



## IT251

Level converter, direction signal decoder and programmable impulse divider

### Features:

- Level conversion from TTL / RS 422 to HTL 10 ... 30 V and vice versa
- Programmable divider for error- free and position-true division of quadrature encoder Signals (A, B, 90°)
- Separate marker pulse divider with individual settings
- 300 kHz of maximum frequency
- Push-pull outputs for direct PLC interfacing
- 18 ... 30 VDC power supply

Version:	Description:
It25101e/ TJ/ Sep 03/5	HTL input circuit resistors
It25102a/ hk/ Jan07	Brochure format, improved clarification of functions
It2510_2b_oi/ ag/ Sep-15	Design, Technical Specifications and Safety Instructions updated

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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 observe all safety and warning instructions! Keep the manual for later use.**

**A pertinent qualification of the respective staff is a fundamental requirement in order to use these 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 reserve 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 has 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 (see chapter 8). 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 conform 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 (see chapter 8).

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.

For placement, wiring, environmental conditions as well as shielding and earthing/grounding of the supply lines the general standards of industrial automation industry and the specific shielding instructions of the manufacturer are valid. Please find all respective hints and rules on [www.motrona.com/download.html](http://www.motrona.com/download.html) --> "[General EMC Rules for Wiring, Screening and Earthing]".

### 1.4. 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

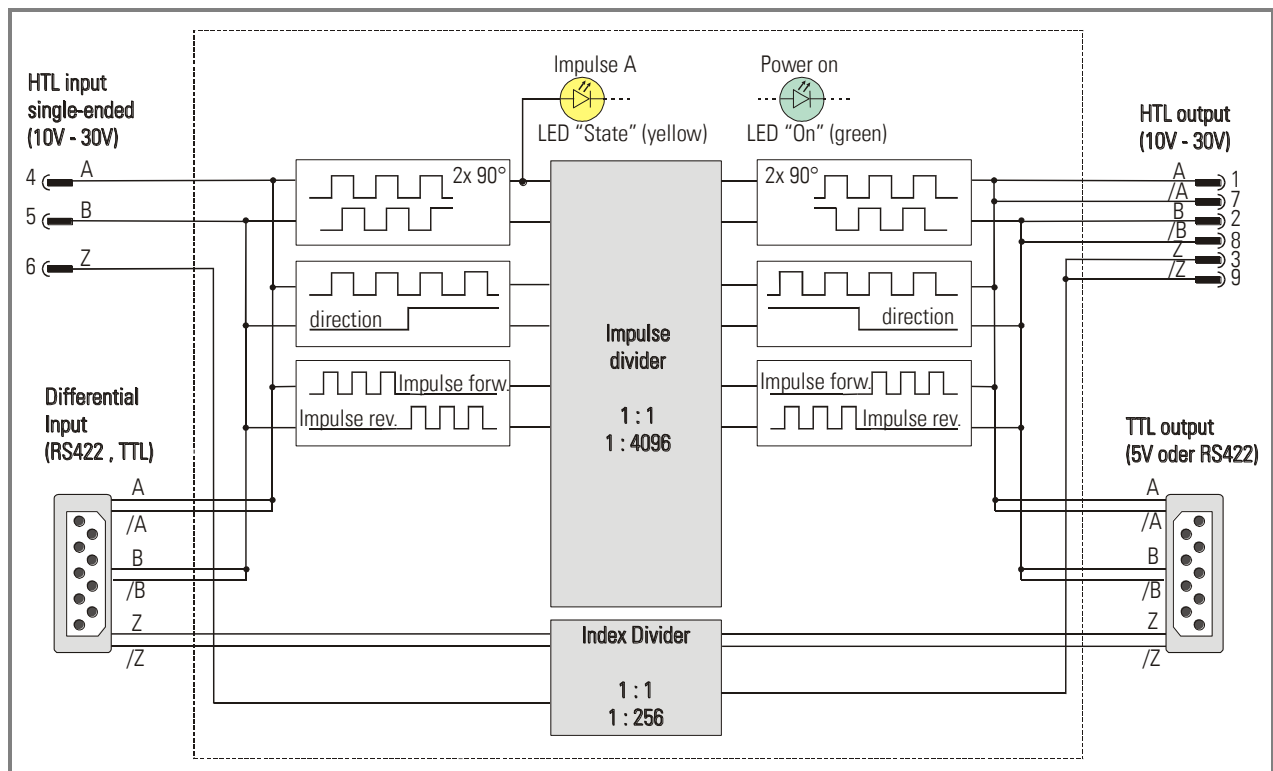
IT 251 has been designed as a universal encoder interface for use with incremental encoder signals. The unit is suitable to solve the following applications:

- Level conversion from TTL / RS422 to HTL and vice-versa
- Division of quadrature encoder pulses, with adjustable division rate from 1:1 to 1:4096
- Separately programmable division of the marker pulses
- Translation from any of the three common standards of indication of the direction to any other standard (quadrature A/B 90° or A = pulse and B = direction or A = forward impulse and B = reverse impulse)

All settings occur from the top or bottom side of the unit, by means of four 8-position DIL switches.

The unit is built into a compact housing with 12 screw terminals and two SUB-D-connectors and can be mounted to DIN rails

## 3. Block Diagram

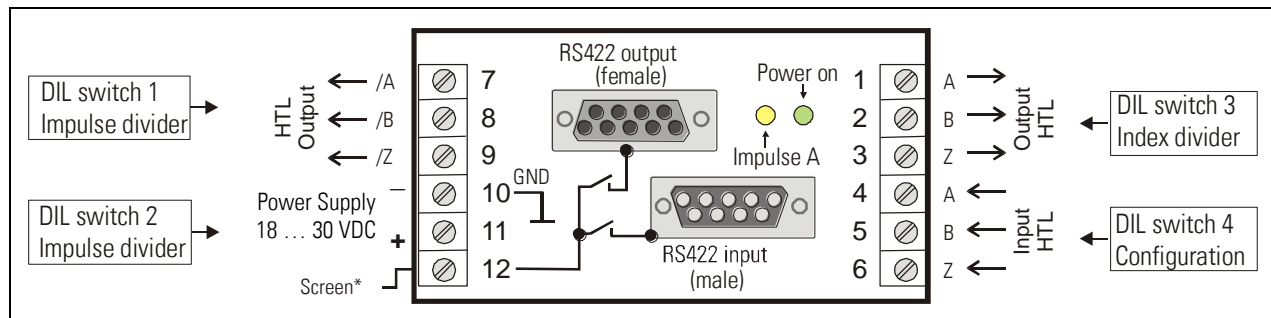


## 4. Connections and Terminal Assignments

For frequency input, either the RS 422 inputs (D-SUB) or the 10 ... 30 V HTL inputs can be used. The other inputs, which are not in use, must remain unconnected or must be disabled by corresponding DIL switch setting.

The outputs provide impulse signals at TTL / RS422 level as well as at a 10 ... 30 V HTL level, and either one or the other or both at a time can be used, whichever is applicable.

Please note that all input and output signals refer to the same common potential (GND) which at the same time is also the minus potential of the power supply.



\*) This screen terminal allows to connect the metallic housings of the SUB-D-connectors to the potential applied to terminal 12 (e.g. PE or external GND or else), when the corresponding DIL switch is on (see settings of DIL 4 switch)

The D-SUB input connector provides an auxiliary output of +5 V / 130 mA for encoder supply.

The **HTL inputs** provide PNP characteristics and must be switched to +.

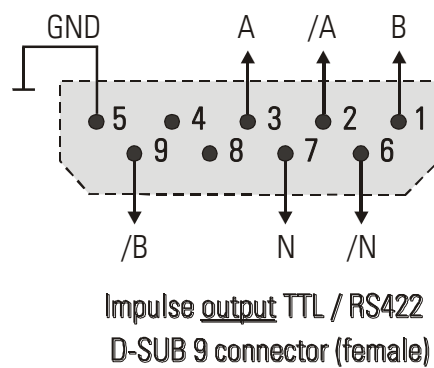
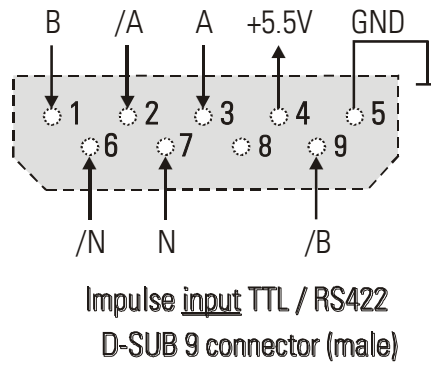
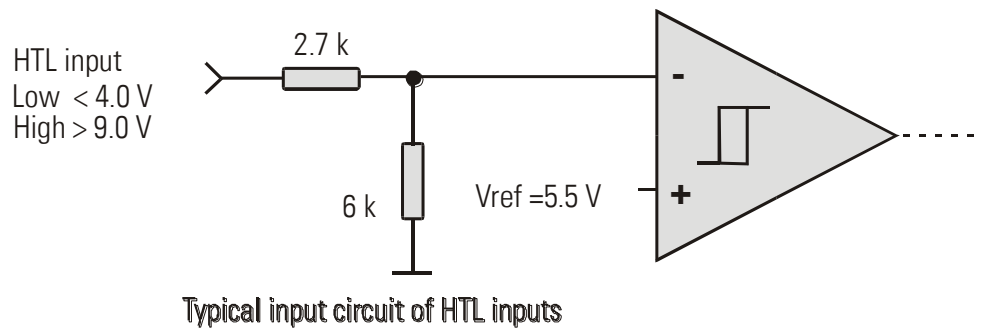
Where you use encoders with PNP or push-pull outputs, there will be no problem.

Encoders with NPN outputs (open collector type) will however need an external pull-up resistor (e.g. 2.7 kOhm). See the schematics of the input circuit for calculation of the resistance.

At any time, the total transmission characteristics of encoder, external components and capacity of the cable must ensure proper signals at the input terminals of the unit, with respect to the levels, the shape and the phase displacement A/B.

The output swing on the HTL push- pull outputs corresponds to the input supply voltage applied to terminals 10 and 11.

The green front LED signals that power is on, and the yellow LED signals the input impulses from input channel A respectively A, /A.



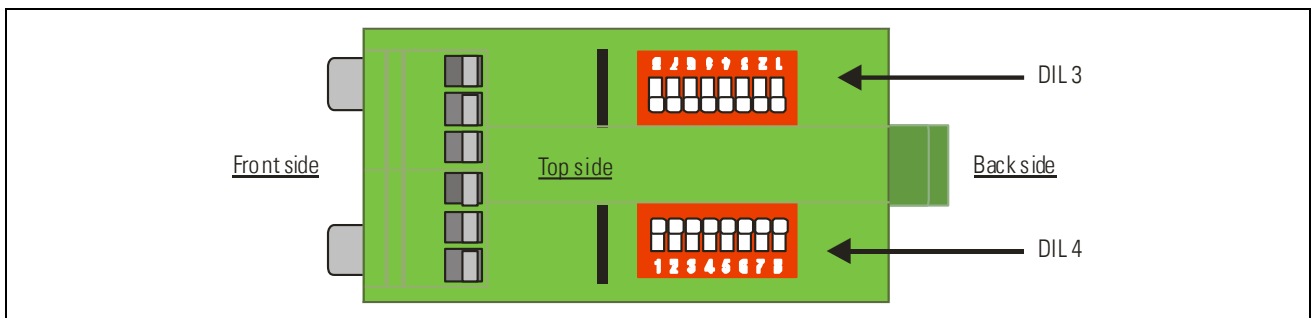
## 5. Basic Switch Settings

Upon commissioning, some basic settings must be done by switch **DIL4**.

These settings select one of the possible standards for expressing the direction of rotation on inputs and outputs. Also the potential of the metallic housings of the SUB-D-connectors can be set, and the inputs can be enabled or disabled (RS422 signals or HTL signals)

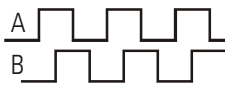
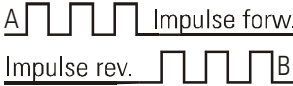
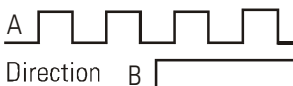
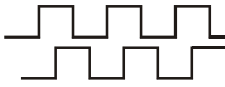
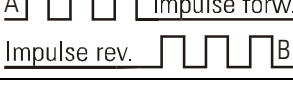



Changes of the DIL switch positions will become active only after the next power-up of the unit!



DIL switches **DIL3** and **DIL4** are located on the top side and switches **DIL1** and **DIL2** are located on the bottom side of the unit.



Configuration											
DIL4											
8	7	6	5	4	3	2	1				
						on	on		1**	Output direction standard	
						on	off		2		
						off	on		3		
				on	on				1	Input direction standard	
				on	off				2*		
				off	on				3*		
			on					Connects the metallic housing of SUB-D-connector "RS422 Input" to terminal 12			
			off					Metallic housing of the SUB-D-connector "RS422 Input" is potential-free			
		on						Connects the metallic housing of SUB-D-connector "RS422 Output" to terminal 12			
		off						Metallic housing of the SUB-D-connector "RS422 Output" is potential-free			
	on							HTL Inputs disabled			
	off							HTL Inputs enabled			
on								TTL / RS422 Inputs disabled			
off								TTL / RS422 Inputs enabled			



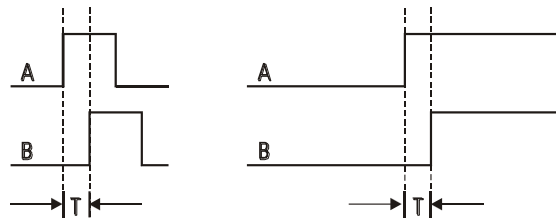
\*) Where your application uses input format 2 or 3 to indicate the direction, you should ensure that changes of direction occur always while the pulse lines are low. Otherwise there is a risk of cumulating error pulses at the output with frequent changes of direction.

\*\*) Also from input signals according to direction standards 2 or 3, the unit can generate a quadrature output with A/B phase displacement, according to direction standard 1. However, with the divider set to 1:1, the phase displacement then is **constant in time**, i.e. the phase between A and B corresponds to 90° only at a certain input frequency, and becomes smaller with lower input frequencies.

This, in general, is not a restriction for proper detection of the direction, because practically every counter or position controller can clearly interpret

this information, even when the phase is barely visible on an oscilloscope. For this kind of application, please set the A/B delay time by DIL switch 2, with consideration of your maximum output frequency.

For division rates higher than 1:1, the phase displacement gets more and more close to a real 90° quadrature signal, independent of the input frequency.



A/B time displacement when converting direction standard 2 or 3 to quadrature standard

A/B Time Displacement		
DIL2		
8	7	
on	on	$T = 0,4 \mu s$
on	off	$T = 1,2 \mu s$
off	on	$T = 4,4 \mu s$
off	off	$T = 10,0 \mu s$

## 6. Setting of the Impulse Division Rate

The incremental division rate for the A/B input pulses can be set by means of switch **DIL1** and by positions 1 – 4 of switch **DIL2**.

The marker pulse Z uses a separate divider and marker division is described later.

The switch positions use a binary code like shown in the subsequent list. For technical reasons, a switch in **ON** position means logical **"0"** and a switch in **OFF** position means logical **"1"**.

Set all switch positions to a binary code that corresponds to the desired division rate – 1

Impulse Divider [A / B]												<div>on = log.0, off = log.1</div> <div>← Binary value</div>
DIL2				DIL1								
4	3	2	1	8	7	6	5	4	3	2	1	
2048	1024	512	256	128	64	32	16	8	4	2	1	
on	on	on	on	on	on	on	on	on	on	on	on	(0) = Division 1 : 1
on	on	on	on	on	on	on	on	on	on	on	off	(1) = Division 1 : 2
on	on	on	on	on	on	on	on	on	on	off	on	(2) = Division 1 : 3
on	on	on	on	on	on	on	on	on	on	off	off	(3) = Division1 : 4
on	on	on	on	on	on	on	on	on	off	on	on	(4) = Division 1 : 5
on	on	on	on	on	on	on	on	on	off	on	off	(5) = Division 1 : 6
on	on	on	on	on	on	on	on	on	off	off	on	(6) = Division 1 : 7
on	on	on	on	on	on	on	on	on	off	off	off	(7) = Division 1 : 8
												...etc.
on	on	on	on	on	on	on	off	on	on	on	on	1 : 17
on	on	on	on	on	on	off	on	on	on	on	on	1 : 33
on	on	on	on	on	off	on	on	on	on	on	on	1 : 65
on	on	on	on	off	on	on	on	on	on	on	on	1 : 129
on	on	on	off	on	on	on	on	on	on	on	on	1 : 257
on	on	off	on	on	on	on	on	on	on	on	on	1 : 513
on	off	on	on	on	on	on	on	on	on	on	on	1 : 1025
off	on	on	on	on	on	on	on	on	on	on	on	1 : 2049
												...etc.
off	off	off	off	off	off	off	off	off	on	off	off	1 : 4092
off	off	off	off	off	off	off	off	off	off	on	on	1 : 4093
off	off	off	off	off	off	off	off	off	off	on	off	1 : 4094
off	off	off	off	off	off	off	off	off	off	off	on	1 : 4095
off	off	off	off	off	off	off	off	off	off	off	off	1 : 4096

## 7. Index Pulse Divider (Marker Pulse Z)

### 7.1. Unchanged index pulse (bypass)

When you like to just bypass the index pulse from the input to the output (without any changes of frequency, position and pulse width), please use the following DIL switch settings:

DIL3								DIL2	
8	7	6	5	4	3	2	1	6	5
on	on	on	on	on	on	on	on	off	off

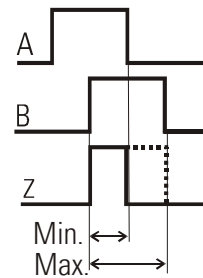
In this case you can ignore all further information given in this chapter.

### 7.2. Modifications of the index pulse

The programmable index divider allows modifications of the pulse distance, the pulse width and the pulse position.



As a precondition for use of the subsequent functions, the input index pulse needs to have a minimum width of one fourth of the period and a maximum width of one half of the period of the input frequency



Switch DIL3 allows setting of the division rate between input and output.

Positions 5 and 6 of switch DIL2 allow modification of width and position of the output pulse.

### 7.3. Setting of the division rate of the index divider

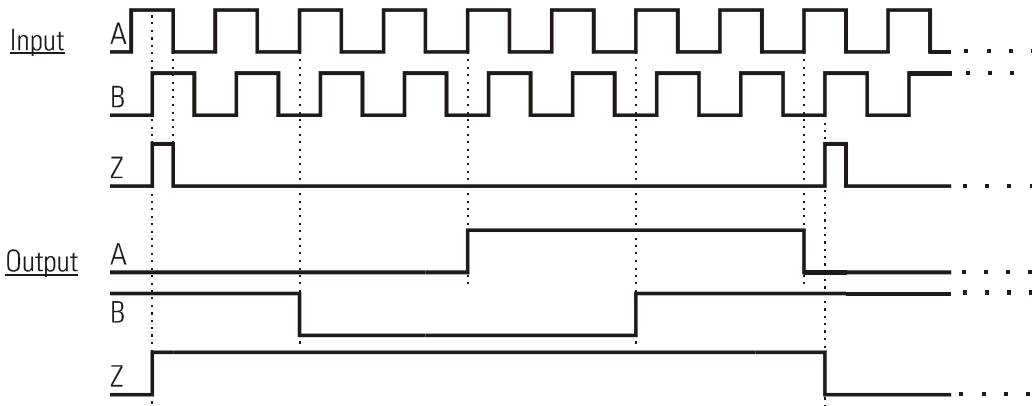
These settings use the same rules and codes as shown with the main divider (see section 6)

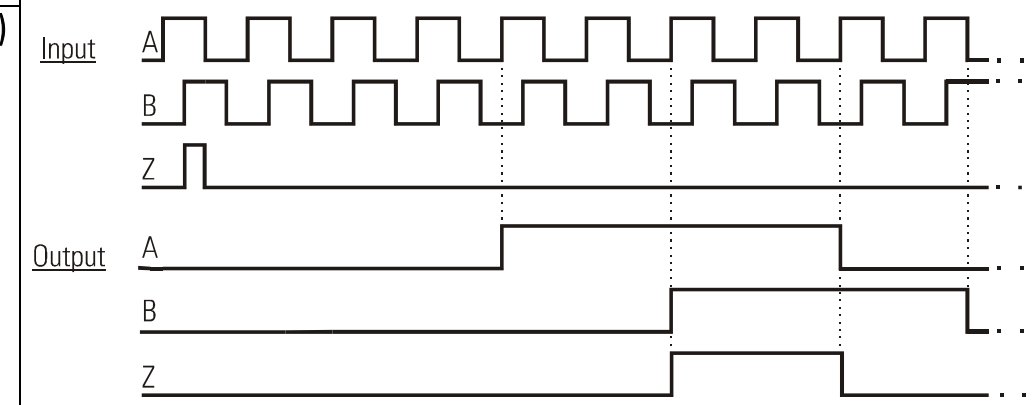

Index Divider [Z]								
DIL3								on = log.0, off = log.1 ← Binary value
8	7	6	5	4	3	2	1	
128	64	32	16	8	4	2	1	
on	on	on	on	on	on	on	on	1 : 1
on	on	on	on	on	on	on	off	1 : 2
on	on	on	on	on	on	off	on	1 : 3
on	on	on	on	on	on	off	off	1 : 4
off	off	off	off	off	off	on	on	1 : 253
off	off	off	off	off	off	on	off	1 : 254
off	off	off	off	off	off	off	on	1 : 255
off	off	off	off	off	off	off	off	1 : 256

### 7.4. Position and width of the index pulse

For illustration of the functions, the drawings of this chapter assume that the main impulse divider of the A/B input pulses would be set to 8. The index pulse will appear at the output according to the division rate set (see section 7.3 above).

DIL2		Small index pulse (1/4 of the input period time)
6	5	
off	off	<p>The pulse width on the output is 1/4 of one period on the input side</p> <p>Input</p> <p>A</p> <p>B</p> <p>Z</p> <p>Output</p> <p>A</p> <p>B</p> <p>Z</p>

DIL2		Enlarged index pulse (one full encoder revolution)
6	5	
off	on	<p>The pulse width of the enlarged output index pulse corresponds to the distance between two input index pulses (with index divider &gt; 1 only).</p> 

DIL2		Index pulse width adapted to output frequency (1/4 output period) (only applicable with quadrature input A/B, 90°)
6	5	
on	off*)	<p>The pulse width corresponds to 1/4 of one period of the output frequency</p> 
on	on**)	
		<p>This mode of index treatment requires divider settings of the A/B impulse divider and the index divider that ensure a clear assignment of the output index pulse to the A/B output frequency, with no cumulating remainders. Where the signal division does not come out even, jumps of the output index pulse position will occur.</p> <p><u>Example:</u> With use of a 1000 ppr encoder we would set the A/B impulse divider to 3 and the index divider to 2. As a result the index output pulse should appear after every 666.6..... input pulses, what physically is impossible without jumps.</p> <p>*) Pulse width = 1/4 output period, even with index divider set to 1:1</p> <p>**) Divider setting 1:1 will bypass the input index pulse to the output</p>

## 8. Technical Specifications

<b>Power supply:</b>	Input voltage: Protection circuit: Ripple: Consumption: (unloaded encoder supply) Connections:	18 ... 30 VDC reverse polarity protection $\leq 10\%$ at 24 VDC approx. 250 mA (at 18 V) approx. 150 mA (at 30 V) screw terminal, 1.5 mm <sup>2</sup> / AWG 16
<b>Encoder supply:</b>	Output voltage: Output current: Connections:	+ 5.5 VDC / +/- 5 % max. 130 mA male 9-pin SUB-D connector
<b>Incremental input:</b>	Signal levels:  HTL internal resistance Channels:  Frequency: Connections:	TTL / RS422, differential voltage > 1 V HTL, LOW: 0 ... 4 V / HIGH: 10 ... 30 V $R_i \approx 4.7\text{ k}\Omega$ A, B, Z (HTL, asymmetrical) A, /A, B, /B, Z, /Z (TTL / RS422 symmetrical) 300 kHz screw terminal, 1.5 mm <sup>2</sup> / AWG 16 (HTL) or female 9-pin SUB-D connector (TTL / RS422)
<b>Incremental output:</b>	Signal levels:  Channels:  Output current: Connections:	17 ... 29 V at HTL (depends on power supply voltage) 5 V at TTL / RS422 A, B, Z (HTL, asymmetrical) A, /A, B, /B, Z, /Z (TTL / RS422 symmetrical) max. 20 mA / push-pull screw terminal, 1.5 mm <sup>2</sup> / AWG 16 (HTL) and male 9-pin SUB-D connector (TTL / RS422)
<b>Housing:</b>	Material: Mounting: Dimensions:  Protection class: Weight:	plastic 35 mm top hat rail (according to EN 60715) w x h x d = 40 x 79 x 91 mm resp. 1.5748 x 3.1102 x 3.5827 inch IP20 approx. 200 g
<b>Ambient temperature:</b>	Operation: Storage:	0 °C ... +45 °C / +32 ... +113 °F (not condensing) -25 °C ... +70 °C / -13 ... +158 °F (not condensing)
<b>Failure rate:</b>	MTBF in years:	55.4 a (long-term usage at 60 °C / 140 °F )
<b>Conformity &amp; standards:</b>	EMC 2004/108/EC: Guideline 2011/65/EU:	EN 61000-6-2, EN 61000-6-3, EN 61000-6-4 RoHS-conform

## 9. Dimensions

