

Temposonics®

Magnetostrictive, Absolute, Non-contact
Linear-Position Sensors



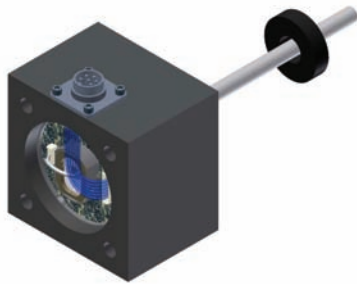
G-Series Model GE

Analog and Digital Outputs

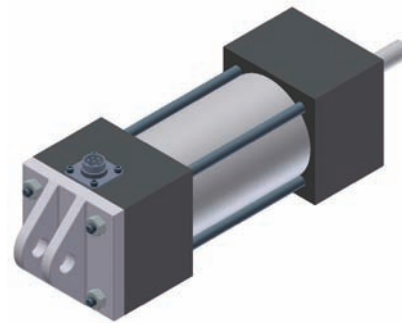
Document No.: 551121

Revision A

Product Specification



Model GE sensor installation in cylinder end cap



FEATURES

- G-Series Embedded Model (GE) sensor
- Modular, non-contact, absolute linear-position sensing
- Excellent resolution and repeatability
- Designed to be fully embedded into a cylinder end cap

BENEFITS

- Threaded flange on sensor rod provides easy installation
- Short installed height is ideal for clevis mount cylinders
- Smart solution for many difficult, space limited applications
- 2 year warranty

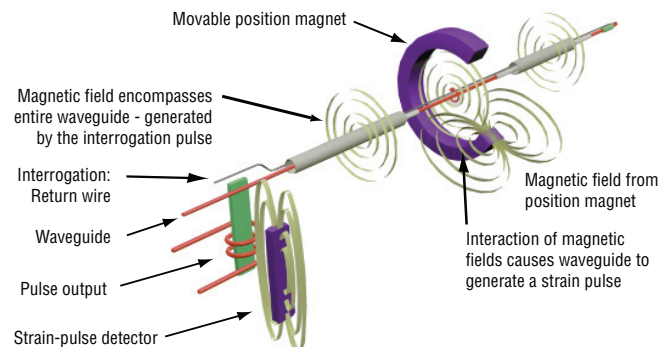
PRODUCT OVERVIEW

Temposonics G-Series Model GE position sensors are specifically designed for applications which have limited space. The sensing element is connected to the electronic module via an interconnection cable allowing the complete assembly to be mounted inside an actuator cylinder end cap.

Like other Temposonics G-Series position sensor models, the G-Series Model GE is available with voltage, current, start/stop, and Pulse-Width Modulated (PWM) outputs. All outputs are absolute rather than incremental so that power-down situations do not require re-homing.

In addition, Model GE position sensors use non-contacting magnetostrictive technology. Typical industry applications for G-Series position sensors include primary woodworking, plastic processing, hydraulics, and pneumatics.

Time-based Magnetostrictive position sensing principle



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 movable 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 ultrasonic 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.

All specifications are subject to change. Contact MTS for specifications and engineering drawings that are critical to your application. Drawings contained in this document are for reference only. Go to <http://www.mtssensors.com> for the latest support documentation and related media.

Product Specifications

Parameters	Specifications
Measured variable:	Displacement
Resolution:	Analog: Infinite Digital: $1 \div [\text{gradient} \times \text{crystal freq. (MHz)} \times \text{circulations}]$
Non-linearity:	$\pm 0.02\%$ or $\pm 0.05 \text{ mm}$ ($\pm 0.002 \text{ in.}$) whichever is greater
Repeatability:	$\pm 0.001\%$ of full stroke or $\pm 0.0001 \text{ in.}$ ($\pm 0.0025 \text{ mm}$), whichever is greater
Outputs:	Analog: voltage or current Digital: Start/Stop or PWM
Measuring range:	50 to 2540 mm (2 to 100 in.)
Operating voltage:	+24 Vdc nominal: -15 or +20%
Power consumption:	100 mA typical
Operating temperature:	-40 °C (-40 °F) to 80 °C (176 °F)
EMC test:**	Emissions IEC/EN 61000-6-3 Immunity IEC/EN 61000-6-2 IEC/EN 61000-4-2/3/4/5/6/8 level 3/4 criterion A, CE qualified
Shock rating:*	100 g (single hit)/IEC standard 68-2-27 (survivability)
Vibration rating:*	5 g / 10 to 150 Hz, IEC standard 68-2-6
Adjustability:	Field adjustable null and span setpoints (for analog outputs only)
Update time:	Analog: < 1 ms (typical) Digital (external interrogate): Minimum = (2.5 + null + stroke) \times 10.0 us/in. \times (number of recirculations)
Sensor rod:	304L stainless steel
Operating pressure:	350 bar static, 690 bar spike, (5000 psi static, 10,000 psi spike)
Mounting:	Threaded flange 3/4 - 16 UNF-3A
Typical mounting torque:	45 N-m (33 ft. - lbs.)
Magnet type:	Ring magnet, open-ring magnet, or magnet float

* Rating is valid when installed in recommended cylinder cavity.

** Installed in cylinder end cap, fully enclosed.

Product specifications for analog output sensors are based on the assumption that output ripple is averaged by the measuring device as with any typical analog device.

Outputs

DIGITAL OUTPUTS

The G-Series Model GE position sensor provides direct Start/Stop and PWM outputs. The Start/Stop output consists of two differential pairs of signals, (based on the RS-422 standard), that use TTL voltage levels, (0 to 5 volts). One differential pair is used for Start, and the other for Stop. These differential signals provide for better noise immunity.

Each Start/Stop or PWM output style sensor is provided with its actual measured gradient value indicated on the sensor's label. The gradient is the inverse of the rate at which a pulse signal, (generated at the position magnet), propagates through the magnetostrictive waveguide inside the sensor's rod, (about 9 microseconds per inch). As the position magnet is moved further down the sensor rod, more time is required for the pulse signals the magnet generates to travel back to the sensor's electronics at the head. To determine the absolute position of the position magnet it is only necessary to divide the difference in time between the Start signal and the Stop signal by the gradient (see Figure 1).

The PWM output provides the same elapsed time information, but rather than separate Start and Stop signals, it is represented on one differential pair of signals as a varying pulse width.

For both Start/Stop and PWM standard resolution is 0.004 inches, (when using a 28 MHz counter). Higher resolutions are possible with increased circulations or with the use of higher resolution counters.

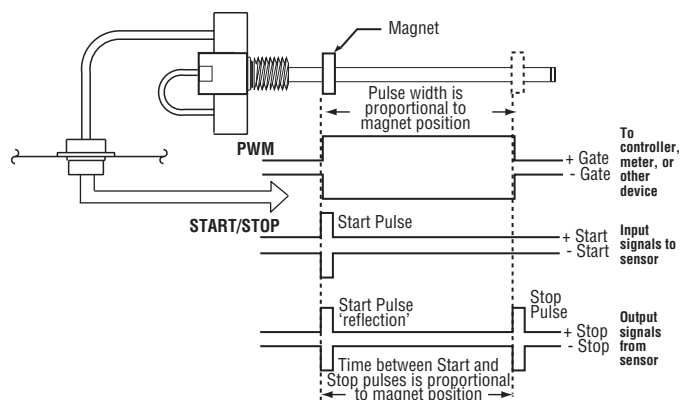


Figure 1. Direct Start/Stop and PWM output signals

ANALOG OUTPUTS

The Model GE position sensor provides direct analog output, including voltage and current (see page 7 for details). Both voltage and current outputs allow adjustments of zero and span setpoints. Resolution is limited only by the output ripple. Since the outputs are direct, no signal-conditioning electronics are needed when interfacing with controllers or meters (see Figure 2).

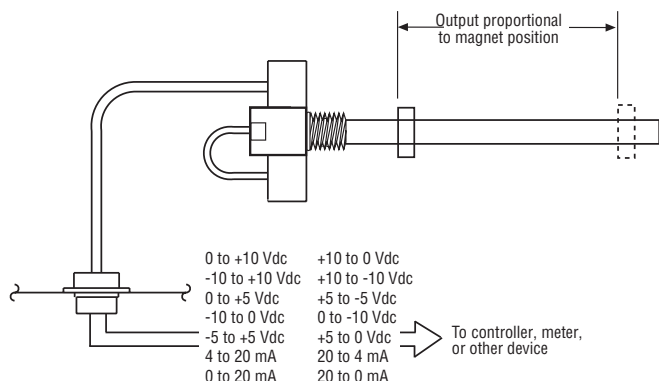


Figure 2. Direct voltage and current output signals

Dimensions - Electronics module and sensing element installations

Notes:

1. The GE is shown (see Figure 5) in a sample 50.8 mm (2 in.) bore NFPA cylinder end cap installation (not provided). This is the minimum recommended cylinder size for the Model GE sensor. The dimension, $54.99 + 0.13 / - 0.00$ mm dia., for the cylinder end cap must be observed to provide proper support for the electronics module. Other dimensions shown are for reference only.
2. Cylinder manufacturer must provide adequate method for end cap sealing to achieve desired ingress protection.
3. Shown with standard 6-pin DIN panel mount connector option (see page 4).
4. Standard null spacing from pressure flange face is 50.8 mm (2 in.). Special null spacing of 25.4 mm (1 in.) is also available. Contact factory for details.

ELECTRONICS MODULE AND SENSOR ROD

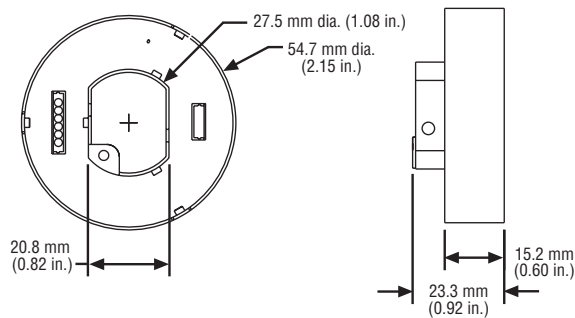


Figure 3. Electronics module

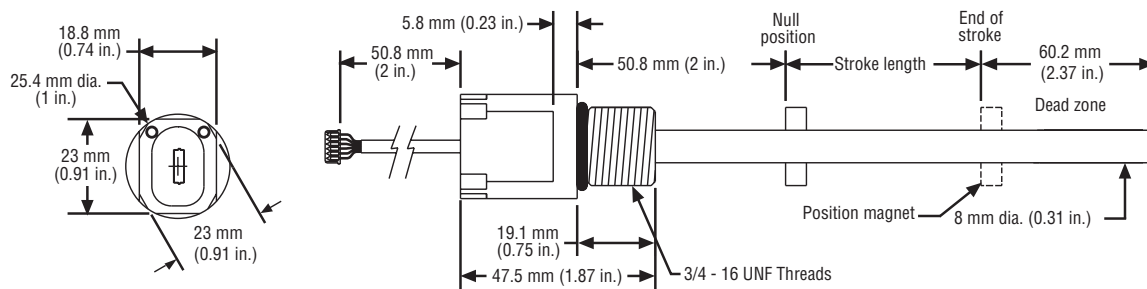


Figure 4. Sensor rod

TYPICAL CYLINDER INSTALLATION

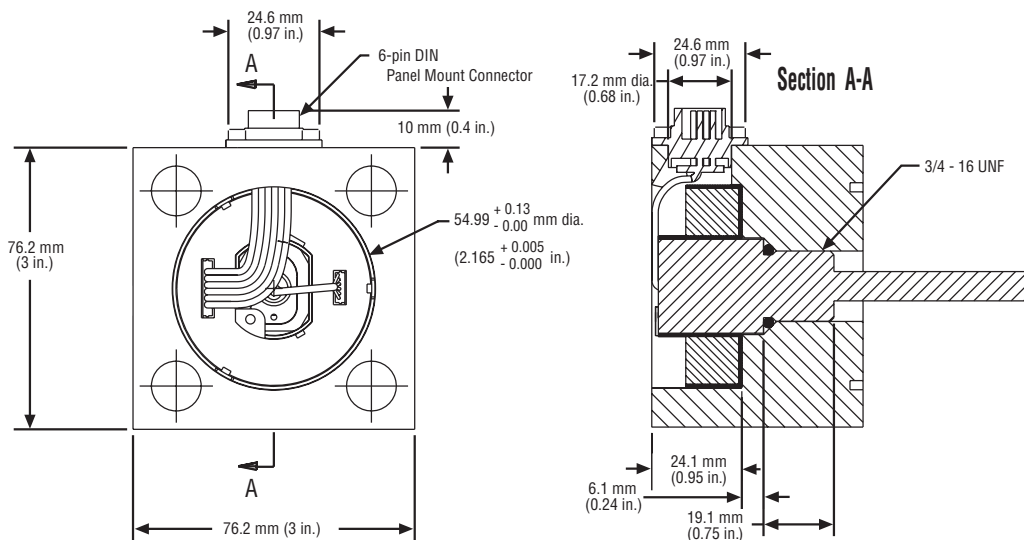


Figure 5. Typical Cylinder installation

Wiring and connections

CONNECTION TYPES, PANEL MOUNT CONNECTOR ASSEMBLY

Notes:

- 1. Appropriate grounding of extension cable shield is required at the controller end.
- 2. **When using analog output:**
 - Minimum load impedance for voltage outputs is 5K Ω .
 - Maximum load impedance for current output is 500 Ω . (*Reference to Ground Only, see page 6*)
- 3. **When using digital output:**
 - When using PWM with internal interrogation, both interrogation input signals are not used and can be left unconnected or connected to ground.

Refer to the following tables and figures for panel mount connector and cable assembly connections:

Pin no.	Extension cable wire color	Function - Digital-pulse outputs	Function - Analog outputs
1	Gray	(-) Gate for PWM (-) Stop for Start/Stop or Programming (RS-422 TX-)	0 to 10 Vdc, -10 to +10 Vdc or 4 to 20 mA, 0 to 20 mA <i>or</i> reverse acting: 10 to 0 Vdc, 10 to -10 Vdc or 20 to 4 mA, 20 to 0 mA
2	Pink	(+) Gate for PWM (+) Stop for Start/Stop or Programming (RS-422 TX+)	Return for Pin 1
3	Yellow	(+) Interrogation for PWM (+) Start for Start/Stop or Programming (RS-422 RX+)	Programming (RS-485+)
4	Green	(-) Interrogation for PWM (-) Start for Start/Stop Programming (RS-422 RX-)	Programming (RS-485-)
5	Red or Brown	Supply voltage (+Vdc)	Supply voltage (+Vdc)
6	White	DC ground (for supply)	DC ground (for supply)

Table 1. Panel mount connector (D6) male wiring

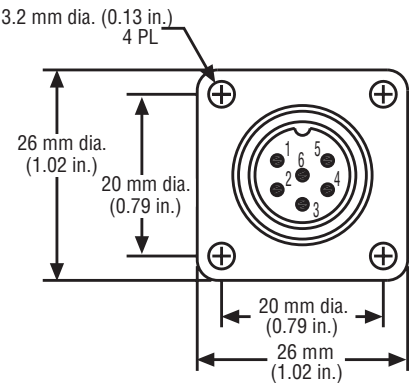


Figure 6. Panel mount connector (D6) male

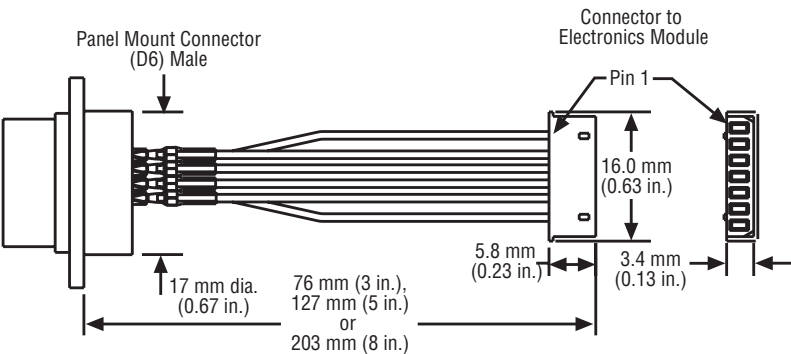


Figure 7. Panel mount connector assembly

ELECTRONICS MODULE CONNECTIONS, HARMONICA-STYLE CONNECTOR

Electronics module connections for analog and digital-pulse sensor outputs are described on page 5 in tables 2 and 3.

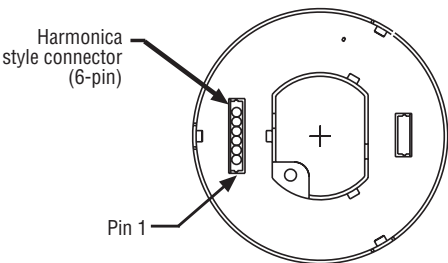


Figure 8. Electronics module with harmonica style connector

WIRING AND CONNECTIONS (CONTINUED)

ELECTRONICS MODULE CONNECTIONS, HARMONICA-STYLE CONNECTOR

Tables below contain electronics module connection information for analog and digital-pulse sensor outputs.

Pin no.	wire color	Function
1	Red	Supply voltage (+Vdc)
2	Green	(-) Interrogation for PWM or (-) Start for Start/Stop or Programming (RS-422 RX-)
3	Gray	(-) Gate for PWM or (-) Stop for Start/Stop or Programming (RS-422 TX-)
4	Yellow	(+) Interrogation for PWM or (+) Start for Start/Stop or Programming (RS-422 RX+)
5	Pink	(+) Gate for PWM (+) Stop for Start/Stop or Programming (RS-422 TX+)
6	White	DC ground (for supply)

Table 2. Connection reference for digital-pulse sensor outputs

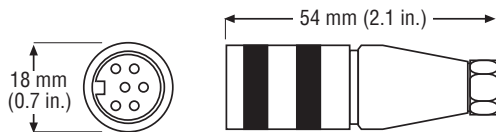
Pin no.	Wire color	Function
1	Red	Supply voltage (+Vdc)
2	Yellow	Programming (RS-485+)
3	Gray	0 to 10 Vdc, -10 to +10 Vdc or 4 to 20 mA, 0 to 20 mA or reverse acting: 10 to 0 Vdc, 10 to -10 Vdc or 20 to 4 mA, 20 to 0 mA
4	Green	Programming (RS-485-)
5	Pink	Return for Pin 3
6	White	DC ground (for supply)

Table 3. Connection reference for analog sensor outputs

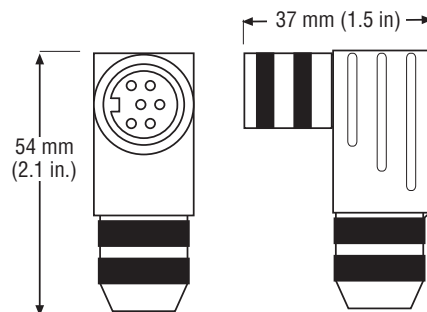
Dimensions, cable connectors and position magnets

CABLE CONNECTORS

Field-installable D6 female, mates with sensor panel mount D6 connector



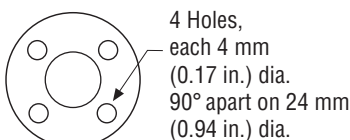
D6 Straight-exit connector, Part no. 560700



D6 90° connector, Part no. 560778

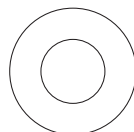
POSITION MAGNET SELECTIONS (MUST BE ORDERED SEPARATELY)

Position magnets must be ordered separately for Temposonics GE sensors. A variety of magnet styles are available to meet your particular application requirements. The standard ring magnet (*Part no. 201542-2*) is suitable for most applications.



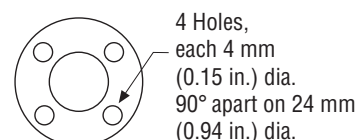
I.D.: 13.5 mm (0.53 in.)
O.D.: 33 mm (1.29 in.)
Thickness: 8 mm (0.31 in.)

Standard ring magnet
Part no. 201542-2



I.D.: 13.5 mm (0.53 in.)
O.D.: 25 mm (1.0 in.)
Thickness: 8 mm (0.31 in.)

Ring magnet, Part no. 400533

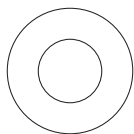


I.D.: 14 mm (0.56 in.)
O.D.: 32 mm (1.25 in.)
Thickness: 3.2 mm (0.125 in.)

Magnet spacer
(non-ferrous spacer for use with standard
ring magnet)
Part no. 400633

DIMENSIONS, POSITION MAGNETS (CONTINUED)

POSITION MAGNET SELECTIONS (MUST BE ORDERED SEPARATELY)



I.D.: 12 mm (0.47 in.)
O.D.: 17.4 mm (0.69 in.)
Thickness: 10.5 mm (0.41 in.)

Ring magnet, Part no. 253572



I.D.: 9.7 mm (0.38 in.)
O.D.: 13.5 mm (0.53 in.)
Thickness: 5.8 mm (0.23 in.)

Small ring magnet, Part no. 253538

G-Series, sensor model GE installation

TYPICAL WIRING FOR CURRENT OUTPUT

Notes:

1. Sensor requires connection to customer supplied power and can not be loop-powered from controller.
2. The 4-20 mA current loop is powered only by the sensor.
3. The sensor's output return connection is referenced to DC Ground, (connected internally). To avoid output errors, the optional connection to ground at the controller must be at the same potential as DC Ground (see Figure 9).

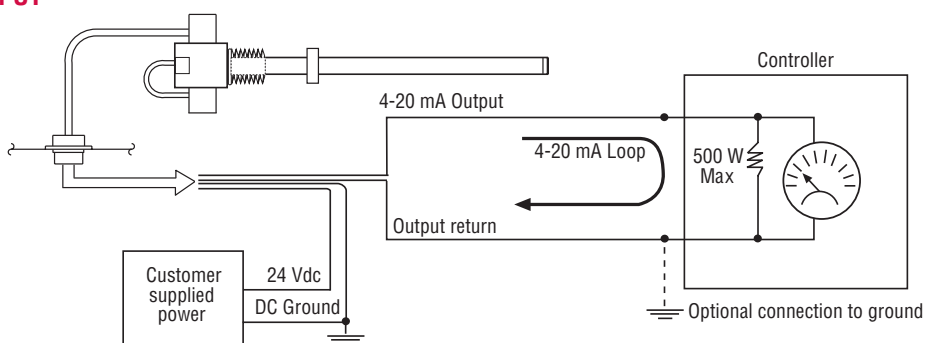


Figure 9. Typical wiring for current output

CYLINDER INSTALLATION

G-Series Model GE position sensors are designed for installation into hydraulic cylinders. The sensor's high-pressure, stainless-steel tube installs into a 10 millimeter (0.39 in.) bore in the piston head and rod assembly as illustrated (see Figure 9). Installation of the Model GE sensor requires modification of the cylinder end cap as indicated. Proper sealing of the end cap surrounding the electronics module is required to achieve the desired ingress protection.

Notes:

1. The position magnet requires minimum distances away from ferrous metals to allow proper sensor output. The minimum distance from the front of the magnet to the cylinder end cap is 15 mm (0.6 in.).
2. The minimum distance from the back of the magnet to the position head is provided by the non-ferrous spacer, (see Part no. 400633 on page 5 for thickness)
3. Figure 10 details a typical installation. Some installation requirements may be application specific.

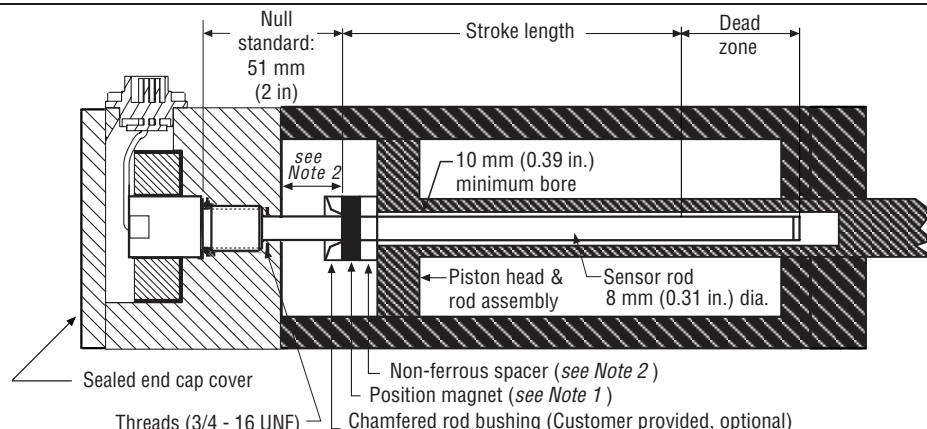


Figure 10. Typical cylinder installation

When placing an order, build your sensor model number using the *model number guide below* . A range of Temposonics G-Series Model GE sensor configurations are available to meet the demands of your particular application.

GE		E															
SENSOR MODEL																	
GE	=	G-Series, for embedded applications															
PRESSURE HOUSING STYLE																	
T	=	US customary threads and pressure tube															
STROKE LENGTH																	
_____	M	=	Millimeters (Encode in 5 mm increments)														
_____.__	U	=	Inches and tenths (Encode in 0.1 in. increments)														
CONNECTION TYPE																	
F01	=	Panel mount connector assembly, 3 in. length															
F02	=	Panel mount connector assembly, 5 in. length															
F03	=	Panel mount connector assembly, 8 in. length															
000	=	No connector and cable assembly included															
INPUT VOLTAGE																	
1	=	+24 Vdc (+20%, -15%)															
OUTPUT (2 or 3 digit code depending on output selected)																	
V0	=	Voltage 0 to +10 Vdc				V1	=	Voltage +10 to 0 Vdc									
V2	=	Voltage -10 to +10 Vdc				V3	=	Voltage +10 to -10 Vdc									
V4	=	Voltage 0 to +5 Vdc				V5	=	Voltage +5 to -5 Vdc									
V6	=	Voltage -10 to 0 Vdc				V7	=	Voltage 0 to -10 Vdc									
V8	=	Voltage -5 to +5 Vdc				V9	=	Voltage +5 to 0 Vdc									
A0	=	Current 4 to 20 mA				A1	=	Current 20 to 4 mA									
A2	=	Current 0 to 20 mA				A3	=	Current 20 to 0 mA									
R0X	=	Start/Stop, if more than one magnet, the 'X' denotes number of magnets in hexadecimal, (2 to F)															
DIX	=	PWM, internal interrogation, the 'X' denotes number of circulations in hexadecimal, (1 to F)															
DEX	=	PWM, external interrogation, the 'X' denotes number of circulations in hexadecimal, (1 to F)															

Stroke length note:

Model GE stroke length =
2 - 100 in. (50 - 2540 mm)

Note:

Mating connectors, extension cables and magnets are sold separately. For more information, refer to the *Industrial Product Catalog, Part no. 551075*.

Note:

Analog output is referenced from null to span.
For example;
'4 to 20 mA' output is 4 mA when the magnet is closest to the electronics head.

Decimal:	1	2	3	4	5	6	7	
Hexadecimal:	1	2	3	4	5	6	7	
Decimal:	8	9	10	11	12	13	14	15
Hexadecimal:	8	9	A	B	C	D	E	F

HOW TO ORDER, CONTINUED

Use the model number guide below to order an extension cable with connectors for (D6) and (D60) connection types:

D							
1	2	3	4	5	6	7	8

SENSOR CONNECTION TYPE (1-2)

- D6** = Female connector, (straight exit), and standard cable, part no. 530026 (PVC jacket) for sensors with (D6) or (D60) connector.
- DA** = Female connector, (90° exit), and standard cable, part no. 530026 (PVC jacket) for sensors with (D6) or (D60) connector.
- DJ** = Female connector, (straight exit) and cable, part no. 530045 (black polyurethane jacket for higher resistance to moisture and oil), for sensors with (D6) or (D60) connector.
- DK** = Female connector, (90° exit), and cable, part no. 530045 (black polyurethane jacket for higher resistance to moisture and oil), for sensors with (D6) or (D60) connector.

CABLE LENGTHS* (3-5)

For standard length cables up to 100 ft.

- 005** = 5 ft.
- 015** = 15 ft.
- 025** = 25 ft.
- 050** = 50 ft.
- 100** = 100 ft.
- = Cable length (ft.)*

CABLE TERMINATION (6-8) (2 or 3 characters depending on your 'Sensor Connection Type (1-2)' option selection)

- P0** = Pigtail connection, (no connector)
- D6M** = D6 male connector, (Straight exit). Only available with option '**D6**' sensor connection type (and standard cable, part no. 530026).
- D6F** = Female connector, (straight exit). Only available with option '**D6**' sensor connection type (and standard cable, part no. 530026).
- DAF** = Female connector, (90° exit). Only available with option '**DA**' sensor connection type (and standard cable, part no. 530026).



Type **DJ** female connector
with cable, part no. 530045



Type **DK** female connector
with cable, part no. 530045

Part Number: 551121 Revision A 01-09



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All Temposonics sensors are covered by US patent number 5,545,984. Additional patents are pending.
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