MTS®

Level Plus®

Liquid Level Transmitter
Model MC420
Analog Output

Operation and Installation Manual

550760 Revision A

Table of Contents

1 INTRODUCTION

MTS is recognized as the pioneer, innovator and leader in magnetostrictive sensing. The new Level Plus® MC420 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 information about the Level Plus M-Series transmitter, to include:

- Product Description
- Dimensions
- Theory of Operation
- Wiring/Electrical Connections
- Specifications
- Model Numbers
- Mounting
- Adjustments
- Maintenance
- Network HART® Interface

2 PRODUCT DESCRIPTION

The Level Plus MC420 liquid level sensor is a multifunctional transmitter with a 4-20 mA loop and HART® (Highway Addressable Remote Transducer) communications. It provides one analog output for level or interface. The output can be monitored using the 4-20 mA signal or a HART® device (hand-held or MTS PC-compatible software).

The Level Plus MC420 transmitter housing is a NEMA 4X electropolished stainless steel with I.S. approval.

The outer pipe is constructed of:

- 5/8 in. diameter rigid outer pipe (316L stainless steel)

2.1 MC420 Transmitter Specifications

PARAMETER	*SPECIFICATIONS*
LEVEL OUTPUT	
Measured Variable:	Product level/ interface depending on float selection
Full Range:	18 to 216 in. (451 mm to 5486 mm)
Non-linearity:	0.02% F.S. (Independent BSL) or 1/32 in. (0.794 mm)*
Repeatability:	0.005% F.S. or 0.005 in. (0.127 mm)*
Time Constant:	1 second
Sensor Operating Temperature:	-30 to 248°F (-34 to 120°C)
Transmitter Loop	
Input Voltage Range:	10.5 to 36.1 Vdc
Reverse Polarity Protection:	Series diodes
Transient Protection:	Stage 1: line-to-ground surge suppressor; 2500 Amps peak (8/20 µsec.) Stage 2: line-to-line and line-to-ground transient suppressors; 1500 Watts peak (10/1000 µsec.)
Safety Approval:**	CSA/FM approval intrinsically safe for Class 1, Division 1, Groups A, B, C, D, E, F, and G
Calibration	
Zero Adjust Range:	Anywhere within the active length
Span Adjust Range:	Full scale ≥ 6.0 in. (152 mm) from zero
Environmental	
Humidity:	0 to 100% R.H.
Electronic Operating Temperature:	- 30 to 160°F (-34 to 71°C)
Vessel Pressure:	Dependent on float pressure rating
Materials (wetted parts):	316L stainless steel
Field Installation	
Gauge Length:	Up to 216 inches (5486 mm)
Mounting:	3/4 in. NPT adjustable fitting
Wiring:	15' (457cm), 2-wire connection, 1/2" NPTF conduit fitting, integral cable (pigtail)
HART® COMMUNICATIONS	
Method of Communication:	Frequency Shift Keying (FSK) conforms with Bell 202 Modem Standard with respect to baud rate and digital "1" and "0" frequencies.
Baud Rate:	1200 bps.
Digital "0" Frequency:	2200 Hz.
Digital "1" Frequency:	1200 Hz.
Data Byte Structure:	1 Start Bit, 8 Data Bits, 1 Odd Parity Bit, 1 Stop Bit
Digital Process Variable Rate:	Poll/Response Model 2.0 per second
AGENCY APPROVALS	
Canadian Standards (CSA) **Factory Mutual (FM)**	*Intrinsically Safe**:* Class I, Groups A, B, C, D Class II, Groups E, F, G Division 1, NEMA 4X Models: All

** Whichever is greater*

*** When installed with approved I.S. barriers*

All specifications are subject to change without notice. Consult MTS for verification of specifications critical to your needs.

2.2 Accuracy

The absolute accuracy of the transmitter is a function of the manufacture of the waveguide. That is, any imperfections in the waveguide are reflected in the linearity of its output. MTS tolerances reflect a maximum non-linearity of 0.02% of full scale. Due to its high degree of repeatability, the differential accuracy is extremely high.

2.3 Theory of Operation

The magnetostrictive Level Plus 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 (Refer to Figure 2-1).

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 4 - 20 mA loop signal.

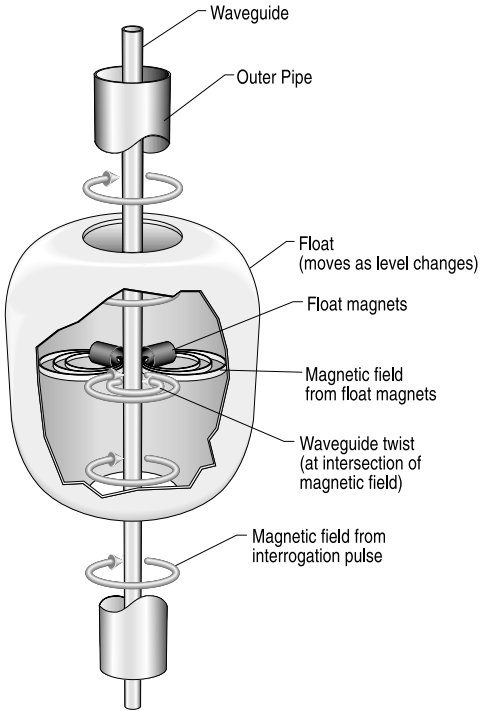
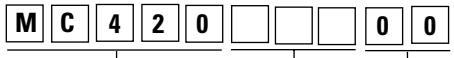


Figure 2-1
Principle of Magnetostriction

3 ORDERING GUIDE

How to Order MC420 Transmitters

Use the guide below to build model numbers for the MC420 transmitters. Model numbers are required to place orders and are helpful in identifying installed products.



MODEL

MC420 = Level Transmitter (-30 to 248˚F, -34 to 120˚C)

TRANSMITTER ORDER LENGTH

Standard Range: 18 to 216 in. (457 to 5486 mm), encode as 018 to 216

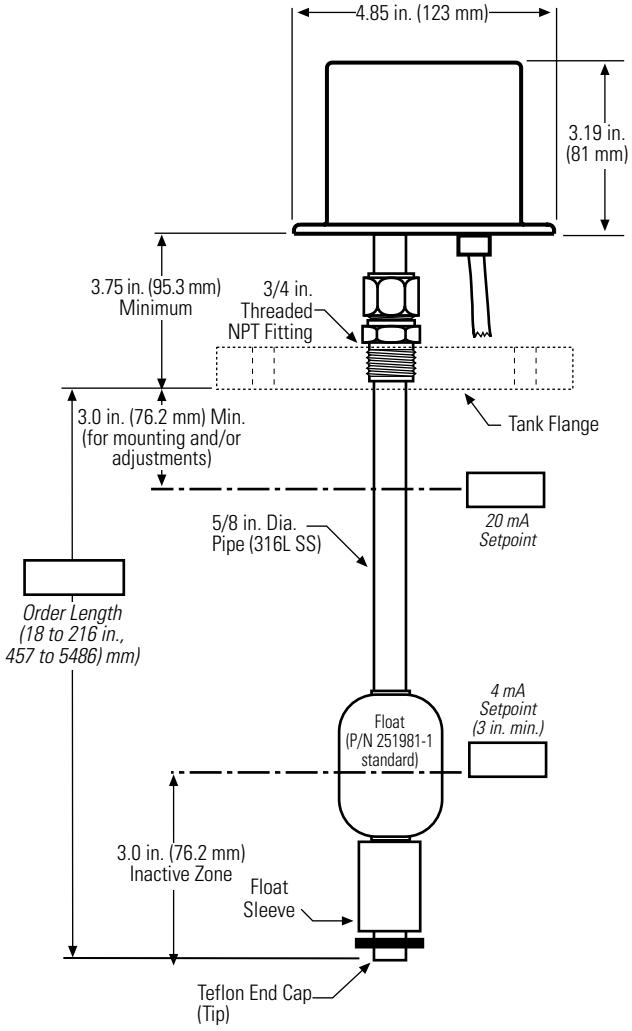
Standard Lengths:

Length	*Code*	*Length*	*Code*	*Length*	*Code*
18 in. (457 mm)	018	84 in. (2134 mm)	084	156 in. (3962 mm)	156
24 in. (610 mm)	024	96 in. (2438 mm)	096	168 in. (4267 mm)	168
36 in. (914 mm)	036	108 in. (2743 mm)	108	180 in. (4572 mm)	180
48 in. (1219 mm)	048	120 in. (3048 mm)	120	192 in. (4877mm)	192
60 in. (1524 mm)	060	132 in. (3353 mm)	132	204 in. (5182 mm)	204
72 in. (1829 mm)	072	144 in. (3658 mm)	144	216 in. (5486 mm)	216

OPTIONS

OO = Standard float (251981-1)
FO = Non-Standard float
TO = Stainless steel tag
FT = Non-standard float and stainless steel tag

NOTE: *A completed Application Data Sheet is required before an order can be processed.*



TAG NUMBER(S) 316 STAINLESS STEEL

Notes:
1. Inactive Zone from tip to center of float is __3__ in.
2. Allow overhead clearance for installation and removal of sensor

MTS Quote/Order #:

Company Name:

Customer Reference #:

Model #: Quantity:

Order Length:

Sensor Pipe Material: ***316L Stainless Steel***

Flange/Process Connection: ***3/4 in. NPT Male Fitting (included)***

Product Float P/N: ***251981-1 (400 PSI max., sg = 0.67)***

Float Material: ***316L Stainless Steel***

Product Specific Gravity:

Signal Output: ***4-20 mA***

4 mA Location: (from tip)

20 mA Location: (from tip)

Power Supply Required: ***10.5 - 36.1 Vdc***

Maximum Vessel Operating Pressure: ***(dependent on float pressure rating)***

Maximum Vessel Operating Temperature Range: ***-30 to 248°F (-34 to 120°C)***

Approval Required (check one): FM ___ CSA ___

Check One:

Market Code	Description	Market Code	Description
___ FB	Food and Beverage	___ PR	Petroleum Production
___ CH	General Chemicals	___ RE	Petroleum Refining
___ HP	High Value Petrochemicals	___ PB	Pharmaceutical/Biotech
___ LP	LPG/LNG	___ SG	Sight Glass
___ PE	Petrochemical	___ SV	Solvents
___ MA	Petroleum Marketing	___ TR	Transportation
___ PL	Petroleum Pipeline	___ US	Ultrapure chemicals/Semiconductor

Customer Signature: _____ **Date:** _____

Phone Number: _____

4 INSTALLATION/MOUNTING

4.1 Threaded Flange Mounting

The MC420 is typically mounted in a blind flange that has been drilled and tapped to accept it. First, remove the float from the transmitter by removing the float securing clip (E-ring) and the stainless steel sleever (See important note, below).

NOTES:
The SST sleeve is installed on the transmitter so that the float magnet is at the 4 ma position.

Second, mount the tansmitter in the flange and re-install the float along with the securing clip and sleeve. Third, mount the transmitter, flange and float as a unit onto the tank or vessel.

The tank geometry may change while filling, the transmitter must be appropriately positioned to take this into account. In most applications, the transmitter should be raised off the tank bottom approximately 2 inches before the fitting is tightened to allow for tank dimensional changes due to temperature or other factors.

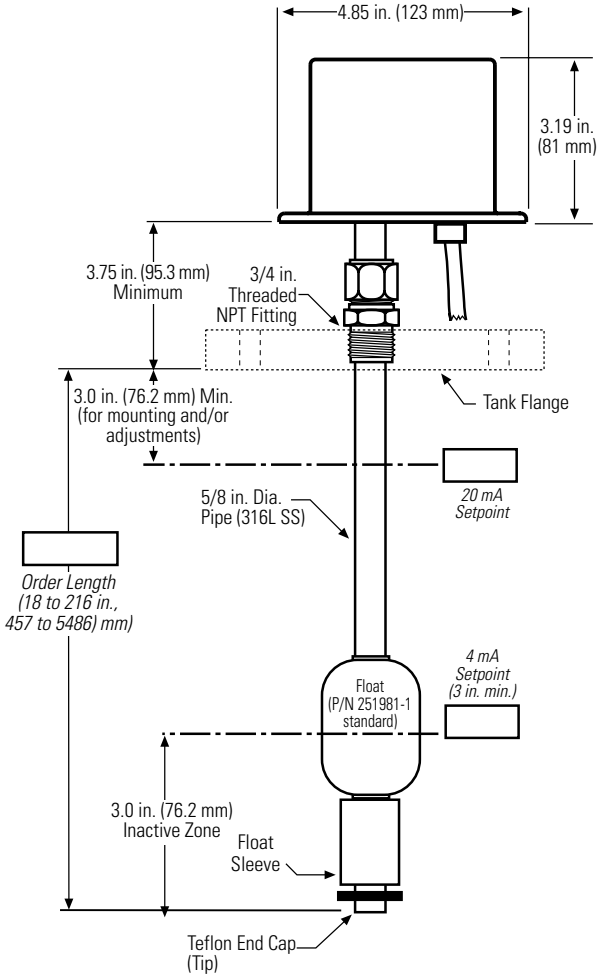
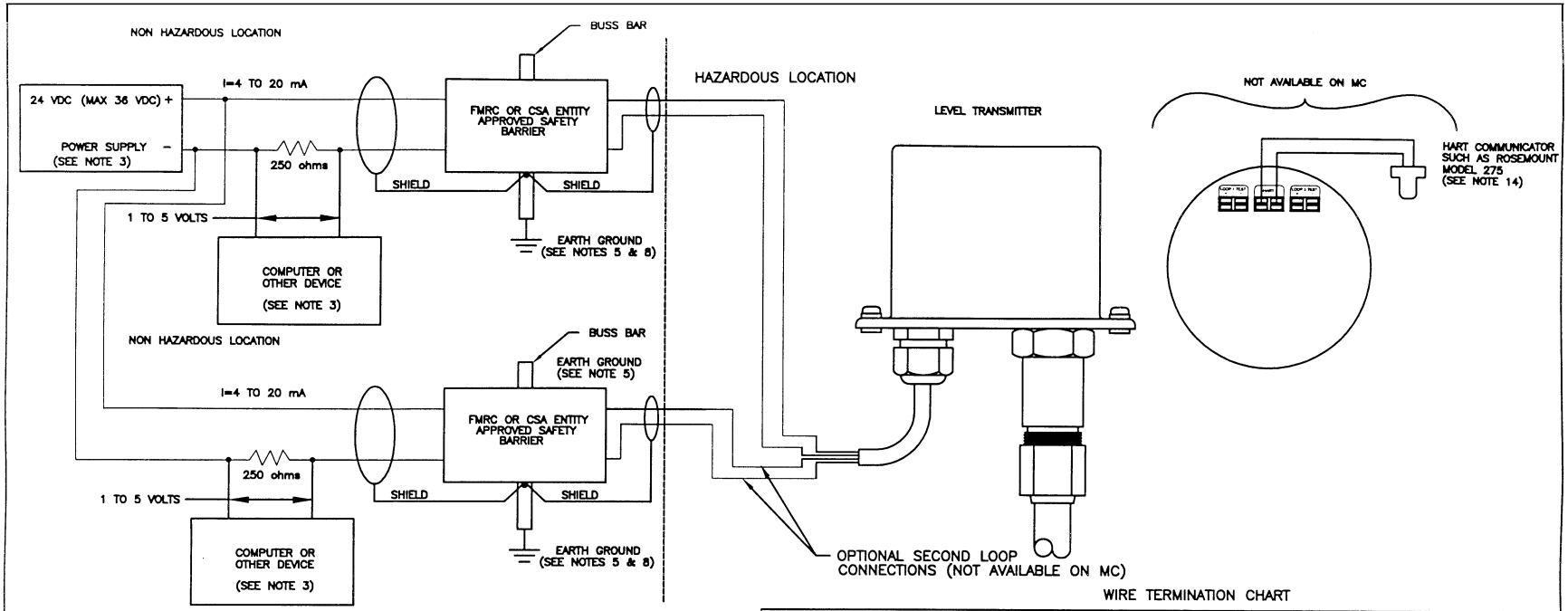


Figure 3-1
Flange Mounting

5 ELECTRICAL CONNECTIONS AND WIRING PROCEDURES

A typical intrinsically safe connection for the Level Plus transmitters includes protective safety barriers, a power supply, and a reading or monitoring device. Refer to MTS drawing number 650805 on the following pages.



NOTES:

1. FOR I.S. FIELD INSTALLATION WIRING SHALL BE INSTALLED IN ACCORDANCE WITH THE COUNTRY IN USE (eg CANADIAN ELECTRICAL CODE, PART 1, NATIONAL ELECTRIC CODE ANSI/NFPA 70 ARTICLE 504–30.)
2. SHIELDED TWISTED CABLE OF 24 AWG OR HEAVIER SHOULD BE USED. CABLE CAPACITANCE SHALL BE LESS THAN 30 PF PER FOOT.
3. CONTROL ROOM EQUIPMENT SHOULD NOT USE OR GENERATE MORE THAN 250 V RMS.
4. FOR FMRC & CSA APPROVED GAUGES, BARRIERS MUST BE FMRC & CSA APPROVED.
5. THE CONNECTION BETWEEN THE EARTH GROUND TERMINAL OF FMRC OR CSA ENTITY APPROVED SAFETY BARRIERS AND SYSTEM EARTH GROUND MUST BE LESS THAN 1 ohm.
6. SAFETY BARRIERS ARE FMRC AND CSA ENTITY APPROVED SAFETY BARRIERS USED IN AN APPROVED CONFIGURATION WHERE TRANSMITTER Vmax IS GREATER THAN BARRIER Voc AND TRANSMITTER Imax IS GREATER THAN BARRIER Isc.
7. TRANSMITTER Ci PLUS TOTAL CABLE CAPACITANCE FOR EACH LOOP MUST NOT EXCEED BARRIER Ca. TRANSMITTER Li PLUS TOTAL CABLE INDUCTANCE FOR EACH LOOP MUST NOT EXCEED BARRIER La. (SEE NOTE 14)
8. GAUGE SHALL BE GROUNDED TO EARTH GROUND THROUGH THE PROVIDED GROUND LUG IN THE ENCLOSURE. WHERE INTEGRAL CABLE IS PROVIDED, LOOP 2 SHIELD IS INSTRUMENT GROUND.
9. NO REVISIONS SHALL BE MADE WITHOUT NOTIFICATION OF APPROVAL AGENCY(S).
10. INTRINSICIALLY SAFE FOR:
    CLASS I, DIVISION 1, GROUPS A, B, C AND D
    CLASS II, DIVISION 1, GROUPS E, F AND G, CLASS III
    WITH NEMA/TYPE 4X, FOR OUTDOOR USE.
11. EACH LOOP ENTITY PARAMETERS (PRINTED ON LABEL)
    Vmax= 36V
    Imax= 118mA
    C_i = 0
    L_i = 200 uH

WIRE TERMINATION CHART

MODEL		SIGNAL	WIRE COLOR	6 PIN CONN CABLE WIRE COLOR
MC	MR (M–SERIES)	LOOP 1 +	RED	RED
		LOOP 1 –	BLACK	RED W/WHITE TRACE
		LOOP 2 +	WHITE	RED W/YELLOW TRACE
		LOOP 2 –	BLUE	GREEN
		GROUND	BARE (SEE NOTE 8)	RED W/BLUE TRACE

12. TEMPERATURE CODE IS T4.
13. APPROVED METHODS FOR SEPARATION OF EACH LOOP ARE:
    * RUNNING LOOPS IN SEPARATE CABLES.
    * RUNNING LOOPS IN SEPARATE GROUNDED SHIELDS.
14. HART COMMUNICATOR WHICH FM & CSA APPROVED (AS APPLICABLE) MUST ONLY BE CONNECTED IN ACCORDANCE WITH MFG IS INSTALLATION INSTRUCTIONS.
15. USE ONLY NRTL LISTED AND CSA CERTIFIED DUST–TIGHT SEAL FOR CLASS II AND CLASS III HAZARDOUS LOCATIONS.

NO REVISIONS SHALL BE MADE WITHOUT NOTIFICATION TO APPROVAL AGENCY(S).

REV.	DATE	BY	DCR NO.	DESCRIPTION

UNLESS OTHERWISE SPECIFIED
XX = ± .01
.XXX = ± .005
ANGULAR = ± 1°
REMOVE BURRS AND SHARP EDGES .015 MAX
DIA LIMITS HELD AFTER PLATING OR CONVERSION COATING
DRILL DEPTHS ARE TO FULL DIAMETER
TAP DEPTHS ARE MINIMUM FULL THREADS

MATERIAL: ---
FINISH: ---
DO NOT SCALE DRAWING

DRAWN	BB	DATE 4/27/99
CHK		DATE
ENGR		DATE
QC		DATE
MFG		DATE

SCALE: ---
SHEET 2 OF 2

MTS SENSORS DIVISION
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27709

TITLE: INSTALLATION DRAWING, I.S. MC & M–SERIES GAUGE NEMA 4X HOUSING

DWG NO. 650805 REV D

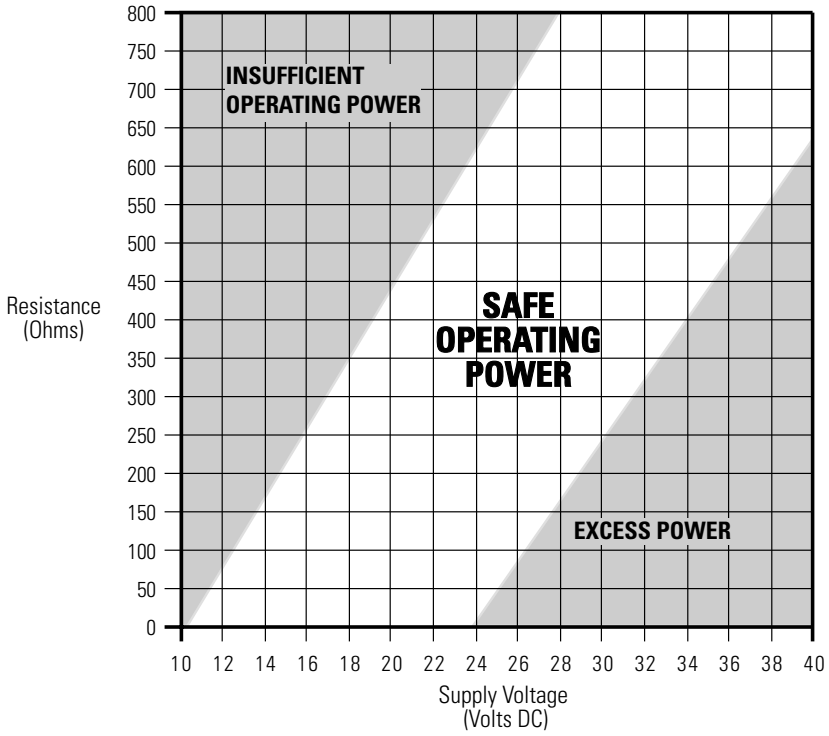
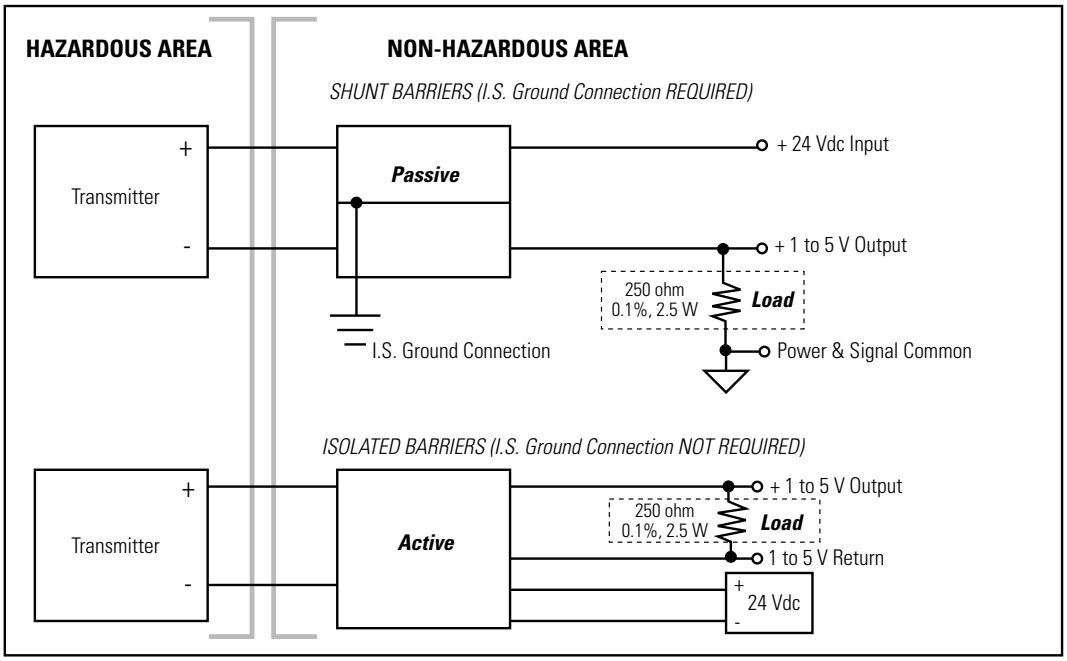


Figure 5-2
Loop Resistance vs. Power Supply

5.3 Recommended Safety Barriers for IS Installation



NOTES:

- *When selecting barrier types, the electrical specifications for the MC420 transmitter are: Vmax = 36.1 Vdc, Imax = 118 mA (total current), Ci = 0.0 µF, Li = 0.0 µHy*
- *MTS stocks Stahl barriers 9001/01-280-100-10 (MTS part number 560669).*

Figure 5-3
Suggested Safety Barrier Types for MC420 Transmitter

6 SYSTEM CHECK

After completing the MC420 wiring, the system is ready to be checked out. Apply power to the unit. Using a DC volt meter, measure the voltage at loop #1 connections. The voltage must be ≥ 10.5V. If the voltage levels are too low, shut down the system. Check for shorts, power supply voltage, and excessive loop resistance. Refer to the Safe Operating Power chart (Fig. 5-2) which shows the relationship between loop resistance and operating voltage.

6.1 Loop #1 Test

To test loop #1 on a bench, move the float along the operational range of the MC420 transmitter. If functioning properly, the output current will change as the float moves.

An output current of less than 4 mA or greater than 20 mA could indicate a problem with the MC420 transmitter.

7 FLOATS

The MC420 comes standard with the 251987- (sq=0.67), float. This float will work in most applications where the vessel pressure does not exceed 400 psi. This float is 1.85" (47mm) in diameter and is 3.01" (76.5mm) long.

For information on floats, please refer to the Float Specification document, MTS part number 550537. For float application information please contact the MTS Level Plus Applications Department.

When contacting MTS for assistance on floats, please provide the following information:

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

8 MAINTENANCE

MTS liquid level gauges 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 sensor pipe annually for build up of process material. Floats should move freely along the sensor pipe. If they do not, routine cleaning should be performed.

9 ADJUSTMENTS FOR LEVEL/PLUS MC420 TRANSMITTER

NOTE:
To ensure that the new settings are correct, place a current meter in line with the MC420 so that is is visible during the calibration process.

9.1 Calibration

The MC420 level transmitter comes calibrated from the factory per the application data sheet which was submitted with the order. To change the zero (4 mA) or Span (20 mA) settings, use the following procedure:

9.2 To set zero (4 mA):

1. Place float in desired position for the zero (4 mA) point.
2. Locate the recess marked (Z) on the underside of the baseplate.
3. Using the MTS provided magnet briefly tap the (Z) to enable the CAL mode.
4. Place the magnet in the recess marked (Z) and hold for 3 seconds, then release.

9.3 To set the Span (20 mA) position

1. Move the float to the desired span (20 mA) location.
2. Locate the recess marked (S) on the underside of the base plate.
3. Using the MTS provided magnet, briefly tap the recess marked (S) to enable the CAL mode.
4. Place the magnet in the recess marked (S) for 3 seconds, then release.

10 ADJUSTMENTS FOR LEVEL PLUS M-SERIES TRANSMITTERS (via HART)

Refer to the documentation supplied with your specific HART software package or hand held communicator for details on performing sensor calibration. This section describes how the HART protocol is applied to the MC420 level transmitter only.

Using the HART interface allows for calibration without having to remove the transmitter from the process and position the floats. The HART commands 35 and 65 are implemented for this function.

Any measured output may be assigned to any variable. Loop 1 is always the primary variable (P.V.); normally level one is assigned to loop 1. The 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. For example, if the desired ZERO position for level #1 is given as 5 inches, the MC420 will produce 4 mA when the float is 5 inches from the tip of the transmitter. If the desired SPAN position for level #1 is given as 30 inches, the MC420 will produce 20 mA when the float is 35 inches from the tip of the transmitter.

10.1 HART Quick Start

The Level Plus MC420 transmitter can be re-calibrated using a HART model 275 hand held terminal. Follow the simple instructions below to reset the low and high values for loop #1.

RULES:

1. Be sure the MC420 is connected to a clean 24 Vdc power supply with a minimum of 250 Ohms load in series. 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 as applicable for working on live equipment in a hazardous location. When safety is secured, remove housing cover.

4. Connect the HART communicator.

NOTE:
Be sure you have the transmitter loop #1 connected to a load of 250 to 500 Ohms. A unit installed in a control loop is a good example of this loop load. You may also use a load resistor in the range of the above value.

5. Press the black and white "I/O" button on the HART terminal. The terminal will go into self test, then into the main screen. If not connected properly, you will get a "No device found" message.

6 From the main screen, press keypad key #1, "Device Setup".

7. From the "Device Setup screen, press key #3, "Basic Setup".

8. Press key #3, you are now in "Range Values" screen.

To set low value

9. To set the low value (4 mA), Select key #1, PV LRV (Process Variable, Lower Range Value). You are now in the PV LRV screen. The current low value is displayed. Below this value is a highlighted value. Key in the desire low value (example 3.00 in. is shown; if 4 inches is desired, key in 4.) When the new desired low value is keyed in, press "enter" (F4) button located below the LCD display, right. To write the changed lower value to memory, press the "SEND" key now. Next you will see two "WARNING" screens that ask if you are sure. If your new low values are correct, press "OK" for both messages.

   This action resets the Lower Range Value, or 4 mA position into the transmitter's memory.

   Go back to the "Range Values" screen to verify that the new parameters have been accepted into the transmitter memory.

   You may now exit program mode or continue on to reset the upper value. If you choose to exit the program mode, replace the calibration jumper to the "ON" position, and return your controllers to automatic.

To set high value

10. You should now be in the "Range Values" screen. To set the 20 mA (Upper Range), press key #2. You are now in the "PV URV" (Process Variable, Upper Range Value) screen. As in the lower value screen, the current value is displayed with a highlighted number below it. To change the upper value, key in the desired value. You may use whole numbers or whole numbers and decimal numbers (40 = 40 inches, or 40.5 = 40.50 inches.) Whole numbers will be entered as their decimal equivalents by HART automatically. Key in the desired upper range value desired. Press the "Enter" (F4) button.

> ***CAUTION!***
> *Do not enter a high value that exceeds the active length of the sensor!*

11. You are back in the "Range Values" screen. If the numbers for lower and upper are correct, press the "Send" key. You will get a "WARNING!". Press the "OK" button. You will again get "WARNING!" Press "OK" again.

12. Startup is now complete.

11. ADJUSTMENTS VIA OPTIONAL SOFTWARE SETUP PROGRAM (CD/3.5" DISKETTE)

Adjustments to the calibration and set up parameters of the transmitter may be done using the M-Series Setup software package and a RS232 to HART converter (SMAR). This software package allows the user to view and/or modify the following parameters:

1. Basic
   a. Manufacturing Information

2. Advanced
   a. Gauge length
   b. Gradient
   c. Head adder
   d. Set alarm output to low, or high

3. Calibration
   a. Level 1 span & offset

4. Output
   a. Level 1 units of measure
   d. Output units of measure
   e. View output data

MTS Part Numbers:
252273-1: M-Series PC Setup Software on CD/Diskettes and Hart Adapter
252273-2: M-Series PC Setup Software on CD/Diskettes
380068: HART to RS232 Adapter (SMAR HI-311)

Installation:
1. Place CD or Diskette 1 of 3 in proper drive.
2. Run setup.exe from proper drive
3. Follow on screen instructions for loading program.
4. Configure serial port for 1200 baud.

Operation:
1. Connect Hart adapter to COM port on back of PC
2. Connect Hart adapter clip leads to Hart Port on M-Series electronic puck module.
3. Apply power to M-Series Transmitter.
4. Run M-Series Field Setup Program.
5. Program will auto search and receive configuration data from the Level Transmitter. The program will display this data in the “Basic Setup” screen. If there is no communication then try assigning a different serial communications port and click on the “FIND” button in top left corner to run the search program again.
6. Click on the “Advanced Setup Tab” and confirm that the gradient, length, and head adder have been received from the level transmitter. If they are not shown, then click the “Read” button at the bottom of the screen to fill in the missing data.
7. Click on the “Calibration” Tab and adjust zero, span and units from the appropriate channel. Press “Write” after completing each section individually.
8. Click on the “Output” Tab and confirm the output mapping. If changes are made, press “Write” to send the level transmitter the new mapping. Confirm that the output units are set correctly.

MTS®

SENSORS
GROUP

Pioneers,
Innovators,
Leaders in
Magnetostrictive
Sensing

LEVEL PLUS®

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ISO 9001 CERTIFIED

HART FIELD COMMUNICATIONS PROTOCOL