

TR420 TRANSMITTER

Installation and Operating Manual

*CONTINUOUS
OUTPUT
TRANSMITTER*



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Read this Manual Before Installing

This manual provides information on the TR420 transmitter. It is important that all instructions are read carefully and followed in sequence. The **QuickStart Installation** instructions are a brief guide to the sequence of steps for experienced technicians to follow when installing the equipment. Detailed instructions are included in the **Complete Installation** section of this manual.

Conventions Used in this Manual

Certain conventions are used in this manual to convey specific types of information. General technical material, support data, and safety information are presented in narrative form. The following styles are used for notes, cautions, and warnings.

Notes

Notes contain information that augments or clarifies an operating step. Notes do not normally contain actions. They follow the procedural steps to which they refer.

Cautions

Cautions alert the technician to special conditions that could injure personnel, damage equipment, or reduce a component's mechanical integrity. Cautions are also used to alert the technician to unsafe practices or the need for special protective equipment or specific materials. In this manual, a caution box indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

Warnings

Warnings identify potentially dangerous situations or serious hazards. In this manual, a warning indicates an imminently hazardous situation which, if not avoided, could result in serious injury or death.

Safety Messages

Follow all standard industry procedures for servicing electrical and computer equipment when working with or around high voltage. Always shut off the power supply before touching any components. Although high voltage is not present in this system, it may be present in other systems.

Electrical components are sensitive to electrostatic discharge. To prevent equipment damage, observe safety procedures when working with electrostatic sensitive components.

Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) This device must accept any interference received, including interference that may cause undesired operation.

WARNING! Explosion hazard. Do not connect or disconnect transmitters rated Explosion-proof or Non-incendive unless power has been switched off and/or the area is known to be non-hazardous.

Low Voltage Directive

If equipment is used in a manner not specified by the manufacturer, protection provided by equipment may be impaired.

Notice of Copyright and Limitations

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Innovative Solutions reserves the right to make changes to the product described in this manual at any time without notice. Innovative Solutions makes no warranty with respect to the accuracy of the information in this manual.

Warranty

All Innovative Solutions electronic level and flow controls are warranted free of defects in materials or workmanship for one full year from the date of original factory shipment. If returned within the warranty period; and, upon factory inspection of the control, the cause of the claim is determined to be covered under the warranty; then, Innovative Solutions will repair or replace the control at no cost to the purchaser (or owner) other than transportation.

Innovative Solutions shall not be liable for misapplication, labor claims, direct or consequential damage or expense arising from the installation or use of equipment. There are no other warranties expressed or implied, except special written warranties covering some Innovative Solutions products.

Quality Assurance

The quality assurance system in place at Innovative Solutions guarantees the highest level of quality throughout the company. We are committed to providing full customer satisfaction both in quality products and quality service.

TR420

CONTINUOUS OUTPUT TRANSMITTER

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1.0 QuickStart Installation

The QuickStart Installation procedures provide the key steps for mounting, wiring, and configuring the TR420 transmitter. These procedures are intended for experienced installers of electronic level measurement instruments.

Refer to **Complete Installation, Section 2.0** for detailed installation instructions.

WARNING! *TR420 transmitter probes should be installed so the maximum overfill level is a minimum of 1" (25.4 mm) below the process connection. This may include utilizing a nozzle or spool piece to raise the probe. Consult factory to ensure proper installation.*

1.1 Getting Started

Have the proper equipment, tools, and information available before beginning the QuickStart Installation procedures.

1.1.1 Equipment and Tools

- Open-end wrenches or adjustable wrench to fit the process connection size and type
- Small Flat-blade screwdriver
- Cable Cutter
- Digital multimeter or digital volt/ammeter
- 12 VDC or 24 VDC power supply (depends on input voltage)

1.1.2 Configuration Information

The TR420 Transmitter is factory calibrated, configuration is not required. Refer to **Section 2.7** for calibration instructions.

2.0 Complete Installation

This section provides detailed procedures for properly installing and configuring the TR420 Transmitter.

2.1 Unpacking

Unpack the instrument carefully. Make sure all components have been removed from the packing material. Inspect all components for damage. Report any concealed damage to the carrier within 24 hours. Check the contents against the packing slip and report any discrepancies to the factory. Check the model number and/or part number to be sure it agrees with the packing slip and purchase order. Check and record the sales order number and/or the serial number for future reference when ordering parts.

Before proceeding with the installation, do the following:

- Inspect all components for damage. Report any damage to the carrier within 24 hours.
- Make sure the laser marked model number on the probe and transmitter correspond with the packing slip and purchase order.
- Record the model and serial numbers for future reference when ordering parts.

Model Number _____

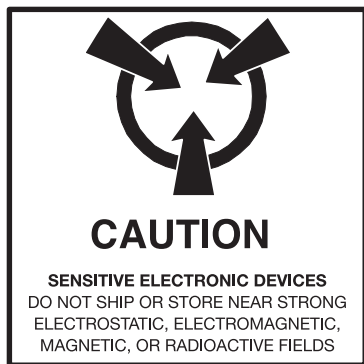
Serial Number _____

2.2 Installation Location

TR420 Transmitter Sensors should be located for easy access for service, calibration and monitoring. Sensors should not be exposed to ambient temperatures below -40°F (-40°C) or above $+185^{\circ}\text{F}$ ($+85^{\circ}\text{C}$). Special precaution should be made to prevent exposure to corrosive atmosphere, excessive vibration, shock, or physical damage.

It is common practice to use the metal tank wall as the reference ground. In such cases, it is required that the probe housing makes a good electrical connection to the tank wall. If there is any doubt about this connection due to the use of PTFE thread tape, gaskets, paint, rust, or any other reason, a separate strap should be installed between the probe housing and the tank.

Caution: *This unit contains electronics which may be damaged by static electricity. Do not touch any semi-conductor devices unless you are properly grounded.*



2.3 Electrostatic Discharge (ESD) Handling Procedure

Innovative Solutions's electronic instruments are manufactured to the highest quality standards. These instruments use electronic components that may be damaged by static electricity present in most work environments.

The following steps are recommended to reduce the risk of component failure due to electrostatic discharge.

- Ship and store circuit boards in anti-static bags. If an anti-static bag is not available, wrap the board in aluminum foil. Do not place boards on foam packing materials.
- Use a grounding wrist strap when installing and removing circuit boards. A grounded workstation is recommended.
- Handle circuit boards only by the edges. Do not touch components or connector pins.
- Make sure that all electrical connections are completely secure and none are partial or floating. Ground all equipment to a good, earth ground.

2.4 Before You Begin

2.4.1 Site Preparation

Each TR420 transmitter is built to match the specific physical specifications of the required installation. Make sure the probe connection is correct for the threaded or flanged mounting on the vessel or tank where the transmitter will be placed. Refer to **Mounting, Section 2.5**.

Make sure that the wiring between the power supply and TR420 transmitter are complete and correct for the type of installation. Refer to **Specifications, Section 3.4**.

When installing the TR420 transmitter in a general purpose or hazardous area, all local, state, and federal regulations and guidelines must be observed.

Refer to **Wiring, Section 2.6**.

2.4.2 Equipment and Tools

No special equipment or tools are required to install the TR420 transmitter. The following items are recommended:

- Open-end wrenches or adjustable wrench to fit the process connection size and type
- Small Flat-blade screwdriver
- Digital multimeter or digital volt/ammeter
- 12 VDC or 24 VDC power supply (depending on input voltage)

2.4.3 Operational Considerations

Operating specifications vary based on Probe model number. Refer to **Specifications, Section 3.4.**

2.5 Mounting

The TR420 transmitter can be mounted vertically inside a tank using a variety of process connections. Generally either a threaded or flanged connection is used. For information about the sizes and types of connections available, refer to **Probe Model Numbers, Section 3.6.1.**

NOTE: Do not place insulating material around any part of the TR420 transmitter including the probe flange as this may cause excessive heat build-up.

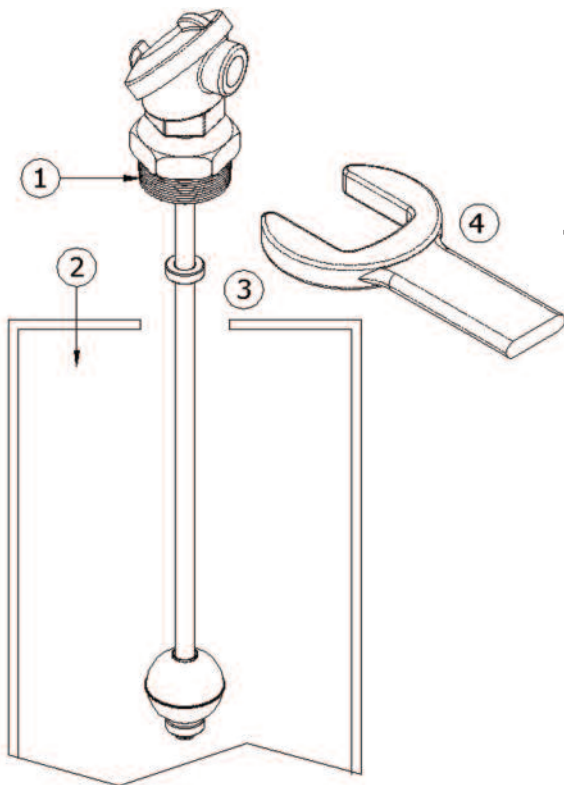
WARNING! TR420 probes should be installed so the maximum over-fill level is a minimum of 1" (25.4 mm) below the process connection. Consult factory to ensure proper installation.

WARNING! Do not disassemble probe when it is in service and/or under pressure.

2.5.1 Installing a TR420 Probe

Before installing, make sure the:

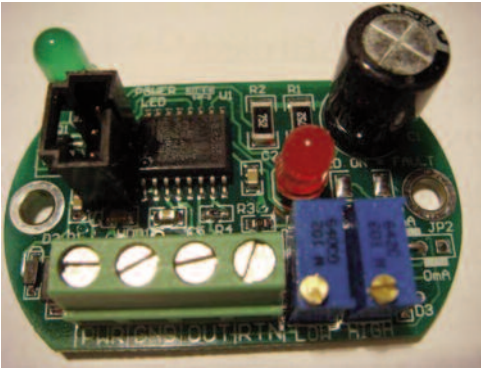
- Probe has adequate room for installation and has unobstructed entry to the bottom of the vessel. Refer to **Physical Specifications, Section 3.4.6.**
- Process temperature, pressure, and specific gravity are within the probe specifications for the installation. Refer to **Specifications, Section 3.4.**



To install a TR420 probe:

- ① Make sure the process connection is at least 1-1/2" NPT, 2" NPT or a flanged mounting.
- ② Carefully place the probe into the vessel. Align the gasket on flanged installations.
- ③ Align the probe process connection with the threaded or flanged mounting on the vessel.
- ④ For threaded connections, tighten the hex nut of the probe process connection. For flanged connections, tighten flange bolts.

2.6 Wiring



TR420 Controller Board

Caution: The TR420 transmitter operates at voltages of 8-18 VDC or 19-30VDC. Higher voltage will damage the transmitter.

Wiring between the power supply and the TR420 transmitter should be made using 18-22 AWG shielded twisted pair instrument cable. Within the transmitter enclosure, connections are made to the terminal strip and the ground connections. The instructions for wiring the TR420 transmitter depend on the application:

- General Purpose or Non-Incendive (CI I, Div. 2)
- Intrinsically Safe
- Explosion Proof (TR42E only)

WARNING! Explosion hazard. Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

2.6.1 General Purpose or Non-Incendive (CI I, Div. 2)

- A general purpose installation does not have flammable media present.
- Areas rated Non-Incendive (CI I, Div. 2) have flammable media present only under abnormal conditions (no special electrical connections are required).
- If flammable media is contained in the vessel, the transmitter must be installed per CI I, Div. 1 standards of area classification.
- Power is to be shut off before attempting to wire the device.

To install General Purpose or Non-Incendive wiring:

1. Remove the cover of the transmitter. Install the conduit plug in the unused opening.
2. Install a conduit fitting and pull the supply wires through.
3. Connect the positive supply wire to the “PWR” terminal and the negative supply wire to the “GND” terminal.
4. Connect the signal wire to “OUT” terminal and return wire to “RTN” terminal. Run wires to your device to make proper terminations for signal there.
5. Replace the cover of the transmitter.

2.6.2 Intrinsically Safe

An intrinsically safe (IS) installation potentially has flammable media present. An approved IS barrier must be installed in the non-hazardous (safe) area

To install Intrinsically Safe wiring:

1. Make sure the IS barrier is properly installed in the safe area (refer to local plant or facility procedures). Complete the wiring from the barrier to the TR420 transmitter.
2. Remove the cover of the transmitter. Install the conduit plug in the unused opening.
3. Install a conduit fitting and pull the supply wires through.
4. Connect the positive supply wire to the “PWR” terminal and the negative supply wire to the “GND” terminal.
5. Connect the signal wire to “OUT” terminal and return wire to “RTN” terminal. Run wires to your device to make proper terminations for signal there.
6. Replace the cover of the transmitter.

2.7 Calibrating the TR420 Transmitter

2.7.1 Calibration

The TR420 Transmitter is designed to require minimal to no initial calibration. The transmitter is shipped from the factory with the 4 mA (0%) point set on empty indication, and the 20 mA (100%) point set at the full indication. The 4 mA and/or 20 mA points can be readjusted if need be.

2.7.2 Procedure

This procedure should be used when the process level can be moved from empty to full, or from the actual 4 to 20 mA points. A Digital multi-meter (DMM) is recommended but not required for calibration.

1. If desired, connect a DMM (set to read 20.0 mA full scale) to the control board of the transmitter. Connect the “common” or black lead from the DMM to the “RTN” terminal of the control board and connect the “mA” or red lead to the “OUT” terminal of the control board.

2. Upon application of power, the green LED will light up, indicating power to the board.

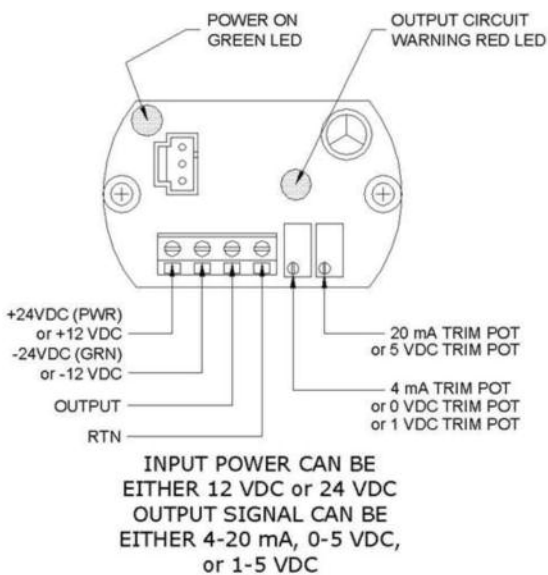
3. Make sure that the float on the probe is fully bottomed, indicating an empty tank. The DMM should be reading 4.0 mA. If needed, you can adjust the “low” trim pot with a small flat blade screwdriver. Turning clockwise will raise the reading, counter-clockwise will lower the reading. Turn accordingly to achieve 4.0 mA.

4. Next, make sure that the float on the probe is raised fully to the top of the indication length. The DMM should be reading 20.0 mA. If needed, you can adjust the “high” trim pot with a small flat blade screwdriver. Turning clockwise will raise the reading, counter-clockwise will lower the reading. Turn accordingly to achieve 20.0 mA.

5. Cycle the float from the bottom to the top of the indication length and check the readings at the full and empty positions. You can repeat steps 3 & 4 if needed to obtain the best accuracy.

2.7.3 Fault Mode

A fault condition will be shown by a lit red LED on the control board. This will occur if the output signal is not wired properly or wired at all.



3.0 Reference Information

This section presents an overview of operating the TR420 Transmitter as well as information on troubleshooting common problems, listings of agency approvals, lists of replacement parts, and detailed physical, functional, and performance specifications.

3.1 Description

The 4-20 mA Resistive probe is designed to detect fluid levels of liquids. The output is a proportional 4-20 mA output. The unit must be calibrated before use. Once calibrated, the resistive probe measures level within $\frac{1}{4}$ or $\frac{1}{2}$ inch resolution.

The PCB/electronics is located inside the top of the Probe Housing. Two parts comprise the complete 4-20 mA Resistive probe design: the probe itself and the 4-20mA controller board. The probe is made up of segments that are 16" in length and connect together, end to end to form the desired length. The 4-20 mA controller is connected to the probe segments using three wires.

3.2 Theory of Operation

3.2.1 Basic Operating Principle

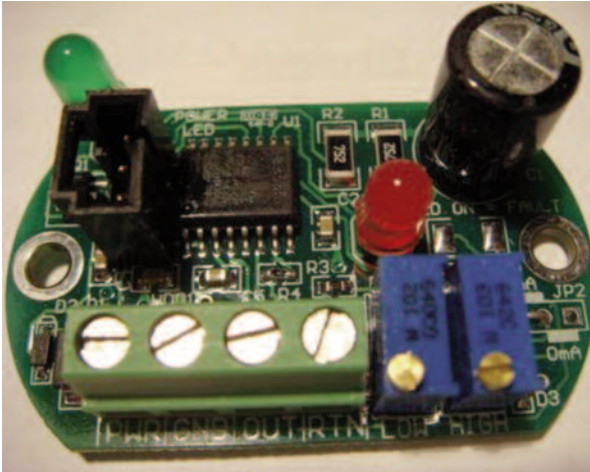
The TR420 Transmitter employs a series of magnetic reed switches inside the vertical sensor stem that are actuated by a magnet within the moving float. The switching of the reed switches introduce voltage across a sequence of resistors which provides a proportionate voltage signal over that segment of the voltage divider network. That signal is proportional to the relative position of the float and is electronically conditioned through the transmitter controller board to provide the proportional output in mA or volts DC (depending on the model selected).

3.2.2 TR420 Transmitter Probe

Each probe segment contains 64 discrete resistors. They form a resistive daisy chain (series circuit). The segments have been configured as a voltage divider where the magnetic reed switches is the tapping point to the circuit. As each switch closes, the voltage divider varies in proportion to each switch position. The probe connectors allow the voltage divider to extend to a very long length.



3.2.3 TR420 Controller Board



TR420 Controller Board

The controller is a current transmitter that accepts high level signal inputs from the resistive probe and drives a standard 4–20 mA current loop for the control of valves, actuators, and other devices commonly used in process control. The input signal is buffered by an input amplifier that is used to scale the input signal. The signal from the probe is voltage divided and fed back to the signal input. Very little interaction between set points allow the user to “set-once” each trimpot and avoid bouncing back and forth many times to “lock in” the values.

A RED LED alarm warns of an open 4–20 mA loop or noncompliance of the output stage. In the event the wire from HDR1 pin 3 is opened, or if a large input overdrive forces this signal too close to the input power supply voltage, the LED is illuminated.

A GREEN LED indicates power.

3.3 Troubleshooting

The TR420 transmitter is designed and engineered for trouble-free operation over a wide range of operating conditions. Common transmitter problems are discussed in terms of their symptoms and recommended corrective actions. Information on how to handle material build-up on the probe is also provided in this section.

WARNING! *Explosion hazard. Do not connect or disconnect equipment unless power has been switched off or the area is known to be non-hazardous.*

3.3.1 TR420 Transmitter Problems

Symptom	Problem	Solution
Output current is inaccurate	Calibration is questionable	Recalibrate the transmitter
Output current is repeatable but consistently high or low from actual by a fixed amount	Calibration is questionable	Recalibrate the transmitter
Output current fluctuates	Turbulence	Relocate probe
Output current reading low vs. actual	Coating or build-up on float and stem	Clean float and stem of contaminants
	Coating, clumping or build-up on stem	Clean stem of contaminants

3.4 Specifications

3.4.1 Functional

System Design

Measurement Principle Voltage divider network

Input

Measured Variable Level, determined by the float position closing reed switches and a proportionally conditioned voltage signal

Zero and Span 6 to 180 inches (15 cm to 458 cm)

Output

Type Analog 4-20 mA; 0-5 VDC; 1-5VDC

Range Analog 3.6 to 20.5 mA useable; 0-5.5 VDC usable; 0.5-5.5 usable

Digital None

Resolution Analog 0.01 mA; 0.01 VDC

Digital None

User Interface

Keypad None

Indication (2) LEDs

Digital Communication None

Power (Measured at instrument terminals)

General Purpose/Intrinsically Safe (FM/CSA) 19 to 30 VDC; 8-18 VDC

General Purpose/Intrinsically Safe (ATEX) 19 to 30 VDC; 8-18 VDC

Explosion Proof FM/CSA 19 to 30 VDC; 8-18 VDC

Housing

Material Aluminum, Cast Iron

Cable Entry $\frac{3}{4}$ " NPT

3.4.2 Environment

Operating Temperature: -40 to +175° F (-40 to +80° C)

Storage Temperature -50 to +175° F (-45 to +80° C)

Humidity 0-99%, non-condensing

Shock Class ANSI/ISA-S71.03 Class SA1

Vibration Class ANSI/ISA-S71.03 Class VC2

3.4.3 Performance

Linearity ± 0.25 "

Resolution ± 0.25 inch or ± 0.50 inch

Repeatability < 0.25 inch

Response Time < 1 second

Warm-up Time < 3 seconds

Operating Temp. Range -40° to +175° F (-40° to +80° C)

Ambient Temp. Effect Approximately +0.03% of probe length/ ° C

Humidity 0-99%, non-condensing

3.4.4 Materials of Construction

3.4.4.1 Brass and Stainless Steel Probes

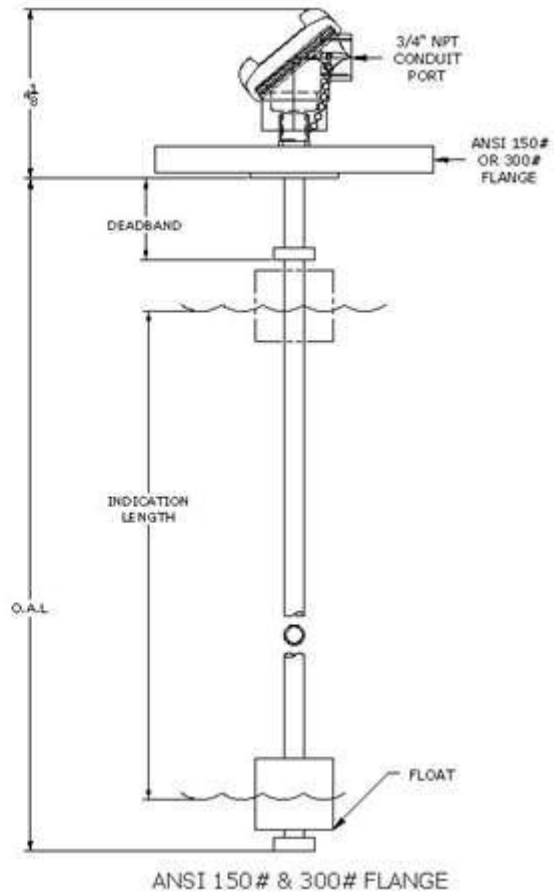
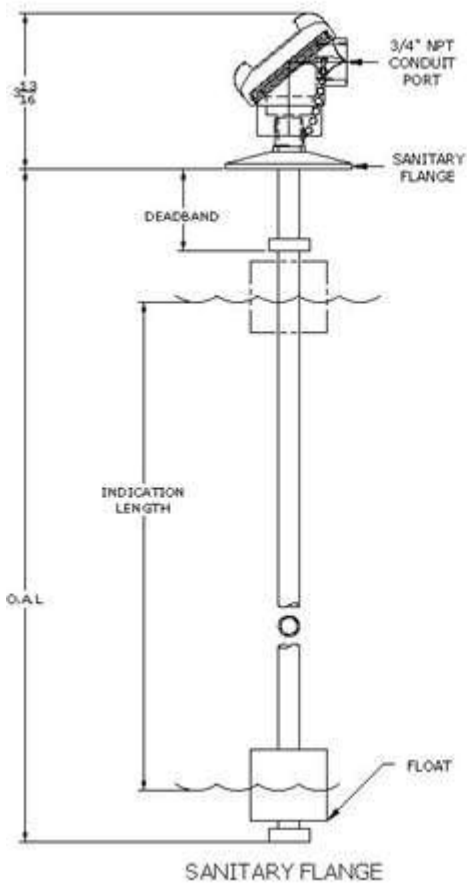
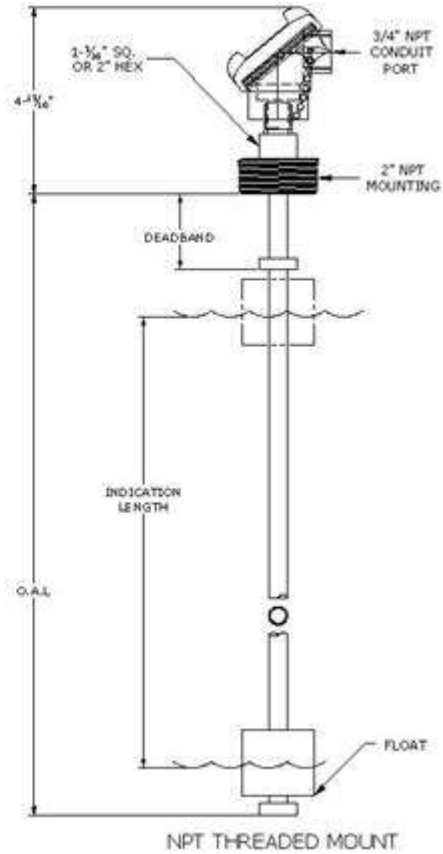
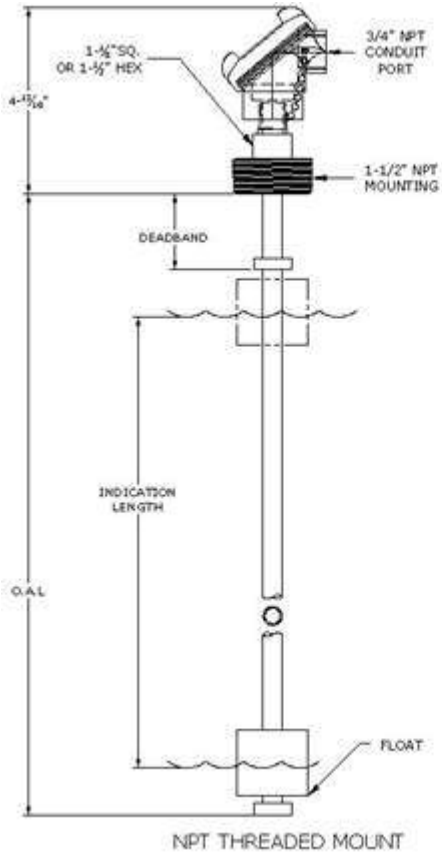
Model	Brass Alloy	Stainless Steel
Junction Box Housing	Cast Iron, Aluminum	
Probe Mount & Stem	Brass Alloy ≥.500" (12.7mm) ø tube	316 Stainless Steel ≥.500" (12.7mm) ø tube
Process Connection	See page 14, <i>Mounting Types</i>	See page 14, <i>Mounting Types</i>
Floats	Buna-N Size To Suit Process Connection Size and Media	316 Stainless Steel To Suit Process Connection Size Size and Media
Retaining Collars	316 Stainless Steel Beryllium Copper, PH 15-7	

3.4.5 Process Conditions

3.4.5.1 Brass and Stainless Steel Probes

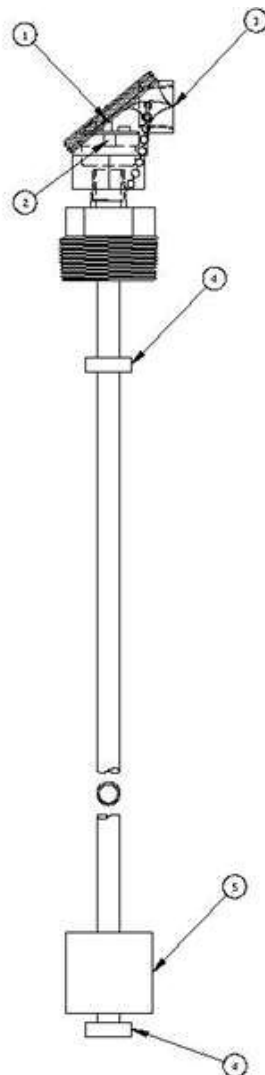
Model	Brass Alloy Mounts & Stems	316 Stainless Steel Mounts & Stems
Maximum Process Temperature	+180° F @ 150 psig (+82° C @ 10 bar)	+300° F @ 150 psig (+149° C @ 10 bar)
Maximum Process Pressure	150 psig @ +70° F (10 bar @ +20° C)	120 psig @ +70° F (8.3 bar @ +20° C) - (2000-1513-0054) 750 psig @ +70° F (51.7 bar @ +20° C) - (2000-2000-0052)
Minimum Media Specific Gravity	0.77 for Buna-N floats	0.80 for 316SS float (2000-2000-0052) 0.90 for 316SS float (2000-1513-0054)

**3.4.6 Physical
(inches)**



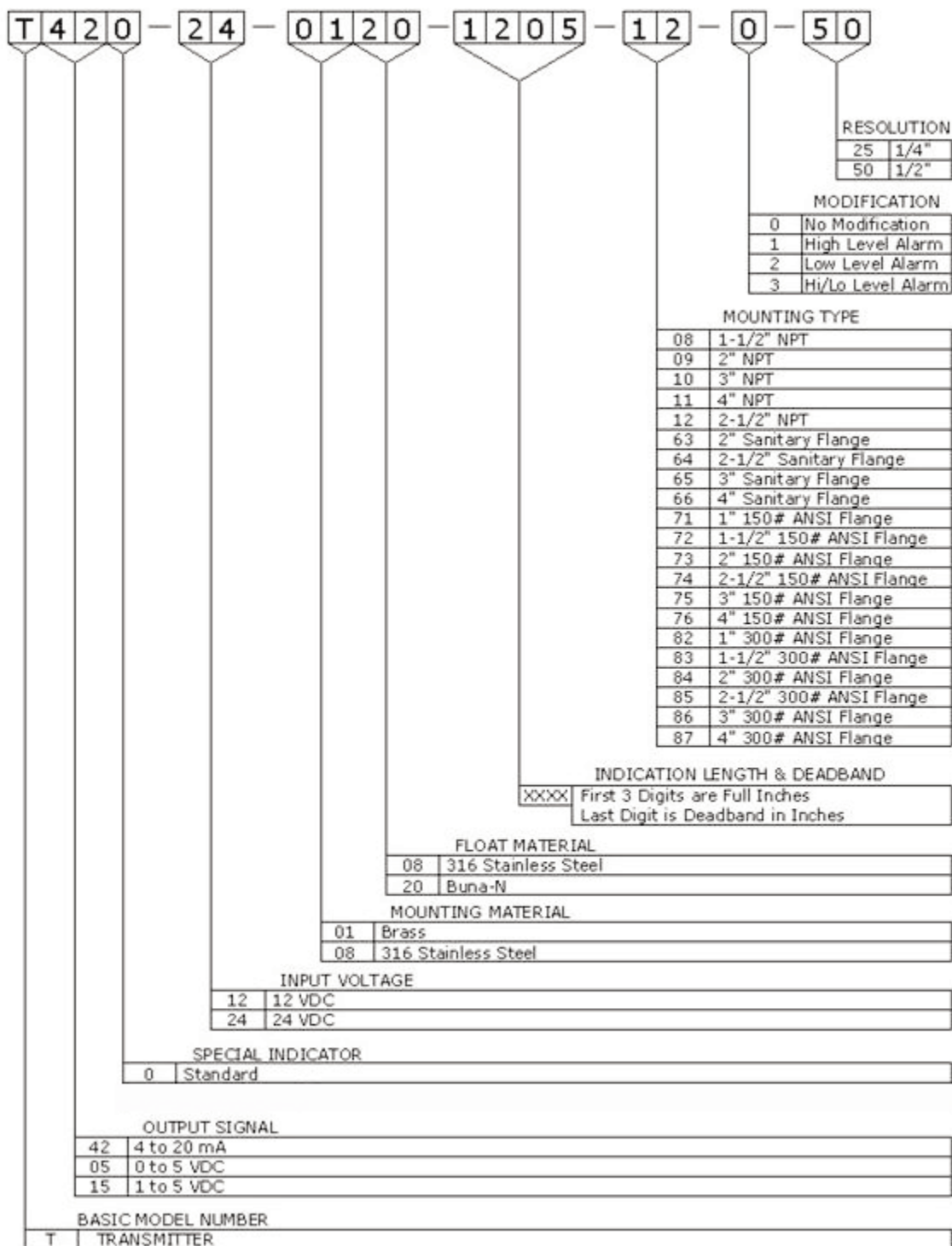
3.5 Replacement Parts

Item	Description	Part Number
1	Controller Board - 12 VDC Input, 0 to 5 VDC Output	0950-T420-0006
	Controller Board - 12 VDC Input, 1 to 5 VDC Output	0950-T420-0003
	Controller Board - 12 VDC Input, 4 to 20 mA Output	0950-T420-0004
	Controller Board - 24 VDC Input, 0 to 5 VDC Output	0950-T420-0007
	Controller Board - 24 VDC Input, 1 to 5 VDC Output	0950-T420-0005
	Controller Board - 24 VDC Input, 4 to 20 mA Output	0950-T420-0002
2	Standoff (2 pcs. Required)	0785-0018-0250
3	Junction Box - Aluminum	0700-0000-0002
	Junction Box - Cast Iron	0700-0000-0004
4	Retaining Ring - Beryllium Copper	0600-0500-0002
	Retaining Ring - Ph 15-7 Mo	0600-0500-0001
	Collar - 316 Stainless Steel	0610-0500-0008
5	Float - Stainless Steel for 1-1/2" NPT mount and larger	2000-1513-0054
	Float - Stainless Steel for 2" NPT mount and larger	2000-2000-0052
	Float - Buna-N for 1-1/2" NPT and larger	2010-1618-0052
	Float - Buna-N for 2" NPT and larger	2010-1818-0052



3.6 Model Numbers

3.6.1 Transmitter



Consult factory for special configurations, material, mounting, and alarm features

Notes

Service Policy

Owners of Innovative Solutions controls may request the return of a control or any part of a control for complete rebuilding or replacement. They will be rebuilt or replaced promptly. Controls returned under our service policy must be returned by Prepaid transportation. Innovative Solutions will repair or replace the control at no cost to the purchaser (or owner) other than transportation if:

1. Returned within the warranty period; and
2. The factory inspection finds the cause of the claim to be covered under the warranty.

If the trouble is the result of conditions beyond our control; or, is NOT covered by the warranty, there will be charges for labor and the parts required to rebuild or replace the equipment.

In some cases it may be expedient to ship replacement parts; or, in extreme cases a complete new control, to replace the original equipment before it is returned. If this is desired, notify the factory of both the model and serial numbers of the control to be replaced. In such cases, credit for the materials returned will be determined on the basis of the applicability of our warranty.

No claims for misapplication, labor, direct or consequential damage will be allowed.

Return Material Procedure

So that we may efficiently process any materials that are returned, it is essential that a "Return Material Authorization" (RMA) number be obtained from the factory prior to the material's return. This is available through Innovative Solutions local representative or by contacting the factory. Please supply the following information:

1. Company Name
2. Description of Material
3. Serial Number
4. Reason for Return
5. Application

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.

All shipments returned to the factory must be by prepaid transportation.

All replacements will be shipped F.O.B. factory.



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