DT301

smar

OPERATION & MAINTENANCE
INSTRUCTION MANUAL

INTELLIGENT CONCENTRATION / DENSITY TRANSMITTER

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DT301

VERSION 2

DT301ME

smar

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Introduction

The **DT301** Intelligent Concentration/Density Transmitter is a device designed for the continuous online measurement of liquid concentration/density, directly in industrial process.

The **DT301** consists of a capacitive type differential pressure transmitter coupled to a pair of pressure repeaters immersed in the process. The repeaters are connected to the external capacitive sensor through capillary tubes. A temperature sensor located between the two pressure repeaters automatically compensates temperature variations in the process

Special techniques in the production and assembly repeaters and temperature sensor ensure that small variations in the process temperature are quickly informed to the transmitter, which calculates the fluid density process accurately through dedicated software.

Depending on the industrial process, density can be expressed in Density, Relative Density, Brix degree, Baumé degree, Plato degree, % of Solids, Concentration, etc.

Designed for process control applications, this 2-wire transmitter generates a 4-20 mA signal proportional to the concentration/density. Digital communication for remote calibration and monitoring is also provided (Hart Protocol).

The digital technology used in the **DT301** allows the choice of several types of transfer functions, an easy interface between the field and the control room and some characteristics that reduce the installation, operation and the maintenance costs considerably.

ATTENTION
Get the best results of the DT301 by carefully reading these instructions. This product is protected by US patent numbers: **6,234,019; D439,855 and 5,827,963.**

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

Table of Contents

TECHNICAL CHARACTERISTICS

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 **DT301**, 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 (hazardous areas)). 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 do not transmit the vibration.

Recommendations for use of DT301

The process fluid should always cover the two diaphragm repeaters (See figure 1.2).

The maximum speed of the process fluid under the diaphragms repeaters must be 0.4 m/s, which in a pipe with diameter of 6 " it corresponds to a flow of 26 m³/h. These data applies to fluids with close viscosity of the water. Fluids with very different viscosity should be analyzed.

This limitation is due to the pressure drop between the diaphragms.
The temperature of the process fluid must be within 0°C and 120°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.

Verify if the fill fluid doesn't evaporate in process extreme conditions of temperature and pressure.

DT301 Concentration / Density Transmitters Models

DT301I - Industrial model, for general purpose.

DT301S - Sanitary model for food, pharmaceutical industry and other applications where sanitary connections are required.

The industrial model uses connection flanges according to 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 have two mounting types: top mounting (straight type) and side mounting (curved type).

The Figure 1.1 shows the dimensions of the **DT301** straight and curved type for industrial and sanitary models.

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

The Figure 1.2 shows some mounting examples.

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

A – Industrial Model Side Mounting

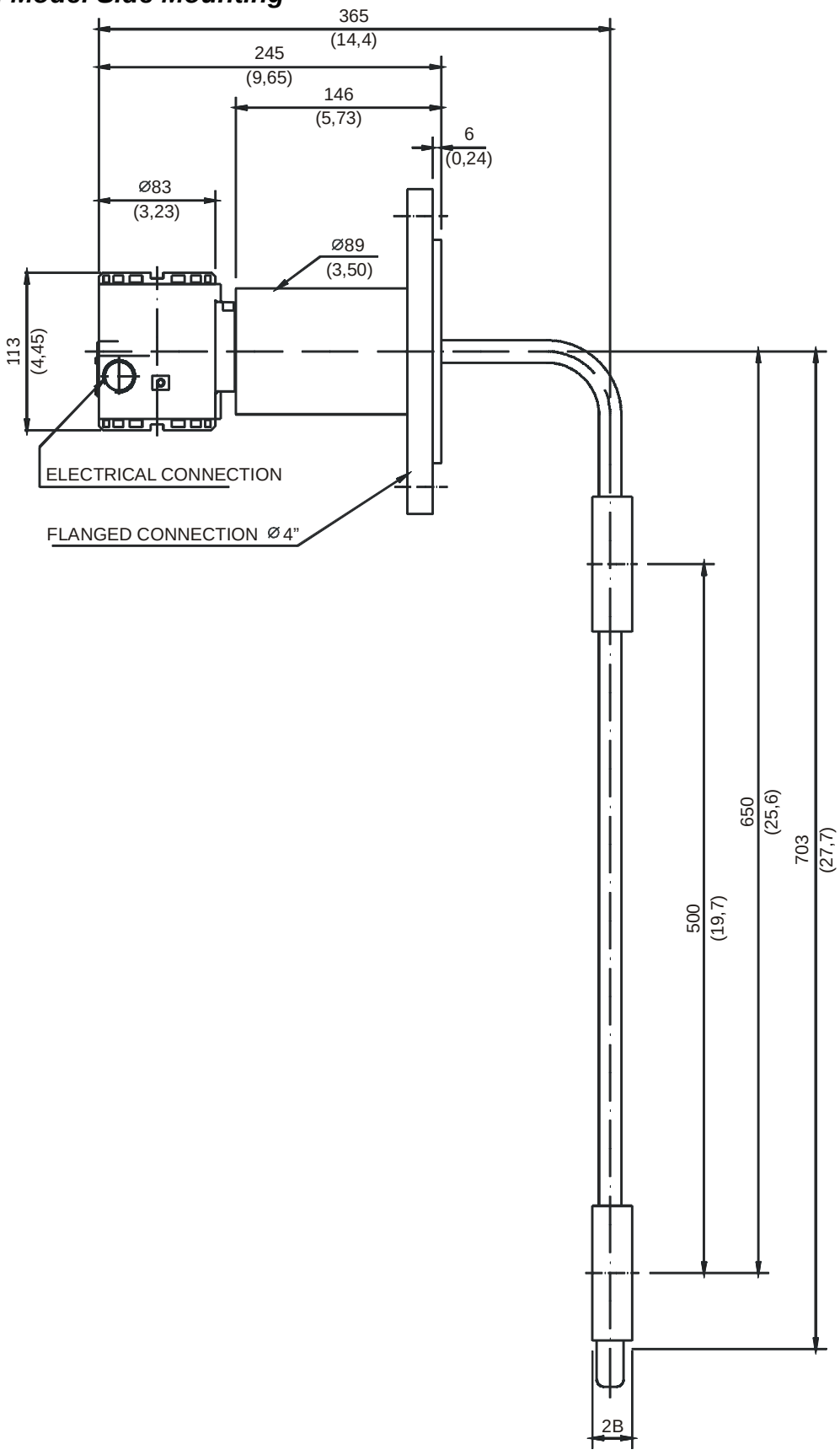


Figure 1.1 – DT301 Dimensionals (A)

B – Sanitary Model Top Mounting

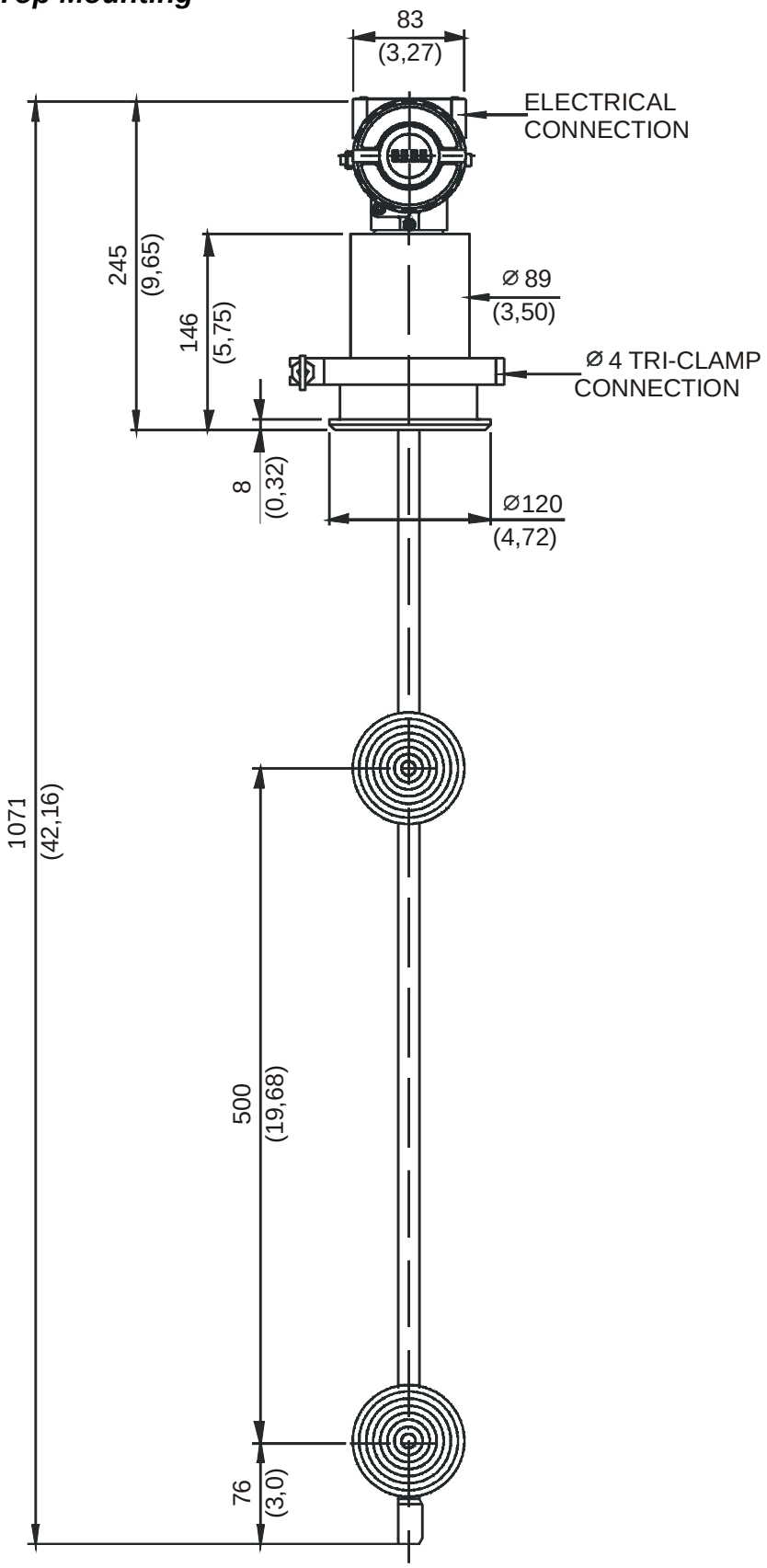


Figure 1.1 – DT301 Dimensionals (B)

C – Sanitary Model Side Mounting

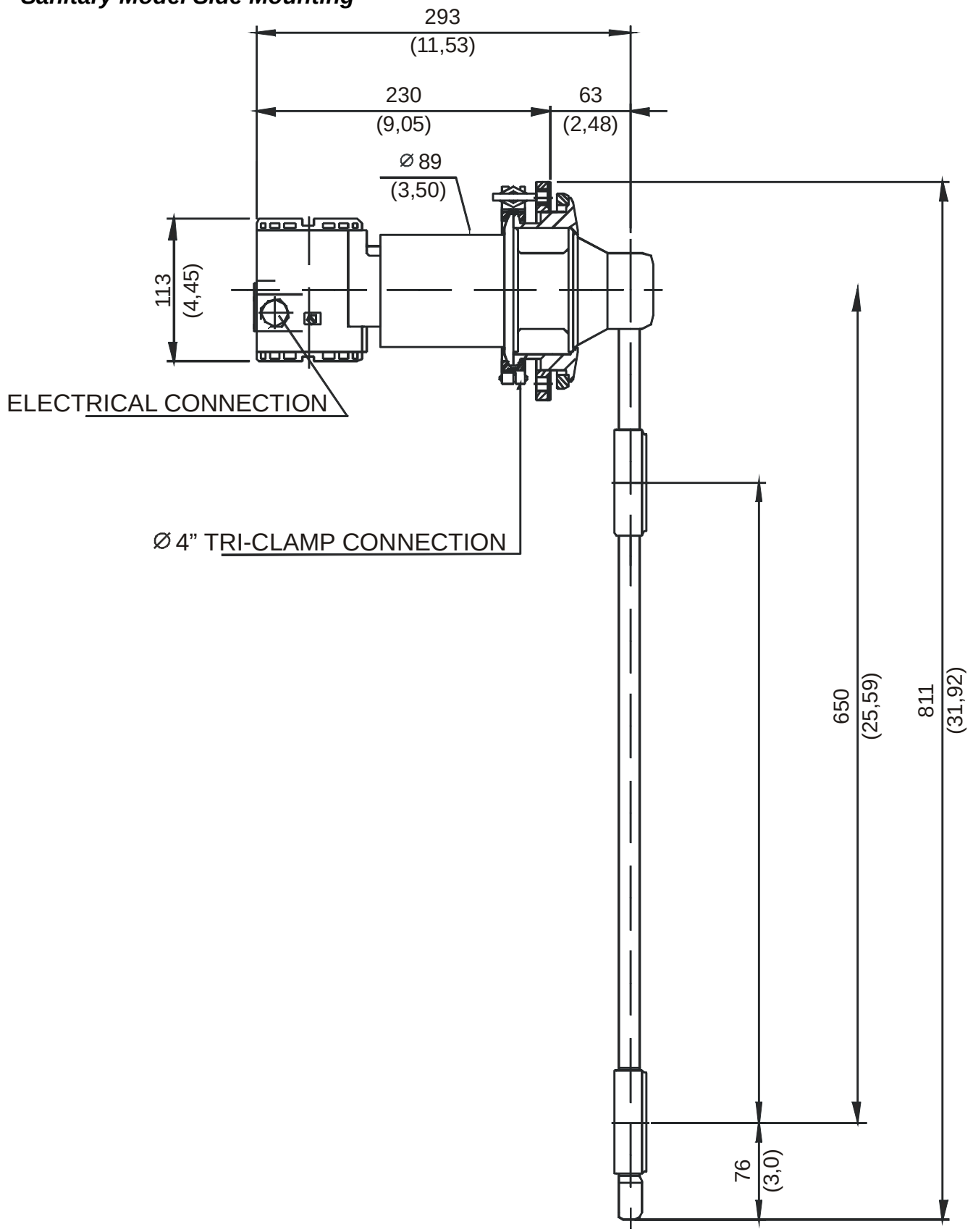


Figure 1.1 – DT301 Dimensionals (C)

D – Industrial Model Top Mounting

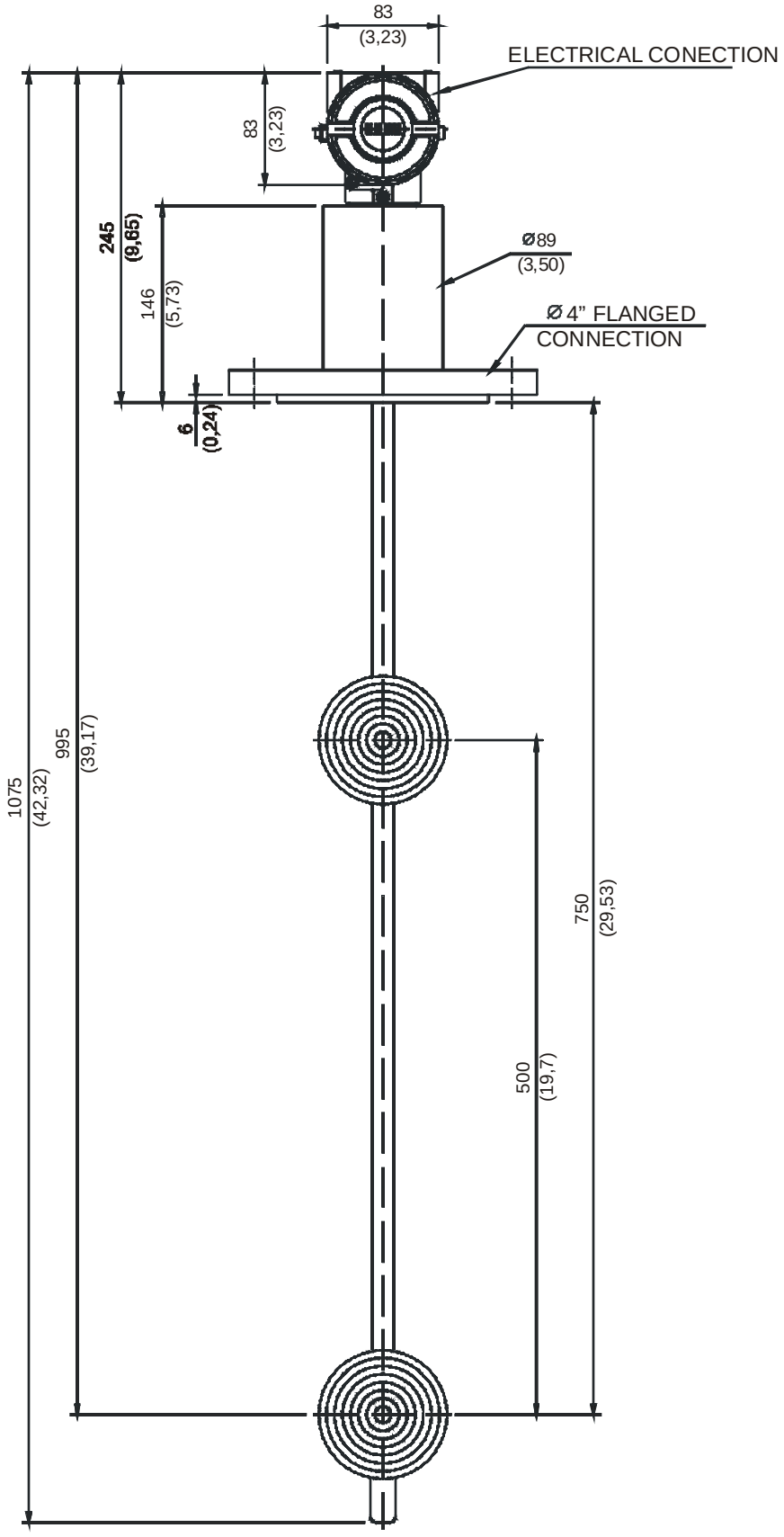


Figure 1.1 – DT301 Dimensionals (D)

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

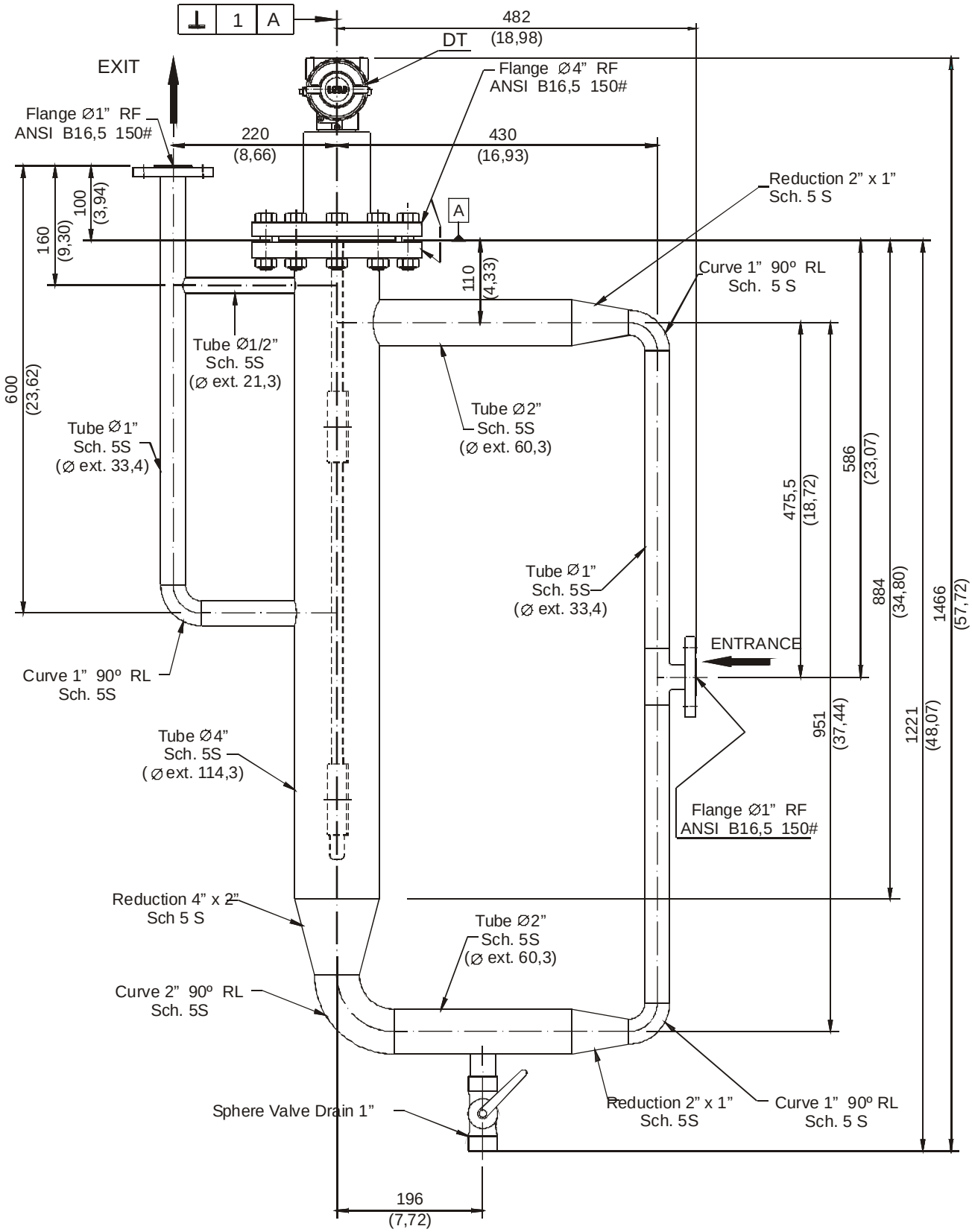


Figure 1.2 – Typical Installation for DT301 (A)

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

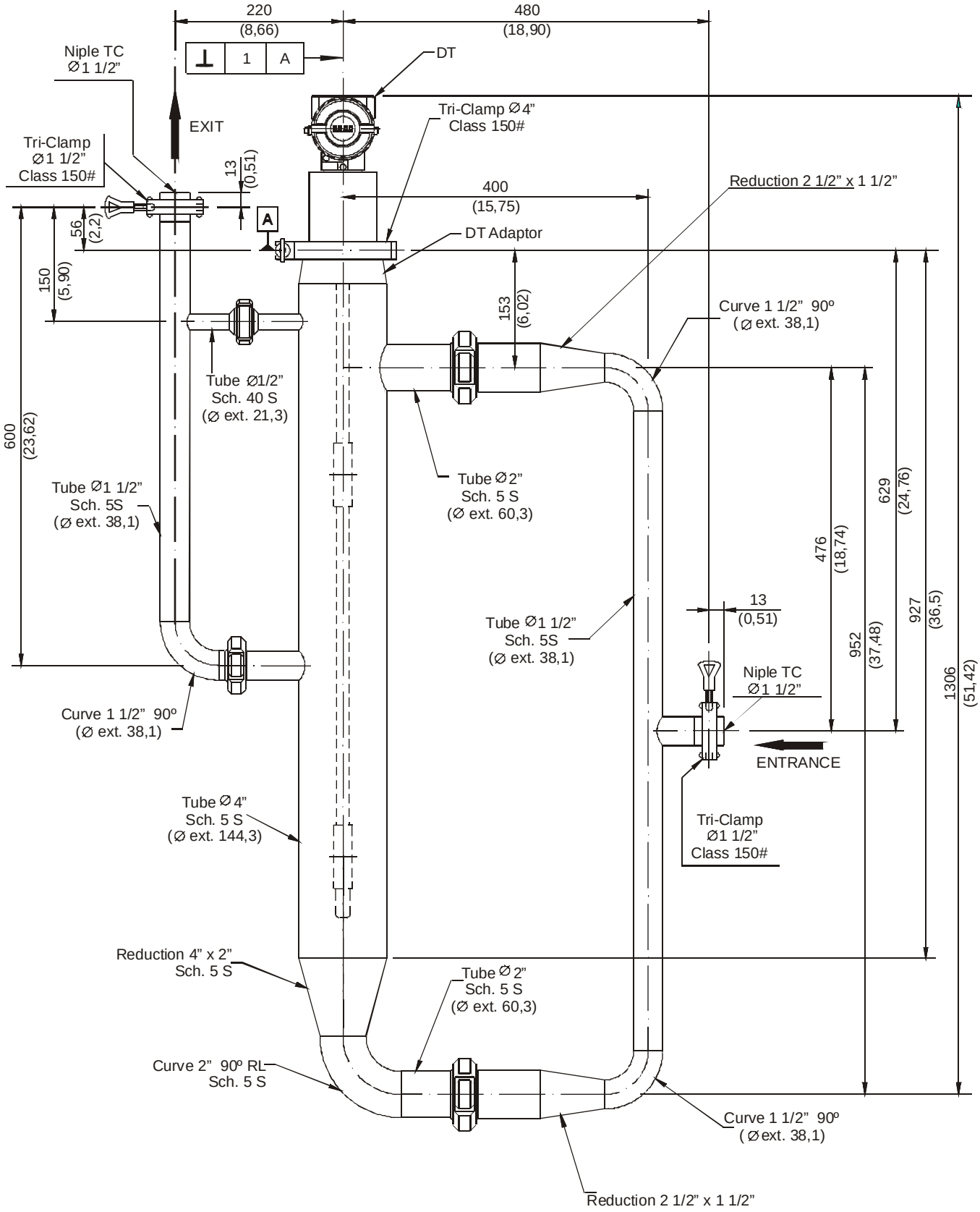


Figure 1.2 – Typical Installation for DT301 (B)

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

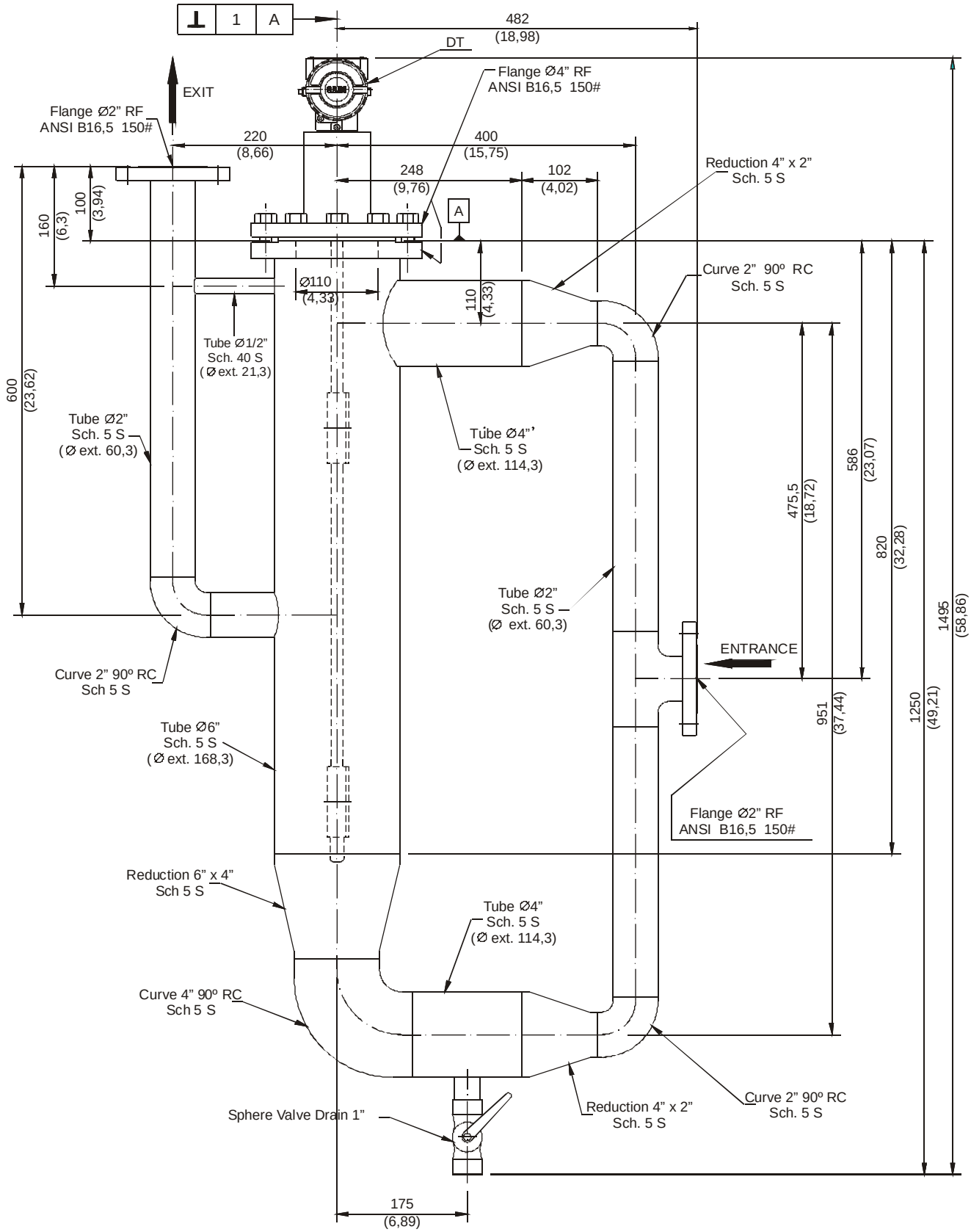


Figure 1.2 – Typical Installation for DT301 (C)

D – Typical Installation in Overflow Tanks

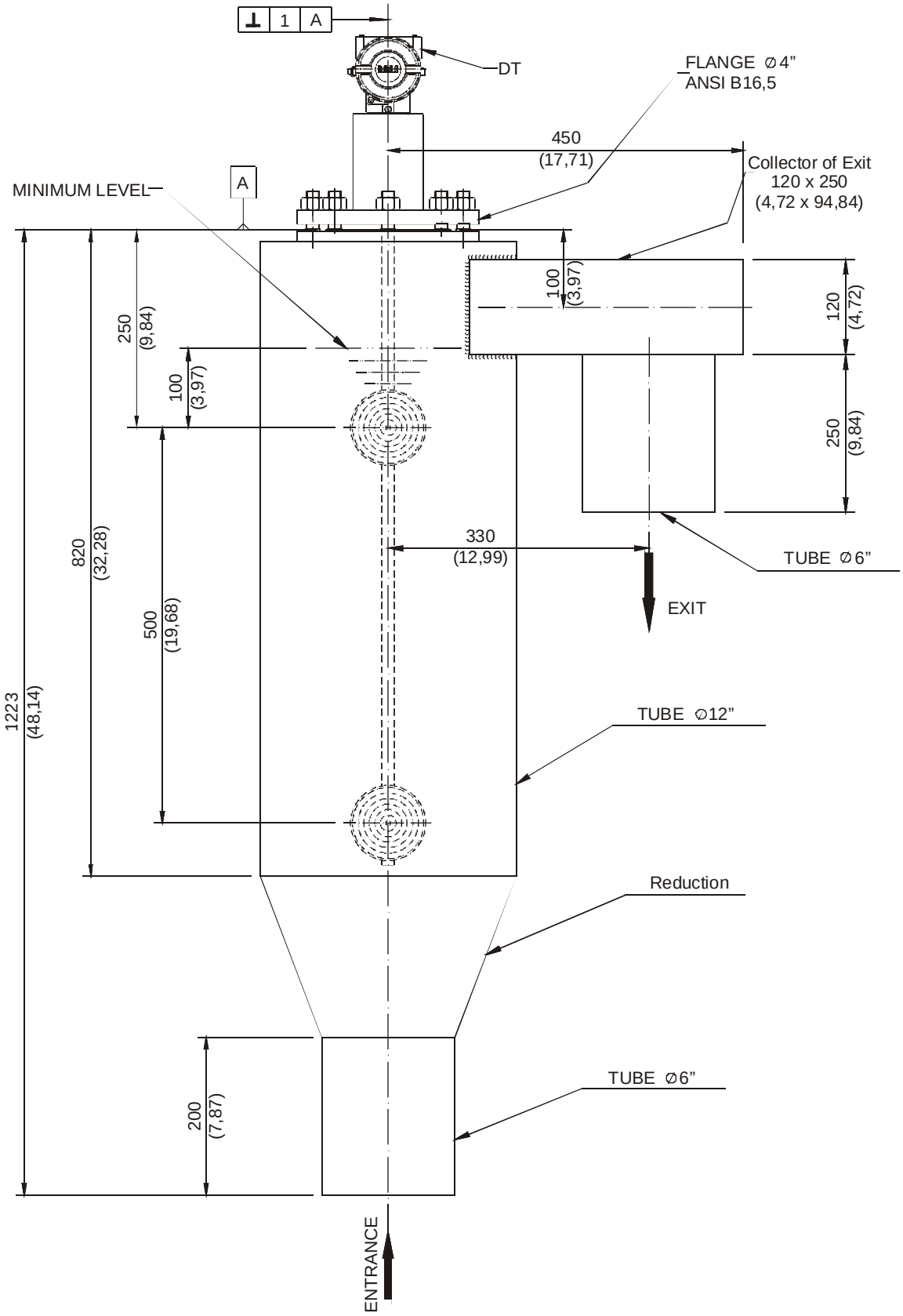


Figure 1.2 – Typical Installation for DT301 (D)

E – Typical Installation in Tank (Industrial Model)

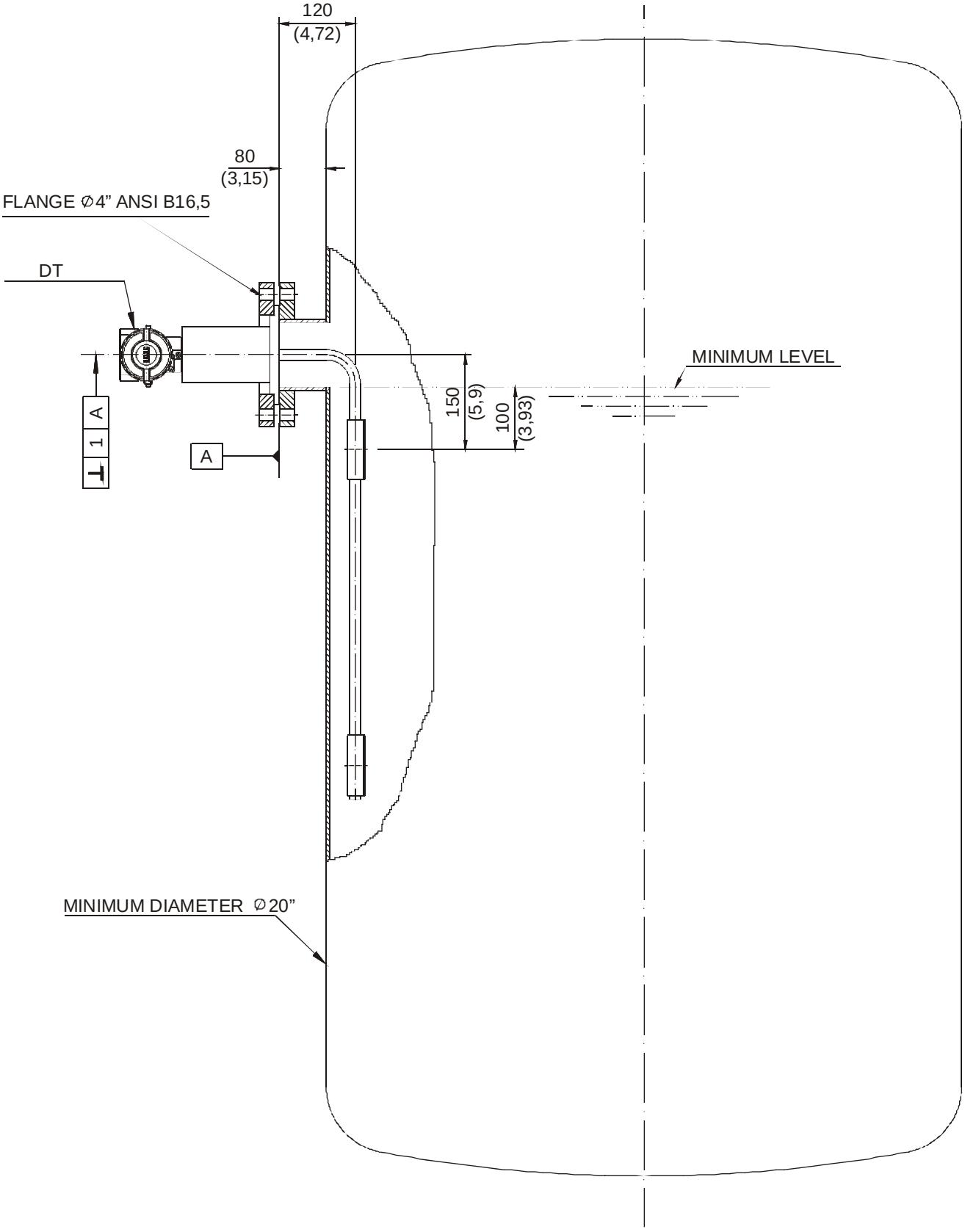


Figure 1.2 – Typical Installation for DT301 (E)

F – Typical Installation in Tank (Sanitary Model)

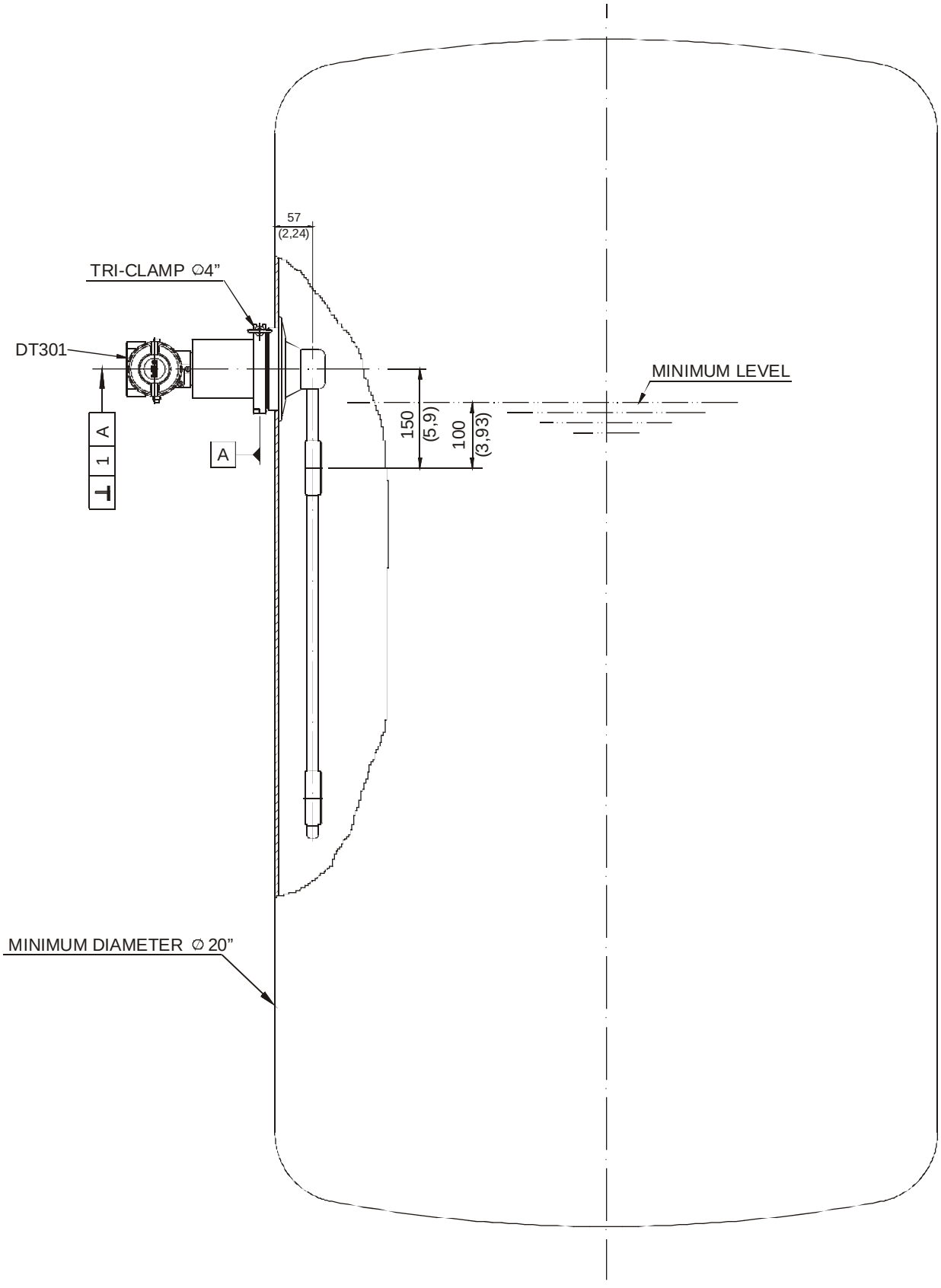


Figure 1.2 – Typical Installation for DT301 (F)

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

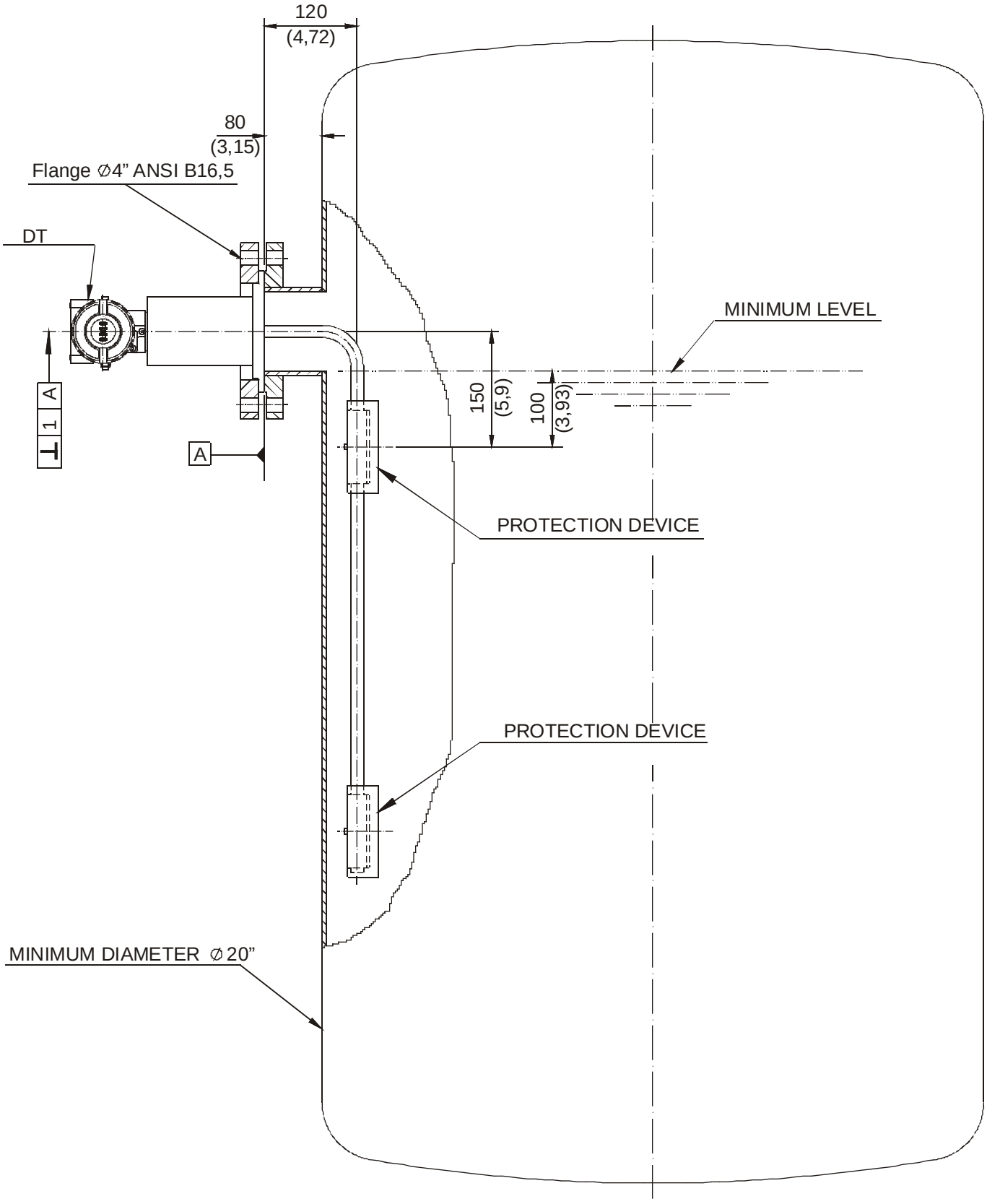


Figure 1.2 – Typical Installation for DT301 (G)

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

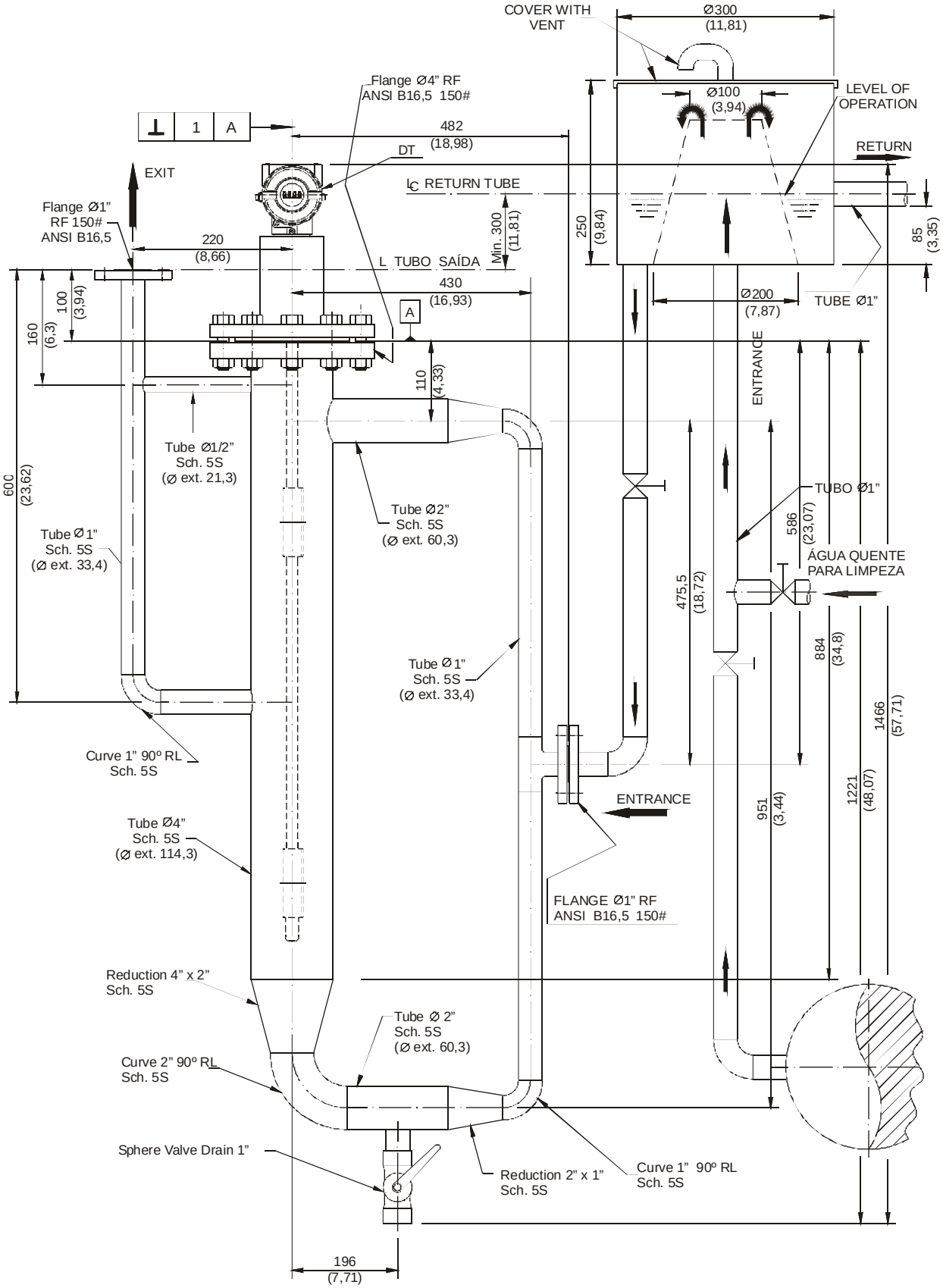


Figure 1.2 – Typical Installation for DT301 (H)

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

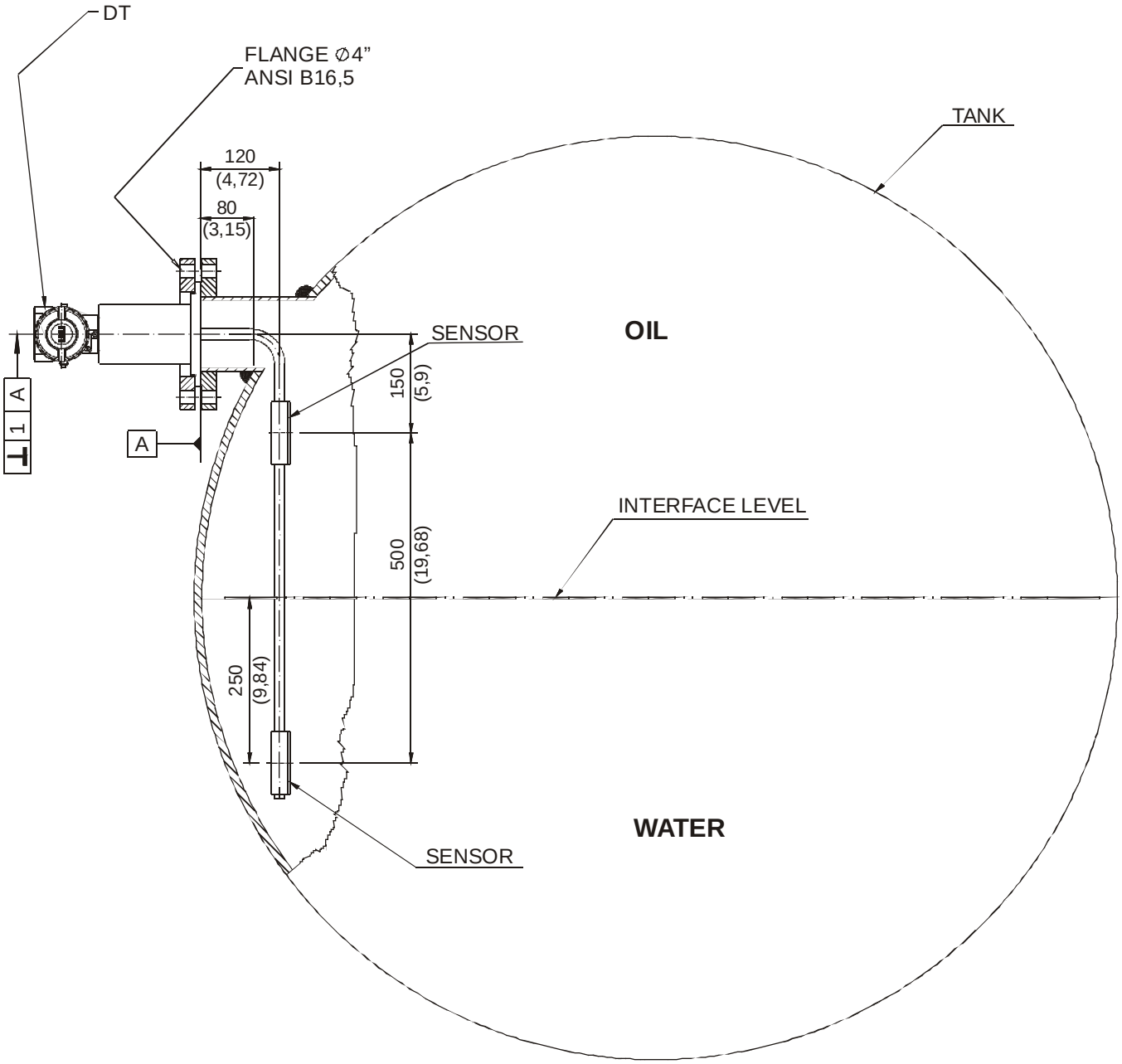


Figure 1.2 – Typical Installation for DT301 (I)

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

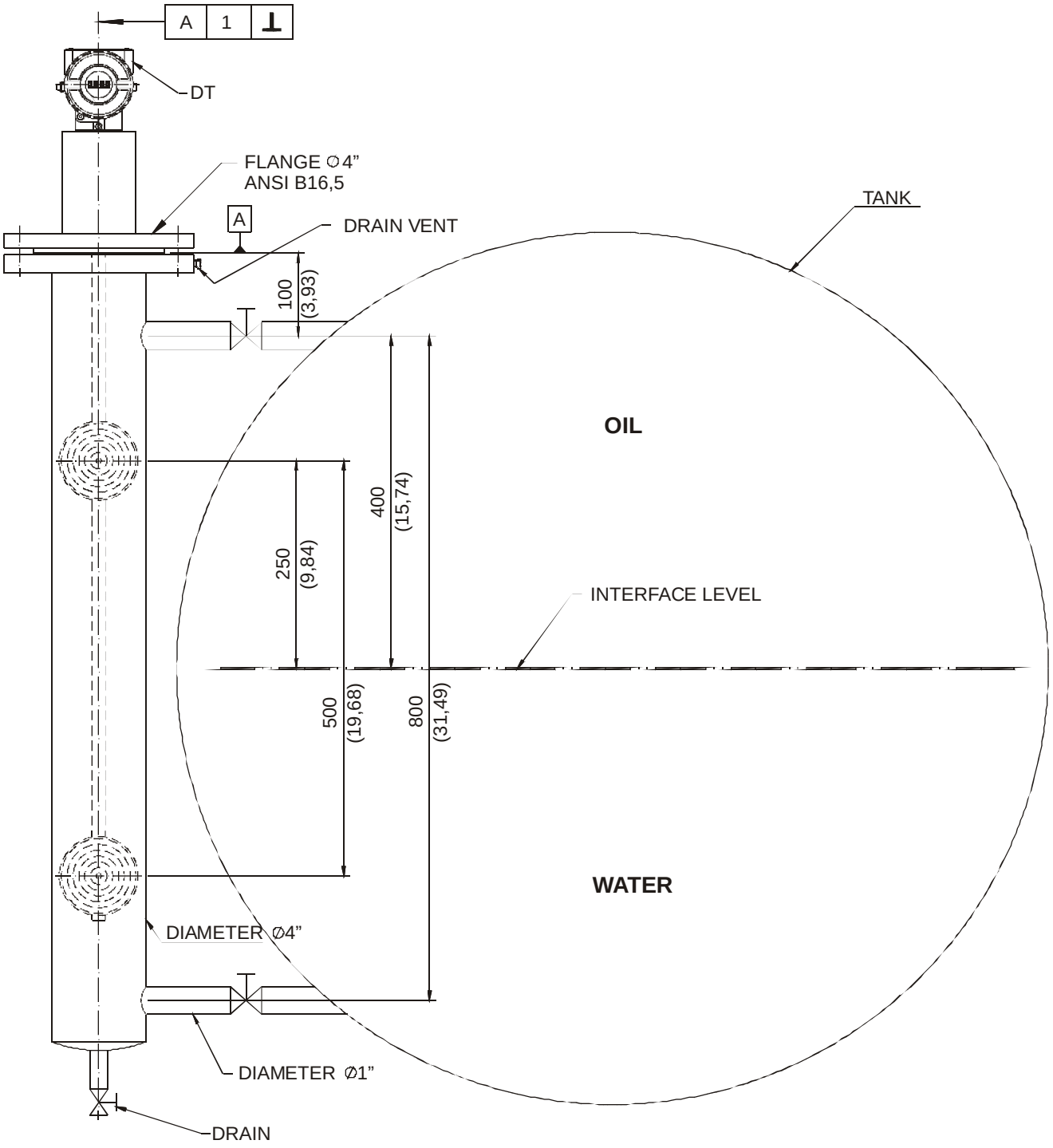


Figure 1.2 – Typical Installation for DT301 (J)

Try to use a valve in the connection to the process before the **DT301**; this simplifies the calibration and maintenance of the equipment.

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

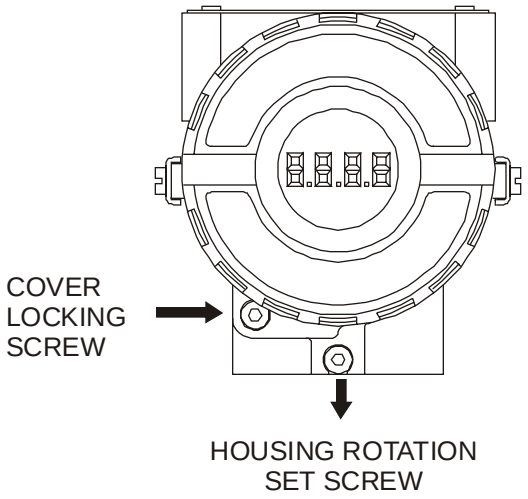


Figure 1.3 – Housing Rotation Set Screw

WARNING: EXPLOSION PROOF INSTALLATIONS
The electronic housing and the sensor assembly in potentially explosive atmospheres must have a minimum of 6 threads fully engaged. The provided joint allows 1 turn extra. Try to adjust the display window position by rotating the housing clockwise. If the thread reaches the end before the desired position, then rotate the housing counterclockwise, but not by more than one turn of the thread end. Transmitters have a stopper that restricts housing rotation to one turn. See Section 4, Figure 4.1.

The digital display can also be rotated. See Section 4, Figure 4.2.

Electric Wiring

Reach the wiring 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.

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

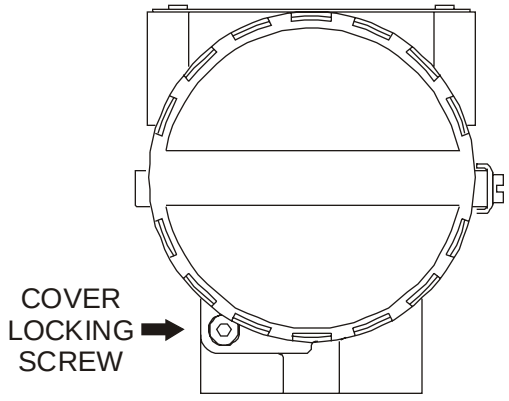


Figure 1.4 – Cover Locking Screw

HAZARDOUS AREAS
In hazardous areas with explosion proof requirements, the covers must be tightened with at least 8 turns. In order to avoid the penetration moisture or corrosive gases, tighten the O'ring until feeling the O'ring touching the housing. Then, tighten more 1/3 turn (120°) to guarantee the sealing. Lock the covers using the locking screw. In hazardous zones with intrinsically safe or nonincendive requirements, the circuit entity parameters and applicable installation procedures must be observed. Cable access to wiring connections is obtained by one of the two conduit outlets. Conduit threads should be sealed by means of code-approved sealing methods. The unused outlet connection should be plugged and sealed accordingly. Explosion proof, nonincendive and intrinsic safety Factory Mutual certification are standards for **DT301** (see control drawing in Appendix A). Should other certifications be necessary, refer to the certification or specific standard for installation limitations..

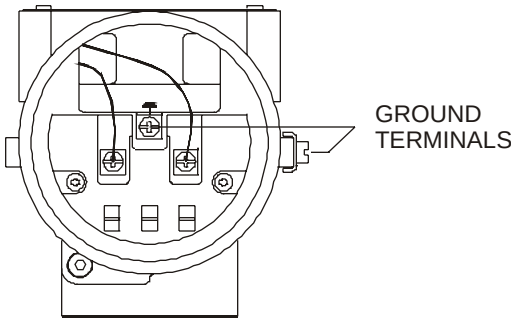


Figure 1.5 – Wiring Block

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

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 **DT301** has protection against reverse polarity.
Connection of the **DT301** should be done as in Figure 1.7.

ATTENTION:
For proper operation, the configurator requires a minimum load of 250 Ohm between it and the power supply. See Figure 1.6.

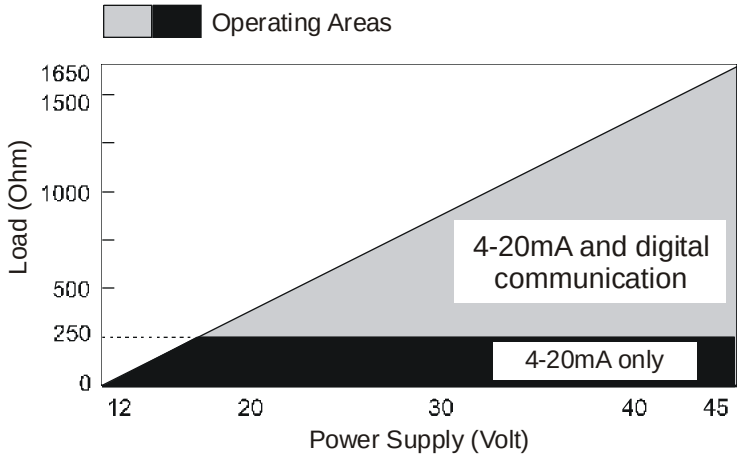


Figure 1.6 – Load Curve

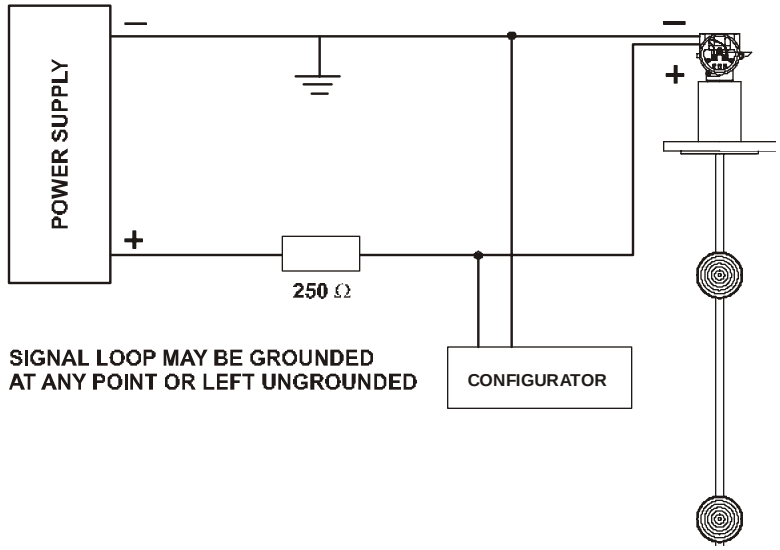


Figure 1.7 – DT301 Connection Diagram

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. Contact Smar Service to specify the requirements for multidrop applications.

Special consideration should be given to the update rate in multidrop configuration communication.

Not however that the updating of the analog output, in controller mode, is not affected.

The **DT301** is factory set to address 0, that 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).

When intrinsic safety is an application requirement, special attention must be paid to the total sum of parameters controlled by is specification:

$$La \geq \sum_{j=1}^{n} Li_j + Lc$$

$$Ca \geq \sum_{j=1}^{n} Ci_j + Cc$$

$$Voc \leq \min\lfloor V\max_j \rfloor$$

$$Isc \leq \min\lfloor \mathrm{Im}\, ax_j \rfloor$$

Where:

Ca, La	Capacitance and Inductance allowed by IS barrier
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 opens 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*

To operate in multidrop mode, it is necessary to verify which transmitters are connected on the same line. The connection of the **DT301** in a multidrop net should be made according to Figure 1.8.

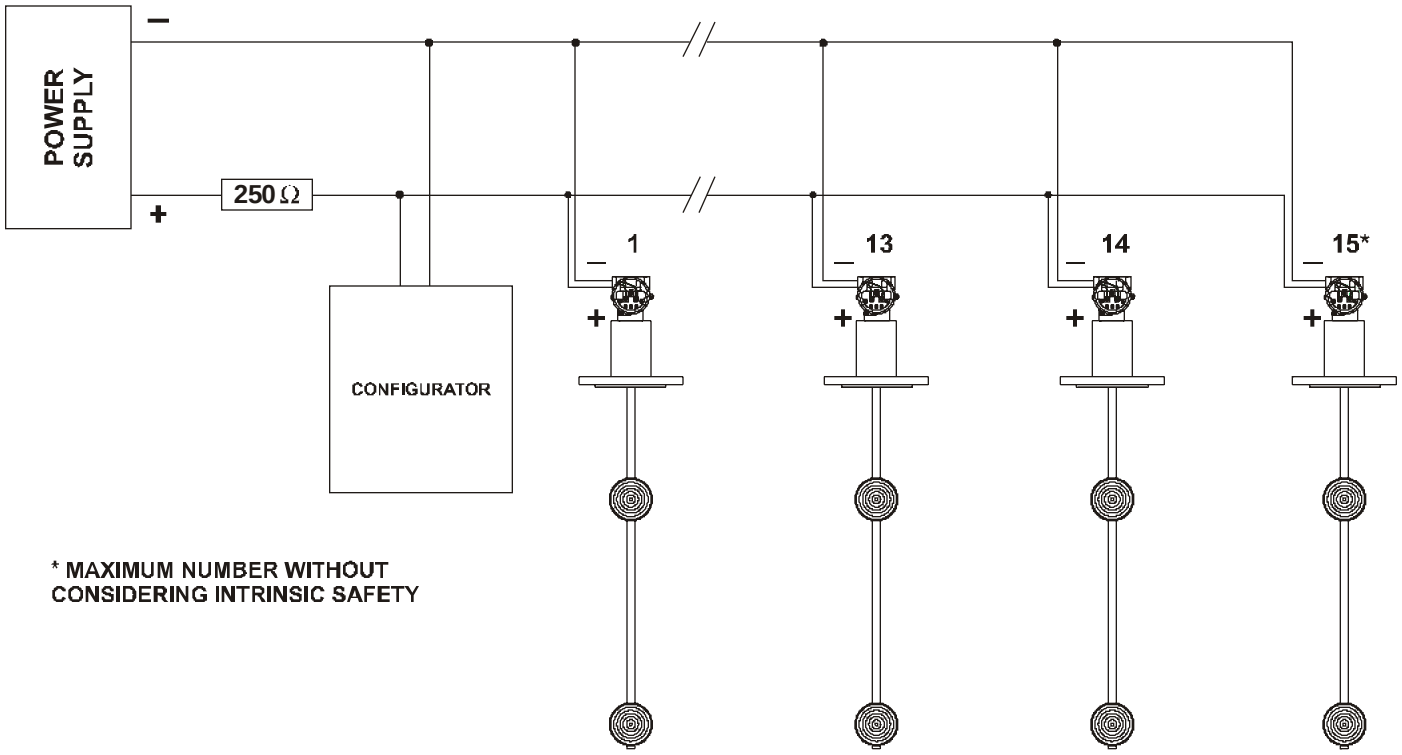


Figure 1.8 – DT301 Diagram for Multidrop Connection

Section 2

Operation

The pressure sensor used by the DT301 Smart Concentration/ Density Transmitter is a capacitive cell, the same type used by the LD301 Smart 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 DT301.

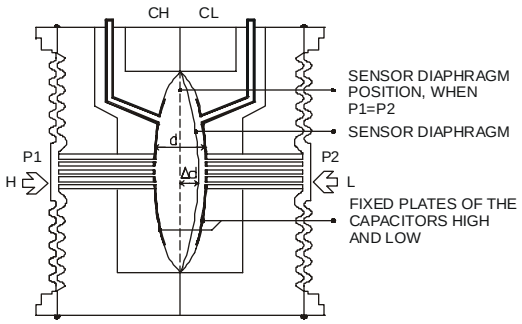


Figure 2.1 – Capacitive Cell

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 P_1 side and the sensing diaphragm.

CL = capacitance between the fixed plate on the P_2 side and the sensing diaphragm.

d = distance between CH and CL fixed plates.

Δd = sensing diaphragm's deflection due to the differential pressure $\Delta P = P_1 - P_2$.

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 DT301 functionally.

Probe

Part of the transmitter 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.

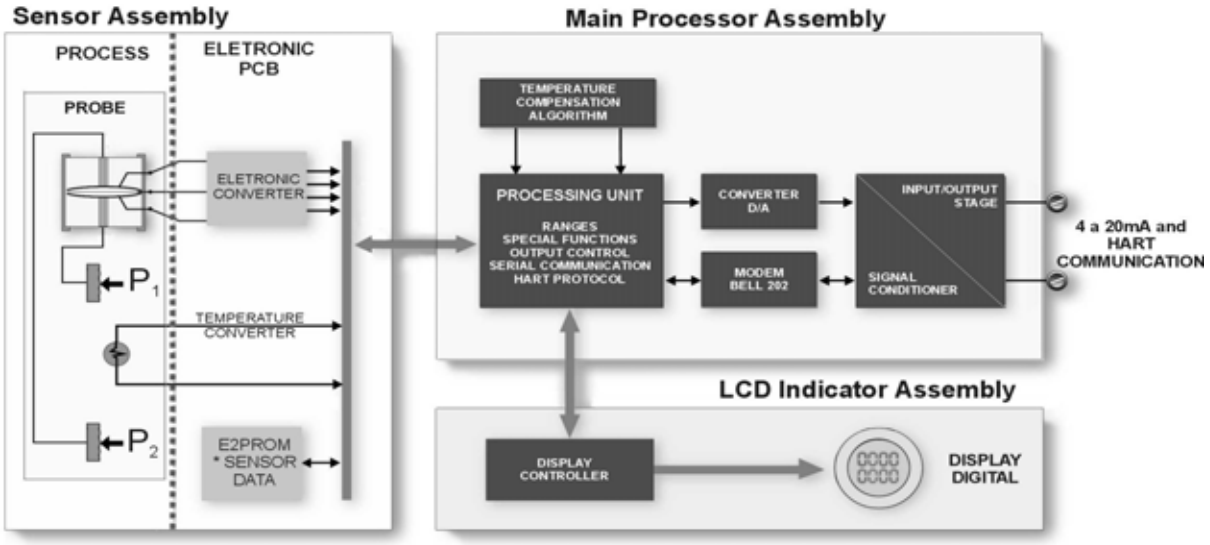


Figure 2.2 – DT301 Hardware Block Diagram

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 DT301 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 HT2 SMAR programmer and the DT301 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 12 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 DT301 transmitter.

Digital Filter
The digital filter is a lowpass 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.

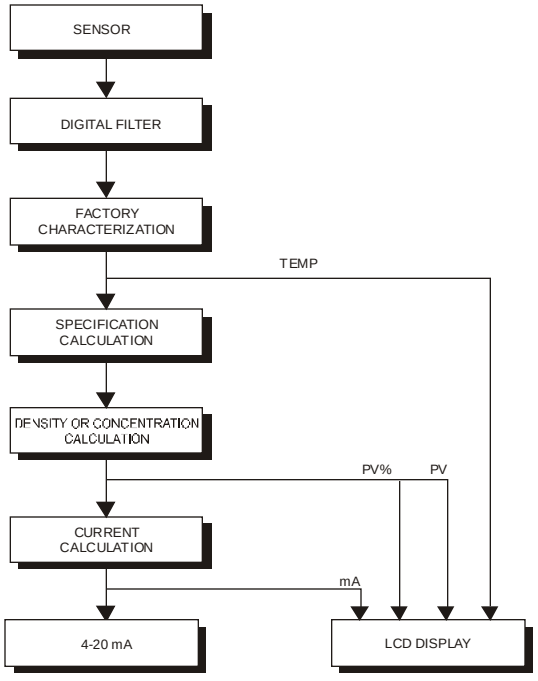


Figure 2.3 – DT301 Software Block Diagram

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 DT301 transmitter.

Monitoring
The DT301 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 DT301 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 DT301 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

Section 3

Configuration

The **DT301** 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 multidrop 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 multidrop 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 acknowledgement mechanism is via Tag, the transmitter's addresses may be "0" while; their output current is still being controlled, even in a multidrop configuration.

In the case of the **DT301**, which can be configured both as Transmitter as a Controller; the HART® addressing is used as follows:

TRANSMITTER MODE - The "0" address causes the **DT301** to control its output current and addresses "1" through "15" place the **DT301** in the multidrop mode with current control.

CONTROLLER MODE - The **DT301** always controls the output current, in accordance with the value calculated for the Controlled Variable, regardless of its network address.

NOTE:

In case of multidrop 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 **DT301** 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. A detailed description of such commands may be found in the manual entitled HART® Command Specification - **DT301** Intelligent Density Transmitter.

Smar 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.

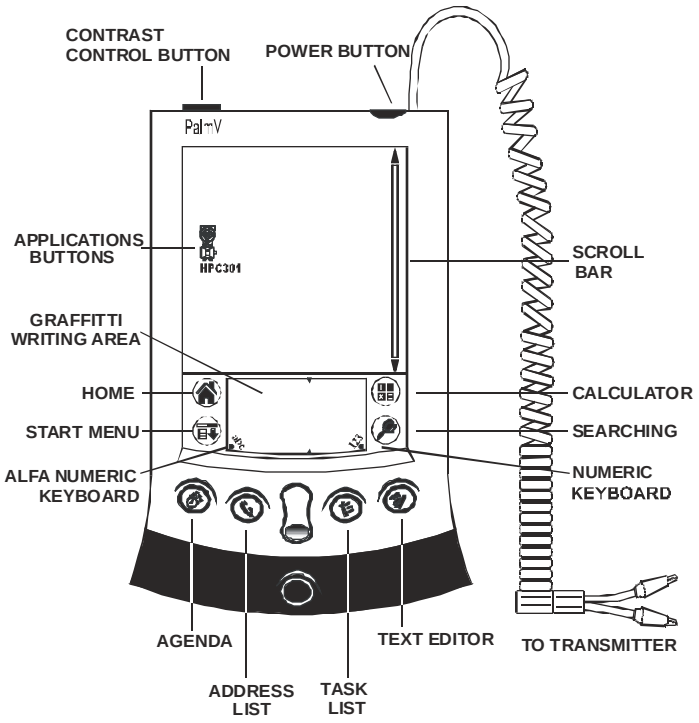


Figure 3.1 - Configurator

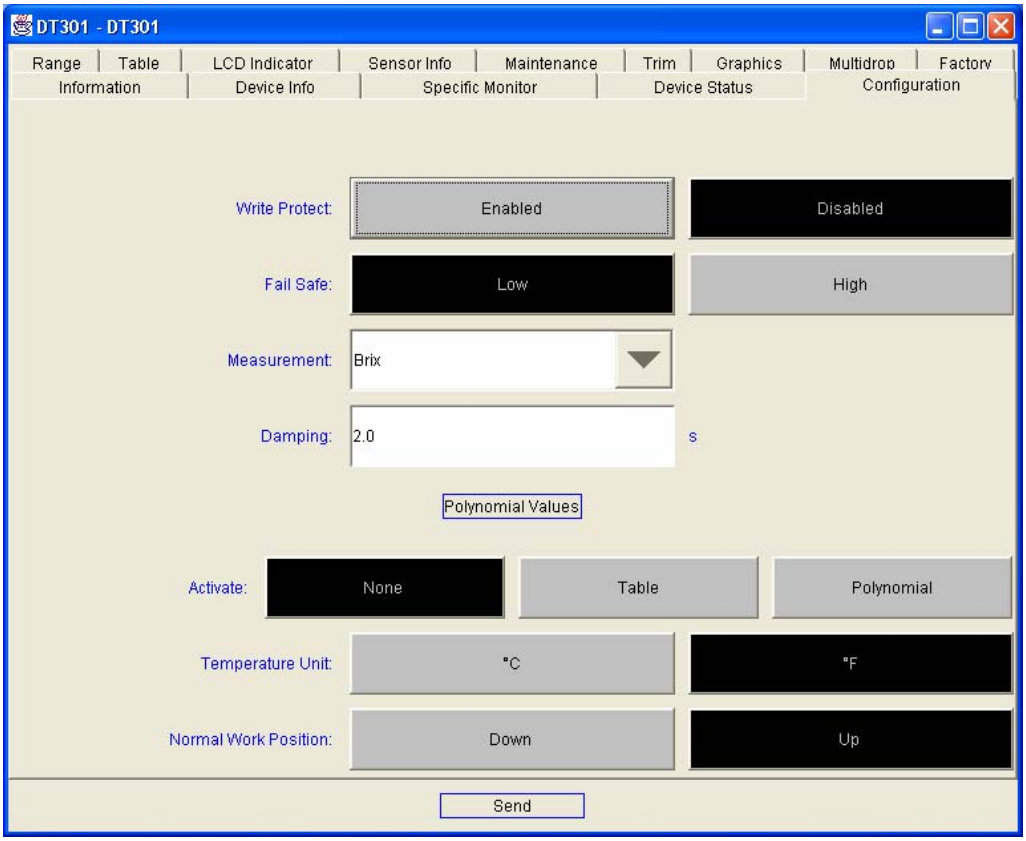


Figure 3.2 –CONF401 Screen

Configuration Resources

By means of the HART® Configurator, the **DT301** 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;
- ✓ Transference Function for Density Measurement;
- ✓ 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 **DT301** manufacturing and identification data is available:

TAG - 8-character alphanumeric field for identification of the transmitter.

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 applied pressure. This may be due to several reasons, among which the following can be mentioned:

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

The Pressure Trim is the method used in order to adjust the measurement as related to the applied pressure, as per the user's pressure standard. The most common discrepancy found in transmitters is usually due to Zero displacement. This may be corrected by means of the zero trim or the lower trim.

FINE ADJUSTMENT - TRIM

The TRIM function is used to adjust the reading of the transmitter with the pressure and the current user's standards. These two reading types: Current and Pressure can be adjusted as much as in form of fine tuning to correct small deviations of the hardware as, in the specific case of the pressure, to determine the work range.

TRIM OF CURRENT (4-20 MA)

When the microprocessor generates a 0% output 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 Smar current standards and your plant current Standard. In this case, the Current Trim adjustment shall be used.

Connect the transmitter accurately with your miliamperimeter in 0.03% of the reading. Select the TRIM function.
The following types of Trim of Pressure are available in DT301:

- ✓ **LOWER TRIM**: Is used to trim the reading at the lower range. The user informs to the transmitter the correct reading for the applied pressure via HART® configurator;

- ✓ **UPPER TRIM:** Is used to trim the reading at the upper range. The user informs the transmitter the correct reading for the applied pressure via HART® configurator.

NOTE:
This adjustment is made in factory and it should not be made in field. If it is necessary, provide a pressure standard with better accuracy or same to 0.015% in value of the pressure to be applied. The density upper trim should be always made after the zero trim.

Lower Pressure Trim

The most common discrepancy is the lower reading. The shift in ZERO may be compensated by the LOWER PRESSURE TRIM. To have a digital reading more accurate it is recommended to calibrate LOWER PRESSURE TRIM with the same value calibrated in the LOWER RANGE VALUE.

Upper Pressure Trim

Under some particular operating conditions, the sensor mechanical gain may be slightly modified. This reflects on the pressure reading. In order to adjust the reading to the desired value, apply the UPPER RANGE VALUE of the desired calibration range and select the UPPER PRESSURE TRIM. In order to have a more accurate digital reading it is recommended to calibrate the UPPER PRESSURE TRIM with the same value as the calibrated UPPER RANGE VALUE.

The Upper Pressure TRIM corrects any distortions occurred on the mechanical gain of the sensor, by acting on the transference curve span. The Upper Pressure Trim adjustment procedure is identical to that of the Lower Pressure trim, which has been explained on the previous paragraph. All steps shall be followed in the same order, simply changing the reference from lower to upper.

Temperature Trim

Trim of Temperature consists of two variables: the actual value and the new value. The value is the current temperature of the equipment online that is monitored and constantly updated. The new value is the temperature value to correct some abnormality presented by the temperature.

Concentration Trim

This Trim is made with the DT301 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.

Autocalibration Trim

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

DT301 Self-Calibration

First Step:

With the **DT301** in the vertical position and facing the air, choose **Kg/m³** for the measurement unit. Enter the **TRIM** menu, choose the option **AIR** Self-Calibration Trim and press **"OK ",** when the indicated error is less than 0.4 Kg/m³ **.**

Second Step:

After the fisrt step, immerse both diaphragms in the water, in the vertical position, and change the measurement unit for **Brix**. Enter the **TRIM** menu, choose the option **WATER** Self-Calibration Trim and press **"OK"** when the indicated error is less than 0.1 Brix.

Following these steps, the DT301 will be calibrated.

In case there is a difference between the DT301 and the standard used as reference, adjust the concentration in the process.

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 DT301 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;
- ✓ **Measure Calibration:** DT301 is manufactured and gauged accordingly to the customer's request. When installing the transmitter in the process could occur the need of a measure adjustment, due to some current deviations of installation. If the required adjustment is only for the measurement engineering units, search for MEASUREMENT item described more after. If the adjustment requires changes in values measurements, make the calibration with reference;
- ✓ **Damping:** The damping item in CALIBRATION menu enables adjustment of the damping factor of pressure 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 a intrinsic mechanical damping of 0.2 seconds.

MEASUREMENT

This function of configuration menu of the Smar 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.

CONSTANT

All measurements performed by the transmitter, with the exception of the fixed current, are calculated in accordance with the physical and chemical properties of the solution and the medium, respectively. However, due to intrinsic characteristics of this transmitter, the only information required for the transmitter to perform correct measurements is the gravity acceleration, expressed in m/s^2. Such information is provided in this option of the configuration menu.

ATTENTION:
Alter this variable only if the local gravity acceleration figure is known. The use of an incorrect value will cause measurement errors in the span, which will require a new calibration. In order to correct a mistakenly entered information, return to the normal acceleration value, 9.80665, if no adjustments have been made.

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

DT301 offers resources to select the engineering unit to be suitable in the measures. The available units are Density, Relative Density, Brix Degree, Baume Degree, INPM Degree, Plato Degree, % of Solids, etc.
As the digital display used in DT301 is of 4 ½ digits, the maximum indicated value would be 19999. Like this, when selecting the unit, be certified that in your application the value won't surpass 19999.

Equipment Configuration

The **DT301** enables the configuration of not only its operational services, but of instrument itself. This group includes services related to: Input Filter, Burn Out, 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 - MONIT

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 **DT301** 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 **DT301** will display the message MDROP for addresses "1" to "15";

NOTE:
The output current will be increased to 4 mA as the **DT301** address, in the Transmitter mode, is altered to another value than "0" (this does not happen when the **DT301** is configured in the Controller mode).

The **DT301** is factory configured with address "0".

✓ **DISPLAY INDICATION** - the **DT301** 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.

CURRENT	Current in milliamperes
PV%	Process variable in percentage
PV	Process variable in engineering units
MV% (*)	Output in percentage
TEMP	Ambient temperature
S/INDIC	Used to cancel the second indication

Table 3.1 - Variables for Indication in Display

NOTE:
Items marked with an asterisk can only be selected in the PID mode.

✓ **PASSWORDS** - this service enables the user to modify the operation passwords used in the `-**DT301**. Each password defines the access for a priority level (1 to 3); such configuration is stored in the **DT301** EEPROM.

Password Level 3 is hierarchically superior to password level 2, which is superior to level 1.

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							

Differential Density Transmitter DT301(D):

Range: 0.5 to 1.8 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 **DT301** 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

SMAR DT301 intelligent pressure 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 **SMAR** whenever necessary.

The **DT301** concentration/density transmitter has been designed to operate for many years without malfunctions. Should the process application require 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 **SMAR** 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 SMAR'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 battery voltage of the configurator lower than 9 V.
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 battery voltage of the configurator lower than 9 V.
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 **DT301** specific command in a transmitter from another manufacturer.
XMTR MALFUNCTION	• Sensor disconnected. • Sensor failure.
COLD START	• Start-up or Reset due to power supplies failure.

ERROR MESSAGES	POTENTIAL SOURCE OF PROBLEM
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

Troubleshooting

***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 12 and 45 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 DT301 terminals must be between 12 and 45 V, 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.

NOTE:
A 3.9 or 21.mA current indicates that the transmitter is in safety output or fail-safe output mode. Use the configurator to investigate the source of problem.

Procedure to change the DT301 Main Board

- Replace the GLL852 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.

Group of the Probe (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.

IMPORTANT:
The transmitters have a stopper that can be released to allow the sensor to rotate more than one turn. See Figure 4.1.

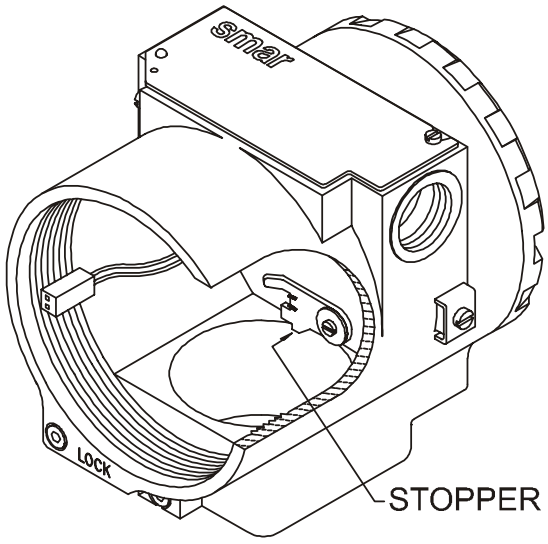


Figure 4.1 – Sensor Rotation Stopper

CAUTION:
Do not rotate the electronic housing more than 180º without disconnecting the electronic circuit from the sensor and from the power supply.

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.

Group of the Probe (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.

Electronic Circuit

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 **SMAR** mark indicates up position.

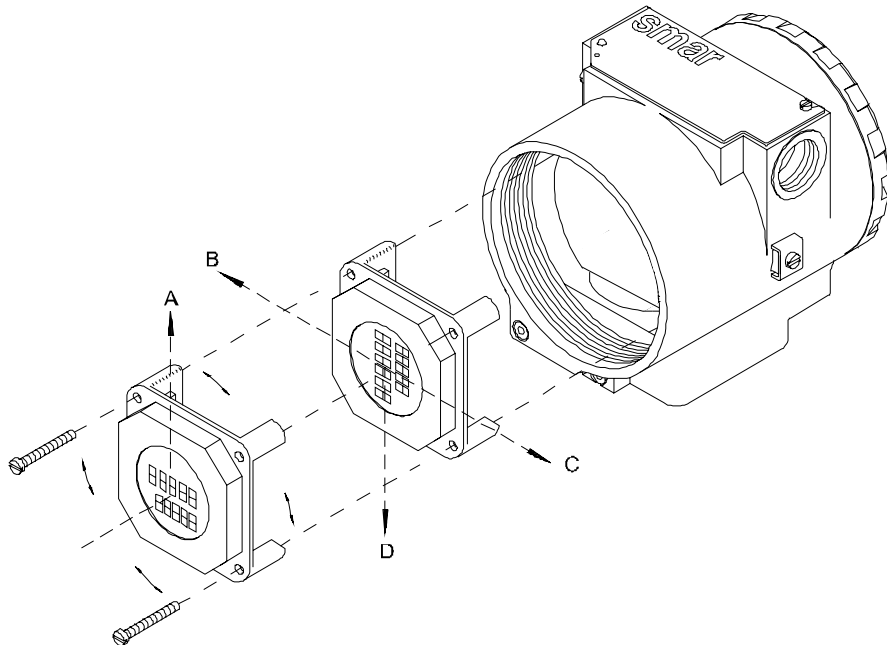


Figure 4.2 – Four Possible Positions of the Display

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 **SMAR**, 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 a description of the failure observed, with as much details as possible. Other information concerning to the instrument operation, such as service and process conditions, is also helpful.

ACCESSORY	
ODERING CODE	**DESCRIPTION**
SD-1	Magnetic Tool for local adjustment.
PalmZIRE71*	16 Mbytes PalmZIRE71 Handheld, Including HPC301's initialization and installation software.
HPC301*	HART® HPI311-M5P for the PalmZIRE71, including the configuration package for the Smar and generic transmitters.
HPI311-M5P*	Just the HART® interface.

* For equipment updates and HPC301 software, just check: **http://www.smarresearch.com/id37.htm.**

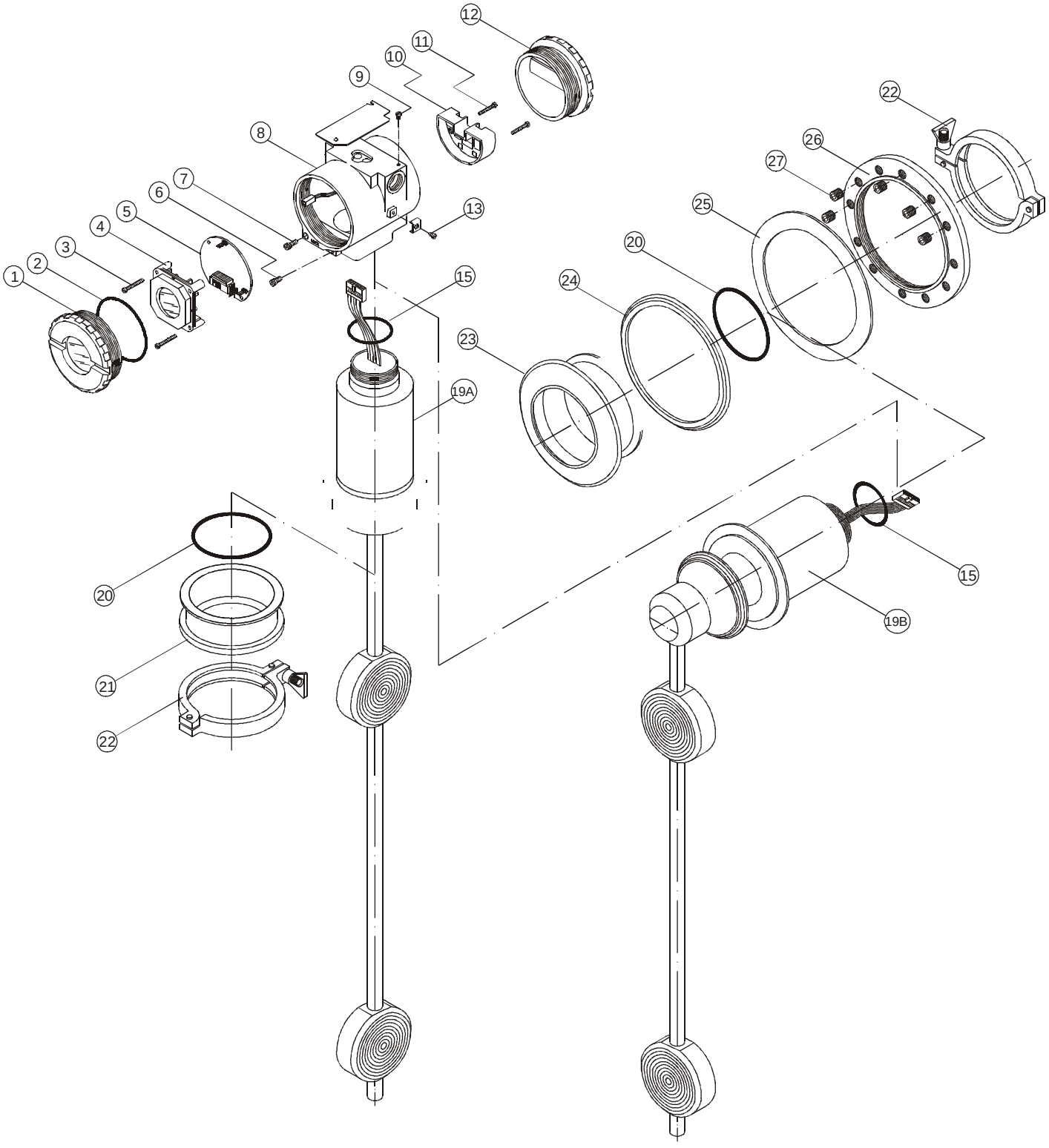


Figure 4.3 - DT301 - Exploded View (Sanitary Model)

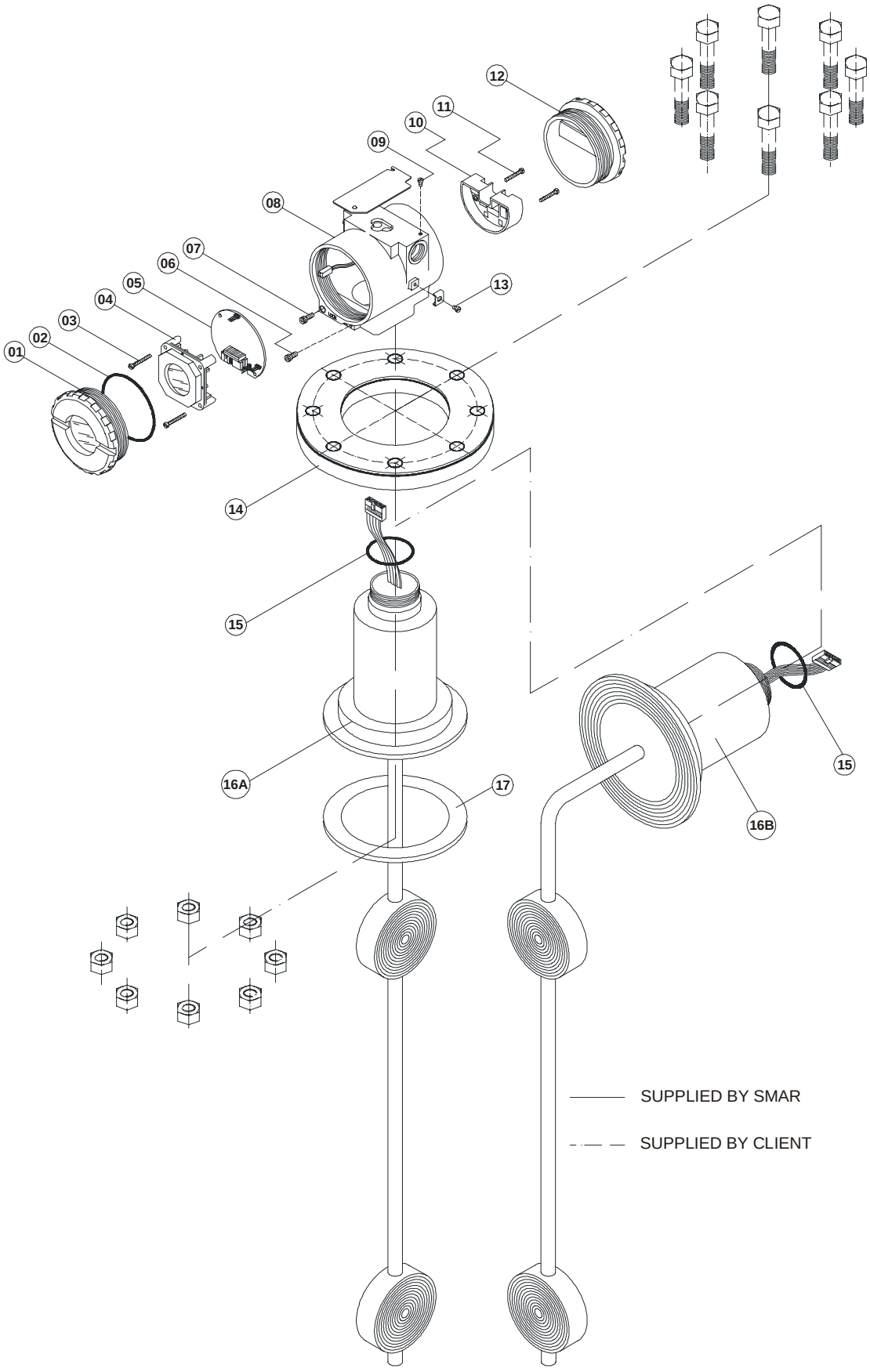


Figure 4.4 - DT301 - Exploded View (Industrial Model)

SPARE PARTS LIST FOR TRANSMITTER			
DESCRIPTION OF PARTS	**POSITION**	**CODE**	**CATEGORY (NOTE 1)**
HOUSING, Aluminum **(NOTE 2)**			
. 1/2 - 14 NPT	8	400-0246	
. M20 x 1.5	8	400-0247	
. PG 13.5 DIN	8	400-0248	
HOUSING, 316 Stainless Steel **(NOTE 2)**			
. 1/2 - 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 e 12	204-0102	
. 316 SS	1 e 12	204-0105	
COVER WITH WINDOW FOR INDICATOR (Includes O-ring)			
. Aluminum	1	204-0103	
. 316 SS	1	204-0106	
COVER LOCKING SCREW	7	204-0120	
SENSOR LOCKING SCREW	6	204-0121	
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-RING **(NOTE 4)**			
. Cover, Buna-N	2	204-0122	B
. Neck, Buna-N	15	204-0113	B
. Process Connection, Buna-N	18	400-0236	B
TERMINAL HOLDING SCREW			
. HOUSING, Aluminum	11	304-0119	
. HOUSING, 316 SS	11	204-0119	
MAIN BOARD SCREW FOR HOUSING, Aluminum			
. Units with indicator	3	304-0118	
. Units without indicator	3	304-0117	
MAIN BOARD SCREW FOR HOUSING, 316 Stainless Steel			
. Units with indicator	3	204-0118	
. Units without indicator	3	204-0117	
PROCESS CONNECTION - INDUSTRIAL MODEL			
. Flange 4" – 150# ANSI B-16.5, AISI 316	14	400-0237	
. Flange 4" – 300# ANSI B-16.5, AISI 316	14	400-0238	
. Flange 4" – 600# ANSI B-16.5, AISI 316	14	400-0239	
. Flange DN 100, PN 25 / 40, din 2526 – Form D, AISI 316	14	400-0240	
. Nylon Isolation Bush	17	400-0719	
. Teflon Closing Junction	18	400-0720	
PROCESS CONNECTION - SANITARY MODEL			
. Tank Adapter for Straight Model	21	400-0241	
. Tri-Clamp de 4", AISI304	22	400-0242	
. Tank Adapter for Curve Model	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	
. Industrial Probe	16A or 16B	**NOTE 5**	B
. Sanitary Probe	19A or 19B	**NOTE 5**	B

Note: 1) For category A, it is recommended to keep, in stock, 25 parts installed for each set, and for category B, 50.
2) Includes Terminal Block, Screws, caps and Identification plate without certification.
3) The main board of DT301 and probe are items.
4) O-rings are packaged with 12 units.
5) To specify sensors, use the following tables.

400-0244 Sanitary Model Probe

COD.	RANGE			Minimum Span
1	0.5	to	1.8 g/cm3	0,025 g/cm^3
2	1.0	to	2.5 g/cm^3	0,025 g/cm^3
3	2.0	to	5.0 g/cm^3	0,025 g/cm^3

COD.	Diaphragm Material
H	Hastelloy C276
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	0.5	to	1.8 g/cm^3	0,025 g/cm^3
2	1.0	to	2.5 g/cm^3	0,025 g/cm^3
3	2.0	to	5.0 g/cm^3	0,025 g/cm^3

COD.	Diaphragm Material
H	Hastelloy C276
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

400-0243 - 1 H - S 1

Section 5

Technical Characteristics

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 DT301, 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)
Syltherm 800	10	0.934	0.0009	General purpose (extreme temperatures, positive and negative)
Propylene Glycol NEOBEE M20 (Food Grade)	9.8	0.90	0.001	Food and beverage, and Pharmaceutical areas
Glycerin and Water (Food Grade)	12.5	1.13	0.00034	Food industries

Table 5.1 – Properties of filling fluids

Functional Specifications

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

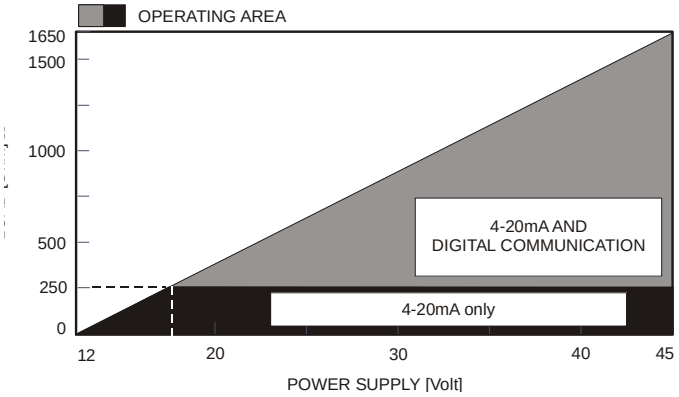
Power Supply
12 to 45 Vdc

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

Hazardous Area Certifications
Explosion proof. Weather proof and intrinsically safe (CENELEC, FM and DTM standards)

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

Load Limitation



Temperature Limits

Ambient:	-40	to	85º C	(-40	to	185º F)
Process:	0	to	150º C	(32	to	248º 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
Performs within specifications in less than 5.0 seconds after power is applied to the transmitter.

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

Static Pressure Limit
7 Mpa (71,4 kgf/cm^2)

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 25º C (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 PRESSURE (per 1 kgf/cm^2)
1	±0.0004 g/cm^3 (±0.1 ^0Bx)	0.003 kg/m^3	0.021 kg/m^3	0.001 kg/m^3
2	±0.0007 g/cm^3	0.013 kg/m^3	0.083 kg/m^3	0.004 kg/m^3
3	±0.0016 g/cm^3	0.041 kg/m^3	0.521 kg/m^3	0.007 kg/m^3

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

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

Mounting Position Effect
It can be eliminated after installation. No span effect.

Electro-Magnetic Interference Effect
Designed to comply with IEC 801.

Physical Specifications

Electrical Connection
1/2" - 14 NPT, Pg 13.5 or M20 x 1.5

Process Connection

- Industrial Model
  316 SST Flange ϕ 4
- Sanitary Model
  304 SST Tri-clamp 4

Wetted Parts

- Isolating Diaphragms
  316L SST or Hastelloy C276
- Probe Material
  316L SST
- Wetted O-Rings (For Sanitary Model)
  Buna N, Viton™ or PTFE

Nonwetted Parts

- Electronic Housing
  Injected aluminum with polyester painting or 316 SST (NEMA 4X, IP67)
- Fill Fluid
  Silicone (DC200/20, DC704), Syltherm 800, Glycerin and Water or NEOBEE M2O
- Cover Rings
  Buna N
- Identification Plate
  316 SST

Mounting
Side or top mounting

Approximate Weights

- Sanitary Model
  9 kg (20 lb)
- Industrial Model
  13 kg (28 lb)

MODEL DT301I — **INDUSTRIAL CONCENTRATION / DENSITY TRANSMITTER**

CODE	Range			Minimum Span
1	0.5	to	1.8 g/cm3	0,025 g/cm^3
2	1.0	to	2.5 g/cm3	0,025 g/cm^3
3	2.0	to	5.0 g/cm3	0,025 g/cm^3

Note: For concentration units ^{0}Brix, ^{0}Plato, ^{0}INPM, ^{0}GL and ^{0}Baume, specify code 1.

CODE	Diaphragm Material
H	Hastelloy C276
I	316L SST
T	Tantalum
Z	Others – Specify

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

CODE	Indicator Local
0	Without Indicator
1	With Digital Indicator

CODE	Electrical Connection
0	½" - 14NPT
A	M20 X ½"
B	Pg 13.5 DIN
Z	Others – Specify

CODE	Mounting
1	Top
2	Side

CODE		Process Connection Size, Rating and Standard
5	1	4" 150# ANSI B – 16.5
5	2	4" 300# ANSI B – 16.5
5	3	4" 600# ANSI B – 16.5
9	C	DN 00 PN25/40 DIN 2526 – FORM D
Z	Z	Others – Specify

CODE	Optional Item (*)
H1	316 SST Housing
ZZ	Special Options – Specify

DT301I - 1 I S - 1 0 1 - 5 1 / *

(*) Leave it Blank for no optional items.

MODEL DT301S — **SANITARY CONCENTRATION / DENSITY TRANSMITTER**

CODE	Range			Minimum Span
1	0.5	to	1.8 g/cm^3	0,025 g/cm^3
2	1.0	to	2.5 g/cm^3	0,025 g/cm^3
3	2.0	to	5.0 g/cm^3	0,025 g/cm^3

Note: For concentration units ^{0}Brix, ^{0}Plato, ^{0}INPM, ^{0}GL and ^{0}Baume, specify code 1.

CODE	Diaphragm Material
H	Hastelloy C276
I	316L SST
T	Tantalum
Z	Others Specify

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

CODE	Local Indicator
0	Without Indicator
1	With Digital Indicator

CODE	Electrical Connection
0	½" - 14NPT
A	M20 X ½"
B	Pg 13.5 DIN
Z	Others – Specify

CODE	Mounting
1	Top
2	Side

CODE	Process Connection
J	Tri-clamp – 4" 300#
Z	Others – Specify

CODE	Wetted O-Rings Material
B	Buna – N
V	Viton
T	Teflon
Z	Others – Specify

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

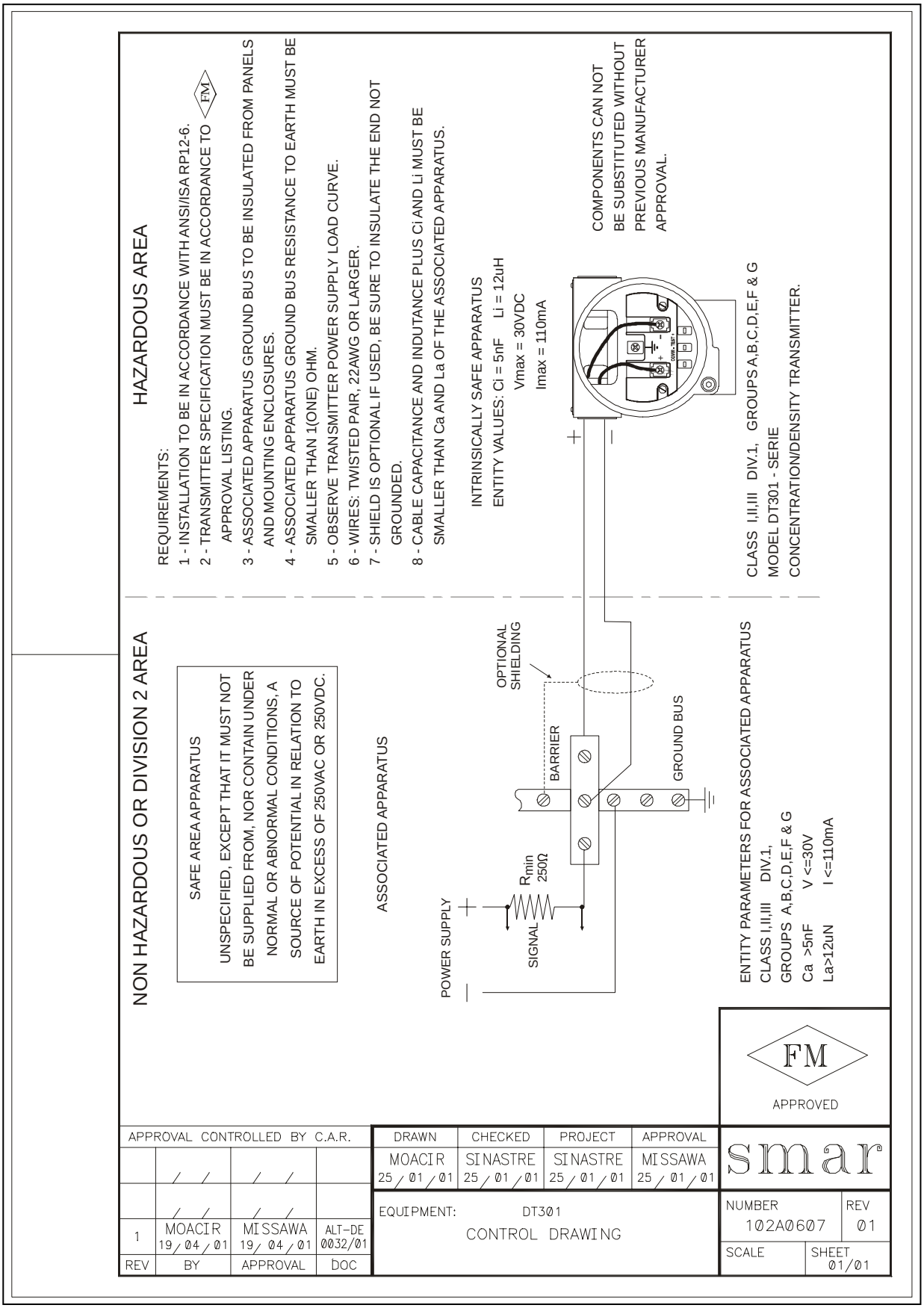
CODE	Tri – clamp
0	Without Tri-clamp
2	With Tank Adapter

COD.	Optional Item (*)
H1	316 SST Housing
ZZ	Special Options – Specify

DT301S	-	1	I	S	-	1	0	1	-	J	B	0	0	/	*

(*) Leave it Blank for optional items.

APPENDIX


HAZARDOUS AREA
REQUIREMENTS:
1 - INSTALLATION TO BE IN ACCORDANCE WITH ANSI/ISA RP12-6.
2 - TRANSMITTER SPECIFICATION MUST BE IN ACCORDANCE TO APPROVAL LISTING.
3 - ASSOCIATED APPARATUS GROUND BUS TO BE INSULATED FROM PANELS AND MOUNTING ENCLOSURES.
4 - ASSOCIATED APPARATUS GROUND BUS RESISTANCE TO EARTH MUST BE SMALLER THAN 1(ONE) OHM.
5 - OBSERVE TRANSMITTER POWER SUPPLY LOAD CURVE.
6 - WIRES: TWISTED PAIR, 22AWG OR LARGER.
7 - SHIELD IS OPTIONAL IF USED, BE SURE TO INSULATE THE END NOT GROUNDED.
8 - CABLE CAPACITANCE AND INDUTANCE PLUS Ci AND Li MUST BE SMALLER THAN Ca AND La OF THE ASSOCIATED APPARATUS.
INTRINSICALLY SAFE APPARATUS
ENTITY VALUES: Ci = 5nF Li = 12uH
Vmax = 30VDC
Imax = 110mA
COMPONENTS CAN NOT BE SUBSTITUTED WITHOUT PREVIOUS MANUFACTURER APPROVAL.
CLASS I,II,III DIV.1, GROUPS A,B,C,D,E,F & G
MODEL DT301 - SERIE
CONCENTRATION/DENSITY TRANSMITTER.
NON HAZARDOUS OR DIVISION 2 AREA
SAFE AREA APPARATUS
UNSPECIFIED, EXCEPT THAT IT MUST NOT BE SUPPLIED FROM, NOR CONTAIN UNDER NORMAL OR ABNORMAL CONDITIONS, A SOURCE OF POTENTIAL IN RELATION TO EARTH IN EXCESS OF 250VAC OR 250VDC.
ASSOCIATED APPARATUS
OPTIONAL SHIELDING
BARRIER
GROUND BUS
POWER SUPPLY
SIGNAL
Rmin 250Ω
ENTITY PARAMETERS FOR ASSOCIATED APPARATUS
CLASS I,II,III DIV.1,
GROUPS A,B,C,D,E,F & G
Ca >5nF V <=30V
La>12uN I <=110mA
FM
APPROVED
APPROVAL CONTROLLED BY C.A.R.
REV
BY
APPROVAL
DOC
1
MOACIR 19/04/01
MISSAWA 19/04/01
ALT-DE 0032/01
DRAWN
CHECKED
PROJECT
APPROVAL
MOACIR 25/01/01
SINASTRE 25/01/01
SINASTRE 25/01/01
MISSAWA 25/01/01
EQUIPMENT: DT301
CONTROL DRAWING
smar
NUMBER 102A0607
REV 01
SCALE
SHEET 01/01