

X20IF10G1-1

Data sheet
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1 General information

1.1 Other applicable documents

For additional and supplementary information, see the following documents.

Other applicable documents

Document name	Title
MAX20	X20 System user's manual

1.2 Order data


Order number	Short description	Figure
	X20 interface module communication	
X20IF10G1-1	X20 interface module for DTM configuration, 1 EtherCAT master interface, electrically isolated	

Table 1: X20IF10G1-1 - Order data

1.3 Module description

The interface module is equipped with an EtherCAT interface. This allows the B&R system (I/O modules, POWERLINK, etc.) to be connected to systems from other manufacturers and makes it possible to quickly and easily transfer data in both directions.

The interface is equipped with 2 RJ45 connections.

Functions:

- [EtherCAT master](#)
- [Error monitoring](#)

EtherCAT

EtherCAT is an Ethernet-based fieldbus developed by Beckhoff. This protocol is suitable for both hard and soft real-time requirements in automation technology.

Error monitoring

The status of the module and fieldbus is monitored. An error code is returned if an error occurs.

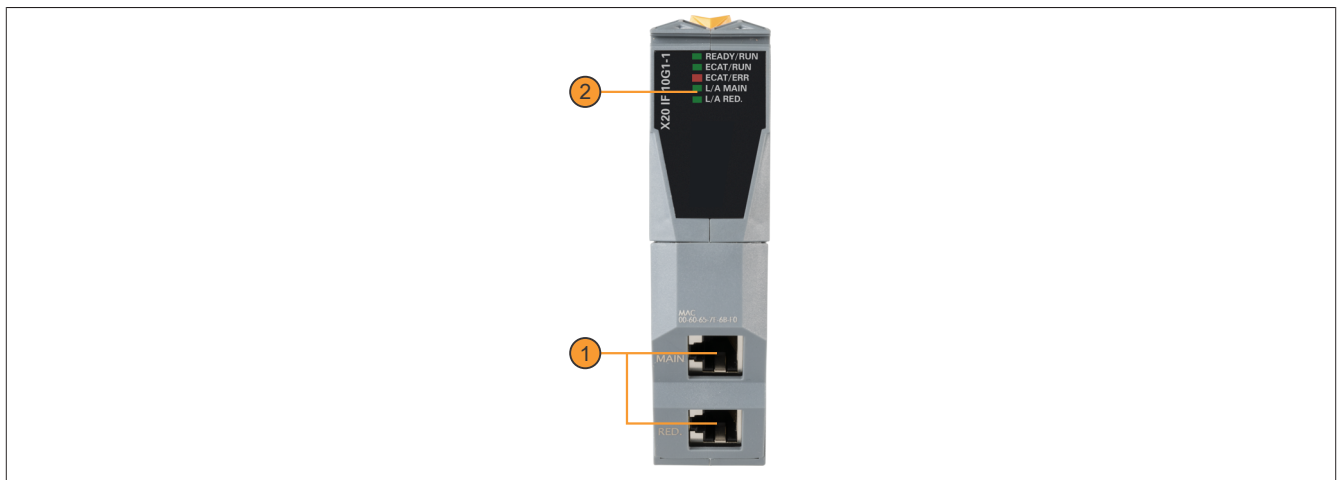
2 Technical description

2.1 Technical data

Order number	X20IF10G1-1
Short description	
Communication module	EtherCAT master
General information	
B&R ID code	0x2E3E
Status indicators	Module status, network status, data transfer
Diagnostics	
Module status	Yes, using LED status indicator and software
Network status	Yes, using LED status indicator and software
Data transfer	Yes, using LED status indicator
Power consumption	2 W
Additional power dissipation caused by actuators (resistive) [W]	-
Certifications	
CE	Yes
UKCA	Yes
ATEX	Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÜ 09 ATEX 0083X
UL	cULus E115267 Industrial control equipment
Interfaces	
Fieldbus	EtherCAT (master)
Variant	2x shielded RJ45
Line length	Max. 100 m between 2 stations (segment length)
Transfer rate	100 Mbit/s
Transfer	
Physical layer	100BASE-TX
Half-duplex	Yes
Full-duplex	Yes
Autonegotiation	Yes
Auto-MDI/MDIX	Yes
Controller	netX100
Memory	8 MB SDRAM
Electrical properties	
Electrical isolation	PLC isolated from EtherCAT (IF1 and IF2)
Operating conditions	
Mounting orientation	
Horizontal	Yes
Vertical	Yes
Installation elevation above sea level	
0 to 2000 m	No limitation
>2000 m	Reduction of ambient temperature by 0.5°C per 100 m
Degree of protection per EN 60529	IP20
Ambient conditions	
Temperature	
Operation	
Horizontal mounting orientation	-25 to 60°C
Vertical mounting orientation	-25 to 50°C
Derating	-
Storage	-40 to 85°C
Transport	-40 to 85°C
Relative humidity	
Operation	5 to 95%, non-condensing
Storage	5 to 95%, non-condensing
Transport	5 to 95%, non-condensing
Mechanical properties	
Slot	In the X20 PLC and expandable bus controller X20BC1083

Table 2: X20IF10G1-1 - Technical data

2.2 Operating and connection elements



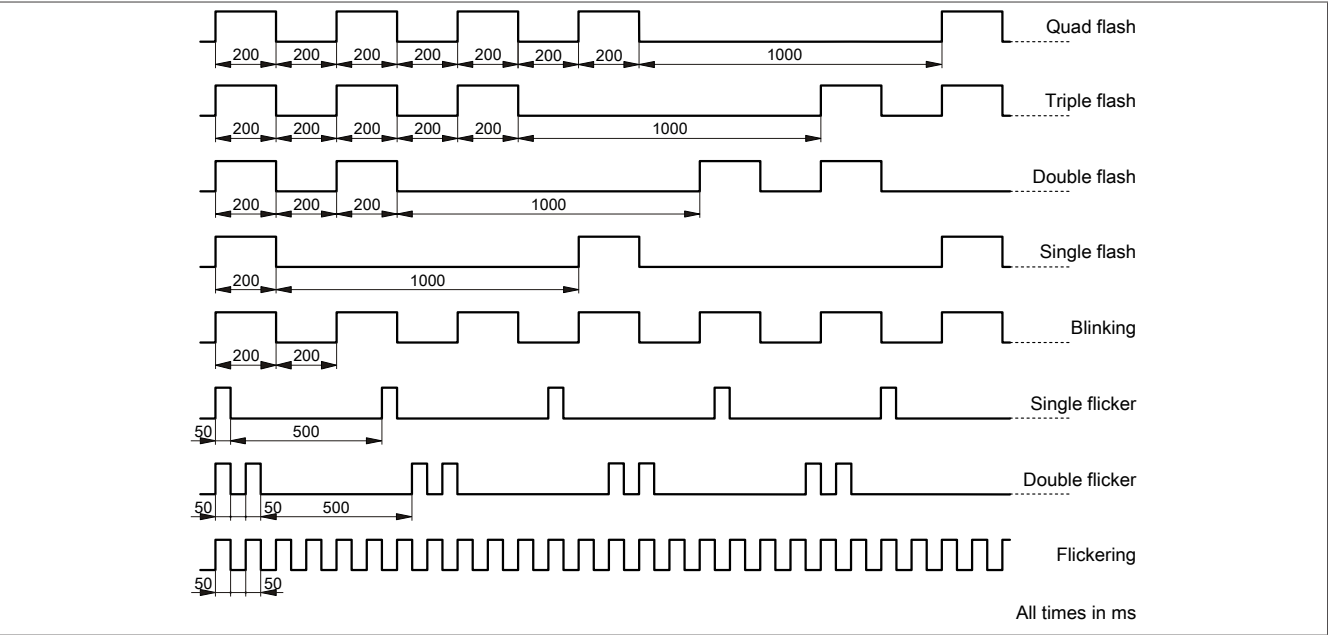
1	EtherCAT connection with 2x RJ45	2	LED status indicators
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2.2.1 LED status indicators

Figure	LED	Color	Status	Description
	READY/RUN	Green/Red	Off	No power to module
		Red	Blinking	Boot error
		Green	On	Communication on the PCI bus has not yet been started.
	ECAT RUN	Green	On	PCI bus communication in progress
			Off	State INIT
			Single flash	State SAFE-OPERATIONAL
			Blinking	State PREOPERATIONAL
			Flickering	Module is not configured.
			On	State OPERATIONAL
	ECAT ERR	Red	Off	No error
			Single flash	BusSync error
			Double flash	Internal stop of the bus cycle
			Triple flash	DPM watchdog was ended.
			Quad flash	There is no master license in the module.
			Blinking	Error in the configuration database
			Single flicker	Channellnit for the master was executed.
				Information: Temporary error, may not be visible.
			Double flicker	Possible causes: <ul style="list-style-type: none"> Slave missing Unconfigured slave present No matching required slave list No bus connected
			Flickering	Startup was aborted due to an error.
	L/A MAIN L/A RED.	Green	Off	There is no physical Ethernet connection (PORT CLOSED).
			Blinking	The respective LED blinks if there is Ethernet activity (PORT OPEN) on the corresponding RJ45 connection (on, off).
			On	There is a connection (link), but no communication is taking place (PORT OPEN).

Technical description

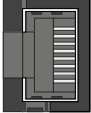
LED status indicators - Blink times



2.2.2 Ethernet interface

For information about wiring X20 modules with an Ethernet interface, see section "Mechanical and electrical configuration - Wiring guidelines for X20 modules with Ethernet cables" in the X20 user's manual.



Interface		Pinout	
		Pin	Ethernet
 1 Shielded RJ45	1	RXD	Receive data
	2	RXD\	Receive data\
	3	TXD	Transmit data
	4	Termination	
	5	Termination	
	6	TXD\	Transmit data\
	7	Termination	
	8	Termination	

3 Function description

3.1 EtherCAT

EtherCAT is an Ethernet-based fieldbus developed by Beckhoff. This protocol is suitable for both hard and soft real-time requirements in automation technology. In addition to a ring structure, which becomes logically necessary because of the summation frame telegram used, the EtherCAT technology also physically supports topologies such as line, tree, star (limited) and combinations of these topologies. B&R's X20BC80G3 (expandable bus controller module) and X20HB88G0 (standalone junction base module) are available for implementing these topologies.

EtherCAT slave devices take the data designated for them from a telegram as it is passing through the device. Input data is also added to the telegram as it is passing through.

Master systems without FoE (File access over EtherCAT) support require an appropriate configuration tool to transfer the configuration (optional).

For additional information, see [The EtherCAT interface](#).

3.2 Error codes

The module returns an error code if an error occurs. A complete list of all error codes in PDF format is available in under item "Communication_Error" in section "Communication / Fieldbus systems / Support with FDT/DTM / Diagnostic functions / Diagnostics on the runtime system / Master diagnostics" in Automation Help.

3.3 Supported protocols

- CoE ... CANopen over EtherCAT (via library in Automation Studio)

4 Commissioning

4.1 Firmware

The module comes with preinstalled firmware. The firmware is part of the Automation Studio project. The module is automatically brought up to this level.

A hardware upgrade must be performed to upgrade the firmware included in Automation Studio (see Help "Project management - Workspace - Upgrades" in Automation Help).

4.2 Operating the module

The interface module can be operated in the slot of a controller or in the slot of an expandable POWERLINK bus controller.

4.2.1 Use in the expandable X20BC1083 POWERLINK bus controller

4.2.1.1 Cyclic data

If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame. This is 1488 bytes each in the input and output directions.

When using multiple X20IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.

4.2.1.2 Operation

It is important to note the following in order to operate the module with the bus controller without problems:

- A minimum revision $\geq E0$ is required for the bus controller.
- The module can only be operated with the POWERLINK V2 setting. V1 is not permitted.
- With SDO access to POWERLINK object 0x1011/1 on the bus controller, the firmware and configuration stored on the bus controller are not reset. They can only be overwritten by accessing them again. This affects objects 0x20C0 and 0x20C8, subindexes 92 to 95.

4.2.1.3 Synchronous data exchange



Information:

Synchronous data exchange is not possible when using module X20IFG1-1 on the bus controller.

4.2.1.4 Timing characteristics

The internal data transfer results in an additional runtime shift of one cycle per direction.



Information:

For additional information about runtime behavior, see section "Runtime shift" in X20BC1083.

5 The EtherCAT interface

From an Ethernet standpoint, the EtherCAT bus is simply a single large Ethernet station. This "station" receives and transmits Ethernet telegrams. The station does not include an Ethernet controller with downstream microprocessor, however, but rather a large number of EtherCAT slaves. These slaves process the incoming telegrams during the cycle and extract the relevant payload data or add it and then forward the telegram to the next EtherCAT slave. The last EtherCAT slave then returns the now fully processed telegram so that it will be sent back to the master by the first slave as a kind of response telegram. This procedure utilizes the fact that Ethernet deals separately with transfers in separate directions (Tx and Rx lines) and operates in full-duplex mode.

The telegrams are processed in a continuous process. While the telegrams are already being sent on, delayed by just a few bits, the slave recognizes certain commands for itself and executes them accordingly. Processing takes place in the hardware and is therefore independent of the response times of the slave. Each station has an addressable memory area of 64 kB, within which it is possible to read, write or write and read simultaneously. Several EtherCAT commands can be embedded within an Ethernet telegram, each of which addresses individual stations and/or memory areas.

5.1 Object dictionary

The object dictionary is divided into different, clearly defined areas. For detailed information about the objects, see the EtherCAT specification.

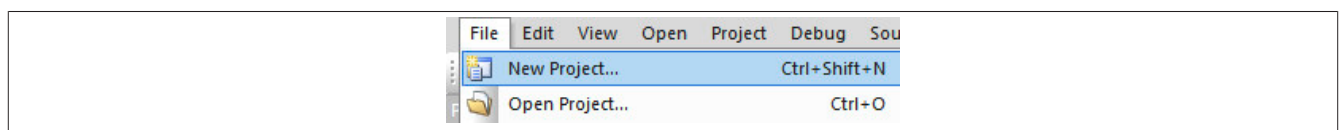
Index	Area	Description
0x0000 to 0x0FFF	Data type area	Definition and description of data types
0x1000 to 0x1FFF	Communication area	Definition of generally valid variables. (Communication objects for all devices are defined in CANopen standard DS301.)
0x2000 to 0x5FFF	Manufacturer-specific area	Definition of manufacturer-specific variables
0x6000 to 0x9FFF	Profile area	Definition of profile-related variables
0xA000 to 0xFFFF	Reserved	Reserved

5.2 Settings in Automation Studio

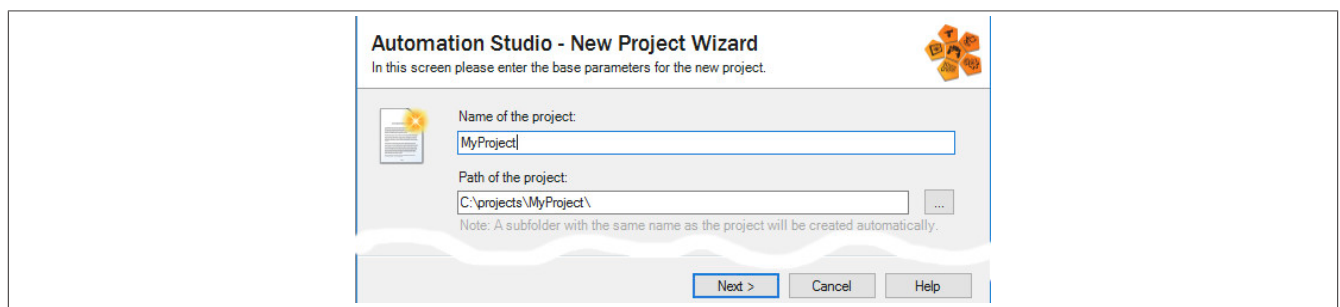
To configure the interface, a new Automation Studio project is created and the suitable settings are made on the module.

5.2.1 Creating an Automation Studio project

- Create a new Automation Studio project by selecting "New project".

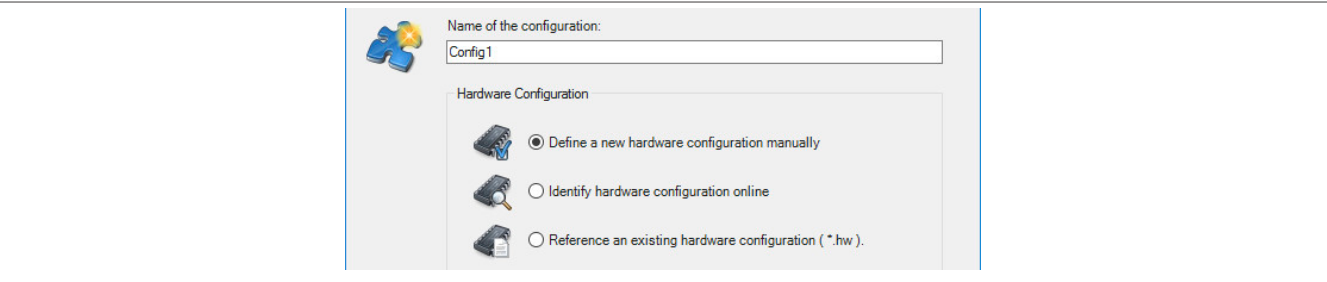


- Assign a project name and set up the project path.

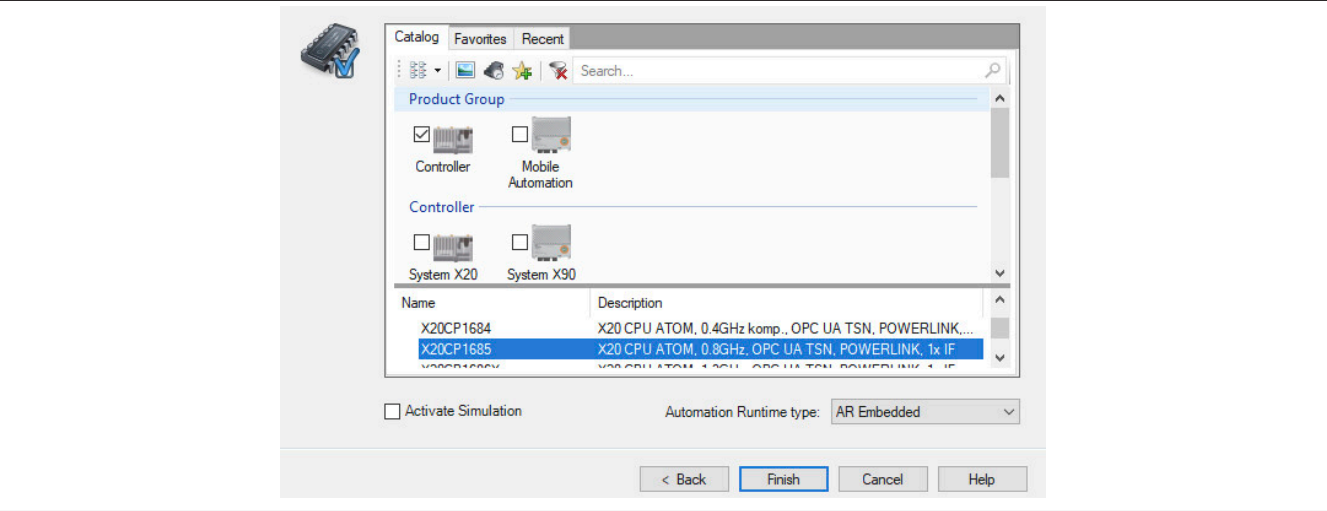


The EtherCAT interface

- The type of hardware configuration is selected, and the name of the configuration is assigned.

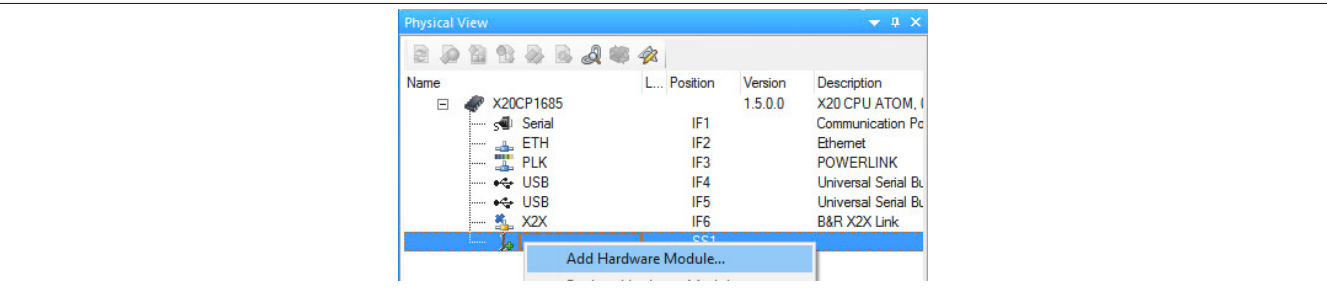


- If "Define a new hardware configuration manually" was selected, the hardware is selected in the next step. In order to simplify the search, different filters can be set for this in the Hardware Catalog. Finally, the Automation Studio project is created by selecting the required hardware is and clicking "Finish".

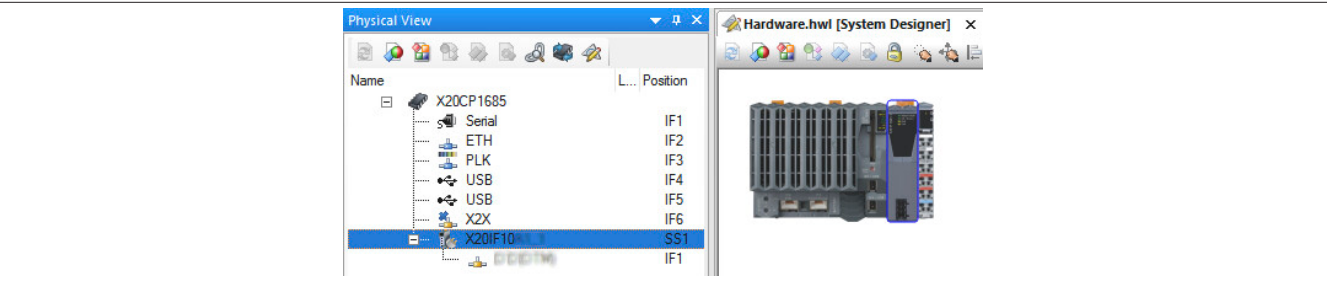


5.2.2 Adding and configuring the interface module

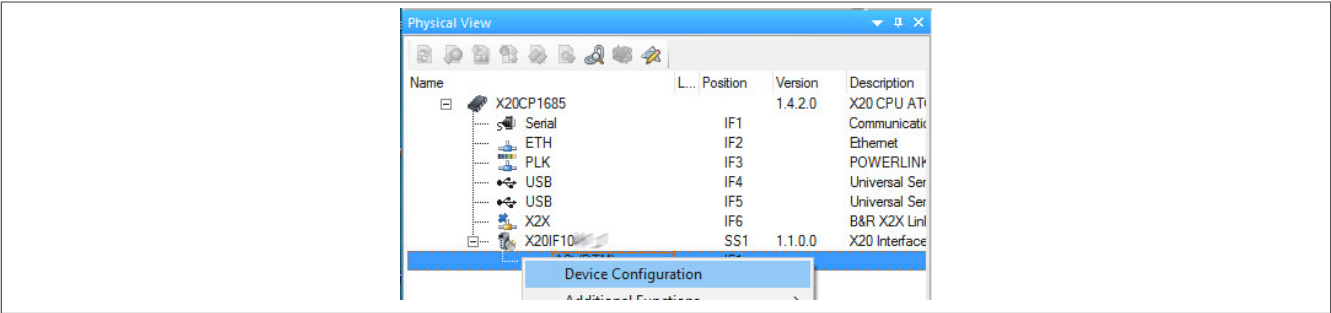
- In this example, the interface card is connected in the slot of a controller. Right-clicking on the slot and selecting "Add hardware module" opens the Hardware Catalog.



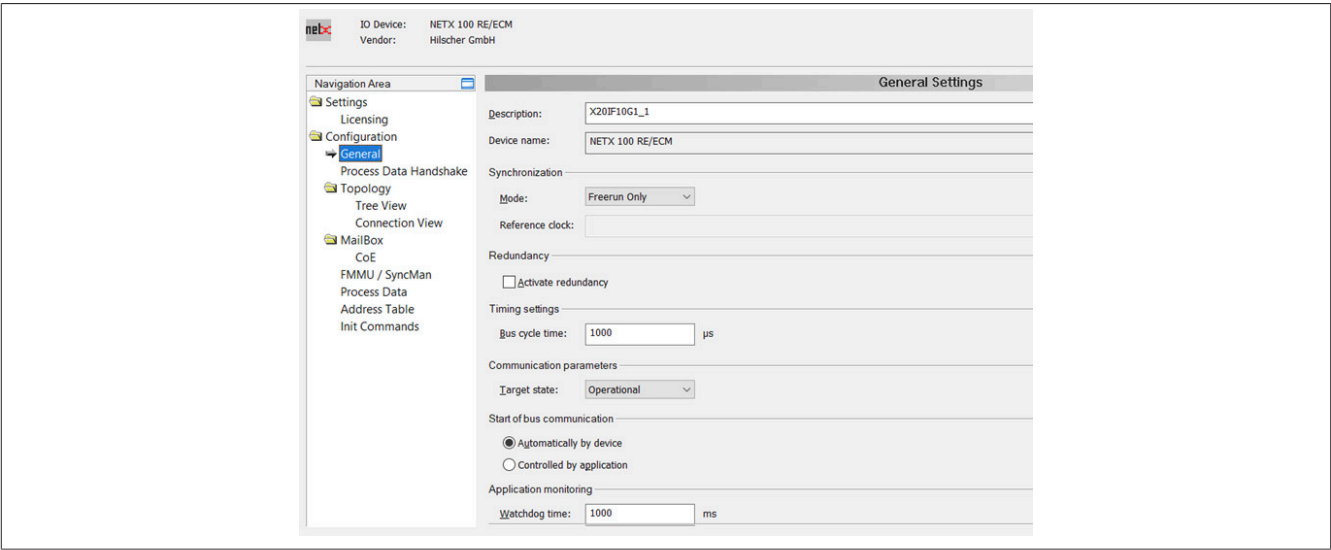
- The module is added to the project via drag-and-drop or by double-clicking on the interface card.



- Additional module settings can be made under "Device configuration". This configuration environment is opened by right-clicking on the IF interface and selecting "Device configuration".



- General settings are made in the device configuration.



5.2.2.1 General

Contains the description and symbolic name of the EtherCAT master.

Parameter	Explanation	Values
Description	Network name of the EtherCAT master station. Must be DNS-compatible.	1 to 240 characters
Device name	Symbolic name of the EtherCAT master DTM.	

- Synchronization

Contains the synchronization modes.

Parameter	Explanation	Values
Mode	There are 3 synchronization modes to choose from.	Freerun only Freerun with DC DC synchronized
Reference clock	Name of EtherCAT slave that is used for the "distributed clock". In addition, the auto-increment value and station address are also specified.	

- Redundancy

This parameter is not supported; ring redundancy is always active.



Information:

Checkbox "Activate redundancy" is not permitted to be selected; otherwise, parameter "Synchronization - Mode" cannot be selected or modified.

The EtherCAT interface

- Time settings

Used EtherCAT cycle time (250 to 65535 µs).

The minimum permissible cycle time for EtherCAT depends on many different factors. This includes the amount of input and output data, number of connected slaves, synchronization mode used, etc.

The following table contains guide values for the minimum cycle time and maximum amount of input and output data. If the maximum amount of data for the respective cycle times is exceeded, malfunctions may occur.

EtherCAT cycle time	Maximum amount of configured input and output data
500 µs	1024 bytes
1000 µs	2048 bytes
2000 µs	4096 bytes
...	

- Communication parameters

Desired state of the EtherCAT master after startup.

- Start of bus communication

It is possible here to select how data exchange is started on the module.

Parameter	Explanation
Automatically by device ¹⁾	Data exchange is started automatically after the module is initialized.
Controlled by application	Data exchange is started by Automation Runtime.

- 1) If "Automatically by device" is used, it is possible that the interface module already boots up and establishes a connection to the remote station before the entire system has booted up. If the system requires another restart during startup, however, the interface module will also be restarted.
Note: In some situations, this may mean that a connection can no longer be established with the remote station.



Information:

"Controlled by application" should preferably be used on the expandable POWERLINK bus controller.

- Application monitoring

The module-internal watchdog time can be set here. If the watchdog has been enabled (watchdog time not equal to 0), the hardware watchdog must be reset after the set time at the latest.

Parameter	Explanation	Values
Watchdog time	Software watchdog disabled	0 ms
	Permissible range of values.	20 to 65535 ms
	Default value: 1000 ms	



Information:

The watchdog time is reset automatically by Automation Runtime.

5.2.2.2 Process data handshake

This parameter configures the handshake for the data exchange between the bus and host application.

5.2.2.3 Topology

An overview of the entire EtherCAT network is shown here. There are 2 different views available.

Tree structure

The upper part represents a tree overview of the network topology for simplified access to the configured EtherCAT slave devices to simplify the overview of the EtherCAT network.

The station address and device name are displayed in short and long form for all slaves. Complex EtherCAT slave devices can be additionally expanded in the view.

- Device info

In addition to the device name, other information is displayed here.

Parameter	Explanation	
Name	Shows the device names of the selected EtherCAT slave. A change made can be saved with "Update".	
Station address	Shows the station address of the selected EtherCAT slave. A change made can be saved with "Update".	
AutoInc	Auto-increment (position address)	
Physics	Connection used:	
	Physical layer	Connection
	K	E-bus ¹⁾
	Y	100BASE-TX
	F	100BASE-FX
	1) Bus system based on the LVDS standard. (LVDS = "Low Voltage Differential Signaling", an interface standard for high-speed data transfer)	

- Project info

Project information is displayed here.

Parameter	Explanation
Name	Shows the EtherCAT project name. A change made can be saved with "Update".
Slaves configured	Number of configured EtherCAT slaves
Slaves deactivated	Number of disabled EtherCAT slaves

Connection view

This view represents the connection view of the network topology. This allows a visual check of how all EtherCAT slave devices are connected to the EtherCAT master. The connections are only displayed for configured EtherCAT slaves.



The type of connection is displayed in color:

- Yellow lines: EtherNet connection (100BASE-TX or 100BASE-FX)
- Red lines: E-bus, see "Physics" on page 13.

Existing EtherCAT devices can be placed as needed using "drag-and-drop". Clicking button "Auto arrange" allows the initial state of the graphical arrangement to be restored as it was before the EtherCAT devices in the network started being rearranged.

"Find device" can be used to find any EtherCAT slave devices in the graphical representation.

5.2.2.4 MailBox / CoE

Information about CANopen over EtherCAT (CoE) functionality for acyclic mailbox-based communication is located here.

The upper part represents a tree overview of the network topology for simplified access to the configured EtherCAT slave devices to simplify the overview of the EtherCAT network. A green check mark indicates configurable EtherCAT slave devices.

3 tabs can be selected in the lower area:

- General

Displays the SyncManager channel number and size for the input and output mailboxes.

- Startup

Indicates which data should be written to the object dictionary of the currently selected device when certain state changes take place in the EtherCAT device. Both the data predefined in the EtherCAT device description file (ESI file) and the data to be specified manually in tab "Userdef startup" are displayed here.





Information:

A key symbol at the beginning of a line indicates an entry specified in the EtherCAT device description file. This cannot be edited.

Parameter	Explanation
Transition	State transition that should trigger write access to the object dictionary.
Index.Subindex	Index and subindex for accessing the object dictionary
Data	Data to be written. The number of values to be specified depends on the particular object used.
Comment	Description of the object.

- Userdef startup

Makes it possible to specify which data should be written to the object dictionary of the currently selected device when certain state changes take place in the EtherCAT device.

Parameter	Explanation											
Transition	State transition that should trigger write access to the object dictionary.											
	Transition	Explanation	I2P	From Init to Pre-Operational	P2S	From Pre-Operational to Safe-Operational	S2P	From Safe-Operational to Pre-Operational	O2S	From Operational to Safe-Operational	S2O	From Safe-Operational to Operational
	Transition	Explanation										
	I2P	From Init to Pre-Operational										
	P2S	From Pre-Operational to Safe-Operational										
	S2P	From Safe-Operational to Pre-Operational										
	O2S	From Operational to Safe-Operational										
S2O	From Safe-Operational to Operational											
<div><div></div><div>Several transitions can also be selected simultaneously.</div></div>												
Index.Subindex ¹⁾	Index and subindex for accessing the object dictionary											
<div><div></div><div>The entry of the index and subindex can also be done automatically by selecting an object from the object dictionary in the lower part (if available).</div></div>												
Data, hexBinary ¹⁾	Data to be written. The number of values to be specified depends on the particular object used.											
Comment	Description of the command											

1) The entry must be made in hexadecimal form.

5.2.2.5 FMMU / SyncMan

- Fieldbus Memory Management Unit

The Fieldbus Memory Management Unit (FMMU) shows the assignment between the logical and physical addresses of the different slaves in the EtherCAT network.

Parameter	Explanation	Values
Station address	Station address assigned to the EtherCAT slave device by the master and stored in the slave.	0 to 65535
Logical start address	Byte address in the address space of the logical memory where the contiguous memory area that should be allocated starts.	0 to $2^{32}-1$
Length	Size of the translated memory area in bytes.	0 to 65535
Logical end bit	Bit offset of the logical end address, i.e. the address of the bit where the contiguous memory area ends.	0 to 255
Physical start address	Byte address of the physical memory area of the memory allocation where the contiguous memory area that should be allocated starts.	0 to 65535
Flags	The following flags exist: <ul style="list-style-type: none"> • Read operation is permitted or not permitted. • Write operation is permitted or not permitted. • Memory allocation is active or inactive. 	True or False
Sync manager	Number of the sync manager	0 to 31
Subunit	Subunit	

- Sync manager

The main task of the sync manager (SyncMan) is to coordinate simultaneous access to the used objects. In order to fulfill this coordination task, the sync manager is composed of a list of control elements, usually referred to as channels. A sync manager channel defines a constant area in the application memory.

Parameter	Explanation	Values
Station address	Station address assigned to the EtherCAT slave device by the master and stored in the slave.	
Channel	Channel number	0 to 3
Start address	Start address of the contiguous area in the application memory.	
Length	Length of the contiguous area in the application memory in bytes.	
Buffer type	Information as to whether the contiguous application memory area was accessed using a queue or buffer.	
Access	Information as to whether the master should perform a read or write operation.	
Watchdog	Information as to whether access monitoring of the contiguous memory area should take place using a watchdog timer.	Enabled or disabled
Master	May contain additional data of the EtherCAT master.	

5.2.2.6 Process data

The process data view shows a list of EtherCAT slaves configured on the EtherCAT master as well as the associated input and output modules.

Parameter	Explanation
Type	Varies depending on the symbol used: <ul style="list-style-type: none"> • Specified device designation and station name (in angled brackets) • Description of modules configured on the device or the input or output signals
Day	Varies depending on the symbol used: <ul style="list-style-type: none"> • Symbolic name of the device • Symbolic name of the module configured on the device • Symbolic name of the input or output signal
SCADA	This parameter is not supported.

The EtherCAT interface

5.2.2.7 Address table

The address table view shows a list of all addresses used in the process data image. The displayed addresses refer to the addresses used in the EtherCAT master. The upper view shows the addresses used for all input data; the lower view shows the addresses of the output data.

"Display mode" allows toggling between decimal and hexadecimal display.

Parameter	Explanation
Device	Descriptive device name
Station address	Station address assigned to the EtherCAT slave device by the master and stored in the slave.
PDO index	Index of the process data object in the object dictionary
PDO name	Descriptive name of the process data object in the object dictionary
PDO entry index	Index of the process data object entry in the object dictionary
PDO entry name	Descriptive name of the process data object entry in the object dictionary
Type	Data type, e.g. Integer or Boolean
Address	Device-internal address
Length	In bytes or bits: <ul style="list-style-type: none">Without decimal point, length in bytesAfter decimal point, length in bits

The address table can also be exported as a CSV file.

5.2.2.8 Init commands

The init commands view allows the sequence of initialization commands of the EtherCAT master and configured EtherCAT slaves in the event of an operating state change to be displayed. All EtherCAT masters and slaves are listed in the upper area.

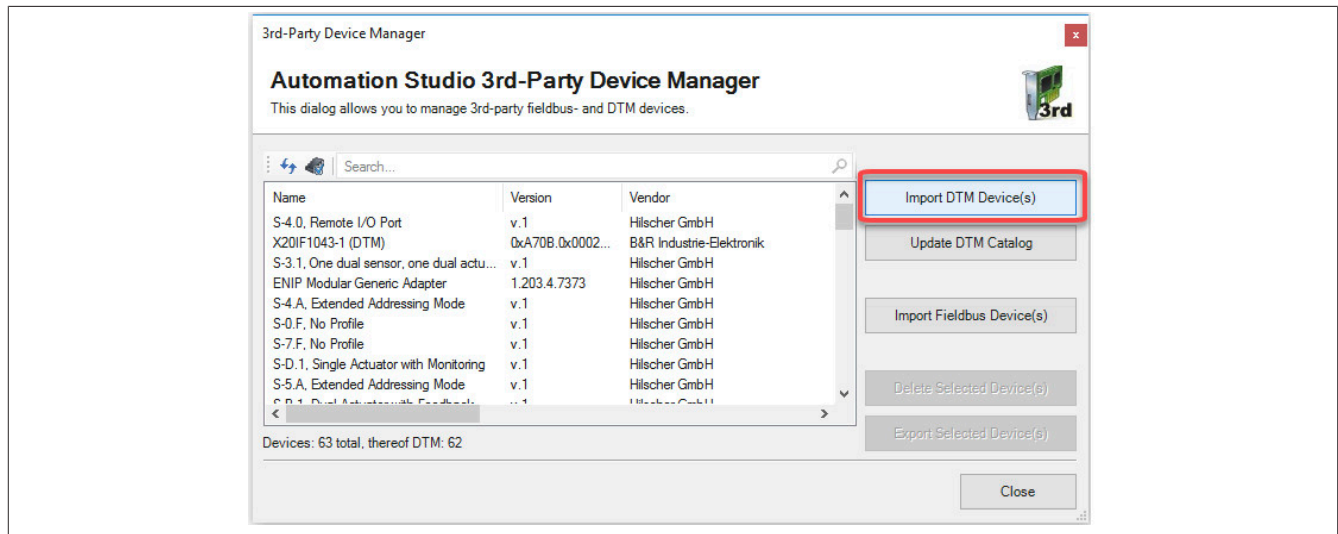
The lower area lists the respective initialization commands for all possible state changes.

Parameter	Explanation	
Command	Command code of the selected line:	
	Command	Explanation
	APRD	Auto-increment physical read
	APWR	Auto-increment physical write
	FPRD	Configured address physical read
	FPWR	Configured address physical write
	NPRD	Node address physical read
	NPWR	Node address physical write
	FRG	Broadcast read
	BWR	Broadcast write
LRD	Logical read	
LWR	Logical write	
ADP	Parameter with the configured station address. This is automatically increased by the slave for APRD and APWR.	
ADO	Parameter with the physical address	
New cycle	Start of a new cycle	
New frame	Start of a new Ethernet frame	
Size	Size of the command	
Timeout	Valid timeout period	
Retries	Repetition limit of the command. Contains the maximum number of retries allowed, including the first retry.	
Validate	Validation area	
Mask	Display mask of the valid bits	
Data	User data	

5.2.3 Adding the ESI file in Automation Studio

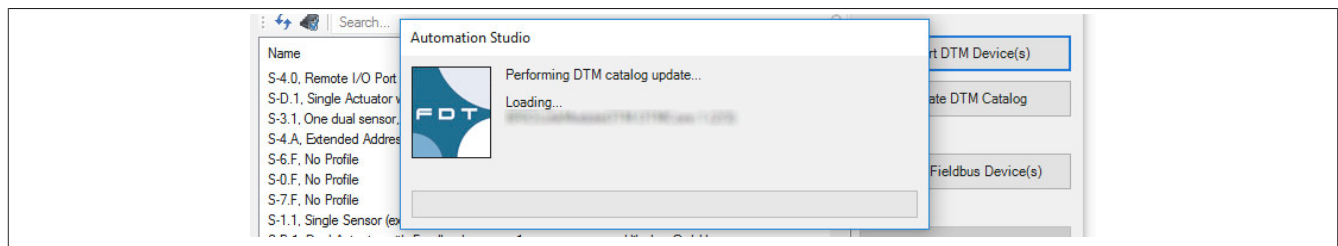
To add and use a device description file in Automation Studio, perform the following steps:

- Open the dialog box in Automation Studio under "Tools - Manage 3rd-party devices" and select "Import DTM device(s)".

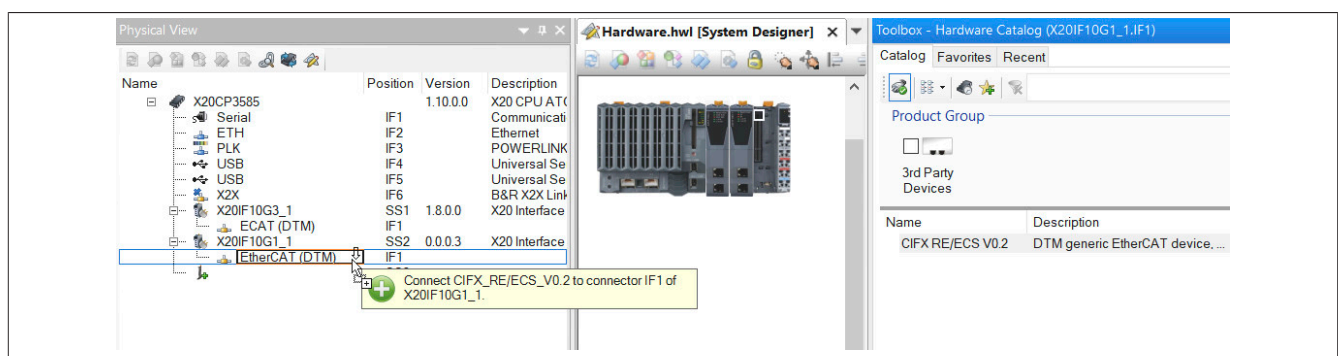


A device description file (ESI file) is required to inform the EtherCAT master which slaves were connected and how they were configured. This must be provided by the manufacturer of the EtherCAT slave.

- Select the ESI file to be imported and confirm with OK. The ESI file is imported into Automation Studio.

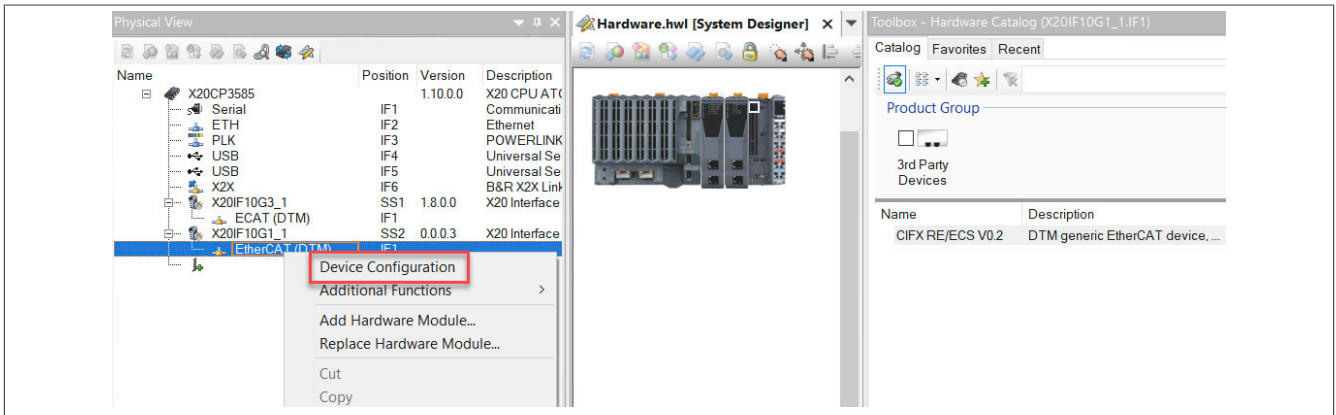


- Click "EtherCAT(DTM)" on EtherCAT master X20IF10G1-1, drag the ESI file from the Hardware Catalog and attach it to the EtherCAT master.



The EtherCAT interface

- Right-click on the IF interface and select "Device configuration" to open the configuration environment for the ESI file.



5.3 Settings for synchronous data exchange between B&R system and EtherCAT bus

The settings specified in this section should be understood as basic settings for an easier understanding of the "synchronous data exchange" function. Different settings may be necessary in special use cases.



Information:

Synchronous data exchange is only possible if the module is used directly on a controller. POWERLINK bus controller X20BC1083 cannot be used.

5.3.1 System requirements and limitations for synchronous data exchange



Information:

To ensure synchronous data exchange between the EtherCAT bus and the B&R system, the controller's system timer must be synchronized with either the X2X or POWERLINK clock.



Information:

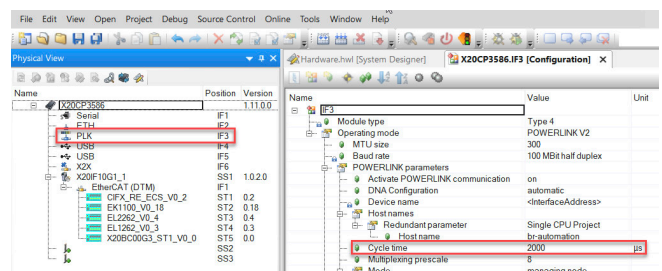
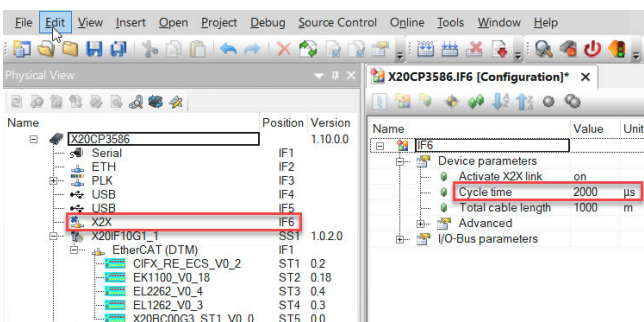
The minimum EtherCAT cycle time for synchronous data exchange is 500 µs.

System requirements

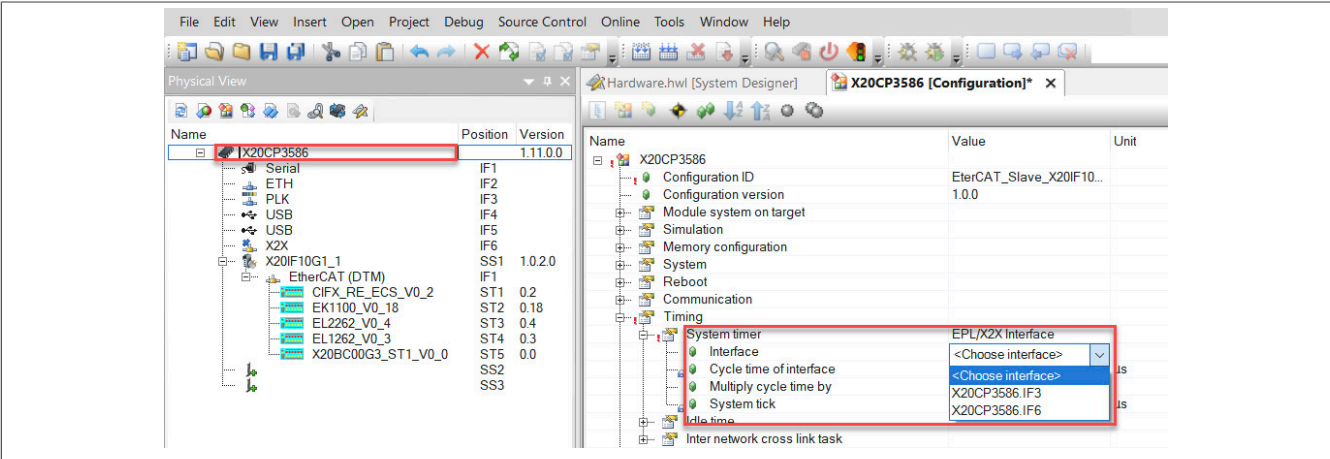
- Hardware upgrade $\geq 1.0.2.0$
- Automation Runtime version
 - Synchronization with X2X Link $\geq E4.93$
 - Synchronization with POWERLINK $\geq L4.93$

5.3.2 Automation Studio settings

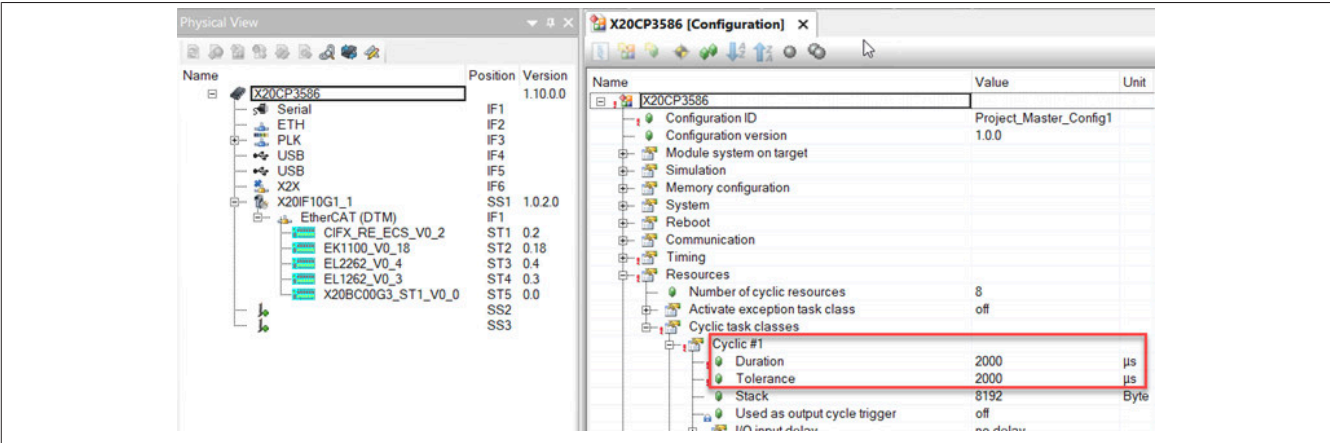
- First set the desired cycle time on the X2X or POWERLINK interface.



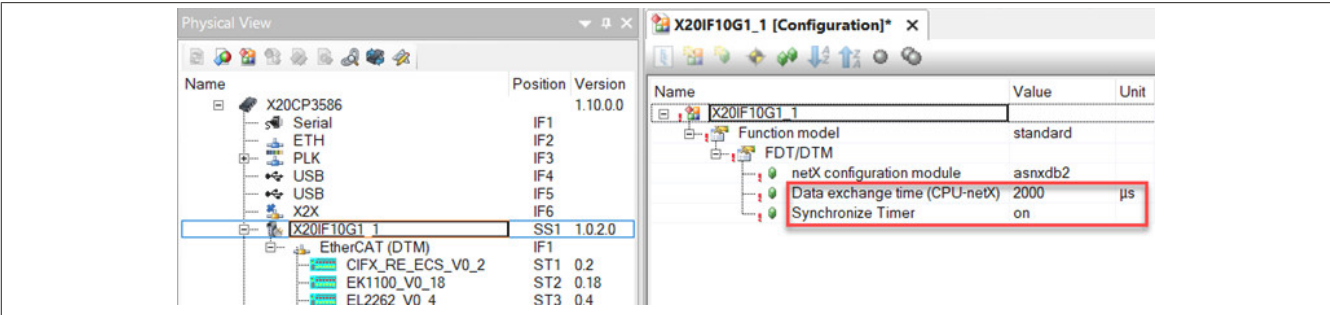
- Couple the system timer with the X2X or POWERLINK clock.



- The optimal response time is achieved if the application is running in task class Cyclic#1 and the cycle time of the task class corresponds to the EtherCAT bus cycle time.

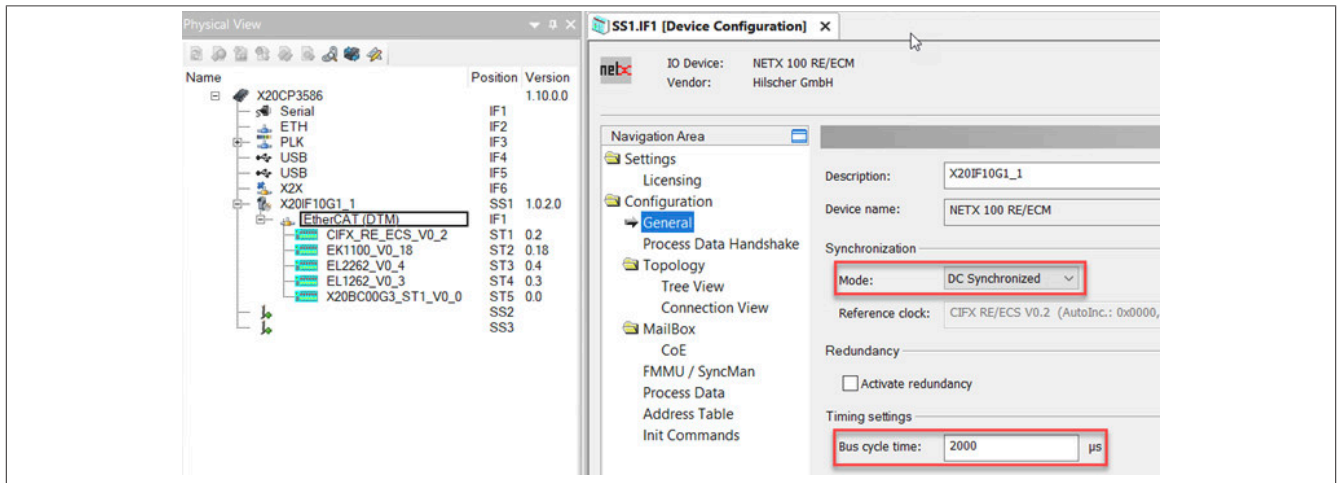


- Adjust "Data exchange time" on the EtherCAT master to the system cycle time (X2X Link or POWERLINK) and enable timer synchronization.



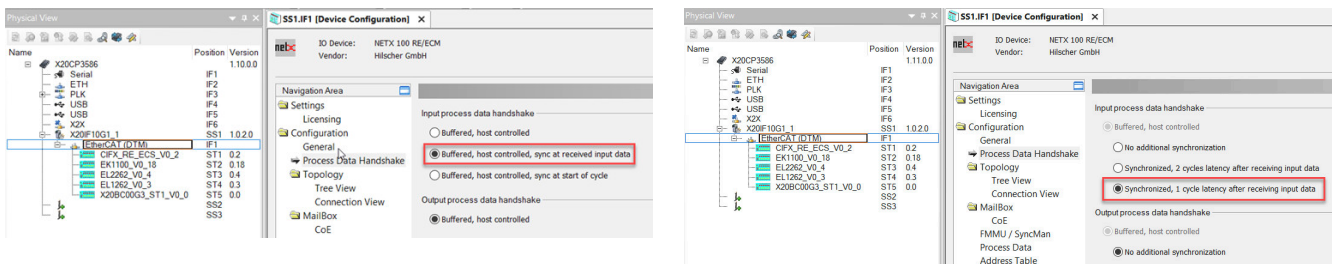
5.3.3 Device configuration in the EtherCAT Master DTM

- In section "General", change the synchronization to "Distributed clocks" and adjust the EtherCAT bus cycle time to the system cycle time (X2X Link or POWERLINK).

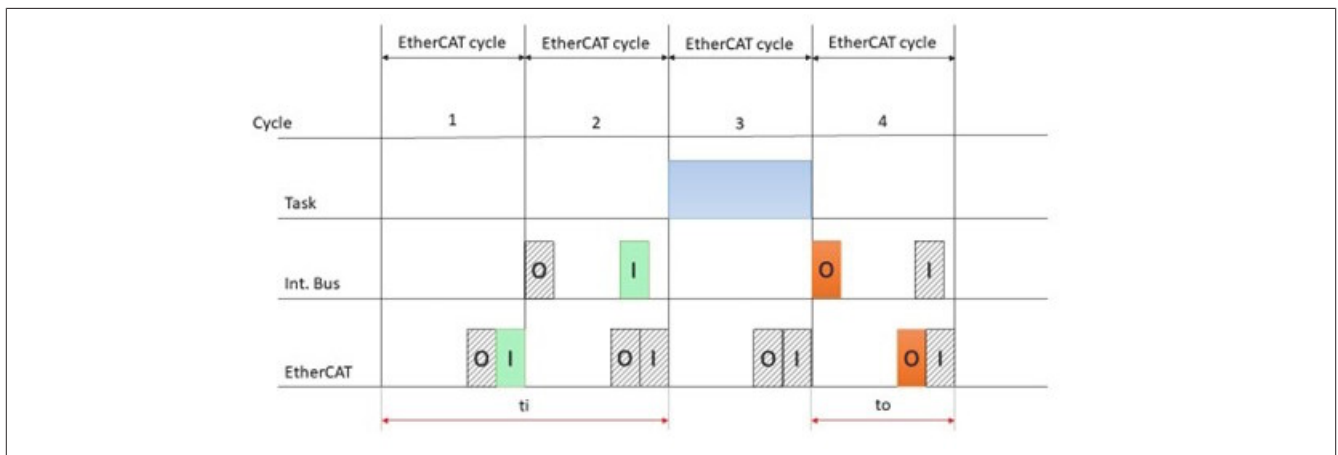


- In section "Process data handshake", adjust the setting for "Input process data handshake".

The display depends on the DTM version used.



Input/Output latency diagramm



Information:

The EtherCAT master sends the old output data again if the application has not finished updating the data in time for the start of the next bus cycle.

5.3.4 Device configuration in the description file (ESI file) of the EtherCAT slave

Example configuration using a Beckhoff EtherCAT slave:

- In the EtherCAT slave the "Activate DC Sync" must be switched on and the trigger must be set to Sync 0.

