BUCHER automation

User Manual



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JX3-AI4-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 the device. 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 | www.bucherautomation.com

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

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 www.bucherautomation.com.

ⓘ 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

The product corresponds to the current state of science and technology when placed on the market.
In addition to this user manual, the laws, regulations and directives 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 recognized safety rules.

2.2 Purpose

2.2.1 Intended use

JX3-AI4-EIC is a JX3 IO module allowing for analog inputs to be added to a controller. This device is used to control machinery, such as conveyors, production lines and handling machines. It can be connected 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

JX3-AI4-EIC is an expansion module with 4 analog inputs for the connection of analog sensors. The analog inputs are electrically isolated from both power supply and each other.

3.1 Design

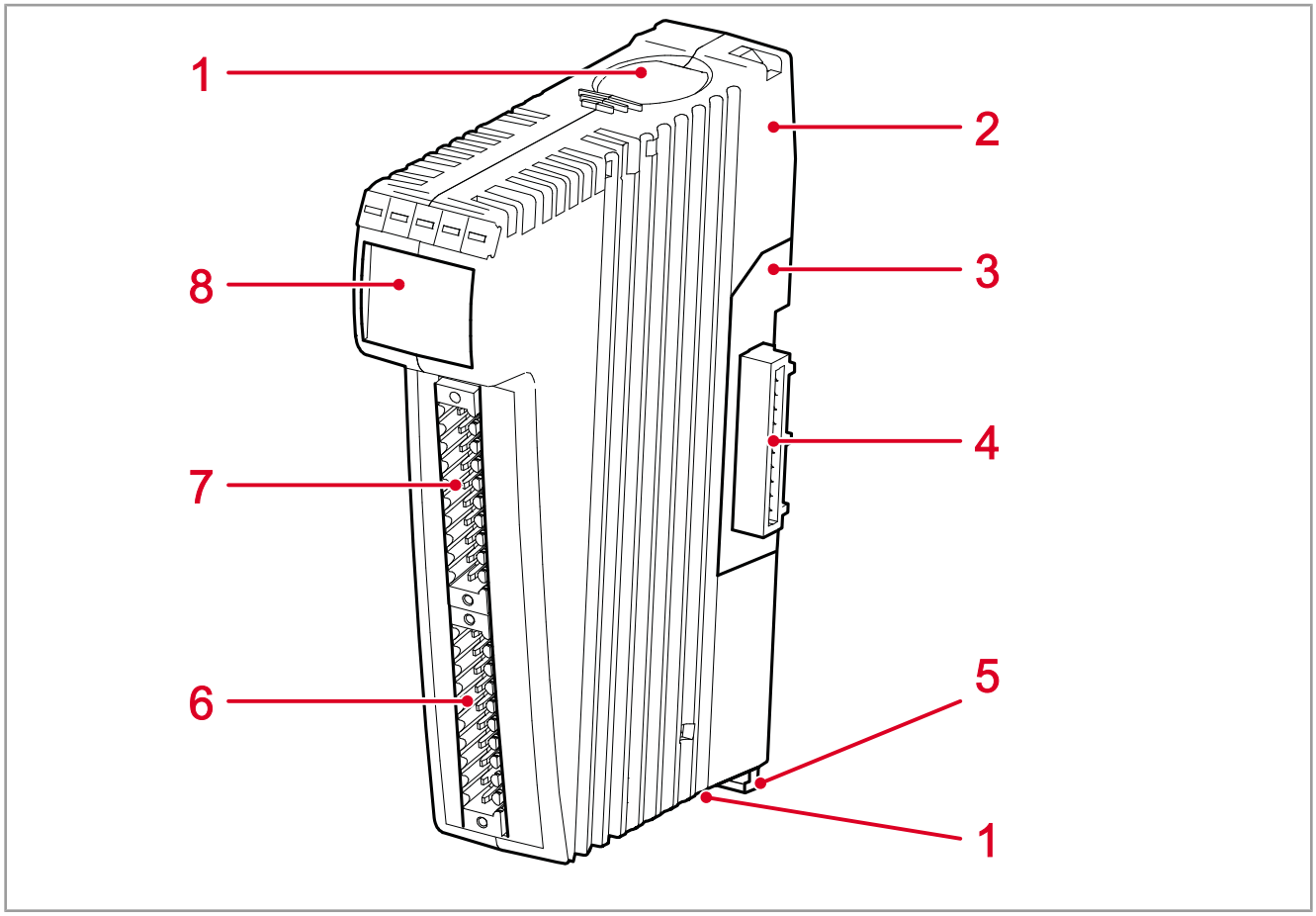


Fig. 1: Design

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

3.2 Product features

– 4 analog inputs
– Selectable input signal per channel
– Software filtering up to 16-fold averaging
– Application-specific scaling
– Monitoring of limit values
– Trailing indicator
– Forcing
– Oscilloscope function

3.3 Status indication

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

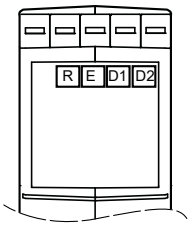


Fig. 2: Status indication

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.

LEDs	Status	Color	Description
R	OFF	---	No logic circuit supply
	ON	Green	Logic voltage supply is OK
E	OFF	---	Communication with controller or bus node is active
	ON	Red	Communication with controller or bus node is Inactive
D1	ON	Red	Hardware errors
D2	Blinking at 1 Hz	Red	There is no valid OS
D1/D2	Blinking	Red	An operating system update is being executed

3.4 Nameplate

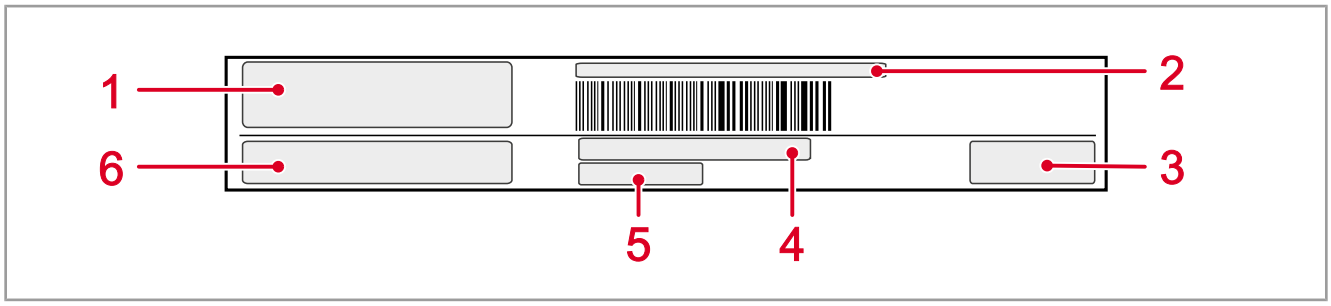


Fig. 3: Sample nameplate

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-AI4-EIC_PI	10001915	1
Male connector with PUSH-IN connection, 10-pin	60869254	2
Terminal labels	60870411	10
Keying pins	60870410	1
Product Documentation Note	60888123	1

4 Technical Specifications

This chapter contains information on both electrical and mechanical data as well as on operating data of the JX3-AI4-EIC device.

4.1 Dimensions

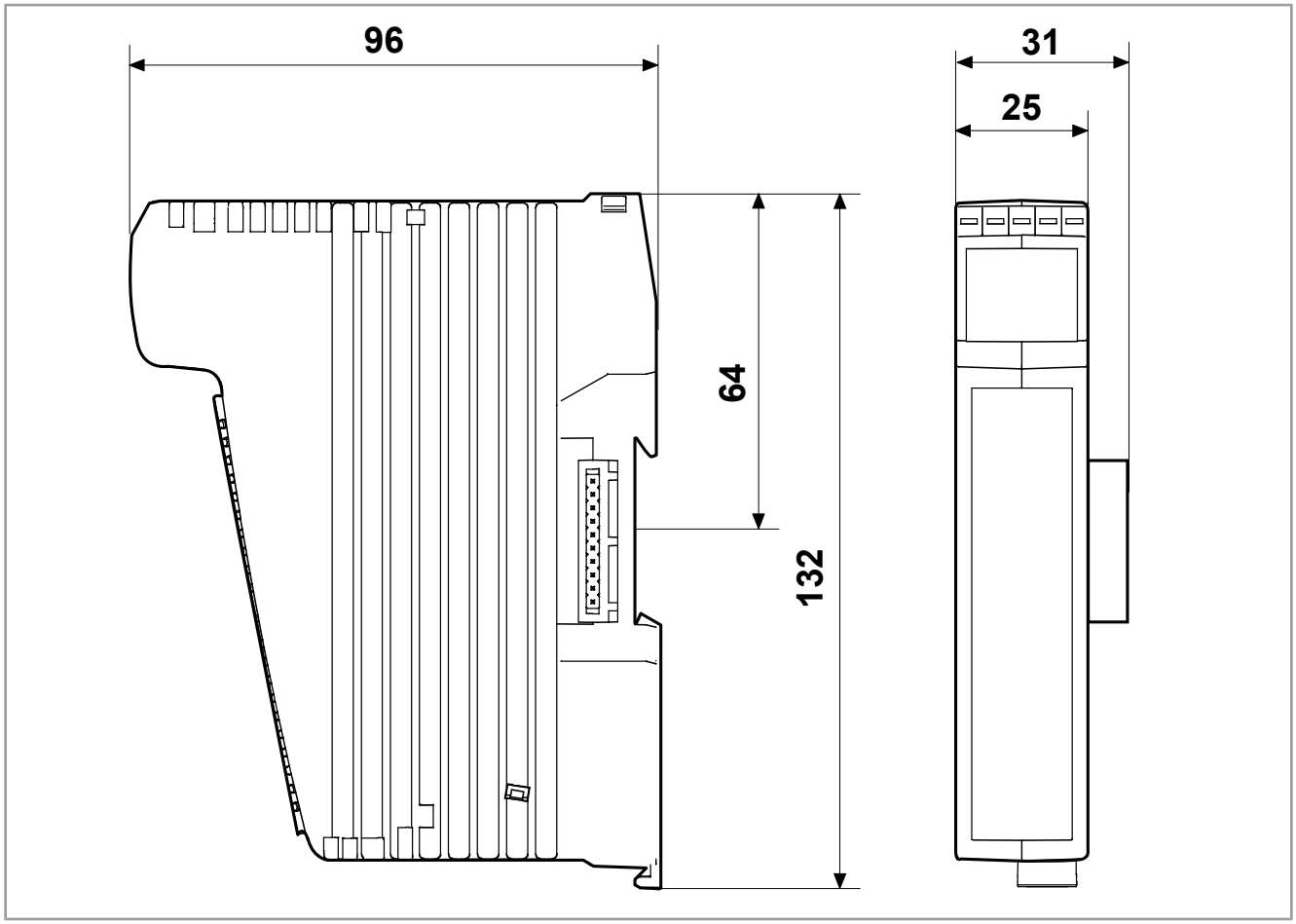


Fig. 4: Dimension in mm

ⓘ Info

CAD data

For CAD data go to www.bucherautomation.com and navigate to the product page *JX3-AI4-EIC > Downloads*.

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. 1: Mechanical specifications

4.3 Electrical properties

Expansion module

Parameter	Description	
Analog inputs	4	
Voltage measuring range	0 V ... +10 V	-10 V ... +10 V
Current measuring range	0 mA ... 20 mA	4 mA … 20 mA using application-specific scaling
Connection type	Differential	
Current consumption via backplane module		
From logic voltage	150 mA	
From additional voltage	0 mA	
Logic voltage	DC 5 V (-15 % … +10 %)	
Additional voltage	DC 24 V (-15 % … +10 %)	
Nominal power consumption	0.75 W	

Tab. 2: Expansion module

Analog voltage inputs

Parameter	Description	
Nominal range	-10 V … +10 V	
Surge withstand capability	-30 V … +30 V	Between input terminals and toward SHLD
Input impedance	180 kΩ	Differential
Measuring error	< 0.5 %	
Resolution	15 bit + sign	
Conversion time	< 1 ms	
Input frequency	0 Hz ... 200 Hz	
Electrical isolation	Yes	

Tab. 3: Analog voltage inputs

Analog current inputs

Parameter	Description	
Nominal range	0 mA ... 20 mA	
Surge withstand capability	-30 V … +30 V	Between input terminals and toward SHLD
Input impedance	< 100 Ω Module powered and no overvoltage at the input	
	> 100 kΩ Module not powered/overvoltage or negative voltage at the input	
Measuring error	< 0.5 %	
Resolution	15 bits	
Conversion time	< 1 ms	
Input frequency	0 Hz ... 200 Hz	
Electrical isolation	Yes	
Current limitation	Electronic monitoring	
Tripping voltage	3.3 V approx. results in a tripping current of approx. 35 mA	

Tab. 4: Analog current inputs

Electrical safety

Parameter	Description	Standards
Class of protection	III	DIN EN 61131-2
Protective connection	0	
Overvoltage category	II	
Dielectric test voltage	Functional ground is internally connected to device ground of the logic section. The difference between the voltages at the analog inputs and the functional ground potential must not exceed ±30 V.	

Tab. 5: Electrical safety

4.4 Environmental Conditions

Parameter	Description	Standards
Operating temperature	0 °C … +50 °C	DIN EN 61131-2
Storage temperature	-40 °C … +70 °C	DIN EN 60068-2-1
Humidity	10 % … 95 %, non-condensing	DIN EN 60068-2-2
Max. operating altitude	2,000 m above sea level	DIN EN 61131-2
Corrosion immunity and chemical resistance	No special protection against corrosion. Ambient air must be free from 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

4.5.1 Housing

Emitted interference

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

Tab. 7: Emitted interference

Immunity to interference

Parameter	Values	Standards
Magnetic field with mains frequency		
Frequency	50 Hz	DIN EN 61131-2 DIN EN 61000-6-2 DIN EN 61000-4-8
Magnetic field	30 A/m	
Criterion	A	
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
Criterion	B	
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	Standards
Signal and control line connections, DC voltage supply inputs and outputs		
Frequency band	**0.15 MHz … 0.5 MHz**	DIN EN 61131-2 DIN EN 61000-6-3
Quasi-peak limit	79 dB (µV)	
Averaging limit	66 dB (µV)	
Frequency band	**0.5 MHz … 30 MHz**	
Quasi-peak limit	73 dB (µV)	
Quasi-peak limit	60 dB (µV)	
Class	B	

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

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 61131-2 DIN EN 61000-6-2 DIN EN 61000-4-4
	tr/tn 5/50 ns	
Repetition frequency	5 kHz	
Criterion	B	
Surge voltages, symmetric, line-to-line		
Differential-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	
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. 10: Immunity to interference of the 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 replace the device.

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.

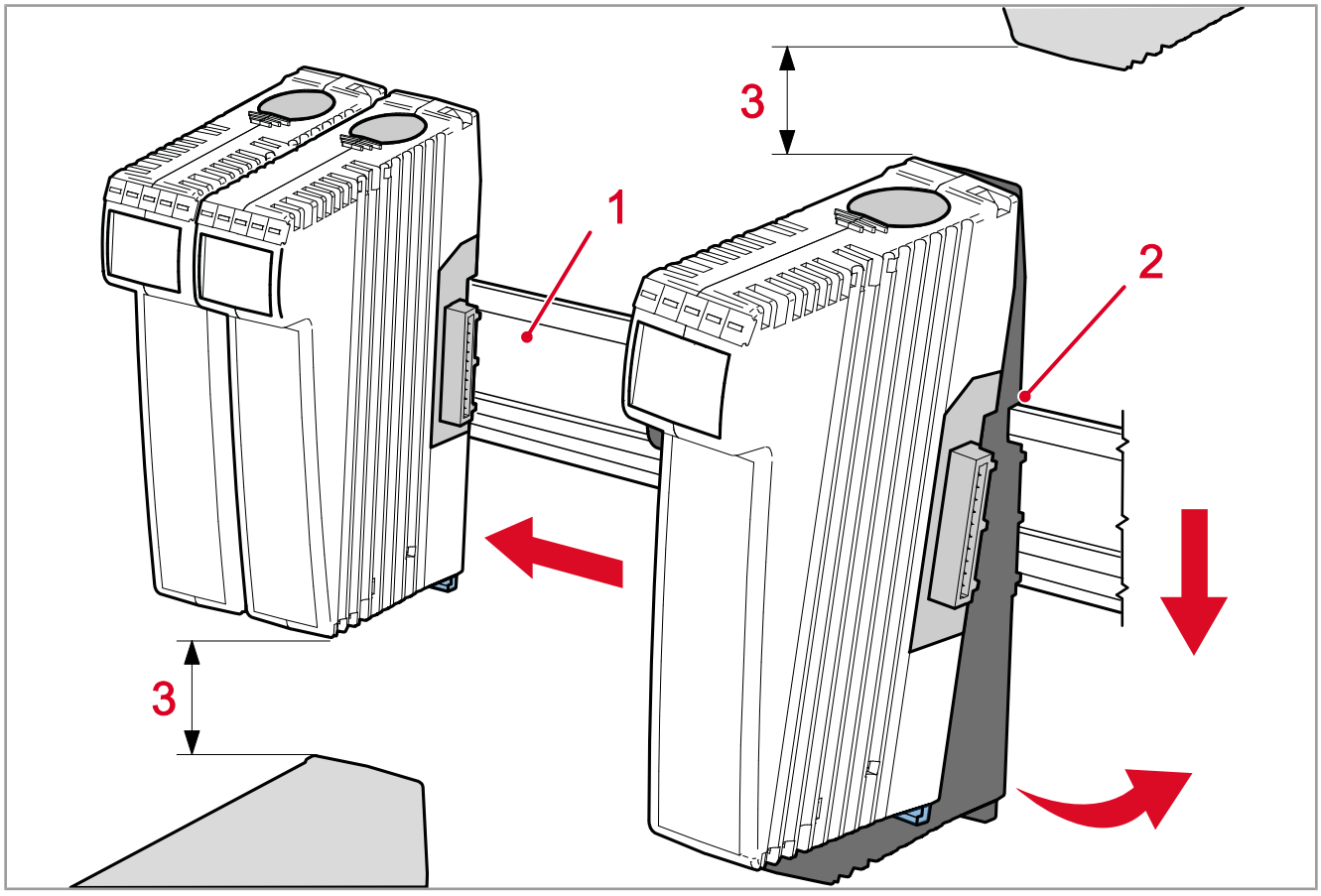


Fig. 5: Installing the device on the DIN rail

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.

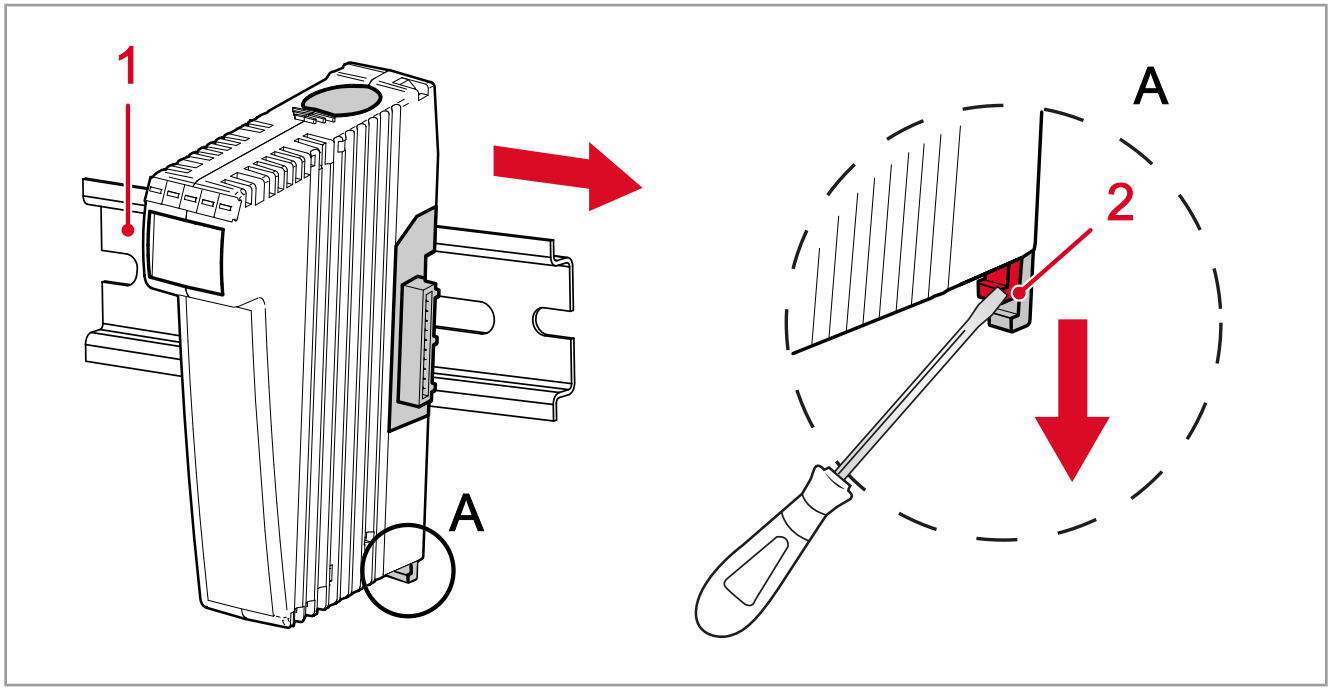


Fig. 6: Removing the device from the DIN rail

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.

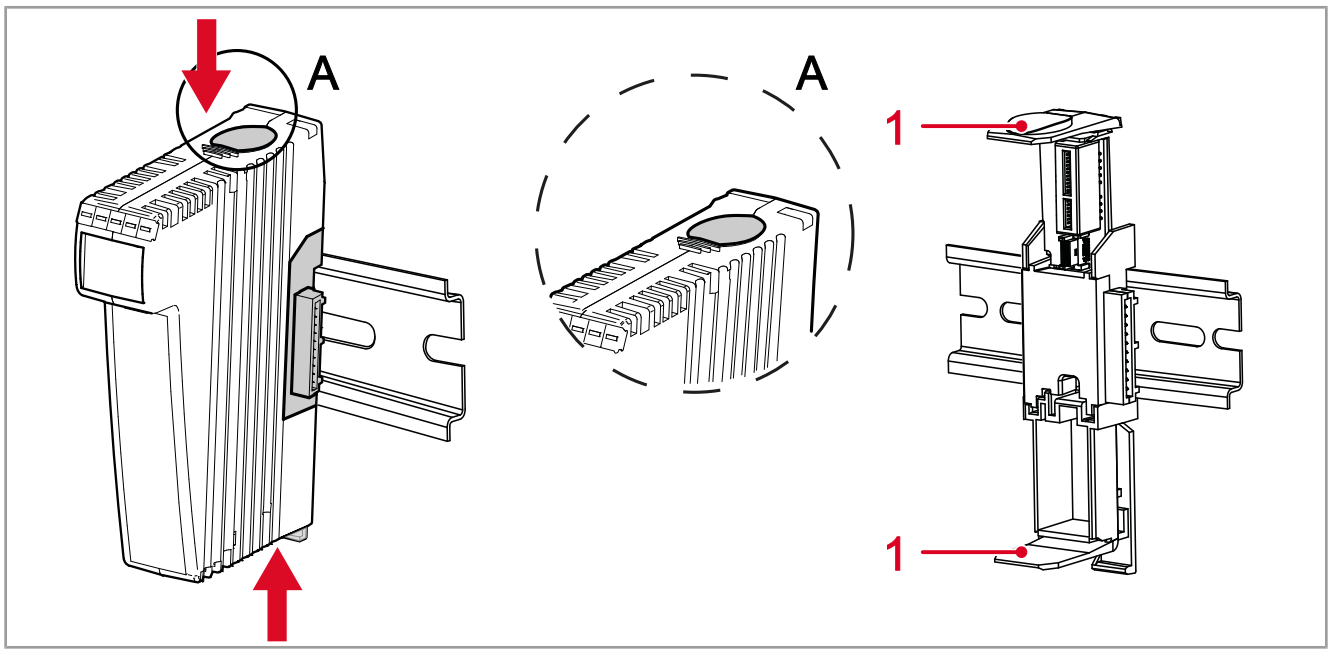


Fig. 7: Removing the enclosure from the backplane module

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. Wire termination methods, lines and proper shielding factor into the equation. 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 www.bucherautomation.com.

DIN rail

- – Mount the JX3-AI4-EIC device on a DIN rail sized 35 mm x 7.5 mm as per DIN EN 60715.
- – 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-AI4-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.

– Tests with an RF injection (10 V/m) resulted in a higher susceptibility to interference.

Use of terminals

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

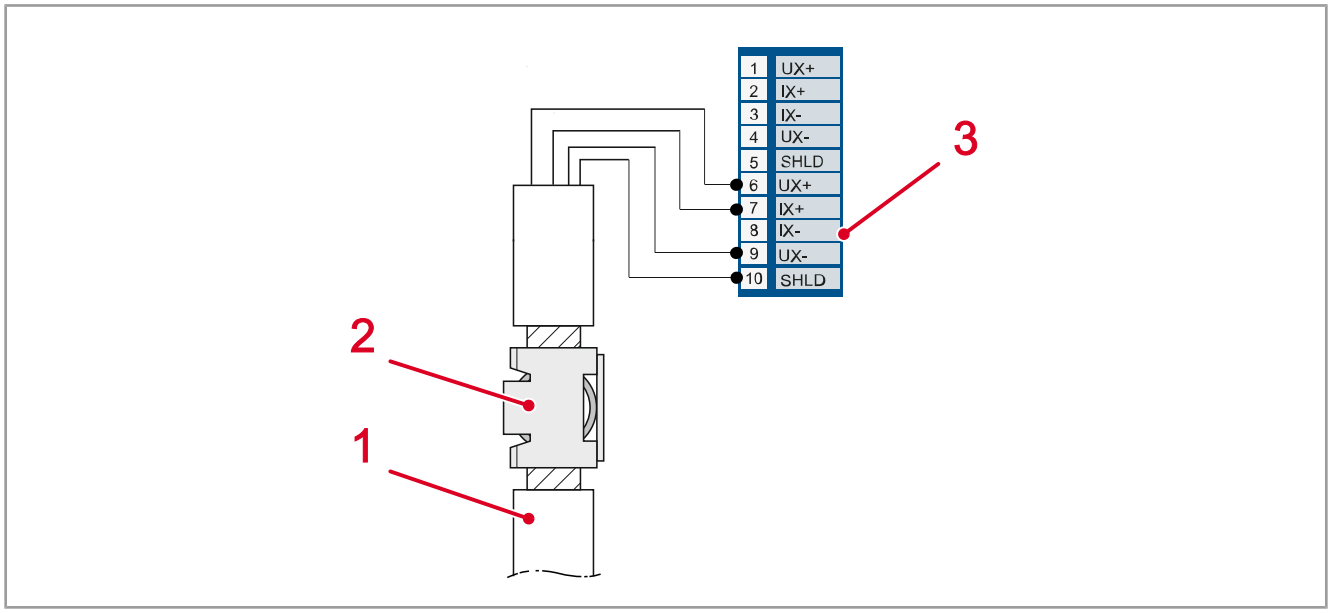


Fig. 8: Shielding measures

1	Line to the analog sensor
2	Shield clamp
3	JX3-AI4-EIC

6.2 Interfaces

6.2.1 Terminals X41, X42 – Analog Inputs

Ports and interfaces

Terminals X41 and X42 let you connect the following devices:

– 2 analog inputs each for the connection of voltage and current sensors

Pinning

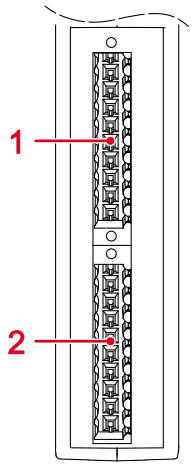
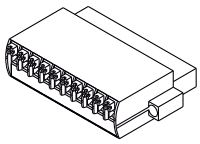


Fig. 9: 2 terminals, 10-pin

Terminal	Terminal point	Description
(1) X41	U1+	Voltage input 1 +
	I1+	Current input 1 +
	I1-	Current input 1 -
	U1-	Voltage input 1 -
	SHLD	Shielding connection
	U2+	Voltage input 2 +
	I2+	Current input 2 +
	I2-	Current input 2 -
	U2-	Voltage input 2 -
	SHLD	Shielding connection
(2) X42	U3+	Voltage input 3 +
	I3+	Current input 3 +
	I3-	Current input 3 -
	U3-	Voltage input 3 -
	SHLD	Shielding connection
	U4+	Voltage input 4 +
	I4+	Current input 4 +
	I4-	Current input 4 -
	U4-	Voltage input 4 -
	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 voltage and current sensors with differential signaling

Connection

The connection of analog sensors is identical for all 4 inputs.

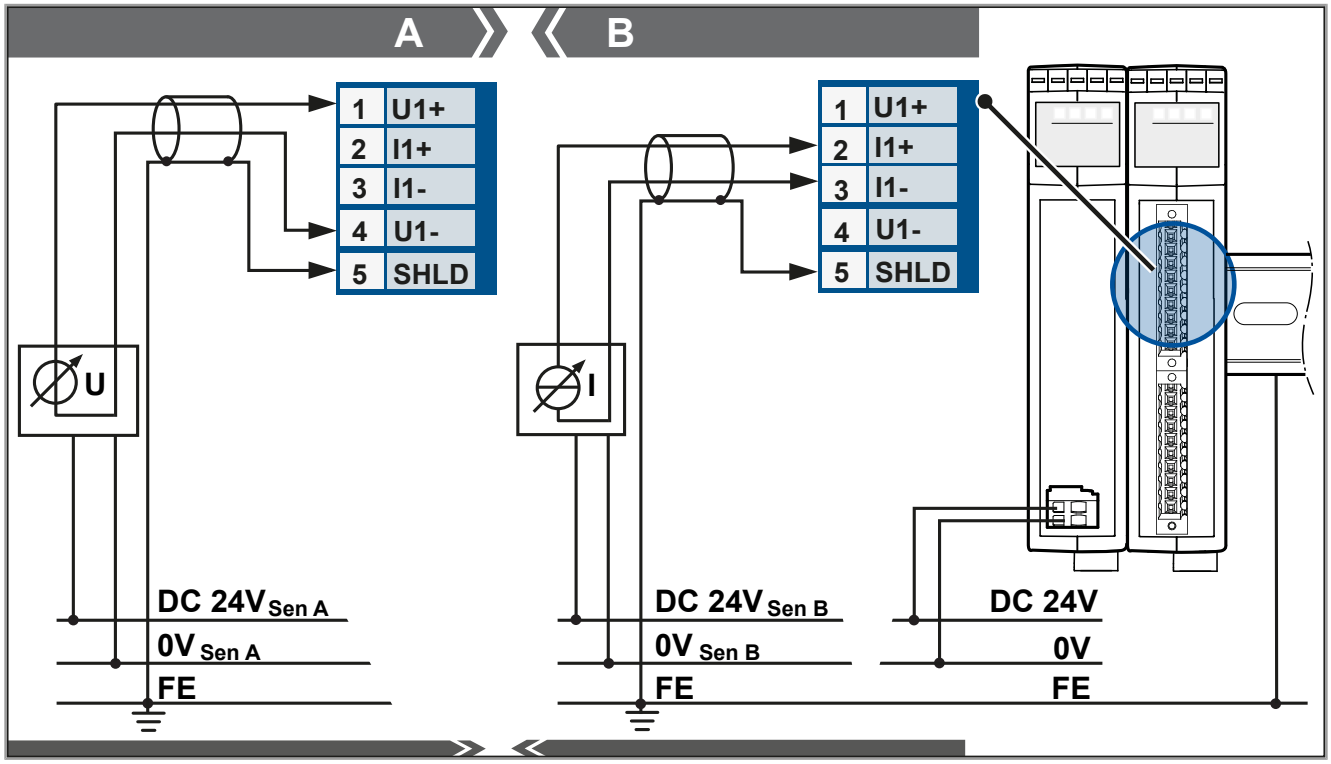


Fig. 10: Differential connection of sensors

A	Voltage sensor, differential mode (isolated)
B	Current sensor, differential mode (isolated)

✓ The system has been de-energized.

✓ A shielded cable is being used.

1. Connect the shield to terminal X41.SHLD and X42.SHLD directly.
   Use a shield clamp to provide additional grounding of the shield.
2. Snap a ferrite core over the shielded cable.
3. Connect the positive sensor output to pin U1+ or I1+ respectively.
4. Connect the negative sensor output to pin U1- or I1- respectively.
5. Repeat the above steps for any other sensors connected to the remaining inputs 2 - 4.

6.4 Commissioning

This chapter outlines the steps for initial configuration of this device.

NOTICE



Surges resulting from missing protection or fusing

Surges may cause malfunctions or damage to the product.

- ► Protect the voltage inputs from surges according to the requirements.
- ► Ensure that the device is handled in accordance with ESD regulations.

✓ The analog sensors have been connected.

✓ The expansion module has been connected to a control system.

1. Configure the voltage or current measuring range via module register 1y07 (y: number of the analog input).
2. Wait until bit 16 *collective bit Validity* in module register 0000 *module state* has been set.
3. Read the digitized values of the analog sensors from module registers 0002 ... 0005.

⇨ Following correct commissioning, LED R is lit green.

ⓘ Info

Further information

For more information, refer to the JetSym online help.

7 Identification

This chapter describes the identification of the JX3-AI4-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)

Register	Section in eds.ini	Name in eds.ini	Description
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-AI4-EIC software version is identified by a 4-part number.

1 . 2 . 3 . 4

Fig. 11: 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

7.2.1 Registers - Description

MR 0009 – Operating system version

MR 0009 stores the operating system version number of the module.

Use JetSym to transfer another operating system to the module.

Property	Description	
Type of access	Read	
Values	Released OS version	IP#1.0.0.0 ... IP#254.255.0.0
	Bootloader version	IP#255.1.0.0 ... IP#255.255.0.0
Value after reset	OS version	

Tab. 17: OS version

MR 0032 – FPGA version

MR 0032 stores the FPGA version number of the module. The FPGA version number cannot be changed by the user.

Property	Description
Type of access	Read
Values	IP#1.0.0.0 ... IP#255.255.0.0
Value after reset	FPGA version

Tab. 18: FPGA version

8 Programming

8.1 Abbreviations, Module Register Properties and Formats

Abbreviations

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

Abbreviation	Meaning
R 100	Register 100
MR 150	Module register 150

Tab. 19: 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	Default
Access	Read/write
Value after reset	0 or undefined (e.g. revision/version number)
Takes effect	Immediately
Write access	Always
Data type	Integer

Tab. 20: 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. 21: 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

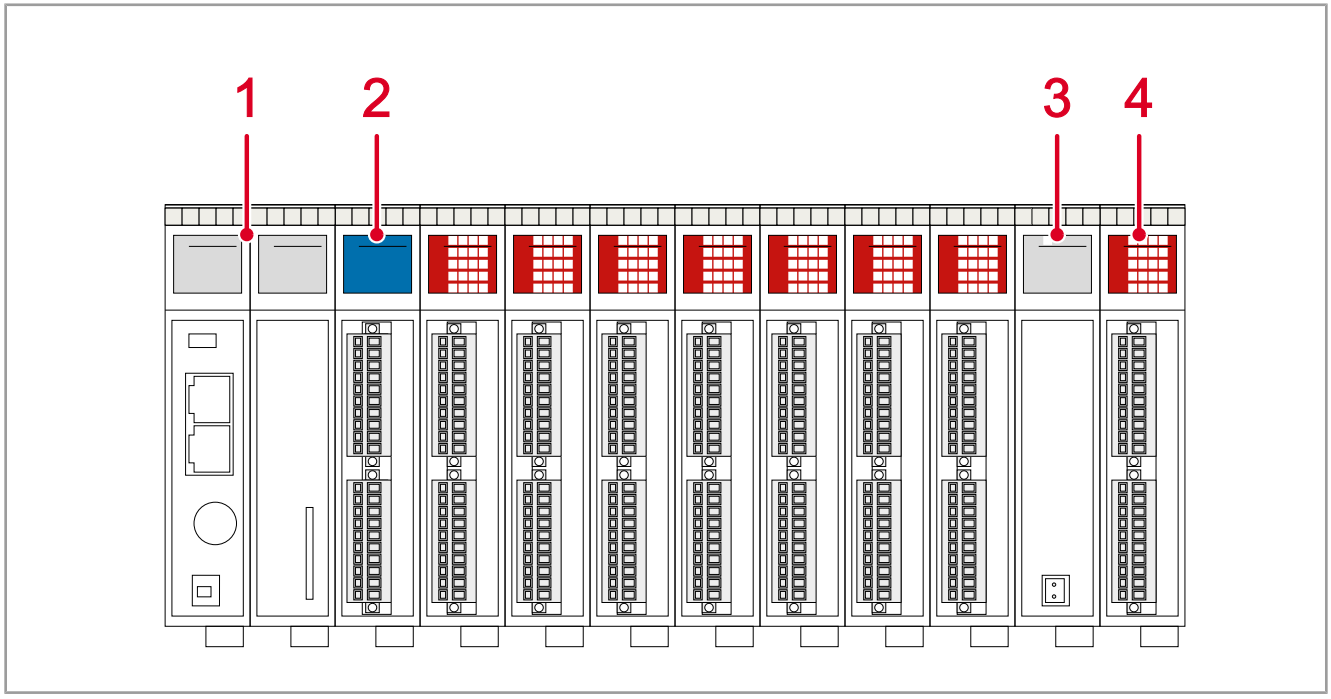


Fig. 12: Example: System overview of a controller together with various expansion modules

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.
The configurator is available for download. Go to www.bucherautomation.com and navigate to the *JX3Modules* product page > *Downloads*.

ⓘ Info

Further information

For in-depth information, see the *JX3 System* application-oriented manual.

For application-oriented manuals open www.bucherautomation.com and go to *product page JX3-AI4-EIC > Product-independent documentation*.

8.2.1 Numbering Registers and I/Os

Definition of module registers

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 gives access to a specific module register within the system.

Definition of registers

There are several ways to access registers directly and indirectly:

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

The register number within the system is unique.

ⓘ Info

Further information

For in-depth information, see the *JX3 System* application-oriented manual.

For application-oriented manuals open www.bucherautomation.com and go to *product page JX3-AI4-EIC > Product-independent documentation*.

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. 13: 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. 14: 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

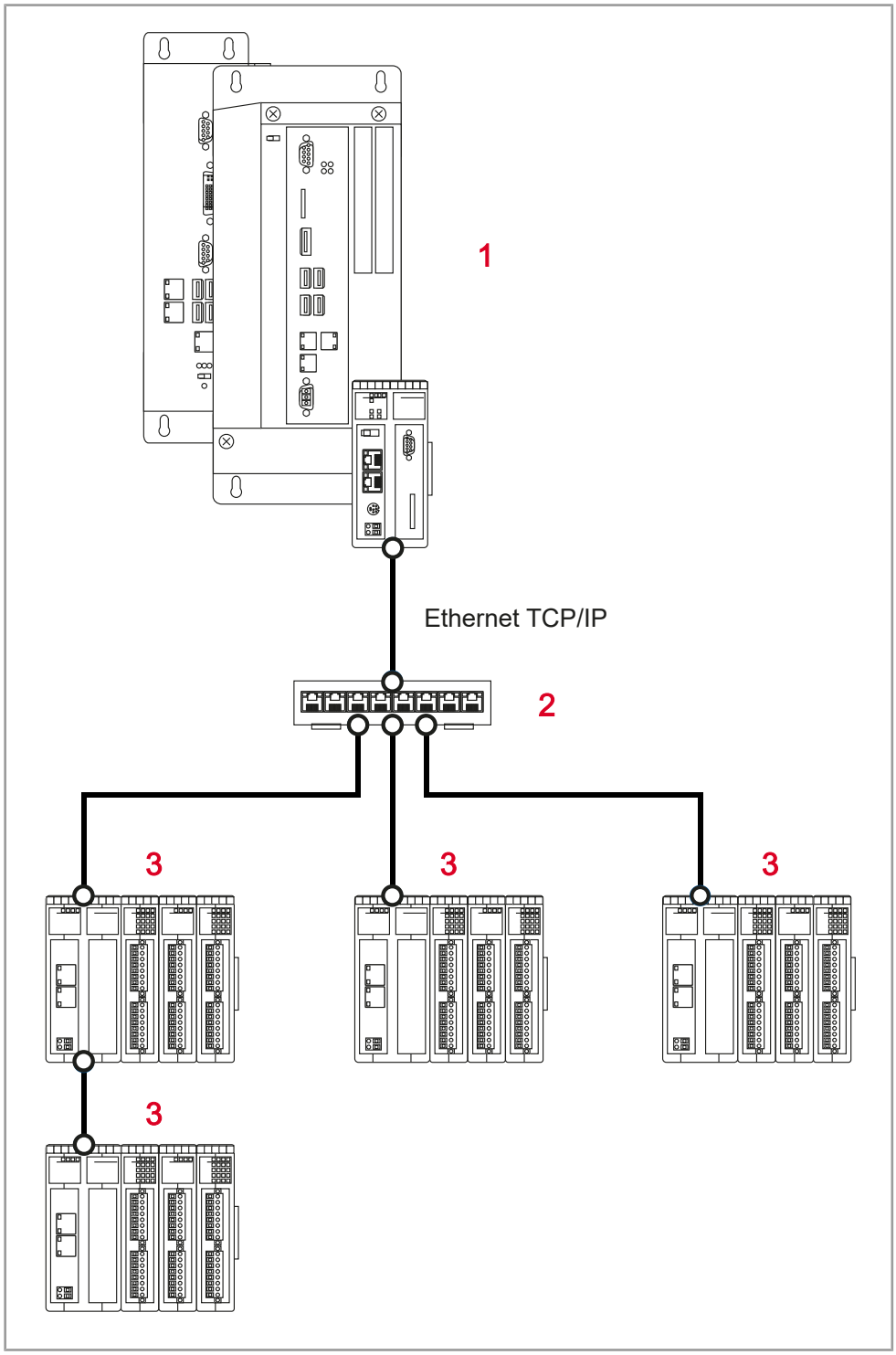


Fig. 15: System overview

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. 16: 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. 17: 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 in-depth information, see the *Ethernet System Bus* application-oriented manual.

For application-oriented manuals open www.bucherautomation.com and go to *product page JX3-AI4-EIC > Product-independent documentation*.

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

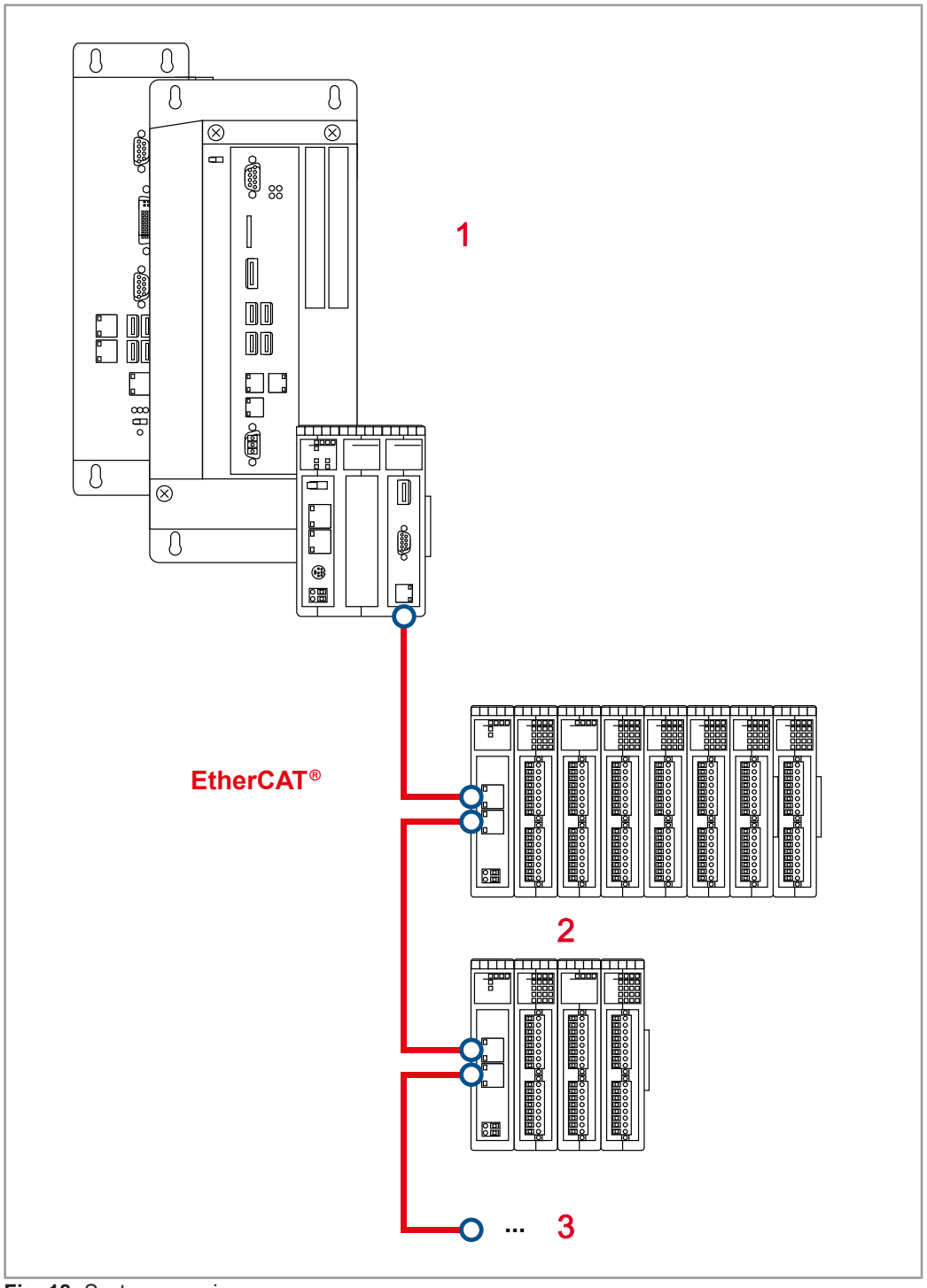


Fig. 18: System overview

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. 19: 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. 20: 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-AI4-EIC module.

The JX3-AI4-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 status

MR 0000 stores 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	0xC1010000 in no-error state	
Meaning of the bits		
Bit 0	**Hardware error**	
	0 =	No error
	1 =	Hardware error It may take an instant for bit 0 to be set after bit 4 and bit 7 have been set. The precise error cause can be retrieved from the bits 4 ... 7.
Bit 4	**Calibration value error**	
	0 =	No error reading reference values
	1 =	Hardware error when reading the stored reference values. The error cannot be fixed by the user. Please contact Support.
Bit 6	**AD converter error**	
	0 =	No error
	1 =	Hardware error when reading the analog input values of the AD converter. This may result from excessive voltage being present at the current inputs during current readings. The error can be acknowledged by means of command 5 *Acknowledging hardware errors*. If the error persists, the hardware is defective. Please contact Support.
Bit 7	**Internal voltage error**	
	0 =	No error
	1 =	At least one internal voltage reading is or was not within the permitted limits. The error bit is set by the JX3-AI4-EIC module.

Property	Description	
Bit 16	**Collective bit: Validity**	
	0 =	The analog input value in MR 0002 ... 0005 is invalid. The system is still busy computing the average value of at least one analog input. The *collective bit Validity* is reset as a result of the following: – Changing the configuration of the analog input – Changing the application-specific scaling – Changing the averaging procedure – Internal voltage error – AD converter error
	1 =	The analog values in MR 0002 ... 0005 are valid. The bit remains set until either the application-specific scaling, the configuration of the analog input or the averaging process have been completed. The bit is also reset whenever a hardware error occurs.
Bit 19	**Collective bit: Value below lower limit**	
	1 =	The value of at least one analog input has fallen below the configured lower limit. The JX3-AI4-EIC module sets this bit if the value falls below the limit. The module does not reset the bit. The bit must be reset by the user.
Bit 20	**Collective bit: Value above upper limit**	
	1 =	The configured upper limit of at least one analog input has been exceeded. The bit is set by the JX3-AI4-EIC module when the value exceeds the limit. The module does not reset the bit. The bit must be reset by the user.
Bit 21	**Collective bit: Measuring range exceeded in negative direction**	
	1 =	A negative voltage was applied to at least one voltage input conflicting with the chosen measuring range of 0 ... +10 V. The bit must be reset by the user.
Bit 22	**Collective bit: Measuring range exceeded in positive direction**	
	1 =	Running in current measuring mode, the voltage applied to at least one current input was greater than 3.3 V. To protect the input, the model shut the input off. The bit must be reset by the user.
Bit 23	**Collective bit: Forcing**	
	0 =	Forcing is not active
	1 =	Forcing is active for at least one analog input Forcing can be enabled and disabled by way of commands written to the command register of the analog input.

Property	Description	
Bit 24	**Monitoring internal voltages**	
	0 =	Monitoring is not active
	1 =	Monitoring is active Monitoring can be enabled and disabled by way of commands.
Bit 30	**Synchronous data exchange**	
	1 =	Data exchange between the JX3-AI4-EIC module and the bus head or controller is synchronous.
Bit 31	**Operating mode**	
	0 =	Collective conversion
	1 =	Single conversion The operating mode can be configured by way of commands.

Tab. 22: Module state

8.4 Module commands

Commands enable or disable module functions.

MR 0001 – Module command register

Use MR 0001 to configure functions provided by the module.

Property	Description
Type of access	Read/write
Value range	32 bits
Value after reset	0
Command	
1	**Enabling the single conversion operating mode**
	The single conversion operating mode is active.
2	**Enabling the collective conversion operating mode**
	The collective conversion operating mode is active.
3	**Disabling monitoring of internal voltages**
	Disables the monitoring function.
4	**Enabling monitoring of internal voltages**
	Enables the monitoring function.
5	**Acknowledging hardware failures**
	Resets all error bits written to module register *Module state*.
6	**Acknowledging collective bits**
	Resets all collective bits written to module register *Module state*.

Tab. 23: Analog input command register

8.5 Operating modes

The JX3-AI4-EIC module supports both the **single conversion** and **collective conversion** operating modes. After power-up, the single conversion operating mode is enabled. To switch operating modes, write command 1 *enable single conversion* or 2 *enable collective conversion* in the module register 0001 *command*.

See also. Module commands [▶ 40]

Single conversion

In the **single conversion** operating mode, 1 analog output is converted every 500 µs. Conversion time for all 4 analog inputs is 2 ms. The **single conversion** operating mode is suitable for analog voltage sensors with high output resistance of the sensor signal.

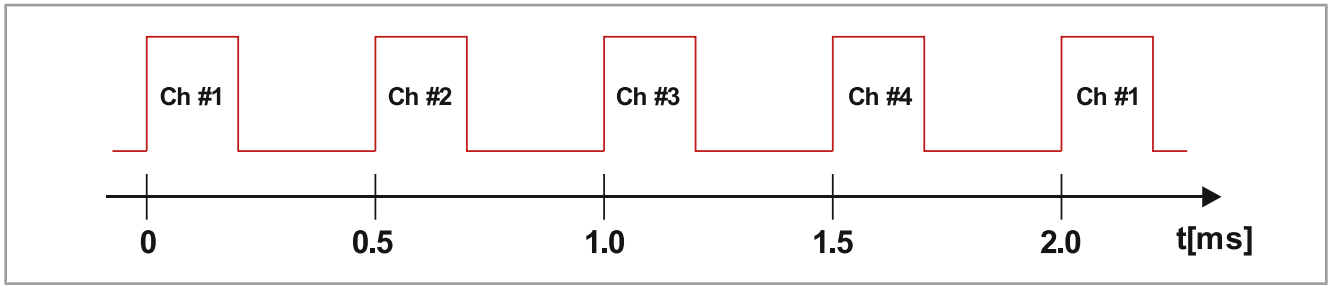


Fig. 21: Single conversion operating mode

Collective conversion

In the operating mode **Collective conversion** all four analog inputs are converted successively in intervals of 1 ms. Conversion time for all 4 analog inputs is 1 ms. The operating mode **Collective conversion** is apt for analog voltage sensors of a high output resistance of the sensor signal.

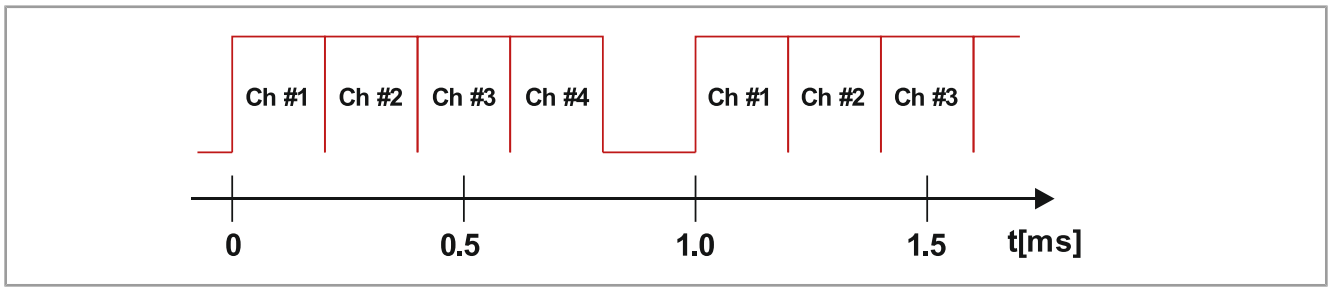


Fig. 22: Collective Conversion operating mode

8.6 Analog inputs 1 ... 4

8.6.1 Address ranges of analog 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 registers of analog input 1
MR 1**2**00 ... 1**2**99	y = 2	Module registers of analog input 2
MR 1**3**00 ... 1**3**99	y = 3	Module registers of analog input 3
MR 1**4**00 ... 1**4**99	y = 4	Module registers of analog input 4

Tab. 24: 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.

8.6.2 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

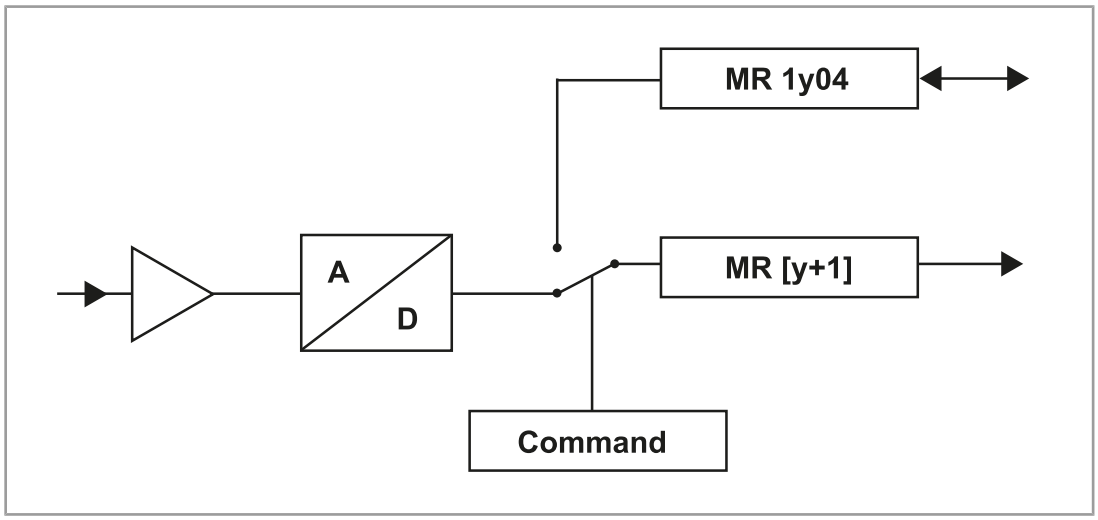


Fig. 23: The Functioning Principle of Forcing

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-AI4-EIC module. All additional features of the JX3-AI4-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.

8.6.3 Registers - Description

MR 1y00 – Analog input status register

MR 1y00 stores status messages of the analog input signaled by the module.

Property	Description	
Type of access	Read	
Value range	32 bits, bit-coded	
Value after reset	0x00010000	
Meaning of the bits		
Bit 16	**Validity of analog input value**	
	0 =	The analog input value in MR 0002 ... 0005 is invalid. The system is still busy computing the average value of the analog input.
	1 =	The analog input value in MR 0002 ... 0005 is valid. The bit remains set until either the application-specific scaling, the configuration of the analog input or the averaging process have been completed. The bit is also reset whenever a hardware error occurs.
Bit 19	**Value below lower limit**	
	1 =	The value of the analog input is below the customized lower limit. The JX3-AI4-EIC module sets this bit if the value falls below the limit. The module does not reset the bit. The bit must be reset by the user.
Bit 20	**Value above upper limit**	
	1 =	The value of the analog input is above the customized upper limit. The bit is set by the JX3-AI4-EIC module when the value exceeds the limit. The module does not reset the bit. The bit must be reset by the user.
Bit 21	**Measuring range exceeded in negative direction**	
	1 =	A negative voltage was applied to at least one voltage input conflicting with the chosen measuring range of 0 V ... +10 V. The bit must be reset by the user.

Property	Description	
Bit 22	**Measuring range exceeded in positive direction**	
	1 =	Running in current measuring mode, the voltage applied to the current input was greater than 3.3 V. To protect the input, the model shut the input off. The bit must be reset by the user.
Bit 23	**Forcing**	
	0 =	Forcing is not active
	1 =	Forcing is enabled for this analog input Forcing can be enabled and disabled by way of commands written to the command register of the analog input.

Tab. 25: Status register of analog input

MR 1y01 – Analog input command register

Use MR 1y01 to configure the functions provided by the module. Use commands to enable and disable the functions of the analog input.

Property	Description
Type of access	Read/write
Value range	32 bits
Value after reset	0
Command	
30	**Disabling the forcing function**
	The AD converter transfers the values present at the analog input y to the controller. Disabling the forcing function invalidates the data of the analog input. Bit 16 of the collective bit *Validity* in MR 0000 *Module status* is reset. Averaging starts over.
31	**Enabling the forcing function**
	Analog input y transfers the values stored in MR 1y04 *Force value* to the controller. Enabling the forcing function invalidates the data of the analog input. The *collective bit 16 Validity* in MR 0000 *Module status* is reset. Averaging starts over.

Tab. 26: Analog input command register

MR 1y04 – Force value

Use MR 1y04 to simulate a value for the analog input y.

Property	Description
Type of access	Read/write
Value range	-32,768 ... 32,767
Value after reset	0

Tab. 27: Force value

MR 1y07 – Configuration

Configure the analog input y in MR 1y07.

Property	Description	
Type of access	Read/write	
Value range	32 bits	
Values	1	Voltage measuring range -10 V ... +10 V
	5	Voltage measuring range 0 V ... +10 V
	6	Current measuring range 0 mA ... 20 mA
Value after reset	1	
Comment	– Each of the 4 analog inputs is configured separately. – Changing the measuring range invalidates the value reading being shown. With every change to the measuring range the module restarts computing the average value.	

Tab. 28: Configuration

8.7 Digitizing the analog values

The process of digitizing analog values always goes through the same sequence. Using additional functions, you can adjust the digital value of any analog output to meet application-specific demands. The following additional functions can be configured separately for each analog input:

– Application-specific scaling
– Averaging
– Monitoring of limit values
– Trailing indicator

Operating principle

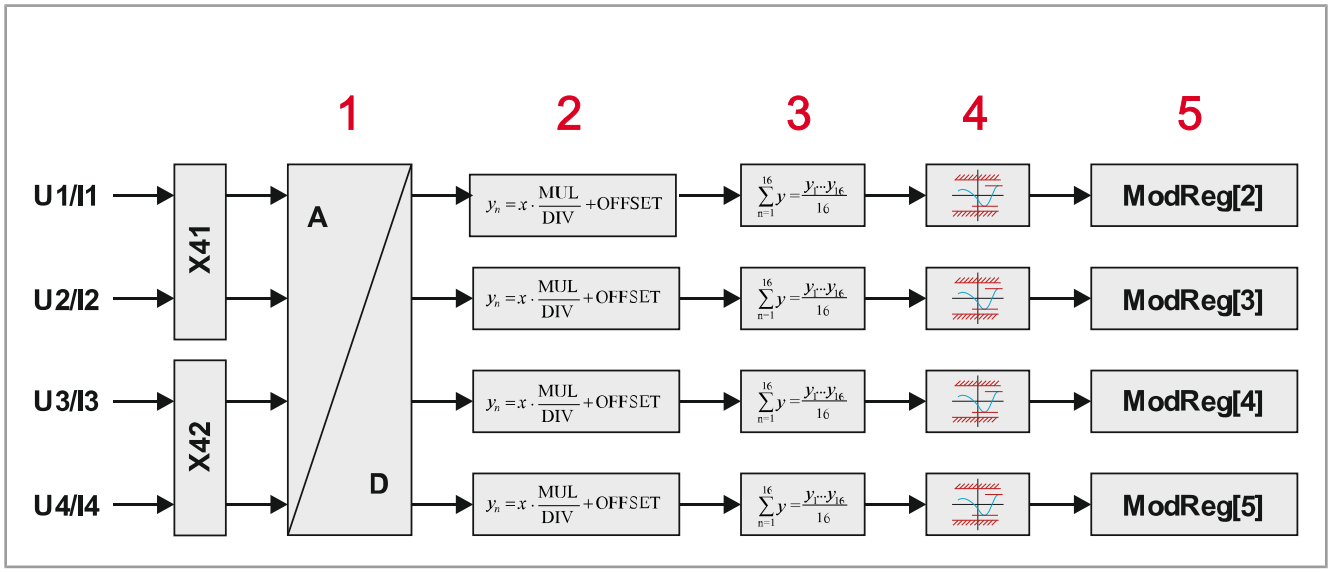


Fig. 24: Processing flow

Step	Description
1	A/D conversion
2	Application-specific scaling
3	Averaging
4	Monitoring of limits / trailing indicator
5	Digitized analog values (outcome)

8.7.1 A/D conversion

Using a 16 bit A/D converter, the JX3-AI4-EIC module converts all analog input values to digital values.

Converting voltage readings

The resolution for digitizing analog input voltages is 16 bits.

– The most significant bit of the digital value (bit 15) is the sign bit.
– If the analog input is configured to a voltage measuring range between 0 V ... +10 V, the smallest digital value is 0. For this configuration, the resolution is 15 bits.
– Digital values are stored in the MR 0002 ... 0005.

ⓘ Info

When using the application-specific scaling, the conversion results and measuring ranges of the digitized value will differ from those described here.

Conversion

The voltage present at the analog input is digitized using a linear equation according to the following formula:

$$MR[2...5] = U \cdot \frac{32767}{10V}$$

Illustration

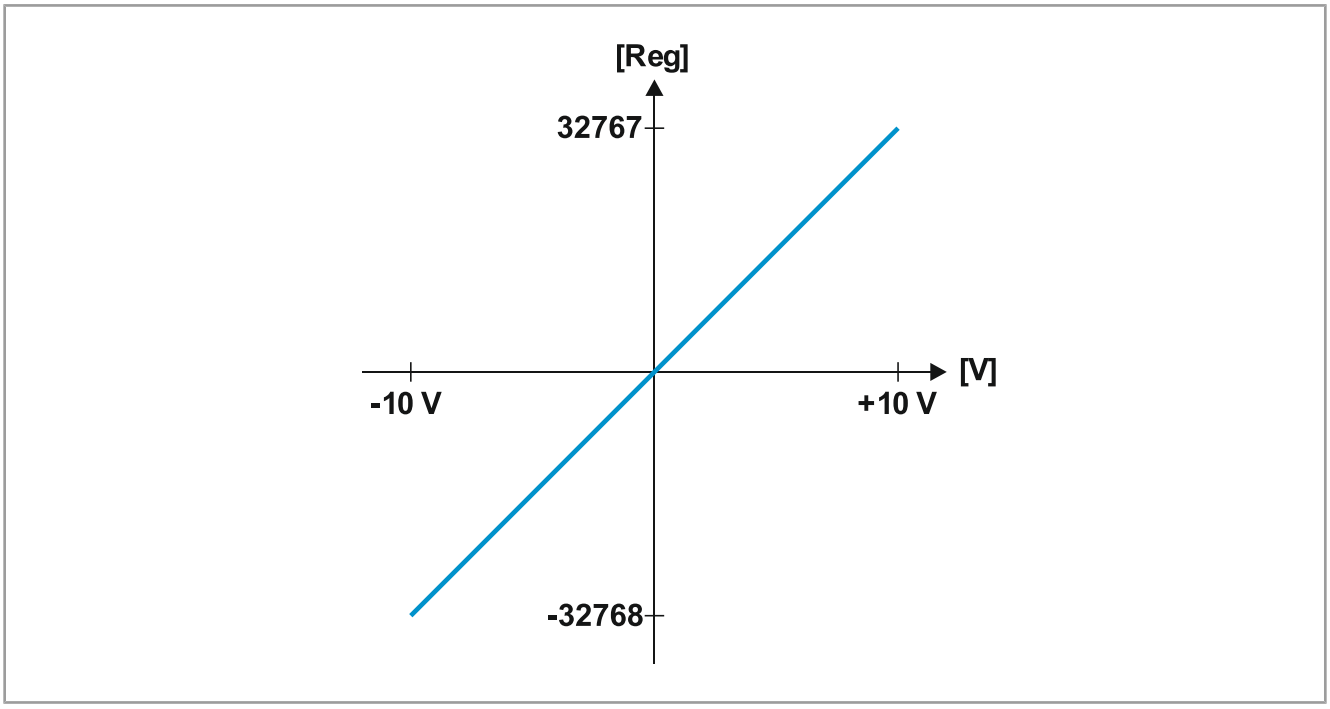


Fig. 25: Correlation between voltage and value in the module register

Configured measuring ranges

Measuring range	Voltage	Measured value in MR
-10 V ... +10 V	+10 V	32,767
	0 V	0
	-10 V	-32,768
0 V ... +10 V	< 0 V	0
	0 V	0
	+10 V	32,767

Tab. 29: Configured voltage measuring ranges

Converting current measurement values

The resolution for digitizing analog input currents is 15 bits.

– The most significant bit of the digital value (bit 15) is 0 at all times.
– Digital values are stored in the MR 0002 ... 0005.

ⓘ Info

When using the application-specific scaling, the conversion results and measuring ranges of the digitized value will differ from those described here.

Conversion

The current present at the analog input is digitized using a linear equation. according to the following formula:

$$MR[2...5] = I \cdot \frac{32767}{20mA}$$

Illustration

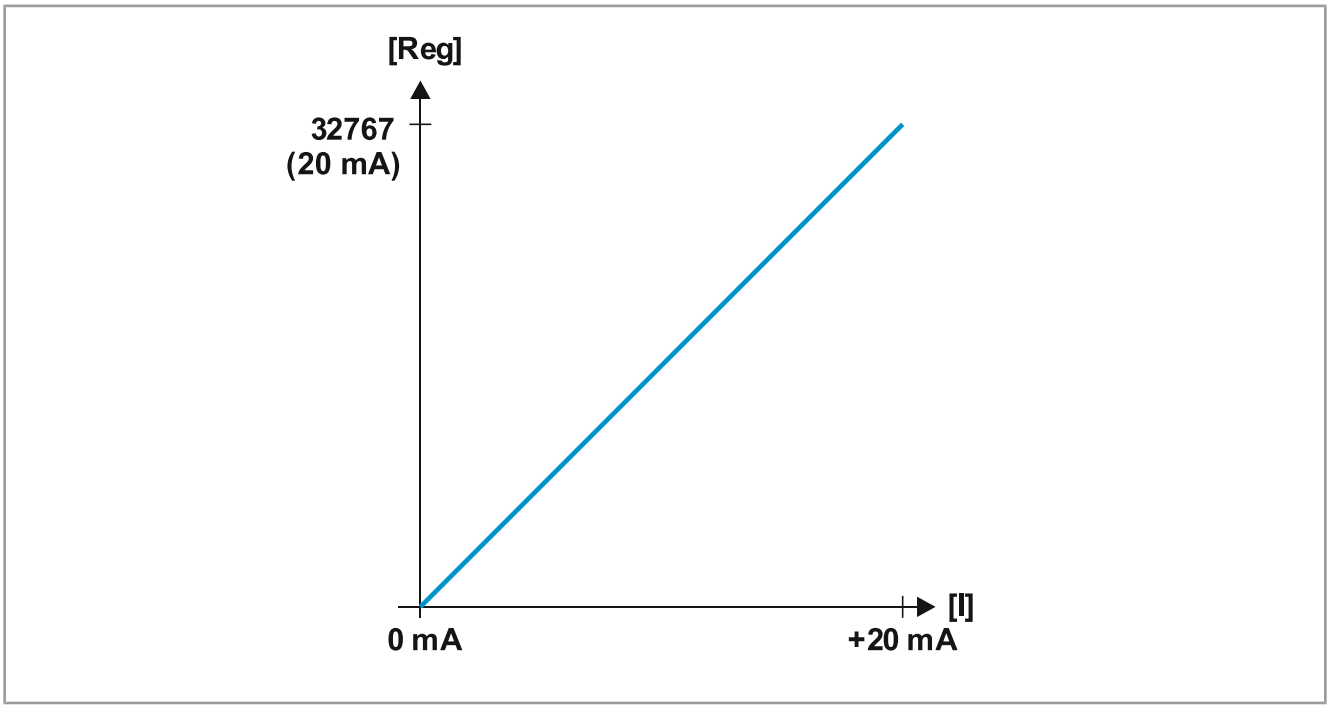


Fig. 26: Correlation between current and value in the module register

Configured measuring ranges

Measuring range	Current	Measured value in MR
0 mA ... 20 mA	0 mA	0
	20 mA	32767

Tab. 30: Configured current measuring ranges

8.7.2 Application-specific scaling

The application-specific scaling allows for digitized analog values to be converted directly on the module. It can be configured separately for each analog input. The application-specific scaling is computed as soon as the A/D converter has been read.

Changing the scaling of the measured valued invalidates the data of the analog input and resets collective bit 16 *Validity* in register 0000 *Module status*. Averaging starts over.

Calculation

The digitized analog value is calculated using the following formula:

$$y_n = x \cdot \frac{\mathrm{MUL}}{\mathrm{DIV}} + \mathrm{OFFSET}$$

Element	Description
x	Internal, sampled ADC value
MUL	Multiplier from MR 1y13 The internal intermediate result of the multiplication is a 32-bit value.
DIV	Divisor from MR 1y14
OFFSET	Offset from MR 1y15
y_n	Result of the calculation. This value will be transfered in MR 0002 ... 0005 to the controller.

The first operation in the scaling process is the multiplication. This produces a 32-bit value to be divided by the divisor. Finally, the OFFSET value is added.

Activation

After power-up, application-specific scaling is disabled. It is enabled by setting two vertex pairs. Each vertex pair consists of a voltage or electic current value and a digitized analog value. The module then calculates the offset, multiplier and divisor used for scaling the digital values. The calculation is triggered by writing the second digital value to MR 1y27.

Graphical representation

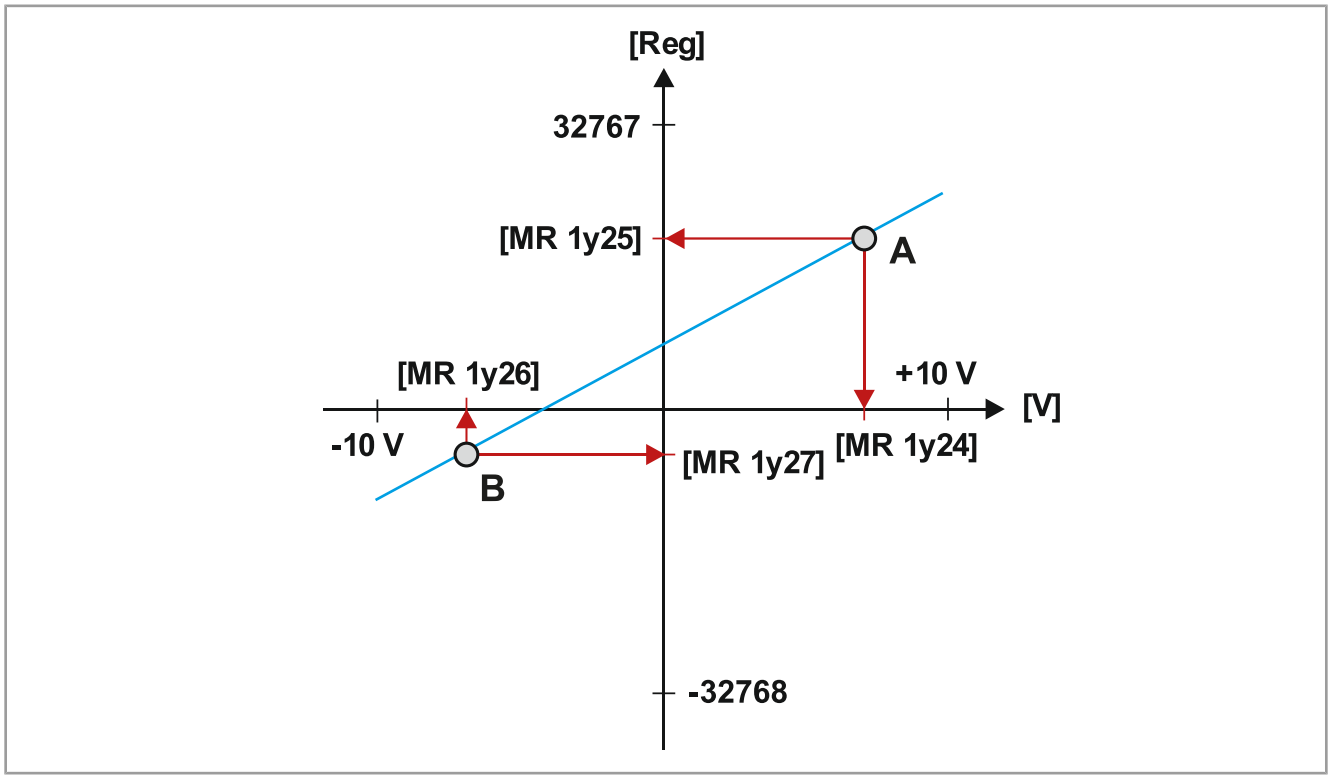


Fig. 27: Application-specific scaling by means of 2 vertex pairs

A	Intercept of first vertex pair
B	Intercept of second vertex pair

The transfer function between the physical analog value and the digitized analog value is a line. A line is determined by 2 points. Running the application-specific scaling, the module computes the linear transfer function such that the connection between both sets of vertex pairs is a line.

Scaling a pressure value

Sample layout

The configured measuring range of analog input 2 of the JX3-AI4-EIC module is -10 V ... +10 V. A pressure sensor for a measuring range of 10 bar ... 200 bar has been connected to the analog input. The pressure sensor outputs a voltage of +10 V. The pressure value is to be displayed by the controller in increments of 10 mbar.

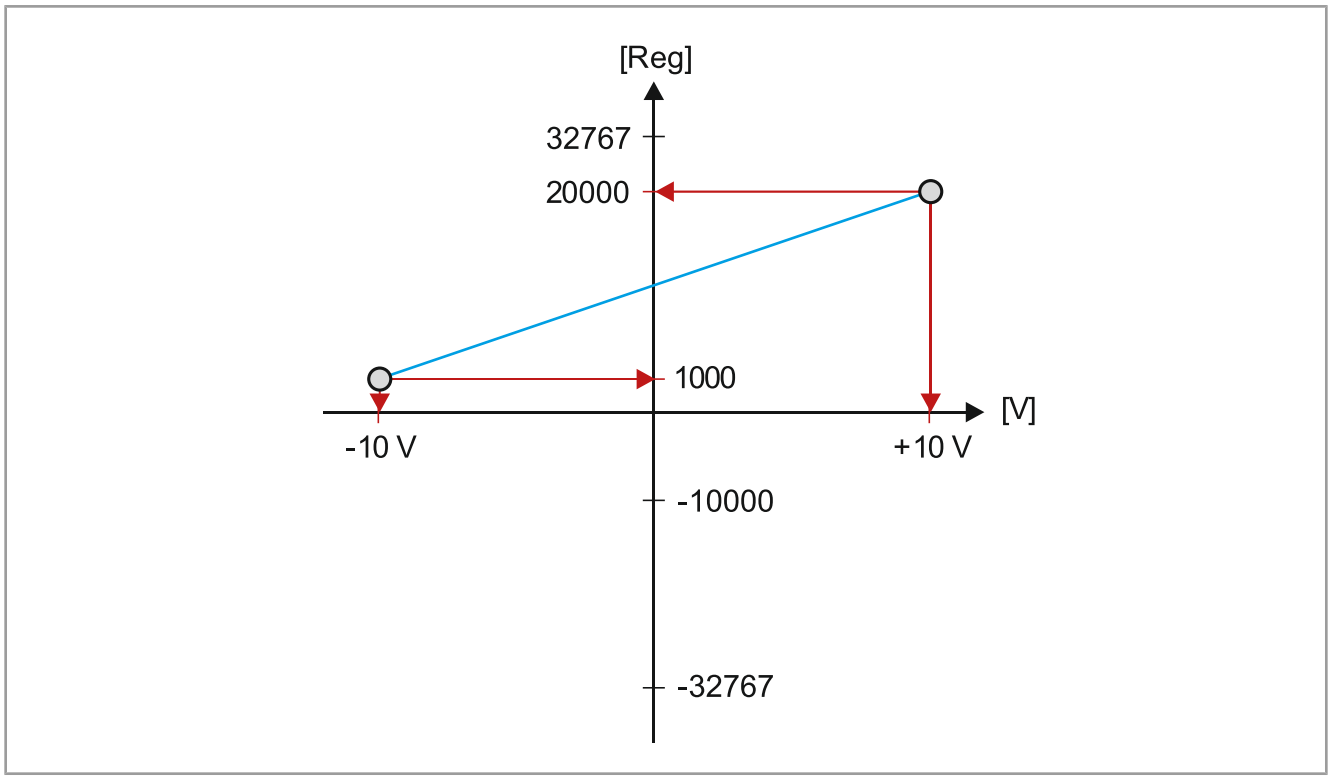


Fig. 28: Scaling a pressure value

Vertex pairs

The conversion function of the measured values is defined by 2 vertex pairs. A voltage of -10 V corresponds to 10 bar. A voltage of +10 V corresponds to 200 bar. Configuration requires that the voltage be specified in millivolts and the pressure in 10 mbar.

For application-specific scaling, set the following vertex pairs:

Voltage value	Digital value
MR 1y24 := -10,000 [mV]	MR 1y25 := 1,000 [10 mbar]
MR 1y26 := 10,000 [mV]	MR 1y27 := 20,000 [10 mbar]

ⓘ Info For current example programs, please refer to the online help of JetSym.

Scaling the measured value to a range of 4 through 20 mA

The configured measuring range of analog input 3 of the JX3-AI4-EIC module is 0 mA ... 20 mA. In digital mode, a current of 4 mA is to equal 0; a current of 20 mA is to equal 32767.

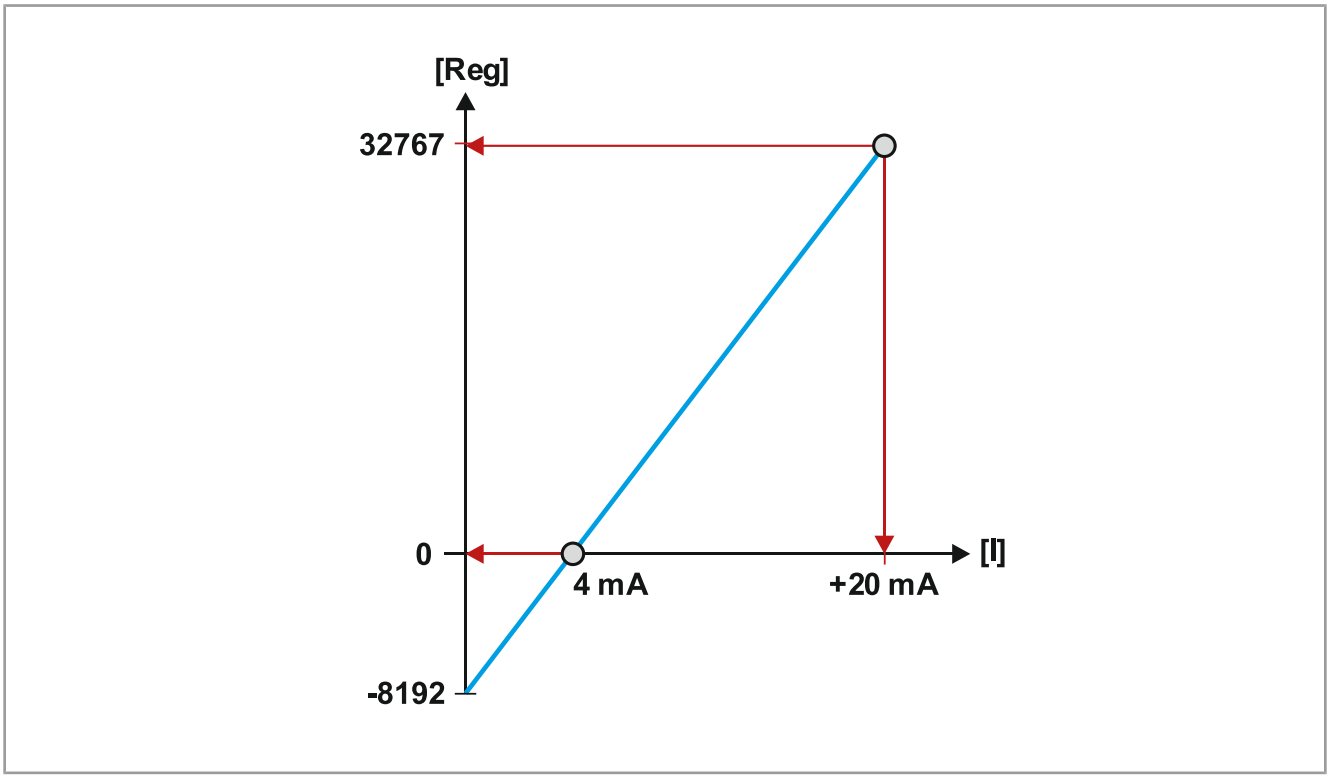


Fig. 29: Scaling the electric current to 4 mA ... 20 mA

Vertex pairs

The conversion function of the measured values is defined by 2 vertex pairs. A current of 4 mA equals 0. A current of 20 mA equals 32767. Configuration requires that the current be specified in 1 mA/1,000.

For application-specific scaling, set the following vertex pairs:

Electric current value	Digital value
MR 1y24 := 4,000 [1 mA/1,000]	MR 1y25 := 0
MR 1y26 := 20,000 [1 mA/1,000]	MR 1y27 := 32,767

ⓘ Info For current example programs, please refer to the online help of JetSym.

Registers - Description

MR 1y24 – 1st voltage/current value for analog input y

The voltage/current value of the first vertex pair is entered into MR 1y24. Values are given in mV or 1/1,000 mA.

Property	Description	
Type of access	Read/write	
Value range	Configured as voltage input	-10,000 ... +10,000
	Configured as current input	-20,000 ... +20,000
Value after reset	-10,000	

Tab. 31: 1st voltage/current value for the analog input y

MR 1y25 – 1st digital value for analog input y

The digital value of the first vertex pair is entered into MR 1y25. Values are given in digitized values.

Property	Description
Type of access	Read/write
Value range	-32,768 ... +32,767
Value after reset	-32,768

Tab. 32: 1st digital value for the analog input y

MR 1y26 – 2nd voltage/current value for analog input y

The voltage/current value of the second vertex pair is entered into MR 1y26. Values are given in mV or 1/1,000 mA.

Property	Description	
Type of access	Read/write	
Value range	Configured as voltage input	-10,000 ... +10,000
	Configured as current input	-20,000 ... +20,000
Value after reset	-10,000	

Tab. 33: 2nd voltage/current value for the analog input y

MR 1y27 – 2st digital value for analog input y

The digital value of the second vertex pair is entered into MR 1y27. Values are given in digitized values.

Property	Description
Type of access	Read/write
Value range	-32,768 ... +32,767
Value after reset	-32,768
Comment	Writing to this module register triggers the computation of the multiplier, divisor and offset. The following bits are reset: bit *Analog input validity* in register 1y00 *Analog input status* and the *collective bit Validity* in Register 0000 *Module status*.

Tab. 34: 2nd digital value for the analog input y

8.7.3 Averaging

The JX3-AI4-EIC module determines the moving average for each analog input individually. With each incoming digitized reading the average of the last 16 or 4 measurements is determined. Averaging is carried out after the application-specific scaling has been calculated.

Mode of operation

Averaging results in a higher accuracy of the analog input signal. Short input signal peaks result only in slight changes in the value contained in module registers 0002 ... 0005. The averaging function works like a filter.

Averaging can be configured separately for each analog input. When the configuration is changed, the data of the analog input become invalid. Bit 16 *collective bit Validity* in register 0 *module state* is reset. Averaging starts anew.

Calculation

The average is calculated using the following formula:

$$\sum_{n=1}^{16} y = \frac{y_1 \cdots y_{16}}{16}$$

Registers - Description

MR 1y06 – Averaging

Configure the averaging parameters in MR 1y06.

Property	Description	
Type of access	Read/write	
Value range	1	No averaging
	4	4-fold averaging
	16	16-fold averaging
Value after reset	16	

Tab. 35: Averaging

8.7.4 Monitoring of limit values

With each conversion procedure, the JX3-AI4-EIC module checks the converted value against the specified upper and lower limits. The user defines the relevant upper and lower limits for each analog input individually. The converted values are checked against the thresholds after the application-specific scaling has been calculated.

Illustration

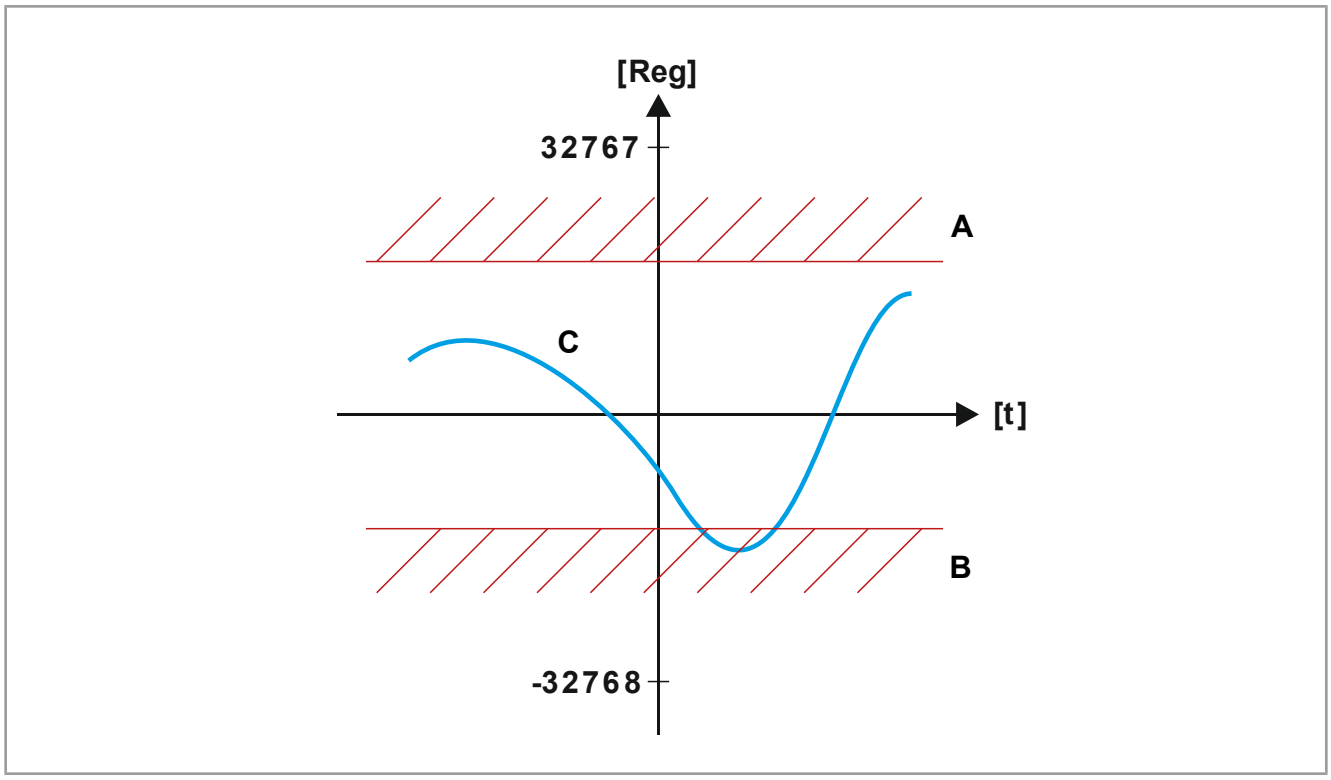


Fig. 30: Monitoring of limit values

A	Upper limit
B	Lower limit
C	Characteristic of the application-specific scaling

Operating principle

The JX3-AI4-EIC module verifies compliance with the limit values as follows:

Step	Description	
1	The module receives a new value in MR 0002 and 0003 *Digital value of the analog input y*.	
2	The module performs the application-specific scaling.	
3	The module compares the result of the application-specific scaling with the limit values stored in MR 1y08 and MR 1y09.	
	If the result is ...	**... then ...**
	< MR 1y08,	Bit 19 = 1 in MR 0000 and bit 19 = 1 MR 1y00 are set.
	> MR 1y09,	Bit 20 = 1 in MR 0000 and bit 20 = 1 MR 1y00 are set.

Configuration

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

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

⇨ The JX3-AI4-EIC module continually checks the digital values of the analog module against the set limits.

Acknowledging Values Exceeding the Limits

To acknowledge values exceeding the limits, proceed as follows:

1. Delete bit 19 or bit 20 in MR 1y00 *Counter state.*
2. Delete bit 19 or bit 20 in MR 0000 *Module state*.

Registers - Description

MR 1y08 – Lower limit

Define the lower limit value in MR 1y08. With each conversion procedure, the JX3-AI4-EIC module checks the converted value against the specified lower limit.

Property	Description
Type of access	Read/write
Value range	-32,768 ... 32,767
Value after reset	-32,768

Tab. 36: Lower limit

MR 1y09 – Upper limit

Define the upper limit value in MR 1y08. With each conversion procedure, the JX3-AI4-EIC module checks the converted value against the specified upper limit.

Property	Description
Type of access	Read/write
Value range	-32,768 ... 32,767
Value after reset	32,767

Tab. 37: Upper limit

8.7.5 Trailing indicator

With each conversion procedure, the JX3-AI4-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 are checked against the thresholds after the application-specific scaling has been calculated.

Initialization

After power-up, the JX3-AI4-EIC module automatically initializes the trailing indicators for minimum and maximum value.

Illustration

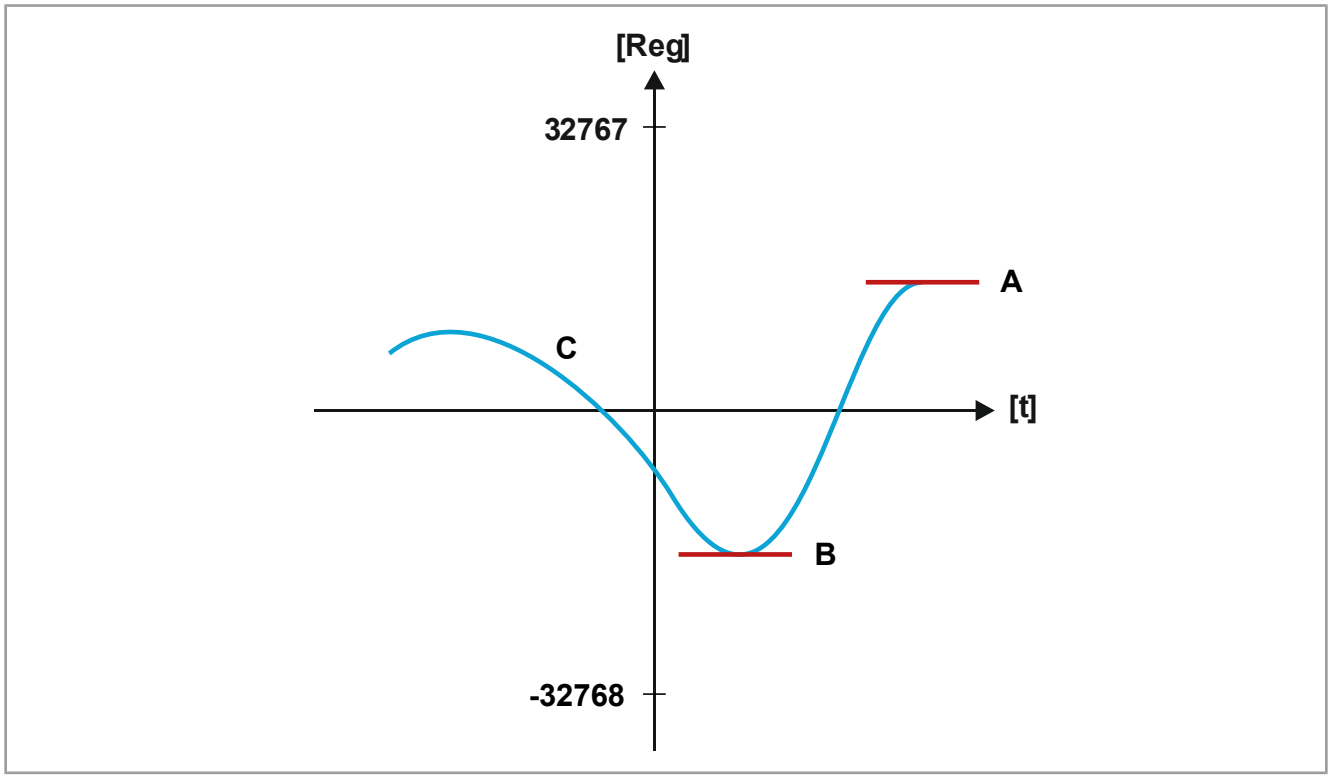


Fig. 31: Trailing indicator

A	Trailing indicator for maximum value
B	Trailing indicator for minimum value
C	Characteristic of the application-specific scaling

Operating principle

The JX3-AI4-EIC module checks the trailing indicators as follows:

Step	Description	
1	The module receives a new value in MR 0002 and 0003 *Digital value of the analog input y*.	
2	The module performs the application-specific scaling.	
3	**If the result is ...**	**... then ...**
	< MR 1y20,	MR 1y20 = outcome
	> MR 1y21,	MR 1y21 = outcome

Registers - Description

MR 1y20 – Trailing indicator for minimum value

MR 1y20 stores the lowest value converted as yet.

Property	Description
Type of access	Read/write
Value range	-32,768 ... 32,767
Value after reset	-32,768

Tab. 38: Trailing indicator for minimum value

MR 1y21 – Trailing indicator for maximum value

MR 1y21 stores the highest value converted as yet.

Property	Description
Type of access	Read/write
Value range	-32,768 ... 32,767
Value after reset	-32,768

Tab. 39: Trailing indicator for minimum value

8.7.6 Digitized analog values

After application-specific scaling, averaging and limit monitoring were applied, you can read the digitized values of the analog inputs from MR 0002 ... 0005.

Registers - Description

MR 0002 … 0005 – Digitized value for analog input y

The digitized values of each analog input can be read from the MR 0002 ... 0005.

Property	Description	
Register assignment	MR 0002	Analog input 1
	MR 0003	Analog input 2
	MR 0004	Analog input 3
	MR 0005	Analog input 4
Type of access	Read	
Value range	-32,768 ... 32,767	
Value after reset	Value present at the analog input	
Comment	If the analog input is configured to measure voltages between 0 ... +10 V or currents between 0 ...20 mA, only positive values factor into the calculation of the application-specific scaling.	

Tab. 40: Digitized value from analog input y

8.8 Oscilloscope function

The JX3-AI4-EIC module features an integrated oscilloscope function. Using this function, the module can record certain values over a given time. The function can be launched via JetSym or via the application program.

Operating principle

The values are recorded on the module in 1 millisecond intervals without putting additional load on the controller. Then, the stored values can be uploaded to JetSym to be displayed as graphs.

ⓘ Info

Loss of recorded data

The recorded data are lost when the module is switched off.

Data summary

Category	Description		
Recordable module registers	0002	Analog input 1	
	0003	Analog input 2	
	0004	Analog input 3	
	0005	Analog input 4	
Time base	1 ms ... 65,535 ms		
Number of readings	4 values simultaneously		300 each
	3 values simultaneously		400 each
	2 values simultaneously		600 each
	1 value		1200

Tab. 41: Data summary of the oscilloscope function

ⓘ Info

Further information

For more information, refer to the JetSym online help.

8.8.1 Registers - Description

MR 9740 – Oscilloscope command register

Use MR 9740 to configure the oscilloscope functions.

Property	Description	
Type of access	Read/write	
Value range	0 … 3	
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.	

Tab. 42: Command register Oscilloscope function

MR 9741 – Parameter index

MR 9741 stores the parameter index. The parameter index is used for selecting the parameters of the oscilloscope function. The parameter value can then be read directly from MR 9742, or written to MR 9742.

Property	Description
Type of access	Read/write
Value range	0 … 23

Tab. 43: Parameter index

MR 9742 – Parameters

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

Property	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

Property	Description	
2	**Max. number of channels**	
	Having reset the module, this parameter shows the maximum number of recordable channels. The parameter can be modified to reduce the number of channels. However, this correlates with an increase in the number of readings per channel.	
	Value range	1, 2, 3, 4
3	**Maximum number of readings per channel**	
	Once a recording session is running, the module stores the readings for the configured channels. When the maximum number is reached, the recording stops. The maximum number of readings depends on the number of channels configured previously.	
	Type of access	Read only
4	**Minimum sampling interval**	
	This parameter returns the minimum sampling interval in milliseconds.	
	Type of access	Read only
10	**Sampling interval**	
	The sampling interval defines the time period between recordings. The interval between 2 recordings (in milliseconds) is the minimum sampling interval multiplied with the sampling interval.	
	Value range	1 ... 65,535
11	**Number of the module register for oscilloscope channel 1**	
	Value range	2, 3, 4, 5
12	**Number of the module register for oscilloscope channel 2**	
	Value range	2, 3, 4, 5
13	**Number of the module register for oscilloscope channel 3**	
	Value range	2, 3, 4, 5
14	**Number of the module register for oscilloscope channel 4**	
	Value range	2, 3, 4, 5
20	**Number of the module register for oscilloscope trigger 1**	
	Value range	2, 3, 4, 5
21	**Value for trigger 1**	
	Value range	-32,768 ... +32,767
22	**Number of the module register for oscilloscope trigger 2**	
	Value range	2, 3, 4, 5
23	**Value for trigger 2**	
	Value range	-32,768 ... +32,767

Tab. 44: Parameter

MR 9743 – Index of recorded values

The recorded values are selected via the index.

MR 9744 – Recorded values

The recorded values are read via the module register.

9 Register overview

This register overview gives a condensed summary of the registers of the JX3-AI4-EIC device as applies to the operating system version 2.00.0.00.

Module code

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

– Module code JX3-AI4-EIC: 340

General overview - Registers

Register range	Description
0000	Status register of the module
0001	Module-Specific Command Registers
0002 ... 0005	Analog channels 1 ... 4
0009, 0032, 0257	Version registers
1100 ... 1199	Configuration of analog channel # 1
1200 ... 1299	Configuration of analog channel # 2
1300 ... 1399	Configuration of analog channel # 3
1400 ... 1499	Configuration of analog channel # 4
9740 ... 9744	Oscilloscope

Module state

Registers	Description
0000	**Status register of the module**
Bit 0 = 1	Hardware error
Bit 4 = 1	Error: Calibration values
Bit 6 = 1	AD converter error
Bit 7 = 1	Error: Internal voltages
Bit 16 = 1	Collective bit: Validity of analog input values
Bit 19 = 1	Collective bit: Lower limit exceeded
Bit 20 = 1	Collective bit: Upper limit exceeded
Bit 21 = 1	Collective bit: Measuring range exceeded in negative direction
Bit 22 = 1	Collective bit: Measuring range exceeded in positive direction
Bit 23 = 1	Collective bit: Forcing
Bit 24 = 1	Monitoring – voltages
Bit 30 = 1	Synchronous data exchange
Bit 31 = 0	Collective conversion operating mode
Bit 31 = 1	Single conversion operating mode

Module commands

Registers	Description
0001	**Module-specific command registers**
1	Enable Single Conversion operating mode
2	Enable Collective Conversion operating mode
3	Internal voltages monitoring OFF
4	Internal voltages monitoring ON
5	Acknowledgment of hardware error
6	Acknowledgment of collective bits

Analog inputs

Registers	Description
0002	Analog input 1
0003	Analog input 2
0004	Analog input 3
0005	Analog input 4

State of analog inputs

Registers	Description
1y00	**Status register of analog input y (y = 1 ... 4)**
Bit 16 = 1	Analog input value is valid
Bit 19 = 1	Lower limit was exceed
Bit 20 = 1	Upper limit was exceeded
Bit 21 = 1	Measuring range exceeded in negative direction
Bit 22 = 1	Measuring range exceeded in positive direction
Bit 23 = 1	Forcing function enabled

Command register of analog input

Registers	Description
1y01	**Command register of analog input y (y = 1 ... 4)**
30	Analog input forcing OFF
31	Analog input forcing ON

Configuration of analog input y

Registers	Description
1y07	**Configuration of analog input y (y = 1 ... 4)**
1	-10 V ... +10 V
5	0 V ... +10 V
6	0 mA ... 20 mA

Application-specific scaling

Registers	Description
1y24	1. Voltage/current value for analog input y
1y25	1. Digital value for analog input y
1y26	2. Voltage/current value for analog input y
1y27	2. Digital value for analog input y

Other configurations

Registers	Description
1y04	Force value for analog input y
1y06	Averaging
1y08	Lower limit of analog input y
1y09	Upper limit of analog input y
1y20	Trailing indicator for minimum value of analog input y
1y21	Trailing indicator for maximum value of analog input y

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 product is maintenance-free. The operation of the product does not required inspection or maintenance efforts.

10.1 Repairs

Defective components can cause dangerous malfunctions and compromise safety.
Only the manufacturer is authorized to perform repair work.
It is forbidden to open the product.

Product modifications

Modifications and alterations to the product and its functions are not allowed. The manufacturer exempts from liability for any modifications made to the product.

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

The manufacturer exempts from liability for any damage resulting from the use of non-original parts and equipment is excluded.

10.2 Storage and Shipment

Storage

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

Shipment and packaging

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

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

10.3 Return and Disposal

The WEEE icon (crossed-out wheeled bin) says that end users must not dispose of waste electrical and electronic equipment together with household waste, but separately in an appropriate way. Applicable local environmental directives and regulations must be complied with.



Fig. 32: WEEE icon – crossed out wheeled bin

Disposal options

To do so, you may either resort to professional disposal service providers or return waste electronics to Bucher Automation AG.

Find detailed information along with the required Return Delivery Form on our website.

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 end user to delete any personal data stored on waste electric and electronic equipment prior to disposal.

Packaging material

The product's packaging materials must not be disposed of together with household waste. Find detailed information on how to return packaging material to Bucher Automation AG on our website.

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 | www.bucherautomation.com

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. 45: 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

Tab. 46: Accessories

Bucher Automation AG
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info@bucherautomation.com

www.bucherautomation.com