IO-Link interface description

1 General information

1.1 Document version

20230207 IO-Link Interface description (replaces earlier versions)

1.2 Valid for firmware version

2.04.07 and higher

2 Table of content

3 The most important in brief

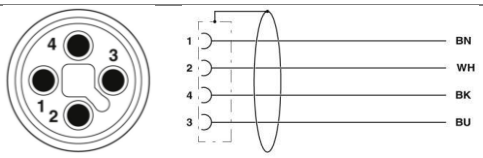
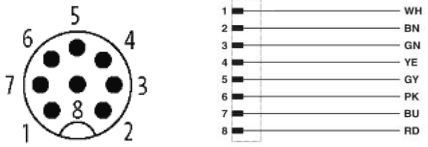
- The cylinder can be used with and without IO-Link
- The configuration data can be written via IO-Link, after which the cylinder can also be operated without IO-Link (via digital signals), but with the new configuration.
- If the IO-Link connection is active, an operating mode (Motion Mode) must be selected. In mode 0, the cylinder is not moved.
- The variables are stored in the IODD together with their description. The meaning of the variables can also be viewed without instructions via the IO-Link master.

IMPORTANT	
	The cyclic process data may be written during operation. The cylinder should be stopped for writing the remaining data. When writing the data, load shedding or even a restart of the device could occur.

IMPORTANT	
	Under no circumstances may the configuration variables be written to cyclically. Writing to these variables too frequently can damage the device. All important properties that must be controlled cyclically can be controlled via the cyclic process data.

IMPORTANT	
	In normal IO-Link operation, the current consumption remains well below 200mA, so all commercially available masters can provide the supply. However, if a large load is to be attached to one of the digital outputs (possible up to 250mA), then a master with a correspondingly higher output current must also be used.

4 Connection

Power	Signal
Plug M12x1, 4-pole T-coded according to EN 61076-2-11	**Plug M12x1, 8-pin** A-coded according to EN 61076-2-101 (Shielded cables are recommended)
	

Pin assignment Digital I/O

Pin	Farbe	Funktion
1	BN	Power voltage 24V-48V ± 15% (max. 10A) At 48V the use of a brake chopper is recommended.
2	WH	Functional earth (FE)
3	BU	GND 0V
4	BK	reserved, do not connect

Pin	Farbe	Funktion
1	WH	DO Ready / IO Link CQ
2	BN	Logic voltage 24V ± 15% (max. 500mA)
3	GN	DO is extended (optional)
4	YE	DO is retracted (optional)
5	GY	DI Retract (optional)
6	PK	DI Extend (optional)
7	BU	GND 0V
8	RD	DI Teach / Reset / Powerless

5 Process data structure

Process input data (Slave->Master):

Byte Nr.:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Variable:	State	Statusbits	Actual Position				Actual Speed				Actual Force			
Data type:	Uint8	Uint8	Float32				Float32				Float32			
Details:	Chapter 7.1	Chapter 7.2												

Process output data (Master->Slave):

Byte Nr.:	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Variable:	Motion Mode	Target Position				Override 1	Override 2	Override 3
Data type:	Uint8	Float32				Uint8	Uint8	Uint8
Details:	Chapter **Fehler! V erweisquelle konnte nicht gefunden werden.**	Chapter 6.6/6.7				Chapter 6.7	Chapter 6.7	Chapter 6.7

Note	
	The above tables show the structure of the process data. The transmission sequence in the IO-Link telegram is shown in the table from left to right.

6 Description of the operating modes

The mode is selected via the cyclic process data with the variable "Motion Mode".

6.1 UserMode_Off = 0

If a command is triggered via the digital IO, it is immediately reset. No movement is executed.

6.2 UserMode_DIO = 1

The device can be controlled via the digital IO. The mode is essentially the same as operation without active IO-Link, but the variables can be read and written.

If no command level is present at the digital IOs, the device stops and remains in control at the current position. If coming from mode 0, the controller remains switched off.

6.3 UserMode_Teach = 2

A learning journey is performed. First, the device travels in the direction corresponding to the "DirectionOfTravel" variable.

The learn drive can only be started when the device is in Idle status. From operation, the mode "UserMode_Off = 0" must be selected first.

6.4 UserMode_MoveOut = 3

A travel to the outer end position is triggered.

6.5 UserMode_MoveIn = 4

A travel to the inner end position is triggered.

6.6 UserMode_FreePos = 5

The target position is specified via the "Target Position" process variable. The device follows this target position with the preconfigured values for speed and force. The position value must love between 0 and the stored maximum stroke, otherwise no movement is started.

IMPORTANT	
	The maximum speed and force for this mode are configured via the "Max. speed free positioning" and "Max. force free positioning" variables.

6.7 UserMode_FreePosPro = 6

The target position is specified via the "Target Position" process variable. The device follows this target position. The position value must lie within the boundaries defined by the parameters «End Position In» und End Position Out», otherwise no movement will be triggered.

The preconfigured values for speed, force and acceleration/deceleration can be scaled from 0-100% via the Override 1-3 process variables.

Assignment:

Process variable	Scaled value
Override 1	Speed
Override 2	Force
Override 3	Acceleration/ Deceleration

IMPORTANT	
	The preconfigured maximum speed and force for this mode are configured via the "Max. speed free positioning" and "Max. force free positioning" variables.

Override 3 will be used for scaling the acceleration in the future. In order not to have to make any changes to the user program during a later firmware update, it is already recommended to write the value 100 to this variable.

6.8 UserMode_HomeDirect = 7

With this mode, the axis can be referenced manually. The actual position is set equal to the «Target Position» process variable. The «Homed» status bit is set active.

WICHTIG	
	When referencing manually, **it must be taken into consideration that the parameterized end positions («End Position Out» and «End Position In») are still approached when using User Mode 3 and 4**, as these end positions are not altered when referencing via Mode 7. These end positions may have to be adapted to the application to prevent unwanted behaviour

6.9 UserMode_PosSequence = 11 to 14

A positioning sequence is a preconfigured motion sequence that can be triggered with a simple command. Up to four sequences can be preconfigured in the parameters, which can then be triggered via User Mode 11 to 14.

Target Position (1)	rw	0.000	d	mm
Target Speed (1)	rw	0	d	mm/s
Target Acceleration (1)	rw	2	d	m/s²
Target Deceleration (1)	rw	2	d	m/s²
Target Positioning Time (1)	rw	0.000	d	ms
Target Positioning Force (1)	rw	400.00	d	N
Target Positioning Mode (1)	rw	Absolute	d	

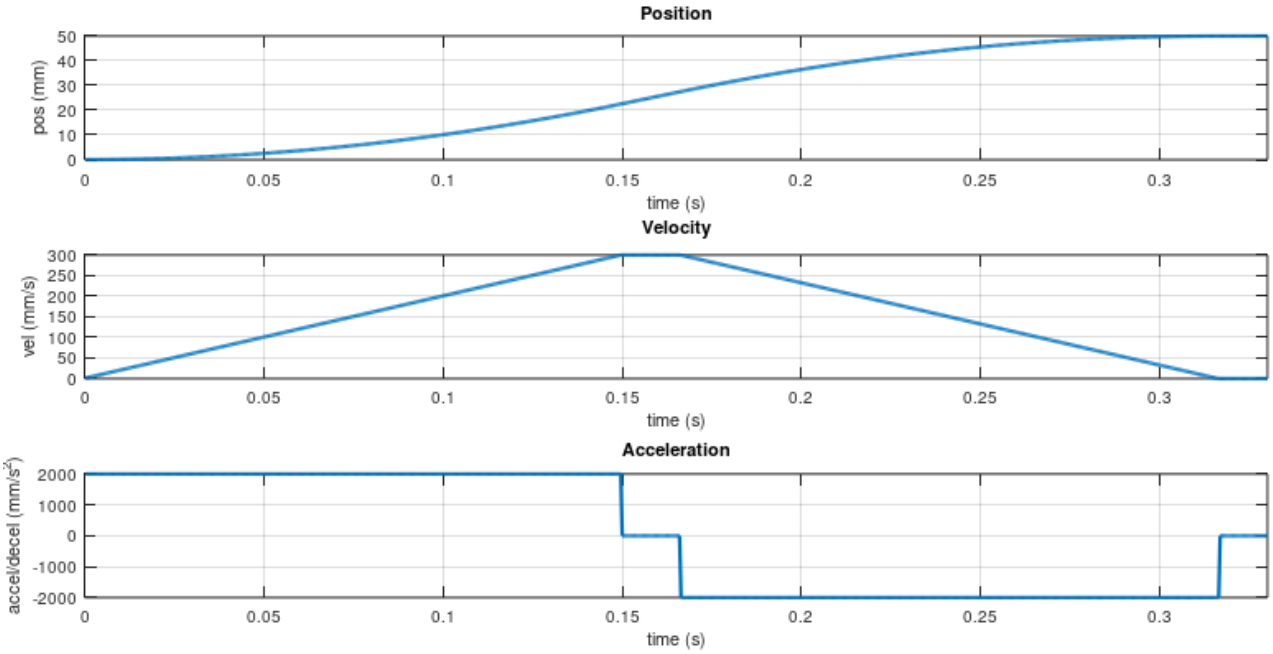
The following applies:

Mode 11: Current actual position → Positioning Sequence 1
Mode 12: Current actual position → Positioning Sequence 2
Mode 13: Current actual position → Positioning Sequence 3
Mode 14: Current actual position → Positioning Sequence 4

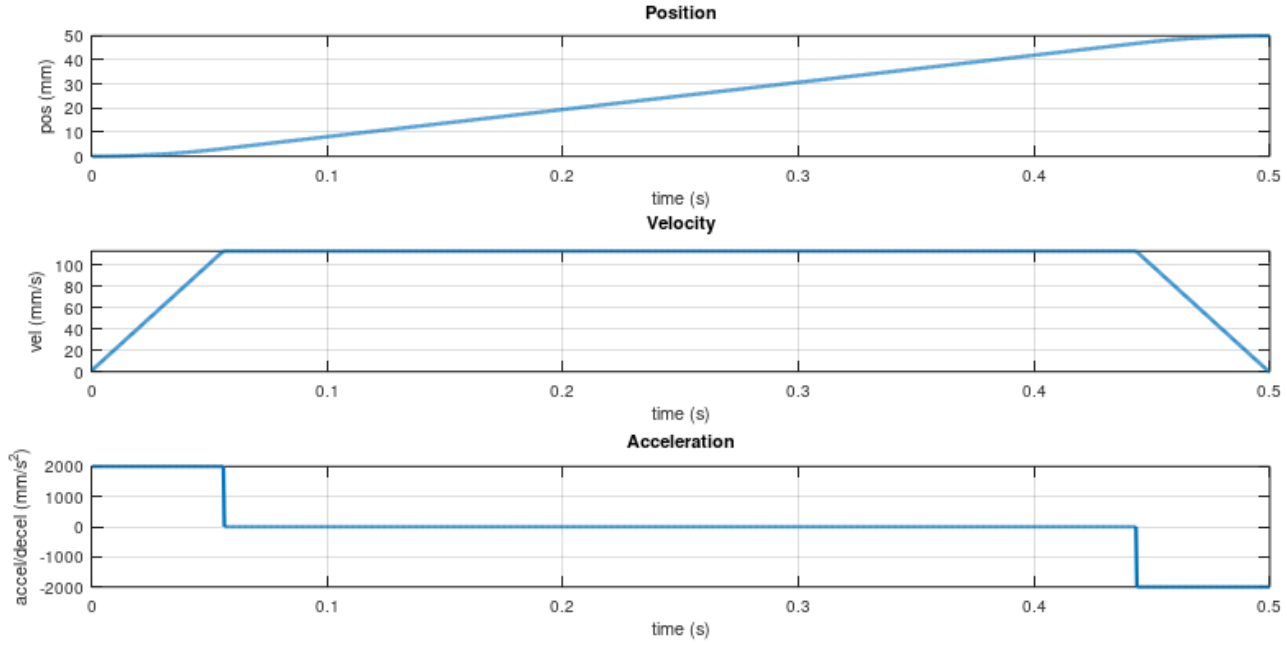
The target position must be within a valid range (see chapter 6.7) and the target speed/acceleration/deceleration must not be 0. If the target positioning time is = 0, the target position is approached with the preconfigured values for speed/acceleration/deceleration. If the target positioning time > 0, the target speed is recalculated so that the movement (from the current position to the target position) is carried out within the preconfigured time. The target acceleration/deceleration parameters are used when calculating the path, and the target speed parameter serves as a limit value if the target positioning time cannot be reached (if, for example, the acceleration/deceleration selected was too small).

HINWEIS	
	The "Target Positioning Mode" sequence parameter is still under development. In the case of all positioning sequences, the target positions are "absolute".

Example for a movement sequence with Target Position = 50mm, Target Speed = 300mm/s, Target Acceleration/Deceleration = 2m/s^2, Target Positioning Time = 0:



Example for a movement sequence with Target Position = 50mm, Target Speed = 300mm/s, Target Acceleration/Deceleration = 2m/s^2, Target Positioning Time = 0.5s:



6.10 UserMode_PressIn = 21 to 27

The Press In Mode uses the positioning sequences (see Chapter 6.9) to sequentially move to two pre-configured positions automatically. There are two variants:

- In mode 21 to 23, the first sequence is completed (i.e. with stop), then the second sequence is triggered.
- In modes 25 to 27 there is a smooth transition between the two sequences. If the target speed of the second sequence is lower than that of the first, the first position will be reached at the target speed of the second sequence. If the target speed of the second sequence is higher than that of the first sequence, the first position will be reached with the target speed of the first sequence

The following applies:

Mode 21 and 25:	Current actual position → Sequence 1 → Sequence 2
Mode 22 and 26:	Current actual position → Sequence 2 → Sequence 3
Mode 23 and 27:	Current actual position → Sequence 3 → Sequence 4

HINWEIS	
	A target positioning time can also be configured for the press-in modes. In modes 25 to 27 (with a smooth transition) however, the cumulative time of both sequences can will be imprecise. It is recommended to select Target Positioning Time = 0 for these modes and to define the movement via Target Speed.

HINWEIS	
	If the current actual position of the cylinder lies between both target positions when starting a press-in mode via mode 25 to 27, the first position is ignored and the cylinder moves directly to position 2.

6.11 UserMode_Reset = 255

Serves to reset one (or more) present errors. The error state is exited again when changing from UserMode 255 to another UserMode (e.g. User Mode 1).

7 Feedback

The current values for position, speed and force are reported back directly via process variables.

7.1 Status byte

The status is reported back via a process byte with the following content:

Value	State	Meaning
0	Idle	Switched off or at standstill
1	Ready	The device is ready to accept a command
2	Active	Positioning mode active
3	Error	Error condition
4	Teach	Teach run in progress

7.2 Status bits

Further process data are available for evaluation; these are stored in the process data in the form of 8 status bits:

Value	State	Meaning
7	Tracking Error Tolerance Exceeded	Configured tracking error tolerance is exceeded
6	Warning active	Temperature or voltage has exceeded the warning limit
5	Motion command completed	The command was completely implemented
4	Motion Mode active	A move command is in execution
3	Limit switch in	The position is within the configured tolerance range of the "virtual limit switch".
2	Limit switch out	The position is within the configured tolerance range of the "virtual limit switch".
1	Homed	The device is referenced
0	Ready	The device is ready to accept a command

8 Simple application examples

8.1 Approaching two taught-in end positions

This procedure corresponds to the use of the digital inputs and outputs. However, the wiring can be saved and everything can be controlled via the software.

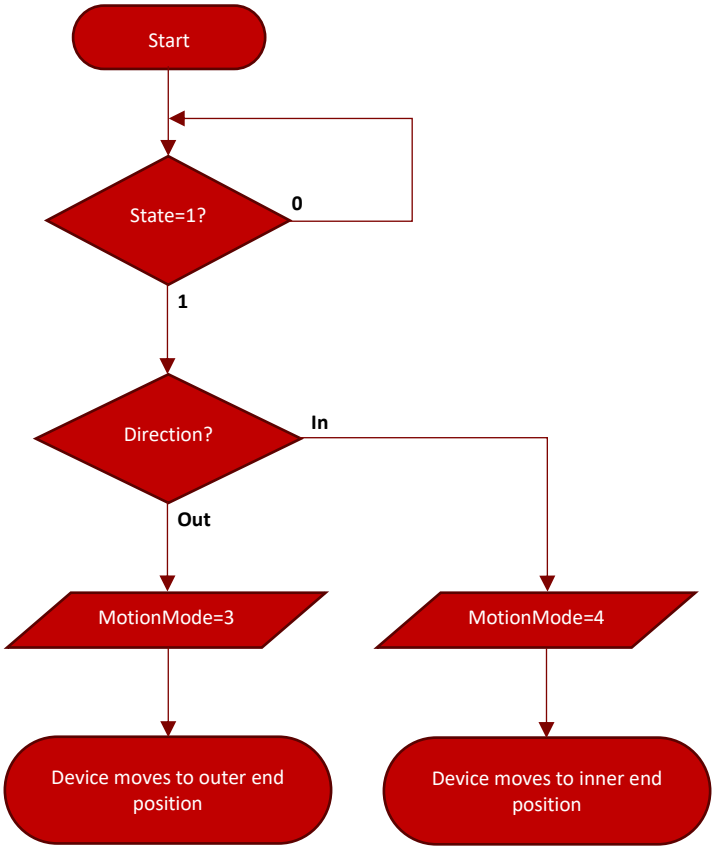


FIGURE 1: APPROACHING TWO TAUGHT IN END POSITIONS

The first movement is performed slowly to detect the end stop.

Afterwards, it is possible to switch back and forth between modes 3 and 4 as desired. A movement can also be stopped on the way by changing to mode 1 (position controller remains active) or mode 0 (position controller is deactivated).

8.2 Free positioning via cyclic data

Free positioning via the cyclic data can be set up as follows. As soon as the device is ready for operation (State=1 or Ready Bit=1), an end position can be approached. The device is then referenced and can be moved in free positioning mode.

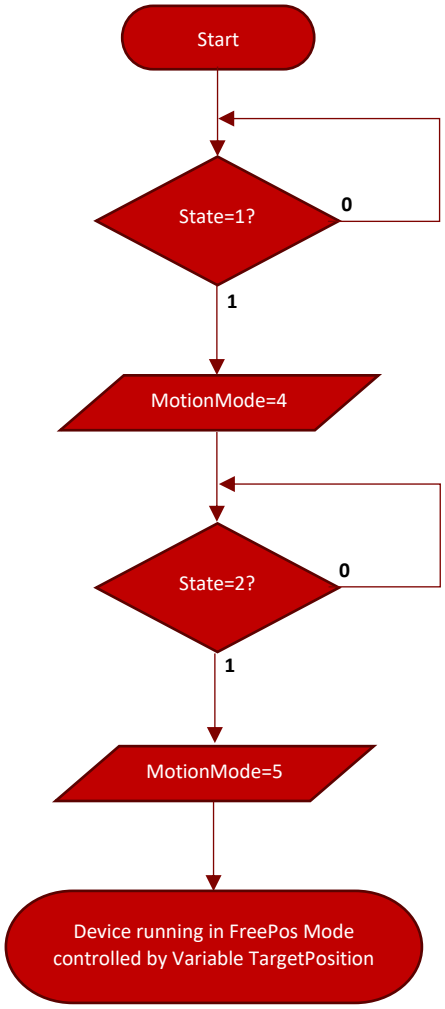


FIGURE 2: POSITIONING VIA CYCLICAL DATA

8.3 Teaching a new travel range

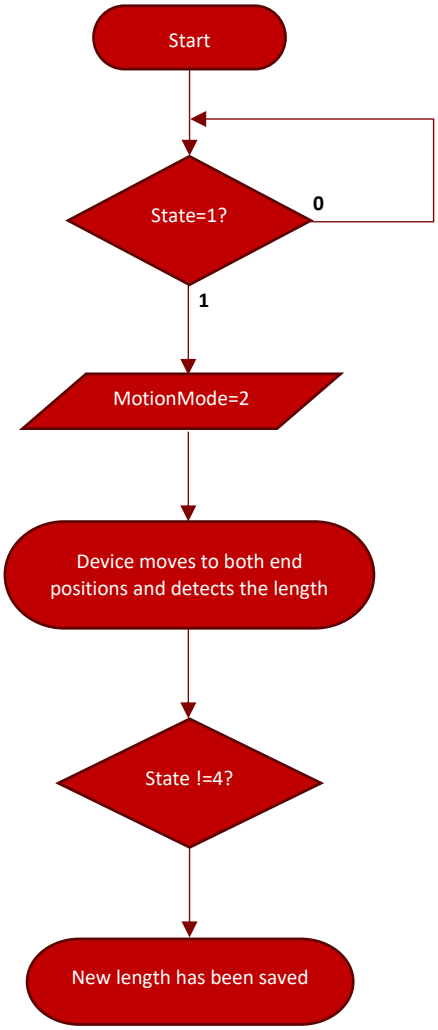


FIGURE 3: TEACHING A NEW TRAVEL RANGE

9 Variable list

9.1 configuration (read/write)

Name	Index	Datatype	Value Range	Single Values
Max. Speed In	64	Float32T	0 to 600	
Max. Speed Out	65	Float32T	0 to 600	
Max. Speed free Positioning	67	Float32T	1 to 600	
Max. Force	66	Float32T	0 to 450	
Max. Acceleration	84	Float32T	0.01 to 20	
Max. Deceleration	68	Float32T	0.01 to 20	
Max. Tracking Error	69	Float32T	0.01 to 10000	
Tracking Error Monitoring	70	Float32T		false (false), true (true)
Position Tolerance for Status Feedback	71	BooleanT	0.01 to 10000	
Tolerance Position Sensor Signal Out (Limit Switch)	72	Float32T	0.01 to 10000	
Tolerance Position Sensor Signal In (Limit Switch)	73	Float32T		
End Position Out	74	Float32T		
End Position In	75	Float32T		
Pos. Sensor Signal Out (limit switch)	76	Float32T		
Pos. Sensor Signal In (limit switch)	77	Float32T		
Reserved	78	Float32T	0.1 to 10	
Max. Speed Teach Mode	79	Float32T	1 to 200	
Rated Power Voltage	80	Float32T	24 to 48	
Control Mode (Bistable, Omnistable)	81	Float32T		Omnistable (0), Bistable (1), PWM Mode (2), DIO-Ramp (3), DIO-Press (4)
Direction of Travel	82	UIntegerT_8		extend (1), retract (0)
Max. Force free positioning	83	UIntegerT_8	0 to 450	
Target Position (1)	90	Float32T		
Target Speed (1)	91	Float32T	0 to 600	
Target Acceleration (1)	92	Float32T	0.01 to 20	
Target Deceleration (1)	93	Float32T	0.01 to 20	
Target Positioning Time (1)	94	Float32T	0 to 10000000	
Target Position (2)	100	Float32T		
Target Speed (2)	101	Float32T	0 to 600	
Target Acceleration (2)	102	Float32T	0.01 to 20	
Target Deceleration (2)	103	Float32T	0.01 to 20	
Target Positioning Time (2)	104	Float32T	0 to 10000000	
Target Position (3)	110	Float32T		
Target Speed (3)	111	Float32T	0 to 600	
Target Acceleration (3)	112	Float32T	0.01 to 20	
Target Deceleration (3)	113	Float32T	0.01 to 20	
Target Positioning Time (3)	114	Float32T	0 to 10000000	
Target Position (4)	120	Float32T		
Target Speed (4)	121	Float32T	0 to 600	
Target Acceleration (4)	122	Float32T	0.01 to 20	
Target Deceleration (4)	123	Float32T	0.01 to 20	
Target Positioning Time (4)	124	Float32T	0 to 10000000	
Target Positioning Force (1)	240	Float32T	0 to 450	

Target Positioning Force (2)	241	Float32T	0 to 450	
Target Positioning Force (3)	242	Float32T	0 to 450	
Target Positioning Force (4)	243	Float32T	0 to 450	
Target Positioning Mode (1)	244	UIntegerT_32		Absolute (0), Relative (1)
Target Positioning Mode (2)	245	UIntegerT_32		Absolute (0), Relative (1)
Target Positioning Mode (3)	246	UIntegerT_32		Absolute (0), Relative (1)
Target Positioning Mode (4)	247	UIntegerT_32		Absolute (0), Relative (1)

9.2 Diagnose (read only)

Name	Index	Datatype	Value Range	Single Values
Lubrication Countdown (in development)	140	Float32T		
Lifetime Countdown (in development)	141	Float32T		
Reserved	142	Float32T		
Temperature Board	143	Float32T		
Temperature Encoder	144	Float32T		
Temperature Power Unit	145	Float32T		
Reserved	146	Float32T		
Temperature Motor	147	Float32T		
Actual Tracking Error (in development)	148	Float32T		
Actual Control Voltage	149	Float32T		
Actual Power Intermediate Circuit Voltage	150	Float32T		
Reserved	151	Float32T		
Cycle Counter	152	IntegerT_32		
EEPROM Version	153	IntegerT_32		
Error counter for "Undervoltage Logic"	160	IntegerT_16		
Error counter for "Overvoltage Logic"	161	IntegerT_16		
Error counter for "Undervoltage Power"	162	IntegerT_16		
Error counter for "Overvoltage Power"	163	IntegerT_16		
Error counter for "Undertemperature Micro Controller"	164	IntegerT_16		
Error counter for "Overtemperature Micro Controller"	165	IntegerT_16		
Error counter for "Undertemperature Controller Board"	166	IntegerT_16		
Error counter for "Overtemperature Controller Board"	167	IntegerT_16		
Error counter for "Undertemperature Encoder Board"	168	IntegerT_16		
Error counter for "Overtemperature Encoder Board"	169	IntegerT_16		
Error counter for "Overtemperature Power Stage Phase U"	170	IntegerT_16		
Error counter for "Overtemperature Power Stage Phase V"	171	IntegerT_16		
Error counter for "Overtemperature Power Stage Phase W"	172	IntegerT_16		
Error counter for "Overtemperature Motor Phase U"	173	IntegerT_16		
Error counter for "Overtemperature Motor Phase V"	174	IntegerT_16		
Error counter for "Overtemperature Motor Phase W"	175	IntegerT_16		
Error Counter Controller Error	176	IntegerT_16		
Error Counter Internal Error	177	IntegerT_16		
Max. Temperature Controller Board	178	Float32T		
Max. Temperature Encoder	179	Float32T		
Max. Temperature Power Unit	180	Float32T		
Reserved	181	Float32T		
Max. Temperature Motor	182	Float32T		

Cycle Stamp Undervoltage Logic	183	IntegerT_32		
Cycle Stamp Overvoltage Logic	184	IntegerT_32		
Cycle Stamp Undervoltage Power	185	IntegerT_32		
Cycle Stamp Overvoltage Power	186	IntegerT_32		
Cycle Stamp Undertemperature Micro Controller	187	IntegerT_32		
Cycle Stamp Overtemperature Micro Controller	188	IntegerT_32		
Cycle Stamp Undertemperature Controller Board	189	IntegerT_32		
Cycle Stamp Overtemperature Controller Board	190	IntegerT_32		
Cycle Stamp Undertemperature Encoder Board	191	IntegerT_32		
Cycle Stamp Overtemperature Encoder Board	192	IntegerT_32		
Cycle Stamp Overtemperature Power Stage Phase U	193	IntegerT_32		
Cycle Stamp Overtemperature Power Stage Phase V	194	IntegerT_32		
Cycle Stamp Overtemperature Power Stage Phase W	195	IntegerT_32		
Cycle Stamp Overtemperature Motor Phase U	196	IntegerT_32		
Cycle Stamp Overtemperature Motor Phase V	197	IntegerT_32		
Cycle Stamp Overtemperature Motor Phase W	198	IntegerT_32		
Cycle Stamp Controller Error	199	IntegerT_32		
Cycle Stamp Internal Error	202	IntegerT_32		
Operating Hours	203	IntegerT_32		

10 Appendix

10.1 Firmware Version History

Version	Release date	Description of changes	Compatible IODD
2.01.01	03.05.2022	Erster Release	Cyltronic-CTC-060-***-20220322-IODD1.1
2.03.01	10.08.2022	New Features: - New Device ID (separate ID per spindle pitch) - Force in "free positioning mode" now defined via "Max. force free positioning" instead of "Max. force" and potentiometer Essential Bugfixes: - Improved saving of parameters - Behavior in UserModeOff improved (no more disturbances by DIOs) - Timing behavior in Basic Mode (Modes 0 and 1) improved - Quieter position controller	From Cyltronic-CTC-060-***-20220719-IODD1.1
2.03.03	30.08.2022	Essential Bugfixes: - Improved saving of parameters - Bugfix at transition between modes 2 and 5/6 to 3 and 4 - Bugfix when homing with DIOs	From Cyltronic-CTC-060-***-20220719-IODD1.1
2.04.07	07.02.2023	New Features: - Controller with Pathplaner - Tracking Error - UserMode 11-14 & 21-27: Positioning Sequences & Press-In Mode - UserMode 7: Manual Referencing - Compatible for CTL Essential Bugfixes: - Prozessvariable Actual Force wird neu aus Ist-Strom gerechnet und nicht aus Soll-Strom - Process variable Actual Force is now calculated through actual current instead of target current - Application Reset fixed for CTC K05 and for CTL K05/10 - Loss of Parameters fixed	From Cyltronic-CTC-060-***-20230207-IODD1.1

10.2 List of figures