X20IF10G3-1

1 General information

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 module can be operated in X20 CPUs or in the expandable POWERLINK bus controller X20BC1083.

The interface is equipped with 2 RJ45 connections. Both connections result in an integrated switch. This makes it easy to implement daisy chain cabling.

- EtherCAT slave
- Integrated switch for efficient cabling

2 Order data

Order number	Short description	Figure
	X20 interface module communication	
X20IF10G3-1	X20 interface module for DTM configuration, 1 EtherCAT slave interface, electrically isolated	

Table 1: X20IF10G3-1 - Order data

Optional accessories

Model number	Short description
X20CA0E61.xxxxx	POWERLINK/Ethernet connection cable, RJ45 to RJ45, 0.2 to 20 m
X20CA0E61.xxxx	POWERLINK/Ethernet connection cable, RJ45 to RJ45, 20 m and longer

3 Technical data

Order number	X20IF10G3-1
Short description	
Communication module	EtherCAT slave
General information	
B&R ID code	0xA72C
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
ATEX	Zone 2, II 3G Ex nA nC IIA T5 Gc IP20, Ta (see X20 user's manual) FTZÚ 09 ATEX 0083X
UL	cULus E115267 Industrial control equipment
HazLoc	cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5
DNV GL	Temperature: **B** (0 - 55°C) Humidity: **B** (up to 100%) Vibration: **B** (4 g) EMC: **B** (bridge and open deck)
LR	ENV1
KR	Yes
ABS	Yes
EAC	Yes
KC	Yes
Interfaces	
Fieldbus	EtherCAT (slave)
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	No
Full-duplex	Yes
Autonegotiation	Yes
Auto-MDI/MDIX	Yes
Controller	netX100
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 CPU and expandable bus controller X20BC1083

Table 2: X20IF10G3-1 - Technical data

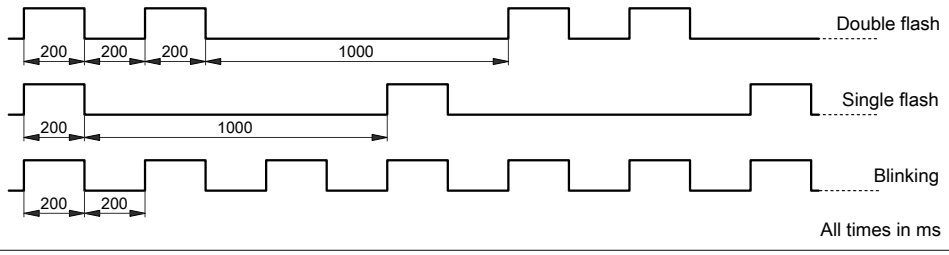
4 Operating and connection elements

1	EtherCAT connection with 2x RJ45 for simple wiring	2	LED status indicators

4.1 LED status indicators

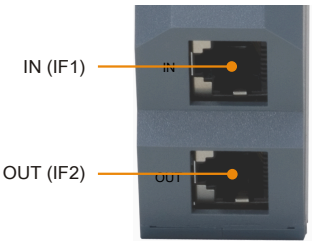
Figure	LED	Color	Status	Description
	READY/RUN	Green/Red	Off	No power to module
		Red	Blinking	Boot error
			On	Communication on the PCI bus has not yet been started
		Green	On	PCI bus communication in progress
	ECAT RUN	Green	Off	Status INIT
			Single flash	Status SAFE-OPERATIONAL
			Blinking	Status PREOPERATIONAL
			On	Status OPERATIONAL
	ECAT ERR	Red	Off	No error
			Single flash	Internal module error, EtherCAT status changed by module
			Double flash	Watchdog timeout (process data watchdog or EtherCAT watchdog)
			Blinking	Invalid configuration data
			On	Critical communication or application error
	L/A IN L/A OUT	Green	Off	No physical Ethernet connection (PORT CLOSED)
			Blinking	The respective LED blinks when Ethernet activity is taking place (PORT OPEN) on the corresponding RJ45 interface (in, out).
			On	Connection (link) established, but no communication taking place (PORT OPEN)

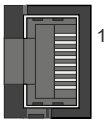
LED status indicators - Blink times



4.2 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	

5 Use in the expandable X20BC1083 POWERLINK bus controller

5.1 Cyclic data

If this module is connected to the expandable POWERLINK bus controller, the amount of cyclic data is limited by the POWERLINK frame to 1488 bytes in each direction (input and output).
When using multiple X20IF10xx-1 interfaces or other X2X modules with a POWERLINK bus controller, the 1488 bytes are divided between all connected modules.

5.2 Operating netX modules

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

- A minimum revision ≥ E0 is required for the bus controller.
- netX modules 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 netX firmware and the 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.

5.3 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.**

6 netX error codes

netX modules return an error code when an error occurs. These error codes are fieldbus-specific. A complete list of all error codes in PDF format is available in Automation Help in section "Communication / Fieldbus systems / Support with FDT/DTM / Diagnostic functions / Diagnostics on the runtime system / Master diagnostics" under item "Communication_Error".

7 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.

To update the firmware contained in Automation Studio, a hardware upgrade must be performed (see "Project management / Workspace / Upgrades" in Automation Help).

8 Supported protocols and functions

Supported protocols:

- File access over EtherCAT (FoE object)
- Complete access (supported since firmware version 18)
    - Enabled: Objects are read or written with all existing subindices.
    - Disabled: Objects are only read or written with the specific subindex.

Additional supported functions:

- 32-bit "distributed clocks" function

Unsupported functions:

- Reading and writing a logical memory area (LRW)

9 The EtherCAT interface

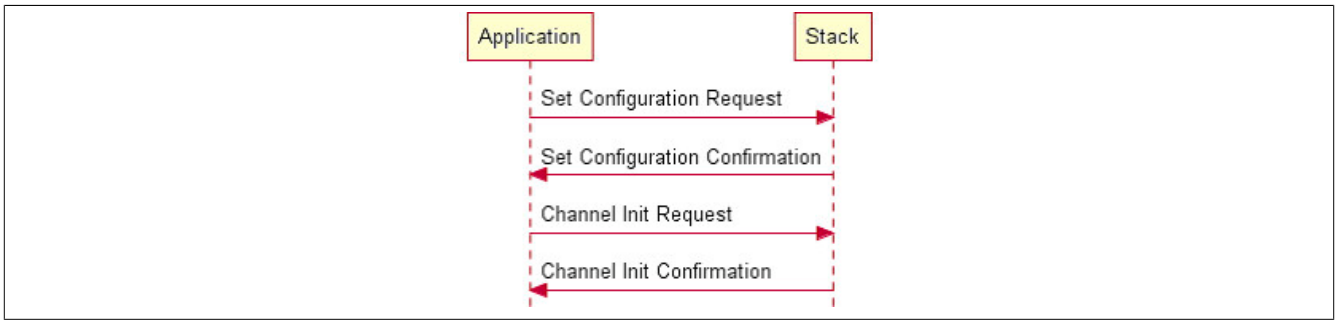
From an Ethernet standpoint, the EtherCAT bus is simply a single large Ethernet station. This "station" receives and transmits Ethernet telegrams. The station does not include an Ethernet controller with downstream microprocessor, however, but rather a large number of EtherCAT slaves. These slaves process 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 the cycle. While the telegrams are delayed by only a few bits before being forwarded, the slave detects and executes commands that were intended for it. Processing occurs in the hardware and is therefore separate from the slave response times. Each station has an addressable 64 kB memory area that can be written to, read from or simultaneously written to and read from. Multiple EtherCAT commands, which each address individual stations and/or memory areas, can be embedded in one Ethernet telegram.

9.1 Startup sequence

Switching on the power triggers the module initialization phase. These contain basic information such as vendor ID and product code. Then comes channel initialization. The new configurations and parameters are sent to the stack. The stack is then ready to start communicating with the EtherCAT master. The LED "READY/RUN" (see "LED status indicators" on page 3) on the interface module indicates any problems during startup by blinking in a certain pattern.

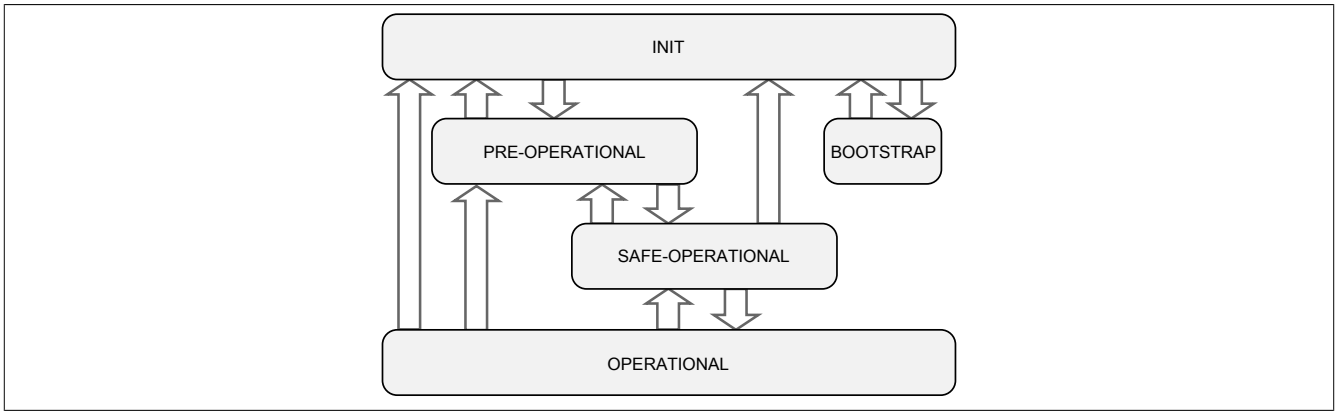
Startup sequence



Operating status

Status	Description
INIT	The EtherCAT is being initialized. No process data is being exchanged yet.
PREOPERATIONAL	The master and slave are not yet operable but are exchanging parameter data acyclically via the mailbox. No process data is being exchanged yet.
SAFE-OPERATIONAL	The EtherCAT slave can process input data. Output data is in status "SAFE"
OPERATIONAL	The EtherCAT slave is operational.
BOOTSTRAP	Permitted according to EtherCAT specification but not necessary.

The following diagram shows the possible status changes within the module.



9.2 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 the CANopen standard DS301)
0x2000 to 0x5FFF	Vendor-specific area	Definition of vendor-specific variables
0x6000 to 0x9FFF	Profile area	Definition of profile-related variables
0xA000 to 0xFFFF	Reserved	Reserved

9.3 AL status codes

The AL status code reflects the current slave error state. It is located in the ESC register and can be read out by the master.

List of standard EtherCAT AL status codes

Code	Description
0x0000	No error
0x0001	Unspecified error
0x0011	Invalid requested state change
0x0012	Unknown requested state
0x0013	Bootstrap not supported
0x0014	No valid firmware
0x0015	Invalid mailbox configuration (BOOTSTRAP)
0x0016	Invalid mailbox configuration (PREOP)
0x0017	Invalid sync manager configuration
0x0018	No valid inputs available
0x0019	No valid outputs available
0x001A	Synchronization error
0x001B	Sync manager watchdog
0x001C	Invalid sync manager type
0x001D	Invalid output configuration
0x001E	Invalid input configuration
0x001F	Invalid watchdog configuration
0x0020	Slave needs cold start
0x0021	Slave needs "INIT"
0x0022	Slave needs "PREOP"
0x0023	Slave needs "SAFEOP"
0x002D	Invalid output "FMMU" configuration
0x002E	Invalid input "FMMU" configuration
0x0030	Invalid DC "SYNCH" configuration
0x0031	Invalid DC latch configuration
0x0032	"PLL" error
0x0033	Invalid DC I/O error
0x0034	Invalid DC timeout error
0x0042	"MBX_EOE"
0x0043	"MBX_COE"
0x0044	"MBX_FOE"
0x0045	"MBX_SOE"
0x004F	"MBX_VOE"
0x0050 to 0x8000	Reserved
0x800 to 0xFFFF	Vendor-specific

If the standard EtherCAT error code does not sufficiently describe the current error, then the status error code with an offset of "0x8000" (vendor-specific range) will be written to the "AL status code register".

Supported vendor-specific AL status codes

Value	AL status code
0x8000	ECAT_AL_STATUS_CODE_HOST_NOT_READY
0x8001	ECAT_AL_STATUS_CODE_IO_DATA_SIZE_NOT_CONFIGURED
0x8002	ECAT_AL_STATUS_CODE_DPM_HOST_WATCHDOG_TRIGGERED
0x8003	ECAT_AL_STATUS_CODE_DC_CFG_INVALID
0x8004	ECAT_AL_STATUS_CODE_FIRMWARE_IS_BOOTING
0x8005	ECAT_AL_STATUS_CODE_WARMSTART_REQUESTED
0x8006	ECAT_AL_STATUS_CODE_CHANNEL_INIT_REQUESTED
0x8007	ECAT_AL_STATUS_CODE_CONFIGURATION_CLEARED

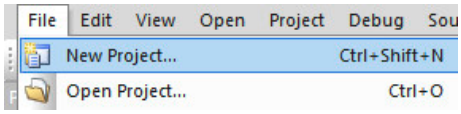
9.4 Settings in Automation Studio

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

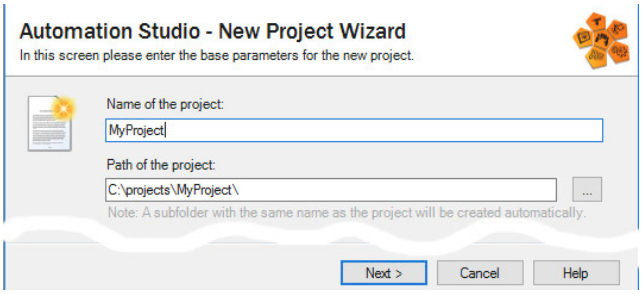
To do this, a new Automation Studio project is created and the suitable settings are made on the module.

9.4.1 Creating an Automation Studio project

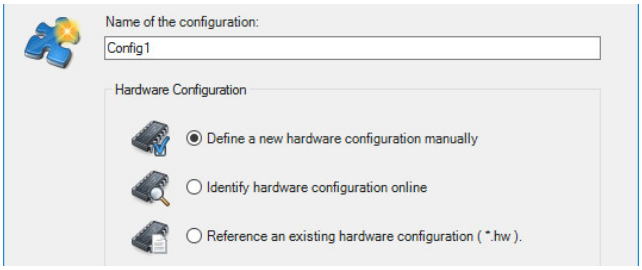
● Create a new Automation Studio project by selecting "New project".



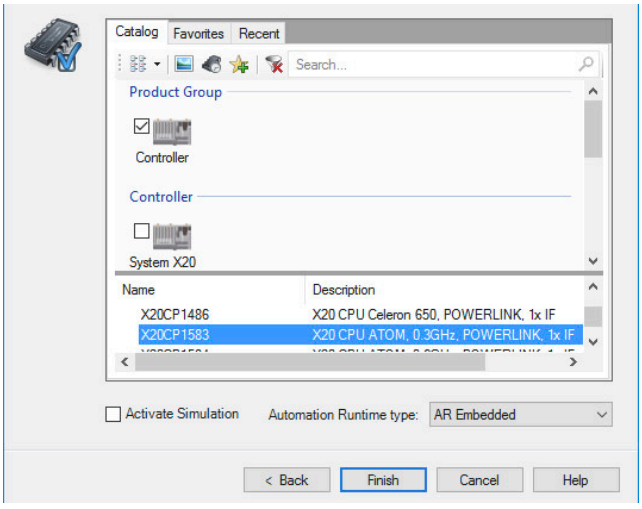
● Assign a project name and set up the project path.



● Assign the hardware configuration type and configuration name.

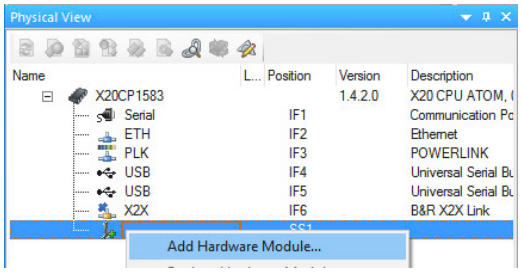


● Select the hardware in the next step if "Define a new hardware configuration manually" was selected.
In order to simplify the search, different filters can be set in the Hardware Catalog. Lastly, highlight the required hardware and create the Automation Studio project by clicking on "Finish".

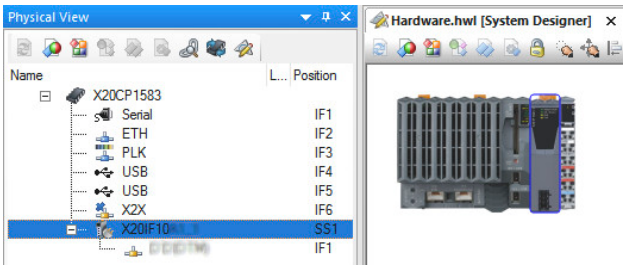


9.4.2 Adding and configuring the interface module

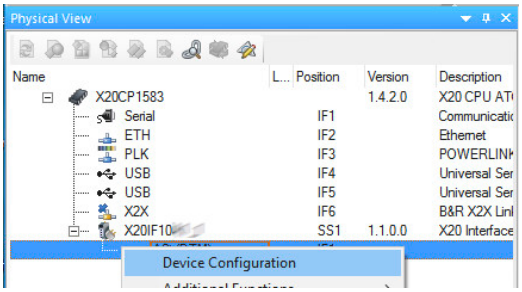
● In this example, the interface card is connected in the slot of a CPU. Right-clicking on the slot and selecting "Add hardware module" opens the Hardware Catalog.



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



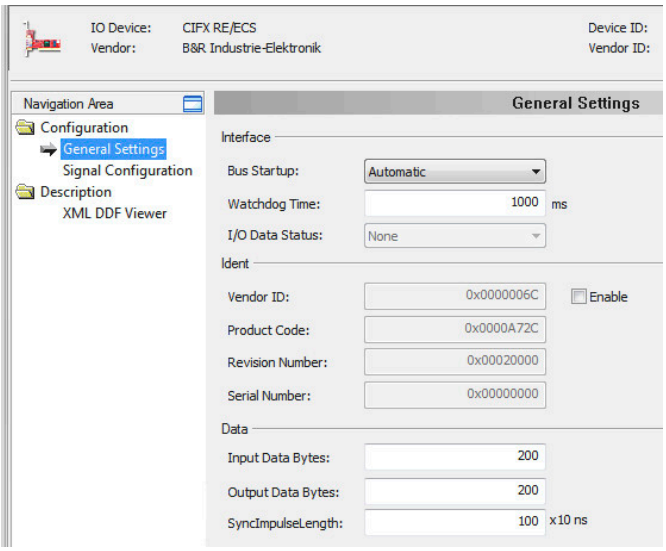
● Additional module settings can be made under "Device configuration". This configuration environment is opened by right-clicking on the IF interface and selecting "Device configuration".



Information:

The settings on the slave must match the settings of the corresponding device description file; otherwise, no connection can be established.

- General settings are made in the device configuration.



9.4.2.1 General settings

- Bus startup

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

Parameter	Explanation
Automatically by device	Data exchange is started automatically after initializing this module.
Controlled by application	Data exchange is started by Automation Runtime.

- Watchdog time

The watchdog is triggered as soon as it receives no feedback after the set "Watchdog time" has expired. In this case, AL status code 0x8002 is output.

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

Information:

The watchdog time is reset automatically by Automation Runtime.

- Ident

Settings such as the vendor ID or product code can be read out or adjusted here.

Parameter	Explanation	Default value	Subindex (in object 0x1018)
Vendor ID	Manufacturer identification of the EtherCAT device	0x0000006C (B&R vendor ID)	1
Product code	Product code of the device	0xA72C (product code of the X20IF10G3-1)	2
Revision number	Manufacturer revision number of the device	0x20000	3
Serial number	Serial number of the device	0	4

To be able to change the identifier, checkbox "Enable" must be selected.

Information:

Care should be taken when changing the identifier parameters. Problems could arise when establishing a connection since the identifier data is compared in the process. The changed data must also be adjusted on the master side in order to avoid communication errors.

- Data

The length of the input and output data as well as the pulse length can be adjusted.

Parameter	Explanation	Default value	Maximum value
Input data bytes	Number of input process data bytes	200 bytes	256 bytes
Output data bytes	Number of output process data bytes	200 bytes	256 bytes
Sync impulse length	Length of the synchronization pulse (optional)	100 (corresponds to 1000 ns)	65535 (655350 ns)

9.4.2.2 Signal configuration

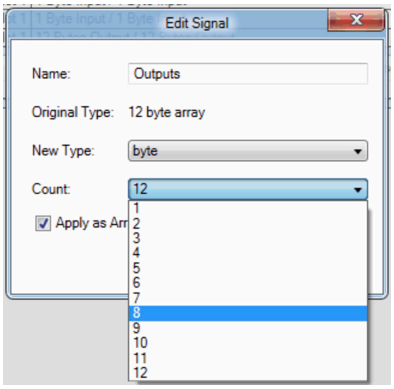
The current signal configuration of the PDOs is displayed here.

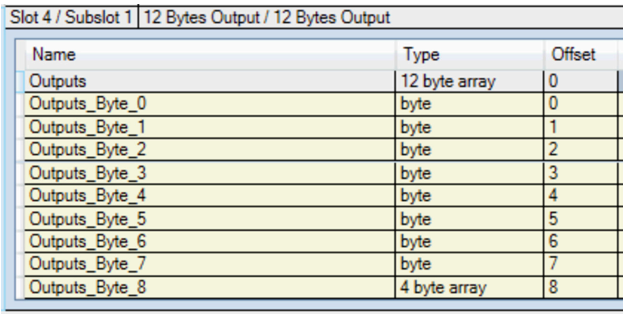
Parameter	Explanation
Name	Signal type
Type	Data type
Offset	Offset of the signal

After right-clicking on the signal to be configured, the following options can be selected in the shortcut menu:

- **Edit signal**
  This allows the currently selected signal to be edited.

Parameter	Explanation
Name	The new name for the signal
New type	The new data type for the signal
Count	Number of individually listed data type elements for the signal. Only the data of the original type is re-structured; the quantity is not adjusted. - The maximum number corresponds to the quantity that the new data type requires to display the original type. - If fewer elements are selected, the last data type element is listed as an array of all remaining elements.
Apply as array	If selected, the new data type is displayed as an array. Otherwise, the data type elements set under "Count" are displayed.





- **Reset**
  This can be used to undo the signal change or a merge previously completed with "Merge signal".
- **Merge signal**
  This allows all signals between "First in group" and "Last in group" to be merged to form a new group. The same settings can be made for the new group as under "Edit signal".

9.4.2.3 XML DDF viewer

The contents of the DDF device description file can be viewed and searched here.

9.5 ESI device description file

The module description is made available to the master in an ESI file. This text file is a general description of the slave. The ESI file can be downloaded from the B&R website (www.br-automation.com) in the Downloads section for the interface module and then imported into the respective master environment.

The device description file defines all necessary sync managers and mailbox parameters.
Mailbox parameter "PdoUpload" is defined with "TRUE". This instructs the EtherCAT master to read all of the process data information via CoE (CANopen over EtherCAT) from the interface card and create a corresponding I/O mapping.

In 3rd-party environments, the interface card is displayed under the name "CIFX RE/ECS".

Sync master

The following entries in the ESI file define the outbox/inbox (required for asynchronous communication between the EtherCAT master and interface card) as well as the properties of the input/output process data (synchronous communication).

```
<!--SM0 MBX OUT-->
<Sm ControlByte="#x36" DefaultSize="128" Enable="1" MaxSize="128" MinSize="128"
    StartAddress="#x1000">MBoxOut</Sm>

<!--SM1 MBX INP-->
<Sm ControlByte="#x32" DefaultSize="128" Enable="1" MaxSize="128" MinSize="128"
    StartAddress="#x1080">MBoxIn</Sm>

<!--SM2 PD OUT-->
<Sm ControlByte="#x74" DefaultSize="200" Enable="1" MaxSize="256" MinSize="0"
    StartAddress="#x1100">Outputs</Sm>

<!--SM3 PD INP-->
<Sm ControlByte="#x30" DefaultSize="200" Enable="1" MaxSize="256" MinSize="0"
    StartAddress="#x1400">Inputs</Sm>
```

Mailbox setting

```
<Mailbox DataLinkLayer="1">
  <CoE CompleteAccess="1"
       PdoUpload="1"
       SdoInfo="1" />
</Mailbox>
```

EEPROM setting

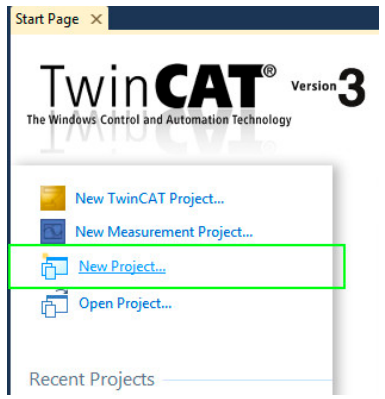
```
<Eeprom>
  <ByteSize>65536</ByteSize>
  <ConfigData>060000CCE8030000</ConfigData>
  <BootStrap>0010800080108000</BootStrap>
</Eeprom>
```

9.6 Usage example: TwinCAT 3

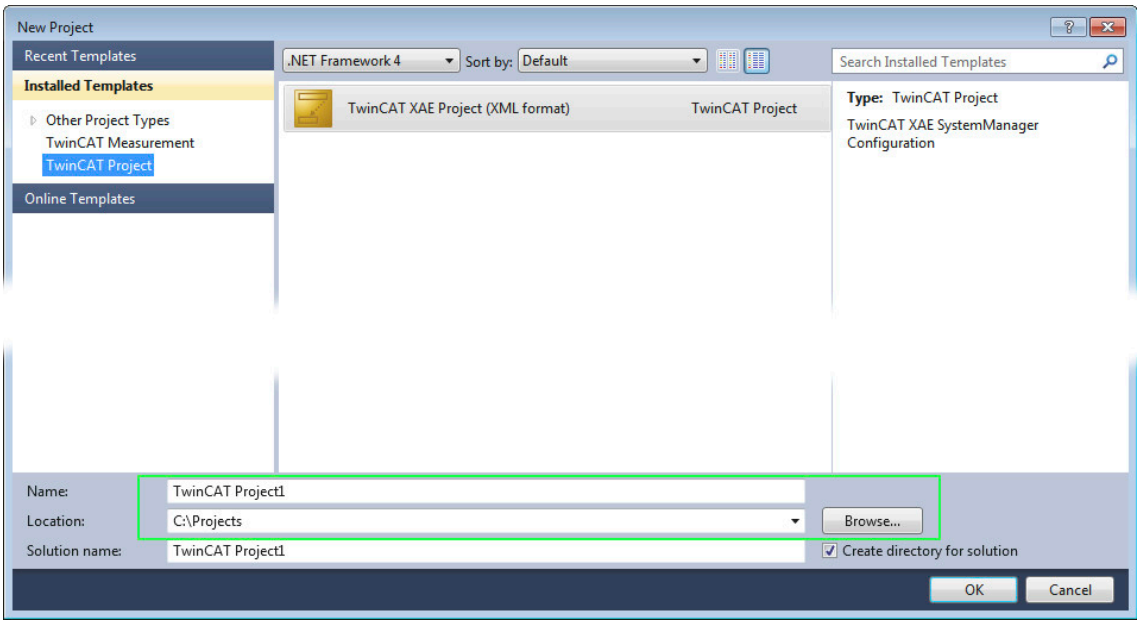
This example uses the Beckhoff environment "TwinCAT 3", and an EtherCAT master is operated on a standard PC using software.

9.6.1 Creating a new project

● First, create a new project. To do this, select "NewProject" on the TwinCAT start page.



● Select "TwinCAT project" as the type and specify the project name and path for saving the project.

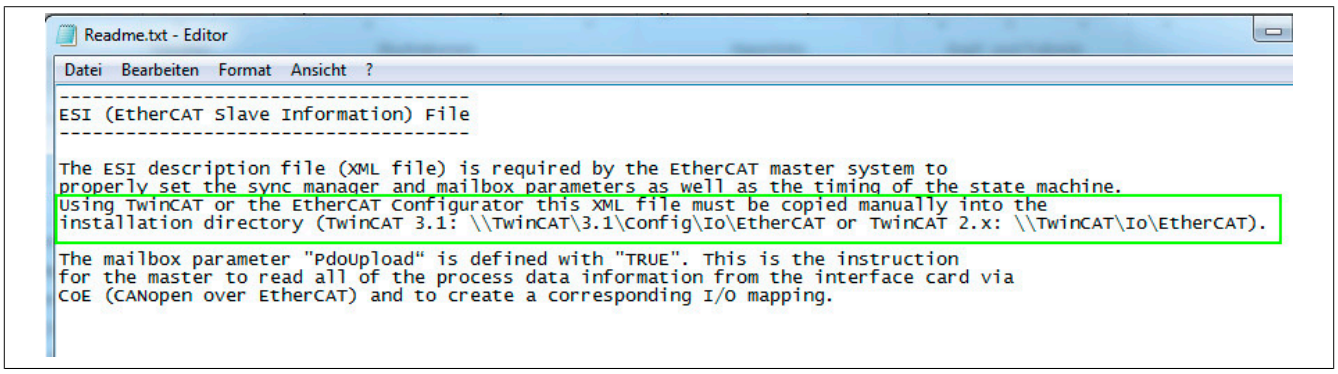


9.6.2 Importing the ESI file

● The required ESI file for the X20IF10G3-1 can be downloaded from the B&R website.

● In order to export the file, it needs to be copied manually into the table of contents. Depending on the TwinCAT version, this is either:

- **TwinCAT 3.1:** \\TwinCAT\3.1\Config\Io\EtherCAT
- **TwinCAT 2.x:** \\TwinCAT\Io\EtherCAT



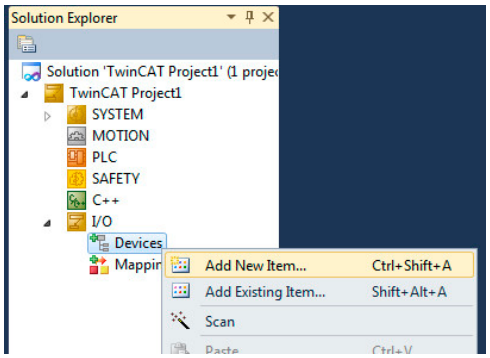
Information:

The imported data is only available after restarting the TwinCAT environment.

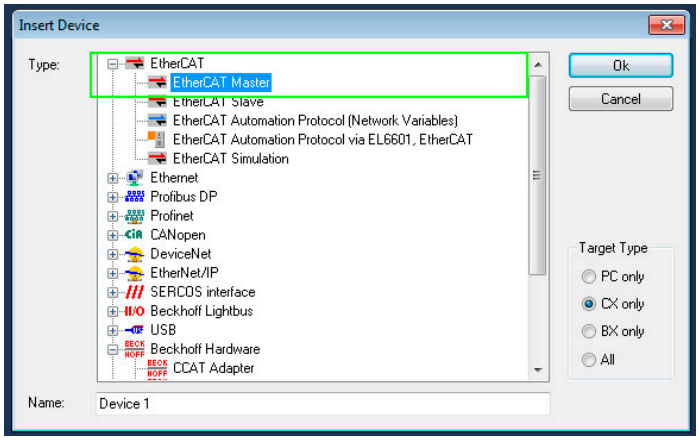
9.6.3 Adding hardware

Adding the EtherCAT master

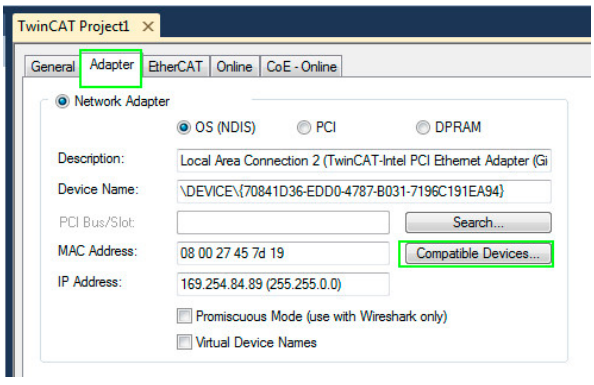
● First, add the EtherCAT master to the project. This is done by right-clicking on "I/O → Devices" and selecting "Add new item".



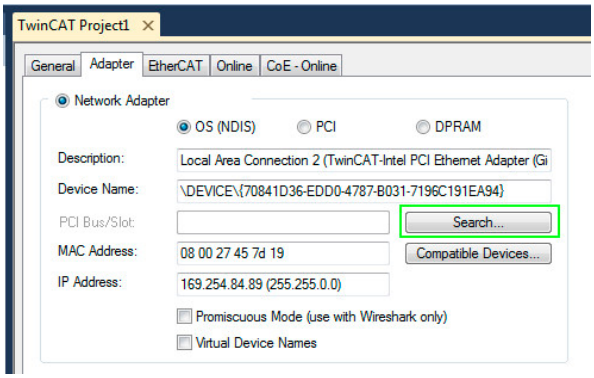
● In the following window, select the EtherCAT master and import it by selecting "OK".



● The master configuration is opened by double-clicking on the added "Device 1".
A connection to the module can be set up via tab "Adapter". To do this, button "Compatible devices" is selected the confirmation prompt is confirmed.



● Now select the Ethernet interface – which is intended to act as an EtherCAT connection and is connected to the EtherCAT slave (X20IF10G3-1) – and confirm by clicking "Install". The connection is established by clicking on "Search".

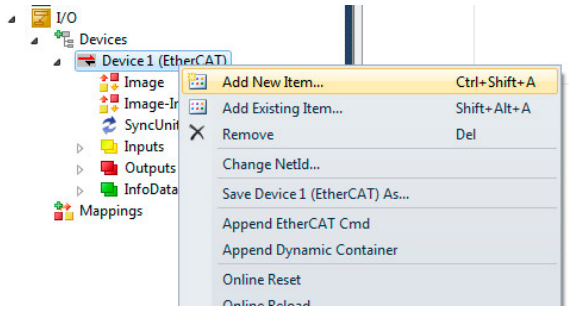


Adding the EtherCAT slave

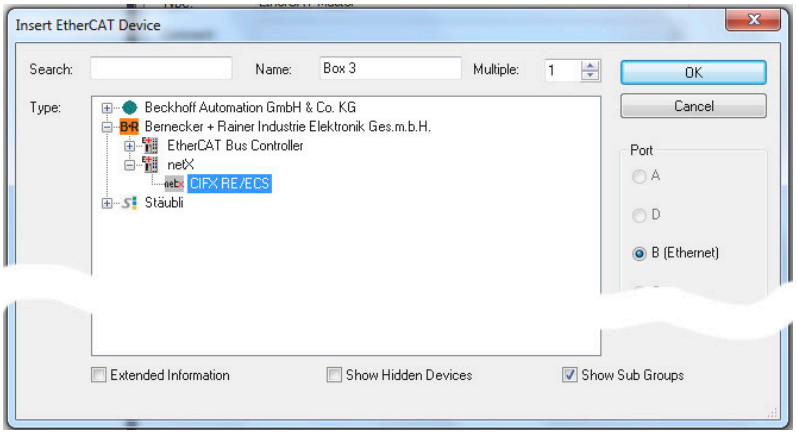
There is the option of adding the EtherCAT slave to the project manually or reading the data by scanning the module.

Adding X20IF10G3-1 manually

● Right-click on the master "Device1" and select "Add new item" to open a list of imported modules.



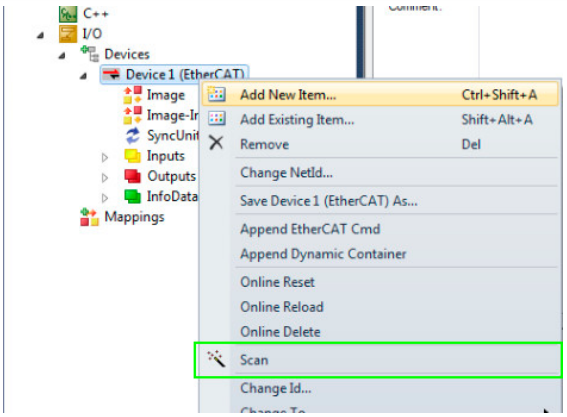
● Slave module X20IF10G3-1 can now be selected; it is marked as "CIFX RE/ECS" in a 3rd-party environment. The module is attached to the master with "OK".



● After the slave hardware has been connected and located in the project, PDO information can be added using button "Load PDO info from device" (see below: "Import PDO information").

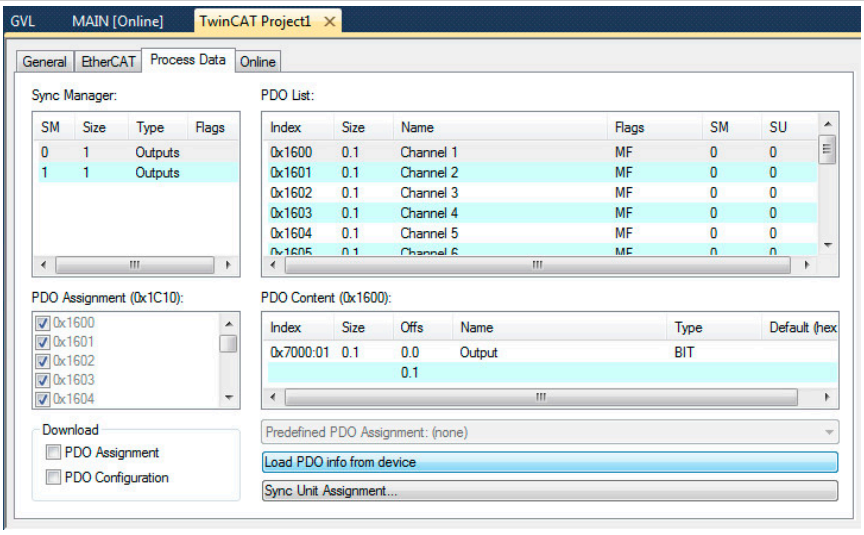
Adding X20IF10G3-1 with the scan function

● The scan function can be used to read all connected modules and automatically add them to the project. For this, the ESI file of the EtherCAT slave module X20IF10G3-1 must already be installed in the TwinCAT environment (see "Importing the ESI file" on page 14).
EtherCAT slave X20IF10G3-1 can now be read into the project with the scan function if it is connected to the PC. Reading is started by right-clicking on master "Device1" and selecting "Scan".

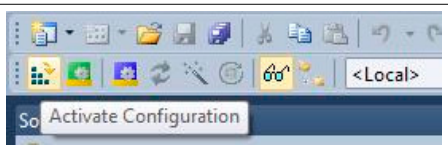


● Import PDO information

If the channels (input and output data) have not been read, they can be imported separately. To do this, double-click module "CIFX RE/ECS". Button "Load PDO info from device" is located under tab "Process data" in the opened configuration window. It reads all PDO information (I/O mapping) of the module and imports it into the project.



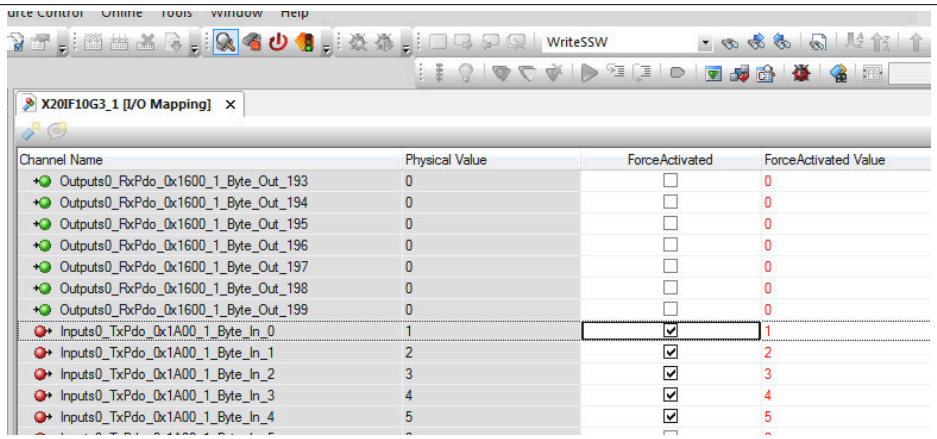
● The configuration can be transferred to the module with button "Activate configuration".



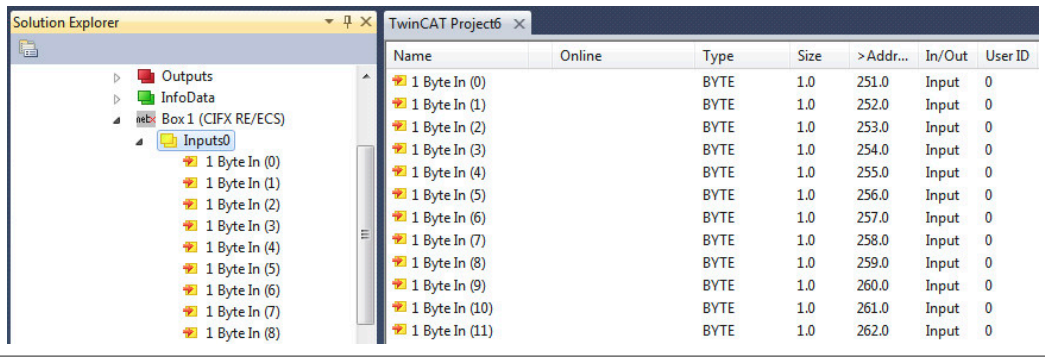
● The system can be restarted with button "Restart TwinCAT".

9.6.4 I/O mapping

● As soon as the project has been transferred to the slave and the slave is in mode "OPERATIONAL", data can be exchanged via the I/O mapping. To do this, double-click on the EtherCAT module on the B&R website to open the I/O mapping and assign any values to the output parameters for testing. To exchange data, monitor mode must be active. This is selected via the magnifying glass in the toolbar.



● The input data in the TwinCAT environment can be read for verification. To do so, double-click on TxPDO (input data) of the EtherCAT slave to open it. The input data can be read in column "Online".



If required, RxPDO output data can also be sent.