

## 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 automation
- X-Y stages
- Pick & Place assembly equipment
- Mechatronics applications

### Key Specifications

Output format.....SSI  
 Absolute position range ....up to 19 mm  
 Resolution.....14 bit / scale-period of 1.2 mm  
 Maximum speed .....up to 15 m/s  
 Airgap .....up to 0.5 mm  
 Supply.....5 V, 30 mA  
 Temperature .....-20 to 100°C

### Description

The AP3403L absolute encoder kit consists of an encoder and a linear scale (Fig. 1). The encoder consists of two integrated circuits in a PCB housing. Each circuit provides an SSI output (Fig. 2). The linear scale is a PCB with passive copper strips arranged in 2 tracks with an unequal number of periods N1 and N2 (Fig. 4 and Table 5). The absolute position is calculated by subtracting the two SSI values. The algorithm for this calculation is available from POSIC.

### Maximum speed

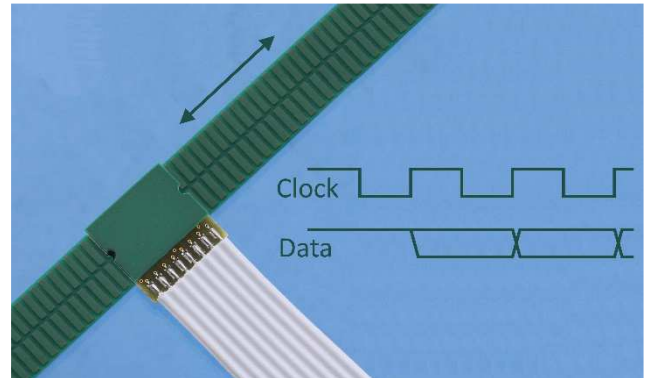
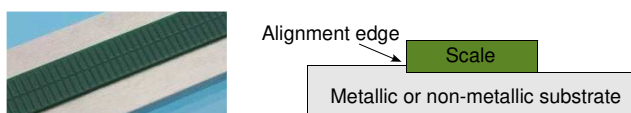
The maximum speed of the encoder is user-programmable or can be programmed ex-factory according to Table 2.

### SSI code

The SSI code is Gray or binary and is user-programmable or can be programmed ex-factory according to Table 3.

### Scales

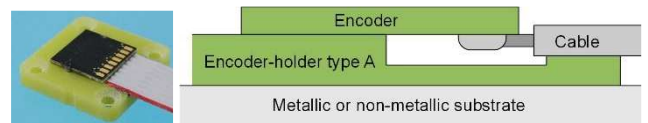
Scales with different absolute measurement ranges are available and are selected in Table 5. The scale may be mounted on any substrate, using an alignment edge <math>\leq 0.2\text{ mm}</math> for accurate positioning in front of the encoder.



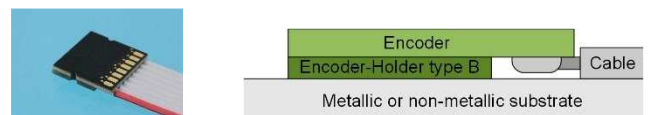
### Encoder holders

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

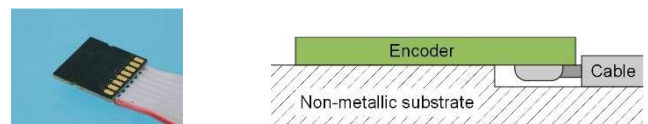
The encoder holder **type A** (Fig. 5) may be mounted on any substrate using 4 screw-holes. It has a strain relief for the cable.



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 on holder can be supplied with a flat cable of pitch 1.27 mm and a connector (Fig. 7). The cable length and the connector type are selected in Tables 7 and 8.

### Encoder programming

The Evaluation and Programming Tool (EPT) including an interface board and the ASSIST software is available for the linearization and programming of the encoder.

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

STEP models are 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>		-20		100	°C
SSI clock frequency	F <sub>SSIClock</sub>		25		600	kHz
SSI Wait time	t <sub>SSWait</sub>	Time between SSI-frames	100			us
Airgap*	Z			0.2	0.5	mm
Lateral tolerance	ΔY				0.1	mm
Airgap tolerance	ΔZ				0.1	mm

Max Airgap depends on max speed (Table 2), linearization (Table 4) and scale (Table 5).

### 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
SSI Time out	t <sub>SSTimeout</sub>	Time-out after SSI-frame	22	65	95	us
Derating for Max speed, Table 2		Temp range 0 to 65°C Temp range -20 to 100°C			-8 -14	%
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

### 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.

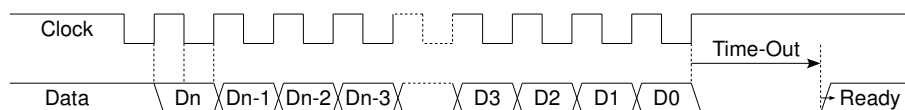


Fig. 2A SSI protocol when the complete data-word is read. D<sub>n</sub> is most significant bit, D<sub>0</sub> is least significant bit. After the time-out, the encoder is "ready" to transmit the next SSI-data-word. The length of the data-word is 14 bits, the coding can be selected Binary or Gray (Table 3). The data-word represents the position within one period of the scale.

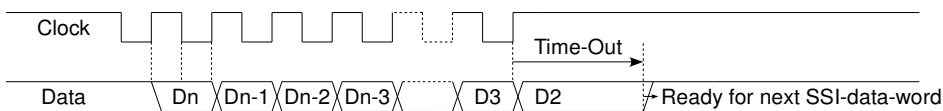


Fig. 2B SSI protocol when data-word is read partially. After time-out, the encoder is "ready" to transmit the next SSI-data-word.

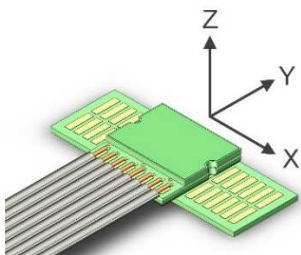


Fig. 1 Coordinate system XYZ.

### Definitions

Airgap	Distance between encoder and scale in Z-direction. See Fig. 1.
°e	Electrical degree (one Cycle is 360°e)
SSI	Serial Synchronous Interface
Period	One copper strip on a linear scale

## Technical drawings

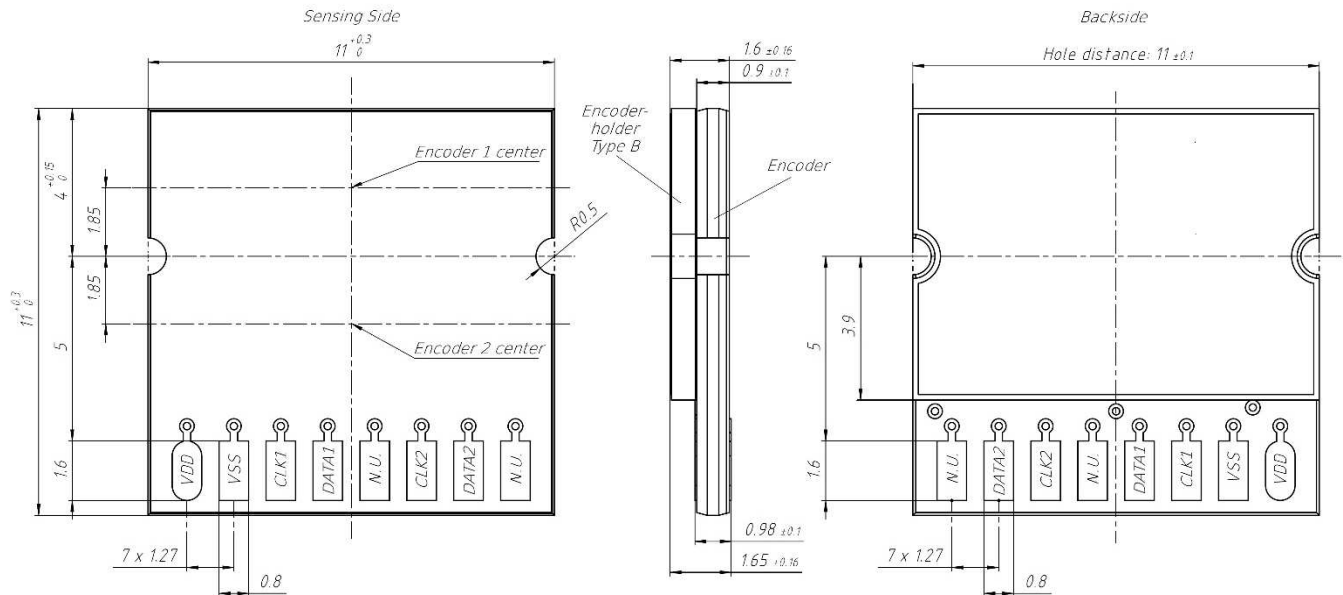
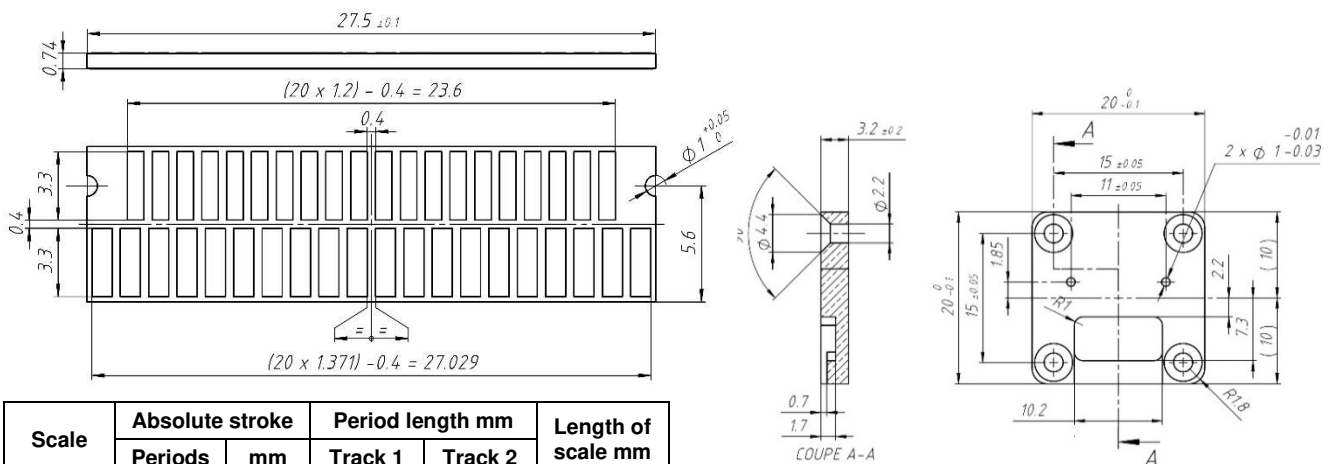


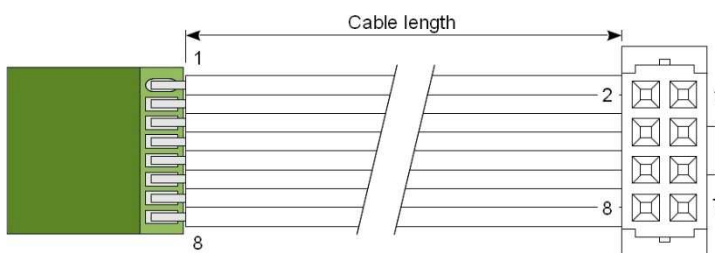
Fig. 3 Dimensions and pin-out of AP3403 encoder. Encoder 1 center must be aligned to Track 1 center (Fig 4) and Encoder 2 to Track 2.



Scale	Absolute stroke		Period length mm		Length of scale mm
	Periods	mm	Track 1	Track 2	
TPLA08	8	9.6	1.2	1.371	27.5
TPLA16	16	19.2	1.2	1.280	35.9
TPLA32	32	38.4	1.2	1.239	54.6

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

Fig. 4 Dimensions of linear Nonius-scales TPLA08, TPLA16 and TPLA32. Track 1 is marked by 2 half-holes.



Pin	Name	Description
1	VDD	5V Supply
2	VSS	Ground
3	CLK1	Clock 1
4	DATA1	Data 1
5	N.U.	Not used
6	CLK2	Clock 2
7	DATA2	Data 2
8	N.U.	Not used

Fig. 7 Dimensions (mm) and connector pin-out of encoder on holder type A with flat cable (pitch 1.27 mm) and 8-pin DIN41651 connector.

**Ordering information**

Ordering code: AP3403L-ABBCCD-EEEE-F-GGG-HH		
A	Orientation	Table 1
BB	Maximum speed	Table 2
CC	SSI code	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 increasing position.

A	Orientation
0	Not progr. (default 0°)
3	0°
5	180°

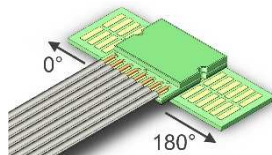


Table 2: Maximum speed

BB	Max speed (m/s)*	Typical delay (ms)
00	Not programmed (default 0.005 m/s)	
01	0.014	30
02	0.029	15
03	0.058	8
04	0.11	4
05	0.23	2
06	0.46	1
07	0.93	0.5
08	1.8	0.25
09	3.7	0.13
21	7.5	0 at const. speed
22	15.0	0 at const. speed

\*Max speed valid at 25°C, temp. derating in specs, page 2. Lower Max speed leads to a lower position-noise level.

Table 3: SSI Code

CC	SSI Code
00	Not programmed (default Gray)
01	Binary
02	Gray

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 (Fig 4)

EEEE	N1	N2	Absolute stroke (mm)	Scale length (mm)
00000	No scale			
08028	8	7	9.6	27.5
16036	16	15	19.2	35.9
32055	32	31	38.4	54.6

The absolute stroke corresponds to N1 periods on track 1 and N2 periods on track 2. 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, length xx cm

Table 8: Connector

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

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