BECKHOFF New Automation Technology

Documentation | EN

FC1100 and FC1121

Application Note (EtherCAT Slave Cards)

Table of contents

Version: 2.4

1 Foreword

1.1 Notes on the documentation

Intended audience

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning these components.
The qualified personnel is obliged to always use the currently valid documentation.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

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The documentation has been prepared with care. The products described are, however, constantly under development.

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1.2   Safety instructions

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Please note the following safety instructions and explanations!
Product-specific safety instructions can be found on following pages or in the areas mounting, wiring, commissioning etc.

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This description is only intended for trained specialists in control, automation and drive engineering who are familiar with the applicable national standards.

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The signal words used in the documentation are classified below. In order to prevent injury and damage to persons and property, read and follow the safety and warning notices.

Personal injury warnings

⚠ DANGER
Hazard with high risk of death or serious injury.

⚠ WARNING
Hazard with medium risk of death or serious injury.

⚠ CAUTION
There is a low-risk hazard that could result in medium or minor injury.

Warning of damage to property or environment

NOTICE
The environment, equipment, or data may be damaged.

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ⓘ   This information includes, for example:
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1.4 Documentation Issue Status

Version	Comment
2.4	• Chapter *Hardware* and *Software* updated
2.3	• Chapter *Software* updated
2.2	• Chapter *Software* updated
2.1.0	• Chapter *TwinCAT* updated
	• Chapter *Notes on information security* added
2.0	• Migration
	• Document structure updated

2   Product overview

2.1   Introduction

This document contains a software installation and configuration guideline for the fieldbus cards FC1100 and FC1121 with TwinCAT and the SlaveStackCode.
Furthermore all required information are provided to develop a new driver for these fieldbus cards.

The basic information about the fieldbus cards is listed in the following table.

FC11xx comparison

Technical data	FC1100	FC1121
Link	http://www.beckhoff.com/FC1100/	http://www.beckhoff.com/FC1121/
Interface to the PC	PCI	PCIe
EtherCAT Slave Controller	ET1100	FPGA-based
RAM	8	8
SYNC manager	8	4
FMMUs	8	3

3   Hardware

3.1   FC1100 | PCI EtherCAT slave card

The PCI ID values of the FC1100 are listed in the following table. The ET1100 (see type and revision register for detailed information) chip is used to access the EtherCAT network. The address range of the ET1100 is mapped to the memory specified by Base Address Register 2 (BAR2) of the PCI device.

> **i** **Configuration bits**
>
> The low nibble of BAR2 contains configuration bits.

FC1100 PCI values

Parameter	Value
DeviceID	0x1100
VendorID	0x15ec

The following figure shows the hardware structure of the FC1100 slave card.
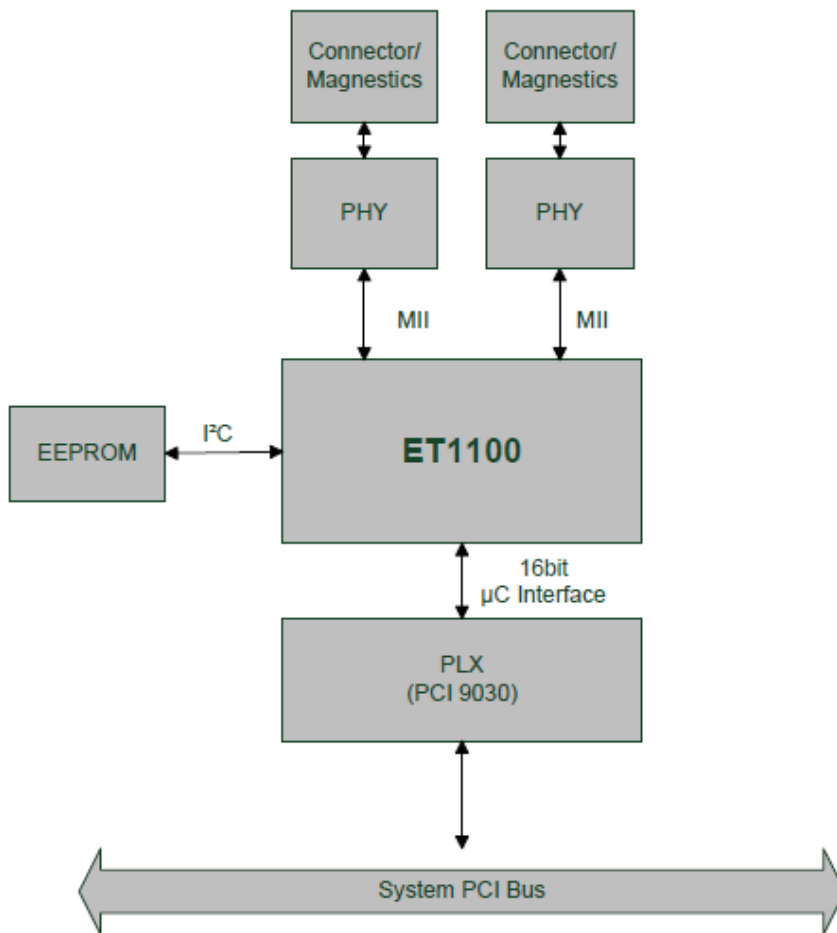
Fig. 1: Hardware scheme

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3.1.1   Interrupt

The Sync0 is routed to the testpoint TP602 and has to be mapped to the AL Event to make use of it. See the ESC datasheet for more details how to map the Sync0 to the AL Event.

The Sync1 is not useable.

The PDI_IRQ is routed to LINTi1 of the PCI controller.

3.2 FC1121 | PCIe EtherCAT slave card

The PCIe ID values of the FC1121 are listed in the following table. An FPGA based EtherCAT Slave Controller (ESC) is used to access the EtherCAT network. For ESC specific information (e. g. type and revision) see the corresponding ESC registers readout by an EtherCAT master or configuration tool.

The address range of the IPCore need to be determined by the information and function description located at the beginning of BAR0 (see *FC1121 BAR0 memory mapping*). The address is BAR0 plus the offset specified in the EtherCAT slave function block (Function type 0x0002).

FC1121 PCIe values

Parameter	Value
DeviceID	0x5000
VendorID	0x15ec

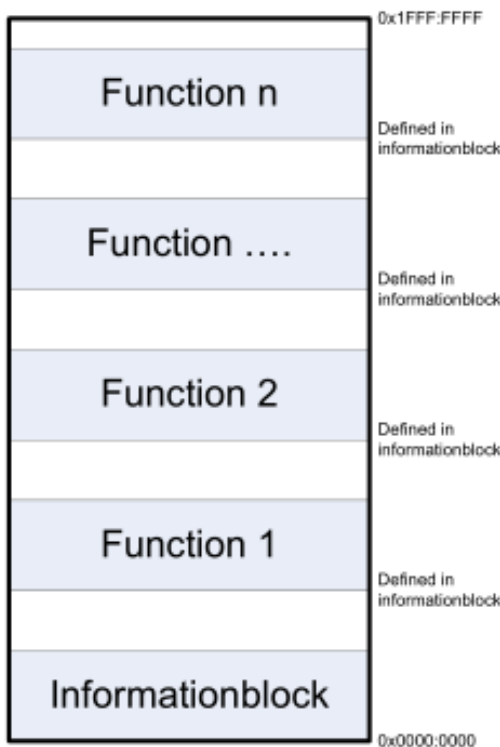The content of FC1121 BAR0 is shown in the following figure.

Fig. 2: FC1121 BAR0 memory mapping

The information block content of the FC1121 is shown in the following table.

FC1121 information block values

Address	Description	Value
0x01:0x00	Type of function	0x0001
0x03:0x02	Revision of function	0x0001
0x04	Number of function blocks	Depends Configuration
0x05	Creation day	Depends on creation date
0x06	Creation month	Depends on creation date
0x07	Creation year	Depends on creation date
0x0b:0x08	Identifier 1	0x0000:88a4
0x0f:0x0c	Identifier 2	"CCAT"

The function block content of the FC1121 is shown in the following table.

FC1121 function block description

Address	Description	Value
0x01:0x00	Type of function	0x0002
0x03:0x02	Revision of function	
0x05:0x04	Parameter of function	
0x07:0x06	reserved	
0x0b:0x08	Base address offset of function	Offset to BAR0
0x0f:0x0c	Size of function on bytes	

3.2.1   Interrupt

The Interrupts are controlled by the Interrupt function block

Interrupt Controller function block description

Address	Description	Value
0x01:0x00	Type of function	0x0011
0x03:0x02	Revision of function	
0x07:0x04	reserved	
0x0b:0x08	Base address offset of function	Offset to BAR0
0x0f:0x0c	Size of function on bytes	

- Default FC1121 firmware
  The Sync0 is fixed configured with the pulse length of 100ns and Sync 1 is not available.

- "Sync acknowledge mode" firmware
  Supports Sync0 and Sync1 in acknowledge mode and mapped to the AL Event ESC register. To get this firmware please contact ethercatssc@beckhoff.com.
  NOTE: The AL Event Mask in the ESC register needs to be adapted to support the Sync signals triggering the PDI_ISR. In case of the Beckhoff Slave Stack Code (SSC) this can be done in the function APPL_StartInputHandler. SSC download: www.beckhoff.com/ET9300

Sync0 (slot2) and PDI_ISR (slot1) states are shown in the Interrupt state register (see following table).

Interrupt State Register (0x00) description

Bit	Description	Reset value
0	Interrupt state of Slot 0	0
1	Interrupt state of Slot 1	0
…	…	…
15	Interrupt state of Slot 15	0

To enable the interrupt forward to the PCIe the following settings need to be done.

- Enable interrupt mask for **slot1** (PDI_ISR) and **slot2** (Sync0) in the interrupt control function block.
- Enable BAR2 register 0x50 bit 7. The interrupt state is shown in BAR2 register 0x40 bit 7.
  In some configurations bit0 has to be set (and the state is also shown in bit0).

Interrupt Mask Register (0x08) description

Bit	Description	Reset value
0	Interrupt mask of Slot 0	0
1	Interrupt mask of Slot 1	0
…	…	…
15	Interrupt mask of Slot 15	0

3.2.2   FC1121-firmware update

To update the firmware of the FC1121 the following steps need to be done.

1. Install TwinCAT in the PC which includes the FC1121. TwinCAT download: www.beckhoff.com/
    Twincat
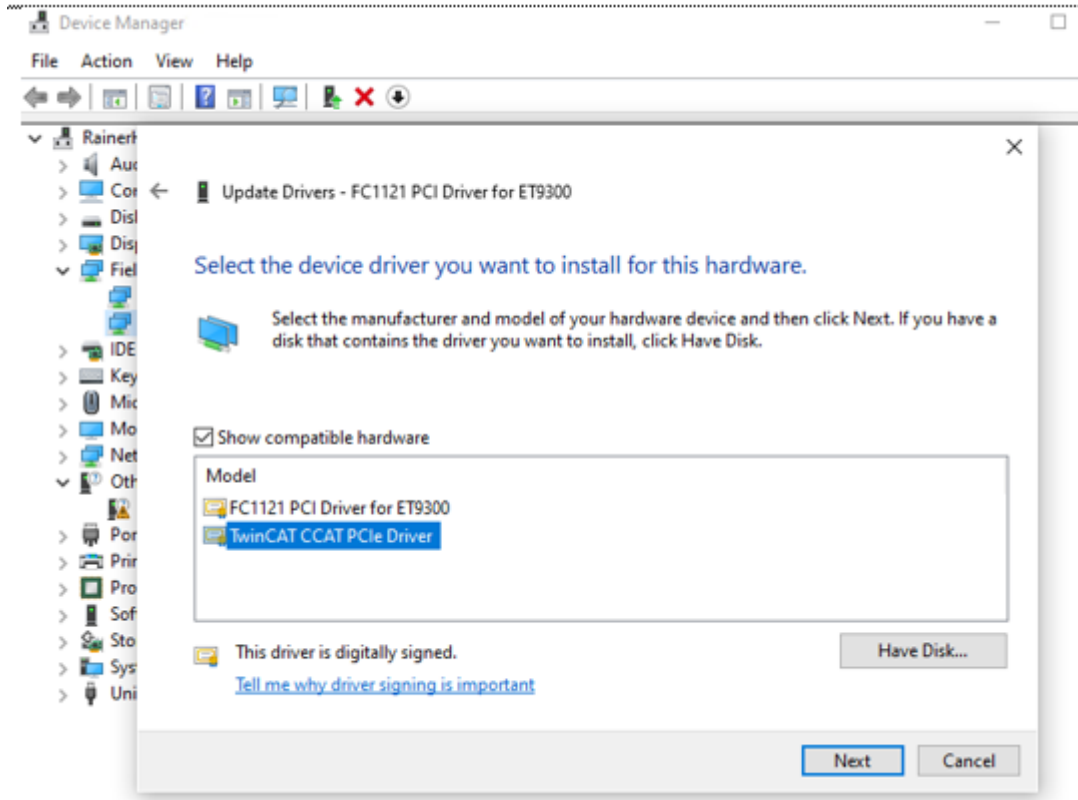2. Install the TwinCAT driver for the FC1121 (see fig. "Install TwinCAT FC1121 driver"

Fig. 3: Install TwinCAT FC1121 driver

3. Start the TwnCAT XAE Shell
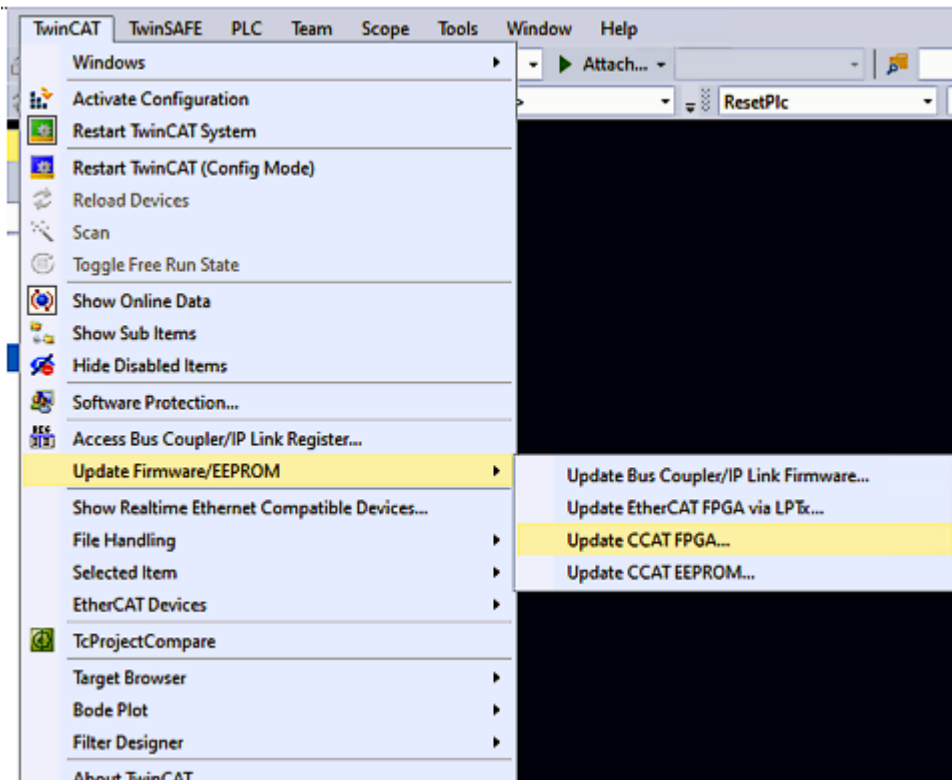4. Select "TwinCAT" -> "Update Firmware/EEPROM" -> "Update CCAT FPGA" (see fig. " FC1121 FPGA Update").

Fig. 4: FC1121 FPGA Update

5. Select the FC1121 to update and click "OK" (see fig. "Select FC1121 to Update")
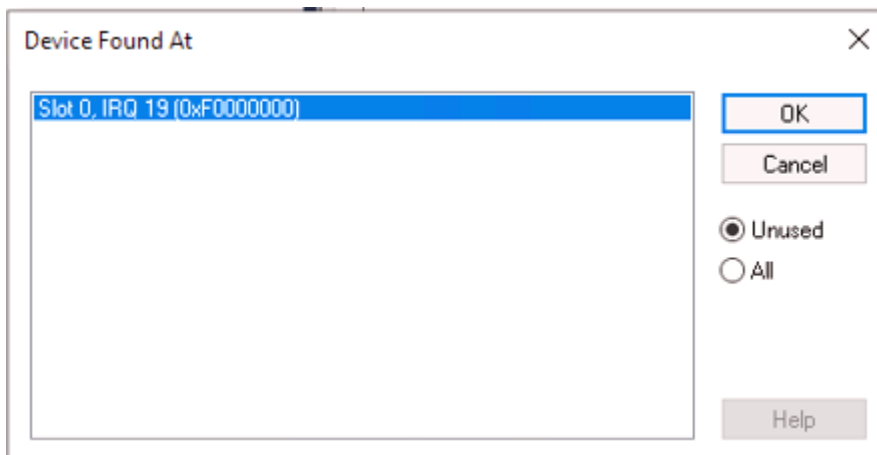
Fig. 5: Select FC1121 to Update

Progress and Final Dialog are shown in following figures.
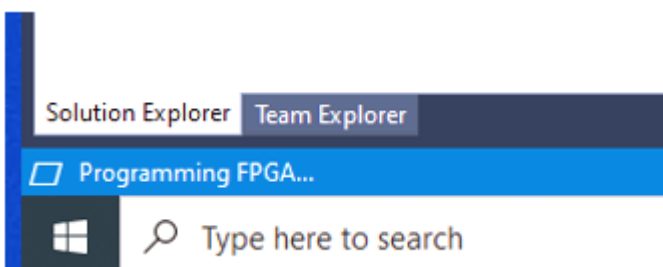
Fig. 6: FC1121 Programming
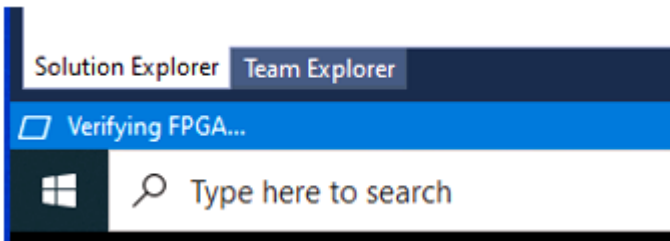
Fig. 7: FC1121 Verifying
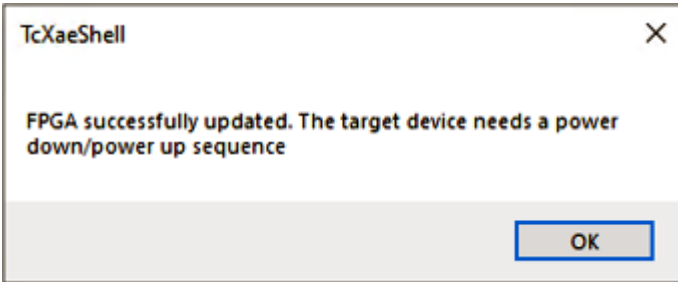

Fig. 8: FC 1121 Update Successful

4 Software

By default, two software solutions are provided:

- TwinCAT (http://www.beckhoff.com/TwinCAT)
- SlaveStackCode (SSC) (http://www.ethercat.org/memberarea/stack_code.aspx)

Both solutions are Windows-based and don't support any kind of synchronization.

Other implementations are not welcome due to EtherCAT slave compability reasons. If necessary, the Windows drivers are available in the SSC download package (free download for ETG members):

- fc11xxAccess.dll (before 2023 named as TcHelper.dll)
- fc11xxAccess.h (before 2023 named as TcHelper.h) - Headerfile that describes the dll-functions
- fc11xx.sys (before 2023 named as TcMM.sys)
- fc11xx.inf (before 2023 named as TcMM.inf)

4.1 TwinCAT

Since TwinCAT version 2.11 R2 it is possible to make PLC data accessible by an EtherCAT master via the EtherCAT network. The available process data size depends on the used ESC (see chapter Hardware [▶ 9]).

> ℹ️ **TwinCAT and a 64 bit operating system**
>
> When using the card with TwinCAT and a 64 bit operating system, the Memory Mapped IO area of the PCI bus must be limited to 4 GB in the BIOS of the PC.

4.1.1 Configure Slave System

The following steps describe how to configure the slave system with TwinCAT and the slave card installed in PCI or PCIe port.

Start TwinCAT software, scan for new I/O Devices and select *EtherCAT Slave* (see fig. *Select EtherCAT Slave*).
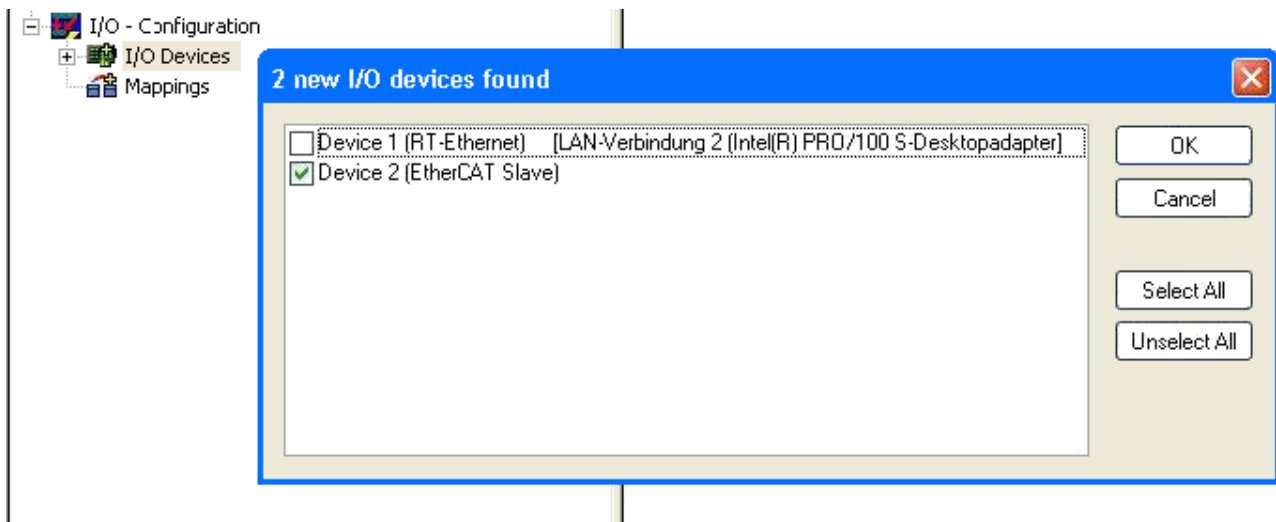

Fig. 9: Select EtherCAT Slave

The process data can be added by right mouse click on the corresponding node (see fig. *Add Process Data Manually*). If a PLC project is already added to the System Manger project which contains user defined structs these are also selectable.
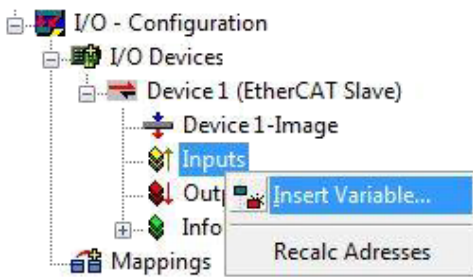
Fig. 10: Add Process Data Manually

If the PLC project is available, the linking between the PLC data and the defined process data is done by right mouse click on the variable and select *Change Link* (see fig. *Create Variable Link*).
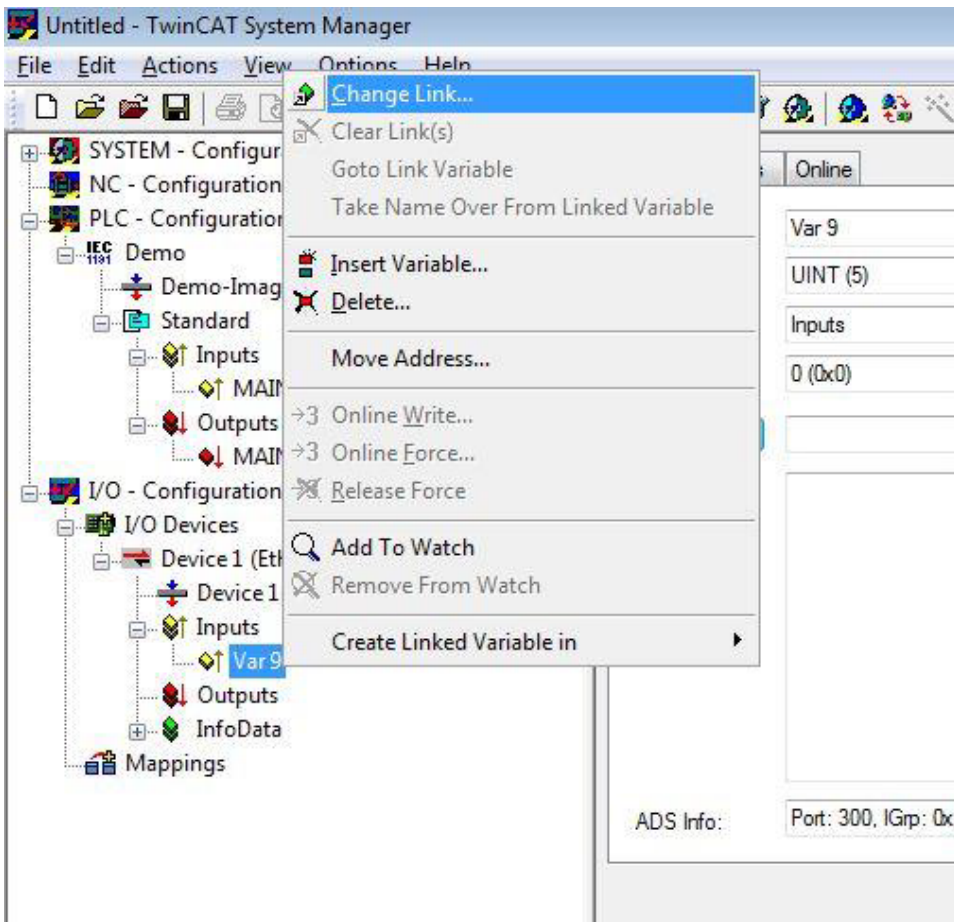

Fig. 11: Create Variable Link

Save the configuration in a tsm-file. This file can be used to provide the PDO setup to the Master configuration.

4.1.2   Configure Master System

In this description the FC1100 is referenced, the configuration for the FC1121 is equal.
Create a new TwinCAT System Manager configuration. Append a new FC1100 EtherCAT Slave (see fig. *Add FC1100 EtherCAT Slave*).
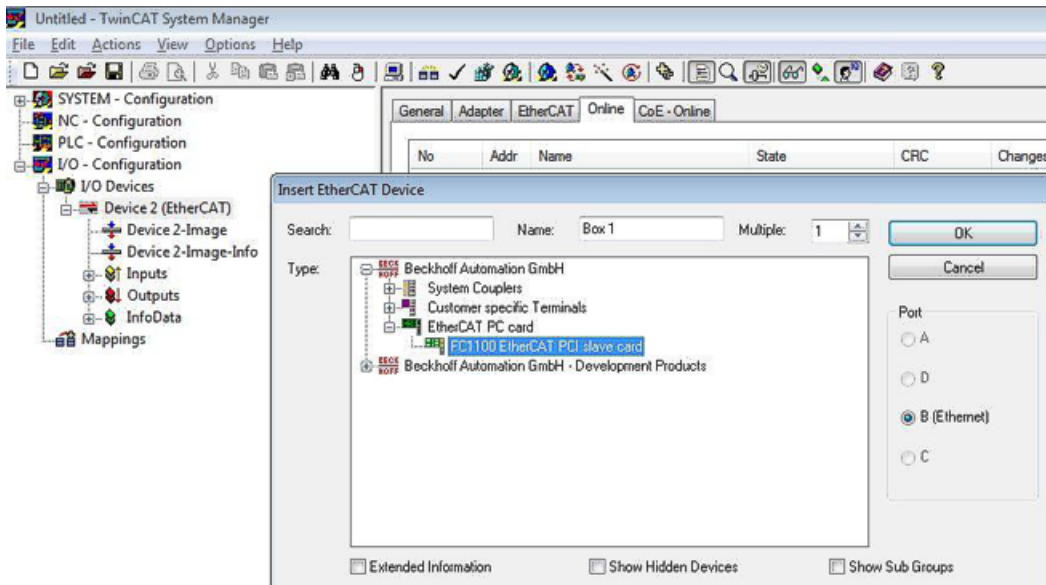

Fig. 12: Add FC1100 EtherCAT Slave

Import the PDO Configuration from the previous stored tsm file (see fig. *Import PDO Configuration*).
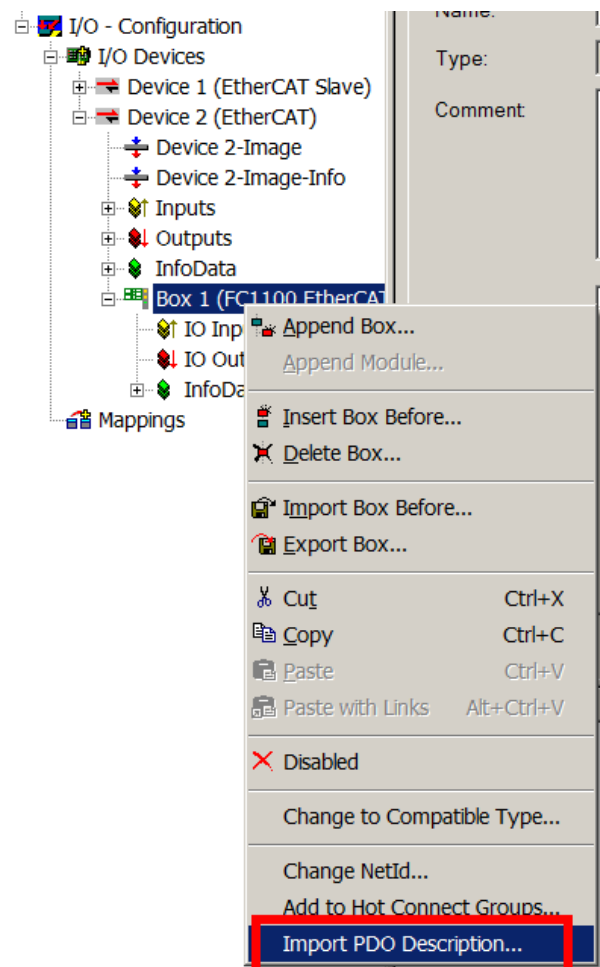

Fig. 13: Import PDO Configuration

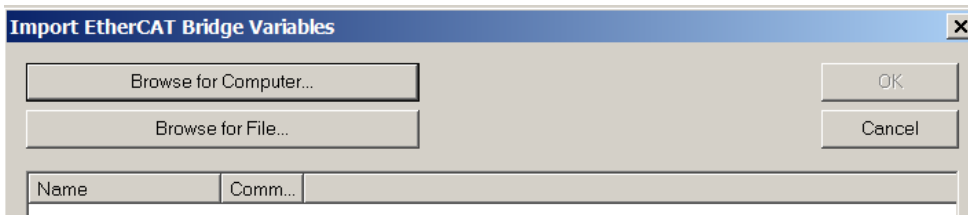The tsm file needs to be loaded to get the required information.

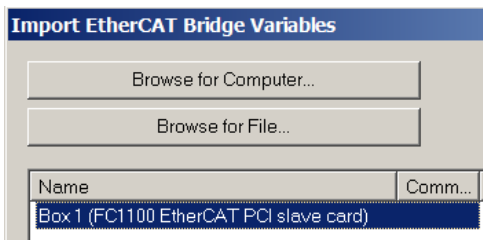Fig. 14: Import PDO Configuration Dialog

Select FC1100 card with PDOs

Fig. 15: Select corresponding Slave from tsm file

4.2 Slave Sample Code

The SlaveStackCode since provides the possibility to create a PC-based slave application without the TwinCAT software. To get this slave application running the FC11xx driver need to be installed (see chapter Driver installation [▶ 20]). This driver creates a black channel between device memory in kernel layer and the application in the user layer.

4.2.1 Driver installation

After plugin the FC11xx EtherCAT PCI Slave card the driver installation window (see fig. *Driver Installation Window*) will be appear. If a driver is already installed, then open this window from the Windows Device Manager dialog.

Fig. 16: Driver Installation Window

Select driver source path from a specific location (see fig. *Select Driver Location*) and choose the path where the files FC11xx.inf and TcMM.sys are located.
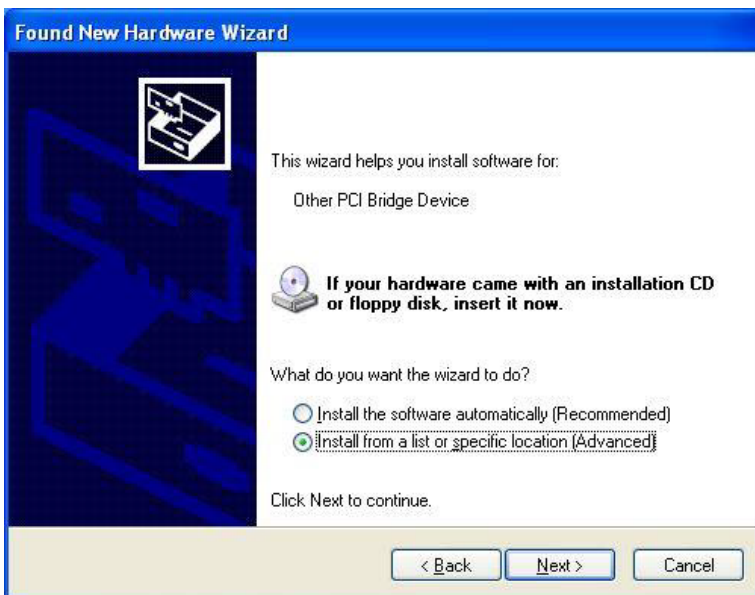

Fig. 17: Select Driver Location

After successful installation the device "FC1100 PCI Driver for ET9300" is listed in the Windows Device Manager (see fig. *Windows Device Manager*).

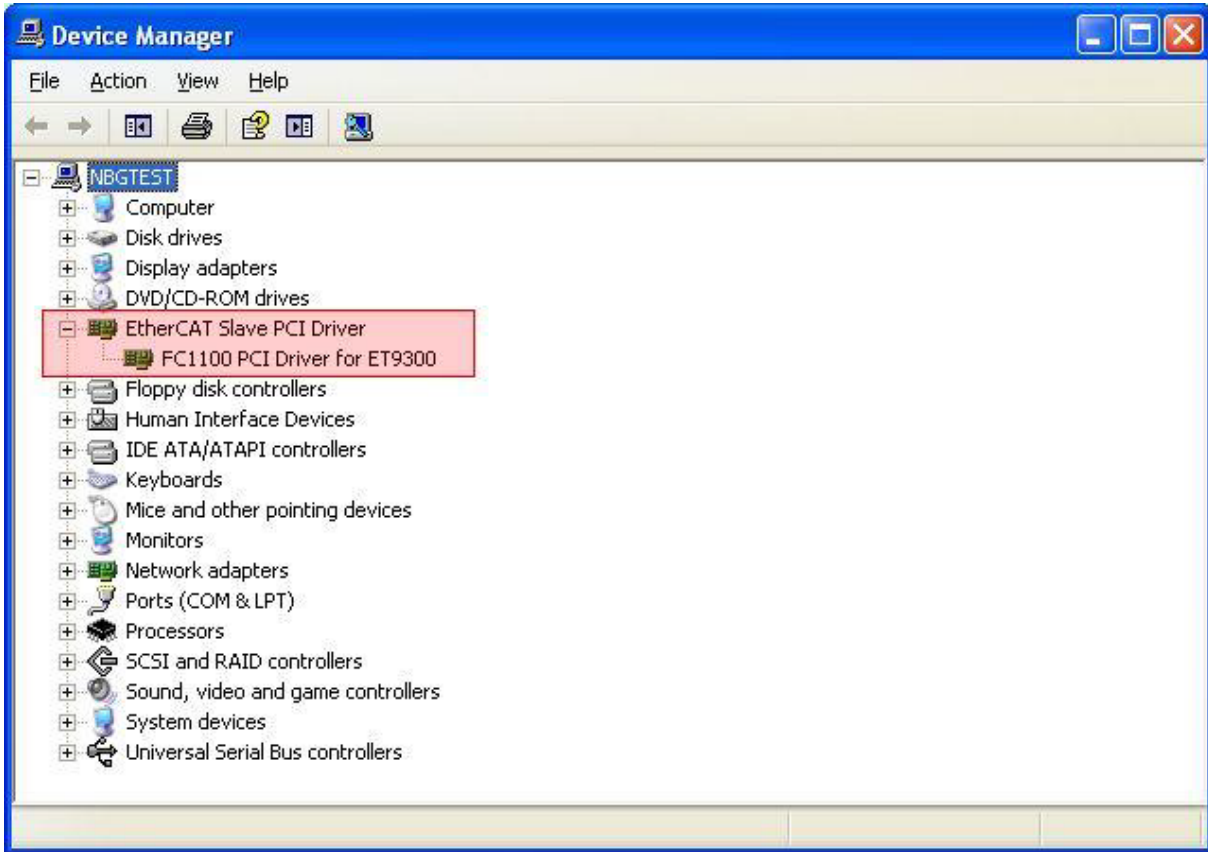In case of the FC1121 card the name "FC1121 PCI Driver for ET9300" is shown.

Fig. 18: Windows Device Manager

The EtherCAT Slave Controller (ESC) is now accessible by using the library TcHelper.dll.

4.2.2 Slave Software

In case that the SSC Tool is used create an FC1100 based project (selectable in the "new project dialog").
Otherwise enable "FC1100_HW" in the file ecat_def.h.
Note: When using the FC1121 slave card, the settings for "FC1100" apply as well.

5   Appendix

5.1   Support and Service

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