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MAXPOS

Application Notes

maxpos.maxongroup.com

MAXPOS Positioning Controllers
Application Notes
CCMC | Edition 2019-08 | DocID rel8960

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TABLE OF CONTENTS

READ THIS FIRST

The present document represents a compilation of helpful “Good-to-Knows” that might come in handy in your daily work with MAXPOS Positioning Controllers. The individual chapters cover particular cases or scenarios and are intended to give you a hand for efficient setup and parameterization of your system.

We strongly stress the following facts:

- *The present document does not replace any other documentation covering the basic installation and/or parameterization described therein!*
- *Also, any aspect in regard to health and safety, as well as to secure and safe operation are not covered in the present document – it is intended and must be understood as complimenting addition to those documents!*

1 ABOUT THIS DOCUMENT

1.1 Intended Purpose

The purpose of the present document is to provide you specific information to cover particular cases or scenarios that might come in handy during commissioning of your drive system.

Use for other and/or additional purposes is not permitted. maxon, the manufacturer of the equipment described, does not assume any liability for loss or damage that may arise from any other and/or additional use than the intended purpose.

The present document is part of a documentation set. Please find below an overview on the documentation hierarchy and the interrelationship of its individual parts:

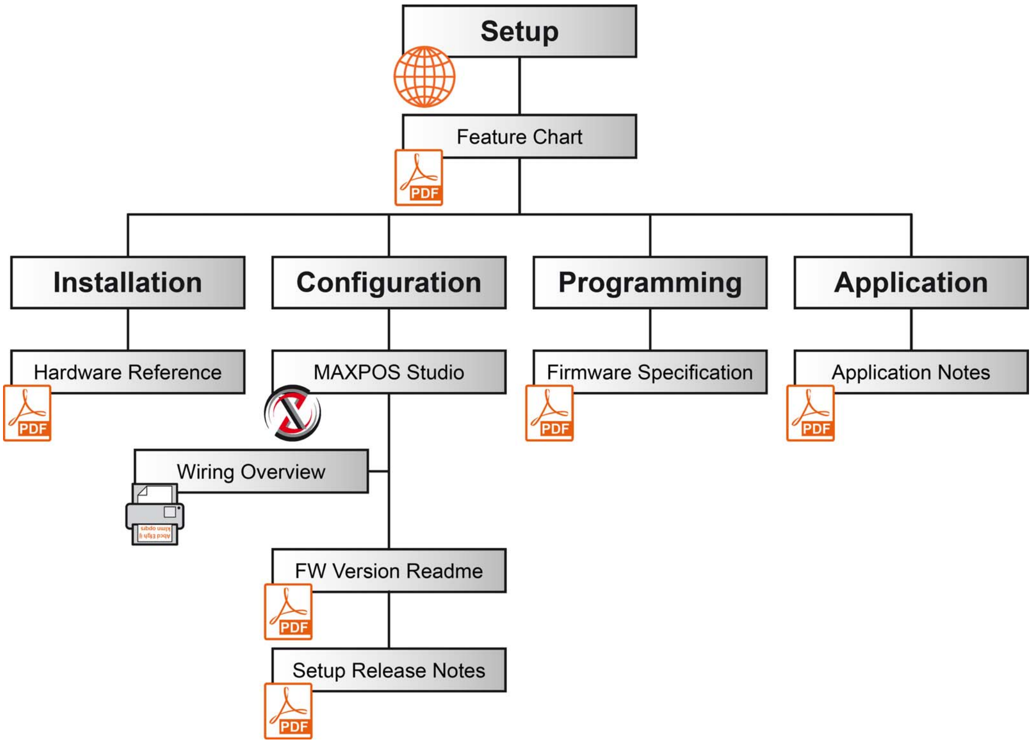

Figure 1-1 Documentation Structure

1.2 Target Audience

This document is meant for trained and skilled personnel working with the equipment described. It conveys information on how to understand and fulfill the respective work and duties.

This document is a reference book. It does require particular knowledge and expertise specific to the equipment described.

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1.3 How to use

Take note of the following notations and codes which will be used throughout the document.

Notation	Explanation
«Abcd»	indicating a title or a name (such as of document, product, mode, etc.)
¤Abcd¤	indicating an action to be performed using a software control element (such as folder, menu, drop-down menu, button, check box, etc.) or a hardware element (such as switch, DIP switch, etc.)
(n)	referring to an item (such as order number, list item, etc.)
→	denotes “see”, “see also”, “take note of” or “go to”

Table 1-1 Notations used in this Document

In the later course of the present document, the following abbreviations and acronyms will be used:

Short	Description
CiA	CAN in Automation
CoE	CAN Application Protocol over EtherCAT
CSP	Cyclic Synchronous Position Mode
CST	Cyclic Synchronous Torque Mode
CSV	Cyclic Synchronous Velocity Mode
ESI	EtherCAT Slave Information (EtherCAT Device Description)
ESM	EtherCAT State Machine
ETG	EtherCAT Technology Group
FoE	File Access over EtherCAT
MAXPOS	MAXPOS Positioning Controller
PDO	Process Data Object
PPM	Profile Position Mode
PVM	Profile Velocity Mode
SDO	Service Data Object
STO	Save Torque Off

Table 1-2 Abbreviations & Acronyms

1.4 Symbols and Signs

In the course of the present document, the following symbols and signs will be used.

Type	Symbol	Meaning	
Safety Alert	 (typical)	DANGER	Indicates an **imminent hazardous situation**. If not avoided, it **will result in death or serious injury**.
		WARNING	Indicates a **potential hazardous situation**. If not avoided, it **can result in death or serious injury**.
		CAUTION	Indicates a **probable hazardous situation** or calls the attention to unsafe practices. If not avoided, it **may result in injury**.
Prohibited Action	 (typical)	Indicates a dangerous action. Hence, **you must not**!	
Mandatory Action	 (typical)	Indicates a mandatory action. Hence, **you must**!	
Information		Requirement / Note / Remark	Indicates an activity you must perform prior continuing, or gives information on a particular item you need to observe.
		Best Practice	Indicates an advice or recommendation on the easiest and best way to further proceed.
		Material Damage	Indicates information particular to possible damage of the equipment.

Table 1-3 Symbols & Signs

1.5 Trademarks and Brand Names

For easier legibility, registered brand names are listed below and will not be further tagged with their respective trademark. It must be understood that the brands (the below list is not necessarily concluding) are protected by copyright and/or other intellectual property rights even if their legal trademarks are omitted in the later course of this document.

Brand Name	Trademark Owner
BiSS	© iC-Haus GmbH, DE-Bodenheim
EnDat	© DR. JOHANNES HEIDENHAIN GmbH, DE-Traunreut
EtherCAT®	© EtherCAT Technology Group, DE-Nuremberg, licensed by Beckhoff Automation GmbH, DE-Verl
Sendix	© Fritz Kübler GmbH, DE-Villingen-Schwenningen
Sysmac	© OMRON Corporation, JP-Kyoto
TwinCAT®	© Beckhoff Automation GmbH, DE-Verl
Windows®	© Microsoft Corporation, USA-Redmond, WA

Table 1-4 Brand Names and Trademark Owners

1.6 Sources for additional Information

Find the latest edition of the present document as well as of additional documentation and software on the Internet: →maxpos.maxongroup.com

For further details and additional information, please refer to below listed sources:

#	Reference
[1]	BiSS-C specifications →www.ichaus.de
[2]	ETG.1000: EtherCAT Specification →www.ethercat.org
[3]	USB Implementers Forum: Universal Serial Bus Revision 2.0 Specification: →www.usb.org/developers/docs/usb20_docs/
[4]	Manufacturer-specific USB protocol: →www.microchip.com/mcp2210/
[5]	IEC 61158-x-12: Industrial communication networks – Fieldbus specifications
[6]	IEC 61800-7: Adjustable speed electrical power drives systems
[7]	maxon: MAXPOS Firmware Specification →maxpos.maxongroup.com
[8]	Dr. Urs Kafader: The selection of high-precision microdrives ISBN 978-3-9520143-6-3 →academy.maxongroup.com

Table 1-5 Sources for additional Information

1.7 Copyright

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2 COMMUNICATION GUIDE

2.1 In Brief

OBJECTIVE

The present application note explains the MAXPOS communication interfaces.

CONTENTS

2.2 Functionality

MAXPOS controllers are commanded by an EtherCAT Master. The USB interface is used for configuration only.

2.3 EtherCAT Interface

The MAXPOS Positioning Controllers' implementation of EtherCAT follows the EtherCAT Technology Group (ETG) specifications.

Reference

You may access all relevant data and the free-for-download documentation (available in different languages) from the EtherCAT website (➔http://ethercat.org/). Navigate to downloads section and search for the document "EtherCAT Technology Introduction".

The document "EtherCAT_Introduction_xxxx.pdf" will serve well as an introduction to EtherCAT and does include information on the technology, implementation, and possible applications.

For MAXPOS firmware and hardware, consult maxon's comprehensive documentation set available at ➔http://maxpos.maxongroup.com. Among others, you will find the following documents:

MAXPOS FIRMWARE SPECIFICATION

- Operating modes
- Communication and error handling
- Object dictionary
- etc.

MAXPOS HARDWARE REFERENCE

- Technical data
- Wiring diagrams and connection overview
- etc.

2.3.1 Communication Specifications

Topic	Description
Applicable Communication Standards	IEC 61158 Type 12 EtherCAT Slave CoE (CAN Application Layer over EtherCAT) according to IEC 61800-7 Profile Type 1 (CiA 402) CANopen-Standard Device Profile for Drives and Motion Control
Physical Layer	IEEE 802.3 100 Base T (100 Mbit/s, Full Duplex)
Fieldbus Connection	X9 (RJ45): EtherCAT Signal IN X10 (RJ45): EtherCAT Signal OUT
SyncManager	SM0: Mailbox output SM1: Mailbox input SM2: Process data outputs SM3: Process data inputs
FMMU	FMMU0: Mapped to process data output (RxPDO) area FMMU1: Mapped to process data input (TxPDO) area FMMU2: Mapped to mailbox status
Process Data	Variable PDO mapping
Mailbox (CoE)	SDO Request, SDO Response, SDO information ***Note:*** *TxPDO/RxPDO and Remote TxPDO/RxPDO are not supported.*
Distributed Clocks	Free-run, DC mode (can be selected) Supported DC cycle: 100 µs minimal (200 µs typical)
LED Indicator	EtherCAT Status (green LED / red LED) EtherCAT Port Activity/Link Status (green LED)

Table 2-6 Communication Specifications

2.3.2 EtherCAT State Machine (ESM)

The EtherCAT State Machine coordinates both Master and Slave during startup and operation. Their interaction (Master ⇔ Slave) results in changes of states being related to writes to the Application Layer Controlword: AL Ctrl (0x0120).

Upon initialization of Data Layer and Application Layer, the ESM enters “Init” state which defines the Application Layer's root of the communication relationship between Master and Slave. In the Application Layer, no direct communication between Master and Slave is possible. The Master uses “Init” state…

- to initialize a configuration register set and
- to configure the Sync Manager.

Operation of the connected MAXPOS (the Slave) requires its prior initialization by the Master via the ESM. Within the ESM, transitions between certain states must follow a given scheme and will be initiated by the Master. The Slave itself must not execute any transition.

For an overview of the EtherCAT State Machine ➔Figure 2-2, for further descriptions ➔as from Table 2-7.

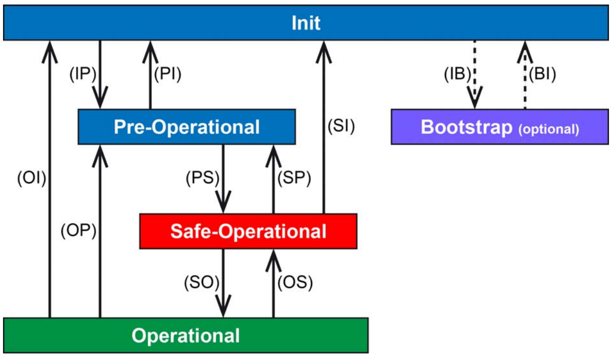

Figure 2-2 EtherCAT State Machine – Scheme

Condition	Description
Power ON	• MAXPOS is ON • MAXPOS autonomously initializes and switches to state "Init"
Init	• Master will synchronize the EtherCAT field bus • Asynchronous communication between Master and Slave (Mailbox) will be established. At this time, no direct communication (Master n Slave) will yet take place. • When all devices have been connected to the field bus and have successfully passed configuration, state will be changed to "Pre-Operational"
Pre-Operational	• Asynchronous communication between Master and Slave (Mailbox) will be active. • Master will setup cyclic communication via PDOs and necessary parameterization via acyclic communication. • Upon successful completion, the Master will change to state "Safe-Operational".
Safe-Operational	• Used to establish a safe operation condition of all devices connected to the EtherCAT field bus. Thereby, the Slave sends actual values to the Master while ignoring new setpoint values of the Master and using save default values instead. • Upon successful completion, the Master will change to state "Operational"
Operational	• Acyclic as well as cyclic communication is active • Master and Slave exchange setpoint and actual values • MAXPOS be enabled and operated via the CoE protocol
Bootstrap	• Only FoE is possible (Mailbox) • Firmware download via FoE

Table 2-7 EtherCAT State Machine – Conditions

Status Transition	Status
IP	Start of acyclic communication (Mailbox)
PI	Stop of acyclic communication (Mailbox)
PS	Start of cyclic communication (Process Data) Slave sends actual values to Master Slave ignores setpoint values by the Master and uses default values
SP	Stop of cyclic communication (Process Data) Slave ceases to send actual values to the Master
SO	Slave evaluates actual setpoint values of the Master
OS	Slave ignores setpoint values from Master and uses internal default values
OP	Stop of cyclic communication (Process Data) Slave ceases to send actual values to the Master Master ceases to send actual values to the Slave
SI	Stop of cyclic communication (Process Data) Stop of acyclic communication (Mailbox) Slave ceases to send actual values to the Master Master ceases to send actual values to the Slave
OI	Stop of cyclic communication (Process Data) Stop of acyclic communication (Mailbox) Slave ceases to send actual values to the Master Master ceases to send actual values to the Slave
IB	Start Bootstrap Mode Firmware download via FoE (Mailbox)
BI	Reset device after successful firmware download

Table 2-8 EtherCAT State Machine – Transitions

Parameter	Address	Bit	Description
Control	0x120	3…0	0x01: Init Request 0x02: Pre-Operational Request 0x03: Bootstrap Mode Request 0x04: Safe-Operational Request 0x08: Operational Request
Error Acknowledge	0x120	4	0x00: No error acknowledgment 0x01: Error acknowledgment at rising edge
Reserved	0x120	7…5	–
Application-specific	0x120	15…8	–

Table 2-9 EtherCAT State Machine – Control Register

2.4 Integration of ESI Files

SDOs are used to access the object dictionary. The corresponding interface is CoE. The MAXPOS is described with an XML file bearing the so-called ESI (EtherCAT Slave Information).

For in-detail description and examples on integration into the EtherCAT Master Environment ➔chapter “3 Integration into EtherCAT Master Environment” on page 3-11.

2.5 USB Interface

The USB interface is used for configuration only, MAXPOS controllers are commanded by an EtherCAT master.

maxon MAXPOS drives' USB interface follows the “Universal Serial Bus Revision 2.0 Specification”. You may wish to download the file from the Internet (for URL ➔page 1-6, item [3]; full details are described in chapter “7.3 Physical Layer”).

For further information on manufacturer-specific USB protocol ➔page 1-6, item [4].

2.6 Error Code Definition

For for detailed information on error codes, device-specific errors, and error handling methodology ➔separate document «MAXPOS Firmware Specification», chapter “Error Handling”.

3 INTEGRATION INTO ETHERCAT MASTER ENVIRONMENT

3.1 In Brief

OBJECTIVE

The present application note explains how to integrate the MAXPOS into several EtherCAT Master Environments by using various tools. Additional Master Environments will follow.

CONTENTS

3.2 Beckhoff TwinCAT

INTEGRATING ESI FILES

To integrate a MAXPOS EtherCAT axis into the Beckhoff Master System, copy the ESI (EtherCAT Slave Information) XML file to the following folder. Note that the actual folder designation (***) depends on the TwinCAT version you are using:

- For **TwinCAT XAE** use path "C:\TwinCAT***3.1\Config\Io\EtherCAT\".
- For **TwinCAT2** use path "C:\TwinCAT\Io\EtherCAT\".

SCANNING THE ETHERCAT SLAVE DEVICE

1) Connect the MAXPOS to the EtherCAT Master and turn on power.
2) Open the Beckhoff System Manager and create a new project using menu ¤File¤, then ¤New¤.
3) Open menu ¤Options¤, then select ¤Show Real Time Ethernet Compatible Devices¤.

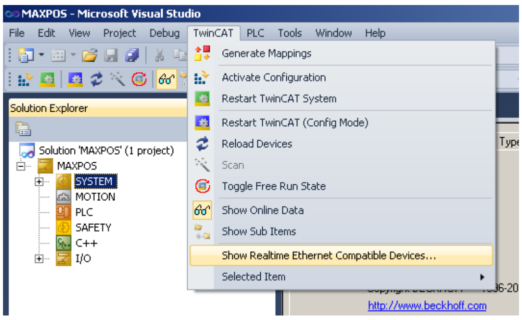

Figure 3-3 Integration – Beckhoff TwinCAT | Create new Project

4) If “Installed and ready to use devices” does not list a network card, you will need to install the EtherCAT driver for one of the present network cards.

a) Click one of the listed network cards.

b) Click ¤Install¤.

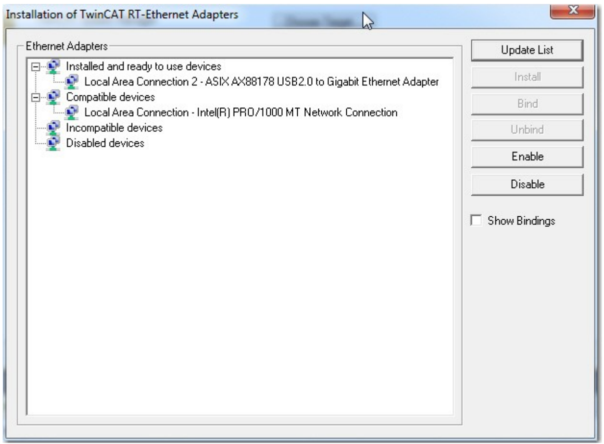

Figure 3-4 Integration – Beckhoff TwinCAT | Install Ethernet Adapters

5) In the TwinCAT System Manager navigation tree, click right on ¤I/O Devices¤, then select ¤Scan¤.

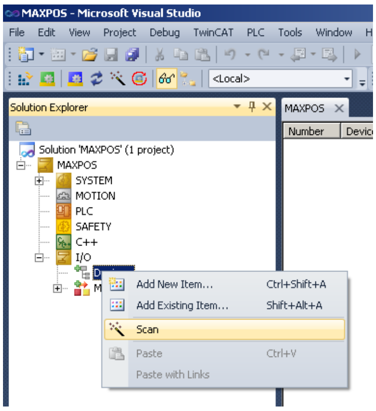

Figure 3-5 Integration – Beckhoff TwinCAT | Scan Devices

6) Click ¤OK¤ to confirm.

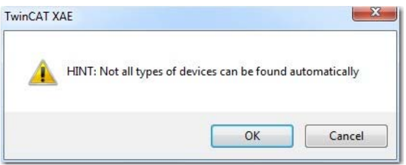

Figure 3-6 Integration – Beckhoff TwinCAT | Confirmation

7) All detected E/A devices (network cards) will be listed.
   a) Tick to select the network card to which the EtherCAT devices are connected to and untick all others.
   b) Click ¤OK¤.

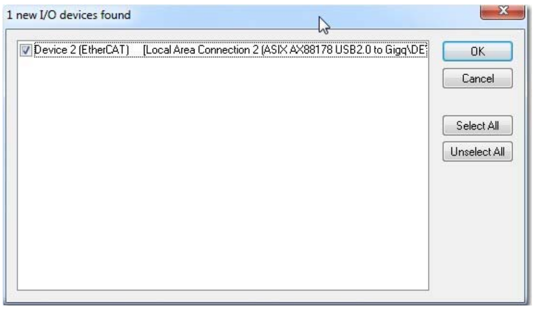

Figure 3-7 Integration – Beckhoff TwinCAT | New I/O Devices found

8) Click ¤YES¤ to confirm.

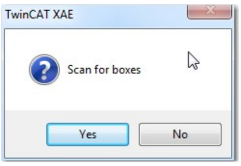

Figure 3-8 Integration – Beckhoff TwinCAT | Scan for Boxes Confirmation

9) The TwinCAT System Manager now searches for connected devices. If one or more controller were found, the following message will appear.
   Click ¤Yes¤.

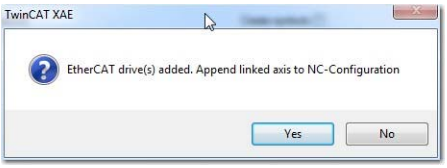

Figure 3-9 Integration – Beckhoff TwinCAT | Add Drives Message

10) Make your selection depending on the intended use:
   • Click ¤Yes¤ if you plan to use the drive as a NC-Configuration
   • Click ¤No¤ if you do not plan to use the drive a NC-Configuration

11) Click ¤Yes¤ to confirm.

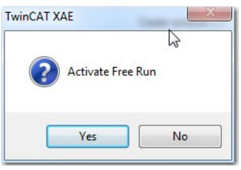

Figure 3-10 Integration – Beckhoff TwinCAT | Activate Free Run Message

12) Save the project.

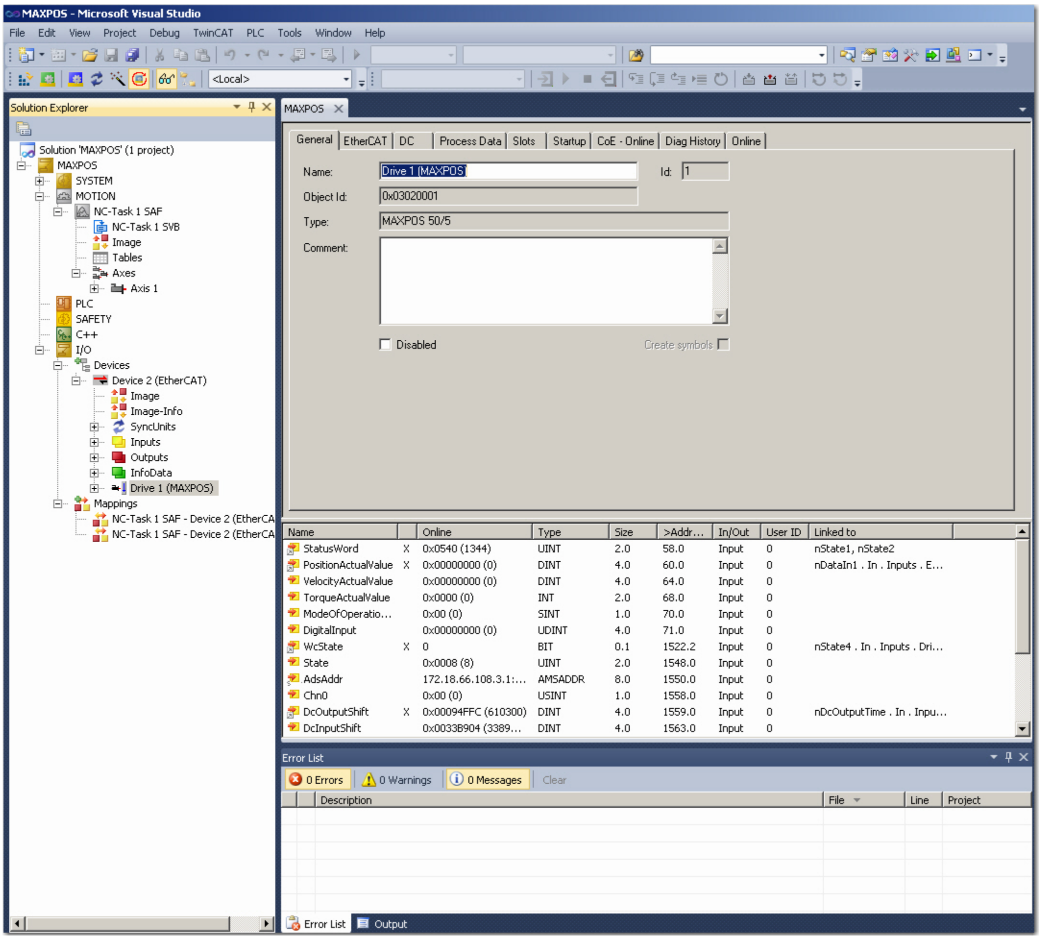

Figure 3-11 Integration – Beckhoff TwinCAT | Save Project

CHANGING OPERATING MODES TO CSP

Via the EtherCAT interface, usually the following operating modes will be used:

- Cyclic Synchronous Position (CSP)
- Cyclic Synchronous Velocity (CSV)
- Cyclic Synchronous Torque (CST)

If you intend to operate the MAXPOS in Cycle Synchronous Mode, you will need to configure PDO Mapping accordingly by defining “Slots”.

Additionally, the following “regular” MAXPOS operating modes may be used:

- Profile Position Mode (PPM)
- Profile Velocity Mode (PVM)

13) Upon recognition of the involved axes, the structure tree will be displayed as to the following example.

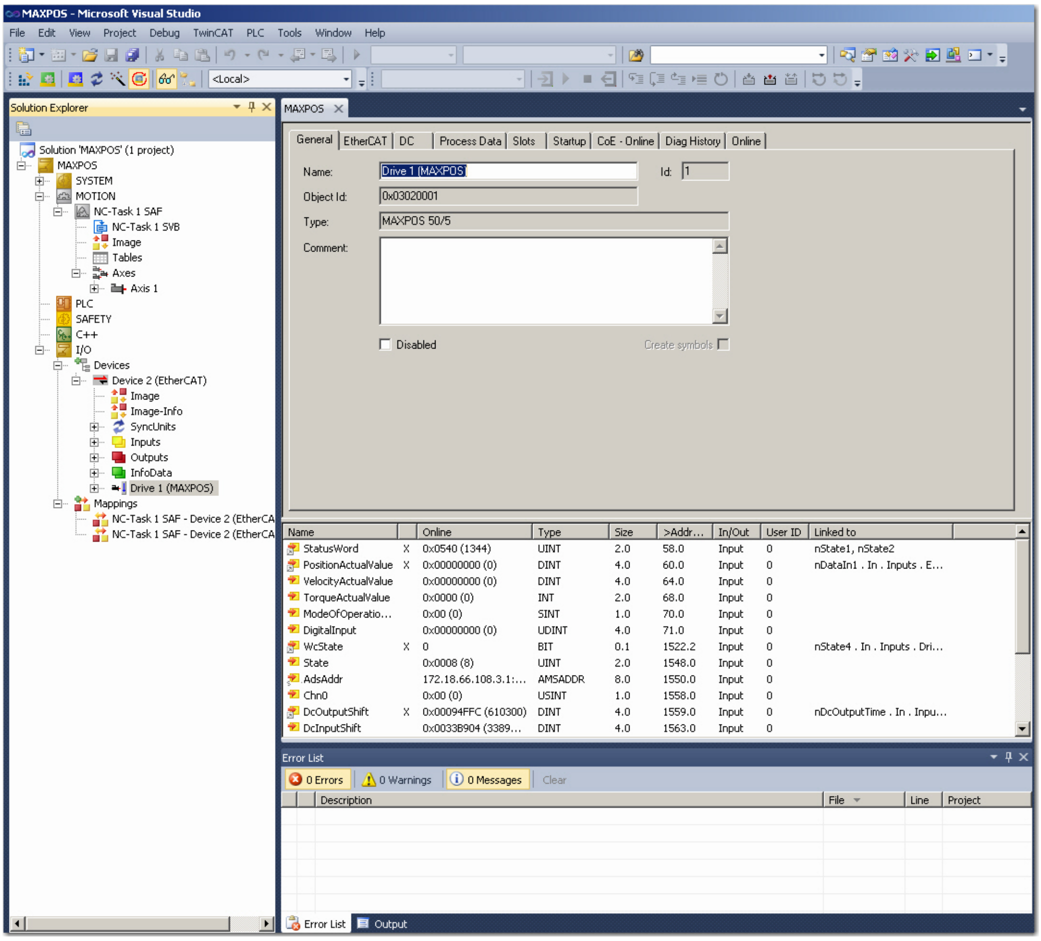

Figure 3-12 Integration – Beckhoff TwinCAT | Structure Tree

14) Use the tab ¤Slots¤ to allocate the operating mode to be used:

a) Select a ¤Slot¤ from the left pane.

b) Select the desired operating mode from the right pane ¤Module¤.

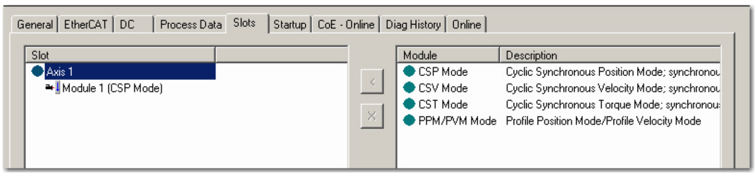

Figure 3-13 Integration – Beckhoff TwinCAT | Configuration of Slots

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VERIFY CSP SETTINGS

15) Enable the Distributed Clock from the MAXPOS.

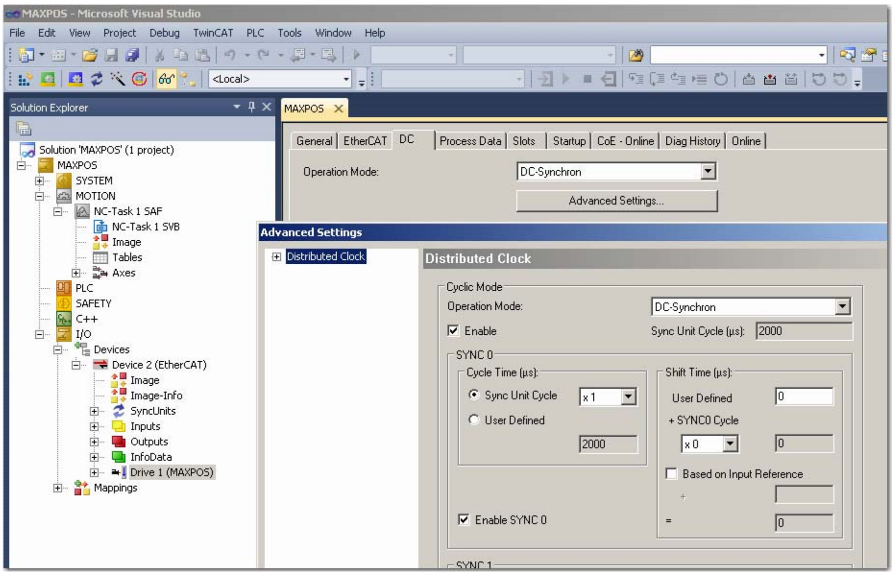

Figure 3-14 Integration – Beckhoff TwinCAT | Distributed Clock

16) In the Solution Explorer, click on tree item ¤NC-Task 1 SAF¤, then tab ¤Task¤.
Set cycle time to 2 ms.

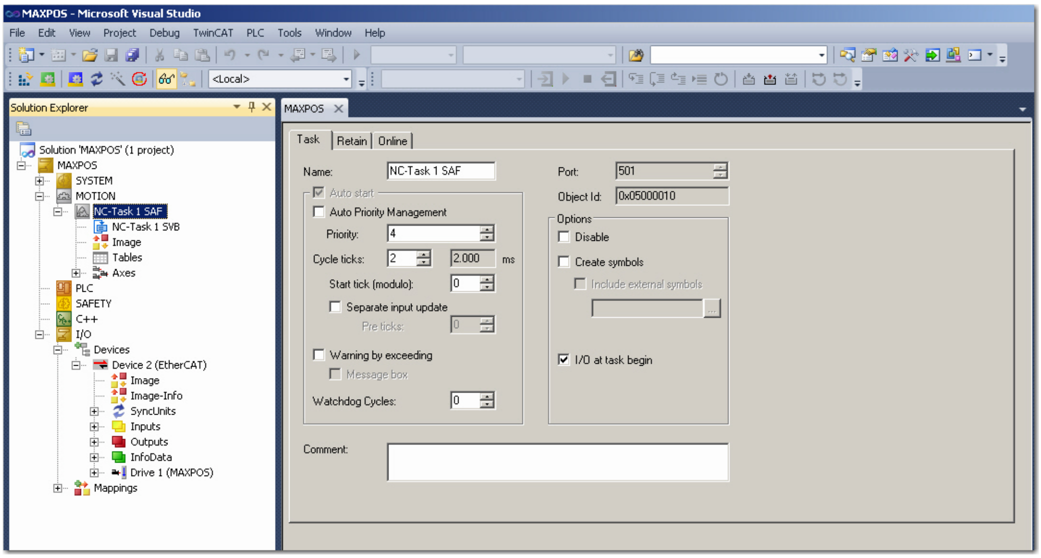

Figure 3-15 Integration – Beckhoff TwinCAT | Cycle Ticks

CONFIGURATION OF THE AXIS

17) In the Settings tab, verify that ¤Link To I/O…¤ is assigned to the MAXPOS axis (naming is by your choice).

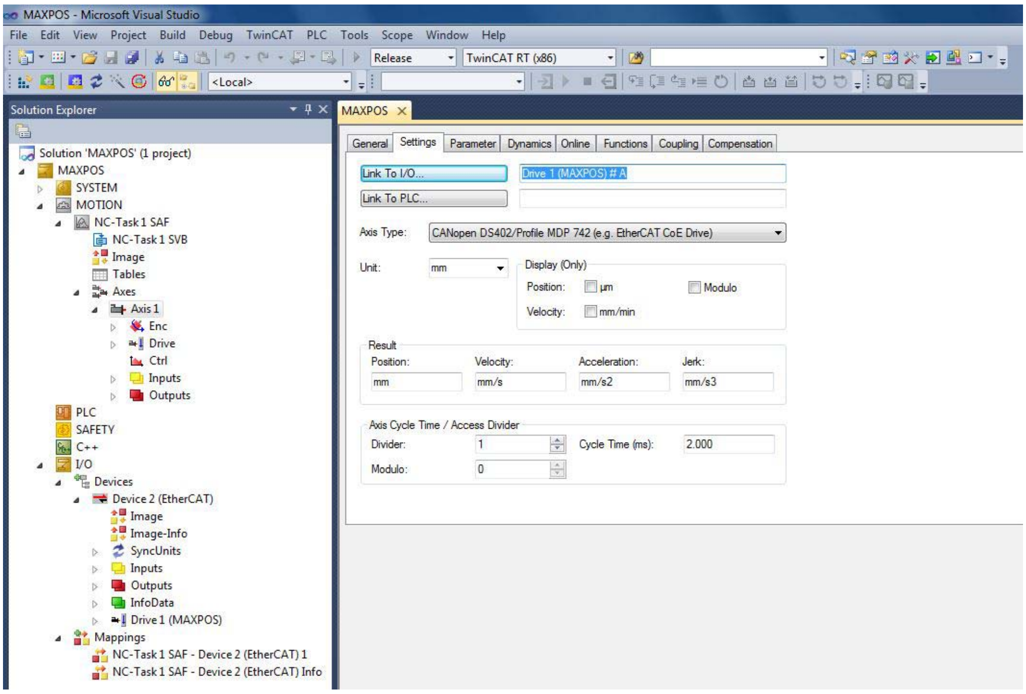

Figure 3-16 Integration – Beckhoff TwinCAT | Axis Link

18) In the Parameter tab, adjust the motor speed settings as to the motor’s capability and to the supply voltage.

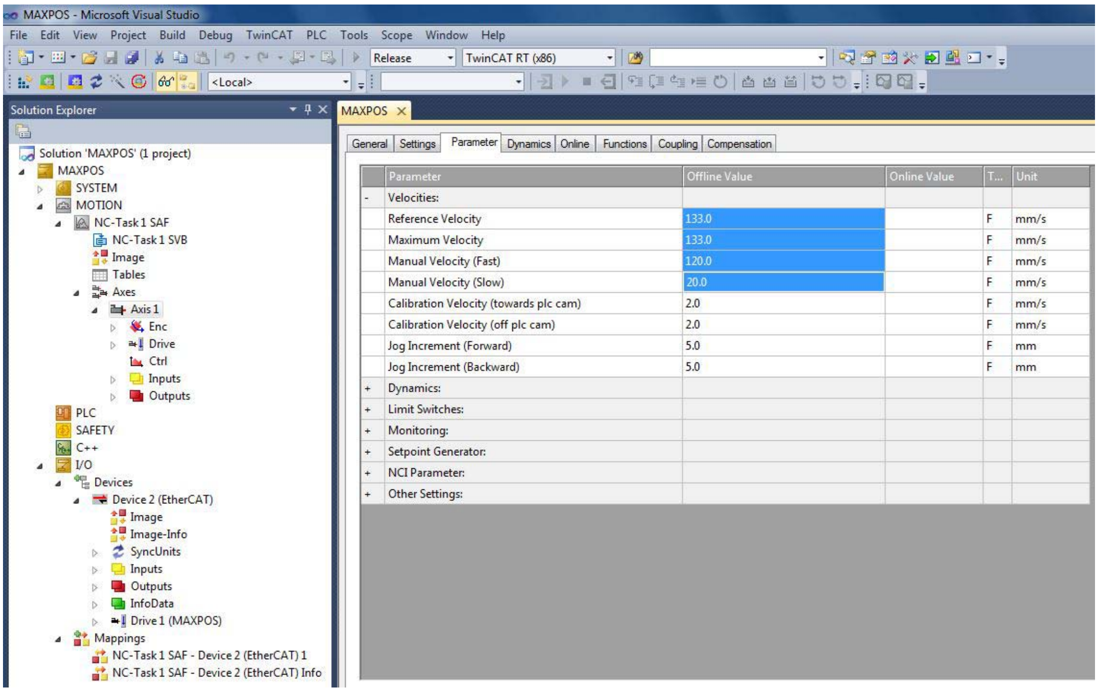

Figure 3-17 Integration – Beckhoff TwinCAT | Speed Settings

19) Set Dead Time Compensation to approximately three to four times the set NC-Task SAF Cycle ticks (➔“Verify CSP Settings” on page 3-16; step 16)

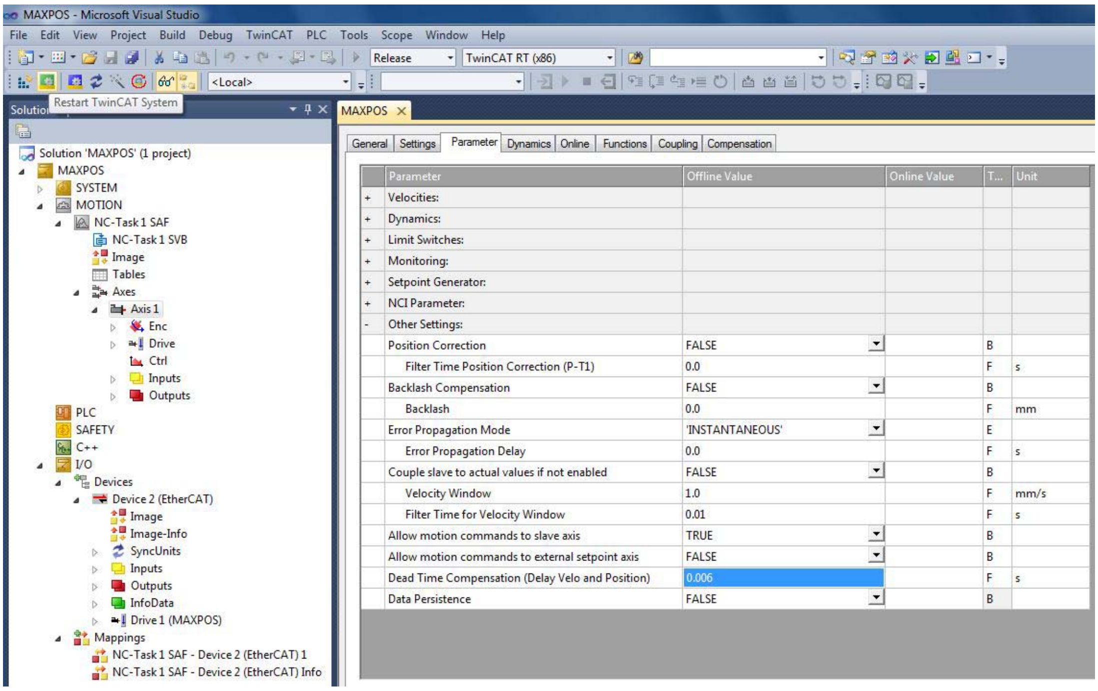

Figure 3-18 Integration – Beckhoff TwinCAT | Dead Time Compensation

20) Make sure to set the correct encoder resolution.

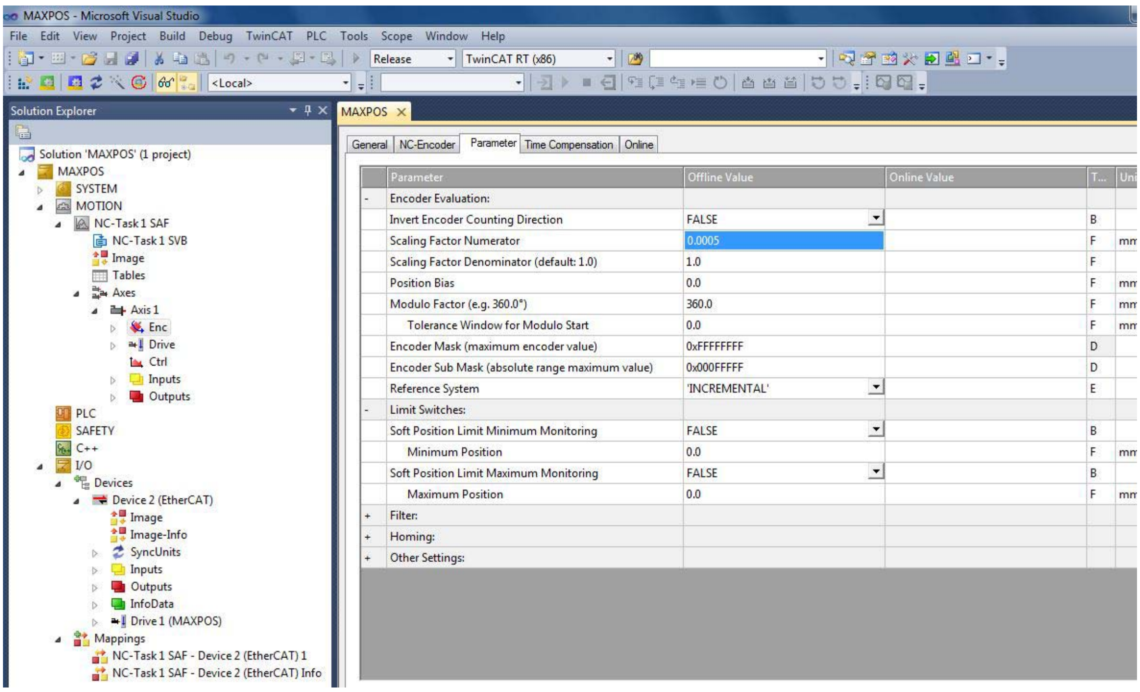

Figure 3-19 Integration – Beckhoff TwinCAT | Encoder Settings

21) Configure the position control loop as follows:
– Position control: Proportional Factor Kv → “0.0”
– Feedforward Velocity: Pre-Control Weighting [0.0…1.0] → “1.0”

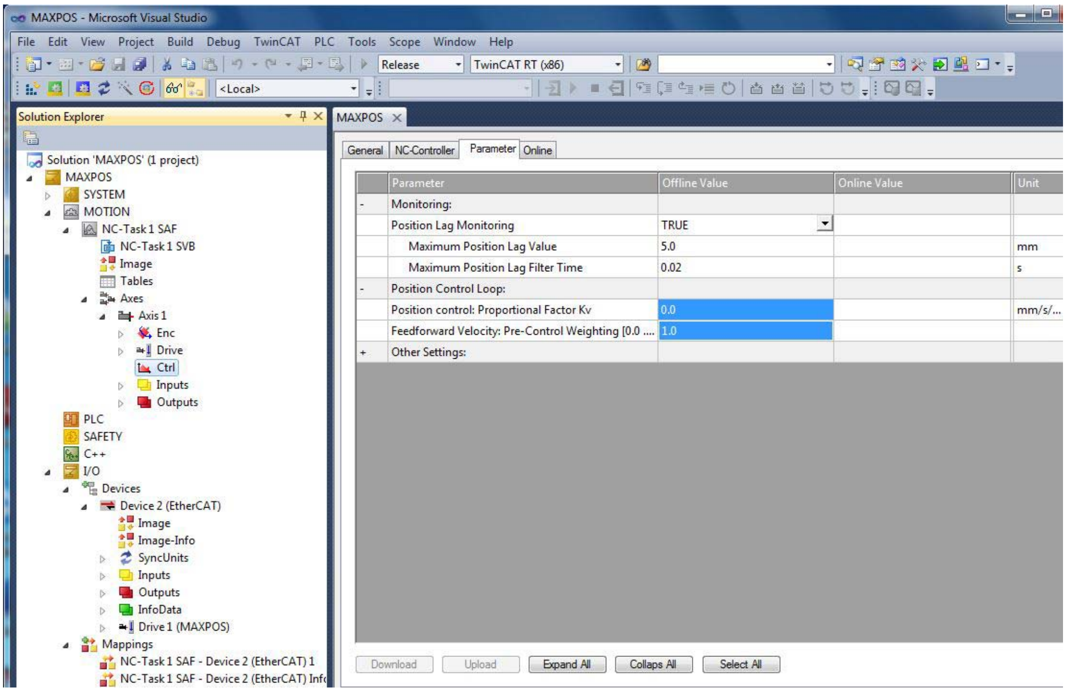

Figure 3-20 Integration – Beckhoff TwinCAT | Position Control Loop Settings

22) In the Parameter tab, set the correct “Output Scaling Factor (Velocity)”. Scaling may be calculated as follows:
– Scaling = 7500 / (Encoder impulse number * 4)
– e.g. Encoder with 500 impulse per turn: Scaling = 7500 / (500 * 4) = 3.75

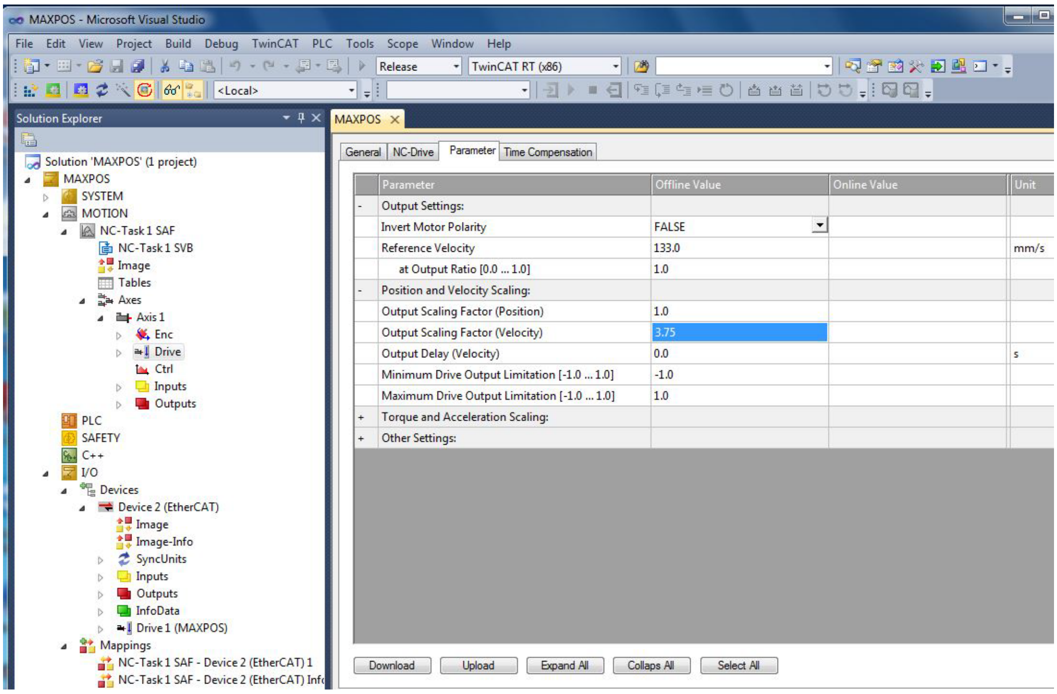

Figure 3-21 Integration – Beckhoff TwinCAT | Output Settings

23) In the Solution Explorer, select ¤CSP Outputs¤ and set the link for the “Velocity Offset” variable.

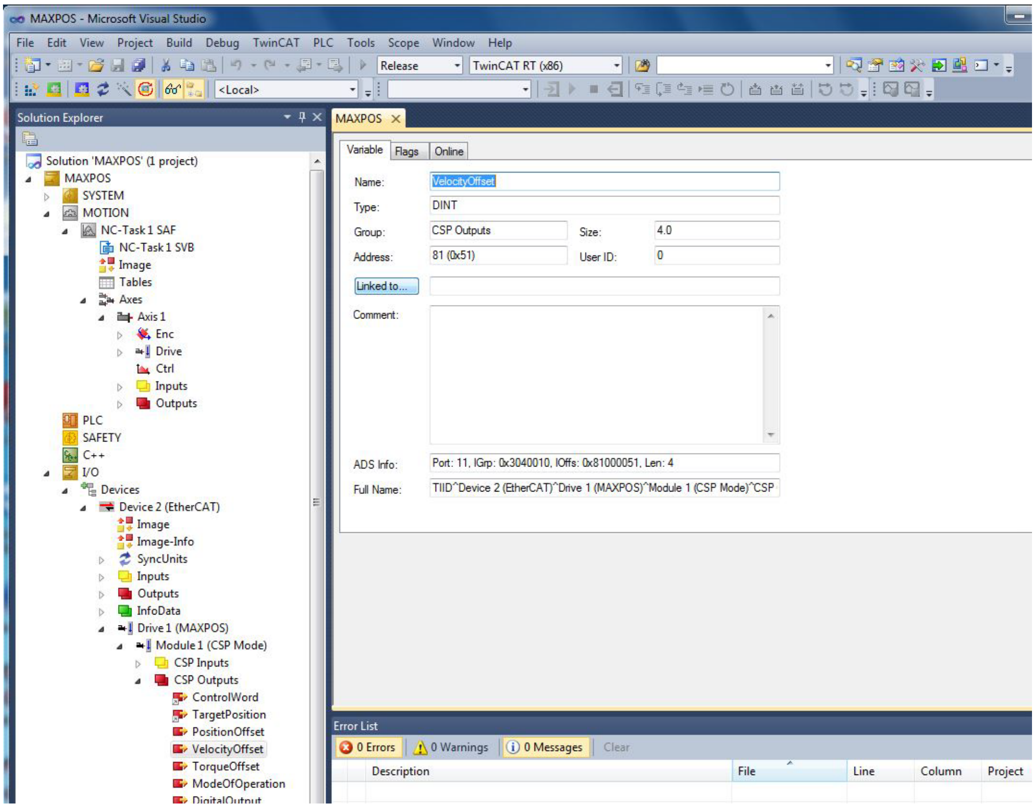

Figure 3-22 Integration – Beckhoff TwinCAT | Variable Settings

24) In folder ¤Drive¤ \ ¤Out¤, select “nDataOut2” of Axis 1 as link variable.

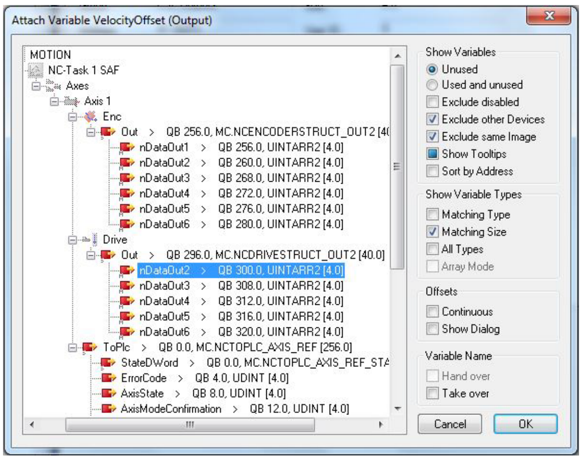

Figure 3-23 Integration – Beckhoff TwinCAT | Variable Offset

3.3 Omron Sysmac NJ

CREATING PROJECT FILE

1) Create a Project File form the Project Window.

ETHERCAT CONFIGURATION

2) In the Multiview Explorer, select ¤Configurations and Setup¤, then ¤EtherCAT¤.

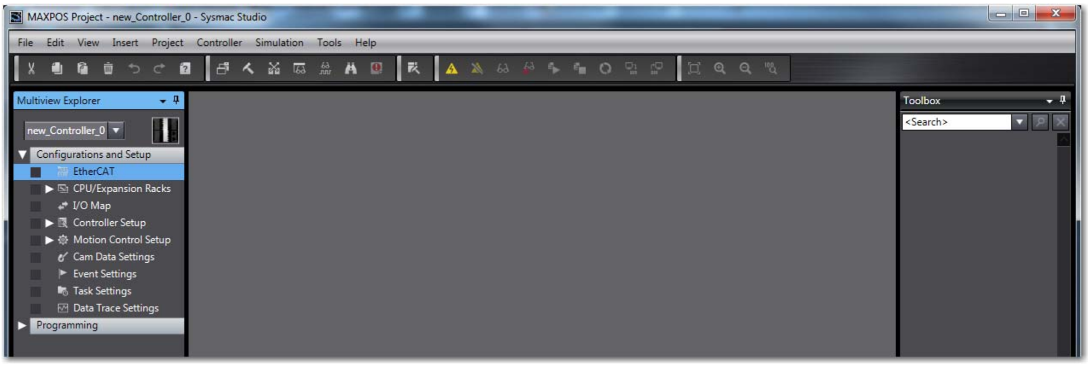

Figure 3-24 Integration – Omron Sysmac NJ | Configuration & Setup

This will open the ¤Edit Pane¤ and will automatically create the master.

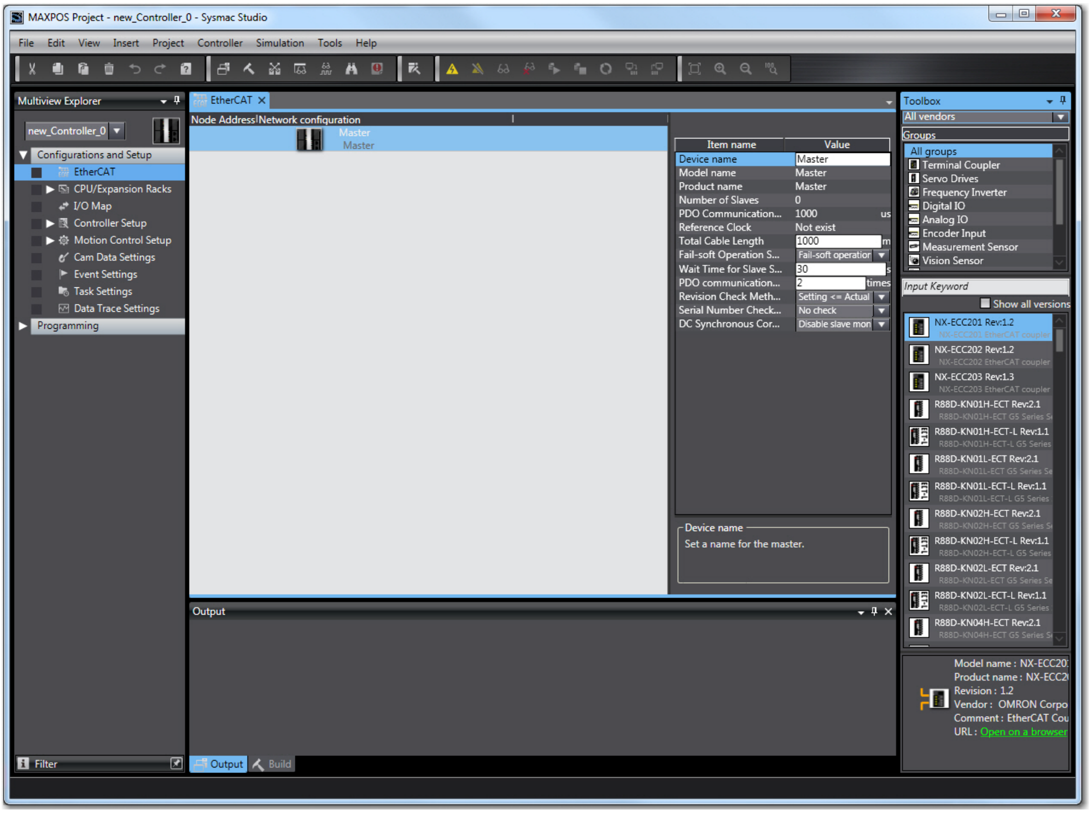

Figure 3-25 Integration – Omron Sysmac NJ | Master

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IMPORT ESI LIBRARY

3) In the EtherCAT tab, click right on the master and select ¤Display ESI Library¤.

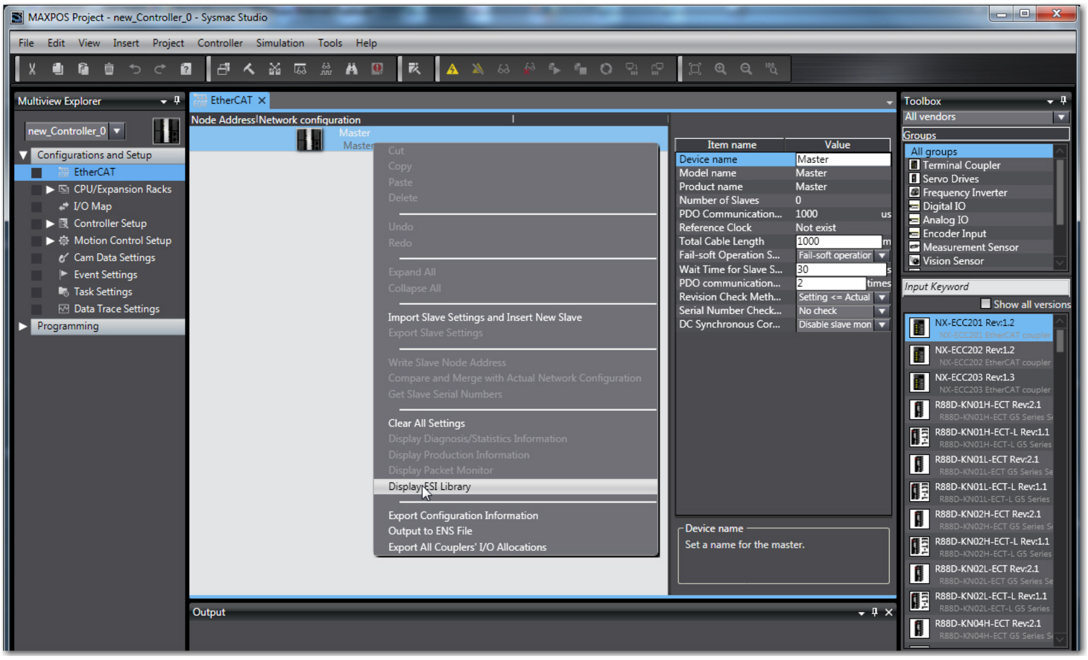


Figure 3-26 Integration – Omron Sysmac NJ | Import of ESI Library

4) Click ¤this Folder¤ to import the MAXPOS ESI file.

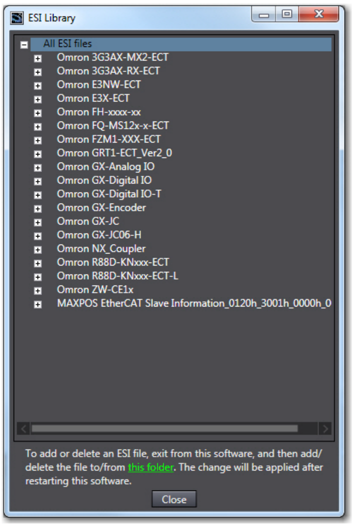


Figure 3-27 Integration – Omron Sysmac NJ | Import of MAXPOS ESI File

5) Store your settings, close and restart the «Sysmac Studio».

6) Select the desired MAXPOS slave(s) from the ¤Toolbox¤ and Drag&Drop it (them) to the ¤Master¤ in the EtherCAT tab.

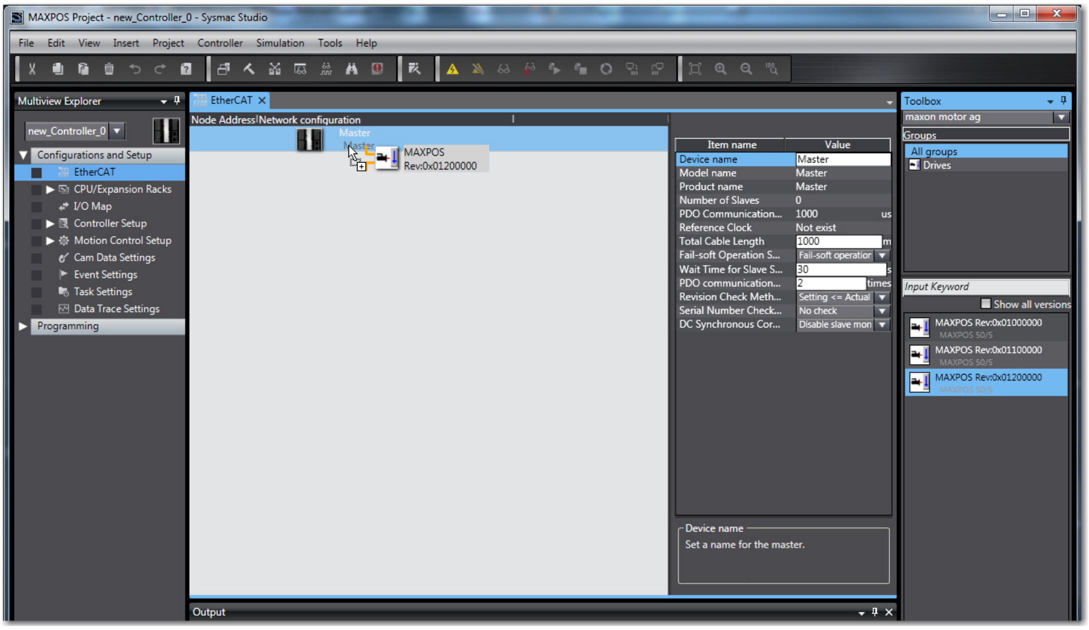


Figure 3-28 Integration – Omron Sysmac NJ | Slave

MAXPOS PARAMETERS

7) In the EtherCAT tab, click right on the slave and select ¤Edit Module Configuration¤.

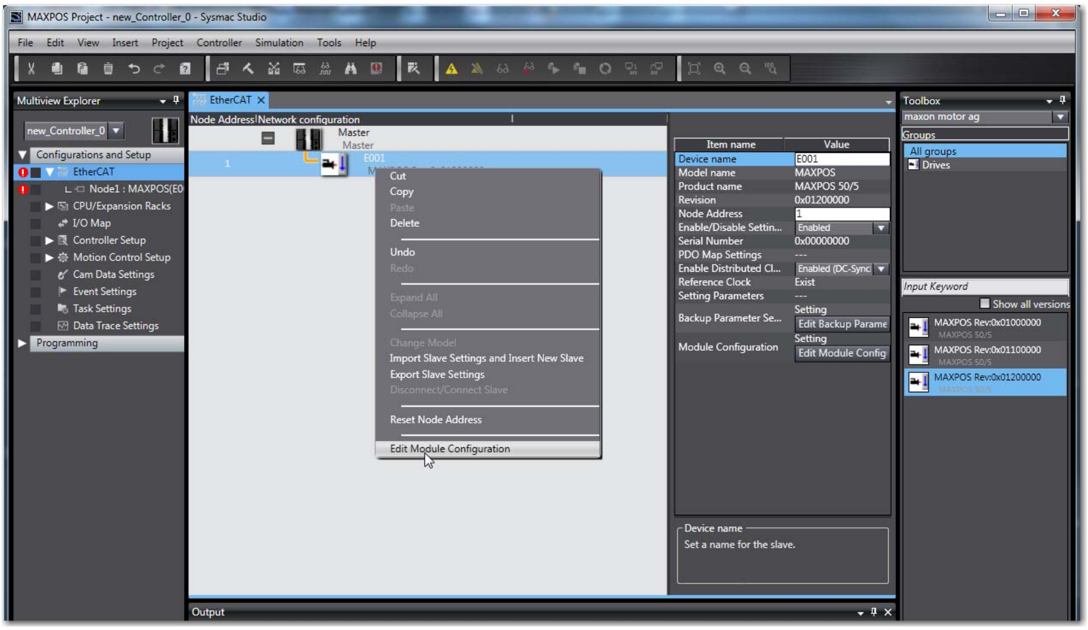


Figure 3-29 Integration – Omron Sysmac NJ | Slave Parameters

This will open a new tab named “Node1: MAXPOS (xxx)”.

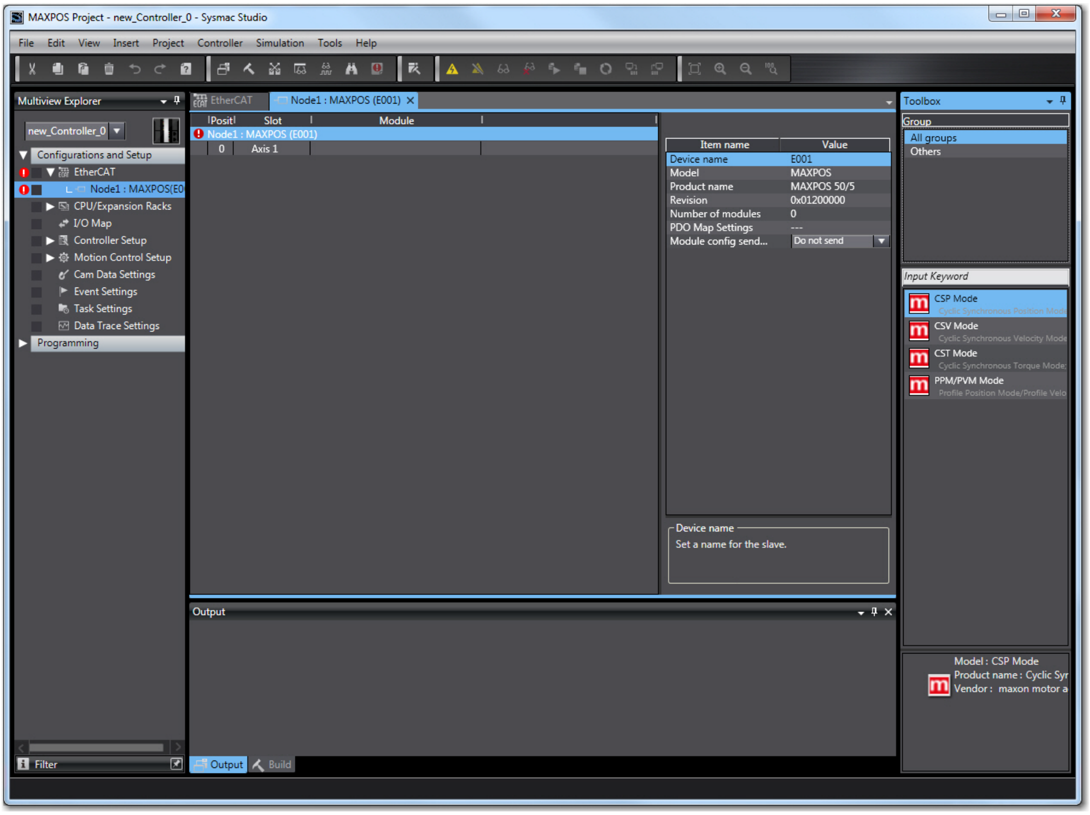


Figure 3-30 Integration – Omron Sysmac NJ | New Node

8) Select the desired operation mode from the ¤Toolbox¤ and Drag&Drop it to the respective axis in the EtherCAT tab.

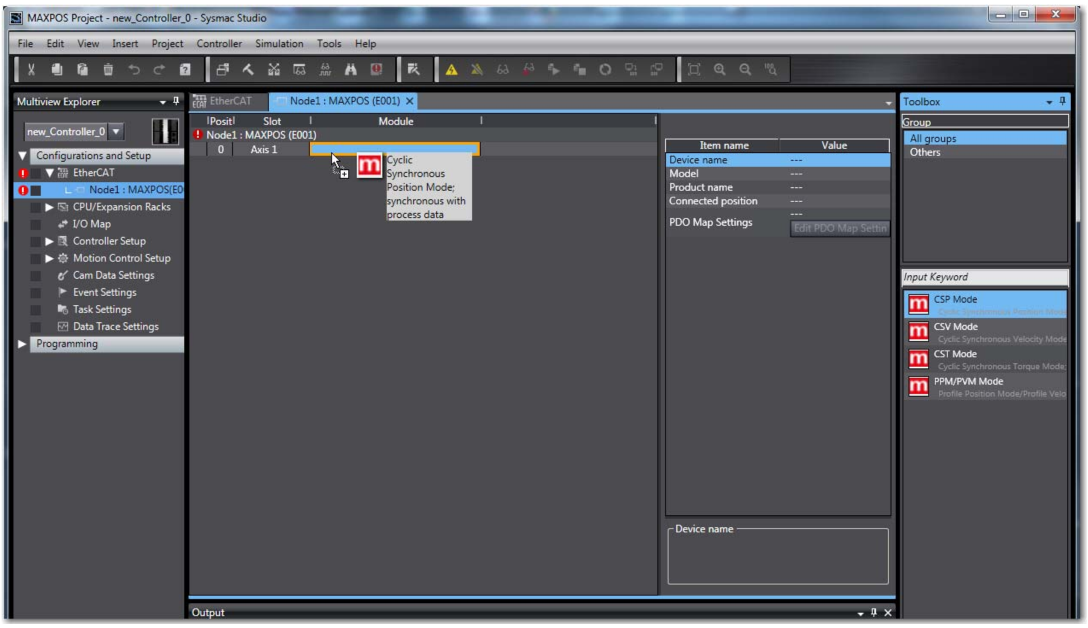


Figure 3-31 Integration – Omron Sysmac NJ | Operation Mode

9) Go Online to set the connection method (➔Omron's "Sysmac Studio Operation Manual").

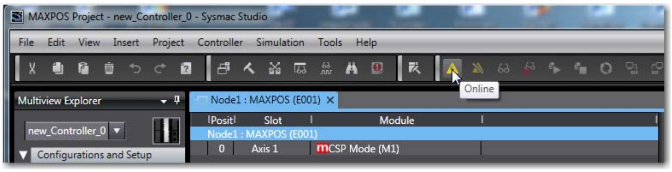


Figure 3-32 Integration – Omron Sysmac NJ | Going Online

10) In the EtherCAT tab, click right on the master and select ¤Write Slave Node Address¤.

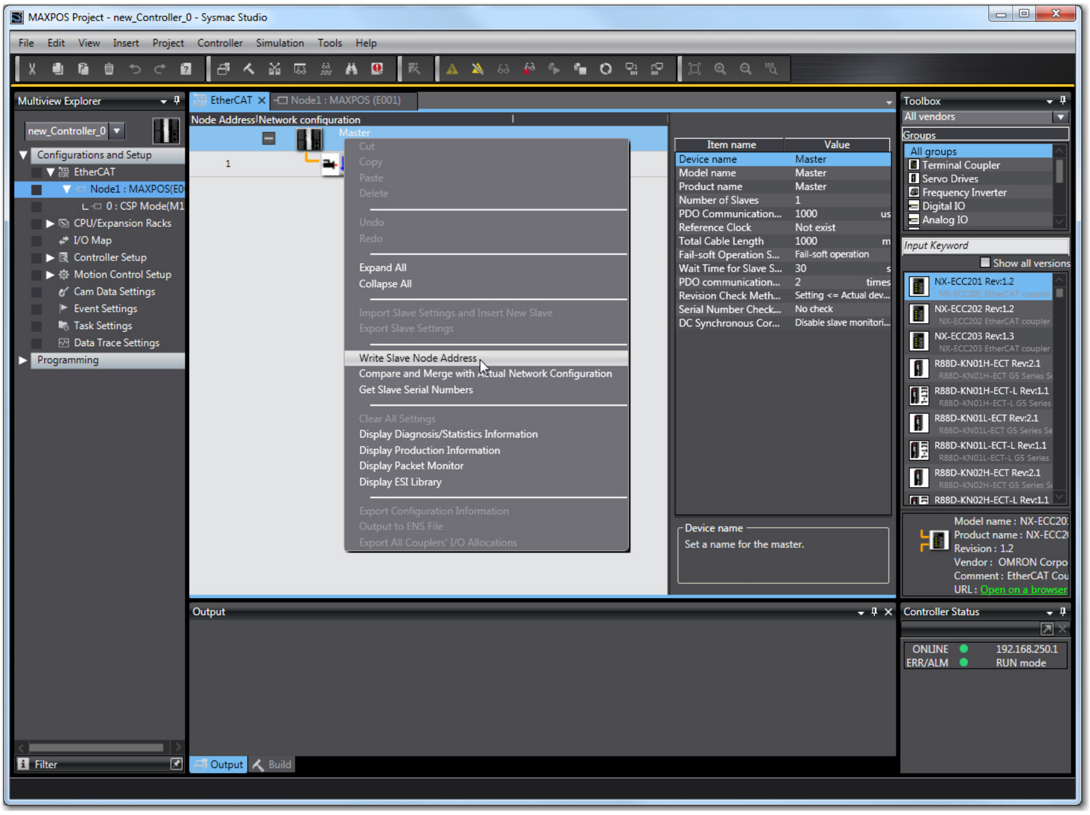


Figure 3-33 Integration – Omron Sysmac NJ | Slave Node Address

This will display a dialog box.

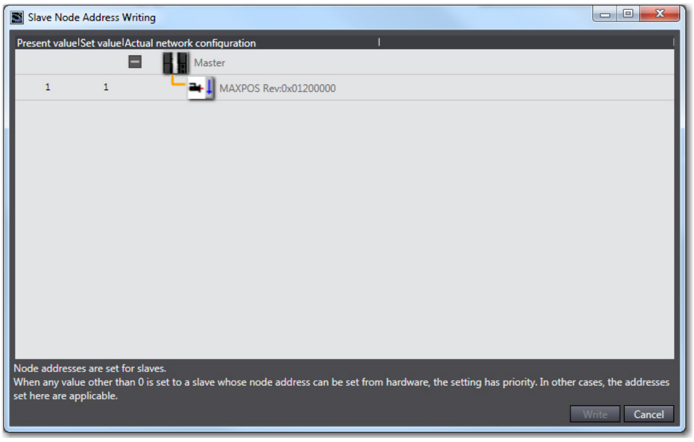


Figure 3-34 Integration – Omron Sysmac NJ | Slave Node Address Writing

11) If the node address is set correct, click ¤Cancel¤. Otherwise edit the node address and click ¤Write¤ and power off/power on the MAXPOS to activate the new node address.

12) In the EtherCAT tab, click right on the master and select ¤Compare and Merge with Actual Network Configuration¤.

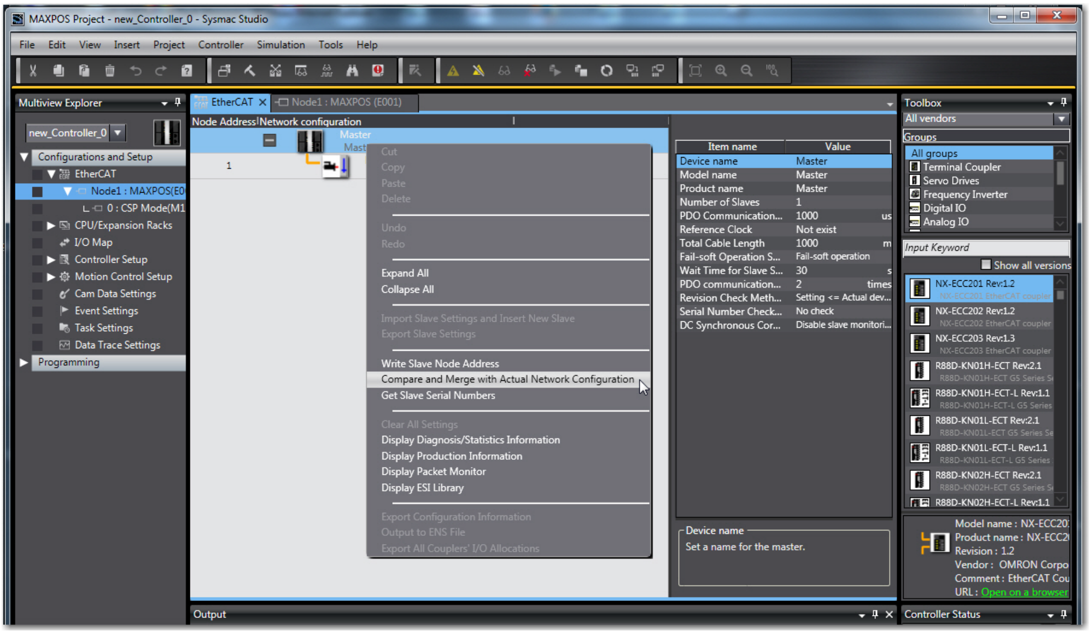


Figure 3-35 Integration – Omron Sysmac NJ | Network Configuration

13) Both the actual network and Sysmac Studio configuration will be read and compared. Upon completion, the results are displayed.

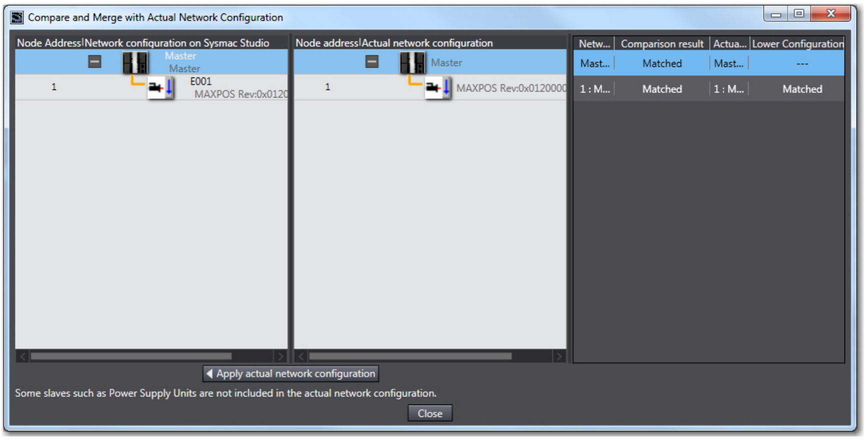


Figure 3-36 Integration – Omron Sysmac NJ | Comparison & Merger

14) Click ¤Apply actual network configuration¤, then click ¤Close¤.
15) Go Offline.
16) In the Multiview Explorer, click right on ¤Axis Settings¤ and select ¤Add¤, then ¤Axis Settings¤.

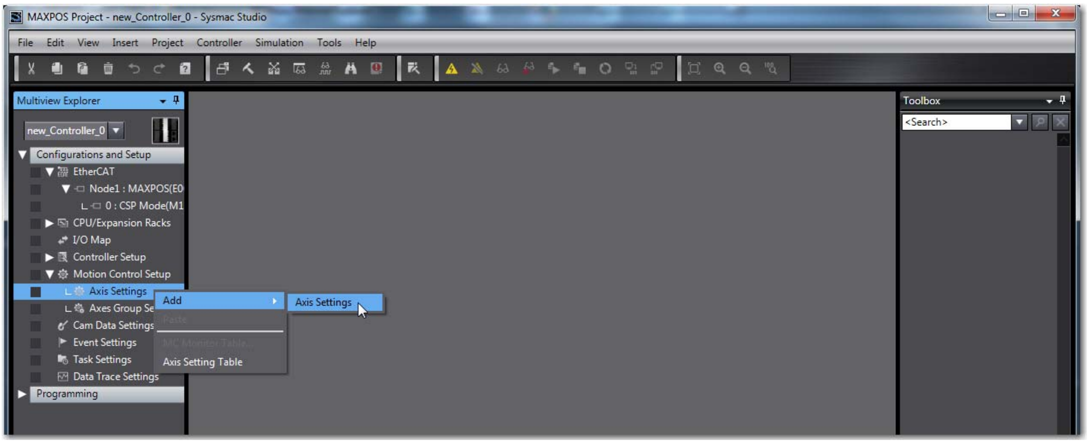


Figure 3-37 Integration – Omron Sysmac NJ | Axis Settings

17) Rename the axis as desired.

18) Go to ¤Axis Basic Settings¤ and set the following parameters:
– Axis use = Used axis
– Axis type = Servo axis
– Output device 1" = Node:1, Slot : 0 CSP Mode(M1)
Expand the Detail Settings pane and set the respective values in the columns ¤Device¤ and ¤Process Data¤.

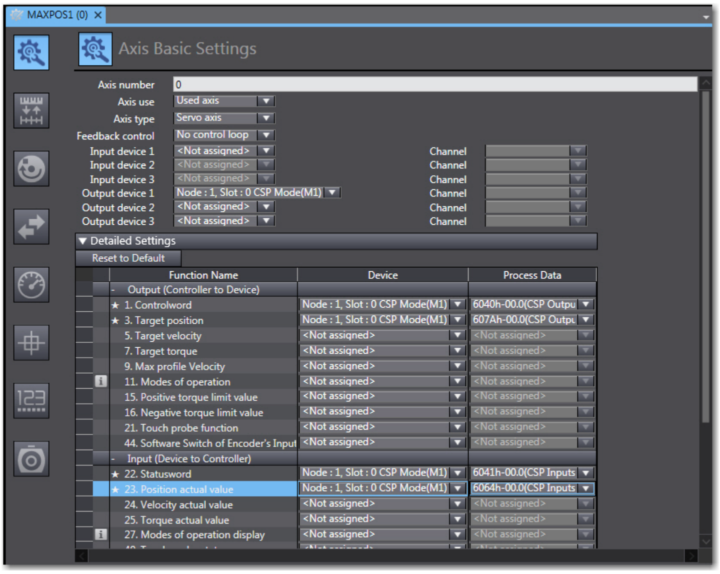


Figure 3-38 Integration – Omron Sysmac NJ | Axis Basic Settings

19) Go to ¤Unit Conversion Settings¤ and set the following parameters:
– pulses per motor rotation
– travel distance per motor rotation

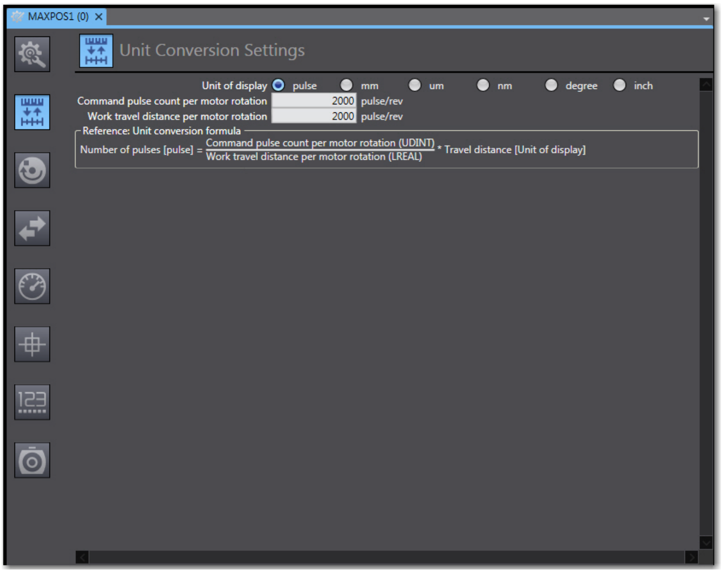


Figure 3-39 Integration – Omron Sysmac NJ | Unit Conversion Settings

20) Go to ¤ Operation Settings¤ and set the following parameters:
– velocity
– acceleration rate
– deceleration rate
– other monitor parameters

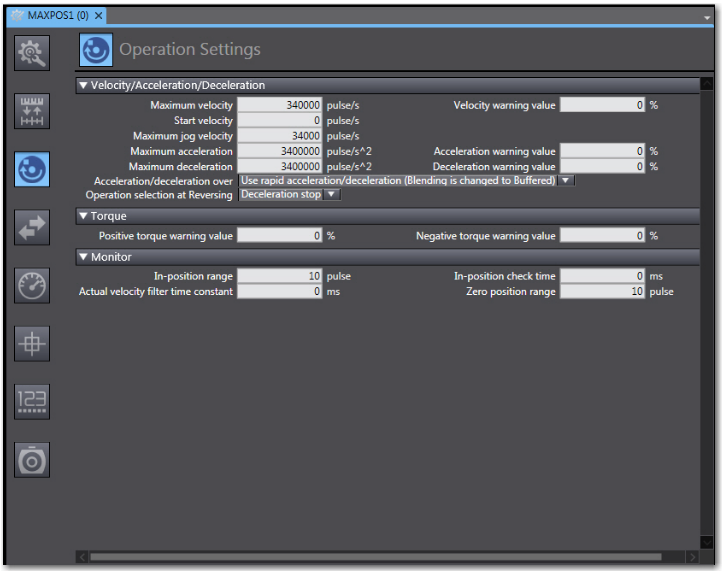


Figure 3-40 Integration – Omron Sysmac NJ | Operation Settings

21) Go to ¤ Servo Drive Settings¤ and set the following parameters:
– maximum position setting
– minimum position setting
– main circuit power supply OFF detection to ¤Do not detect¤.

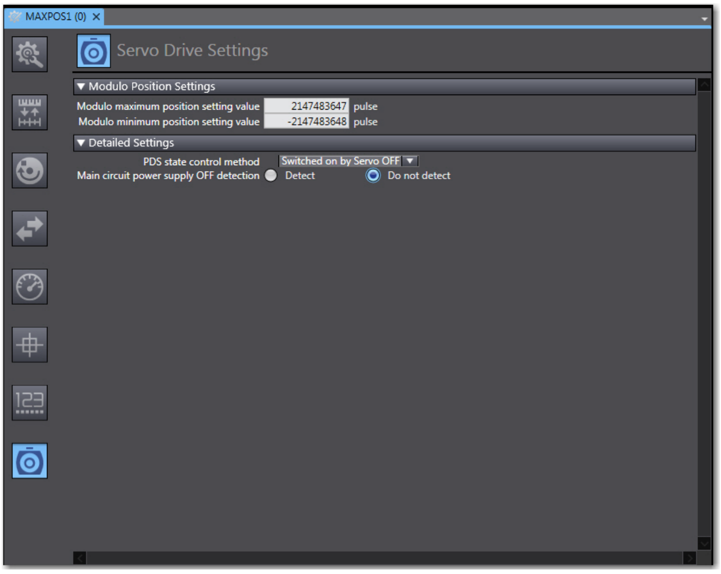


Figure 3-41 Integration – Omron Sysmac NJ | Servo Drive Settings

maxon

REGISTER ST PROGRAM

22) In the Multiview Explorer, select ¤Programming¤ \ ¤POUs¤, click right on ¤Programs¤ and select ¤Add¤ \ ¤Structured text¤.
"Program0" will now be added to ¤Programs¤.
Select ¤Program0¤, click right on ¤Add¤ \ ¤Section¤ to add a new section.

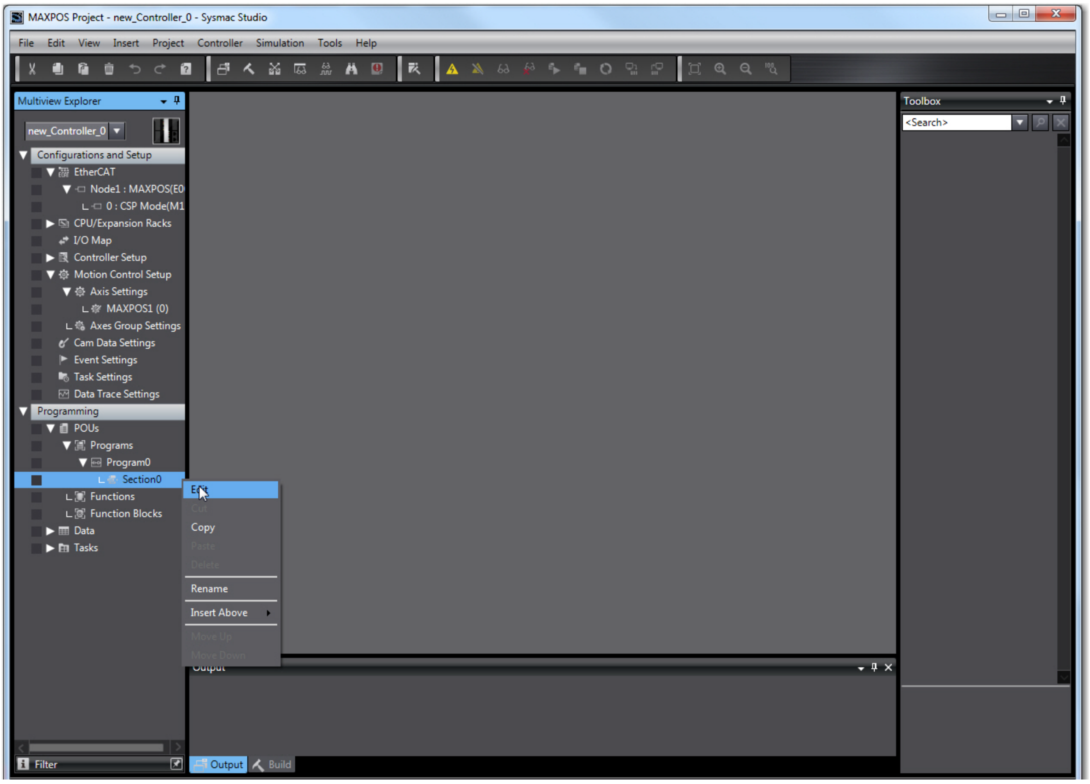


Figure 3-42 Integration – Omron Sysmac NJ | Register ST Program

23) Rename the newly added section to "VelOffsetPart".

24) Insert the following structure text and code. Define the variable as "External". Thereby…
60 = rescaling turns per second to turns per minute,
2000 = encoder impulse number per turn * 4 (for example, encoder with 500 impulses per turn: 500 * 4 = 2000).

Figure 3-43 Integration – Omron Sysmac NJ | Section0 Variables

25) Add the variable “Vel_Rpm_MAXPOS1” to the “I/O Map”.

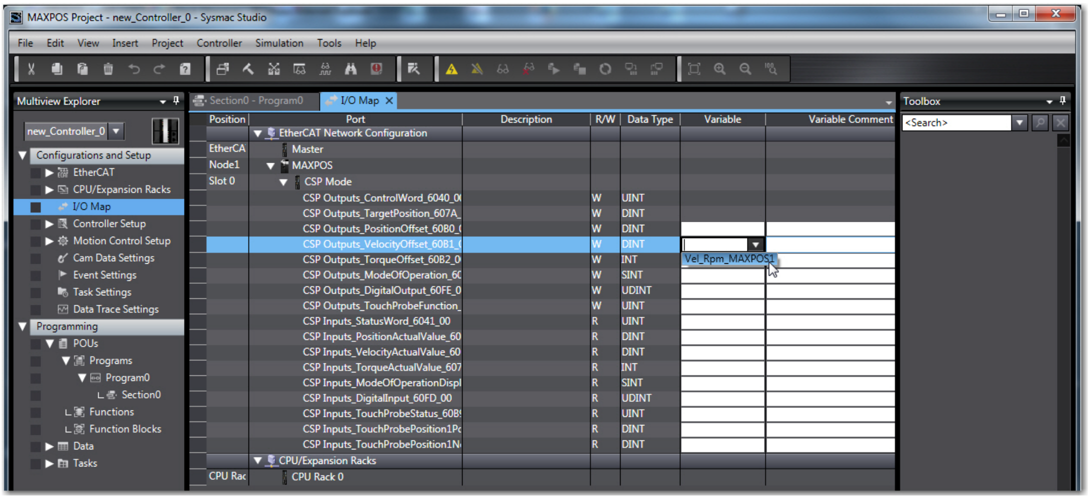


Figure 3-44 Integration – Omron Sysmac NJ | I/O Map

26) Add a new program in folder ¤Programming¤ \ ¤PUOs¤ \ ¤Programs¤.

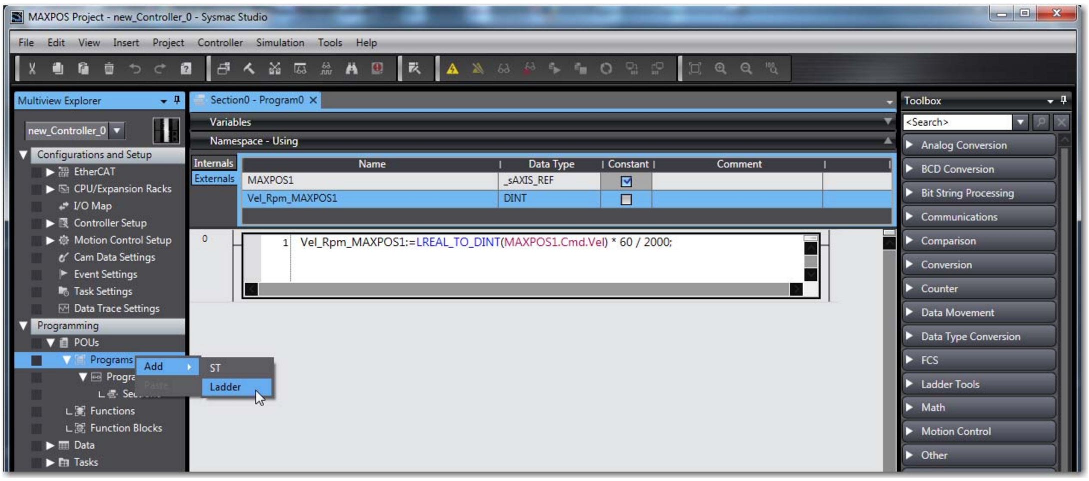


Figure 3-45 Integration – Omron Sysmac NJ | Program

27) Write a short program as to the following example:

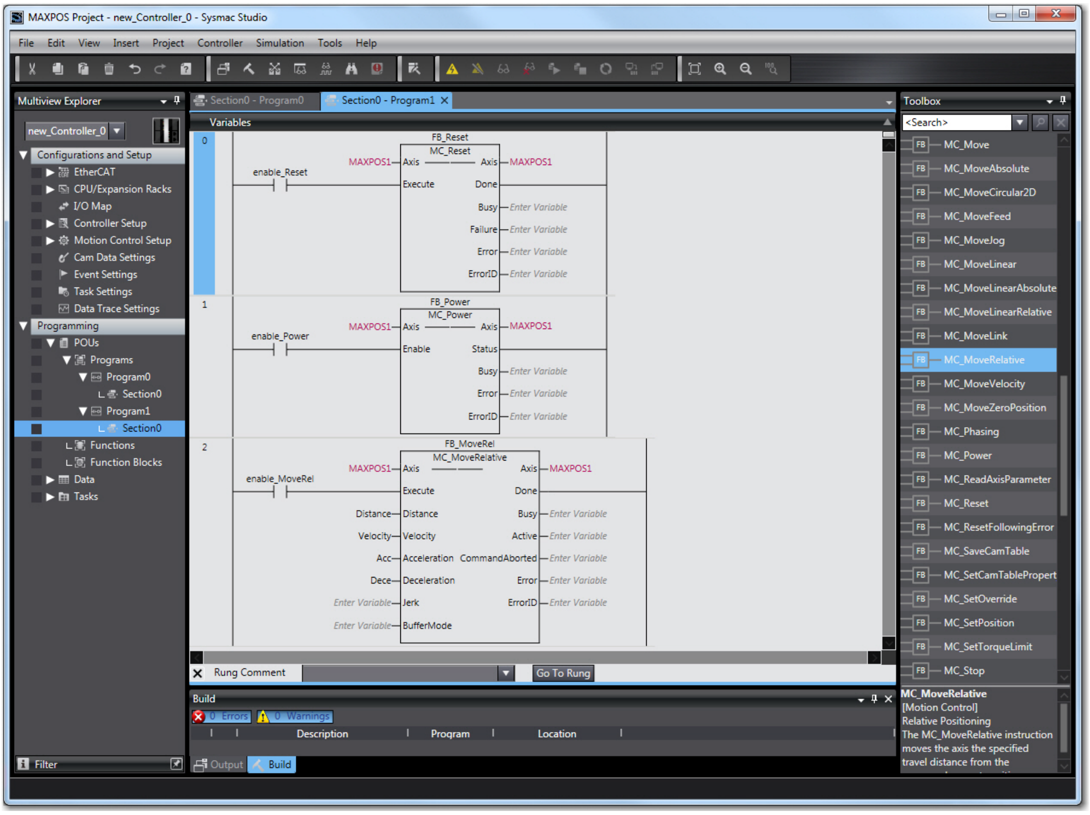


Figure 3-46 Integration – Omron Sysmac NJ | Example Program

TASK SETTINGS

28) Go to ¤Task Settings¤ and set the following parameters:
– Program0 (VelOffsetPart) must executed within the communication task
– the sample program may be executed in a lower task (set the tasks as below)

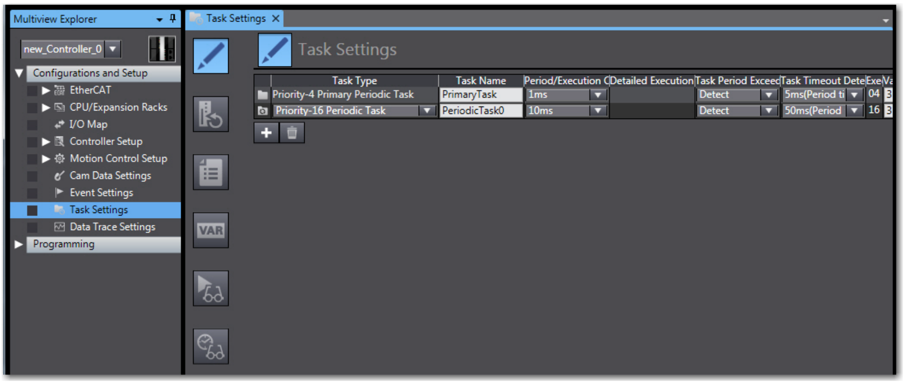


Figure 3-47 Integration – Omron Sysmac NJ | Task Settings

29) Go to ¤Program Assignment Settings¤ and assign the scaling program to the "Primary Task" and the application program to the "Periodic Task".

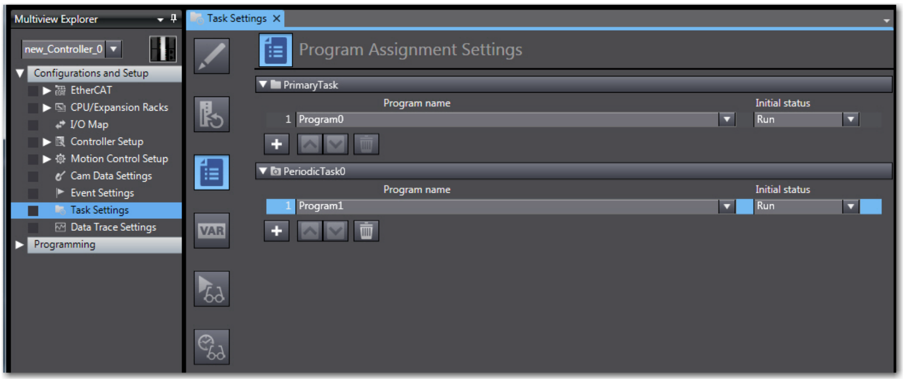


Figure 3-48 Integration – Omron Sysmac NJ | Program Assignment Settings

30) Go Online and download the program.

31) Click ¤Execute¤ to transfer the program to the controller.

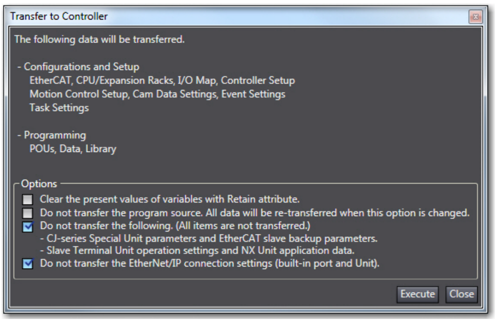


Figure 3-49 Integration – Omron Sysmac NJ | Transfer to Controller Options

32) Click ¤Yes¤ to confirm.

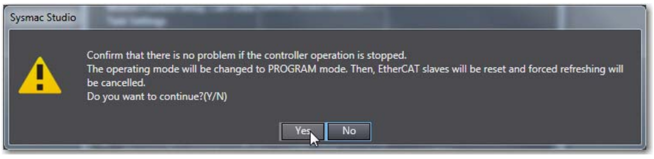


Figure 3-50 Integration – Omron Sysmac NJ | Controller Reset

4 PDO MAPPING

4.1 In Brief

OBJECTIVE

The present application note explains how to change the default PDO mapping settings and how to exclude or customize them using Beckhoff TwinCAT.

4.2 Changing PDO Mapping using Beckhoff TwinCAT

1) Select the device using the project tree in “Solution Explorer”. Click the PDO you wish to edit.

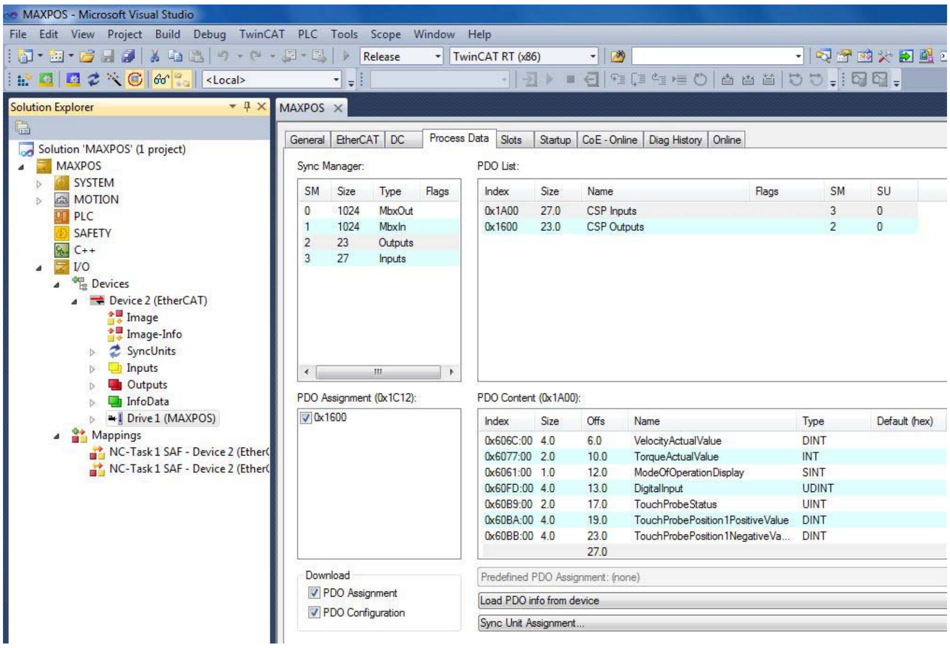


Figure 4-51 PDO Mapping – Beckhoff TwinCAT | Process Data Display

maxon

2) Click the desired preconfigured PDO mapping from the list. Then click right to open the context menu.
Click either ¤Delete¤ to remove an existing variable or ¤Insert¤ to add < new variable.

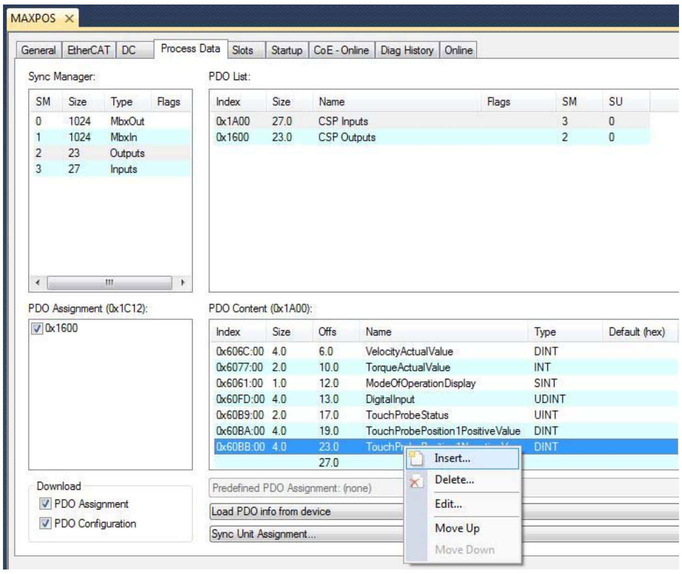


Figure 4-52 PDO Mapping – Beckhoff TwinCAT | Select PDO from Default List

3) Choose the object you wish to map.

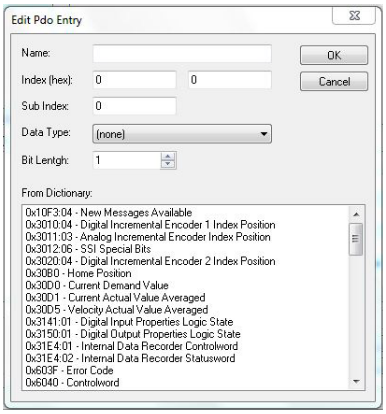


Figure 4-53 PDO Mapping – Beckhoff TwinCAT | Edit PDO Values

4) You may map up to ten objects for RxPDO and ten for TxPDO.
Do so by entering the object name and the desired values, then press ¤OK¤. Repeat for other objects, if desired.
For details on the default settings ➔Table 4-10 and ➔Table 4-11.

PDO Index	Default Value	Bit Length	Description	Function Group
0x1600	0x6040	16	Controlword	Cyclic Synchronous Position Mode
	0x607A	32	Target Position	
	0x60B0	32	Position Offset	
	0x60B1	32	Velocity Offset	
	0x60B2	16	Torque Offset	
	0x6060	8	Mode of Operation	
	0x60FE	32	Digital Output	
	0x60B8	16	Touch Probe Function	
0x1601	0x6040	16	Controlword	Cyclic Synchronous Velocity Mode
	0x60FF	32	Target Velocity	
	0x60B1	32	Velocity Offset	
	0x60B2	16	Torque Offset	
	0x6060	8	Mode of Operation	
	0x60FE	32	Digital Output	
	0x60B8	16	Touch Probe Function	
0x1602	0x6040	16	Controlword	Cyclic Synchronous Torque Mode
	0x6071	16	Target Torque	
	0x60B2	16	Torque Offset	
	0x6060	8	Mode of Operation	
	0x60FE	32	Digital Output	
	0x60B8	16	Touch Probe Function	
0x1603	0x6040	16	Controlword	Profile Position Mode Profile Velocity Mode
	0x607A	32	Target Position	
	0x60FF	32	Target Velocity	
	0x6083	32	Profile Acceleration	
	0x6084	32	Profile Deceleration	
	0x6081	32	Profile Velocity	
	0x6060	8	Mode of Operation	
	0x60FE	32	Digital Output	

Table 4-10 PDO Mapping – Default Values for RxPDO

PDO Index	Default Value	Bit Length	Description	Size [Bits]
0x1A00	0x6041	16	Statusword	Cyclic Synchronous Position Mode
	0x6064	32	Position Actual Value	
	0x606C	32	Velocity Actual Value	
	0x6077	16	Torque Actual Value	
	0x6061	8	Mode of Operation Display	
	0x60FD	32	Digital Input	
	0x60B9	16	Touch Probe Status	
	0x60BA	32	Touch Probe Position 1 Positive Value	
	0x60BB	32	Touch Probe Position 1 Negative Value	
0x1A01	0x6041	16	Statusword	Cyclic Synchronous Velocity Mode
	0x6064	32	Position Actual Value	
	0x606C	32	Velocity Actual Value	
	0x6077	16	Torque Actual Value	
	0x6061	8	Mode of Operation Display	
	0x60FD	32	Digital Input	
	0x60B9	16	Touch Probe Status	
	0x60BA	32	Touch Probe Position 1 Positive Value	
	0x60BB	32	Touch Probe Position 1 Negative Value	
0x1A02	0x6041	16	Statusword	Cyclic Synchronous Torque Mode
	0x6064	32	Position Actual Value	
	0x606C	32	Velocity Actual Value	
	0x6077	16	Torque Actual Value	
	0x6061	8	Mode of Operation Display	
	0x60FD	32	Digital Input	
	0x60B9	16	Touch Probe Status	
	0x60BA	32	Touch Probe Position 1 Positive Value	
	0x60BB	32	Touch Probe Position 1 Negative Value	
0x1A03	0x6041	16	Statusword	Profile Position Mode Profile Velocity Mode
	0x6064	32	Position Actual Value	
	0x606C	32	Velocity Actual Value	
	0x6078	16	Current Actual Value	
	0x60F4	32	Following Error Actual Value	
	0x6061	8	Mode of Operation Display	
	0x60FD	32	Digital Input	

Table 4-11 PDO Mapping – Default Values for TxPDO

5 EXTENDED ENCODERS CONFIGURATION

OBJECTIVE

The present application note explains the configuration of some selected BiSS-C encoder types. Nevertheless, it will not explain BiSS-C fundamentals.

SCOPE

Hardware	Order #	Firmware Version	Reference
MAXPOS		0121h	Firmware Specification
MAXPOS 50/5	447293	0121h or higher	Hardware Reference

Table 5-12 PDO Mapping – covered Hardware and required Documents

TOOLS

Tools	Description
Software	«MAXPOS Studio» Version 1.3 or higher

Table 5-13 PDO Mapping – recommended Tools

5.1 BiSS-C Absolute Serial Encoder

5.1.1 Requirements

Using a BiSS encoder with bidirectional communication capability is mandatory.

The MAXPOS checks on the used type of encoder by polling certain information on the bidirectional data exchange. With a BiSS encoder featuring just unidirectional communication, a respective BiSS error state will be the result due to a timed-out data exchange.

Take note that it is not possible to operate the MAXPOS with a BiSS encoder that offers only unidirectional communication. Therefore, check the BiSS encoder's communication type by consulting the data sheet or other suitable information made available by the supplier of the encoder. If a BiSS encoder with bidirectional communication capability should not be available, choose another type of encoder instead.

TECHNICAL BACKGROUND

BiSS specifies both bidirectional and unidirectional communication. In addition, other features, such as electronic data sheets, are specified although most of these features are not mandatory. There is some variation on these higher layers and features and if and how they actually are implemented by the encoder suppliers.

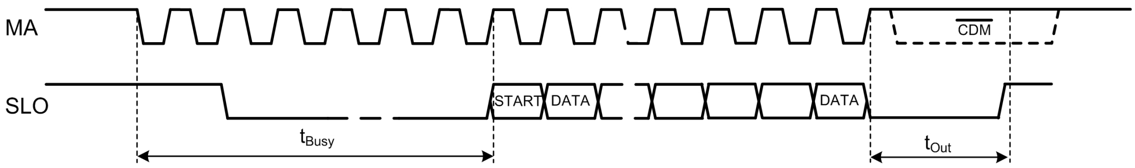
Bidirectional communication enables the controller to read certain information of the encoder. Most BiSS encoders support bidirectional data exchange because this can be seen as one of the BISS-C's key advantages (compared to SSI).

MAXPOS'S BISS IMPLEMENTATION

The MAXPOS uses peer-to-peer communication relying on bidirectional data exchange (with CDM and CDS) during initialization phase to poll certain base data for identification of the encoder. This cannot work if the encoder supports unidirectional communication only. It is then not possible for the MAXPOS to request for data of the encoder, such as reading information of an electronic data sheet. If the encoder does not respond to a bidirectional communication request, as a consequence, the MAXPOS encoder initialization routines will end up with a BiSS time-out error state. The MAXPOS will then stop any further communication due to the missing reaction of the encoder, the MAXPOS' internal state for exchanging position data is not reached because the encoder does not reply to the initial request.

5.1.2 Configuration

5.1.2.1 Timing



CDM	Control Data Master Bit	START	Start Bit
MA	Master Clock	t_{Busy}	Busy Time
SLO	Slave Data Out	t_{Out}	Timeout Time

Figure 5-54 Extended Encoders – BiSS | Timing

Note
If t_{Busy} or $t_{Timeout\ Time}$ (t_{Out}) should not be specified by the manufacturer, start with 40 µs and iteratively reduce until a communication error occurs. Data rate, number of data bits, and timeout time will affect the sampling rate. Therefore, keep timeout time and busy time as short as possible.

5.1.2.2 Data Frame

Data Frame

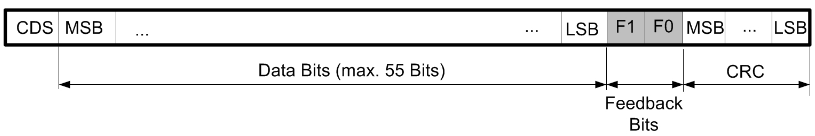


Figure 5-55 Extended Encoders – BiSS | Data Frame

5.1.2.3 Difference between Position Bits and Data Bits

The maximum position size that can be processed by MAXPOS is 32 bits internally. Therefore, the original data size must be manually reduced if necessary. For original multi-turn data sizes smaller 32 bits, no reduction is required. Single-turn encoders are limited by 31 bits.

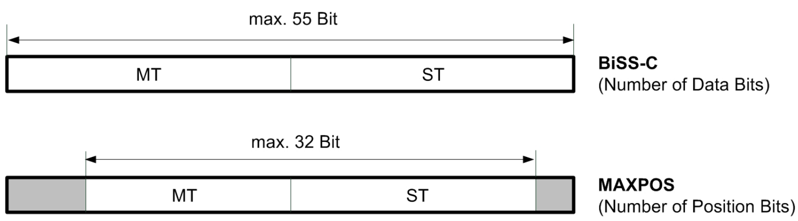
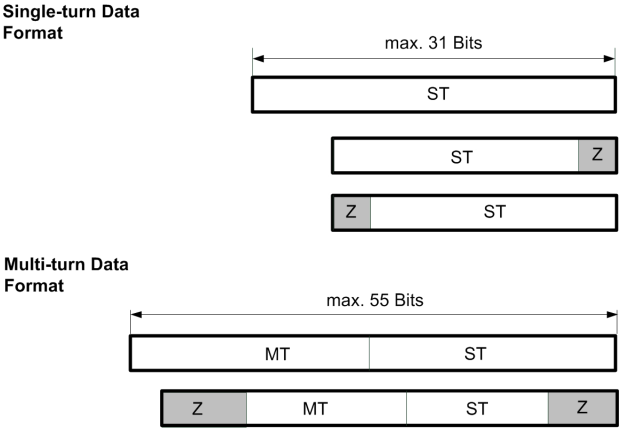


Figure 5-56 Extended Encoders – BiSS | Position Bits

5.1.2.4 Supported Data Formats

Some encoder manufacturers require 12 Bit data patterns (BiSS-C Profile BP1). Therefore, the original data is padded with zeros if its own data format is unequal to n* 12 bit. Zero padding can be left or right aligned. Data alignment is defined by the object "Data Format 0x3014-0x06".



ST	Single-turn	Z	Zero bits (12 bit padding)
MT	Multi-turn		

Figure 5-57 Extended Encoders – BiSS | Data Formats

5.1.3 Configuration Examples

MAXON BISS 12 BIT SINGLE-TURN #488783

Object ID	Object Name	Value	Comment
0x3014-0x03	BiSS Data Rate	3400 kBit/s	Up to 9400 kBit/s possible
0x3014-0x04	BiSS Timeout Time	3 µs	
0x3014-0x05	BiSS Busy Time	1 µs	
0x3014-0x06	BiSS Data Bits		
	Single-turn Bits	12	
	Multi-turn Bits	0	
	Data Format	Single-turn	Without zero bits, right aligned
	F0	none	
	F1	Error	
0x3014-0x07	BiSS Position Bits		
	Single-turn Bits	12	
	Multi-turn Bits	0	
0x3014-0x08	BiSS Encoder Type		
	Direction	CCW	Depending on application
0x3014-0x09	BiSS Encoder Protocol		
	CRC Polarity	CRC inverse	
	CRC Polynomial	0x43	

Table 5-14 Extended Encoders – BiSS | Configuration Example MAXON 12 Bit ST

HENGSTLER 19 BIT SINGLE-TURN, AD34/0019AU.ONBVB

Object ID	Object Name	Value	Comment
0x3014-0x03	BiSS Data Rate	3400 kBit/s	Up to 7500 kBit/s possible
0x3014-0x04	BiSS Timeout Time	15 µs	
0x3014-0x05	BiSS Busy Time	4 µs	
0x3014-0x06	BiSS Data Bits		
	Single-turn Bits	19	
	Multi-turn Bits	0	
	Data Format	Single-turn	Without zero bits, right aligned
	F0	none	
	F1	Error	
0x3014-0x07	BiSS Position Bits		
	Single-turn Bits	19	
	Multi-turn Bits	0	
0x3014-0x08	BiSS Encoder Type		
	Direction	CCW	Depending on application
0x3014-0x09	BiSS Encoder Protocol		
	CRC Polarity	CRC inverse	
	CRC Polynomial	0x43	

Table 5-15 Extended Encoders – BiSS | Configuration Example Hengstler 19 Bit ST

HENGSTLER 12 BIT MULTI-TURN, 19 BIT SINGLE-TURN AD34/1219AU.ONBVB

Object ID	Object Name	Value	Comment
0x3014-0x03	BiSS Data Rate	3400 kBit/s	Up to 9400 kBit/s possible
0x3014-0x04	BiSS Timeout Time	12 µs	
0x3014-0x05	BiSS Busy Time	5 µs	
0x3014-0x06	BiSS Data Bits		
	Single-turn Bits	19	
	Multi-turn Bits	12	
	Data Format	Multi-turn Single-turn	Without zero bits, right aligned
	F0	none	
	F1	Error	
0x3014-0x07	BiSS Position Bits	1	
	Single-turn Bits	19	
	Multi-turn Bits	12	
0x3014-0x08	BiSS Encoder Type		
	Direction	CCW	Depending on application
0x3014-0x09	BiSS Encoder Protocol		
	CRC Polarity	CRC inverse	
	CRC Polynomial	0x43	

Table 5-16 Extended Encoders – BiSS | Configuration Example Hengstler 12 Bit MT

KÜBLER SENDIX ABSOLUTE TYPE 5873, 17 BIT SINGLE-TURN

Object ID	Object Name	Value	Comment
0x3014-0x03	BiSS Data Rate	3400 kBit/s	Up to 7500 kBit/s possible
0x3014-0x04	BiSS Timeout Time	16 µs	
0x3014-0x05	BiSS Busy Time	4 µs	
0x3014-0x06	BiSS Data Bits		
	Single-turn Bits	17	
	Multi-turn Bits	0	
	Data Format	Single-turn	Without zero bits, right aligned
	F0	none	
	F1	Error	
0x3014-0x07	BiSS Position Bits		
	Single-turn Bits	17	
	Multi-turn Bits	0	
0x3014-0x08	BiSS Encoder Type		
	Direction	CCW	Depending on application
0x3014-0x09	BiSS Encoder Protocol		
	CRC Polarity	CRC inverse	
	CRC Polynomial	0x43	

Table 5-17 Extended Encoders – BiSS | Configuration Example Kübler Sendix 17 Bit ST

KÜBLER SENDIX ABSOLUTE TYPE F3663, 24 BIT MULTI-TURN, 17 BIT SINGLE-TURN

Object ID	Object Name	Value	Comment
0x3014-0x03	BiSS Data Rate	3400 kBit/s	Up to 7500 kBit/s possible
0x3014-0x04	BiSS Timeout Time	16 µs	
0x3014-0x05	BiSS Busy Time	4 µs	
0x3014-0x06	BiSS Data Bits		
	Single-turn Bits	17	
	Multi-turn Bits	24	
	Data Format	Single-turn	Without zero bits, right aligned
	F0	none	
	F1	Error	
0x3014-0x07	BiSS Position Bits		
	Single-turn Bits	17	
	Multi-turn Bits	15	Position bits aligned to 32 bits in a sum (MT/ST)
0x3014-0x08	BiSS Encoder Type		
	Direction	CCW	Depending on application
0x3014-0x09	BiSS Encoder Protocol		
	CRC Polarity	CRC inverse	
	CRC Polynomial	0x43	

Table 5-18 Extended Encoders – BiSS | Configuration Example Kübler Sendix 24 Bit MT/17 Bit ST

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6 USING SAFE TORQUE OFF (STO) FUNCTIONALITY

6.1 In Brief

OBJECTIVE

The MAXPOS offers the STO (Safe Torque Off) safety feature based on IEC61800-5-2.

The present application note explains how to setup and configure the MAXPOS controller for using the STO functionality. Certification of the STO functionality is under process but not yet finalized. Thus, up to now, the STO functionality of the MAXPOS is not certified.

6.2 Functionality

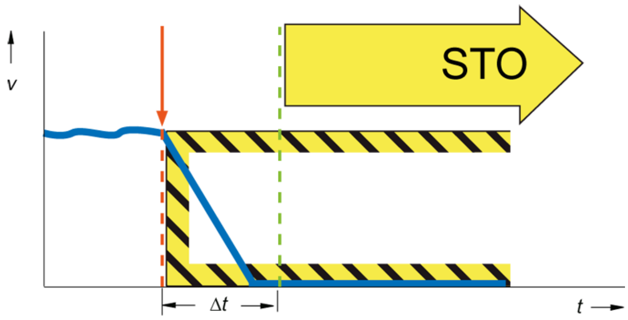

Figure 6-58 Safe Torque Off (STO) – Working Principle

The STO function is the most common and basic drive-integrated safety function. It ensures that no torque-generating energy can continue to act on a motor and prevents unintentional starting.

STO has the immediate effect that the drive can no longer supply any torque-generating energy. STO can be used whenever the drive will be brought to a standstill in a sufficiently short time by load torque or friction, or if coasting down of the drive is not relevant to safety. STO enables safe working when, for example, the protective door is open (restart interlock) and has a wide range of uses in machinery with moving axes (such as handling or conveyor systems).

Mechanical brakes must be used if output shafts of motors or gearboxes are affected by forces that could trigger a movement once the motor has been shut down. Possible applications are vertical axes or motors with high inertia.

6.3 STO I/O States

The below table defines the behavior of the STO inputs.

STO-IN1 (DigIN5)	STO-IN2 (DigIN6)	STO-OUT(DigOUT4)	Power Stage
Inactive	Inactive	Inactive	Disabled
Inactive	Active	Inactive	Disabled
Active	Inactive	Inactive	Disabled
Active	Active	Active	Can be enabled

Table 6-19 Safe Torque Off (STO) – States of STO I/Os

6.4 Configuration

6.4.1 Hardware Settings

By default, the galvanic isolated digital inputs 5 and 6 are defined as “general purpose inputs” and digital output 4 is defined as “general purpose output”. With the following steps they will be set for «Safe Torque OFF».

STOP!
Make sure to disconnect the MAXPOS controller from any power source.

1) Open the housing.
2) Find jumper JP3 (➔Figure 6-59).

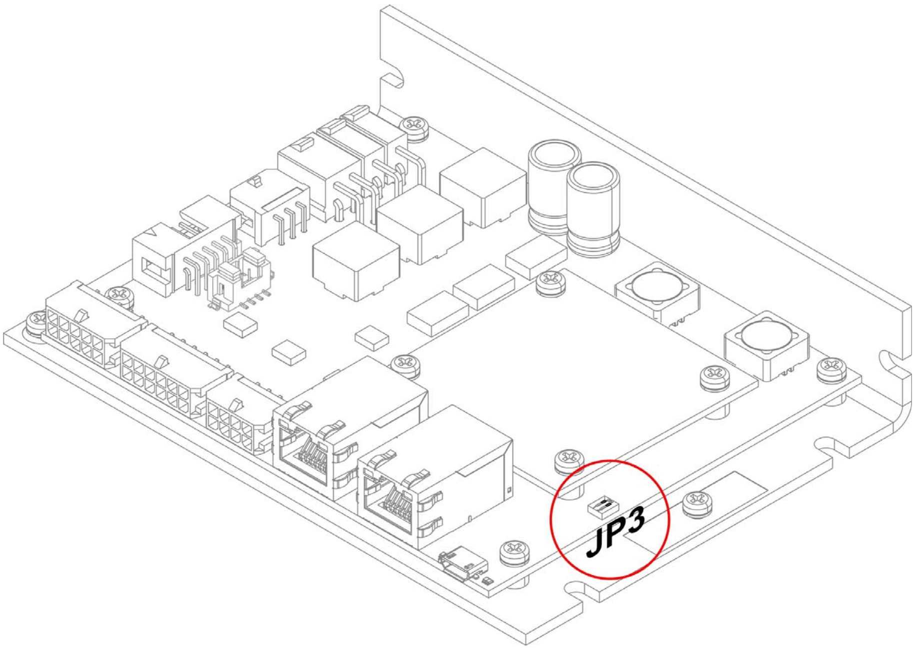

Figure 6-59 Safe Torque Off (STO) | MAXPOS 50/5 – Location JP3

3) Set **both** jumper switches 1 and 2 to “OFF” (➔Figure 6-60).

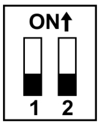

Figure 6-60 Safe Torque Off (STO) | MAXPOS 50/5 – JP3 OFF; STO activated

4) Close the housing.

The MAXPOS controller is now configured for STO functionality:

- DigIN5 (X7 pin 7) and DigIN6 (X7 pin 8) are now set as STO input (STO-IN1 and STO-IN2).
- DigOUT 4 (X8 pin 6) is now set as STO-OUT (Safe Torque OFF output signal).

6.4.2 Digital Inputs 5 and 6 PLC Level

DigIN5…6	
Type of input	Galvanic isolated, single-ended
Input voltage	+24 VDC
Max. input voltage	±30 VDC
Logic 0	U_{in} <5 VDC
Logic 1	U_{in} >9 VDC
Input current at logic 1	>1.5 mA @ 5 VDC >2.0 mA @ 9 VDC typically 2.6 mA @ 24 VDC
Switching delay	<2 µs @ 24 VDC

Table 6-20 Safe Torque Off (STO) | DigIN5…6

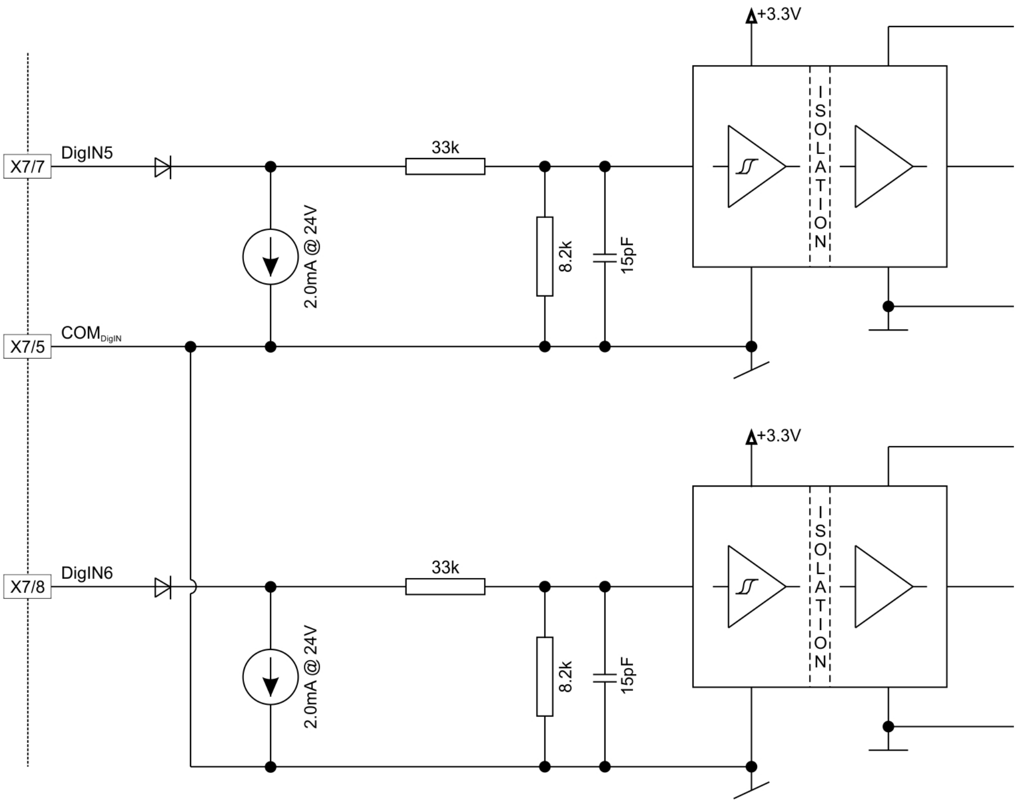

Figure 6-61 Safe Torque Off (STO) | DigIN5…6 Input Circuit – PLC Level

6.4.3 Digital Output 4

DigOUT4	
Type of output	Galvanic isolated, open source
Output voltage	$U_{out} \geq (+V_{DigOUT} - 0.2\ V)$
Max. load current	$I_{load} \leq 500$ mA
Leakage current	$I_{leak} \leq 10$ µA
Switching delay (rising edge)	<50 µs @ 24 VDC; $I_{load} \leq 10$ mA
Switching delay (falling edge)	<200 µs @ 24 VDC; $I_{load} \leq 10$ mA
Max. load inductance	175 mH @ 500 mA

Table 6-21 Safe Torque Off (STO) | DigOUT4

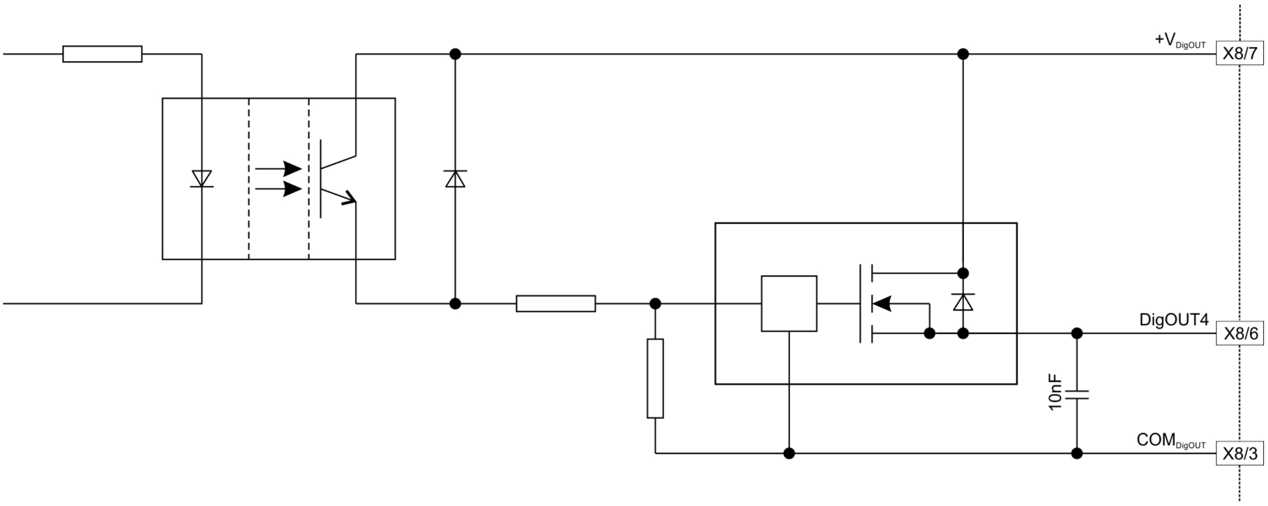

Figure 6-62 Safe Torque Off (STO) | DigOUT4 Output Circuit

LIST OF FIGURES

LIST OF TABLES

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INDEX

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