MTS®

Temposonics®

Position Sensors and Systems

Temposonics® II Position Sensors

Installation & Instruction Manual

11-98 550055 Revision E

GENERAL INFORMATION

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1. Introduction to the Temposonics II Linear Displacement Transducer (LDT)

The Temposonics™II Linear Displacement Transducer precisely senses the position of an external magnet to measure displacement with a high degree of resolution. The system measures the time interval between an interrogation pulse and a return pulse. The interrogation pulse is transmitted through the transducer waveguide, and the return pulse is generated by a movable permanent magnet representing the displacement to be measured.

1.1 Theory of Operation/Magnetostriction

The interrogation pulse travels the length of the transducer by a conducting wire threaded through the hollow waveguide. The waveguide is spring loaded within the transducer rod and exhibits the physical property of magnetostriction. When the magnetic field of the interrogation pulse interacts with the stationary magnetic field of the external magnet, a torsional strain pulse or "twist" is produced in the waveguide. This strain pulse travels in both directions, away from the magnet. At the end of the rod, the strain pulse is damped within the "dead zone". At the head of the transducer, two magnetically coupled sensing coils are attached to strain sensitive tapes. The tapes translate the strain pulse through coils to an electrical "return pulse". The coil voltage is then amplified in the head electronics before it is sent to various measuring devices as the conditioned "return pulse". See the Temposonics II Analog and Digital manuals for more information on analog and digital system configurations.

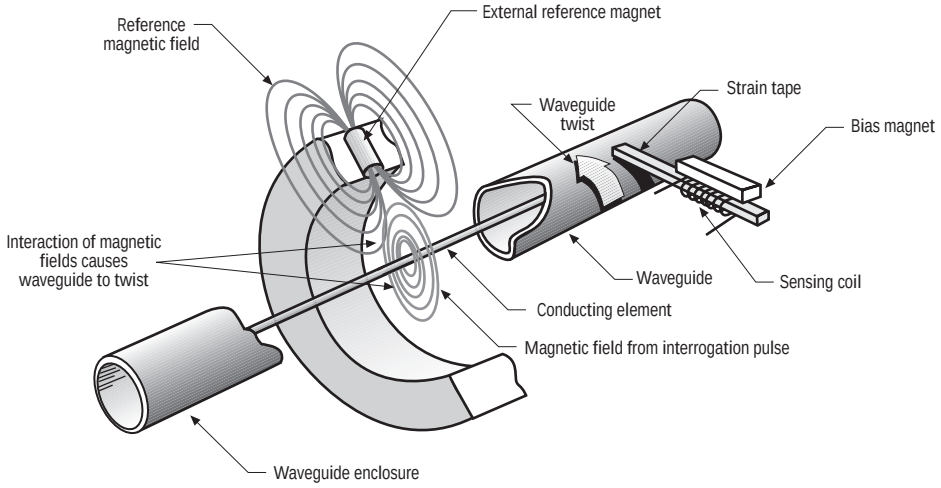


Figure 1-1
Waveguide Interaction

1.2 Temposonics II LDT Specifications for Sensors <180 Inches

Parameter	*Specifications*
Input Voltage:	± 12 to ± 15 Vdc
Current Draw:	Transducer Only: ± 15 Vdc at 100 mA maximum, 25 mA minimum (current draw varies with magnet position, maximum draw occurs when magnet is at 2 in. (50.6 mm) from the flange and minimum update time is being utilized)
Displacement:	Up to 25 feet (7620 millimeters)
Dead Zone:	2.5 inches (63.5 millimeters)
Electronics Enclosure:	IP-67
Non-linearity:	< ± 0.05% of full scale or ± 0.002 inch (±0.05 mm), whichever is greater
Repeatability:	< ± 0.001% of full scale or ± 0.0001 inch (±0.002 mm), whichever is greater
Hysteresis:	0.0008 inch (0.02 mm) maximum
Temperature Coefficient:	
Transducer (length dependent):	3 ppm/°F (5.4 ppm/°C)
Electronics:	<0.00011 in./°F (<0.00503 mm/°C)
Operating Temperature:	
Head Electronics:	- 40 to 150°F (- 40 to 66°C)
Transducer Rod:	- 40 to 185°F (- 40 to 85°C)
Operating Pressure:	3000 psi continuous, 8000 psi static
Output Impedance:	47Ω

Specifications are subject to change without notice. Consult MTS for verification of specifications critical to your application.

1.3 Temposonics II LDT Specifications for Sensors ≥180 Inches

Below is a list of specifications that pertain to Temposonics II transducers with active stroke lengths of 180 inches (4572 mm) to 300 inches (7620 mm). The below specifications apply only to sensors 180 to 300 inches in length. Specifications not listed below may be found in section 1.2, above.

Parameter	*Specifications*
Input Voltage:	• Maximum: ± 15 Vdc, ± 5% at 100 mA • Minimum: ± 15 Vdc at 25 mA (current draw varies with magnet position, maximum draw occurs when magnet is 2 inches (50.8 mm) from the flange and minimum update time is being used)
Dead Zone:	3 in. (76.2 mm)
Cable Length:	• Maximum cable length for neuter version transducer (i.e., Temposonics II without an integrated Personality Module) which requires the use of external interface electronics (Analog Output Module, Digital Interface Box or other signal conditioners) is 250 ft.
Magnet Requirement:	Part Numbers: 201554, 201553, 251416, 201542

2. Temposonics II LDT Installation

Before beginning installation, be sure you know the following dimensions (as illustrated in Figures 2-1 to 2-3a-c.):

- Null Space
- Stroke
- Dead Zone

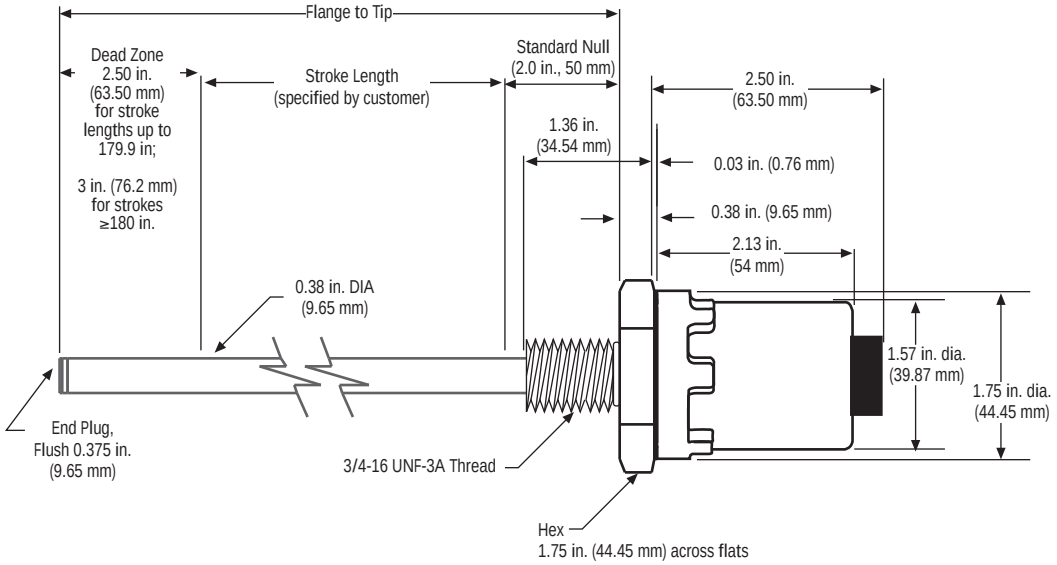


Figure 2-1
Temposonics II Dimensions

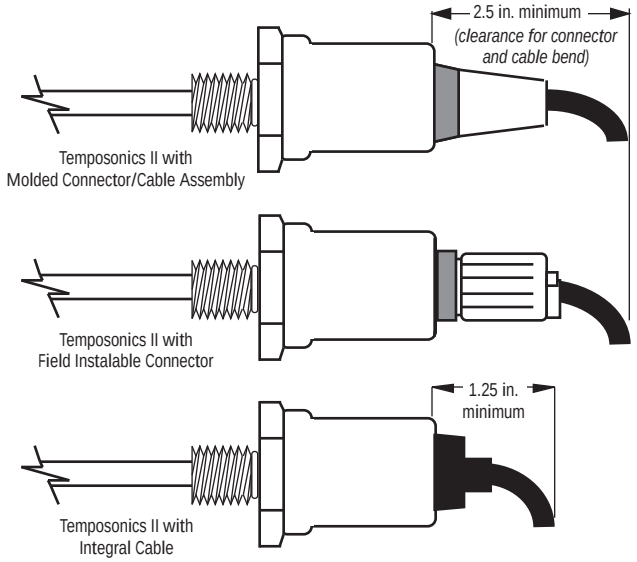


Figure 2-2
Temposonics II Connector/Cable Clearance Requirements

1. Use the 3/4 inch (19 mm), 16 UNF thread of the transducer to mount it at the selected location. Leave room to access the hex head. If a pressure or moisture seal is required, install an O-ring (type MS 28778-8 is recommended) in the special groove. Use the hex head to tighten the transducer assembly.

2. Install the permanent magnet over the LDT rod. Mount the permanent magnet to the movable device whose displacement will be measured. To minimize the effect of magnetic materials (i.e. iron, steel, etc.) on the magnetic field of the permanent magnet, ensure the minimum spacing requirements are met as shown in Figure 2-3a-c. (Any non-magnetic materials can be in direct contact with the permanent magnet without affecting performance.)

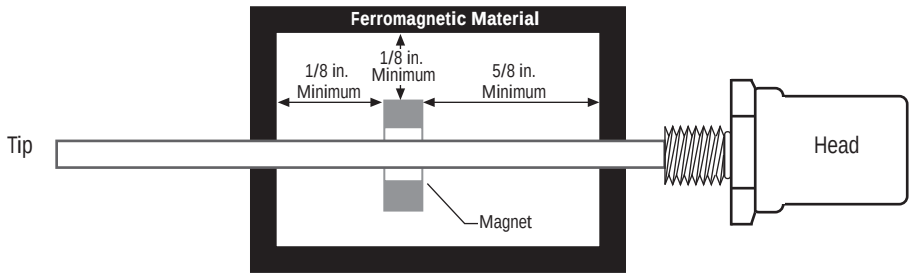


Figure 2-3a
Minimum Magnet Clearance Using Magnetic Supports

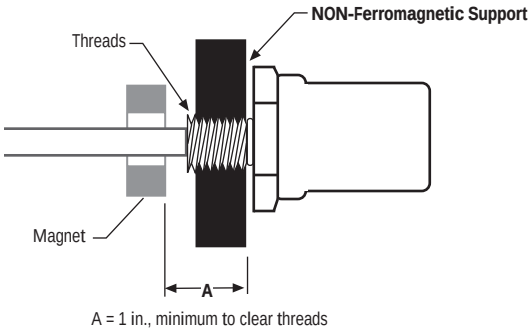


Figure 2-3b
Minimum Null Space Using Non-Magnetic Support

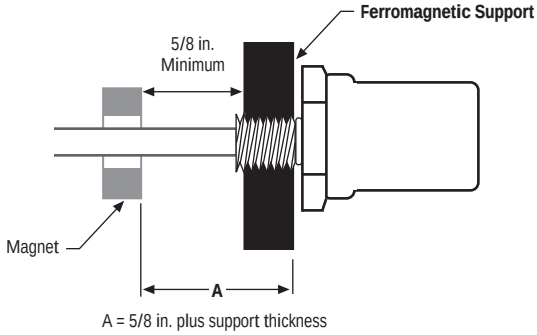


Figure 2-3c
Minimum Null Space Using Magnetic Support

Notes:

1. The magnet must not contact ferromagnetic materials (such as iron or steel). Clearances are required between the surface of the magnet and ferromagnetic material, as shown. Non-ferrous material (such as copper, brass, or 300 series stainless steel) may contact the magnet without affecting transducer performance.
2. Standard Null Space is 2 inches. There is no maximum limit for Null Space. Less then 2 inches can be specified if magnet clearances meet requirements illustrated above.

NOTE:

Clearance between the magnet and the transducer rod is not critical. However, contact between the components will cause wear over time. The installation of supports or readjustment of the supports is recommended if the magnet contacts the transducer rod.

3. Move the permanent magnet full-scale to check that it moves freely and does not rub against the transducer. If the magnet does not move freely, you can correct this by mounting a support bracket to the end of the tranducer. Long transducers may need additional supports to be attached to the transducer rod. Transducer supports are described later in this section.

2.1 Types of Transducer Supports

Long transducers (48 inches or longer) may require supports to maintain proper alignment between the transducer rod and the permanent magnet. When transducer rod supports are used, special, open-ended permanent magnets are required.

Transducer supports attached to the active stroke length must be made of a non-ferrous material, thin enough to permit the permanent magnet to pass without obstruction. Because the permanent magnet does not enter the dead zone, supports connected within the dead zone may be made of any material. The main types of supports are loop, channel, and guide pipe supports.

2.1.1 Loop Supports

Loop supports are fabricated from non-ferrous materials, thin enough to permit free movement of the magnet. Loop supports are recommended for straight transducers and may be spaced apart approximately every three feet. They may be used alone or with channel supports. Figure 2-4 illustrates the fabrication of a loop support.

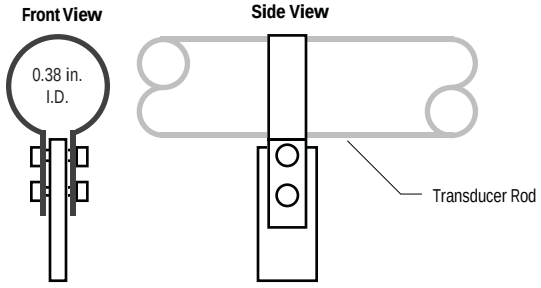


Figure 2-4
Loop Support

NOTE:

When open magnets are used, ensure the transducer rod remains within the inside diameter of the magnet throughout the length of the stroke. If the transducer rod is allowed to enter the cut out area of an open magnet, the transducer signal could attenuate or be lost. See Figure 2-7.

2.1.2 Channel Supports

Channel supports, being typically straight, are normally used with rigid transducers. A channel support consists of a straight channel with loop supports mounted at intervals. The loop supports are required to keep the transducer within the channel. Figure 2-5 shows a channel support. Channel supports are available from various manufacturers or may be fabricated.

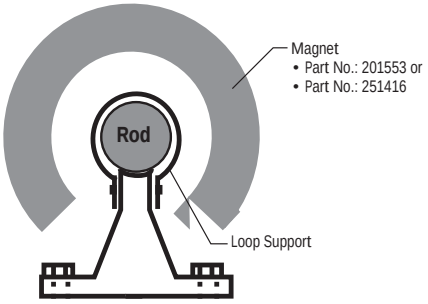


Figure 2-5
Channel Support

2.1.3 Guide Pipe Supports

Guide pipe supports are normally used for flexible transducers. A guide pipe support is constructed of non-ferrous material, straight or bent to the desired shape. As shown in Figure 2-6, both inside and outside dimensions of the pipe are critical:

- Because the transducer rod is installed inside the pipe, the inside diameter of the pipe must be large enough to clear the rod.

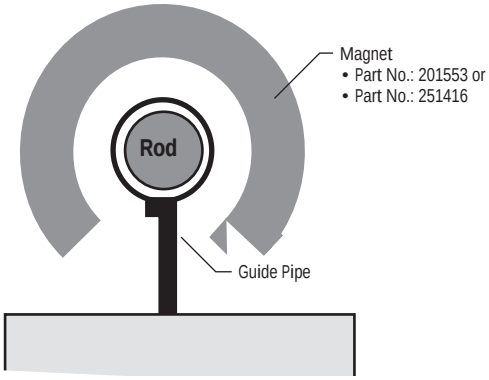


Figure. 2-6
Guide Pipe Support

- The outside diameter of the pipe must be small enough to clear the magnet.

Refer to pipe manufacturers' specifications and dimensions (schedule 10, 40, etc.) to select the appropriate size pipe. Guide pipe is typically supported at each end of the pipe.

2.2 Open Magnets

When using an open magnet, make sure the rod is positioned at all times within the “active” zone of the magnet. The transducer cannot operate properly unless the entire stroke of the transducer rod is located within this zone. The active zone, as shown in Figure 2-7, lies within the inside diameter of the magnet.

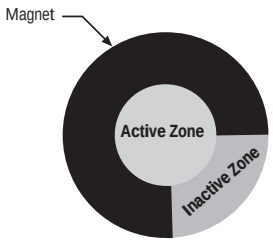


Figure 2-7
Active Zone for Open Magnets

2.3 Spring Loading or Tensioning

The transducer rod can be spring loaded or tensioned using a stationary weight. Attach a spring mechanism or weight to the dead zone of the transducer rod with a clamping device which will not deform the transducer rod. The maximum weight or spring tension is 5 to 7 lbs.

2.4 Cylinder Installation

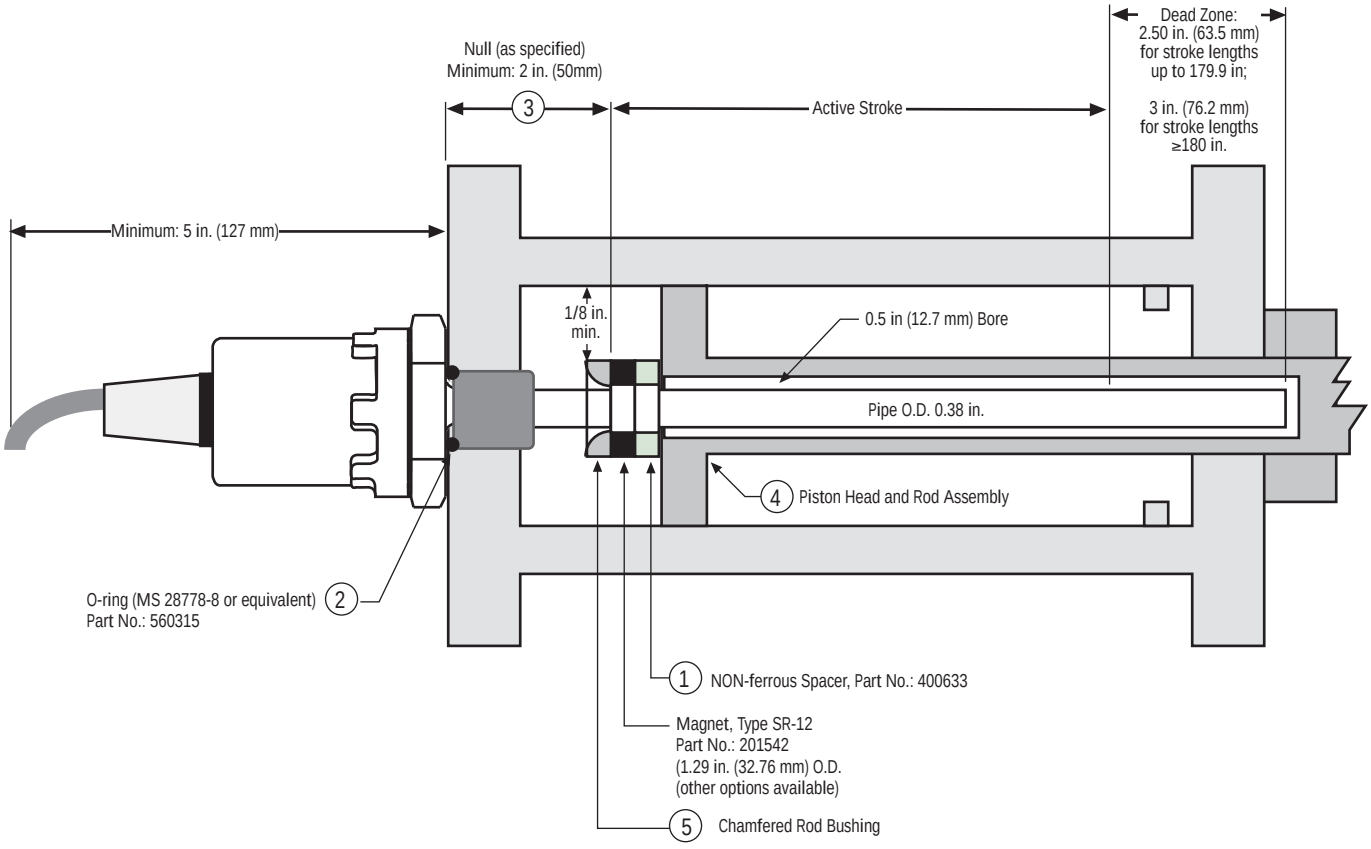
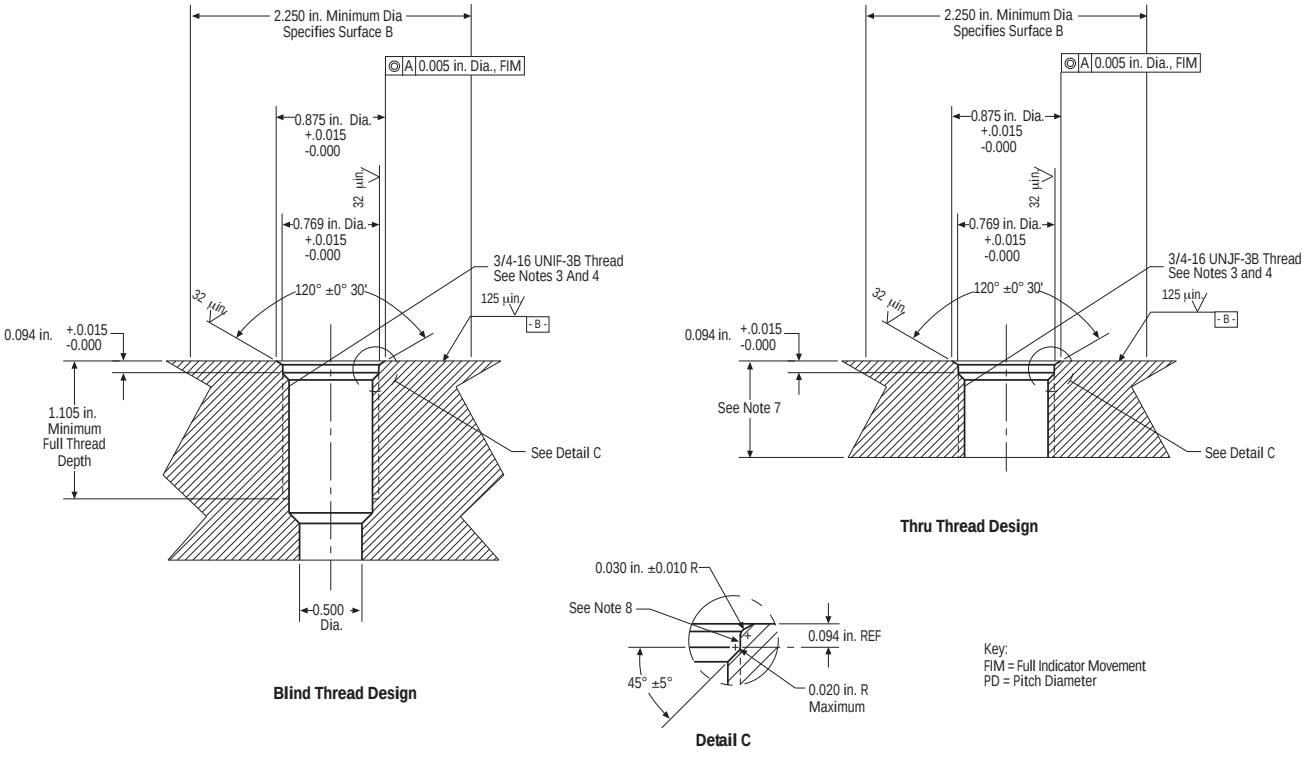


Figure 2-8
Typical Cylinder Installation

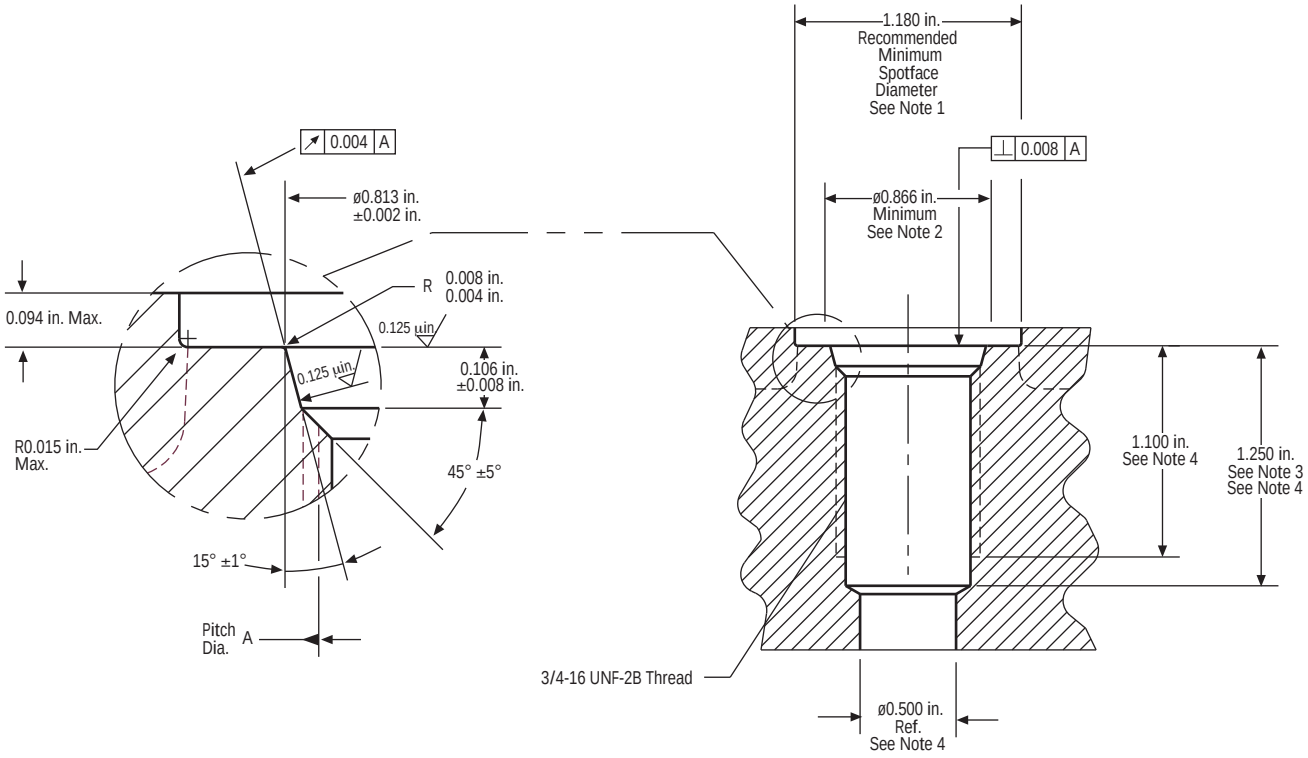
Figure 2-8 shows a typical cylinder installation. Review the following before attempting this type of installation.

- Use a non-ferrous (plastic, brass, Teflon®, etc.) spacer [1] to provide 1/8 inch (32 mm) minimum space between the magnet and the piston.
- An O-ring groove [2] is provided at the base of the transducer hex head for pressure sealing. MTS uses mil-standard MS33514 for the O-ring groove. Refer to mil-standard MS33649 or SAE J514 for machining of mating surfaces.
- The null space [3] is specified according to the installation design and cylinder dimensions. The analog output module provides a null adjustment. Make sure that the magnet can be mounted at the proper null position.
- The piston head [4] shown in Figure 2-8 is typical. For some installations, depending on the clearances, it may be desired to countersink the magnet.
- A chamfered rod bushing [5] should be considered for stokes over 5 feet (1.5 meters) to prevent wear on the magnet as the piston retracts. The bushing should be made from Teflon or similar material.
- The recommended bore for the cylinder rod is 1/2 inch (13 mm). The transducer rod includes a 0.375 inch (9.53 mm) diameter end plug mounted flush. Use standard industry practices for machining and mounting of all components. Consult the cylinder manufacturer for applicable SAE or military specifications.



NOTES:
1. Dimensions and tolerances based on ANSI Y14.5-1982.
2. MTS has extracted all pertinent information from MS33649 to Generate this document.
3. PD must be square with surface B within 0.005 FIM across 2.250 dia minimum.
4. PD must be concentric with 2.250 dia within 0.030 FIM and with 0.769 dia within 0.005 FIM.
5. Surface texture ANSI B46.1-1978
6. Use o-ring MTS part number 560315 for correct sealing.
7. The thread design shall have sufficient threads to meet strength requirements of material used.
8. Finish counter-bore shall be free from longitudinal and spiral tool marks. Annular tool marks up to 32 micro-inches maximum will be permissible.

Figure 2-9
O-ring Boss Detail



NOTES:

1. If face of port is on a machined surface, dimensions 1.180 and 0.094 need not apply as long as R0.008/0.004 is maintained to avoid damage to the O-ring during installation.
2. Measure perpendicularity to A at this diameter.
3. This dimension applies when tap drill cannot pass through entire boss.
4. This dimension does not conform to SAE J1926/1.

Figure 2-10
Port Detail (SAE J1926/1)

2.5 Installing Magnets

Figure 2-11 below shows the standard magnet types and dimensions. The circular magnet with an outside diameter of 1.29 inches and 0.53 inch inside diameter (Part No. 201542) is the most common and is suitable for most applications. Larger magnets, with an outside diameter of 2.5 inches are typically only used with Temposonics transducers that exceed 180 inches in stroke length. Magnets with a 90 degree cut-out are used in applications that require intermediate supports along the transducer rod.

If upon installation, the null adjustment is inadequate, you can design a coupler with adjustments to mount the magnet to the measured member.

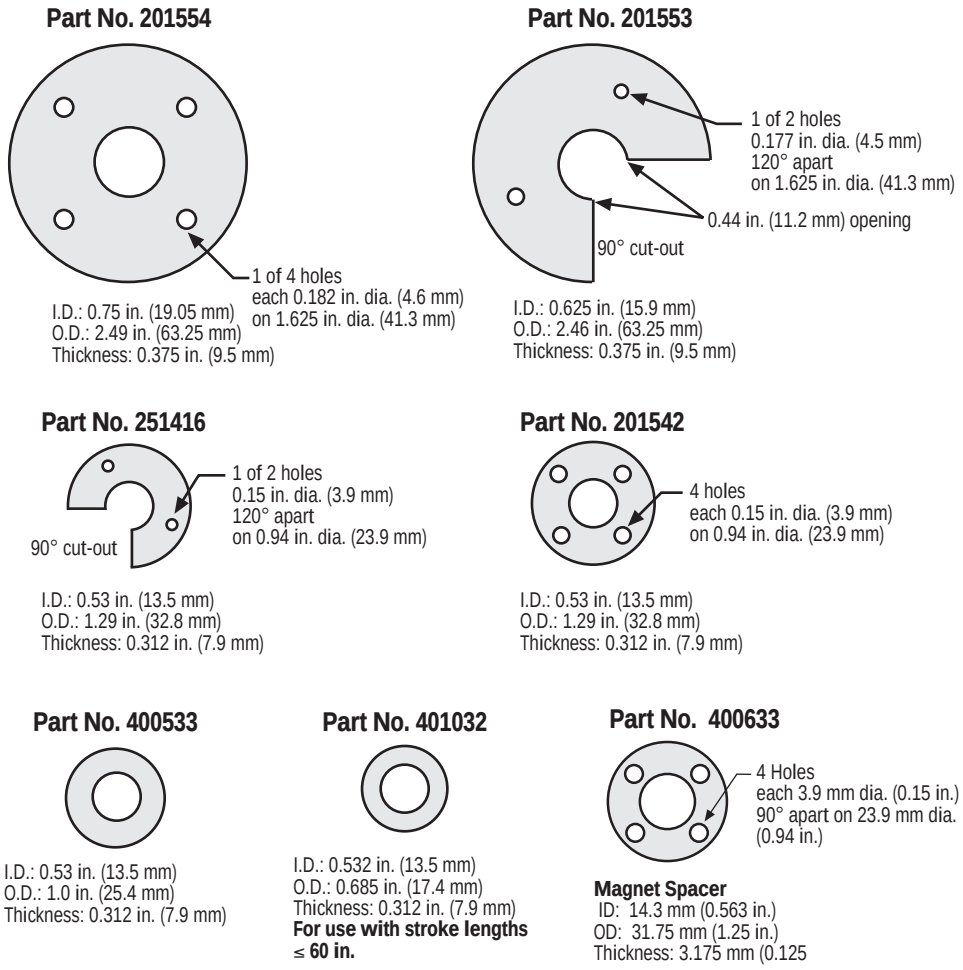


Figure 2-11
Magnet Dimensions

3. Temposonics II Wiring

Table 3A Connections - Temposonics II Transducer with Personality Modules

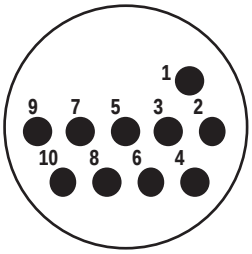
Temposonics II Cable Color Code (See Note 1)

Temposonics II Configurations:
- **Neuter** - No Personality Module
- **DPM** - Digital Personality Module
- **RPM** - RS422 Personality Module
- **APM** - Analog Personality Module

Pin No.	***Wire Color*** *(Striped leads)*	***Wire Color*** *(Solid Leads)*	***Neuter***	***DPM***	***RPM***	***APM***
1	White/Blue Stripe	White	DC Ground	DC Ground	DC Ground	DC Ground
2	Blue/White Stripe	Brown	Frame	Frame	Frame	Frame
3	White/Orange Stripe	Gray	Not Used	(-) Gate Out	(-) Start/Stop Pulse	Displacement Return (GND)
4	Orange/White Stripe	Pink	Not Used	(+) Gate Out	(+) Start/Stop Pulse	Displacement Out
5	White/Green Stripe	Red	+ VDC	+ VDC	+ VDC	+ VDC (See Note 6)
6	Green/White Stripe	Blue	- VDC	- VDC	- VDC	- VDC
7	White/Brown Stripe	Black	Output Pulse Return	Not Used	Not Used	Not Used
8	Brown/White Stripe	Violet	Output Pulse	Not Used	Not Used	Not Used
9	White/Gray Stripe	Yellow	+ Interrogation (See Notes 2, 3)	+ Interrogation (See Notes 2, 4)	+ Interrogation (See Notes 2, 4, 5)	Not Used
10	Gray/White Stripe	Green	- Interrogation (See Notes 2, 3)	- Interrogation (See Notes 2, 4)	- Interrogation (See Notes 2, 4, 5)	Not Used

NOTES:

1. Verify if the cable has striped or solid color leads and make connections accordingly.
2. 1 to 4 microseconds maximum pulse duration.
3. **WARNING:** Under no condition should both the positive (+) and negative (-) interrogation leads be connected at the same time when using the "NEUTER" version Temposonics II transducer. The unused interrogation lead must be connected to DC ground.
4. When using a Temposonics II transducer with a Digital Personality Module (DPM) or an RS422 Personality Module (RPM), it is recommended that both the positive and negative interrogation leads are used to produce a differential interrogation signal.
5. For external interrogation mode ONLY.
6. Temposonics II w/APM requires $^{+}$/-13.5 to $^{+}$/-15 Vdc. All others require +/-12 Vdc to +/-15 Vdc.



Temposonics II 10-Pin Connector

Table 3B Connections - Original Temposonics Transducer

Original Temposonics Connector

Pin Number	***Wire Color Code***	***Signal Function***
A	Green or Gray	+ 15 Vdc
B	Black	DC Ground
C	Orange or Brown	Return Pulse (from LDT)
D	Blue	- 15 Vdc
E	White	Interrogation Pulse
F	Red	+ 12 Vdc

Table 3C Connections - Temposonics II Transducer to Analog Output Module (AOM)

Temposonics II Cable Color Code (See Note 5)				**AOM Connections:** (Stroke Lengths < 180 in.)		**AOM Connections** (Stroke Lengths > 180 in.)	
Pin No.	***Wire Color*** *(Striped leads)*	***Wire Color*** *(Solid Leads)*	***Function***	***Terminal Blocks***	***Military Style Connectors***	***Terminal Blocks***	***Military Style Connectors***
1	White/Blue Stripe	White	DC Ground	TB2-B	J2 Pin B	TB2-B	J2 Pin B
2	Blue/White Stripe	Brown	Frame (see note 1)	TB2-B	J2 Pin B	TB2-B	J2 Pin B
3	White/Orange Stripe	Gray	Not Used	Not Used	Not Used	Not Used	Not Used
4	Orange/White Stripe	Pink	Not Used	Not Used	Not Used	Not Used	Not Used
5	White/Green Stripe	Red	+Vdc	TB2-F	J2 Pin F	TB2-A	J2 Pin A
6	Green/White Stripe	Blue	-Vdc	TB2-D	J2 Pin D	TB2-D	J2 Pin D
7	White/Brown Stripe	Black	Output Pulse Return	TB2-B	J2 Pin B	TB2-B	J2 Pin B
8	Brown/White Stripe	Violet	Output Pulse	TB2-C	J2 Pin C	TB2-C	J2 Pin C
9	White/Gray Stripe	Yellow	+ Interrogation (See notes 2, 4)	TB2-E	J2 Pin E	TB2-E	J2 Pin E
10	Gray/White Stripe	Green	- Interrogation (See notes 3, 4)	TB2-E	J2 Pin B	TB2-E	J2 Pin B

NOTES:

1. Frame ground is isolated from circuit ground inside the transducer head.
2. For retrofitting AOMs or DIBs with strooke lengths greater than 12 inches (+ interrogation pulse).
3. For retrofitting AOMs or DIBs with stroke lengths of 12 inches or less (-interrogation pulse).
4. IMPORTANT: under no condition should both the positive (+) and negative (-) interrogation leads be connected at the same time. The unused interrogation lead must be connected to DC ground.
5. Verify if the cable has striped or solid color leads and make connections accordingly.

Table 3D Connections - Temposonics II to Digital Interface Box (DIB)

Temposonics II Cable Color Code (See Note 1)				**DIB Connections:**	
Pin No.	***Wire Color*** *(Striped leads)*	***Wire Color*** *(Solid Leads)*	***Function***	***J2 Pin Connections***	***Retrofit connections to Mating Connector*** *(P/N 370160, See Note 2)*
1	White/Blue Stripe	White	DC Ground	J2 Pin B	A
2	Blue/White Stripe	Brown	Frame (see note 2)	J2 Pin B	J
3	White/Orange Stripe	Gray	Not Used	Not Used	K
4	Orange/White Stripe	Pink	Not Used	Not Used	G
5	White/Green Stripe	Red	+Vdc	J2 Pin F (Pin A if stroke length is > 180 in.)	H
6	Green/White Stripe	Blue	-Vdc	J2 Pin D	B
7	White/Brown Stripe	Black	Return (Gnd.)	J2 Pin B	Not Used
8	Brown/White Stripe	Violet	Output (return pulse)	J2 Pin C	Not Used
9	White/Gray Stripe	Yellow	+ Interrogation	J2 Pin E	E
10	Gray/White Stripe	Green	- Interrogation	J2Pin B	D

NOTES:

1. Frame ground is isolated from circuit ground inside the transducer head.
2. Verify if the cable has striped or solid color leads and make connections accordingly.
3. Connections to existing mating connector when replacing a Digital Interface Box with a Temposonics II LDT with a Digital Personality Module.

4. Grounding

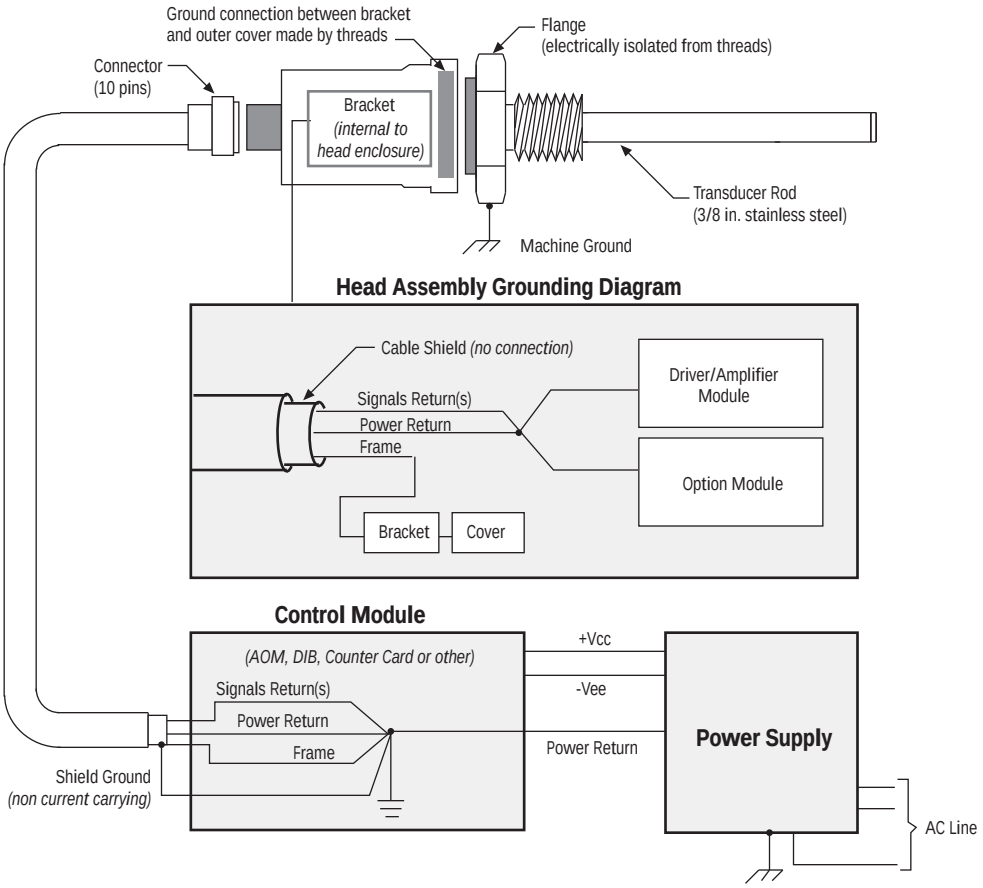


Figure 4-1
Grounding

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Part Number: 11-98 550055 Revision E