EAGLE EYE
POWER SOLUTIONS

DM-Series

Inline Density / Concentration Meters

Instruction Manual

Version 1.1

INTRODUCTION

The **Eagle Eye DM-Series Inline Density Meters** are designed for continuous monitoring and process control of liquid concentration/density and temperature of solutions across a wide range of applications. Available in three different mounting configurations, the DM-Series density meters can be integrated directly into a variety of tanks and inline systems. Temperature compensated values can be measured and displayed in Density, Specific Gravity, Brix, Plato, Baume, API, Concentration, Solid %, and other measurements of density. Designed for process control, measured data can output through a 4-20 mA signal. Digital communication for remote calibration and monitoring is also available.

Each DM-Series Density Meter consists of a capacitive-type differential pressure transmitter which is tied to a pair of pressure repeaters immersed in the solution being measured. Temperature compensation is performed by a temperature sensor located between the two pressure repeaters. Small variations in the process temperature are quickly and accurately calculated through dedicated software.

The DM-Series has been designed for a wide range of applications including petroleum, gas & oil production; food, beverage and alcohol processing, and chemical production and monitoring. The digital LCD display allows the user to easily read any custom-configured units that can be alternated during operation. The DM-Series is low-maintenance after installation, easy to clean, and allows for safe operation and continuous testing. The DM-Series is highly accurate and repeatable and is calibrated for long-term operation. Installation of the density meter is simple and quick with minimal downtime or disturbance. The ability to measure density, density-related values and temperature simultaneously make the DM-Series a cost-effective, long-term solution for any continuous monitoring needs.

The DM-Series is offered in three standard models, the DM-1000A, DM-1000B, and DM-1000C. All three models can be mounted in various ways to fit your needs. The DM-1000A is mounted on the top of a tank, the DM-1000B is mounted on the side, and the DM-1000C is mounted on the side of a pipe/tank and includes a flex-pipe configuration for uncommon fittings. All three meters can be ordered as intrinsically safe for industrial environments or sanitary for the food and beverage industry.

NOTE
This manual is compatible with version 2.XX, where 2 denote software version and XX software release. The indication 2.XX means that this manual is compatible with any release of software version 2.

Waiver of responsibility

The contents of this manual abides by the hardware and software used on the current equipment version. Eventually there may be differences between this manual and the equipment. The information from this document are periodically reviewed and the necessary or identified corrections will be included in the following editions. Suggestions for their improvement are welcome.

Warning

For more objectivity and clarity, this manual does not contain all the detailed information on the product and, in addition, it does not cover every possible mounting, operation or maintenance cases.

Before installing and utilizing the equipment, check if the model of the acquired equipment complies with the technical requirements for the application. This checking is the user's responsibility.

If the user needs more information, or on the event of specific problems not specified or treated in this manual, the information should be sought from Eagle Eye. Furthermore, the user recognizes that the contents of this manual by no means modify past or present agreements, confirmation or judicial relationship, in whole or in part.

Only qualified personnel are allowed to participate in the activities of mounting, electrical connection, startup and maintenance of the equipment. Qualified personnel are understood to be the persons familiar with the mounting, electrical connection, startup and operation of the equipment or other similar apparatus that are technically fit for their work. Eagle Eye provides specific training to instruct and qualify such professionals. However, each country must comply with the local safety procedures, legal provisions and regulations for the mounting and operation of electrical installations, as well as with the laws and regulations on classified areas, such as intrinsic safety, explosion proof, increased safety and instrumented safety systems, among others.

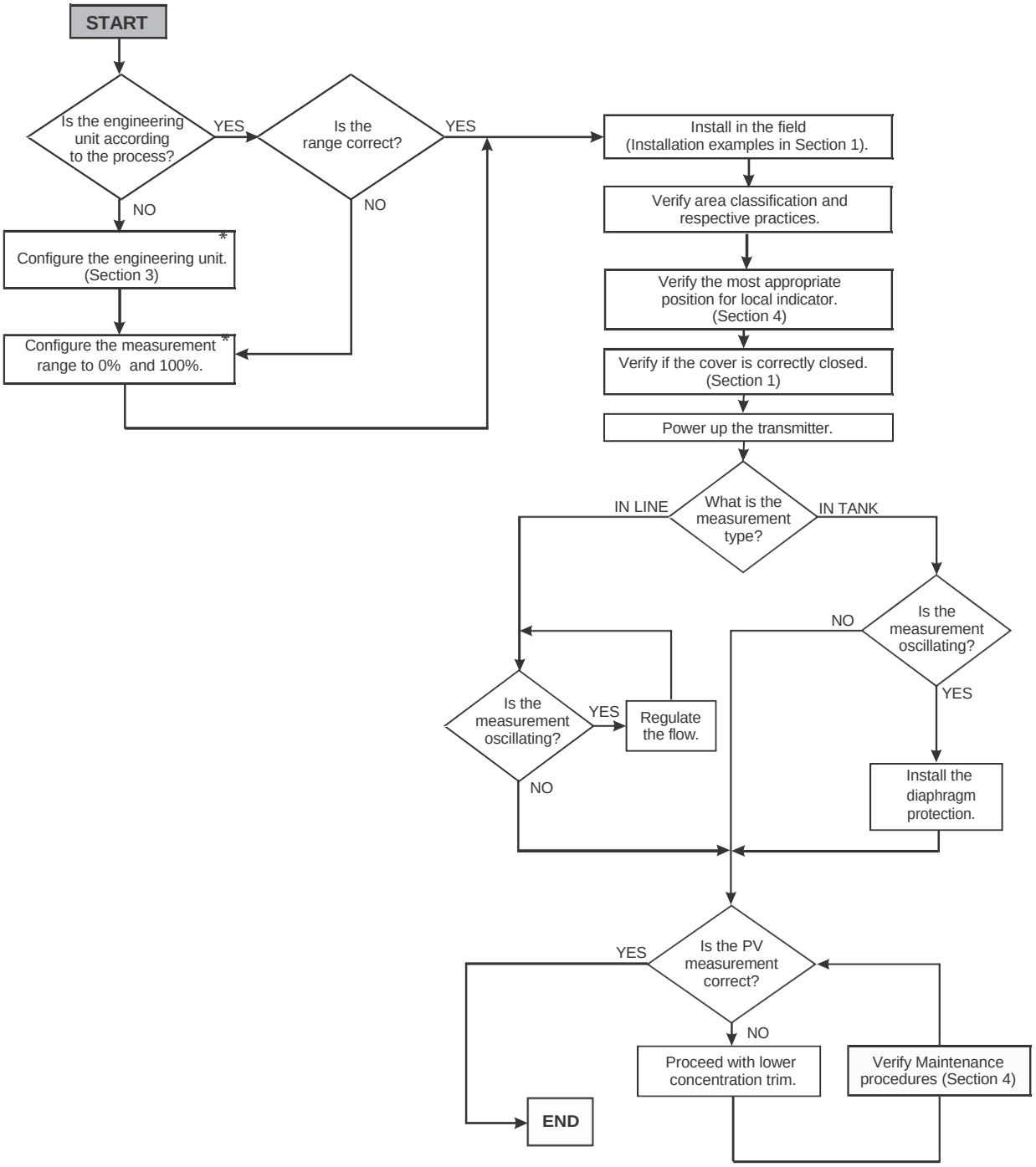
The user is responsible for the incorrect or inadequate handling of equipment run with pneumatic or hydraulic pressure or, still, subject to corrosive, aggressive or combustible products, since their utilization may cause severe bodily harm and/or material damages.

The field equipment referred to in this manual, when acquired for classified or hazardous areas, has its certification void when having its parts replaced or interchanged without functional and approval tests by Eagle Eye or any of Eagle Eye authorized dealers, which are the competent companies for certifying that the equipment in its entirety meets the applicable standards and regulations. The same is true when converting the equipment of a communication protocol to another. In this case, it is necessary sending the equipment to Eagle Eye or any of its authorized dealer. Moreover, the certificates are different and the user is responsible for their correct use.

Always respect the instructions provided in the Manual. Eagle Eye is not responsible for any losses and/or damages resulting from the inadequate use of its equipment. It is the user's responsibility to know and apply the safety practices in his country.

TABLE OF CONTENTS

Installation Flowchart



Section 1

INSTALLATION

General

The overall accuracy of density measurement depends on several variables. Although the transmitter has an outstanding performance, proper installation is essential to maximize its performance.

Among all factors, which may affect transmitter accuracy, environmental conditions are the most difficult to control. There are, however, ways of reducing the effects of temperature, humidity and vibration.

The capacitive sensor of the **DM-Series**, that is located external to the process, is protected of external sources of heat by an enclosure with internal thermal insulation. Nevertheless, the transmitter should be installed in way to avoid to the maximum the direct exhibition to the ray's run.

Humidity is fatal to electronic circuits. In areas subjected to high relative humidity, the O-rings for the electronic housing covers must be correctly placed and the covers must be completely closed by tighten them manually until you feel the o-rings being compressed. See how to close suitably on item – electrical connections. Do not use tools to close the covers. Removal of the electronics cover in the field should be reduced to the minimum necessary, since each time it is removed; the circuits are exposed to the humidity.

The electronic circuit is protected by a humidity proof coating, but frequent exposures to humidity may affect the protection provided. It is also important to keep the covers tightened in place. Every time they are removed, the threads are exposed to corrosion, since painting cannot protect these parts. Code-approved sealing methods should be employed on conduit entering the transmitter. The unused outlet connection should be plugged accordingly.

Although the transmitter is virtually insensitive to vibration, installation close to pumps, turbines or other vibrating equipment should be avoided. If inevitable, install the transmitter at a solid base and use flexible tube which does not transmit the vibration.

Recommendations for use of DM-Series

The process fluid should always cover the two diaphragm repeaters.

The maximum process fluid velocity over the two repeater diaphragms must be 0.4m/sec, what means a flow of 26 m^3/h in a piping of ϕ 6". This information is according to fluids which viscosity is close to that water. For fluids where the viscosity is very different to that water viscosity should be analyzed. This limitation is due to the losing of load between the diaphragms.

The temperature range of the process fluid must be between -20°C and 150°C.

For applications in corrosive fluids, compatible materials should be chosen. The materials of the parts that are not in direct contact with the process, but can be subject to the corrosive atmosphere or drops of the process, should also be observed.

A possible leak of the fill fluid (less than 5 ml), due to a hole in the diaphragm can contaminate the process. In case that is not allowed, choose a fill fluid compatible with the process.

DM-Series Concentration / Density Transmitters Models

DM-Series- Industrial model, for general purpose.

DM-Series/S Sanitary model for food, pharmaceutical industry and other applications where sanitary connections are required.

The industrial model uses connection flanges in compliance with ANSI B16.5 or DIN 2526 Standards.

The sanitary model uses Tri-Clamp connection to allow a quick and easy connection and disconnection from the process. Wetted surface finish is 32RA as standard. These models meet 3A recommendations so that the probe surface is free of crevices where food or bacteria can be collected. 3A is the most widely accepted sanitary standard in the food, drug and beverage industry.

Assembly

Both models (**DM-Series** and **DM-Series/S)** have two mounting types: top mounting (straight type) and side mounting (curved type).

The Figures 1.1 show the dimensions of the **DM-Series** straight and curved type for industrial and sanitary models. The dimensions are in millimeters (inches).

The installation can be done in open or pressurized tanks or through a sampling device, external to the process.

The Figures 1.2 show some mounting examples. The dimensions are in millimeters.

Choose a place for installation that facilitates the access for the measuring point and that be free from mechanical shocks.

Try to use a valve in the connection to the process before the DM-Series. This simplifies the calibration and maintenance of the equipment.

A – Industrial Model Side Mounting

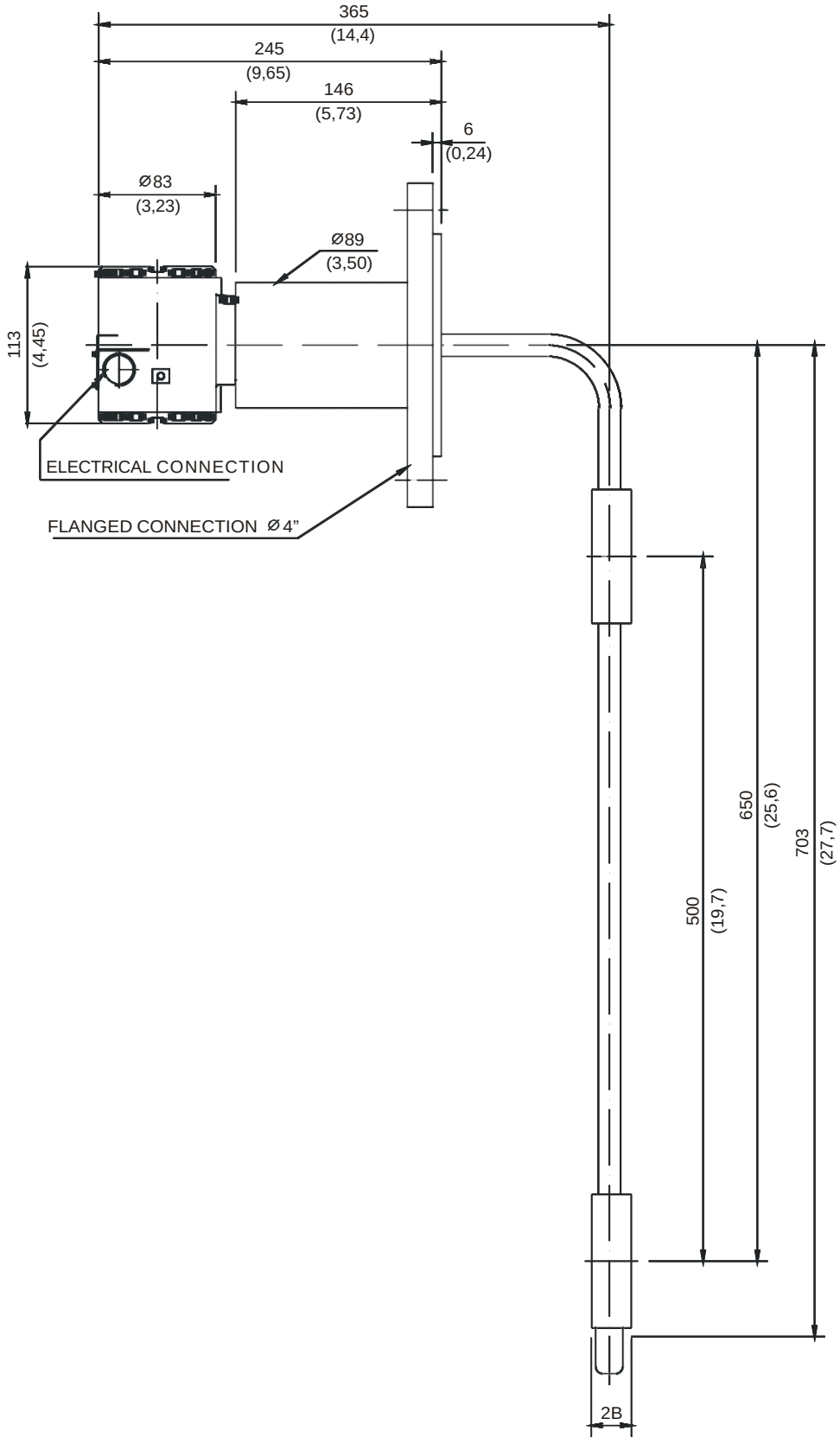


Figure 1.1 *(A)*

B – Sanitary Model Top Mounting - Between Center of the Sensors 500 mm

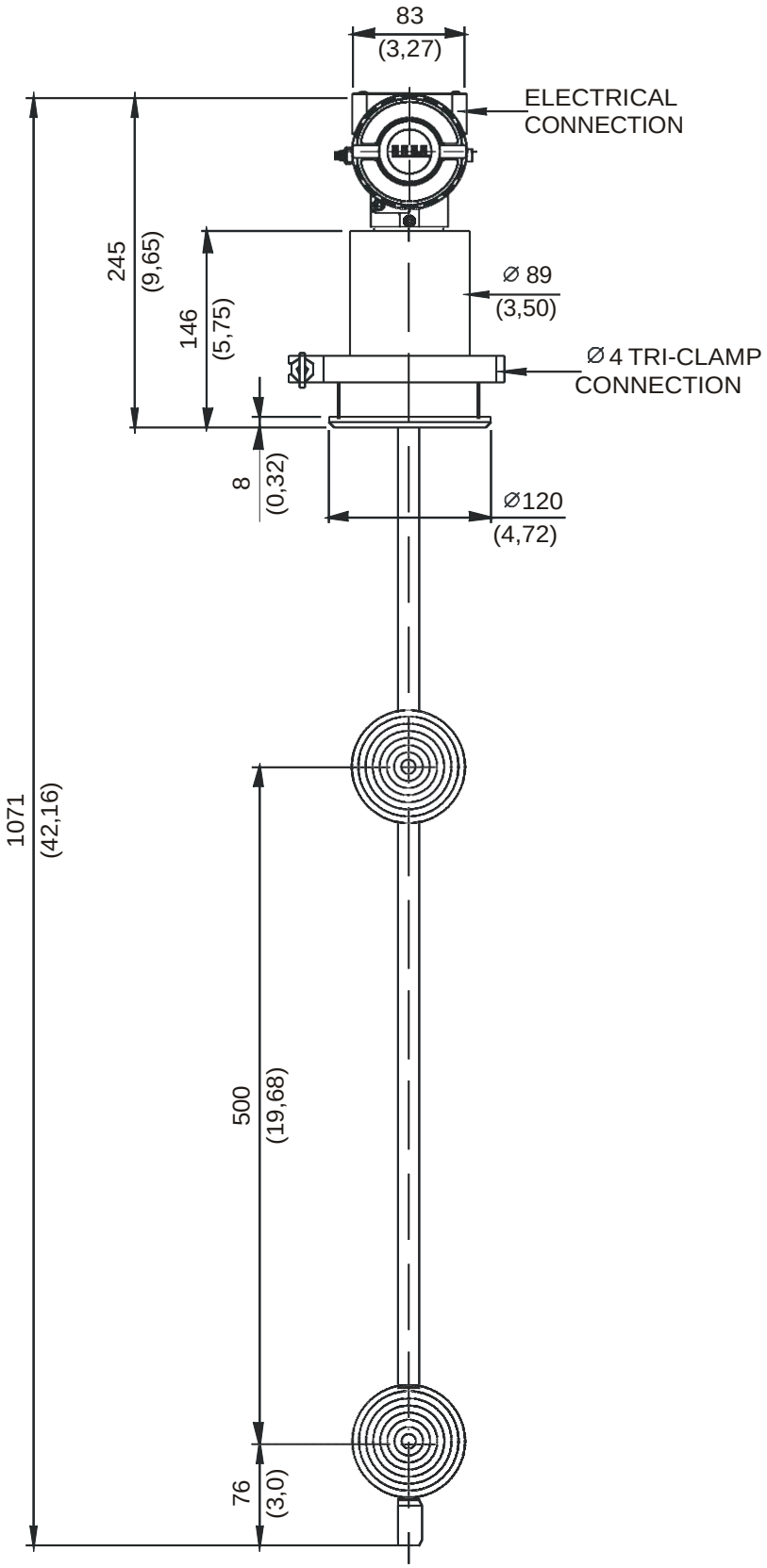


Figure 1.1 ***(B)***

C – Sanitary Model Side Mounting

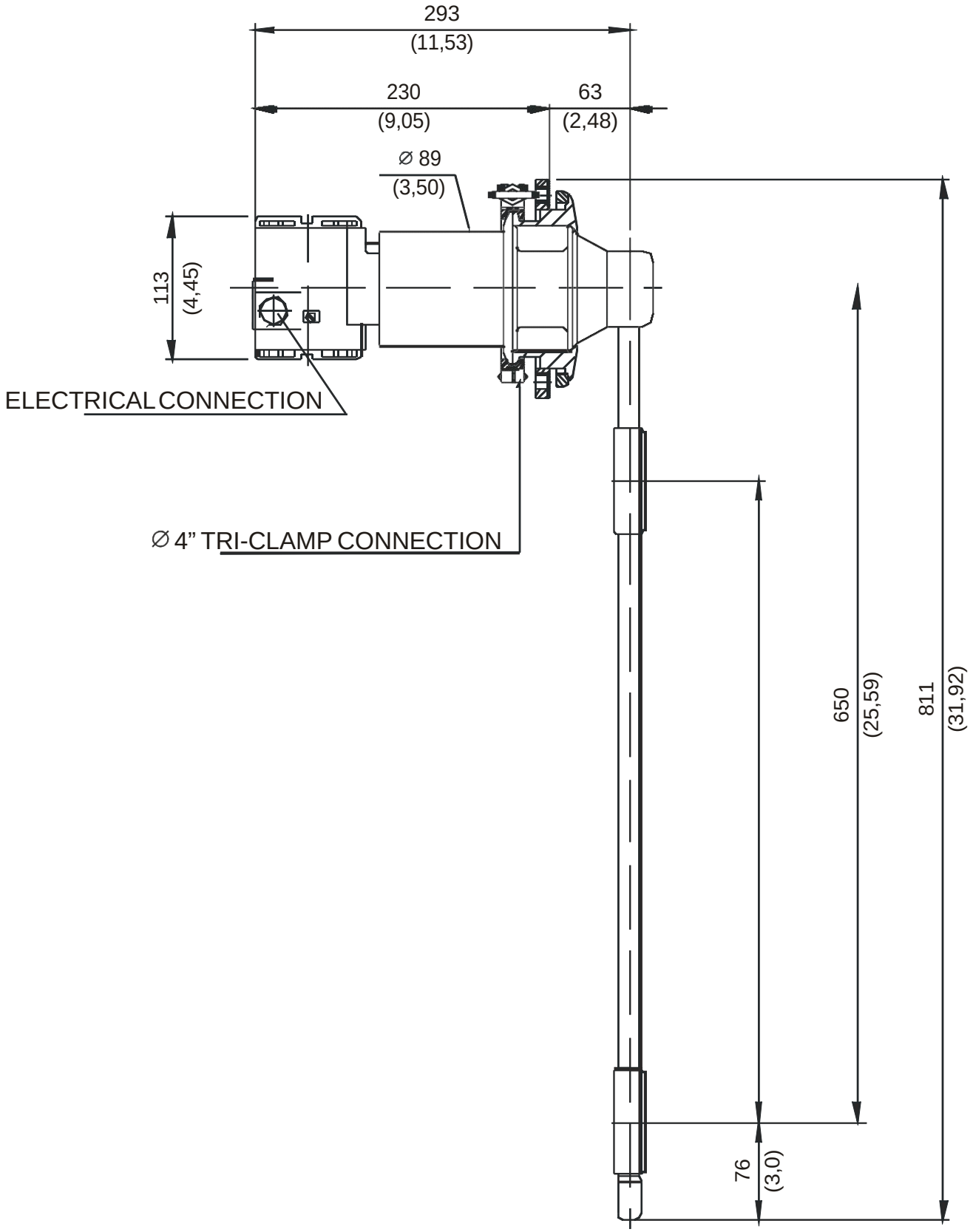


Figure 1.1 – DM-Series Dimension (C)

D – Industrial Model Top Mounting

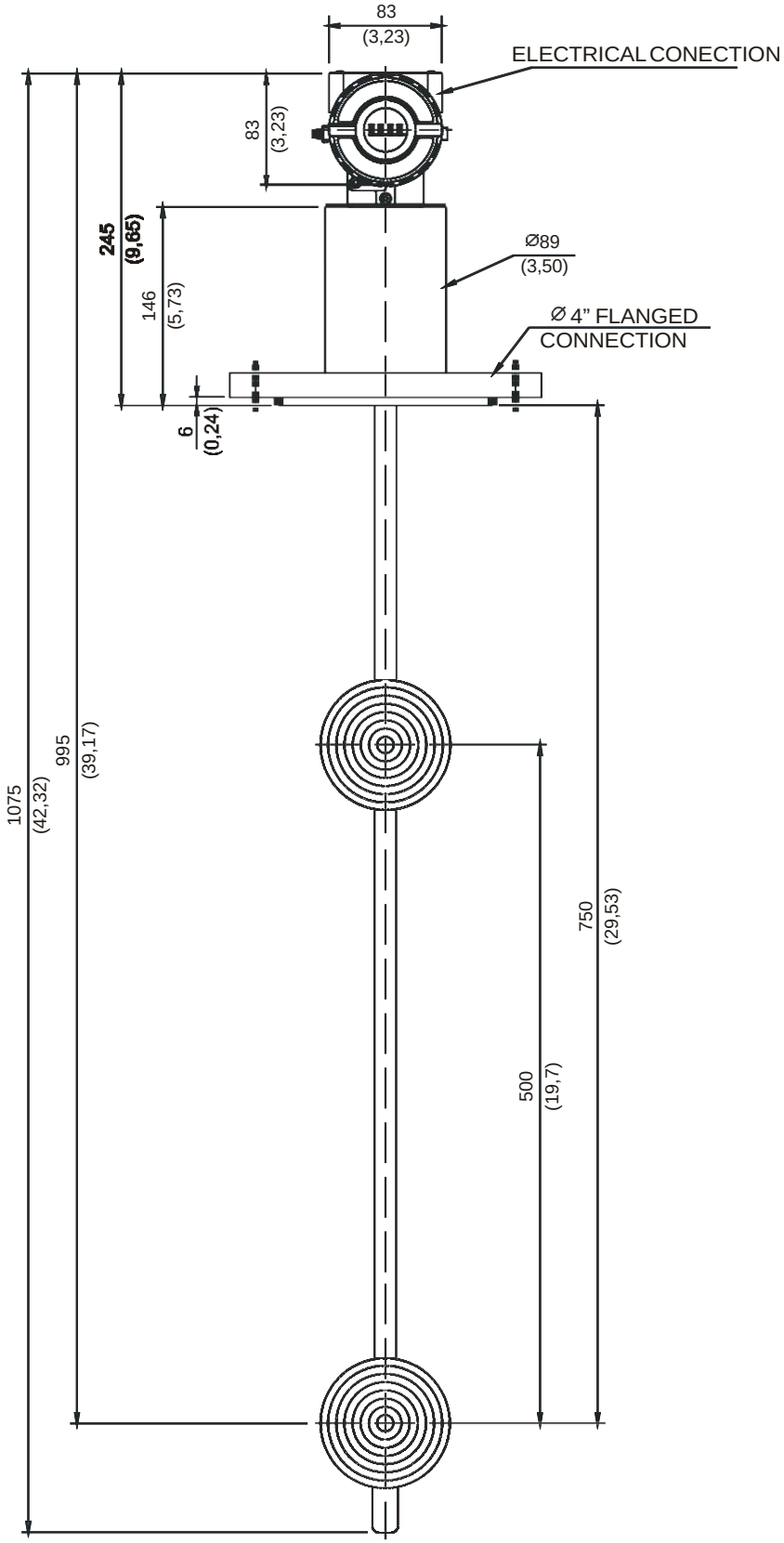


Figure 1.1 – DM-Series Dimension (D)

E – Sanitary Model Top Mounting - Between Centre of the Sensors 800 mm

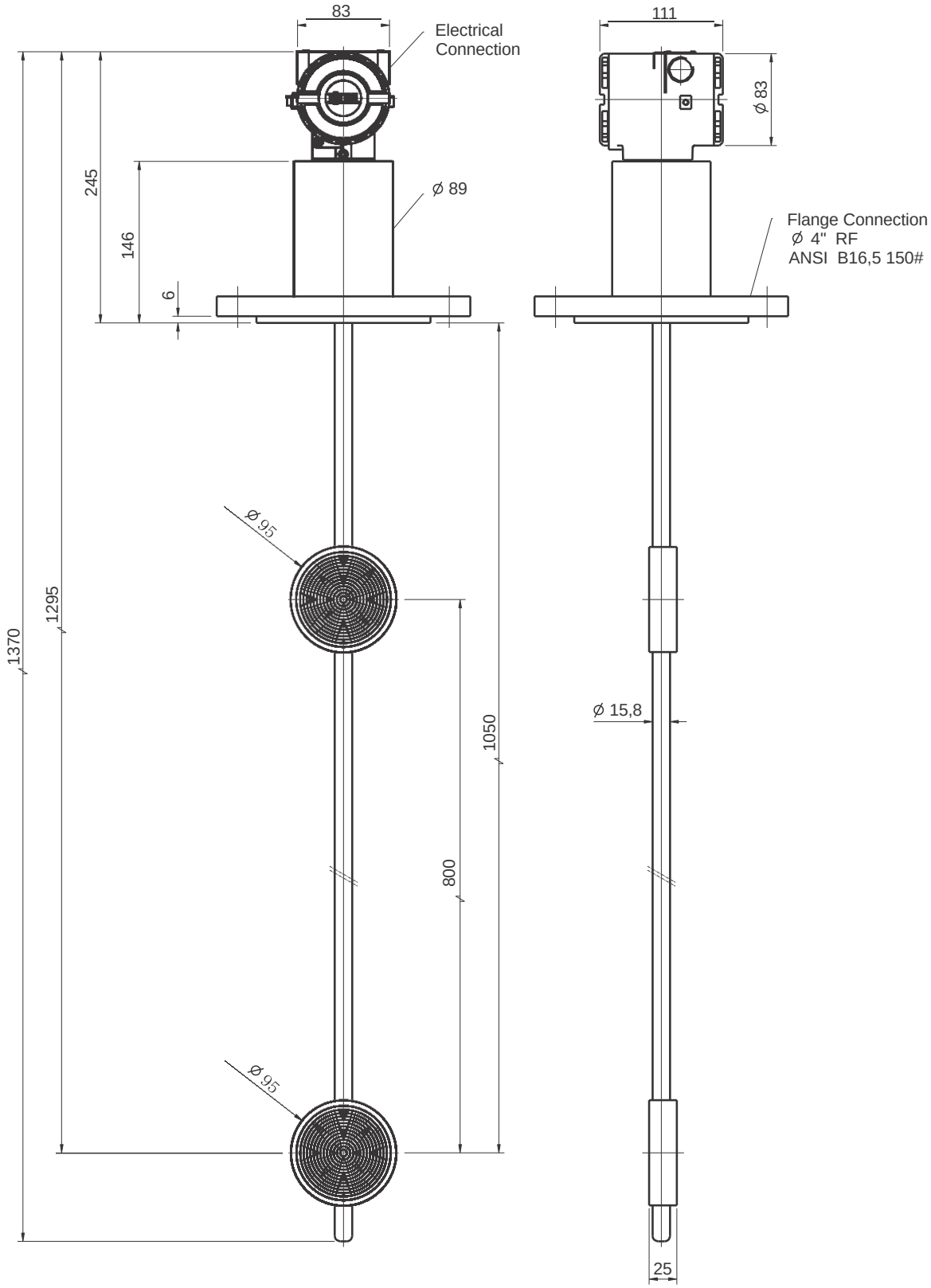


Figure 1.1 – DM-Series Dimension (E)

A – Typical Installation for Low Flow Tank (Industrial Model)

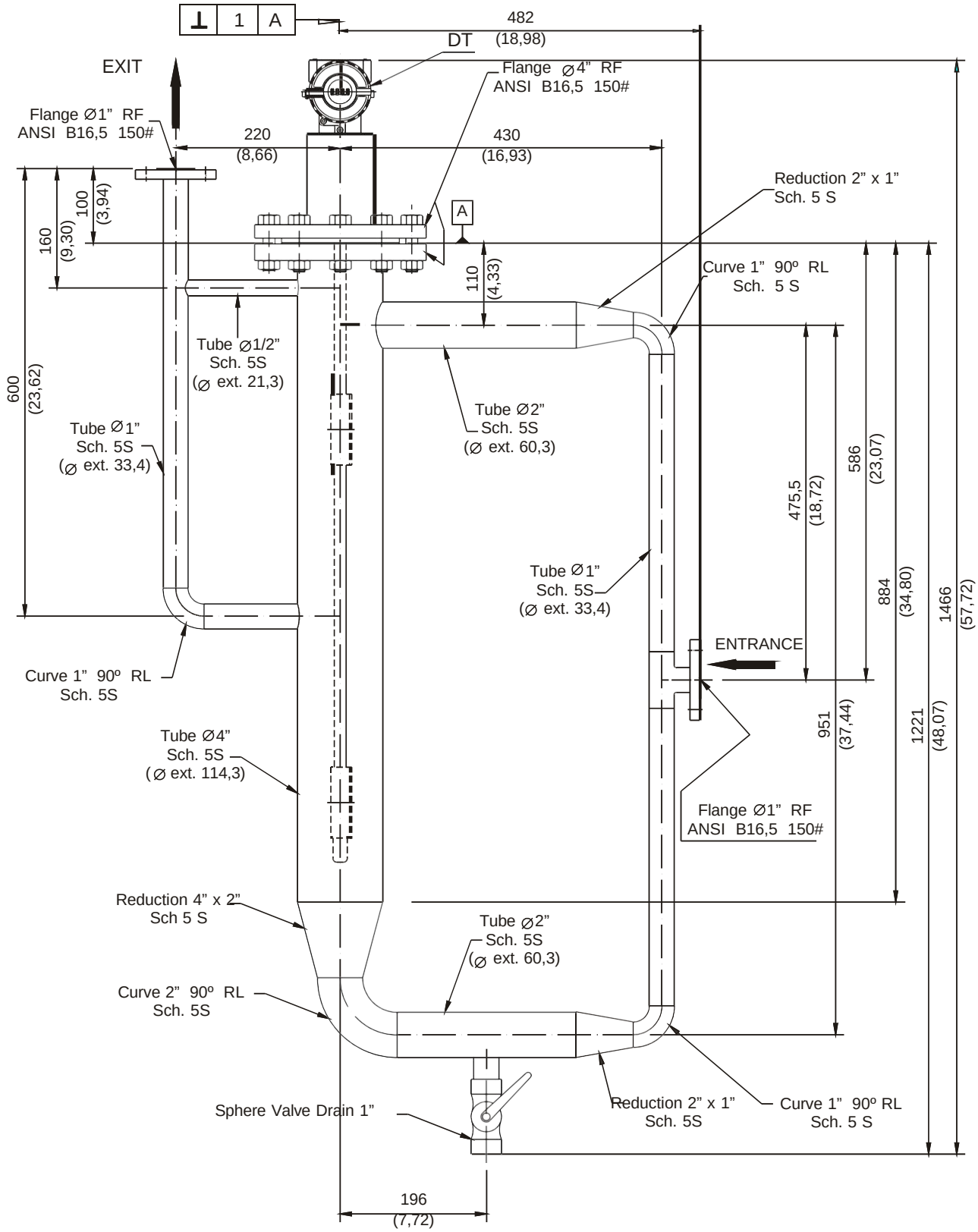


Figure 1.2 – Typical Installation for DM-Series (A)

B – Typical Installation for Low Flow Tank (Sanitary Model)

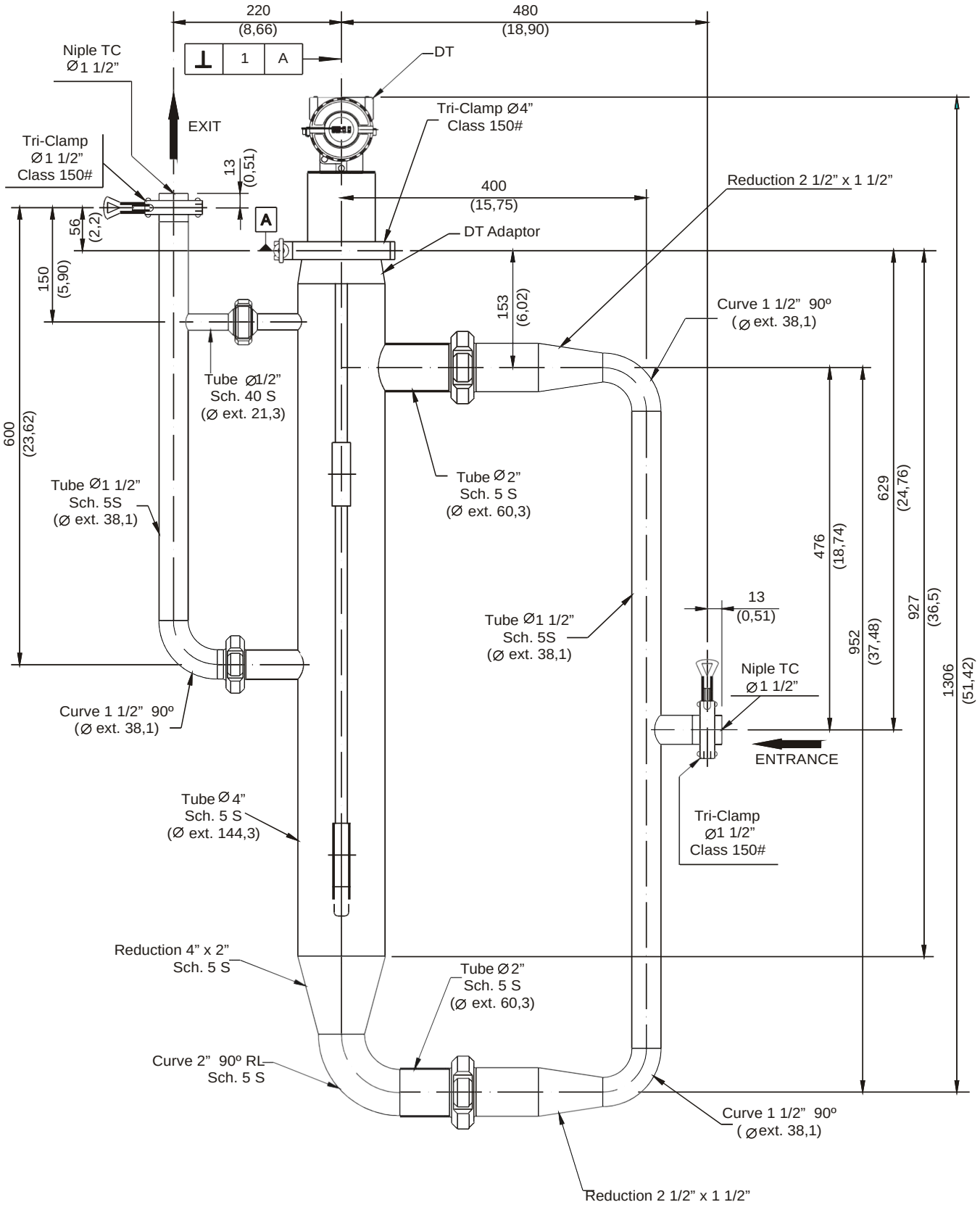


Figure 1.2 – Typical Installation for DM-Series (B)

C – Typical Installation for High Flow Tank (Industrial Model)

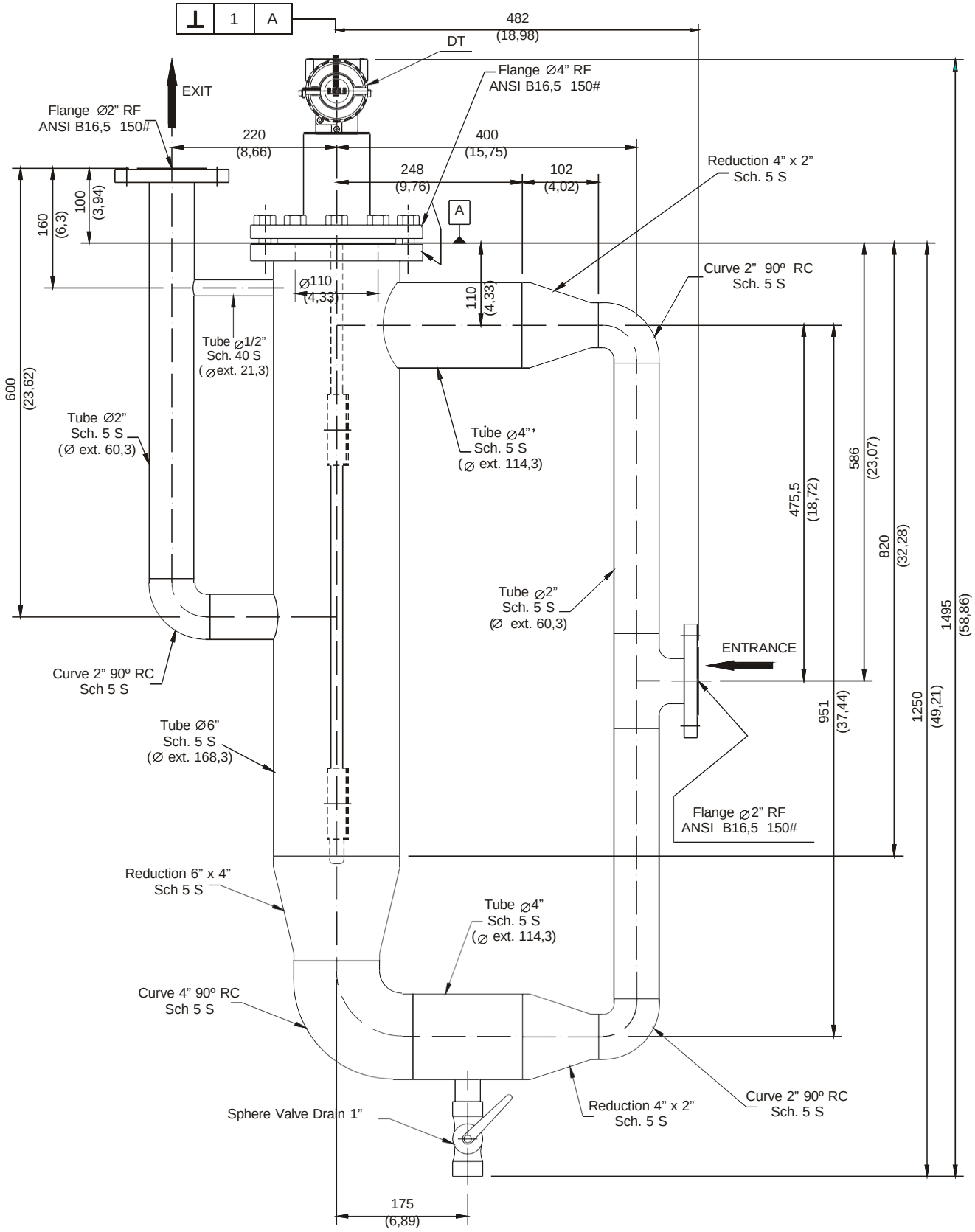


Figure 1.2 – Typical Installation for DM-Series (C)

D – Typical Installation in Overflow Tanks

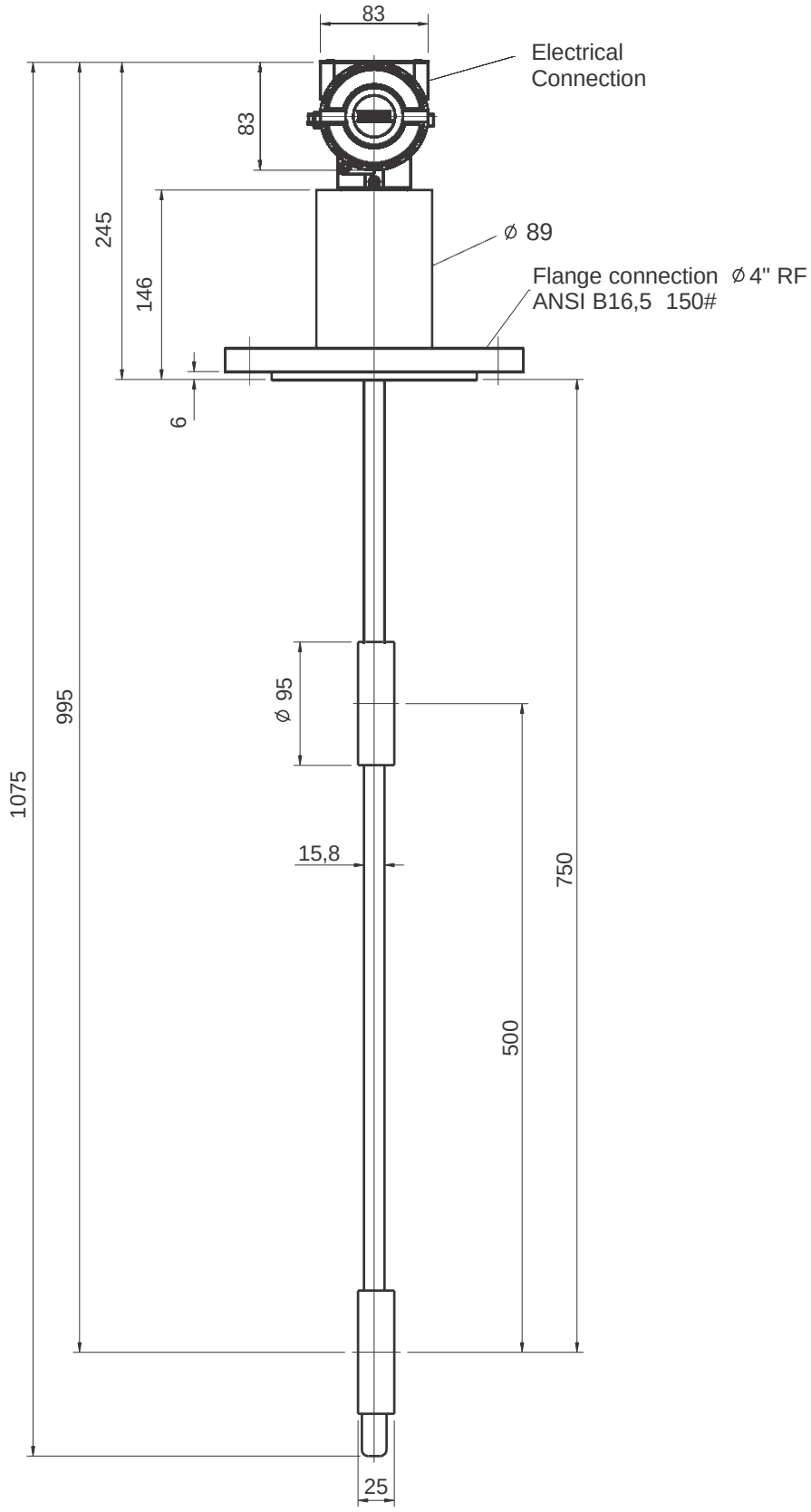


Figure 1.2 – Typical Installation for DM-Series (D)

E – Typical Installation in Tank (Industrial Model)

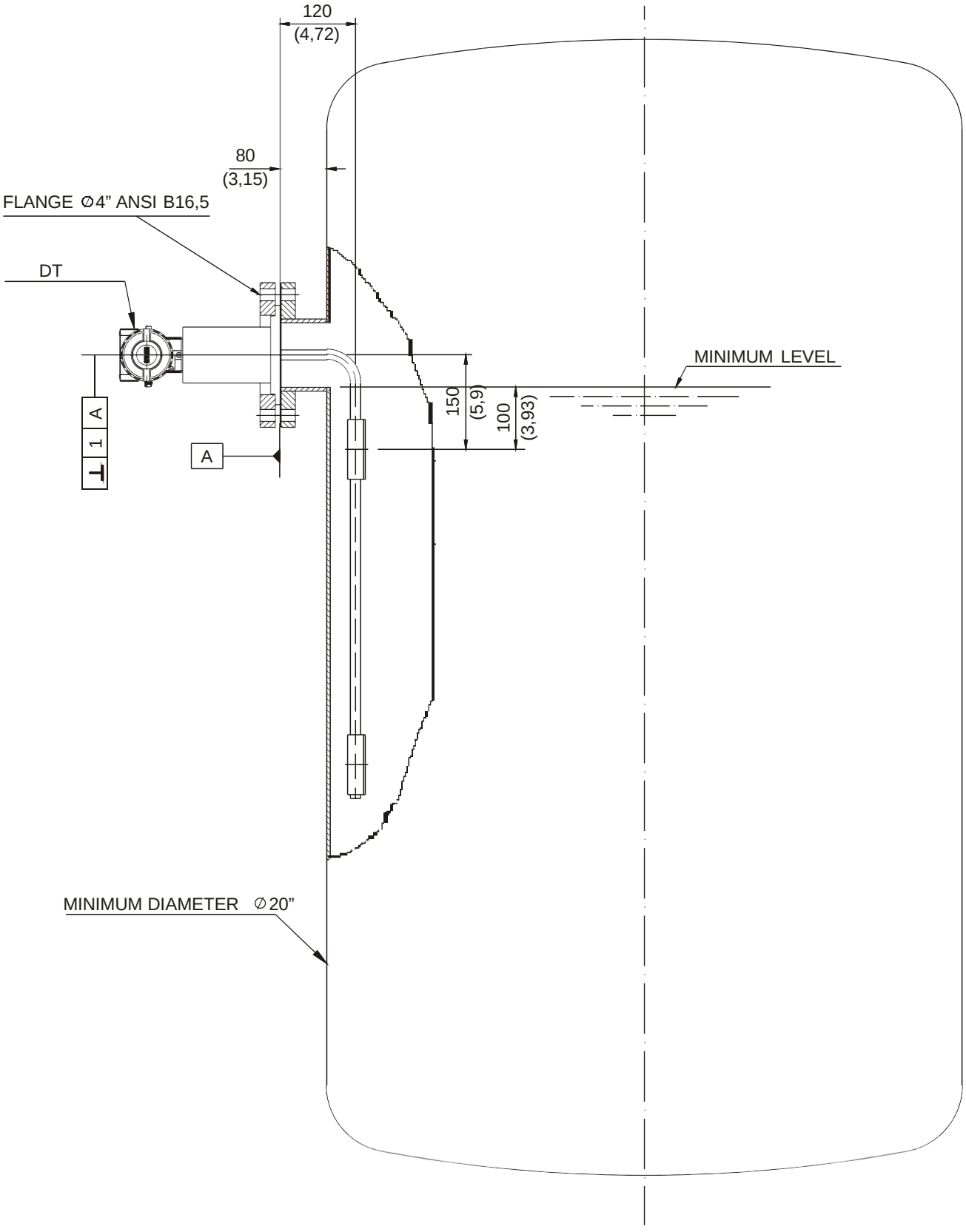


Figure 1.2 – Typical Installation for DM-Series (E)

F – Typical Installation in Tank (Sanitary Model)

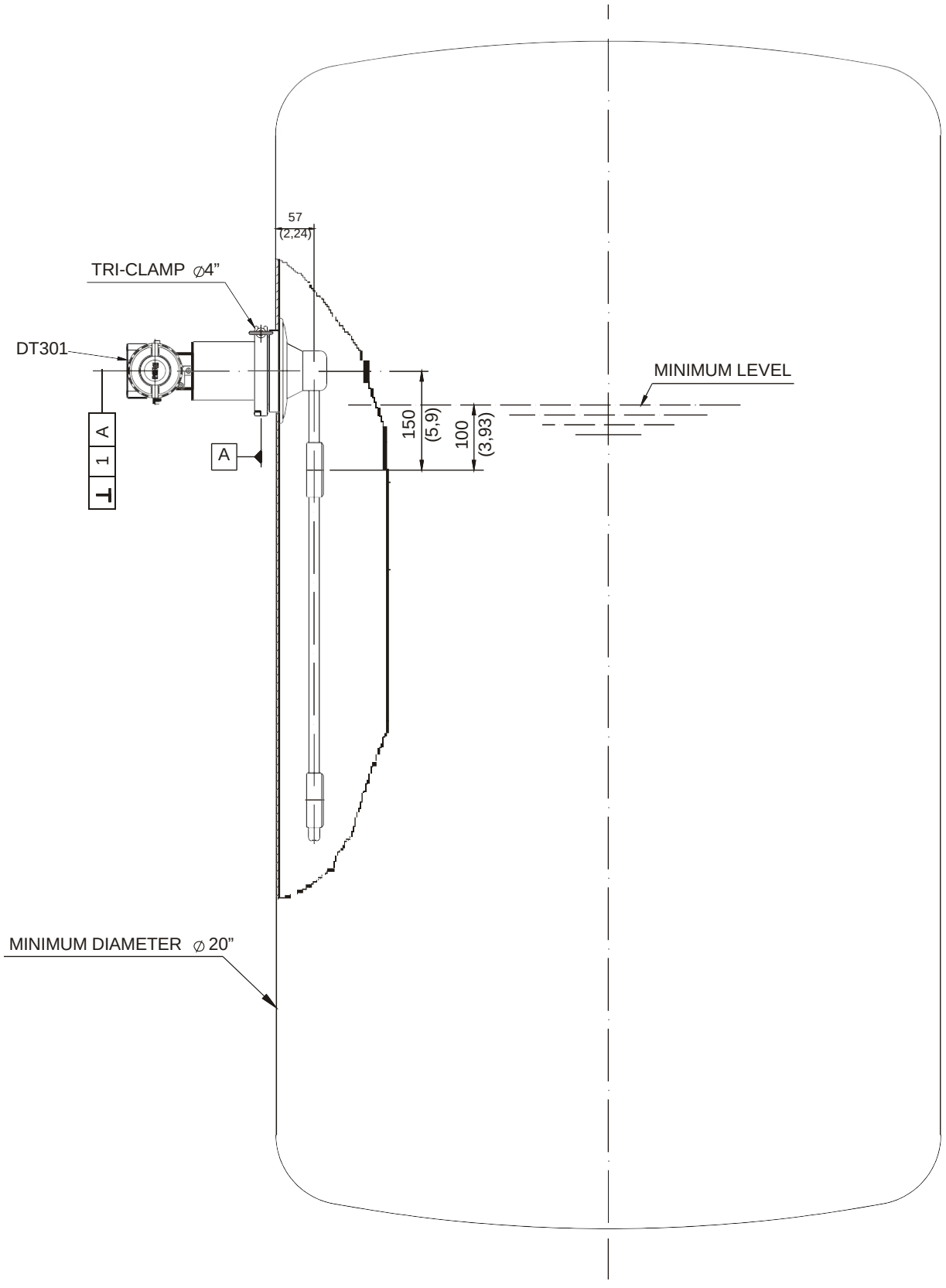


Figure 1.2 – Typical Installation for DM-Series (F)

G - Typical Installation in Tank with Diaphragm Protection (Industrial Model)

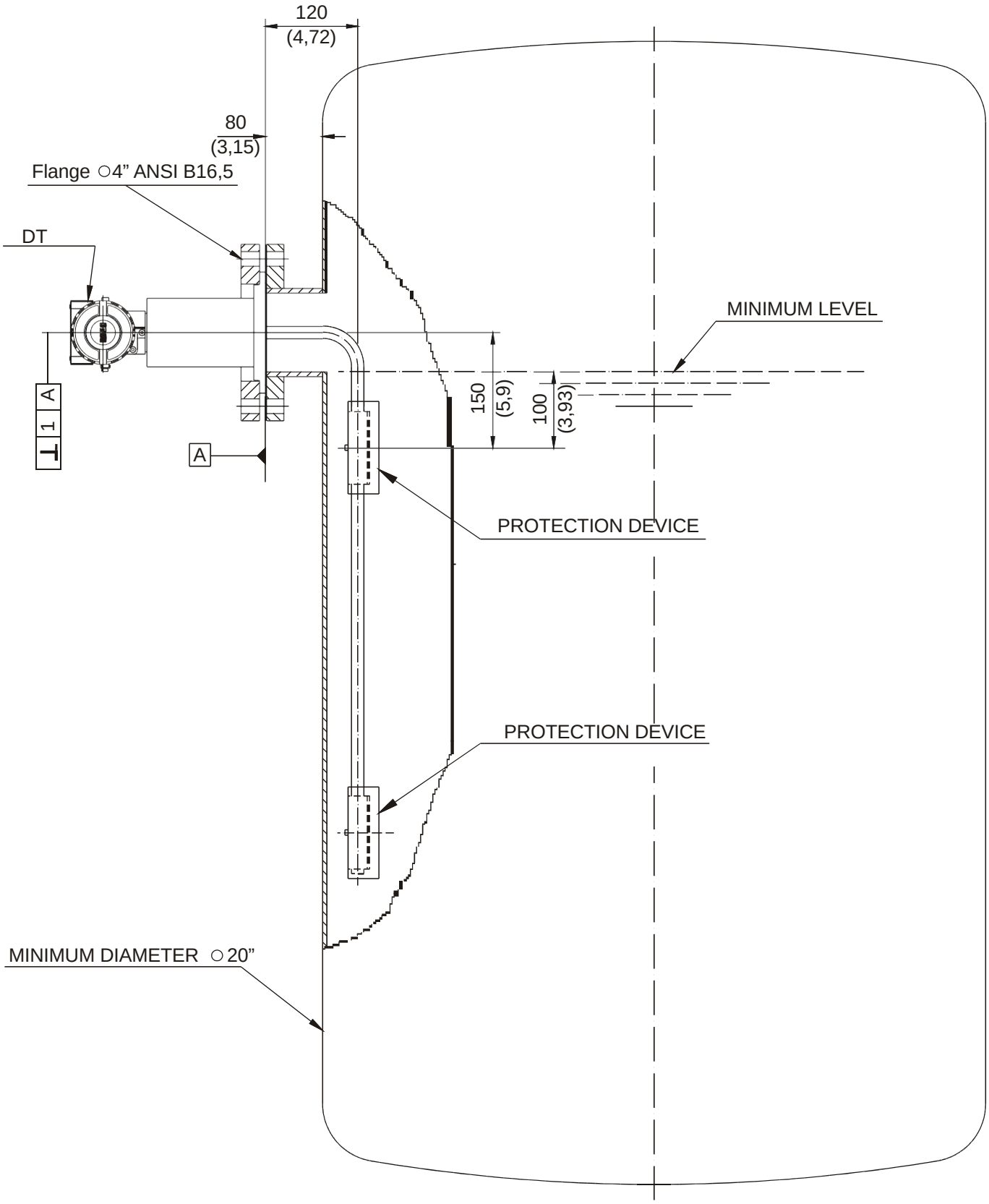


Figure 1.2 – Typical Installation for DM-Series (G)

H - Typical Installation for Low Flow Tank (Industrial Model)

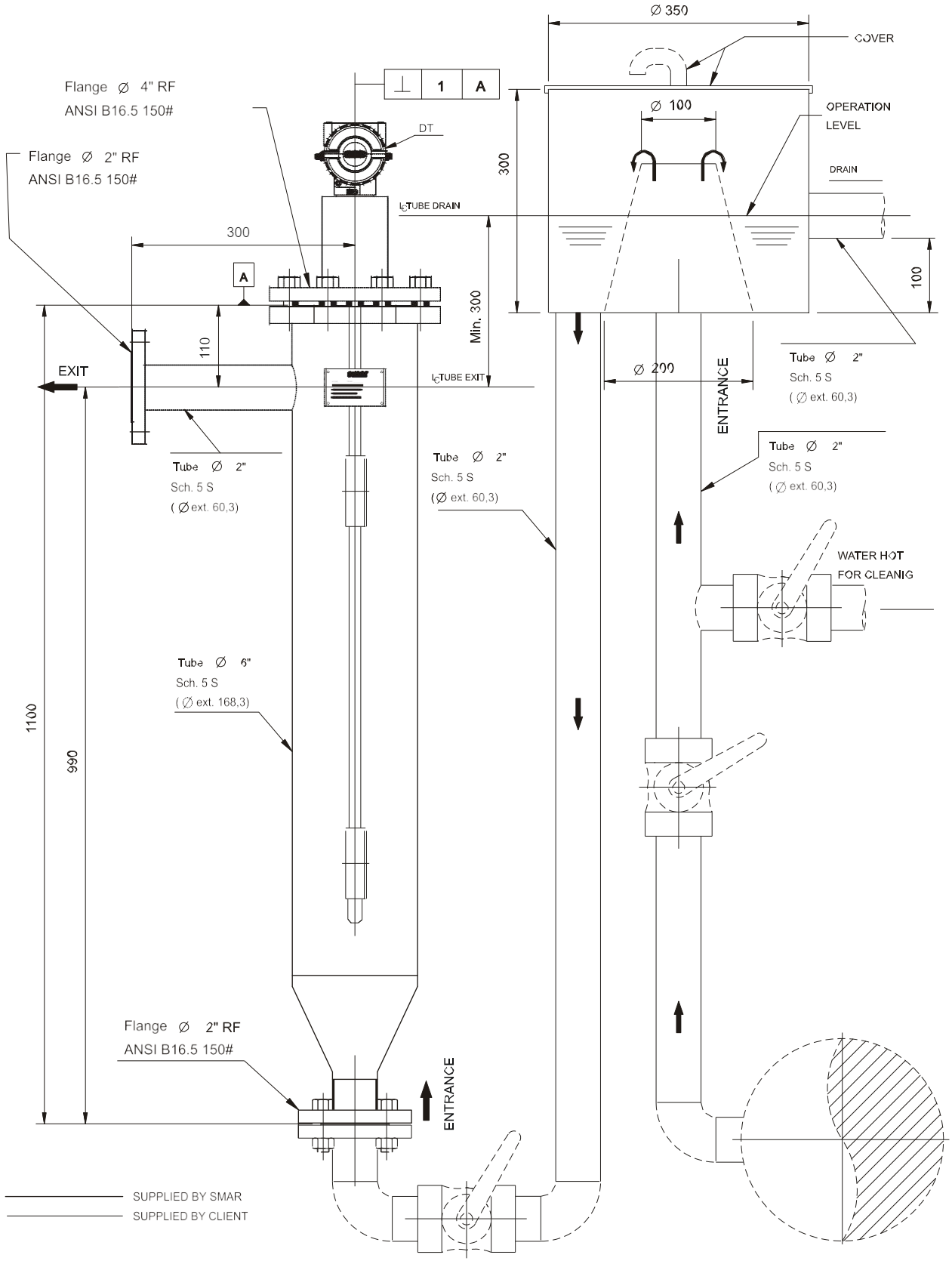


Figure 1.2 – Typical Installation for DM-Series (H)

I - Typical Installation in Tank for Interface Level (Industrial Model)

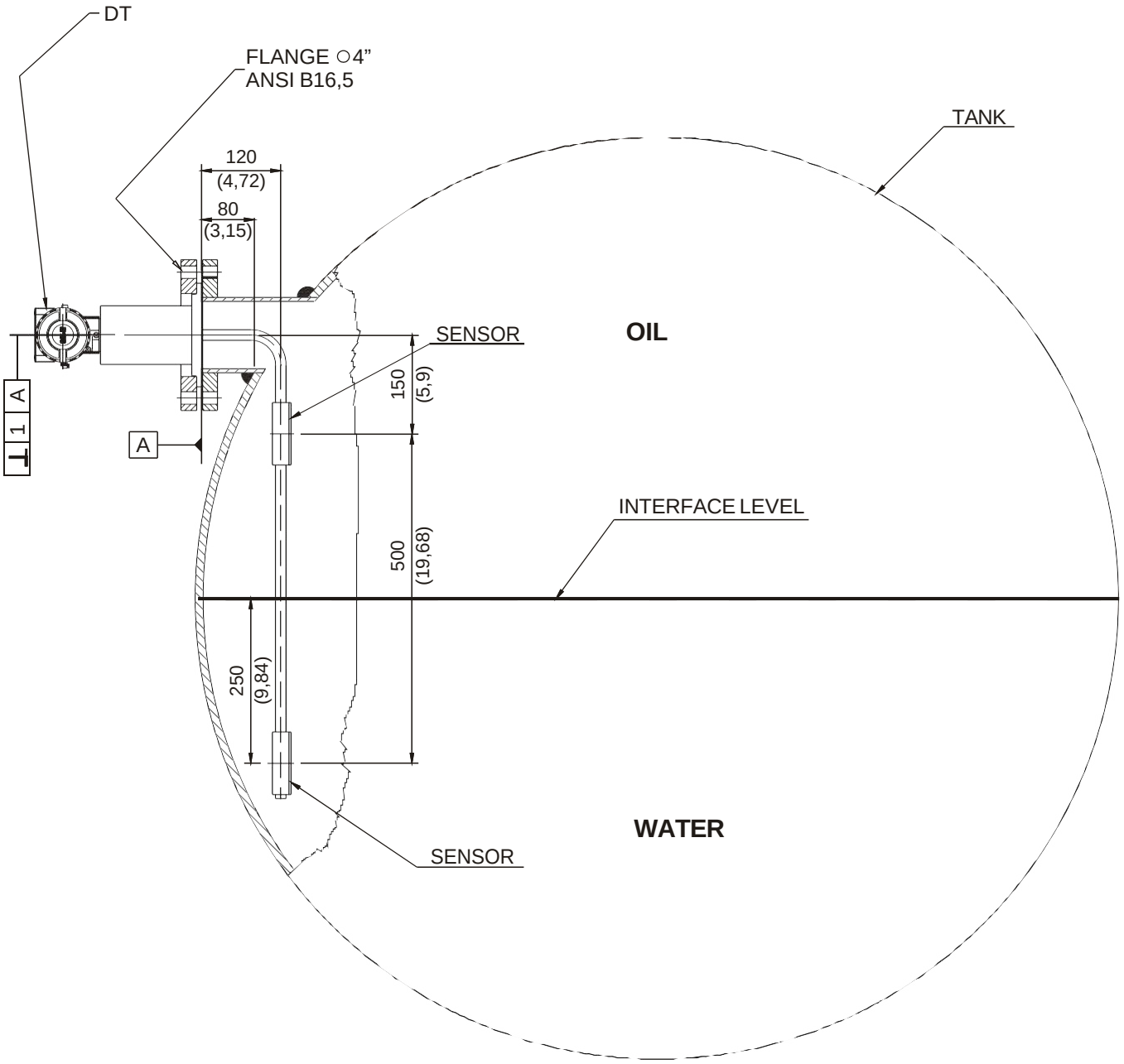


Figure 1.2 – Typical Installation (I)

J - Typical Installation in Tank for Stand Pipe Interface Level (Industrial Model)

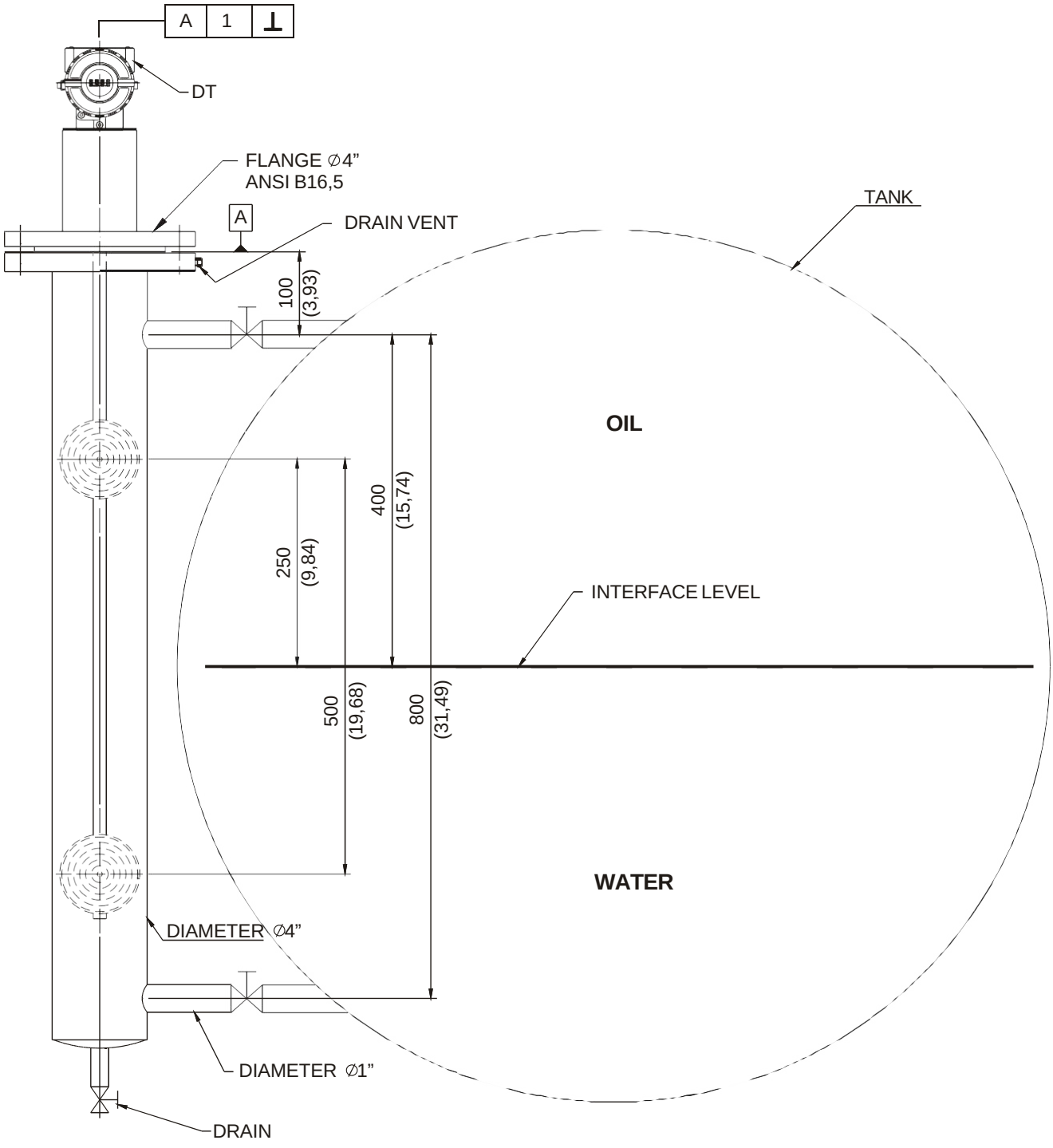


Figure 1.2 – Typical Installation for DM-Series (J)

Electronic Housing Rotation

The electronic housing can be rotated in order for a better position for the digital display. To rotate it, use the housing rotation set screw, see figure 1.3.

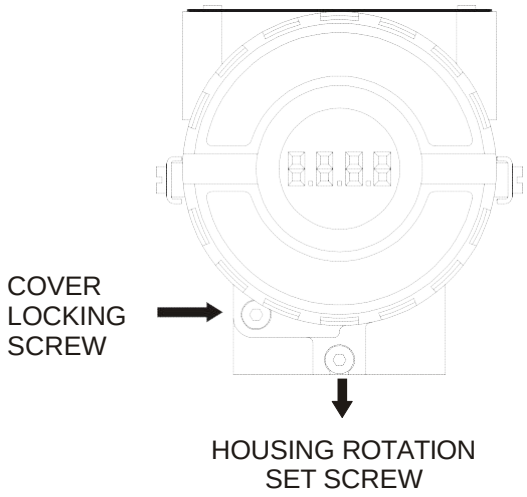


Figure 1.3 – Housing Rotation Set Screw

The digital display can also be rotated. See section 4, figure 4.2.

Electric Wiring

Reach the terminal block by removing the electrical connection cover. The cover locking screw (Figure 1.4) locks this cover. To release the cover, rotate the locking screw clockwise.

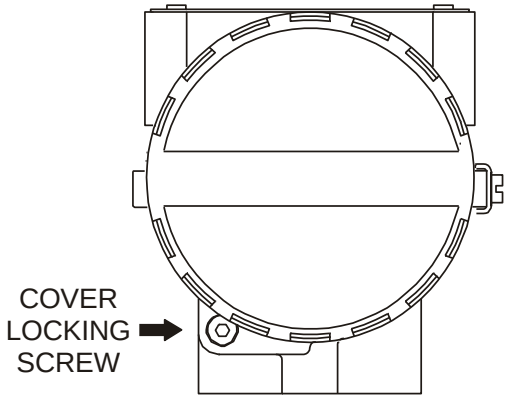


Figure 1.4 – Cover Locking Screw

The terminal block has screws on which fork or ring type terminals can be fastened. See figure 1.5.

For convenience, there are two ground terminals: one inside the cover and two external located close to the conduit entries.

Test and Communication terminals allow, respectively, to measure the current in the 4 - 20 mA loop, without opening the circuit, and also to communicate with the transmitter. The “Test Terminals” must be used to measure the current. The “COMM” terminal must be used for HART communication. See figure 1.5.

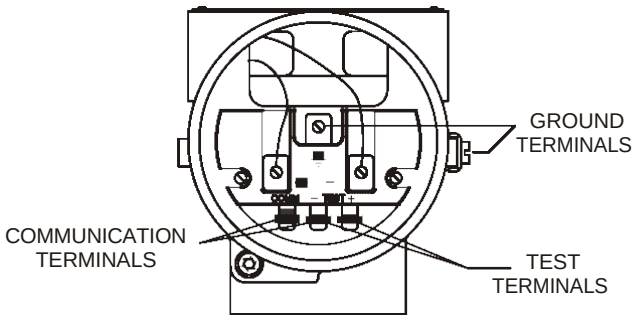


Figure 1.5 – Terminal Block

Use of twisted pair (22 AWG or greater than) cables is recommended.

Avoid routing signal wiring close to power cables or switching equipment. Plug and seal the unused outlet connection accordingly.

The **DM-Series** has protection against reverse polarity.

Connection of the **DM-Series**should be done as in Figure 1.7.

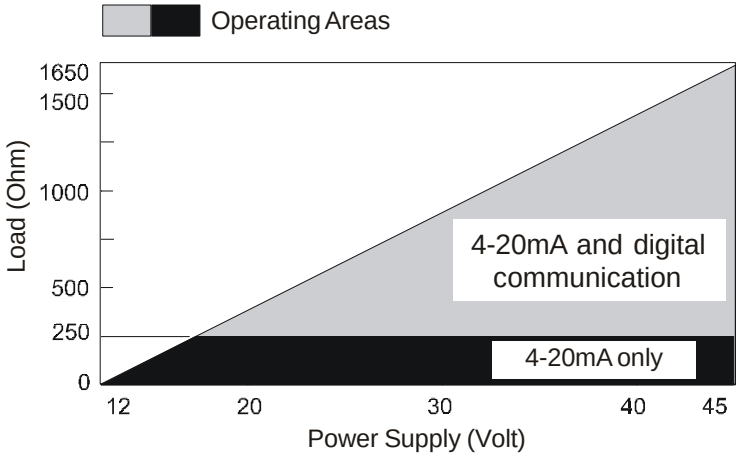


Figure 1.6 – Load Curve

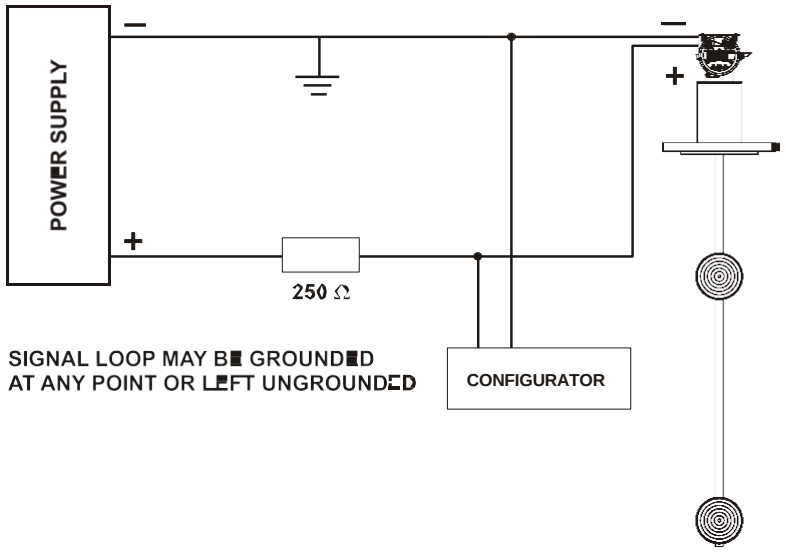


Figure 1.7 – DM-Series Connection Diagram

Multidrop Operation

Multidrop connection is formed by several transmitter connected to a single communication transmission line. Communication between the host and the transmitters takes place digitally with the transmitters analog output deactivated.

The communication with the transmitters and the host (HT2, DCS, Data Acquisition System or PC) can be done with a Bell 202 Modem using Hart Protocol. Each transmitter is identified by a unique address from 1 to 15.

The **DM-Series** is factory set to address 0, which means a non multidrop operation mode, allowing the transmitter to communicative with the Hand-Held Terminal, superimposing the communication on the 4- 20 mA signal. To operate in multidrop mode, the transmitter address must be changed to a number from 1 to 15. This change deactivates the 4-20 mA analog output sending it to 4mA.

NOTE
The current output will be fastened in 4 mA as soon as the transmitter address it is changed of zero (0) for another one in the multidrop range (1 to 15).

To operate in multidrop mode, it is necessary to verify which transmitters are connected on the same line.

The connection of the **DM-Series** in a multidrop net should be made according to figure 1.8.

ATTENTION
For proper operation, the Eagle Eye's configurator requires a minimum load of 250 Ohms between it and the power supply. See figure 1.8.

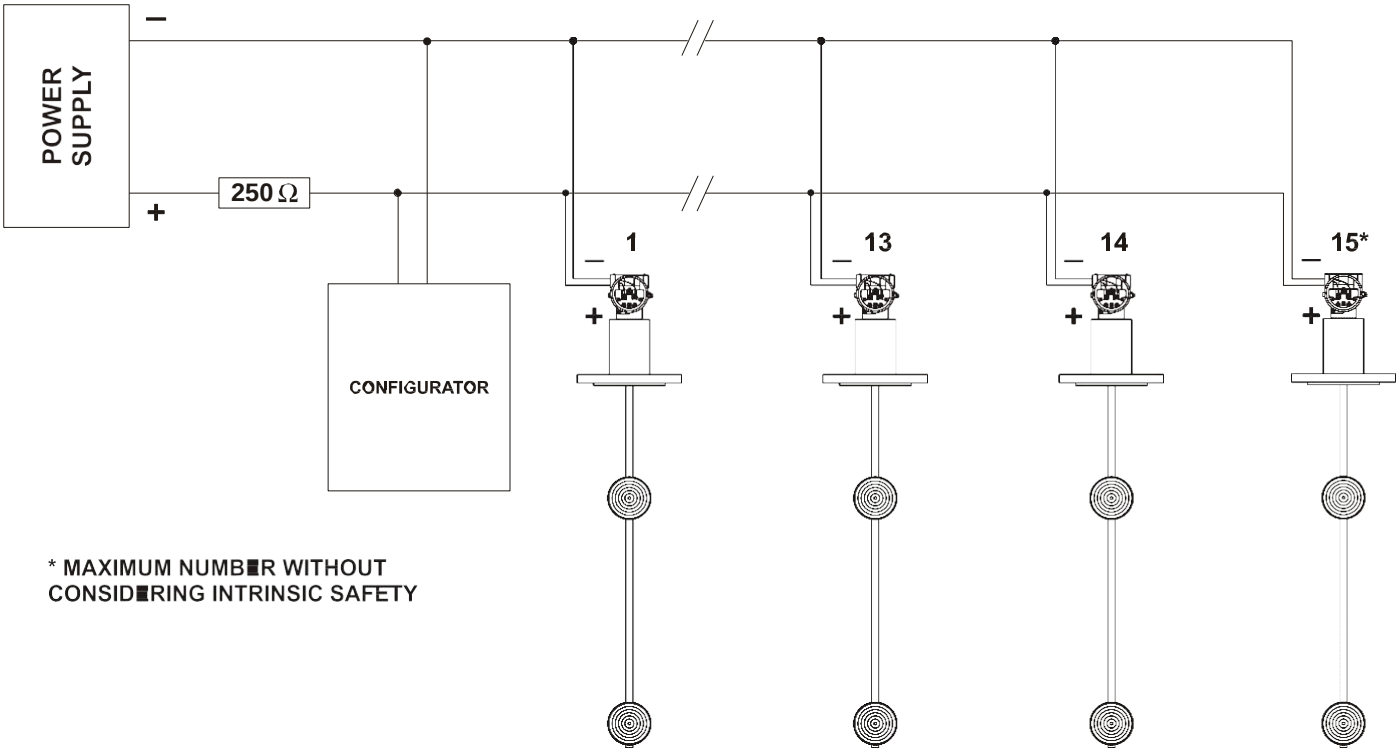


Figure 1.8 – DM-Series Diagram for Multidrop Connection

Installation in Hazardous Areas

WARNING
Explosions could result in death or serious injury, besides financial damage. Installation of this transmitter in explosive areas must be carried out in accordance with the local standards and the protection type adopted .Before continuing the installation make sure the certificate parameters are in accordance with the classified area where the equipment will be installed. The instrument modification or parts replacement supplied by other than authorized representative of Eagle Eye is prohibited and will void the certification. The transmitters are marked with options of the protection type. The certification is valid only when the protection type is indicated by the user. Once a particular type of protection is selected, any other type of protection can not be used. The electronic housing and the sensor installed in hazardous areas must have a minimum of 6 fully engaged threads. Lock the housing using the locking screw (Figure 1.3). The cover must be tighten with at least 8 turns to avoid the penetration of humidity or corrosive gases. The cover must be tighten until it touches the housing. Then, tighten more 1/3 turn (120°) to guarantee the sealing. Lock the covers using the locking screw (Figure 1.3). Consult the Appendix A for further information about certification.

Explosion/Flame Proof

WARNING
The electric connection's entries must be connected or closed using the appropriate Ex-d metal cable gland and/or metal blanking plug with certified IP66 rating. As the transmitter is non-ignition capable under normal conditions, the statement "Seal not Required" could be applied for Explosion Proof Version. The standard plugs provided by Eagle Eye are certified according to the standards at FM, CSA and CEPEL. If the plug needs to be replaced, a certified plug must be used. In the electrical connection with NPT thread, for waterproofing installation, use a non-hardening silicone sealant. **Do not remove the transmitter covers when power is ON.**

Intrinsically Safe

WARNING
In hazardous zones with intrinsically safe or non-incendive requirements, the circuit entity parameters and applicable installation procedures must be observed. To protect the application the transmitter **must be connected to a barrier**. Match the parameters between barrier and the equipment (Consider the cable parameters). Associated apparatus ground bus shall be insulated from panels and mounting enclosures. Shield is optional. If used, be sure to insulate the end not grounded. Cable capacitance and inductance plus Ci and Li must be smaller than Co and Lo of the associated Apparatus. For free access to the Hart bus in the explosive environment, ensure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices. Use only Ex Hart communicator approved according to the type of protection Ex-i (IS) or Ex-n (NI). It is not recommended to remove the transmitter cover when the power is ON.

Section 2

OPERATION

The pressure sensor used by the **DM-Series** Concentration/ Density Transmitter is a capacitive cell, the same type used by the DM-Series Pressure Transmitter. This sensor is connected to a probe to accomplish the measures through of the pressure differential reading. The figure 2.1 schematizes the sensor used by the **DM-Series.**

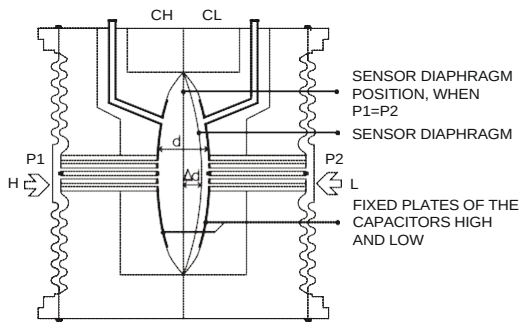


Figure 2.1 – Capacitive Cell

Functional Description – Sensor

Where,

P_1 and P_2 are the pressures applied in cameras H and L.

CH = capacitance between the fixed plate on P1 side and the sensing diaphragm.

CL = capacitance between the fixed plate on the P2 side and the sensing diaphragm.

d = distance between CH and CL fixed plates.

Δd = sensing diaphragm's deflection due to the differential pressure ΔP = P1 - P2.

The capacitance of a capacitor with flat, parallel plates may be expressed as a function of plate area (A) and distance (d) between the plates:

$$C = \frac{\in A}{d}$$

Where,

ε = dielectric constant of the medium between the capacitor's plates.

If *CH* and *CL* be considered the capacity of flat and parallel plates with identical areas, then:

$$CH = \frac{\in .A}{(d/2) + \Delta d} \quad \text{and} \quad CL = \frac{\in .A}{(d/2) - \Delta d}$$

However, if the differential pressure (ΔP) applied to the capacitive cell not deflect the sensing diaphragm beyond d/4, it is possible to assume ΔP as proportional to Δd, that is:

$\Delta P \ \alpha \ \Delta d$

By developing the expression (CL - CH)/ (CL + CH), it follows that:

As the distance (d) between the fixed plates CH and CL is constant, is possible to conclude that the expression
(CL - CH) / (CL + CH) is proportional to Δd and, therefore, to the differential pressure to be measured.

Thus it is possible to conclude that the capacitive cell is a pressure sensor formed by two capacitors whose capacitances vary according to the differential pressure applied.

Functional Description - Hardware

The transmitter blocks Diagram, as it shows the Figure 2.2, it describes the circuit used by the **DM-Series** functionally.

Probe

The probe is the transmitter part that is directly in contact with the process.

Pressure Repeaters
It transfers to the capacitive sensor the differential pressure detected in the process.

Temperature Sensor
It captures the process fluid temperature.

Sensor Board

It implements the transducer that converts the sensor sign for a measure that can be treated by CPU.

Oscillator
It generates a proportional frequency to the capacitive generated by sensor.

Signal Isolator
It accomplishes the isolation of signs between the sensor and CPU. The Control signals from the CPU are transferred through optocouples, and the signal from the oscillator is transferred through transformer

Memory EEPROM
It is a non-volatile memory and it contains the specific information of the sensor, such as, construction materials, calibration of the sensor, production and customer's data.

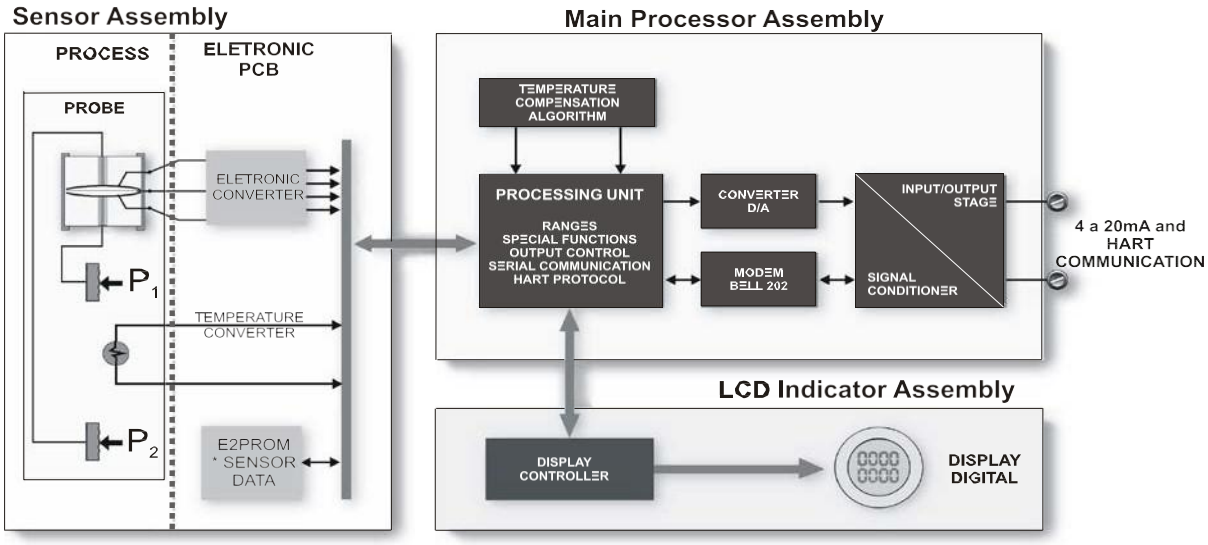


Figure 2.2 – DM-Series Hardware Block Diagram

Main Board

(CPU) Central Processing Unit and PROM
The (CPU) Central Processing Unit is the intelligent part of the transmitter responsible for the management and operation of the circuits, sign treatment and accomplish the communication digital with other devices. For temporary data storage, CPU uses the memory position of its internal RAM. The data stored in this RAM are those that can be destroyed in the case of energy lack. The data that request its retention, CPU stores them in its memory it not interns volatile (EEPROM). This EEPROM memory admits 10.000 recordings in the same memory position.
The program is stored in a PROM external memory.

D/A Converter
It converts the digital data from the CPU to an analog signal with 14-bits resolution.

Output
It accomplishes the current control in the line of feeding of the transmitter. This current control is made to form to generate a proportional current to the value of the variable reading. The work range of the transmitter defines the values for the currents 4 and 20 MA. The control current of the **DM-Series** transmitter obeys the specifications of the NAMUR NE-43 norm.

Modem
The function of this circuit is to become possible the change of information between the Eagle Eye configurator and the **DM-Series**transmitter, through protocol HART. The communication sign is symmetrical and it doesn't affect the level DC in the output of 4-20mA.

Power Supply
The transmitter gets the energy of the communication line for its own operation (transmitter to two wires). The minimum tension for the transmitter operation is of 16 VDC, measure in the block.

Display Controller
It controls the lit of the liquid crystal Display segments in agreement with the correspondent data for CPU. The user has the option of selecting the variable shown in the display, through digital communication.

Functional Description - Software

The figure 2.3 shows the software functional diagram of the **DM-Series** transmitter.

Digital Filter
The digital filter is a low pass filter with an adjustable time constant Damping. It is used to smooth noisy signals. The Damping value is the time required for the output reaching 63.2% for a step input of 100%.

Customer Characterization
It calculates the real pressure through layer capacitive readings and sensor temperature, considering the data of factory calibration stored in EEPROM of the sensor. This module has as output the values of differential pressure and temperature.

Specific Weight Calculation
It calculates the specific weight of the solution, being taken in consideration its properties physical chemistries.

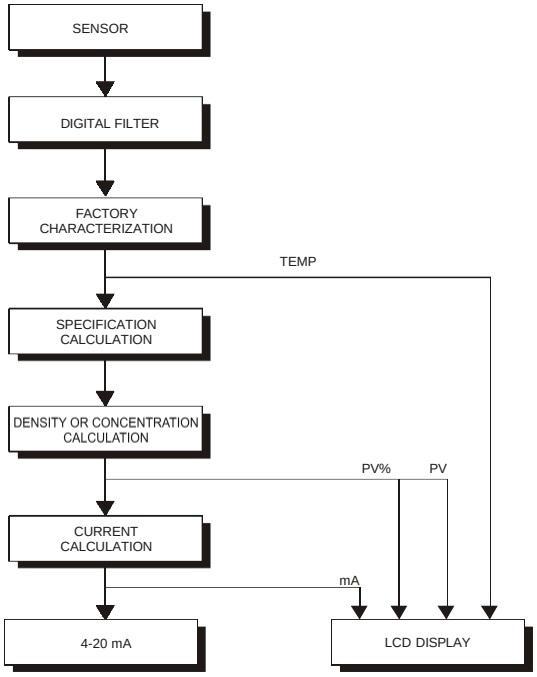


Figure 2.3 – DM-Series Software Block Diagram

Density or Concentration Calculation
Obtained the value of the specific weight, it can be determined its density or concentration easily. In this point, obtain the value of the PV main variable, so much in percentage as in engineering units.

Current Calculation
It makes the correlation of PV with the current values in calculation.

Display

The indicator, constituted by the liquid crystal display, it can show one or two variables in agreement with the user's selection. When it is shown two variables, the indicator will alternate between both with an interval of approximately 3 seconds.

Beyond the numeric and alphanumeric fields, the display shows some alphanumeric icons to indicate the transmitter states. The figure 2.4 shows the segment configuration used by **DM-Series** transmitter.

Monitoring
The **DM-Series** transmitter stays continually in the mode monitoring. In this mode, the indication at the display alternates between the primary and secondary variable, according to the user's configuration. The indicator has the capacity to show the value, the engineering unit and the variable type, simultaneously with most of the state indications. See in the figure 2.4 a sample of a **DM-Series** indication standard.

The display is capable also to show messages and mistakes (See the table 2.1).

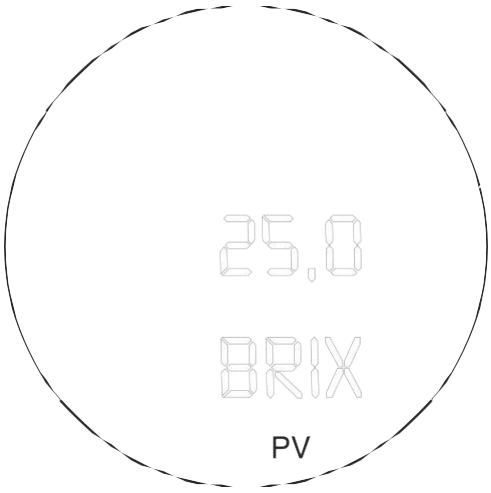


Figure 2.4 – Typical Monitoring Mode Display Showing PV, in this case 25.0 BRIX

DISPLAY	DESCRIPTION
INIT	The **DM-Series** is in initializing after power on.
FAIL	Fails in the transmitter. See Section 4 – Maintenance.
SAT	Primary or secondary Variable out of the range operation. See Section 4 - Maintenance.

Table 2.1 - Display Errors and Messages

CONFIGURATION

The **DM-Series** Intelligent Density Transmitter is a digital instrument with the most up-to-date features a measurement device can possibly have. Its digital communication protocol (HART®) enables the instrument to be connected to a computer in order to be configured in a very simple and complete way. Such computers connected to the transmitters are called HOST computers. They can either be Primary or Secondary Masters. Therefore, even the HART® being a master-slave type of protocol, it is possible to work with up to two masters in a bus. The Primary HOST plays the supervisory role and the Secondary HOST plays the Configurator role.

The transmitters may be connected in a point-to-point or multi drop type network. In a point-to-point connection, the equipment must be in its "0" address so that the output current may be modulated in 4 to 20 mA, as per the measurement. In a multi drop network, if the devices are recognized by their addresses, the transmitters shall be configured with a network address between "1" and "15. In this case, the transmitter's output current is kept constant, with a consumption of 4 mA each. If the devices are recognized by their tag, the transmitter's addresses may be "0" while, their output current is still being controlled, even in a multi drop configuration.

In the case of the **DM-Series**, which can be configured a transmitter; the HART® addressing is used as follows:

Transmitter Mode - The "0" address causes the **DM-Series** to control its output current and addresses "1" through "15" place the **DM-Series** in the multi drop mode with current control.

NOTE

In case of multi drop network configuration for classified areas, the entity parameters allowed for the area shall be strictly observed. Therefore, the following shall be checked:

$$Ca \geq \Sigma Ci_j + Cc \qquad La \geq \Sigma Li_j + Lc$$

$$Voc \leq min\,[Vmax_j] \qquad Isc \leq min\,[Imax_j]$$

Where:
Ca, La - Barrier Allowable Capacitance and Inductance
Ci_j, Li_j - Non protected internal Capacitance/Inductance of transmitter *j (j = up to 15)*
Cc, *Lc* - Cable capacitance and Inductance
V_{oc} - Barrier open circuit voltage
I_{sc} - Barrier short circuit current
$Vmax_j$ - Maximum allowable voltage to be applied to the instrument *j*
$Imax_j$ - Maximum allowable current to be applied to the instrument *j*

The **DM-Series** Intelligent Density Transmitter includes a very encompassing set of HART® Command functions that make it possible to access the functionality of what has been implemented. Such commands comply with the HART® protocol specifications, and are grouped as Overall Commands, Common Practice Controls Commands and Specific Commands.

Eagle Eye developed two types of Configurators for its HART® devices: CONF401 and HPC301 Configurator. The first works in Windows platform (95, 98, 2000, XP and NT) and UNIX. It supplies an easy configuration, field instruments monitoring, and capacity to analyze data and to modify the performance of field instruments. The second, HPC301, is the newest technology in portable computers PalmZIRE71 Handheld.

For operation and function characteristics of mentioned configurators, refer to the respective manuals.

Figures 3.1 and 3.2 show the front of the Palm and the CONF401 screen, with active configuration.

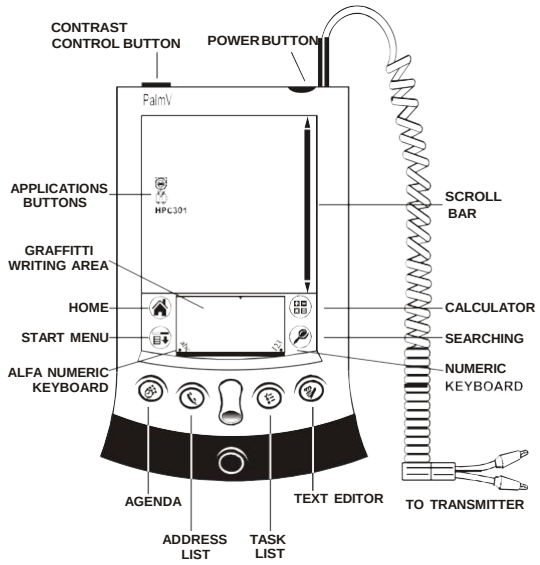


Figure 3.1 – Configurator

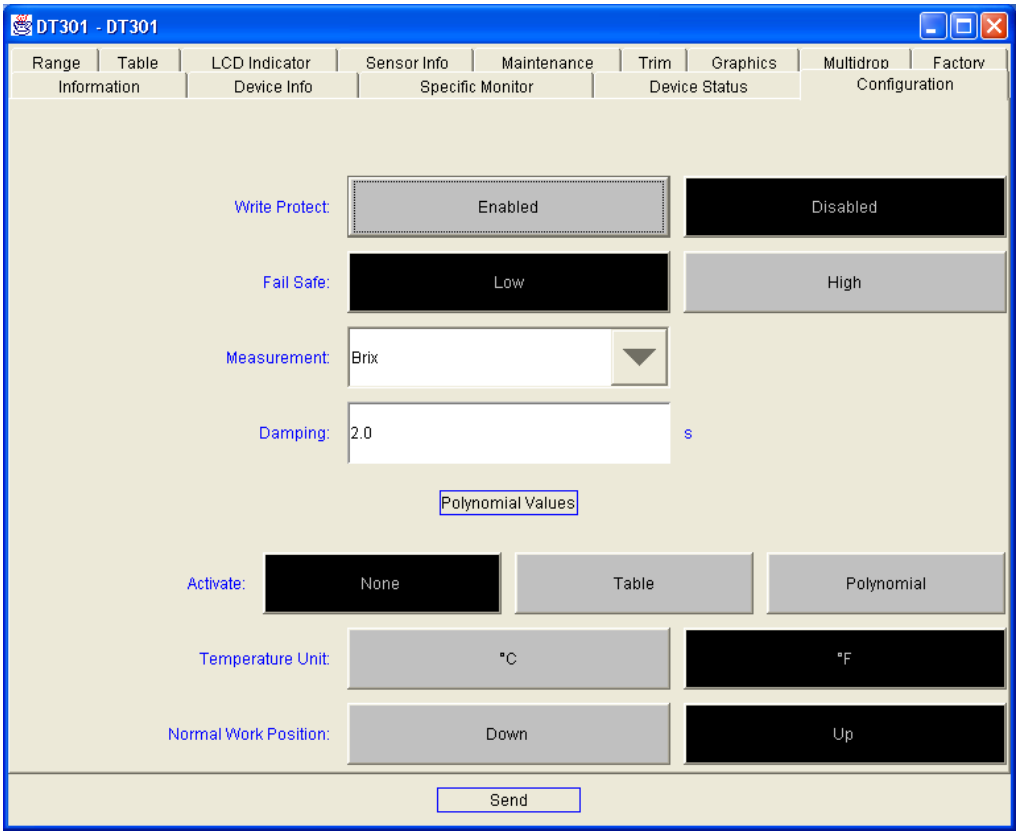


Figure 3.2 – CONF401 Screen

Configuration Resources

By means of the HART® configurator, the **DM-Series** firmware allows the following configuration features to be accessed:

- ✓ Transmitter identification and manufacturing data
- ✓ Primary variable trim – density
- ✓ Primary variable trim – current

- ✓ Transmitter adjustment to the working range
- ✓ Engineering unit selection
- ✓ Linearization table
- ✓ Device configuration
- ✓ Equipment maintenance

The operations, which take place between the configurator and the transmitter do not interrupt the density measurement, and do not disturb the output signal. The configurator can be connected on the same pair of wires as the 4-20 mA signal, up to 2 km away from the transmitter.

Manufacturing Data and Identification

The following information about the **DM-Series** manufacturing and identification data is available:

TAG - 8-character alphanumeric field for transmitter identification.

DESCRIPTOR - 16-character alphanumeric field for additional identification of the transmitter. May be used to identify a service or location.

DATE - The date may be used to identify a relevant date as the last calibration, the next calibration or the installation. The date is presented in the form of bytes where DD = [1,..31], MM = [1..12], AA = [0..255], where the effective year is calculated by [Year = 1900 + AA].

MESSAGE - 32-character alphanumeric field for any other information, such as the name of the person who made the last calibration, some special care to be taken, or if a ladder is needed for accessing.

FLANGE TYPE - Ø 4” x 150 #ANSI B16.5 RF, Ø 4” x 300 #ANSI B16.5 RF, Ø 4” x 600 #ANSI B16.5 RF, DN 100 PN25/40, DIN2526-Forma D, 03 " Tri Clamp, Special.

FLANGE MATERIAL - 316L SST, Hastelloy C276, Special.

O-RING MATERIAL - Buna-N, Viton, Teflon and Special.

LOCAL INDICATOR - Installed or None.

REMOTE SEAL TYPE - Straight Type, Side Type.

REMOTE SEAL FLUID - DC200/20 Silicone Oil, DC704 Silicone Oil, Glycerin / Water, Sylthern 800, Propylene Glycol (NEOBEE M20).

REMOTE SEAL DIAPHRAGM - 316L SST, Hastelloy C276, Special.

SENSOR FLUID* - DC200/20 Silicone Oil, DC704 Silicone Oil, Glycerin / Water, Sylthern 800, Propylene Glycol (NEOBEE M20).

SENSOR ISOLATING DIAPHRAGM* - 316 SST, Hastelloy C, Monel, Tantalum and Special.

SENSOR TYPE* - It shows the sensor type.

SENSOR RANGE* - It shows the sensor range in engineering units chosen by user. See Configuration Unit.

NOTE
Items marked with asterisk cannot be changed. They come directly the sensor memory.

Trim of the Primary Variable - Density

Density, defined as a primary variable, is determined from the sensor readout by means of a conversion method. Such a method uses parameters obtained during the fabrication process. They depend on the electric and mechanical characteristics of the sensor, and on the temperature change to which the sensor is submitted. These parameters are recorded in the sensor's EEPROM memory. When the sensor is connected to the transmitter, such information is made available to the transmitter's microprocessor, which sets a relationship between the sensor signal and the measured density.

Sometimes, the measure shown on the transmitter's display is different from the user's standard. This may be due to several reasons, among which the following can be mentioned:

- The transmitter mounting position.
- The user's standard differs from the factory standard.
- Sensor's original characteristics shifted by overpressure, over temperature or other special conditions of use.

The concentration trim is the method used in order to adjust the measurement as related to the density/concentration of the process, as per the user's standard. The most common discrepancy found in transmitters is usually due to zero displacement. This may be corrected by means of the lower concentration trim.

Concentration Trim

This trim is made with the DM-Series installed in the process fluid. Catch a sample of the process fluid and determine the density or concentration in laboratory. Enter the trim menu to adjust the lower concentration, informing the value read in laboratory or another standard.

Self-Calibration Trim

Self-calibration trim makes the transmitter calibration considering as reference the density of the air and of the water.

DM-Series Self Calibration

First Step – Air Self calibration
Place the **DM-Series i**n work position (vertical) facing the air, wait approximately **5** minutes for stabilization, choose **Kg/m³** for measurement unit. Enter the **TRIM** menu, choose the option **AIR** self-calibration trim and click on **SEND**, when the indicated error is between ±0.4 Kg/m**³,** press OK.

Second Step – Water Self calibration
After air calibration, place the **DM-Series** in vertically in water, immersing both diaphragms, wait approximately **5** minutes for stabilization and change the measurement unit for **Brix**. Enter the **TRIM** menu, choose the option **WATER** self-calibration trim and click on **SEND**, when the indicated error is between ±0.1 Brix, press OK.

Figure 3.3 – Air Self Calibration

Figure 3.4 – Water Self Calibration

Following these steps, the **DM-Series** will be calibrated. In case there is a difference between the **DM-Series** and the standard used as reference, adjust the concentration in the process.

Temperature Trim

There might be differences between the Eagle Eye temperature standards and your temperature plant Standard. In this case, the Temperature Trim adjustment shall be done to correct this difference in the Temperature Trim menu.

Primary Variable Current Trim

When the microprocessor generates a 0% signal, the Digital to Analog converter and associated electronics are supposed to deliver a 4 mA output. If the signal is 100%, the output should be 20 mA.

There might be differences between the Eagle Eye current standards and your current plant Standard. In this case, the Current Trim adjustment shall be done with a precision ammeter as measurement reference. Two Current Trim types are available:

- ✓ **4 mA TRIM:** this is used to adjust the output current value corresponding to **0%** of the measurement;
- ✓ **20 mA TRIM:** this is used to adjust the output current value corresponding to **100%** of the measurement;

The Current Trim shall be carried out as per the following procedure:

- ✓ Connect the transmitter to the precision ammeter;
- ✓ Select one of the Trim types;
- ✓ Wait a while for the current to stabilize and inform the transmitter the current readout of the precision ammeter.

NOTE
The transmitter presents a resolution that makes it possible to control currents as low as microamperes. Therefore, when informing the current readout to the transmitter, it is recommended that data input consider values up to tenths of microamperes.

Adjustment of the Transmitter to Work Range

This function affects, directly, the 4-20 mA output of the transmitter. It is used to define the work range of the transmitter and, in this document; this process is defined as transmitter calibration. The transmitter **DM-Series** implements two calibration resources:

OUTPUT CURRENT CALIBRATION: The output current shall be calibrated so that lower concentration value represents 4 mA and the upper concentration value represent 20 mA;

MEASUREMENT CALIBRATION: The **DM-Series** is manufactured and calibrated in accordance with the customer's request. During the installation some changes can occur on the device and an adjustment on the measurement can be necessary. If the required adjustment is only for the measurement engineering units, search for measurement item described in the sequence. If the adjustment requires changes in measurement values, make the calibration with reference;

DAMPING: The damping item in calibration menu enables adjustment of the damping factor of engineering unit (PV) reading of filter, performed by software. The damping is a digital filter where time constant, may be adjusted between 0 and 32 seconds. The transmitter has an intrinsic mechanical damping of 0.2 seconds.

MEASUREMENT

This function of configuration menu of the programmer makes it possible to select the type of transference function the transmitter is expected to perform. There are several functions related with the measurement of density and concentration, and there is a special function which makes it possible to check the 4 to 20 mA current generated by the transmitter. The following transference functions have been implemented:

- **Density**

The transference functions related to the density measurement correspond to the measurement of absolute density measurement, which takes into consideration the chemical properties of the solution and the physical properties of the medium, and to the measurement of specific gravity, which is based on the density of water. Therefore, it is possible to perform measurements in the following units: kg/m^3, g/cm^3, SGU@ 20ºC, SGU@ 4ºC.

- **Concentration**

Such measurements inform the composition of a solution in comparison with several worldwide accepted units, such as: Baumé Degree, Plato Degree, Brix Degree and INPM Degree.

- **Constant Output**

This measurement allows the user to check the consistency of the input current generation values between 3.9 and 21 mA. This is also an extremely important characteristic while performing the Loop Testing during the Startup of an Industrial plant.

DISPLAY

This option makes it possible to configure up to two variables to be shown on the display of the transmitter. Should the user for using only one variable, the same variable shall be entered as the second variable or, alternatively, none shall be chosen as the option for the second variable.

Engineering Unit Selection

The user can also choose the measured type:

- Density in g/cm³;
- Density in Kg/m³;
- Relative Density @ 20°C;
- Relative Density @ 4°C;
- Density in lb/ft^3 ;
- Density in t/m³;
- Baume;
- Brix;
- Plato;
- INPM;
- GL;
- Solid Percent;
- API.

Solid Percent (% sol)

The concentration/ density transmitter DM-Series offers resources with the objective of relating Baume degree to solid percent.

The general equation to determine the solid percent is:

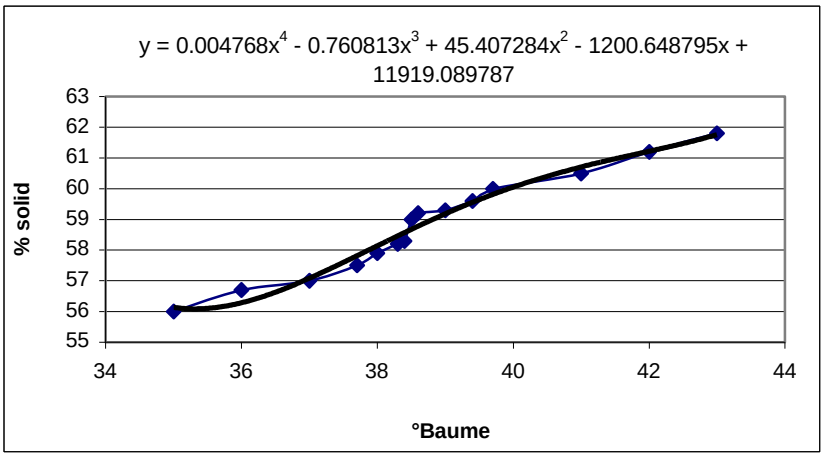
$$\%sol = a_0 + a_1\ bme^1 + a_2\ bme^2 + a_3\ bme^3 + a_4 bme^4 + a_5\ bme^5$$

The table and the graph below indicate the application of the **DM-Series** polynomial that relates Baume degree to solid percent, generating the polynomial:

$y = 0.004768x^4 - 0.760813x^3 + 45.407284x^2 - 1200.648795x + 11919.089787.$

X		
1	Bme	%SOL.
2	35	56
3	36	56,7
4	37	57
5	37,7	57,5
6	38	57,9
7	38,3	58,2
8	38,4	58,3
9	38,5	59
10	38,6	59,2
11	39	59,3
12	39,4	59,6
13	39,7	60
14	41	60,5
15	42	61,2
16	43	61,8

POLYNOMIAL REGRESSION



Concentration Percentage (% conc)
For applications that demand other relation among measures, the polynomial used is:

$$f(a,d,t) = a_0 + a_1 d + a_2 d^2 + a_3 d^3 + a\, d^4 + a_5 d^5 + a_6 d\, t + a_7 d^2 t + a_8 d^3 t + a_9 d\, t^2 + a_{10} d\, t^3 + a_{11} d^2 t^2 + a_{12} d^3 t^3 + a_{13} t + a_{14} t^2 + a_{15} t^3 + a_{16} t^4 + a_{17} t^5$$

This function is applied to a higher number of applications. It relates three measurements: density, temperature and concentration.

As the digital display used in **DM-Series**is of 4 ½ digits, the maximum indicated value would be 19999. When selecting the unit, be certified that in your application the value won't surpass 19999.

Equipment Configuration

The **DM-Series** enables the configuration of not only its operational services, but of instrument itself. This group includes services related to: input filter, burnout, addressing, display indication and passwords.

✓ **INPUT FILTER** - The input filter, also referenced to as damping, is a first class digital filter implemented by the firmware, where the time constant may be adjusted between 0 and 32 seconds. The transmitter's mechanical damping is 0.2 seconds;

✓ **BURNOUT** - This configuration option includes the possibility of choosing the output current action, should a failure occur. The output current will remain fixed within the limits of Lower Burnout or Upper Burnout, depending on the failure mode chosen.

The user does not choose the upper and lower burnout current limits. These limits are previously determined in accordance with the transmitter version. The lower current limit is 3.9 mA and the latest versions comply with the specifications of standard NAMUR NE-43, that is, 3.6 mA. In what respects to the upper limit, all versions use the same limit: 21 mA. The selection of lower burnout and upper burnout is done by means of mode switching device.

✓ **MONITORING -** This function allows the remote monitoring of one of the transmitter variables in the display of configurator. To activate it, select “monit” in the main menu.

✓ **ADDRESSING** - The **DM-Series** includes a variable to define the equipment address in a HART® network. Addresses may go from value "0" to "15"; addresses from "1" to "15" are specific addresses for multidrop connections. This means that, in a multidrop configuration, the **DM-Series** will display the message MDROP for addresses "1" to "15";

NOTE
The output current will be increased to 4 mA as the **DM-Series** address is altered to another value than "0".

✓ **DISPLAY INDICATION** - the **DM-Series** digital display is comprised of three distinct fields: an information field with icons indicating the active configuration status, a 4 ½ digit numeric field for values indication and a 5 digit alphanumeric field for units and status information.

The **DT301** may work with up to two display configurations to be alternately displayed at 2 second intervals. Parameters that may be selected for visualization are those listed on Table 3.1, below.

PV (%)	Process variable in percentage.
PV	Process variable in engineering units.
OUT (%)	Output in percentage.
OUT (mA)	Output in milliamperes.
TEMP	Process temperature.
S/INDIC	Used to cancel the second indication.

Table 3.1 - Variables for Indication in Display

Equipment Maintenance

Here are grouped maintenance services related with the collection of information required for equipment maintenance. The following services are available: Order Code, Serial Number, Operation Counter and Backup/Restore.

✓ **ORDER CODE** - The Order Code is the one used for purchasing the equipment, in accordance with the User specification. There are 22 characters available in the **DT301** to define this code.

Example:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
D	T	3	0	1	1	I	S	0	0	1	J	B	0	2							

Density Transmitter **DM-Series**(D):
Range: 0 to 2.0 g/cm³ (1);
Diaphragm of 316L SS (I);
Silicone Oil Fill Fluid DC 200/20 (S);
Without Local Indicator (0);
Electric Connection 1/2 - 14NPT (0);
Type of Assembly - Straight (1);
Connection to the Process Tri-Camp 4" 300 # (J);
Wetted ring Material of Buna N (B);
Without Tank Adapter (0) and
Inox Steel Tri-Camp 304 (2).

✓ **SERIAL NUMBER** - Three serial numbers are stored:

Circuit Number - This number is unique to every main circuit board and cannot be changed.

Sensor Number - The serial number of the sensor connected to the **DM-Series** and cannot be changed. This number is read from the sensor every time a new sensor is inserted in the main board.

Transmitter Number - the number that is written at the identification plate each transmitter.

NOTE
The transmitter number must be changed whenever there is the main plate change to avoid communication problems.

✓ **OPERATION COUNTER** - Every time a change is made, there is an increment in the respective change counter for each monitored variable, according to the following list. The counter is cyclic, from 0 to 255. The monitored items are:

LRV/URV: when any type of calibration is done;
Function: when any change in the transference function is done, e.g., linear, square root or table;
Trim_4mA: when the current trim is done at 4mA;
Trim_20mA: when the current trim is done at 20mA;
Trim_Zero/Lower: when pressure trim is done at Zero or Lower Density;
Trim Upper Density: when the trim is done at Upper Density;
Characterization: when any change is made in any point of the density characterization table in trim mode;
Multidrop: when any change is made in the communication mode, for example, multidrop or single transmitter.

✓ **BACKUP -** When the sensor or main circuit is changed, it is necessary, immediately after the assembly, to transfer the data of the new sensor to the main board or the old sensor data for the new main board.

Most of the parameters are automatically transferred. The calibration parameters, however, remain safe in the main board, so that the working range cannot be accidentally modified. When the replaced part is the sensor, it becomes necessary to transfer calibration data from the main board to the sensor and vice-versa if the replaced part is the main board.
Backup operation saves the contents of the main board in the sensor memory and the restore function performs the reverse operation.

Section 4

MAINTENANCE PROCEDURES

General

Eagle Eye **DM-Series** Intelligent Density/Concentration Transmitters are extensively tested and inspected before delivery to the end user. Nevertheless, during their design and development, consideration was given to the possibility of repairs by the end user, if necessary.

As main characteristics how much to the maintenance easiness it can be detached its modularity and its reduced number of electronic board.

In general, it is recommended that end users do not try to repair printed circuit boards. Spare circuit boards may be ordered from Eagle Eye whenever necessary.

The **DM-Series** concentration/density transmitter has been designed to operate for many years without malfunctions. In case the process application requires periodic cleaning of the repeater diaphragms, the flanges may be easily removed and reinstalled.

If the transmitter eventually requires maintenance, it may be changed in the field. In this case, the possibly damaged sensor should be returned to Eagle Eye for evaluation and, if necessary, repair. Refer to the item "Returning Materials" at the end of this Section.

Diagnostic with Configurator

If any problem be noticed relating to the transmitter output, investigation may be carried out by the configurator, as long as power is supplied and communication and the processing unit are operating normally (see table 4.1).

The programmer should be connected to the transmitter according to the wiring diagram shown on Section 1, figures, 1.7 and 1.8.

Error Messages

When communicating using the configurator the user will be informed about any problem found by the transmitter self-diagnostics.

The mistake messages always are alternate with the information shown in the first line of programmer Eagle Eye's display. The table 4.1 lists the mistake messages. For more details on the corrective action, see referred table.

ERROR MESSAGES	POTENTIAL SOURCE OF PROBLEM
PARITY ERROR **OVERRUN ERROR** **CHECK SUM ERROR** **FRAMING ERROR**	• The line resistance is not according to load curve. • Excessive noise or ripple. • Low level signal. • Interface damaged. • Power supply or configurator without battery.
NO RESPONSE	• Transmitter line resistance is not according to load curve. • Transmitter not powered. • Interface not connected or damaged. • Transmitter configured in multidrop mode being accessed by ON LINE SINGLE UNIT. • Transmitter reversibly powered (polarity is reversed). • Interface damaged. • Power supply or configurator without battery.
LINE BUSY	• Other device using the line.
CMD NOT IMPLEMENTED	• Software version not compatible between configurator and transmitter. • Configurator is trying to carry out a **DM-Series** specific command in a transmitter from another manufacturer.

ERROR MESSAGES	POTENTIAL SOURCE OF PROBLEM
XMTR MALFUNCTION	• Sensor disconnected. • Sensor failure.
COLD START	• Start-up or reset due to power supplies failure.
OUTPUT FIXED	• Output in constant mode. • Transmitter in multidrop mode.
OUTPUT SATURATED	• Pressure out of calibrated span or in fail-safe (Output current in 3.90 or 21.00 mA).
SV OUT OF LIMITS	• Temperature out of operating limits. • Temperature sensor damaged.
PV OUT OF LIMITS	• Pressure out of operation limits. • Sensor damaged or sensors module not connected. • Transmitter with false configuration.
LOWER RANGE VALUE TOO HIGH	• The 4 mA point was set to a value above a value corresponding to (upper range limit! minimum span).
LOWER RANGE VALUE TOO LOW	• The 4 mA point was set to a value below a value corresponding to (! upper range limit).
UPPER RANGE VALUE TOO HIGH	• The 20 mA point was set to a value above the 1.24 H (upper range limit).
UPPER RANGE VALUE TOO LOW	• The 20 mA point was set to a value below a value corresponding to (! upper range limit + minimum span).
UPPER & LOWER RANGE VALUES OUT OF LIMITS	• Both the 4 and 20 mA points were outside the sensor's range limit.
SPAN TOO SMALL	• The difference, between the 4 and 20 mA points, is less than the 0.75 H (minimum span) allowed by the transmitter.
APPLIED PROCESS TOO HIGH	• The pressure applied on the sensor was above the 1.24 H (upper range limit).
APPLIED PROCESS TOO LOW	• The pressure applied on the sensor was below the 1.24 H (upper range limit).
EXCESS CORRECTION	• During digital trim, the trim value entered exceeded the factory-characterized value by more than 10% upper range limit.
PASSED PARAMETER TOO LARGE	• Parameter above operating limits.
PASSED PARAMETER TOO SMALL	• Parameter below operating limits.
CONTROL LOOP SHOULD BE IN MANUAL	• This message appears whenever the possibility exists that the operation will affect the 4-20 mA output signal.
CONTROL LOOP MAY BE RETURNED TO AUTO	• After the operation is completed, you are reminded to return the loop to automatic control.

Table 4.1 - Diagnostic Error and Potential Source

Diagnostic without Configurator

***Symptom**: NO LINE CURRENT*

Probable Source of Trouble:

Transmitter Connections
- Check wiring polarity and continuity.
- Check for shorts or ground loops.
- Check if the power supply connector is connected to main board.

Power Supply
- Check power supply output. The voltage must be between 16 and 30 Vdc at transmitter terminals.

Electronic Circuit Failure
- Check the main board for defect by replacing it with a spare one.

***Symptom**: NO COMMUNICATION*

Probable Source of Trouble:

Terminal Connections
- Check terminal interface connections.
- Check if the interface is connected to the wires leading to the transmitter or to the terminals [COMM] and [-].
- Check if the interface is model IF3 (for Hart Protocol).

Transmitter Connections
- Check if connections are according to wiring diagram.

- Check line resistance; it must be equal to or greater than 250 Ohm between the transmitter and the power supply.

Power Supply
- Check output of power supply. The voltage at the **DM-Series**

and ripple less than 500 mV.

Electronic Circuit Failure
- Locate the failure by alternately replacing the transmitter circuit and the interface with spare parts.

Transmitter Address
- In On Line Multidrop item check if the address is "0."

Symptom: *CURRENT OF 21.0 mA or 3.9 mA*

Probable Source of Trouble:

Pressure Tap (Piping)
- Check the pressure connection.
- Check if bypass valves are closed.
- Check if pressure applied is not over upper limit of transmitter's range.

Sensor to Main Circuit Connection
- Check connection (male and female connectors).

Symptom*: INCORRECT OUTPUT*

Probable Source of Trouble:

Transmitter Connections
- Check power supply voltage.
- Check for intermittent short circuits, open circuits and grounding problems.

Process Fluid Oscillation
- Adjust damping

Pressure Tap
- Check the integrity of the circuit by replacing it with a spare one.

Calibration
- Check the transmitter calibration.

Procedure to change the DM-Series Main Board

- Replace the 3051 main board - 1.0X to 2.0X. version
- Read from sensor (Backup menu).
- Trim the temperature with two temperatures 30°C apart.
- This procedure must be done, when the temperature is steady, a temperature standard must be used as a reference to adjust the DT temperature.
- After the temperature trim, make the self-calibration.

Disassembly Procedure

WARNING
Do not disassemble with power on.

Figures 4.3 and 4.4 show transmitter's exploded view and will help you to understand the text below. The numbers between parentheses are relating to the enumeration of the items of the related drawing.

Probe Set (16A, 16B, 19A or 19B)

To have access to the probe for cleaning, it is necessary to remove it from the process.

Remove the transmitter loosening the against-flange.

Cleaning should be done carefully in order to avoid damaging of the delicate isolating diaphragms. Use of a soft cloth and a nonacid solution is recommended.

To remove the sensor from the electronic housing, the electrical connections (in the field terminal side) and the main board connector must be disconnected.

Loosen the hex screw **(6)** and carefully unscrew the electronic housing from the sensor, observing that the flat cable is not excessively twisted.

WARNING
To avoid damage do not rotate the electronic housing more than 270º starting from the fully threaded without disconnecting the electronic circuit from the sensor and from the power supply. See Figure 4.1.

Figure 4.1 – Safe Housing Rotation

Electronic Circuit

To remove the circuit board **(5)**, loosen the two screws **(3)** that anchor the board.

WARNING
The board has CMOS components, which may be damaged by electrostatic discharges. Observe correct procedures for handling CMOS components. It is also recommended to store the circuit boards in electrostatic-proof cases.

Pull the main board out of the housing and disconnect the power supply and the sensor connectors.

Reassembly Procedure

WARNING
Do not assemble with power on.

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Probe Set (16A, 16B, 19A or 19B)

The bolts, nuts, flanges and other parts should be inspected for corrosion or other eventual damage. Damaged parts should be replaced.

The fitting of the sensor must be done with the main board out of the electronic housing. Mount the sensor to the housing turning clockwise until it stops. Then turn it counterclockwise until it faces the protective cover **(1)** parallel to the process flange. Tighten the hex screw **(6)** to lock the housing to the sensor. Install main board after that.

Display

Plug sensor connector and power supply connector to main board.

Attach the display to the main board. Observe the four possible mounting positions (Figure 4.2). The Eagle Eye mark indicates up position.

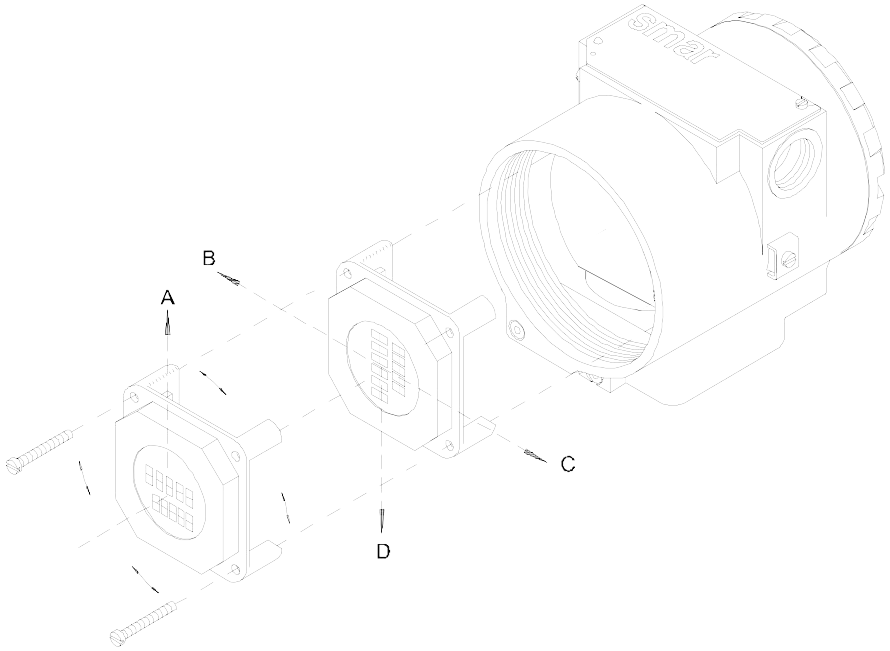

Figure 4.2 – Four Possible Positions of the Display

Anchor the main board and display with their screw **(3)**. After tightening the protective cover **(1)**, mounting procedure is complete. The transmitter is ready to be energized and tested.

Interchangeability

In order to obtain an, accurate and better temperature compensated response, the data of the sensor should be transferred for EEPROM of the main board. That is done automatically when the transmitter is energized.

In this operation, then main circuit reads the number of series of the sensor. If he differs of the number stored in the main board, the circuit will interpreted that there was change of the sensor and it will look for in the new sensor memory its characteristics:

- Temperature compensation coefficients.
- Sensor's trim data, including characterization curve;
- Sensor characteristics: type, range, diaphragm material and fill fluid.

This data must be transferred to the main circuit board.

The other information is stored in the main circuit memory and is not affected by sensor change.

Data transfer from the sensor to the main circuit can also be forced by function MAINT/BACKUP/READ FROM SENSOR.

In the case of change of the main board, the information of the sensor, as described above are up-to-date. Even so, the information of the transmitter as upper value, lower value, damping and output unit must be reconfigured.

Returning Materials

If it becomes necessary to return the transmitter and/or configurator to Eagle Eye, simply contact our office, informing the defective instrument's serial number, and return it to our factory. In order to speed up analysis and solution of the problem, the defective item should be returned with the Service Request Form (SRF – Appendix B) properly filled with a description of the failure observed and with as much details as possible. Other information concerning to the instrument operation, such as service and process conditions, is also helpful.

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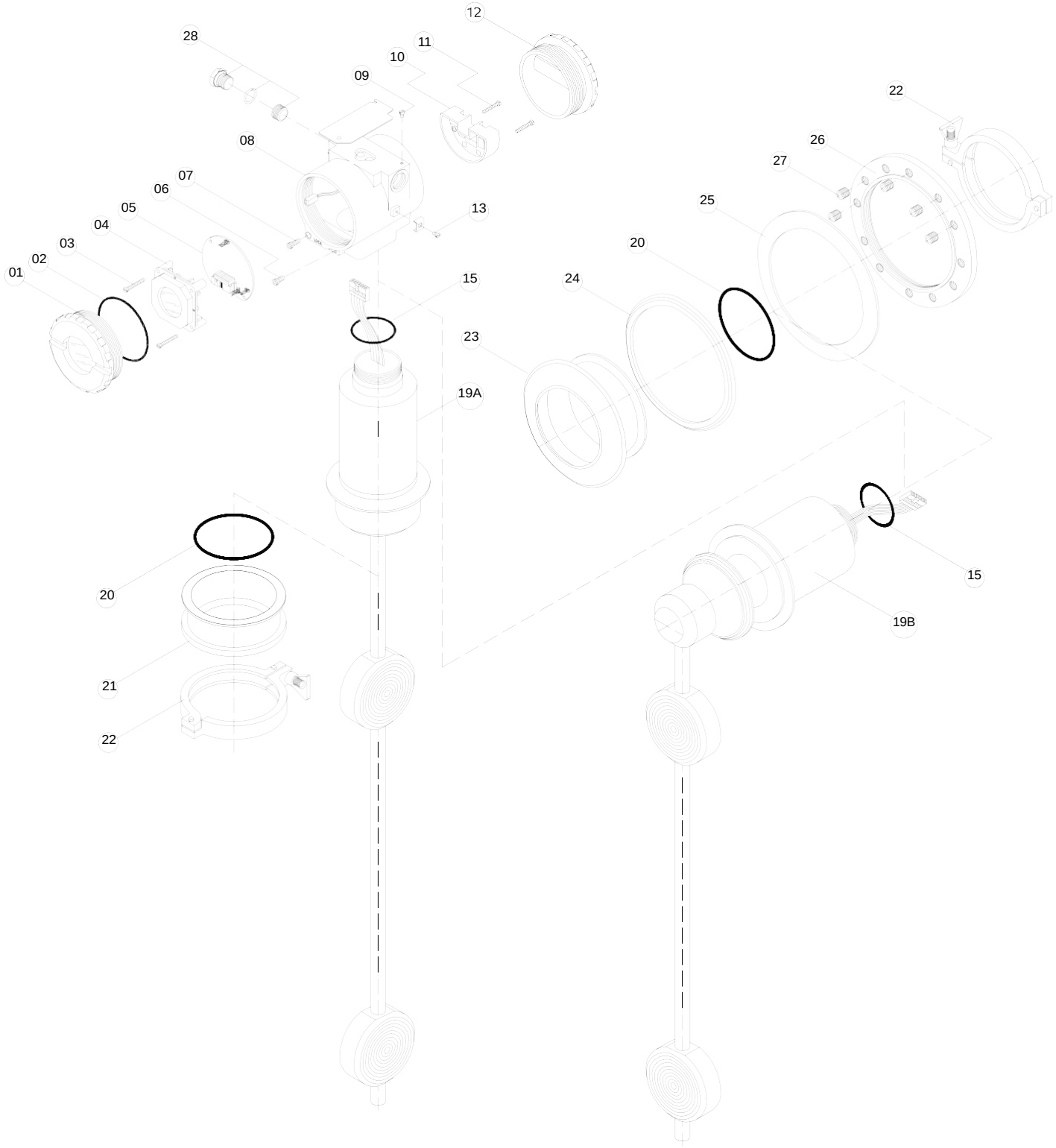

Figure 4.3 - DM-Series - Exploded View (Sanitary Model)

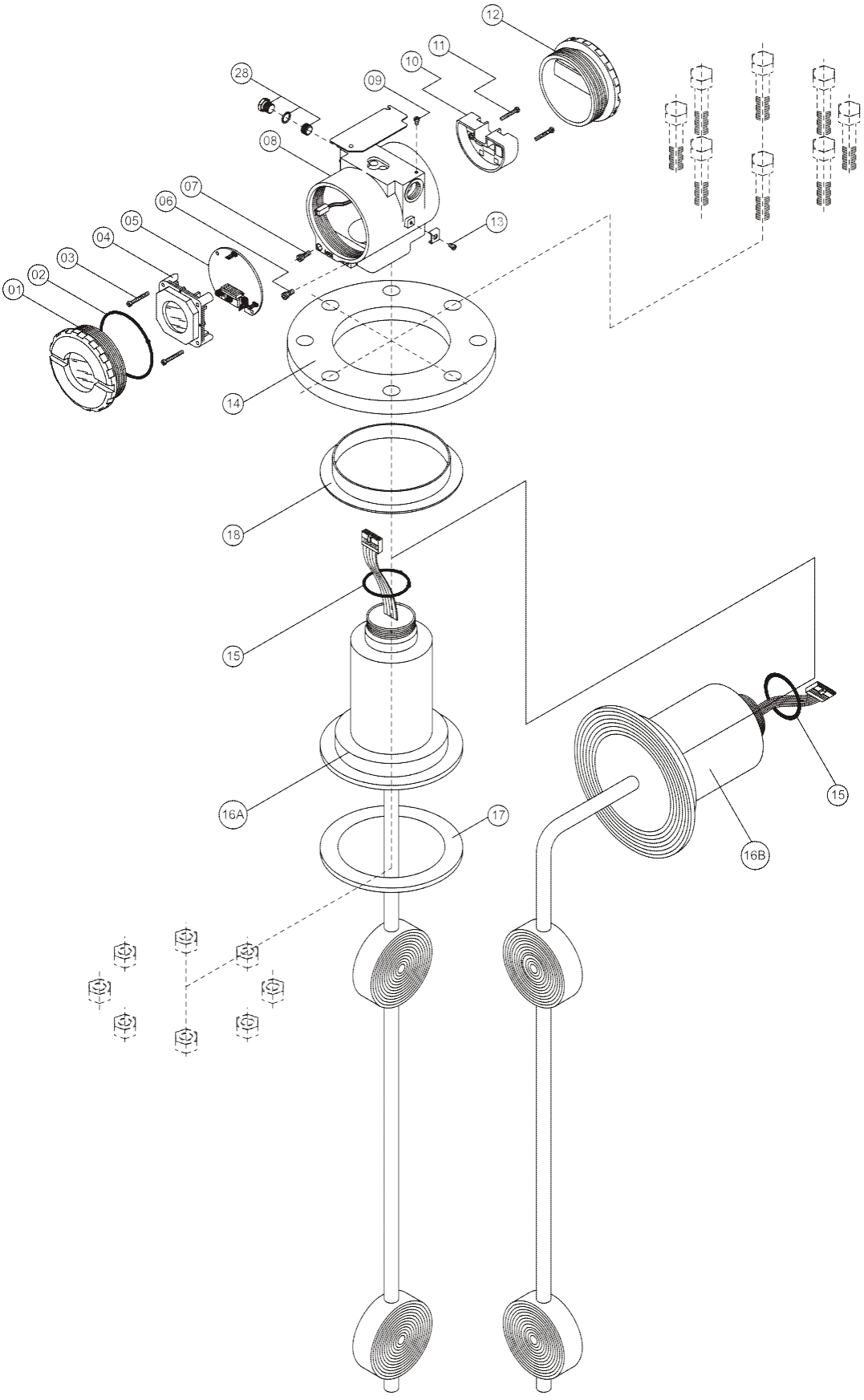

Figure 4.4 DM-Series - Exploded View (Industrial Model)

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SPARE PARTS LIST DESCRIPTION OF PARTS	POSITION	CODE	CATEGORY (NOTE 1)
HOUSING, Aluminum (NOTE 2)			
½ - 14 NPT	8	400-0246	
M20 x 1.5	8	400-0247	
PG 13.5 DIN	8	400-0248	
HOUSING, 316 SS (NOTE 2)			
½ - 14 NPT	8	400-0249	
M20 x 1.5	8	400-0250	
PG 13.5 DIN	8	400-0251	
COVER (INCLUDES O-RING)			
Aluminum	1 and 12	204-0102	
316 SS	1 and 12	204-0105	
COVER WITH WINDOW FOR INDICATION (INCLUDES O-RING)			
Aluminum	1	204-0103	
316 SS	1	204-0106	
COVER LOCKING SCREW	7	204-0120	
SENSOR LOCKING SCREW			
Without head M6 screw	6	400-1121	
EXTERNAL GROUND SCREW	13	204-0124	
IDENTIFICATION PLATE FIXING SCREW	9	204-0116	
DIGITAL INDICATOR	4	214-0108	
TERMINAL INSULATOR	10	400-0058	
MAIN ELECTRONIC CIRCUIT BOARD (NOTE 3)	5	400-0235	A
O-RINGS (NOTE 4)			
Cover, Buna-N	2	204-0122	B
Neck, Buna-N	15	204-0113	B
Process connection, Buna-N (**Sanitary Model**)	20	400-0236	B
Process connection, Viton (**Sanitary Model**)	20	400-0813	B
Process connection, Teflon (**Sanitary Model**)	20	400-0814	B
TERMINAL HOLDING SCREW			
Housing in Aluminum	11	304-0119	
Housing in 316 Stainless Steel	11	204-0119	
MAIN BOARD SCREW HOUSING IN ALUMINUM			
Units with indicator	3	304-0118	
Units without indicator	3	304-0117	
MAIN BOARD SCREW HOUSING IN 316 STAINLESS STEEL			
Units with indicator	3	204-0118	
Units without indicator	3	204-0117	
PROCESS CONECTION – INDUSTRIAL MODEL			
Flange 4" – 150# ANSI B-16.5, 316 SST	14	400-0237	
Flange 4" – 300# ANSI B-16.5, 316 SST	14	400-0238	
Flange 4" – 600# ANSI B-16.5, 316 SST	14	400-0239	
Flange DN 100, PN 25 / 40, DIN 2526 – Form D, 316 SST	14	400-0240	
Teflon Closing Junction	17	400-0720	
Teflon Insulation Junction	18	400-0863	
PROCESS CONNECTION - SANITARY MODEL			
Tank Adapter for Straight Model – 316 SST	21	400-0241	
Tri-Clamp de 4", AISI304 SST	22	400-0242	
Tank Adapter for Curve Model – 316 SST	23	400-0721	
Silicon Closing Ring	24	400-0722	
Protection Flange	25	400-0723	
Tightening Flange	26	400-0724	
Tightening Flange Screw	27	400-0725	
1/2" NPT Internal Socket set Plug in Bichromatized Carbon Steel BR-EX D 1/2" NPT Internal Socket set Plug in 304 SST BR-EX D M20 X 1.5 External Socket set Plug in 316 SST BR-EX D PG13.5 External Socket set Plug in 316 SST BR-EX D 3/4 NPT Adapter in 316 SST BR-EX D	28 28 28 28 28	400-0808 400-0809 400-0810 400-0811 400-0812	
PROBE			
Industrial Probe	16A or 16B	**(NOTE 5)**	B
Sanitary Probe	19A or 19B	**(NOTE 5)**	B

Table 4.2 - Spare Parts List

NOTE 1: For category A, it is recommended to keep, in stock, 25 parts installed for each set, and for category B, 50.
NOTE 2: Includes terminal block, bolts, caps and identification plate without certification.
NOTE 3: The main board of **DM-Series** and probe are items.
NOTE 4: O-rings are pack in packs of 12 units.
NOTE 5: To specify sensors, use the following tables.

400-0244 Sanitary Model Probe

COD.	RANGE	Minimum Span
1	0 to 1 g/cm3	0,001 g/cm^3
2	0 to 2 g/cm^3	0,002 g/cm^3
3	0 to 3..0 g/cm^3	0,002 g/cm^3

COD.	Diaphragm Material
H	316l SST
I	316L SST
T	Tantalum
Z	Others – Specify

COD.	Fill Fluid
S	DC 200/20 - Silicone Oil
D	DC 704 - Silicone Oil
G	Glycerin and water – Food Grade
N	Propylene Glycol – Neobee M2O – Food Grade
T	Sylltherm 800
Z	Others – Specify

COD.	Mounting
1	Top
2	Side

400-0244 - 1 H - S 1

400-0243 Industrial Model Probe

COD.	Range	Minimum Span
1	0 to 1 g/cm^3	0,001 g/cm^3
2	0 to 2 g/cm^3	0,002 g/cm^3
3	0 to 3 g/cm^3	0,002 g/cm^3

COD.	Diaphragm Material / Probe
H	316L SST
I	316L SST / 316L SST
U	Hastelloy C276 / 316L SST
X	316L SST / 316L SST
Z	Others - Specify

COD.	Fill Fluid
S	DC 200/20 - Silicone Oil
D	DC 704 - Silicone Oil
G	Glycerin and water– Food Grade
N	Propylene Glycol – Neobee M2O – Food Grade
T	Sylltherm 800
Z	Others – Specify

COD.	Mounting
1	Top
2	Side

400-0243 - 1 H - S 1

Section 5

TECHNICAL SPECIFICATIONS

Filling Fluids

The filling fluid selection shall take into account its physical properties in what concerns to pressure temperature limits and chemical compatibility with the process fluid. The latter is an important consideration in case the filling fluid happens to come in contact with the process fluid, should a leakage occur.

The table 5.1 presents the filling fluids, which are available for the **DM-Series**, together with some physical properties and applications.

FILLING FLUID	VISCOSITY (cSt) at 25ºC	DENSITY (g/cm³) at 25ºC	THERMAL EXPANSION COEFFICIENT (1/ºC)	APPLICATIONS
Silicone DC 200 / 20	20	0.95	0.00107	General purpose – Standard
Silicone DC 704	39	1.07	0.000799	General purpose (high temperature and vacuum)

Table 5.1 – Properties of Filling Fluids

Functional Specifications

Output Signal
Two-wire, 4-20 mA with superimposed digital communication. (Hart® Protocol)

Power Supply
15 to 30 Vdc

Indicator
Optional 4½ - digit numerical and 5-character alphanumerical LCD indicator.

Hazardous Area Certifications
Explosion, weather and intrinsically safe proof.

Zero and Span Adjustment
Non-interactive, via digital communication.

Temperature Limits

Ambient:	-40	to	85º C	(-40	to	185º F)
Process:	-20	to	150º C	(-04	to	302º F)
Storage:	-40	to	100º C	(-40	to	212º F)
Digital Display:	-10	to	60º C	(14	to	140º F)

Failure Alarm
In case of sensor or circuit failure, the self-diagnostics drives the output to 3.9 or 21.0 mA, according to the user's choice.

Turn-on Time
Approximately 5.0 seconds.

Volumetric Displacement
Less than 0.15 cm^3 (0.01 in^3)

Static Pressure Limit
70 kgf/cm^2 (7 MPa) (1015 PSI)

Humidity Limits
0 to 100% RH

Damping Adjustment
0 to 32 seconds in addition to intrinsic sensor response time (0.2 s) (Via Digital Communication).

Configuration
Through digital communication using Hart® Protocol.

Performance Specifications

Reference conditions: temperature 25ºC (77ºF), atmospheric pressure, power supply of 24 Vdc, silicone oil fill fluid, isolating diaphragms in 316 L SS and digital trim equal to lower and upper range values.

RANGE	ACCURACY (1)	ENVIROMENT	STABILITY (For 3 Months)	ZERO (2) STATIC (per 1 kgf/cm^2)
1	±0.0004 g/cm^3 (±0.1 ^{0}Bx)	0.003 kg/m^3	0.020 kg/m^3	0.001 kg/m^3
2	±0.0007 g/cm^3	0.005 kg/m^3	0.030 kg/m^3	0.004 kg/m^3
3	±0.0016 g/cm^3	0.010 kg/m^3	0.100 kg/m^3	0.007 kg/m^3

(1) Linearity, hysteresis and repeatability effects are included.
(2) This systematic error can be eliminated by calibrating at the operating static pressure.

Power Supply Effect
±0.005% of calibrated span per volt.

Electro-Magnetic Interference Effect
Designed to comply with IEC 61326-1:2006, IEC 61326-2-3:2006, IEC 61000-6-4:2006 and IEC 61000-6-2:2005.

Physical Specifications

Electrical Connection
½ -14 NPT, PG 13.5 or M20 x 1.5.

Process Connection
Industrial model: 316 SST flange ANSI B16.5, Flange DIN 2526 Form D, DN100 PN 25/40.
Sanitary model: 304 SST Tri-clamp.

Wetted Parts
Isolating diaphragms: 316L SST
Probe material: 316L SST, Hastelloy C276 or 316L SST O-ring for sanitary model: Buna-N, Viton™ or Teflon™

Non-wetted Parts
Electronic Housing: injected low copper aluminum with polyester painting or 316 SST housing, with Buna-N o-rings on cover (NEMA 4X, IP67).
Fill fluid: Silicone (DC200/20, DC704), Syltherm 800, Glycerin and Water or Neobee M20 Propylene Glycol.
Identification plate: 316 SST.

Mounting
Side or top mounting.
Weight
Sanitary model: 9 kg (20 lb) - Industrial model: 14 kg (31 lb).

Ordering Code

MODEL	SANITARY CONCENTRATION/DENSITY TRANSMITTER

CODE	Range			Minimum Span
1	0	to	1.0 g/cm^3	0,001 g/cm^3
2	0	to	2.0 g/cm^3	0,002 g/cm^3
3	0	to	3.0 g/cm^3	0,002 g/cm^3

CODE	Wetted Parts Material
H	316L SST
I	316L SST
U	Probe in 316 SST and Diaphragms in Hastelloy C276
Z	Others – Specify

CODE	Fill Fluid
N	Neobee - M20 Propylene Glycol – Food Grade **(8)**
D	DC 704 - Silicone Oil
S	DC 200/20 - Silicone Oil
G	Glycerin and Water – Food Grade
T	Syltherm 800
Z	Others – Specify

CODE	Local Indicator
0	Without Indicator
1	With Digital Indicator

CODE	Electrical Connection
0	½ - 14 NPT **(4)**
1	½ - 14 NPT x ¾ NPT (AI 316) – With Adapter **(5)**
2	½ - 14 NPT x ¾ BSP (AI 316) – With Adapter **(6)**
3	½ - 14 NPT x ½ BSP (AI 316) – With Adapter **(6)**
4	½ - ½ NPTF (AI 316) - With Adapter
5	½ - ¾ NPTF (AI 316) - With Adapter
A	M20 X1.5 **(4)**
B	PG 13.5 DIN **(7)**
Z	Others - Specify

CODE	Mounting
1	Top
2	Side

CODE	Process Connection
J	Tri-clamp – 4" 300# **(8)**
Z	Others - Specify

CODE	Wetted O-Rings Material
B	Buna-N **(8)**
V	Viton **(8)**
T	Teflon **(8)**
Z	Others - Specify

CODE	Tank Adapter
0	Without Tank Adapter (Supplied by Customer)
1	With Tank Adapter 316 SST

CODE	Tri-Clamp
0	Without Tri-clamp
1	With Tri-clamp in 304 SST

CODE	Continues next page

DT301S	1	I	N	1	0	2	J	B	1	1	*

⬅ **TYPICAL MODEL NUMBER**

* Leave it blank for no optional items.

MODEL | **SANITARY CONCENTRATION/DENSITY TRANSMITTER (CONTINUATION)**

CODE	Identification Plate
I1	FM: XP, IS, NI, DI
I4	EXAM (DMT): EX-IA; NEMKO: EX-D
I5	CEPEL: EX-D, EX-IA
I6	Without Certification
I7	EXAM (DMT) GRUPO I, M1 EX-IA

CODE	Housing Material (1) (2)
H0	Aluminum (IP/Type)
H1	316 SST (IP/Type)
H2	Aluminum for Saline Atmosphere **(3)** (IPW/TypeX)
H3	316 SST for Saline Atmosphere **(3)** (IPW/TypeX)
H4	Copper Free Aluminum **(3)** (IPW/TypeX)

CODE	Tag Plate
J0	With Tag
J1	Blank
J2	User's Specification

CODE	Display Unit
Y0	Percentage
Y1	1: Current – I (mA)
Y2	1: Density/Concentration (Eng. Unit)
Y3	1: Temperature (Temperature)
Y4	2: Current – I (mA)
Y5	2: Density/Concentration (Eng. Unit)
Y6	2: Temperature (Temperature)
YU	2: User's Specification

CODE	Painting
P0	Gray Munsell N 6,5
P3	Black Polyester
P4	White Epoxy
P5	Yellow Polyester
P8	Without Painting
P9	Blue Safety Epoxy – Electrostatic Painting
PC	Blue Safety Polyester – Electrostatic Painting

CODE	Optional Item (*)
ZZ	Special Options

DT301S / I6 H0 J0 Y0 P0 * ← **TYPICAL MODEL NUMBER**

* Leave it blank for no optional items.

Notes

(1) IPX8 tested in 10 meters of water column for 24 hours.
(2) Ingress Protection:

Product	CEPEL	NEMKO / EXAM	FM	CSA	NEPSI
DT30X	IP66/68/W	IP66/68/W	Type 4X/6	Type 4X	IP67

(3) IPW / TypeX tested for 200 hours according to NBR 8094 / ASTM B 117 standard.
(4) Certified for use in Explosive Atmosphere (CEPEL, FM, NEMKO, CSA and EXAM).
(5) Certified for use in Explosive Atmosphere (CEPEL and CSA).
(6) Options not certified for Explosive Atmosphere.
(7) Certified for use in Explosive Atmosphere (CEPEL, NEMKO, and EXAM).
(8) Compliant with 3A-7403 standard for food and other applications where sanitary connections are required.
- Neobee M2O Fill Fluid
- Finishing wet Face: 0.8 µm Ra (32 µ" AA)
- Wet O-Ring: Viton, Teflon and Buna-N

MODEL — **INDUSTRIAL CONCENTRATION/DENSITY TRANSMITTER**

CODE	Range	Minimum Span
1	0 to 1.0 g/cm³	0,001 g/cm³
2	1.0 to 2.5 g/cm³	0,002 g/cm³
3	2.0 to 5.0 g/cm³	

CODE	Diaphragm Material / Probe
H	Hastelloy C276 / Hastelloy C276
I	316L SST / 316L SST
U	Hastelloy C276 / 316L SST
X	316L SST / 316L SST with plated TEFZEL (ETFE)
Z	Others - Specify

CODE	Fill Fluid
N	Neobee - M20 Propylene Glycol – Food Grade
D	DC 704 - Silicone Oil
S	DC 200/20 - Silicone Oil
G	Glycerin and Water – Food Grade
T	Syltherm 800
Z	Others – Specify

CODE	Local Indicator
0	Without Indicator
1	With Digital Indicator

CODE	Electrical Connection
0	½ - 14 NPT **(4)**
1	½ - 14 NPT x ¾ NPT (AI 316) – With Adapter **(5)**
2	½ - 14 NPT x ¾ BSP (AI 316) – With Adapter **(6)**
3	½ - 14 NPT x ½ BSP (AI 316) – With Adapter **(6)**
4	½ - ½ NPTF (AI 316) - With Adapter
5	½ - ¾ NPTF (AI 316) - With Adapter
A	M20 X1.5 **(4)**
B	PG 13.5 DIN **(7)**
Z	Others - Specify

CODE	Mounting
1	Top – Between Centre of the Sensors 500 mm
2	Side - Between Centre of the Sensors 500 mm
3	Top – Between Centre of the Sensors 800 mm
4	Side - Between Centre of the Sensors 800 mm
5	Top – Between Centre of the Sensors 250 mm
6	Side - Between Centre of the Sensors 250 mm

CODE	Process Connection Size, Rating and Standard
5	4" ANSI B – 16.5
9	DN 100 DIN 2526 – FORM D
A	DN 80 DIN 2526 – FORM D
Z	Others – Specify

CODE	Pressure Class
1	150#
2	300#
3	600#
C	PN 25/40
Z	Others - Specify

CODE	Continues Next Page

DT301I	1	I	S	1	0	1	5	1	*

⬅ TYPICAL MODEL NUMBER

* Leave it blank for no optional items.

MODEL	INDUSTRIAL CONCENTRATION/DENSITY TRANSMITTER (CONTINUATION)

CODE	Identification Plate
I1	FM: XP, IS, NI, DI
I4	EXAM (DMT): EX-IA; NEMKO: EX-D
I5	CEPEL: EX-D, EX-IA
I6	Without Certification
I7	EXAM (DMT) GRUPO I, M1 EX-IA

CODE	Housing Material (1) (2)
H0	Aluminum (IP/Type)
H1	316 SST (IP/Type)
H2	Aluminum for Saline Atmosphere (IPW/TypeX) **(3)**
H3	316 SST for Saline Atmosphere (IPW/TypeX) **(3)**
H4	Copper Free Aluminum (IPW/TypeX) **(3)**

CODE	Tag Plate
J0	With Tag
J1	Blank
J2	User's Specification

CODE	Display Unit
Y0	Percentage
Y1	1: Current – I (mA)
Y2	1: Density/Concentration (Eng. Unit)
Y3	1: Temperature (Temperature)
Y4	2: Current – I (mA)
Y5	2: Density/Concentration (Eng. Unit)
Y6	2: Temperature (Temperature)
YU	2: User's Specification

CODE	Painting
P0	Gray Munsell N 6,5
P3	Black Polyester
P4	White Epoxy
P5	Yellow Polyester
P8	Without Painting
P9	Blue Safety Epoxy – Electrostatic Painting
PC	Blue Safety Polyester – Electrostatic Painting

CODE	Optional Item (*)
ZZ	Special Options

	/	I6	H0	J0	Y0	P0	*

⬅ TYPICAL MODEL NUMBER

* Leave it blank for no optional items.