

Temposonics®

Magnetostrictive Linear-Position Sensors

R-Series Models RP and RH
EtherNet/IP™ Industrial Ethernet Interface

Data Sheet



Document Part Number
551253 Revision C



Model RP Profile-style position sensor



Model RH Rod-style position sensor



FEATURES

- Linear, Absolute Measurement
- LEDs For Sensor Diagnostics
- Superior Accuracy, Resolution down to 1 μm
- Non-Contact Sensing Technology
- Linearity Less Than 0.01 %
- Repeatability Within 0.001 %
- Direct EtherNet/IP™ Interface, Position + Velocity

BENEFITS

- Rugged Industrial Sensor
- Position + Velocity Measurements For Up to 20 Magnets

APPLICATIONS

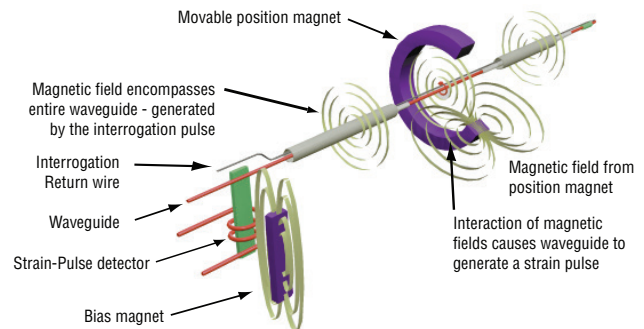
- Continuous Operation In Harsh Industrial Conditions
- High Pressure Conditions
- For Accurate, Simultaneous Multi-Position and Velocity Measurements

TYPICAL INDUSTRIES

- Factory Automation
- Fluid Power
- Plastic Injection and Blow Molding
- Material Handling and Packaging



Time-based Magnetostrictive position sensing principle



Benefits of Magnetostriction

Temposonics® linear-position sensors use the time-based magnetostrictive position sensing principle developed by MTS Sensors. 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 sonic speed along the waveguide and is detected at the head of the sensing element.

The position of the magnet is determined with high precision and speed by accurately measuring the elapsed time between the application of the interrogation pulse and the arrival of the resulting strain pulse with a high-speed counter. The elapsed time measurement is directly proportional to the position of the permanent magnet and is an absolute value. Therefore, the sensor's output signal corresponds to absolute position, instead of incremental, and never requires recalibration or re-homing after a power loss. Absolute, non-contact sensing eliminates wear, and guarantees the best durability and output repeatability.

EtherNet/IP™ is a trademark used under license by ODVA.
ODVA CONFORMANT™ is a certification mark of ODVA.

All specifications are subject to change. Contact MTS Sensors 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 Overview and Specifications

Product overview

Temposonics® R-Series EtherNet/IP™ sensors represent MTS Sensors' development and product offering in networked position feedback. EtherNet/IP™ systems require only a single point of connection for both configuration and control, because EtherNet/IP™ supports both I/O (or implicit) messages—those that typically contain time-critical control data—and explicit messages—those in which the data field carries both protocol information and instructions for

service performance. And, as a producer-consumer network that supports multiple communication hierarchies and message prioritization, EtherNet/IP™ provides more efficient use of bandwidth than a device network based on a source-destination model. EtherNet/IP™ systems can be configured to operate either in a master/slave or distributed control architecture using peer-to-peer communication.

Product specifications

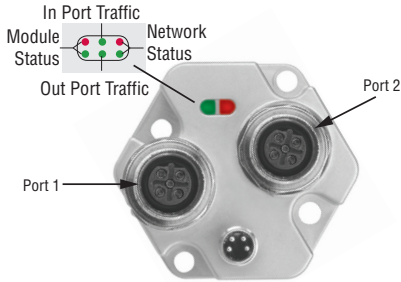
Parameters	Specifications	Parameters	Specifications
OUTPUT		ENVIRONMENTAL	
Measured output variables:	Simultaneous multi-position and velocity measurements up to 20 magnets.	Operating conditions:	Operating temperature: -40 °C (-40 °F) to +75 °C (+167 °F) Humidity: 90 % no condensation Temperature coefficient: < 15 ppm/°C
Resolution:	1 to 1000 µm selectable	EMC test:	Electromagnetic emission: EN 61000-6-4 Electromagnetic immunity: EN 61000-6-2 CE qualified
Cycle time:	1.0 ms up to 2000 mm 2.0 ms up to 4800 mm, 4.0 ms up to 7600 mm stroke length	Shock rating:	100 g (single hit)/IEC standard 60068-2-27(survivability)
Linearity:	< ± 0.01% full stroke (minimum ± 50 µm)	Vibration rating:	15 g / 10 to 2000 Hz / IEC standard 60068-2-6 (excluding resonance frequencies)
Repeatability:	< ± 0.001% full stroke (minimum ± 2.5 µm)	WIRING	
Hysteresis:	< 4 µm	Connection type:	D56 option: Two female 4-pin (M12-D) plus one 4-pin male (M8) connector
Outputs:	Interface: EtherNet/IP™ Data transmission rate max: 100 Mbit/s	PROFILE STYLE SENSOR (MODEL RP)	
Stroke length:	Range (Profile style): 25 mm to 5080 mm (1 in. to 200 in.) Range (Rod style): 25 mm to 7620 mm (1 in. to 300 in.)	Sensor electronics housing:	Aluminum housing with diagnostic LED display (LEDs located beside connectors)
ELECTRONICS		Ingress protection:	IP 65**
Operating voltage:	+24 Vdc nominal: -15% or +20%* Polarity protection: up to -30 Vdc Over voltage protection: up to 36 Vdc Current drain: 110 mA typical <i>(Note: Due to variations in cable length and topology as well as inrush current draw on power up, MTS Sensors recommends that 1 amp per sensor be available on the power supply used.)</i> Dielectric withstand voltage: 500 Vdc (DC ground to machine ground)	Sensor extrusion:	Aluminum (Temposonics® profile style)
		Mounting:	Any orientation. Adjustable mounting feet or T-slot nut (M5 threads) in bottom groove
		Magnet types:	Captive-sliding magnet or U-magnet
		ROD STYLE SENSOR (MODEL RH)	
		Sensor electronics housing:	Aluminum housing with diagnostic LED display (LEDs located beside connectors)
		Ingress protection:	IP 67**
		Sensor rod:	1.4306 (AISI 304L)
		Operating pressure:	350 bar static, 690 bar peak (5000 psi static, 10,000 psi peak)
		Mounting:	Any orientation. Threaded flange M18 x 1.5 or 3/4 - 16 UNF-3A
		Typical mounting torque:	45 N-m (33 ft. - lbs.)
		Magnet types:	Ring magnet, U-magnet, or magnet float

* UL Recognition requires an approved power supply with energy limitation (UL61010-1), or Class 2 rating according to the National Electrical Code (USA) / Canadian Electrical Code.

** The IP rating is not part of the UL Recognition.

Enhanced monitoring and diagnostics

SENSOR STATUS AND DIAGNOSTIC DISPLAY



Integrated green and red diagnostic LEDs are located beside the sensor's connectors as shown in 'Figure 1', the LEDs provide basic visual monitoring for normal sensor operation and troubleshooting. These diagnostic display LEDs indicate four modes as described in 'Table 1. Diagnostic display indicator modes'

Figure 1. R-Series sensor Integrated diagnostic LEDs

EtherNet Port 1 (INLET)		
Green	On:	Ethernet connection established
Green	Flickering:	Data activity
Red	On:	Magnet not detected or wrong quantity of magnets
EtherNet Port 2 (OUTLET)		
Green	On:	Ethernet connection established
Green	Flickering:	Data activity
Network Status		
Green	On:	At least one connection established
Green	Flashing:	No connection established
Red	On:	Unrecoverable fault detected
Red	Flashing:	Recoverable fault detected
Module Status		
Green	On:	IP address configured
Green	Flashing:	IP address not configured
Red	Flashing:	Duplicate IP address detected

Table 1. Diagnostic display indicator modes

EtherNet/IP™ interface

EtherNet/IP™ is an Industrial Ethernet implementation of the Common Industrial Protocol (CIP), managed by the Open DeviceNet Vendors Association (ODVA), which defines communication services for automation. Ethernet/IP™ uses standard IEEE 802.3 technology at both the Physical Layer and Data Layers for compatibility with other applications and protocols. The protocol is also compliant with IEC 61158-2 for the physical layer and IEC 61784-1, -2 for measurement and control profiles. The MTS Sensors R-Series EtherNet/IP™ sensor last passed the ODVA EtherNet/IP™ Conformance Test in September of 2015 (Composite Conformance Test CT12).

Note:

Go to www.mtssensors.com to download latest EDS file.

This Ethernet/IP™ device also offers Device-Level-Ring (DLR) capability to directly connect devices to a ring topology without the use of external switches. DLR provides device-level network re-routing and failure point identification to improve reliability and network recovery time.

The ODVA DLR Conformance Test was also completed in September of 2015.

Operation modes and output

N101 Single and Multi-magnet position and velocity:

Up to 20 simultaneous magnet measurements are possible when using multiple magnets. The minimum allowed distance between magnets is 75 mm (3 in.) to maintain proper sensor output (see 'Figure 2').

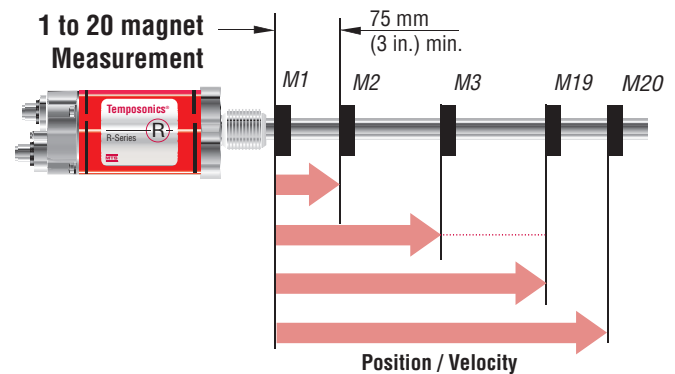


Figure 2. Single to multi-magnet output diagram

Model RP Profile-Style Sensor
Sensor Dimension References

Model RP profile-style sensor dimension references

MODEL RP, PROFILE-STYLE SENSOR WITH CAPTIVE-SLIDING MAGNET

Drawing is for reference only, contact applications engineering for tolerance specific information.

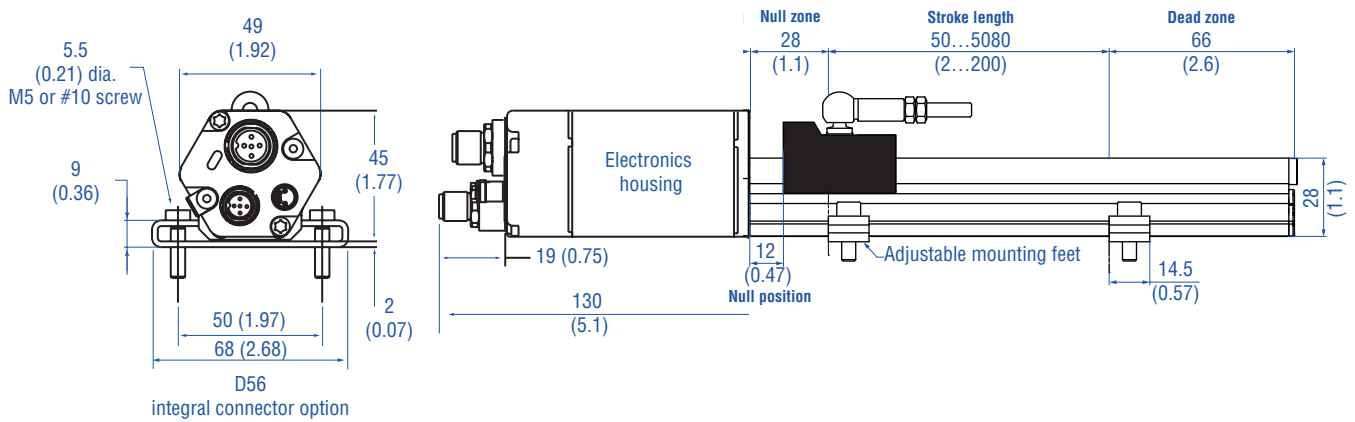


Figure 3. R-Series Model RP Profile-style sensor dimension reference (Shown with the **D56** connector option)

MODEL RP, PROFILE-STYLE SENSOR WITH OPEN-RING MAGNET

Drawing is for reference only, contact applications engineering for tolerance specific information.

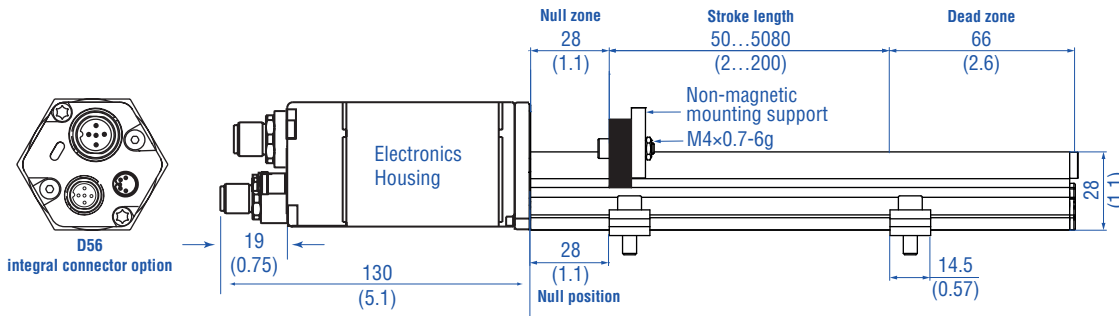


Figure 4. R-Series Model RP Profile-style sensor dimension reference (Shown with the **D56** connector option)

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

Standard magnet selections (Model RP)

SELECTION OF POSITION MAGNETS

A choice of two magnet mounting configurations are available with the profile-style sensor; A 'captive-sliding' magnet, *Styles S or V* or an U-magnet. Captive-sliding magnets utilize slide bearings of special material that reduce friction, and if required, help mitigate dirt build up. The slide bearings are designed to operate dry, requiring no external lubrication or maintenance.

The U-magnet mounts on the moving machine part and travels just above the sensor's profile extrusion. The U-magnet requires a minimum distance away from ferrous metals to allow proper sensor output. It must be mounted using non-ferrous screws and a non-ferrous support bracket, or utilize a non-ferrous spacer of at least 5 mm (0.2 in.) thickness.

POSITION MAGNET SELECTIONS *(Drawing dimensions are for reference only)*

Magnet dimensions and mounted magnet dimensions	Description	Part number
<p>14 mm (0.55 in.)</p> <p>43 mm (1.69 in.)</p> <p>20 mm (0.79 in.)</p> <p>40 mm (1.58 in.)</p> <p>25 mm (1 in.)</p> <p>Rotation: Vertical: 18° Horizontal: 360°</p> <p>Ball-jointed arm (M5 thread)</p>	<p>Captive-sliding magnet, Style S For Model RP profile-style sensor</p>	<p>252182</p>
<p>14 mm (0.55 in.)</p> <p>57 mm (2.24 in.)</p> <p>25 mm (1 in.)</p> <p>40 mm (1.58 in.)</p> <p>9 mm (0.35 in.)</p> <p>Rotation: Vertical: 18°</p> <p>Ball-jointed arm (M5 thread)</p>	<p>Captive-sliding magnet, Style V For Model RP profile-style sensor</p>	<p>252184</p>
<p>60°</p> <p>14 mm (0.55 in.)</p> <p>25 mm (0.97 in.)</p> <p>21 mm (0.81 in.)</p> <p>2 Holes Each 4.3 mm (0.17 in.) dia. on 24 mm (0.94 in.) dia</p> <p>Non-ferrous mounting support and screws 21 mm (0.81 in.)</p> <p>29 mm (1.14 in.)</p> <p>Max gap 3 mm ± 1 mm (0.12 in. ± 0.04 in)</p> <p>U-magnet</p>	<p>U-magnet I.D.: 13.5 mm (0.53 in.) O.D.: 33 mm (1.29 in.) Thickness: 8 mm (0.31 in.) Operating temperature: -40 °C to 100 °C</p> <p>This magnet may influence the sensor performance specifications for some applications.</p>	<p>251416-2</p>

**Model RP Profile-Style Sensor
Sensor Mounting Reference**

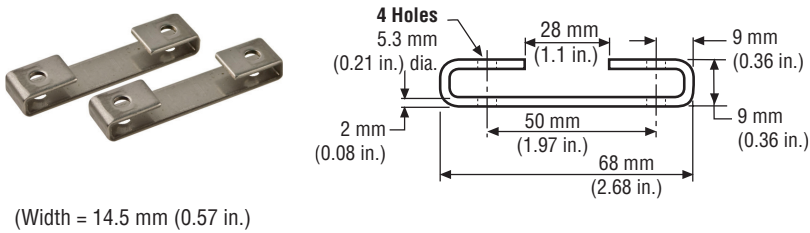
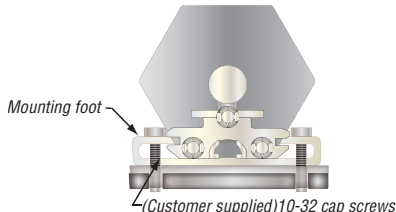
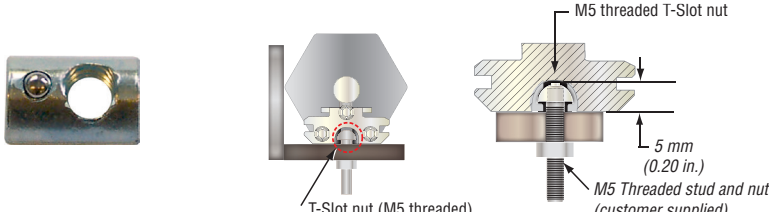
Sensor mounting

Model RP profile-style sensor mounting flexible installation in any position!

Temposonics® Model RP profile-style sensors offer two basic mounting methods; side grooves for use with mounting feet or a bottom groove that accepts special T-Slot nuts. Both the mounting feet and T-Slot nuts can be positioned along the sensor extrusion to best secure the sensor for each particular application.

Notes:

1. Model RP sensors include two mounting feet (part no. 400802) for sensors stroke lengths up to 1250 mm (50 in.)
2. One additional mounting foot is included for stroke lengths over 1250 mm (50 in.) and for each additional 500 mm (20 in.), thereafter.
3. MTS Sensors recommends using 10-32 cap screws (*customer supplied*) at a maximum torque of 44 in. lbs. when fastening mounting feet.

Profile-Style sensor mounting and installation reference	Mounting method	Part number
 <p>(Width = 14.5 mm (0.57 in.))</p>	<p>Mounting feet, standard (304 SS) Profile-style sensor mounting for sensor model RP</p>	<p>400802</p>
<p>10 - 32 Cap screws Recommended (Customer supplied)</p>  <p>Mounting foot (Customer supplied) 10-32 cap screws</p>	<p>Mounting feet and screws Profile-style sensor foot installation</p>	<p>See Mounting Feet part number: 400802</p>
 <p>M5 threaded T-Slot nut T-Slot nut (M5 threaded) M5 Threaded stud and nut (customer supplied) 5 mm (0.20 in.)</p>	<p>T-Slot nut Nut for mounting model RP sensor. M5 thread (Optional, ordered separately)</p>	<p>401602</p>

Model RH rod-style sensor dimension reference

The Temposonics® R-Series rod-style sensor (Model RH) offers modular construction, flexible mounting configurations, and easy installation. The Model RH sensor is designed for mounting in applications where high pressure conditions exist (5000 psi continuous, 10,000 psi spike) such as inside hydraulic cylinders. The Model RH sensor (see 'Figure 5') may also be mounted externally in many applications.

Stroke-dependent Dead Zones:	
Stroke length:	Dead zone:
25 mm (1 in.) - 5000 mm (197 in.)	63.5 mm (2.5 in.)
5005 mm (197 in.) - 7620 mm (300 in.)	66 mm (2.6 in.)

MODEL RH, ROD-STYLE SENSOR WITH RING MAGNET (MAGNET ORDERED SEPARATELY)

Drawing is for reference only, contact applications engineering for tolerance specific information.

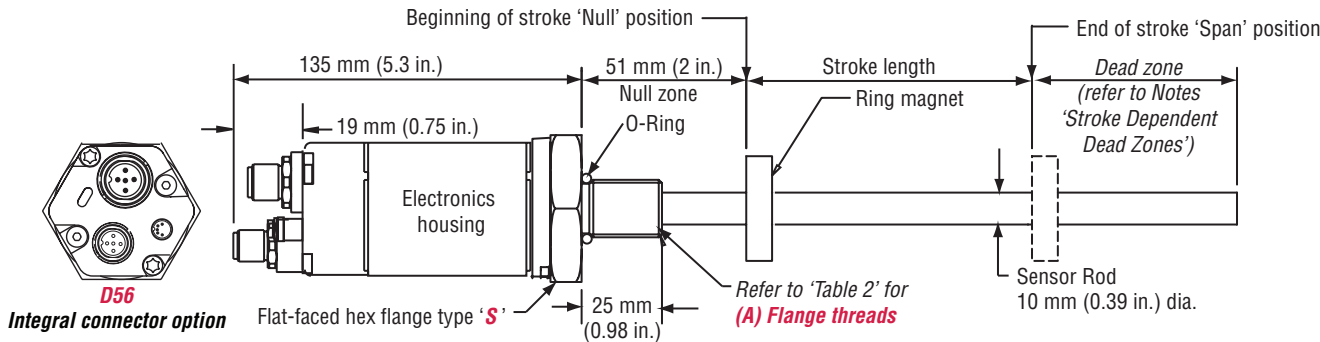


Figure 5. Model RH Rod-style sensor dimension reference (shown with D56 integral connector options)

MODEL RH, ROD-STYLE SENSOR WITH RING MAGNET (MAGNET ORDERED SEPARATELY)

Drawing is for reference only, contact applications engineering for tolerance specific information.

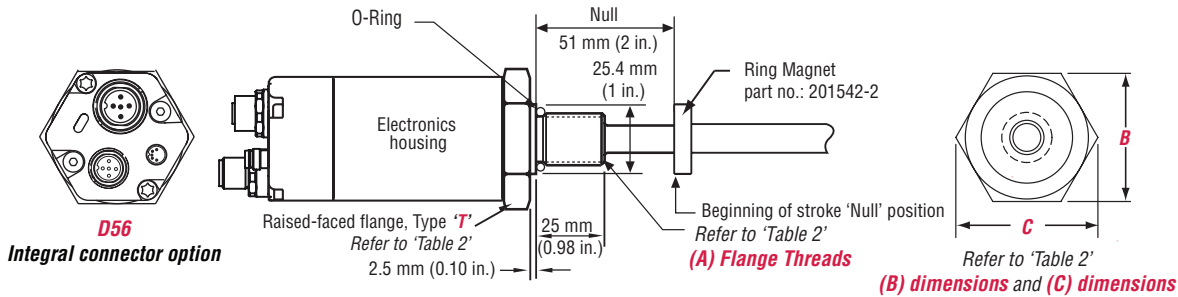


Figure 6. Model RH Rod-style sensor dimension reference (Shown with the D56 integral cable connection type option)

Housing style Flange type	Description	(A) Flange threads	(B) Dimensions	(C) Dimensions
T	US customary threads with raised-face flange	3/4" - 16 UNF-3A	1.75 in.	2 in.
S	US customary threads with flat-faced flange	3/4" - 16 UNF-3A	1.75 in.	2 in.
M	Metric threads with flat-faced flange	M18 x 1.5	46 mm	53 mm

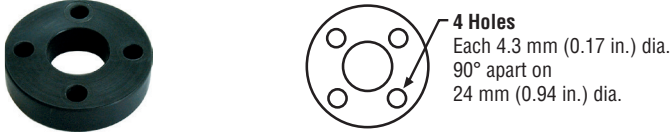
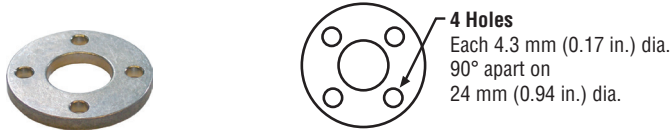
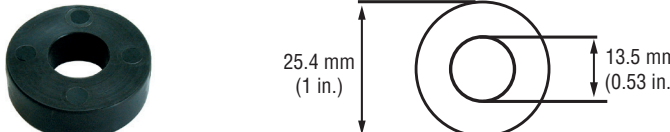
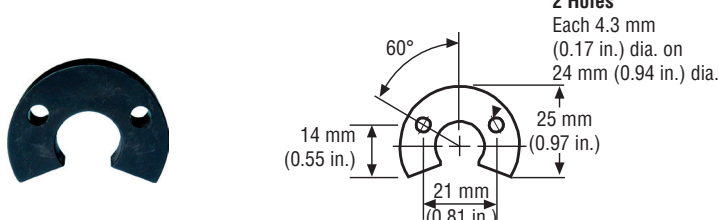
Table 2. Model RH Rod-style sensor housing style and flange type references

**Model RH Rod-Style Sensor
Standard Magnet Selections**

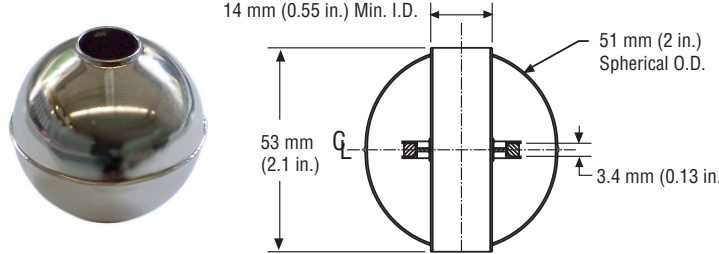
Standard magnet selections (Model RH)

Magnets must be ordered separately with Model RH position sensors. The standard ring magnet (part number 201542-2) is suitable for most applications.

POSITION MAGNET SELECTIONS (Magnet must be ordered separately) *(Drawing dimensions are for reference only)*

Magnet and magnet dimensions	Description	Part number
	<p>Standard ring magnet I.D.: 13.5 mm (0.53 in.) O.D.: 33 mm (1.3 in.) Thickness: 8 mm (0.3 in.) Operating temperature: -40 °C to 100 °C</p>	201542-2
	<p>Magnet spacer (Non-ferrous, use with ring magnet Part number: 201542-2) I.D.: 14 mm (0.56 in.) O.D.: 32 mm (1.25 in.) Thickness: 3.2 mm (0.125 in.)</p>	400633
	<p>Ring magnet I.D.: 13.5 mm (0.53 in.) O.D.: 25.4 mm (1 in.) Thickness: 8 mm (0.3 in.) Operating temperature: -40 °C to 100 °C</p>	400533
	<p>U-magnet I.D.: 13.5 mm (0.53 in.) O.D.: 33 mm (1.3 in.) Thickness: 8 mm (0.3 in.) Operating temperature: -40 °C to 100 °C</p> <p>This magnet may influence the sensor performance specifications for some applications.</p>	251416-2

MAGNET FLOAT SELECTION *(Drawing dimensions are for reference only)*

	<p>Magnet float (Level sensing applications) Specific gravity: 0.70 maximum Pressure: 870 psi maximum</p> <p>(This float is used with Model RH rod-style sensors for hydraulic fluid or fresh water applications only). Collar (part no.: 560777) is recommended for end of stroke stops.</p>	251447
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Model RH Rod-Style sensor mounting

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.).

The minimum distance from the back of the magnet to the piston head is 3.2 mm (0.125 in.). However, a minimum distance of at least 5 mm (0.197 in.) is preferred for added performance margin. The non-ferrous spacer (part no.: 400633) provides this minimum distance when used along with the standard ring magnet (part no.: 201542-2), as shown in 'Figure 7'.

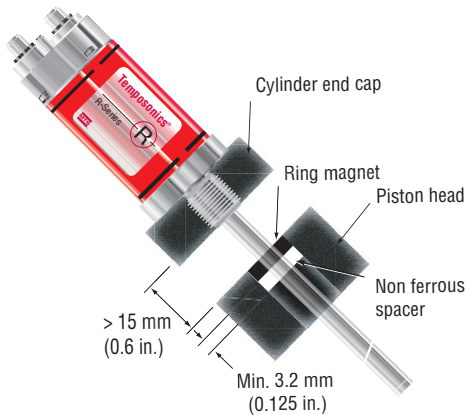


Figure 7. Model RH rod-style mounting

Cylinder installation

When used for direct-stroke measurement in fluid cylinders, the sensor's high pressure, stainless steel rod installs into a bore in the piston head/rod assembly as shown in 'Figure 8'. This method guarantees a long-life and trouble-free operation.

The sensor cartridge can be removed from the flange and rod housing while still installed in the cylinder. This procedure allows quick and easy sensor cartridge replacement without the loss of hydraulic pressure.

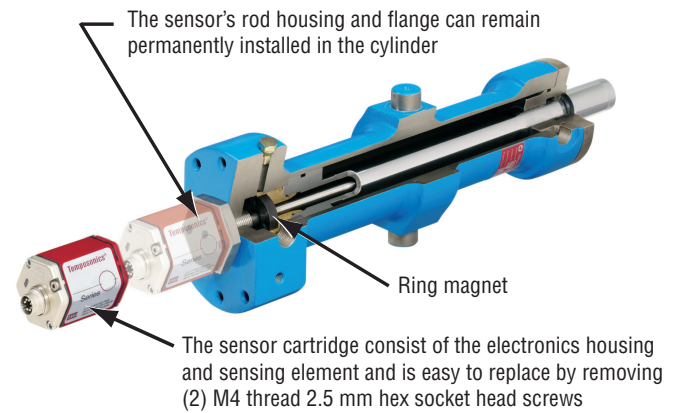
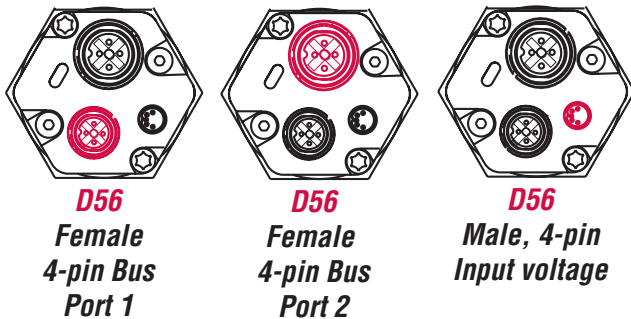


Figure 8. Fluid cylinder installation

Connections and wiring

(D56) BUS CONNECTOR OPTION

D56 connector option for 'daisy chain' topologies. A separate cable is used for the supply voltage. Unused connectors should be covered by a protective cap (part no.: 370537).



BUS CONNECTIONS PORTS 1 AND 2



Female, 4-pin (M12-D) Integral connector pin-out as viewed from the end of the sensor

Pin number	Cable color	Function
1	Yellow	Tx+
2	White	Rx+
3	Orange	Tx-
4	Blue	Rx-

INPUT VOLTAGE



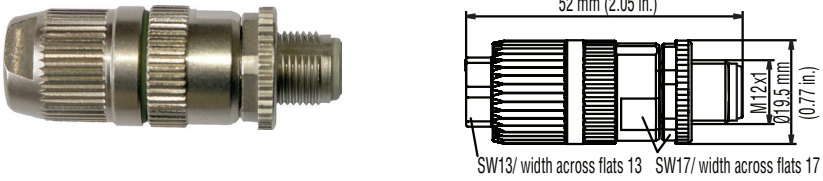


Input voltage, male, 4-pin (M8) integral connector pin-out as viewed from the end of the sensor

Pin number	Cable color	Operating voltage
1	Brown	+24 Vdc (-15/+20%)
2	White	No connection
3	Blue	DC ground (for supply)
4	Black	No connection


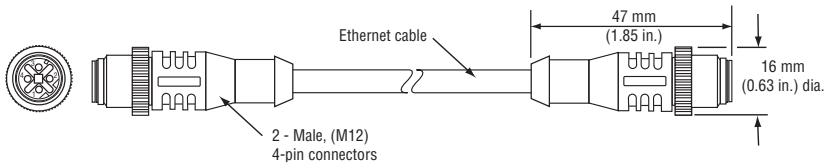

Model RP and RH Sensors

Ordering Information; Connector and Cable Assembly Options

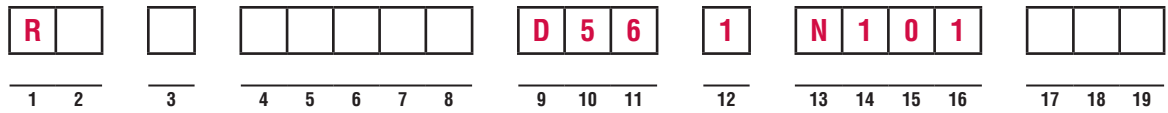
(D56) CABLE CONNECTOR OPTIONS (Drawing dimensions are for reference only)

Connector and connector dimensions	Description	Part number
	<p>Bus Cable Connector, Male 4-pin (M12), D-coded with insulation displacement technology</p>	370523
	<p>Connector, Female 4-pin (M8) and cable with pigtail termination</p> <p>For 24 Vdc input. Wire gage 4x0.25 mm2 shielded, PUR cable jacket</p>	<p>5 m length = 530066 10 m length = 530096 15 m length = 530093</p>
	<p>Connector end cap</p> <p>(Unused connectors should be covered by this protective cap)</p>	370537

BUS CABLE WITH CONNECTORS (Drawing dimensions are for reference only)

Bus cable and connector assemblies	Description	Part number
 	<p>Industrial Ethernet Bus Cable, 5 m length (Cat 5e ES)</p> <p>Assembly Includes two 4-pin (M12) connectors (D-coded) and PUR cable jacket (green)</p>	530064
	<p>Industrial Ethernet Bus Cable, 5 m length (Cat 5e ES)</p> <p>Assembly includes one RJ45 connector and one 4-pin (M12) connector (D-coded) with PUR cable jacket (green). Cables using the RJ45 connector provide convenient sensor connection to a PC for setup and programming but are not recommended for factory floor installations.</p>	530065

Model RP and RH Sensors Ordering Information



SENSOR MODEL

RP = Profile style **RH** = Hydraulic rod style

HOUSING STYLE

Model RP profile-style sensor (includes one magnet):

S = Captive-sliding magnet with ball joint at top (part no. 252182) **V** = Captive-sliding magnet with ball joint at front (part no. 252184) **M** = U-magnet (part no. 251416-2)

Model RH rod-style sensor (magnet(s) must be ordered separately):

T = US customary threads, raised-faced flange and pressure tube, standard **U** = Same as option "T", except uses fluoroelastomer seals for the sensor electronics housing **B** = Sensor cartridge only (no flange or pressure tube, stroke length < 1830 mm (72 in.))

S = US customary threads, flat-faced flange and pressure tube, standard **H** = Same as option "S", except uses fluoroelastomer seals for the sensor electronics housing

M = Metric threads, flat-faced flange and pressure tube, standard **V** = Same as option "M", except uses fluoroelastomer seals for the sensor electronics housing

STROKE LENGTH

----- **M** = Millimeters (Encode in 5 mm increments)

----- **U** = Inches and tenths (Encode in 0.1 in. increments)

Stroke Length Notes:

- Profile-style sensor (model RP) stroke length = 25 mm (1 in.) - 5080 mm. (200 in.)
- Rod-style sensor (model RH) stroke length = 25 mm (1 in.) - 7620 mm (300 in.)

CONNECTION TYPE

Integral connector:
D56 = Two 4-pin female (M12-D), plus one 4-pin male (M8)

INPUT VOLTAGE

1 = +24 Vdc (-15% or +20%)

OUTPUT

N101 = EtherNet/IP™, position and velocity, maximum 20 magnets

NUMBER OF MAGNETS

For multi-position measurement only (Order additional magnets separately).
Z _____ = Number of magnets for output **N101** (range 02 to 20)

**Model RP and RH Sensors
Declaration of Conformity**



DECLARATION OF CONFORMITY

Declaration of Conformity (DOC) Reference Information		
File Number: 10872.05	Part 1 of 1	Year Last Issued: 2015
Length of Validity:	Continues in effect so long as the named entity (i) remains an ODVA Licensed Vendor for the ODVA technology(ies) defined by the above specification(s); (ii) continues to fulfill its user responsibilities as defined in its Terms of Usage Agreement with ODVA; and (iii) the CIP Identity for the Product(s) remains identical to those enumerated in this Declaration of Conformity.	

ODVA Licensed Vendor to Whom this DOC Has Been Issued	
Entity Name: MTS Systems Corporation	Vendor ID: 116

Overview of Compliant Product(s) Covered by This DOC (The list of product(s) covered by this DOC begins on page 2.)	
Networks(s) Supported:	EtherNet/IP™
CIP Device Profile Supported:	Encoder
Classification of Declaration:	Single Product

Trademark(s) Approved for Use in the Labeling and Promotion of the Products Named Herein (Color variations of logo marks allowed pursuant to ODVA Brand Standards+Identity Guidelines. No abbreviation of word marks allowed.)	
Logo Marks	Word Marks
ODVA Certification Marks	
	ODVA CONFORMANT™
ODVA Technology Marks	
	EtherNet/IP™

This Declaration of Conformity, and approval of the use of ODVA's trademarks as shown above, has been granted by ODVA, Inc. based on its determination that the Product(s) identified herein fulfill(s) ODVA's standards for compliance with ODVA's specifications listed below at the ODVA composite Conformance Test (CT) level shown in parentheses:

The EtherNet/IP™ Specification (CT 12)

This Declaration of Conformity is issued on September 30, 2015 on behalf of ODVA by:

Katherine Voss, Executive Director

The list of product(s) covered by this DOC begins on page 2.

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**Model RP and RH Sensors
Declaration of Conformity**

CIP Identity for Product(s) Covered Under this Declaration of Conformity (per CIP Identity Object)			
No.	Vendor Product Code (attribute 3)	Vendor Product Revision (attribute 4)	Vendor Product Name (attribute 7)
1	3	1.005	MTS Linear Encoder

Declaration of Conformity

File No.: 10872.05

Part 1 of 1 - page 2 of 2

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