



# Triamec TwinCat

## Quick Startup Guide

Version	Date	Editor	Comment
1.5	2011-05-11	mvx	Add Hmi information and sample code
1.6	2011-10-31	mvx	New simulation mode and modulo axes
1.7	2011-11-21	mvx	Update for smart sync
1.8	2012-04-04	mvx	Update for sample code 1.7
2.0	2012-09-12	mvx	Update for sample code 2.0
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023	2014-03-28	mvx	New object gCnc for Task exceed compensation
024	2016-02-02	chm	Section 3.1: USB observer loop-back configuration
025	2019-09-23	dg	Synchronized with TSD Setup Guide EP001
026	2020-12-09	bl	Updated Nomenclature, removed references to TIOB
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## 1 Introduction

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

- Install TwinCat TC31-Full-Setup.3.1.4022.27 and TF5210-TC3-CNC-Export-3062.2 or similar.
- Setup your drives using the Triamec TAM System Explorer as explained in the “Servo Drive Setup Guide” (see <http://triamec.com/en/documents.html>).
- 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 The sample code

Two sample codes are available in the sample package at [triamec.com/en/tria-link.html](http://triamec.com/en/tria-link.html)

- Triamec\_nci.tnzip using the Beckhoff NCI module.
- Triamec\_cnc.tnzip using the Beckhoff CNC.

Open visual Studio and import the sample using "File/Open/OpenSolutionFromArchive".

### 2.1 The Trialink PCI adapter

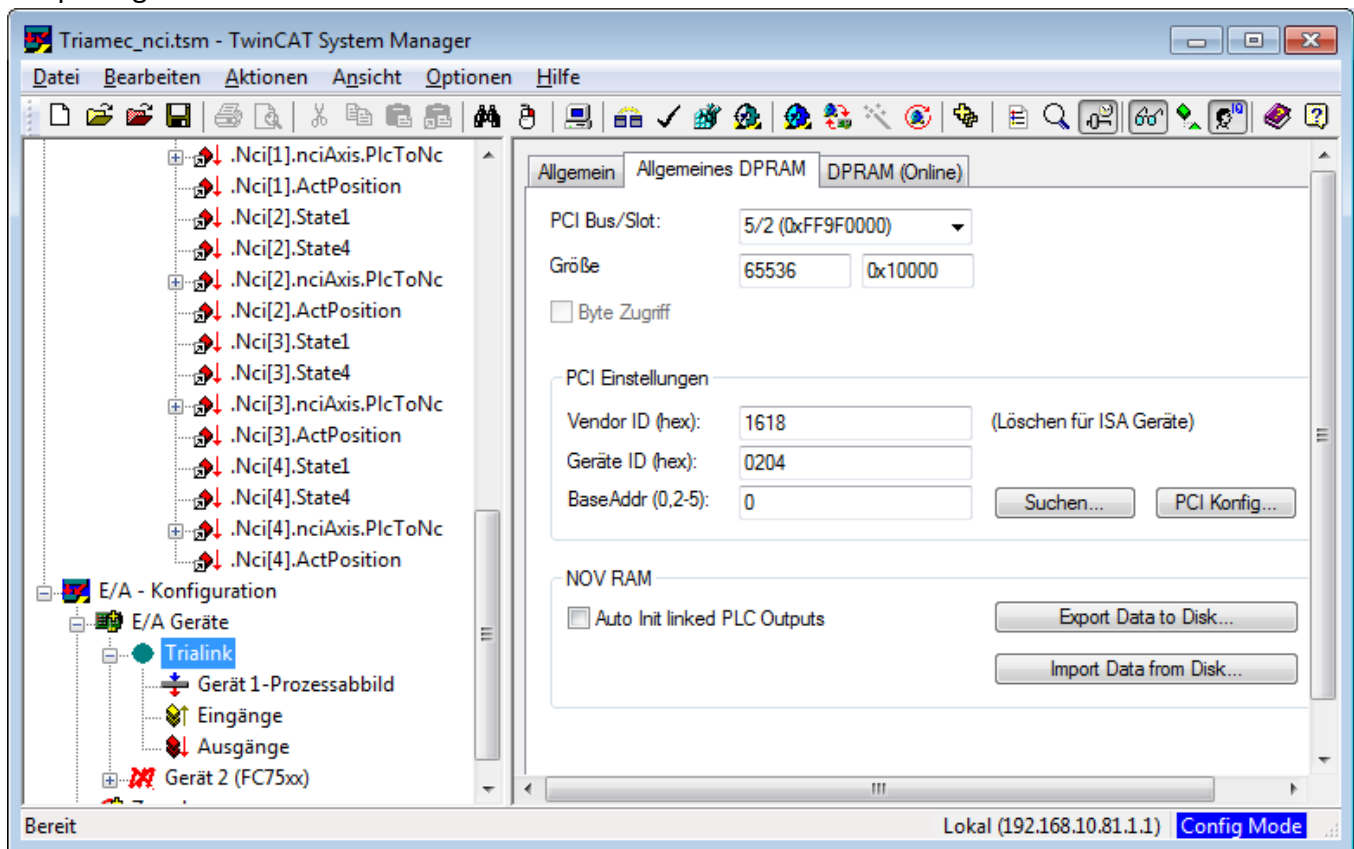
Open the DPRAM settings for the Tria-Link adapter board in “I/O/Devices/Trialink-GenericDPRAM”, see figure below. The vendor ID is 1618 and the device ID is

- 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 TL (formerly TLO300) (PCI-Express with USB Observer)
- 0206 for a TLOC100 (with USB Observer and additional controller)
- 0211 for a TL-DMA (formerly TLO400) (PCI Express with DMA and USB Observer)

Choose search and TwinCat should find the Adapter.

- Be aware that TwinCAT must be in Configuration mode for this step.
- Be aware that the 0x211 device requires a DMA driver for optimal performance. This is installed automatically with the Triamec Software or manually using the folder "dmaDrivers" of the sample package.



The variable **.CommunicationEnable** boots the Trialink bus. Set this to 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.

## 2.2 The structure of the PLC code

The PLC sample code uses two objects of the Triamec library called in two tasks of the sample code

- `TL_Trialink2` is the PCI adapter board object (instance `Trialink` in the sample code).
- `TL_Axis2` is the object that interacts with an axis (array `gAxis[]` in the sample code).
- `MAIN_SLOW` is the task for configuration and asynchronous state handling (Enable, Homing)
- `MAIN_FAST` is the task for synchronizing and where positions are sent to the Tria-Link.

In standard mode, the pathplanner of TwinCAT sends positions to the drive. Two additional function blocks of the library allow using the drive pathPlanner for axis movements: `TL_MC_MoveAbsolute` and `TL_MC_MoveVelocity` are described in AN108.

See application note AN109 on how to access drive registers with `TL_MC_RegisterRead` and `TL_MC_RegisterWrite`.

All settings are configured in the function block "ConfigurationManager".

The adapter object `Trialink` is linked to the IO module using the `nDevId`

- Open the header "General" of the DPRAM IO module and see the device-ID.
- Enter this id in the ConfigurationManager as `Trialink.Config.nDevId`.

## 2.3 Axis modules

All axes are defined and controlled by library axis modules "`gAxis[iAxis]`" of type `Triamec.TL_Axis2`. Such a module contains the following inputs

- `enable` to enable the axis
- `stop` to force a stop as long as this remains TRUE
- `couple` to connect the axis with the TwinCAT pathPlanner
- `referenceEnable` to enable homing
- `referenceStart` This is a trigger input to set `referenceEnable` TRUE.
- `reset` to reset any axis errors
- `iAxis` This logical axis number must be specified uniquely and is usually the index of the array of `TL_Axis2` objects. It is currently limited in the library to `TL_CH_AX_MAX = 32`

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

There is a simulation mode of an axis

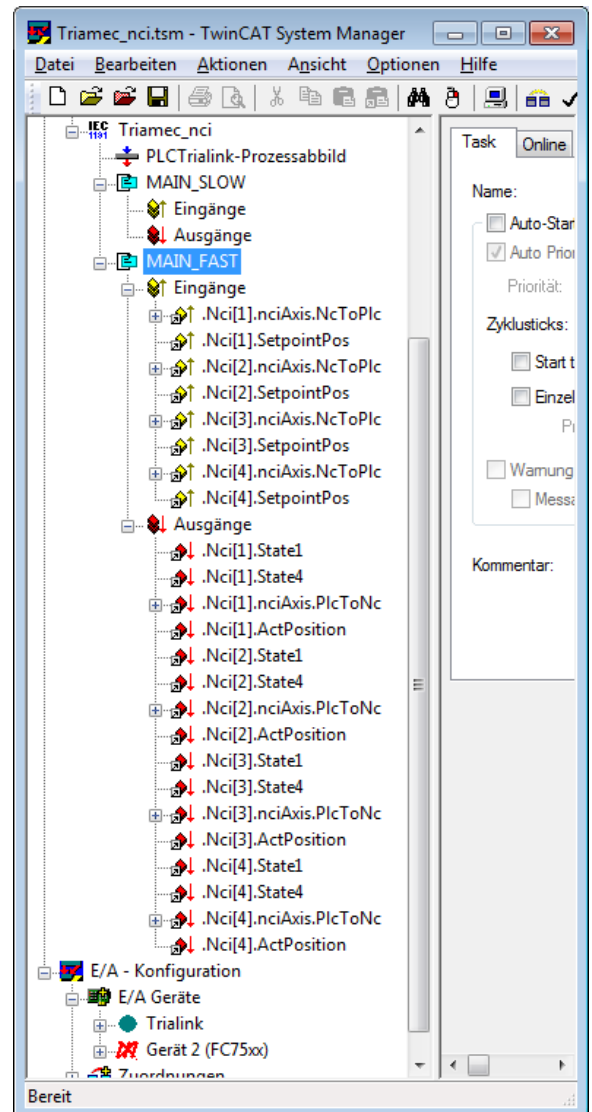
- In simulation mode (`Config.Simulate` is TRUE), the state information are set independent of the drive and the drive does not enable. However, if the axis is disabled, the actual position information is correctly propagated if possible.
- Start in simulation mode and then, if position information seem correct, turn simulation off. After changing this mode, toggle `Triamec.CommunicationEnable` or restart TwinCAT.

## 2.4 Getting Started

Now we are ready for position scaling, modulo, and referencing (see next chapters). Open the PLC project.

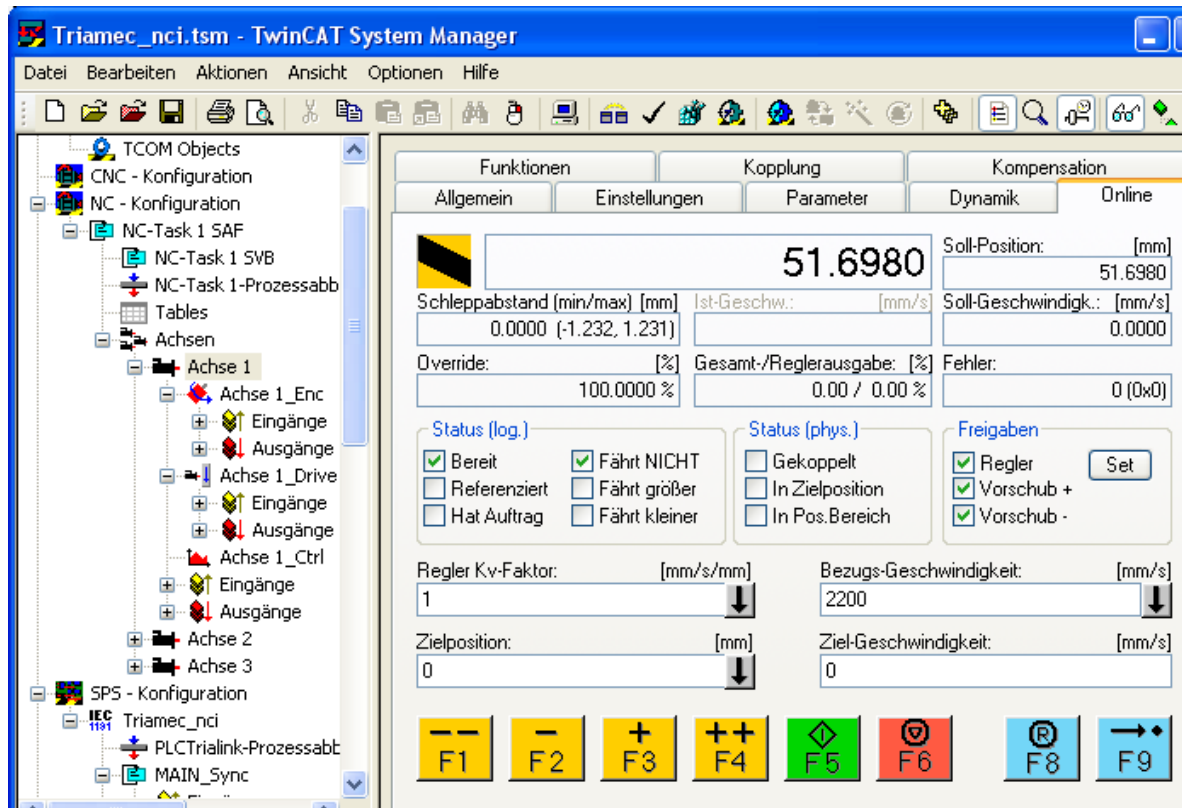
- Make sure the library “TriamecLibX.compiled-library” is installed.
- Choose **Build > CleanSolution** before first time use of the PLC program.
- Set `ConfigurationManager.axes[].simulate` TRUE for all axes.
- The IO's of the axes are visible in the PLC instance. Make sure, these are connected to the CNC/NC axes of the CNC/NCI module as described in chapter 4.2.
- Make sure the ring is closed and, if drives are in the ring, the drives must have 24V supplied.
- Build Solution, Activate the configuration Login and start.
- 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.



## 2.5 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”.

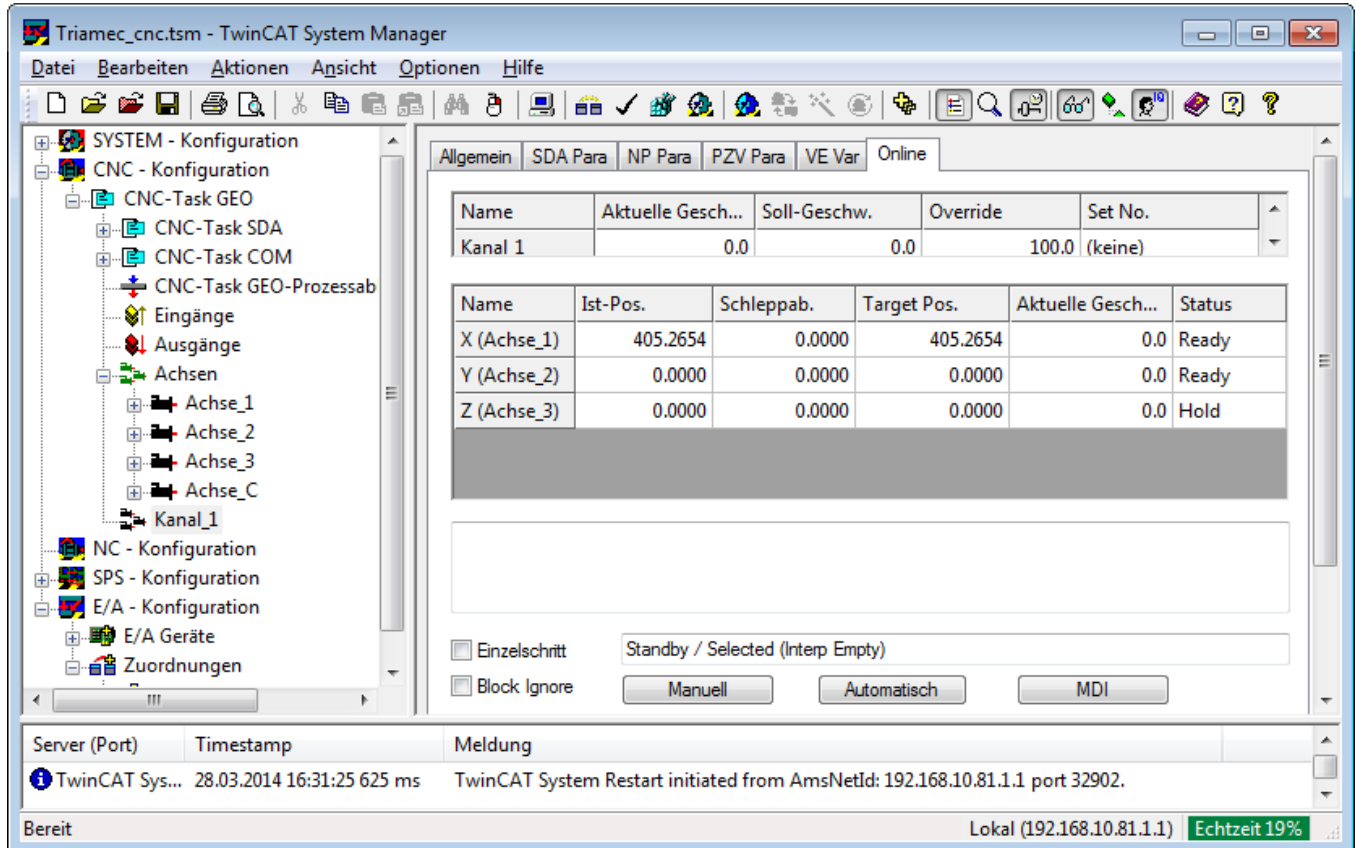
Set enable back to FALSE. If an axis is already configured as shown in the next chapters (but still simulated) the axis can be moved by hand and the ActualPosition should change correctly.

Set the dynamic parameters in NC/Achsen/Achse\_n/Dynamik.

## 2.6 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.

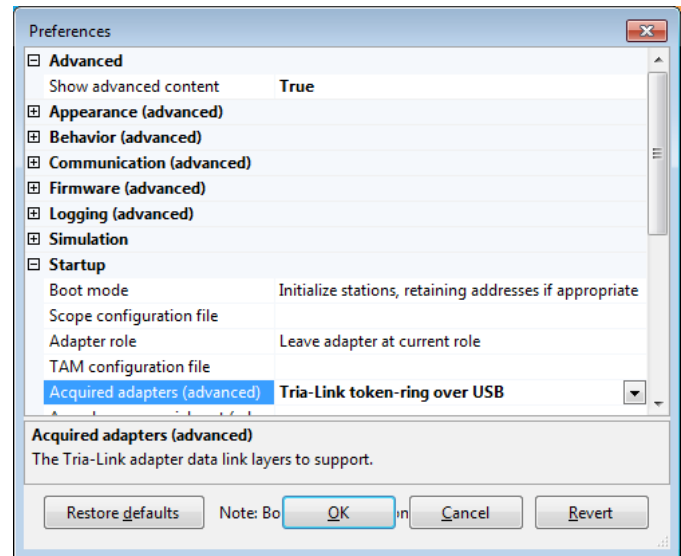
Configure the CNC channel in CNC-Konfiguration/CNC-Task GEO/Kanal\_1 and the CNC axes in CNC-Konfiguration/CNC-Task GEO/Achsen/Achse\_n/Parameter as shown in the CNC-documentation.

## 3 Configuring the axes

### 3.1 TAM System Explorer

Configure the drives with the (Triamec) TAM System Explorer to set drive parameters, install new firmware, and store parameters persistently. This application is usually installed on a Service or development PC for optimal flexibility.

If the customer chooses to install this application on the TwinCAT PC: Be aware that the PCI Adapter cannot be accessed simultaneously by TwinCAT and TAM System Explorer. On a TwinCAT PC set `Triamec.CommunicationEnable FALSE` in the PLC code before starting the explorer or use the Explorer in a mode that does not access PCI (USB or Ethernet) using the menu **File | Preferences | AcquiredAdapters**, see figure to the right.



Specifying, which adapters should be acquired in the TAM System Explorer

The Explorer may fully control the axes, if `Triamec.CommunicationEnable:=FALSE` in TwinCAT. Otherwise, it is in Observer mode and may observe any drive signals online, even while TwinCat is running.

There are four connection methods.

- Ethernet connection to the drive auxiliary port is the preferred method because of its high immunity to EMC (noise), read application note AN123.
- USB connection to a drive is also possible
- USB connection to a PCI adapter is possible, for the products TLO100, TLOC100 or TL (formerly TLO300).
- Finally, connection is possible using any PCI board from Triamec with the conditions discussed above.

### 3.2 Setting Up the Drives

Before a drive can be used with TwinCAT, the drive has to be configured with the TAM System Explorer. See the Servo Drive Setup Guide<sup>(1)</sup> on how to setup the drive parameter, install new firmware and on how to save the parameters persistently on the drive.

In TwinCAT, drives are accessed using there station address.

- Station addresses must be set unique on the ring. As a convention we use addresses starting at 17.
- In the PLC code this address is entered as the “**axis.Config.station**” parameter in the Configuration-Manager function block.
- Be aware that a drive may control two axes. These have the same station address and a different subAxis parameter in `ConfigurationManager.axes[2].Config.SubAxis`, use `TL_Config.SubAxis.FirstAxis`

1 See Servo Drive Setup Guid in <https://www.triamec.com/en/documents.html>

or .. SecondAxis.

- Use the TAM System Explorer to set this address in the drive at *General/Parameters/LinkAddress*
- and set *General/Parameters/UseDedicatedLinkAddresses* to TRUE.<sup>2</sup>

Drive parameters are lost after a power cycle if not saved persistently

- Prevent loss of drive settings by saving the configuration persistently on the drive as described in <sup>(1)</sup>. Later changes of the configuration need to be persisted again to not be lost after a power-down.
- Also save the configuration as a \*.TAMcfg backup file on the PC.

### 3.3 Position Scaling and Modulo

TwinCAT uses integer32 for positions whereas Triamec drives use the double format representing SI units (double **meter** or **rad** or similar). Therefore the code needs to convert the integer from the CNC module to the double value in the PLC code. This is done in the gCnc or gNci objects of the sample code.

The scale of the position data in the PLC is usually identical to the drives. Therefore set  
`ConfigurationManager.axes[].Config.GearFactor := 1;`

The standard scale factor between CNC/NCI and PLC is 10'000 inc/**mm** or 10'000 inc/**degree**.

To change the default scaling, use `ConfigurationManager.gCncAx[].inc_per_unit`. To get for example 1nm resolution, choose the value 1000'000. Be aware that this reduces the maximum possible position to  $2^{31} * 1\text{nm} = 2.1\text{m}$ . This changes the scale at the interface. The TwinCAT path planner modules must also know this scaling factor:

#### CNC

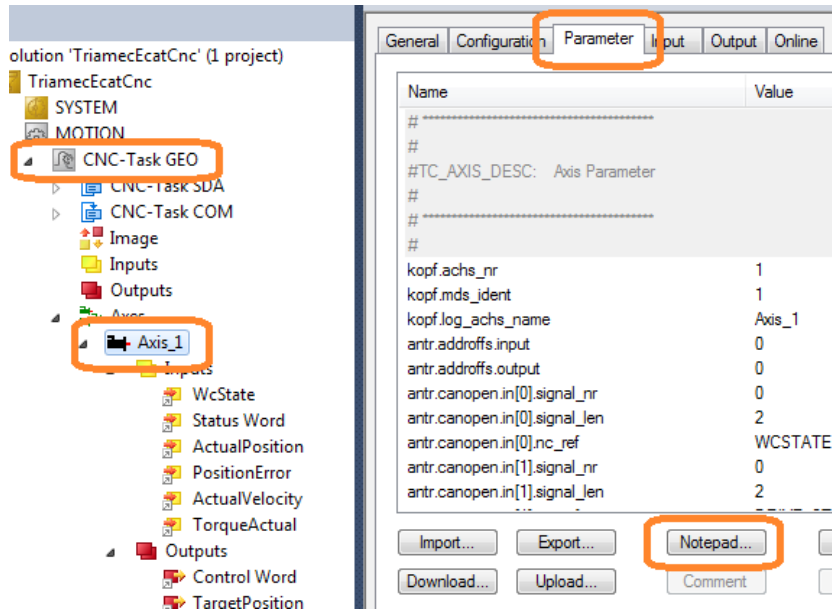
If a CNC is attached adapt the CNC axis parameter (see figure below)

`getriebe[0].wegaufz 1` P-AXIS-00234 : Path resolution of the measuring system (num).

The unit of this parameter is 10'000 inc/mm or inc/degree. Its default is 1. Use this equation for the values of the drive and CNC parameters

`ConfigurationManager.gCncAx[].inc_per_unit = wegaufz * 10'000`

<sup>2</sup> For previous drive generation: Right-click on the Device and choose "Manage Persistence", set the "Addresses Source" to "Static" and set the "Station Address". Also set the persistence to "Activated" and click "Save".



## NCI

Another use case is NCI. Lets assume the same finer resolution of 1nm as for the CNC example.

- Set NC/Achsen/Achse\_N/Achse\_N\_Enc/Parameter/ScalingFactorNumerator to 1E-6.  
Select the row and use “Download, Save” to save the settings.  
Reload the solution to activate the changes
- Set the Sercos-Axis Startup Value S-0-0077 to 1 and S-0-0078 to -9.

For a rotational axis the standard resolution is 10'000 inc/**degree**. and the wrap value is set using

- ConfigurationManager.axes[].Config.ModuloWrap:= 360;
- and in the drive set  
Axes[]/Parameters/PathPlanner/ModuloPositionMaximum = 360.0  
Axes[]/Parameters/PathPlanner/ModuloPositionMinimum = 0.0

To increase the resolution refer to the procedure for linear axis above.

## 3.4 Referencing (Homing)

The axis module **TL\_Axis2** (called **gAxis** in the sample code) contains a homing function which implements several homing procedures and the parameters **gAxis[n].Config.Reference\***. See Configuration-Manager and **AN108** for details.

## 4 More Details of the sample code

### 4.1 System settings

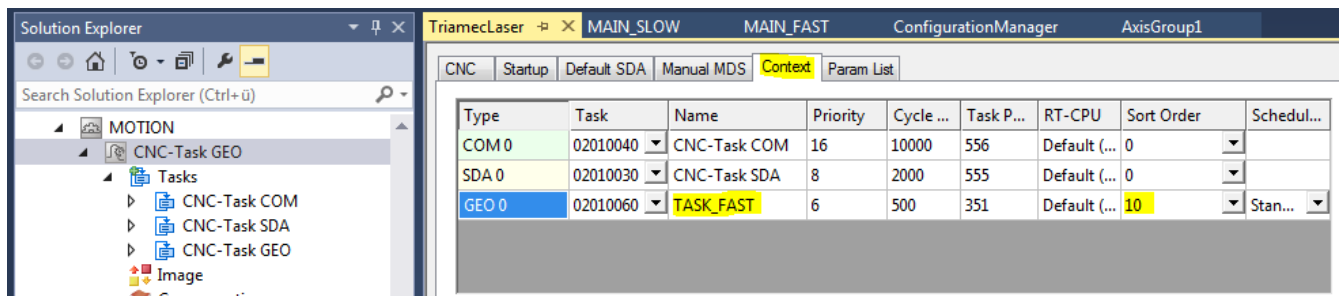
If changing the task rate is necessary

- adjust the task cycle time in **System > RealTime**.
- 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 10ms).
- Go back to the TwinCat configuration, reload the PLC. Check the task priorities:  
**System > Real-Time > Priorities> Automatic Priority Management.**

Some realtime issues on a heavily loaded system may be solved by synchronizing the CNC with the Triamec library. When using the CNC, run the calls for MAIN\_FAST in the CNC GEO object as shown in sample code TriamecCnc or use the following guide:

- Open the “Context” tab under “MOTION” - “CNC-Task GEO”.
- For “GEO 0” select “TASK\_FAST” from the pull down menu in the “Task” column.
- With “Sort Order” the sequence of the calls can be configured. To call the “CNC-Task GEO” before the PLC sequence the value has to be set to 0 < “Sort Order” < 100.



Type	Task	Name	Priority	Cycle ...	Task P...	RT-CPU	Sort Order	Schedul...
COM 0	02010040	CNC-Task COM	16	10000	556	Default (...)	0	
SDA 0	02010030	CNC-Task SDA	8	2000	555	Default (...)	0	
GEO 0	02010060	TASK_FAST	6	500	351	Default (...)	10	Stan...

## 4.2 Adding more axes

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 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:

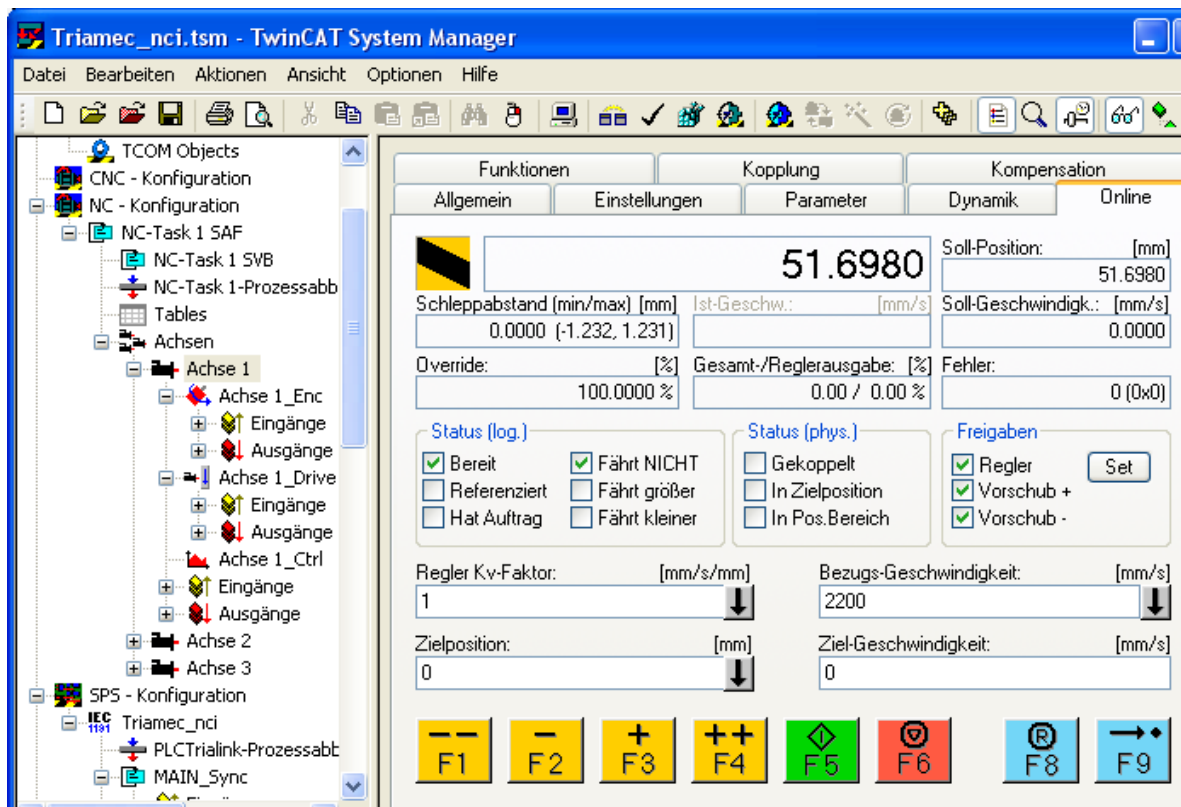
## NCI-Configuration

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.

## 4.3 Path planner and Coordinates

While the axis *position controller* runs 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 <b><code>gAxis[].couple</code></b> of <code>TL_AxisSlow</code> .

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 and sends actual position information back to NCI/CNC.  
  `gCnc[]`
- `gAxis[].fastPositionCmd`              takes the last positions, interpolates them to 100kHz and sends data to drives.
- `gAxis[].ActualPositionfast(Trialink:=Trialink)` reads the actual position of an axis

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. If the actual position is required at higher speed, use the new PCI-Express board TL-DMA with the DMA-Feature (Direct Memory Access) .

## 4.4 Error display using TwinCat Events

Errors, warnings and information are made available at the function block outputs and using the TwinCat 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`.