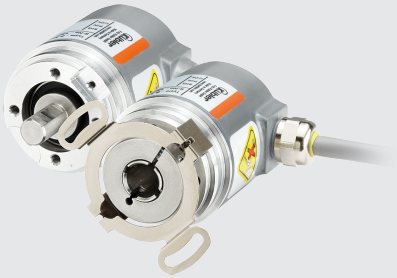
R67071.0002 - 5



Manual

Encoders with IO-Link interface

Use IO-Link
Universal · Smart · Easy

pulses for automation

Table of Contents

1 Document

This is the English translation of the original manual in German language.

Publisher	Kübler Group, Fritz Kübler GmbH Schubertstraße 47 78054 Villingen-Schwenningen Germany www.kuebler.com
Issue date	11/2021
Copyright	© 2021, Kübler Group, Fritz Kübler GmbH

Text sources	IO-Link_Planungsrichtlinie_10911_V11_Jan18
	IO-Link_Interface_and_System_Specification_Version 1.1.2 July 2013
	Wie funktioniert IO-Link https://wiki.induux.de/IO-Link
Image sources	IO-Link_Planungsrichtlinie_10911_V11_Jan18
	IO-Link_Interface_and_System_Specification_Version 1.1.2 July 2013
	IO-Link Master Control Tool (TEConcept)
	Next steps in fluid power connections - Paul Heney April 21, 2020 https://www.designworldonline.com/next-steps-in-fluid-power-connections/

Legal Notices

2 General Information

Please read this document carefully before working with the product, mounting it or starting it up.

2.1 Target Group

The device may only be planned, mounted, commissioned and serviced by persons having the following qualifications and fulfilling the following conditions:

- Technical training.
- Briefing in the relevant safety guidelines.
- Constant access to this documentation.

2.2 Symbols used / Classification of the Warnings and Safety instructions

⚠ DANGER	**Classification:** This symbol, together with the signal word **DANGER** , warns against immediately imminent threat to life and health of persons. The non-compliance with this safety instruction will lead to death or severe adverse health effects.
⚠ WARNING	**Classification:** This symbol, together with the signal word **WARNING** , warns against a potential danger to life and health of persons. The non-compliance with this safety instruction may lead to death or severe adverse health effects.
⚠ CAUTION	**Classification:** This symbol, together with the signal word **CAUTION** , warns against a potential danger for the health of persons. The non-compliance with this safety instruction may lead to slight or minor adverse health effects.
ATTENTION	**Classification:** The non-compliance with the **ATTENTION** note may lead to material damage.

NOTICE	**Classification:** Additional information relating to the operation of the product, and hints and recommendations for efficient and trouble-free operation.

3 Product Description

3.1 Technical Data Sendix M36xx, M36xxA, M58xx, M58xxA

Mechanical characteristics for the Sendix M36xx, M36xxA encoders

Maximum rotary speed IP65 IP67	 6000 min^{-1}, 3000 min^{-1} (continuous operation) 4000 min^{-1}, 2000 min^{-1} (continuous operation)
Starting torque (at 20 °C) IP65 IP67	 < 0,007 Nm < 0,01 Nm
Permissible shaft load radial axial	 40 N 20 N
Protection level acc. to EN 60529	IP65, IP67
Working temperature range	-40 °C ... +85 °C
Materials Shaft/Hollow shaft Flange Housing Cable	 Stainless steel Aluminum Die-cast zinc PVC
Shock resistance according to EN 60068-2-27	2500 m/s^2, 6 ms
Vibration resistance according to EN 60068-2-6	300 m/s^2, 10 ... 2000 Hz

Mechanical characteristics for the Sendix M58xx M58xxA encoders

Maximum rotary spee IP65	 6000 min^{-1}, 3000 min^{-1} (continuous operation)
Starting torque (at 20 °C) IP65	 < 0,01 Nm
Permissible shaft load radial axial	 80 N 40 N
Protection level acc. to EN 60529	IP65
Working temperature range	-40 °C ... +85 °C
Materials Shaft/Hollow shaft Flange Housing Cable	 Stainless steel Aluminum Die-cast zinc PVC
Shock resistance according to EN 60068-2-27	5000 m/s^2, 6 ms
Vibration resistance according to EN 60068-2-6	300 m/s^2, 10 ... 2000 Hz

Electrical characteristics for the Sendix M36xx, M36xxR, M36xxA, M36xxAR, M58xx, M58xxA encoders

Supply voltage	10 … 30 V DC
Current consumption	Max. 30 mA (without load)

Electrical characteristics for the Sendix M36xx, M58xx encoders

Supply voltage	18 … 30 V DC
Current consumption 18 … 30 V DC	max. 30 mA (without load)

Output	IO-Link according to IEC 60947-5-2
Type of connection	Cable or connector
Interface	IO-Link
SIO mode	No
Transmission speed	230,4 kBit/s, COM3
Min. cycle time	1 ms
Port class	A
Singleturn technology	Magnetic
Multiturn technology	Magnetic, electronic counter, Energy Harvesting
Power ON time	< 300 ms

Mechanical characteristics for the Sendix M36xxR encoders

Maximum rotary speed IP67	 4000 min^{-1}, 2000 min^{-1} (continuous operation)
Starting torque (at 20 °C) IP67	 < 0,01 Nm
Permissible shaft load radial axial	 80 N 40 N
Protection level acc. to EN 60529	IP65, IP67, IP69k
Working temperature range	-40 °C ... +85 °C
Materials Shaft/Hollow shaft Flange Housing Cable	 V2A / V4A Stainless steel V4A / Aluminum V4A / Die-cast zinc PVC
Shock resistance according to EN 60068-2-27	5000 m/s^2, 4 ms
Vibration resistance according to EN 60068-2-6	300 m/s^2, 10 ... 2000 Hz

3.2 Supported Standards and Protocols

The encoders of the M36X8/M58X8 series support the IO-Link protocol according to the following standards:

- IO-Link Interface and System Specification V1.1.2
- IODD Version V1.1
- IO-Link Common Profile V1.0
- IO-Link BLOB Transfer & Firmware Update V1.1

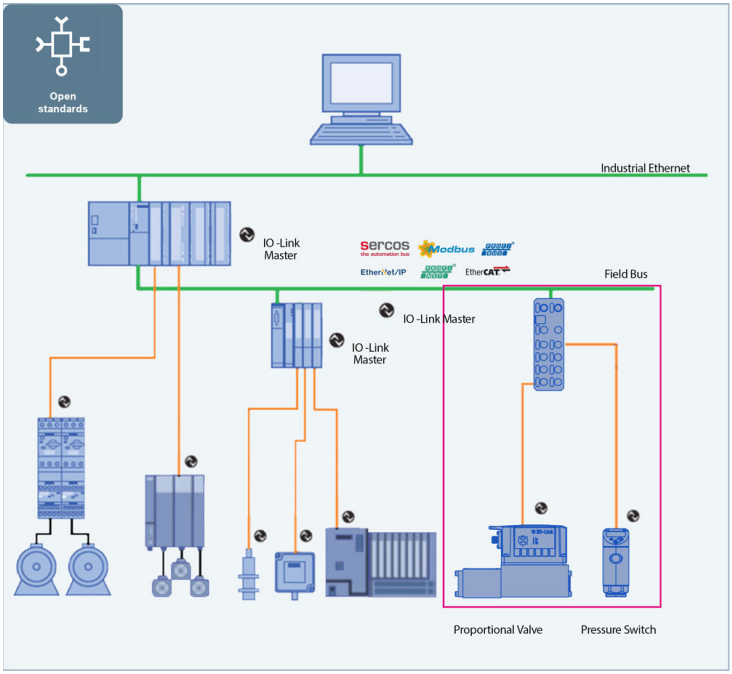
The device description file (IODD) can be downloaded from the website of the device manufacturer (Contact) or by means of the IODD finder on the IO-Link website.

3.3 Interface Description

IO-Link is a brand name. The original designation of this communication system is SDCI and is described in Section 9 of European Standard EN 61131 (Single-drop digital communication interface for small sensors and actuators).

IO-Link is not a field bus. It is based on the conventional 3-wire connection for sensor and actuator(s) and is thus compatible with the existing 3-wire system with switching sensors in today's machines and facilities.

An IO-Link configuration can be operated as a standalone installation for the communication between PLC and devices. But it can also be integrated in other field bus networks such as e. g. ProfiNet, EtherCAT, EtherNet/IP with 100% backwards compatibility. This results in the system structure shown in the illustration.



IMG-ID: 9007199389068555

Since IO-Link achieves a serial point-to-point communication, the star topology is the only device architecture that can be realized. IO-Link devices (hubs) with an expansion port are an exception. The IO-Link device communicates point-to-point via a standard sensor cable with an IO-Link master. The IO-Link master combines the data with other IO-Link devices and communicates with the control via an industrial network or a backplane.

The IO-Link communication thus allows transmitting one or several measured or analog values in addition to the switching signal. A plurality of switching points or a mix of analog and digital data can also be transmitted.

Usual field bus or Ethernet software tools can be used for parameterizing and centralized data storage of the IO-Link devices. There are also dedicated IO-Link tools. The corresponding description files of the IO-Link devices (IODD) are stored centrally on the so-called IODD finder.

IO-Link has two logical data channels, which separate the cyclic and the acyclic data. The IO-Link communication takes place continuously between the control and the IO-Link devices. It allows accessing to all process data, diagnostic data and device information. Device-specific data is also accessible. It is thus also possible to access to the actuators and sensors of a facility, independently of the location, and to perform a remote diagnostic.

IO-Link uses an unshielded standard three or four-wire sensor cable. Cables between the IO-Link master and a device can reach a length of up to 20 meters. Usually, M12 A-coded, unshielded standard automation cables are used.

Most of the IO-Link devices use a Class A IO-Link port. Output devices with a Class B IO-Link port are also available. The port type of the master and/or the IO-Link device, i. e. Class A or Class B, must be determined.

IO-Link allows, besides the most simple diagnostic (cable break), far more complex diagnostics, which come directly from the IO-Link device. IO-Link also offers the possibilities of a dynamic change of the parameters in IO-Link devices.

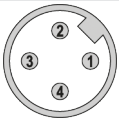
4 Installation

4.1 Electrical Installation

4.1.1 General Information for the Connection

ATTENTION	**Destruction of the device** Before connecting or disconnecting the signal cable, always disconnect the power supply and secure it against switching on again.
NOTICE	**General safety instructions** Make sure that the whole plant remains switched off during the electrical installation. Make sure that the operating voltage is switched on or off simultaneously for the device and the downstream device.
NOTICE	**Traction relief** Always mount all cables with traction relief.

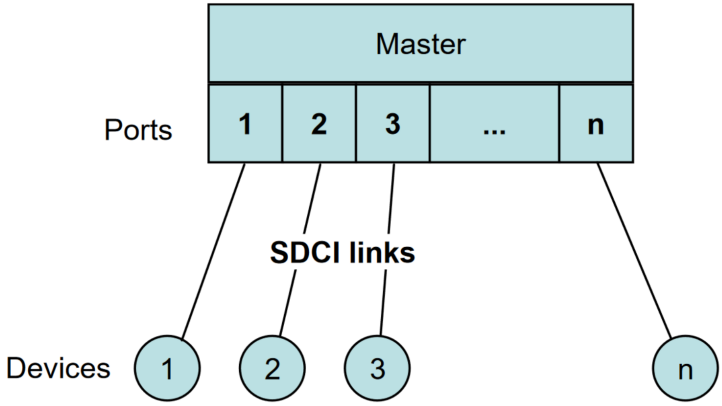
4.1.2 Terminal Assignment M36, M58

Interface	**Connection type**	**M12 connector, 4-pole**					**Connector**
4	M36: 3, 4 M58: 4	Signal	Supply voltage +V DC	Reserved (no function)	Supply voltage 0 V (GND)	IO-Link communication (Data line)	
		Abbreviation	L+	res.	L-	C/Q	
		Pin	1	2	3	4	

NOTICE	**Use of pin 2**
	The IO-Link signal I/Q, which represents an optional and currently not realized digital In/Output, is applied on pin 2, in compliance with the standard. The use of this pin is currently not planned (marked accordingly as Reserved in the table). IO-Link Masters offer the possibility to connect the I/Q signal. When using a 4 on 4-pin (5 on 5-pin), A-coded IO-Link cable, the proper connection is ensured directly by the orientation of the connector. For devices with cable outlet, the white cable (I/Q signal) must be connected to the corresponding contact of the IO-Link master.

4.1.3 Network Topology

IO-Link uses a point-to-point communication.

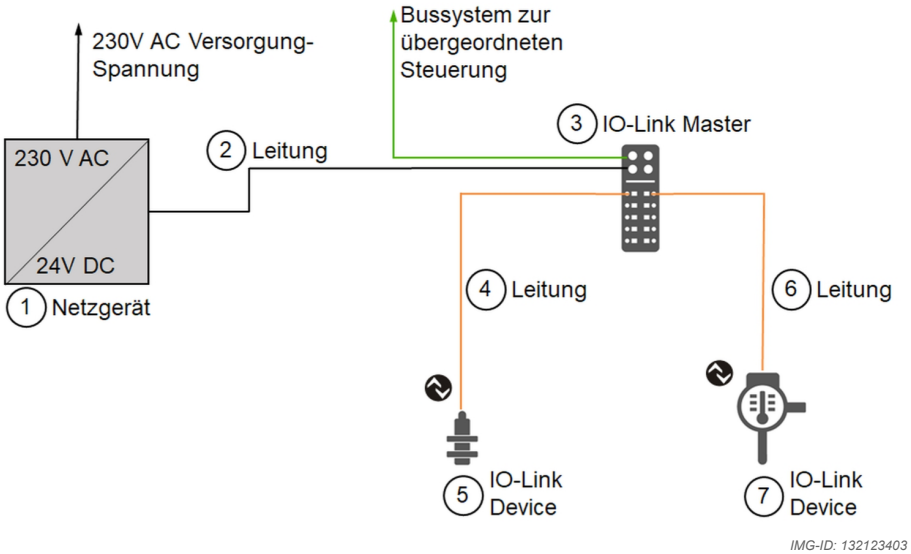


IMG-ID: 132121483

IO-Link provides for the use of an unshielded line. If the encoder is operated with an unshielded line, its interference immunity falls in Criterion B and its radiation in Class A according to 61326-1.

If the application requires a higher EMC protection, it is possible to use a **shielded cable**. If the encoder is operated with a **shielded cable**, its interference immunity falls in Criterion A and its radiation in Class B according to 61326-1.

For currents lower than 200 mA in the IO-Link device, a cable with wire cross-section 0.35 mm² can be used. The maximum line length can be 20 m.
The illustration below shows an example of a topology:



	Description	Characteristics
1	Power supply unit	Rated voltage: 24 V DC ±1% tolerance
2	Control line: Power supply unit – IO-Link Master	Length: 10 m Wire cross-section: 0.75 mm²
3	IO-Link Master	Voltage drop: 0,5 V Rated current: 100 mA
4	Control line: IO-Link Master – IO-Link Device 1	Length: 15 m Wire cross-section: 0.35 mm²
5	IO-Link Device 1	Rated current: 200 mA Rated voltage: 19 ... 30 V
6	Control line: IO-Link Master – IO-Link Device 2	Length: 15 m Wire cross-section: 0.35 mm²
7	IO-Link Device 2	Rated current: 100 mA Rated voltage: 19 ... 30 V

5 Commissioning and Operation

DANGER

Risk of injury due to rotating shafts

Hair and loose clothing can be caught by rotating shafts.

- Prepare all work as follows:

⇨ Switch the operating voltage off and stop the drive shaft.

⇨ Cover the drive shaft if the operating voltage cannot be switched off.

5.1 Function and Status LED

A two-color LED shows the different operating states.

Green = Run

Red = Error

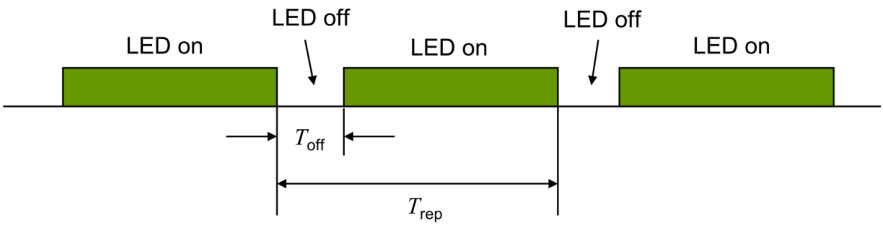
Blinking behavior in the Run operating state

Display	LED	Meaning	Cause	Note
LED off	○	OFF	Device switched off	
LED triple flash	●●●	Program/ firmware download	A firmware download is performed on the device.	The device is in Bootloader mode.
LED on	●	IDLE	The device is the IDLE state. Waiting for the IO-Link WakeUp Request.	No IO-Link communication.
LED IO-Link	●○●	COMMUNICATE	A short periodic interruption shows that the device is in the COMx communication state.	IO-Link communication active.

Blinking behavior in the Error operating state

Display	LED	Meaning	Error cause	Note
LED off		No error	Device ready for operation / in operation	LED off relates here only to the red color.
LED blinking		Error	IO-Link error	The IO-Link event code shows the reason of the IO-Link error. Red appears in combination with green.
LED single flash		Warning	IO-Link warning	The IO-Link event code shows the reason of the IO-Link warning. Red appears in combination with green.
LED on		Critical error	The device is defective.	See Contact.

The COMMUNICATE state is described for IO-Link:

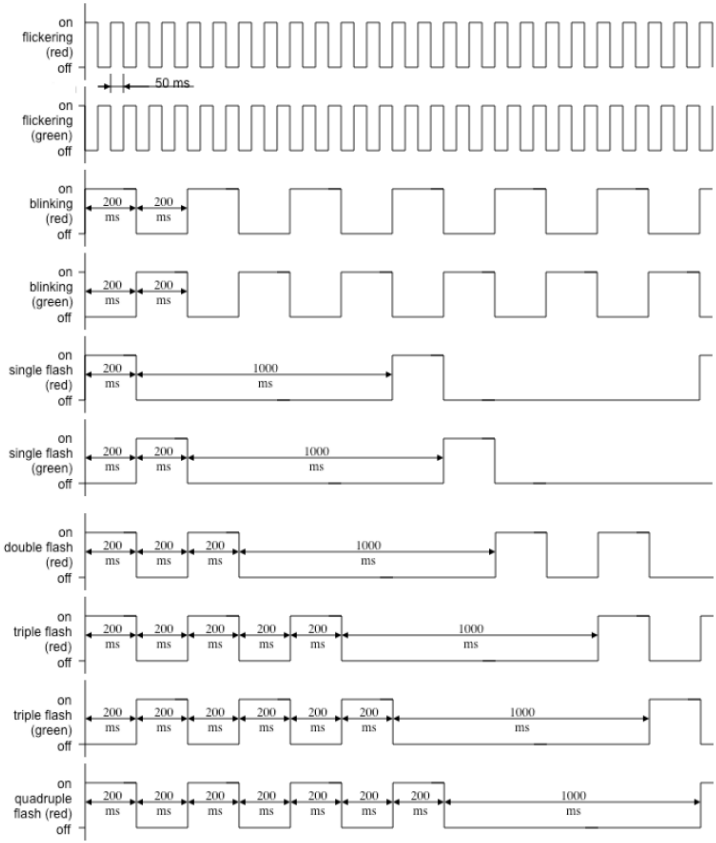


IMG-ID: 132131211

All other flash codes comply with CiA 303:

LED flash codes	Description
LED off	The LED must be continuously off.
LED blinking	This flash code shows the switch-on and switch-off phase with a frequency of approximately 2.5 Hz: ON for approx. 200 ms followed by OFF for approx. 200 ms.
LED single flash	This flash code must show a short flash (approx. 200 ms) followed by a long off phase (approx 1000 ms).
LED triple flash	This flash code must show a sequence of three short flashes (approx. 200 ms) separated by an off phase (approx. 200 ms). This sequence is concluded by a long off phase (approx. 1000 ms).
LED on	The LED must be continuously on.

The cycle times of the flash codes are precisely defined.



IMG-ID: 132146443

5.2 Quick Start Guide

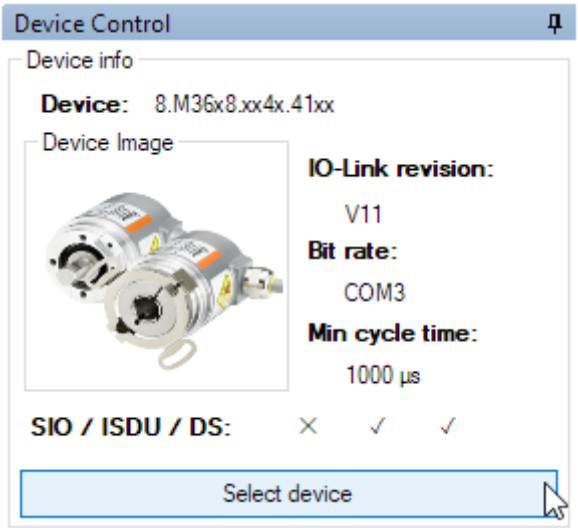
5.2.1 Connection Setup

A tool of the IO-Link master manufacturer is required for operating the device. The screenshots in this manual refer to the tool **IO-Link Master Control Tool** of the manufacturer **TEConcept**.

The IODD is required for general commissioning. The device description file (IODD) can be downloaded from the website of the device manufacturer or by means of the IODD finder on the IO-Link website.

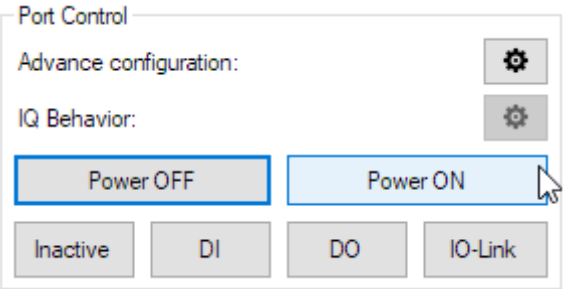
✓ The IODD can be imported in the tool of the IO-Link master and the connection can subsequently be set up.

a) Select the IODD



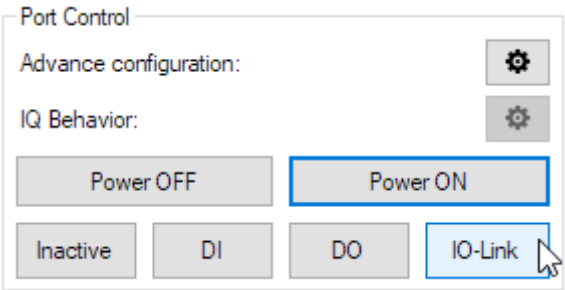
IMG-ID: 131388043

b) Switch the voltage supply on



IMG-ID: 131386123

c) Set up the IO-Link communication



IMG-ID: 131384203

d) Display the state

Connected device state

Vendor ID:	0x0198
Device ID:	0x201000
Product ID:	8.M3668.1544.4122
Serial number:	2013600001
Vendor name:	Fritz Kübler GmbH
Product name:	8.M3668.1544.4122
Cycle time:	1 000 µs
IO-Link Revision:	V1.1
Port state:	**IO-Link**
Operate in IO-Link:	Yes
Fault:	NOFAULT

IMG-ID: 138697995

The device state and the green LED (flash code **IO-Link**) signal the IO-Link communication when communication setup has been successful.

5.2.2 Default Settings

Index (hex)	Index (dec)	Object name	Values (bold -> standard)	Remark
0041	65	Position format	**0: Counts**	Is always Counts
0043	67	Position upper limit	0 ... **(TMR-1)**	Position upper limit >= Position lower limit
0045	69	Position limit control	0: Position limit control disabled **1: Position limit control enabled**	If enabled: When the position value drops below/exceeds the limit values, the warning flag is set.
004E	78	Counting direction	**0: clockwise (CW)** 1: counter-clockwise (CCW)	Looking at the shaft
0058	88	Measuring units per revolution (MUR)	1...**16,384**	Singleturn resolution is 14 bits
0059	89	Total measuring range (TMR)	MT: 4... **4,294,967,296** ST: 4... **16,384**	The "Position value" data type is uint32, therefore the maximum value is 2^{32}-1
005B	91	Endless shaft control	Enables the endless shaft functionality (also scaling must be enabled) **0**: **Endless shaft disabled** 1: Endless shaft enabled	off: Use of MUR & TMR on: Use of NDR =(Numerator/Divisor) & TMR **ST: not used**
005C	92	Number of turns, numerator	1... **262,144**	Numerator for the number of turns **ST: not used**
005D	93	Number of turns, denominator	**1**... 4,096	Denominator for the number of turns **ST: not used**
006F	111	Velocity format	Velocity unit: 1: Counts/s 2: Counts/ms **3: Turns/min** 4: Turns/s 5: Turns/h	Unit for velocity setting Also accordingly for the acceleration (for turns/min & turns/h -> Acceleration turns/s^2)
0070	112	Integration time for velocity filter	0...128 **1**	Moving average filter (number of measured values from which an average value is formed) 0 = disabled

Index (hex)	Index (dec)	Object name	Values (bold -> standard)	Remark
0071	113	Velocity filter bandwidth	0...500 [Hz] **100 [Hz]**	Bandwidth of the first-order low-pass filter 0 = disabled
0072	114	Velocity lower limit	**-6,000 [turns/min]**	Velocity lower limit <= Velocity upper limit The unit changes with the speed format. The values are then automatically converted into the new unit.
0073	115	Velocity upper limit	**6,000 [turns/min]**	Velocity upper limit >= Velocity lower limit The unit changes with the speed format. The values are then automatically converted into the new unit.
0074	116	Velocity hysteresis	**0**...6,000 [turns/min]	(Velocity upper limit - Velocity hysteresis) >= (Velocity lower limit + Velocity hysteresis) Hysteresis for the speed limits. The device depends on the speed format.
0075	117	Velocity limit control	0: Velocity limit control disabled **1: Velocity limit control enabled**	If enabled: When the velocity value drops below/exceeds the limit values, the warning flag is set
007F	127	Acceleration filter integration time	0...128 **1**	Moving average filter (number of measured values from which an average value is formed) 0 = disabled
0080	128	Acceleration filter bandwidth	0...500 [Hz] **100 [Hz]**	Bandwidth of the first-order low-pass filter 0 = disabled
0081	129	Acceleration lower limit	**-27,852 [turns/s^2]**	Acceleration lower limit <= Acceleration upper limit The closest to the signed min/max 32-bit integer and the 32-bit floating-point value without loss of accuracy. The unit changes with the acceleration format. The limit values must then be converted accordingly, e. g. 2 counts/ms^2 = 2,000,000 counts/s^2.
0082	130	Acceleration upper limit	**-27,852 [turns/s^2]**	Acceleration upper limit >= Acceleration lower limit Close to the signed min/max 32-bit integer and the 32-bit floating-

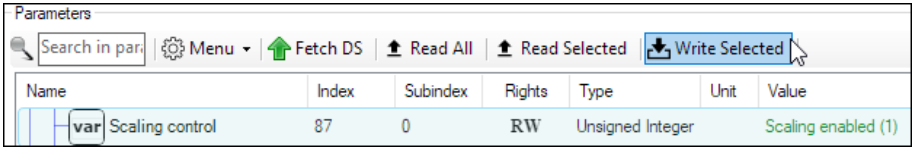
Index (hex)	Index (dec)	Object name	Values (bold -> standard)	Remark
				point value without loss of accuracy. The unit changes with the acceleration format. The limit values must then be converted accordingly, e. g. 2 counts/ms^2 = 2,000,000 counts/s^2.
0083	131	Acceleration hysteresis	**0**.. 27,852 [turns/s^2]	Hysteresis for the acceleration limits. The device depends on the acceleration format.
0084	132	Acceleration limit control	0: Acceleration limit control disabled **1: Acceleration limit control enabled**	If enabled: When the acceleration value drops below/exceeds the limit values, the warning flag is set.
008E	142	Temperature lower limit	**-40 [°C]**	Temperature lower limit <= Temperature upper limit The unit changes with the temperature format. The values are then automatically converted into the new unit.
008F	143	Temperature upper limit	**100 [°C]**	Temperature upper limit >= Temperature lower limit The unit changes with the temperature format. The values are then automatically converted into the new unit.
0090	144	Temperature hysteresis	0...100 [°C] 0...212 [°F] **2 degrees Fahrenheit**	Hysteresis for the temperature limit value..
0091	145	Acceleration lower limit	**-27,852 [turns/s^2]**	Acceleration lower limit <= Acceleration upper limit The closest to the signed min/max 32-bit integer and the 32-bit floating-point value without loss of accuracy. The unit changes with the acceleration format. The limit values must then be converted accordingly, e. g. 2 counts/ms^2 = 2,000,000 counts/s^2.

5.2.3 Changing the Parameters

Parameters can be modified by means of individual parameterizing or block parameterizing. The parameters are automatically saved in a non-volatile way in the device.

Individual parameterizing

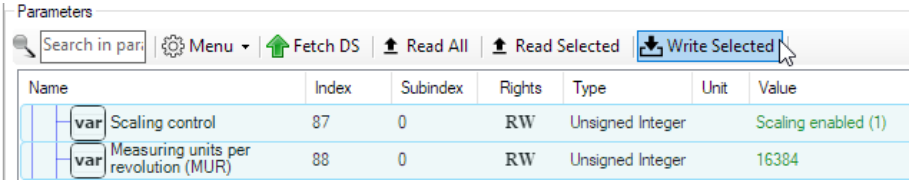
Modify, mark and write an individual parameter.



IMG-ID: 132178699

Block parameterizing

Modify, mark and write collectively several parameters.



IMG-ID: 131380363

NOTICE	**Error behavior**
	The device checks the access rights, structure, validity and consistency of the data and answers if necessary with an error code. In the event of an error, the new data is not taken over and operation continues with the previous values. See ISDU Error Codes [▸ 57].

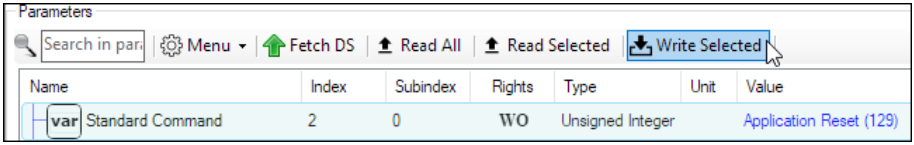
NOTICE	**Updating the values**
	A data storage upload from the device to the master only takes place when the system command "0x05 (5): ParamDownloadStore" is used at the end of the block parameterization. No data storage upload takes place after an individual parameterization.

Resetting the settings to the standard values

The original standard values (default values at the delivery) can be restored by sending system commands when the IO-Link communication is active. This takes place via the ISDU Index 2.

With system command
0x81 (129): APPLICATION RESET
all settings are reset to standard values, excepted the following:

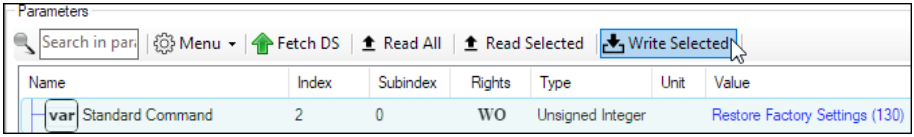
- Application-specific tag
- Function tag
- Location tag



IMG-ID: 132201227

Restoring the standard values

With system command
0x82 (130): RESTORE FACTORY SETTINGS
all settings are reset to standard values.



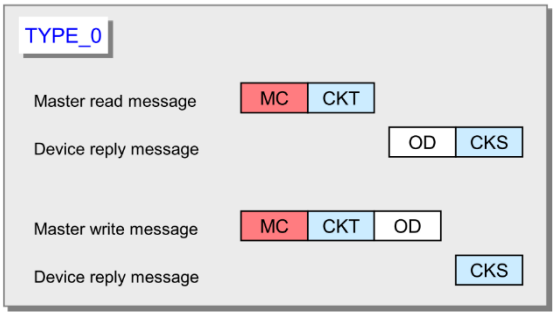
IMG-ID: 132198795

5.3 Protocol Features

5.3.1 Data Transmission

Data transmission takes place with the help of so-called M sequence types. The device uses 3 of 11 possible M sequence types.

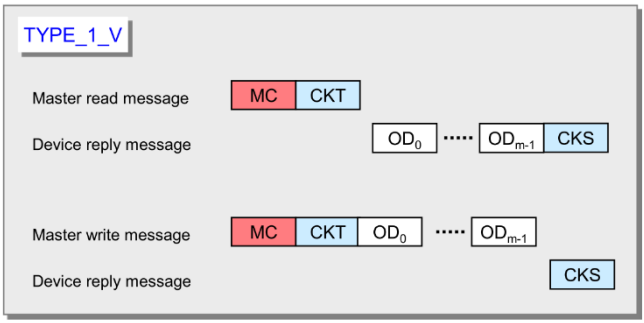
STARTUP: Type_0



IMG-ID: 132204683

PRE-OPERATE: Type 1_V

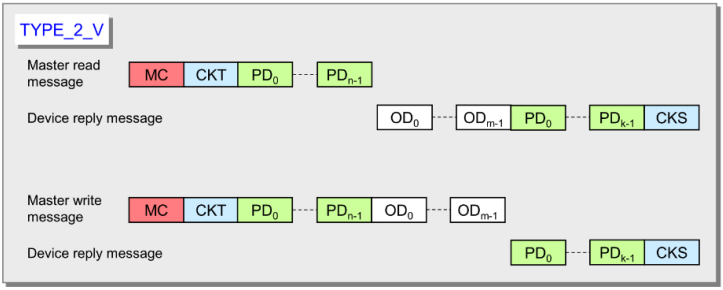
- Output process data (Master -> Device): 0 bytes
- On-request data: 8 bytes
- Input process data (Device -> Master): 0 bytes



IMG-ID: 132206347

OPERATE: Type 2_V

- Output process data (Master -> Device): 0 bytes
- On-request data: 1 bytes
- Input process data (Device -> Master)
  - Standard Profile: 8 bytes
  - Smart Sensor profile (PDI48) 6 bytes



IMG-ID: 132208011

5.3.2 Input Process Data (PDIN)

NOTICE	**Configuration** Parameter "ISDU 225: PROCESS DATA SWITCH" allows switching between the profiles.

5.3.2.1 Standard Profile

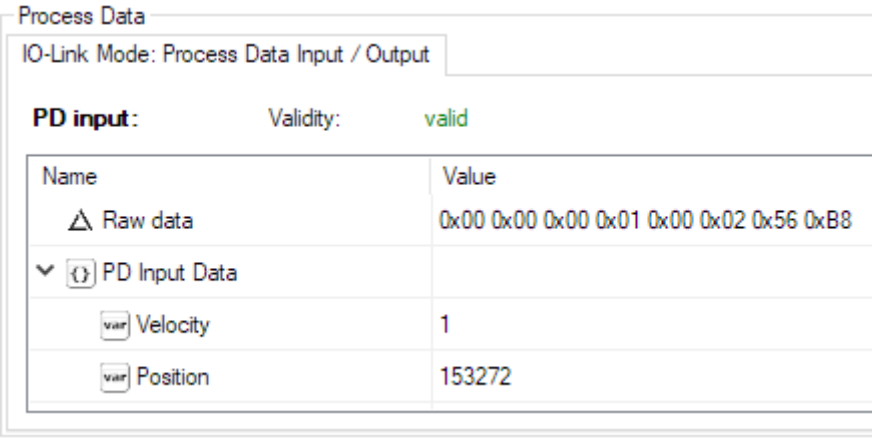
The following data is transmitted cyclically from the device to the master:

Item	Velocity				Position			
PVinD number	PVinD 2				PVinD 1			
Octet	octet 0	octet 1	octet 2	octet 3	octet 4	octet 5	octet 6	octet 7
Subindex	subindex 0							
	subindex 1				subindex 2			
Bit offset	63			32	31			0
	31 (MSB)			0 (LSB)	31 (MSB)			0 (LSB)
Datatype	int32				uint32			
Transmission direction	←							
Time	0	→						t

IMG-ID: 152806027

Data length is 8 bytes.

The example below shows the data in 8-byte blocks:



IMG-ID: 152800267

5.3.2.2 Smart Sensor Profile (PDI48)

The following data is transmitted cyclically from the device to the master:

Item	Measurement Value				Scale		Vendor Specific	
PVinD number	PVinD 3				PVinD 2		PVinD 1	
Octet	octet 0	octet 1	octet 2	octet 3	octet 4		octet 5	
Subindex	subindex 0							
	subindex 1				subindex 2		subindex 3	
Bit offset	47			16	15	8	7	0
	31 (MSB)			0 (LSB)	7 (MSB)	0 (LSB)	7 (MSB)	0 (LSB)
Datatype	int32				int8		uint8	

Transmission direction	←	
Time	0 →	t

IMG-ID: 152807947

Data length is 6 bytes.

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

- Unit: "revolution" (unit code 1009)
- Scaling factor
  - Multiturn devices: 10^{-3}

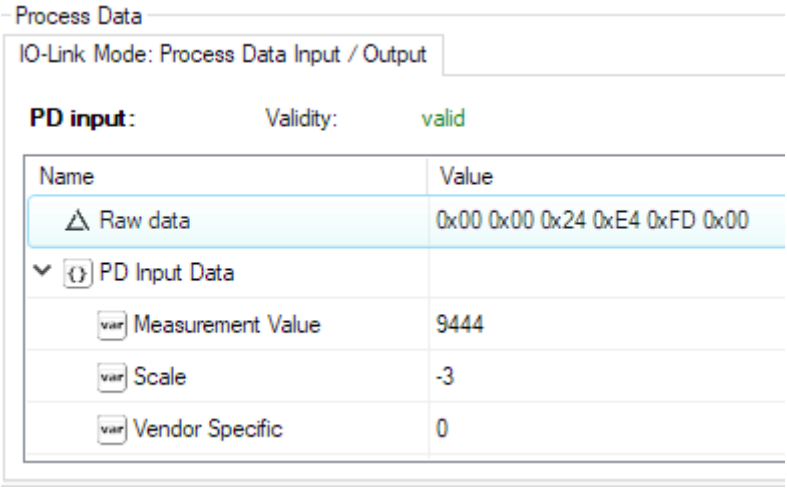
Position [counts]	Position [revolution]	Position as PDI48		
		Measurement value	Scale	Vendor-specific
0..16	0.000	0	-3	0 (not used)
17..32	0.001	1		
33..49	0.002	2		
…				
16,384..16,400	1.000	1000		
…				
4,294,967,295				

– Singleturn devices: 10^{-6}

Position [counts]	Position [revolutions]	Position as PDI48		
		Measurement value	Scale	Vendor-specific
0	0.000,000	0	-6	0 (not used)
1	0.000,061	61		
2	0.000,122	122		
…				
16,383	0.999,938	999,938		

NOTICE	**Substitute value**
	If no measured value is available temporarily, the substitute value "no measurement data", i. e. 0x7FFF FFFC (2,147,483,644) is output during this period. The process data is only marked as "invalid" in the event of a permanent error.

Example of a transmission



IMG-ID: 152809867

5.3.3 Service Data (ISDU)

Service data (ISDU) is used for the acyclic transmission of parameters.

Index (hex)	Index (dec)	Subindex	Object name	Access	Length	Data type	Values	Remark
0000	0		Direct parameter Page 1	R		RecordT	IO-Link specification	
		1	Master command	W	1 byte		IO-Link specification	Master command to switch to operating states
		2	Master cycle time	R/W	1 byte		depending on the master	Actual cycle time used by the master to address the device. Can be used as a parameter for monitoring process data transmission.
		3	Min cycle time	R	1 byte		0x0A (10) [100 µs] = 1 [ms]	Minimum cycle time supported by a device.
		4	M sequence capability	R	1 byte		0x29 (41)	Information about the implemented options in connection with the M sequences and the physical configuration
		5	Revision ID	R/W	1 byte		0x11 (17)	ID of the protocol version used for the implementation (must be set to 0x11)
		6	Process data In	R	1 byte		0x87 (135) Smart Sensor Profile: 0x85 (133)	Type and length of the input data (process data from the device to the master)
		7	Process data Out	R	1 byte		0x00	Type and length of the output data (process data from the master to the device)
		8	Vendor ID 1 (MSB)	R	1 byte		0x198 (408)	Unique vendor identification
		9	Vendor ID 2 (LSB)		1 byte			

Index (hex)	Index (dec)	Sub-index	Object name	Access	Length	Data type	Values	Remark
		10	Device ID 1 (byte 2, MSB)	R/W	1 byte		MT (Standard profile): 0x201000 (2101248) MT (Smart Sensor profile): 0x201010 (2101264) ST (Standard profile): 0x200800 (2099200) ST (Smart Sensor profile): 0x200810 (2099216) Bootloader mode: 0x200000 (2097152)	Unique device identification assigned by a manufacturer. In bootloader mode, the Device ID is modified to display the bootloader mode.
		11	Device ID 2 (byte 1)		1 byte			
		12	Device ID 3 (byte 0, LSB)		1 byte			
		13	Function ID 1 (MSB)	R	1 byte		0	Reserved
		14	Function ID 2 (LSB)		1 byte		0	
		15		R	1 byte		0	Reserved
		16	System command	W	1 byte		0	Command interface, only for end user applications and devices without ISDU support (optional)
0001	1		Direct parameter Page 2	R/W		RecordT	IO-Link specification	Manufacturer-specific (optional)
0002	2		System command	W	1 byte	UIntegerT	0x01 (1): ParamUploadStart 0x02 (2): ParamUploadEnd 0x03 (3): ParamDownloadStart 0x04 (4): ParamDownloadEnd 0x05 (5): ParamDownloadStore 0x06 (6): ParamBreak	Command 0x53 (BM_ACTIVATE) is only available in bootloader mode.

Index (hex)	Index (dec)	Sub-bind ex	Object name	Ac-cess	Length	Data type	Values	Remark
							0x50 (80): BM_UNLOCK_S (Start un-lock sequence) 0 x51 (81): BM_UNLOCK_F (Unlock command 1) 0x52 (82): BM_UNLOCK_T (Unlock command 2) 0x53 (83): BM_ACTIVATE (End communication and activate new firmware) 0x80 (128): Device Reset 0x81 (129): Application reset 0x82 (130): Restore Factory settings	
0003	3		Data storage index	R/W	variable	RecordT		
000C	12		Device access locks	R/W	2 bytes	RecordT	0	
000D	13		Profile characteristic	R	variable	ArrayT of UIntegerT16	IO-Link specification	
		1	Profile identifier (Device Profile ID)	R		uint16	0x0001 (1): Generic profile Sensor Smart Sensor profile: 0x000B (11): DMS (Measuring Sensor, high resolution)	
		2	Profile identifier (Common application profile ID)	R		uint16	0x0030 (48): BLOB transfer support	

Index (hex)	Index (dec)	Sub-index	Object name	Access	Length	Data type	Values	Remark
		3	Profile identifier (Common application profile ID)	R		uint16	0x0031 (49): Firmware upgrade support	
		4	Profile identifier (Common application profile ID)	R		uint16	0x4000 (16384): Identification & Diagnosis (ID)	
		5	Smart Sensor profile: Profile identifier (Function class ID)	R		uint16	0x800B (32779): Measurement data channel, (high resolution)	
000E	14		PD input descriptor	R		ArrayT of OctetStringT3	IO-Link specification	
		1	Position	R	3 bytes		0x02: Data type UIntegerT 0x20: Type length (32 bits) 0x00: Bit offset (0 bit) Smart Sensor profile: Vendor-specific 0x02: Data type UIntegerT 0x08: Type length (8 bits) 0x00: Bit offset (0 bit)	PVinD 1
		2	Velocity	R	3 bytes		0x03: Data type IntegerT 0x20: Type length (32 bits) 0x20: Bit offset (32 bits) Smart Sensor profile: Scale 0x03: Data type IntegerT 0x08: Type length (8 bits) 0x08: Bit offset (8 bits)	PVinD 2
		3	Smart Sensor profile: Measurement value	R	3 bytes	OctetStringT3	0x03: Data type IntegerT 0x20: Type length (32 bits) 0x10: Bit offset (16 bits)	PVinD 3

Index (hex)	Index (dec)	Sub-index	Object name	Access	Length	Data type	Values	Remark
0010	16		Vendor name	R	max. 64 bytes	StringT	Fritz Kuebler GmbH	Vendor information
0011	17		Vendor text	R	max. 64 bytes	StringT	Homepage:kuebler.com	Additional vendor information
0012	18		Product name	R	max. 64 bytes	StringT		Detailed product or type name
0013	19		Product ID	R	max. 64 bytes	StringT	(Bootloader mode: xxxxxx)	Product or type identification
0014	20		Product text	R	max. 64 bytes	StringT	MT: Absolute encoder, multiturn ST: Absolute encoder, singleturn (bootloader mode: Absolute encoder multiturn/singleturn)	Description of the device function or of the characteristic
0015	21		Serial number	R	max. 16 bytes	StringT		Manufacturer-specific serial number
0016	22		Hardware Revision	R	max. 64 bytes	StringT	v0 (bootloader mode: vx)	Manufacturer-specific format
0017	23		Firmware revision	R	max. 64 bytes	StringT	v1.0.0 (Bootloader mode: v1.0.0)	Manufacturer-specific format
0018	24		Application specific tag	R/W	min. 16, max. 32 bytes	StringT	***	User-defined tag
0019	25		Function tag	R/W	max.32 bytes	StringT	***	

Index (hex)	Index (dec)	Sub-index	Object name	Access	Length	Data type	Values	Remark
001A	26		Location tag	R/W	max.32 bytes	StringT	***	
0024	36		Device status	R	1 byte	UIntegerT	0: Device operates properly 1: Maintenance required 2: Out of specification 3: Functional check 4: Failure 5 – 255: Reserved	Device status information (diagnostic)
0025	37		Detailed device status	R	36 bytes	ArrayT of OctetStringT3		Information on the currently pending events in the device. When switching off or resetting the device, the content of all array elements is set to the initial settings.
		1	Error_Warning_1	R	3 bytes	OctetStringT3	All bytes 0x00: No error / no warning Octet 1: Event qualifier Byte 2, 3: Event code	
		2	Error_Warning_2	R	3 bytes	OctetStringT3		
		…						
		12	Error_Warning_12	R	3 bytes	OctetStringT3		
0028	40		Process data input	R	PD length	Device specific	Last valid process data	Data type and structure are identical with the process-linked input data, which is transmitted in the process communication channel.

Index (hex)	Index (dec)	Su-bind ex	Object name	Ac-cess	Length	Data type	Values	Remark
		1	Velocity Smart Sensor profile: Measurement value	R	4 bytes	int32	See ISDU 0x006E (Velocity value) Position	PVinD 2 PVinD 3
		2	Position Smart Sensor profile: Scale	R	4bytes 1 byte	uint32 int8	See ISDU 0x0040 (Position value) Scale value	PVinD 1 PVinD 2
		3	Smart Sensor profile: Vendor-specific	R	1 byte	uint8	Not used	PVinD 1
0031	49		BLOB_ID	R	2 bytes	IntegerT		The BLOB identifier indicates the BLOB that is currently being transmitted. (Only available in bootloader mode.)
0032	50		BLOB_CH	R/W	variable	OctetString		Defines the transmission channel for a determined BLOB through a determined BLOB_ID. (Only available in bootloader mode.)

Manufacturer-specific

Index (hex)	Index (dec)	Object name	Access	Length	Data type	Values (default bold)	Remark
0040	64	Position value	R	4 bytes	uint32	0..(TMR-1)	
0041	65	Position format	R/W	1 byte	uint8	**0: Counts**	Is always Counts

Index (hex)	Index (dec)	Object name	Access	Length	Data type	Values (default bold)	Remark
0042	66	Position lower limit	R/W	4 bytes	uint32	0..(TMR-1)	Position lower limit <= Position upper limit
0043	67	Position upper limit	R/W	4 bytes	uint32	0..**(TMR-1)**	Position upper limit >= Position lower limit
0045	69	Position limit control	R/W	1 byte	uint8	0: Position limit control disabled **1: Position limit control enabled**	When enabled: When the position value drops below/exceeds the limit values, the warning flag is set
004C	76	Raw position	R	8 bytes	uint64	MT: 0... (2^{32}-1) ST: 0... (2^{14}-1)	Unscaled, without offset, with counting direction
004E	78	Counting direction	R/W	1 byte	uint8	**0: clockwise (CW)** 1: counter-clockwise (CCW)	Looking at the shaft
0050	80	Preset value	R/W	4 bytes	uint32	**0**..(TMR-1)	

Index (hex)	Index (dec)	Object name	Access	Length	Data type	Values (default bold)	Remark
0051	81	Do position preset	W	1 byte	uint8	1: Set preset position	Sets the position value at the preset value
0052	82	Offset	R	8 bytes	int64	-	The offset value is calculated when setting the preset position
0057	87	Scaling control	R/W	1 byte	uint8	**0 = Scaling disabled** 1 = Scaling enabled	
0058	88	Measuring units per revolution (MUR)	R/W	4 bytes	uint32	1...**16,384**	Singleturn resolution is 14 bits
0059	89	Total measuring range (TMR)	R/W	8 bytes	uint64	MT: 4…**4,294,967,296** ST: 4…**16,384**	The data type **Position value** is uint32, therefore the maximum value is 2^{31}-1

Index (hex)	Index (dec)	Object name	Access	Length	Data type	Values (default bold)	Remark
005B	91	Endless shaft control	R/W	1 byte	uint8	Enables the endless shaft functionality (also scaling must be enabled) **0 =Endless shaft disabled** 1 =Endless shaft enabled	off: Use of MUR & TMR on: Use of NDR (=Numerator/Denominator) & TMR **ST: not used**
005C	92	Number of turns, numerator	R/W	4 bytes	uint32	1...**262,144**	Counter for the number of turns **ST: not used**
005D	93	Number of turns, denominator	R/W	4 bytes	uint32	**1**...4096	Denominator for the number of turns **ST: not used**
006E	110	Velocity value	R	4 bytes	int32		
006F	111	Velocity format	R/W	1 byte	uint8	Velocity unit: 1: Counts/s 2: Counts/ms **3: Turns/min** 4: Turns/s 5: Turns/h	Unit for velocity setting and acceleration accordingly (for turns/min & turns/h -> Acceleration turns/s^2)
0070	112	Velocity filter integration time	R/W	2 bytes	uint16	0...128 **1**	Moving average filter (number of measured values from which an average value is formed) 0 = disabled
0071	113	Velocity filter bandwidth	R/W	2 bytes	uint16	0...500 [Hz] **100 [Hz]**	Bandwidth of the first-order low-pass filter 0 = disabled
0072	114	Velocity lower limit	R/W	4 bytes	int32	**-6,000 [turns/min]**	Velocity lower limit <= Velocity upper limit The unit changes with the speed format. The values are then automatically converted into the new unit.

Index (hex)	Index (dec)	Object name	Access	Length	Data type	Values (default bold)	Remark
0073	115	Velocity upper limit	R/W	4 bytes	int32	**6000 [Turns/min]**	Velocity upper limit >= Velocity lower limit The unit changes with the speed format. The values are then automatically converted into the new unit.
0074	116	Velocity hysteresis	R/W	4 bytes	uint32	**0**...6,000 [turns/min]	Hysteresis for the acceleration limits. The unit depends on the velocity format.
0075	117	Velocity limit control	R/W	1 byte	uint8	0: Velocity limit control disabled **1: Velocity limit control enabled**	When enabled: When the velocity value drops below/exceeds the limit values, the warning flag is set
007D	125	Acceleration Value	R	4 bytes	int32		
007E	126	Acceleration format	R/W	1 byte	uint8	Acceleration unit: 1: Counts/s² 2: Counts/ms² **3: Turns/s²**	
007F	127	Acceleration filter integration time	R/W	2 bytes	uint16	0…128 **1**	Moving average filter (number of measured values from which an average value is formed) 0 = disabled
0080	128	Acceleration filter bandwidth	R/W	2 bytes	uint16	0...500 [Hz] **100 [Hz]**	Bandwidth of the first-order low-pass filter 0 = disabled
0081	129	Acceleration lower limit	R/W	4 bytes	int32	**-27,852 [turns/s²]**	Acceleration lower limit <= Acceleration upper limit

Index (hex)	Index (dec)	Object name	Access	Length	Data type	Values (default bold)	Remark
							The closest to the signed minimal 32-bit integer and the 32-bit floating-point value without loss of accuracy. The unit changes with the acceleration format. The values are then automatically converted into the new unit.
0082	130	Acceleration upper limit	R/W	4 bytes	int32	**27,852 [turns/s^2]**	Acceleration upper limit >= Acceleration lower limit The closest to the signed minimal 32-bit integer and the 32-bit floating-point value without loss of accuracy. The unit changes with the acceleration format. The values are then automatically converted into the new unit.
0083	131	Acceleration hysteresis	R/W	4 bytes	uint32	**0**…27,852 [Turns/s^2]	Hysteresis for the acceleration limits. The unit depends on the acceleration format.
0084	132	Acceleration limit control	R/W	1 byte	uint8	0: Acceleration limit control disabled **1: Acceleration limit control enabled**	If enabled: When the acceleration value drops below/exceeds the limit values, the warning flag is set.
008C	140	Temperature value	R	2 bytes	int16	-40 … +100 [°C] -40 … 212 [°F]	Internal encoder temperature sensor (accuracy 2 °C)
008D	141	Temperature format	R/W	1 byte	uint8	Temperature unit: **0: °C (Celsius)** 1: °F (Fahrenheit)	

Index (hex)	Index (dec)	Object name	Access	Length	Data type	Values (default bold)	Remark
008E	142	Temperature lower limit	R/W	2 bytes	int16	**-40 [°C]**	Temperature lower limit <= Temperature upper limit The unit changes with the temperature format. The values are then automatically converted into the new unit.
008F	143	Temperature upper limit	R/W	2 bytes	int16	**100 [°C]**	Temperature upper limit >= Temperature lower limit The unit changes with the temperature format. The values are then automatically converted into the new unit.
0090	144	Temperature hysteresis	R/W	2 bytes	uint16	0 … 100 [C] 0 … 212 [F] **2°C**	The hystereses may overlap
0091	145	Temperature limit control	R/W	1 byte	uint8	0: Temperature limit control disabled **1: Temperature limit control enabled**	When enabled: When the temperature value drops below/exceeds the limit values, the warning flag is set.
0093	147	Temperature min	R	2 bytes	int16	–40 ... +100 [°C]	Lowest temperature value since the last reset by the user.
0094	148	Temperature max	R	2 bytes	int16	–40 ... +100 [°C]	Highest temperature value since the last reset by the user.
0095	149	Temperature min / max reset	W	1 byte	uint8	1: reset the min / max values	Resets the current min / max values.
009B	155	Device status flags	R	2 bytes	uint16	Displays the encoder status Bit_0: Error - position general fault at startup Bit_1: Warning - position out of range Bit_4: Warning - velocity out of	

Index (hex)	Index (dec)	Object name	Access	Length	Data type	Values (default bold)	Remark
						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 - check-sum	
00A5	165	Operating hours	R	4 bytes	uint32	Operating hours counter	(is incremented as soon as the encoder is powered) 1 digit = 1 hour
00E1	225	Process data switch	R/W	1 byte	uint8	0: Standard profile 1: Smart Sensor profile	Process data configuration
00E6	230	Pin2 configuration	R/W	4 bytes	uint32	Reserved	Use of pin 2
00FB	251	Firmware checksum	R	max. 16 bytes	String	0xABCD1234	

Profile-specific

Index (hex)	Index (dec)	Sub index	Object name	Access	Length	Data type	Values (default bold)	Remark
4,080	16,512		MDC Descr	R	11 bytes	RecordT		Smart Sensor profile
		1	Lower Limit	R	4 bytes	int32	0	Lower value limit of the measuring range
		2	Upper Limit	R	4 bytes	int32	MT: 262,143,999 ST: 999,938	Upper value limit of the measuring range
		3	Unit code	R	2 bytes	uint16	1,009 (revolution)	Defined in the IO-Link units table

Index (hex)	Index (dec)	Sub index	Object name	Access	Length	Data type	Values (default bold)	Remark
		4	Scale	R	1 byte	int8	MT: -3 ST: -6	Area displacement (power of 10)
43BD	17,341		FW_Password	W	max. 64 bytes	StringT	unlock	The password must be input before the unlocking sequence can be performed in the current firmware. (Used only for firmware updates.)
43BE	17,342		HW_ID_Key	R	max. 64 bytes	StringT	m36-v0 Bootloader Mode: m36-bootloader-vx	Identifier inside of a device and in a FW update file, to make sure that both match. (Used only for firmware updates.)
43BF	17,343		Boot mode status	R	1 byte	UIn-tegerT	0: Bootloader inactive 1: Bootloader active	The flag indicates whether the bootloader is active or inactive. (Used only for firmware updates.)

5.3.4 Data Storage (DS)

The following ISDUs are stored by the Data Storage mechanism:

Position

- Position format
- Position lower limit
- Position upper limit
- Position limit control
- Counting direction
- Preset value
- Scaling control
- Measuring units per revolution (MUR)
- Total measuring range (TMR)
- Endless shaft control
- Number of revolutions, nominator
- Number of revolutions, divisor

Velocity

- Velocity format
- Velocity filter integration time
- Velocity filter bandwidth
- Velocity lower limit
- Velocity upper limit
- Velocity hysteresis
- Velocity limit control

Acceleration

- Acceleration format
- Acceleration filter integration time
- Acceleration filter bandwidth
- Acceleration lower limit
- Acceleration upper limit
- Acceleration hysteresis
- Acceleration limit control

Temperature

- Temperature format
- Temperature lower limit
- Temperature upper limit

- Temperature hysteresis
- Temperature limit control

Others

- Process data switch
- Pin2 configuration
- Device access locks
- Application-specific tag
- Function tag
- Location tag

5.4 Configuration Parameters Description

5.4.1 ISDU 66 / 67 - Position Lower / Upper Limit

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

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

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

Conditions:

- Position upper limit < TMR
- Position upper limit ≥ Position lower limit

5.4.2 ISDU 76 - Raw Position

Returns the raw position value, independent from any offset or scaling.

5.4.3 ISDU 78 - Counting Direction

Setting of the counting direction, looking at the shaft.

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

5.4.4 ISDU 80 - Preset

This parameter indicates the position set by a preset. This is used e. g. for zero adjustment.

Validity ranges

Preset value <= Total measuring range (TMR) – 1

NOTICE	**Preset outside of the allowable positions range**
	If, when the position events are enabled, a preset value is selected outside of the defined positions range, an event takes place when the preset is performed.

5.4.5 ISDU 81 - Do Position Preset

The value set by ISDU 80 is taken over.

NOTICE	**Check the standstill**
	Perform the preset while the shaft is standing still.

5.4.6 ISDU 82 - Offset

Returns the relative difference value with respect to the actual encoder position (raw position, ISDU°76).

Example

- Preset 0, raw position at 10, offset -10
- Preset 100, raw position at 60, offset 40

The raw position can be called by means of ISDU 76 "Raw position".

5.4.7 ISDU 112 - Velocity Filter Integration Time

This parameter defines the number of values used to form an average value.

The values range is 0 … 128, the value 0 disables the average value filter.

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

5.4.8 ISDU 113 - Velocity Filter Bandwidth

This parameter defines the limit frequency of the low-pass filter.

The values range is 0 … 500 Hz, the value 0 disables the low-pass filter.

NOTICE	**Note the filter chain**
	The low-pass filtering takes place after the average value filtering.

5.4.9 ISDU 127 - Acceleration Filter Integration Time

This parameter defines the number of values used to form an average value.

The values range is 0 … 128, the value 0 disables the average value filter.

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

5.4.10 ISDU 128 - Acceleration Filter Bandwidth

This parameter defines the limit frequency of the low-pass filter.

The values range is 0 … 500 Hz, the value 0 disables the low-pass filter.

NOTICE	**Note the filter chain**
	The low-pass filtering takes place after the average value filtering.

5.4.11 ISDU 140 - Temperature Value

Returns the current measured temperature. The measurement uses the temperature sensor with an accuracy of approx. ± 2°C integrated in the encoder.

5.4.12 ISDU 147 - Temperature Min

Returns the lowest temperature measured since resetting with ISDU 149.

5.4.13 ISDU 148 - Temperature Max

Returns the highest temperature measured since resetting with ISDU 149.

5.4.14 ISDU 149 - Temperature Min / Max Reset

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

5.4.15 ISDU 165 - Operating Hours

This parameter returns the operating hours. The value is the number of hours since the very first start-up.

5.4.16 ISDU 225 - Process Data Switch

This parameter allows configuring the position data output.

Value	Description
0	Process data according to the Standard Profile (position / velocity)
1	Process data according to the Smart Sensor Profile (PDI48)
others	Reserved for future use

The devices are supplied with preset "Standard Profile" or "Smart Sensor Profile", according to the order code. Manual change is possible by writing the desired value via ISDU.

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

- Restoring the factory setting
  - the scaling parameters are reset.
- Device reset
  - the change is taken into account after device restart. The device logs in with the new device ID and outputs the process data according to the selected profile.

NOTICE	**Profile change**
	Process data length is different for profiles "Standard Profil" and "Smart Sensor Profil", requiring separate device IDs and therefore IODDs. In the event of a profile change, the suitable IODD must be selected subsequently. If the data storage mechanism is active in the master, it must be disabled before changing the profile, to avoid an error message due to a different device ID when restarting the device. After the change, the functionality can be enabled again.

5.4.17 ISDU 230 - Pin2 Configuration

This parameter allows configuring the use of Pin2 of the IO-Link interface.

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

5.5 Functionalities

5.5.1 Velocity Events

- Parameter "Velocity limit control" activates the velocity events. In addition, the following settings can be made:
- Setting of the velocity events by the two parameters "Velocity lower limit" and "Velocity upper limit".
- Hysteresis adjustable by parameter "Velocity hysteresis".

Conditions:

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

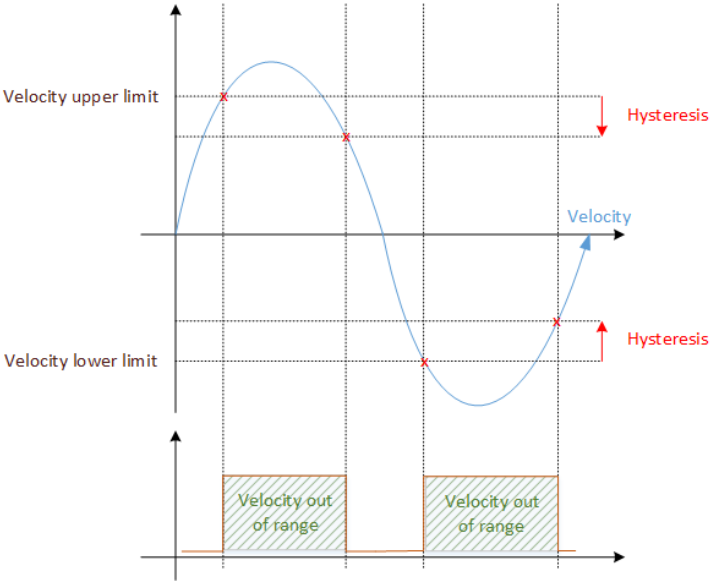
The setting of the velocity events always is performed in the set unit,
parameter "Velocity format". The validity ranges of the values always depend on the selected unit.

The following limits apply:

Unit	Values range
counts/s	-1,638,400 … 1,638,400
counts/ms	-1,638 … 1,638
turns/min	-6,000 … 6,000
turns/s	-100 ... 100
turns/h	-360,000 ... 360,000

Over or underrun of the set event limits is signaled by event "Velocity out of range". The event limits are configured by the user, "Velocity lower limit" and "Velocity upper limit".

The user can use a hysteresis defined relative to the event limit to shift the point at which event signaling is canceled. The following picture illustrates this with the evolution of the velocity.



IMG-ID: 9007199387424907

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

If the velocity drops below the "Velocity lower limit" point, the "Velocity out of range" event is issued. If it increases again above the "Velocity lower limit" point plus the hysteresis, the event signaling is canceled.

5.5.2 Acceleration Events

Parameter "Acceleration limit control" activates the acceleration events. In addition, the following settings can be made:

- Setting of the acceleration events by the two parameters "Acceleration lower limit" and "Acceleration upper limit".
- Hysteresis adjustable by parameter "Acceleration hysteresis".

Conditions:

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

The setting of the acceleration events always is performed in the set unit, parameter "Acceleration format".

Maximum acceleration is 175,000 rad/s².

The validity ranges of the values always depend on the selected unit. The following limits apply:

Unit	Values range
counts/s²	-456,329,052 … +456,329,052
counts/ms²	-456 … +456
turns/s²	-27,852 ... +27,852

5.5.3 Temperature Events

- Enabling of the temperature events by parameter "Temperature limit control".
- Setting of the temperature events by the two parameters "Temperature lower limit" and "Temperature upper limit".
- Hysteresis adjustable by parameter "Temperature hysteresis".

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

The setting of the temperature events always is performed in the set unit, parameter "Temperature format". The validity ranges of the values always depend on the selected unit. The following limits apply:

Unit	Values range
°C	-40 … +100
°F	-40 … +212

5.5.4 Position Scaling

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

NOTICE	**Possible position differences**
	When it is switched off, the encoder may move at the maximum 1/4 of the physical total measuring range in one direction (65535 revolutions). Otherwise, position errors may occur when switching the encoder on again.

Binary scaling

- Binary scaling is enabled by parameter "Scaling Control".
- With binary scaling, the "Total measuring range (TMR)" must be the 2^n-fold of "Measuring units per revolution (MUR)".
- TMR gives the total measuring range and MUR the measuring range per revolution.
- The ratio of TMR and MUR gives the number of revolutions, which always must correspond to the 2n ratio.

Example for multiturn

TMR = 16,777,216 (2^{24}); MUR = 16,384 (2^{14}) | Number of revolutions = 1,024 (2^{10})

TMR = 1,073,741,824 (2^{30}); MUR = 4,096 (2^{12}) | Number of revolutions = 262,144 (2^{18})

Validity ranges

TMR:

4 ... 4,294,967,296 (multiturn, 2^{32})

4 ... 16,384 (singleturn, 2^{14})

MUR:

1 ... 16,384

Maximum number of revolutions multiturn: 1 ... 262,144 (2^{18})

Number of revolutions for singleturn: 1

NOTICE	**Observe the measuring range**
	If the measuring range is modified, the position limits are set as follows: Position lower limit = 0 Position upper limit = TMR-1 If the preset value is outside of the measuring range, it is set to 0.

Endless shaft function

- The endless shaft function is enabled by parameter "Endless shaft control".
- The endless shaft function is set by parameters "Total measuring range (TMR)", "Number of revolutions, numerator" and "Number of revolutions, denominator".

- The endless shaft function uses rational scaling, parameters "Numerator" and "Denominator" allow setting the correct number of revolutions.
- TMR gives the valid measuring range.

Example

TMR = 10,000,000; Numerator = 1,950; Denominator = 3

TMR = MUR x (numerator / denominator)

Number of revolutions MUR = 15.384,615384

Validity ranges

TMR:

4 ... 4,294,967,296

Numerator:

1 ... 262,144

Denominator:

1 ... 4,096

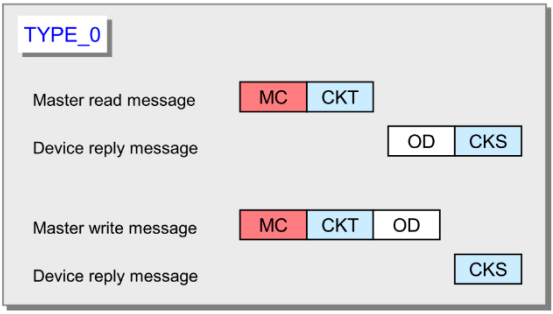
NOTICE	**Consider Endless shaft and the measuring range**
	Endless shaft can only be enabled when scaling control (Index 92) is disabled. The endless shaft function is only available on a multiturn encoder.

5.5.5 Firmware Update

The device supports firmware updates according to the IO-Link Specification.

Used M sequence types

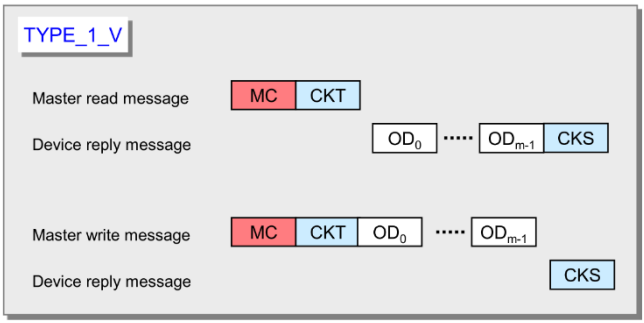
STARTUP:Type_0



IMG-ID: 132704011

PRE-OPERATE and OPERATE: Type 1_V

- Output process data (Master -> Device): 0 bytes
- On-request data: 32 bytes
- Input process data (Device -> Master): 0 bytes



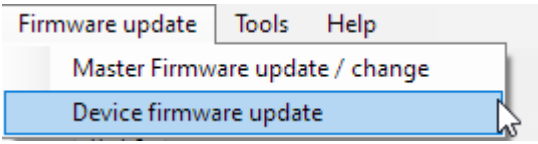
IMG-ID: 132705675

Perform the firmware update with the IO-Link master control tool (TEConcept):

✓ Set up the connection with the device

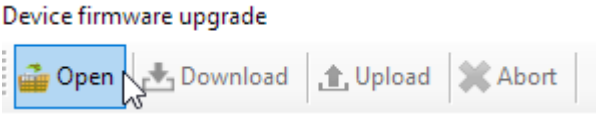
✓ Disable the data storage functionality in the master during the firmware update process.

a) Select the menu item for firmware update



b) Open the firmware update file

⇨ The IOLFW file can be downloaded from the Kübler website.

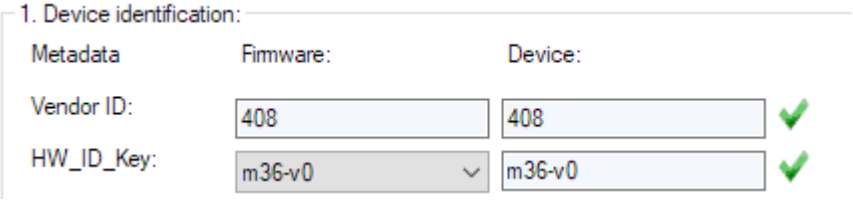


c) Check the bootmode status

d) Input the password

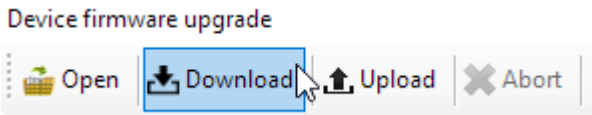
⇨ The pass word is: unlock

e) Check the compatibility

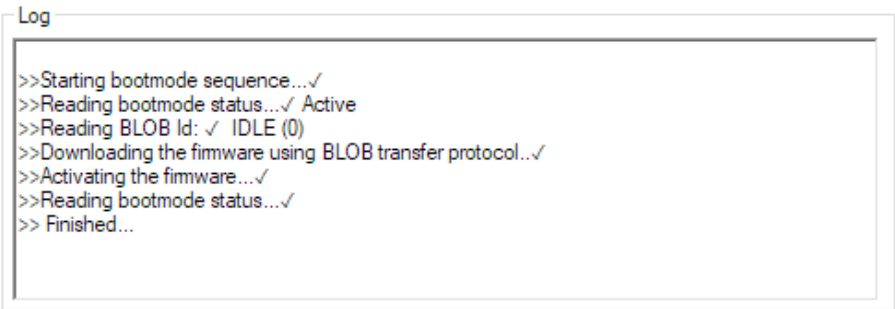


f) Start the firmware download

⇨ The success of the download of the firmware is displayed accordingly and the IO-Link communication continues with the new firmware.



NOTICE	**Bootloader mode**
	The firmware update file is transferred by BLOB transfer. The BLOB transfer is started as soon as the device is in bootloader mode. This operation can require some minutes.



Only a minimized IO-Link range of functions is available in bootloader mode. For the following ISDUs, generalized values are issued, which are different from the values in normal mode.

- Device ID
- Product name
- Product ID
- Product text
- Serial number
- Hardware revision
- Firmware revision
- HW_ID_Key

BLOB transfer

The BLOB transfer is used for transferring a firmware update file, as soon as the device is in bootloader mode.

A BLOB transfer is not possible in normal mode.

5.6 Status messages

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

IO-Link-specific

Event code	Status text	Device status	Type	Mode
0x1000	General error function - Unknown error	4:error	Error	Appear/ Disappear
0x4210	Device temperature overshoot - Clear heat source	2:Out of specification	Warning	Appear/ Disappear
0x4220	Device temperature undershoot - Insulate the device	2:Out of specification	Warning	Appear/ Disappear
0x5000	Device hardware error - Device replacement	4:error	Error	Appear/ Disappear
0x6320	Parameter error - Check data sheet and values	4:error	Error	Appear/ Disappear
0xFF91	Upload request for data storage ("DS_UP-LOAD_REQ") Internal, not visible for the user	0:Device in operation	Notification	Single-shot

Manufacturer-specific

Event code	Status text	Device status	Type	Mode	Note
0x8CA0	Position outside of the valid range	2: Out of specification	Warning	Appear/ Disappear	Requires activ-ated position limits
0x8CA1	Velocity outside of the valid range	2: Out of specification	Warning	Appear/ Disappear	Requires activ-ated velocity limits
0x8CA2	Acceleration outside of the valid range	2: Out of specification	Warning	Appear/ Disappear	Requires activ-ated accelera-tion limits
0x8CA5	Memory check sum error	4:error	Error	Appear/ Disappear	Details for error diagnostic

5.7 ISDU Error Codes

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

Error	Error code	Additional code	Description
Device application error – no details	0x80	0x00	The requested service has been refused by the device application, and no detailed information on the event is available.
Index not available	0x80	0x11	A read or write access is attempted on a non-available index, with or without subindex access.
Subindex not available	0x80	0x12	A read or write access is attempted on a non-available subindex of an existing index.
Service temporarily not available	0x80	0x20	No access to a parameter due to the current status of the device application.
Access denied	0x80	0x23	A write service tries to access a write-protected parameter or a read service tries to access a read-protected parameter.
Parameter value out of range	0x80	0x30	A write service for a parameter outside of the permitted values range (e. g. enumerations (list of single values), combination of values ranges and enumeration).
Parameter value overrun	0x80	0x33	The content of a write service for a parameter exceeds the indicated length of the parameter.
Parameter value underrun	0x80	0x34	The content of a write service for a parameter is shorter than the indicated length of the parameter (e. g. write access of an unsigned16 value to an unsigned32 parameter.
Resource not available:	0x80	0x35	Write service with a command value not supported by the device application (e. g. a system command with a non-implemented value).
Function temporarily not available	0x80	0x36	A write service with a command value calling a device function that is not available due to the current status of the device application (e. g. system command).
Invalid parameter set	0x80	0x40	Values sent by transmission of individual parameters do not match with other actual parameter settings (e. g. overlapping setpoint values for a binary data setting).
Inconsistent parameter set	0x80	0x41	Occurs when ending a block parameter transmission with ParamDownloadEnd or ParamDownloadStore when the plausibility check shows inconsistencies.

6 Annex

6.1 Dependence on the position parameters

	Direction	Scaling enable	Endless shaft enable	Numerator	Divisor	Range (TMR)	Resolution (MUR)	Preset value	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											

Individual parameterizing	Block parameterizing
a1: If the TMR is modified, the preset is set to 0 if it is larger than or equal to TMR.	a1: If the TMR is modified, the preset is set to 0 if it is larger than or equal to TMR, provided the preset did not change. Otherwise, the new value is taken over.
a2: If the TMR is modified, the position lower limit is set to 0 and the position upper limit is set to TMR-1.	a2: If the TMR is modified, the position lower limit is set to 0 and the position upper is set to TMR-1, provided they did not change. Otherwise, the new value is taken over.
z1: Position upper limit >= Position lower limit.	z1: Position upper limit >= Position lower limit.
z2: Either Scaling or Endless shaft can be activated.	z2: Either Scaling or Endless shaft can be activated.
z3: If Scaling is active, the ratio of TMR and MUR must be a 2^n ratio.	z3: If Scaling is active, the ratio of TMR and MUR must be a 2^n ratio.
z4: If Endless shaft is active, the ratio of TMR, numerator and divisor must match.	z4: If Endless shaft is active, the ratio of TMR, numerator and divisor must match.
z5: Maximum allowed value: TMR-1.	z5: Maximum allowed value: TMR-1.

6.2 Decimal / Hexadecimal conversion table

Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex
0	*0*	51	*33*	102	*66*	153	*99*	204	*CC*
1	*1*	52	*34*	103	*67*	154	*9A*	205	*CD*
2	*2*	53	*35*	104	*68*	155	*9B*	206	*CE*
3	*3*	54	*36*	105	*69*	156	*9C*	207	*CF*
4	*4*	55	*37*	106	*6A*	157	*9D*	208	*D0*
5	*5*	56	*38*	107	*6B*	158	*9E*	209	*D1*
6	*6*	57	*39*	108	*6C*	159	*9F*	210	*D2*
7	*7*	58	*3A*	109	*6D*	160	*A0*	211	*D3*
8	*8*	59	*3B*	110	*6E*	161	*A1*	212	*D4*
9	*9*	60	*3C*	111	*6F*	162	*A2*	213	*D5*
10	*0A*	61	*3D*	112	*70*	163	*A3*	214	*D6*
11	*0B*	62	*3E*	113	*71*	164	*A4*	215	*D7*
12	*0C*	63	*3F*	114	*72*	165	*A5*	216	*D8*
13	*0D*	64	*40*	115	*73*	166	*A6*	217	*D9*
14	*0E*	65	*41*	116	*74*	167	*A7*	218	*DA*
15	*0F*	66	*42*	117	*75*	168	*A8*	219	*DB*
16	*10*	67	*43*	118	*76*	169	*A9*	220	*DC*
17	*11*	68	*44*	119	*77*	170	*AA*	221	*DD*
18	*12*	69	*45*	120	*78*	171	*AB*	222	*DE*
19	*13*	70	*46*	121	*79*	172	*AC*	223	*DF*
20	*14*	71	*47*	122	*7A*	173	*AD*	224	*E0*
21	*15*	72	*48*	123	*7B*	174	*AE*	225	*E1*
22	*16*	73	*49*	124	*7C*	175	*AF*	226	*E2*
23	*17*	74	*4A*	125	*7D*	176	*B0*	227	*E3*
24	*18*	75	*4B*	126	*7E*	177	*B1*	228	*E4*
25	*19*	76	*4C*	127	*7F*	178	*B2*	229	*E5*
26	*1A*	77	*4D*	128	*80*	179	*B3*	230	*E6*
27	*1B*	78	*4E*	129	*81*	180	*B4*	231	*E7*
28	*1C*	79	*4F*	130	*82*	181	*B5*	232	*E8*
29	*1D*	80	*50*	131	*83*	182	*B6*	233	*E9*
30	*1E*	81	*51*	132	*84*	183	*B7*	234	*EA*

Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex	Dec	Hex
31	*1F*	82	*52*	133	*85*	184	*B8*	235	*EB*
32	*20*	83	*53*	134	*86*	185	*B9*	236	*EC*
33	*21*	84	*54*	135	*87*	186	*BA*	237	*ED*
34	*22*	85	*55*	136	*88*	187	*BB*	238	*EE*
35	*23*	86	*56*	137	*89*	188	*BC*	239	*EF*
36	*24*	87	*57*	138	*8A*	189	*BD*	240	*F0*
37	*25*	88	*58*	139	*8B*	190	*BE*	241	*F1*
38	*26*	89	*59*	140	*8C*	191	*BF*	242	*F2*
39	*27*	90	*5A*	141	*8D*	192	*C0*	243	*F3*
40	*28*	91	*5B*	142	*8E*	193	*C1*	244	*F4*
41	*29*	92	*5C*	143	*8F*	194	*C2*	245	*F5*
42	*2A*	93	*5D*	144	*90*	195	*C3*	246	*F6*
43	*2B*	94	*5E*	145	*91*	196	*C4*	247	*F7*
44	*2C*	95	*5F*	146	*92*	197	*C5*	248	*F8*
45	*2D*	96	*60*	147	*93*	198	*C6*	249	*F9*
46	*2E*	97	*61*	148	*94*	199	*C7*	250	*FA*
47	*2F*	98	*62*	149	*95*	200	*C8*	251	*FB*
48	*30*	99	*63*	150	*96*	201	*C9*	252	*FC*
49	*31*	100	*64*	151	*97*	202	*CA*	253	*FD*
50	*32*	101	*65*	152	*98*	203	*CB*	254	*FE*
								255	*FF*

7 Contact

You want to contact us:

Technical advice

Kübler's worldwide applications team is available on site all over the world for technical advice, analysis or installation support.

International support (English-speaking)

+49 7720 3903 952

support@kuebler.com

Kübler Germany +49 7720 3903 849

Kübler France +33 3 89 53 45 45

Kübler Italy +39 0 26 42 33 45

Kübler Austria +43 3322 43723 12

Kübler Poland +48 6 18 49 99 02

Kübler Turkey +90 216 999 9791

Kübler China +86 10 8471 0818

Kübler India +91 8600 147 280

Kübler USA +1 855 583 2537

Repair service / RMA form

In case of returns, please package the product sufficiently and attach the completed "Returns form".

www.kuebler.com/rma

Please send your return to the address below.

Kübler Group
Fritz Kübler GmbH

Schubertstraße 47
D-78054 Villingen-Schwenningen
Germany

Phone +49 7720 3903 0
Fax +49 7720 21564

info@kuebler.com
www.kuebler.com

Glossary

BLOB

Binary Large Object - Larger volume of data to be transferred

ccw

counterclockwise, counting direction

cw

clockwise, counting direction

DS

Data Storage

Hubs

Abbreviated designation Hub for Repeating Hub. Node point

IODD

Device description file IO-Link

ISDU

Indexed Service Data Unit

M sequence

Message type used between master and device. IO-Link specifies 11 different M sequence types

MUR

Measuring Units per Revolution

PDIN

Process Data Object

SDCI

Single-drop digital communication interface for small sensors and actuators

TMR

Total Measuring Range

Kübler Group
Fritz Kübler GmbH
Schubertstr. 47
D-78054 Villingen-Schwenningen
Germany
Phone +49 7720 3903-0
Fax +49 7720 21564
info@kuebler.com
www.kuebler.com