

**Beckhoff TwinCAT with
XENAX® Xvi Servo Controller
EtherCAT**

User Manual

Edition June 2014



**Beckhoff TwinCAT, the open PC
software solution for SPS and NC
to interpolate the XENAX® Xvi
servo controller with real time
EtherCAT technology.**

General

This instruction manual describes the integration of the XENAX® servo controller with EtherCAT bus modules in a Beckhoff system with TwinCAT.

This document contains an example application to set up your system efficiently.

XENAX® can be put into operation simply and quickly with the intuitive user-software WebMotion®.

We will gladly answer any questions you may have or provide you with additional information.

Alois Jenny
Jenny Science AG

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1 System Overview

Beckhoff industrial-PC with EtherCAT interface.

The programming of the machine control is operated with TwinCAT.

www.beckhoff.ch



The parameter setting and programming of the XENAX® servo controller can be carried out over a standard web browser via TCP/IP.

Simply enter the XENAX® IP address in the web browser and the WebMotion® user interface will be opened to configure and test the XENAX® servo controller.



LINAX® linear motors in the modular system.

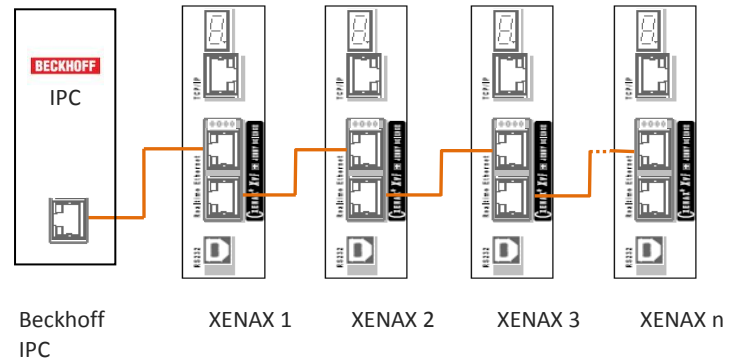


ELAX® linear motor slide

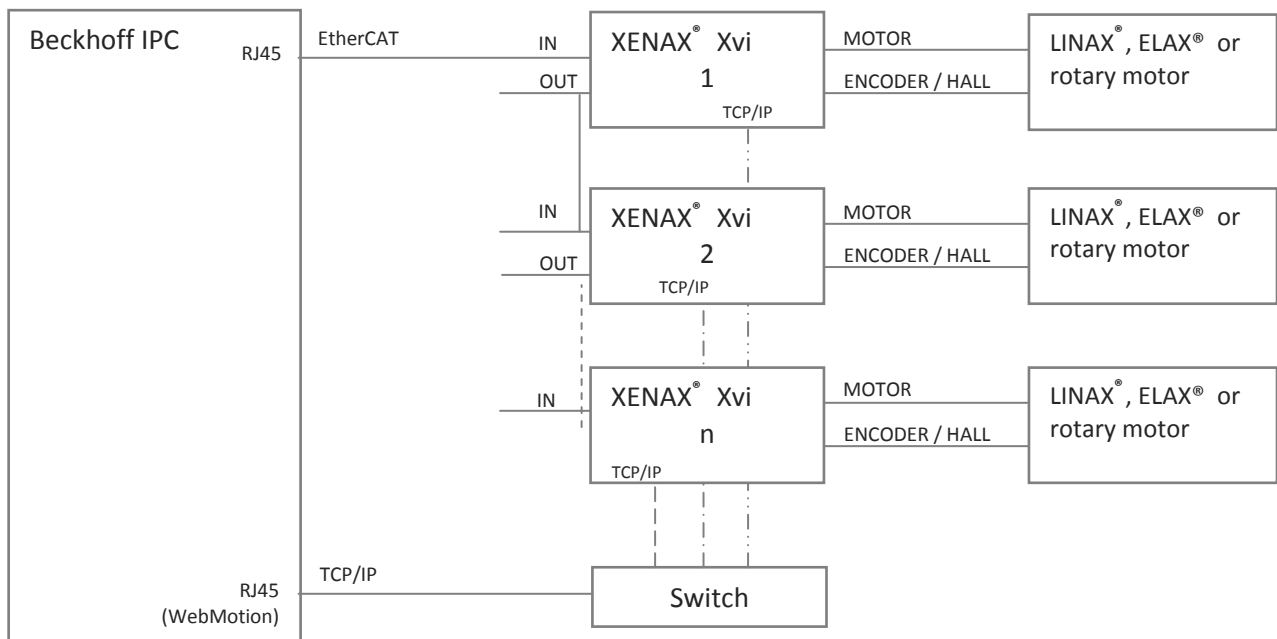


2 EtherCAT Bus

Der EtherCAT is connected with the XENAX® servo controller (IN/OUT).



3 Cabling



4 Developing Environment / Tools

The following tools are needed to program the system:

WebMotion®

To set the parameters for the XENAX® servo controller.



TwinCAT

Programs: System Manager und PLC Control
To program the Beckhoff machine control.



5 Setting the Parameters for the XENAX® Servo Controller

The following parameters have to be set in the XENAX® servo controller to operate with TwinCAT:

PCT PDO Cycle Time [μs]
Cycle time of the EtherCAT master controller (standard 1000 μs).
Can be modified in the menu online *move axis / by command line*.

For example: 2ms cycle time: PCT2000

The currently set value can be read by entering „PCT?“.

The cycle time of the Beckhoff TwinCAT System can be identified under:

- System Configuration / Real Time settings/ basic time
- NC-Configuration / NC-Task1SAF / Cycle ticks

Note:

The parameter PCT in the XENAX® Xvi servo controller is set automatically, as soon as the object 0x60C2 (interpolation time period) can be seen in the startup list
-> see chapter “Configuration of the Axis” / Automatic transfer of the cycle time to XENAX® servo controller.

6 Setup XENAX® Servo Controller

Before the XENAX® servo controller can be connected to the EtherCAT, the setup in WebMotion® has to be completed. The only parameters that have to be entered manually are the payload, the soft limit etc. The Identification of the motor and the upload of the XENAX® settings will be done automatically as soon as WebMotion® is started.

For more information on WebMotion® please refer to the XENAX® servo controller manual or the tutorial videos available on www.jennyscience.ch/en for detailed information and step by step guidance.

7 Application Example

This example shows the configuration of a Beckhoff TwinCAT to communicate with the servo controller XENAX® Xvi 75V8 via EtherCAT.

7.1 Install and transfer TwinCAT and XENAX XML files

You need a XENAX® Xvi75V8 servo controller with optional bus module EtherCAT.

Install TwinCAT with NC-PTP or NCI stage.

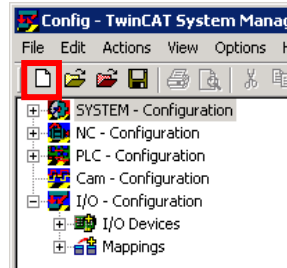
Copy file *Xenax.xml* from CD to
C:\TwinCAT\IO\EtherCAT
(In order to successfully transfer the current .xml file, the System Manager has to be closed.)

7.2 Start TwinCAT System Manager

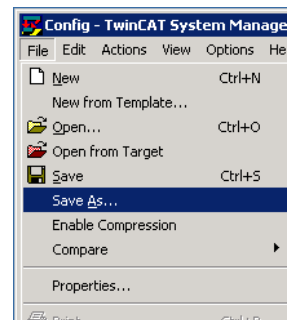
Connect number of desired XENAX® servo controller with motor power and EtherCAT cable.

Start System Manager:
Programs → TwinCAT System

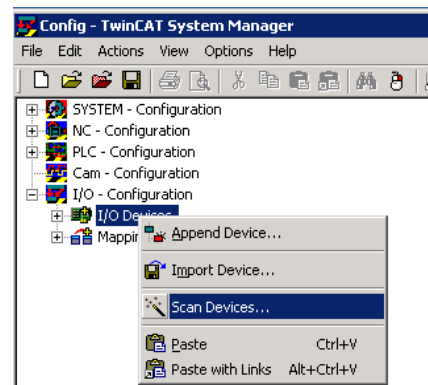
Open a new project



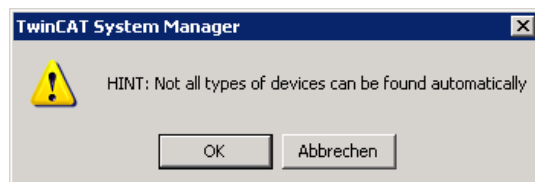
Menu: File -> Save As... Save the project wherever you would like to locate it.



Right mouse click on I/O Device -> Scan Devices...

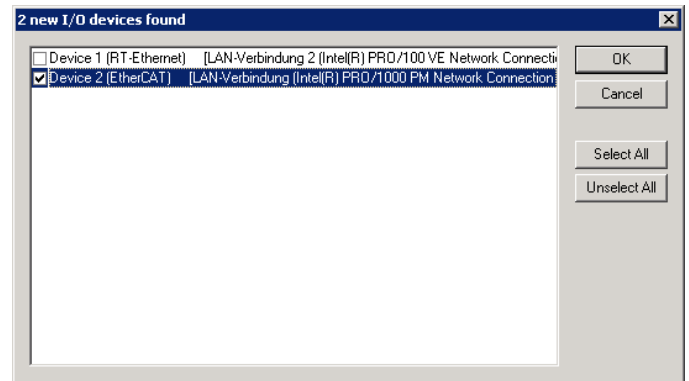


HINT: Not all types of device can be found automatically
Press "OK"



Select "Device x (EtherCAT)", "OK"

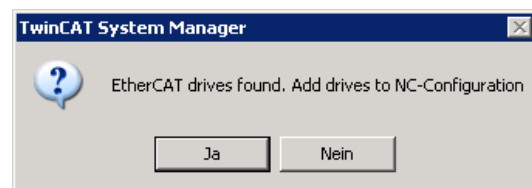
All XENAX[®] servo controller, which are currently in the system integrated are recognized automatically.



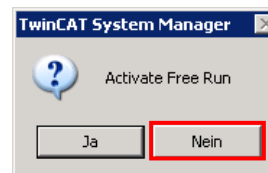
Scan for boxes
→ Press "Yes"



EtherCAT drives found. Add drives to NC-Configuration
→ Press "Yes"



Activate Free Run
→ Press "No"

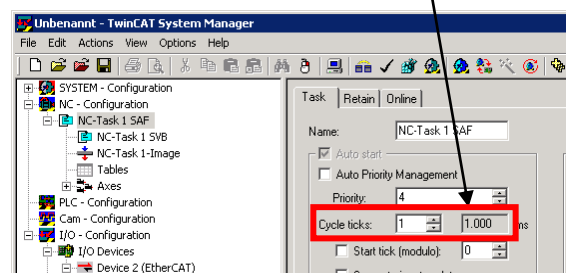
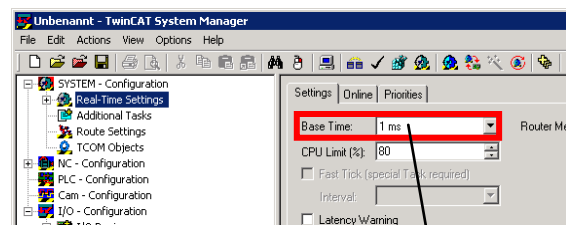


7.1 Set Cycle Time

Under *SYSTEM-Configuration* → *Real-Time Settings*, tab: *Settings*, → set the base time of the PC.
This is the real time task with which Windows is interrupted and TwinCAT is executed.

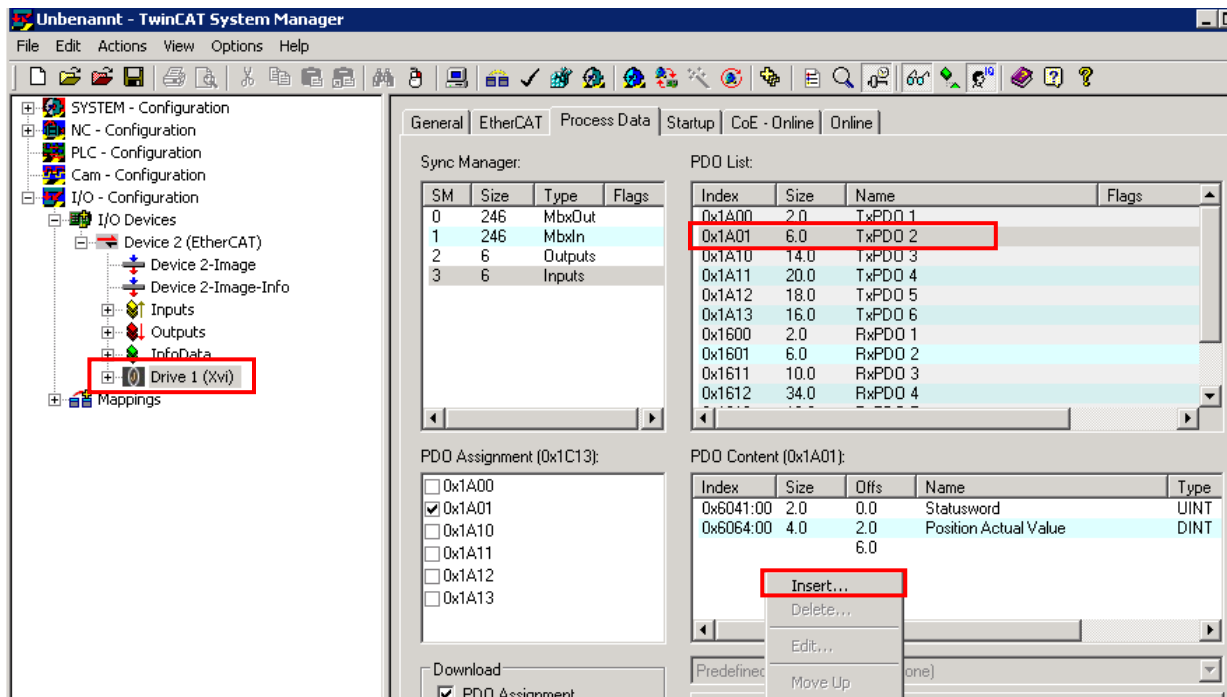
The cycle tick on the bus can be entered under *NC-Configuration* → *NC-Task 1 SAF*. The time can only be slower or the same as the basis time. This is the transmission pulse of the parameters in the Cyclic Synchronized Position Mode.

Possible values are 200us to 2ms.
Typical is 1 ms.

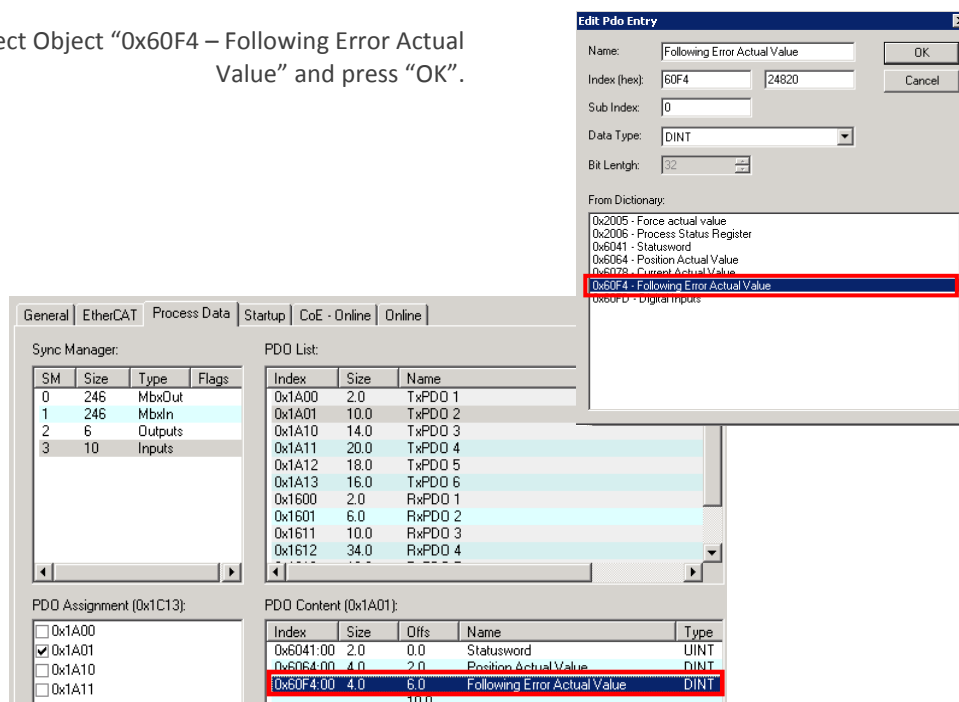


7.1 Add PDO Data

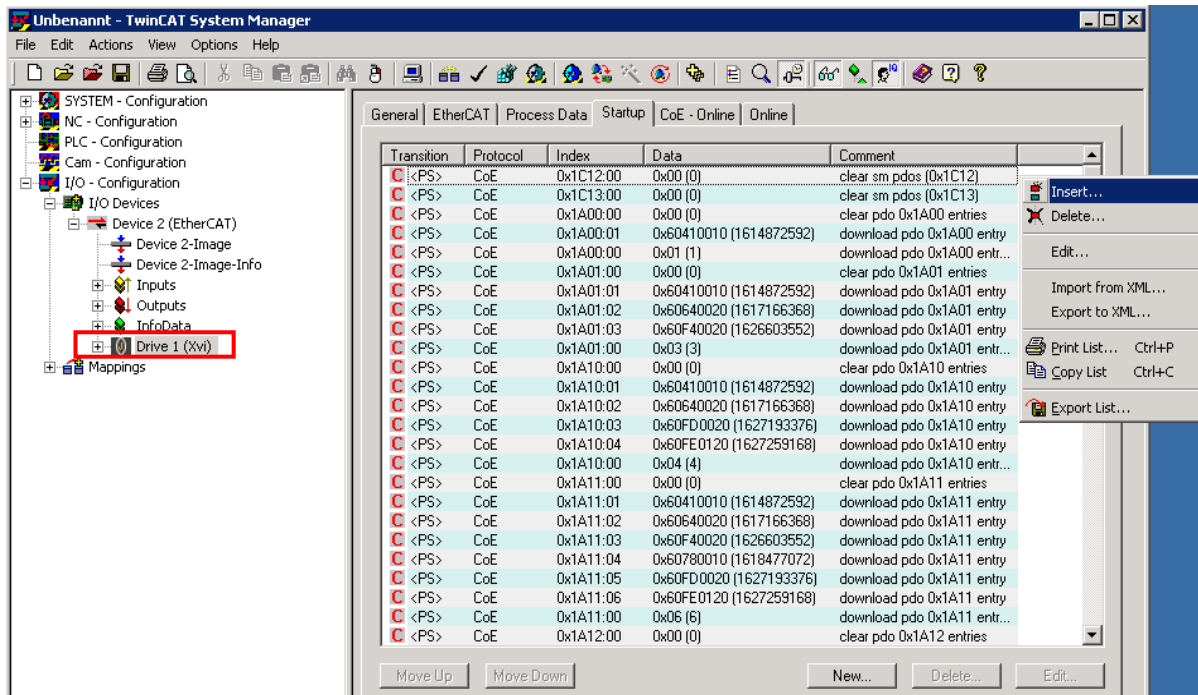
Add object „Following Error Actual Value“ in
PDO's. *I/O – Configuration* → *I/O Device* →
Device 2 (EtherCAT) → Select *Drive 1*, tab:
Process Data, select the object “0x1A01” in the
PDO list. Then go to *PDO Content (0x1A0)*, click
right → “insert”.



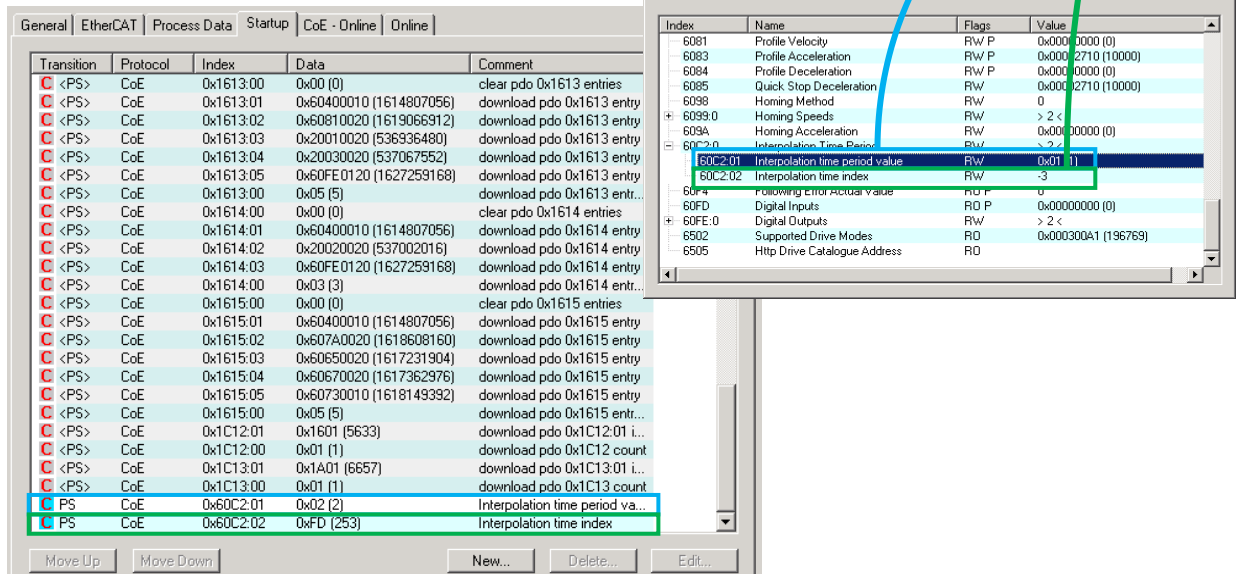
Select Object “0x60F4 – Following Error Actual Value” and press “OK”.



Add interpolation time period to PDO Data:
 I/O – Configuration → I/O Device → Device 2
 (EtherCAT) → Select “Drive 1”, tab: Startup,
 right click → “Insert”

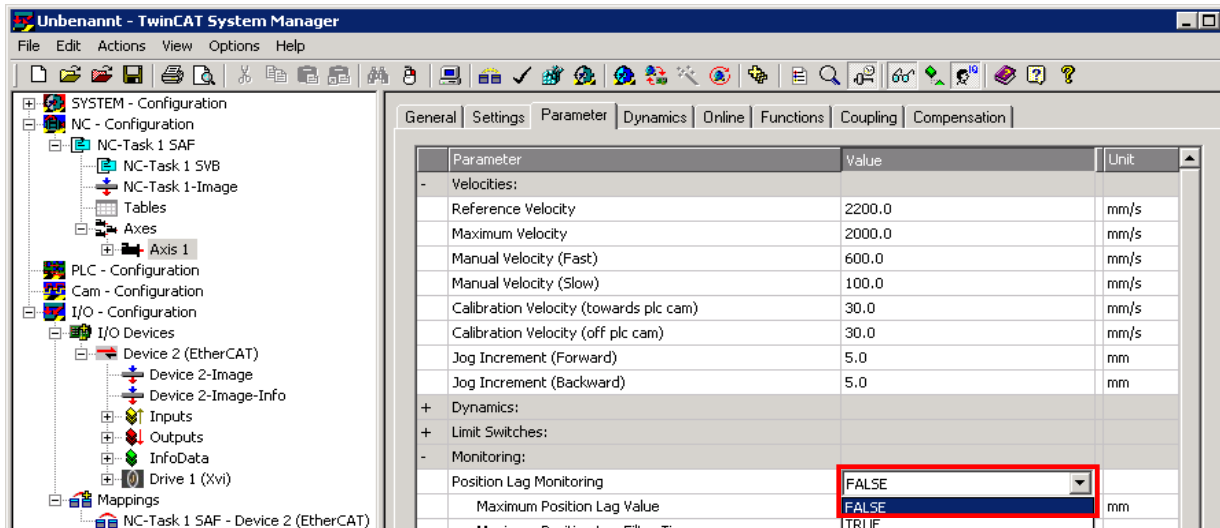


In Object “0x60C2” select sub index 1
 „Interpolation time period value “ and press
 “OK”.
 Repeat the same steps with sub index 2
 „Interpolation time index“.



7.2 NC-Configuration of the Axis

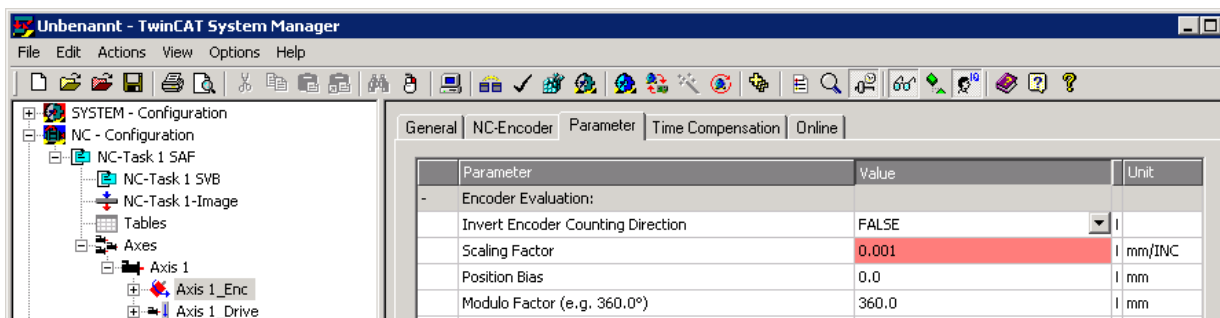
Before referencing the axis with the XENAX® servo controller, the “Position Lag Monitoring” has to be deactivated with “FALSE”.



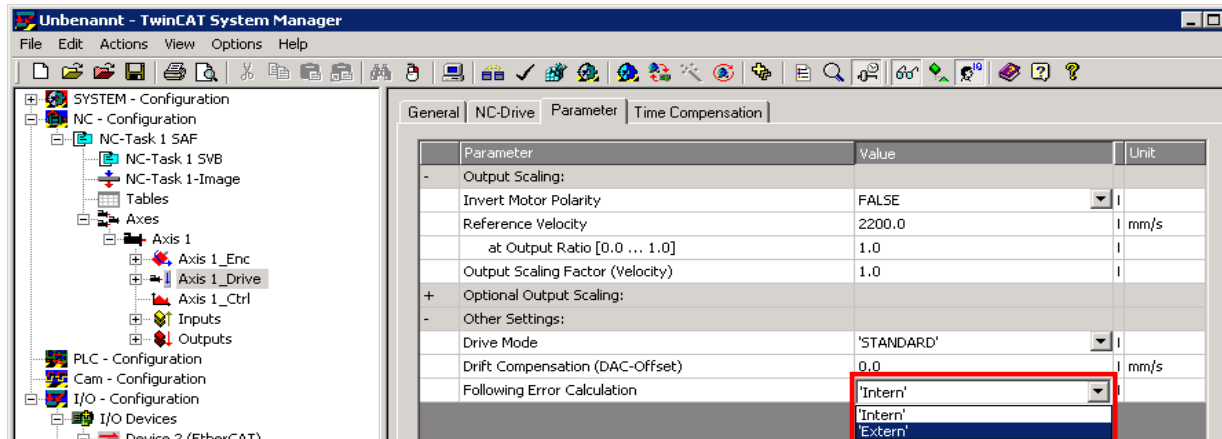
Adjust “Scaling Factor” to the measuring scale of the used linear motor.

If the linear motor has a measuring resolution of 100nm, the scaling factor has to be set to 0.0001.

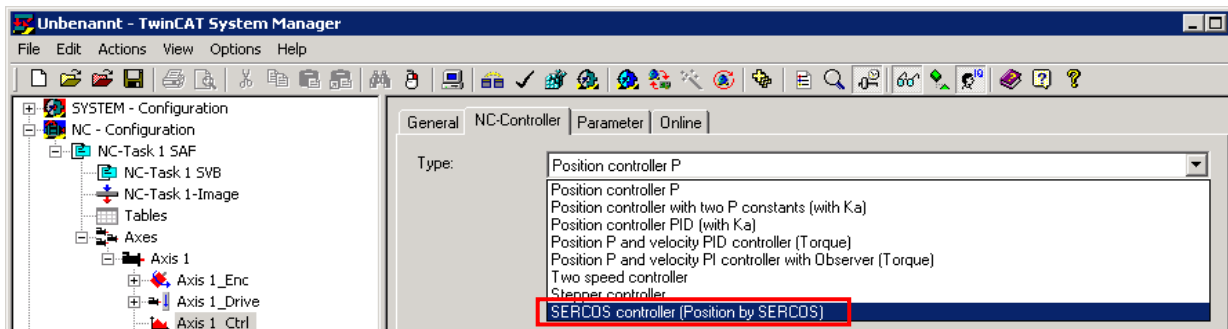
Resolution of Measuring System	Scaling Factor
1um	0.001
100nm	0.0001



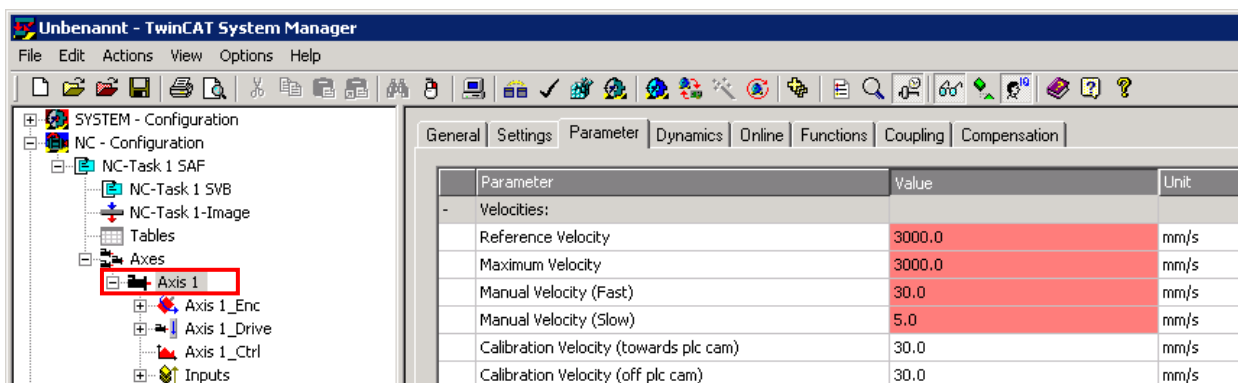
Under *Axis Drive* set „Following Error Calculation” on “External”.



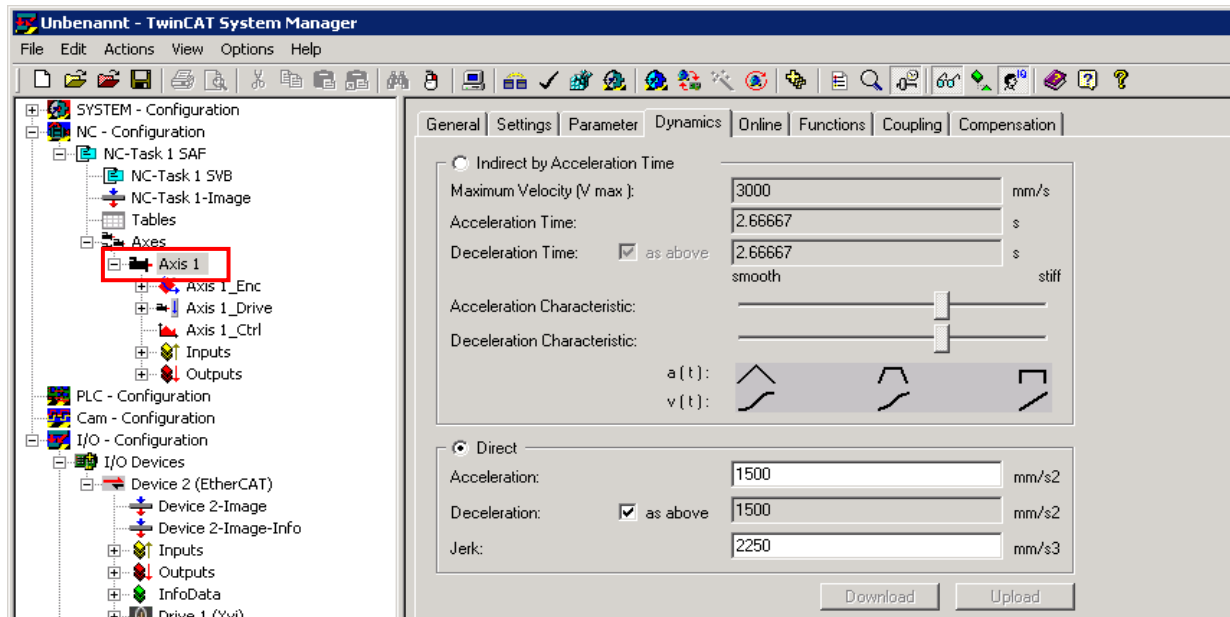
Because the XENAX® servo controller has an integrated NC-controller, we need to switch off the Beckhoff controller by selecting “SERCOS controller (Position by SERCOS)” under the tab: *NC-Controller*.



Velocities:



Acceleration and Dynamics:

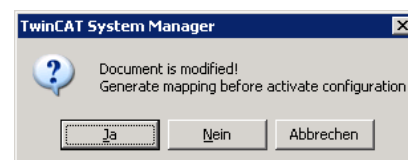


7.3 Drive with System Manager

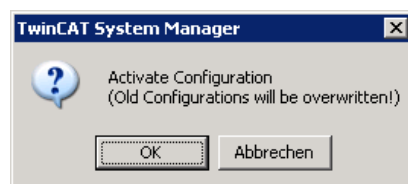
The configuration is activated by pressing on the blue cube.



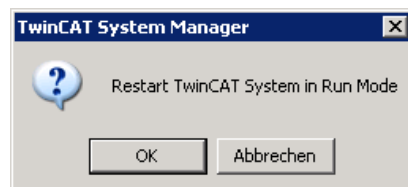
Document is modified! Generate mapping before activate configuration
→ Press "OK"



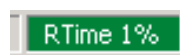
Activate Configuration (Old Configurations will be overwritten!)
→ Press "OK"



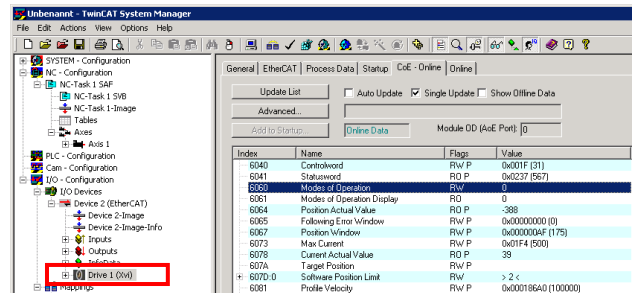
Restart TwinCAT System in Run Mode
→ Press "OK"



In the lower right corner the green panel for real time mode will appear.

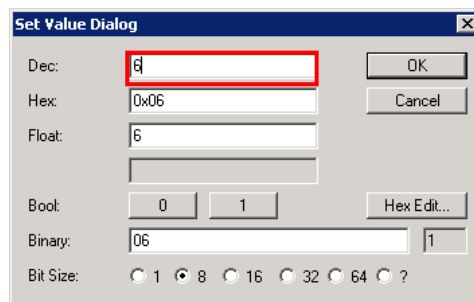


Under I/O → Configuration → I/O Device → Device 2 (EtherCAT) → Drive 1 (Xvi), tab: CoE – Online, double click on object “6060”.



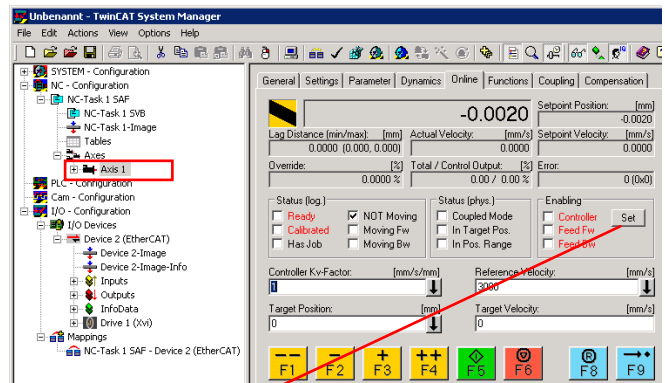
When the window *Set Value Dialog* is opened, activate the reference mode by putting the object “6060” on 6.

This reference mode has to be activated each time the XENAX® servo controller is restarted.

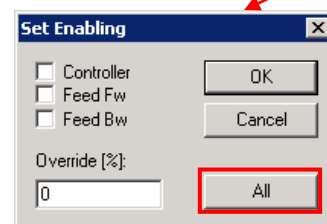


Under NC- Configuration → NC-Task 1 SAF → Axes → Axis 1, tab: Online, the number (position), framed red in the picture, should appear in black.

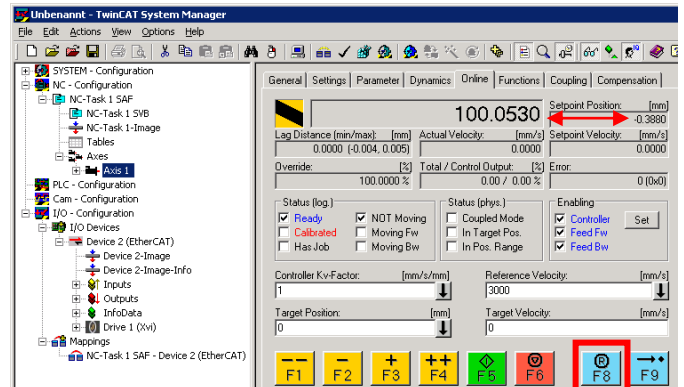
If the number (position) appears in grey, there are communication problems between Beckhoff and XENAX® over EtherCAT. Please check the connection, the power supply and the settings.



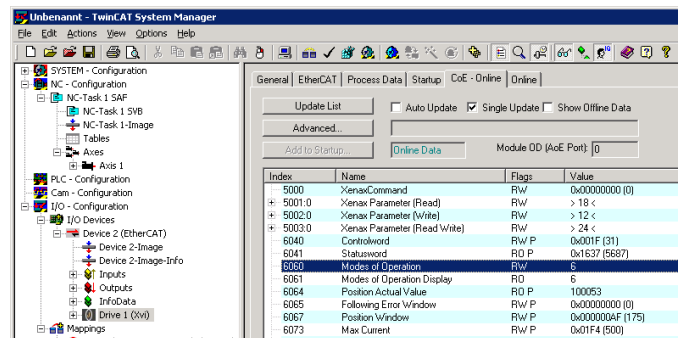
Under *Enabling*, press “Set” → Press “All” in the window that was opened. This window will be closed automatically. The motor will be unlocked and the reference will be executed.



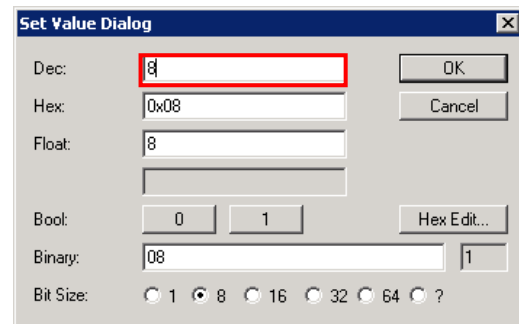
Please wait until the linear motor axis has finished its motion. You can transfer the absolute position of the linear motor axis to TwinCAT by pressing the button “F8” (Reset).



Activating Cyclic Synchronous Position Mode: I/O – Configuration → I/O Device → Device 2 (EtherCAT) → Drive, registry: “CoE – Online” double click on object 6060.



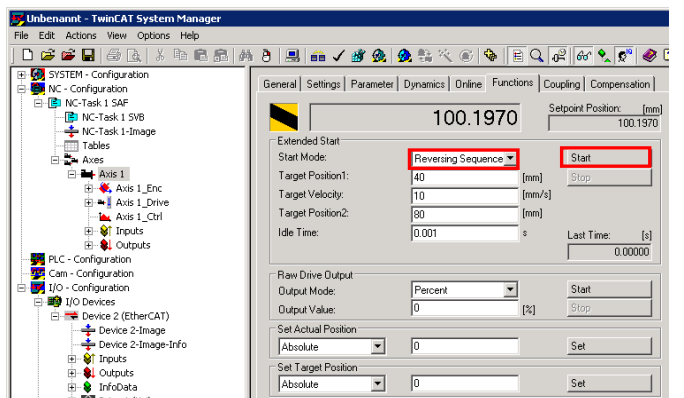
The Cyclic Synchronous Position Mode is activated by setting the object 6060 on 8. The linear motor LINAX® is now ready to drive.



Under NC-Configuration → NC-Task 1 SAF → Axis 1, tab: Functions, you can enter the start mode such as positive motion, negative motion, reversing sequence etc. Enter the remaining parameters such as target positions and set the LINAX® linear motor axis in motion by pressing “Start”.

In the picture on the right side, the motor moves back and forth from the Target Position 1 to Target Position 2.

This is a function test to check the communication between Beckhoff and XENAX®.



7.4 PLC Control, SPS Test Program

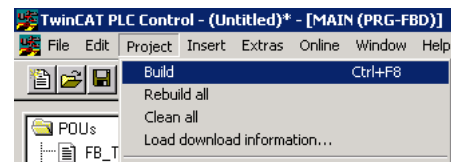
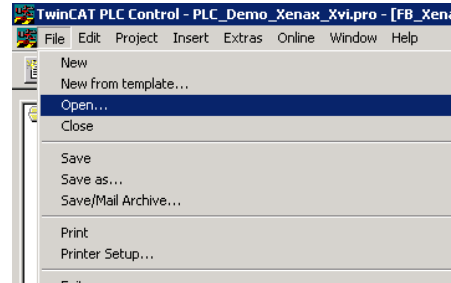
Start TwinCAT PLC Control:
Programs → TwinCAT System

Open example application
„PLC_Demo_Xenax_Xvi.pro“:
File → Open

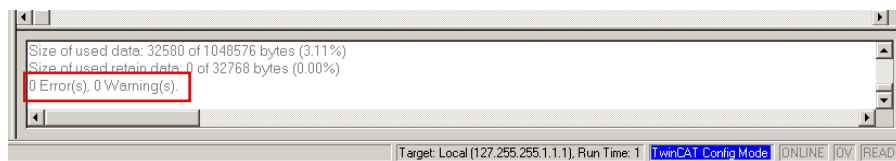
Note:

The example application contains already one
XENAX® servo controller.

Compile SPS Project in PLC Control Software:
Project → Build

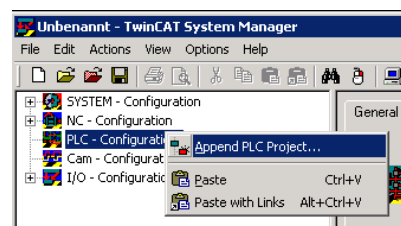


→ Compilation has to be on error 0!

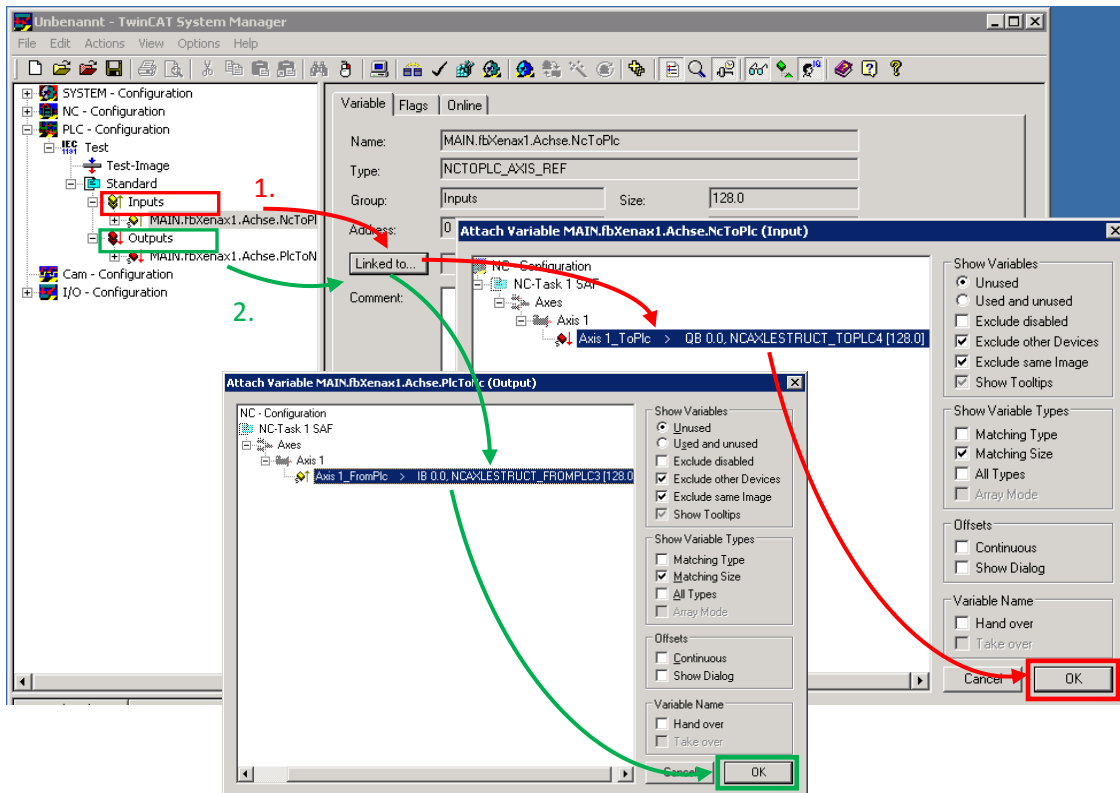


7.5 Connect SPS project and System Manager

To integrate SPS project in the System Manager, click right in System Manager on *PLC - Configuration* → *Append PLC Project...*, choose program.

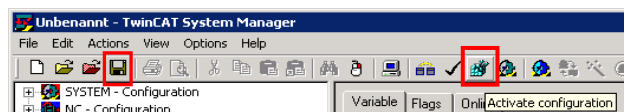


Connect SPS variables with NC (Standard Mapping of Beckhoff TCMC2.lib)
Complete these connections with the **inputs** as well as with the **outputs**.

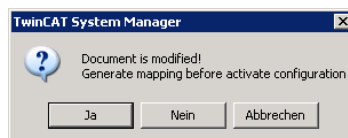


7.6 Start SPS Project

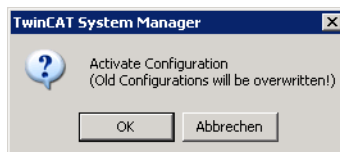
Save TwinCAT System Manager and set Run Modus by clicking on blue cube symbol.



Document is modified!
Generate mapping before activate configuration
→ Press "Yes"



Activate Configuration
(Old Configurations will be overwritten!)
→ Press "OK"



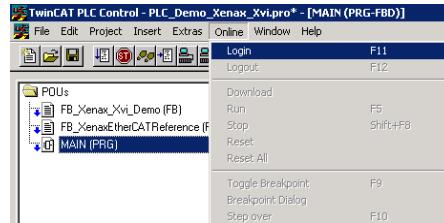
Restart TwinCAT system in Run Mode
→ Press "OK"



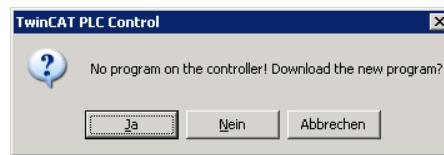
In the lower right corner the green panel for real time mode will appear again.



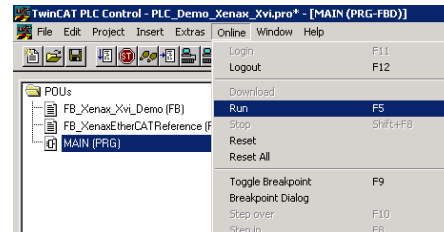
Start SPS project in the PLC Control Software
Menu: *Online* → *Login*



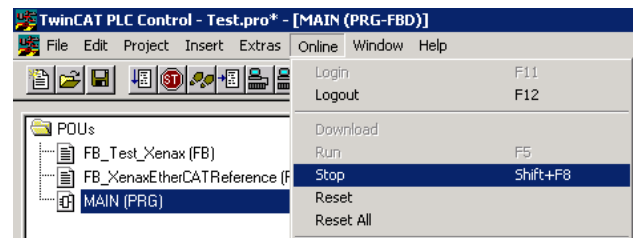
No program on the controller! Download the new program?
→ Press “Yes”



Menu: *Online* → *Run*



The motor will now be switched on and completes a reference. Then the axis moves to position 1 and continues with a repeat reverse from position 2 to position 1 until the program is stopped in the menu:
Online → *Stop*

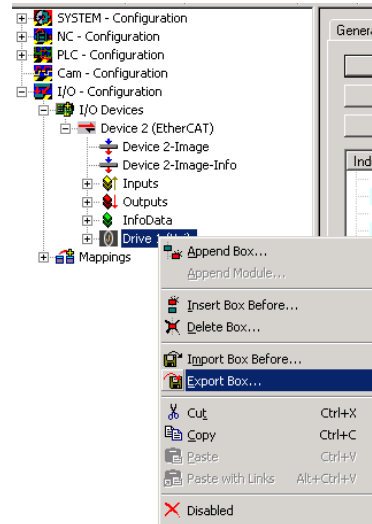


7.7 Add a XENAX® Servo Controller

Connect XENAX® servo controller with the linear motor, the power supply and EtherCAT.

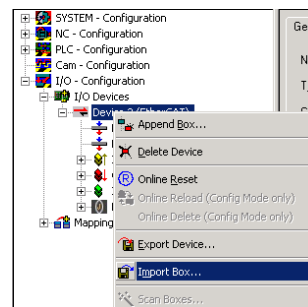
System Manager I/O – Configuration → I/O Device → Device 2 (EtherCAT) → Drive, right click, Export Box....

Select file memory location and file name for the controller.

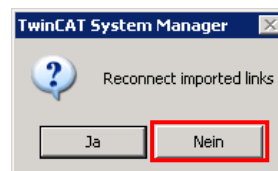


I/O – Configuration → I/O Devices → Device 2 (EtherCAT,) right click → Import Box... .

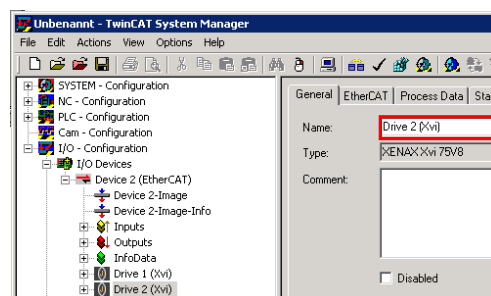
Open memory location, select the axis which was exported before and insert.



Reconnect imported links
→ Press: "No"

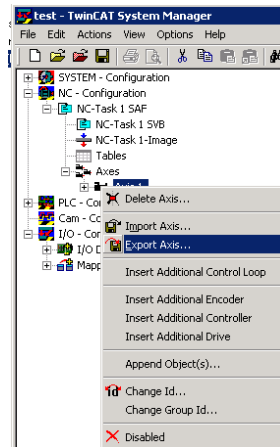


Click on the lower "Drive 1", and change its name to for example "Drive 2" in tab: General.



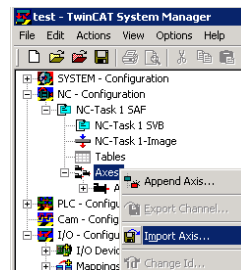
Under *NC-Configuration* → *NC-Task 1 SAF* →
Axes → *Axis*, right click → *Export Axis...*

Select file memory location and file name for
the controller.

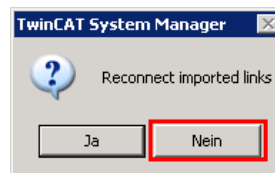


Under *NC-Configuration* → *NC-Task 1 SAF* →
Axes click right → *Import Axis*

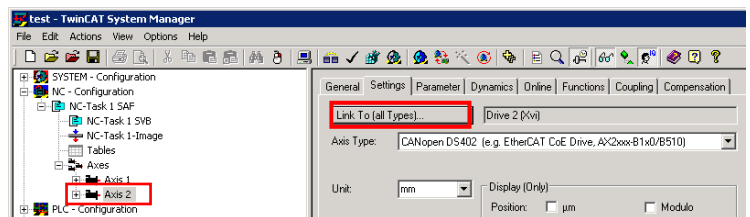
Open memory location, select the before
exported axis and insert.



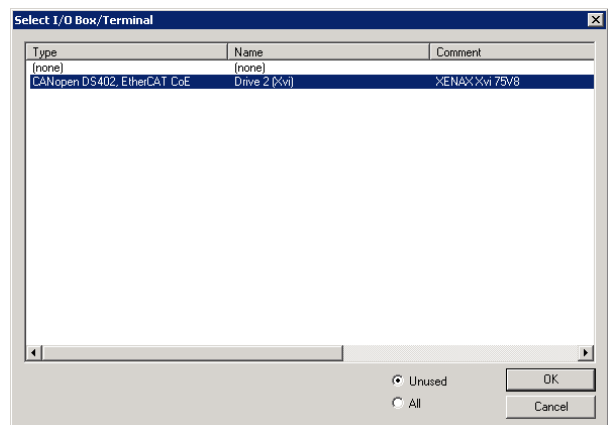
Reconnect imported links
Press "No"



Select "Axis 2" → tab: *Settings*
→ *Link To (all Types)...*



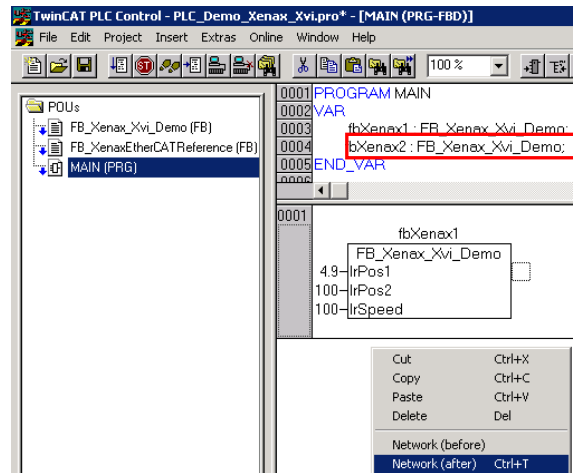
Select "Drive 2 (Xvi)" and press "OK"



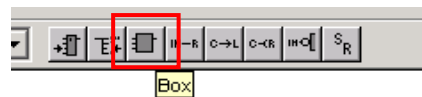
Adjust PLC program

Main (PRG) → Install second XENAX® servo controller under VAR (Variable) called
"fbXenax2: FB_Xenax_Xvi_Demo:"

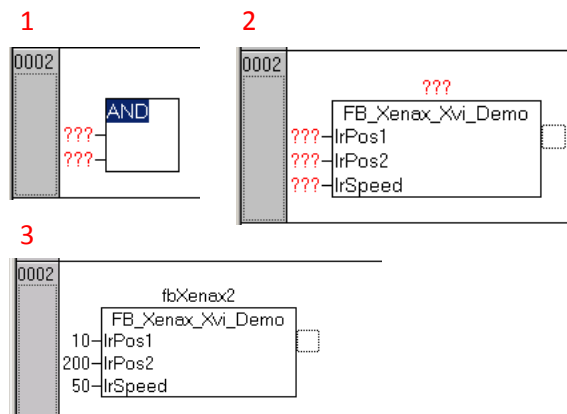
Install a network by pressing "Network (after)".



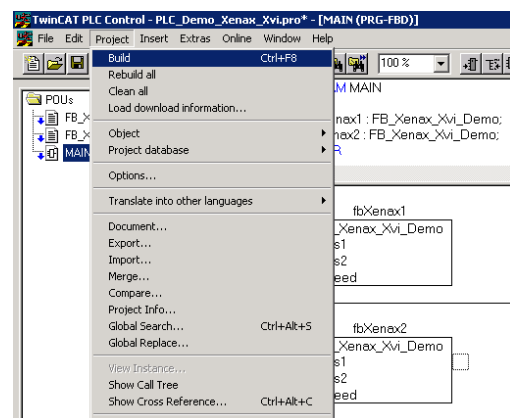
Click on box symbol like illustrated on the right side.



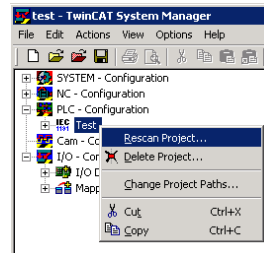
Replace "AND" with "FB_Xenax_Xvi_Demo"
and the "???" on the top with "fbXenax2".
Enter the input values where the "???" on the
side are located.



Menu: *Project* → *Build*



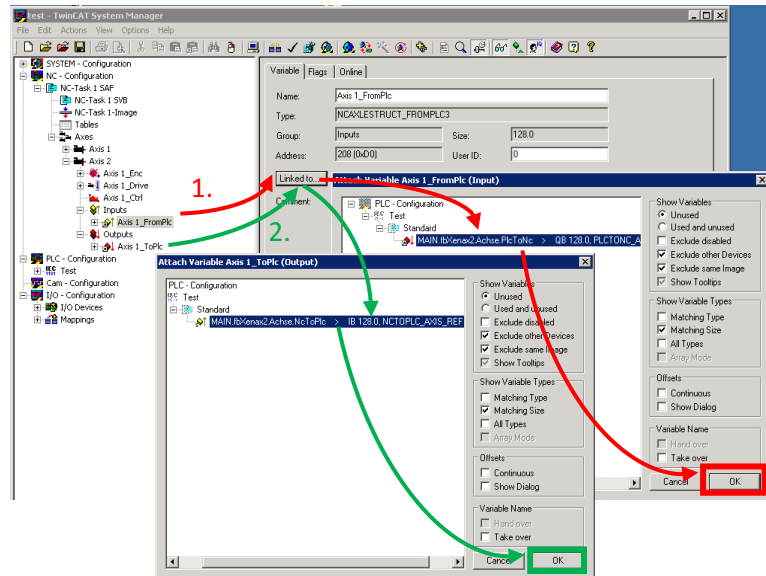
TwinCAT System Manager → PLC-Configuration → Test → Rescan Project



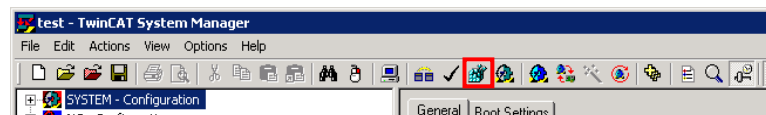
Under NC-Configuration → NC-Task 1 SAF → Axes → Axis 2 → Inputs → Click on “Axis 1_FromPlc” and connect to fbXenax2.

Repeat those steps for the Outputs.

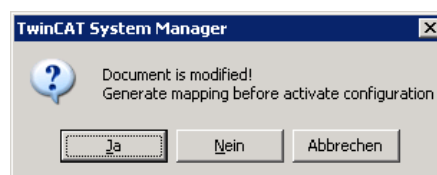
This process has to be completed for each XENAX® servo controller that is being used.



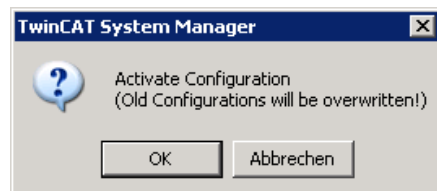
Save TwinCAT System Manager and set run mode (with blue cube symbol)



Document is modified!
Generate mapping before activate configuration
Press “Yes”



Activate Configuration
(Old Configurations will be overwritten!)
Press “OK”



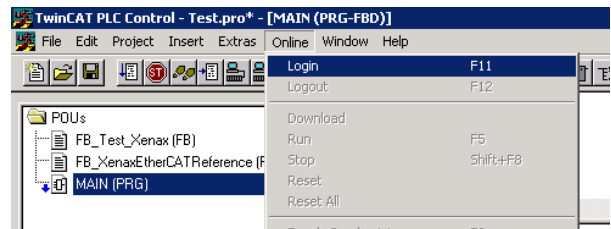
Restart TwinCAT System in Run Mode
Press “OK”



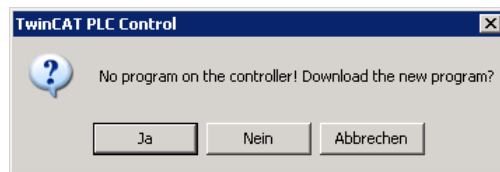
In the lower right corner the green panel for real time mode appears.



Start SPS project in PLC Control Software
Menu: *Online* → *Login*

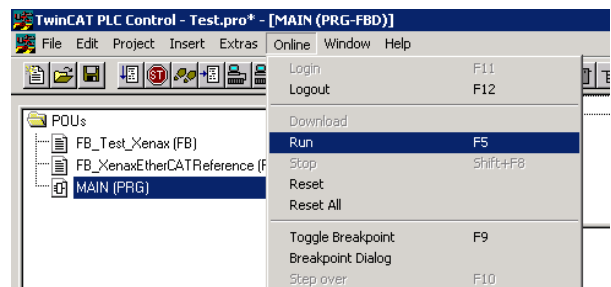


No program on the controller! Download the new program?
Press "Yes"



Menu: *Online* → *Start*

The linear motors are now turned on and each will complete a reference. Then each motor will independently drive to the corresponding position 1 and then position 2. This will be repeated until the axes are stopped with menu: *Online* → *Stop*



8 Information on EtherCAT with XENAX®

8.1 Controlword object 0x6040

Bit 0	switch on
Bit 1	enable voltage
Bit 2	quick stop (switch off power)
Bit 3	enable operation
	Reference start (Reference mode)
Bit 4	Move to new Position (Profile position mode)
	Start moving (Cyclic synchronous position mode)
Bit 5	not used
	(Profile position mode)
Bit 6	0: Absolute Position
	1: Relative Distance
Bit 7	fault reset
Bit 8	halt (usable in motion only)
Bit 9	operation mode-specific
Bit 10	reserved
Bit 11-15	manufacturer-specific

8.2 Statusword object 0x6041

Bit 0	ready to switch on
Bit 1	switched on
Bit 2	operation enabled
Bit 3	fault
Bit 4	voltage enabled
Bit 5	quick stop
Bit 6	switch on disabled
Bit 7	warning
Bit 8	manufacturer-specific
Bit 9	remote
Bit 10	target position reached
Bit 11*	Soft-Limit position reached
	Reference achieved (Reference mode)
Bit 12	Acknowledge of moving to target position (Profile Pos Mode)
	Target position (Cyclic Synchronous Profile Position Mode)
	Reference error (Reference mode)
Bit 13	Following position error (Profile Position Mode)
	Cyclic Synchronous Profile Position Mode)
Bit 14-15	manufacturer-specific

* Currently not implemented, reserved for future.

8.3 Process Status Register object 0x2006

The process status register is a producer-specific object 0x2006 from Jenny Science and contains XENAX® specific binary coded operating time information.

Definition

Bit 0	Error
Bit 1	Reference
Bit 2	In Motion
Bit 3	In Position (within target position window)
Bit 4	End of Program
Bit 5	Currently not implemented, reserved for future.
Bit 6	Currently not implemented, reserved for future.
Bit 7	Currently not implemented, reserved for future.
Bit 8	Inverter voltage present
Bit 9	End of gantry Init
Bit 10	Hardware Limit Switch Left reached
Bit 11	Hardware Limit Switch Right reached
Bit 12	Emergency Exit, remain power on
Bit 13	Emergency Exit, power off
Bit 14	Float sensing process is running
Bit 15-28	unused
Bit 29-31	Reserved

8.4 CANopen over EtherCAT

You can find the CANopen object lists as well as the pre-defined process data objects (PDO) in the description file Xenax.xml. These objects are also provided in a legible version in the file Xenax.html which you can find in the delivered CD under XENAX_Xvi_Servo_Controller / XENAX_Xvi_EtherCAT.

8.5 Firmware Update

A possible firmware update after the XENAX® servo controller has been delivered to you involves an update of the following files:

Firmware	File Xv75V8_Vx.xxx.mot
WebMotion	File WebMotion_V.x.xx.lxi
EtherCAT	File Xenax_EtherCAT_protocol_x.xx.flash

You can download these files from our website:

<http://www.jennyscience.de/en/download/>.

Note:

You can find a detailed tutorial video “Firmware and WebMotion Update for the XENAX® Servo Controller” on our website: www.jennyscience.ch/en

Firmware

- Save your XENAX® servo controller application under *Save* → *Save to file*
 - If possible please remove PLC-connector and bus module pin.
- We suggest downloading the firmware directly from a PC through a point to point connection (no switch).
- Click on “Firmware” and choose the file with the firmware update (ending “.mot”). The download will be completed automatically.
- After the update go to menu: *move axis* / *by command line* and enter the command “RES” for reset.
- Reload your application: *Open* → *from File* and save it to the XENAX® servo controller with: *save* → *to XENAX*.



WebMotion®

Refer to document
„Update_WebMotion_E.pdf“ on
<http://www.jennyscience.de/en/download/>.

Protocol

Select and install file
Xenax_EtherCAT_protocol_x.xx.flash.

9 Frequently asked questions (FAQ)

The linear motor axes move rough.

The parameters PCT (PDO Cycle Time) in XENAX® servo controller do not correspond to the PDO cycle time of the Beckhoff system and have to be adjusted. PCT is defined in “µs”. Please refer to chapter “Setting the Parameters for XENAX® servo controller. “

Is the XENAX® Xvi75V8 servo controller a standard device in a Beckhoff system configuration and could be used in other master controllers?

In order to setup the XENAX® Xvi 75V8 servo controller together with a Beckhoff IPC controller, the according optional bus module is necessary. The device can also be used with other EtherCAT masters, for example MC464 from Triomotion.

Notes

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