

## Product data

### Features

- Highly miniaturized encoder
- Differential inductive sensing principle
- Insensitive to magnetic interference fields
- Robust against oil, water, dust, particles
- Ultra-thin encoder and scale (total < 2 mm)
- Optional with cable, connector and holder

### Applications

- Linear actuators
- Industrial / laboratory / office automation
- X-Y stages
- Pick & Place assembly equipment
- High-speed motion control
- Mechatronics applications

### Key Specifications

Output format.....A and B in quadrature + Index  
 Resolution.....down to 37 nm  
 Maximum speed .....up to 11 m/s  
 Airgap .....up to 0.6 mm  
 Supply.....5 V, 30 mA  
 Temperature .....-40 to 125°C

### Description

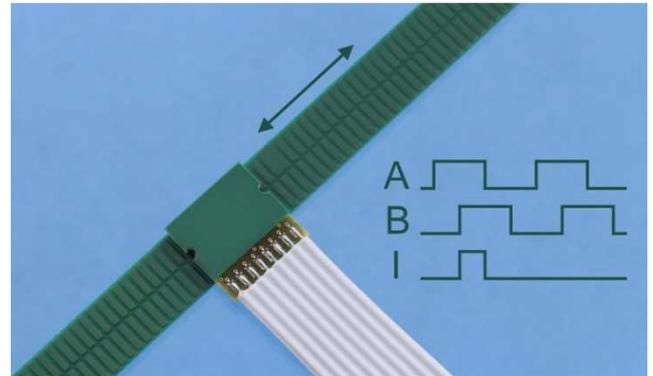
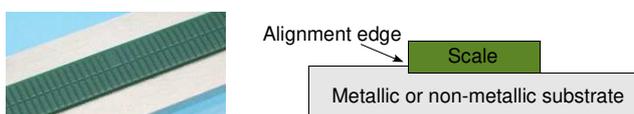
The IT3402L incremental encoder kit consists of an encoder and a linear scale (Fig. 1). The encoder consists of two integrated circuits in a PCB housing. It provides incremental A and B output signals in quadrature and an Index signal, which is synchronous to A and B (Fig. 2). The linear scale is a PCB with passive copper strips.

### Resolution, maximum speed and airgap

The resolution and the maximum speed of the encoder are user-programmable or can be programmed ex-factory. The resolution depends on a filter setting that limits the maximum speed of the encoder vs. the scale. The resolution also depends on the maximum distance between the encoder and the scale. Tables 2 and 3 allow the configuration of resolution and maximum speed for a certain maximum air-gap.

### Scales

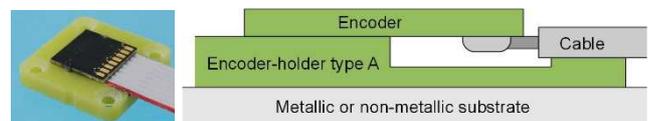
Scales with different dimensions and index-positions are available (Fig. 4) and are selected in Table 5. The scale may be mounted on any substrate, using an edge for accurate positioning in front of the encoder.



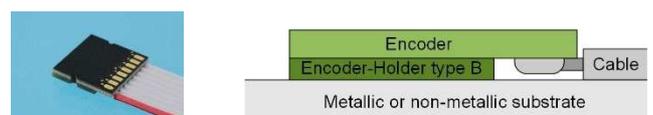
### Encoder holders

Different encoder holder options are available and can be selected in Table 6.

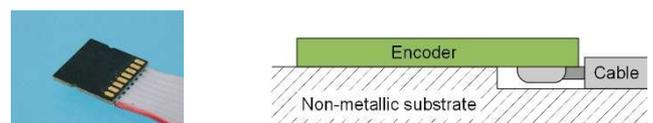
The encoder holder **type A** (Fig. 5) may be mounted on any substrate using 4 screw-holes. It has a strain relief for the cable.



The encoder holder **type B** (Fig. 3) may be mounted on any substrate. Use half-holes on encoder PCB housing and alignment pins for accurate positioning.



The encoder without holder may be mounted on non-metallic substrates. Use half-holes on encoder housing and alignment pins for accurate positioning.



### Encoder cable and connector

The encoder is supplied with a flat cable of pitch 1.27 mm and a connector (Fig. 6). The cable type and length and the connector type are selected in Tables 7 and 8.

### 3D models of encoder, holders and scales

STEP and IGES 3D models available on [www.posic.com](http://www.posic.com).

## Specifications

### Recommended Operating Conditions

Parameter	Symbol	Remark	Min	Typ	Max	Unit
Supply voltage	VDD		4.5	5.0	5.5	V
Operating Temperature	T <sub>A</sub>		-40		125	°C
Airgap	Z			0.2		mm
Lateral tolerance	ΔY				0.1	mm
Airgap tolerance	ΔZ				0.1	mm

### Electrical Characteristics

Electrical characteristics over recommended operating conditions, typical values at VDD = 5.0 V, T<sub>A</sub> = 25°C.

Parameter	Symbol	Remark	Min	Typ	Max	Unit
Supply current	IDD	No load	15	30	45	mA
Maximum frequency A/B signals	F <sub>A/B</sub>	CC = 04 – 10 (Table 3) CC = 11 – 15 (Table 3)			1200 120	kHz
Derating for F <sub>A/B</sub> and for Max speed (Table 2)		Temp range 0 to 65°C Temp range -20 to 100°C Temp range -40 to 125°C			-8 -14 -20	%
High level output voltage	V <sub>OH</sub>	I <sub>L</sub> = 2 mA	VDD-0.5			V
Low level output voltage	V <sub>OL</sub>	I <sub>L</sub> = 2 mA			0.5	V
Rise time, fall time	t <sub>r</sub> , t <sub>f</sub>	C <sub>L</sub> = 47 pF			20	ns

If A is pulled up and B pulled down during power-up, the encoder enters into a test mode with a 50 kHz square wave on all outputs.

### Encoding Characteristics

Encoding characteristics over recommended operating conditions, typical values at VDD = 5.0V, T<sub>A</sub> = 25°C, airgap = 0.2mm, speed = 10mm/s.

Parameter	Symbol	Remark	Min	Typ	Max	Unit
Pulse width error	ΔP	Nominal value 180°e		10	50	°e
State width error	ΔS	Nominal value 90°e		10	60	°e
Phase shift error	ΔΦ	Nominal value 90°e		10	45	°e

### Linearity

For high-resolution high-precision applications, it is possible to linearize the encoder by means of a Look-Up Table (LUT) that is located inside the encoder. The LUT can be programmed in volatile or in non-volatile memory by means of the Evaluation and Programming Tool (EPT) or it can be pre-programmed ex-factory. The LUT option is selected in Table 4.

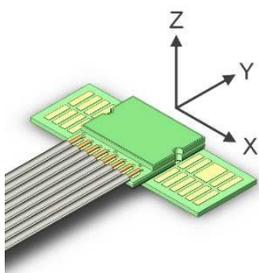


Fig. 1 Coordinate system XYZ.

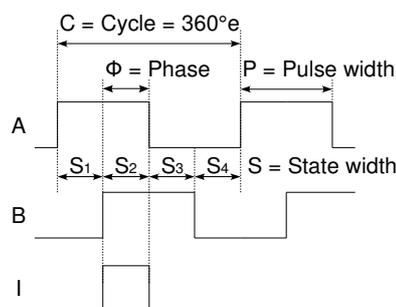


Fig. 2 Encoder output signals A and B in quadrature and Index.

### Definitions

Airgap	Distance between encoder and scale in Z-direction. See Fig. 1.
Cycle	One A quad B period, see Fig. 2.
CPP	Cycles per scale-period.
°e	Electrical degree (one Cycle is 360°e)
Phase shift Φ	Number of electrical degrees between the center of the high state of channel A and the center of high state of channel B. Nominal 90°e. Fig. 2.
Pulse width P	Number of electrical degrees that an output is high during one cycle. Nominal 180°e. Fig. 2.
State width S	Number of electrical degrees between two neighboring A and B transitions. Nominal value is 90°e. See Fig. 2.

**Technical drawings**

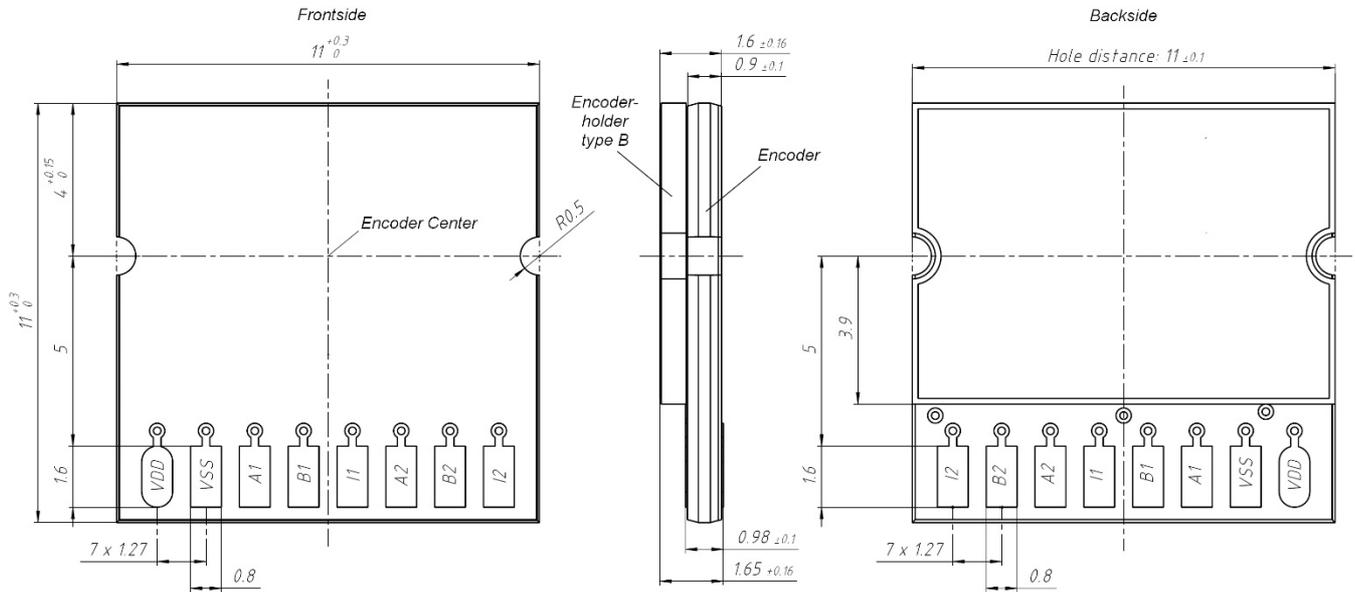


Fig. 3 Dimensions of IT3402 encoder on encoder-holder type B. The “Encoder center” must be centered with respect to the width of the linear scale (Fig 4).

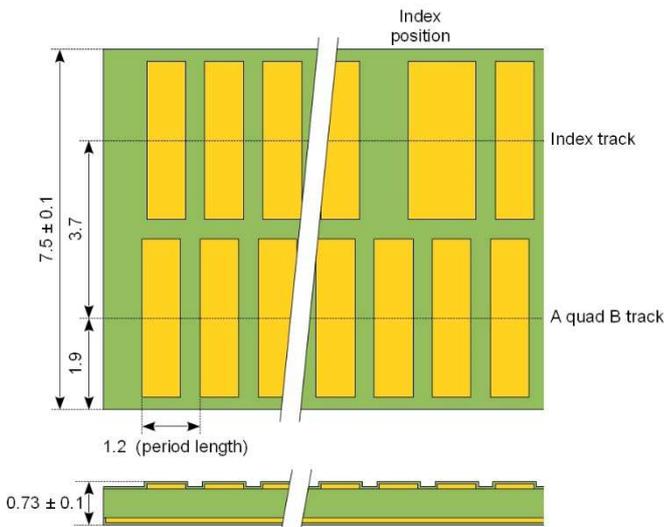


Fig. 4 Linear scale with period length 1.2 mm (drawing not to scale).

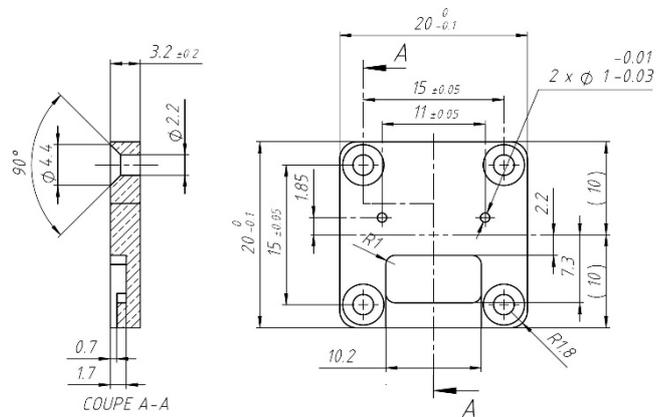


Fig. 5 Encoder Holder type A (see Table 6).

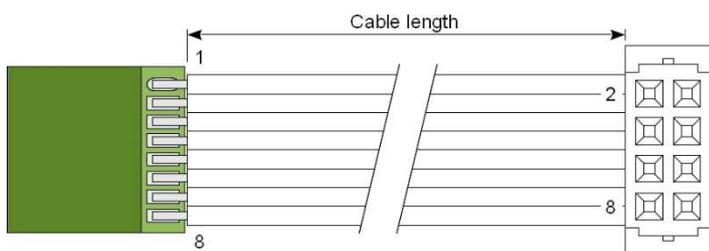


Fig. 6 Encoder with flat cable (pitch 1.27 mm) and 8-pin DIN41651 connector.

Connector pin	Name	Description
1	VDD	5V Supply
2	VSS	Ground
3	A1	For programming purposes
4	B1	
5	I1	
6	A2	Output A
7	B2	Output B
8	I2	Output Index

**Ordering information**

Ordering code: IT3402L-ABBCCD-EEEE-F-GGG-HH

A	Orientation	Table 1
BB	Maximum speed	Table 2
CC	Resolution	Table 3
D	Look-Up Table	Table 4
EEEE	Linear scale	Table 5
F	Encoder holder	Table 6
GGG	Cable	Table 7
HH	Connector	Table 8

Table 1: Orientation. Arrows indicate direction of movement of the scale with rising edge A prior to B.

A	Orientation
0	Not progr.
3	0°

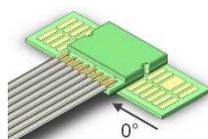


Table 2: Maximum speed

BB	Max speed (m/s)*	Max value CC
00	Not programmed	
01	0.005	15
02	0.010	15
03	0.021	14
04	0.043	13
05	0.086	12
06	0.17	11
07	0.34	10
08	0.69	10
20	5.5	10
21	11.0	09

\*Max speed valid at 25°C, temp. derating in specs, page 2.  
Lower Max speed leads to a lower jitter of the A/B outputs.

Table 3: Resolution

CC	Resolution		Max value BB	Maximum Airgap* (mm)
	CPP	um		
00	Not programmed			
04	4	75	21	0.6
05	8	37.5	21	0.6
06	16	18.8	21	0.5
07	32	9.4	21	0.5
08	64	4.7	21	0.4
09	128	2.3	21	0.4
10	256	1.2	20	0.3

11	512	0.6	06	0.3
12	1024	0.3	05	0.2
13	2048	0.15	04	0.2
14	4096	0.073	03	0.2
15	8192	0.037	02	0.2

\* Recommended airgap = 0.2 mm. Sequence of A and B transitions is correct up to Maximum Airgap, but encoding specifications may be out of range.

Table 4: Look-Up Table (LUT)

D	Look-Up Table programmed in OTP
0	Not programmed
1	LUT according to scale, to be specified
8	Custom LUT, to be specified
9	Default LUT, no scale specified

Table 5: Linear scale

EEEE	Linear scale
00000	No scale
03204	Length 204 mm, centered Index

The scale is made of FR4-material and can be cut to the desired length.

Table 6: Encoder holder

F	Encoder holder
0	No holder
A	Holder A (Fig. 5)
B	Holder B (Fig. 3)

Table 7: Cable

GGG	Cable
000	No cable
0xx	Flat ribbon cable, -20 to 100°C, length xx cm
1xx	Flat ribbon cable, -40 to 125°C, length xx cm

Table 8: Connector

HH	Connector*
00	No connector
04	8-pin connector DIN 41651 (Fig. 6)
05	10-pin connector DIN 41651

\* Connector temperature range -20 to 100°C

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