

# Level Plus<sup>®</sup>

Magnetostrictive Liquid Level Transmitters  
with Temposonics<sup>®</sup> Technology

**RefineME<sup>®</sup>**  
Operation Manual



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## 1. Contact information

### United States

#### General

Tel: +1-919-677-0100  
Fax: +1-919-677-2343  
E-mail: [info.us@mtssensors.com](mailto:info.us@mtssensors.com)  
<http://www.mtssensors.com>

#### Mailing and shipping address

MTS Systems Corporation  
Sensors Division  
3001 Sheldon Drive  
Cary, North Carolina, 27513, USA

#### Customer service

Tel: +1-800-633-7609  
Fax: +1-800-498-4442  
E-mail: [info.us@mtssensors.com](mailto:info.us@mtssensors.com)

#### Technical support and applications

24 Hour Emergency Technical Support  
Tel: +1-800-633-7609  
e-mail: [levelplus@mts.com](mailto:levelplus@mts.com)

### Germany

#### General

Tel.: +49-2351-9587-0  
Fax: +49-2351-56491  
e-mail: [info.de@mtssensors.com](mailto:info.de@mtssensors.com)  
<http://www.mtssensors.com>

#### Mailing and shipping address

MTS Sensor Technologie, GmbH & Co. KG  
Auf dem Schüffel 9  
D - 58513 Lüdenscheid, Germany

#### Technical support and applications

Tel.: +49-2351-9587-0  
e-mail: [info.de@mtssensors.com](mailto:info.de@mtssensors.com)  
<http://www.mtssensors.com>

### Japan

#### General

Tel.: +81-42-775-3838  
Fax: +81-42-775-5516  
e-mail: [info.jp@mtssensors.com](mailto:info.jp@mtssensors.com)  
<http://www.mtssensors.com>

#### Mailing and shipping address

MTS Sensors Technology Corporation  
737 Aihara-cho, Machida-shi  
Tokyo 194-0211, Japan

#### Technical support and applications

Tel.: +81-42-775-3838  
Fax: +81-42-775-5512

## 2. Terms and definitions

### 6A Heavy Oils

'Generalized Crude Oils', Correction of Volume to 60 °F against API Gravity.

### 6B Light Oils

'Generalized Products', Correction of Volume to 60 °F against API Gravity.

### 6C Chemical

'Volume Correction Factors (VCF)' for individual and special applications, volume correction to 60 °F against thermal expansion coefficients.

### 6C Mod

An adjustable temperature reference for defining VCF.

## A

### API Gravity

The measure of how heavy or light a petroleum liquid is compared to water. Allowable values are 0 to 100 degrees *API* for (6A) and 0 to 85 degrees *API* for (6B).

## D

### DDA

'Direct Digital Access' – The proprietary digital protocol developed by MTS for use in intrinsically safe areas.

### Density

Mass divided by the volume of an object at a specific temperature. The density value should be entered as lb / cu. ft..

## E

### Explosionproof

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.

## 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.

### FOUNDATION™ fieldbus

An all digital, serial, two-way communications system that serves as the base-level network in a plant or factory automation environment. Developed and administered by the fieldbus FOUNDATION™.

## G

### GOVI

'Gross Observed Volume of the Interface' – The total volume of the tank occupied by the interface liquid. The *GOVI* is only given when measuring two liquids and is calculated by subtracting the volume of the product from the total volume of liquid in the tank ( $GOVT - GOVP$ ).

### GOVP

'Gross Observed Volume of the Product' – The total volume of the tank occupied by the product liquid. When measuring only one liquid, it is also the total volume of liquid in the tank (*GOVT*). When measuring two liquids it is the total volume of liquid in the tank minus the volume of the interface liquid ( $GOVT - GOVI$ ).

### GOVT

'Total Gross Observed Volume' – The total volume of liquid in the tank. When measuring only one liquid it is equal to the volume of the product (*GOVP*). When measuring two liquids it is equal to the volume of the product and interface liquids ( $GOVP + GOVI$ ).

### GOVU

'Gross Observed Volume Ullage' – the difference in volume between the working capacity of a tank and the total volume in the tank (Working Capacity – *GOVT*).

## 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*, *DDA*, *MODBUS*).

### 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.

## M

### Mass

The property of a body that causes it to have weight in a gravitational field, calculated by density at the reference temperature multiplied by the volume correction factor ( $Density * VCF$ ).

### MODBUS

A *serial communications protocol* published by Modicon in 1979 for use with its programmable logic controllers (PLCs). It has become a de facto standard communications protocol in industry, and is now the most commonly available means of connecting industrial electronic devices.

## 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.

### NSVP

'Net Standard Volume of the Product' – The temperature corrected volume for the product liquid in the tank, requires the transmitter to be ordered with temperature measurement capabilities. The *NSVP* is calculated by multiplying the volume of the product liquid by a volume correction factor based on temperature ( $GOVP * VCF$ ).

## R

### Reference Temperature

The *temperature* at which the density measurement is given, the allowable values are 32 °F to 150 °F.

## S

### Specific Gravity

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

### Sphere Radius

The *internal radius* of the sphere that contains the liquid, the value is used to calculate the volume along with the *Sphere Offset*.

### Sphere Offset

An *offset value* that accounts for additional volume in a sphere from non-uniform sphere geometry, the value is used to calculate the volume along with the *Sphere Radius*.

### Strap Table

A *table of measurement* correlating the height of a vessel to the volume that is contained at that height. The transmitter can contain up to 100 points.

## T

### TEC

'Thermal Expansion Coefficient' - a value correlating the change in temperature for an object with the change in its volume. Allowable values are 270.0 to 930.0. TEC units are in 10 E-6/Deg F.

### Temperature Correction Method

One of five *product correction methods* used to correct the product volume in the tank due to changes in temperature from 60 °F including (*6A, 6B, 6C, 6C Mod, and Custom Table*).

## V

### Volume Calculation Mode

One of two methods use to calculate volume measurements from level measurements, including *Sphere* and *Strap Table*.

### VCF

'Volume Correction Factor' – A table of measurements correlating temperature points with correction factors for the liquids expansion/contraction. The transmitter can contain up to 50 points.

## W

### Working Capacity

The *maximum volume of liquid* that the user desires for their vessel to hold, typically 80% of the vessels maximum volume before overflow.

### 3. Introduction

#### 3.1 Purpose and use of this manual

**Important:**  
Before starting the operation of the equipment read this documentation thoroughly and follow the safety information.

The content of this technical documentation and of its various annexes is intended to provide information on mounting, installation and commissioning by qualified service personnel according to IEC 60079-14 and local regulations or MTS trained service technicians.

#### 3.2 Used symbols and warnings

Warnings are intended for your personal safety and for avoidance of damage to the described product or connected devices. In this documentation, safety information and warnings to avoid dangers that might affect the life and health of personnel or cause material damage are highlighted by the preceding pictogram, which is defined below.

Symbol	Meaning
<b>NOTICE</b>	This symbol is used to point to situations that may lead to material damage and/or personal injury.

### 4. Safety instructions

#### 4.1 Intended use

The liquid level transmitter is intended to be used to measure the level of liquid(s) contained by a structure as well as the temperature of the liquid. The product may only be used for the applications defined under item 1 to item 4 below and only in conjunction with third-party devices and components recommended or approved by MTS Sensors. As a prerequisite of proper and safe operation, the product requires correct transport, storage, mounting and commissioning and must be operated with utmost care.

1. Application does not exceed product's performance specification in section 5.6.
2. Product may only be installed in hazardous areas as specified by approval certifications in section 12 following special conditions of safe use outlined in section 12 or in safe areas.
3. The liquid(s) being measured are compatible with the selected wetted parts of the product.
4. MTS floats should be used for proper functionality and safety approval.

#### 4.2 Foreseeable misuse

Foreseeable misuse	Consequence
Wrong sensor connection	Possible damage to electronics See Section 7 for Electrical Connections
Improper Installation	Physical damage to packaging See Section 6 for Installation
Installation in unapproved Hazardous Area	Potential Spark See Section 12 for Agency Information

Foreseeable misuse	Consequence
Process Temperature out of range	Signal Degradation, Possible Damage to Sensor See Section 5.6 for Specifications
Power Supply out of range	No Communication, Possible Damage to Sensor See Section 5.6 for Specifications
Process Pressure out of range	Possible Damage to Sensor, See Section 5.6 for Specifications
Improper Chemical Compatibility	Possible Damage to Sensor, Customer Must Select Wetted Material that is compatible with liquid(s) in tank
Modifying Sensor	Warranty Void, Hazardous Approval Void Customer should contact factory for custom unit
Improper Grounding	Possible Damage to Sensor, Full Protection Compromised, See Section 7.6 for Grounding

Table 1: Foreseeable misuse

#### 4.3 Installation, commissioning and operation

1. Wear proper personal protection equipment such as hard hat, safety shoes, flame resistant clothing, safety glasses, gloves, and hearing protection.
2. Follow the specifications given in the technical documentation.
3. Two (2) individuals are recommended to conduct proper installation, commissioning, and repair of the level transmitter.
4. Ensure the equipment used in a hazardous environment is selected and installed in compliance with regulations governing the geographical installation and facility. Only install equipment that complies with the types of protection relevant to the applicable classes, division, zones, category, gas group, and temperature code.
5. Protect the sensor against mechanical damage during installation and operation.
6. Do not use damaged products and secure them against unintentional use. Mark damaged products as being defective.
7. Connect the sensor very carefully and pay attention to the polarity of connections. MTS recommends to not make connections while power is live.
8. Before turning on power, ensure that nobody's safety is jeopardized by starting level transmitter and/or process.
9. Regularly follow preventative maintenance to prevent safety risks.
10. Make sure that no wire strands are loose or sticking out of the terminal block connection which could short and cause a problem.
11. Make sure that no wire strands, including shield, are in contact with the electronic module enclosure.

### 5. Product overview

The Level Plus® RefineME® Liquid-Level transmitter is a continuous multi-functional magnetostrictive transmitter that provides product level, interface level, and temperature to the user Modbus, DDA, Analog (4-20 mA), 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 35 years.

### Industries

- » Petroleum
- » Liquid petroleum gas
- » Pharmaceutical
- » Food & beverage
- » Chemical
- » Mining

### Applications

- » Tank farms
- » Terminals
- » Bullet tanks
- » Separator tanks
- » Battery tanks
- » Storage tanks
- » Solvent extraction

### Features

- » 3-in-1 measurement
  - » Product level
  - » Interface level
  - » Temperature
- » No scheduled maintenance or recalibration
- » Field repairable
- » Inherent Accuracy  $\pm 1$ mm
- » 200 Point Strap Table
- » API Temperature Corrected Volumes

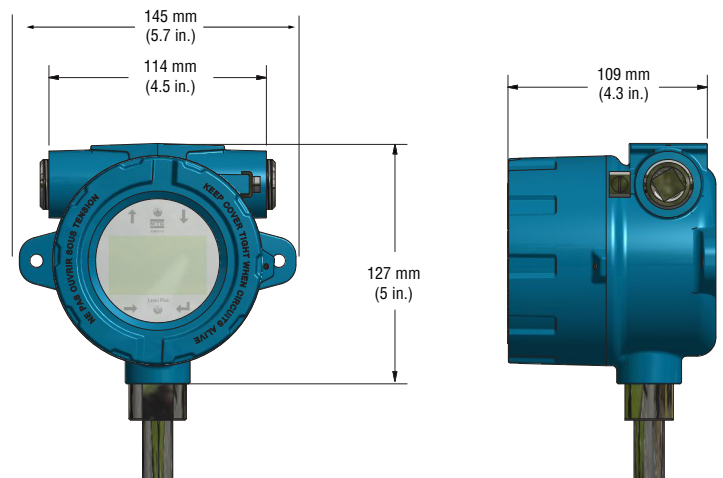


Fig. 2: Single cavity explosion-proof housing

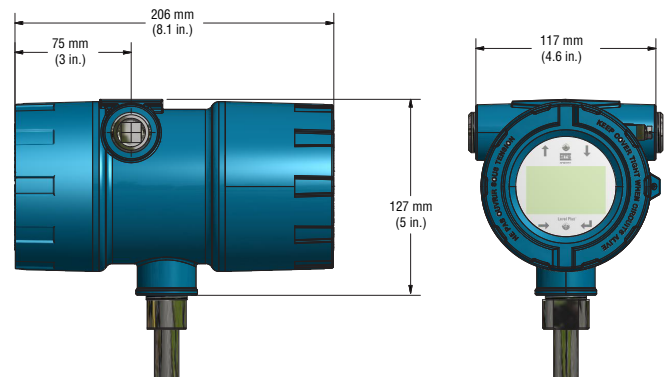


Fig. 3: Dual cavity explosion-proof housing

### 5.1 Components

The Level Plus® RefineME® 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® RefineME® transmitters are available in three housing configurations; NEMA Type 4X 316L stainless steel, explosion-proof single and dual-cavity housings as shown:

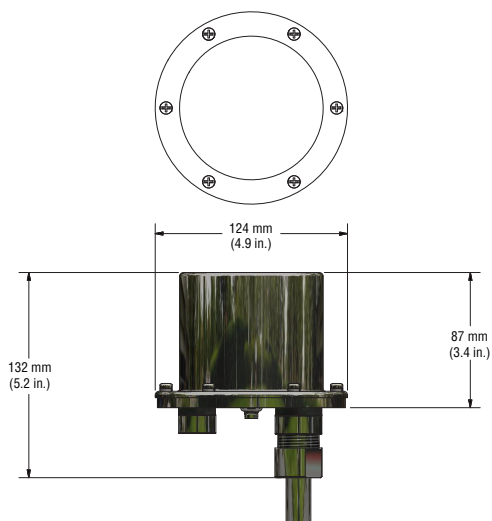


Fig. 1: NEMA Type 4X 316L stainless-steel housing

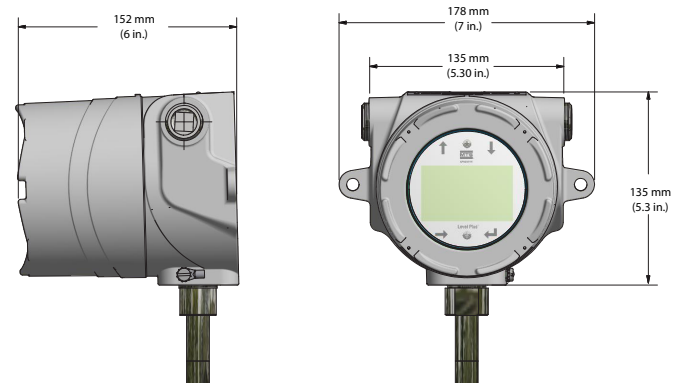


Fig. 4: SS single cavity housing

### Outer pipe configurations

The outer pipe is constructed of a variety of configurations. The RefineME® is available in a rigid pipe. For other pipe options please consult other MTS options such as Tank Slayer®, SoClean®, and/or USTDII.

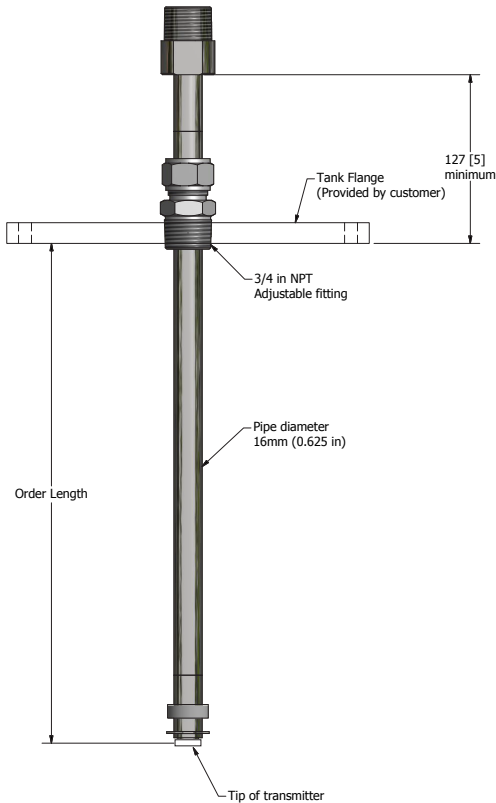


Fig. 5: Outer pipe configuration

### Floats

RefineME® transmitters offer numerous floats for different applications such as stainless steel, 3-A sanitary, Hastelloy, Teflon, and Nitrophyli® 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 ATEX and IECEx approvals, RefineME® 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-metallic floats with a projected surface area of less than 5,000 mm<sup>2</sup> 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 and 251120 should not be used in a hazardous area application.

### Internal electronics

All transmitters come with two electronic components of a sensing element and a board set. Rigid sensing elements are standard on RefineME®. Flexible sensing elements may be ordered on request. The board set consists of up to three electronic boards and a display. The display is capable of displaying the product level, interface level, and temperature. Designed into the display are five buttons for local setup of level transmitter using the stylus.

A temperature sensing function is optional with the RefineME® transmitter. The temperature sensing device is a Digital Thermometer mounted inside the transmitter's outer pipe assembly. The RefineME® can be ordered with 1, 5, 12, or 16 temperature points.

### Accessories

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

### 5.2 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  $\pm 1$ mm. 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.

### 5.3 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 Level Plus® 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.

### 5.4 Storage

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



### 5.5 Model number identification (Order code)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
L	P	R																				
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o				p				

a	Sensor model
L P R	RefineME® Level Transmitter

b	Output
M	Modbus
D	DDA
1	1 Loop with HART®
2	2 Loop with HART®

c	Housing type
A	NEMA housing w/cable
B	NEMA housing w/terminal
C	NEMA housing w/connector
D	Single cavity with display
E	Dual cavity with display
L	SS single cavity w/display

d	Electronics mounting
1	Standard

e	Sensor pipe
B	5/8" OD Rigid Pipe

f	Materials of construction (Wetted parts)
1	316L stainless steel
3	Hastelloy C
A	Teflon

**Note:** Contact factory for other materials

g	Process connection type
1	NPT adjustable
2	BSPP adjustable
6	150 lb. welded RF flange
7	300 lb. welded RF flange
8	600 lb. welded RF flange
A	PN16, DIN 2572 welded flange
B	PN40, DIN 2572 welded flange
C	PN64, DIN 2572 welded flange
D	PN100, DIN 2572 welded flange

h	Process connection size
A	3/4 in. (DN20)
D	2 in. (DN50)
E	2 1/2 in. (DN65)
F	3 in. (DN80)
G	4 in. (DN100)
H	5 in. (DN 125)
J	6 in. (DN150)
X	None

i	Number of DT's (Digital Thermometer)
0	None
1	One DT
5	5 DTs
K	Twelve DTs
M	Sixteen DTs

j	DT Placement
F	Evenly spaced per API
C	Custom
X	None

k	Notified body
C	CEC (FMC)
E	ATEX
F	NEC (FM)
I	IEC
X	None

l	Protection method
I	IS
X	No approval

(Continued on next page)

**5.5 Model number identification (Order code) (continued)**

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
L	P	R																			
a	b	c	d	e	f	g	h	i	j	k	l	m	n	o				p			


m	Gas group
A	Group A
B	Group B
C	Group C
D	Group D
1	IIA
2	IIB
3	IIC
X	None

n	Unit of measure
M	Metric - Millimeters
U	US customary - Inches

o	Length (no decimal spaces)
X X X X X	Rigid pipe: 12 to 300 in. (code as 01200 to 30000)
X X X X X	Rigid pipe: 305 to 7620 mm (code as 00305 to 07620)

p	Special
S	Standard Product

**ORDERING NOTE**

 Accessories such as floats, cables, and displays have to be ordered separately. All accessories are shown in the Accessories Catalog (551103).

## 5.6 Specifications (Technical data)

Level Output	
Measured variable	Product level and interface level
Output signal /Protocol	Modbus RTU, DDA, Analog (4-20 mA), HART®
Order length	<b>Rigid Pipe:</b> 305 mm (12 in.) to 7620 mm (300 in.) Δ§
Inherent Accuracy	±1 mm (0.039 in.)
Repeatability	0.001% F.S. or 0.381 mm (0.015 in.) * (any direction)
Temperature Output	
Measured variable	Average and multipoint temperatures (Modbus, DDA) Single point temperature (Analog, HART®)
Temperature accuracy (Modbus, DDA)	±0.2 °C (0.4 °F) range -40 °C (-40 °F) to -20 °C (-4 °F), ±0.1 °C (0.2 °F) range -20 °C (-4 °F) to 70 °C (158 °F), ±0.15 °C (0.3 °F) range 70 °C (158 °F) to 100 °C (212 °F), ±0.5 °C (0.9 °F) range 100 °C (212 °F) to 105 °C (221 °F)
Temperature accuracy (Analog, HART®)	±0.28 °C (0.5 °F) range -40 °C (-40 °F) to 105 °C (221 °F)
Electronics	
Input voltage	10.5 to 28 Vdc
Fail safe	High, Full scale (Modbus, DDA) Low, 3.5 mA default or High, 22.8 mA (Analog, HART®)
Reverse polarity protection	Series diode
EMC	EN 61326-1, EN 61326-2-3, EN 61326-3-2, EN 61000-6-2, EN 61000-6-3, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6, EN 61000-4-8, EN 61000-4-11
Environmental	
Enclosure rating	NEMA Type 4X, IP65
Humidity	0 to 100% relative humidity, non-condensing
Operating temperatures	<b>Electronics:</b> -40 °C (-40 °F) to 71 °C (160 °F) <b>Sensing element:</b> -40 °C (-40 °F) to 125 °C (257 °F) ◇ <b>Temperature element:</b> -40 °C (-40 °F) to 105 °C (221 °F)
Vessel pressure	<b>Rigid Pipe:</b> 2000psi (138 bar) <b>Teflon Pipe:</b> 25psi (1.75 bar)
Materials	<b>Wetted parts:</b> 316L stainless steel, Hastelloy C, Teflon † <b>Non-wetted parts:</b> 316L stainless steel, Epoxy coated aluminum
Field Installation	
Housing dimensions	<b>Single cavity:</b> 145 mm (5.7 in.) W x by 127 mm (5 in.) D x 109 mm (4.3 in.) H <b>Dual cavity:</b> 117 mm (4.6 in.) W x by 127 mm (5 in.) D x 206 mm (8.1 in.) H <b>Stainless steel single cavity:</b> 178 mm (7.1 in.) W x by 135 mm (5.3 in.) D x 153 mm (6 in.) H <b>NEMA Type 4X:</b> 87 mm (3.4 in.) W x by 124 mm (4.9 in.) D x 132 mm (5.2 in.) H
Mounting	
Rigid pipe	¾ in. Adjustable MNPT or BSPP fitting, Flange mount
Wiring	
Connections	4-wire shielded cable or twisted pair 4570 mm (180 in.) integral cable with pigtail
Electrical Connections	
Single and Dual Cavity	¾ in. FNPT conduit opening, M20 for ATEX/IECEx version
NEMA Type 4X	½ in. FNPT conduit opening
Display	
Measured variables	Product level, interface level and temperature

\* Whichever is greater

Δ Contact factory for longer lengths.  
◇ Contact factory for specific temperature ranges.  
† Contact factory for alternative materials.  
§ Order length equals the measurement range plus the inactive zone.

## 6. Installation and mounting

### 6.1 Training

Installation should only be conducted by qualified service personnel according to IEC 60079-14 and local regulations or MTS trained service technicians. MTS offers web based and in person training for installation, commissioning, maintenance, and repair. MTS also offers factory direct services for these same functions. Contact MTS to discuss training or factory direct services before starting.

### 6.2 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 an 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. A stilling well is highly recommended for agitated, turbulent, and/or fast filling tanks.

### 6.3 Tools

- » Channel Lock pliers
- » 5/16" Hex Key (Allen wrench)
- » 3/4" Open End wrench
- » Common head screwdriver

### 6.4 Installation steps

#### Caution:

It is recommended that assembly and mounting of this transmitter should not be done alone. To ensure proper and safe assembly of the RefineME® 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.

1. Consult Section 4.3 before starting.
2. Perform Commissioning Steps 1-10 in Section 8.4.
3. Remove the stop collar and E-ring. With assistance, feed the pipe through the hole of the removed tank flange until the flange is positioned at the top of the pipe. 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 pipe as damage may result.
4. Slide the product float onto the pipe. Slide the interface float (optional) onto the pipe. Install stop collar 3 inches from the bottom of rigid section (see 'Note' below). Install E-ring. Do not drop float(s) or allow them to free fall along the pipe as damage may result.

#### Notes:

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

5. Slide float(s) back down to the stop collar to prevent them from free falling during installation into the tank. Insert the pipe and floats through the tank riser pipe and lower the transmitter/float assembly into the tank until it rests on the bottom.
6. Secure the flange onto the tank riser pipe.
7. Pull the transmitter upward to straighten the pipe. Tighten the adjustable fitting to hold the transmitter in place.
8. Terminate the field wire cables noting proper wire orientation.

### 6.5 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 two typical methods for mounting; threaded flange mounting and welded flange mounting.

#### Threaded flange mounting

In most applications, the RefineME® transmitter can be mounted directly to the tank or flange via a NPT or BSPP 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*.

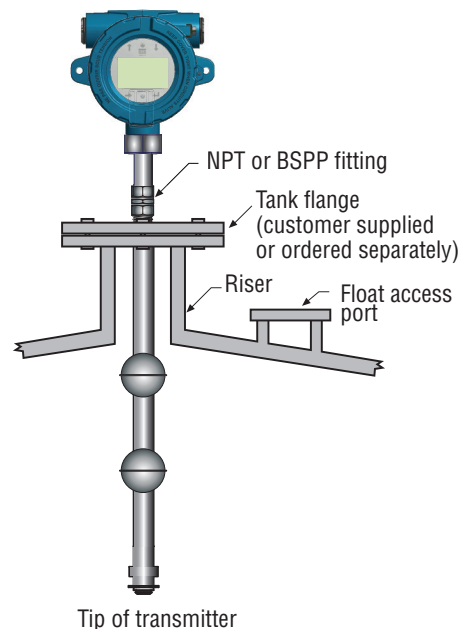


Fig. 6: Threaded flange mounting for industrial pipe

### Welded flange mounting

The RefineME® 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.

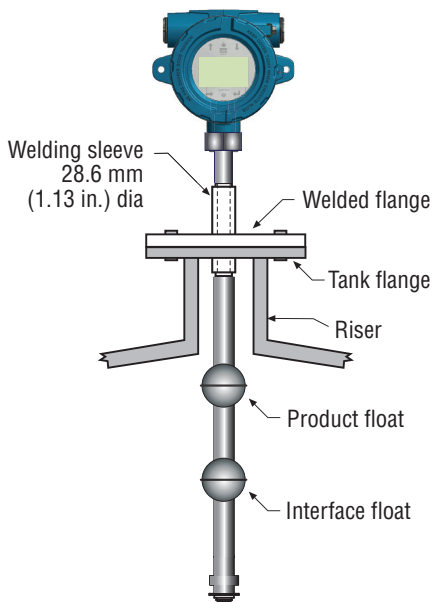


Fig. 7: Welded flange mounting for industrial pipe

## 7. Electrical connections

### 7.1 Basic information

A typical intrinsically safe connection for the Level Plus® RefineME® transmitter includes protective safety barriers, a power supply and a reading or monitoring device. Refer to Agency information in Section 12.

### 7.2 Safety recommendations

#### 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 RefineME® 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.

### 7.3 Industrial topologies

There are four topologies described and illustrated below. However, the daisy chain topology is not recommended by MTS.

#### Point-to-point

The point-to-point topology consists of having only one device on the loop as shown in Figure 8. This topology is not usually used with a bus network since it does not take advantage of placing multiple devices on a loop.

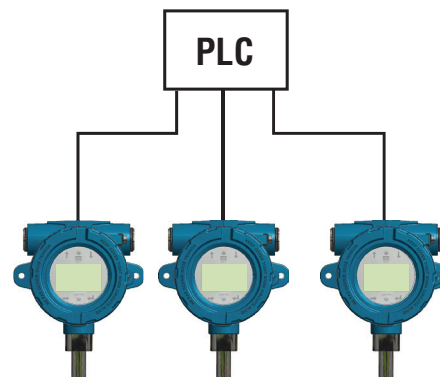


Fig. 8: Point-to-point topology

### Bus with spurs

The bus with spurs topology has a main trunk cable that has each device connected via its own spur at a junction box as shown in Figure 9. The bus with spurs and tree topologies can also be used together to form a hybrid topology.

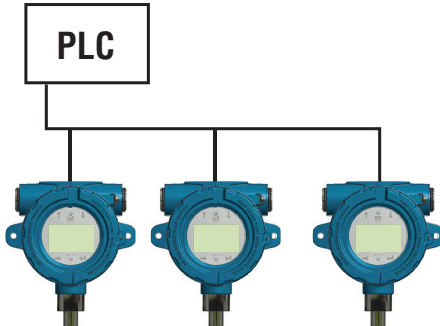


Fig. 9: Bus with spurs topology

### Tree alignment

The tree topology is very similar to the bus with spurs topology with the main difference of having a common junction box for all of the transmitters as shown in Figure 10. Bus with spurs and tree topologies can also be used together to form a hybrid topology.

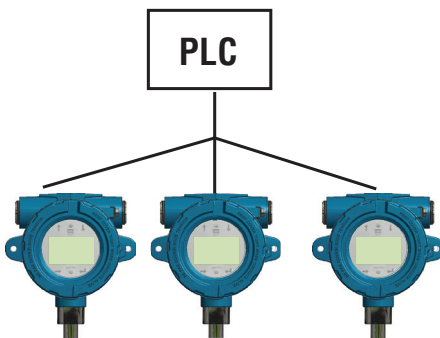


Fig. 10: Tree topology

### Daisy chain

The daisy-chain topology utilizes a single cable that is connected to all of the transmitters with the cable being interconnected at each field device. When using this topology make sure that the wiring practice allows for one transmitter to be disconnected without disconnecting the entire loop as shown in Figure 11. MTS does not suggest using the daisy-chain topology.

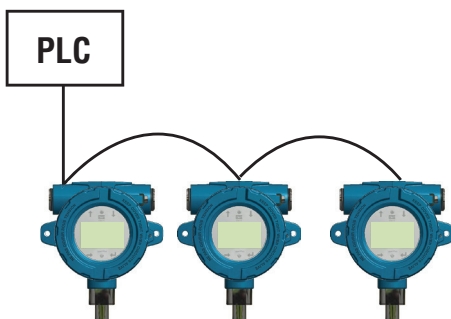


Fig. 11: Daisy-chain topology

## 7.4 Cable recommendations

Refer to 'Table 2' below for general requirements of cable types for the Level Plus® RefineME® transmitter.

### Cable specifications

Parameter	Specification
Minimum cable size	24 to 14 AWG (0.51 to 1.6 mm diameter)
Cable type	Single pair shielded or multiple pair with overall shield; minimum 0.010 in. (0.25 mm) insulation thickness
Capacitance	Less than 30 pF/ft (98 pF/m)

Table 2: Cable specification and parameters

## 7.5 Electrical conduit

### Notes:

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

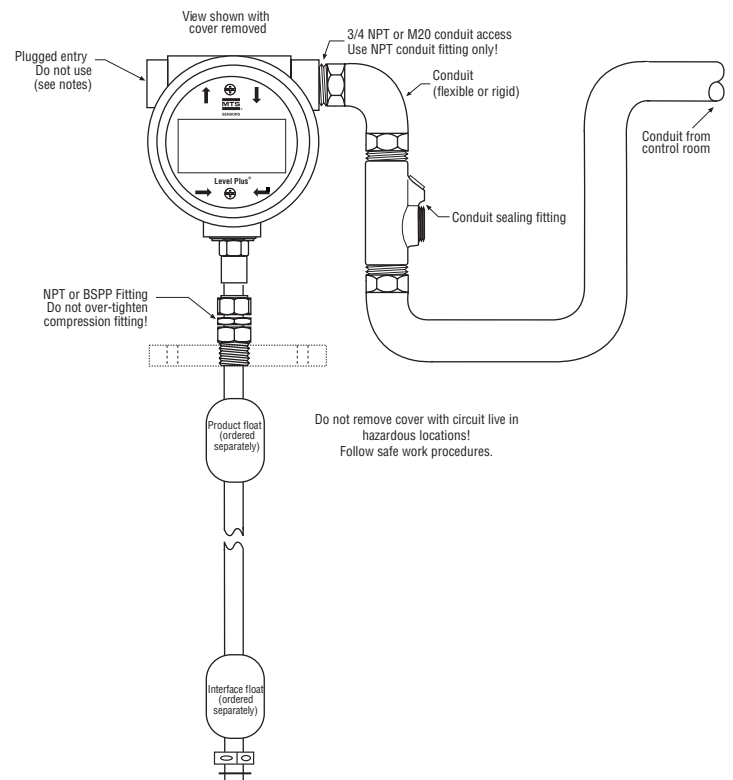


Fig. 12: Electrical conduit installation

## 7.6 Grounding

### 7.6.1 Safety grounding

**Warning:**

Grounding the transmitter through a threaded conduit connection does not meet the requirements as a grounding of the sensor for safety.

There are two methods to provide an earth ground to the earth ground of the electronics. Either method must result in a resistance of less than 1 Ohm. Refer to 'Table 3' 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.

### 7.6.2 Shield grounding

**Warning:**

The shield ground does not meet the requirements as grounding of the sensor for Safety.

Immunity performance of the sensor from external sources of surge, burst, RF, radiated emissions and other noise is dependent on a proper ground for the shield of the communications cable. The communications cable shield should be of a braided type and connected to the internal ground lug of the sensor housing.

#### Runs in a continuous metallic conduit

When installed inside a dedicated continuous metallic conduit, the conduit provides a level of shielding protection from external interference and a level of ground to the sensor housing. In this case a foil type shielded cable with a drain wire connected to the internal ground lug may be sufficient.

Sharing of the metallic conduit with other cables will result in loss of effective shielding performance of the communication cable and possible degradation in performance of the sensor. In this case a braided type shielded cable connected to the sensor internal ground lug would be recommended.

In all cases paralleling the communications cable with any noise generating cable inside of a conduit or with noise generating cables in close proximity to the conduit may degrade the performance of the sensor

#### Runs without a conduit

In some rare applications, or where safety may not be required, a metallic conduit may not exist. The communications cable shield should be of a braided type and connected to the internal ground lug of the sensor housing.

Alternatively a safety approved EMC Cable Gland can be used for grounding the shield. Contact MTS for information before using one of these cable glands.

#### NEC

Undesirable currents (ground loops) is a violation of the NEC and is a safety hazard.

## 7.7 Safety barriers

Refer to Table 3 for entity parameters and Table 4 for example safety barriers

Entity parameters	
Digital supply (1 per LT)	Ui = 28 Vdc
	Ii = 100 mA
	Ci = 0.0 µF
	Li = 0 mH
	Pi = 700 mW
Digital communication (2 per LT)	Ui = 8.6 Vdc
	Ii = 10 mA
	Ci = 0.0 µF
	Li = 0.0 mH
	Pi = 21.5 mW
Analog (1 per loop)	Ui = 28 Vdc
	Ii = 120 mA
	Ci = 0 µF
	Li = 5 µH
	Pi = 840 mW

Table 3: Safety barrier entity parameter references

Supplier	STAHL	STAHL	STAHL
Type	9001/01-280-100-101	9001/51-280-110-141	9001/01-086-010-101
Maximum voltage	28 Vdc	28 Vdc	8.6 Vdc
Maximum current (each channel)	100 mA	110 mA	10 mA
Maximum power (each channel)	700 mW	770 mW	21.5 mW
Number of channels	1	1	1
Interface	Modbus/DDA	HART®	Modbus/DDA

Table 4: Safety barrier entity parameter references

## 8. Commissioning

### 8.1 Training

Commissioning should only be conducted by qualified service personnel according to IEC 60079-14 or MTS trained service technicians and local regulations. MTS offers web based and in person training for installation, commissioning, maintenance, and repair. MTS also offers factory direct services for these same functions. Contact MTS to discuss training or factory direct services before starting.

### 8.2 Tools

- » Channel Lock pliers
- » 5/16" Hex Key (Allen wrench)
- » 3/4" Open End wrench
- » RS485 to USB Converter (MTS Part # 380114)[Modbus and DDA]
- » PC
- » Linear Regulated Power Supply
- » MTS Setup Software
- » HART® to USB Converter (MTS Part # 380068)[HART®]

### 8.3 Setup software

MTS offers Setup Software that is shipped with the level transmitter and is also available for download from [www.mtssensors.com](http://www.mtssensors.com). The Setup Software is to be used for installation, commissioning, and troubleshooting. For further details on how to use the setup software consult the Modbus Interface Manual (MTS Part# 551700), the DDA Interface Manual (MTS Part# 551701), and HART® Interface Manual (MTS Part# 551702).

### 8.4 Commissioning steps

#### Note:

For Additional details consult the protocol specific Modbus Interface Manual (MTS Part #551700), DDA Interface Manual (MTS Part #551701), and HART® Interface Manual (MTS Part #551702).

#### 8.4.1 Modbus or DDA

1. Consult Section 4.3 before starting
2. Remove level transmitter from shipping container.
3. Remove stop collar.
4. Insert pipe into float(s) making sure float(s) are in the active range. Install product float first.
5. Connect power, RS485 to USB converter, and PC.
6. Open MTS Setup Software.
7. Establish Communication.
8. For DDA Interface – Set Address.
9. For Modbus Interface – Set Address, Enter Strap Table, Setup Volume Correction Method.
10. Disconnect Power and Communication. Remove floats. Prepare level transmitter for transport to the top of the tank.
11. Complete Installation in Section 6.4.
12. Have qualified technician perform hand measurement. Enter hand measurement into MTS Setup Software and calibrate.
13. Store all settings as backup file according to site name and tank number.

#### 8.4.2 HART®

1. Consult Section 4.3 before starting
2. Remove level transmitter from shipping container.
3. Remove e-ring and stop collar.
4. Insert pipe into float(s) making sure float(s) are in the active range.
5. Connect power, HART® to USB converter, and PC
6. Open MTS Setup Software.
7. Establish Communication.
8. Set/Update 4 and 20 mA setpoints
9. Disconnect Power and Communication. Remove floats. Prepare flexible level transmitter for transport to the top of the tank.
10. Complete Installation in Section 6.4.
11. Have qualified technician perform hand measurement. Enter hand measurement into MTS Setup Software and calibrate.

## 9. Maintenance

### 9.1 Training

Maintenance should only be conducted by qualified service personnel according to IEC 60079-14 and local regulations or MTS trained service technicians. MTS offers web based and in person training for installation, commissioning, maintenance, and repair. MTS also offers factory direct services for these same functions. Contact MTS to discuss training or factory direct services before starting.

### 9.2 Tools

- » Channel Lock pliers
- » 5/16" Hex Key (Allen wrench)
- » 3/4" Open End wrench
- » RS485 to USB Converter (MTS Part # 380114)[Modbus and DDA]
- » PC
- » Linear Regulated Power Supply
- » HART® to USB Converter (MTS Part # 380068)[HART®]

### 9.3 Inspection

Below are some standard items that should be inspected on a regular basis to make sure that the level transmitter and surrounding environment are in operating condition.

- » Hazardous Area Label is present and legible
- » Hazardous Area approval is correct for installation
- » There are no visible unauthorized modifications
- » Electrical connections are tight
- » Condition of enclosure O-ring is satisfactory
- » No water ingress (white powder)
- » No obvious damage to cable
- » Sealing of conduit or cable gland is satisfactory
- » Earth ground is satisfactory
- » Single or Dual Cavity Enclosure threads are not damaged
- » Housing o-ring is not damaged or cracked
- » No corrosion on visible parts
- » Printed circuit boards are clean and undamaged



## 9.4 Preventative maintenance

Level Plus® level transmitters do not typically require preventative maintenance but may require preventative maintenance dependent on the application. For general purpose applications where there is no potential for buildup on the pipe and/or float there is no need for preventative maintenance but routine inspection is still suggested. For severe service applications where there is potential for buildup on the pipe and/or float then preventative maintenance is required.

### 9.4.1 General purpose applications

#### 9.4.1.1

Perform Inspection suggested in section 9.3

#### 9.4.1.2

No additional preventative maintenance is necessary. Preventative maintenance suggested for Severe Service Applications may be performed.

### 9.4.2 Severe Service Applications

#### 9.4.2.1

Perform Inspection suggested in section 9.3

#### 9.4.2.2

Disconnect Power.

#### 9.4.2.3

Disconnect process connection from tank. Remove pipe from tank.

#### Note:

It is best to clean the pipe as it is removed from the tank to minimize the amount of product that is removed from the tank. The user should take caution and abide by all regulations so that product is not spilled and the environment is not contaminated.

#### 9.4.2.4

When the bottom of the pipe is reached inspect the floats.

#### 9.4.2.4.1

If the floats are highly contaminated then remove the assembly from the tank and remove the floats from the pipe.

#### 9.4.2.4.2

If the floats are slightly contaminated then clean the floats without removing the floats from the pipe.

#### 9.4.2.5

Replace pipe and floats in tank.

#### 9.4.2.6

Connect process connection to tank.

#### 9.4.2.7

Connect Power.

#### 9.4.2.8

The process should be carried out regularly until a consistent pattern has been established as to how long the intervals between cleanings should be.

## 10. Repair

### 10.1 RMA policy

#### 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 Level Plus® 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.

### 10.2 Training

Repair should only be conducted by qualified service personnel according to IEC 60079-14 and local regulations or MTS trained service technicians. MTS offers web based and in person training for installation, commissioning, maintenance, and repair. MTS also offers factory direct services for these same functions. Contact MTS to discuss training or factory direct services before starting.

### 10.3 Tools

- » Channel Lock pliers
- » 5/16" Hex Key (Allen wrench)
- » 3/4" Open End wrench
- » Phillips head screwdriver
- » Common head screwdriver
- » RS485 to USB Converter (MTS Part # 380114)[Modbus and DDA]
- » PC
- » Linear Regulated Power Supply
- » HART® to USB Converter (MTS Part # 380068)[HART®]

## 10.4 Troubleshooting

Symptom	Possible cause	Action
No communication with transmitter	No power	Check voltage at transmitter
	Wiring incorrect	Reference installation drawing section 12
	Wrong address	DDA factory default is '192' Modbus factory default is '247'
	Wrong software	Confirm correct software
	Wrong protocol	Confirm software and transmitter are same protocol
Missing magnet error or Alarm output	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.
Trigger level error	Gain needs to be adjusted	Consult Factory
	SE is damaged	Consult Factory
	Min. trigger level too high	Consult Factory
Volume calculation error	No strap table entered	Enter strap table
	Level outside range of strap table	Enter additional points in strap table
	Strap table incorrect	Check value entries
VCF error	No VCF table entered	Enter VCF table
	VCF table incorrect	Check VCF value entries

Table 5: Troubleshooting reference

## 10.5 Setup software

MTS offers Setup Software that is shipped with the level transmitter and is also available for download from [www.mtssensors.com](http://www.mtssensors.com). The Setup Software is to be used for installation, commissioning, and troubleshooting. For further details on how to use the setup software consult the Modbus Interface Manual (MTS Part# 551700), the DDA Interface Manual (MTS Part# 551701), and HART® Interface Manual MTS Part# 551702).

## 11. Interface

RefineME® is available with multiple outputs including Modbus, DDA, and HART®. This Operation and Installation Manual includes all of these outputs. Each output has its own specialized Interface Manual that should be consulted for additional information on the specific output.

### 11.1 Modbus

MTS offers Modbus RTU over a RS485 half-duplex network. For additional information consult Interface Manual Modbus, MTS Part# 551700.

### 11.2 DDA

MTS offers DDA (Direct Digital Access) over a RS485 half-duplex network. For additional information consult Interface Manual DDA, MTS Part# 551701.

### 11.3 HART®

MTS offers HART® over a 4 to 20 mA signal. For additional information consult HART® Interface Manual, MTS Part# 551702.

## 12. Agency information

### 12.1 Approvals overview

The Notified Body is designated in the 13th digit of the model number and the Protection Method is designated in the 14th digit of the model number. These two digits of the model number specify the hazardous area approval that provided with the selected level transmitter.

Notified body	Protection method	Classifications	Standard
C = CEC	I = Intrinsic Safety	Class I, Division 1, Groups A, B, C, D Class I, Zone 0/1, Ex ia IIC T4 Ta = -50 °C to 71 °C	CSA C22.2 No. 1010.1 2004, CSA C22.2 No. 157-92 (2012), CSA C22.2 No. 60079-0:2011, CSA C22.2 No. 60079-11:2014 CSA C22.2 No. 60529: 2005
E = ATEX	I = Intrinsic Safety	Ex II 1/2 G Ex ia IIC T4 Ta = -50 °C to 71 °C	EN 60079-0:2012 EN 60079-11:2012
F = NEC	I = Intrinsic Safety	Class I, Division 1, Groups A, B, C, D Class I, Zone 0/1, AEx ia IIC T4 Ta = -50 °C to 71 °C	FM 3600:2011 FM 3610:2010 FM 3810: 2005 ANSI/ISA 60079-0:2013, ANSI/ISA 60079-11:2014, ANSI/ISA 60529-:2004
I = IEC	I = Intrinsic Safety	Ex ia IIC T4 Ga/Gb Ta = -50 °C to 71 °C	IEC 60079-0:2011 IEC 60079-11:2011

### 12.2 Certificates

Downloadable copies of all certificates are located at [www.mtssensors.com](http://www.mtssensors.com) and can be downloaded on the product specific landing page. If there is any difficulty in obtaining the certificates from the web contact MTS Technical Support and they will be sent electronically.

### 12.3 FM (NEC)

#### 12.3.1 Special Conditions of Safe Use

1. The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction. ( When installed in a Ga Approval)
2. The maximum permitted ambient temperature of the Level Plus Digital/Analog Level Transmitter is 71 °C. To avoid the effects of process temperature and other thermal effects care shall be taken to ensure the surrounding ambient and the ambient inside the transmitter housing does not exceed 71°C
3. Some models contain non-metallic enclosure parts, to prevent the risk of electrostatic sparking the nonmetallic surface should only be cleaned with a damp cloth.

### 12.3.2 Labels

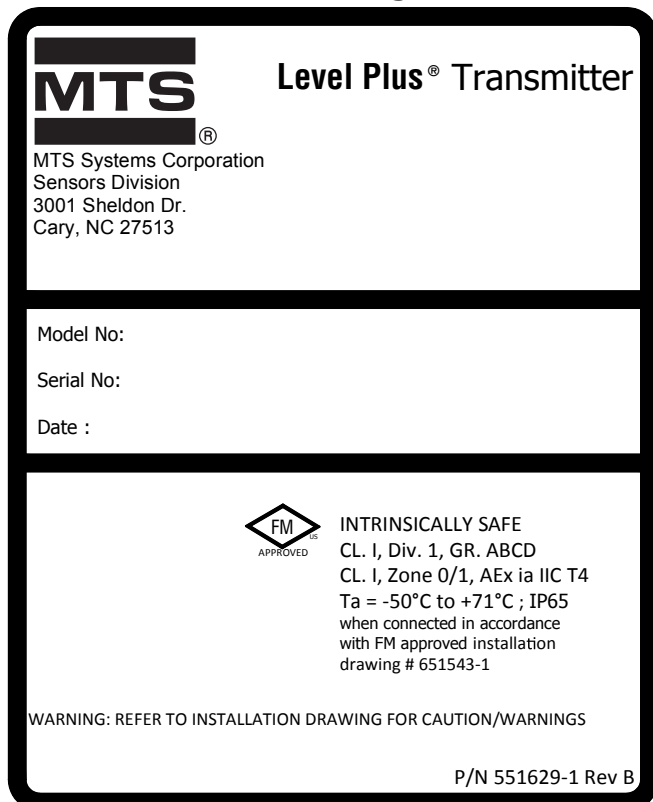


Fig. 13: FM label, Modbus or DDA

### 12.3.2 Labels (cont'd.)

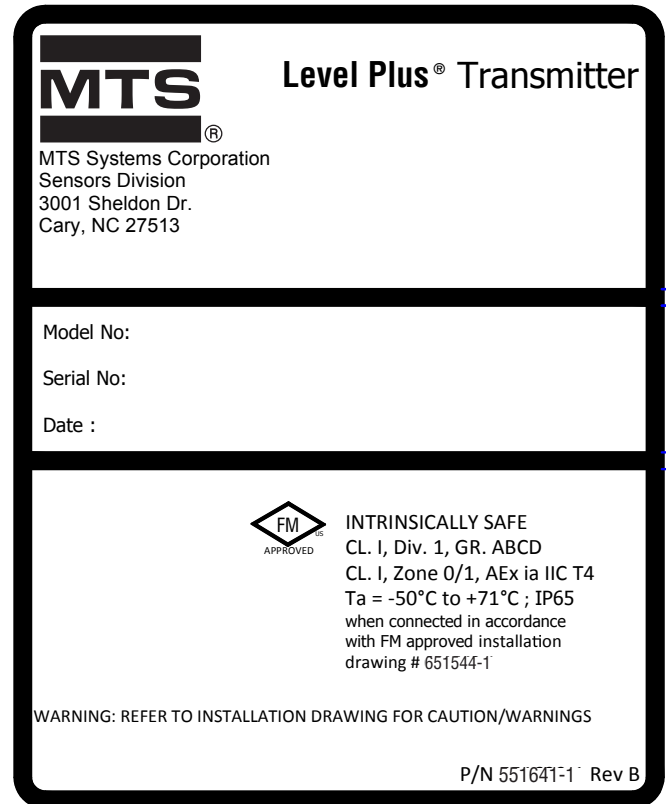


Fig. 14: FM label, HART®

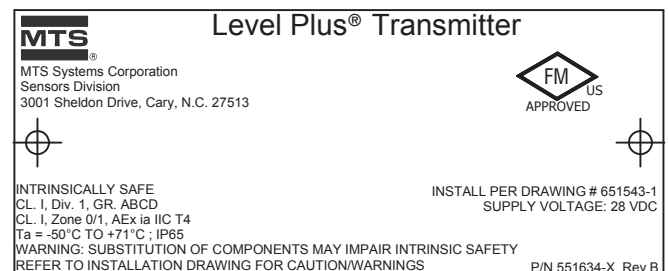


Fig. 15: FM label, Modbus or DDA

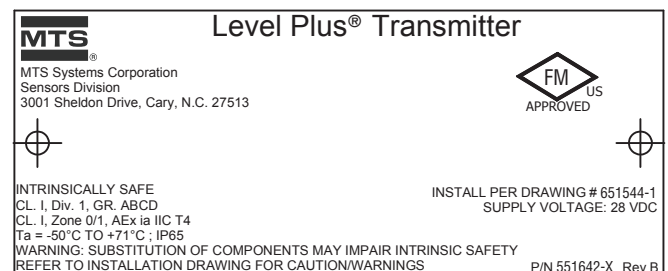


Fig. 16: FM label, HART®

12.3.3 Installation drawing

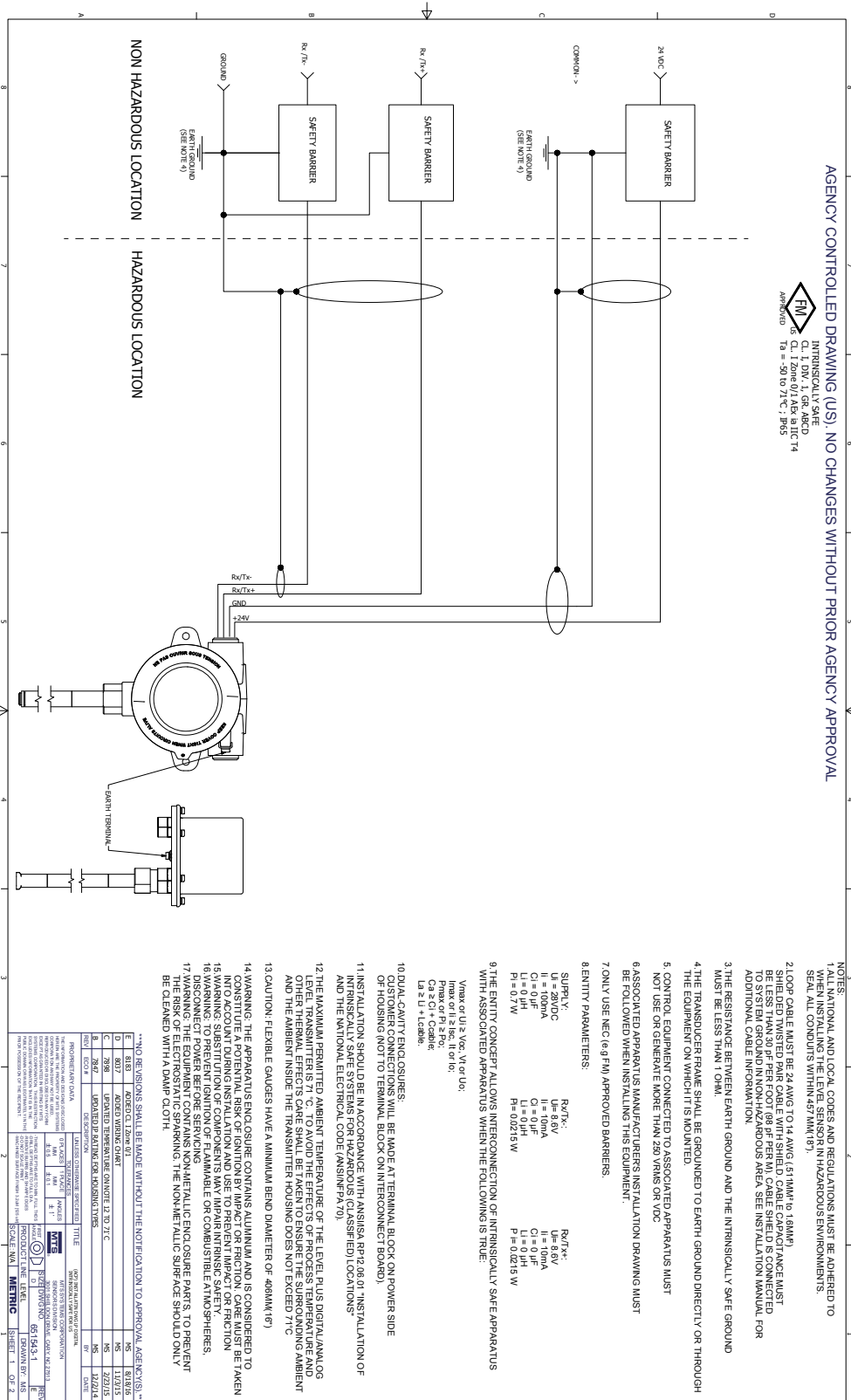


Fig. 17: FM installation drawing, Modbus and DDA

12.3.3 Installation drawing (cont.)

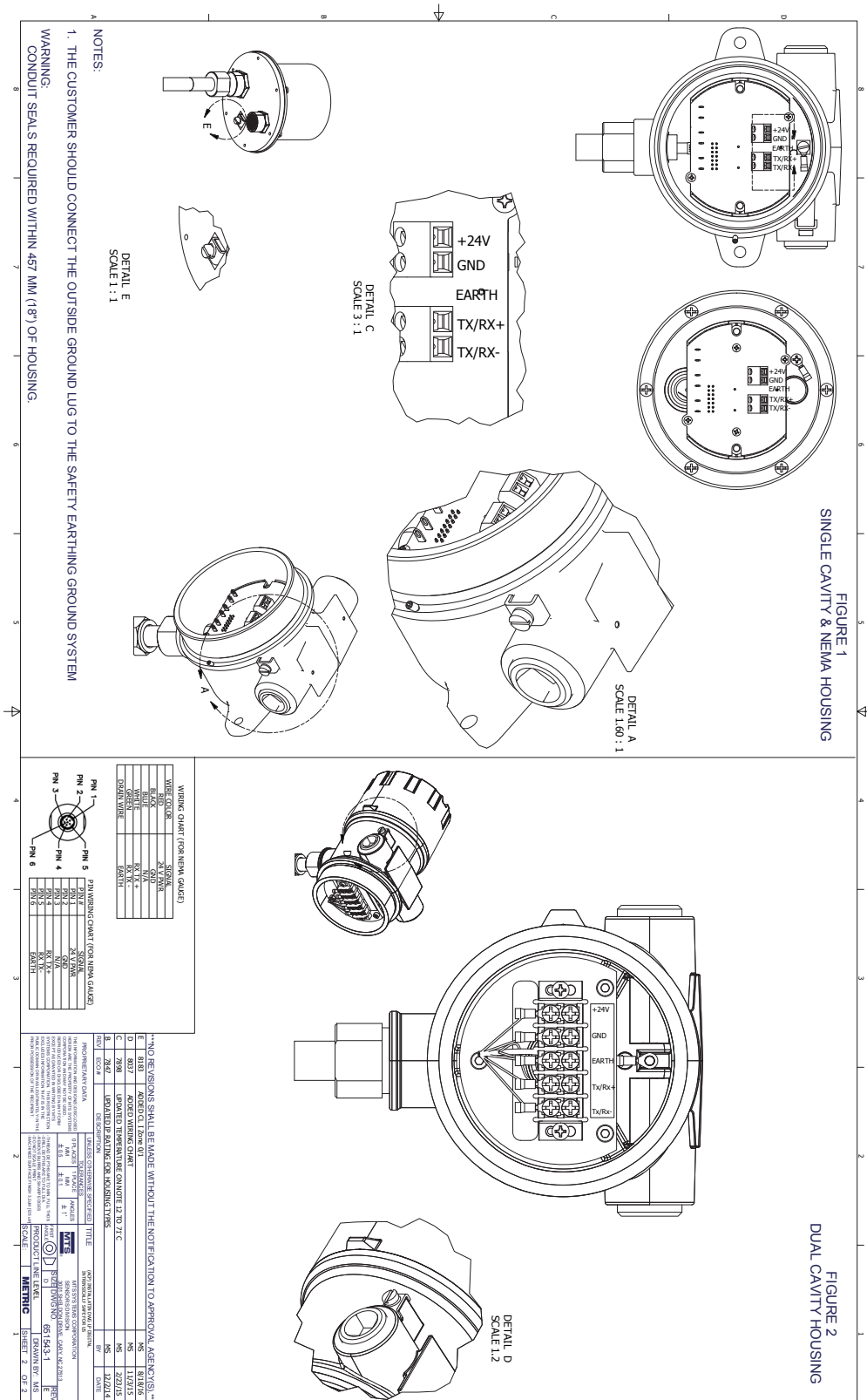


Fig. 18: FM installation drawing, Modbus and DDA

12.3.3 Installation drawing (cont.)

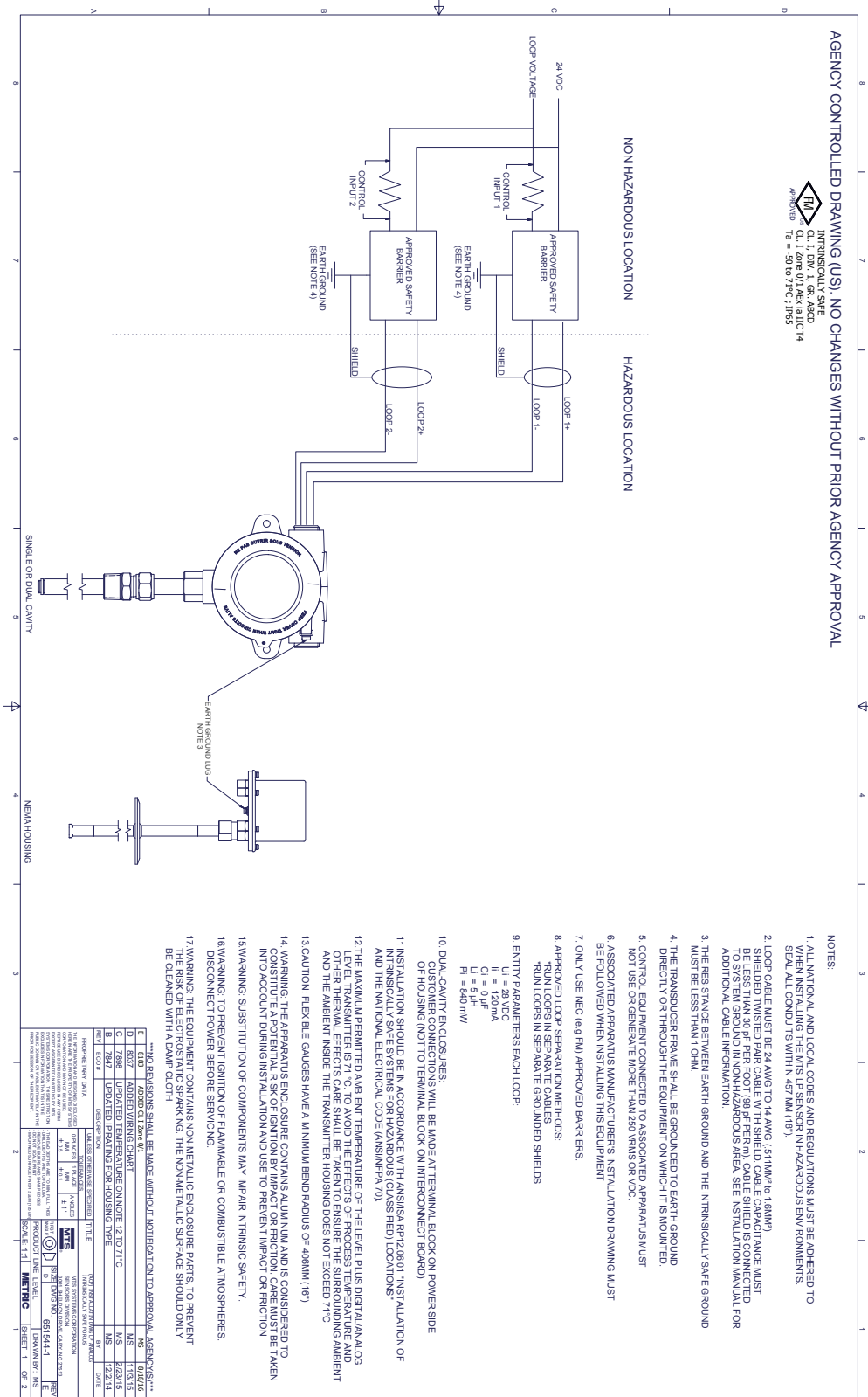


Fig. 19: FM installation drawing, HART®

12.3.3 Installation drawing (cont.)

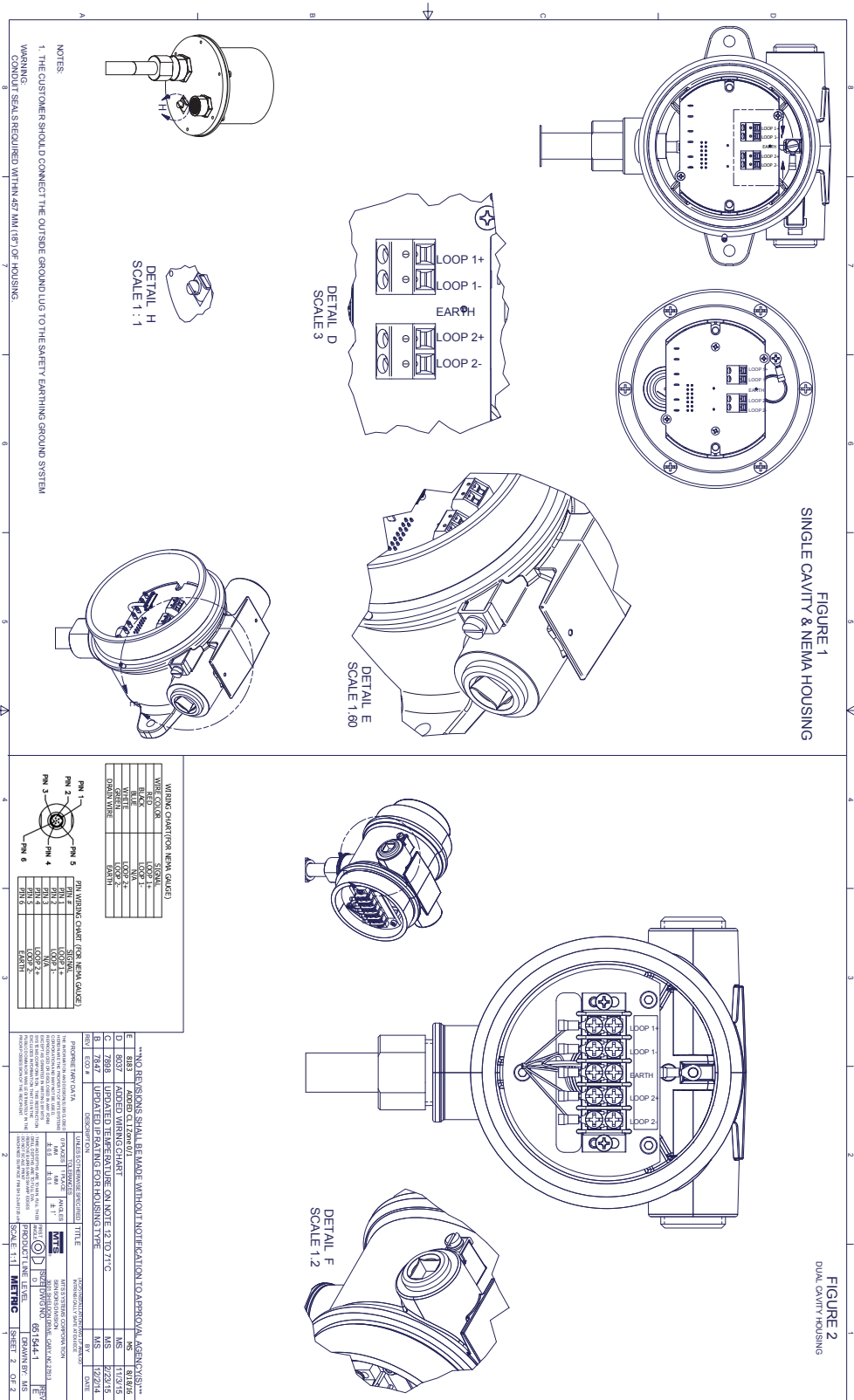


Fig. 20: FM installation drawing, HART®

12.4 FMC (CEC)

12.4.1 Special conditions of safe use

1. The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction. ( When installed in a Ga Approval)
2. The maximum permitted ambient temperature of the Level Plus® Digital/Analog Level Transmitter is 71 °C. To avoid the effects of process temperature and other thermal effects care shall be taken to ensure the surrounding ambient and the ambient inside the transmitter housing does not exceed 71°C
3. Some models contain non-metallic enclosure parts, to prevent the risk of electrostatic sparking the nonmetallic surface should only be cleaned with a damp cloth.

12.4.2 Labels

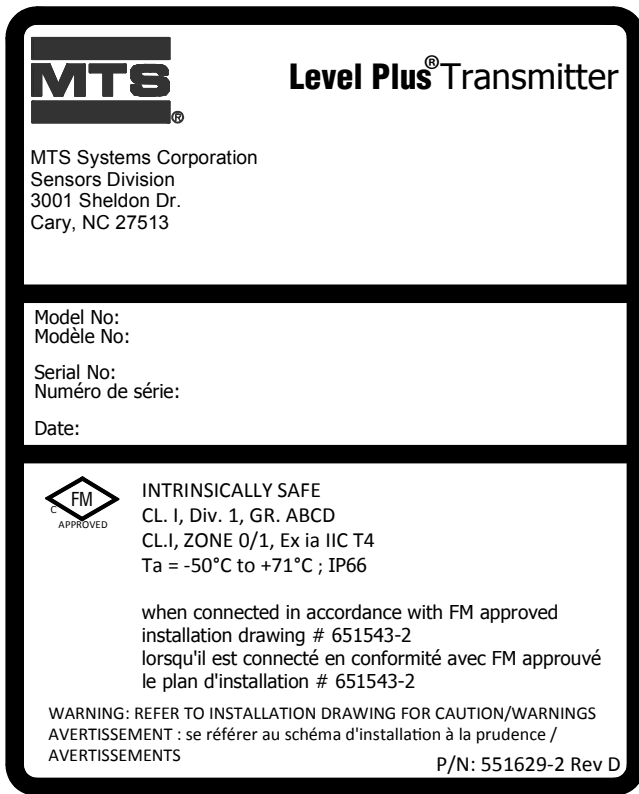


Fig. 22: FMC label, Modbus and DDA

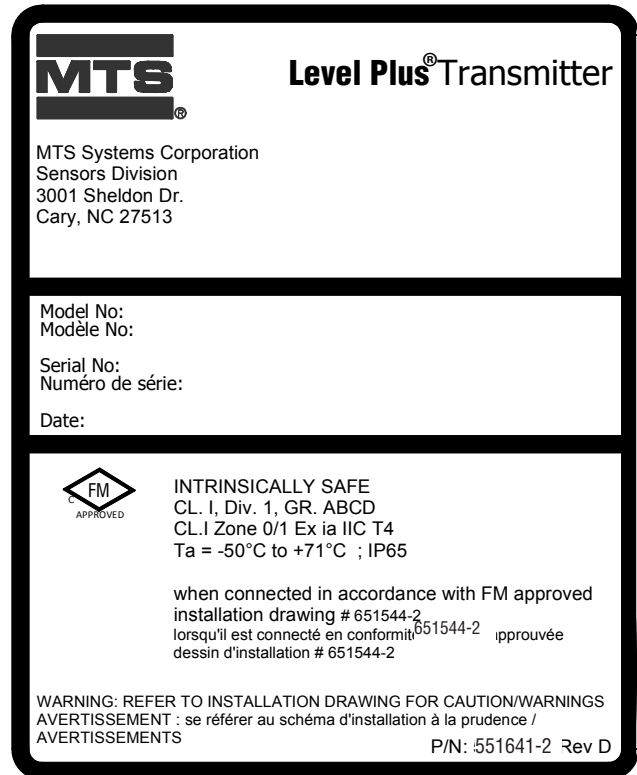


Fig. 23: FMC label, HART®



Fig. 24: FMC label, Modbus and DDA

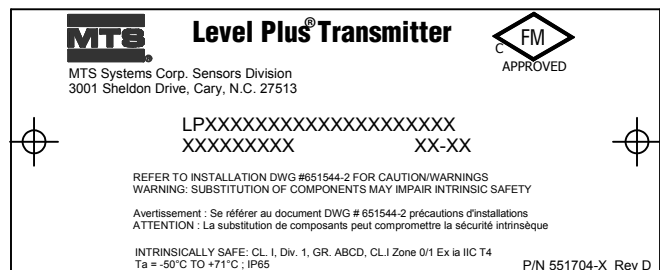


Fig. 25: FMC label, HART®



12.4.3 Installation drawing

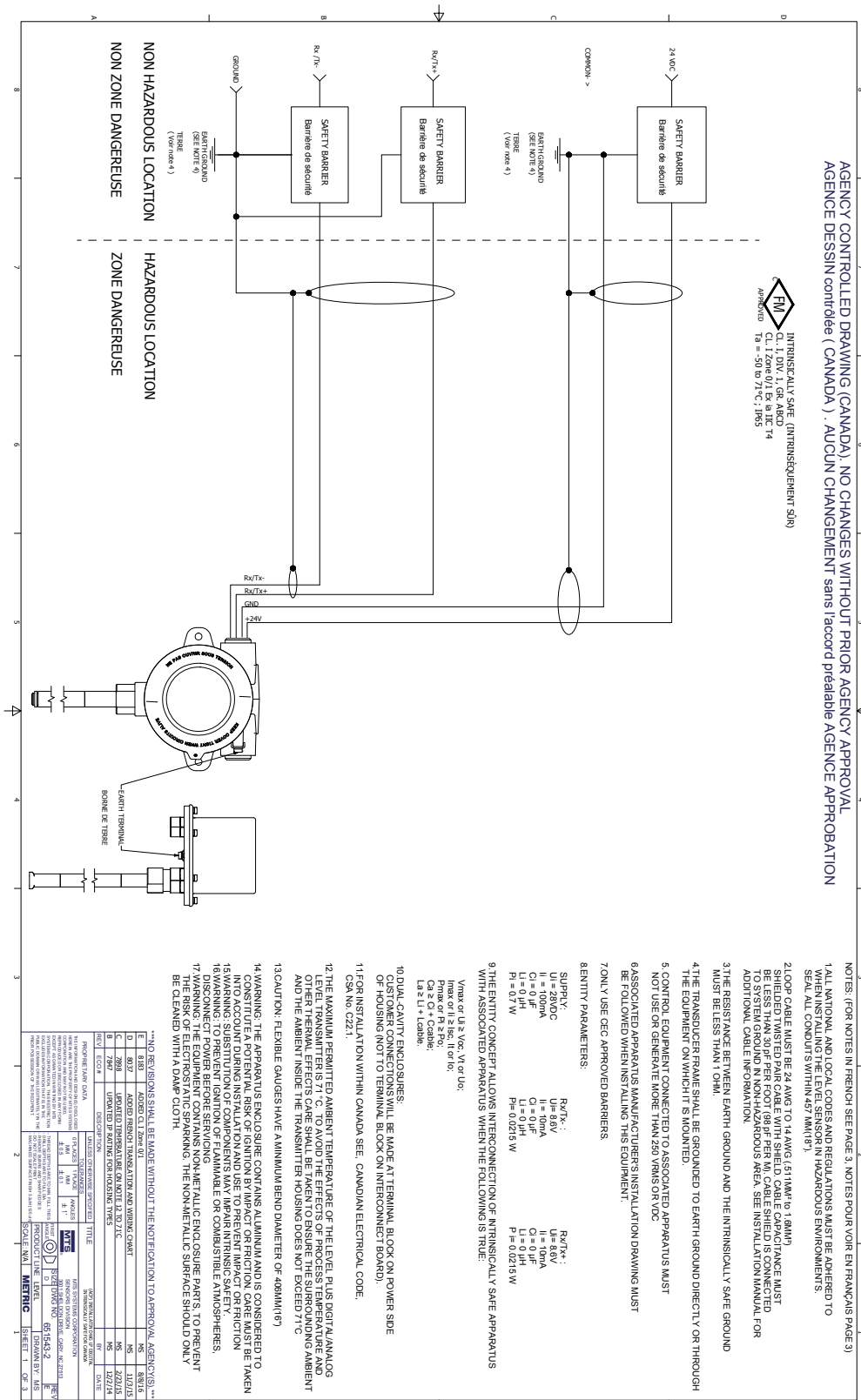


Fig. 24: FMC installation drawing, Modbus and DDA



12.4.3 Installation drawing (cont.)

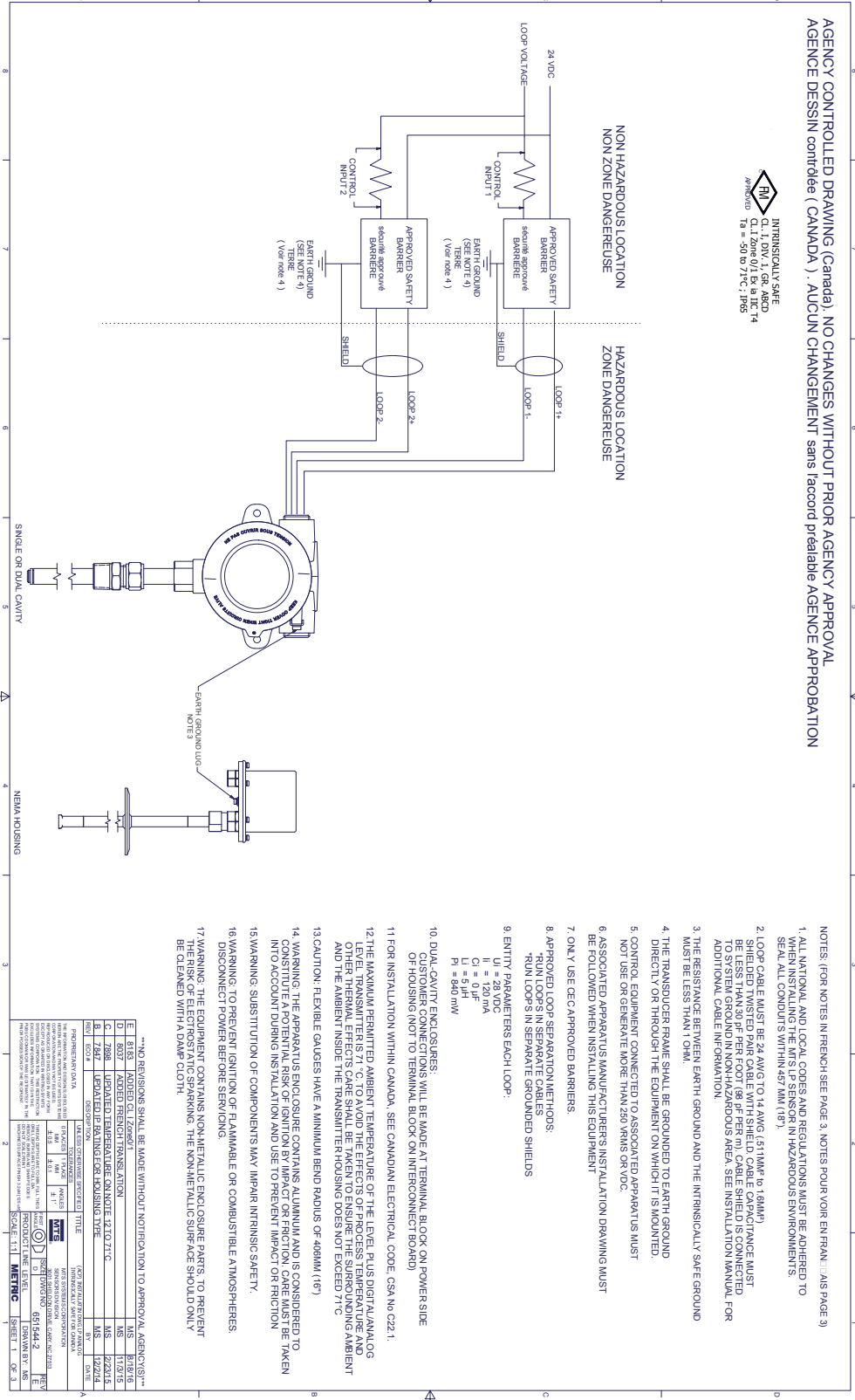


Fig. 27: FMC installation drawing, HART®

12.4.3 Installation drawing (cont.)

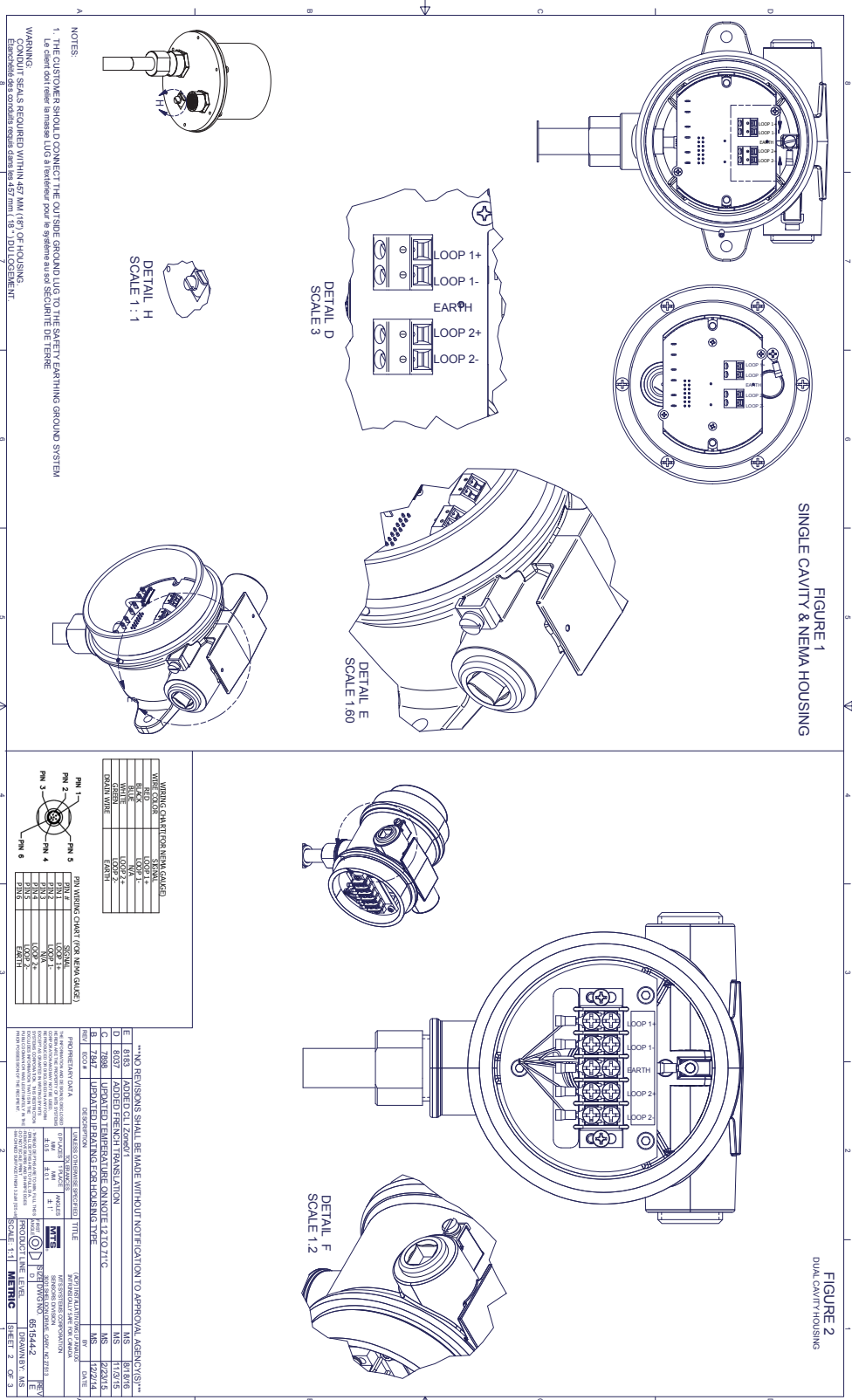


Fig. 28: FMC installation drawing, HART®

## 12.5 ATEX and IECEx

### 12.5.1 Special conditions of safe use

1. The apparatus enclosure contains aluminum and is considered to constitute a potential risk of ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction. ( When installed in a Ga Approval)
2. The maximum permitted ambient temperature of the Level Plus® Digital/Analog Level Transmitter is 71 °C. To avoid the effects of process temperature and other thermal effects care shall be taken to ensure the surrounding ambient and the ambient inside the transmitter housing does not exceed 71°C
3. Some models contain non-metallic enclosure parts, to prevent the risk of electrostatic sparking the nonmetallic surface should only be cleaned with a damp cloth.

### 12.5.2 Labels

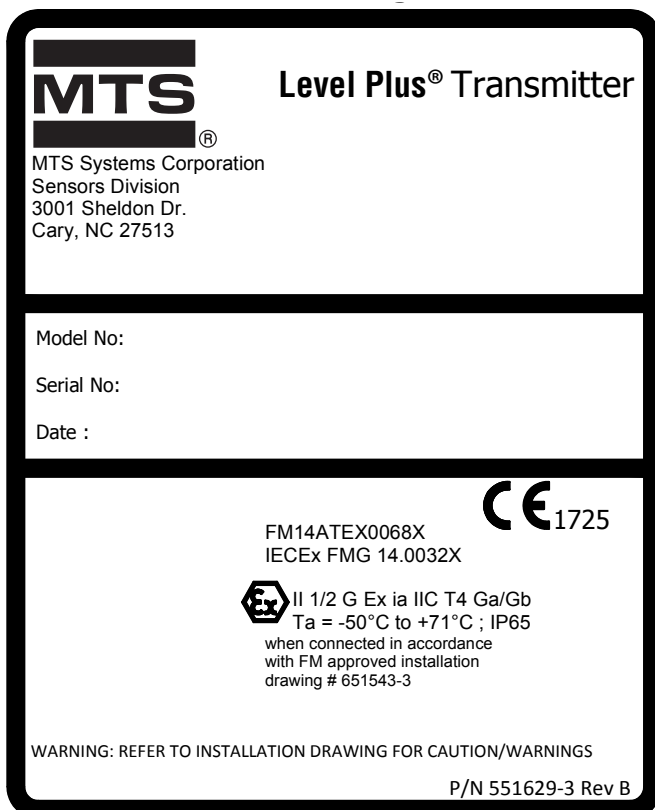


Fig. 29: ATEX/IECEx label, Modbus and DDA

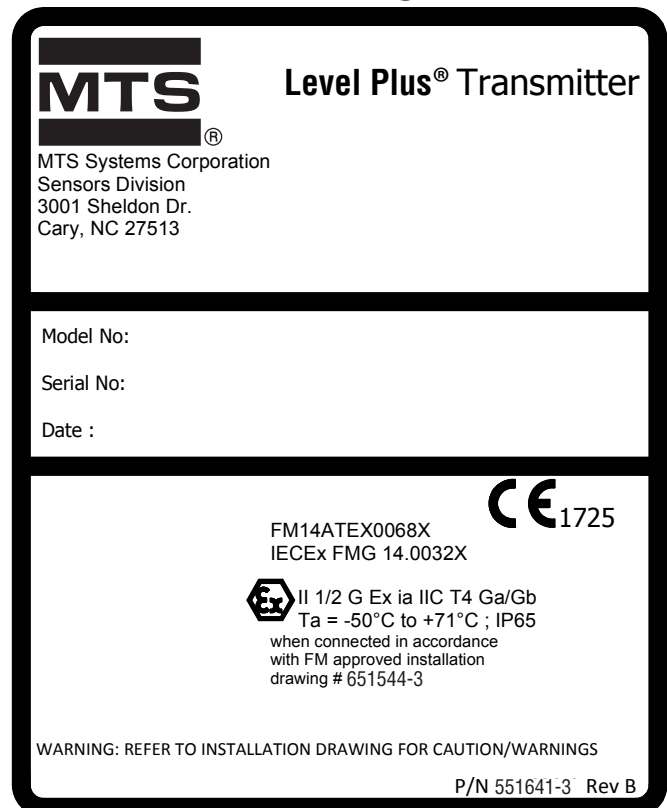


Fig. 30: ATEX/IECEx label, HART®



Fig. 31: ATEX/IECEx label, Modbus and DDA



Fig. 32: ATEX/IECEx label, HART®

12.5.3 Installation drawing

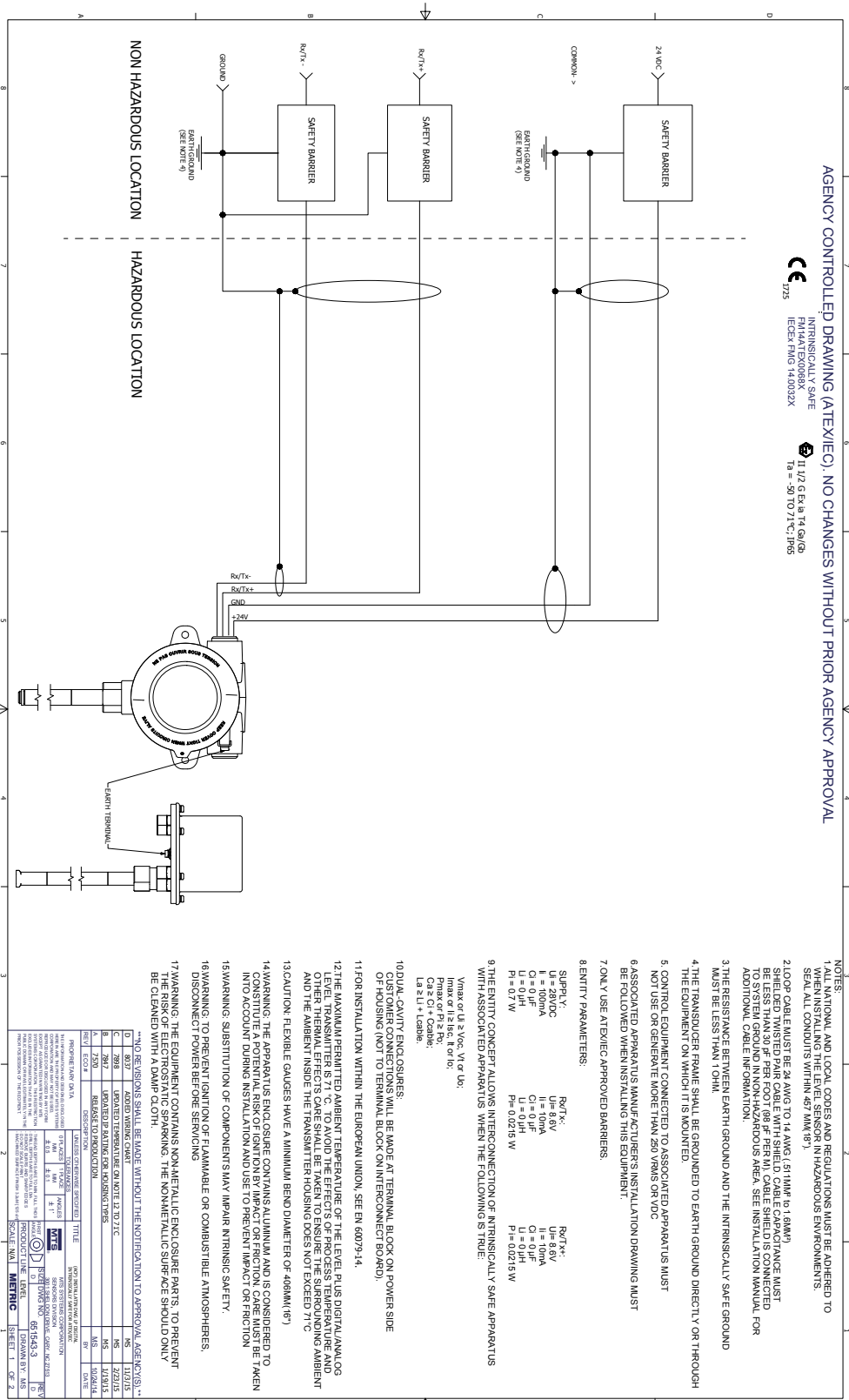


Fig. 33: ATEX / IECEx installation drawing, Modbus and DDA

12.5.3 Installation drawing (cont.)

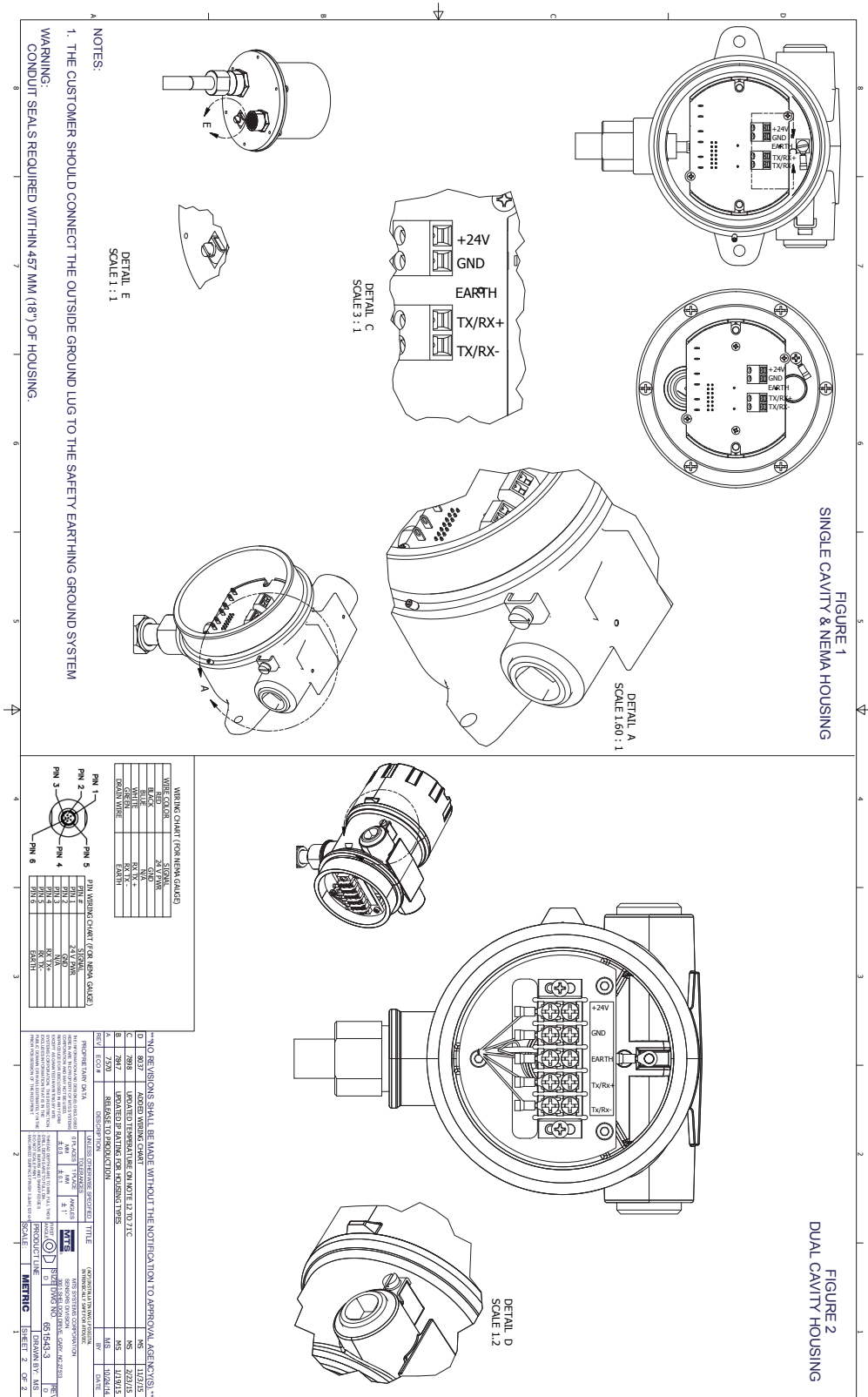


Fig. 34: ATEX / IECEx installation drawing, Modbus and DDA

12.5.3 Installation drawing (cont.)

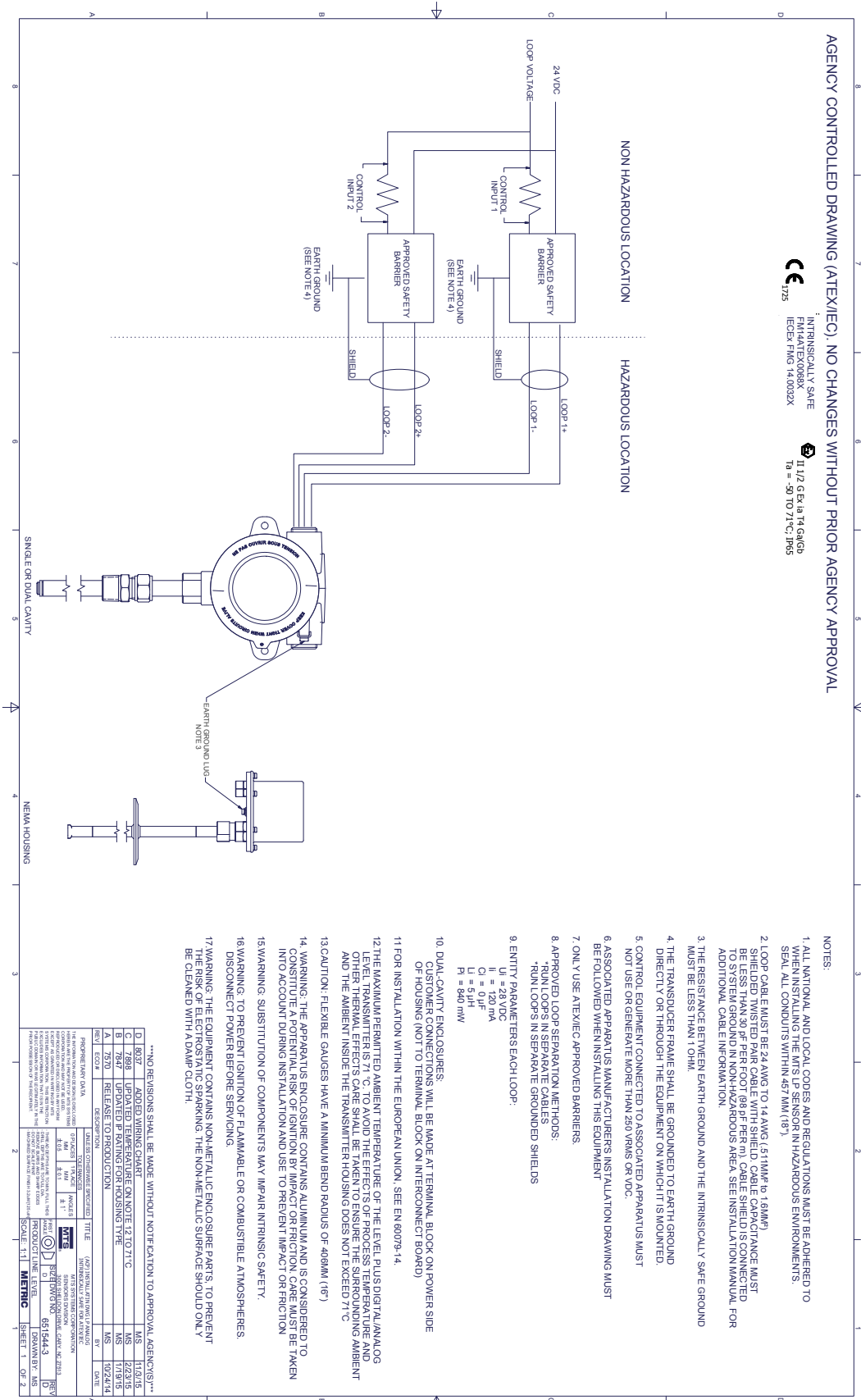


Fig. 35: ATEX / IECEx installation drawing, HART®



12.5.3 Installation drawing (cont.)

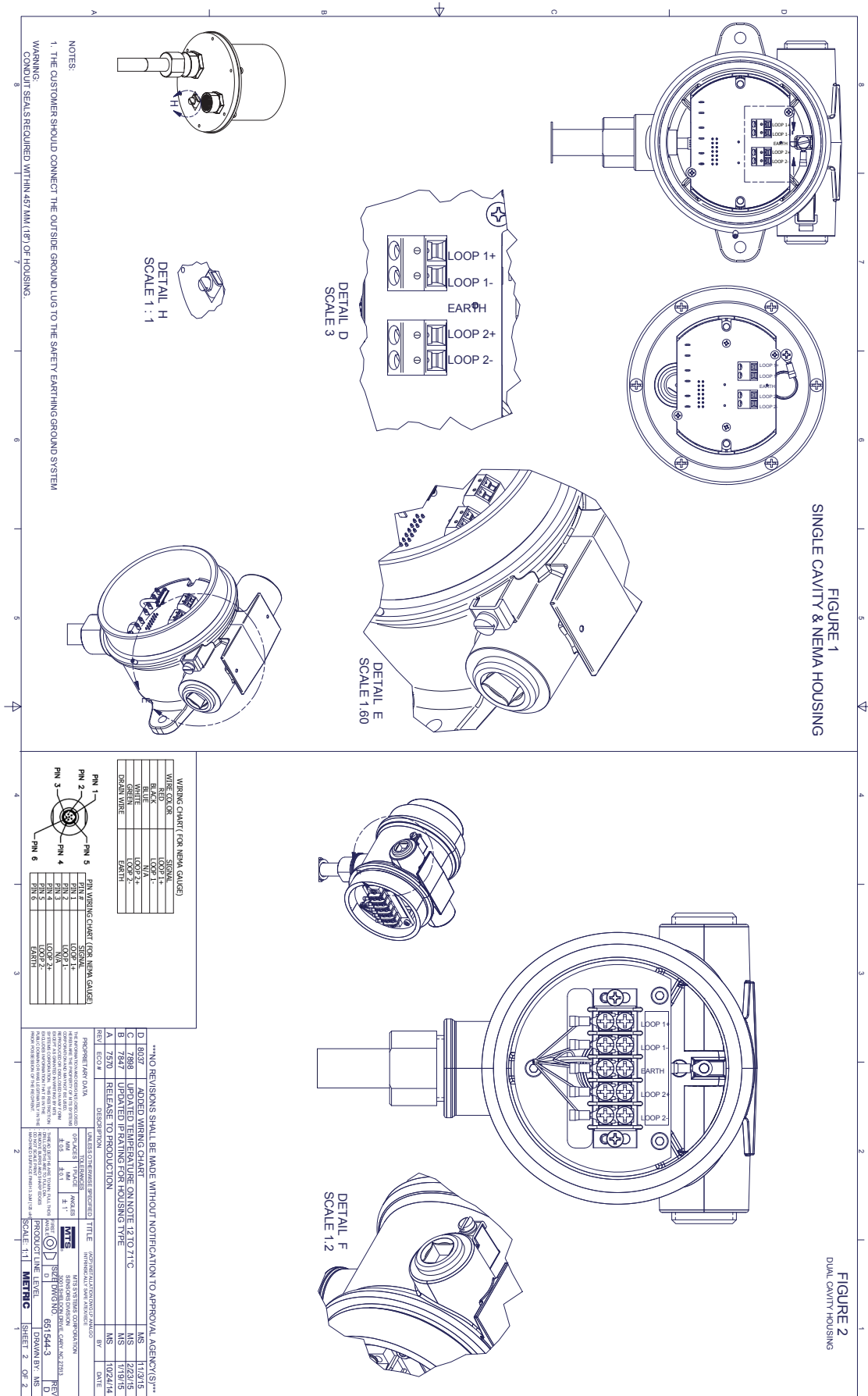


Fig. 36: ATEX / IECEx installation drawing, HART®

12.5.3 EC Declaration of Conformity



**EC Declaration of Conformity**  
**EG-Konformitätserklärung**  
**Déclaration CE de Conformité**

EC14.012B

**MTS Systems Corporation, Sensors Division, 3001 Sheldon Drive, Cary NC 27513, USA**

declares as manufacturer in sole responsibility that the products  
erklärt als Hersteller in alleiniger Verantwortung, dass die Produkte  
déclare en qualité de fabricant sous sa seule responsabilité que les produits

- Level Plus LPT** x x x x x x x x **E** x x x x x x x x (Tank Slayer)
- Level Plus LPR** x x x x x x x x **E** x x x x x x x x (RefineME)
- Level Plus LPS** x x x x x x x x **E** x x x x x x x x (SoClean)
- Level Plus LPC** x x x x x x x x **E** x x x x x x x x (Chambered)

comply with the regulations of the following European Directives:  
den Vorschriften folgender europäischer Richtlinien entsprechen:  
sont conformes aux prescriptions des directives européennes suivantes :

- 94/9/EC** Equipment and protective systems for use in potentially explosive atmospheres  
Geräte und Schutzsysteme zur Verwendung in explosionsgefährdeten Bereichen Appareils  
et systèmes de protection à être utilisés en atmosphères explosibles
- 2004/108/EC** Electromagnetic Compatibility  
Elektromagnetische Verträglichkeit  
Compatibilité électromagnétique

Applied harmonized standards:  
Angewandte harmonisierte Normen:  
Normes harmonisées appliquées :

**EN 60079-0:2012, EN 60079-11:2012, EN 60529:1991+A1:2000, EN 61326-1:2013, EN 61326-2-3:2013**

EC type examination certificate:  
EG-Baumusterprüfbescheinigung:  
Certificat de l'examen CE de type :  
issued by / ausgestellt durch / exposé par:

**FM 14 ATEX 0068 X, 1st Supplement**  
**FM Approvals Ltd.**  
**Windsor, Berkshire, United Kingdom**

Notified body for quality assurance control:  
Benannte Stelle für Qualitätsüberwachung:  
Organisme notifié pour l'assurance qualité :  
Ident number / Kennnummer / Numéro d'identification :

**FM Approvals Ltd.**  
**Windsor, Berkshire, United Kingdom**  
**1725**

Marking / Kennzeichnung / Marquage :

**II 1/2 G Ex ia IIC/ T4**  
**Ta = -50 °C to +71 °C**

Lüdenscheid, 2015-07-07  
MTS Sensor Technologie GmbH & Co. KG, Auf dem Schüffel 9, 58513 Lüdenscheid, Germany

Thomas Muckenhaupt  
Quality Management  
ATEX Representative



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## LOCATIONS

**USA**  
**MTS Systems Corporation**  
**Sensors Division**  
3001 Sheldon Drive  
Cary, N.C. 27513, USA  
Tel. +1 919 677-0100  
Fax +1 919 677-0200  
info.us@mtssensors.com  
www.mtssensors.com

**JAPAN**  
**MTS Sensors Technology Corp.**  
737 Aihara-machi,  
Machida-shi,  
Tokyo 194-0211, Japan  
Tel. +81 42 775-3838  
Fax +81 42 775-5512  
info.jp@mtssensors.com  
www.mtssensors.com

**FRANCE**  
**MTS Systems SAS**  
Zone EUROPARC Bâtiment EXA 16  
16/18, rue Eugène Dupuis  
94046 Creteil, France  
Tel. +33 1 58 4390-28  
Fax +33 1 58 4390-03  
info.fr@mtssensors.com  
www.mtssensors.com

**GERMANY**  
**MTS Sensor Technologie**  
**GmbH & Co. KG**  
Auf dem Schüffel 9  
58513 Lüdenscheid, Germany  
Tel. +49 2351 9587-0  
Fax +49 2351 56491  
info.de@mtssensors.com  
www.mtssensors.com

**CHINA**  
**MTS Sensors**  
Room 504, Huajing Commercial Center,  
No. 188, North Qinzhou Road  
200233 Shanghai, China  
Tel. +86 21 6485 5800  
Fax +86 21 6495 6329  
info.cn@mtssensors.com  
www.mtssensors.com

**ITALY**  
**MTS Systems Srl.**  
**Sensor Division**  
Via Camillo Golgi, 5/7  
25064 Gussago (BS), Italy  
Tel. +39 030 988 3819  
Fax +39 030 982 3359  
info.it@mtssensors.com  
www.mtssensors.com

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