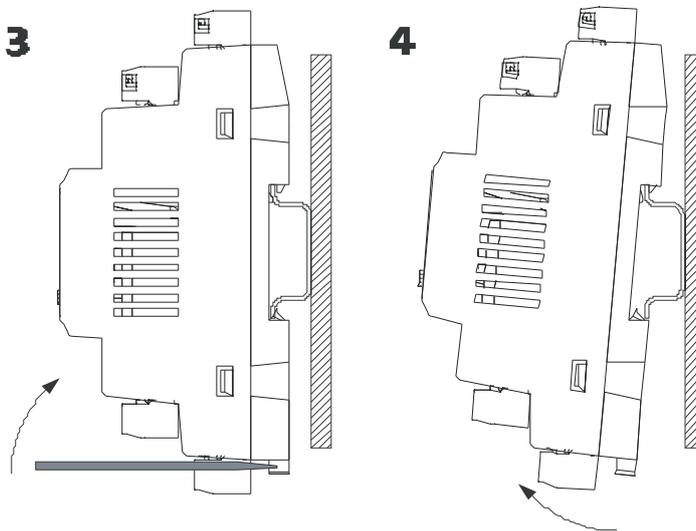
2.4.3. Installation on DIN Rail

The M168 controller and expansion modules must be installed on 35 mm/1.38 in DIN rail complying with EN 50022. The DIN rail depth can be either 7.5 mm/0.29 in or 15 mm/0.59 in.

To install the controller, proceed as indicated in figures 1 and 2.



To remove the controller, use a screw driver and proceed as indicated in figures 3 and 4.



2.4.4. Environmental Features

Environmental Feature	Description
Purpose of the device	Programmable controller for refrigeration, ventilation and air conditioning applications
Type of device	Component to be integrated into HVAC equipment
Connections	Plug-in terminal block 5mm (0.19 in) pitch for conductors up to 2.5 mm ² (14 AWG)
Storage temperature	-30...70 °C (-22...158 °F)
Ambient temperature	-20...65 °C (-4...149 °F) -10...60 °C (14...140 °F) for version with integrated LCD NOTE: for UL conformance, ambient operation temperature is de-rated to a maximum of 55°C (131 °F).
Humidity	Relative Humidity 5...95% non-condensing

Operation altitude	from 0 to 2000 m (0 to 6562 ft)
Transport altitude	from 0 to 3048 m (0 to 10000 ft)
Vibration	5...8.4 Hz: 3.5 mm/0.14 in displacement 8.4 Hz...150 Hz: 1 g _n acceleration
Mechanical shock	15 g _{peak} – 11 ms; half-sine test
Shipping	10 g _n 6 ms (product off)
Pollution degree	2
Overvoltage category	3
EMC compliance level	EN/IEC 60730-1 Annex 16
Product conformity	EN/IEC 60730-1
Environmental regulations	ROHS 2002/95 – WEEE 2002/96/EC- REACH CE1907/2006

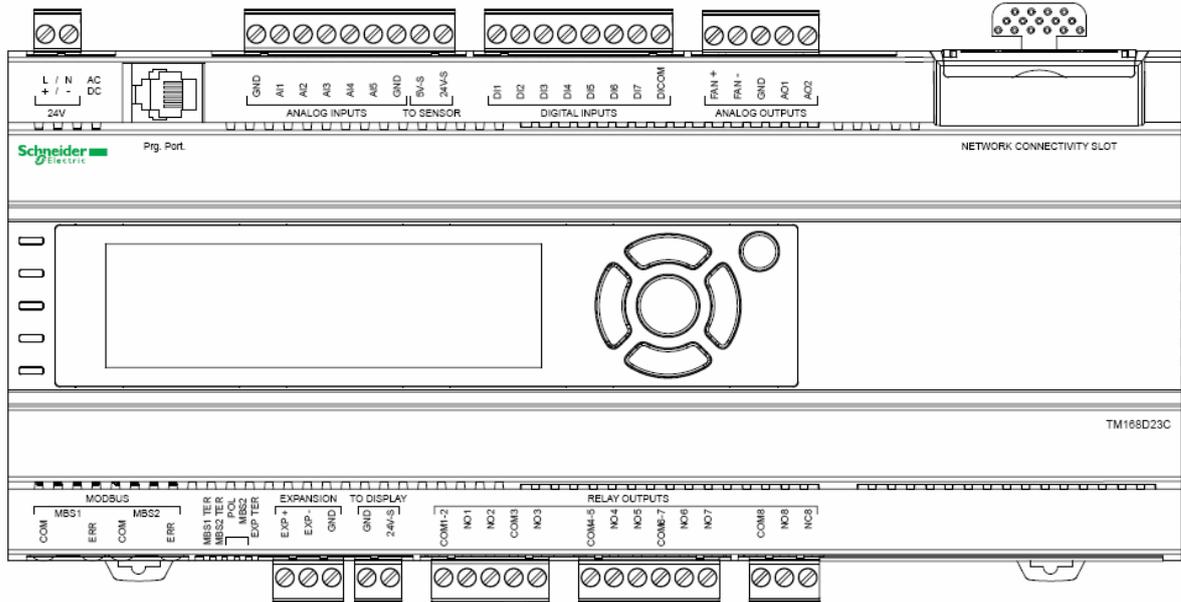
2.4.5. Housing

Installation	35-mm DIN/EN 50022
Housing	DIN 43880
Material	Plastic UL 94 V0
Resistance to fire and heat	IEC/EN 60730 - 1
Protection level	IP 20
Protection level *	IP 40

* When mounted into a panel surface exposing only the display portion of the controller.

2.5. I/O and Connections

2.5.1. Controller Base Wiring Connection Descriptions



The following table describes the available inputs and outputs of TM168●23●:

Letter Code	Description
Analog Outputs	
FAN +	Reserved for future expansions
FAN -	Reserved for future expansions
GND	common terminal for analog outputs
AO 1	analog output number 1 – configurable 0...10 Vdc / 0-4...20 mA
AO 2	analog output number 2 – configurable 0...10 Vdc / 0-4...20 mA

Letter Code	Description
Digital Inputs	
DI 1	low voltage digital input no. 1
DI 2	low voltage digital input no. 2
DI 3	low voltage digital input no. 3
DI 4	low voltage digital input no. 4
DI 5	low voltage digital input no. 5
DI 6	low voltage digital input no. 6

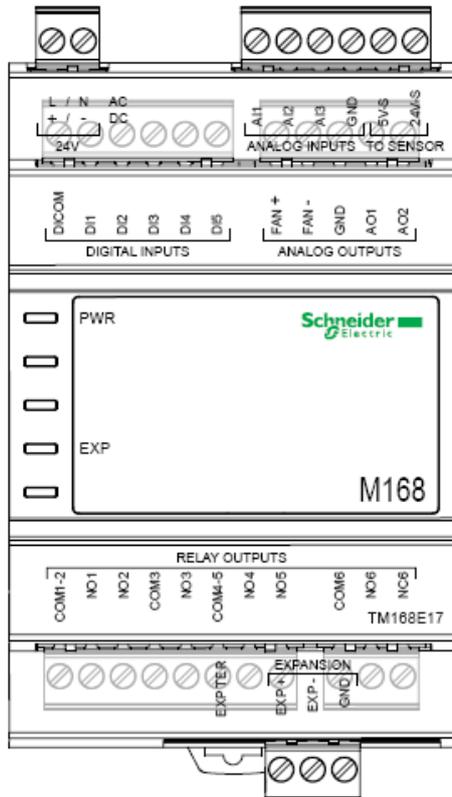
DI 7	low voltage digital input no. 7
DICOM	common terminal for digital inputs
Analog Inputs	
GND	common terminal for analog inputs
AI 1	analog input 1, configurable (NTC, PTC, PT1000, 0...20 mA, 4...20 mA, 0...5 Vdc, 0...10 Vdc)
AI 2	analog input 2, configurable (NTC, PTC, PT1000, 0...20 mA, 4...20 mA, 0...5 Vdc, 0...10 Vdc)
AI 3	analog input 3, configurable (NTC, PTC, PT1000, 0...20 mA, 4...20 mA, 0...5 Vdc, 0...10 Vdc)
AI 4	analog input 4, configurable (NTC, PTC, PT1000, 0...20 mA, 4...20 mA, 0...5 Vdc, 0...10 Vdc)
AI 5	analog input 5, configurable (NTC, PTC, PT1000, 0...20 mA, 4...20 mA, 0...5 Vdc, 0...10 Vdc)
GND	common terminal for probes power supply
5V-S	ratiometric probes power supply output
24V-S	sensor power supply output
Programming Port	
Prg. Port.	RJ11 connector for programming purposes
Power Supply	
L / +	controller power supply
N / -	controller power supply

Letter Code	Description
Digital Outputs	
COM 1-2	common relay number 1...2
NO 1	normally open contact relay number 1
NO 2	normally open contact relay number 2
COM3	common relay number3
NO 3	normally open contact relay number 3
COM 4-5	common relay number 4...5
NO 4	normally open contact relay number 4
NO 5	normally open contact relay number 5
COM 6-7	common relay number 6...7

NO 6	normally open contact relay number 6
NO 7	normally open contact relay number 7
COM8	common relay number 8
NO 8	normally open contact relay number 8
NC 8	normally closed contact relay number 8
Remote User Interface Power Supply	
24V-S	display auxiliary power supply 24 Vdc
GND	display auxiliary power supply common
Expansion Bus Port	
EXP+	expansion bus + signal
EXP-	expansion bus - signal
GND	expansion bus common
Line Termination/Polarization Dip Switch	
1	ON: Modbus Serial 1 line terminated
2	ON: Modbus Serial 2 line terminated
3	ON: Modbus Serial 2 polarized (Dip Switches 3 and 4 have to be in the same position)
4	ON: Modbus Serial 2 polarized (Dip Switches 3 and 4 have to be in the same position)
5	ON: expansion bus line terminated

Letter Code	Description
Modbus Serial Port	
MBS1	Modbus serial 1 port - RJ45 connector
MBS2	Modbus serial 2 port - RJ45 connector

2.5.2. TM168E17 I/O Expansion Module Wiring Connection Descriptions



The following table describes the available inputs and outputs of TM168E17.

Lower Board	
Analog Inputs	
AI 1	analog input 1, configurable (PTC, NTC, 0...20 mA, 4...20 mA, 0...5 Vdc, 0...0 Vdc, PT1000)
AI 2	analog input 2, configurable (PTC, NTC, 0...20 mA, 4...20 mA, 0...5 Vdc, 0...10 Vdc, PT1000)
AI 3	analog input 3, configurable (PTC, NTC, 0...20 mA, 4...20 mA, 0...5 Vdc, 0...10 Vdc, PT1000)
GND	common terminal for probes power supply
5V-S	ratiometric probes power supply output
24V-S	sensor power supply output

Lower Board	
Power Supply	
L / +	controller power supply
N / -	controller power supply
Expansion Bus Port	
EXP+	expansion bus + signal
EXP-	expansion bus - signal
GND	expansion bus common
Dip Switch	
Switch 1	Not Used
Switch 2	EXP TER ON: expansion bus line terminated

Upper Board	
Analog Outputs	
FAN +	reserved for future expansions
FAN -	reserved for future expansions
GND	common terminal for analog outputs
AO 1	analog output number 1 – configurable 0...10 Vdc / 0...20 mA, 4...20 mA
AO 2	analog output number 2 – configurable 0...10 Vdc / 0...20 mA, 4...20mA
Digital Inputs	
DICO M	common terminal for digital inputs
DI 1	dry contact digital input number 1
DI 2	dry contact digital input number 2
DI 3	dry contact digital input number 3
DI 4	dry contact digital input number 4
DI 5	dry contact digital input number 5

Upper Board	
Digital Outputs	
COM 1-2	common relay number 1...2
NO 1	normally open contact relay number 1
NO 2	normally open contact relay number 2
COM 3	common relay number 3
NO 3	normally open contact relay number 3
COM 4-5	common relay number 4...5
NO 4	normally open contact relay number 4
NO 5	normally open contact relay number 5
COM 6	common relay number 6
NO 6	normally open contact relay number 6
NC 6	normally closed contact relay number 6

2.5.3. Cabling Length

I/O and Serial Lines Maximum Length

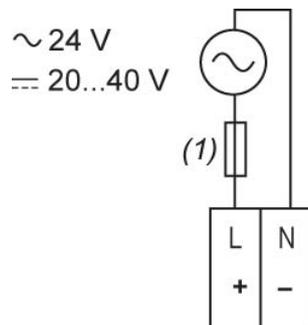
Peripheral Type	Maximum Length
Power supply	30 m (98.42 ft)
Embedded sensor PS	100 m (328.08 ft)
Digital inputs	100 m (328.08 ft)
Analog inputs	100 m (328.08 ft)
Relay digital outputs	100 m (328.08 ft)
Configurable analog outputs	100 m (328.08 ft)
FAN analog output	1 m (3.28 ft)
Modbus SL1 bus	1000 m (3280.83 ft)
Modbus SL2 bus	1000 m (3280.83 ft)
Expansion bus	1000 m (3280.83 ft) (Refer to the section <i>Expansion Bus Serial Port</i> , page Erreur ! Signet non défini.)
Supply for remote display	30 m (98.42 ft)

PC programming port	5 m (16.40 ft)
---------------------	----------------

2.6. Electrical Characteristics

2.6.1. Power Supply

Power Supply	Description
Voltage	24 Vac \pm 15%/20...40 Vdc
Frequency	50/60 Hz \pm 3 Hz
Isolation	isolated SELV or Class 2
Built-in protection	Reverse Polarity
Maximum Consumption	TM168•23•••: - AC supply power: 30 VA - DC supply power: 22 W TM168E17: - AC supply power: 10 VA - DC supply power: 6 W
Protection	TM168•23••• : - External 2.5 A Type T fuse required TM168E17: - External 0.8 A Type T fuse required
Micro-breaks immunity	10 ms



(1) 2.5 A Type T fuse

2.6.2. Analog Inputs

Input Characteristics for Voltage Sensing

Range	0...5 Vdc ratiometric / 0...10 Vdc
Input Impedance	$\geq 10 \text{ k}\Omega$
Accuracy	$\pm 0.5 \%$ of Full scale
Resolution	0.01 Vdc
Conversion time	100 ms
Value of LSB (ADC)	5 mV
Isolation	None
Built-in protection	Reverse protection
Digital Resolution	A/D Conversion: 10 bits

Input Characteristics for Current Sensing

Range	0/4...20 mA
Input Impedance	$\leq 200 \Omega$
Accuracy	$\pm 0.5 \%$ of full scale
Resolution	0.01 mA
Conversion time	100 ms
Value of LSB (ADC)	0.01 mA
Isolation	None
Maximum current	25 mA
Built-in protection	None
Digital Resolution	A/D Conversion: 10 bits

Input Characteristics for Temperature Sensing (NTC at 10 k Ω at 25 °C/77 °F)

NTC type	10 k beta 3435
Range	-50...120 °C (-58...248 °F)
Accuracy	$\pm 0.7 \text{ }^\circ\text{C}$ ($\pm 33,26 \text{ }^\circ\text{F}$) of full scale (-40...100 °C range) (-40... 212 °F range) / $\pm 1 \text{ }^\circ\text{C}$ (-50...- 40 range and 100...120 °C range) (-58...-40 range and -148...302 °F)
Resolution	0.1 °C (32.18 °F)
Conversion time	100 ms

Value of LSB	0.07 °C (32 °F)
Isolation	none
Built-in protection	none
Digital resolution	A/D Conversion: 10 bits

Input Characteristics for Temperature Sensing (PT1000)

Range	-100...200 °C (-148...392 °F)
Accuracy	± 0.5 % of full scale
Resolution	0.5 °C (32.9 °F)
Conversion time	100 ms
Value of LSB (ADC)	0.15 °C (32.27 °F)
Isolation	none
Built-in protection	none
Digital resolution	A/D Conversion: 10 bits

Input Characteristics for Temperature Sensing (PTC at 950 Ω at 25 °C)

PTC type	KTY81_121
Range	-50...150 °C (-58...302 °F)
Accuracy	± 0.5 % of full scale (- 40...100 °C range) (-40...-148 °F range) / ±1 °C (±33.8 °F) (-50...-40;100...150 °C range) (-58...-40; -148...302 °F range)
Resolution	0.1 °C (32.18 °F)
Conversion time	100 ms
Value of LSB	0.07 °C (32 °F)
Isolation	none
Built-in protection	none
Digital resolution	A/D Conversion: 10 bits

Built-in Power Supply for Sensors

+5Vdc	
Voltage	4.4...5 Vdc
Current	40 mA max.
Built-in protection	against overload and short-circuit (thermal protection)

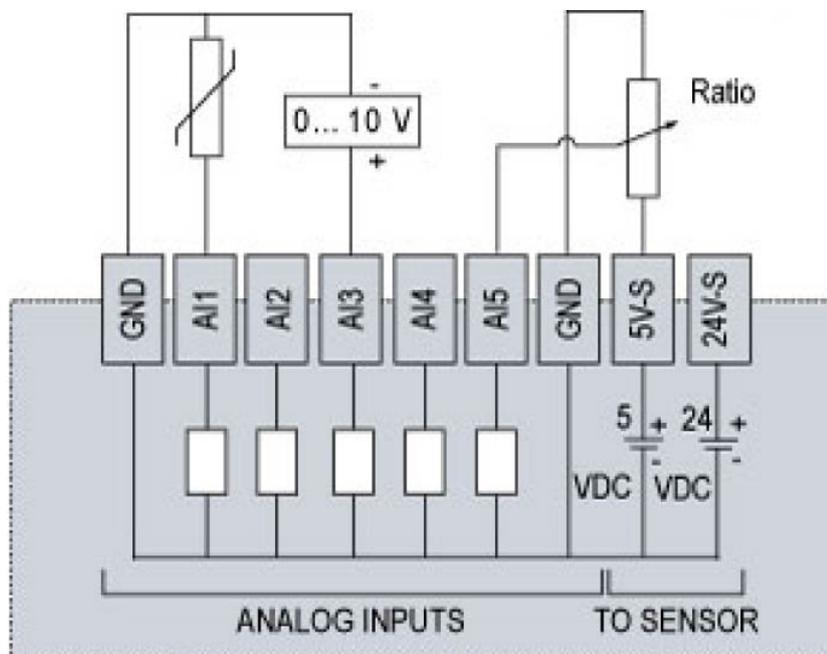
+24Vdc	
Voltage	18...28 Vdc
Current	120 mA max.
Built-in protection	against overload and short-circuit (thermal protection)

The power supply protection is thermal in nature. Once the temperature of the supply diminishes below the temperature threshold, it will automatically attempt to rearm itself.

▲ WARNING
UNINTENDED EQUIPMENT OPERATION
Be sure to remove all power from all equipment when correcting a short-circuit or overload condition
Failure to follow these instructions can result in death, serious injury, or equipment damage.

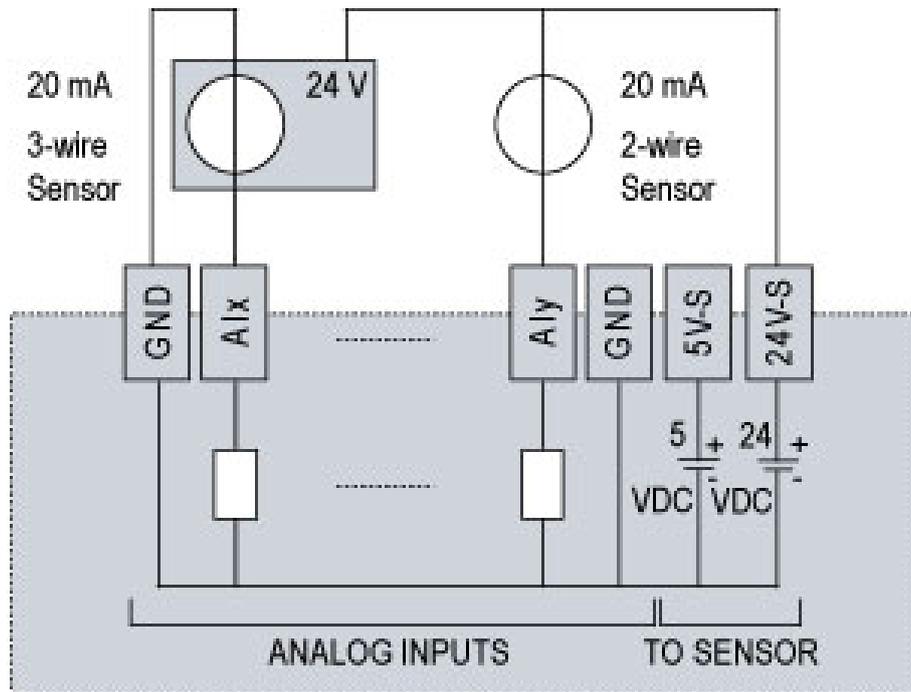
Wiring Diagram for Temperature and Voltage Sensing

Temperature and Voltage mode:



Note: The two common connections (GND) are internally connected.

Wiring Diagram for Current Sensing

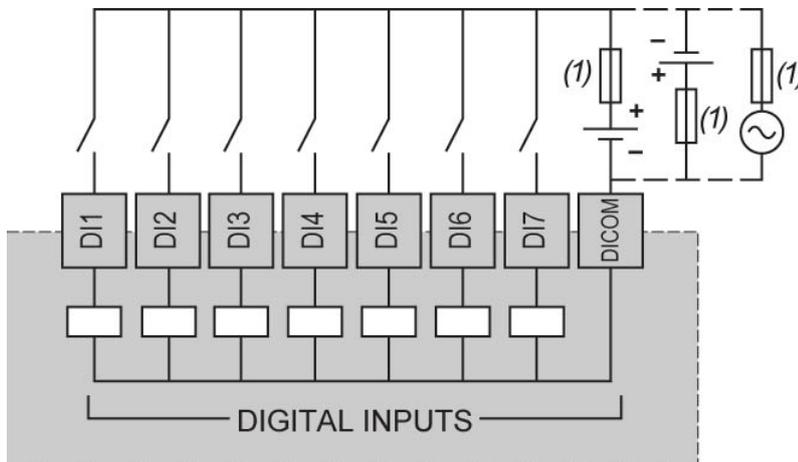


2.6.3. Digital Inputs

Type	24 Vac/24 Vdc opto-isolated voltage input
Auxiliary	Vdc: 20...40 V Vac: 24 V ±15 %; Frequency: 50/60 Hz ± 3 HZ
Input Impedance	> 10 kΩ
Protection against overvoltage	none

Wiring Diagram

Sink/source inputs (positive/negative logic) external power



(1) 0.5 A fast-blow fuse

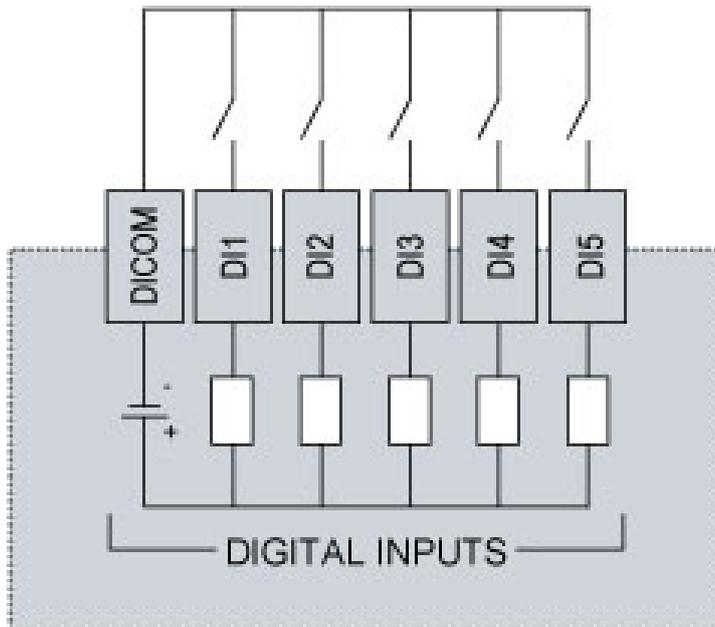
NOTE: You can use either a 24 Vdc or a 24 Vac external power supply.

2.6.4. Dry Contact Digital Inputs

The TM168DEVCM Expansion Module dry contact inputs supply power to the connected input devices. No external power supply is needed.

Type	Dry Contact Input
Level 1	resistance < 500 Ω
Level 0	resistance > 6 kΩ
ON to OFF detection time	< 200 ms (hardware delay)
OFF to ON detection time	< 200 ms (hardware delay)

Wiring Diagram



NOTE: Do not use an external power supply to provide power to devices connected to these inputs. The use of an external power supply with these inputs can damage your TM168E17 I/O Expansion Module.

▲ CAUTION

INOPERABLE EQUIPMENT

Do not connect an external power supply to the dry contact inputs of the I/O Expansion Module.

Failure to follow these instructions can result in equipment damage.

2.6.5. Digital Outputs

Wiring Diagram

⚠ DANGER

FIRE HAZARD

Use only the recommended wire sizes for I/O channels and power supplies.

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

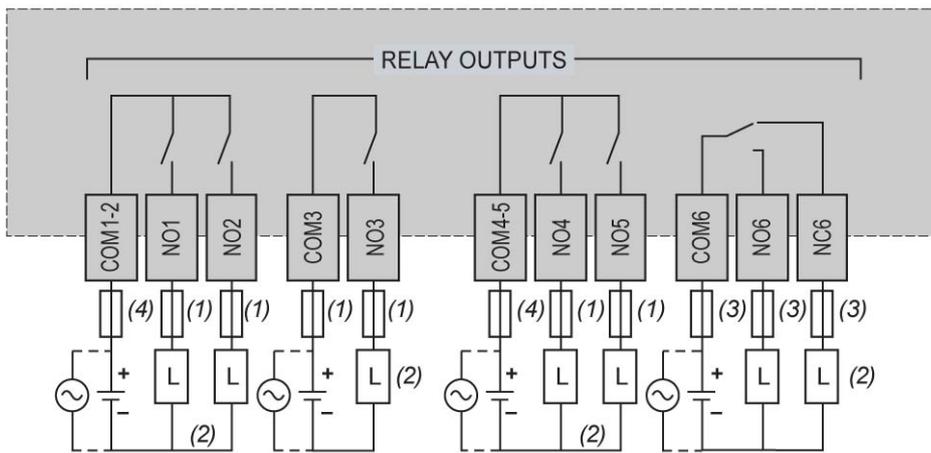
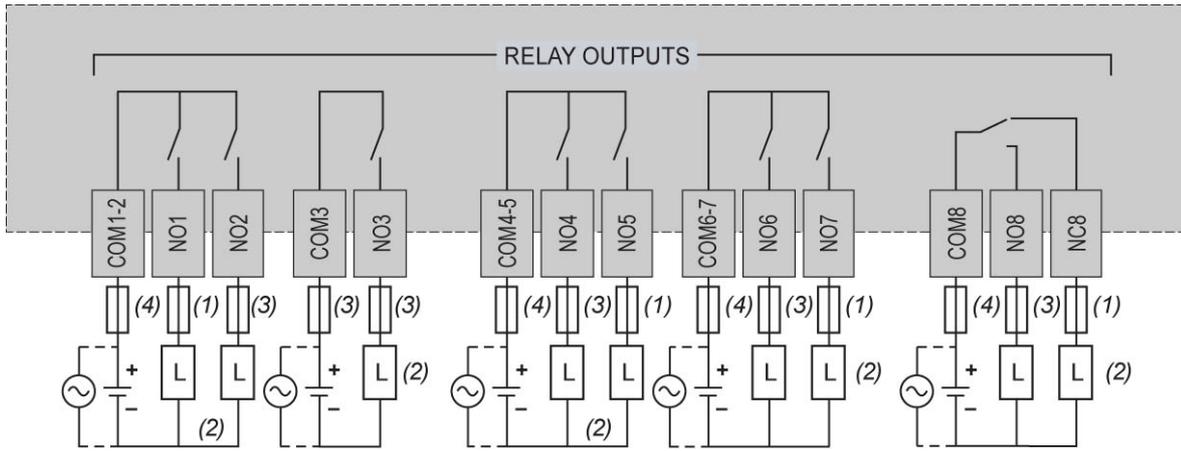
⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Do not exceed any of the rated values specified in the following tables.

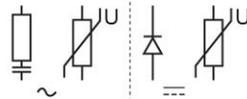
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Example with different sources:



- (1) 5 A max. fuse
- (3) 8 A max. fuse
- (4) 10 A max. fuse

(2) Protection for inductive load



Relay Groups

The outputs are divided into groups with different commons (COMx, COMy, COMx-y).

The groups are as follows (see the connections layout):

- TM168●23●●
 - Group n°1 : COM1-2 / NO1 / NO2; COM3 / NO3
 - Group n°2 : COM4-5 / NO4 / NO5; COM6-7 / NO6 / NO7
 - Group n°3 : COM8 / NO8 / NC8
- TM168E17
 - Group n°1 : COM1-2 / NO1 / NO2 / COM3 / NO3 / COM4-5/ NO4 / NO5 (5A relay)
 - Group n°2 : COM6 / NO6 / NC6 (8 A relay)

There are varying levels of isolation between the groups and consequently these may have different voltages.

The relays belonging to the same group have minimal level of isolation between their commons and therefore must have the same energy level (24 Vac, 24 Vdc or 230 Vac).

The current through the common terminals must not exceed the rated current:

- COMx: maximum current of the relay
- COMx-y: maximum current of 10 A

Maximum current per connector pin for the Controller TM168●23●●:

Board	Terminal	Maximum Current
Controller	COM1-2	10 A
	NO1	5 A
	NO2	8 A
	COM3	8 A
	NO3	8 A
	COM4-5	10 A
	NO4	8 A
	NO5	5 A
	COM6-7	10 A
	NO6	8 A
	NO7	5 A
	COM8	8 A
	NO8	8 A
	NC8	8 A

Maximum current per connector pin for the Expansion TM168E17:

Board	Terminal	Maximum Current
Expansion	COM1-2	10 A
	NO1	5 A
	NO2	5 A
	COM3	5 A
	NO3	5 A
	COM4-5	10 A
	NO4	5 A
	NO5	5 A
	COM6	8 A
	NO6	8 A

	NC6	8 A
--	-----	-----

8A Relay Characteristics

Voltage range	5...30 Vdc 24... 250 Vac
Maximum current	8 A
Minimum switching capacity	10 mA (minimum voltage at 12 Vdc or 24 Vac)
Maximum switching rate	0.1 Hz
Response time	Close = 10 ms Open = 5 ms
Mechanical life	10 000 000 operations (cycles)
Electrical durability, 500 000 operating cycles Conforming to IEC/EN 60947-5-1	DC 12: 24 Vdc 1.5A
	DC 13: 24Vdc 0.6A (L/R = 10 ms)
	AC 12: 230 Vac 1.5 A
	AC 15: 230 Vac 0.9 A

5A Relay Characteristics

Voltage range	5...30 Vdc 24... 250 Vac
Maximum current	5 A
Minimum switching capacity	10 mA / 5 Vac
Maximum switching rate	Off load: 20 Hz At operating current: 0.1 Hz
Response time	Close = 8 ms Open = 4 ms
Mechanical life	10 000 000 operations (cycles)
Electrical durability	120 000 operating cycles DC 12: 30 Vdc 2 A
	200 000 operating cycles DC 13: 24 Vdc 1A (L/R = 48 ms)
	300 000 operating cycles AC 12: 250 Vac 2.5 A
	50 000 operating cycles AC 15: 250 Vac 3 A cos phi = 0.4

2.6.6. Analog (Fan) Outputs [reserved for future evolutions]

2. Voltage

Range	0...10 Vdc
Minimum load impedance	1 k Ω
Accuracy	-5 %...2 % of full scale for load impedance from 1...5 k Ω ±2 % of full scale for load impedance > 5 k Ω
Step-wise resolution	0.01 Vdc
Conversion time	1 s
Isolation	none
Built-in protection	against overload (thermal protection)

Current

Range	0/4...20 mA
Load impedance	40...300 Ω range
Accuracy	±3 % of full scale
Resolution	0.02 mA
Conversion time	1 s
Isolation	none
Built-in protection	against overload (thermal protection)

The output protection is thermal in nature. Once the temperature of the output diminishes below the temperature threshold, it will automatically attempt to rearm itself.

<p>⚠ WARNING</p> <p>UNINTENDED EQUIPMENT OPERATION</p> <p>Be sure to remove all power from all equipment when correcting a short-circuit or overload condition</p> <p>Failure to follow these instructions can result in death, serious injury, or equipment damage.</p>

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 death, serious injury, or equipment damage.

Relay 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 be equipped with a protection device such as a peak limiter, RC circuit or flyback diode. Capacitive loads are not supported by these relays.

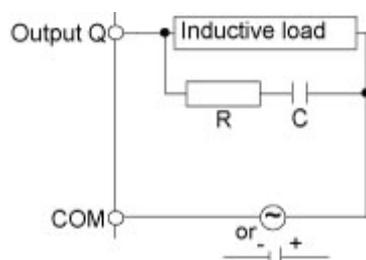
⚠ WARNING

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.

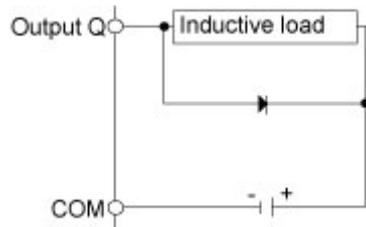
Failure to follow these instructions can result in death, serious injury, or equipment damage.

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



- C represents a value from 0.1 to 1 μF .
- R represents a resistor of approximately the same resistance value as the load.

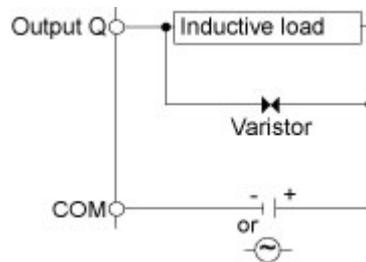
Protective circuit B: This protection circuit can be used for DC load power circuits.



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, you must ensure that the continuous energy rating (J) of the varistor exceeds the peak load energy by 20% or more.

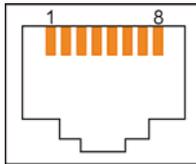
2.7. Serial Ports

2.7.1. Modbus Serial Ports

2.7.1.1. Modbus Serial Port MBS1

MBS1 is an RS485, 2-wire Modbus serial line using an RJ45 connector. It can be configured only as a Modbus Slave.

RJ45 - I/O Layout Description



RJ45 Pin	Signal	Description
1	-	N.C.
2	-	N.C.
3	-	N.C.
4	D1 (A+)	transceiver terminal 1, V1 voltage
5	D0 (B-)	transceiver terminal 0, V0 voltage
6	-	N.C.
7	-	N.C.
8	Common	signal common

Communication and Status Indicators

The MBS1 RJ45 connector has:

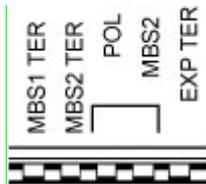
- 1 amber LED for communication
- 1 red LED for error detection

Amber LED for Communication	Description
On flashing	Serial port configured Data exchange
On	Serial port configured No data exchange
Off	Serial port not configured

Red LED for a detected error	Description
Off	No detected errors
On flashing	Configuration detected error
On	Internal detected error

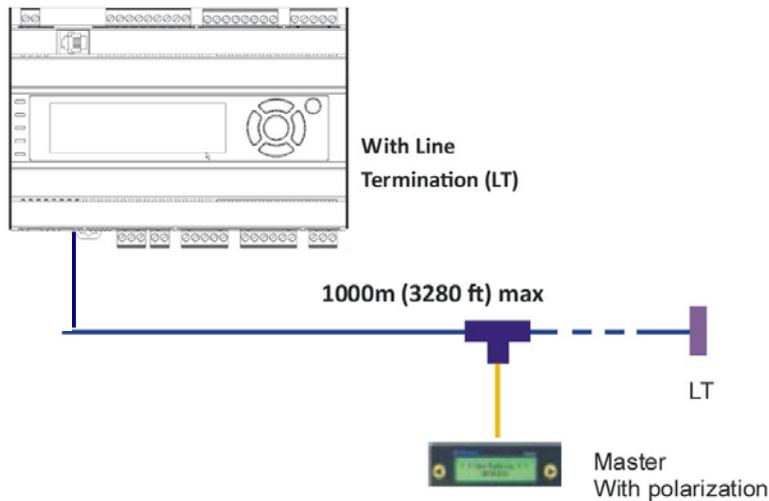
Setting the Built-in Line Termination Mode

The dip-switch MBS1 TER, found just to the right of the MBS2 port, is used to connect a 120 Ω /0.25 W resistor for line termination.



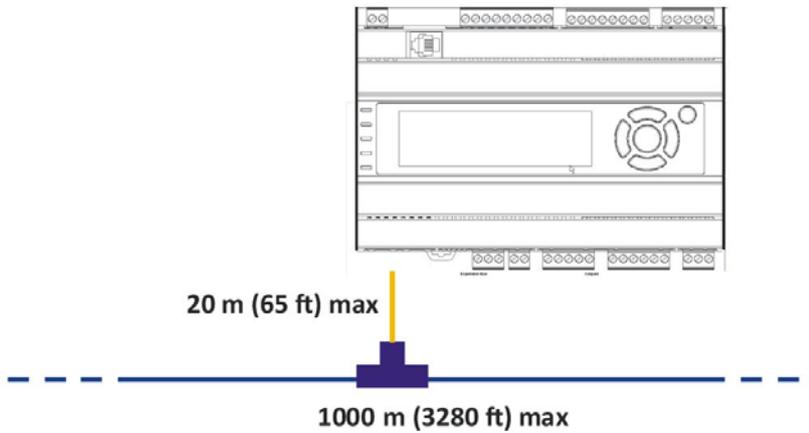
Installation as Slave with Line Termination

If the controller is installed at one end of the main Modbus fieldbus, line termination (the MBS1 TER dip switch) must be turned on. If line termination is not applied for this fieldbus layout, the Modbus communications will not function reliably.



Installation as Slave without Line Termination

If the controller is installed on a trunk line of the main Modbus fieldbus, line termination (the MBS1 TER dip switch) must be turned off. The trunk line must not exceed 20 m (65 ft) in length.



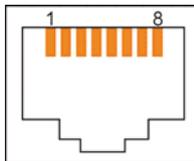
2.7.1.2. Modbus Serial Port MBS2

MBS2 is an RS485, 2-wire Modbus serial line using an RJ45 connector.

It can be configured as Modbus Master or Modbus Slave.

Master/Slave configuration is adjustable using either the SoHVAC software or by setting the parameter using the device configuration screens.

RJ45 – I/O Layout Description



RJ45 Pin	Signal	Description
1	-	N.C.
2	-	N.C.
3	-	N.C.
4	D1 (A+)	transceiver terminal 1, V1 Voltage
5	D0 (B-)	transceiver terminal 0, V0 Voltage
6	-	N.C.
7	-	N.C.
8	Common	Signal common

Communication and Status Indicators

The MBS2 RJ45 connector has:

- 1 amber LED for communication
- 1 red LED for error detection

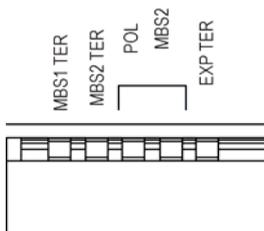
Amber LED for Communication	Description
On flashing	Serial port configured Data exchange
On	Serial port configured No data exchange
Off	Serial port not configured

Red LED for a detected error	Description
Off	No detected errors
On flashing	Configuration detected error
On	Internal detected error

Setting the Built-in Line Termination and Fieldbus Polarization Modes

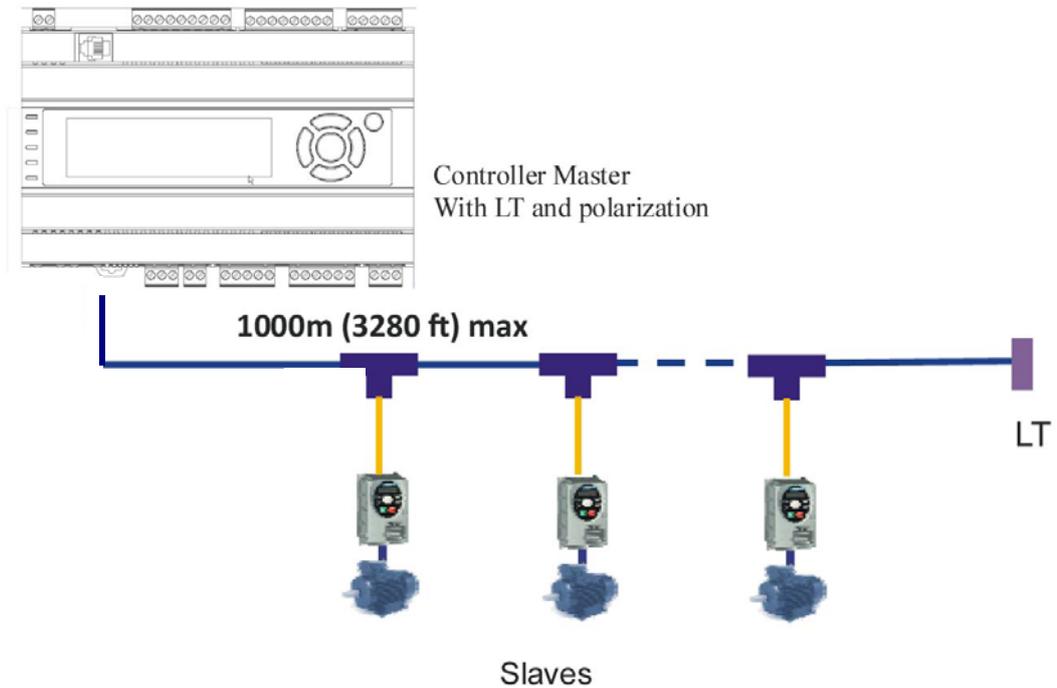
The dip-switch MBS2 TER, found just to the right of the MBS2 port, is used to connect a 120 Ω/0.25 W resistor for line termination.

The dip-switches POL MBS2 (dip switch 3 and 4) are used for polarization of the Modbus line with a 560 Ω/0.25 W resistor.



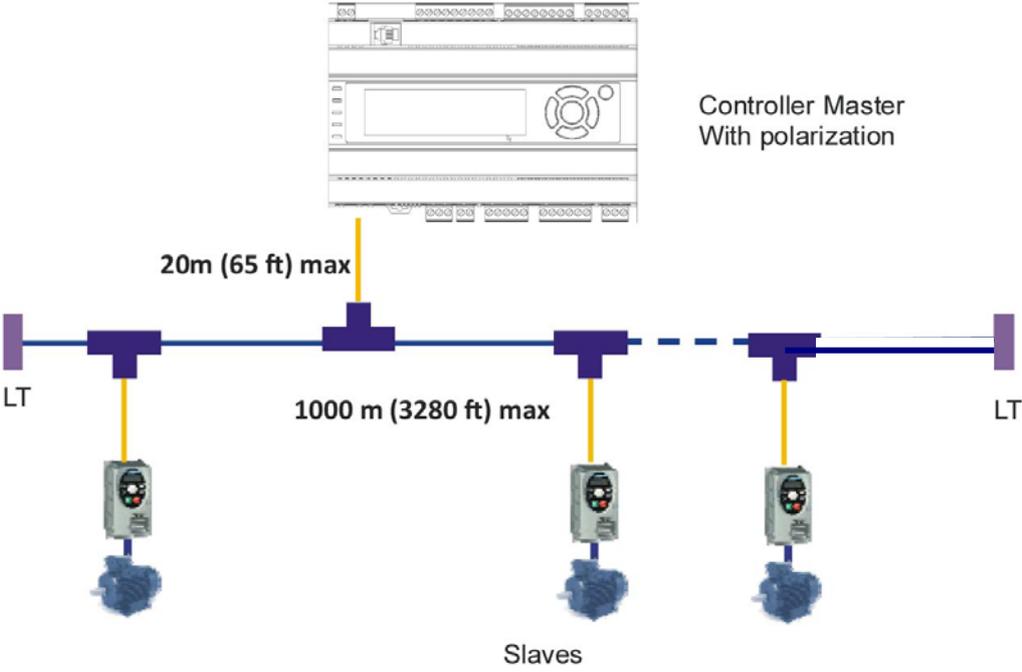
Installation as Master Using Line Termination and Polarization

If the controller is installed at one end of the main Modbus fieldbus, line termination (the MBS2 TER dip switch) and polarization (both POL MBS2 dip switches) must be turned on. If line termination and polarization are not applied for this fieldbus layout, the Modbus communications will not function reliably.



Installation as Master Using Polarization Only

If the controller is installed on a trunk line of the main Modbus fieldbus, line termination (the MBS2 TER dip switch) must be turned off and polarization (both POL MBS2 dip switches) must be turned on. The trunk line must not exceed 20 m (65 ft) in length.

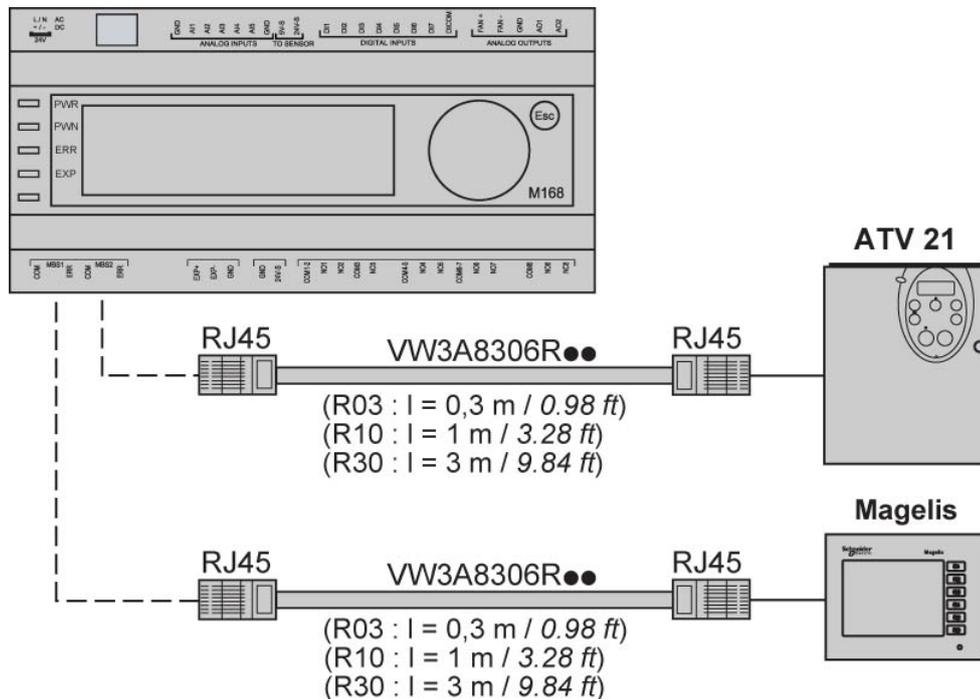


2.7.1.3. Modbus Settings and Supported Functions

Data Link Layer																									
Slave address	1...247																								
Baud Rate (Bds)	1200, 24000, 4800, 9600, 19200, 28800, 38400, 57600. The default value is 19200.																								
Parity	None, Odd and Even The default value is even.																								
Mode	RTU																								
Broadcast	Yes																								
Application Layer																									
Messaging Class	Functions supported:																								
	<table border="1"> <thead> <tr> <th>Function</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>FC 01</td> <td>Read coils</td> </tr> <tr> <td>FC 02</td> <td>Read discrete inputs</td> </tr> <tr> <td>FC 03</td> <td>Read multiple registers</td> </tr> <tr> <td>FC 04</td> <td>Read input registers</td> </tr> <tr> <td>FC 05</td> <td>Write single coil</td> </tr> <tr> <td>FC 06</td> <td>Write single register</td> </tr> <tr> <td>FC 08</td> <td>Diagnostic</td> </tr> <tr> <td>FC 15</td> <td>Write multiple coils</td> </tr> <tr> <td>FC 16</td> <td>Write multiple registers</td> </tr> <tr> <td>FC 23</td> <td>Read write multiple registers</td> </tr> <tr> <td>FC 43</td> <td>Read device identification</td> </tr> </tbody> </table>	Function	Description	FC 01	Read coils	FC 02	Read discrete inputs	FC 03	Read multiple registers	FC 04	Read input registers	FC 05	Write single coil	FC 06	Write single register	FC 08	Diagnostic	FC 15	Write multiple coils	FC 16	Write multiple registers	FC 23	Read write multiple registers	FC 43	Read device identification
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FC 06	Write single register																								
FC 08	Diagnostic																								
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Access type	Level 1 (Vendor name, product code, version)																								

For the Modbus Function Codes supported when the serial port is configured as a Modbus master, refer to the *Standard Library User Guide*.

2.7.1.4. Modbus Cabling



NOTE: If you do not use the pre-fabricated cable indicated above, you must use shielded cables with the shield connected to Pin 8 of the RJ45 connector.

⚠ CAUTION
<p>UNRELIABLE MODBUS COMMUNICATION</p> <ul style="list-style-type: none"> • Only use shielded cables that have Pin 8 of the RJ45 connector connected to the cable shield. • Be sure that at least one of the devices you are connecting via Modbus has its serial port connected to the functional ground (FE) or protective ground (PE) of your installation. <p>Failure to follow these instructions can result in death, serious injury, or equipment damage.</p>

2.7.2. Expansion Bus Serial Port

This expansion bus is used to connect the controller to other devices as I/O Expansions and to remote user interface. A maximum of 32 devices can be connected to the expansion bus.

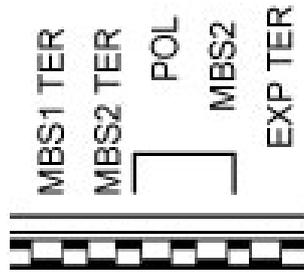
The number of devices which can be connected to the expansion bus depends on the baud rate, the type of device, and the cable and wiring of the expansion bus network.

The following table provides the recommended maximum number of devices:

Baud Rate	Recommended Maximum Number
500 kbit/s	8 devices
20 kbit/s	32 devices

Line Termination

The dip-switch **EXP TER** is used to connect the 120 Ω /0.5 W resistor for line termination.

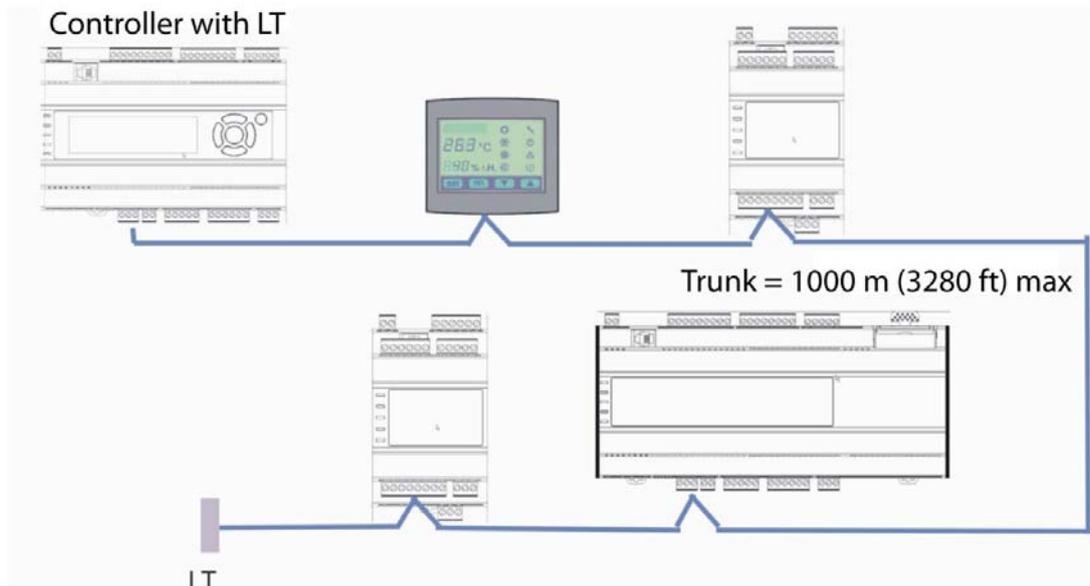


The bus is realized using a double twisted pair wire with line termination on each end. If any of the devices at either end of the cable do not have a built-in possibility to terminate the line, you will need to add a 120 Ω /0.5 W resistor to help ensure reliable communications.

Communication and Status Indicator

One Red LED for status bus provides the following information:

Red LED	Description
Rapid flashes	Expansion Bus status OK
Slow flashes	Communication Initialization
On	Error detected on Expansion Bus
Off	Bus not connected or inoperative



Expansion Bus Baud Rate vs Length

Max length	Rate (Kbit/s)
1000 m (3280 ft)	20
500 m (1640 ft)	50
250 m (820 ft)	125
50 m (164 ft)	500

Display Supply Output (To Display)

Characteristic	Description
Voltage	+24 Vdc±15 %
Current	120 mA max (max. 1 Display, cable length max. 30 m/98 ft.)
Built-in protection	against overload and short-circuit (thermal protection)

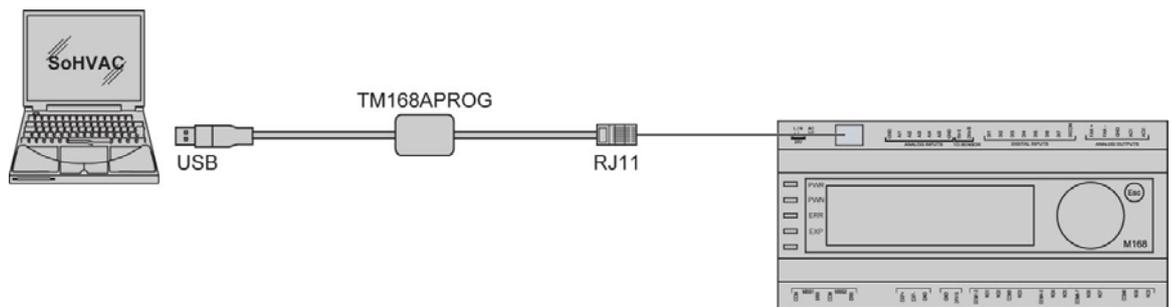
The power supply protection is thermal in nature. Once the temperature of the supply diminishes below the temperature threshold, it will automatically attempt to rearm itself.

⚠ WARNING
UNINTENDED EQUIPMENT OPERATION
Be sure to remove all power from all equipment when correcting a short-circuit or overload condition
Failure to follow these instructions can result in death, serious injury, or equipment damage.

2.7.3. Programming Port

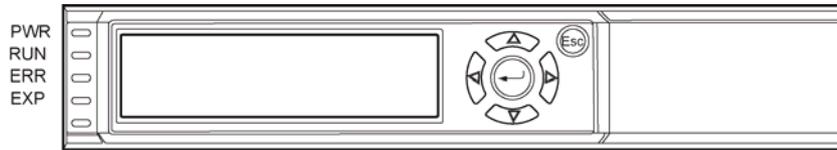
Programming Connector

The TM168●23●● has a Female RJ11 connector dedicated to all programming functions.



2.8. Configuration Screens

2.8.1. Built-in User Interface



The built-in user interface has:

- 120 x 32 graphic LCD display with backlight
- Keypad with 6 keys and 4 signal LEDs
- Buzzer

LED	Main Function	Meaning
PWR	Power	Off: No power supply On: Presence of power supply
Run	Run	Off: The controller is in the Stop state ¹ On: Controller is in a RUN state Slow Flashing: Controller in the Run state. The installed application program has been compiled for debugging, which is useful during system testing and commissioning. Fast Flashing: Controller is in the Run state. The installed application program has been compiled for debugging, which is useful during system testing and commissioning. During execution, the program halted at a breakpoint.
Err	Alarm	Off: No alarms On: An error was detected that must be corrected before the alarm can be cleared. Slow Flashing: An error was detected that, once corrected, the controller will automatically clear the alarm. Fast Flashing: An error was detected that requires manual acknowledgement before the alarm can be cleared.
Exp	ExpBus	Off: bus stop On: configured, but no communication Slow Flashing: communication information Fast Flashing: communication ok

¹ If the LED remains Off, it may mean that your application is not compatible with the controller.

Key	Main Function	Other
	Predefined as DOWN	Editing mode: parameters modification Other modes: cursor displacement
	Predefined as UP	
	Predefined as LEFT	Display the pages of the same level in succession
	Predefined as RIGHT	
	Predefined as ENTER	Used to select menu options and objects to edit, and also to confirm the modification of edited objects.
	Predefined as ESC	Used to return to the main page, or cancel modifications to objects while editing.

2.8.2. TM168D23●● Configuration Screens

To gain access to the configuration screens:

1. Make sure that power is applied.
2. Press and hold down the **UP** and **DOWN** buttons simultaneously for about 3 seconds: the display shows the following menu:

(Hereinafter called **Main** menu).

<TM168D23>
Info
English
Parameters
...
Parameter Key
Diagnostic
Debug

NOTE: It is also possible to show the **Main** menu using a remote display. Refer to the chapter *Displays*, page 88.

To access the **Parameters** submenu, the **Networks** submenu, the **Password** submenu and the **Parameter Key** submenu, you need to enter a password.

The default value of the password is -12.

To cancel access to this menu when the password is required, press **esc** button.

Configuration Menu Options for Controllers

Submenu	Item name	Min.	Max.	Unit	Default	Description	
Info	PROJ	read only item					information about the application project (project, version and revision)
Info	FW	read only item					information about the firmware (project, version, revision and subrevision)
Info	HW	read only item					information about the hardware (version, revision, generic "G" or special "S")
Info	SW	read only item					information about the SoHVAC (version and revision)
Info	SN	read only item					information about the serial number (result of the test)
Info	MASK	read only item					information about the mask (builder's software coding system)
Info	date and time	read only item					date and time of the last compiling date
Language						Selection of the language: English Italiano Francais Espanol Deutch	
Parameters(1)	AI1	---	---	---	NTC	Kind of probe for the analog input #1 PTC = PTC probe NTC = NTC probe 0...20 mA = 0...20 mA transducer 4...20 mA = 4...20 mA transducer 0...5 V = 0...5 Vdc transducer 0...10 V = 0...10 Vdc transducer PT1000 = Pt 1000 probe	
Parameters(1)	AI2	---	---	---	NTC	Kind of probe for the analog input #2 PTC = PTC probe NTC = NTC probe 0...20 mA = 0...20 mA transducer 4...20 mA = 4...20 mA	

Submenu	Item name	Min.	Max.	Unit	Default	Description
						transducer 0...5 V = 0...5 Vdc transducer 0...10 V = 0...10 Vdc transducer PT1000 = Pt 1000 probe
Parameters(1)	AI3	---	---	---	NTC	Kind of probe for the analog input #3 PTC = PTC probe NTC = NTC probe 0...20 mA = 0...20 mA transducer 4...20 mA = 4...20 mA transducer 0...5 V = 0...5 Vdc transducer 0...10 V = 0...10 Vdc transducer PT1000 = Pt 1000 probe
Parameters(1)	AI4	---	---	---	NTC	Kind of probe for the analog input #4 PTC = PTC probe NTC = NTC probe 0...20 mA = 0...20 mA transducer 4...20 mA = 4...20 mA transducer 0...5 V = 0...5 Vdc transducer 0...10 V = 0...10 Vdc transducer PT1000 = Pt 1000 probe
Parameters(1)	AI5	---	---	---	NTC	Kind of probe for the analog input #5 PTC = PTC probe NTC = NTC probe 0...20 mA = 0...20 mA transducer 4...20 mA = 4...20 mA transducer 0...5 V = 0...5 Vdc transducer 0...10 V = 0...10 Vdc transducer PT1000 = Pt 1000 probe
Parameters(1)	AI Err Time	0	240	s	2	analog inputs time-out

Submenu	Item name	Min.	Max.	Unit	Default	Description
Parameters(1)	AO1	---	---	---	0...10 Vdc	Kind of signal for the analog output #1 0...20 mA = 0...20 mA 4...20 mA = 4...20 mA 0...10 V = 0...10 Vdc
Parameters(1)	AO2	---	---	---	0...10 Vdc	Kind of signal for the analog output #2 0...20 mA = 0...20 mA 4...20 mA = 4...20 mA 0...10 V = 0...10 Vdc
Parameters(1)	AO3	---	---	---	PWM	Kind of signal for the analog output #3 PWM = Pulse Width Modulated output
Parameters(1)	CosPhi 10us	---	---	---	---	Reserved
Parameters(2) Press RIGHT button to show it	I/O Timeout	1	240	s	60	Time-out of the ExpBus. If no communication signal has been received during this time on the I/O expansion port, the controller will indicate that there is an I/O communication error. In addition, the controller will disable all I/O.
Parameters(2) Press RIGHT button to show it	En. Prg Level	---	---	---	NO	Enable the short-cut access method to the individual menu levels. YES = Enables the following shot-cuts: <ul style="list-style-type: none"> ▪ press and hold down the ENTER button for 3 seconds to gain access to the first page of level 1 ▪ press and hold down the ENTER and ESC buttons simultaneously for about 3 seconds to gain access to the first page of level 2 ▪ press and hold down the LEFT and RIGHT buttons simultaneously for about 3 seconds to gain access to the first page of level 3
Parameters(2) Press RIGHT button to show it	Password Indi	---	---	---	NO	Disables password hierarchy NO = given the level of user authorization, the user has

Submenu	Item name	Min.	Max.	Unit	Default	Description
						access to any lower levels YES = each level is individually protected, i.e., given the level of user authorization, the user does not have access to any lower levels--access is granted just to that given level.
Parameters(2) Press RIGHT button to show it	Backlight	---	---	---	TIME	Kind of backlight OFF = backlight is never lit ON = backlight is always lit TIME = backlight is lit the time you have set with parameter B. Time since the last operation with the buttons
Parameters(2) Press RIGHT button to show it	B.time	0	60	s	240	Backlight duration (only if parameter <i>Backlight</i> has value <i>TIME</i>)
Parameters(2) Press RIGHT button to show it	Contrast	0	100	---	50	Display contrast
Parameters(2) Press RIGHT button to show it	Date Char Sep	---	---	---	/	Date separator (ASCII character)
Parameters(2) Press RIGHT button to show it	Year format	---	---	---	YY	Year format: <ul style="list-style-type: none"> ▪ YY = two numbers (for example 10) ▪ YYYY = four numbers (for example 2010)
Parameters(2) Press RIGHT button to show it	Date format	---	---	---	D-M-Y	Date format: <ul style="list-style-type: none"> ▪ D-M-Y = day, month and year ▪ M-D-Y = month, day and year ▪ Y-M-D = year, month and day
Parameters(2) Press RIGHT button to show it	Time Char Sep	---	---	---	:	Time separator (ASCII character)
Parameters(2) Press RIGHT button to show it	Time With Sec	---	---	---	YES	Showing the seconds in the real time YES = yes

Submenu	Item name	Min.	Max.	Unit	Default	Description
Parameters(2) Press RIGHT button to show it	Time AM/PM	---	---	---	NO	Time format: <ul style="list-style-type: none"> No = 24 h (for example 15:20) YES = 12 h (for example 3:20 PM)
Parameters(2) Press RIGHT button to show it	Debug Baud	---	---	---	19200	Debugger baud rate: <ul style="list-style-type: none"> 19200 = 19,200 baud 28800 = 28,800 baud 38400 = 38,400 baud 57600 = 57,600 baud 76800 = 76,800 baud 115k2 = 115,200 baud
Networks						Gives access to the ExpBus, BMS, MBS1 and MBS2 configuration menu
Networks/ExpBus	MyNode	1	127	---	1	Controller ExpBus node address
Networks/ExpBus	Master	---	---	---	YES	Operation as master YES = yes
Networks/ExpBus	Baud	---	---	---	20 k	ExpBus communication baud rate: <ul style="list-style-type: none"> 20 K = 20,000 baud 50 K = 50,000 baud 125 K = 125,000 baud 500 K = 500,000 baud
Networks/ExpBus	Timeout	1	60	s	5	Device time-out period on the ExpBus. If a device does not communicate on the ExpBus in this period, it will be excluded from all further communication. The controller will indicate an error for this device.
Networks/ExpBus	NetworkNode	[1] 0	[32] 127	---	[1] 99	Logical and physical address of devices on the ExpBus. <ul style="list-style-type: none"> [1] = Logical node address of the device 2 = Physical node address of the device

Submenu	Item name	Min.	Max.	Unit	Default	Description
Networks/ExpBus Press RIGHT button to show it	TESG1	0	63	---	31	Reserved
Networks/ExpBus Press RIGHT button to show it	TESG1	1	7	---	7	Reserved
Networks/ExpBus Press RIGHT button to show it	SJW	0	3	---	0	Reserved
Networks/ExpBus Press RIGHT button to show it	BTR(1)	1	15	---	15	Reserved
Networks/BMS (look at node 1)	MAC ID	0	127	---	1	BACnet MS/TP network address of the node 255 = not configured
Networks/BMS (look at node 1)	Baud Rate	---	---	---	9600	BACnet MS/TP network baud rate: <ul style="list-style-type: none"> ▪ 9600 = 9,600 baud ▪ 19200 = 19,200 baud ▪ 38400 = 38,400 baud ▪ 76800 = 76,800 baud
Networks/BMS (look at node 1)	Max Master	0	127	---	127	Maximum number of masters for token pass
Networks/BMS (look at node 1)	Max InfoFram	0	127	---	3	Each time the token is received, maximum number of exchanges before passing the token to next equipment.
Networks/BMS (look at node 1)	Device ID	1	419430 3	---	108	Instance of a device in a BACnet MSPT network
Networks/UART1 (look at node 2)	Address	1	247	---	1	MBS1 Modbus address
Networks/UART1 (look at node 2)	Baud Rate	---	---	---	9600	MBS 1 Modbus communication baud MS/TP rate: <ul style="list-style-type: none"> ▪ 1200 = 1,200 baud ▪ 2400 = 2,400 baud ▪ 4800 = 4,800 baud ▪ 9600 = 9,600 baud

Submenu	Item name	Min.	Max.	Unit	Default	Description
						<ul style="list-style-type: none"> ▪ 19200 = 19,200 baud ▪ 28800 = 28,800 baud ▪ 38400 = 38,400 baud ▪ 57600 = 57,600 baud
Networks/UART1 (look at node 2)	Parity	---	---	---	EVEN	MBS 1 Modbus communication parity: <ul style="list-style-type: none"> ▪ NONE = no parity ▪ ODD = odd ▪ EVEN = even
Networks/UART1 (look at node 2)	Stop	---	---	---	1 BIT	MBS 1 Modbus communication bit stop number: <ul style="list-style-type: none"> ▪ 1 BIT = 1 bit ▪ 2 BIT = 2 bit
Networks/UART2 (look at node 3)	Address	1	247	---	1	MBS 2 Modbus address; only for Modbus slave.
Networks/UART2 (look at node 3)	Baud Rate	---	---	---	9600	MBS 2 Modbus communication baud rate: <ul style="list-style-type: none"> ▪ 1200 = 1,200 baud ▪ 2400 = 2,400 baud ▪ 4800 = 4,800 baud ▪ 9600 = 9,600 baud ▪ 19200 = 19,200 baud ▪ 28800 = 28,800 baud ▪ 38400 = 38,400 baud ▪ 57600 = 57,600 baud
Networks/UART2 (look at node 3)	Parity	---	---	---	EVEN	MBS 2 Modbus communication parity: <ul style="list-style-type: none"> ▪ NONE = no parity ▪ ODD = odd ▪ EVEN = even
Networks/UART2 (look at node 3)	Stop	---	---	---	1 BIT	MBS 2 Modbus communication bit stop number: <ul style="list-style-type: none"> ▪ 1 BIT = 1 bit ▪ 2 BIT = 2 bit
Networks/UART2 (look at node 3)	Timeout	2	240	S	10	Local communication time-out to check the I/O remote values (after this time, the answer is considered not sent and the controller moves to the following transmission); only for Modbus Master.
Password	Level 1:	-32767	32767	---	0	Level 1 access password

Submenu	Item name	Min.	Max.	Unit	Default	Description
						value
		---	---	---	ON	Enabling the level 1 access password: <ul style="list-style-type: none"> OFF = one has not to set a password to gain access to level 1 ON = one has to set a password to gain access to level 1
Password	Level 2:	-32767	32767	---	0	Level 2 access password value
		---	---	---	ON	Enabling the level 2 access password: <ul style="list-style-type: none"> OFF = no password is required to gain access to level 2 ON = a password is required to gain access to level 2
Password	Level 3:	-32767	32767	---	0	Level 3 access password value
		---	---	---	ON	Enabling the level 3 access password: <ul style="list-style-type: none"> OFF = no password is required to gain access to level 3 ON = a password is required to gain access to level 3
Password	Level 4:	-32767	32767	---	0	Level 4 access password value
		---	---	---	ON	Enabling the level 4 access password: <ul style="list-style-type: none"> OFF = no password is required to gain access to level 4 ON = a password is required to gain access to level 4
Password	Level 5:	-32767	32767	---	0	Level 5 access password value
		---	---	---	ON	Enabling the level 5 access password: <ul style="list-style-type: none"> OFF = no password is required to gain access to level 5 ON = a password is required to gain access to level 5

Submenu	Item name	Min.	Max.	Unit	Default	Description
Password	Timeout	0	240	S	240	Level 1... 5 access password time-out. If you do not operate a key for this period of time, you will be logged out of your current level and will need to re-enter your password to re-establish access.
Date and time		read only item				Allow to modify the RTC value
Diagnostic	FRAM	read only item				Non volatile memory status: <ul style="list-style-type: none"> ▪ ok = ok ▪ err = detected error
Diagnostic	RTC	read only item				Real Time Clock status: <ul style="list-style-type: none"> ▪ ok = ok ▪ err = detected error ▪ low = invalid time display
Diagnostic	STACK	read only item				Stack status: <ul style="list-style-type: none"> ▪ ok = ok ▪ err = detected error (overflow)
Diagnostic	Power Supply	read only item				Power supply status: <ul style="list-style-type: none"> ▪ ok = ok ▪ err = detected error (out of range)
Diagnostic	5 V ratio	read only item				Power supply for ratiometric transducers status: <ul style="list-style-type: none"> ▪ ok = ok ▪ err = detected error (out of range)
Diagnostic	24 V Sensor	read only item				24 Vdc sensor power status: <ul style="list-style-type: none"> ▪ ok = ok ▪ err = detected error (out of range)
Diagnostic	24 V ExpBus	read only item				24 Vdc ExpBus power status: <ul style="list-style-type: none"> ▪ ok = ok ▪ err = detected error (out of range)
Diagnostic	Math	read only item				Math status: <ul style="list-style-type: none"> ▪ Ok = ok ▪ Err = detected error (overflow or underflow)

Submenu	Item name	Min.	Max.	Unit	Default	Description
						or division by zero or NaN)
Diagnostic	Key Par					read only item Result of the copy of the application configuration from the controller to the parameter key (and vice-versa): <ul style="list-style-type: none"> ▪ ok = ok ▪ err = detected error
Debug	Algo time (first column): Main time					read only item Application program main cycle time (ms)
	Algo time (second column): Int. time					read only item Application program interrupt cycle time (ms)
Debug	Ebus rxtx (first column): rx					read only item Number of packages in reception
	Ebus rxtx (second column): tx					read only item Number of packages in transmission
Debug	Ebus err (first column): err					read only item Number of packages in reception
	Ebus err (second column): ovf					read only item Number of packages in transmission
Debug	24PS					read only item Value of the controller power supply in Vdc or Vac, depending on the supply
	5VP					read only item Value of the power supply for the Ratiometric transducer in Vdc
Debug	24VP					read only item Value of the sensor power supply in Vdc
	4VE					read only item Value of the ExpBus power supply in Vdc
Debug	Stack					read only item Minimum free stack
	Buf					read only item Free buffer numbers

NOTE:

1. Visible on condition that the BMS is configured for BACnet MS/TP.
2. Visible on condition that the MBS1 is configured for Modbus.
3. Visible on condition that the MBS2 is configured for Modbus.

Parameter Key Operation

To copy the application configuration from the controller to the parameter key, operate as follows:

- Make sure that power is applied.
- Connect the parameter key.
- In the configuration Screens, gain access to the **Parameter Key** submenu (**PAR APP** or **PAR DRV**).
- Select **SAVE**.
- Press **ENTER**:

The application configuration will be copied from the controller to the parameter key (this operation usually takes a few seconds). If an error is detected, the Alarm LED will be ON and the value of the “key Par” parameter will be set to “Err”. You may view the value of the Key Par parameter under the Diagnostic submenu of the Configuration screen.

- Disconnect the parameter key.

To copy the application configuration from the parameter key to the controller, operate as follows:

- Make sure the power supply is switched on.
- Connect the parameter key.
- Access the **Parameter Key** submenu.
- Select **RESTOR**.
- Press **ENTER**:

The application configuration will be copied from the parameter key to the controller (this operation usually takes a few seconds). If an error is detected, the Alarm LED will be ON and the value of the “Key Par” parameter will be set to “Err”. You may view the value of the Key Par parameter under the Diagnostic submenu of the Configuration screen.

- Disconnect the parameter key.

NOTE: The copy of the application configuration from the parameter key to the controller is only allowed if the version of the application program from the source controller is the same as the version of the application program in the destination controller.

Though it checks the application program version before initiating a transfer, the Parameter Key cannot be used to transfer application programs between controllers. It can only transfer the application configuration parameters.

TM168B23●● Configuration

These controllers do not have a built-in display. Configuration is possible through a remote display.

To access the configuration pages of a controller without a built-in display:

- Connect the remote terminal to the controller using the ExpBus port.
- In the display, configure the physical node address of the controller (**NOTE:** the factory settings for this value is the same as the factory settings for the controller)
- When the node is recognized, **Ok** appears in the third row
- Enter the controller main page
- Refer to Configuration of a controller with built-in display

2.8.3. TM168E17 Configuration Screens

This is possible through remote displays.

To configure an expansion, operate as follows:

- Connect the remote terminal to the controller using the ExpBus port.

- In the display, the physical node address of the I/O Expansion module (Note: the factory settings for the I/O Expansion module is 2).
- When the node is recognized, **Ok** appears in the third row.
- The expansion configuration pages are accessible

Main menu of the Expansion:

<exp m168-2>
Info
Parameters
networks
...
Digital I/O
Debug
Diagnostic

Configuration Menu Options for I/O Expansions

Submenu	Item name	Min.	Max.	Unit	Def.	Description
Info	PROJ	read only item				Information about the application project (project, version and revision).
Info	FW	read only item				Information about the firmware (project, version, revision and sub revision).
Info	HW	read only item				Information about the hardware (version, revision).
Info	SN	read only item				Information about the serial number (result of the test).
Info	MASK	read only item				Information about the mask (software coding system of the builder).
Info	Date and time	read only item				Date and time of the last compiling date.
Parameters	I/O Timeout	1	240	s	60	Device time-out period on the ExpBus. If a device does not communicate on the ExpBus in this period, it will be excluded from all further communication. The controller will indicate an error for this device.
Parameters	Ai Err Timeout	0	240	s	2	analog inputs time-out if no analog input signal has been received during this time, the controller will indicate that there is an analog input error.
Networks/ExpBus	MyNode	1	127	---	2	Local (or of the expansion) ExpBus node address.
Networks/ExpBus	Master	read only item			NO	Operation as master
Networks/ExpBus	Baud	---	---	---	20 K	ExpBus communication baud rate: <ul style="list-style-type: none"> ▪ 20 K = 20,000 baud ▪ 50 K = 50,000 baud ▪ 125 K = 125,000 baud ▪ 500 K = 500,000 baud
Networks/ExpBus	NetworkNode	[0] 0	[32] 127	---	[0] 2	Logical and physical address of devices on the ExpBus <ul style="list-style-type: none"> ▪ [1] = logical node address of the device ▪ 2 = physical node address of the device
Networks/UART1	None					
Analog I/O	AI 1	---	---	---	NTC	Kind of probe for the analog

Submenu	Item name	Min.	Max.	Unit	Def.	Description
						input #1: <ul style="list-style-type: none"> ▪ PTC = PTC probe ▪ NTC = NTC probe ▪ 0...20 mA = 0...20 mA transducer ▪ 4...20 mA = 4...20 mA transducer ▪ 0...5 V = 0...5 Vdc transducer ▪ 0...10 V = 0...10 Vdc transducer ▪ PT1000 = Pt 1000 probe
Analog I/O	AI 2	---	---	---	NTC	Kind of probe for the analog input #2: <ul style="list-style-type: none"> ▪ PTC = PTC probe ▪ NTC = NTC probe ▪ 0...20 mA = 0...20 mA transducer ▪ 4...20 mA = 4...20 mA transducer ▪ 0...5 V = 0...5 Vdc transducer ▪ 0...10 V = 0...10 Vdc transducer ▪ PT1000 = Pt 1000 probe
Analog I/O	AI 3	---	---	---	NTC	Kind of probe for the analog input #3: <ul style="list-style-type: none"> ▪ PTC = PTC probe ▪ NTC = NTC probe ▪ 0...20 mA = 0...20 mA transducer ▪ 4...20 mA = 4...20 mA transducer ▪ 0...5 V = 0...5 Vdc transducer ▪ 0...10 V = 0...10 Vdc transducer ▪ PT1000 = Pt 1000 probe
Analog I/O	A0 1	---	---	---	0...10 V	Kind of signal for the analog output #1: <ul style="list-style-type: none"> ▪ 0...20 mA = 0-20 mA ▪ 4...20 mA = 4...20 mA ▪ 0...10 V = 0...10 Vdc
Analog I/O	A0 2	---	---	---	0...10 V	Kind of signal for the analog output #2: <ul style="list-style-type: none"> ▪ 0...20 mA = 0-20 mA

Submenu	Item name	Min.	Max.	Unit	Def.	Description
						<ul style="list-style-type: none"> ▪ 4...20 mA = 4...20 mA ▪ 0...10 V = 0...10 Vdc
Analog I/O	A0 3	---	---	---	0...10 V	Kind of signal for the analog output #3: <ul style="list-style-type: none"> ▪ PWM = Pulse Width Modulated output
Digital I/O	DI 1	read only parameter				Digital input #1 status
Digital I/O	DI 2	read only parameter				Digital input #2 status
Digital I/O	DI 3	read only parameter				Digital input #3 status
Digital I/O	DI 4	read only parameter				Digital input #4 status
Digital I/O	DI 5	read only parameter				Digital input #5 status
Digital I/O	DO 1	---	---	---	---	Digital output #1 status: <ul style="list-style-type: none"> ▪ OFF = turned off ▪ ON = turned on The status of the output could be overwritten by the application software.
Digital I/O	DO 2	---	---	---	---	Digital output #2 status: <ul style="list-style-type: none"> ▪ OFF = turned off ▪ ON = turned on The status of the output could be overwritten by the application software.
Digital I/O	DO 3	---	---	---	---	Digital output #3 status: <ul style="list-style-type: none"> ▪ OFF = turned off ▪ ON = turned on The status of the output could be overwritten by the application software.
Digital I/O	DO 4	---	---	---	---	Digital output #4 status: <ul style="list-style-type: none"> ▪ OFF = turned off ▪ ON = turned on The status of the output could be overwritten by the application software.
Digital I/O	DO 5	---	---	---	---	Digital output #5 status: <ul style="list-style-type: none"> ▪ OFF = turned off ▪ ON = turned on The status of the output could be overwritten by the application software.

Submenu	Item name	Min.	Max.	Unit	Def.	Description
Digital I/O	DO 6	---	---	---	---	Digital output #6 status: <ul style="list-style-type: none"> OFF = turned off ON = turned on The status of the output could be overwritten by the application software.
Debug (Algo)	Main time	read only item				Application program main cycle time (ms)
	Int. time	read only item				Application program interrupt cycle time (ms)
Debug (ExpBus)	rx	read only item				Number of packages in reception
	tx	read only item				Number of packages in transmission
Debug (ExpBus)	err	read only item				Number of packages in reception
	ovf	read only item				Number of packages in overflow
Debug	5VP	read only item				Value of the power supply for the Ratiometric transducer in Vdc
	24VP	read only item				Value of the sensor power supply in Vdc
Debug	Stack	read only item				Minimum free stack
	Buf	read only item				Free buffer numbers
Diagnostic	FRAM	read only item				Non volatile memory status: <ul style="list-style-type: none"> ok = ok err = detected error
Diagnostic	5 V ratio	read only item				Power supply for ratiometric transducers status: <ul style="list-style-type: none"> ok = ok err = detected error (out of range)
Diagnostic	24 V Sensor	read only item				24 Vdc sensor status: <ul style="list-style-type: none"> ok = ok err = detected error (out of range)

2.8.4. Memory

Flash program memory	544 kB
RAM data storage memory	24 kB

2.8.5. RTC (Real Time Clock)

Function	Description
Backup type	Supercap
RTC data retention time in the event of a power loss	3 days
Drift value	≤ 30 sec/month at 25 °C

3. Displays

3.1. Overview

The TM168●23 range includes displays that can be connected to and optionally powered by the controller using the Expansion Bus (ExpBus).

The displays can:

- display the same information as the built-in display.
- display dedicated information of one controller at a time.

Reference	Display Size	Display Pixels	RTC	Buzzer
TM168GDB	55×27.5 mm (2.16×1.08 in)	128×64	Yes	Yes
TM168GBTS	78.5×45.8 (3.09×1.80 in)	240×140	Yes	Yes

3.2. Physical Description



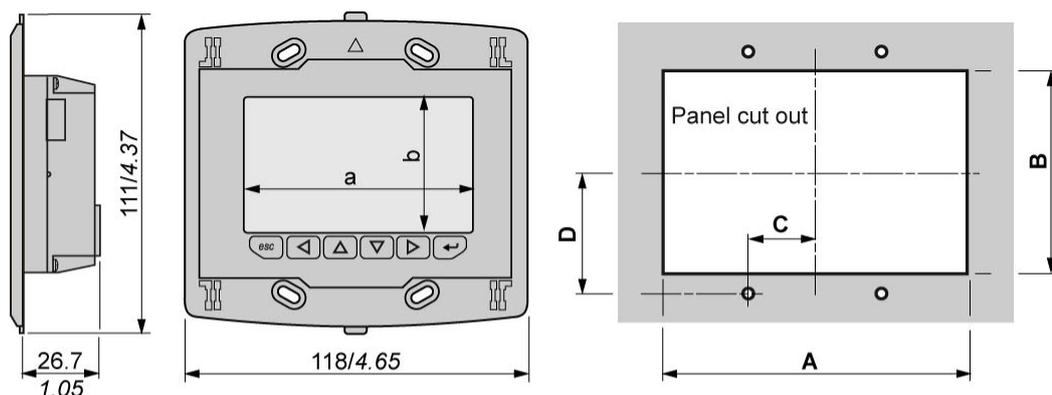
1. Display area
2. Escape button
3. 4 navigation buttons
4. Enter button

3.3. Installation

3.3.1. Installation and Maintenance Requirements

Dimensions

The display TM168GDB and TM168GBTS dimensions are as depicted below. All dimensions are in millimeters and inches.

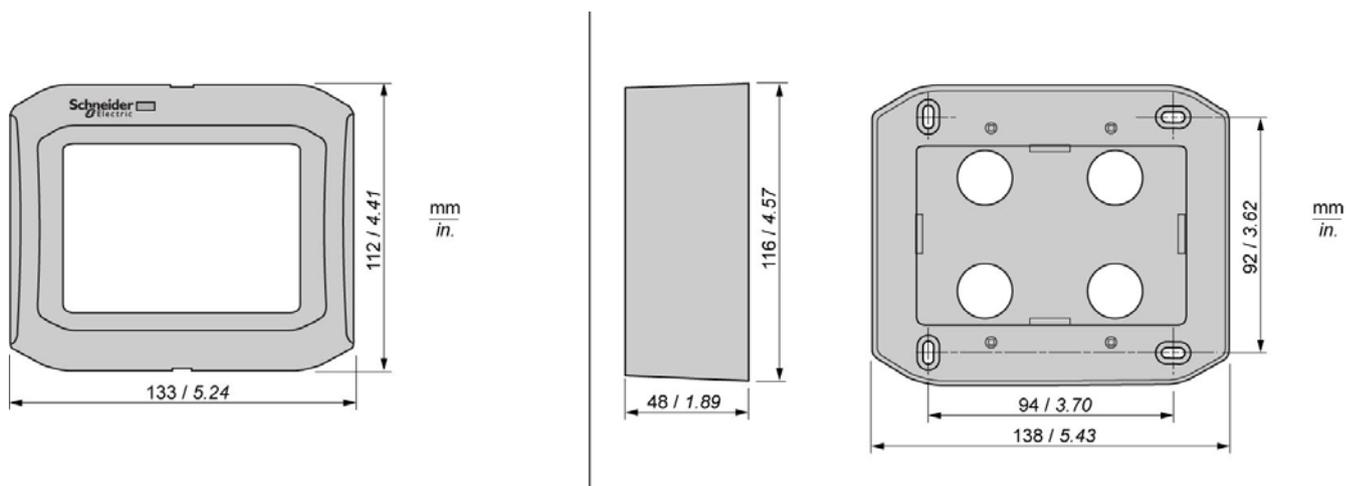


mm
in.

	TM168GDB	TM168GDBTS
a	58/2.28	81.5/3.21
b	30/1.18	48.5/1.91

TM168GDB/ TM168GDBTS	Minimum	Typical	Maximum
A	104/4.09	104/4.09	104.8/4.13
B	70/2.76	70/2.76	70.8/2.79
C	22/0.87	23/2.28	24/0.94
D	40.8/1.61	41.8/1.65	42.8/1.69

Front frame and TM168AGD1 Wall mounting support :



mm
in.

mm
in.

3.3.2. Environmental Features

Environmental Feature	Description
Connections	Plug-in terminal block 3, 81 mm (3.18 in) pitch for conductors up to 1.5 mm ² (16 AWG)
Storage temperature	-20...70 °C (-4...158 °F)
Ambient temperature	0...55 °C (32...131 °F)
Humidity	Relative humidity 5% - 95% non-condensing
Operation Altitude	0...2000 m (0...6561 ft)
Transport Altitude	0...3048 m (0...10000 ft)
Vibration	5...8.4 Hz: 3.5 mm (0.137 in) displacement
	8.4 Hz...150 Hz: 1 g _n acceleration
Shocks	15 g peak – 11 ms; half-sine test
Shipping	10 g _n 6 ms (product off)
Pollution degree	2
Overvoltage category	3
EMC compliance level	EN/IEC 60730-1 Annex 16
Product conformity	EN/IEC 60730-1
Environmental regulations	ROHS 2002/95 – WEEE 2002/96/EC - REACH CE1907/2006

3.3.3. Housing

Protection level	IP 40
Protection level (with gasket accessory)	IP 65

There is an optional gasket available for your display (TM168AGDIP65). Although you may optionally install the gasket, it is necessary to help absorb vibration and to resist liquids from passing behind the display. Place the gasket on the surface of the panel opening, aligning it with the mounting fram of the display before installing the display in the panel opening.

After installing and commissioning, inspect the gasket periodically for signs of damage, age or dirt and replace the gasket when necessary to maintain the IP65 rating of your installation.

⚠ WARNING

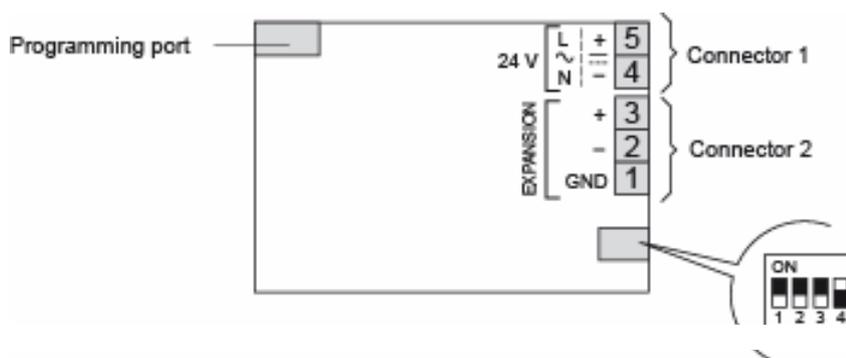
COMPROMISED IP RATING DUE TO GASKET DAMAGE

- Inspect the gasket periodically as required by your operating environment to ensure the initial IP level.
- Replace worn or damaged gaskets immediately, or at least replace the gasket regularly as part of a preventative maintenance program.

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

3.4. Display Connections

3.4.1. Display Wiring Layout (Product Backside)



If the device is at the end of the ExpBus, position the micro-switch 4 to ON. Micro-switches 1, 2 and 3 are reserved.

Connector 1: power supply
(see specification below)

PIN	MEANING
4	power supply
5	power supply

Connector 2: Expansion bus

PIN	MEANING
1	common (GND)
2	signal –
3	signal +

 Solid wires 0.05...1.5 mm² (30...16 AWG)
 Stranded wires 0.05...1.0 mm² (30...17 AWG)
 Stripping length 5...6 mm (0.20...0.24 in.)
 Tightening torque 0.2...0.25 Nm (1.77...1.21 lb-in)

3.4.2. Expansion Bus Designations

The following table describes the terminal connections:

Letter code	Description
Power supply	
L/+	24 Vac phase/+24 Vdc
N/-	24 Vac neutral/0 Vdc
EXPbus port	
GND	Expansion bus common
EXP-	Expansion bus - signal
EXP+	Expansion bus + signal
Line Termination/Polarization Dip Switch	
4	Expansion bus line termination
3	Not used
2	Not used
1	Not used

3.4.3. Cabling Length

Peripheral Type	Maximum Length
Power supply	30 m (98 ft)
Expansion bus	1000 m (3280 ft)

3.5. Power Supply Characteristics

Voltage range	24 Vac \pm 15%/20...40 Vdc
Frequency	50/60 Hz \pm 3 Hz
Isolation	No
Protection	Built-in/external fuse protection for over-current or short-circuit
Consumption	3 VA (Vac) max/2 W (Vdc) max
Micro-breaks immunity	10 ms

3.6. Configuration Screens

3.6.1. Preliminary Information

The following table shows the main meaning of the buttons:

Button	Meaning
	button escape (hereinafter called button ESC)
	button move to left (hereinafter called button LEFT)
	button increase (hereinafter called button UP)
	button decrease (hereinafter called button DOWN)
	button move to right (hereinafter called button RIGHT)
	button confirm (hereinafter called button ENTER)

3.6.2. Configuring the Interface

Follow these steps to access and use the display configuration menu:

1. Switch off the power supply.
2. Press and hold down the **ESC** and **RIGHT** buttons.
3. Switch on the power supply.
4. When the display shows the following menu (hereinafter called **Main** menu), release the **ESC** and **RIGHT** buttons:

TM168GDB
Parameters
Contrast
ExpBus
Modbus
Digital I/O
Info
<i>Real date and time</i>

NOTE: It is also possible to show the **Main** menu operating as follows:

5. Make sure the power supply is switched on.
6. Press and hold down the **LEFT** and **ENTER** buttons simultaneously for about 2 seconds: the display shows the following menu (hereinafter called **Network Status** menu):

Network Status

Loc	99	OK	>> (back to the Main menu)
1	1	-	>>
2	0	-	>>
3	0	-	>>
4	0	-	>>
5	0	-	>>

7. Press and release the button **ENTER**: the display shows the Main menu.

To gain access to a submenu, operate as follows:

8. From step 4, press and release button **UP/DOWN** to select the submenu.

9. Press and release button **ENTER**.

NOTE: The access to the **ExpBus** submenu is protected by password.

To gain access to the **ExpBus** submenu, operate as follows:

10. From step 4, press and release button **UP/DOWN** to select the submenu *ExpBus*.

11. Press and release button **ENTER**.

12. Press and release again button **ENTER**.

13. Press and release over and over again button **DOWN** to set "**-12**".

14. Press and release button **ENTER**.

To modify a configuration parameter belonging to the **Parameters** submenu, to the **ExpBus** submenu or to the **Modbus** submenu, operate as follows:

15. From step 9, press and release button **UP/DOWN** to select the parameter.

16. Press and release button **ENTER**.

17. Press and release button **UP/DOWN** to modify the value.

18. Press and release button **ENTER** to confirm the value.

19. Press and release button **ESC** to go back to the **Main** menu.

To modify the contrast of the display, operate as follows:

20. From step 4, press and release button **UP/DOWN** to select the **Contrast** submenu.

21. Press and release button **ENTER**.

22. Press and release button **UP/DOWN** to modify the value.

23. Press and release button **ENTER** to confirm the value.

24. Press and release button **ESC** to go back to the **Main** menu.

To modify the real date and time, operate as follows:

25. From step 4, press and release button **UP/DOWN** to select the item *Real date and time*.

26. Press and release button **ENTER**.

27. Press and release button **UP/DOWN** to modify the value.

28. Press and release button **ENTER** or button **RIGHT** to confirm the value and modify the following field.
29. Repeat steps 26 and 27.
30. Press and release button **ESC** to go back to the **Main** menu.

To quit the procedure:

31. Press and release the **ESC** button to cancel changes and return to the menu superior to the current menu.

▲ WARNING

UNINTENDED EQUIPMENT OPERATION

- Remove power and then reapply after at least 3 seconds when any configuration modifications have been made.

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

3.6.3. Display Configuration Parameters

Submenu	Parameter	Min.	Max.	Unit	Default	Description
Parameters	DateCharSep	---	---	---	/	Date separator (ASCII character)
Parameters	Year format	---	---	---	YY	Year format: <ul style="list-style-type: none"> ▪ YY = 2 numbers (for example 10) ▪ YYYY = 4 numbers (for example 2010)
Parameters	Date format	---	---	---	dmy	Date format: <ul style="list-style-type: none"> ▪ ymd = year, month and day ▪ mdy = month, day and year ▪ dmy = day, month and year
Parameters	TimeCharSep	---	---	---	:	Time separator (ASCII character)
Parameters	TimeWithSec	0	1	---	1	Showing the seconds in the real time <ul style="list-style-type: none"> ▪ 1 = yes
Parameters	Time AM/PM	0	1	---	0	Time format <ul style="list-style-type: none"> ▪ 0 = 24 h (for example 15:20) ▪ 1 = 12 h (for example 3:20 PM)
Parameters	Back Mode	---	---	---	TIME	Backlight mode <ul style="list-style-type: none"> ▪ OFF = backlight is never lit ▪ ON = backlight is always lit ▪ TIME = backlight is lit the time one has set with parameter <i>BackTimeout</i> since the last operation with the buttons.
Parameters	BackTimeout	0	240	s	60	Backlight duration (only if parameter <i>Back Mode</i> has value <i>TIME</i>)
Parameters	I/OTimeout	0	240	s	60	Timeout of the ExpBus. If no communication signal had been received during this time on the I/O expansion port, the controller will indicate that there is an I/O communication error. In addition, the controller will disable all I/O.
Parameters	PW Timeout	0	240	s	60	ExpBus submenu access password time-out (after this time without one has operated with the buttons, to gain

Submenu	Parameter	Min.	Max.	Unit	Default	Description
						access again to the submenu one has to set the password again)
Parameters	Contrast	0	63	---	25	Displays contrast
Parameters	Buzz On Key	0	1	---	1	Uttering a beep while pressing a button <ul style="list-style-type: none"> ▪ 1 = yes
Parameters	Print Load	0	1	---	0	Showing the indication <i>Loading...</i> while loading a page <ul style="list-style-type: none"> ▪ 1 = yes
Parameters	Print Frame	0	1	---	0	Showing frames instead small size pages <ul style="list-style-type: none"> ▪ 1 = yes
ExpBus	MyNode	1	127	---	99	Local (or of the interface) ExpBus node's address
ExpBus	Master	---	---	---	YES	When set to YES, the display acts as an ExpBus master; otherwise the display acts as an ExpBus slave
ExpBus	Baud	---	---	---	Auto	ExpBus communication baud rate <ul style="list-style-type: none"> ▪ 20 K = 20,000 baud ▪ 50 K = 50,000 baud ▪ 125 K = 125,000 baud ▪ 500 K = 500,000 baud ▪ Auto = the interface recognizes these baud rates automatically
ExpBus	Net Timeout	1	240	s	5	Timeout of the ExpBus. If no communication signal has been received during this time on the ExpBus port, the display will show the word 'Checking...'.
ExpBus	NW Node	[1] 1	[32] 127	---	---	Logical and physical address of devices on the ExpBus <p>[1] = logical node address of the device</p> <p>2 = physical node address of the device</p>
Modbus	Address	1	247	---	1	Modbus address (reserved)
Modbus	Parity	---	---	---	even	Modbus communication parity (reserved): <ul style="list-style-type: none"> ▪ none = no parity

Submenu	Parameter	Min.	Max.	Unit	Default	Description
						<ul style="list-style-type: none"> ▪ odd = odd ▪ even = even
Modbus	Baudrate	---	---	---	9600	Modbus communication baud rate (reserved): <ul style="list-style-type: none"> ▪ 1200 = 1,200 baud ▪ 2400 = 2,400 baud ▪ 4800 = 4,800 baud ▪ 9600 = 9,600 baud ▪ 19200 = 19,200 baud ▪ 28800 = 28,800 baud ▪ 38400 = 38,400 baud ▪ 57600 = 57,600 baud
Modbus	BitStop	---	---	---	1 bit	Modbus communication stop bit number (reserved)

3.6.4. Configuring a device

Operate as follows:

1. Remove power to the device and to the interface.
2. Connect the device to the interface through the ExpBus port. Refer to the *Electrical Characteristics*, page 92.
3. Reapply power to the device and to the interface.
4. Set the parameter *NW Node*. Refer to the *Configuration Screens*, page 93.

NOTE: Parameter *NW Node* belongs to the **ExpBus** submenu.

According to the default settings, the ExpBus node address of a controller has value 1 (set the parameter *NW Node* to [1] 1) and the ExpBus node address of an expansion has value 2 (set the parameter *NW Node* to [2] 2).

5. Press and hold down the **LEFT** and **ENTER** buttons of the interface simultaneously for about 2 seconds: the display shows the **Network Status** menu:

Network Status			
Loc	99	OK	>>
1	1	OK	>>
2	2	OK	>>
3	0	-	>>
4	0	-	>>
5	0	-	>>

6. Press and release button **UP/DOWN** to select the device.
7. Press and release button **ENTER**: the display shows the **Main** menu of the device.
8. Operate as indicated in *Configuring the interface*, page 93.

▲ WARNING

UNINTENDED EQUIPMENT OPERATION

- Remove power and then reapply after at least 3 seconds when any configuration modifications have been made.

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

3.7. Display Operations

LED	Main Function	Meaning
PWR	Power	Off: no power supply On: presence of power supply
RX	ExpBus	Off: no reception On: message reception
TX	ExpBus	Off: no transmission On: message transmission

3.7.1. Configuration Memory

Function	Meaning
Backup type	EEPROM
Data retention time	10 years

3.7.2. RTC (Real Time Clock)

Function	Meaning
Backup type	Supercap
RTC data retention time in the event of a power loss	2 days
Drift value	≤ 30 sec/month at 25 °C

4. Electronic Valve Expansion Module

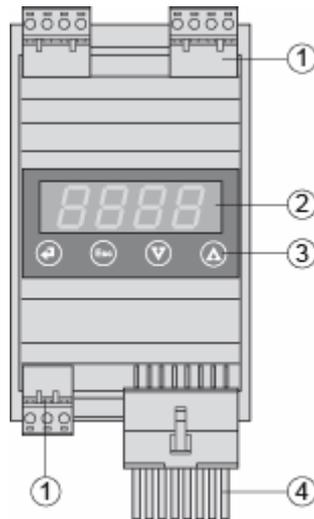
4.1. Overview

The TM168DEVCM is an expansion module dedicated to electronic expansion valves control. It can work in two modes:

1. Stand alone mode, without connectivity to the controller. The module will be configured by the built-in display.
2. Network mode, connected to the TM168•23• controller through the TM168AVCMCOM interface. The module may be configured and monitored through the TM168•23 controller.

NOTE: The TM168DEVCM Electronic Valve Expansion Module is intended for use only with the Alco-Emerson electronic expansion valve references from the series EXM-246, EXL-246, EX4, EX5, EX6, EX7, EX8 and EX9. Do not use this electronic valve expansion module with other products as they will not function.

4.2. Physical Description of a TM168DEVCM Module

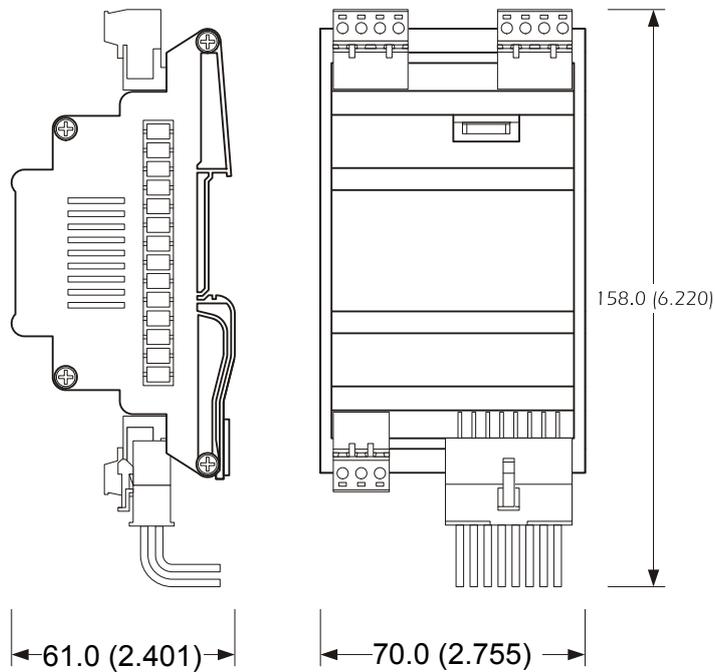


- ① 5 mm connectors
- ② 4 digits 7 segment display
- ③ 4 keyboard buttons
- ④ 16 pins connector

4.3. Installation

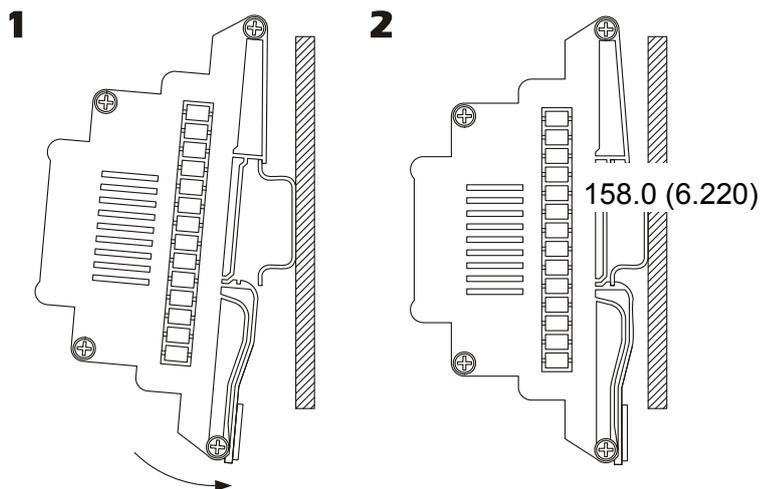
4.3.1. Dimensions

The TM168DEVCM dimensions are displayed below. All dimensions are in millimetres and inches.

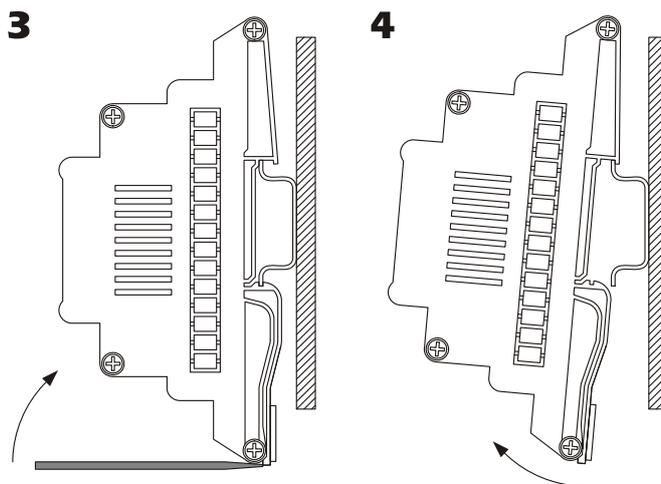


4.3.2. Installation on Din Rail

To install the TM168DEVCM, follow the indications in the illustrations below (points 1 and 2).



To remove the TM168DEVCM, use a screwdriver and follow the indications in the illustrations below (points 3 and 4).



4.3.3. Environmental Features

Environmental Feature	Description
Connections	3 x Plug-in terminal block 5 mm (0.196 in) pitch for conductors upto 2.5 mm ² (13 AWG) 1 x Plug-in Miniconnect connectors
Storage temperature	-10...65 °C (14...149 °F)
Ambient temperature	0...50 °C (32...122 °F)
Humidity	Relative humidity 5...80% non-condensing
Operation Altitude	0...2000 m (0...6561 ft)
Transport Altitude	0...3048 m (0...10000 ft)
Vibration withstand	5...8.4 Hz: 3.5 mm (0.137 in) displacement 8.4 Hz...150Hz: 1 g _n acceleration
Shocks withstand	15 g peak – 11 ms; half-sine test
Transportation bumps withstand	10 g _n 6 ms (product off)
Environmental Feature	Description
Pollution degree	2
Overvoltage category	3
PTI of the insulating materials	≥ 250 V
EMC compliance level	EN61000-6-3, EN61000-6-1
Product safety conformity	EN/IEC 60730-1
CE declaration conformity	Low Voltage Directive 2006/95/EEC,

	EMC Directive 2004/108/EC
Environmental regulations	ROHS 2002/95/EC– WEEE 2002/96/EC - REACH CE1907/2006

4.3.4. Housing

Installation	35 mm DIN Guide according to EN 50022
Protection level	IP 40*

*This IP rating is a customer declaration and has not been subject to UL testing to this level.

4.4. I/O and Connections

4.4.1. Connection Rules

Power Supply

TM168DEVCM is powered by a 24 VAC or 24 VDC power supply. The power connection cables have a maximum length of 1 m. The TM168DEVCM power supply is not isolated. The power supply must be galvanically isolated from other devices.

⚠ WARNING
<p>UNINTENDED EQUIPMENT OPERATION</p> <ul style="list-style-type: none"> • Use only an isolated power supply. • Do not use a cable longer than 1m (3.28 ft) to connect the power supply to the TM168DEVCM Expansion Module. <p>Failure to follow these instructions can result in death, serious injury, or equipment damage.</p>

Connection to the TM168AVCM Battery Backup Module

The TM168DEVCM can be connected to an external backup power module (TM168AVCM) to help ensure the closing of the valve in case of a power outage.

Analog Input Connections

TM168DEVCM has two analog inputs, one for NTC temperature probe and one for pressure transducer 4...20 mA. The pressure transducer can be powered via a 12 Vdc voltage available on the terminal block. The input connection cables have a maximum length of 3 m (9.84 ft).

Digital Input Connections

TM168DEVCM has 2 non opto-isolated digital (dry contact) inputs and 1 high-voltage (230 Vac) opto-isolated input (optional 24 Vac). The digital input connection cables have a maximum length of 3 m (9.84 ft).

Digital Output Connections

TM168DEVCM has one digital electro-mechanical relay output. The maximum length of the output connection cables is 10 m (32.81 ft).

Connection of the Electronic Expansion Valve

The module connects to stepper motors driven electronic valves from Alco-Emerson.

The maximum length of the electronic expansion valve connection cables is 6 m (19.69 ft).

RS485 Connection

The MicroMatch connector allows you to connect Modbus with the TM168AVCMCOM accessory.

Wiring Considerations

⚠ 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.
- Always use a properly rated voltage sensing device to confirm the power is removed.
- Replace and secure all covers, accessories, hardware, cables, and wires and confirm that a proper ground connection exists before applying power to the unit.
- Use only the specified voltage when operating this equipment and any associated products.

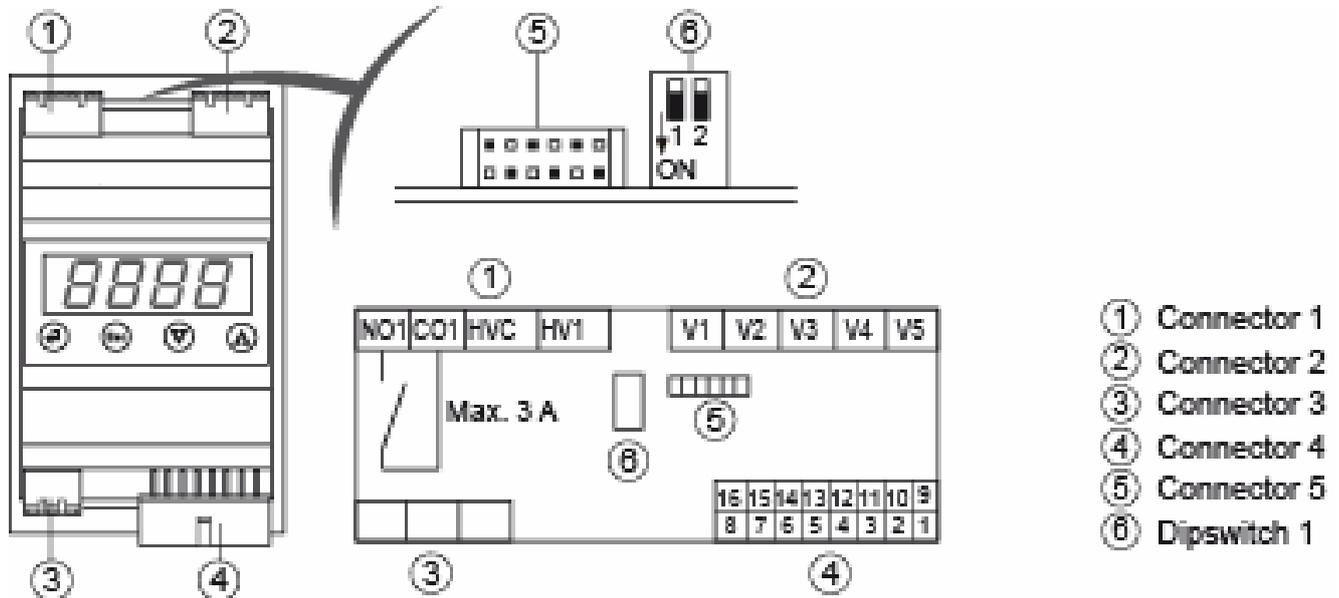
Failure to follow these instructions will result in death or serious injury.

The following rules must be applied when wiring the TM168 System:

- I/O and communication wiring must be kept separate from the power wiring. Route these 2 types of wiring in separate cable ducting.
- Verify that the operating conditions and environment are within the specification values.
- Use proper wire sizes to meet voltage and current requirements.
- Use copper conductors only.
- Avoid wiring near any sources of electromagnetic interference, such as high gain antennas.
- Avoid wiring low level signals, such as analog inputs, near high voltage signal wires, such as relay outputs.

4.4.2. TM168DEVCM Wiring Diagram

The TM168DEVCM connection layout with related tables describing each input, output and power connection are found below.



4.4.3. TM168DEVCM Wiring Description

Connector 1: Enable relay output and digital input (high voltage).

Code	Description
NO1	Relay normally open contact used by the system for alarms
COM	Relay common
HVC	Digital input common
HV1	Digital enable input (230 Vac \pm 15 %)

Connector 2: Electronic expansion valve.

Code	Description for EXM-246/EXL-246 valves
V1 (SH)	Shield
V2 (2B)	White wire
V3 (2A)	Orange wire
V4 (1B)	Blue wire
V5 (1A)	Yellow wire
Not Used	Red wire

Not Used	Brown wire
----------	------------

Code	Description for EX4/EX5/EX6/EX7/EX8/EX9 valves
V1 (SH)	Shield
V2 (2B)	White wire
V3 (2A)	Black wire
V4 (1B)	Blue wire
V5 (1A)	Brown wire

Connector 4: Instrument power supply, back-up battery power supply, measurement inputs and digital inputs.

Code	Description
1	power supply TM168DEVCM (24 Vac/dc)
2	common for analog and low voltage digital inputs
3	common for analog and low voltage digital inputs
4	common for analog and low voltage digital inputs
5	not connected
6	not connected
7	analog input 2 (suction temperature sensor; NTC)
8	analog input 1 (evaporation pressure sensor; 4-20 mA)
9	power supply TM168DEVCM (24 Vac/dc)
10	input power supply coming from the TM168AVCM battery backup module (12 Vdc)
11	power supply pressure transducer (12 Vdc)
12	not connected
13	not connected
14	not connected
15	low voltage digital input 1 (enable)
16	low voltage digital input 2 (backup battery loading status)

Connector 4 Type:

SPECIFICATIONS OF THE 16-WAY MINI-FIT CONNECTOR		
SUPPLIER	CONNECTOR CODE	CONTACTS CODE

Note: use the appropriate tool for crimping		
CVILUX	CP-01 116010 (V2) CP-01 116020 (V0)	CP-01 1000102 (AWG16÷24)
JUSCOM	1090-557-162 (V2)	1150-156-012 (AWG18÷22) 1150-156-002 (AWG22÷26)
MOLEX	39-01-21650 (V2) 39-01-2165 (V0)	39-00-0038 (AWG18÷24) 39-00-0046 (AWG22÷28)

Connector 5: Micromatch connector to the TTL / RS-485 interface

4.5. Electrical Characteristics

4.5.1. Power Supply (Connector 4)

Nominal voltage	24 Vac / 24 Vdc
Voltage limits	-10 %...+15 %
Acceptable AC frequencies	50/60 Hz
Isolation	None
Power consumption	30 W
Built-in protection	None. External fuse required: 2 A, Type T, 250 Vac

4.5.2. Digital Output (Connector 1)

Number	1
Type	Electro-mechanical relays
Maximum breaking voltage	5...30 Vdc 24...250 Vac
Maximum breaking current	3 A
Electrical durability (resistive mode)	Typically 100,000 operating cycles
Built-in protection	None. External fuse required: 2 A, Type T, 250 Vac

4.5.3. High-Voltage Digital Input (Connector 1)

Number	1
Type	Opto isolated
Voltage range	230 Vac \pm 20 %
Min. detection time from OFF to ON	100 ms
Min. detection time from ON to OFF	100 ms

4.5.4. Dry Contact Digital Input (connector 4)

Do not use an external power supply to provide power to devices connected to these inputs. The use of an external power supply with these inputs can damage your module.

⚠ CAUTION
INOPERABLE EQUIPMENT
<ul style="list-style-type: none"> Do not connect an external power supply to the dry contact I/O of the Expansion Module digital inputs. Do not use a cable longer than 1m (3.28 ft) to connect the power supply to the TM168DEVCM Expansion Module.
Failure to follow these instructions can result in equipment damage.

Number	2
Type	Potential-free (dry) contact
Current when contact is closed	2 mA
Open circuit voltage	5 V
Maximum closure resistance (for digital = 1)	100 Ω
Minimum detection time from OFF to ON	100 ms
Minimum detection time from ON to OFF	100 ms

4.5.5. Battery Back-up Power Supply Input (Connector 4)

Voltage	12 Vdc
Battery characteristics	12 Vdc, 7.2 Ah rechargeable lead battery
Battery charger	$I_{\max} = 150 \text{ mA}$, $V_{\max} = 15 \text{ V}$

4.5.6. NTC Input (Connector 4)

Number	1
NTC Type	10 k Ω NTC beta 3977
NTC range	10 k Ω @ 25 $^{\circ}\text{C}$ (77 $^{\circ}\text{F}$), Range: -40...105 $^{\circ}\text{C}$ (-40...221 $^{\circ}\text{F}$)
Precision	$\pm 0.5 \text{ }^{\circ}\text{C}$ ($\pm 32.9 \text{ }^{\circ}\text{F}$)
Resolution	0.1 $^{\circ}\text{C}$ (32.18 $^{\circ}\text{F}$)

Isolation	None
Protection	None

4.5.7. Pressure Input (Connector 4)

Number	1
Type	Current
Current measurement range	4-20 mA
Power supply	From module 8...30 Vdc
Precision	± 0.02 mA
Resolution	0.01 mA
Input resistance	200 Ω

4.5.8. Valve Output (Connector 2)

Number	1
Type	Step-by-step motor driver
Power supply	Generated inside the module
Supported valves from EMERSON/ALCO	EX4/5/6/7/8 EXM-246/EXL-246

4.6. User Interface

4.6.1. Interface Definition

The built-in interface on the controller includes:

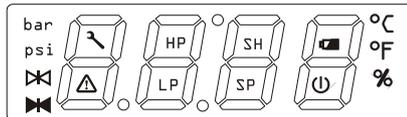
- A 4 digit 7-segment display
- 15 icons
- A keypad with 4 keys

Particular button functions:

Key Pressed	Function
DOWN from power-up	View version/review firmware
DOWN for 2 seconds	Temporary values view
SET/ENTER for 2 seconds	View/modify overheating set-point

	PH30= 0 modification disabled
DOWN + UP for 4 seconds	View/modify/reset parameters
UP for 2 seconds	View alarms
ESC for 2 seconds	View/modify valve output % in manual mode
SET/ENTER + DOWN for 2 seconds	Lock/Unlock control panel

Meaning of the icons:



Icon	Color	Function
bar	Green	Identifies the unit of measurement selected. If on, it indicates that the pressure is expressed in bar.
psi	Green	Identifies the unit of measurement selected. If on, it indicates that the pressure is expressed in psi.
 valve closed	Green	Identifies the valve status (closing): <ul style="list-style-type: none"> • Off: the valve is closed or < 5% • On: the valve is open at a value of > 95% • Flashing: the valve is in operation
%	Amber	If on, it indicates that the % opening of the valve is being displayed.
°F	Red	Identifies the unit of measurement selected. If on, it indicates that the temperature is expressed in °F.
°C	Red	Identifies the unit of measurement selected. If on, it indicates that the temperature is expressed in °C.
 maintenance	Red	Blinking: identifies the request for maintenance. On: the valve is operating in manual mode.
 alarm	Red	Identifies the presence or not of alarms. On: at least one alarm is activated.
HP (MOP)	Green	It is active when the MOP function is activated (parameter PA50): <ul style="list-style-type: none"> • Off: function disabled • On: MOP function active • Flashing: MOP alarm
LP (LOP)	Green	It is active when the LOP function is activated (parameter PA40). <ul style="list-style-type: none"> • Off: function disabled • On: LOP function enabled • Flashing: LOP alarm

Icon	Color	Description
SH	Green	ON when the SuperHeat value is being displayed. Flashing: LSH, HSH alarm
SP	Green	Identifies that a set-point is being displayed. Flashing: the set-point is being modified.
 back-up battery	Green	Battery state (DI2) <ul style="list-style-type: none"> • Off: Battery charged • On: Back-up battery being charged or back-up module disconnected
 on/stand-by	Red	Identifies the state of the valve <ul style="list-style-type: none"> • Off: valve on (enabled) • On: valve off (disabled) • Flashing: valve in start-up
central higher decimal dot	Red	Identifies the Intrabus/Modbus communication state. If Pr06= 0 or 1: <ul style="list-style-type: none"> • Off: No Intrabus/Modbus communication • On: Intrabus/Modbus communication detected error • Flashing: Intrabus/Modbus communication ok If Pr06= 2: <ul style="list-style-type: none"> • Off: No Intrabus communication • On: Intrabus communication detected error • Flashing: Intrabus communication ok If Pr06= 3: <ul style="list-style-type: none"> • Off: No Modbus communication • On: Modbus communication detected error • Flashing: Modbus communication ok

4.6.2. Main Screen

The main screen changes according to the state of the valve:

- If the valve is disabled (valve open and regulation deactivated), the display shows the **OFF** message and the relative (stand-by) icon is illuminated.
- If the valve is enabled (valve closed and regulation activated), the display shows the selected value from the *PdIS* parameter (or else an error message). The relative (stand-by) icon is off or will only flash during start-up.

4.6.3. Default Display

In order to change the default viewing selection, while the machine is on, follow the procedure below:

1. Press the DOWN button for 2 seconds, the SH label is displayed.
2. Press the ENTER button to display the measured over-heating value.
3. Press the UP/DOWN button to change the default display according to the following table:

SH	measured overheating value
PrES	measured pressure value
PErC	valve open %
TEMP	measured temperature value
TSAT	calculated temperature value (from pressure)
SHSP	overheating set point value
SEtP	selected parameter set

To exit the procedure, press the ESC button.

After 60 seconds without keypad new entry, the menu is exited.

4.6.4. Setting the Operating Set-point

While the machine is on, press and hold down the ENTER button in order to view the currently selected overheating set point (based on the selected functioning mode or parameter set):

- Press the UP/DOWN button to change the value
- Press the SET/ENTER button to confirm.

The *PH30* parameter can be used to lock the set point. In this case, if a user attempts to modify the set point, the message **LOC** appears for about 2 seconds.

4.6.5. Setting the Configuration Parameters

The general menu is structured as follows:

- User menu (Level 1)
- Installer menu (Level 2)

Password

Level 2 is protected by a password which allows access to the various functionalities that menu offers. Once the password has been entered correctly, the protected functions will be accessible.

The password can be set with a range of numeric values from -99 to 999. (Default value -19)

If no button is pressed for 1 minute, the password expires and will have to be set again.

User Menu

This menu can be accessed/viewed from any point within the **User** menu by pressing the UP+DOWN buttons for about 4 seconds.

The first variable displayed is r100 (evaporation pressure).

r100 to r115 and PA menus are accessible.

- Press the ENTER button to view the relative value.
- Press the ENTER button again to come back to the variable list.
- Use the UP/DOWN button to scroll through the list of module variables.

If the DOWN button is pressed while the r100 variable is being displayed, the device requests the **PA** password to access **Installer** menu.

The only variable which can be modified from this level is **PA**, the password.

Installer Menu

To access the **Installer** menu:

- Select the PA variable,
- Press the ENTER button and enter the password value using the UP/DOWN button
- Confirm the value by pressing the ENTER button
- Finally, press and hold down the UP and DOWN buttons for 4 seconds.

At this point, the user can scroll through all of the selectable parameters by pressing the UP/DOWN button.

To quit the procedure:

- Press and hold down the UP and DOWN buttons for 4 seconds, do nothing for 60 seconds, or press the ESC button.

4.6.6. Restore the Default Value of the Configuration Parameters

All of the parameters of the valves can be reset to their default values by following this procedure.

In order to avoid unintended system behaviors, the driver should be turned off and on again after completing this operation.

⚠ WARNING

UNINTENDED EQUIPMENT OPERATION

Remove power and then reapply after at least 3 seconds when any configuration modifications have been made.

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

To restore the default configuration parameters:

- Make sure no procedure is in progress.
- Press and hold down the UP and DOWN buttons for 4 seconds, the display will show a label.
- Press the UP/DOWN button to select PA.
- Press the ENTER button.
- Press the UP/DOWN button to set 743.
- Press the ENTER button or do not operate for 15 seconds
- Press and hold down the UP and DOWN buttons for 4 seconds, the display will show dEF.
- Press the ENTER button.
- Press the UP/DOWN to set 149.
- Press the ENTER button or do not operate for 15 seconds, the display shows flashing dEF for 4 seconds, after which the instrument will exit the procedure.
- Cut the instrument power supply off.

4.6.7. Displaying the Firmware ID

On switch-on, during the start-up test phase, holding the DOWN button, the project identification is displayed for about 2 seconds. The information regarding the versions/revisions of the project is displayed in sequence. The procedure is exited automatically at the end of the start-up.

4.7. Valve Monitoring and Operation

4.7.1. Enabling Valve Control

If the valve is off (valve closed, disabled with regulation disabled), the display indicates **OFF** and the stand-by ON icon will be illuminated.

The valve can be turned on (valve open, enabled with regulation enabled) by means of 2 possible procedures (which can be selected from the *Pr06* parameter):

1. **From the digital input** (stand-alone functionality enabled by the parameter *Pr06=0* or 1):

The valve regulation can be enabled from the opto-isolated digital input (**DIHV**, *Pr06=1*) or from the non opto-isolated digital input (**DI1**, *Pr06=0*).

Typical usage includes the use of an opto-isolated digital input (230 Vac) connected in parallel to the compressor. In this case, the valve regulates when the compressor is on, otherwise it is off.

This method allows the refrigeration circuit to function in a stand-alone configuration, independent of all of the other components, with local temperature and pressure sensors.

2. **From Modbus** (functionality enabled by the parameter *Pr06=3*):

The valve can be enabled through the serial port with TM168AVCMCOM module.

Modbus parameters Mod1 to Mod4 must be adjusted with built-in HMI before to initiate Modbus communication.

Regardless of which enabling method is used, a start-up procedure exists which keeps the valve open at a certain percentage (from parameter *PI06*) for a certain settable amount of time (from parameter *PI05*); the blinking stand-by icon indicates this status.

4.7.2. Manual Operation

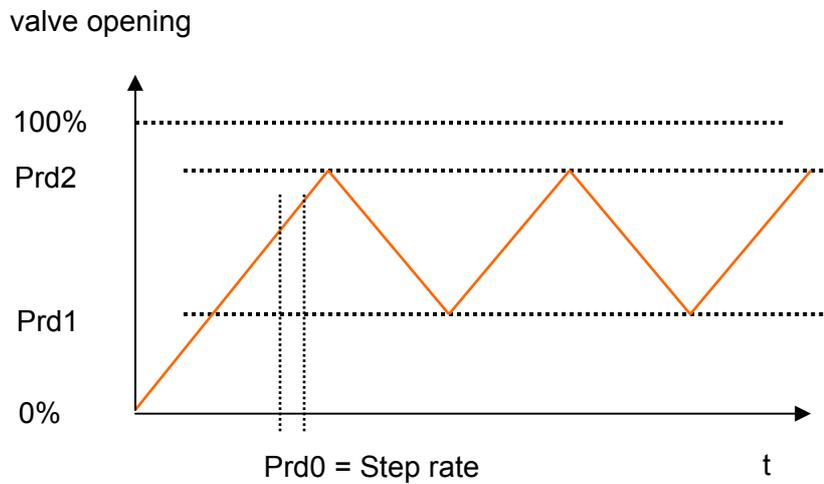
In manual mode, the user directly commands the position of the valve. The local pressure and temperature can be read remotely. The overheating algorithm in the module is not used.

This operation can be used for integration testing or in order to control the valve opening from controller algorithm.

The valve must be on (enabled) in order to work in manual mode.

During manual operation, the Maintenance icon appears on the display. The valve is forced by means of the appropriate parameters *Pr02* and *Pr03*. In particular, *Pr02=0* disables manual function, while *Pr02=1* enables it. *Pr03* represents the % value with which the valve output is to be set.

With $Pr02=2$, a particular manual command is enabled for inspections where the valve output is driven as represented in the following figure; for every $Prd0 \cdot 100$ ms, the valve output % is increased or decreased between a value minimum $Prd1$ and a maximum value $Prd2$.



In the case of loss of power, the driver memorises the status and then restarts in manual mode.

In manual mode, the % value of the valve opening can be displayed and set by pressing the ESC button for about 2 seconds.

4.7.3. Valve Status

The valve can be in any one of the following operative states (also identified by appropriate icons):

	Status	Description	Icon	Display
0	OFF	Valve closed (mechanical stop)	Stand-by	OFF
1	ON_START	Valve starting	Stand-by + Valve	(PdIS)
2	ON	Valve maintaining its position	Valve	(PdIS)
3	ON	Valve opening	Valve opening	(PdIS)
4	ON	Valve closing	Valve closing	(PdIS)
5	ON-MAN	Valve in manual mode	Maintenance	(PdIS)
6	OFF_ALL	Valve closed following an alarm	Alarm	OFF (flashing)
7	ON_ALL	Valve forced following an alarm	Alarm	(PdIS)

The display normally shows the value selected through the PdIS parameter (+ the symbol which indicates the type of value being displayed).

4.7.4. Diagnostics

The application can manage a series of alarms relative to the valve. On the basis of various types of alarms, it is possible to configure a reset (whether manual or automatic), a signalling delay as well as actions to be performed in specific circumstances.

The icon flashes when one or more alarms are active.

In order to view the various alarms, press the UP button for about two seconds from the main menu. The first active alarm is displayed. Use the UP/DOWN button to scroll through the list of active alarms. If no alarms are active, pressing the UP button for two seconds will have no effect.

When the causes of the alarm have disappeared, the instrument will go back to normal functioning.

All of the digital inputs relative to the alarms (for example, battery charger input) are managed by an Alarms Logic parameter that has the following meaning:

- if set at NO, the inputs will be normally opened.
- if set at NC, the inputs will be normally closed.

Inoperative Sensor

If a sensor becomes inoperative or the input signal is lost, the VCM module will automatically close the valve. You can use the *Pr04* and *Pr05* parameters to override this automatic behavior of the VCM expansion module and enable manual control. The *Pr04* parameter is used to enable/disable manual control, and the *Pr05* parameter is used to define the percentage (%) open valve position in the event of manual operation.

Alarm Relay

The VCM expansion module can be programmed to manage the alarm relay on the NO1 / COM terminals of connector 1 ([TM168DEVCM wiring layout](#)). The PH01 and PH02 parameters are used to determine the behaviour of the alarm relay. The following PH01 parameter values are possible:

- PH01 = 0: The alarm relay is disabled.
- PH01 = 1: The alarm relay will operate for all alarm conditions except for display-only alarms.
- PH01 = 2: The alarm relay operates only when errors are detected by the sensors or on the loss of a sensor input signal.

The PH02 parameter defines whether the alarm relay will behave as a NO or NC contact. The following values are possible:

- PH02 = 0: The alarm relay operates as a NO contact.
- PH02 = 1: The alarm relay operates as a NC contact.

Alarms Table

Below is a list of all alarms managed by the application. The order of presentation is the same as the order with which the alarms are presented when active.

NOTE: The signal-only alarms only act upon the icon and the signalling bits, not on the relays.

Code	Alarm Description	Alarm Impact	Consequence	Notes
ESPI	Internal detected error	Signal	The valve closes completely	Fixed delay
ECom	Intrabus communication detected error with main controller	Signal + Alarm relay (PA01=1)	The valve closes completely	PA01, PA02 = adjustable delay
EPr1	Pressure sensor malfunction or disconnection	Signal + Alarm relay	The valve closes completely	-
EPr2	Temperature sensor malfunction or disconnection	Signal + Alarm relay	The valve closes completely	-
ALSm	Valve step-by-step motor detected error	Signal + Alarm relay	Valve position unknown	-
ALHS	High over-heating	The SH LED flashes	-	PA20, PA21, and PA22
ALLS	Low over-heating	The SH LED flashes	-	PA10, PA11, and PA12
ALLP	Low pressure	The LP LED switches on	-	PA30, PA31, PA32, and PA33
LOP	LOP	The LP LED flashes	-	PA40, PA41, and PA42
MOP	MOP	The HP LED flashes	Valve control continues	PA50, PA51, PA52 = adjustable delay
PFir	Power outage on the electric mains (displayed only if back-up battery is present).	-	-	-

4.7.5. Parameter Sets

In order to meet the regulation requirements of different type of machines, 3 sets of parameters are available. Each set of parameters includes start-up parameters (*opening time and value*), the SH (*super heating*) set point, the SH (*super heating*) high/low alarm sets, the LOP set (*minimum evaporation temperature*) and the MOP set (*maximum evaporation temperature*).

The parameter set can be selected with the *SEtP* parameter. The 3 sets represent by default the parameters for the chiller, heat-pump or defrost functionalities.

- Set 1 parameters: SEt1 that is, chiller functionality
- Set 2 parameters: SEt2 that is, heat-pump functionality
- Set 3 parameters: SEt3 that is, defrost functionality

During machine operation, it is possible to change the *SEtP* parameters to adapt the regulation.

Selecting the Superheat Setpoint

Once the functioning mode has been selected, the regulator uses the relative parameter which contains the superheat SP from *PC01*, *PP01*, and *Pd01*. The adjustment of this parameter is fundamental as it is used to manage the correct regulation of the electronic valve. A low set point ensures increased evaporator yield, but has the possible disadvantage of liquid reaching the compressor.

4.8. Parameters List

All of the TM168DEVCM parameters are listed below. Every parameter is listed with a brief description, its range of admissible values, its unit of measure, its preset default value and the menu in which it is found.

The menus are structured based on the following logic:

- Through the built-In HMI, the **User** menu and **Installer** menu are accessible. The **Installer** menu is password protected.
- Through Modbus communication, the **Installer** menu, the **Modbus** menu and some of the **User** menu information are available.

User Menu

Variable	Description	Min.	Max.	Resolution	Modbus Address	Read/Write	Note
Machine Status Readings							
rI00	Evaporation pressure	-0,7 (-10.0)	50,0 (700.0)	0.1 Bar (0.1psi)	517	R	From pressure transducer
rI01	Evaporation temperature	-50,0	50,0	0.1 °C	516	R	From evaporation pressure
rI02	Coil Out temperature	-50,0	50,0	0.1 °C	516	R	From aspiration temperature transducer
rI03	Superheat value	-50,0	50,0	0.1 °K	1366	R	
rI04	Valve open % value	0,0	100,0	0.1 %	1367	R	
rI05	Pressure sensor error	0	2	-	N/A		0= ok 1= Sensor short circuit 2= Sensor open For Modbus, see <i>Alarms register 1368</i> , page 131.
rI06	Temperature sensor error	0	2	-	N/A		0= ok 1= Sensor short circuit 2= Sensor open For Modbus, see <i>Alarms register 1368</i> , page 131.
rI07	Stepper motor error	0	1	-	1368 Bit 10	R	0= ok 1= error
rI08	Group alarm from VCM	0	7	-	N/A	R	Alarm bits status, see note below the table.
rI12	Digital inputs state	0	3	-	1361 Bit 0...2	R	Status of digital inputs, see note below the table.
rI15	VCM module revisions	0	3	-	65289 65290	R	65289: Firmware ID 65290: Firmware variation/revision

Note:**rI08**

BIT	7	6	5	4	3	2	1	0
EGROUP	X	X	X	X	X	Motor error	SI2 error	SI1 error

Example: alarm 7 is Motor error + SI2 error + SI1 error

rI12

BIT	7	6	5	4	3	2	1	0
DIGIN	X	X	X	X	X	X	DI2 (VCM)	DI1 (VCM)

Installer Menu

Code	Parameter Description	Default	Min	Max	U.M.	Modbus Address	Read/Write	Note
Working set point								
PC01	Chiller Superheat Set Point	6.0	0.5 (1.0)	30.0 (50.0)	0.1 °K (0.1 °R)	1539	R/W	Overheating SP SET1
PP01	Heat Pump Superheat Set Point	6.0	0.5 (1.0)	30.0 (50.0)	0.1 °K (0.1 °R)	1546	R/W	Overheating SP SET2
Pd01	Defrost Superheat Set Point	6.0	0.5 (1.0)	30.0 (50.0)	0.1 °K (0.1 °R)	1553	R/W	Overheating SP SET3
OPERATING MODE: (select one of 3 possible parameter sets)								
By default:								
Set1 Parameters= Chiller								
Set2 Parameters= Heat Pump								
Set3 Parameters= Defrost								
SEtP	Operating Mode	1	1	3	-	1538	R/W	1= Set1 Parameters 2= Set2 Parameters 3= Set3 Parameters
SYSTEM SETTINGS								
PI00	Refrigerant type	1	0	7	-	1607	R/W	0 = R22 1 = R134A 2 = R507 3 = R404A 4 = R407C 5 = R410A 6 = R124 7 = R744
PI03	Superheat control method	0	2	2	-	1608	R/W	0 = standard 1 = slow 2 = PID

Code	Parameter Description	Default	Min	Max	U.M.	Modbus Address	Read/Write	Note
SYSTEM SETTINGS								
PI07	Valve type	2	1	7	-	1609	R/W	1 = EX4 Alco 2 = EX5 Alco 3 = EX6 Alco 4 = EX7 Alco 5 = EX8 Alco 6 = EX9 Alco 7 = EXM-246/EXL-246 Alco
PI08	Evaporation pressure transducer type	0	0	9	-	1610	R/W	0 = 0...7 bar/4...20 mA 1 = 0...18 bar/4...20 mA 2 = 0...30 bar/4...20 mA 3 = 0...50 bar/4...20 mA
PI09	Restricted Use (Do not modify)					1611	R/W	
PI10	Restricted Use (Do not modify)					1612	R/W	
PI11	Restricted Use (Do not modify)					1613	R/W	
SET1								
PC02	Low Chiller Superheat Set Point	2.0	0.5 (1.0)	30.0 (50.0)	0.1 °K (0.1 °R)	1540	R/W	
PC03	High Chiller Superheat SP Alarm	30.0	0.5 (1.0)	50.0 (90.0)	0.1 °K (0.1 °R)	1541	R/W	
PC04	LOP Chiller Temperature	-30.0	-40.0 (-40.0)	+40.0 (100.0)	0.1 °C (0.1 °F)	1542	R/W	
PC05	MOP Chiller Temperature	30	-40.0 (-40..0)	+40.0 (100.0)	0.1 °C (0.1 °F)	1543	R/W	
PC06	Valve opening duration from Start-up	5	1	30	s	1544	R/W	
PC07	Valve opening % from Start-up	50	10	100	%	1545	R/W	

Code	Parameter Description	Default	Min	Max	U.M.	Modbus Address	Read/Write	Note
SET2								
PP02	Low Heat Pump Superheat Set Point	2.0	0.5 (1.0)	30.0 (50..0)	0.1 °K (0.1 °R)	1547	R/W	
PP03	High Heat Pump Superheat SP Alarm	30.0	0.5 (1.0)	50.0 (90.0)	0.1 °K (0.1 °R)	1548	R/W	
PP04	LOP Heat Pump Temperature	-30.0	-40.0 (-40.0)	+40.0 (100.0)	0.1 °C (0.1 °F)	1549	R/W	
PP05	MOP Heat Pump Temperature	30	-40.0 (-40.0)	+40.0 (100.0)	0.1 °C (0.1 °F)	1550	R/W	
PP06	Valve opening duration from Start-up	5	1	30	s	1551	R/W	
PP07	Valve opening % from Start-up	50	10	100	%	1552	R/W	
SET3								
Pd02	Defrost Low Superheat Set Point	2.0	0.5 (1.0)	30.0 (50..0)	0.1 °K (0.1 °R)	1554	R/W	
Pd03	Defrost High Superheat SP Alarm	30.0	0.5 (1.0)	50.0 (90..0)	0.1 °K (0.1 °R)	1555	R/W	
Pd04	Defrost LOP Temperature	-30.0	-40.0 (-40.0)	+40.0 (100.0)	0.1 °C (0.1 °F)	1556	R/W	
Pd05	Defrost MOP Temperature	30	-40.0 (-40.0)	+40.0 (100.0)	0.1 °C (0.1 °F)	1557	R/W	
Pd06	Valve opening duration from Start-up	5	1	30	s	1558	R/W	
Pd07	Valve opening % from Start-up	50	10	100	%	1559	R/W	
PROTECTION ALARMS								
PA01	Enables communication Alarm	0	0	1	-	1560	R/W	0= disabled 1= enabled
PA02	Communication Alarm Delay Time	30	5	200	s	1561	R/W	
PA10	Enable Low Superheat Alarm	0	0	1	1	1562	R/W	0= disabled 1= enabled
PA11	Low Superheat alarm hysteresis	3.0	0.5 (1.0)	30.0 (50.0)	0.1 K (0.1 °R)	1563	R/W	
PA12	Low Superheat alarm delay T.	3	0	250	min	1564	R/W	
PA20	Enable High Superheat Alarm	0	0	1	-	1565	R/W	0= disabled 1= enabled

Code	Parameter Description	Default	Min	Max	U.M.	Modbus Address	Read/Write	Note
PA21	High Superheat alarm hysteresis	3.0	0.5 (1.0)	30.0 (50.0)	0.1 °K (0.1 °R)	1566	R/W	
PA22	High Superheat alarm delay T.	3	0	250	min	1567	R/W	
PA30	Enable Low Pressure Alarm	0	0	1	-	1568	R/W	0= disabled 1= enabled
PA31	SP Low Pressure Alarm	0	-0.8 (-10.0)	50.0 (700.0)	0.1 Bar (0.1 psi)	1569	R/W	
PA32	Low Pressure alarm hysteresis	0.3	0.1 (0.1)	1.0 (15.0)	0.1 Bar (0.1 psi)	1570	R/W	
PA33	Low Pressure alarm delay T.	3	0	250	min	1571	R/W	
PA40	Enable LOP Protection Alarm	0	0	1	-	1572	R/W	0= disabled 1= enabled
PA41	LOP alarm hysteresis	3.0	0.1 (0.1)	15.0 (35.0)	0.1 °C (0.1 °F)	1573	R/W	
PA42	LOP alarm delay T.	3	0	250	min	1574	R/W	
PA50	Enables MOP Protection Alarm	0	0	1	-	1575	R/W	0= disabled 1= enabled
PA51	Hysteresis Alarm MOP Alarm	3.0	0.1 0.1	15.0 30.0	°C °F	1576	R/W	
PdA52	MOP Alarm Delay Time	30	5	200	s	1577	R/W	
DISPLAY								
PdIS	Value to be shown on the display	0	0	6	-	1578	R/W	0 = Overheating value (K) 1 = Measured evaporation pressure (bar) 2 = Valve opening % 3 = Measured aspiration temperature (°C) 4 = Saturated gas temperature (°C) calculated (from P) 5 = Overheating SP value 6 = Selected parameter SET

Code	Parameter Description	Default	Min	Max	U.M.	Modbus Address	Read/Write	Note
VALVE and Driver enabling								
Pr02	Enables manual valve operation	0	0	1	-	1579	R/W	0= No 1= Yes, manual 2= Yes, manual for debugging
Pr03	Sets the valve output % for manual operation	0	0	100	%	1580	R/W	
Pr04	Enables valve forcing with sensor errors	0	0	1	-	1581	R/W	0= No 1= Yes
Pr05	Valve % in case of sensor detected errors	0	0	100	%	1582	R/W	
Pr06	Valve regulation enabling mode	0	0	3	-	1583	R/W	0= From DI1 digital input 1= From DIHV digital input 2= From serial Intrabus 3= From serial RS-485 (Modbus via an external serial interface)
Prd0	Step rate	10	0	200		1584	R/W	Step rate (ms) = Prd0*100
Prd1	Minimum opening %	0	0	100	%	1585	R/W	
Prd2	Minimum opening %	100	0	100	%	1586	R/W	
BACKUP								
Pb01	Backup battery	0	0	1	-	1587	R/W	0= absent 1= present
VARIOUS								
PH01	Enables alarm relay	0	0	3	-	1588	R/W	0= disabled 1= enabled by any alarm 2 = enabled only for sensor detected errors
PH02	Alarm relay logic	0	0	1	-	1589	R/W	0= normally not stimulated 1= normally stimulated

Code	Parameter Description	Default	Min	Max	U.M.	Modbus Address	Read/Write	Note
VARIOUS								
PH10	Sets DI1 digital input logic	0	0	1	-	1590	R/W	0= Normally open NO 1= Normally closed NC
PH11	Sets DI2 digital input logic	1	0	1	-	1591	R/W	0= Normally open NO 1= Normally closed NC
PH12	Sets DIHV digital input logic	0	0	1	-	1592	R/W	0= Normally open NO 1= Normally closed NC
PH20	Sets the unit of measure for pressure	0	0	1	-	1593	R/W	0= Bar 1= psi
PH21	Sets the unit of measure for temperature	0	0	1	-	1594	R/W	0= °C 1=°F Note K for overheating
PH30	Disables set point modification with the SET/ENTER control panel button	0	0	1	-	1596	R/W	0= lock function disabled 1= lock function enabled
PSPI	Restricted Use (Do not modify)	2				1597	R/W	
MODBUS PORT								
Mod5	Module address	1	1	247	n	1602	R/W	
Mod6	Card communication Baud Rate	2	0	3	n	1603	R/W	0= 2400 1= 4800 2= 9600 3= 19200
Mod7	Modbus Parity	2	0	2	n	1604	R/W	0= none 1= Odd 2= Even
Mod8	Modbus StopBits	0	0	1	n	1605	R/W	0= 1bit 1= 2bit

Code	Parameter Description	Default	Min	Max	U.M.	Modbus Address	Read/Write	Note
PASSWORD								
PASS	Sets the Installer level protection password	-19	-99	999	n	1606	R/W	

Modbus Menu (Additional Information accessible through Modbus)

Legend:

Accessible through Modbus Master
Accessible with Read/Write function blocks

Parameter Description	Min	Max	U.M.	Modbus Address	Read/Write	Note
PROBES AREA						
Suction pressure in mA			0.01 mA	514	R	
Coil Out temperature			0.1 °C (0.1 °F)	515	R	
Saturation temperature from suction pressure			0.1 °C (0.1 °F)	516	R	
Suction pressure in Bar/psi			0.1 Bar (0.1 psi)	517	R	
DIGITAL OUTPUTS						
Relay status	0	1	-	386	R	Bit0 = Alarm relay status

Parameter Description	Min	Max	U.M.	Modbus Address	Read/Write	Note
CONTIGUOUS INFORMATIONS ABOUT INSTRUMENT STATUS						
Digital inputs/output			-	1361	R	Bit0= di1 Bit1= battery status Bit2= diHV Bit3= reserved Bit4= reserved Bit8= Alarm relay status
Suction pressure in mA			0.01 mA	1362	R	Same data as register 514
Coil out temperature			0.1 °C (0.1 °F)	1363	R	Same data as register 515
Saturation temperature from suction pressure			0.1 °C (0.1 °F)	1364	R	Same data as register 516
Suction pressure in Bar/psi			0.1 Bar (0.1 psi)	1365	R	Same data as register 517
Superheat value [K]			0.1 °K	1366	R	See rI03
Valve opening in %			%	1367	R	See rI04

Parameter Description	Min	Max	U.M.	Modbus Address	Read/Write	Note
CONTIGUOUS INFORMATIONS ABOUT INSTRUMENT STATUS						
Alarms			-	1368	R	Bit0= Low superheat Bit1= High superheat Bit2= LOP Bit3= MOP Bit4= SPI communication detected error Bit5= Battery status (1= battery empty or charging) Bit6= Low pressure Bit7= Electrical net is active Bit8= Pressure probe inoperable Bit9= Temperature probe inoperable Bit10= Motor inoperable Bit 11= reserved Bit12= Detected error in TM168APARAKEY saving Bit13= Detected error in TM168APARAKEY loading
Regulator Flag				1369	R	Bit0= Manual function activated Bit1= Enabling input status Bit3= Input HV Bit4= Manual function activated during probe inoperable Bit5= Remote valve enabling Bit6= On/off status Bit7= VCM module compatibility

Parameter Description	Min	Max	U.M.	Modbus Address	Read/Write	Note
DEVICE STATUS						
Status Flag				1370	R	Bit0= Power failure occurred Bit1= Device configuration changed Bit5= Hardware status changed (For example, DI1, DI2, and DIHV).
Mode configuration (<i>SEtP</i> parameter)				1371	R	Equal to <i>SEtP</i> data. Data available at a different address to allow use of multiple register read functions.
Superheat set point			0.1 °K (0.1 °R)	1372	R	
VALVE STATUS						
Valve status	0	4	-	1283	R	0= off 1= starting 2= running 3= close (<5 %) 4= open (>95 %)
LOP temperature set point			0.1 °C (0.1 °F)	1297	R	
MOP temperature set point			0.1 °C (0.1 °F)	1298	R	
Set point super heat			0.1 °K (0.1 °R)	1299	R	
Length of valve initialization			s	1300	R	
Percent opening during valve initialization			%	1301	R	
Set point low superheat alarm				1302	R	
Set point high superheat alarm				1303	R	

Parameter Description	Min	Max	U.M.	Modbus Address	Read/Write	Note
PARAMETERS						
Number of parameters				1537	R	
Kbd lock				57428	R	1= keyboard locked
INFO						
Firmware ID				65289	R	
Firmware variation/revision				65290	R	

4.9. Modbus Communication

4.9.1. Communication Accessory

Modbus communication is available through TM168AVCMCOM module.

This module connects on MicroMatch Connector on one side.

4.9.2. Addressing Conventions

Please note that according to MODBUS specs:

- the first register is called register 1
- register x must be read at address x-1

4.9.3. Implemented Modbus Function Codes

Command	Function Code	Notes
READ HOLDING REGISTERS	\$03	Maximum 95 registers at once
WRITE SINGLE REGISTER	\$06	
WRITE MULTIPLE HOLDING REGISTERS	\$10	Maximum 95 registers at once

4.9.4. Data Exchange Examples

Example 1:

Reading Holding Register at register 1538 (the *SEtP* parameter).

	Slave Address	Function Code	High Starting Address	Low Starting Address	High Quantity of register	Low Quality of register	Low CRC	High CRC
TX	\$F7	\$03	\$06	\$01	\$00	\$01	\$C1	\$D4

	Slave Address	Function Code	High Starting Address	Low Starting Address	High Quantity of register	Low Quality of register	Low CRC	High CRC
RX	\$F7	\$03	\$06	\$01	\$00	\$01	\$C1	\$D4

The value is 1.

Example 2:

Reading Holding Register at register 65289, representing the FW.ID field (FirmWare Identifier).

	Slave Address	Function Code	High Starting Address	Low Starting Address	High Quantity of register	Low Quality of register	Low CRC	High CRC
TX	\$F7	\$03	\$FF	\$08	\$00	\$01	\$21	\$4A

	Slave Address	Function Code	High Starting Address	Low Starting Address	High Quantity of register	Low Quality of register	Low CRC	
RX	\$F7	\$03	\$02	\$01	\$8D	\$B1	\$A4	

The value is \$018D = 397.

Example 3:

Writing two Holding Register at register 1543 (parameters PC06 and PC07) with values 10 and 100.

	Slave Address	Function Code	High Starting Address	Low Starting Address	High Num HR	Low Num HR	Byte cnt	Data1 High	Data1 Low	Data2 High	Data2 Low	CRC High	CRC High
TX	\$F7	\$10	\$06	\$07	\$00	\$02	\$04	\$00	\$0A	\$00	\$64	\$A5	\$8B

	Slave Address	Function Code	High Starting Address	Low Starting Address	High Num HR	Low Num HR	CRC High	CRC High
RX	\$F7	\$10	\$06	\$07	\$00	\$02	\$E4	\$17

4.10.Backup Battery Module

If the back-up battery is present ($Pb01= 1$), it will be possible to close the valve even in the case of loss of power.

For this purpose, a rechargeable 12 Vdc battery is used along with a TM168AVCM module for battery charging. The charge status of the battery can be monitored with the DI2 digital input

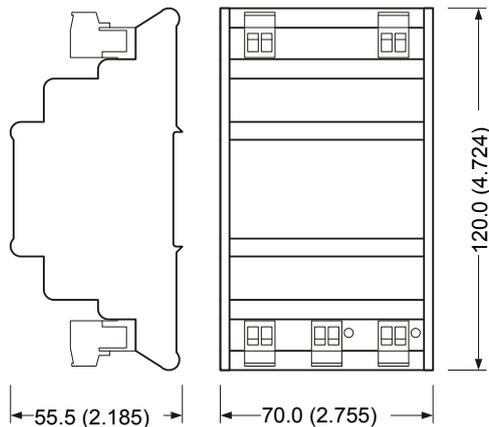
NOTE: The parameter of the inputs can be modified in order to reverse its logic.

If closed, the input indicates that the battery is fully charged. If open, it indicates that the battery is being charged or that the input is not connected. The status of the charge input is represented by an icon, as well as by a status bit in serial communication.

The battery charger module has 2 additional led indicators.

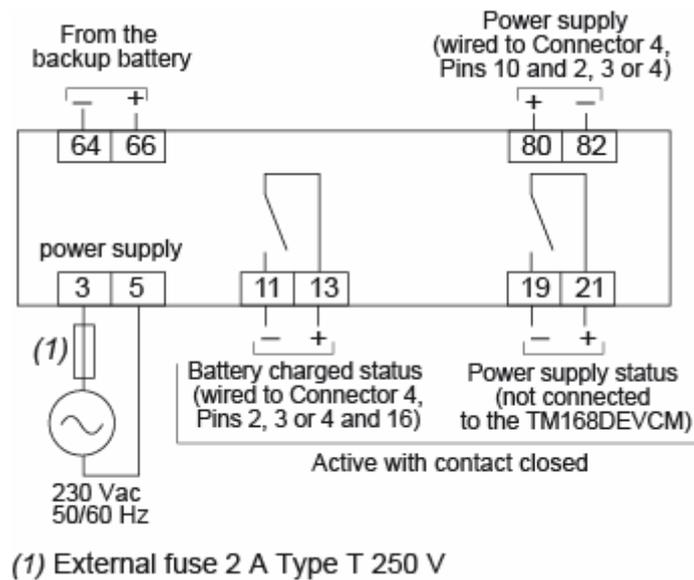
1. A green illuminated led indicator indicates that the charger is receiving electrical current.
2. A red illuminated led indicator indicates that the battery is being charged.

Dimensions:



TM168AVCM Wiring Layout

Below picture indicates the typical wiring between the electronic expansion valve driver module and the battery backup module.



⚠ DANGER

EXPLOSIVE POTENTIAL

- Verify the polarity of the connections between the TM168AVCM module and the 12 Vdc lead battery.
- Always connect positive to positive and negative to negative.

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

APPENDIX - 1

NTC 10k beta 3435 Resistance - Temperature Table

T (°C)	Rt (Ω) 103AP-2
-40	187,400
-39	177,500
-38	168,200
-37	159,400
-36	151,100
-35	143,400
-34	136,100
-33	129,200
-32	122,800
-31	116,700
-30	110,900
-29	105,400
-28	100,100
-27	95,220
-26	90,570
-25	86,180
-24	82,040
-23	78,130
-22	74,440
-21	70,940
-20	67,640
-19	64,440
-18	61,420
-17	58,570
-16	55,870
-15	53,310
-14	50,880

T (°C)	Rt (Ω) 103AP-2
-13	48,590
-12	46,410
-11	44,350
-10	42,390
-9	40,500
-8	38,700
-7	37,000
-6	35,380
-5	33,850
-4	32,390
-3	31,000
-2	29,690
-1	28,440
0	27,250
1	26,100
2	25,000
3	23,960
4	22,970
5	22,030
6	21,130
7	20,280
8	19,460
9	18,690
10	17,950
11	17,230
12	16,550
13	15,900
14	15,270
15	14,680
16	14,110

T (°C)	Rt (Ω) 103AP-2
17	13,570
18	13,050
19	12,560
20	12,090
21	11,630
22	11,200
23	10,780
24	10,380
25	10,000
26	9,633
27	9,281
28	8,945
29	8,623
30	8,314
31	8,016
32	7,730
33	7,456
34	7,193
35	6,941
36	6,700
37	6,468
38	6,246
39	6,033
40	5,829
41	5,630
42	5,440
43	5,257
44	5,081
45	4,912
46	4,750

T (°C)	Rt (Ω) 103AP-2
47	4,594
48	4,444
49	4,300
50	4,162
51	4,027
52	3,897
53	3,773
54	3,653
55	3,537
56	3,426
57	3,319
58	3,216
59	3,117
60	3,022
61	2,929
62	2,839
63	2,753
64	2,670
65	2,589
66	2,512
67	2,438
68	2,366
69	2,296
70	2,229
71	2,164
72	2,101
73	2,040
74	1,981
75	1,925
76	1,870

T (°C)	Rt (Ω) 103AP-2
77	1,817
78	1,766
79	1,716
80	1,669
81	1,622
82	1,577
83	1,534
84	1,492
85	1,451
86	1,412
87	1,374
88	1,337
89	1,301
90	1,266
91	1,233
92	1,200
93	1,169
94	1,138
95	1,108
96	1,080
97	1,052
98	1,025
99	999.0
100	973.7
101	949.0
102	925.0
103	901.8
104	879.3
105	857.4
106	836.3

T (°C)	Rt (Ω) 103AP-2
107	815.7
108	795.8
109	776.4
110	757.6
111	739.2
112	721.4
113	704.1
114	687.3
115	671.0
116	655.2
117	639.8
118	624.8
119	610.3
120	596.1

APPENDIX - 2

PTC KTY81_121 Resistance - Temperature Table

T (°C)	Rt (Ω) KTY81_121
-50	509.71
-49	514.74
-48	519.81
-47	524.92
-46	530.06
-45	535.24
-44	540.46
-43	545.71
-42	551.00
-41	556.33
-40	561.69
-39	567.09
-38	572.53
-37	578.01
-36	583.52
-35	589.07
-34	594.66
-33	600.29
-32	605.95
-31	611.65
-30	617.38
-29	623.16
-28	628.97
-27	634.81
-26	640.70
-25	646.62
-24	652.58

T (°C)	Rt (Ω) KTY81_121
-23	658.57
-22	664.61
-21	670.68
-20	676.78
-19	682.93
-18	689.11
-17	695.33
-16	701.58
-15	707.87
-14	714.20
-13	720.57
-12	726.97
-11	733.41
-10	739.89
-9	746.41
-8	752.96
-7	759.55
-6	766.18
-5	772.84
-4	779.54
-3	786.28
-2	793.05
-1	799.86
0	806.71
1	813.60
2	820.52
3	827.48
4	834.48
5	841.52
6	848.59

T (°C)	Rt (Ω) KTY81_121
7	855.70
8	862.84
9	870.03
10	877.25
11	884.50
12	891.80
13	899.13
14	906.50
15	913.90
16	921.35
17	928.83
18	936.34
19	943.90
20	951.49
21	959.12
22	966.78
23	974.48
24	982.22
25	990.00
26	997.81
27	1005.66
28	1013.55
29	1021.48
30	1029.44
31	1037.44
32	1045.48
33	1053.55
34	1061.66
35	1069.81
36	1077.99

T (°C)	Rt (Ω) KTY81_121
37	1086.21
38	1094.47
39	1102.77
40	1111.10
41	1119.47
42	1127.88
43	1136.33
44	1144.81
45	1153.33
46	1161.88
47	1170.48
48	1179.11
49	1187.77
50	1196.48
51	1205.22
52	1214.00
53	1222.81
54	1231.67
55	1240.56
56	1249.48
57	1258.45
58	1267.45
59	1276.49
60	1285.56
61	1294.67
62	1303.82
63	1313.01
64	1322.23
65	1331.49
66	1340.79

T (°C)	Rt (Ω) KTY81_121
67	1350.13
68	1359.50
69	1368.91
70	1378.36
71	1387.84
72	1397.36
73	1406.92
74	1416.51
75	1426.14
76	1435.81
77	1445.52
78	1455.26
79	1465.04
80	1474.86
81	1484.72
82	1494.61
83	1504.54
84	1514.50
85	1524.50
86	1534.55
87	1544.62
88	1554.74
89	1564.89
90	1575.08
91	1585.30
92	1595.57
93	1605.86
94	1616.20
95	1626.58
96	1636.99

T (°C)	Rt (Ω) KTY81_121
97	1647.44
98	1657.92
99	1668.44
100	1679.00
101	1689.60
102	1700.23
103	1710.90
104	1721.61
105	1732.34
106	1743.11
107	1753.91
108	1764.74
109	1775.59
110	1786.47
111	1797.37
112	1808.28
113	1819.21
114	1830.14
115	1841.09
116	1852.04
117	1862.98
118	1873.93
119	1884.86
120	1895.78
121	1906.68
122	1917.56
123	1928.42
124	1939.24
125	1950.02
126	1960.75

T (°C)	Rt (Ω) KTY81_121
127	1971.44
128	1982.08
129	1992.65
130	2003.16
131	2013.59
132	2023.95
133	2034.22
134	2044.40
135	2054.48
136	2064.45
137	2074.31
138	2084.06
139	2093.67
140	2103.15
141	2112.49
142	2121.68
143	2130.71
144	2139.58
145	2148.27
146	2156.79
147	2165.11
148	2173.23
149	2181.15
150	2188.85

APPENDIX - 3

PT1000 Resistance - Temperature Table

T (°C)	Rt (PT1000)
-100	602.56
-99	606.61
-98	610.66
-97	614.71
-96	618.76
-95	622.80
-94	626.84
-93	630.88
-92	634.92
-91	638.96
-90	643.00
-89	647.03
-88	651.06
-87	655.09
-86	659.12
-85	663.15
-84	667.17
-83	671.20
-82	675.22
-81	679.24
-80	683.25
-79	687.27
-78	691.29
-77	695.30
-76	699.31
-75	703.32
-74	707.33

T (°C)	Rt (PT1000)
-73	711.34
-72	715.34
-71	719.34
-70	723.35
-69	727.35
-68	731.34
-67	735.34
-66	739.34
-65	743.33
-64	747.32
-63	751.31
-62	755.30
-61	759.29
-60	763.28
-59	767.26
-58	771.25
-57	775.23
-56	779.21
-55	783.19
-54	787.17
-53	791.14
-52	795.12
-51	799.09
-50	803.06
-49	807.03
-48	811.00
-47	814.97
-46	818.94
-45	822.90
-44	826.87

T (°C)	Rt (PT1000)
-43	830.83
-42	834.79
-41	838.75
-40	842.71
-39	846.66
-38	850.62
-37	854.57
-36	858.53
-35	862.48
-34	866.43
-33	870.38
-32	874.32
-31	878.27
-30	882.22
-29	886.16
-28	890.10
-27	894.04
-26	897.98
-25	901.92
-24	905.86
-23	909.80
-22	913.73
-21	917.67
-20	921.60
-19	925.53
-18	929.46
-17	933.39
-16	937.32
-15	941.24
-14	945.17

T (°C)	Rt (PT1000)
-13	949.09
-12	953.02
-11	956.94
-10	960.86
-9	964.78
-8	968.70
-7	972.61
-6	976.53
-5	980.44
-4	984.36
-3	988.27
-2	992.18
-1	996.09
0	1000.00
1	1003.91
2	1007.81
3	1011.72
4	1015.62
5	1019.53
6	1023.43
7	1027.33
8	1031.23
9	1035.13
10	1039.03
11	1042.92
12	1046.82
13	1050.71
14	1054.60
15	1058.49
16	1062.38

T (°C)	Rt (PT1000)
17	1066.27
18	1070.16
19	1074.05
20	1077.94
21	1081.82
22	1085.70
23	1089.59
24	1093.47
25	1097.35
26	1101.23
27	1105.10
28	1108.98
29	1112.86
30	1116.73
31	1120.60
32	1124.47
33	1128.35
34	1132.21
35	1136.08
36	1139.95
37	1143.82
38	1147.68
39	1151.55
40	1155.41
41	1159.27
42	1163.13
43	1166.99
44	1170.85
45	1174.70
46	1178.56

T (°C)	Rt (PT1000)
47	1182.41
48	1186.27
49	1190.12
50	1193.97
51	1197.82
52	1201.67
53	1205.52
54	1209.36
55	1213.21
56	1217.05
57	1220.90
58	1224.74
59	1228.58
60	1232.42
61	1236.26
62	1240.09
63	1243.93
64	1247.77
65	1251.60
66	1255.43
67	1259.26
68	1263.09
69	1266.92
70	1270.75
71	1274.58
72	1278.40
73	1282.23
74	1286.05
75	1289.87
76	1293.70

T (°C)	Rt (PT1000)
77	1297.52
78	1301.33
79	1305.15
80	1308.97
81	1312.78
82	1316.60
83	1320.41
84	1324.22
85	1328.03
86	1331.84
87	1335.65
88	1339.46
89	1343.26
90	1347.07
91	1350.87
92	1354.68
93	1358.48
94	1362.28
95	1366.08
96	1369.87
97	1373.67
98	1377.47
99	1381.26
100	1385.06
101	1388.85
102	1392.64
103	1396.43
104	1400.22
105	1404.00
106	1407.79

T (°C)	Rt (PT1000)
107	1411.58
108	1415.36
109	1419.14
110	1422.93
111	1426.71
112	1430.49
113	1434.26
114	1438.04
115	1441.82
116	1445.59
117	1449.37
118	1453.14
119	1456.91
120	1460.68
121	1464.45
122	1468.22
123	1471.98
124	1475.75
125	1479.51
126	1483.28
127	1487.04
128	1490.80
129	1494.56
130	1498.32
131	1502.08
132	1505.83
133	1509.59
134	1513.34
135	1517.10
136	1520.85

T (°C)	Rt (PT1000)
137	1524.60
138	1528.35
139	1532.10
140	1535.84
141	1539.59
142	1543.33
143	1547.08
144	1550.82
145	1554.56
146	1558.30
147	1562.04
148	1565.78
149	1569.52
150	1573.25
151	1576.99
152	1580.72
153	1584.45
154	1588.18
155	1591.91
156	1595.64
157	1599.37
158	1603.09
159	1606.82
160	1610.54
161	1614.27
162	1617.99
163	1621.71
164	1625.43
165	1629.15
166	1632.86

T (°C)	Rt (PT1000)
167	1636.58
168	1640.30
169	1644.01
170	1647.72
171	1651.43
172	1655.14
173	1658.85
174	1662.56
175	1666.27
176	1669.97
177	1673.68
178	1677.38
179	1681.08
180	1684.78
181	1688.48
182	1692.18
183	1695.88
184	1699.58
185	1703.27
186	1706.96
187	1710.66
188	1714.35
189	1718.04
190	1721.73
191	1725.42
192	1729.10
193	1732.79
194	1736.48
195	1740.16
196	1743.84

T (°C)	Rt (PT1000)
197	1747.52
198	1751.20
199	1754.88
200	1758.56

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