# HITACHI PROGRAMMABLE AUTOMATION CONTROLLER



# APPLICATION MANUAL (Motion) (SERVICE MANUAL)



### O Warranty period and coverage

The warranty period is the shorter period either 18 months from the date of manufacture or 12 months from the date of installation.

However within the warranty period, the warranty will be void if the fault is due to;

- (1) Incorrect use as directed in this manual and the application manual.
- (2) Malfunction or failure of external other devices than this unit.
- (3) Attempted repair by unauthorized personnel.
- (4) Natural disasters.

The warranty is for the PLC only, any damage caused to third party equipment by malfunction of the PLC is not covered by the warranty.

### O Repair

Any examination or repair after the warranty period is not covered. And within the warranty period any repair and examination which results in information showing the fault was caused by any of the items mentioned above, the repair and examination cost are not covered. If you have any questions regarding the warranty please contact with your supplier or the local Hitachi Distributor. (Depending on failure part, examination might be impossible.)

### O Ordering parts or asking questions

When contacting us for repair, ordering parts or inquiring about other items, please have the following details ready before contacting the place of purchase.

- (1) Model
- (2) Manufacturing number (MFG.NO.)
- (3) Details of the malfunction

### O Reader of this manual

This manual is described for the following person.

- Person considering the introduction of PLC
- PLC system engineer
- · Person handling PLC
- Manager after installing PLC

### Warning

- (1) This manual may not be reproduced in its entirety or ant portion thereof without prior consent.
- (2) The content of this document may be changed without notice.
- (3) This document has been created with utmost care. However, if errors or questionable areas are found, please contact us.

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# Safety Precautions

Read this manual and related documents thoroughly before installing, operating, performing preventive maintenance or performing inspection, and be sure to use the unit correctly. Use this product after acquiring adequate knowledge of the unit, all safety information, and all cautionary information. Also, make sure this manual enters the possession of the chief person in charge of safety maintenance.

Safety caution items are classifies as "Danger" and "Caution" in this document.



: Cases where if handled incorrectly a dangerous circumstance may be created, resulting in possible death or severe injury.



: Cases where if handled incorrectly a dangerous circumstance may be created, resulting in possible minor to medium injury to the body, or only mechanical damage

However, depending on the circumstances, items marked with



may result in major accidents.

In any case, they both contain important information, so please follow them closely.

Icons for prohibited items and required items are shown blow:

: Indicates prohibited items (items that may not be performed). For example, when open flames are prohibited, is shown.

: Indicates required items (items that must be performed). For example, when grounding must be performed, is shown.

### 1. Installation

# 

- Use this product in an environment as described in the catalog and this document. If this product is used in an environment subject to high temperature, high humidity, excessive dust, corrosive gases, vibration or shock, it may result in electric shock, fire or malfunction.
- Perform installation according to this manual. If installation is not performed adequately, it may result in dropping, malfunction or an operational error in the unit.
- Do not allow foreign objects such as wire chips to enter the unit. They may become the cause of fire, malfunction or failure.

## 2. Wiring

# REQUIRED

• Always perform grounding (FE terminal).

If grounding is not performed, there is a risk of electric shocks and malfunctions.

# ▲ CAUTION

- Connect power supply that meets rating. If a power supply that does not meet rating is connected, fire may be caused.
- The wiring operation should be performed by qualified personnel.

If wiring is performed incorrectly, it may result in fire, damage, or electric shock.

## 3. Precautions before using

# DANGER

- Do not touch the terminals while the power is on. There is a risk of electric shock.
- Structure the emergency stop circuit, interlock circuit, etc. outside the programmable controller (hereinafter referred to as PLC).

Damage to the equipment or accidents may occur due to failure of the PLC.

However, do not interlock the unit to external load via relay drive power supply of the relay output module.

# 

• When performing program change, forced output, RUN, STOP, etc., while the unit is running, be sure to verify safety.

Damage to the equipment or accidents may occur due to operation error.

• Supply power according to the power-up order. Damage to the equipment or accidents may occur due to malfunctions.

# 

DO NOT CONNECT EH-PSD/HX-PSD DIRECTLY TO LINE VOLTAGE. LINE VOLTAGE MUST BE SUPPLIED BY A SUITABLE, APPROVED ISOLATING TRANSFORMER HAVING SHORT CIRCUIT CAPACITY NOT EXCEEDING 150VA MAXIMUM.

## 4. Preventive maintenance

# DANGER

• Do not connect the battery (+) and (-) in reverse. Do not charge, disassemble, heat, place in fire, or short circuit the battery. There is a risk of explosion or fire.

# S PROHIBITED

• Do not disassemble or modify the unit. Electric shock, malfunction or failure may result.

# 

• Turn off the power supply before removing or attaching module/unit. Electric shock, malfunction or failure may result.

# Revision History

No.	Description of revision	Date of revision	Manual number
1	The first edition	2018.1	NJI-650(X)
2	CNC model added. Chapter layout revised.	2018.9	NJI-650A(X)

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Appendix 2 List of Motion Commands

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MEMO

# Chapter 1 Introduction of SoftMotion

# 1.1 Features

The HX-series CPU module (hereinafter called HX-CPU) supports SoftMotion functionality with built-in Ethernet port configured as EtherCAT master. Variety of motion controls such as single axis positioning, synchronous control with electronic cam, speed control, torque control can be performed. The commands for motion control are basically standard function blocks defined by PLCopen®\*.

EtherCAT slaves of servo drives supporting CiA402 drive profile can be operated easily without users considering status word, control word, mode register and other mapping parameters.

\* PLCopen is a worldwide association to standardize global standard IEC61131-3. Motion control library, safety, XML specification and other standard not defined in IEC61131-3 are defined by PLCopen.

## 1.2 Steps to Set Up

The following steps are required for motion control.

```
Create new project

↓

Configure EtherCAT network (Chapter 3)

↓

Configure EtherCAT slave (Chapter 3)

↓

Configure motion parameters (Chapter 3)

↓

Programming (Chapter 4 to 9)

↓

Change program

↓

Debug (Chapter 10 to 11)

↓

Finish
```

# 1.3 EtherCAT Communication

## **1.3.1 EtherCAT Communication Architecture**

HX-CPU SoftMotion is to access slave devices in EtherCAT network. Communication protocol for motion control is CAN application protocol over EtherCAT (CoE), and supported profile is IEC61800-7 (CiA402). EtherCAT architecture is shown in the block diagram below.



CoE support area

### 1.3.2 CoE Profile

2 types of communication are defined in CoE. The one is PDO (process data object) and the other is SDO (service data object). PDO is cyclic communication to object dictionary which can be mapped as PDO. SDO is non-cyclic message communication to whole the object dictionary.

- PDO: From application view point, data is accessed in cyclic as variables (I/O) mapped in PDO mapping table.
- SDO: From application view point, data is accessed by special function block in user program or by startup parameters (as initial values).

## 1.3.3 ESI File

Vendor name, device group, PDO mapping, sync manager and other parameters of the EtherCAT<sup>®</sup> slave are defined in ESI (EtherCAT Slave Information). When ESI file is installed in configurator (HX-CODESYS), ENI file having network information is created, which will be downloaded to the EtherCAT master.





## 1.3.4 EtherCAT State Machine

EtherCAT slaves follow ESM (EtherCAT State Machine), which is controlled by an EtherCAT master. Availability of PDO and SDO are defined according to ESM.



State transitions

Available	commun	ication

Status Description		SDO	PDO	
Init	Under initialization of communication.			
IIIIt	No service is available.	-	-	
	Only SDO is available.			
Pre-Operational	After initialization completed, the state goes to	$\checkmark$	-	
	pre-operational mode.			
	Besides SDO communication, input of PDO			
Safa Operational	communication is available. If an error is found in		$\checkmark$	
Sale-Operational	operational mode, the state goes to safe-operational	•	(input only)	
	mode.			
	Normal communication state.			
Operational	Input and output of PDO communication are	$\checkmark$	$\checkmark$	
	available.			

## 1.3.5 Differences Between Motion and CNC Motion

The following table shows the main differences between motion and CNC motion features.

Category			Motion (HX-CP1S08M)	CNC Motion (HX-CP1H16M)
PLCopen	PLCopen FB part 1 & 2 (&3*)		•	•
	PLCopen FB 1	part 4	-	•
Operation Multi-axis control		ntrol	•	•
	Linear/circular	r interpolation	-	•
	Coordinated Master/slave		•	•
controlAxis groupRobot control		-	•	
			-	•
Programming	IEC language		•	•
	G-code		-	•
	Cam editor		•	•
	CNC editor		-	•
Library name	SM3_Basic		•	•
	SM3_CNC		-	•
	SM3_Robotic	s	-	•

\* PLCopen FB Part 3 is users guidelines.

# Chapter 2 Precautions

If DC (Distributed Clock) is enabled, be sure to follow the instructions below. DC is a function to compensate hardware delay by sharing system clock between a master and all slaves. If slaves do not receive data from master within specified time, slaves stop operation with DC error.

## 2.1 Project Settings

Be sure to set the following parameters according to your system configuration.

### 2.1.1 DC Cycle Time

Set appropriate DC cycle time. The table below shows recommended cycle time according to the number of axes, however these values are based on the minimum conditions (small user program without additional communication load such as Modbus). Set appropriate cycle time according to your system configurations.

The number of axes	DC cycle time
1 to 4	2ms
5 to 8	4ms
9 or more	8ms

### 2.1.2 Priority of Task

Be sure to set 0 for the EtherCAT task (EtherCAT\_Master\_SoftMotion.EtherCAT.Task). If the EtherCAT master device is added, it will be allocated under MainTask (priority 0) automatically. If 2 or more tasks exist, it will be allocated under the task located at the top. POU handling motion control should be executed by the EtherCAT task.

Other programs than motion control and time consuming programs should be separated from motion control and executed by lower priority task than MainTask. Set priority 5 or lower (5 to 31) to this task. In the figure below, SubTask with priority 5 is added and POU1 is assigned.

	🐞 MainTask 🗙
Device (HX-CP1S08M)	Configuration
PLC Logic	
🖃 💮 Application	Priority ( 031 ): 0
📲 📶 Library Manager	Tune
PLC_PRG (PRG)	Cyclic Interval (e.g. t#200mp): t#4ms
POU1 (PRG)	incirvit (eig. t#200115).
🖹 🙀 Task Configuration	SubTask X
🖃 🍪 MainTask	Configuration
EtherCAT_Master_SoftMotion.EtherCAT_Task	
PLC_PRG	Priority ( 031 ): 5
🗏 🥩 SubTask	Туре
POU1	Cyclic   Interval (e.g. t#200ms): t#20ms

## Task Cycle Time

Actual cycle time of each task can be monitored in [Task Configuration]. Double-click [Task Configuration] in device tree and choose [Monitor] tab.

ļ	Task Configuration 🗙							
	Properties System Events Monitor							
	Task	Status	IEC-Cycle Count	Cycle Count	Last Cycle Time (µs)	Average Cycle Time (µs)	Max. Cycle Time (µs)	Min. Cycle Time (µs)
	(b) MainTask	Valid	859	1021	2089	1692	2110	14
	🕑 SubTask	Valid	172	204	9802	8317	10284	9

## CAUTION

If you use Modbus-RTU master or slave, be sure to set priority 5 or lower (5 to 31) to the bus cycle task. If priority 0 to 4 is set, motors might stop due to DC synchronization lost. In addition, set 10ms or more to the cycle time (interval), otherwise it may be delayed to receive responses from slaves.

The bus cycle task for Modbus-RTU master and slave are defined as follows. If [Use parent bus cycle setting] is chosen, the shortest cycle task is taken.



### 2.1.3 Sync Offset

Allowable jitter of EtherCAT frame for DC synchronization can be set in Sync Offset. Default value is 20%. If DC synchronization fails by big jitter, set greater value up to 50%.

EtherCAT_Master X		
General	☑ Autoconfig Master/Slaves	Ether CAT.
Sync Unit Assignment	EtherCAT NIC Setting	
EtherCAT I/O Mapping	Destination Address (MAC) FF-FF-FF-FF-FF	Enable Redundancy
Status	Source Address (MAC)     00-01-02-03-04-11     Browse       Network Name     eth2	
Information	Select network by MAC	
	▲ Distributed Clock	
	Cycletime 2000 🐥 µs	VR/LRD
	Sync Offset 20 %	dSK
	Sync Window Monitoring	
	Sync window 1 µs	

#### 2.1.4 I/O Mapping

There are 2 different mappings available to access external I/O and Modbus I/O. The one is that variables are directly mapped in mapping table and used in POUs. The other is that variables are declared in POU or GVL and referred from mapping table.

The secondary mentioned mapping could give extra CPU load when online change, which can lead to DC synchronous failure. If this mapping is necessary, do not map more than 200 variables to be referred. If variables over 200 are to be mapped, use direct mapping.

#### (1) Direct mapping

Modbus_TCP_Slave X						
General	Channels					
	Variable	Mapping	Channel	Address	Туре	
Modbus Slave Channel			Channel 0	%IW0	ARRA	
Modbus Slave Init	i 🍬		Channel	%IW0	WORD	
	👋 test0	***	Bit0	%IX0.0	BOOL	
ModbusTCPSlave Parameters	👋 test1	**	Bit1	%IX0.1	BOOL	
MadbusTCDSlave I/O Mapping	👋 test2	**	Bit2	%IX0.2	BOOL	
	👋 test3	**	Bit3	%IX0.3	BOOL	



#### (2) Declaration in POU/GVL and referred from mapping table

Modbus_TCP_Slave X + PLC_PRG						
General	Channels					
	Variable	Mapping	Channel	Address	Туре	
Modbus Slave Channel			Channel 0	%IW0	ARRA	
Modbus Slave Init	i 🍫		Channel	%IW0	WORD	
	Application.PLC_PRG.test0	<b>~</b>	Bit0	%IX0.0	BOOL	
ModbusTCPSlave Parameters	Application.PLC_PRG.test1	<b>~</b>	Bit1	%IX0.1	BOOL	
MadhuaTCRSIava I/O Mapping	Application.PLC_PRG.test2	<b>~</b>	Bit2	%IX0.2	BOOL	
	Application.PLC_PRG.test3	<b>~</b>	Bit3	%IX0.3	BOOL	

DO bit0
ī
4.0
-

## 2.2 Restrictions of Function

Do not use functions below while PLC is in RUN status, otherwise DC synchronous could fail.

### 2.2.1 FTP Server

Since FTP server could have heavy load on communication process of CPU, do not use it when PLC is in RUN status. If it is necessary to use while CPU running, use it only when drives are stopping.

### 2.2.2 File Transfer

Since file transfer function in [Device]-[File] could have heavy load on communication process of CPU, do not use it when PLC is in RUN status. If it is necessary to use while CPU running, use it only when drives are stopping.



# 2.3 Restrictions of Configuration

Follow the instruction below, otherwise DC synchronous could fail.

### 2.3.1 Modbus-TCP Master / Slave

Be sure to use an Ethernet Adapter version 3.5.10.0 or newer. The Ethernet Adapter is required when using Modbus-TCP master or slave.

Name	Vendor	Version			
Image: Miscellaneous					
Fieldbusses					
CANbus					
💷 📲 🖬 🖬 🐨 🐨					
🖃 🕮 Ethernet Adapter					
Ethernet	3S - Smart Software Solutions GmbH	3.5.10.0			

### Device version can be seen in [Information] tab.

f Ethernet 🗙	
Ganaral	General:
	Name: Ethernet
Status	Vendor: 3S - Smart Software Solutions GmbH
	Groups: Ethernet Adapter, Ethernet Adapter, Ethernet Adapter
Ethernet Device I/O Mapping	Type: 110
Information	<b>ID:</b> 0000 0002 <b>Version:</b> 3.5.10.0
	Model Number: -
	Description: Ethernet Link.

### 2.3.2 PLC Settings (Update IO while in stop)

Update IO while in stop of HX-CP1S08M and HX-CP1H16M is disabled as default.

Device X		
Communication Settings	Application for I/O handling:	Application 👻
Applications	PLC settings	
Backup and Restore	Behaviour for outputs in Stop:	Set all outputs to default
Files	Always update variables:	Disabled (update only if used in a task)
Log	Edit Licenses	
PLC settings	Bus cycle options Bus cycle task:	<unspecified></unspecified>

## CAUTION

<u>Do not enable this parameter</u>, otherwise drives could move rapidly when reset operation (Reset warm, Reset cold, Reset origin) because target position is reset at that time. If this parameter is to be enabled, be sure to check carefully how drives react on reset operation when the current position is not 0.

# 2.4 CPU Load

If CPU load exceeds 80%, CPU stops with processor overload exception (error code 25). Check the CPU load as follows and make your application program so as not to exceed 80%.

## 2.4.1 PLC Shell

CPU load can be checked manually with PLC shell function of HX-CODESYS. Double-click [Device], choose [PLC shell], type 'plcload' in the field at the bottom, and hit [Enter] key. The current CPU load is shown.

Device X	
Communication Settings	plcload
Applications	PLC Load: 43%
Backup and Restore	
Files	
Log	
PLC settings	
PLC shell	
Users and Groups	
PLC Parameters	
PLC I/O Mapping	
Task deployment	
Status	
Information	
	pldoad 🗸 🗤

### 2.4.2 CmpSchedule Library

CPU load can be taken with a special function in your application program. This could be used for warning of CPU load.

(1) Add CmpSchedule library.

1	👔 Library Manager 🗙					
🔁 Ado	跲 Add library 🗙 Delete library 🛛 😁 Properties 🗃 Details 🛛 💷 Placeholders 🛛 🎁 Library repository					
Name	2	Namespace	Effective version			
0- <u>1.0</u>	CmpHIESErrors_HX = CmpHIESErrors_HX, 3.5.8.21 (HIES)	CmpHIESErrors_HX	3.5.8.21			
0- <mark>10</mark>	CmpHIESLib_HX = CmpHIESLib_HX, 3.5.8.22 (HIES)	CmpHIESLib_HX	3.5.8.22			
±	CmpSchedule, 3.5.8.0 (System)	CmpSchedule	3.5.8.0			
±… ≎ <mark>10</mark>	IoStandard = IoStandard, 3.5.8.0 (System)	IoStandard	3.5.8.0			

### (2) CPU load is taken by output of FUNCTION SchedGetProcessorLoad.

	SchedGetProcessorL	oad		
_	pResult POINTER TO RTS_IEC_RESULT	UDINT	SchedGetProcessorLoad	-

## Sample program

## FBD/LD

POU	_LD ×
1	PROGRAM POU_LD
2	VAR
3	test: BOOL;
4	result: INT;
5	plcload: UDINT;
6	END_VAR
7	A . W
1	
	test SchedGetProcessorLoad
	EN ENO
	ADR(result) - pResult - plcload
PO	U_ST X
1	PROGRAM POU ST
2	VAR
3	result: INT:
4	nlcload: UDINT:
	FND VAD
2	
0	
1	
1 2	<pre>plcload:=SchedGetProcessorload(ADR(result));</pre>
	POU 1 2 3 4 5 6 7 7 1 1 2 3 4 5 6 6 7 7 1 2 3 4 5 6 6 6 7 7 7 1 2 3 4 5 6 6 6 6 6 7 7 7 7 7 7 7 7 7 7 7 7 7

# 2.5 Other Tips

## 2.5.1 Data Type of Axis

Data type of axis used in motion FBs is AXIS\_REF\_SM3 (FB).



The data of AXIS\_REF\_SM3 members can be monitored however, only variables mapped in PDO can be updated basically. For example, actual position fActPosition is updated in realtime, but actual jerk fActJerk is always 0.

Reference to axis	
State of the axis according to the ``P	LCopen
Parameter number: 1010	
Parameter number: 1011	
``TRUE``: Communication OK	ت
Parameter number: 1013	
Drive interface error number	ت <b>ڊ</b>
Parameter number: 1100, 1	
Parameter number: 1101	
Parameter number: 1140	
December number 1141	
	Parameter number: 1140 Parameter number: 1141

### 2.5.2 Jerk

Jerk is the rate of change of acceleration.

The relation of position, velocity, acceleration and jerk are shown as follows.





### 2.5.3 EthSoftReset Command

Function block EthSoftReset in CmpHIESLib\_HX library is to reset Ethernet port.

EthSoftReset is to reset a designated Ethernet port in hardware level. If Ethernet port does not work due to hardware reasons, it could restore by executing this function block.

Motion type HX-CPU (HX-CP1S08M) and CNC motion type HX-CPU (HX-CP1H16M) do not support this function block because this FB may affect motion control even if designated port is different from motion control. If executed, xError output will be activated as follows.

Just in case a port is out of control, try to restore by reset warm or power rebooting (CPU stops by reset warm ).



# Chapter 3 Configuration of EtherCAT and Motion Axis

## 3.1 EtherCAT Network

### 3.1.1 EtherCAT Master

Right-click on [Device] and choose [Add Device...]. [Add Device] window appears. Click [EtherCAT Master SoftMotion] and [Add Device] button.

Devices		<b>→</b> ₽ <b>×</b>
🖻 🎒 Untitled41		
🖃 💮 Device (HX-CP 1S08M)		
🗏 🗐 PLC Logic	ж	Cut
E 🔘 Application	P)	Сору
👘 Library Man	Ē.	Paste
PLC_PRG (P	$\times$	Delete
🖃 🎆 Task Config	æ	Properties
🖻 👙 MainTa	*:::	Add Object
PLC	6	Add Folder
🗏 📺 Basic (Basic)		Add Device
⊶K <empty> (<em< th=""><th></th><th>Update Device</th></em<></empty>		Update Device



Double click [EtherCAT\_Master\_SoftMotion (EtherCAT Master SoftMotion) ] to configure Ethernet port. After communication between PC and HX-CPU configured, click [Browse...] button and choose Ethernet port for the EtherCAT master.

EtherCAT_Master_SoftMot	tion X	
General	✓ AutoconfigMaster/Slaves	Ether <b>CAT</b>
Sync Unit Assignment	EtherCAT NIC Setting	
EtherCAT Parameters	Destination Address (MAC) FF-FF-FF-FF-FF	ast 🔲 Enable Redundancy * [Enable Redundancy] is
EtherCAT I/O Mapping	Source Address (MAC) 00-01-02-03-04-11 Browse Network Name eth2	not supported.
Status	Select Network by MAC	
MAC address Name Desc 000000000000 lo 000102030413 eth1 000102030411 eth2 Ch	rription oose Ethernet port to be used.	
	OK Abo	* Be sure to use [eth1] or [eth2] for EtherCAT master.

### NOTE

Only one EtherCAT master can be configured per CPU module. If two or more EtherCAT master devices are configured, performance of EtherCAT may be degraded or DC synchronization may be lost.

Click <sup>b</sup> mark at [Options] to open optional setting parameters.

EtherCAT_Master_Soft	Motion X
General	V Autoconfig Master/Slaves EtherCAT
Sync Unit Assignment	EtherCAT NIC Setting
EtherCAT I/O Mapping	Destination Address (MAC) FF-FF-FF-FF-FF-FF I Broadcast Enable Redundancy
Status	Source Address (MAC) 00-01-02-03-04-11 Browse Network Name eth2
Information	Select network by MAC     Select network by Name
	Distributed Clock     Options
	Cycletime       4000       µs       □ Use LRW instead of LWR/LRD         Sync Offset       20       ∞       %         Sync Window Monitoring       ✓ Auto restart slaves
	Sync window 1 hs

#### Use LRW instead of LWR/LRD

Disable: Read command (LRD) and write command (LWR) are used. Enable: Read/write command (LRW) is used.

If LRW is used, communication efficiency is higher since the packet length is shorter. Be noted some of slave devices may not support LRW command (this information is written in ESI file).

If this parameter is enabled and FMMU (Fieldbus memory management unit) of slave is customized, it is possible to communicate directly between slaves without master control. FMMU setting appears in each slave device by disabling [AutoconfigMaster/Slaves] then enabling [Show generic device configuration views] in [Tool] - [Options] - [Device editor]. Customizing FMMU is for experts only. You don't have to enable this parameter because direct communication between slaves is not used in normal operation with function block.

#### Enable messages per task

Enable: Variables in PDO mapping are updated by the task of POU instead of EtherCAT task. (e.g. Even if the EtherCAT master is assigned to 4ms task, variable is transferred every 20ms cycle because the POU including this variable is assigned to 20ms task.)

Disable: Variables in PDO mapping are updated by EtherCAT task.

#### Auto restart slaves

Enable: If communication stops due to cable disconnection or other temporary reasons, communication restarts automatically.

Disable: Once communication stops, it does not restart.

## 3.1.2 Installation of ESI File

Install the ESI file (EtherCAT Slave Information file) of your EtherCAT slave devices on HX-CODESYS. This installation is required once per PC for every slave device. If you installed before, it is not necessary to install for every new project. The ESI file is provided by slave's vendor.

Choose [Tools]-[Device repository] and click [Install] button. Then new dialog appears to choose file. Click [Open] to install the ESI file.

🧝 Device R	epository			×
<u>L</u> ocation:	System Repository (C:\ProgramData\	CODESYS\D	vevices)	Edit Locations
Installed de	e <u>v</u> ice descriptions:			Testall
Name	liscellaneous ieldbusses	Vendor	Version	Uninstall
⊞∭ P ⊞ 🔗 S	LCs oftMotiondrives			Install DT <u>M</u>
				Details
				Close

### 3.1.3 Slave Device

Right-click on [EtherCAT\_Master\_SoftMotion] and choose [Add Devices...]. Devices of the ESI file installed before are listed in [Add Devices] window. Choose slave devices and click [Add Device] button.



### NOTE

In case right ESI file is configured in the project and the ESI file is not registered in device repository (e.g. project file is opened in another PC than originally created), [?] sign is indicated at the icon as follows however, operation of PLC is no problem because information of ESI file is saved in the project file.

EtherCAT\_Master\_SoftMotion (EtherCAT Master SoftMotion)
 ADVA\_EC (HITACHI AC SERVO DRIVES ADV Series)
 SetherCAT OUT
 adv (SM\_Drive\_GenericDSP402)
 SoftMotion General Axis Pool

If slave devices are connected to EtherCAT network, configuration data can be read out from the network. This must be done in offline (logout) after online (login) once. Righ-click on [EtherCAT\_Master\_SoftMotion], choose [Scan for Devices...] and click [Copy All Devices to Project]. Then connected devices will be configured under [EtherCAT Master SoftMotion].



If [Scan For Devices] is executed for two or more drives, they will be configured like a tree as the figure below. In this case, SoftMotion axis (SoftMotion CiA402 Axis: refer to section 3.2 Configuration of SoftMotion Axis) cannot be added except for the drive at the bottom. If you use 2 or more drives, configure manually instead of Scan For Devices.

EtherCAT\_Master\_SoftMotion (EtherCAT Master SoftMotion)

ADVA\_EC (HITACHI AC SERVO DRIVES ADV Series)

EtherCAT OUT

ADVA\_EC\_1 (HITACHI AC SERVO DRIVES ADV Series)

Compared by EtherCAT OUT

### 3.1.4 EtherCAT Task Cycle

If the EtherCAT Master Softmotion is added, an object to execute the EtherCAT master will be automatically created under the task located to the top. Double click the task having [EtherCAT\_Master\_SoftMotion.EtherCAT\_Task] (MainTask in case of the picture below) to open configuration window.



Be sure to set the same cycle time as the cycle time of Distributed Clock to this task.

🍏 MainTask 🗙		Ŧ
Configuration		
Priority ( 031 ): 0		
Type		
Cyclic   Interval (	.g. t#200ms): 4000	

### 3.1.5 EtherCAT Distributed Clock (Master)

Distributed Clock, one of the features of EtherCAT, is used in motion control for synchronization between master and slaves in general. The type and enabling/disabling are configured in each slave device however, cycle time is set in master. Double click on [EtherCAT\_Master\_SoftMotion] and set the cycle time in [General] tab.

General	Value Autoconfig Master/Slaves	Ether CAT.
Sync Unit Assignment	EtherCAT NIC Setting	
EtherCAT I/O Mapping	Destination Address (MAC) FF-FF-FF-FF-FF-FF	adcast 📃 Enable Redundancy
Status	Source Address (MAC) 00-00-00-00-00 Brows	;e
Information	Select network by MAC     Select network by Name	
	▲ Distributed Clock	
	Cycletime 4000 🛓 µs	
	Sync Offset 20 🔦 %	
	Sync Window Monitoring	
	Sync window 1 🖨 µs	

#### NOTE

- Allowable cycle time of Distributed Clock are 250µs / 500µs / 1ms / 2ms / 4ms / 8ms in general however, it is recommended to use 1 to 8ms for HX-CPU, otherwise drives do not work properly.
- Depending on the number of axes, DC synchronization could be lost. As a reference, set 2ms for 4 axes, and 4ms for 8 axes at minimum.
- If you change DC cycle time of EtherCAT, task cycle time of [EtherCAT\_Master\_SoftMotion.EtherCAT\_Task] is automatically changed. But if you change the task cycle at first, DC cycle time of EtherCAT is not changed.
- If you add the EtherCAT master device, the task cycle of EtherCAT\_Master\_SoftMotion.EtherCAT\_Task is automatically changed to 4000µs.

#### 3.1.6 EtherCAT Distributed Clock (Slave)

Double click on a slave device and configure DC types. The contents of this drop-down menu are different in drives because this information is described in ESI file. Refer to the instruction manual of drives for further information.

ADVA_EC X				
General	Address		Additional	
Evoart Process Data	AutoInc Address	0	📝 Enable Expert Settings	EtherCAT.
Expert Process Data	EtherCAT Address	1001	Optional	
Process Data	▲ Distributed Clock			
Startup Parameters	Select DC	DC for synchronization	on 👻	
EtherCAT Parameters	🔽 Enable	4000 Sync U	Jnit Cycle (μs)	

### 3.1.7 Node Address

Two types of addresses, auto increment address and station alias, are available in EtherCAT. The default setting of HX-CODESYS is auto increment address.

#### Auto Increment address

Station address is automatically assigned by a master according to physical location in the network. You don't have to set addresses on slave devices.

#### **Station Alias**

NOTE

Each slave has unique address. Since this address is independent from position, you don't have to modify application program if you change EtherCAT cable routing.

Enable [Optional] at [Additional] and set [Station alias] according to the slave address.

General	Address			— Additional –		_
	AutoInc Address	0	*	🔽 Enable E	opert Settings	EtherCAT.
Expert Process Data	EtherCAT Address	1001	*	V Optional	ר	
Process Data	▲ Distributed Clock					
Startup Parameters	Select DC	DC for syn	chronizatio	n	•	
EtherCAT Parameters	📝 Enable	4000	Sync U	nit Cycle (µs)		
EtherCAT I/O Mapping	Sync0: Enable Sync 0					
Status	Sync Unit Cycle	x 1	•	4000	Cycle Time (µs)	)
Information	O User Defined			0	Shift Time (µs)	
	Sync1:					
	Enable Sync 1					
	Sync Unit Cycle	x 1	-	4000	Cycle Time (µs)	)
	User Defined			0	Shift Time (µs)	
	> Startup checking			- D Timeouts		
	DC cyclic unit con	trol: assign t	to local µ	c		
	Vatchdog					
	Station alias					
	✓ Enable 1001		<b></b>			

If the station alias is enabled, [Auto restart slaves] does not work properly. If you need to enable [Auto restart slaves], use AutoInc address.

### 3.1.8 Additional Settings

If [Enable Expert Settings] in [Additional] is activated, [Startup checking], [Timeouts] and other expert settings appear. If [Download Expected Slot Configuration] in [Startup checking] is activated, an error message might appear depending on drives. Do not activate this parameter because it is about MDP (Modular Device Profile), which is not used in standard drives.

Expert Process Data Process Data Startup Parameters EtherCAT Parameters EtherCAT I/O Mapping	AutoInc Address EtherCAT Address Distributed Clock Select DC	0 1001		Enable Ex	pert Settings	Ether <b>CAT</b> .
Process Data Startup Parameters EtherCAT Parameters	Distributed Clock     Select DC     Trackle	DC for and	· ·			
Startup Parameters EtherCAT Parameters	Select DC	DC for synch				
EtherCAT Parameters	E Fachla	DC for synch	nonization		•	
EtherCAT I/O Mapping	Enable	4000	Sync Un	it Cycle (µs)		
Etherex 1 to Mapping	Sync0: Enable Sync 0					
Status	Sync Unit Cycle	x 1	•	4000	Cycle Time (µs)	1
Information	🔘 User Defined			0	Shift Time (µs)	
	Sync1.  Enable Sync 1  Sync Unit Cycle  Sync Unit Cycle  User Defined  Startup checking  Check Vendor ID  Check Product ID  Check Revision Num  Download Expected  DC cyclic unit contr  Watchdog  Microsoft .NET Frameword  Continue, the app continue, If you c	x 1  ber  Slot Configura  rol: assign to  k  tion has occurre lication will igno lick Quit, the ap	ation local µC	4000 D D Timeouts D Timeouts application. If you clic or and attempt to ill close immediately	Cycle Time (µs) Shift Time (µs)	

### 3.1.9 Process Data Object

In EtherCAT communication, the data called Process Data Object (PDO) is cyclically read and written. The data structure of PDO is defined in ESI file and can be configurable by users. Please refer to instruction manual of slave devices for further information.

eneral	Select the Outputs				Select the Inputs			
	Name	Туре	Index	*	Name	Туре	Index	
ocess Data	16#1600 1st receive PDO Mapping (				16#1A00 1st transmit PDO Map			
tartup Parameters	✓ 16#1701 258th receive PDO Mappin				✓ 16#1B01 258th transmit PDO M			
	Controlword	UINT	16#6040:00		Error code	UINT	16#603F:00	
therCAT Parameters	Targetposition	DINT	16#607A:00		Statusword	UINT	16#6041:00	
HarcaT I/O Managina	Physical output	UDINT	16#60FE:01		Position actual value	DINT	16#6064:00	
therCAT I/O Mapping	Touch probe function	UINT	16#60B8:00		Torque actual value	INT	16#6077:00	
tatus	Modes of operation	SINT	16#6060:00		Digital inputs	UDINT	16#60FD:00	
	16#1702 259th receive PDO Mappin				Touch probe status	UINT	16#60B9:00	
formation	Controlword	UINT	16#6040:00		Touch probe positive 1 positive value	DINT	16#60BA:00	
	Target position	DINT	16#607A:00	=	Modes of operation display	SINT	16#6061:00	
	Profile velocity	UDINT	16#6081:00		🗌 16#1B02 259th transmit PDO M			
	Physical output	UDINT	16#60FE:01		Error code	UINT	16#603F:00	
	Modes of operation	SINT	16#6060:00		Statusword	UINT	16#6041:00	
	16#1703 260th receive PDO Mappin				Position actual value	DINT	16#6064:00	
	Controlword	UINT	16#6040:00		Torque actual value	INT	16#6077:00	
	Targetposition	DINT	16#607A:00		Velocity actual value	DINT	16#606C:00	
	Target velocity	DINT	16#60FF:00		Digital inputs	UDINT	16#60FD:00	
	Target torque	INT	16#6071:00		Modes of operation display	SINT	16#6061:00	
	Physical output	UDINT	16#60FE:01		🔲 16#1B03 260th transmit PDO M			
	Touch probe function	UINT	16#60B8:00		Error code	UINT	16#603F:00	
	Modes of operation	SINT	16#6060:00		Statusword	UINT	16#6041:00	
	🗌 16#1704 261th receive PDO Mappin				Position actual value	DINT	16#6064:00	
	Controlword	UINT	16#6040:00		Torque actual value	INT	16#6077:00	
	Targetposition	DINT	16#607A:00		Following error actual value	DINT	16#60F4:00	
	Target velocity	DINT	16#60FF:00	-	Digital inputs	UDINT	16#60FD:00	

### How to change PDO mapping

(1) Deactivate the PDO mapping currently activated.

elect the Outputs				Select the Inputs		
Name	Туре	Index	-	Name	Туре	Index
16#1600 1st receive PDO Mapping (				🗌 16#1A00 1st transmit PDO Mag	•	
☑ 16#1701 258th receive PDO Mappin				✓ 16#1B01 258th transmit PDO N	1	
Controlword	UINT	16#6040:00		Error code	UINT	16#603F:00
Targetposition	DINT	16#607A:00		Statusword	UINT	16#6041:00
Physical output	UDINT	16#60FE:01		Position actual value	DINT	16#6064:00
Touch probe function	UINT	16#60B8:00		Torque actual value	INT	16#6077:00
Modes of operation	SINT	16#6060:00		Digital inputs	UDINT	16#60FD:00
16#1702 259th receive PDO Mappin				Touch probe status	UINT	16#60B9:00
Controlword	UINT	16#6040:00	-	Touch probe positive 1 positive value	e DINT	16#60BA:00
Targetposition	DINT	16#607A:00	=	Modes of operation display	SINT	16#6061:00
Profilevelocity	UDINT	16#6081:00		🗌 16#1B02 259th transmit PDO M	1	
Physical output	UDINT	16#60FE:01		Error code	UINT	16#603F:00
Modes of operation	SINT	16#6060:00		Statusword	UINT	16#6041:00
16#1703 260th receive PDO Mappin				Position actual value	DINT	16#6064:00
Controlword	UINT	16#6040:00		Torque actual value	INT	16#6077:00
Targetposition	DINT	16#607A:00		Velocity actual value	DINT	16#606C:00
Target velocity	DINT	16#60FF:00		Digital inputs	UDINT	16#60FD:00
Target torque	INT	16#6071:00		Modes of operation display	SINT	16#6061:00
Physical output	UDINT	16#60FE:01		□ 16#1B03 260th transmit PDO N	1	

### (2) The other PDO mappings are highlighted (ready to be chosen).

#### Select the Outputs

Select the Outputs			
Name	Туре	Index	-
16#1600 1st receive PDO Mapping			
16#1701 258th receive PDO Mappin			
Controlword	UINT	16#6040:00	
Targetposition	DINT	16#607A:00	
Physical output	UDINT	16#60FE:01	
Touch probe function	UINT	16#60B8:00	
Modes of operation	SINT	16#6060:00	
16#1702 259th receive PDO Mappin			٦
Controlword	UINT	16#6040:00	_
Targetposition	DINT	16#607A:00	1
Profilevelocity	UDINT	16#6081:00	
Physical output	UDINT	16#60FE:01	
Modes of operation	SINT	16#6060:00	
16#1703 260th receive PDO Mappin			
Controlword	UINT	16#6040:00	
Targetposition	DINT	16#607A:00	
Target velocity	DINT	16#60FF:00	
Target torque	INT	16#6071:00	
Physical output	UDINT	16#60FE:01	ľ
Touch probe function	UINT	16#60B8:00	
Modes of operation	SINT	16#6060:00	
16#1704 261th receive PDO Mappin			
Controlword	UINT	16#6040:00	
Targetposition	DINT	16#607A:00	
Target velocity	DINT	16#60FF:00	J.

Select the Inputs			
Name	Туре	Index	-
🗌 16#1A00 1st transmit PDO Map			
☑ 16#1B01 258th transmit PDO M			
Error code	UINT	16#603F:00	
Statusword	UINT	16#6041:00	
Position actual value	DINT	16#6064:00	
Torque actual value	INT	16#6077:00	
Digital inputs	UDINT	16#60FD:00	
Touch probe status	UINT	16#60B9:00	=
Touch probe positive 1 positive value	DINT	16#60BA:00	
Modes of operation display	SINT	16#6061:00	
🗌 16#1B02 259th transmit PDO M			
Error code	UINT	16#603F:00	
Statusword	UINT	16#6041:00	
Position actual value	DINT	16#6064:00	
Torque actual value	INT	16#6077:00	
Velocity actual value	DINT	16#606C:00	
Digital inputs	UDINT	16#60FD:00	
Modes of operation display	SINT	16#6061:00	
16#1B03 260th transmit PDO M			
Error code	UINT	16#603F:00	
Statusword	UINT	16#6041:00	
Position actual value	DINT	16#6064:00	
Torque actual value	INT	16#6077:00	
Following error actual value	DINT	16#60F4:00	
Digital inputs	UDINT	16#60FD:00	-

### (3) Choose new PDO mapping.

elect the Outputs			Sele	ct the Inputs		
Name	Туре	Index	^ Na	me	Туре	Inde
] 16#1600 1st receive PDO Mapping (				6#1A00 1st transmit PDO Map		
16#1701 258th receive PDO Mappin			v 1	6#1B01 258th transmit PDO M		
Controlword	UINT	16#6040:00	E	irror code	UINT	16#603F:0
Targetposition	DINT	16#607A:00	S	tatusword	UINT	16#6041:0
Physical output	UDINT	16#60FE:01	P	osition actual value	DINT	16#6064:0
Touch probe function	UINT	16#60B8:00	Т	orque actual value	INT	16#6077:0
Modes of operation	SINT	16#6060:00	D	)igital inputs	UDINT	16#60FD:0
16#1702 259th receive PDO Mappin			Т	ouch probe status	UINT	16#60B9:0
Controlword	UINT	16#6040:00	_   Т	ouch probe positive 1 positive value	DINT	16#60BA:0
Targetposition	DINT	16#607A:00	= N	1odes of operation display	SINT	16#6061:0
Profilevelocity	UDINT	16#6081:00		6#1B02 259th transmit PDO M		
Physical output	UDINT	16#60FE:01	E	rror code	UINT	16#603F:0
Modes of operation	SINT	16#6060:00	S	tatusword	UINT	16#6041:0
16#1703 260th receive PDO Mappin			P	osition actual value	DINT	16#6064:0
Controlword	UINT	16#6040:00	Т	orque actual value	INT	16#6077:0
Targetposition	DINT	16#607A:00	V	elocity actual value	DINT	16#606C:0
Target velocity	DINT	16#60FF:00	D	)igital inputs	UDINT	16#60FD:0
Target torque	INT	16#6071:00	N	1odes of operation display	SINT	16#6061:0
Physical output	UDINT	16#60FE:01		6#1B03 260th transmit PDO M		
Touch probe function	UINT	16#60B8:00	E	rror code	UINT	16#603F:0
Modes of operation	SINT	16#6060:00	S	tatusword	UINT	16#6041:0

PDO mapping is seen at [EtherCAT I/O Mapping] tab. Put variable names on this mapping and create application program same as standard I/Os.
## 3.1.10 Startup Parameters

Initial value of SDO (service data object) can be set in [Startup parameter] tab. These values are set at starting of PLC. SDO can be read and written by dedicated function blocks in application program.

#### How to set Startup Parameters?

(1) Click [Add] in [Startup Parameters] tab.

ADVA_EC 🗙										
General	🕂 Add	Add Z Edit 🗙 Delete 🗣 Move Up 🗣 Move Down								
Process Data	Line	Index:Subindex	Name	Value	Bitlength	Abort if error	Jump to line if er			
Startup Parameters										
EtherCAT Parameters										

(2) Choose a parameter, enter a value and click [OK].

Tender of Cooking days	N In sec.	51	Ture	
Index:Subindex	Name	Flags	Type	
16#310E:16#00	Motor forward direction(FA-14)	RW	UINT	C
16#3110:16#00	DB operation(FA-16)	RW	UINT	C
16#3111:16#00	Torque/force limit mode(FA-17)	RW	UINT	2
16#3118:16#00	Servo off wait time(FA-24)	RW	UINT	C
	Brake operation start speed(FA-26)	RW	UINT	
16#311B:16#00	Brake operation start time(FA-27)	RW	UINT	C
16#311C:16#00	Electronic thermal level(FA-28)	RW	UINT	1
16#3133:16#00	Online tuning mode(FA-51)	RW	UINT	1
16#3148:16#00	Operation for STO input(FA-72)	RW	UINT	C
16#314B:16#00	Operation Servo warning switch(FA-75)	RW	UINT	C
16#314C:16#00	Servo warning switch 2(FA-76)	RW	UINT	C
16#3150:16#00	Encoder type selection(FA-80)	RW	UINT	C
16#3151:16#00	Encoder selection(FA-81)	RW	UINT	1
•	III			•
Name Bra	ke operation start speed(FA-26)			
Index: 16# 31	IA 🚔 Bitlength: 16	-	ОК	
SubIndex: 16# 0	Value: 30		Contra	_

The contents of SDO parameters (object dictionary) depend on slave device. Refer to instruction manual of slave device for further information.

(3) Startup parameter is added in the list.

ADVA_EC X							
General	🕂 Add	🗹 Edit 🗙 Delete	1 Move U	p 🕀 Mov	ve Down		
Process Data	Line	Index:Subindex	Name	Value	Bitlength	Abort if error	Jump to line
	1	16#311A:16#00	Brake	30	16		
<b>-</b> . <b>-</b> .							

# 3.1.11 Read/Write Object Dictionary

If [Enable Expert Settings] in [Additional] is activated, [CoE Online] tab appears and values of object dictionary can be read and written in this window.

ADVA_EC X				
General	Address		Additional	
Expert Process Data	AutoInc Address	0	📝 Enable Expert Settings	Ether <b>CAT</b>
	EtherCAT Address	1001	Optional	
Process Data	Distributed Clock			

ADVA_EC X					
General	Read Objects	🔲 Auto Update 🛛 💿 Offline from ESI File 💿 Online fro	om Device		
Expert Process Data	Index:Subindex	Name	Flags	Туре	Value
· · · · · · · · · · · · · · · · · · ·	16#1000:16#00	RO	UDINT	131474	
Process Data	16#1001:16#00	#1001:16#00 Error register			0
Startup Parameters	16#1008:16#00	···· 16#1008:16#00 Manufacturer device name			
· · · · · · · · · · · · · · · · · · ·	16#1009:16#00	Manufacturer hardware version	RO	STRING(4)	'0000'
Online	16#100A:16#00	Manufacturer software version	RO	STRING(4)	'0101'
CoE Online	I6#1010:16#00	Store parameters	RO	USINT	1
	⊞ 16#1011:16#00	Restore default parameters	RO	USINT	1
EtherCAT Parameters	⊞ 16#1018:16#00	Identity object	RO	USINT	4
	. 16#10F1:16#00	Error Settings	RO	USINT	2
EtherCAT I/O Mapping	■ 16#10F3:16#00	Diagnosis History	RO	UDINT	5
Status	⊞ 16#1600:16#00	1st receive PDO Mapping	RW	USINT	0
	⊞ 16#1701:16#00	258th receive PDO Mapping	RO	USINT	5
Information	⊞ 16#1702:16#00	259th receive PDO Mapping	RO	USINT	5
	⊞ 16#1703:16#00	260th receive PDO Mapping	RO	USINT	7
	⊞ 16#1704:16#00	261th receive PDO Mapping	RO	USINT	10
	⊞ 16#1A00:16#00	1st transmit PDO Mapping	RW	USINT	0
	. 16#1B01:16#00	258th transmit PDO Mapping	RO	USINT	8
	⊞ 16#1B02:16#00	259th transmit PDO Mapping	RO	USINT	7

## NOTE

Negative value cannot be set in CoE Online window. If you need to write negative value, use Startup Parameters or dedicated function blocks (ETC\_CO\_SdoWrite, etc.).

#### 3.1.12 Programming

I/O mapping of slave device is shown in [EtherCAT I/O Mapping] tab. Put variable names on this mapping and create application program same as standard I/Os.

ADVA_EC 🗙								
General	Channels							
	Variable Ma	apping	Channel	Address	Туре	Defau	Unit	Description
Process Data			Controlword	%QW0	UINT			Controlword
Startup Parameters			Target position	%QD1	DINT			Target position
-	÷	1	Profile velocity	%QD2	UDINT			Profile velocity
EtherCAT Parameters	÷	1	Physical output	%QD3	UDINT			Physical output
The CAT I/O Menning	I IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	1	Modes of operation	%QB16	SINT			Modes of operation
EtherCAT 1/0 Mapping	±	1	Error code	%IW0	UINT			Error code
Status	1	1	Statusword	%IW1	UINT			Statusword
	1	1	Position actual value	%ID1	DINT			Position actual value
Information	1		Torque actual value	%IW4	INT			Torque actual value
	1	1	Digital inputs	%ID3	UDINT			Digital inputs
	1 <b>V</b>		Touch probe status	%IW8	UINT			Touch probe status
	1		Touch probe positive 1 positive value	%ID5	DINT			Touch probe positive
	i≟ ¥≱	1	Modes of operation display	%IB24	SINT			Modes of operation d

In case of motion axis, state machine of CiA402 drive profile is controlled by dedicated function blocks. You don't have to create a program to control state machine by using Controlword, Statusword, Modes of operation and Modes of operation display. (variable field can be left as empty)

#### NOTE

- When PLC is powered up with RUN switch position in RUN, I/O refresh of the EtherCAT slaves starts about a few second after I/O refresh of standard I/O started because of configuration between the EtherCAT master and all slaves. If this delay is not accepted, use a special bit register 'EtherCAT\_Master.xConfigFinished', which turns on when EtherCAT configuration is finished. The codes below are sample program in ST language.
- Since EtherCAT communication is handled by EtherCAT\_Master task, I/O refresh cycle of the EtherCAT slave is delayed one cycle at maximum compared to I/O refresh cycle of external I/O in basic and expansion bases.

#### Sample program

Use same instance of EtherCAT master SoftMotion.

Programs under END\_IF are not executed while this bit is FALSE.

## 3.1.13 Wiring

(1) Cable

Use category 5 or higher STP (Shielded Twisted Pair) cable.

(2) Network switch

Standard network switch is not allowed to use in EtherCAT network. If necessary, use dedicated EtherCAT hub such as CU1128 sold by Beckhoff.

# NOTE

When the port is used for the EtherCAT master, do not use this port for other Ethernet based communication such as gateway (communication with HX-CODESYS or HMI), Modbus-TCP or global network variable list, otherwise EtherCAT communication performance may be limited.

# 3.2 Configuration of SoftMotion Axis

# 3.2.1 Adding SoftMotion Axis

Add SoftMotion axis to EtherCAT slave drives, so as to use motion control libraries. Right click on slave drive and choose [Add SoftMotion CiA402 Axis].

Devices		<b>→</b> ∓ X
Dutitled37		
🖃 👔 Device (HX-CP 1S08M)		
🖃 📳 PLC Logic		
Application		
📲 🎁 Library Manager		
PLC_PRG (PRG)		
🖃 🎆 Task Configuration		
🗏 😂 MainTask		
EtherCAT_Mas	ster_S	SoftMotion.EtherCAT_Task
PLC_PRG		
Basic (Basic)		
EtherCAT_Master_SoftMotion (	(Ether	rCAT Master SoftMotion)
ADVA_EC (HITACHI AC SE		DDIVES ADV Series)
LetherCAT OUT	đō Par	cut
🍐 沾 SoftMotion General Axis Pool	43	Сору
		Paste
	×	Delete
		Refactoring •
	æ	Properties
	52 1 0 0 0 0 0	Add Object
		Add Folder
		Insert Device
		Disable Device
		Update Device
		Add SoftMotion CiA402 Axis
		Add SoftMotionLight CiA402 Axis
	ß	Edit Object
Г		
		_
	$\checkmark$	·
🖃 💮 ADVA_EC (HITACHI AC SE	RVO	DRIVES ADV Series)
EtherCAT OUT		
SM Drive GenericDS	SP 40	2 (SM Drive GenericDSP402)
SoftMotion General Axis Pool		/

#### 3.2.2 Renaming SoftMotion Axis

The name of SoftMotion axis can be renamed by single clicking or right-mouse clicking menu [Refactoring] on SoftMotion axis. Since this name is used as an instance of axis (AXIS\_REF\_SM3) in all the motion function blocks, shorter name would be easy to handle.

EtherCAT\_Master\_SoftMotion (EtherCAT Master SoftMotion)
 ADVA\_EC (HITACHI AC SERVO DRIVES ADV Series)
 Series
 EtherCAT OUT
 Drive

If the instance name is changed, a dialog appears to adapt automatically all references. Click [Yes] to proceed.

Automatic Refactoring: Rename	
You did rename the object SM_Drive automatically adapt all references wi	e_GenericDSP402 to Drive. Do you want to ithin the project?
Configure Refactoring	Yes <u>N</u> o <u>C</u> ancel

Then reference list appears. Click [OK] to proceed.

Rename Torxice.EtherCAT_Master_SoftMotionADVA_EC.SM_Drive_CenericDSP402' to 'Drive'.       Apply all change.       Details.         Image: Device       Image: Device       Image: Device       Image: Device       Image: Device         Image: Device	Refactor						-	×
<sup>2</sup> O Device </th <th>Rename 'Device.EtherCAT_Master_SoftMotion.ADVA_EC.SM_Drive</th> <th>GenericDSP402' to 'Drive'.</th> <th></th> <th></th> <th>Арр</th> <th>ly all changes</th> <th>. Deta</th> <th>ils</th>	Rename 'Device.EtherCAT_Master_SoftMotion.ADVA_EC.SM_Drive	GenericDSP402' to 'Drive'.			Арр	ly all changes	. Deta	ils
<ul> <li>Project Settings</li> <li>SoftMotion General Axis Pool</li> <li>SoftMotion General Axis Pool</li> <li>Project Settings</li> <li>SoftMotion General Axis Pool</li> <li>Project Settings</li> <li>Address_9000</li> <li>STRING</li> <li>Address_9000</li> <li>STRING</li> <li>Address_9000</li> <li>STRING</li> <li>Type_8020</li> <li>STRING</li> <li>Address_9000</li> <li>ST</li></ul>	🖃 🚮 Device	名前	型	値	変数	アドレス	説明	-
<ul> <li>AXIS_REF: Scalings</li> <li>CherCAT_Master_SoftMotion</li> <li>CherCAT_OUT</li> <li>CherCATOUT</li> <li>CherCATOUT<!--</th--><th>🗷 🗐 PlcLogic</th><td>🖶 🗀 AXIS_REF: Standard</td><td></td><td></td><td></td><td></td><td></td><td></td></li></ul>	🗷 🗐 PlcLogic	🖶 🗀 AXIS_REF: Standard						
<ul> <li>■ BorcAT_Master_SoftMotion</li> <li>■ Bogical device settings</li> <li>■ ADVA_EC</li> <li>■ Address_B00</li> <li>■ ADVA_EC</li> <li>■ Address_B00</li> <li>■ Address_B00&lt;</li></ul>	· · · · · · · · · · · · · · · · · · ·	AXIS_REF: Scalings						
<ul> <li>ADVA_EC</li> <li>AttS_REF: DS#042configuration</li> <li>Drive</li> <li>AttS_REF: DS#042configuration</li> <li>Possible cyclic driver in-/outputs</li> <li>Project Settings</li> <li>Project Settings</li> <li>String</li> <li>String</li> <li>Project Settings</li> <li>Address_8000</li> <li>STRING</li> <li>Vipe_8010</li> <li>STRING</li> <li>Vipe_8010</li> <li>STRING</li> <li>Vipe_8010</li> <li>STRING</li> <li>Vipe_8010</li> <li>STRING</li> <li>Vipe_8010</li> <li>STRING</li> <li>Address_8000</li> <li>STRING</li> <li>A</li></ul>	EtherCAT_Master_SoftMotion	🖲 🗀 logical device settings						
• EtherCATOUT         • Origination         • Opsibile cyclic driver in-/outputs         • Opsibile cyclic driver in-/outputs         • Opsibile cyclic driver in-/outputs         • Address_800         • Vace, 8010         • Vace, 8020         • Vace, 8030         • STRING         • Vace, 8030         • Vace, 8040         • V	B-M ADVA_EC	🗉 🗀 standard driver settings						E
Image: SoftMotion General Axis Pool	EtherCAT OUT	AXIS_REF: DSP402 configuration						
<ul> <li>Address_8010</li> <li>STRING</li> <li>Yope,8010</li> <li>Type,8010</li> <li>AddressPointer_8010</li> <li>AddressPointer_8010</li> <li>AddressPointer_8010</li> <li>AddressPointer_8010</li> <li>AddressPointer_8020</li> <li>STRING</li> <li>AddressPointer_8020</li> <li>STRING</li> <li>AddressPointer_8020</li> <li>STRING</li> <li>AddressPointer_8020</li> <li>STRING</li> <li>Address_8020</li> <li>Time<!--</th--><th>Drive</th><td>🗊 🗀 possible cyclic driver in-/outputs</td><td></td><td></td><td></td><td></td><td></td><td></td></li></ul>	Drive	🗊 🗀 possible cyclic driver in-/outputs						
• Type_8010           STRING         UINT             • AddressPointer_8010           POINTER TO BYTE         ADR(%QW0)             • Address_8020           STRING         %Q01'             • Address_8020           STRING         %Q01'             • Address_8020           STRING         %Q01'             • Address_8020           STRING         %Q01'             • Address_8020           STRING             • Address_8020             • Address_8020             • Type_8030             • Type_8040             • Type_8040             • Type_8040             • Address_8050             • Type_8050             • Address_8050             • Type_8050             • Address_8050             • Address_8050	SoftMotion General Axis Pool	Address_8010	STRING	'%QW0'				
- ● AddressPointer_8010       POINTER TO BYTE       ADR(%QW0)         - ● AddressPointer_8020       STRING       %QD1'         - ● Type_8020       STRING       DINT         - ● AddressPointer_8020       POINTER TO BYTE       ADR(%QD1)         - ● AddressPointer_8020       STRING       *         - ● AddressPointer_8040       STRING       *         - ● AddressPointer_8050       STRING       %QB14'         - ● AddressPointer_8050       POINTER TO BYTE       ADA(%QB14)         - ● Address_8060       STRING       %QW6'         ● Type_8040       STRING       %QW6'	- Project Settings	🌵 Type_8010	STRING	'UINT'				
- ◆ Address_8020       STRING       %QD1'         - ♥ Type,8020       STRING       DINT         - ♦ Address_8020       STRING       DINT         - ♦ Address_8020       STRING       Control         - ♥ Address_8020       STRING       *         - ♥ Type,8030       STRING       *         - ♥ Type,8030       STRING       *         - ♥ Address_8040       STRING       *         - ♥ Address_90inter_8050       POINTER TO BYTE       0         - ♥ Address_90inter_8050       POINTER TO BYTE       0         - ♥ Address_90inter_8050       POINTER TO BYTE       0         - ♥ Address_9060       STRING       %Q04'         - ♥ Address_9060       STRING       Yint         - ♥ Address_9060       STRING       YaQW6'         - ♥ Type, 8060       STRING       %QW6'		AddressPointer_8010	POINTER TO BYTE	ADR(%QW0)				
-       Type_8820       STRING       DINT*         -       AddressPointer_8020       POINTER TO BYTE       ADR(%QD1)         -       AddressPointer_8020       STRING       *         -       Type_8030       STRING       *         -       Type_8030       STRING       *         -       AddressPointer_8030       POINTER TO BYTE       0         -       AddressPointer_8030       POINTER TO BYTE       0         -       AddressPointer_8030       STRING       *         -       AddressPointer_8040       STRING       %QB14'         -       AddressPointer_8050       POINTER TO BYTE       ADR(%QB14)         -       AddressPointer_8050       POINTER TO BYTE       ADR(%QB14)         -       AddressPointer_8050       STRING       %QW6'         -       Address_8060       STRING       Yung.8060 <th></th> <td>Address_8020</td> <td>STRING</td> <td>'%QD1'</td> <td></td> <td></td> <td></td> <td></td>		Address_8020	STRING	'%QD1'				
- ● Address-Pointer_8020       POINTER TO BYTE       ADR(% QD1)         - ● Address_8030       STRING       *         - ● Type_8030       STRING       *         - ● Address_8040       STRING       *         - ● Address_9040       STRING       *         - ● Address_9040       STRING       *         - ● Address_9040       STRING       *         - ● Type_8040       STRING       *         - ● Address_9050       STRING       *         - ● Address_9050       STRING       *         - ● Address_9050       STRING       *         - ● Address_8050       STRING       %Q814'         - ● Address_8050       STRING       %Q84'         - ● Address_8050       STRING       %Q84'         - ● Address_8050       STRING       %Q84'		• Type_8020	STRING	'DINT'				
- • Address_8000       STRING       *         • • Type_8030       STRING       *         • • Address_9030       STRING       *         • • Address_904       STRING       *         • • Address_9040       STRING       *         • • Address_9040       STRING       *         • • Address_9040       STRING       *         • • Address_9050       STRING       \$\sum_1\$         • • Address_9050       STRING       \$\sum_2\$         • • Type_8060       STRING       \$\sum_2\$         • • Address_9060       STRING       \$\sum_2\$         • • Type_8060       STRING       \$\sum_2\$		AddressPointer_8020	POINTER TO BYTE	ADR(%QD1)				
-       • Type_8030       STRING       *         -       ◆ AddressPointe_8030       POINTER TO BYTE       0         -       ◆ AddressPointe_8030       STRING       *         -       ◆ AddressPointe_9040       STRING       *         -       ◆ AddressPointe_9040       STRING       *         -       ◆ AddressPointe_9040       POINTER TO BYTE       0         -       ◆ AddressPointe_9040       STRING       *         -       ◆ AddressPointe_9040       STRING       *         -       ◆ AddressPointe_9040       STRING       *         -       ◆ AddressPointe_9050       SOINTER TO BYTE       0         -       ◆ AddressPointe_9050       POINTER TO BYTE       ADR(%Q814)         -       ◆ AddressPointe_9050       POINTER TO BYTE       ADR(%Q814)         -       ◆ AddressPointe_9050       STRING       *         -       ◆ AddressPointe_9050       STRING       *       ADR(%Q814)         -       ◆ AddressPointe_9050       STRING       *       ADR(%QW6'         -       ▼ TUPE_8060       STRING       *       ADR(%QW6'		Address_8030	STRING	-				
-          • Address_8040        POINTER TO BYTE         0          -          • Address_8040        STRING          -          • Type,8040        STRING          -          • Address_8040        STRING          -          • Address_8040        STRING          -          • Address_8040        POINTER TO BYTE          -          • Address_8050        STRING          -          • Address_8060           • STRING          -          • Type, 8050           • TING          -          • Address_8060		🏼 Type_8030	STRING	-				
- ● Address_8040       STRING       *         - ● Type_8040       STRING       *         - ● Address_8040       STRING       *         - ● Address_8040       POINTER TO BYTE       0         - ● Address_8050       STRING       %QB14'         - ● Address_8050       STRING       %QW5'         - ● Address_8060       STRING       %QW5'		AddressPointer_8030	POINTER TO BYTE	0				
-         • Type_8040         STRING         *           -         ◆ AddressPointer_8040         POINTER TO BYTE         0           -         ◆ Address_8050         STRING         %QB14'           -         ◆ Address_8050         STRING         %QB14'           -         ◆ Address_8050         STRING         %QB14'           -         ◆ Address_8050         POINTER TO BYTE         ADR(%QB14)           -         ◆ Address_8050         STRING         %GW6'           -         ◆ Address_8050         STRING         %GW6'           -         ▼ Type_8060         STRING         %GW6'		Address_8040	STRING	-				
-              • AddressPointer_80+0          POINTER TO BYTE          0            -              • AddressPointer_8050               STRING               % G/B14'            -              • Type_8050               STRING               % G/B14'            -              • AddressPointer_8050               POINTER TO BYTE               ADR(% Q/B14)            -              • AddressPointer_8050               POINTER TO BYTE               ADR(% Q/B14)            -              • AddressPointer_8050               POINTER TO BYTE               ADR(% Q/B14)            -              • AddressPointer_8050               STRING               % Q/W6'            -              • Tupe_ 8060               STRING               % Q/W6'		Type_8040	STRING	-				
- ◆ Address_8050         STRING         %QB14'           - ◆ Type_8050         STRING         'SINT'           - ◆ Address_8050         POINTER TO BYTE         ADR(%QB14)           - ◆ Address_8060         STRING         '%QW6'           - ◆ Type_8050         STRING         '%QW6'           - ◆ Address_8060         STRING         '1/INT'		AddressPointer_8040	POINTER TO BYTE	0				
-         ◆ Type_8050         STRING         SINT           -         ◆ AddressPointer_8050         POINTER TO BYTE         ADR(%QB14)           -         ◆ Address_8060         STRING         %QW6'           -         ▼ Type_8060         STRING         11INT		Address_8050	STRING	'%QB14'				
AddressPointer_8050     POINTER TO BYTE     ADR(%QB14)     Address_8050     STRING     %QW6'     Type_8060     STRING     11INT     Type_8060     STRING     11INT		🏼 Type_8050	STRING	'SINT'				
▲ Address_8060 STRING %QW6'		AddressPointer_8050	POINTER TO BYTE	ADR(%QB14)				
		Address_8060	STRING	'%QW6'				
		Ø Type 8060	STRING	'HINT'				-
					(	<u>о</u> к	⊆an	cel

## NOTE

If certified drive by 3S is used, the special SoftMotion axis for the drive is automatically added. If the other uncertified drive is used, you must add a generic SoftMotion axis manually. In that case, the dialog below appears. Read the message and click [OK].



## NOTE

If you delete a SoftMotion axis, slave status is failed (red triangle icon) because <Empty> slot is remained. If a SoftMotion axis is to be deleted, delete the slave device and add again.

EtherCAT\_Master\_SoftMotion (EtherCAT Master SoftMotion)
 ADVA\_EC (HITACHI AC SERVO DRIVES ADV Series)
 SoftMotion Cempty>)
 SoftMotion General Axis Pool

# 3.2.3 Configuration of SoftMotion Axis

Double click SoftMotion axis to open configuration parameters. [General]

General	Axis type and limits	tware limite			Velocity ramp type
Scaling/Mapping	Virtual mode	] Activated	Negative [u]:	0.0	<ul> <li>Trapezoid</li> <li>Sin<sup>2</sup></li> </ul>
Commissioning	<ul> <li>Finite</li> </ul>		Positive [u]:	1000.0	Quadratic
M_Drive_ETC_GenericDSP402:	Sof	tware error reacti Decelerate	Deceleration [u/s²]:	0	Quadratic (smooth)
M_Drive_ETC_GenericDSP402: I/O			Max. distance [u]:	0	ID: 0
itatus	Limits for CNC (SMC_Contro	olAxisBy*)	Positio	n lag supervision	
Information	Velocity [u/s]: Acceler	ation [u/s²] Dece	eleration [u/s <sup>2</sup> ] deact	ivated 🔻	
	1e3 1e5	165	Lag lir	nit [u]: 1.0	
General	Axis type and limits	165	Lag lir	nit [u]: 1.0	Velocity ramp type
General	Axis type and limits	dulo settings	Lag lir	nit [u]: 1.0	Velocity ramp type
Scaling/Mapping	Axis type and limits	idulo settings 10dulo value [u]	: 360.0	nit [u]: 1.0	Velocity ramp type Trapezoid Sin <sup>2</sup>
General Scaling/Mapping Commissioning	Axis type and limits Virtual mode Modulo Finite	dulo settings 10dulo value [u]	: 360.0	nit [u]: 1.0	Velocity ramp type Trapezoid Sin <sup>2</sup> Quadratic
General Scaling/Mapping Commissioning SM_Drive_ETC_GenericDSP402: Parameters	Axis type and limits Virtual mode Modulo Finite	dulo settings Modulo value [u] ftware error react	: 360.0 Deceleration [u/s²]:	nit [u]: 1.0	Velocity ramp type Trapezoid Sin <sup>2</sup> Quadratic Quadratic (smooth) Identification
Commissioning SM_Drive_ETC_GenericDSP402: Parameters SM_Drive_ETC_GenericDSP402: I/O Mapping	Axis type and limits Virtual mode Modulo Finite	dulo settings Modulo value [u] ftware error react Decelerate	: 360.0 tion Deceleration [u/s²]: Max. distance [u]:	0 0	Velocity ramp type Trapezoid Sin <sup>2</sup> Quadratic Quadratic (smooth) Identification ID: 0
General Scaling/Mapping Commissioning SM_Drive_ETC_GenericDSP402: Parameters SM_Drive_ETC_GenericDSP402: I/O Mapping Status	Axis type and limits Virtual mode Modulo Finite So	idulo settings Modulo value [u] ftware error react Decelerate	: 360.0 tion Deceleration [u/s <sup>2</sup> ]: Max. distance [u]:	0 0 0 0	Velocity ramp type Trapezoid Sin <sup>2</sup> Quadratic Quadratic (smooth) Identification ID: 0

-			
No.	Name	Description	Default
1	Axis type and limits	Virtual mode: The drive will be replaced by a simulation similar to a	Disabled
		virtual drive device.	
		Modulo: The drive turns endlessly without limiting the traversing range	Finite
		(e.g. belt drive)	
		Finite: The drive has a fixed work area (e.g. linear drive)	
2	Software limits	Activate the option if you want to limit the position values.	Disabled
3	Modulo settings	The maximum value of the position value (unit: u). If the current position	360.0
		value exceeds the modulo value, the position value goes back to 0. It is	
		possible to set a larger value than modulo value, but the maximum value	
		of the current position data read out from drive is this modulo value.	
4	Software error reaction	Drive decelerates with specified deceleration when the position exceeds	Enabled
		the software limits.	
5	Limits for CNC	Define limit values for velocity, acceleration and deceleration. The limits	1e3, 1e5,
		are used by the library named SMC_ControlAxisBy* to detect jumps.	1e5
6	Position lag supervision	Define the reaction of the system after detection a lag error.	deactivated
7	Velocity ramp type	The velocity ramp type defines the velocity profile for the velocity	Trapezoid
		generating one-axis and the master/slave-modules.	
		Trapezoid: Trapezoid velocity profile (with constant acceleration in each	
		section).	
		Sin <sup>2</sup> : A velocity profile as defined as sin <sup>2</sup> function (with constant	
		acceleration curve).	
		Quadratic: Acceleration profile in trapezoidal form with jerk limitation.	
		Quadratic (smooth): Like Quadratic but generates a jerk profile without	
		jumps.	
8	Identification	ID: Integer identifier. Should be unique for each drive. For example, this	0
		identifier is used in the PLC log in order to identify the drive when an	
		error occurs.	

# Velocity ramp type

## <u>Trapezoid</u>

Velocity profile is linear since acceleration is constant.



# <u>Sin<sup>2</sup></u>

A velocity profile as defined by the  $\sin^2$  function (with constant acceleration curve).



# <u>Quadratic</u>

Acceleration profile in trapezoidal form with jerk limitation.



## Quadratic (smooth)

## Like Quadratic but generates a jerk profile without jump.



# [Scaling/Mapping]

∕∷l⊮ Drive X										
General	Scaling									
Scaling/Mapping	16#10000	1								
Commissioning	1	motor turns <=> ge	ar output turr	ıs	1					
	1 ge	ear output turns <=>	units in applic	ation	1	7				
SM_Drive_ETC_GenericDSP402: Parameters	Mapping									
SM_Drive_ETC_GenericDSP402: I/O Mapping	Automatic mapping									
Status	Inputs:									
	Cyclic object	Object number	Address	Туре		<u> </u>				
Information	status word (in.wStatusWord)	16#6041:16#00	'%IW1'	'UINT'						
	actual position (diActDosition)	16 #6064 16 #00	'9/JTD 1'							

Г

No.	Name	Description
1	Invert direction	The direction of rotation is reversed. The motor receives the
		specified values with inversed signs.
2	Increments < = > motor turns	Number of increments that correspond to a given number of
		motor rotations. You can see the parameter in the Configuration
		tab of the device editor.
		e.g. 17-bit encoder increments :16#20000, motor turns:1
		e.g. 20-bit encoder increments :16#100000, motor turns:1
3	Motor turns < = > gear output turns	Number of motor rotations that correspond to a given number of
		gear output rotations.
		e.g. motor 3 turns = gear 1 turn
		motor turns :3, gear output turns:1
4	Gear output turns < = > units in application	Number of gear output rotations that correspond to a unit in the
		application.
		e.g. gear 1 turn = 1mm movement with ball screw
		gear output turns :1, units in application:1
		e.g. gear 1 turn = 0.1mm movement with ball screw
		gear output turns :10, units in application:1
5	Automatic mapping	IEC parameters that affect the drive are automatically mapped to
		the corresponding inputs and outputs of the device.

Chapter 3 Configuration of EtherCAT and Motion Axis

Example 1 Servo motor 17-bit encoder 131,072 pulses/turn

Ball screw pitch: 10mm (10mm / turn)

Gear reduction ratio: 1/5 (motor 5 turns = gear 1 turn)

General	Axis type and limits	Coffman limits			
Scaling/Mapping	Virtual mode	Activated	Negative [u]:	0.0	
Commissioning	<ul> <li>Finite</li> </ul>		Positive [u]:	1000.0	
₩ Drive X					
General	Scaling				
General Scaling/Mapping	Scaling Invert direction	incre	ments <=> motor turn	s	1
General Scaling/Mapping Commissioning	Scaling Invert direction 16#20000 5	incre motor ti	ments <=> motor turn urns <=> gear output t	s urns	1

In this case, if you set 10 units for distance, motor rotates 5 turns, and consequently the table of ball screw moves 10mm. (10 units equals to 10 mm)

Example 2

Servo motor 17-bit encoder 131,072 pulses/turn		Gear r (motor	eduction ratio: 1/10 10 turns = gear 1 turn)
∷⊮ Drive X			
General	Axis type and limits	- Modulo settings	
Scaling/Mapping	<ul> <li>Virtual mode</li> <li>Modulo</li> </ul>	Modulo value [u]: 360.0	
Commissioning	Finite		
∷⊮ Drive X			
General	Scaling Invert direction		
Scaling/Mapping	16#20000	increments <=> motor turns	1
Commissioning	10	motor turns <=> gear output turns	1
SM_Drive_ETC_GenericDSP402:	1	gear output turns <=> units in application	360

In this case, if you set 360 units for distance, motor rotates 10 turns, and consequently the turn table rotates 1 turn (360 degrees). (360 units equals to 360 degrees)

#### 3.2.4 Virtual Axis

Virtual drives are simulated drives in software. If a virtual axis is configured as a master axis and real axes are configured as slaves, synchronous motion control can be easily realized by controlling the master axis with using cam and gear functions. Right-click on [SoftMotion General Axis Pool] and choose [Add Device...]. Then [Add Device] window appears. Click [SM\_Drive\_Virtual].

EtherCAT_Master_SoftMotion (EtherCAT Master SoftMotion)				
ADVA_EC (HITACHI AC SERVO DRIVES ADV Series)				
EtherCAT OUT				
SM_Drive_GenericDSP402 (SM_Drive_GenericDSP402)				
SoftMotion General Axis Pool				
	*	Cut		
	Ð	Сору		
	e	Paste		
	$\times$	Delete		
	G.	Properties		
		Add Object		
		Add Folder		
		Add Device		
		Insert Device		

Add Device Name: SM_Drive_Virtual			×	
Action:				
Device:				
Vendor: <all vendors=""></all>			•	
Name	Vendor	Version		
SoftMotion drives				
🗉 - 🔗 Free Encoders				
position controlled drives				
- 🖉 virtual drives				
SM_Drive_Virtual	3S - Smart Software Solutions GmbH	4.0.0.0		
EtherCAT_Master_softMotion (Et	herCAT Maste			

	ADVA_EC (HITACHI AC SERVO DRIVES AD				
	🔤 🚡 EtherCAT OUT				
	adv (SM_Drive_GenericDSP402)				
ė. <b>X</b>	🔉 🚡 SoftMotion General Axis Pool				
	SM_Drive_Virtual (SM_Drive_Virtual)				

If this 'SM\_Drive\_Virtual', which can be renamed, is set to axis input (AXIS\_REF\_SM3) of motion function blocks, virtual drive can be controlled as same as real drives.

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# Chapter 4 Manual Operation

# 4.1 State Diagram

The following diagram normatively defines the behavior of the axis at a high level when multiple motion control function blocks are simultaneously activated. The axis is always in one of the defined states. Arrows within the state diagram show the possible state transitions between the states. State transitions due to an issued command are shown by full arrows. Dashed arrows are used for state transitions that occur when a command of an axis corresponding motion state are listed above the states. These motion commands may also be issued when the axis is already in the according motion state.



\*1 From any state. An error in the axis occurred.

- \*2 From any state. MC\_Power.Enable=TRUE AND MC\_Power.bRegulatorOn=FALSE and there is no error in the axis.
- \*3 MC\_Reset AND MC\_Power.Status=FALSE

\*4 MC\_Reset AND MC\_Power.Status=TRUE AND MC\_Power.Enable=TRUE AND MC\_Power.bRegulatorOn=TRUE AND AND MC\_Power.bDriveStart=TRUE AND MC\_Power.Status=TRUE

\*5 MC\_Power.Enable=TRUE AND MC\_Power.bRegulatorOn=TRUE AND MC\_Power.bDriveStart=TRUE AND MC\_Power.Status=TRUE

\*6 MC\_Stop.Done=TRUE AND MC\_Stop.Execute=FALSE

## NOTE

The state behavior is different from the diagram defined by PLCopen for some function blocks.

- · After MC\_PositionProfile done, the state is in [Discrete Motion] instead of [Standstill].
- While MC\_VelocityProfile and MC\_AccelerationProfile, the state is [Discrete Motion] instead of [Continuous Motion].

# 4.2 Servo-On

In this chapter, it's described about how to configure and program with the HX-CPU and the servo drives. Configure parameters according to your drives. (In this sample, 17-bit encoder (resolution 131,072 = #20000) is used.

General Scaling/Mapping	Axis type and limits Virtual mode Modulo vi	ngs alue [u]: 360.0		
Commissioning	© Finite	Modulo     Finite		
General	-Scaling Invert direction			
	16#20000 increm	ients <=> motor turns	1	
caling/Mapping	10#20000 Increm			
Scaling/Mapping	1 motor tur	ns <=> gear output turns	1	

The servo drive is activated (energized) by the command MC\_Power.



Then an undefined function block is created.



(2) Specify the function block by either of the following ways.

## Direct typing

Type 'MC\_Power' at '???' in the function block and hit [Enter] key.



#### Search in Input Assistant

Click [...] and search 'mc\_power' at [Text search] tab.



## Choose in Input Assistant

Click [...] and choose 'MC\_Power' under SM3\_Basic library in [Categories] tab.

Input Assistant			×
Text search Categories			
Function blocks	Name	Туре	Orig ^
Module Calls		Library	SM3_Basic, 4
Keywords	🗈 💼 DataTypes		
Conversion Operators	🗉 🖻 DriveInterface		
	E- 🛅 POUs		
	🗈 ·· 🚞 Commissioning		
	🗈 ·· 🚞 DriveBasic		E
	🗈 🧰 File		
	🗈 – 🧰 Managers		
	🖃 ·· 🚞 PLCopen		
	🗈 🧰 Additional		
	🗉 🚞 Master/Slave Function Blocks		
	🖃 - 🛅 Single Axis Function Blocks		
	🖽 🔂 Part I		-

(3) New instance 'MC\_Power\_0' is automatically assigned. Hit [Enter] key to open Auto Declare dialog. Click [OK] or hit [Enter] key to close the dialog.

М	C_Power_0	
	MC_Power	
222. → Axis	Status	
222 Enable	bRegulatorRealState	- 2.2.2.
222 bRegulatorOn	bDriveStartRealState	- 2.2.2.
222 bDriveStart	Busy	- 2.2.2.
	Error	- 2.2.2.
	ErrorID	- 2.2.2.
Auto Declare		×
<u>S</u> cope:	<u>N</u> ame:	<u>T</u> ype:
VAR 🔻	MC_Power_0	MC_Power
<u>O</u> bject:	Initialization:	<u>A</u> ddress:
PLC_PRG [Application]		
Flags:	Comment:	
RETAIN		
PERSISTENT		T

(4) Set inputs and outputs



# 4.3 Jogging

Add MC\_Power and MC\_Jog as same like the last section and put inputs and outputs as the sample below.

After servo-ON by setting TRUE to servoOn input, the motor rotates in forward direction with velocity 360 [u/s] and acceleration 360  $[u/s^2]$  while JOGFWD input is TRUE. If JOGBWD is TRUE, the motor rotates in backward direction. If the both JOGFWD and JOGBWD are TRUE, motor stops.



# 4.4 Inching

While IFWD input is TRUE, the motor rotates in forward direction with distance 10 [u], velocity 360 [u/s] and acceleration 3600  $[u/s^2]$ . While IBWD input is TRUE, the motor rotates in backward direction with same distance, velocity and acceleration. If the both IFWD and IBWD are TRUE, motor stops.



Chapter 4 Manual Operation

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# Chapter 5 Single-Axis Control

# 5.1 Homing

If this function block is executed, the axis performs homing according to the homing method, velocity, acceleration and other parameters configured in the drive. Those parameters can be set by startup parameters or mailbox (function block such as ETC\_CO\_SdoWrite, etc.) or special configuration software provided by drive's vendor.



# 5.2 Position Control

A sample program is introduced about MC\_MoveAbsolute with absolute position.

When EXE input is TRUE, the axis goes to position 1800 [u] with velocity 500 [u/s] and acceleration 3000  $[u/s^2]$ . As soon as arrived, the axis goes back to position 0 [u] with velocity 1000 [u/s] and acceleration 3000  $[u/s^2]$ .



# Direction in modulo

If direction is specified as shortest or fastest, actual direction is determined according to the current position, gear reduction ratio and modulo value.

#### Example

Modulo value : 360 Scaling : shown as follows

16#20000	increments <=> motor turns	1
1	motor turns <=> gear output turns	1
1	gear output turns <=> units in application	360



Name	value	Description
MC Direction fastest	3	Selects the direction automatically to reach the target position as fast as
Mc_Direction: lastest		possible timewise. (only modulo axes)
MC_Direction.current 2		Keeps the current direction (only modulo axes)
MC_Direction.positive	1	Moves in positive direction
MC_Direction.shortest	0	Selects the direction according to the shortest distance (only modulo axes)
MC_Direction.negative	-1	Moves in negative direction

## The following function blocks are available for position control. Refer to chapter 9 for further information.

Function Block	Name
MC_MoveAbsolute	Moves to a specified absolute position.
MC_MoveRelative	Moves to a specified relative position.
MC_MoveAdditive	Specifies relative distance additional to the most recent commanded position.
MC_MoveSuperImposed	Specifies relative distance additional to an existing motion.
SMC_MoveContinuousAbsolute	Moves to a specified absolute position ending with the specified velocity.
SMC_MoveContinuousRelative	Moves to a specified relative position ending with the specified velocity.
MC_PositionProfile	Moves according to time-position locked motion profile.

# 5.3 Velocity Control

Velocity control is to specify velocity, acceleration, deceleration and jerk without specifying target position. The function block for velocity control is MC\_MoveVelocity.

#### **Change velocity**

Velocity, acceleration, deceleration and direction can be changed while movement. In order to apply new parameters, rising edge must be input to [Execute] input. Alternatively another instance of MC\_MoveVelocity can be executed. In that case, originally executed MC\_MoveVelocity is aborted, which results in CommandAborted output TRUE.

### Velocity Control -> Switching to Position Control

It is possible to switch from velocity control to position control while movement. If MV\_exe is TRUE, the axis rotates with constant velocity 500 [u/s]. If MC\_MoveRelative is executed while the axis is in constant movement, the axis moves, decelerates and stops with specified distance 360 [u] and deceleration 1000  $[u/s^2]$ . MC\_MoveVelocity is aborted with CommandAborted output TRUE.



# 5.4 Stop

The usage of MC\_Halt and MC\_Stop are to decelerate and stop motion for both, but there are some differences as follows.

## MC\_Halt

MC\_Halt is used to stop the axis under normal operation conditions. Even the axis is in deceleration by MC\_Halt command, the next command can be issued and effective.

## MC\_Stop

MC\_Stop is primarily intended for emergency stop functionality or exceptional situations. As long as 'Execute' input is TRUE, the axis remains in the state 'Stopping' and may not be executing any other motion command. If Execute input is FALSE, the axis goes to 'Standstill' status.



# Chapter 6 Multi-Axis Control

# 6.1 Cam Synchronization

# 6.1.1 Cam Table Definition

Right click on [Application] and choose [Add Object]-[Cam table...].

Device (HX-CP1S	08M)		
🖻 🗐 PLC Logic			
🗏 🔘 Applicat	tion		
👘 Lit 🕅	Cut	1	
	🖹 Сору		
в- 🎆 та 🛱	B Paste		
<b>⊨</b> ~ <b>∛</b> >	< Delete		
	Refactoring	•	
	Properties		
	Add Object 🔹 🕨		Alarm configuration
	Add Folder	0	Application
	ິງ Edit Object	82	Axis Group
Be l	Edit Object With	8	Cam table
SoftMotior	🖇 Login	8	CNC program

New cam table is created. The horizontal axis is the position of the master, and the vertical axes are position, velocity, acceleration and jerk of the slave for each. Graphic editor can be edited directly with mouse dragging. In addition, it is possible to specify with numeric data in [cam table] tab. Graphic data and numeric data are related dynamically.





For example, in case the cam profile below is defined, master and slave axis rotate as follows.

#### 6.1.2 Sample Program

The minimum configuration for cam is shown as follows. 'CamTable' input of MC\_CamTableSelect must be same name as cam table's name under the device tree. Connect 'CamTableID' output of MC\_CamTableSelect to 'CamTableID' input of MC\_CamIn.



# 6.2 Gear Synchronization

A sample program of gearing is shown as below. When 's1' input is TRUE, the slave axis (Drive\_B) rotates according to the master axis (Drive\_A) with gear ratio [2:1]. If 's1' input is FALSE, the slave axis stops.



# The following function blocks are available for synchronous control. Refer to chapter 9 for further information.

Function Block	Description	
MC_CamIn	Engages the CAM.	
MC_CamOut	Disengages the slave axis from the master axis.	
MC_CamTableSelect	Selects the CAM table.	
MC_GearIn	Commands a ratio between the velocity of the slave and master axis.	
MC GearInPos	Commands a ratio between the position of the slave and master axes from the	
	synchronization point onwards.	
MC_GearOut	Disengages the slave axis from the master axis.	
MC_Phasing	Creates an phase shift in the master position of a slave axis.	

# MEMO

# Chapter 7 CNC Control

The features described in this chapter are supported by CNC motion type (HX-CP1H16M) only. Be noted that motion type (HX-CP1S08M) does not support CNC features.

# 7.1 CNC Editor

# 7.1.1 Configuration of CNC Editor

Right-click on [Application] and choose [Add Object]-[CNC program ...].



CNC editor dialog appears. Choose [Implementation] and [Compile mode] and click [Add] button.

Add CNC program
CNC program
Name:
CNC
Implementation: Din66025
Compile mode: SMC_OutQueue 🔹
Add Cancel

Item	Options	Description	
Implementation	Din66025	The path elements are programmed with CNC text editor according to	
		Din66025 (G-code)	
	Table	The path elements are listed in a table.	
Compile mode	SMC_OutQueue	SMC_OutQueue type data	
	SMC_CNC_REF	SMC_CNC_REF type data (Select if you want program variables)	
	File	Select this if you want a file to be creaeted out of the G-code.	

The CNC editor consisits of the text editor for G-code in the upper part and the graphic editor in the lower part as shown below. If you enter G-code program in the text editor, path elements are displayed accordingly in the graphic editor. If you draw path elements in the graphic editor, G-code program is displayed in the text editor.



## 7.1.2 CNC Editor Features

Acceleration and deceleration

Choose [CNC]-[Show Interpolation Points] or click *[* icon to display velocity status.



### Angle tolerance

Normally an object stops at end of element. If you set angle torelance, an object does not stop at the angle under the torelance value. Double-click on [CNC settings] or right-mouse click on [CNC settings] and choose [Edit Object], then double-click on [SMC\_CheckVelocities]. Set a value to dAngleTol.



## Analyze Dynamics

Choose [CNC]-[Analyze Dynamics] to show the dynamics of the path. Position, velocity, acceleration, deceleration and jerk of each axis are displayed as below.



Γ

# 7.2 G-code

# 7.2.1 G-code List

Code	Description		
G0	Direct movement without tool contact, positioning		
G1	Linear (straight) movement with tool contact		
G2	Circle (-segment) clockwise		
G3	Circle (-segment) counterclockwise		
G4	Delay time		
G5	Point of a 2D cardinal spline		
G6	Parabola		
G8	Ellipse (-segment) clockwise		
G9	Ellipse (-segment) counterclockwise		
G10	Point of a 3D cardinal spline		
G15	Switch to 2D		
G16	Switch to 3D by activating 3D mode with normal vector I/J/K to the plane		
G17	Switch to 3D by activating 3D mode in X/Y plane		
G18	Switch to 3D by activating 3D mode in Z/X plane		
G19	Switch to 3D by activating 3D mode in Y/Z plane		
G20	Conditional jump to L, if K<>0		
G36	Write value D to variable O		
G37	Increment variable O by value D		
G38	Activate the extended preprocessor functions		
G39	Deactivate the extended preprocessor functions		
G40	End of the tool radius correction		
G41	Start the tool radius correction to the left of the workpiece		
G42	Start the tool radius correction to the right of the workpiece		
G50	End of round path/smooth path function		
G51	Start the smooth path function (SMC_SmoothPath)		
G52	Start the round path function (SMC_RoundPath)		
G53	End the shift coordinate function		
G54	Set offset of all following coordinates to the specified position		
G55	Add the specified position to the current offset		
G56	Set the offset such that the current position equals the specified position		
G60	End of the avoid-loop function (SMC_AvoidLoop)		
G61	Start of the avoid-loop function (SMC_AvoidLoop)		
G70	End of the smoothing of additional axis (See SMC_SmoothAddAxes)		
G71	Start of the smoothing of additional axis (See SMC_SmoothAddAxes)		

Code	Description
G75	Time synchronization with interpolator
G90	Start interpreting the following coordinate values for X/Y/Z/A/B/C/P/Q/U/V/W) as absolute values.
G91	Start interpreting the following coordinate values for X/Y/Z/A/B/C/P/Q/U/V/W) as relative to the current position.
G92	Positioning by jump
G98	The axis midpoints (I/J/K) are interpreted as absolute values.
G99	The axis midpoints (I/J/K) are interpreted as values relative to the start position.

## 7.2.2 G-code Parameters

Parameter	Description	Remarks
X, Y, Z	X,Y,Z-coordinate of the target position	
A, B, C, P, Q, U, V, W	Target position of the additional axis	
D	Tool radius	G1-3, 5, 6, 8, 9, 10
	Variable value	G36-G37
	Tool radius for compensation	G40-G42
	Tool distance for angle rounding	G50-G52
Е	Max. path acceleration/deceleration	Value < 0 : deceleration
EF	Path acceleration/deceleration for G0 movements	
F	Velocity	
FF	Velocity of a G0 movement only for the positioning	
	command in this sentence.	
H L/O	Switch point for H-function	
I, J	Circle/ellipse midpoint or parabola vertex	Circle, Ellipse
К	Direction of the primary ellipse axis	Ellipse
	dT1 parameter value for M function	SMC_GetMParameters
L	Jump target	G20
	dT2 parameter value for M function	SMC_GetMParameters
М	M function	Eg. M5
0	Variable value	G36-G37
	Data structure for the parameter for an M function	
R	Circle radius	Circle
	Length ratio of the elliptical secondary/primary axis	Ellipse
S	S profile	
Т	Aperture angle in degree	Circle
	Time in second	Delay time

#### 7.2.3 G-code Sample Program

#### (1) Linear interpolation

N000	F100	) E20	0 E-20	0
N010	G01	X100	Y0	
N020	G01	X100	Y100	
N030	G01	X0 Y	0	

Velocity: 100, Acc.: 200, Dec. :200 Move to (100, 0) Move to (100, 100) Move to (0, 0)



#### (2) Linear interpolation (smooth)



### NOTE

When G51 is used, add SMC\_SmoothPath to the Active function block instances. When G52 is used, add SMC\_RoundPath to the Active function block instances.

A CNC settings [Device: PLC Logic: Application]	×			•
Path preprocessors Preinterpolation Table editor				
Available function blocks			Active function block instances	
SMC_AvoidLoop		>	SMC_SmoothPath	×
SMC_LimitDynamics			SMC_CheckVelocities	
SMC_LimitCircularVelocity SMC_ObjectSplitter				
SMC_RotateQueue2D SMC_RoundPath				~
SMC_ScaleQueue3D				
SMC_SmoothAddAxes				

Activate [Show preprocessed Path] to display the path with smooth/round applied.



CNC	<u>T</u> ools <u>W</u> indow <u>H</u> elp
Γ	Show preprocessed Path
ſ	Show Interpolation Points
$\langle \rangle$	Step Suppression
Ħ	Show <u>G</u> rid

(4) Linear interpolation with tool radius correction (left) N000 F100 E200 E-200 N010 **G41** D10 N020 G00 X0 Y0 N030 G01 X100 Y0 N040 G01 X100 Y100 N050 G01 X0 Y0 N060 **G40** 

#### (5) Linear interpolation with tool radius correction (right)

N000 F100 E200 E-200 N010 **G42** D10 N020 G00 X0 Y0 N030 G01 X100 Y0 N040 G01 X100 Y100 N050 G01 X0 Y0 N060 **G40** 



# NOTE

When G41 or G42 is used, add SMC\_ToolCorr to the Active function block instances.


#### (6) Circlar interpolation

Target position and radius N000 F100 E200 E-200 N010 G02 X100 Y0 R50

Target position and center

N000 F100 E200 E-200 N010 G02 X100 Y0 I50 J0

Center and aperture angle N000 F100 E200 E-200 N010 **G02** I50 J0 T180

Center (50, 0) with aperture angle 180

From (0, 0) to (100, 0) with radius 50



(7) Delay time

N000 **G04** T1 1 second delay

#### (8) 2.5D spline

N000 F100 E200 E-200 N010 **G05** X100 Y0 N020 **G05** X100 Y100 N030 **G05** X0 Y0

(9) Parabola N000 F100 E200 E-200 N010 G06 X100 Y0 I50 J80 From (0, 0) to (100, 0) with vertex (50, 80)

(10) Ellipse N000 F100 E200 E-200 N010 G08 X100 Y0 I50 J0 K45 R0.5

From (0, 0) to (100, 0) with center (50, 0), angle 45, ratio 0.5







#### 7.2.4 G-code M Function

M function makes the movement stop and restart.

With below sample codes, it stops at  $\diamond$  sign (100, 100) and at the same time value 10 is set to wM output of SMC\_Interpolator. Set TRUE to bAcknM input of SMC\_Interpolator to restart.



# 7.3 CNC Programming

# 7.3.1 Overview

The basic flow of CNC programming is shown below.



#### 7.3.2 Programming (without variable)

(1) Set [SMC\_OutQueue] to the compile mode of CNC and connect CNC data via ADR function to [poqDataIn] input of SMC\_Interpolator. Be sure to set EtherCAT cycle time to [dwIpoTime] input in µs unit.

Connect [bStopIpo] output of each axis to [bEmergency\_Stop] input with OR function.



(2) Connect [piSetPosition] output of SMC\_Interpolator to [pi] input of SMC\_TRAFO function block, which must be selected according to kinematics of your system.



 $(3) Connect \ [dx] \ and \ [dy] \ output \ of \ SMC\_TRAFO \ function \ block \ to \ [fSetPosition] \ input \ of \ SMC\_ControlAxisByPos.$ 





#### 7.3.3 Programming (with variable)

(1) Set [SMC\_CNC\_REF] to the compile mode of CNC and connect CNC data to [ncprog] input of SMC\_NCDecoder.



(2) Connect [poqDataOut] output of SMC\_NCDecoder to [poqDataIn] input of SMC\_CheckVelocities.



(3) Connect [poqDataout] output of SMC\_CheckVelocities to [poqDataIn] input of SMC\_Interpolator.

Be sure to set EtherCAT cycle time to [dwIpoTime] input in  $\mu$ s unit.

Connect [bStopIpo] output of each axis to [bEmergency\_Stop] input with OR function.



(4) Same as the previous section, Connect [piSetPosition] output of SMC\_Interpolator to [pi] input of SMC\_TRAFO function block, which must be selected according to kinematics of your system.



(5) Connect [dx] and [dy] output of SMC\_TRAFO function block to [fSetPosition] input of SMC\_ControlAxisByPos.





# MEMO

# Chapter 8 Robotics

The features described in this chapter are supported by CNC motion type (HX-CP1H16M) only. Be noted that motion type (HX-CP1S08M) does not support robotics features.

# 8.1 Overview

# 8.1.1 Coordinate System

Coordinate system used in Robotics control are defined as follows.

Short name	Name	Description
ACS	Axes Coordinate System	The system of coordinates related to the physical motors and the single movements caused by the single drive.
MCS	Machine Coordinate System	The system of coordinates that is related to the machine. A Cartesian coordinate system with the origin in a fixed position relative to the machine (the origin is defined during the machine setup). Sometimes called "World Coordinate System" or "Base Coordinate System". (Note: with Cartesian build machines, MCS is a Cartesian Coordinate system and may be identical to ACS, or mapped via a trivial transformation). The coordinate system from the physical multiple axes ACS is linked to the MCS via a kinematic transformation (forward and backward conversion). The MCS represents an imaginable space with up to 6 dimensions.
PCS	Product Coordinate System Program Coordinate System	The coordinate system of the product can be called PCS – Product Coordinate System (or "Program Coordinate System" in CNC world, or Programmers Coordinate System). The PCS is based on the MCS typically by shifting and maybe rotating the MCS. The Zero point of the PCS is related to the product and can be changed during runtime by the program. The real work piece can have a rotation or shift to the MCS coordinate system or even might be moving relative to the MCS coordinate system. By specifying a trajectory in PCS one is able to describe the trajectory independent from the machine situation. To map these two worlds (MCS to PCS and vice versa), a cartesian or cylindrical transformation is normally done.



#### 8.1.2 Coordinate System Example

The example below demonstrates how a point P, which is situated on a 2D workpiece (red trapezoid), can be described equivalent in PCS (blue), MCS (black) and ACS (green). Point P could be specified by referring to PCS resulting in the position  $P_{PCS} = (x_{PCS}, y_{PCS})$ . Given the shift and orientation of PCS relative to MCS, point P equivalently could be specified by  $P_{MCS} = (x_{MCS}, y_{MCS})$ . Assuming a SCARA robot with two rotary axes point P also could be described by the angles of the axes  $P_{ACS} = (\phi_1, \phi_2)$ .



#### 8.1.3 Kinematic Transformation

Axes are connected via mechanical links providing movements of the 'Tool Center Point', TCP in space. TCP is a distinguished point of the machine, sometimes also called 'Point of Interest', POI, or 'effector'. The physical assembly of the axes and therefore the position of the TCP in MCS is described by a so called kinematic transformation. The kinematic transformation connects ACS to MCS (forward conversion). By applying the kinematic transformation on a position related to ACS, this position can be transformed into a position in MCS. The other way round, applying the inverse kinematic transformation, a position related to MCS can be transformed into a position in ACS (backward conversion).

With simple cartesian machine constructions, in which axes are directly oriented in X-, Y-, and Z-directions of MCS, the kinematic transformation can easily be specified. One just has to define which axis is in the X-direction, which in Y, and which in the Z-direction. In the simplest case ACS is identically to MCS and one needn't distinguish between both. But in praxis there are many non-cartesian structures, like SCARA robots or Tripods, where the kinematic transformation is more complex.



Above example demonstrates how a position in space could be reached by a cartesian handling or a SCARA. Whereas the positions of the linear axes are more or less identical to the coordinates of the position in MCS, the positions of the axes of the SCARA are not that easy to calculate. Additionally there are two possible solutions of the backward kinematic transformation, different configurations of the machine: elbow down and elbow up.

#### 8.1.4 Movements

Basically there are two types of movements which have to be distinguished.

(1) PTP (Point-to-Point)

With this type the essence is to reach the commanded position as fast as possible. This can be achieved by moving each axis on the shortest way from its starting position to its target position. Usually this kind of movement is the fastest way to reach a new commanded position, because at any time at least one axis moving at it's dynamic limit. The path and the path velocity of the TCP are not important. They are determined by the process of the positions of the axes and the kinematic transformation of the machine. Therefore this kind of movement is applicable for handlings and whenever the path of the TCP is not crucial. It is recommended that all axes will arrive at the commanded position at the same point in time (synchronized).

The applicable Function Blocks as specified herein are:

- MC\_MoveDirectAbsolute
- MC\_MoveDirectRelative

#### (2) CP (Cartesian Path)

CP movements cause the TCP to move along a defined path in Cartesian space. A path can be (a set of) a straight line, a circular movement, or a spline function. The path via which the new commanded position is reached is important. For example, this is essential if a workpiece is being processed. Further, the path velocity of the TCP can be controlled directly. Contrary to joint interpolated movements the process of the position of each axis is determined by the desired path and the inverse kinematic transformation.

The applicable Function Blocks as specified herein are:

- MC\_MoveLinearAbsolute
- MC\_MoveLinearRelative
- MC\_MoveCircularAbsolute
- MC\_MoveCircularRelative

The figure below illustrates the difference between different types of movement by means of a theoretical machine. (black: MC\_MoveDirect, green: MC\_MoveLinear, blue: MC\_MoveCircular)



#### 8.1.5 Buffer Mode (Blending)

A fundamental part of interpolated motion control is blending of (buffered) consecutive motion commands on an axis group. Without blending the TCP of an axis group moves towards the commanded position, decelerates and comes to standstill exactly at the commanded position. In many applications a different behaviour of the TCP is desired and one wants to concatenate movements without stopping.

Reasons for this are:

- Reduction of the process cycle time (e.g. pick and place)
- Generate a smoother movement in order to reduce the mechanical stress
- Some applications demand a constant Velocity of the TCP (e.g. applying glue, painting, welding, etc.)

All this can be achieved by different types of blending. Common to all types of blending is a modification of the original path, resulting in a smooth trajectory without corners. There are 3 types of buffer mode.

Aborting: Current motion is aborted and new FB starts immediately.Buffered without blending: New FB starts after current motion has been finished.Blending: Velocity is blended during transition period.

	Aborting	Buffered without blending	Blending	
Trajectory of TCP	p <sub>2</sub> p <sub>3</sub>	p <sub>2</sub> p <sub>3</sub> p <sub>1</sub>	p <sub>2</sub> p <sub>3</sub> p <sub>4</sub>	
Speed of TCP				

#### Details of ENUM MC\_BUFFER\_MODE are shown below.

No.	MC_BUFFER_MODE	Description
0	Aborting	Start FB immediately
1	Buffered	Start FB after the currently last motion in queue has finished.
2	BlendingLow	The velocity is blended with the lowest velocity of both FBs.
3	BlendingPrevious	The velocity is blended with the velocity of the first FBs.
4	BlendingNext	The velocity is blended with the velocity of the second FBs.
5	BlendingHigh	The velocity is blended with the highest velocity of both FBs.

#### Details of ENUM MC\_TRANSITION\_MODE are shown below.

No.	MC_TRANSITION_MODE	Description
0	TMNone	No blending
1	TMStartVelocity	Velocity based blending
2	TMCornerDistance	Distance based blending

# 8.2 Axis Group

# 8.2.1 State Diagram

The state diagram of axis group is shown below. The state diagram reflects the state of the group and the issued FBs. Continuous lines are commanded transitions. Dotted lines are automatic transitions.



\*1 Applicable for all non-administrative (moving) function blocks.

\*2 MC\_GroupStop.done = TRUE AND MC\_GroupStop.execute = FALSE

# 8.2.2 Add Axis Group

Right-click on [Application] and choose [Add Object]-[Axis Group...].

Devices	<b>→</b> ∓ X 🖊	PLC_PRG X
🗉 🎒 Untitled65		1 PROGRAM PLC_PRG
E Device (HX-CP1H16M)		2 VAR
PLC Logic		3 END_VAR
Applicati Library PLC_PI Task C Max Max Max Max Max Max Max Max	Cut Copy Paste Delete	
Basic (Basic)	Properties	
K <empty> (</empty>	Add Object 🕨 🕨	Alarm configuration
📫 <empty> ( 🛅</empty>	Add Folder	Application
<empty> (</empty>	Edit Object	Axis Group
<empty> (</empty>	Edit Object With	🔕 Cam table

Axis Group dialog appears. Click [Add] button.

Add Axis Group	<b>—</b> —
🔗 Axis Group	
Name:	
AxisGroup	
	Add Cancel

Click [Select kinematics] and choose kinematics according to your system.

AxisGroup X			
Kinematics			
Select kinematics	Select kinematics		
🖌 Tasks			
Bus Task:	<unknown></unknown>		
Planning Task:	SoftMotion_PlanningTask		

Kinematics	Description
TRAFO.Kin_CAxis	Transformation FB for a C-axis. The TCP will only turned around the Z axis.
TDAEO Kin CAria Taal	Transformation FB for a C-axis. The TCP will only turned around the Z axis
IKAFO.KIII_CAXIS_1001	and be moved in direction of the new x axis.
	Transformation FB for a constant translation. The TCP will be shifted about a
TRAFO.Kin_Tool	constant position vector (dToolx, dToolY, dToolZ). The orientation of the tool
	is not be changed with respect to the base (position) kinematics.
	Transformation FB for a 2-axis inline wrist, where a0 rotates around the Z axis
IKAFO.Kin_whst2	and a1 around the new Y axis.
	Transformation FB for a 3-axis inline wrist, where a0 rotates around the Z axis,
TRAFO.Kin_Wrist3	a1 around the new Y axis, and a2 around the new Z axis. The tool points in
	direction of the negative Z axis of the TCP coordinate system.
TRAFO.Kin_Gantry2	Transformation FB for a 2-axis gantry.
TRAFO.Kin_Gantry3	Transformation FB for a 3-axis gantry.
TRAFO.Kin_HGantry2	Transformation FB for a 2-axis H gantry.
TRAFO.Kin_HGantry3	Transformation FB for a 3-axis H gantry.
TRAFO.Kin_TGantry2	Transformation FB for a 2-axis T gantry.
TRAFO.Kin_Bipod_Rotary	Transformation FB for bipod kinematics.
TRAFO.Kin_Tripod_Linear	Transformation FB for tripod kinematics with linear axes.
TRAFO.Kin_Tripod_Rotary	Transformation FB for tripod kinematics with rotary axes.
TRAFO.Kin_Polar	Transformation FB for polar kinematics.
TRAFO.Kin_Scara2_Z	Transformation FB for SCARA2 kinematics with an additional axis.
	Transformation FB for 5-axis-gantries. This is possible way how a coupled
IKAFO.Kin_SAxes	kinematic can be realized based on existing kinematics.
TRAFO.Kin_Scara3_Z	Transformation FB for SCARA3 kinematics with an additional axis.
TRAFO.Kin_4AxesPalletizer	Transformation FB for a 4-axis palletizer.
TRAFO.Kin_ArticulatedRobot_6DOF	Transformation FB for a 6-axis articulated robot.

Configure the drives according to the kinematics.

Mapping to Axes TRAFO.Kin_Gantry2	
X (Configure) Driv	e_X
Y (Configure) Driv	e_Y

#### 8.3 **Robotics Programming**

The following sample program is to demonstrate TCP moving along the red colored trajectory.



#### Program

grs(AxisGroup:=AxisGroup, Enable:=TRUE); // MC\_GroupReadStatus

```
CASE state OF
      // SMC GroupPower
0:
      gp(AxisGroup:=AxisGroup, Enable:=TRUE, bRegulatorOn:=ServoOn, bDriveStart:=TRUE);
      IF gp.Status THEN
              state:=state+1;
      END_IF
```

```
// MC Home & MC GroupEnable
1:
              mh1(Axis:=Drive X, Execute:=TRUE, Position:=0);
              mh2(Axis:=Drive_Y, Execute:=TRUE, Position:=0);
              IF mh1.Done=TRUE AND mh2.Done=TRUE THEN
                      gre(AxisGroup:=AxisGroup, Execute:=TRUE);
                      state:=state+1;
              END IF
2:
      // MC MoveLinearAbsolute : path 1 from (0,0) to (100,0)
      IF gre.Done THEN // GroupEnable done
              mla1.Position.c.X:=100; // Target position X=100
              mla1.Position.c.Y:=0;
                                      // Target position Y=0
              mla1.Velocity:=100;
                                      // Velocity 100
              mla1.Acceleration:=100; // Acceleration 100
              mla1.Deceleration:=100; // Deceleration 100
              mla1.Jerk:=100;
                                       // Jerk 100
              mla1.CoordSystem:=SMC COORD SYSTEM.MCS;
              mla1.BufferMode:=MC BUFFER MODE.Aborting;
              mla1(AxisGroup:=AxisGroup, Execute:=TRUE);
              state:=state+1;
      END IF
3:
      // MC MoveLinearAbsolute : path 2 from (100,0) to (100,100)
      IF mla1.CommandAccepted THEN
                                        // Target position X=100
              mla2.Position.c.X:=100;
              mla2.Position.c.Y:=100; // Target position Y=100
              mla2.Velocity:=100;
              mla2.Acceleration:=100;
              mla2.Deceleration:=100;
              mla2.Jerk:=100;
              mla2.CoordSystem:=SMC COORD SYSTEM.MCS;
              mla2.BufferMode:=MC BUFFER MODE.BlendingLow;
              mla2.TransitionMode:=MC TRANSITION MODE.TMCornerDistance;
              mla2.TransitionParameter[0]:=10; // Blending with radius 10
              mla2(AxisGroup:=AxisGroup, Execute:=TRUE);
              state:=state+1;
      END_IF
      // MC MoveLinearAbsolute : path 3 from (100,100) to (0,100)
4:
      IF mla2.CommandAccepted THEN
              mla3.Position.c.X:=0;
                                       // Target position X=0
              mla3.Position.c.Y:=100;
                                        // Target position Y=100
              mla3.Velocity:=100;
              mla3.Acceleration:=100;
              mla3.Deceleration:=100;
              mla3.Jerk:=100;
              mla3.CoordSystem:=SMC COORD SYSTEM.MCS;
              mla3.BufferMode:=MC BUFFER MODE.BlendingLow;
              mla3.TransitionMode:=MC TRANSITION MODE.TMCornerDistance;
              mla3.TransitionParameter[0]:=10; // Blending with radius 10
              mla3(AxisGroup:=AxisGroup, Execute:=TRUE);
              state:=state+1;
```

END\_IF

#### Chapter 8 Robotics

```
5:
      // MC MoveLinearAbsolute : path 4 from (0,100) to (0,0)
      IF mla3.CommandAccepted THEN
                                      // Target position X=0
              mla4.Position.c.X:=0;
                                      // Target position Y=0
              mla4.Position.c.Y:=0;
              mla4.Velocity:=100;
              mla4.Acceleration:=100;
              mla4.Deceleration:=100;
              mla4.Jerk:=100;
              mla4.CoordSystem:=SMC_COORD_SYSTEM.MCS;
              mla4.BufferMode:=MC BUFFER MODE.BlendingLow;
              mla4.TransitionMode:=MC_TRANSITION_MODE.TMCornerDistance;
              mla4.TransitionParameter[0]:=10; // Blending with radius 10
              mla4(AxisGroup:=AxisGroup, Execute:=TRUE);
              state:=state+1;
      END IF
6:
              mla1(AxisGroup:=AxisGroup);
              mla2(AxisGroup:=AxisGroup);
              mla3(AxisGroup:=AxisGroup);
              mla4(AxisGroup:=AxisGroup);
      IF mla4.Done THEN
              mla1(AxisGroup:=AxisGroup, Execute:=FALSE);
              mla2(AxisGroup:=AxisGroup, Execute:=FALSE);
              mla3(AxisGroup:=AxisGroup, Execute:=FALSE);
              mla4(AxisGroup:=AxisGroup, Execute:=FALSE);
              state:=state+1;
```

END IF

7:

CycleDone:=TRUE;

END CASE

# Chapter 9 Function Blocks for Motion Control

This chapter describes the specifications of frequently used function blocks. Refer to Appendix 2 in this manual or online help of HX-CODESYS for the information about other function blocks.

# 9.1 Function Blocks for Motion Control

# 9.1.1 Libraries for Motion Control

The function blocks for motion control are included in the libraries as shown below.

			Support	ted CPU
Library name	Function blocks	Prefix	Motion type	CNC motion type
			(HX-CP1S08M)	(HX-CP1H16M)
SM3_Basic	PLCopen 1 Single-axis	MC_***	•	•
	PLCopen 2 Single-axis		•	•
	PLCopen 1, 2 Multi-axis		•	•
	PLCopen 3 Single-axis		•	•
	Others	SMC_***	•	•
SM3_CNC	CNC	SMC_***	-	•
SM3_Robotics	PLCopen 4 Coordinated motion (administrative)	MC_***	-	•
	PLCopen 4 Coordinated motion (moving)		-	•

Function blocks with prefix "MC" conform with PLCopen.

# 9.1.2 Function Block Interface

General rules of function block interface are described as follows.

Input parameters	With 'Execute':
	The parameters are used with the rising edge of the 'Execute' input. To modify any parameter
	it is necessary to change the input parameter(s) and to trigger the 'Execute' input again.
	With 'Enable':
	The parameters are used with the rising edge of the enable input and can be modified
	continuously.
Missing input	If any parameter of a function block input is missing ("open") then the value from the previous
parameters	invocation of this instance will be used. In the first invocation the initial value is applied.
Acceleration,	If the input 'Acceleration', 'Deceleration' or 'Jerk' is open, initial value (0) is applied, which
Deceleration and	causes that 'Error' output of the function block is TRUE.
Jerk inputs	If velocity ramp type is 'Trapezoid' or 'Sin <sup>2</sup> ', 'Jerk' input can be open (initial value 0).
	However, if velocity ramp type is 'Quadratic' or 'Quadratic (smooth)', 'Jerk' input must not be
	zero, otherwise 'Error' output of the function block is TRUE.
Output exclusivity	With 'Execute':
	The outputs 'Busy', 'Done', 'Error' and 'CommandAborted' are mutually exclusive: only one
	of them can be TRUE on one FB. If 'Execute' is TRUE, one of these outputs has to be TRUE.
	With 'Enable':
	The outputs 'Valid' and 'Error' are mutually exclusive: only one of them can be TRUE on one
	FB.

Output status	With 'Execute':
-	The 'Done', 'Error', 'ErrorID' and 'CommandAborted' outputs are reset with the falling edge
	of 'Execute'. However the falling edge of 'Execute' does not stop or even influence the
	execution of the actual FB. It must be guaranteed that the corresponding outputs are set for at
	least one cycle if the situation occurs, even if execute was reset before the FB completed.
	If an instance of a FB receives a new execute before it finished (as a series of commands on the
	same instance) the FB won't return any feedback like 'Done' or 'Command Aborted' for the
	previous action
	With 'Enable':
	The 'Valid' 'Enabled' 'Busy' 'Error' and 'ErrorID' outputs are reset with the falling edge of
	'Fnable' as soon as possible
Behavior of Done	The 'Done' output is set when the commanded action has been completed successfully
	With multiple Eurotion Blocks working on the same axis in a sequence, the following applies:
ομιραί	when one measurement on on ovis is intermented with enother measurement on the some ovis without
	when one movement on an axis is interrupted with another movement on the same axis without
	naving reached the final goal, Done of the first FB will not be set.
Behavior of Busy	With Execute :
output	Every FB can have an output 'Busy', reflecting that the FB is not finished and new output
	values can be expected. 'Busy' is SET at the rising edge of 'Execute' and RESET when one of
	the outputs 'Done', 'Aborted', or 'Error' is set.
	With 'Enable':
	Every FB can have an output 'Busy', reflecting that the FB is working and new output values
	can be expected. 'Busy' is SET at the rising edge of 'Enable' and stays SET as long as the FB
	is performing any action.
	It is recommended that the FB should be kept in the active loop of the application program for
	at least as long as 'Busy' is true, because the outputs may still change.
Behavior of	The outputs 'InVelocity', 'InGear', 'InTorque', and 'InSync' (from now on referred to as
InVelocity,	'Inxxx') have a different behavior than the 'Done' output.
InGear, InTorque	As long as the FB is Active, 'Inxxx' is SET when the set value equals the commanded value,
and InSync	and will be RESET when at a later time they are unequal. For example, the InVelocity output is
	SET when the set velocity is equal to the commanded velocity. This is similar for 'InGear',
	'InTorque', and 'InSync' outputs in the applicable FBs.
	'Inxxx' is updated even if 'Execute' is FALSE as long as the FB has control of the axis
	('Active' and 'Busy' are SET).
	'Inxxx' definition does not refer to the actual axis value, but must refer to the internal
	instantaneous setpoint.
Behavior of	'CommandAborted' is set, when a commanded motion is interrupted by another motion
CommandAborted	command. The reset-behavior of 'CommandAborted' is like that of 'Done'. When
	'CommandAborted' occurs, the other output-signals such as 'InVelocity' are reset.
Enable input and	The 'Enable' input is coupled to a 'Valid' output. 'Enable' is level sensitive, and 'Valid' shows
Valid output	that a valid set of outputs is available at the FB.
	The 'Valid' output is TRUE as long as a valid output value is available and the 'Enable' input
	is TRUE. The relevant output value can be refreshed as long as the input 'Enable' is TRUE.
	If there is a FB error, the output is not valid ('Valid' set to FALSE). When the error condition
	disappears, the values will reappear and 'Valid' output will be set again.
Position,	'Position' is a value defined within a coordinate system. 'Distance' is a relative measure
Distance	related to technical units. 'Distance' is the difference between two positions.
Sign rules	The 'Velocity', 'Acceleration', 'Deceleration' and 'Jerk' are always positive values. 'Position'
	and 'Distance' can be both positive and negative.

Without error Execute Execute Busy Busy Done Done Error Error CommandAborted CommandAborted With Execute input keeping TRUE With rising edge of Execute input With error Execute Execute Busy Busy Done Done Error Error CommandAborted CommandAborted With Execute input keeping TRUE With rising edge of Execute input Execute Execute Command aborted Busy Busy Done Done Error Error CommandAborted CommandAborted With Execute input keeping TRUE With rising edge of Execute input

#### The behavior of FB with 'Execute' input and 'Done' output

# 9.2 PLCopen Part 1 for Single-Axis

#### 9.2.1 MC\_Power

Na	ame	Description	n		Туре
MC_Po	wer	This FB con	ntrols the power stage	(On or Off)	FB
			xis <i>AXI5_REF_SM3</i> inable <i>BOOL</i> RegulatorOn <i>BOOL</i> DriveStart <i>BOOL</i>	MC_Power BOOL Status BOOL bRegulatorRealState BOOL bDriveStartRealState BOOL Busy BOOL Error SMC_ERROR ErrorID	
Name			Туре	Description	
IN_OUT	Axis		AXIS_REF_SM3	Reference to the axis	
IN	Enable		BOOL	TRUE: Enables the execution of the FB.	
	bRegulator	On	BOOL	TRUE: Enables the power stage. FALSE: Disables the power	er stage.
	hDrivo Stort	+	POOL	TRUE: Disables the quickstop mechanism.	
	oDriveStari	l	BOOL	FALSE: Enables the quickstop mechanism.	
OUT	Status		BOOL	TRUE: Axis is ready to move.	
	bRegulator	RealState	BOOL	TRUE: The power stage has been switched on.	
	bDriveStart	RealState	BOOL	TRUE: Drive is not blocked by the quickstop mechanism.	
	Busy		BOOL	TRUE: The FB is in operation.	
	Error		BOOL	TRUE: Error has occurred within the FB.	
	ErrorID		SMC_ERROR	Error identification	

# NOTE

When MC\_Power is executed, there is a momentary 'Stopping' status (50 to 100ms) between 'Disabled' and 'Standstill', which can be seen with MC\_ReadStatus. Although it is not described in the state diagram in page 4-1, this is expected behavior.

# 9.2.2 MC\_Home

Na	ame	Description	I		Туре
MC_Home This FB comm		mmands the axis to p	perform the search home sequence according to the drive.	FB	
	– (controlled by the drive)				
MC_Home         Axis AXIS_REF_SM3       BOOL Done         Execute BOOL       BOOL Busy         Position LREAL       BOOL CommandAborted         BOOL Error       BOOL Error         SMC_ERROR ErrorID					
	Name		Туре	Description	
IN_OUT	Axis		AXIS_REF_SM3	Reference to the axis	
IN	Execute		BOOL	Starts the execution of the FB at rising edge.	
	Position		BOOL	Absolute position when the reference signal is detected.	
OUT	Done		BOOL	TRUE: Reference known and set successfully.	
	Busy		BOOL	TRUE: The FB is in operation.	
	Command	Aborted	BOOL	TRUE: Command has been aborted by another command.	
	Error		BOOL	TRUE: Error has occurred within the FB.	
	ErrorID		SMC_ERROR	Error identification	

# NOTE

If a value other than 0 is set to 'Position' input, the sign of the current position might be inverted depending on drives. If inverted, set a right value with MC\_SetPosition.

# 9.2.3 MC\_Stop

Name	Description			
MC_Stop This FB commands a controlled motion stop and transfers the axis to the state 'Stopping'. It				
aborts any ongoing Function Block execution. While the axis is in state 'Stopping', no other FB				
	can perform any motion on the same axis.			
	MC_Stop			
	Axis AXI5_REF_SM3 BOOL Done			
	Execute BOOL Busy			
	Deceleration LREAL BOOL Error			
	Jerk LREAL SMC_ERROR ErrorID			

	Name	Туре	Description
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis
IN	Execute	BOOL	Starts the execution of the FB at rising edge.
	Deceleration	LREAL	Value of the 'deceleration' [u/s <sup>2</sup> ] (positive value)
	Jerk	LREAL	Value of the 'Jerk' [u/s <sup>3</sup> ] (positive value)
OUT	Done	BOOL	TRUE: Zero velocity reached.
	Busy	BOOL	TRUE: The FB is in operation.
	Error	BOOL	TRUE: Error has occurred within the FB.
	ErrorID	SMC_ERROR	Error identification

## 9.2.4 MC\_Halt

Na	ame			Description	Туре
MC_Ha	lt	This FB con	nmands a controlled n	notion stop. It is possible to set another motion command	FB
		during dece	leration of the axis, wh	hich will abort the MC_Halt and will be executed immediately.	
MC_Halt Axis AXIS_REF_SM3 BOOL Done Execute BOOL BOOL Busy Deceleration LREAL BOOL CommandAborted Jerk LREAL BOOL Error SMC_ERROR ErrorID					
	Name		Туре	Description	
IN_OUT	Axis		AXIS_REF_SM3	Reference to the axis	
IN	Execute		BOOL	Starts the execution of the FB at rising edge.	
	Decelerati	on	LREAL	Value of the 'deceleration' [u/s <sup>2</sup> ] (positive value)	
	Jerk		LREAL	Value of the 'Jerk' [u/s <sup>3</sup> ] (positive value)	
OUT	Done		BOOL	TRUE: Zero velocity reached.	
	Busy		BOOL	TRUE: The FB is in operation.	
	Command	Aborted	BOOL	TRUE: Command has been aborted by another command.	
	Error		BOOL	TRUE: Error has occurred within the FB.	
	ErrorID		SMC_ERROR	Error identification	

	Name		Description Type	Э
MC_Mo	2.5 MC_MoveAbsol Name MC_MoveAbsolute MC_MoveA	This FB commands a controll	led motion to a specified absolute position. FB	
		Axis AXIS_REF_SM — Execute BOOL — Position LREAL — Velocity LREAL — Acceleration LREAL — Deceleration LREAL — Jerk LREAL — Direction MC_Dire	MC_MoveAbsolute BOOL Done BOOL Busy BOOL CommandAborted BOOL Error L SMC_ERROR ErrorID L ction	
	Name	Туре	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
	Position	LREAL	Target position [u] (positive or negative)	
	Velocity	LREAL	Maximum velocity [u/s] (positive)	
	Acceleration	LREAL	Acceleration $[u/s^2]$ (positive)	
	Deceleration	LREAL	Deceleration [u/s <sup>2</sup> ] (positive)	
	Jerk	LREAL	Jerk [u/s <sup>3</sup> ] (positive)	
	Direction	MC_Direction	fastest (3), current (2), positive (1), shortest (0), negative (-1) (Refer to section 9.11 Enumeration (ENUM))	
OUT	Done	BOOL	TRUE: End position has been achieved.	
	Busy	BOOL	TRUE: The FB is in operation.	
	CommandAbor	ted BOOL	TRUE: Command has been aborted by another command.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

Γ

# 9.2.5 MC\_MoveAbsolute

#### MC\_DIRECTION (ENUM)

Name	Value	Description
factor	2	Selects the direction automatically in order to reach the target position as fast as
Tastest	3	possible (only modulo axes).
current	2	Keeps the current direction to reach the target (only modulo axes).
positive	1	Moves in positive direction.
shortest	0	Selects the direction according to the shortest distance (only modulo axes).
negative	-1	Moves in negative direction.

#### 9.2.6 MC\_MoveRelative

I	Name			Description	Туре
MC_Mc	oveRelative	This FB	commands a controll	ed motion to a specified distance relative to the set position.	FB
			Axis AXIS_REF_SM. Execute BOOL Distance LREAL Velocity LREAL Acceleration LREAL Deceleration LREAL Jerk LREAL	MC_MoveRelative 3 BOOL Done BOOL Busy BOOL CommandAborted BOOL Error SMC_ERROR ErrorID	
	Name		Туре	Description	
IN_OUT	Axis		AXIS_REF_SM3	Reference to the axis	
IN	Execute		BOOL	Starts the execution of the FB at rising edge.	
	Distance		LREAL	Relative distance [u] (positive or negative)	
	Velocity		LREAL	Maximum velocity [u/s] (positive)	
	Acceleration		LREAL	Acceleration [u/s <sup>2</sup> ] (positive)	
	Deceleration		LREAL	Deceleration [u/s <sup>2</sup> ] (positive)	
	Jerk		LREAL	Jerk [u/s <sup>3</sup> ] (positive)	
OUT	Done		BOOL	TRUE: Distance has been achieved.	
	Busy		BOOL	TRUE: The FB is in operation.	
	CommandAbo	rted	BOOL	TRUE: Command has been aborted by another command.	
	Error		BOOL	TRUE: Error has occurred within the FB.	
	ErrorID		SMC_ERROR	Error identification	

# 9.2.7 MC\_MoveAdditive

	Name			Description	Туре
MC_Mc	oveAdditive	This FB	commands a controll	ed motion of a specified relative distance additional to the most	FB
recent commanded position in the axis state 'DiscreteMotion'.				the axis state 'DiscreteMotion'.	
			Axis AXIS_REF_SM Execute BOOL Distance LREAL Velocity LREAL Acceleration LREAL Deceleration LREAL Jerk LREAL	MC_MoveAdditive 3 BOOL Done BOOL Busy BOOL CommandAborted BOOL Error SMC_ERROR ErrorID	
	Name		Туре	Description	
IN_OUT	Axis		AXIS_REF_SM3	Reference to the axis	
IN	Execute		BOOL	Starts the execution of the FB at rising edge.	
	Distance		LREAL	Relative distance [u] (positive or negative)	
	Velocity		LREAL	Maximum velocity [u/s] (positive)	
	Acceleration		LREAL	Acceleration [u/s <sup>2</sup> ] (positive)	
	Deceleration		LREAL	Deceleration [u/s <sup>2</sup> ] (positive)	
	Jerk		LREAL	Jerk [u/s <sup>3</sup> ] (positive)	
OUT	Done		BOOL	TRUE: Distance has been achieved.	
	Busy		BOOL	TRUE: The FB is in operation.	
	CommandAbo	orted	BOOL	TRUE: Command has been aborted by another command.	
	Error		BOOL	TRUE: Error has occurred within the FB.	
	ErrorID		SMC_ERROR	Error identification	

01210 111						
	Name		Description	Туре		
MC_Mo	oveSuperImposed	This FB commands a controlled motion of a specified relative distance additional to an FB				
	existing motion. The existing Motion is not interrupted, but is superimposed by the additional motion.					
		additional motion.				
		MC_ Axis AXIS_REF_SM Execute BOOL Distance LREAL VelocityDiff LREAL Acceleration LREAL Deceleration LREAL Jerk LREAL	_MoveSuperImposed 13 BOOL Done BOOL Busy BOOL CommandAborted BOOL Error L SMC_ERROR ErrorID L			
	Name	Туре	Description			
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis			
IN	Execute	BOOL	Starts the execution of the FB at rising edge.			
	Distance	LREAL	Additional distance that is to be superimposed [u] (positive or r	negative)		
	VelocityDiff	LREAL	Maximum velocity difference [u/s] (positive)			
	Acceleration	LREAL	Acceleration [u/s <sup>2</sup> ] (positive)			
	Deceleration	LREAL	Deceleration [u/s <sup>2</sup> ] (positive)			
	Jerk	LREAL	Jerk [u/s <sup>3</sup> ] (positive)			
OUT	Done	BOOL	TRUE: Distance is reached.			
	Busy	BOOL	TRUE: The FB is in operation.			
	CommandAborted	BOOL	TRUE: Command has been aborted by another command.			
	Error	BOOL	TRUE: Error has occurred within the FB.			
	ErrorID	SMC_ERROR	Error identification			

### 9.2.8 MC\_MoveSuperImposed

	Name		Description	Туре
MC_MoveVelocity T		This FB commands a ne	This FB commands a never ending controlled motion at a specified velocity.	
		Axis AXIS_REF_SM Execute BOOL Velocity LREAL Acceleration LREAL Deceleration LREAL Jerk LREAL Direction MC_Dire	MC_MoveVelocity 3 BOOL InVelocity BOOL Busy BOOL CommandAborted L BOOL Error L SMC_ERROR ErrorID ction	
	Name	Туре	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
	Velocity	LREAL	Maximum velocity [u/s] (positive)	
	Acceleration	LREAL	Acceleration [u/s <sup>2</sup> ] (positive)	
	Deceleration	LREAL	Deceleration [u/s <sup>2</sup> ] (positive)	
	Jerk	LREAL	Jerk [u/s <sup>3</sup> ] (positive)	
	Direction	MC_Direction	fastest (3), current (2), positive (1), shortest (0), negative (-1) (Refer to section 9.11 Enumeration (ENUM))	
OUT	InVelocity	BOOL	TRUE: The set velocity has been reached for the first time.	
	Busy	BOOL	TRUE: The FB is in operation.	
	CommandAborted	BOOL	TRUE: Command has been aborted by another command.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

# NOTE

This FB is used for speed control. However, the drives are controlled by position based control instead of speed based control internally. For this reason, 'Modes of operation' (0x6060) and Modes of operation display' (0x6061) in the object dictionary are both '8' (cyclic synchronous position mode) instead of '9' (cyclic synchronous velocity mode).

# 9.2.10 MC\_PositionProfile

Name		Description		
MC_Po	sitionProfile	This FB commands a time-position locked motion profile.		
		Axis AXIS_REF_SM3 TimePosition MC_TP_R Execute BOOL ArraySize INT PositionScale LREAL Offset LREAL	1C_PositionProfile BOOL Done EF BOOL Busy BOOL CommandAborted BOOL Error SMC_ERROR ErrorID	
	Name	Туре	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
	TimePosition	MC_TP_REF	Reference to time-position description	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
	ArraySize	INT	The number of time-position profiles.	
	PositionScale	LREAL	Overall position scaling factor (initial value: 1)	
	Offset	LREAL	Overall offset for profile [u]	
OUT	Done	BOOL	The profile has been completed.	
	Busy	BOOL	TRUE: The FB is in operation.	
	CommandAborted	BOOL	TRUE: Command has been aborted by another command.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

# 9.2.11 MC\_VelocityProfile

Name		Description				
MC_VelocityProfile This FB comma			me-velocity locked motion profile.	FB		
MC_VelocityProfile         Axis       AXIS_REF_SM3       BOOL       Done         TimeVelocity       MC_TV_REF       BOOL       Busy         Execute       BOOL       BOOL       Busy         ArraySize       INT       BOOL       Error         VelocityScale       LREAL       SMC_ERROR       ErrorID         Offset       LREAL       SMC_ERROR       ErrorID						
	Name	Туре	Description			
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis			
	TimeVelocity	MC_TV_REF	Reference to time-velocity description			
IN	Execute	BOOL	Starts the execution of the FB at rising edge.			
	ArraySize	INT	The number of time-velocity profiles.			
	VelocityScale	LREAL	Overall velocity scaling factor (initial value: 1)			
	Offset	LREAL	Overall offset for profile [u/s]			
OUT	Done	BOOL	The profile has been completed.			
	Busy	BOOL	TRUE: The FB is in operation.			
	CommandAborted	BOOL	TRUE: Command has been aborted by another command.			
	Error	BOOL	TRUE: Error has occurred within the FB.			
	ErrorID	SMC_ERROR	Error identification			

	Name		Description	Туре
MC_Ac	celerationProfile	This FB commands a time	me-acceleration locked motion profile.	FB
	Axis Time Exec Arra Acce Offs	MC AXIS_REF_SM3 Acceleration MC_TA_R ute BOOL ySize INT lerationScale LREAL et LREAL	AccelerationProfile <i>BOOL</i> Done <i>BOOL</i> Busy <i>BOOL</i> CommandAborted <i>BOOL</i> Error <i>SMC_ERROR</i> ErrorID	
	Name	Туре	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
	TimeAcceleration	MC_TA_REF	Reference to time-acceleration description	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
	ArraySize	INT	The number of time-acceleration profiles.	
	AccelerationScale	LREAL	Overall acceleration scaling factor (initial value: 1)	
	Offset	LREAL	Overall offset for profile [u/s <sup>2</sup> ]	
OUT	Done	BOOL	The profile has been completed.	
	Busy	BOOL	TRUE: The FB is in operation.	
	CommandAborted	BOOL	TRUE: Command has been aborted by another command.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

# 9.2.12 MC\_AccelerationProfile

# 9.2.13 MC ReadActualPosition

Name			Description	Туре		
MC_Re	MC_ReadActualPosition This FB returns the actual position.					
MC_ReadActualPosition Axis AXI5_REF_SM3 BOOL Valid Enable BOOL Busy BOOL Error SMC_ERROR ErrorID LREAL Position						
	Name	Туре	Description			
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis			
IN	Enable	BOOL	TRUE: Enables the execution of the FB.			
OUT	Valid	BOOL	TRUE: A valid output is available.			
	Busy	BOOL	TRUE: The FB is in operation.			
	Error	BOOL	TRUE: Error has occurred within the FB.			
	ErrorID	SMC_ERROR	Error identification			
	Position	LREAL	New absolute position [u]			

# 9.2.14 MC\_ReadAxisError

	Name	Description			
MC_Re	adAxisError	This FB presents genera	al axis errors not relating to the function blocks.	FB	
MC_ReadAxisError Axis AXI5_REF_SM3 Enable BOOL BOOL Busy BOOL Error SMC_ERROR ErrorID BOOL AxisError DWORD AxisErrorID BOOL SWEndSwitchActive					
	Name	Туре	Description		
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis		
IN	Enable	BOOL	TRUE: Enables the execution of the FB.		
OUT	Valid	BOOL	TRUE: A valid output is available.		
	Busy	BOOL	TRUE: The FB is in operation.		
	Error	BOOL	TRUE: Error has occurred within the FB.		
	ErrorID	SMC_ERROR	Error identification		
	AxisError	BOOL	TRUE: Axis error has occurred.		
	AxisErrorID	DWORD	Vendor specific identification of the axis error.		
	SWEndSwitchActive	BOOL	TRUE: Software limits are exceeded.		

# 9.2.15 MC\_ReadParameter

	Name	Description			
MC_Re	adParameter	This FB returns the value	e of a vendor specific parameter with data type LREAL.	FB	
MC_ReadParameter Axis AXIS_REF_SM3 BOOL Valid Enable BOOL BOOL Busy ParameterNumber DIVT BOOL Error SMC_ERROR ErrorID LREAL Value					
	Name	Туре	Description		
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis		
IN	Enable	BOOL	TRUE: Enables the execution of the FB.		
	ParameterNumber	DINT	Number of the parameter (see the table below)		
OUT	Valid	BOOL	TRUE: A valid output is available.		
	Busy	BOOL	TRUE: The FB is in operation.		
	Error	BOOL	TRUE: Error has occurred within the FB.		
	ErrorID	SMC_ERROR	Error identification		
	Value	LREAL	Value of the parameter specified in input 'ParameterNumber'		

PN	Name	Туре	B/E	R/W	Description
1	CommandedPosition	REAL	В	R	Commanded position
2	SWLimitPos	REAL	Е	R/W	Positive software limit switch position
3	SWLimitNeg	REAL	Е	R/W	Negative software limit switch position
4	EnableLimitPos	BOOL	Е	R/W	Enable positive software limit switch
5	EnableLimitNeg	BOOL	Е	R/W	Enable negative software limit switch
6	EnablePosLagMonitoring	BOOL	Е	R/W	Enable monitoring of position lag
7	MaxPositionLag	REAL	Е	R/W	Maximal position lag
8	MaxVelocitySystem	REAL	Е	R	Maximal allowed velocity of the axis in the motion system
9	MaxVelocityAppl	REAL	В	R/W	Maximal allowed velocity of the axis in the application
10	ActualVelocity	REAL	В	R	Actual velocity
11	CommandedVelocity	REAL	В	R	Commanded velocity
12	MaxAccelerationSystem	REAL	Е	R	Maximal allowed acceleration of the axis in the motion system
13	MaxAccelerationAppl	REAL	Е	R/W	Maximal allowed acceleration of the axis in the application
14	MaxDecelerationSystem	REAL	Е	R	Maximal allowed deceleration of the axis in the motion system
15	MaxDecelerationAppl	REAL	Е	R/W	Maximal allowed deceleration of the axis in the application
16	MaxJerkSystem	REAL	Е	R	Maximal allowed jerk of the axis in the motion system
17	MaxJerkAppl	REAL	Е	R/W	Maximal allowed jerk of the axis in the application

PN: Parameter Number

B: Basic E: Expanded

R: Read only R/W: Read and Write

# 9.2.16 MC\_ReadBoolParameter

	Name		Description	Туре
MC_ReadBoolParameter This FB returns the value			e of a vendor specific parameter with data type BOOL.	FB
		MC_ — Axis AXIS_REF_SM. — Enable BOOL — ParameterNumber	ReadBoolParameter 3 BOOL Valid BOOL Busy DINT BOOL Error SMC_ERROR ErrorID BOOL Value	
	Name	Туре	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
IN	Enable	BOOL	TRUE: Enables the execution of the FB.	
	ParameterNumber	DINT	Number of the parameter (see section 9.2.15 MC_ReadParamet	er)
OUT	Valid	BOOL	TRUE: A valid output is available.	
	Busy	BOOL	TRUE: The FB is in operation.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	
	Value	BOOL	Value of the parameter specified in input 'ParameterNumber'	

# 9.2.17 MC\_WriteParameter

	Name		Description	Туре			
MC_Wr	iteParameter	This FB modifies the va	lue of a vendor specific parameter with data type LREAL.	FB			
	MC_WriteParameter         Axis AXIS_REF_SM3       BOOL Done         Execute BOOL       BOOL Busy         ParameterNumber DINT       BOOL Error         Value LREAL       SMC_ERROR ErrorID						
	Name	Туре	Description				
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis				
IN	Execute	BOOL	Starts the execution of the FB at rising edge.				
	ParameteNumber	DINT	Number of the parameter (see section 9.2.15 MC_ReadParameter	er)			
	Value	LREAL	New value of the specified parameter				
OUT	Done	BOOL	TRUE: Parameter successfully written				
	Busy	BOOL	TRUE: The FB is in operation.				
	Error	BOOL	TRUE: Error has occurred within the FB.				
	ErrorID	SMC_ERROR	Error identification				

	Name		Description	Type
MC_Wr	riteBoolParameter	This FB modifies the va	lue of a vendor specific parameter with data type BOOL.	FB
		MC_ — Axis <i>AXIS_REF_SM</i> — Execute <i>BOOL</i> — ParameterNumber — Value <i>BOOL</i>	WriteBoolParameter BOOL Done BOOL Busy DINT BOOL Error SMC_ERROR ErrorID	
	Name	Туре	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
	ParameterNumber	DINT	Number of the parameter (see section 9.2.15 MC_ReadParameter	er)
	Value	BOOL	New value of the specified parameter	
OUT	Done	BOOL	TRUE: Parameter successfully written	
	Busy	BOOL	TRUE: The FB is in operation.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

# 9.2.18 MC\_WriteBoolParameter

# 9.2.19 MC\_ReadStatus

Name		Description		
MC_Re	adStatus	This FB returns in detai	ls the status of the state diagram of the selected axis.	FB
MC_ReadStatus       MC_ReadStatus         MC_ReadStatus       BOOL Valid         Axis AXIS_REF_SM3       BOOL Busy         Enable BOOL       BOOL Error         SMC_ERROR ErrorID       BOOL Disabled         BOOL Stopping       BOOL Stopping         BOOL StandStill       BOOL ContinuousMotion         BOOL SynchronizedMotion       BOOL ConstantVelocity         BOOL ConstantVelocity       BOOL Accelerating         BOOL Decelerating       BOOL Decelerating         BOOL DEBErrorCorured       BOOL DEBErrorCorured				
	Name	Туре	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
IN	Enable	BOOL	TRUE: Enables the execution of the FB.	
OUT	Valid	BOOL	TRUE: A valid output is available.	
	Busy	BOOL	TRUE: The FB is in operation.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	
	Disabled	BOOL	TRUE: Disabled (see section 4.1 State diagram)	
	Errorstop	BOOL	TRUE: Errorstop (see section 4.1 State diagram)	
	Stopping	BOOL	TRUE: Stopping (see section 4.1 State diagram)	
	StandStill	BOOL	TRUE: StandStill (see section 4.1 State diagram)	
	DiscreteMotion	BOOL	TRUE: DiscreteMotion (see section 4.1 State diagram)	
	ContinuousMotion	BOOL	TRUE: ContiuousMotion (see section 4.1 State diagram)	
	SynchronizedMotion	BOOL	TRUE: SynchronizedMotion (see section 4.1 State diagram)	
	Homing	BOOL	TRUE: Homing (see section 4.1 State diagram)	
	ConstantVelocity	BOOL	TRUE: Motor moves with constant velocity.	
	Accelerating	BOOL	TRUE: Motor moves with increasing velocity.	
	Decelerating	BOOL	TRUE: Motor moves with decreasing velocity.	
	FBErrorOccurred	BOOL	TRUE: FB error has occurred.	
### 9.2.20 MC\_Reset

Name Description		Description	Туре	
MC_Reset This FB makes the transition from the state 'ErrorStop' to 'Standstill' or 'Disabled' by		FB		
		resetting all internal axi	s-related errors.	
		—Axis AXI5_REF_SM —Execute BOOL	MC_Reset 13 BOOL Done BOOL Busy BOOL Error SMC_ERROR ErrorID	
	Name	Туре	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
OUT	Done	BOOL	TRUE: Reset has been executed.	
	Busy	BOOL	TRUE: The FB is in operation.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

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# 9.3 PLCopen Part 2 for Single-Axis

# 9.3.1 MC\_TouchProbe

	Name	Description		Туре
MC_To	uchProbe	This FB is used to recor	d an axis position at a trigger event.	FB
MC_TouchProbe         Axis       AXIS_REF_SM3       BOOL       Done         TriggerInput       TRIGGER_REF       BOOL       Busy         Execute       BOOL       BOOL       Error         WindowOnly       BOOL       SMC_ERROR       ErrorID         FirstPosition       LREAL       LREAL       RecordedPosition         LastPosition       LREAL       BOOL       CommandAborted				
Name Type			Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
	TriggerInput	TRIGGER_REF	EF Reference to trigger signal source	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
	WindowOnly	BOOL	TRUE: Trigger events will be accepted only within the window.	specified
	FirstPosition	LREAL	Start position from whereon (in positive direction) trigger even accepted [u].	nts will be
	LastPosition	LREAL	End position up to which trigger events will be accepted [u].	
OUT	Done	BOOL	TRUE: Trigger event has been recorded.	
	Busy	BOOL	TRUE: The FB is in operation.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	
	RecordedPosition	LREAL	Position, where trigger event has occurred [u].	
	CommandAborted	BOOL	TRUE: Command has been aborted by another command.	

### 9.3.2 MC\_AbortTrigger

	Name Description			Туре
MC_Ab	ortTrigger	This FB is used to abort	function block which are connected to trigger events.	FB
MC_AbortTrigger Axis AXIS_REF_SM3 BOOL Done TriggerInput TRIGGER_REF BOOL Busy Execute BOOL BOOL Error SMC_ERROR ErrorID				
	Name	Туре	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
	TriggerInput	TRIGGER_REF	Reference to trigger signal source	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
OUT	Done	BOOL	TRUE: Latching has been aborted successfully.	
	Busy	BOOL	TRUE: The FB is in operation.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

# NOTE

MC\_AbortTrigger might not work depending on drives. Possible countermeasure in this case could be to set parameter directly to drives.

# 9.3.3 MC\_DigitalCamSwitch

	Name	Description Type			
MC_Di	gitalCamSwitch	This FB is the analogy to switches on a motor shaft: it commands a group of discrete FB			
		output bits to switch in analo	ogy to a set of mechanical cam controlled switches		
		connected to an axis.			
MC_DigitalCamSwitch         Axis AXIS_REF_SM3       BOOL InOperation         Switches MC_CAMSWITCH_REF       BOOL Busy         Outputs MC_OUTPUT_REF       BOOL Error         TrackOptions MC_TRACK_REF       SMC_ERROR ErrorID         Enable BOOL       EnableMask DWORD         TappetMode MC_TAPPETMODE       TappetMode MC_TAPPETMODE					
	Name	Туре	Description		
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis		
	Switches	MC_CAMSWITCH_REF	Reference to switching actions		
	Outputs MC_OUTPUT_REF Reference to signal outputs referenced tracks. (ARRAY		Reference to signal outputs that are directly relate referenced tracks. (ARRAY [132] OF BOOL)	ed to the	
	TrackOptions	MC_TRACK_REF	Reference to structure containing track related propertie e.g. the on/off compensations per output/track. (ARRAY [132] OF MC_TRACK_TR)	ÿS,	
IN	Enable	BOOL	TRUE: Enables the execution of the FB.		
	EnableMask	32 bits of BOOL enabling the different tracks. Lead         DWORD       data is related to the lowest TrackNumber.         (initial value: 16#FFFFFFF)		significant	
	TappetMode	MC_TAPPETMODE	ENUM		
OUT	InOperation	BOOL	TRUE: Commanded tracks have been enabled.		
	Busy	BOOL	TRUE: The FB is in operation.		
	Error	BOOL	TRUE: Error has occurred within the FB.		
	ErrorID	SMC_ERROR	Error identification		

# MC\_CAMSWITCH\_REF (STRUCT)

Name	Туре	Initial	Description
NoOfSwitches	BYTE	0	Number of switch positions
CamSwitchPtr	POINTER TO MC_CAMSWITCH_TR	0	Address of MC_CAMSWITCH_TR

# MC\_CAMSWITCH\_TR (STRUCT)

Name	Туре	Initial	Description	
TrackNumber	INT		Number of the output; several position ranges per output are possible. [132]	
FirstOnPosition	LREAL		Switch-on position of the output	
LastOnPosition	LREAL		Switch-off position of the output	
			0: The output is switched in two directions.	
AxisDirection	tisDirection INT 1: The output is only switched in positive		1: The output is only switched in positive direction.	
			2: The output is only switched in negative direction.	
2: The output is only switched in negative di         0: The tappets are calculated position-based.		0: The tappets are calculated position-based.		
	INT		1: The tappets are calculated time-based, whereby only the value of	
Cams witchwode			FirstOnPosition will be used and the output stays TRUE for the given time	
			(Duration).	
Duration	TIME		Period of time for which the tappet output stays TRUE in case of	
Duration	TIME		CAMSwitchMode=1.	

#### Name Туре Initial Description 0 A delay (value positive) of switch-on or an early switch-on (value OnCompensation LREAL negative) can be set. The time is given in seconds. 0 A delay (value positive) of switch-off or an early switch-off (value OffCompensation LREAL negative) can be set. The time is given in seconds. 0 Additionally a hysteresis can be set, which avoids a permanent switching of the output, which might occur e.g. if the servo-controller is exactly in LREAL Hysteresis switch-position and slightly swinging around that position due to the position control.

### MC\_TRACK\_TR (STRUCT)

#### **MC\_TAPPETMODE (ENUM)**

Name	Value	Description
tp_mode_auto	0	Auto mode
tp_mode_demandposition	1	Use set values
tp_mode_actualposition	2	Use actual values

### NOTE

If the following conditions are fulfilled, output might oscillate wrongly. Be sure to read information below and avoid that.

By setting a certain time to OnCompensation, activated time of tappet output can be exactly 0, which is normally unnecessary usage. In that case, tappet output might oscillate. Be sure to set parameters so that tappet output is activated in a certain time.

#### 9.3.4 MC\_ReadActualTorque

	Name Description			
MC_Re	eadActualTorque	This FB returns the va	alue of the actual torque.	FB
MC_ReadActualTorque Axis AXI5_REF_SM3 BOOL Valid Enable BOOL BUSY BOOL Error SMC_ERROR ErrorID LREAL Torque				
	Name	Туре	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
IN	Enable	BOOL	TRUE: Enables the execution of the FB.	
OUT	Valid	BOOL	TRUE: A valid output is available.	
	Busy	BOOL	TRUE: The FB is in operation.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	
	Torque	LREAL	Value of current torque	

### 9.3.5 MC\_ReadActualVelocity

	Name		Description		
MC_Re	eadActualVelocity	This FB returns the va	alue of the actual velocity.	FB	
MC_ReadActualVelocity Axis AXI5_REF_SM3 BOOL Valid Enable BOOL BUSY BOOL Error SMC_ERROR ErrorID LREAL Velocity					
	Name	Туре	Description		
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis		
IN	Enable	BOOL	TRUE: Enables the execution of the FB.		
OUT	Valid	BOOL	TRUE: A valid output is available.		
	Busy	BOOL	TRUE: The FB is in operation.		
	Error	BOOL	TRUE: Error has occurred within the FB.		
	ErrorID	SMC_ERROR	Error identification		
	Velocity	LREAL	Value of current velocity [u/s]		

### 9.3.6 MC\_SetPosition

	Name		Description	Туре
MC_Se	tPosition	This FB shifts the coo	rdinate system of an axis by manipulating both the set-point	FB
		position as well as the	actual position of an axis with the same value without any	
		movement caused.		
MC_SetPosition         Axis AXIS_REF_SM3       BOOL Done         Execute BOOL       BOOL Busy         Position LREAL       BOOL Error         Mode BOOL       SMC_ERROR ErrorID				
	Name	Туре	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
	Position	LREAL	Position unit [u]	
	Mode	BOOL	TRUE: Relative FALSE: Absolute	
OUT	Done	BOOL	TRUE: Position has been assigned to new value.	
	Busy	BOOL	TRUE: The FB is in operation.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

9.3.7 31			Description		Turne
	Name				Туре
SMC_N	NoveContinuousAbsolute	This FB comman	ds a controlled motion to a spec	cified absolute position	FB
		ending with the sp	pecified velocity.		
		SMC_Move	eContinuousAbsolute		
	— Axis AXIS_R — Execute BO	REF_SM3	BOOL In	EndVelocity	
	-Position LR	EAL	BOOL Comm	andAborted —	
		EAL		BOOL Error —	
	- EndVelocity EndVelocity	LREAL Direction MC Directi	on	OR ErrorID	
	-Acceleration	LREAL			
	- Deceleration	ILREAL			
	— Jerk LREAL — Direction M	C Direction			
	Name	Туре	Des	scription	
IN_OUT	Axis	AXIS_REF_SM3	13 Reference to the axis		
IN	Execute	BOOL	Starts the execution of the FB at rising edge.		
	Position	LREAL	Target position [u] (positive or negative)		
	Velocity	LREAL	Maximum velocity [u/s] (positive)		
	EndVelocity	LREAL	End velocity [u/s] (positive)		
		MC_Direction	Determines direction of end velocity.		
			Permissible values:	Not applicable:	
	EndVelocityDirection		current (2)	fastest (3)	
			positive (1)	shortest (0)	
			negative (-1)		
			(Refer to section 9.11 Enumeration (ENUM))		
	Acceleration	LREAL	Acceleration $[u/s^2]$ (positive)		
	Deceleration	LREAL	Deceleration $[u/s^2]$ (positive)		
	Jerk	LREAL	Jerk [u/s <sup>3</sup> ] (positive)		
			Direction		
	Direction	MC Direction	for linear/finite axes: positive (1), negative (-1)		
			for rotary/modulo axes: fastest (	(3), current (2), positive (1	), shortest
(0), negative (-1) (Refer to section 9.1		tion 9.11 Enumeration (EN	UM))		
OUT	InEndVelocity	BOOL	TRUE: Commanded position has	s been reached.	
	Busy	BOOL	TRUE: The FB is in operation.		
	CommandAborted	BOOL	TRUE: Command has been abor	ted by another command.	
	Error	BOOL	TRUE: Error has occurred within	n the FB.	
	ErrorID	SMC_ERROR	Error identification		

# 9.3.7 SMC\_MoveContinuousAbsolute

# 9.3.8 MC\_MoveContinuousRelative

	Name	Description			Туре
SMC_N	IoveContinuousRelative	This FB commands a controlled motion to a specified relative distance			FB
		ending with the sp	pecified velocity.		l
		•			
SMC_MoveContinuousRelative         Axis       AXIS_REF_SM3       BOOL       InEndVelocity         Execute       BOOL       BOOL       Busy         Distance       LREAL       BOOL       CommandAborted         Velocity       LREAL       BOOL       Error         EndVelocity       LREAL       SMC_ERROR       ErrorID         EndVelocityDirection       MC_Direction       Acceleration       LREAL         Deceleration       LREAL       Jerk       LREAL         Jerk       LREAL       Description					
	Name	Туре	Description		
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis		
IN	Execute	BOOL	Starts the execution of the FB at	rising edge.	
	Distance	LREAL	Relative distance [u] (positive or negative)		
	Velocity	LREAL	Maximum velocity [u/s] (positive)		
	EndVelocity	LREAL	End velocity [u/s] (positive)		
		MC_Direction	Determines direction of end velocity.		
			Permissible values:	Not applicable:	
	EndVelocityDirection		current (2)	fastest (3)	
	Lind VelocityDirection		positive (1)	shortest (0)	
			negative (-1)		
			(Refer to section 9.11 Enumeration (ENUM))		
	Acceleration	LREAL	Acceleration [u/s <sup>2</sup> ] (positive)		
	Deceleration	LREAL	Deceleration [u/s <sup>2</sup> ] (positive)		
	Jerk	LREAL	Jerk [u/s <sup>3</sup> ] (positive)		
OUT	InEndVelocity	BOOL	TRUE: Commanded distance has	s been reached.	
	Busy	BOOL	TRUE: The FB is in operation.		
	CommandAborted	BOOL	TRUE: Command has been abor	ted by another command.	
	Error	BOOL	TRUE: Error has occurred within	the FB.	
	ErrorID	SMC_ERROR	Error identification		

# 9.4 PLCopen Part 3 for Single-Axis

### 9.4.1 MC\_Jog

Na	ame	Description	Туре					
MC_Jo	g	This FB	commands a jogged	I movement to a specified axis as long as the input	FB			
'JogForward/Backward' is set.								
				MC log				
		-	Axis AXI5_REF_SM.	3 BOOL Busy —				
		-	JogForward BOOL	BOOL CommandAborted				
		-	JogBackward BOOL Velocity / REA/	SMC Fror Frord				
		-	Acceleration LREAL					
		-	Deceleration LREAL	L				
		-						
	Name		Туре	Description				
IN_OUT	Axis		AXIS_REF_SM3	Reference to the axis				
IN				TRUE: Axis is moved with the specified dynamic values	velocity,			
	JogForwar	rd	BOOL	acceleration, deceleration and jerk in a positive direction.				
				(No motion is executed if JogBackward is TRUE at the same time	me)			
				TRUE: Axis is moved with the specified dynamic values	velocity,			
	JogBackw	ard	BOOL	acceleration, deceleration and jerk in a negative direction.				
				(No motion is executed if JogForward is TRUE at the same tim	e)			
	Velocity		LREAL	Maximum velocity [u/s] (positive)				
	Accelerati	on	LREAL	Acceleration [u/s <sup>2</sup> ] (positive)				
	Decelerati	on	LREAL	Deceleration [u/s <sup>2</sup> ] (positive)				
	Jerk		LREAL	Jerk [u/s <sup>3</sup> ] (positive)				
OUT	Busy		BOOL	TRUE: The FB is in operation.				
	Command	Aborted	BOOL	TRUE: Command has been aborted by another command.				
	Error		BOOL	TRUE: Error has occurred within the FB.				
	ErrorID		SMC_ERROR	Error identification				

### NOTE

When 'JogForward' input or 'JogBackward' input is reset (TRUE to FALSE), the specified axis is in deceleration. If the axis status changes to Errorstop while deceleration before stopping by an unexpected reason, for example limit switch detected, then 'Busy' output of MC\_Jog is activated, and no command can be accepted. In this case, perform [Reset warm] or [Reset cold] to restart the PLC.

### 9.4.2 SMC\_Inch

Name	ame Description				
SMC_Inch	This FB commands an inching movement to a specified axis as long as the moving distance is	FB			
	not reached and the input 'InchForward' or 'InchBackward' is set.				
	SMC_Inch         Axis AXIS_REF_SM3       BOOL Busy         InchForward BOOL       BOOL CommandAborted         InchBackward BOOL       BOOL Error         Distance LREAL       SMC_ERROR ErrorId         Velocity LREAL       Acceleration LREAL         Deceleration LREAL       Jerk LREAL				

	Name	Туре	Description
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis
IN	InchForward	BOOL	TRUE: Axis is moved with the dynamic values velocity, acceleration, deceleration and jerk in a positive direction until distance has been travelled. If 'InchForward' is set to FALSE and back to TRUE, a further motion is started. If 'InchForward' is set to FALSE before distance has been travelled, the axis is immediately decelerated to the velocity value zero. 'Busy' is then set to FALSE. If 'InchBackward' and 'InchForward' are TRUE at the same time, then
	InchBackward	BOOL	no motions are carried out. TRUE: Axis is moved with the dynamic values velocity, acceleration, deceleration and jerk in a negative direction until distance has been travelled. If 'InchBackward' is set to FALSE and back to TRUE, a further motion is started. If 'InchBackward' is set to FALSE before distance has been travelled, the axis is immediately decelerated to the velocity value zero. 'Busy' is then set to FALSE. If 'InchBackward' and 'InchForward' are TRUE at the same time, then no motions are carried out.
	Distance	LREAL	Distance that is travelled [u] (positive)
	Velocity	LREAL	Maximum velocity [u/s] (positive)
	Acceleration	LREAL	Acceleration [u/s <sup>2</sup> ] (positive)
	Deceleration	LREAL	Deceleration [u/s <sup>2</sup> ] (positive)
	Jerk	LREAL	Jerk [u/s <sup>3</sup> ] (positive)
OUT	Busy	BOOL	TRUE: The FB is in operation.
	CommandAborted	BOOL	TRUE: Command has been aborted by another command.
	Error	BOOL	TRUE: Error has occurred within the FB.
	ErrorID	SMC_ERROR	Error identification

# 9.5 PLCopen for Multi-Axis

# 9.5.1 MC\_CamIn

Name		Description					
MC_Ca	mIn	This FB eng	gages the CAM.		FB		
	MC_CamIn         Master AXIS_REF_SM3       BOOL InSync         Slave AXIS_REF_SM3       BOOL Busy         Execute BOOL       BOOL CommandAborted         MasterOffset LREAL       BOOL Error         SlaveOffset LREAL       SMC_ERROR ErrorID         MasterScaling LREAL       SMC_TappetData Tappets         StartMode       CamTableID         VelocityDiff LREAL       SMC_TappetData Tappets         Deceleration LREAL       Deceleration LREAL         Jerk LREAL       TappetHysteresis LREAL						
	Name		Туре	Description			
IN_OUT	Master		AXIS_REF_SM3	Reference to master axis			
	Slave		AXIS_REF_SM3	Reference to slave axis			
IN	Execute		BOOL	Starts the execution of the FB at rising edge.			
	MasterOff	set	LREAL	Offset on master table			
	SlaveOffs	et	LREAL	Offset on slave table			
	MasterSca	ling	LREAL	Scaling factor for master profile			
	SlaveScali	ing	LREAL	Scaling factor for slave profile			
	StartMode	e.	MC_StartMode	Start mode			
	CamTable	EID	MC_CAM_ID	Identification of the cam table. The input is connected with the the instance of MC_CamTableSelect.	output of		
	VelocityD	viff	LREAL	Maximum velocity difference for 'ramp in' mode. [u/s]			
	Accelerati	ration LREAL Acceleration for 'ramp_in' mode. [u/s <sup>2</sup> ]		Acceleration for 'ramp_in' mode. [u/s <sup>2</sup> ]			
	Decelerati	on	LREAL	Deceleration for 'ramp_in' mode. [u/s <sup>2</sup> ]			
	Jerk		LREAL	Jerk for 'ramp_in' mode. [u/s <sup>3</sup> ]			
	TappetHy	steresis	LREAL	Size of the hysteresis for tappets in [u]. A positive value mean tappet cannot fire immediately after it has fired. The master po- needs to move away from the tappet by more than the value TappetHysteresis. For example, if the master is an encoder, the master pos- oscillate by a few increments around the tappet position. The hysteresis, the tappet may fire all the time.	is that the sition first given for ition may Without a		
OUT	InSync		BOOL	TRUE: Cam has been engaged for the first time.			
	Busy		BOOL	TRUE: The FB is in operation.			
	Command	Aborted	BOOL	TRUE: Command has been aborted by another command.			
	Error		BOOL	TRUE: Error has occurred within the FB.			
	ErrorID		SMC_ERROR	Error identification			
	EndOfPro	file	BOOL	Pulsed output: Cyclic end of the cam profile			
	Tappets		SMC_TappetData	Tappets: Has to be evaluated by SMC_GetTappetValue FB.			

### MC\_STARTMODE (ENUM)

Name	Value	Description
absolute	0	Cam plate is positioned absolutely with respect to the current master and slave.
relative	1	Cam plate is positioned relative to the current master and slave.
ramp_in	2	With acceleration
ramp_in_pos	3	With acceleration in positive direction
ramp_in_neg	4	With acceleration in negative direction

# SMC\_TAPPETDATA (STRUCT)

Name	Туре	Initial	Description
pTaps	ARRAY [02] OF POINTER TO SMC_CAMTappet		This is a STRUCT for interface
dwCycleTime	DWORD		between MC_CamIn output and
byChannels	BYTE	3	SMC_GetTappetValue input.
bRestart	BOOL		

### SMC\_CAMTAPPET (STRUCT)

Name	Туре	Initial	Description
Ctt	SMC_CAMTAPPETTYPE (ENUM)		See SMC_CAMTAPPETTYPE below.
Cta	SMC_CAMTAPPETACTION (ENUM)		See SMC_CAMTAPPETACTION below.
dwDalay	DWORD		In case of 'cta' =Tappetaction.tappetaction_time, this value
dwDelay	DWORD		determines the delay time [µs].
			In case of 'cta' =Tappetaction.tappetaction_time, this value
dwDuration	DWORD		determines the time for which the tappet is switched to on.
			[µs]
iGroupID	INT		Group or track ID of the tappet output that is switched.
Х	LREAL		Master position where tappet is switched.
dwActive	DWORD	16#FFFFFFFF	Internal variable

### SMC\_CAMTAPPETTYPE (ENUM)

Name	Value	Description
TAPPET_pos	0	Tappet action active when the master passes its position in positive direction.
TAPPET_all	1	Tappet action active when the master passes its position in both directions.
TAPPET_neg	2	Tappet action active when the master passes its position in negative direction.

### SMC\_CAMTAPPETACTION (ENUM)

Name	Value	Description
TAPPETACTION_on	0	Switches on.
TAPPETACTION_off	1	Switches off.
TAPPETACTION_inv	2	Inverts.
TAPPETACTION_time	3	Switches on after a delay for a certain time period.

### 9.5.2 MC\_CamOut

	Name	Description					
MC_Ca	imOut	This FB disengages the slav	e axis from the master axis immediately.	FB			
	MC_CamOut — Slave AXIS_REF_SM3 BOOL Done — Execute BOOL BOOL Busy BOOL Error SMC_ERROR ErrorID						
	Name	Туре	Description				
IN_OUT	Slave	AXIS_REF_SM3	Reference to the slave axis				
IN	Execute	BOOL	Starts the execution of the FB at rising edge.				
OUT	Done	BOOL	TRUE: Cam has been disengaged.				
	Busy	BOOL	TRUE: The FB is in operation.				
	Error	BOOL	TRUE: Error has occurred within the FB.				
	ErrorID	SMC_ERROR	Error identification				

### 9.5.3 MC\_CamTableSelect

	Name	Description				
MC_Ca	mTableSelect	This FB selects the CAM tables by setting the connections to the relevant tables.				
MC_CamTableSelect         Master AXIS_REF_SM3       BOOL Done         Slave AXIS_REF_SM3       BOOL Busy         CamTable MC_CAM_REF       BOOL Error         Execute BOOL       SMC_ERROR ErrorID         Periodic BOOL       MC_CAM_ID CamTableID         MasterAbsolute BOOL       SlaveAbsolute BOOL						
Name		Туре	Description			
IN_OUT	Master	AXIS_REF_SM3	Reference to the master axis			
	Slave	AXIS_REF_SM3	Reference to the slave axis			
	CamTable	MC_CAM_REF	Reference to the cam description			
IN	Execute	BOOL	Starts the execution of the FB at rising edge.			
	Periodic	BOOL	TRUE: Periodic FALSE: Non periodic			
	MasterAbsolute	BOOL	TRUE: Absolute FALSE: Relative coordinates			
	SlaveAbsolute	BOOL	TRUE: Absolute FALSE: Relative coordinates			
OUT	Done	BOOL	TRUE: Preselection has been done.			
	Busy	BOOL	TRUE: The FB is in operation.			
	Error	BOOL	TRUE: Error has occurred within the FB.			
	ErrorID	SMC_ERROR	Error identification			
	CamTableID	MC_CAM_ID	Identifier of the cam table be used for the function block. (Connect to input of MC_CamIn)			

# 9.5.4 MC\_GearIn

	Name	Description					
MC_GearIn		This FB commands a ratio b	between the velocity of the slave and master axis.	FB			
MC_GearIn         Master AXIS_REF_SM3       BOOL InGear         Slave AXIS_REF_SM3       BOOL Busy         Execute BOOL       BOOL CommandAborted         RatioNumerator DINT       BOOL Error         RatioDenominator UDINT       SMC_ERROR ErrorID         Acceleration LREAL       Deceleration LREAL         Jerk LREAL       Jerk LREAL							
Name		Туре	Description				
IN_OUT	Master	AXIS_REF_SM3	Reference to the master axis				
	Slave	AXIS_REF_SM3	Reference to the slave axis				
IN	Execute	BOOL	Starts the execution of the FB at rising edge.				
	RatioNumerator	DINT	Gear ratio Numerator				
	RatioDenominat	or UDINT	Gear ratio Denominator				
	Acceleration	LREAL	Target acceleration when coupling[u/s <sup>2</sup> ]				
	Deceleration	LREAL	Target deceleration when coupling[u/s <sup>2</sup> ]				
	Jerk	LREAL	Jerk when coupling [u/s <sup>3</sup> ]				
OUT	InGear	BOOL	TRUE: Coupling has taken place.				
	Busy	BOOL	TRUE: The FB is in operation.				
	CommandAbort	ed BOOL	TRUE: Command has been aborted by another command.				
	Error	BOOL	TRUE: Error has occurred within the FB.				
	ErrorID	SMC_ERROR	Error identification				

### 9.5.5 MC\_GearInPos

Name			Description		
MC_Ge	earInPos	This FE	FB commands a gear ratio between the position of the slave and master from the		
		synchro	nization point onward	ls.	
		Ma Sla Exe Rat Ma Sla Ma Avo	ster AXIS_REF_SM3 ve AXIS_REF_SM3 ecute BOOL tioNumerator DINT tioDenominator DINT sterSyncPosition LREA veSyncPosition LREA sterStartDistance LR oidReversal BOOL	MC_GearInPos BOOL StartSync BOOL InSync BOOL Busy BOOL CommandAborted BOOL Error SAL SMC_ERROR ErrorID AL EAL	
	Name		Туре	Description	
IN_OUT	Master		AXIS_REF_SM3	Reference to the master axis	
	Slave		AXIS_REF_SM3	Reference to the slave axis	
IN	Execute		BOOL	Starts the execution of the FB at rising edge.	
	RatioNumerator		DINT	Gear ratio Numerator	
	RatioDenomina	tor	DINT	Gear ratio Denominator	
	MasterSyncPosition		LREAL	Master position where the axes run in sync.	
	SlaveSyncPosition		LREAL	Slave position where the axes run in sync.	
	MasterStartDistance LR AvoidReversal BC		LREAL	Master distance for the gear in procedure (where the slave axis will started for getting into synchronization). In other words, the slave brought into sync with the master during this distance, i.e. fr MasterSyncPosition - MasterStartDistance until MasterSyncPosition If MasterStartDistance is 0 (or negative), then the slave movemen started immediately	
			BOOL	TRUE: Signals that the reversal of the module slave is physically impossible or might lead to damage. FALSE: Signals that the reversal of the slave is physically possible and acceptable.	
OUT	StartSync		BOOL	TRUE: Commanded gearing has been started.	
	InSync		BOOL	TRUE: Commanded gearing has been completed.	
	Busy		BOOL	TRUE: The FB is in operation.	
	CommandAbor	ted	BOOL	TRUE: Command has been aborted by another command.	
	Error		BOOL	TRUE: Error has occurred within the FB.	
	ErrorID		SMC_ERROR	Error identification	

# 9.5.6 MC\_GearOut

	Name	Description		
MC_Ge	GearOut This FB disengages the slave axis from the master axis.			FB
MC_GearOut 				
	Name	Туре	Description	
IN_OUT	Slave	AXIS_REF_SM3	Reference to the slave axis	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
OUT	Done	BOOL	TRUE: Slave axis has been disengaged.	
	Busy	BOOL TRUE: The FB is in operation.		
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

Ν	lame			Description	Туре
MC_Ph	asing '	This Functi	ion Block creates a pha	ase shift in the master position of a slave axis relative to the	FB
existing phase shift. The mast			ase shift. The master p	osition is shifted in relation to the real physical position.	
			laster AXIS_REF_SM3 lave AXIS_REF_SM3 xecute BOOL haseShift LREAL elocity LREAL cceleration LREAL leceleration LREAL erk LREAL	MC_Phasing BOOL Done BOOL Busy BOOL CommandAborted BOOL Error SMC_ERROR ErrorID	
	Name		Туре	Description	
IN_OUT	Master		AXIS_REF_SM3	Reference to the master axis	
	Slave		AXIS_REF_SM3	Reference to the slave axis	
IN	Execute		BOOL	Starts the execution of the FB at rising edge.	
	PhaseShift		LREAL	Phase difference between master and slave [u]	
	Velocity		LREAL	Maximum velocity for reaching phase difference [u/s]	
	Acceleration		LREAL	Maximum acceleration for reaching phase difference [u/s <sup>2</sup> ]	
	Deceleration		IDEAL	Maximum deceleration for reaching phase difference $[u/s^2]$	
			LKLAL	Maximum deceleration for reaching phase difference [u/s]	
	Jerk		LREAL	Maximum deceneration for reaching phase difference $[u/s^3]$	
OUT	Jerk Done		LREAL BOOL	Maximum deceneration for reaching phase difference [u/s <sup>3</sup> ] Maximum jerk for reaching phase difference [u/s <sup>3</sup> ] TRUE: Commanded phasing has been reached.	
OUT	Jerk Done Busy		LREAL BOOL BOOL	Maximum deceneration for reaching phase difference [u/s <sup>3</sup> ]         Maximum jerk for reaching phase difference [u/s <sup>3</sup> ]         TRUE: Commanded phasing has been reached.         TRUE: The FB is in operation.	
OUT	Jerk Done Busy CommandAbo	orted	LREAL BOOL BOOL BOOL	Maximum deceneration for reaching phase difference [u/s <sup>3</sup> ]         Maximum jerk for reaching phase difference [u/s <sup>3</sup> ]         TRUE: Commanded phasing has been reached.         TRUE: The FB is in operation.         TRUE: Command has been aborted by another command.	
OUT	Jerk Done Busy CommandAbo Error	orted	LREAL BOOL BOOL BOOL BOOL	Maximum deceleration for reaching phase difference [u/s <sup>3</sup> ]         Maximum jerk for reaching phase difference [u/s <sup>3</sup> ]         TRUE: Commanded phasing has been reached.         TRUE: The FB is in operation.         TRUE: Command has been aborted by another command.         TRUE: Error has occurred within the FB.	

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# 9.6 Utility Function Blocks

# 9.6.1 SMC3\_ReinitDrive

	Name	Description			
SMC3	ReinitDrive	This FB reinits a drive/ax	is. That means that the start-up phase is run through again and	FB	
	the application cannot control the drive until the function block set bDone = TRUE.				
SMC3_ReinitDrive Axis AXI5_REF_SM3 BOOL bDone bExecute BOOL BOOL bBusy bVirtual BOOL BOOL bError SMC_ERROR nErrorID					
	Name	Туре	Description		
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis		
IN	bExecute	BOOL	Starts the execution of the FB at rising edge.		
	bVirtual	BOOL	TRUE: Virtual mode		
OUT	bDone	BOOL	TRUE: Reinitialization has been completed.		
bBusyBOOLbErrorBOOL		BOOL	TRUE: The FB is in operation.		
		BOOL	TRUE: Error has occurred within the FB.		
	nErrorID	SMC_ERROR	Error identification		

# 9.6.2 SMC\_GetTappetValue

	Name			Description	Туре
SMC_C	GetTappetValue	This F	B evaluates the output	t Tappets of function block MC_CamIn and contains the	FB
		curren	t tappet status.		
			SMC	GetTannetValue	
	_	Тарре	ts SMC_TappetData	BOOL bTappet —	
	-	−iID 』	VT		
	_	binitv bSetTr	alue <i>BOOL</i> nitValueAtReset <i>BOOL</i>		
	Name		Туре	Description	
IN_OUT	Tappets		SMC_TappetData	Tappet signals to be evaluated by MC_GetTappetValue	
IN	iID		INT	Group ID of the tappet to be evaluated	
	bInitValue		BOOL	Initial value of the tappet to be assigned at first call	
				TRUE: Sets the value of the tappet to bInitValue at a res	tart of the
	bSetInitValueAtR	eset	BOOL	MC_CamIn FB.	
				FALSE: Retains the tappet value at a restart of the MC_Car	nIn FB.
OUT	bTappet		BOOL	Tappet value	

#### 9.6.3 SMC Homing Description Name Туре SMC Homing This FB causes the execution of a homing drive of the axis. If SMC\_Homing is executed, FB the axis is moved at fVelocityFast in the direction specified by nDirection as long as bReferenceSwitch = FALSE. The reference switch is then closed. The axis is decelerated and driven at fVelocitySlow in the opposite direction. At the point at which the reference switch opens with bReferenceSwitch = TRUE, the reference position fHomePosition is set and the drive is stopped. SMC\_Homing Axis AXIS\_REF\_SM3 BOOL bDone bExecute BOOL BOOL bBusy fHomePosition LREAL BOOL bCommandAborted fVelocitySlow LREAL BOOL bError fVelocityFast LREAL SMC\_ERROR nErrorID fAcceleration LREAL BOOL bStartLatchingIndex fDeceleration LREAL fJerk LREAL nDirection MC\_Direction bReferenceSwitch BOOL fSignalDelay LREAL nHomingMode SMC HOMING MODE bReturnToZero BOOL bIndexOccured BOOL fIndexPosition LREAL bIgnoreHWLimit BOOL Name Description Type IN\_OUT Axis AXIS\_REF\_SM3 Reference to the axis IN hExecute BOOL Starts the execution of the FB at rising edge. fHomePosition LREAL Home position taken after homing completed [u]. LREAL Low velocity; used to drive out of the reference switch [u/s] fVelocitySlow fVelocityFast LREAL High velocity; used until reference switch is found [u/s] fAcceleration LREAL Acceleration $[u/s^2]$ (positive) **f**Deceleration LREAL Deceleration $[u/s^2]$ (positive) fJerk LREAL Jerk $[u/s^3]$ (positive) Direction positive (1), negative (-1) (Refer to section 9.11 nDirection MC\_Direction Enumeration (ENUM)) TRUE: Switches the reference. bReferenceSwitch BOOL Time [s] for bReferenceSwitch to be transmitted. fSignalDelay LREAL (The result of (fVelocitySlow \* fSignalDelay) will be added to home position as a offset after homing done.) SMC\_HOMING\_MODE nHomingMode Homing mode (Refer to section 9.11 Enumeration (ENUM)) bReturnToZero BOOL TRUE: Moves to position zero after homing. bIndexOccurred BOOL Index pulse fIndexPosition LREAL Position where index occurred TRUE: Sets bHWLimitEnable (parameter in AXIS\_REF\_SM3) bIgnoreHWLimit BOOL = FALSE during homing. OUT bDone BOOL TRUE: Homing has been done. BOOL bBusy TRUE: The FB is in operation. TRUE: Command has been aborted by another command. bCommandAborted BOOL bError BOOL TRUE: Error has occurred within the FB. nErrorID SMC\_ERROR Error identification For some homing modes, the index pulse is evaluated. TRUE: Storing of the index pulse has been started and must be bStartLatchingIndex BOOL done by the application. The result is expected in the inputs bIndexOccured and fIndexPosition.

# 9.6.4 SMC\_SetTorque

	Name	Description			
SMC_S	SetTorque	This FB can be used to	create a torque if the drive is in controller mode 'torque'.	FB	
SMC_SetTorque         Axis AXI5_REF_SM3       BOOL bBusy         bEnable BOOL       BOOL bError         fTorque LREAL       SMC_ERROR nErrorID					
	Name	Туре	Description		
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis		
IN	bEnable	BOOL	TRUE: Enables the execution of the FB.		
	fTorque	LREAL	Torque [Nm]		
OUT	bBusy	BOOL	TRUE: The FB is in operation.		
bError BOOL TRUE: Error has occurred with		TRUE: Error has occurred within the FB.			
	nErrorID	SMC_ERROR	Error identification		

### 9.6.5 SMC\_SetControllerMode

Name Description			Description	Туре	
SMC_S	SMC_SetControllerMode This FB sets the byControllerMode (command value of operation mode) parameter of				
		the axis and waits until the parameter	byRealControllerMode (actual value of operation		
		mode) reflects this value.			
		SMC SetContro	llerMode		
	-Axis AXIS_REF	_SM3	BOOL bDone		
	-bExecute BOO	02	BOOL bBusy		
		de SMC_CONTROLLER_MODE			
	Name	Туре	Description		
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis		
IN	bExecute	BOOL	Starts the execution of the FB at rising edge.		
	nControllerMode	SMC_CONTROLLER_MODE	Controller mode (ENUM)		
OUT	bDone	BOOL	TRUE: Mode switching has been done.		
bBusy BOOL		BOOL	TRUE: The FB is in operation.		
	bError	BOOL	TRUE: Error has occurred within the FB.		
	nErrorID	SMC_ERROR	Error identification		

	Name		Description	Type	
SMC_S	SetMovementType	This FB sets the movement type of a virtual axis to linear or modulo.			
		SMC_S — Axis AXI5_REF_SM3 — bExecute BOOL — iMovementType INT — fPositionPeriod LREAL	etMovementType BOOL bDone BOOL bError SMC_ERROR eErrorID		
	Name	Туре	Description		
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis		
IN	bExecute	BOOL	Starts the execution of the FB at rising edge.		
	iMovementType	INT	0: modulo 1: linear		
	fPositionPeriod	LREAL	The new position period for modulo movement, must be po	sitive.	
OUT	bDone	BOOL	TRUE: Movement setting has been done.		
	bError	BOOL	TRUE: Error has occurred within the FB.		
	eErrorID	SMC_ERROR	Error identification		

# 9.6.6 SMC\_SetMovementType

# 9.6.7 SMC\_SetRampType

	Name Description			Туре
SMC_S	SetRampType	This FB sets the ramp type of an axis	to a new value. Can only be used when the axis is	FB
		in the state 'Standstill' or power_off.		
		SMC_SetRan	npType	
	_	bExecute BOOL	BOOL bError	
	_	eRampType <i>SMC_RAMPTYPE</i>	SMC_ERROR eErrorID	
	Name	Туре	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
IN	bExecute	BOOL	Starts the execution of the FB at rising edge.	
	eRampType	SMC_RAMPTYPE (ENUM)	Defines the new ramp type.	
OUT	bDone	BOOL	TRUE: Ramp type has been set.	
	bError	BOOL	TRUE: Error has occurred within the FB.	
	eErrorID	SMC_ERROR (ENUM)	Error identification	

### 9.6.8 SMC\_InPosition

	Name	Description Ty		
SMC_InPosition This FB monitors the offset betw			the nominal and actual positions of an axis (drag	FB
		error). This tests whether the drag error	or lies within a specified value range for over a	
defined period of time (position window).				
		SMC_InPos Axis AXI5_REF_SM3 bEnable BOOL fPosWindow LREAL fPosTime LREAL TimeOut LREAL	ition BOOL bInPosition BOOL bBusy BOOL bTimeOut	
	Name	Туре	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
IN	bEnable	BOOL	TRUE: Enables the execution of the FB.	
	fPosWindow	LREAL	The drive is inside the position window, if fPosW Distance (actual position, set position) [u].	/indow >=
	fPosTime	LREAL	Time that the FB has to stay inside the positio before bInPosition is set [s].	n window
	fTimeOut	LREAL	If the time since enabling the FB is larger than and bInPosition is not set, bTimeOut is set; this n is deactivated, if fTimeOut = 0.	this value nechanism
OUT	bInPosition	BOOL	TRUE: Parameter is available	
	bBusy	BOOL	TRUE: The FB is in operation.	
	bTimeout	BOOL	TRUE: Error has occurred within the FB.	

# 9.7 CNC Control

### 9.7.1 SMC\_NCDecoder

	Name	Description				
SMC_N	CDecoder	This FB converts a CNC program (G-co	ode) into a list of SMC_GEOINFO structure	FB		
		objects. In each cycle, one line will be d	lecoded.			
<ul> <li>ncpro</li> <li>bExec</li> <li>bAbo</li> <li>bApp</li> <li>bStep</li> <li>piStar</li> <li>nSizel</li> <li>pbyB</li> <li>bEnat</li> </ul>	g SMC_CNC_REF rute BOOL end BOOL Suppress BOOL rtPosition SMC_POS OutQueue UDINT ufferOutQueue POI pleSyntaxChecks Bo	SMC_NC SINFO NTER TO ARRAY [00] OF SMC_GEOINFO DOL	Decoder E SMC_ERR POINTER TO SMC_OUTQUEUE SMC_DEC_STA DINT iLineNun SMC_GCODE_TEXT	100L bDone 100L bBusy 100L bError 100L bE		
	Name	Туре	Description			
IN_OUT	ncprog	SMC_CNC_REF	CNC program			
IN	bExecute	BOOL	Starts the execution of the FB at rising edge.			
	bAbort	BOOL	TRUE: The current processing is aborted.			
	h Amman d	ROOL	TRUE: Newly incoming data to be written to t	he end of the		
	DAppend	BOOL	DataOutQueue.			
	bStepSuppress	BOOL	TRUE: Lines of the CNC program starting wi	th "/" will be		
			ignored.			
	piStartPosition	SMC POSINEO	Position of point, from where the interpolated movement is			
	pistari osition	SMC_105H10	supposed to start.			
	nSizeOutQueue	e UDINT	The size of the data buffer			
	pbyBufferOutQ	POINTER TO ARRAY [00] OF	The first byte of the memory area that is all	ocated for the		
	ueue	SMC_GEOINFO	OUTQUEUE structure.			
	bEnableSystax		TRUE: Invalid G-code is detected.			
	hecks					
OUT	bDone	BOOL	TRUE: The input data from DataIn has be completely.	en processed		
	bBusy	BOOL	TRUE: The FB is in operation.			
	bError	BOOL	TRUE: Error has occurred within the FB.			
	wErrorID	SMC_ERROR	Error identification			
	poqDataOut	POINTER TO SMC_OUTQUEUE	Pointer to the SMC_OUTQUEUE			
	iStatus	SMC_DEC_STATUS	The current status of the module			
	iLineNumberD	e DINT	0-based line number of the CNC file			
	coded					
	GCodeText	SMC_GCODE_TEXT	G-code text			

# 9.7.2 SMC\_Interpolator

Name Description				tion	Туре	
SMC_I	nterpolator	This FB conver	ts a continuous path described	by SMC_GEOINFO-objects into discrete	FB	
		path position po	oints taking into account a define	ed velocity profile and time pattern.		
		LEwente Book	SMC_Interpolator	ROOL PROC		
		— pogDataIn POI	NTER TO SMC_OUTQUEUE	BOOL bBusy		
		-bSlow_Stop BC	DOL	BOOL bError		
		— bEmergency_Sto — bWaitAtNextSto	p BOOL	SMC_ERROR WERFORID		
		-d0verride LREA	12	SMC_INT_STATUS iStatus		
			INT_VELMODE IORD	BOOL bWorking		
		-dLastWayPos L	REAL	LREAL dVel		
		-bAbort BOOL	001	SMC_VECTOR3D_vecActTangent — IVIT_il_astSwitch		
		-bAcknM BOOL	02	DWORD dwSwitches		
		— bQuick_Stop Bi — dQuickDecelerat	00L tion (REA)	LREAL dWayPos		
		-dJerkMax LREA	L	WORD WIT		
		<ul> <li>dQuickStopJerk</li> </ul>	LREAL			
		Douppressbyste				
	Name		Type	Description		
IN	bExecute		BOOI	Starts the execution of the EB at rising edu	ge	
	pogDataIn		POINTER TO SMC_OUTOUEUE	Pointer to SMC_GEOINEO structure obje	ects.	
	1 21 2		Poor	TRUE: FB will be caused to reduce the	velocity to 0	
	bSlow_Stop		BOOL	according to the defined velocity profile (	iVelMode).	
	bEmergency_	Stop	BOOL	TRUE: FB will cause an immediate stop.		
	bWaitAtNext5	Ston	BOOL	TRUE: FB will be caused to retain the	position at the	
		F		next regular stop.		
	dOverride		LREAL	The scheduled velocity of the particular of the	bjects will get	
	iValMada		SMC INT VELMODE	scaled by dOverride. (default: 1, min.:0.01	.)	
			SWIC_INT_VELWIODE	Cycle time, which must be same as Ethe	erCAT Master	
	dwIpoTime		DWORD	cycle time (unit: μs)		
	dLastWavPos		LREAL	When dWayPos output is connected, me	easured length	
			DOOL	of the path is seen in dLastWayPos.		
	bAbort		BOOL	TRUE: The current processing is aborted.	waan two noth	
	bSingleStep		BOOL	objects for the duration of one cycle.	ween two path	
	h Aakn M		POOL	TRUE: M-option is cleared and the path p	processing will	
	UACKIIW		BOOL	be continued.		
	bQuick_stop		BOOL	TRUE: FB will reduce the velocity to 0	with velocity	
	dOuickDecele	eration	LREAL	Deceleration value used for bOuick ston	Tationj.	
	dJerkMax	Julion	LREAL	Max. jerk only used for Quadratic velocity modes		
	dOuickStopJe	rk	LREAL	Max, jerk used by a quick stop	<u>,</u>	
	hSummagaSug	tomMEunotions	DOOI	TRUE: The output wM will not be se	et for internal	
	bsuppresssys	ternivirunctions	BOOL	M-functions created by G75 or G4 comma	ands.	
OUT	bDone		BOOL	TRUE: The input data (poqDataIn) has been processed		
	1-D		DOOL	completely.		
	bBusy		BOOL	TRUE: The FB is in operation.		
	UEIIOI		SMC EPPOP	From identification		
	niSetPosition		SMC_ERROR	Calculated set position		
	iStatus		SMC_IOSITIO	The current status of the FB		
	bWorking		BOOL	Connect to bEnable input of SMC Control	alAxisBvPos	
	i A atObi+0	uraoNc.	DINT	Value of member of active SMC_GEOIN	FOR object of	
	IACIODJectSol	urceino		poqDataIn-queue		
	dVel		LREAL	The current path velocity		
	vecAct fanger	nt	SMC_VECTOR3D	The path tangent (unit: vector)		
	1LastSwitch		INT	The last switch passed	4- 22	
	dWayDag			I ne current switch status of all switches 1	10 32	
	uwayros		LALAL	This output will be set to the value ass	ociated to the	
	wM		WORD	M-function.	control to the	

#### 9.7.3 SMC\_CheckVelocities Name Description Туре SMC CheckVelocities This FB checks the track speed of the particular path segments. If OutQueue has FΒ not been created by the editor, but by the IEC program (e.g. SMC\_NCDecoder), this FB has to be called straight before each call to the interpolator. SMC\_CheckVelocities bExecute BOOL BOOL bBusy bAbort BOOL BOOL **bError** pogDataIn POINTER TO SMC\_OUTQUEUE SMC\_ERROR wErrorID dAngleTol LREAL POINTER TO SMC\_OUTQUEUE poqDataOut bCheckAddAxVelJump BOOL dMaxAddAxVelDifference LREAL Name Type Description IN bExecute BOOL Starts the execution of the FB at rising edge. BOOL TRUE: The current processing is aborted. bAbort Points to the SMC\_OUTQUEUE structure object, which POINTER TO SMC\_OUTQUEUE poqDataIn describes the SMC\_GEOINFO objects of the path. Tolerance angle (angle leeway) up to which at a sharp bend dAngleTol LREAL of the path no stop shall be executed. bCheckAddAxVelJump BOOL TRUE: Velocity jumps are checked. dMaxAddAxVelDifference LREAL Max. allowed velocity jumps [u/s] OUT BOOL bBusy TRUE: The FB is in operation. bError BOOL TRUE: Error has occurred within the FB. wErrorID SMC\_ERROR Error identification POINTER TO SMC\_OUTQUEUE poqDataOut The output path queue of SMC\_OUTQUEUE

# 9.7.4 SMC\_TRAFO\_Gantry2

	Name	Des	scription	Туре
SMC_T	SMC_TRAFO_Gantry2         Reverse transformation for two-dimentional portal systems.			FB
		SMC_TRAFO_Gan — pi <i>SMC_PosInfo</i> — dOffsetX <i>LREAL</i> — dOffsetY <i>LREAL</i>	try2 LREAL dx LREAL dy	
	Name	Туре	Description	
IN	pi	SMC_PosInfo	Target vector position (x, y), output of int	erpolator.
	dOffsetX	LREAL	Additional offset for x-axis	
	dOffsetY	LREAL	Additional offset for y-axis	
OUT	dx	LREAL	Resulting position for x-axis	
	dy	LREAL	Resulting position for y-axis	

# 9.7.5 SMC\_ControlAxisByPos

Name		Description		Туре	
SMC_C	ControlAxisByPos	This FB writes the set positi	ion to the drive structure Axis and monitors Axis for jumps.	FB	
	SMC_ControlAxisByPos         Axis AXIS_REF_SM3       BOOL bBusy         iStatus SMC_INT_STATUS       BOOL bCommandAborted         bEnable BOOL       BOOL bError         bAvoidGaps BOOL       SMC_ERROR iErrorID         -       FSetPosition LREAL         -       fGapVelocity LREAL         -       fGapDeceleration LREAL         -       fGapJerk LREAL				
	Name	Туре	Description		
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis		
IN	iStatus	SMC_INT_STATUS	Status of the instance of SMC_Interpolator (connect iStatus	output)	
	bEnable	BOOL	TRUE: Enables the execution of the FB.		
bAvoidGaps BOOL TRUE: Starts the monitoring of the the limit value which is set in A2 and configured in the drive dialog v the bStopIpo output is set. The axis values fGapVelocity, fGapAcceler reaching the set position bStopIpo		TRUE: Starts the monitoring of the position. If the velocit the limit value which is set in AXIS_REF_SM3.fSWMa and configured in the drive dialog with the max. values se the bStopIpo output is set. The axis is moved to the positio values fGapVelocity, fGapAcceleration and fGapDeceler reaching the set position, bStopIpo is set to FALSE.	y exceeds ixVelocity tting, then n with the ration. On		
	fSetPosition	LREAL	Set position of the axis. Typically connected to the output SMC_TRAFO.	put of the	
	fGapVelocity	LREAL	Velocity for the bypassing of the jump in [u/s]		
	fGapAcceleration	LREAL	Acceleration for the bypassing of the jump in [u/s <sup>2</sup> ]		
	fGapDeceleration	LREAL	Deceleration for the bypassing of the jump in $[u/s^2]$		
	fGapJerk	LREAL	Jerk for the bypassing of the jump in [u/s <sup>3</sup> ]		
OUT	bBusy	BOOL	TRUE: The FB is in operation.		
	bCommandAborted	BOOL	TRUE: Command has been aborted by another command.		
bError BOOL		BOOL	TRUE: Error has occurred within the FB.		
	iErrorID	SMC_ERROR	Error identification		
	bStopIpo	BOOL	TRUE: Jump in velocity or position occurred and adaptati position is running.	on to new	

	Name		Description	Туре
SMC GetMParameters This		This FB can be used to p	oll the parameters that have been set for this	FB
		M-function.	-	
	— Interpolat — bEnable <i>E</i>	SMC_GetMF or SMC_Interpolator 800L	Parameters BOOL bMActive LREAL dK LREAL dL SMC_M_PARAMETERS MParameters	
	Name	Туре	Description	
IN_OUT	Interpolator	SMC_Interpolator	Instance of interpolator	
IN	bEnable	BOOL	TRUE: Enables the execution of the FB.	
OUT	bMActive	BOOL	TRUE: M-function is currently processed.	
	dK	LREAL	M-parameter specified via word K	
	dL	LREAL	M-parameter specified via word L	
	MParameters	SMC_M_PARAMETERS	M-parameters, specified by the global da gSMC_MParameters or by the variable passed by	ata structure O.

I

### 9.7.6 SMC\_GetMParameters

# 9.8 PLCopen Part 4 Coordinated Motion (Administrative)

# 9.8.1 MC\_GroupEnable

	Name	Description		Туре
MC_Gr	MC_GroupEnable This FB changes the state for a group from GroupDisabled to GroupStandby.			FB
	— AxisGroup / — Execute <i>BO</i>	<b>MC_Grou</b> AXIS_GROUP_REF_SM3 IOL	IpEnable BOOL Done BOOL Busy BOOL Error SMC_ERROR ErrorID	
	Name	Туре	Description	
IN_OUT	AxisGroup	AXIS_GROUP_REF_SM3	Reference to an axis group	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
OUT	Done	BOOL	TRUE: Group is in state GroupStandby	
	Busy	BOOL	TRUE: The FB is in operation.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

### 9.8.2 MC\_GroupDisable

	Name	Description		Туре
MC_Gr	MC_GroupDisable This FB changes the state for a group from GroupStandby to GroupDisabled.		FB	
	— AxisGroup / — Execute <i>BC</i>	MC_Grou AXIS_GROUP_REF_SM3 DOL	I <b>pDisable</b> BOOL Done BOOL Busy BOOL Error SMC_ERROR ErrorID	
	Name	Туре	Description	
IN_OUT	AxisGroup	AXIS_GROUP_REF_SM3	Reference to an axis group	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
OUT	Done	BOOL	TRUE: Group is in state GroupDisabled	
	Busy	BOOL	TRUE: The FB is in operation.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

	Name	Description		Туре
MC_GroupReadStatus This FB retu		This FB returns the status of a	in axis group.	FB
MC_Group — AxisGroup AXIS_GROUP_REF_SM3 — Enable BOOL			ReadStatus BOOL Valid BOOL Busy BOOL Error SMC_ERROR ErrorID BOOL GroupMoving BOOL GroupHoming BOOL GroupErrorStop BOOL GroupStandby BOOL GroupStandby BOOL GroupStandby BOOL GroupStopping BOOL GroupDisabled BOOL TrackingDynamicCS BOOL InSync SMC_Movement_Id ActiveMovementId	
	Name	Туре	Description	
IN_OUT	AxisGroup	AXIS_GROUP_REF_SM3	Reference to an axis group	
IN	Enable	BOOL	TRUE: Enables the execution of the FB.	
OUT	Valid	BOOL	TRUE: A valid output is available.	
	Busy	BOOL	TRUE: The FB is in operation.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	
	GroupMoving	BOOL	TRUE: GroupMoving (see section 8.2.1 State dia	gram)
	GroupHoming	BOOL	TRUE: GroupHoming (see section 8.2.1 State dia	gram)
	GroupErrorStop	BOOL	TRUE: GroupErrorStop (see section 8.2.1 State d	iagram)
	GroupStandby	BOOL	TRUE: GroupStandby (see section 8.2.1 State dia	gram)
	GroupStopping	BOOL	TRUE: GroupStopping (see section 8.2.1 State di	agram)
	GroupDisabled	BOOL	TRUE: GroupDisabled (see section 8.2.1 State dia	agram)
	TrackingDynamicCS	BOOL	TRUE: The active movement is commanded u coordination system.	ising dynamic
	InSync	BOOL	Only used in case of TrackingDynamicCS: Continuous path movements: the current position specified path. PTP movements: the current position equals the of the movements.	belongs to the target position
	ActiveMovementId	SMC_Movement_Id	The identifier of the active movement. An Id of movement is active.	of 0 means no

### 9.8.3 MC\_GroupReadStatus

### 9.8.4 MC\_GroupReset

	Name	Description		Туре
MC_GroupReset This FB makes the transition from the state C		from the state GroupErrorStop to GroupStandby	FB	
	by resetting all internal group-related errors.			
	— AxisGroup → — Execute BO	MC_Gro AXIS_GROUP_REF_SM3 IOL	upReset BOOL Done BOOL Busy BOOL Error SMC_ERROR ErrorID	
	Name	Туре	Description	
IN_OUT	AxisGroup	AXIS_GROUP_REF_SM3	Reference to an axis group	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
OUT	Done	BOOL	TRUE: Reset for axis group and all axes in this gr	oup done
	Busy	BOOL	TRUE: The FB is in operation.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

### 9.8.5 MC\_GroupSetOverride

Name			Description	Туре
MC_Gr	MC_GroupSetOverride This FB allows to change the		the velocity, acceleration, or jerk of active and	FB
		commanded movements.		
		MC C		
	AxisGroup	MC_Groups	BOO/ Enabled	
	-Enable BOG	0L	BOOL Busy	
		REAL	BOOL Error	
	-AccFactor /	LREAL	SMC_ERROR ErrorID	
	PathVelFact	or LREAL		
	-PathAccFact	or LREAL		
	-PathJerkFac	tor LREAL		
	Name	Type	Description	
IN OUT	AxisGroup	AXIS GROUP REF SM3	Reference to an axis group	
IN	Enable	BOOL	TRUE: Enables the execution of the FB.	
	VelFactor	LREAL	Factor for axis velocity (0.0 to 1.0)	
	AccFactor	LREAL	Factor for axis acceleration and deceleration (0.0	to 1.0)
	JerkFactor	LREAL	Factor for axis jerk (0.0 to 1.0)	
	PathVelFactor	LREAL	Factor for path velocity (0.0 to 1.0)	
	PathAccFactor	LREAL	Factor for path acceleration and deceleration (0.0	to 1.0)
	PathJerkFactor	LREAL	Factor for path jerk (0.0 to 1.0)	
OUT	Done	BOOL	TRUE: signals that the override factors ha	ave been set
		DOOL	successfully.	
	Busy	BOOL	TRUE: The FB is in operation.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

# 9.9 PLCopen Part 4 Coordinated Motion (Motion)

	Name	Description Type		Туре
MC_Mc	oveDirectAbsolute	This FB commands a movement of an axis group to the specified absolute position		FB
	in the specific coord		system. Each axis is moved to its target position	
		independently, the movement	is only synchronized such that all axes reach the	
		target at the same time. This m	eans that the path travelled by the TCP depends on	
		the kinematic transformation us	ed. In general, it will no be a line.	
AxisGroup AXIS_GROUP_REF_SM3         Execute BOOL         Position SMC_POS_REF         CoordSystem SMC_COORD_SYSTEM         BufferMode MC_BUFFER_MODE         TransitionMode MC_TRANSTION_MODE         TransitionParameter ARRAY [0(SMC_RCNST.MAX_TRANS_PARAMS - 1)] OF         VelFactor LREAL         AccFactor LREAL         JerkFactor LREAL			EtAbsolute B BOOL Comma BOOL Comma BOOL Comma SMC_ERRC SMC_Movement_Id M	00L Done 100L Busy 10L Active ndAborted dAccepted 00L Error 2R ErrorID ovementId
	Name	Туре	Description	
IN_OUT	AxisGroup	AXIS_GROUP_REF_SM3	Reference to an axis group	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
	Position	SMC_POS_REF	End position	
	CoordSystem	SMC_COORD_SYSTEM	Reference to the applicable coordinate system	
	BufferMode	MC_BUFFER_MODE	Defines the chronological sequence of the FB rela previous block.	tive to the
	TransitionMode	MC_TRANSITION_MODE	Defines the blending in case of a bending buffer mo	ode.
	TransitionParameter	ARRAY	Parameters for blending	
		[0(SMC_RCNST.MAX_TRANS_P		
		ARAMS-1)] OF LREAL		
	VelFactor	LREAL	Max. velocity of each axis is multiplied by this factor	or (0 to 1)
	AccFactor	LREAL	Max. acceleration of each axis is multiplied by this to 1)	s factor (0
	JerkFactor	LREAL	Max. jerk of each axis is multiplied by this factor (0	to 1)
OUT	Done	BOOL	TRUE: Commanded end positions reached for all as	xes.
	Busy	BOOL	TRUE: The FB is in operation.	
	Active	BOOL	TRUE: The FB has control on the axis	
	CommandAborted	BOOL	TRUE: Command has been aborted by another com	mand.
	CommandAccepted	BOOL	TRUE: Command has been accepted.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	
	MovementId	SMC_Movement_Id	The unique identifier of the movement.	

### 9.9.1 MC\_MoveDirectAbsolute

	Name		Description	Туре
MC M	oveDirectRelative	This FB commands a movement	This FB commands a movement of an axis group to the specified relative position	
		in the specific coordinate system	in the specific coordinate system. Each axis is moved to its target position	
		independently, the movement is only synchronized such that all axes reach the		
		target at the same time. This means that the path travelled by the TCP depends on		
		the kinematic transformation us	sed. In general, it will no be a line.	
Axis Gro Execute Distanc CoordS BufferM Transiti VelFact AccFact JerkFac	bup AXIS_GROUP_REF_SM3 & BOOL & BOOL & SMC_POS_REF ystem SMC_COORD_SYSTEM Node MC_BUFFER_MODE IonMade MC_TRANSITION_MODE IonParameter ARRAY[0(SMC_RCI or LREAL tor LREAL tor LREAL	NST.MAX_TRANS_PARAMS - 1)] OF LREAL	B B BOOL Comman BOOL Comman B SMC_ERRC SMC_Movement_Id M	00L Done 800L Busy 20L Active ndAborted dAccepted 00L Error 20R ErrorID ovementId
	Name	Туре	Description	
IN_OUT	AxisGroup	AXIS_GROUP_REF_SM3	Reference to an axis group	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
	Distance	SMC_POS_REF	Relative distance in the specified coordinate system [u]	
	CoordSystem	SMC_COORD_SYSTEM	Reference to the applicable coordinate system	
	BufferMode	MC_BUFFER_MODE	Defines the chronological sequence of the FB relation	tive to the
			previous block.	
	TransitionMode	MC_TRANSITION_MODE	Defines the blending in case of a bending buffer mo	de.
	TransitionParameter	ARRAY	Parameters for blending	
		[0(SMC_RCNST.MAX_TRANS_P		
		ARAMS-1)] OF LREAL		
	VelFactor	LREAL	Max. velocity of each axis is multiplied by this factor	or (0 to 1)
	AccFactor	LREAL	Max. acceleration of each axis is multiplied by this to 1)	s factor (0
	JerkFactor	LREAL	Max. jerk of each axis is multiplied by this factor (0	to 1)
OUT	Done	BOOL	TRUE: Commanded end positions reached for all as	xes.
	Busy	BOOL	TRUE: The FB is in operation.	
	Active	BOOL	TRUE: The FB has control on the axis	
	CommandAborted	BOOL	TRUE: Command has been aborted by another com	mand.
	CommandAccepted	BOOL	TRUE: Command has been accepted.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	
	MovementId	SMC_Movement_Id	The unique identifier of the movement.	

### 9.9.3 MC\_MoveLinearAbsolute

Name			Description	Туре
MC_MoveLinearAbsolute		This FB commands an interpolated linear movement of an axis group to an FB		FB
		absolute position in the specifie	ed coordinate system.	
Axis Gro Positio Velocit Acceler Decelee Jerk L Coords Bufferh Transit Orienta VelFact AccFac JerkFac	oup AXIS_GROUP_REF_SM3 = BOOL n SMC_POS_REF y LREAL ration LREAL REAL System SMC_COORD_SYSTEM Mode MC_BUFFER_MODE ionParameter ARRAY[0(SMC_RCI tionMode SMC_ORIENTATION_MODE tor LREAL tor LREAL tor LREAL	MC_MoveLine NST.MAX_TRANS_PARAMS - 1)] OF LREAL IDE	arAbsolute B B BOOL Comman BOOL Comman B SMC_ERRO SMC_Movement_Id Mo	00L Done 00L Busy ndAborted dAccepted 00L Error & ErrorID ovementId
	Name	Туре	Description	
IN_OUT	AxisGroup	AXIS_GROUP_REF_SM3	Reference to an axis group	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
	Position	SMC_POS_REF	End position [u]	
	Velocity	LREAL	Max. path velocity [u/s] for the coordinate system the path is defined. Always positive. Not necessarily	in which y reached.
	Acceleration	LREAL	Max. path acceleration [u/s <sup>2</sup> ]. Always positive. Not necessarily reached.	
	Deceleration	LREAL	Max. path deceleration [u/s <sup>2</sup> ]. Always positive. Not necessarily reached.	
	Jerk	LREAL	Max. path jerk [u/s <sup>3</sup> ]. Always positive. Not necessarily reached.	
	CoordSystem	SMC_COORD_SYSTEM	Reference to the applicable coordinate system	
	BufferMode	MC_BUFFER_MODE	Defines the chronological sequence of the FB relat previous block.	tive to the
	TransitionMode	MC_TRANSITION_MODE	Defines the blending in case of a bending buffer mo	de.
	TransitionParameter	ARRAY [0(SMC_RCNST.MAX_TRANS_P ARAMS-1)] OF LREAL	Parameters for blending	
	OrientationMode	SMC_ORIENTATION_MODE	Determines how the orientation is interpolated.	
	VelFactor	LREAL	Max. velocity of each axis is multiplied by this factor	or (0 to 1)
	AccFactor	LREAL	Max. acceleration of each axis is multiplied by this to 1)	s factor (0
	JerkFactor	LREAL	Max. jerk of each axis is multiplied by this factor (0	to 1)
OUT	Done	BOOL	TRUE: Commanded end positions reached for all as	kes.
	Busy	BOOL	TRUE: The FB is in operation.	
	Active	BOOL	TRUE: The FB has control on the axis	
	CommandAborted	BOOL	TRUE: Command has been aborted by another com	mand.
	CommandAccepted	BOOL	TRUE: Command has been accepted.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	
	MovementId	SMC_Movement_Id	The unique identifier of the movement.	

### 9.9.4 MC\_MoveLinearRelative

Name		Description		Туре		
MC_MoveLinearRelative		This FB commands an interpolated linear movement of an axis group by a FB				
	(relative) distance in the specified coordinate system.					
— AxisGro — Execute	oup AXI5_GROUP_REF_SM3 9 BOOL	MC_MoveLine	arRelative	BOOL Done BOOL Busy		
Distance     Velocit     Acceler     Decelei     Jerk L     Coord5     BufferN     Transit     Orienta	Distance SMC_PDS_REF     BOOL Active       Velocity LREAL     BOOL CommandAccepted       Acceleration LREAL     BOOL CommandAccepted       Deceleration LREAL     BOOL CommandAccepted       Jerk LREAL     BOOL CommandAccepted       Jerk LREAL     SMC_ERROR ErrorID       CoordSystem SMC_COORD_SYSTEM     SMC_Movement_Id       BufferMode MC_BUFFE_MODE     TransitionParameter ARRAY[0.(SMC_RCNST.MAX_TRANS_PARAMS - 1)] OF LREAL       OrientationMode SMC_ORIENTATION_MODE     VelFactor LREAL					
— VelFact — AccFact — JerkFac	tor LREAL tor LREAL ttor LREAL					
	Name	Туре	Description			
IN_OUT	AxisGroup	AXIS_GROUP_REF_SM3	Reference to an axis group			
IN	Execute	BOOL	Starts the execution of the FB at rising edge.			
	Distance	SMC_POS_REF	Relative distance in the specified coordinate sys	tem [u]		
	Velocity	LREAL	Max. path velocity [u/s] for the coordinate systhe path is defined. Always positive. Not necess	stem in which arily reached.		
	Acceleration	LREAL	Max. path acceleration [u/s <sup>2</sup> ]. Always positive. Not necessarily reached.			
	Deceleration	LREAL	Max. path deceleration [u/s <sup>2</sup> ]. Always positive. Not necessarily reached.			
	Jerk	LREAL	Max. path jerk [u/s <sup>3</sup> ]. Always positive. Not necessarily reached.			
	CoordSystem	SMC_COORD_SYSTEM	Reference to the applicable coordinate system			
	BufferMode	MC_BUFFER_MODE	Defines the chronological sequence of the FB previous block.	relative to the		
	TransitionMode	MC_TRANSITION_MODE	Defines the blending in case of a bending buffer	mode.		
	TransitionParameter	ARRAY [0(SMC_RCNST.MAX_TRANS_P ARAMS-1)] OF LREAL	Parameters for blending			
	OrientationMode	SMC_ORIENTATION_MODE	Determines how the orientation is interpolated.			
	VelFactor	LREAL	Max. velocity of each axis is multiplied by this	factor (0 to 1)		
	AccFactor	LREAL	Max. acceleration of each axis is multiplied by to 1)	this factor (0		
	JerkFactor	LREAL	Max. jerk of each axis is multiplied by this factor	or (0 to 1)		
OUT	Done	BOOL	TRUE: Commanded end positions reached for a	ıll axes.		
	Busy	BOOL	TRUE: The FB is in operation.			
	Active	BOOL	TRUE: The FB has control on the axis			
	CommandAborted	BOOL	TRUE: Command has been aborted by another	command.		
	CommandAccepted	BOOL	TRUE: Command has been accepted.			
	Error	BOOL	TRUE: Error has occurred within the FB.			
	ErrorID	SMC_ERROR	Error identification			
	MovementId	SMC_Movement_Id	The unique identifier of the movement.			

# 9.9.5 MC\_MoveCircularAbsolute

Name MC_MoveCircularAbsolute			Description	
		This FB commands an interpolated circular movement of an axis group to an FB		
		absolute position in the specifie	ed coordinate system.	
		MC Maus Circu		
Axis Gre Execute CircMoo AuxPoin EndPoin PathCh Velocit Acceler Deceler Deceler Deceler Deceler CoordS BufferN Transit Orienta VelFact DerkFac	pup AXIS_GROUP_REF_SM3 BOOL de SMC_CIRC_MODE nt SMC_POS_REF nt SMC_POS_REF oice MC_CIRC_PATHCHOICE y LREAL ation LREAL REAL System SMC_COORD_SYSTEM Aode MC_BUFFER_MODE ionParameter ARRAY[OL_SYSTEM tor LREAL tor LREAL tor LREAL	MC_MoveCircu NST.MAX_TRANS_PARAMS - 1)] OF LREAL DDE	BOOL Co BOOL Co SMC_ SMC_Movement_	BOOL Done BOOL Busy BOOL Active mmandAccepted BOOL Error ERROR ErrorID Id MovementId
	Name	Туре	Description	
IN_OUT	AxisGroup	AXIS_GROUP_REF_SM3	Reference to an axis group	
IN	Execute	BOOL	Starts the execution of the FB at rising edge.	
	CircMode	SMC_CIRC_MODE	Specifies the meaning of the inputs A CircDirection.	uxPoint and
	AuxPoint	SMC_POS_REF	Auxiliary point in the specified coordinate syste	m.
	EndPoint	SMC_POS_REF	End position in the specified coordinate system.	
	PathChoice	MC_CIRC_PATHCHOICE	Choice of path: clockwise or counterclockwise	
	Velocity	LREAL	Max. path velocity [u/s] for the coordinate system the path is defined. Always positive. Not necess	stem in which arily reached.
	Acceleration	LREAL	Max. path acceleration [u/s <sup>2</sup> ]. Always positive. Not necessarily reached.	
	Deceleration	LREAL	Max. path deceleration [u/s <sup>2</sup> ]. Always positive. Not necessarily reached.	
	Jerk	LREAL	Max. path jerk [u/s <sup>3</sup> ]. Always positive. Not necessarily reached.	
	CoordSystem	SMC_COORD_SYSTEM	Reference to the applicable coordinate system	
	BufferMode	MC_BUFFER_MODE	Defines the chronological sequence of the FB previous block.	relative to the
	TransitionMode	MC_TRANSITION_MODE	Defines the blending in case of a bending buffer	mode.
	TransitionParameter	ARRAY [0(SMC_RCNST.MAX_TRANS_P ARAMS-1)] OF LREAL	Parameters for blending	
	OrientationMode	SMC_ORIENTATION_MODE	Determines how the orientation is interpolated.	
	VelFactor	LREAL	Max. velocity of each axis is multiplied by this	factor (0 to 1)
	AccFactor	LREAL	Max. acceleration of each axis is multiplied by to 1)	this factor (0
	JerkFactor	LREAL	Max. jerk of each axis is multiplied by this factor	or (0 to 1)
OUT	Done	BOOL	TRUE: Commanded end positions reached for a	Ill axes.
	Busy	BOOL	TRUE: The FB is in operation.	
	Active	BOOL	TRUE: The FB has control on the axis	
	CommandAborted	BOOL	TRUE: Command has been aborted by another	command.
	CommandAccepted	BOOL	TRUE: Command has been accepted.	
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	
	MovementId	SMC_Movement_Id	The unique identifier of the movement.	

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# 9.9.6 MC\_MoveCircularRelative

Name		Description		Туре			
MC_MoveCircularRelative		This FB commands an interpolated circular movement of an axis group to a		FB			
		relative position in the specified coordinate system.					
MC MoveCircularRelative							
AxisGru Execute CircMo AuxPoi EndPoi Velocit Acceler Decelei Jerk L Coord5 Bufferh Transit Orienta VelFact AccFact JerkFac	bup AXIS_GROUP_REF_SM3 = BOOL de SMC_CIRC_MODE th SMC_POS_REF nt SMC_POS_REF oice MC_CIRC_PATHCHOICE y LREAL ration LREAL REAL System SMC_COORD_SYSTEM You AMC_BUFFER_MODE ionMode MC_BUFFER_MODE ionParameter ARRAY [0(SMC_RCN tionMode SMC_ORIENTATION_MODE ionParameter ARRAY [0(SMC_RCN tor LREAL tor LREAL tor LREAL	ST.MAX_TRANS_PARAM5 - 1)] OF LREAL DE	BOOL Co BOOL Co SMC_Movement_	BOOL Done BOOL Busy BOOL Active mmandAborted BOOL Error ERROR Error D Id MovementId			
	Name	Туре	Description				
IN_OUT	AxisGroup	AXIS_GROUP_REF_SM3	Reference to an axis group				
IN	Execute	BOOL	Starts the execution of the FB at rising edge.				
	CircMode	SMC_CIRC_MODE	Specifies the meaning of the inputs A CircDirection.	uxPoint and			
	AuxPoint	SMC_POS_REF	Auxiliary point in the specified coordinate syst is relative to the starting point.	em. The point			
	EndPoint	SMC_POS_REF	End position in the specified coordinate system relative to the starting point.	1. The point is			
	PathChoice	MC_CIRC_PATHCHOICE	Choice of path: clockwise or counterclockwise				
	Velocity	LREAL	Max. path velocity [u/s] for the coordinate system the path is defined. Always positive. Not necess	stem in which sarily reached.			
	Acceleration	LREAL	Max. path acceleration [u/s <sup>2</sup> ]. Always positive. Not necessarily reached.				
	Deceleration	LREAL	Max. path deceleration [u/s <sup>2</sup> ]. Always positive. Not necessarily reached.				
	Jerk	LREAL	Max. path jerk [u/s <sup>3</sup> ]. Always positive. Not necessarily reached.				
	CoordSystem	SMC_COORD_SYSTEM	Reference to the applicable coordinate system				
	BufferMode	MC_BUFFER_MODE	Defines the chronological sequence of the FB previous block.	relative to the			
	TransitionMode	MC_TRANSITION_MODE	Defines the blending in case of a bending buffer	r mode.			
	TransitionParameter	ARRAY [0(SMC_RCNST.MAX_TRANS_P ARAMS-1)] OF LREAL	Parameters for blending				
	OrientationMode	SMC_ORIENTATION_MODE	Determines how the orientation is interpolated.				
	VelFactor	LREAL	Max. velocity of each axis is multiplied by this factor (0 to 1)				
	AccFactor	LREAL	Max. acceleration of each axis is multiplied by this factor (0 to 1)				
	JerkFactor	LREAL	Max. jerk of each axis is multiplied by this factor (0 to 1)				
OUT	Done	BOOL	TRUE: Commanded end positions reached for all axes.				
	Busy	BOOL	TRUE: The FB is in operation.				
	Active	BOOL	TRUE: The FB has control on the axis				
	CommandAborted	BOOL	TRUE: Command has been aborted by another	command.			
	CommandAccepted	BOOL	TRUE: Command has been accepted.				
	Error	BOOL	TRUE: Error has occurred within the FB.				
	ErrorID	SMC_ERROR	Error identification				
	MovementId	SMC_Movement_Id	The unique identifier of the movement.				
# 9.10 STRUCT

# 9.10.1 MC\_TP\_REF

Name	Туре	Initial	Description
Number_of_pairs	INT	0	This variable is not used.
lsAbsolute	BOOL	TRUE	TRUE: Absolute FALSE: Relative
MC_TP_Array	ARRAY [1100] OF SMC_TP		Time/Positions

# 9.10.2 MC\_TV\_REF

Name	Туре	Initial	Description
Number_of_pairs	INT	0	This variable is not used.
lsAbsolute	BOOL	TRUE	TRUE: Absolute FALSE: Relative
MC_TV_Array	ARRAY [1100] OF SMC_TV		Time/Velocity

## 9.10.3 MC\_TA\_REF

Name	Туре	Initial	Description
Number_of_pairs	INT	0	This variable is not used.
lsAbsolute	BOOL	TRUE	TRUE: Absolute FALSE: Relative
MC_TA_Array	ARRAY [1100] OF SMC_TA		Time/Acceleration

# 9.10.4 SMC\_TP

Name	Туре	Initial	Description
delta_time	TIME	0	Period of time between reaching the last and the current point
position	LREAL	0	Position

## 9.10.5 SMC\_TV

Name	Туре	Initial	Description
delta_time	TIME	0	Period of time between reaching the last and the current point
Velocity	LREAL	0	Velocity

# 9.10.6 SMC\_TA

Name	Туре	Initial	Description
delta_time	TIME	0	Period of time between reaching the last and the current point
Acceleration	LREAL	0	Acceleration

## 9.10.7 TRIGGER\_REF

Name	Туре	Initial	Description		
iTriggerNumber	INT	-1	Trigger channel; defined by driver (only used when bFastLatching=TRUE)		
bFastLatching	BOOL	TRUE	TRUE: Latching is done in drive (precise). FALSE: Latching is done with bInput in the cycle of the motion task (unprecise).		
bInput	BOOL		Trigger signal when bFastLatching=FALSE.		
bActive	BOOL	FALSE	Internal variable		

#### 9.10.8 MC\_CAMSWITCH\_REF

Name	Туре	Initial	Description
NoOfSwitches	BYTE	0	Number of switch positions
CamSwitchPtr	POINTER TO MC_CAMSWITCH_TR	0	Address of MC_CAMSWITCH_TR

# 9.10.9 MC\_CAMSWITCH\_TR

Name	Туре	Initial	Description	
TrackNumber	INT		Number of the output; several position ranges per output are possible. [132]	
FirstOnPosition	LREAL		Switch-on position of the output	
LastOnPosition	LREAL		Switch-off position of the output	
AxisDirection	INT		<ul><li>0: The output is switched in two directions.</li><li>1: The output is only switched in positive direction.</li><li>2: The output is only switched in negative direction.</li></ul>	
CamSwitchMode	INT		<ul><li>0: The tappets are calculated position-based.</li><li>1: The tappets are calculated time-based, whereby only the value of FirstOnPosition will be used and the output will stay TRUE for the given time 'Duration'.</li></ul>	
Duration	TIME		Period of time for which the tappet output stays TRUE in case of CamSwitchMode=1.	

# 9.10.10 MC\_CAM\_ID

Name	Туре	Initial	Description
pCT	POINTER TO BYTE		This STRUCT is an interface
Periodic	BOOL	FALSE	between output of
MasterAbsolute	BOOL	FALSE	MC_CamTableSelect and input
SlaveAbsolute	BOOL	FALSE	of MC_CamIn.
StartMaster	LREAL	0	
EndMaster	LREAL	0	
StartSlave	LREAL	0	
EndSlave	LREAL	0	
byCompatibilityMode	BYTE		

# 9.10.11 SMC\_TAPPETDATA

Name	Туре	Initial	Description
pTaps	ARRAY [02] OF POINTER TO SMC_CAMTappet		This STRUCT is an interface
dwCycleTime	DWORD		between output of MC_CamIn
byChannels	BYTE	3	and input of
bRestart	BOOL		SMC_GetTappetValue.

# 9.10.12 SMC\_CAMTAPPET

Name	Туре	Initial	Description
ctt	SMC_CAMTAPPETTYPE (ENUM)		
cta	SMC_CAMTAPPETACTION (ENUM)		
dwDelay	DWORD		In case of cta = TAPPETACTION.TAPPETACTION_time, this value determines the delay time in $\mu$ s.
dwDuration	DWORD		In case of cta = TAPPETACTION.TAPPETACTION_time, this value determines the time in $\mu$ s, for which the tappet is switched to on.
iGroupID	INT		Group or track ID of the tappet output that is switched.
x	LREAL		Master position where tappet is switched.
dwActive	DWORD	16#FFFFFFFF	Internal variable

# 9.10.13 MC\_TRACK\_TR

Name	Туре	Initial	Description
OnCompensation	LREAL		ON delay time [s]
OffCompensation	LREAL		OFF delay time [s]
Hysteresis	LREAL		Hysteresis

# 9.10.14 MC\_COORD\_REF

Name	Туре	Initial	Description
Х	LREAL		X-coordinate of position
Y	LREAL		Y-coordinate of position
Ζ	LREAL		Z-coordinate of position
А	LREAL		Angle around z-axis [deg]
В	LREAL		Angle around y'-axis [deg]
С	LREAL		Angle around z'-axis [deg]

# 9.11 Enumeration (ENUM)

# 9.11.1 MC\_DIRECTION

Name	Value	Description
fastest	3	Selects the direction automatically in order to reach the target position as fast as
		possible (only modulo axes).
current	2	Keeps the current direction to reach the target (only modulo axes).
positive	1	Moves in positive direction.
shortest	0	Selects the direction according to the shortest distance (only modulo axes).
negative	-1	Moves in negative direction.

## 9.11.2 MC\_TAPPETMODE

Name	Value	Description
tp_mode_auto	0	Auto mode
tp_mode_demandposition	1	Use set values
tp_mode_actualposition	2	Use actual values

## 9.11.3 MC\_STARTMODE

Name	Value	Description
absolute	0	Absolute position
relative	1	Relative position
ramp_in	2	With acceleration
ramp_in_pos	3	With acceleration (positive)
ramp_in_neg	4	With acceleration (negative)

# 9.11.4 SMC\_CAMTAPPETTYPE

Name	Value	Description
TAPPET_pos	0	Tappet action active when the master passes its position in positive direction.
TAPPET_all	1	Tappet action active when the master passes its position in both directions.
TAPPET_neg	2	Tappet action active when the master passes its position in negative direction.

# 9.11.5 SMC\_CAMTAPPETACTION

Name	Value	Description
TAPPETACTION_on	0	Switches on.
TAPPETACTION_off	1	Switches off.
TAPPETACTION_inv	2	Inverts.
TAPPETACTION_time	3	Switches on after a delay for a certain time period.

## 9.11.6 SMC\_RAMPTYPE

Name	Value	Description
trapez	0	Trapezoid
sinsquare	1	Sin <sup>2</sup>
quadratic_ramp	2	Quadratic ramp
quadratic_smooth_ramp	3	Quadratic ramp (smooth)

### 9.11.7 SMC\_CONTROLLER\_MODE

Name	Value	Description
SMC_nocontrol	0	_
SMC_torque	1	Torque
SMC_velocity	2	Velocity
SMC_position	3	Position
SMC_current	4	Current

## 9.11.8 SMC\_HOMING\_MODE

Name	Value	Description
	0	Move with fast velocity onto the reference switch; invert and move with slow
FAST_BSLOW_S_STOP		velocity out of the reference switch; execute 'Set position'; stop
EAST DELOW STOD S	1	Move with fast velocity onto the reference switch; invert and move with slow
FAST_BSLOW_STOP_S		velocity out of the reference switch; stop; execute 'Set position'
	2	Move with fast velocity onto the reference switch; invert and move with slow velocity out of
FASI_DSLOW_I_S_STOP		the reference switch; wait for the index pulse; execute 'Set position'; stop
FAST_SLOW_S_STOP	4	Move with fast velocity onto the reference switch; move with slow velocity out of
		the reference switch; execute 'Set position'; stop
EAST SLOW STOD S	5	Move with fast velocity onto the reference switch; move with slow velocity out of
FAS1_SLUW_S1UP_S		the reference switch; stop; execute 'Set position'
FAST_SLOW_I_S_STOP	6	Move with fast velocity onto the reference switch; move with slow velocity out of
		the reference switch; wait for the index pulse; execute 'Set position'; stop

### 9.11.9 SMC\_COORD\_SYSTEM

Name	Value	Description
	0	Axis coordinate system. This is not a Cartesian coordinate system. Instead, each
ACS		axis of the axis group spans one dimension. A point in this coordinate system is
		simply the assignment of a value for each axis of the axis group.
	1	Machine coordinate system. This coordinate system is directly associated with the
MCS		kinematic of one axis group. The position and orientation of the MCS is defined by
		the kinematic transformation.
WCS	2	World coordinate system. This coordinate system is the common coordinate
wcs		system for all axis groups working together to solve some task.
DCG 1	3	Product coordinate system number 1. This coordinate system is attached to a
PCS_1		product. It may be static or dynamic.
DCS 2	4	Product coordinate system number 2. This coordinate system is attached to a
PCS_2		product. It may be static or dynamic.

# 9.11.10 MC\_BUFFER\_MODE

Name	Value	Description
Aborting	0	Start FB immediately (default mode).
Buffered	1	Start FB after the currently last motion in queue has finished.
BlendingLow	2	The velocity is blended with the lowest velocity of both FBs.
BlendingPrevious	3	The velocity is blended with the velocity of the first FBs.
BlendingNext	4	The velocity is blended with the velocity of the second FBs.
BlendingHigh	5	The velocity is blended with the highest velocity of both FBs.

# 9.11.11 MC\_TRANSITION\_MODE

Name	Value	Description
TMNone	0	No blending
TMStartVelocity	1	Velocity based blending
TMCornerDistance	2	Distance based blending

# 9.11.12 SMC\_CIRC\_MODE

Name	Value	Description
Border	0	The circle is defined by a start point, an end point and a border point (AuxPoint).
Center	1	The circle is defined by a start point, an end point and a center point (AuxPoint).
Radius	2	The circle is defined by a start point, an end point and a radius (AuxPoint).

#### 9.11.13 SMC\_CIRC\_PATHCHOICE

Name	Value	Description
CLOCKWISE	0	Clockwise
COUNTER_CLOCKWISE	1	Counterclockwise

## 9.11.14 SMC\_ORIENTATION\_MODE

Name	Value	Description
GreatCircle		The orientation is interpolated from the start orientation to the target orientation along
	0	the shortest path. Even if the start and the target orientation are in the working space,
		this interpolation mode may leave the working space.
Axis		The orientation axes are interpolated in axis space from their start values to their target
	1	values. This mode can be used to move through singularities of the orientation. Not all
		kinematic transformations support this mode.

# 9.11.15 SMC\_ERROR

Name	Value	Description
SMC_NO_ERROR	0	No error
SMC_DI_GENERAL_COMMUNICATION_ERROR	1	Communication error. For example, Sercos ring has
		broken.
SMC_DI_AXIS_ERROR	2	Axis error
SMC_DI_FIELDBUS_LOST_SYNCRONICITY	3	Fieldbus has lost synchronism.
SMC_DI_SWLIMITS_EXCEEDED	10	Position outside of permissible range of SWLimit
SMC_DI_HWLIMITS_EXCEEDED	11	Hardware end switch is active.
SMC_DI_LINEAR_AXIS_OUTOFRANGE	12	This error occurs if a linear axis has more than 2^15
		32-bit overflows of the position in increments.
SMC_DI_HALT_OR_QUICKSTOP_NOT_SUPPORTED	13	Drive status Halt or Quickstop is not supported.
SMC_DI_VOLTAGE_DISABLED	14	Drive has no power.
SMC_DI_IRREGULAR_ACTPOSITION	15	This error is no longer used.
SMC_DI_POSITIONLAGERROR	16	Position lag error. Difference between set and current
		position exceeds the given limit.
SMC_DI_HOMING_ERROR	17	Homing error reported by axis.
SMC_REGULATOR_OR_START_NOT_SET	20	Controller enable not done or brake applied.
SMC_WRONG_CONTROLLER_MODE	21	Axis in wrong controller mode
SMC_INVALID_ACTION_FOR_LOGICAL	25	Invalid action at logical axis
SMC_FB_WASNT_CALLED_DURING_MOTION	30	Motion creating module has not been called again before
		end of the motion.
SMC_AXIS_IS_NO_AXIS_REF	31	Type of given AXIS_REF variable is not AXIS_REF.
SMC_AXIS_REF_CHANGED_DURING_OPERATION	32	AXIS_REF variable has been exchanged while the
		module was active.
SMC_FB_ACTIVE_AXIS_DISABLED	33	Axis disabled while being moved.
		MC_Power.bRegulatorOn
SMC_AXIS_NOT_READY_FOR_MOTION	34	Axis in its current state cannot execute a motion
		command, because the axis doesn't signal currently that it
		follows the target values.
SMC_AXIS_ERROR_DURING_MOTION	35	The drive reported an error during an ongoing movement.
SMC_VD_MAX_VELOCITY_EXCEEDED	40	Maximum velocity fMaxVelocity exceeded.
SMC_VD_MAX_ACCELERATION_EXCEEDED	41	Maximum acceleration fMaxAcceleration exceeded.
SMC_VD_MAX_DECELERATION_EXCEEDED	42	Maximum deceleration fMaxDeceleration exceeded.
SMC_3SH_INVALID_VELACC_VALUES	50	Invalid velocity or acceleration values (SMC_Homing)
SMC_3SH_MODE_NEEDS_HWLIMIT	51	Mode requests for safety reasons use of end switches.
	60	(SMC_Homing)
SMC_FRC_NO_FREE_HANDLE	60	No free handle has been sent to open file.
SMC_SCM_NOT_SUPPORTED	70	Mode not supported (SMC_SetControllerMode)
SMC_SCM_AXIS_IN_WRONG_STATE	/1	In current mode, controller mode cannot be changed.
	70	(SMC_SetControllerMode)
SMC_SCM_INTERRUPTED	12	SMC_SetControllerMode has been interrupted by
SMC ST WRONG CONTROLLER MODE	75	Aria not in correct controllor mode. Depresented an
SWIC_SI_WKUNG_CUNIKULLEK_MUDE	/5	Axis not in correct controller mode. Deprecated, no
SMC DAG EDDOD DUDING STADTUD	00	Error at startup of the axis group
SWIC_KAO_EKKOK_DUKINO_STAKTUP	00	(SMC Reset Axis Group)
SMC DAC EDDOD AVIS NOT INITIALIZED	01	(SINC_RESCIANSOLULD)
SWIC_KAU_EKKUK_AAIS_NUI_INITIALIZED	01	The axis is not yet in the required state.

Name	Value	Description
SMC_PP_WRONG_AXIS_TYPE	85	The function block does not support virtual or logical
		axes.
SMC_PP_NUMBER_OF_ABSOLUTE_BITS_INVALID	86	The number of absolute bits is invalid, must be in the
		range 8 32.
SMC_CGR_ZERO_VALUES	90	Invalid values (SMC_ChangeGearingRatio)
SMC_CGR_DRIVE_POWERED	91	Gearing parameters must not be changed as long as the
		drive is under control. (SMC_ChangeGearingRatio)
SMC_CGR_INVALID_POSPERIOD	92	Invalid modulo period (<= 0 or greater than half the bus
		bandwidth) (SMC_ChangeGearingRatio)
SMC_CGR_POSPERIOD_NOT_INTEGRAL	93	The modulo period in increments is not an integer, but
		the modulo-handling is done by the drive.
		(SMC_ChangeGearingRatio)
SMC_P_FTASKCYCLE_EMPTY	110	Axis contain no information on cycle time (fTaskCycle =
		0). (MC_Reset)
SMC_R_NO_ERROR_TO_RESET	120	Axis without error (MC_Reset)
SMC_R_DRIVE_DOESNT_ANSWER	121	Axis does not perform error-reset. (MC_Reset)
SMC_R_ERROR_NOT_RESETTABLE	122	Error could not be reset. (MC_Reset)
SMC_R_DRIVE_DOESNT_ANSWER_IN_TIME	123	Communication with the axis did not work. (MC_Reset)
SMC_RP_PARAM_UNKNOWN	130	Parameter number unknown (MC_ReadParameter)
SMC_RP_REQUESTING_ERROR	131	Error during transmission to the drives. See error number
		in function block instance ReadDriveParameter.
		(MC_ReadParameter)
SMC_RP_DRIVE_PARAMETER_NOT_MAPPED	132	No assignment for drive parameters available
		(MC_ReadParameter)
SMC_RP_PARAM_CONVERSION_ERROR	133	Conversion of the value to / from the drive parameters
		failed. Unknown SoftMotion parameters.
	1.40	(MC_ReadParameter)
SMC_WP_PARAM_INVALID	140	Parameter number unknown or writing not allowed
CMC WD SENDING EDDOD	1.4.1	(MC_whiteParameter)
SMC_WP_SENDING_ERROR	141	WriteDriveDeremeter (MC WriteDeremeter)
SMC WE DELVE DADAMETED NOT MADDED	142	No assignment for drive perspectors available
SMC_WF_DRIVE_FARAMETER_NOT_MAFFED	142	(MC WriteParameter)
SMC WP PARAM CONVERSION ERROR	143	Conversion of the value to / from the drive parameters
	145	failed Unknown SoftMotion parameters
		(MC_WriteParameter)
SMC H AXIS WASNT STANDSTILL	170	Axis has not been in standstill state. (MC Home)
SMC H AXIS DIDNT START HOMING	171	Error at start of homing action. (MC Home)
SMC H AXIS DIDNT ANSWER	172	Error at start of homing action. (MC Home)
SMC H ERROR WHEN STOPPING	173	Error at stop after homing. Deceleration may not be set.
		(MC Home)
SMC H AXIS IN ERRORSTOP	174	Drive is in errorstop status. Homing cannot be executed.
		(MC_Home)
SMC_MS_UNKNOWN_STOPPING_ERROR	180	Unknown error at stop (MC_Stop)
SMC_MS_INVALID_ACCDEC_VALUES	181	Invalid velocity or acceleration values (MC_Stop)
SMC_MS_DIRECTION_NOT_APPLICABLE	182	Direction = shortest not applicable (MC_Stop)

Name	Value	Description
SMC_MS_AXIS_IN_ERRORSTOP	183	Drive is in errorstop status. Stop cannot be executed.
		(MC_Stop)
SMC_BLOCKING_MC_STOP_WASNT_CALLED	184	Instance of MC_Stop blocking the axis by Execute =
		TRUE has not been called yet. MC_Stop (Execute =
		FALSE) has to be called.
SMC_UNKNOWN_TASK_INTERVAL	200	The task interval of the bus task could not be determined.
SMC_MA_INVALID_VELACC_VALUES	201	Invalid velocity or acceleration values
		(MC_MoveAbsolute)
SMC_MA_INVALID_DIRECTION	202	Direction error (MC_MoveAbsolute)
SMC_MR_INVALID_VELACC_VALUES	226	Invalid velocity or acceleration values
		(MC_MoveRelative)
SMC_MR_INVALID_DIRECTION	227	Direction error (MC_MoveRelative)
SMC_MAD_INVALID_VELACC_VALUES	251	Invalid velocity or acceleration values
		(MC_MoveAdditive)
SMC_MAD_INVALID_DIRECTION	252	Direction error (MC_MoveAdditive)
SMC_MSI_INVALID_VELACC_VALUES	276	Invalid velocity or acceleration values
		(MC_MoveSuperImposed)
SMC_MSI_INVALID_DIRECTION	277	Direction error (MC_MoveSuperImposed)
SMC_LOGICAL_NO_REAL_AXIS	300	No longer used; only for compatibility
SMC_MV_INVALID_ACCDEC_VALUES	301	Invalid velocity or acceleration values
		(MC_MoveVelocity)
SMC_MV_DIRECTION_NOT_APPLICABLE	302	Direction = shortest/fastest not applicable
		(MC_MoveVelocity)
SMC_PP_ARRAYSIZE	325	Erroneous array size (MC_PositionProfile)
SMC_PP_STEP0MS	326	Step time = t#0s (MC_PositionProfile)
SMC_VP_ARRAYSIZE	350	Erroneous array size (MC_VelocityProfile)
SMC_VP_STEP0MS	351	Step time = t#0s (MC_VelocityProfile)
SMC_AP_ARRAYSIZE	375	Erroneous array size (MC_AccelerationProfile)
SMC_AP_STEP0MS	376	Step time = t#0s (MC_AccelerationProfile)
SMC_TP_TRIGGEROCCUPIED	400	Trigger already active (MC_TouchProbe)
SMC_TP_COULDNT_SET_WINDOW	401	DriveInterface does not support the window function.
		(MC_TouchProbe)
SMC_TP_COMM_ERROR	402	Communication error (MC_TouchProbe)
SMC_AT_TRIGGERNOTOCCUPIED	410	Trigger already de-allocated (MC_AbortTrigger)
SMC_MCR_INVALID_VELACC_VALUES	426	Invalid velocity or acceleration values
		(MC_MoveContinuousRelative)
SMC_MCR_INVALID_DIRECTION	427	Invalid direction (MC_MoveContinuousRelative)
SMC_MCA_INVALID_VELACC_VALUES	451	Invalid velocity or acceleration values
		(MC_MoveContinuousAbsolute)
SMC_MCA_INVALID_DIRECTION	452	Invalid direction (MC_MoveContinuousAbsolute)
SMC_MCA_DIRECTION_NOT_APPLICABLE	453	Direction = fastest not applicable
		(MC_MoveContinuousAbsolute)
SMC_SDL_INVALID_AXIS_STATE	475	SMC_ChangeDynamicLimits may only be called in state
		standstill or power_off. (SMC_changeDynamicLimits)
SMC_SDL_INVALID_VELACC_VALUES	476	Invalid velocity, acceleration, deceleration or jerk values
		(SMC_changeDynamicLimits)

Name	Value	Description
SMC_CR_NO_TAPPETS_IN_CAM	600	Cam does not contain any tappets. (SMC_CamRegister)
SMC_CR_TOO_MANY_TAPPETS	601	Tappet group ID exceeds MAX_NUM_TAPPETS.
		(SMC_CamRegister)
SMC_CR_MORE_THAN_32_ACCESSES	602	More than 32 accesses on one CAM_REF.
		(SMC_CamRegister)
SMC_CI_NO_CAM_SELECTED	625	No cam selected (MC_CamIn)
SMC_CI_MASTER_OUT_OF_SCALE	626	Master axis out of valid range (MC_CamIn)
SMC_CI_RAMPIN_NEEDS_VELACC_VALUES	627	Velocity and acceleration values must be specified for
		ramp_in function. (MC_CamIn)
SMC_CI_SCALING_INCORRECT	628	Scaling variables fEditor/TableMasterMin/Max are not
		correct. (MC_CamIn)
SMC_CI_TOO_MANY_TAPPETS_PER_CYCLE	629	Too many tappets became active during one cycle.
		(MC_CamIn)
SMC_CB_NOT_IMPLEMENTED	640	Function block for the given cam format is not
		implemented.
		(SMC_CAMBounds, SMC_CAMBounds_Pos)
SMC_GI_RATIO_DENOM	675	RatioDenominator = 0 (MC_GearIn)
SMC_GI_INVALID_ACC	676	Acceleration invalid (MC_GearIn)
SMC_GI_INVALID_DEC	677	Deceleration invalid (MC_GearIn)
SMC_GI_MASTER_REGULATOR_CHANGED	678	Status Enable/Disable of the master has changed without
		permission. (MC_GearIn)
SMC_GI_INVALID_JERK	679	Jerk invalid (MC_GearIn)
SMC_PH_INVALID_VELACCDEC	725	Velocity and acceleration/deceleration values invalid
		(MC_Phase)
SMC_PH_ROTARYAXIS_PERIOD0	726	Rotation axis with fPositionPeriod = 0 (MC_Phase)
SMC_NO_CAM_REF_TYPE	750	Type of given cam is not MC_CAM_REF.
SMC_CAM_TABLE_DOES_NOT_COVER_MASTER_SCALE	751	Master area, xStart and xEnd, from CamTable is not
		covered by curve data. (MC_CamTableSelect)
SMC_CAM_TABLE_EMPTY_MASTER_RANGE	752	Cam data table has empty master range.
		(MC_CamTableSelect)
SMC_CAM_TABLE_INVALID_MASTER_MINMAX	753	Cam data master has invalid max-, min-values.
		(MC_CamTableSelect)
SMC_CAM_TABLE_INVALID_SLAVE_MINMAX	754	Cam data slave has invalid max-, min-values.
		(MC_CamTableSelect)
SMC_GIP_MASTER_DIRECTION_CHANGE	775	During coupling of slave axis, master axis has changed
		direction of rotation. (MC_GearInPos)
SMC_GIP_SLAVE_REVERSAL_CANNOT_BE_AVOIDED	776	Input AvoidReversal is set, but slave reversal cannot be
		avoided. (MC_GearInPos)
SMC_GIP_AVOID_REVERSAL_FOR_FINITE_AXIS	777	Input AvoidReversal must not be set for finite slave axes.
		(MC_GearInPos)
SMC_BC_BL_TOO_BIG	800	Gear backlash fBacklash too large (> position period/2)
		(SMC_BacklashCompensation)
SMC_QPROF_DIVERGES	825	Internal error: computation of quadratic trajectory failed
SMC_QPROF_INVALID_PARAMETER	826	Internal error: computation of quadratic trajectory failed
SMC_QPROF_NO_RESULT	827	Internal error: computation of quadratic trajectory failed
SMC_QPROF_INVALID_NEW_LBD	828	Internal error: computation of quadratic trajectory failed

Name	Value	Description
SMC_QPROF_BAD_NEGOTIATION	829	Internal error: computation of quadratic trajectory failed
SMC_QPROF_INVALID_INTERVAL	830	Internal error: computation of quadratic trajectory failed
SMC_QPROF_NOT_ENOUGH_PHASES	831	Internal error: computation of quadratic trajectory failed
SMC_SRT_NOT_STANDSTILL_OR_POWEROFF	850	Action only permitted in standstill or power_off
		(SMC_SetRampType)
SMC_SRT_INVALID_RAMPTYPE	851	Invalid ramp type (SMC_SetRampType)
SMC_SMT_NOT_STANDSTILL_OR_POWEROFF	852	Action only permitted in standstill or power_off
		(SMC_SetMovementType)
SMC_SMT_INVALID_MOVEMENTTYPE_OR_	853	Invalid motion type or position period
POSITIONPERIOD		(SMC_SetMovementType)
SMC_SMT_AXIS_NOT_VIRTUAL	854	Function block only applicable to virtual axis
		(SMC_SetMovementType)
SMC_NO_LICENSE	1000	Target is not licensed for CNC.
SMC_INT_VEL_ZERO	1001	Path cannot be processed because set velocity $= 0$
		(SMC_Interpolator).
SMC_INT_NO_STOP_AT_END	1002	Last object of path has Vel_End > 0 (SMC_Interpolator).
SMC_INT_DATA_UNDERRUN	1003	Warning: GEOINFO-List processed in DataIn but end of
		list not reached
		Reason :
		- EndOfList of the queue in DataIn not be set
		- SMC_Interpolator faster than path generating function
		blocks
SMC_INT_VEL_NONZERO_AT_STOP	1004	Velocity at Stop > 0 (SMC_Interpolator)
SMC_INT_TOO_MANY_RECURSIONS	1005	Too much SMC_Interpolator recursions.
SMC INT NO CHECKVELOCITIES	1000	SoftMotion-Error (SMC_Interpolator)
SMC_INT_NO_CHECKVELOCITIES	1006	SMC_Check Velocities is not the last processed function
SMC INT DATH EXCEEDED	1007	Internal or numeric error
SMC_INT_FAIT_EXCEEDED	1007	Velocity and acceleration (deceleration is pull or to low
SMC_INT_VEL_ACC_DEC_ZERO	1008	Velocity and acceleration / deceleration is null of to low. EB called with $dwInoTime = 0$
SMC_INT_DWITOTIWE_ZERO	1009	Lerk invalid because jerk must be positive
SMC_INT_JERK_NON OSTITVE	1010	Internal error Calculation algorithm incorrectly
SMC_INT_OFROI_DIVERGES	1011	Invalid velocity mode
SMC_INT_TOO MANY AXES INTERPOLATED	1012	More than the allowed number of axes has ben
SMC_INT_TOO_MANT_AALS_INTER OLATED	1015	interpolated
SMC INT2DIR BLIFFER TOO SMALL	1050	Warning: pogDataIn of OutOueue is created too small
	1050	Adherence of stops not guaranteed
SMC INT2DIR PATH FITS NOT IN QUEUE	1051	Path does not go completely in queue.
SMC XINT INVALID DIRECTION	1070	Direction input has an invalid value.
SMC XINT NOINTERSECTION	1071	Could not determine position on CNC path for the given
	10/1	x-position.
SMC WAR INT OUTOUEUE TOO SMALL	1080	Warning: pooDataIn of OutOueue is created too small
	2000	Adherence of stops not guaranteed
SMC WAR END VELOCITIES INCORRECT	1081	Warning: Final velocities inconsistent
SMC CV ACC DEC VEL NONPOSITIVE	1100	Velocity and acceleration/deceleration values
		non-positive

Name	Value	Description
SMC_CA_INVALID_ACCDEC_VALUES	1120	Values of fGapVelocity / fGapAcceleration /
		fGapDeceleration non-positive
SMC_DEC_ACC_TOO_LITTLE	1200	Acceleration value impermissible
SMC_DEC_RET_TOO_LITTLE	1201	Deceleration value impermissible
SMC_DEC_OUTQUEUE_RAN_EMPTY	1202	Data underrun. Queue has been read and is empty.
SMC_DEC_JUMP_TO_UNKNOWN_LINE	1203	Jump to line cannot be executed because line number is
		unknown.
SMC_DEC_INVALID_SYNTAX	1204	Syntax invalid
SMC_DEC_3DMODE_OBJECT_NOT_SUPPORTED	1205	Objects are not supported in 3D mode.
SMC_DEC_NEGATIVE_PERIOD	1206	Negative value as a period of additional axes invalid
SMC_DEC_DIMENSIONS_EXCLUSIVE_AU	1207	Not both axes A and U are interpolated. PA and PU are
		mutually exclusive.
SMC_DEC_DIMENSIONS_EXCLUSIVE_BV	1208	Not both axes B and V are interpolated. PB and PV are
		mutually exclusive.
SMC_DEC_DIMENSIONS_EXCLUSIVE_CW	1209	Not both axes C and W are interpolated. PC and PW are
		mutually exclusive.
SMC_GCV_BUFFER_TOO_SMALL	1300	Buffer too small
SMC_GCV_BUFFER_WRONG_TYPE	1301	Buffer elements have wrong type.
SMC_GCV_UNKNOWN_IPO_LINE	1302	Current line of the Interpolator could not be found.
SMC_NO_CNC_REF_TYPE	1500	Given CNC program is not of type SMC_CNC_REF.
SMC_NO_OUTQUEUE_TYPE	1501	Given OutQueue is not of type SMC_OUTQUEUE.
SMC_GEOINFO_BUFFER_MISALIGNED	1502	4-byte aligned buffer part is not used in pbyBuffer.
SMC_3D_MODE_NOT_SUPPORTED	1600	Function block only works with 2D paths.
SMC_SAA_SMOOTHAREA_TOO_LARGE	1700	Range for smoothing too large
SMC_SAA_SP_INVALID_INPUT	1701	Invalid input dSmoothingPart [01]
SMC_SA_QUEUE_NOT_IN_BUFFER	1800	SMC_SegmentAnalyzer detects that OutQueue buffer is
		full but not completed. The function block can only
		operate when OutQueue fits the buffer completely.
SMC_SA_QUEUE_CHANGED_DURING_OP	1801	OutQueue buffer changed while the function block is
		operating on them
SMC_OS_INVALID_PARAMETER	1820	Invalid input value in dSplittingParameter
SMC_BSSP_IPO_NOT_ACTIVE	1830	Position cannot be saved. Interpolator is inactive.
SMC_BS_SAVEDPOS_NOT_REACHED	1831	Saved position has not been found so far. It is probably
		on a different path.
SMC_BS_NO_POS_STORED	1832	Structure passed in ePos contains no saved position.
		SMC_BlockSearchSavePos is not executed or in a wrong
		way.
SMC_INVALID_FEATURE_FLAG	1900	Feature flag must be in the range {1,, 31}.
SMC_SMB_HFUN_NOT_SUPPORTED	1901	Function block does not support h-functions.
SMC_SMB_ONLY_3DMODE	1902	Function block only works in 3D-Mode.
SMC_SMB_ERROR_COMPUTING_SPLINE	1903	Internal error computing the spline.
SMC_SMM_INVALID_PARAM_NUMBER	1910	wAdditionalParameter is too big.
SMC_RNCF_FILE_DOESNT_EXIST	2000	File does not exist.
SMC_RNCF_NO_BUFFER	2001	No buffer allocated
SMC_RNCF_BUFFER_TOO_SMALL	2002	Buffer too small
SMC_RNCF_DATA_UNDERRUN	2003	Data underrun. Buffer has been read, is empty.

Name	Value	Description
SMC_RNCF_VAR_COULDNT_BE_REPLACED	2004	Placeholder variable could not be replaced.
SMC_RNCF_NOT_VARLIST	2005	Input pvl does not point to a SMC_VARLIST object.
SMC_RNCF_NO_STRINGBUFFER	2006	Input pStringBuffer is not used or does not point to a
		variable of type SMC_StringBuffer.
SMC_RNCF_STRINGBUFFER_OVERRUN	2007	In the CNC program more different strings are used as
		reserved in pStringBuffer.
SMC_RNCQ_FILE_DOESNT_EXIST	2050	File could not be opened.
SMC_RNCQ_NO_BUFFER	2051	No buffer defined
SMC_RNCQ_BUFFER_TOO_SMALL	2052	Buffer too small
SMC_RNCQ_UNEXPECTED_EOF	2053	Unexpected end of file
SMC_ADL_FILE_CANNOT_BE_OPENED	2100	File could not be opened.
SMC_ADL_BUFFER_OVERRUN	2101	Buffer overrun. WriteToFile must be called more
		frequently.
SMC_RCAM_FILE_DOESNT_EXIST	2200	File could not be opened.
SMC_RCAM_TOO_MUCH_DATA	2201	Saved cam too big
SMC_RCAM_WRONG_COMPILE_TYPE	2202	Wrong compilation mode
SMC_RCAM_WRONG_VERSION	2203	File has wrong version.
SMC_RCAM_UNEXPECTED_EOF	2204	Unexpected end of file
SMC_ENC_DENOM_ZERO	5000	Nominator of the conversion factor
		dwRatioTechUnitsDenom of the Encoder reference is 0.
SMC_ENC_AXISUSEDBYOTHERFB	5001	Other module trying to process motion on the Encoder
		axis
SMC_ENC_FILTER_DEPTH_INVALID	5002	Filter depth is invalid.
SMC_PCCQ_POINTBUFFERTOOSMALL	10000	Buffer pBuffer too small
SMC_PCCQ_INPUTBUFFERFULLBUTNOTFINALIZE	10001	The function block must be applied to a path that fit
D		completely in the buffer.
SMC_AXIS_GROUP_WRONG_STATE	11000	The axis group is in the wrong state for the requested
		operation.
SMC_AXIS_GROUP_TOO_MANY_AXES	11001	More than the maximum allowed number of axes has
		been added to an axis group.
SMC_AXIS_GROUP_INVALID_DYNLIMITS	11002	The dynamic limits of a single axis are invalid.
		(fSWMaxVelocity/Acceleration/Deceleration/Jerk)
SMC_AXIS_GROUP_INVALID_COORD_SYSTEM	11004	The given coordinate system is invalid for the requested
	1100 -	operation.
SMC_AXIS_GROUP_SINGLE_AXIS_ERROR	11005	An axis of the axis group is in state error.
SMC_MOVE_INVALID_BUFFER_MODE	11006	The given buffer mode is not supported.
SMC_MOVE_INVALID_DYNAMIC_FACTOR	11007	The dynamic factor is not in the range [01].
SMC_MOVE_INVALID_DYNAMICS	11008	The dynamic limits for the movement are invalid.
SMC_AXIS_GROUP_AXIS_NOT_PART_OF_GROUP	11009	The given axis is not part of the axis group.
SMC_AXIS_GROUP_NOT_SUPPORTED	11010	The requested operation is not supported.
SMC_AXIS_GROUP_KINEMATICS_NOT_SET	11011	No kinematic configuration has been configured.
SMC_AXIS_GROUP_WRONG_NUMBER_OF_AXES	11012	The number of axes is not equal to the number of axes
		needed by the kinematic transformation

Name	Value	Description
SMC_AXIS_GROUP_INTERRUPTED_BY_SINGLE_A	11013	A coordinated movement has been interrupted by a single
XIS		axis movement.
SMC_AXIS_GROUP_FOLLOW_SETVALUES	11014	An error occurred while following the computed set
		values.
SMC_AXIS_GROUP_TOO_MANY_DEPENDENCIES	11015	An axis group cannot depend on more than one master
		axis group.
SMC_AXIS_GROUP_MUTUAL_DEPENDENCY	11016	An axis group A may not depend on another axis group
		that depends on A.
SMC_AXIS_GROUP_DEPENDENCY_IN_DIFFERENT_	11017	A dependant axis group must be executed in the same
TASK		task.
SMC_AXIS_GROUP_AXIS_IN_DIFFERENT_TASK	11018	An axis belonging to an axis group must be executed in
		the same task.
SMC_AXIS_GROUP_PCS_STILL_IN_USE	11019	A second activation of the function block occurred while
		the PCS was still used by buffered motion commands.
SMC_AXIS_GROUP_CMD_ABORTED_DUE_TO_ERR	11020	An error ocurred in a previous motion command.
OR		
SMC_AXIS_GROUP_INVALID_PARAMETER	11021	A parameter of an administrative function block is
		invalid.
SMC_AXIS_GROUP_UNSUPPORTED_RAMPTYPE	11022	One of the axes of the group uses an unsupported ramp
		type. Only trapez and quadratic are supported.
SMC_MOVE_INVALID_TRANSITION_PARAMETER	11023	Invalid transition parameter
SMC_AXIS_GROUP_INTERNAL_ERROR	11024	Internal error in the state machine of the axis group.
SMC_AXIS_GROUP_CPTR_CANNOT_FOLLOW	11025	CP-Tracking: Cannot keep the path; try to reduce the
		dynamics on the path and / or the dynamics when
		entering CP-Tracking.
SMC_AXIS_GROUP_CONTINUE_WRONG_POSITION	11026	Current position does not allow continuation.
SMC_AXIS_GROUP_CONTINUE_BUFFER_TOO_SMA	11027	Buffer in continueData is too small; big external
LL		movement-queue-buffer in use.
SMC_AXIS_GROUP_CONTINUE_WRONG_CHECKSU	11028	The checksum stored in the continue data is wrong.
М		The continue data either was not written by
		MC_GroupInterrupt, or was modified afterwards.
SMC_KERNEL_PTP_INTERNAL_ERROR	11100	Internal error in the kernel
SMC_KERNEL_PTP_INVALID_TASKCYCLETIME	11101	Task cycle time not positive
SMC_TRAFO_INVALID_PARAMETERS	12000	Invalid parameters
SMC_TRAFO_INVALID_CONSTELLATION	12001	The input constellation (typ. cartesian values) are
		incompatible with the configuration. Typically this means
		that the given position is outside of the working area of
		the kinematic transformation.
SMC_TRAFO_INVALID_COUPLING	12002	The tool cannot work together with the positioning-part
		of the machine. Either, the positioning-part doesn't
		implement ISMPositionKinematics2, or the tool cannot
		deal with the positioning's image of orientations.
SMC_CP_CACHE_FULL	12100	The cache of the CP planner is too small.
SMC_CP_EVAL_ERROR	12101	The evaluation of the position on a geometric element
		failed.
SMC_CP_NON_CONTINUABLE_STATE	12102	Non-continuable state reached (internal error).
SMC_CP_MAX_LENGTH_EXCEEDED	12103	Maximum trajectory length exceeded (internal error).

Name	Value	Description
SMC_CP_ACCELERATION_TOO_HIGH	12104	Path acceleration too high (invalid state, internal error).
SMC_CP_MAX_ITERATIONS_EXCEEDED	12105	Maximum number of iterations exceeded (internal error).
SMC_CP_NO_TRAJECTORY	12106	No trajectory could be computed (internal error).
SMC_CP_OUT_QUEUE_FULL	12107	The out-queue is full (internal error).
SMC_CP_QUEUE_UNDERRUN	12108	Queue underrun: no element left in queue.
SMC_CP_INVALID_QUEUE	12109	Invalid queue (invalid size or pointer)
SMC_CP_BLENDING_INTERNAL_ERROR	12110	An internal error occurred while blending two CP
		movements.
SMC_CP_CIRCLE_COLLINEAR_POINTS	12111	The three points that define the circle are collinear.
SMC_CP_CIRCLE_CENTER_NOT_ON_BISECTOR	12112	The center point is not on the perpendicular bisector of
		the start and end point.
SMC_CP_CIRCLE_RADIUS_ZERO	12113	The radius is zero.
SMC_CP_CIRCLE_DISTANCE_LARGER_THAN_DIA	12114	The distance between start and end point is larger than
METER		the diameter. (When trying to create a circle using
		SMC_Circ_Mode.Radius.)
SMC_CP_CIRCLE_START_AND_ENDPOINT_EQUAL	12115	The start and end point are equal.
		(SMC_Circ_Mode.Radius)
SMC_CP_BLENDING_DEGENERATE_SPLINE	12116	The blending spline is degenerate
		(too short or non-regular).
SMC_CP_ELEMENT_TOO_SHORT	12117	The path element cannot be created because it is too
		short.
SMC_CP_COULD_NOT_CUT_PATH	12118	The path could not be cut for aborting movement
		(internal error).
SMC_CP_INVALID_ANGULAR_VEL_ACC	12119	The given angular velocity or acceleration is invalid
		(quaternion with non-zero real part, internal error).
SMC_CP_INVALID_ORIENTATION	12120	The given orientation is invalid (non-orthonormal matrix
		or non-unit quaternion, internal error).
SMC_CP_TIME_BUDGET_EXCEEDED	12121	The given time budget for the computation is exceeded
		(internal error).
SMC_AXIS_GROUP_AXIS_LIMIT_VIOLATED	12122	A limit of an axis has been violated. This can happen if a
		CP movement is done too close to a singularity of the
		robot or crosses the software position limit of an axis.
SMC_CP_CONFIG_OF_STARTPOS_DIFFERS	12123	The kinematic configuration of the start position differs
		from the current configuration. The CP movement would
		pass a singularity.
SMC_CP_CONFIG_OF_ENDPOS_DIFFERS	12124	The kinematic configuration of the end position differs
		from the current configuration. The CP movement would
		pass a singularity.
SMC_CP_CONFIGS_DIFFER	12125	The kinematic configuration of the start position differs
		from the end position. The CP movement would pass a
		singularity.

Name	Value	Description
SMC_CP_NO_ROOT_IN_INTERVAL_FOUND	12127	The stop trajectory could not be found in the interval
		(internal error).
SMC_CP_KIN_DOES_NOT_SUPPORT_AXIS_ORIENT	12128	The kinematics does not support the orientation mode
ATION_IPO		"Axis" for continuous path movements.
SMC_CP_AXIS_ORIENTATION_IPO_NOT_SUPPORT	12129	The axis orientation interpolation mode is not supported
ED_FOR_CPTR		for CP movements with a dynamic PCS (tracking).
SMC_CP_INVALID_PATH_ELEM	12130	An invalid path element has been created (internal error).
SMC_TRANSITION_NOT_SMOOTH	12131	The transition between two path elements is not G2
		continuous, and there is no stop (internal error).

# 9.12 UNION

# 9.12.1 SMC\_POS\_REF

Name	Туре	Description		
a	TRAFO.AXISPOS_REF	Axis coordinates		
с	MC_COORD_REF	Cartesian position		
v	ARRAY [05] OF LREAL	Array of values, interpolation depends on coordinate system used		

## Chapter 9 Function Blocks for Motion Control

# MEMO

# Chapter 10 Visualization Template

# 10.1 Overview

Visualization templates enable efficient debugging without inputs and outputs for function blocks in POUs.

MC_Power	_Power_0		
Enable bRegulatorOr bDriveStart	0	Status bRegulatorRealState bDriveStartRealState Busy Error ErrorID	
MC_MoveR	Celative _MoveRelative_0		
Execute Distance Velocity Acceleration Deceleration Jerk	<ul> <li>360.000000</li> <li>360.000000</li> <li>360.000000</li> <li>360.000000</li> <li>0.000000</li> </ul>	Done Busy CommandAborted Error ErrorID	0

# 10.2 Programming and Operation

This is a simple program including MC\_Power and MC\_MoveRelative only. As shown below, all the inputs and outputs other than Axis input can be opened.



Right click on [Application] and choose [Add Object]-[Visualization...].



# NOTE

When [Visualization] is added, also [WebVisualization] is added together automatically. However, the motion type CPU (HX-CP1S08M) does not support WebVisualization. It works only 30 minutes as a demo mode.

If you click [SM3\_Basic] in the Visualization page, the templates for all FBs in SM3\_Basic library appear. Drag VISU\_MC\_Power or VISU\_NEW\_MC\_Power to the Visualization page.

ToolBox 🝷 म		
🏢   🏢   🚬		
Basic Common controls Alarm manager		
Measurement controls Lamps/Switches/Bitmaps		
Special controls Date/time managing controls	M. Parm	
ImagePool_sm3ImagePool_cnc_sm3		The 1 Mary 1
ImagePoolDialogs SM3_Basic SM3_CNC		<u> </u>
VisuDialogs SM3_Robotics_Visu Favorite		
	VISU_MC_Power	VISU_NEW_MC_Po
VISU_SMC_MoveCont inuousRelative inuousAbsolute		
VISU_MC_TouchPro VISU_MC_SetPosition		
VISU_MC_AbortTrigg helpVISU_SMC_ARRO er W	FB name can be searched.	
helpVISU_OUTPUT_R EF helpVISU_DWORD		
151 items		
noolBox 💼 Properties		

Then [Assign parameters] dialog appears. Click [OK] to proceed.

Parameter	Туре	Value			
🐜 🍫 m_Input_FB	MC_POWER				

The template VISU\_MC\_xxx and VISU\_NEW\_MC\_xxx are completely same except for external design.

VISU_MO		VISU_NI	EW_MC_Power		
MC_F	Power	MC_Power Instance: %s			
Enable	Status	Enable bRegulatorOn	() ()	Status bRegulatorRealState	•
bRegulatorOn	bRegulatorRealState	bDriveStart	۲	bDriveStartRealState	e 🕚
bDriveStart	bDriveStartRealState			Busy Error	•
	Error			ErronD	%d
Control	ErrorID : %d				

Click the template and click [...] button at [m\_Input\_FB] under [References] and choose the right instance to be connected ('MC\_Power\_0' in this sample).

Properties	-						
√ Filter •   Sort by • A/2 ↓ Sort order • ✓ Expert							
Property	Value						
Elementname	GenElemInst_1						
Type of element	Frame						
Clipping							
Show frame	No frame						
Scaling type	Anisotropic						
Deactivate the background dra							
References	Configure						
SM3_Basic.VISU_NEW_MC							
m_Input_FB							
Position							

out Assistant Text search Categories				
Variables	<ul> <li>Name</li> </ul>	Туре	Address	0 ^
	Free Contraction	Application		
	PLC_PRG	PROGRAM		
		MC_MoveRelative		-
	🗄 🖉 🕸 MC_Power_0	MC_Power		
	BPLog	Library		Breakpoin
	■ {} CAA	Library		CAA Type.

Set up a template for MC\_MoveRelative too.

After login and starting PLC, inputs and outputs of function blocks can be accessed with Visualization. The left hand side is input. Boolean inputs can be set or reset like a button and numerical data can be entered in the input field. The right hand side is output. The status of Boolean outputs can be seen as lamps. The numerical data can be seen in the output field.



Chapter 10 Visualization Template

MEMO

# Chapter 11 Trouble Shooting

# 11.1 Power-up Sequence

Power-up sequence is shown in the figure below. If your system does not work as expected, possible cause can be located in different area widely. Refer to the hints below or section 11.2 Trouble Shooting to solve.

Possible causes:

- In application program (e.g. Wrong usage of function block)
- In drives (e.g. stopped at Safe-Operational status)
- In network (e.g. DC synchronization is lost)
- In EtherCAT master (e.g. stopped with error)
- In CPU (e.g. stopped with overload error)



# 11.2 Trouble Shooting

	Check point	How to check	Action
1	Error indication of CPU	Check error LED and 7-segment LED.	Refer to HX application
	module	Login with HX-CODESYS and check CPU log.	manual (Hardware).
2	Error indication of drives	Check error LED or error code.	Refer to drive's
		Connect dedicated tool and check diagnostic information.	instruction manual.
3	Status of EtherCAT	Login with HX-CODESYS and check the EtherCAT master	Restart the EtherCAT
	Master	device.	master.
		[No error] [Error]	[Refer to Action-1]
		😔 🗊 EtherCAT_Master 🛆 🗊 EtherCAT_Master	
		adva_ec (hit) 🔤 🛆 😭 adva_ec (hit)	
		CAT	
		Cotton Contraction Contr	
4	Status of drives	(1) Login with HX-CODESYS and check drives' status icon.	Check the drive's status
			and make the status be
		[No error] [Error]	'Operational'.
		😌 🔟 EtherCAT_Master_ 😏 🗊 EtherCAT_Master_	[Refer to Action-3]
		adva_ec (hiti 😑 😏 🚮 adva_ec (hiti	
		S EtherCAT	
		Crive_A	
		ADVA_EC_1 () ADVA_EC_1 ()	
		(2) Login with HX-CODES IS and check staves status	
5	Status of avia	(1) Login with HY CODESYS and sheek awas' status ison	Execute MC Deset or
5	Status of axis	(1) Login with HX-CODES 15 and check axes status icon.	SMC3 ReinitDrive
		[No error] [Error]	[Refer to Action-5]
		Com EtherCAT_Master_ Com EtherCAT_Master_	
		😔 🏅 EtherCAT 🔤 🔂 EtherCAT	
		SHY Drive_C ▲HY Drive_C	
		(2) Login with HX-CODESYS and check axes' status.	
		[Refer to Action-4]	
6	Status of function blocks	Check the status of 'Error' output for all function blocks.	Check input values.
		MC_MoveVelocity_0	(The left figure shows
		MC_MoveVelocity	error output because
		MVVelo Velocity CommandAborted FALSE 1000 Acceleration Error THUE	velocity is 0. This can be
		1000 — Deceleration ErrorID - SMC AXIS N 0 - Jerk	fixed by setting a value
		direc positive Direction	other than 0.)

#### << Conditions to reproduce the error status No. 3 to 5 >>

No.3 Error in the EtherCAT master

- The power of the first slave (connected to master) is temporary down.
- Wire breaking between the master and the first slave.

No.4 Error in the drives

- The power of the 2<sup>nd</sup> or backward slave is temporary down.
- Wire breaking between slaves.

No.5 Error in the axes

• Axis became errorstop mode while 'Operational' mode.

#### Action-1: Restart the EtherCAT master

(a) Status checking and restarting the EtherCAT master by function block

Add the function block IoDrvEtherCAT to your program in advance. This FB returns the status and restarts the EtherCAT master.



	Name			Description Type				
loDrvE	EtherCAT	This FB retu	urns the statu	as of EtherCAT network and commands to restart or stop bus.	FB			
IoDrvEtherCAT — xRestart BOOL BOOL xConfigFinished — xStopBus BOOL BOOL xDistributedClockInSync BOOL xError BOOL xSyncInWindow								
Name Type Description								
IN	xRestart		BOOL	Rising edge: The master is restarted and all configuration parameters	s are reloaded.			
	xStopBus		BOOL	TRUE: Communication is stopped. No more EtherCAT telegrams are sent. On mos devices, a restart is necessary after this because they are switched to error status.				
OUT	xConfigFinis	shed	BOOL	L TRUE: Transfer of all configuration parameters was completed with r errors. Communication is running on the bus.				
	xDistributed	ClockInSync	BOOL	OOL If distributed clocks are used, then the PLC is synchronized with the f EtherCAT slave with the DC option activated.				
	xError BOOL TRUE: Error has occurred when starting the EtherCAT stack or communic with the slave is interrupted because no more messages can be received.							
	xSyncInWin	dow	BOOL	The output is TRUE when the <i>Sync Window Monitoring</i> opti and the synchronization of all slaves is within the Sync Wind	on is activated ow.			

(b) Reset operation

Instead of the FB IoDrvEtherCAT, EtherCAT master can be restarted by manual reset operation from HX-CODESYS. Be noted that CPU stops with this reset operation. The steps to reset are; Login with HX-CODESYS and choose [Online]-[Reset warm]. Then PLC is stopped and network is initialized. Start again manually afterward.

# Action-2: Check slave's status

Double click a slave device in the device tree and check [Diagnostics] in [General] tab.

General	Address			Additional	
Process Data	AutoInc Address	0	A V	Enable E	xpert Settings
Hotess Data	EtherCAT Address	1001	A. V	Optiona	I
Startup Parameters	Distributed Clock				
EtherCAT Parameters	Select DC	DC for synchro	onization		-
EtherCAT I/O Mapping	🗸 Enable	4000	Sync Unit Cyc	:le (µs)	
Status	Sync0: Enable Sync 0				
Information	Sync Unit Cycle	x 1	-	0	Cycle Time (µs)
	O User Defined		0	* V	Shift Time (µs)
	Sync1:				
	Enable Sync 1				
	Sync Unit Cycle	x 1	-	0	Cycle Time (µs)
	🔵 User Defined		0	×	Shift Time (µs)
	Diagnostics				

Just in case status is <Bad>, close the dialog and open again to update the status.

#### Action-3: Change the status to 'Operational'

(a) Manual operation

Login with HX-CODESYS, double click the slave device and click [Online] tab.

Change the status manually by the buttons in [State Machine]; [Init]→[Pre-Op]→[Safe-Op]→[Op].

ADVA_EC X			
General	State Machine		
Expert Process Data	Pre-Op Safe-Op	Current State:	Operational
Process Data	Ор	Requested State:	Operational
Startup Parameters	File access over EtherCAT		
Online	Download Upload		

#### NOTE

Activate [Enable Expert Settings] in [General] tab to show [Online] tab.

2	ADVA_EC X					
	General	Address		Additional		
	Evpart Process Data	AutoInc Address	0	📝 Enable Expert Settings		
	Expert Process Data	EtherCAT Address	1001	Optional		

(b) Change status by function block

Add the function block ETCS lave to your program in advance. This FB commands a setting operation mode.



Use the same instance as EtherCAT slave device. Since this FB is implicitly declared when a slave device is added, do not declare again in POU. If declaration is duplicated, CPU may stop with error.

Name			Desc	cription	Туре
E	TCSlave	This FB re	eturns the current operation mode	and commands a setting operation mode.	FB
	ETCSlave —xSetOperational BOOL ETC_SLAVE_STATE wState				
Name			Туре	Description	
IN	xSetOperational		BOOL	Rising edge: An attempt is made to s ETC_SLAVE_OPERATIONAL mode.	switch to the
OUT	wState		ETC_SLAVE_STATE	Current state of the slave	

#### ETC\_SLAVE\_STATE (ENUM)

Name	Value	Description
ETC_SLAVE_BOOT	3	Bootstrap (for firmware downloading)
ETC_SLAVE_INIT	1	Init
ETC_SLAVE_PREOPERATIONAL	2	Pre-Operational
ETC_SLAVE_SAVEOPERATIONAL	4	Safe-Operational
ETC_SLAVE_OPERATIONAL	8	Operational

#### NOTE

xSetOperational input of ETCSlave is effective only when the current mode is 'Safe-Operational'.

If the current mode is 'Init' or 'Pre-Operational', use ETCSlave.SetOpMode and set operation mode in the sequence Init  $\rightarrow$  Pre-Op $\rightarrow$  Safe-Op $\rightarrow$ Op. The data type of wOpMode is ETC\_SLAVE\_STATE or WORD.

#### Tip

If [Auto restart slaves] in EtherCAT master device is enabled, communication status is changed from 'Init' to 'Operational' automatically after temporary cable disconnection.

EtherCAT_Master_SoftMotion X				
General	☑ AutoconfigMaster/Slaves	Ether CAT		
Sync Unit Assignment	EtherCAT NIC Setting			
EtherCAT I/O Mapping	Destination Address (MAC) FF-FF-FF-FF-FF	🖉 Broadcast 🛛 🔲 Enable Redundancy		
Status	Source Address (MAC) 00-01-02-03-04-11	Browse		
	Network Name eth2			
Information	● Select network by MAC	Name		
	▲ Distributed Clock			
	Cycletime 4000 🚔 µs 🔲 Use LRW in	nstead of LWR/LRD		
	Sync Offset 20 🚔 % 📃 Enable mes	ssages pertask		
	Sync Window Monitoring	rt slaves		

#### (c) Reset operation

Instead of the FB ETCSlave, communication status can be changed to 'Operational' by manual reset operation from HX-CODESYS. Be noted that CPU stops with this reset operation. The steps to reset are; Login with HX-CODESYS and choose [Online]-[Reset warm]. Then PLC is stopped and network is initialized. Start again manually afterward.

#### Action-4: Check the status of axis

Double click the axis in the device tree and check the status in [General] tab.

EtherCAT\_Master\_SoftMotion (E
 ADVA\_EC (HITACHI AC SER
 ADVA\_EC (HITACHI AC SER
 ADVA\_EC (MITACHI AC

#### 🕢 😥 Drive\_A 🗙

General Scaling/Mapping	Axis type and limits Virtual mode Modulo	lodulo settings Modulo value [u]: 36	0.0	Velocity ramp type Trapezoid Sin <sup>2</sup>
Commissioning SM_Drive_ETC_GenericDSP402: Parameters SM_Drive_ETC_GenericDSP402: I/O Mapping Status	Finite     So     Dynamic limits     Velocity [u/s]: Acc	oftware error reaction Deceleration [u/s <sup>2</sup> ]: 0 Max. distance [u]: 0 celeration [u/s <sup>2</sup> ] Deceleration [u/s <sup>2</sup> ]		Quadratic Quadratic (smooth) Identification ID: 3 Position lag supervision deactivated
	1e	1e5		Lag limit [u]: 1.0
	variable set valu	ue actual value	Status: SMC AXIS STATE.err	rorstop
	Position [u]	0.00 0.00		
	Velocity [u/s]	0.00 0.00	Communication: error (1100)	
	Acceleration [u/s <sup>2</sup> ]	0.00 0.00	Errors	
	Torque [Nm]	0.00 0.00	Axis Error:	
			0 [16#0000000]	
			FB Error:	
			SMC_ERROR.SMC_DI_GENERAL_COM	IMUNICATION_ERROR
			uiDriveInterfaceError:	
			10	
			strDriveInterfaceError:	
			ETC device is no longer in mode opera	itional

In addition, MC\_ReadStatus returns the current axis status as follows.



#### Action-5: Reset error

(a) MC\_Reset



(b) If it's still 'Errorstop' status, execute SMC3\_ReinitDrive to initialize the axis.



Appendix 1	Abbreviations

Abbreviations	Text
ACS	Axes Coordinate System
CiA	CAN in Automation
CoE	CANopen over EtherCAT
CNC	Computer Numerical Control
DC	Distributed Clock
ENI	EtherCAT Network Information
EoE	Ethernet over EtherCAT
ESI	EtherCAT Slave Information
ESM	EtherCAT State Machine
FB	Function Block
FMMU	Fieldbus Memory Management Unit
FoE	File access over EtherCAT
FTP	File Transfer Protocol
GVL	Global Variable List
MCS	Machine Coordinate System
DCS	Product Coordinate System
rCS	Progrma Coordinate System
PDO	Process Data Object
POU	Program Organization Unit
SDO	Service Data Object
SoE	Servo drive over EtherCAT
ТСР	Tool Center Point

Appendix 1 Abbreviations

# MEMO

# Appendix 2 List of Motion Commands

SM3	Basic	4.2.1.0
~		

1				SM3 Basic GetVersion (FUN)
2	Da	taTv	/Des	
3		Dr	iveBasic	
4			CAM Types	MC CAM REF (FB)
5	Dri	iveIr	nterface	
6		AX	KIS REF	AXIS REF SM3 (FB)
7				SMC3 CommunicateDriveParameter (FB)
8				SMC3 ReadDriveParameter (FB)
9				SMC3 ReadParameter (FB)
10				SMC3 ReinitDrive (FR)
11				SMC3_MC1HIEDFIVE (FB)
12				SMC3 WriteDarameter (FB)
12		43		AVIS DEE LOCICAL SM3 (ED)
14			VIS DEE MADDING	AKIS_REF_LOGICAL_SHS (FB)
14		A		AAIS_REF_MAPPING_SMS (FB)
15		AZ EN	ICODED DEE	AXIS REF VIRTUAL SM3 (FB)
10		EN	T I I	ENCODER REF SM3 (FB)
1/		FB	_1emplates	FB Template Edge (FB)
18				FB Template EdgeAbort (FB)
19				FB_l'emplate_EdgeAbort'l'imeout (FB)
20		FR	EE_ENCODER_REF	FREE_ENCODER_REF (FB)
21		Per	rformance	SMC PerfStat (FB)
22				SMC_PerfTimerSum (FUN)
23				SMC_SeriesStat (FB)
24	PO	Us		
25		Co	ommissioning	SMC_Commissioning (FB)
26		Dr	iveBasic	
27			Brake Control	SMC3_BrakeControl (FB)
28				SMC3 BrakeStatus (FB)
29			Config	SMC3_PersistPosition (FB)
30				SMC3 PersistPositionLogical (FB)
31				SMC3_PersistPositionSingleturn (FB)
32				SMC_ChangeDynamicLimits (FB)
33				SMC_SetControllerMode (FB)
34				SMC SetCustomRampType (FB)
35				SMC_SetMovementType (FB)
36				SMC SetRampType (FB)
37				SMC_SetSoftwareLimits (FB)
38			Diagnostic	SMC_CheckAxisCommunication (FB)
39				SMC GetMaxSetAccDec (FB)
40				SMC GetMaxSetVelocity (FB)
41				SMC GetTrackingError (FB)
42				SMC InPosition (FB)
43				SMC MeasureDistance (FB)
44			Direct Axis Control	SMC CheckLimits (FB)
45				SMC FollowPosition (FB)
46				SMC FollowPositionVelocity (FB)
47				SMC FollowSetValues (FB)
48				SMC FollowVelocity (FB)
49			Error Handling	SMC ClearFBError (FUN)
50				SMC ReadFBError (FB)
51			Homing	SMC Homing (FB)
52			Scale Manipulation	SMC ChangeGearingRatio (FR)
53			Standard	the changedeat ingracio (ib)
54			String Functions	SMC CONCAT (FUN)
55			Virtual Axis	SMC VIRTUAL AVIS (FR)
55	1		·	

	Fil	e	
		CAM FBs	SMC ReadCAM (FB)
			SMC WriteCAM (FB)
-	Diagnostic		SMC AvisDiagnosticLog (FD)
-	Managars		SMC_AXISDIAGNOSCICLOG (FB)
-	Managers		SMC_CAM_ODJectManager (FB)
	PL	Copen	
_		Additional	
_		CAM	SMC_CAMBounds (FB)
_			SMC_CAMBounds_Pos (FB)
			SMC CamEditor (FB)
			SMC_CamRegister (FB)
			SMC GetCamSlaveSetPosition (FB)
			SMC GetTappetValue (FB)
			SMC BacklashCompensation (FB)
			SMC ReadSetPosition (FB)
			SMC SetTorque (FB)
-		Master/Slave Function Blocks	MC CamIn (FB)
			MC CamOut (FB)
			MC_CamEableCalect (ED)
-			MC CamiableSelect (FB)
-			MC_Gearin (FB)
-			MC_GearInPos (FB)
_			MC GearOut (FB)
_			MC_Phasing (FB)
		Single Axis Function Blocks	
		Part I	MC AccelerationProfile (FB)
			MC_Halt (FB)
			MC_Home (FB)
			MC MoveAbsolute (FB)
			MC MoveAdditive (FB)
			MC MoveRelative (FB)
			MC MoveSuperImposed (FB)
			MC MoveVelocity (FB)
			MC PositionProfile (FB)
			MC Power (FB)
			MC ReadletualPosition (FB)
-			MC ReadActuarrosition (FB)
-			MC_ReadAxISEITOT (FB)
-			MC_ReadBoolPalameter (FB)
-			MC ReadParameter (FB)
-			MC_ReadStatus (FB)
-			MC Reset (FB)
_			MC Stop (FB)
-			MC_VelocityProfile (FB)
			MC_WriteBoolParameter (FB)
			MC WriteParameter (FB)
)		Part II	MC_AbortTrigger (FB)
			MC_DigitalCamSwitch (FB)
2			MC ReadActualTorque (FB)
5			MC_ReadActualVelocity (FB)
ļ			MC_SetPosition (FB)
i			MC TouchProbe (FB)
5			SMC MoveContinuousAbsolute (FB)
1			SMC MoveContinuousRelative (FB)
3		Part III	MC Jog (FB)
)			SMC Inch (FB)
)	Sir	npleTest	SMC StartupDrive (FB)
Pr	oject	Information	GetBooleanProperty (FUN)
	5,000		GetCompany (FUN)
			GetNumberProperty (FUN)
			CetText Property (FUN)
			CotToxtToperty2 (FUN)
:			Getrextrioperty2 (FUN)
,			Getticte (FUN)
			Getversion (FUN)
>			GetversionProperty (FUN)
SM3\_CNC 4.2.1.3

1				SM3 CNC GetVersion (FUN)
2	Projektinformationen			GetBooleanProperty (FUN)
3				GetCompany (FUN)
4				GetNumberProperty (FUN)
5				GetTextProperty (FUN)
6				GetTextProperty2 (FUN)
7				GetTitle (FUN)
8				GetVersion (FUN)
9				GetVersionProperty (FUN)
10	SM	[_C]	VC_Data types	
11		So	ftMotion CNC	SMC CNC REF (FB)
12				SMC OUTQUEUE (FB)
13	SM	[_C]	NC_POUs	
14		Fil	e	
15			Help functions	SMC StringBuffer (FB)
16			ReadNCFile	
17			Stream	SMC FileStream (FB)
18				SMC StringStream (FB)
19			Token	SMC NCTokenizer (FB)
20				SMC ReadNCTokens (FB)
21				SMC Token (FB)
22				SMC TokenQueue (FB)
23				SMC ReadNCFile (FB)
24				SMC ReadNCQueue (FB)
25		So	ftMotion CNC	
26			Coordinate Transformations	SMC CoordinateTransformation3D (FB)
27				SMC DetermineCuboidBearing (FB)
28				SMC InvCoordinateTransformation3D (FB)
29				SMC TeachCoordinateSystem (FB)
30				SMC_UnitVectorToRPY (FB)
31			Direct Axis Control	SMC ControlAxisByPos (FB)
32				SMC ControlAxisByPosVel (FB)
33				SMC ControlAxisByVel (FB)
34			GCode Viewer	SMC_GCodeViewer (FB)
35			GeoInfo Help Functions	SMC_AdaptHelpMarks (FUN)
36				SMC CalcEndPnt (FUN)
37				SMC_CalcLengthGeo (FUN)
38				SMC CalcStartPnt (FUN)
39				SMC CutEnd (FUN)
40				SMC_CutStart (FUN)
41				SMC_GeoinfoInit (FUN)
42				SMC GetAccVec (FUN)
43				SMC_GetAddAxValue (FUN)
44				SMC_GetClosestPnt (FUN)
45				SMC GetLengthOfPrefix (FUN)
46				SMC_GetPnt (FUN)
47				SMC_GetPntPI (FUN)
48				SMC GetTanVec (FUN)
49				SMC_GetTanVec3D (FUN)
50				SMC_InvertDirection (FUN)
51				SMC RampInCorr (FUN)
52				SMC_RampOutCorr (FUN)
53				SMC_RecalculateHelpMarks (FUN)
54				SMC SingleCorr (FUN)

55	OutQueue Functions	SMC_AppendObj (FUN)
56		SMC_DeleteObj (FUN)
57		SMC GetCount (FUN)
58		SMC GetHistoryCount (FUN)
59		SMC GetLastObj (FUN)
60		SMC GetObj (FUN)
61		SMC GetObjFromEnd (FUN)
62		SMC GetObjFromHistory (FUN)
63		SMC OutQueueInit (FUN)
64		SMC OutOueueIsSyncing (FUN)
65		SMC OutOueueRestoreHistory (FUN)
66		SMC RestoreOueue (FUN)
67		SMC SetObj (FUN)
68		SMC SetOueueCapacity (FUN)
69	Oueue manipulatoin	SMC OueueSetReservedEntries (FB)
70		SMC RotateOueue2D (FB)
71		SMC ScaleOueue3D (FB)
72		SMC TranslateQueue3D (FB)
73	SoftMotion Function Blocks	
74	BlockSearch	SMC BlockSearch (FB)
75		SMC BlockSearchSavePos (FB)
76	M Functions	SMC GetMParameters (FB)
77		SMC PreAcknowledgeMFunction (FB)
78	NCDecoder Help Functions	SMC GetGWORD (FB)
79		SMC AvoidLoop (FB)
80		SMC CheckForLimits (FB)
81		SMC CheckVelocities (FB)
82		SMC ExtendedVelocityChecks (FB)
83		SMC Interpolator (FB)
84		SMC Interpolator2Dir (FB)
85		SMC Interpolator2Dir SlowTask (FB)
86		SMC LimitCircularVelocity (FB)
87		SMC LimitDynamics (FB)
88		SMC NCDecoder (FB)
89		SMC ObjectSplitter (FB)
90		SMC RecomputeABCSlopes (FB)
91		SMC ReduceVelEndAtCorner (FB)
92		SMC RoundPath (FB)
93		SMC SegmentAnalyzer (FB)
94		SMC SmoothAddAxes (FB)
95		SMC SmoothBSpline (FB)
96		SMC SmoothMerge (FB)
97		SMC SmoothPath (FB)
98		SMC ToolCorr (FB)
99		SMC_XInterpolator (FB)

100	00 SM_Trafo_POUs				
101	ſ	So	ftMotion Transformations		
102			Additional FBs	SMC CalcDirectionFromVector (FB)	
103			Gantry systems	SMC TRAFOF 5Axes (FB)	
104				SMC TRAFOF Gantry2 (FB)	
105				SMC TRAFOF Gantry2Tool1 (FB)	
106				SMC TRAFOF Gantry2Tool2 (FB)	
107				SMC TRAFOF Gantry3 (FB)	
108				SMC TRAFOF Gantry3D (FB)	
109				SMC TRAFOF GantryCutter2 (FB)	
110				SMC TRAFOF GantryCutter3 (FB)	
111				SMC TRAFOF GantryH2 (FB)	
112				SMC TRAFOF GantryT2 (FB)	
113				SMC TRAFOF GantryT2 O (FB)	
114				SMC TRAFOV Gantry2 (FB)	
115				SMC TRAFOV Gantry3 (FB)	
116				SMC TRAFOV GantryCutter2 (FB)	
117				SMC TRAFOV GantryCutter3 (FB)	
118				SMC TRAFOV GantryH2 (FB)	
119				SMC TRAFOV GantryT2 (FB)	
120				SMC TRAFOV GantryT2 O (FB)	
121				SMC TRAFO 5Axes (FB)	
122				SMC TRAFO Gantry2 (FB)	
123				SMC TRAFO Gantry2Tool1 (FB)	
124				SMC TRAFO Gantry2Tool2 (FB)	
125				SMC TRAFO Gantry3 (FB)	
126				SMC TRAFO GantryCutter2 (FB)	
127				SMC TRAFO GantryCutter3 (FB)	
128				SMC TRAFO GantryH2 (FB)	
129				SMC TRAFO GantryT2 (FB)	
130				SMC TRAFO GantryT2 O (FB)	
131			Parallel Systems		
132			Bipod_Arm	SMC_TRAFOF_Bipod_Arm (FB)	
133				SMC TRAFO Bipod Arm (FB)	
134			Tripod	SMC TRAFOF Tripod (FB)	
135				SMC_TRAFO_Tripod (FB)	
136			Tripod_Arm	SMC_TRAFOF_Tripod_Arm (FB)	
137				SMC TRAFO Tripod Arm (FB)	
138			Tripod_Lin	SMC_TrafoF_Tripod_Lin (FB)	
139				SMC Trafo Tripod Lin (FB)	
140			Robot Kinematiks	SMC TrafoF 4AxisPalletizer (FB)	
141				SMC_TrafoF_ArticulatedRobot_6DOF (FB)	
142				SMC_Trafo_4AxisPalletizer (FB)	
143				SMC Trafo ArticulatedRobot 6DOF (FB)	
144			Scara System	SMC_TRAFOF_Polar (FB)	
145				SMC_TRAFOF_Scara2 (FB)	
146				SMC TRAFOF Scara3 (FB)	
147				SMC_TRAFO_Polar (FB)	
148				SMC_TRAFO_Scara2 (FB)	
149				SMC TRAFO Scara3 (FB)	

SM3 Robotics	4.2.1.0
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1	SM3	Robotics	
2	<u> </u>	Administrative	MC AddAxisToGroup (FB)
3	Ĺ		MC GroupContinue (FB)
1			MC_GroupDischlo_(FP)
5			MC CroupEnable (FB)
6			
7			MC_GroupInterrupt (FB)
/			MC_GroupReadActualAcceleration (FB)
8			MC GroupReadActualPosition (FB)
9			MC_GroupReadActualVelocity (FB)
10			MC GroupReadConfiguration (FB)
11			MC_GroupReadError (FB)
12			MC_GroupReadStatus (FB)
13			MC_GroupReset (FB)
14			MC GroupSetOverride (FB)
15			MC_GroupSetPosition (FB)
16			MC_ReadCoordinateTransform (FB)
17			MC ReadKinTransform (FB)
18			MC_RemoveAxisFromGroup (FB)
19			MC SetCoordinateTransform (FB)
20			 MC SetDvnCoordTransform (FB)
21			MC SetKinTransform (FB)
22			MC TrackConveyorBelt (FB)
23			MC TrackBotaryTable (FB)
24			MC UngroupAllAxes (FB)
25			SMC GroupConvertPosition (FB)
25			SMC_GroupCotContinueDocition (FB)
20			SMC GroupBercontinuerOsition (FB)
27			SMC GloupPower (FB)
20			SMC_GroupReadSetAcceleration (FB)
29			SMC GroupReadSetPosition (FB)
30			SMC_GroupReadSetVelocity (FB)
31			SMC_GroupSetAncillaryAxisLimits (FB)
32			SMC GroupSetAncillaryPathLimits (FB)
33			SMC GroupTargetPosition (FB)
34			SMC_GroupUpdate (FB)
35			SMC_SetDynCoordTransformEx (FB)
36			SMC SetDynamicLimitFactors (FB)
37			SMC_SetKinConfiguration (FB)
38			SMC SetMovementQueueBuffer (FB)
39			SMC TuneCPKernel (FB)
40	1	Axis_Group	
41		Helpers	SMC_ISClosePos (FUN)
42		Movements	SMC GetEffectiveAxisDynLimits (FUN)
43		Schedule	SMC_Schedule_Planning (FB)
44			AXIS_GROUP_REF_SM3 (FB)
45	(	Coordinated	MC GroupHalt (FB)
46			MC GroupStop (FB)
47			MC MoveCircularAbsolute (FB)
48			MC MoveCircularRelative (FB)
49			MC MoveDirectAbsolute (FB)
50			MC MoveDirectRelative (FB)
51			MC MoveLinearAbsolute (FB)
52			MC MoveLinearRelative (FB)
53			SMC Group.Log (FB)
55			SHO STORPOOD (TD)