# AP3403L
# Dual-track Absolute Linear Encoder Kit with SSI outputs

## *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

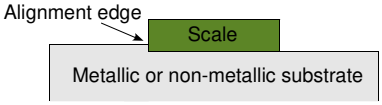
### Description

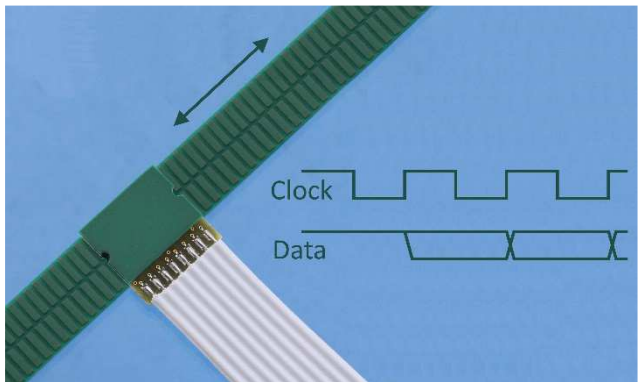
The AP3403L absolute encoder kit consists of an encoder and a linear scale (Fig. 1). The encoder consists of two integrated circuits in a PCB housing. Each circuit provides an SSI output (Fig. 2). The linear scale is a PCB with passive copper strips arranged in 2 tracks with an unequal number of periods 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.

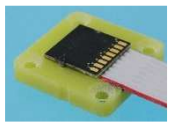
**SSI code**
The SSI code is Gray or binary and is user-programmable or can be programmed ex-factory according to Table 3.

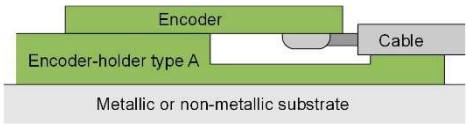
**Scales**
Scales with different absolute measurement ranges are available and are selected in Table 5. The scale may be mounted on any substrate, using an alignment edge ≤ 0.2 mm for accurate positioning in front of the encoder.



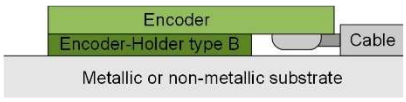




**Encoder holders**
Different encoder holder options are available and can be selected in Table 6.
The encoder holder **type A** (Fig. 5) may be mounted on any substrate using 4 screw-holes. It has a strain relief for the cable.

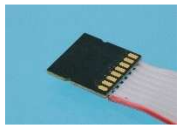


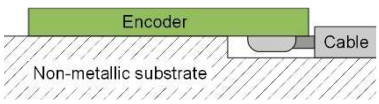



The encoder holder **type B** (Fig. 3) may be mounted on any substrate. Use half-holes on encoder PCB housing and alignment pins for accurate positioning.




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.

## Specifications

**Recommended Operating Conditions**

| Parameter | Symbol | Remark | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Supply voltage | VDD | | 4.5 | 5.0 | 5.5 | V |
| Operating Temperature | $T_A$ | | -20 | | 100 | °C |
| SSI clock frequency | $F_{SSIclock}$ | | 25 | | 600 | kHz |
| SSI Wait time | $t_{SSIwait}$ | 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, $T_A$ = 25°C.

| Parameter | Symbol | Remark | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Supply current | IDD | No load | 15 | 30 | 45 | mA |
| SSI Time out | $t_{SSItimeout}$ | Time-out after SSI-frame | 22 | 65 | 95 | us |
| Derating for Max speed, Table 2 | | Temp range 0 to 65°C<br>Temp range -20 to 100°C | | | -8<br>-14 | % |
| High level output voltage | $V_{OH}$ | $I_L$ = 2 mA | VDD–0.5 | | | V |
| Low level output voltage | $V_{OL}$ | $I_L$ = 2 mA | | | 0.5 | V |
| Rise time, fall time | $t_r$, $t_f$ | $C_L$ = 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.

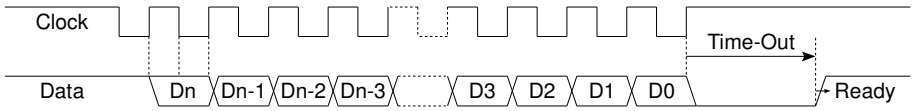



Fig. 2A SSI protocol when the complete data-word is read. Dn is most significant bit, D0 is least significant bit. After the time-out, the encoder is "ready" to transmit the next SSI-data-word. The length of the data-word is 14 bits, the coding can be selected Binary or Gray (Table 3). The data-word represents the position within one period of the scale.

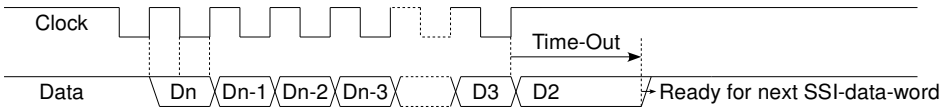



Fig. 2B SSI protocol when data-word is read partially. After time-out, the encoder is "ready" to transmit the next SSI-data-word.

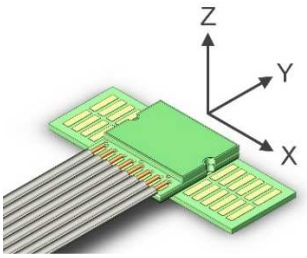



Fig. 1 Coordinate system XYZ.

**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

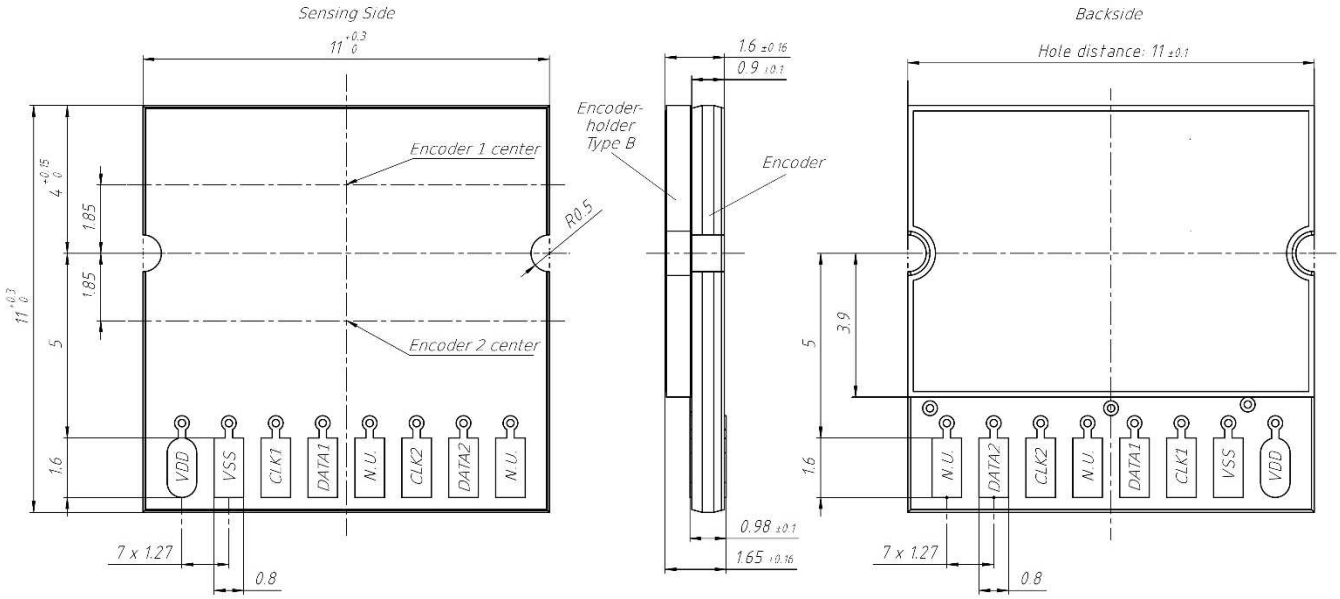
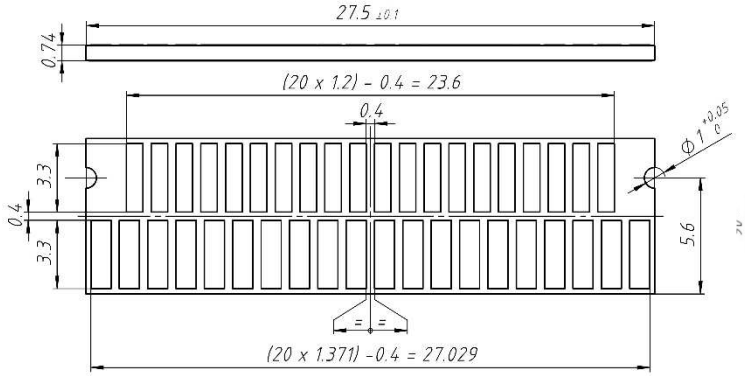



Fig. 3 Dimensions and pin-out of AP3403 encoder. Encoder 1 center must be aligned to Track 1 center (Fig 4) and Encoder 2 to Track 2.




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

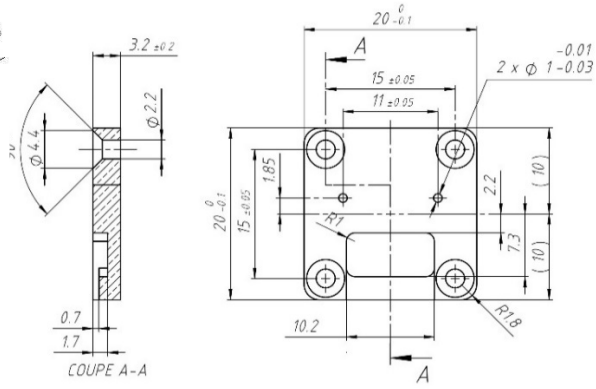
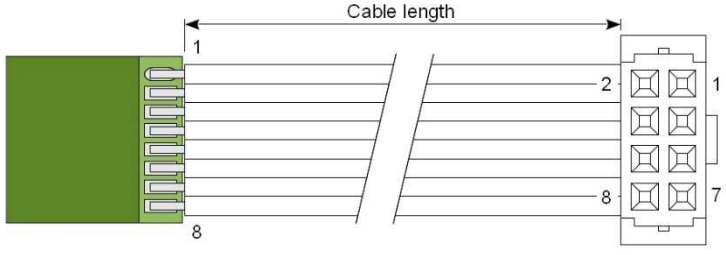



Fig. 5 Encoder Holder type A (see Table 6).




| 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-EEEEE-F-GGG-HH

| | | |
|---|---|---|
| A | Orientation | Table 1 |
| BB | Maximum speed | Table 2 |
| CC | SSI code | Table 3 |
| D | Look-Up Table | Table 4 |
| EEEEE | 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° |

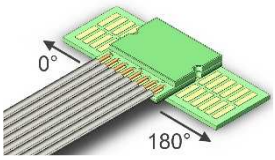



Table 2: Maximum speed

| 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)

| EEEEE | 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) |