## 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 ant repair and examination which results in information showing the fault was caused by ant 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

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- 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.

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• 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.

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• Use power supply unit of EH-PS series for supplying electric power.

# ▲ CAUTION

• Do not connect DC power supply module EH-PSD to a master power circuit. Supply a power to EH-PSD through an appropriate isolation transformer less than up to 150VA by all means.

#### 4. Preventive maintenance

# DANGER

Do not connect the ⊕, ⊖ of the battery in reverse. Also, do not charge, disassemble, heat, place in fire, or short circuit the battery.

There is a risk of explosion or fire.

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• 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	2017.9	NJI-650(X)

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----------	---------------

MEMO

# Chapter 1 Introduction of SoftMotion

## 1.1 Features

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

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 7)

↓

Change program

↓

Debug (Chapter 8 to 9)

↓

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  $\mathcal{O}$  CAN application protocol over EtherCAT (CoE), and supported profile is IEC61800-7 (CiA402). EtherCAT architecture is shown as below block diagram.



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 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 EtherCAT master.



#### 1.3.4 EtherCAT State Machine

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



State transitions

Available	communication
-----------	---------------

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	1	$\checkmark$
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.		

#### Chapter 1 Introduction of SoftMotion

## MEMO

# 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 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). Tune 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 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 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 below figure, SubTask with priority 5 is added and POU1 is assigned.

⊢∭ Device (HX-CP 1508M) ⊨-∰ Pic Logic	Configuration
<ul> <li>▲ Application</li> <li>▲ ゴラリマネージャ</li> <li>▲ PLC_PRG (PRG)</li> <li>▲ POU1 (PRG)</li> <li>■ POU1 (PRG)</li> <li>■ Task Configuration</li> <li>▲ MainTask</li> <li>▲ EtherCAT_Master_SoftMotion.EtherCAT_Task</li> </ul>	Priority ( 031 ): 0 Type Cyclic  Interval (e.g. t#200ms): t#4ms SubTask X Configuration
□ 型 PLC_PRG ■ 参 SubTask □ 型 POU1	Priority ( 031 ): 5 Type 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.

Task Configuration X								
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)	
🕑 MainTask	Valid	859	1021	2089	1692	2110	14	
🕑 SubTask	Valid	172	204	9802	8317	10284	9	

#### 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%.

Sync Unit Assignment EtherCAT NIC Setting EtherCAT I/O Mapping Destination Address (MAC) FF-FF-FF-FF I I Broadcast □ Enable Redur Source Address (MAC) 00-01-02-03-04-11 Browse Network Name eth2 Information Select network by MAC OSelect network by Name Distributed Clock Options Cycletime 2000 ♀ µs Sync Offset 20 ♀ % □ Enable messages per task Sync Window Monitoring ♀ Auto restart slaves	General	V Autoconfig Master/Slaves Ether CAT.			
EtherCAT I/O Mapping Destination Address (MAC) FF-FF-FF-FF  Source Address (MAC) 00-01-02-03-04-11 Browse Browse Browse Browse Browse Browse Cycletime 2000 ♀ µs Sync Offset 20 ♀ % Sync Offset 20 ♀ % Sync Window Monitoring Auto restart slaves	Sync Unit Assignment	EtherCAT NIC Setting			
Status Source Address (MAC) 00-01-02-03-04-11 Browse Network Name eth2  Select network by MAC Select network by NAME Distributed Clock Options Cycletime 2000 + µs Sync Offset 20 + % Sync Offset 20 + % Sync Window Monitoring Auto restart slaves	EtherCAT I/O Mapping	Destination Address (MAC) FF-FF-FF-FF-FF	dcast 📃 Enable Redundanc		
Information	Status	Source Address (MAC) 00-01-02-03-04-11 Brows Network Name eth2	e		
Distributed Clock     Options     Cycletime     2000     ↓µs     Sync Offset     20	Information	Select network by MAC Select network by Name			
Cycletime 2000 ↓ µs □ Use LRW instead of LWR/LRD Sync Offset 20 ↓ % □ Enable messages per task Sync Window Monitoring ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓		▲ Distributed Clock			
		Cycletime       2000       ↓µs       □ Use LRW instead         Sync Offset       20       ↓       %       □ Enable messages         Sync Window Monitoring       ✓ Auto restart slave	of LWR/LRD pertask s		

#### 2.1.4 I/O Mapping

There are 2 different mappings available to access external I/O or 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 POS 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			
ModbusTCPSlave I/O Mapping	🗤 🦆 test2	*	Bit2	%IX0.2	BOOL			
noobus ter blave t/o happing	👋 test3	*	Bit3	%IX0.3	BOOL			



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

#### Modbus\_TCP\_Slave X PLC\_PRG Channels General Variable Mapping Channel Address Туре Modbus Slave Channel 🖃 -- 🍓 Channel 0 ARRA... %IW0 🖮 👋 Channel ... WORD %IW0 Modbus Slave Init َو Bit0 BOOL Application.PLC\_PRG.test0 %TX0.0 ModbusTCPSlave Parameters Application.PLC\_PRG.test1 ٩ Bit1 BOOL %IX0.1 Application.PLC\_PRG.test2 Bit2 BOOL ି %IX0.2 ModbusTCPSlave I/O Mapping Application.PLC\_PRG.test3 ั) Bit3 %IX0.3 BOOL



## 2.2 Restrictions of Function

Do not use below functions 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 Ethernet Adapter version 3.5.10.0 or newer. Ethernet Adapter is required when using Modbus-TCP master or slave.

Name	Vendor	Version					
Miscellaneous							
🖃 📶 Fieldbusses							
CANbus							
⊞… <mark>®</mark> w∰ EtherCAT							
🖃 🕮 Ethernet Adapter							
Ethernet	3S - Smart Software Solutions GmbH	3.5.10.0					

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

Ethernet 🗙	
General	General:
· · · · · · · · · · · · · · · · · · ·	Name: Ethernet
Status	Vendor: 3S - Smart Software Solutions GmbH
	Groups: Ethernet Adapter, Ethernet Adapter, Ethernet Adapter
Ethernet Device I/O Mapping	Type: 110
	<b>ID:</b> 0000 0002
Information	Version: 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 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 for 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		
	pidoad -	

#### 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

👔 Library Manager 🗙						
飸 Add library 🗙 Delete library 🛛 😁 Properties 🗃 Details 🛛 🛒 Placeholders 🛛 🎁 Library repository						
Name	Namespace	Effective version				
CmpHIESErrors_HX = CmpHIESErrors_HX, 3.5.8.21 (HIES)	CmpHIESErrors_HX	3.5.8.21				
CmpHIESLib_HX = CmpHIESLib_HX, 3.5.8.22 (HIES)	CmpHIESLib_HX	3.5.8.22				
EmpSchedule, 3.5.8.0 (System)	CmpSchedule	3.5.8.0				
IoStandard = IoStandard, 3.5.8.0 (System)	IoStandard	3.5.8.0				

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

	SchedGetProcesso	rLoad	
_	pResult POINTER TO RTS_IEC_RESULT	UDINT SchedGetProcessorLoad	

## Sample program

#### FBD/LD

	POU	
× 1	1	PROGRAM POU LD
-	2	VAR
	3	test: BOOL;
	4	result: INT;
	5	plcload: UDINT;
	6	END_VAR
	7	
	1	test SchedGetProcessorLoad EN ENO pResult - plcload
ST	ם ו	
Z []	1	
_	-	PROBAN POD_SI
	2	VAR
	3	result: INT;
	4	picload: UDINT;
	5	END_VAR
	6	
	1	
	2	<pre>plcload:=SchedGetProcessorload(ADR(result));</pre>
	з	

## 2.5 Other Tips

#### 2.5.1 Data Type of Axis

Data type of axis used in motion FBs is AXIS\_REF\_SM3 having more than hundreds of members.



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.

MC_MoveRelative_0	MC_MoveRelative				
🖃 🍫 Axis	REFERENCE TO AXI			Reference to axis	
🐐 wAxisStructID	WORD	65042			
🍬 nAxisState	SMC_AXIS_STATE	standstill		State of the axis according to the ``PLC	open
🏘 bRegulatorOn	BOOL	TRUE		Parameter number: 1010	
🍬 bDriveStart	BOOL	TRUE		Parameter number: 1011	
M bCommunication	BOOL	TRUE		``TRUE``: Communication OK	تې
N wCommunicationState	WORD	100		Parameter number: 1013	
🐌 uiDriveInterfaceError	UINT	0		Drive interface error number	تې
			_		
* fSetPosition	LREAL	110.0000152587		Parameter number: 1100, 1	
🍬 fActPosition	LREAL	110.0000152587		Parameter number: 1101	
No. SCAPIAN		0		Parameter numbers 1140	
W ISELERK	LKEAL	U		Parameter number: 1140	
🍫 fActJerk	LREAL	0		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 soft reset Ethernet port.

HX-CPU (HX-CP1S08M) does not support this function block. If executed, xError output will be activated as follows.



EthSoftReset is to soft reset on designated Ethernet port. If Ethernet port does not work due to some reasons, it could restore by executing this function block. If this happens in motion type CPU, 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> 4 ×
🗉 👌 Untitled 41	
🖃 💮 Device (HX-CP 1S08M)	
PLC Logic	🐰 Cut
🖃 🧔 Application	🖹 Сору
📶 Library Man	Paste
PLC_PRG (P	Delete
🖃 🎆 Task Config	Properties
🖻 👹 MainTa	Add Object
E PLC	Add Folder
Basic (Basic)	Add Device
⊶C <empty> (<em< 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 EtherCAT master.

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-FF	Enable Redundancy	* [Enable Redundancy] is
Status	Source Address (MAC) 00-00-00-00-00 Browse Network Name		not supported.
Information	Select network by MAC     Select network by Name		
	Distributed Clock     Doptions		
	Cycletime 4000 , µs Sync Offset 20 , % Sync Window Monitoring Sync window 1 , µs		
Select Network Adapter			
MAC address Name Desc	ription		
00000000000 lo 000102030413 eth1 000102030411 eth2 } Ch	noose Ethernet port to be used.	* Be sur Ether	re to use [eth1] or [eth2] for CAT master.
	OK Ab	ort	

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

EtherCAT_Master_Soft	lotion 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 I 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       ↓s       Enable messages pertask         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 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 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. 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 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 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].



### NOTE

If [Scan For Devices] is executed for two or more drives, they will be configured like a tree as below figure. In this case, SoftMotion axis (SoftMotion CiA402 Axis: refer to chapter 3.2) 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 EtherCAT Master Softmotion is added, an object to execute 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 below figure) to open configuration window.



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

🔮 MainTask 🗙	-
Configuration	
Priority ( 031 ): 0	
Type	
Cyclic   Interval (e.g. t#200ms):  4000	µs ▼

#### 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.

EtherCAT_Master_SoftMotion	x x	
General	AutoconfigMaster/Slaves	Ether CAT.
Sync Unit Assignment	EtherCAT NIC Setting	
EtherCAT I/O Mapping	Destination Address (MAC) FF-FF-FF-FF-FF V Broadcast	Enable Redundancy
Status	Source Address (MAC) 00-00-00-00-00 Browse Network Name	
Information	Select network by MAC	
	Distributed Clock     Options     Cycletime 4000	

#### 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 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	A.	🔽 Enable E	xpert Settings	EtherCAT.
Expert Process Data	EtherCAT Address	1001	A V	V Optional	ר	
Process Data	Distributed Clock				_	
Startup Parameters	Select DC	DC for syn	nchronizatio	n	•	
EtherCAT Parameters	V 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	to local µ	c		
	Vatchdog					
	Station alias					
	🗸 Enable 1001		*			

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.

General	Address		- Additional		
Expert Process Data	AutoInc Address	0 ×	Enable E	xpert Settings	Ether <b>CAT</b>
Process Data	▲ Distributed Clock —	¥.			
Startup Parameters	Select DC	DC for synchronization	ı	-	
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 User Defined Startup checking Check Vendor ID Check Product ID Check Revision Number Download Expected SI DC cyclic unit control Watchdog	x 1 v er ot Configuration : assign to local µ0	4000 x 0 x - ▷ Timeouts	Cycle Time (µs)	)
	Unhandled exception Continue, the applic.	n has occurred in your ation will ignore this e	application. If you cli rror and attempt to	ck	
	Continue. If you click Object reference no	Quit, the application t set to an instance of	will close immediately an object.	<i>i.</i>	
		<u>C</u> ontinue	e Quit		

#### 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
Process Data	16#1600 1st receive PDO Mapping (				16#1A00 1st transmit PDO Map		
Startup 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
therCAT I/O Manaping	Physical output	UDINT	16#60FE:01		Position actual value	DINT	16#6064:00
chercar 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
nformation	Controlword	UINT	16#6040:00	-	Touch probe positive 1 positive value	DINT	16#60BA:00
	Targetposition	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.

lect the Outputs				Select the Inputs		
Name	Туре	Index		Name	Туре	Index
16#1600 1st receive PDO Mapping (				16#1A00 1st transmit PDO Map		
☑ 16#1701 258th receive PDO Mappin				☑ 16#1B01 258th transmit PDO M		
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	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		
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		

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

#### Select the Outputs

Serect 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	
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	
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	

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.

Select the Outputs				Select the Inputs		
Name	Туре	Index	*	Name	Туре	Index
16#1600 1st receive PDO Mapping (				🗌 16#1A00 1st transmit PDO Map		
16#1701 258th receive PDO Mappin				☑ 16#1B01 258th transmit PDO M		
Controlword	UINT	16#6040:00		Error code	UINT	16#603F:0
Targetposition	DINT	16#607A:00		Statusword	UINT	16#6041:0
Physical output	UDINT	16#60FE:01		Position actual value	DINT	16#6064:0
Touch probe function	UINT	16#60B8:00		Torque actual value	INT	16#6077:0
Modes of operation	SINT	16#6060:00		Digital inputs	UDINT	16#60FD:0
✓ 16#1702 259th receive PDO Mappin				Touch probe status	UINT	16#60B9:0
Controlword	UINT	16#6040:00	-	Touch probe positive 1 positive value	e DINT	16#60BA:0
Targetposition	DINT	16#607A:00	=	Modes of operation display	SINT	16#6061:00
Profilevelocity	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#6041:0
16#1703 260th receive PDO Mappin				Position actual value	DINT	16#6064:0
Controlword	UINT	16#6040:00		Torque actual value	INT	16#6077:0
Targetposition	DINT	16#607A:00		Velocity actual value	DINT	16#606C:0
Target velocity	DINT	16#60FF:00		Digital inputs	UDINT	16#60FD:0
Target torque	INT	16#6071:00		Modes of operation display	SINT	16#6061:0
Physical output	UDINT	16#60FE:01		16#1B03 260th transmit PDO M		
Touch probe function	UINT	16#60B8:00		Error code	UINT	16#603F:0
Modes of operation	SINT	16#6060:00		Statusword	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 🗹 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].

Index:Subindex	Name	Flags	Туре	ſ
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
16#311A:16#00	Brake operation start speed(FA-26)	RW	UINT	
16#311B:16#00	RW	UINT	C	
16#311C:16#00	RW	UINT	1	
16#3133:16#00	RW	UINT	1	
16#3148:16#00	RW	UINT	C	
16#314B:16#00	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
Name B	ake operation start speed(FA-26)			
Index: 16# 3	1A Bitlength: 16	÷	ОК	
SubIndex: 16# 0	Value: 30	i i	Canco	

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 🕆 Move Up 🗣 Move 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  $\mathcal{O}$  be read and written in this window.

ADVA_EC X								
General	Address		Additional					
Event Brasses Data	AutoInc Address	0	🕼 Enable Expert Settings	Ether CAT.				
Expert Process Data	EtherCAT Address	1001	Optional					
Process Data	▲ Distributed Clock							

ADVA_EC X							
General	Read Objects 📄 Auto Update 💿 Offline from ESI File 💿 Online from Device						
Expert Process Data	Index:Subindex	Name	Flags	Туре	Value		
· · · · · · · · · · · · · · · · · · ·	16#1000:16#00	Device Type	RO	UDINT	131474		
Process Data	16#1001:16#00	Error register	RO	USINT	0		
Startup Parameters	16#1008:16#00	Manufacturer device name	RO	STRING(4)	'ADVA'		
· · · · · · · · · · · · · · · · · · ·	16#1009:16#00	Manufacturer hardware version	RO	STRING(4)	'0000'		
Online	16#100A:16#00	16#100A:16#00 Manufacturer software version					
CoE Online	■ 16#1010:16#00	Store parameters	RO	USINT	1		
	⊞ 16#1011:16#00	Restore default parameters		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 X								
General	Channels							
-	Variable	Mapping	Channel	Address	Туре	Defau	Unit	Description
Process Data			Controlword	%QW0	UINT			Controlword
Startup Parameters	±		Target position	%QD1	DINT			Target position
· · · · · · · · · · · · · · · · · · ·			Profile velocity	%QD2	UDINT			Profile velocity
EtherCAT Parameters	±		Physical output	%QD3	UDINT			Physical output
EtherCAT I/O Manning			Modes of operation	%QB16	SINT			Modes of operation
Land CAT 1/0 Happing	- ···· *		Error code	%IW0	UINT			Error code
Status			Statusword	%IW1	UINT			Statusword
			Position actual value	%ID1	DINT			Position actual value
Information			Torque actual value	%IW4	INT			Torque actual value
			Digital inputs	%ID3	UDINT			Digital inputs
			Touch probe status	%IW8	UINT			Touch probe status
			Touch probe positive 1 positive value	%ID5	DINT			Touch probe positive
	- 🖄 🖷 🦄		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 EtherCAT slaves starts about a few second after I/O refresh of standard I/O started because of configuration between 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 below codes are sample program in ST language.
- Since EtherCAT communication is handled by EtherCAT\_Master task, I/O refresh cycle of 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.

```
IF EtherCAT_Master_SoftMotion.xConfigFinished=FALSE THEN
    RETURN;
END_IF
```

Programs here (below 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 a port is used for EtherCAT master, do not use this port for other Ethernet based communication such as gateway feature (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
Untitled37		
🖃 👔 Device (HX-CP1S08M)		
PLC Logic		
Application		
👘 📶 Library Manager		
PLC_PRG (PRG)		
🖃 🎉 Task Configuration		
🖃 😻 MainTask		
EtherCAT_Ma	ster_S	SoftMotion.EtherCAT_Task
PLC_PRG		
Basic (Basic)		
EtherCAT_Master_SoftMotion	(Ether	CAT Master SoftMotion)
ADVA_EC (HITACHI AC SE	PVO F	DIVES ADV Series)
EtherCAT OUT	ð.	cut
🍐 SoftMotion General Axis Pool	•	Сору
	Ē	Paste
	X	Delete
		Refactoring •
	æ	Properties
		Add Object
	6	Add Folder
		Insert Device
		Disable Device
		Update Device
		Add SoftMotion CiA402 Axis
		Add SoftMotionLight CiA402 Axis
	ĥ	Edit Object
Г		
۲ ۲	7	,
		DRIVES ADV Series)
		orareo nor ocreaj
SM_Drive_GenericD	SP40	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 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)
EtherCAT OUT
Drive

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



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

Refactor						
Rename 'Device.EtherCAT Master SoftMotion.ADVA	EC.SM Drive GenericDSP402' to 'Drive'.				Apply all changes.	Details
= 🗂 Device	名前	型	値	変数	アドレス 訪	明
⊮ 🗐 PlcLogic	AXIS_REF: Standard					
Basic	AXIS_REF: Scalings					
EtherCAT_Master_SoftMotion	😟 🖾 logical device settings					
E-M ADVA_EC	🗈 🗀 standard driver settings					1
- L EtherCAT OUT	AXIS_REF: DSP402 configuration	on				
	🕫 🖾 possible cyclic driver in-/output	ts				
SoftMotion General Axis Pool	Address_8010	STRING	'%QW0'			
Project Settings	Type_8010	STRING	'UINT'			
	AddressPointer_8010	POINTER TO BYTE	ADR(%QW0)			
	Address_8020	STRING	'%QD1'			
	Type_8020	STRING	'DINT'			
	AddressPointer_8020	POINTER TO BYTE	ADR(%QD1)			
	Address_8030	STRING	-			
	Type_8030	STRING	-			
	AddressPointer_8030	POINTER TO BYTE	0			
	Address_8040	STRING	-			
	Type_8040	STRING	-			
	AddressPointer_8040	POINTER TO BYTE	0			
	Address_8050	STRING	'%QB14'			
	Type_8050	STRING	'SINT'			
	AddressPointer_8050	POINTER TO BYTE	ADR(%QB14)			
	Address_8060	STRING	'%QW6'			
	VDP 8060	STRING	'LITNIT'			
					<u>O</u> K	<u>C</u> ancel

#### 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, following dialog 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	are limite			Velocity ramp type
Scaling/Mapping	Virtual mode A	ctivated Negativ	re [u]:	0.0	<ul> <li>Trapezoid</li> <li>Sin<sup>2</sup></li> </ul>
Commissioning	Finite	Positive	e [u]:	1000.0	Quadratic
SM_Drive_ETC_GenericDSP402: Parameters	Softwa	re error reaction ecelerate Deceler	ation [u/s²]:	0	Quadratic (smooth)
SM_Drive_ETC_GenericDSP402: I/O Mapping		Max. di	stance [u]:	0	ID: 0
Status	Limits for CNC (SMC_ControlAx	ásBy*)	Positio	n lag supervision	
Information	Velocity [u/s]: Acceleratio	In [u/s <sup>2</sup> ] Deceleration	[u/s²] [deact	vated •	
:₩ Drive X	123 123	les	Lag lin	nit [u]: 1.0	
:⊌ Drive X	Axis type and limits	165	Lag lin	nt [u]: 1.0	Velocity ramp type
General	Axis type and limits	o settings	Lag lin	nt [u]: 1.0	Velocity ramp type Trapezoid Sin2
: Drive X General Scaling/Mapping	Axis type and limits Virtual mode Modulo	o settings Julo value [u]: 360	.0	nt [u]: 1.0	Velocity ramp type Trapezoid Sin <sup>2</sup> Quadratic
General Scaling/Mapping Commissioning SM_Drive_ETC_GenericDSP402:	Axis type and limits Virtual mode Modulo Finite	o settings Julo value [u]: 360 are error reaction	.0	Int [u]: 1.0	Velocity ramp type <ul> <li>Trapezoid</li> <li>Sin<sup>2</sup></li> <li>Quadratic</li> <li>Quadratic (smooth)</li> </ul>
Event of the second seco	Axis type and limits Virtual mode Modulo Finite Softw V C	o settings dulo value [u]: 360 are error reaction Decelerate Decele Max. d	.0 ration [u/s <sup>2</sup> ]:	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	Axis type and limits Virtual mode Modulo Finite	o settings Julo value [u]: 360 are error reaction Decelerate Decele Max. d	.0 ration [u/s <sup>2</sup> ]: istance [u]:	0 0	Velocity ramp type Trapezoid Sin <sup>2</sup> Quadratic Quadratic (smooth) Identification ID: 0
: Drive X General Scaling/Mapping Commissioning SM_Drive_ETC_GenericDSP402: Parameters SM_Drive_ETC_GenericDSP402: I/O Mapping Status	Axis type and limits Axis type and limits Virtual mode Modulo Finite Softw III	o settings dulo value [u]: 360 are error reaction Decelerate Decele Max. d xisBy*)	.0 ration [u/s <sup>2</sup> ]: istance [u]: [u/s <sup>2</sup> ]	0 0 0 on lag supervision	Velocity ramp type Trapezoid Sin <sup>2</sup> Quadratic Quadratic (smooth) Identification ID: 0

No.	Name	説明	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.





A velocity profile as defined by the sin<sup>2</sup> 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]

记 Drive 🗙						
General	Scaling Invert direction					
Scaling/Mapping	16#10000	increments <=>	motor turns		1	
Commissioning	1	motor turns <=> ge	ar output turn	IS	1	
commonly	1 gea	r output turns <=> i	units in applic	ation	1	
SM_Drive_ETC_GenericDSP402: Parameters	Mapping					
SM_Drive_ETC_GenericDSP402: I/O Mapping	Automatic mapping					
Status	Inputs:					
	Cyclic object	Object number	Address	Туре		<b>_</b>
Information	status word (in.wStatusWord)	16#6041:16#00	'%IW1'	'UINT'		
	actual position (diActDosition)	16#6064+16#00	'94TD 1'	'DINT'		

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 < = > unis 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, unis in application:1
		e.g. gear 1 turn = $0.1$ mm movement with ball screw
		gear output turns :10, unis in application:1
5	Automatic mapping	IEC parameters that affect the drive are automatically mapped
		to the corresponding inputs and outputs of the device.

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				
Scaling/Mapping	Virtual mode	Software limits	Negative [u]:	0.0	
Commissioning	Finite		Positive [u]:	1000.0	
General	Scaling				
General Scaling/Mapping	Scaling Invert direction	increi	ments <=> motor turn	s	1
General Scaling/Mapping Commissioning	Scaling Invert direction 16#20000 5	increi motor tu	ments <=> motor turn rns <=> 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

Example 1

Servo motor 17-bit encoder 131,072 pulses/turn		0	Gear reduct (motor 10 tr	ion ratio: 1/10 urns = gear 1 turn)
He Drive X				
General Scaling/Mapping	Axis type and limits	Modulo settings Modulo value [u]: 360.0		
Commissioning	Finite			
······································				
General	Scaling Invert direction			
Scaling/Mapping	16#20000	increments <=> motor turns		1
Commissioning	10	motor turns <=> gear output turn gear output turns <=> units in appli	ns cation	1
SM_Drive_ETC_GenericDSP402:		2		

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_SoftMotio	on (E	therCAT Master SoftMotion)
🖹 🔟 ADVA_EC (HITACHI AC	SER\	O DRIVES ADV Series)
EtherCAT OUT		
SM_Drive_Generic	:DSP4	402 (SM_Drive_GenericDSP402)
🚡 SoftMotion General Axis Poo	bl	
	Ж	Cut
	e.	Сору
	e.	Paste
	$\times$	Delete
	Ē.	Properties
		Add Object
	6	Add Folder
		Add Device
		Insert Device

Add Device			
Name: SM_Drive_Virtual			
Action: <u>A</u> ppend device <u>I</u> nsert device	O Plug device O Update device		
Device:			
Vendor: <a>All vendors&gt;</a>			•
Name	Vendor	Version	
Soften Galaxies     S	5		
	35 - Smart Software Solutions CmbH	4000	
SM_Drive_Virtual	55 - Smart Sortware Solddons Gmbri	4.0.0.0	

adv (SM\_Drive\_GenericDSP402)

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.

### MEMO

## Chapter 4 Manual Operation

In this chapter, it is described about how to configure and program with HX-CPU and servo drive ADV series. The parameter settings are shown as follows. (Resolution of 17-bit encoder is 131072 (16#20000))

₩ Drive X		
General	Axis type and limits	
Scaling/Mapping	Virtual mode     Modulo settings     Modulo value [u]: 360.0	
Commissioning	Finite	
₩ Drive X		
General	Scaling Invert direction	
Scaling/Mapping	16#20000 increments <=> motor turns	1
Commissioning	1 motor turns <=> gear output turns	1
SM Drive FTC GenericDSP402	1 gear output turns <=> units in applica	tion 360

## 4.1 Servo-On

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





(2) Specify the function block by either of 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 [Category] tab.

		<b>×</b>
Name	Туре	Orig ^
BM3_Basic     Data Types     Data Types     DriveInterface     POUs     Commissioning     DriveBasic     Pile     Managers     PLCopen     Additional     Master/Slave Function Blocks     Single Axis Function Blocks	Lībrary	SM3_Basic, 4
	Name  SM3_Basic  SM3_Basic  DataTypes  DiveInterface  POUs  Commissioning  DiveBasic  File  Managers  PLCopen  Additional  Master/Slave Function Blodss  Single Axis Function Blodss  File  Part I	Name       Type         SM3_Basic       Library         DataTypes       DriveInterface         DriveInterface       Ormissioning         DriveBasic       DriveBasic         DriveBasic       File         Managers       PLCopen         Additional       Master/Slave Function Blods         Single Axis Function Blods       Single Axis Function Blods

(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.

MC_	Power_0	
M	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		<b>—</b>
Franci	Namer	Type
	MC Power 0	MC Power
<u>O</u> bject:	Initialization:	<u>A</u> ddress:
PLC_PRG [Application]		
<u>F</u> lags:	Co <u>m</u> ment:	
		*
PERSISTENT		-
		OK Cancel

(4) Set inputs and outputs



## 4.2 Jogging

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

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.



### 4.3 Inching

While IFWD input is TRUE, the motor rotates in forward direction with distance 10, 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 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<sup>2</sup>). As soon as arrived, the axis goes back to position 0 [u] with velocity 1000 (u/s) and acceleration 3000 (u/s<sup>2</sup>).



#### **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

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.tastest		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)
MC_Direction.negative	-1	Moves in negative direction

#### Following function blocks are available for position control. Refer to chapter 7 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 and jerk without specifying target position. The function block for velocity control is MC\_MoveVelocity.

#### Change velocity

Velocity, acceleration and direction can be changed while movement. In order to apply new parameters, rising edge must be input to [Execute] input. Alternatively atnoher 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 (360u) and deceleration (1000 u/s). 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' statues.



## 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-CP1S0	8M)		
🖻 🗐 PLC Logic			
🗏 🔘 Applicat	ion		
- 📶 Lit 🐰	Cut		
	о Сору		
в- 🐼 та 🛱	Paste		
ė- 🔮 🗙	Delete		
	Refactoring	:	
	Properties		
	Add Object		Alarm configuration
	Add Folder	0	Application
	Édit Object	8	Axis Group
	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 below cam is defined, master and slave axis rotate as follows.

#### 6.1.2 Sample Program

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



#### Following function blocks are available for synchronous control. Refer to chapter 7 for further information.

Function Block	Name
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 Function Blocks for Motion Control

## 7.1 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=FALSE and there is no error in the axis

\*3 MC\_Reset AND MC\_Power.Status=FALSE

\*4 MC\_ResetAND MC\_Power.Status=TRUE AND MC\_Power.Enable=TRUE AND MC\_Power.bRegulator =TRUE

\*5 MC\_Power.Enable=TRUE AND MC\_Power.bRegulator =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]

# 7.2 Function Block Interface

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 set to 0 or open, 'Error' output of the
Deceleration and	function block is TRUE.
Jerk inputs	If velocity ramp type is 'Trapezoid' or 'Sin <sup>2</sup> ', 'Jerk' input can be 0. However, if velocity ramp
Ĩ	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':
1 5	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':
- ···I	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 'CommandAborted', for the
	previous action.
	With 'Enable':
	The 'Valid', 'Enabled', 'Busy', 'Error' and 'ErrorID' outputs are reset with the falling edge of
	'Enable' as soon as possible.
Behaviour of	The 'Done' output is set when the commanded action has been completed successfully.
Done output	With multiple Function Blocks working on the same axis in a sequence, the following applies:
	when one movement on an axis is interrupted with another movement on the same axis without
	having reached the final goal, 'Done' of the first FB will not be set.
Behaviour of	With 'Execute':
Busy 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.

General rules of function block interface are described as follows.

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 low as long as the FB has control of the axis ('Active'			
	and 'Busy' are SET).			
	The behavior of 'Inxxx' directly after 'Execute' is SET again while the condition of 'Inxxx' is			
	already met, is implementation specific.			
	'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 and Valid	The 'Enable' input is coupled to a 'Valid' output. 'Enable' is level sensitive, and 'Valid' shows			
	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 related			
Distance	to technical units. 'Distance' is the difference between two positions.			
Sign rules	The 'Acceleration', 'Deceleration' and 'Jerk' are always positive values. 'Velocity', 'Position'			
	and 'Distance' can be both positive and negative.			

Γ

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



## 7.3 PLCopen Part 1 for Single-Axis

#### 7.3.1 MC\_Power

Name		MC_Power		Type: FB
This FB	controls the power	stage (On or Off)		
		Axis AXIS_REF_SM3 —Enable BOOL —bRegulatorOn BOOL —bDriveStart BOOL	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.	
	bRegulatorOn	BOOL	TRUE: Enables the power stage. FALSE: Disables the	e power stage.
	bDriveStart	BOOL	TRUE: Disables the quickstop mechanism. FALSE: Enables the quickstop mechanism.	
OUT	Status	BOOL	TRUE: Axis is ready to move.	
	bRegulatorRealSta	ate BOOL	TRUE: The power stage has been switched on.	
	bDriveStartRealSt	ate BOOL	TRUE: Drive is not blocked by the quickstop mechanis	m.
	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 7-1, this is expected behavior.

#### 7.3.2 MC\_Home

	Name	MC_Home	Туре	: FB
This FB	This FB commands the axis to perform the search home sequence according to the drive. (controlled by the drive)			
		— Axis AXIS_REF_SM — Execute BOOL — Position LREAL	MC_Home 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.	
	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.	
	CommandAborte	d 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.

#### 7.3.3 MC\_Stop

Name	MC_Stop	Type: FB	
This FB commands a controlled motion stop and transfers the axis to the state 'Stopping'. It aborts any ongoing Function Bloc			
execution. While the axis is in state 'Stopping', no other FB can perform any motion on the same axis.			



	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

#### 7.3.4 MC\_Halt

CommandAborted

Error

ErrorID

BOOL

BOOL

SMC\_ERROR

Name		MC_Halt	Type: FB			
This FE	This FB commands a controlled motion stop. It is possible to set another motion command during deceleration of the					
axis, wl	hich will abort th	e MC_Halt and will be ex	ecuted immediately.			
			MC_Halt			
		<ul> <li>Axis AXIS_REF_SM.</li> </ul>	3 BOOL Done			
			BOOL Busy			
		— 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.			
	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.			

TRUE: Command has been aborted by another command.

TRUE: Error has occurred within the FB.

Error identification

#### 7.3.5 MC MoveAbsolute Name MC\_MoveAbsolute Type: FB This FB commands a controlled motion to a specified absolute position. MC\_MoveAbsolute Axis AXIS\_REF\_SM3 BOOL Done Execute BOOL BOOL Busy Position LREAL BOOL CommandAborted Velocity LREAL BOOL Error SMC\_ERROR ErrorID Acceleration LREAL Deceleration LREAL Jerk LREAL Direction MC\_Direction 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) LREAL Velocity Maximum velocity [u/s] (positive) LREAL Acceleration $[u/s^2]$ (positive) Acceleration LREAL Deceleration $[u/s^2]$ (positive) Deceleration Jerk LREAL Jerk [u/s<sup>3</sup>] (positive) fastest (3), current (2), positive (1), shortest (0), negative (-1) Direction MC\_Direction (Refer to section 7.9 Enumeration) OUT BOOL TRUE: End position has been achieved. Done BOOL TRUE: The FB is in operation. Busy CommandAborted BOOL TRUE: Command has been aborted by another command. BOOL Error TRUE: Error has occurred within the FB. ErrorID SMC\_ERROR Error identification

#### 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.	

7.3.6 M	7.3.6 MC_MoveRelative					
Name	Name MC_MoveRelative Type: FB					
This FB	This FB commands a controlled motion to a specified distance relative to the set position.					
		Axis AXI5_RE Execute BOO Distance LRE Velocity LREA Acceleration Deceleration Jerk LREAL	F_SM3 L AL LREAL LREAL	<b>1C_MoveRelative</b> 3 BOOL Done BOOL Busy BOOL CommandAborted BOOL Error SMC_ERROR ErrorID		
Name Type				Description		
IN_OUT	Axis	AXIS_REF_S	M3	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.		
	CommandAborted	BOOL		TRUE: Command has been aborted by another command.		
	Error	BOOL		TRUE: Error has occurred within the FB.		
	ErrorID	SMC_ERROF	ર	Error identification		

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#### 7.3.7 MC MoveAdditive

Name		MC_MoveAdditive		Type: FB		
This FB	This FB commands a controlled motion of a specified relative distance additional to the most recent commanded position in the					
axis stat	e 'DiscreteMotion'	· · · · · · · · · · · · · · · · · · ·		I		
		1	MC_MoveAdditive			
		- Axis AXIS_REF_SM.	3 BOOL Done			
			BOOL Busy			
		-Velocity LREAL	BOOL Error			
		-Acceleration LREAL				
		Deceleration LREAL	<u>_</u>			
		Jerk LREAL				
	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.			
	CommandAborted	BOOL	TRUE: Command has been aborted by another comman	ıd.		
	Error	BOOL	TRUE: Error has occurred within the FB.			
	ErrorID	SMC_ERROR	Error identification			

#### 7.3.8 MC\_MoveSuperImposed

Name	MC_MoveSuperImposed	Type: FB		
This FB commands a controlled motion of a specified relative distance additional to an existing motion. The existing Motion is				
not interrupted, but is superimposed by the additional motion.				

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	MC_MoveSuper	rImposed	
	Axis AXI5_REF_SM3	BOOL Done	-
	Execute BOOL	BOOL Busy	-
	Distance LREAL	BOOL CommandAborted	-
	VelocityDiff LREAL	BOOL Error	-
	Acceleration LREAL	SMC ERROR ErrorID	-
	Deceleration LREAL	_	
_	Jerk LREAL		

	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 negative)
	VelocityDiff	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)
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

Name		MC_MoveVelocity		Type: FB
This FB	commands a never	ending controlled motion a	t a specified velocity.	
		Axis AXIS_REF_SM Execute BOOL Velocity LREAL Acceleration LREAL Deceleration LREAL Jerk LREAL Direction MC_Direc	MC_MoveVelocity I3 BOOL InVelocity BOOL Busy BOOL CommandAborted L BOOL Error L SMC_ERROR ErrorID Dection	
	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 $[u/s^2]$ (positive)	
	Deceleration	LREAL	Deceleration $[u/s^2]$ (positive)	
	Jerk	LREAL	Jerk [u/s <sup>3</sup> ] (positive)	
	Direction	MC_Direction	fastest (3), current (2), positive (1), shortest (0), negative (Refer to section 7.9 Enumeration)	ve (-1)
OUT	InVelocity	BOOL	TRUE: The set velocity has been reached for the first ti	me.
	Busy	BOOL	TRUE: The FB is in operation.	
	CommandAborte	d BOOL	TRUE: Command has been aborted by another comma	nd.
	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).
### 7.3.10 MC\_PositionProfile

Name	١	AC_PositionProfile		Type: FB
This FB	commands a time-p	osition locked motion prof	ile.	
		Axis AXIS_REF_SM3 TimePosition MC_TP_R Execute BOOL ArraySize INT PositionScale LREAL Offset LREAL	AC_PositionProfile BOOL Done 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.	
1	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 comman	ıd.
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

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### 7.3.11 MC\_VelocityProfile

Name MC_VelocityProfile			Type: FB		
This FB	commands a time-v	elocity locked motion prof	īle.		
MC_VelocityProfile         Axis AXIS_REF_SM3       BOOL Done         TimeVelocity MC_TV_REF       BOOL Busy         Execute BOOL       BOOL CommandAborted         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]		
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 comman	ıd.	
	Error	BOOL	TRUE: Error has occurred within the FB.		
	ErrorID	SMC_ERROR	Error identification		

### 7.3.12 MC\_AccelerationProfile

Name	MC_	AccelerationProfile		Type: FB			
This FB	commands a time-accel	eration locked motion	profile.				
	MC_AccelerationProfile						
	Axis AXIS_REF_SM3 BOOL Done						
	TimeA	cceleration MC_TA_R	E BOOL Busy -				
		ize INT					
	-Accele	rationScale LREAL	SMC_ERROR ErrorID				
	-Offset LREAL						
	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]				
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 comman	ıd.			
	Error	BOOL	TRUE: Error has occurred within the FB.				
	ErrorID	SMC_ERROR	Error identification				

### 7.3.13 MC\_ReadActualPosition

Name	N	IC_ReadActualPosition		Type: FB
This FB	returns the actual po	osition.		
		MC_ — Axis AXIS_REF_SM — Enable BOOL	ReadActualPosition <i>BOOL</i> Valid <i>BOOL</i> Busy <i>BOOL</i> Error <i>SMC_ERROR</i> ErrorID <i>LREAL</i> 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]	

### 7.3.14 MC\_ReadAxisError

Name	M	C_ReadAxisError		Type: FB	
This FB	presents general axis	errors not relating to the	function blocks.		
MC_ReadAxisError Axis AXIS_REF_SM3 BOOL Valid 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.		
	SWEndSwitchActiv	e BOOL	TRUE: Software limits are exceeded.		

### 7.3.15 MC\_ReadParameter

Name		MC_ReadParameter		Type: FB
This FB	returns the value of	f a vendor specific paramete	er with data type LREAL.	
MC_ReadParameter Axis AXIS_REF_SM3 BOOL Valid Enable BOOL BOOL Busy ParameterNumber DINT 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	r 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 'ParameterNu	mber'

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

### 7.3.16 MC\_ReadBoolParameter

7.3.16 MC_ReadBoolParameter						
Name	Ν	IC_ReadBoolParamete	r	Type: FB		
This FB	This FB returns the value of a vendor specific parameter with data type BOOL.					
MC_ReadBoolParameter Axis AXIS_REF_SM3 BOOL Valid Enable BOOL BOOL Busy ParameterNumber 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.			
IN	Enable ParameterNumber	BOOL DINT	TRUE: Enables the execution of the FB.Number of the parameter (see the table in 7.3.15)			
IN OUT	Enable ParameterNumber Valid	BOOL DINT BOOL	TRUE: Enables the execution of the FB.Number of the parameter (see the table in 7.3.15)TRUE: A valid output is available.			
IN OUT	Enable ParameterNumber Valid Busy	BOOL DINT BOOL BOOL	TRUE: Enables the execution of the FB.Number of the parameter (see the table in 7.3.15)TRUE: A valid output is available.TRUE: The FB is in operation.			
IN OUT	Enable ParameterNumber Valid Busy Error	BOOL DINT BOOL BOOL BOOL	TRUE: Enables the execution of the FB.Number of the parameter (see the table in 7.3.15)TRUE: A valid output is available.TRUE: The FB is in operation.TRUE: Error has occurred within the FB.			
OUT	Enable ParameterNumber Valid Busy Error ErrorID	BOOL DINT BOOL BOOL BOOL SMC_ERROR	TRUE: Enables the execution of the FB.Number of the parameter (see the table in 7.3.15)TRUE: A valid output is available.TRUE: The FB is in operation.TRUE: Error has occurred within the FB.Error identification			

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### 7.3.17 MC\_WriteParameter

Name MC_WriteParameter						
This FB	modifies the value of	of a vendor specific parame	eter with data type LREAL.			
	MC_WriteParameter					
		Execute BOOL	BOOL Busy			
			DINT BOOL Error			
		Value LREAL	SMC_ERROR ErrorID			
		-				
	Name	Гуре	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 the table in 7.3.15)			
	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			

### 7.3.18 MC\_WriteBoolParameter

Name		MC_WriteBoolParameter	r	Type: FB		
This FB	modifies the value	of a vendor specific parame	eter with data type BOOL.			
		МС	WriteBoolDarameter			
	Axis AXIS REF 5M3 BOOL Done					
		- Execute BOOL	BOOL Busy			
		- ParameterNumber	DINT BOOL Error			
		Value BOOL	SMC_ERROR ErrorID			
	Name	Туре	Description			
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis			
TAT						
IIN	Execute	BOOL	Starts the execution of the FB at rising edge.			
IN	Execute ParameterNumber	BOOL DINT	Starts the execution of the FB at rising edge. Number of the parameter (see the table in 7.3.15)			
IN	Execute ParameterNumber Value	BOOL DINT BOOL	Starts the execution of the FB at rising edge.Number of the parameter (see the table in 7.3.15)New value of the specified parameter			
OUT	Execute ParameterNumber Value Done	BOOL DINT BOOL BOOL	Starts the execution of the FB at rising edge.Number of the parameter (see the table in 7.3.15)New value of the specified parameterTRUE: Parameter successfully written			
OUT	Execute ParameterNumber Value Done Busy	BOOL DINT BOOL BOOL BOOL	Starts the execution of the FB at rising edge.Number of the parameter (see the table in 7.3.15)New value of the specified parameterTRUE: Parameter successfully writtenTRUE: The FB is in operation.			
OUT	Execute ParameterNumber Value Done Busy Error	BOOL DINT BOOL BOOL BOOL BOOL BOOL	Starts the execution of the FB at rising edge.Number of the parameter (see the table in 7.3.15)New value of the specified parameterTRUE: Parameter successfully writtenTRUE: The FB is in operation.TRUE: Error has occurred within the FB.			

### 7.3.19 MC\_ReadStatus

Name MC_ReadStatus				
This FB	returns in details the sta	tus of the state diagram	n of the selected axis.	
			MC ReadStatus	
	_	Axis AXI5_REF_SM3	BOOL Valid	
	_	Enable BOOL	BOOL Busy	
			BOOL Error	
			SMC_ERROR ErrorID	
			BOOL Errorstop	
			BOOL Stopping	
			BOOL StandStill	
			BOOL DiscreteMotion	
			BOOL SynchronizedMotion	
			BOOL Homing	
			BOOL ConstantVelocity	
			BOOL Accelerating	
			BOOL BEErrorOccured	
	Namo	Tupo	Description	
IN OUT	Avis		Pafarance to the axis	
IN_OUT	Enable	BOOI	TRUE: Enables the execution of the ER	
	Valid	BOOL	TRUE: A valid output is available	
001	Busy	BOOL	TRUE: The FB is in operation	
	Error	BOOL	TRUE: Firor has occurred within the FB	
	ErrorID	SMC ERROR	Error identification	
	Disabled	BOOL	TRUE: Disabled (see 7.1 State diagram)	
	Errorstop	BOOL	TRUE: Errorstop (see 7.1 State diagram)	
	Stopping	BOOL	TRUE: Stopping (see 7.1 State diagram)	
	StandStill	BOOL	TRUE: StandStill (see 7.1 State diagram)	
	DiscreteMotion	BOOL	TRUE: DiscreteMotion (see 7.1 State diagram)	
	ContinuousMotion	BOOL	TRUE: ContiuousMotion (see 7.1 State diagram)	
	SynchronizedMotion	BOOL	TRUE: SynchronizedMotion (see 7.1 State diagram)	
	Homing	BOOL	TRUE: Homing (see 7.1 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.	

### 7.3.20 MC\_Reset

Name		MC_Reset		Type: FB		
This FB	This FB makes the transition from the state 'ErrorStop' to 'Standstill' or 'Disabled' by resetting all internal axis-related errors.					
MC_Reset Axis AXIS_REF_SM3 BOOL Done Execute 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			

# 7.4 PLCopen Part 2 for Single-Axis

### 7.4.1 MC\_TouchProbe

Name MC_TouchProbe		C_TouchProbe		Type: FB
This FB	is used to record an a	xis position at a trigger e	vent.	
	As Tr Ex W Fi La	tis AXIS_REF_SM3 iggerInput TRIGGER_R tecute BOOL indowOnly BOOL rstPosition LREAL testPosition LREAL	MC_TouchProbe BOOL Done BOOL Busy BOOL Error SMC_ERROR ErrorID LREAL RecordedPosition BOOL CommandAborted	
	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.	
	WindowOnly	BOOL	TRUE: Trigger events will be accepted only with window.	nin the specified
	FirstPosition	LREAL	Start position from whereon (in positive direction) trig accepted [u].	ger events will be
	LastPosition	LREAL	End position up to which trigger events will be accepted	1 [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 comman	nd.

#### 7.4.2 MC AbortTrigger

Name	М	C_AbortTrigger		Type: FB		
This FB	This FB is used to abort function block which are connected to trigger events.					
			MC_AbortTrigger			
	— A:	is AXIS_REF_SM3	BOOL Done			
		iggerinput TRIGGER_R	EF BOOL BUSY			
		ecule DOOL				
	_		SHO_ERROR EROND			
	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.

7.4.3 M	7.4.3 MC_DigitalCamSwitch					
Name	MC	_DigitalCamSwitch		Type: FB		
This FB	is the analogy to switc	hes on a motor shaft: it comma	ands a group of discrete output bits to switch in	analogy to a set of		
mechani	mechanical am controlled switches connected to an axis.					
	— Axis AX — Switche — Outputs	MC_Digit IS_REF_SM3 MC_CAMSWITCH_REF MC_OUTPUT_REF	alCamSwitch BOOL InOperation BOOL Busy BOOL Error			
	— TrackOp — Enable — EnableM — Tappeti	tions MC_TRACK_REF BOOL lask DWORD lode MC_TAPPETMODE	<i>SMC_ERROR</i> ErrorID			
	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 that are direct referenced tracks. (ARRAY [132] OF BC	ly related to the		
	TrackOptions	MC_TRACK_REF	Reference to structure containing track related p e.g. the on/off compensations per output/track. (ARRAY [132] OF MC_TRACK_TR)	properties,		
IN	Enable	BOOL	TRUE: Enables the execution of the FB.			
	EnableMask	DWORD	32 bits of BOOL enabling the different tracks data is related to the lowest TrackNumber. (initial value: 16#FFFFFFFF)	. Least 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 Type		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	I 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	INT		1: The output is only switched in positive direction	
			-1: The output is only switched in positive direction	
	INT		0: The tappets are calculated position-based	
ComSwitchMode			1: The tappets are calculated time-based, whereby only the value of	
Camswitchwode			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.	

### MC\_TRACK\_TR (STRUCT)

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

### 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 following conditions are fulfilled, output might oscillate wrongly. Be sure to read below information 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.

### 7.4.4 MC\_ReadActualTorque

Name		MC_ReadActualTorque		Type: FB		
This FE	This FB returns the value of the actual torque.					
	MC_ReadActualTorque Axis AXIS_REF_SM3 BOOL Valid Enable BOOL 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			

### 7.4.5 MC\_ReadActualVelocity

Name		MC_ReadActualVelocity		Type: FB		
This FE	This FB returns the value of the actual velocity.					
	MC_ReadActualVelocity Axis AXI5_REF_SM3 BOOL Valid Enable BOOL 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			

### 7.4.6 MC\_SetPosition

Name		MC_SetPosition		Type: FB
This F	B shifts the coordi	nate system of an axis by m	nanipulating both the set-point position as well as the act	ual position of an
axis w	ith the same value	without any movement cause	ed.	
			MC SetPosition	
		-Axis AXIS_REF_SN	M3 BOOL Done	
		- Execute BOOL	BOOL Busy	
			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	

ErrorID

#### 7.4.7 SMC MoveContinuousAbsolute Name SMC\_MoveContinuousAbsolute Type: FB This FB commands a controlled motion to a specified absolute position ending with the specified velocity. SMC\_MoveContinuousAbsolute Axis AXIS REF SM3 **BOOL InEndVelocity** Execute BOOL BOOL Busy Position LREAL BOOL CommandAborted Velocity LREAL BOOL Error EndVelocity LREAL SMC\_ERROR ErrorID EndVelocityDirection MC\_Direction Acceleration LREAL Deceleration LREAL Jerk LREAL Direction MC\_Direction Name Type 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) EndVelocity LREAL End velocity [u/s] (positive) Determines direction of end velocity. Permissible values: current (2), positive (1), negative (-1), Not applicable: fastest (3), shortest (0) EndVelocityDirection MC\_Direction (Refer to section 7.9 Enumeration) Acceleration LREAL Acceleration $[u/s^2]$ (positive) Deceleration LREAL Deceleration $[u/s^2]$ (positive) Jerk LREAL Jerk [u/s<sup>3</sup>] (positive) Direction for linear/finite axes: positive (1), negative (-1) Direction MC\_Direction for rotary/modulo axes: fastest (3), current (2), positive (1), shortest (0), negative (-1) (Refer to section 7.9 Enumeration) OUT InEndVelocity BOOL TRUE: Commanded position has been reached. BOOL Busy TRUE: The FB is in operation. CommandAborted BOOL TRUE: Command has been aborted by another command. Error TRUE: Error has occurred within the FB. BOOL

SMC\_ERROR

Error identification

7.4.8 M	C_MoveContinuousRe	elative			
Name	SMC_M	loveContinuousRela	tive	Type: FB	
This FE	3 commands a controlled	motion to a specified	d relative distance ending with the specified velo	city.	
		eContinuousRelative BOOL InEndVelocity BOOL Busy BOOL CommandAborted BOOL Error			
EndVelocity LREAL SMC_ERROR ErrorID     EndVelocityDirection MC_Direction     Acceleration LREAL     Deceleration LREAL     Jerk LREAL					
	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)		
	EndVelocityDirection	MC_Direction	Determines direction of end velocity. Permissible v positive (1), negative (-1), Not applicable: fastest (3 (Refer to section 7.9 Enumeration)	alues: current (2), ), shortest (0)	
	Acceleration	LREAL	Acceleration $[u/s^2]$ (positive)		
	Deceleration	LREAL	Deceleration $[u/s^2]$ (positive)		
	Jerk	LREAL	Jerk [u/s <sup>3</sup> ] (positive)		
OUT	InEndVelocity	BOOL	TRUE: Commanded distance has been reached.		
	Busy	BOOL	TRUE: The FB is in operation.		
	CommandAborted	BOOL	TRUE: Command has been aborted by another com	mand.	
	Error	BOOL	TRUE: Error has occurred within the FB.		
	ErrorID	SMC_ERROR	Error identification		

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### 7.5 PLCopen Part 3 for Single-Axis

### 7.5.1 MC\_Jog

Name		MC_Jog		Type: FB
This FB	commands a jogg	ed movement to a specified a	axis as long as the input 'JogForward/Backward' is set.	
		Axis AXIS_REF_SM JogForward BOOL JogBackward BOO Velocity LREAL Acceleration LREAL Deceleration LREAL Jerk LREAL	MC_Jog BOOL CommandAborted L BOOL Error SMC_Error ErrorId L	
Name		Туре	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
IN	JogForward	BOOL	TRUE: Axis is moved with the specified dynamic acceleration, deceleration and jerk in a positive direction (No motion is executed if JogBackward is TRUE at the	values velocity, n. same time)
	JogBackward	BOOL	<ul><li>TRUE: Axis is moved with the specified dynamic values velocity, acceleration, deceleration and jerk in a negative direction.</li><li>(No motion is executed if JogForward is TRUE at the same time)</li></ul>	
	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.	
	CommandAborte	ed BOOL	TRUE: Command has been aborted by another comman	ıd.
	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.

Type: FB

### 7.5.2 SMC\_Inch

Name	SMC_Inch
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This FB commands an inching movement to a specified axis as long as the moving distance is not reached and the input 'InchForward' or 'InchBackward' is set.

		SMC_Inch
	Axis AXI5_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	<ul> <li>TRUE: Axis is moved with the dynamic values velocity, acceleration, deceleration and jerk in a positive direction until distance has been travelled.</li> <li>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.</li> <li>If 'InchBackward' and 'InchForward' are TRUE at the same time, then no motions are carried out.</li> </ul>
	InchBackward	BOOL	<ul> <li>TRUE: Axis is moved with the dynamic values velocity, acceleration, deceleration and jerk in a negative direction until distance has been travelled.</li> <li>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.</li> <li>If 'InchBackward' and 'InchForward' are TRUE at the same time, then no motions are carried out.</li> </ul>
	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

# 7.6 PLCopen for Multi-Axis

### 7.6.1 MC\_CamIn

Name	M	C_CamIn		Type: FB
This FB	engages the CAM.			
			MC CamIn	
		Master AXIS REF SM	M3 BOOL InSync	
	-	Slave AXIS_REF_SM.	3 BOOL Busy	
	-	Execute BOOL	BOOL CommandAborted	
	-	SlaveOffset LREAL	SMC ERROR ErrorID	
	-	MasterScaling LREAL	BOOL EndOfProfile	
	-	SlaveScaling LREAL	SMC_TappetData Tappets	
	-	CamTableID MC_CA	M_ID	
	-	VelocityDiff LREAL		
	-	Deceleration LREAL		
	-	Jerk LREAL		
	-	TappetHysteresis LR	?EAL	
	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.	
	MasterOffset	LREAL	Offset on master table	
	SlaveOffset	LREAL	Offset on slave table	
	MasterScaling	LREAL	Scaling factor for master profile	
	SlaveScaling	LREAL	Scaling factor for slave profile	
	StartMode	MC_StartMode	Start mode	
	CamTableID	MC_CAM_ID	Identification of the cam plate. The input is connected the instance of MC_CamTableSelect.	with the output of
	VelocityDiff	LREAL	Maximum velocity difference for 'ramp in' mode. [u/s]	
	Acceleration	LREAL	Acceleration for 'ramp_in' mode. [u/s <sup>2</sup> ]	
	Deceleration	LREAL	Deceleration for 'ramp_in' mode. [u/s <sup>2</sup> ]	
	Jerk	LREAL	Jerk for 'ramp_in' mode. [u/s <sup>3</sup> ]	
			Size of the hysteresis for tappets in [u]. A positive val	ue means that the
			tappet cannot fire immediately after it has fired. The m	aster position first
			needs to move away from the tappet by more than the	e value given for
	TappetHysteresis	LREAL	TappetHysteresis.	
			For example, if the master is an encoder, the mast	ster position may
			oscillate by a few increments around the tappet po	sition. Without a
			hysteresis, the tappet may fire all the time.	
OUT	InSync	BOOL	TRUE: Cam has been engaged for the first time.	
	Busy	BOOL	TRUE: The FB is in operation.	
	CommandAborted	BOOL	TRUE: Command has been aborted by another comman	ıd.
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	
	EndOfProfile	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)		
Cta	SMC_CAMTAPPETACTION (ENUM)		
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.

### 7.6.2 MC\_CamOut

Name	Name MC_CamOut				
This FB	disengages the sla	we axis from the master axis	immediately.		
MC_CamOut — Slave AXI5_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		

### 7.6.3 MC\_CamTableSelect

Name MC_CamTableSelect				Type: FB		
This FB	This FB selects the CAM tables by setting the connections to the relevant tables.					
	MC_CamTableSelect         Master AXI5_REF_SM3       BOOL Done         Slave AXI5_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)	ζ.		

Name MC_GearIn			Type: FB	
This FB commands a ratio between the velocity of the slave and master axis.				
			MC Coovin	
			M3 BOOL InGear	
			3 BOOL Busy	
		Execute BOOL	BOOL CommandAborted —	
		<ul> <li>RatioNumerator DIN</li> </ul>	IT BOOL Error	
		Acceleration (REA)	DIVI SMC_ERROR ErrorID	
		Deceleration 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	
	RatioDenominator	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.	
	CommandAborted	BOOL	TRUE: Command has been aborted by another comman	nd.
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

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### 7.6.5 MC\_GearInPos

Name	MC_G	earInPos		Type: FB
This FB	commands a gear ratio bet	ween the position of the	he slave and master from the synchronization point onw	ards.
	- Ma - Sla - Exe - Rat - Rat - Sla - Sla - Sla - Sla - Ave	ster AXIS_REF_SM3 ve AXIS_REF_SM3 ve AXIS_REF_SM3 vecte BOOL ioNumerator DINT ioDenominator DINT ioDenominator DINT sterSyncPosition LREA veSyncPosition LREA sterStartDistance LR oidReversal BOOL	MC_GearInPos BOOL StartSync BOOL InSync BOOL Busy BOOL CommandAborted T BOOL Error SAL SMC_ERROR ErrorID AL PEAL	ards.
	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	
	RatioDenominator	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	LREAL	Master distance for the gear in procedure (where the started for getting into synchronization). In other w brought into sync with the master during this d MasterSyncPosition - MasterStartDistance until Mast If MasterStartDistance is 0 (or negative), then the s started immediately.	slave axis will be vords, the slave is istance, i.e. from erSyncPosition. lave movement is
AvoidReversal BOOL		BOOL	TRUE: Signals that the reversal of the module s impossible or might lead to damage. FALSE: Signals that the reversal of the slave is physi- acceptable.	ave is physically
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.	
	CommandAborted	BOOL	TRUE: Command has been aborted by another comm	and.
	Error	BOOL	TRUE: Error has occurred within the FB.	
	ErrorID	SMC_ERROR	Error identification	

### 7.6.6 MC\_GearOut

Name		MC_GearOut		Type: FB		
This FB	This FB disengages the slave axis from the master axis.					
	MC_GearOut — Slave AXIS_REF_SM3 BOOL Done — Execute 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: 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			

### 7.6.7 MC\_Phasing

Name	MC	Phasing		Type: FB		
This Fu	nction Block creates a pha	se shift in the master po	osition of a slave axis relative to the existing phase shift.			
The mas	ster position is shifted in 1	elation to the real physi	cal position.			
		Master AXIS_REF_SM3 Slave AXIS_REF_SM3 Execute BOOL PhaseShift LREAL Velocity LREAL Acceleration LREAL Deceleration LREAL Derk LREAL	MC_Phasing 3 BOOL Done BOOL Busy BOOL CommandAborted BOOL Error SMC_ERROR ErrorID			
	Name Type 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	$[u/s^2]$		
	Deceleration	LREAL	Maximum deceleration for reaching phase difference	$[u/s^2]$		
	Jerk	LREAL	Maximum jerk for reaching phase difference [u/s <sup>3</sup> ]			
OUT	Done	BOOL	TRUE: Commanded phasing has been reached.			
	Busy	BOOL	TRUE: The FB is in operation.			
	CommandAborted	BOOL	TRUE: Command has been aborted by another comm	and.		
	Error	BOOL	TRUE: Error has occurred within the FB.			
	ErrorID	SMC_ERROR	Error identification			

# 7.7 Utility Function Blocks

### 7.7.1 SMC3\_ReinitDrive

Name	ame SMC3_ReinitDrive			Type: FB		
This FB	This FB reinits a drive/axis. That means that the start-up phase is run through again and the application cannot control the drive					
until the	e 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	DUT         bDone         BOOL         TRUE: Reinitialization has been completed.					
	bBusy	Busy BOOL TRUE: The FB is in operation.				
bError BOOL TRUE: Error has occurred within the FB.						
	nErrorID SMC_ERROR Error identification					

### 7.7.2 SMC\_GetTappetValue

Name SMC_GetTappetValue			Type: FB			
This FB	This FB evaluates the output Tappets of function block MC_CamIn and contains the current tappet status.					
	SMC_GetTappetValue Tappets SMC_TappetData BOOL bTappet ID INT bInitValue BOOL bSetInitValueAtReset BOOL					
	Name	Туре	Description			
IN_OUT	Tappets	SMC_TappetData	Tappet signals to be evaluated by MC_GetTappetV	alue		
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 restart of the		
bSetInitValueAtReset BOOL MC_CamIn FB.						
FALSE: Retains the tappet value at a restart of the MC_C				MC_CamIn FB.		
OUT	bTappet	BOOL	Tappet value			

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### 7.7.3 SMC\_Homing

Name	SMC_Homing	Type: FB			
This FB causes the execution of a homing drive of the axis. If SMC_Homing is executed, the axis is moved at fVelocityFast in the					
direction specified by nDi	direction specified by nDirection as long as bEndSwitch = FALSE. The reference switch is then closed. The axis is decelerated				
and driven at fVelocitySlo	w in the opposite direction. At the point at which the reference switch opens with bEn	dSwitch = TRUE,			
the reference position fHor	mePosition is set and the drive is stopped.				

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SMC_H	oming
Axis AXI5_REF_SM3	BOOL bDone
bExecute BOOL	BOOL bBusy
fHomePosition LREAL	BOOL bCommandAborted
fVelocitySlow LREAL	BOOL bErro
fVelocityFast LREAL	SMC ERROR nErrorID
fAcceleration LREAL	BOOL bStartLatchingInde
fDeceleration LREAL	-
fJerk LREAL	
nDirection MC_Direction	
bReferenceSwitch BOOL	
fSignalDelay LREAL	
nHomingMode SMC_HOMING_MODE	
bReturnToZero BOOL	
bIndexOccured BOOL	
fIndexPosition LREAL	
bIanoreHWLimit BOOL	

	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.
	fHomePosition	LREAL	Home position taken after homing completed [u].
	fVelocitySlow	LREAL	Low velocity; used to drive out of the reference switch [u/s]
	fVelocityFast	LREAL	High velocity; used until reference switch is found [u/s]
	fAcceleration	LREAL	Acceleration [u/s <sup>2</sup> ] (positive)
	fDeceleration	LREAL	Deceleration [u/s <sup>2</sup> ] (positive)
	fJerk	LREAL	Jerk [u/s <sup>3</sup> ] (positive)
	nDirection	MC_Direction	Direction positive (1), negative (-1) (Refer to 7.9)
	bReferenceSwitch	BOOL	TRUE: Switches the reference.
	fSignalDelay	LREAL	Time [s] for bReferenceSwitch to be transmitted. (The result of (fVelocitySlow * fSignalDelay) will be added to home position as a offset after homing done.)
	nHomingMode	SMC_HOMING_MODE	Homing mode (Refer to 7.9 Enumeration)
	bReturnToZero	BOOL	TRUE: Moves to position zero after homing.
	bIndexOccurred	BOOL	Index pulse
	fIndexPosition	LREAL	Position where index occurred
	bIgnoreHWLimit	BOOL	TRUE: Sets bHWLmitEnable (parameter in AXIS_REF_SM3) = FALSE during homing.
OUT	bDone	BOOL	TRUE: Homing has been done.
	bBusy	BOOL	TRUE: The FB is in operation.
	bCommandAborted	BOOL	TRUE: Command has been aborted by another command.
	bError	BOOL	TRUE: Command has been aborted by another command.
	nErrorID	SMC_ERROR	TRUE: Error has occurred within the FB.
	bStartLatchingIndex	BOOL	For some homing modes, the index pulse is evaluated. TRUE: Storing of the index pulse has been started and must be done by the application. The result is expected in the inputs bIndexOccured and fIndexPosition.

### 7.7.4 SMC\_SetTorque

Name	ame SMC_SetTorque Ty			Type: FB
This FB	can be used to create	e a torque if the drive is in	controller mode "torque".	
	SMC_SetTorque         — Axis AXI5_REF_SM3       BOOL bBusy         — bEnable BOOL       BOOL bError			
			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 within the FB.	
	nErrorID SMC_ERROR Error identification			

### 7.7.5 SMC\_SetControllerMode

Name	SMC	_SetControllerMode		Type: FB
This FB	sets the byControllerM	lode (command value of operation	mode) parameter of the axis and waits u	ntil the parameter
byRealC	ControllerMode (actual va	alue of operation mode) reflects this	value.	
		SMC SetContro	llerMode	
	Axis AXIS_REF_S	M3	BOOL bDo	one —
	<ul> <li>bExecute BOOL</li> </ul>		BOOL bBu	usy —
		SMC_CONTROLLER_MODE	BOOL bEr	ror—
			SMC_ERROR <b>nErro</b>	
	Name	Type	Description	
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis	
IN	bExecute	BOOL	Starts the execution of the FB at rising ed	ge.
	nControllerMode	SMC_CONTROLLER_MODE	Controller mode (ENUM)	
OUT bDone BOOL TRUE: Mode switching has bee				
	bBusy	BOOL	TRUE: The FB is in operation.	
	bError	BOOL	TRUE: Error has occurred within the FB.	
	nErrorID	SMC_ERROR	Error identification	

### 7.7.6 SMC\_SetMovementType

Name		SMC_SetMovementType		Type: FB			
This FB	This FB sets the movement type of a virtual axis to linear or modulo.						
	SMC_SetMovementType         Axis       AXIS_REF_SM3       BOOL       bDone         bExecute       BOOL       BOOL       bError         iMovementType       IVT       SMC_ERROR       eErrorID         iMovementType       IVT       SMC_ERROR       eErrorID         iMovementType       LREAL       Image: 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 positive						
OUT	bDone	BOOL	TRUE: Movement setting has been done.				
	bError BOOL TRUE: Error has occurred within the FB.						
eErrorID SMC_ERROR Error identification							

### 7.7.7 SMC\_SetRampType

Name SMC_SetRampType					Type: FB		
This FB	This FB sets the ramp type of an axis to a new value. Can only be used when the axis is in state standstill or power_off.						
	SMC_SetRampType         Axis       AXIS_REF_SM3       BOOL       bDone         bExecute       BOOL       BOOL       bError         eRampType       SMC_RAMPTYPE       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 ed	ge.		
	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			

### 7.7.8 SMC\_InPosition

Nomo		SMC InPosition		Type: EB				
Name								
This FB monitors the offset between the nominal and actual positions of an axis (drag error). This tests whether the drag error lies								
within a specified value range for over a defined period of time (position window).								
	SMC_InPosition							
	Axis AXIS_REF_SM3 BOOL bInPosition							
			BOOL bBusy					
			BOOL blimeOut					
		-fTimeOut LREAL						
Name Type Description								
IN_OUT	Axis	AXIS_REF_SM3	Reference to the axis					
IN	bEnable	BOOL	TRUE: Enables the execution of the FB.					
	fDocWindow	IDEAL	The drive is inside the position window, i	f fPosWindow >=				
	IF OS WINDOW	LKEAL	Distance (actual position, set position) [u]					
	fDa -Tima		Time that the FB has to stay inside the position window					
	iPostille	LKEAL	before bInPosition is set [s].					
			If the time since enabling the FB is larg	er than this value				
	fTimeOut	LREAL	and bInPosition is not set, bTimeOut is set	et; this mechanism				
			is deactivated, if $fTimeOut = 0$ .					
OUT	bInPosition	BOOL	TRUE: Parameter is available					
	bBusy	BOOL	TRUE: The FB is in operation.					
	bTimeout	imeout BOOL TRUE: Error has occurred within the FB.						

I

## 7.8 STRUCT

### 7.8.1 MC\_TP\_REF

Name Type		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	

### 7.8.2 MC\_TV\_REF

Name Type		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	

### 7.8.3 MC\_TA\_REF

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

### 7.8.4 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	

### 7.8.5 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

### 7.8.6 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

### 7.8.7 TRIGGER\_REF

Name	Туре	Initial	Description		
iTriggerNumber	INT	-1	Trigger channel; defined by driver (only used when		
Tinggenvunioer			bFastLatching=TRUE)		
			TRUE: Latching is done in drive (precise)		
bFastLatching	BOOL	TRUE	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		

### 7.8.8 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	

### 7.8.9 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		0: The tappets are calculated position-based 1: The tappets are calculated time-based, whereby only the value of FirstOnPositionwill be used and the output stays TRE for the given time 'Duration'.		
Duration         TIME         Period of time for which the tappet output CamSwitchMode=1.		Period of time for which the tappet output stays TRUE in case of CamSwitchMode=1.			

### 7.8.10 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		

### 7.8.11 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.

### 7.8.12 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

#### 7.8.13 MC\_TRACK\_TR

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

## 7.9 Enumeration (ENUM)

### 7.9.1 MC\_DIRECTION

Name	Value	Description
factor	2	Selects the direction automatically in order to reach the target position as fast as
lastest	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.

### 7.9.2 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

### 7.9.3 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)	

### 7.9.4 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.

### 7.9.5 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.

### 7.9.6 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)	

### 7.9.7 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

### 7.9.8 SMC\_HOMING\_MODE

Name	Value	Description
EAST DELOW S STOD	0	Move with fast velocity onto the reference switch; invert and move with slow
FASI_DSLOW_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"
EAST DELOW I S STOD	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
EAST SLOW S STOD	4	Move with fast velocity onto the reference switch; move with slow velocity out of
FAS1_SLUW_S_S10P		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
FASI_SLOW_STOP_S		the reference switch; stop; execute "Set position"
EAST SLOW LS STOD	6	Move with fast velocity onto the reference switch; move with slow velocity out of
rasi_slow_1_s_stop		the reference switch; wait for the index pulse; execute "Set position"; stop

### 7.9.9 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 <sup>15</sup>
		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	A problem with the license occurred
SMC_WRONG_CONTROLLER_MODE	21	Controller enable not done or brake applied
SMC_INVALID_ACTION_FOR_LOGICAL	25	Axis in wrong controller mode
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.
		(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	71	In current mode, controller mode cannot be changed.
		(SMC_SetControllerMode)
SMC_SCM_INTERRUPTED	12	SMC_SetControllerMode has been interrupted by
INC IT WDONG CONTROLLED MODE	75	MC_Stop or errorstop.
SWIC_S1_WKUNG_CONTROLLER_MODE	/5	Axis not in correct controller mode. Deprecated, no
SMC DAC EDDOD DUDDIC STADTUD	00	Ionger returned by SMC_SetTorque.
SWIC_KAG_EKKOK_DUKING_STAKTUP	80	Error at startup of the axis group
INC DAG EDDOD ANTO NOT BUTTALITED	01	(SMC_KesetAxisGroup)
SMC_KAG_ERKOR_AXIS_NOT_INITIALIZED	81	I ne 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
	100	(MC_ReadParameter)
SMC_RP_PARAM_CONVERSION_ERROR	133	Conversion of the value to / from the drive parameters
		failed. Unknown SoftMotion parameters
	140	(MC_ReadParameter)
SMC_WP_PARAM_INVALID	140	Parameter number unknown or writing not allowed
SMC WD SENDING EDDOD	1.4.1	(MC_whierarameter)
SMC_WP_SENDING_ERROR	141	WriteDriveDeremeter (MC, WriteDeremeter)
SMC WD DDIVE DADAMETED NOT MADDED	142	No assignment for drive persenters evollable
SMC_WP_DRIVE_PARAMETER_NOT_MAPPED	142	(MC_WriteParameter)
SMC WE DADAM CONVERSION EDDOD	1/3	(MC_while a dameter)
SMC_WI_IARAW_CONVERSION_ERROR	145	failed Unknown SoftMotion parameters
		(MC_WriteParameter)
SMC H AXIS WASNT STANDSTILL	170	Axis has not been in standstill state (MC Home)
SMC_H_XIS_UNSIT_START_HOMING	170	From at start of homing action (MC Home)
SMC_H_XXIS_DIDXT_START_HOWING	171	Error at start of homing action. (MC Home)
SMC_H_RROR_WHEN_STOPPING	172	Error at stop after homing Deceleration may not be set
	175	(MC Home)
SMC H AXIS IN FRRORSTOP	174	Drive is in errorston status. Homing cannot be executed
	1/4	(MC Home)
SMC MS UNKNOWN STOPPING FRROR	180	Unknown error at stop (MC_Stop)
SMC_MS_INVALID_ACCDEC_VALUES	181	Invalid velocity or acceleration values (MC Stop)
SMC_MS_DIRECTION_NOT_ADDI ICARI E	187	Direction - shortest not applicable (MC_Stop)
SINC_INS_DIRECTION_NOT_AFFLICADLE	102	Direction – shortest not applicable (MC_Stop)

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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
	(70	permission (MC_GearIn)
SMC_GI_INVALID_JERK	679	Jerk invalid (MC_Gearin)
SMC_PH_INVALID_VELACCDEC	125	(MC Phase)
SMC DH DOTADVAVIS DEDIODO	726	(MC_Phase)
SMC_PH_ROTARTAAIS_PERIODO	720	Turne of given com is not MC_CAM_PEE
SMC_NO_CAM_KET_TITE	750	Master area, vStart and vEnd from CamTable is not
SMC_CAM_TABLE_DOES_NOT_COVER_MASTER_SCALE	751	covered by curve data (MC CamTableSelect)
SMC CAM TABLE EMPTY MASTER RANGE	752	Cam data table has empty master range
	152	(MC_CamTableSelect)
SMC CAM TABLE INVALID MASTER MINMAX	753	Cam data master has invalid max- min-values
	155	(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

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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)

# Chapter 8 Visualization Template



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

MC_Power Instance: POU.MC_Power_0							
Enable bRegulatorOr bDriveStart	0	Status bRegulatorRealState bDriveStartRealState Busy Error ErrorID	0 0				
MC_MoveF	elative	_					
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	<ul><li>○</li><li>●</li><li>0</li></ul>				

### 8.2 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	₩ Ф		
🏢   🏢   🔊			
Basic Common controls Alarm	manager		
Measurement controls Lamps/Switche	es/Bitmaps		
Special controls Date/time managin	g controls	W. Parm	
ImagePool_sm3 ImagePool_c	nc_sm3		mine i mineue i
ImagePoolDialogs SM3_Basic SM3_Basic			<u> </u>
VisuDialogs SM3_Robotics_Visu	Favorite		
		VISU_MC_Power	VISU_NEW_MC_Po
VISU_SMC_MoveCont VISU_SMC_MoveCont inuousRelative inuousAbsolute			
VISU_MC_TouchPro VISU_MC_SetPosition			
VISU_MC_AbortTrigg helpVISU_SMC_ARRO		FB name can be searched.	
EF neipviso_DWORD			
	-		
- <b>)</b> Q	151 items		
Y ToolBox 🗃 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_N	IC_Power	VISU_NEW_MC_Power			IEW_MC_Power	
MC_F	Power		MC_Power Instance: %s			
Enable	Status		Enable bRegulatorOn	0	Status bRegulatorRealState	•
bDriveStart	bDriveStartRealState		DDriveStart		Busy Error	•
PLCopen PLCopen Million control	Error ErrorD:%d			_	ErrorlD	%d

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

Properties 🔹					
🍸 Filter 🝷 🖹 🛠 Sort by 🝷 🧕 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					



Set up a template for MC\_MoveRelative too.

After logging in 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 8 Visualization Template

### MEMO

## Chapter 9 Trouble Shooting

## 9.1 Power-up Sequence

Power-up sequence is shown below figure. If your system does not work as expected, possible cause can be located in different area widely. Refer to the hints below or section 9.2 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)



# 9.2 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.
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 EtherCAT master	Restart EtherCAT
	Master	device.	master.
		[No error] [Error]	[Refer to Action-1]
		😌 📆 EtherCAT_Master 🛆 🚮 EtherCAT_Master	
		adva_ec (HII) 🗎 🛆 🚮 Adva_ec (HII)	
		CAT	
		Drive_A	
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 (HIT) 🔍 🖓 🚮 ADVA_EC (HIT)	
		Contraction of the second seco	
		ADVA_EC_1 ()	
		(2) Login with HX-CODESYS and check slaves' status	
5	Statur of ania	[Refer to Action-2]	Ensuria MC Deset an
5	Status of axis	(1) Login with HX-CODES IS and check axes status icon.	Execute MC_Reset or SMC2 PoinitDrive
		[No arror] [Error]	[Pofer to Action 5]
			[Kelef to Action-5]
		😏 🔟 EtherCAT_Master_ 😏 🔟 EtherCAT_Master	
		SetterCAT	
		S & EtherCAT	
		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 Drive_A Axis InVelocity MV exe TOUR Execute Busy FINSE	error output because
		MVVelo 0 Velocity CommandAborted ZAISE 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.)

#### << Above error status No. 3 to 5 can be reproduced >>

No.3 Error in 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 EtherCAT master

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

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



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

Namo	IoDn/Ett			Type: FR				
			1 14 44 41	туре. РВ				
Inis FB	This FB returns the status of EtherCAI network and commands to restart or stop bus.							
	IoDrvEtherCAT							
			-					
Name Type Description								
IN	xRestart BOOL Rising edge: The master is restarted and all configuration parameters are reloaded		s are reloaded.					
		ROOI	TRUE: Communication is stopped. No more EtherCAT telegrams	s are sent. On most				
	xStopBus	BOOL	devices, a restart is necessary after this because they are switched to error status.					
OUT		DOOL	TRUE: Transfer of all configuration parameters was complet	ed with no errors.				
	xConfigFinished	BOOL	Communication is running on the bus.					
	-Distribute dClasslatur Com a	DOOL	If distributed clocks are used, then the PLC is synchroniz	zed with the first				
xDistributedClockInSylic		BOOL	EtherCAT slave with the DC option activated.					
	Г	DOOL	TRUE: Error has occurred when starting the EtherCAT stack or communication w					
xError		BOOL	slave is interrupted because no more messages can be received.					
		DOOL	The output is TRUE when the Sync Window Monitoring optic	on is activated and				
xSyncInWindow BOOL the synchronization of all slaves is			the synchronization of all slaves is within the Sync Window.					

(b) Restart EtherCAT master

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	*	Enable E	xpert Settings
PIOLESS Dala	EtherCAT Address	1001	*	Optiona	I
Startup Parameters	▲ Distributed Clock				
EtherCAT Parameters	Select DC	DC for synchr	onization		•
EtherCAT I/O Mapping	✓ Enable	4000	Sync Uni	t Cycle (µs)	
Status	Sync0: Enable Sync 0				
Information	Sync Unit Cycle	x 1	-	4000	Cycle Time (µs)
	💿 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)
	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]  $\rightarrow$  [Pre-Op]  $\rightarrow$  [Safe-Op]  $\rightarrow$  [Op].

ADVA_EC X			
General	State Machine		
Expert Process Data	Init Bootstrap	Current State:	Operational
Process Data	0p	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
	Evenant Braccase Data	AutoInc Address	0	👿 Enable Expert Settings
	Expert Process Data	EtherCAT Address	1001	Optional

(b) Change status by function block

Add the function block ETCSlave 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	ETCSlave			
This FB	This FB returns the current operation mode and commands a setting operation mode.				
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.	witch 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_Soft	lotion X			
General	✓ Autoconfig Master/Slaves     EtherCAT			
Sync Unit Assignment	EtherCAT NIC Setting	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 Select network by MAC	lame		
	▲ Distributed Clock			
	Cycletime 4000 📮 µs 🗍 Use LRW ins	stead of LWR/LRD		
	Sync Offset 20 🐳 % 🔲 Enable mess	sages pertask		
	Sync Window Monitoring	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_SoftMotio	n <mark>(</mark> E				
🚊 😏 🛐 ADVA_EC (HITACHI AC S	SER				
😔 🏅 EtherCAT OUT					
Drive_A (SM_Drive	:_Gŧ				
· Drive_A ★					
General	Axis type and limits				Velocity ramp type
	Virtual mode	-Modulo s	ettings		Trapezoid
Scaling/Mapping	Modulo	Modul	o value [u]: 360	0.0	Sin <sup>2</sup>
Commissioning	Finite				Quadratic
Software error reaction				Quadratic (smooth)	
Parameters			Dec	eleration [u/s²]: 0	Identification
SM_Drive_ETC_GenericDSP402: I/O Mapping			Max	<pre>distance [u]: 0</pre>	ID: 3
Status	-Dynamic limits			Position lag supervision	
-	Velocity [u/s]:	Accelerati	ion [u/s²] Decele	ration [u/s²]	deactivated 👻
Information	1e3	1e5	1e5		Lag limit [u]: 1.0
	Online	Dnline			
	variable	set value	actual value	Status: SMC_AXIS_STATE	.errorstop
	Position [u]	0.00	0.00	Communication: error (1100)	
	Velocity [u/s]	0.00	0.00	Errors	
	Torque [Nm]	0.00	0.00	Axis Error:	
		$\sim$		0 [16#0000000]	
				FB Error: SMC_ERROR.SMC_DI_GENERAL_COMMUNICATION_ERROR	
		•			
		<b>A</b>			
			/	strDriveInterfaceError:	
				ETC device is no longer in mode op	erational

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 Abbreviations

CoE	CANopen over EtherCAT
DC	Distributed Clock
ENI	EtherCAT Network Information
EoE	Ethernet over EtherCAT
ESI	EtherCAT Slave Information
ESM	EtherCAT State Machine
FB	Function Block
FoE	File access over EtherCAT
FTP	File Transfer Protocol
GVL	Global Variable List
PDO	Process Data Object
POU	Program Organization Unit
SDO	Service Data Object
SoE	Servo drive over EtherCAT