

1 Functional description

The analog output module XI482204 generates output signals in the adjustable ranges from 0 V to +10 V, -10 V to +10 V, 0 to 20 mA and 4 to 20 mA in a ctrlX I/O station. The value range can be set on a channel-granular basis. The output signal is output galvanically isolated from the system level with a resolution of 16 bits. The four output channels have a common mass potential. The output stages are fed via the 24 V supply from U_P .

The logic and peripheral voltage supply as well as the EtherCAT-based module communication are routed through the module.



For an application manual of the ctrlX I/O modules, refer to the Download Center www.boschrexroth.com/mediadirectory and enter the search term "R911423458".

Ensure that the current documentation is consulted. For the current documentations, go to www.boschrexroth.com/mediadirectory and enter the module type as search term.

For the integration into the parent system, the respective ESI files are available. For the ESI files, go to <http://www.boschrexroth.com/electrics>, search term "ESI-Files".

For the currently valid declarations of conformity and certificates, go to: "DCTC-30455"

2 Ordering data

Type	Part number	Description
XI482204	R911430123	4-channel analog output module (adjustable value range, 0 V to +10 V, -10 V to +10 V, 0 to 20 mA, 4 to 20 mA, 16 bit, diff. outputs)

For more ordering data (accessories), go to the product catalog under www.boschrexroth.com/electrics.

3 Technical data

3.1 General technical data

Number of outputs	4
Connection method	Push-in terminal
Connection technique	2-wire bipolar, shielded, twisted in pairs
Output signal	0 V to +10 V, -10 V to +10 V, 0 to 20 mA, 4 to 20 mA can be set channel-granularly
Output load Voltage mode	$\geq 5 \text{ k}\Omega$
Output load Current mode	$\leq 500 \Omega$
Resolution D/A	16 bits
Accuracy	Typ. $\pm 0.1 \%$ of the end value of the measured range (MBE) Max. $\pm 0.25\%$ of MBE (depending on load, aging and temperature drift)
Process data update	250 μs
Overload protection	Yes
Voltage supply	U_P via jumper contacts
Nominal voltage (U_L / U_P)	24 V DC (19.2 V to 30 V, including tolerance and residual ripple) PELV/SELV (safety extra-low voltage)
Current consumption U_L	40 mA max.
Current consumption U_P	80 mA max.
Max. power consumption of the module	2.1 W
Bit width, output data in the process data image	12 bytes (can be set channel-granularly)
Bit width, input data in the process data image (including fill bits)	10 bytes (can be set channel-granularly)
Parameterization	Via ctrlX Works (startup parameter)
Configuration	No address or configuration setting required
Dimensions	12 mm \times 105 mm \times 99 mm (width \times height \times depth)
Weight	100 g (module including connector)
Electrical isolation	1200 V DC U_P to U_L , 707 V DC U_P/U_L to FE, tested for 60 s each (not evaluated by UL)
EMC resistance	Acc. to EN 61000-6-2 and EN 61000-6-4
Mounting position	Vertical, on a horizontal mounting rail
Labeling, approvals	CE, UKCA, UL

3.2 Internal schematic diagram

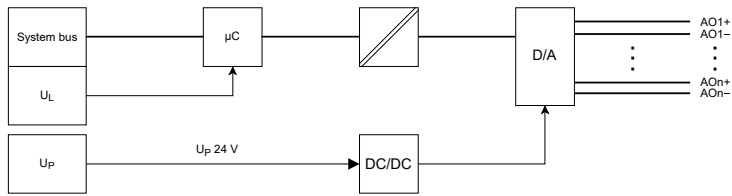


Fig. 1: Internal schematic diagram

3.3 Ambient conditions

Ambient temperature	
≤ 2,000 m	-25 to +55 °C
2,000 m to 3,000 m	-25 to +50 °C
3,000 m to 4,000 m	-25 to +45 °C
4,000 m to 5,000 m	-25 to +40 °C
Maximum operating altitude Acc. to DIN 60204	5,000 m
Ambient temperature (storage and transport)	-40 to +70 °C
Permitted air humidity according to DIN EN 61131-2 (Operation, storage, transport)	10 to 95 %
Degree of protection Acc. to DIN EN 60 529	IP20 (not evaluated by UL)
Protection class Acc. to DIN EN 61010-2-201	III
Overvoltage category Acc. to IEC 60664-1	2
Contamination level Acc. to EN 61010-1	2, no condensation

NOTICE

Defective device due to contaminated air!

- The ambient air must not contain acids, alkaline solutions, corrosive agents, salts, metal vapors and other electrically conductive contaminants in high concentrations.
- The devices to be installed into the housings and installation compartments must at least comply with the degree of protection IP 54 according to DIN EN 60529.
- The device shall be provided in a suitable fire enclosure in the end-use application.

NOTICE

Defective device due to gases jeopardizing functions

Due to the risk of corrosion, avoid sulphureous gases (e.g. sulphur dioxide (SO₂) and hydrogen sulphide (H₂S)). The device is not resistant against these gases.

NOTICE

Defective device due to overheating

To avoid overheating and to ensure a trouble-free operation of the device, the ambient air has to circulate. Also refer to the chapter "Installation notes" in the application manual.

3.4 Mechanical tests

Vibration resistance Acc. to DIN EN 60068-2-6	Oscillations, sinusoidal in all three axes, 5 Hz - 8,4 Hz with 3.5 mm amplitude 8.4 Hz -150 Hz with 1 g peak acceleration
Shock test Acc. to DIN EN 60068-2-27	Shock stress: Shock resistance in all three axes 11 ms semi-sinusoidal 15 g
Broadband noise Acc. to DIN EN 60068-2-64	20-500 Hz with 1.22 g RMS (Root Mean Square), 30 min in all three axes

For the current approvals, go to www.boschrexroth.com/electrics.

4 For your safety

4.1 Intended use

Use the module only as specified in the data sheet.

4.2 User qualification

The product use described in this data sheet is only intended for qualified electricians and staff trained by these qualified electricians. The user has to be familiar with the known safety concepts on automation technology, applicable standards and other guidelines.

4.3 Electrical safety

NOTICE

Loss of electric safety

Unintended handling can affect the device safety! Observe the notes in the present data sheet during installation, commissioning and operation.

5 Signal processing

5.1 General information on signal processing

The signal processing of the module consists of several steps shown in this section.

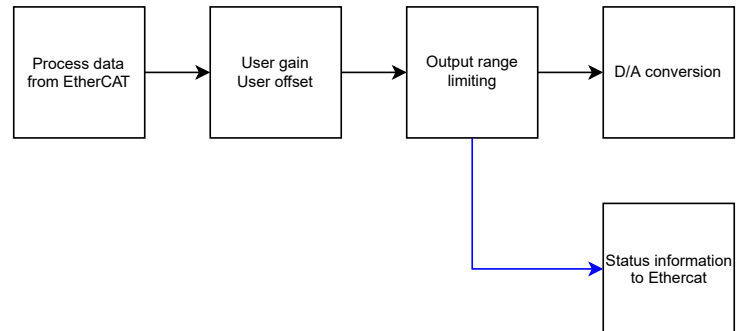


Fig. 2: Overview on signal processing

Diagnostic information is generated from firmware and hardware functions (e.g. overcurrent, wire break). This is displayed in the process data and in the CoE objects. No diagnostic information is generated for disabled channels.

To disable channels, see Chapter 7.2 "Disabling channels" on page 5.

5.2 Distinctive values and data format

5.2.1 Voltage mode

The process data (output signals) is transmitted as normalized mV values in the format "signed int 16". The process data corresponds to the voltage value of the value provided at the output. Depending on the setting, gain and offset calculation are added. Thus, the conversion to an abstract value range is omitted.

One bit at the DAC (digital-analog converter) corresponds to the value 366 µV.

Voltage 0 to 10 V

Process data Value	Equivalent voltage	Percent	Edition Value limited	Notes
>10800			10.8 V	Output limited to 10.8 V
10800	10.8 V	108%	10.8 V	Message on the upper range limit
10000	10 V	100%	10 V	–
0	0 V	0%	0 V	–

Values smaller than 0 V are not output.

Voltage -10 V to +10 V

Process data		Percent	Edition Value limited	Notes
Value	Equivalent voltage			
>10800			10.8 V	Output limited to 10.8 V
10800	10.8 V	108%	10.8 V	Message on the upper range limit
10000	10 V	100%	10 V	-
0	0 V	0%	0 V	-
-10000	-10 V	-100%	-10 V	-
-10800	-10.8 V	-108%	-10.8 V	Message on the lower range limit
< -10800			-10.8 V	Output limited to -10.8 V

Values smaller than -10.8 V are not output.

5.2.2 Current mode

The process data (output signals) is transmitted as normalized μA values in the format "signed int 16". The process data corresponds to the current value of the value provided at the output. Depending on the setting, gain and offset calculation are added. Thus, the conversion to an abstract value range is omitted.

One bit at the DAC (digital-analog converter) corresponds to the value 0.366 μA .

Current 0 to 20 mA

Process data		Percent	Edition Value limited	Notes
Value	Equivalent current in μA			
>21600			21.6 mA	Output limited to 21.6 mA
21600	21.6 mA	108%	21.6 mA	Message on the upper range limit
20000	20 mA	100%	20 mA	-
0	0 mA	0%	0 mA	-
< 0			0 mA	Message on the lower range limit

Values smaller than 0 mA are not output.

Current 4 to 20 mA

Process data		Percent	Edition Value limited	Notes
Value	Equivalent current in μA			
>21600			21.6 mA	Output limited to 21.6 mA
21600	21.6 mA	108%	21.6 mA	Message on the upper range limit
20000	20 mA	100%	20 mA	-
4000	4 mA	20.0%	4 mA	-
3999	3.999 mA		4 mA	Message, lower range limit, output limited to 4.0 mA
0	0 mA	0%	4 mA	Output limited to 4.0 mA

Values smaller than 4 mA are not output.

5.3 Synchronizing the application

The application is synchronized in the mode "SM synchronous". New values are output with each EtherCAT cycle.

5.4 User Scale: Gain and offset adjustment

The "User Scale" functionality allows an individual correction of the gain (User Gain) and the offset (User Offset) for each channel.

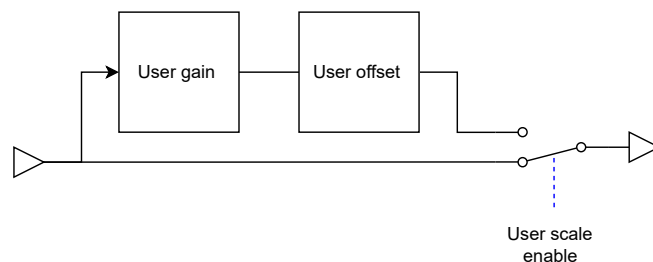


Fig. 3: User Gain and Offset

Enable the functionality "User Scale" to apply the correction. Therefore, set the parameter 80x0:05(hex) "User scale enable" to 1.

Output values to calculate gain and offset:

Value_Range:	The value range at the input of the "User Scale" calculation
Scaled_Value_Range:	The desired value range at the output of the User Scale calculation
Lower_Range_End_Value:	The value at the lower end of the input value range
Scaled_Lower_Range_End_Value:	The desired value at the lower end of the output value range

The values for gain and offset are calculated as follows:

$$\text{Gain_Factor} = \text{Scaled_Value_Range} \div \text{Value_Range}$$

$$\text{User_gain} = (\text{Gain_Factor} \times 10000) - 10000$$

Enter the value "User_gain" into the parameter 80x0:01(hex) "User gain".

$$\text{Offset} = (\text{Scaled_Lower_Range_End_Value}) - (\text{Lower_Range_End_Value} \times \text{Gain_Factor})$$

$$\text{User_offset} = \text{Offset} \times 1000$$

Enter the value "User_offset" into the parameter 80x0:02(hex) "User offset".

⚠ Note that possible limitations of the value range also remain after the "User Scale" calculation. For more detailed information, refer to the chapter "Distinctive values and data format".

⚠ Offset and gain settings can only be made in the "Pre-OP" state. Set the settings via "Start parameters" to ensure that the start parameters are automatically written to the module each time the EtherCAT bus starts.

Example 1:

Module is XI422204, analog output with $\pm 10\text{ V}$. The target is to reduce the value range to values between -3V and +8V while the values of the application still use the value range from -10 V to +10 V.

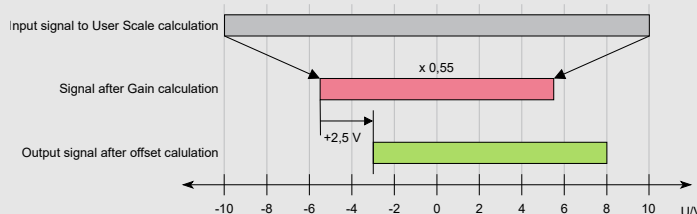


Fig. 4: Value range offset from -10 V .. +10 V to -3 V .. +8 V

Value_Range	= 10 V - (-10 V) = 20 V
Scaled_Value_Range	= 8 V - (-3 V) = 11 V
Lower_Range_End_Value	= -10 V
Scaled_Lower_Range_End_Value	= -3 V

Gain_Factor	= $11\text{ V} \div 20\text{ V} = 0.55$
User_gain	= $(0.55 \times 10000) - 10000 = -4500$
Offset	= $(-3\text{ V}) - (-10\text{ V} \times 0.55) = 2.5\text{ V}$
User_offset	= $2.5 \times 1000 = 2500$

Example 2

Module is XI342204, analog input from 4 to 20 mA. The connected system specifies 4.5 mA as minimum value and 18.5 mA as maximum value. The values should be mapped to a value range from 4 to 20 mA.

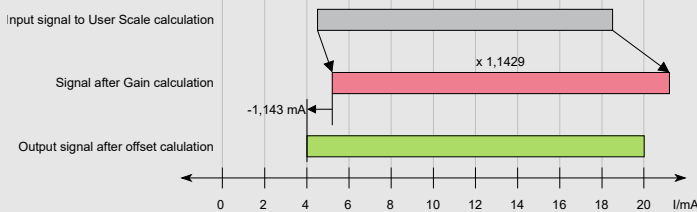


Fig. 5: Value range offset from the range 4.5 mA to 18.5 mA to the range 4 mA to 20 mA

Value_Range	= $18.5\text{ mA} - 4.5\text{ mA} = 14\text{ mA}$
Scaled_Value_Range	= $20\text{ mA} - 4\text{ mA} = 16\text{ mA}$
Lower_Range_End_Value	= 4.5 mA
Scaled_Lower_Range_End_Value	= 4 mA

Gain_Factor	= $16\text{ mA} \div 14\text{ mA} = 1.1429$
User_gain	= $(1.1429 \times 10000) - 10000 = 1429$
Offset	= $4\text{ mA} - (4.5\text{ mA} \times 1.1429) = -1.143$
User_offset	= $-1.143 \times 1000 = -1143$

5.5 Limiting the value range at the output

Output values on the digital analog converter are limited to the module-specific limits. No values greater or smaller values than the limit values specified under "Distinctive values and data format" are output, see chapter "Distinctive values and data format".

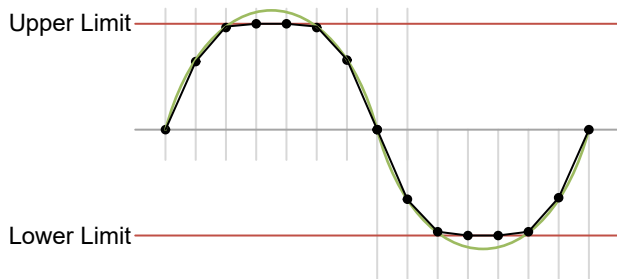


Fig. 6: Limiting the value range at the output

If a value is detected beyond the limits, the value is set to the limit value, the respective bit is set in the process data and in the respective CoE object and a diagnostic message is created.

5.6 Substitute Value

When the module starts up initially, 0 V is output as start value. After switching to 0..20 mA, 0 mA is output, for 4..20 mA 4 mA are output correspondingly. Only from the first change in the "SAFE-OP" phase, the substitute value set via the object 80x0:03(hex) is applied. This substitute value is then also output when the module is switched back to the "INIT", "PRE-OP" and "BOOTSTRAP" states.

The "User Scale" functionality does not affect the set substitute value.

Disabled channels remain at 0 V and 0 mA.

6 Object directory

6.1 CoE standard objects

The object directory of the module contains objects that can be triggered via SDO services. These are defined in the ETG standards:

Index (hex)	Name
1000	Device type
1001	Error register
1008	Device name
1009	Hardware version
100A	Software version
1018	Identify
10F1	Error settings
10F3	Diagnosis history
10F8	Timestamp object
16nn	PDO mapping RxPDO
1Ann	PDO mapping TxPDO
1C00	Sync manager type
1C12	Sync manager 2 assignment
1C13	Sync manager 3 assignment
1C32	SM output parameter
1C33	SM input parameter
F000	Modular device profile
F100	Device state
F800	Device settings

6.2 Module-specific CoE objects

Objects with a module-specific design are described in the following table.

Index (hex)	Object name	Data type	Access	Description
A000	Module identification			
A000:0	Material number	String(20)	RO	Part number of the module
A010:0	Full serial number	String(20)	RO	Complete serial number of the module
F100	Module diagnostics and information			
F100:01	Periphery voltage OK	BIT1	RO	Indicates the peripheral voltage state, 1 = OK; 0 = Not OK
F100:02	Error	BIT1	RO	General module error

6.3 COE objects for parameterization

The module can be parameterized using these objects. Each channel can be freely parameterized. To do so, use the start parameters. The Engineering provides user-friendly support. The initial value for the objects is either "0" or "false".

The module does not permanently store the parameter values. To automatically load the settings required upon each bus start, set the values in the start parameters of the Engineering.

Index (hex)	Object name	Data type	Access	Description	Default
8000	Channel 1, 2, 3, 4 settings				
8010					
8020					
8030					
80x0:01	User gain	Int32	RW	Defines user gain. Maximum value range -32768 .. +32767	0
80x0:02	User offset	Int16	RW	Specifies user offset.	0

Index (hex)	Object name	Data type	Access	Description	Default
80x0:03	Substitute value	Int16	RW	Specifies substitute values. The substitute value is not affected by the "User Scale" functionality.	0
80x0:04	User scale enable	Bit	RW	Enables the "User Scale" functionality	0
80x0:05	Output mode	Bit4, Enum	RW	Specifies output mode. If the object F800(hex) is enabled in the process data, this setting is overwritten. 0: 0...10V 1: -10...10V 2: 0...20mA 3: 4...20mA	0
80x0:06		Bit11		Fill bits	

6.4 Writing "Configured Station Alias"

The "Configured Station Alias" allows the fixed address assignment for the module within the EtherCAT topology. The address is saved in the EEPROM of the module.

Bring the system into the safe state to write the "Configured Station Alias" before starting the programming. Apart from the "Configured Station Alias", no other values of the EEPROM content may be changed. After writing, the respective module has to be restarted via a voltage cycle of the complete station to use the value.

7 Process data

7.1 Process data

The output data of the module in the cyclic process data image can be disabled channel-granularly if required.

The object to set the value range of the channels in the process data can also be disabled. The setting is then made via the CoE objects 80x0:05(hex).

The diagnostic information is transmitted to the input process data. To save data volume in the application, the diagnostic objects can also be disabled on a channel-granular basis.

7.1.1 Input process data

Index (hex)	Object name	Data type	Access	Description	Default (hex)
6000	Channel 1, 2, 3, 4 state				
6010					
6020					
6030					
6000:01	Overload	Bit	RO	Overload detected at output. In voltage mode, this indicates a short circuit or generally too low resistance at the output. In current mode, it indicates a wire break or too high resistance at the output.	0
6000:02	Range limit active	Bit	RO	Output value beyond the specified range 0: Output value OK 1: Output value beyond the specified range	0
6000:03		Bit14		Fill bits	

7.1.2 Output process data

Index (hex)	Object name	Data type	Access	Description	Default (hex)
7000	Channel 1, 2, 3, 4				
7010					
7020					
7030					

Index (hex)	Object name	Data type	Access	Description	Default (hex)
70x0:01	Value	INT16	RW	Output data at channel. In voltage mode: Voltage in mV; 3.141V corresponds to 3141 as process date. In current mode: Current in µA; 2.718mA corresponds to 2718 as process date.	0

F800 Device settings

F800:01	Ch. 1 Output mode	UINT8	RW	Specifies the output mode for channel 1. If this object is enabled, the setting of the CoE object 80x0:05(hex) is overwritten. 0: 0...10V 1: -10...10V 2: 0...20mA 3: 4...20mA	0
F800:02	Ch. 2 Output mode	UINT8	RW	Specifies the output mode for channel 2.	0
F800:03	Ch. 3 Output mode	UINT8	RW	Specifies the output mode for channel 3.	0
F800:04	Ch. 4 Output mode	UINT8	RW	Specifies the output mode for channel 4.	0

7.2 Disabling channels

Do not disable unused channels in the process data image. This reduces the data width in the process data image. Disabled channels are also disabled in the signal processing. No diagnostic messages are generated for these channels and the error bits in the respective CoE object no longer contain any valid information.

To disable a channel, edit the process data mapping (PDO assignment) of the module in the I/O Engineering Tool. The mapping can be set separately for input and output data. Disable process data of the channel. If the channel has its own Control/Status object in the input/output data, disable it as well.

8 Diagnostic strategy

8.1 Mechanisms

Different mechanisms are used for the diagnostics of the module.

Mechanism	Diagnostics
EtherCAT state machine	EtherCAT system diagnostics
EtherCAT hardware watchdog	
Diagnostic objects in the CoE object directory	Extended diagnostics, e.g. peripheral errors
10F1(hex)	Error settings
Diagnosis history object	20 diagnostic messages can be stored
10F3(hex)	Diagnosis history
Module status LED	Shows the general module status

8.2 Diagnosis history

All diagnostics from the module are written to the Diagnosis history object. This is implemented in the CoE object 10F3(hex) as ring buffer in overwrite mode. The last 20 diagnostic messages are saved, older messages are deleted.

The diagnostics can be retrieved from these CoE objects. The diagnostic messages are displayed in ctrlX I/O Engineering for each module in the module-specific diagnostics tab if the module is connected via the network

For further information on the function of the "Diagnosis history", refer to the application manual.

8.3 Status codes

Text ID (hex)	Type	Text
1000	Error	Module error <opt. info>
1020	Warning	Error during update, data corrupted, please update again
2340	Warning	Overload at channel <Channel no.>
3400	Error	Periphery supply voltage (UP) missing <opt. info>
6801	Warning	Configuration not allowed at channel <Channel no.>
8910	Warning	Ovrrange at channel <Channel no.>
8920	Warning	Underrange at channel <Channel no.>

The diagnostics "Overload" runs channel-granularly. Individual channels can be switched off. Then, no diagnostics is run.

The overload detection (wire break or short circuit) for current outputs requires a minimum output value to work. Minimum output value for detection: Typical 1 mA.

† To disable channels, see → Chapter 7.2 "Disabling channels" on page 5.

8.4 Module status LED (diagnostic and device status)

Device state	LED flashing pattern
Booting or firmware update	BU BU BU BU BU - - - - - →
Initialization or firmware update completed	BU BU BU BU BU BU BU BU BU BU BU →
It is currently configured. Module not yet ready.	GN GN GN GN GN - - - - - →
Process data transmission, outputs inactive.	GN GN GN GN GN GN GN GN GN GN →
Module in "Run" state	GN GN GN GN GN GN GN GN GN GN →
Error and warning states	
Logic or peripheral voltage error	RD RD RD RD RD RD RD RD RD RD →
Communication or configuration error	RD RD RD RD RD - - - - - →
Channel error	YE YE YE YE YE - - - - - →

† One square corresponds to a period of 200 ms. The arrow represents the end of a cycle.

- LED is not on.

BU LED is blue.

GN LED is green.

RD LED is red.

YE LED is yellow.

† A new status is only displayed after the previous flashing cycle has elapsed. A change in status can thus be delayed up to two seconds.

8.5 Channel status LED

The modules have no channel status LED. Apart from the diagnostics via EtherCAT at the module, channel errors are only displayed via the state of the module status LED.

9 Installation

9.1 Clamping point assignment

Clamping point	Signal	LED	Pusher
1	AO channel 1	None	Grey
2	AO channel 1 GND	None	Dark blue
3	AO channel 2	None	Grey
4	AO channel 2 GND	None	Dark blue
5	AO channel 3	None	Grey

Clamping point	Signal	LED	Pusher
6	AO channel 3 GND	None	Dark blue
7	AO channel 4	None	Grey
8	AO channel 4 GND	None	Dark blue

† Connection notes:

- The channel GND outputs are only to be used as reference potential for the respective output.
- These outputs may not be used as peripheral supply GND.
- To supply the connected actuators, use the potential distribution terminals, e.g. XI821116.

9.2 Connection instructions

9.2.1 Cable and shielding

NOTICE

Electronic damages and measuring errors

Unshielded cables can cause that tolerance limits are easily exceeded in an environment prone to interferences.

Always connect the components with shielded cables twisted in pairs.

Connect the cable shielding to the functional earth immediately after entering the control cabinet. Route the cable with its shielding up to the module. The signal cables should be routed the shortest possible without shielding.

For the best connection directly in front of the module, the shield connection set (R911173030) is provided together with the busbar (R911173283).

9.3 Pin example

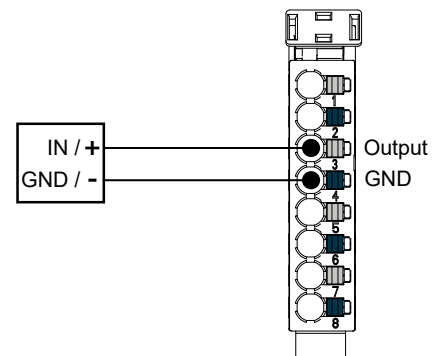


Fig. 7: Pin example

9.4 Mounting and installation

The application manual for the ctrlX I/O modules contains notes on installation, mounting and dismounting. For the application description, go to:

- → www.boschrexroth.com/MediaDirectory, Search term: → "R911423458" or
- → <https://docs.automation.boschrexroth.com/doc/4126711705/ctrlx-i-o-anwendungsbeschreibung/latest/en/>.

NOTICE

Destruction of the device due to non-compliance with the application manual

Follow the mounting instructions in the application manual to ensure a correct mounting and to prevent damage to the device.

10 Firmware update via FoE

▲ WARNING

Risk of injury due to unsafe machine states

The machine has to be in a safe state before updating.

The firmware of the module can be updated via FoE. For new firmware files, go to → www.boschrexroth.com/mediadirectory and search for the type code of the module.

A firmware module can be updated with all EtherCAT Masters supporting the file download via FoE. The module has to be in the BOOTSTRAP state. Entering a password or a file name is not required.

If the update has been completed successfully, the module is restarted as soon as the module state changes from BOOTSTRAP to another state. The reloaded firmware is started.

⚠ Do not disconnect the voltage supply of the module during the file transfer.

Please note that the logic voltage supply is temporarily interrupted for the following modules when completing the firmware update of the module and a subsequent restart.

⚠ If switching to INIT is not possible, disconnect the ctrlX I/O system from the power supply and connect it again.

⚠ The new firmware version might require an updated description file in the Engineering to use new functions. For details, refer to the release notes.

Check whether the latest version of the description file is installed.

10.1 ctrlX I/O Engineering

Within ctrlX I/O Engineering, the required user interface is only displayed for modules supporting a firmware update.

1. Switch the EtherCAT Master of the ctrlX CORE to the "INIT" state.
2. First change to the active state in the ctrlX I/O Engineering by enabling "Show online data".
 - This is the prerequisite to update the firmware. The corresponding user interface tab is only displayed if the prerequisite is met.
3. To open the device editor, double-click on the module in the ctrlX I/O Engineering device tree and select the "FoE" tab.
4. In the "Download" section, select the firmware file (*.EFW) under "Local file name". Ensure that this is the correct file for the module to be updated.
5. Check that the option "Required state" is active under "Details" and that "BOOTSTRAP" is selected.
6. Use the "Download" button to start the firmware update.

11 License information

11.1 EtherCAT®



The ctrlX I/O modules use EtherCAT® technology. "EtherCAT®" is a registered trademark and patented technology licensed by the Beckhoff Automation GmbH, Germany. EtherCAT is an open, internationally standardized standard and developed further by the "EtherCAT Technology Group" (ETG).

11.2 Libhydrogen

ISC License

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11.3 Ring-buffer

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