X67SM4320

1 General information

This stepper motor module is used to control up to 4 stepper motors with a rated voltage of 24 VDC ±25% at a motor current up to 1 A (1.5 A peak).

By individually adjusting the coil currents, the motor is only operated with the current it actually needs. This simplifies selection of the available motors and prevents unnecessary heating. Because the latter reduces energy consumption and thermal load, the effects are positive on the lifespan of the complete system. Complete flexibility is achieved by using the values for holding current, boost current and continuous current, which are completely independent of each other. The current for microsteps is automatically adjusted to the configured current values.

A stall detection mechanism is integrated to analyze the motor load. The stall is recognized using a configurable threshold. This allows an overload or motor standstill to be detected precisely in many different types of applications.

- 4 stepper motors, 24 VDC ±25%, 1.0 A (1.5 A peak)
- Current value resolution of 1%
- Boost, nominal and holding current configured independent of each other
- 38.5 kHz PWM frequency
- 256 microsteps
- Stall detection
- Complete integration in Automation Studio and CNC applications
- Function model 3 (ramp) is based on the CANopen communication profile DS402
- NetTime timestamp: Position change

NetTime timestamp for the position

It is not just the position value that is important for highly dynamic positioning tasks, but also the exact time the position is measured. The module is equipped with a NetTime function for this that supplies a timestamp for the recorded position with microsecond accuracy.

The timestamp function is based on synchronized timers. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise time, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

2 Order data

Model number	Short description	Figure
	Motor modules	
X67SM4320	X67 stepper motor module, I/O power supply 24 VDC ±25%, 4 motor connections, 1 A continuous current, 1.5 A peak current, NetTime function	

Table 1: X67SM4320 - Order data

Required accessories
For a general overview, see section "Accessories - General overview" of the X67 system user's manual.

3 Technical data

Model number	X67SM4320
Short description	
I/O module	4 full bridges for controlling stepper motors
General information	
B&R ID code	0x1DCC
Status indicators	"Motor active" per channel, bus function
Diagnostics	
I/O power supply	Yes, using status LED and software
Motor status	Yes, using status LED and software
Connection type	
X2X Link	M12, B-keyed
Outputs	4x M12, A-keyed
I/O power supply	M8, 4-pin
Power consumption	
Internal I/O	2 W
X2X Link power supply	0.75 W
Certifications	
CE	Yes
KC	Yes
EAC	Yes
UL	cULus E115267 Industrial control equipment
HazLoc	cCSAus 244665 Process control equipment for hazardous locations Class I, Division 2, Groups ABCD, T5
ATEX	Zone 2, II 3G Ex nA IIA T5 Gc IP67, Ta = 0 - Max. 60°C TÜV 05 ATEX 7201X
Motor bridge - Power unit	
Quantity	4
Type	2-phase bipolar stepper motor
Nominal voltage	24 VDC ±25%
Nominal current	1 A
Max. current/motor	1.5 A for 2 s (after a recovery time of at least 10 s at maximal 1 A)
Max. current/module	6 A
Controller frequency	38.5 kHz
DC bus capacitance	440 µF
Step resolution	256 microsteps per full step
I/O power supply	
Nominal voltage	24 VDC ±25%
Integrated protection	
Short-circuit protection, overload protection	Yes
Reverse polarity protection	No
Electrical properties	
Electrical isolation	Channel isolated from bus Channel not isolated from channel
Operating conditions	
Mounting orientation	
Any	Yes
Installation elevation above sea level	
0 to 2000 m	No limitations
>2000 m	Reduction of ambient temperature by 0.5°C per 100 m
Degree of protection per EN 60529	IP67
Ambient conditions	
Temperature	
Operation	0 to 50°C
Derating	-
Storage	-40 to 85°C
Transport	-40 to 85°C
Mechanical properties	
Dimensions	
Width	53 mm
Height	85 mm
Depth	42 mm
Weight	195 g
Torque for connections	
M8	Max. 0.4 Nm
M12	Max. 0.6 Nm

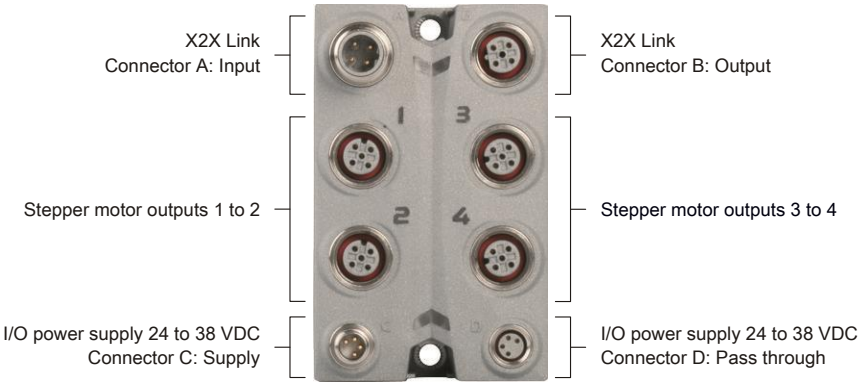
Table 2: X67SM4320 - Technical data

4 LED status indicators

Figure	LED	Color/Status		Description
	**Status indicator 1: Status indicator for X2X Link**			
	Left/Right	**Green (left)**	**Red (right)**	**Description**
		Off	Off	No supply via X2X Link
		On	Off	X2X Link supplied, communication is functioning
		Off	On	X2X Link supplied, but X2X Link communication is not functioning
		On	On	Preoperational: X2X Link supplied, module not initialized
	I/O LEDs: Status display			
	1 - 4	**Color**	**Status**	**Description**
		Yellow	On	Motors 1 to 4 are active
	Status indicator 2: Status indicator for module function			
	Left arrow	**Color**	**Status**	**Description**
		Green	Off	No power to module
			Single flash	RESET mode
			Double flash	BOOT mode (during firmware update)[1)]
			Blinking	PREOPERATIONAL mode
			On	RUN mode
	Right arrow	**Color**	**Status**	**Description**
		Red	Off	No power to module or everything OK
			On	Error or reset status
			Single flash	Warning/Error on an I/O channel. Overflow in analog inputs.
			Double flash	Supply voltage not in the valid range

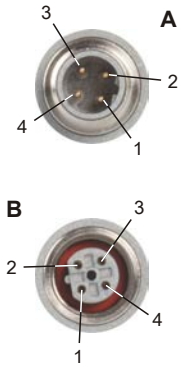
1) Depending on the configuration, a firmware update can take up to several minutes.

5 Connection elements



6 X2X Link

This module is connected to X2X Link using pre-assembled cables. The connection is made using M12 circular connectors.

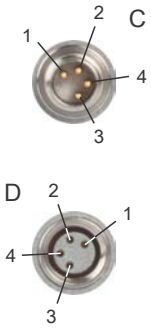
Connection	Pinout	
	**Pin**	**Description**
	1	X2X+
	2	X2X
	3	X2X⊥
	4	X2X\
	Shield connection made via threaded insert in the module. A → B-keyed (male), input B → B-keyed (female), output	

7 24 VDC I/O power supply

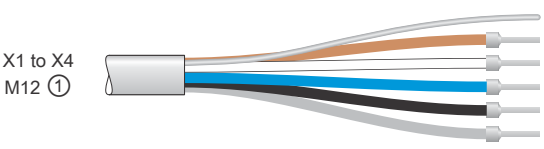
The I/O power supply is connected using circular connectors (M8, 4-pin). The supply is connected via connector C (male). Connector D (female) is used to route the power supply to other modules.

Information:

The maximum current per supply is 4 A (in summation 8 A)!

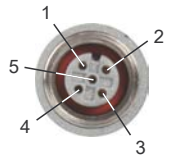
Connection	Pinout	
	**Pin**	**Name**
	1	24 VDC ±25%
	2	24 VDC ±25%
	3	GND
	4	GND
	C → Connector (male) in module supply D → Connector (female) in module routing	

8 Pinout



① X67CA0A41.xxxx: M12 sensor cable, straight
X67CA0A51.xxxx: M12 sensor cable, angled

8.1 Connections X1 to X4

M12, 5-pin	Pinout	
Connection X1/X2	**Pin**	**Name**
	1	Stepper motor A
	2	Stepper motor A\
	3	Stepper motor B
	4	Stepper motor B\
	5	Shield
	Shield connection made via threaded insert in the module	
		
Connection X3/X4		

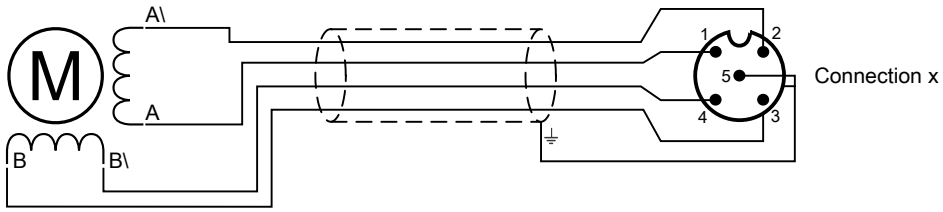
Warning!

Circular connectors are not permitted to be plugged in or unplugged during operation.

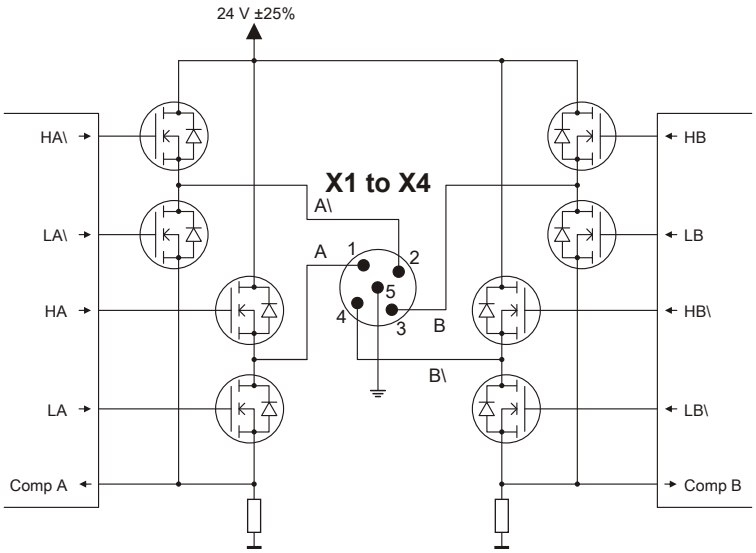
Information:

Shielded motor cables must be used in order to meet the limits according to the EN55011 standard (emissions).

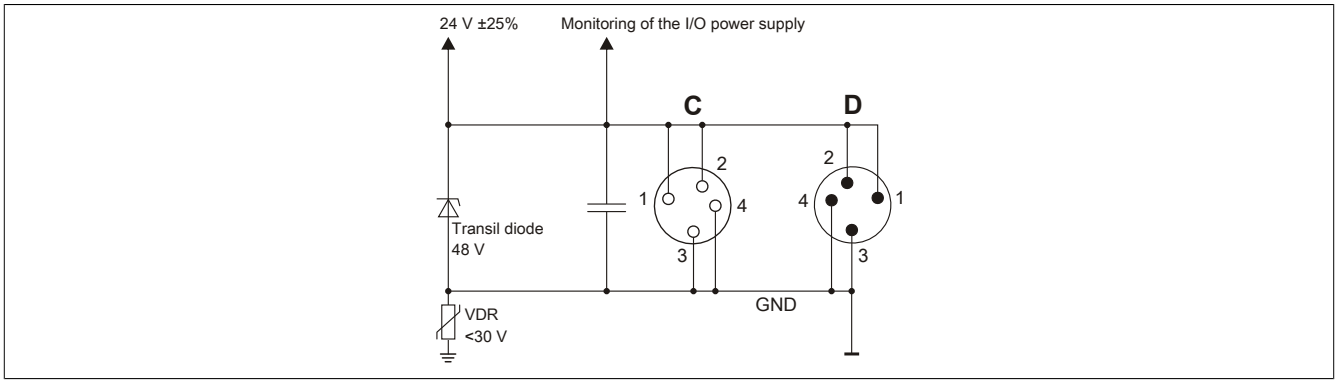
9 Connection example



10 Output circuit diagram



11 I/O power supply circuit diagram



12 Monitoring the module supply

The module supply voltage is continually monitored. Its status can be read. The error "Module power supply error" occurs when the voltage falls below 18 V or rises above 30 V.

Overvoltage cutoff

If the supply voltage on the module exceeds 30 V (e.g. due to feedback during generator operation), then the motor output is switched off. The motor output is reactivated as soon as the supply voltage is back within the valid range.

12.1 Energy regeneration of the voltage

If voltage is regenerated during generator operation of the motor, the built-in Transil diode may be overloaded and the module could be irreparably damaged as a result. The following recovery values are therefore not permitted to be exceeded:

- 6W at more than 40 V

> **Important!**
>
> **Overshoot of the limit values must not be avoided by means of suitable technical measures or by disconnecting cables during maintenance work.**

13 Overtemperature cutoff (at 85°C)

If the module temperature reaches or exceeds 85°C...

- ... the application receives notification via the "Overtemperature" error bit
- ... The PWM outputs are disabled.

Once the module temperature sinks to 83°C, the error bit is automatically cleared by the module and the outputs become operational again.

14 Installation

Top-hat rail installation can only be recommended if the module is used for low power ratings.

To improve heat dissipation, we recommended mounting the module on a cooler part of the machine or on a base plate that is at least 1 dm². A minimum distance of 1 cm must be maintained between X67 modules.

15 Power supply dimensioning

The motor's current consumption depends on the defined motor currents, the available power and the actual motor being used. An increase in the motor load causes an increase in the current consumption.

An increase in the motor load causes an increase in the effective current of the module supply.

16 Protection

The power supply line should be protected by a circuit breaker or a fuse. In general, dimensioning the supply line and overcurrent protection depends on the structure of the power supply (modules can be connected individually or in groups).

Information:

The effective current for the power supply depends on the load but is always less than the motor current. Make sure that the maximum nominal current of 8 A (4 A per pin) is not exceeded on the power supply terminals of the power unit.

When choosing a suitable fuse, the user must also account for characteristics such as aging effects, temperature derating, overcurrent capacity and the definition of the rated current, which can vary by manufacturer and type. In addition, the fuse that is selected must also be able to handle application-specific characteristics (e.g. overcurrent that occurs in acceleration cycles).

The cross section of the power mains and the rated current of the overcurrent protection used are chosen according to the current load so that the maximum current load for the cable cross section selected (based on the type of wiring, see table) is greater than or equal to the current load in the power mains. The rated current of the overcurrent protection must be less than or equal to the maximum current load for the cable cross section selected (based on the type of wiring, see table):

$$I_{Mains} \leq I_b \leq I_Z$$

Mains ≤ Fuse ≤ Line/cable

Wire cross-section [mm²]	Current load of the cable cross section I_Z / rated current of the over current protection I_b [A] according to type of installation in an ambient air temperature of + 40°C in accordance to EN 60204-1			
	B1	**B2**	**C**	**E**
1.5	13.5 / 13	13.1 / 10	15.2 / 13	16.1 / 16
2.5	18.3 / 16	16.5 / 16	21 / 20	22 / 20

Table 3: Cable cross section of the mains power input depending on the type of wiring

The tripping current of the fuse cannot exceed the rated current of the fuse I_b.

Type of wiring	Description
B1	Wires in conduit or cable duct
B2	Cables in conduit or cable duct
C	Cables or wires on walls
E	Cables or wires on open-ended cable tray

Table 4: Type of wiring used for the mains power input

17 Register description

17.1 General data points

In addition to the registers listed in the register description, the module also has other more general data points. These registers are not specific to the module but contain general information such as serial number and hardware version.

These general data points are listed in section "Additional information - General data points" of the X67 system user's manual.

17.2 Function model 0 - default

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Configuration						
64	ConfigOutput01 (stall threshold)	UINT				•
66	ConfigOutput02 (module configuration)	UINT				•
52	ConfigOutput03 (holding current for channel 1)	USINT				•
53	ConfigOutput04 (nominal current for channel 1)	USINT				•
54	ConfigOutput05 (maximum current for channel 1)	USINT				•
55	ConfigOutput06 (holding current for channel 2)	USINT				•
56	ConfigOutput07 (nominal current for channel 2)	USINT				•
57	ConfigOutput08 (maximum current for channel 2)	USINT				•
58	ConfigOutput09 (holding current for channel 3)	USINT				•
59	ConfigOutput10 (nominal current for channel 3)	USINT				•
60	ConfigOutput11 (maximum current for channel 3)	USINT				•
61	ConfigOutput12 (holding current for channel 4)	USINT				•
62	ConfigOutput13 (nominal current for channel 4)	USINT				•
63	ConfigOutput14 (maximum current for channel 4)	USINT				•
68	ConfigOutput16 (mixed decay threshold)	UINT				•
92	StallDetectMinSpeed01	UINT				•
94	StallDetectMinSpeed02	UINT				•
96	StallDetectMinSpeed03	UINT				•
98	StallDetectMinSpeed04	UINT				•
102	SdcConfig01	USINT				•
103	MotorSettlingTime01	USINT				•
104	MotorSettlingTime02	USINT				•
105	MotorSettlingTime03	USINT				•
106	MotorSettlingTime04	USINT				•
107	DelayedCurrentSwitchOff01	USINT				•
108	DelayedCurrentSwitchOff02	USINT				•
109	DelayedCurrentSwitchOff03	USINT				•
110	DelayedCurrentSwitchOff04	USINT				•
Communication						
20	Motor1Step1	UINT			•	
22	Motor1Step2	UINT			•	
28	Motor2Step1	UINT			•	
30	Motor2Step2	UINT			•	
36	Motor3Step1	UINT			•	
38	Motor3Step2	UINT			•	
44	Motor4Step1	UINT			•	
46	Motor4Step2	UINT			•	
70	Error acknowledgment	USINT			•	
	ErrorReset01	Bit 0				
	...	...				
	ErrorReset04	Bit 3				
74	MotorLoad	UINT	•			
0	Position1Sync	INT	•			
2	Position2Sync	INT	•			
4	Position3Sync	INT	•			

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
6	Position4Sync	INT	•			
8	Motor error	UINT	•			
	StallError01	Bit 0				
	OvertemperaturError01	Bit 1				
	OpenLoadError01	Bit 2				
	OvercurrentError01	Bit 3				
	...	...				
	StallError04	Bit 12				
	OvertemperaturError04	Bit 13				
	OpenLoadError04	Bit 14				
	OvercurrentError04	Bit 15				
10	Module status	USINT	•			
	ModulePowerSupplyError	Bit 7				

17.3 Function model 0 - Standard with SDC

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Configuration						
64	ConfigOutput01 (stall threshold)	UINT				•
66	ConfigOutput02 (module configuration)	UINT				•
52	ConfigOutput03 (holding current for channel 1)	USINT				•
53	ConfigOutput04 (nominal current for channel 1)	USINT				•
54	ConfigOutput05 (maximum current for channel 1)	USINT				•
55	ConfigOutput06 (holding current for channel 2)	USINT				•
56	ConfigOutput07 (nominal current for channel 2)	USINT				•
57	ConfigOutput08 (maximum current for channel 2)	USINT				•
58	ConfigOutput09 (holding current for channel 3)	USINT				•
59	ConfigOutput10 (nominal current for channel 3)	USINT				•
60	ConfigOutput11 (maximum current for channel 3)	USINT				•
61	ConfigOutput12 (holding current for channel 4)	USINT				•
62	ConfigOutput13 (nominal current for channel 4)	USINT				•
63	ConfigOutput14 (maximum current for channel 4)	USINT				•
68	ConfigOutput16 (mixed decay threshold)	UINT				•
92	StallDetectMinSpeed01	UINT				•
94	StallDetectMinSpeed02	UINT				•
96	StallDetectMinSpeed03	UINT				•
98	StallDetectMinSpeed04	UINT				•
102	SdcConfig01	USINT				•
103	MotorSettlingTime01	USINT				•
104	MotorSettlingTime02	USINT				•
105	MotorSettlingTime03	USINT				•
106	MotorSettlingTime04	USINT				•
107	DelayedCurrentSwitchOff01	USINT				•
108	DelayedCurrentSwitchOff02	USINT				•
109	DelayedCurrentSwitchOff03	USINT				•
110	DelayedCurrentSwitchOff04	USINT				•
Communication						
73	LifeCnt	SINT	•			
112	SetTime01	INT			•	
114	SetTime02	INT			•	
116	SetTime03	INT			•	
118	SetTime04	INT			•	
20	Motor1Step0	UINT			•	
28	Motor2Step0	UINT			•	
36	Motor3Step0	UINT			•	
44	Motor4Step0	UINT			•	
74	MotorLoad	UINT	•			
0	ActPos01	INT	•			
2	ActPos02	INT	•			

Register	Name	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
4	ActPos03	INT	•			
6	ActPos04	INT	•			
220	ActTime01	INT	•			
220	ActTime02	INT	•			
220	ActTime03	INT	•			
220	ActTime04	INT	•			
100	Motor current	UINT			•	
	DriveEnable01	Bit 0				
	BoostCurrent01	Bit 1				
	StandstillCurrent01	Bit 3				
	...	...				
	DriveEnable04	Bit 12				
	BoostCurrent04	Bit 13				
	StandstillCurrent04	Bit 14				
70	Error acknowledgment	USINT			•	
	ClearError01	Bit 0				
	...	...				
	ClearError04	Bit 3				
10	Module status	USINT	•			
	DrvOk01	Bit 0				
	...	...				
	DrvOk04	Bit 3				
	ModulePowerSupplyError	Bit 7				
8	Motor error	UINT	•			
	StallError01	Bit 0				
	OvertemperatureError01	Bit 1				
	OpenLoadError01	Bit 2				
	OvercurrentError01	Bit 3				
	...	...				
	StallError04	Bit 12				
	OvertemperatureError04	Bit 13				
	OpenLoadError04	Bit 14				
	OvercurrentError04	Bit 15				

17.4 Function model 254 - Bus controller and function model 3 - Ramp

Register	Offset[1)]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
Configuration							
48	-	ConfigOutput03a (holding current for channel 1)	USINT				•
49	-	ConfigOutput04a (nominal current for channel 1)	USINT				•
50	-	ConfigOutput05a (maximum current for channel 1)	USINT				•
112	-	ConfigOutput06a (holding current for channel 2)	USINT				•
113	-	ConfigOutput07a (nominal current for channel 2)	USINT				•
114	-	ConfigOutput08a (maximum current for channel 2)	USINT				•
176	-	ConfigOutput09a (holding current for channel 3)	USINT				•
177	-	ConfigOutput10a (nominal current for channel 3)	USINT				•
178	-	ConfigOutput11a (maximum current for channel 3)	USINT				•
240	-	ConfigOutput12a (holding current for channel 4)	USINT				•
241	-	ConfigOutput13a (nominal current for channel 4)	USINT				•
242	-	ConfigOutput14a (maximum current for channel 4)	USINT				•
52	-	MaxSpeed01	UINT				•
116	-	MaxSpeed02	UINT				•
180	-	MaxSpeed03	UINT				•
244	-	MaxSpeed04	UINT				•
54	-	MaxAcc01	UINT				•
56	-	MaxDec01	UINT				•
118	-	MaxAcc02	UINT				•
120	-	MaxDec02	UINT				•
182	-	MaxAcc03	UINT				•
184	-	MaxDec03	UINT				•
246	-	MaxAcc04	UINT				•
248	-	MaxiDec04	UINT				•
58	-	RevLoop01	INT				•
122	-	RevLoop02	INT				•
186	-	RevLoop03	INT				•
250	-	RevLoop04	INT				•
60	-	FixedPos01a	DINT				•
64	-	FixedPos01b	DINT				•
124	-	FixedPos02a	DINT				•
128	-	FixedPos02b	DINT				•
188	-	FixedPos03a	DINT				•
192	-	FixedPos03b	DINT				•
250	-	FixedPos04a	DINT				•
252	-	FixedPos04b	DINT				•
68	-	RefSpeed01	UINT				•
132	-	RefSpeed02	UINT				•
196	-	RefSpeed03	UINT				•
260	-	RefSpeed04	UINT				•
70	-	RefConfig01	SINT				•
134	-	RefConfig02	SINT				•
198	-	RefConfig03	SINT				•
262	-	RefConfig04	SINT				•
51	-	StallDetectConfig01	USINT				•
115	-	StallDetectConfig02	USINT				•
179	-	StallDetectConfig03	USINT				•
243	-	StallDetectConfig04	USINT				•
74	-	StallRecognitionDelay01	USINT				•
138	-	StallRecognitionDelay02	USINT				•
202	-	StallRecognitionDelay03	USINT				•
266	-	StallRecognitionDelay04	USINT				•
78	-	StallDetectMinSpeed01	UINT				•
142	-	StallDetectMinSpeed02	UINT				•
206	-	StallDetectMinSpeed03	UINT				•
270	-	StallDetectMinSpeed04	UINT				•
75	-	JoltTime01	USINT				•
139	-	JoltTime02	USINT				•
203	-	JoltTime03	USINT				•
267	-	JoltTime04	USINT				•

Register	Offset[1)]	Name	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
308	-	GeneralConfig01	USINT				•
448	-	PositionLimitMin01	DINT				•
452	-	PositionLimitMax01	DINT				•
456	-	PositionLimitMin02	DINT				•
460	-	PositionLimitMax02	DINT				•
464	-	PositionLimitMin03	DINT				•
468	-	PositionLimitMax03	DINT				•
472	-	PositionLimitMin04	DINT				•
476	-	PositionLimitMax04	DINT				•
Communication							
0	0	AbsPos01	DINT			•	
8	8	AbsPos02	DINT			•	
16	16	AbsPos03	DINT			•	
24	24	AbsPos04	DINT			•	
6	6	MpGenMode01	SINT			•	
14	14	MpGenMode02	SINT			•	
22	22	MpGenMode03	SINT			•	
30	30	MpGenMode04	SINT			•	
4	4	MpGenControl01	UINT			•	
12	12	MpGenControl02	UINT			•	
20	20	MpGenControl03	UINT			•	
28	28	MpGenControl04	UINT			•	
0	0	AbsPos01ActVal	DINT	•			
8	8	AbsPos02ActVal	DINT	•			
16	16	AbsPos03Val	DINT	•			
24	24	AbsPos04Val	DINT	•			
4	4	MpGenStatus01	UINT	•			
12	12	MpGenStatus02	UINT	•			
20	20	MpGenStatus03	UINT	•			
28	28	MpGenStatus04	UINT	•			
86	-	RefPos01CyclicCounter	DINT		•		
150	-	RefPos02CyclicCounter	DINT		•		
214	-	RefPos03CyclicCounter	DINT		•		
278	-	RefPos04CyclicCounter	DINT		•		
80	-	ControlReadback01	UINT		•		
144	-	ControlReadback02	UINT		•		
208	-	ControlReadback03	UINT		•		
272	-	ControlReadback04	UINT		•		
82	-	ModeReadback01	SINT		•		
146	-	ModeReadback02	SINT		•		
210	-	ModeReadback03	SINT		•		
274	-	ModeReadback04	SINT		•		
98	-	ErrorCode01	UINT		•		
162	-	ErrorCode02	UINT		•		
226	-	ErrorCode03	UINT		•		
290	-	ErrorCode04	UINT		•		

1) The offset specifies the position of the register within the CAN object.

17.4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use additional registers and functions depending on the fieldbus used.

For detailed information, see section "Additional information - Using I/O modules on the bus controller" of the X67 user's manual (version 3.30 or later).

17.4.2 CAN I/O bus controller

The module occupies 4 analog logical slots on CAN I/O.

17.5 Register description: Function model "Standard", general registers

17.5.1 Configuration registers

17.5.1.1 Stall threshold

Name:
ConfigOutput01

The SM module features integrated sensorless load measurement for the motor axis. This is especially useful for detecting a "stall condition" (e.g. if the motor moves to the endpoint during a homing procedure). It cannot be used for torque monitoring during dynamic movements.

With the "stall threshold" register, a threshold can be defined according to the motor load, and the module detects a stall condition started at this threshold (see "Motor error" on page 18).

This threshold value must be determined on a case-by-case basis, since the results of load measurement are influenced by a variety of factors.

- Motor speed: A higher speed results in higher measured values.
- Speeds that cause motor resonances (which interfere with load measurement) are to be avoided.
- Motor accelerations that create a dynamic load (and also affect the measurement) should also be avoided
- It is especially important to be aware that mixed decay mode must be optimized for reliable stall detection (see "Mixed decay threshold" on page 14).

The higher the load measured value, the lower the load. This means that a stall condition is detected if the load measured value drops below the trigger threshold for stall detection.

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 2	Trigger threshold stall detection for Motor 1	0	Stall detection is disabled
		1	Minimum sensitivity for stall detection
		2 to 6	Setting the sensitivity of stall detection
		7	Maximum sensitivity for stall detection
3	Reserved	0	
4 - 6	Trigger threshold stall detection for Motor 2	0	Stall detection is disabled
		1	Minimum sensitivity for stall detection
		2 to 6	Setting the sensitivity of stall detection
		7	Maximum sensitivity for stall detection
7	Reserved	0	
8 - 10	Trigger threshold stall detection for Motor 3	0	Stall detection is disabled
		1	Minimum sensitivity for stall detection
		2 to 6	Setting the sensitivity of stall detection
		7	Maximum sensitivity for stall detection
11	Reserved	0	
12 - 14	Trigger threshold stall detection for Motor 4	0	Stall detection is disabled
		1	Minimum sensitivity for stall detection
		2 to 6	Setting the sensitivity of stall detection
		7	Maximum sensitivity for stall detection
15	Reserved	0	

17.5.1.2 Measuring motor load

Name:
MotorLoad

This register contains the current measured load value for stall detection. This can be used to tune stall detection.

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 2	Motor 1	0 to 7	Motor load value
3	Reserved	-	
4 - 6	Motor 2	0 to 7	Motor load value
7	Reserved	-	
8 - 10	Motor 3	0 to 7	Motor load value
11	Reserved	-	
12 - 14	Motor 4	0 to 7	Motor load value
15	Reserved	-	

17.5.1.3 Mixed decay threshold

Name:
ConfigOutput16

The mixed decay threshold is configured in this register. This value must be adjusted according to the motor being used, current and voltage when using "stall detection" on page 13. Otherwise, the default value 15 will be used.

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 3	Mixed Decay Threshold Motor 1	0	Mixed decay disabled
		1 to 14	Setting for mixed decay threshold
		15	Mixed decay always enabled
4 - 7	Mixed Decay Threshold Motor 2	0 to 15	See motor 1
8 - 11	Mixed Decay Threshold Motor 3	0 to 15	See motor 1
12 - 15	Mixed Decay Threshold Motor 4	0 to 15	See motor 1

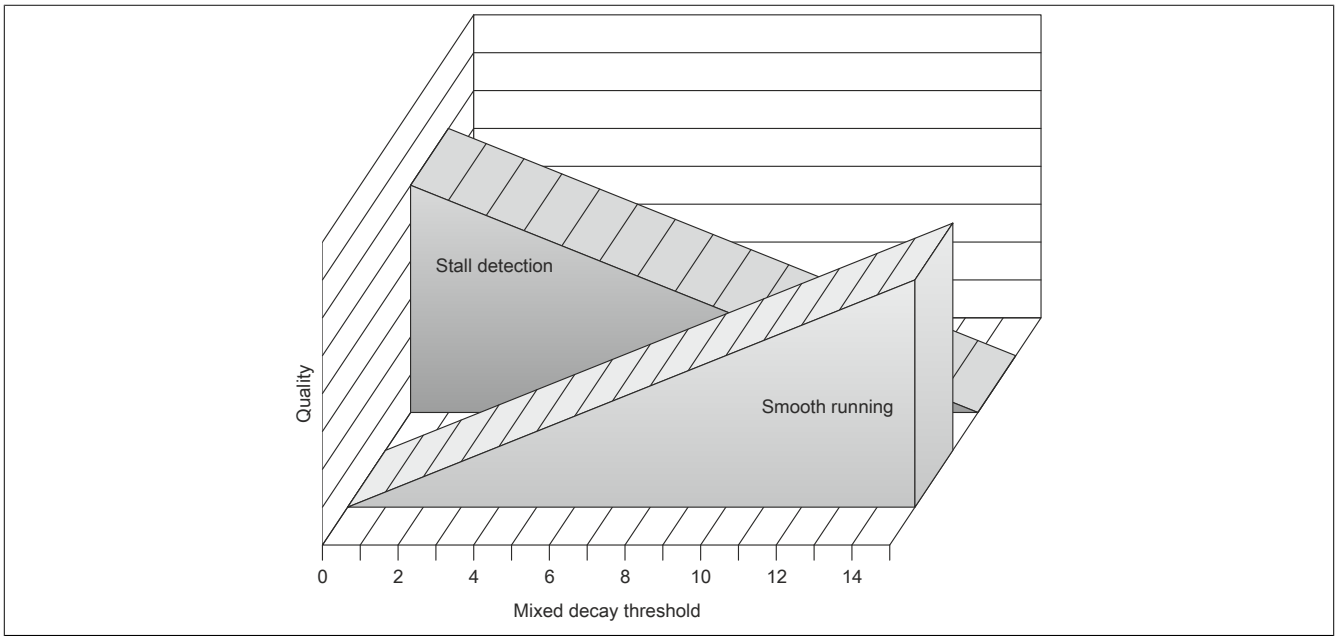
Mixed decay modules provide a greatly optimized sinusoidal current profile in the individual phases of the stepper motor, especially for fast current changes and low current values.

Mixed decay interferes with reliable stall detection, however. For this reason, mixed decay mode can be disabled during stall detection (motor load measurement) using the mixed decay threshold. The smaller the configured mixed decay threshold, the larger the range in which mixed decay is disabled while motor load measurement takes place.

Mixed decay mode is always enabled if the mixed decay threshold is set to 15.

Relationship between stall detection and mixed decay

Depending on the application and the motor used, satisfactorily smooth operation can be achieved while using stall detection by setting the mixed decay threshold to a value between 1 and 14. This is a compromise between smooth operation and stall detection quality and must be fine tuned during commissioning.



17.5.1.4 Minimum speed for stall detection

Name:
StallDetectMinSpeed01 to StallDetectMinSpeed04

If the motor speed exceeds the value set in this register, then stall detection is enabled and the configured "mixed decay threshold" on page 14 is used. The value 15 is always used for the mixed decay threshold below this threshold value, and no stall error is reported. This means that mixed decay mode is always enabled at low speeds where stall detection principally does not work.

Data type	Value	Information
UINT	0 to 65535	Minimum speed in steps per second.

17.5.1.5 Holding current, rated current and maximum current

Name:
ConfigOutput03 to ConfigOutput14

The holding current, nominal current and maximum current registers are used to configure the desired motor current.

Reasonable values are:

- Holding current < Nominal current < Maximum current

The motor's nominal current is entered in the nominal current register according to the motor's data sheet.

Register	Description
Nominal current	Current during normal operation
Maximum current	Should be selected if a higher motor torque is required briefly during acceleration phases.
Holding current	The holding current should be used in situations when less torque is required (e.g. at a standstill). This reduces the amount of heat generated by the motor.

Switching between preset current values (holding current, rated current, maximum current):

Function model	Switching between preset current values at runtime
Standard	Using bits 14 and 15 in the registers "Number of steps and direction" on page 21
Standard with enabled SDC information	Using the register "Motor current" on page 24

Data type	Value	Unit
USINT	0 to 150	Percent of the module's rated current • 100% corresponds to the rated current of the motor bridge power unit listed in the technical data • 150% corresponds to the maximum current of the motor bridge power unit listed in the technical data

17.5.2 Communication registers

17.5.2.1 Module status

Name:
DrvOk01 to DrvOk04 (only for standard function model with SDC)
ModulePowerSupplyError

The status of the drive is indicated in this register.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit				Description	Value	Information
Motor 1	Motor 2	Motor 3	Motor 4			
0	1	2	3	DrvOk01-04[1)]	0	An error was triggered for the motor axis
					1	The drive is running error-free
4 - 6				Reserved	0	
7				ModulePowerSupplyError	0	I/O power supply voltage within the valid range
					1	I/O power supply voltage outside the valid range

1) Only for standard function model with SDC

Status of the drive

The status of the drive is only shown in the standard function model when SDC information is enabled. Bit DrvOk is 1 if the following conditions are met:

- Motor turned on (see "Motor current" on page 24)
- Motor is supplied with current
- Motor settling time has passed
- Supply voltage is in the valid range
- No overtemperature fault
- Preset position value is valid (see "SDC life sign monitoring" on page 23)

17.5.2.2 Motor error

Name:
StallError01 to StallError04
OvertemperatureError01 to OvertemperatureError04
OpenLoadError01 to OpenLoadError04
OvercurrentError01 to OvercurrentError04

The error status of the drive is indicated in this register. Each bit indicates a certain error. If an error is registered in bits 0 to 15, then the corresponding bit remains set until the error has been acknowledged (see "Error acknowledgment" on page 19).

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit				Description	Value	Information
Motor 1	Motor 2	Motor 3	Motor 4			
0	4	8	12	StallError01-04	0	No stall
					1	Stall
1	5	9	13	OvertemperatureError01-04	0	No overtemperature
					1	Overtemperature
2	6	10	14	OpenLoadError01-04	0	No current error
					1	Current error
3	7	11	15	OvercurrentError01-04	0	No overcurrent
					1	Overcurrent

Stall error

The stall error bit is set if the load measurement value is below the stall threshold.

Overtemperature error

The "Overtemperature" error bit can be set for the following reasons:

- A specific temperature was exceeded near the channel due to overload
- Module temperature exceeds 85°C

Current error

This error bit occurs whenever the required current cannot be supplied to the motor windings. This can be (but is not necessarily) caused by an open line. At higher speeds (depending on the motor), this error can also occur without an open line. In this case it is simply no longer possible to supply the desired current to the motor windings. Because of the Back-EMF on the motor, this bit is set at slightly lower speeds if the motor is operated with no load compared with full or partial loads.

Overcurrent error

Overcurrent occurs if the motor current measured in the motor windings is twice as high as it should be (e.g. short circuit).

17.5.2.3 Error acknowledgment

Name:

Standard functional model without SDC	Standard functional model with SDC
ErrorReset01	ClearError01
ErrorReset02	ClearError02
ErrorReset03	ClearError03
ErrorReset04	ClearError04

This register can be used to acknowledge errors that have occurred on the motor.

For more info, see "Motor error" on page 18.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0	ClearError01 or ErrorReset01	0	No effect
		1	Error acknowledgment for motor 1
1	ClearError02 or ErrorReset02	0	No effect
		1	Error acknowledgment for Motor 2
2	ClearError03 or ErrorReset03	0	No effect
		1	Error acknowledgment for motor 3
3	ClearError04 or ErrorReset04	0	No effect
		1	Error acknowledgment for motor 4
4 - 7	Reserved	0	

17.5.2.4 Current position

Name:

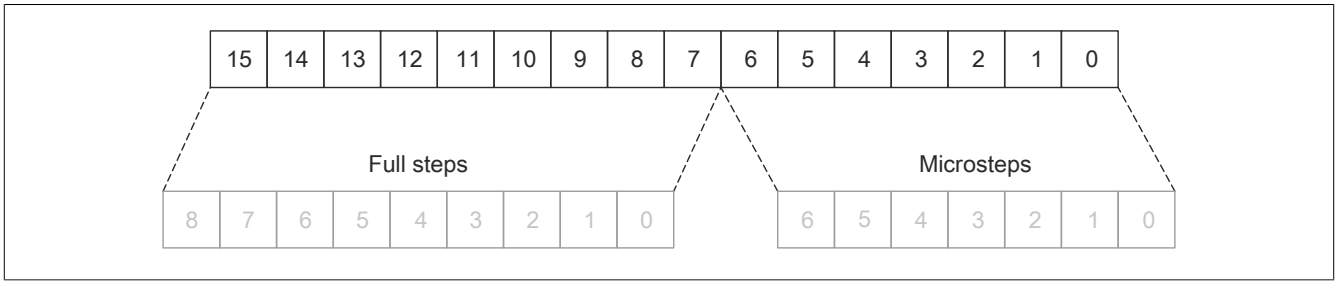
Standard functional model without SDC	Standard functional model with SDC
Position1Sync	ActPos01
Position2Sync	ActPos02
Position3Sync	ActPos03
Position4Sync	ActPos04

This register represents the motor position calculated by the module (position setpoint). Each of these is a cyclic 16-bit counter for each channel.

The lowest 5 to 8 bits represent microsteps, while the highest 8 to 11 bits represent full steps (depending on bits 5 and 6 of the "Module configuration" on page 20).

Data type	Values
INT	-32768 to 32767

Example of the "current position" format (7-bit microsteps, i.e. setting bits 5 and 6 of the module configuration register to binary 10):



Information:

The smallest physical full-step division of the modules that is possible is 1/64 of a full-step. Therefore, bits with a rating of 1/128 or 1/256 of a full-step remain 0. This must be taken into consideration if this position register is used for controller feedback.

17.6 Register description: Function model "Standard" without SDC information

17.6.1 Configuration registers

17.6.1.1 Module configuration

Name:
ConfigOutput02

The number of transfer values and the resolution of microsteps for the drive can be configured in this register.

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 2	Reserved	0	
3 - 4	Number of transfer values per X2X Link cycle (See "Number of steps and direction" on page 21)	**This setting applies to all 4 channels.**	
		00	1x Δs / Δt (transfer values: MotorXStep1)
		01	2x Δs / Δt (transfer values: MotorXStep1 - MotorXStep2)
		10	Reserved
		11	Reserved
5 - 6	Resolution of microsteps for the following registers: • "Number of steps and direction" on page 21 • "Current position" on page 19	00	Resolution: 5 bits (bit 0 - 4) microsteps; 8 bits (bit 5 - 12) full steps
		01	Resolution: 6 bits (bit 0 - 5) microsteps; 7 bits (bit 6 - 12) full steps
		10	Resolution: 7 bits (bit 0 - 6) microsteps; 6 bits (bit 7 - 12) full steps
		11	Resolution: 8 bits (bit 0 - 7) microsteps; 5 bits (bit 8 - 12) full steps
7 - 10	Reserved	0	
11	Operating mode	0	Normal mode (default)
		1	Enhanced mode
12 - 15	Reserved	0	

17.6.2 Communication registers

17.6.2.1 Number of steps and direction

Name:
Motor1Step1 to Motor4Step1
Motor1Step2 to Motor4Step2

These registers are used to specify the number and direction of steps that must be carried out by the module during the next X2X Link cycle, and to select the motor current (see also "Holding current, rated current and maximum current" on page 16).

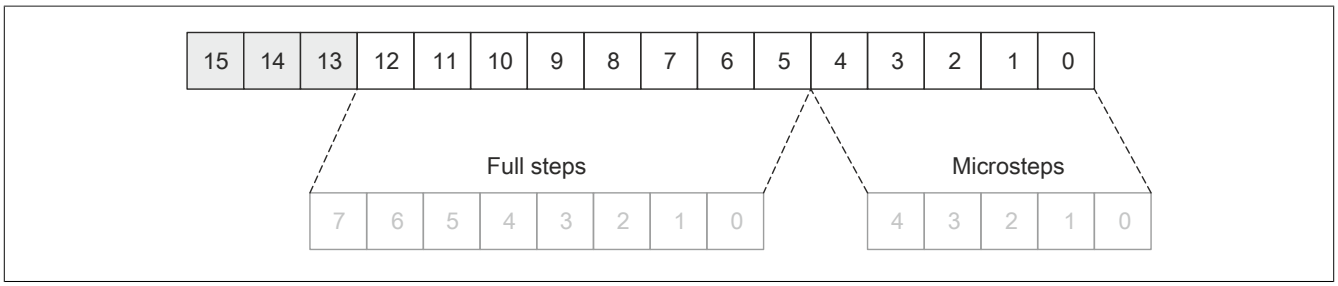
Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 12	Number of steps for the module to move during the next X2X Link cycle	x	
13	Direction of movement	0	Positive
		1	Negative
14 - 15	Selection of motor current	00	Motor not powered
		01	Holding current
		10	Nominal current
		11	Maximum current

Depending on the required resolution and maximum configurable speed, the module configuration can be used to specify which bit position is used as the 1's position for full steps (see bits 5 and 6 of "Module configuration" on page 20).

Example for 5-bit microsteps (set bits 5 and 6 of the module configuration to binary 00):



The number of transfer values per X2X Link cycle is specified by bits 3 and 4 in the module configuration (see "Module configuration" on page 20). If only one transfer value (bits 3 and 4 = 00) is specified, then the motor is advanced by MotorXStepX until the next X2X Link cycle. If 2 or 4 transfer values are specified, then the X2X Link is subdivided accordingly.

Example: X2X Link cycle = 1 ms (1000 µs)

Time	Number of transfer values (see "Module configuration" on page 20)	
	1 (bits 3 - 4 = 00)	2 (bits 3 - 4 = 01)
0 - 500 µs	MotorXStep1	MotorXStep1
500 - 1000 µs		MotorXStep2

17.7 Register description: Function model "Standard" with SDC information

17.7.1 Configuration registers

17.7.1.1 SDC configuration

Name:
SdcConfig01

This register can be used to enable/disable additional SDC information.

Enabling/disabling the SDC information shows or hides additional cyclic registers. It is possible here to compare the two variants of the standard function model, i.e. with and without enabled SDC information.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 5	Reserved	0	
6	SDC life sign monitoring	0	Disabled
		1	Enabled
7	SDC information	0	Disabled
		1	Enabled

> **Note:**
>
> **Neither SDC information nor SDC life sign monitoring is permitted to be changed at runtime.**

17.7.1.2 Motor settling time

Name:
MotorSettlingTime01 to MotorSettlingTime04

The motor settling time determines the minimum time from powering on the motor up to setting the drive bit (DrvOk) (see section "Motor error" on page 18). The setting is made in steps of 10 ms.

Data type	Value	Information
USINT	1 to 255	10 ms to 2.55 s, default: 10 ms

17.7.1.3 Turn-off delay

Name:
DelayedCurrentSwitchOff01 to DelayedCurrentSwitchOff04

If the "SDC life sign monitoring" on page 23 is triggered (i.e. the NetTime timestamp is in the past) the motor is decelerated at nominal current with speed setpoint = 0.

Then the motor is switched off after the delay configured with this register.

Data type	Value	Information
USINT	0 to 255	0 to 25.5 ms in steps of 100 ms (default: 100 ms)

17.7.2 Communication registers

17.7.2.1 Lifecycle counter

Name:
LifeCnt

This register is incremented by one with each X2X Link cycle.

Data type	Values
SINT	-128 to 127

17.7.2.2 SDC life sign monitoring

Name:
SetTime01 to SetTime04

The module uses SDC life sign monitoring to check whether valid values have been received for the speed setpoint. SDC life sign monitoring is activated in register "SDC configuration" on page 22 by setting bit 6 (SDCSetTime = on).

If the specified NetTime timestamp is in the past, then an error is triggered for the motor axis (only when the motor is switched on). The module performs the following steps:

1) The CPU is informed of the error using the Drive bit (DrvOk) = 0

2) Braking at configured nominal current with speed setpoint = 0

3) Wait for configured turn-off delay to expire

4) Power off motor

When the timestamp is back within the valid range, the motor can be operated again by a rising edge on the DriveEnable bit (see section "Motor current" on page 24).

Data type	Values
INT	-32768 to 32767

17.7.2.3 Number of steps and direction

Name:
Motor1Step0 to Motor4Step0

This registers is used to specify the number and direction of steps that should be carried out by the module during the next X2X cycle.

The value is specified with a resolution of 1/256 of a full step (corresponds to 8-bit microsteps).

The direction of movement is derived from the value's sign:

Data type	Values	Information
INT	>0	Movement in positive direction in 1/256 full steps
	<0	Movement in negative direction in 1/256 full steps

Unlike the standard function model without enabled SDC information, the motor current is selected using a separate register (see register "Motor current" on page 24).

17.7.2.4 Motor current

Name:
DriveEnable01 to DriveEnable04
BoostCurrent01 to BoostCurrent04
StandstillCurrent01 to StandstillCurrent04

Bits 0 to 14 of this register can be used to control the motors' current supply.

Data type	Values
USINT	See the bit structure.

Bit structure:

Bit				Description	Value	Information
Motor 1	Motor 2	Motor 3	Motor 4			
0	4	8	12	DriveEnable01-04	x	Motor powered
1	5	9	13	BoostCurrent01-04	x	Maximum current
2	6	10	14	StandstillCurrent01-04	x	Holding current
3	7	11	15	Reserved	0	

The possible status of bits 0 to 14

StandstillCurrent0x	BoostCurrent0x	DriveEnable0x	Description
x	x	0	Motor not supplied with current
0	0	1	Rated current supplied to motor
0	1	1	Maximum current supplied to motor
1	0	1	Holding current supplied to motor
1	1	1	Holding current supplied to motor

17.7.2.5 NetTime of the position value

Name:
ActTime01 to ActTime04

This register contains the NetTime of the most recent valid position value.

For more information about NetTime and timestamps, see "NetTime technology" on page 42.

Data type	Values
INT	-32768 to 32767

17.8 Register description: Function model 254 - "Bus controller" and function model 3 - "Ramp"

17.8.1 Configuration registers

17.8.1.1 General configuration

Name:
GeneralConfig01

Bit 0 of this register can be used to switch the positioning mode. This register can also be used to configure the cycle time of the motion profile generator.

- 0: "Mode 1: Position mode without extended control word" on page 33
- 1: "Mode 1: Position mode with extended control word" on page 33

Data type	Values	Bus controller default setting
USINT	See bit structure.	0

Bit structure:

Bit	Description	Value	Information
0	Position mode	0	Without extended control word (bus controller default setting)
		1	With extended control word
1 - 2	Cycle time of the motion profile generator[1)]	00	25 ms (bus controller default setting)
		01	10 ms
		10	5 ms
		11	Reserved
3 - 7	Reserved	0	

1) This parameter is supported starting with upgrade 1.3.1.1 (firmware version 100).

The cycle time for the motion profile generator is configured with this cycle. This cycle time affects the unit for specifying the speed and acceleration:

- Unit for speed: Microsteps/Cycle
- Unit for acceleration: Microsteps/Cycle^2

17.8.1.2 Holding current, rated current and maximum current

Name:
ConfigOutput03a to ConfigOutput14a

The holding current, nominal current and maximum current registers are used to configure the desired motor current.

Reasonable values are:

- Holding current < Nominal current < Maximum current

The motor's nominal current is entered in the nominal current register according to the motor's data sheet.

Register	Description
Nominal current	Current during operation at constant speed
Maximum current	Current during acceleration phases. In the mode "Referencing during stall" on page 36, the rated current is always used instead of the maximum current, even in acceleration phases.
Holding current	Current when motor is at standstill

When the current changes to a weaker value (e.g. when transitioning from the acceleration phase to the constant speed mode), the stronger current is maintained for an additional 100 ms. This is done according to the following priority regardless of the actual defined values: maximum current before rated current before holding current.

Data type	Value	Unit
USINT	0 to 150	Percent of the module's rated current • 100% corresponds to the rated current of the motor bridge power unit listed in the technical data • 150% corresponds to the maximum current of the motor bridge power unit listed in the technical data Bus controller default setting: 0

17.8.1.3 Maximum speed

Name:
MaxSpeed01 to MaxSpeed04

This register defines the maximum speed for the absolute positioning modes (1, -125, -126).

> **Information:**
>
> **The setting does not apply to the speed and homing modes (2, -127, -128).**

Data type	Value	Information
UNIT	0 to 65,535	Speed in microsteps/cycle. Bus controller default setting: 0

17.8.1.4 Maximum acceleration

Name:
MaxAcc01 to MaxAcc04

This register defines the maximum acceleration (also applies to homing modes).

Data type	Value	Information
UINT	0 to 65,535	Acceleration in microsteps/cycle². Bus controller default setting: 0

17.8.1.5 Maximum deceleration

Name:
MaxDec01 to MaxDec04

This register defines the maximum deceleration (also applies to homing modes).

Data type	Value	Information
UINT	0 to 65,535	Brake deceleration in microsteps/cycle². Bus controller default setting: 0

17.8.1.6 Reversing loop

Name:
RevLoop01 to RevLoop04

This parameter is only used in modes 1, -125, -126 (absolute positioning modes).

If the value for the reversing loop is not equal to 0, the target position is approached directly when coming from one direction; when coming from the other direction, the target position is initially overshot by the configured number of steps before finally moving to the target position. This ensures that the target position is always approached from the same direction (to avoid mechanical backlash).

The sign of the defined value determines the direction in which the reversing loop runs.

Sign	Effective direction
Positive	Reversing loop in positive direction of movement
Negative	Reversing loop in negative direction of movement

Data type	Values	Information
INT	-32768 to 32767	Bus controller default setting: 0

17.8.1.7 Fixed position A

Name:
FixedPos01a to FixedPos04a

This register defines the position to move to in mode -125.

Data type	Values	Information
DINT	-2,147,483,648 to 2,147,483,647	Bus controller default setting: 0

17.8.1.8 Fixed position B

Name:
FixedPos01b to FixedPos04b

This register defines the position to move to in mode -126.

Data type	Values	Information
DINT	-2,147,483,648 to 2,147,483,647	Bus controller default setting: 0

17.8.1.9 Homing speed

Name:
RefSpeed01 to RefSpeed04

This register sets the speed for homing modes -127 and -128.

Data type	Value	Information
UINT	0 to 65,535	Speed in microsteps/cycle. Bus controller default setting: 0

17.8.1.10 Homing configuration

Name:
RefConfig01 to RefConfig04

The homing mode can be set with this register.

Data type	Value	Information
SINT	-120	Set home position
	-127	Homing during stall detection[1]. Bus controller default setting
	-128	Immediate homing
	Everything else	No effect

1) Stall detection is enabled automatically when this mode is selected.

17.8.1.11 Stall detection configuration / Mixed decay

Name:
StallDetectConfig01 to StallDetectConfig04

The mixed decay threshold and stall detection sensitivity can be configured in this register.

Data type	Values	Bus controller default setting
USINT	See bit structure.	0

Bit structure:

Bit	Description	Value	Information
0 - 3	Mixed decay threshold	0	Mixed decay disabled (bus controller default setting)
		1 to 14	Setting for mixed decay threshold
		15	Mixed decay always enabled
4 - 6	Stall threshold	0	Stall detection is disabled (bus controller default setting).
		1 to 6	Steps involved in setting stall detection sensitivity
		7	Maximum sensitivity for stall detection
7	Motor load	0	The motor load value is not shown (bus controller default setting).
		1	Show value in register "Status word" on page 32[1]

1) If this bit is 1, then the motor load value is indicated in bits 13 to 15 of the status word register (otherwise these bits are 0). This value can help when testing stall detection and "Home during stall" on page 36 mode.

Stall threshold

The SM module features integrated sensorless load measurement for the motor axis. This is especially useful for detecting a "stall condition" (e.g. if the motor moves to the end point during a homing procedure). It cannot be used for torque monitoring during dynamic movements.

The "stall threshold" (bits 4 to 6 of this register) can be used to define a threshold value for each axis individually according to the motor load, beyond which the motor will detect a stall condition.

This threshold value must be determined on a case-by-case basis, since the results of load measurement are influenced by a variety of factors.

- Motor speed: A higher speed results in higher measurement values
- Speeds that cause motor resonances (which interfere with load measurement) are to be avoided
- Motor accelerations that create a dynamic load (and also affect the measurement) should also be avoided
- It is especially important to be aware that mixed decay mode must be optimized for reliable stall detection.

The higher the load measurement value, the lower the load. This means that a stall condition is detected if the load measurement value drops below the trigger threshold for stall detection.

Mixed decay threshold

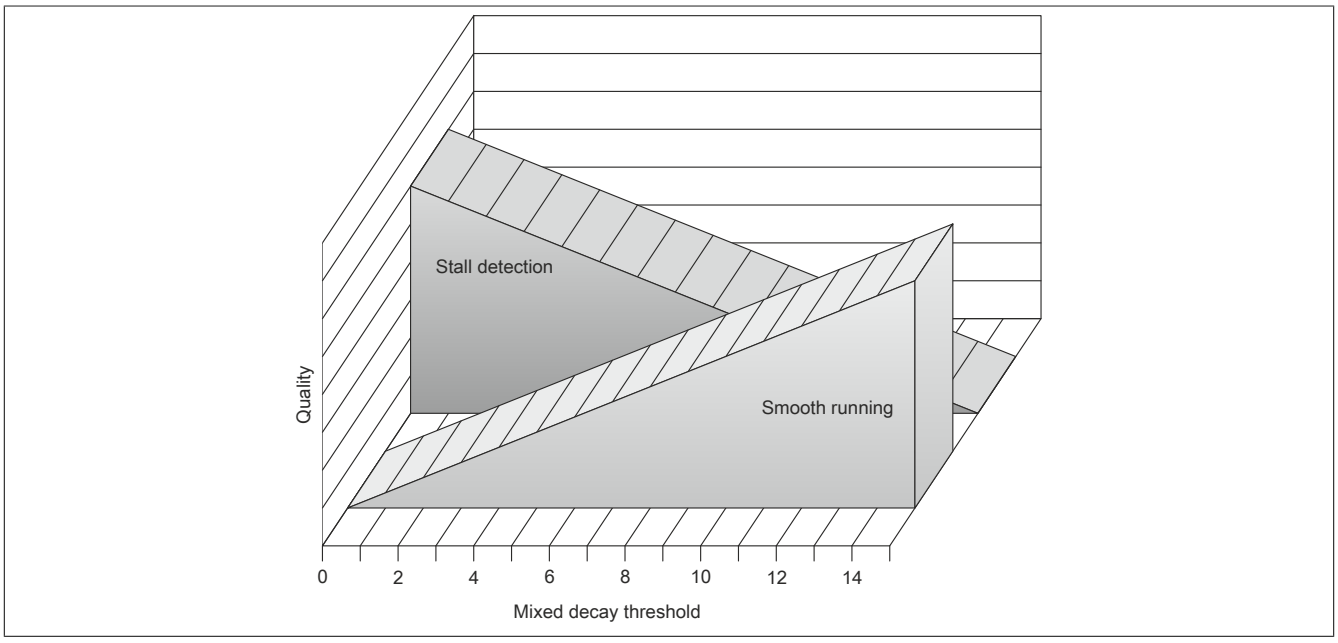
Mixed decay modules provide a greatly optimized sinusoidal current profile in the individual phases of the stepper motor, especially for fast current changes and low current values.

Mixed decay interferes with reliable stall detection, however. For this reason, mixed decay mode can be disabled during stall detection (motor load measurement) using the mixed decay threshold. The smaller the configured mixed decay threshold, the larger the range in which mixed decay is disabled while motor load measurement takes place.

Mixed decay mode is always enabled if the mixed decay threshold is set to 15.

Relationship between stall detection and mixed decay

Depending on the application and the motor used, satisfactorily smooth operation can be achieved while using stall detection by setting the mixed decay threshold to a value between 1 and 14. This is a compromise between smooth operation and stall detection quality and must be fine tuned during commissioning.



17.8.1.12 Minimum speed for stall detection

Name:
StallDetectMinSpeed01 to StallDetectMinSpeed04

If the motor speed exceeds the value set in this register, then stall detection is enabled and the configured "mixed decay threshold" on page 14 is used. The value 15 is always used for the mixed decay threshold below this threshold value, and no stall error is reported. This means that mixed decay mode is always enabled at low speeds where stall detection principally does not work.

Data type	Value	Information
UINT	0 to 65535	Minimum speed in microsteps per cycle. Bus controller default setting: 0

17.8.1.13 Stall recognition delay

Name:
StallRecognitionDelay01 to StallRecognitionDelay04

The value in this register is only relevant for "Referencing during stall" on page 36.

A stall is only detected after the time specified here has expired and after the homing procedure has started.

For example, a setting of 4 (and a cycle time of 25 ms) means that a stall will not be detected until 100 ms after the motor starts moving (start of the homing procedure).

Set to 0 to eliminate delay.

Data type	Value	Information
USINT	0 to 255	In cycles, see "General configuration" on page 25. Bus controller default setting: 0

17.8.1.14 Jolt time

Name:
JoltTime01 to JoltTime04

If a value other than 0 is assigned to this register, then jolt limitation is performed. This is done by averaging the values for the steps to be carried out (speed setpoint) in each cycle using FIFO memory. The jolt time corresponds to the number of FIFO elements (0 to 80). If a value greater than 80 is entered, then it will be limited internally to 80.

Changes made while a motor is running will be applied as soon as ...

- the motor has reached the position setpoint (positioning modes only)
- the motor has stopped (all modes)

Data type	Value	Information
USINT	0	No jerk time limitation. Bus controller default setting
	1 to 80[1)]	Number of FIFO elements

1) Starting with upgrade 1.3.1.1 (firmware version 100); For older versions: 16

17.8.1.15 Software limit

Name:
PositionLimitMin01 to PositionLimitMin04
PositionLimitMax01 to PositionLimitMax04

This register configures software limits. The function is enabled if at least one of the registers is not equal to zero.

These limits are effective in all positioning modes. Position overrun is not possible when this function is enabled. Movement is always contained within the two limits.

If a position is specified that violates the minimum/maximum software limit, the "Internal limit active" bit will be set in the "Status word" on page 32 register. The motor movement will be stopped until a position is specified within the limits.

The "Internal limit active" bit will also be set in the "Status word" register if there is a configuration error (minimum > maximum).

Data type	Values	Information
DINT	-2,147,483,648 to 2,147,483,647	Bus controller default setting: 0

Information:

The software limits will only be monitored when using the following CANopen bus controllers:

- **X20BC0043-10**
- **X20BC0143-10**
- **X67BC4321-10**
- **X67BC4321.L08-10**
- **X67BC4321.L12-10**

17.8.2 Communication registers

17.8.2.1 Setting target position/speed

Name:
AbsPos01 to AbsPos04

This register is used to set position or speed, depending on the operating mode.

- Position mode (see "Mode" on page 32): Cyclic setting of the position setpoint in microsteps. In this mode, one micro-step is always 1/256 full-step.
- Speed mode (see "Mode" on page 32): In this mode, this register is considered a signed speed setpoint.

Data type	Values
DINT	-2,147,483,648 to 2,147,483,647

17.8.2.2 Control word

Name:
MpGenControl01 to MpGenControl04

This register can be used to issue commands based on the module's state.

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0	Switch on	x	
1	Enable voltage	x	
2	Quick stop	x	
3	Enable operation	x	
4 - 6	Mode-specific	x	
7	Fault reset	x	
8	Stop[1)]	x	
9 - 11	Reserved	0	
12	Warning reset	0	No effect
		1	Rising edge: Reset warnings
13	Undercurrent detection	0	Disable current fault detection
		1	Enable current error detection
14	Reserved	0	
15	Stall detection warning	0	Disable stall detection warning
		1	Enable stall detection warning

1) The "Halt" bit is only evaluated when the extended control word is enabled (see "General configuration" on page 25).

17.8.2.3 Status word

Name:
MpGenStatus01 to MpGenStatus04

The bits in this register reflect the state of the state machine. For a more detailed description, see "Status word" on page 39 and "State machine" on page 40.

Bit structure:

Bit	Description	Value	Information
0	Ready to switch on	x	
1	Switched on	x	
2	Operation enabled	x	
3	Fault (error bit)	x	
4	Voltage enabled	x	
5	Quick stop	x	
6	Switch on disabled	x	
7	Warning	x	
8	Reserved	0	
9	Remote	1	Always 1 since there is no local mode for the SM module
10	Target reached	x	
11	Internal limit active	0	No limit violation
		1	Internal limit is active (upper or lower software limit violated)
12	Mode-specific	x	
13 - 15	Reserved / Motor load value	0	Always 0 if bit 7 in register "Stall detection configuration / Mixed decay" on page 27 is set to 0.
		x	Returned motor load value

17.8.2.4 Mode

Name:
MpGenMode01 to MpGenMode04

Data type	Value	Information
SINT	0	No mode selected
	1	Depending on bit 0 in the "General configuration" on page 25 register, the position mode will behave as follows: • Position mode without extended control word: Move to target position as soon as the target position changes • Position mode with extended control word: Move to position setpoint as described in "Mode 1: Position mode with extended control word" on page 33
	2	Speed mode: Constant speed
	-120	Set reference position
	-122	Set actual position
	-125	Move to fixed position A (position set acyclically)
	-126	Move to fixed position B (position set acyclically)
	-127	Positive homing (see also "Homing configuration" on page 27)
	-128	Negative homing (see also "Homing configuration" on page 27)

Information:

For all modes: The "Target reached" bit is set in the "Status word" on page 32 register when the current action is finished (i.e. when the position or speed is reached, depending on the mode).

A new position or speed can be specified even before the current action is finished.

17.8.2.4.1 Mode 1: Position mode

The position setpoint is specified in the "Setting target position/speed" on page 31 register. The motor is then moved to this new position. This is done with a ramp function that accounts for the defined maximum speed and acceleration values.

The position setpoint can also be changed during an active positioning procedure.

The position setpoint is specified in microsteps (1/256 of a full step).

If bit 0 in the "General configuration" on page 25 register is 0 (no extended control word), then the position setpoint will be applied as soon as it is different from the current position. Then the new position is used for the movement.

However, if bit 0 in the "General configuration" on page 25 register is set to 1 (extended control word), then the position setpoint will be applied as described under "Mode 1: Position mode with extended control word" on page 33.

17.8.2.4.2 Mode 1: Position mode with extended control word

Position mode with extended control word behaves like "Position mode 1" on page 33 as described previously (without the extended control word), but the new position setpoint ("Position/Speed" on page 31 register) is applied according to the "extended control word" on page 33.

Extended control word

This register can be used to issue commands based on the module's state (see "Ramp function model operation" on page 38).

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 3	Corresponds to the standard Control word	x	
4	New setpoint	0	Do not apply target position
		1	Apply target position
5	Change set immediately	0	Complete current positioning movement and then start next positioning movement
		1	Interrupt current positioning movement and then start next positioning movement
6	abs / rel	0	Position setpoint is an absolute value
		1	Position setpoint is a relative value
7	Corresponds to the standard Control word	x	
8	Stop[1)]	0	Execute positioning
		1	Stop axis with deceleration
9 - 15	Corresponds to the standard Control word	x	

1) This bit applies to all modes.

Extended status word

The bits in the status word reflect the status of the state machine (for a detailed description, see "Status word" on page 39 and "State machine" on page 40).

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Description	Value	Information
0 - 9	Corresponds to the standard Status word	x	
10	Target reached, depending on bit 8 (Halt) in the Control word register		**If Halt = 0**
		0	Position setpoint not reached
		1	End position reached
			If Halt = 1
		0	Axis decelerating
		1	Axis speed = 0
11	Corresponds to the standard Status word	x	
12	Setpoint acknowledge	0	Ramp generator did not apply the position value
		1	Ramp generator applied the position value
13 - 15	Corresponds to the standard Status word	x	

Position setting

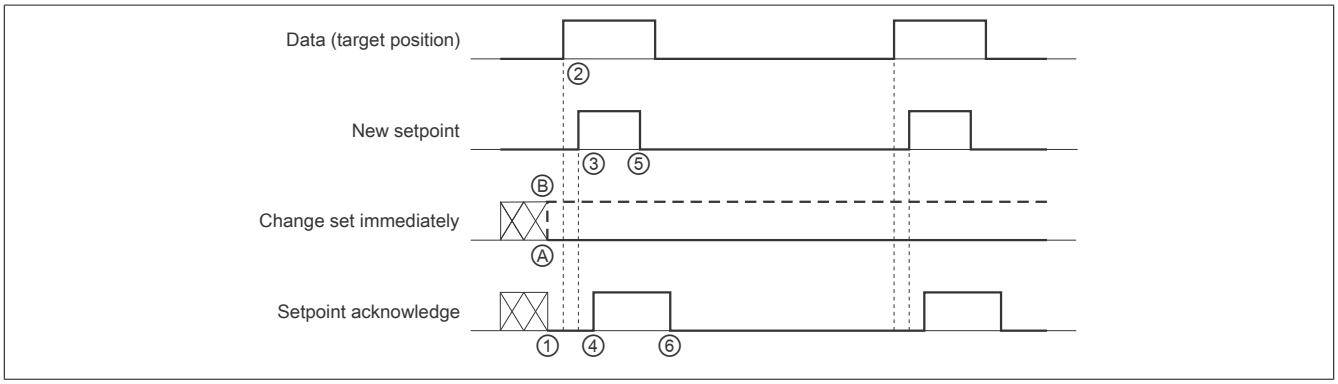
The position setpoint can be defined in 2 different ways:

Type of setpoint definition	Description
Single setpoint	Once the position setpoint is reached, the *Target reached* bit in the "Status word" on page 32 register is set. Then a new position setpoint is defined. The drive stops at each position setpoint before starting the movement to the next position setpoint.
Set of setpoints	Once a setpoint has been reached, the movement to the next setpoint is started immediately without stopping the drive. It is therefore not possible to initiate a new positioning movement by transferring a new position setpoint during an active positioning movement.

The two modes "Single setpoint" and "Set of setpoints" are controlled by the timing of the bits *New setpoint* and *Change set immediately* in the *"extended control word" on page 33* and *Setpoint acknowledge* in the *"Extended control word" on page 33* register.

These bits can be used to create a Request-Response mechanism. This makes it possible to specify a position setpoint while previous setpoint is still being processed.

Transferring the position setpoint



Transferring a new setpoint:

1) When the *Setpoint acknowledge* bit in the "Extended status word" on page 33 register is 0, the module will accept a new position setpoint.
2) The new position setpoint is specified in the *"Setting target position/speed" on page 31*.
3) A rising edge of the *New setpoint* bit in the Extended control word register signals that the new position setpoint in the *"Setting target position/speed" on page 31* register is valid and can be used for the next positioning movement.
4) Once the module has received and saved the new position setpoint, the *Setpoint acknowledge* bit in the *Status word* register is set to 1.
5) Now the controller can reset the *New setpoint* bit to 0.
6) Then the module resets the *Setpoint acknowledge* bit to 0 to signal when a new position setpoint is accepted.

"Single setpoint" mode

When the *Change set immediately* bit is set to 0 (Ⓐ in figure ""), then the module is operating in *Single setpoint* mode. This mechanism results in a speed of 0 when the motor reaches position setpoint x_1 at time t_1. After the controller has been notified that the setpoint has been reached, the next setpoint x_2 will be processed at time t_2 and reached at t_3.

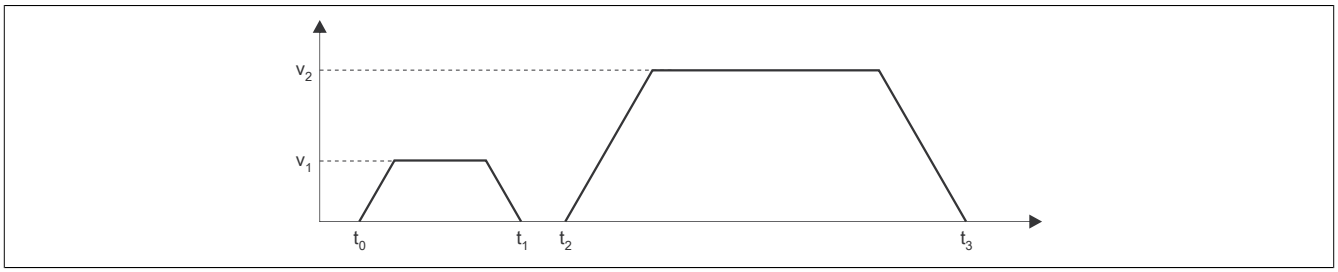


Figure 1: Ramp in *Single setpoint*

"Set of setpoints" preset position value

When the *Change set immediately* bit is set to 1 (Ⓑ in figure ""), then the module is operating in *Single setpoint* mode. This means that the module receives the first position setpoint at t_0. A second position setpoint is received at the time t_1. The drive immediately adapts the current movement to the new setpoint.

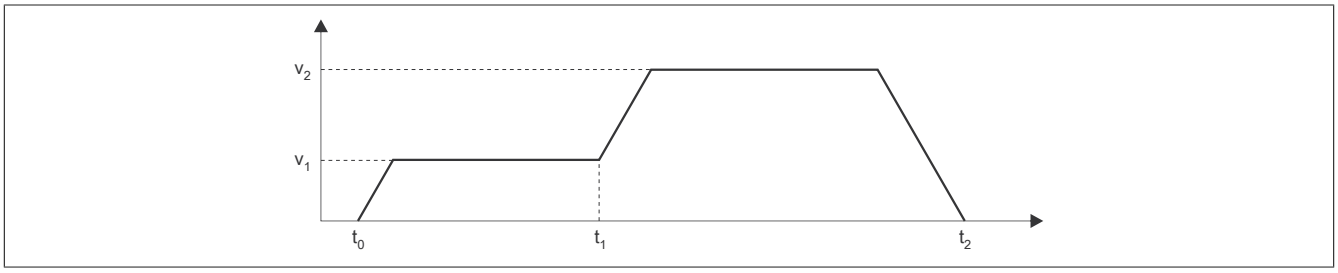


Figure 2: Ramp in *Set of setpoints*

Relative position setting

When the *abs / rel* bit in the Extended control word register is set, then the position setpoint is interpreted as a relative value. At each *New setpoint* trigger, the position setpoint will be increased by this value (or decreased if the value is negative).

If the mode changes between the position settings, relative movement will then proceed starting at the last specified position. The position setpoint mode is initialized with 0 when the module is started.

17.8.2.4.3 Mode 2: Speed mode - Constant speed (pos./neg.)

The value in the "Position/Speed" on page 31 register is now interpreted as the speed setpoint (microsteps/ cycle).

Observing the maximum permissible acceleration, the motor moves with a ramp to the desired speed setpoint and maintains this speed until a new speed setpoint is specified.

Values are allowed within the range -65535 to 65535. When a value is entered outside of this range, it is readjusted to these limits.

17.8.2.4.4 Mode -120: Set home position

This mode is supported starting with upgrade 1.3.1.1 (firmware version 100).

The current value for the actual position is modified so that the position specified by the "Position/Speed" on page 31 register is the home position. If you subsequently move to this position, the motor is at the home position.

The home position in the "Home position" on page 37 register is also set to this value.

Before this mode is called, the motor must be at a standstill and the home position must have been determined using "Positive / negative homing" on page 36 mode. In order to set the position, the "State machine" on page 40 must be in the "Operation Enable" state.

17.8.2.4.5 Mode -122: Set the actual position

The position setpoint set in the "Position/Speed" on page 31 register is accepted as the current actual position in the internal position counter when the state machine is in the "Operation Enable" state.

Before this mode is started, the motor must be at a standstill and physically located at the point for which the position being set should be applied.

17.8.2.4.6 Mode -125/-126: Move to fixed position X

The purpose of these modes is to enable a virtual switch from the speed mode to the position mode, which otherwise is not possible because of the double use of the register for position – and speed specification.

- Mode -125: "Fixed position A" on page 26
- Mode -126: "Fixed position B" on page 27

17.8.2.4.7 Mode -127/-128: Homing (positive/negative)

Mode -127 and -128 are used to select which direction to move.

The motor must be at a standstill before switching from another mode to one of the homing modes.

If the referencing condition occurs, then the motor stops and the values of the position counter valid at the moment when the referencing condition occurs are written to the "Referenced zero position" on page 37 register.

Whether homing should occur during a stall or unconditionally must be set in the "homing configuration" on page 27.

Referencing during stall

Movement continues in the referencing direction until a stall is detected. When a stall is detected, the value of the position counter is entered in the "Referenced zero position" on page 37 register within one millisecond. The motor is then stopped abruptly (not using the deceleration ramp). However, it can take up to 25 ms to stop the motor because the ramp generator runs with a configurable internal cycle of up to 25 ms (see "General configuration" on page 25).

In this mode, the rated current is always used instead of the maximum current, even in acceleration phases.

To test the response behavior of this homing mode, the motor load value used for identifying a stall can be made visible in the status word (see "Stall detection configuration / Mixed decay" on page 27).

Unconditional referencing (immediate)

Immediate referencing: The current values of the position counter are immediately entered in register "homed zero position" on page 37, no motor movement.

17.8.2.5 Current position (cyclic)

Name:
AbsPos01ActVal to AbsPos04ActVal

This cyclic register contains the current position.

Default: Value of the internal step counter

Data type	Values
DINT	-2,147,483,648 to 2,147,483,647

17.8.2.6 Homing the zero position for cyclic counter

Name:
RefPos01CyclicCounter to RefPos04CyclicCounter

After a referencing procedure, the reference position of the position counter can be read with these registers.

Data type	Values
DINT	-2,147,483,648 to 2,147,483,647

17.8.2.7 Read back control word

Name:
ControlReadback01 to ControlReadback04

This register can be used to read the content of the "Control word" on page 31 register.

Data type	Values
UINT	0 to 65,535

17.8.2.8 Read back mode

Name:
ModeReadback01 to ModeReadback04

This register can be used to read the content of the "Mode" on page 32 register.

Data type	Values
SINT	-128 to 127

17.8.2.9 Error code

Name:
ErrorCode01 to ErrorCode04

The cause of an error or warning can be read in this register.

Data type	Error code	Error type	Priority	Description
UINT	0x0000	-	-	No error
	0x3000	Errors	Portrait	Voltage
	0x4200	Errors	:	Overtemperature
	0x2300	Warning	:	Overcurrent
	0xFF00	Warning	:	Current error[1)]
	0xFF01	Warning	:	Stall [2)]
			:	
			Low	

1) A current error is only detected if bit 13 = 1 in the control word (current error detection enabled).
2) Stall is only detected if bit 15 = 1 in the control word (stall detection warning enabled).

Information regarding the handling of errors and warnings:

- Bit 3 (Fault) and bit 7 (Warning) in the "status word" on page 32 can be used to query whether an error or a warning was reported in the Error code register.
- Bit 7 (Fault Reset) and bit 12 (Warning Reset) in the "control word" on page 31 are used to acknowledge pending errors and warnings.
- If two or more errors/warnings are pending, the one with the highest priority (the order in the table above) will be displayed in the Error code register.

17.8.3 Ramp function model operation

Control for this model has been based on the CANopen communication profile DS402.

Commands for controlling the modules are written to the "Control word" on page 38. The current module state is returned to the "Status word" on page 39 register. The function mode (absolute position, constant speed, homing, etc.) is set in the "Mode" on page 32 register.

17.8.3.1 Control word

Control word bits and their state for the commands of the state machine:

Com-mand	Stall detection warning	Reserved	Current error detection	Warning reset	Reserved	Reserved	Reserved	Stop 2)	Fault reset	Mode-specific	Mode-specific	Mode-specific	Enable operation	Quick stop	Enable voltage	Switch on
Bit[1]	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Shut-down	x	0	x	x	x	0	0	x	0	x	x	x	x	1	1	0
Switch on	x	0	x	x	x	0	0	x	0	x	x	x	0	1	1	1
Disable voltage	x	0	x	x	x	0	0	x	0	x	x	x	x	x	0	x
Quick stop	x	0	x	x	x	0	0	x	0	x	x	x	x	0	1	x
Disable opera-tion	x	0	x	x	x	0	0	x	0	x	x	x	0	1	1	1
Enable opera-tion	x	0	x	x	x	0	0	x	0	x	x	x	1	1	1	1
Fault reset	x	0	x	x	x	0	0	x	↑	x	x	x	x	x	x	x

1) x ... Any; ↑ ... Rising edge
2) Bit 8 (stop) is only evaluated if the extended control word is enabled in register "General configuration" on page 25.

Bits 0, 1, 2, 3 and 7 (light gray in the previous table)	These bits control the state of the "State machine" on page 40 according to the commands in the table above.
Halt	0 ... Perform motor movement 1 ... Stop axis with deceleration This bit is only evaluated when the extended control word is activated in the "General configuration" on page 25 register.
Warning reset	A rising edge resets warnings (no effect on errors, which are reset using "Fault Reset"; the state machine is not affected by this bit)
Fault reset	A rising edge resets errors and warnings (see "State machine" on page 40)
Current error detection	0 ... Current error detection disabled 1 ... Current error detection enabled
Stall detection warning	0 ... Stall detection warning disabled 1 ... Stall detection warning enabled

17.8.3.2 Status word

The individual bits of this register and its states depend on the current state of the state machine:

Status	Reserviert / MotorLoadBit 2 [1]	Reserviert / MotorLoadBit 1 [1]	Reserviert / MotorLoadBit 0 [1]	Reserved	Int. limit active	Target reached	Remote	Reserved	Warning	Switch on disabled	Quick stop	Voltage enabled	Fault	Operation enabled	Switched on	Ready to switch on
Bit	**15**	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Not ready to switch on	x	x	x	x	x	x	1	0	x	0	x	0	0	0	0	0
Switch on disabled	x	x	x	x	x	x	1	0	x	1	x	0	0	0	0	0
Ready to switch on	x	x	x	x	x	x	1	0	x	0	1	0	0	0	0	1
Switched on	x	x	x	x	x	x	1	0	x	0	1	1	0	0	1	1
Operation enable	x	x	x	x	x	x	1	0	x	0	1	1	0	1	1	1
Quick stop active	x	x	x	x	x	x	1	0	x	0	0	1	0	1	1	1
Fault reaction active	x	x	x	x	x	x	1	0	x	0	x	0	1	1	1	1
Fault	x	x	x	x	x	x	1	0	x	0	x	0	1	0	0	0

1) If bit 7 is set to 1 in the "Mixed Decay / Stall Detection" on page 27 register, then the motor load value is returned in bits 13-15 of the status word. Otherwise these bits are always 0.

Information about the status word:

Bits 0, 1, 2, 3, 5 and 6 (light gray in the previous table)	These bits are set according to the current state of the "State machine" on page 40.	
Voltage enabled	Becomes 1 as soon as the motor is powered	
Warning	Becomes 1 if a warning is detected ("Overcurrent", "Undercurrent"). The type of warning is indicated in the "Error code" on page 37 register. The highest priority error / warning is shown in each case, with the priority corresponding to the order in the respective table. Warnings can be reset with a rising edge on the "Warning reset" bit in the control word.	
Remote	Always 1 since there is no local mode on the SM module	
Target reached[1], depending on bit 8 (Halt) in the register Control word	**If Halt = 0**	**If Halt = 1**
	In modes 1, -125, -126 (absolute positioning): 0...Positioning begins 1...Target has been reached **In mode 2 (constant speed):** 0...Motor accelerates/brakes 1...Speed setpoint reached **In modes -127 and -128 (homing):** 0...Homing started 1...Homing ended **In mode -122 (set actual position):** The bit briefly becomes 0 and immediately becomes 1 again as soon as the position is set.	**In all modes:** 0...Axis decelerating 1...Axis speed = 0
Internal limit active	0 ... No limit violation 1 ... Internal limit is active (upper/lower software limit violated)	

1) If Halt has not been activated in the "General configuration" on page 25 register, then "Target Reached" behaves the same as when Halt = 0.

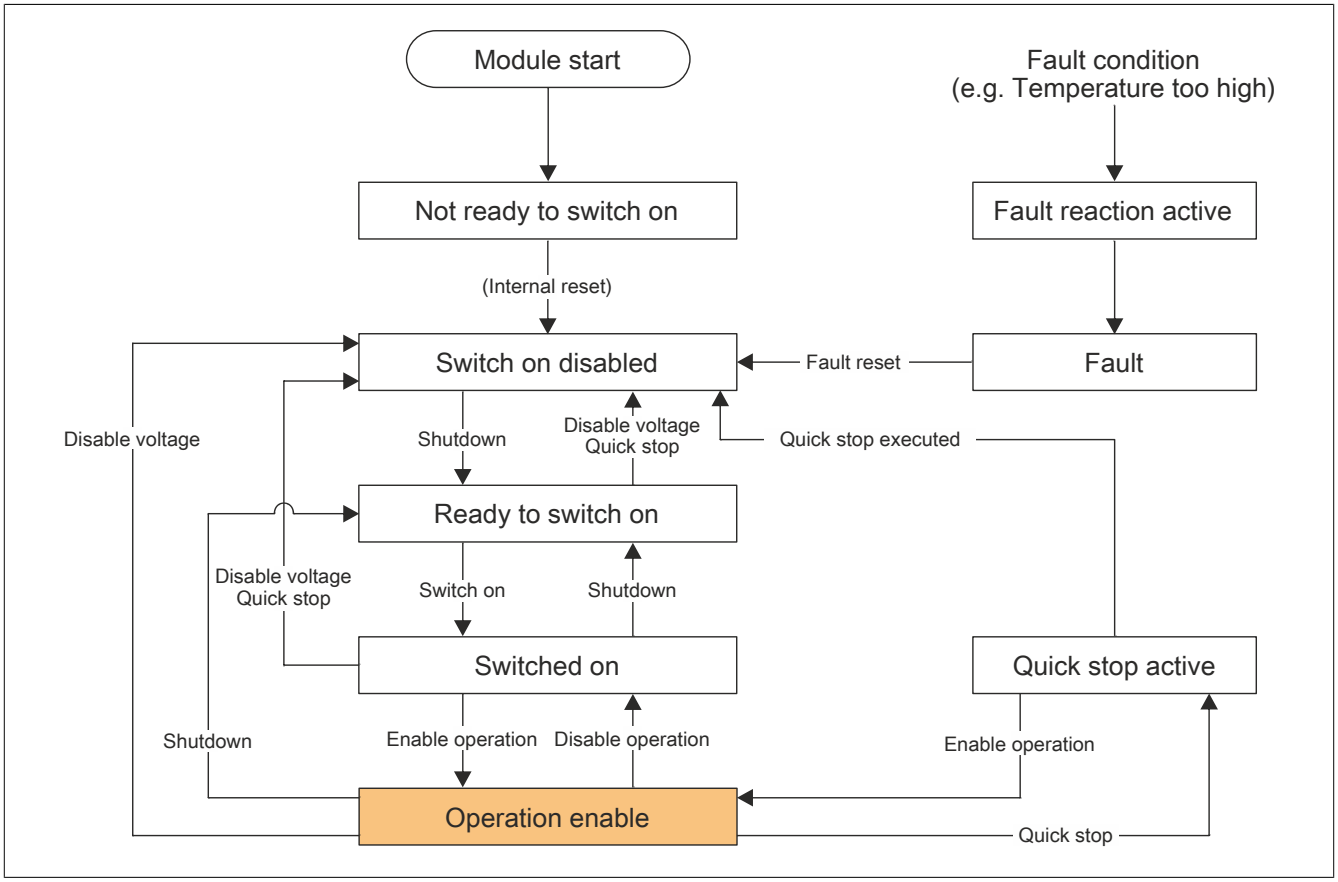
17.8.3.3 State machine

The motor is controlled according to the state machine illustrated below. After the module is started, the state machine automatically changes to the state "*Not ready to switch on*". The application then operates the state machine by writing commands to the "Control word" on page 38.

The state machine successively reaches the states "*Ready to switch on*", "*Switched on*" and "*Operation enable*" by writing the consecutive commands "*Shutdown*", "*Switch on*" and "*Enable operation*".

Information:

Motor movements are not performed according to the setting in the "Mode" on page 32 register (see section) until the "*Operation enable*" state.



State change	Description
Not ready to switch on → Switch on disabled	This state change occurs automatically after starting the module and internal initialization has taken place.
Switch on disabled → Ready to switch on	This state change is brought on by the *Shutdown* command. No others actions are performed.
Ready to switch on → Switch on disabled	This state change is brought on by the command *Disable voltage* or *Quick stop*. No others actions are performed.
Switched on → Switch on disabled	This state change is brought on by the command *Disable voltage* or *Quick stop*. The motor voltage is switched off immediately.
Ready to switch on → Switched on	This state change is brought on by the *Switch on* command. The motor voltage is switched on. When this state change occurs for the first time since the module is started, the motor ID measurement is performed before the *Switched on* state is achieved. This can take approximately 1 second.
Switched on → Ready to switch on	This state change is brought on by the *Shutdown* command. The motor voltage is switched off immediately.
Switched on → Operation enable	This state change is brought on by the *Enable operation* command. Motor movements are now performed depending on the defined mode.
Operation enable → Switched on	This state change is brought on by the *Disable operation* command. If in motion, the motor is decelerated with the configured deceleration. Motor voltage remains on in the *Switched on* state.
Operation enable → Ready to switch on	This state change is brought on by the *Shutdown* command. The motor voltage is switched off immediately.

State change	Description
Operation enable → Switch on disabled	This state change is brought on by the *Disable voltage* command. Motor voltage switched off. It is strongly recommended to only make this state change on a stopped motor since regeneration on a motor running at no load can cause an overvoltage error on the DC bus (0x3210).
Operation enable → Quick stop active	This state change is brought on by the *Quick stop* command. If in motion, the motor is decelerated with the configured deceleration. During the deceleration, the state machine remains in the *Quick stop active* state. Once the motor is at standstill, the state automatically changes to the *Switch on disabled* state. While the state machine is in the *Quick stop active* state, the *Enable operation* command can be used to switch it back to the *Operation enable* state.
→ Fault reaction active	This state change is brought on when an error occurs and cannot be triggered by a command from the user. It can be triggered by error types classified as an "Error" (see "Error code" on page 37). (Other error types listed as "Warning" only cause the "Warning" bit to be set in the status word and do not cause a state change in the state machine.) Motor voltage is switched off and the state machine then changes immediately to the *Fault* state. The type of error is listed in the Error code register (see the table under "Error code" on page 37). The highest priority error is shown. The priority corresponds to the order in the error code table.
Fault → Switch on disabled	This state change is brought on by the *Fault reset* command. However, the state only changes if no more errors are present when the command is written. All errors and warnings are reset. The error code register contains 0 or the warning code if a warning is still present.

17.9 NetTime technology

NetTime refers to the ability to precisely synchronize and transfer system times between individual components of the controller or network (CPU, I/O modules, X2X Link, POWERLINK, etc.).

This allows the time that events occur to be determined system-wide with microsecond precision. Upcoming events can also be executed precisely at a given time.

17.9.1 Time information

Various time information is available in the controller or on the network:

- System time (on the PLC, Automation PC, etc.)
- X2X Link time (for each X2X Link network)
- POWERLINK time (for each POWERLINK network)
- Time data points of I/O modules

The NetTime is based on 32-bit counters, which are increased with µs timing. The sign of the time information changes after 35 min, 47 s, 483 ms and 648 µs; an overflow occurs after 71 min, 34 s, 967 ms and 296 µs.

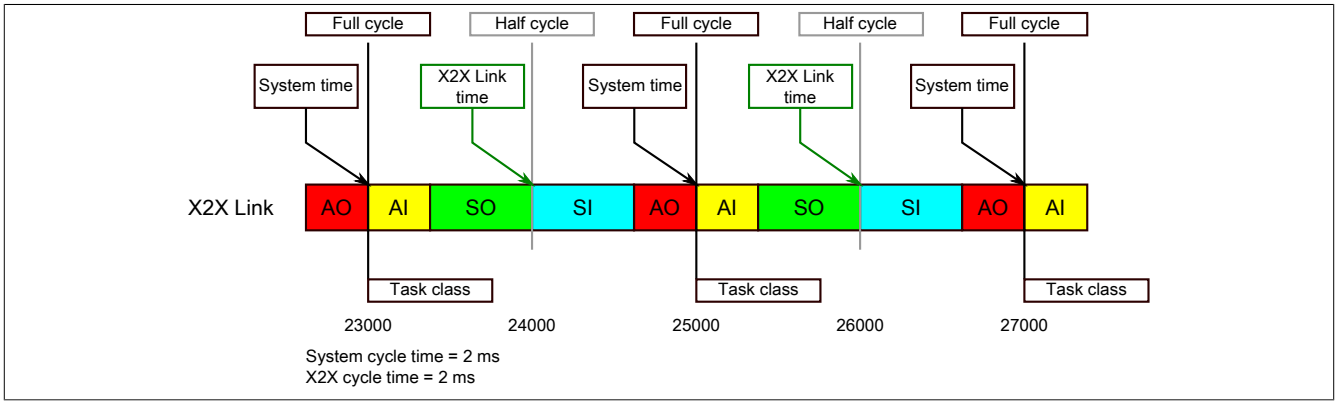
The initialization of the times is based on the system time during the startup of the X2X Link, the I/O modules or the POWERLINK interface.

Current time information in the application can also be determined via library AsIOTime.

17.9.1.1 PLC/Controller data points

The NetTime I/O data points of the PLC or the controller are latched to each system clock and made available.

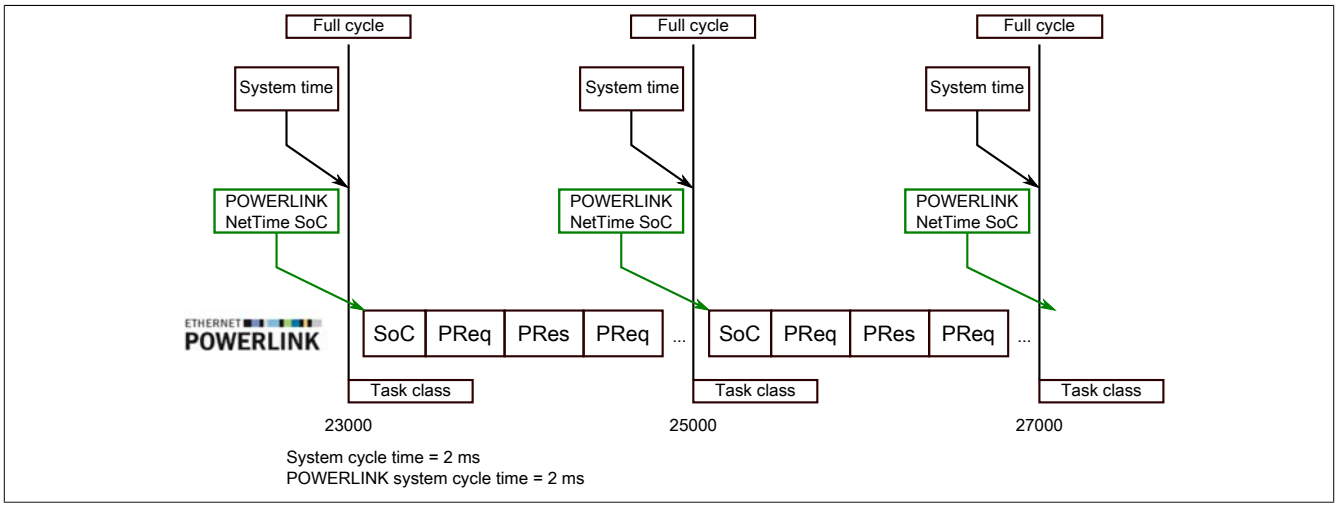
17.9.1.2 X2X Link reference time



The reference time on the X2X Link network is always formed at the half cycle of the X2X Link cycle. This results in a difference between the system time and the X2X Link reference time when the reference time is read out.

In the example above, this results in a difference of 1 ms, i.e. if the system time and X2X Link reference time are compared at time 25000 in the task, then the system time returns the value 25000 and the X2X Link reference time returns the value 24000.

17.9.1.3 POWERLINK reference time

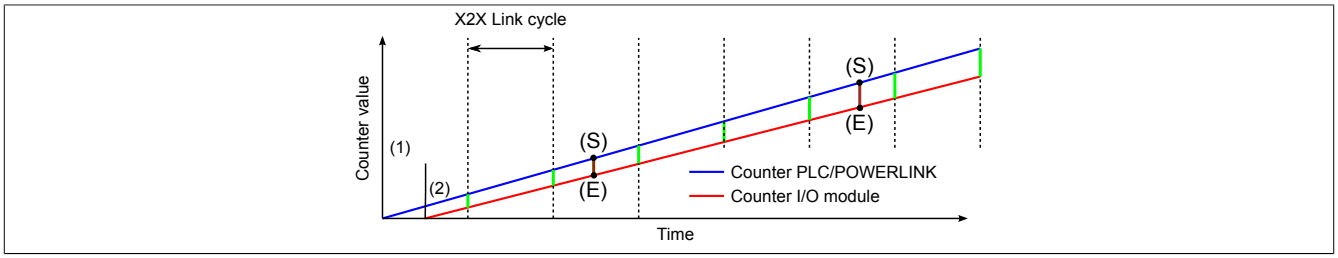


The reference time at POWERLINK is always formed at the SoC (Start of Cycle) of the POWERLINK network. The SoC starts 20 µs after the system tick. This results in the following difference between the system time and the POWERLINK reference time:

POWERLINK reference time = System time - POWERLINK cycle time + 20 µs.

In the example above, this means a difference of 1980 µs, i.e. if the system time and POWERLINK reference time are compared at time 25000 in the task, then the system time returns the value 25000 and the POWERLINK reference time returns the value 23020.

17.9.1.4 Synchronization of system time/POWERLINK time and I/O module



At startup, the internal counters for the PLC/POWERLINK (1) and the I/O module (2) start at different times and increase the values at µs intervals.

At the beginning of each X2X Link cycle, the PLC or the POWERLINK network sends time information to the I/O module. The I/O module compares this time information with the module's internal time and forms a difference (green line) between the two times and stores it.

When a NetTime event (E) occurs, the internal module time is read out and corrected with the stored difference value (brown line). This means that the exact system time (S) of an event can always be determined, even if the counters are not absolutely synchronous.

Note

The deviation from the clock signal is strongly exaggerated in the picture as a red line.

17.9.2 Timestamp functions

NetTime-capable modules provide various timestamp functions depending on the scope of functions. If a timestamp event occurs, the module immediately saves the current NetTime. After the respective data is transferred to the CPU, including this precise time, the CPU can then evaluate the data using its own NetTime (or system time), if necessary.

17.9.2.1 Time-based inputs

NetTime Technology can be used to determine the exact time of a rising edge at an input. The rising and falling edges can also be detected and the duration between 2 events can be determined.

> **Information:**
>
> **The determined time always lies in the past.**

17.9.2.2 Time-based outputs

NetTime Technology can be used to specify the exact time of a rising edge at an output. The rising and falling edges can also be specified and a pulse pattern generated from them.

> **Information:**
>
> **The specified time must always be in the future and the set X2X Link cycle time must be taken into account for the definition of the time.**

17.9.2.3 Time-based measurements

NetTime Technology can be used to determine the exact time of a measurement that has taken place. Both the start and the end time of the measurement can be transmitted.

17.10 Minimum cycle time

The minimum cycle time specifies the time up to which the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

	Minimum cycle time
Standard function model	400 µs
Ramp function model	400 µs

17.11 Minimum I/O update time

The minimum I/O update time defines how far the bus cycle can be reduced while still allowing an I/O update to take place in each cycle.

	Minimum I/O update time
Standard function model	400 µs
Ramp function model	
Inputs	400 µs
Outputs[1)]	25 ms

1) Depends on the configuration of the "motion profile generator" on page .