MTS SENSORS

Level Plus®

Magnetostrictive Liquid-Level Transmitters
with Temposonics® Technology

OPERATION AND INSTALLATION MANUAL

M-Series Model MR Analog Transmitter

The Measurable Difference

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Notices used in this manual

This manual contains notices to highlight specific information as follows:

Notes:

These notices provide important tips, guidance, or advice.

Important:

These notices provide information that might help you avoid inconvenient or problem situations.

Attention:

These notices indicate possible damage to programs, devices, or data and is placed just before the instruction or situation in which damage could occur.

Caution:

These notices indicate situations that can be potentially hazardous to you. A Caution notice is placed just before a description of a potentially hazardous procedure, step, or situation.

Related publications

The following publications are listed below by part number followed by description and are available in Adobe Acrobat Portable Document Format (PDF) at http://www.mtssensors.com/. The documents below are only available in English.

550677 - Product Specification, Model MR Analog Transmitter
551103 - Level Plus Accessories Catalog
550731 - Component Replacement Guide
550904 - Application Datasheet Rigid
550905 - Application Datasheet Sanitary
550906 - Application Datasheet 7/8" Flex
551409 - Brief Operation Manual for Safe Use

How this manual is organized

"Introduction", provides an overview of the manual.
"Terms and Definitions", provides definitions of terms used in this manual.
"Product Overview", gives an overall product description for the Level Plus liquid-level transmitter, its specifications, use, output, and electronics.
"Installation and Mounting", provides detailed installation and mounting information.
"Electrical Connections and Wiring Procedures", provides engineering specifications and wiring diagrams to assist in the installation process.
"Maintenance and Field Service", provides guidelines for general float maintenance and procedures required for replacing the Model MR electronic module or level transmitter.
"Troubleshooting", provides a list of symptoms, their possible cause and the action to be taken when troubleshooting the transmitter.
Setup using keypad display - describes modes of operation, LCD display functionality, alarm settings and how to calibrate the unit manually.
Setup using HART® Field Communicator - provides procedures for setting 4 and 20 mA set points
Setup using MTS Field Setup Software - provides software installation, parameter setup, and calibration procedures.
"Agency Information" provides comprehensive listings of agency approvals and standards, installation drawings, labels and applicable protocols.

Getting information, help, and service

You can get the latest ordering information and software updates by visiting www.mtssensors.com website
General contact information, shipping and office hours are available on page i.

Contact information

Reference information

Introduction

Terms and Definitions

Model MR product overview

Model MR transmitter installation and mounting

Electrical connections and wiring procedures

Maintenance and field service

Troubleshooting

Setup

Agency Information

Introduction

MTS is recognized as the pioneer, innovator and leader in magnetostrictive sensing. The new Level Plus® M-Series transmitter design represents a continuation of our on-going effort to provide effective, innovative and reliable products to the Liquid Level marketplace.

This manual will provide the following information about the Level Plus Model MR analog transmitter:

- Terms and definitions
- Product overview
- Installation and mounting
- Electrical connections and wiring procedures
- Maintenance and field service
- Troubleshooting
- Quick start-up guide
- Setup using the keypad display
- Setup using a HART® Field Communicator
- Setup using MTS Field Setup Software
- Agency information
- Product certifications

Public website support portal

Visit our support portal at http://www.mtssensors.com for:

- Building Level Plus M-Series Model MR analog transmitter model numbers
- Latest documentation releases
- Detailed ordering information
- Latest software updates

Terms and definitions reference

F

Flameproof – Type of protection based on enclosure in which the parts which can ignite an explosive gas atmosphere are placed within, and which can withstand the pressure developed during an internal explosion of an explosive mixture, and which prevents the transmission of the explosion to the explosive gas atmosphere surrounding the enclosure.

H

HART® – a *Bidirectional communication protocol* that provides data access between intelligent field instruments and host systems.

I

Interface – *Noun*; The measurement of the level of one liquid when that liquid is below another liquid.

Interface – *Adj.*; The *Software Graphical User Interface (GUI)* that allows the user to access software protocols *(HART)*.

Intrinsic safety – 'Intrinsically safe' - Type of protection based on the restriction of electrical energy within apparatus of interconnecting wiring exposed to potentially explosive atmosphere to a level below that which can cause ignition by either sparking or heating effects.

N

NEMA Type 4X – A product *Enclosure* intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, and hose-directed water; and to be undamaged by the formation of ice on the enclosure. They are not intended to provide protection against conditions such as internal condensation or internal icing.

NPT – *U.S. standard* defining tapered pipe threads used to join pipes and fittings.

S

Specific Gravity – The *density ratio* of a liquid to the density of water at the same conditions.

Model MR product overview

The Level Plus Model MR Liquid-Level transmitter is a continuous multi-functional magnetostrictive transmitter that provides product level, interface level, and temperature to the user via 4 to 20 mA current loops or HART. Magnetostrictive technology is one of the most accurate and repeatable level technologies available to date. MTS is the inventor and purveyor of magnetostrictive technology and has been serving the level industry for over 30 years.

INDUSTRIES

- Petroleum
- Liquid petroleum gas
- Pharmaceutical
- Food & beverage
- Chemical
- Wastewater

APPLICATIONS

- Tank farms
- Terminals
- Bullet tanks
- Separator tanks
- Battery tanks
- Storage tanks

FEATURES

- 3-in-1 measurement
  - Product level
  - Interface level
  - Temperature
- No scheduled maintenance or recalibration
- Field repairable
- AMS Aware

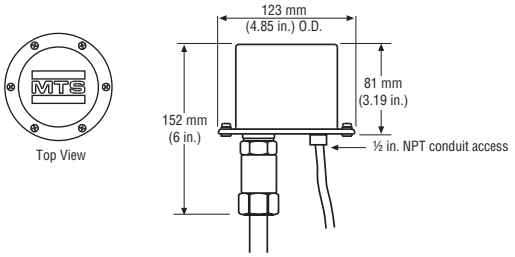
Components

The Level Plus Model MR liquid level transmitter consists of four main components; a housing, outer pipe, float, and electronics. Varying the components of the transmitter allows the transmitter to be customized to almost any application.

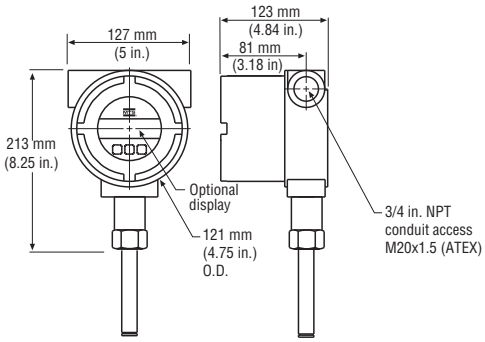
HOUSINGS

Level Plus Model MR transmitters are available in three housing configurations; NEMA Type 4X 316L stainless steel, flameproof single and dual-cavity housings as shown below:

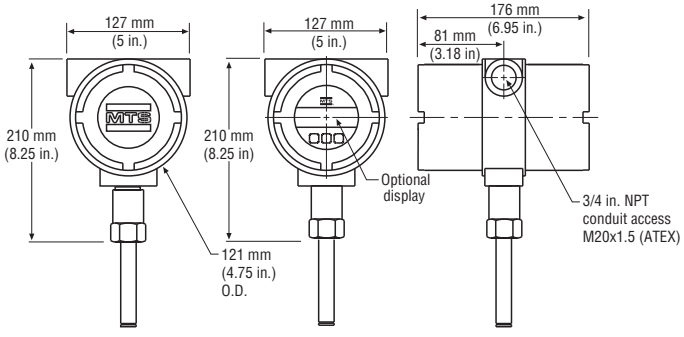
NEMA Type 4X 316L stainless-steel housing



Single cavity flameproof housing



Dual cavity flameproof housing



Product Overview

OUTER PIPE CONFIGURATIONS

The outer pipe is constructed of a variety of configurations, shown below. Contact factory for other materials (such as Hastelloy C or Teflon).

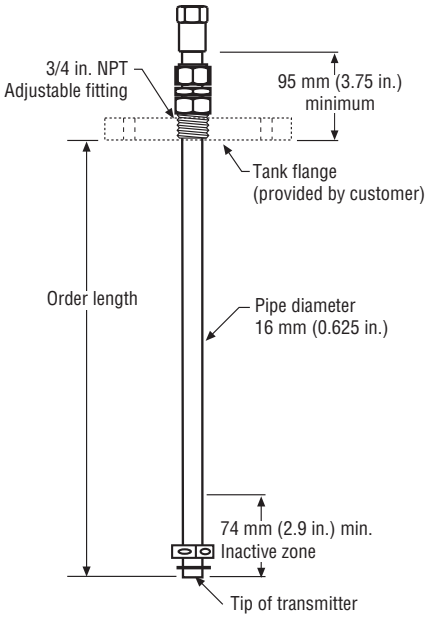


Figure 1. 5/8 in. diameter rigid outer pipe of 316L stainless steel

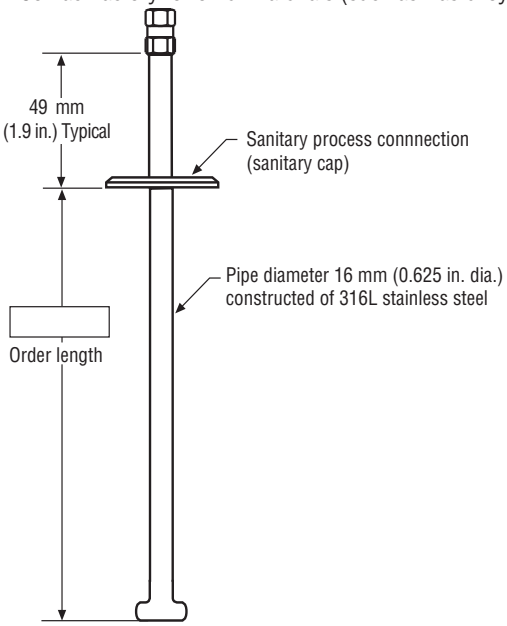


Figure 2. 5/8 in. diameter rigid outer pipe of polished 316L stainless steel with sanitary process connection and end plug

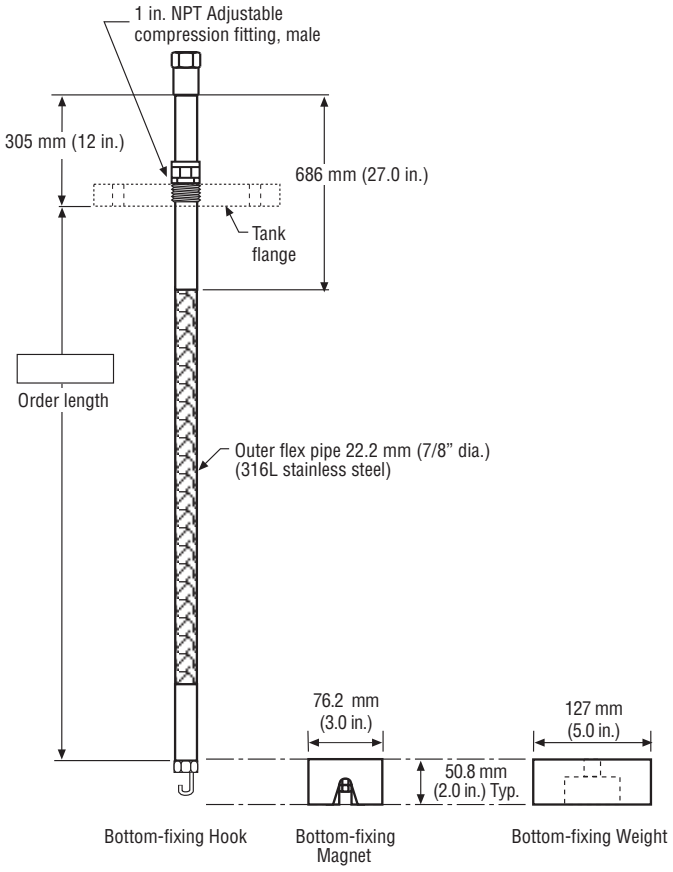


Figure 3. 7/8 in. diameter flexible pipe of 316L stainless steel

FLOATS

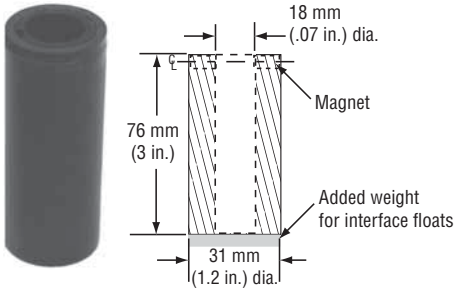
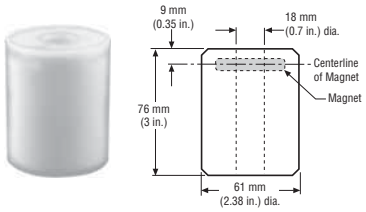
Model MR transmitters offer numerous floats for different applications such as stainless steel, 3-A sanitary, Hastelloy, Teflon, and Nitrophyl for both product level and interface level. To be able to accurately detect the interface level there needs to be a difference of at least 0.05 in specific gravities between the product and interface liquids. For detailed information about floats, refer to the 'Accessories Catalog', MTS part number 551103.

For assistance with selecting a specific float for your application, please contact *Technical Support* with the following information:

- Specific gravity of liquid(s) being measured
- Process temperature
- Process Opening Size
- Vessel pressure

For KC approval, Model MR transmitters should be used with a float having an offset weight and made of stainless steel or Hastelloy C. This allows the float to stay in contact with the pipe to prevent the buildup of an electrostatic charge. For detailed information about floats, refer to the 'Accessories Catalog', MTS part number 551103.

Non-metalic floats with a projected surface area of less than 5,000 mm² should only be used in Zone 0, Gas group IIA such as float part numbers 201643-2, 201649-2, 201650-2, 201109, 251115 and 251116. All other non-metallic floats offered by MTS such as, 251939, 251119, 251120 and 252999, should not be used in a hazardous area application.

NITROPHYL FLOATS **Float and dimension reference**	**Projected surface area**	**Part number**
	2356 mm²	201643-2
		201649-2
		201650-2
TEFLON FLOATS **Float and dimension reference**	**Projected surface area**	**Part number**
	4635 mm²	201109
		251115
		251116

INTERNAL ELECTRONICS

All transmitters come with two electronic components of a sensing element and a board set. All sensing elements up to 300 inches (7620 mm) are rigid and greater lengths have flexible sensing elements. Flexible sensing elements are only available under 300 inches (7620 mm) as special orders. The board set consists of a electronic puck and interconnect board. The board set can be configured for single or dual loop output offering the ability to output the product level, interface level, and temperature. All three variables can be communicated via HART.

The electronic puck can be ordered with or without a display. The optional display is capable of displaying the product level, interface level, and temperature. Designed into the optional display are three push buttons for local setup of 4 and 20 mA set points.

A temperature sensing function is optional with the Model MR transmitter. The temperature sensing device is a Resistive Temperature Device (RTD) mounted inside the transmitter's outer pipe assembly. The RTD is a 1000 ohm platinum film device.

ACCESSORIES

MTS also offers a series of displays, housings, converters, and other accessories, please refer to the *'Accessories Catalog'*, MTS part number 551103.

Theory of operation

Magnetostrictive M-Series transmitters precisely sense the position of an external float by applying an interrogation pulse to a waveguide medium. This current pulse causes a magnetic field to instantly surround the waveguide. The magnet installed within the float also creates a magnetic field. Where the magnetic fields from the waveguide and float intersect, a rotational force is created (waveguide twist). This, in turn, creates a torsional-sonic pulse that travels along the waveguide as shown in *Figure 4*.

The head of the transmitter houses the sensing circuit, which detects the torsional-sonic pulse and converts it to an electrical pulse. The distance from a reference point to the float is determined by measuring the time interval between the initiating current pulse and the return pulse and precisely knowing the speed of these pulses. The time interval is converted into a level measurement.

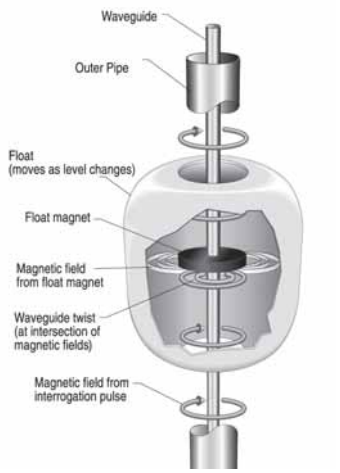


Figure 4. Theory of operation

Accuracy

For magnetostrictive transmitters inherent accuracy is measured in terms of non-linearity. Non-linearity is a measurement of any imperfections in the waveguide that are reflected in the linearity of the transmitter's output. MTS tolerances reflect a maximum non-linearity of 0.02% of full scale. MTS is able to achieve such strict tolerances by manufacturing all of its own waveguide from a proprietary alloy and testing 100% of all transmitters before shipping.

Warranty

Important:

Contact Technical Support or Customer Service for assistance if you suspect that the transmitter is not working correctly. Technical support can assist you with troubleshooting, part replacement, and *Returned Material Authorization* (RMA) information if required.

All M-Series transmitters come with a two year limited warranty from the factory shipment date. A *Return Materials Authorization* (RMA) number is required and must accompany any transmitter returns. Any unit that was used in a process must be properly cleaned in accordance with OSHA standards, before it is returned to the factory. A *Material Safety Data Sheet* (MSDS) must also accompany the transmitter that was used in any process.

Model number identification for KC approval

TRANSMITTER MODEL = M 1

M = Magnetostrictive transmitter

TYPE = R 2

R = Analog output level transmitter

APPROVAL AGENCY = 3

K = KC Approval

OUTPUT = 4

1 = 4-20 mA Single loop with HART

2 = 4-20 mA Dual loops with HART

HOUSING TYPE = 5

B = SIngle cavity (Flameproof IIB)

C = Dual cavity (Flameproof IIB)

D = Single cavity with display (Flameproof IIB)

E = Dual cavity with display (Flameproof IIB)

P = NEMA Type 4X, 316L stainless steel with cable (No approval)

ELECTRONICS MOUNTING = 6

1 = Integral electronics

TRANSMITTER PIPE/HOSE = 7

B = Industrial end-plug with stop collar

C = Sanitary, T-bar, TB

D = Sanitary, drain-in-place, DP

E = Sanitary, clean-in-place, CP

F = Sanitary, drain-in-place, no hole, DN

H = Flexible w/bottom fixing hook (stainless steel only)

J = Flexible w/bottom fixing weight (stainless steel only)

K = Flexible w/bottom fixing magnet (stainless steel only)

MATERIALS OF CONSTRUCTION (WETTED PARTS) **(Note:** contact factory for other materials) = 8

1 = Stainless steel, 1.4404

2 = Stainless steel, 1.4404 electropolished

3 = Hastelloy C

A = Teflon / FEP

PROCESS CONNECTION TYPE = 9

1 = NPT, Adjustable fitting

4 = Sanitary, welded

5 = Sanitary, adjustable fitting

6 = 150 lbs. welded RF flange

7 = 300 lbs. welded RF flange

8 = 600 lbs. welded RF flange

9 = DIN flange welded according to specification

PROCESS CONNECTION SIZE = 10

A = ¾ in. (NPT for ⅝ in. pipe)

B = 1 in. (NPT for ⅞ in. hose)

C = 1½ in.

D = 2 in.

E = 2½ in.

F = 3 in.

G = 4 in.

H = 5 in. (except sanitary)

J = 6 in.

TEMPERATURE = 11

0 = None

2 = One RTD, customer defined position ǂ

1 = One RTD, fixed position 76 mm (3 in.) from the end of pipe

Note: ǂ*If this RTD option is selected, option '**18 E**' must also be selected*

UNIT OF MEASUREMENT = 12

M = Metric (millimeters) Encode length in millimeters if using metric (XXXXX mm)

U = US Customary (inches) Encode length in inches if ordering in US Customary (XXX.XX in.)

Product Overview

Model number identification for KC

LENGTH (Order length based on unit of measurement) = ☐☐☐☐☐ 13-17

= Rigid or Sanitary transmitter: 508 mm (20 in.) to 7620 mm (300 in.) = Teflon: 508 mm (20 in.) to 6096 mm (240 in.)

= Flexible transmitter: 3048 mm (120 in.) to 12,192 mm (480 in.)

SPECIAL = ☐ 18

S = Standard product **E** = Engineering special (not affecting agency controlled parts or features)

Product Overview

Model MR product specifications

Parameters	Specifications
LEVEL OUTPUT	
Measured variable:	Product level and interface level
Output signal / Protocol:	4 to 20 mA with HART®, 1 or 2 loop
Order length:	**Flexible hose:** 3048 mm (120 in.) to 12200 mm (480 in.) Δ§ **Rigid pipe:** 508 mm (20 in.) to 7620 mm (300 in.) Δ § **Sanitary pipe:** 508 mm (20 in.) to 7620 mm (300 in.) Δ § Δ Contact factory for longer lengths. § Order length equals the measurement range plus the inactive zone.
Non-linearity:	0.02% F.S. or 0.794 mm (1/32 in.)* * Whichever is greater
Repeatability:	0.01% F.S. or 0.381 mm (0.015 in.)* (any direction) † Contact factory for alternative materials.
TEMPERATURE OUTPUT	
Measured variable:	Single-point temperatures
Type:	4 to 20 mA from 1000Ω platinum RTD at 0 °C
Repeatability:	±0.1 °C (±0.18 °F)
Temperature accuracy:	±1.5 °C (±2.7 °F)
Drift:	±0.5 °C (±0.9 °F) per year
ELECTRONICS	
Input voltage:	10.5 to 36 Vdc
Fail safe:	High (21.4 mA), or Low (3.8 mA)
Reverse polarity protection:	Series diode
Lightning/ Transient protection:	**Stage 1:** Line-to-ground surge suppression; IEC 61000-4-5 **Stage 2:** Line-to-line and line-to-ground transient suppressors; IEC 61000-4-4
CALIBRATION	
Zero adjust range:	Anywhere within the active length
Span adjust range:	Full scale to 152 mm (6 in.) from zero

Parameters	Specifications
ENVIRONMENTAL	
Enclosure rating:	NEMA Type 4X
Humidity:	0 to 100% relative humidity, non-condensing
Operating temperatures:	**Electronics:** -40 °C (-40 °F) to 71 °C (160 °F) **Sensing element:** -40 °C (-40 °F) to 125 °C (257 °F) ◊ **Temperature element:** -40 °C (-40 °F) to 105 °C (221 °F) ◊ Contact factory for specific temperature ranges.
Vessel pressure:	**Industrial rigid pipe:** 1000 psi (70 bar) **Sanitary pipe:** 435 psi (30 bar) **Teflon pipe:** 100 psi (7 bar) **Flexible Hose:** 260 psi (18 bar)
Materials:	**Wetted parts:** 316L stainless steel † **Non-wetted parts:** 316L stainless steel, Epoxy coated aluminum † Contact factory for alternative materials.
FIELD INSTALLATION	
Housing dimensions:	**Single cavity:** 127 mm (5 in.) by 133 mm (5.25 in.) 123 mm (4.84 in.) O.D. **Dual cavity:** 127 mm (5 in.) by 177 mm (6.95 in.) 123 mm (4.84 in.) O.D. **NEMA Type 4X:** 81 mm (3.2 in.) by 123 mm (4.85 in.) O.D.
MOUNTING	
Rigid pipe:	¾ in. Adjustable MNPT fitting Flange or Tri-Clamp® Mount
Flexible hose:	1 in. Adjustable MNPT fitting Flange mount
WIRING	
Connections:	2-wire shielded cable or twisted pair, Daniel Woodhead 6-pin male connector, 4570 mm (180 in.) integral cable with pigtail
ELECTRICAL CONNECTIONS	
Single and Dual Cavity:	M20 FNPT conduit opening
NEMA Type 4X:	½ in. FNPT conduit opening
DISPLAY	
Measured variables:	Product level, interface level and temperature
Size:	13 mm (0.5 in.)
Number of digits:	16

Installation and mounting

If the installation is going to occur in a hazadous area, completely read the Agency Information section before starting any work. The Agency Information outlines additional regulations that need to be followed in order for the installation to comply with hazardous area regulations.

This section contains information about storing your transmitter (prior to installation) and detailed procedures for installing and mounting your transmitter.

Storage

If storage is required prior to installation, store indoors in a dry environment at ambient temperature range not exceeding -40 °C (-40 °F) to 71 °C (160 °F).

Stilling wells and guide poles

Level Plus transmitters can be mounted in slotted or unslotted stilling wells but a slotted stilling well is always preferred. Using a unslotted stilling well will negatively affect performance of any level device as the level in the stilling well can differ from the level in the tank. The Level Plus transmitter can also be installed to one side of the stilling well to also allow for sampling and manual gauging from the same opening as the automatic tank gauging. Contact *Technical Support* for details.

Level Plus transmitters do not require a stilling well for installation. Our transmitters are installed in numerous tanks without stilling wells with no loss in performance due to our patented flexible waveguide and hose. A stilling well is highly recommended for agitated, turbulent, and/or fast filling tanks.

Installation

The installation procedures below are illustrated using the adjustable NPT fitting for a threaded flange mount. The procedures will have to be slightly adjusted if using a welded flange or sanitary Tri-Clamp mount.

RIGID PROBE

Tools Required:

- Channel lock pliers
- Common screwdriver
- 5/32 in. Hex key (allen wrench)

Caution:

It is recommended that assembly and mounting of this transmitter should not be performed alone. To ensure proper and safe assembly of the M-Series transmitter, a minimum of two (2) individuals are recommended. Gloves are also recommended. In addition, PPE is required for work areas such as safety shoes, safety glasses, hard hat, and fire resistant clothing.

Perform the following steps to Install the Model MR transmitter:

1. Remove the stop collar and E-ring. With assistance, feed the rigid pipe through the hole of the removed tank flange until the flange is positioned near the top of the transmitter. Insert the threaded portion of the adjustable fitting into the customer supplied flange and tighten (apply pipe thread sealant if required). Be careful not to drop the flange as it can damage the transmitter.
2. Slide the product float onto the rigid pipe. Slide the interface float (optional) onto the rigid pipe. Install stop collar 2 inches from the bottom (see '***Note***' below). Do not drop the float(s) or allow them to free fall along the rigid pipe as damage may result.

Note:

The stop collar can be removed or adjusted based on the float selected for the application. Please consult the factory for more information.

3. Slide float(s) back down to the stop collar to prevent them from free falling during installation into the tank. Insert the rigid pipe (with floats) through the tank opening and lower the transmitter/float assembly into the tank until it rests on the bottom. DO NOT DROP OR DAMAGE THE PIPE.
4. Secure the flange onto the tank mount.
5. Pull the transmitter upward so the end plug is just resting on the floor of the tank. Tighten the adjustable fitting to hold the transmitter in place.
6. Terminate the field wire cables noting proper wire orientation.

FLEXIBLE PROBE

Caution:

When assembling and installing the Model MR transmitter, be careful not to allow the flexible hose to kink or be coiled in less than 16 in. (406.5 mm) diameter. It is recommended that assembly and mounting of this transmitter should not be done alone. To ensure proper and safe assembly of the Model MR transmitter, a minimum of two (2) individuals are recommended. Gloves are also recommended. PPE is required for work areas such as safety shoes, safety glasses, hard hat, and fire resistant clothing.

Tools Required:

- 9/16 in. Socket and ratchet
- Channel lock pliers
- 3/16 in. Hex key (allen wrench)

1. Remove the stop collar. With assistance, feed the flexible hose through the hole of the removed tank flange until the flange is positioned at the rigid section of pipe near the top of the transmitter. Insert the threaded portion of the adjustable fitting into the customer supplied flange and tighten (apply pipe thread sealant if required). Be careful not to drop flange on the flexible hose as damage may result.
2. Slide the product float onto the flexible pipe. Slide the interface float (optional) onto the flexible pipe. Install stop collar 3 inches from the bottom of rigid section (see '***Note***' below). Do not drop float(s) or allow them to free fall along the flexible pipe as damage may result.

Note:

The stop collar can be removed or adjusted based on the float selected for the application. Please consult the factory for more information.

3. Mount the hook, weight, or the magnet to the welded end-plug section of the pipe (this is the bottom rigid section of the pipe) using the supplied nut, spacer and washer, tighten securely as shown in *Figure 5*. **For the magnet, remove washer before installing in tank**.

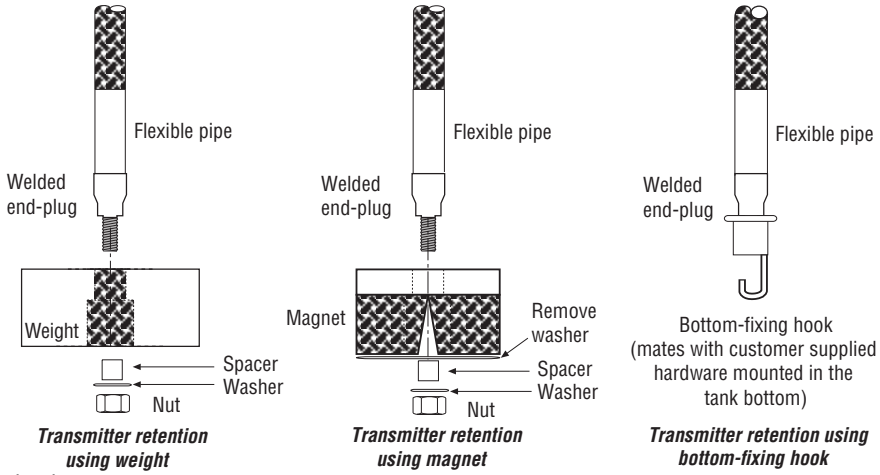


Figure 5. Bottom fixing hardware

DO NOT DROP OR DAMAGE THE PIPE

Important: *Avoid kinking or bending the flexible pipe in less than 16 inch (406 mm) diameter or damage may result.*

4. Slide float(s) back down to the stop collar to prevent them from free falling during installation into the tank. Insert the flex pipe and floats through the tank riser pipe and lower the transmitter/float assembly into the tank until it rests on the bottom. If you are using a bottom-fixing hook, fasten the hook to the appropriate customer-supplied mating hardware at the tank bottom.
5. Secure the flange onto the tank riser pipe.
6. Pull the transmitter upward to straighten the flexible pipe until the resistance of the weight, magnet, or hook is felt without raising the weight or magnet off the floor of the tank. Tighten the adjustable fitting to hold the transmitter in place.
7. Terminate the field wire cables noting proper wire orientation.

Mounting

The method of mounting the transmitter is dependent on the vessel or tank in which it is being used, and what type of transmitter is being mounted. There are three typical methods for mounting; threaded flange mounting, welded flange mounting, and sanitary Tri-Clamp mounting.

THREADED FLANGE MOUNTING

In most applications, the Model MR transmitter can be mounted directly to the tank or flange via a NPT threaded fitting, assuming there is a proper threaded connection available. If the float will not fit through the flange opening when the flange is removed, there must be some alternative means to mount the float on the transmitter from inside the vessel; this may require an access port nearby the entry point of the transmitter as shown in *Figure 6.*

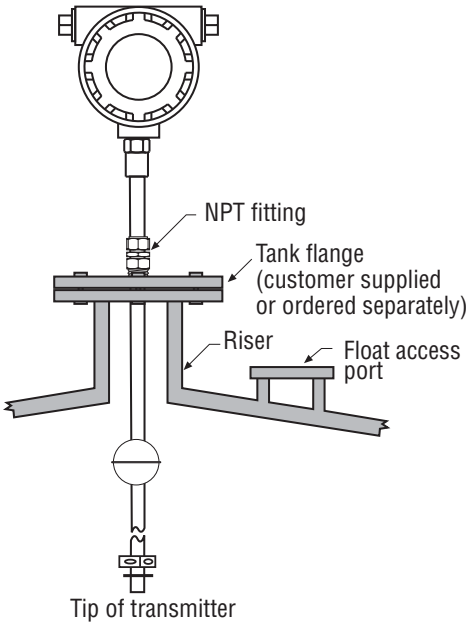


Figure 6. Threaded flange mounting for rigid (shown) and flexible pipe

WELDED FLANGE MOUNTING

The Model MR transmitter can also be mounted to a tank flange as shown in *Figure 7*. First, install float(s) onto the transmitter. Second, install the float retaining hardware on the tip of the transmitter. To complete the installation, mount the transmitter, flange and float(s) as a unit in to the tank.

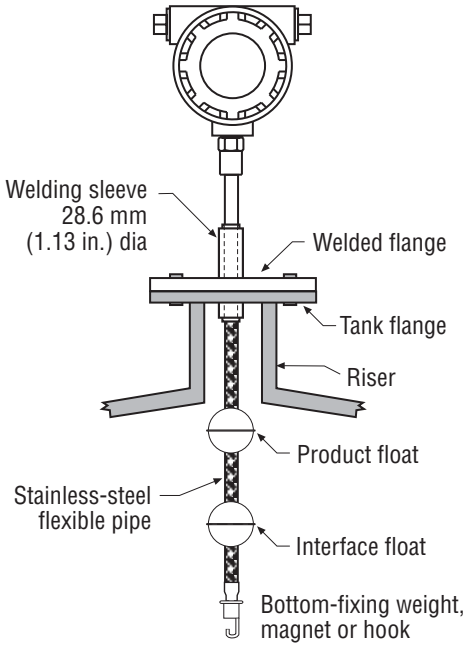


Figure 7. Welded flange mounting for rigid and flexible (shown) pipe

Installation & Mounting

SANITARY TRI-CLAMP MOUNTING

In sanitary applications, the Model MR transmitter is mounted to the tank using a standard sanitary connection and clamp as shown in *Figure 8*. In most cases it is not necessary to remove the float as the sanitary end-plug fitting is sized to allow installation with the float in place. Please note that some sanitary end-plug styles have float(s) permanently mounted as shown in *Figure 9*. To install the clamp, the transmitter and float(s) into the mating process connection and attach the sanitary Tri-Clamp.

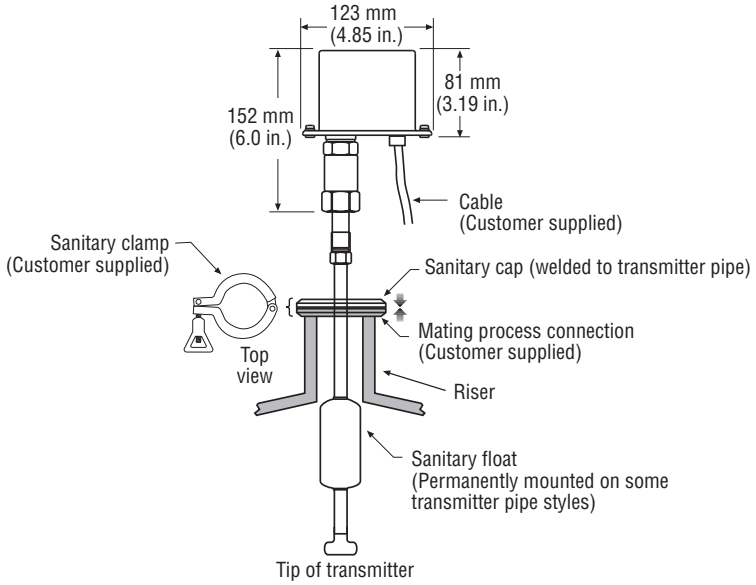
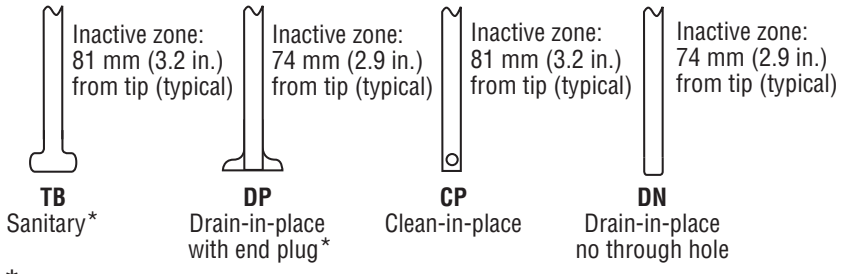


Figure 8. M-Series Model MR transmitter. Tank mounted with sanitary connection



*This end plug style has permanently mounted floats. Floats cannot be removed from pipe.

Figure 9. End-plug options for transmitters in a sanitary pipe application

Electrical connections and wiring procedures

A typical intrinsically safe connection for the Level Plus Model MR transmitter includes protective safety barriers, a power supply and a reading or monitoring device. Refer to *Agency information* and *Brief Operation Manual for Safe Use* for detailed information.

A typical explosion proof connection for the Model MR transmitter includes a power supply and a reading or monitoring device connected using explosion proof conduit. Refer to *Agency information* and *Brief Operation Manual for Safe Use* for detailed information.

Notes:

For explosion proof installation, safety barriers are not required and wiring shall be installed in accordance with the National Electric Code ANSI/NFPA 70, Article 501-30 or the regional equivalent.

Safety recommendations for installation

Be sure to:

1. Always follow applicable local and national electrical codes and observe polarity when making electrical connections.
2. Never make electrical connections to the M-Series transmitter with power turned on.
3. Make sure that no wire strands are loose or sticking out of the terminal block connection which could short and cause a problem.
4. Make sure that no wire strands, including shield, are in contact with the electronic module enclosure.
5. The electronics module enclosure is grounded through internal circuitry and is electronically isolated from the explosion-proof housing.

Refer to the safe operating power chart (see *Figure 10*), which shows the relationship between loop resistance and operating voltage.

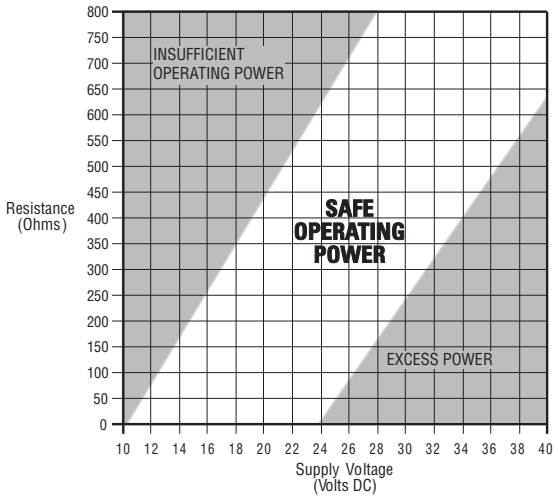


Figure 10. Safe operating power chart

Recommended cable types

Refer to *'Table 1'* below for general requirements of cable types for the Level Plus Model MR analog transmitter.

CABLE SPECIFICATIONS

Parameter	Specification
Minimum cable size	24 AWG or heavier (0.51 mm diameter) Contact factory for assistance selecting proper cable.
Cable type	Single pair shielded or multiple pair with overall shield
Maximum cable length	Twisted pair: 10,000 ft. (3,048 m) Multiple twisted pair: 5,000 ft. (1,524 m)
Maximum cable length formula	Use the following formula to determine the maximum cable length for a specific application:
	Where: L = [(65 x 106) ÷ (R x C)] - [(Cf + 10,000) ÷ C] L = Length in meters or feet R = Resistance in ohms, current sense resistance plus barrier resistance C = Cable capacitance in pF/ft, or pF/m Cf = Maximum shunt capacitance of smart field devices in pF Example: Assume a high performing smart transmitter, a control system, and a single pair of shielded wires. R = 250 ohms C = 50 pF/ 0,3 m (ft) Cf = 5,000 pF L = [(65 x 106) ÷ 250 x 50)] - [(5,000 + 10,000) ÷ 50] L = 1,494 m (4,900 ft.)

Table 1. Cable specification and parameters

Electrical conduit installation

Important:

Seal all conduits within 457mm (18 in.)

Notes:

1. Use a flameproof type conduit sealing fitting.
2. Tighten housing cover (both front and back covers if dual cavity) to full stop against the O-ring. Make sure O-ring(s) are present and clean.
3. Do not over-tighten compression fittings.
4. Use side conduit entry only.
5. In high humidity areas, use a breather drain type conduit sealing fitting to minimize moisture intrusion.

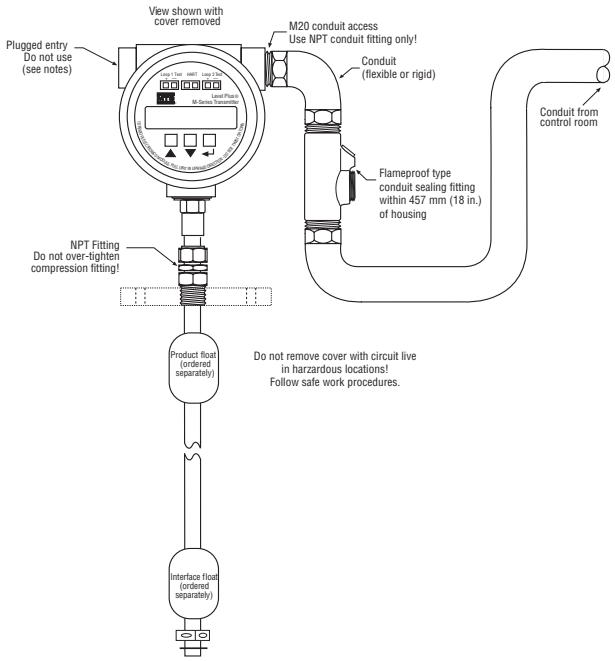


Figure 11. Electrical conduit installation

Grounding

Note:

Grounding the transmitter through a threaded conduit connection does not provide sufficient ground.

There are two methods to provide an earth ground to the earth ground of the electronics. Refer to *' Table 2'* for safety barrier references.

- Run an earth ground through the conduit and connect directly to the earth ground lug inside the housing.
- Run an earth ground directly to the ground lug on the outside of the housing.

Maintenance and field service

This section contains information about post installation maintenance and provides an overview of MTS Sensors' repair and replacement procedures.

General maintenance and field service requirements

Notes:

Please contact Technical Support or Customer Service for help when damage occurs in order to obtain a return materials authorization (RMA) number. Packages without a RMA number may be rejected. Any unit that was used in a process must be properly cleaned in accordance with OSHA standards, before it is returned to the factory. A Material Safety Data Sheet (MSDS) must accompany material that was used in any media.

FLOAT MAINTENANCE

Level Plus M-Series transmitters use magnetostrictive technology and only have one moving part—the float. This technology ensures no scheduled maintenance or recalibration is required. However, MTS recommends that you check the transmitter pipe annually for build up of process material. Floats should move freely along the pipe. If they do not, routine cleaning should be performed.

FIELD SERVICE

If damage does occur to a M-Series transmitter, the transmitter can be serviced in the field with replacement parts. All electronic parts can be changed in the field without having to open the process vessel. Please contact Technical Support and refer to the Transmitter Electronics Replacement Guide (MTS part no. 550731) for detailed steps of field replacement.

SERVICE / RMA POLICY

If the customer suspects their transmitter is damaged or not functioning correctly, call *MTS Technical Support* for further instruction. If it is necessary to return the transmitter to the factory, an RMA number is required and can only be issued by Technical Support. Product returns that do not include an RMA will be returned to the customer. MTS evaluates the transmitter and advises the customer whether a repair or replacement is necessary and any cost that might be incurred. If the customer declines repair/replacement or the transmitter has no fault found, the unit is sent back as is and the customer is charged with a standard evaluation fee.

If the transmitter is under warranty and a manufacturer's defect is detected, there will be no cost to the customer for repair or replacement. If the transmitter is out of warranty or if the customer has damaged the transmitter, a repair or replacement quote will be provided. In specific cases where the transmitter can not be removed and returned to the factory for evaluation, field evaluations can be performed in the field by an MTS technician. If field evaluation must be performed, the customer is responsible for all expenses incurred for travel, evaluation, parts and repair time. However, if the transmitter is under warranty and the problem is due to a manufacturer's defect, there is no cost to the customer for replacement parts. To discuss all service options, contact *Technical Support*.

Troubleshooting

The table below contains troubleshooting information for the Model MR analog transmitter.

TROUBLESHOOTING PROCEDURES

Symptom	Possible Cause	Action
No communication with transmitter	No power	Check voltage at transmitter
	Wiring incorrect	Reference installation drawing (*see 'Electrical* connections and wiring')
	Wrong software	Confirm correct software
Output in Alarm (3.8 mA or 21.4 mA)	Float not recognized	Confirm that the float is attached
	Float is in the dead zone	Raise float to see if the error stops
	Wrong number of floats selected	Confirm that the number of floats on the transmitter and the number of floats the transmitter is attempting to verify are the same.

Table 3. Troubleshooting reference

Quick start-up guide

BEFORE YOU BEGIN

Note:

Output will vary depending on the location of the 4 and 20 mA set points.

Tools Needed:

- 24 Vdc linear regulated power supply
- Current Meter

QUICK START-UP PROCEDURE

1. Connect 24 Vdc power supply
2. Turn on power supply
3. Connect Current Meter to test pins on the front of the puck
4. Move the float to the tip of the pipe and verify 4 mA output
5. Move the float to the top of the pipe and verify 20 mA output
6. If using two floats, repeat steps 4 and 5 for second float
7. Turn off power and disconnect power supply
8. Install in tank
9. Connect power and turn on

Setup using keypad display

The Model MR transmitter can be calibrated by using the HART communications protocol or it may be manually calibrated using the optional *keypad display.* This section explains modes of operation and the steps you need to perform to calibrate your transmitter manually using the keypad display.

OPERATION MODES

The Model MR transmitter runs in one of the following modes of operation. You can use these modes to calibrate and set up various operating parameters.

Run Mode

Run mode is the primary mode of operation. This mode will perform measurements, display data, and respond to HART commands. The run mode can be configured for various output options. The minimum configuration will only perform a single-level measurement. More complex configurations will perform a second float measurement (interface), or temperature measurements. Level measurement. More complex configurations will perform a second float measurement (interface), or temperature measurements.

Program Mode

The program mode is only applicable to Model MR transmitter with the keypad display option. Enter this mode by pressing any of the three keys, *Up keypad, Down keypad, and Enter keypad* as shown in *Figure 12.* Menus guide the user through various programming options. When in the program mode, HART communications are not functional. An automatic time out feature is provided so that the transmitter does not remain inadvertently in program mode.

Display Test Mode

This mode is invoked through the keypad.

Display / Keypad usage in Program Mode

The Model MR transmitter can be configured by pressing three keys, the Up keypad, Down keypad, and Enter keypad as shown in *Figure 13.* This gives the user a means to calibrate and set up various operating parameters.

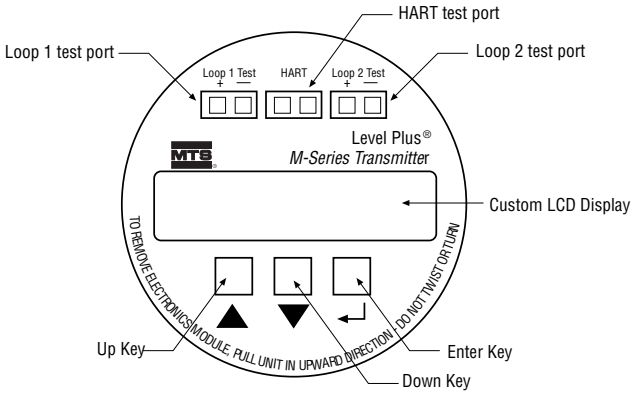


Figure 13. Keypad display

The three keypads are identified with "∇" "Δ", and "<—". The "Δ" keypad may be used to indicate Up responses, the "∇" symbol indicates Down responses, and "<—" indicates an Enter response. Normally, the Model MR transmitter will remain in run mode. When you press any three keys, the transmitter will enter program mode. In program mode, the electronics module menu displays options that you can scroll through using the Up and Down keypads. To select an option, press Enter.

Notes:

In program mode, the transmitter will not respond to incoming HART commands. This function will prevent a user at a remote terminal from overwriting a parameter that is being entered at the same time from a local site.

Program Mode Timer

After you enter the programming mode, a one-minute timer is started. Each time you press a button, the timer is reset. If you do not press a menu button within one minute, the timer will expire and the transmitter will return to the *run mode*.

Loop 1 and Loop 2 Test Ports

Using a standard multi-meter set the meter to DC current and attach across the terminals, loop current can be read directly from ports 1 and 2 (see *Figure 14)*. The current read on the meter should correspond with the data being displayed. These ports allow the loop current to be read directly without having to interrupt power.

HART Port

This port allows for direct connection of the HART field calibrator or other HART host device as long as there is a load on loop 1.

LCD DISPLAY AND KEYPAD (OPTIONAL)

A sixteen character, seven-segment LCD display and three push-button "keypad" option is available. Level and temperature measurements are displayed when in run mode. When power is applied to the unit, a start" message is displayed. Then, while in run mode, the display is updated every three seconds with new data. There are three data fields on the display [Level 1, Level 2, Temperature]. If a measurement is not available, there will be dashes (- - - - -) shown in the corresponding field.

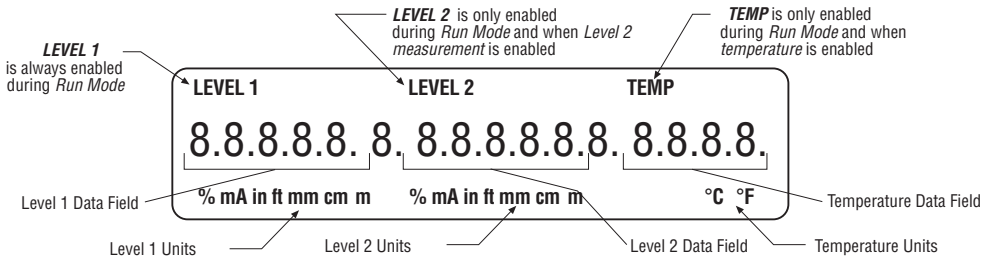


Figure 14. Keypad display LCD display

ALARM SETTINGS

When a fault condition is detected by the internal microprocessor, the 4 to 20 mA current will go to the selected alarm mode. If in the 4 mA alarm mode when a fault is detected, the output will be continuous at 3.8 ± 0.1 mA. If in the 20 mA alarm mode when a fault is detected, the output will be continuous at 21.5 ±0.2 mA.

MANUAL CALIBRATION

The procedure to enter calibration mode and modify levels 1 and 2, adjust LCD contrast and perform a LCD testis shown in *Figure 15 on the next page*.

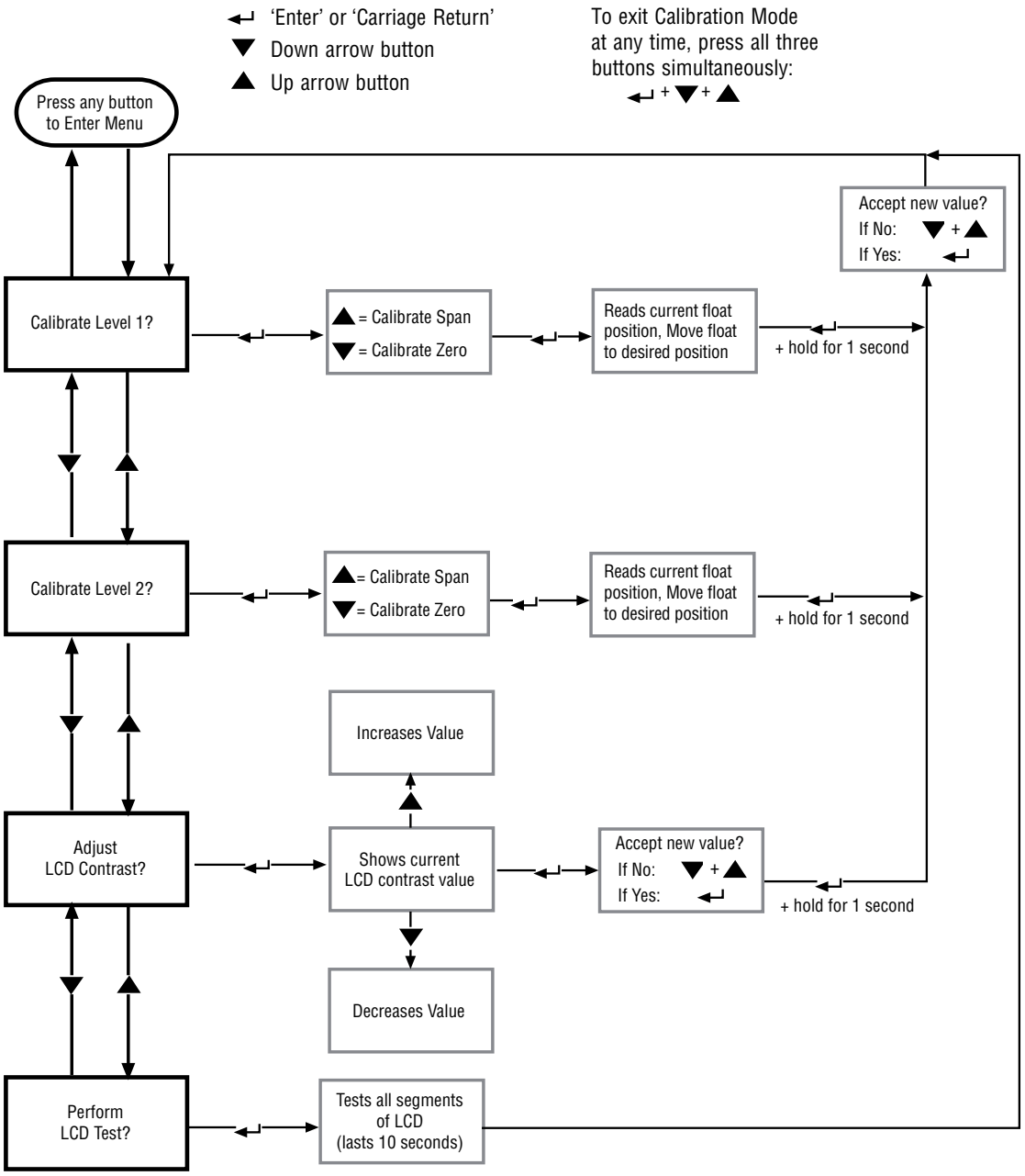


Figure 15. Manual calibration matrix

Setup using HART Field Communicator

Refer to the documentation that comes with the *Rosemount Model 275 and 375 Field Communicator* for specific sensor calibration information. This section describes how the HART protocol is applied to the Level Plus Model MR transmitter only.

Using the HART interface allows for calibration without having to remove the transmitter from the process and position of the floats. You can perform this function by using HART commands 35 and 65.

Any measured output may be assigned to any variable. Loop #1 is always the primary variable (PV); level 1 is usually assigned to loop 1. Loop 2 is always the Second Variable (SV); usually represents temperature or level 2. The Third Variable (TV) and Fourth Variable (FV) may be assigned to any remaining output such as, level 2, temperature. Analog output codes are 0, 1, and 2 respectively.

Calibration set points for level are given as the absolute displacement (in the appropriate units) from the tip of the sensor pipe. For example, if the Zero (LRV) position for level 1 is given as 5 inches, the transmitter will produce 4 mA when the float is 5 inches from the tip of the sensor pipe. If the Span (URV) position for level 1 is given as 30 inches, the transmitter will produce 20 mA when the float is 35 inches from the top of the sensor pipe. To calibrate the temperature set points, the Zero (LRV) and Span (URV) points are given in degrees. For temperature, the Zero (LRV) value (in degrees) must always be less than the Span (URV) value (in degrees).

PREPARING THE TRANSMITTER FOR RE-CALIBRATION

The Model MR transmitter can be re-calibrated by using the model 275 and 375 Field Communicator. Complete the following procedure to reset the zero and span values for loop 1 (only loop 1 can be calibrated with the HART Field Communicator using the generic XMTR type driver. To access both loops as well as other parameters, the MTS device driver must be purchased and installed in to the 275/375 field communicator. For more information about the HART device driver, go to *HARTcomm.org*.

Attention:

DO NOT enter a high value that exceeds the active length of the sensor.

Before you begin, perform the following steps:

1. Connect the transmitter to a clean 24 Vdc power supply. Use a linear supply, switching types do not provide ripple-free power. HART cannot tolerate more than a 25 mV voltage ripple.
2. If the unit is installed in a live application, place your automatic controllers in manual mode and be advised that the output current will change during calibration.
3. Follow safe working procedures for working on live equipment in a hazardous location before you remove the housing cover.
4. Connect the HART Field Communicator to the terminals that are labeled HART located on the front panel display of the Level Plus transmitter.
5. Press the black and white I/O button on the HART terminal. The HART terminal will perform an automatic self test. The Main window displays. If the device is not connected properly, the message “No device found” displays.
6. In the Main window, press the **Key #1**, the Device Setup window displays.
7. In the Device setup window, press **Key #3**. The Basic Setup window displays.
8. In the Basic Setup window, press **Key #3**. The Range Values window displays.

SETTING THE LOW VALUE

Complete the following steps to set the low value:

1. To set the low value, Process Variable, Low Range Value (PV LRV) to 4 mA, select Key #1. The PV LRV window displays the current low value. Below the highlighted value located under the current value, key in the low value you want (example 3.00 in. is shown; if 4 inches is the value you want, key in 4.) then, press Enter (F4) located below the LCD display.
2. To write the changed lower value to memory, press the Send key.
3. Two Warning messages will display before the new values take affect; if your new low values are correct, respond to the Warning messages by pressing OK when prompted. This action resets the Low Range Value, or 4 mA position into the transmitter’s memory.
4. Go back to the Range Values window to verify that the new parameters have been accepted into the transmitter’s memory.
5. ***Do one of the following:***

   5a. Exit program mode.
   5b. To reset the upper value, continue with “Setting the Upper Range Value.

SETTING THE UPPER RANGE VALUE

Complete the following steps to set the Upper Range Value:

Caution:

DO NOT enter a high value that exceeds the active length of the sensor.

1. Open the Range Values window. To set the 20 mA Upper Range Value, press Key #2. The Process Variable, Upper Range Value (PV URV) window displays.
2. As shown the Lower Value window, the current value displays with a highlighted number below the value displayed. To change the upper value, key in the new value. You can use whole numbers or whole numbers and decimals (example, 40 = 40 inches, or 40.5 = 40.50 inches.) Whole numbers will be converted as decimal equivalents automatically by the HART terminal.
3. Key in the new Upper Range Value and press Enter or (F4). The Range Values window displays.
4. Verify that the upper and lower values are correct. If the values are correct, press Send.
5. You will be prompted with two Warning messages, press OK in response to both warnings.

Setup using MTS Field Setup software

Adjustments to the calibration and setup parameters of the transmitter may be done using the MTS Field Setup Software and a RS232 to HART converter (SMAR HI-311, MTS Part # 380068). Be sure to install the latest software package, go to www.mtssensors.com for more information.

USING THE MTS FIELD SETUP SOFTWARE

Tools Required:

- HART adapter/converter
- 24 Vdc power supply
- PC

Complete the following steps to Install Setup Software

1. Insert the software installation CD into computer or go to www.mtssensors.com and download the latest software.
2. Open folder “Setup software Analog_Digital”
3. Open folder “Analog”
4. Open file “M-Series Field Setup”
5. Follow on screen instructions

Complete the following steps to Install the hardware

1. Connect Power Supply to level transmitter
2. Connect HART adapter to level transmitter and PC

Attention:

Be sure loop #1 is connected to a load of 250 to 500 ohm. A transmitter installed in a control loop is a good example of the loop load. A 250 ohm load resistor may need to be added to the loop for HART to communicate effectively.

3. Turn on power
4. Open Setup Software. Data should fill in. If no data appears select a different serial communication port.

ADVANCED SETUP TAB

Gradient : A calibration factor that is specific to each level transmitter. This value should not be changed unless directed to do so by Technical Support.
Length: The order length of the transmitter. This value should not be changed unless directed to do so by Technical Support.
Units: The unit of measure for Length and Head Adder. This is used when writing new values of Length and Head Adder to the transmitter. Use the Output Tab to change units of measure for all data.
Head Adder: The distance between the sensing element and the order length. Each model has a slightly different head adder. This value should not be changed unless directed to do so by Technical Support.

Transmitter style	Length
NEMA 4X housing, standard rigid pipe	4.3 to 4.5 in (109 to 114 mm)
Single or Dual Cavity Housing, standard rigid pipe	5.6 to 5.7 in (142 to 145 mm)
NEMA 4X housing, flexible hose	14.0 to 14.5 in (356 to 368 mm)
Single or Dual Cavity Housing, flexible hose	14.0 to 14.5 in (356 to 368 mm)

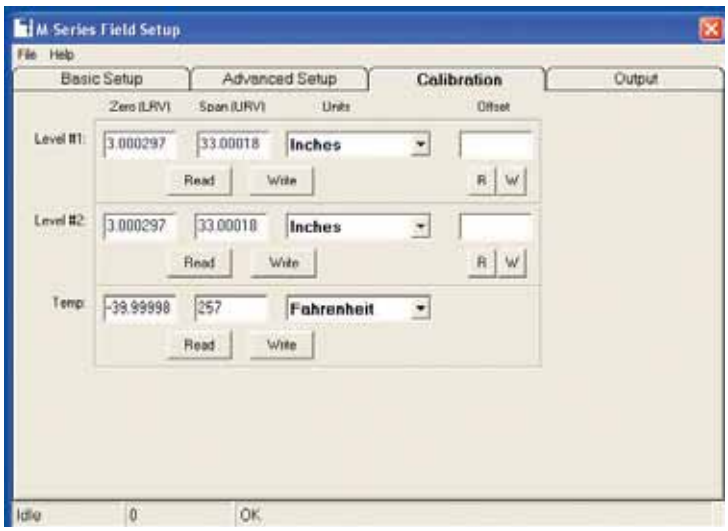
Display Units: Units used only on LCD display of units, mA, or percent Float #2: The second or interface float that can be enabled or disabled

Temperature: The ability to measure temperature that can be enabled or disabled

Display: The optional LCD display that can be enabled or disabled

Alarm: The output state that the level transmitter enters upon failure. Alarm can be Low (3.8 mA) or High (21.5 mA).

CALIBRATION TAB

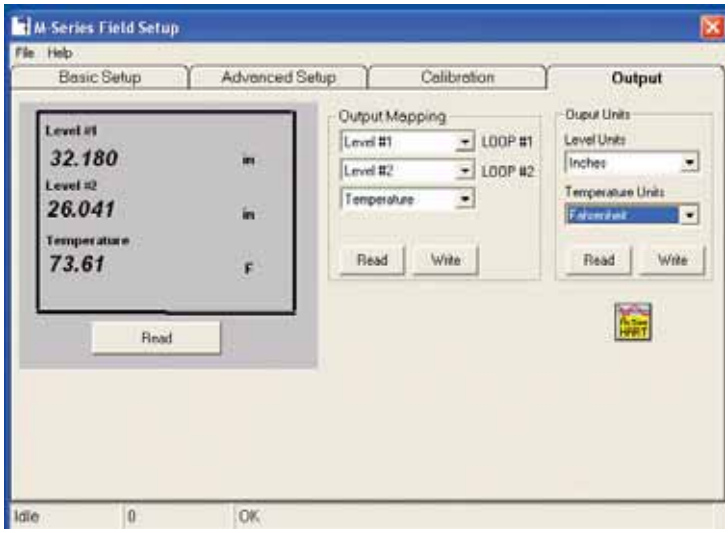


1. Changing the 4 and 20 mA set points occurs on the Calibration Tab. The procedure is the same for Level 1, Level 2 and Temperature.
2. Click 'Read' to determine current set point and units.
3. Select units from drop down menu.
4. Change set point. The 4 mA set point is the Zero or Lower Range Value (LRV). The 20 mA set point is the Span or Upper Range Value (URV).
5. Click 'Write.' Click 'Read' and confirm the new set points are correct.

The Offset field can be used for making adjustments to the optional LCD display, not the current output. This allows the display to be scaled for local viewing only.

1. Click 'R' to determine current offset
2. Enter offset in same units as set points and click 'W'
3. Click 'R' and validate offset is correct. Display should now be adjusted.

OUTPUT TAB



Output Mapping: allows process variables measured by the level transmitter to be mapped to current loops of level transmitter and HART variables. Contact Technical Support for questions.

Output Units: The units of measure for level and temperature may be selected using the pull down menus. When changing units, these selections should be changed on this screen first, prior to changing units on any of the other tabs (Advance Setup or Calibration).

Read: This button sends a single read command to the transmitter and displays the data which the transmitter responds with.

Agency approvals

MTS maintains IECEx, ATEX, FM, CSA, NEPSI, and other hazardous area approvals. For additional information please consult the English manual or MTS Sensors.

KC

KC SPECIFIC MODEL MR NUMBER REQUIRED AS SHOWN ON PAGE 7.

Model	Approval Type	Classification	Standard
MRK	Flameproof	Ex d IIB T4 Ga/Gb	IEC 60079-0:2012 IEC 60079-1:2007 IEC 60079-26:2007

IP / NEMA RATING

IEC 60529:2001 IP66

KC Installation Drawings

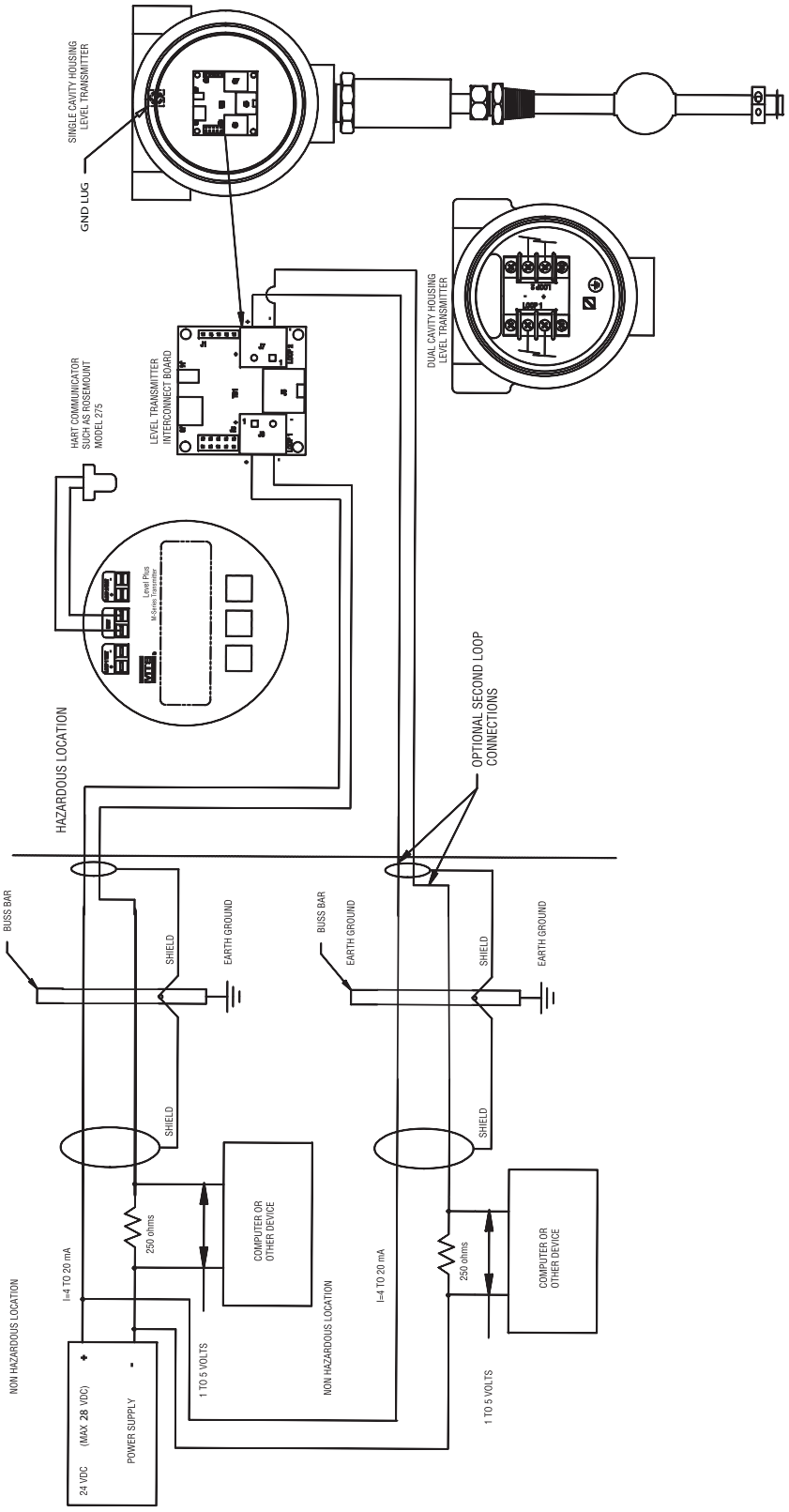


Figure 25. KC installation drawing

KC INSTALLATION DRAWING NOTES

1. For field installation wiring shall be installed in accordance with the country in use.
2. Shielded twisted cable of 0.511 mm^2 up to 2.5 mm^2 max. should be used. Cable capacitance shall be less than 30 pF per 0.3m.
3. Control room equipment should not use or generate more than 250 V RMS.
4. Transmitter enclosure shall be grounded to earth through the provided ground lug in the enclosure.
5. For transmitters with dual cavity enclosures, customer connections will be made at terminal block on power side of housing and not to terminal block on interconnect board.
6. For flameproof installations, conduit seal is required within 457 mm (18 in.) of housing.

KC INSTALLATION DRAWING NOTES

Model number	Approval agency	Approval type	Approval classification	Ground connection (*Figure reference*)
	KTL (KC)	Flameproof		
MRK _ B **MRK _ D**	X	X	Ex d IIB T4 Ga/Gb	Figure 28
MRK _ C **MRK _ E**	X	X	Ex d IIB T4 Ga/Gb	Figure 29

Table 5. ATEX and IECEx model number approval classification

WIRING AND CONNECTIONS (CONTINUED)

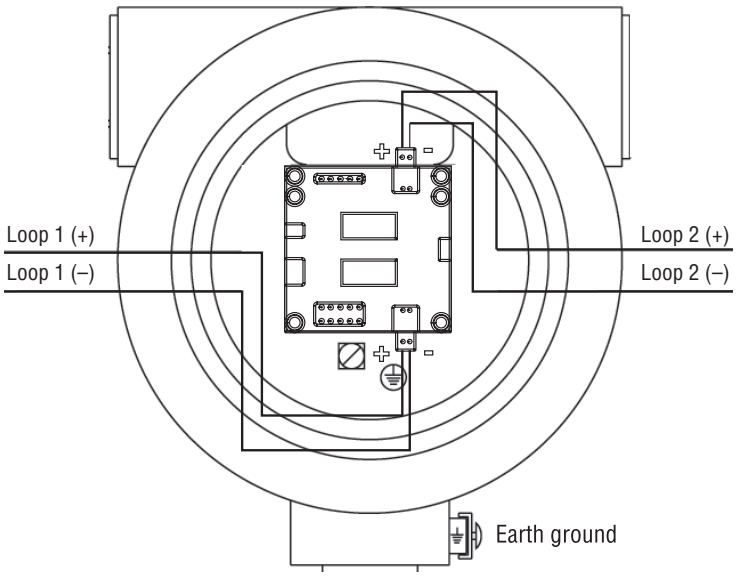


Figure 28. Single-cavity housing

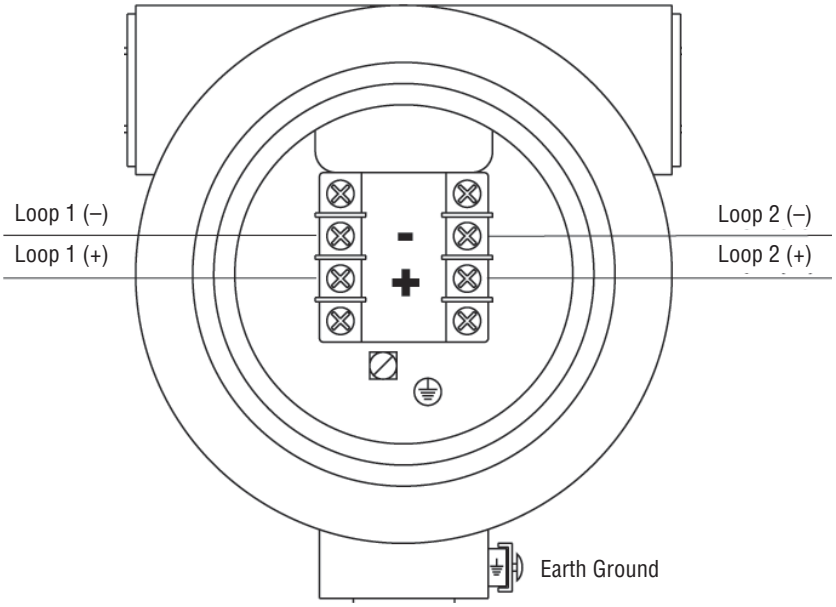


Figure 29. Dual-cavity housing

PRODUCT LABEL IDENTIFICATION (CONTINUED)

Figure 32. Product label for M-Series Models MRK _ B, C, D and E with industrial rigid pipe

Figure 33. Product label for M-Series Models MRK _ B, C, D and E with flexible hose

SPECIAL CONDITIONS FOR USE

- The electronics housing is to be installed in zone 1 (category 2G, EPL Gb}. The sensor pipe/hose may be installed in zone 0 (category 1, EPL Ga} if not restricted below.
- Equipotential bonding shall be installed inside and outside the hazardous area along the cable for supply and data.
- Float usage:
  - Metallic floats may only be used if they have a weight offset (asymmetric weight distribution).
  - Metallic floats on non-metallic pipes may not be used.
  - Aluminum floats may not be used.
- Plastic floats may only be installed in hazardous areas which require apparatus of category 1G (for zone 0} with explosion group IIA. Plastic floats may not be used on non-metallic pipes.
- Sensors with flexible measuring hoses:
  - The hose has to be mechanically protected from external impacts which may affect its function as separation wall.
  - Avoid kinking or bending the flexible hose in less than 16 inch (406 mm) diameter.
- Consult MTS if dimensional information on flameproof joints are necessary.

MTS®
SENSORS

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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 product information.