MTS® SENSORS

# Temposonics®

Magnetostrictive Linear Position Sensors

## DATA SHEET
A-Series Linear Encoder


*The Measurable Difference*

## BENEFITS OF MAGNETOSTRICTION

Temposonics linear-position sensors use the time-based magnetostrictive position sensing principle developed by MTS. Within the sensing element, a sonic-strain pulse is induced in a specially designed magnetostrictive waveguide by the momentary interaction of two magnetic fields. One field comes from a moveable permanent magnet that passes along the outside of the sensor. The other field comes from an "interrogation" current pulse applied along the waveguide. The resulting strain pulse travels at sonic speed along the waveguide and is detected at the head of the sensing element.
The position of the magnet is determined with high precision and speed by accurately measuring the elapsed time between the application of the interrogation pulse and the arrival of the resulting strain pulse with a high-speed counter. The elapsed time measurement is directly proportional to the position of the permanent magnet and is an absolute value. Therefore, the sensor's output signal corresponds to absolute position, instead of incremental, and never requires recalibration or re-homing after a power loss. Absolute, non-contact sensing eliminates wear, and guarantees the best durability and output repeatability.

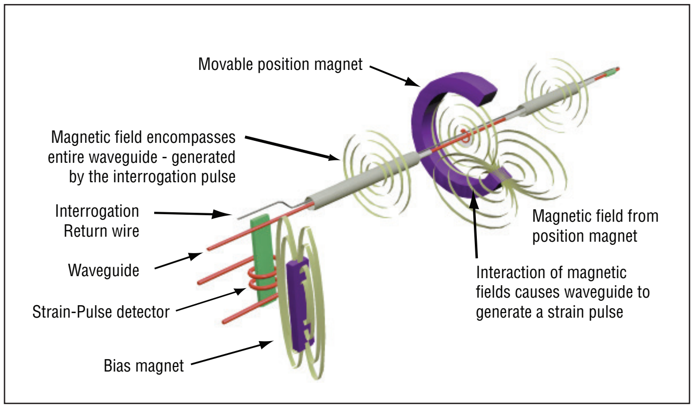



***Fig. 1:*** *Time-based Magnetostrictive position sensing principle*

## A-SERIES DUO LINEAR ENCODER

Robust, non-contact and wear free, the Temposonics® linear position transducers provide best durability and accurate position measurement solutions in harsh industrial environments. The position measurement accuracy is tightly controlled by the quality of the waveguide which is manufactured by MTS. The position magnet is mounted on the moving machine part and travels non-contact over the sensor rod with the built-in waveguide.

Temposonics® A-Series Duo Linear Encoder is a robust solution for combining absolute encoder feedback with an incremental encoder in a single sensor housing. With its easy installation and cabling, the A-Series is a cost-effective method to increase productivity.

***Fig. 2:*** *A-Series Duo Linear Encoder*

## TECHNICAL DATA

| | |
|---|---|
| **Output** | |
| Measured value | Position |
| Linearity deviation | ≤ ±0.01% F.S. (minimum 40 µm) |
| Outputs:<br>**Absolute** | <br>**SSI:** (Synchronous Serial Interface)<br>**Absolute calculation time:** 1 ms<br>**Resolution:** 1 µm |
| **Incremental (analog)** | 1Vpp sin/cos<br>**Signal period:** 20 µm or 50 µm<br>**Cuttoff frequency:** >100 kHz<br>**Measuring step:** 1 µm |
| **Incremental (digital)** | TTL A/B quadrature<br>**Signal period:** 1, 5, 10, 20, 50 µm<br>**Cutoff frequency:** >250 kHz<br>**Measure step:** 1 µm |
| Stroke length | 25 mm to 2000 mm (1 in. to 80 in.) |
| **Electronics** | |
| Operating voltage | 24 Vdc (+20% / -15%) |
| Current drain | < 110 mA (Typical) |
| **Environmental** | |
| Operating conditions | **Ingress protection:**<br>IP67, when appropriate connectors are correctly fitted<br>**Operating temperature:**<br>-40 °C to +85 °C (+185 °F)<br>**Relative humidity:** 90% no condensation<br>**Temperature coefficient:** < 15 ppm/ °C |
| EMC test | **Electromagnetic emission:**<br>IEC 61000-6-3:2011<br>**Electromagnetic susceptibility:**<br>IEC 61000-6-2:2005<br>The sensors meets the requirements of the EC directives and is marked with CE. |
| Shock rating | 100 g<br>IEC standard EN 60068-2-27 |
| Vibration rating | 15 g ( 20 - 2000 Hz) resonance frequency excluded<br>IEC standard EN 60068-2-6 |
| **Wiring** | |
| Connection type | 8-pin (M12) male connector and<br>12-pin (M12) male connector |

## Technical Drawing

*Drawing is for reference only and is subject to change. Contact applications engineering for application specific information.*

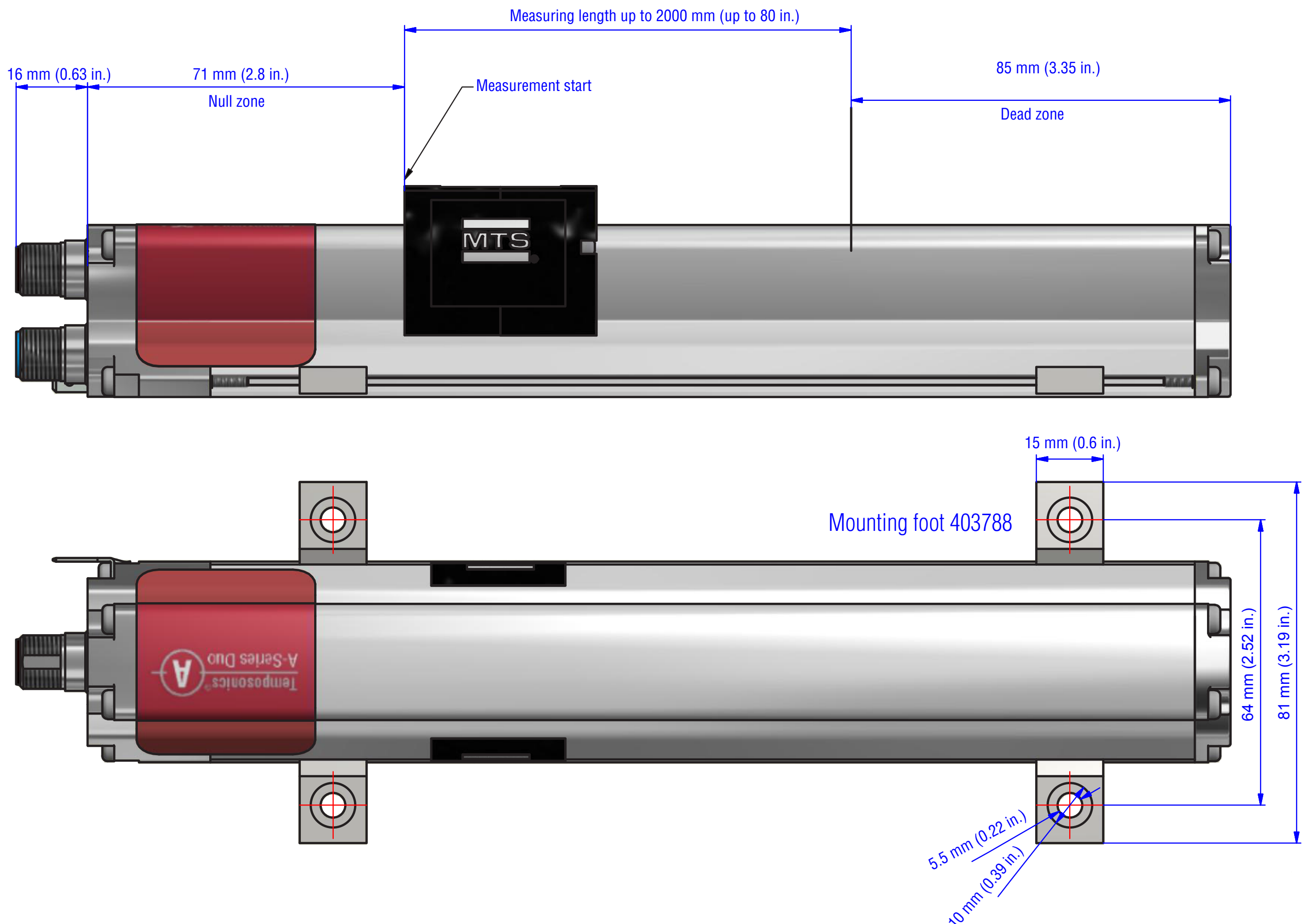



***Fig. 3:*** *Dual Channel linear encoder dimension reference*

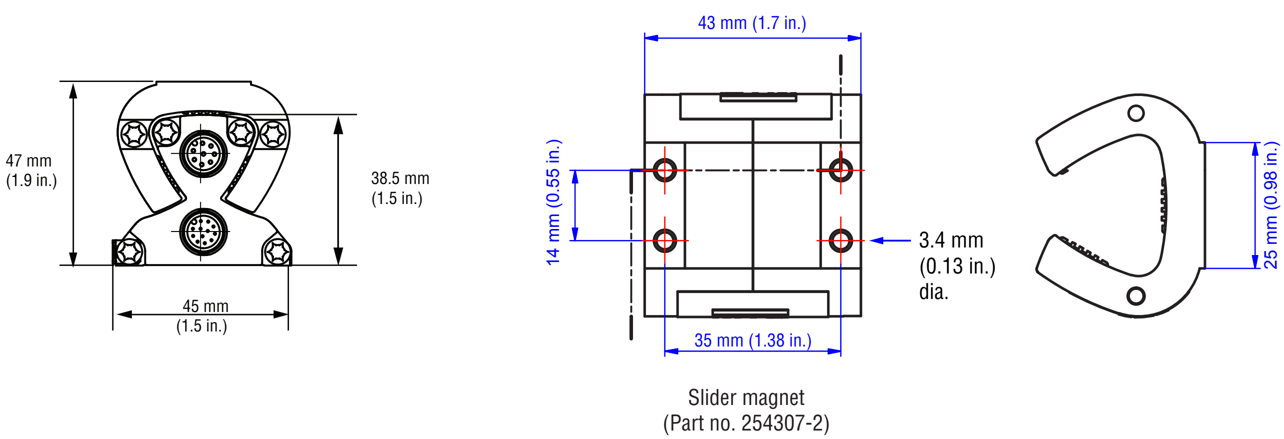
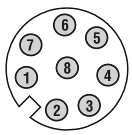



***Fig. 4:*** *Dual Channel linear encoder dimension reference*

## CONNECTOR WIRING

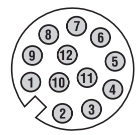
### M12-8 pole connector




(Mates with extension cable 531140)

| M12-8 | Pin | Signal | Extension Cable Color |
|---|---|---|---|
| | 3 | Sin+ | Brown |
| | 2 | Sin- | Brown/White |
| | 8 | Cos+ | Green |
| | 5 | Cos- | Green/White |
| | | Reserved | ----------------- |
| | | Reserved | ----------------- |
| | | Reserved | ----------------- |
| | | Reserved | ----------------- |

### M12-12 pole connector




(Mates with extension cable 531139)

| M12-12 | Pin | Signal | Extension Cable Color |
|---|---|---|---|
| | 12 | VCC 24 VDC | Red/Blue |
| | 11 | Ground | Gray/Pink |
| | 10 | Apos | Purple |
| | 7 | Aneg | Black |
| | 8 | Bpos | Gray |
| | 5 | Bneg | Pink |
| | 6 | DATA+ | Yellow |
| | 4 | DATA- | Green |
| | 1 | CLOCK+ | Brown |
| | 3 | CLOCK- | White |
| | 2 | INDEX+ | Blue |
| | 9 | INDEX- | Red |

## INCREMENTAL QUADRATURE

The signal period is 1,5,10,20, or 50 micrometers for 1X counting.

Index is selectable by the user!

Due to the Incremental nature of the output, the signal period is established after traveling the minimum defined distance for the selected signal period.

## Index

The index is gated to the leading signal edge. The index signal delay is < 600 ns from the leading edge. The length of the index pulse is one increment.

### Quadrature interface

| Transmission standard for A/B/Z | RS422 differential / incremental |
|---|---|
| Amplitude of differential signals | 5V |
| Maximum operating speed | 250 kHz |
| Frequency A/B- signal | variable, depending on operating speed |
| Length Z- pulse | 1 increment |

***Fig. 5:*** *Quadrature interface*

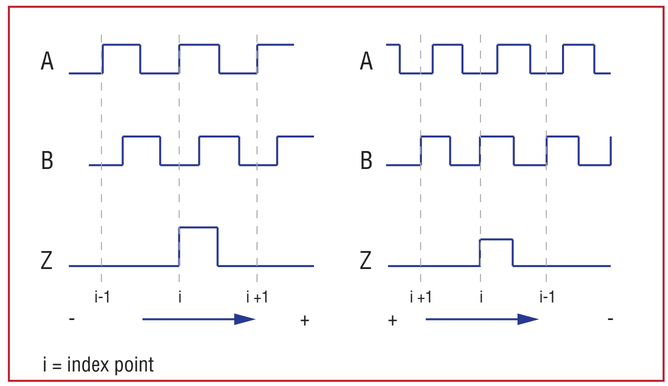



***Fig. 6:*** *Gated to Leading Signal Edge*

## INCREMENTAL SIN/COS

The signal period is 20 or 50 micrometers. Max operating frequency is 100kHz.

Max Speed calculations: 100kHz * signal period in micrometer => meters per second, e.g. 20 micrometers signal period equals 2000mm/s max speed, 50 micrometers signal period equals 5000mm/s max speed.

The amplitude for the differential sin/cos is 1Vpp with common mode at 0.5V as depicted in Figure 7.

The signal period is depicted in Figure 8. Due to the Incremental nature of the output, the signal period is established after traveling the minimum distance for the selected signal period.

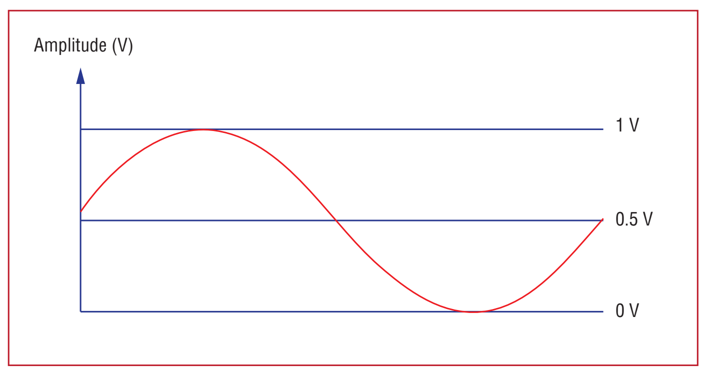



***Fig. 7:*** *Amplitude for Sin/Cos*

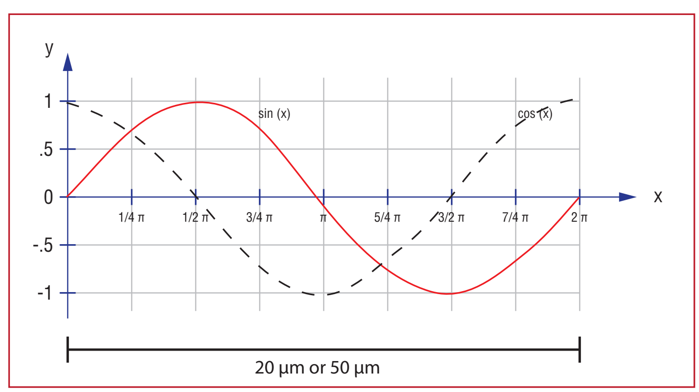



***Fig. 8:*** *Signal period*

## ABSOLUTE SYNCHRONOUS SERIAL INTERFACE (SSI)

Temposonics R-Series sensors with SSI fulfill all requirements of the SSI standard for an absolute encoder. The position value is encoded in a 24/25/26 bit code format and is transmitted at high speed in SSI standard format to the control device. The main feature of SSI is the synchronized data transfer. Data transfer synchronization simplifies the closed-loop control system.

A clock pulse train from a controller is used to gate out sensor data. One bit of position data is transmitted to the controller for each clock pulse received by the sensor (see 'Figures 9 and 10'). The absolute position data is continually updated by the sensor and converted by the shift register into serial information. (see 'Figure 11').

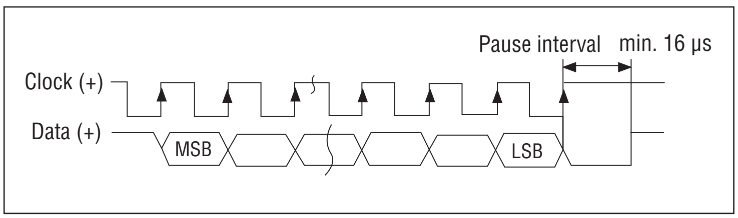



***Fig. 9:** Timing diagram*

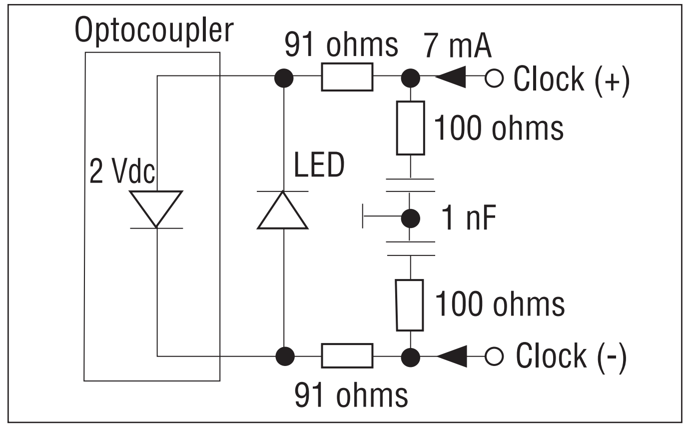



***Fig. 10:** Sensor input*

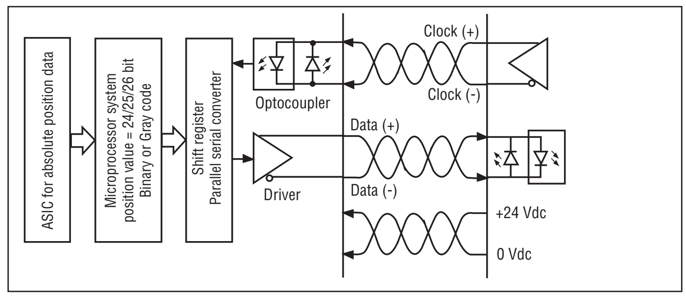



***Fig. 11:** Logic diagram*

## MEASURING MODE

### The Sensor Measurement Cycle

For all Temposonics position sensors, the measurement cycle begins with a very short electrical current pulse being applied to the sensor's waveguide. This is called the 'interrogation pulse'. It creates a magnetic field that interacts with another magnetic field emanating from the position magnet. This interaction produces the magnetostrictive effect and results in a localized mechanical strain in the sensor's waveguide. When the interrogation pulse ends, the strain is suddenly released, sending a rotational sonic strain pulse down the waveguide. The measurement cycle ends when the sonic strain pulse arrives at the end of the waveguide and is detected by the sensor's electronics. By accurately measuring the travel time of the sonic strain pulse the magnet's precise position is determined.

### Asynchronous Measuring Mode

For the SSI sensor, the position data is always communicated to the controller or PLC using the Synchronous Serial Interface format. When the SSI sensor is operated as fast as possible, i.e. in Asynchronous Measuring Mode, the position data is updated and stored inside the sensor as quickly as the sensor's measurement cycle will allow. The minimum time for the measurement cycle is determined by the sensor's overall stroke length.
The controller's loop time will determine when the sensor's stored data is collected. For this mode the controller loop time is not synchronized with the sensor's measurement cycle time. However, if it is always slower than the sensor's cycle time then there will always be new position data available in the sensor's shift register, waiting to be clocked out over the SSI interface.
As shown in 'Figure 12 ', although the sensor is updating the position data as fast as possible, the actual data values collected by the controller can have varying delay times. This is shown as the delays from when the magnet's position was captured, (at the instant the interrogation pulse had started the relevant measurement cycle), to when the data is delivered at the end of the controller loop cycle.

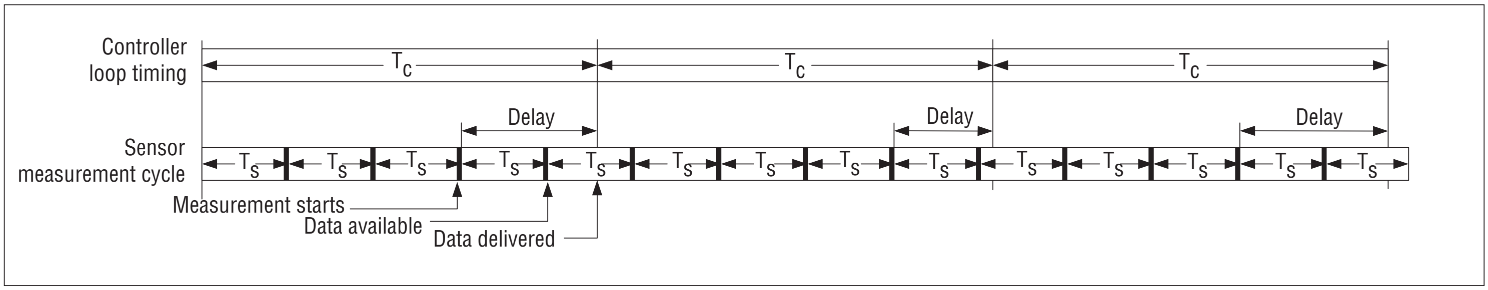


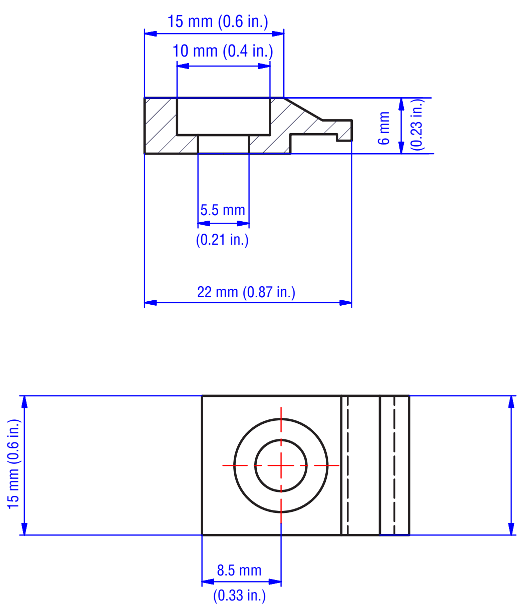
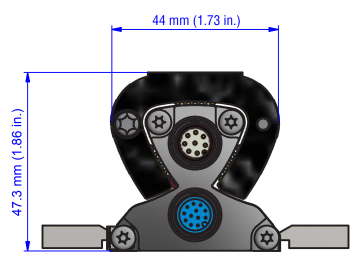

***Fig. 12:** Asynchronous SSI Interface*

## A-Series Sensor mounting

**A-Series profile-style sensor mounting flexible installation in any position!**

**Notes:**

1. A-Series profile-style sensors include mounting feet (part no. 403788) for sensors stroke lengths up to 1250 mm (50 in.)
2. Two additional mounting feet are included for stroke lengths over 1250 mm (50 in.) and for each additional 500 mm (20 in.), thereafter.
3. MTS recommends using M5 or 10-32 cap screws *(customer supplied)* at a maximum torque of 5 Nm (44 in. lbs.) when fastening mounting feet.

| Profile-Style sensor mounting and installation reference | Mounting method | Part number |
|---|---|---|
|   | **Mounting feet, standard (303 SS)**<br>Profile-style sensor mounting for A-Series<br>  | 403788 |

## ORDER CODE

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | P | A | | | | | | D | 2 | | 1 | D | 1 | | | | | | |
| | | a | b | | | | | c | | | d | e | | | | | | f | |

### a Form factor

| | |
|---|---|
| A | A-Series floating horseshoe style magnet (provided with sensor) |

### b Stroke length

| | |
|---|---|
| □□□□ M | M = millimeters (25 to 2000 mm in 5 mm increments) |
| □□□.□ U | U = Inches and tenths (1 to 80 in 0.1" increments) |

### c Connector type

| | |
|---|---|
| D 2 0 | One 12-pin male M12 connector (A-coded) for TTL/SSI (and a metal cap on the 2nd M12 connector) |
| D 2 1 | One 12-pin male M12 connector (A-coded) for SSI and one 8-pin male M12 connector (A-coded) for sin/cos |

### d Input voltage

| | |
|---|---|
| 1 | +24 VDC (+20 %, –15 %), standard |

### e Absolute output

D □□□□□

#### Interface

D ■□□□□

| | |
|---|---|
| 1 | SSI |

#### Data length

D □■□□□

| | |
|---|---|
| 1 | 25 bit |
| 2 | 24 bit |
| 3 | 26 bit |

#### Output format

D □□■□□

| | |
|---|---|
| G | Gray code |
| B | Binary |

### e Absolute output (continued)

#### Absolute channel resolution

D □□□■□

| | |
|---|---|
| 1 | 0.005 mm |
| 2 | 0.01 mm |
| 3 | 0.05 mm |
| 4 | 0.1 mm |
| 5 | 0.02 mm |
| 6 | 0.01 mm |
| 8 | 0.001 mm |

#### Direction

D □□□□■

| | |
|---|---|
| 0 | forward-acting, async mode |
| 1 | reverse-acting, async mode |

### f Incremental output

#### Incremental signal

■□

| | |
|---|---|
| 1 | Sine/Cosine, 1Vpp |
| 2 | TTL (A/B Quadrature) |

#### Incremental signal period

□■

| | |
|---|---|
| 1 | 0.005 mm (TTL only) |
| 2 | 0.01 mm (TTL only) |
| 3 | 0.05 mm |
| 5 | 0.02 mm |
| 8 | 0.001 mm (TTL only) |

## STANDARD STROKE LENGTH

| Stroke length (mm) | Ordering steps |
|---|---|
| < 500 mm | 5 mm |
| 500…750 mm | 10 mm |
| 750…1000 mm | 25 mm |
| 1000…2000 mm | 50 mm |

| Stroke length (IN) | Ordering steps |
|---|---|
| ≤ 20 in. | 0.2 in. |
| > 20 in. and ≤ 30 in. | 0.5 in. |
| > 30 in. and ≤ 40 in. | 1 in. |
| > 40 in. and ≤ 80 in. | 2 in. |