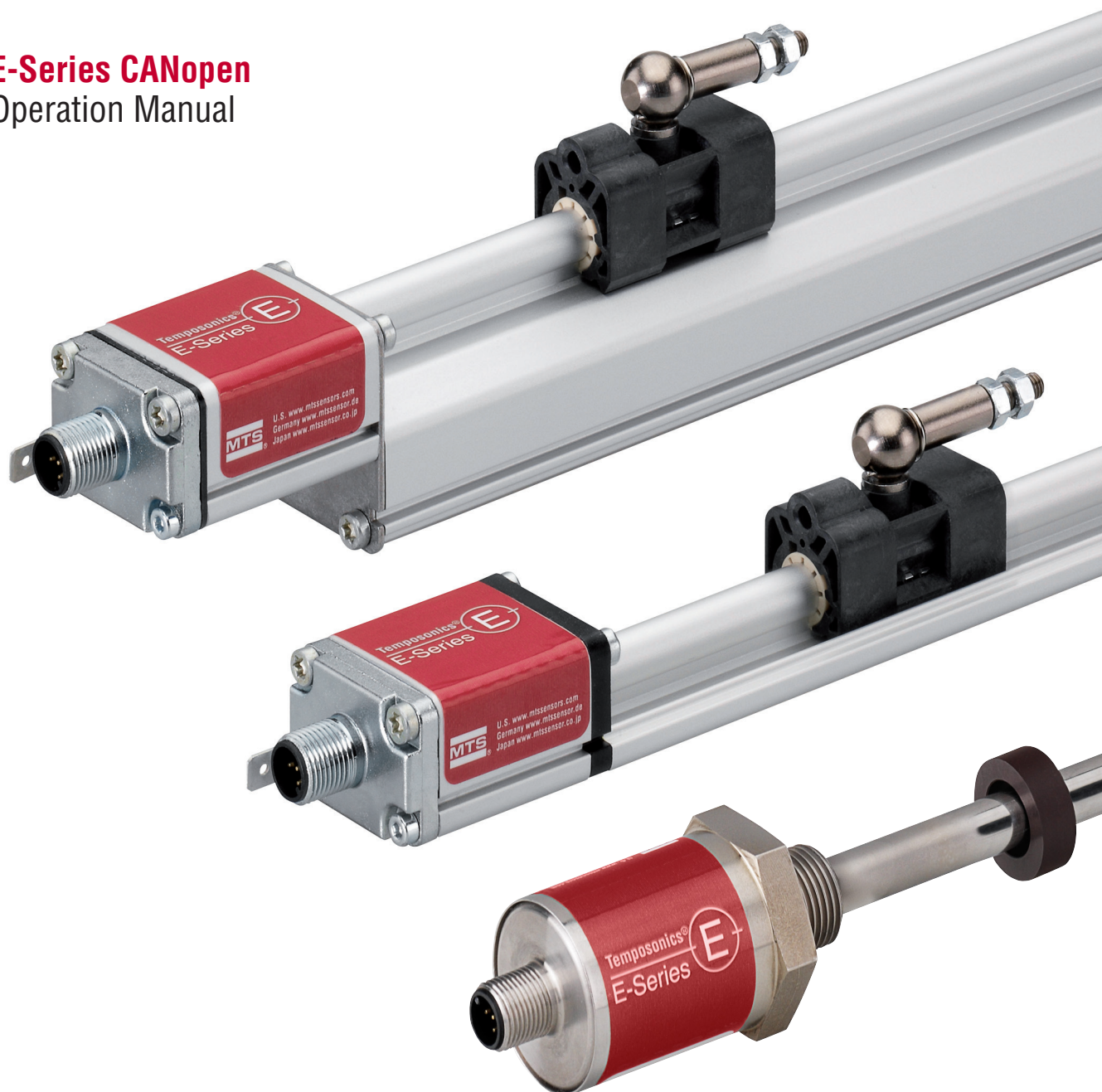


# Temposonics®

Magnetostrictive Linear Position Sensors

## E-Series CANopen Operation Manual



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## 1. Introduction

### 1.1 Purpose and use of this manual

The content of this technical documentation and of its various annexes is intended to provide information on mounting, installation and commissioning by qualified automation personnel<sup>1</sup> or instructed service technicians who are familiar with the project planning and dealing with Temposonics® sensors.

Before starting the operation of Temposonics® sensors read this documentation thoroughly and follow the safety information. Keep the manual for future reference!

### 1.2 Used symbols and warnings

Warnings are intended for your personal safety and for avoidance of damage to the described product or connected devices. In this documentation, safety information and warnings to avoid danger that might affect the life and health of operating or service personnel or cause material damage are highlighted by the preceding pictogram, which is defined below.

Symbol	Meaning
<b>NOTICE</b>	This symbol is used to point to situations that may lead to material damage, but not to personal injury.

<sup>1/</sup> The term *qualified technical personnel* characterizes persons who:

- are familiar with the safety concepts of automation technology applicable to the particular project,
- are competent in the field of EMC,

- have received adequate training for commissioning and service operations
- are familiar with the operation of the device and know the information required for correct operation provided in the product documentation.

## 2. Safety instructions

### 2.1 Intended use

This product may be used only for the applications defined under item 1 in conjunction with the third-party devices and components recommended or approved by MTS Sensors. As a prerequisite of proper and safe operation, the product requires correct transport, storage, mounting and commissioning and must be operated with utmost care.

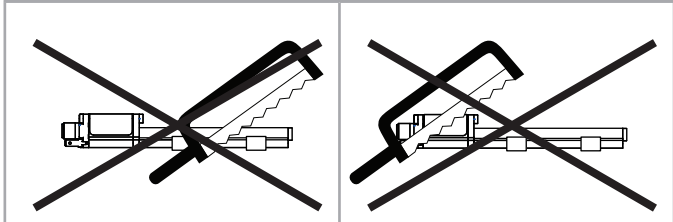
1. The sensor systems of all Temposonics® series are intended exclusively for measurement tasks encountered in industrial, commercial and laboratory applications. The sensors are considered as system accessories and must be connected to suitable evaluation electronics, e.g. a PLC, IPC, indicator or other electronic control unit.

### 2.2 Forseeable misuse

Forseeable misuse	Consequence
Wrong sensor connection	The sensor does not work properly or will be destroyed
Operate the sensor out off the operating temperature	No signal output The sensor can be damaged
Power supply is out of the defined range	Signal output is wrong / no signal output / the sensor will be damaged
Position measurement is influenced by an external magnetic field	Signal output is wrong
Cables are damaged	Short circuit – the sensor can be destroyed / sensor does not respond
Spacers are missing / are installed in a wrong order	Error in position measurement
Wrong connection of ground / shield	Signal output is disturbed The electronics can be damaged
Use of a magnet that is not certified by MTS Sensors	Error in position measurement

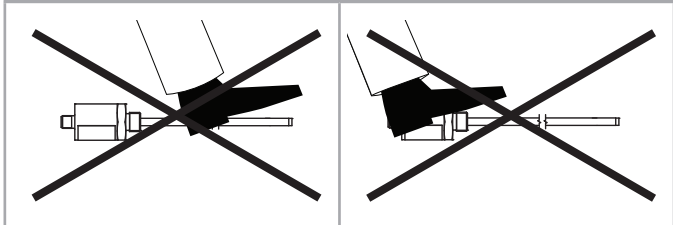
Do not reprocess the sensor afterwards.

→ The sensor might be damaged.



Do not step on the sensor.

→ The sensor might be damaged.



### 2.3 Installation, commissioning and operation

The position sensors must be used only in technically safe condition. To maintain this condition and to ensure safe operation, installation, connection and service work may be performed only by qualified technical personnel.

If danger of injury to persons or of damage to operating equipment is caused by sensor failure or malfunction, additional safety measures such as plausibility checks, limit switches, EMERGENCY STOP systems, protective devices etc. are required. In the event of trouble, shut down the sensor and protect it against accidental operation.

#### Safety instructions for commissioning

To maintain the sensor operability, it is mandatory to follow the instructions given below.

1. Protect the sensor against mechanical damage during installation and operation.
2. Do not open or dismantle the sensor.
3. Connect the sensor very carefully and pay attention to the polarity of connections and power supply.
4. Use only approved power supplies.
5. It is indispensable to ensure that the specified permissible limit values of the sensor for operating voltage, environmental conditions, etc. are met.
6. Check the function of the sensor regularly and provide documentation of the checks.
7. Before system switch-on, ensure that nobody's safety is jeopardized by starting machines.

### 2.4 Safety instructions for use in explosion-hazardous areas

The sensor is not suitable for operation in explosion-hazardous areas.

### 2.5 Warranty

MTS Sensors grants a warranty<sup>2</sup> period for the Temposonics® position sensors and supplied accessories relating to material defects and faults that occur despite correct use in accordance with the intended application<sup>2</sup>. The MTS Sensors obligation is limited to repair or replacement of any defective part of the unit. No warranty can be taken for defects that are due to improper use or above average stress of the product, as well as for wear parts. Under no circumstances will MTS Sensors accept liability in the event of offense against the warranty rules, no matter if these have been assured or expected, even in case of fault or negligence of the company.

MTS Sensors explicitly excludes any further warranties. Neither the company's representatives, agents, dealers nor employees are authorized to increase or change the scope of warranty.

### 2.6 Return

For diagnostic purposes, the sensor can be returned to MTS Sensor Technologie GmbH & Co. KG. Any shipment cost will be borne by the sender<sup>2</sup>. For a corresponding form, see chapter "9. Annex" on page 42.

<sup>2/</sup> See also applicable MTS Sensors sales and supply conditions, e.g. under [www.mtssensors.com](http://www.mtssensors.com)

### 3. Identification

#### 3.1 Order structure of E-Series EP

##### Temposonics® order code

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
E	P	0						D	3	4	1	C						1			
a		b	c					d			e	f			g	h	i	j optional			

#### a Sensor model

E	P	Profile
---	---	---------

#### b Design

0	Without position magnet
---	-------------------------

#### c Stroke length

X	X	X	X	M	0050...2540 mm
X	X	X	X	U	002.0...100.0 in.

##### Standard stroke length (mm)\*

Stroke length	Ordering steps
50 ... 500 mm	25 mm
500...2540 mm	50 mm

##### Standard stroke length (in.)\*

Stroke length	Ordering steps
2 ... 20 in.	1.0 in.
20...100 in.	2.0 in.

#### d Connection type

D	3	4	5 pin M12
---	---	---	-----------

#### e Operating voltage

1	+24 VDC (-15 / +20 %)
---	-----------------------

#### f Output

C	3	0	4	CANopen
C	4	0	4	CANopen (duo terminator)

#### g Baud rate

1	1000 kBit/s
2	500 kBit/s
3	250 kBit/s
4	125 kBit/s

#### h Resolution

4	10 µm
5	20 µm

#### i Type

1	Standard
---	----------

##### Optional:

#### j Magnet number for multi position measurement

Z	0	2	2 magnets
---	---	---	-----------

\* / Non standard stroke lengths are available; must be encoded in 5 mm / 0.1 in. increments

### 3.2 Order structure of E-Series EL

#### Temposonics® order code

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
E	L	0						D	3	4	1	C						1				
a		b	c					d			e	f				g	h	i	j optional			

a	Sensor model	
E	L	Low profile

b	Design	
0	Without position magnet	

c	Stroke length				
X	X	X	X	M	0050...2540 mm
X	X	X	X	U	002.0...100.0 in.

#### Standard stroke length (mm)\*

Stroke length	Ordering steps
50 ... 500 mm	25 mm
500...2540 mm	50 mm

#### Standard stroke length (in.)\*

Stroke length	Ordering steps
2 ... 20 in.	1.0 in.
20...100 in.	2.0 in.

d	Connection type		
D	3	4	5 pin M12

e	Operating voltage	
1	+24 VDC (-15 / +20 %)	

f	Output			
C	3	0	4	CANopen
C	4	0	4	CANopen (duo terminator)

g	Baud rate	
1	1000 kBit/s	
2	500 kBit/s	
3	250 kBit/s	
4	125 kBit/s	

h	Resolution	
4	10 µm	
5	20 µm	

i	Type	
1	Standard	

#### Optional:

j	Magnet number for multi position measurement		
Z	0	2	2 magnets

\*/ Non standard stroke lengths are available; must be encoded in 5 mm / 0.1 in. increments

### 3.3 Order structure of E-Series EH

#### Temposonics® order code

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
E	H										1	C							1			
a		b	c					d			e	f				g	h	i	j			
optional																						

a	Sensor model
E H	Rod

b	Design
<b>Model EH rod-style sensor with housing 1.4305 (AISI 303) rod, material 1.4301 (AISI 304)</b>	

K	Flange M18×1.5-6g / rod Ø 7 mm
L	Flange ¾"-UNF-3A / rod Ø 7 mm

<b>Model EH rod-style sensor with housing 1.4305 (AISI 303) rod, material 1.4306 (AISI 304L)</b>	
--	--

M	Flange M18×1.5-6g / rod Ø 10 mm
S	Flange ¾"-UNF-3A / rod Ø 10 mm

<b>Model EH rod-style sensor with housing 1.4404 (AISI 316L) rod, material 1.4404 (AISI 316L)</b>	
---	--

F	Flange ¾"-UNF-3A / rod Ø 10 mm
W	Flange M18×1.5-6g / rod Ø 10 mm

c	Stroke length
X X X X M	0050...2540 mm
X X X X U	002.0...100.0 in.

#### Standard stroke length (mm)\*

Stroke length	Ordering steps
50 ... 500 mm	5 mm
500 ... 750 mm	10 mm
750...1000 mm	25 mm
1000...2540 mm	50 mm

#### Standard stroke length (in.)\*

Stroke length	Ordering steps
2... 20 in.	0.2 in.
20... 30 in.	0.4 in.
30... 40 in.	1.0 in.
40...100 in.	2.0 in.

d	Connection type
D 3 4	5 pin M12
E H 1	2 m PUR cable (Part no. 530 166)
E H 2	5 m PUR cable (Part no. 530 166)
E H 3	10 m PUR cable (Part no. 530 166)
E H 4	15 m PUR cable (Part no. 530 166)
E T 1	2 m Teflon® cable (Part no. 530 157)
E T 2	5 m Teflon® cable (Part no. 530 157)
E T 3	10 m Teflon® cable (Part no. 530 157)
E T 4	15 m Teflon® cable (Part no. 530 157)

e	Operating voltage
1	+24 VDC (-15 / +20 %)

f	Output
C 3 0 4	CANopen
C 4 0 4	CANopen (duo terminator)

g	Baud rate
1	1000 kBit/s
2	500 kBit/s
3	250 kBit/s
4	125 kBit/s

h	Resolution
4	10 µm
5	20 µm

i	Type
1	Standard

#### Optional:

j	Magnet number for multi position measurement
Z 0 2	2 magnets

\*/ Non standard stroke lengths are available; must be encoded in 5 mm / 0.1 in. increments



### 3.4 Nameplate

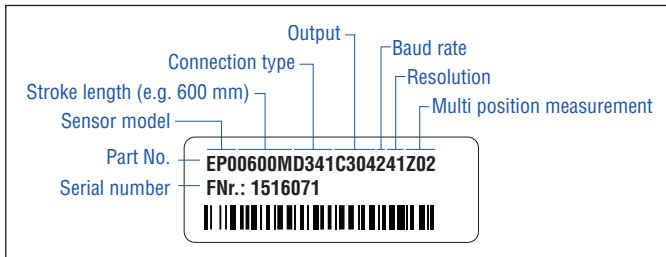


Fig. 1: Example of nameplate

### 3.5 Approvals

CE certification, UL/cUL certified\*

### 3.6 Scope of delivery

#### E-Series EP (profile)

Sensor, 2 mounting clamps up to 1250 mm (49 in.) +  
1 clamp for each 500 mm (20 in.)

#### E-Series EL (low profile)

Sensor, 2 mounting clamps up to 1250 mm (49 in.) +  
1 clamp for each 500 mm (20 in.)

#### E-Series EH (rod)

Sensor and O-ring

3/ Only sensors with connector outlets are UL/cUL certified

## 4. Product description and commissioning

### 4.1 Functionality and system design

#### Product designation

- Position sensor Temposonics® E-Series

#### Construction serie

- Temposonics® E-Series EP/EL/EH
- Stroke length: EP 50...2540 mm (2...100 in.)  
EL 50...2540 mm (2...100 in.)  
EH 50...2540 mm (2...100 in.)
- Output signal: CANopen

#### Application

The Temposonics® sensor is used for measurement and conversion of the length (position) variable in the fields of automated systems and mechanical engineering.

#### Principle of operation and system construction

For position measurement, the absolute, linear Temposonics® position sensors make use of the properties offered by the specially designed magnetostrictive waveguide. Inside the sensor a torsional strain pulse is induced in the waveguide by momentary interaction of two magnetic fields. The interaction between these two magnetic fields produces a strain pulse, which is detected by the converter at the sensor electronics housing. One field is produced by a moving position magnet, which travels along the sensor rod with the waveguide inside. The other field is generated by a current pulse applied to the waveguide. The position of the moving magnet is determined precisely by measuring the time-of-flight between the application of the current pulse and the arrival of the strain pulse at the sensor head. The result is a reliable position measurement with high accuracy and repeatability.

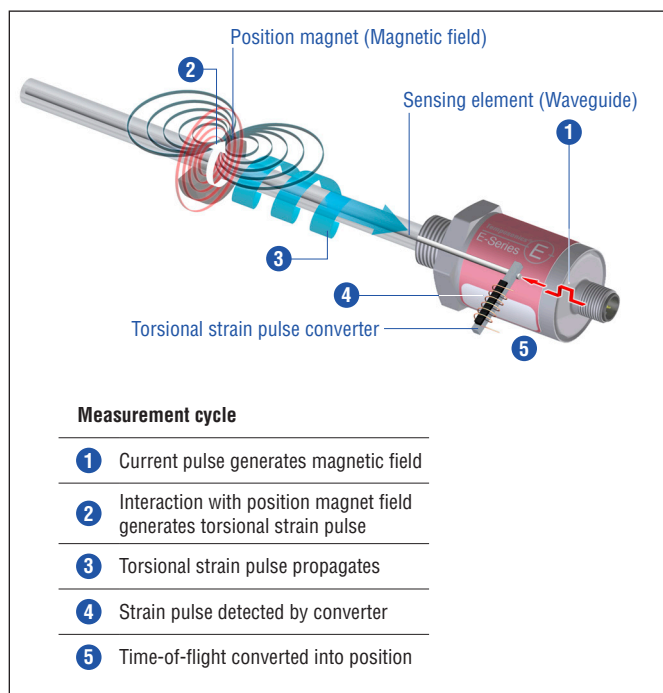


Fig. 2: Principle of operation: Time-of-flight based magnetostrictive position sensing principle

#### Modular mechanical and electronic construction

- The sensor housing (rod/profile) protects the sensor element.
- The sensor electronics housing, a rugged aluminum/stainless steel construction, contains the complete electronic interface with active signal conditioning.
- The external position magnet is a permanent magnet. Mounted on the mobile machine part, it travels along the sensing element and triggers the measurement through the housing wall.
- Depending on the type, the sensor is connected to the controller via a plug.
- The sensor can be connected directly to a control system. Its electronics generates a strictly position-proportional signal output between zero and end position.

## 4.2 Styles and installation of E-Series EP

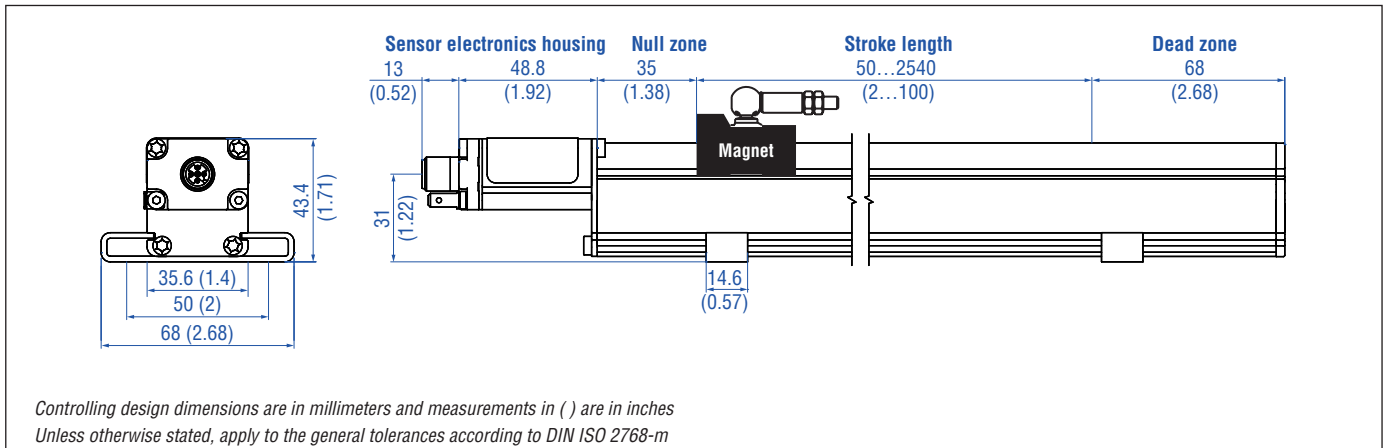


Fig. 3: Temposonics® E-Series EP

### Installation of EP

The position sensor can be installed in any position. Normally, the sensor is firmly installed and the position magnet is fastened to the mobile machine part. Thus it can travel along the sensor rod contactlessly.

The sensor is fitted on a flat machine surface using mounting clamps (Fig. 4). A length-dependent number of these clamps are delivered with the sensor and must be distributed over the profile at regular distances.

For fastening, we recommend using M5×20 screws according to DIN 6912 that should be tightened with a maximum fastening torque of 5 Nm.

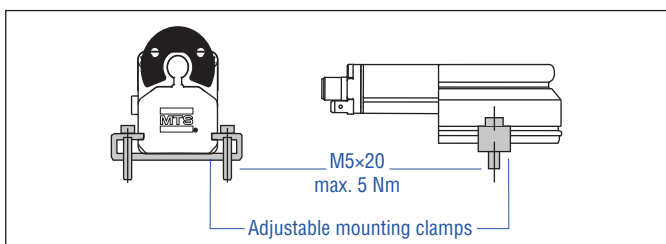


Fig. 4: Mounting clamps with cylinder screw M5×20, fastening torque ≤ 5 Nm on a Temposonics® E-Series EP sensor with U-magnet

### NOTICE

Do not mount the sensors in the area of strong magnetic or electric noise fields. Take care to mount the sensor in an axially parallel position to avoid damaging the carriage, magnet and sensor rod.

The sensor is isolated from the machine ground. For this reason, grounding via grounding lug on the sensor electronics housing is indispensable (Fig. 5).

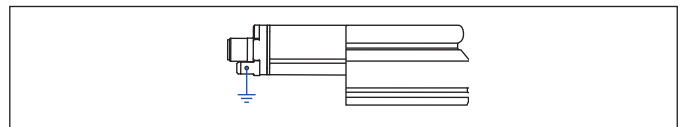


Fig. 5: Grounding profile sensor

### 4.3 Styles and installation of E-Series EL

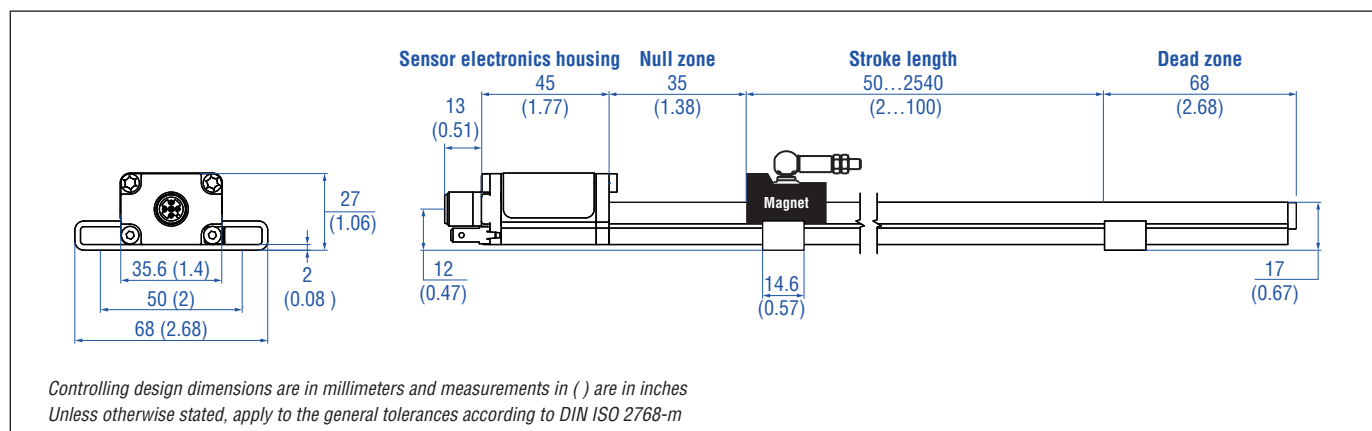


Fig. 6: Temposonics® E-Series EL

#### Installation of EL

The position sensor can be installed in any position. Normally, the sensor is firmly installed and the position magnet is fastened to the mobile machine part. Thus it can travel along the sensor rod contactlessly.

The sensor is fitted on a flat machine surface using the mounting clamps (Fig. 7). A length-dependent number of these clamps are delivered with the sensor and must be distributed over the profile at regular distances.

For fastening, we recommend using M5×20 screws according to DIN 6912 that should be tightened with a maximum fastening torque of 5 Nm.

#### NOTICE

Do not mount the sensors in the area of strong magnetic or electric noise fields. Take care to mount the sensor in an axially parallel position to avoid damaging the carriage, magnet and sensor rod.

The sensor is isolated from the machine ground. For this reason, grounding via grounding lug on the sensor electronics housing is indispensable (Fig. 5).

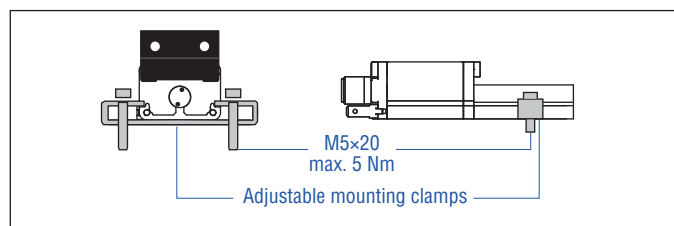


Fig. 7: Mounting clamps with cylinder screw M5×20, fastening torque ≤ 5 Nm  
on a Temposonics® E-Series EL sensor with block magnet

#### 4.4 Styles and installation of E-Series EH

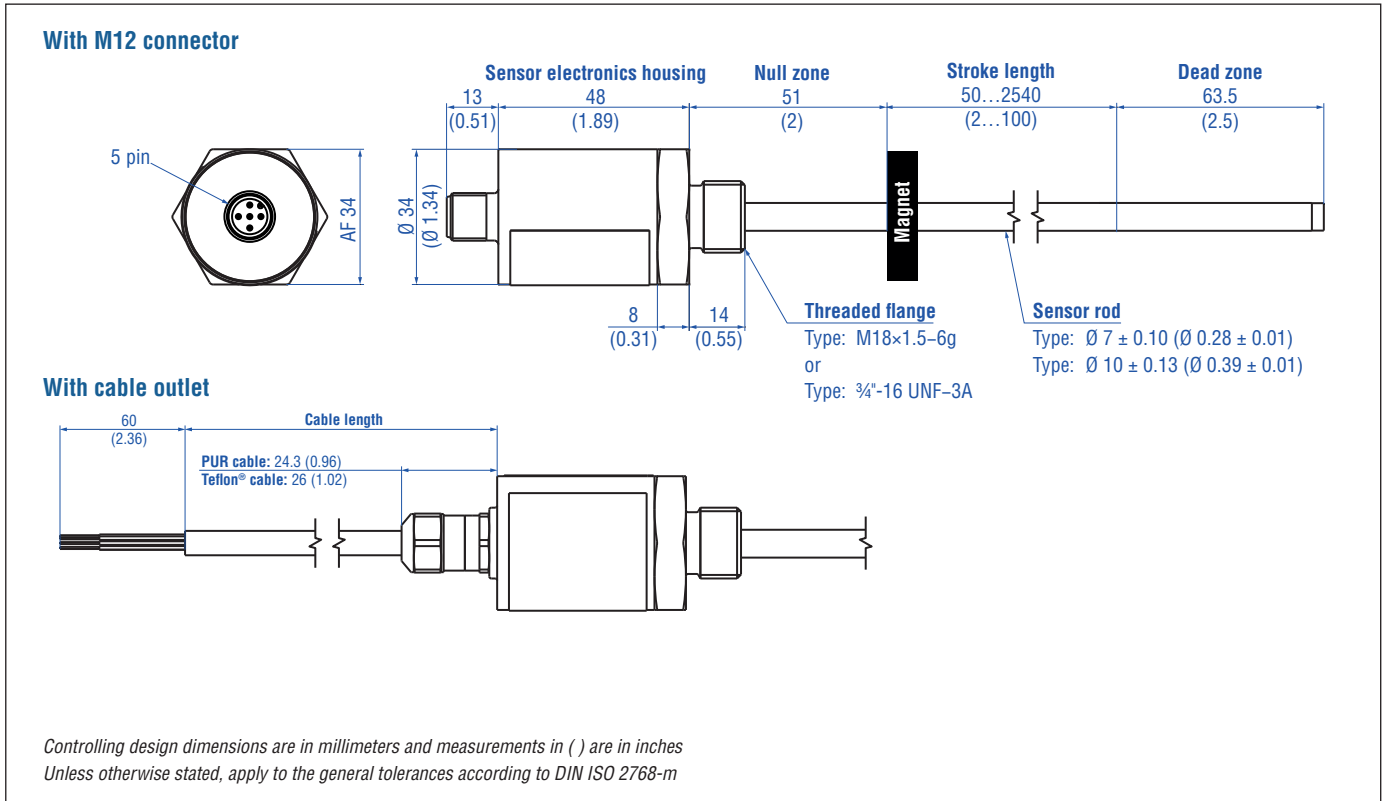


Fig. 8: Temposonics® E-Series EH

#### Installation of EH

The rod-style version has been developed for direct stroke measurement in a fluid cylinder. Mounted on the bottom of the piston, the ring magnet travels over the rod contactlessly and marks the position exactly through the rod wall – independent of the hydraulic fluid.

#### Hydraulic sealing

The sealing via a 15.3 × 2.2 O-ring in the undercut is possible (Fig. 9). A screw hole based on ISO 6149-1 (Fig. 10) must be provided.

- The flange contact surface must be seated completely on the cylinder mounting surface.
- The cylinder manufacturer determines the pressure-resistant gasket (copper gasket, O-ring, etc.).
- The position magnet should not grind on the rod.
- The plunger borehole (Ø 10 mm rod: ≥ Ø 13 mm (≥ Ø 0.52 in.) / Ø 7 mm rod: ≥ Ø 10 mm (≥ Ø 0.4 in.)) depends on the pressure and piston speed.
- The peak pressure should not be exceeded.
- Protect the sensor rod from wear using suitable constructive measures.

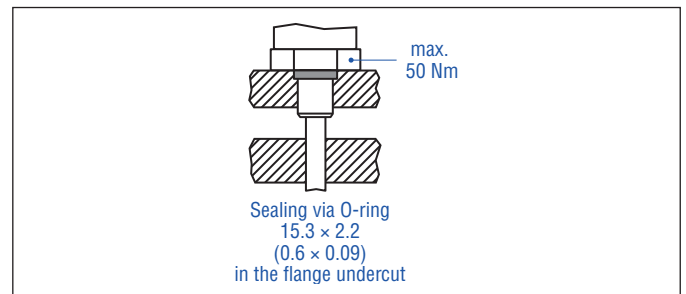


Fig. 9: Sealing via O-ring 15.3 × 2.2 in the flange undercut

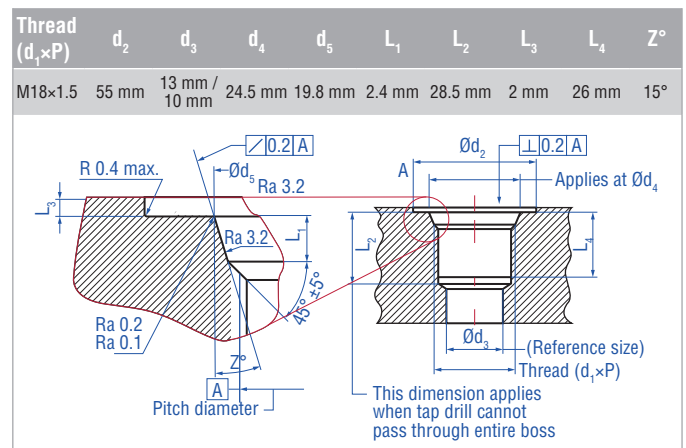


Fig. 10: Notice for threaded flange M18x1.5-6g lean on DIN ISO 6149-1

#### 4.5 Magnet installation

##### Mounting the ring magnet

Install the magnet using non-magnetizable material for mounting device, screws, spacers etc.

- Max. permissible surface pressure: 40 N/mm<sup>2</sup>
- Max. fastening torque for M4 screws: 1 Nm; use washers, if necessary
- Minimum distance between position magnet and any magnetic material have to be 15 mm (0.6 in.).  
If no other option exists and magnetic material is used, observe the specified dimensions (Fig. 11)

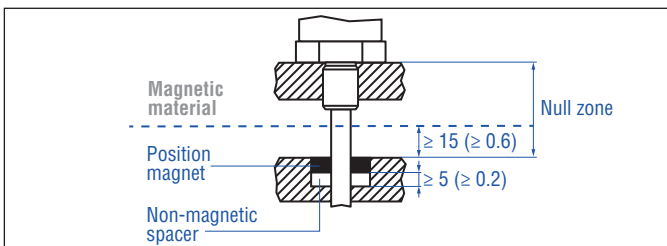


Fig. 11: Installation with magnetizable material

##### Mounting the U-magnet

Using a non-magnetizable mounting device is mandatory. The magnet must not grind on the sensor rod. Alignment errors are compensated via the air gap.

- Max. surface pressure: 40 N/mm<sup>2</sup>
- Max. fastening torque for M4 screws: 1 Nm; use washer, if necessary

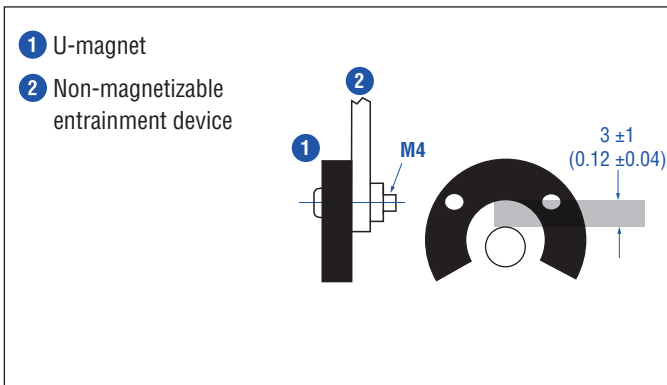


Fig. 12: Mounting device for U-magnet

#### NOTICE

A maximum permissible air gap of 3 mm (0.12 in.) must not be exceeded.

##### Large stroke lengths from 1 meter (39 in.)

Horizontally installed sensors should be supported mechanically at the rod end. Longer rods require evenly distributed mechanical support over the entire length. In this case (Fig. 13) the sensor rod can be supported by fixing clips and an U-magnet can be used for measurement.

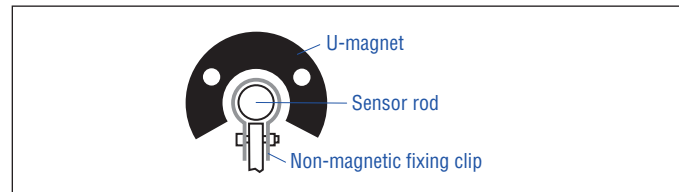


Fig. 13: Example of sensor support

### Active measuring range

The technical data of each sensor is checked as well as documented and the active stroke length (useful electrical stroke) with its start and end position is adjusted during final inspection and testing.

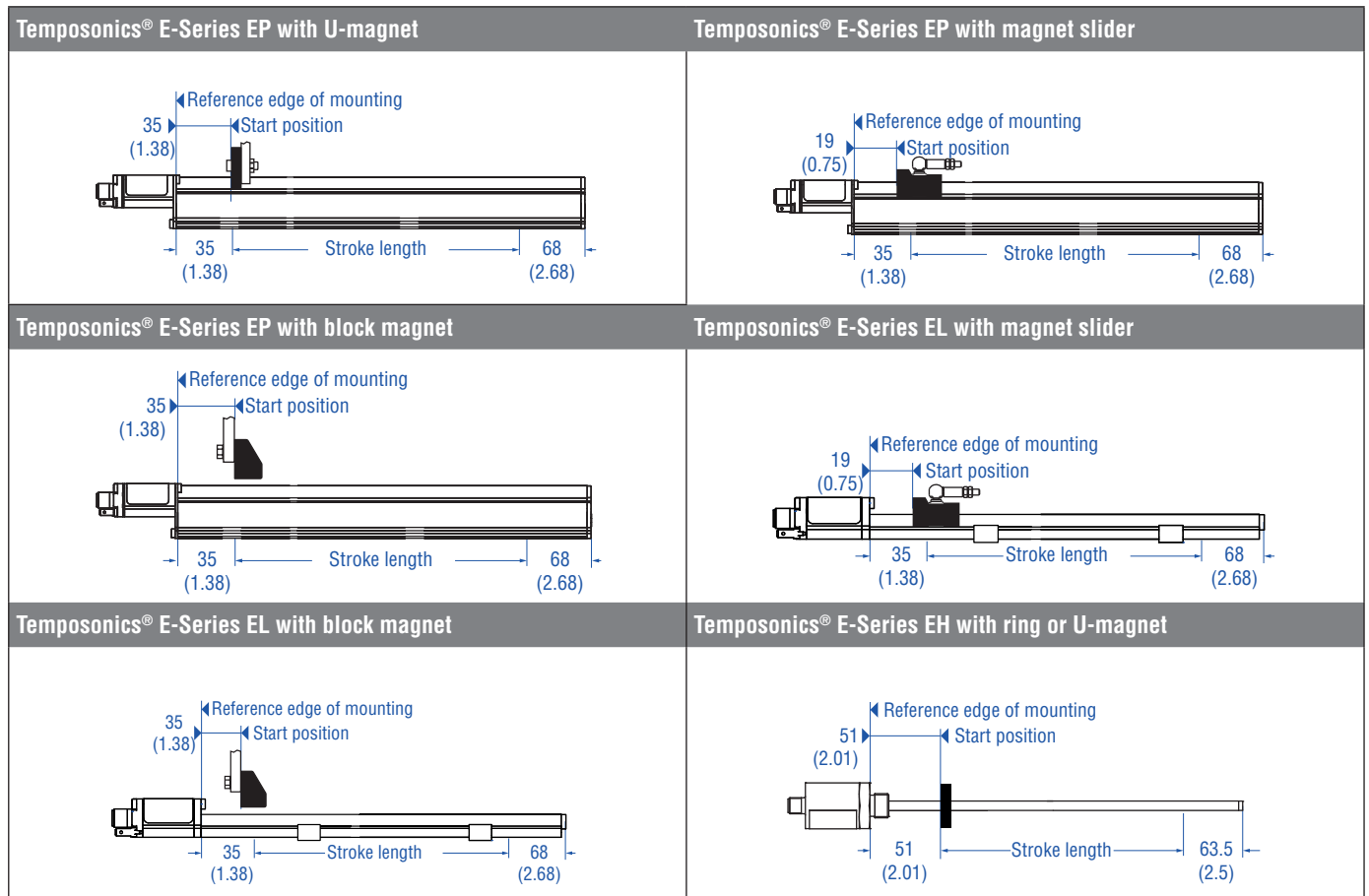


Fig. 14: Active measuring range

### NOTICE

On all sensors, the areas left and right of the active stroke length are provided for mounting and damping of the measuring signal. They should not be used for measurement, but the active stroke length can be exceeded.

**Multi position measurement**

The minimum distance between the magnets is 75 mm (3 in.).

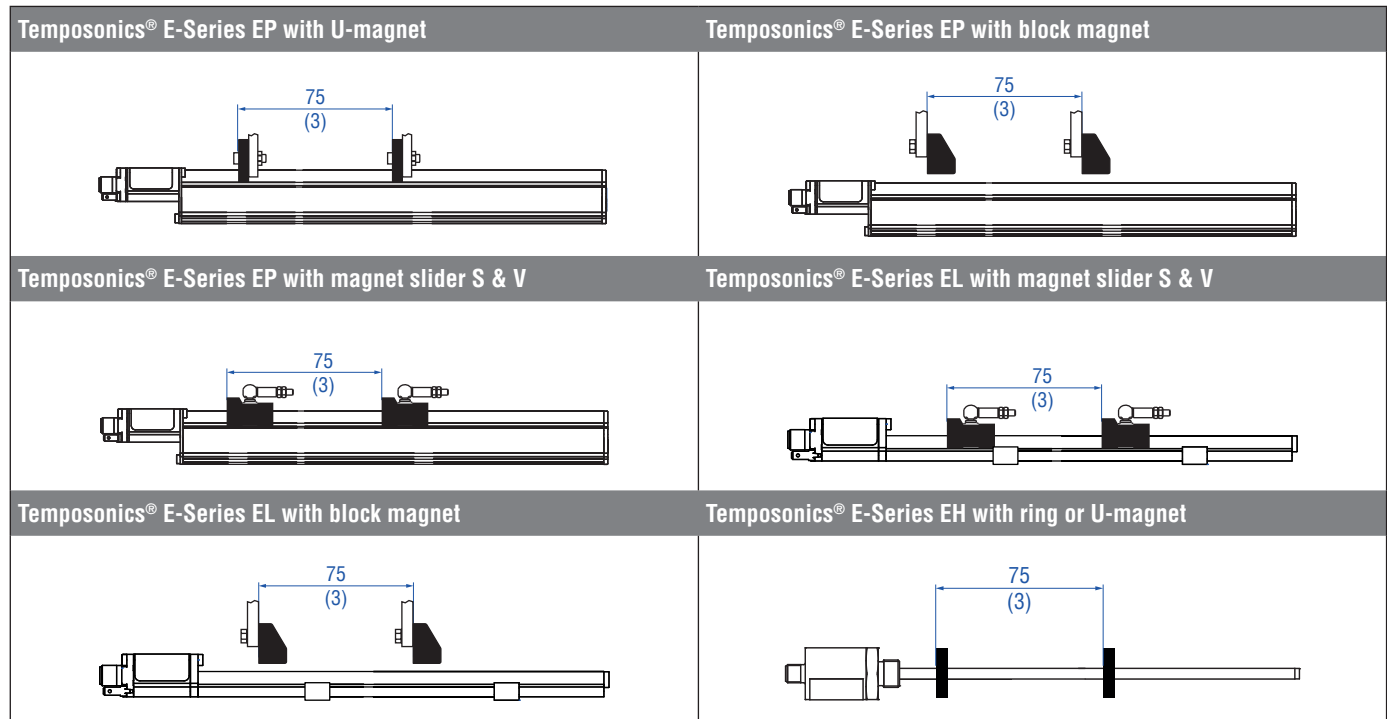


Fig. 15: Minimum distance for multi position measurement

Controlling design dimensions are in millimeters and measurements in ( ) are in inches



#### 4.6 Electrical connections

Placement of installation and cabling have vital influence on the sensor EMC (electromagnetic compatibility). Hence correct installation of this active electronic system and the EMC of the entire system must be ensured by using suitable metal connectors, shielded cables and grounding. Overvoltages or faulty connections can damage its electronics despite protection against wrong polarity.

#### NOTICE

Never connect/disconnect the sensor when voltage is applied.

#### Instructions for connection

- Use low-resistance twisted pair and shielded cables and connect the shield to ground externally via the controller equipment.
- Keep control and sign leads separate from power cables and sufficiently far away from motor cables, frequency inverters, valve lines, relays, etc.
- Use only connectors with metal housing and connect the shielding to the connector housing.
- Keep the connection surface at both screening ends as large as possible.
- Keep all non-shielded leads as short as possible.
- Keep the earth connection as short as possible with a large cross section. Avoid ground loops.
- With potential differences between the ground connection of the machine and the electronics, no compensating current flowing over the shield is allowed. We recommend using an equipotential bonding conductor with large cross-section or a cable with separate dual shielding and connecting the shields only at one end.
- Use only stabilized power supplies and make sure that the specified connecting values are met.
- Install potential compensating leads with large cross section, or use cables with separate double shielding, and connect only one end of the shield.
- Use only stabilized power supplies in compliance with the specified connecting values.


#### NOTICE

The E-Series EP and EL sensors must be grounded via grounding lug on the sensor electronics housing (Fig. 5).

#### Connection types

Connect the sensor directly to the control system, indicator or other evaluating systems as follows:

#### D34

M12 A-coded	Pin	Function
	1	Shield
	2	+24 VDC (-15 / +20 %)
	3	DC Ground (0 V)
	4	CAN_H
	5	CAN_L

#### Cable outlet (EH model only)

Cable color	Function
GY	CAN_L
PK	CAN_H
YE	–
GN	–
BN	+24 VDC (-15 / +20 %)
WH	DC Ground (0 V)

4.7 Frequently ordered accessories – Additional options available in our Accessories Guide [551444](#)

Position magnets

<p><b>Magnet slider S</b> Part no. 252 182</p> <p>For: <b>EP and EL</b> Material: GFK, magnet hard ferrite Weight: Ca. 35 g Operating temperature: -40...+75 °C (-40...+167 °F)</p>	<p><b>Magnet slider V</b> Part no. 252 184</p> <p>For: <b>EP and EL</b> Material: GFK, magnet hard ferrite Weight: Ca. 35 g Operating temperature: -40...+75 °C (-40...+167 °F)</p>	<p><b>U-magnet OD33</b> Part no. 251 416-2</p> <p>For: <b>EP and EH</b> Material: PA ferrite Weight: Ca. 11 g Surface pressure: max. 40 N/mm<sup>2</sup> Fastening torque for M4 screws: Max. 1 Nm Operating temperature: -40...+105 °C (-40...+221 °F)</p>	<p><b>Block magnet</b> Part no. 403 448</p> <p>For: <b>EP, EL and EH</b> Material: hard ferrite Weight: Ca. 20 g Operating temperature: -40...+75 °C (-40...+167 °F) Fastening torque for M4 screws: Max. 1 Nm</p>

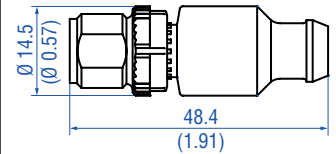
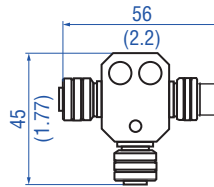
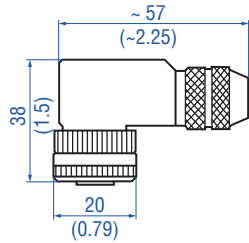
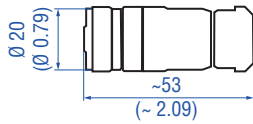
Position magnets

<p><b>Ring magnet OD33</b> Part no. 201 542-2</p> <p>For: <b>EH</b> Material: PA ferrite GF20 Weight: Ca. 14 g Surface pressure: max. 40 N/mm<sup>2</sup> Fastening torque for M4 screws: Max. 1 Nm Operating temperature: -40...+105 °C (-40...+221 °F)</p>	<p><b>Ring magnet OD25,4</b> Part no. 400 533</p> <p>For: <b>EH</b> Material: PA ferrite Weight: Ca. 10 g Surface pressure: Max. 40 N/mm<sup>2</sup> Operating temperature: -40...+105 °C (-40...+221 °F)</p>

Controlling design dimensions are in millimeters and measurements in ( ) are in inches

Cable connector

Connection accessories



**Female, straight, 5 pin  
Part no. 370 677**

Housing: GD-Zn, Ni / IP67  
Termination: Screw; max. 0.75 mm<sup>2</sup>  
Contact insert: CuZn  
Cable Ø: 4...8 mm  
Fastening torque: Max. 0.6 Nm

**Female, angled, 5 pin  
Part no. 370 678**

Housing: GD-Zn, Ni / IP67  
Termination: Screw; max. 0.75 mm<sup>2</sup>  
Contact insert: CuZn  
Cable Ø: 5...8 mm  
Fastening torque: Max. 0.6 Nm

**CANopen T-Connector, M12, 5 pin  
Part no. 370 691**

Selfcuring coupling nut  
2 × cable connector female  
1 × cable connector male shielded

**CANopen bus terminator  
Part no. 370 700**

Housing: PUR  
Contact insert: Au

Controlling design dimensions are in millimeters and measurements in ( ) are in inches

## 5. Operation

### CANopen bus interface

CANbus (Controller Area Network) is designed for high-speed data exchange at machine level. CAN is a vendor independent open fieldbus system, based on standard ISO 11898. CAN specifies the functional and technical parameters with which the intelligent digital automation devices can be networked via a master-slave serial link by using a communication profile. Protocol architecture of functional and applications data is oriented to the OSI reference model (ISO 7498). Bus technology is administrated and developed by the user organisation CiA (CAN in Automation).

### 5.1 Encoder functionality system description

Temposonics® sensors are linear transducers and are suitable for a CANopen protocol network. That is a CAN based higher layer protocol. The sensor can be used as a CAN bus slave in networks with the CANopen data protocol (CiA Standard DS 301 V4.02), the encoder profile DS 406 V3.1 and the LSS Service DS 305 V2.1.1. The sensor is performing Class C2 functionality.

### Network Management (NMT) – Slave

The NMT state machine defines the communication behavior of the CANopen device.

### Layer Setting Services (LSS) DS 305

Layer Setting Services (LSS) are used in order to configure the sensor in terms of node ID and / or the baud rate. The sensor can be switched to LSS configuration mode either globally or selectively.

### Service Data Object (SDO)

SDO messages are used for reading and writing access to all entries of the object dictionary. SDOs are used for device configuration in the first place.

### Identity objects

Identity including vendor ID, product code, revision number and serial number.

### Variable Process Data Object (PDO) mapping

The real-time data transfer of position, velocity and limit switch states is performed by PDO messages. Data is transmitted within four TPDO's (transmit PDO) and each with a maximum 8 byte wide data block. Variable PDO mapping can be configured via SDO messages.

### Special Function Object (SFO) sync object

The sync object is broadcasted periodically by the synchronisation device to all application devices. Synchronous PDOs will be transmitted to the controller after receiving the sync message.

### Emergency object

Emergency messages are triggered by the occurrence of a device internal fatal error situation and are transmitted from the application device concerned to the other devices with highest priority. This makes them suitable for interrupting type error alerts.

### Nodeguard object

The nodeguard object is used to monitor the whole network state. The nodeguard object is sent cyclically to detect the sensor that the controller works well. On a missing nodeguard object (i.e. controller stopped) the sensor automatically can stop PDO data transmission to reduce the busload.

### Heartbeat function

Instead of the node-guarding the heartbeat-function can be used. The Producer-Heartbeat-Time defines the time frame in which a new heartbeat message is sent.

### Event timer

The event timer defines the asynchronous transmission period for PDOs.

### Encoder profile DS 406

Up to four work areas with upper and lower limits and corresponding status register. Up to four cam switches with upper or lower threshold level and status register

### CANbus connection

The CANopen encoders are equipped with a bus trunk line in various lengths and can be terminated in the device. The devices do not have an integrated T-coupler nor they are looped internally. If possible, drop lines should be avoided, as in principle they lead to signal reflections. As a rule the reflections caused by the drop lines are not critical, if they have completely decayed before the point in time when the scanning occurs.

## 5.2 Encoder installations configuration of node parameters

### LSS address

Each sensor (node) in the CAN network is defined unique by the LSS address. This address consists of:

Vendor-ID: 0x40  
Product Code: 0x43333034 (C304)  
Revision No.: 0x00010001  
Serial No.: 04301234

CANbus specific parameters like baud rate and node address (node ID) can be configured and recorded by LSS service routines.

### Configure baud rate

The maximum baud rate depends on the cable length of the total CAN network. The sensor is shipped with an order dependent baud rate, as printed on the sensor label. If necessary, the baud rate can be changed via LSS service.

#### NOTICE

Program the baud rates according to the LSS protocol.  
Note the parameters given in table 1.

Cable length	Baud rate
< 25 m (82 ft.)	1000 kBit/s
< 50 m (164 ft.)	800 kBit/s
< 100 m (328 ft.)	500 kBit/s
< 250 m (820 ft.)	250 kBit/s

Table 1: Baud rate according to cable length (see CiA DS 301)

### Configure node ID

Each node gets a node identifier (node ID) for identification in a CANopen network. Each node ID can be assigned only once in a CAN network. Valid node IDs range is from 1...127, with 127 being the default setting on delivery.

### Bus termination

The internal bus termination resistor with 120 Ω is not attached but can be ordered as an additional option (output option).

### EDS file

The EDS file is the standardized format for the description of devices. It contains information about:

- File properties (name, version, release date,...)
- General device information (manufacturer name and code)
- Device name and type, version, LSS address
- Supported baud rates and boot-up options
- Description of supported objects and attributes

## 5.3 Configuration of process parameters

The sensor starts up using the parameters stored in its internal EEPROM; the user can change and/or permanently store settings using SDO uploads as desired. Please be aware that in case the node ID is changed using LSS, the identifiers for PDOs etc. will be changed accordingly.

The sensors implement the encoder communication profile “Device Profile for Encoder – DS 406 V3.1”. In the following object dictionary the programming of the operating parameters is described.

## 5.4 CANopen Network Management (NMT)

The following description is part of the CANopen communication profile DS 301.

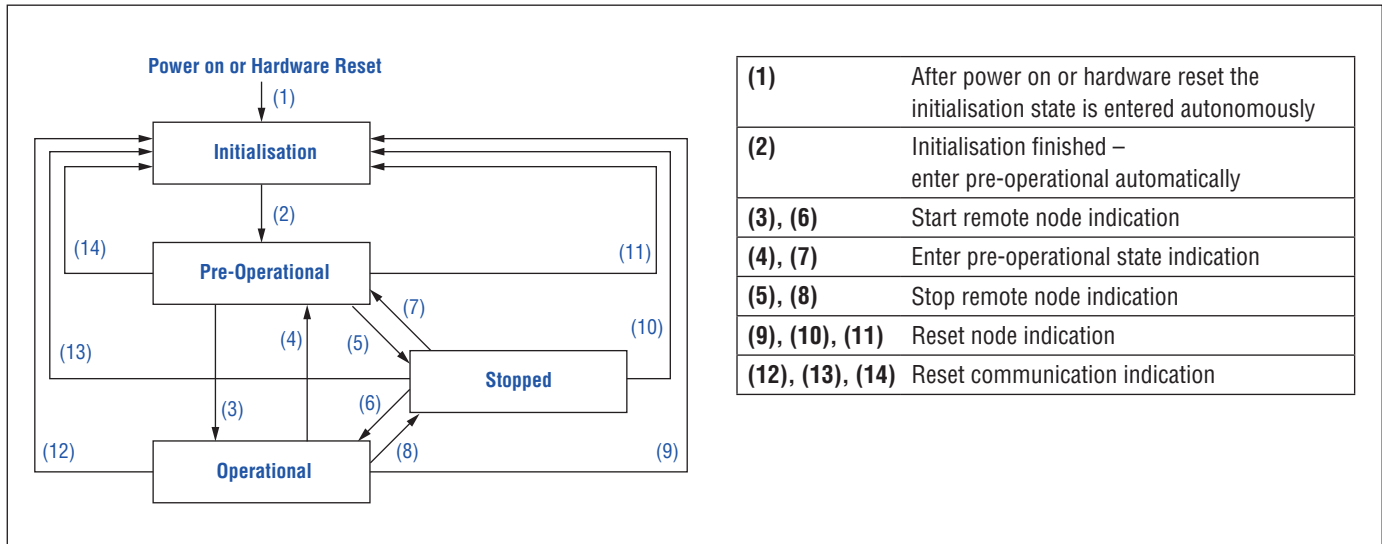


Fig. 16: CANopen state machine

COB-ID	Request / Respond	DLC	Data		Description
			D0	D1	
0x000	Rx	2	<b>Command</b>	<b>Address</b>	
			0x01		<b>Start remote node (3), (6):</b> Through this service the NMT master sets the state of the selected NMT slave(s) to “operational”.
			0x02		<b>Stop remote node (5), (8):</b> Through this service the NMT master sets the state of the selected NMT slave(s) to “stopped”.
			0x80		<b>Enter pre-operational state (4), (7):</b> Through this service the NMT master sets the state of the selected NMT slave(s) to “pre-operational”.
			0x81		<b>Reset node (9), (10), (11):</b> Through this service the NMT master sets the state of the selected NMT slave(s) from any state to the “reset application” sub-state.
			0x82		<b>Reset communication (12), (13), (14):</b> Through this service the NMT master sets the state of the selected NMT slave(s) from any state to the “reset communication” sub-state. After completion of the service, the state of the selected remote nodes will reset communication.
			0x00		set 0x00 for all devices (global mode)
			Node ID		set node ID (0x01...0x7F) for a specific device

Table 2: Description of NMT commands

### Network initialisation

When powering the sensor after a Network Management (NMT) reset command (chapter 5.4) or after an internal reset, the sensor automatically enters the NMT initialisation state. In this state the sensor loads all parameters from the non-volatile memory into the RAM. The sensor performs several test functions and configuration tasks. In this state there is no communication with the sensor. After finishing the NMT initialisation state the sensor automatically enters the NMT pre-operational state. During this state transition the CANopen sensor sends its boot-up message (Table 3).

COB ID	Rx/Tx	DLC	DATA
			DO
0x700 + Node-ID	Tx	1	0x00

Table 3: Boot-up message

### Network Pre-Operational state

In the pre-operational state communication via SDOs (chapter 5.6) is possible, while (PDO) communication is not allowed. Configuration of PDOs and device parameters may be performed. Also the emergency objects and error control service like the CANopen sensors “heartbeat message” occur in this state. The node will be switched into the operational state directly by sending a NMT “start remote node” (3) (Fig. 16).

### Network Operational State

In the operational state all communication objects – including PDO handling – are active. Object dictionary access via SDO is possible.

### Network Stopped State

By switching a device into the stopped state it is forced to stop the communication, except node guarding and heartbeat, if active.

## 5.5 Configuration

The complete configuration of the E-Series CANopen sensor is done through the CANbus interface.

### 5.5.1 Layer Setting Service (LSS)

Every CANopen device must have a unique node identifier in the CANopen network.

The node ID and the baud rate can be programmed by using the LSS protocol DS 305 published by the CiA.

To program the node ID and/or the baud rate the E-Series CANopen sensor has changed to the LSS configuration state.

COB ID	Request / Respond	DLC	DATA								Description		
			D0	D1	D2	D3	D4	D5	D6	D7			
0x7E5	Rx	8	<b>Entry</b>	<b>Index</b>	0x00	0x00	0x00	0x00	0x00	0x00	0x00		
			0x04	0x01								Configuration mode ( <i>without confirmation</i> )	
				0x00									Normal mode ( <i>without confirmation</i> )
			0x11	0x01...0x7F									Set node ID (1...127)
			0x13	0x00	0x00								Set baud rate 1000 kbit/s
				0x00	0x01								Set baud rate 800 kbit/s
				0x00	0x02								Set baud rate 500 kbit/s
				0x00	0x03								Set baud rate 250 kbit/s
			0x13	0x00	0x04								Set baud rate 125 kbit/s
				0x15	Switch delay								Activate bit timing parameter Switch delay: Timing in ms internal multiplied by 2 when the new bit timing parameters become active.
			0x17										Store configuration in EEPROM
			0x40										Vendor ID
			0x41										Product code
			0x42										Revision number
			0x43										Serial number
			0x5A										Inquire identity vendor ID
			0x5B										Inquire identity product code
			0x5C										Inquire identity revision number
			0x5D										Inquire identity serial number
			0x5E										Inquire node ID
0x7E4	Tx	8	<b>Entry</b>	<b>Status</b>	0x00	0x00	0x00	0x00	0x00	0x00	0x00		
			0x11	0								Protocol successfully completed	
			0x11	1								Node ID out of range	
			0x13	0								Protocol successfully completed	
			0x13	1								Bit timing not supported	
			0x17	0								Protocol successfully completed	
			0x17	2								Storage media access error	

Table 4: LSS commands and options



**Example: How to configure a new node ID**

COB ID	Request / Respond	DLC	Byte								Description	
			0	1	2	3	4	5	6	7		
0x7E5	Rx	8	0x04	0x01								Configuration mode global
0x7E5	Rx	8	0x11	0x7F								Configure new node ID 0x7F (127)
0x7E4	Tx	8	0x11									Protocol successfully completed
0x7E5	Rx	8	0x17									Store configuration EEPROM
0x7E4	Tx	8	0x17									Protocol successfully completed
0x7E5	Rx	8	0x04									Waiting state / Normal mode
0x000	Rx	2	0x81									NMT reset node ID

**Example: How to read a node ID**

0x7E5	Rx	8	0x04	0x01								Configuration mode global
0x7E5	Rx	8	0x5E									Inquire node ID
0x7E4	Tx	8	0x5E	0x7F								Node ID: 0x7F (127)

*Example 1: Configuration of node ID*

**NOTICE**

The new node ID will get active after a reset of the sensor. Furthermore the following COB IDs will be automatically updated according to the pre-defined connection set of the #2 DS 301:

- DO(Tx);
- SDO(Rx);
- Emergency;
- Error control;
- PDO1(Tx)

**Example: Configure the baud rate to 500 kbit/s**

COB ID	Request / Respond	DLC	Byte								Description	
			0	1	2	3	4	5	6	7		
0x00	Rx	2	0x80	0x7F								Enter pre-operational state (node ID 127)
0x7E5	Rx	8	0x04	0x01								Configuration mode (global) (without confirmation)
0x7E5	Rx	8	0x13	0x00	0x02							Set baud rate 500 kbit/s
0x7E4	Tx	8	0x13									Protocol successfully completed
0x7E5	Rx	8	0x17									Store configuration in EEPROM
0x7E4	Tx	8	0x17									Protocol successfully completed
0x7E5	Rx	8	0x04									Normal mode (without confirmation)

*Example 2: Configure the baud rate to 500 kbit/s*

**NOTICE**

The baud rate will get active after receiving the “activate bit timing parameters” command or after the “store configuration data” command with the next power on reset

## Emergency messages (EMCY)

Emergency objects are triggered by the incident of a CANopen device internal error situation and are transmitted onto the network. Emergency objects are suitable for error alerts. An emergency object is transmitted only once per event. After starting the system (Power-on, reset) the sensor will transmit an emergency object without reasonable data (power-on message). This just indicates that the device is present in the network. Emergency objects go along with changes of the internal error status register. An emergency object consists of 8 data bytes and is built like shown (Table 5).

COB ID	Request / Respond	DLC	Byte								Description		
			0	1	2	3	4	5	6	7			
0x080 + Node ID	Tx	8	<b>Error code</b>								<b>Register</b>	<b>Manufacturer specific error field</b>	
			0x0000										Error reset or no error
			0x3100										Main voltage (generic)
			0x5000										CANopen device hardware – generic error
			0x6300										Data set (generic)
			0x8100										Communication (generic)
			0x8110										CAN overrun (objects lost)
			0x8120										CAN in error or heartbeat error
			0x8130										Life guard error or heartbeat error
			0x8140										Recovered from bus off
			0x8150										CAN ID collision
			0x8210										PDO not processed due to length error

Table 5: Error codes

Register								Hex	Description
Bit									
7	6	5	4	3	2	1	0		
Manufacturer specific	Reserved	Device profile specific	Communication error	Temperature	Voltage	Current	Generic error		
0	0	0	0	0	0	0	0	0x00	No error
0	0	0	1	0	0	0	1	0x11	Communication error
0	0	0	0	0	1	0	1	0x05	Main voltage error
1	0	0	0	0	0	0	1	0x81	Transducer error

Table 6: Error code register

**NOTICE**  
The emergency message error register is equal to the content of register 1001.

Example											
COB ID	Request / Respond	DLC	Byte								Description
			0	1	2	3	4	5	6	7	
0x080 + Node ID	Tx	8	0x00	0x31	0x05						Main operating voltage error generic

Example 3: Emergency message for voltage error

### 5.5.2 Error control service

Through error control services the NMT detects failures in a CAN based network.

When the error control service is enabled the E-Series CANopen sensor transmits a heartbeat message cyclically.

One or more heartbeat consumers receive the indication. The relationship between producer and consumer is configurable via the object dictionary by SDOs. By default the heartbeat is disabled.

The data byte of the heartbeat message contains the current network management state of the CANopen sensor.

Consider the change of the node ID takes place after a restart of the device or “immediately”.

COB ID	Request / Respond	DLC	Byte	Description
			0	
0x700 + Node ID	Tx	1	<b>State</b>	
			0x00	Boot up
			0x04	Stopped
			0x05	Operational
			0x7F	Pre-operational

Table 7: Heartbeat message

## 5.6 Programming parameter

### 5.6.1 SDO download

The SDO download service is used to configure the communication, device and manufacturer specific parameters of the E-Series CANopen sensor.

COB ID	Request / Respond	DLC	DATA							
			D0	D1	D2	D3	D4	D5	D6	D7
0x600 + Node ID	Rx	8	0x2x	Index		Subindex	Data LSB	Data	Data	Data MSB
0x580 + Node ID	Tx	8	0x60	Index		Subindex	0x00	0x00	0x00	0x00

Table 8: SDO download and sensor response

D0	Description
0x22	Write bytes without explicit length specification
0x23	Write 4 bytes
0x2B	Write 2 bytes
0x2F	Write 1 byte

Table 9: Explanation of the command byte "D0"

### 5.6.2 SDO upload

The SDO upload service is used to read the communication, device and manufacturer specific parameters of the E-Series CANopen sensor.

COB ID	Request / Respond	DLC	DATA							
			D0	D1	D2	D3	D4	D5	D6	D7
0x600 + Node ID	Rx	8	0x40	Index		Subindex	0x00	0x00	0x00	0x00
0x580 + Node ID	Tx	8	0x4x	Index		Subindex	Data LSB	Data	Data	Data MSB

Table 10: SDO upload and sensor response

D0	Description
0x43	Upload of 4 bytes
0x4B	Upload of 2 bytes
0x4F	Upload of 1 byte

Table 11: Explanation of the response byte "D0"

### 5.6.3 SDO abort

If SDO download or SDO upload service fails for any reason the CANopen sensor does not respond with the corresponding SDO message, but with a SDO abort protocol.

COB ID	Request / Respond	DLC	Byte								Description
			0	1	2	3	4	5	6	7	
0x580 + Node ID	Tx	8	0x80	Index	Subindex	<b>Abort code</b>					
						0x06	0x09	0x00	0x11	Subindex does not exist	
						0x06	0x09	0x00	0x30	Value exceeded	
						0x06	0x02	0x00	0x00	Object does not exist in the object dictionary	
						0x06	0x01	0x00	0x01	Object is write only	
						0x06	0x01	0x00	0x02	Attempt to write a read only object	
						0x08	0x00	0x00	0x20	Data transport error	
						0x08	0x00	0x00	0x00	General error	
						0x08	0x00	0x00	0x22	Wrong state	
						0x06	0x01	0x00	0x00	Unsupported access to an object	
						0x06	0x07	0x00	0x01	Data type does not match	

Table 12: SDO abort codes

### 5.6.4 SDO TPDO communication parameter: Index 1800 (PDO1) to index 1803 (PDO4)

#### Example

COB ID	Request / Respond	DLC	Byte								Description
			0	1	2	3	4	5	6	7	
<b>Subindex 1 COB ID of the TPDO</b>											
600 + Node ID	Rx	8	0x23	0x00	0x18	0x01	0x80 + Node ID	0x01	0x00	0x40	Set transmission types example (11-bit CAN-ID 1FFh, no RTR allowed, valid: yes)
580 + Node ID	Tx	8	0x60	0x00	0x18	0x01	0x00	0x00	0x00	0x00	
600 + Node ID	Rx	8	0x40	0x00	0x18	0x01	0x00	0x00	0x00	0x00	Readout transmission types example
580 + Node ID	Tx	8	0x43	0x00	0x18	0x01	0x80 + Node ID	0x01	0x00	0x40	
<b>Subindex 2 transmission character</b>											
0x67F	Rx	8	0x2F	0x00	0x18	0x02	0xFE	0x00	0x00	0x00	Set transmission character "FE event-driven (manufacturer-specific)"
0x5FF	Tx	8	0x60	0x00	0x18	0x02	0x00	0x00	0x00	0x00	
0x67F	Rx	8	0x40	0x00	0x18	0x02	0x00	0x00	0x00	0x00	Readout transmission character example "FE"
0x5FF	Tx	8	0x4F	0x00	0x18	0x02	0xFE	0x00	0x00	0x00	
<b>Subindex 5 contains the event-timer</b> (The value is defined as multiple of 1 msec. A value of "0" disables the event-timer.)											
0x67F	Rx	8	0x2B	0x00	0x18	0x05	0x01	0x00	0x00	0x00	Set event timer example "1 ms"
0x5FF	Tx	8	0x60	0x00	0x18	0x05	0x00	0x00	0x00	0x00	
0x67F	Rx	8	0x40	0x00	0x18	0x05	0x00	0x00	0x00	0x00	Readout event timer example "1 ms"
0x5FF	Tx	8	0x4B	0x00	0x18	0x05	0x01	0x00	0x00	0x00	

Example 4: Configuration of Index 1800 (PDO1)

### 5.6.5 SDO PDO mapping: Index 1A00 to index 1A03

This object contains the mapping for the PDOs the device is able to transmit. Make sure to disable the dedicated PDO by setting the number of mapping entries to zero before changing it. Subindex 0x00 contains the number of valid object entries within the mapping record.

**Example**

COB ID	Request / Respond	DLC	Byte								Description
			0	1	2	3	4	5	6	7	
0x67F	Rx	8	0x40	0x00	0x1A	0x00	0x00	0x00	0x00	0x00	Readout of amount of currently mapping PDOs "3"
0x5FF	Tx	8	0x4F	0x00	0x1A	0x00	0x03	0x00	0x00	0x00	
0x67F	Rx	8	0x2F	0x00	0x1A	0x00	0x00	0x00	0x00	0x00	Set number of application objects "0 disable"
0x5FF	Tx	8	0x60	0x00	0x1A	0x00	0x00	0x00	0x00	0x00	
<b>Subindex 1: PDO mapping for the 1st application object</b>											
0x67F	Rx	8	0x23	0x00	0x1A	0x01	0x20	0x01	0x20	0x60	Set the mapping PDO1 to Position1 "Object: Index 6020 subindex 1; length bits: 20h"
0x5FF	Tx	8	0x60	0x00	0x1A	0x01	0x00	0x00	0x00	0x00	
0x67F	Rx	8	0x40	0x00	0x1A	0x01	0x00	0x00	0x00	0x00	Readout of the mapping PDO1 to Position1 "0x60200120"
0x5FF	Tx	8	0x43	0x00	0x1A	0x01	0x20	0x01	0x20	0x60	
<b>Subindex 2: PDO mapping for the 2nd application object</b>											
0x67F	Rx	8	0x23	0x00	0x1A	0x02	0x10	0x01	0x30	0x60	Set the mapping PDO1 to Velocity1 "Object: Index 6030 subindex 1; length bits: 10h"
0x5FF	Tx	8	0x60	0x00	0x1A	0x02	0x00	0x00	0x00	0x00	
0x67F	Rx	8	0x40	0x00	0x1A	0x02	0x00	0x00	0x00	0x00	Readout of the mapping PDO1 to Velocity1 "60300110h"
0x5FF	Tx	8	0x43	0x00	0x1A	0x02	0x10	0x01	0x30	0x60	
<b>Subindex 3: PDO mapping for the 3rd application object</b>											
0x67F	Rx	8	0x23	0x00	0x1A	0x03	0x08	0x01	0x00	0x64	Set the mapping PDO1 to WorkAreaRegister, Object 0x6400, subindex 0x01, length 8 bits
0x5FF	Tx	8	0x60	0x00	0x1A	0x03	0x00	0x00	0x00	0x00	
0x67F	Rx	8	0x40	0x00	0x1A	0x03	0x00	0x00	0x00	0x00	Readout of the mapping PDO1 to WorkAreaRegister "64000108h"
0x5FF	Tx	8	0x43	0x00	0x1A	0x03	0x08	0x01	0x00	0x64	
<b>Set number of application objects</b>											
0x67F	Rx	8	0x2F	0x00	0x1A	0x00	0x03	0x00	0x00	0x00	Set number of application objects to "3"
0x5FF	Tx	8	0x60	0x00	0x1A	0x00	0x00	0x00	0x00	0x00	

Example 5: How to modify the PDO settings

### 5.6.6 SDO store parameter index 1010

Using the store parameter command, all current settings are transferred into permanent memory.

COB ID	Request / Respond	DLC	Byte								Description
			0	1	2	3	4	5	6	7	
0x67F	Rx	8	0x22	0x10	0x10	0x01	0x73	0x61	0x76	0x65	<b>Note:</b> This takes at least 20 ms of time!
0x5FF	Tx	8	0x60	0x10	0x10	0x01	0x00	0x00	0x00	0x00	

Table 13: Store parameter and sensor response

### 5.6.7 Restore default parameters index 1011

Using the restore parameter command, all current settings are restored to default values.

COB ID	Request / Respond	DLC	Byte								Description
			0	1	2	3	4	5	6	7	
0x67F	Rx	8	0x22	0x11	0x10	0x01	0x6C	0x6F	0x61	0x64	
0x5FF	Tx	8	0x60	0x11	0x10	0x01	0x00	0x00	0x00	0x00	

Table 15: Restore parameters

### 5.6.8 Sensor communication default parameter

These parameters are related to the ordinary C304 order code configuration type.

Index	Sub	Description	Type	Attribute	Default value	Comment
1005		COB ID sync	Unsigned 32	rw	0x080	
1008		Device name	String	ro	MTS	
1009		Hardware version release	String	ro	1.00	
100A		Software version release	String	ro	1.04	
100C		Guard time	Unsigned 16	rw	0	
100D		Life time factor	Unsigned 8	rw	0	
1014		EMCY ID	Unsigned 32	rw	0x080 + Node ID	
1017		Producer heartbeat	Unsigned 16	rw	0	
1018	0	Identity object	Unsigned 8	ro	4	
	1	Vendor ID	Unsigned 32	ro	0x00000040	MTS Sensor
	2	Product code	Unsigned 32	ro	0x0000000E	E-Series
	3	Revision number	Unsigned 32	ro	0x03090001	
	4	Serial number	Unsigned 32	ro	09501234	

Table 14: Device properties

## 5.6.9 PDO mapping

Index	Subindex	Description	Type	Attribute	Default Value	Description
<b>Process Data Object (PDO1)</b>						
1800	0	Transmit 1st PDO	Unsigned 8	ro	5	Number of largest subindex
	1	COB ID used by PDO1	Unsigned 32	rw	0x40000180 + Node ID	PDO enabled
	2	Transmission type	Unsigned 8	rw	0xFE	254 (async)
	3	Inhibit time	Unsigned 16	rw	0x0000	
	5	Event timer	Unsigned 16	rw	1	msec
1A00	0	1st transmit PDO mapping	Unsigned 8	rw	3	Number of largest subindex
	1	1st application object	Unsigned 32	rw	0x60200120	Position
	2	2nd application object	Unsigned 32	rw	0x60300110	Velocity
	3	3rd application object	Unsigned 32	rw	0x64000108	Work area state reg.
<b>Process Data Object (PDO2)</b>						
1801	0	Transmit 2nd PDO	Unsigned 8	ro	5	Number of largest subindex
	1	COB ID used by PDO2	Unsigned 32	rw	0xC0000280 + Node ID	PDO disabled
	2	Transmission type	Unsigned 8	rw	0xFE	254 (async)
	3	Inhibit time	Unsigned 16	rw	0x0000	
	5	Event timer	Unsigned 16	rw	1	msec
1A01	0	2nd transmit PDO mapping	Unsigned 8	rw	3	Number of largest subindex
	1	1st application object	Unsigned 32	rw	0x60200220	Position
	2	2nd application object	Unsigned 32	rw	0x60300210	Velocity
	3	3rd application object	Unsigned 32	rw	0x64000208	Work area state reg.
<b>Process Data Object (PDO3)</b>						
1802	0	Transmit 3rd PDO	Unsigned 8	ro	5	Number of largest subindex
	1	COB ID used by PDO3	Unsigned 32	rw	0xC0000380 + Node ID	PDO disabled
	2	Transmission type	Unsigned 8	rw	0xFE	254 (async)
	3	Inhibit time	Unsigned 16	rw	0x0000	
	5	Event timer	Unsigned 16	rw	1	msec
1A02	0	3rd transmit PDO mapping	Unsigned 8	rw	0	Number of largest subindex
	1	1st application object	Unsigned 32	rw	0x60200320	Position
	2	2nd application object	Unsigned 32	rw	0x60300310	Velocity
	3	3rd application object	Unsigned 32	rw	0x64000308	Work area state reg.
<b>Process Data Object (PDO4)</b>						
1803	0	Transmit 4th PDO	Unsigned 8	ro	5	Number of largest subindex
	1	COB ID used by PDO4	Unsigned 32	rw	0xC0000480 + Node ID	PDO disabled
	2	Transmission type	Unsigned 8	rw	0xFE	254 (async)
	3	Inhibit time	Unsigned 16	rw	0x0000	
	5	Event timer	Unsigned 16	rw	1	msec
1A03	0	4th transmit PDO mapping	Unsigned 8	rw	0	Number of largest subindex
	1	1st application object	Unsigned 32	rw	0x60200420	Position
	2	2nd application object	Unsigned 32	rw	0x60300410	Velocity
	3	3rd application object	Unsigned 32	rw	0x64000408	Work area state reg.

Table 16: PDO configuration



### 5.6.10 Device properties according to CiA DS 406

Index	Sub index	Description	Type	Attribute	Default Value	Description
6000		Operating parameter	Unsigned 16	rw	0x0000	Scaling fix
6002		Total measuring range	Unsigned 32	rw	0	Total measuring range in measuring units
6005	0	Linear encoder measuring step settings	Unsigned 8	ro	2	Number of objects
	1	Position measuring step	Unsigned 32	ro	Resolution dependend	Position step in 0.001 µm
	2	Velocity measuring step	Unsigned 32	ro		Velocity step in 0.01 mm/s
6200		Cyclic timer	Unsigned 16	rw	0x01	Cycle time in msec
6500		Operating status	Unsigned 16	ro		
6501		Measuring step	Unsigned 32	ro	Resolution dependend	Measuring step in 0.001 µm
6503		Alarms occured	Unsigned 16	ro	0x0000	Missing magnet
6504		Alarms supported	Unsigned 16	ro	0x0001	
6505		Warning occured	Unsigned 16	ro	0x0000	
6506		Warning supported	Unsigned 16	ro	0x7000	
6507		Profile and software version	Unsigned 32	ro		
6508		Operation time	Unsigned 32	ro	FF FF FF FF	Not supported
6509		Offset value read out	Integer 32	ro		
650A	0	Module identification	Unsigned 8	ro		
	1	Manufacturer offset value	Integer 32	ro		
	2	Manufacturer min. position value	Integer 32	ro	Start position	Sensor units
	3	Manufacturer max. position value	Integer 32	ro	Max. position	Sensor units
650B		Serial number	Unsigned 32	ro		
650E		Device capability	Unsigned 32	ro		

Table 17: Device properties

### 5.6.11 Cam Channels

Index	Sub index	Description	Type	Attribute	Default Value	Description
<b>Cam Channel 1</b>						
6010	1	Preset value channel 1	Integer 32	rw	0	Sensor units, clear preset with 0xFFFFFFFF
6020	1	Position value channel 1	Integer 32	ro		Current position in sensor units
6030	1	Velocity value channel 1	Integer 16	ro		Current velocity in sensor units
6300	1	Cam state channel 1	Unsigned 8	ro		
6301	1	Cam enable channel 1	Unsigned 8	rw	0	
6302	1	Cam polarity channel 1	Unsigned 8	rw	0	
6310	1	Cam1 low limit channel 1	Integer 32	rw	0	
6311	1	Cam2 low limit channel 1	Integer 32	rw	0	
6312	1	Cam3 low limit channel 1	Integer 32	rw	0	
6313	1	Cam4 low limit channel 1	Integer 32	rw	0	
650C	1	Offset value for multi sensor devices	Integer 32	ro	0	
6400	1	Work area state channel 1	Unsigned 8	ro		
6401	1	Work area low limit channel 1	Integer 32	rw	Start position	Sensor units
6402	1	Work area high limit channel 1	Integer 32	rw	Max. position	Sensor units
<b>Cam Channel 2</b>						
6010	2	Preset value channel 2	Integer 32	rw	0	Sensor units, clear preset with 0xFFFFFFFF
6020	2	Position value channel 2	Integer 32	ro		Current position in sensor units
6030	2	Velocity value channel 2	Integer 16	ro		Current velocity in sensor units
6300	2	Cam state channel 2	Unsigned 8	ro		
6301	2	Cam enable channel 2	Unsigned 8	rw	0	
6302	2	Cam polarity channel 2	Unsigned 8	rw	0	
6310	2	Cam1 low limit channel 2	Integer 32	rw	0	
6311	2	Cam2 low limit channel 2	Integer 32	rw	0	
6312	2	Cam3 low limit channel 2	Integer 32	rw	0	
6313	2	Cam4 low limit channel 2	Integer 32	rw	0	
650C	2	Offset value for multi sensor devices	Integer 32	ro	0	
6400	2	Work area state channel 2	Unsigned 8	ro		
6401	2	Work area low limit channel 2	Integer 32	rw	Start position	Sensor units
6402	2	Work area high limit channel 2	Integer 32	rw	Max. position	Sensor units

Table 18: Cam/work area configuration

Index	Sub index	Description	Type	Attribute	Default Value	Description
<b>Cam Channel 3</b>						
6010	3	Preset value channel 3	Integer 32	rw	0	Sensor units, clear preset with 0xFFFFFFFF
6020	3	Position value channel 3	Integer 32	ro		Current position in sensor units
6030	3	Velocity value channel 3	Integer 16	ro		Current velocity in sensor units
6300	3	Cam state channel 3	Unsigned 8	ro		
6301	3	Cam enable channel 3	Unsigned 8	rw	0	
6302	3	Cam polarity channel 3	Unsigned 8	rw	0	
6310	3	Cam1 low limit channel 3	Integer 32	rw	0	
6311	3	Cam2 low limit channel 3	Integer 32	rw	0	
6312	3	Cam3 low limit channel 3	Integer 32	rw	0	
6313	3	Cam4 low limit channel 3	Integer 32	rw	0	
650C	3	Offset value for multi sensor devices	Integer 32	ro	0	
6400	3	Work area state channel 3	Unsigned 8	ro		
6401	3	Work area low limit channel 3	Integer 32	rw	Start position	Sensor units
6402	3	Work area high limit channel 3	Integer 32	rw	Max. position	Sensor units
<b>Cam Channel 4</b>						
6010	4	Preset value channel 4	Integer 32	rw	0	Sensor units, clear preset with 0xFFFFFFFF
6020	4	Position value channel 4	Integer 32	ro		Current position in sensor units
6030	4	Velocity value channel 4	Integer 16	ro		Current velocity in sensor units
6300	4	Cam state channel 4	Unsigned 8	ro		
6301	4	Cam enable channel 4	Unsigned 8	rw	0	
6302	4	Cam polarity channel 4	Unsigned 8	rw	0	
6310	4	Cam1 low limit channel 4	Integer 32	rw	0	
6311	4	Cam2 low limit channel 4	Integer 32	rw	0	
6312	4	Cam3 low limit channel 4	Integer 32	rw	0	
6313	4	Cam4 low limit channel 4	Integer 32	rw	0	
650C	4	Offset value for multi sensor devices	Integer 32	ro	0	
6400	4	Work area state channel 4	Unsigned 8	ro		
6401	4	Work area low limit channel 4	Integer 32	rw	Start position	Sensor units
6402	4	Work area high limit channel 4	Integer 32	rw	Max. position	Sensor units

Table 19: Cam/work area configuration

## 5.7 Process data

### Transmission the data

The transmission type object (index 1800 ff subindex 2) enables to switch between the different transmission modes synchronous and asynchronous mode.

#### 5.7.1 Synchronous mode

When the CANopen sensor is in NMT operational state and the transmission type (Index 1800 ff subindex 2) is between  $n = 0 \dots 240$  the synchronous mode is enabled.

The PDO is transmitted by the CANopen sensor after receiving every  $n$ th sync object.

The sync object has the following format:

COB ID	Rx/Tx	DLC	DATA							
			D0	D1	D2	D3	D4	D5	D6	D7
0x080	Rx	0	–	–	–	–	–	–	–	–

Table 20: Sync object

#### NOTICE

The COB ID of the sync object message can be programmed individually with index 1005.  
So the COB ID of the sync message may be different, depending on the configuration of the sensor.

#### 5.7.2 Asynchronous mode

When the CANopen sensor is in NMT operational state and the transmission type (Index 1800 ff subindex 2) is 254 or 255 the asynchronous mode is enabled. The PDO is transmitted by the CANopen sensor after the event timer (Index 1800 ff subindex 5) is expired. The value of the timer is given in ms.

#### 5.7.3 PDO message format

This is the format of the CAN sensor default PDO message. The current PDO mapping can be seen at Index 1A00 ff.

COB ID	Rx/Tx	DLC	DATA							
			D0	D1	D2	D3	D4	D5	D6	D7
0x180 + Node-ID	Tx	6	Pos LSB	Pos	Pos	Pos MSB	Velocity LSB	Velocity MSB	Status	–

Table 21: Default PDO format

#### NOTICE

For the PDO message the measuring steps for the position (Pos) and velocity values can be read with object linear encoder measuring step settings (Index 6005).

### 5.7.4 PDO transmission time consideration

For the configuration of the network it is helpful to estimate the time of data transmission.

According to the physical cable length the baud rate of the data transmission is limited. Furthermore the event timer interval indicates how often PDOs are generated. The number of PDOs generated by the slave double the time required for these continues transmission.

In case of default PDO mapping (hosting 1 PDO with 4 byte position, 2 byte velocity and 1 byte for status data) the CAN message becomes 103...126 bits (depending on stuff bit count).

Data transmission times depends on the baud rate in the network assuming default PDO mapping.

Baud rate [kbaud]	Time [ $\mu$ s]
125	824...1004
250	412 ... 502
500	206 ... 251
1000	103 ... 125.5

Table 22: Data transmission times

### 5.7.5 Cam switch

The sensor enables a cam switch depending on the position of the magnet. When the magnet passes the switch position the cam is activated or inactivated respectively.

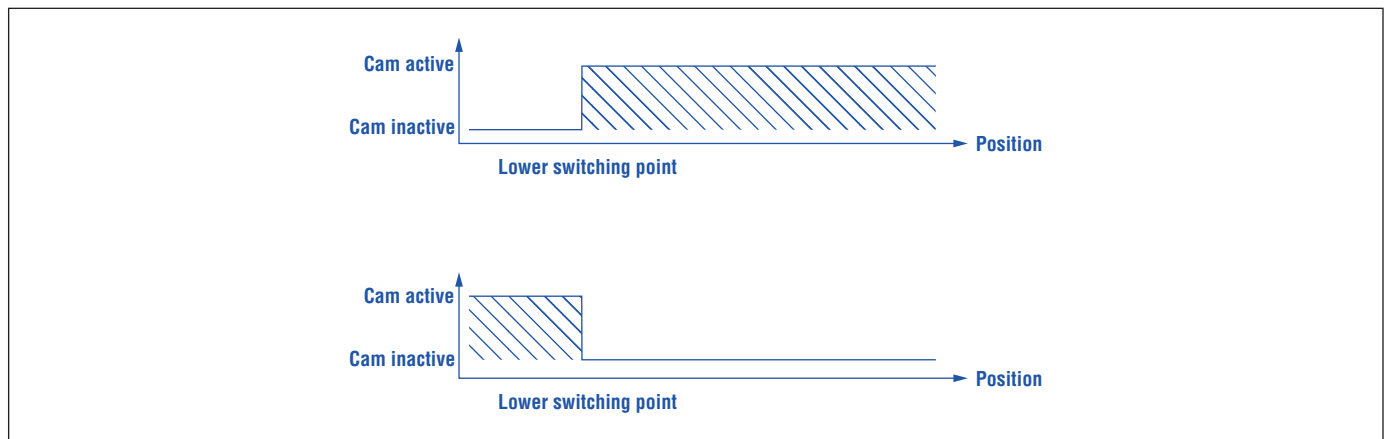


Fig. 17: CAM switch

## 6. Maintenance and troubleshooting

### 6.1 Error conditions, troubleshooting

See chapter 5.

### 6.2 Maintenance

The sensor is maintenance-free.

### 6.3 Repair

Repairs on the sensor may be performed only by MTS Sensors or an explicitly authorized body.

### 6.4 List of spare parts

No spare parts are available for this sensor.

## 7. Removal from service / dismantling

The product contains electronic components and must be disposed of in accordance with the local regulations.

## 8. Technical data

Output	
Interface	CAN System ISO-11898
Data protocol	CANopen: CIA Standard DS 301 V3.0 / Encoder Profile DS 406 V3.1
Baud rate, kBit/s	1000    800    500    250    125
Cable length, m	< 25    < 50    < 100    < 250    < 500
Measured value	Position
The sensor will be supplied with ordered baud rate, changeable by customer via LSS	
Measurement parameters	
Resolution	10 µm, 20 µm
Cycle time	1 ms
Linearity <sup>3</sup>	≤ ±0.02 % F.S. (minimum ±60 µm)
Repeatability	≤ ±0.005 % F.S. (minimum ±20 µm)
Operating conditions	
Operating temperature	-40...+75 °C (-40...+167 °F)
Humidity	90 % rel. humidity, no condensation
Ingress protection <sup>4</sup>	EP <sup>5</sup> /EL <sup>5</sup> /EH: IP67 with proper mating connector EH: IP69K with proper mating connector
Shock test	100 g (single shock) IEC standard 60068-2-27
Vibration test	15 g / 10...2000 Hz IEC standard 60068-2-6 (resonance frequencies excluded)
EMC test	Electromagnetic emission according to EN 61000-6-4 Electromagnetic immunity according to EN 61000-6-2 The sensor meets the requirements of the EC directives and is marked with <b>CE</b> .
Magnet movement velocity	Ring & U-magnets: Any Magnet sliders: 10 m/s
Design/Material	
Sensor electronics housing (EP/EL)	Aluminum
Sensor profile (EP/EL)	Aluminum
Sensor electronics housing (EH)	Stainless steel 1.4305 (AISI 303); Option: 1.4404 (AISI 316L)
Sensor rod (EH)	Rod Ø 7 mm (0.28 in.): Stainless steel 1.4301 (AISI 304) Rod Ø 10 mm (0.39 in.): Stainless steel 1.4306 (AISI 304L); Option: Stainless steel 1.4404 (AISI 316L)
Stroke length	50...2540 mm (2...100 in.)
Operating pressure (EH)	Rod Ø 7 mm (0.28 in.): 300 bar (4351 psi), 450 bar (6527 psi) peak Rod Ø 10 mm (0.39 in.): 350 bar (5076 psi), 530 bar (7687 psi) peak
Mechanical mounting	
Mounting position	Any

4/ EP/EL: With position magnet #252 182; EH: With position magnet #251 416-2

5/ The IP rating is not part of the UL approval

6/ EP/EL: The IP rating is valid for the sensor electronics only



### Electrical connection

Connection type 5 pin connector M12 or cable outlet (EH only)

Cable	<b>EHx (530166)</b>	<b>ETx (530157)</b>
Dimension	3 × 2 × 0.14 mm <sup>2</sup>	3 × 2 × 0.14 mm <sup>2</sup>
Cable Ø	6.2 mm (0.24 in.)	6.7 mm (0.26 in.)
Material	PUR, silver-grey	FEP, black
Operating temperature	-40...+80 °C (-40...+176 °F)	-100...+180 °C (-148...+356 °F)
Characteristics	Oil resistant, energy chain, halogen free	

Operating voltage +24 VDC (-15 / +20 %); UL Recognition requires an approved power supply with energy limitation (UL 61010-1), or Class 2 rating according to the National Electrical Code (USA) / Canadian Electrical Code. <sup>6</sup>

Ripple ≤ 0.28 V<sub>pp</sub>

Current consumption 40...60 mA depending on stroke length

Dielectric strength 500 VDC (DC ground to machine ground)

Polarity protection Up to -30 VDC

Overvoltage protection Up to 36 VDC

7/ Only sensors with connector outlets are UL/cUL certified

## 9. Annex

### Safety Declaration

Dear Customer,

If you return one or several sensors for checking or repair, we need you to sign a safety declaration. The purpose of this declaration is to ensure that the returned items do not contain residues of harmful substances and / or that any danger to persons when handling these items is excluded.

MTS Sensors order number: \_\_\_\_\_ Sensor type(s): \_\_\_\_\_

Serial number(s): \_\_\_\_\_ Sensor length: \_\_\_\_\_

#### The sensor has been in contact with the following materials:

Do not specify chemical formulas.  
Please, include safety data sheets of the substances, if applicable.

In the event of suspected penetration of substances into the sensor, consult MTS Sensors to determine measures to be taken before shipment, if necessary.

#### Short description of malfunction:

#### Corporate information

Company: \_\_\_\_\_

Address: \_\_\_\_\_

#### Contact partner

Name: \_\_\_\_\_

Phone: \_\_\_\_\_

E-Mail: \_\_\_\_\_

We hereby certify that the measuring equipment has been cleaned and neutralized. Equipment handling is safe.  
Personnel exposure to health risks during transport and repair is excluded.

Stamp

Signature

Date

**GERMANY**  
**MTS Sensor Technologie GmbH & Co.KG**  
Auf dem Schüffel 9  
58513 Lüdenscheid, Germany  
Tel. +49-23 51-95 87 0  
Fax. +49-23 51-5 64 91  
info.de@mtssensors.com  
www.mtssensors.com

**USA**  
**MTS Systems Corporation Sensors Division**  
3001 Sheldon Drive  
Cary, N.C. 27513, USA  
Tel. +1 919 677-0100  
Fax +1 919 677-0200  
info.us@mtssensors.com  
www.mtssensors.com

**JAPAN**  
**MTS Sensors Technology Corp.**  
737 Aihara-machi,  
Machida-shi,  
Tokyo 194-0211, Japan  
Tel. +81 42 775-3838  
Fax +81 42 775-5512  
info.jp@mtssensors.com  
www.mtssensors.com

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## LOCATIONS

**USA**  
**MTS Systems Corporation**  
**Sensors Division**  
3001 Sheldon Drive  
Cary, N.C. 27513, USA  
Tel. +1-919-677-0100  
Fax +1-919-677-0200  
info.us@mtssensors.com  
www.mtssensors.com

**JAPAN**  
**MTS Sensors Technology Corp.**  
737 Aihara-machi,  
Machida-shi,  
Tokyo 194-0211, Japan  
Tel. +81-42-775-3838  
Fax +81-42-775-5512  
info.jp@mtssensors.com  
www.mtssensors.com

**FRANCE**  
**MTS Systems SAS**  
Zone EUROPARC Bâtiment  
EXA 16  
16/18, rue Eugène Dupuis  
94046 Creteil, France  
Tel.: +33-1 58 43 90 28  
Fax: +33-1 58 43 90 03  
info.fr@mtssensors.com  
www.mtssensors.com

**GERMANY**  
**MTS Sensor Technologie**  
**GmbH & Co. KG**  
Auf dem Schüffel 9  
58513 Lüdenscheid, Germany  
Tel. +49-23 51-95 87 0  
Fax +49-23 51-5 64 91  
info.de@mtssensors.com  
www.mtssensors.com

**CHINA**  
**MTS Sensors**  
Room 504, Huajing Commercial Center,  
No. 188, North Qinzhou Road  
200233 Shanghai, China  
Tel: +86-21 6485 5800  
Fax: +86-21 6495 6329  
info.cn@mtssensors.com  
www.mtssensors.com

**ITALY**  
**MTS Systems Srl.Sensor Division**  
Via Diaz, 4  
25050 Provaglio d'Iseo (BS), Italy  
Tel.: +39-030 988 38 19  
Fax: +39-030 982 33 59  
info.it@mtssensors.com  
www.mtssensors.com

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