TELEDYNE
ANALYTICAL INSTRUMENTS
Everywhereyoulook™

User Manual

MODEL 5650

Use and Disclosure of Data
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WATER IN OIL MONITOR/WATERCUT ANALYZER

M5650, Rev. C/ May 2022

EU DECLARATION OF CONFORMITY

This declaration of conformity is issued under the sole responsibility of the manufacturer

APPLICATION OF COUNCIL DIRECTIVE	: 2014/34/EU
STANDARDS TO WHICH CONFORMITY IS DECLARED	: EN IEC 60079-0: 2018 EN IEC 60079-1: 2014
MANUFACTURER'S NAME	: TELEDYNE ANALYTICAL INSTRUMENTS
MANUFACTURER'S ADDRESS	: 16830 Chestnut Street City of Industry, CA 91748 U.S.A.
TYPE OF EQUIPMENT	: 5650 Water in Oil Monitor (Explosion-proof)
EQUIPMENT CLASS	: Ex db IIC T4 Gb
MODEL NUMBER	: 5650

I, THE UNDERSIGNED, HEREBY DECLARE THAT THE EQUIPMENT SPECIFIED ABOVE CONFORMS TO THE ABOVE STANDARD(S) PER 2014/34/EU and have been type-approved by QPS Evaluation Services Inc. 81 Kelfield St., Unit 8 Toronto, Ontario, M9W 5A3, Canada,.
Marking: II 2G
IECEx Certificate Number: IECEx QPS 21.0015X
EU Certificate Number: QPS 21ATEX5003X

SIGNATURE: Judy Thomas

FULL NAME: Judy Thomas

POSITION: QA Director

Date: May 6, 2022

SIGNATURE: Angel Alegria

FULL NAME: Angel Alegria

POSITION: New Products Manager

Date: 5/06/2022

Special Conditions for Safe Use

- **Read and follow the installation instructions**
- **Maximum process temperature is 130^0C**
- **Due to the risk of static charges, clean surface of the equipment using a damp cloth.**
- **The enclosure housing service temperature range should not exceed from -40^0C to $+76^0$C.**
- **Entry devices with thread type other than metric or NPT are not permitted.**
- **Regardless of the type of mounting it is required to ensure that the line bushing is secured against twisting or loosening.**

WARNING: ALL INDIVIDUALS WHO, HAVE OR WILL HAVE, RESPONSIBILITY FOR USING, MAINTAINING, OR SERVICING THIS PRODUCT, MUST READ THIS ENTIRE MANUAL CAREFULLY. FAILURE TO USE THIS EQUIPMENT PROPERLY COULD RESULT IN SERIOUS INJURY OR DEATH.

Warranty

Teledyne Analytical Instruments (referred to hereafter as "the Company") warrants this equipment is free from defects of material and of construction, and that the Company's liability shall be limited to replacing or repairing at the Company's factory (without charge, except for transportation), or at customer plant at the Company's option, any material or construction in which defects become apparent within one year from the date of shipment, except in cases where quotations or acknowledgments provide for a shorter period. Components manufactured by others bear the warranty of their manufacturer. This warranty does not cover defects caused by wear, accident, misuse, neglect, or repairs other than those performed by the Company or an authorized service center. The Company assumes no liability for direct or indirect damages of any kind, and the purchaser by the acceptance of the equipment will assume all liability for any damage which may result from its use or misuse.

The Company reserves the right to employ any suitable material in the manufacture of our apparatus, and to make any alterations in the dimensions, shape or weight of any parts, in so far as such alterations do not adversely affect our warranty.

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The Company reserves the right to revise this documentation and to make changes in content from time to time without obligation on the part of the Company to provide notification of such revision or change.

The Company provides this documentation without warranty, term, or condition of any kind, either implied or expressed, including, but not limited to, the implied warranties, terms or conditions of merchantability, satisfactory quality, and fitness for a particular purpose. The Company may make improvements or changes in the product(s) described in this documentation at any time.

While every effort has been made to ensure accuracy in this guide, no responsibility can be accepted for errors or omissions. This publication is not intended to form the basis of a contract, and the Company reserves the right to amend the design, content, and specifications of the detector without notice.

The international transport of this device is regulated under United States export regulations and may be regulated by the import regulations of other countries.

Important Notice

This instrument provides measurement readings to its user, and serves as a tool by which valuable data can be gathered. The information provided by the instrument may assist the user in eliminating potential hazards caused by his process; however, it is essential that all personnel involved in the use of the instrument or its interface be properly trained in the process being measured, as well as all instrumentation related to it.

The safety of personnel is ultimately the responsibility of those who control process conditions. While this instrument may be able to provide early warning of imminent danger, it has no control over process conditions, and it can be misused. In particular, any alarm or control systems installed must be tested and understood, both as to how they operate and as to how they can be defeated. Any safeguards required, such as locks, labels, or redundancy, must be provided by the user or specifically requested of the Company at the time the order is placed.

Therefore, the purchaser must be aware of the hazardous process conditions. The purchaser is responsible for the training of personnel, for providing hazard warning methods and instrumentation per the appropriate standards, and for ensuring that hazard warning devices and instrumentation are maintained and operated properly.

The Company cannot accept responsibility for conditions beyond its knowledge and control. No statement expressed or implied by this document, or any information disseminated by the manufacturer or its agents, is to be construed as a warranty of adequate safety control under the user's process conditions.

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Table of Contents

1. About This Manual

This manual provides instructions on the features and usage of the Model 5650 Water in Oil Monitor/ Water Cut Analyzer (also referred to as "Monitor/Analyzer"). It also provides information on configuration, operation, maintenance, specifications, and trouble shooting. This user manual assumes the reader has a basic knowledge of liquid analytical instrumentation.

1.1. Guide Conventions

The following visual elements are used throughout this manual:

WARNING: THIS ICON AND TEXT INDICATE A POTENTIALLY HAZARDOUS SITUATION, WHICH, IF NOT AVOIDED, COULD RESULT IN DEATH OR INJURY.

CAUTION: This icon and text indicate an action or situation, which, if not avoided, could result in damage to the equipment.

NOTE: This icon and text designates information of special note to the operator.

1.2. Certification Schemes

Certification	Notes
QPS(CSA/UL)	Class I Zone 1 AEx db IIC T4 Gb Ex db IIC T4 Gb Class I Division 1 Gr. BCD Ta= -20°C to +60°C
ICECx	IECEx QPS 21.0015X; QPS 21ATEX5003X Ex db IIC T4 Gb Ta= -20°C to +60°C
ATEX 	II 2G Ex db IIC T4 Gb Ta= -20°C to +60°C

1.3. General Safety Information

WARNING: FLAMMABLE LIQUID USAGE!
THE MONITOR/ANALYZER IS HOUSED IN AN FLAME PROOF/EXPLOSION PROOF HOUSING AND IS DESIGNED FOR USE IN A CLASS 1, DIVISION 1, GROUP A, B, C, D ENVIRONMENT. IT IS THE CUSTOMER'S RESPONSIBILITY TO ENSURE SAFETY ESPECIALLY WHEN FLAMMABLE LIQUIDS ARE BEING ANALYZED SINCE THE POTENTIAL OF LEAKS ALWAYS EXIST.

THE CUSTOMER SHOULD ENSURE THAT THE PRINCIPLES OF OPERATING OF THIS EQUIPMENT ARE WELL UNDERSTOOD BY THE USER. MISUSE OF THIS PRODUCT IN ANY MANNER, TAMPERING WITH ITS COMPONENTS, OR UNAUTHORIZED SUBSTITUTION OF ANY COMPONENT MAY ADVERSELY AFFECT THE SAFETY OF THIS INSTRUMENT.

SINCE THE USE OF THIS MONITOR/ANALYZER IS BEYOND THE CONTROL OF THE COMPANY, NO RESPONSIBILITY BY THE COMPANY, ITS AFFILIATES, AND AGENTS FOR DAMAGE OR INJURY FROM MISUSE OR NEGLECT OF THIS EQUIPMENT IS IMPLIED OR ASSUMED.

WARNING: YOU MUST READ CAREFULLY ALL THE INSTRUCTIONS OF THIS MANUAL. YOU MUST NOT START THE INSTALLATION BEFORE TAKING THESE INSTRUCTIONS INTO ACCOUNT. THIS EQUIPMENT MIGHT RECEIVE SOME HAZARDOUS VOLTAGES. IF YOU DO NOT CONSIDER THESE INSTRUCTIONS, YOU RISK TO FACE SERIOUS CORPORAL AND / OR MATERIAL INJURIES.

BEFORE SETTING UP YOUR INSTALLATION, ENSURE THE MODEL SUITS YOUR APPLICATION. THE WIRING OF THIS MONITOR/ANALYZER MUST BE EXECUTED WITH THE IN FORCE RULES BY QUALIFIED PERSONNEL.

WARNING: TO REDUCE THE RISK OF IGNITION OF HAZARDOUS ATMOSPHERES, DISCONNECT THE SUPPLY CIRCUIT BEFORE OPENING. KEEP COVER TIGHT WHILE CIRCUITS ARE ALIVE.

The Company takes no responsibility for use of its equipment if it is not used in accordance with the instructions. If further operational or maintenance details are required but not provided in this manual, contact the Company or their agent. The Company shall not be liable for any incidental or consequential damages in connection with any modifications, errors, or omissions in this manual.

Observed all pertinent regional and local safety regulations when installing and using this product. For reasons of safety, and to assure compliance with documented system data, only the manufacturer may perform repairs to components.

Additionally, industry standards, codes, and legislation are subject to change. Users must obtain updated copies to ensure the most recently issued regulations, standards and guidelines are available.

Observed all pertinent regional and local safety regulations when handling and disposing of hazardous material, batteries, and other similar items that may fall under the classification of hazardous material.

The Monitor/Analyzer is designed for measuring water content in hydrocarbon liquids. This instrument produces a 4-20 mA signal that is proportional to the measured water content over the analysis range.

This equipment can be installed in some explosive atmospheres and is in compliance with the 94/9/EC ATEX directive. The surface temperature must not exceed the one indicated on the cover.

The housing must be protected against mechanical shocks. No drilling or machining must be done. Make sure the cable gland is appropriately tightened and make a loop with your cable to avoid running water alongside. If you do not take these precautions into account, the envelop certification would be put at risk, and the ingress of protection of the housing might be modified!

Electrical wiring must be executed when DE-ENERGIZED after mounting and fixing the instrument. Electrical wiring must be executed with respect to the sound engineering practice and the in-force norms. Cables must be shielded type and fit cable inputs furnished as standard. In order to guarantee a perfect tightness, the cable gland should be screwed with an appropriate spanner. Terminals wiring is designed for 1.5mm^2 max wires. Earthing connection must be connected to an equipotential earthing network.

The characteristics of the cable furnished for the Monitor/Analyzer are the following: MBL type – shielded type – PVC coated – 2 x 0.6mm^2. The electrical connection of the Monitor/Analyzer must comply with the EN 50020 (1994) norm and, in particular § 6.1.

The type and the path of cables (I.S. cables) must comply with the in-force rules. Careful precautions must be taken to avoid electromagnetic couplings with other cables capable of causing hazardous voltages or currents. Cables and wires must be protected against any damages.

NOTE: The Monitor/Analyzer described in this manual is protected by ATEX Class 1, Zone 1 IIB T4. Verify regulations and ensure that the grade of protection is sufficient for the area of use.

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2. Introduction

The Model 5650 Water-In-Oil Monitor/Watercut Analyzer is a sophisticated instrument designed to measure water concentration in oil. It consists of an electronics assembly and a Capacitance Probe section.

The Monitor/Analyzer is housed in an explosion proof housing. Certain versions may be fitted with a window and a control unit display. Setup is available through HART.

The electronics is fully integrated with the Sensor Probe and to maintain safety and certification integrity only a fully qualified engineer should attempt to dismantle electronics housing from the probe. The main PCB board can be swapped out by user, given specific instructions are followed, but no other work should be performed as it can violate the hazardous area safety.

The Monitor/Analyzer is equipped with a 4-20mA analogue output with Out Of Range alarm level and can be interfaced with using HART.

2.1. Operating Principle

The dielectric properties of oil and water are vastly different and the Monitor/Analyzer is able to determine the ratio by measuring the capacitance of the passing stream. The Monitor/Analyzer constantly measures the temperature and compensates for capacitance changes that are due to temperature fluctuations.

The Monitor/Analyzer is available in Standard Version capable of 0-25% of water as well as in High Range versions capable of 0-100% water.

The Dielectric Constant (DC) varies from oil to oil and is mainly a function of the Specific Gravity (SG). The Monitor/Analyzer will measure any oil with a DC in the range of 1.7 to 2.3 without a need for any additional tweaking. This covers all normal fuels, lubrication and hydraulic oils as well as crude oils. The Monitor/Analyzer will also work fine with most vegetable oils and biofuels. A simple calibration procedure will get the Monitor/Analyzer ready for your oil. In most cases a single press of a button will do.

NOTE: The dielectric constant is the ratio of the permittivity of a substance to the permittivity of free space. It is an expression of the extent to which a material concentrates electric flux, and is the electrical equivalent of relative magnetic permeability.

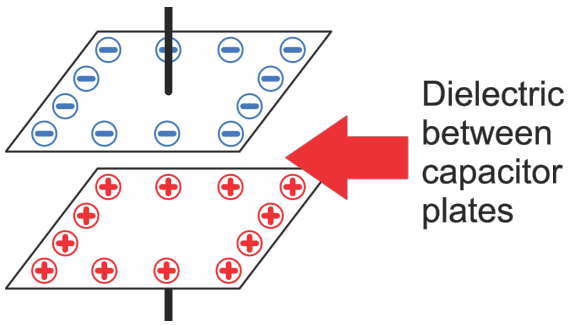


Figure 2-1: Dielectric Constant

2.2. Process Temperature Considerations

CAUTION: The Monitor/Analyzer is certified for up to 130° C surface temperature (T4) for EXD components and an ambient temperature up to 60° C. This must not be exceeded.

Calculations have shown that the Monitor/Analyzer will stay within it's limitations for all standard models/designs regardless of materials for process temperatures up to 130° C with an ambient temperature at 60° C.

Higher process temperature may be achieved for certain models/configurations, in which case a Thermal Evaluation will be performed to support such an installation.

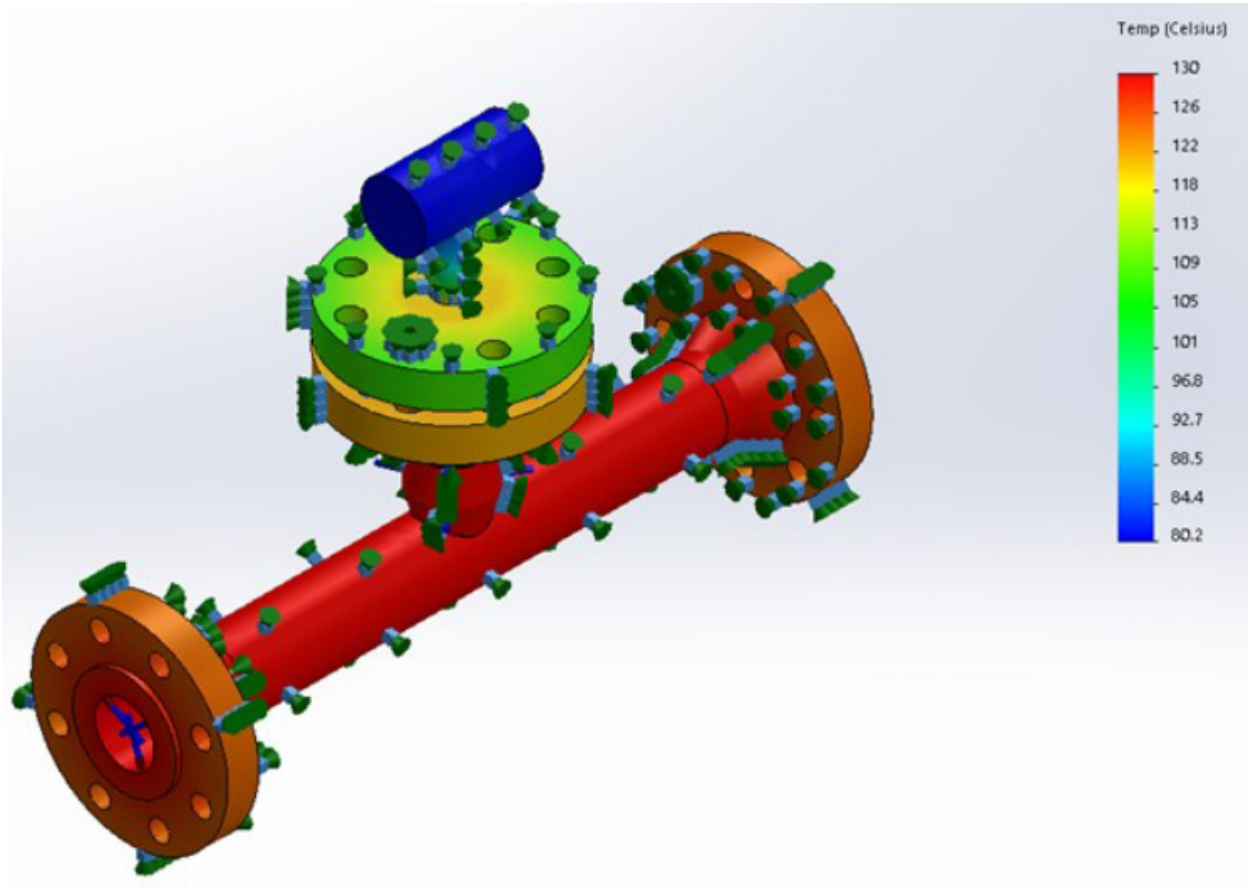


Figure 2-2: Thermal Evaluation

2.3. Model 5650 Monitor/Analyzer Series

The Monitor/Analyzer is available in 3 main variations:

2.3.1. S-Series

The S-Series sensor is a spool section for inline measurements from 1 to 8 inch. Sizes 1 to 3 inch are available with threaded connections. S-Series is available in SS316L Stainless Steel and a variety of higher grade steel such as Duplex and Super Duplex up to Class 600# working pres-sure. Not all components on the S-Series allow full NDT.

Figure 2-3: S-Series

2.3.2. F-Series

The F-Series sensor is a spool section for inline measurements from 3 to 48 inch. The F-Series uses a fully flanged design and can be provided with complete NDT for all welds. This model is made for working pres-sure up to Class 1500#. The F-Series can be supplied in most common piping materials including Carbon Steel to match existing pipe line specifications.

Figure 2-4: F-Series

2.3.3. I-Series

The I-Series sensor is an insertion model that can be provided as a fixed length flanged unit or supplied with a kit providing retraction under pressure. Materials for wetted parts is available as SS316L or higher qualities such as Duplex, Super Duplex or other specialized steels. Carbon steel is not available. Pressure Class up to 1500#. The I-Series can be supplied with a measurement spool in any readily available piping material.

Figure 2-5: I-Series

2.4. Additional Variations

2.4.1. Static Mixer

S-Series, F-Series and measurement spools for I-Series can be supplied with Static Mixer to homogenize the Oil/Water flow before measurement.

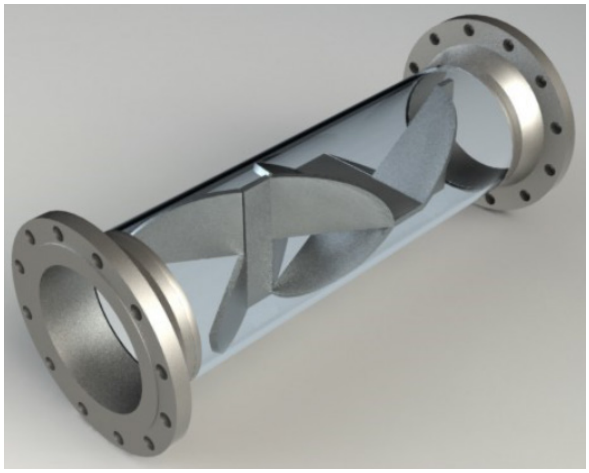


Figure 2-6: Static Mixer

2.4.2. S-Series - Flanged and Threaded Version

The S-Series sensor consists of a EXD certified Electronics Enclosure with cable entries for electrical wiring, a spool section for mounting into the pipe line to be measured. Smaller sizes are well suited for installation into by-pass or fast-loop arrangements. The EXD enclosure is available in different versions to suit different markets/ certification requirements.

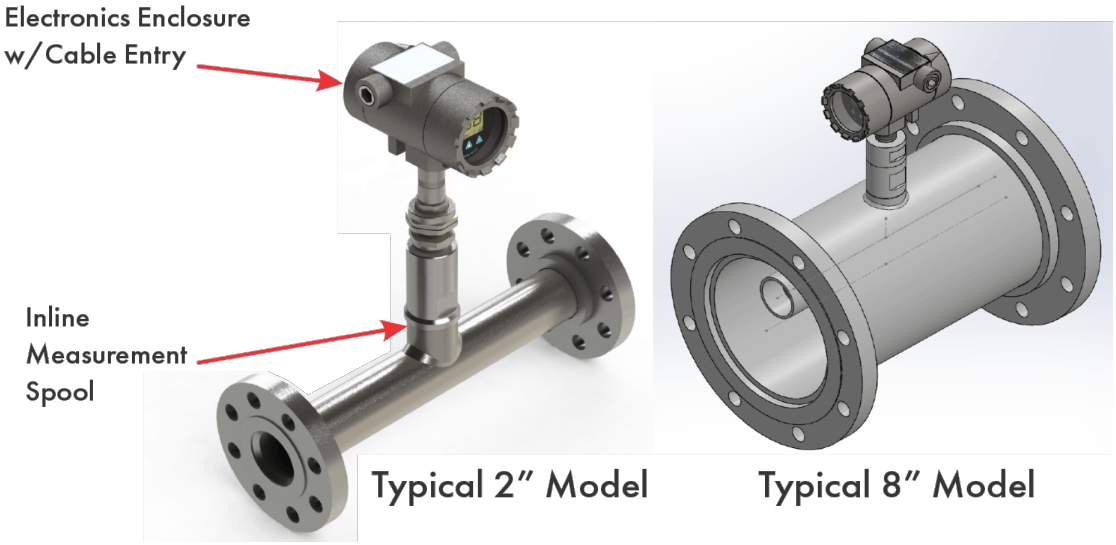


Figure 2-7: Flanged and Threaded Version

2.4.3. SM-Series — Built in Static Mixer

Oil and water does not mix well. Depending on location, type of oil, flow rate, upstream obstructions causing mixing these meters can be supplied with built in static mixer. This ensures that the water and oil do not travel in separate layers risking water to slipstream passed the sensor undetected.

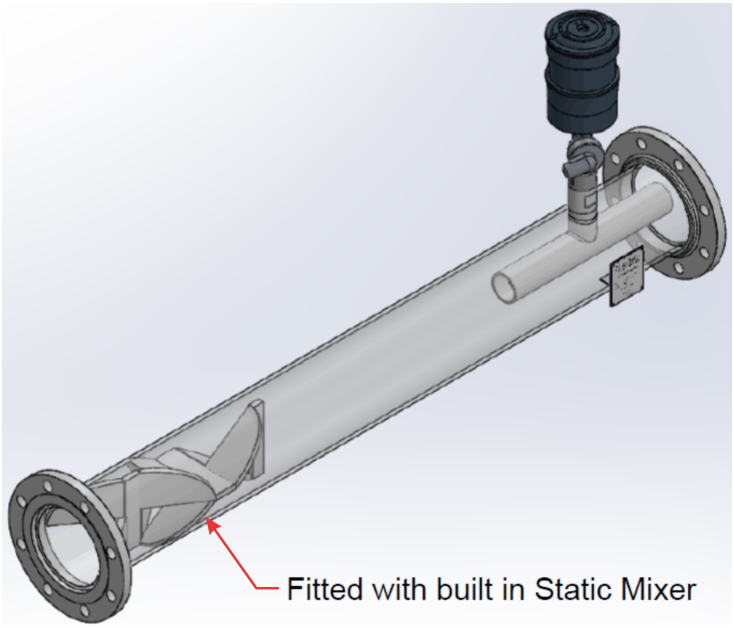


Figure 2-8: Built-In Static Mixer

2.4.4. F-Series - Fully Flanged Analyzers

The F-Series sensor consists of a EXD certified Electronics Enclosure with cable entries for electrical wiring, a spool section for mounting into the pipe line to be measured. The EXD enclosure is available in different versions to suit different markets/ certification requirements.

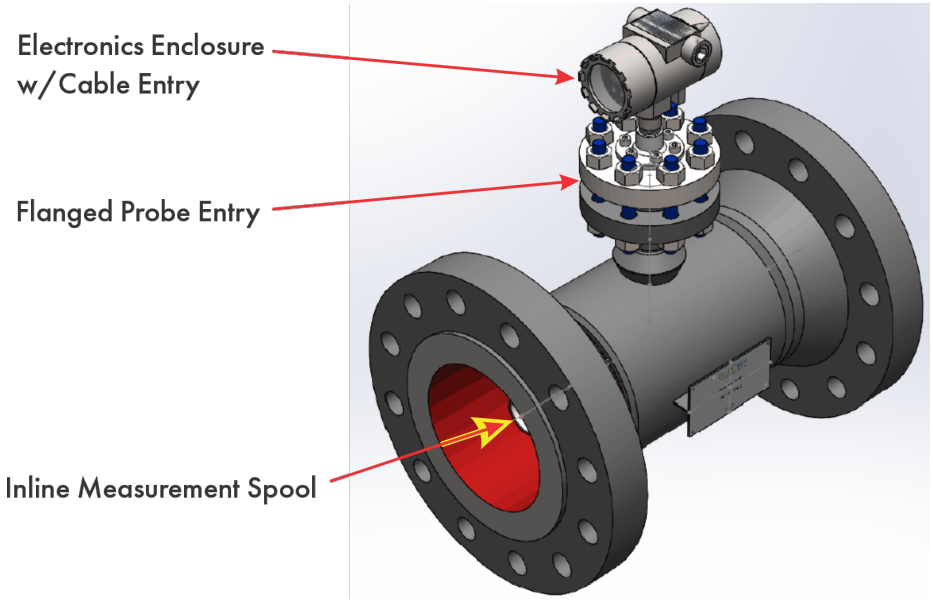


Figure 2-9: Fully Flanged Analyzers

2.4.5. FM-Series — Built in Static Mixer

Oil and water does not mix well. Depending on location, type of oil, flow rate, upstream obstructions causing mixing these meters can be supplied with built in static mixer. This ensures that the water and oil do not travel in separate layers risking water to slipstream passed the sensor undetected.

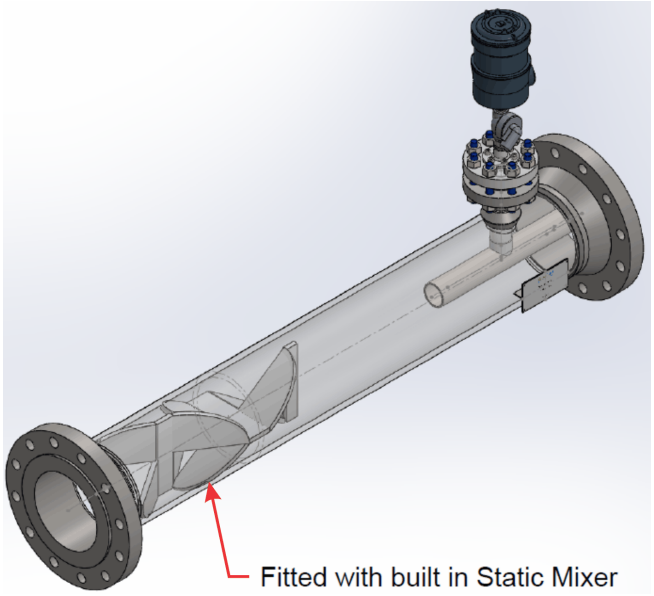


Figure 2-10: FM-Series — Built in Static Mixer

2.4.6. I-Series — Flanged Version

he flanged I-Series consists of a EXD certified Electronics Enclosure with cable entries for electrical wiring, a flanged probe section for insertion into the pipe line to be measured. The EXD enclosure is available in different versions to suit different markets/ certification requirements.

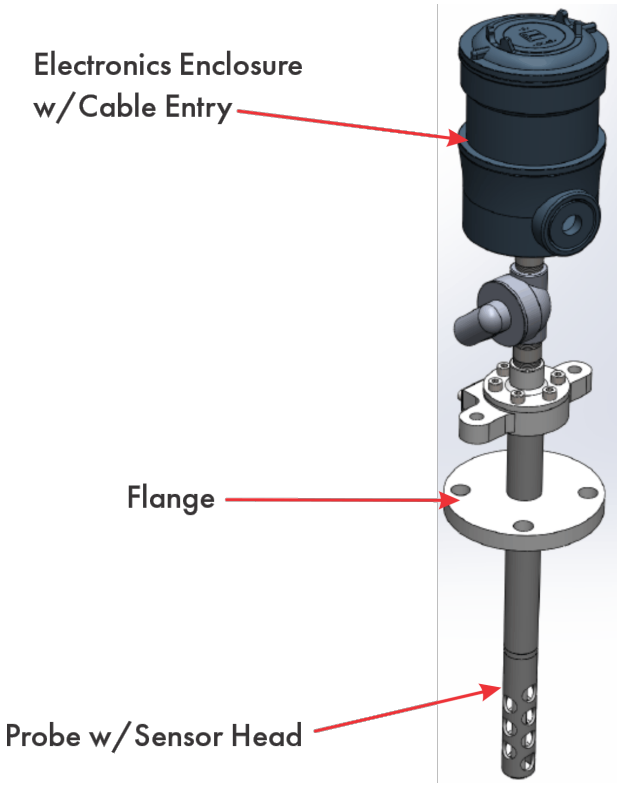


Figure 2-11: I-Series — Flanged Version

2.4.7. Installation Examples — Flanged I-Series

2.4.7.1 Installation into Larger Pipe Through a 2″ or 3″ Side Port

Works with 6 inch or larger lines.

Pressure Rating up to 1500#.

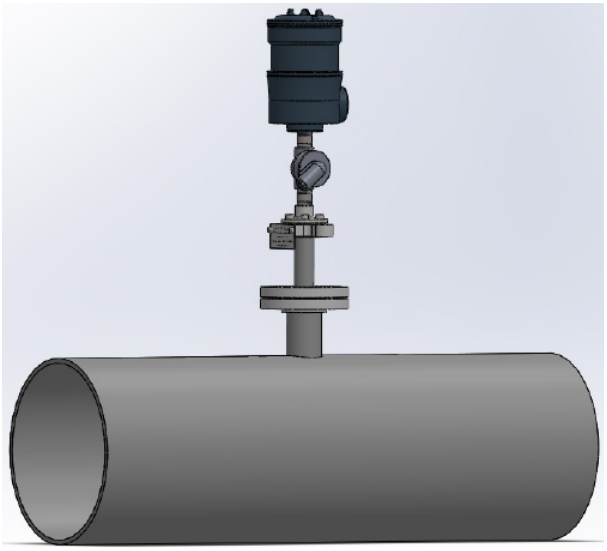


Figure 2-12: Installation into Larger Pipe Through a 2″ or 3″ Side Port

2.4.7.2 Installation into Smaller Pipe through a Pipe Bend or T-Section

Installation into smaller pipe through a pipe bend, T-section or similar arrangement allowing probe to insert along the main line.

Generally for 2" to 4", but can be used also for larger pipe.

Pressure Rating up to 1500#.

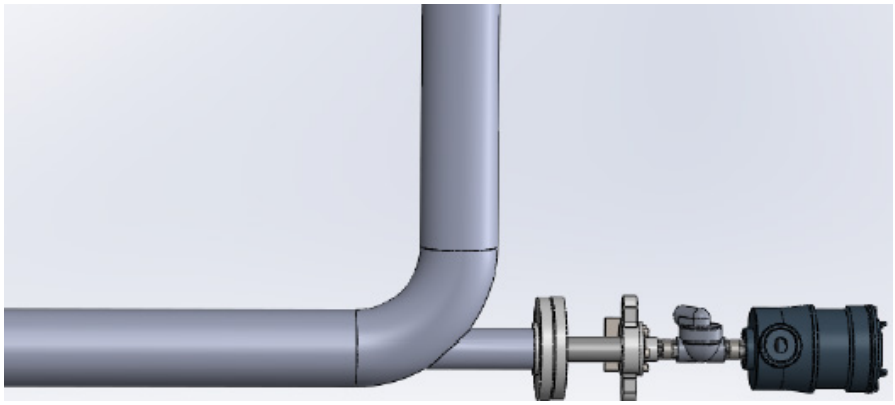


Figure 2-13: Installation into Smaller Pipe through a Pipe Bend

2.4.7.3 Fitted with Measurement Spool, Static Mixer, and Other Features

The I-Series can be supplied with a measurement spool fitted with static mixer and other features such as sampling ports

Figure 2-14: Installation into Smaller Pipe through a Pipe Bend

2.4.7.4 I-Series — Version for Extraction under Line Pressure

The non-flanged I-Series consists of a EXD certified Electronics Enclosure with cable entries for electrical wiring and a rod style probe section for insertion into the pipe line to be measured through a process gland. The EXD enclosure is available in different versions to suit different markets/ certification requirements.

The Extraction Kit allows inserting/removing the I-Series probe safely through a ball valve under line pressure.

Figure 2-15: I-Series for Extraction under Line Pressure

2.4.7.5 I-Series Installation Example

Installation into larger pipe through a 2″ or 3″ side port.

Perpendicular installation works with 6″ or larger lines. For 2″ to 4″ it can be used at an elbow/T-Section or similar as shown for the flanged version.

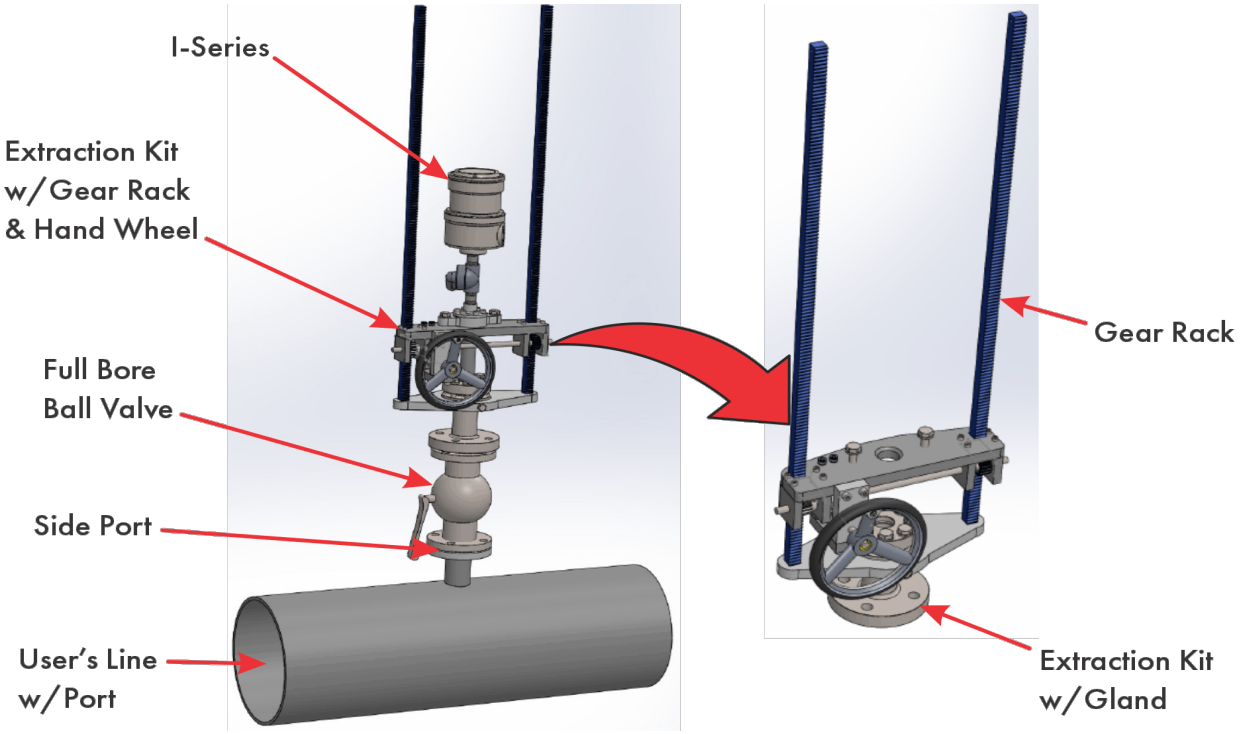


Figure 2-16: Installation into Larger Pipe through a 2" or 3" Side Port

3. Installation

CAUTION: Ensure that product marking is suitable for the classified area of installation. Ambient temperature shall not exceed 60 deg C.

CAUTION: The housing must be protected against mechanical shocks. No drilling or machining must be done. Make sure the cable gland is appropriately tightened and make a loop with your cable to avoid running water alongside. If you do not take these precautions into account, the envelop certification would be put at risk, and the ingress of protection of the housing might be modified!

CAUTION: Electrical wiring must be executed when DE-ENERGIZED after mounting and fixing the instrument. Electrical wiring must be executed with respect to the sound engineering practice and the in force norms. Cables used must be selected according to area classification standard used. Use shielded cables to minimize interference. Shield shall be grounded control side only, do not ground shield in instrument. In order to guarantee a perfect tightness, the cable gland should be screwed with an appropriate spanner. Terminals wiring are designed for 2.5mm² max. wires.

CAUTION: The type and the path of cables must comply with the in force rules. Careful precautions must be taken to avoid electro-magnetic couplings with other cables capable of causing hazardous voltages or currents. Cables and wires must be protected against any damages.

CAUTION: Setup in safe area can be done using the RS-232 terminal located under the cover of the unit. RS-232 shall not be used in hazardous area without special precaution/approvals (Hot Work Permit). The provided HART interface allows safe access/setup/calibration for hazardous area locations. For insitu setup and calibration use HART interface as this does not require opening the EXD enclosure.

CAUTION: The dismantling of the equipment must be executed when DE-ENERGIZED. The Company guarantees the certification of the equipment EX Works. Any wiring except connecting the 4-20mA cable in therefore provided connector will rule out the Company's responsibility in case of failure. If a fault is suspected or observed, the equipment must be immediately de-energized and returned to safe area for service / fault finding. Only authorized personnel should repair the equipment.

3.1. Electrical: 4-20mA

3.1.1. Power Supply - 4-20mA Current Loop

Voltage:	12 to 26VDC (Floating/Isolated)
Power Consumption:	0.66W

The Monitor/Analyzer provides a 4-20mA analog signal that is proportional to the measured water content. The current loop must be powered externally and will provide sufficient power for the Monitor/Analyzer to operate. The Monitor/Analyzer operates from 12 to 26VDC.

3.1.2. Power requirements

Maximum ripple (47 to 125 Hz):	0.2 V p-p
Maximum noise (500 Hz to 10 kHz):	1.2 mV rms
Maximum series impedance (500 Hz to 10 kHz):	10 Ω

Power for a two-wire instrument loop is typically 24VDC. As always, the voltage must be sufficient to provide the necessary lift-off voltage for the field device. Take into account voltage drops in the cable and load resistor, as well as from any passive intrinsic safety, or IS, barrier present. Smart devices may take up to 22mA to indicate an alarm condition. Use this value to calculate the worst case drop in loop voltage.

3.1.3. Cable Considerations

If possible, use individually shielded twisted pair cable. Unshielded cables may be used for short distances, provided ambient noise and cross-talk will not adversely impact communication. The minimum conductor size is 0.51mm diameter (#24 AWG) for cable runs less than 1,500 meters (@5,000 ft.) and 0.81mm diameter (#20 AWG) for longer distances.

Shield shall be grounded in ONE end only to avoid earth loops.

CAUTION: The Current Loop MUST be floating! Grounded or poorly isolated loop WILL cause damage to the Monitor/Analyzer electronics! To verify, measure resistance between +24VDC and pipeline as well as –24VDC and pipeline. Resistance must be infinite or the Monitor/Analyzer electronics may be damaged.

Figure 3-1: Monitor/Analyzer Wiring Terminal (2-Loop Powered)

3.1.3.1 Enclosure Cable Entries, Cable Glands, and Stopping Plugs

For threaded entries use only already certified connection facil-ities suitable for application and rated for a minimum of 80°C.

Unused openings shall be closed using certified stopping plugs suitable for application and rated for a minimum of 80°C.

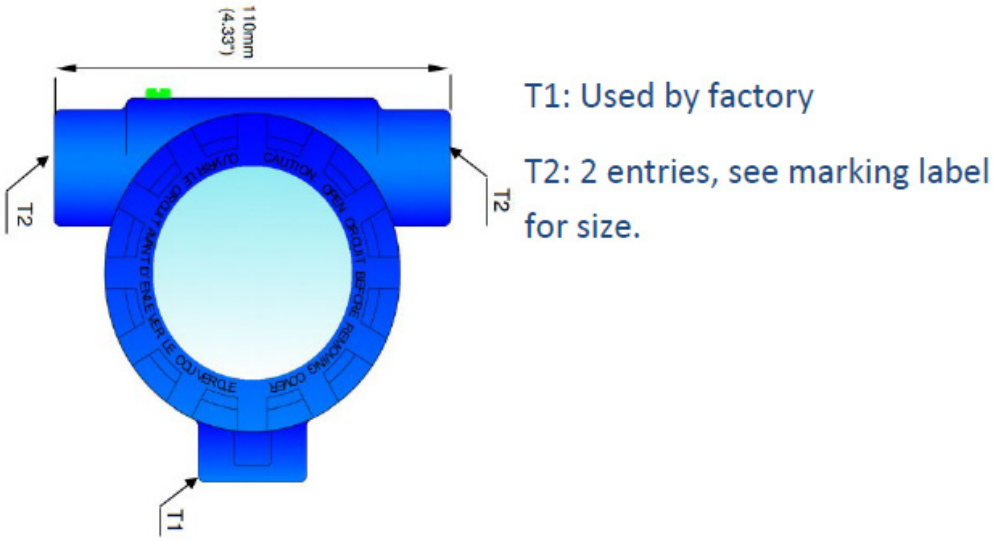


Figure 3-2: Enclosure Cable Entries

3.2. Communication RS-232 Interface

WARNING: NOT TO BE USED IN HAZARDOUS AREA!

The Monitor/Analyzer is fitted with a RS-232 terminal interface. The interface is accessible using the supplied RS-232 cable only. Connect the cable to terminal J7 on the PCB. Connect the other end to a PC with RS-232 interface, or since many PCs today lack RS-232, use a USB-RS-232 Converter. The

supplied RS-232 cable has a small PCB in the black RS-232 Connector and communication will not work with any other cable.

Bits per second:	9600
Data Bits:	8
Parity:	None
Stop Bits:	1
Flow Control:	None

3.3. Terminal Software

There are many alternatives available.

PUTTY.EXE is free open source terminal software that can easily be found for free download.

INTERFACE.EXE is a windows only software that is capable of RS-232 as well as HART modem communication. Contact the Company for a copy.

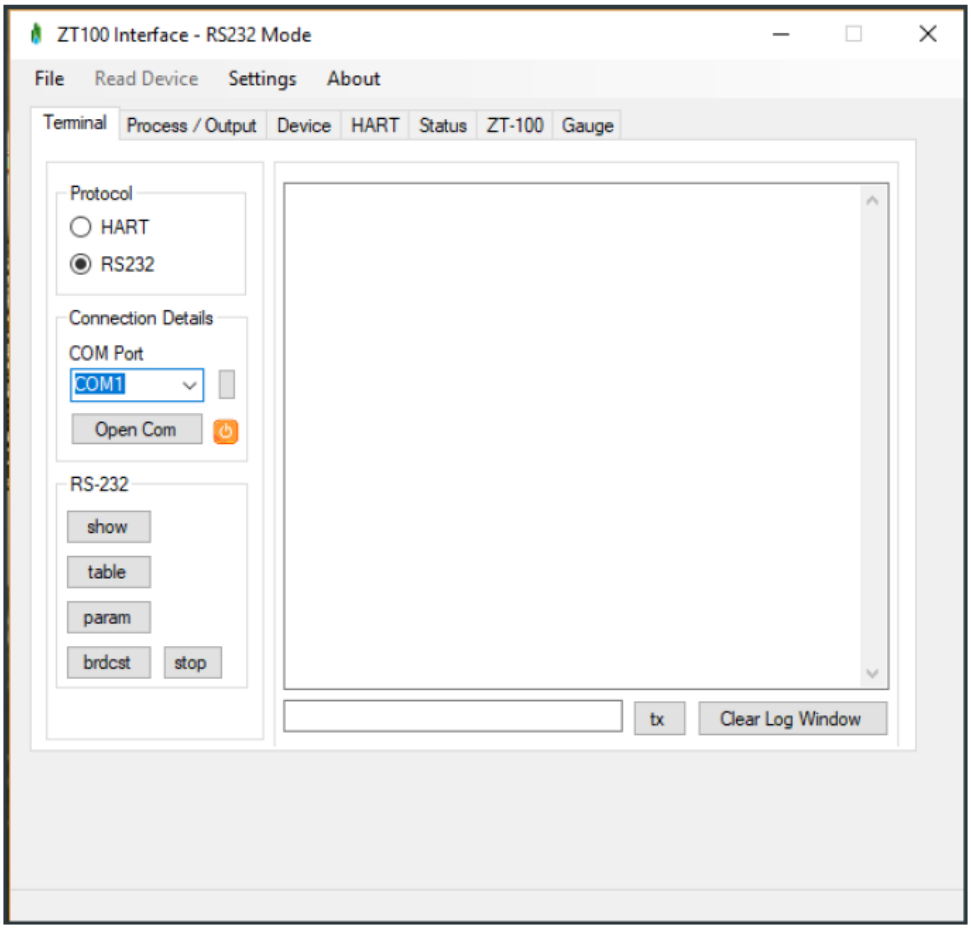


Figure 3-3: INTERFACE.EXE

3.4. General Installation Guidelines

The following images provides a few pointers to good vs. bad installation. Key to a good measurement is to avoid slugging,

partially filled pipes, gas/air pockets, fast pressure drops, open end outlets, pump interference and stratified water/oil.

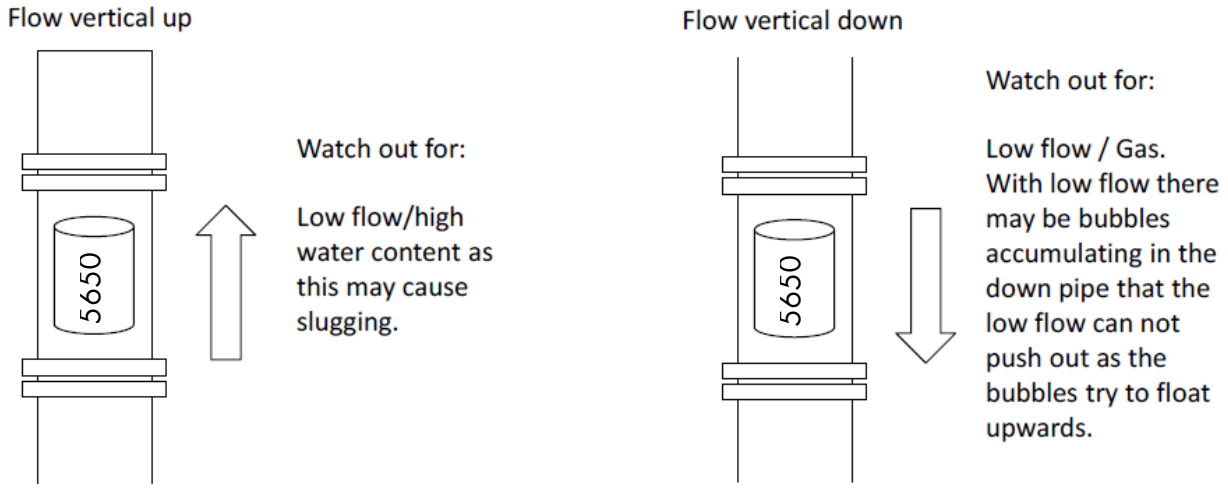
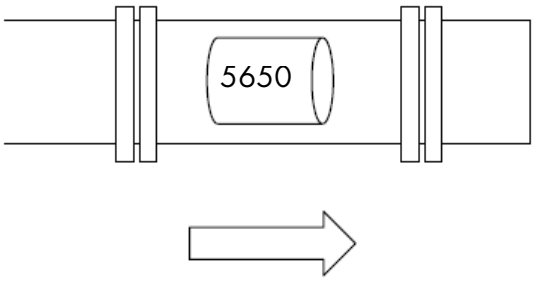


Figure 3-4: Vertical Installation



Ensure the oil/water is properly mixed. Especially in larger pipes the water and oil may travel in different layers and oil or water my slip by undetected.
Make sure pipe is full.

Figure 3-5: Horizontal Installation

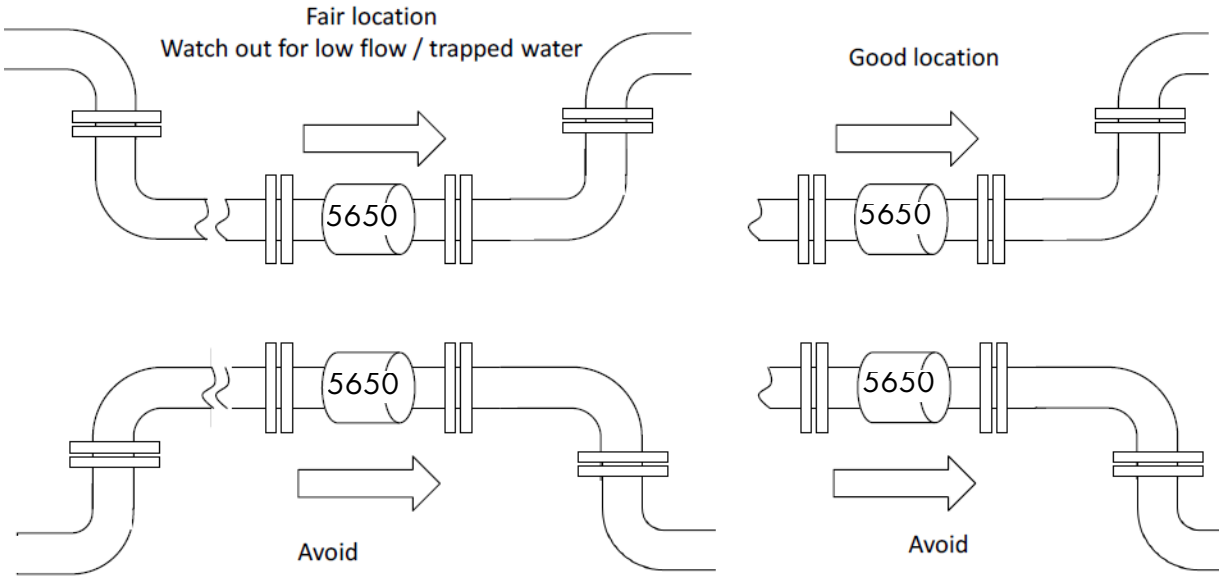


Figure 3-6: Installation Location

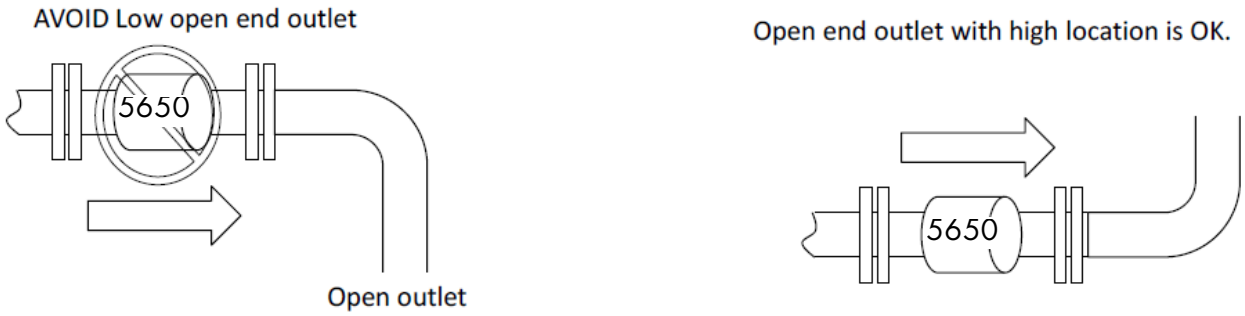


Figure 3-7: Installation Location - At Outlet

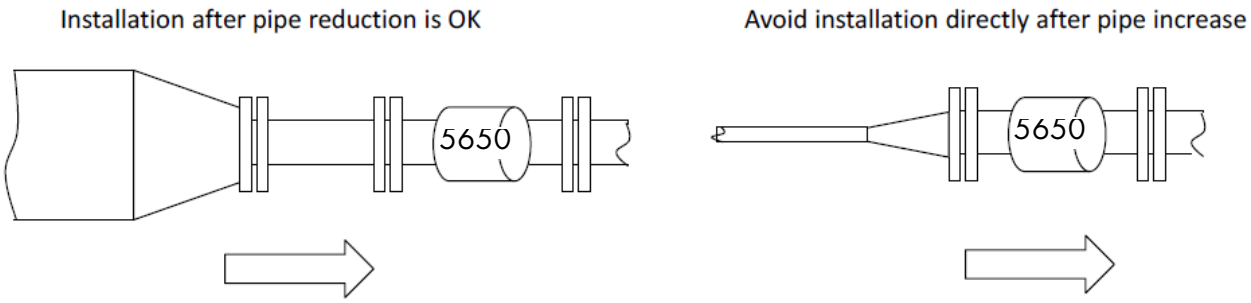


Figure 3-8: Installation Location - Near Pipe Reducer/Expander

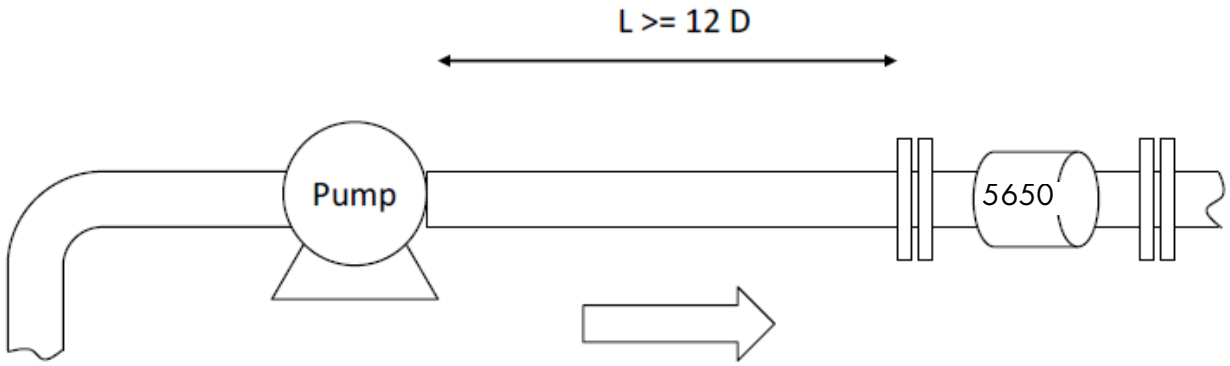


Figure 3-9: Installation Location - Do Not Install Near Pump

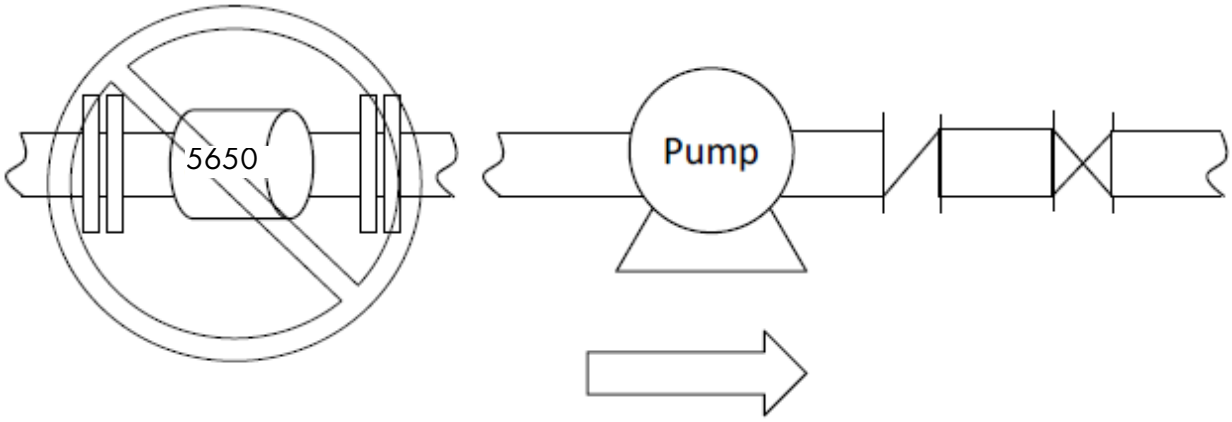


Figure 3-10: Installation Location - DO Not Install on Suction Side of Pump

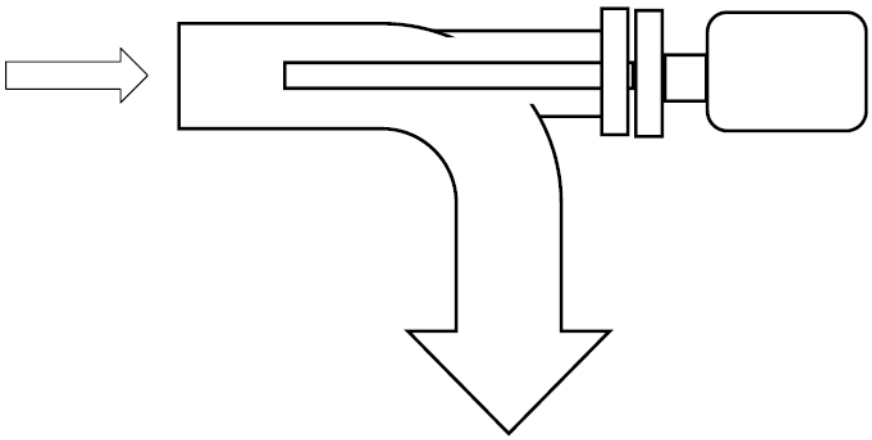


Figure 3-11: Installation Location - Insert I-Series Against Flow

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4. Field Calibration

4.1. Zero Offset

4.1.1. Field Calibration Overview

Field calibration is the process of teaching the Monitor/Analyzer what level of capacitance corresponds to a given level of water content. This is a single point offset; the electronics will take care of the rest. This teaching process is referred to as Zero Offset. The process can be performed at any water content, the software will automatically calculate the zero point from any given water content.

As an option, applications with large temperature fluctuations can compensate for temperature inflicted changes in capacitance. Temperature is compensated for using a Temperature Compensation Factor.

4.1.2. Zero Offset

Zero Offset can be performed using 3 different methods:

1. S1 button located inside the unit.
2. Using the RS-232 terminal interface.
3. Using the HART interface.

4.1.2.1. Zero Offset using S1 Button

WARNING: NOT TO BE USED IN HAZARDOUS AREA!

Pressing the S1 button located on the PCB inside the unit will instantly zero the unit to the liquid inside the unit and use the current temperature as the point of origin for temperature compensation. It will assume the oil is dry (0%). The Zero level can, if needed, be modified using the command cal should a lab result be available at a later point in time.

4.1.2.2. Zero offset using RS-232 Interface

WARNING: NOT TO BE USED IN HAZARDOUS AREA!

This is a 2step process using 2 different commands.

1. The **SAVE** command will save the current capacitance and temperature reading to memory.
2. The **cal #.##** command (#.## being known or estimated water content) will offset the internal reference table to match given water content using the values saved with command save.

It is quite possible to enter an estimate for cal directly after having performed the save command. This estimate can be corrected at a later time should a lab result or better estimate be available later on.

NOTE: Do not save again as this will overwrite the saved reference points that you have water content data for.

WARNING: ABOVE METHODS CAN BE USED ONLY IF YOU HAVE A HOT WORK PERMIT AS THEY REQUIRE OPENING THE EXD ENCLOSURE.

4.1.2.2.1. RS-232 TERMINAL

4.1.2.2.1.1. Zero Offset Commands

The following commands will save the current readings and tell the unit that current water content is 0%. Water content level can be changed to match lab results later.

- save[enter]
- cal 0[enter]

The following command will tell the unit that the water content (at time of save) was 0.25%.

- cal 0.25[enter]

4.1.2.2.1.2. Calibration Samples

Take sample as close in time as possible to the time of issuing the save command.

Take sample from a location close to the MODEL 5650 Monitor.

Ensure your sample is representative.

Allow sample line/points to flush stagnant liquid to ensure a fresh sample for calibration.

4.1.2.3. Zero Offset using HART Interface

Performed exactly as the RS-232 process. save command is represented by HART Command #144 cal command is represented by HART Command #143 See Device Specific HART Commands for byte format.

4.2. Temp Compensation

4.2.1. Temperature Coefficient

The temperature coefficient (TC) is the relationship between temperature and capacitance. The coefficient is applied to the measured capacitance per degree Celsius of temperature change and pivots around the temperature saved using the Save command.

4.2.1.1. Find the TC

Record T1 and C1 as temperature and capacitance while running at a lower temperature. Record T2 and C2 as temperature and capacitance while running at an elevated temperature.

Calculate TC using the formula below.

4.2.1.2. Apply the TC

The temperature compensation coefficient is entered into the Monitor using the RS232 interface.

4.2.1.2.1. TEMPERATURE COEFFICIENT FORMULA

$$tc = 1 - \frac{\left(\frac{C2 - C1}{T2 - T1}\right)}{C1}$$

4.2.1.2.2. RS-232 TERMINAL/HART

The RS-232 command for setting the temperature coefficient is tec #.####. (#.### being the TC).

Command #142 is used to set tc using HART. See HART Command reference for byte format.

NOTE: In most field applications the process temperature stay within a few degrees over long periods of time and there is no need to apply any temp compensation factor. Keeping tc=1 will do just fine.

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5. RS-232 Protocol

Command	Action	Terminal Output Example
show	Provides a terminal output of the latest reading	Capacitance 270.1pF Per cent H_2O: 13.6% Temperature: 21.7C
param	Printout of current parameters	Calibrated to: 0.0% H_2O Range: 3% Tempco:1.0000 Alarm level: high
table	Printout of the Lookup Table showing the relationship between probe capacitance and the water content.	a. Capacitance: 179.8pF H_2O: 0% b. Capacitance: 185.3pF H_2O: 1% c. Capacitance: 190.9pF H_2O: 2%
reset	Reset the lookup table to Factory Default	Reset [enter]
alarm	Set current loop alarm level for out of range values. Can be either high or low, where low is 3.8mA and high is 20.2mA, e.g. In parameters: low or high. Default is high.	alarm high [enter]
tec	Temperature Coefficient Factor. Allows values between 0.5 and 2, maximum 4 decimals	tec 1.0007 [enter]
save	This command will tell MODEL 5650 to save its latest capacitance and temperature measurement as a calibration reference value to be used with the cal command. Manual storage of pF or temp value is possible.	Save [enter] Save pf 199.9 [enter] Save t 75.5 [enter]
avg	Sets the number of measurements over which reading is averaged. In effect a damping. Max: 20 Default 20 Min: 1	avg 10 [enter]

Command	Action	Terminal Output Example
cal	Sets the percentage value used after cal to match the pF value stored using store. The internal calibration table will be offset using the value saved with command save. Accepts 2 decimals. The S1 button on the PCB performs command save followed by cal 0 and therefore allows zeroing to dry oil without computer.	cal 0.00 [enter]
brdcst	Broadcast readings continuously over RS-232 at whatever rate is set by command average. Stop broadcasting by pressing q [enter] capacitance (pF), water content (%), temp (°c)	Brdcst [enter]
scale	This command will scale the 4-20mA output to desired range. Max 25 for Low Range units, max 100 for High Range units.	scale 10[enter]

6. HART

6.1. HART Protocol

DD	device description	PLC	programmable logic controller
FSK	frequency shift keying	PV	primary (1st) variable
HCF	HART Communication Foundation	SV	secondary (2nd) variable
LSB	least significant bit	TV	tertiary (3rd) variable
MSB	most significant bit	QV	quaternary (4th) variable
PDU	protocol unit data		

6.1.1. Introduction

Model 5650 complies with HART protocol revision 6. This document specifies all device specific features and documents HART protocol implementation.

6.1.2. HART Communication - Basics

HART (Highway Addressable Remote Transducer) is a digital protocol for field communication. It is widely accepted as a standard for digitally enhanced 4-20 mA communication with smart and microprocessorbased field devices.

HART is a digital master/slave protocol. Slaves only send information when requested to do so by a master. The digital signal is superimposed onto the analog current loop without affecting it. The serial digital data channel is used to configure the device as well as allowing access to multiple process variables. To superimpose the digital signal with the current loop, a frequency shift keying (FSK) technique, based on the Bell 202 communication standard is used. Two frequencies, 1200 Hz and 2200 Hz are used to represent binary 1 and 0. Thus, HART communication is limited to 1200 Baud.

HART provides two different masters (primary and secondary) to each loop. Primary masters are typically PLCs, computer-based controllers or monitoring systems. Secondary masters are for example handheld communicators. Both masters can be connected to one current loop without disturbing the communication.

HART devices can operate in one of two network configurations:

- point-to-point
- multidrop connection

In case of a point-to-point connection, the 4-20 mA signal is used to communicate one process variable, while other process variables or configuration data are transferred digitally.

For multidrop mode the 4-20mA is locked at 4mA and all data is transferred digitally over HART.

6.1.3. HART Setup

Poll address can be reset to 0 by keeping button S1 pressed during power up.

6.2. Universal Commands

The following universal commands are implemented. Please refer to your HART documentation for extensive information on each of these commands.

Commands from 0-100 in the HART protocol are standardized, i.e. all common HART filed communicators can interact with the 5650 using these commands without any setup or programming being required.

Command No.	Command Description
Command 0:	Read unique identifier.
Command 1:	Read primary variable.
Command 2:	Read loop current and percent of range.
Command 3:	Read dynamic values and loop current.
Command 6:	Write polling address and set/reset multi-drop mode.
Command 7:	Read loop configuration.
Command 11:	Read unique identifier associated with tag.
Command 12:	Read message.
Command 13:	Read tag, descriptor and date.
Command 14:	Read primary variable transducer information.
Command 15:	Read device information.
Command 16:	Read final assembly number.
Command 17:	Write message.
Command 18:	Write tag, descriptor and date.
Command 19:	Write final assembly number.
Command 20:	Read long tag.
Command 22:	Write long tag.
Command 34:	Write primary variable damping factor.
Command 35:	Write primary variable range values.
Command 38:	Reset configuration changed flag.
Command 40:	Enter/exit fixed current mode.
Command 42:	Perform device reset.

Command No.	Command Description
Command 43:	Set primary variable 0.
Command 45:	Trim loop current zero.
Command 46:	Trim loop current gain.
Command 48:	Read additional device status.
Command 56:	Write device variable transducer serial number.
Command 59:	Write number of response preambles.

6.3. Device Specific Commands

Byte No.	Description	Action	Result
Command 141	Load the capacitance /H_2O table with the default values.	Request Data Bytes:	none
		Response Data Bytes:	none
		Response Codes:	0x0 Success
Command 142	Set temperature coefficient	Request Data Bytes:	0-3, float
		Response Data Bytes:	0-3, float
		Response Codes:	0x0 Success
			0x3 Parameter Too Large
			0x4 Parameter Too Small
			0x8 Warning, set to nearest value
Command 143	Calibrate to entered percentage of water	Request Data Bytes:	0-3, float
		Response Data Bytes:	0-3, float
		Response Codes:	0x0 Success
			0x3 Parameter Too Large
			0x4 Parameter Too Small
			0x8 Warning, set to nearest value
			0x72 Capacitance Not Set
			0x73 Temperature Not Set

Byte No.	Description	Action	Result
Command 144	Store current value of capacitance and temp. Return values to master	Request Data Bytes:	none
		Response Data Bytes:	0-3, float (capacitance)
			4-7, float (temperature)
		Response Codes:	0x0 Success
Command 145	Store an entered value of capacitance to use for future calibration	Request Data Bytes:	0-3, float
		Response Data Bytes:	0-3, float
		Response Codes:	0x0 Success
			0x3 Parameter Too Large
			0x4 Parameter Too Small
			0x8 Warning, set to nearest value
Command 146	Store an entered value of temperature to use for future calibration AND for reference when calculating temperature drift	Request Data Bytes:	0-3, float
		Response Data Bytes:	0-3, float
		Response Codes:	0x0 Success
			0x3 Parameter Too Large
			0x4 Parameter Too Small
			0x8 Warning, set to nearest value
Command 147	Read H_2O calibration value, temperature co-efficient and reference temperature	Request Data Bytes:	none
		Response Data Bytes:	0-3, float (H2O calibration value)
			4-7, float (temperature coefficient)
			8-11, float (calibration temperature)
		Response Codes:	0x0 Success
Command 148	Read the table of Capaci-tance and $\%H_2O$	Request Data Bytes:	none
		Response Data Bytes:	0-50, 3*17 bytes
			Table of 17 rows of 3 bytes
			2byte unsigned int = Capacitance
			1 unsigned char = Water Content (%)

Byte No.	Description	Action	Result
Command 149	Write a complete cap/H_2O table to the card	Request Data Bytes:	0-50, 3 byte X 17 entries
			0-1 : unsigned int = Capacitance
			2: unsigned char = Water Content (%)
		Response Data Bytes:	0-50, 3 byte X 17 entries
			0-1 : unsigned int = Capacitance
			2: unsigned char = Water Content (%)
		Response Codes:	0x0 Success
Command 150	Change single row in cap/H_2O table	Request Data Bytes:	0-4
			0: unsigned char = Table position
			1-2 : unsigned int = Capacitance
			3: unsigned char = Water Content (%)
		Response Data Bytes:	0-4
			0: unsigned char = Table position
			1-2 : unsigned int = Capacitance
			3: unsigned char = Water Content (%)
		Response Codes:	0x0 Success
			0x02 Invalid selection
			0x3 Parameter Too Large
			0x4 Parameter Too Small

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Appendix A. Area Certificate

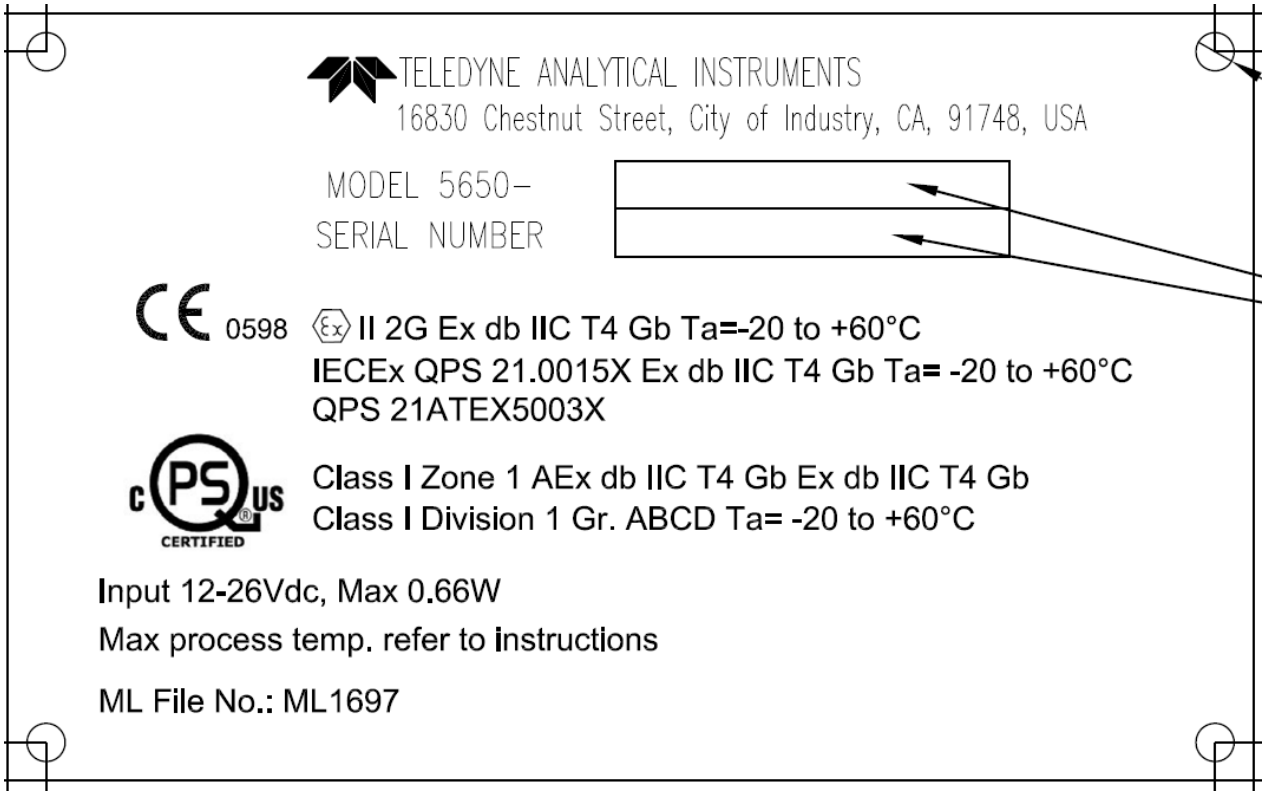

Figure A-1: Area Certificate

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Appendix B. HART Connection

HART is connected the same way as 4-20mA (see Output section for detailed write up of how 4-20mA is

connected).

A 280 Ohm resistor is put across the 4-20mA interface. HART is a superimposed signal over 4-20mA by

fluctuating the voltage. Hence a resistor is needed to access the HART Protocol

NOTE: RS-232 PROTOCOL needs to be unplugged in order to access HART.

B.1. Calibration

B.1.1. Standardization

Calibration of this analyzer requires a lab sample grab. The following command series assumes that the analyzer is installed in process, and sample is already flowing through the pipe. And commands are issued through the RS-232 Protocol

B.1.1.1. Standardization Procedure

While Sample is Running:

1. "show" – command screen shows current readout

2. "save" – unit saves present readout

a. DO NOT Save again, the saved reading is what one needs to calibrate the lab grab sample to.

3. Lab results comes back

4. "cal ##" - unit calibrated to lab sample and correlates to "saved" setting.

Typical mistake, user saves the reading multiple time where only they only need to save ONLY when lab sample is grabbed.

B.1.2. Electrical Calibration

The sample grab standardization method described above is suitable for site installation, but for factory calibration or dry testing a capacitor can be used to demonstrate the unit.

NOTE: In this demonstration:
1. the range is 0-100%
2. capacitor used is 220pF ±1%
3. following are factory set zero's
   a. 0% Water for Low range unit is 178 ±1% pF
   b. 0% water for High range unit is 25 ±1% pF
4. all Mdl. 5650 is calibrated through precision capacitor

B.1.2.1. Electrical Calibration Procedure

1. Insert capacitor in pin 3 and 6 at sensor connection.

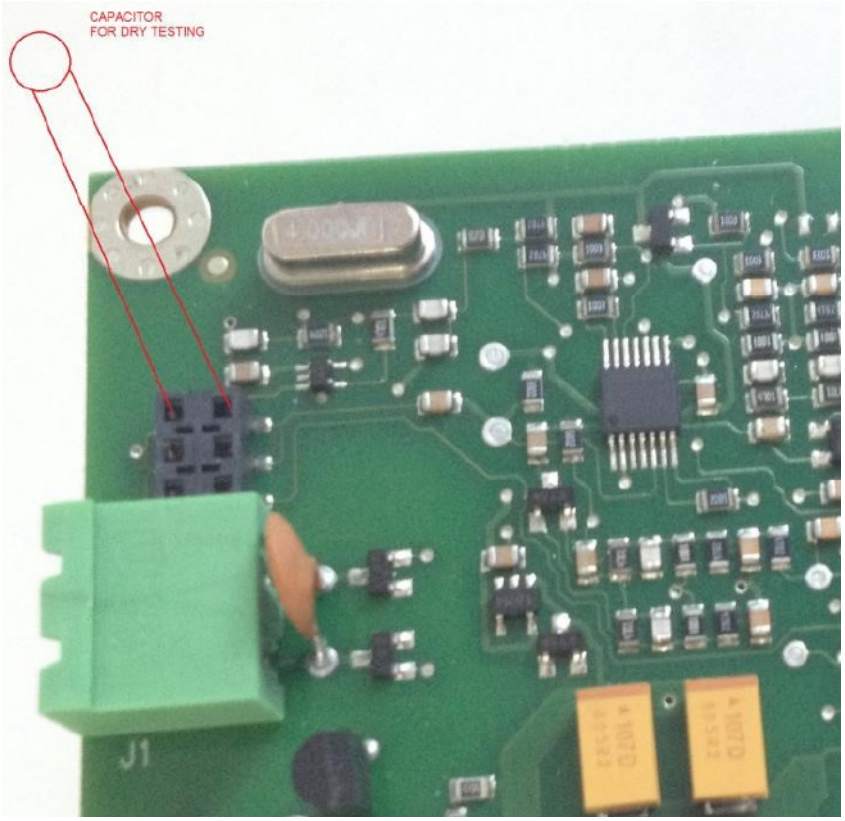

Figure B-1: Insert Capacitor

2. Hook multi-meter as per the 4-20mA diagram (see analog output section).

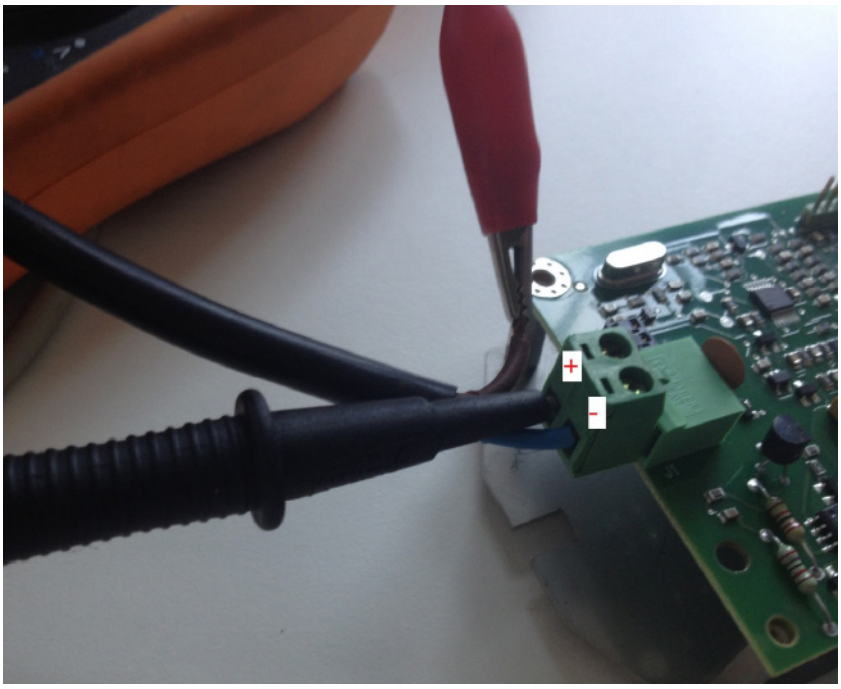

Figure B-1: Attach Multimeter

3. Run **Show** command to show present reading.
4. Check 4-20mA output and see if output respond correctly to capacitor load (see note section for the correct starting point)
5. Run **Table** command to show calibration curve.

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Appendix C. Capacitance Simulation & Verification Chart

Low Range: 0-25% Water Cut		High Range: 0-100% Water Cut	
0-25% Range	**Capacitance Value (pF)**	**0-100% Range**	**Capacitance Value (pF)**
0	179.8	0	25.0
1	185.3	4	28.1
2	190.9	8	31.6
3	196.7	12	35.6
4	202.6	16	40.0
5	208.7	20	45.1
6	215.0	24	50.7
7	221.5	28	57.0
8	228.1	32	64.1
9	235.0	36	73.9
10	242.0	40	87.0
12	256.9	48	120.4
15	280.9	60	195.0
18	307.0	72	566.0
21	385.6	84	740.0
24	366.9	96	893.0
25	377.9	100	930.0

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Appendix D. Start Up & Routine Maintenance Procedure

1. Equipment maintenance must be performed only after removing power from the unit. If a fault is suspected or observed, the equipment must be immediately de-energized and removed to a safe area for service or troubleshooting. Only authorized personnel should repair the equipment.
2. No cleaning, if there is no paraffin or high level of solids. Otherwise you can do steam cleaning, if required.
3. If the BS&W reading goes to FS on normal operation, it is a real indication of chocking at the measurement point.
4. Normally capacitance probe not required much maintenance.
5. For removing the probe from the process, kindly isolate the isolation valve from inlet & outlet of the process line and drain the crude in safe closed pit.
6. Then remove the probe from the process and do flushing the probe by using hot water for proper cleaning and clean the probe with soft cloth.
7. Then follow the TAI testing procedure and install probe back to process and tighten all the bolts.
8. Then first open the outlet valve and then followed by inlet of the process isolation valve.
9. Now 5650 BS&W Analyzer is ready to read the actual process value.

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Appendix E. 8080MK Field Mounted, Loop-Powered Indicator

E.1. Introduction

IME Model 8080MK Loop Powered Digital Indicators allow the process variable from any 4~20 mA current source to be monitored. Since the unit derives its power from the loop, no additional power supply or wiring is needed. Because of its low voltage drop (5 Volts at 20mA), it can be incorporated into almost any 2 wire loop, where local indication of a process variable is needed, because the integral transmitter indicator is inaccessible to view or is at a different location.

E.2. Description

IME Model 8080MK Indicators are designed for use in process industries where vibration, inclement weather and corrosive atmospheres prevail. The electronics are enclosed in a copper-free epoxy coated Aluminum housing and for more aggressive environments, a SS316 housing is optionally available. The housings meet the requirements of NEMA 4X & IP68, and are also certified Explosion Proof by ATEX/IECEx.

E.3. LED Meter

The Model 8080MK has 4 digit display and can be configured to read from 999 to 9999 with a 4~20 mA input signal. The decimal point location and engineering units can be adjusted using membrane switches, eliminating all potentiometric adjustments.

E.4. Mounting

The Model 8080MK can be wall mounted or mounted on a 2" pipe. For mounting the unit on a wall or 2" pipe, a wide choice of stainless steel mounting brackets are also available.

E.5. Certification System

Mark	Notes
	II 2G D Ex d IIC T6 Gb Ex tb IIIC T85°C Db IP68 Ta = -40°C to +60°C
	Ex d IIC T6 Gb Ex tb IIIC T85°C Db IP68 Ta = -40°C to +60°C

E.6. Functional Specifications

Indication of Accuracy:	0.1% of calibrated range ±1 digit
Calibration:	Via membrane switches on the front panel
Display Height:	8mm (0.3") high
Stability Over Time:	0.1% of calibrated range ±1 digit over 6 months
Over Range Indication:	Indication of "Err" on display
Response Time:	Typically 20 ms
Failure Mode:	Failure will not affect the loop integrity
Voltage Drop:	5V at 20mA
Operating Temperature:	-40°C to +60°C
Weight:	0.9Kg (2 lbs) for Aluminum Unit and 1.4Kg (3 lbs) for SS316 Unit
Material of Construction of Enclosure:	Epoxy coated Copper-Free Aluminum or SS316 as specified
O Rings:	Buna N (Nitrile)
Optional Accessories:	Mounting Brackets (Model 175PM, 175RC, 175NR, 175MM)

E.7. Ordering Information for 8080MK

Model	Description
8080MK	Field Mounted LED Loop Powered Indicator

	Code	Options, Housing
	A	Die cast Aluminum, Epoxy Coated
	T	SS316, Electro Polished

	Code	Instrument Connection (T1)	Conduit Size (T2)
	01	M16 x 2P (See note 1)	¾" NPT
	02	M16 x 2P (See note 1)	½" NPT
	03	M16 x 2P (See note 1)	M20 x 1.5P
	04	½" NPT	¾" NPT
	05	½" NPT	½" NPT
	06	½" NPT	M20 x 1.5P
	07	¾" NPT	¾" NPT
	08	¾" NPT	½" NPT
	09	¾" NPT	M20 x 1.5P
	10	½" BSP	¾" NPT
	11	½" BSP	½" NPT
	12	½" BSP	M20 x 1.5P
	13	¾" NPT	None
	14	M20 x 1.5P	None
	16	½" BSP	None
	17	½" NPT	None

		Code	Certification
		NN	None
		E1	ATEX / IECEx Explosion Proof Certified, IP68, T6

			Code	Accessories
			RC	Model 175RC Mounting Bracket (See note 1)
			PM	Model 175PM Mounting Bracket (See note 1)
			NR	Model 175NR Mounting Bracket
			MM	Model 175MM Mounting Bracket

				Code	2 Inch "U" Bolt w/Nuts & Washers
				00	None
				01	Model 17508, 1 Set (For Model 175RC)
				02	Model 17508, 2 Sets (For Model 175PM & 175NR)

8080MK	A	02	E1	PM	02	Typical Model Numer

Note:

1. Ports with M16 x 2P thread are not through holes, they are for use with Model 175RC and 175PM Mounting Brackets only.

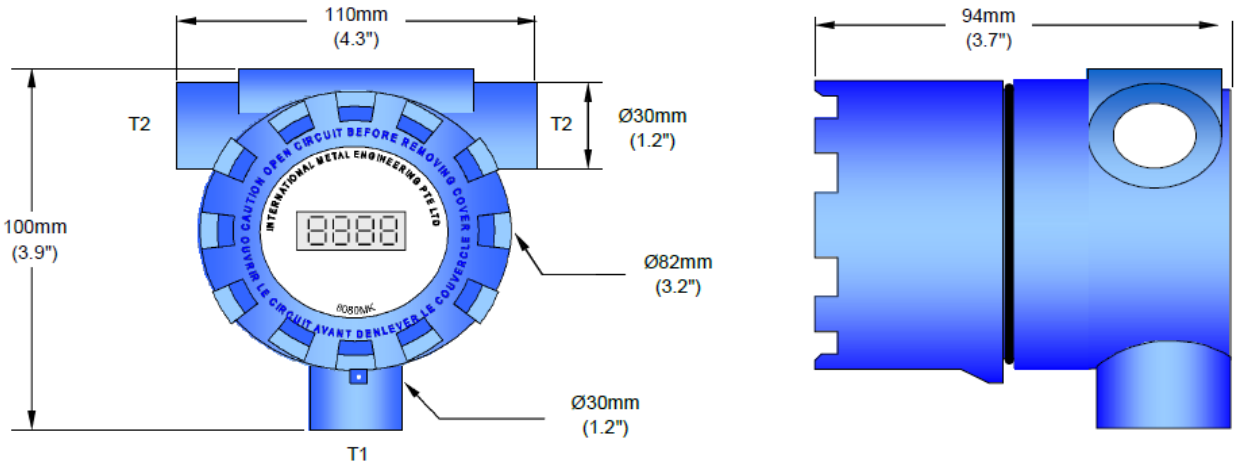

Figure E-1: Dimensions

E.8. Installation

E.8.1. Mounting Methods

E.8.1.1. Model 175RC

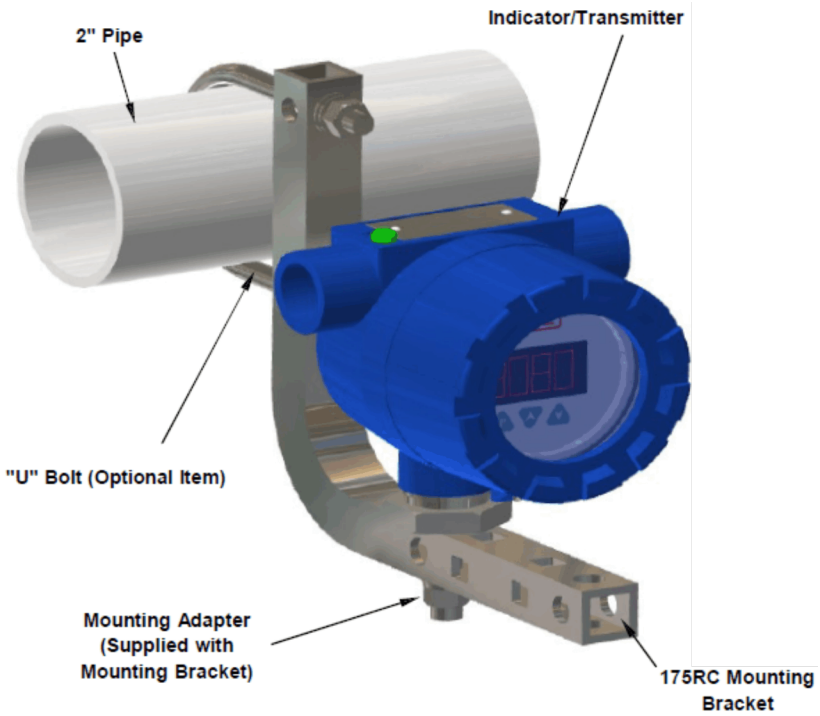

Figure E-2: Model 175RC - Pipe Mounting

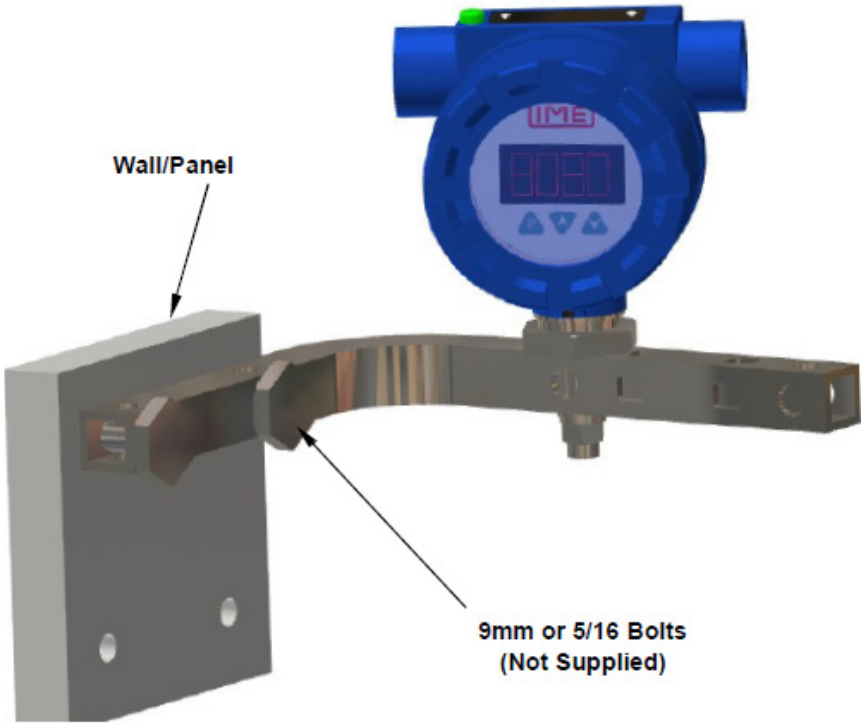

Figure E-3: Model 175RC - Panel Mounting

E.8.1.2. Model 175PM

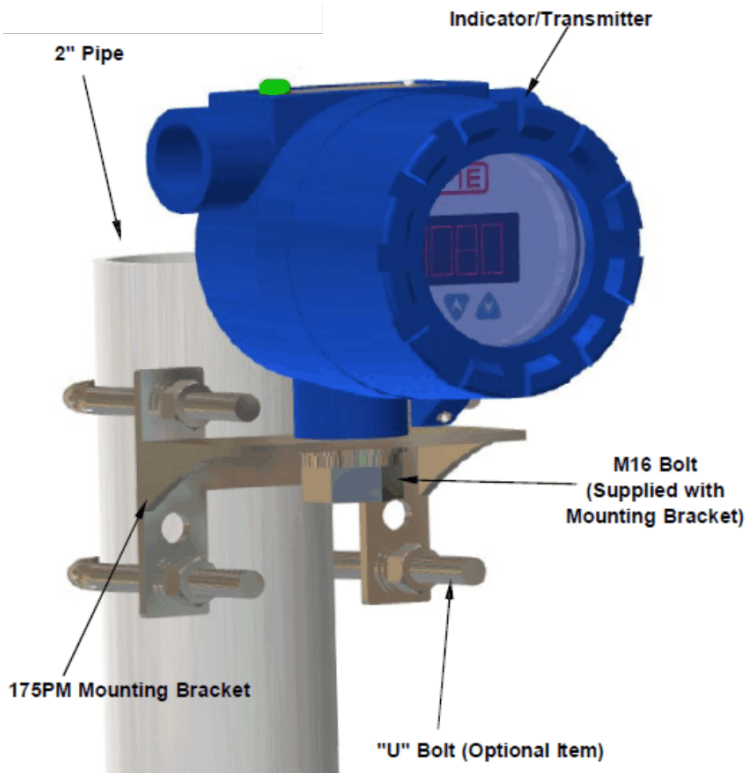

Figure E-4: Model 175PM - Pipe Mounting

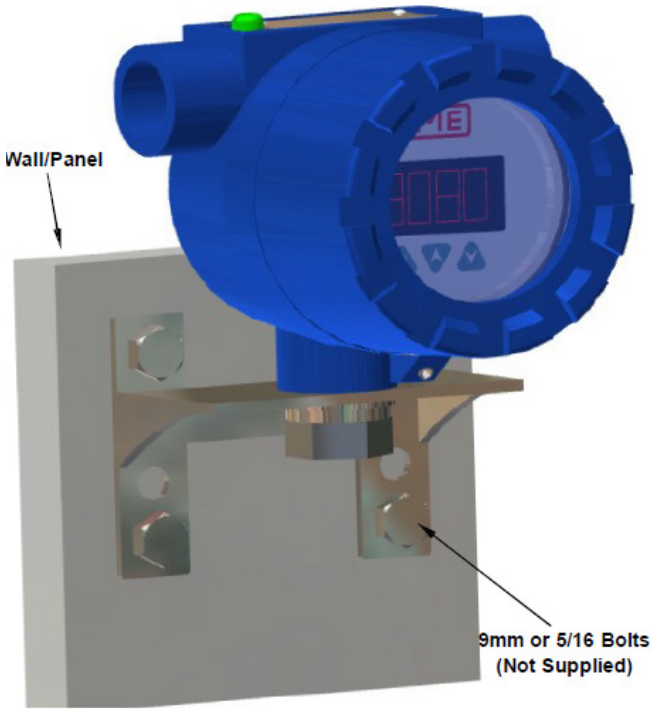

Figure E-5: Model 175POM - Panel Mounting

E.8.1.3. Model 175NR

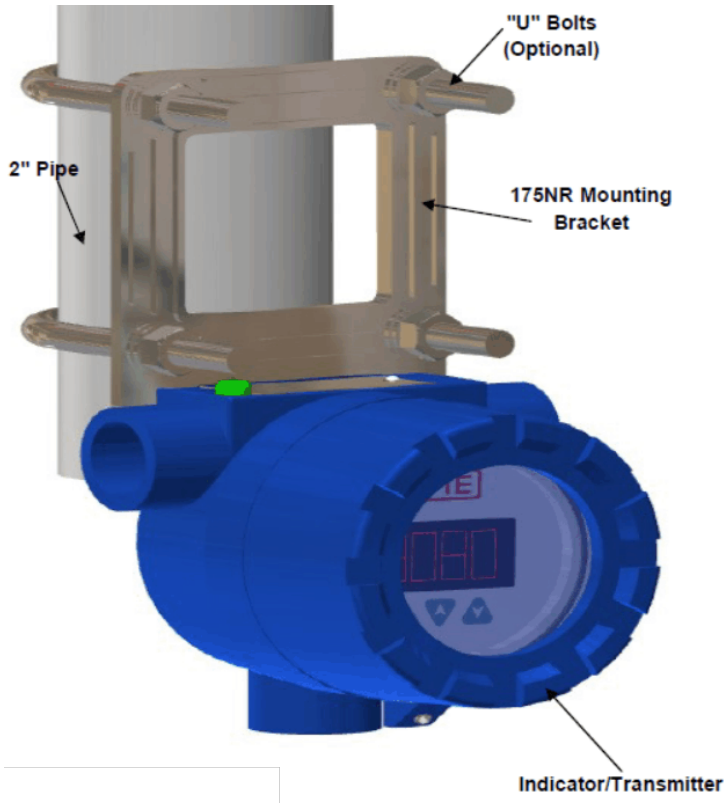

Figure E-6: Model 175NR - Vertical Pipe Mounting

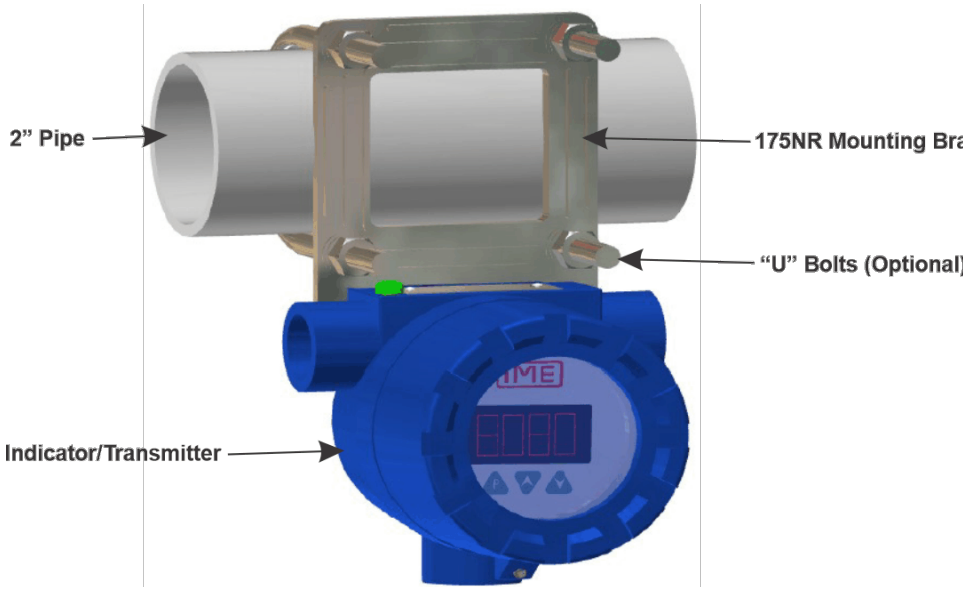

Figure E-7: Model 175NR - Horizontal Pipe Mounting

E.8.1.4. Model 175MM

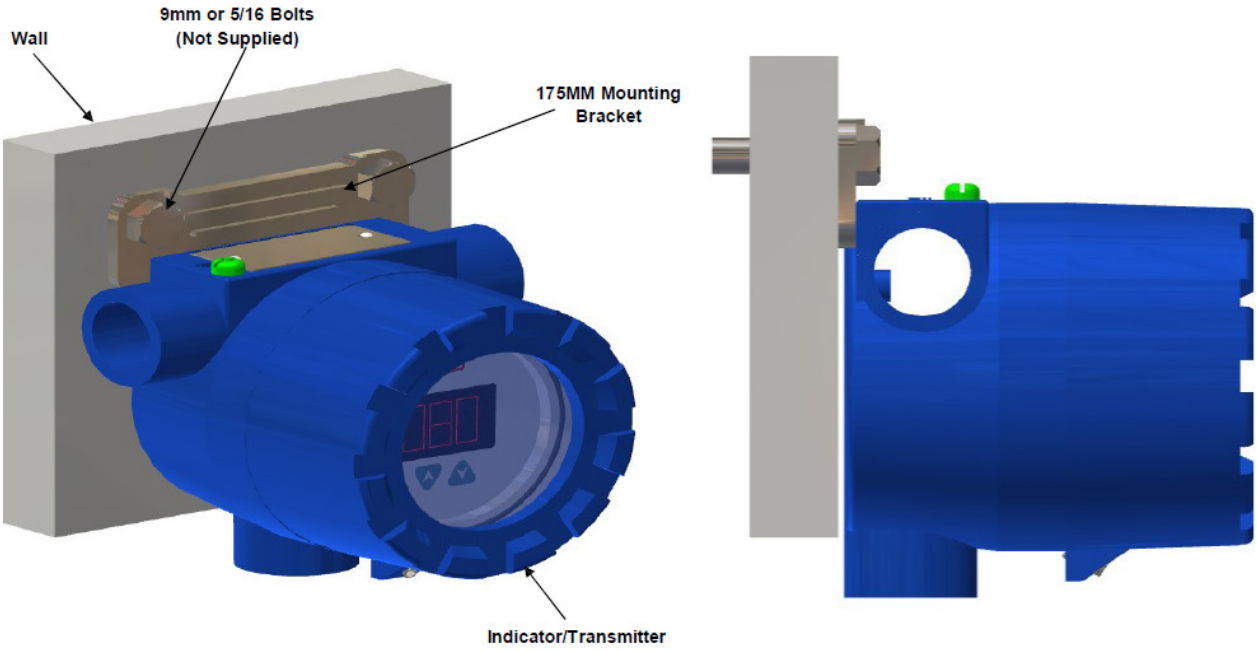

Figure E-8: Model 175MM - Wall/Panel Mounting

E.8.2. Mounting Brackets

E.8.2.1. Model 5RC

This simple hollow square mounting bracket constructed out of SS316 Stainless Steel, can be used to mount a variety of field devices, either on a wall or panel or a 2" Pipe.

When mounting on a 2" pipe, a "U" Bolt is required, which can be supplied optionally.

The Model 17508 consists of a complete assembly of a 2" U bolt along with the nuts and washers required.

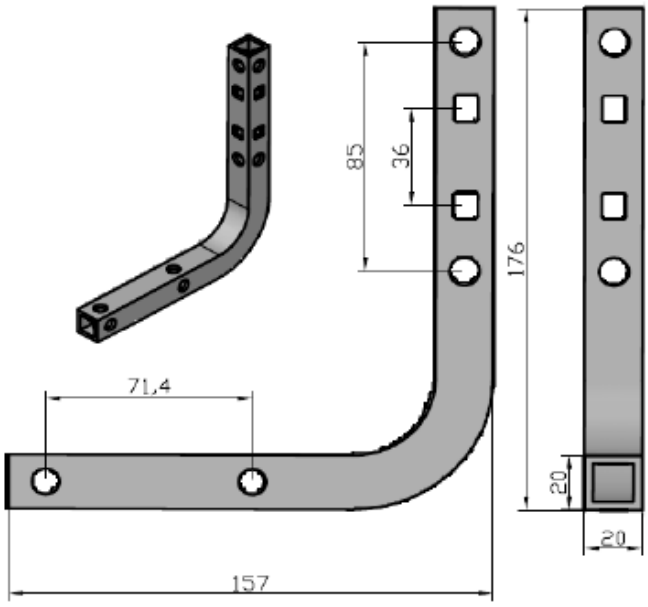

Figure E-9: Model 5RC Mounting Bracket

E.8.2.2. Model 175PM

This simple "L" Shape mounting bracket constructed out of SS316 Stainless Steel, can be used to mount a variety of field devices, either on a wall or panel or on a 2" pipe.

When mounting on a 2" pipe, a "U" Bolt is required, which can be supplied optionally.

The Model 17508 consists of a complete assembly of a 2" U bolt along with the nuts and washers required.

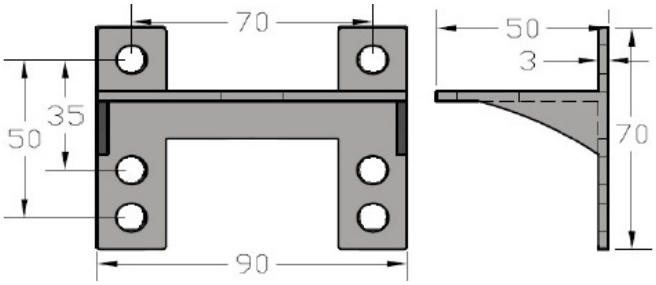

Figure E-10: Model 175PM Mounting Bracket

E.8.2.3. Model 175NR

The Model 175NR is Stainless Steel Mounting Brackets made exclusively for the Model 8080 Instrument Enclosure to mount on a 2 " Pipe.

This Bracket is available for customers who require all 3 ports on the enclosure for other purposes.

The 175NR is symmetrical, so it can be rotated 90° to suit the viewing position of the Indicator/ Transmitter.

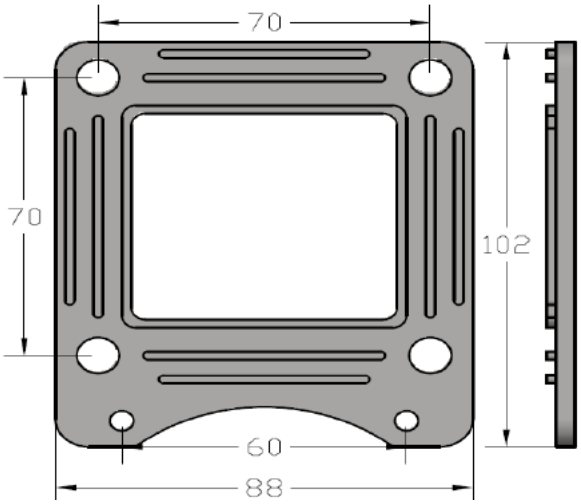

Figure E-11: Model 175NR Mounting Bracket

E.8.2.4. Model 175MM

The Model 175MM is Stainless Steel Mounting Brackets made exclusively for the Model 8080 Instrument Enclosure to mount on wall.

This low cost Bracket is available for customers who require all 3 ports on the enclosure for other purposes.

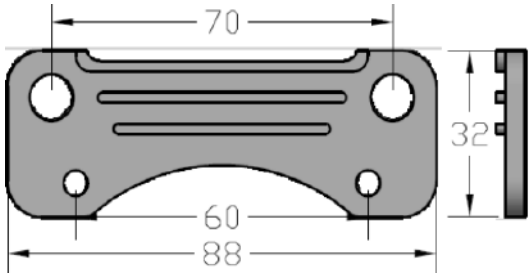

Figure E-12: Model 175MM Mounting Bracket

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Appendix F. Technical Support

This product is designed to provide you with reliable, trouble-free service. Contact your regional Technical Support if you have technical questions, need support, or if you need to return a product. Details can be found at:

Tech Support website: http://www.teledyne-ai.com/services/tech-support-repairs

Tech Support email: taitechsupport@Teledyne.com

Customer Service email: tai_rma@Teledyne.com

NOTE: When returning a product, contact Technical Support to obtain a Return Material Authorization (RMA) number prior to shipping.

TELEDYNE
ANALYTICAL INSTRUMENTS
Everywhereyoulook™

TELEDYNE ANALYTICAL INSTRUMENTS

16830 Chestnut Street
City of Industry, CA 91748, USA

Tel: 626-934-1500

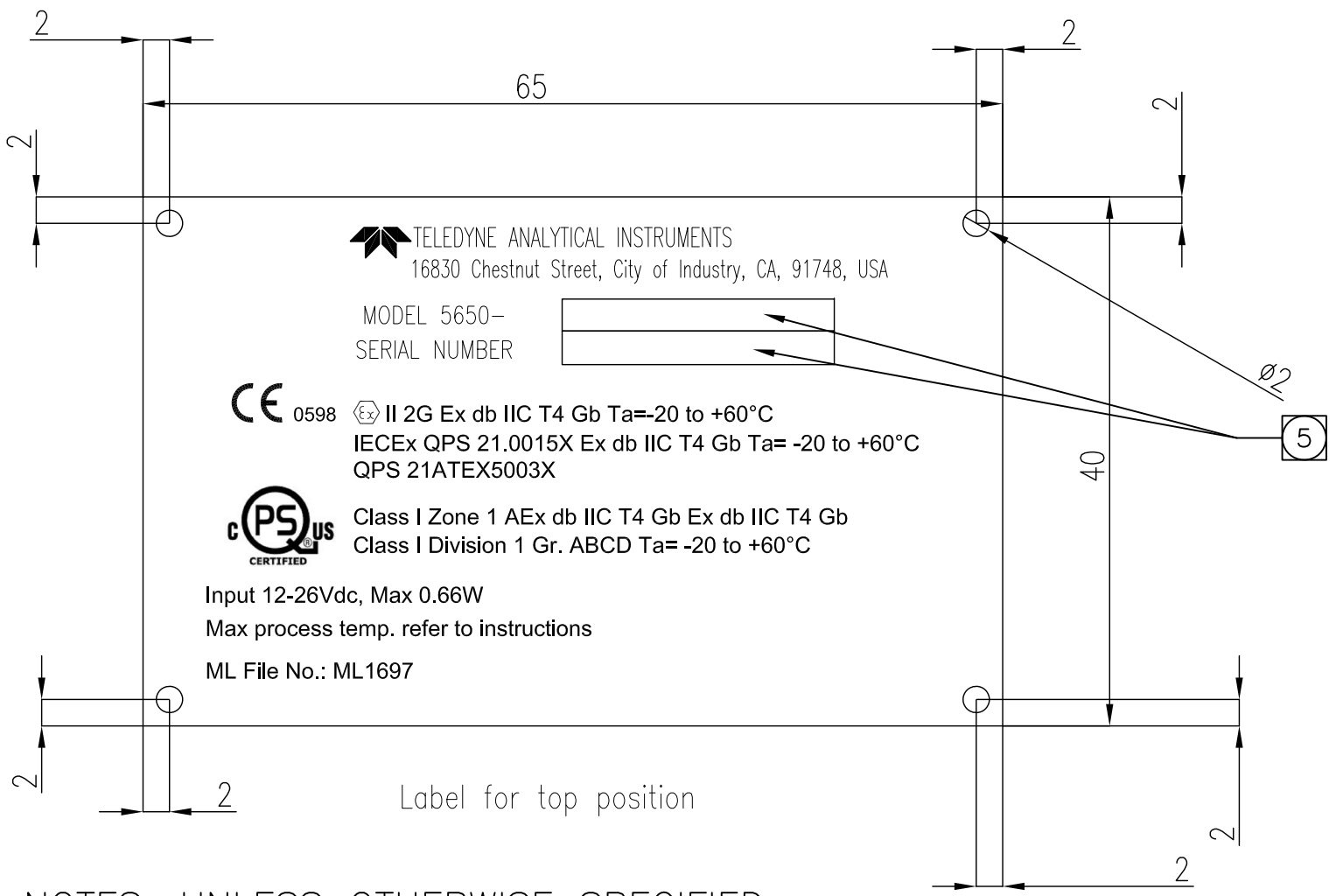
www.teledyne-ai.com

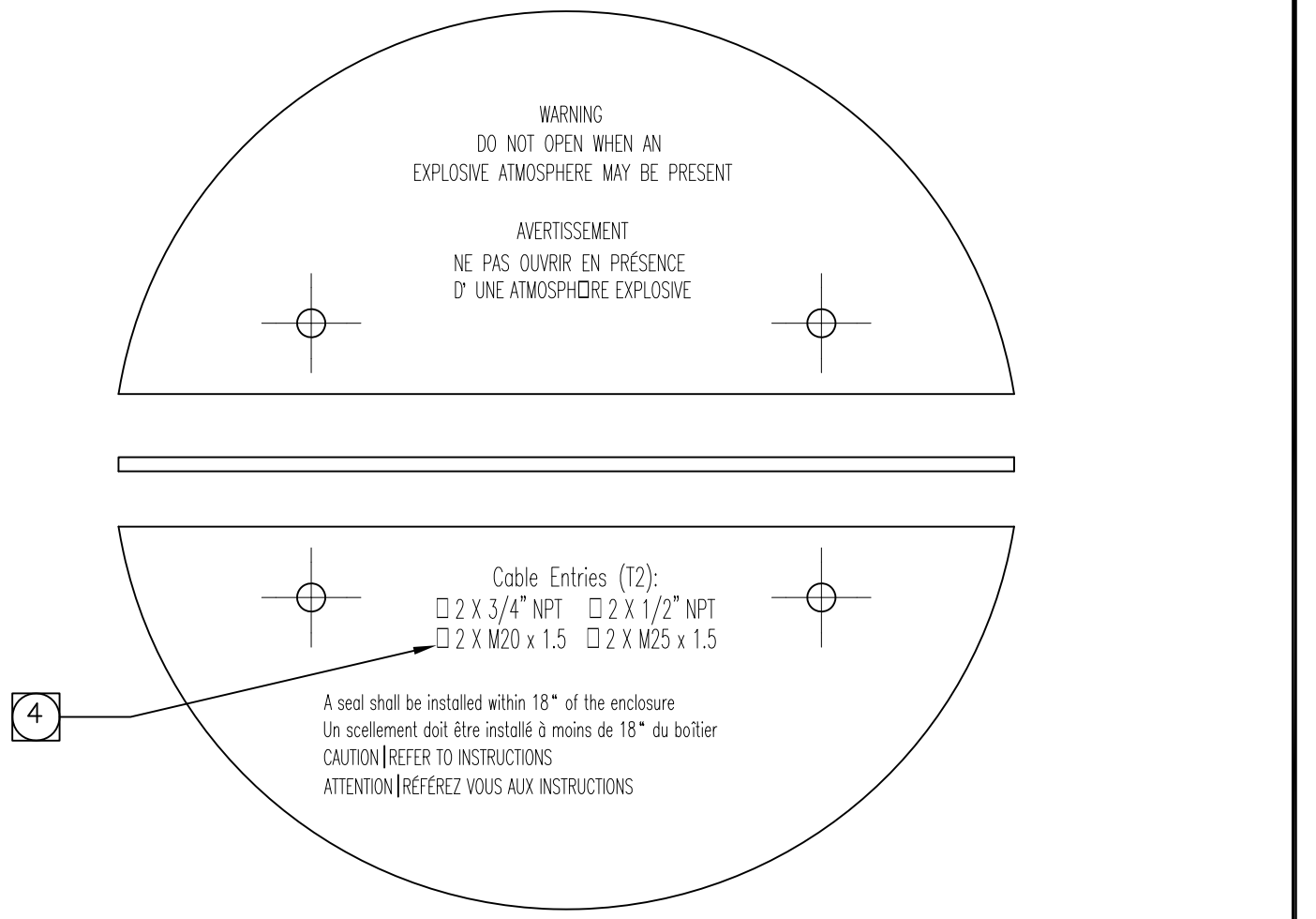
P/N M5650, Rev. B / December 2020

Use and Disclosure of Data
"Information contained herein is classified as EAR99 under the U.S. Export Administration Regulation.
Export, reexport or diversion contrary to U.S. law is prohibited."

ATEX Certified Product
No modification permitted without reference to QPS

REVISIONS				
REV	DESCRIPTION	DATE	APP.	REV. BY
0	Initial Release INC ECO 22-0002	03/07/22	AA	--





Label for connection compartment lid
(2 half circles)

NOTES: UNLESS OTHERWISE SPECIFIED.

1) LABEL MATERIAL: SS316L THICKNESS: 0.2-1mm

2) TEXT, LINES AND LOGO TO BE BLACK SILKSCREENED ACCORDINGLY TO TAG AS SHOWN.

3) LABEL IS FITTED BY DRIVE SCREWS INTO EXISTING ENCLOSURE HOLES AS PER ENCLOSURE MANUFACTURERS SPECIFICATION.

(4) ALTERNATIVE CABLE ENTRIES SELECTION TO BE ENGRAVE INSIDE RECTANGLE AND BLACK FILLED BY TAI

(5) ENGRAVE MODEL NUMBER AND SERIAL NUMBER [.06] HIGH, BLACK FILLED BY TAI

S/	SIGNATURES	DATE
N/	DRFT: VINCE	01/13/22
I/	CHK:	
P/	APPR:	
O/	ENGR: A.ALEGRIA	
F/	C.O.:	
REFERENCE	CAD I.D.	

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MILLIMETERS [INCHES]
TOLERANCE:
ANGULAR ±1° LINEAR [.XX]= ±.01 mm = ±1

TELEDYNE
Analytical Instruments
A Business Unit of Teledyne Instruments, Inc.
City of Industry, California 91748, USA

TITLE
LABEL CERTIFICATION (CqpsUS)
CLASS 1, ZONE 1, EX-PROOF
TELEDYNE 5650 SERIES

SCALE 2:1
SIM
SHEET 1 OF 1

MATL. NOTED
DWG NO. **B-** 95838
REV 0