AG03/1

Actuator with IO-Link Interface

User Manual

102/22

Table of Contents

1 General Information

1.1 Documentation

The following documents are available for this product:

- Data sheet: describes the technical data, the dimensions, the pin assignments, the accessories and the order code.
- Assembly instructions: these describe the mechanical and electrical assembly with all safety-relevant conditions and the associated technical specifications.
- User manual for connecting the actuator to an IO-Link master and for commissioning.
- IODD file (IO-Link Device Description): connection and configuration with an IO-Link master is possible with the help of this file using commercially available IO-Link masters and their configurators.

These documents are also available at **http://www.siko-global.com/p/ag03-1**.

1.1.1 History

Change	Date	Description
189/20	September 17, 2020	Document prepared
025/21	February 08, 2021	From FW-V1.02 Section 1.1.1 History new Section 2.3.2 Ex-works setting new Section 3.2.1 Emergency operation revised Section 3.6.2.1 Error Codes Code 53 new/13 removed Section 4.8.3 ErrorCounters new Section 5.7 IO-Link Event Codes: Code 6163 new/6153 removed Status word bit bs13_CalibrationRequest new Supplements and corrections
		From FW-V2.00 Section 3.6.2.1 Error Codes Code 52 new Section 5.7 IO-Link Event Codes Code 6162 new
102/22	May 16, 2022	From FW V2.01 Chapter 5.2.1 Process data in Position Mode operating mode add text, text swapped in columns Chapter 5.2.2 Process data in Velocity Mode add text, text swapped in columns

1.2 Definitions

If not explicitly stated, decimal values are given as digits without addition (e.g., 1234), binary values are marked with b (e.g.; 1011b), hexadecimal values with h (e.g.; 280h) after the digits.

Individual bits of the ControlWord or StatusWord are abbreviated as follows:

ControlWord Bit 7: CW.7

StatusWord Bit 10: SW.10

1.3 Intended Use

Unless otherwise described, normal operation of the system with unchanged factory settings is assumed for the further functional description.

The AG03/1 actuator is used for adjustment and positioning tasks on systems and machines. The actuator is only intended for use in industrial applications that are not subject to any particular electrical or mechanical safety requirements.

1.4 Switching on the operating voltage

After the operating voltage control is switched on, the device initializes itself. The device parameters are loaded from the nonvolatile memory into the main memory of the controller during initialization. At first use, the default values are used during initialization. After the external power supply is supplied again or a software reset (warm start), the actuator works with the last saved parameters. If no error has been detected, the actuator starts normal operation and can communicate with an IO-Link master. To be able to start a travel job, the operating voltage output stage must be switched on.

2 Display and control keys

2.1 General information

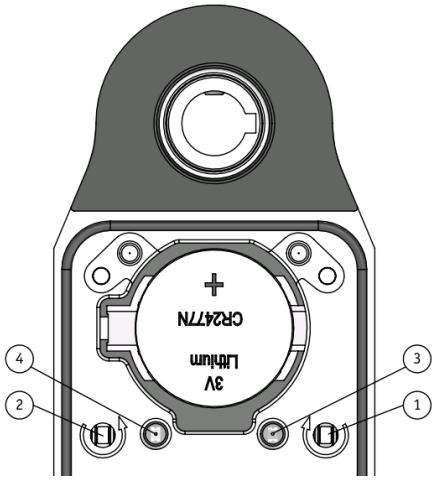

Fig. 1: Control elements

2.2 LED displays

Two LEDs inform about the operating state of the actuator.

③ Status LED

④ COM LED

2.2.1 Status LED

NOTICE	The state of the operating voltage output stage is only signaled when the operating voltage control is switched on.

LED status	Description
Green	All operating voltages OK
Green, flashes 50:50	Operating voltage control OK Operating voltage output stage is missing or outside the permissible range
Red	Error
Red, flashes 50:50	Switch-on lock active
Red, Flashes 2x	Battery emergency operation active
orange, flashes	Delay time for setting the factory setting via operating keys expires
Off	Operating voltage control is missing or outside the permissible range

Table 1: Status LED

2.2.2 COM LED

LED status	Description
Green	Operating voltage control OK
Green, flashes 90:10	Operating voltage control OK IO-Link SDCI communication active
Off	Operating voltage control is missing or outside the permissible range

Table 2: COM LED

2.3 Operating keys

2.3.1 Setup Operation

NOTICE	Manual setup mode is only available if IO-Link SDCI communication is not active.

The operating keys can be used to start manual setup mode (corresponds to inching mode 2). This makes it possible to move the actuator without a higher-level control.

① Clockwise button

② Counterclockwise button

2.3.2 Ex-works setting

NOTICE	The ex-works setting can only be established using the operating keys if IO-Link SDCI communication is not active and the operating voltage output stage is switched off.

Pressing the clockwise and counterclockwise buttons simultaneously for at least 5 seconds resets all parameters to the ex-works setting. The elapse of the delay time is signaled by orange flashing of the status LED. A warm restart is then initiated, and the status LED switches off briefly.

3 Operation description

3.1 Operating modes

A distinction is made between the operating modes of positioning mode and speed mode. In the positioning mode, it is also possible to move in inching mode.

3.1.1 Positioning Mode

In the positioning mode, positioning to the specified target value is performed using a ramp function (cf. Fig. 3: Ramp travel positioning mode direct), which is calculated based on the instantaneous actual position as well as the programmed controller parameters acceleration and speed.

After activation of the travel job, the actuator accelerates with the programmed acceleration AccelerationPositionMode to the predetermined speedVelocityPositionMode. The amount of delay to the target value is also determined by the parameter AccelerationPositionMode.

Alternatively, the DecelerationPositionMode parameter can be used to select a value that differs from the acceleration.

The actuator is tracked by means of a PID positioning controller of the calculated path. If you change the coefficients ControllerParameterP, ControllerParameterI and ControllerParameterD, adjustments can be made to the controlled system.

Changing the controller parameters during a positioning operation has no effect on the current positioning mode.

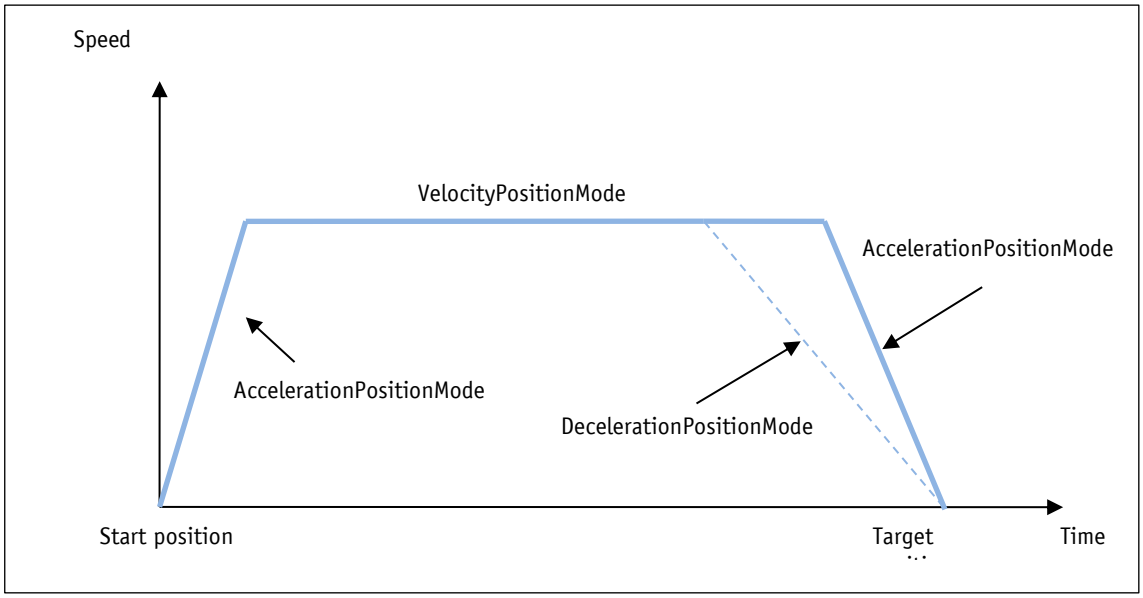

Fig. 2: Ramp travel positioning mode direct

3.1.1.1 Target Window Positioning Mode

If the actual position is within the window defined by the TargetWindow parameter, this is signaled in the StatusWord with SW. 5 = 1. The behavior of the drive after reaching the programmed window can be defined by the TargetWindowReachedMode parameter.

Example:

- TargetWindow = 5
- TargetPosition = 100

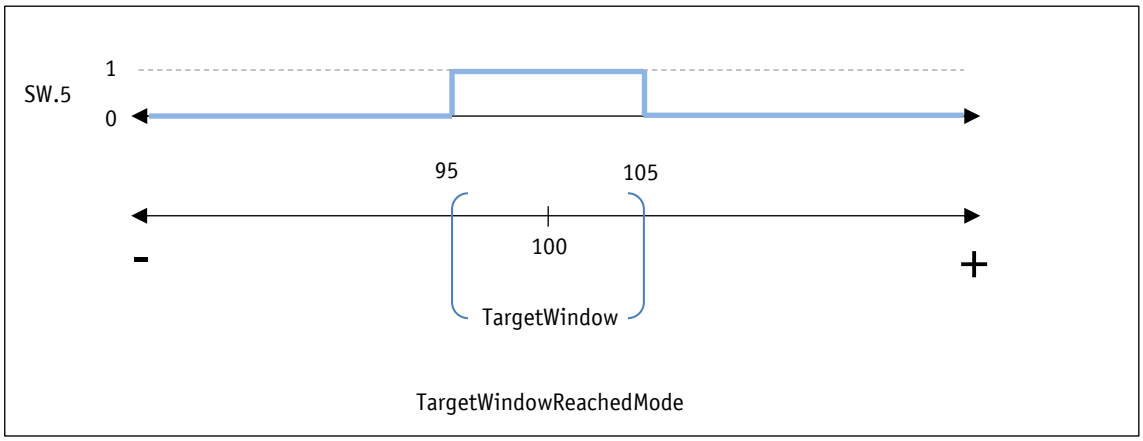

Fig. 3: Target Window Positioning Mode

3.1.1.2 Travel range

The travel range depends on the encoder and the scaling (cf. Section 3.5.1). The number of revolutions according to the product data sheet cannot be exceeded!

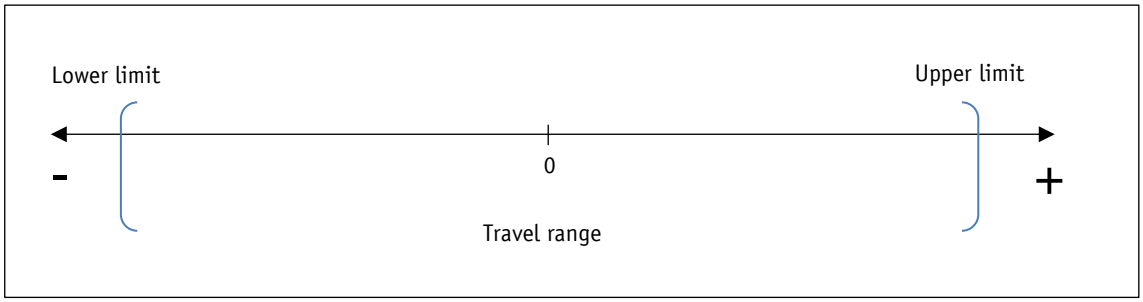

Fig. 4: Travel range

3.1.1.3 Software Limits

NOTICE	If the actual position is outside the range defined by the SoftwareLimit1 and SoftwareLimit2 parameters, you must move from this position in the direction of the permitted range using inching mode 1 or 2!

NOTICE	If SoftwareLimit1 is equal to SoftwareLimit2, limit value monitoring is deactivated. When the encoder resolution is exceeded, the actual position changes suddenly.

The target position is checked for validity based on the two parameters SoftwareLimit1 and SoftwareLimit2 . If the target position is outside the defined range or equal to the limits, the travel job is not executed. There is no acknowledgment via SW.10. If the permissible range is left, e.g., in inching mode, the actuator is activated and coasts to a stop. This must be considered in parameterizing the software limits.

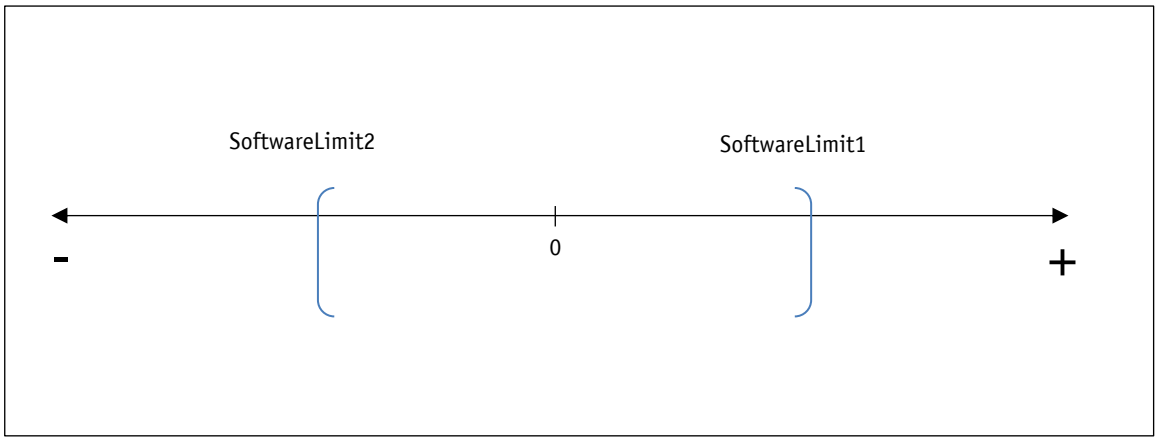

Fig. 5: Software Limits

3.1.1.4 Loop positioning

NOTICE	A travel job is not executed if a loop positioning would exceed the limits set by the SoftwareLimit1 and SoftwareLimit2 parameters even though the target value is within the limits.

When operating the drive, it is possible to compensate for a mechanical clearance by means of the loop positioning. In this case, the target value is always taken from the same direction.

This approach direction can be determined with the LoopType parameter. The loop length is set via the LoopLength parameter.

Example:

The direction in which each target position is to be moved is positive.

- Case 1 new position is greater than actual position:

The target position is approached directly.

- Case 2 new position is smaller than actual position:

The actuator extends the loop length beyond the target position, and then the target value is approached in the positive direction.

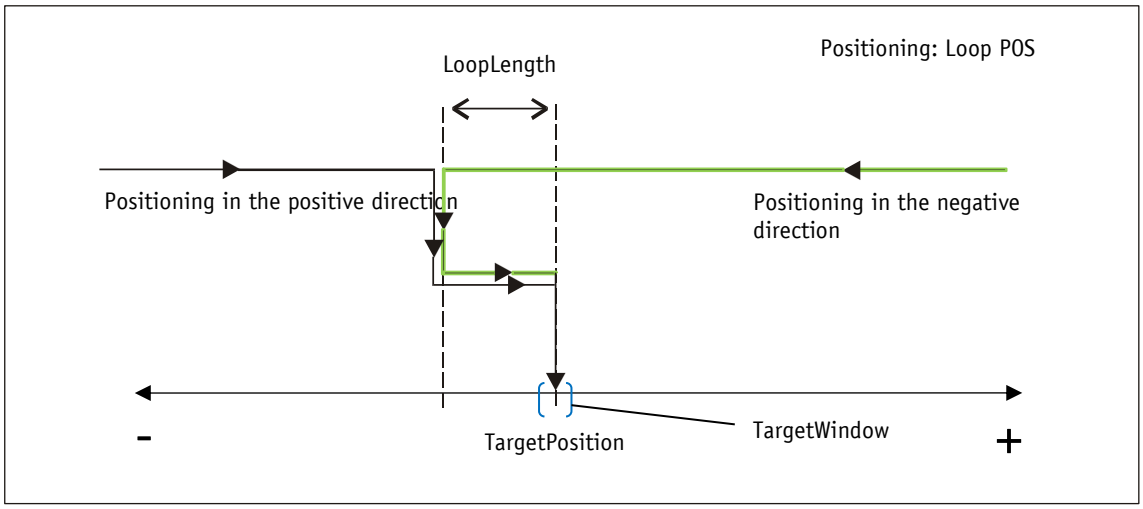

Fig. 6: Loop POS positioning

3.1.1.5 Inching mode

NOTICE	The spindle play (loop positioning) is not compensated in this operating mode

Inching mode is only possible in positioning mode. Acceleration as well as speed in inching mode can be programmed via parameters.

3.1.1.5.1 Inching mode 1

NOTICE	If the value of the SpindlePitch parameter is zero, the travel path is specified in increments. If the SpindlePitch parameter is not equal to zero, the specification of the DeltaInch parameter refers to the travel path in user units.

NOTICE	If the actual position is outside the programmed limit values, inching mode 1 or 2 must be used to move from this position in the corresponding direction!

The actuator travels from the current actual position once by the value DeltaInch, depending on the sign of the entered value.

- Delta Inch < 0: Travel direction negative
- Delta Inch > 0: Travel direction positive

When the target position is reached, this is signaled accordingly.

The following conditions must be met for inching mode 1 and 2 to be started:

- Output stage operating voltage is present
- Operation enabled
- Drive stationary

3.1.1.5.2 Inching mode 2

The actuator travels from the current actual position as long as the command for this is present. The inching speed can be influenced by two parameters and is calculated in the actuator as shown in the following example:

VelocityInchingMode = 10 rpm (can only be changed at standstill)

Inching2Offset = 85% (can be changed during inching mode)

The resulting inching speed in this example is:

Inching speed = VelocityInchingMode * Inching2Offset = 10 rpm * 85% = 9 rpm

Results are always rounded to whole numbers.

The minimum speed is 1 rpm.

The Inching2AccelerationMode parameter can be used to set a step-by-step acceleration to the end value VelocityInchingMode. The velocity profile then corresponds to the following process:

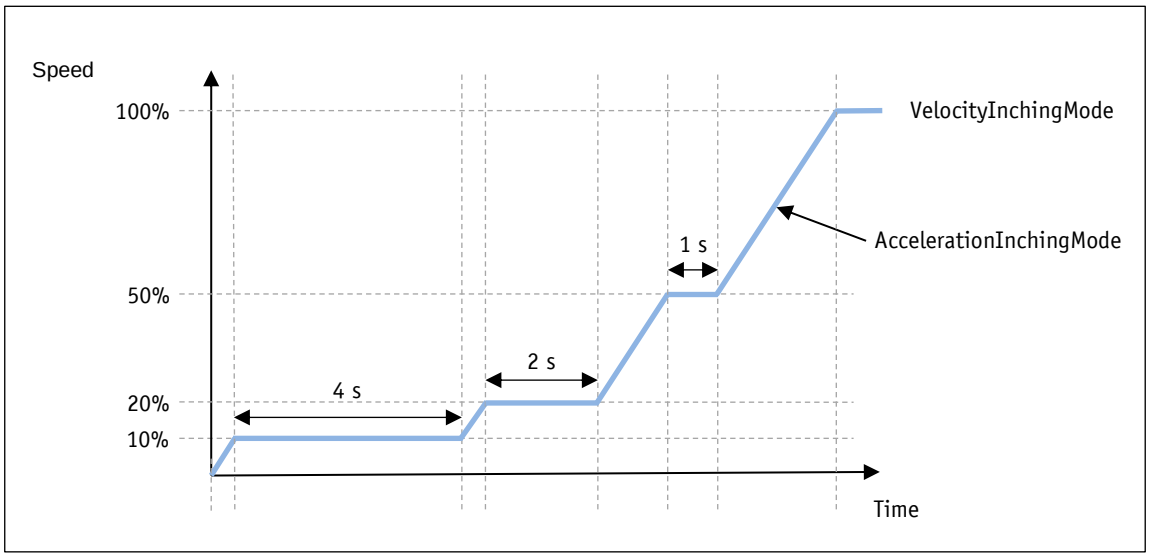

Fig. 7: Inching mode 2 – Inching2AccelerationMode

3.1.1.6 ControlWord in positioning mode

The ControlWord differs in function depending on the operating mode (cf. OperatingMode parameter).

The designation of the individual bits of the ControlWord as well as their significance:

Bit	Designation	Value = 0	Value = 1
0	bc00_CoastStop	Coast Stop active Cancellation of travel job. The motor is de-energized and coasts to a standstill without any control.	Coast Stop not active (Operating condition)
1	bc01_QuickStop	Quick Stop active Cancellation of travel order. The motor is braked to a standstill with maximum deceleration and remains in control.	Quick Stop not active (Operating condition)
2	bc02_NormalStop	Normal Stop active Cancellation of travel job. The motor is braked to a standstill with maximum deceleration and remains in control.	Normal Stop not active (Operating condition)
3	bc03_IntermediateStop	No intermediate stop	Intermediate stop active
4	bc04_StartTravelJob	-	Start travel job (edge-controlled, positive)
5	bc05_ErrorAck	-	Acknowledge error (Edge-controlled, positive) The actuator then changes to the switch-on lock state.
6	bc06_InchingMode1	No inching mode 1 If the travel job has not yet ended, it is aborted.	Inching mode 1 As long as this bit is set, the actuator travels once around the distance defined in the DeltaInch parameter.
7	bc07_InchingMode2Pos	No inching mode 2 positive	Inching mode 2 positive The actuator travels in the positive direction.
8	bc08_InchingMode2Neg	No inching mode 2 negative	Inching mode 2 negative The actuator travels in the negative direction.
9	bc09_Reserved	Always 0	-
10	bc10_MoveRelative	Absolute positioning	Relative positioning
11	bc11_Reserved	Always 0	-
12	bc12_Reserved	Always 0	-

Bit	Designation	Value = 0	Value = 1
13	bc13_Reserved	Always 0	-
14	bc14_GuardingBit	Is mirrored in StatusWord	Is mirrored in StatusWord
15	bc15_CalibrationExecute	-	Trigger calibration (edge-controlled, positive)

Table 3: ControlWord in positioning mode

3.1.1.7 StatusWord in positioning mode

The StatusWord shows the current status of the actuator.

The designation of the individual bits of the ControlWord as well as their significance:

Bit	Designation	Value = 0	Value = 1
0	bs00_Supply	Operating voltage output stage is missing or outside the permissible range	Operating voltage output stage OK
1	bs01_ReadyToTravel	No travel readiness	Travel readiness available
2	bs02_UpperLimit	No limit value violation	Upper limit value exceeded
3	bs03_LowerLimit	No limit value violation	Lower limit value undershot
4	bs04_ActuatorTravels	Actuator stationary (speed < 2 rpm)	Actuator travels
5	bs05_TarWinReached	Actuator is outside the target window	Position value is within the target window
6	bs06_ActiveTravelJob	No travel job active	Travel job active
7	bs07_GeneralError	No error	Error acknowledgment with positive edge at CW.5
8	bs08_OperationEnabled	Operation not enabled	Operation enabled The state of the drive is defined by the TargetWindowReachedMode parameter.
9	bs09_SwitchLock	No switch-on lock	Switch-on lock (cf. Section 3.1.1.8)
10	bs10_TravelJobAck	No acknowledgment	Acknowledgment The bit is set when the travel job has been accepted. If bit CW.4 is reset, this bit is also reset.
11	bs11_BatteryState	Charging state OK	Charging state critical
12	bs12_TorqueDeactState	Torque deactivation not active	Torque deactivation active The motor current was greater than set under TorqueDeactivation parameter.

Bit	Designation	Value = 0	Value = 1
13	bs13_CalibrationRequest	No calibration request	Calibration Request The drive can only be moved in jog mode 2. The software limits are ignored.
14	bs14_GuardingBit	Mirrored from ControlWord	Mirrored from ControlWord
15	bs15_CalibrationExecuted	No acknowledgment	Acknowledgment The bit is set when the calibration has been performed successfully. If bit CW.15 is reset, this bit is also reset.

Table 4: StatusWord in positioning mode

3.1.1.8 Sequence schedule in positioning mode

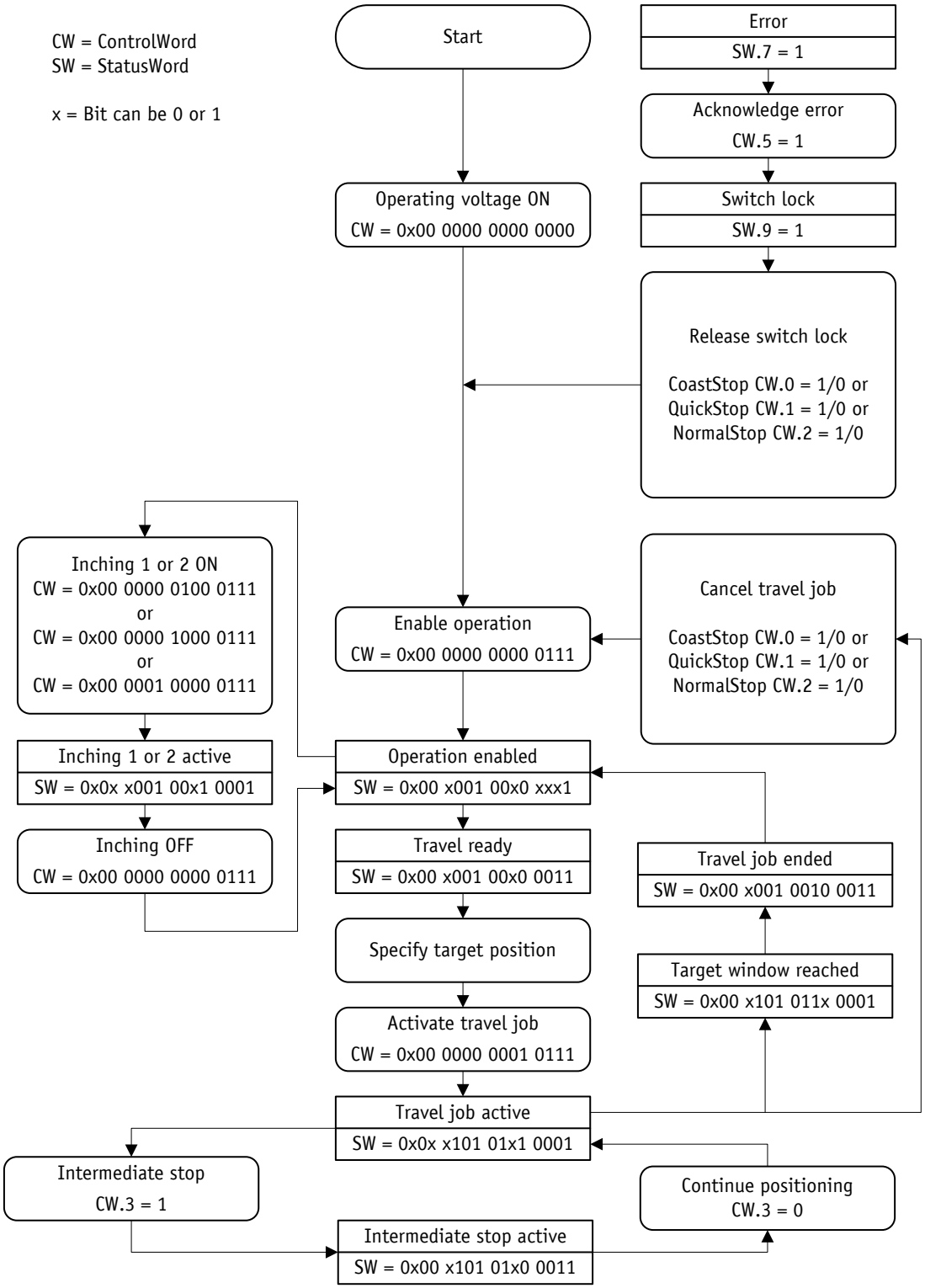

Fig. 8: Sequence schedule in positioning mode

3.1.2 Speed Mode

NOTICE	SoftwareLimit1 + 2 are disabled in this operating mode.

NOTICE	When the absolute value encoder resolution is exceeded, there is a jump to the actual position.

The speed mode is set with the OperatingMode parameter. In speed mode, the actuator accelerates to the target speed after the target value is released and maintains this speed until the target value is blocked or a new target speed is specified. When the set speed is changed, the speed is immediately adjusted to the new value.

The travel direction in speed mode is determined by the sign of the target value.

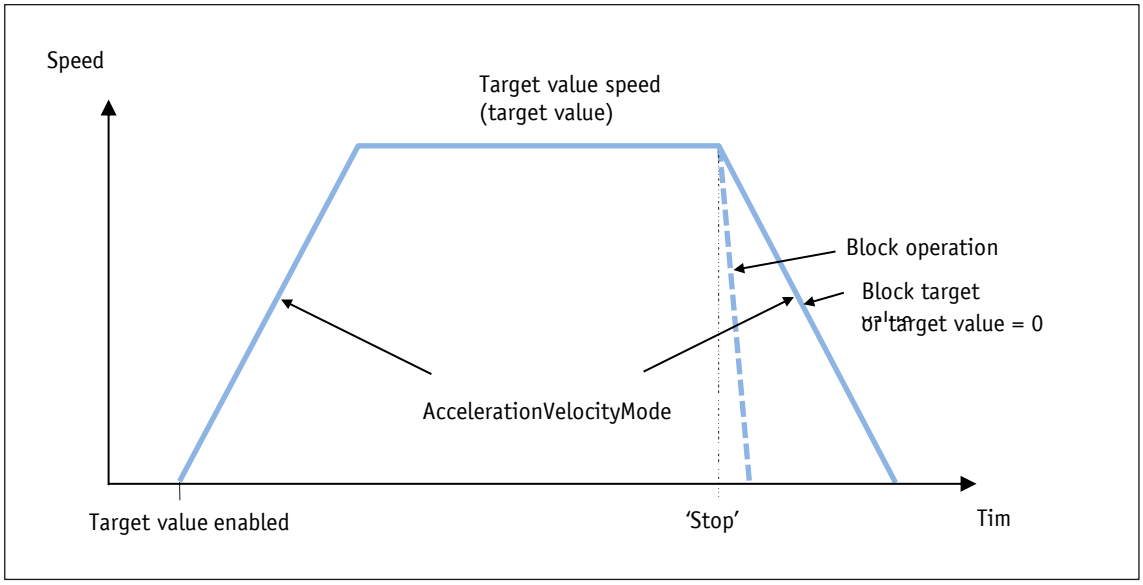

Fig. 9: Ramp Speed Mode

The following conditions must be met for speed mode to be started:

- Output stage operating voltage is present
- Operation enabled
- Drive stationary

3.1.2.1 Target window speed mode

If the actual speed is within the window defined by the TargetWindow parameter, this is signaled in the StatusWord.

Example:

- TargetVelocity = 80
- TargetWindow = 5

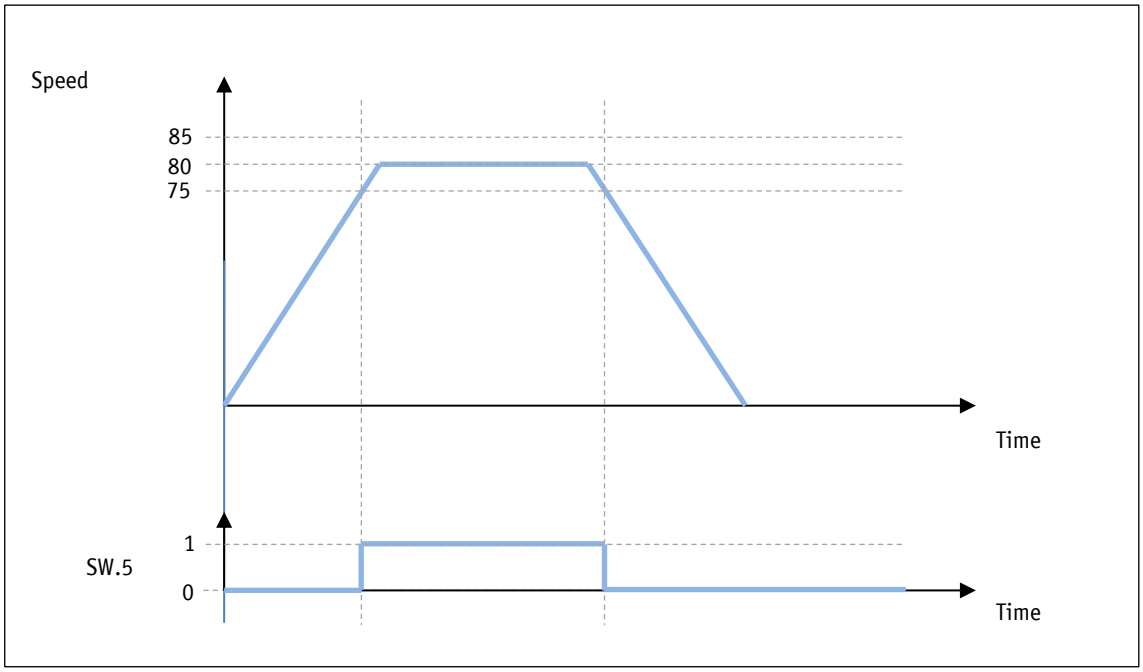

Fig. 10: Target window speed mode

3.1.2.2 ControlWord in speed mode

The ControlWord differs in function depending on the operating mode (cf. OperatingMode parameter).

The designation of the individual bits of the ControlWord as well as their significance:

Bit	Designation	Value = 0	Value = 1
0	bc00_CoastStop	Coast Stop active Cancellation of travel job. The motor is de-energized and coasts to a standstill without any control.	Coast Stop not active (Operating condition)
1	bc01_QuickStop	Quick Stop active Cancellation of travel order. The motor is braked to a standstill with maximum deceleration and remains in control.	Quick Stop not active (Operating condition)
2	bc02_NormalStop	Normal Stop active Cancellation of travel job. The motor is braked to a standstill with maximum deceleration and remains in control.	Normal Stop not active (Operating condition)
3	bc03_Reserved	Always 0	
4	bc04_StartTravelJob	-	Start travel job (edge-controlled, positive)
5	bc05_ErrorAck	-	Acknowledge error

Bit	Designation	Value = 0	Value = 1
			(Edge-controlled, positive) The actuator then changes to the switch-on lock state.
6	bc06_Reserved	Always 0	-
7	bc07_Reserved	Always 0	-
8	bc08_Reserved	Always 0	-
9	bc09_Reserved	Always 0	-
10	bc10_Reserved	Always 0	-
11	bc11_Reserved	Always 0	-
12	bc12_Reserved	Always 0	-
13	bc13_Reserved	Always 0	-
14	bc14_GuardingBit	Is mirrored in StatusWord	Is mirrored in StatusWord
15	bc15_CalibrationExecute	-	Trigger calibration (edge-controlled, positive)

Table 5: ControlWord in speed mode

3.1.2.3 StatusWord in speed mode

The StatusWord shows the current status of the actuator.

The designation of the individual bits of the ControlWord as well as their significance:

Bit	Designation	Value = 0	Value = 1
0	bs00_Supply	Operating voltage output stage is missing or outside the permissible range	Operating voltage output stage OK
1	bs01_ReadyToTravel	No travel readiness	Travel readiness available
2	bs02_Reserved	Always 0	-
3	bs03_Reserved	Always 0	-
4	bs04_ActuatorTravels	Actuator stationary (speed < 2 rpm)	Actuator travels
5	bs05_TarWinReached	Actual speed is outside the target window	Actual speed is within the target window
6	bs06_ActiveTravelJob	No travel job active	Travel job active
7	bs07_GeneralError	No error	Error Error acknowledgment with positive edge at CW.5
8	bs08_OperationEnabled	Operation not enabled	Operation enabled The position control of the actuator is activated
9	bs09_SwitchLock	No switch-on lock	Switch-on lock (cf. Section 3.1.2.4)
10	bs10_TravelJobAck	No acknowledgment	Acknowledgment

Bit	Designation	Value = 0	Value = 1
			The bit is set when the travel job has been accepted. If bit CW.4 is reset, this bit is also reset.
11	bs11_BatteryState	Charging state OK	Charging state critical
12	bs12_Reserved	Always 0	-
13	bs13_CalibrationRequest	No calibration request	Calibration Request Operation is possible without restrictions
14	bs14_GuardingBit	Mirrored from ControlWord	Mirrored from ControlWord
15	bs15_CalibrationExecuted	No acknowledgment	Acknowledgment The bit is set when the calibration has been performed successfully. If bit CW.15 is reset, this bit is also reset.

Table 6: StatusWord speed mode

3.1.2.4 Sequence schedule in speed mode

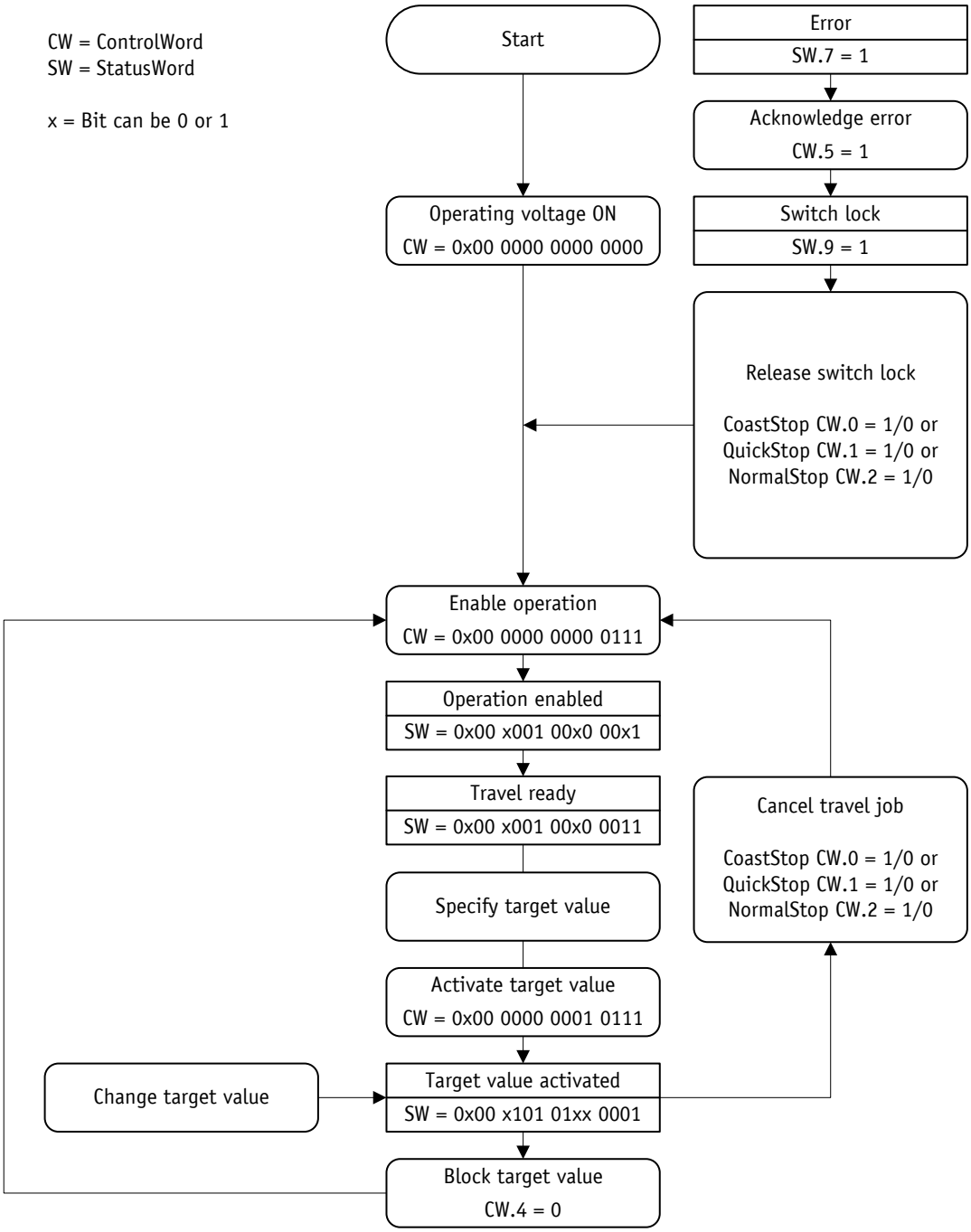

Fig. 11: Sequence schedule in speed mode

3.2 Battery buffering

NOTICE	A charged battery is required in all operating modes for regular operation.

Without an external power supply, encoder changes are recorded with battery support. Depending on the duration of battery operation (including storage) and the frequency of adjustments without an external power supply, the battery life is approximately 5 years. The battery voltage is checked in a time interval of approx. 5 minutes. If the battery voltage drops below a certain value, this is signaled by SW.11. If the battery voltage drops further, the

battery undervoltage error (error code 06h) is triggered. The battery should be replaced within approximately three months after the first warning appears. When you replace the battery on site, the instructions in the assembly instructions must be observed. Replacement can also take place at the SIKO distribution partners or in the SIKO main plant.

3.2.1 Emergency operation

NOTICE	An empty battery leads to loss of calibration if the operating voltage control is missing at the same time.

If a discharged battery is detected immediately after the operating voltage control is switched on, the battery undervoltage fault is triggered. The actual position is considered invalid because data loss is to be expected due to the lack of battery buffering. After the fault is subsequently acknowledged, bit SW.13 is set. In this case, the drive can only be moved using jog mode 2. The software limits are ignored. After calibration, bit SW.13 is reset and the drive can be used without restriction. The status LED signals emergency operation.

If a discharged battery is detected when the operating voltage control is switched on, the battery undervoltage fault is triggered. The actual position is still considered valid. After the fault is subsequently acknowledged, the drive can be used without restriction. The status LED signals emergency operation.

Emergency operation can be acknowledged by inserting a charged battery. The display of the status LED changes to normal operation at the latest after 5 minutes or a power-on reset.

3.3 Parameterization

The actuator can be completely parameterized via the IO-Link interface.

3.4 Calibration

NOTICE	Calibration is only possible if no travel job is active!

Two steps are required to perform a calibration:

- Write calibration value: CalibrationValue parameter
- Perform calibration (software command)

A calibration can be triggered with a positive edge at CW.15 or by means of SystemCommand (cf. Section 5.5).

Due to the absolute measuring system, calibration is only required once during commissioning. During calibration, the calibration value is used to calculate the position value. In the case of calibration, the following applies:

Position value = 0 + CalibrationValue + OffsetApplication

3.5 Additional functions

3.5.1 Scaling

In the factory setting, the drive has a resolution of 1600 increments per revolution. The internal gear is already taken into account.

If scaling is required in user units, the SpindlePitch, GearRatioNumerator and GearRatioDenominator parameters must be set accordingly. A combination of these scalings is possible.

The scaled position value is calculated as follows:

$$\text{ActualPosition [user units]} = \frac{\text{internal position value [increments]} \times \text{SpindlePitch}}{\text{1600 [increments]} \times \text{ext. gear ratio}}$$

The external gear ratio is calculated as follows (cf. Section 3.5.1.3):

$$\text{external gear ratio} = \frac{\text{GearRatioNumerator}}{\text{GearRatioDenominator}}$$

If the basic resolution of the absolute encoder of 1600 increments per revolution is exceeded by scaling, value jumps occur.

For this reason, the following condition must be observed:

$$\frac{\text{SpindlePitch}}{\text{external gear ratio}} \leq 1600$$

The travel range in user units is calculated using the following formula:

$$\text{travel range max. [User units]} = \frac{\text{13091200 [increments]} \times \text{SpindlePitch}}{\text{1600 [increments]} \times \text{external gear ratio}}$$

$$\text{travel range min. [User units]} = \frac{\text{-13091200 [increments]} \times \text{SpindlePitch}}{\text{1600 [increments]} \times \text{external gear ratio}}$$

3.5.1.1 Example of spindle drive

Spindle pitch p = 2 mm

The drive is mounted directly on a spindle.

The desired unit of the position value is 1/100 mm.

The SpindlePitch parameter is calculated using the following formula:

$$\text{SpindlePitch} = \frac{\text{p}}{\text{Benutzereinheit}} = \frac{\text{2 mm}}{\text{0.01 mm}} = 200$$

3.5.1.2 Example rack/pinion straight toothed, metric pitch

Pitch p = 5 mm

Pinion number of teeth z = 20

The desired unit of the position value is 1/10 mm.

The SpindlePitch parameter is calculated using the following formula:

$$\text{SpindlePitch} = \frac{p \times z}{\text{Benutzereinheit}} = \frac{5\ \text{mm} \times 20}{0.1\ \text{mm}} = 1000$$

3.5.1.3 Example of external gear

When you use an external gear, it is possible to program a factor using the GearRatioNumerator and GearRatioDenominator parameters to include the gear ratio in the position determination.

Example (cf. Fig. 2: External gears):

The actuator is operated on a gear with a reduction ratio of 5:1. The GearRatioNumerator and GearRatioDenominator parameters must be programmed as follows.

- GearRatioNumerator parameter = 5
- GearRatioDenominator parameter = 1

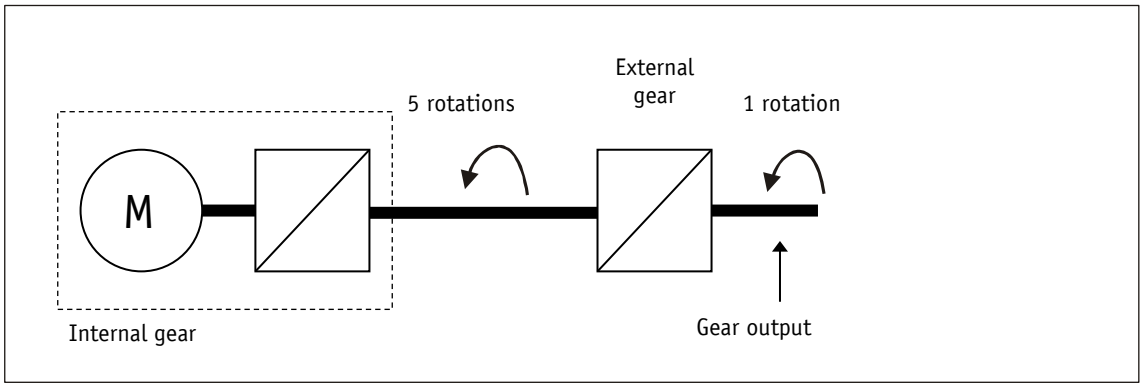

Fig. 12: external gear

The input of non-integer gear ratios is possible according to the following example:

- Gear Reduction = 3.78
- GearRatioNumerator parameter = 378
- GearRatioDenominator parameter = 100

3.5.2 Protection functions

3.5.2.1 Limiting of current

NOTICE	When the supply current is measured, no statement can be made about the actual motor current. The supply current does not correspond to the motor current for clocked output stages. The actual motor current can be read via the interface.

The permissible peak motor current can be set via the PeakCurrentLimit parameter. An overload of the drive results in limiting the motor current to the permissible peak motor current. I²t monitoring limits the time during which a current may flow greater than the permissible motor current (cf. Section 3.5.2.2). The permissible motor current is set using the ContinuousCurrent parameter.

3.5.2.2 I²t monitoring

NOTICE	The values of the PeakCurrentLimit, PeakCurrentTime and ContinuousCurrent parameters are adjusted in the factory setting for the protection of the actuator. If the application requires adjustments to these parameters, the value of the PeakCurrentLimit parameter must be set to twice the value of the ContinuousCurrent parameter.

NOTICE	If the value of the PeakCurrentLimit parameter is less than the value of ContinuousCurrent, I²t monitoring is disabled.

NOTICE	When torque deactivation is enabled, I²t monitoring is disabled.

I²t monitoring is used to protect the motor winding, the output stage and the gear. The limit value I²t limit is calculated using the PeakCurrentLimit, PeakCurrentTime and ContinuousCurrent parameters. If the motor current exceeds the value ContinuousCurrent, the difference between the square of the motor current and the square of ContinuousCurrent is integrated. If the integral exceeds the limit value I²t-limit, the motor overcurrent fault is triggered. The percentage ratio of the actual value of the integral to the I²t limit can be read via the I2tOverload parameter.

The following figure shows how the monitoring function works:

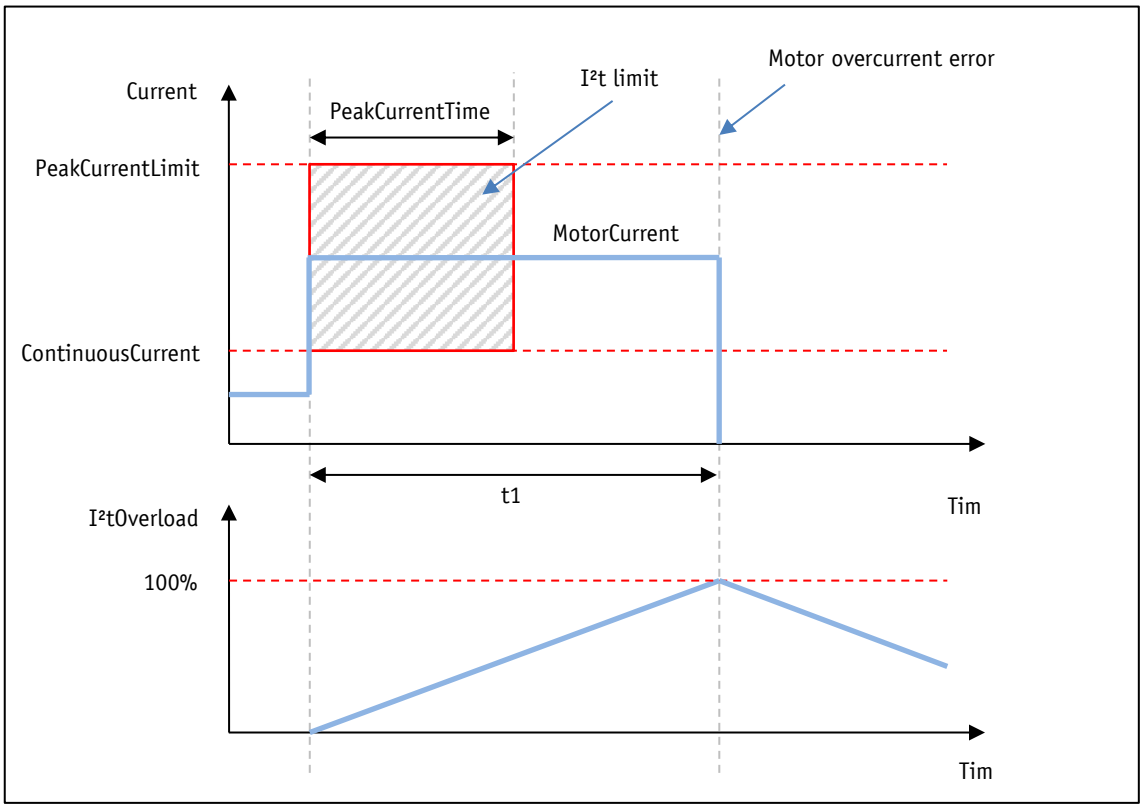

Fig. 13: I²t monitoring

Calculation of the I²t limit:

I²t-Limit [A²s]=((PeakCurrentLimit [A])² - (ContinuousCurrentLimit [A])² × PeakCurrentTime [s])

Calculation of overload time:

$$t1\ [s] = \frac{I^2t\text{-Limit } [A^2s]}{(\text{MotorCurrent } [A])^2 - (\text{ContinuousCurrentLimit } [A])^2}$$

3.5.2.3 Torque deactivation

NOTICE	An active torque deactivation does not result in an error!

NOTICE	This function is only available in the positioning mode.

NOTICE	If the torque deactivation function is enabled, I²t monitoring is automatically disabled.

A shutdown threshold is defined by the TorqueDeactivation parameter. This is specified as a percentage of the rated motor current. With a parameter value of 125%, the torque deactivation function is disabled.

If the shutdown threshold is exceeded, the drive brakes with a maximum delay. The drive remains in control.

An active torque deactivation is reported via SW.12 = 1. This bit is reset automatically when the current travel job is resumed.

3.5.2.4 Temperature monitoring

NOTICE	The actuator does not have the thermal memory preservation. Switching off the operating voltage control after the response of the thermal monitoring of the motor (error code 26h: Thermal overload motor) resets the thermal memory. In this case, the actuator must cool completely before restarting to ensure motor protection. Otherwise, the motor can be destroyed thermally.

The motor temperature is calculated from the motor current using a thermal model. The calculated thermal load can be read via the MotorThermalLoad parameter. If the load reaches 100%, the error thermal overload motor is triggered.

The output stage temperature is measured directly in the output stage. If the measured temperature exceeds the value of 90° C, the error output stage overtemperature is triggered.

3.5.2.5 Overvoltage protection in case of feedback

NOTICE	Active overvoltage protection of the operating voltage output stage is effective only when the operating voltage control is switched on.

NOTICE	The response of the active overvoltage protection results in direct sluggishness of the drive shaft. This must be observed when the drive shaft is adjusted manually.

In addition to the overvoltage protection by passive overvoltage protection elements, the actuator also provides active overvoltage protection of the operating voltage output stage. In the event of a voltage increase due to feedback (e.g., external adjustment), the motor windings are short-circuited for at least 4 s if a voltage of 32 V is exceeded. The excess energy is converted into heat in the motor windings.

3.5.2.6 Position lag monitoring

Error variables such as load and friction can cause the actuator not to follow the calculated travel profile. If the control deviation of the PID positioning controller exceeds the value ContouringErrorLimit defined by parameters for more than 2 seconds, a position lag error is triggered.

The control deviation is calculated as follows:

Control Deviation [Increments] = Setpoint Position (Path Generator) [Increments] – Actual Position [Increments]

3.5.2.7 Oscillation detection

If the PID positioning controller is operated outside the stability limit, the axis of the actuator can begin to oscillate. When the position control is at a standstill and active at the same time (no travel job active), it is monitored whether vibrations occur on the axis. If the vibrations exceed a specified threshold value, the error position control unstable is triggered.

3.5.3 Restore factory setting

To restore the delivery state of the device, the following options exist:

Access	Coding		The following are set to the factory setting
Interface	SystemCommands (cf. Section 5.5)	130 (82h)	All parameters
Operating keys			All parameters Cf. Section 2.3.2.

Table 7: Access factory settings

3.6 Warnings/errors

3.6.1 Warnings

Warnings have no influence on the sequence of the actuator.

Warnings disappear after the cause has been eliminated.

Possible warnings are:

Battery charge critical: Bit SW.11 is set in StatusWord (Cf. Sections 3.1.1.7 and 3.1.2.3).

3.6.2 Errors

Errors trigger an immediate stop of the drive movement.

An error is indicated by the drive status LED.

Bit SW.7 is set in StatusWord (cf. sections 3.1.1.7 and 3.1.2.3).

The error messages are entered in the error memory in the sequence in which they are recorded. When the error memory is full, the last 10 error messages are displayed. To obtain the most recent error, the ErrorCount parameter must be read.

Example:

ErrorCount = 7

The last (most recent) error entered is in error memory at memory location No.7 (Error7).

The cause of the error can be determined based on the error code

Each fault is stored in the assigned fault counter (cf. Section 4.8.3). The fault counters cannot be reset.

3.6.2.1 Error Codes

NOTICE	If the error cannot be acknowledged after the cause of the error has been eliminated and the error is still present even after a power-on reset, the drive must be checked in the factory.

Error code	Error	Troubleshooting
0 (00h)	No error	
6 (06h)	Battery undervoltage	Battery dead Change battery
		Contact errors: Check battery contacts
		Incorrect battery type inserted: use correct battery type
7 (07h)	Control electronics undervoltage	Check operating voltage control
		Check line losses
		Check contacts of the plug and terminals
8 (08h)	Control electronics overvoltage	Check operating voltage control
9 (09h)	Power electronics overvoltage	Operating voltage output stage
10 (0Ah)	Output stage overtemperature (cf. Section 3.5.2.4)	Reduce ambient temperature
		Reduce load
11 (0Bh)	Position lag (cf. Section 3.5.2.6)	Reduce load
		Reduce acceleration or speed
		Operating voltage output stage
		Check line losses
12 (0Ch)	Output shaft blocked	Loosen shaft
15 (0Fh)	SIN/COS monitoring Vector length out of range, invalid actual position	Shield foreign magnetic fields
		Check EMC measures
		Calibration required after fault elimination and acknowledgment
33 (21h)	Motor overcurrent (cf. Section 3.5.2.2)	Reduce load or switch-on time
37 (25h)	Position control unstable (cf. Section 3.5.2.7)	Check PID parameters
38 (26h)	Thermal overload of motor (cf. Section 3.5.2.4)	Reduce load
		Reduce switch-on time
48 (30h)	Internal error 1 SPI interface timeout	Check EMC measures
49 (31h)	Internal error 2 SPI interface data loss	Check EMC measures
50 (32h)	Internal error 3 SPI interface initialization communication error	Check EMC measures

Error code	Error	Troubleshooting
51 (33h)	Internal error 4 Initialization error position counter, invalid actual position	Check EMC measures
		Calibration required after fault elimination and acknowledgment
52 (34h)	Internal error 5 Data loss position counter detected when switched on, invalid actual position Battery change was carried out without applied operating voltage control	Replace the battery only when the operating voltage control is switched on
		Calibration required after fault elimination and acknowledgment
53 (35h)	Internal error 6 Data loss position counter during operation, invalid actual position	Check EMC measures
		Calibration required after fault elimination and acknowledgment

Table 8: Error Codes

4 Parameter

All parameters stored in the EEPROM can be reset to factory default settings if necessary (cf. Section 3.5.3).

4.1 Process data

4.1.1 ControlWord

General properties

EEPROM	No
Unit	-
Value range	(cf. Section 5.2)
Default	0

IO-Link

Data type	UnsignedInteger16		
Access	wo		
Index	-	Subindex	-
Data Storage	No		

4.1.2 StatusWord

General properties

EEPROM	No
Unit	-
Value range	(cf. Section 5.2)
Default	-

IO-Link

Data type	UnsignedInteger16		
Access	ro		
Index	70	Subindex	0
Data Storage	No		

4.1.3 TargetValue

General properties

EEPROM	No
Unit	Position Mode operating mode: User units (cf. Section 3.5.1) Velocity Mode: U/min
Value range	Depends on the operating mode and scaling
Default	0

IO-Link

Data type	SignedInteger32		
Access	rw		
Index	69	Subindex	0
Data Storage	No		

4.1.4 ActualValue

General properties

EEPROM	No
Unit	Position Mode operating mode: User units (cf. Chapter3.5.1) Velocity Mode: U/min
Value range	Depends on the operating mode and scaling

Default	-

IO-Link

Data type	SignedInteger32		
Access	ro		
Index	68	Subindex	0
Data Storage	No		

4.1.5 GenericMappingParameter1

General properties

EEPROM	No
Unit	-
Value range	(cf. Section 5.3)
Default	0

IO-Link

Data type	UnsignedInteger8		
Access	wo		
Index	-	Subindex	-
Data Storage	No		

4.1.6 UnsignedInteger8

General properties

EEPROM	No
Unit	-
Value range	(cf. Section 5.3)
Default	0

IO-Link

Data type	UnsignedInteger8		
Access	wo		
Index	-	Subindex	-
Data Storage	No		

4.1.7 GenericMappingChannel1

General properties

EEPROM	No
Unit	-
Value range	(cf. Section 5.3)

Default	-

IO-Link

Data type	SignedInteger8		
Access	ro		
Index	-	Subindex	-
Data Storage	No		

4.1.8 GenericMappingChannel2

General properties

EEPROM	No
Unit	-
Value range	(cf. Section 5.3)
Default	-

IO-Link

Data type	SignedInteger8		
Access	ro		
Index	-	Subindex	-
Data Storage	No		

4.2 Positioning

4.2.1 OffsetApplication

General properties

EEPROM	Yes
Unit	User units (cf. Section 3.5.1)
Value range	-999999 ... 999999
Default	0

IO-Link

Data type	SignedInteger32		
Access	rw		
Index	66	Subindex	0
Data Storage	Yes		

4.2.2 SpindlePitch

General properties

EEPROM	Yes
Unit	-
Value range	0 ... 1000000
Default	0

IO-Link

Data type	SignedInteger32		
Access	rw		
Index	71	Subindex	0
Data Storage	Yes		

4.2.3 CountingDirection

General properties

EEPROM	Yes
Unit	-
Value range	0 ... 1
Default	0

IO-Link

Data type	UnsignedInteger8		
Access	rw		
Index	76	Subindex	0
Data Storage	Yes		

Parameter selection

Value	Description
0	Rotation direction i: increasing position values during clockwise rotation
1	Rotation direction e: increasing position values during counterclockwise rotation

4.2.4 CalibrationValue

General properties

EEPROM	Yes
Unit	User units (cf. Section 3.5.1)
Value range	-999999 ... 999999
Default	0

IO-Link

Data type	SignedInteger32		
Access	rw		
Index	77	Subindex	0
Data Storage	Yes		

4.2.5 TargetWindow

General properties

EEPROM	Yes
Unit	User units (cf. Section 3.5.1)
Value range	0 ... 1000
Default	10

IO-Link

Data type	UnsignedInteger16		
Access	rw		
Index	78	Subindex	0
Data Storage	Yes		

4.2.6 LoopType

General properties

EEPROM	Yes
Unit	-
Value range	0 ... 2
Default	0

IO-Link

Data type	UnsignedInteger8		
Access	rw		
Index	79	Subindex	0
Data Storage	Yes		

Parameter selection

Value	Description
0	The target value is approached directly from the current position.
1	To compensate for the spindle play, the target value is always approached in the positive direction.
2	To compensate for the spindle play, the target value is always approached in the negative direction.

4.2.7 LoopLength

General properties

EEPROM	Yes
Unit	User units (cf. Section 3.5.1)
Value range	0 ... 30000
Default	800

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	80	Subindex	0
Data Storage	Yes		

4.2.8 GearRatioNumerator

General properties

EEPROM	Yes
Unit	-
Value range	1 ... 10000
Default	1

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	129	Subindex	0
Data Storage	Yes		

4.2.9 GearRatioDenominator

General properties

EEPROM	Yes
Unit	-
Value range	1 ... 10000
Default	1

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	130	Subindex	0
Data Storage	Yes		

4.2.10 DeltaInch

General properties

EEPROM	Yes
Unit	User units (cf. Section 3.5.1)
Value range	-1000000 ... 1000000
Default	1600

IO-Link

Data type	SignedInteger32		
Access	rw		
Index	133	Subindex	0
Data Storage	Yes		

4.2.11 TargetWindowReachedMode

General properties

EEPROM	Yes
Unit	-
Value range	0 ... 2
Default	0

IO-Link

Data type	UnsignedInteger8		
Access	rw		
Index	137	Subindex	0
Data Storage	Yes		

Parameter selection

Value	Description
0	Permanent position control to target value
1	Position control OFF and short circuit of the motor windings
2	Position control OFF and activation of the drive

4.3 Actuator

4.3.1 OperatingMode

General properties

EEPROM	Yes
Unit	-
Value range	0 ... 1

Default	0

IO-Link

Data type	SignedInteger8		
Access	rw		
Index	92	Subindex	0
Data Storage	Yes		

Parameter selection

Value	Description
0	Positioning Mode
1	Speed Mode

4.3.2 AccelerationPositionMode

General properties

EEPROM	Yes
Unit	%, 100% = 4 U/s²
Value range	1 ... 100
Default	50

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	123	Subindex	0
Data Storage	Yes		

4.3.3 VelocityPositionMode

General properties

EEPROM	Yes
Unit	U/min
Value range	i=24: 1 ... 200 i=48: 1 ... 100
Default	30

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	124	Subindex	0
Data Storage	Yes		

4.3.4 DecelerationPositionMode

General properties

EEPROM	Yes
Unit	%, 100% = 4 U/s²
Value range	1 ... 101
Default	101

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	125	Subindex	0
Data Storage	Yes		

Parameter selection

Value	Description
101	Delay is determined by the AccelerationPositionMode parameter
1 - 100	Delay in percent

4.3.5 AccelerationVelocityMode

General properties

EEPROM	Yes
Unit	%, 100% = 4 U/s²
Value range	1 ... 100
Default	50

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	126	Subindex	0
Data Storage	Yes		

4.3.6 AccelerationInchingMode

General properties

EEPROM	Yes
Unit	%, 100% = 4 U/s²
Value range	1 ... 100
Default	50

IO-Link

Data type	SignedInteger16
Access	rw

Index	127	Subindex	0
Data Storage	Yes		

4.3.7 VelocityInchingMode

General properties

EEPROM	Yes
Unit	U/min
Value range	i = 24: 1 ... 200 i = 48: 1 ... 100
Default	30

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	128	Subindex	0
Data Storage	Yes		

4.3.8 Inching2Offset

General properties

EEPROM	No
Unit	%VelocityInchingMode
Value range	10 ... 100
Default	100

IO-Link

Data type	UnsignedInteger8		
Access	rw		
Index	135	Subindex	0
Data Storage	No		

4.4 Limit values

4.4.1 SoftwareLimit1

General properties

EEPROM	Yes
Unit	User units (cf. Section 3.5.1)
Value range	-9999999 ... 9999999
Default	1000000

IO-Link

Data type	SignedInteger32		
Access	rw		
Index	131	Subindex	0
Data Storage	Yes		

4.4.2 SoftwareLimit2

General properties

EEPROM	Yes
Unit	User units (cf. Section 3.5.1)
Value range	-9999999 ... 9999999
Default	-1000000

IO-Link

Data type	SignedInteger32		
Access	rw		
Index	132	Subindex	0
Data Storage	Yes		

4.4.3 ContouringErrorLimit

General properties

EEPROM	Yes
Unit	Increments
Value range	1 ... 30000
Default	400

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	138	Subindex	0
Data Storage	Yes		

4.4.4 TorqueDeactivation

General properties

EEPROM	Yes
Unit	%
Value range	20 ... 125
Default	125

IO-Link

Data type	UnsignedInteger8		
Access	rw		
Index	139	Subindex	0
Data Storage	Yes		

Parameter selection

Value	Description
125	Torque deactivation function disabled
20 ... 124	Trigger threshold of torque deactivation as a percentage of the rated motor current

4.4.5 PeakCurrentLimit

General properties

EEPROM	Yes
Unit	mA
Value range	0 ... 5600
Default	5600

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	181	Subindex	0
Data Storage	Yes		

4.4.6 PeakCurrentTime

General properties

EEPROM	Yes
Unit	x100 ms
Value range	0 ... 20
Default	20

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	182	Subindex	0
Data Storage	Yes		

4.4.7 ContinuousCurrent

General properties

EEPROM	Yes
Unit	mA
Value range	0 ... 2800
Default	2800

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	183	Subindex	0
Data Storage	Yes		

4.5 Options

4.5.1 Inching2StopMode

General properties

EEPROM	Yes
Unit	-
Value range	0 ... 1
Default	0

IO-Link

Data type	UnsignedInteger8		
Access	rw		
Index	134	Subindex	0
Data Storage	Yes		

Parameter selection

Value	Description
0	Stop with maximum delay
1	Stop with programmed delay

4.5.2 Inching2AccelerationMode

General properties

EEPROM	Yes
Unit	-
Value range	0 ... 1
Default	0

IO-Link

Data type	UnsignedInteger8		
Access	rw		
Index	136	Subindex	0
Data Storage	Yes		

Parameter selection

Value	Description
0	Static acceleration The acceleration occurs as defined in the AccelerationInchingMode parameter up to the final velocity VelocityInchingMode.
1	Incremental acceleration The acceleration occurs as defined in the parameters AccelerationInchingMode up to the final velocity VelocityInchingMode in the following steps: 4 s at 20% of the final speed 2 s at 50% of the final speed 1 s at 100% of the final speed

4.6 Controller parameter

4.6.1 ControllerParameterP

General properties

EEPROM	Yes
Unit	-
Value range	1 ... 500
Default	100

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	120	Subindex	0
Data Storage	Yes		

4.6.2 ControllerParameterI

General properties

EEPROM	Yes
Unit	-
Value range	0 ... 500
Default	2

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	121	Subindex	0
Data Storage	Yes		

4.6.3 ControllerParameterD

General properties

EEPROM	Yes
Unit	-
Value range	0 ... 500
Default	0

IO-Link

Data type	SignedInteger16		
Access	rw		
Index	122	Subindex	0
Data Storage	Yes		

4.7 Device information

4.7.1 OutputStageTemperature

General properties

EEPROM	No
Unit	1/10° C
Value range	-
Default	-

IO-Link

Data type	SignedInteger16		
Access	ro		
Index	140	Subindex	0
Data Storage	No		

4.7.2 ControlVoltage

General properties

EEPROM	No
Unit	1/10 V

Value range	-
Default	-

IO-Link

Data type	SignedInteger16		
Access	ro		
Index	141	Subindex	0
Data Storage	No		

4.7.3 OutputStageVoltage

General properties

EEPROM	No
Unit	1/10 V
Value range	-
Default	-

IO-Link

Data type	SignedInteger16		
Access	ro		
Index	142	Subindex	0
Data Storage	No		

4.7.4 BatteryVoltage

General properties

EEPROM	No
Unit	1/100 V
Value range	-
Default	-

IO-Link

Data type	SignedInteger16		
Access	ro		
Index	143	Subindex	0
Data Storage	No		

4.7.5 MotorCurrent

General properties

EEPROM	No
Unit	mA

Value range	-
Default	-

IO-Link

Data type	SignedInteger16		
Access	ro		
Index	144	Subindex	0
Data Storage	No		

4.7.6 ActualPosition

General properties

EEPROM	No
Unit	User units (cf. Section 3.5.1)
Value range	-
Default	-

IO-Link

Data type	SignedInteger32		
Access	ro		
Index	145	Subindex	0
Data Storage	No		

4.7.7 ActualVelocity

General properties

EEPROM	No
Unit	U/min
Value range	-
Default	-

IO-Link

Data type	SignedInteger16		
Access	ro		
Index	146	Subindex	0
Data Storage	No		

4.7.8 MotorThermalLoad

General properties

EEPROM	No
Unit	%

Value range:	-
Default	-

IO-Link

Data type	SignedInteger16		
Access	ro		
Index	149	Subindex	0
Data Storage	No		

4.7.9 DiagnosticParameter

General properties

EEPROM	No
Unit	-
Value range	-
Default	-

IO-Link

Data type	Record		
Access	ro		
Index	150	Subindex	0
Data Storage	No		

Record

Subindex	Data type	Name
1	SignedInteger16	DiagnosticParameter1
2	SignedInteger16	DiagnosticParameter2

4.7.10 Production Date

General properties

EEPROM	Yes
Unit	DDMMYYYY
Value range	-
Default	-

IO-Link

Data type	StringT		
Access	ro		
Index	180	Subindex	0
Data Storage	No		

4.7.11 I2tOverload

General properties

EEPROM	No
Unit	%
Value range:	-
Default	-

IO-Link

Data type	UnsignedInteger8		
Access	ro		
Index	184	Subindex	0
Data Storage	No		

4.7.12 ActualContouringError

General properties

EEPROM	No
Unit	Increments
Value range	-
Default	-

IO-Link

Data type	SignedInteger32		
Access	ro		
Index	185	Subindex	0
Data Storage	No		

4.8 Error memory

4.8.1 ErrorCount

General properties

EEPROM	No
Unit	-
Value range	0 ... 10
Default	-

IO-Link

Data type	UnsignedInteger8		
Access	ro		
Index	147	Subindex	0

Data Storage	No

4.8.2 ErrorBuffer

General properties

EEPROM	Yes
Unit	-
Value range	-
Default	-

IO-Link

Data type	Record		
Access	ro		
Index	148	Subindex	0
Data Storage	No		

Record

Subindex	Data type	Name
1	UnsignedInteger8	Error1
2	UnsignedInteger8	Error2
3	UnsignedInteger8	Error3
4	UnsignedInteger8	Error4
5	UnsignedInteger8	Error5
6	UnsignedInteger8	Error6
7	UnsignedInteger8	Error7
8	UnsignedInteger8	Error8
9	UnsignedInteger8	Error9
10	UnsignedInteger8	Error10

4.8.3 ErrorCounters

General properties

EEPROM	Yes
Unit	-
Value range	-
Default	-

IO-Link

Data type	Record		
Access	ro		
Index	186	Subindex	0
Data Storage	No		

Record

Subindex	Data type	Name
1	SignedInteger16	Battery empty
2	SignedInteger16	Control electronics undervoltage
3	SignedInteger16	Control electronics overvoltage
4	SignedInteger16	Control electronics overvoltage
5	SignedInteger16	Output stage excess temperature
6	SignedInteger16	Contouring error
7	SignedInteger16	Output shaft blocked
8	SignedInteger16	SIN COS monitoring
9	SignedInteger16	Motor overcurrent
10	SignedInteger16	Internal error 1
11	SignedInteger16	Internal error 2
12	SignedInteger16	Internal error 3
13	SignedInteger16	Internal error 4
14	SignedInteger16	PID loop unstable
15	SignedInteger16	Motor thermal overload
16	SignedInteger16	Internal error 5
17	SignedInteger16	Internal error 6

5 IO-Link

5.1 Description

The device description is available for download as IODD at http://www.siko-global.com/p/ag03-1 and in the IODD finder of the IO-Link Community.

IO-Link Version	V1.1
SIO Mode	No
COM Mode	COM2 (38.4 kbaud)
Min Cycle Time	9.6 ms
Process Data In	8 bytes
Process Data Out	8 Byte
Data Storage	Yes
Block Parameter	Yes
DEVICE ID AG03-24 FW-V1.01	256
DEVICE ID AG03-48 FW-V1.01	512
Device ID AG03-24 ≥ FW-V1.02	768
Device ID AG03-48 ≥ FW-V1.02	1024

Table 9: General Interface Information

5.2 Process data input / output

All process data are displayed within 8 bytes and have different significance depending on the operating mode.

Transmission sequence:

Byte	0	1	2	3	4	5	6	7
Subindex	19 … 12	11 … 4	3	2	1			
Bit offset	63 … 56	55 … 48	47 … 40	39 … 32	31 … 24	23 … 16	15 … 8	7 … 0

Table 10: Assignment of transfer sequence, subindex and bit offset

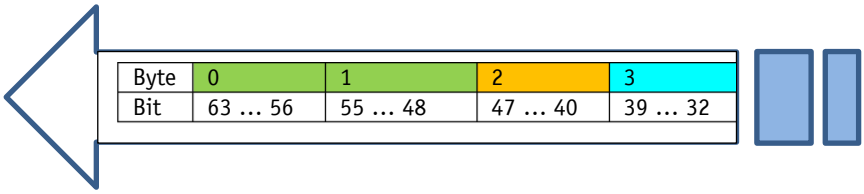

Fig. 14: Transmission sequence:

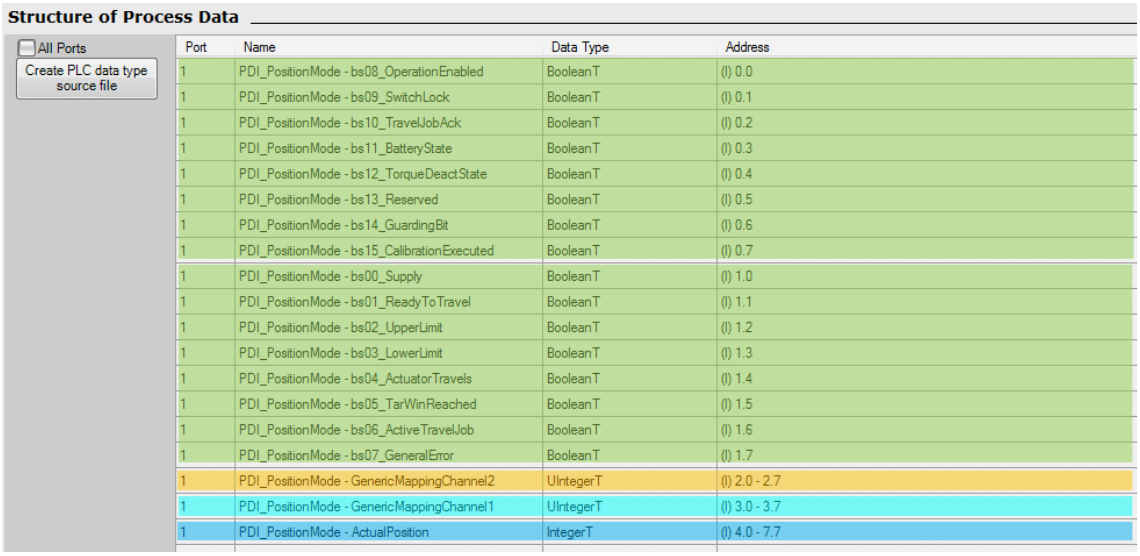

Fig. 15: Example representation in IO-Link master

5.2.1 Process data in Position Mode operating mode

Sub-index	Significance (Position Mode operating mode)		Bit offset	Byte	Length
	In (to master)	Out (from master)			
1	ActualPosition	TargetPosition	0	4 … 7	32
2	GenericMappingChannel1	GenericMappingParameter1	32	3	8
3	GenericMappingChannel2	GenericMappingParameter2	40	2	8
4 … 19	StatusWord	ControlWord	48	0 … 1	16

Table 11: Process Data Definition Position Mode

5.2.1.1 Process data output (Master ⇒ Device)

Sub-index	Name	Bit offset	Bit length	Data type	Note
1	TargetPosition	0	32	Signed integer	Target position
2	GenericMappingParameter1	32	8	Unsigned integer	Set content of mapping channel 1
3	GenericMappingParameter2	40	8	Unsigned integer	Set content of mapping channel 2
4	bc00_CoastStop	48	1	Bool	Coast stop command
5	bc01_QuickStop	49	1	Bool	Quick stop command
6	bc02_NormalStop	50	1	Bool	Normal stop command
7	bc03_IntermediateStop	51	1	Bool	Interrupt active travel job
8	bc04_StartTravelJob	52	1	Bool	Rising edge starts travel job
9	bc05_ErrorAck	53	1	Bool	If true, the actual error is acknowledged
10	bc06_InchingMode1	54	1	Bool	Inching with positioning steps
11	bc07_InchingMode2Pos	55	1	Bool	Inching in positive direction
12	bc08_InchingMode2Neg	56	1	Bool	Inching in negative direction
13	bc09_Reserved	57	1	Bool	Reserved
14	bc10_MoveRelative	58	1	Bool	Select absolute or relative positioning
15	bc11_Reserved	59	1	Bool	Reserved
16	bc12_Reserved	60	1	Bool	Reserved
17	bc13_Reserved	61	1	Bool	Reserved
18	bc14_GuardingBit	62	1	Bool	Communication guarding
19	bc15_CalibrationExecute	63	1	Bool	If true calibration becomes executed

Table 12: PDI in Position Mode

5.2.1.2 Process data input (Device ⇒ Master)

Sub-index	Name	Bit offset	Bit length	Data type	Note
1	ActualPosition	0	32	Signed integer	Actual position
2	GenericMappingChannel1	32	8	Signed integer	Content selectable via generic mapping parameter 1

Sub-index	Name	Bit offset	Bit length	Data type	Note
3	GenericMappingChannel2	40	8	Signed integer	Content selectable via generic mapping parameter 2
4	bs00_Supply	48	1	Bool	Output stage voltage status
5	bs01_ReadyToTravel	49	1	Bool	True if ready to travel
6	bs02_UpperLimit	50	1	Bool	True if upper limit is purple
7	bs03_LowerLimit	51	1	Bool	True if lower limit is purple
8	bs04_ActuatorTravels	52	1	Bool	True if actuator travels
9	bs05_TarWinReached	53	1	Bool	True if target window is reached
10	bs06_ActiveTravelJob	54	1	Bool	True if travel job is active
11	bs07_GeneralError	55	1	Bool	True if error is active
12	bs08_OperationEnabled	56	1	Bool	True if operation is enabled
13	bs09_SwitchLock	57	1	Bool	True if switch-lock is active
14	bs10_TravelJobAck	58	1	Bool	True if travel job is acknowledged
15	bs11_BatteryState	59	1	Bool	True if battery state is critical or low
16	bs12_TorqueDeactState	60	1	Bool	True if torque deactivation is active
17	bs13_CalibrationRequest	61	1	Bool	True if calibration is required
18	bs14_GuardingBit	62	1	Bool	Communication guarding
19	bs15_CalibrationExecuted	63	1	Bool	True if calibration command is executed

Table 13: PDI in Position Mode operating mode

5.2.2 Process data in Velocity Mode

Sub-index	Significance (Velocity Mode)		Bit offset	Byte	Length
	In (to master)	Out (from master)			
1	ActualVelocity	TargetVelocity	0	4 … 7	32
2	GenericMappingChannel1	GenericMappingParameter1	32	3	8
3	GenericMappingChannel2	GenericMappingParameter2	40	2	8
4 … 19	StatusWord	ControlWord	48	0 … 1	16

Table 14: Process Data Definition Velocity Mode

5.2.2.1 Process data output (Master ⇒ Device)

Sub-index	Name	Bit offset	Bit length	Data type	Note
1	TargetVelocity	0	32	Signed integer	Target velocity
2	GenericMappingParameter1	32	8	Unsigned integer	Set content of mapping channel 1
3	GenericMappingParameter2	40	8	Unsigned integer	Set content of mapping channel 2
4	bc00_CoastStop	48	1	Bool	Coast stop command
5	bc01_QuickStop	49	1	Bool	Quick stop command
6	bc02_NormalStop	50	1	Bool	Normal stop command
7	bc03_Reserved	51	1	Bool	Reserved
8	bc04_StartTravelJob	52	1	Bool	Rising edge starts travel job
9	bc05_ErrorAck	53	1	Bool	If true, the actual error is acknowledged
10	bc06_Reserved	54	1	Bool	Reserved
11	bc07_Reserved	55	1	Bool	Reserved
12	bc08_Reserved	56	1	Bool	Reserved
13	bc09_Reserved	57	1	Bool	Reserved
14	bc10_Reserved	58	1	Bool	Reserved
15	bc11_Reserved	59	1	Bool	Reserved
16	bc12_Reserved	60	1	Bool	Reserved
17	bc13_Reserved	61	1	Bool	Reserved
18	bc14_GuardingBit	62	1	Bool	Communication guarding
19	bc15_CalibrationExecute	63	1	Bool	If true calibration becomes executed

Table 15: PDO in Velocity Mode operating mode

5.2.2.2 Process data input (Device ⇒ Master)

Sub-index	Name	Bit offset	Bit length	Data type	Note
1	ActualVelocity	0	32	Signed integer	Actual velocity
2	GenericMappingChannel1	32	8	Signed integer	Content selectable via generic mapping parameter 1
3	GenericMappingChannel2	40	8	Signed integer	Content selectable via generic mapping parameter 2
4	bs00_Supply	48	1	Bool	Output stage voltage status
5	bs01_ReadyToTravel	49	1	Bool	True if ready to travel

Sub-index	Name	Bit offset	Bit length	Data type	Note
6	bs02_Reserved	50	1	Bool	Reserved
7	bs03_Reserved	51	1	Bool	Reserved
8	bs04_ActuatorTravels	52	1	Bool	True if actuator travels
9	bs05_TarWinReached	53	1	Bool	True if target window is reached
10	bs06_ActiveTravelJob	54	1	Bool	True if travel job is active
11	bs07_GeneralError	55	1	Bool	True if error is active
12	bs08_OperationEnabled	56	1	Bool	True if operation is enabled
13	bs09_SwitchLock	57	1	Bool	True if switch-lock is active
14	bs10_TravelJobAck	58	1	Bool	True if travel job is acknowledged
15	bs11_BatteryState	59	1	Bool	True if battery state is critical or low
16	bs12_Reserved	60	1	Bool	Reserved
17	bs13_CalibrationRequest	61	1	Bool	True if calibration is required
18	bs14_GuardingBit	62	1	Bool	Communication guarding
19	bs15_CalibrationExecuted	63	1	Bool	True if calibration command is executed

Table 16: PDI in Velocity Mode

5.3 Generic Mapping Channels

In addition to the predefined process input data, additional drive data can be transferred using the two mapping channels. The content of the Generic Mapping Channel is defined by the Generic Mapping parameter in the process output data. The Generic Mapping parameter can be changed at any time.

Generic Mapping Parameter		Generic Mapping Channel / Unit
Value	Name	
0	Error Status	
1	Output stage temperature	[°C]
2	Control voltage	[V]
3	Output stage voltage	[V]
4	Battery voltage	[1/10 V]
5	Motor current	[1/10 A]
6	Actual velocity	Actual velocity / Max velocity [%]
7	Motor thermal load	Motor thermal load / Max thermal load [%]
8	I2t overload	I2t actual value / I2t limit [%]
9	Diagnostic parameter 1	

Generic Mapping Parameter		Generic Mapping Channel / Unit
Value	Name	
10	Diagnostic parameter 2	

Table 17: Generic Mapping Parameter

5.4 Object Directory

5.4.1 IO-Link specific objects

Index (hex)	Name	Type	Length	Access	Default	Note
0 (00h)	DirectParameter1	Record	16 bytes	rw		Cf. IO-Link Interface Spec.
1 (01h)	DirectParameter2	Record	16 bytes	rw		Cf. IO-Link Interface Spec.
2 (02h)	System Commands			wo		Cf. IO-Link Interface Spec. and 5.5
3 (03h)	DataStorageIndex	Record	72 bytes	ro		Cf. IO-Link Interface Spec.
12 (0Ch)	DeviceAccesLocks	Record	2 bytes	wr		Cf. IO-Link Interface Spec. and 5.6
13 (0Dh)	Profile Characteristic	Record	2 bytes	ro		Cf. IO-Link Interface Spec.
14 (0Eh)	PDInputDescriptor	Unsigned Integer16	3 bytes	ro		Cf. IO-Link Interface Spec.
15 (0Fh)	PDOutputDescriptor	Unsigned Integer16	3 bytes	ro		Cf. IO-Link Interface Spec.
16 (10h)	Vendor Name	String	9 bytes	ro	SIKO GmbH	
17 (11h)	Vendor Text	String	19 bytes	ro	www.siko-global.com	
18 (12h)	Product Name	String	11 bytes 12 bytes 11 bytes 12 bytes	ro	AG03-24-IOL AG03-24-IOL2 AG03-48-IOL AG03-48-IOL2	
19 (13h)	Product ID	String	1 byte	ro	1 = IOL 2 = IOL2	
20 (14h)	Product Text	String	8 byte	ro	Actuator	
21 (15h)	Serial Number	String	8 bytes	ro	xxxxxxxx	

Index (hex)	Name	Type	Length	Access	Default	Note
22 (16h)	Hardware Revision	String	7 bytes	ro	HW-Vxxx	
23 (17h)	Firmware Revision	String	7 bytes	ro	FW-Vxxx	
24 (18h)	Application Specific Tag	String	32 bytes	rw	***	Cf. IO-Link Interface Spec.
36 (24h)	Device Status	Uint	1 byte	ro		Cf. IO-Link Interface Spec.

Table 18: IO-Link specific indexes

5.5 IO-Link System Commands

Index (hex)	Name	Access	Value	Name	Note
2 (02h)	System Commands	wo	1	ParamUploadStart	IO-Link Spec.
			2	ParamUploadEnd	
			3	ParamDownloadStart	
			4	ParamDownloadStart	
			5	ParamDownloadStore	
			6	ParamBreak	
			128	Device Reset	
			130	Restore Factory Settings	
			161	Enable Bootloader	Bootloading not via IO-Link
			163	Clear Error Buffer	
			252	Execute Calibration	Cf. Section 3.4.

Table 19: System Commands

5.6 IO-Link DeviceAccessLocks

Index (hex)	Name	Access	Supported Access Locks	Note
12 (0Ch)	DeviceAccessLocks	rw	Data Storage	IO-Link Spec.
			Local Parameterization	IO-Link Spec.

Table 20: DeviceAccessLocks

5.7 IO-Link Event Codes

Event Code	Name	Type	Note
6146 (1802h)	Battery empty	Error	Charge level empty
6147 (1803h)	Control electronics undervoltage	Error	Control voltage too low
6148 (1804h)	Control electronics overvoltage	Error	Control voltage too high
6149 (1805h)	Control electronics overvoltage	Error	Output stage voltage too high
6150 (1806h)	Output stage excess temperature	Error	Output stage temperature too high
6151 (1807h)	Contouring error	Error	Position lag
6152 (1808h)	Output shaft blocked	Error	Shaft blocked
6154 (180Ah)	SIN COS monitoring	Error	Encoder error
6155 (180Bh)	Motor overcurrent	Error	Motor current too high
6156 (180Ch)	Internal error 1	Error	Internal error 1
6157 (180Dh)	Internal error 2	Error	Internal error 2
6158 (180Eh)	Internal error 3	Error	Internal error 3
6159 (180Fh)	Internal error 4	Error	Internal error 4
6160 (1810h)	PID loop unstable	Error	Position control unstable
6161 (1811h)	Motor thermal overload	Error	Thermal overload of the motor
6162 (1812h)	Internal error 5	Error	Internal error 5
6163 (1813h)	Internal error 6	Error	Internal error 6
20498 (5012h)	Battery low	Warning	Charging state is critical
25376 (6320h)	Parameter error	Error	IO-Link Spec. V1.1.2 Appendix D.

Table 21: EventCodes

5.8 IO-Link Event Codes

Value 1. Byte	Value 2. Byte	Name	Note
80h	xxh	Error Code	IO-Link Spec. V1.1.2 Appendix C.
	00h	Device application error, no details	
	11h	Index not available	
	12h	Subindex not available	
	20h	Service temporarily not available	
	21h	Service temporarily not available, local control	
	22h	Service temporarily not available, device control	
	23h	Write access denied	
	30h	Parameter value out of range	
	31h	Parameter value above limit	
	32h	Parameter value below limit	
	33h	Parameter length overrun	
	34h	Parameters length underrun	
	35h	Function not available	

Value 1. Byte	Value 2. Byte	Name	Note
	36h	Function temporarily not available	
	40h	Invalid parameter set	
	41h	Inconsistent parameter set	
	82h	Application not ready	
81h	xxh	Vendor specific error code	

Table 22: ErrorCodes

6 Block wiring diagram

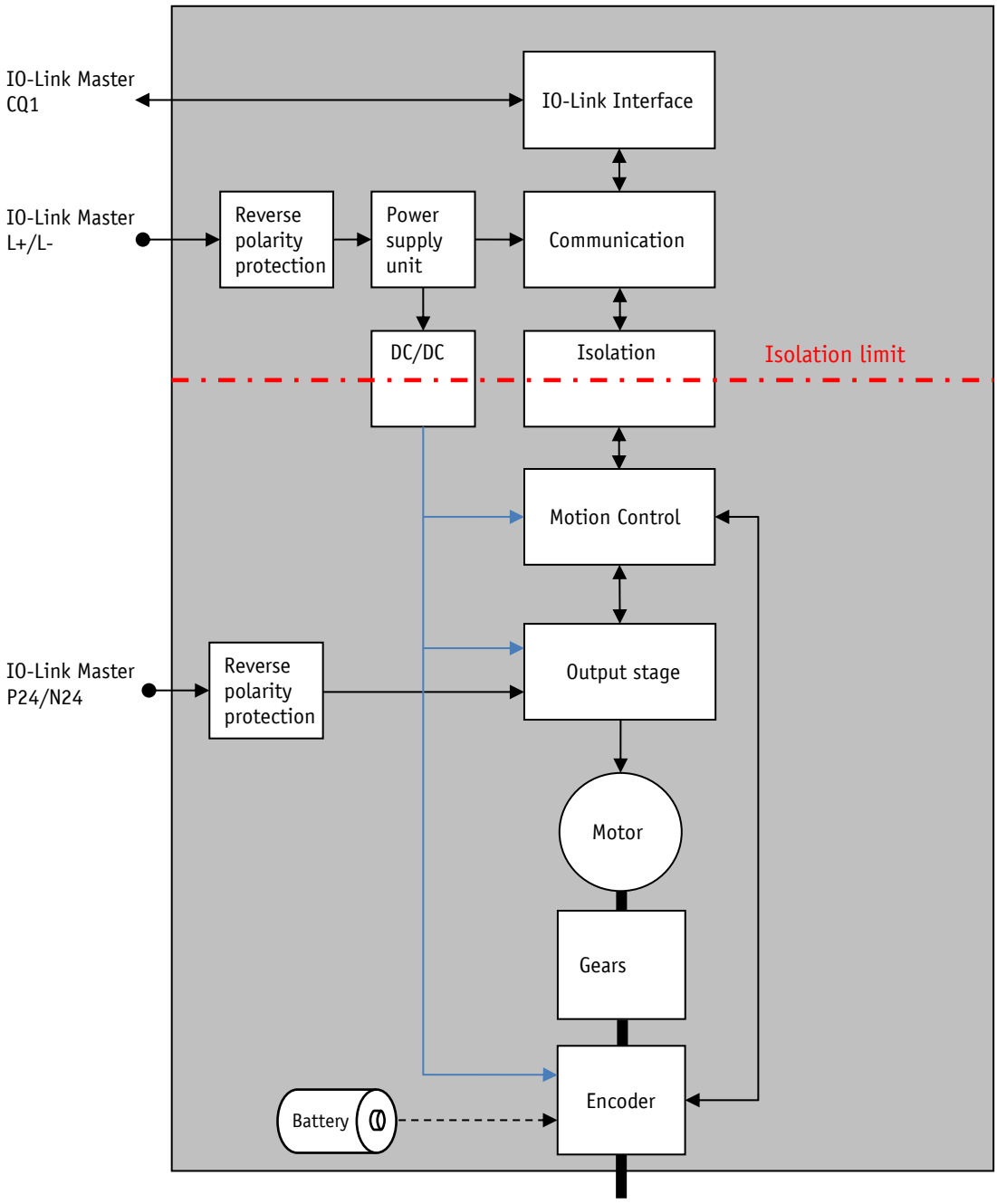

Fig. 16: Block wiring diagram

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