Operating Manual

motrona®
automation technology

Signal converter
IO222 and IO222/CO
Incremental → IO – Link (V1.1)

Product Features:

- 1x incremental input for "A/Bx90" signals or 2x incremental inputs for individual tracks (A and B channel)
- Universal incremental inputs (HTL/TTL/RS422) for NPN/PNP/NAMUR encoders and sensors
- Operating modes as frequency converter or position converter (pulse counter) possible
- Useful functions such as links (e.g. A+B), filters, round-loop function, ... can be activated
- Wire break monitoring for differential input signals
- Simple device parameterization possible via IO-Link using various engineering tools
- Adjustable limit value monitoring possible
- Numerous connection options via expansion option (IO222/CO) (three additional control inputs and two additional control outputs)
- Generation of pending events (z.B. Oberer Grenzwert überschritten, Encoder Error, …) möglich
- Auxiliary voltage output 5 and 24VDC for encoder supply
- Compact rail housing to EN60715

Available Options:

IO222:	Basic device with incremental input and auxiliary voltage output
IO222/CO:	Basic device with incemental input, auxiliary voltage output, 3x HTL PNP control inputs and 2x PNP control outputs

Die deutsche Beschreibung ist verfügbar unter:
https://www.motrona.com/fileadmin/files/bedienungsanleitungen/lo222_d.pdf

The English description is available at:
https://www.motrona.com/fileadmin/files/bedienungsanleitungen/lo222_e.pdf

La description en français est disponible sur:
https://www.motrona.com/fileadmin/files/bedienungsanleitungen/lo222_f.pdf

The operator software OS (freeware) is available at:
https://www.motrona.com/en/support/software.html

Version:	Description:
lo222_01a_oi/tgo/mbo/Apr-24	First version

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1. Safety Instructions and Responsibility

1.1. General Safety Instructions

This operation manual is a significant component of the unit and includes important rules and hints about the installation, function and usage. Non-observance can result in damage and/or impairment of the functions to the unit or the machine or even in injury to persons using the equipment!

Please read the following instructions carefully before operating the device and <u>observe all safety and warning instructions!</u> Keep the manual for later use.

A pertinent qualification of the respective staff is a fundamental requirement in order to use this manual. The unit must be installed, connected and put into operation by a qualified electrician.

Liability exclusion: The manufacturer is not liable for personal injury and/or damage to property and for consequential damage, due to incorrect handling, installation and operation. Further claims, due to errors in the operation manual as well as misinterpretations are excluded from liability.

In addition, the manufacturer reserves the right to modify the hardware, software or operation manual at any time and without prior notice. Therefore, there might be minor differences between the unit and the descriptions in operation manual.

The raiser respectively positioner is exclusively responsible for the safety of the system and equipment where the unit will be integrated.

During installation or maintenance all general and also all country- and application-specific safety rules and standards must be observed.

If the device is used in processes, where a failure or faulty operation could damage the system or injure persons, appropriate precautions to avoid such consequences must be taken.

1.2. Use according to the intended purpose

The unit is intended exclusively for use in industrial machines, constructions and systems. Non-conforming usage does not correspond to the provisions and lies within the sole responsibility of the user. The manufacturer is not liable for damages which have arisen through unsuitable and improper use.
Please note that device may only be installed in proper form and used in a technically perfect condition (in accordance to the Technical Specifications). The device is not suitable for operation in explosion-proof areas or areas which are excluded by the EN 61010-1 standard.

1.3. Installation

The device is only allowed to be installed and operated within the permissible temperature range. Please ensure an adequate ventilation and avoid all direct contact between the device and hot or aggressive gases and liquids.

Before installation or maintenance, the unit must be disconnected from all voltage-sources. Further it must be ensured that no danger can arise by touching the disconnected voltage-sources.

Devices which are supplied by AC-voltages must be connected exclusively by switches, respectively circuit-breakers with the low voltage network. The switch or circuit-breaker must be placed as near as possible to the device and further indicated as separator.

Incoming as well as outgoing wires and wires for extra low voltages (ELV) must be separated from dangerous electrical cables (SELV circuits) by using a double resp. increased isolation.

All selected wires and isolations must be conformed to the provided voltage- and temperature-ranges. Further all country- and application-specific standards, which are relevant for structure, form and quality of the wires, must be ensured. Indications about the permissible wire cross-sections for wiring are described in the Technical Specifications.

Before first start-up it must be ensured that all connections and wires are firmly seated and secured in the screw terminals. All (inclusively unused) terminals must be fastened by turning the relevant screws clockwise up to the stop.

Overvoltages at the connections must be limited to values in accordance to the overvoltage category II.

1.4. EMC Guidelines

All motrona devices are designed to provide high protection against electromagnetic interference. Nevertheless you must minimize the influence of electromagnetic noise to the device and all connected cables.

Therefore the following measures are mandatory for a successful installation and operation:

- **Use shielded cables for all signal and control input and output lines.**
- **Cables for digital controls (digital I/O, relay outputs) must not exceed a length of 30 m and are allowed for in building operation only**
- Use shield connection clamps to connect the cable shields properly to earth
- The wiring of the common ground lines must be star-shaped and common ground must be connected to earth at only one single point
- The device should be mounted in a metal enclosure with sufficient distance to sources of electromagnetic noise.
- Run signal and control cables apart from power lines and other cables emitting electromagnetic noise.

Please also refer to motrona manual "General Rules for Cabling, Grounding, Cabinet Assembly". You can download that manual by the link
https://www.motrona.com/en/support/general-certificates.html

1.5. Cleaning, Maintenance and Service Notes

To clean the front of the unit please use only a slightly damp (not wet!), soft cloth. For the rear no cleaning is necessary. For an unscheduled, individual cleaning of the rear the maintenance staff or assembler is self-responsible.

During normal operation no maintenance is necessary. In case of unexpected problems, failures or malfunctions the device must be shipped for back to the manufacturer for checking, adjustment and reparation (if necessary). Unauthorized opening and repairing can have negative effects or failures to the protection-measures of the unit.

2. Introduction

The device can be used as a signal converter for incremental encoders. The recorded position values or the recorded frequencies of both channels as well as their linked measurement results (e.g. A+B) are cyclically transmitted as process values via IO link. If desired, helpful functions such as the round-loop function or filters can also be activated.

The "CO" expansion option also has three HTL PNP control inputs and two PNP switching outputs. The switching outputs can be used to signal that limit values set by the user have been exceeded or not reached.
The current status of the digital inputs and outputs is also transmitted cyclically with the process input data, so that a wide variety of requirements can be covered here.

In addition, any pending events (e.g. lower limit value exceeded, wire break...) can be generated if this is desired by the user. The individual device parameters can be set and saved using various engineering tools or during operation via IO-Link. The supported "data storage" mechanism makes device replacement easy and hassle-free.

2.1.   Operating Mode

Basically, all functions have to be configured in the parameter menu. The device can be used in the following operating modes:

- Operation as a frequency converter for incremental input signals
- Operation as a position converter / counter for incremental input signals

2.2. Function diagram
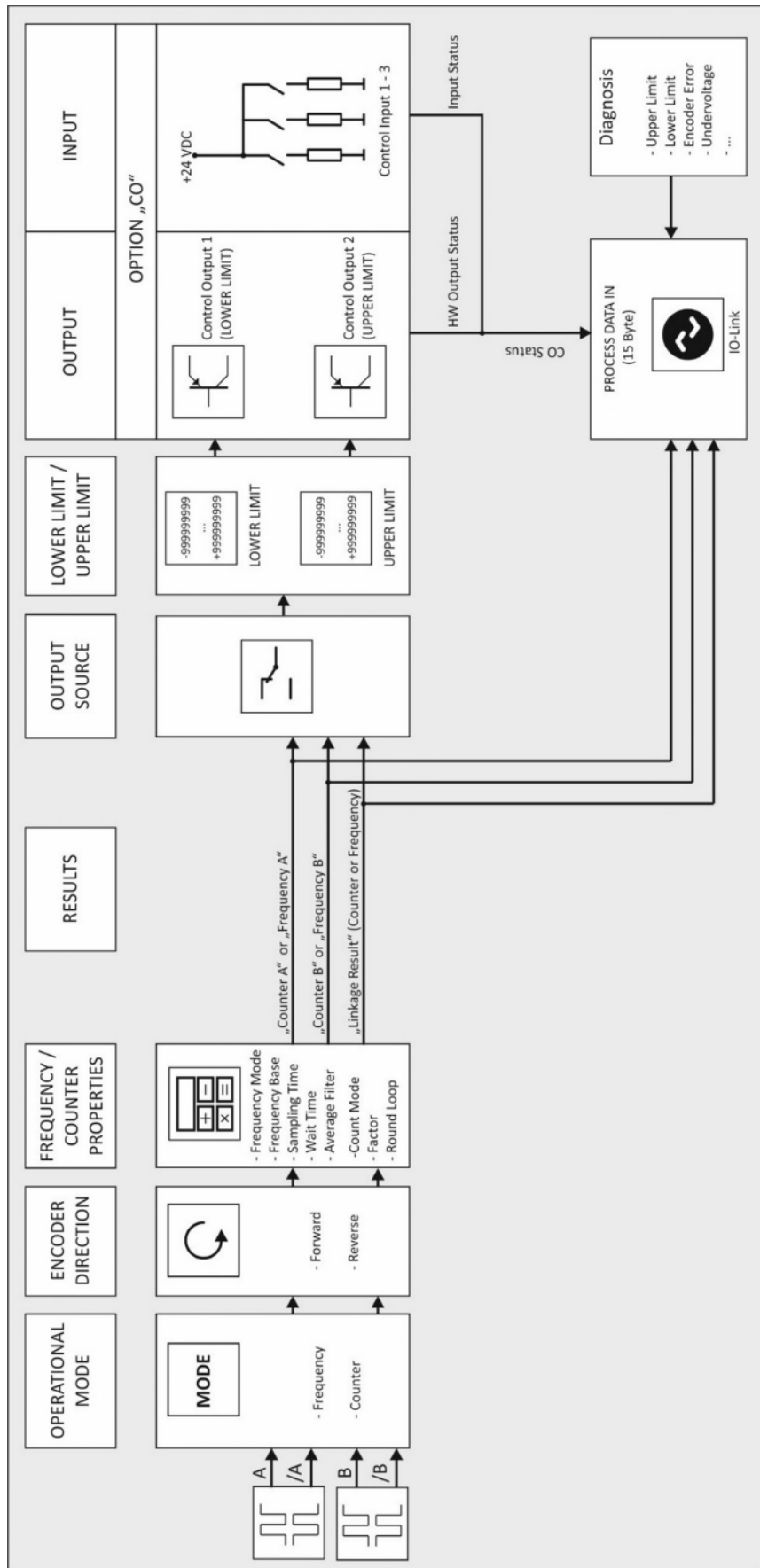
3. Electrical Connections

The terminal screws should be tightened with a slotted screwdriver (blade width 2mm).

The connections table shown in the figure:

	X1	X2	X3	X4	X5	USB
IO220 & IO220/CO	*	*				
IO221 & IO221/CO	*		*			
IO222 & IO222/CO	*			*		
IO223 & IO223/CO	*				*	
IO224/CO	*	*	*	*	*	*
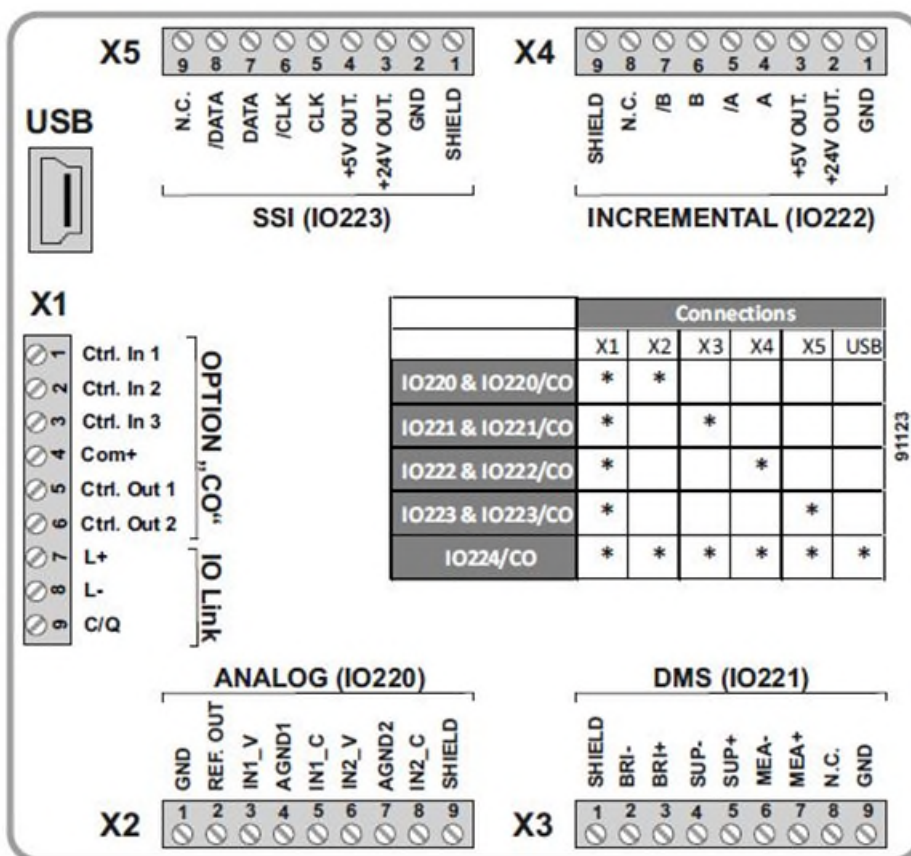
3.1. DC Power Supply

The unit accepts DC supply from 18 to 30 V at the terminals X1 pins 7 (+) and 8 (-). The power consumption depends on the level of the supply voltage with approx. 75 mA (at 24V).

All GND terminals are internally interconnected.

3.2. Auxiliary Voltage Output

A short-circuit-proof 24 VDC resp. 5VDC auxiliary voltage is available at terminal X4 pins 1, 2 and 3, which can be used as an encoder supply, for example. The 24 VDC output voltage depends on the device supply. The maximum current load capacity of the auxiliary voltage output can be found in the technical data in the appendix.

3.3. Incremental Encoder Input

Terminal X4 pins 4, 5, 6 and 7 provide a connection for various incremental signals.

RS422
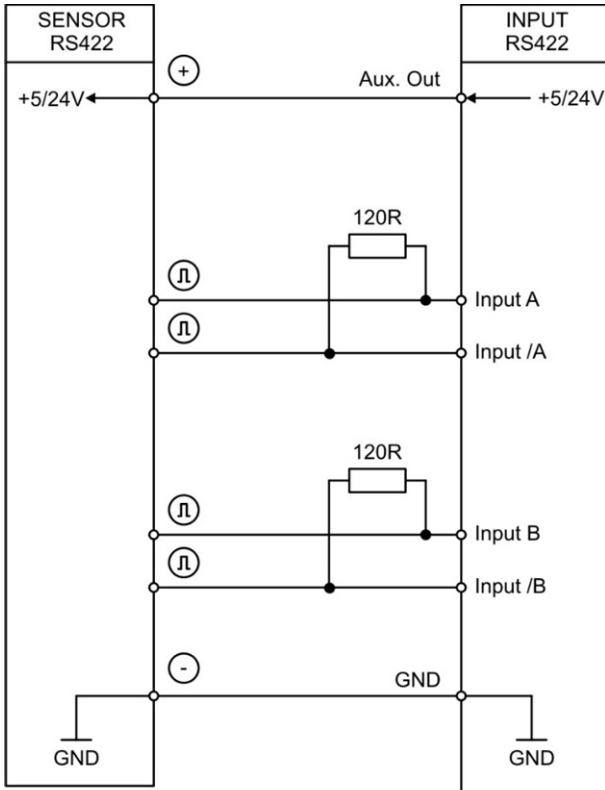
HTL DIFFERENTIAL
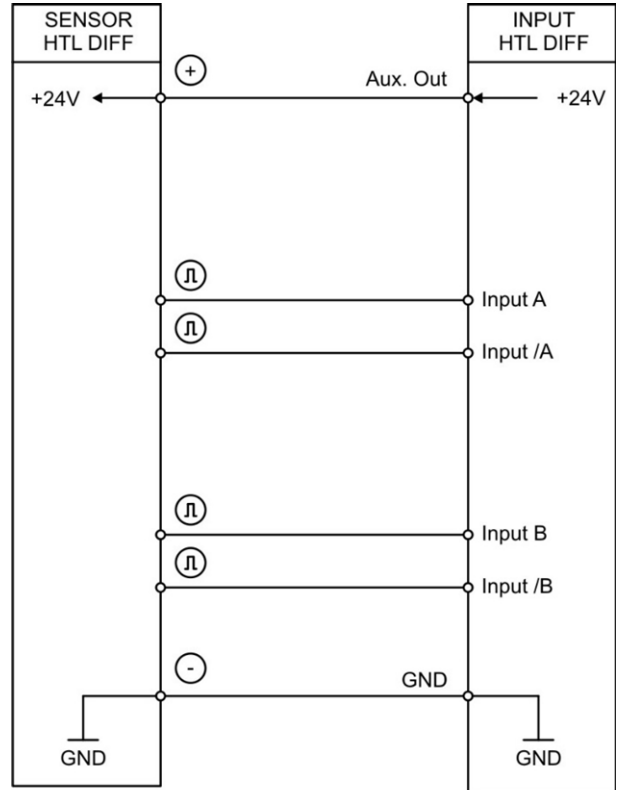
HTL PNP
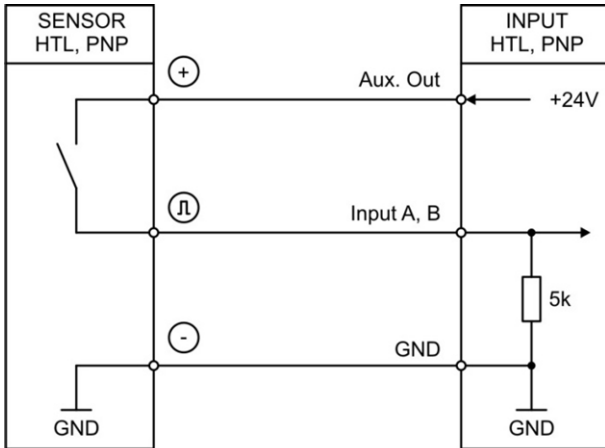
HTL NPN
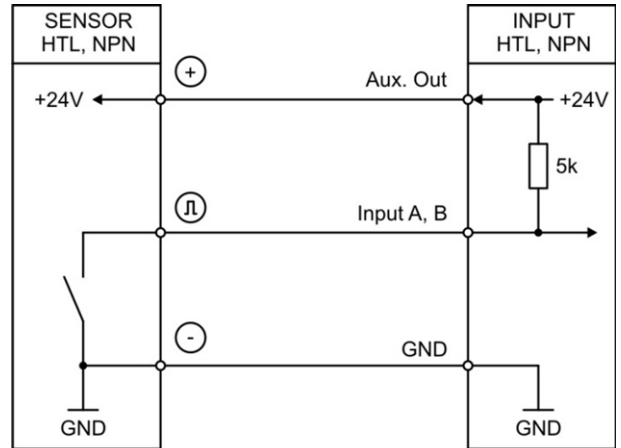
Continuation "**Incremental Encoder Input**":
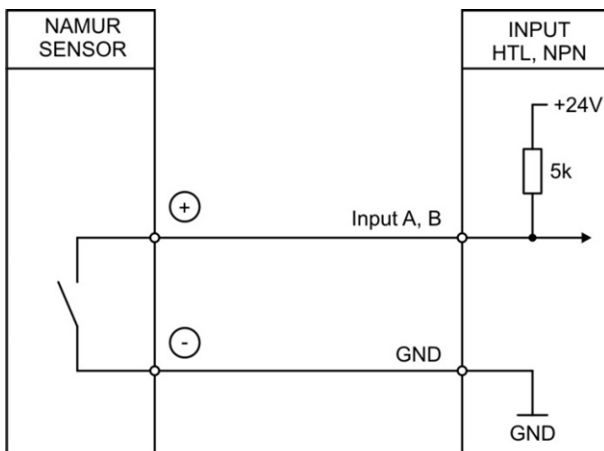
HTL NPN (NAMUR)　　　　　　　　　　　　　TTL (PNP)
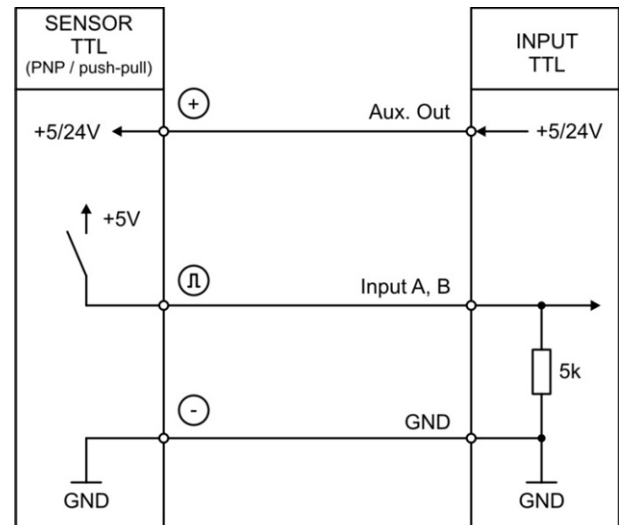
The desired input characteristic can be set using the "*ENCODER PROPERTIES*" parameter.

Unconnected PNP inputs are always "LOW" and unconnected NPN inputs are always "HIGH".
All inputs are designed to receive impulses from electrical impulse sources.

Notice for wire break monitoring:
For a safe wire break monitoring, the differential inputs A and /A as well as B and /B must be terminated with a suitable resistor (e.g. 120 Ohm). Otherwise, safe wire break detection is not guaranteed.

Notice for mechanical switching contacts:
When exceptionally mechanical contacts are used, please connect an external capacitor between GND (-) and the corresponding input (+). A capacity of 10 µF will reduce the input frequency to
20 Hz and miscounting due to contact bouncing will be eliminated

3.4. Control Inputs (only with option "CO")

At terminal X1 pins 1, 2 and 3 there are three control inputs with HTL PNP characteristic available. The current status of the control inputs is exchanged cyclically with the process data and can therefore be used for a wide variety of functions (e.g. as a trigger signal to initiate a "system command" or to read out current actual values).

Wiring of control inputs:
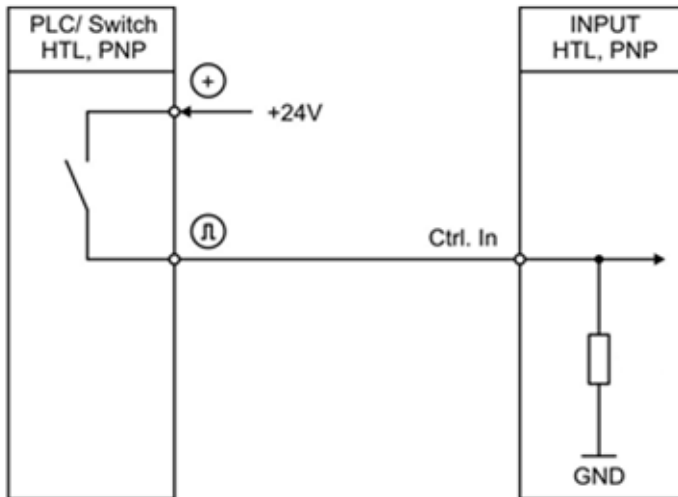
	Unconnected control inputs are always "LOW". All inputs are designed to receive impulses from an electronic impulse source.
	Notice for mechanical switching contacts: When exceptionally mechanical contacts are used, please connect an external capacitor between GND (-) and the corresponding input (+). A capacity of 10 µF will reduce the input frequency to 20 Hz and miscounting due to contact bouncing will be eliminated.

3.5. Control Outputs (only with option "CO")

Two control outputs are available on terminal X1, pins 5 and 6. These signal, when limit values defined by the user have been undercut or exceeded. Control output 1 always reacts as soon as the lower limit value is undercut. Control output 2 always reacts as soon as the upper limit value has been exceeded.

⚠️ 👉	**Notice:** Which process value is to be used for this monitoring can be set using the "OUTPUT SOURCE" parameter in the "GENERAL MENU"

These outputs Ctrl. Out 1 and 2 are designed as high side drivers. The status of the outputs is also transmitted cyclically with the IO-Link process data.

The switching voltage is determined by the external voltage supplied to terminal X1 pin 4 (COM+) External damping measures are recommended for switching inductive loads.

Connection of the control outputs:
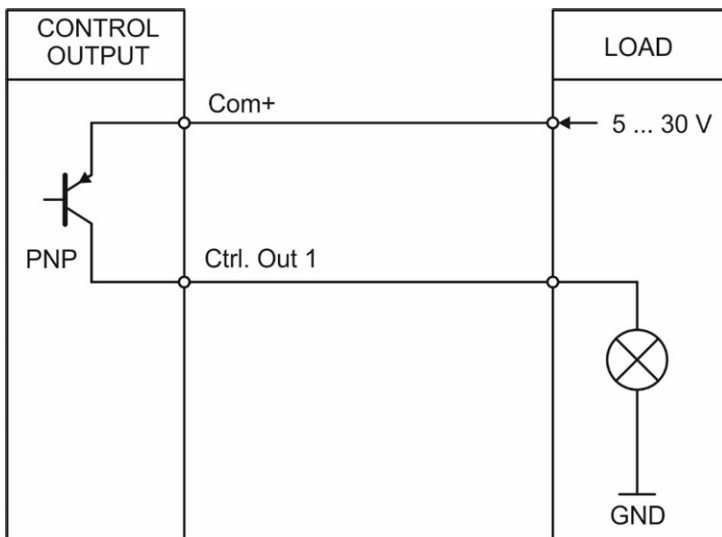
3.6. IO-Link Interface

This chapter contains important notes and information regarding IO-Link communication data. In addition to general information on the IO-Link connection, the parameter data of the device, the exchanged process data and the implemented system commands, error codes and events are discussed.

3.6.1. Useable IO Link masters

All IO-Link masters that support IO-Link Standard V1.1

3.6.2. Communications data

Parameters	Values
Communication speed	COM 3
Transmission rate	230,4 kbit/s
IO-Link Revision	V1.1
Cycle time	min. 2 ms
Port class	Class A

3.6.3. Features

Feature	Supports
Block parametrization	Yes
Data Storage	Yes
Events	Yes
SIO Mode	No

3.6.4. Front LED

In the case of devices <u>without</u> the "CO" option, the green LED on the front is used exclusively as a ready-to-operate display. As soon as a supply voltage has been applied to the device, it lights up continuously.

For devices <u>with the extended "CO" option</u>, the green LED on the front serves as a ready-to-operate display. It also signals the current IO-Link system status.

LED lights up continuously:
The device is connected to the supply voltage and there is no IO-Link communication.The device is in "START UP MODE".

LED flashes at 0.5 Hz:
Device is connected to the supply voltage and IO-Link communication is currently in "PREOPERATE MODE" (no cyclic data exchange takes place).

LED flashes at 1 Hz cycle:
The device is connected to the supply voltage and IO-Link communication is currently in "OPERATE MODE" (cyclic data exchange is taking place).

3.6.5. Connection of the IO Link interface

An interface for connecting to an IO-Link master port is available on terminal X1 pin 7 (*L-*), 8 (*L+*) and 9 (*C/Q*).

Figure 1 shows the pin assignment of a standard M12 connector plug.
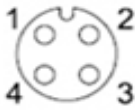
Assignment			
	Pin 1		Clamp L+
	Pin 2		Not connected
	Pin 3		Clamp L-
	Pin 4		IO-Link data line, C/Q

Fig.. 1: Pin assignement M12 connection plug r

Pin	Wire color
1 (L+)	brown
2 (n.c.)	white
3 (L-)	blue
4 (C/Q)	black

3.6.6. Parameter data

ISDU Index	DPP1 Index	Name of the Parameter	Access	Length in bytes	Default Value	Range
Identification Menu						
	7	VendorID	R	2	980 / 0x 03D4	-
	8					
	9	Device ID	R	3	2294017 / 0x230101	-
	10					
	11					
16		Vendor Name	R	12	motrona GmbH	-
17		Vendor Text	R	21	http://www.motrona.com	-
18		Product Name	R	15	signalconverter	-
19		Product ID	R	8	IO222 or IO222/CO	-
20		Product Text	R	44	Incremental converter with IO-Link interface	-
21		Serial Number	R	9	-	-
22		Hardware Revision	R	7	e.g.: 224IO11	-
23		Firmware Revision	R	8	e.g.: IO22201A	-
24		Application Specific Tag	R/W	Max. 32	***	-
36		Device Status	R	1	0x00	0: Device is working properly 1: Maintenance required 2: Out of specification 3: functional test 4: Error 5-255: Reserved
40		Prozess Data Input	R	15	-	-

ISDU Index	DPP1 Index	Name of the Parameter	Access	Length in bytes	Default Value	Range
		GENERAL MENU				
278		OPERATIONAL MODE	R/W	4	0	0..1
279		ENCODER PROPERTIES	R/W	4	0	0..4
280		ENCODER DIRECTION	R/W	4	0	0..1
281		BACKUP MEMORY	R/W	4	1	0..1
282		LOWER LIMIT	R/W	4	0	-999999999 .. +999999999
283		UPPER LIMIT	R/W	4	+999999999	-999999999 .. +999999999
284		DIAGNOSIS SETUP	R/W	4	0 (0x00)	0..4095
285		OUTPUT SOURCE	R/W	4	0	0..2
		FREQUENCY MENU				
258		FREQUENCY MODE	R/W	4	0	0..5
259		FREQUENCY BASE	R/W	4	1	0...3
260		SAMPLING TIME 1 (s)	R/W	4	1	1..9999
261		WAIT TIME 1 (s)	R/W	4	100	1..7999
262		AVERAGE FILTER 1	R/W	4	0	0..16
263		SAMPLING TIME 2 (s)	R/W	4	1	1..9999
264		WAIT TIME 2 (s)	R/W	4	100	1..7999
265		AVERAGE FILTER 2	R/W	4	0	0..16
		COUNTER MENU				
269		COUNT MODE	R/W	4	3	0..5
270		FACTOR A	R/W	4	100000	1..9999999
271		SET VALUE A	R/W	4	0	-999999999 .. +999999999
272		FACTOR B	R/W	4	100000	1..9999999
273		SET VALUE B	R/W	4	0	-999999999 .. +999999999
274		ROUND LOOP VALUE	R/W	4	0	0 .. +999999999

3.6.7. System Commands

> A system command is a write-only parameter that causes an action in the device. To invoke the desired action, the corresponding value must be written to **index 2, subindex 0**. If the desired command is a static command (s), this command remains active until the corresponding value is written again to index 2, subindex 0. By resending the command, the action is terminated.

Predefined commands

Name	Index	Subindex	Valuet	Description of the action	dynamic (d) / static (s)
RESTORE FACTORY SETTINGS	2	0	130	Resets <u>all</u> parameters to factory settings.	(d)
APPLICATION RESET	2	0	129	Resets all device parameters to "default values".	(d)

Application specific commands

Name	Index	Subindex	Value	Description of the action	dynamic (d) / static (s)
CLEAR MIN/MAX VALUES	2	0	160	Reset of the Min. / Max. values.	(d)
RESET / SET A	2	0	162	Reset / set the counter value of channel A to the value set in SET VALUE A.	(d)
RESET / SET B	2	0	163	Reset / set the counter value of channel B to the value set in SET VALUE B.	(d)
RESET / SET	2	0	164	Reset / set of both counter values (channel A and B) to the values set in SET VALUE A and B.	(d)
LOCK COUNTER A	2	0	165	Counter (channel A) is locked and does not count any further pulses as long as this command is present.	(s)
LOCK COUNTER B	2	0	166	Counter (channel B) is locked and does not count any further pulses as long as this command is present.	(s)
STORE EEPROM	2	0	168	The current parameter settings are saved non-volatile.	(d)

3.6.8. IO-Link Process data

Process input data (Total: 15 Byte):

Bit	Byte	Subindex	Description
Bit 0	Byte 14	1	**Diagnosis:** Upper set threshold (Upper Limit) exceeded
Bit 1		2	**Diagnosis:** Below the lower set threshold value (Lower Limit)
Bit 2		3	**Diagnosis:** Device supply undervoltage (< 17 V)
Bit 3		4	**Diagnosis:** Out of the measuring range – "Linkage Result (Frequency)" (> 999999999 bzw. < --999999999)
Bit 4		5	**Diagnosis:** Out of the measuring range – "Frequency A" (> 999999999 bzw. < --999999999)
Bit 5		6	**Diagnosis:** Out of the measuring range – "Frequency B" (> 999999999 bzw. < --999999999)
Bit 6		7	**Diagnosis:** Out of the measuring range – "Linkage Result (Counter)" (> 999999999 bzw. < --999999999)
Bit 7		8	**Diagnosis:** Out of the measuring range – "Counter A" (> 999999999 bzw. < --999999999)
Bit 0	Byte 13	9	**Diagnosis:** Out of the measuring range – "Counter B" (> 999999999 bzw. < --999999999)
Bit 1		10	**Diagnosis:** Wire break detected (MAX14890)
Bit 2		11	**Diagnosis:** Maximum frequency (channel A) with exponential filter
Bit 3		12	**Diagnosis:** Maximum frequency (channel B) with exponential filter
Bit 4		13	**Diagnosis:** Reserved
Bit 5		14	**Diagnosis:** Reserved
Bit 6		15	**Diagnosis:** Reserved
Bit 7		16	**Diagnosis:** Reserved
Bit 0	Byte 12	17	**Input State:** Control Input 1 (0: OFF / 1: ON)
Bit 1		18	**Input State:** Control Input 2 (0: OFF / 1: ON)
Bit 2		19	**Input State:** Control Input 3 (0: OFF / 1: ON)
Bit 3		20	**HW Output State:** Control Output 1 (0: OFF / 1: ON)
Bit 4		21	**HW Output State:** Control Output 2 (0: OFF / 1: ON)
Bit 5		22	Reserved
Bit 6		23	Reserved
Bit 7		24	Reserved
-	Byte 8..11	25	Process value 3: „Frequency B" - (**Daten type: Float32**) or „Counter B" - (**Data type: Int32**)
-	Byte 4..7	26	Process value 2: „Frequency A" - (**Data type: Float32**) or „Counter A" - (**Data type: Int32**)
-	Byte 0..3	27	Process value 1: „Linkage Result (Frequency)" - (**Data type: Float32**) or „Linkage Result (Counter)" - (**Data type: Int32**) (Combined measurement result of both channels e.g. Frequency A + Frequency B

The acyclic request address of the process input data is **index 40**. The corresponding **subindex** and the corresponding **data type** of the desired value that is to be read can be found in the table above.

Note on the transmitted process values (Byte 0…11):

Depending on the operating mode setting (*"OPERATIONAL MODE"* parameter), either the frequency results or the counter results are transmitted cyclically as process data.

3.6.9. Error types

Error code	Name	Description
32768 / 0x 8000	Application errors in the device-no details	Access was denied by the device. No detailed information is available.
32785 / 0x 8011	Index does not exist	Access to a non-existent index.
32786 / 0x 8012	Subindex does not exiat	Access to a non-existent subindex.
32800 / 0x 8020	Service not available at this time	The parameter cannot be accessed at this moment. The device does not allow this in the current state.
32803 / 0x 8023	Access denied	Write access to a read-only parameter.
32816 / 0x 8030	Parameter value out of range	Parameter value is outside the allowed range of values.
32817 / 0x 8031	Parameter value greater than specified range	The written parameter value is greater than the specified value range.
32818 / 0x 8032	Parameter value less than specified range	The written parameter value is smaller than the specified value range.
32819 / 0x 8033	Parameter length too large	Parameter length is greater than allowed.
32820 / 0x 8034	Parameter length too small	Parameter length is less than allowed.
32821 / 0x 8035	Function not available	The device does not support the command.
32822 / 0x 8036	Function not available at this time	The command is not supported by the device in its current state.
32832 / 0x 8040	Invalid parameter set	Written single parameter value collides with the other parameter settings.
32833 / 0x 8041	Inconsistent parameter set	Inconsistencies were detected at the end of the block parameter transfer. The device plausibility check failed.
32898 / 0x 8082	Application not ready	Access was denied because the device is not ready.

3.6.10. Events

Code	Type	Device State	Condition
0x180E	Warning	0x00	**Diagnosis:** Upper set threshold (Upper Limit) exceeded
0x180F	Warning	0x00	**Diagnosis**: Below the lower set threshold value (Lower Limit
0x180C	Warning	0x02	**Diagnosis:** Device supply undervoltage (< 17 V)
0x1810	Warning	0x02	**Diagnosis:** Out of the measuring range – "Linkage Result (Frequency)" (> +999999999 bzw. < -999999999)
0x1811	Warning	0x02	**Diagnosis:** Out of the measuring range – "Frequency A" (> +999999999 bzw. < -999999999)
0x1812	Warning	0x02	**Diagnosis:** Out of the measuring range – "Frequency B" (> +999999999 bzw. < -999999999)
0x1813	Warning	0x02	**Diagnosis:** Out of the measuring range – "Linkage Result (Counter)" (> +999999999 bzw. < -999999999)
0x1814	Warning	0x02	**Diagnosis:** Out of the measuring range – "Counter A" (> +999999999 bzw. < -999999999)
0x1815	Warning	0x02	**Diagnosis:** Out of the measuring range – "Counter B" (> +999999999 bzw. < -999999999)
0x1816	Warning	0x02	**Diagnosis:** Maximum frequency (channel A) with exponential filter
0x1817	Warning	0x02	**Diagnosis:** Maximum frequency (channel B) with exponential filte
0x1853	Error	0x04	**Diagnosis:** Wire break detected (MAX14890)
0x8D68	Error	0x00	Device Test – Error (For test purposes only!))
0x8D04	Warning	0x00	Device Test – Warning (For test purposes only!)

4. Parameter / Overview – Menu Structure

The device is parameterized via the IO-Link interface using a suitable engineering tool, which is usually provided by the IO-Link master manufacturers.

This section shows the overview of the individual menus and their parameters. The menu name is written in bold, the associated parameters are arranged directly under the menu name

Menu / Parameter
GENERAL MENU
OPERATIONAL MODE
ENCODER PROPERTIES
ENCODER DIRECTION
BACKUP MEMORY
LOWER LIMIT
UPPER LIMIT
DIAGNOSIS SETUP
OUTPUT SOURCE
FREQUENCY MENU
FREQUENCY MODE
FREQUENCY BASE
SAMPLING TIME 1 (S)
WAIT TIME 1 (S)
AVERAGE FILTER 1
SAMPLING TIME 2 (S)
WAIT TIME 2 (S)
AVERAGE FILTER 2
COUNTER MENU
COUNT MODE
FACTOR A
SET VALUE A
FACTOR B
SET VALUE B
ROUND LOOP VALUE

4.1. General Menu

The general parameters for this signal converter are described in this menu.

OPERATIONAL MODE		
This parameter specifies the selected measuring function.		
0	FREQUENCY	Operating mode: frequency converter
2	COUNTER	Operating mode: counter / position

ENCODER PROPERTIES		
This parameter specifies the characteristics of the incremental input.		
0	RS422	RS422 Standard
1	HTL DIFFERENTIAL	HTL differential
2	HTL PNP	PNP (switch to +)
3	HTL NPN	NPN (switch to -)
4	TTL PNP	TTL PNP (switch to +)

ENCODER DIRECTION		
This parameter reverses the counting or traversing direction.		
0	FORWARD	Forward
1	REVERSE	Reverse

BACKUP MEMORY		
Saves the actual value of the counter readings in case of power failure.		
0	NO	No back up memory –up by power failure
1	YES	Back up memory is active.

LOWER LIMIT		
This parameter defines the <u>lower</u> limit. (The reference source for limit value monitoring can be set using the "OUTPUT SOURCE" parameter.)		
	-999999999	Smallest value
	0	Default value
	+999999999	Highest value

If the value set here is <u>underrun</u>, control output 1 is set, the corresponding bit is set in the "Diagnosis Word" of the cyclic process data and, if necessary, an "Event Appears" is generated (provided that the generation of this event was previously activated accordingly in "DIAGNOSIS SETUP").

Continuation "**General Menu**":

UPPER LIMIT
This parameter defines the <u>upper</u> limit.
(The reference source for limit value monitoring can be set using the "OUTPUT SOURCE" parameter.)

	-999999999	Smallest value
	+999999999	Default value
	+999999999	Highest value

> If the value set here is <u>exceeded</u>, control output 2 is set, the corresponding bit is set in the "Diagnosis Word" of the cyclic process data and, if necessary, an "Event Appears" is generated (provided that the generation of this event was previously activated accordingly in "DIAGNOSIS SETUP").

DIAGNOSIS SETUP
This parameter can be used to specify which "<u>events</u>" are to be generated by the device.

Corresponding bit = 1→ associated event is generated as soon as the event is pending (appears) or is no longer pending (disappears).
Corresponding bit = 0 → associated event is <u>not</u> generated.

Min:	0x0000
Default:	0x0000
Max:	0x0FFF

Bit 0	0	Upper set threshold (Upper Limit) exceeded
Bit 1	0	Below the lower set threshold value (Lower Limit)
Bit 2	0	Device supply undervoltage (< 17 V)
Bit 3	0	Out of the measuring range – "Linkage Result (Frequency)" (> +999999999 bzw. < -999999999)
Bit 4	0	Out of the measuring range – "Frequency A" (> +999999999 bzw. < -999999999)
Bit 5	0	Out of the measuring range – "Frequency B" (> +999999999 bzw. < -999999999)
Bit 6	0	Out of the measuring range – "Linkage Result (Counter)" (> +999999999 bzw. < -999999999)
Bit 7	0	Out of the measuring range – "Counter A" (> +999999999 bzw. < -999999999)
Bit 8	0	Out of the measuring range – "Counter B" (> +999999999 bzw. < -999999999)
Bit 9	0	Maximum frequency (channel A) with exponential filter
Bit 10	0	Maximum frequency (channel B) with exponential filter
Bit 11	0	Wire break detected (MAX14890)
Bit 12	0	Reserved
Bit 13	0	Reserved
Bit 14	0	Reserved
Bit 15	0	Reserved

> <u>Notice:</u>
> The "Diagnosis Word" in the cyclic process data (byte 9 + byte10) <u>always</u> shows which events are currently pending. Only the associated events can be switched on or off with the appropriate setting of this parameter.

Continuation "**General Menu**":

<table>
<tr><td colspan="3">**OUTPUT SOURCE**
This parameter defines the reference source to which the two switching outputs should react during limit value monitoring.</td></tr>
<tr><td>0</td><td>CHANEL A</td><td>Reference source is "Frequency A" or "Counter A" (depending on operating mode)</td></tr>
<tr><td>1</td><td>CHANEL B</td><td>Reference source is "Frequency B" or "Counter B" (depending on operating mode)</td></tr>
<tr><td>2</td><td>LINKAGE RESULT</td><td>Reference source "Linkage Result (Frequency)" or "Linkage Result (Counter)" depending on the selected operating mode (e.g. linked result of both channels e.g. A+B)</td></tr>
</table>

4.2. Frequency Menu

The individual parameters for "Frequency" mode are described in this menu. Depending on the set operating mode (frequency mode), only channel A or both channels (channel A <u>and</u> channel B) are active.

FREQUENCY MODE This parameter defines which operating mode of frequency measurement is required.		
0	A ONLY	Single-channel frequency measurement (only for channel A, channel B inactive) <u>Note:</u> Frequency resolution depending on the selected "FREQUENCY BASE"
1	RATIO	Frequency ratio of both channels (channel B / channel A). <u>Note:</u> Interpretation of the result "Linkage Result (Frequency)" with 4 decimal places in the format +/- x.xxxx
2	PERCENT	Percent deviation from channel B to channel A. <u>Note:</u> Interpretation of the result "Linkage Result (Frequency)" with 2 decimal places in the format +/- xxx.xx %
3	A + B	Frequency addition of both channels (channel A + channel B) <u>Note:</u> Frequency resolution depending on the selected "FREQUENCY BASE"
4	A - B	Frequency subtraction of both channels (channel A - channel B) <u>Note:</u> Frequency resolution depending on the selected "FREQUENCY BASE"
5	A/B x 90°	Frequency measurement with A/B x 90° signal. (Forward / reverse direction of rotation detection) <u>Note:</u> Frequency resolution depending on the selected "FREQUENCY BASE"

FREQUENCY BASE Setting the desired basis for the frequency measurement (resolution).		
	0	1 Hz (Interpretation of the result in the format: xxxxxxxx Hz)
	1	1/10 Hz (Interpretation of the result in the format: xxxxxxx.x Hz)
	2	1/100 Hz (Interpretation of the result in the format: xxxxx.xx Hz)
	3	1/1000 Hz (Interpretation of the result in the format: xxxxx.xxx Hz)

Continuation "**Frequency Menu**":

SAMPLING TIME 1 (S)		
The set value corresponds to the minimum measuring time (for channel A) in seconds. The sampling time serves as a filter at irregular frequencies. This parameter directly influences the reaction time of the device.		
	0,001	Shortest sampling time in seconds
	0,100	Default value
	9,999	Longest sampling time in seconds

$$f = \frac{6}{T}$$

Sampling Time (Setting)

T = Real Sampling Time

WAIT TIME 1 (S)		
This parameter defines the period time of the lowest frequency, accordingly the time between two rising signal edges on channel A detecting frequency 0 Hz. Frequencies with a period time higher than the set "WAIT TIME 1" will be detected as frequency = 0 Hz.		
	0,01	Frequency = 0 Hz, for frequencies below 100 Hz
	1,00	Default value
	79,99	Frequency = 0 Hz, for frequencies below ~0,01 Hz

Wait Time

f

f = "0"

t

Continuation "**Frequency Menu**":

AVERAGE FILTER 1

Selectable averaging or filter function for unstable frequencies at input A. At settings 5 to 16, the device uses an exponential function. The time constant T (63%) corresponds to the sampling cycles.

For example: If SAMPLING TIME = 0,1 s and AVERAGE FILTER = Exponential Filter, T (63 %) = 2 x Sampling Time, after 0,2 seconds, 63% of the step size are reached.

	0	No average value will be created (quick reaction to every change)
	1	2 numbers of floating average cycles
	2	4 numbers of floating average cycles
	3	8 numbers of floating average cycles
	4	16 numbers of floating average cycles
	5	Exponential filter, T (63 %) = 2x SAMPLING TIME
	6	Exponential filter, T (63 %) = 4x SAMPLING TIME
	7	Exponential filter, T (63 %) = 8x SAMPLING TIME
	8	Exponential filter, T (63 %) = 16x SAMPLING TIME
	9	Exponential filter, T (63 %) = 32x SAMPLING TIME
	10	Exponential filter, T (63 %) = 64x SAMPLING TIME
	11	Exponential filter, T (63 %) = 128x SAMPLING TIME
	12	Exponential filter, T (63 %) = 256x SAMPLING TIME
	13	Exponential filter, T (63 %) = 512x SAMPLING TIME
	14	Exponential filter, T (63 %) = 1024x SAMPLING TIME
	15	Exponential filter, T (63 %) = 2048x SAMPLING TIME
	16	Exponential filter, T (63 %) = 4096x SAMPLING TIME (very slow reaction)

Note:

When using the exponential filter, the maximum permissible frequencies at the input must not be exceeded due to an otherwise following data type overflow!

If the frequency is nevertheless exceeded, the frequency is replaced by the maximum permissible value (with corresponding setting) and the corresponding bit in the "Diagnostic Word" of the cyclic process data is set.

The maximum allowable frequencies are listed below for the associated settings.

		FREQUENCY BASE			
		[0] - 1 Hz	[1] - 1/10 Hz	[2] - 1/100 Hz	[3] - 1/1000 Hz
	[5] - 2x	1.073.741.823 Hz	107.374.182,3 Hz	10.737.418,23 Hz	1.073.741,823 Hz
	[6] - 4x	536.870.911 Hz	53.687.091,1 Hz	5.368.709,11 Hz	536.870,911 Hz
	[7] - 8x	268.435.455 Hz	26.843.545,5 Hz	2.684.354,55 Hz	268.435,455 Hz
	[8] - 16x	134.217.727 Hz	13.421.772,7 Hz	1.342.177,27 Hz	134.217,727 Hz
AVERAGE FILTER 1+2	[9] - 32x	67.108.863 Hz	6.710.886,3 Hz	671.088,63 Hz	67.108,863 Hz
	[10] - 64x	33.554.431 Hz	3.355.443,1 Hz	335.544,31 Hz	33.554,431 Hz
	[11] - 128x	16.777.215 Hz	1.677.721,5 Hz	167.772,15 Hz	16.777,215 Hz
	[12] - 256x	8.388.607 Hz	838.860,7 Hz	83.886,07 Hz	8.388,607 Hz
	[13] - 512x	4.194.303 Hz	419.430,3 Hz	41.943,03 Hz	4.194,303 Hz
	[14] - 1024x	2.097.151 Hz	209.715,1 Hz	20.971,51 Hz	2.097,151 Hz
	[15] - 2048x	1.048.575 Hz	104.857,5 Hz	10.485,75 Hz	1.048,575 Hz
	[16] - 4096x	524.287 Hz	52.428,7 Hz	5.242,87 Hz	524,287 Hz

Continuation "**Frequency Menu**":

SAMPLING TIME 2 (S)	
The set value corresponds to the minimum measuring time (for channel B) in seconds. The sampling time serves as a filter at irregular frequencies. This parameter directly influences the reaction time of the device.	

	0,001	Shortest Sampling time in seconds
	0,100	Default Wert
	9,999	Longest Sampling time in seconds

$$f = \frac{6}{T}$$
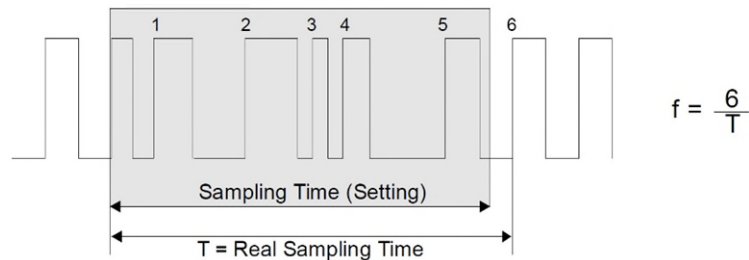
WAIT TIME 2 (S)	
This parameter defines the period time of the lowest frequency, accordingly the time between two rising signal edges on channel B detecting frequency 0 Hz. Frequencies with a period time higher than the set "WAIT TIME 2" will be detected as frequency = 0 Hz.	

	0,01	Frequency = 0 Hz, for frequencies below 100 Hz
	1,00	Default value
	79,99	Frequency = 0 Hz, for frequencies below ~0,01 Hz
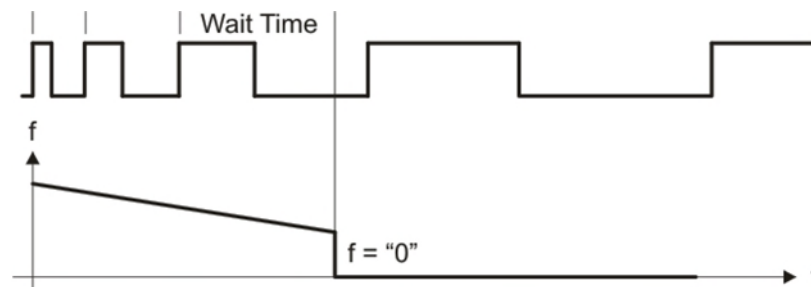
Continuation "**Mode Frequency**":

AVERAGE FILTER 2

Selectable averaging or filter function for unstable frequencies at input B. At settings 5 to 16, the device uses an exponential function. The time constant T (63%) corresponds to the sampling cycles.

For example: If SAMPLING TIME = 0,1 s and AVERAGE FILTER = Exponential Filter, T (63 %) = 2 x Sampling Time, after 0,2 seconds, 63% of the step size are reached.

	0	No average value will be created (quick reaction to every change)
	1	2 numbers of floating average cycles
	2	4 numbers of floating average cycles
	3	8 numbers of floating average cycles
	4	16 numbers of floating average cycles
	5	Exponential filter, T (63 %) = 2x SAMPLING TIME
	6	Exponential filter, T (63 %) = 4x SAMPLING TIME
	7	Exponential filter, T (63 %) = 8x SAMPLING TIME
	8	Exponential filter, T (63 %) = 16x SAMPLING TIME
	9	Exponentialfilter, T (63 %) = 32x SAMPLING TIME
	10	Exponential filter, T (63 %) = 64x SAMPLING TIME
	11	Exponential filter, T (63 %) = 128x SAMPLING TIME
	12	Exponential filter, T (63 %) = 256x SAMPLING TIME
	13	Exponential filter, T (63 %) = 512x SAMPLING TIME
	14	Exponential filter, T (63 %) = 1024x SAMPLING TIME
	15	Exponential filter, T (63 %) = 2048x SAMPLING TIME
	16	Exponential filter, T (63 %) = 4096x SAMPLING TIME (very slow reaction)

Note:

When using the exponential filter, the maximum permissible frequencies at the input must not be exceeded due to an otherwise following data type overflow!

If the frequency is nevertheless exceeded, the frequency is replaced by the maximum permissible value (with corresponding setting) and the corresponding bit in the "Diagnostic Word" of the cyclic process data is set.

The maximum permissible frequencies have already been listed in the AVERAGE FILTER 1 parameter and can be taken from there.

4.3. Counter Menu

In this menu, the operation is defined as a position transducer (pulse, sum, difference, up or down counter). Input A and B are active.

COUNT MODE			
Selecting the counter configuration			
	0	A SINGLE	Input A is a counting input. Input B defines the counting direction: „LOW" = forward / „HIGH" = reverse
	1	A + B	Sum counter: Impulses at A + Impulses at B
	2	A - B	Differential counter: Impulses at A – impulses at B
	3	A/B 90 x1	Quadrature counter: Pulses A, B with 2x90° offset (simple edge evaluation 1x)
	4	A/B 90 x2	Quadrature counter: Pulses A, B with 2x90° offset (double edge evaluation 2x)
	5	A/B 90 x4	Quadrature counter: Pulses A, B with 2x90° offset (quadruble edge evaluation 4x)

FACTOR A		
Scaling factor for input A.		
e.g. with a setting of 1.23456, the device displays the value 123456 after 100.000 input pulses.		
	0,00001	Smallest value
	1,00000	Default value
	99,99999	Highest value

SET VALUE A		
With a "RESET / SET COUNTER A" command, the counter of input A is set to this value.		
	-99999999	Smallest value
	0	Default value
	+99999999	Highest value

FACTOR B		
Scaling factor for input B.		
For example: A setting of factor 1.23456 and 100.000 input pulses will result in a value of 123456 for input B.		
	0,00001	Smallest value
	1,00000	Default value
	99,99999	Highest value

SET VALUE B		
With a "RESET / SET COUNTER B" command, the counter of input B is set to this value.		
	-99999999	Smallest value
	0	Default value
	+99999999	Highest value

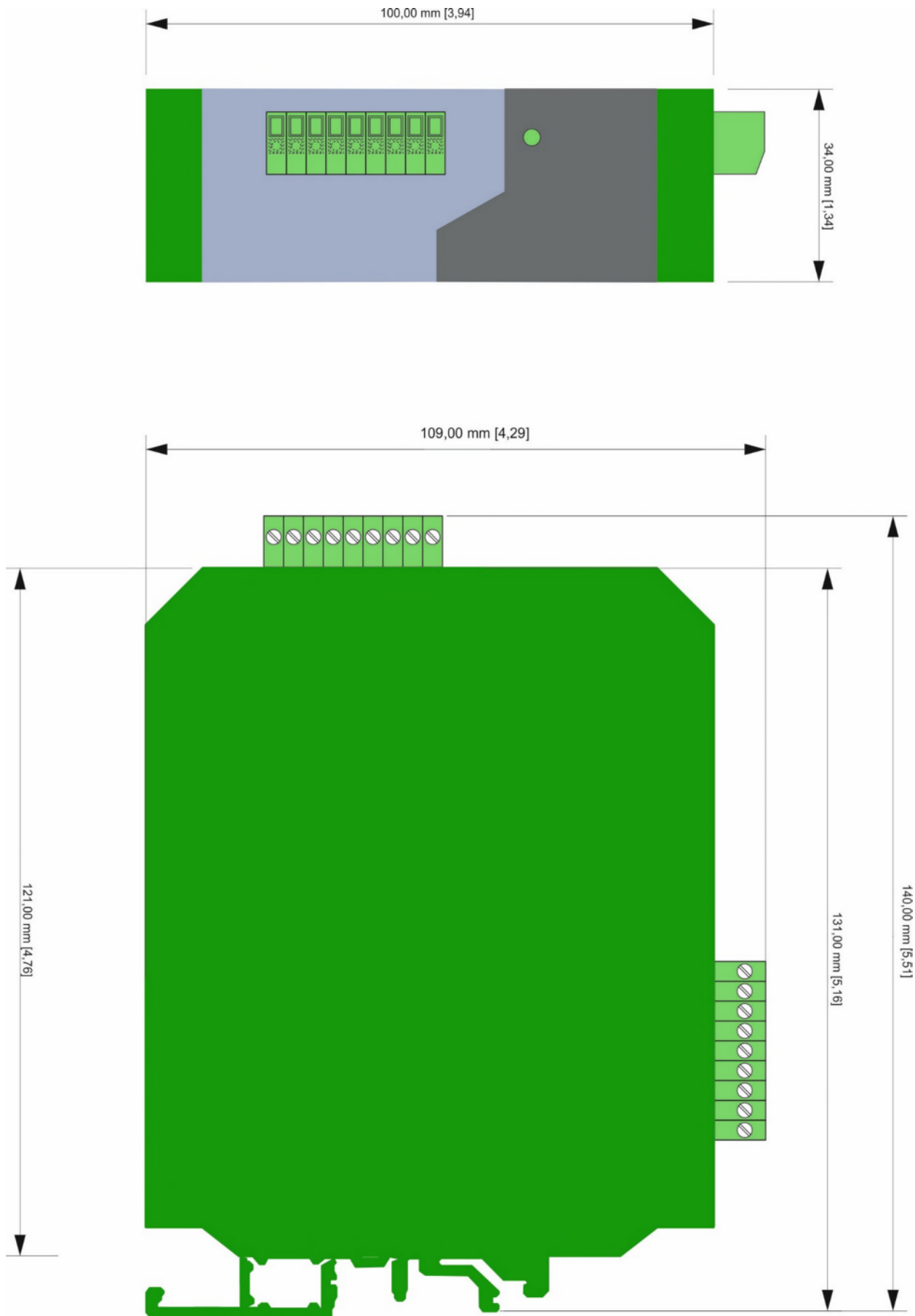Continuation "**Counter Menu**":

ROUND LOOP VALUE		
Definition of the number of encoder steps if a round-loop function is desired. (only for COUNT MODE: A SINGLE and A / B x 90)		
	0	Round-loop function is turned off.
	...	
	99999999	Number of steps for the round-loop function.

5. Appendix

5.1. Parameter / serial codes

#	Menu	Name	Ser.Code	Min	Max	Default
1	FREQUENCY MENU	FREQUENCY MODE	00	0	5	0
2	FREQUENCY MENU	FREQUENCY BASE	01	0	3	1
3	MODE FREQUENCY	SAMPLING TIME 1 (S)	02	1	9999	100
4	FREQUENCY MENU	WAIT TIME 1 (S)	03	1	7999	100
5	FREQUENCY MENU	AVERAGE FILTER 1	04	0	16	0
6	FREQUENCY MENU	SAMPLING TIME 2 (S)	05	1	9999	100
7	FREQUENCY MENU	WAIT TIME 2 (S)	06	1	7999	100
8	FREQUENCY MENU	AVERAGE FILTER 2	07	0	16	0
10	COUNTER MENU	COUNT MODE	10	0	5	3
11	COUNTER MENU	FACTOR A	11	1	9999999	100000
12	COUNTER MENU	SET VALUE A	12	-999999999	999999999	0
13	COUNTER MENU	FACTOR B	13	1	9999999	100000
14	COUNTER MENU	SET VALUE B	14	-999999999	999999999	0
15	COUNTER MENU	ROUND LOOP VALUE	15	0	999999999	0
17	GENERAL MENU	OPERATIONAL MODE	18	0	1	0
18	GENERAL MENU	ENCODER PROPERTIES	19	0	4	0
19	GENERAL MENU	ENCODER DIRECTION	20	0	1	0
20	GENERAL MENU	BACKUP MEMORY	21	0	1	1
21	GENERAL MENU	LOWER LIMIT	22	-999999999	999999999	0
22	GENERAL MENU	UPPER LIMIT	23	-999999999	999999999	999999999
23	GENERAL MENU	DIAGNOSIS SETUP	24	0	4095	0
24	GENERAL MENU	OUTPUT SOURCE	25	0	2	0
25	GENERAL MENU	FACTORY SETTINGS	26	0	1	0

5.2. Dimensions

5.3. Technical Specifications

Technical Specifications:		
Connections:	Connector type:	screw terminal, 1,5 mm² / AWG 16
Power Supply:	Input voltage:	24 VDC (18 … 30 VDC) through IO-Link
	Protection circuit:	reverse polarity protection
	Consumption:	approx. 75 mA (unloaded)
Encoder supply:	Output voltage:	5 VDC and 24 VDC (approx.1 V lower than the power supply)
	Output current:	max. 250 mA
		IO Link Masterport: min. 200mA
		Device supply: – 75 mA
		_____
		= 125 mA
Incremental inputs:	Number of inputs:	2
	Channels:	A, B (HTL Single Ended, TTL Single Ended)
		A, /A, B, /B (RS422, HTL differential)
	Configuration:	RS-422, HTL differential, HTL Single Ended, TTL
	RS422:	max. 1 MHz (RS-422 differential signal > 0.5 V)
	HTL differential:	max. 1 MHz (HTL differential signal > 1 V)
	HTL Single Ended:	max. 350kHz, (Low: 0 … 5V, High: 9 … 30 V)
	TTL:	max. 350kHz, (Low: 0 … 0.6V, High: 2.2 … 5V
	Frequency measurement accuracy:	+/- 50 ppm
Control inputs:	Number of inputs:	3
(option "CO")	Format:	HTL, PNP (Low: 0 … 3 V, High: 9 … 30 V)
	Frequency:	max. 1 kHz
	Reaction Time:	approx. 1ms
	Transmission time (IO Link):	every 2 ms - (Cycle Time IO Link)
	Load:	max. 2 mA at 24VDC
Control outputs:	Number of outputs:	2
(with option "CO")	Format:	5 … 30 V (depends on the Com+ voltage), PNP
	Output current:	max. 100 mA each output (with external Com+ supply!)
	Reaction time:	min. 1 ms
		(depending on "Sampling Time (s)" setting etc.)
	Transmission time (IO Link):	every 2 ms - (Cycle Time IO Link)
IO-Link:	Module / Specification:	Device / IO Link V1.1
	Bit rate:	COM 3 (230,4 kBit / s)
	Port Class:	Typ A
	Cycle time:	min. 2ms
	Data width:	15 Byte
		(3 x 4 Byte (input data) + 1 Byte ("CO" Status) + 2 Byte (diagnosis data)
Indicators:	Number of indicators:	1 LED
	Function:	1 x green for "ready for operate" state
		or actual "IO Link state" (with option "CO")
Housing:	Material:	Plastic
	Mounting:	35 mm top hat rail (according to EN 60715)
	Dimensions (B x H x T):	34 x 100 x 131 mm / 1.34 x 3.94 x 5.16 inches
	(without connectors)	
	Dimensions (B x H x T):	34 x 109 x 140 mm / 1.34 x 4.65 x 5.51 inches
	(inclusive connectors)	
	Weight:	approx. 160 g
	Protection:	IP20
Ambient temperature:	Operation:	-20 °C … +60 °C resp. -4 °F … + 140 °F not condensing
	Storage:	-25 °C … +70°C resp. -13 °F … + 158 °F
Ambient conditions:	Altitude:	max. 2000 meter above sea level
	Humidity:	max. 80% relative humidity to 30 °C / 86 °F
	Degree of pollution:	2
Failure rate::	MTBF in years:	IO222: 96,0 a
	(continuous operation at 60 °C)	IO222/CO: 87,4 a
Conformity and standards:	EMC 2014/30/EU:	EN 61326-1: 2013 for industrial location
		EN 55011: 2016 + A1: 2017 + A11: 2020 Class A
	RoHS (II) 2011/65/EU	
	RoHS (III) 2015/863:	EN IEC 63000: 2018