LinMot®

EtherCAT®

Documentation of the EtherCAT SoE Interface of the following Drives:

- **C1150-SE-XC-0S/1S**
- **C1250-SE-XC-0S/1S**
- **E1250-SE-UC**
- **E1450-SE-QN-0S/1S**

EtherCAT SoE Interface

User Manual

Document version 6.4 / Whp, October 2015

1. System overview

EtherCAT is the open real-time Ethernet network originally developed by Beckhoff. The LinMot act as Slave in this network and is implemented with the standard ASIC ET1100 from Beckhoff. With the SoE (Sercos over Ethernet) Protocol it is possible to use the Sercos functionality over the EtherCAT bus, the drive behaves as a Sercos drive.

For further information on the EtherCAT fieldbus please visit:
http://www.ethercat.org/

1.1 References

All user manuals are distributed with the LinMot-Talk software the newest versions can be downloaded from the LinMot homepage in the download section.

Ref	Title	Source
1	User Manual Motion Control SW	www.linmot.com
2	LinMot Drive Configuration over Fieldbus Interfaces SG5	www.linmot.com

1.2 Connecting In and Out

In the EtherCAT the cabling is directed due topology support, so In and Out is different! The real time Ethernet RJ45 connector X17 is the input and the real time RJ45 connector X18 is the output.

2. Setup in the PLC

In the following steps the integration of a LinMot EtherCAT Sercos Servo Drive in the PLC is described. In the example a Beckhoff master PLC is used. The easiest way is the online configuration when the device is connected to the EtherCAT network.

2.1 Copy Device Description File

The LinMot Servo Drive is described with *.xml device description file distributed with the LinMot-Talk software. This file is only used when offline configuration is desired.

Copy this file to PLC so it can access it.

Example Source path of EtherCAT Device description file:

C:\Programme\LinMot\LinMot-Talk 6.2 Build 20140915\Firmware\Interfaces\EtherCAT\XML\ NTIL_SoE_Servos_V1_2.xml

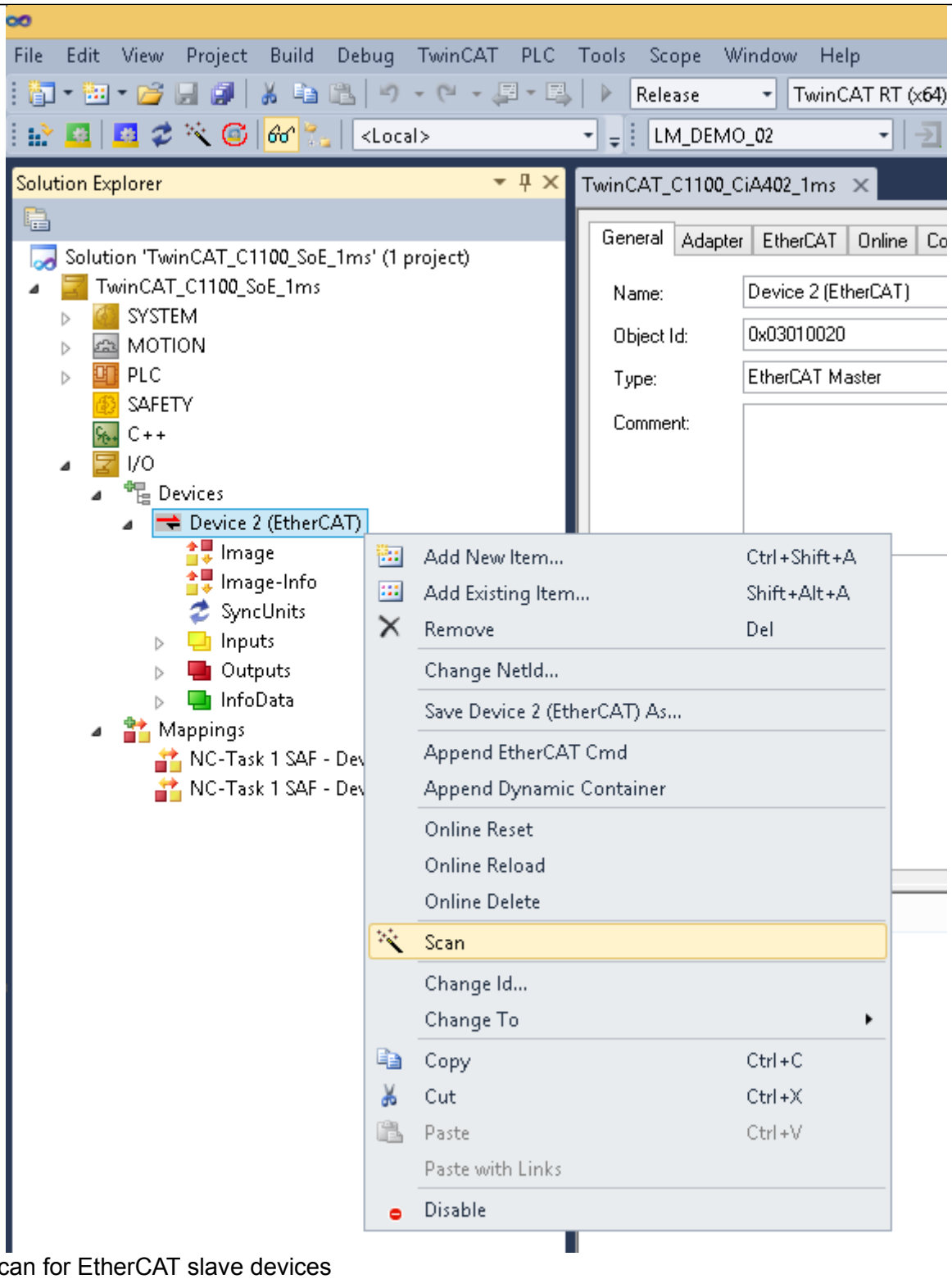
Example Destination path of EtherCAT Device description file:

C:\TwinCAT\Io\EtherCAT\ NTIL_SoE_Servos_V1_2.xml (for TwinCAT version 2)
C:\TwinCAT\3.1\Config\Io\EtherCAT NTIL_SoE_Servos_V1_2.xml (for TwinCAT version 3)

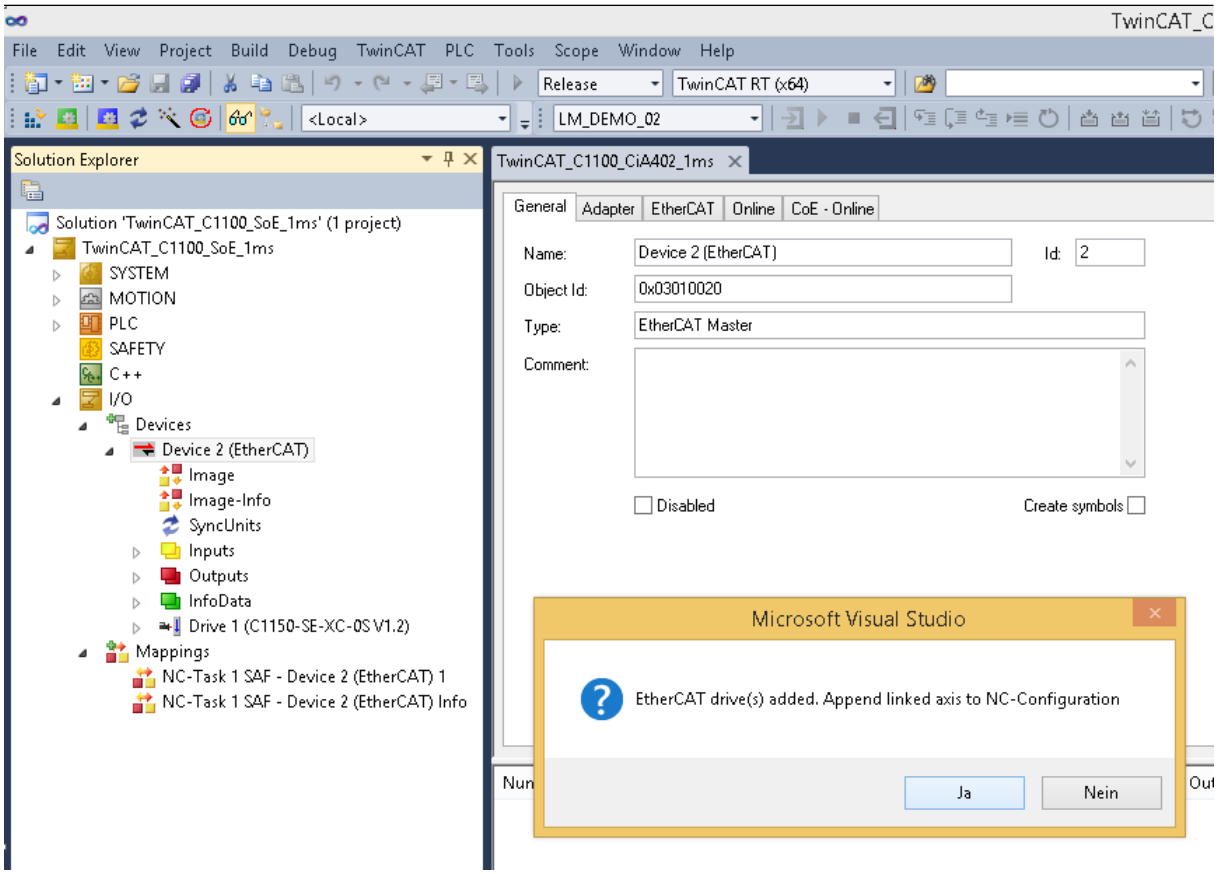
If this is done the PLC should recognize the corresponding LinMot drives on the EtherCAT fieldbus automatically.

2.2 Scan the EtherCAT slave devices

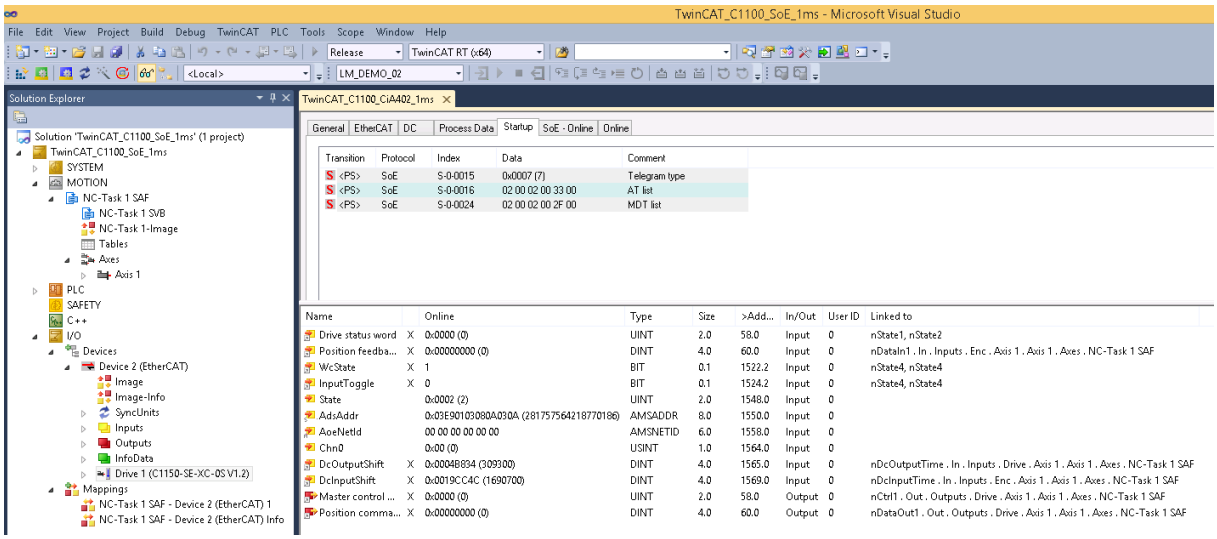
Connect the EtherCAT LinMot CiA402 Servo Drive to the EtherCAT-Master and power on the signal supply. Then scan for the connected devices in the System Manager:



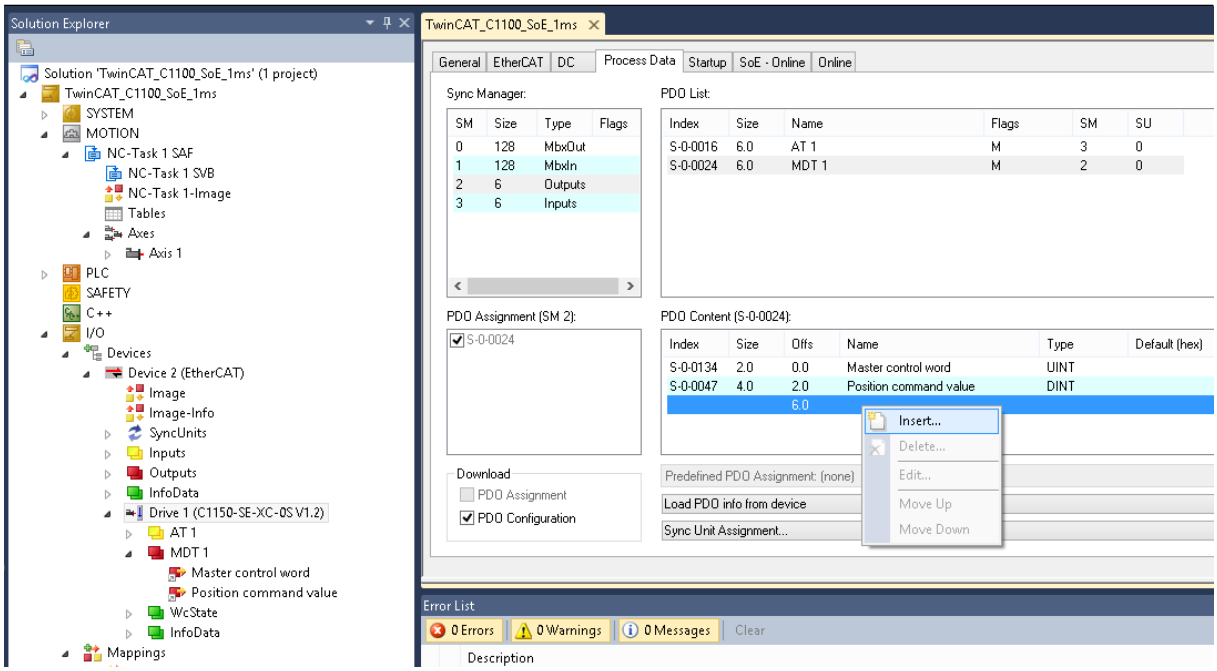
Scan for EtherCAT slave devices



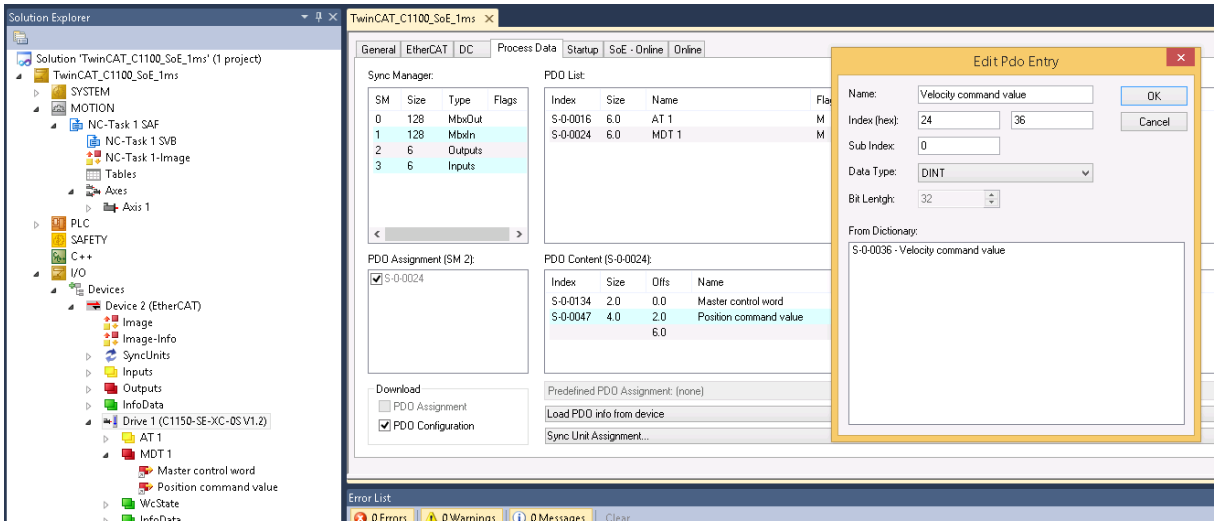
With the question Add drives to NC-configuration select yes.



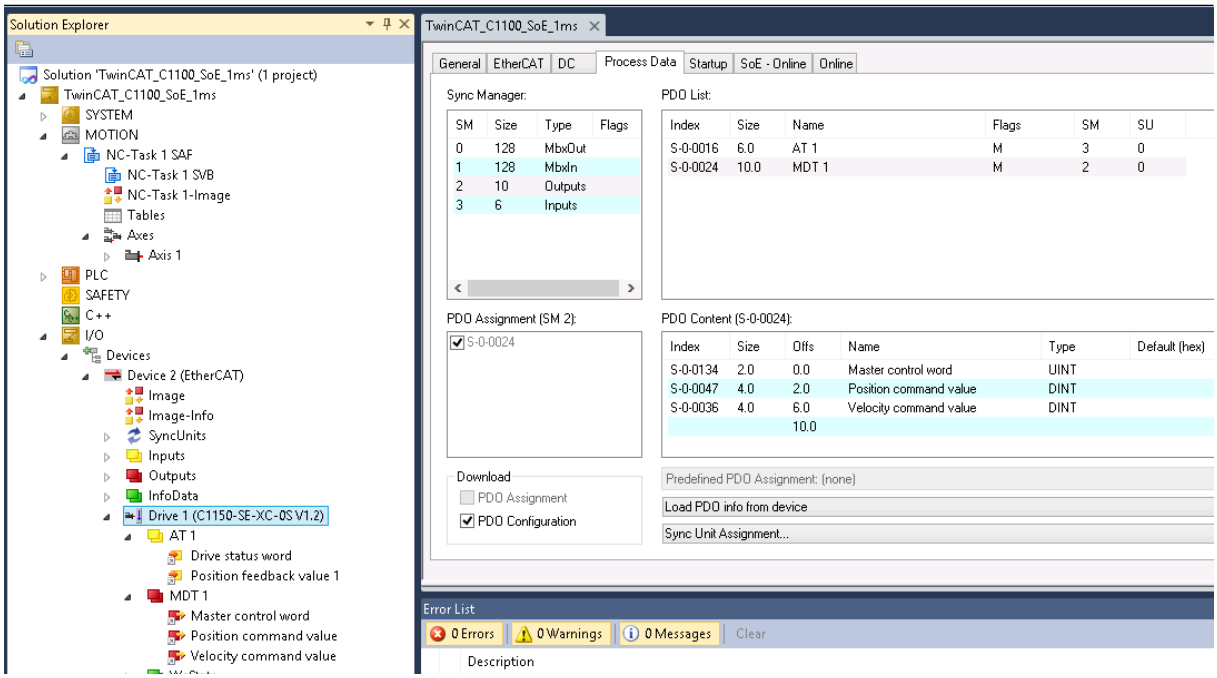
These steps add the servo drive and its NC-axis to the project.



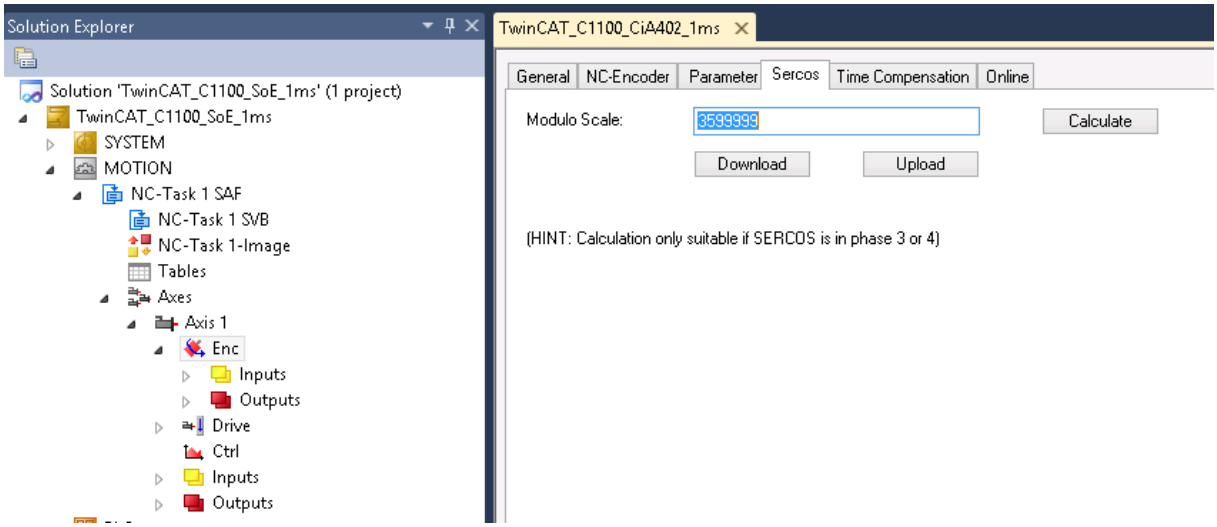
If the master also supports also the mapping Velocity command value it is strongly recommended to add this to MDT1 data.



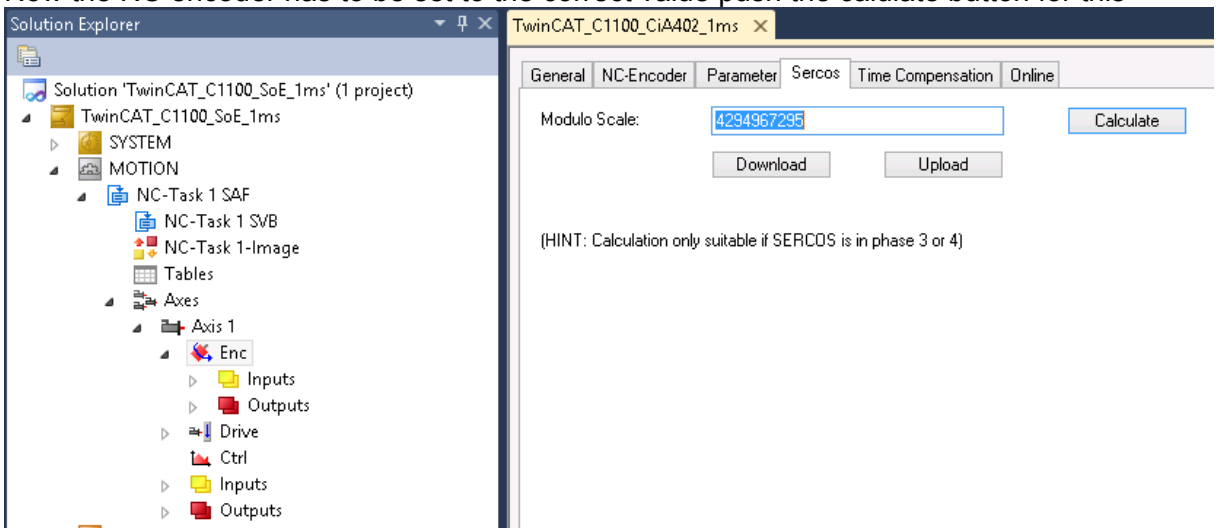
Add the Velocity command value by selecting it from the dictionary



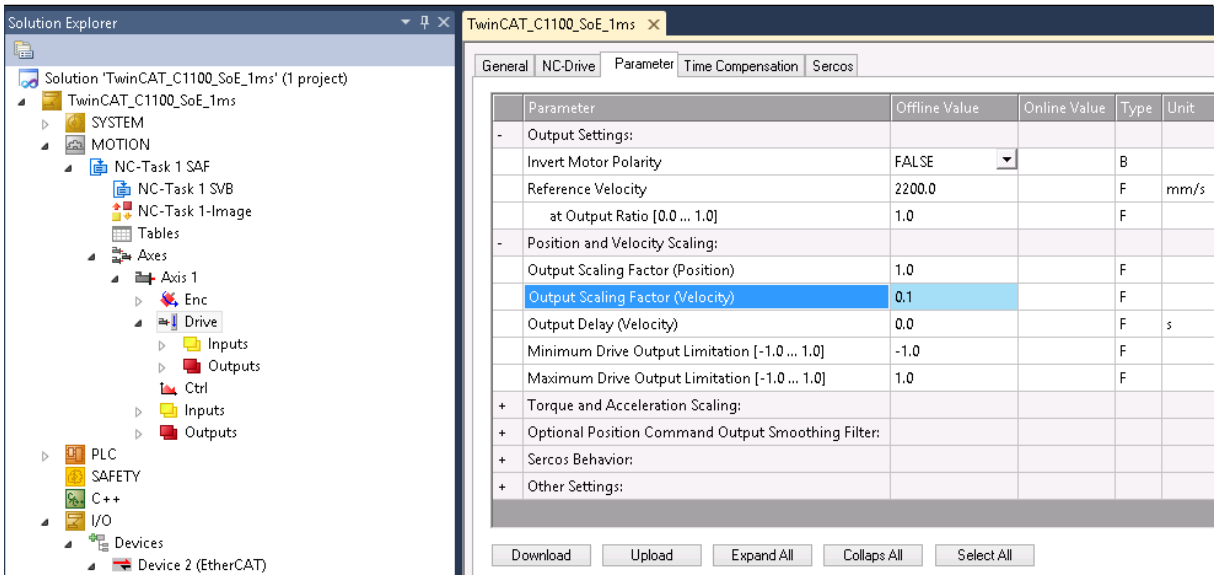
MDT1 telegram with added Velocity command value



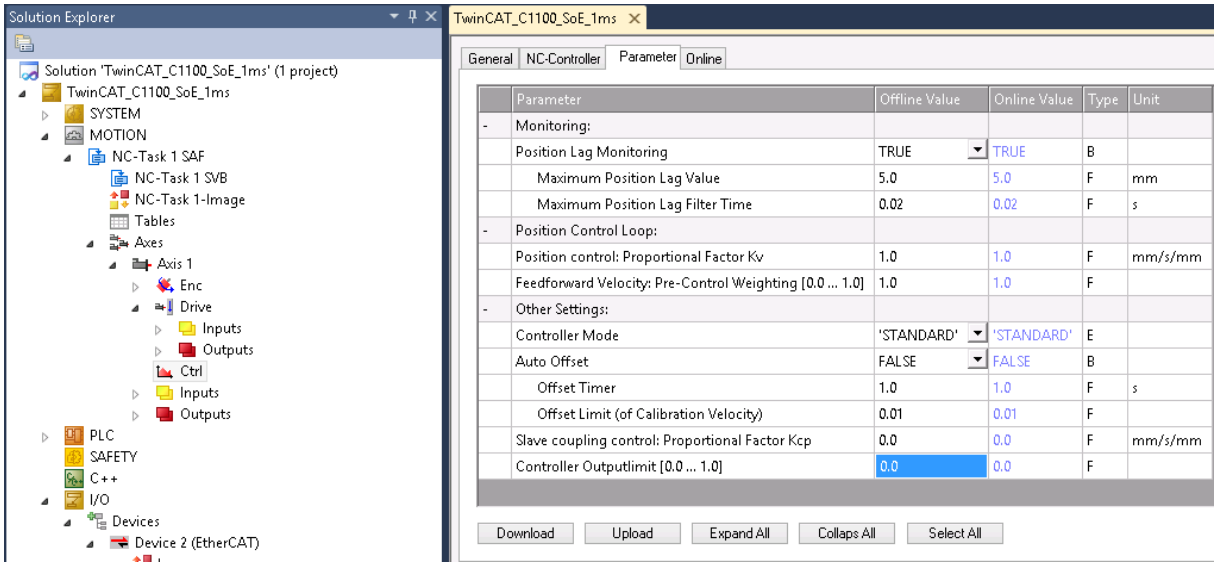
Now the NC encoder has to be set to the correct value push the calulate button for this



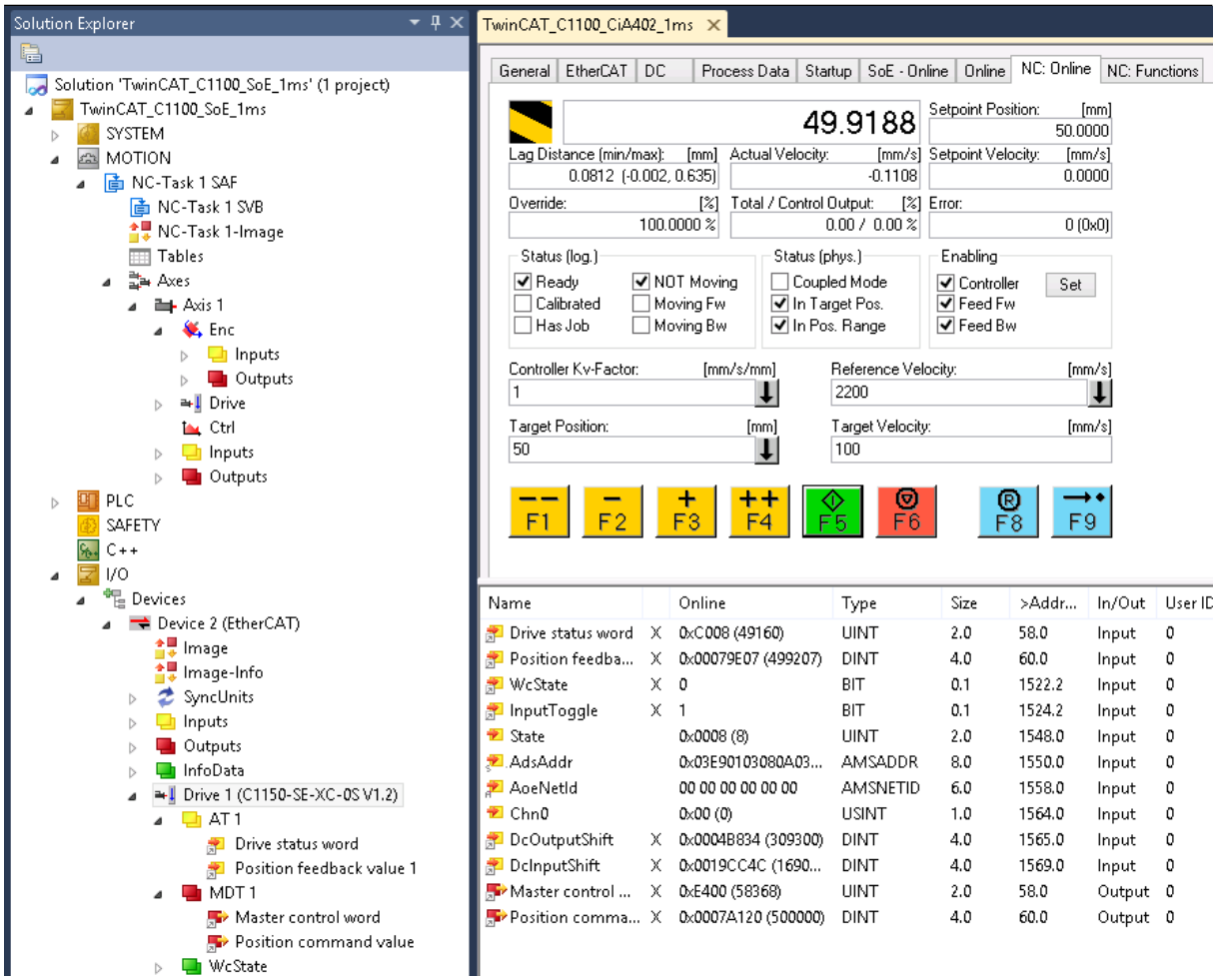
After this action the value should stand at this value (2^32).



Then the velocity output scale factor has to be set to 0.1 for correct operation



Though the position controlling is done in the drive the controller output has to be set to 0. If this is forgotten, the behaviour could be noisy. To set these NC parameters they have to be downloaded.



Now the servo drive can be used with system manager NC functionality when started.

3. Process Data Object (PDO) Configuration

The cyclic process data is configured in the master and transmitted to the slave during startup. The default mapping is documented in the tables below. The inputs and outputs correspond to the PLC point of view. For a detailed description of the exchanged data and its meaning refer to [1].
For a detailed description of the PDO data refer to [1] or have a look at the TwinCAT demo program, which is included with the LinMot-Talk software.

3.1 Input PDO Modules

3.1.1. Default Inputs: AT 1

Index	Size [Byte]	Byte Offset	Name	Data Type
S-0-0016	***6***	***-***	***Variables***	***RECORD***
S-0-0135	2	0	Sdrive status word	Uint16
S-0-0051	4	2	Position feedback value 1	Int32

Default input PDO mapping of 6 Bytes

3.1.2. Input: Following distance S-0-0189

Index	Size [Byte]	Byte Offset	Name	Data Type
S-0-0189	4	0	Following distance	Int32

3.1.3. Input: DC bus voltage S-0-0380

Index	Size [Byte]	Byte Offset	Name	Data Type
S-0-0380	4	0	DC bus Voltage	Int32

3.1.4. Input: State Var P-1-2914

Index	Size [Byte]	Byte Offset	Name	Data Type
P-1-2914	2	0	State Var	Uint16

3.1.5. Input: X4 Inputs P-1-3205

Index	Size [Byte]	Byte Offset	Name	Data Type
P-1-3205	2	0	X4 inputs	Uint16

3.2 Output PDO Modules

3.2.1. Default Outputs: MDT 1

Index	Size [Byte]	Byte Offset	Name	Data TypeS-0-0024
S-0-0024	***6***	***-***	***Variables***	***RECORD***
S-0-0134	2	0	Master control word	Uint16
S-0-0047	4	2	Position command value	Int32

Default output PDO mapping of 6 Bytes
The default mapping could be extended with the following value.

If the master also supports also the mapping Velocity command value it is strongly recommended to add this to MDT1 data.

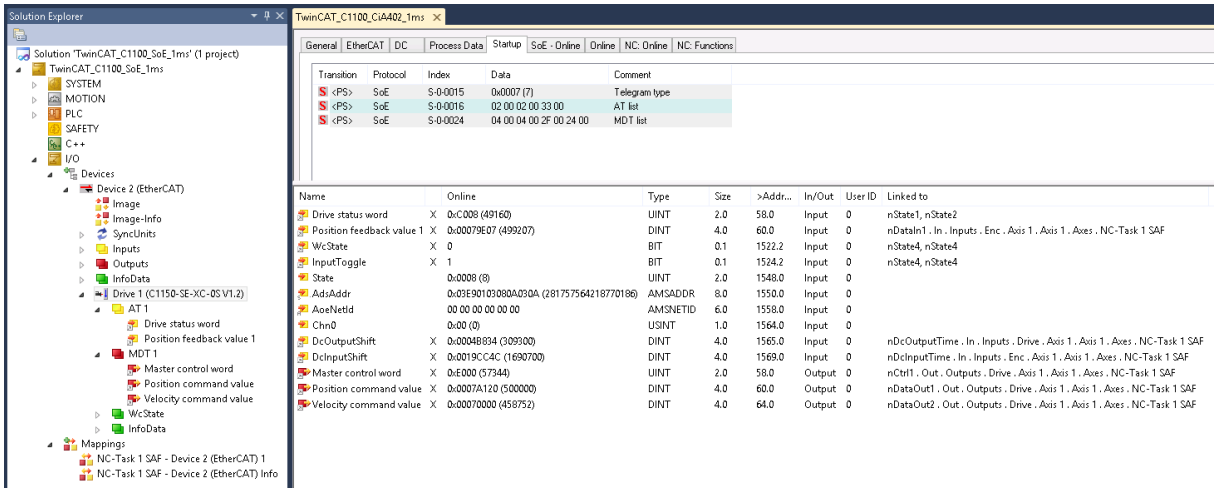
Index	Size [Byte]	Byte Offset	Name	Data TypeS-0-0024
S-0-0024	***6***	***-***	***Variables***	***RECORD***
S-0-0134	2	0	Master control word	Uint16
S-0-0047	4	2	Position command value	Int32
S-0-0036	4	6	Velocity command value	Int32

3.2.2. Output: Velocity Command value S-0-0036

Index	Size [Byte]	Byte Offset	Name	Data Type
S-0-0036	4	0	Velocity command value	Int32

If the master supports also the Velocity command value, it is strongly recommended to at this part to the MDT 1 telegram. With this a much better dynamic could be reached.

3.3 Typical Startup Telegrams



This figure shows the startup telegram list of LinMot SE servo drive

4. Asynchronous Configuration Protocol SoE

For configuration purpose (Parameter Handling) the standard Sercos over EtherCAT SoE-Protocol is used.

4.1 Communication Profile Area(1000h-1FFFh)

General | EtherCAT | DC | Process Data | Startup | SoE - Online | Online | NC: Online | NC: Functions

Diagnosis (Id.95) | Warning:Motor not homed

Reset (Id.99) | Update List | Auto Update

IDN	Name	Unit	Value
S-0-0001	NC cycle time (TNcyc)	us	0
S-0-0002	Communication cycle time (TScyc)	us	0
S-0-0011	Class 1 diagnostic		00000000 00000000
S-0-0012	Class 2 diagnostic		00000000 00000000
S-0-0015	Telegram Type Parameter		00000000 00000111
S-0-0016	AT List		(list)
S-0-0017	Operation Data List		(list)
S-0-0024	MDT List		(list)
S-0-0032	Primary Operation Mode		00000000 00000000
S-0-0036	Velocity command value	m/s	0.000000
S-0-0041	Homing velocity	m/s	0.010000
S-0-0043	Velocity polarity parameter		00000000 00000000
S-0-0044	Velocity scaling type		00000000 00101001
S-0-0045	Velocity scaling type		1
S-0-0046	velocity scaling exponent		-6
S-0-0047	Position command value	mm	50.0000
S-0-0049	Positive Position Limit	mm	0.0000
S-0-0050	Negative Position Limit	mm	0.0000
S-0-0051	Position feedback value 1	mm	49.9207
S-0-0055	Position polarity parameter		00000000 00000000
S-0-0076	Position Data Scaling Type		00000000 00000010
S-0-0095	Diagnose Message		Warning:Motor not homed
S-0-0099	Reset class 1 diagnostic		00000000 00000000
S-0-0134	Master Control Word		0xE000
S-0-0135	Drive Status Word		0xC008
S-0-0148	Drive Controlled Homing		00000000 00000000
S-0-0187	IDN-list of IDNs in AT		(list)
S-0-0188	IDN-list of IDNs in MDT		(list)
S-0-0189	Following distance	mm	0.0793
S-0-0380	DC bus Voltage	V	80.40
S-0-0403	Position feedback status		0x0000
P-1-2914	State Var		0x0820
P-1-0964	Homing Mode		0x0001
P-1-0967	Home Position	mm	-10.0000
P-1-0970	Slider Home Position	mm	10.0000
P-1-3205	X4 inputs		0x0030

LinMot SoE Object Dictionary

4.2 Generic LinMot SoE Parameter Mapping

Apart from the above described parameters with the LinMot servo drives, there exists a generic parameter mapping of the LinMot parameters by UPID to the SoE parameter index by adding the UPID to 0x8000h. Reading and writing the value accesses the RAM value of the UPID. Writing to the default value accesses the ROM value of the UPID.

5. EtherCAT SoE Parameters

5.1 Parameters

The EtherCAT SoE Interface has an additional parameter tree branch (Parameters → EtherCAT SoE), which can be configured with the distributed LinMot-Talk software.

With these parameters, the EtherCAT interface can be enabled or disabled.
The LinMot-Talk software can be downloaded from http://www.linmot.com under the section download, software & manuals.

5.1.1. EtherCAT SoE/Dis-/Enable

With the Dis-/Enable parameter the LinMot Servo Drive can be run without the Ethernet EtherCAT Interface going online. So in a first step the system can be configured and run without any bus connection.

ETHERCAT SoE\ Dis-/Enable	
Disable	Servo Drive runs without ETHERCAT.
Enable	Servo Drive runs with ETHERCAT connection.

IMPORTANT: If the ETHERCAT Interface is disabled, the integrated ETHERCAT-ASIC rests in reset state! No messages will be sent to other devices connected to the ETHERCAT-Network via the servo drive.

5.1.2. EtherCAT SoE/Station Alias/Alias Address Source

With this parameter the station alias address source is defined.

If a station alias address is defined in the ET1100 Eeprom (could be programmed from the master over the Network), this alias address is taken.

ETHERCAT SoE/Station Alias/Alias Address Source	
None	No station alias address is generated
ID Switches	The ID switches defines the station alias address
RT MAC	The lowest 2 bytes of the device MAC address are used as station alias address
Parameter	The Station alias address parameter value defines the Alias Address
Masked RT MAC and Parameter	The station alias address is defined by the masked parameter ored with the RT MAC masked with the inverse mask

5.1.3. EtherCAT SoE/Station Alias/Alias Address Parameter

Parameter value of the station alias address.

5.1.4. EtherCAT SoE/Station Alias/Alias Address Parameter Mask

Mask value for the parameter value of the station alias address.

5.1.5. EtherCAT SoE/NC Configuration/Velocity Scale Numerator /Denominator

This two parameters are taken to Scale the PDO Value of “Target velocity” (Index 0x60FF) to the Drive Resolution which is [1um/s]. The Scaling factor is Velocity Scale Numerator divided by Velocity Scale Denominator.

For the Beckoff this factor is typically 1/60 -> Velocity Scale Numerator = 1 and Velocity Scale Denominator = 60.

5.1.6. EtherCAT SoE/Connection Timeout/Timeout Behavior

With this parameter the drive behavior on an Connection timeout could be set. This parameter is also represented in the profile parameter with index 0x6007.

ETHERCAT SoE\ Conection Timeout/Timeout Behavior	
Ignore	Nothing happens if an IO timeout occurs.
Error with Disable Voltage	Drive goes to Error State and the Voltage is disabled immediately when the IO timeout occurs.
Error with Quick Stop	Drive goes to Error State before the Voltage is disabled a Quick Stop is performed, when the IO timeout occurs.
Error with Go To Pos	Drive goes to Error State before the Voltage is disabled a Go To Position is performed, when the IO timeout occurs.

6. Connecting to the EtherCAT Network

6.1 Pin Assignment of the Connectors X17-X18

The ETHERCAT connector is a standard RJ45 female connector with a pin assignment as defined by EIA/TIA T568B:

X17 – X18	ETHERCAT Connector
Pin	**Wire color code**
1	WHT/ORG
2	ORG
3	WHT/GRN
4	BLU
5	WHT/BLU
6	GRN
7	WHT/BRN
8	BRN
case	-
RJ-45	Use standard patch cables (twisted pair, S/UTP, AWG26) for wiring. This type of cable is usually referred to as a “Cat5e-Cable”.

7. Contact Addresses

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