WH3650M, WV3650M

Absolut encoder with ◉ IO-Link interface

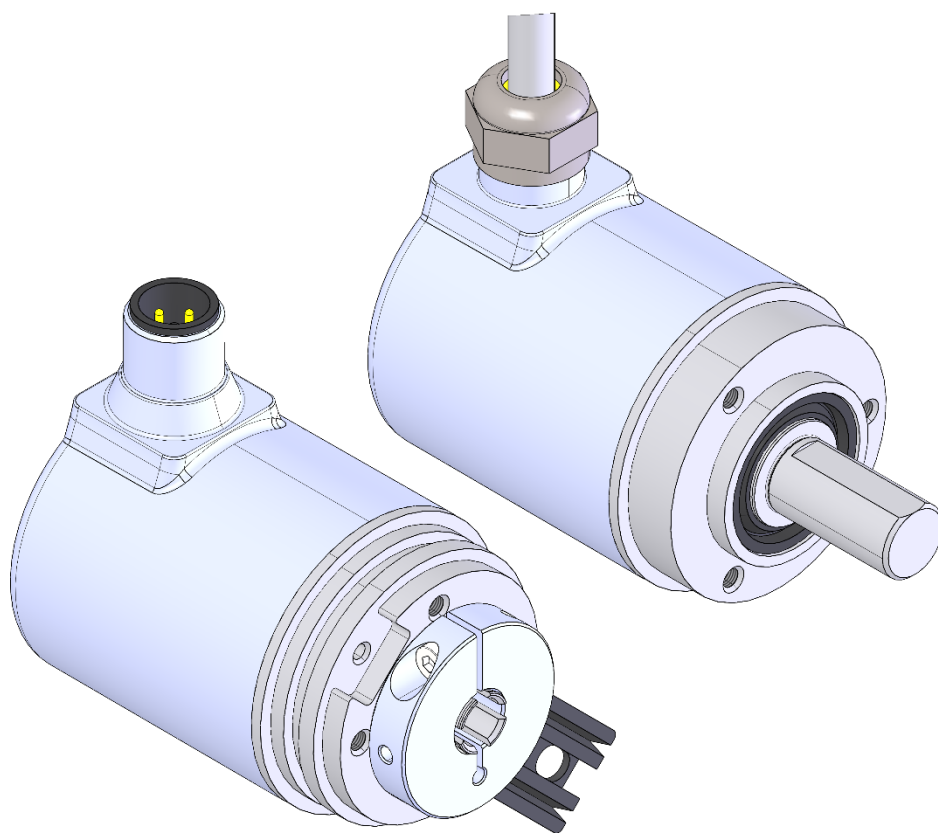## User manual

SIKO

Table of contents

1 General Information

1.1 Documentation

The following documents describe this product:

- The data sheet describes the technical data, the dimensions, the pin assignment, the accessories and the order key.

- The installation instructions describe the mechanical and electrical installation with all safety-relevant conditions and the associated technical specifications.

- User manual for connecting the display to an IO-Link master and for commissioning.

- IODD file (IO-Link Device Description); with the help of this file, the connection and configuration with an IO-Link master is possible by means of commercially available IO-Link masters and their configurators.

You can also download these documents at **http://www.siko-global.com/p/wh3650m** and **http://www.siko-global.com/p/wV3650m**.

1.2 Definitions

If not explicitly stated otherwise, decimal values are given as figures without an extension (e. g. 1234), binary values are marked after the figure with a "b" (e. g. 1011b), hexadecimal values with an "h" (e. g. 280h).

1.2.1 History

Mod. status	Date	Description
092/22	10.05.2022	Document prepared

2 LED function and status display

2.1 General
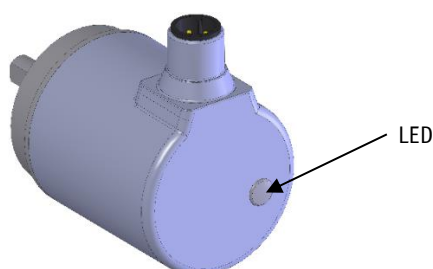
Fig. 1: Devices LED

2.2   Flashing behavior

A bicolor LED indicates the various operating states.

Green = Run

Red = Error

Flashing behavior in the run operating state

Display	LED	Significance	Fault cause	Note
Off	○	OFF	Device switched off	
Flashes three times	🟢🟢🟢	Program / firmware download	A firmware download is running on the device.	Device is in boot loader mode.
On	🟢	IDLE	The device is in IDLE status. Waiting for the IO-Link wake-up request.	No IO-Link communication.
Flashing status	🟢○🟢	COMMUNICATE	The device is in communications standard.	IO-Link communication active.

Table 1: Flashing behavior in the run operating state

Flashing behavior in the Error operating state

Display	LED	Significance	Fault cause	Note
Off	○	No error	Device ready for use / in use	LED off refers here only to the color red.
Flashing	🔴○🔴	Error	IO-Link Error	See IO-Link event codes. Red occurs in combination with green.
Simply flashing	🔴○	Warning	IO-Link warning	See IO-Link event codes. Red occurs in combination with green.
On	🔴	Critical error	The device is faulty	Contact SIKO

Table 2: Flashing behavior in the Error operating state

LED flash codes	Description
Off	LED is permanently off
Flashing	LED flashes at a frequency of 2.5 Hz (200 ms on/off)
Single Flash	LED is 200 ms on, 1000 ms off
Flashes three times	LED is 200 ms on, 200 ms off, 200 ms on, 200 ms off s, 200 ms on, 1000 ms off
On	LED in permanently on
Flashing status	A short periodic interruption

Table 3: LED flash codes

3 IO-Link

3.1 Process data

NOTICE	Configuration: Using parameter "ISDU 225: PROCESS DATA SWITCH" can be switched between the profiles.

3.1.1 Standard Profile

Transmission sequence:

Item	Velocity				Position			
PVinD number	PVinD 2				PVinD 1			
Byte	0	1	2	3	4	5	6	7
Sub-index	Sub-index 0							
	Sub-index 1				Sub-index 2			
Bit Offset	63 … 56	55 … 48	47 … 40	39 … 32	31 … 24	23 … 16	15 … 8	7 … 0
Data type	Int32				Uint32			

Table 4: Assignment of transfer sequence, STD

3.1.2 Smart Sensor Profile (PDI48)

NOTICE	Replacement value If a measured value is temporarily not available, the substitute value "no measured data" is used as the "Measurement value", i. e., 7FFF FFFCh (2147483644). The process data are only marked as "invalid" if a permanent error occurs.

Transmission sequence:

Item	Measurement Value				Scale	Vendor Specific
PVinD number	PVinD 3				PVinD 2	PVinD 1
Byte	0	1	2	3	4	5
Sub-index	Sub-index 0					
	Sub-index 1				Sub-index 2	Sub-index 3
Bit Offset	47 … 16				15 … 8	7 … 0
Data type	Int32				Int8	Uint8

Table 5: Assignment of transfer sequence, SSP

The data length is 6 bytes.

The number of revolutions is output as "Measurement value".

- Unit: "revolution"
- Scaling factor

Multiturn devices: 10^{-3}

Position [counts]	Position [revolutions]	Position as PDI48		
		Measurement value	Scale	Vendor specific
0 … 16	0.000	0	-3	0 (not used)
17 … 32	0.001	1		
33 … 49	0.002	2		
…				
16384 … 16400	1.000	1000		
…				
4294967295				

Table 6: SSP process data of multiturn devices

Single-turn devices: 10^{-6}

Position [counts]	Position [revolutions]	Position as PDI48		
		Measurement value	Scale	Vendor specific
0	0.000000	0	-6	0 (not used)
1	0.000061	61		
2	0.000122	122		
…				
16383	0.999938	999938		

Table 7: SSP process data of singleturn devices

3.2 Directory of objects

3.2.1 IO-Link specific objects

Index (hex)	Name	Type	Length	Access	Default	Comment
0 (00h)	DirectParameter1	Record	16 Byte	rw		See IO-Link Interface Spec.
1 (01h)	DirectParameter2	Record	16 Byte	rw		See IO-Link Interface Spec.
2 (02h)	SystemCommands			wo		See IO-Link Interface Spec. or chapter 3.2.2
3 (03h)	DataStorageIndex	Record	72 Byte	ro		See IO-Link Interface Spec.

Index (hex)	Name	Type	Length	Access	Default	Comment
12 (0Ch)	DeviceAccesLocks	Record	2 Byte	wr		See IO-Link Interface Spec.
13 (0Dh)	ProfileCharacteristic	Record	2 Byte	ro		See IO-Link Interface Spec.
14 (0Eh)	PDInputDescriptor	Unsigned Integer16	3 Byte	ro		See IO-Link Interface Spec.
16 (10h)	VendorName	String	9 Byte	ro	SIKO GmbH	
17 (11h)	VendorText	String	19 Byte	ro	www.siko-global.com	
18 (12h)	ProduktName	String	6 Byte	ro	Wx3650M-xT-xxx	Dependent on variants
19 (13h)	ProduktID	String	1 Byte	ro	1: WV3650M-xT-xxx 2: WH3650M-xT-xxx	Dependent on variants
20 (14h)	ProduktText	String	37 Byte	ro	Absolute encoder multiturn (singleturn)	Dependent on variants
21 (15h)	SerialNumber	String	7 Byte	ro	xxxxxxx	
22 (16h)	HardwareRevision	String	13 Byte	ro	V0	
23 (17h)	FirmwareRevision	String	9 Byte	ro	z. B. V 1.0.2-K080	
24 (18h)	ApplicationSpecific Tag	String	32 Byte	rw	***	See IO-Link Interface Spec.
25 (19h)	Function Tag	String	max 32 Byte	rw	***	See IO-Link Interface Spec.
26 (1Ah)	Location Tag	String	max 32 Byte	rw	***	See IO-Link Interface Spec.
36 (24h)	DeviceStatus	Uint	1 Byte	ro		See chapter 3.2.3
37 (25h)	Detailed DeviceStatus	Array of String	36 Byte	ro	***	See chapter 3.2.4
40 (28h)	Process-DataInput	Device specific	PD Length	ro		See chapter 3.1
49 (31h)	BLOB-ID	Integer	2 Byte	ro		Bootloader Modus
50 (32h)	BLOB_CH	String	variable	rw		Bootloader Modus

Table 8: IO-Link specific objects

3.2.2 System-Commands

Index (hex)	Name	Access	Value	Name	Comment
2 (02h)	SystemCommands	wo	1	ParamUploadStart	IO-Link Spec.
			2	ParamUploadEnd	
			3	ParamDownloadStart	
			4	ParamDownloadEnd	
			5	ParamDownloadStore	
			6	ParamBreak	
			80	BM_UNLOCK_S	
			81	BM_UNLOCK_F	
			82	BM_UNLOCK_T	
			83	BM_ACTIVATE	
			128	Device Reset	
			129	Application Reset	
			130	Restore Factory Settings	

Table 9: System-Commands

3.2.3 DeviceStatus

Information on the device status (diagnosis).

Value	Description
0	The device functions flawlessly
1	Maintenance required
2	Out of specification
3	Function check
4	Error
5	Reserved

Table 10: Device Status

3.2.4 Detailed DeviceStatus

Information about currently pending events in the device. When the device is powered off or reset, the contents of all array elements are reset to their initial settings.

Array elements

Name	Sub-index	Access	Length	Type
Error_Warning_1	1	ro	3 Byte	String
Error_Warning_2	2	ro	3 Byte	String
…	…	…	…	…

Name	Sub-index	Access	Length	Type
Error_Warning_12	12	ro	3 Byte	String

Table 11: Detailed DeviceStatus array elements

For data content, see IO-Link specification

Byte	Meaning
Alle Bytes 00h	No error/warning
Byte 1	EventQualifier
Byte 2	EventCode
Byte 3	EventCode

Table 12: Detailed DeviceStatus data content

3.2.5 Device-specific parameters

3.2.5.1 Position Value

General characteristics

Unit	counts
Value range	0 ... (TMR-1)
Default	0
Comment	

IO-Link

Data type	Uint32		
Access	rw		
Index	40	Sub-index	0
Data Storage	yes		

3.2.5.2 Position Format

General characteristics

Unit	counts
Value range	0
Default	0
Comment	Is always counts

IO-Link

Data type	Uint8		
Access	ro		
Index	41	Sub-index	0
Data Storage	yes		

3.2.5.3 Position Lower Limit

General characteristics

Unit	counts		
Value range	0 … (TMR-1)		
Default	0		
Comment	Position lower limit ≤ Position upper limit		

IO-Link

Data type	Uint32		
Access	rw		
Index	42	Sub-index	0
Data Storage	yes		

3.2.5.4 Position Upper Limit

General characteristics

Unit	counts		
Value range	0 … (TMR-1)		
Default	(TMR-1)		
Comment	Position upper limit ≥ Position lower limit		

IO-Link

Data type	Uint32		
Access	rw		
Index	43	Sub-index	0
Data Storage	yes		

3.2.5.5 Position Limit Control

General characteristics

Unit	counts		
Value range	0 … 1		
Default	1		
Comment	When activated: If the position value falls below/exceeds the limit values, the warning flag is set.		

IO-Link

Data type	Uint8		
Access	rw		
Index	45	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
0	deactivated
1	activated

3.2.5.6 Raw Position

General characteristics

Unit	-
Value range	MT: 0 ... $(2^{32}-1)$ ST: 0 ... $(2^{14}-1)$
Default	-
Comment	Unscaled, without offset, with counting direction

IO-Link

Data type	Uint64		
Access	ro		
Index	4Ch	Sub-index	0
Data Storage	yes		

3.2.5.7 Counting Direction

General characteristics

Unit	-
Value range	0 ... 1
Default	0
Comment	View of the shaft

IO-Link

Data type	Uint8		
Access	rw		
Index	4Eh	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
0	Clockwise (CW)
1	Counter Clockwise (CCW)

3.2.5.8 Preset Value

General characteristics

Unit	counts
Value range	0 ... (TMR-1)
Default	0
Comment	

IO-Link

Data type	Uint32		
Access	rw		
Index	50h	Sub-index	0
Data Storage	yes		

3.2.5.9 Do Position Preset

General characteristics

Unit	-
Value range	1
Default	0
Comment	Set the position value to the preset value.

IO-Link

Data type	Uint8		
Access	wo		
Index	51h	Sub-index	0
Data Storage	no		

Parameter selection

Value	Description
1	Take preset position

3.2.5.10 Offset

General characteristics

Unit	counts
Value range	-
Default	0
Comment	The offset value is calculated when taking the preset position.

IO-Link

Data type	Uint64		
Access	Ro		
Index	52h	Sub-index	0
Data Storage	no		

3.2.5.11 Scaling Control

General characteristics

Unit	-
Value range	0 … 1
Default	0
Comment	

IO-Link

Data type	Uint8		
Access	rw		
Index	57h	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
0	deactivated
1	activated

3.2.5.12 Measuring Units per Revolution (MUR)

General characteristics

Unit	counts
Value range	1 … 16384
Default	16384
Comment	The resolution of the singleturn is 14 bits.

IO-Link

Data type	Uint32		
Access	rw		
Index	58h	Sub-index	0
Data Storage	yes		

3.2.5.13 Total Measuring Range (TMR)

General characteristics

Unit	counts
Value range	MT: 4 … 4294967296 ST: 4 … 16384
Default	MT: 4294967296 ST: 16384
Comment	The data type position value is uint32, and therefore the maximum value is 2^{32}-1.

IO-Link

Data type	Uint64		
Access	rw		
Index	59h	Sub-index	0
Data Storage	yes		

3.2.5.14 Endless Shaft Control

General characteristics

Unit	-
Value range	0 … 1
Default	0
Comment	ST: is not used Scaling Control must be deactivated.

IO-Link

Data type	Uint8		
Access	rw		
Index	5Bh	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
0	Deactivated $\Rightarrow$ Use of MUR & TMR
1	Activated $\Rightarrow$ Use of numerator/denominator & TMR

3.2.5.15 Number of Revolutions Numerator

General characteristics

Unit	counts
Value range	1 ... 262144
Default	262144
Comment	Counter for the number of revolutions ST: not used

IO-Link

Data type	Uint32		
Access	rw		
Index	5Ch	Sub-index	0
Data Storage	yes		

3.2.5.16 Number of Revolutions Denominator

General characteristics

Unit	counts
Value range	1 ... 4096
Default	1
Comment	Denominator for the number of revolutions ST: not used

IO-Link

Data type	Uint32		
Access	rw		
Index	5Dh	Sub-index	0
Data Storage	yes		

3.2.5.17 Velocity Value

General characteristics

Unit	counts
Value range	0 ... 128
Default	1
Comment	Floating average filter

IO-Link

Data type	Uint32		
Access	ro		
Index	6Eh	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
0	deactivated
1 … 128	Number of measured values from which an average value is formed.

3.2.5.18 Velocity Format

General characteristics

Unit	-
Value range	1 … 5
Default	3
Comment	Corresponding velocity adjustment and acceleration unit (at turns/min & turns/h $\Rightarrow$ acceleration turns /s^2).

IO-Link

Data type	Uint8		
Access	rw		
Index	6Fh	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
1	Counts/s
2	Counts/ms
3	Turns/min
4	Turns/s
5	Turns/h

3.2.5.19 Velocity Filter Integration Time

General characteristics

Unit	-
Value range	0 … 128
Default	1
Comment	Floating average filter

IO-Link

Data type	Uint16		
Access	rw		
Index	70h	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
0	deactivated
1 … 128	Number of measured values from which an average value is formed.

3.2.5.20 Velocity Filter Bandwidth

General characteristics

Unit	Hz
Value range	0 … 500
Default	100
Comment	Bandwidth of the first-order low-pass filter.

IO-Link

Data type	Uint16		
Access	rw		
Index	71h	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
0	deactivated
1 … 500	Bandwidth

3.2.5.21 Velocity Lower Limit

General characteristics

Unit	Turns/min
Value range	-1638400 … 1638400
Default	-6000
Comment	Velocity lower limit ≤ Velocity upper limit The unit changes with the velocity format. The values are automatically converted to the new unit.

IO-Link

Data type	Uint32		
Access	rw		
Index	72h	Sub-index	0
Data Storage	yes		

3.2.5.22 Velocity Upper Limit

General characteristics

Unit	See velocity format		
Value range	-1638400 ... 1638400		
Default	6000		
Comment	Velocity upper limit ≥ Velocity lower limit The unit changes with the velocity format. The values are automatically converted to the new unit.		

IO-Link

Data type	Uint32		
Access	rw		
Index	73h	Sub-index	0
Data Storage	yes		

3.2.5.23 Velocity Hysteresis

General characteristics

Unit	See velocity format		
Value range	0 ... 6000		
Default	0		
Comment	Hysteresis for velocity limits. The unit depends on the velocity format.		

IO-Link

Data type	Uint32		
Access	rw		
Index	74h	Sub-index	0
Data Storage	yes		

3.2.5.24 Velocity Limit Control

General characteristics

Unit	-		
Value range	0 ... 1		
Default	1		
Comment	When activated: If the velocity value falls below/exceeds the limit values, the warning flag is set.		

IO-Link

Data type	Uint8		
Access	rw		
Index	75h	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
0	deactivated
1	activated

3.2.5.25   Acceleration Value

General characteristics

Unit	See Acceleration format
Value range	-2147483648 ... 2147483647
Default	0
Comment	

IO-Link

Data type	int32		
Access	ro		
Index	7Dh	Sub-index	0
Data Storage	yes		

3.2.5.26   Acceleration Format

General characteristics

Unit	-
Value range	1 ... 3
Default	
Comment	Acceleration Unit

IO-Link

Data type	Uint8		
Access	rw		
Index	7Eh	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
1	Counts/s²
2	Counts/ms²

Value	Description
3	Turns/s²

3.2.5.27 Acceleration Filter Integration Time

General characteristics

Unit	-
Value range	0 ... 128
Default	1
Comment	Floating average filter

IO-Link

Data type	Uint16		
Access	rw		
Index	7Fh	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
0	deactivated
1 ... 128	Number of measured values from which an average value is formed.

3.2.5.28 Acceleration Filter Bandwidth

General characteristics

Unit	Hz
Value range	0 ... 500
Default	100
Comment	Bandwidth of the first-order low-pass filter

IO-Link

Data type	Uint16		
Access	rw		
Index	80h	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
0	deactivated
1 ... 500	Bandwidth

3.2.5.29   Acceleration Lower Limit

General characteristics

Unit	See Acceleration format
Value range	-2147483520 ... 2147483520
Default	-27852
Comment	Acceleration lower limit ≤ Acceleration upper limit The unit changes with the acceleration format. The values are automatically converted to the new unit.

IO-Link

Data type	Uint32		
Access	rw		
Index	81h	Sub-index	0
Data Storage	yes		

3.2.5.30   Acceleration Upper Limit

General characteristics

Unit	Siehe Acceleration Format
Value range	-2147483520 ... 2147483520
Default	27852
Comment	Acceleration upper limit ≥ Acceleration lower limit The unit changes with the acceleration format. The values are automatically converted to the new unit.

IO-Link

Data type	Uint32		
Access	rw		
Index	82h	Sub-index	0
Data Storage	yes		

3.2.5.31   Acceleration Hysteresis

General characteristics

Unit	See Acceleration format
Value range	0 ... 27852
Default	0
Comment	Hysteresis for acceleration limits. The unit depends on the acceleration format.

IO-Link

Data type	Uint32		
Access	rw		
Index	83h	Sub-index	0
Data Storage	yes		

3.2.5.32 Acceleration Limit Control

General characteristics

Unit	-
Value range	0 ... 1
Default	1
Comment	

IO-Link

Data type	Uint8		
Access	rw		
Index	84h	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
0	deactivated
1	activated

3.2.5.33 Temperature Value

General characteristics

Unit	°C / °F
Value range	-40 ... 100 [°C] -40 ... 212 [°F]
Default	-40
Comment	Internal temperature sensor of the rotary encoder (accuracy of 2 °C).

IO-Link

Data type	Uint16		
Access	ro		
Index	8Ch	Sub-index	0
Data Storage	yes		

3.2.5.34 Temperature Format

General characteristics

Unit	-
Value range	0 ... 1
Default	0
Comment	

IO-Link

Data type	Uint8		
Access	rw		
Index	8Dh	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
0	°C (Celsius)
1	°F (Fahrenheit)

3.2.5.35 Temperature Lower Limit

General characteristics

Unit	°C / °F
Value range	-40 ... 100 [°C] -40 ... 212 [°F]
Default	-40
Comment	Temperature lower limit ≤ Temperature upper limit The unit changes with the temperature format. The values are automatically converted to the new unit.

IO-Link

Data type	Uint16		
Access	rw		
Index	8Eh	Sub-index	0
Data Storage	yes		

3.2.5.36 Temperature Upper Limit

General characteristics

Unit	°C / °F
Value range	-40 ... 100 [°C] -40 ... 212 [°F]
Default	100
Comment	Temperature upper limit ≥ Temperature lower limit The unit changes with the temperature format. The values are automatically converted to the new unit.

IO-Link

Data type	Uint16		
Access	rw		
Index	8Fh	Sub-index	0
Data Storage	yes		

3.2.5.37 Temperature Hysteresis

General characteristics

Unit	°C / °F
Value range	0 ... 100 [°C] 0 ... 212 [°F]
Default	2
Comment	

IO-Link

Data type	Uint16		
Access	rw		
Index	90h	Sub-index	0
Data Storage	yes		

3.2.5.38 Temperature Limit Control

General characteristics

Unit	°C / °F
Value range	0 ... 1
Default	1
Comment	When activated: If the temperature value falls below or exceeds the limit values, the warning flag is set.

IO-Link

Data type	Uint8		
Access	rw		
Index	91h	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
0	deactivated
1	activated

3.2.5.39 Temperature Min

General characteristics

Unit	°C / °F
Value range	-40 ... 100 [°C] -40 ... 212 [°F]
Default	0
Comment	Lowest temperature value since last reset by user.

IO-Link

Data type	Uint16		
Access	ro		
Index	93h	Sub-index	0
Data Storage	yes		

3.2.5.40 Temperature Max

General characteristics

Unit	°C / °F
Value range	-40 ... 100 [°C] -40 ... 212 [°F]
Default	0
Comment	Highest temperature value since last reset by user.

IO-Link

Data type	Uint16		
Access	ro		
Index	94h	Sub-index	0
Data Storage	yes		

3.2.5.41 Temperature Min / Max Reset

General characteristics

Unit	-
Value range	1
Default	0
Comment	Resets the current min/max values.

IO-Link

Data type	Uint8		
Access	wo		
Index	95h	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
1	Reset temperature min/max values

3.2.5.42 Device Status Flags

General characteristics

Unit	-
Value range	See parameter selection
Default	-
Comment	Displays the rotary encoder status

IO-Link

Data type	Uint16		
Access	wo		
Index	9Bh	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
Bit_0	Error - position general fault at startup
Bit_1	Warning - position out of range
Bit_4	Warning - velocity out of range
Bit_7	Warning - acceleration out of range
Bit_10	Warning - temperature out of range
Bit_13	General Error
Bit_14	Memory Error - invalid communication to device
Bit_15	Memory Error - checksum

3.2.5.43 Operating Hours

General characteristics

Unit	digit
Value range	0 ... 4294967295
Default	0
Comment	(increases as soon as the rotary encoder is switched on) 1 digit = 1 hour

IO-Link

Data type	Uint32		
Access	ro		
Index	A5h	Sub-index	0
Data Storage	yes		

3.2.5.44 Process Data Switch

General characteristics

Unit	-
Value range	0 ... 1
Default	Depending on the device variant
Comment	Process data configuration

IO-Link

Data type	Uint8		
Access	rw		
Index	E1h	Sub-index	0
Data Storage	yes		

Parameter selection

Value	Description
0	Standard Profile
1	Smart Sensor Profile

3.2.5.45 Pin2 Configuration

General characteristics

Unit	-
Value range	Reserved
Default	-
Comment	Use of pin2

IO-Link

Data type	Uint32		
Access	rw		
Index	E6h	Sub-index	0
Data Storage	yes		

3.2.5.46 Firmware Checksum

General characteristics

Unit	-
Value range	ABCD1234h
Default	-
Comment	

IO-Link

Data type	String		
Access	ro		
Index	FBh	Sub-index	0
Data Storage	yes		

3.3 Description of configuration parameters

3.3.1 ISDU 66 / 67 – Position Lower / Upper Limit

Setting of the position events "Position lower limit" and "Position upper limit".

If the position runs outside the defined range of "Position lower limit" and "Position upper limit", the event "Position out of range" is signaled as "appear". If the position moves back into the valid range, the event "Position out of range" is signaled as "disappear".

Event signaling is activated by ISDU 69 "Position limit control".

Conditions:

- Position upper limit < TMR

- Position upper limit ≥ Position lower limit

3.3.2 ISDU 76 – Raw Position

States the raw position value, which is independent of an offset or a scaling.

3.3.3 ISDU 78 – Counting Direction

Setting the counting direction with a view of the shaft.

Description	Value
Clockwise (CW)	0
Counter Clockwise (CCW)	1

Table 13: Counting direction of data content

3.3.4 ISDU 80 – Preset

NOTICE	Preset outside the defined position range. If a preset value is selected outside the defined position range for activated position events, an event occurs during the preset execution.

The parameter specifies the position that is set for a preset. For example, this is used for a zero adjustment.

Validity ranges:

Preset value $\leq$ total measurement range (TMR) – 1

3.3.5 ISDU 81 – Do Position Preset

NOTICE	Pay attention to standstill. Perform the preset when the shaft is at a standstill.

The value set by ISDU 80 is used.

3.3.6 ISDU 82 – Offset

States the relative difference value to the actual position of the encoder (raw position, IS-DU°76).

Example:

- Preset to 0, raw position at 10, offset -10

- Preset to 100, raw position at 60, offset 40

3.3.7 ISDU 112 – Velocity Filter Integration Time

NOTICE	Observe the filter chain. The average filtering value takes place before the low-pass filter.

The parameter specifies the number of values over which an average value is formed.

The value range is from 0 ... 128, where the value 0 deactivates the average filter value.

3.3.8 ISDU 113 – Velocity Filter Bandwidth

NOTICE	Observe the filter chain. Low-pass filtering takes place after the average filtering.

The parameter specifies the limit frequency of the low-pass filter.

The value range is from 0 ... 500 Hz, where the value 0 deactivates the low-pass filter.

3.3.9 ISDU 127 – Acceleration Filter Integration Time

NOTICE	Observe the filter chain. The average filtering value takes place before the low-pass filter.

The parameter specifies the number of values over which an average value is formed.

The value range is from 0 ... 128, where the value 0 deactivates the average filter value.

3.3.10 ISDU 128 – Acceleration Filter Bandwidth

NOTICE	Observe the filter chain. The average filtering value takes place before the low-pass filter.

The parameter specifies the limit frequency of the low-pass filter.

The value range is from 0 ... 500 Hz, where the value 0 deactivates the low-pass filter.

3.3.11 ISDU 140 – Temperature Value

States the current measured temperature. The temperature sensor integrated in the rotary encoder is used with an accuracy of approx. ±2 °C.

3.3.12 ISDU 147 – Temperature Min

States the lowest temperature measured since reset using ISDU 149.

3.3.13 ISDU 148 – Temperature Max

States the lowest temperature measured since reset using ISDU 149.

3.3.14 ISDU 149 – Temperature Min / Max Reset

The values in ISDU 147 and ISDU 148 are reset to the currently measured temperature.

3.3.15 ISDU 165 – Operating Hours

This parameter states the operating hours. The value states the number of hours since the very first commissioning.

3.3.16 ISDU 225 – Process Data Switch

NOTICE	Profile switch The process data length is different for the profiles "Standard Profile" and "Smart Sensor Profile", which means that separate device IDs and thus IODDs are required. When you change the profile, the appropriate IODD must then be selected. If the data storage mechanism is active in the master, it must be deactivated before changing the profile to avoid an error message during device restart due to a different device ID. After the change, the functionality can be reactivated.

The parameter can be used to configure the output process data.

Value	Description
0	Process data according to standard profile (position/velocity)
1	Process data according to Smart Sensor Profile (PDI48)
Other	Reserved for future use

Table 14: Process data profile selection

Devices are delivered with a preset "Standard Profile" or "Smart Sensor Profile", depending on the order key. A manual change is possible by writing the desired value via ISDU.

If the value is accepted, the device automatically performs the following actions:

- Restores factory setting
  The scaling parameters are reset.

- Device Reset
  The change takes effect after a restart of the device. The device logs on with the new device ID and outputs the process data according to the selected profile.

3.3.17 ISDU 230 – Pin2 Configuration

The parameter can be used to configure the use of Pin2 of the IO-Link interface.

Value	Description
0	Pin2 is not used
>0	Not permitted. Reserved for future use.

Table 15: Pin2 Configuration of Data Content

3.4 Functionalities

3.4.1 Velocity Events

The "Velocity limit control" parameter activates the speed events. In addition, the following settings can be made:

- Sets the velocity events using the two parameters "Velocity lower limit" and "Velocity upper limit".

- Adjustable hysteresis via "Velocity hysteresis" parameter. If the velocity exceeds the "Velocity upper limit" point, the "Velocity out of range" event is set. If it falls below the point "Velocity upper limit" minus hysteresis, event signaling is canceled.

Conditions:

- Velocity upper limit ≤ maximum velocity in the corresponding unit.

- Velocity lower limit ≥ minimum velocity in the corresponding unit.

The velocity events are always set in the set unit, "Velocity Format" parameter. The validity ranges of the values always depend on the selected unit.

The following limits are given:

Unit	Value range
Counts/s	-1638400 … 1638400
Counts/ms	-1638 … 1638
Turns/min	-6000 … 6000
Turns/s	-100 … 100
Turns/h	-360000 … 360000

Table 16: Range limits

The event "Velocity out of range" signals that the set event limits have been exceeded/undershot. The event limits are configured by the user, "Velocity lower limit" and "Velocity upper limit".

By means of a hysteresis that is specified relative to the event limit, the user can move the point at which event signaling is canceled. The following figure illustrates this by means of the velocity curve.
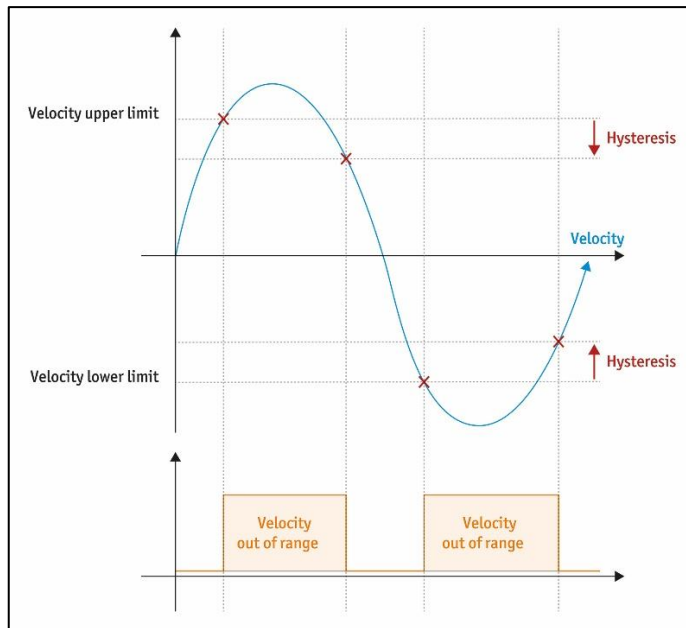
Fig. 2: Velocity hysteresis

If the velocity exceeds the "Velocity upper limit" point, the "Velocity out of range" event is set. If it falls below the "Velocity upper limit" point minus hysteresis, event signaling is canceled.

If the velocity falls below the "Velocity lower limit" point, the "Velocity out of range" event is set. If it exceeds the point "Velocity upper limit" plus hysteresis, event signaling is canceled.

3.4.2 Acceleration Events

The "Acceleration limit control" parameter activates the speed events.

If the acceleration value falls below or exceeds the limit values, the warning flag is set. In addition, the following settings can be made.

- Sets acceleration events using the two parameters "Acceleration lower limit" and "Acceleration upper limit".
- Adjustable hysteresis via "Velocity hysteresis" parameter.

Conditions:

- Acceleration upper limit ≤ maximum acceleration in the corresponding unit.
- Acceleration lower limit ≥ minimum acceleration in the corresponding unit.

Acceleration events are always set in the set unit, "Acceleration Format" parameter.

Maximum acceleration is 175000 rad/s².

The validity ranges of the values always depend on the selected unit.

The following limits are given:

Unit	Value range
Counts/s²	-456329052 ... 456329052
Counts/ms²	-456 ... 456
Turns/s²	-27852 ... 27852

Table 17: Velocity range limits

3.4.3 Temperature Events

- Activation of temperature events by parameter "Temperature limit control".

- Sets temperature events using the two parameters "Temperature lower limit" and "Temperature upper limit".

- Adjustable hysteresis via "Temperature hysteresis" parameter.

Conditions:

- Temperature upper limit ≤ maximum temperature in the corresponding unit.

- Temperature lower limit ≥ minimum temperature in the corresponding unit.

- (Temperature upper limit - hysteresis) ≥ Temperature lower limit

- (Temperature lower limit + hysteresis) ≤ Temperature upper limit

- Temperature events are always set in the set unit, "Temperature Format" parameter. The validity ranges of the values always depend on the selected unit.

The following limits are given:

Unit	Value range
°C	-40 ... 100
°F	-40 ... 212

Table 18: Hysteresis limits

3.4.4 Scaling of the Position

NOTICE	Possible position differences: In the switched-off state, the rotary encoder may move in one direction by a maximum of ¼ of the total physical measuring range (65536 revolutions). Failure to comply may result in position errors when the encoder is switched on.

NOTICE	Observe the measuring range! If the measuring range is changed, then the position limits are set to the following: • Position Lower Limit = 0 • Position Upper Limit = TMR -1 If the preset value is outside the measuring range, it is set to 0.

NOTICE	Observe the endless shaft & measuring range! Can only be activated if Scaling Control (Index 92) is deactivated. The Endless shaft function is only available on a multiturn rotary encoder.

The device offers two different types of position scaling: binary and rational scaling. Both functionalities are described below.

Binary scaling:

- Activation of binary scaling by the "Scaling Control" parameter.

- In binary scaling, the "Total measuring range (TMR)" must be 2n-times that of "Measuring units per revolution (MUR)".

- TMR indicates the total measuring range and MUR the measuring range per revolution.

- The ratio of TMR to MUR gives the number of revolutions, which must always correspond to the ratio 2^n.

Example for multiturn

MUR * Number of revolutions = TMR

$16384 (2^{14})$ x $1024 (2^{10})$ = $16777216 (2^{24})$

$4096 (2^{12})$ x $262144 (2^{18})$ = $1073741824 (2^{30})$

$4069 (2^{12})$ x $1024 (2^{10})$ = $4166656 (2^{22})$

$16384 (2^{14})$ x $262144 (2^{18})$ = $4294967296 (2^{32})$

Validity ranges:

TMR:

4 ... 4294967296 (Multiturn, 2^{32})

4 ... 16384 (Singleturn, 2^{14})

MUR:

1 ... 16384

Number of maximum multiturn revolutions: 262144 (2^{18})

Number of revolutions for singleturn: 1

Endless shaft function:

- Activation of the endless shaft via parameter "Endless shaft control".

- Endless shaft is set via the parameters "Total measuring range (TMR)", "Number of revolutions, numerator" and "Number of revolutions, denominator".

- Endless shaft scales rationally; the exact number of revolutions can be set by the parameters "Numerator" and "Denominator".

- TMR specifies the valid measuring range.

Example:

TMR = 10000000; Numerator = 1950; Denominator = 3

TMR = MUR x (Numerator / Denominator)

MUR = 10000000 x (1950/3)

MUR = 15384,615384 $\Rightarrow$ 15385

Validity ranges:

TMR:

4 ... 4294967296

Numerator:

1 ... 262144

Denominator:

1 ... 4096

3.5   Status messages

Events are signaled via the event flag in the cyclic data.

Specific IO-Link

Event Code	Status text	Device Status	Type	Mode
1000h	General malfunctions Unknown error	Error	Error	Appear/ Disappear
4210h	Device temperature exceeded Clear heat source	Out-Of Spec.	Warning	Appear/ Disappear
4220h	Device temperature undershot Insulate device	Out-Of Spec.	Warning	Appear/ Disappear
5000h	Device hardware failure Replace device	Error	Error	Appear/ Disappear
6320h	Parameter error — check data sheet and values	Error	Error	Appear/ Disappear
FF91h	Upload request for data storage ("DS_UPLOAD_REQ") Internal, not visible to the user	Device is working	Notification	Singleshot

Table 19: IO-Link-specific status messages

Manufacturer-specific

Event Code	Status text	Device Status	Type	Mode	Note
8CA0h	Position out of validity range	Out-Of Spec.	Warning	Appear/ Disappear	With activated position limit
8CA1h	Velocity out of validity range	Out-Of Spec.	Warning	Appear/ Disappear	With activated velocity limits
8A2h	Acceleration out of validity range	Out-Of Spec.	Warning	Appear/ Disappear	With activated acceleration limits
8CA5h	Memory checksum error	Error	Error	Appear/ Disappear	Troubleshooting details

Table 20: Manufacturer-specific status messages

3.6   ISDU Error Codes

The error code follows a failed ISDU read or write access.

Value 1. Byte	Value 2. Byte	Name	Comment
80	xx	Error Code	IO-Link Spec. V1.1.2 Annex D
81	xx	Vendor specific error code	
	00	Device application error, no details	
	11	Index not available	
	12	Sub-index not available	
	20	Service temporarily not available	
	23	Write access denied	
	30	Parameter value out of range	
	33	Parameter length overrun	
	34	Parameter length underrun	
	35	Function not available	
	36	Function temporarily not available	
	40	Invalid parameter set	
	41	Inconsistent parameter set	

Table 21: ISDU Error Codes

4 Appendix

4.1 Dependency of the Position Parameters

	Direction	Scaling Enable	Endless Shaft Enable	Numerator	Divisor	Range (TMR)	Resolution (MUR)	Presetvalue	Position Limit Low	Position Limit High	Position Limit Control
Direction											
Scaling Enable			z2			z3	z3				
Endless Shaft Enable		z2		z4	z4	z4					
Numerator					z4	z4					
Divisor				z4		z4					
Range (TMR)				z4	z4		z3	a1	a2	a2	
Resolution (MUR)						z3					
Preset Value						z5					
Position Limit Low						z5				z1	
Position Limit High						z5			z1		
Position Limit Control											

Table 22: Dependency of the Position Parameters

Individual parameterization	Individual parameterization
a1: If the TMR is changed, the preset is set to 0 if it is greater than or equal to TMR.	a1: If the TMR is changed, the preset is set to 0 if it is greater than or equal to TMR, provided that the preset has not changed. Otherwise, the new value is used.
a2: If the TMR is changed, the position lower limit is set to 0 and the position upper limit is set to TMR-1.	a2: If the TMR is changed, the position lower limit is set to 0 and the position upper limit is set to TMR-1 unless they have changed. Otherwise, the new value is used.
z1: Position upper limit $\geq$ Position lower limit.	z1: Position upper limit $\geq$ Position lower limit.
z2: Either Scaling or Endless Shaft may be activated.	z2: Either Scaling or Endless Shaft may be activated.

Individual parameterization	Individual parameterization
z3: When Scaling is active, the ratio of TMR to MUR must be 2^n.	z3: When Scaling is active, the ratio of TMR to MUR must be 2^n.
z4: If Endless Shaft is active, then the ratio of TMR, numerator and denominator must match.	z4: If Endless Shaft is active, then the ratio of TMR, numerator and denominator must match.
z5: Value must not exceed TMR-1.	z5: Value must not exceed TMR-1.

Table 23: Explanation of dependencies

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