LD291

smar

OPERATION AND MAINTENANCE
INSTRUCTION / MANUAL

INTELLIGENT PRESSURE TRANSMITTER

HART COMMUNICATION PROTOCOL

MAR / 15
LD291
Version 6

LD291ME

smar

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INTRODUCTION

The **LD291** is a smart pressure transmitter for gauge and level measurement. It is based on a field-proven capacitive sensor that provides reliable operation and high performance. The digital technology used in the **LD291** enables an easy interface between the field and the control room and several interesting features that considerably reduce the installation, operation and maintenance costs.

The **LD291** is the economical alternative in routine gage pressure measurement. This lightweight design eliminates the need for mounting brackets and transmitter supports in many applications.

The model **LD291** offers digital HART® based communication simplifying calibration and providing remote diagnostics. Also, an optional LCD meter can be added to provide additional operations and local indication.

Its microprocessor- based electronics allow for total interchangeability with SMAR capacitive sensors. It automatically corrects sensor characteristic changes caused by temperature fluctuations.

The **LD291**, besides the normal functions offered by other smart transmitters, offers the following functions:

- ✓ **TABLE** - the pressure signal is custom linearized according to a 16-point table, enabling, e.g., conversion of level to volume of a horizontal cylindrical tank.
- ✓ **LOCAL ADJUSTMENT** - not only for lower and upper value, but input/output function, indication, as well.
- ✓ **PASSWORD** - three levels for different functions.
- ✓ **OPERATION COUNTER** - shows the number of changes in each function.
- ✓ **USER-UNIT** - indication in engineering unit of the property actually measured, e.g., level, flow or volume.
- ✓ **WRITE-PROTECT-** via hardware.

Get the best results of the LD291 by carefully reading these instructions.

Smar's pressure transmitters are protected by U.S. patents 6,433,791 and 6,621,443.

NOTE
This manual is compatible with version 6.XX, where 6 denote software version and XX software release. The indication 6.XX means that this manual is compatible with any release of software version 6.

WARNING
To ensure that our products are safe and without risk to health, the manual must be read carefully before proceeding and warning labels on packages must be observed. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the **Operation and Maintenance Instruction Manual**.

Waiver of responsibility

The contents of this manual abides by the hardware and software used on the current equipment version. Eventually there may occur divergencies 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 Smar. 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.

All of Smar's obligation result from the purchasing agreement signed between the parties, which includes the complete and sole valid warranty term. Contractual clauses related to the warranty are not limited nor extended by virtue of the technical information contained in this manual.

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. Smar 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 equipments 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 Smar or any of Smar 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 Smar 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. Smar is not responsible for any losses and/or damages resulting from the inadequate use of its equipments. It is the user's responsibility to know and apply the safety practices in his country.

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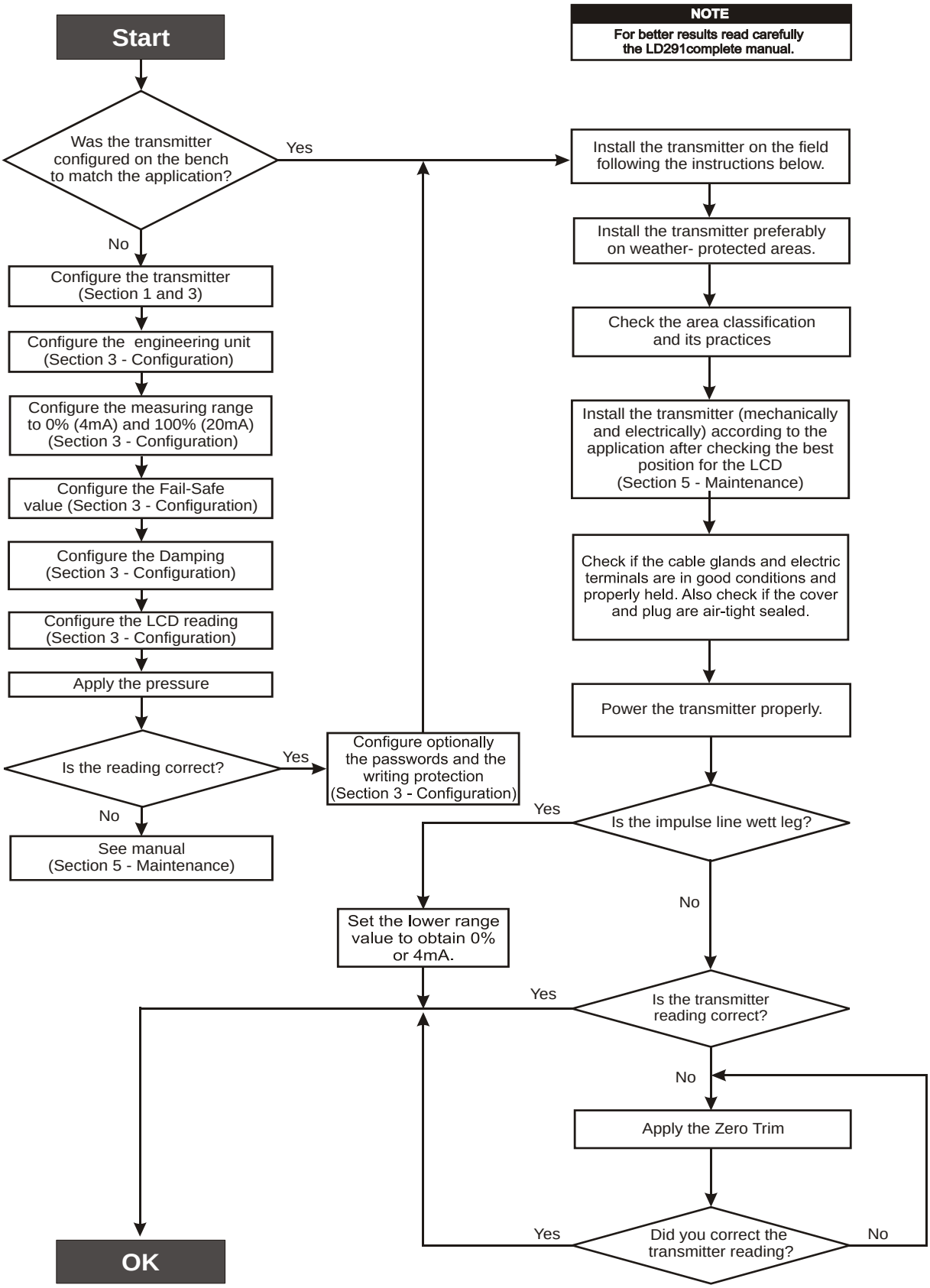


Section 1

INSTALLATION

General

NOTE
The installation carried out in hazardous areas should follow the recommendations of the IEC60079-14 standard.

The overall accuracy of a flow, level, or pressure 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 **LD291** has a built-in temperature sensor to compensate for temperature variations. At the factory, each transmitter is submitted to a temperature cycle, and the characteristics under different temperatures are recorded in the transmitter memory. At the field, this feature minimizes the temperature variation effect.

Mounting

Putting the transmitter in areas protected from extreme environmental changes can minimize temperature fluctuation effects.

In warm environments, the transmitter should be installed to avoid, as much as possible, direct exposure to the sun. Installation close to lines and vessels subjected to high temperatures should also be avoided. Use longer sections of impulse piping between tap and transmitter whenever the process fluid is at high temperatures. Use of sunshades or heat shields to protect the transmitter from external heat sources should be considered, if necessary.

Proper winterization (freeze protection) should be employed to prevent freezing within the measuring chamber, since this will result in an inoperative transmitter and could even damage the cell.

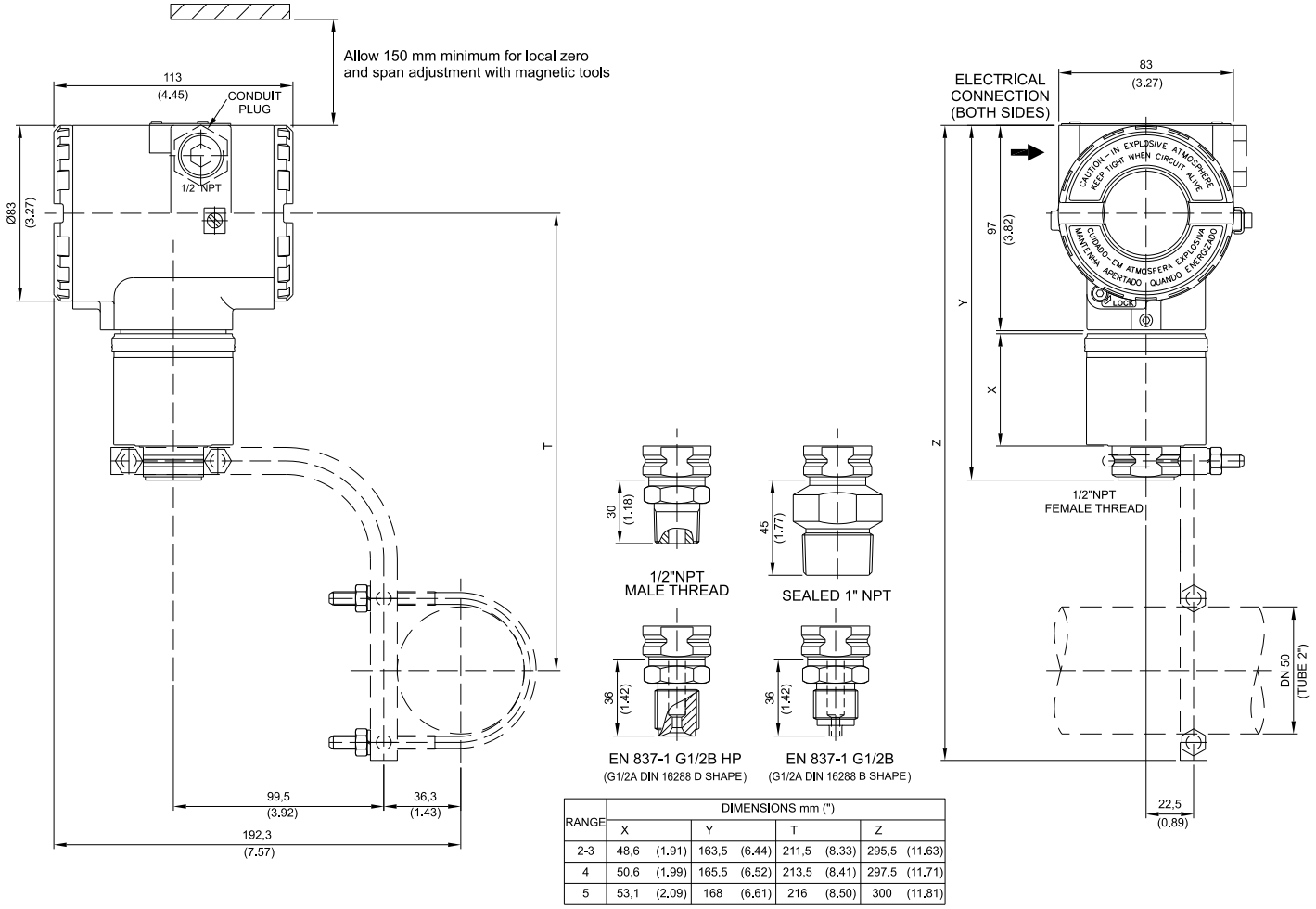
Although the transmitter is virtually insensitive to vibration, installation close to pumps, turbines or other vibrating equipment should be avoided.

The transmitter has been designed to be both rugged and lightweight at the same time. This make its mounting easier mounting positions are shown in Figure 1.1.

Should the process fluid contain solids in suspension, install valves or rod-out fittings at regular intervals to clean out the pipes.

The pipes should be internally cleaned by using steam or compressed air, or by draining the line with the process fluid, before such lines are connected to the transmitter (blow-down).

NOTE
When installing or storing the level transmitter, the diaphragm must be protected avoid scratching-denting or perforation of its surface.



RANGE	DIMENSIONS mm (")							
	X		Y		T		Z	
2-3	48,6	(1.91)	163,5	(6.44)	211,5	(8.33)	295,5	(11.63)
4	50,6	(1.99)	165,5	(6.52)	213,5	(8.41)	297,5	(11.71)
5	53,1	(2.09)	168	(6.61)	216	(8.50)	300	(11.81)

Figure 1.1(a) – Dimensional Drawing and Mounting Position for LD291

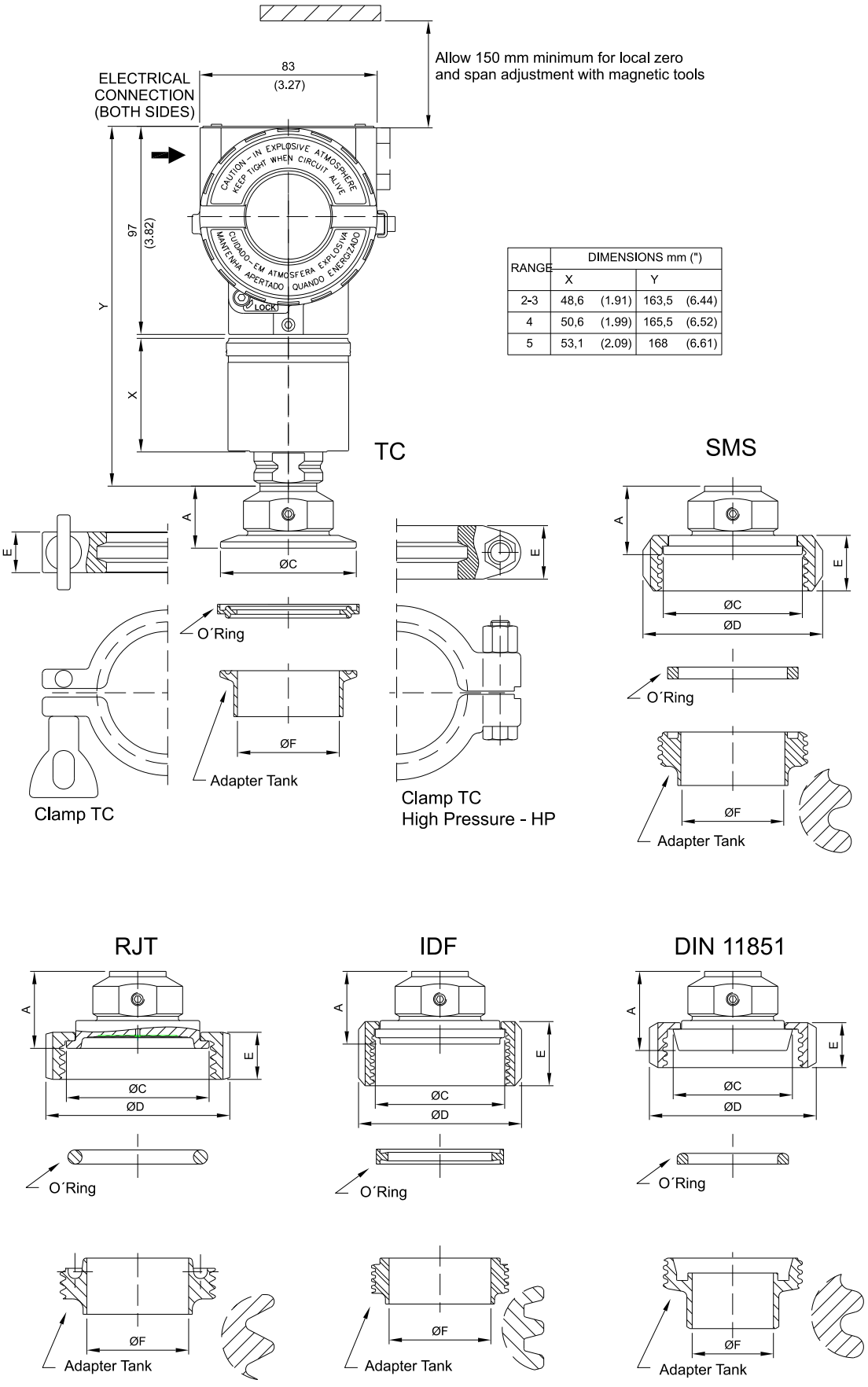
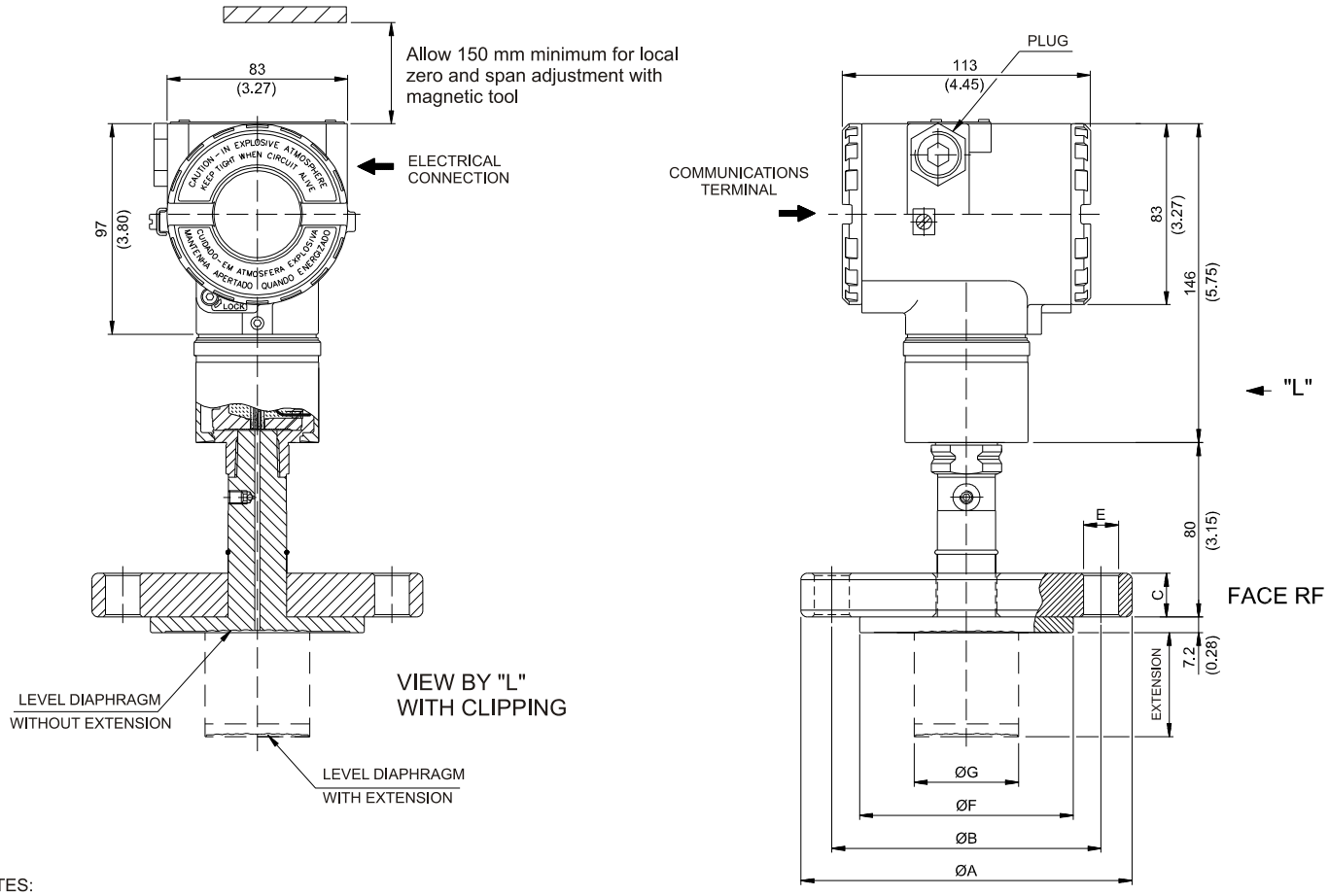


Figure 1.1(b) – Dimensional Drawing and Mounting Position for LD291 - Sanitary

LD290S - CONNECTIONS					
CONNECTION	Dimensions in mm (inche)				
	A	ØC	ØD	E	ØF
Tri-Clamp - 1 1/2" - wihtout extension	27 (1.06)	50 (1.96)	61 (2.40)	18 (0.71)	35 (1.38)
Tri-Clamp - 1 1/2" HP - without extension	27 (1.06)	50 (1.96)	66 (2.59)	25 (0.98)	35 (1.38)
Tri-Clamp - 2" - without extension	29 (1.14)	63,5 (2.50)	76,5 (3.01)	18 (0.71)	47,6 (1.87)
Tri-Clamp - 2" HP - without extension	29 (1.14)	63,5 (2.50)	81 (3.19)	25 (0.98)	47,6 (1.87)
Threaded DN40 - DIN 11851 - without extension	37 (1.46)	56 (2.20)	78 (3.07)	21 (0.83)	38 (1.50)
Threaded DN50 - DIN 11851 - without extension	38 (1.50)	68,5 (2.70)	92 (3.62)	22 (0.86)	50 (1.96)
Threaded SMS - 1 1/2" - without extension	31 (1.22)	55 (2.16)	74 (2.91)	25 (0.98)	35 (1.38)
Threaded SMS - 2" - without extension	32 (1.26)	65 (2.56)	84 (3.30)	26 (1.02)	48,6 (1.91)
Threaded RJT - 2" - without extension	35 (1.38)	66,7 (2.63)	86 (3.38)	22 (0.86)	47,6 (1.87)
Threaded IDF - 2" - without extension	34 (1.34)	60.5 (2.38)	76 (2.99)	30 (1.18)	47,6 (1.87)

Figure 1.1(c) – Dimensional Drawing and Mounting Position for LD291 – Sanitary

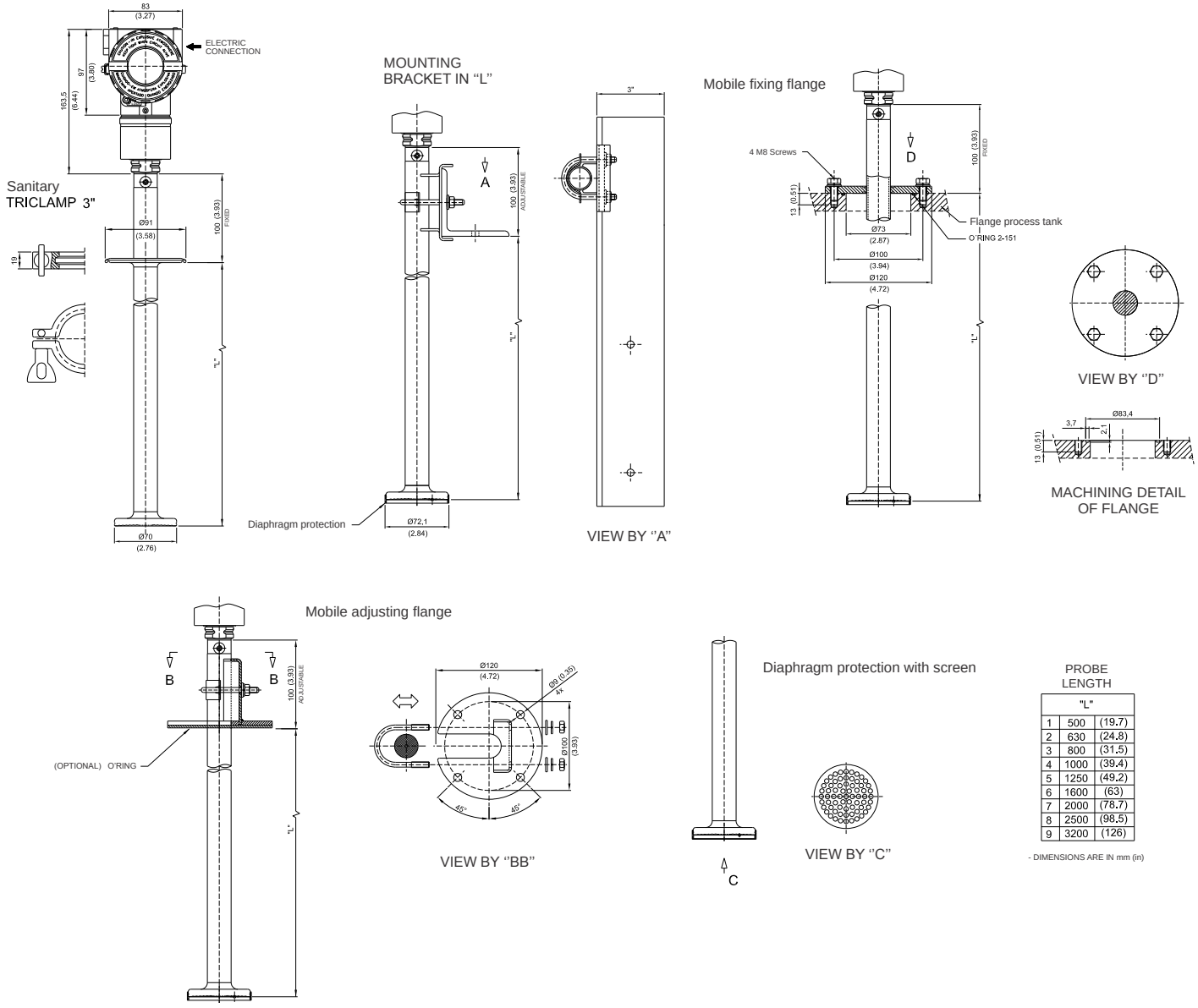


NOTES:
-EXTENSION LENGHT mm (in): 0, 50 (1.96), 100 (3.93), 150 (5.9) OR 200 (7.87)
-DIMENSIONS ARE mm (in)

ANSI-B 16.5 DIMENSIONS								
DN	CLASS	A	B	C	E	F (RF) (FF)	G	HOLES
1"	150	108 (4.25)	79.4 (3.16)	14.3 (0.56)	16 (0.63)	50.8 (2)	-	4
	300/600	124 (4.88)	88.9 (3.5)	17.5 (0.69)	19 (0.75)	50.8 (2)	-	4
1.1/2"	150	127 (5)	98.6 (3.88)	20 (0.78)	16 (0.63)	73.2 (2.88)	40 (1.57)	4
	300	155.4 (6.12)	114,3 (4.5)	21 (0.83)	22 (0.87)	73.2 (2.88)	40 (1.57)	4
	600	155.4 (6.12)	114,3 (4.5)	29,3 (1.15)	22 (0.87)	73.2 (2.88)	40 (1.57)	4
2"	150	152.4 (6)	120.7 (4.75)	17.5 (0.69)	19 (0.75)	92 (3.62)	48 (1.89)	4
	300	165.1 (6.5)	127 (5)	20.7 (0.8)	19 (0.75)	92 (3.62)	48 (1.89)	8
	600	165.1 (6.5)	127 (5)	25.4 (1)	19 (0.75)	92 (3.62)	48 (1.89)	8
3"	150	190.5 (7.5)	152.4 (6)	22.3 (0.87)	19 (0.75)	127 (5)	73 (2.87)	4
	300	209.5 (8.25)	168.1 (6.62)	27 (1.06)	22 (0.87)	127 (5)	73 (2.87)	8
	600	209.5 (8.25)	168.1 (6.62)	31.8 (1.25)	22 (0.87)	127 (5)	73 (2.87)	8
4"	150	228.6 (9)	190.5 (7.5)	22.3 (0.87)	19 (0.75)	158 (6.22)	89 (3.5)	8
	300	254 (10)	200 (7.87)	30.2 (1.18)	22 (0.87)	158 (6.22)	89 (3.5)	8
	600	273 (10.75)	215.9 (8.5)	38.1 (1.5)	25 (1)	158 (6.22)	89 (3.5)	8

EN 1092-1 / DIN2501 DIMENSIONS								
DN	PN	A	B	C	E	F	G	HOLES
25	10/40	115 (4.53)	85 (3.35)	18 (0.71)	14 (0.55)	68 (2.68)	-	4
40	10/40	150 (5.9)	110 (4.33)	20 (0.78)	18 (0.71)	88 (3.46)	40 (1.57)	4
50	10/40	165 (6.50)	125 (4.92)	20 (0.78)	18 (0.71)	102 (4.01)	48 (1.89)	4
80	10/40	200 (7.87)	160 (6.30)	24 (0.95)	18 (0.71)	138 (5.43)	73 (2.87)	8
100	10/16	220 (8.67)	180 (7.08)	20 (0.78)	18 (0.71)	158 (6.22)	89 (3.5)	8
	25/40	235 (9.25)	190 (7.50)	24 (0.95)	22 (0.87)	162 (6.38)	89 (3.5)	8

Figure 1.1(d) – Dimensional Drawing and Mounting Position for LD291 – Level



	"L"	
1	500	(19.7)
2	630	(24.8)
3	800	(31.5)
4	1000	(39.4)
5	1250	(49.2)
6	1600	(63)
7	2000	(78.7)
8	2500	(98.5)
9	3200	(126)

Figure 1.1 (e) – Dimensional Drawing and Mounting Position for LD291 – Level (Insertion)

The figure 1.2 shows how to use the tool to fix the process transmitter tap.

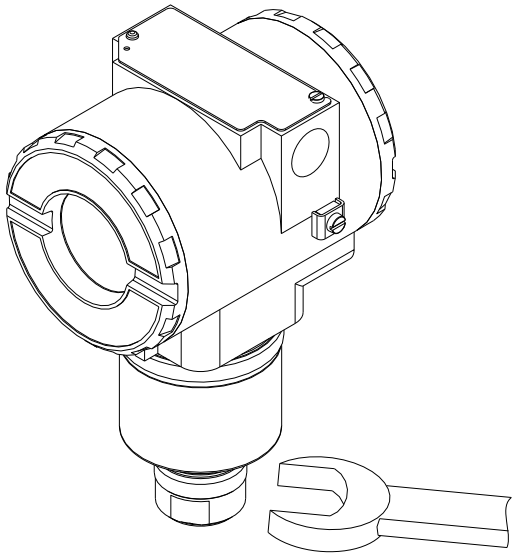


Figure 1.2 – Fixing of the Transmitter in the Tap

Observe operating safety rules during wiring, draining or blow-down.

WARNING
Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
Electrical shock can result in death or serious injury.
Avoid contact with the leads and terminals.
Process leaks could result in death or serious injury
Do not attempt to loosen or remove flange bolts while the transmitter is in service.
Replacement equipment or spare parts not approved by Smar could reduce the pressure retaining capabilities of the transmitter and may render the instrument dangerous.
Use only bolts supplied or sold by Smar as spare parts.

Some examples of installation, illustrating the position of the transmitter in relation to the taps, are shown in Figure 1.3.

The location of pressure taps and the relative position of the transmitter are indicated in Table 1.1.

Process Fluid	Location of Taps	Location of LD291 in Relation to the Taps
Gas	Top or Side	Above the Taps.
Liquid	Side	Below the Taps or at the Piping Centerline.
Steam	Side	Below the Taps using Sealing (Condensate) Pots.

Table 1.1 - Location of Pressure Taps

NOTE
Except for dry gases, all impulse lines should slope at the ratio 1:10, in order to avoid trapping bubbles in the case of liquids, or condensate for steam or wet gases.

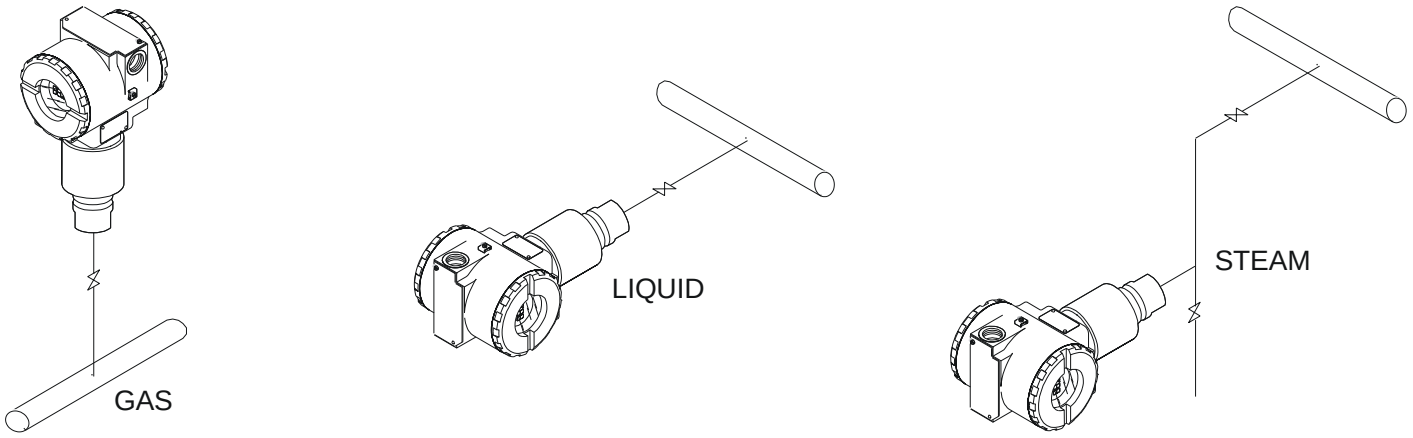
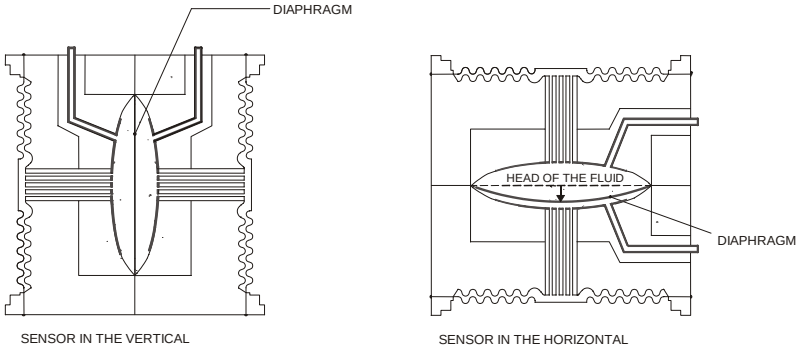


Figure 1.3 – Position of the Transmitter and Taps

NOTE

The transmitters are calibrated in the vertical position and a different mounting position displaces the zero point. Consequently, the indicator will indicate a different value from the applied pressure. In these conditions, it is recommended to do the zero pressure trim. The zero trim is to compensate the final assembly position and its performance, when the transmitter is in its final position. When the zero trim is executed, make sure the equalization valve is open and the wet leg levels are correct.

For the absolute pressure transmitter, the assembly effects correction should be done using the Lower trim, due to the fact that the absolute zero is the reference for these transmitters, so there is no need for a zero value for the Lower trim.



Electronic Housing

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 by hand until you feel the O-rings being compressed. 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.

WARNING

The unused cable entries should be plugged and sealed accordingly to avoid humidity entering, which can cause the loss of the product's warranty.

The electronic housing can be rotated to adjust the digital display on a better position. To rotate it, loose the Housing Rotation Set Screw, see Figure 1.4 (a). To prevent humidity entering, the electric housing and the sensor joint must have a minimum of 6 fully engaged threads. The provided joint allows 1 extra turn to adjust the position of the display window by rotating the housing clockwise. If the thread reaches the end before the desired position, then rotate the housing counterclockwise, but not more than one thread turn. Transmitters have a stopper that restricts housing rotation to one turn. See Section 4, Figure 4.1.

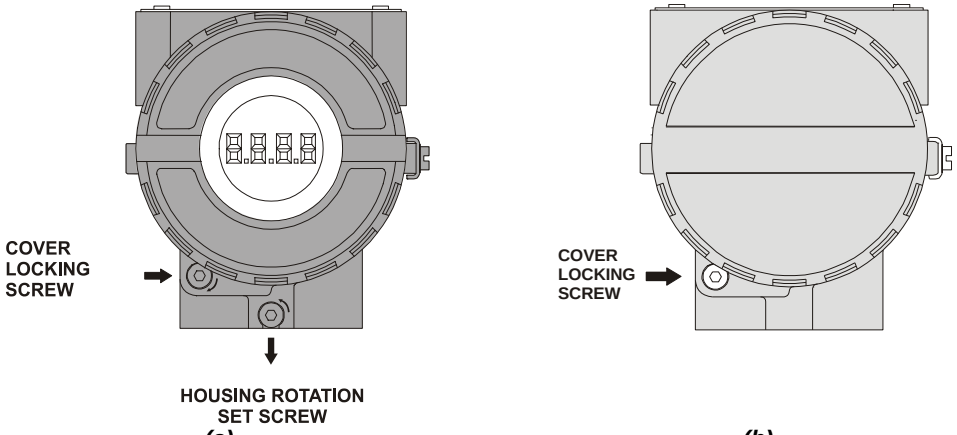


Figure 1.4 - Cover Locking and Housing Rotating Set Screw (a) Electronic Board Side (b) Terminal Connection Side

Wiring

To release the cover that gives access to the wiring block, turn the cover locking screw clock wise, see the direction of the arrow in the figure 1.4.

Test and **Communication terminals** allow, respectively, to measure the current in the 4 - 20 mA loop, without opening it, and to communicate with the transmitter. To measure it, connect a multimeter in the mA scale in the "**-**" and "**+**" terminals, and to communicate, use a **HART** configurator in the "**COMM**" and "**-**" terminals. The wiring block has screws on which fork or ring-type terminals can be fastened. See Figure 1.6.

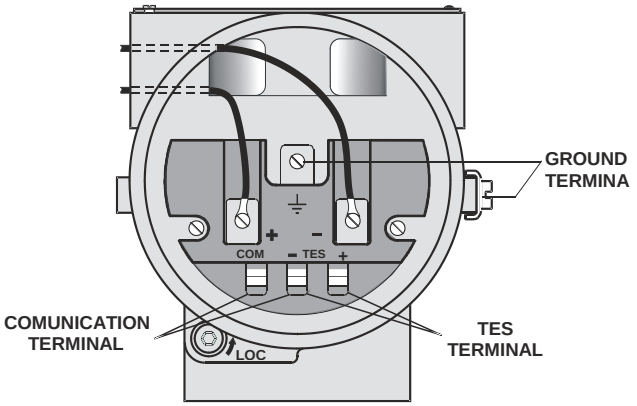


Figure 1.5– Wiring Block

The **LD291** is protected against reverse polarity

For convenience there are two ground terminals: one inside the cover and one 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.

The Figure 1.6 shows the correct installation of the conduit, to avoid penetration of water, or other substance, which may cause malfunctioning of the equipment.

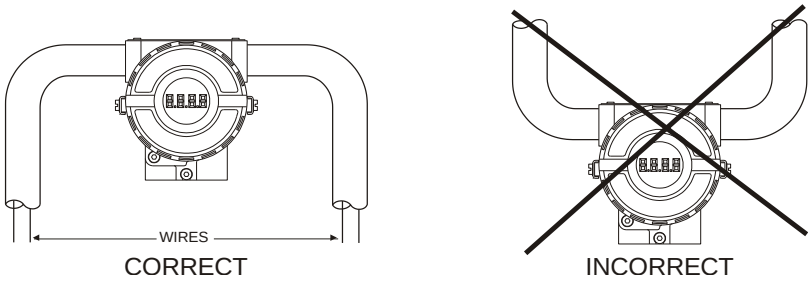


Figure 1.6 - Conduit Installation

Loop Conections

Connection of the **LD291** should be done as in Figure 1.7. Connection in multi-drop configuration should be done as in Figure 1.8. Note that a maximum of 15 transmitters can be connected on the same line and that they should be connected in parallel.

Take care to the power supply as well, when many transmitters are connected on the same line. The current through the 250 Ohm resistor will be high causing a high voltage drop. Therefore make sure that the power supply voltage is sufficient.

The configuration can be connected to the communication terminals of the transmitter or at any point of the signal line by using the alligator clips. It is also recommended to ground the shield of shielded cables at only one end. The ungrounded end must be carefully isolated.

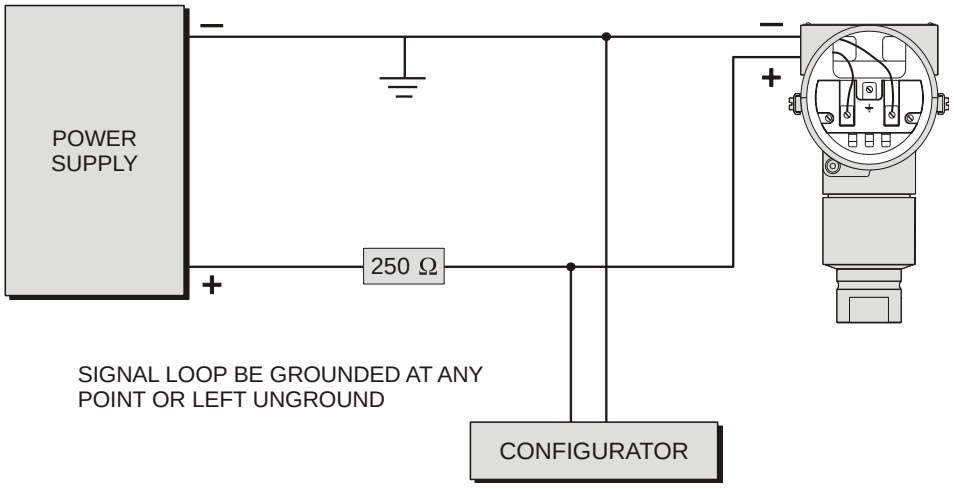


Figure 1.7 – Wiring Diagram for the LD291

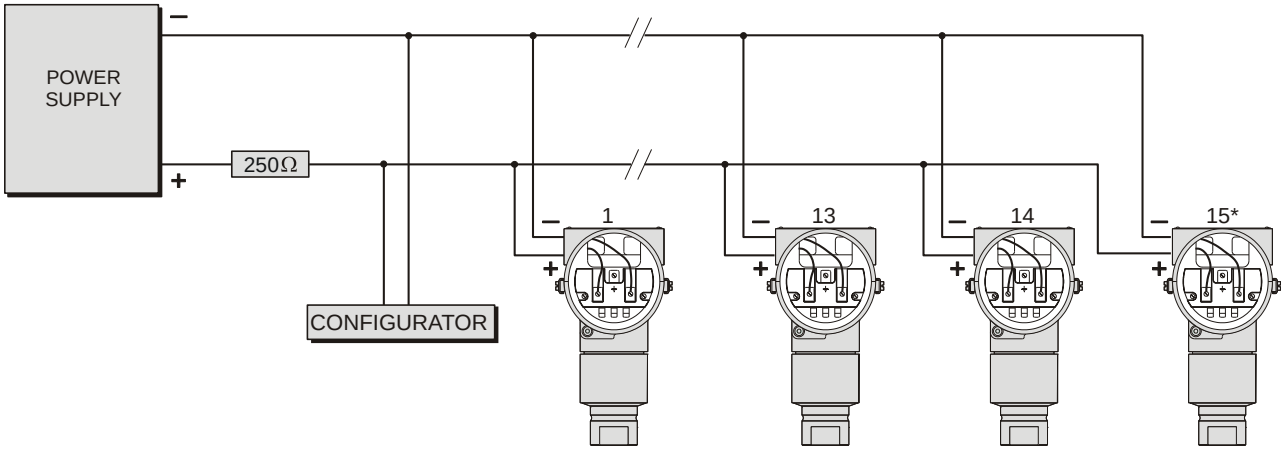


Figure 1.8 – Wiring Diagram for the LD291 in Multidrop Configuration

NOTE
Make sure that the transmitter is operating within the operating area as shown on the load curve (Figure 1.9). Communication requires a minimum load of 250 Ohm.

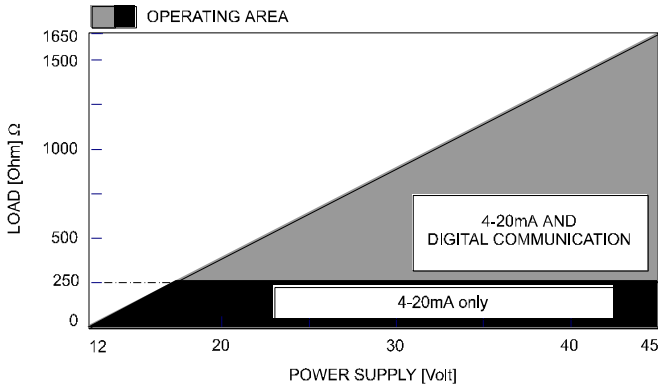


Figure 1.9 – Load Curve

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 I n accordance with the classified area where the equipment will be installed.

The instrument modification or parts replacement supplied by other than authorized representative of Smar 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 1.4).

The cover must be tightened with at least 8 turns to avoid the penetration of humidity or corrosive gases. The cover must be tightened until it touches the housing. Then, tighten more 1/3 turn (120°) to guarantee the sealing. Lock the covers using the locking screw (Figure 1.4).

Consult the Appendix A for further information about certification.

Explosion/Flame Proof

WARNING

Only use Explosion Proof/Flameproof certified Plugs, Adapters and Cable glands.

In Explosion-Proof installations the cable entries must be connected or closed using metal cable gland and metal blanking plug, both with at least IP66 and Ex-d certification.

The standard plugs provided by Smar are certified according to CEPEL certificate. If the plug needs to be replaced, a certified plug must be used.

The electrical connection with NPT thread must use waterproofing sealant. A non-hardening silicone sealant is recommended.

For NEMKO ATEX certificate please to follow the installation guidelines in hazardous locations below: Group II Category 2G, Ex d, Group IIC, Temperature Class T6, EPL Gb U = 28VDC
Ambient Temperature: -20 to 60ºC for T6
Environmental Protection: IP66/687 or IP66W/687W
The electrical connection available are ½ - 14NPT and M20x1,5.

Cable entries must be connected or closed using metal cable gland and metal blanking plug, both with at least IP66 and Ex-d certification or any appropriate ATEX approved metal cable gland and metal blanking plug. 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 C_i and L_i 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

Functional Description - Sensor

The **LD291** Series Intelligent Pressure Transmitters uses capacitive sensors (capacitive cells) as pressure sensing elements, as shown in Figure 2.1.

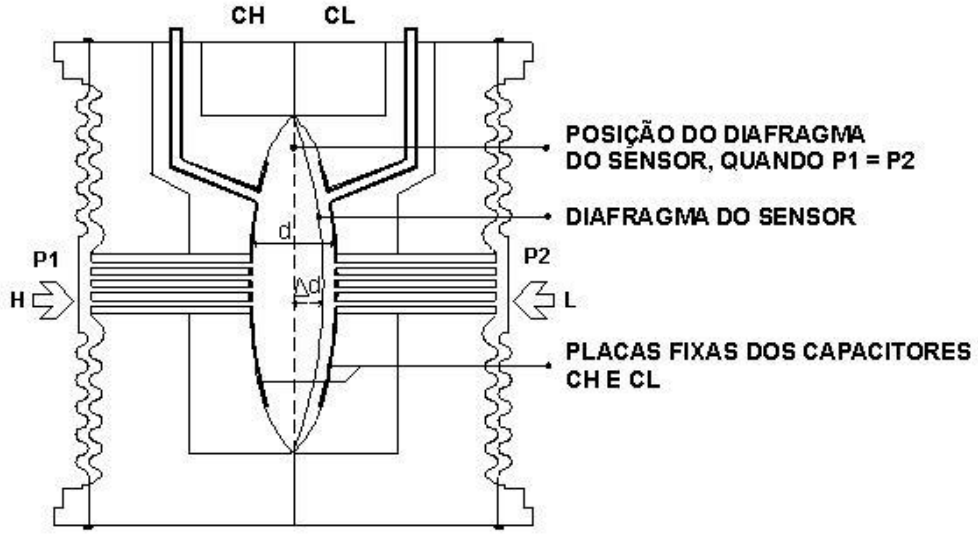


Figure 2.1 – Capacitive Cell

Where,

P_1 and **P_2** are the pressures in chambers **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 is a function expressed by plate area (A) and distance (d) between the plates as:

$$C \approx \frac{\varepsilon \times A}{d}$$

Where,

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

CH and *CL* are capacitances from flat parallel plates with identical areas, then:

$$CH \approx \frac{\varepsilon \times A}{(d/2) + \Delta d} \text{ and } \frac{\varepsilon \times A}{(d/2) - \Delta d} \approx CL$$

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

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

$$\Delta P = \frac{CL - CH}{CL + CH} = \frac{2\Delta d}{d}$$

Because the distance (d) between the fixed plates CH and CL is constant, it 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 applied differential pressure.

Functional Description - Hardware

Refer to the block diagram Figure 2.2. The function of each block is described below.

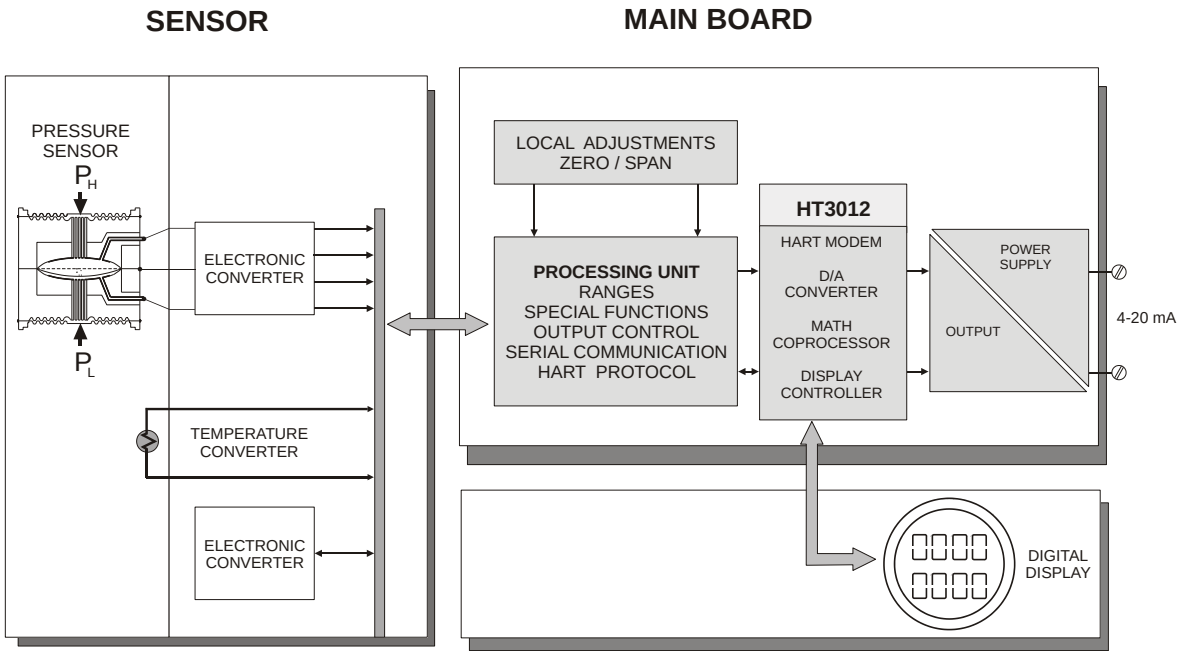


Figure 2.2 – LD291 Block Diagram Hardware

Oscillator
This oscillator generates a frequency as a function of sensor capacitance.

Signal Isolator
The Control signals from the CPU are transferred through optical couplers, and the signal from the oscillator is transferred through a transformer.

(CPU) Central Processing Unit and PROM
The CPU is the intelligent portion of the transmitter, being responsible for the management and operation of all other blocks, linearization and communication.
The program is stored in an external PROM. For temporary storage of data, the CPU has an internal RAM. The data in the RAM is lost, if the power is switched off, however the CPU also has an internal nonvolatile EEPROM where data that must be retained is stored. Examples of such data are: calibration, configuration and identification data.

EEPROM
Another EEPROM is located within the sensor assembly. It contains data pertaining to the sensor's characteristics at different pressures and temperatures. This characterization is done for each sensor at the factory.

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

Output
Control the current in the line feeding the transmitters.
It acts as a variable resistive load whose value depends on the voltage from the D/A converter.

Modem
This system provider the data exchange between the serve-master digital communications. The transmitter demodulates serial information transmitted by the configurator from the current line, and after treating it, modulates the response sending it over the line. A "1" is represented by 1200 Hz and "0" by 2200 Hz. The frequency signal is symmetrical and does not affect the DC-level of the 4-20 mA signal.

Power Supply
Power shall be supplied to the transmitter circuit using the signal line (2-wire system). The transmitter quiescent consumption is 3.6 mA; during operation, consumption may be as high as 21 mA, depending on the measurement and sensor status.

The **LD291** shows failure indication at 3.6 mA, if configured for low signal failure. At 21 mA, it will show the indication when configured for high signal failure. In case of low saturation, it will indicate failure at 3.6 mA and for high saturation, 21 mA, and measurements, proportional to the applied pressure in the range between 3.8 mA and 20.5 mA. 4 mA corresponds to 0% of the working range and 20 mA to100 % of the working range.

Power Supply Isolation
The sensor power supply is isolated from the main circuit by this module.

Display Controller
It receives the data from the CPU and actives the LCD segments. Also it actives the back plane and the control signals for each segment.

Local Adjustment
Two switches magnetically activated. The magnetic tool without mechanical or electrical contact can activate them.

Functional Description - Software

Refer to the Figure 2.3. The function of each Block is described below.

Factory Characterization
Calculate the actual pressure from the capacitances and temperature readings obtained from the sensor using the factory characterization data stored in the sensor EEPROM.

Digital Filter
The digital filter is a low pass filter with an adjustable time constant. 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
The characterization TRIM points (P1 to P5) can be used to complement the transmitter's original characterization.

Pressure Trim
Here the values obtained by Zero Pressure TRIM and Upper Pressure TRIM corrects the transmitter for long term drift or the shift in zero or upper pressure reading due to installation or over pressure.

Ranging
It used to set the pressure values corresponding to the output 4 and 20 mA. The LOWER-VALUE is the point corresponding to 4 mA, and UPPER-VALUE is the point corresponding to 20 mA.

Function
Depending on the application, the transmitter output or controller PV may have the following characteristics according to the applied pressure: Linear (for pressure, and level measurement).
The function is selected with FUNCTION.

Customer Linearization
This block relates the output (4-20 mA) to the input (applied pressure) according to a look-up table from 2 to 16 points.

The output is calculated by the interpolation of these points. The points are given in the function "TABLE POINTS" in percent of the range (Xi) and in percent of the output (Yi). It may be used to linearize, e.g., a level measurement to volume or mass. In flow measurement it can be used to correct for varying Reynolds number.

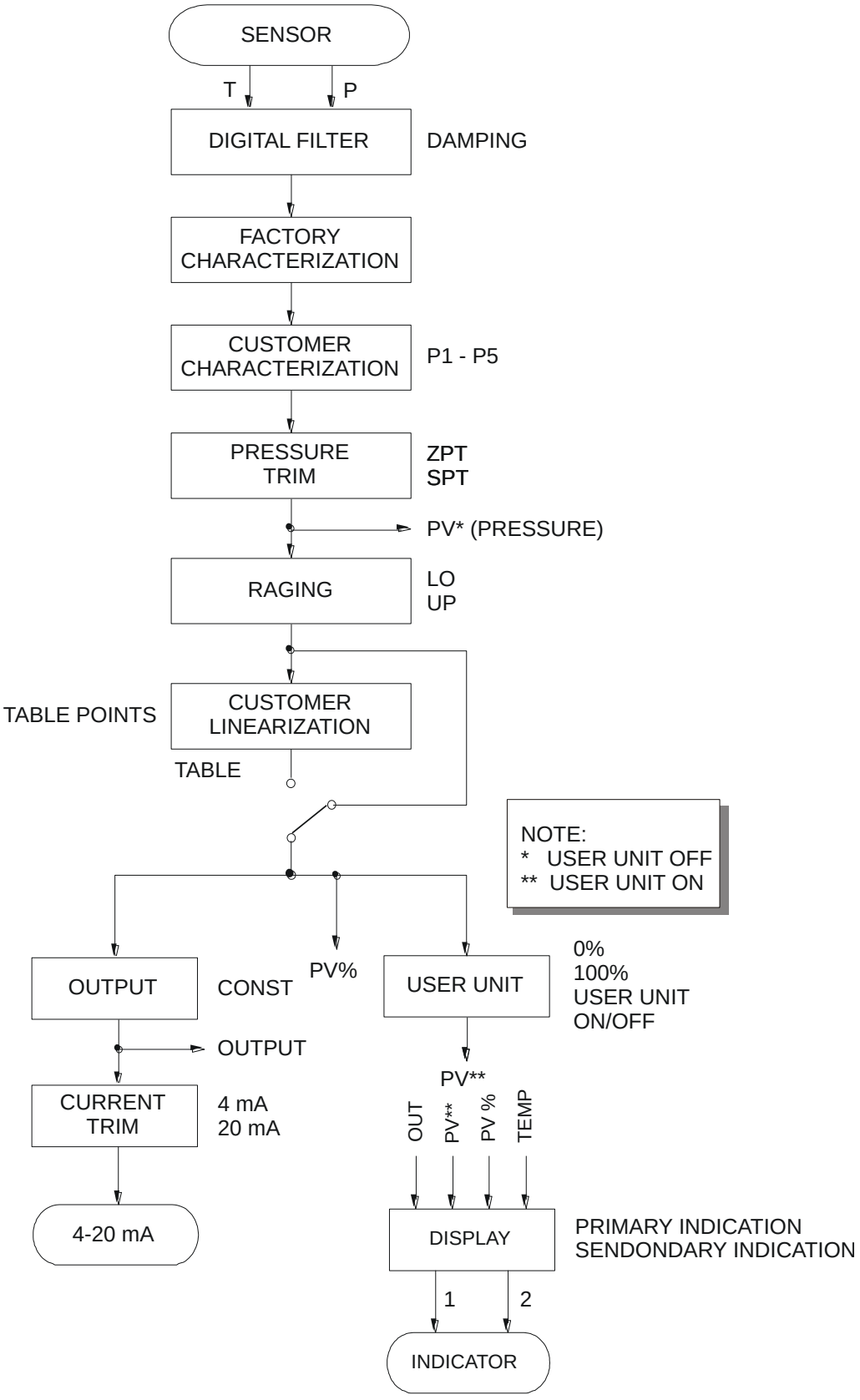


Figure 2.3 – LD291 – Software Block Diagram

Output
Calculates the current proportional to the process variable or manipulated variable to be transmitted on the 4-20 mA output depending on the configuration in OP-MODE. This block also contains the constant current function configured in OUTPUT. The output is physically limited to 3.6 to 21 mA.

Current Trim
The 4 mA TRIM and 20 mA TRIM adjustment is used to make the transmitter current comply with a current standard, should a deviation arise.

User Unit
Converts 0 and 100% of the process variable to a desired engineering unit read out available for the display and communication. It is used, e.g., to get a volume or from a level measurement, respectively. A unit for the variable can also be selected.

Display
Can alternate between two indications as configured in DISPLAY.

The Display

The integral indicator is able to display one or two variables, which are user selectable. When two variables are chosen, the display will alternate between the two with an interval of 3 seconds.

The liquid crystal display includes a field with 4 1/2 numeric digits, a field with 5 alphanumeric digits and an information field, as shown on Figure 2.4.

DISPLAY V6.00
The display controller, from release V6.00 on, is integral to the main board. Please observe the new spare parts codes.

Monitoring
During normal operation, the **LD291** is in the monitoring mode. In this mode, indication alternates between the primary and secondary variable as configured by the user. See Figure. 2.5. The display indicates engineering units, values and parameters simultaneously with most status indicators.

The monitoring mode is interrupted when the user does complete local adjustment.

The display is also capable of displaying an error and other messages (See table 2.1).

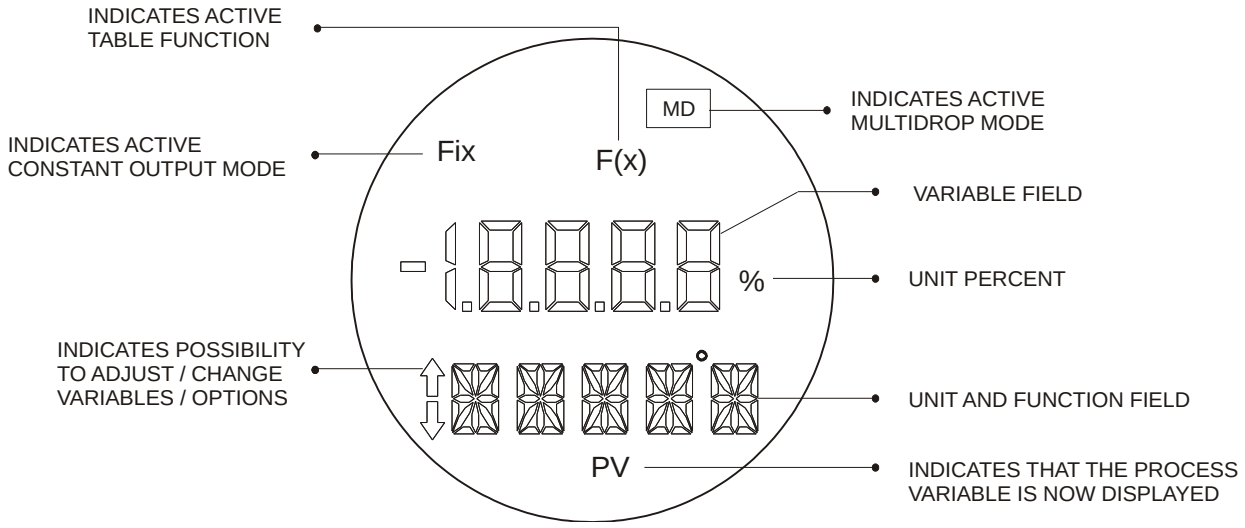


Figure 2.4 - Display

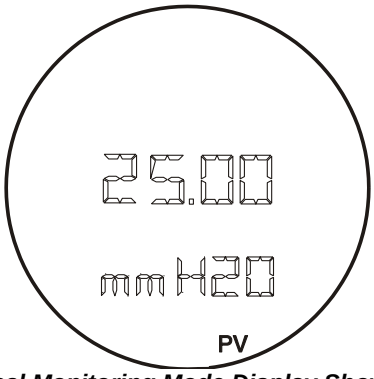


Figure 2.5 – Typical Monitoring Mode Display Showing PV, in this case 25.00 mmH_20

DISPLAY	DESCRIPTION
INIT	The **LD291** is in initializing after power on.
CHAR	The **LD291** is characterization mode. See Section 3 – Trim.
FAIL SENS	Sensor failure. Refer to Section 5 - Maintenance.
SAT	Current output saturated in 3.8 or 20.5 mA. See Section 5 – Maintenance.

Table 2.1 - Display Messages

CONFIGURATION

The **LD291** Intelligent Pressure 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 **LD291 the** "0" address causes the **LD291** to control its output current and addresses "1" through "15" place the **LD291** in the multidrop mode with current control.

NOTE

In the 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 = 1 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 **LD291** Intelligent Pressure 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 - **LD291** Intelligent Pressure Transmitter.

Smar developed the **CONF401** and **HPC301** software, the first one works in Windows platform (**95, 98, 2000, XP and NT**) and **UNIX**. The second one, **HPC301**, works in the most recent technology in PDA´s. They bring easy configuration and monitoring of field devices, capacity to analyze data and to modify the action of these devices. **The operation characteristics and use of each one of the configurators are stated on their respective manuals.**

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

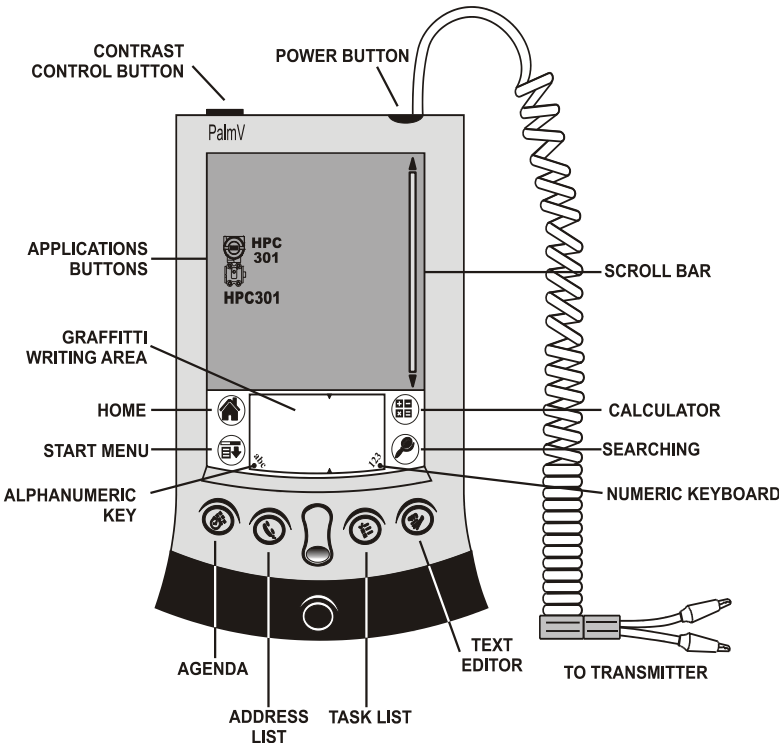


Figure 3.1 – Smar's Configurator

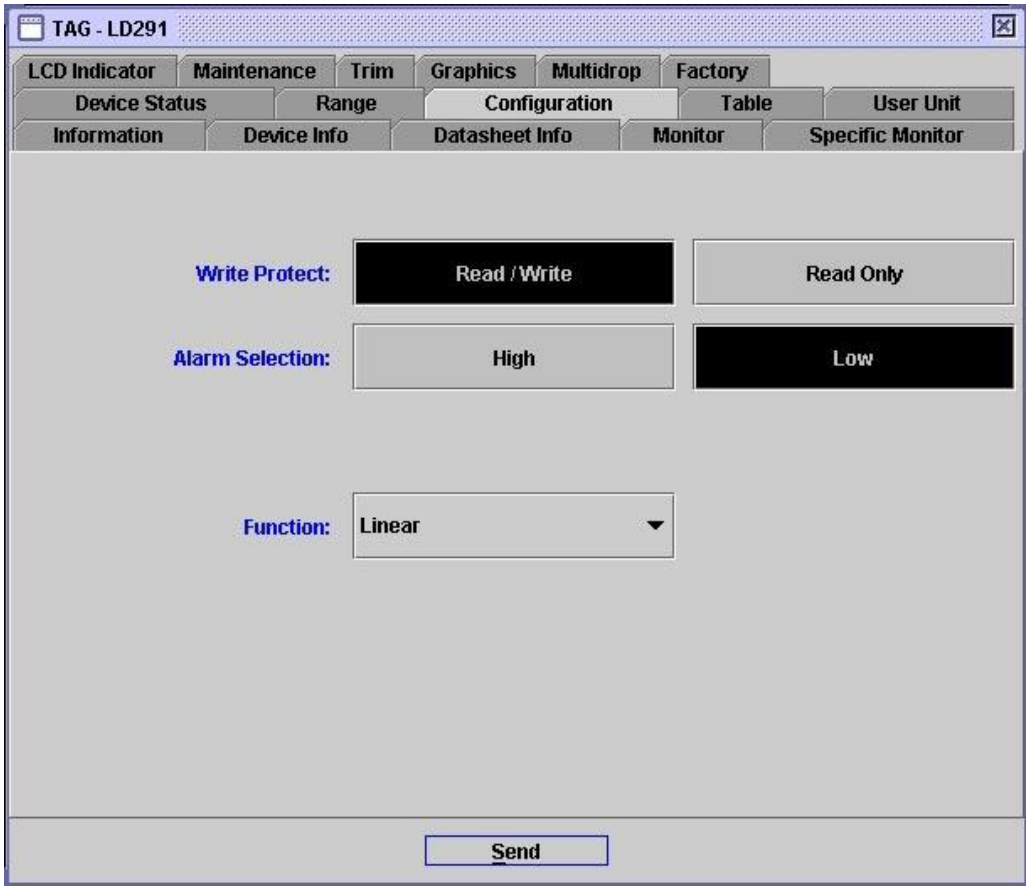


Figure 3.2 – Screen of the Configurator

Configuration Features

By means of the HART® Configurator, the **LD291** firmware allows the following configuration features to be accessed:

- ✓ Transmitter Identification and Manufacturing Data;
- ✓ Primary Variable Trim – Pressure;
- ✓ 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 Pressure 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 **LD291** 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 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;

INTEGRAL METER – Installed, Inert, Special, Unknown and None;

SENSOR FLUID* - Silicone, Inert, Special, Unknown and None;

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 are read directly from the sensor memory.

Primary Variable Trim - Pressure

Pressure, defined as a Primary Variable, is determined from the sensor readout by means of a conversion method. This 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 pressure.

Sometimes, the pressure 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 by long-term drift.

NOTE
Some users prefer to use this feature for zero elevation or suppression when the measurement refers to a certain point of the tank or tap (wet tap). Such practice, however, is not recommended when frequent laboratory calibrations are required, because the equipment adjustment refers to a relative measurement, and not to an absolute one, as per a specific pressure standard.

The Pressure Trim, as described on this document, 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.

There are four types of pressure trim available:

- ✓ **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.

NOTE
Check on section 1, the note on the influence of the mounting position on the indicator. For better accuracy, the trim adjustment should be made in the lower and upper values of the operation range values.

- ✓ **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.

ATTENTION
The upper pressure trim shall always be done after the zero trim.

- ✓ **ZERO TRIM:** is similar to the LOWER TRIM, but is assumed that the applied pressure is zero. The reading equal to zero must be active when the pressures of differential transmitter cameras are equalized or when a manometric transmitter opened to atmosphere or when the absolute transmitter is applied to the vacuum. Therefore, the user does not need to enter with any value.
- ✓ **CHARACTERIZATION:** this is used to correct an eventual non-linearity intrinsic to the conversion process. Characterization is done by means of a linearization table, with up to five points. The user shall apply pressure and use the HART® configurators to inform the pressure value applied to each point of the table. In most cases, characterization is not required, due to the efficiency of the fabrication procedure. The transmitter will display "CHAR", thus indicating that the characterization process is activated. The **LD291** has a parameter to enable or disable the use of the Characterization Table.

WARNING
The characterization trim changes the transmitter characteristics. Read the instructions carefully and certify that you are working with a pressure standard with accuracy 0.03% or better, otherwise the transmitter accuracy will be seriously affected.

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 Smar current standards and your plant current Standard. In this case, the Current Trim adjustment shall be used, 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 moment 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 tenth of microamperes.

Transmitter Adjustment to the Working Range

This function directly affects the transmitter's 4-20 mA output. It is used to define the transmitter's working range; in this document it is referred to as the transmitter's calibration. The **LD291** transmitter includes two calibration features:

- ✓ **CALIBRATION WITH REFERENCE:** this is used to adjust the transmitter's working range, using a pressure standard as a reference.
- ✓ **CALIBRATION WITHOUT REFERENCE:** this is used to adjust the transmitter's working range, simply by having limit values informed by the user.

Both calibration methods define the Working Range Upper and Lower values, in reference to some applied pressure or simply informed by entered values. **CALIBRATION WITH REFERENCE** differs from the Pressure Trim, since **CALIBRATION WITH REFERENCE** establishes a relationship between the applied pressure and the 4 to 20 mA signal, and the Pressure Trim is used to correct the measurement value.

In the transmitter mode, the Lower Value always corresponds to 4 mA and the Upper Value to 20 mA. In the controller mode, the Lower Value corresponds to PV = 0 % and the Upper Value to PV = 100 %.

The calibration process calculates the **LOWER** and the **UPPER** values in a completely independent way. The adjustment of value does not affect the other. The following rules shall, however, be observed:

- ✓ The Lower and Upper values shall be within the range limited by the Minimum and maximum Ranges supported by the transmitter. As a tolerance, values exceeding such limits by up to 24 % are accepted, although with some accuracy degradation.
- ✓ The Working Range Span, determined by modulus of the difference between the Upper and Lower Values, shall be greater than the minimum span, defined by [Transmitter Range / 120]. Values up to 0.75 of the minimum span are acceptable with slight accuracy degradation.

NOTE
If the transmitter is operating with a very small span, it will be extremely sensitive to pressure variations. Keep in mind that the gain will be very high and any pressure change, no matter how small, will be amplified.

If it is necessary to perform a reverse calibration, that is, to work with an UPPER VALUE smaller than the LOWER VALUE, proceed as follows:

- ✓ Place the Lower Limit in a value as far from the present Upper Value and from the new adjusted Upper value as possible, observing the minimum span allowed. Adjust the Upper Value at the desired point and, then, adjust the Lower Value.

This type of calibration is intended to prevent the calibration from reaching, at any moment, values not compatible with the range. For example: lower value equals to upper value or separated by a value smaller than the minimum span.

This calibration procedure is also recommended for zero suppression or elevation in those cases where the instrument installation results in a residual measurement in relation to a certain reference. This is the specific case of the wetted tap.

NOTE
In most applications with wetted taps, indication is usually expressed as a percentage. Should readout in engineering units with zero suppression be required, it is recommended to use the User Unit feature for such conversion.

Engineering Unit Selection

Transmitter **LD291** includes a selection of engineering units to be used in measurement indication.

For pressure measurements, the **LD291** includes an option list with the most common units. The internal reference unit is inH_2O @ 20 ^oC; should the desired unit be other than this one, it will be automatically converted using conversion factors included in Table 3.1.

As the **LD291** uses a 4 ½ digit display, the largest indication will be 19999. Therefore, when selecting a unit, make sure that it will not require readouts greater than this limit. For User reference, Table 3.1 presents a list of recommended sensor ranges for each available unit.

CONVERSION FACTOR	NEW UNITS	RECOMMEND RANGE
1.00000	Inches H_2O at 20 ^oC	1, 2,3 & 4
0.0734241	Inches Hg at 0 ^oC	all
0.0833333	Feet H_2O at 20 ^oC	all
25.4000	Millimeters H_2O at 20 ^oC	1 & 2
1.86497	Millimeters Hg at 0 ^oC	1, 2, 3 & 4
0.0360625	Pound/square inch - psi	2, 3, 4, 5 & 6
0.00248642	Bar	3, 4, 5 & 6
2.48642	Millibar	1, 2, 3 & 4
2.53545	Gram/square centimeter	1, 2, 3 & 4
0.00253545	kilogram/square centimeter	3, 4, 5 & 6
248.642	Pascal	1
0.248642	KiloPascal	1, 2, 3 & 4
1.86497	Torr at 0 ^oC	1, 2, 3 & 4
0.00245391	Atmosphere	3, 4, 5 & 6
0.000248642	MegaPascal	4, 5 & 6
0.998205	Inches of water at 4 ^oC	1, 2, 3 & 4
25.3545	Millimeters of water at 4 ^oC	1 & 2

Table 3.1 - Available Pressure Units

In applications where the **LD291** will be used to measure variables other than pressure or in the cases where a relative adjustment has been selected, the new unit may be displayed by means of the User Unit feature. This is the case of measurements such as level, volume, and flow rate or mass flow obtained indirectly from pressure measurements.

The User Unit is calculated taking the working range limits as a reference, which is, defining a value corresponding to 0% and another corresponding to 100% of the measurement:

- ✓ **0%** - Desired readout when the pressure is equal to the Lower Value (PV% = 0%, or transmitter mode output equal to 4 mA).
- ✓ **100%** - Desired readout when the pressure is equal to the Upper Value (PV% = 100%, or transmitter mode output equal to 20 mA).

The user unit may be selected from a list of options included in the **LD291**. Table 3.2 makes it possible to associate the new measurement to the new unit so that all supervisory systems fitted with HART® protocol can access the special unit included in this table. The user will be responsible for the consistency of such information. The **LD291** cannot verify if the values corresponding to 0% and 100% included by the user are compatible with the selected unit.

VARIABLE	UNITS
Pressure	inH2O, InHg, ftH2O, mmH2O, mmHg, psi, bar ,mbar, g/cm^2, kg/cm^2 , Pa, kPa, Torr, atm, MPa, in H2O^4, mmH2O^4
Volumetric Flow	ft^3/min, gal/min, l/min, Gal/min, m^3/h, gal/s, l/s, Ml/d, ft^3/s, ft^3/d, m^3/s, m^3/d, Gal/h, Gal/d, ft^3/h, m^3/min, bbl/s, bbl/min, bbl/h, bbl/d, gal/h, Gal/s, l/h, gal/d
Velocity	ft/s, m/s, m/h
Volume	gal, liter, Gal, m^3, bbl, bush, Yd^3, ft^3, In^3, hl
Level	ft, m, in, cm, mm
Mass	gram, kg, Ton, lb, Sh ton, Lton
Mass Flow	g/s, g/min, g/h, kg/s, kg/min, kg/h, kg/d, Ton/min, Ton/h, Ton/d, lb/s, lb/min, lb/h, lb/d
Density	SGU, g/m^3, kg/m^3, g/ml, kg/l, g/l, Twad, Brix, Baum H, Baum L, API, % Solw, % Solv, Ball
Others	cSo, cPo, mA, %
special	5 characters

Table 3.2 – Available User Units

Should a special unit other than those presented on Table 3.2 be required, the **LD291** allows the user to create a new unit by entering up to 5 alphanumeric digits.

The **LD291** includes an internal feature to enable and disable the User Unit.

Example: transmitter **LD291** is connected to a horizontal cylindrical tank (6 meters long and 2 meters in diameter), linearized for volume measurement using camber table data in its linearization table. Measurement is done at the high-pressure tap and the transmitter is located 250 mm below the support base. The fluid to be measured is water at 20 °C. Tank volume is: $[(\pi.d^2)/4].l = [(\pi.2^2)/4]\pi.6 = 18{,}85\ m^3$.

The wet tap shall be subtracted from the measured pressure in order to obtain the tank level. Therefore, a calibration without reference shall be carried out, as follows:

In Calibration:
Lower = 250 mmH_2O
Superior = 2250 mmH_2O
Pressure unit = mmH_2O

In User Unit:
User Unit 0% = 0
User Unit 100% = 18.85 m³
User Unit = m³
When activating the User's Unit, **LD291** it will start to indicate the new measurement.

Table Points

If the option TABLE is selected, the output will follow a curve given in the option TABLE POINTS. If you want to have your 4-20 mA proportional to the volume or mass of fluid inside a tank, you must transform the pressure measurement "X" into volume (or mass) "Y" using the tank strapping table, as shown in Table 3.3.

POINT	LEVEL (PRESSURE)	X	VOLUME	Y
1	-	-10%	-	-0.62%
2	250 mmH_2O	0%	0 m^3	0%
3	450 mmH_2O	10%	0.98 m^3	5.22%
4	750 mmH_2O	25%	2.90 m^3	15.38%
5	957.2 mmH_2O	35.36%	4.71 m^3	25%
6	1050 mmH_2O	40%	7.04 m^3	37.36%
7	1150 mmH_2O	45%	8.23 m^3	43.65%
8	1250 mmH_2O	50%	9.42 m^3	50%
…	…	…	…	…
15	2250 mmH_2O	100%	18.85 m^3	100%
16	-	110%	-	106%

Table 3.3 - Tank Strapping Table

As shown on the previous example, the points may be freely distributed for any desired value of X. In order to achieve a better linearization, the distribution should be concentrated in the less linear parts of the measurement.

The **LD291** includes an internal feature to enable and disable the Linearization Table.

Equipment Configuration

The **LD291** 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 128 seconds. The transmitter's mechanical damping is 0.2 seconds.
- ✓ **BURN OUT** - The output current may be programmed to go to the maximum limit of 21 mA (Full Scale) or to the minimum limit of 3.6 mA in case of transmitter failure. Configuring the BURNOUT parameter for Upper or Lower may do this.
- ✓ **ADDRESSING** - The **LD291** includes a variable parameter 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 **LD291** will display the message MDROP for addresses "1" to "15".

  The **LD291** is factory configured with address "0".

- ✓ **DISPLAY INDICATION** - the **LD291** 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 **LD291** 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 3.4, below.

CURRENT	CURRENT IN MILIAMPÈRES
CO	Analog Output Current in mA
PR	Pressre in pressure unit.
PV%	Process Variable in percentage.
PV	Process Variable in engineering units.
TE	Ambient temperature.
	NONE - No variable on display (only LCD_2)
ESC	Escape.

Table 3.4 - Variables for Display Indication

- ✓ **WRITING PROTECTION** - This feature is used to protect the transmitter configuration from changes via communication. All configuration data are writing protected.
  The **LD291** include two write protection mechanisms: software and hardware locking; software locking has higher priority.
  When the **LD291** writing software protection mechanism is enabled, it is possible, by means of specific commands, to enable or disable the write protection.
- ✓ **PASSWORDS** - this service enables the user to modify the operation passwords used in the **LD291**. Each password defines the access for a priority level (1 to 3); such configuration is stored in the **LD291** EEPROM.

  Password Level 3 is hierarchically upper to password level 2, which is upper 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 13 characters available in the **LD291** to define this code.

EXAMPLE:

1	2	3	4	5	6	7	8	9	10	11	12	13
L	D	2	9	1	M	2	1I	1	1	0	1	H1

LD291 Intelligent Pressure Transmitter (D); Range: 1.25 to 50 kPa **(2)**; Diaphragm of 316L SS, Silicone Oil Fill Fluid **(1)**, and Connection to the process with 316L SS **(1I)**; with Digital Indicator **(1)**; Electrical Connection 1/2 - 14 NPT **(0)**; with Local Adjustment **(1)**; with Carbon Steel Bracket and accessories **(1)**; housing in SS **(HI)**.

✓ **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 **LD291** 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.

✓ **OP_COUNT** - 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, const, table;

- ✓ **Trim_4mA:** when the current trim is done at 4 mA;
- ✓ **Trim_20mA:** when the current trim is done at 20 mA;
- ✓ **Trim_Zero/Lower:** when pressure trim is done at Zero or Lower Pressure;
- ✓ **Trim Upper Pressure:** when the trim is done at Upper Pressure;

Characterization: when any change is made in any point of the pressure characterization table in trim mode;

Multidrop: when any change is made in the communication mode, for example, multidrop or single transmitter;

Pswd/C-Level: when any change is made in the password or the level configuration.

✓ **BACKUP**
When the main board is replaced, after assembling and powering it, the data saved in the sensor memory are automatically copied to the main board memory.

✓ **RESTORE**
This option allows copying or restoring the data saved in the sensor memory to the main board memory.

PROGRAMMING USING LOCAL ADJUSTMENT

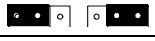
The Magnetic Tool

Smar's magnetic tool is the second man machine interface. It comprises the advantage of the powerful HHT and the convenience of the magnetic tool.

If the transmitter is fitted with a display, and configured for Complete Local Adjustment (using the internal jumper), the magnetic tool is almost as powerful as the HHT. It eliminates the need for an HHT in most basic applications.

If the transmitter is not fitted with a display, or is configured for Simple Local Adjustment (using the internal jumper) the adjustment capability is reduced to ranging.

To select the function mode of the magnetic switches configures the jumpers located at the top of the main circuit board as indicated in Table 4.1.

SI/COM OFF/ON	NOTE	WRITE PROTECT	SIMPLE LOCAL ADJUSTMENT	COMPLETE LOCAL ADJUSTMENT
		Disables	Disables	Disables
	**1**	**Enables**	Disables	Disables
	**2**	Disables	**Enables**	Disables
		Disables	Disables	**Enables**

Notes: **1** - If the hardware protection is selected, the EEPROM will be protected.
2 - The local adjustment default condition is simple enabled and write protect disabled.

Table 4.1 – Local adjustment Selection

The transmitter has, under the identification plate, holes for two magnetic switches activated by the magnetic tool (See Figure 4.1).

S - ACTION / SPAN
Z - MOVE AROUND / ZERO

Figure 4.1 – Local Zero and Span Adjustment and Local Adjustment Switches

The holes are marked with **Z** (Zero) and **S** (Span) and from now on will be designated simply by (**Z**) and (**S**), respectively. Table 4.2 shows the action performed by the magnetic tool while inserted in (**Z**) and (**S**) in accordance with the selected adjustment type.

Browsing the functions and their branches works as follows:

1. Inserting the handle of the magnetic tool in (**Z**), the transmitter passes from the normal measurement state to the transmitter configuration state. The transmitter software automatically starts to display the available functions in a cyclic routine.
2. In order to reach the desired option, browse the options, wait until they are displayed and move the magnetic tool from (**Z**) to (**S**). Refer to Figure 4.2 – Programming Tree Using Local Adjustment, in order to know the position of the desired option. By placing the magnetic tool once again in (**Z**), it is possible to browse for other options within this new branch.
3. The procedure to reach the desired option is similar to the one described on the previous item, for the whole hierarchical level of the programming tree.

Action	Simple Local Adjustment	Complete Local Adjustment
Z	Selects the Lower Range Value	Moves among all the options
S	Selects the Upper Range Value	Activates the selected Functions

Table 4.2 - Local Adjustment Description

NOTE
For **LD291** versions prior to a **V6.00**, the digital display shall be number **214-0108** as per spare parts list for **LD291 V6.XX.** For **LD291** versions **V6.XX**, the digital display shall be number **400-0559**, as per the updated spare parts list

Simple Local Adjustment

The **LD291** allows only the calibration of the values inferior and superior in this configuration.

Zero and Span Reranging

The **LD291** can be very easily calibrated. It requires only Zero and Span adjustment in accordance with the working range.

The jumpers shall be configured for simple local adjustment. In case the **LD291** display is not connected, the simple local adjustment is automatically activated.

Zero calibration with reference shall be done as follows:

- ✓ Apply the Lower Value pressure.
- ✓ Wait for the pressure to stabilize.
- ✓ Insert the magnetic tool in the ZERO adjustment hole. (See Figure 4.1)
- ✓ Wait about 2 seconds. The transmitter should be reading 4 mA.
- ✓ Remove the tool.

Zero calibration with reference does not affect the span. In order to change the span, the following procedure shall be observed:

- ✓ Apply the Upper Value pressure.
- ✓ Wait for the pressure to stabilize.
- ✓ Insert the magnetic tool in the SPAN adjustment hole.
- ✓ Wait 2 seconds. The transmitter should be reading 20 mA.
- ✓ Remove the tool.

Zero adjustment causes zero elevation / suppression and a new upper value (URV) is calculated in accordance with the effective span. In case the resulting URV is higher than the Upper Limit Value (URL), the URV will be limited to the URL value, and the span will be automatically affected.

Complete Local Adjustment

The transmitter must be fitted with the digital display for this function to be enabled. The following functions are available for local adjustment: Constant Current, Table Points Adjustment, User Units, and Fail-safe, Current Trim and Pressure, Address change and some items of function INFORMATION.

WARNING
When programming using local adjustment, the transmitter will not prompt, "**Control loop should be in manual**!" as it does when programming using the HART® configurator. Therefore it is a good idea, before configuration, to switch the loop to manual. And do not forget to return to auto after configuration is completed.

Local Programming Tree

The local adjustment uses a tree structure where, by placing the magnetic tool in **(Z)** it is possible to browse the options of a branch and by placing it in **(S)**; details of the chosen option are shown. Figure 4.2 shows the **LD291** available options.

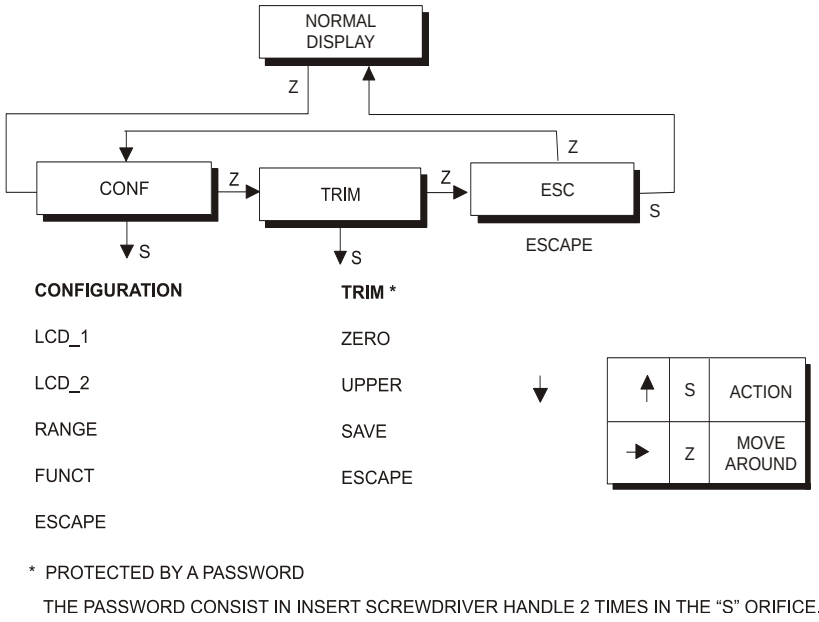


Figure 4.2 – Local Adjustment Programming Tree – Main Menu

CONFIGURATION (CONF) - Is the option where the output and display related parameters are configured: unit, primary and secondary display, calibration, and function.

TRIM (TRIM) – It is the option used to calibrate the "without reference" characterization and the digital reading.

ESCAPE (ESC) – It is the option used to go back to normal monitoring mode.
The local adjustment is actived by actuation in **(Z).**

Configuration [CONF]

Configuration functions affect directly the 4-20 mA output current and the display indication. The configuration options implemented in this branch are the following:

- ✓ Selection of the variable to be shown on Display 1 and / or Display 2;
- ✓ Working range calibration of work. Options With and Without Reference are available;
- ✓ Digital filter damping time configuration of the readout signal input.
- ✓ Selection of the transference function to be applied to the measured variable.

Figure 4.3 shows branch CONF with the available options.

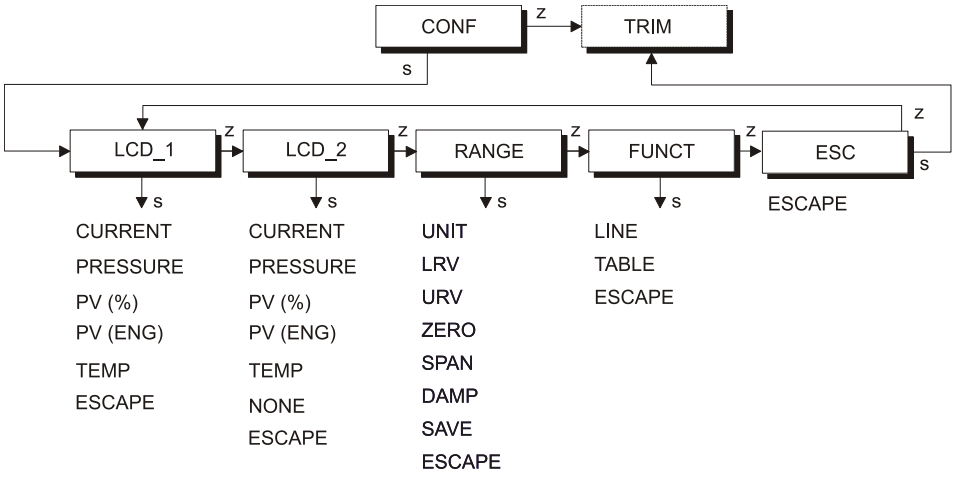
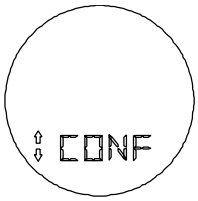


Figure 4.3 - Local Adjustment Configuration Tree

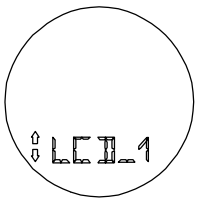
Configuration Branch (CONF)



Z: Moves to the TRIM branch.

S: Enters the CONFIGURATION branch, starting with function display (LCD_1).

Display 1 (LCD_1)

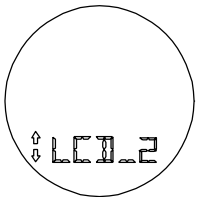


Z: Moves to the function Display 2 (LCD_2).

S: Starts selection of variable to be indicated as primary display.
After activating (**S**), you can move around the options available in the following table by activating (**Z**). See table 4.3.

The desired variable is activated using (**S**). Escape leaves primary variable unchanged.

Display 2 (LCD_2)



Z: Moves to the RANGE function.

S: Starts selection of variable to be indicated as secondary display.
The procedure for selection is the same as for LCD_1, previous.

CURRENT	CURRENT IN MILIAMPÈRES
CO	Analog Output Current in mA
PR	Pressre in pressure unit.
PV%	Process Variable in percentage.
PV	Process Variable in engineering units.
TE	Ambient temperature.
	NONE - No variable on display (only LCD_2)
ESC	Escape.

Table 4.3 - Display Indication

Range (RANGE)

Function Calibration (RANGE) presents the calibration options as a tree branch, as described on Figure 4.4.

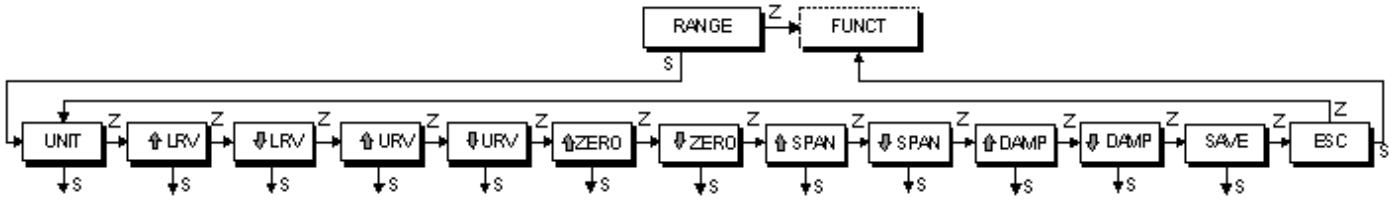
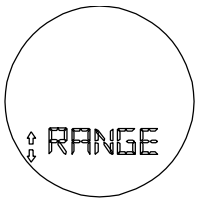


Figure 4.4 – Local Range Tree

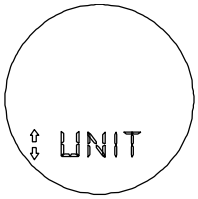
Range Branch (RANGE)



Unit (UNIT)

Z: Moves to the FUNCT function from range branch.

S: Enters the RANGE branch, starting with the function UNIT.



Z: Moves to the LRV function.

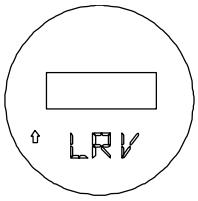
S: Starts selection of engineering unit for process variable. After activating (**S**), you can move around the options available in the table below by activating (**Z**). Using (S) activates the desired unit. Escape leaves the unit unchanged.

UNIT	
DISPLAY	**DESCRIPTION**
InH_2O	Inches water column at 20 ^oC
InHg	Inches mercury column at 0 ^oC
ftH_2O	Feet water column at 20 ^oC
mmH_2O	Millimeter water column at 20 ^oC
mmHg	Millimeter mercury column at 0 ^oC
psi	Pounds per square centimeter
Bar	Bar
Mbar	Millibar
g/cm^2	Grams per square centimeter
k/cm^2	Kilograms per square centimeter
Pa	Pascals
kPa	Kilo Pascals
Torr*	Torr at 0 ^oC
atm	Atmospheres
ESC	Escape

* The **Torr** unit has been changed to mH_2O@20 ºC for version 6.04 or greater.

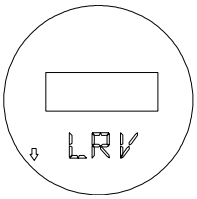
Table 4.4 – Units

Lower Range Value Adjustment without Reference (LRV)



Z: Moves to the LRV DECREASE function.

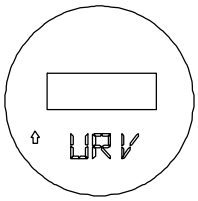
S: Increases the Lower Value until the magnetic tool is removed or the maximum limit for the Lower Value is reached.



Z: Moves to the URV ADJUSTMENT function.

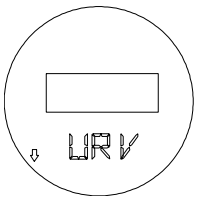
S: Decreases the Lower Value until the magnetic tool is removed or the minimum limit for the Lower Value is reached.

Upper Range Value Adjust without Reference (URV)



Z: Moves to the URV DECREASE function.

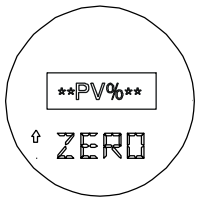
S: Increases the Upper Value until the magnetic tool is removed or the maximum limit for the Upper Value is reached.



Z: Moves to the ZERO ADJUSTMENT function.

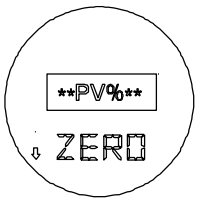
S: Decreases the Upper Value until the magnetic tool is removed or the minimum limit for the Upper Value is reached.

Zero Adjust with Reference (ZERO)



Z: Moves to the ZERO DECREASE function.

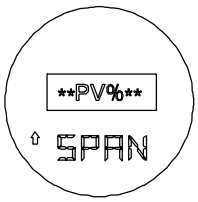
S: Increases output in transmitter mode, decreases the Lower Pressure Value until the magnetic tool is removed or the maximum limit for the Lower Value is reached. The span is maintained.



Z: Moves to the SPAN ADJUSTMENT function.

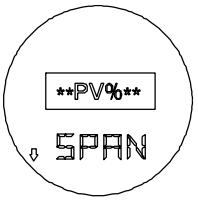
S: Decreases Output in transmitter mode, increases the Lower Pressure Value until the magnetic tool is removed or the minimum limit for the Lower Value is reached. The span is maintained.

Span Adjust with Reference (SPAN)



Z: Moves to the SPAN DECREASE function.

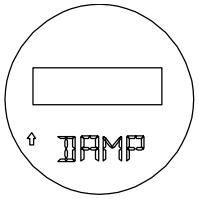
S: Increases the Output in transmitter mode, decreases the Upper Pressure Value until the magnetic tool is removed or the maximum limit for the Upper Value is reached.



Z: Moves to the DAMPING function.

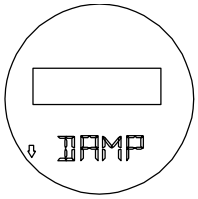
S: Decreases the Output in transmitter mode, increases the Upper Pressure Value until the magnetic tool is removed or the minimum limit for the Upper Value is reached.

Damping (DAMP)



Z: Moves to the DAMPING DECREASE function.

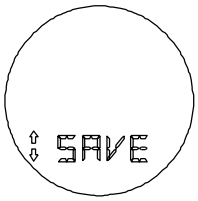
S: Increases the damping time constant until the magnetic tool is removed or 128 seconds are reached.



Z: Moves to the SAVE function.

S: Decreases the damping time constant until the magnetic tool is removed or 0 second is reached.

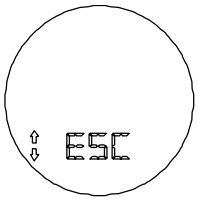
Save (SAVE)



Z: Moves to the ESCAPE of RANGE menu.

S: Saves the LRV, URV, ZERO, SPAN and DAMP values in the transmitter EEPROM.

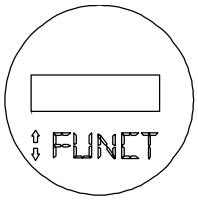
Escape (ESC)



Z: Moves to the UNIT function.

S: Moves to the FUNCT menu, of the MAIN menu.

Function (FUNCT)



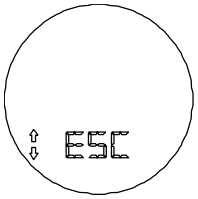
Z: Moves to the ESCAPE function.

S: Starts selection of input function. After activating (**S**) you can move around the available options in the table below by activating (**Z**).

FUNCTIONS	
DISPLAY	**DESCRIPTION**
LINE	Linear to Pressure.
TABLE	16 Point Table.
ESC	ESC to Escape from the superior Branch.

Table 4.5 – Functions

The desired function is activated using (**S**). Escape leaves function unchanged.



Z: Recycles for menu LCD – 1.

S: Moves to the CONF function of the main menu.

Pressure Trim [TRIM]

This field of the tree is used to adjust the digital reading according to the applied pressure. The pressure TRIM differs from RANGING WITH REFERENCE, since the TRIM is used to correct the measure and RANGING WITH REFERENCE reach only the applied pressure with the output signal of 4 to 20 mA.

Figure 4.5 shows the options available to run the pressure TRIM.

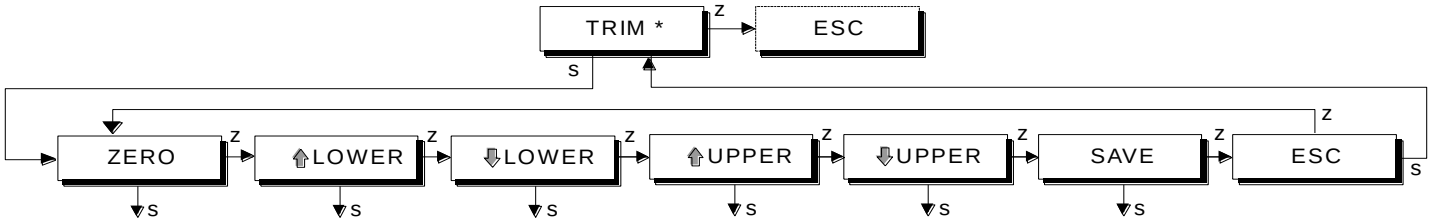
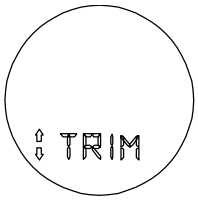


Figure 4.5 – Pressure Trim Tree

Trim Branch (TRIM)

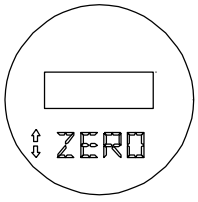


Z: Moves to ESC function.

S: These functions are protected by a "password." When prompted PSWD activates (**S**) 2 times to proceed. After entering the password, the TRIM branch starting with the Zero Trim function is accessed.

NOTE
Check on section 1, the note on the influence of the mounting position on the indicator. For better accuracy, the trim adjustment should be made in the lower and upper values of the operation range values.

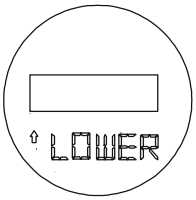
Zero Pressure Trim (ZERO)



Z: Moves to the LOWER pressure TRIM function.

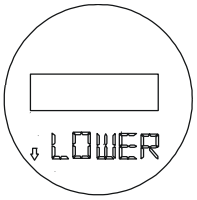
S: Trims the transmitters' internal reference to read 0 at the applied pressure.

Lower Pressure Trim (LOWER)



Z: Moves to option DECREASES THE LOWER PRESSURE VALUE.

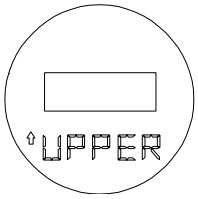
S: Adjusts the transmitter's internal reference, increasing the displayed value that will be interpreted as the Lower Pressure value corresponding to the applied pressure.



Z: Moves on to function SAVE if the Lower Pressure Trim (LOWER) is running or to the Upper Pressure Trim (UPPER).

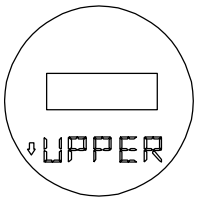
S: Adjusts the transmitter's internal reference, decreasing the displayed value that will be interpreted as the Lower Pressure value corresponding to the applied pressure.

Upper Pressure Trim (UPPER)



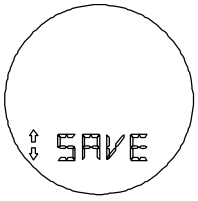
Z: Moves to the decrease Upper Pressure reading.

S: Sets the transmitters' internal reference increasing to the value on the display, which is the reading of the applied pressure.



Z: Moves to the SAVE function.

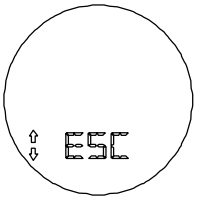
S: Sets the transmitters' internal reference decreasing to the value on the display, which is the reading of the applied pressure.



Z: Moves to the ESCAPE from TRIM menu.

S: Saves the LOWER and UPPER TRIM point in the transmitter EEPROM and actualize the internal parameters pressure measurement.

Escape (ESC)

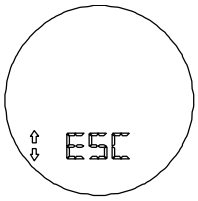


Z: Moves to the ZERO TRIM function.

S: Escapes to the MAIN menu.

Escape Local Adjustment [ESC]

This branch of the main tree is used to leave the Local Adjustment mode, placing the Transmitter or Controller in the monitoring mode.



Z: Selects the OPERATION branch.

S: Escapes to NORMAL DISPLAY mode.

Section 5

MAINTENANCE PROCEDURES

General

NOTE
Equipments installed in hazardous atmospheres must be inspected in compliance with the IEC60079-17 standard.

SMAR LD291 intelligent pressure transmitters are extensively tested and inspected before delivery to the end user. Nevertheless, its design includes additional information for diagnosis purposes, in order to provide an easier fault detection capability and, as a consequence, an easier maintenance.

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 sensor has been designed to operate for many years without malfunctions. Should the process application require periodic cleaning of the transmitter, the flanges may be easily removed and reinstalled.

Should the sensor eventually require maintenance, it may not 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 the Configurator

Should any problem be noticed relating to the transmitter output, the configurator may carry out investigation, as long as power is supplied and communication and the processing unit are operating normally (see Table 5.1).

The configurator should be connected to the transmitter according to the wiring diagram shown on Section 1, Figures 1.10 and 1.11.

Error Messages

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

Table 5.1 presents a list of error messages with details for corrective actions that may be necessary.

ERROR MESSAGES	POTENTIAL SOURCE OF PROBLEM
UART RECEIVER FAILURE: • **PARITY ERROR** • **OVERRUN ERROR** • **ERROR CHECK SUM** • **FRAMING ERROR**	• The line resistance is not according to load curve. • Excessive noise or ripple in the line. • Low level signal. • Interface damaged. • Power supply with inadequate voltage.
CONFIGURATOR RECEIVES NO ANSWER FROM TRANSMITTER	• Transmitter line resistance is not according to load curve; • Transmitter not powered; • Interface not connected or damaged; • Repeated bus address; • Transmitter polarity is reversed; • Interface damaged; • Power supply with inadequate voltage.
CMD NOT IMPLEMENTED	• Software version not compatible between configurator and transmitter. Configurator is trying to carry out a **LD291** specific command in a transmitter from another manufacturer.
TRANSMITTER BUSY	• Transmitter carrying out an important task, e.g., local adjustment.
XMTR MALFUNCTION	• Sensor disconnected. • Sensor failure.

ERROR MESSAGES	POTENTIAL SOURCE OF PROBLEM
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 state (Output current in 3.8 or 20.5 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 sensor module not connected. • Transmitter with false configuration.
LOWER RANGE VALUE TOO HIGH	• Lower value exceeds 24% of the Upper Range Limit.
LOWER RANGE VALUE TOO LOW	• Lower value exceeds 24% of the Lower Range Limit.
UPPER RANGE VALUE TOO HIGH	• Upper value exceeds 24% of the Upper Range Limit.
UPPER RANGE VALUE TOO LOW	• Upper value exceeds 24% of the Lower Range Limit.
UPPER & LOWER RANGE VALUES OUT OF LIMITS	• Lower and Upper Values are out of the sensor range limits.
SPAN TOO SMALL	• The difference, between the Lower and Upper values is less than the 0.75 x (minimum span).
APPLIED PRESURE TOO HIGH	• The pressure applied was above the 24% upper range limit.
APPLIED PRESURE TOO LOW	• The pressure applied was below the 24% lower range limit.
EXCESS CORRECTION	• The trim value entered exceeded the factory-characterized value by more than 10%.
PASSED PARAMETER TOO LARGE	• Parameter above operating limits.
PASSED PARAMETER TOO SMALL	• Parameter below operating limits.

Table 5.1 - Error Messages and Potential Source

Diagnostic with the Transmitter

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 using a spare one.

Symptom**: **NO COMMUNICATION

Probable Source of Trouble:

✓ **Terminal Connections**

- Check the terminal interface connection of the configurator.
- Check if the interface is connected to the wires leading to the transmitter or to the terminals [**+**] and [**-**].
- Check if the interface is models IF3 (for Hart protocol).

✓ **Transmitter Connections**

- Check if connections are according to wiring diagram.
- Check if there is resistance in the 250 Ω line.

✓ **Power Supply**

- Check output of power supply. The voltage at the **LD291** terminals must be between 12 and 45 Vdc, and ripple less than 500 mV.

✓ **Electronic Circuit Failure**

- Locate the failure by alternately testing the transmitter circuit and the interface with spare parts.

✓ **Transmitter Address**

- Check if the transmitter address is compatible with the one expected by the configurator.

Symptom**: **CURRENT OF 21.0 mA or 3.6 mA

Probable Source of Trouble:

✓ **Pressure Tap (Piping)**

- Verify if blocking valves are fully open;
- Check for gas in liquid lines or for liquid in dry lines;
- Check the specific gravity of process fluid;
- Check process flanges for sediments;
- 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).

✓ **Electronic Circuit Failure**

- Check the sensor circuit for damage by replacing it with a spare one.
- Replace sensor.

Symptom**: **INCORRECT OUTPUT

Probable Source of Trouble:

✓ **Transmitter Connections**

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

✓ **Noise Measurement Fluid**

- Adjust damping

✓ **Pressure Tap**

- Check for gas in liquid lines and for liquid in steam or gases lines.
- Check the integrity of the circuit by replacing it with a spare one.

✓ **Calibration**

- Check calibration of the transmitter.

NOTE
A 21.0 or 3.6 mA current indicates that the transmitter is in Burnout (TRM) or safety output . Use the configurator to investigate the source of the problem.

Symptom: DISPLAY INDICATES "FAIL SENS"

Probable Error Source:

✓ **Sensor Connection to the Main Board**
Check the connection (flat cable, male and female connectors).

✓ **Type of Sensor Connected to the Main Board**
Check if the sensor connected to the main board is the one specified for the **LD291** model: sensor type shall be hyper - High Performance.

✓ **Electronic Circuit Failure**
Check if the sensor set is damaged, replacing it for a spare one.

Disassembly Procedure

WARNING
Do not disassemble with power on.

Figure 5.3 shows transmitter's exploded view and will help you to visualize the following:

SENSOR
In order to have access to the sensor (**18**) for cleaning purposes, the transmitter should be removed from its process connections.

Loosen the hex screw (**8**) 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 5.1.

Figure 5.1 – Safety Housing Rotation

ELECTRONIC CIRCUIT
To remove the circuit board (**6**), loosen the two screws (**5**) that anchor the board and hold the (**7**) spacers in the other side to avoid losing them.

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.

SENSOR
When mounting the sensor (**18**), it is recommended to make use of a new set of gaskets (**17**) compatible with the process fluid.

O'rings should be lightly lubricated with silicone oil before they are fitted into their recesses. Use halogen grease for inert fill applications.

The fitting of the sensor must be done with the main board out of the electronic housing. Mount the sensor to the housing turning it clockwise until it stops. Tighten the screw (**8**) to lock the body to the sensor.

ELECTRONIC CIRCUIT
Plug sensor connector and power supply connector to main board. If there is a display, attach it to the main board by means of 4 screws (**3**). The display can be installed in any of the 4 possible positions(See Figure 5.2).

The "▲" mark indicates up position.

Pass the screws (**5**) through the main board holes (**6**) and the spacers (**7**) as shown on Figure 5.3 and tighten them to the body.

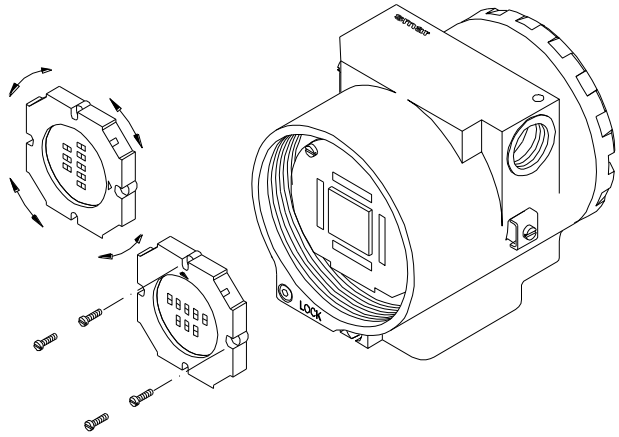


Figure 5.2 – Four Possible Positions of the Display

After tightening the protective cover (**1**), mounting procedure is complete. The transmitter is ready to be energized and tested. It is recommended that adjustment be done on the ZERO TRIM and on the UPPER PRESSURE TRIM.

Interchangeability

In order to obtain an accurate and better temperature compensated response, each sensor is submitted to a characterization process and the specific data is stored in an EEPROM located in the sensor body.

The main board, in this operation, reads the sensor serial number and compares it with the number stored in the main board. In case they do not match, the circuit considers that the sensor has been changed and will probe the memory of the new sensor for the following information:

- ✓ Temperature compensation coefficients;
- ✓ Sensor trim data, including 5-point characterization curve;
- ✓ Sensor characteristics: type, range, diaphragm material and fill fluid.

Information not transferred during sensor replacement will remain unchanged in the main board memory. Thus, information such as Upper Value, Lower Value, Damping, Pressure Unit and replaceable transmitter parts (Flange, O-ring, etc.) shall be updated, depending whether the correct information is that of the sensor or the main board. In the case of a new sensor, the main board will have the most updated information about the process; in the opposite case, the sensor will have it. Depending on the situation, the updating shall be from one or the other.

Data transference from the main board to the sensor or vice versa, can also be forced by function BACKUP/RESTORE from sensor.

Returning Materials

Should it become necessary to return the transmitter and/or configurator to **SMAR**, simply contact our office, informing the defective instrument serial number, and return it to our factory.

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 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.

Instruments returned or to be revised outside the guarantee term should be accompanied by a purchase order or a quote request.

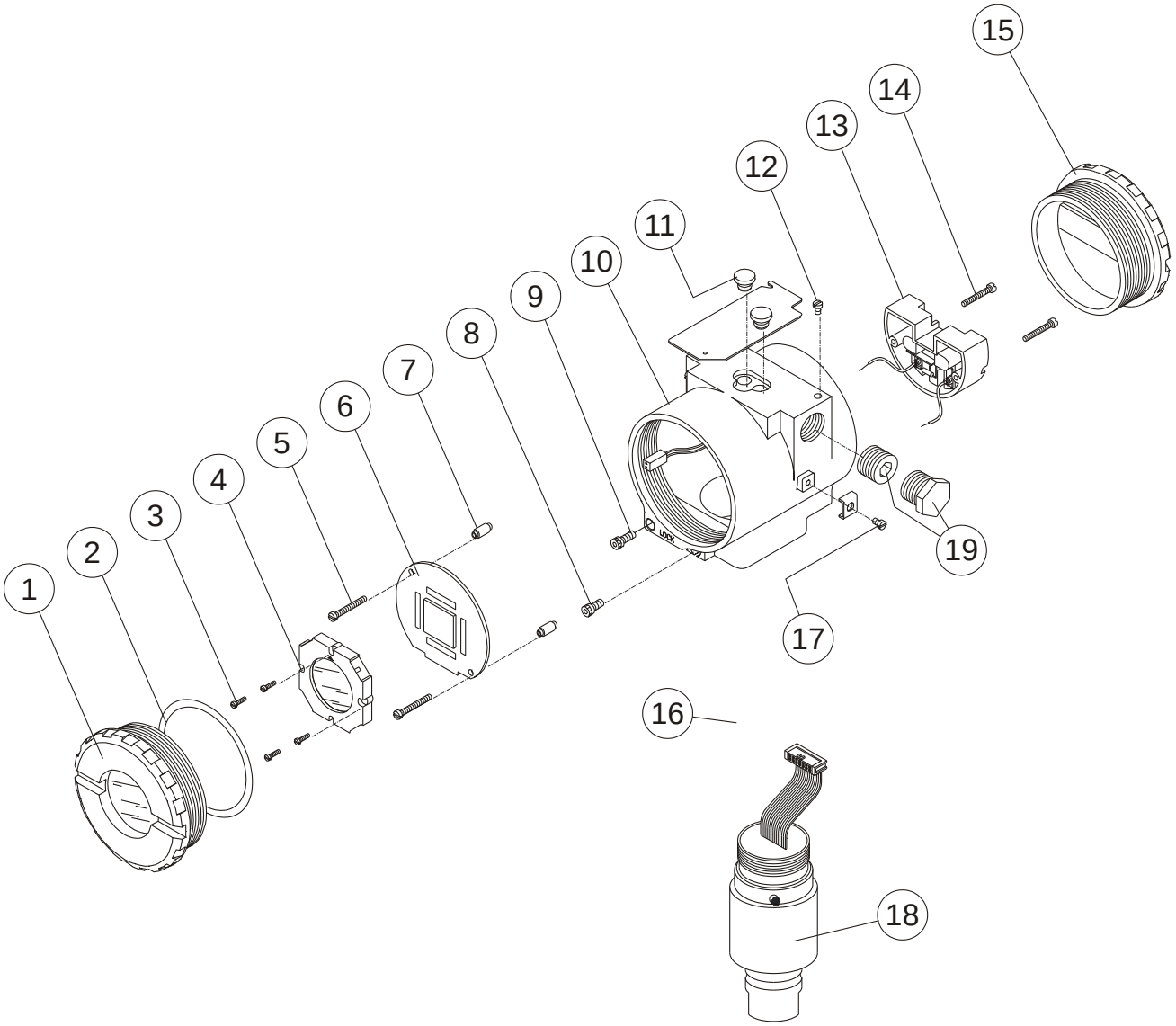


Figure 5.1 – Exploded View

ACCESSORIES	
ORDERING CODE	**DESCRIPTION**
SD-1	Magnetic Tool for local adjustment.
Palm	8 Mbytes Palm Handheld, including installation and initialization software for the HPC301.
HPC301-SF1-V	HART® Interface HPI311-V for Palm, including the configuration package for Smar transmitters and for third parties transmitters.
HPI311-V	HART® interface.

SPARE PARTS LIST FOR TRANSMITTER				
DESCRIPTION OF PARTS		**POSITION**	**CODE**	**CATEGORY (NOTE 1)**
HOUSING (**NOTE 2**)		10	400-1314	
COVER (Includes O-ring)	. Aluminum	1 and 15	204-0102	
	. Stainless Steel 316	1 and 15	204-0105	
COVER WITH WINDOW FOR INDICATOR (Includes O-ring)	. Aluminum	1	204-0103	
	. Stainless Steel 316	1	204-0106	
COVER LOCKING SCREW.		9	204-0120	
SENSOR LOCKING SCREW.	. Without Head M6 Screw	8	400-1121	
EXTERNAL GROUND SCREW.		17	204-0124	
IDENTIFICATION PLATE FIXING SCREW.		12	204-0116	
DISPLAY (Included Screws).		3 and 4	400-0559	
TERMINAL BLOCK ISOLATOR.		13	400-0058	
MAIN BOARD (Display and mounting Kit Included) GLL 1071.		6	400-0610	A
MAIN BOARD (Display and Mounting Kit not Included) – GLL 1071.		6	400-0572	A
MAN BOARD with Mounting Kit and without display - GLL 1071.		6	400-0609	A
MAIN FIXATION BOARD KIT (Screws and Spacers).		5 and 7	400-0560	
O-RINGS (**NOTE 3**).	. Cover, BUNA-N.	2	204-0122	B
	. Neck, BUNA-N.	16	204-0113	B
TERMINAL HOLDING SCREW.	. HOUSING, Aluminum.	14	304-0119	
	. HOUSING, 316 SS.	14	204-0119	
MAIN BOARD SCREW HOUSING IN ALUMINUM.	.Units without indicator.	3	304-0118	
	.Units with indicator.	3	304-0117	
MAIN BOARD SCREW HOUSING IN 316 STAINLESS STEEL.	.Units with indicator.	3	204-0118	
	.Units without indicator.	3	204-0117	
MOUNTING BRACKET FOR 2" PIPE MOUNTING (**NOTE 5**).	. Carbon Steel.	-	209-0801	
	. Stainless Steel 316.	-	209-0802	
	. Carbon Steel with bolts, nuts, washers and U-clamp in 316SS.	-	209-0803	
LOCAL ADJUSTMENT PROTECTION CAP.		11	204-0114	
SENSOR.		18	(**NOTA 4**)	B
PLUG	1/2 NPT Internal Hexagon Plug in Plated CS BR Ex d. 1/2 NPT Internal Hexagon Plug in 304 SST BR Ex d. M20 X 1.5 External Hexagon Plug in 316 SST BR Ex d. PG13.5 External Hexagon Plug in 316 SST BR Ex d.	19 19 19 19	400-0808 400-0809 400-0810 400-0811	

Note: 1) for category **A**, it is recommended to keep, in stock, 25 parts installed for each set, and 50.for category **B**.
2) Include Terminal Block, Screws, caps, and Identification plate without certification.
3) O-rings and Backup Rings are packaged in packs of 12 units, except for spring loaded.
4) To specify sensors, use the following tables.
5) Including U-Clamp, nuts, bolts and washers

Ordering Code for Housing

CODE	DESCRIPTION
400-1314 - 2	HOUSING: LD291

Option	Communication Protocol
H	HART and 4-20 mA

Option	Electrical Connection
0	½ NPT
A	M20 X 1.5
B	PG13.5

Option	Material
H0	Aluminium (IP/Type)
H1	316 SST (IP/Type)
H2	Aluminium – for saline atmospheres (IPW/Type X)
H4	Aluminium Copper Free (IPW/Type X)

Option	Painting
P0	Gray Munsell N 6,5
P8	Without Painting
P9	Safe Blue Base EPÓXI – electrostatic painting

400-1314 - 2	H	0	H0	P0

Ordering Code for Sensor

209-0241	SPARE PART NUMBER FOR PRESSURE GAGE SENSOR

CODE	Type	Range Limits		
		Min.	Max.	Unit
M2	Gage	12.5	500	mbar
M3	Gage	-1000	2500	mbar
M4	Gage	-1	25	bar
M5	Gage	-1	250	bar

CODE	Diaphragm Material and Fill Fluid	CODE	Diaphragm Material and Fill Fluid
1	316L SST - Silicone Oil	E	Hastelloy C276 – Inert Krytox Oil **(2)**
2	316L SST – Inert Fluorolube Oil **(2)**	Q	316L SST – Inert Halocarbon 4.2 Oil **(2)**
3	Hastelloy C276 - Silicone Oil **(1)**	R	Hastelloy C276 – Inert Halocarbon 4.2 Oil **(2)**
4	Hastelloy C276 – Inert Fluorolube Oil **(2)**	Z	User's specifications
D	316L SST – Inert Krytox Oil **(2)**		

CODE	Process Connections Material	CODE	Process Connections Material	CODE	Process Connections Material
H	Hastelloy C276 **(1)**	I	316L SST	Z	User's specifications

CODE	Process Connections	CODE	Process Connections
1	1/2 - 14 NPT - Female	U	1/2 BSP – Male
A	M20 X 1.5 Male	V	Valve Manifold integrated to the transmitter
G	G 1/2 A DIN 16288 - Form B **(3)**	X	1" NPT Sealed
H	G 1/2 DIN 16288 - Form D **(3)**	Z	User's specifications
M	1/2 - 14 NPT - Male		

209-0241	M2	1	I	A

← Typical Model Number

NOTE
(1) Meets NECE MR - 01 - 75/ISO 15156 recommendations. (2) Inert Fluid: safe for oxygen service. (3) The DIN 16288 standards was substituted by the DIN EN 837-1.

209-0241	SPARE PART NUMBER FOR SANITARY PRESSURE SENSOR						
CODE	Type	Range Limits			Range Limits		
		Min.	Max.	Unit	Min.	Max.	Unit
2	Sanitary	12.5	500	mbar	5.02	201.09	inH_2O
3	Sanitary	62.5	2500	mbar	25.13	1005,45	inH_2O
4	Sanitary	0.625	25	bar	157.1	10054.5	inH_2O
5	Sanitary	6.25	55.15	bar	90.65	799.89	psi

CODE	Diaphragm Material	CODE	Diaphragm Material
H	Hastelloy C276	M	Monel
I	316L SST	T	Tantalum

CODE	Fill Fluid (Low Side)	CODE	Fill Fluid (Low Side)
D	Silicone DC-704 Oil **(2)**	N	Propileno Glicol Neobee M20 Oil (Approved 3A) **(3)**
F	Inert Fluorolube MO-10 Oil **(1) (4)**	S	Silicone DC-200/20 Oil **(2)**
K	Inert Krytox Oil **(1) (4)**	T	Sylltherm 800 Oil

CODE	Process Connections	CODE	Process Connections
B	Thread IDF - 2” 300#	H	DN40 300# - DIN 11851
C	Thread RJT - 2” 300#	P	Tri-Clamp - 2” 800#
D	Tri-Clamp - 2” 300#	Q	Tri-Clamp - 1 1/2” 800#
E	Thread SMS - 2” 300#	Z	User’s specifications
F	Tri-Clamp - 1 1/2” 300#		

CODE	Optional Items

209-0241	2	I	N	D	*	← Typical Model Number

*Leave blank for no optional items.

NOTES

(1) Meets NACE MR – 01 – 75/ISO 15156 recommendations.
(2) Silicone Oil is not recommended for Oxygen (O_2) or Chlorine service.
(3) 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, Buna-N and Teflon

(4) Inert Fluid: Oxygen Compatibility, safe for oxygen service.

209-0241 SPARE PART NUMBER FOR FLANGED PRESSURE SENSOR

COD.	Type	Range Limits Min.	Range Limits Max.	Min. Span	Unit	Range Limits Min.	Range Limits Max.	Min. Span	Unit	
L2	Level	-50	50	1,25	kPa	-200	200	5	inH_2O	Note: The range can be extended up to 0.75 LRL and 1.2 URL with small degradation of accuracy. The upper range value must be limited to the flange rating.
L3	Level	-250	250	2,08	kPa	-36	36	0,3	psi	
L4	Level	-2500	2500	20,83	kPa	-360	360	3	psi	
L5	Level	-25000	25000	208,30	kPa	-3625	3625	30,2	psi	

COD.	Diaphragm Material (Sensor) and Fill Fluid (Sensor)
1	316L SST - Silicone Oil

COD.	Process Connection	COD.	Process Connection
U	1" 150# (ANSI B16.5)	C	3" 600# (ANSI B16.5)
V	1" 300# (ANSI B16.5)	3	4" 150# (ANSI B16.5)
W	1" 600# (ANSI B16.5)	4	4" 300# (ANSI B16.5)
O	1½" 150# (ANSI B16.5)	D	4" 600# (ANSI B16.5)
P	1½" 300# (ANSI B16.5)	5	DN25 PN 10/40
Q	1½" 600# (ANSI B16.5)	R	DN40 PN 10/10
9	2" 150# (ANSI B16.5)	E	DN50 PN10/40
A	2" 300# (ANSI B16.5)	6	DN80 PN25/40
B	2" 600# (ANSI B16.5)	7	DN100 PN10/16
1	3" 150 # (ANSI B16.5)	8	DN100 PN25/40
2	3" 300# (ANSI B16.5)	Z	User´s specifications

COD.	Type and Material Flange	COD.	Type and Material Flange
4	304 SST (slip-on flange)	6	Carbon Steel (slip-on flange)
5	316 SST (slip-on flange)	Z	User´s specifications

COD.	Extension Lenght	COD.	Extension Lenght
0	0 mm (0")	3	150 mm (6")
1	50 mm (2")	4	200 mm (8")
2	100 mm (4")	Z	User´s specifications

COD.	Diaphragm Material/Extension (Process Connection)	COD.	Diaphragm Material/Extension (Process Connection)
1	316 L SST / 316 SST	5	Titanium / 316 SST **(3)**
2	Hastelloy C276 / 316 SST	6	316L SST with Teflon Lining
3	Monel 400 / 316 SST	L	316L SST with Halar Lining
4	Tantalum / 316 SST **(3)**	Z	User´s specifications

COD.	Fill Fluid (Process Connection)	COD.	Fill Fluid (Process Connection)
S	Silicone DC-200/20 Oil	H	Halocarbon 4.2 Oil
F	Inert Fluorolube MO-10 Oil **(4)**	N	Propileno Glicol (Neobee) Oil
D	Silicone DC-704 Oil	T	Sylthern 800 Oil
K	Krytox Oil	Z	User´s specifications

COD.	Lower Housing Material	COD.	Lower Housing Material
0	Without Lower Housing	4	Duplex (UNS 31803)
1	316L SST	5	304L SST
2	Hastelloy C276	Z	User´s specifications
3	Super Duplex (UNS 32750)		

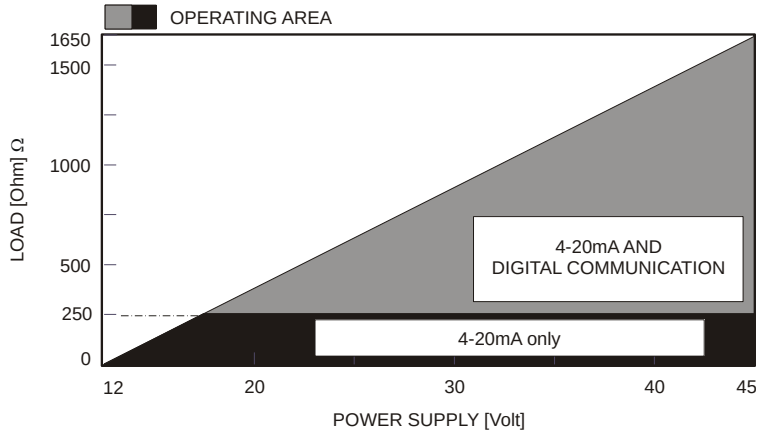
COD.	Gasket Material	COD.	Gasket Material
0	Without Gasket	T	Teflon (PTFE)
C	Copper	Z	User´s specifications
G	Grafoil (Flaxible Lead)		

209-0241	L2	1	1	6	0	1	S	1	0	TYPICAL MODEL NUMBER

NOTES

(1) Silicone Oils not recommendations for Oxygen (O_2) or Chlorine service.
(2) Not applicable for vacuum service.
(3) Attention, check corrosion rate for the process, tantalum plate 0.1 mm, AISI 316L extension 3 to 6mm.
(4) Fluorolube fill fluid is not available for Monel diaphragm.
(5) Inert Fluid: Safe for oxygen service.

TECHNICAL CHARACTERISTICS

<table>
<tr><th colspan="2">Functional Specifications</th></tr>
<tr><td>Process Fluid</td><td>Liquid, gas or steam.</td></tr>
<tr><td>Output Signal and Protocol Communication</td><td>Two-wire, 4-20 mA controlled according to NAMUR NE43 Specification and with superimposed digital communication (HART Protocol). See the figure below.</td></tr>
<tr><td>Power Supply</td><td>12 to 45 Vdc.</td></tr>
<tr><td>Load Limitation</td><td> 
</td></tr>
<tr><td>Indicator</td><td>Optional 4½-digit numerical and 5-character alphanumerical LCD indicator.</td></tr>
<tr><td>Hazardous Area Certifications</td><td>Intrinsic Safe (FM, CSA, NEMKO, DEKRA/EXAM, CEPEL and NEPSI), non-incendive (FM, CSA and CEPEL), explosion proof (FM, NEMKO and CEPEL) and dust ignition proof (FM).</td></tr>
<tr><td>European Directive Information</td><td>Authorized representative in European Community
Smar Gmbh-Rheingaustrasse 9-55545 Bad Kreuzanach

PED Directive (97/23/EC) – Pressure Equipment Directive
This product is in compliance with the directive and it was designed and manufactured in accordance with sound engineering practice using several standards from ANSI, ASTM, DIN and JIS.

EMC Directive (2004/108/EC) - Eletromagnetic Compatibility
The EMC test was performed according to IEC standard: IEC61326-1:2006, IEC61326-2-3:2006, IEC61000-6-4:2006, IEC61000-6-2:2005. For use in environment only.
Keep the shield insulated at the instrument side, connecting the other one to the ground if necessary to use shielded cable.

ATEX Directive (94/9/EC) – Equipment and protective systems intended for use in potentially explosive atmospheres.
This product was certified according European Standards at NEMKO and EXAM (old DMT). The certified body for manufacturing quality assessment is EXAM (number 0158).

LVD Directive 2006/95/EC – Electrical Equipment designed for use within certain voltage limits
According the LVD directive Annex II the equipment under ATEX “Electrical equipment for use in an explosive atmosphere” directive are excluded from scope from this directive.

The EC declarations of conformity for all applicable European directives for this product can be found at www.smar.com.</td></tr>
<tr><td>Temperature Limits</td><td>
<table>
<tr><th colspan="8">Temperature Limits</th></tr>
<tr><td rowspan="2">Ambient</td><td>-40</td><td>to</td><td>85 ºC</td><td>-40</td><td>to</td><td>185 ºF</td><td></td></tr>
<tr><td>-15</td><td>to</td><td>85 ºC</td><td>-59</td><td>to</td><td>185 ºF</td><td>LD290I</td></tr>
<tr><td rowspan="5">Process</td><td>-40</td><td>to</td><td>100 ºC</td><td>-40</td><td>to</td><td>212 ºF</td><td>Silicone Oil</td></tr>
<tr><td>0</td><td>to</td><td>85 ºC</td><td>32</td><td>to</td><td>185 ºF</td><td>Fluorolube Oil</td></tr>
<tr><td>-25</td><td>to</td><td>85 ºC</td><td>-13</td><td>to</td><td>185 ºF</td><td>Viton ‘Ring</td></tr>
<tr><td>-40</td><td>to</td><td>150 ºC</td><td>-40</td><td>to</td><td>302 ºF</td><td>LD290L</td></tr>
<tr><td>-15</td><td>to</td><td>150 ºC</td><td>-59</td><td>to</td><td>302 ºF</td><td>LD290I</td></tr>
<tr><td>Storage</td><td>40</td><td>to</td><td>100 ºC</td><td>-40</td><td>to</td><td>212 ºF</td><td></td></tr>
<tr><td>Digital Display</td><td>-20</td><td>to</td><td>80 ºC</td><td>-4</td><td>to</td><td>176 ºF</td><td>Operation</td></tr>
<tr><td></td><td>-40</td><td>to</td><td>85 ºC</td><td>-40</td><td>to</td><td>185 ºF</td><td>without damage</td></tr>
</table>
</td></tr>
<tr><td>Turn-on Time</td><td>Performs within specifications in less than 5 seconds after power is applied to the transmitter.</td></tr>
</table>

Zero and Span Adjustments	By configurator or local adjustment from 0 to 0.975 URL, URL = Upper Range Limit.
Failure Alarm	In case of sensor or circuit failure, the self-diagnostics drives the output to 3.6 or 21.0 mA, according to the user's choice.
Volumetric Displacement	Less than 0.15 cm^3 (0.01 in^3)

Overpressure and Static Pressure Limits (MWP – Maximum Working Pressure)

14 MPa (138 bar) for ranges 2, 3, 4.
31 MPa (310 bar) for range 5.

For Level Ranges ANSI/DIN (models **LD290L**):
150#: 6 psia to 235 psi (-0,6 to 16 bar) to 199,4 °F (93 °C)
300#: 6 psia to 620 psi (-0,6 to 43 bar) to 199,4 °F (93 °C)
600#: 6 psia to 1240 psi (-0,6 to 85 bar) to 199,4 °F (93 °C)
PN10/16: -60 kPa to 1,02 MPa to 212 °F (100 °C)
PN25/40: -60 kPa to 2,55 MPa to 212 °F (100 °C)

Overpressures above will not damage the transmitter, but a new calibration may be necessary.

WARNING
It is described here only the maximum pressures of the materials referenced in each rule, it can not be manufactured on request. Temperatures above 150 ° C are not available in standard models.

PRESSURES TABLE FOR SEAL AND LEVEL FLANGES DIN EN 1092-1 2008 STANDARD

Material Group	Pressure Class	Maximum Temperature Allowed						
		RT	100	150	200	250	300	350
		Maximum Pressure Allowed (bar)						
10E0 AISI 304/304L	PN 16	16	13.7	12.3	11.2	10.4	9,6	9.2
	PN 25	25	21.5	19.2	17.5	16.3	15.1	14.4
	PN 40	40	34.4	30.8	28	26	24.1	23
	PN 63	63	63	57.3	53.1	50.1	46.8	45
	PN 100	100	86.1	77.1	70	65.2	60.4	57.6
	PN 160	160	137.9	123.4	112	104.3	96.7	92.1
	PN 250	250	215.4	192.8	175	163	151.1	144

Material Group	Pressure Class	Maximum Temperature Allowed						
		RT	100	150	200	250	300	350
		Maximum Pressure Allowed (bar)						
14E0 AISI 316/316L	PN 16	16	16	14.5	13.4	12.7	11.8	11.4
	PN 25	25	25	22.7	21	19.8	18.5	17.8
	PN 40	40	40	36.3	33.7	31.8	29.7	28.5
	PN 63	63	63	57.3	53.1	50.1	46.8	45
	PN 100	100	100	90.9	84.2	79.5	74.2	71.4
	PN 160	160	160	145.5	134.8	127.2	118.8	114.2
	PN 250	250	250	227.3	210.7	198.8	185.7	178.5

Material Group	Pressure Class	Maximum Temperature Allowed						
		RT	100	150	200	250	300	350
		Maximum Pressure Allowed (bar)						
16E0 1.4410 Super Duplex 1.4462 Duplex	PN 16	16	16	16	16	16	-	-
	PN 25	25	25	25	25	25	-	-
	PN 40	40	40	40	40	40	-	-
	PN 63	63	63	63	63	63	-	-
	PN 100	100	100	100	100	100	-	-
	PN 160	160	160	160	160	160	-	-
	PN 250	250	250	250	250	250	-	-

Overpressure and Static Pressure Limits (MWP – Maximum Working Pressure) (continuation)

PRESSURES TABLE FOR SEAL AND LEVEL FLANGES ASME B16.5 2009 STANDARD

Material Group	Pressure Class	Maximum Temperature Allowed								
		-29 to 38	50	100	150	200	250	300	325	350
		Maximum Pressure Allowed (bar)								
Hastelloy C276	150	20	19.5	17.7	15.8	13.8	12.1	10.2	9.3	8.4
	300	51.7	51.7	51.5	50.3	48.3	46.3	42.9	41.4	40.3
	400	68.9	68.9	68.7	66.8	64.5	61.7	57	55	53.6
	600	103.4	103.4	103	100.3	96.7	92.7	85.7	82.6	80.4
	900	155.1	155.1	154.6	150.6	145	139	128.6	124	120.7
	1500	258.6	258.6	257.6	250.8	241.7	231.8	214.4	206.6	201.1
	2500	430.9	430.9	429.4	418.2	402.8	386.2	357.1	344.3	335.3

Material Group	Pressure Class	Maximum Temperature Allowed								
		-29 to 38	50	100	150	200	250	300	325	350
		Maximum Pressure Allowed (bar)								
S31803 Duplex S32750 Super Duplex	150	20	19.5	17.7	15.8	13.8	12.1	10.2	9.3	8.4
	300	51.7	51.7	50.7	45.9	42.7	40.5	38.9	38.2	37.6
	400	68.9	68.9	67.5	61.2	56.9	53.9	51.8	50.9	50.2
	600	103.4	103.4	101.3	91.9	85.3	80.9	77.7	76.3	75.3
	900	155.1	155.1	152	137.8	128	121.4	116.6	114.5	112.9
	1500	258.6	258.6	253.3	229.6	213.3	202.3	194.3	190.8	188.2
	2500	430.9	430.9	422.2	382.7	355.4	337.2	323.8	318	313.7

Material Group	Pressure Class	Maximum Temperature Allowed								
		-29 to 38	50	100	150	200	250	300	325	350
		Maximum Pressure Allowed (bar)								
AISI316L	150	15.9	15.3	13.3	12	11.2	10.5	10	9.3	8.4
	300	41.4	40	34.8	31.4	29.2	27.5	26.1	25.5	25.1
	400	55.2	53.4	46.4	41.9	38.9	36.6	34.8	34	33.4
	600	82.7	80	69.6	62.8	58.3	54.9	52.1	51	50.1
	900	124.1	120.1	104.4	94.2	87.5	82.4	78.2	76.4	75.2
	1500	206.8	200.1	173.9	157	145.8	137.3	130.3	127.4	125.4
	2500	344.7	333.5	289.9	261.6	243	228.9	217.2	212.3	208.9

Material Group	Pressure Class	Maximum Temperature Allowed								
		-29 to 38	50	100	150	200	250	300	325	350
		Maximum Pressure Allowed (bar)								
AISI316	150	19	18.4	16.2	14.8	13.7	12.1	10.2	9.3	8.4
	300	49.6	48.1	42.2	38.5	35.7	33.4	31.6	30.9	30.3
	400	66.2	64.2	56.3	51.3	47.6	44.5	42.2	41.2	40.4
	600	99.3	96.2	84.4	77	71.3	66.8	63.2	61.8	60.7
	900	148.9	144.3	126.6	115.5	107	100.1	94.9	92.7	91
	1500	248.2	240.6	211	192.5	178.3	166.9	158.1	154.4	151.6
	2500	413.7	400.9	351.6	320.8	297.2	278.1	263.5	257.4	252.7

Material Group	Pressure Class	Maximum Temperature Allowed								
		-29 to 38	50	100	150	200	250	300	325	350
		Maximum Pressure Allowed (bar)								
AISI304	150	19	18.3	15.7	14.2	13.2	12.1	10.2	9.3	8.4
	300	49.6	47.8	40.9	37	34.5	32.5	30.9	30.2	29.6
	600	99.3	95.6	81.7	74	69	65	61.8	60.4	59.3
	1500	248.2	239.1	204.3	185	172.4	162.4	154.6	151.1	148.1
	2500	413.7	398.5	340.4	308.4	287.3	270.7	257.6	251.9	246.9

Damping Adjustment	0 to 128 seconds in addition to intrinsic sensor response time (0.2 s) (via digital communication).
Humidity Limits	0 to 100% RH.
Configuration	Can be done through digital communication using the Hart Protocol or, partially, through local adjustment.

Configuration (continuation)	**Configurator** • **CONF 401** It works in the windows platform (95, 98, 2000, XP and NT. For equipment updates and HPC301 software, just check: **www.smarreasearch.com** • **Palm** See Palm Handbook.

Performance Specifications	
Reference Conditions	Range starting at zero, temperature 25 °C (77 °F), atmospheric pressure, power supply of 24 Vdc, silicone oil fill fluid, isolating diaphragms in 316L SS and digital trim equal to lower and upper range values.
Accuracy	For ranges 2, 3, 4 and 5: ±0.075% of span (for span >= 0.1 URL) ±[0.0375 + 0.00375 URL/SPAN] % of span (for span < 0.1 URL) For Level Transmitter: ± 0.08 % of span (for span ≥ 0.1 URL) ± [0.0504 + 0.0047 URL/span] % of span (for span < 0.1 URL) For Insertion Transmitter: ±0.2% of span Linearity effects, hysterese and repeatability are included.
Stability	± 0.15% of URL for 5 years
Temperature Effect	± [0.02 URL + 0.06% of span], per 20 ºC (68 ºF) for span >= 0.2 URL ± [0.023 URL+0.045% of span], per 20ºC (68 ºF) for span < 0.2 URL For Level Transmitter: 6 mmH_2O per 20ºC for 4" and DN100. 17 mmH_2O per 20ºC for 3" and DN80.
Power Supply Effect	± 0.005% of calibrated span per volt.
Mounting Position Effect	Zero shift of up to 250 Pa (1 inH_2O), which can be calibrated out. No span effect.
Electromagnetic Interference Effect	Designed to comply with, Approved according to IEC61326-1:2006, IEC61326-2-3:2006, IEC61000-6-4:2006, IEC61000-6-2:2005.

Physical Specifications	
Electrical Connection	See options in ordering code.
Process Connection	See options in ordering code.
Wetted Parts	316L SST and Hastelloy C276. Diaphragm for sanitary models available in Monel 400 and Tantalum.
Nonwetted Parts	**Electronic Housing** Injected aluminum with polyester painting or 316 SST. According to NEMA Type 4X or Type 4, IP66, IP66W*. *The IP66W sealing test (immersion) was performed at 1 bar for 24 hours. For any other situation, please consult Smar. IP66W tested for 200h to according NBR 8094 / ASTM B 117 standard. **Level Flange (LD290L)** 316L SST, 304 SST and Plated Carbon Steel. **Fill Fluid** Silicone or Fluorolube Oil. **Cover O-Rings** Buna N. **Mounting Bracket** Optional universal mounting bracket for surface or vertical/horizontal 2"-pipe (DN 50) carbon steel with polyester painting or 316 SST. Accessories (bolts, nuts, washers and U-clamp) in carbon steel or 316 SST. **Identification Plate** 316 SST. **Approximate Weights** < 2.0kg (4 lb):aluminum.housing bracket.

Ordering Code

MODEL	GAGE PRESSURE TRANSMITTERS
LD291M	4-20 mA + HART®

CODE	Type	Range Limits		
		Min.	Max.	Unit
2	Gage	12.5	500	mbar
3	Gage	-1000	2500	mbar
4	Gage	-1	25	bar
5	Gage	-1	250	bar

CODE	Diaphragm Material and Fill Fluid
1	316L SST - Silicone Oil
2	316L SST – Inert Fluorolube Oil **(2)**
3	Hastelloy C276 - Silicone Oil **(1)**
4	Hastelloy C276 – Inert Fluorolube Oil **(2)**
D	316L SST – Inert Krytox Oil **(2)**
E	Hastelloy C276 – Inert Krytox Oil **(2)**
Q	316L SST – Inert Halocarbon 4.2 Oil **(2)**
R	Hastelloy C276 – Inert Halocarbon 4.2 Oil **(2)**

CODE	Process Connections Material
H	Hastelloy C276 **(1)**
I	316L SST
Z	User's specifications

CODE	Local Indicator	CODE	Local Indicator
0	Without Indicator	1	With Indicator

CODE	Process Connections	CODE	Process Connections
1	1/2 - 14 NPT - Female	U	1/2 BSP – Male
A	M20 X 1,5 Male	V	Valve Manifold integrated to the transmitter
G	G 1/2 A DIN 16288 - Form B	X	1" NPT Sealed
H	G 1/2 DIN 16288 - Form D	Z	User's specifications
M	1/2 - 14 NPT - Male		

CODE	Electrical Connections	CODE	Electrical Connections
0	1/2 - 14 NPT **(3)**	A	M20 X 1.5 **(5)**
1	1/2 - 14 NPT X 3/4 NPT (316 SST) - with adapter **(4)**	B	PG 13.5 DIN **(5)**
2	1/2 - 14 NPT X 3/4 BSP (316 SST) - with adapter **(6)**	Z	User's specifications
3	1/2 - 14 NPT X 1/2 BSP (316 SST) - with adapter **(6)**		
4	1/2 - 1/2 NPTF (316 SST) - with adapter		
5	1/2 - 3/4 NPTF (316 SST) - with adapter		

CODE	Mounting Bracket
0	Without Mounting Bracket
1	Carbon Steel Mounting Bracket with Carbon Steel accessories
2	316 SST Mounting Bracket with 316 SST accessories
7	Carbon Steel Mounting Bracket with 316 SST accessories
A	Flat; 304 SST Mounting Bracket with 316SST accessories

CODE	Optional Items

LD291M	2	1	I	1	1	A	0	*	TYPICAL MODEL NUMBER

* Leave blank for no optional items.

MODEL	GAGE PRESSURE TRANSMITTER (CONTINUATION)

CODE	Output Signal
G0	4-20 mA
G4	4 - 20 mA + Output for Remote Indicator

CODE	Housing Material (9) (10)		
H0	Aluminium (IP/TYPE)	H3	316 SST for Saline Atmosphere (IPW/TYPEX) **(8)**
H1	316 SST (IP/TYPE)	H4	Copper Free Aluminium (IPW/TYPEX) **(8)**
H2	Aluminium for Saline Atmosphere (IPW/TYPEX) **(8)**		

CODE	Identification Plate				
I1	FM: XP, IS, NI, DI	I5	CEPEL: Ex-d, Ex-ia	I7	EXAM (DMT) Grupo I, M1 Ex-ia
I3	CSA: XP, IS, NI, DI	I6	Without Certification	ID	NEPSI: Ex-ia, Ex-d
I4	EXAM (DMT): Ex-ia; NEMKO: Ex-d				

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

CODE	Display Unit 1		
Y0	Percentage	Y3	Temperature (Temperature)
Y1	Current (mA)	YU	User's specification **(7)**
Y2	Pressure (Eng. Unit)		

CODE	Display Unit 2		
Y0	Percentage	Y6	Temperature (Temperature)
Y4	Current (mA)	YU	User's specification **(7)**
Y5	Pressure (Eng. Unit)		

CODE	Tag Plate		
J0	With TAG	J2	User's specification
J1	Without TAG		

LD291M	G0	H0	I1	P0	Y0	Y5	J0	← TYPICAL MODEL NUMBER

Optional Items

Special Procedures	**C1** –Degrease Cleaning (Oxygen or Chlorine Service)
Burnout	**BD** – Down Scale **BU** – Up Scale
Características Especiais	**ZZ** – User Specification

NOTES

(1) Meets NACE material recommendation per MR-01-75.
(2) Inert fluid: safe for oxygen service.
(3) Certificate for use in Hazardous Locations (CEPEL, NEPSI, NEMKO, EXAM, FM, CSA).
(4) Certificate for use in Hazardous Locations (CEPEL, CSA).
(5) Certificate for use in Hazardous Locations (CEPEL, NEPSI, NEMKO, EXAM).
(6) Not certified for use in hazardous locations.
(7) Limited values to 4 1/2 digits; limited unit to 5 characters.
(8) IPW/TYPEX was tested for 200 hours according to NBR 8094 / ASTM B 117 standard.
(9) IPX8 tested for 10 meters of water column for 24 hours.
(10) Ingress Protection:

Products	CEPEL	NEMKO/EXAM	FM	CSA	NEPSI
LD29X	IP66/W	IP66/68/W	Type 4X/6/6P	Type 4X	IP67

MODEL	SANITARY PRESSURE TRANSMITTERS
LD291S	4-20 mA + HART®

CODE	Type	Range Limits			Range Limits		
		Min.	Max.	Unit	Min.	Max.	Unit
2	Sanitary	12.5	500	mbar	5.02	201.09	inH_2O
3	Sanitary	62.5	2500	mbar	25.13	1005,45	inH_2O
4	Sanitary	0.625	25	bar	157.1	10054.5	inH_2O
5	Sanitary	6.25	55.15	bar	90.65	799.89	psi

CODE	Diaphragm Material
I	316L SST

CODE	Fill Fluid
S	Silicone DC-200/20 Oil

CODE	Local Indicator
0	Without Indicator
1	With Indicator

CODE	Process Connections	CODE	Process Connections
B	Thread IDF - 2” 300# **(2)**	H	DN40 300# - DIN 11851
C	Thread RJT - 2” 300#	P	Tri-Clamp - 2” 800# **(2)**
D	Tri-Clamp - 2” 300# **(2)**	Q	Tri-Clamp - 1 1/2” 800# **(2)**
E	Thread SMS - 2” 300# **(2)**	Z	User’s specifications
F	Tri-Clamp - 1 1/2” 300# **(2)**		

CODE	Electrical Connections	CODE	Electrical Connections
0	1/2 - 14 NPT **(3)**	A	M20 X 1.5 **(5)**
1	1/2 - 14 NPT X 3/4 NPT (316 SST) - with adapter **(4)**	B	PG 13.5 DIN **(5)**
2	1/2 - 14 NPT X 3/4 BSP (316 SST) - with adapter **(9)**	Z	User’s specifications
3	1/2 - 14 NPT X 1/2 BSP (316 SST) - with adapter **(9)**		
4	1/2 - 1/2 NPTF (316 SST) - with adapter		
5	1/2 - 3/4 NPTF (316 SST) - with adapter		

CODE	O’Ring Material	CODE	O’Ring Material
0	Without O’Ring	V	Viton **(2)**
B	Buna-N **(2)**	Z	User´s specifications
T	Teflon **(2)**		

CODE	Adaptation Sleeve
0	Without Sleeve
1	With Adaptation Sleeve in 316 SST

CODE	Tri-Clamp Connection
0	Without Clamp
2	With Tri-Clamp in 304 SST

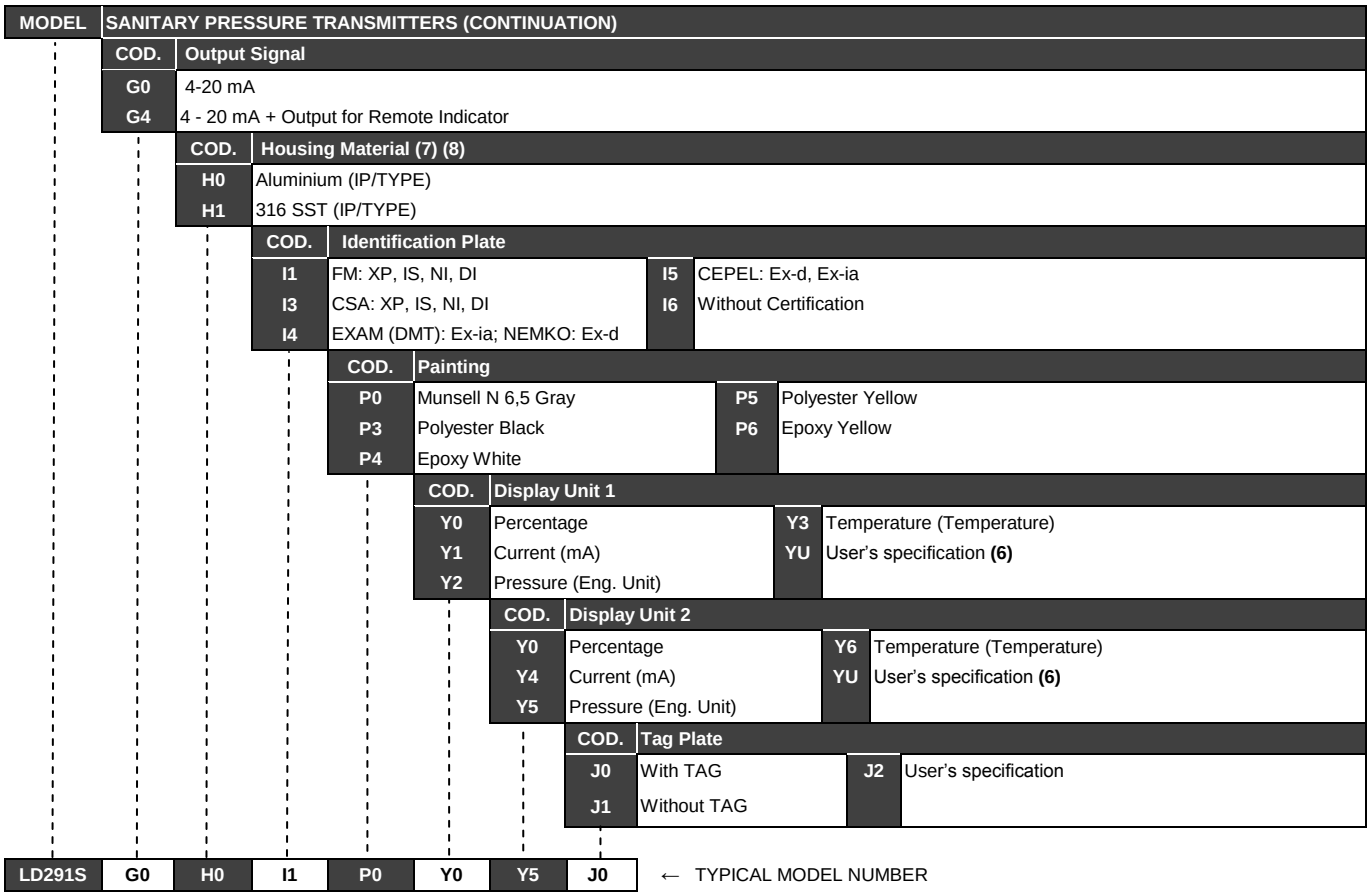
CODE	Diaphragm Material (Sanitary Connection)
H	Hastelloy C276
I	316L SST

CODE	Fill Fluid (Sanitary Connection)
D	Silicone DC-704 Oil
F	Fluorolube MO-10 Oil **(1)**
N	Propilene Glicol (Neobee) Oil **(2)**
S	Silicone DC-200/20 Oil
T	Sylthern 800 Oil
Z	User’s specifications

CODE	Optional Items

LD291S	2	I	N	1	D	0	V	1	2	I	D	*	← Typical Model Number

*Leave blank for no optional items.



Optional Items

Special Procedures	**C1** –Degrease Cleaning (Oxygen or Chlorine Service) **C4** - Polishing of the sanitary connections according to 3A Certification **(2)**
Burnout	**BD** – Down Scale **BU** – Up Scale

NOTE

(1) Inert Fluid: safe for oxygen service.
(2) 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

(3) Certificate for use in Hazardous Locations (CEPEL, NEPSI, NEMKO, EXAM, FM, CSA).
(4) Certificate for use in Hazardous Locations (CEPEL, CSA).
(5) Certificate for use in Hazardous Locations (CEPEL, NEPSI, NEMKO, EXAM).
(6) Limited values to 4 1/2 digits; limited unit to 5 characters.
(7) IPX8 tested for 10 meters of water column for 24 hours.
(8) Ingress Protection:

Produtos	CEPEL	NEMKO/EXAM	FM	CSA	NEPSI
LD29X	IP66/W	IP66/68/W	Type 4X/6/6P	Type 4X	IP67

(9) Not certified for use in hazardous locations.

MODEL	LOW COST FLANGED PRESSURE TRANSMITTER
LD291L	4-20 mA + HART®

COD.	Type	Range Limits Min.	Range Limits Max.	Unit	Range Limits Min.	Range Limits Max.	Unit
2	Level	12.5	500	mbar	5.02	201.09	inH_2O
3	Level	62.5	2500	mbar	25.13	1005.45	inH_2O
4	Level	0.625	25	bar	157.1	10054.5	inH_2O
5	Level	6.25	250	bar	90.65	3625.94	psi

COD.	Diaphragm Material (Sensor) and Fill Fluid (Sensor)
1	316L SST - Silicone Oil

COD.	Local Indicator		
0	Without Indicator	1	With Digital Indicator

COD.	Process Connection	COD.	Process Connection
U	1" 150# (ANSI B16.5)	C	3" 600# (ANSI B16.5)
V	1" 300# (ANSI B16.5)	3	4" 150# (ANSI B16.5)
W	1" 600# (ANSI B16.5)	4	4" 300# (ANSI B16.5)
O	1½" 150# (ANSI B16.5)	D	4" 600# (ANSI B16.5)
P	1½" 300# (ANSI B16.5)	5	DN25 PN 10/40
Q	1½" 600# (ANSI B16.5)	R	DN40 PN 10/10
9	2" 150# (ANSI B16.5)	E	DN50 PN10/40
A	2" 300# (ANSI B16.5)	6	DN80 PN25/40
B	2" 600# (ANSI B16.5)	7	DN100 PN10/16
1	3" 150 # (ANSI B16.5)	8	DN100 PN25/40
2	3" 300# (ANSI B16.5)	Z	User´s specifications

COD.	Electrical Connection	COD.	Electrical Connection
0	1/2 - 14 NPT **(3)**	5	1/2 - 3/4 NPTF (AI 316) - with adapter
1	1/2 - 14 NPT X 3/4 NPT (AI 316) - with adapter **(4)**	A	M20 X 1.5 **(5)**
2	1/2 - 14 NPT X 3/4 BSP (AI 316) - with adapter **(13)**	B	PG 13.5 DIN **(5)**
3	1/2 - 14 NPT X 1/2 BSP (AI 316) - with adapter **(13)**	Z	User´s specifications
4	1/2 - 1/2 NPTF (AI 316) - with adapter		

COD.	Type and Material Flange	COD.	Type and Material Flange
4	304 SST (slip-on flange)	6	Carbon Steel (slip-on flange)
5	316 SST (slip-on flange)	Z	User´s specifications

COD.	Extension Lenght	COD.	Extension Lenght	COD.	Extension Lenght
0	0 mm (0")	2	100 mm (4")	4	200 mm (8")
1	50 mm (2")	3	150 mm (6")	Z	User´s specifications

COD.	Diaphragm Material / Extension (Process Connection)	COD.	Diaphragm Material / Extension (Process Connection)
1	316 L SST / 316 SST	5	Titanium / 316 SST **(6)**
2	Hastelloy C276 / 316 SST	6	316L SST with Teflon Lining
3	Monel 400 / 316 SST	L	316L SST with Halar Lining
4	Tantalum / 316 SST **(6)**	Z	User´s specifications

COD.	Fill Fluid (Process Connection)	COD.	Fill Fluid (Process Connection)
S	Silicone DC-200/20 Oil	H	Halocarbon 4.2 Oil
F	Inert Fluorolube MO-10 Oil **(7)**	N	Propileno Glicol (Neobee) Oil
D	Silicone DC-704 Oil	T	Syltherm 800 Oil
K	Krytox Oil	Z	User´s specifications

COD.	Lower Housing Material	COD.	Lower Housing Material
0	Without Lower Housing	4	Duplex (UNS 31803)
1	316L SST	5	304L SST
2	Hastelloy C276	Z	User´s specifications
3	Super Duplex (UNS 32750)		

COD.	Gasket Material	COD.	Gasket Material
0	Without Gasket	I	316L SST
C	Copper	T	Teflon (PTFE)
G	Grafoil (Flexible Lead)	Z	User´s specifications

CODE	Optional Items

LD291L	2	1	1	1	0	6	2	1	S	1	T	*

TYPICAL MODEL NUMBER

*Leave it blank when there are not optional items.

MODEL	LOW COST FLANGED PRESSURE TRANSMITTER (CONTINUATION)		
COD.	Output Signal		
G0	4-20 mA		
G4	4 - 20 mA + Output for Remote Indicator		
COD.	Housing Material (11) (12)		
H0	Aluminium (IP/TYPE)	H3	316 SST for saline atmosphere (IPW/TYPEX) **(10)**
H1	316 SST (IP/TYPE)	H4	Copper Free Aluminium (IPW/TYPEX) **(10)**
H2	Aluminium for saline atmosphere (IPW/TYPEX) **(10)**		
COD.	Identification Plate		
I1	FM: XP, IS, NI, DI	I5	CEPEL: Ex-d, Ex-ia
I3	CSA: XP, IS, NI, DI	I6	Without Certification
I4	EXAM (DMT): Ex-ia; NEMKO: Ex-d	I7	EXAM (DMT) Grupo I, M1 Ex-ia
COD.	Painting		
P0	Munsell N 6,5 Gray	P6	Epoxy Yellow
P3	Polyester Black	P8	Without Painting
P4	Epoxy White	P9	Blue Safety Base Epoxy – Eletrostatic Painting
P5	Polyester Yellow	PC	Safety Base Polyester – Eletrostatic Painting
COD.	Display Unit 1		
Y0	Percentage	Y3	Temperature (Temperature)
Y1	Current (mA)	YU	User's specification **(9)**
Y2	Pressure (Eng. Unit)		
COD.	Display Unit 2		
Y0	Percentage	Y6	Temperature (Temperature)
Y4	Current (mA)	YU	User's specification **(9)**
Y5	Pressure (Eng. Unit)		
COD.	Tag Plate		
J0	With TAG	J2	User's specification
J1	Without TAG		

LD291L	G0	H0	I1	P0	Y0	Y5	J0

← TYPICAL MODEL NUMBER

Optional Items

Special Procedures	**C1** –Degrease Cleaning (Oxygen or Chlorine Service)
Burnout	**BD** – Down Scale **BU** – Up Scale
Lower Housing Connection	**U0** – With 1 Flush Connection 1/4" NPT (if supplied with lower housing) **U1** – With 2 Flush Connections 1/4" NPT per 180º **U2** – With 2 Flush Connections 1/4" NPT per 90º **U3** – With 2 Flush Connections 1/2" - 14 NPT per 180º (with cover) **U4** – Without Flush Connection

NOTES

(1) Silicone Oils not recommendations for Oxygen (O_2) or Chlorine service.
(2) Not applicable for vacuum service.
(3) Certificate for use in Hazardous Locations (CEPEL, NEPSI, NEMKO, EXAM, FM, CSA).
(4) Certificate for use in Hazardous Locations (CEPEL, CSA).
(5) Certificate for use in Hazardous Locations (CEPEL, NEPSI, NEMKO, EXAM).
(6) Attention, check corrosion rate for the process, tantalum plate 0.1 mm, AISI 316L extension 3 to 6mm.
(7) Fluorolube fill fluid is not available for Monel diaphragm.
(8) Inert Fluid: Safe for oxygen service.
(9) Limited values to 4 1/2 digits; limited unit to 5 characters.
(10) IPW/TYPEX was tested for 200 hours according to NBR 8094 / ASTM B 117 standard.
(11) IPX8 tested for 10 meters of water column for 24 hours.
(12) Ingress Protection:

Products	CEPEL	NEMKO/EXAM	FM	CSA	NEPSI
LD29X	IP66/W	IP66/68/W	Type 4X/6/6P	Type 4X	IP67

(13) Not certified for use in hazardous locations.

MODEL	PRESSURE TRANSMITTER WITH EXTENDED PROBE
LD291I	4-20 mA + HART®

COD.	Type	Range Limits		
		Min.	Max.	Unit
2	Level	12.5	500	mbar

COD.	Diaphragm Material and Fill Fluid
1	316L SST – Silicon Oil **(1)**

COD.	Local Indicator
0	Without Indicator
1	With Indicator

COD.	Fixing Transmitter		
1	Bracket in L	Z	User's specification
2	Flanged Bracket		
3	Triclamp 3" **(10)**		

COD.	Electrical Connection		
0	1/2 - 14 NPT **(2)**	A	M20 X 1.5 **(4)**
1	1/2 - 14 NPT X 3/4 NPT (316 SST) – with adapter **(3)**	B	PG 13.5 DIN **(4)**
2	1/2 - 14 NPT X 3/4 BSP (316 SST) - with adapter **(5)**	Z	User's specification
3	1/2 - 14 NPT X 1/2 BSP (316 SST) - with adapter **(5)**		
4	1/2 - 1/2 NPTF (316 SST) - with adapter		
5	1/2 - 3/4 NPTF (316 SST) - with adapter		

COD.	Probe Material/Diaphragm (Wetted Parts)
A	304L SST / 316L SST
I	316L SST / 316L SST
U	316L SST / Hastelloy C276
Z	User's specification

COD.	Probe Length	COD.	Probe Length
1	500 mm	6	1600 mm
2	630 mm	7	2000 mm
3	800 mm	8	2500 mm
4	1000 mm	9	3200 mm
5	1250 mm	Z	User's specification

COD.	Probe Fill Fluid
N	Propileno Glicol Oil (Neobee M20) **(10)**
Z	User's specification

COD.	Optional Items

LD291I	2	1	1	3	A	I	1	N	*	← TYPICAL MODEL

*Leave blank for no optional items.

MODEL	PRESSURE TRANSMITTER WITH EXTENDED PROBE (CONTINUATION)		
COD.	**Output Signal**		
G0	4-20 mA		
G4	4-20 mA + Output for Remote Indicator		
COD.	**Housing Material (8) (9)**		
H0	Aluminium (IP/TYPE)	**H3**	316 SST for saline atmosphere (IPW/TYPEX) **(7)**
H1	316 SST (IP/TYPE)	**H4**	Copper Free Aluminium (IPW/TYPEX) **(7)**
H2	Aluminium for saline atmosphere (IPW/TYPEX) **(7)**		
COD.	**Identification Plate**		
IN	CEPEL: Ex-ia		
COD.	**Painting**		
P0	Munsell N 6,5 Gray	**P6**	Epoxy Yellow
P3	Polyester Black	**P8**	Without Painting
P4	Epoxy White	**P9**	Blue Safety Base Epoxy – Eletrostatic Painting
P5	Polyester Yellow	**PC**	Safety Base Polyester – Eletrostatic Painting
COD.	**Display Unit 1**		
Y0	Percentage	**Y3**	Temperature (Temperature)
Y1	Current (mA)	**YU**	User Specification **(6)**
Y2	Pressure (Eng. Unit)		
COD.	**Display Unit 2**		
Y0	Percentage	**Y6**	Temperature (Temperature)
Y4	Current (mA)	**YU**	User Specification **(6)**
Y5	Pressure (Eng. Unit)		
COD.	**Tag Plate**		
J0	With TAG	**J2**	User Specification
J1	Without TAG		

LD291I	G0	H0	IN	P0	Y0	Y5	J0	*

← TYPICAL MODEL NUMBER

Optional Items

Special Procedures	**C1** –Degrease Cleaning (Oxygen or Chlorine Service) **C4** - Polishing of the sanitary connections according to 3A Certification **(10)**
Burnout	**BD** – Down Scale **BU** – Up Scale
Special Characteristics	**ZZ** – User's specifications

NOTES

(1) Silicone Oils not recommendations for Oxygen (O_2) or Chlorine service.
(2) Certificate for use in Hazardous Locations (CEPEL, NEPSI, NEMKO, EXAM, FM, CSA).
(3) Certificate for use in Hazardous Locations (CEPEL, CSA).
(4) Certificate for use in Hazardous Locations (CEPEL, NEPSI, NEMKO, EXAM).
(5) Not certified for use in hazardous locations.
(6) Limited values to 4 1/2 digits; limited unit to 5 characters.
(7) IPW/TYPEX was tested for 200 hours according to NBR 8094 / ASTM B 117 standard.
(8) IPX8 tested for 10 meters of water column for 24 hours.
(9) Ingress Protection:

Products	CEPEL	NEMKO/EXAM	FM	CSA	NEPSI
LD29X	IP66/W	IP66/68/W	Type 4X/6/6P	Type 4X	IP67

(10) 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

Appendix A

CERTIFICATIONS INFORMATIONS

European Directive Information

Authorized representative in European Community
Smar Gmbh-Rheingaustrasse 9-55545 Bad Kreuzanach

PED Directive (97/23/EC) – Pressure Equipment Directive
This product is in compliance with the directive and it was designed and manufactured in accordance with sound engineering practice using several standards from ANSI, ASTM, DIN and JIS.

EMC Directive (2004/108/EC) - Eletromagnetic Compatibility
The EMC test was performed according to IEC standard: IEC61326-1:2006, IEC61326-2-3:2006, IEC61000-6-4:2006, IEC61000-6-2:2005. For use in environment only.
Keep the shield insulated at the instrument side, connecting the other one to the ground if necessary to use shielded cable.

ATEX Directive (94/9/EC) – Equipment and protective systems intended for use in potentially explosive atmospheres.
This product was certified according European Standards at NEMKO and EXAM (old DMT). The certified body for manufacturing quality assessment is EXAM (number 0158).

LVD Directive 2006/95/EC – Electrical Equipment designed for use within certain voltage limits
According the LVD directive Annex II the equipment under ATEX “Electrical equipment for use in an explosive atmosphere” directive are excluded from scope from this directive.

The EC declarations of conformity for all applicable European directives for this product can be found at **www.smar.com.**

Other Aprovals

FMEDA Report

Certifier Body: Exida
Failure Modes, Effects and Diagnostics Analysis (Report No. R02 / 11-19).

Hazardous Locations General Information

Ex Standards:
Ex Standards:
IEC 60079-0: 2008 General Requirements
IEC 60079-1:2009 Flameproof Enclosures “d”
IEC 60079-11:2009 Intrinsic Safety “i”
IEC 60079-26:2008 Equipment with equipment protection level (EPL) Ga
IEC 60529:2005 Classification of degrees of protection provided by enclosures (IP Code)

Customer responsibility:
IEC 60079-10 Classification of Hazardous Areas
IEC 60079-14 Electrical installation design, selection and erection
IEC 60079-17 Electrical Installations, Inspections and Maintenance

Warning:
Explosions could result in death or serious injury, besides financial damage. Installation of this instrument in an explosive environment must be in accordance with the national standards and according to the local environmental protection method. Before proceeding with the installation match the certificate parameters according to the environmental classification.

General Notes:
- **Maintenance and Repair**

The instrument modification or replaced parts supplied by any other supplier than authorized representative of Smar Equipamentos Industriais Ltda is prohibited and will void the Certification.

- **Marking Label**

Once a device labeled with multiple approval types is installed, do not reinstall it using any other approval types. Scratch off or mark unused approval types on the approval label.

- **For Ex-i protection application**

- Connect the instrument to a proper intrinsically safe barrier.
- Check the intrinsically safe parameters involving the barrier, equipment including the cable and connections.
- Associated apparatus ground bus shall be insulated from panels and mounting enclosures.
- When using shielded cable, isolate the not grounded cable end.
- Cable capacitance and inductance plus C_i and L_i must be smaller than C_o and L_o of the Associated Apparatus.

- **For Ex-d protection application**

- Only use Explosion Proof/Flameproof certified Plugs, Adapters and Cable glands.
- As the instrument is non-ignition capable under normal conditions, the statement “Seal Not Required” could be applied for Explosion Proof version regarding to electric conduits connection. (CSA Approved)
- In an Explosion-Proof/Flame-Proof installation, do not remove the instrument housing covers when powered on.

- Electrical Connection

In Explosion-Proof installations the cable entries must be connected through conduit with sealed unit or closed using metal cable gland or closed using metal blanking plug, all with at least IP66 and Ex-d certification. For enclosure with saline environment protection (W) and ingress protection (IP) applications, all NPT thread parts must apply a proper water-proof sealant (a non-hardening silicone group sealant is recommended).

- **For Ex-d and Ex-i protection application**

- The transmitter has a double protection. In this case the transmitter shall be fitted with appropriate certified cable entries Ex-d and the electric circuit supplied by a certified diode safety barrier as specified for the protection Ex-ia.

- **Environmental Protection**

- Enclosure Types (Type X): Supplementary letter X meaning special condition defined as default by Smar the following: Saline Environment approved - salt spray exposed for 200 hours at 35ºC. (Ref: NEMA 250).
- Ingress protection (IP W): Supplementary letter W meaning special condition defined as default by Smar the following: Saline Environment approved - salt spray exposed for 200 hours at 35ºC. (Ref: IEC60529).
- Ingress protection (IP x8): Second numeral meaning continuous immersion in water under special condition defined as default by Smar the following: 1 Bar pressure during 24hours. (Ref: IEC60529).

Hazardous Locations Certifications

NOTE
The IP68 sealing test (immersion) was performed at 1 bar for 24 hours. For any other situation, please consult Smar.

North American Certifications

FM Approvals

Intrinsic Safety (FM 4B9A4.AX)
IS Class I, Division 1, Groups A, B, C and D
IS Class II, Division 1, Groups E, F and G
IS Class III, Division 1

Explosion Proof (FM 4B9A4.AX)
XP Class I, Division 1, Groups A, B, C and D

Dust Ignition Proof (FM 4B9A4.AX)
DIP Class II, Division 1, Groups E, F and G
DIP Class III, Division 1

Non Incendive (FM 4B9A4.AX)
NI Class I, Division 2, Groups A, B, C and D

Environmental Protection (FM 4B9A4.AX)
Option: Type 4X/6P or Type 4/6P

CSA International (Canadian Standards Association)

Class 2258 02 – Process Control Equipment – For Hazardous Locations (CSA1111005)

Class I, Division 1, Groups B, C and D
Class II, Division 1, Groups E, F and G
Class III, Division 1
Class I, Division 2, Groups A, B, C and D
Class II, Division 2, Groups E, F and G
Class III
Dual Seal

Class 2258 03 – Process Control Equipment – Intrinsically Safe and Non-Incendive Systems – For Hazardous Locations (CSA 1111005)
Class I, Division 1, Groups A, B, C and D
Class II, Division 1, Groups E, F and G
Class III, Division 1

Model LD291 Series Pressure Transmitters, supply 12 – 42Vdc, 4-20mA; Maximum pressure 3600 psi; Enclosure Type 4/4X; intrinsically safe when connected through CSA Certified Diode Safety Barrier, 28V max, 300 ohms min, per Smar Installation Drawing 102A0435; Dual Seal.

Class 2258 04 – Process Control Equipment – Intrinsically Safe Entity – For Hazardous Locations (CSA 1111005)
Class I, Division 1, Groups A, B, C and D
Class II, Division 1, Groups E, F and G
Class III, Division 1

Model LD290 Series Pressure Transmitters, supply 12 – 42Vdc, 4-20mA; Maximum pressure 3600 psi; Enclosure Type 4/4X; intrinsically safe with Entity parameters:
Vmax = 28 V, Imax = 110 mA, Ci = 5 nF, Li = 0 uH,
when connected through CSA Certified Safety Barriers as per Smar Installation Drawing 102A0435; Dual Seal.
Note: Only models with stainless steel external fittings are Certified as Type 4X.

Special conditions for safe use:
Maximum Working Pressure: 3600psi
Maximum Ambient Temperature: 40ºC (-20 to 40 ºC)
Dual Seal (Process)

European Certifications

Certificate No: NEMKO 13 ATEX 1574X
Explosion Proof: Group II, Category 2 G, Ex d, Group IIC, Temperature Class T6, EPL Gb

Ambient Temperature: -20 to 60 ºC
Environmental Protection: IP66W/68W

Special Conditions for Safe Use
Repairs of the flameproof joints must be made in compliance with the structural specifications provided by the manufacturer. Repairs must not be made on the basis of values specified in tables 1 and 2 of EN/IEC 60079-1

The Essential Health and Safety Requirements are assured by compliance with:
EN 60079-0:2012 General Requirements
EN 60079-1:2007 Flameproof Enclosures “d”

Certificate No: DMT 01 ATEX E 059 – In progress
Group I, Category M1, Ex ia, Group I, EPL Mb
Group II, Category 1/2 G, Ex ia, Group IIC, Temperature Class T4/T5/T6, EPL Ga

Supply and signal circuit designed for the connection to an intrinsically safe 4-20 mA current loop:
Ui = 28 Vdc, Ii = 93 mA, Ci ≤ 5 nF, Li = Neg

Maximum Permissible power:

Max. Ambient temperature Ta	Temperature Class	Power Pi
85°C	T4	700mW
75°C	T4	760mW
44°C	T5	760mW
50ºC	T5	700mW
55ºC	T5	650mW
60ºC	T5	575mW
65ºC	T5	500mW
70ºC	T5	425mW
40ºC	T6	575mW

Ambient Temperature: -40ºC ≤ Ta ≤ + 85ºC

The Essential Health and Safety Requirements are assured by compliance with:
EN 60079-0:2009 General Requirements
EN 60079-11:2007 Intrinsic Safety “i”
EN 60079-26:2007 Equipment with equipment protection level (EPL) Ga

South American Certifications

Certificate No: CEPEL 95.0049X
Intrinsic Safe - Ex-ia IIC T5, EPL Ga
• Parameters: Ui = 30 Vdc Ii = 100 Ma Ci = 6,4nF Li = neg Pi=0,7 W
Ambient Temperature: (-20 ºC < Tamb <+50 ºC).

Certificate No: CEPEL 96.0039
Explosion Proof - Ex-d IIC T6 EPL Gb
Ambient Temperature: (-20 ºC < Tamb<+40 ºC).

Environment Protection: IP66/68 or IP66/68W.

Special conditions for safe use:
The certificate number ends with the letter "X" to indicate that for the version of Pressure Transmitter model LD291 equipped with housing made of aluminum alloy, only can be installed in "Zone 0" if is excluded the risk of occurs impact or friction between the housing and iron/steel itens.

The Essential Health and Safety Requirements are assured by compliance with:
ABNT NBR IEC 60079-0:2008 General Requirements
ABNT NBR IEC 60079-1:2009 Flameproof Enclosures “d”
ABNT NBR IEC 60079-11:2009 Intrinsic Safety “i”
ABNT NBR IEC 60079-26:2008 Equipment with equipment protection level (EPL) Ga
ABNT NBR IEC 60529:2005 Classification of degrees of protection provided by enclosures (IP Code)

Asian Certifications

Certificate No: Nepsi GYJ05602
Intrinsically safe - Ex ia, IIC T4/T5/T6
Ambient Temperature: -40 ºC < T_{amb} <+85 ºC
Entity Parameters: Ui = 28 Vdc Ii = 93 mA Ci ≤ 5 nF Li = neg

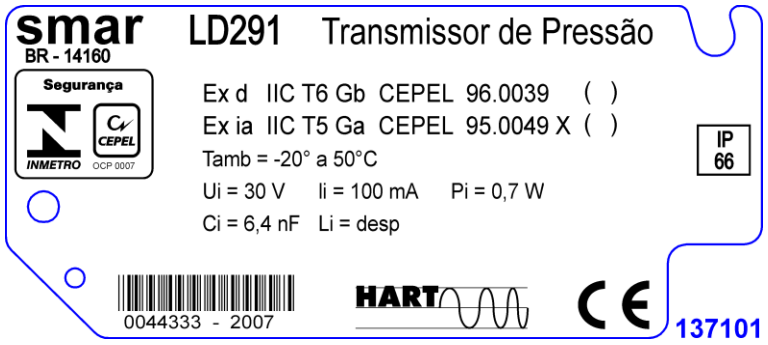
Certificate No: Nepsi GYJ05601
Explosion proof - Ex d IIC T6
Ambient Temperature: -20 ºC < T_{amb} <+40 ºC.

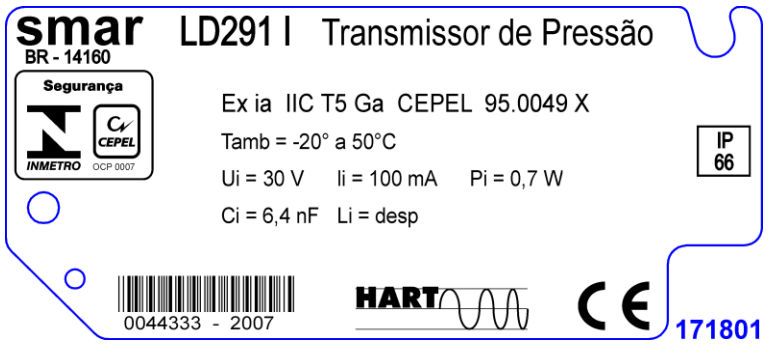
Identification Plate and Control Drawing

Identification Plate

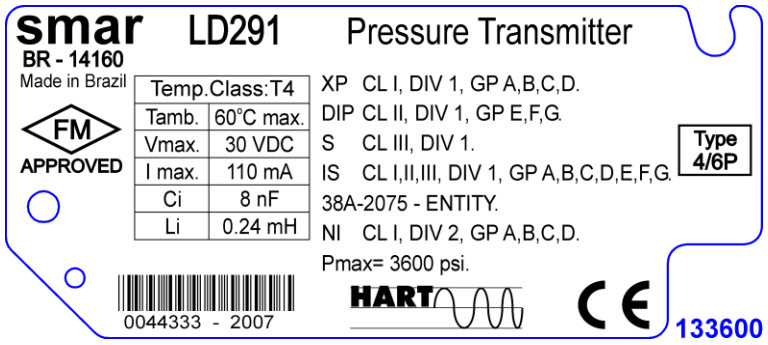
- Identification of Intrinsically Safe and Explosion Proof for gas and steam:

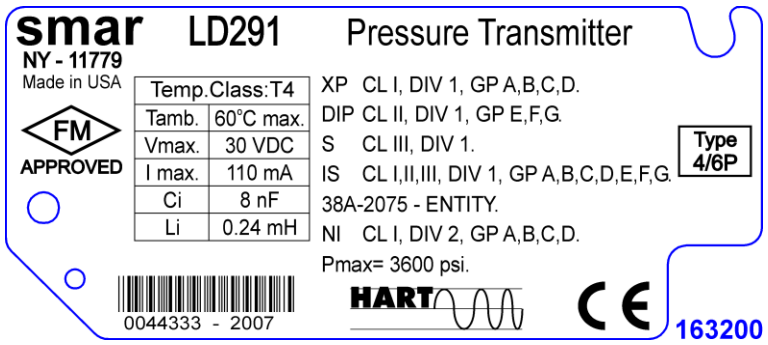
CEPEL





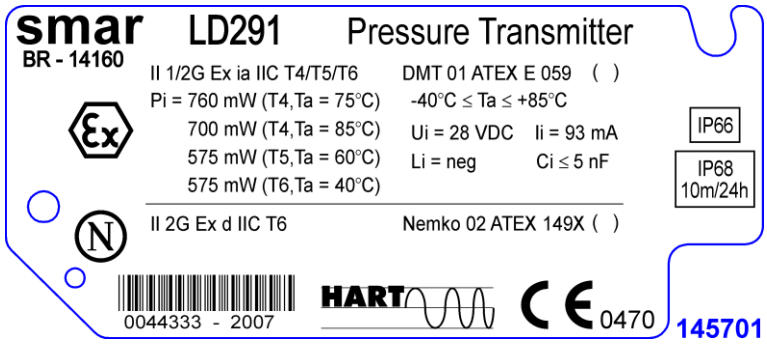
FM





CSA

NEMKO and DMT



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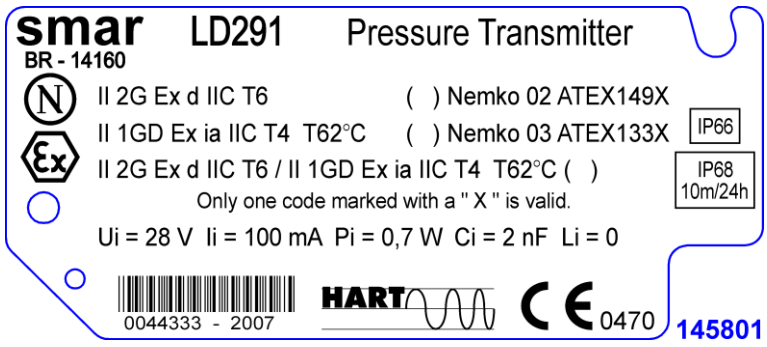

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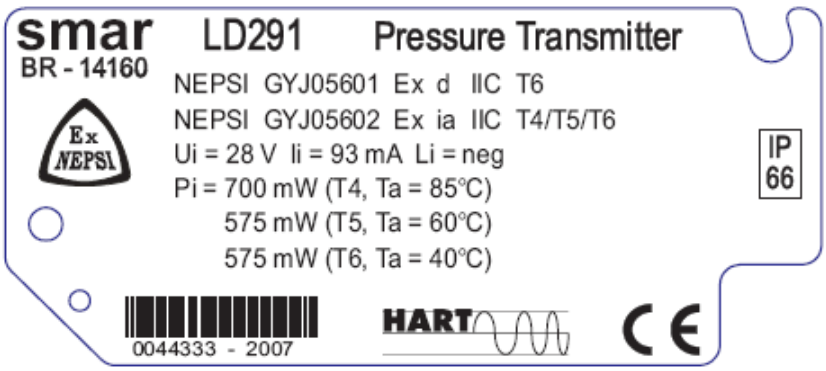
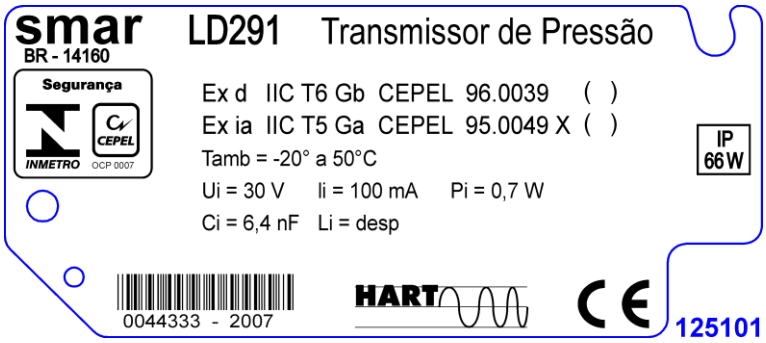
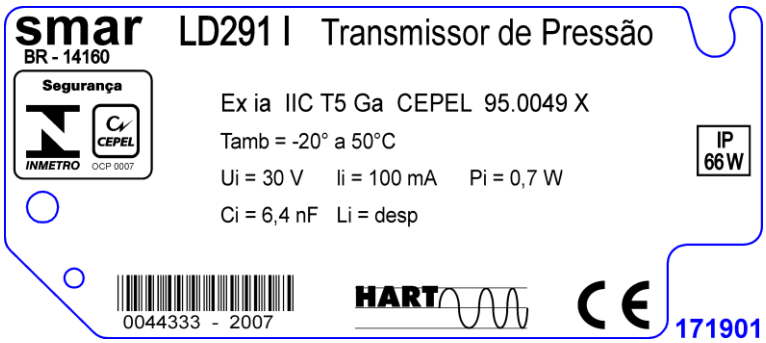


- Identification if Intrinsically Safe and Explosion Proof for saline atmospheres:

CEPEL





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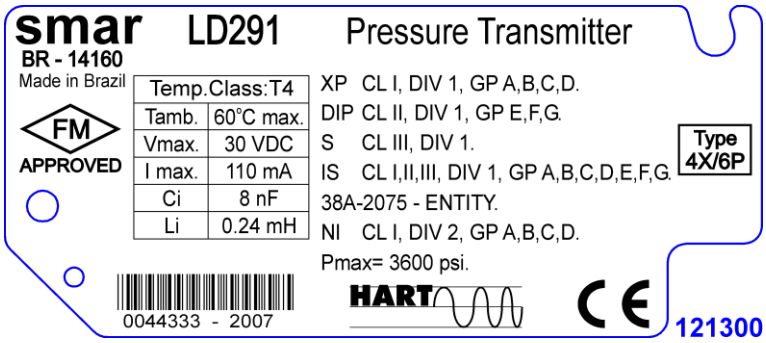
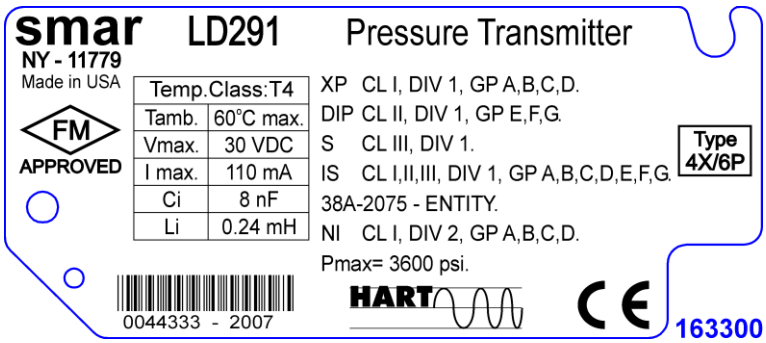
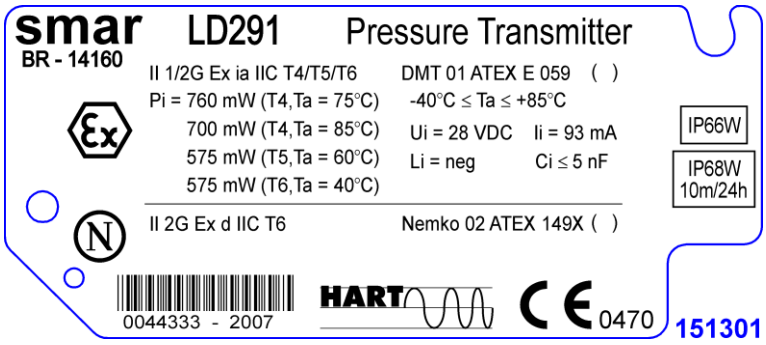




CSA

NEMKO and DMT



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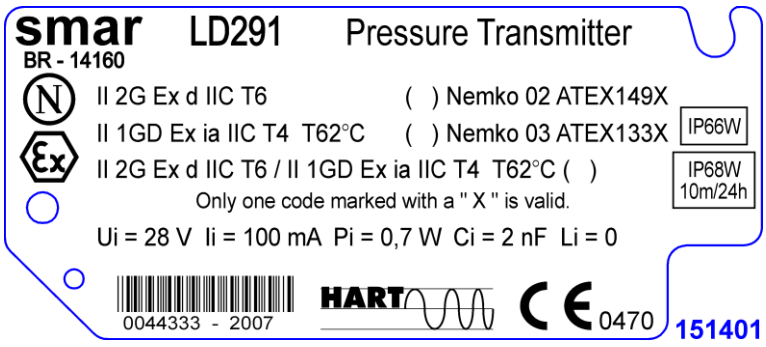

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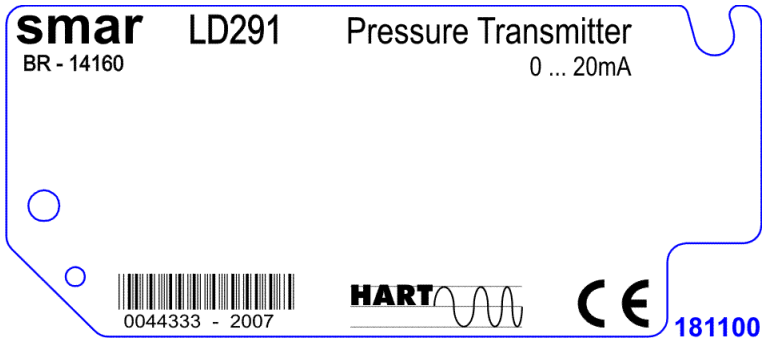
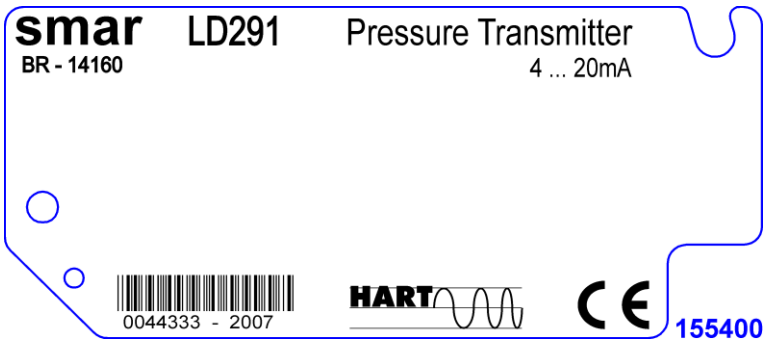
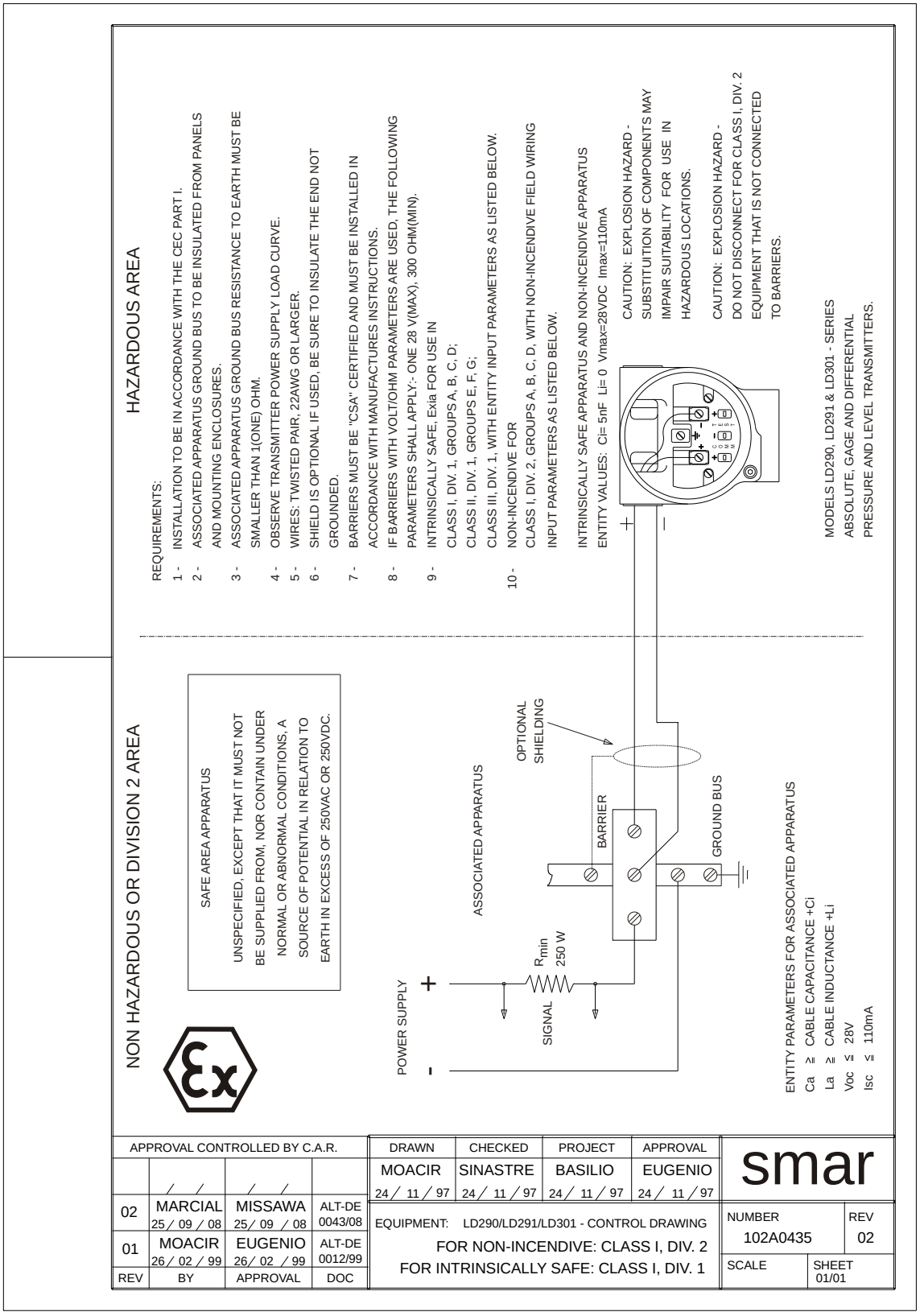



smar
LD291
Pressure Transmitter
BR - 14160
4 ... 20mA
0044333 - 2007
HART
155400

Control Drawing

CSA



APPROVAL CONTROLLED BY C.A.R.			
	/ /	/ /	
02	MARCIAL 25 / 09 / 08	MISSAWA 25 / 09 / 08	ALT-DE 0043/08
01	MOACIR 26 / 02 / 99	EUGENIO 26 / 02 / 99	ALT-DE 0012/99
REV	BY	APPROVAL	DOC

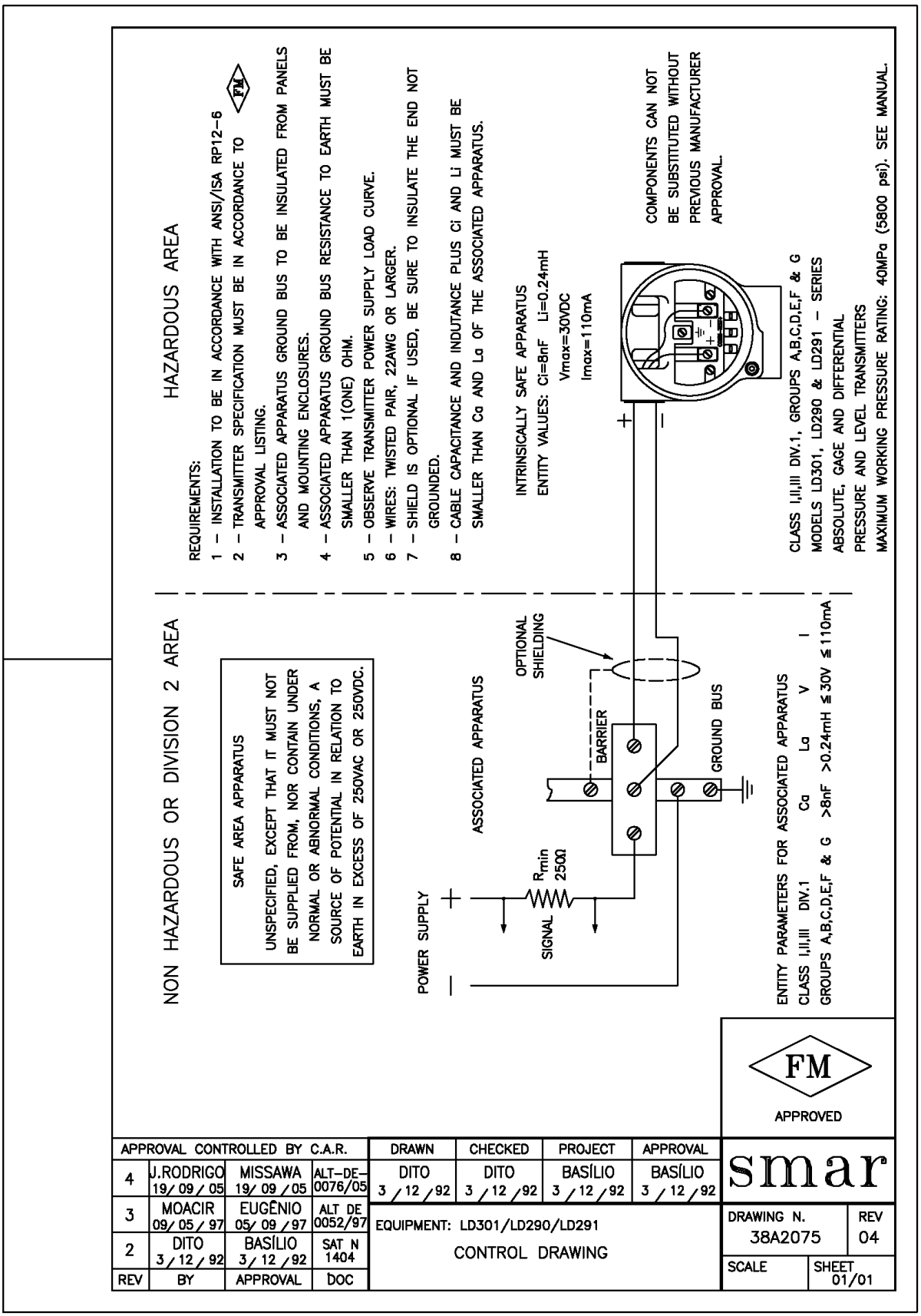
DRAWN	CHECKED	PROJECT	APPROVAL
MOACIR 24 / 11 / 97	SINASTRE 24 / 11 / 97	BASILIO 24 / 11 / 97	EUGENIO 24 / 11 / 97

EQUIPMENT: LD290/LD291/LD301 - CONTROL DRAWING
FOR NON-INCENDIVE: CLASS I, DIV. 2
FOR INTRINSICALLY SAFE: CLASS I, DIV. 1

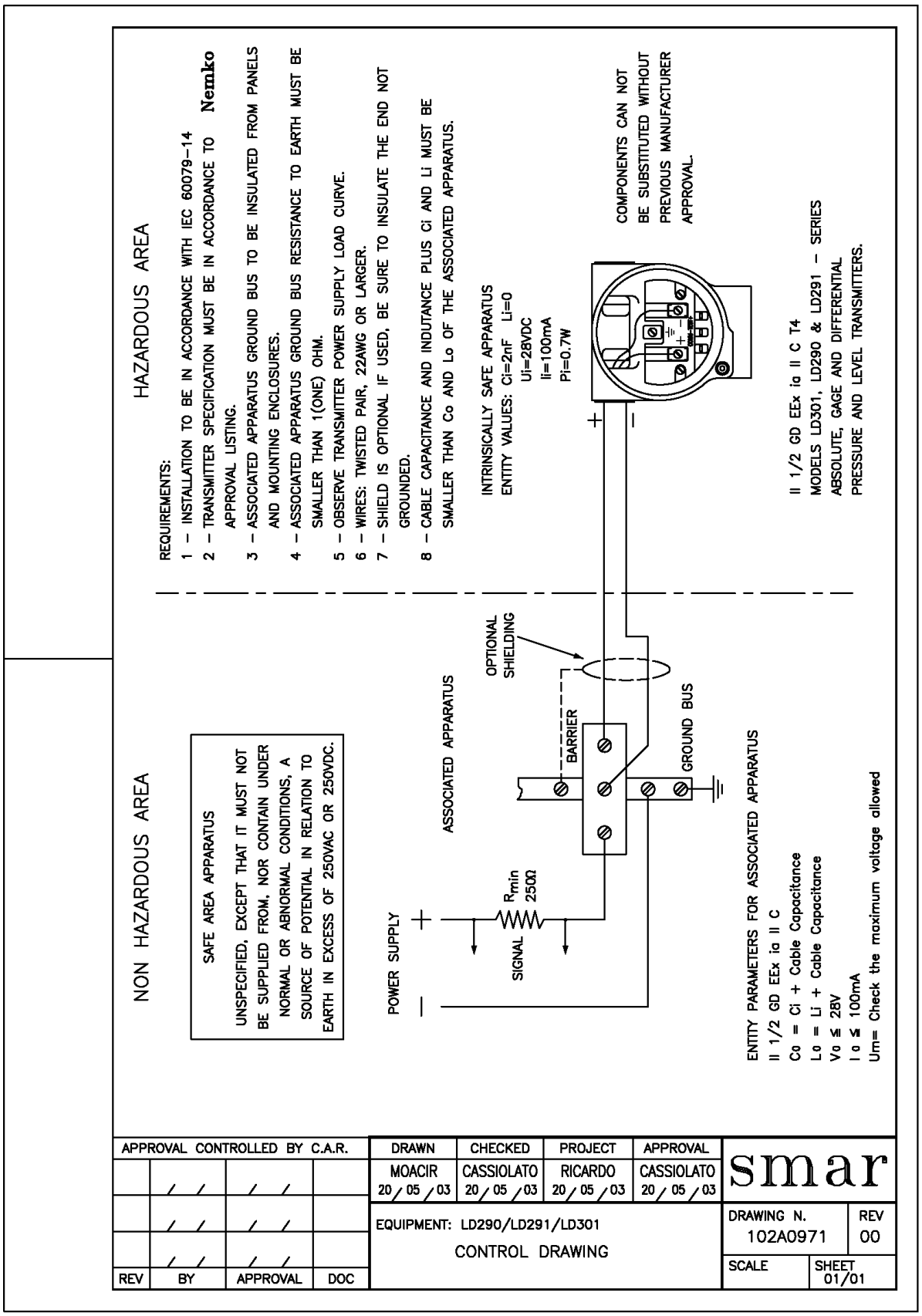
smar

NUMBER	REV
102A0435	02
SCALE	SHEET 01/01

FM


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=8nF Li=0.24mH
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
MODELS LD301, LD290 & LD291 – SERIES
ABSOLUTE, GAGE AND DIFFERENTIAL
PRESSURE AND LEVEL TRANSMITTERS
MAXIMUM WORKING PRESSURE RATING: 40MPa (5800 psi). SEE MANUAL.
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 Ca La V I
GROUPS A,B,C,D,E,F & G >8nF >0.24mH ≤ 30V ≤ 110mA
FM
APPROVED
APPROVAL CONTROLLED BY C.A.R.
REV | BY | APPROVAL | DOC
4 | J.RODRIGO 19/09/05 | MISSAWA 19/09/05 | ALT-DE-0076/05
3 | MOACIR 09/05/97 | EUGÊNIO 05/09/97 | ALT DE 0052/97
2 | DITO 3/12/92 | BASÍLIO 3/12/92 | SAT N 1404
DRAWN: DITO 3/12/92
CHECKED: DITO 3/12/92
PROJECT: BASÍLIO 3/12/92
APPROVAL: BASÍLIO 3/12/92
EQUIPMENT: LD301/LD290/LD291
CONTROL DRAWING
smar
DRAWING N. 38A2075
REV 04
SCALE
SHEET 01/01

NEMKO


HAZARDOUS AREA
NON HAZARDOUS AREA
REQUIREMENTS:
1 – INSTALLATION TO BE IN ACCORDANCE WITH IEC 60079–14
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 Co AND Lo OF THE ASSOCIATED APPARATUS.
Nemko
INTRINSICALLY SAFE APPARATUS
ENTITY VALUES: Ci=2nF Li=0
Ui=28VDC
Ii=100mA
Pi=0.7W
COMPONENTS CAN NOT BE SUBSTITUTED WITHOUT PREVIOUS MANUFACTURER APPROVAL.
II 1/2 GD EEx ia II C T4
MODELS LD301, LD290 & LD291 – SERIES
ABSOLUTE, GAGE AND DIFFERENTIAL
PRESSURE AND LEVEL TRANSMITTERS.
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
II 1/2 GD EEx ia II C
Co = Ci + Cable Capacitance
Lo = Li + Cable Capacitance
Vo ≤ 28V
Io ≤ 100mA
Um= Check the maximum voltage allowed
APPROVAL CONTROLLED BY C.A.R.
REV
BY
APPROVAL
DOC
DRAWN
MOACIR 20/05/03
CHECKED
CASSIOLATO 20/05/03
PROJECT
RICARDO 20/05/03
APPROVAL
CASSIOLATO 20/05/03
smar
EQUIPMENT: LD290/LD291/LD301
CONTROL DRAWING
DRAWING N.
102A0971
REV
00
SCALE
SHEET
01/01

Appendix B

smar	**SRF – Service Request Form Pressure Transmitters**	**Proposal No.:**

Company:	**Unit:**	**Invoice:**

COMMERCIAL CONTACT		**TECHNICAL CONTACT**	
Full Name:		**Full Name:**	
Function:		**Function:**	
Phone:	**Extension:**	**Phone:**	**Extension:**
Fax:		**Fax:**	
Email:		**Email:**	

EQUIPMENT DATA

Model:	**Serial Number:**	**Sensor Number:**
Technology: **( ) 4-20 mA ( ) HART® ( ) FOUNDATION fieldbus™ ( ) PROFIBUS PA**		**Version Firmware:**

PROCESS DATA

Process Fluid:

Calibration Range		**Ambient Temperature (ºF)**		**Process Temperature (ºF)**		**Process Pressure**	
Min.:	**Max.:**	**Min.:**	**Max.:**	**Min.:**	**Max.:**	**Min.:**	**Max.:**
Static Pressure		**Vacuum**					
Min.:	**Max.:**	**Min.:**	**Max.:**				

Normal Operation Time:	**Failure Date:**

FAILURE DESCRIPTION
(Please, describe the observed behavior, if it is repetitive, how it reproduces, etc.)

OBSERVATIONS

USER INFORMATION

Company:

Contact: Title: Section:

Phone: Extension: E-mail:

Date: Signature:

For warranty or non-warranty repair, please contact your representative.
Further information about address and contacts can be found on **www.smar.com/contactus.asp**.