LinMot PROFIdrive and Siemens SIMOTION

Application Note

Note
The information in this documentation reflects the stage of development at the time of press and is therefore without obligation. NTI AG reserves itself the right to make changes at any time and without notice to reflect further technical advance or product improvement.

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Use of This Document

Description: Application note for commissioning a LinMot C1250-PD drive connected to a Siemens SIMOTION PLC.

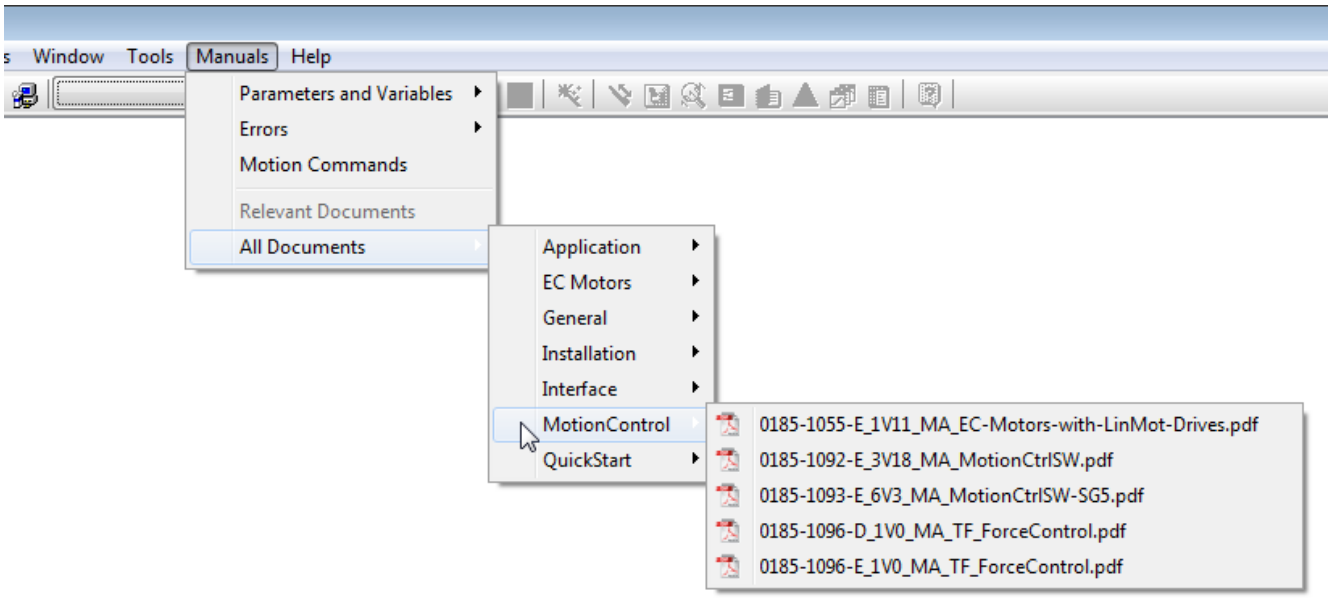
Drive: C1250-PD-XC-xx-xxx

Classification:
[x] Application Note
[ ] Installation Guide
[ ] User Manual
[ ] Documentation
[ ] LinMot internally

Recommended Documentation

Reading the following user manuals is essential to understand the communication between the PLC and the LinMot drive. The manuals are included in LinMot-Talk software (*Menu Manuals → All Documents* or *Relevant Documents* if logged in to a drive) or can be downloaded from the LinMot eCatalogue (search by document reference): http://shop.linmot.com

User Manual	Document Reference
LinMot-Talk	0185-1059
Motion Control Software	0185-1092 / 0185-1093
PROFIdrive	0185-1132



General

Used components:

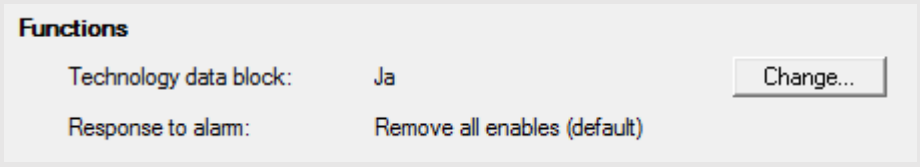
- LinMot C1250-PD-XC-0S / C1250-PD-XC-1S
  (Firmware 6.8 Build 20200120)

- SIMOTION D445-2 DP/PN, Control Unit D445-2 DP/PN; Firmware V5.2
  Part number: 6AU1 445-2AD00-0AA0

- TIA 15 Update 4 / SCOUT TIA V5.2.1.0 / SIMOTION SCOUT V4.4.0.6

Example project(s) for TIA15, SCOUT TIA: http://download.linmot.com/plc_lib/preliminary/Simotion_PD/

Note:
From firmware 6.6 Build 20170522 the LinMot drive supports the SIEMENS Technology data block:

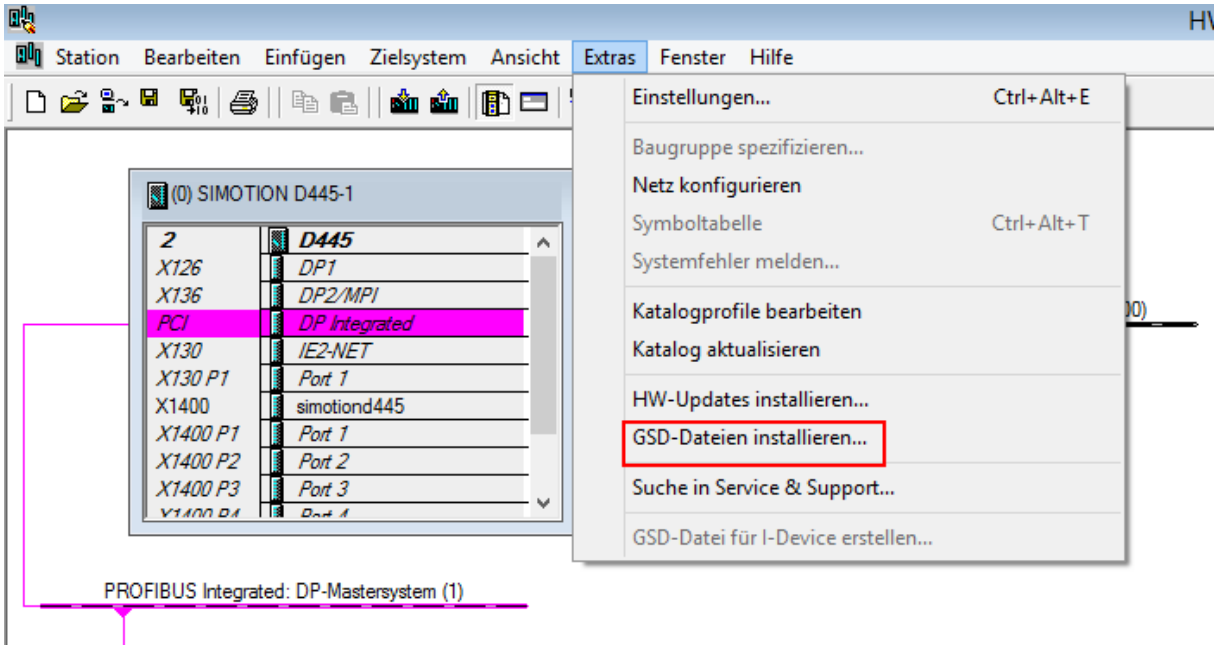


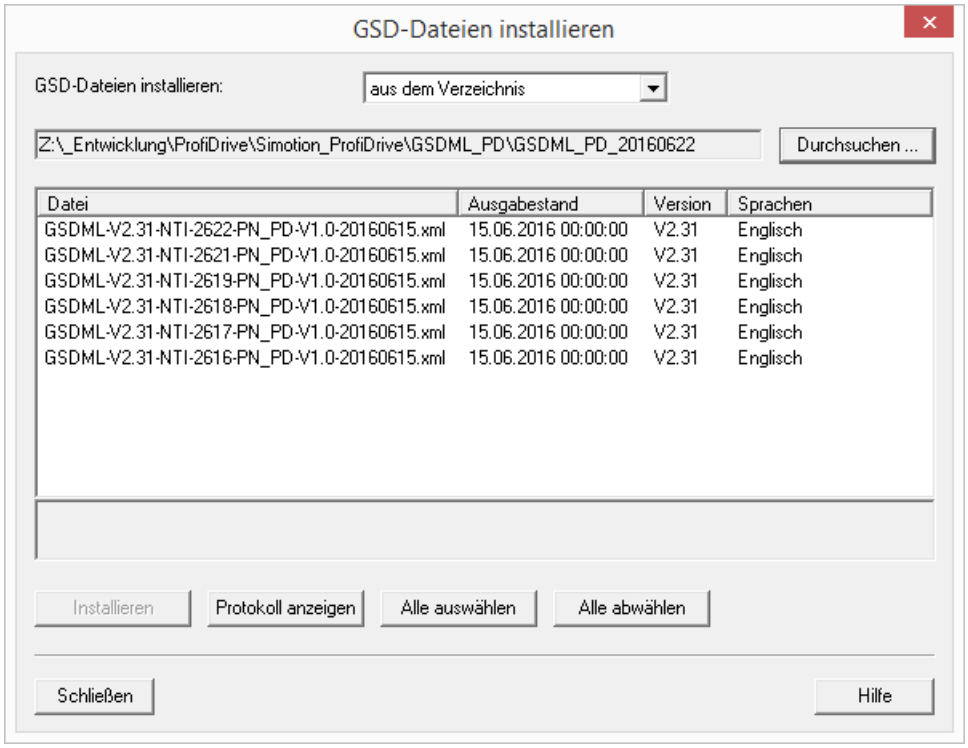
1 HW Config

In this application note the commissioning using SCOUT 4.4 is shown. For TIA example projects are available.

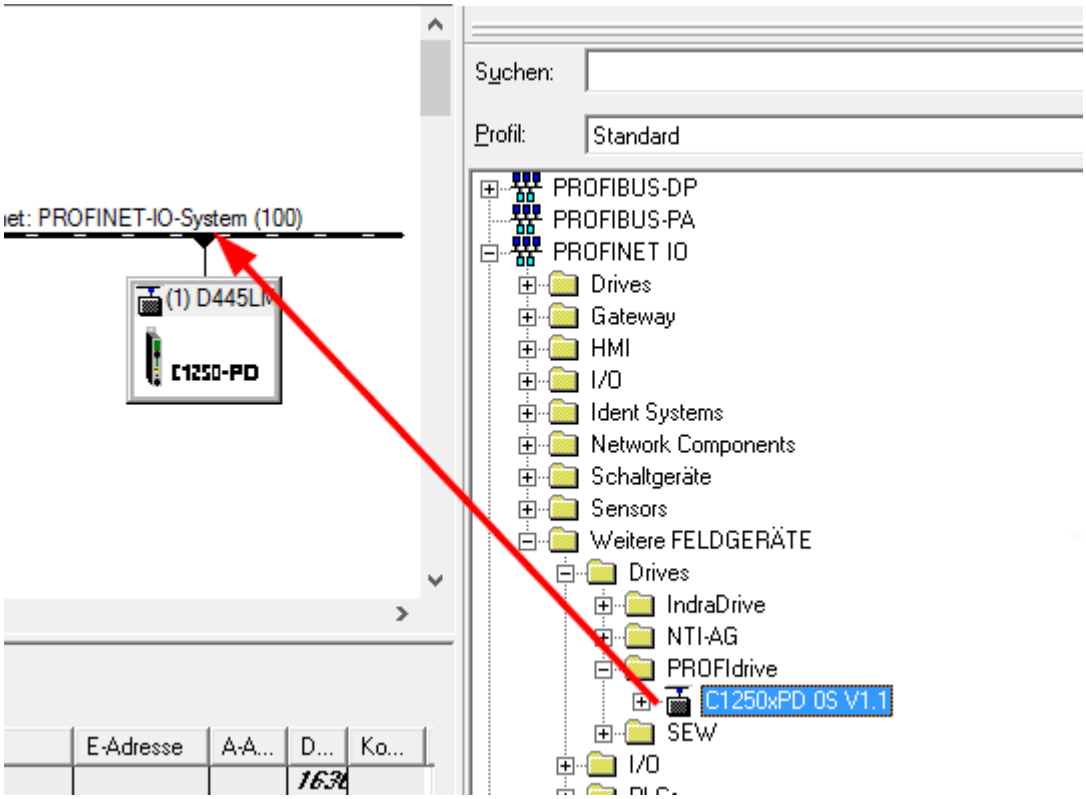
1.1 Install GSDML file and add device

Install the GSDML file(s) that is part of the LinMot-Talk software/firmware you are using. The GSDML files are located by default in the installation path of LinMot-Talk:
\\LinMot-Talk X.X Build XXXXXXXX\Firmware\Interfaces\PROFINET\GSDML_PD

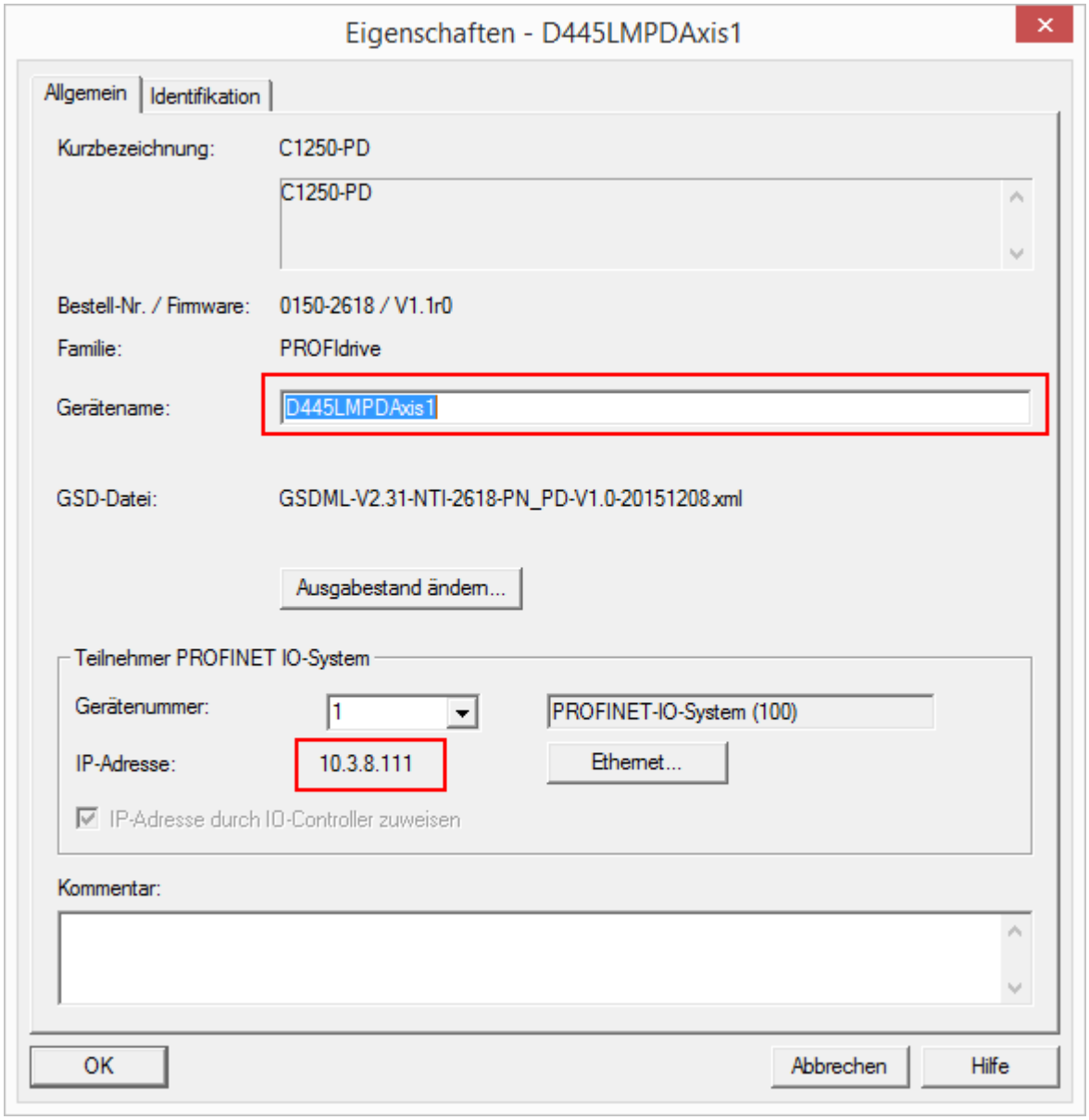




Afterwards drag & drop the desired device on your PROFINET-IO-System:

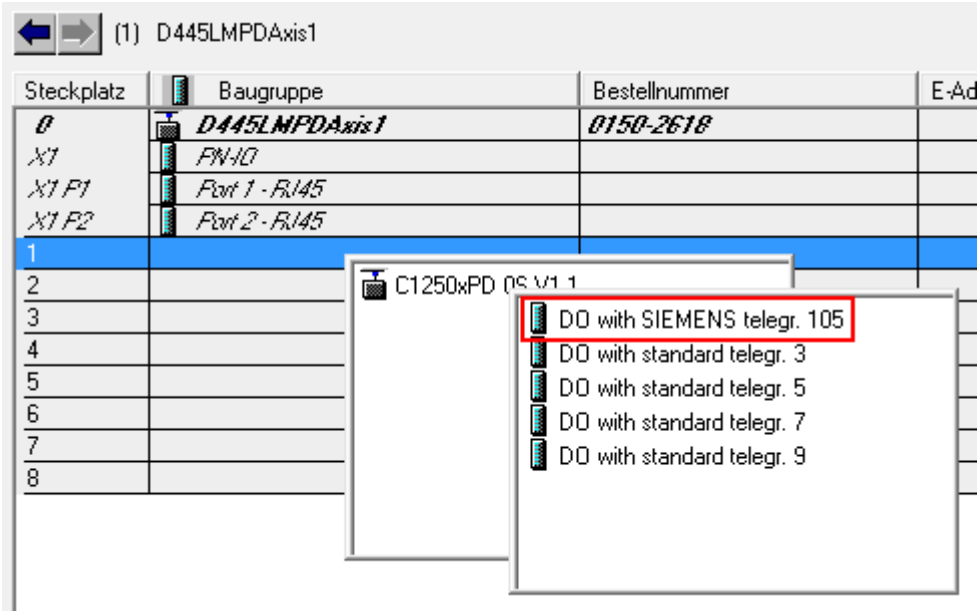


By double-click on the device the name and IP address can be set:

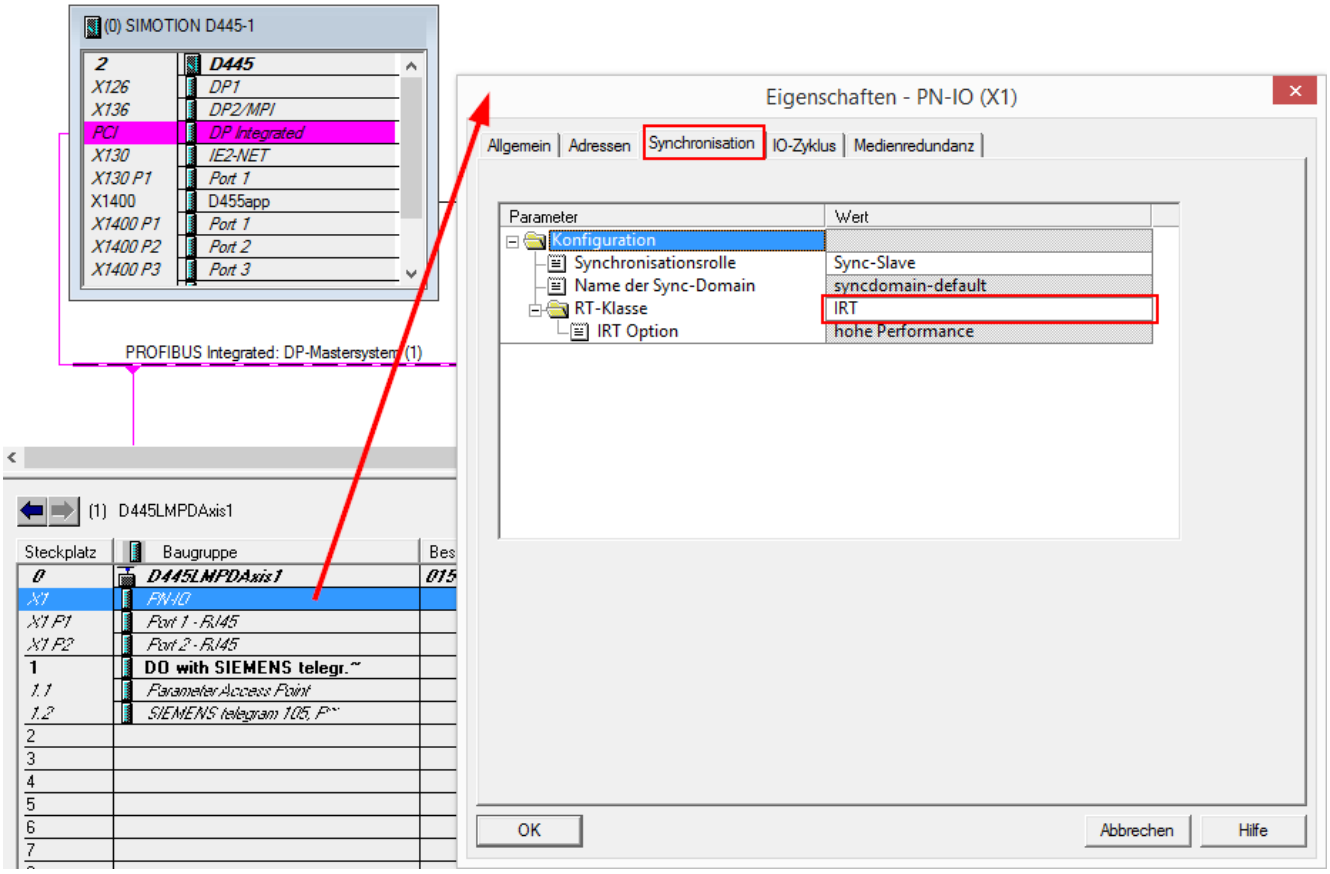


1.2 Insert Standard Telegram 5 / SIEMENS Telegram 105 and setup the Topology

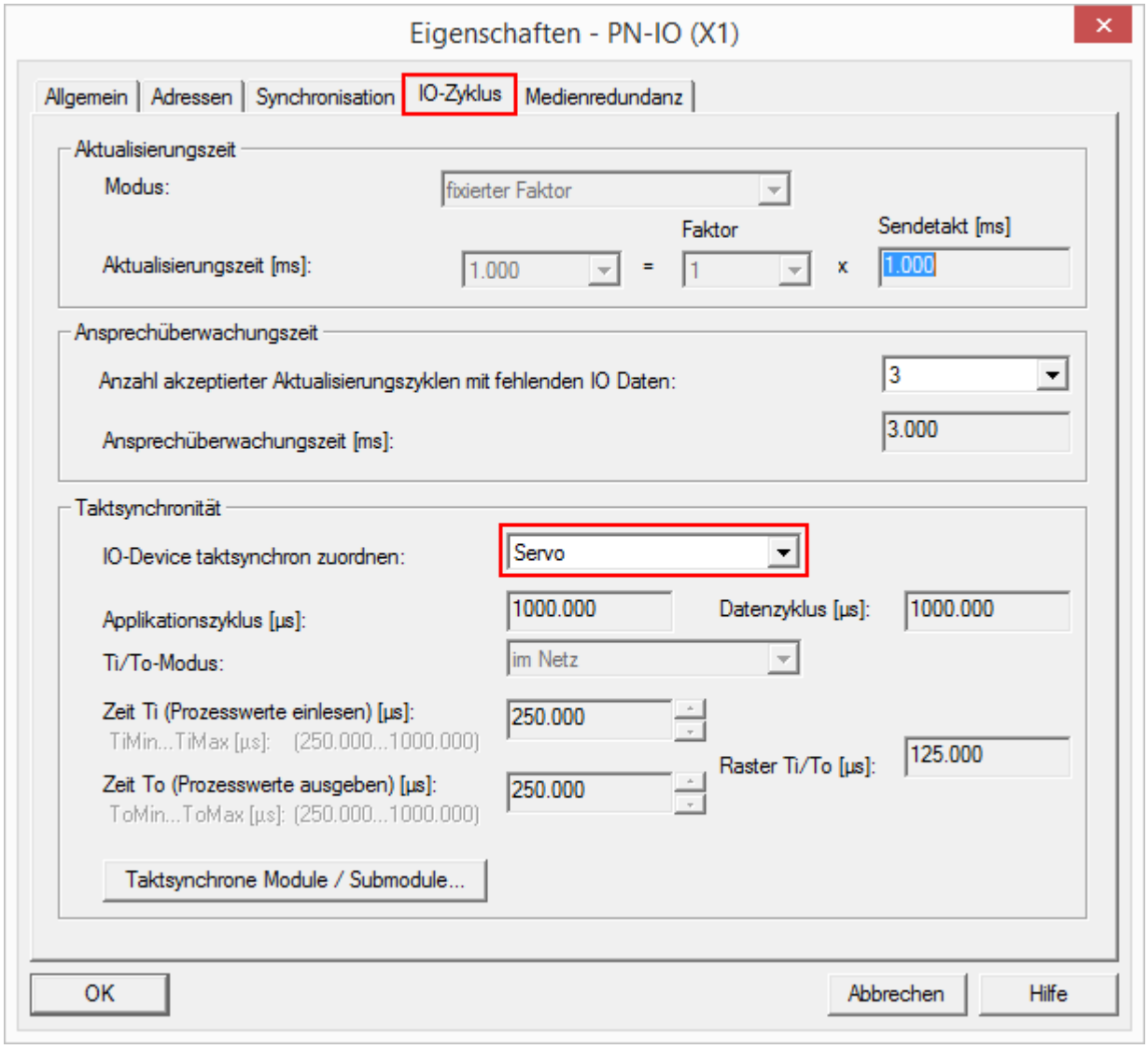
By right-click on slot 1 select the desired telegram (standard telegram. 5 or SIEMENS telegram 105):



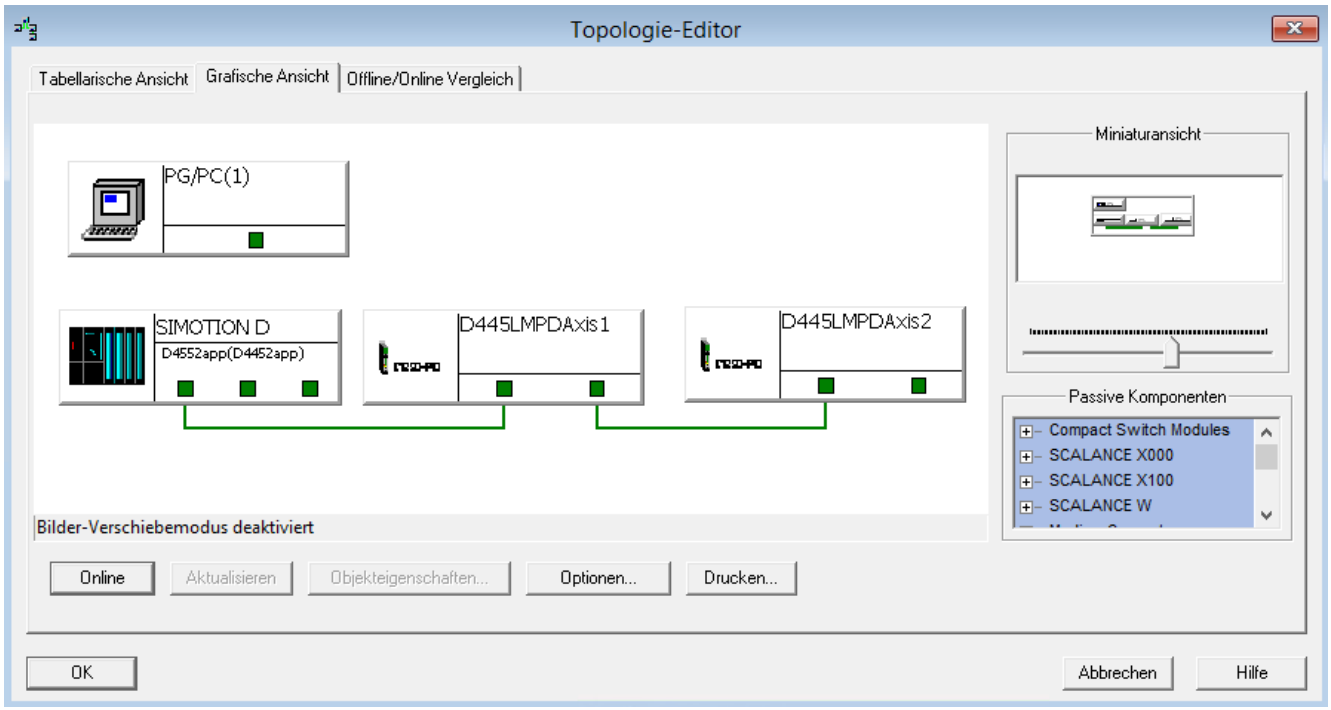
Afterwards double-click on X1 (PN-IO), open the tab *Synchronization* and set *RT-Klasse* to *IRT*:



On tab *IO-Zyklus* select *Servo* for „IO-Device taktsynchron zuordnen“:



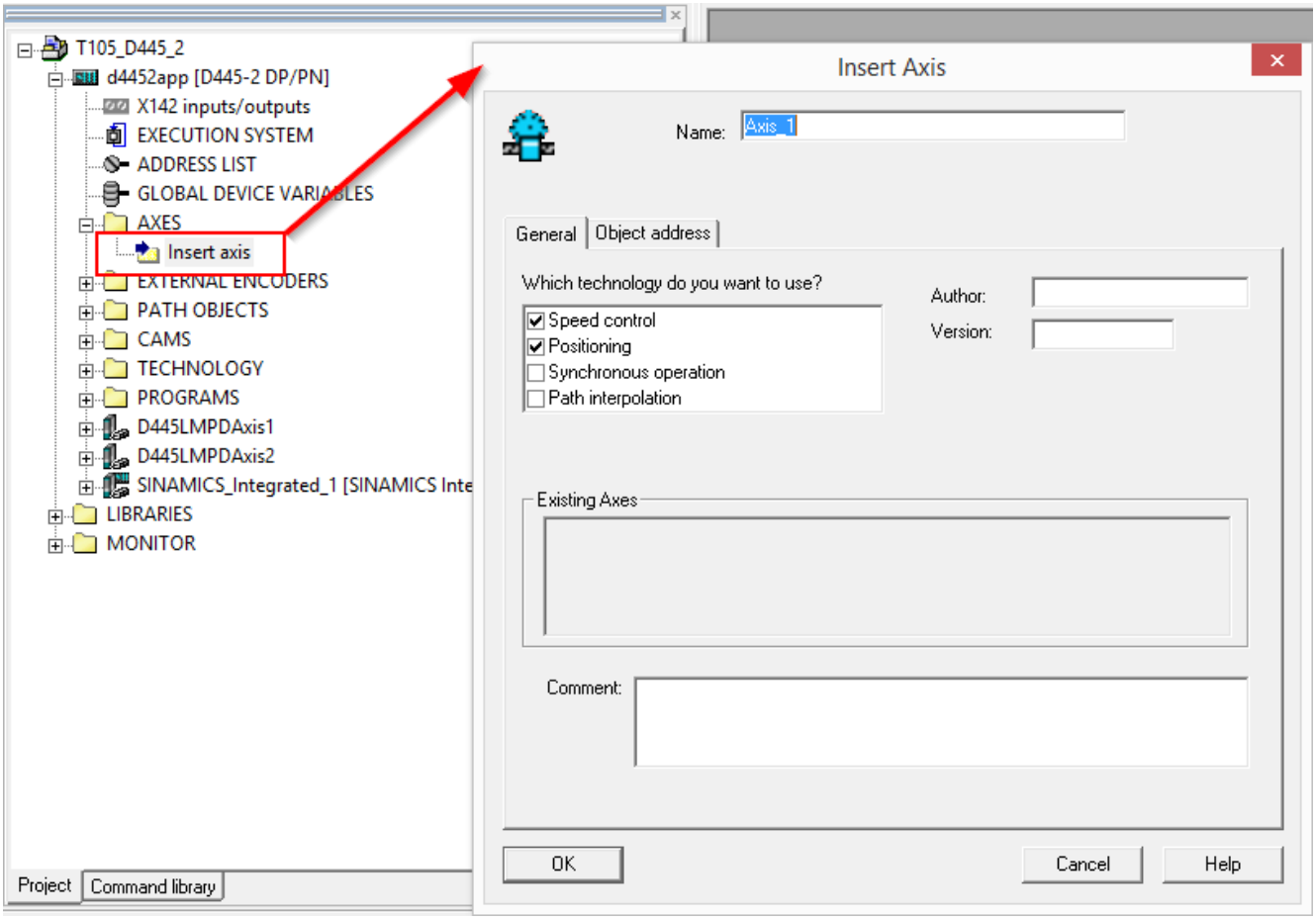
In the topology editor draw the connection between the SIMOTION PLC (Port 1 in this example) and the LinMot drive (Port 1).



2 SIMOTION SCOUT (as Linear Motor)

2.1 Insert a new Axis

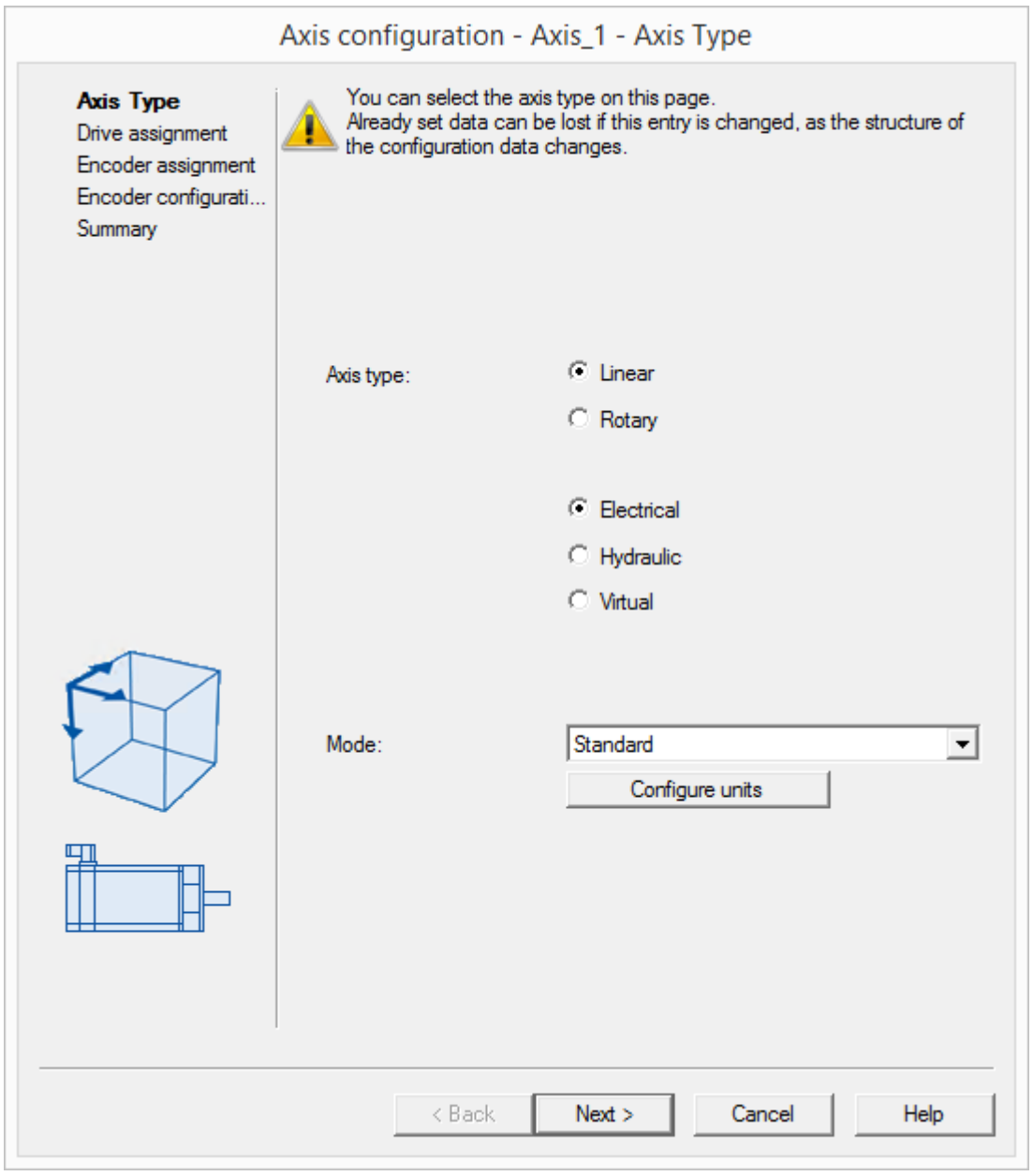
Double-click on Insert axis opens the Wizard:



After entering the name press OK to continue.

2.1.1 Axis Type

The settings for Axis Type can be left on default for a LinMot linear motor:



Afterwards continue with *Next*

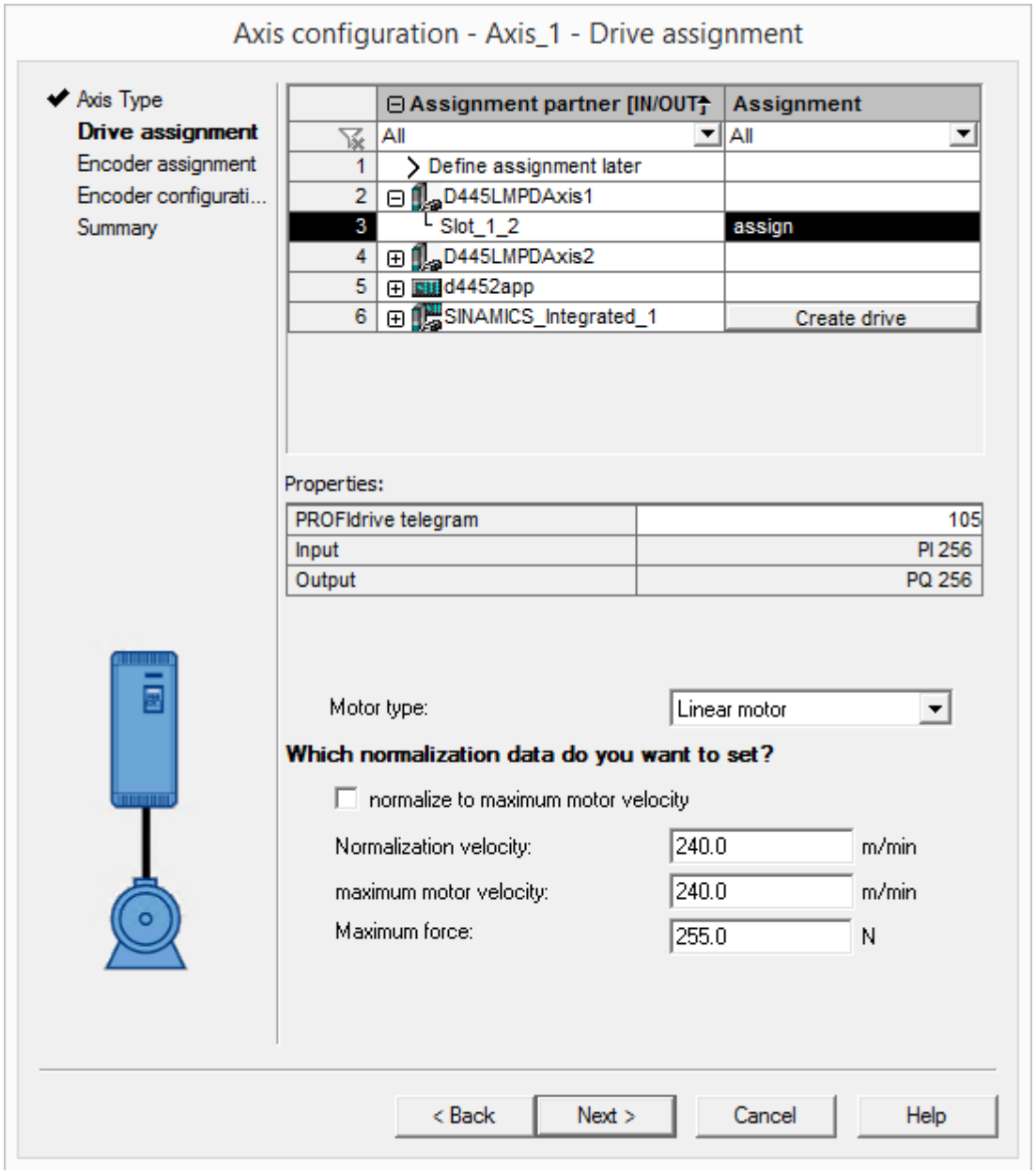
2.1.2 Drive Assignment

Assign the newly created axis to the LinMot drive.

- As *Motor type* select *Linear motor*
- Set *Normalization velocity* to 240 m/min (4 m/s -> motor depending)
- Set *maximum motor velocity* to 240 m/min (4 m/s -> motor depending).
  The *maximum motor velocity* can be set up to 200% of the *Nomalization velocity* if the used motor supports it.

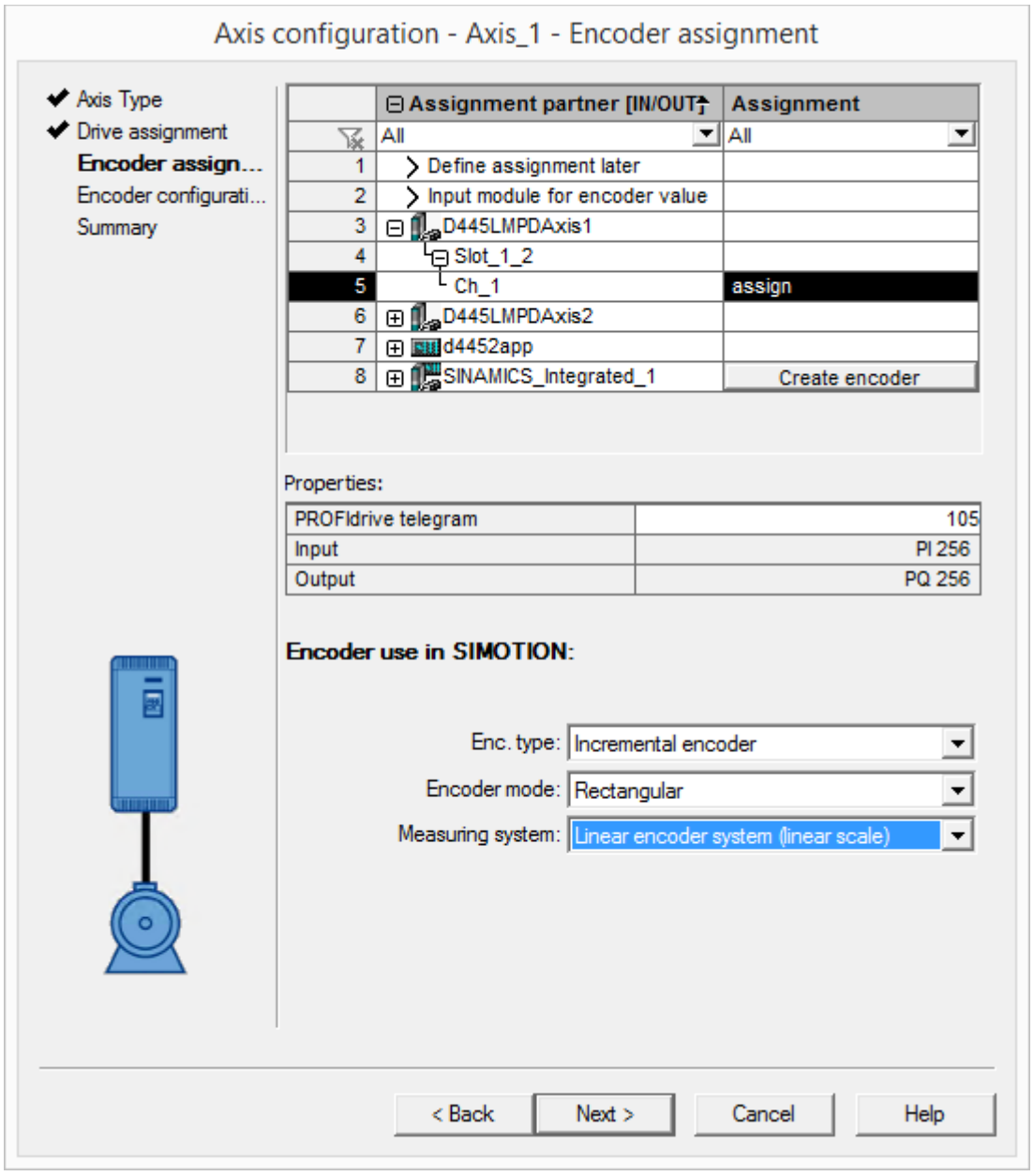
If PROFIdrive-telegram 105 (SIEMENS Telegram 105) is chosen, then additionally:

- Set *Maximum force* to 255 N (motor depending -> see motor data sheet)



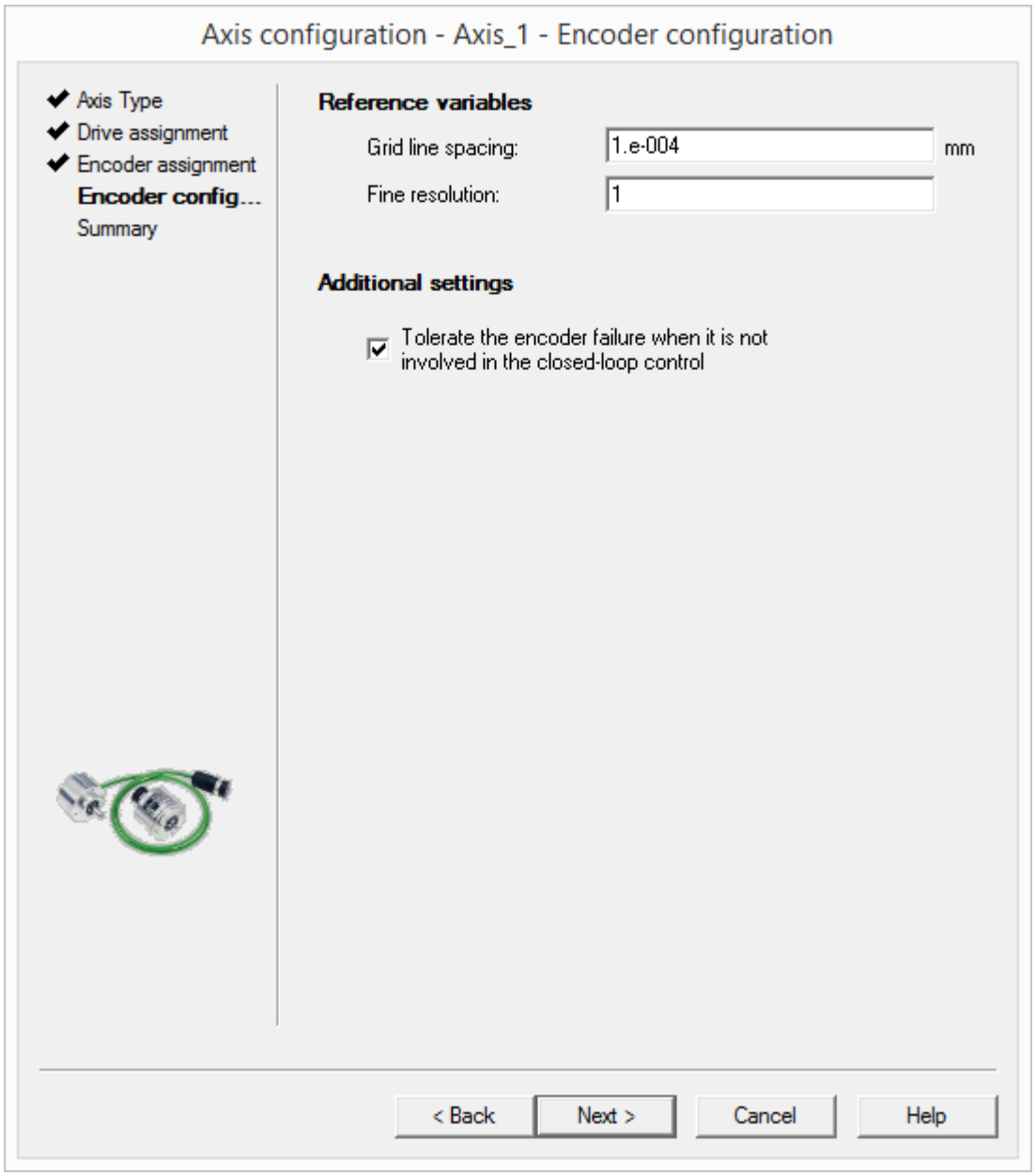
2.1.3 Encoder Assignment

Enc. type: Incremental encoder
Encoder mode: Rectangular
Measuring system: Linear encoder system (linear scale)



2.1.4 Encoder Configuration

Grid line spacing: 1.e-004 (100nm)
Fine resolution: 1

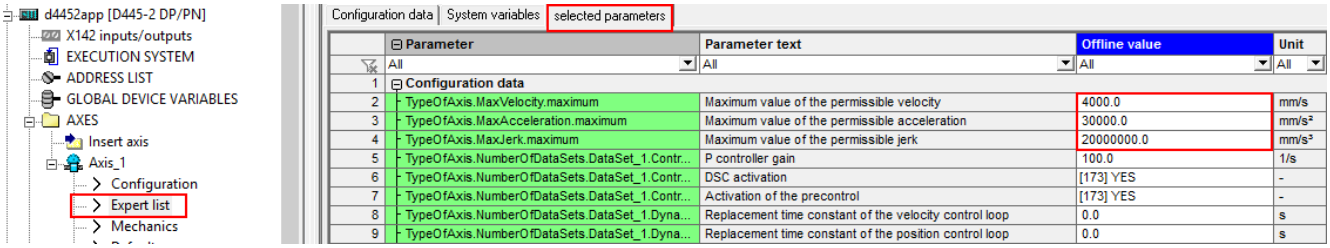


Finish the wizard by pressing *Next* and then *Finish*

2.2 Setup the Axis Parameters

The following axis parameters have to be setup.

Select “Expert list -> selected parameters” to set the dynamics of the motor:



Increase the frequency limit of the encoder:

Configuration data -> TypeOfAxis -> NumberOfEncoders -> Encoder_1 -> FrequencyLimit -> encoderFrequencyLimit

-> 1000000000.0

Configuration data | System variables | selected parameters

	Parameter	Parameter text	Offline value	Unit
	All	All	All	All
6	Simulation	Process coupling		
7	TypeOfAxis	Axis type-specific configuration		
8	ActualAccelerationMonitoring	Actual acceleration monitoring		
9	ActualVelocityMonitoring	Actual velocity monitoring		
10	CommandValueQuantization	Quantization filter		
11	DecodingConfig	Command execution		
12	DistributedMotion	Distributed motion control		
13	Drift	Drift compensation		
14	DriveControlConfig	Drive-related settings		
15	EmergencyRampGenerator	Emergency stop ramp generator		
16	Extrapolation	Actual value smoothing		
17	FineInterpolator	Fine interpolator		
18	Friction	Friction compensation		
19	HWEndPos	Hardware limit switch		
20	Homing	Homing		
21	MaxAcceleration	Maximum acceleration		
22	MaxJerk	Maximum jerk		
23	MaxVelocity	Maximum velocity		
24	NeutralBand	Dead zone compensation		
25	NumberOfDataSets	Data sets for the controller configuration		
26	NumberOfEncoders	Configured encoders		
27	Encoder_1	Encoder 1		
28	AdaptDrive	Gear ratio of the measuring system for drive-...		
29	AdaptExtern	Gear ratio of the measuring system for extern...		
30	AdaptLoad	Gear ratio of the measuring system for load-si...		
31	AssemblyBase	Measuring system mounting type		
32	DriverInfo	Actual value interface		
33	Filter	Actual value filter		
34	FrequencyLimit	Measuring system limiting frequency		
35	encoderFrequencyLimit	Encoder limiting frequency	100000000.0	Hz
36	IncBackLash	Incremental measuring system backlash on re...		
37	IncHomingEncoder	Incremental measuring system homing		
38	InversCountDirection	Count direction inversion		
39	PathPerRevolution	Distance per revolution		

When using SIEMENS telegram 105 the fine resolution of the torque reduction (forceReductionGranularity) has to be set to **[0] STANDARD**.

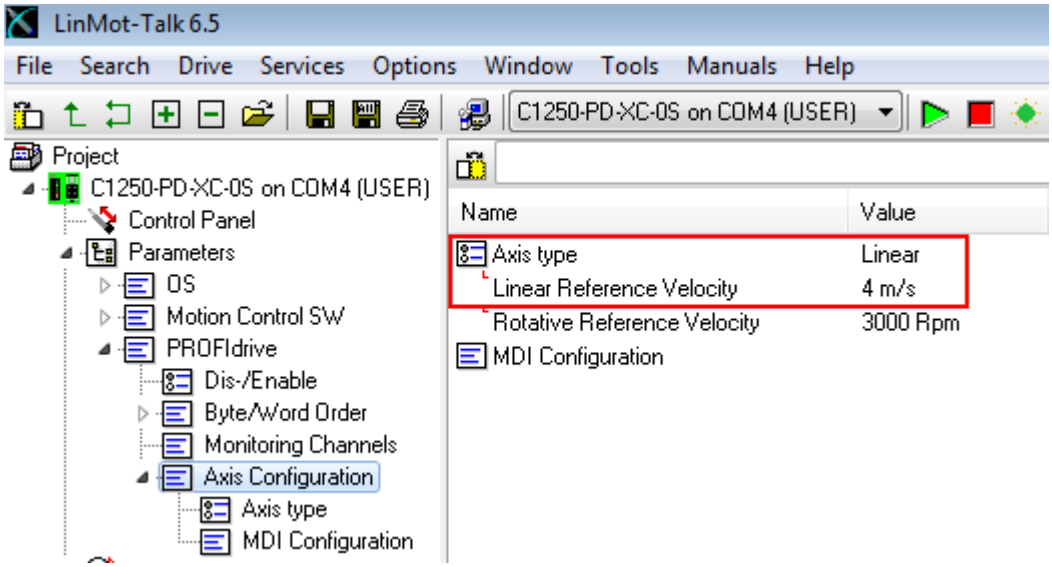
Configuration data -> TypeOfAxis -> SetPointDriverInfo -> LinearMotorDriveData -> forceReductionGranularity

Configuration data | System variables | selected parameters

	Parameter	Parameter text	Offline value	Unit
	All	All	All	All
6	⊞ Simulation	Process coupling		
7	⊟ TypeOfAxis	Axis type-specific configuration		
8	⊞ ActualAccelerationMonitoring	Actual acceleration monitoring		
9	⊞ ActualVelocityMonitoring	Actual velocity monitoring		
10	⊞ CommandValueQuantization	Quantization filter		
11	⊞ DecodingConfig	Command execution		
12	⊞ DistributedMotion	Distributed motion control		
13	⊞ Drift	Drift compensation		
14	⊞ DriveControlConfig	Drive-related settings		
15	⊞ EmergencyRampGenerator	Emergency stop ramp generator		
16	⊞ Extrapolation	Actual value smoothing		
17	⊞ FineInterpolator	Fine interpolator		
18	⊞ Friction	Friction compensation		
19	⊞ HWEndPos	Hardware limit switch		
20	⊞ Homing	Homing		
21	⊞ MaxAcceleration	Maximum acceleration		
22	⊞ MaxJerk	Maximum jerk		
23	⊞ MaxVelocity	Maximum velocity		
24	⊞ NeutralBand	Dead zone compensation		
25	⊞ NumberOfDataSets	Data sets for the controller configuration		
26	⊞ NumberOfEncoders	Configured encoders		
27	⊞ PathSyncAxisPosTolerance	Setpoint difference monitoring of the synchro...		
28	⊞ PositionMonitoring	Position monitoring		
29	⊞ ServoMonitoring	Activate control loop monitoring with active pr...		
30	⊟ SetPointDriverInfo	Drive interface		
31	⊞ InvertSetPoint	Direction of rotation adjustment		
32	⊟ LinearMotorDriveData	Drive characteristic values for linear motors		
33	forceReductionGranularity	Fine resolution of the torque reduction	[0] STANDARD	-
34	forceReference	Selection setting for the normalization: Refere...	[0] MAX_VALUE	-
35	maxForce	Maximum force	255.0	N

2.3 LinMot Drive Settings

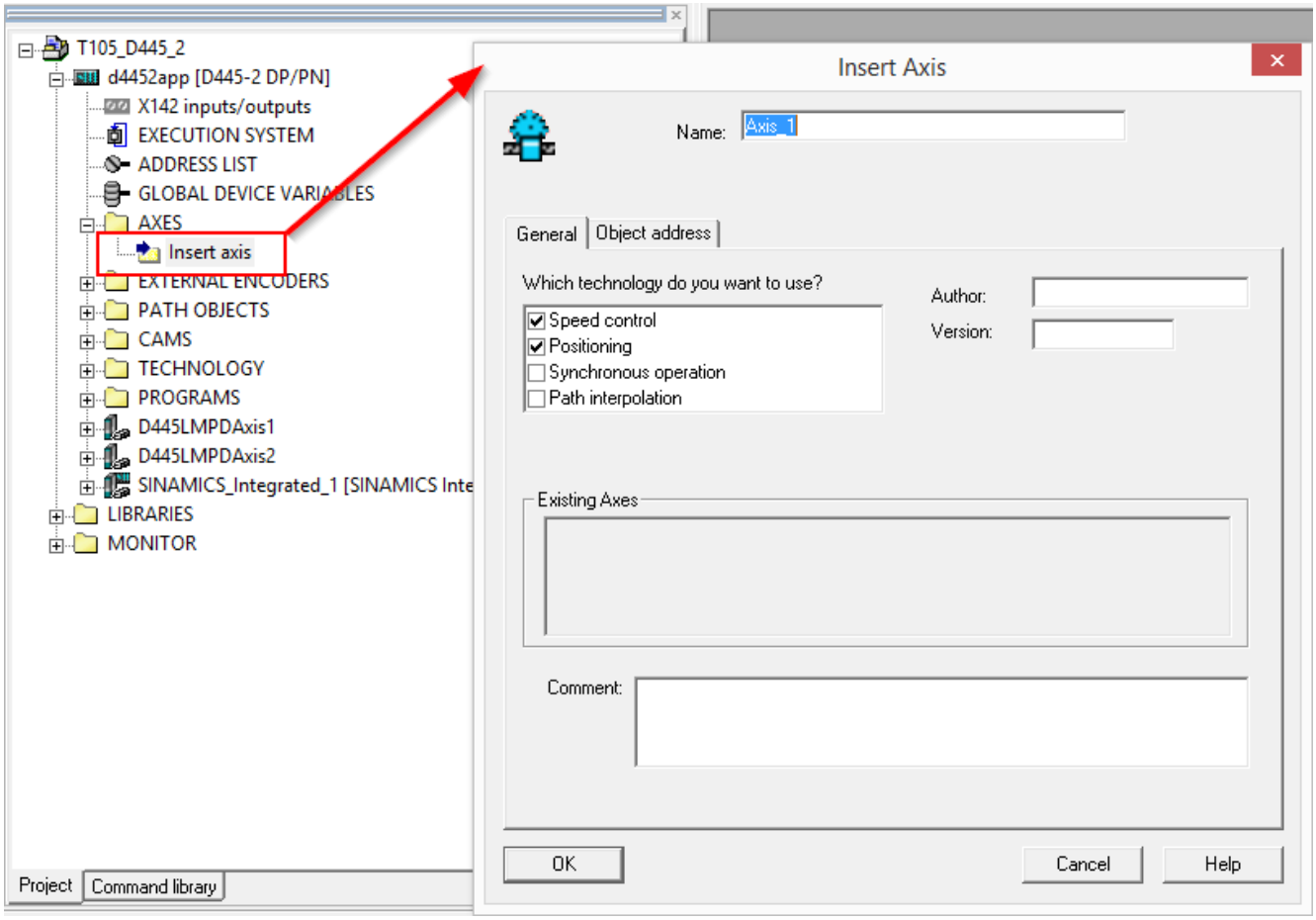
In chapter 2.1.2 the maximal motor velocity was set to 240m/min (4m/s).
To scale correctly the demand velocity sent from the SIMOTION to the LinMot drive the *Linear Reference Velocity* (linear motor) or *Rotative Reference Velocity* (rotary motor) respectively has to be set to the maximal velocity in the SIMOTION axis. As we use a linear motor in this example *Axis type Linear* has to be selected.



3 SIMOTION SCOUT (as Rotary Motor)

3.1 Insert a new axis

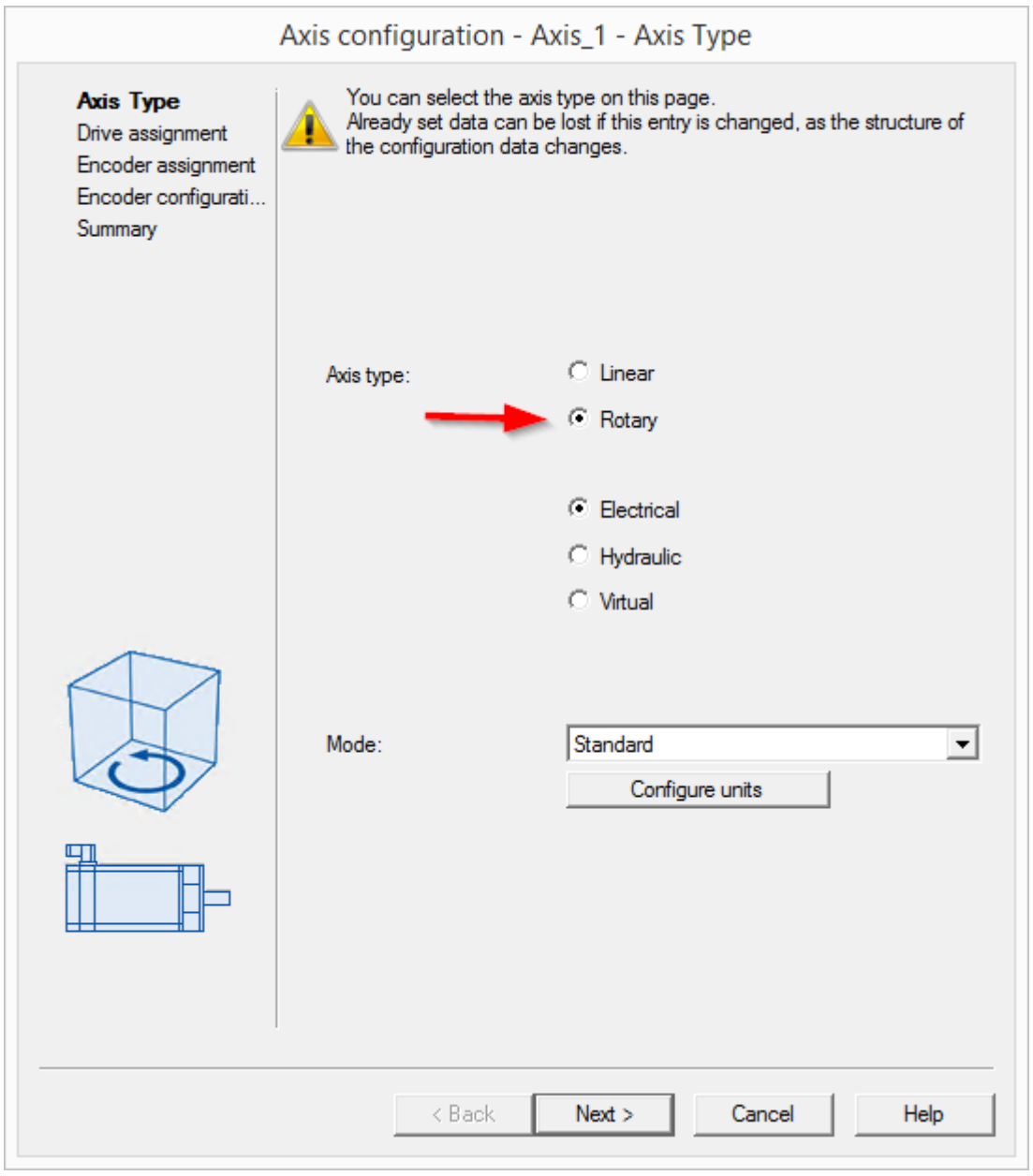
Double-click on Insert axis opens the Wizard:



After entering the name press OK to continue.

3.1.1 Axis Type

Set Axis Type to *Rotary*:



Afterwards continue with *Next*

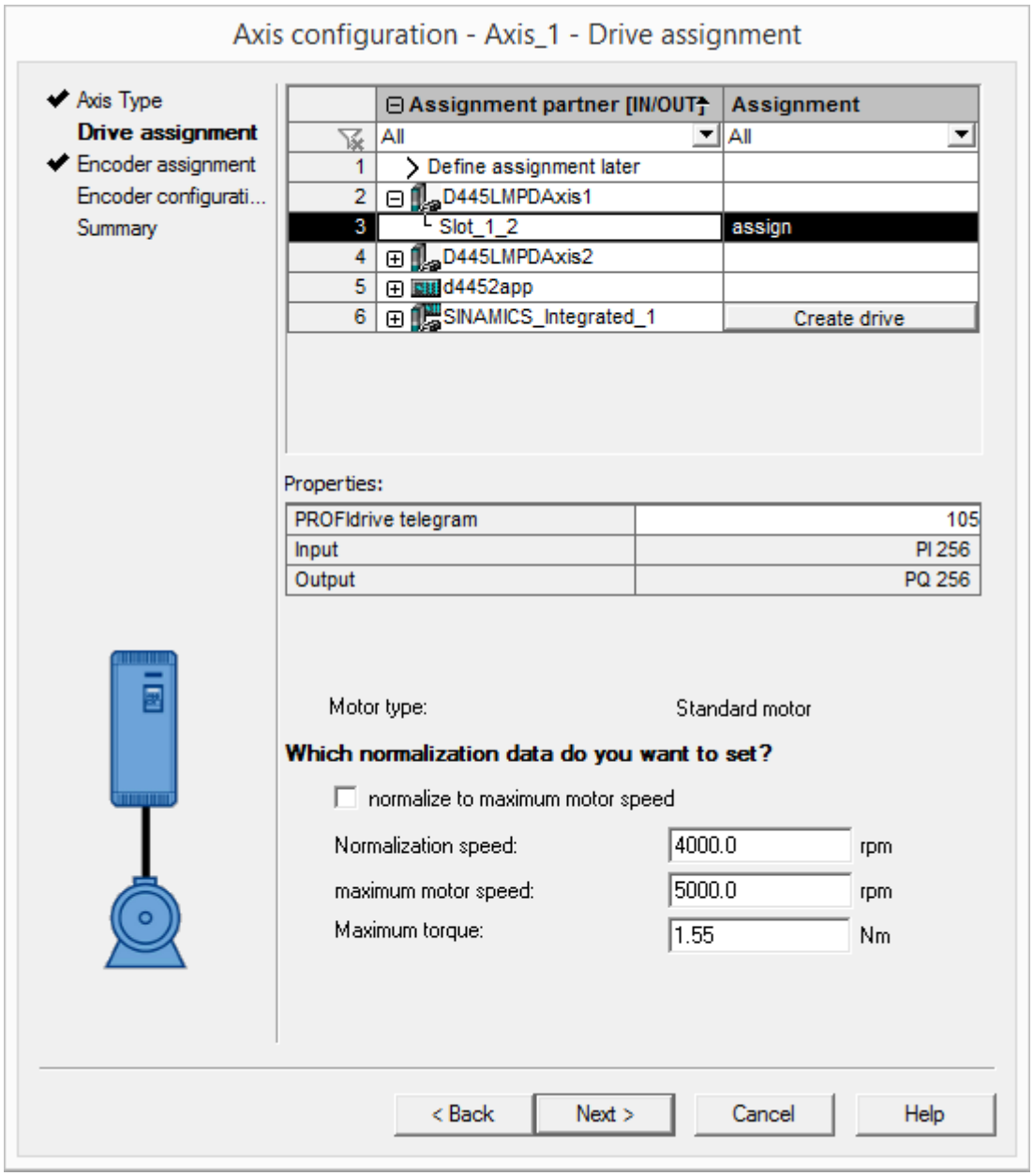
3.1.2 Drive Assignment

Assign the newly created axis to the LinMot drive.
In this example, a **LinMot EC02-40/140** motor is used (see data-sheet that can be found on http://shop.linmot.com)

- Set *Normalization speed* to 4000 1/min (motor depending -> see motor data sheet)
- Set *maximum motor speed* to 5000 1/min (motor depending -> see motor data sheet)

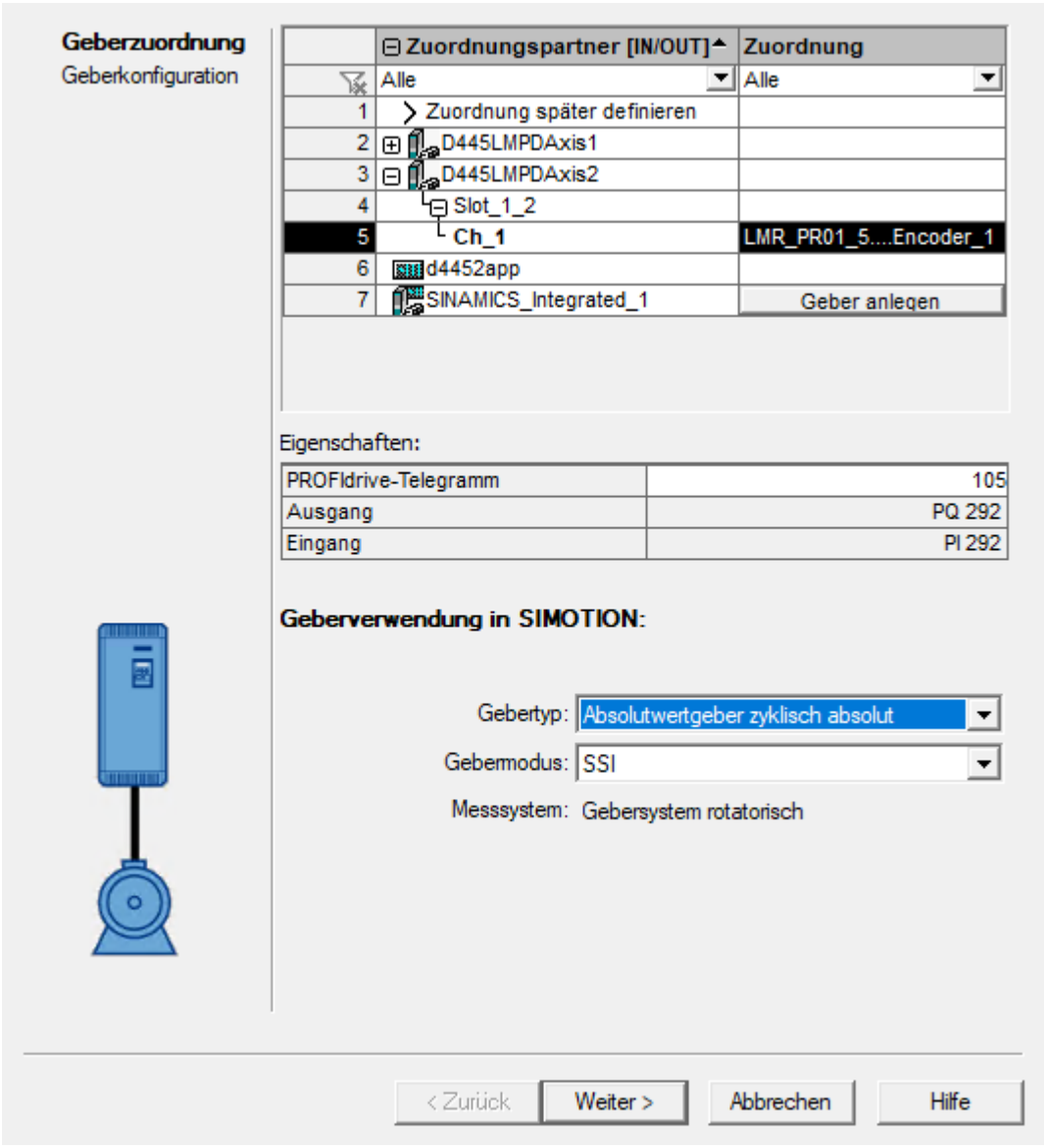
If PROFIdrive-telegram 105 (SIEMENS Telegram 105) is chosen, then additionally:

- Set *Maximum torque* to 1.55 Nm (motor depending -> see motor data sheet)



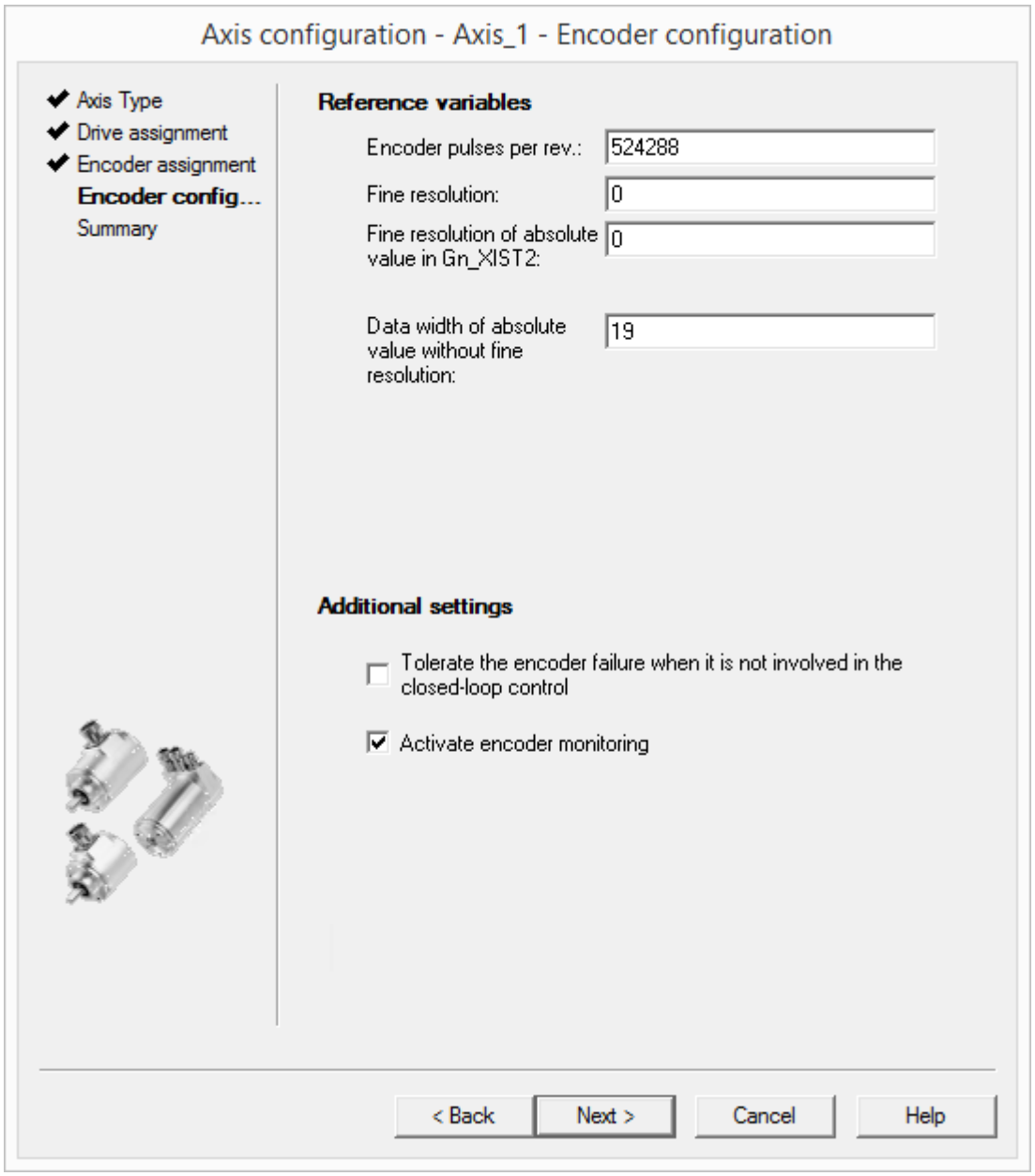
3.1.3 Encoder Assignment

Enc. type: Cyclic absolute encoder (**Important** as EC02 and PR01 hava single-turn encoder)
Encoder mode: SSI



3.1.4 Encoder Configuration

Encoder pulses per rev:	524288 (When using default settings on the LinMot drive)
Fine resolution:	0
Fine resolution of absolute…	0
Data width of absolute…	19



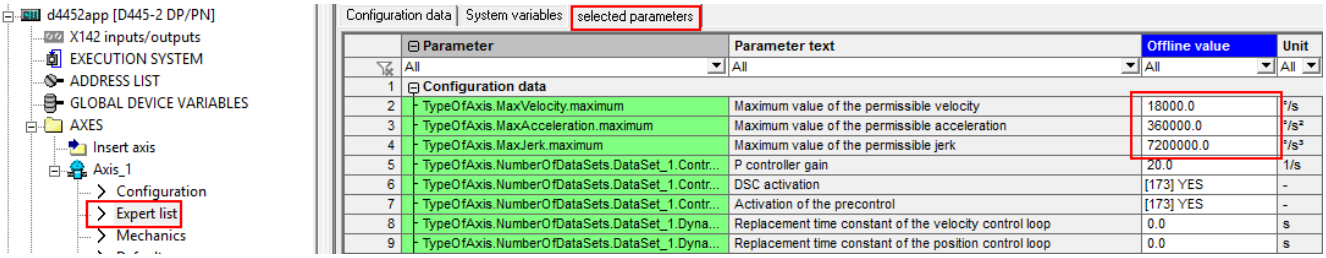
Finish the wizard by pressing *Next* and then *Finish*

Note:
If the rotary part of a LinMot linear rotary motor (**PR01**-…) is setup the **Encoder pulses per rev** has to be set to **360000** (When using default settings on the LinMot drive)

3.2 Setup the Axis Parameters

The following axis parameters have to be setup.

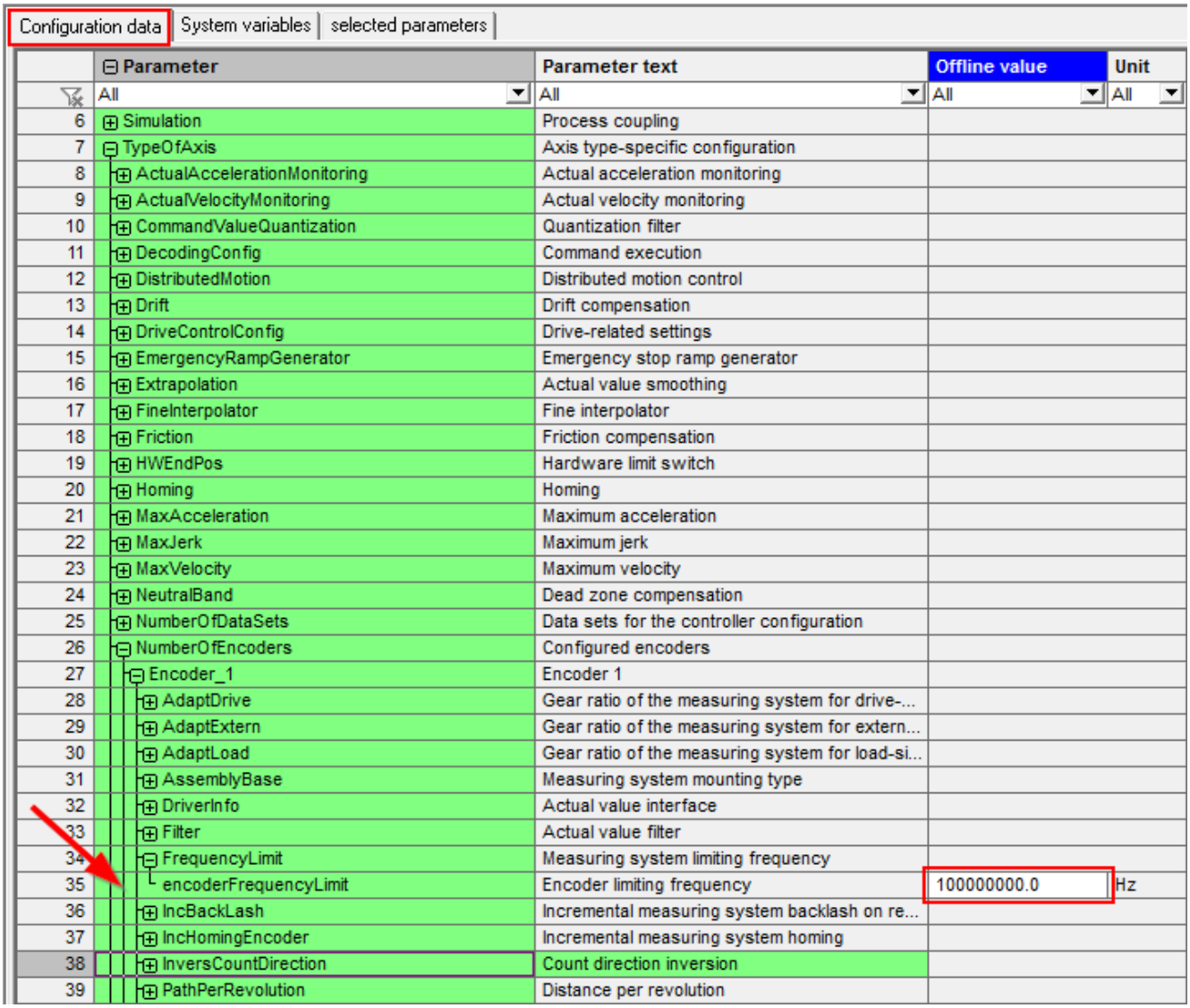
Select “Expert list -> selected parameters” to set the dynamics of the motor:



Increase the frequency limit of the encoder:

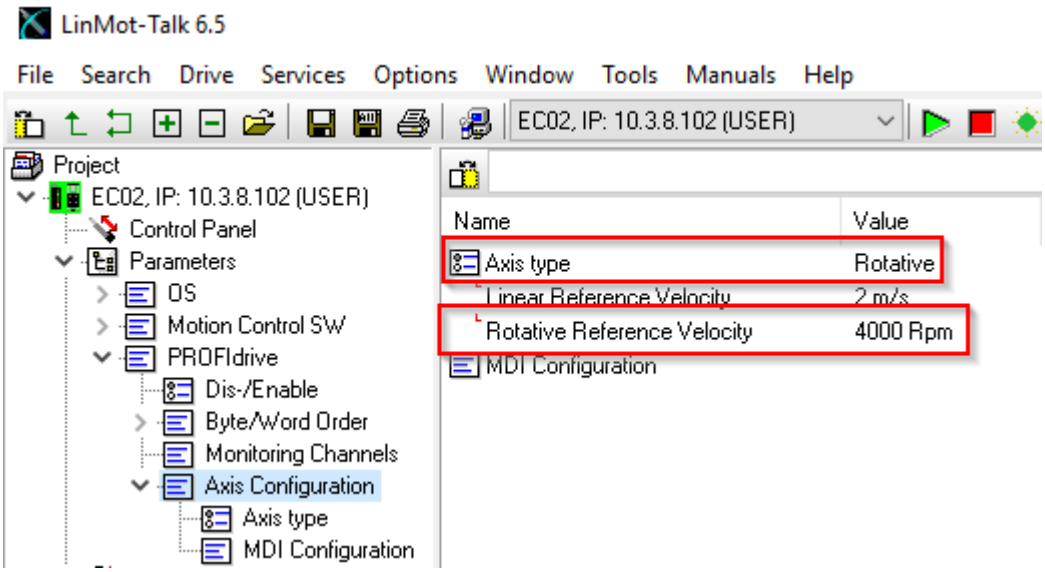
Configuration data -> TypeOfAxis -> NumberOfEncoders -> Encoder_1 -> FrequencyLimit -> encoderFrequencyLimit

-> 1000000000.0



3.3 LinMot Drive Settings

In chapter 3.1.2 the *Normalization speed* was set to 4000 rpm.
To scale correctly the demand velocity sent from the SIMOTION to the LinMot drive *Rotative Reference Velocity* (rotary motor) has to be set to the normalization speed in the SIMOTION axis. As we use a rotary motor in this example *Axis type Rotative* has to be selected.

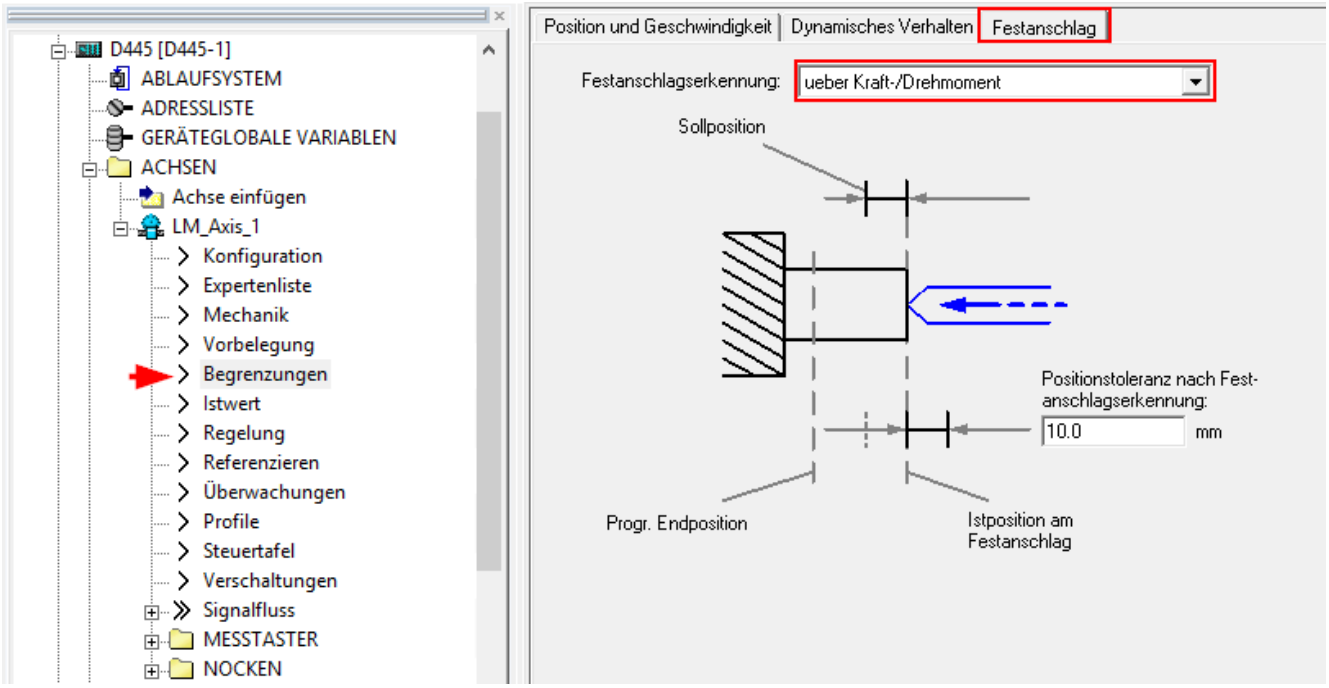


4 Homing

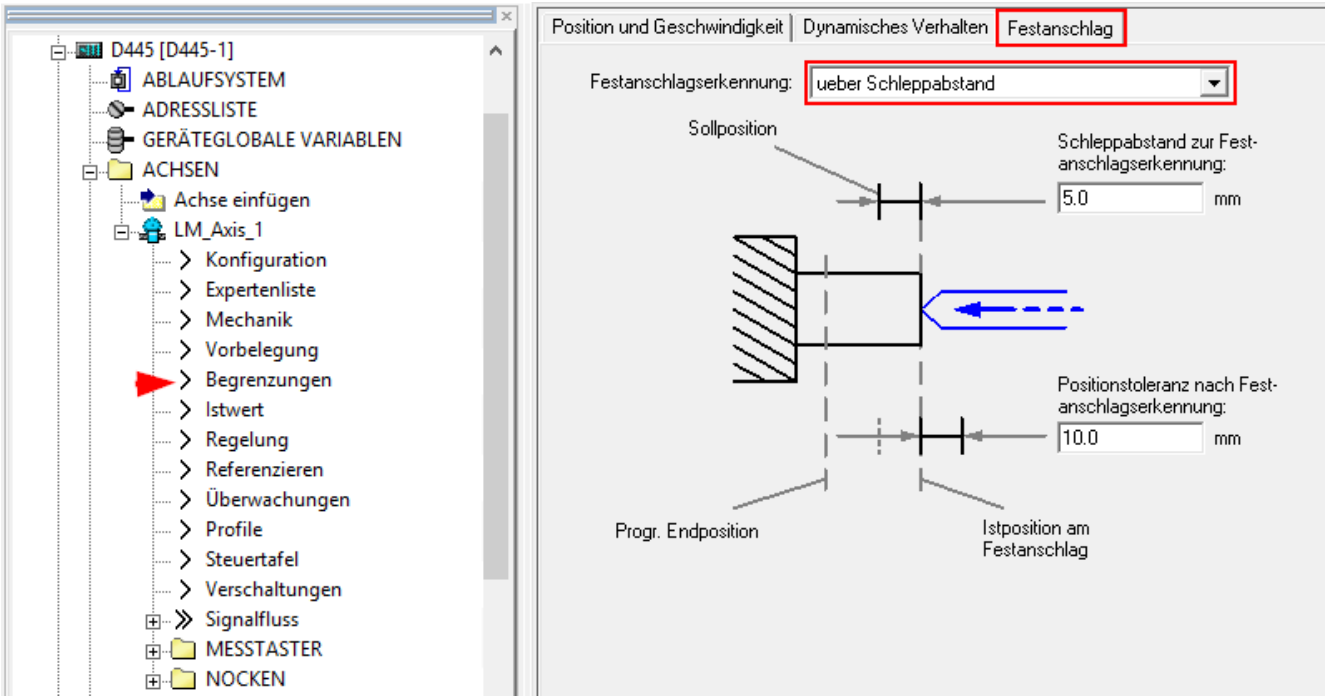
The reference move can be realised using the moving to end stop function (Via force/torque or Via following error), or by an external switch.

Note:
This is not required for motors with absolute feedback (e.g. LinMot EC02 or LinMot RS01)

4.1 Moving to End Stop (Via force/torque), recommended with Siemens Telegram 105



4.2 Moving to End Stop (Via following error), recommended with Standard Telegram 5



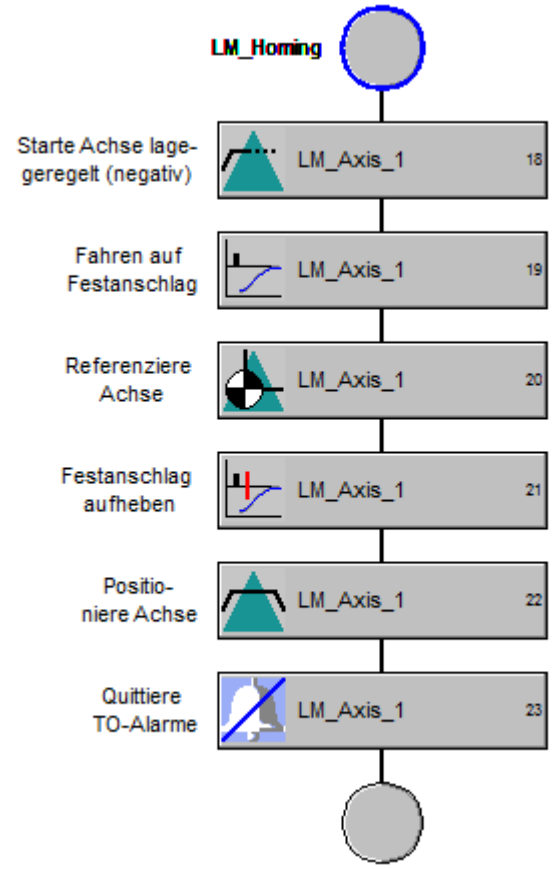
Konfigurationsdaten | Systemvariablen | ausgewählte Parameter

	Parameter	Parametertex	Offlinewert	Einheit	Datentyp
	Alle	Alle	Alle	Alle	Alle
101	swLimitState	Status SW-E...			
102	torqueLimitNegative	Programmiert...			
103	torqueLimitNegativeIn	Eingangs-Int...			
104	torqueLimitPositive	Programmiert...			
105	torqueLimitPositiveIn	Eingangs-Int...			
106	torqueLimitingCommand	Bearbeitung...			
107	typeOfAxis	Achseinstell...	[112] REAL_AXIS	-	'EnumAxisOperatingMode' = enum/DINT
108	userDefaultClamping	Anwenderv...			
109	clampingValue	Klemmwert	5.0	-	LREAL
110	userDefaultDynamics	Anwenderv...			
111	direction	Richtungsan...	[107] POSITIVE	-	'EnumDirection' = enum/DINT

4.3 Example Sequence for Homing using the Moving to End Stop Function (MCC):

The following MCC chart is part of the example program.

Basically the axis is moved in negative/positive direction und the end stop is detected. Afterwards the axis is referenced and moved away from the end stop.



With clamping value (e.g. 50%)

Set reference position (e.g. -5mm)

Move away from end stop (e.g. to 0mm)

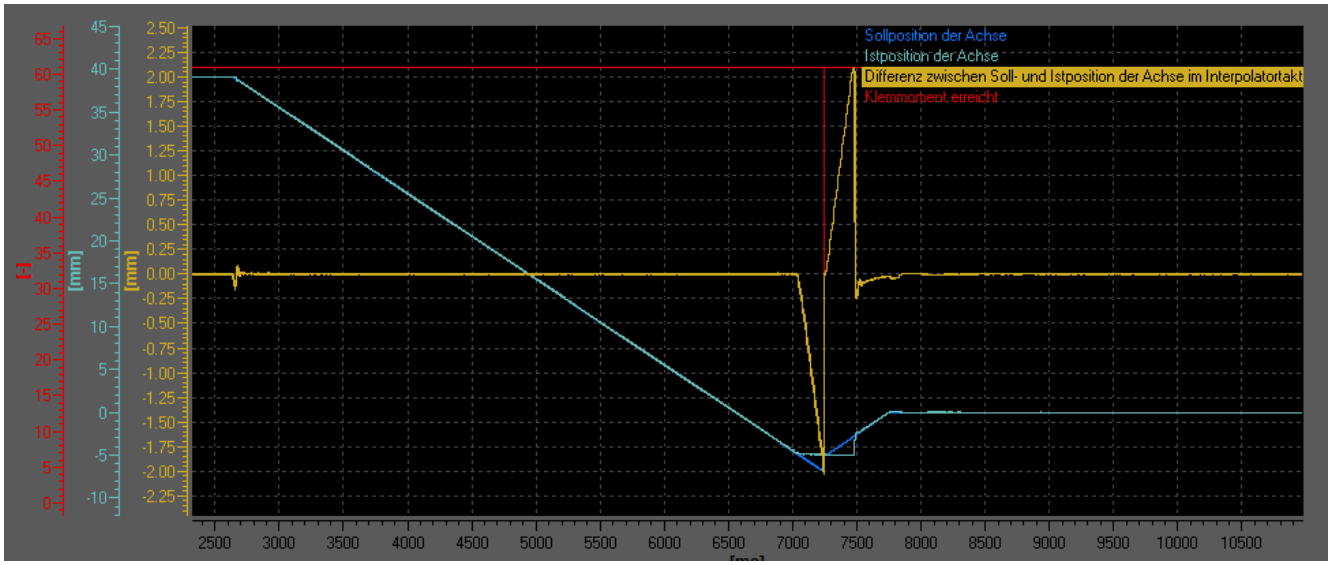
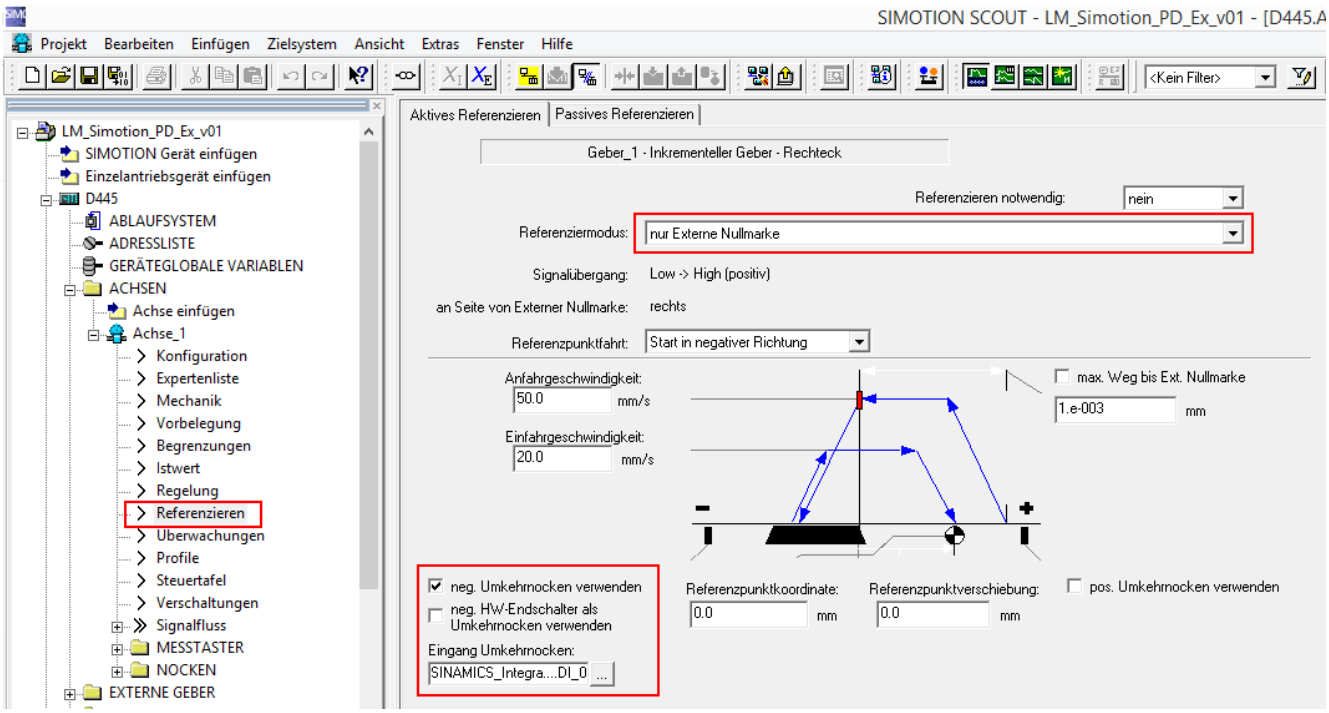


Figure 1: Homing the axis with moving to end stop (Via force/torque)

4.4 Homing using an External Switch

If you want to do the reference move using an external switch the settings for doing this could look as follows:



5 Parameter Access

5.1 Read RAM Value of Drive Parameter

Read access to the RAM value of a LinMot drive parameter can be done using the function *_readDriveParameter()*. To the UPID an offset of 16#2000 has to be added.

Example: To read the LinMot parameter with UPID 16#13A6 (Maximal Current) the input **parameterNumber** of the function must be set to 16#13A6 + 16#2000 = **16#33A6**.

Implementation example:

```
PROGRAM readDriveRAMParameter
    VAR
        bParameterRead : BOOL;
        uiUPIDParameterRead : UINT;
        stRetParameterRead : StructRetReadDriveParameter;
        diValueParameterRead : DINT;
        CmdID : CommandIDType;
    END_VAR
    //*************************************************
    // Drive Parameter Access (Read Parameter RAM value by UPID)
    //*************************************************
    IF bParameterRead THEN
        stRetParameterRead :=
        _readDriveParameter(
            logAddress:= 16365, //Address of the Parameter Access Point of the drive -> See HW Config > Select Drive > Slot 1.1
            parameterNumber:= 16#2000 + uiUPIDParameterRead, //16#2000 + UPID -> e.g. 16#2000 + 16#13A6 (maximal current) = 16#33A6
            nextcommand:=IMMEDIATELY,
            commandid:=CmdID
            );

         IF (stRetParameterRead.functionResult = 0) THEN
            bParameterRead := FALSE;
            diValueParameterRead := BIGBYTEARRAY_TO_ANYTYPE(stRetParameterRead.data,0);
         END_IF;
    END_IF;
END_PROGRAM
```

5.2 Write RAM Value of Drive Parameter

Write access to the RAM value of a LinMot drive parameter can be done using the function *_writeDriveParameter()*. To the UPID an offset of 16#2000 has to be added.

Example: To write the LinMot parameter with UPID 16#13A6 (Maximal Current) the input **parameterNumber** of the function must be set to 16#13A6 + 16#2000 = **16#33A6**.

Implementation example:

```
PROGRAM writeDriveRAMParameter
    VAR
        bParameterWrite : BOOL;
        uiUPIDParameterWrite : UINT;
        stRetParameterWrite : StructRetWriteDriveParameter;
        diValueParameterWrite :DINT;
        CmdID : CommandIDType;
    END_VAR
    //*************************************************
    // Drive Parameter Access (Write parameter RAM value by UPID)
    //*************************************************
    IF bParameterWrite THEN
        stRetParameterWrite :=
        _writeDriveParameter(
            logAddress:= 16365, //Address of the Parameter Access Point of the drive -> See HW Config > Select Drive > Slot 1.1
            parameterNumber:= 16#2000 + uiUPIDParameterWrite, //16#2000 + UPID -> e.g. 16#2000 + 16#13A6 (maximal current) = 16#33A6
            nextcommand:=IMMEDIATELY,
            commandid:=CmdID,
            datalength:=DINT_TO_UDINT(_sizeof(diValueParameterWrite)),
            data:=ANYTYPE_TO_BIGBYTEARRAY(diValueParameterWrite,0)
            );

        IF (stRetParameterWrite.functionResult = 0) THEN
            bParameterWrite := FALSE;
        END_IF;
    END_IF;
END_PROGRAM
```

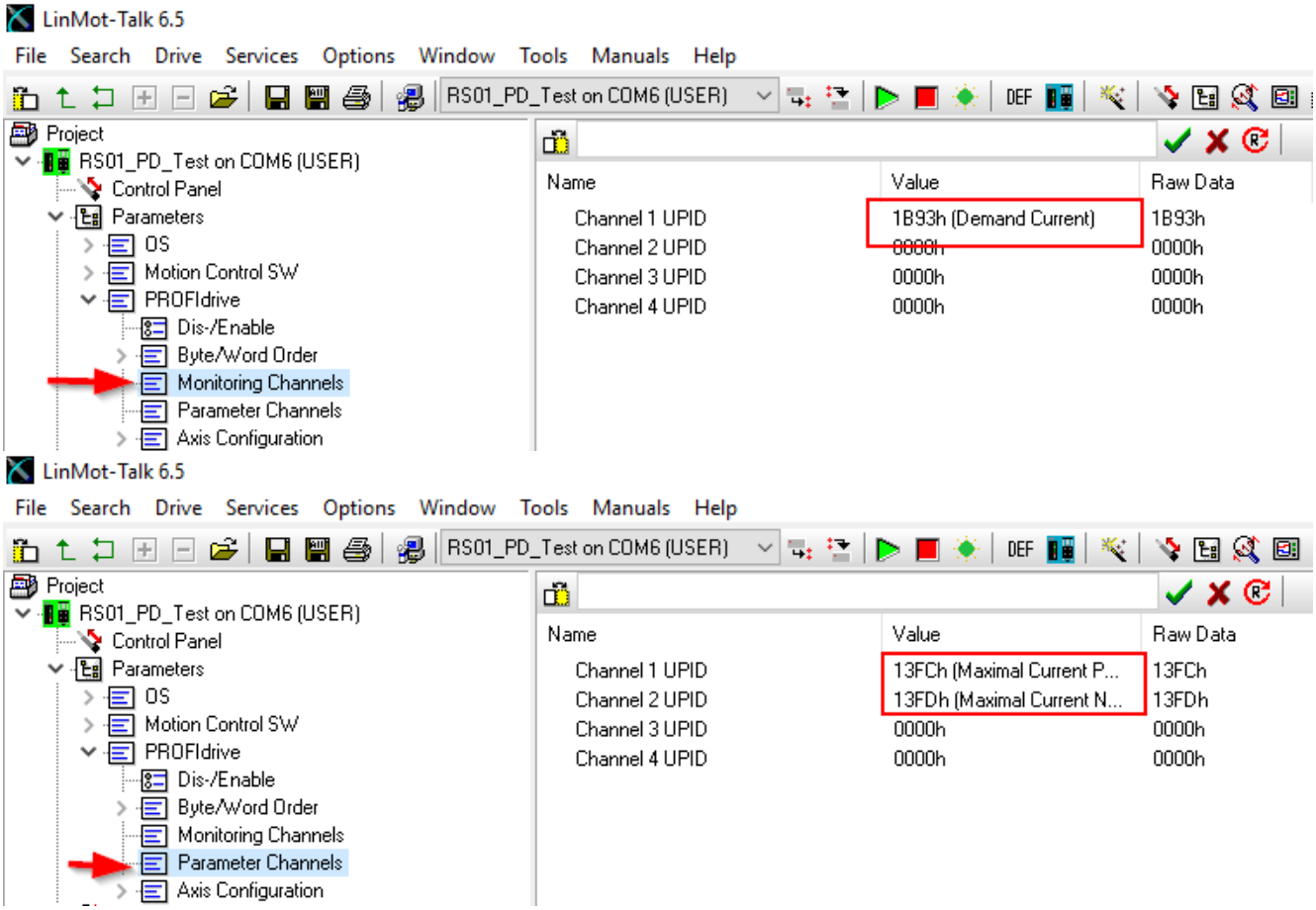
6 Adding Additional Parameters/ Variables to the Real Time Channel

It is possible to add additional parameters or variables of the drive to the real time channel to allow read and write access. There are 4 channels from the Drive to the PLC (32Bit each, Mon Channel 1-4) and 4 channels from the PLC to the Drive (32Bit each, Par Channel 1-4) available.

6.1 Drive Configuration

In LinMot-Talk the UPID (parameter/variable address) is entered in the particular channel.

As example in Monitoring Channel 1 the UPID *1B93h (Demand Current)* and in Parameter Channel 1 & 2 the UPID *13FCh (Maximal Current Positive)* and *13FDh (Maximal Current Negative)* are entered.



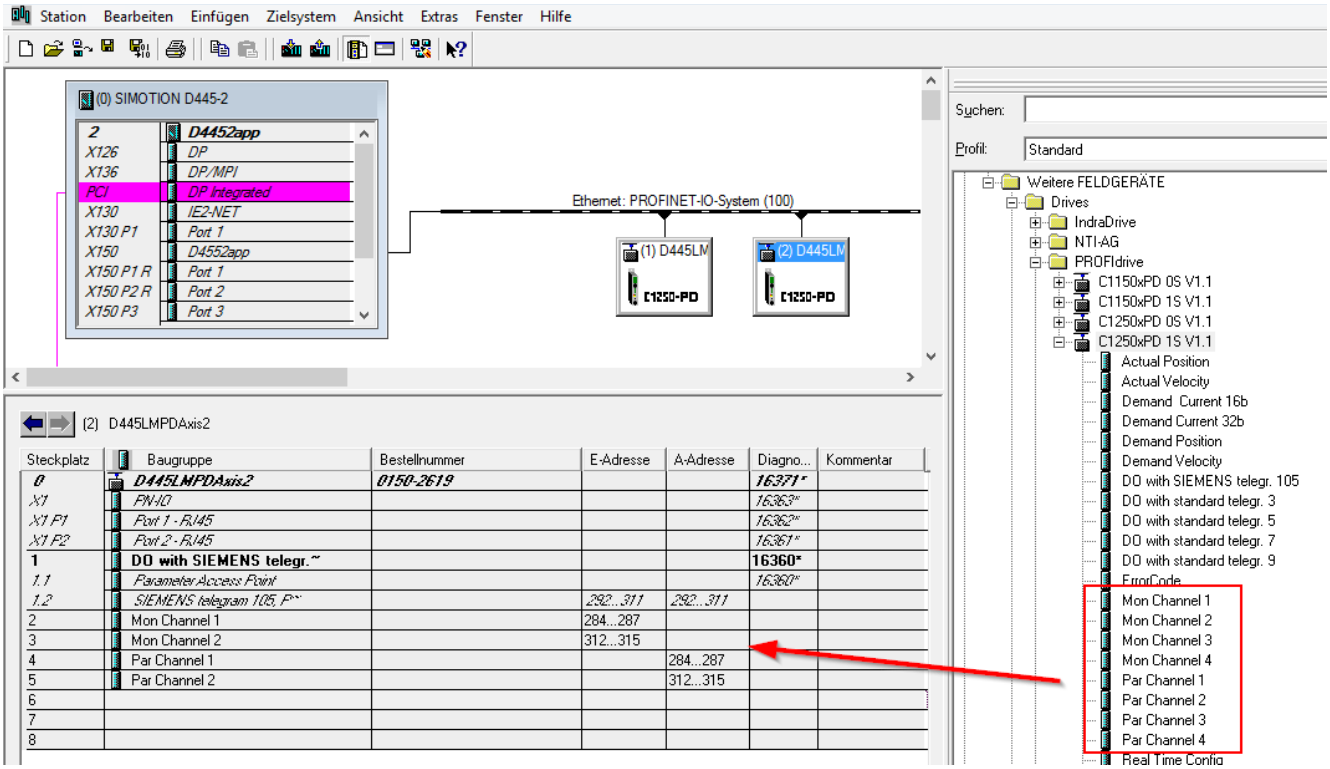
Attention:
The above used parameters are thought to be an example only.

If the parameters in Parameter Channel 1 & 2 have a value of 0 the motor cannot move as they limit the maximal allowed positive and negative motor current in the drive.

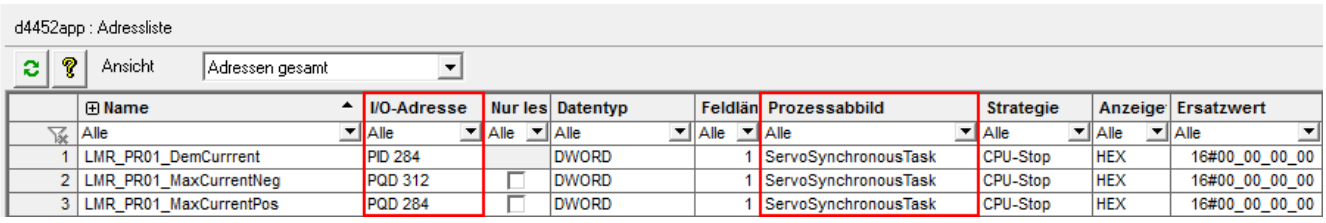
Note:
On Siemens PLCs the double words are transmitted in big endian organization. Therefore, it is required to swap the high and the low word.
This can be done by using the function ROR().
E.g. *DemandCurrent:=**ROR(**DemandCurrent,16);*

6.2 PLC Configuration

In the HW Config drag&drop the desired modules from the catalogue to the slots of the drive:



In SCOUT add new variables that access the addresses of the modules:

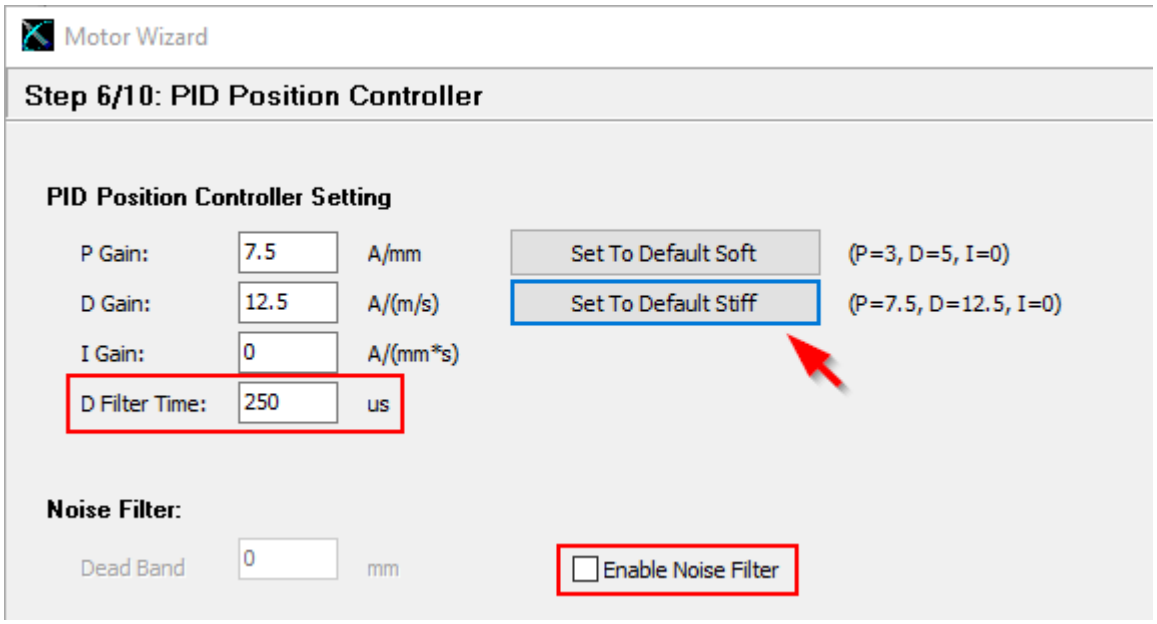


	Name	I/O-Adresse	Nur les	Datentyp	Feldlän	Prozessabbild	Strategie	Anzeige	Ersatzwert
	Alle	Alle	Alle	Alle	Alle	Alle	Alle	Alle	Alle
1	LMR_PR01_DemCurrrent	PID 284		DWORD	1	ServoSynchronousTask	CPU-Stop	HEX	16#00_00_00_00
2	LMR_PR01_MaxCurrentNeg	PQD 312		DWORD	1	ServoSynchronousTask	CPU-Stop	HEX	16#00_00_00_00
3	LMR_PR01_MaxCurrentPos	PQD 284		DWORD	1	ServoSynchronousTask	CPU-Stop	HEX	16#00_00_00_00

7 Tuning the Control Loops

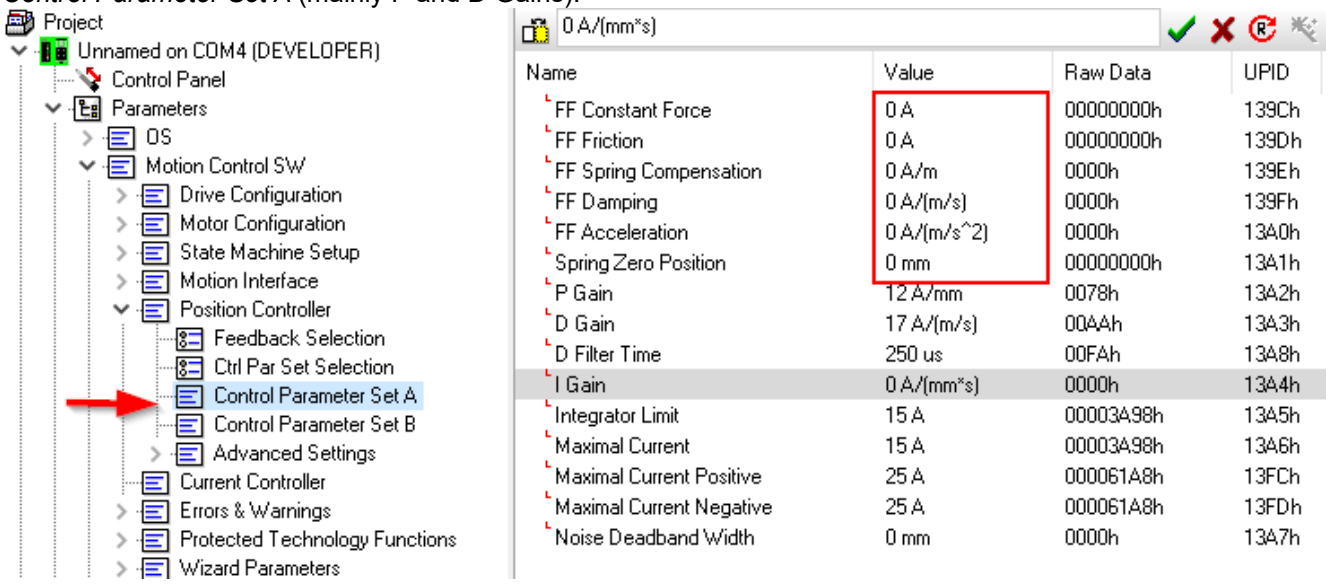
7.1 Drive Control Loop

To start tuning use the **default soft** settings in the Motor Wizard within LinMot-Talk (motor depending).
Then during operation increase the P and D Gains until you get a good positioning.
It is also possible to start with the default stiff settings. But in case the motor becomes loud and vibrates reduce the P and D Gains.



Make sure the “Enable Noise Filter” is unchecked. If the motor makes too much noise try to set the D Filter Time to 250us.

After finishing the motor wizard and restarting the drive, the control loop parameters can be tuned in the *Control Parameter Set A* (mainly P and D Gains):



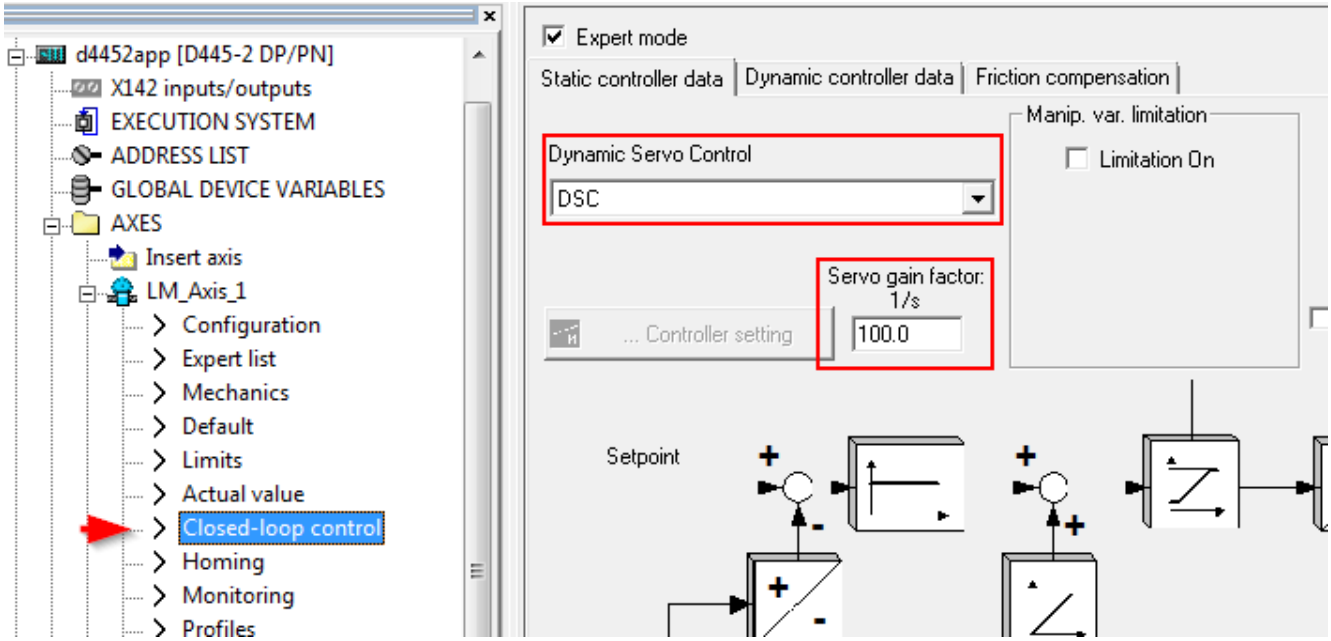
It's recommended to set all FF parameters except *FF Constant* Force to 0 in the beginning. They can be increased afterwards to improve the start/stop of the motion. Or just leave them on the values preset by the Motor Wizard and check if they work for you application.

Attention:
Up to firmware 6.6 Build 20170410 the I Gain in the Control Parameters Set A of the LinMot drive must be set to 0 (zero).

From firmware 6.6 Build 20170522 the I-Gain must be set to a value to exactly reach the end position.

7.2 PLC Control Loop

Within the technology object configuration set the servo gain factor (Kv factor) to 100.
From this value increase until you reach the required stiffness and accuracy.



Make sure DSC is enabled.

Now you are ready to enable the motor and start some movements to optimize the control parameters in both the drive and the PLC

8 Version History

Version	Date	Author	Description
1V0	05 Jul 2017	fj	First Release
1V1	18 Feb 2020	fj	Updated chapter Encoder Assignment

Notes

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