



Triamec TwinCat

Quick Startup Guide

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1 Introduction

This is user guide for the Triamec interface to the Beckhoff Twincat NC system explains, how to use Beckhoff NCI or Beckhoff CNC in conjunction with Triamec drives. Setting up your Triamec drive for Beckhoff Twincat CNC requires the following steps:

- Install TwinCat NCI 2.11.1551 (tcat_2110_1552.exe) and CNC v2.11.1551 (TwinCATCnc210_1019.exe) or similar.
- Setup your drives using the Triamec TAM System Explorer as explained in the “Drive Setup User Guide” linked in the TAM SDK start menu.
- Assign the drive an address and store the data persistent as discussed here.
- Adjust the twincat sample configuration as discussed here.
- Use the sample PLC code to implement the drive in your control SW as discussed here.

2 Simulation Mode

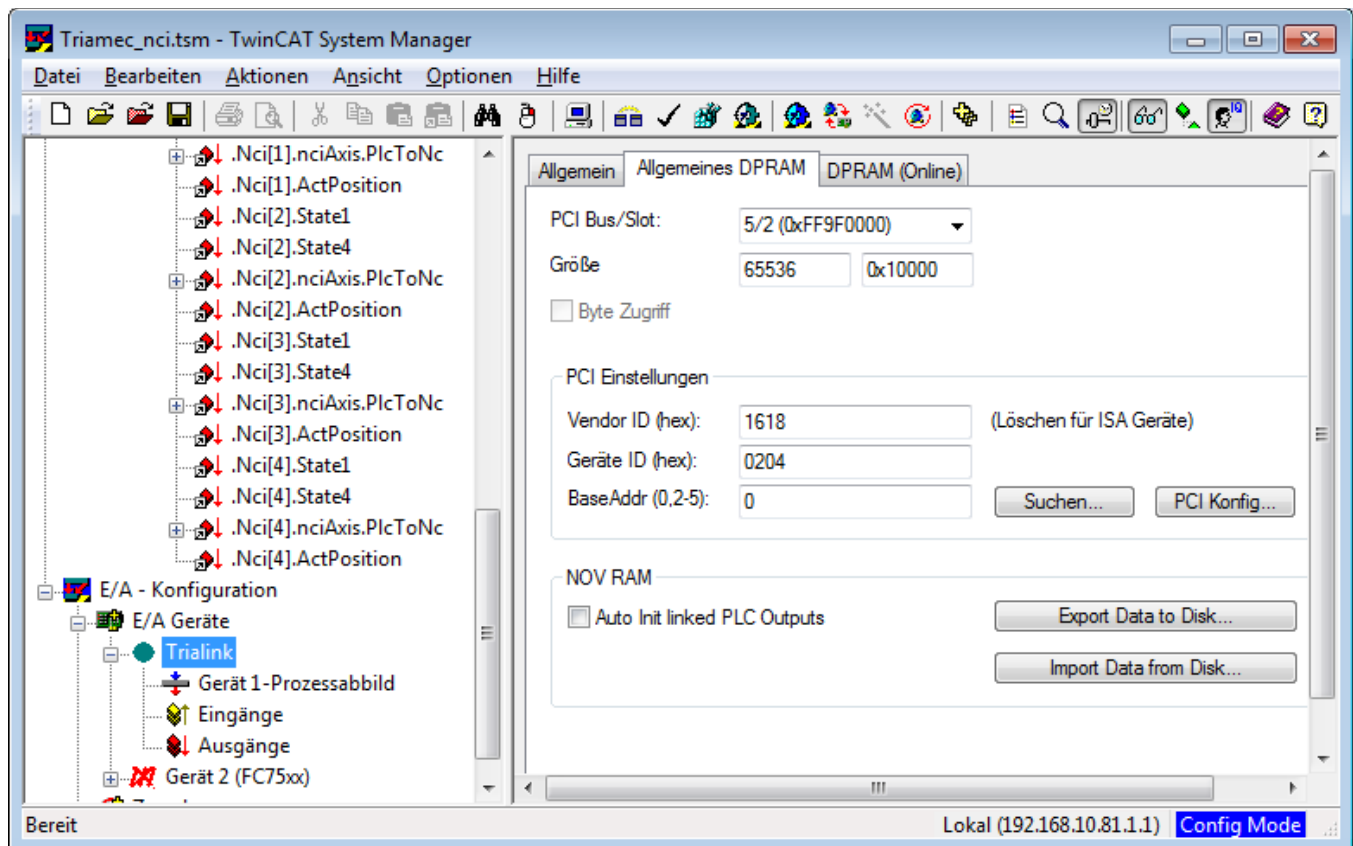
Two sample codes are available with increasing complexity

- Triamec_nci strait forward use of the Beckhoff NCI module.
- Triamec_cnc using the Beckhoff CNC.

Open a Twincat sample configuration (*.tsm) in the folder “plc”. Open the DPRAM settings for the Tria-Link adapter board in “I/O-Configuration/I/O Devices/Trialink/GenericDPRAM”, see below. The vendor ID is 1618 and the device ID is

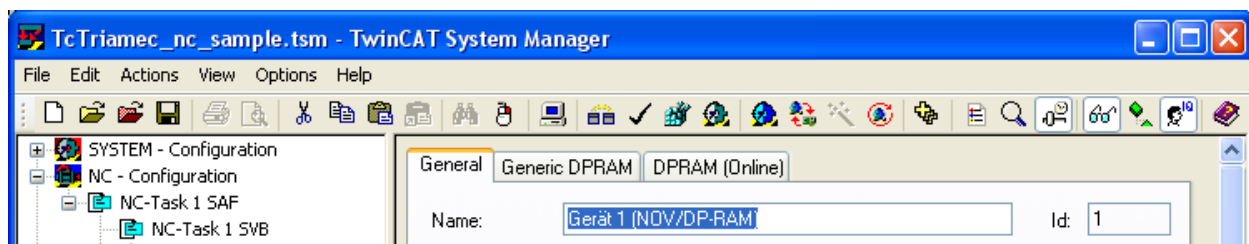
- 0200 for a TL100
- 0201 for a TLC201
- 0202 for a TLC 100
- 0203 for a TL300 PCI-Express
- 0204 for a TLO100 (with USB Observer)
- 0205 for a TLO300 (PCI-Express with USB Observer)

Choose search and Twincat should find the Adapter.



Open the header “General=Allgemein” and see the device-ID “1”. This id identifies the Tria-Link board in the PLC code, see Trialink.Config.nDevId.

Activate the configuration.

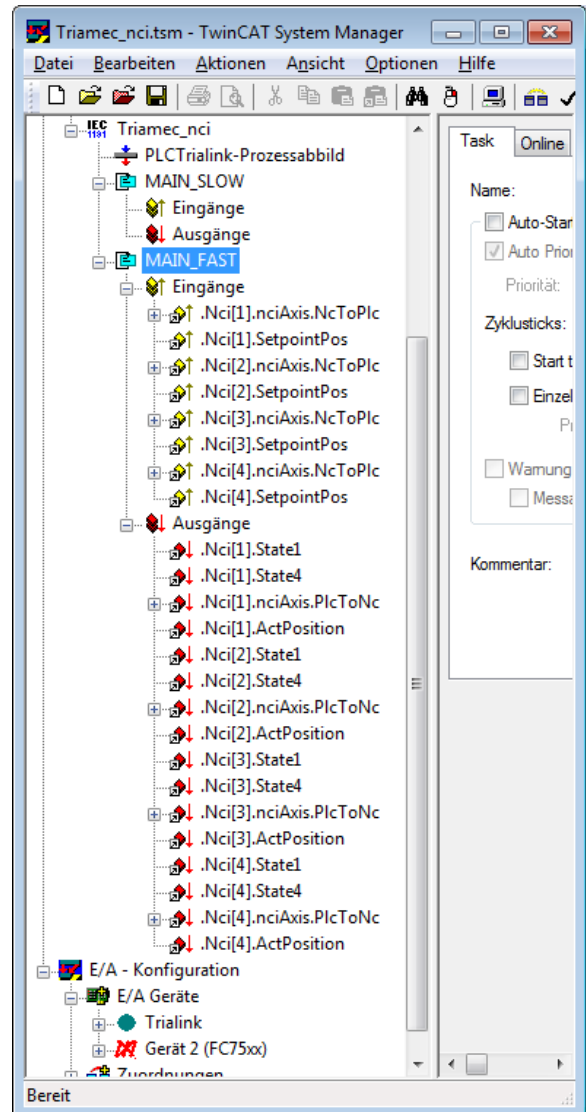


Open the PLC code (*.pro).

- Make sure the library “Triamec_lib.lib” is in the search path.
- Choose **Project > CleanAll** before first time use of the PLC program and answer “Do not keep configuration unchanged”.
- Set `TL_ConfigurationManager.axes[iAxis].simulate` TRUE for all axes iAxis.
- **Project > Compile, Online > Login, Online > GenerateBootProject.**
- Re-read the PLC into the TwinCatSystemManager.
- The IO's of the axes are visible in the PLC part of the TwinCatSystemManager. *They might have to be moved in the TwinCatSystemManager to MAIN_FAST for proper task synchronization.*
- Make sure the ring is closed and, if drives are in the ring, the drives must have 24V supplied.
- Reactivate the configuration and start the PLC code.

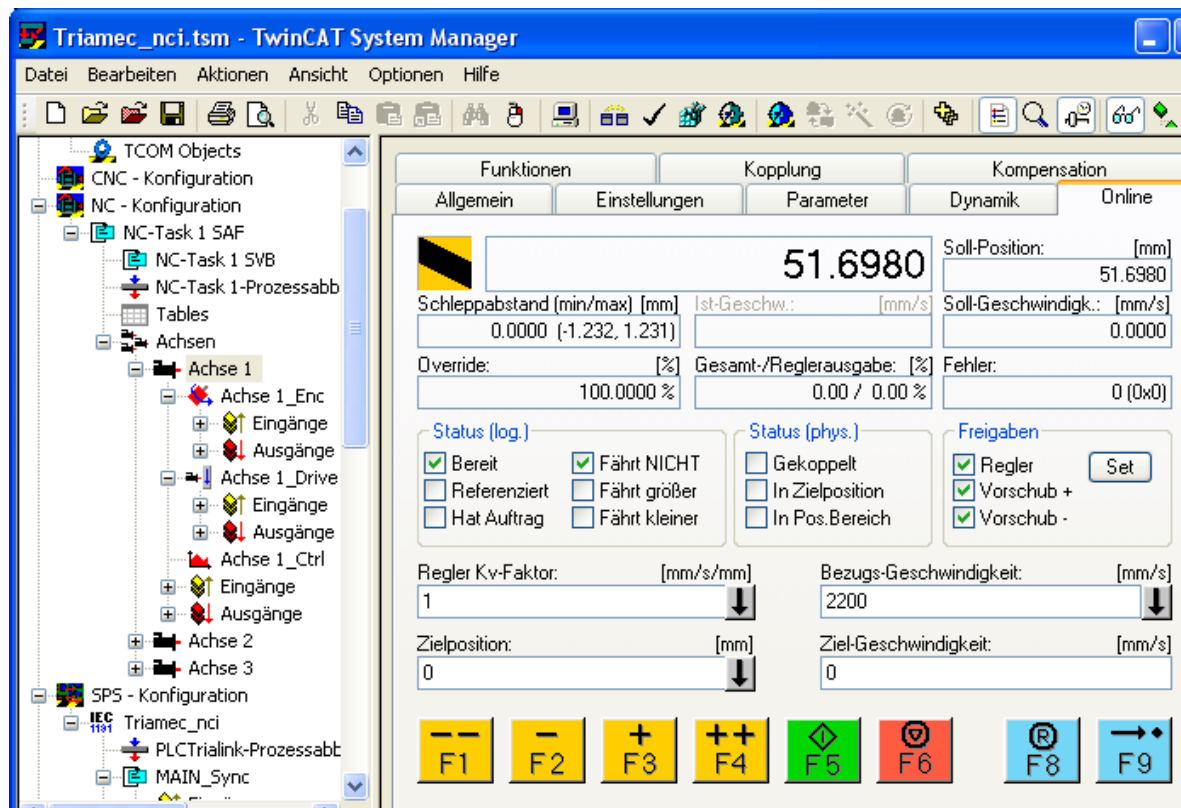
At this stage, you should be able to control the axes in simulated mode. The next chapters show how to use the TwinCat interface in the NCI and CNC case.

Later, we have to configure the real axes in the PLC code and switch each axis from simulation to real one by one.



2.1 Sample Code NCI

Set .AxisGroup.enable to TRUE. Then the NCI interface should look like



Press + and - to move the axis. The actual position should change accordingly. If the actual position is gray, the axis state is not valid. Check if enable is on and check the connections between TwinCat and PLC as shown in chapter “NCI configuration”.

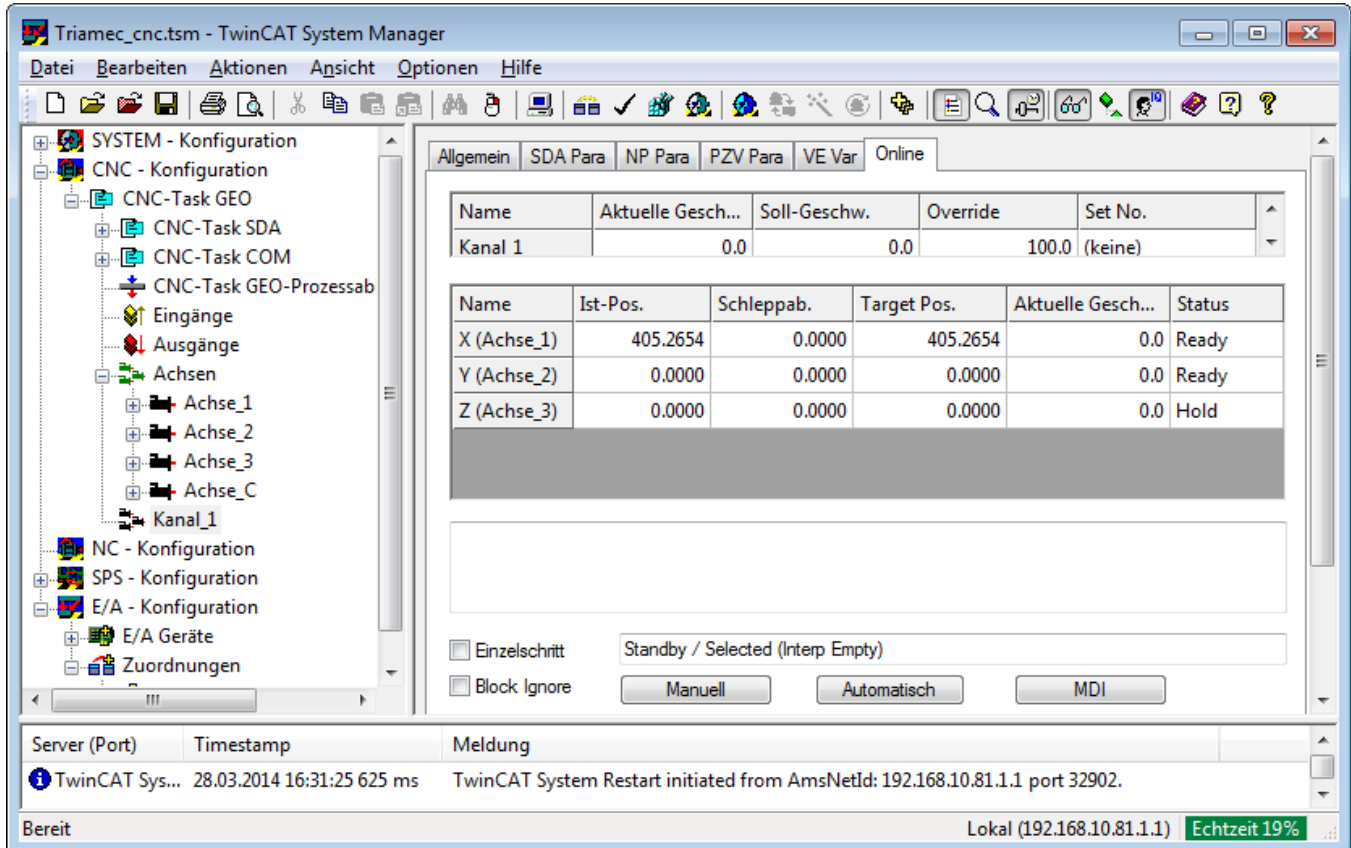
Set enable back to FALSE. If an axis is already configured as shown in the next chapters (but still simulated) the axis can be moved by hand and the ActualPosition should change correctly.

Set the dynamic parameters in NC/Achsen/Achse_n/Dynamik.

2.2 Sample Code CNC

Set AxisGroup.enable to TRUE and open the CNC control window: CNC-Task GEO/Kanal_1/Online.

Switch to Operation mode “Manual”. Select the first axis. Press + and - to move the axis. The actual position should change accordingly. The position “DistanceToGo” should reach zero at standstill.



Triamec_cnc.tsm - TwinCAT System Manager

Algemein SDA Para NP Para PZV Para VE Var Online

Name	Aktuelle Gesch...	Soll-Geschw.	Override	Set No.
Kanal 1	0.0	0.0	100.0	(keine)

Name	Ist-Pos.	Schleppab.	Target Pos.	Aktuelle Gesch...	Status
X (Achse_1)	405.2654	0.0000	405.2654	0.0	Ready
Y (Achse_2)	0.0000	0.0000	0.0000	0.0	Ready
Z (Achse_3)	0.0000	0.0000	0.0000	0.0	Hold

☐ Einzelschritt Standby / Selected (Interp Empty)

☐ Block Ignore

Server (Port)	Timestamp	Meldung
TwinCAT Sys...	28.03.2014 16:31:25 625 ms	TwinCAT System Restart initiated from AmsNetId: 192.168.10.81.1.1 port 32902.

Bereit Lokal (192.168.10.81.1.1) Echtzeit 19%

Set enable back to FALSE. If an axis is already configured as shown in the next chapters (but still simulated) the axis can be moved by hand and the ActualPosition should change correctly in the CNC window.

Configure the CNC channel in CNC-Konfiguration/CNC-Task GEO/Kanal_1 and the CNC axes in CNC-Konfiguration/CNC-Task GEO/Achsen/Achse_n/Parameter as shown in the CNC-documentation.

3 Configuring the axes

3.1 TAM System Explorer

Configure the drives with the TAM (Triamec) System Explorer to set drive parameters, install new firmware, and store parameters persistently. In a series environment with drives already setup, it is not necessary to install the Explorer on the TwinCat PC. In a development environment, however, the Explorer should be installed. Before using the explorer for the *first time*, see ⁽¹⁾.

Be aware that the PCI Adapter cannot be accessed simultaneously by Beckhoff and Explorer. On a Beckhoff PC set `Triamec.CommunicationEnable:=FALSE` in the PLC code before starting the explorer.

The Explorer may also be used in Observer mode to observe any drive signals online, even while Twin-Cat is running. There are two methods. The preferred method is using a USB cable from an independent PC/Laptop to the PCI adapter in the control PC. The PCI adapter must be a TLO100 or TLO300 in this case. The observer mode is also possible with TL100 or similar ⁽²⁾.

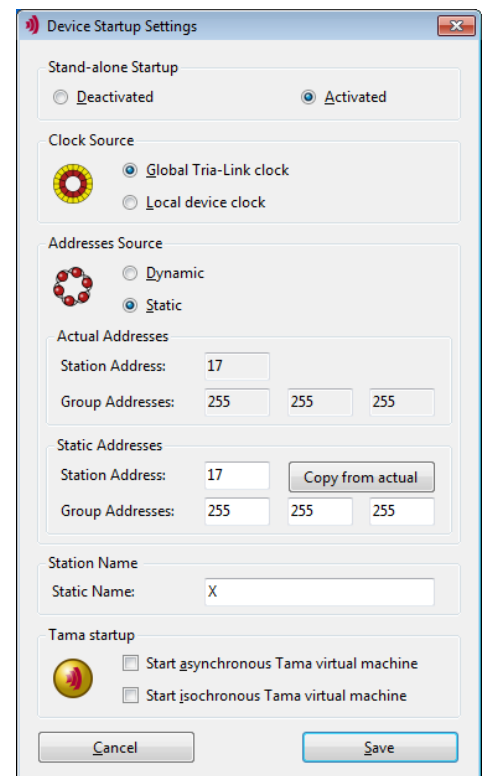
3.2 Setting Up the Drives

See the “Drive Setup Guide” ⁽³⁾ on the triamec CD on how to configure the drives and save the parameters of all drives in one configuration file *.TAMcfg.

These settings are lost on power-down of a drive and must be loaded again from the configuration file after next power-up.

The settings are then permanently stored on a drive (Persistence). Use the TAM Explorer. Right-Click on the Drive/Device and choose “Device Startup Settings” as shown at the right side. Station addresses must be unique on the ring. As a convention we use static **addresses** starting at 17 for all drives (TS150, 151, 350, 351) and TIOB. These address settings will be entered as “**axis.-Config.station**” parameter in the PLC code. Give the drive a meaningful static **name**. Whatever settings are active before this step, will be made persistent.

Later changes of the configuration are only active until power-down and fall back to the persistent setting on the next power-up. Use this startup settings function again to update the persistent setting with a new configuration.



3.3 Setting Up the PLC

The PLC part of the axes is configured according to their logical axis number iAxis which is currently lim-

- 1 After installation, use the Preferences menu of the TAM System Explorer and adjust the Startup parameter "Boot mode" to "Identify stations without assigning new addresses". If the explorer is used as Observer, set also "Adapter role" to "Observer".
- 2 In this case the second PC must also contain a PCI board: Include the PCI-Adapter of the observer PC into the Tria-Link ring. Start the Explorer on the observer PC. Start Beckhoff Use the Explorer to adjust parameters and to log real-time data while Beckhoff is running.
- 3 SW_Drive-Setup-UserGuide_EPnnn.pdf

ited in the library to `TL_CH_AX_MAX = 32`.

- Configure the drive belonging to an axis with its station address in `TL_ConfigurationManager.axes[iAxis].Config.Station`
- Be aware that a drive may control two (DC-motor) axes. Therefore two axes (`iAxis`) may be configured to the same station address. The second axis must then set `TL_ConfigurationManager.axes[iAxis].Config.subAxis := TRUE`;
- If the axis is in simulation mode (`TL_ConfigurationManager.axes[iAxis].Config.Simulate := TRUE`), the state information are set independent of the drive and the drive does not enable. However, if the axis is disabled, the actual position information is correctly propagated if possible.
- Start in simulation mode and then, if position information seem correct, turn simulation off. After changing this mode, toggle `Triamec.CommunicationEnable` or restart Beckhoff.

Now we are ready for position scaling, modulo, and referencing (see next chapters). Then download the PLC and start.

3.4 Position Scaling and Modulo

There are different position units in CNC/NCI (integer) and PLC (LREAL 64bit) and drive (40bit REAL). As a first use case we discuss the CNC in units of 0.1 μm , the PLC in mm and drive in m.

- Set the scale of the position data between CNC and PLC in `TL_ConfigurationManager/gCnc[1].inc_per_unit:=10'000`.
- Set the scale of the position data between PLC and Drives in `TL_ConfigurationManager.axes[iAxis].Config.GearFactor := 1000`;

If the axis is rotational with the CNC in units of 0.0001 $^\circ$, PLC in $^\circ$, and drive in rad.

- Set the scale of the position data between NCI/CNC and PLC in `TL_ConfigurationManager/gCnc[1]:=10'000`.
- Set the scale of the position data between PLC and Drives in `TL_ConfigurationManager.axes[iAxis].Config.GearFactor := 180/PI`;
- Set the modulo in `TL_ConfigurationManager.axes[iAxis].Config.ModuloWrap:= 360`;

For details on CNC axis, spindle, and channel settings see our Application notes and the Beckhoff documentation.

An other use case is NCI with finer resolution of 1nm and PLC in mm and Drive in m.

- Set the scale of the position data between NCI/CNC and PLC in `TL_ConfigurationManager/gNci[1].inc_per_unit to 1E6`.
- Set `NC/Achsen/Achse_N/Achse_N_Enc/Parameter/Skalierungsfaktor` to 1E-6.
- Set the Sercos-Axis Startup Value `S-0-0077` to 1 and `S-0-0078` to -9.
- Set the scale of the position data between PLC and Drives in `TL_ConfigurationManager.axes[iAxis].Config.GearFactor := 1000`;

3.5 Referencing (Homing)

The triamec homing function block TL_MC_Home implements several homing procedures. Our standard axis module **TL_AxisSlow** (called **gAxis** in the sample code) contains this function already and maps these parameters to `gAxis[n].Config.Reference*`. See TL_ConfigurationManager and **AN108** for details.

4 Introduction to the PLC Code

The PLC sample code is written in the language “structured text (ST)” and implements two PLC Tasks

- MAIN_SLOW configuration, asynchronous state handling (Enable, Homing)
- MAIN_FAST synchronization between Trialink and TwinCat and coordinates

The sample code contains an array of axes **gAxis[]** of type **TL_AxisSlow**. The logical axis numbers **gAxis[].iAxis** are unique among all axes belonging to one PCI-Adapter.

4.1 Path planner and Coordinates

While the axis *position controller* is always in the drive, the axis *path planner* is running either on the drive or in TwinCat. After enabling, the axis starts up in the drive path planner.

Drive pathplanner	The path planner runs on the drive. Moving to a new position or starting a velocity move is commanded asynchronously by PLCopen function blocks. These are used in the homing sequence.
TwinCat coupled pathplanner	The NC/CNC or a custom PLC code runs the path planner. An axis enters coupled mode using the input gAxis[].couple of TL_AxisSlow.

See **AN108** for more details.

The following blocks in the FOR-loop of MAIN_FAST are used for coordinate calculations and sending position information to the PCI-Adapter in coupled mode.

- gNci[] gets NC/CNC path values.
gCnc[]
- AxesPath[] takes the last positions, interpolates them to 50kHz and sends data to drives or TIOB.
- gNci[] sends actual position information back to NCI/CNC.
gCnc[]

The actual position feedback is usually acquired with the rate of MAIN_SLOW and made available in AxesPath with a time correction. This is usually sufficiently fast, if all setpoint calculation is based on CNC data and no feedback from the drives must be used for setpoint calculation (actual position not in the control loop). If the actual position is required at higher speed, this drive needs to publish fast information to TwinCat, see application note AN105.

4.2 Accessing the adapter

For each PCI-Adapter, there is one global instance **Trialink**. The call `Trialink.CallFast()` in MAIN_FAST synchronizes Beckhoff with the Tria-Link. The call `.Trialink.CallSlow` in MAIN_SLOW supplies the asynchronous communication to the Tria-Link.

If changing the task rate is necessary

- adjust the task cycle time in **Ressources > TaskConfiguration**.
- MAIN_FAST must have a high prio (0) and a rate not slower than 2ms (standard is 0.5ms).
- CNC-GEO or NCI-SAF must have the same cycle time as MAIN_FAST.
- MAIN_SLOW must be slower than MAIN_FAST (standard is 2ms).
- Go back to the TwinCat configuration, reload the PLC. Check the task priorities:
SystemConfiguration > EchtzeitEinstellungen > Prioritäten > Automatisch.

The variable **.CommunicationEnable** boots the Trialink bus. It is TRUE by default. If rebooting is necessary, toggle this variable FALSE and TRUE again. If the ring is successfully booted, the variable **.CommunicationReady** is TRUE. It may take up to 6s to boot the bus.

Some realtime issues on a heavily loaded system may be solved by synchronizing the CNC with the Triamec library. Replace the calls for the Trialink object by the gCnc object as shown in sample code TriamecCnc.

4.3 Configuration

Set the number of axes in the PLC program under **Global_Variables_Triamec > N_Axis**. These are all Triamec axes including handling axes, not only those that are to be accessed by CNC/NCI. The axes are configured in TL_ConfigurationManager. Make sure there is one configuration setting for each axis.

To add more axes, we use a dummy Sercos Master and add more Sercos Slaves. Later we will brake this connection and direct the data to our drives in the PLC.

- In I/O/Devices go to the device "Master FC75xx".
- Master/AppendBox/"Drive Generic (Sercos)"(for each additional axis)

Typical settings of the Sercos drives are

- SERCOS, Betriebsart Position 1 ohne Schleppabstand
- Startup S-0-0032 Hauptbetriebsart 11
- Eingänge S-0-0051 Lage-Istwert Geber 1
- Ausgänge S-0-0047 Lage-Sollwert
- Ausgänge S-0-0036 Geschwindigkeits-Sollwert

The further configuration is different for NCI and CNC:

NCI-Configuration

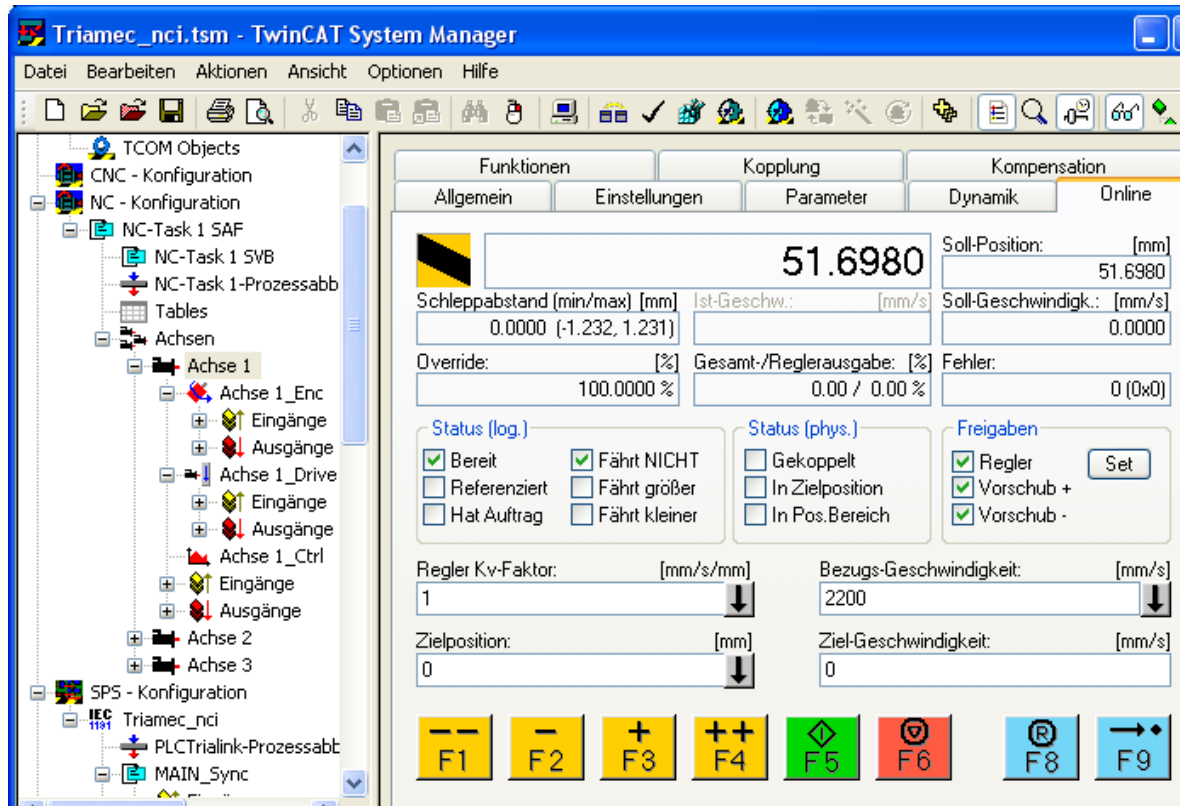
Add a NC-Task to the configuration. Then add as many axes to the NCI as you need under **NC-Configuration > NC-Task > Achsen**. Choose Sercos under **Einstellungen > Achstyp** then connect these axes with the Sercos axes described above.

Now disconnect the automatic connections to these axes on the NCI side and connect the NCI with the PLC.

- .Nci[k].State1 Axis[k].Drive_In.nStatus1
- .Nci[k].State4 Axis[k].Drive_In.nStatus4
- .Nci[k].ActPosition Axis[k].Enc_in.nInData1 (ActPosition)

- .Nci[k].SetpointPos Axis[k].Drive_Out.nOutData1 (SetpointPos)

Finally disable the Sercos master by right-clicking on the icon but do not delete it. Activate the configuration then run the PLC.



CNC-Configuration

Add a CNC-Task to the configuration. Then add as many axes to the CNC as you need under **CNC-Configuration > CNC-Task > Achsen**. Note that removing an axis is not possible, only disabling. Connect these axes with the Sercos axes.

Now disconnect any automatic connections to these axes on the CNC side and connect the CNC with the PLC.

- .gCnc[k].SercosStatus Axis[k].Eingänge.Statuswort
- .gCnc[k].SercosPhase Axis[k].Eingänge.SercosPhase
- .gCnc[k].SercosPosCmd Axis[k].Ausgänge.Lage-Sollwert
- .gCnc[k].SercosPosAct Axis[k].Eingänge.Lage-Istwert Geber 1

Finally disable the Sercos master by right-clicking on the icon but do not delete it.

4.4 Library modules

All axes are defined and controlled by axis modules ".gAxis[iAxis]" of type `TL_AxisSlow`, where `iAxis` is the logical axis number of an axis. Such a module contains the following inputs which are connected to internal PLCopen blocks

- enable connected to TL_MC_Power

- stop connected to TL_MC_Stop
- couple connected to TL_MC_MoveSynchronized (not PLCopen)
- referenceEnable connected to TL_MC_Home
referenceStart This is a trigger input to set referenceEnable TRUE.
- reset connected to TL_MC_Reset

The code of this module is shown in Application Note AN108. The following internal PLC open blocks are described in Application note AN108.

- TL_MC_Power
- TL_MC_Stop
- TL_MC_MoveSynchronized

Optional function blocks for axis movements *TL_MC_MoveAbsolute* and *TL_MC_MoveVelocity* are also described in AN108. See application note AN109 on how to access drive registers with ***TL_MC_RegisterRead*** and ***TL_MC_RegisterWrite***.

A group of axes [iL..iH] is combined for enabling and referencing using the function block AxisGroup in the sample code.

4.5 TIOB

To receive data from and sending data to a *TIOB* drive see application note AN110.

4.6 Windows 7

To set the TwinCat bootmode, the TwinCat System Control must not be opened through the fast access window, because it will not open in admin mode this way. Instead open the System Control in the **start > Programs > TwinCat** list as Admin.

Be aware that the standard TwinCat EventConfigurator does not run under Windows7 as of version 2.11.1551. Ask Beckhoff for an upgrade if starting the configurator is not possible.

4.7 Beginners Hints on Using the PLC

With **Online > Create Bootproject** a boot-project is generated in the TwinCat bootPath C:\TwinCat and linked to the Twincat configuration. Now the application runs independent of the editor.

- With **Online > Login** the editor hooks up into the running code. After LOGIN the user might find it surprising, that, e.g., an initialization sequence is not gone through. Be aware, that the PLC code can already be running before LOGIN.
- A neat feature of the editor is on-the-fly-changing of code. We can edit code, compile and download to the TwinCat while code is running real-time. Since the behavior is strongly cyclic the code is just replaced between two calls of the task.

If more than one task is running (at for example different frequencies) only one can be logged at a time. The active task is defined using **PLC Control > Ressources > TaskConfiguration** then right click on, e.g., "main_slow" and set "debugging task".

Be aware that the statement "IF a AND b THEN will always calculate both variables a and b before continuing. If you want to make sure b is not calculated if a=FALSE (for example if b contains an empty

pointer, use two cascaded IF statements instead.

5 Error display using TwinCat Events

Errors, warnings and information are made available at the function block outputs and using the Twin-Cat event concept. The meaning of the output **errorId** of a function block is listed in AN103. An errorId not equal to zero corresponds to an error if **error**=TRUE and a warning or information if **error**=FALSE.

The error description file *triamec\plc\events\Event Configuration Triamec.ecpx* must be made available to TwinCat as described in *triamec\plc\events\readme.txt*.

6 Hmi

The sample code *Triamec_cnc* contains the task *Standard/MAIN* with the CNC and HMI code from Beckhoff. This must be the first task in the task configuration list (not the highest prio). Only code in the folder *Triamec* is from Triamec.

The HMI *TcHmiProX* is based on Beckhoff C# code with the following modifications

6.1 Messages

All *TcEventClass* objects are shown under “active”, but not all are logged by log4net. In the standard Hmi, only errors are logged. We added further events:

- *TcEventClass.Warning*: MainApp.log.Warn
- *TcEventClass.ParameterError*: MainApp.log.Error
- *TcEventClass.Alarm*: MainApp.log.Error
- *TcEventClass.Instruction*: MainApp.log.Info
- *TcEventClass.StateInfo*: MainApp.log.Info
- *TcEventClass.Hint*: MainApp.log.Info
- *TcEventClass.Message*: MainApp.log.Info
- *TcEventClass.Maintenance*: MainApp.log.Info

Other options of log4net which are not used: “debug” and “Fatal”

6.2 Status Display

Five status strings are shown in the HMI-CNC-window.

- *.StateGeneral[1-4]* 2x2 state displays in the header in the order
1rowLeft, 1rowRight, 2rowLeft, 2rowRight
- *.StatusSpindle* Next to spindle display

Detailed state information under **PlcStatus > Triamec > Positions** etc.