

Documentation | EN

FC1100 and FC1121

Application note for EtherCAT Slave Cards



Table of contents

1 Foreword	5
1.1 Notes on the documentation	5
1.2 Safety instructions	6
1.3 Notes on information security	7
1.4 Documentation Issue Status	7
2 Product overview	8
2.1 Introduction	8
3 Hardware	9
3.1 FC1100 - PCI EtherCAT slave card	9
3.1.1 Interrupt	10
3.2 FC1121 - PCIe EtherCAT slave card	11
3.2.1 Interrupt	12
3.2.2 FC1121 - Firmware update	13
3.2.3 FC1121 - LED displays	16
4 Software	17
4.1 TwinCAT	17
4.1.1 Configure Slave System	17
4.1.2 Configure Master System	19
4.2 Slave Sample Code	21
4.2.1 Driver installation	21
4.2.2 Slave Software	22
5 Appendix	23
5.1 Support and Service	23

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.

Disclaimer

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

We reserve the right to revise and change the documentation at any time and without prior announcement.

No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

Trademarks

Beckhoff®, ATRO®, EtherCAT®, EtherCAT G®, EtherCAT G10®, EtherCAT P®, MX-System®, Safety over EtherCAT®, TC/BSD®, TwinCAT®, TwinCAT/BSD®, TwinSAFE®, XFC®, XPlanar® and XTS® are registered trademarks of and licensed by Beckhoff Automation GmbH.

Other designations used in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owners.



EtherCAT® and EtherCAT P® are registered trademarks and patented technologies, licensed by Beckhoff Automation GmbH, Germany.

Copyright

© Beckhoff Automation GmbH & Co. KG, Germany.

The reproduction, distribution and utilization of this document as well as the communication of its contents to others without express authorization are prohibited.

Offenders will be held liable for the payment of damages. All rights reserved in the event of the grant of a patent, utility model or design.

Third-party brands

Trademarks of third parties may be used in this documentation. You can find the trademark notices here: <https://www.beckhoff.com/trademarks>

1.2 Safety instructions

Safety regulations

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.

Exclusion of liability

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

Personnel qualification

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

Signal words

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.

Information on handling the product



This information includes, for example:
recommendations for action, assistance or further information on the product.

1.3 Notes on information security

The products of Beckhoff Automation GmbH & Co. KG (Beckhoff), insofar as they can be accessed online, are equipped with security functions that support the secure operation of plants, systems, machines and networks. Despite the security functions, the creation, implementation and constant updating of a holistic security concept for the operation are necessary to protect the respective plant, system, machine and networks against cyber threats. The products sold by Beckhoff are only part of the overall security concept. The customer is responsible for preventing unauthorized access by third parties to its equipment, systems, machines and networks. The latter should be connected to the corporate network or the Internet only if appropriate protective measures have been set up.

In addition, the recommendations from Beckhoff regarding appropriate protective measures should be observed. Further information regarding information security and industrial security can be found in our <https://www.beckhoff.com/secguide>.

Beckhoff products and solutions undergo continuous further development. This also applies to security functions. In light of this continuous further development, Beckhoff expressly recommends that the products are kept up to date at all times and that updates are installed for the products once they have been made available. Using outdated or unsupported product versions can increase the risk of cyber threats.

To stay informed about information security for Beckhoff products, subscribe to the RSS feed at <https://www.beckhoff.com/secinfo>.

1.4 Documentation Issue Status

Version	Comment
2.5.0	• Chapter <i>FC1121 - LED displays</i> added
2.4	• Chapter <i>Hardware</i> and <i>Software</i> updated
2.3	• Chapter <i>Software</i> updated
2.2	• Chapter <i>Software</i> updated
2.1.0	• Chapter <i>TwinCAT</i> updated • Chapter <i>Notes on information security</i> 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	www.beckhoff.com/FC1100	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.



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.

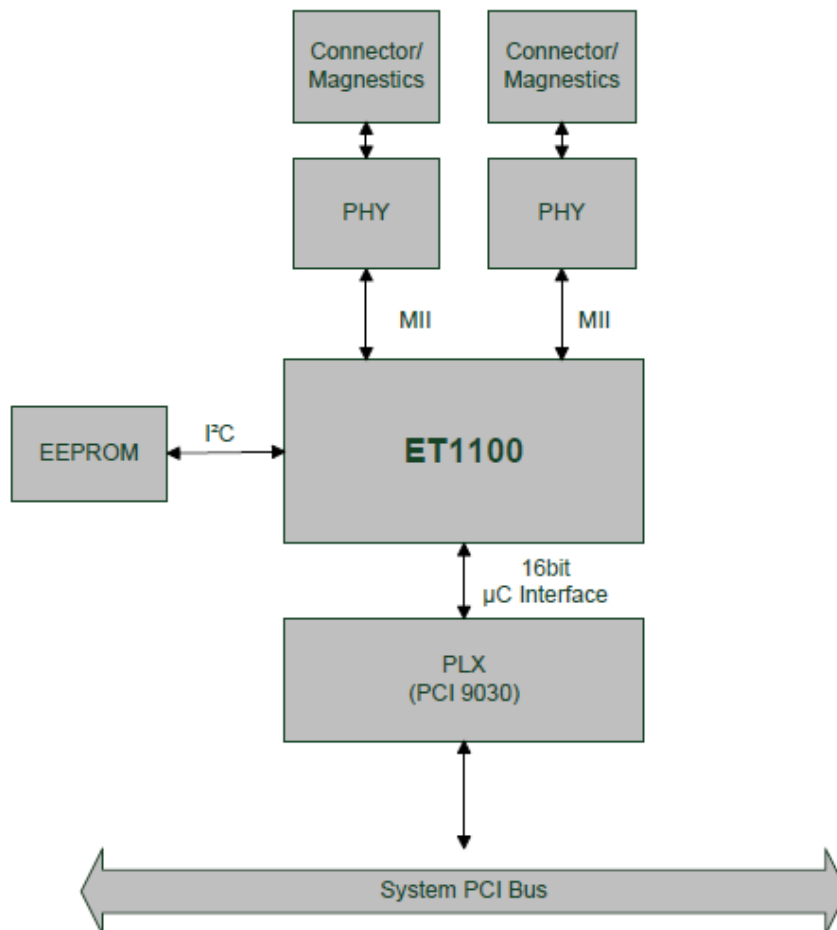


Fig. 1: FC1100 - Hardware scheme

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 needs 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.

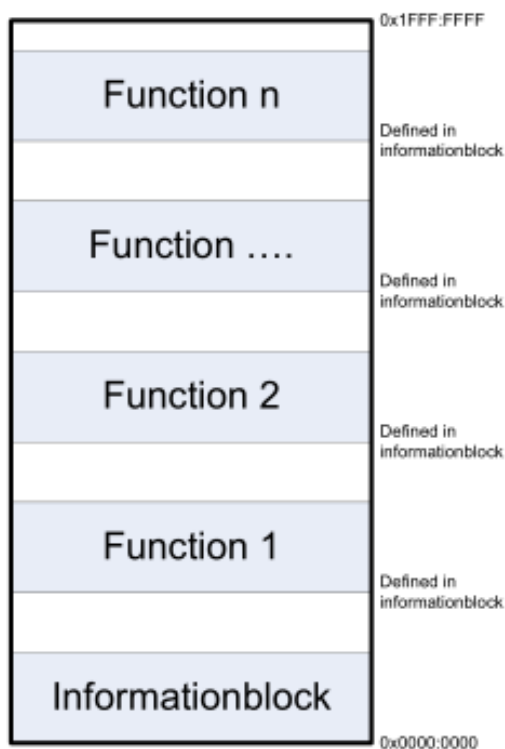


Fig. 2: FC1121 - BAR0 memory mapping

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")

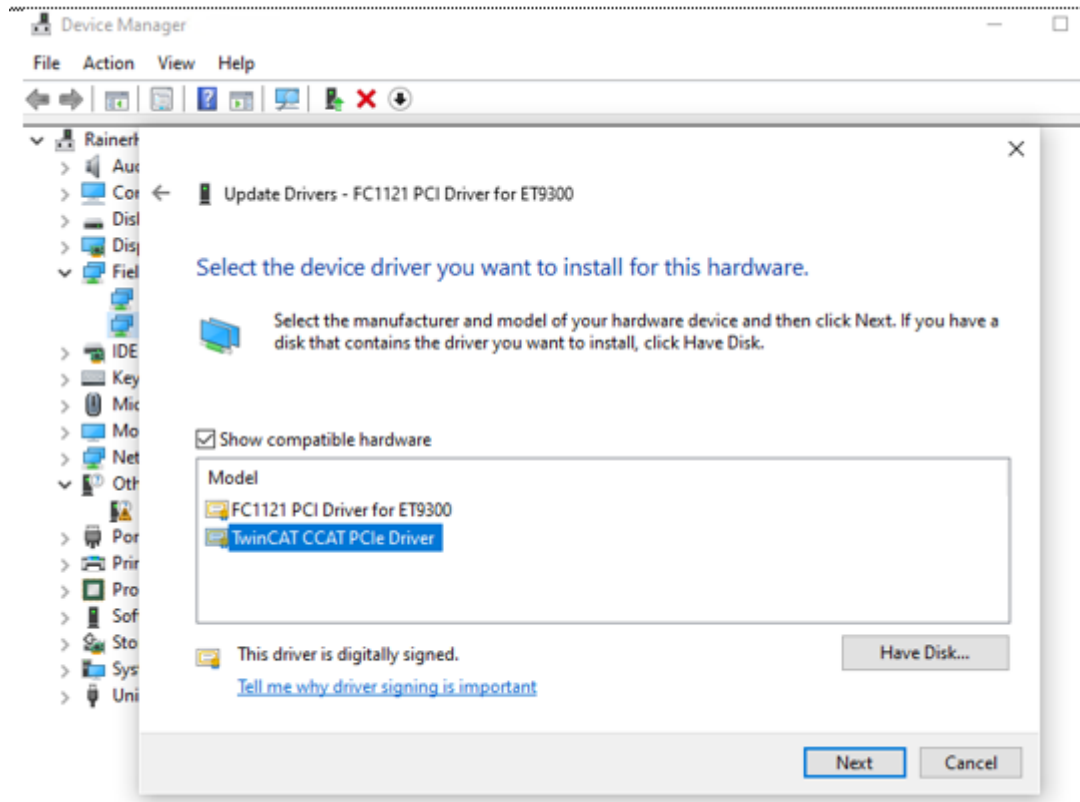


Fig. 3: FC1121 - Install TwinCAT driver

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

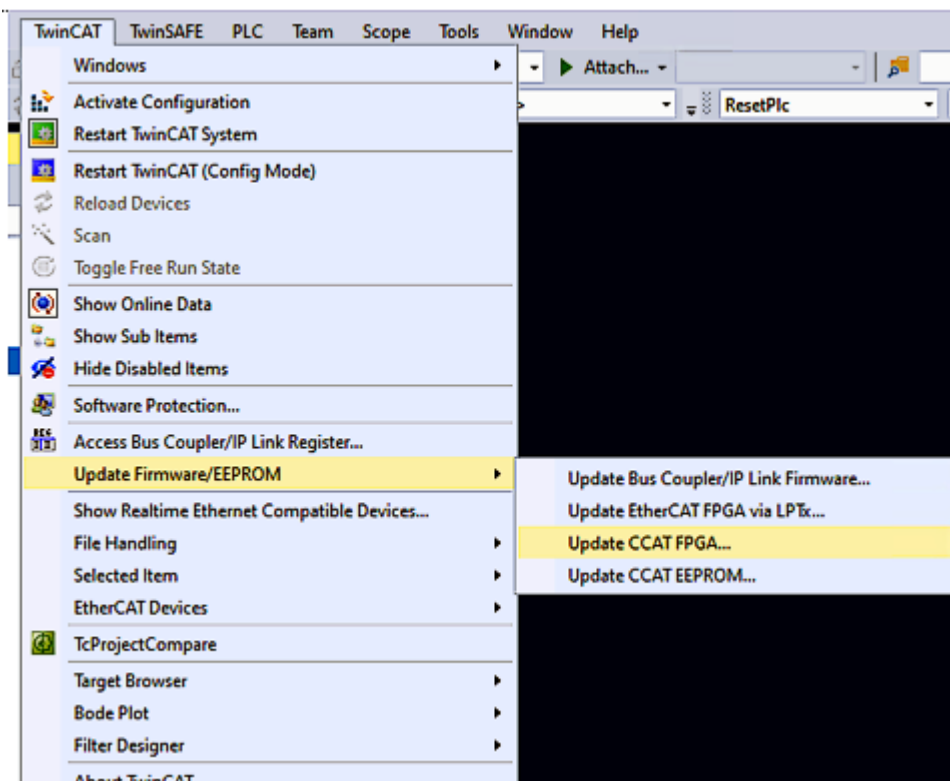


Fig. 4: FC1121 - FPGA Update

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

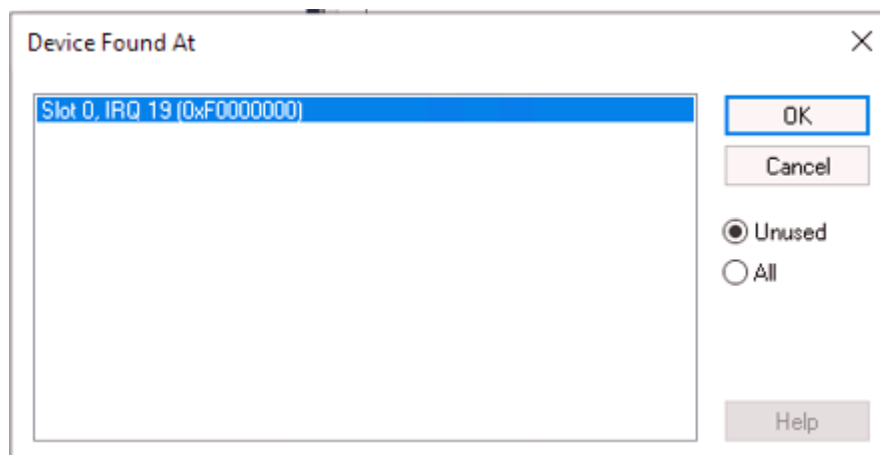


Fig. 5: Select FC1121 to Update

Progress and Final Dialog are shown in following figures.

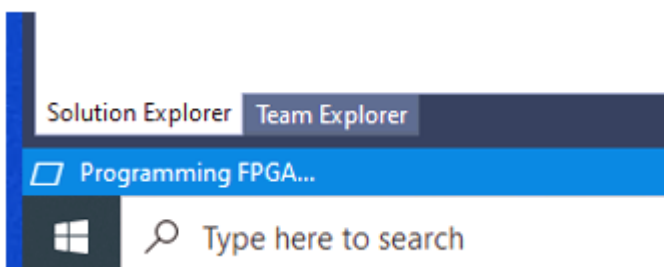


Fig. 6: FC1121 - Programming

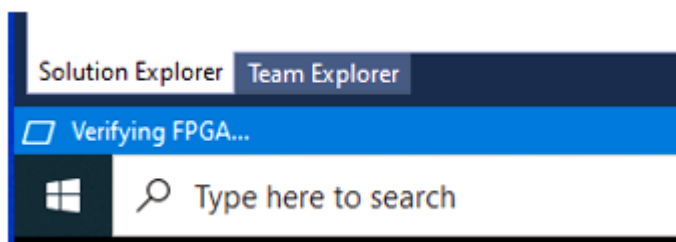


Fig. 7: FC1121 - Verifying

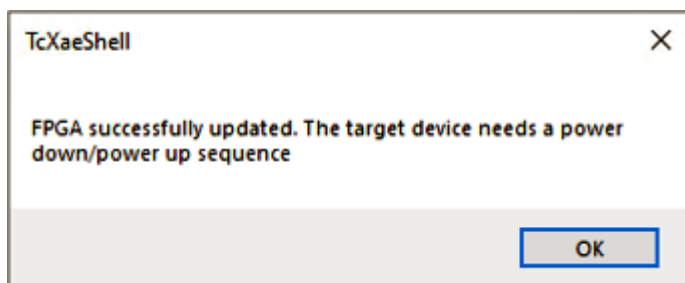


Fig. 8: FC 1121 - Update Successful

3.2.3 FC1121 - LED displays

RUN LED

LED	Color	Meaning
Run	green	This LED indicates the card's operating state:
		off State of the EtherCAT State Machine: INIT = initialization of the terminal or BOOTSTRAP = function for firmware updates of the terminal
		flashing State of the EtherCAT State Machine: PREOP = function for mailbox communication and different standard-settings set
		single flash State of the EtherCAT State Machine: SAFEOP = verification of the Sync Manager channels and the distributed clocks. Outputs remain in safe state
		on State of the EtherCAT State Machine: OP = normal operating state; mailbox and process data communication is possible

Error LED

The ERR LED indicates local errors and application errors. It is either connected to the application controller or to the ESC (optional ESC feature). If it is connected to the ESC, some errors are automatically indicated by the ESC, other error states are detected by the application controller and indicated by writing to the ERR LED override register 0x0139.

The following ERR LED states can be automatically generated by an ESC, without interaction of an application controller. The support of individual error states is ESC specific.

LED	Color	Meaning		
Error	red	State	Description	Examples
		off	no error	
		flickering (fast)	SII EEPROM loading error	no SII EEPROM device, SII CRC error
		blinking (slow)	invalid hardware configuration	ESC pin sharing violation
		single flash	AL status register error indication bit 0x0130[4] is set while device emulation is disabled.	local application controller sets error indication bit NOTE: E.g.: If the µController makes a state change with error indication bit 0x0130[4] set after a process data watchdog timeout, it has to manually set the ERR LED to Double Flash again. Otherwise the ESC would generate a single flash due to the error indication bit automatically.
		double flash	Process data watchdog timeout (edge detected) while device is OPERATIONAL	master is disconnected/not sending process data any more
		om	PDI watchdog timeout (edge detected) or build-in self-test error	local application controller failure or self-test failure

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 \[► 9\]](#)).

i 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*).

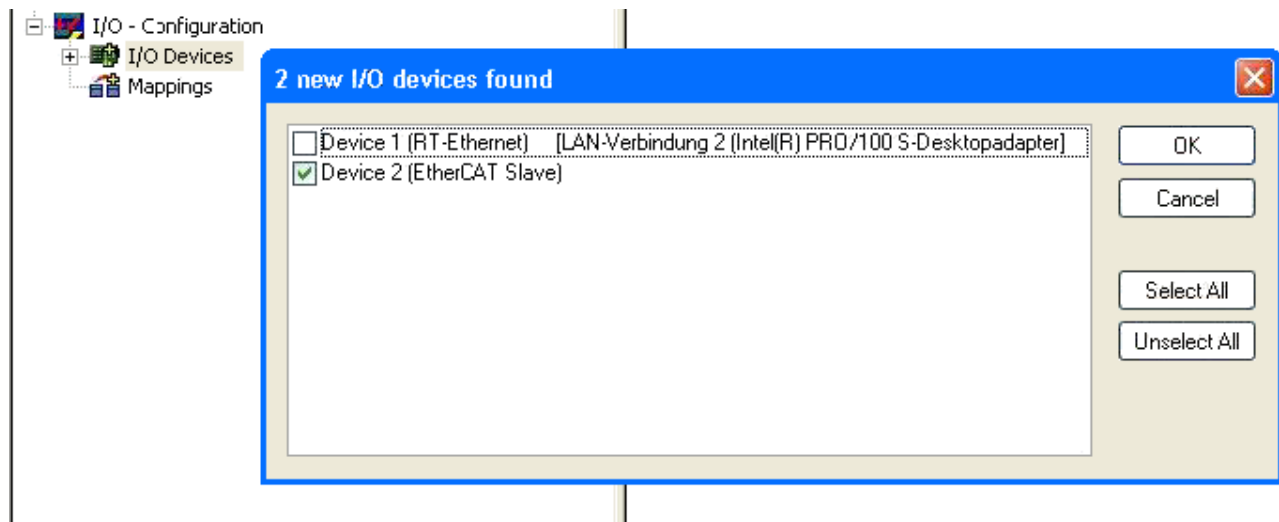


Fig. 9: Select EtherCAT Slave

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.

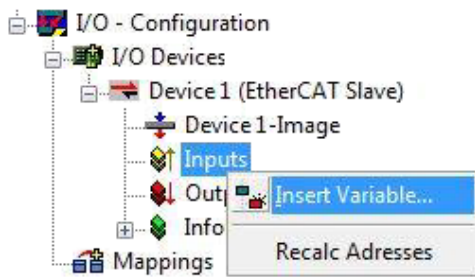


Fig. 10: Add Process Data Manually

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*).

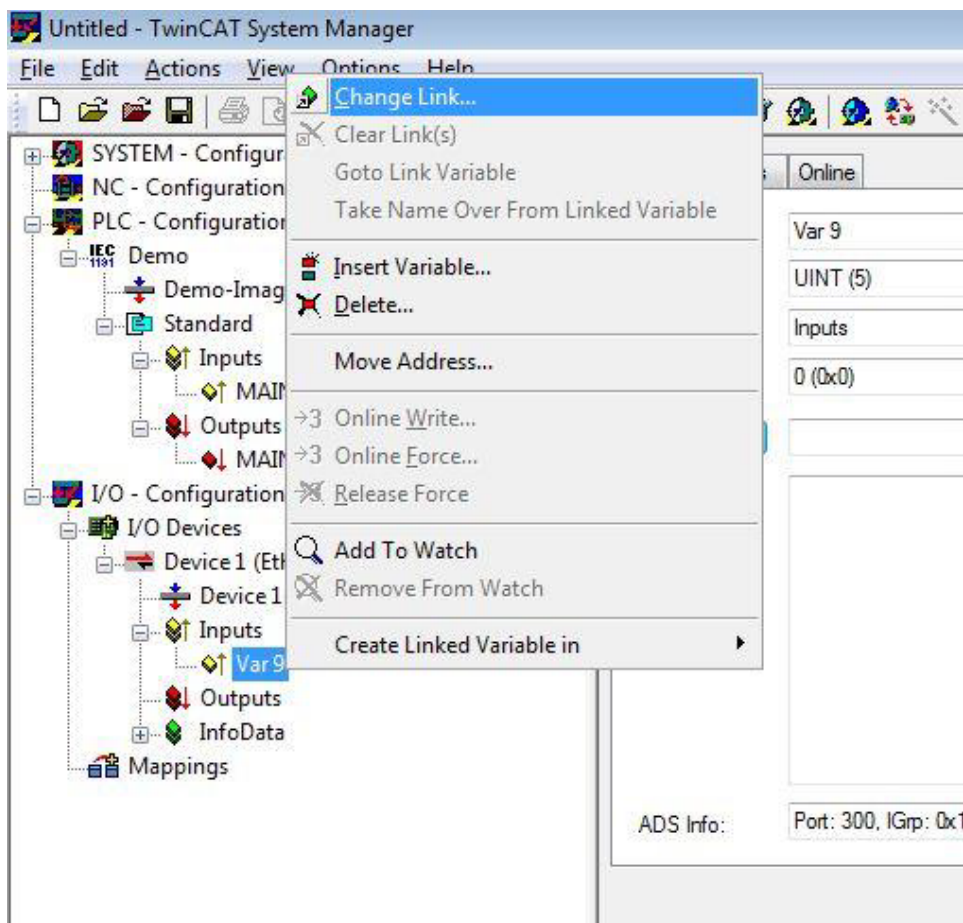


Fig. 11: Create Variable Link

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*).

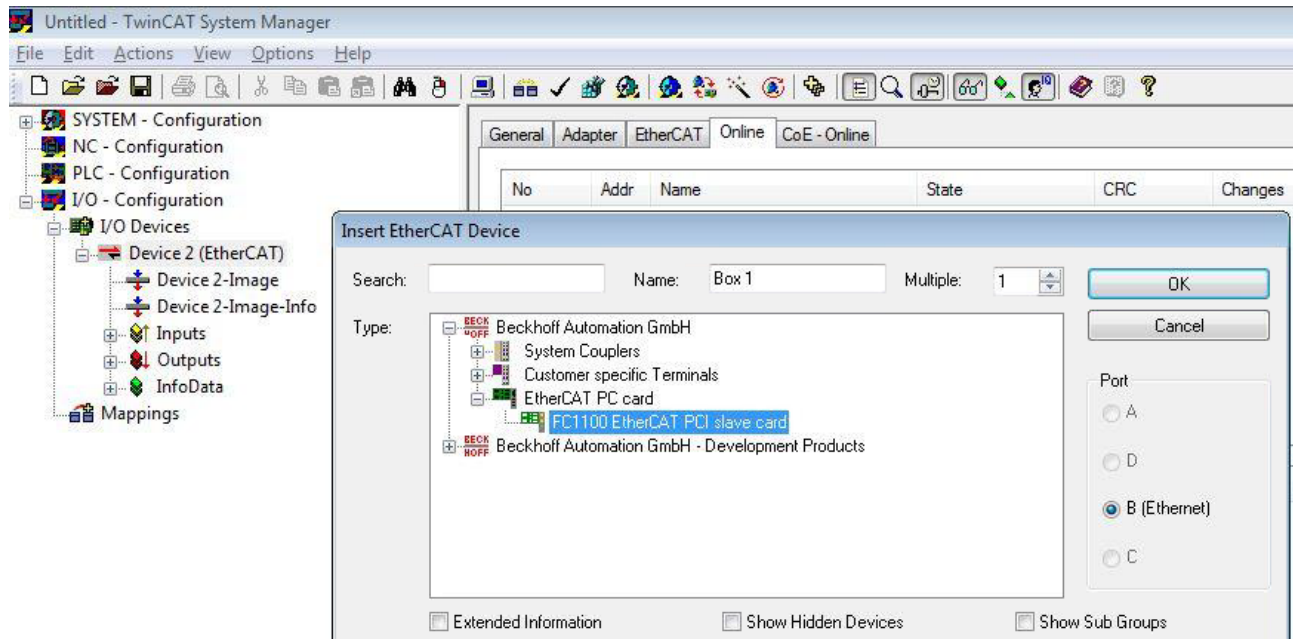


Fig. 12: Add FC1100 EtherCAT Slave

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

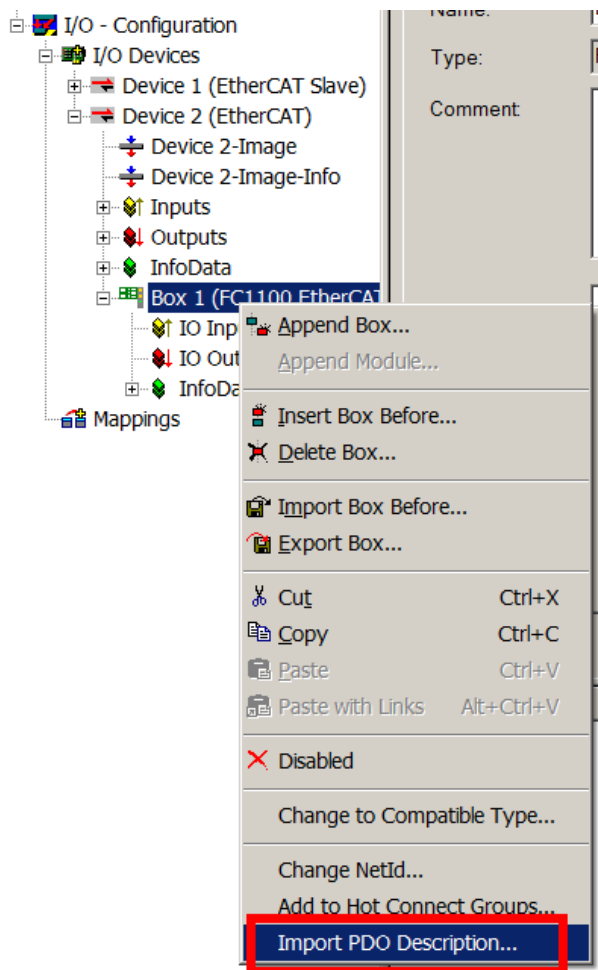


Fig. 13: Import PDO Configuration

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

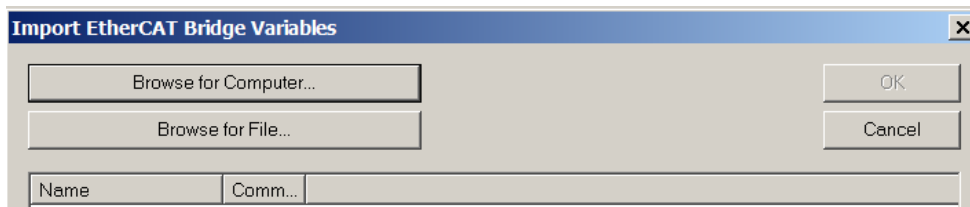


Fig. 14: Import PDO Configuration Dialog

Select FC1100 card with PDOs

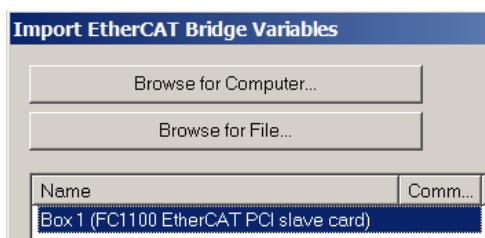


Fig. 15: Select corresponding Slave from tsm file

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](#) [▶ 21]). 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.

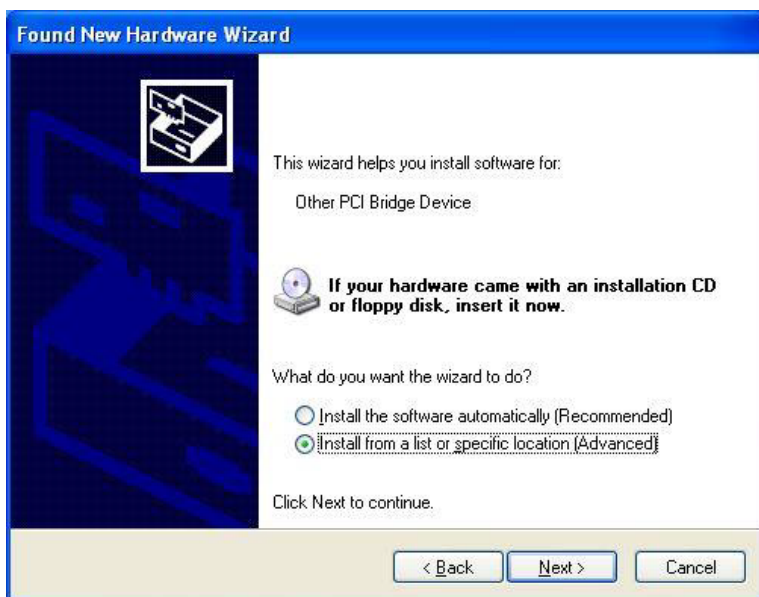


Fig. 17: Select Driver Location

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.

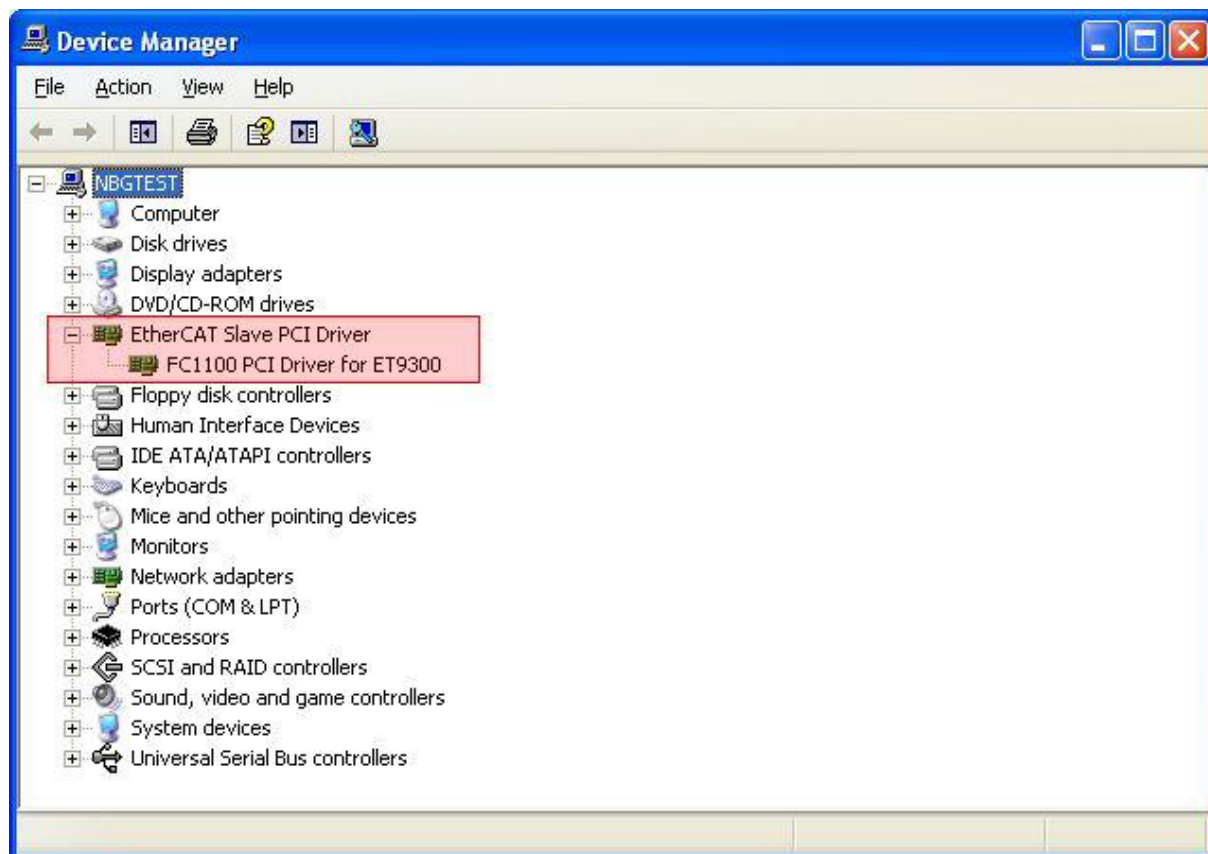


Fig. 18: Windows Device Manager

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

Beckhoff Support and Service provides assistance with questions regarding Beckhoff products and system solutions, as well as with their planning, commissioning, and operation.

Beckhoff subsidiaries and representative offices

Please contact your Beckhoff subsidiary or your representative office for local support and service for Beckhoff products. You can find the addresses of Beckhoff subsidiaries and representative offices at: www.beckhoff.com/worldwide.

For Beckhoff products and technologies, we offer [Training programs](#), [tutorials](#), and [webinars](#).

Beckhoff Support

Beckhoff Support provides assistance with technical questions regarding the use, planning, programming, and commissioning of Beckhoff products.

☎ Hotline: +49 5246 963-157
✉ Email: support@beckhoff.com, [Support form](#)
Web page: www.beckhoff.com/support

Beckhoff Service

Our service specialists are here to assist you with any questions you may have regarding after-sales service processes, such as replacement parts, repairs, etc.

☎ Hotline: +49 5246 963-460
✉ Email: service@beckhoff.com, [Service form](#)
Web page: www.beckhoff.com/service

Download finder

The [Download finder](#) serves as a central source for downloadable documents and files related to Beckhoff products, such as application reports, technical documentation, drawings, and configuration files.

Beckhoff Information System

The [Beckhoff Information System](#) is the central online documentation resource for Beckhoff products and contains documentation on products and automation topics, as well as sample code.

Beckhoff Headquarters

Beckhoff Automation GmbH & Co. KG
Hülshorstweg 20
33415 Verl, Germany

☎ Phone: +49 5246 963-0
✉ Email: info@beckhoff.com
Web page: www.beckhoff.com

Trademark statements

Beckhoff®, ATRO®, EtherCAT®, EtherCAT G®, EtherCAT G10®, EtherCAT P®, MX-System®, Safety over EtherCAT®, TC/BSD®, TwinCAT®, TwinCAT/BSD®, TwinSAFE®, XFC®, XPlanar® and XTS® are registered and licensed trademarks of Beckhoff Automation GmbH.

Third-party trademark statements

Excel, IntelliSense, Microsoft, Microsoft Azure, Microsoft Edge, PowerShell, Visual Studio, Windows and Xbox are trademarks of the Microsoft group of companies.

PCI Express®, PCIe®, PCI™ and PCI HOT PLUG™ are trademarks or registered trademarks and/or service marks of PCI-SIG.

More Information:
www.beckhoff.com/FC1121

Beckhoff Automation GmbH & Co. KG
Hülshorstweg 20
33415 Verl
Germany
Phone: +49 5246 9630
info@beckhoff.com
www.beckhoff.com

