BUCHER automation

User Manual



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JX3-THI2-TC-EIC

Peripheral Module

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Translation of the german original User Manual

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1 Introduction

1.1 Information on this document

This document forms an integral part of the product and must be read and understood prior to using it. It contains important and safety-related information for the proper use of the product as intended.

Target Groups

This document is intended for specialists with appropriate qualifications.
Only competent and trained personnel are allowed to put this device into operation.
During the whole product life cycle, safe handling and operation of the device must be ensured. In the case of missing or inadequate technical knowledge or knowledge of this document any liability is excluded.

Availability of Information

Make sure this document is kept at the ready in the vicinity of the product throughout its service life.
For information on new revisions of this document, visit the download area on our website. This document is not subject to any updating service.

Start | Bucher Automation - We automate your success.

For further information refer to the following information products:

– Online help for the JetSym software
  Functions of software products with application examples
– Application-oriented manuals
  Product-independent documentation
– Version updates
  Information about changes to the software products and operating system of your device

ⓘ Info

EtherCAT®

EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

1.2 Typographical conventions

This manual uses different typographical effects to support you in finding and classifying information. Below, there is an example of a step-by-step instruction:

✓ This symbol indicates requirements which have to be met before executing the following action.

► This sign or a numbering at the beginning of a paragraph marks an action instruction that must be executed by the user. Execute the instructions one after the other.

⇨ The target after a list of instructions indicates reactions to, or results of these actions.

ⓘ Info

Further information and practical tips

In the info box you will find helpful information and practical tips about your product.

2 Safety

2.1 General Information

When placed on the market, this product corresponds to the current state of science and technology.
In addition to the operating instructions, the laws, regulations and guidelines of the country of operation or the EU apply to the operation of the product. The operator is responsible for compliance with the relevant accident prevention regulations and generally accepted safety rules.

2.2 Purpose

2.2.1 Intended use

The expansion module is designed to do temperature measurements in tandem with our controllers. It connects to the JX3 system bus.

Operate the device only in accordance with the intended conditions of use and within the limits set forth in the technical specifications.
Intended use of the product includes its operation in accordance with this manual.

SELV

The operating voltage of this device is classified as Safety Extra Low Voltage and is, therefore, not subject to the EU Low Voltage Directive. The device may only be operated from a SELV source.

2.2.2 Usage other than intended

This device must not be used in technical systems which to a high degree have to be fail-safe.

Machinery Directive

This device is no safety-related part as per Machinery Directive 2006/42/EC, and must, therefore, not be used for safety-relevant applications. This device is NOT intended for the purpose of personal safety, and must, therefore, not be used to protect persons.

2.3 Warnings used in this document

⚠ DANGER



High risk

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING



Medium risk

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION



Low risk

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

NOTICE



Material damage

Indicates a situation which, if not avoided, could result in malfunctions or material damage.

3 Product description

The JX3-THI2-TC-EIC expansion module is designed to perform temperature readings in tandem with a Bucher-Automation controller. It features 2 isolated thermocouple inputs designed to interface with grounded and ungrounded junctions. The inputs of both thermal sensors are galvanically isolated from one another.

3.1 Design

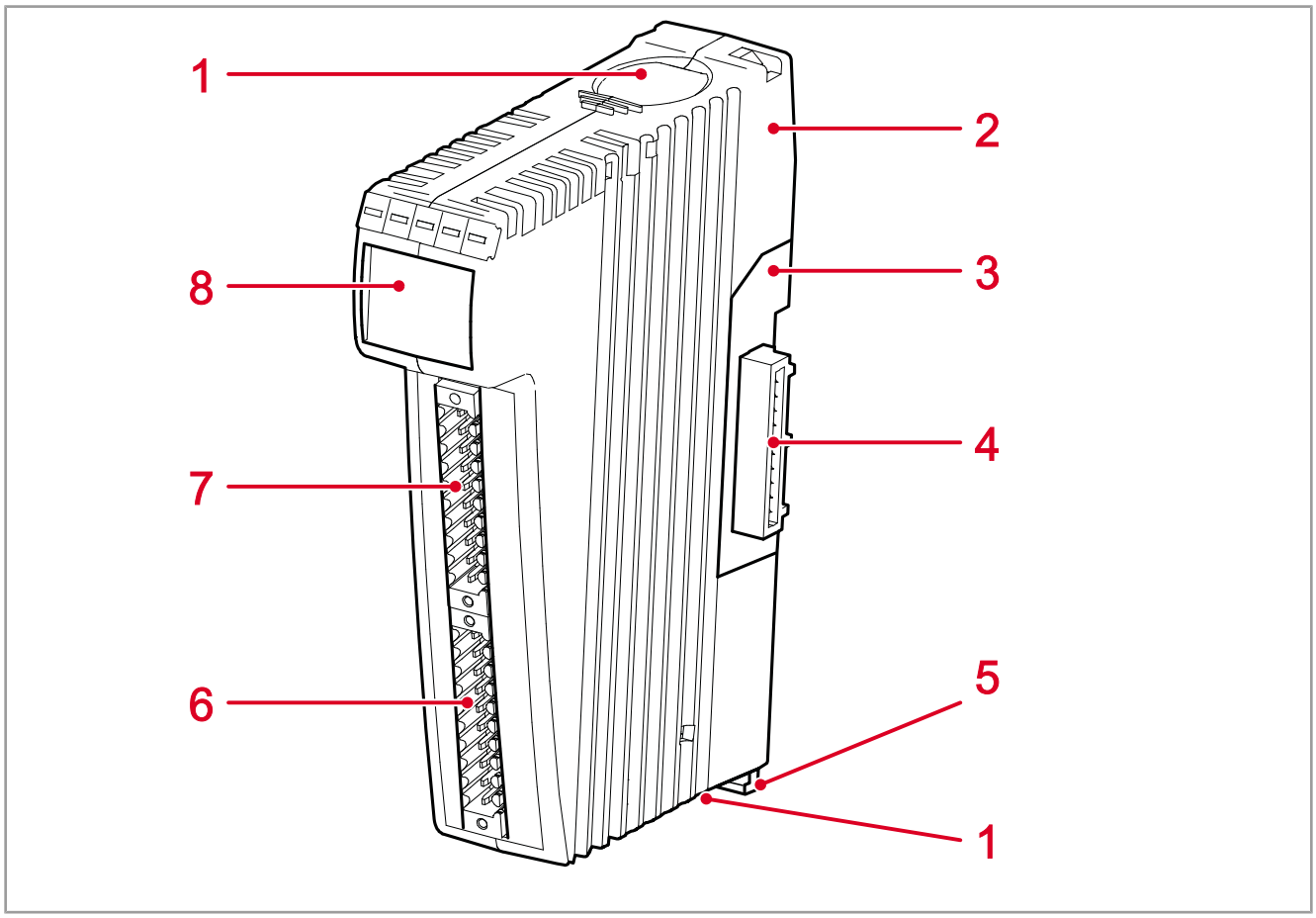


Fig. 1: Design

1	Latch
2	Housing
3	Backplane module
4	X119 connector: Interface to JX3-IO modules
5	DIN rail release latch
6	X42 terminal: Temperature input 2 [▶ 22]
7	X41 terminal: Temperature input 1 [▶ 22]
8	Status indication [▶ 9]

3.2 Product features

– Moving average calculation from 2 ... 128 values
– Monitoring of limit values
– Storing minimum/maximum values
– Oscilloscope function
– Forcing

3.3 Status indication

Status indication LEDs indicate the communication status of the device as well as the status of the power supply.

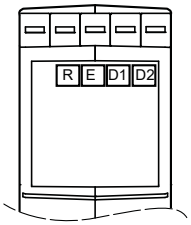


Fig. 2: Status indication

LED	Description
R	Logic circuit supply
E	Communication with controller or bus node
D1	Hardware errors
D2	Operating system

3.3.1 Diagnostics capabilities by means of status indication

Color and status of the LEDs are an excellent source of information for analyzing various states. In the JetSym programming tool, diagnostics can be performed in the Hardware Manager or via the Setup pane by entering the corresponding register number.

LED	Status	Color	Description
R	OFF	---	No logic circuit supply present.
	ON	Green	Logic circuit supply is OK.
E	OFF	---	Communication with controller or bus node is active.
	ON	Red	Communication with controller or bus node is inactive.
D2	Blinking	Red	There is no valid OS. Update OS.
	ON	Red	Cable breakage, excess or insufficient temperature on at least one channel.
D1/D2	Blinking	Red	Operating system is being updated.

3.4 Nameplate

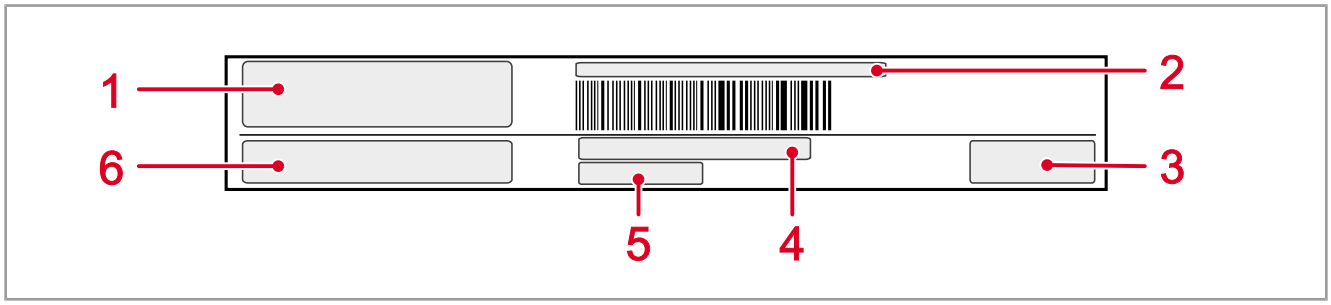


Fig. 3: Sample nameplate

1	Company logo
2	Serial number
3	Certification mark
4	Item number
5	Hardware revision
6	Item name

3.5 Scope of Delivery

Scope of delivery	Item number	Quantity
JX3-THI2-TC-EIC_PI	10001913	1
Male connector with PUSH-IN connection, 10-pin	60869254	2
Terminal labels	60870411	10
Keying pins	60870410	1
Installation manual	60885921	1

3.6 Connectable thermocouple types

Enter the sensor type as number into register 1107 for channel 1, and register 1207 for channel 2.

TC type	B	E	J	K	N	R	S	T
No.	3	4	5	6 (default)	7	8	9	10
Values in °C	+250 … +1,820	-200 … +1,000	-210 … +1,200	-200 … +1,372	-200 … +1,300	-50 … +1,768	-50 … +1,768	-200 … +400

Tab. 1: Connectible thermocouples

4 Technical Specifications

This chapter contains information on both electrical and mechanical data as well as on operating data of the JX3-THI2-TC-EIC device.

4.1 Dimensions

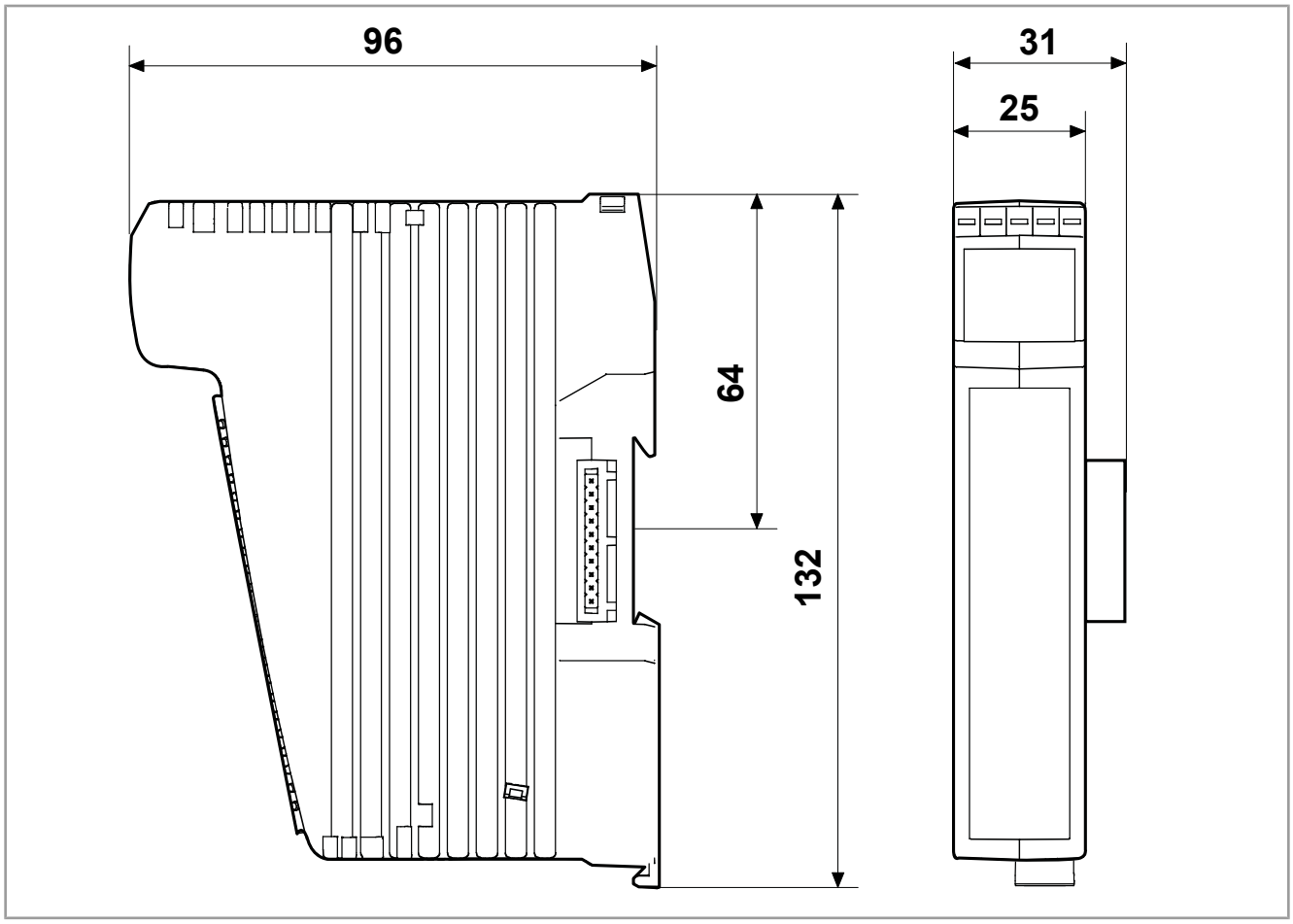


Fig. 4: Dimension in mm

Info

CAD data

CAD data of the device can be found in the download area of our homepage.

4.2 Mechanical Specifications

Parameter	Description	Standards
Mounting orientation	Vertically mounted on DIN rail	
Weight	170 g	
Enclosure specifications		
Material	Plastic	
Maximum height of fall		
with shipping packaging	1 m	DIN EN 61131-2 DIN EN 60068-2-31
with product packaging	0.3 m	
Vibration resistance		
Frequency sweeps	1 octave/minute, sinusoidal	DIN EN 61131-2 DIN EN 60068-2-6
Constant amplitude	3.5 mm	5 Hz ≤ f ≤ 9 Hz
Constant acceleration	1 g	9 Hz ≤ f ≤ 150 Hz
Number and direction	10 sweeps for all 3 spatial axes	
Shock resistance		
Type of shock	Half-sine wave	DIN EN 61131-2 DIN EN 60068-2-27
Intensity and duration	15 g for 11 ms	
Number and direction	3 shocks in the directions of all 3 spatial axes	
Degree of protection		
Degree of protection	IP20	DIN EN 60529

Tab. 2: Mechanical specifications

4.3 Electrical properties

Backplane module current consumption

Parameter	Description
From logic voltage	210 mA
Power supply	The backplane module ensures the logic supply.

Tab. 3: Backplane module current consumption

Temperature inputs

Parameter	Description
Temperature range	The thermal range depends on the type of thermo element being connected (see Connectable thermocouple types [▶ 10]).
Electr. measuring range	±128 mV
Tolerance	±2 °C

Tab. 4: Temperature inputs

Electrical safety

Parameter	Values	Standard
Class of protection	III	DIN EN 61140
Dielectric test voltage	Functional ground is internally connected to chassis ground.	
Overvoltage category	II	DIN EN 61131-2 DIN EN 60664-1

Tab. 5: Electrical safety

4.4 Environmental conditions

Parameter	Description	Standards
Operating temperature	0 °C … +55 °C	DIN EN 61131-2
Storage temperature	-40 °C … +70 °C	
Humidity	10 % … 95 %, non-condensing	
Max. operating altitude	2,000 m above sea level	
Corrosion immunity and chemical resistance	No special anti-corrosion precautions have been taken. The ambient air must not contain higher concentrations of acids, alkaline solutions, corrosive agents, salts, metal vapors and other corrosive or electroconductive contaminants.	
Degree of pollution – Electronics	Level 2	DIN EN 61131-2
	Usually, the pollution is non-conductive. However, temporary conductivity due to condensation may occur.	

Tab. 6: Environmental conditions

4.5 EMC Values

JX3-THI2-TC-EIC is suitable for use in residential and industrial environments.

4.5.1 Enclosure

Emitted interference

Parameter	Values	Standards
Frequency band	**30 MHz … 230 MHz**	DIN EN 61000-6-3 DIN EN 61131-2 DIN EN 55011
Limit value	30 dB (µV/m) at 10 m distance	
Frequency band	**230 MHz … 1,000 MHz**	
Limit value	37 dB (µV/m) at 10 m distance	

Tab. 7: Emitted interference

Immunity to interference

Parameter	Values	Standard
RF field, amplitude-modulated		
Frequency band	80 MHz … 1 GHz	DIN EN 61131-2 DIN EN 61000-6-2 DIN EN 61000-4-3
Test field strength	10 V/m	
	AM 80 % with 1 kHz	
Criterion	A	
ESD		
Discharge through air Test peak voltage	8 kV	DIN EN 61131-2 DIN EN 61000-6-2 DIN EN 61000-4-2
Discharge through air Test peak voltage	4 kV	
Criterion	B	

Tab. 8: Immunity to interference

4.5.2 DC power supply inputs and outputs

Emitted interference

Parameter	Values	Standard
Frequency band	**0.15 MHz … 0.5 MHz**	DIN EN 61131-2 DIN EN 61000-6-3 DIN EN 55016-2-1
Quasi-peak limit	79 dB (µV)	
Averaging limit	66 dB (µV)	
Frequency band	**0.5 MHz … 30 MHz**	
Quasi-peak limit	73 dB (µV)	
Averaging limit	60 dB (µV)	

Tab. 9: Emitted interference – DC power supply inputs and outputs

Immunity to interference

Parameter	Values	Standard
Radio frequency, asymmetric, amplitude-modulated		
Frequency band	0.15 MHz … 80 MHz	DIN EN 61131-2 DIN EN 61000-6-2 DIN EN 61000-4-6
Test voltage	10 V	
	AM 80 % with 1 kHz	
Criterion	A	
Bursts		
Test voltage	2 kV	DIN EN 61131-2 DIN EN 61000-6-2 DIN EN 61000-4-4
	tr/td 5/50 ns	
Repetition frequency	5 kHz	
Criterion	B	
Surge voltages, symmetric, line-to-line		
Differential-mode coupling	tr/td 1.2/50 µs	DIN EN 61131-2 DIN EN 61000-6-2 DIN EN 61000-4-5
	0.5 kV	
Criterion	B	
Surge voltages, asymmetric, line-to-ground		
Common-mode coupling	tr/th 1.2/50 µs	DIN EN 61131-2 DIN EN 61000-6-2 DIN EN 61000-4-5
	0.5 kV	
Criterion	B	

Tab. 10: Immunity to interference – DC power supply inputs and outputs

4.5.3 Shielded data and I/O lines

Immunity to interference

Parameter	Values	Standards
RF field, asymmetric, amplitude-modulated		
Frequency band	0.15 MHz … 80 MHz	DIN EN 61131-2 DIN EN 61000-6-2 DIN EN 61000-4-6
Test voltage	10 V	
	AM 80 % with 1 kHz	
Criterion	A	
Bursts		
Test voltage	1 kV	DIN EN 61000-6-2 DIN EN 61000-6-2 DIN EN 61000-4-4
	tr/tn 5/50 ns	
Repetition frequency	5 kHz	
Criterion	B	
Surge voltages, asymmetric, line-to-ground		
Common-mode coupling	tr/th 1.2/50 µs	DIN EN 61131-2 DIN EN 61000-6-2 DIN EN 61000-4-5
	1 kV	
Criterion	B	

Tab. 11: Immunity of shielded data lines and I/O lines

5 Mechanical Installation

This chapter describes how to install and remove the JX3-THI2-TC-EIC.

NOTICE

Damaged devices

Damaged devices may cause considerable physical damage.

- ► Check the device for external damage and faulty connections.
- ► Ensure to install only fully functional devices.

5.1 Installing Device on DIN Rail

NOTICE

Functional impairment caused by unfavorable installation

- ► Install the device only in vertical position on the DIN rail (DIN EN 60715).
- ► Keep a minimum distance of 30 mm to surrounding parts.

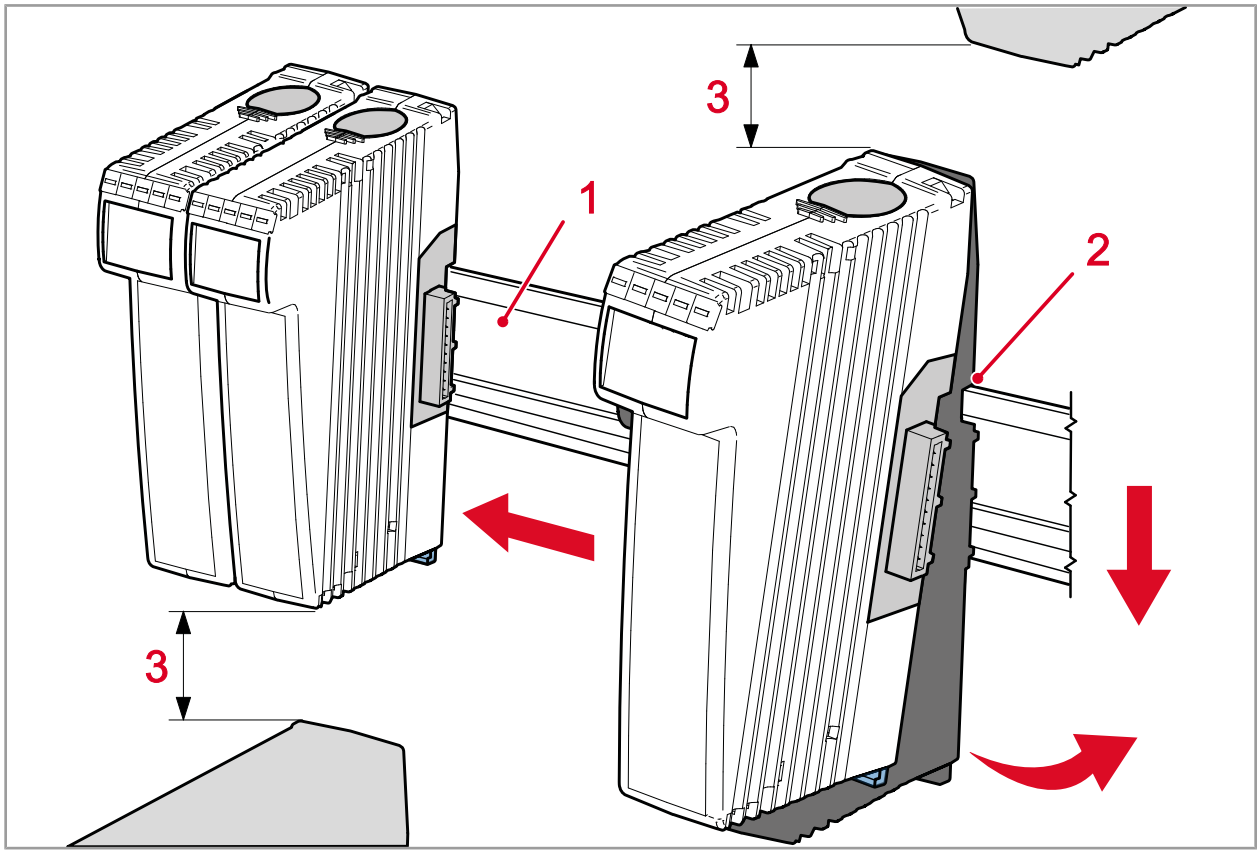


Fig. 5: Installing the device on the DIN rail

1	DIN rail
2	Upper latch
3	Minimum distance to surrounding parts (30 mm min.)

1. Disconnect the system from the power supply.
2. Place the upper latch (2) in an angled position on the DIN rail (1).
3. Snap the lower latch of the device onto the DIN rail.
4. Slide the device on the DIN rail to its intended position.

5.2 Removing Device from DIN Rail

Applying force to the release latch disengages the device from the DIN rail.

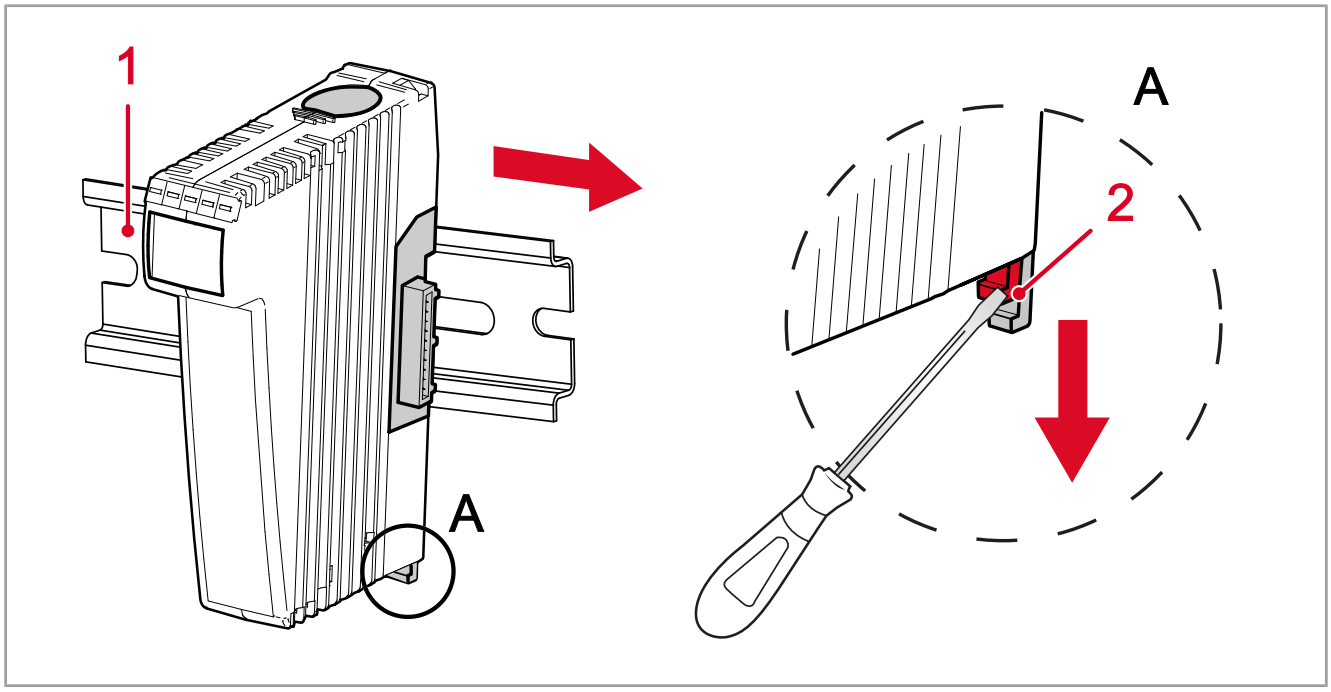


Fig. 6: Removing the device from the DIN rail

1	DIN rail
2	DIN rail release latch
A	Detail view

1. Disconnect the system from the power supply.
2. Pull the device off the overall assembly.
3. Pry the release latch (2) downwards and pull the device off the DIN rail (1).

5.3 Dismounting Enclosure from Backplane Module

Pressing down on the upper and the lower backplane latches of the device allows you to remove the enclosure from the backplane module.

NOTICE

Mechanical damage and reduced EMC noise immunity

If devices are replaced, degree of protection IP20 is not ensured. Touching the EMC clip may lead to mechanical damage to the device and reduced EMC noise immunity.

► Do not touch any electronic components once the enclosure has been removed from the backplane module.

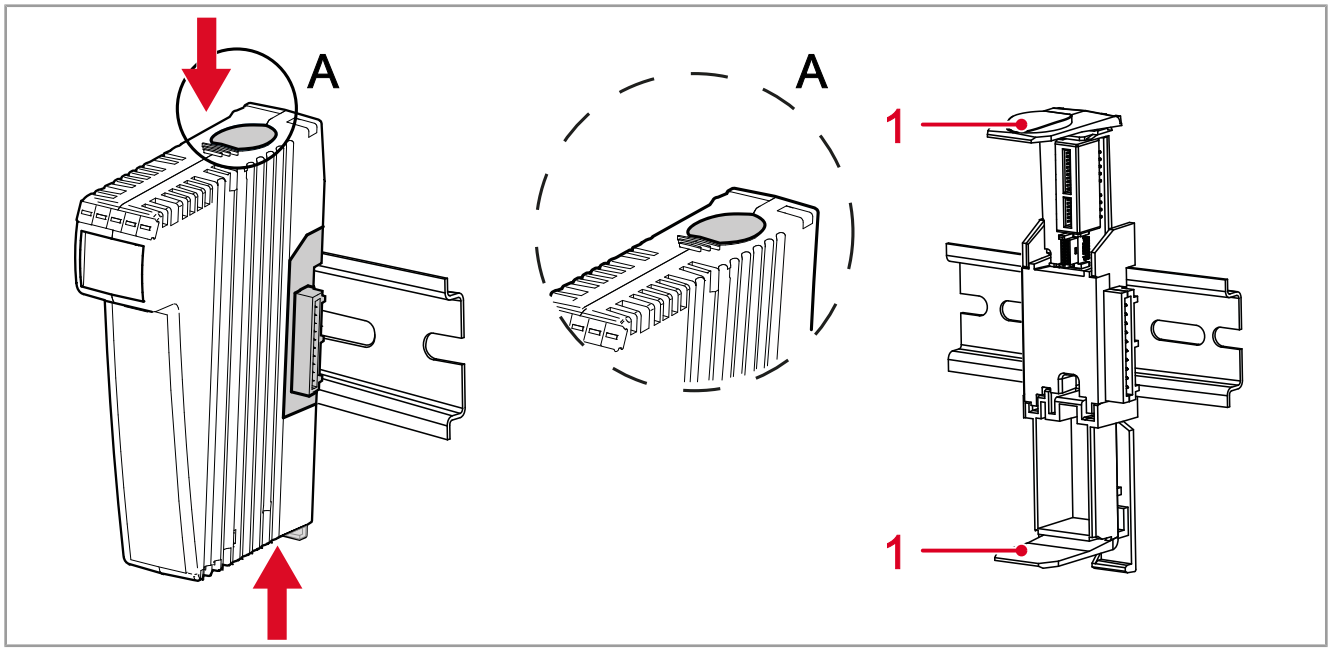


Fig. 7: Removing the enclosure from the backplane module

A	Detail view
1	Latch

1. Disconnect the system from the power supply.
2. Simultaneously, press and hold the upper and lower latches (1) of the device.
3. With the latches pressed down pull the enclosure away from DIN rail.

6 Electrical Connection

NOTICE



Damages to material or functional impairment

Improper implementation of the wiring harness may cause mechanical stress.

- ► Protect the cables from bending, twisting or chafing.
- ► Install strain reliefs for the connecting cables.

6.1 Improving EMC Noise Immunity

A system's immunity to noise is determined by its weakest component. Key factors are correct connections, lines and proper shielding. Take note of the measures described in this section.

ⓘ Info

Further Information

For further information on the noise immunity of a system, please refer to the Application Note 016 *EMC-Compatible Installation of the Electric Cabinet* available for download on our website.

DIN rail

- Attach the JX3-THI2-TC-EIC device to a DIN rail to EN 60715 with the dimensions 35 x 7.5 mm.
- The DIN rail must be electrically conducting and grounded by either of the following two ways:
  - Directly
  - Via rear panel of the electric cabinet

Application Note 016

Follow the instructions given in Application Note 016 *EMC-Compatible Installation of the Electric Cabinet*.

The following instructions are excerpts from Application Note 016:

- Keep signal and power lines **separated from each other** at all times. Bucher Automation AG recommends that there be a minimum distance of 20 cm. Cables and lines should cross each other at an angle of 90°.
- Shield the following cables and lines:
  - Analog lines
  - Data lines
  - Motor cables coming from inverter drives (servo output stage, frequency converter)
  - Lines between components and interference suppressor filter, where the suppressor filter is located not immediately adjacent to the component.
- Place the shield **on both sides**.
- Keep unshielded wire ends of shielded cables as short as possible.
- Span the shield **entirely** across the isolation. For **wide-area grounding**, clamp it down tightly with an extensively earthed strain relief.

Sensor Lines

– For accurate measurement results, run the sensor lines to the inputs of the JX3-THI2-TC-EIC module at least once (as a loop) **through one ferrite core each**.
Use a **ferrite clamp on core** (for example 74271222 from Würth Elektronik) for this purpose.

Use of terminals

To ensure the highest level of noise immunity, use extensive shielding measures.

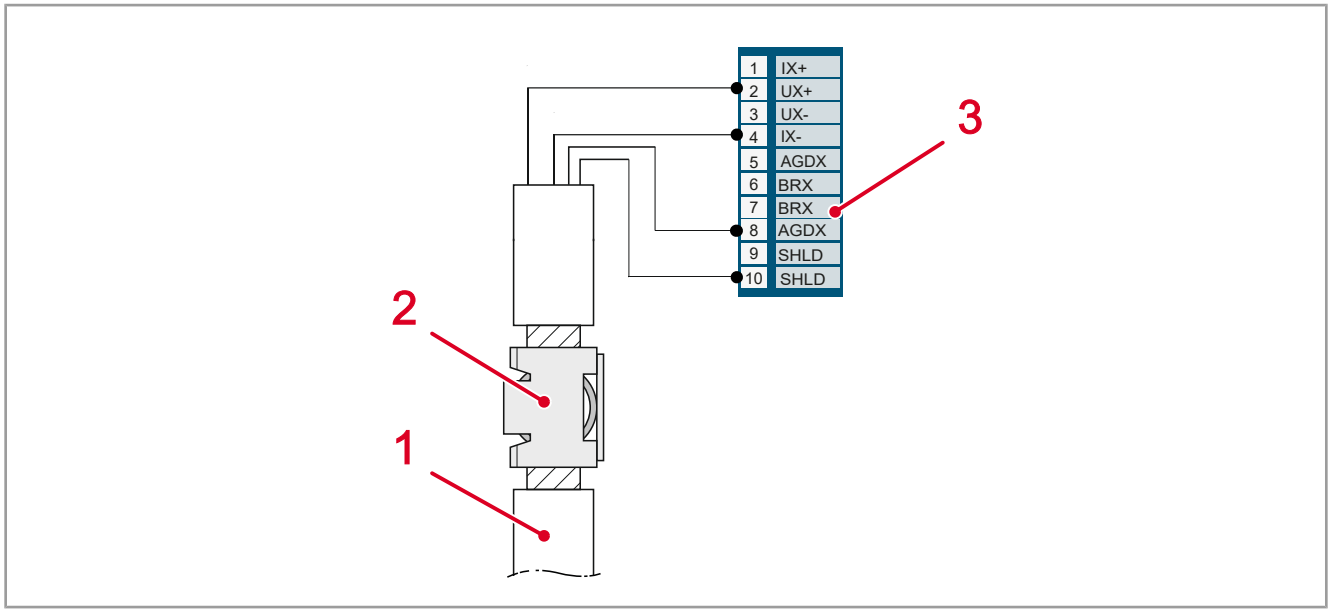


Fig. 8: Shielding measures

1	Line to the analog sensor
2	Shield clamp
3	JX3-THI2-TC-EIC

6.2 Interfaces

6.2.1 Terminals X41, X42 – Temperature Inputs

NOTICE

Destruction of the module by voltage or current source at terminals X41 and X42

The temperature inputs at terminals X41 and X42 are purely measuring inputs.

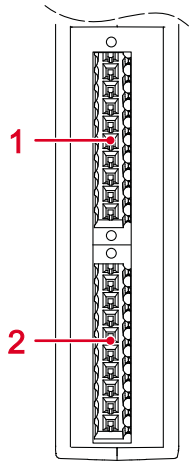
► Do not connect an active voltage or current source to the input pins.

Ports and interfaces

Terminals X41 and X42 connect to:

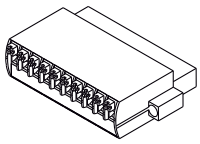
– 1 temperature measurement input each to interface with thermocouples

Pinning



Terminal	Terminal point	Description
(1) X41	I1+	Jumper I1+ / U1- / AGD1
	U1+	Positive termination TC 1
	U1-	Jumper I1+ / U1- / AGD1
	I1-	Negative termination -TC 1
	AGD1	Analog ground
	BR1	Free
	BR2	Free
	AGD1	Analog ground
	SHLD	Shielding connection
	SHLD	Shielding connection
(2) X42	I2+	Jumper I2+ / U2- / AGD2
	U2+	Positive termination TC 2
	U2-	Jumper I2+ / U2- / AGD2
	I2-	Negative termination -TC 2
	AGD2	Analog ground
	BR3	Free
	BR4	Free
	AGD2	Analog ground
	SHLD	Shielding connection
	SHLD	Shielding connection

10-pin male connector with PUSH-IN connection



Parameter	Description	Standards
Connector		
Designation	BU_10_E_BL-I/O_GE_RM3.5	
Item number	60869254	
Connector technology	Spring connection, push-in	
Type	10-pin, 3.5 mm pattern	
Connectible conductors		
Outer diameter of the isolation	Max. 2.90 mm	
AWG	16 … 24	
Terminal range	0.2 mm^2 … 1.5 mm^2	
Stripping length	10 mm	
Specification without wire end ferrules		
Solid conductor	H05(07) V-U	
	0.2 mm^2 … 1.5 mm^2	
Flexible conductor	H05(07) V-K	
	0.2 mm^2 … 1.5 mm^2	
Specification with wire end ferrules		
Wire end ferrule without sleeve	0.25 mm^2 … 1.0 mm^2	DIN 46228/1
Wire end ferrule with sleeve	0.25 mm^2 … 0.75 mm^2	DIN 46228/4
Crimping tool	PZ 4, PZ 6 ROTO, PZ 6/5	DIN 46228

Tab. 12: Connector specification, 10-pin, PUSH-IN connection

6.3 Connecting a thermocouple

The thermocouples connect identically to both inputs.

Info

Improving EMC noise immunity

For improving EMC noise immunity, follow the rules listed below:

– Snap a ferrite core over the entire diameter of the sensor connecting cable (e.g. Item 74271222 by Würth Elektronik).

– Position the ferrite core as close to the terminal as possible.

Connectivity

It is possible to connect thermocouples to the X41 and X42 terminals with or without shield. The illustration below shows a thermocouple with shield connected to terminal X41 and a thermocouple without shield connected to terminal X42. **NOTICE! Hardware revisions 05.0X and later do no longer require jumpers.**

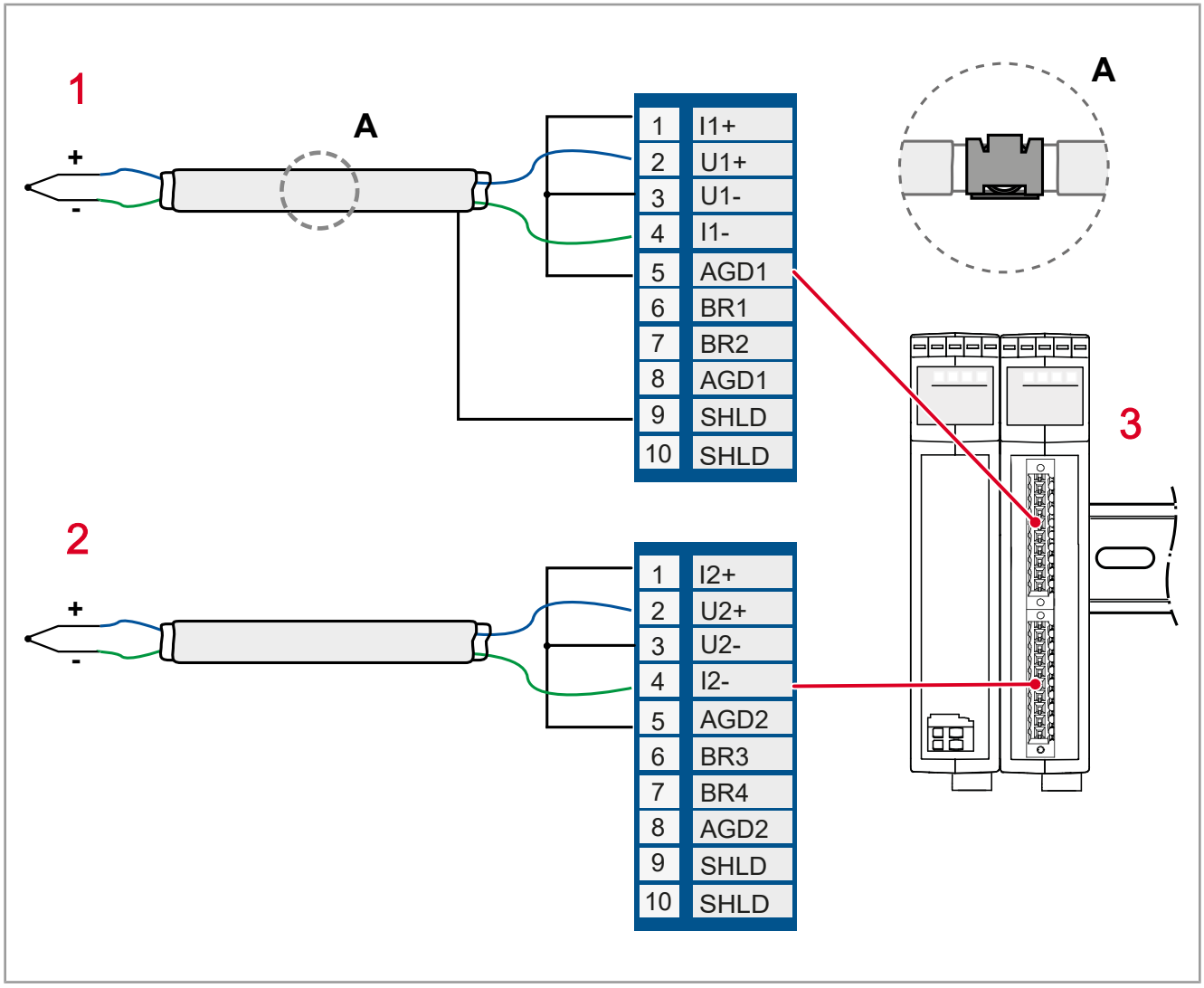


Fig. 9: Connecting thermocouples

1	Connecting a thermocouple with shield to terminal X41
2	Connecting a thermocouple without shield to terminal X42
3	JX3 station

Connecting thermocouples with shield

✓ The system has been de-energized.

✓ A shielded cable is being used.

1. Connect the thermocouple and wire jumpers to the module. Ensure the connection is low-ohmic and the jumpers' contact resistance is low as well.
2. Connect the cable shield to any of the SHLD ports of the respective terminal.
3. Position the shield with the greatest possible surface area on the shield clamp (A).

Connecting thermocouples without shield

✓ The system has been de-energized.

1. Connect the thermocouple and wire jumpers to the module. Ensure the connection is low-ohmic and the jumpers' contact resistance is low as well.
2. Connect the thermocouple cable to the module.

6.4 Commissioning

To commission the JX3-THI2-TC-EIC module proceed as follows:

1. Connect the thermocouple(s) to the X41/X42 terminals.
   Hardware revisions 00.0X of the JX3-THI2-TC-EIC module require the following jumpers:
   Channel 1: I1+ to U1- and U1- to AGD1
   Channel 2: I2+ to U2- and U2- to AGD2
2. Configure the channel according to the type of sensor: To do so, use module register 1y07 to set the sensor type (e.g. thermocouple type K).
3. Once any additional functions have been configured, wait until bit 16 Collective bit *Validity* in module register 0000 *Module Status* has been set.
4. Read the digitized values of the temperature sensors via module registers 0002 and 0003, where
   temperature input 1 maps to module register 0002
   temperature input 2 maps to module register 0003

7 Identification

This chapter describes the identification of the JX3-THI2-TC-EIC:

– Determining the versions of the module
– Retrieving Electronic Data Sheet (EDS) information. The EDS holds numerous non-volatile production-relevant data.

Requirements

To be able to identify the module, the following requirements must be fulfilled:

– The module has been connected to a JC controller.
– The controller must be connected to a PC.
– The JetSym programming software has been installed on the PC.
– The minimum requirements regarding modules, controllers and software are fulfilled.

7.1 Electronic Data Sheet EDS

Each device in a JX3 system features an Electronic Data Sheet EDS. Numerous production-relevant data are permanently stored in the EDS. The EDS data can be read out via files in the file system of the controller or via special registers.

7.1.1 EDS Registers

Use the EDS registers to retrieve Electronic Data Sheet (EDS) information. These registers contain the exact same information as the EDS file. They are read only (ro).

Register Numbers

The basic register number is dependent on the controller. The register number is calculated by adding the number of the module register (MR) to the number of the basic register.

Device	Basic register number	Register numbers
JX3 bus master (e.g. JC-4xx)	100000	100500 ... 100827

Tab. 13: EDS register numbers

Register Overview

The following table gives an overview of the EDS registers. By means of this register array, you can have the EDS of the controller or of a JX3 module displayed. For this, you must select the controller or the desired JX3 module via module registers 500 and 501. Data of the selected EDS can be retrieved from MR 600 onwards.

Register	Section in eds.ini	Name in eds.ini	Description
MR 500	-	-	Functional group 0: CPU 1: JX3 modules
MR 501	-	-	Module number (if MR 500 > 0)
MR 600	IDENTIFICATION	Version	Version of this section
MR 601		Code	Module code
MR 602 … MR 612		Name	Module name or controller name
MR 613		PcbRev	PCB revision
MR 614		PcbOpt	PCB option
MR 700	PRODUCTION	Version	Version of this section
MR 701 … MR 707		SerNum	Serial number
MR 708		Day	Production date: Day
MR 709		Month	Production date: Month
MR 710		Year	Production date: Year
MR 711		TestNum	Internal usage
MR 712		TestRev	Internal usage

Tab. 14: EDS register summary

7.2 Version registers

Each JX3 module features software with a unique revision number which can be read via module registers. You will need the revision data if you have to contact the Technical Support of Bucher Automation AG in case of a problem.

Format of software version numbers

The JX3-THI2-TC-EIC software version is identified by a 4-part number.

1 . 2 . 3 . 4

Fig. 10: Software version numbers

Digits	Description
1	Represents major or main version number
2	Represents minor or secondary version number
3	Represents branch or intermediate version number
4	Represents build version number

Tab. 15: Format of software version numbers

Released version

A released version is identified by both the branch and build values being 0.

Register overview

The versions can be read out from the following registers:

Register	Description
MR 0009	OS version
MR 0032	FPGA version
MR 0257	Bootloader version

Tab. 16: Register overview

8 Programming

8.1 Abbreviations, module register properties and formats

Abbreviations

The abbreviations used in this document are listed in the table below:

Abbreviation	Description
R 100	Register 100
MR 150	Module register 150

Tab. 17: Abbreviations

Module register properties

Each module register is characterized by certain properties. Most properties are identical for many module registers. In the following description, module register properties are mentioned only if a property deviates from the default properties listed below.

Property	Standard design
Access	Read/write
Value after reset	0 or undefined (e.g. revision/version number)
Takes effect	Immediately
Write access	Always
Data type	Integer

Tab. 18: Module register properties

Numerical formats

The numerical formats used in this document are listed in the table below:

Notation	Format of numerical values
100	Decimal
0x100	Hexadecimal
0b100	Binary

Tab. 19: Numerical formats

8.2 Addressing I/O Expansion Modules

The JX3 I/O module connects to sensors and actuators. The data are either sent directly to the controller via the JX3 system bus or, if the JX3 modules are located remotely, via Ethernet bus nodes or EtherCAT® bus nodes.

Each JX3 I/O module provides 10,000 module registers.

These module registers are mapped to registers in the controller. The only way of writing and reading process, configuration and diagnostic data to and from an expansion module is via controller registers. Controller registers can be accessed in the application program of the controller, in a setup pane of JetSym or via a visualization application.

The number of a controller register or I/O being mapped to a module register depends on the following parameters:

- Controller model
- Type of connection between controller and expansion module
  - Local direct connection
  - Remote connection via Ethernet
  - Remote connection via EtherCAT®
- Position and number of expansion modules in the system
  The number of expansion modules that can be connected to a controller depends on the model of the expansion module. After max. 8 expansion modules, a power supply module must be inserted.

Example system overview

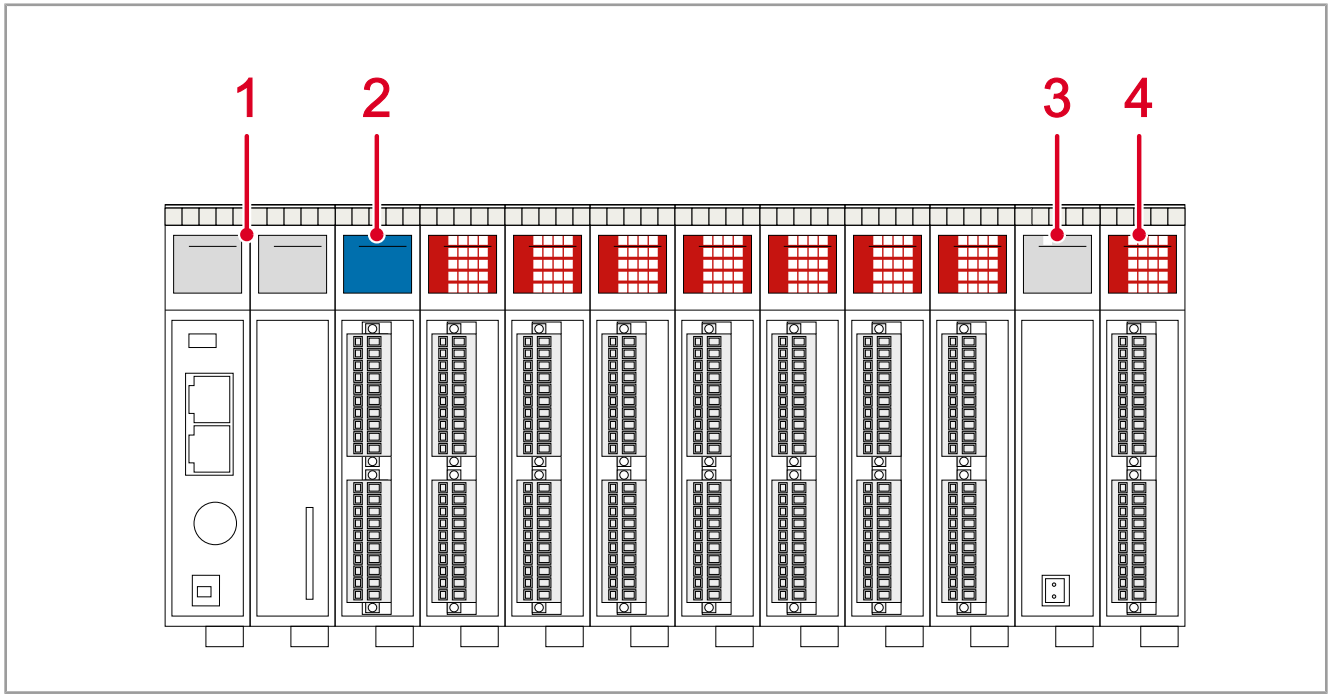


Fig. 11: Example: System overview of a controller together with various expansion modules

1	Controller
2	First expansion module
3	Power supply module
4	Further expansion modules

ⓘ Info

Number of connectible expansion modules

You can calculate the exact amount of connectible expansion modules by means of the system bus configurator, JX3-sysbus_configurator_xxx_e, which is available for download on our website.

ⓘ Info

Further Information

For further information, please refer to the JX3 *System* application-oriented manual in the download area of our website.

8.2.1 Numbering Registers and I/Os

Module registers – definition

Module registers are the data interface of the JX3 module. Use module registers to read process, configuration and diagnostics data from the JX3 module, or write such data to the JX3 module.

– The module register number within a module is unique.
– This unique register number lets you access a specific module register within the system.

Registers - Definition

There are several ways to access registers directly and indirectly:

– From an application program
– From the Setup pane of JetSym
– From a visualization application

The register number within the system is unique.

ⓘ Info

Further Information

For further information, please refer to the JX3 *System* application-oriented manual in the download area of our website.

Expansion modules connected with a controller

Our products offer a host of features accessible to the user via registers. Each register is addressed by a unique number – the register number. Each digital input and output has a unique I/O number.

Register numbering system

Register numbers consist of a prefix, the module position in the system and the module register number. If the expansion modules are connected with the controller via JX3 system bus, the prefix is 100. In this case, the module register number is always a four-digit number.

100XXZZZZ

Fig. 12: Example: Register numbers

Digits	Description	Value range
100	Prefix	
XX	Position of the module in the system	02 … 17
ZZZZ	Module register number	0000 … 9999

I/O numbering system

I/O numbers provide direct access to the inputs or outputs of the module. These I/O numbers consist of a five-digit prefix, the module position in the system and the I/O number of the module. The I/O numbers always start with the constant prefix **10000**.

10000XXZZ

Fig. 13: Example: I/O numbers

Digits	Description	Value range
10000	Prefix	
XX	Position of the module in the system	02 … 17
ZZ	Module-specific I/O number	01 … 16

Expansion modules connected to an Ethernet bus node

The Ethernet bus node and the controller communicate via Ethernet system bus. When addressing expansion modules via Ethernet bus node, the Global Node Number (GNN) becomes part of the register number.

System overview

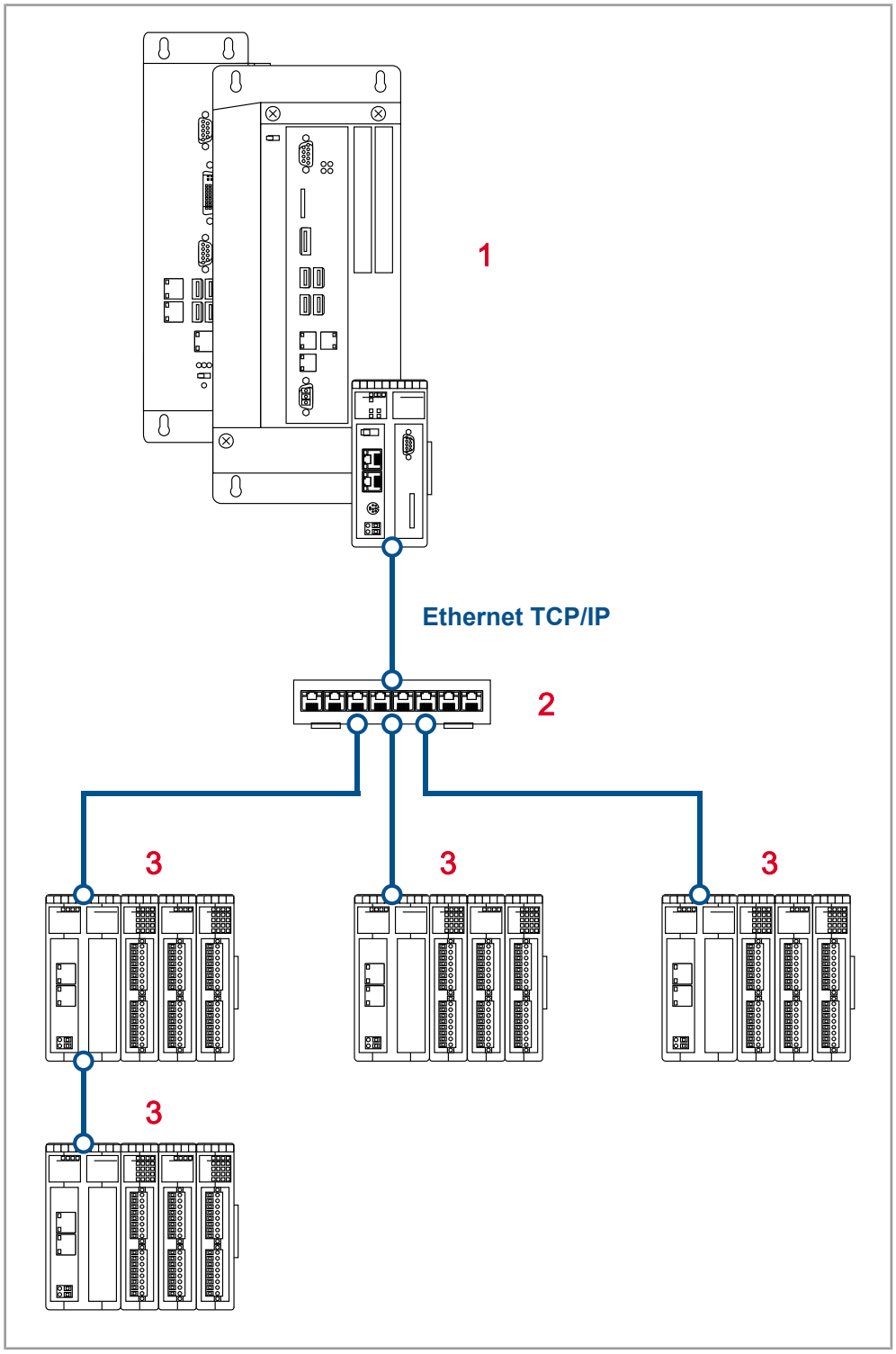


Fig. 14: System overview

1	Controller
2	Ethernet switch
3	Up to 64 Ethernet bus nodes per controller and up to 16 JX3-IO modules per Ethernet bus node

Definition of global node number

The Global Node Number (GNN) is used to identify Bucher Automation devices (e.g. controllers, bus nodes) within an Ethernet network:

– Within one network, each Bucher Automation device must have a unique GNN.
– The JetSym Hardware Manager automatically assigns the GNN during configuration.
– The value range of the GNN within a project is 000 ... 199.
– The GNN of the controller is always 000.

Register numbering system

Register numbers consist of a prefix, the GNN, the module position within the system and the module-specific register number.

1NNNXXZZZZ

Fig. 15: Example: Register numbers

Digits	Description	Value range
1	Prefix	
NNN	Bus node ID, GNN	001 … 199
XX	Position of the module within the station	02 … 17
ZZZZ	Module register number	0000 … 9999

I/O numbering system

I/O numbers provide direct access to the inputs or outputs of the module. The I/O numbers consist of prefix 1, the GNN, prefix 2, the module position in the system and the module-specific I/O number.

1NNN01XXZZ

Fig. 16: Example: I/O numbers

Digits	Description	Value range
1	Prefix 1	
NNN	Bus node ID, GNN	001 … 199
01	Prefix 2	
XX	Position of the module within the station	02 … 17
ZZ	Module-specific I/O number	01 … 16

ⓘ Info

Further information

For further information, please refer to the Bucher-Automation *Ethernet system bus* application-oriented manual in the download area of our website.

Expansion modules connected to an EtherCAT® bus node

EtherCAT® bus node and controller communicate via EtherCAT® system bus. When addressing the expansion modules via EtherCAT® bus node, the EtherCAT® Node Number (ENN) becomes part of the register number. The ENN is used to identify controllers and EtherCAT® bus nodes within an EtherCAT® network. The ENN is automatically assigned by JetSym.

System overview

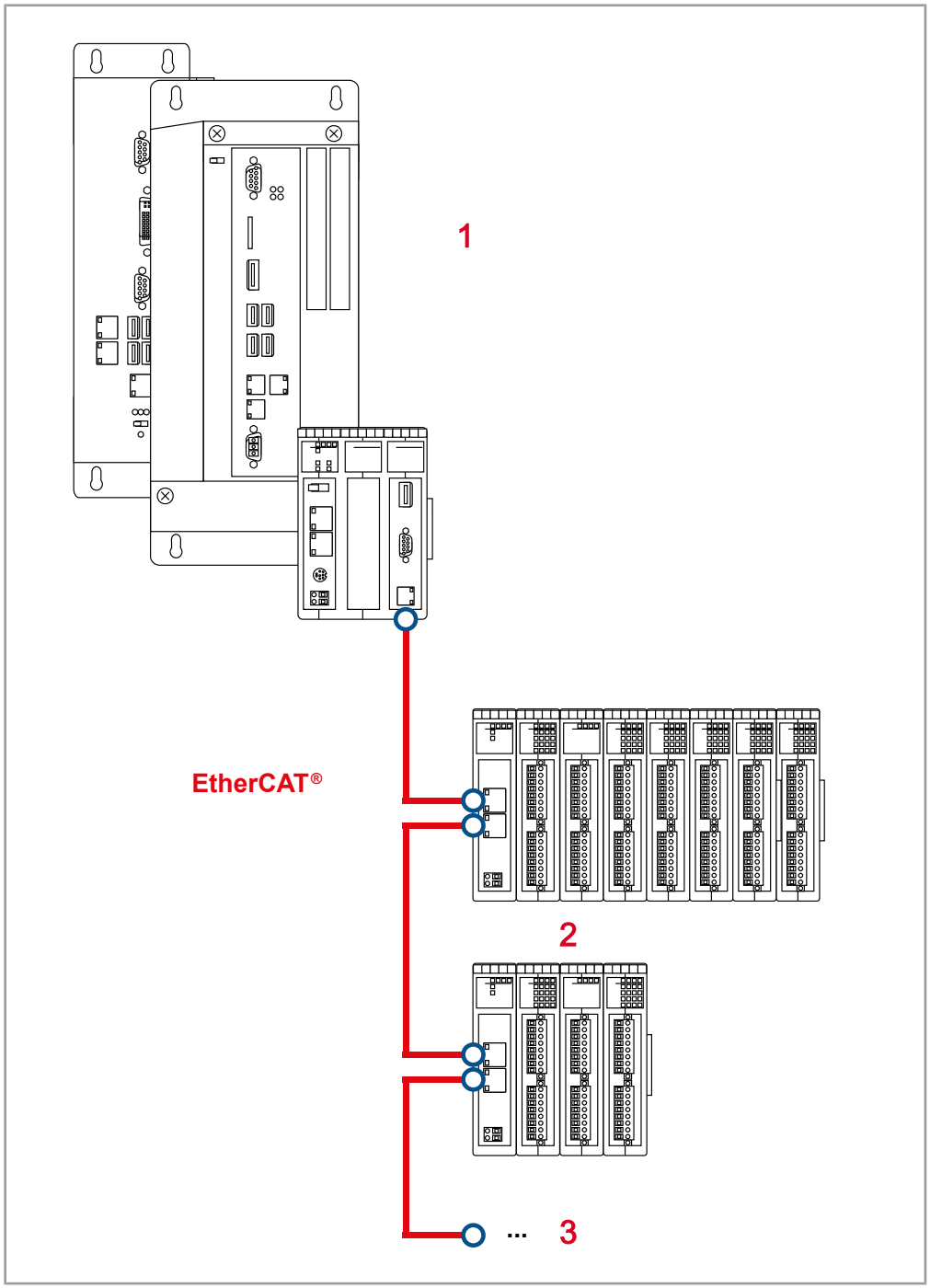


Fig. 17: System overview

1	EtherCAT® master
2	EtherCAT® bus node with up to 16 JX3 I/O modules
3	Up to 99 JX3-BN-EC

Register numbering system

The register numbers consist of a prefix, the ENN, the module position within the system and the module-specific register number.

12NNXXZZZZ

Fig. 18: Register numbers

Digits	Description	Value range
12	Prefix	
NN	Bus node ID, ENN	01 … 99
XX	Position of the module within the station	02 … 33
ZZZZ	Module register number	0000 … 9999

I/O numbering system

I/O numbers provide direct access to the inputs or outputs of the module. The I/O numbers consist of prefix 1, the ENN, prefix 2, the module position in the system and the module-specific I/O number.

12NN00XXZZ

Fig. 19: I/O numbers

Digits	Description	Value range
12	Prefix 1	
NN	Bus node ID, ENN	01 … 99
00	Prefix 2	
XX	Position of the module within the station	02 … 33
ZZ	Module-specific I/O number	01 … 16

8.3 Module state

The module register 0000 *Module state* allows you to diagnose and manage the JX3-THI2-TC-EIC module.

The JX3-THI2-TC-EIC module regularly checks the hardware for various errors. When an error is detected, the module switches to the error state. The cause of the error is entered into the module register 0000 *Module stat*e.

MR 0000

Module state

The module register 0000 displays status and error messages of the module and all analog channels.

Property	Description	
Type of access	Read	
Value range	32 bits, bit-coded	
Value after reset	0x00100000 in faultless condition	
	0x40100000	
Meaning of the bits		
Bit 0	**Hardware errors**	
	0=	No error
	1=	Hardware error: The precise error cause can be read from bits 4 ... 7. Bit 0 can be set only after bits 4 ... 7 were set.
Bit 4	**Reference value errors**	
	0=	No error occurred while reading reference values.
	1=	A hardware error occurred while reading the stored reference values. This error cannot be fixed by the user. Please contact the Technical Support.
Bit 6	**A/D converter error**	
	0=	No error
	1=	Hardware failure at reading the analog input values of the A/D converter. To acknowledge the error, use command 5. If the error persists, the hardware is defective. In this case, the error cannot be fixed by the user. Please contact the Technical Support.
Bit 7	**Internal voltages**	
	0=	No error
	1=	Internal voltages out of permissible range.

Property	Description	
Bit 16	**Collective bit: Validity**	
	0 =	The analog input value in module registers 0002 and 0003 is not valid. The average of at least one temperature input is still being calculated. The collective bit *Validity* is reset in the following circumstances: – A change of the temperature input configuration; – A change of the averaging procedure; – An internal voltage error; – An A/D converter error.
	1 =	Analog input values of all temperature channels are valid.
Bit 17	**Collective bit: Cable break**	
	0=	No error
	1=	The system detected a cable break on at least one channel. The bit is set by the module; it is reset by the user.
Bit 19	**Collective bit: Lower limit exceeded**	
	1 =	Value exceeds lower limit. At least one temperature input recorded a value exceeding the lower limit. The bit is set by the module; it is reset by the user.
Bit 20	**Collective bit: Value exceeds upper limit**	
	1 =	Value exceeds the upper limit. At least one temperature input recorded a value exceeding the upper limit. The bit is set by the module; it is reset by the user.
Bit 23	**Collective bit: Forcing**	
	0 =	Forcing is disabled.
	1 =	Forcing is enabled for at least one temperature input.
Bit 30	**Synchronous data exchange**	
	1 =	Synchronous data exchange takes place between the JX3-THI2-TC-EIC module and the bus node or the controller.

Tab. 20: Module state

8.4 Temperature inputs 1 ... 2

8.4.1 Address ranges of the temperature inputs

Introduction

Each input and some of the special features are assigned a dedicated address range. The address ranges are structured such that identical features of different inputs have the same register number ending (last two digits).

Meaning of the “y” variable

The variable “y” stands for identical functions provided by different inputs. Replacing the second digit of the register number (e.g. 1Y00), variable "y" identifies the input.

Register range	y	Description
MR 1**1**00 ... 1**1**99	y = 1	Module register for temperature input 1
MR 1**2**00 ... 1**2**99	y = 2	Module register for temperature input 2

Tab. 21: Meaning of the variable "y" in this user manual

Examples of module registers

– The status register for all inputs is 1y00.
– The command register for all Inputs is 1y01.
– etc.

8.4.2 Forcing analog inputs

When forcing, the value contained in module register 1y04 *force value* is transferred to the controller instead of the analog value of a connected sensor. This way, the behavior of the connected sensor can be simulated during commissioning. This option also allows to simulate exceptional situations not normally occurring during operation. The controller reads the simulated analog input value.

Operating principle

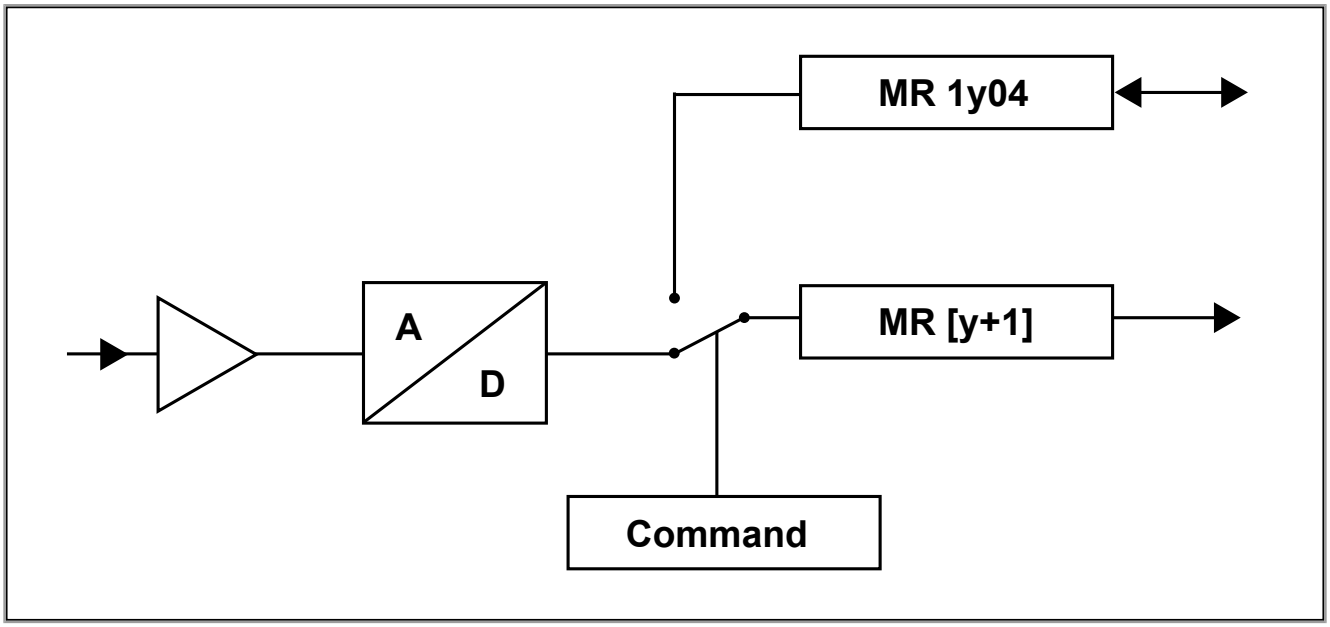


Fig. 20: The Functioning Principle of Forcing

Enabling the forcing feature disconnects the A/D converter within the module. The module copies the value stored in module register 1y04 *Force value* is transferred to the module register y+1 *Analogue input value*.

The controller reads the simulated analog input from the JX3-THI2-TC-EIC module. All additional features of the JX3-THI2-TC-EIC module remain fully operational. The only thing the module does not do is check whether the measuring range has been exceeded. The forcing function can be configured for each analog input separately.

When the forcing function is enabled and disabled, the data of the analog input become invalid. Bit 16 of the Collective bit *Validity* in module register 0000 *Module Status* is reset. Averaging starts anew.

8.4.3 Register description

MR 1y00

Status register - temperature input

Module register MR 1y00 signals status messages of the temperature input.

Property	Description	
Type of access	Read	
Value range	16 bits, bit-coded	
Value after reset	0x4ac2 Bits 1, 6, 7, 9, 11, 14 are set	
Meaning of the bits		
Bit 0	**Displays the reading in °F or °C**	
	0 =	displays the reading in °C
	1 =	displays the reading in °F
Bit 1	**Cold junction compensation**	
	0 =	inactive
	1 =	active
Bit 5	**Measuring mode**	
	0 =	slow measuring mode (approx. 100 ms for a new reading)
	1 =	rapid measuring mode (approx. 10 ms for a new reading)
Bit 6	**Validity of the values of the channel**	
	0 =	invalid
	1 =	valid
Bit 7	**Channel calibration**	
	0 =	channel is not calibrated
	1 =	Channel calibration
Bit 8	**Force value of a channel**	
	0 =	inactive
	1 =	active
Bit 9	**Toggles between temperature of the thermocouple or cold junction compensation**	
	0 =	Displays the cold junction compensation temperature
	1 =	Displays the thermocouple temperature
Bit 11	**Toggles between electrical unit and temperature reading**	
	0 =	displays the electrical unit in µV or Ω
	1 =	displays the temperature reading
Bit 12	**Calibration mode**	
	0 =	inactive
	1 =	active

Property	Description	
Bit 14	**Channel is active/inactive**	
	0 =	inactive
	1 =	active
Bit 15	**Reset**	
	0 =	no reset / normal measuring mode
	1 =	Initiates a reset (synchronously)
Bit 16	**No-load (cable break)**	
	1 =	cable break was detected.
Bit 18	**Value exceeds lower limit**	
	1 =	value in MR 1y08 exceeds lower limit
Bit 19	**Value exceeds upper limit**	
	1 =	value in MR 1y09 exceeds upper limit

Tab. 22: Status register - temperature input

MR 1y01

Command register - temperature input

MR 1y01 configures the functions provided by the module. Use commands to enable and disable various functions of the temperature input.

Property	Description
Type of access	Read/write
Value range	8 bits
Value after reset	0
Command	
6	**Status reset**
	Reset after no-load, overtemperature and undertemperature events
70	**Lower limit reset**
	Reset lower limit when saving min/max values
71	**Upper limit reset**
	Reset upper limit when saving min/max values
72	**Lower and upper limit values reset**
	Reset both, the upper and lower limits when saving min/max values
105	**Fast mode (not recommended)**
	Sampling in around 10 ms
106	**Slow mode**
	Sampling in around 100 ms
107	Show reading in °C
	Also affects trailing indicators and limit values.

Property	Description
108	Show reading in °F
	Also affects trailing indicators and limit values.
112	Disable channel
113	(Re-)enable channel
160	Show temperatures in MR
161	Show thermal voltage of the thermocouple in MR 0002-0003 or PT100 resistance towards cold junction compensation
170	**Disable forcing function**
	MR 1y04 allows you to write a simulated value to the temperature input. Command 170 disables this option and displays the live reading in the module register.
171	**Enable forcing function**
	The value defined in module register MR 1y04 is displayed. The status bits are set to signal that a value is being forced.
180	Display the thermocouple temperature at the point of measurement
181	Display the temperature at the reference point on the module
190	Enable cold junction compensation
191	Disable cold junction compensation (see bit 1 in status register)

Tab. 23: Command register - temperature input

MR 1y04

Force value

MR 1y04 allows you to write a simulated value to the temperature input.

Property	Description
Type of access	Read/write
Value range	Value multiplied by factor 1,000
	Example: 123,456 is for 123.456 °C
Value after reset	0

Tab. 24: Force value

MR 1y07

Thermocouple sensor type

Define the thermocouple sensor type by entering the relevant integer.

Property	Description	
Type of access	Read/write	
Value range	3 … 10	
	Value	**TC type**
	3	B
	4	E
	5	J
	6	K
	7	N
	8	R
	9	S
	10	T
Value after reset	6	

Tab. 25: Thermocouple sensor type

8.5 Digitizing the analog values

The process of digitizing analog values always consists of the same sequence. Using additional functions, you can adjust the digital value of any temperature input to the respective application. These additional functions can be configured separately for each temperature input:

– Averaging
– Conversion to temperature values
– Monitoring of limit values
– Trailing indicator

8.5.1 A/D conversion

The A/D converter records thermal voltages during the set sampling interval (fast/slow mode). During the same interval, the terminal temperature is read. The microcontroller then computes the terminal temperature into the equivalent thermal voltage and it deducts it from the read voltage. The subtraction result is re-converted into a temperature value.

8.5.2 Averaging

The JX3-THI2-TC-EIC module determines the moving average for each temperature input individually. With each incoming digitized reading the average of the last n measurements is recalculated. Averaging is carried out upon completion of the analog-to-digital conversion.

Averaging is carried out for the measured thermoelectric voltage of the sensors (2 independent channels), and separately for the cold junction compensation as third and forth averaged channel.

Effect

Averaging increases the accuracy of the analog input signal. Short input signal peaks have a minimal effect on the value contained in module registers 0002 and 0003. The averaging function works like a first-order low-pass filter. The second effect of such a filter is that it slows down the rate at which the result changes: If, for example, a new reading in slow mode requires 100 ms with averaging set to 40, it takes 4 s for the change to become effective, because the filter requires as much to adjust all individual values to the new reading, i.e. to pass all readings through it. In the module register, the change already shows because of the changed values. With temperature measurements, however, there are no input steps. Typically, temperature acquisition is a steady and slow process.

Averaging can be configured separately for each analog input. With every change of the configuration, the data of the temperature input become invalid. Bit 16 (collective bit *Validity*) in register 0000 *Module Status* is reset. Averaging starts anew.

Calculation

The average of is calculated using the following formula:

$$\sum_{n=1}^{a} y = \frac{y_1 \cdots y_a}{a}$$

Register description

MR 1y06

Thermocouple averaging

Configure the averaging parameters in MR 1y06.

Property	Description	
Type of access	Read/write	
Value range	1	No averaging
	2	Averaging of the last 2 ...
	…	…
	128	... 128 values
Value after reset	16 (averaging of the last 16 values)	

Tab. 26: Thermocouple averaging

MR 1y23

Cold junction compensation averaging

Configure the averaging parameters in MR 1y23.

Property	Description	
Type of access	Read/write	
Value range	1	No averaging
	2	Averaging of the last 2 ...
	…	…
	128	... 128 values
Value after reset	16 (averaging of the last 16 values)	

Tab. 27: Cold junction compensation averaging

8.5.3 Cold junction compensation

To calculate the temperature at the measuring point reliably, the junction temperature serves as a correcting quantity. This process is called cold junction compensation.

Step 1 – Reading the cold junction

The cold junction temperature ϑ is measured in the form of a digital voltage value.

Step 2 – Converting to temperature values

The value read at the cold junction is converted into a temperature using a formula.

> **Info**
>
> **Rendition of temperature values**
>
> By default, the measured value is displayed in degrees centigrade for each channel. However, you can change the settings in the command registers to render the temperature value in Fahrenheit or the measured value in microvolts.

Temperature conversion

For temperature conversion, the following formulas are used:

– °F to °C:

$$T_{°C} = \frac{5}{9} (T_F - 32)$$

– °C to °F:

$$T_F = \frac{9}{5} T_{°C} + 32$$

Step 3 – Averaging the reference junction

Following temperature value conversion, the JX3-THI2-TC-EIC module calculates the average value. The maximum number of readings factoring into the calculation of the reference junction average value is set to 128 and cannot be modified.

For further details see Averaging [▶ 45].

Step 4 – Converting the cold junction

The averaging result is converted into an equivalent voltage corresponding to the thermocouple type. The calculation uses the LUT (look-up tables) defined in DIN-EN 60584-1.

Step 5 – Aggregating into a total voltage

All thermal voltage values are aggregated into a total voltage.

Step 6 – Converting the total voltage

The total voltage is converted into a temperature value. For this conversion, the tables defined in DIN-EN 60584-1 are used.

8.5.4 Monitoring of limit values

With each conversion procedure, the JX3-THI2-TC-EIC module checks the converted value against specified limit values. The user defines the relevant upper and lower limits for each temperature input individually. The verification is carried out after the conversion into temperature values. Limit values can be configured for each temperature input individually.

Illustration

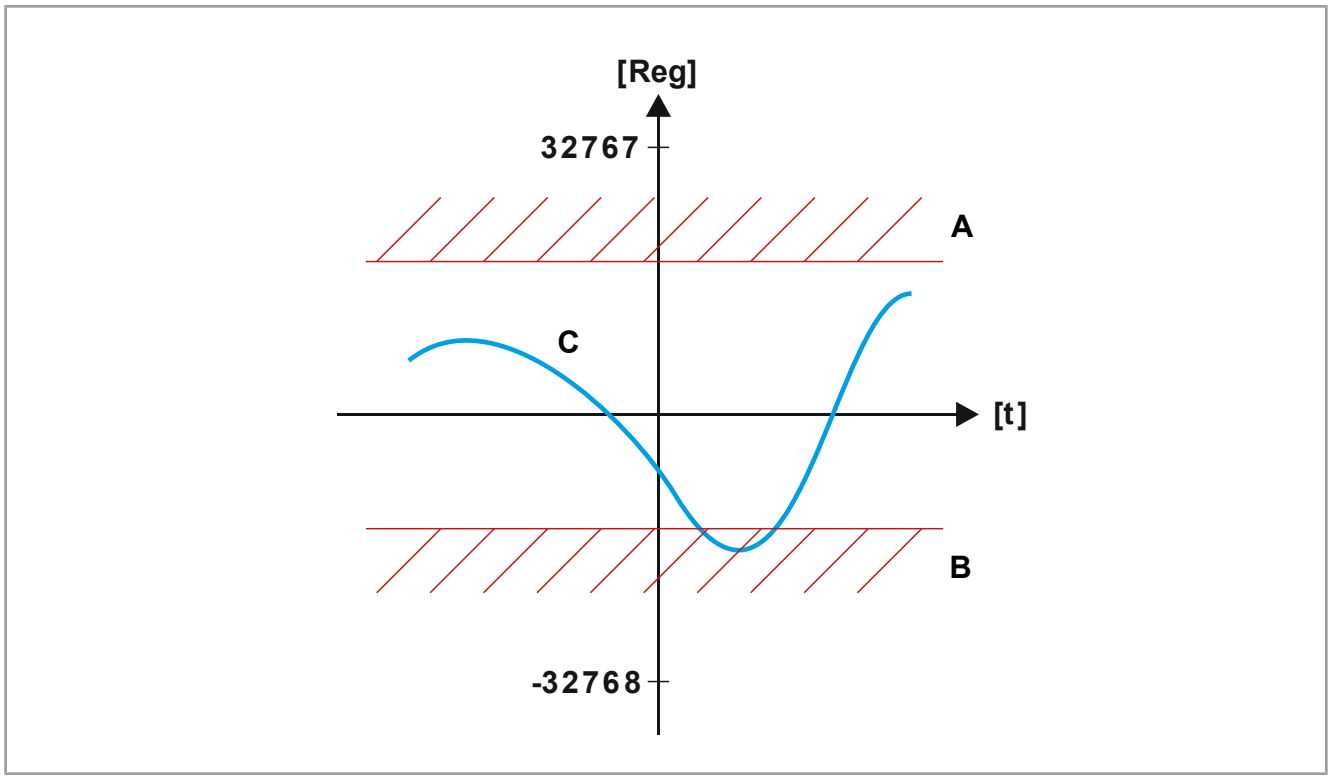


Fig. 21: Monitoring of limit values

A	Upper limit
B	Lower limit
C	Conversion result

Operating principle

The JX3-THI2-TC-EIC module verifies the limit values as follows:

Step	Description	
1	The module receives a new value in the *Channel input y* module registers 0002 and 0003.	
2	The module runs the conversion procedure.	
3	The module compares the conversion result against the limit values in MR 1y08 and MR 1y09.	
	If the result is ...	**... then ...**
	< MR 1y08,	bit 19 = 1 in MR 0000 and bit 18 = 1 in MR 1y00 are set.
	> MR 1y09,	bit 20 = 1 in MR 0000 and bit 19 = 1 in MR 1y00 are set.

Configuration

To configure the limit value monitoring settings, proceed as follows:

1. Enter the lower limit value for the temperature input y in MR 1y08.
2. Enter the upper limit value for the temperature input y in MR 1y09.

⇨ Now, the JX3-THI2-TC-EIC module continually checks digital values of the temperature input against the set limits.

Acknowledging values outside the limits

In command register MR 1y01, use commands the 6 *Status reset*, 70 *Lower limit reset*, 71 *Upper limit reset* and 72 *Lower and upper limit reset* to acknowledge limit value violations.

Register description

MR 1y08

Lower limit

Define the lower limit value in MR 1y08. With each conversion procedure, the JX3-THI2-TC-EIC module checks the converted value against the specified lower limit.

Property	Description
Type of access	Read/write
Value range	Temperature value x factor 1,000
	Example: -50,700 is for -50.7 °C
Data type	Integer
Value after reset	-50000

Tab. 28: Lower limit

MR 1y09

Upper limit

Define the upper limit value in MR 1y08. With each conversion procedure, the JX3-THI2-TC-EIC module checks the converted value against the specified upper limit.

Property	Description
Type of access	Read/write
Value range	Temperature value x factor 1,000
	Example: +680,700 is for +680.7 °C
Value after reset	+450000

Tab. 29: Upper limit

8.5.5 Trailing indicator

With each conversion procedure, the JX3-THI2-TC-EIC module updates the trailing indicators for the lower and upper limits. The trailing indicators show the lowest and highest values that have been measured to date. The trailing indicator contents are not kept when the module is switched off. The trailing indicators verification follows averaging.

Both the thermocouple and cold junction compensation have their own trailing indicators.

Initialization

After power-up, the JX3-THI2-TC-EIC module automatically initializes the trailing indicators for minimum and maximum value.

Illustration

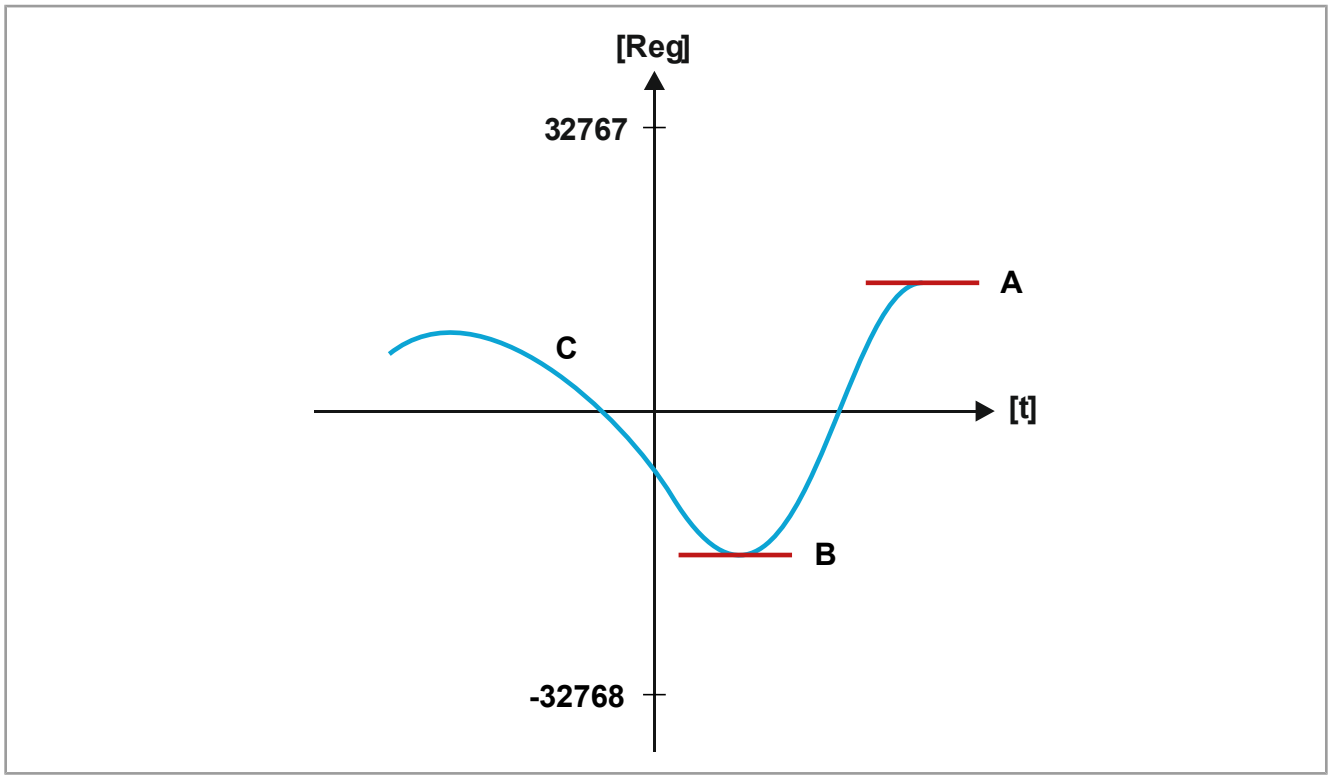


Fig. 22: Trailing indicator

A	Trailing indicator for maximum value
B	Trailing indicator for minimum value
C	Averaging result

Operating principle

The JX3-THI2-TC-EIC module checks the trailing indicators as follows:

Step	Description	
1	A new value is written to the module registers 0002 ... 0003 (*channel input y*).	
2	The module runs the averaging procedure.	
3	**If the result is ...**	**... then ...**
	< MR 1y20,	MR 1y20 = outcome
	> MR 1y21,	MR 1y21 = outcome

Register description

MR 1y20

Trailing indicator for minimum value – thermocouple

MR 1y20 contains the lowest value converted as yet. The trailing indicator acquires the lower limit of the value contained in module registers 0002 or 0003 independently of its output format (°C, °F).

Property	Description
Type of access	Read/write
Value range	Value multiplied by factor 1,000
	Example: 123,456 for 123.456
Data type	Integer
Output format	°C, °F
Value after reset	Maximum thermocouple temperature (automatically shows the new minimum value)

Tab. 30: Trailing indicator for minimum value – thermocouple

MR 1y21

Trailing indicator for maximum value – thermocouple

MR 1y21 contains the highest value converted as yet. The trailing indicator acquires the upper limit of the value contained in module registers 0002 or 0003 independently of its output format (°C, °F).

Property	Description
Type of access	Read/write
Value range	Value multiplied by factor 1,000
	Example: 123,456 for 123.456
Data type	Integer
Output format	°C, °F
Value after reset	Minimum thermocouple temperature (automatically shows the new maximum value)

Tab. 31: Trailing indicator for minimum value – thermocouple

MR 1y24

Trailing indicator for minimum value – cold junction compensation

MR 1y24 contains the lowest value converted as yet. The trailing indicator acquires the lower limit of the value contained in module registers 0002 or 0003 independently of its output format (°C, °F).

Property	Description
Type of access	Read/write
Value range	Value multiplied by factor 1,000
	Example: 123,456 for 123.456
Data type	Integer
Output format	°C, °F
Value after reset	Maximum junction temperature (automatically shows the new minimum value)

Tab. 32: Trailing indicator for minimum value – cold junction compensation

MR 1y25

Trailing indicator for maximum value – cold junction compensation

MR 1y25 contains the highest value converted as yet. The trailing indicator acquires the upper limit of the value contained in module registers 0002 or 0003 independently of its output format (°C, °F).

Property	Description
Type of access	Read/write
Value range	Value multiplied by factor 1,000
	Example: 123,456 for 123.456
Data type	Integer
Output format	°C, °F
Value after reset	Minimum junction temperature (automatically shows the new maximum value)

Tab. 33: Trailing indicator for minimum value – cold junction compensation

8.5.6 Digitized analog values

As soon as averaging and limit monitoring were applied, you can read the digitized values of the temperature inputs from module registers 0002 ... 0003.

Register description

MR 0002 … 0003

Digitized value from temperature input y

The digitized values of each temperature input is written to its respective module register 0002 or 0003.

Property	Description	
Register assignment	MR 0002	Temperature input 1
	MR 0003	Temperature input 2
Type of access	Read	
Data type	Float	
Value after reset	Value present at the temperature input	
Default value	The reading is shown in °C. Set the unit of measurement in the command registers.	

Tab. 34: Digitized value from analog input y

8.6 Oscilloscope Function

The JX3-THI2-TC-EIC module features an integrated oscilloscope function. The oscilloscope function enables you to record values from several module registers.

ⓘ Info

JetSym

The JetSym programming tool lets you operate the oscilloscope function and have the recorded values displayed as diagrams in a very convenient way.

Technical specifications

Parameter	Description
Recording interval	1 ms ... 65,535 ms
Number of channels	2 max.
Number of readings per channel	300 max.
Recordable module registers	MR 0002: Digital value of input 1 MR 0003: Digital value of input 2
Module registers that can a assigned a trigger condition	MR 0002: Digital value of input 1 MR 0003: Digital value of input 2

Tab. 35: Oscilloscope – technical specifications

Applications

The following applications are possible:

– Graphical visualization of output values, e.g. for documentation purposes.

8.6.1 Start/Stop Recording

In start/stop recording mode, the JX3-THI2-TC-EIC module records values until the maximum number of measured values per channel is reached. Initiate the start/stop recording mode via command 1.

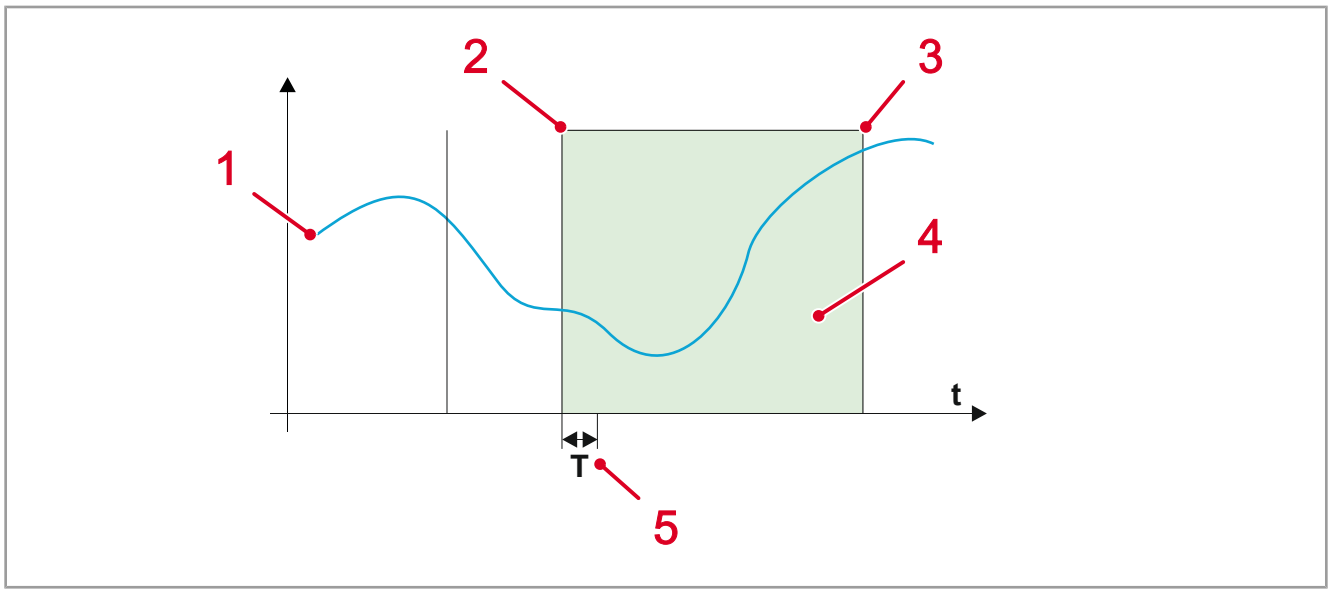


Fig. 23: Start/stop recording mode

1	Values of the module register selected for recording.
2	Starting point of the recording
3	Endpoint of the recording
4	Recorded values
5	Recording interval

Configuration

Configuration of the start/stop recording mode includes the following steps:

1. Configure the module registers to be recorded.
   MR 9741 := 11 ... 14;
   MR 9742 := module register number;
2. Configure the recording interval.
   MR 9741 := 10;
   MR 9742 := recording interval;
3. Write value 1 to MR 9740 *Command oscilloscope*.
4. Check bit 0 of the *Status* parameter.
   MR 9741 := 0;
   If bit 0 = 0 in MR 9742, the module has finished recording.
   - ⇨ The JX3-THI2-TC-EIC module starts recording.
   - ⇨ The JX3-THI2-TC-EIC module continues to record values until the maximum number of measured values per channel has been recorded.

8.6.2 Continuous recording mode

In continuous recording mode, the JX3-THI2-TC-EIC module continually records measured values. If you call *Stop* command (command 2), the JX3-THI2-TC-EIC module continues recording values until the post buffer is full. To initiate the continuous recording mode, enter command 4.

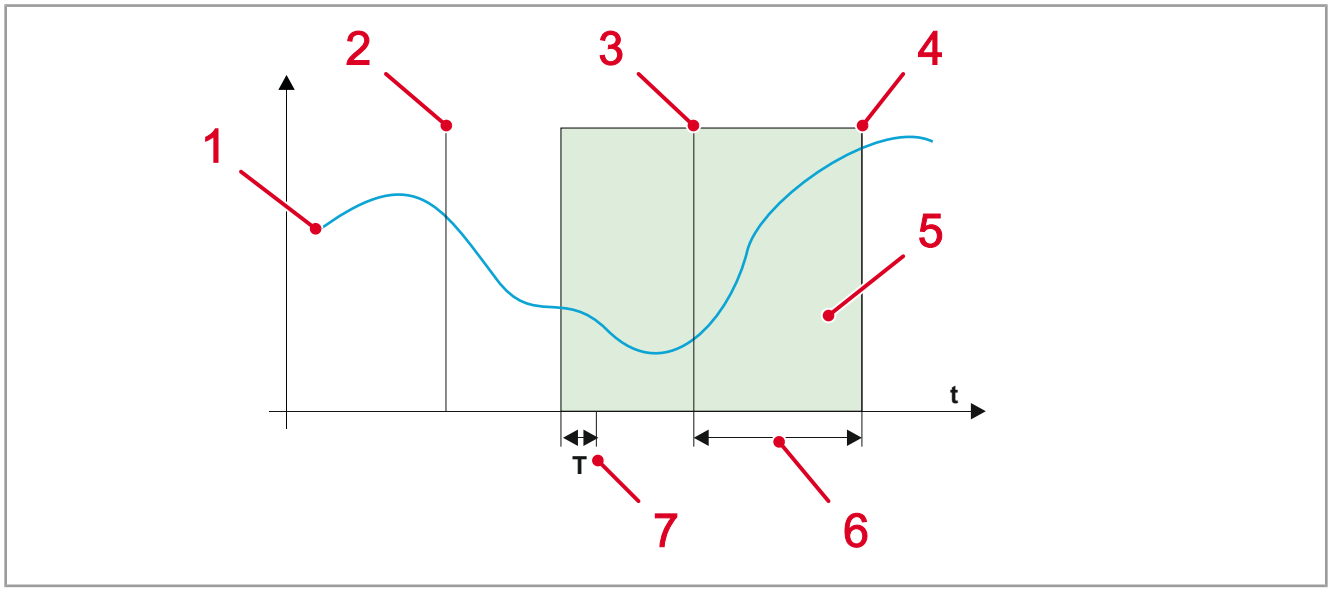


Fig. 24: Continuous recording mode

1	Values of the module register to be recorded
2	Continuous recording starts
3	Stop command is called
4	Continuous recording stops; post buffer is full
5	Recorded values
6	Size of the post buffer
7	Recording interval

Configuration

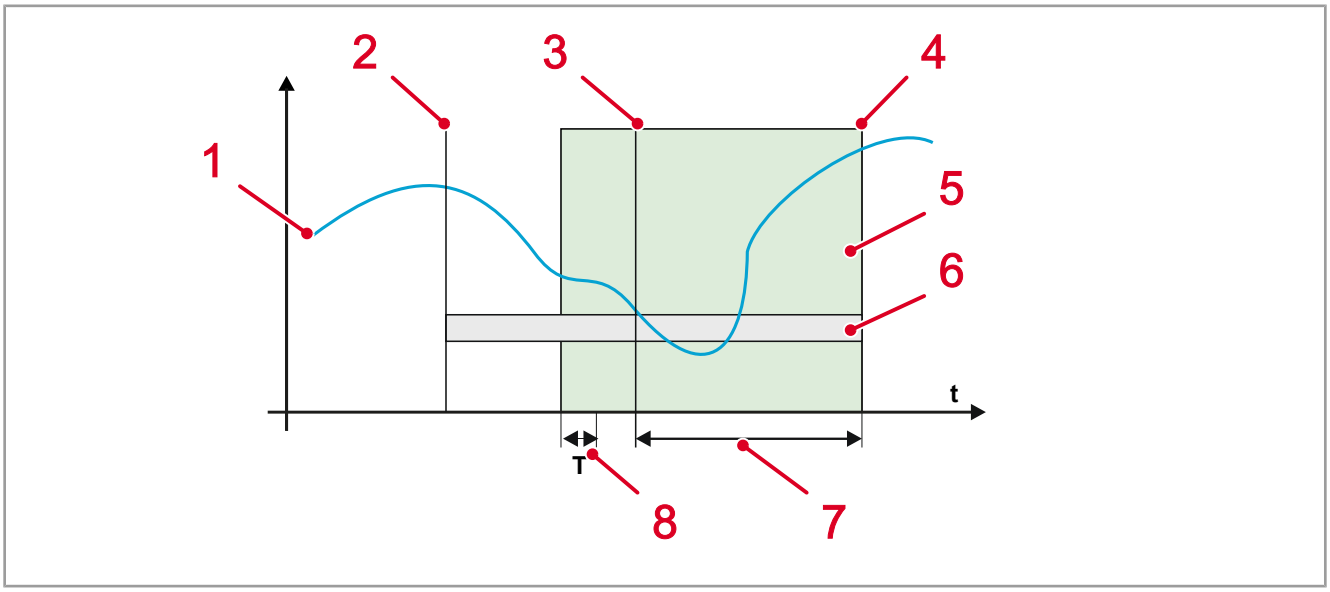
Configuration of the continuous recording mode includes the following steps:

1. Configure the module registers to be recorded.
   MR 9741 := 11 ... 14;
   MR 9742 := module register number;
2. Configure the recording interval.
   MR 9741 := 10;
   MR 9742 := recording interval;
3. Configure the size of the post buffer.
   MR 9741 := 30;
   MR 9742 := percentage of the maximum number of measured values per channel;
4. Write value 4 to MR 9740 *Command oscilloscope*.
5. Stop the recording by writing value 2 to MR 9740 *Command oscilloscope*.
6. The JX3-THI2-TC-EIC module continues to record values until the post buffer is full.

7. Check bit 0 of the *Status* parameter.
   MR 9741 := 0;
   If bit 0 = 0 in MR 9742, the module has finished recording.
   ⇨ The JX3-THI2-TC-EIC module starts recording.

8.6.3 Recording with Trigger Condition

When recording with trigger condition, the JX3-THI2-TC-EIC module constantly records measured values. As soon as the trigger condition is met, recording continues until the post-buffer is filled with values. Recording with trigger condition is started via command 3.



1	Values of the module register selected for recording.
2	Start time of recording with trigger condition
3	Trigger condition met
4	Continuous recording stops; post buffer is full
5	Recorded values
6	Value range of trigger condition
7	Size of the post buffer
8	Recording interval

Trigger Condition

The JX3-THI2-TC-EIC module checks the trigger condition using the following rules:

– The value in the module register for trigger # 1 must be greater than a configured value.
– The value in the module register for trigger # 2 must be smaller than a configured value.
– The module register numbers for trigger # 1 and 2 can be different.

MR [trigger 1] > VAL [trigger 1]

AND

MR [trigger 2] < VAL [trigger 2]

Element	Description
MR [Trigger 1]	Value in module register for trigger 1
VAL [Trigger 1]	Value for trigger 1
MR [Trigger 2]	Value in module register for trigger 2
VAL [Trigger 2]	Value for trigger 2

Configuration

Recording with trigger condition is configured as follows:

1. Configure the module registers to be recorded:
   MR 9741 := 11 ... 14;
   MR 9742 := module register number;
2. Configure the recording interval:
   MR 9741 := 10;
   MR 9742 := recording interval;
3. Configure the size of the post-buffer:
   MR 9741 := 30;
   MR 9742 := percentage of the maximum number of measured values per channel;
4. Configure trigger # 1:
   MR 9741 := 20;
   MR 9742 := module register number for trigger # 1;
   MR 9741 := 21;
   MR 9742 := value for trigger # 1;
5. Configure trigger # 2:
   MR 9741 := 22;
   MR 9742 := module register number for trigger # 2;
   MR 9741 := 23;
   MR 9742 := value for trigger # 2;
6. Write value 3 to MR 9740 *Command oscilloscope*.
7. Check bit 0 of parameter *Index*.
   MR 9741 := 0;
   If bit 0 = 0 in MR 9742, the module has finished recording.
   - ⇨ The JX3-THI2-TC-EIC module starts recording.
   - ⇨ The JX3-THI2-TC-EIC module constantly checks the trigger condition.
     If the trigger condition is met, the JX3-THI2-TC-EIC module continues to record values until the post-buffer is filled.

8.6.4 Reading Out Recorded Values

The JX3-THI2-TC-EIC module stores recorded values in a volatile memory area. The recorded data are lost when the module is switched off. Also, if a new recording cycle is started, these values are overwritten.

Reading Out the Recorded Values

To read out the recorded values, proceed as follows:

1. Check bit 0 of parameter *Status*.
   MR 9741 := 0;
   If bit 0 = 0 in MR 9742, the module has finished recording.
2. Enter the value 0 into MR 9743 *Index of recorded values*.
   MR 9743 := 0;
3. Each read access to MR 9744 *Recorded values* reads out the next recorded value.
   If you have read out MR 9744 300 times, then all recorded values from channel 1 have been read.
4. Enter the value 300 into MR 9743 *Index of recorded values*.
   MR 9743 := 300;
5. Each read access to MR 9744 *Recorded values* reads out the next recorded value.
   If you have read out MR 9744 300 times, then all recorded values from channel 2 have been read.
6. Enter the value 300 into MR 9743 *Index of recorded values*.
   MR 9743 := 600;

8.6.5 Register description

MR 9740

Command register Oscilloscope function

MR 9740 lets you configure the functionalities of the oscilloscope functions.

Property	Description
Type of access	Read/write
Value range	0 … 4
Value after reset	0
Command	
1	**Starting a recording session**
	The module starts recording the previously configured values. Once the internal memory is full, the module stops recording.
2	**Stopping a recording session**
	The *Stop* command pauses a recording that has been started.
3	**Starting a recording session once a trigger condition is fulfilled**
	The module starts monitoring the trigger condition. Once the trigger condition is fulfilled, the module starts recording the values. Recording stops once the memory for the measured values is full.
4	**Starting continuous recording**
	The module starts recording immediately. Recording is continues until you call command *Stopping a recording session*.

Tab. 36: Command register Oscilloscope function

MR 9742

Parameter

MR 9742 contains the parameter. The parameter is selected via the parameter index (MR 9741).

Index	Description	
Type of access	Read/write	
Value range	32 bits	
Value after reset	0	
Parameter		
0	**Status (read-only)**	
	Bit 0 = 1	Recording
	Bit 1 = 1	Trigger enabled
10	**Sampling interval**	
	The sampling interval defines the time period between recordings. The interval between 2 recordings (in milliseconds) results from the product of minimum sampling interval and sampling interval.	
	Value range	1 ... 65,535
11 ... 12	**Module register number for channels 1 ... 2**	
	Parameters 11 to 12 are used to configure the module registers to be recorded.	
20	**Module register number for trigger 1**	
	Number of the module register for trigger condition 1.	
21	**Value for trigger 1**	
	Value defined in module register for trigger condition 1.	
22	**Module register number for trigger 2**	
	Number of the module register for trigger condition 2.	
23	**Value for trigger 2**	
	Value defined in module register for trigger condition 2.	
30	**Size of the post buffer**	
	Value range	0 % ... 100 %

Tab. 37: Parameter

9 Register overview

This register overview gives a condensed summary of the registers of the JX3-THI2-TC-EIC device as applies to the operating system version 1.09.x.xx.

Module code

Each module has a
unique module code for identification purposes (see module register
100601 *Module code*).

– Module code JX3-THI2-TC-EIC: 342

General overview – registers

Register range	Description
0000	Module-specific status register
0002 … 0003	Temperature inputs 1 ... 2
0009, 0032, 0257	Version registers
1100 ... 1199	Configuration of temperature input 1
1200 ... 1299	Configuration of temperature input 2
9740 ... 9744	Oscilloscope function

Module state

Register	Description
0000	**Module-specific status register**
Bit 0 = 1	There is a hardware error
Bit 4 = 1	Error when reading reference values
Bit 6 = 1	A/D converter error
Bit 7 = 1	Error: Internal voltages
Bit 16 = 1	Collective bit: Readings are valid
Bit 17 = 1	Collective bit: Cable break
Bit 19 = 1	Collective bit Lower limit
Bit 20 = 1	Collective bit Upper limit
Bit 23 = 1	Collective bit: Forcing
Bit 30 = 1	Synchronous data exchange

Temperature inputs

Register	Description
0002	Digital value for analog input 1
0003	Digital value for analog input 2

Status of temperature input

Register description	
1y00	**Status register – temperature input y (y = 1 ... 2)**
Bit 0 = 0	Displays the reading in °C
Bit 0 = 1	Displays the reading in °F
Bit 1 = 1	Cold junction compensation is enabled
Bit 5 = 0	Slow measuring mode (approx. 100 ms)
Bit 5 = 1	Fast measuring mode (approx. 10 ms)
Bit 6 = 1	Values of this channel are valid
Bit 7 = 1	Channel calibration
Bit 8 = 1	Force value is displayed
Bit 9 = 0	Cold junction compensation temperature is being displayed
Bit 9 = 1	Thermocouple temperature is being displayed
Bit 11 = 0	Voltage value is being displayed
Bit 11 = 1	displays the temperature reading
Bit 12 = 1	Calibration mode is active
Bit 14 = 1	Channel y is active
Bit 15 = 1	Initiates a reset (synchronously)
Bit 16 = 1	No-load (cable break)
Bit 18 = 1	Value exceeds lower limits
Bit 19 = 1	Value exceeds upper limits

Command register – temperature input

Register description	
1y01	**Command register – temperature input y (y = 1 ... 2)**
6	Status reset
70	Lower limit reset
71	Upper limit reset
72	Lower and upper limit values reset
105	Fast mode
106	Slow mode
107	Show reading in °C
108	Show reading in °F
112	Disable channel
113	(Re-)enable channel
160	Display temperature value
161	Display resistance value
170	Show temperature value (again) (forcing function OFF)
171	Show force value
180	Display temperature measured by thermocouple at measuring point
181	Show reference temperature
190	Enable cold junction compensation
191	Disable cold junction compensation

Type of sensor of the thermocouple

Register	Description
1y07	**Thermocouple sensor type for channel y (y = 1 ... 2)**
3	B
4	E
5	J
6	K
7	N
8	R
9	S
10	T

Other configurations

Register	Description
1y04	Force value for temperature input y
1y06	Thermocouple averaging
1y07	Type TC
1y08	Lower limit of temperature input y
1y09	Upper limit of temperature input y
1y20	Trailing indicator for minimum value – thermocouple
1y21	Trailing indicator for maximum value – thermocouple
1y23	Cold junction compensation averaging
1y24	Trailing indicator for minimum value – cold junction compensation
1y25	Trailing indicator for maximum value – cold junction compensation

Oscilloscope function

Register	Description
9740	Command
9741	Parameter index
9742	Parameter
9743	Data index
9744	Data

Revisions

Registers	Description
0009	OS version
0032	FPGA version
0257	Bootloader version

Electronic Data Sheet (EDS)

This register range is located in the JX3 bus master (e.g. controller) and not on the JX3 I/O module.

Register range	Description
100500 … 100501	**EDS data selection**
100500	Interface: 1= Position of the expansion modules in the system
100501	Module number within the system
100600 … 100614	**Data of the EDS page 0 (identification)**
100600	Revision of EDS page 0
100601	Module code
100602 … 100612	Module name
100613	Hardware revision
100614	Hardware option
100700 … 100710	**Data of the EDS page 1 (production)**
100700	Revision of EDS page 1
100701 … 100707	Serial number of the module
100708	Production date: Day
100709	Production date: Month
100710	Production date: Year

10 Maintenance

This device is maintenance free.
Therefore, for the operation of the device, no inspection or maintenance is required.

10.1 Repairs

Defective components could cause dangerous malfunctions and could compromise safety.
Only the manufacturer is allowed to repair the device.
It is forbidden to open the device.

Modifications to the device

Modifications and alterations to the device and its functions are not allowed. In the case of modifications to the device, any liability is excluded.

The original parts are specifically designed for the device. Parts and equipment from other manufacturers must, therefore, not be used.

Any liability for any damages resulting from the use of non-original parts and equipment is excluded.

10.2 Storage and Shipment

Storage

When storing the device observe the environmental conditions given in chapter “Technical specifications”.

Shipment and packaging

The device contains electrostatically sensitive components which can be damaged if not handled properly. Damages to the device may impair its reliability.

To protect the device from impact or shock, it must be shipped in its original packaging, or in an appropriate protective ESD packaging.
In case of damaged packaging inspect the device for any visible damage, and inform your freight forwarder and the Bucher Automation AG of the damage caused during shipment. If the device is damaged or has been dropped, it is strictly forbidden to use it.

10.3 Return and Disposal

Disposal options

Return your Bucher Automation AG product to us for proper disposal. Visit our website for detailed information and to download the required Returns form.

Meaning of WEEE icon



Fig. 25: WEEE icon – crossed out trash can

The product is waste electronic equipment and must be disposed of by a certified waste management facility. Do not dispose of the product with normal household waste. Applicable local environmental directives and regulations must be complied with.

Batteries

Prior to disposing of waste electronics, remove any batteries where this is possible in a safe and non-destructive way. Dispose of batteries properly.

Personal data

It is the responsibility of the customers to delete any personal data stored on waste electric and electronic equipment prior to disposal.

11 Service

11.1 Technical support

In case of questions, suggestions, or issues, please contact our experts from Technical Support. You may reach out by phone or through the contact form on our homepage:

Technical Support | Bucher Automation - We automate your success.

Or email us:

support@bucherautomation.com

Please supply the following information when contacting Technical Support:

– Hardware revision and serial number
  The hardware revision and serial number is printed on the nameplate of the product.
– OS version
  To determine the operating system version, use the functions of the development environment.

12 Spare parts and accessories

NOTICE



Inadequate accessories might cause damage to the product

Parts and equipment from other manufacturers might impede the function of the device and cause damage to the product.

► Only use accessories recommended by Bucher Automation AG.

12.1 Spare Parts

Component	Item number
Terminal labels	60870411
Key	60870410
Male connector with PUSH-IN connection, 10-pin	60869254

Tab. 38: Spare parts

12.2 Accessories

Info

Ordering Accessories

The accessories are not part of the scope of delivery.

Suitable accessories can be obtained from Bucher Automation AG.

Component	Item number
Screwdriver	60871712
End clamp for DIN rail	60863970
Strain relief	60870963

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