Operating Manual

English

CX27C-R

SomatXR
Industrial-Ethernet-Gateway

HBM

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1 Safety instructions

Intended use

The module and the measurement modules and transducers connected to it must only be used for measurements and directly related control and regulation tasks. Use for any purpose other than the above is deemed improper use.

In the interests of safety, the module must only be used as described in the operating manual. When the module is in use, it is essential to comply with the applicable legal and safety requirements for the relevant application. The same applies to the use of accessories.

Before starting up the module for the first time, you must first run a project planning and risk analysis that takes into account all the safety aspects of automation technology. This particularly concerns personal and machine protection.

Additional safety precautions must be taken in plants where malfunctions could cause major damage, loss of data or even personal injury. If an error occurs, these precautions will ensure that safe operating conditions have been established.

This can be achieved, for example, through mechanical interlocking, fault messages, limit value switches, and similar things.

Safety requirements

A module must not be directly connected to a power supply system. The allowed supply voltage range is:

- CX Module 10 DC ... 30 DC
- EX23-R 10 DC ... 36 DC
- MX Module 10 DC ... 30 DC
- UPX Module 10 DC ... 30 DC

The supply voltage connection as well as the signal and sense leads must be installed in such a way that electromagnetic interference does not adversely affect device functionality. (HBM recommendation: "Greenline shielding design", can be downloaded from http://www.hbm.com/greenline).

Automation equipment and devices must be covered over in such a way that adequate protection or locking against unintentional actuation is provided (e.g. access checks, password protection, etc.).
When devices are working in a network, these networks must be designed in such a way that interference in individual nodes can be detected and the nodes can be shut down.

Safety precautions must be taken both in terms of hardware and software, so that a line break or other interruptions to signal transmission, e.g. via the bus interfaces, do not cause undefined states or loss of data in the automation device.

Conditions on site

For all modules:

- Please observe the maximum allowed ambient temperatures stated in the specifications.
- Make sure that the device is exposed to as little direct sunlight as possible in hot operating environments.

Maintenance and cleaning

The modules are maintenance-free. Note the following points when cleaning the housing:

- Before cleaning, disconnect the module from all connections.
- Clean the housing with a soft, slightly damp (not wet!) cloth. You should *never* use solvents, since they could damage the label on the front panel and damage the display.
- Do not subject the device to high water pressure while cleaning.

General dangers of failing to follow the safety instructions

The module is a state of the art device and as such is fail-safe. The module may give rise to residual dangers if it is inappropriately installed and operated by untrained personnel. Any person instructed to carry out installation, start-up, maintenance or repair of the module must have read and understood the operating manual and in particular the technical safety instructions.

Residual dangers

The scope of supply and performance of the module covers only a small area of measurement technology. In addition, equipment planners, installers and operators should plan, implement and respond to the safety engineering considerations of measurement technology in such a way as to minimize residual dangers. On-site regulations must be complied with at all times. There must be reference to the residual dangers connected with measurement technology. After making settings and carrying out activities that are password-protected, you must make sure that any controls that may be connected remain in safe condition until the switching performance of the module has been tested.

Product liability

In the following cases, the protection provided for the device may be adversely affected. Liability for equipment functionality passes to the operator when:

- The device is not used in accordance with the operating manual.
- The device is used outside the field of application described in this chapter.
- The operator makes unauthorized changes to the device.

Working safely

Error messages can only be confirmed once the cause of the error has been resolved and there is no further danger.
The devices meet EMC standards EN61326-1 / EN61326-2-x. The norms used include definitions of limit values and test levels for multiple environments.

In terms of emission (EME), the requirements for industrial environments (Class A) and household/laboratory environments (Class B) must be met. The standard here references to CISPR 11:2009+A1:2010.

Regarding immunity to interference, requirements for controlled electro-magnetic environments (lowest requirements), general environments and industrial environments (highest requirement) are included.
SomatXR modules listed in the declaration of conformity meet the requirements for:

- Emission (EME): Class A
- Immunity to interference: Industrial environment

The SomatXR-series and the individual modules are designed essentially for use in an industrial environment. When used in residential and commercial applications, additional measures may be necessary to limit emission (EME).

Conversions and modifications

The module must not be modified from the design or safety engineering point of view except with our express agreement. Any modification shall exclude all liability on our part for any resultant damage.

In particular, any repair or soldering work on motherboards (exchange of components) is prohibited. When exchanging complete modules, use only original parts from HBM.

The module is delivered from the factory with a fixed hardware and software configuration. Changes may only be made within the options documented in the instructions.

Qualified personnel

Qualified personnel means persons entrusted with installing, mounting, starting up and operating the product who possess the appropriate qualifications for their work. This module may only be used by qualified personnel in accordance

with the specifications and in compliance with the safety requirements and regulations.

This includes people who meet at least one of the three following criteria:

- The safety concepts for the automation technology must be known. The project personnel must be familiar with these concepts.
- The operators of the automation system must be instructed in how to handle the machine and must know how to operate the modules and technologies that are described in this documentation.
- The commissioning engineers and service technicians must have successfully completed training that qualifies them to repair automation systems. They are also authorized to operate, ground and label circuits and equipment in accordance with safety engineering standards.

It is also essential to comply with the legal regulations and safety rules applicable to the application concerned during use. The same applies to the use of accessories.

2 Markings used

2.1 The markings used in this document

Important instructions for your safety are highlighted. It is essential to follow these instructions to prevent accidents and damage to property.

Symbol	Meaning
	This marking warns of a *potentially* dangerous situation in which failure to comply with safety requirements *could* result in death or serious physical injury.
	This marking warns of a *potentially* dangerous situation in which failure to comply with safety requirements *could* result in slight or moderate physical injury.
	This marking draws your attention to a situation in which failure to comply with safety requirements *could* lead to property damage.
 **Important**	This marking draws your attention to *important* information about the product or about handling the product.
 **Information**	This marking draws your attention to information about the product or about handling the product.
Emphasis *See …*	Italics are used to emphasize and highlight text and identify references to chapters, diagrams, or external documents and files.
Device -> New	Bold text indicates menu items, as well as dialog and window headings in the program environment. Arrows between menu items indicate the sequence in which the menus and sub-menus are called up
Sample rate	Bold text in italics indicates inputs and input fields in the user interfaces.

2.2 Symbols on the device

CE mark

With the CE mark, the manufacturer guarantees that the product complies with the requirements of the relevant EC Directives (the Declaration of Conformity can be found on the HBM website HBM (www.hbm.com) under Service and Support \ Downloads).

Statutory waste disposal marking

In accordance with national and local environmental protection and material recovery and recycling regulations, old devices that can no longer be used must be disposed of separately and not with normal household waste.
See also Chapter 7 „Waste disposal and environmental protection“ on Page 60.

Marking in accordance with the requirements of SJ/T 11364-2014 and SJ/T 11363-2006 (“China RoHS-2”)

Marking for products that do not contain hazardous materials or that contain only certain quantities of these materials below the highest concentration allowed.

Observe supply voltage

This symbol indicates that the supply voltage must be monitored. You can find the individual supply voltage ranges on the respective data sheet.

3 Introduction

These instructions will help you get started using the SomatXR Industrial Ethernet gateway CX27C-R. It should help you to use the measurement modules in real-time automation tasks via the EtherCAT or PROFINET IRT. It also explains how XCP-on-Ethernet can be used for integration in other data acquisition software.

This manual shows you:

- How to start up the module.
- What can be connected and what to look out for.
- How to parameterize the module in order to integrate your measured data into your automation software.

The following documentation is also available:

- SomatXR operating manual with the pin assignment of the MX modules
- Data sheets
- Online help in the MX Assistant software

Further information

EtherCAT is an open standard (IEC/FDIS 61158), therefore note the information available from www.ethercat.org as an additional source that may be necessary.

CANopen documentation can be requested from the user organization CAN in Automation (CiA) (www.can-cia.de).

The Universal Measurement and Calibration Protocol (XCP) is described in the ASAM MCD-1 XCP standard. You can also find further information at www.asam.net.

4 Connections and displays

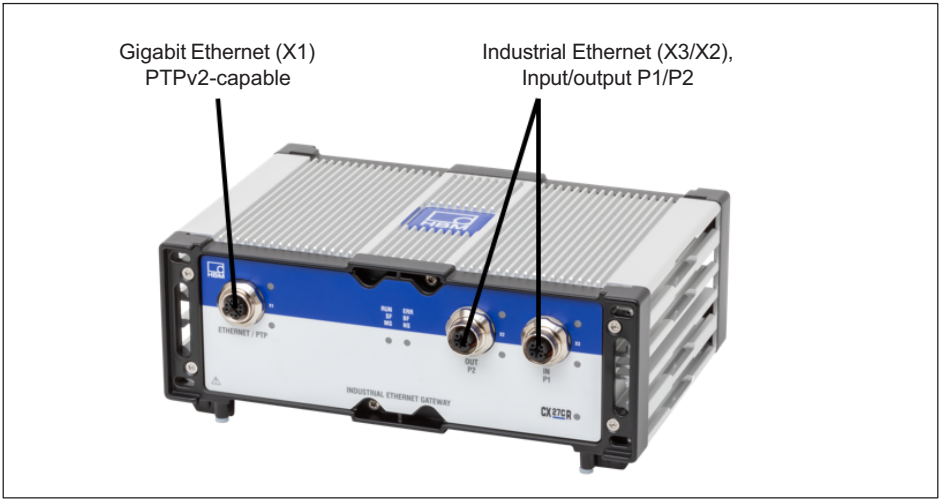


Fig. 4.1 CX27C-R connections on the front

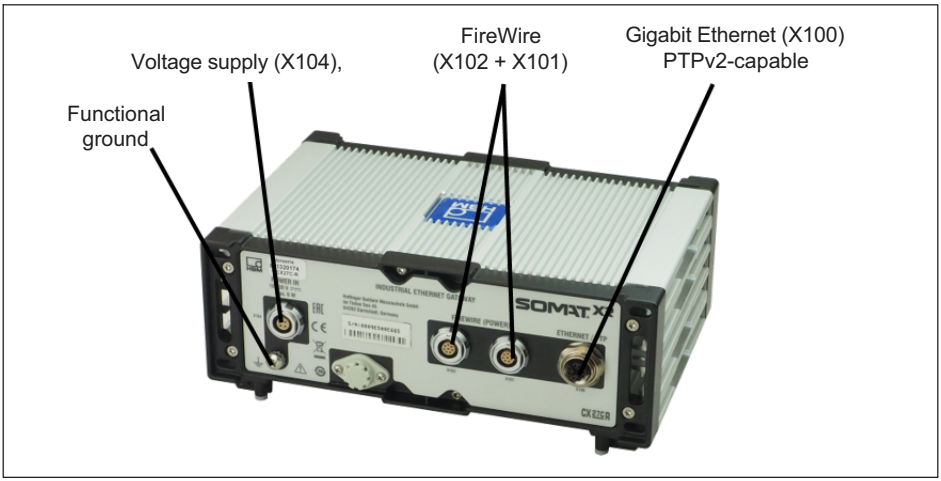


Fig. 4.2 Connectors on the back of the CX27C-R

4.1 Power supply

Connect a DC supply voltage of 10 - 30 V to connector X104. Use a voltage supply with sufficient power if any MX modules connected to the CX27C-R also need to be supplied.

The DC voltage supply must be a SELV voltage supply, meeting the requirements of IEC/EN/DIN EN 60950-1. The supply voltage must be protected by an adequate DC fuse (e.g. LITTELFUSE KLKD 6, LFPHV001) with a maximum current of 5 A.

HBM offers the NTX002 power supply for laboratory or general steady-state operation. On the primary side, this provides a selection of international connector types and 24 V and 30 watts on the secondary side. A CX27C-R and two additional MX modules can be supplied in this way.

4.2 Ground connection and grounding

Lay the signal and data leads separately from the current-carrying power line. Cable ducts made of sheet metal with an internal partition are ideal.

When there are differences in potential in or at the connected measurement system, you will have to integrate the CX27C-R into the potential equalization line through the functional earth connector.

4.3 Connecting the measurement modules

The SomatXR module CX27C-R is a so-called gateway. A gateway is used so that networks based on completely different protocols can communicate with each other.

Thus the main task of the Industrial Ethernet gateway CX27C-R is to receive and forward data from the modules connected via FireWire.

Data is transmitted via the FireWire connections and the module is synchronized for time and supplied with the optimum voltage. Data transmission is asynchronous (all nodes) or isochronous (to a specific node, e.g. CX27C-R). You can connect a total of twelve modules with each other in series via FireWire.

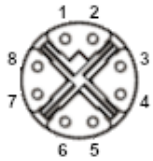
SomatXR or QuantumX modules are connected to the gateway via FireWire. Connect cable 1-KAB272-x to any of the gateway's connectors and the other end to connector X102 of the first measurement module.

Then keep threading: connector X101 to X102 of the second measurement module, etc. You will usually have to provide another voltage supply after three modules. The supply voltage of the modules is connected through FireWire (maximum 1.5 A via FireWire). The power consumption of a module is explained in the data sheet. The supply voltages in a system should all have about the same voltage value.

4.4 Inclusion of Industrial Ethernet fieldbus and connection to PC.

The CX27C-R Gateway has two Ethernet interfaces and one fieldbus interface (IN/OUT) for a network connection. The Ethernet interfaces on the front and back of the module are equivalent, and are implemented as M12 sockets (X coded).

Ethernet	M12 X coded	RJ45
TX_D1+	1	1
TX_D1-	2	2
RX_D2+	3	3
RX_D2-	4	6
BI_D3+	7	4
BI_D3-	8	5
BI_D4+	5	7
BI_D4-	6	8



M12
X coded

Generally, only one of the two Ethernet interfaces should be used in order to prevent problems with the network configuration. The XCP-on-Ethernet protocol can also be used via these two Ethernet interfaces.

Measurement tasks: central interface for all connected modules and their measured values.

Maintenance tasks: central interface for all connected modules for diagnosis or updates.

Information

The factory settings of the modules can be restored with the MX Assistant.

Important

The Ethernet interfaces on the front and back of the gateway must have different IP addresses! You can configure both interfaces with the MX Assistant.

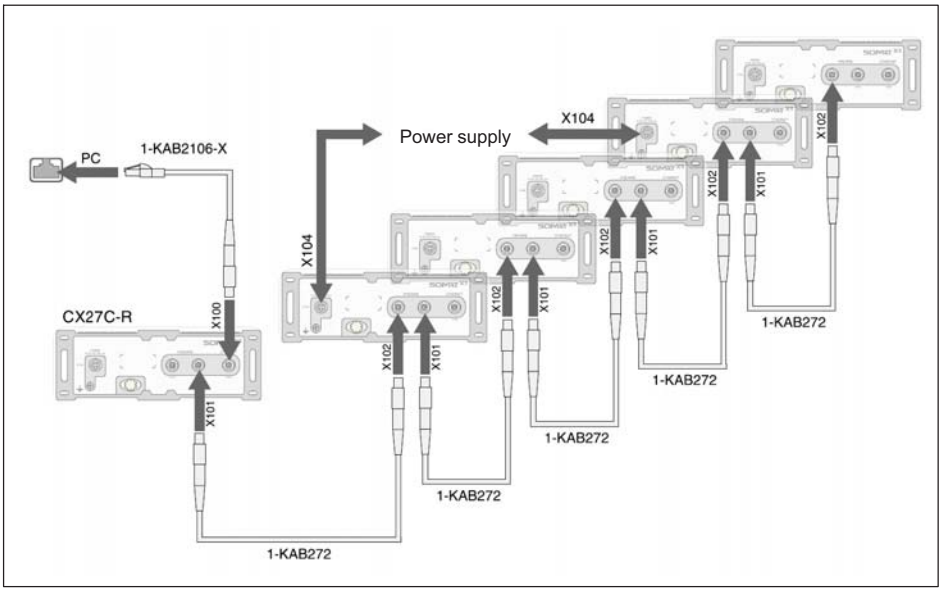


Fig. 4.3 Example: Ethernet connection to a PC/laptop via CX27C-R

Important

Running from the data sources to the receiving terminal, the connection between the modules must always run from the FireWire port X102 to the X101 port.

The D coded M12 connector sockets X2 and X3 on the front are intended for connecting to the Industrial Ethernet fieldbus with real-time capability.

Ethernet	M12 D coded	RJ45
TX+	1	1
TX-	3	2
RX+	2	3
RX-	4	6

M12
D coded

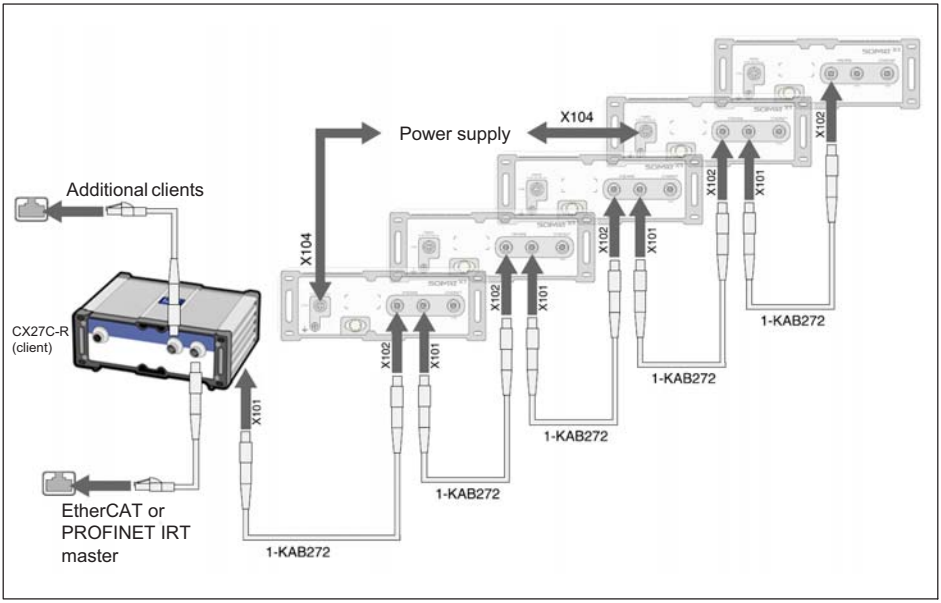


Fig. 4.4 Example: Connection between SomatXR and Industrial Ethernet via CX27C-R

4.5 LED displays

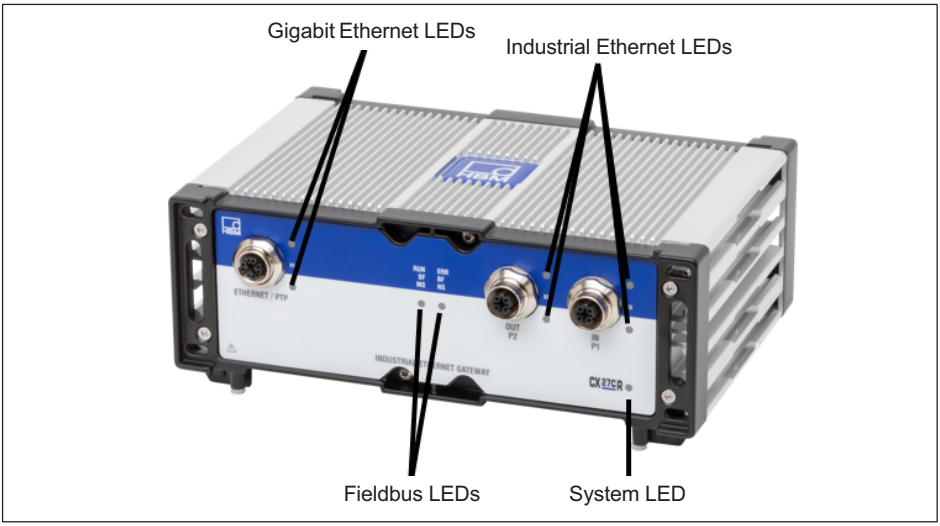


Fig. 4.5 Position of the LEDs

System LED

Color	Meaning
Green	Error-free operation
Yellow	System not ready, booting procedure active
Flashing yellow	Download procedure is active, detection of identification
Red	Error/faulty synchronization

Fieldbus LEDs

EtherCAT

ERR/BF/NS	Meaning
OFF	EtherCAT has no connection
Flashing	EtherCAT has a connection - data transfer
Lit continuously	EtherCAT has a connection - no data transfer

RUN/SF/MS	Meaning
OFF	EtherCAT in INIT state
Flashing slowly	EtherCAT in PRE-OPERATIONAL state
Single flashing	EtherCAT in SAFE-OPERATIONAL state
Lit continuously	EtherCAT in OPERATIONAL state
Flashing fast	EtherCAT in BOOTSTRAP state

PROFINET

Status	RUN/SF/MS	ERR/BF/NS
Boot sequence	OFF	OFF
Hardware error[1)] Licensing error	OFF	RED
Connected[2)]	GREEN	OFF
DCP signal (1 Hz, 3 seconds)	FLASHING ORANGE	FLASHING ORANGE
All others	FLASHING GREEN	OFF

1) Error is triggered by the SDAI stack (e.g. “Ethernet interface not working or IP core problem” from the source file demo.c)
2) Connection established between PLC and CX27C-R (name and IP input range match)

Ethernet LEDs (gigabit Ethernet and industrial Ethernet)

Color	Meaning
Green lights up	Ethernet connection status OK
Flashing yellow	Ethernet data transmission

5 Configuration

5.1 Adjustment of the Industrial Ethernet mode

When connecting the SomatXR to an industrial fieldbus, the CX27 platform uses an adjustable protocol stack with the following options: PROFINET IRT, EtherCAT, and others.

Starting with firmware version 4.32, CX27C-R supports EtherCAT and PROFINET Device IRT.

At delivery, the EtherCAT fieldbus mode is already preset. You can change modes using the MX Assistant:

1. Connect your PC to the CX27C-R gateway via an Ethernet cable.
2. Supply voltage to the CX27C-R.
3. Start the MX Assistant, scan for modules and connect the MX Assistant with CX27C-R.
4. You can pull up the fieldbus mode menu by right-clicking on the CX27C-R (*see Fig. 5.1*). There you can choose between EtherCAT and PROFINET (*see Fig. 5.2*).
5. Restart the gateway in order to activate the selected mode.

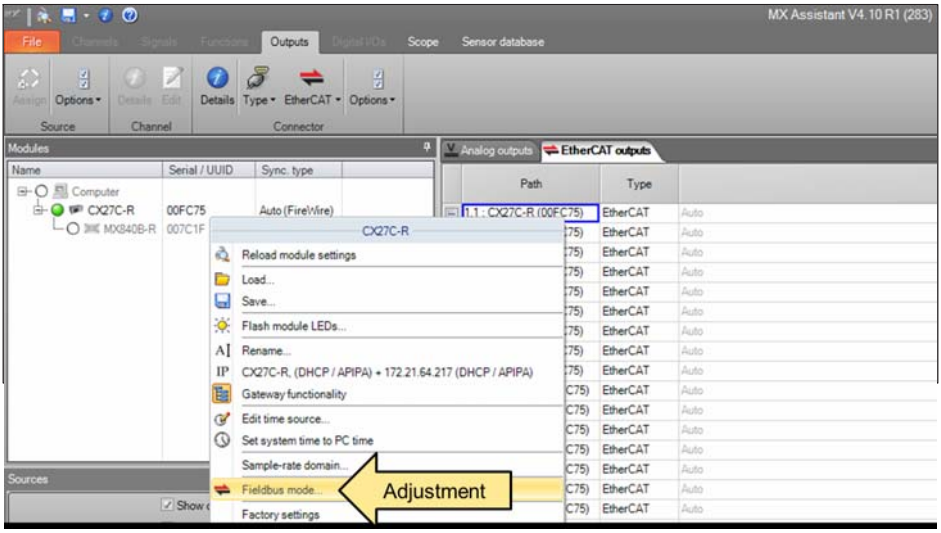


Fig. 5.1 Switch fieldbus mode

Fig. 5.2 Select fieldbus

5.2 Adjustment of isochronous data transmission

You must first configure the relevant module channels for isochronous data transmission with the MX Assistant ("Signals" tab) and via Ethernet TCP/IP:

1. Connect your modules in the deactivated state to the CX27C-R gateway via FireWire cable 1-KAB272 (from connector X102 to X101, etc.).
2. Connect your PC to the CX27C-R gateway via an Ethernet cable.
3. Switch on the supply voltage.

4. Start the MX Assistant, scan for modules and connect the MX Assistant with CX27C-R.
5. In the "Signals" tab, activate isochronous data transfer (*see Fig. 5.3*).

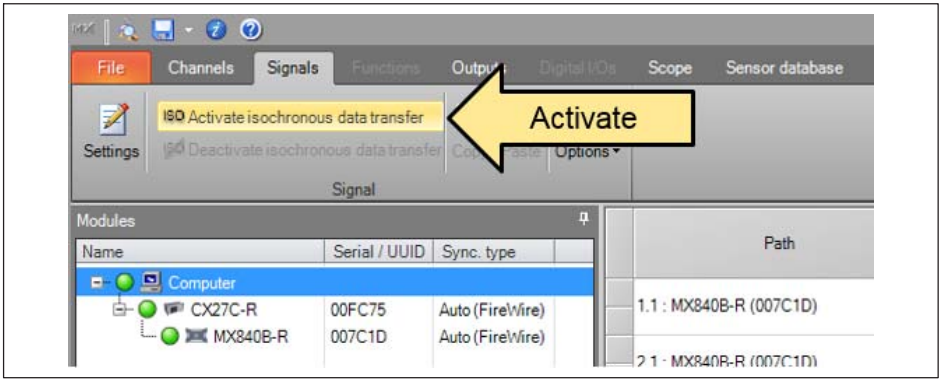


Fig. 5.3 Activation of isochronous data transmission

You can now work via the Industrial Ethernet gateway and configure your modules for EtherCAT or PROFINET applications.

5.3 EtherCAT

5.3.1 Basic principles - EtherCAT

EtherCAT (Ethernet for Control Automation Technology) is an open and standardized fieldbus system, characterized by a high performance capability and corresponding in principle to a specifically adapted Ethernet solution (standard: IEC/FDIS 61158):

EtherCAT uses Ethernet frames (data frames) as they are defined in IEEE 802.3 and supports the use of other Ethernet protocols in the same network.

End users of EtherCAT have banded together in the EtherCAT Technology Group (ETG) to promote EtherCAT technology (www.ethercat.org).

EtherCAT replaces the classic star topology of Ethernet hubs and switches (although this can still be used) with an easy-to-wire line topology. It supports branches and stub lines. Typically a master and additional clients are combined to form a group.

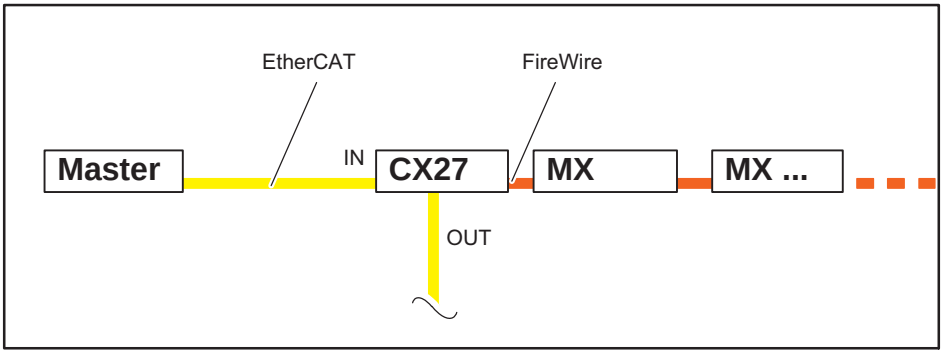


Fig. 5.4 Example: CX27 gateway to EtherCAT, modules are connected via FireWire

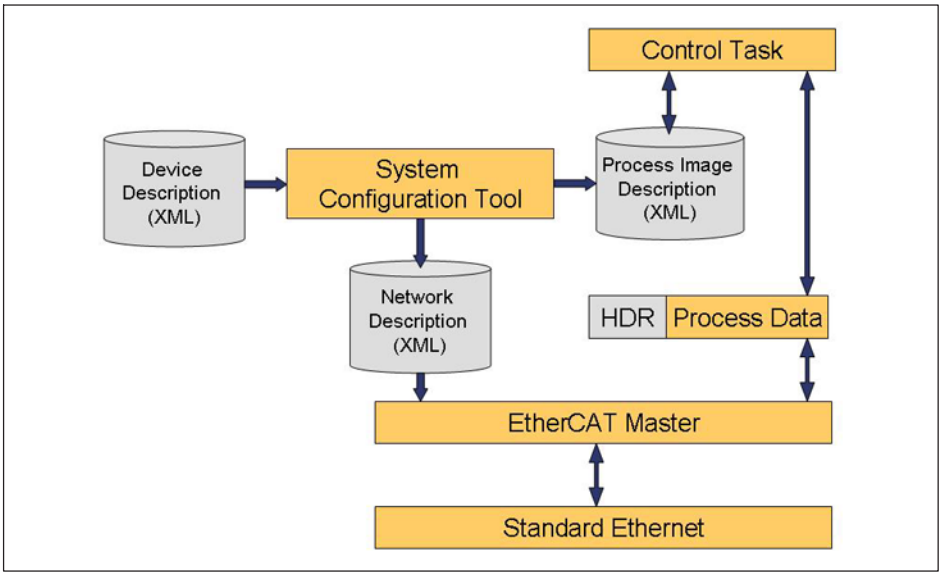
Operating principle

In contrast to standard Ethernet, the Ethernet frames from the clients are processed in passing (IN and OUT sockets). The standard Ethernet frame sent by the master (as per IEEE 802.3) is not first received, then interpreted and the process data is not copied at every interconnection, as is the case with other industrial Ethernet solutions. The EtherCAT client devices read the data relevant to them as the telegram passes through the device. Input data is also inserted into the telegram as it passes through the device. Thus a frame is not fully received before being processed. Instead the processing starts as early as possible. The send process also begins with a minimum time offset of only a few bits. The master is supported by a standard Ethernet controller.

Configuration

The majority of the work required for implementation is usually done by the configuration tool. Clearly defined interfaces have been created to minimize the required effort. The configuration tool learns the device properties from the Device Description XML data set (EtherCAT Slave Information File = ESI). Then the configuration tool generates an XML data set containing all relevant information about the network topology, arrangement of process data, start-up

and diagnosis. When the master is actually implemented, this data set only needs to be loaded, and for starting and operating the network the required Ethernet frames have to be extracted.



The SomatXR EtherCAT clients can be configured either via an ESI data set or by a search function and the EEPROM integrated into the client. This makes it possible to read the SM/FMMU information (SYNC Manager/Fieldbus Memory Management Unit).

Communication

By default, EtherCAT uses CANopen (CoE - CANopen over EtherCAT) as the application layer.

CANopen (CAN: **C**ontroller **A**rea **N**etwork) is the open protocol standard for CAN in automation technology and has been standardized in the "CAN in Automation" (CiA) association. The protocol uses CAN bus as the transmission medium and specifies the fundamental structures for network management, the use of the CAN Identifier (message address), the behavior on the bus over time, the data transmission types, and application-specific profiles. This is intended to ensure that CANopen modules from different manufacturers can be

combined with each other (that the devices "speak the same language"). CANopen defines the application layer (OSI Layer 7) as the communication profile specified by the CiA in Standard DS30x as the same for all applications. It establishes how communication is to take place. As with some other field-buses, a distinction is also made between real-time data and parameter data.

CANopen uses communication objects with different properties:

Service Data Objects (SDO)

In the parameter channel, all the CX27 parameters can be read and modified by the SDO service. The required parameter is addressed within an SDO telegram with index and sub-index.
SDOs determine the features of the communication channel for the transmission of device parameters, for example the sample rate of the A/D converter. As these parameters are transmitted acyclically (for example, once only, when turning on the network), SDOs have a subordinate priority.

Process Data Objects (PDOs)

A PDO telegram is used for example to transfer cyclic measured data in real time. The measured data is used in turn to control, regulate and observe the running process. The transmission times here are linked to the cycle times/ clock rates specified by a master. No objects are addressed in the telegram, instead the content of previously selected parameters is directly sent.

All the device parameters are stored in an object dictionary. This object dictionary contains the description, data type and structure of the parameters, as well as the address (index). For the SomatXR CX27 gateway, the standardized DS404 device profile for the sensor/controller group is listed with useful additions. Only the index values required for the configuration are described there, starting at 0x6000. A description of the other index ranges can be found in the CiA standard.

Object dictionary DS404 (Version 1.2.2)

All the variables and parameters (objects) of a CANopen device are grouped together in the object dictionary. The process image of the data is created in this manner and the operating behavior of a CANopen device can then be influenced by means of the parameters.

An object dictionary is structured in such a way that some parameters are specified (mandatory) for all the devices of the relevant category and others can be freely defined and used. In CANopen, objects are first given a number (the so-called index), which uniquely identifies them and can also be used to address them. Objects can be implemented as simple data types such as bytes, whole numbers (integers), "longs" or also as character sequences (strings). With more complex structures such as arrays and structures, a sub-index is introduced to address the individual elements.

The structure of the object dictionary, the assignment of index numbers, and some mandatory entries are specified in the device profiles. For the user, the object dictionary is stored in an EDS data set (Electronic Data Sheet). In the EDS data set, all the objects are stored with index, sub-index, name, data type, default value, minimum, maximum and access options (read/write, transmission by SDO only or also by PDO, etc.). This means that the EDS data set describes the full functionality of a CANopen device.

CANopen standard objects (from address 0x1xxx) are available from the CiA (www.can-cia.de).

Synchronization

For the timing of all nodes in the network it is important for all of them to be exactly synchronized if simultaneous actions are required for widely distributed processes. The synchronization process based on the Distributed Clock concept is used to transfer the timing of the master clock signal via the EtherCAT network to the client clock generator and to align it to compensate for a time offset. The main clock generator in an EtherCAT group is in a client device, because the master should deliberately be assigned to standard components. All nodes can then be synchronized with an error of less than 1 µs.

The "Distributed Clocks" option can be activated and deactivated by a corresponding tag in the ESI. If "Distributed Clocks" is activated, the timing master forwards the time to the SomatXR client, which distributes the timing to the modules.

The Distributed Clock concept is also useful when measurements will be performed in parallel via Ethernet and same time stamp will be acquired as a reference value.

If the master does not support the "Distributed Clocks" option, the time is set to zero when the module is started up and timing begins from there on.

The EtherCAT CX27 client connects the powerful, modular SomatXR data acquisition system to this fieldbus with up to 199 time-synchronized signals. The maximum sample rate here is 1200 Hz. It is also possible to provide 30 signals at a rate of 4800 Hz.

Up to 3 Sync Managers can be assigned.

CX27 operates with the "SYNC 0" pulse. The cycle time can be set up to the magnitude of 125 µs. Smaller values cause the loss of real-time data.

5.3.2 EtherCAT configuration

Incorporating it into an EtherCAT network involves the following essential steps:

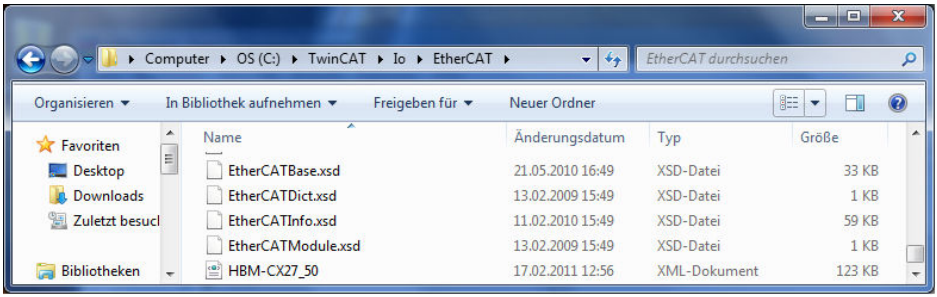
1. One-time setup of isochronous data traffic using the MX Assistant
2. Adjustment and configuration of the individual channels using the EtherCAT master or XML file (*.esi)
   - Channel configuration (service data object, SDO)
   - Process data allocation (process data object, PDO)

Various different masters are available for EtherCAT integration, all of which are configured using the corresponding software tools (e.g. König PA KPA EtherCAT Studio, Beckhoff TwinCAT).

As an alternative, you can use MX Assistant to create an XML file or utilize the included standard files for configuration (system DVD or website). The XML file is the electronic data sheet for the connected EtherCAT client and therefore varies for each device. It is also referred to as EtherCAT Slave Information (*.esi). This *.esi must then be conveyed to the EtherCAT master by copying it into the corresponding file path (e.g. C:\TwinCAT\Io\EtherCAT).

Information

All EtherCAT master can manage only one CX27 ESI data file.



5.3.3 EtherCAT Data Integration Workflow with TwinCAT3

CX27 is able to route the QuantumX/SomatXR measurement values to EtherCAT. To do so, configuration on the QuantumX/SomatXR side and the EtherCAT side is necessary. This document describes briefly the appropriate steps needed to transfer QuantumX/SomatXR measurement data and make it visible on TwinCAT3.

Setup

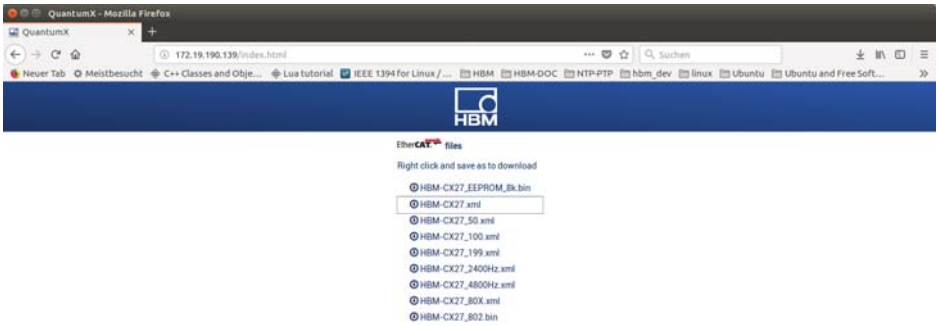
For this example a single MX module (MX840B) is connected to CX27 (FireWire). For the configuration and TwinCAT (PLC) a PC with two Ethernet interfaces is used. The first Ethernet interface of PC is only used for EtherCAT and directly connected with EtherCAT IN of CX27 over RJ45 cable. The second interface of PC is connected with one of Ethernet interfaces of CX27 and used for the configuration.

Steps for Configuration the QuantumX/SomatXR System

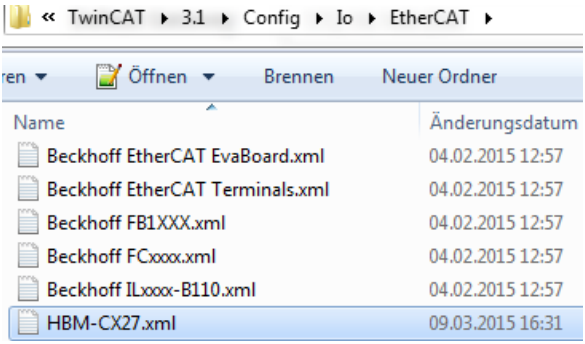
Detailed information can be found in the Operating Manual of the CX27 in *chapter 5.1*.

Configuration steps of TwinCAT 3

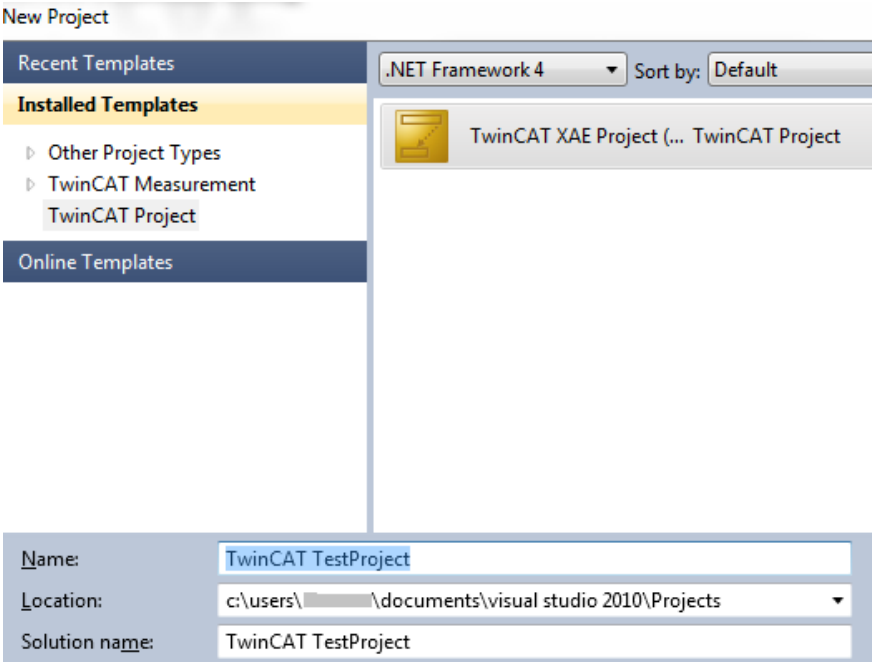
1. Install TwinCAT3
2. Restart PC
3. Connect CX27 Ethernet Port (X1 or X100) with your PC (Ethernet Port)



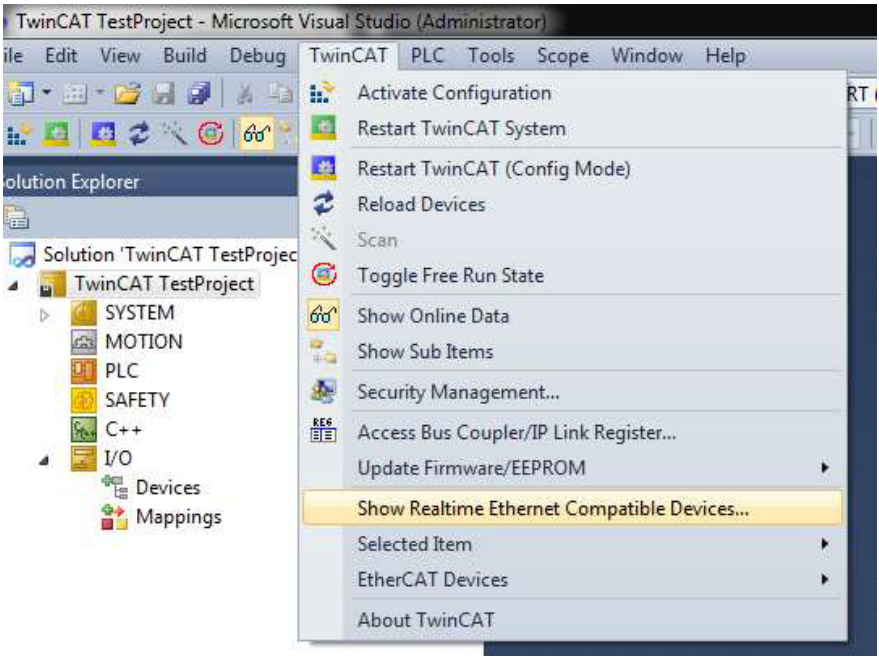
4. Move to “C:\TwinCAT\3.1\Config\Io\EtherCAT” and paste the included file "HBM_CX27.xml" (ESI file).



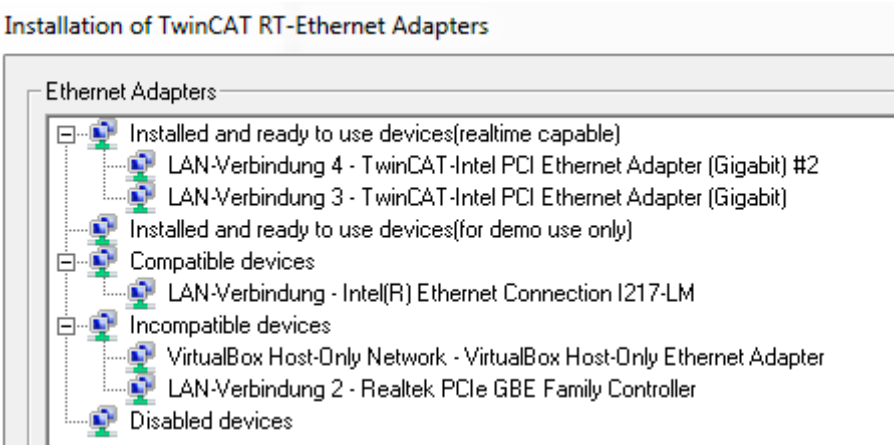
5. Open now TwinCAT3: System Tray -> right-click on the TwinCAT icon -> TwinCAT XAE
6. Create a test project (e.g. project name = “TwinCAT TestProject”); press OK



7. After project is created, open menu “TwinCAT” -> “Show Realtime Ethernet Compatible Devices…”



8. Make sure that your network card you want to use for EtherCAT communications is mentioned below “Installed and ready to use device (real-time capable)



Fix it, if it is not like shown above and then go on with the following steps

9. Now you have the following buttons:

 Activate configuration

 Run mode

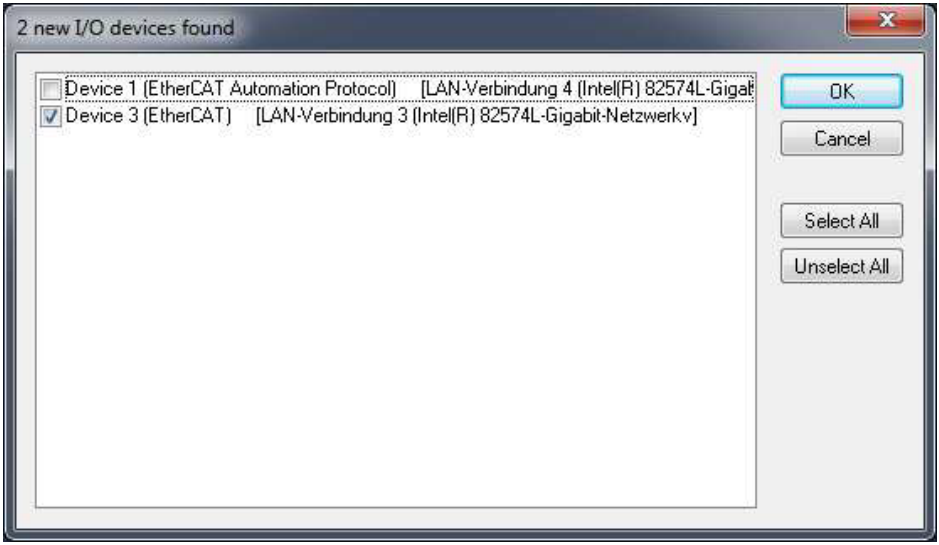
 Config mode

 Scan

 Free run

10. Press „Scan“-button
    - Press „OK“

- Mark the Device “EtherCAT”

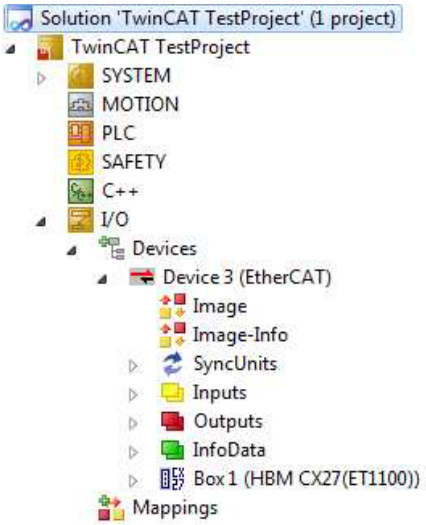


- Press “Yes”

- Press “Yes”

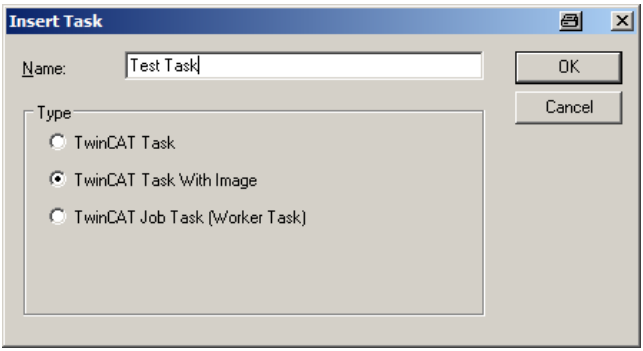
You are now still in Config-mode with free-run activated.

Your project tree should look like this:

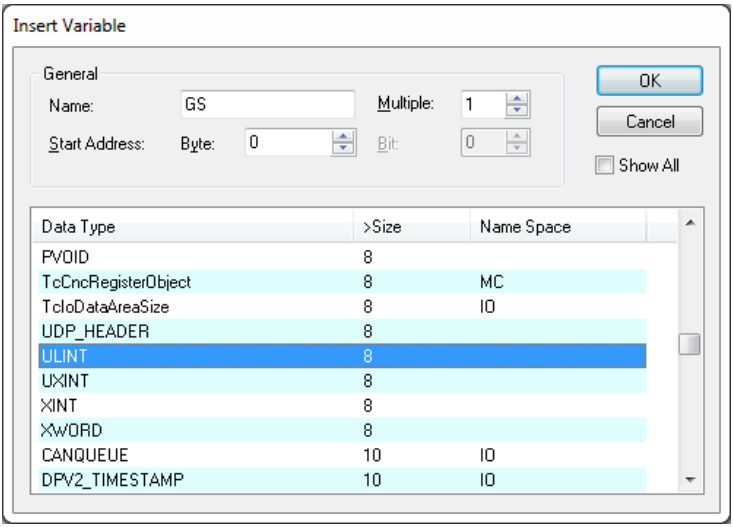


11. Create new task in project tree: “System” -> right-click on “Tasks” -> “Add new Item…”

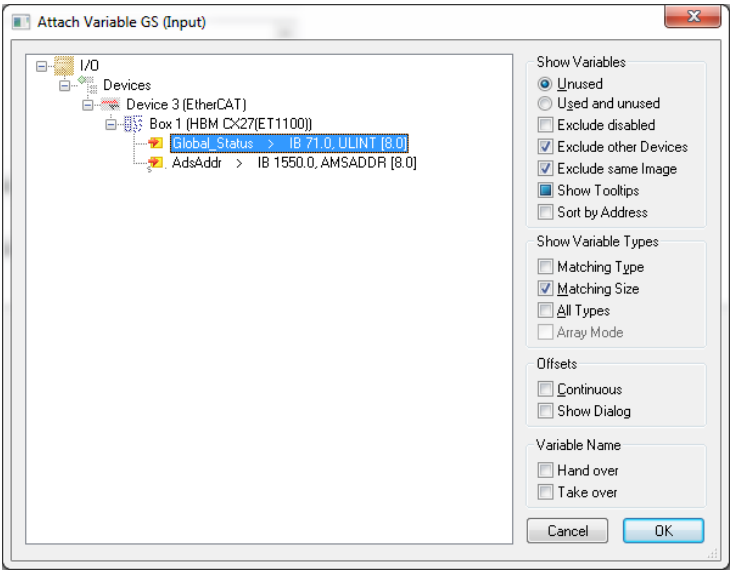
12. Enter Task name and mark the Option “TwinCAT Task With Image”



13. Create new Task variable and link it to a variable of CX27 (e.g. Global-Status): Right-click on “Inputs” -> “Add new Item…” -> Change Variable name and choose matching data type (for Global-Status it is ULINT)

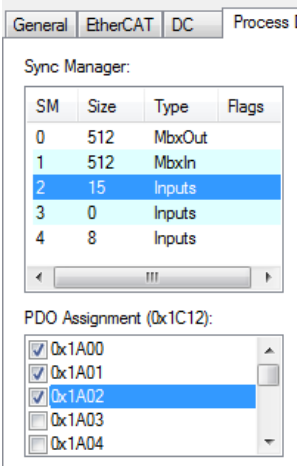


14. Press “Ok” and double-click on your new variable “GS” to link it

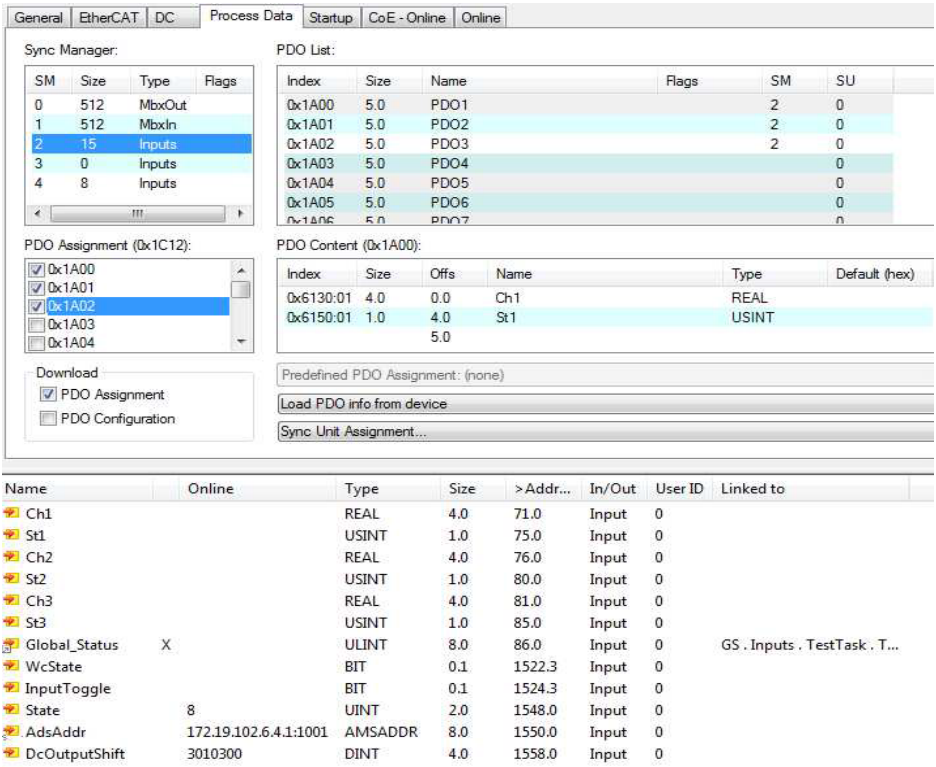


15. Choose Global_Status and press “Ok”

16. Double-click on “Box1 (HBM CX27…)” -> Open tab “Process Data”
17. Mark Sync Manager 2 (left-click on column “SM”, row 2)
18. Assign PDOs to display measurement values: add PDO 0x1A00, 0x1A01 and 0x1A02



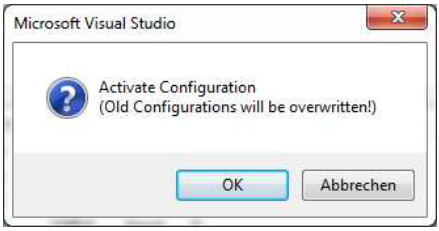
19. The PDO become now visible in the table below (PDO1 = “Ch1”, “St1” etc.)



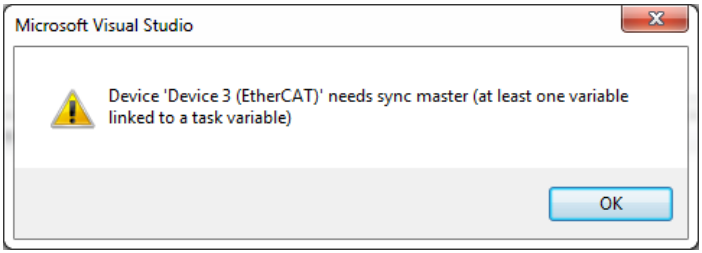
20. Save all

21. Activate your configuration

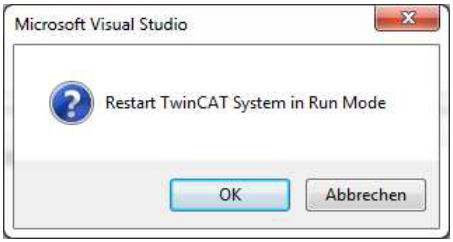
    - Press “Ok”



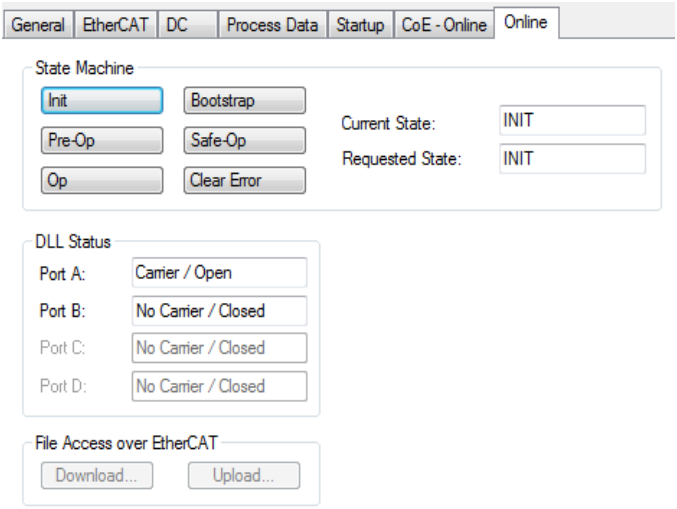
- Press “Ok”.
  This Dialog only appears if you forgot to link task and variable.

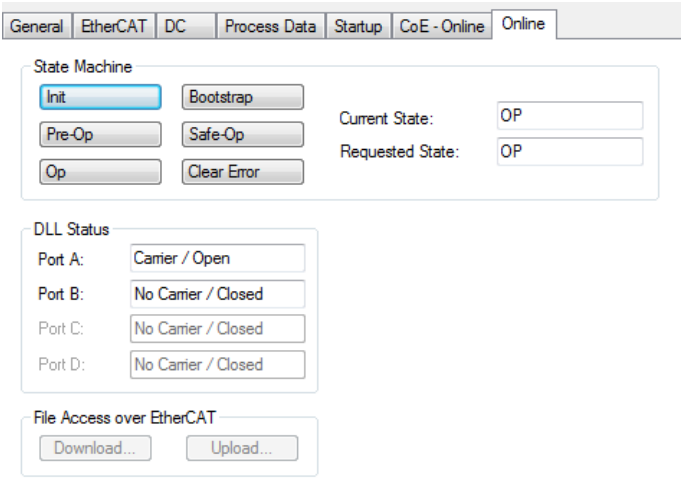


- Press “Ok”

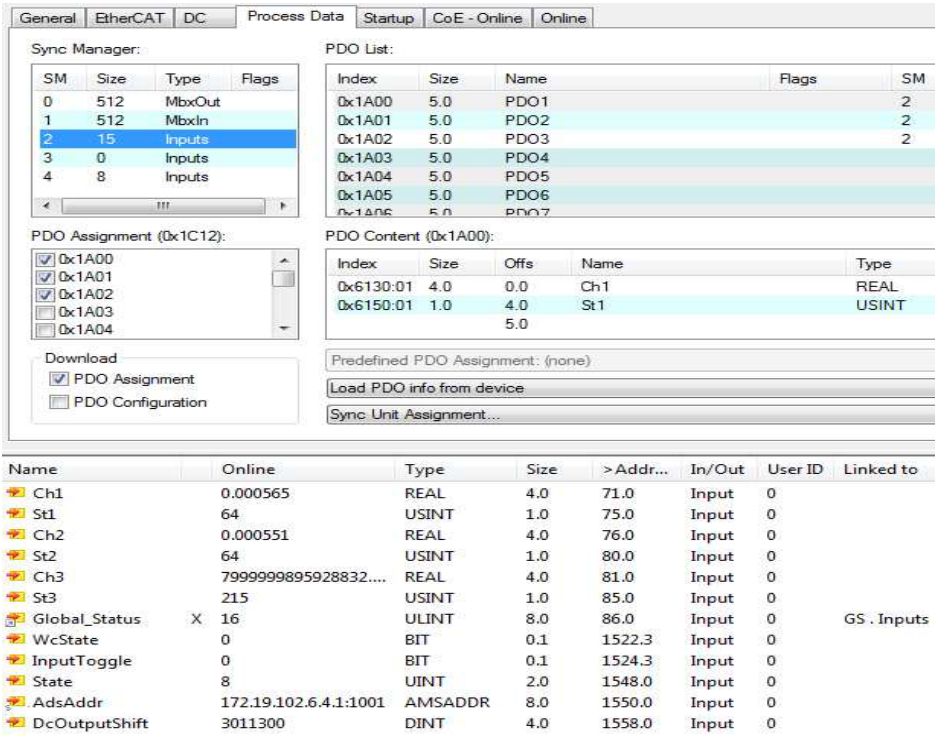


22. Open tab “Online”
23. Test if state change requests work -> press “INIT” and then “OP” and verify the behavior





24. Global Status is marked with “X” (linked) and its value is toggling in the table below (Column “online”)



Ch1 shows measurement values of channel 1 of a MX module. St1 indicates the status of the Connector. In this case a MX840B module was connected.

5.4 PROFINET IRT

5.4.1 Basic principles - PROFINET

PROFINET IRT is the name of an industrial, Ethernet-based digital network protocol family used for real-time controlling (prioritized, planned, fixed time latency) and test automation of machines and test benches.

A wide range of PROFINET master controllers is available and is connected to decentralized units (DAQ with sensors and actuators such as valves or drives). All of these PROFINET master controllers and the companies behind them are

made for different applications and sometimes even different markets. QuantumX/SomatXR is meant to be easily integrated into this powerful fieldbus, providing system integrators or end users with added value with data acquisition solutions QuantumX and SomatXR from HBM – flexible universal inputs, high precision, distributable, etc.

5.4.2 PROFINET system configuration

Connect all SomatXR MX modules together via FireWire and connect a CX27C-R gateway into the overall configuration.

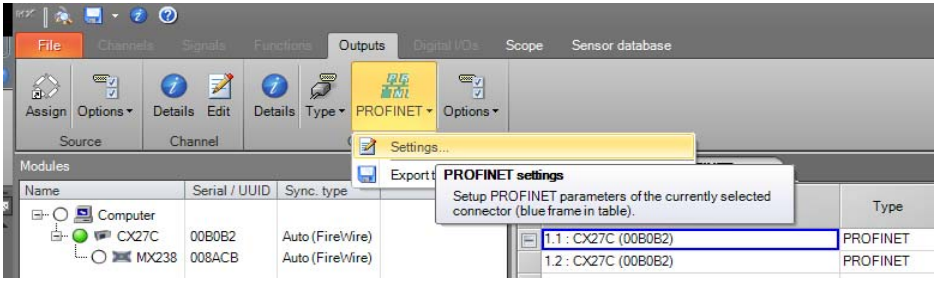
Connect the CX27C-R with PROFINET via the Ethernet cable (M12 plug connector, at least Cat5e). The PROFINET bus does not need any termination resistors, as active nodes are involved. A standard device description file (GSDXML) can be downloaded form HBM or generated using the MX Assistant software.
The file facilitates easy configuration of the master (*Chapter 5.4.4 „PROFINET data integration process“*).

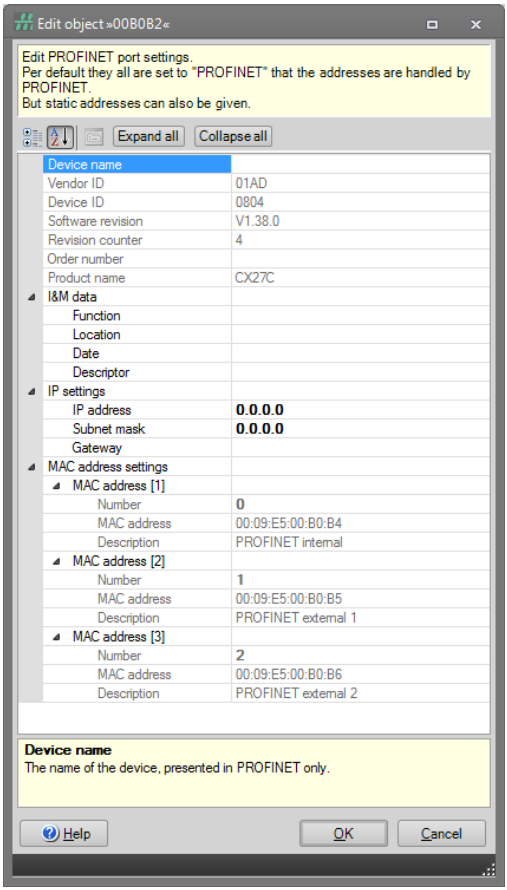
5.4.3 Cyclical transmission of data to PROFINET

SomatXR MX modules are NOT synchronized by the PROFINET controller (completely isochronal operation).

Example: Configure a 2 ms real-time loop in the controller for the fieldbus. SomatXR data is oversampled at 1200 Hz and remains at the ready for when the bus requests this data.

With the MX Assistant software and the settings dialog, you can configure an individual IP address for the PROFINET connector.



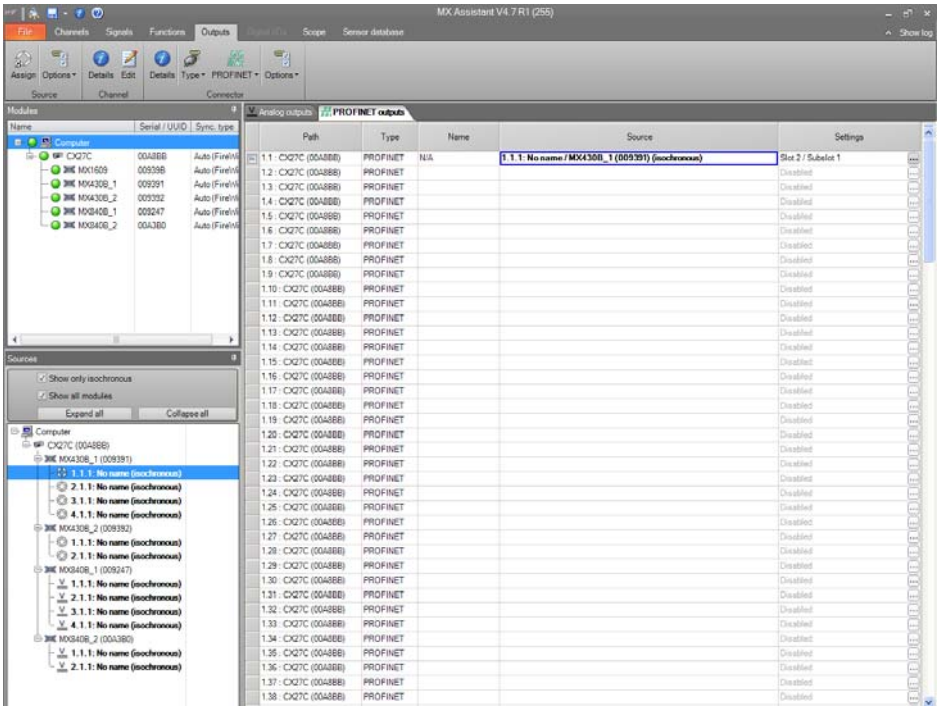


5.4.4 PROFINET data integration process

When your DAQ system meets your requirements, you can start all channels.

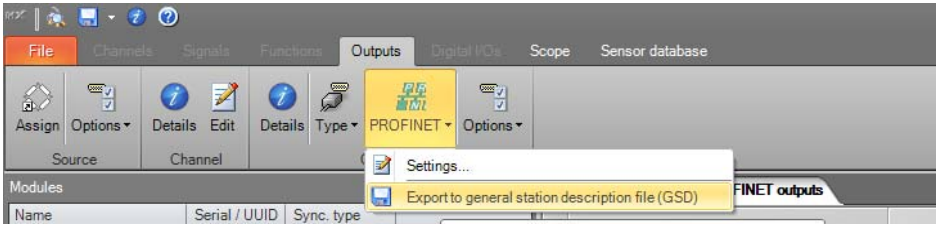
Please configure all channels with the software MX Assistant and assign the signals to PROFINET as follows.

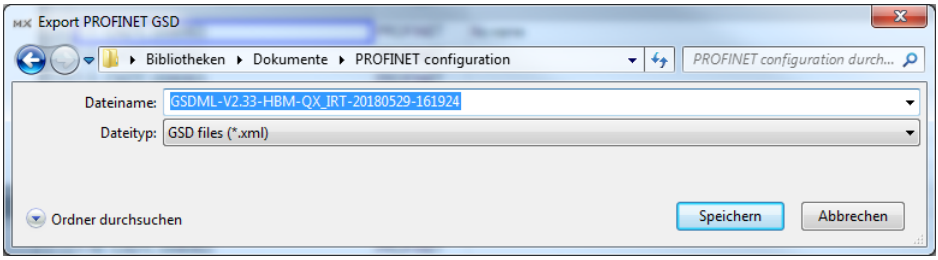
Assign all isochronous signals to PROFINET via the **Outputs** tab and the **PROFINET Outputs** sub-tab.



Use the PROFINET dialog in the menu bar to generate a **GSDML file**. This XML-based file describes your system configuration (e.g. number of slots, subslots, scaling, etc.) and serves as the basis for configuring the inputs and outputs of the PROFINET controller during project configuration. The automatically generated file can be imported into a PROFINET setup tool. If you want to change something in the SomatXR system configuration, e.g. add sensors, you will have to generate this special file again.
The file is zipped for technical reasons.

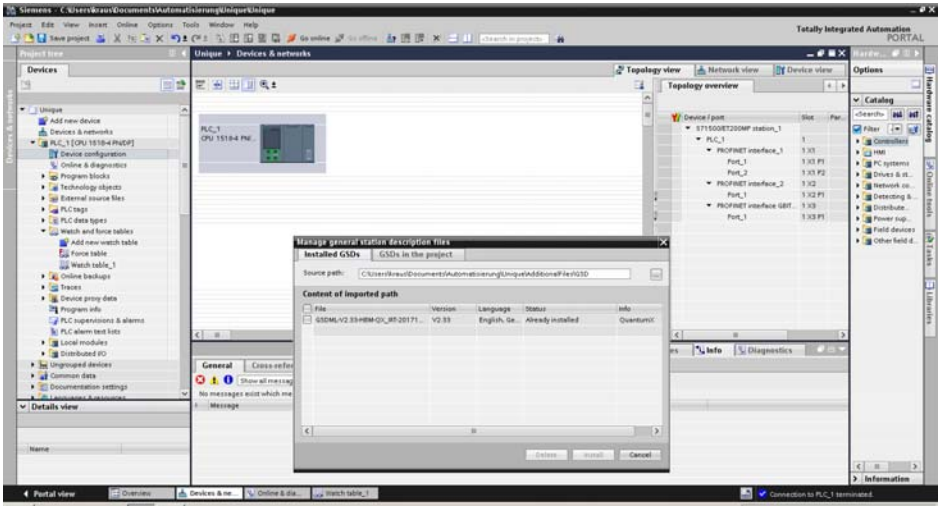
TIA Portal controller software from Siemens is used in the following example steps. There are of course other controllers on the market that can also be used.

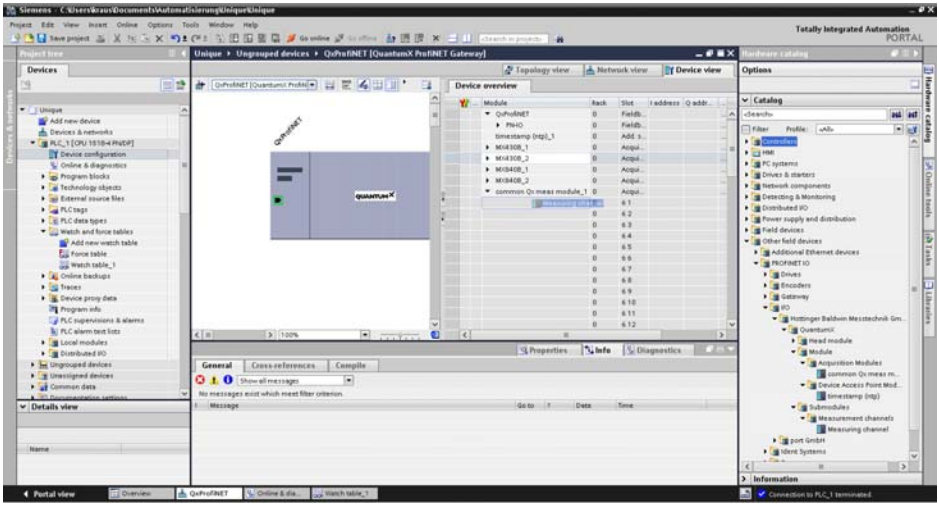


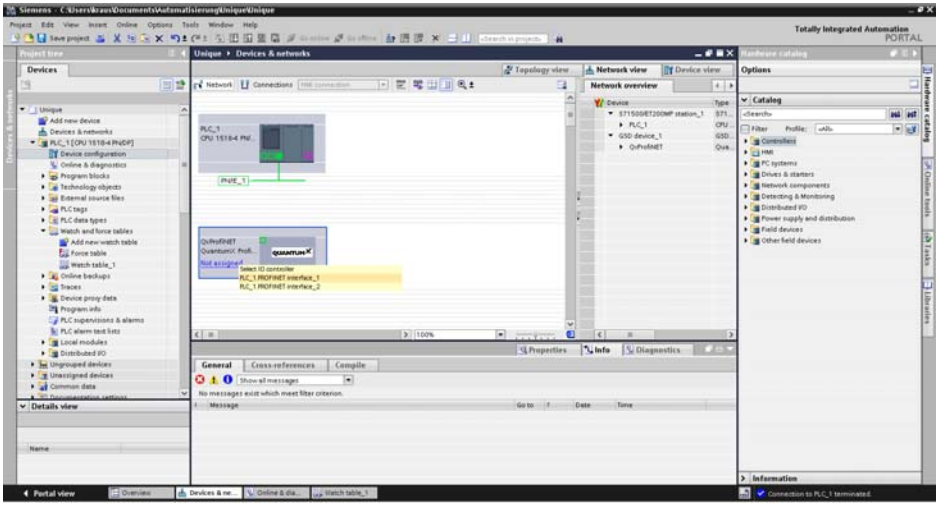


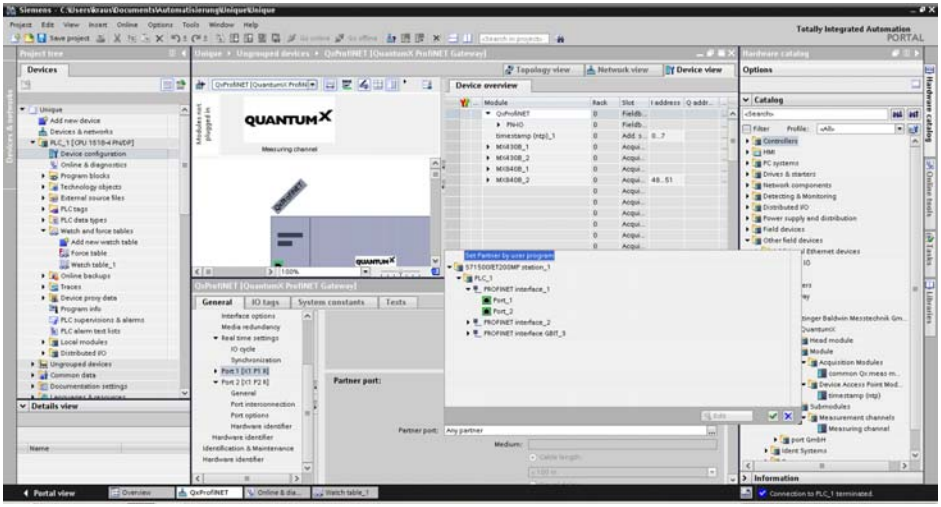
Sample: *GSDML-Version-HBM-QX_IRT-Year/Month/Day-Hour/Minute/Second*

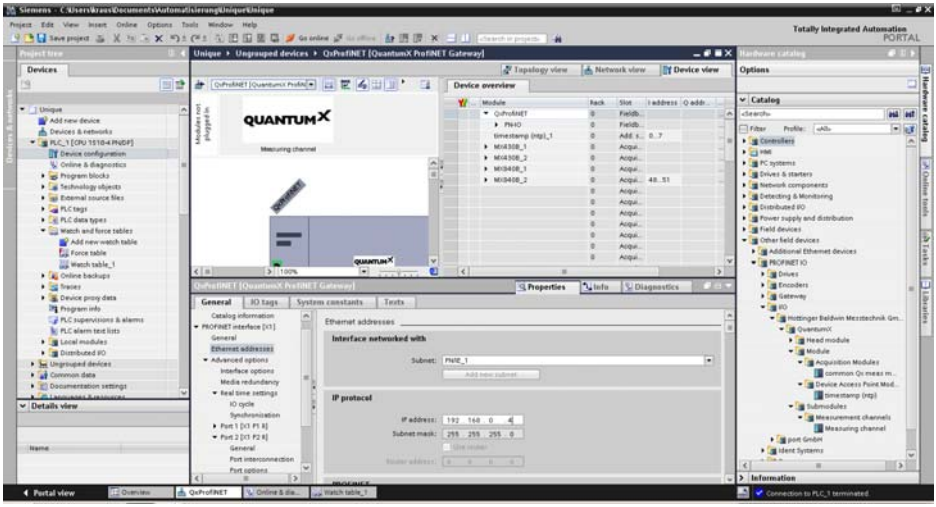
Let us now take a look at the generated file in the TIA Portal.

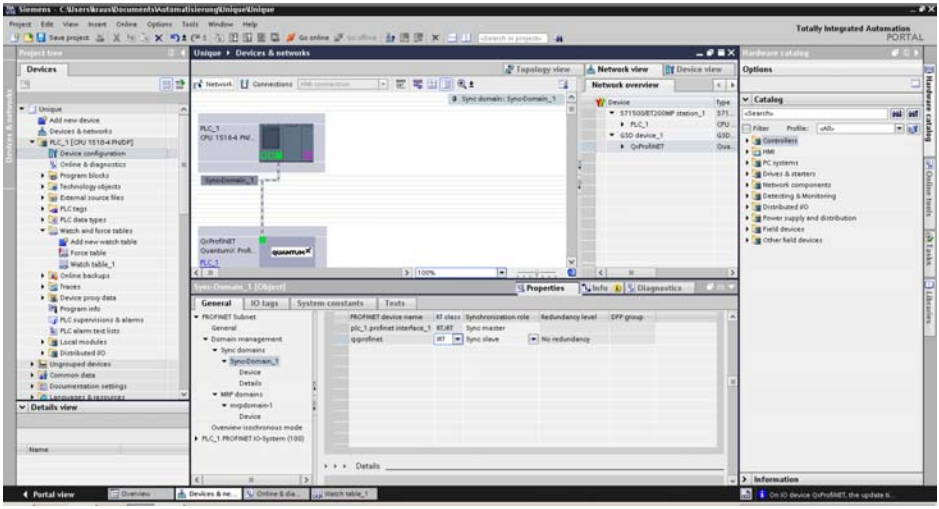


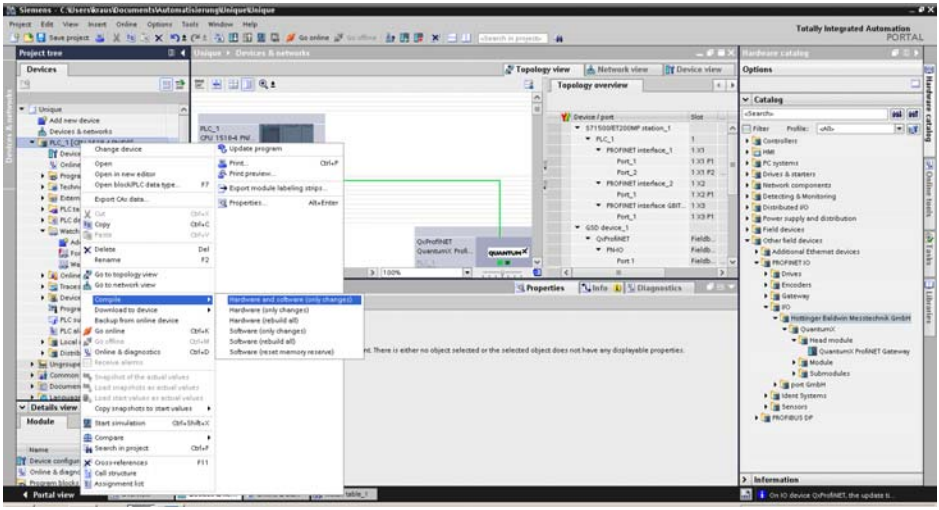


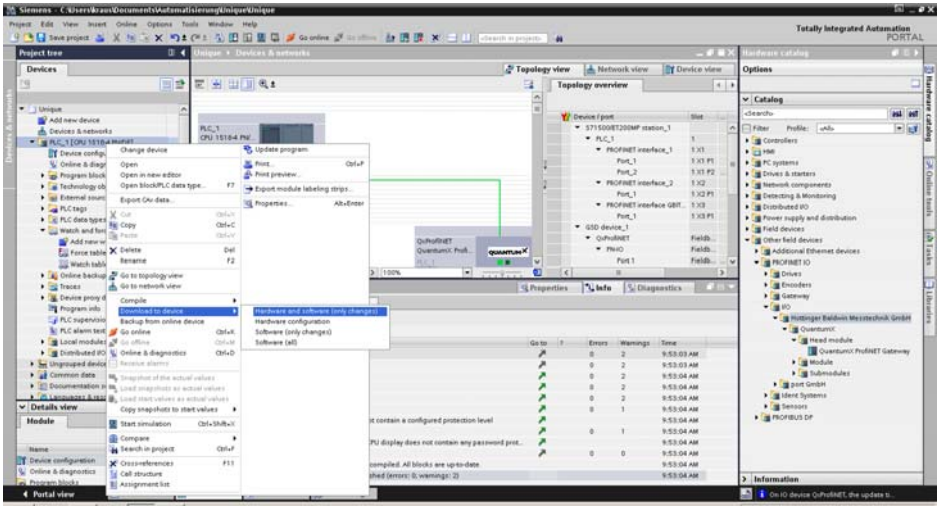


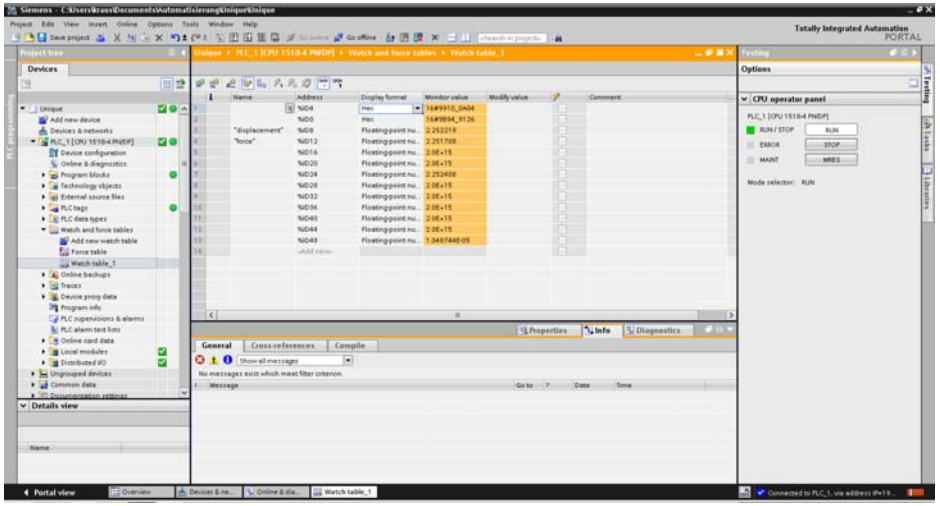

Totally Integrated Automation
PORTAL
QUANTUMX
Partner port:


Totally Integrated Automation
PORTAL
QUANTUMX
Ethernet addresses
Interface networked with
IP protocol









5.4.5 SomatXR PROFINET client diagnosis – status byte

The status of each individual signal can be assessed for diagnostics purposes. When the status is transferred to the process data level, handling becomes much easier since truly synchronous communication is involved.

The status is transmitted as an additional status byte (8 bit) right before the actual measured value.

Signal status

Status information is transmitted together with each individual measured value:

Status information	Bit
Sensor not connected	7
Reserved	6
Signal source disconnected	5
Reserved	4
Not synchronized	3
Reserved	2
Reserved	1
Invalid	0

Bit 0

This bit shows the user if the measured value is valid or not: 0 when the measured value is valid, otherwise 1, then please check the other status bits.

This bit will also be set to “1” when one or more of the bits 5 or 7 are set to “1”. In all other cases, this bit will be set to “0”, which means the measured value is valid.

Bit 3 does not influence Bit 0. It is therefore OK if the source is not synchronous (Bit 3 = 1), but the measured value is valid (Bit 0 = 0).

Bit 3

This bit indicates if the module (source of the measured value of this signal) is synchronous with its time source: 1 if not synchronized, otherwise 0.

When bit 5 = 1, bit 3 = undefined

Bit 5

This bit indicates if the assigned signal is available or not: 0 when the signal source is available isochronously, otherwise 1.
Possible sources of error:

- The source signal is not released isochronously (e.g. RtAvailable = false, signal is not available on FireWire as isochronous data).
- The module that provides the signal is not being supplied with voltage.
- The FireWire cable between the source module and CX27C-R has been pulled out or is defective.

Bit 7

This bit indicates if the assigned signal is connected with a sensor: 1 when the sensor is not connected, otherwise 0.

When the sensor is not connected => bit 7 = 1, otherwise 0.

When bit 5 = 1, bit 7 = undefined

System or module status

An entire system or module status is also transmitted.

Reserved	CX is not synchronized with external clock pulse	Loss of internal QuantumX synchronization
15:2	1	0

Bit 0: When at least one connected MX module is not synchronized (or the signal status bit 3 is set for any connected module), this bit = 1, otherwise 0.

Bit 1: If CX27C is not synchronized with an external clock pulse, this bit will be set to 1, otherwise 0.

5.5 XCP-on-Ethernet

5.5.1 Basics

What is XCP?

The aim of the ASAM (Association for Standardization of Automation and Measuring Systems) is to ensure the smart networking of tools and seamless exchange of data through standardization of the development chain. The tools are used to develop and validate vehicles, their components, and their control systems.

The term XCP is based on the ASAM standard CAN Calibration Protocol (CCP). The first version of XCP in 2003 was created in particular for the development, calibration and testing of electronic control units (ECUs) in the automotive industry. Today, ASAM MCD-1 XCP is a standard for practically all leading tools in the field of measurement calibration. ASAM MCD-1 XCP is needed in order to read and process the memory of the ECU. By optimizing the parameters of the ECU algorithms, data exchange between the ECU and the tools can be coordinated.

As HBM is a member of ASAM, the sharing of information and collaboration with other suppliers on the market help us to give our customers maximum flexibility in achieving their project objectives.

What does HBM use XCP for?

Additional sensor data via XCP-on-Ethernet ensures the coordination of software parameters

As size and complexity increase, functional software development plays a vital role in vehicles of every kind. The algorithms that run on modern ECUs must be precisely coordinated and regularly adapted before vehicles are approved. Fine tuning and optimization begin in a simulated environment on a PC, but validation still largely takes place in real-life conditions on a test bench or on a test track.

Additional sensor data provides a better understanding of the physics involved and is of fundamental importance for rapid optimization and software release. The inclusion of SomatXR measurement modules, with their extremely universal inputs that cover all types of sensor in a scalable manner, enables

the superimposition of all data sources – sensors in the vehicle and bus signals from additional sensors.

With the standardized XCP protocol, all data can be integrated in the same workflow easily and very flexibly. All this means user-friendly integration in your software tools and test setups for MCD (measurement, calibration and diagnostics), therefore optimizing embedded software.

CX27 via XCP features:

- Includes XCP-on-Ethernet client function (50-100 times faster than CAN)
- Supports XCP version 1.4, but is also backward-compatible with version 1.0.
- Channels are configured via an expandable sensor database or automatically via smart sensor support (TEDS, IEE1451.4)
- The overall configuration is produced as an **A2L** file and imported into the MCD tool
- Parallel integration in EtherCAT or PROFINET IRT

5.5.2 Configuration

To integrate HBM test and measuring equipment in MCD software that is not from HBM (e.g. CANape from Vector Informatik, INCA from ETAS, Vision from ATI, PUMA Open from AVL, ControlDesk from dSpace, and diagraX from RA Consulting), you must perform the following basic steps:

1. Connect the test and measuring equipment
2. Configure the test and measuring equipment and assign signals to the XCP paths
3. Export the channel configuration into the A2L file
4. Import the channel configuration in your third party software

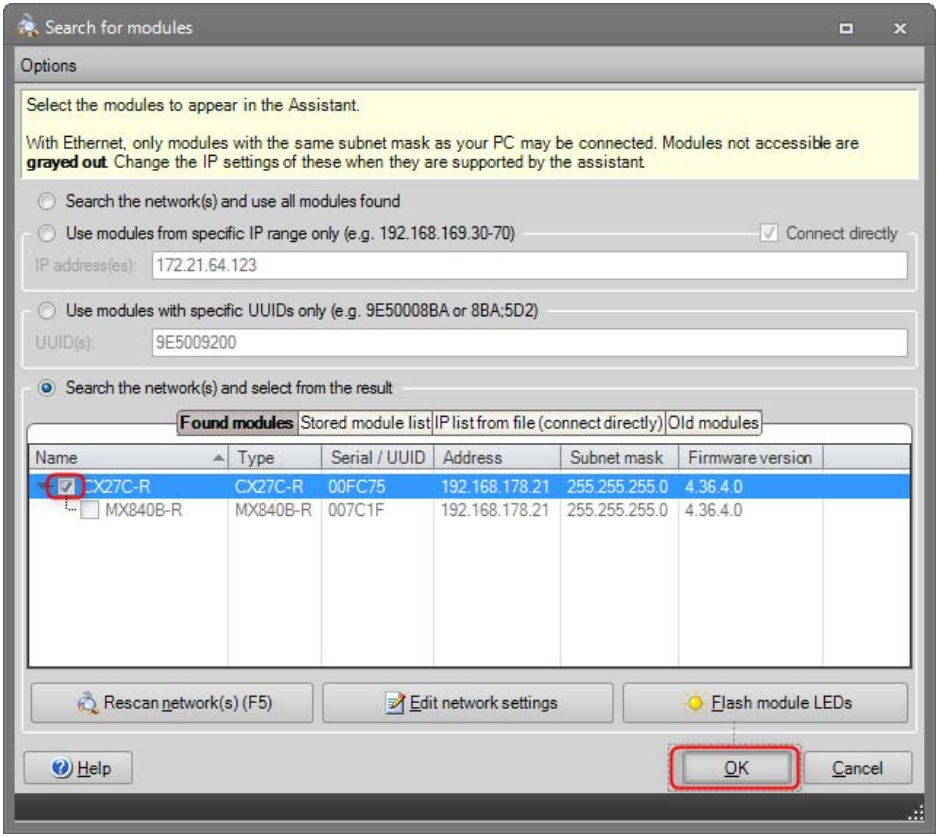
Connecting the test and measuring equipment

► Connect all sensors to the SomatXR modules and connect these to the CX27C-R Industrial Ethernet gateway via FireWire cable.

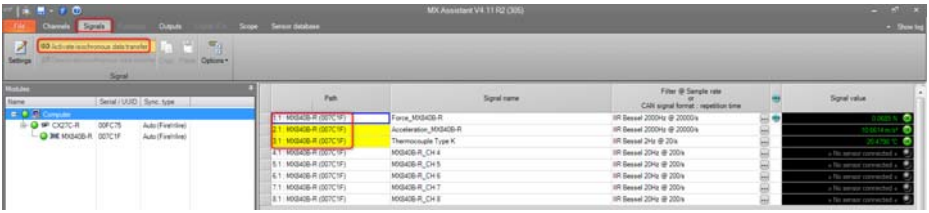
► After this, switch on power to the modules. You can find details in the MX manual, which you can download from www.hbm.com.

Configuring the test and measuring equipment and assigning signals to the XCP paths

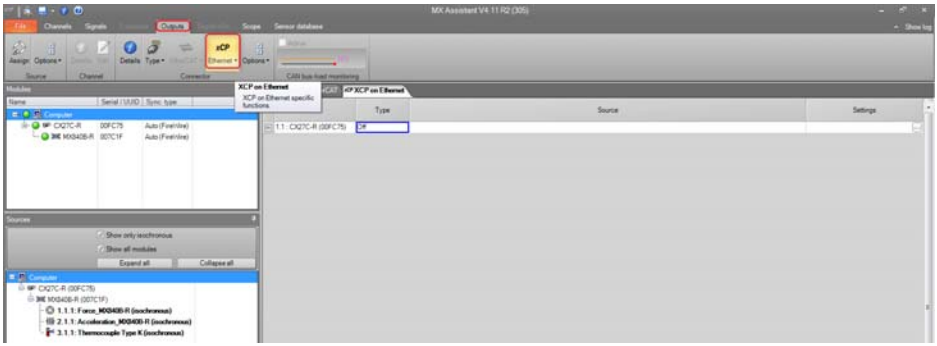
► Start the MX Assistant and scan for modules (press F4).



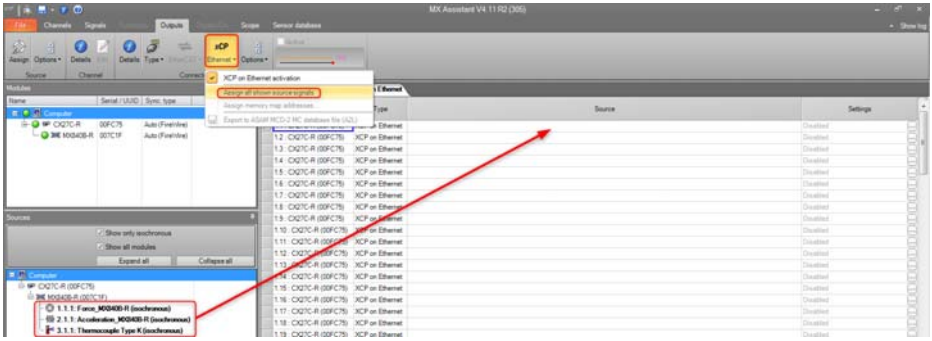
- ► Select CX27C-R (the modules connected via FireWire are automatically connected as well) and click ‘OK’ to confirm.
- ► Now configure the input channels of your SomatXR modules. Connected TEDS sensors are configured automatically, while others can be configured using the integrated sensor database (SDB).
- ► Open the “Signals” tab and set the required sample rate and filter for each signal. Select all active signals and activate isochronous data transfer.



- ► In the “Outputs” tabs, select “XPC on Ethernet” and activate XCP on Ethernet.

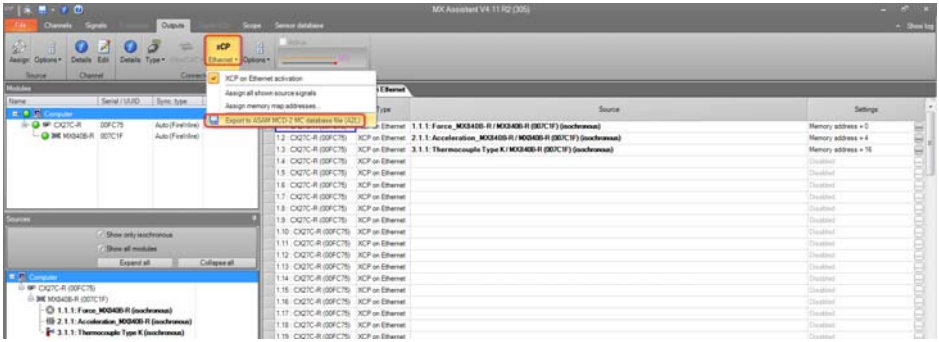


► Either assign all signal sources automatically or assign the XCP paths using drag & drop, and correct the address of the memory if necessary.



Export the channel configuration into the A2L file

► Now export this configuration into an A2L file and save it on your PC.



Importing the channel configuration in your third party software

► Now open the software in which you wish to import the SomatXR signals. Here, you can import the A2L file, so that the completed configuration is copied there automatically. You can find some examples in the Tech Notes on our website: /www.hbm.com

6 Description of diagnosis and alarms

Possible SDOs for the gateway are described in this section (name, description, value range, data type, index/sub-index).

Index

The index gives the position of the object in the object dictionary. The index value is specified in hexadecimal. The values for the DS404 device profile begin with address 0x6xxx.

Object code

The object code indicates the data structure of the object.

Object code	Meaning	Coding
VAR	A simple value; types include Integer8, Unsigned32 and Visible String8.	7
ARRAY	A data field in which every entry belongs to the same data type.	8
RECORD	A data field with entries that are a combination of simple data types.	9

Data type	Value range	Data length
Boolean	0 = false, 1 = true	1 byte
INT8	-128 to +128	1 byte
INT16	-32768 to +32768	2 bytes
INT32	-2147483648 to +2147483648	4 bytes
UINT8	0 to 255	1 byte
UINT16	0 to 65535	2 bytes
UINT32	0 to 4294967295	4 bytes
Visible string8	ASCII characters	8 bytes
Visible String16	ASCII characters	16 bytes

Access

ro: Read only
rw: Read/write
wo: Write only

PDO assignment

The PDO assignment means the assignment of application objects (real-time data) from the object directory to process data objects. CANopen device profiles offer a standard assignment for each device type, which are suitable for most applications.

Organization of the object index

Object index (hexadecimal)	Object index (decimal)	Object
0000	0	Not in use
0001 - 001F	1 / 31	Static data types
0020 - 003F	32 / 63	Complex data types
0040 - 005F	64 / 95	Manufacturer-specific complex data types
0060 - 007F	96 / 127	Device-specific static data types
0080 - 009F	128 / 159	Device-specific complex data types
00A0 - 0FFF	160 / 4095	Reserved for future use
1000 - 1FFF	4096 / 8191	Range for communication profile
2000 - 5FFF	8192 / 24575	Range for manufacturer-specific profile
6000 - 9FFF	24576 / 40959	Range for standardized device profile
A000 - FFFF	40960 / 65535	Reserved for future use

Overview of SDO objects

Description	Object name	Index (hex)	Access
Sensor			
Sensor type	AI_Sensor_type	6110	ro
Operating mode	AI_Operating_ mode	6112	ro
Sample rate of the A/D converter	AI_ADC_sample_rate	6114	rw
Manufacturer of the transducer	AI_Sensor_ manufacturer	6115	ro
Model of the transducer	AI_Sensor_ model	6116	ro
Serial number of the transducer	AI_Sensor_ serialnumber	6118	ro
Location of the transducer	AI_Sensor_ location	6119	ro
Calibration period of the transducer	AI_Sensor_calibration_period	611B	ro
TEDS			
TEDS chip control	AI_TEDS_ control	611C	rw
Scaling			
Input scaling 1 FV	AI_Input_scaling_1_FV	6120	rw
Input scaling 1 PV	AI_Input_scaling_1_PV	6121	rw
Input scaling 2 FV	AI_Input_scaling_2_FV	6122	rw
Input scaling 2 PV	AI_Input_scaling_2_PV	6123	rw
Input offset	AI_Input_offset	6124	rw
Automatic zero balance	AI_Autozero	6125	wo
Scaling factor	AI_Scaling_ factor	6126	rw
Scaling offset	AI_Scaling_ offset	6127	rw

Description	Object name	Index (hex)	Access
Display value of the process value			
Input of the PV	AI_Input_PV	6130	ro
Physical unit of the PV	AI_Physical_unit_PV	6131	rw
Overflow limits for process values			
Min.	AI_Span_start	61148	ro
Max.	AI_Span_end	61149	ro
Input status			
Status	AI_Status	6150	ro
Filter type	AI_Filter_type	61A0	rw
Filter frequency	AI_Filter_ frequency	61A2	rw
Identification			
Signal name of the connector	AI_Signal_name	61B0	rw
Connector identification	AI_Connector_ identification	61B1	ro

7 Waste disposal and environmental protection

All electrical and electronic products must be disposed of as hazardous waste. The correct disposal of old equipment prevents ecological damage and health hazards.

Statutory waste disposal marking

The electrical and electronic devices that bear this symbol are subject to the European waste electrical and electronic equipment directive 2002/96/EC. The symbol indicates that, in accordance with national and local environmental protection and material recovery and recycling regulations, old devices that can no longer be used must be disposed of separately and not with normal household garbage.

If you require more information about disposal, please contact your local authorities or the dealer from whom you purchased the product.

As waste disposal regulations may differ from country to country, we ask that you contact your supplier to determine what type of disposal or recycling is legally applicable in your country.

Packaging

The original packaging of HBM devices is made from recyclable material and can be sent for recycling. For ecological reasons, empty packaging should not be returned to us.

Environmental protection

The product should maintain the general hazardous material limit values for at least 20 years and become ecologically harmless as well as recyclable during this time.

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