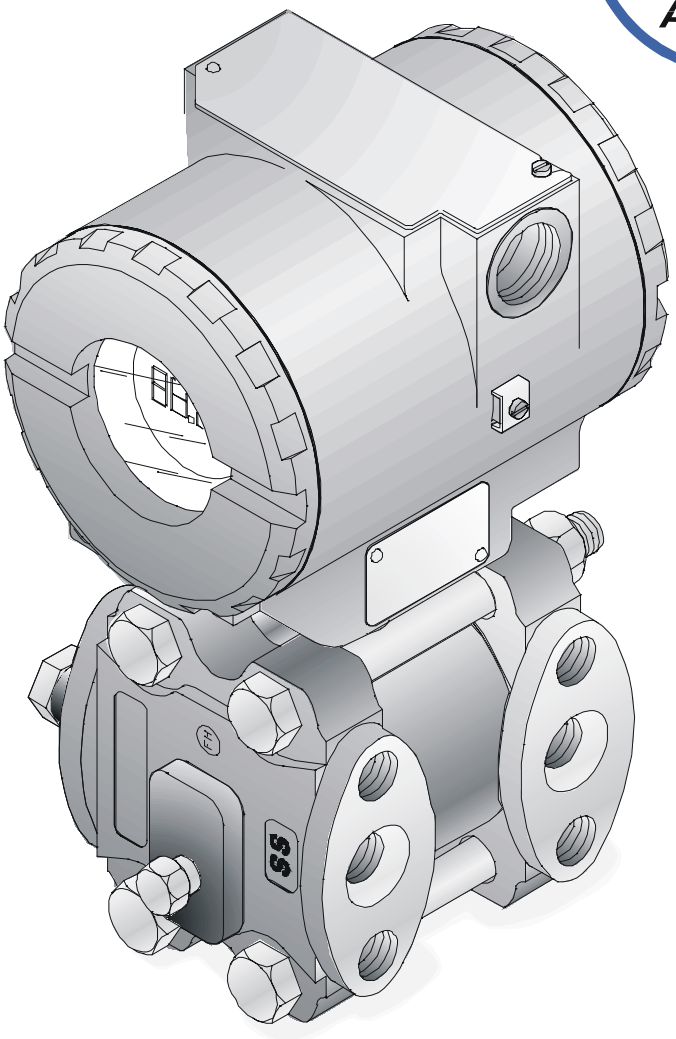
LD301

smar

OPERATION AND MAINTENANCE
INSTRUCTION / MANUAL

INTELLIGENT PRESSURE TRANSMITTER WITH CONTROL CAPABILITY

I'VE GOT HART FIELD COMMUNICATIONS PROTOCOL ABILITY



MAR / 03
LD301
VERSION 6

LD301ME

INTRODUCTION

The **LD301** is a smart pressure transmitter for differential, absolute, gauge, level and flow measurements. It is based on a field-proven capacitive sensor that provides reliable operation and high performance. The digital technology used in the **LD301** enables the choice of several types of transfer functions, an easy interface between the field and the control room and several interesting features that considerably reduce the installation, operation and maintenance costs.

The **LD301**, besides the normal functions offered by other smart transmitters, offers the following functions:

- ✓ **$\sqrt{(\Delta P)^3}$** - used for trapezoidal weirs in open channel flow metering.
- ✓ **$\sqrt{(\Delta P)^5}$** - used for V-notch weirs in open channel flow metering.
- ✓ **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.

- ✓ **CONTROLLER** - the Process Variable is compared to a Setpoint. The deviation acts on the output signal according to a PID algorithm (optional).
- ✓ **PID OUTPUT CHARACTERIZATION** - The PID output signal (MV) follows a curve determined by 16 points, which can be freely configured
- ✓ **LOCAL ADJUSTMENT** - not Only for Lower and Upper value, but input/output function, operation mode, indication, setpoint, PID parameters (optional) as well.
- ✓ **PASSWORD** - three levels for different functions.
- ✓ **OPERATION COUNTER** - shows the number of changes in each function.
- ✓ **TOTALIZATION** - flow totalization into volume or mass.
- ✓ **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 LD301 by carefully reading these instructions.

Smar's pressure transmitters are protected by U.S. patents 643379.

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

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Installation

GENERAL

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 LD301 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.

Locating 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.

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. The unused outlet connection should be plugged accordingly.

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

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.

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

MOUNTING

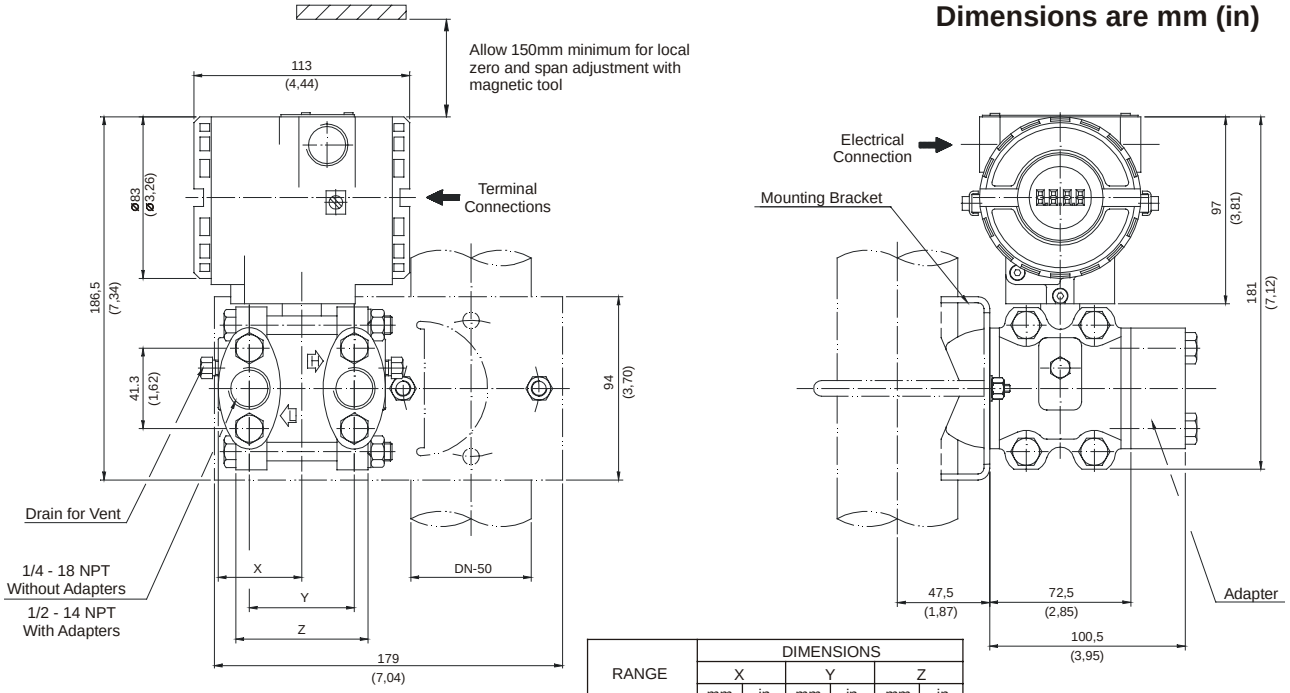
The transmitter has been designed to be both rugged and lightweight at the same time. This make its mounting easier mounting positions are shown in Figure 1.1.

Existing standards for the manifolds have also been taken into account, and standard designs fit perfectly to the transmitter flanges.

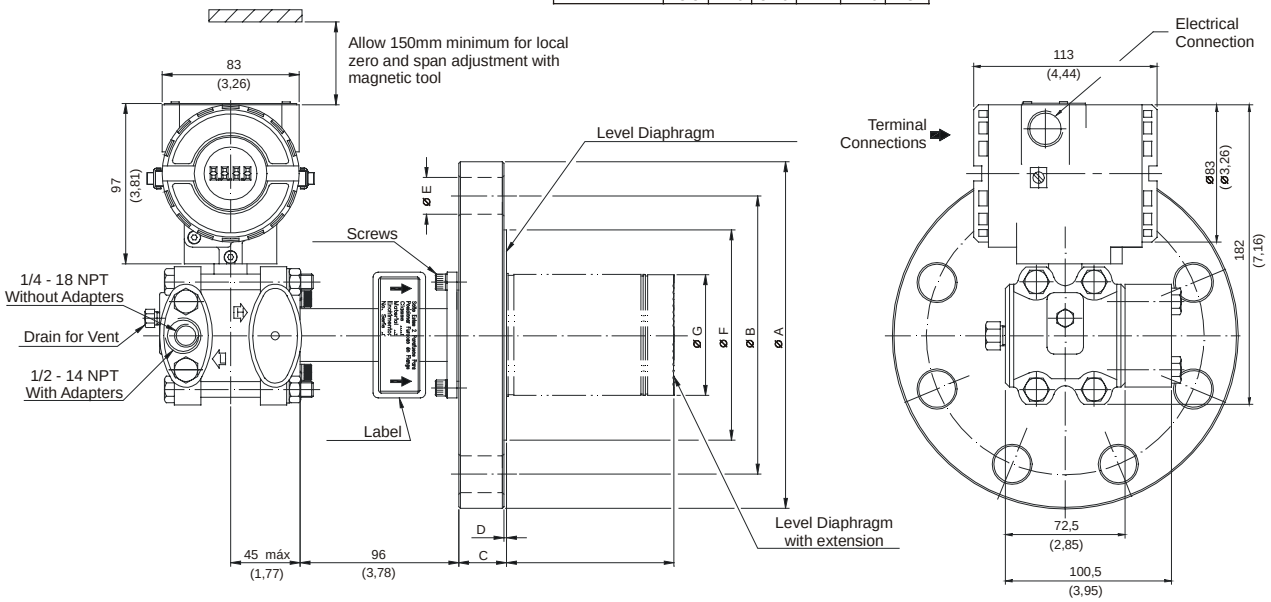
Should the process fluid contain solids in suspension, install valves or rod-out fittings at regular intervals to clean out the pipes.

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).

Dimensions are mm (in)



RANGE	DIMENSIONS					
	X		Y		Z	
	mm	in	mm	in	mm	in
F1 - F2 - F3	43.5	1.71	54.0	2.13	68.0	2.68
F4	44.5	1.75	56.0	2.20	70.0	2.76
F5	45.0	1.77	57.2	2.25	70.6	2.78
F6	45.5	1.79	57.6	2.27	71.6	2.82



ANSI-B 16.5 - DIMENSIONS									
p	class	A	B	C	D	E	F	G	X
2”	150	152.4	120.7	22	1.6	19.1	91.9	48	4
	300	165.1	127	22.8	1.6	19.1	91.9	48	8
	600	165.1	127	32.3	6.4	19.1	91.9	48	8
3”	150	190.5	152.4	24.4	1.6	19.1	127	73	4
	300	209.5	168.1	29	1.6	22.2	127	73	8
	600	209.5	168.1	38.7	6.4	22.2	127	73	8
4”	150	228.6	190.5	24.4	1.6	19.1	158	96	8
	300	254	200	32.2	1.6	22.3	158	96	8
	600	273	215.9	45	6.4	25.4	158	96	8

DIN 2501 / 2526 form D - DIMENSIONS									
DN	PN	A	B	C	D	E	F	G	X
50	10/40	165	125	20	3	18	102	48	4
80	10/40	200	160	24	3	18	138	73	8
100	10/16	220	180	20	3	18	158	96	8
	25/40	235	190	24	3	22	162	96	8

Fig. 1.1 – Dimensional Drawing and Mounting Position for LD301

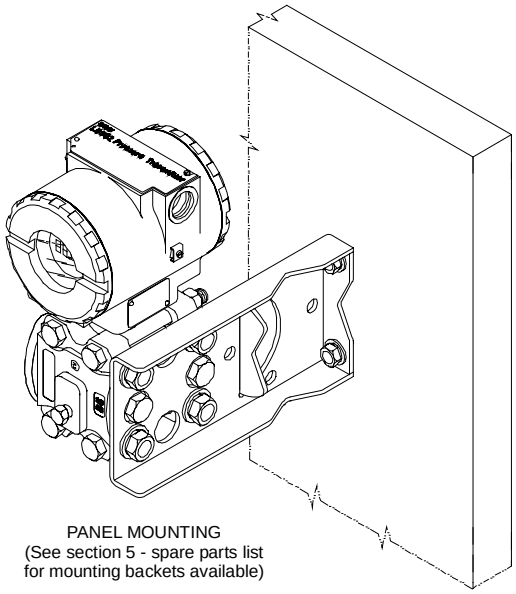


Fig. 1.2 – Drawing Mounting of LD301 on the Panel

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

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 LD301 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.

ELECTRONIC HOUSING ROTATION

The electronic housing can be rotated in order to better position the digital display. To rotate it, use the Housing Rotation Set Screw, see Figure 1.4

WARNING: EXPLOSION PROOF INSTALLATIONS
The electronic housing and the sensor assembly in potentially explosive atmospheres must have a minimum of 6 threads fully engaged. The provided joint allows 1 turn extra. Try to adjust the display window position by rotating the housing clockwise. If the thread reaches the end before the desired position, then rotate the housing counterclockwise, but not by more than one turn of the thread end. Transmitters have a stopper that restricts housing rotation to one turn. See Section 5, Figure 5.1.

The digital display itself can also be rotated. See Section 5, Figure 5.4.

NOTE
The process flange of the level transmitters can be rotated ±45º. To do this just loosens the two screws (Fig. 1.1) and rotate the flange. Do not take the screws out. There is a label (Fig. 1.1) on the transmitter with these instructions

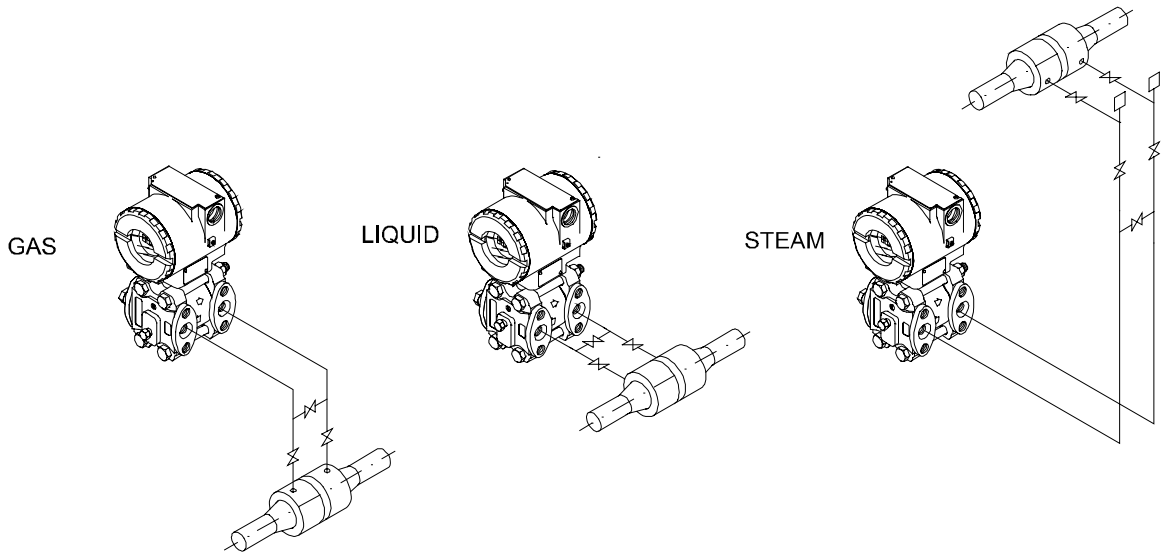


Fig 1.3 – Position of the Transmitter and Taps

ELECTRIC WIRING

Reach the wiring block by removing the Electrical Connection Cover. This cover can be locked closed by the cover locking screw (Figure 1.4). To release the cover, rotate the locking screw clockwise.

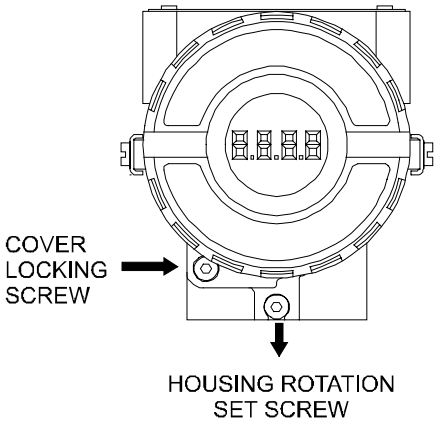


Fig. 1.4 – Housing Rotating Set Screw

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

HAZARDOUS AREAS
In hazardous areas with explosion proof requirements, the covers must be tightened with at least 8 turns. In order to avoid the penetration moisture or corrosive gases, tighten the O'ring until feeling the O'ring touching the housing. Then, tighten more 1/3 turn (120°) to guarantee the sealing. Lock the covers using the locking screw.
In hazardous zones with intrinsically safe or nonincendive requirements, the circuit entity parameters and applicable installation procedures must be observed.
Cable access to wiring connections is obtained by one of the two conduit outlets. Conduit threads should be sealed by means of code-approved sealing methods. The unused outlet connection should be plugged and sealed accordingly.
Explosion proof, nonincendive and intrinsic safety Factory Mutual certification are standards for **LD301** (see control drawing in Appendix A).
Should other certifications be necessary, refer to the certification or specific standard for installation limitations.

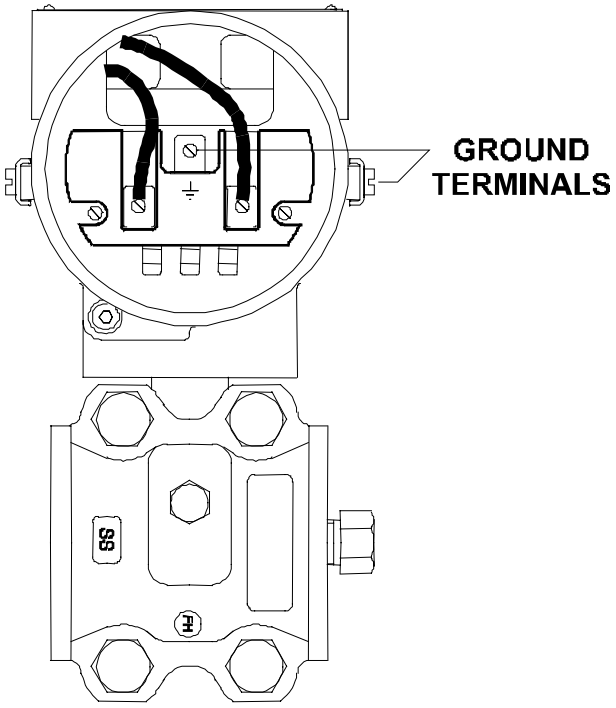


Fig. 1.5 – Wiring Block

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 unused outlet connection should be plugged and sealed accordingly.

The **LD301** is protected against reverse polarity.

The Figure 1.6 - Conduit Installation Diagram, shows the correct installation of the conduit, in order to avoid penetration of water, or other substance, which may cause malfunctioning of the equipment.

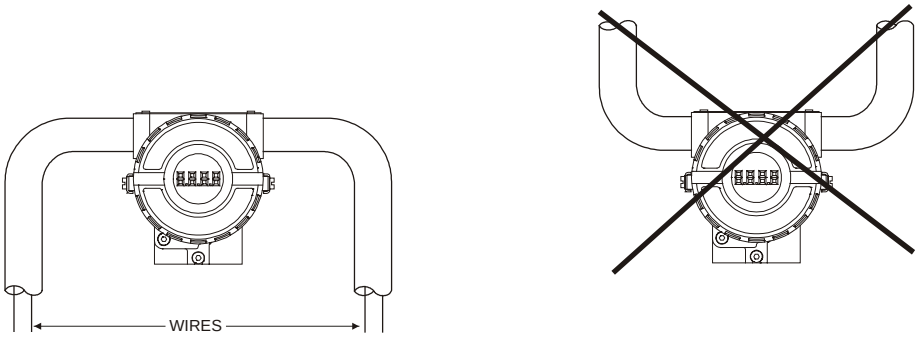


Figure 1.6 - Conduit Installation Diagram.

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.

When the sensor is in the horizontal position, the weight of the fluid pushes the diaphragm down, making it necessary a Lower Pressure Trim.

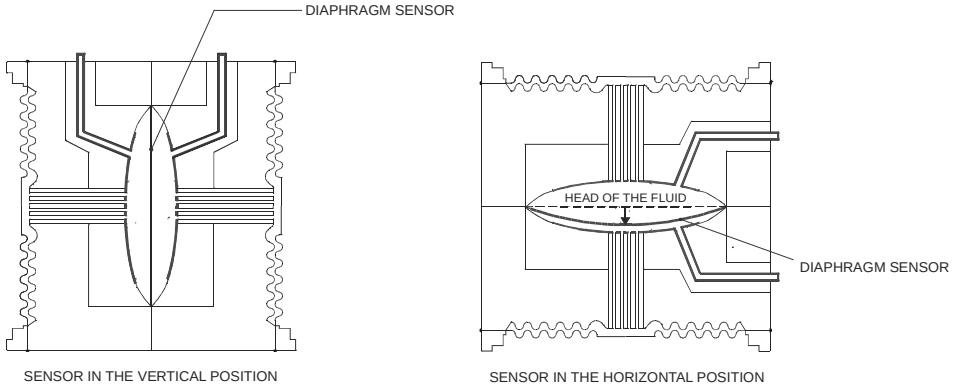


Fig.1.7 - Sensor Positions

Connection of the **LD301** working as transmitter should be done as in Figure 1.8.

Connection of the **LD301** working as a controller should be as indicated in Figure 1.9.

Connection of the **LD301** in multidrop configuration should be done as in Figure 1.10. 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 Hand-Held Terminal 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.

NOTE:
Make sure that the transmitter is operating within the operating area as shown on the load curve (Figure 1.11). Communication requires a minimum load of 250 Ohm.

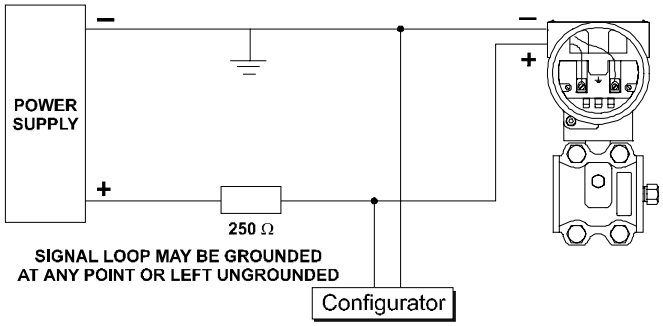


Fig. 1.8 - Wiring Diagram for the LD301 Working as a Transmitter

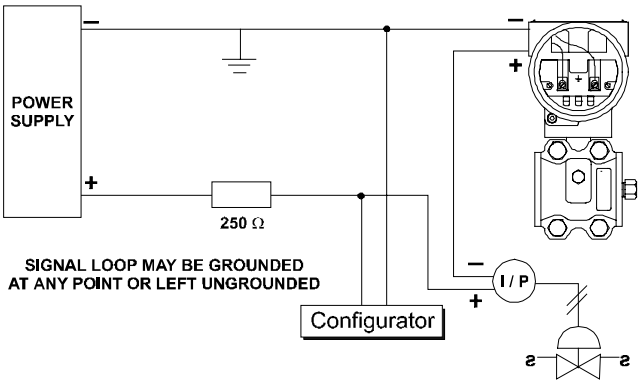


Fig. 1.9 - Wiring Diagram for the LD301 Working as a Controller (Optional)

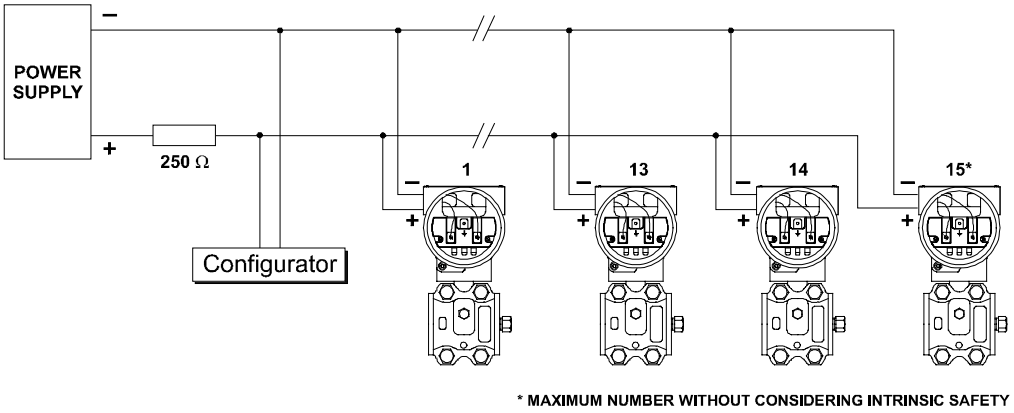


Fig. 1.10 - Wiring Diagram for the LD301 in Multidrop Configuration

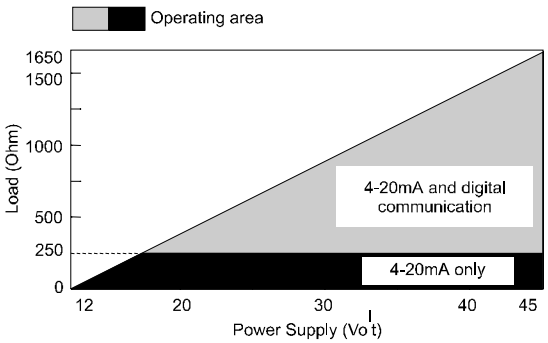


Fig. 1.11 – Load Curve

Operation

FUNCTIONAL DESCRIPTION - SENSOR

The **LD301** Series Intelligent Pressure Transmitters use capacitive sensors (capacitive cells) as pressure sensing elements, as shown in Figure 2.1.

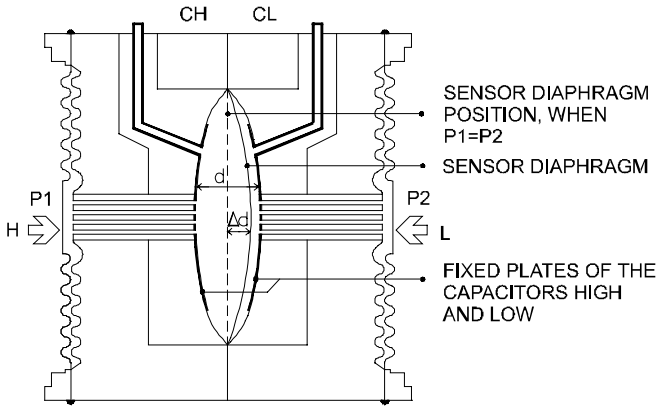


Fig. 2.1 *– Capacitive Cell*

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 $\Delta P = P_1 - P_2$.

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

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

Where,

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

Should *CH* and *CL* be considered as capacitances of flat and parallel plates with identical areas, then:

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

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

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

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

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

as 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.

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
Controls 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 providers the data exchange between the se serve-master digital communication . The transmitter demodulates information from the current line, then modulates the relies sending then 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 LD301, in the transmitter mode, shows failure indication at 3.6 mA if configured for low signal failure; at 21 mA, if configured for high signal failure; 3.8 mA in the case of low saturation; 20.5 mA in the case of high saturation 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.

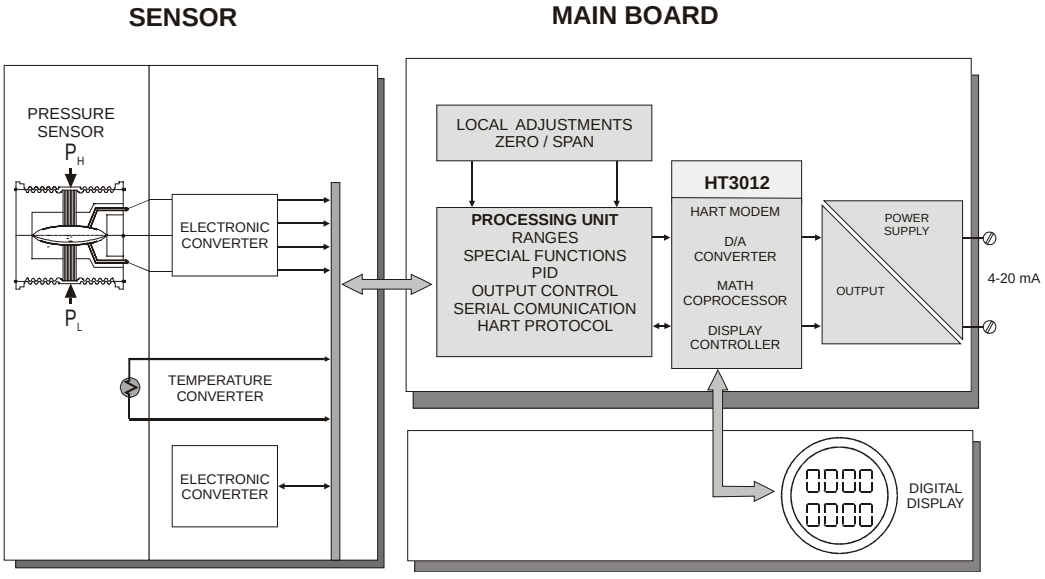


Fig. 2.2 *– LD301 Block Diagram Hardware*

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 that are magnetically activated. The magnetic tool without mechanical or electrical contact can activate them.

FUNCTIONAL DESCRIPTION - SOFTWARE

Factory Characterization
Calculates 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%.
This value (in seconds) may be freely configured by the user.

Customer Characterization
The characterization TRIM points P1-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
Used to set the pressure values corresponding to the output 4 and 20 mA. In transmitter mode the LOWER-VALUE is the point corresponding to 4 mA, and UPPER-VALUE is the point corresponding to 20 mA. In PID mode the LOWER-VALUE corresponds to MV = 0% and UPPER-VALUE corresponds to MV = 100%.

Function
Depending on the application, the transmitter output or controller PV may have the following characteristics according to the applied pressure: *Linear* (for pressure, differential pressure and level measurement); *Square-root* (for flow measurement with differential pressure producers) and *Square-root of the Third and Fifth power* (for flow measurements in open channels). The function is selected with FUNCTION.

Customer Linearization
This block relates the output (4-20 mA or Process Variable) 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 (X_i) and in percent of the output (Y_i). 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.

Setpoint
Is the desired value in the process variable when the controller is activated. The operator in the \CONTR\INDIC option adjusts it.

PID
First, the error is calculated: SP-PV (DIRECT ACTION) or PV-SP (REVERSE ACTION), then the MV (manipulated value) is calculated, according to the algorithm of the PID. The PID output signal may follow a curve determined by the user, in up to 16 configurable points. If the table is enabled, there will be a display indication (F(X)).

Auto/Manual
The Auto/Manual mode is configured in CONTR/INDIC. With the PID in Manual, the MV can be adjusted by the user in the range LOW LIMIT to HIGH LIMIT (adjustable by the user) in the CONTR/LIM-SEG option. The POWER-ON option is used here to determine in which mode the controller should be upon powering it on.

Limits
This block makes sure that the MV does not go beyond its minimum and maximum limits as established by the HIGH-LIMIT and LOW-LIMIT. It also makes sure that the Rate-of-Change does not exceed the value set in OUT-CHG/S.

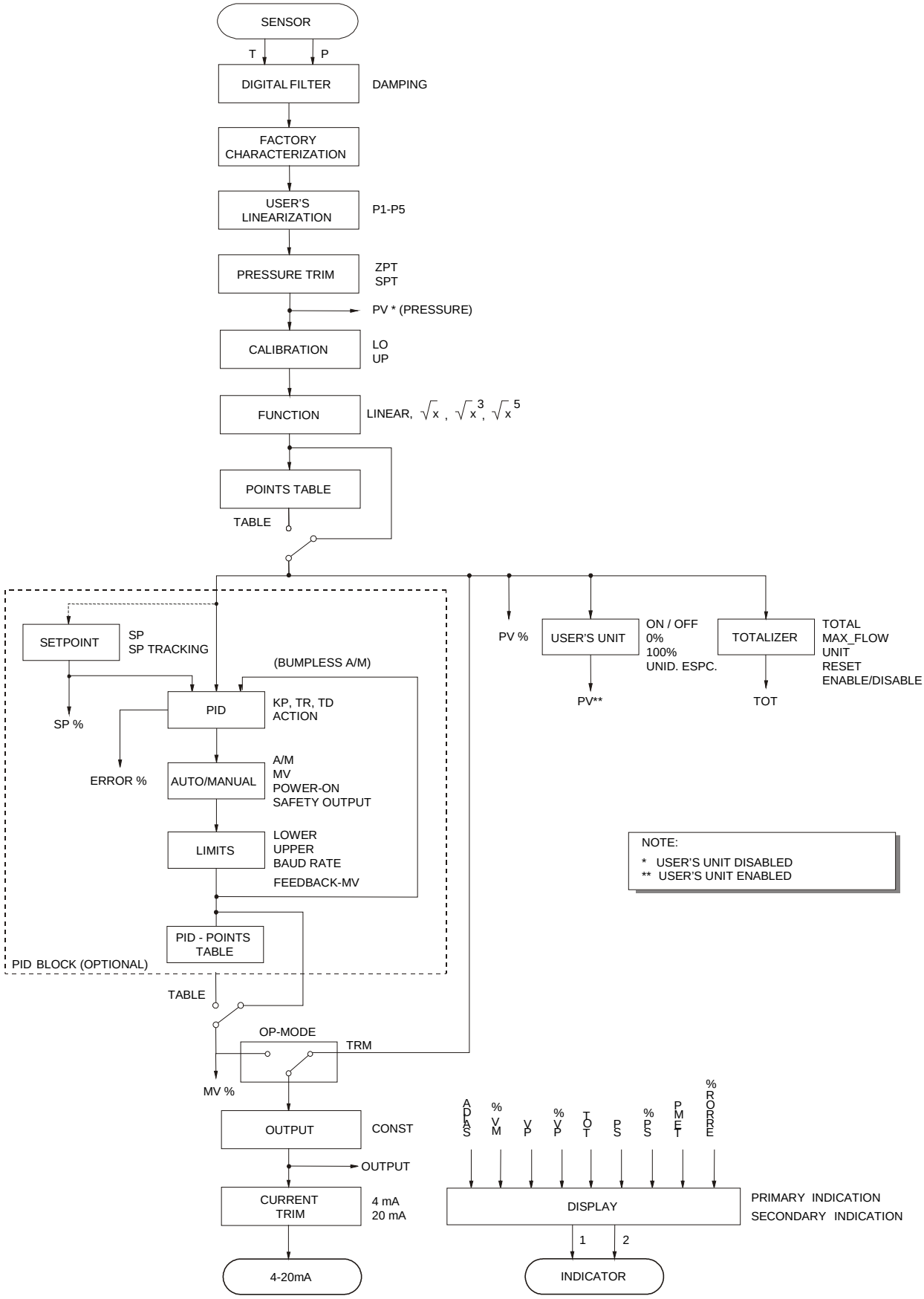


Fig.2.3 – LD301 – Software Block Diagram

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 flow indication from a level or differential pressure measurement, respectively. A unit for the variable can also be selected.

Totalization
Used for flow to application totalize the accumulated total since the last reset, getting the volume or the transferred.
The totalized value is persistent; the totalization may proceed even after a power failure. Only the totalization residue value is discarded.

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 ½ numeric digits, a field with 5 alphanumeric digits and an information field, as shown on Figure 2.4.

When the total is displayed, the significant most part appears in the unit and function field (upper) and the least significant part in the variable field (lower). See Totalization in Section 3.

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 **LD301** 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).

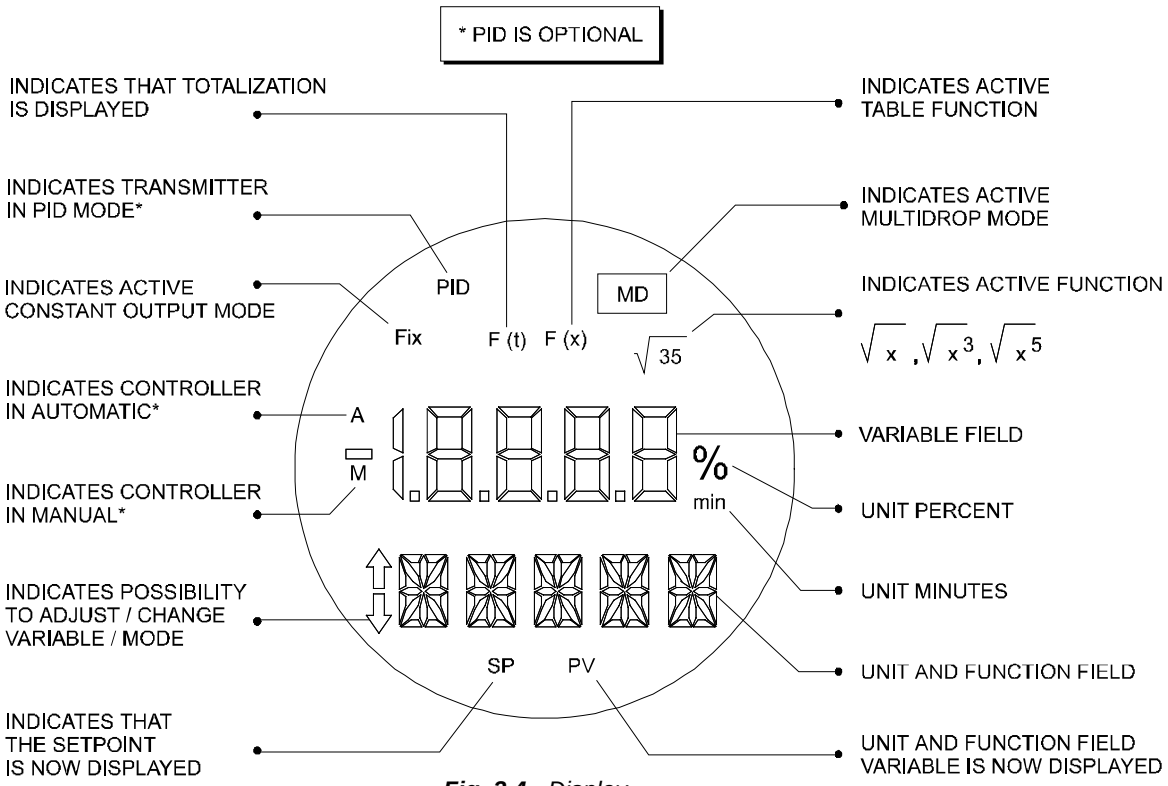


Fig. 2.4 *- Display*

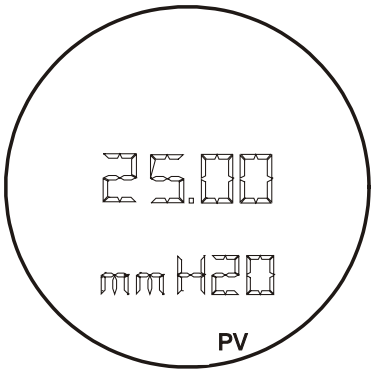


Fig. 2.5 *– Typical Monitoring Mode Display Showing PV, in this case 25.00 mmH_20*

NEW

DISPLAY	DESCRIPTION
INIT	The **LD301** is in initializing after power on.
CHAR	The **LD301** is characterization mode. See Section 3 – Trim.
FAIL SENS	Sensor failure. Refer to Section 5 - Maintenance.
SAT	Current output saturated in 3.6 or 21 mA. See Section 5 – Maintenance.

Table 2.1 *- Display Messages*

Configuration

The **LD301** 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 transmitters output current is kept constant, with a consumption of 4 mA each. If the acknowledgement mechanism is via Tag, the transmitters addresses may be "0" while, their output current is still being controlled, even in a multidrop configuration.

In the case of the **LD301**, which can be configured both as Transmitter as a Controller; the HART® addressing is used as follows:

TRANSMITTER MODE - The "0" address causes the **LD301** to control its output current and addresses "1" through "15" place the **LD301** in the multidrop mode with current control.

CONTROLLER MODE - The **LD301** always controls the output current, in accordance with the value calculated for the Controlled Variable, regardless of its network address.

NOTA

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:

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

$Voc \leq min\ [Vmax_j]$ $\quad Isc \leq min\ [Imax_j]$

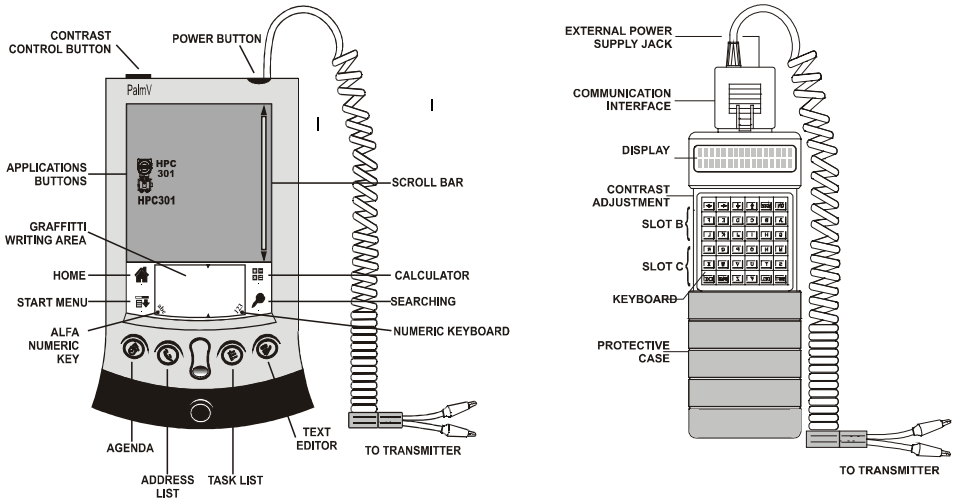
Where:
Ca, La - Barrier Allowable Capacitance and Inductance
Ci_j, Li_j - Non protected internal Capacitance/Inductance of transmitter *j (j = up to 15)*
Cc, *Lc* - Cable capacitance and Inductance
V_{oc} - Barrier open circuit voltage
I_{sc} - Barrier short circuit current
$Vmax_j$ - Maximum allowable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

$Imax_j$ - Maximum allowable current to be applied to the instrument *j*

The **LD301** 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 - **LD301** Intelligent Pressure Transmitter.

Smar developed two types of Configurators for its HART® devices: HT2 Configurator (old) and HPC301 Configurator (current). The HT2 Configurator uses the PSION pocket computer platform and the HPC301 uses the up-to-date technology of Palm Vx Handheld computers. The operational details of each configurator are described on their specific manuals.

Figure 3.1 shows the front of each type of each Smar Configurator.



Configurator HPC301 ***Configurator HT2***

Figure 3.1 – Smar's configurator

Configuration Features

By means of the HART® Configurator, the **LD301** 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.
- ✓ Transference Function for Flow rates Measurement.
- ✓ Linearization Table.
- ✓ Totalizer Configuration.

NEW

- ✓ PID Controller Configuration and MV% Characterization 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 **LD301** 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.

FLANGE TYPE - Conventional, Coplanar, Remote Seal,
Level 3 in # 150, Level 4 in # 150, Level 3 in # 300, Level 4 in # 300, Level DN80 PN10/16, Level DN80 PN25/40, Level DN100 PN10/16, Level DN100 PN25/40, Level 2 in # 150, Level 2 in # 300, Level DN50 PN10/16, Level DN50 PN25/40, None, Unknown and Special.

FLANGE MATERIAL - Carbon Steel, 316 SST, Hastelloy C, Monel, Unknown and Special.

O-RING MATERIAL - PTFE, Viton, Buna-N, Ethyl-prop, None, Unknown and Special.

INTEGRAL METER - Installed, None and Unknown.

DRAIN/VENT MATERIAL - Carbon Steel, 316 SST, Hastelloy C, Monel, None, Unknown and Special.

REMOTE SEAL TYPE - Chemical Tee, Flanged Extended, Pancake, Flanged, Threaded, Sanitary, Sanitary Tank Spud, None, Unknown and Special.

REMOTE SEAL FLUID - Silicone, Syltherm 800, Inert, Glycerin/H20, Prop gly/H20, Neobee-M20, None, Unknown and Special.

REMOTE SEAL DIAPHRAGM - 316L SST, Hastelloy C, Monel, Tantalum, Titanium, None, Unknown and Special.

REMOTE SEAL QUANTITY - One, Two, None, Unknown and Special.

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 come 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. Such a method uses parameters obtained during the fabrication process. They depend on the electric and mechanical characteristics of the sensor, and on the temperature change to which the sensor is submitted. These parameters are recorded in the sensor's EEPROM memory. When the sensor is connected to the transmitter, such information is made available to the transmitter's microprocessor, which sets a relationship between the sensor signal and the measured 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 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 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 **LD301** is fitted with an internal feature 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 tenths 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 **LD301** 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.

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 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:
Should the transmitter operate with a very small span, it will be extremely sensitive to pressure variations. Keep in mind that the gain will be very high and that 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 **LD301** includes a selection of engineering units to be used in measurement indication.

CONVERSION FACTOR	NEW UNITS	RECOMMEND RANGE
1.00000	Inches H_2O at 20° C	1, 2,3 & 4
0.0734241	Inches Hg at 0° C	all
0.0833333	Feet H_2O at 20° C	all
25.4000	Millimeters H_2O at 20° C	1 & 2
1.86497	Millimeters Hg at 0° C	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° C	1, 2, 3 & 4
0.00245391	Atmosphere	3, 4, 5 & 6
0.000248642	MegaPascal	4, 5 & 6
0.998205	inches of water at 4° C	1, 2, 3 & 4
25.3545	Millimeters of water at 4° C	1 & 2

Table 3.1 - Available Pressure Units

For pressure measurements, the **LD301** includes an option list with the most common units. The internal reference unit is inH_2O @20°C; should the desired unit be other than this one, it will be automatically converted using conversion factors included in Table 3.1.

As the **LD301** 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.

In applications where the **LD301** 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, that 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 **LD301**. 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 **LD301** cannot verify if the values corresponding to 0% and 100% included by the user are compatible with the selected unit.

VARIABLE	UNITS
Pressure	inH2O[20], InHg, ftH2O, mmH2O[20], mmHg, psi, bar ,mbar, g/cm^2, kg/cm^2 , Pa, kPa, Torr, atm, MPa, in H2O[4], mmH2O[4]
Volumetric Flow	ft^3/m, gal/m, l/min, Gal/m, 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/m, bbl/s, bbl/m, 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/m, kg/h, kg/d, Ton/m, Ton/h, Ton/d, lb/s, lb/m, 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

VARIABLE	UNITS
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 **LD301** allows the user to create a new unit by entering up to 5 alphanumeric digits.

The **LD301** includes an internal feature to enable and disable the User Unit.

Example: transmitter **LD301** 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 = 250mmH_2O
Superior = 2250 mmH_2O
Pressure unit = mmH_2O

In User Unit:
User Unit 0% = 0
User Unit 100% = 18.85
User Unit = m^3
When activating the User's Unit, LD301 it will start to indicate the new measurement.

Transfer Function For Flow Measurement

The function can be used to linearize the measured pressure to, flow or volume. The following functions are available:

SQRT - Square Root. Considering the pressure input X varying between 0 and 100%, the output will be 10 $\sqrt{x}$. This function is used in flow measurement with, e.g., orifice or Venturi tube etc.

The Square Root has an adjustable cutoff point. Below this point the output is linear, if the cutoff mode is bumpless with the differential pressure as indicated by the Figure 3.2. If the cutoff mode is hard the output will be 0% below the cutoff point. The default value for Cutoff is 6% of ranged pressure input. The maximum value for cutoff is 100%. Cutoff is used to limit the high gain, which results from square root extraction on small values.
This gives a more stable reading at low flows.

In order to find the square root, the LD301 configurable parameters are: cutoff point defined at a certain pressure expressed as % and the cutoff mode, hard or bumpless.

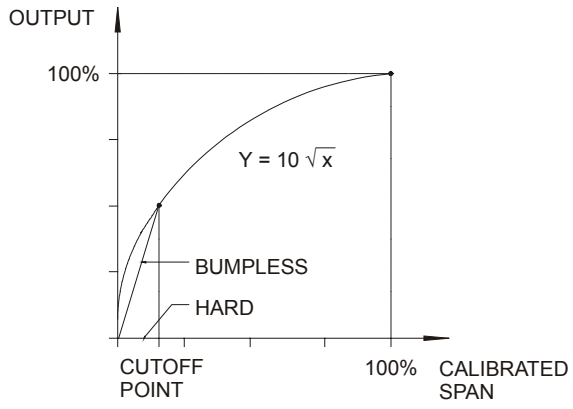


Figure 3.2 – Square Root curve with Cutoff point

NOTE:
In bumpless cutoff mode the gain below the cutoff point is given by the equation: $G = \frac{10}{\sqrt{cutoff}}$ For example, at 1% the gain is 10, i.e., a 0.1% error in differential pressure, gives a 1% error in Flow reading. The lower the cutoff, the higher is the gain.

- ✓ **SQRT**3** - Square Root of the Third Power.
  The output will be 0.1 $\sqrt{x^3}$. This function is used in open channel Flow measurement with weirs or flumes.

- ✓ **SQRT**5** - Square Root of the Fifth Power. The output will be 0.001$\sqrt{x^5}$. This function is used in open channel Flow measurement with V-notch weirs.

It is possible to combine the previous functions with a table. The flow can be connected according to the table to compensate, for example, the variation of Reynolds number at the flow measurement.

- ✓ **TABLE** - The output is a curve formed by 16 points. These points may be edited directly on the XY Table of the **LD301**. For example, it may be used as a camber table for tanks in applications where the tank volume is not linear in relation to the measured pressure.
- ✓ **SQRT & TABLE** - Square root and Table. Same application as square roots, but also allows additional compensation of, e.g., varying Reynolds number.
- ✓ **SQRT**3 & TABLE** - Square Root of the Third Power AND TABLE.
- ✓ **SQRT**5 & TABLE** - Square Root of the Fifth Power AND TABLE.

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.

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

Table 3.3 - Tank Strapping Table

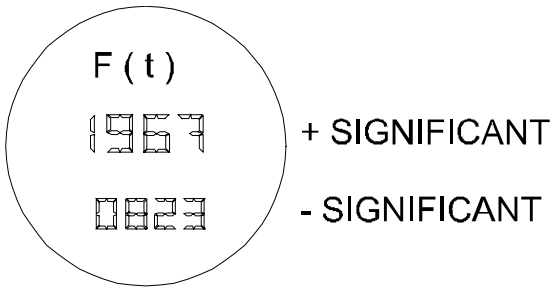
As shown on the previous example, the points may be freely distributed for any desired value of X. In order to achieve a better linearization, the distribution should be concentrated in the less linear parts of the measurement.

The **LD301** includes an internal feature to enable and disable the Linearization Table.

Totalization Configuration

When the **LD301** works in flow applications it is often desirable to totalize the flow in **,**order to know the accumulated volume or mass that has flown through the pipe/channel.

The totalizer integrates PV% over time:



The totalizer integrates the PV% along time, working with a time scheduling based on seconds, as per the following formula:

$$TOT = \int \frac{MAXIMUM\ \ FLOWRATE}{TOTALIZATION\ \ INCREMENT} PV\%\ dt$$

The totalization method uses such totalized value and, through three parameters (MAXIMUM FLOWRATE, TOTALIZATION INCREMENT and TOTALIZATION UNIT), converts it to the user defined totalization unit:

- ✓ **MAXIMUM FLOWRATE -** this is the maximum flow rate expressed in units of volume or mass per second, corresponding to the measurement (PV%=100%). For example: m^3/s, bbl/s, kg/s, lb/s.
- ✓ **TOTALIZATION INCREMENT** - this is used to convert the flow rate base unit into a multiple unit of mass or volume. For example, a flow rate totalized in gallons/s may be converted to a volume in m^3; a mass flow rate of g/s may be converted to kilos, etc.

TOTALIZATION UNIT - this is the engineering unit. It shall be associated to the totalized value. It may be a standard unit or a special unit with up to five characters.

ATTENTION:
The totalizer shall be disabled so that any of these parameters can be configured.

The largest totalized value is 99.999.999 totalizing units. When the totalization is displayed, the most significant part is shown on the numeric field, and the less significant part is shown on the alphanumeric field. Figure 3.3 shows a typical display indication.

NOTE:
F(t) indication is activated every time the totalized value is shown on the digital display.

Figure 3.3 – Typical Monitoring Mode Display Showing the Total, in this case 19670823

The following services are associated with the Totalizer:

- ✓ **INITIALIZATION** - Totalization is reinitialized from value "0".
- ✓ **ENABLING / DISABLING -** this allows the totalization function to be enabled or disabled.

NEW

ATTENTION:
From Version V6.00 on, with the use of the new main board, the totalized value is persistent, i.e., there is no longer the risk of losing this information in case of power failure.

Example: A differential pressure of 0 - 20 inH2O represents a flow of 0 - 6800 dm^3/minute.

In CONF set Lower = 0 inH2O and Upper = 20 inH2O.

In order to adjust the MAX._FLOW, the maximum flow must be converted to cubic decimeters per second: 6800 / 60 = 113,3 dm^3 /s.

The selection of the totalization unit (U_TOTAL) is made in function of the maximum flow and the minimum time allowable for the counter overrun, i.e., the time required for the totalization to reach 99.999.999.

In the example, if U_TOTAL = 1, the totalization increment is 1 dm^3. The time required for the overrun with maximum flow is 245 hours, 10 minutes and 12,5 seconds.
On the other hand, in case a TOTALIZATION INCREMENT equal to 10 is used, the totalized unit will be deciliter (dal) and the totalizer will receive one increment at every 10 dm^3. Considering the maximum flow rate (113.3 dm^3/s), the totalizer will reach its maximum value and return to zero in 102 days, 3 hours, 42 minutes and 5.243 seconds.

PID Controller Configuration

The **LD301** may be factory configured to work as Transmitter Only or as Transmitter / Controller. In case the **LD301** is configured as a Transmitter / Controller, the end user may change its operation mode at any time simply by configuring an internal status variable.

As a PID Controller, the **LD301** may run a PID type control algorithm, where its 4 to 20 mA will represent the status of the Manipulated variable (MV). In such a mode, output is 4 mA when the MV = 0% and 20 mA when MV= 100%.

The PID implementation algorithm is:

$$MV = Kp\ (e + 1/Tr \int e\,dt + Td\,dPV/dt)$$

Where:

e(t) = PV-SP (direct) SP-PV (reverse)
SP = Setpoint
PV = Process Variable (Pressure, Level, Flow, etc.)
Kp = Proportional Gain
Tr = Integration Time
Td = Derivative Time
MV = Manipulated Variable (output)

The three configuration groups below are pertinent to the PID controller:

- ✓ **SAFETY LIMITS** - this group enables the configuration of: Safety Output, Output Rate and Output Lower and Upper Limits.

  The Safety Output defines the value of the output in the case of equipment failure.

  Output Rate is the maximum variation Rate allowed for the output, expressed in %/s.

  The Lower and Upper Limits define the output range.

- ✓ **TUNING** - this group enables the PID tuning to be performed. The following parameters may be adjusted: Kp, Tr and Td.

  Parameter Kp is the proportional gain (not the proportional band) that controls the PID proportional action. It may be adjusted from 0 to 100.

  Parameter Tr is the integral time that controls the PID integral action. It may be adjusted from 0 to 999 minutes per repetition.

  Parameter Td is the derivative time controlling the PID derivative action. It may be adjusted from 0 to 999 seconds.

NOTE:
All these parameters accept zero as input. Such value simply nullifies the corresponding PID control actions.

- ✓ **OPERATION MODES** - this group enables the configuration of: Control Action, Setpoint Tracking and Power On.

  The Control Action Mode enables the selection of the desired output action: direct or reverse. In direct action, a PV increase causes an output increase; in reverse action, a PV increase causes an output decrease.

  When the Setpoint Tracking mode is enabled, it is possible for the Setpoint to follow the PV while in Manual Control. Thus, when control passes to Auto, the Setpoint value will be that of the last PV prior to the switching.

  When the PID is enabled, the Power On mode allows the adjustment of the mode in which the PID controls shall return after a power failure: Manual mode, Automatic mode or the last mode prior to the power failure.

- ✓ **TABLE** – If the table option is selected, the MV output will follow a curve according to the values typed in the LD 301's characterization table. The points can freely be configured as percentage. For a better linearization, it is recommendable, that the points are closer together, in the less linear regions of the curve. The LD301 has an internal variable to enable and disable the characterization table of the MV output of the PID.

Equipment Configuration

The **LD301** enables the configuration of not only its operational services, but of instrument itself. This group includes services related to: Input Filter, Burn Out, Addressing, Display Indication and Passwords.

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

  The BURNOUT configuration is only valid in the transmitter mode. When a failure occurs in the PID mode, output is driven to a safety Output value, between 3.8 and 20.5 mA.
- ✓ **ADDRESSING** - The **LD301** includes a variable to define the equipment address in a HART® network. Addresses may go from value "0" to "15"; addresses from "1" to "15" are specific addresses for multidrop connections. This means that, in a multidrop configuration, the **LD301** will display the message MDROP for addresses "1" to "15".

NOTE:
The output current will be increased to 4 mA as the **LD301** address, in the Transmitter mode, is altered to another value than "0" (this does not happen when the **LD301** is configured in the Controller mode).

  The **LD301** is factory configured with address "0".
- ✓ **DISPLAY INDICATION** - the **LD301** 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 **LD301** 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 milliampères
PV%	Process Variable in percentage
PV	Process Variable in engineering units
MV% (*)	Output in percentage
TEMP	Ambient temperature
TOTAL	Total accumulated by the totalizer
SP% (*)	Setpoint in percentage
SP (*)	Setpoint in engineering units
ER% (*)	Error in percentage (PV% - SP%)
S/INDIC	Used to cancel the second indication

Table 3.4 - Variables for Display Indication

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

- ✓ **WRITING PROTECTION** - This feature is used to protect the transmitter configuration from changes via communication. All configuration data are writing protected.

  The **LD301** include two write protection mechanisms: software and hardware locking; software locking has higher priority.

  When the **LD301** 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 **LD301**. Each password defines the access for a priority level (1 to 3); such configuration is stored in the **LD301** EEPROM.

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

Equipment Maintenance

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

- ✓ **ORDER CODE** - THE Order Code is the one used for purchasing the equipment, in accordance with the User specification. There are 22 characters available in the **LD301** to define this code.

EXAMPLE:

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

LD301 Differential Pressure Transmitter (D); Range: 1.25 to 50 kPa (2); Diaphragm of 316L SS and Silicone Oil Fill Fluid (1); Flanges, Adapters and Drains of 316L SS (I); Buna N O-Rings (B); Drains on the TOP (U); with Digital Indicator (1); Connections to the Process 1/4 NPT (O); Electrical Connection 1/2 NPT (O); with Local Adjustment (1); with Carbon Steel Bracket (1); without other Special Feature (O).

- ✓ **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 **LD301** 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 writtenat 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 4mA.

  Trim_20mA: when the current trim is done at 20mA.

  Trim_Zero/Lower: when pressure trim is done at Zero or Lower Pressure.

  Trim Upper Pressure: when the trim is done at Upper Pressure.

  TRM/PID: when any change is made in the operation mode, i.e., from PID to TRM or vice-versa.

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

  Write Protect: when any change is made in the writing protection.

  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.

  Totalization: when any change is made in the totalization, configuration or in the reset.

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

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

  Backup operation saves the contents of the main board in the sensor memory and the RESTORE function performs the reverse operation.

Programming Using Local Adjustment

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 HART configuration. It eliminates the need for a configuration tool in most basic applications.

If the **LD301** display is not connected, while the instrument is in the Controller mode, no local adjustment mode will be enabled. When the display is connected, the simple local adjustment procedure in the controller mode is rather different from the one in the transmitter mode. In simple mode, the complete mode functionality is restricted to the options OPER and TOTAL, only.

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.

NEW

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).

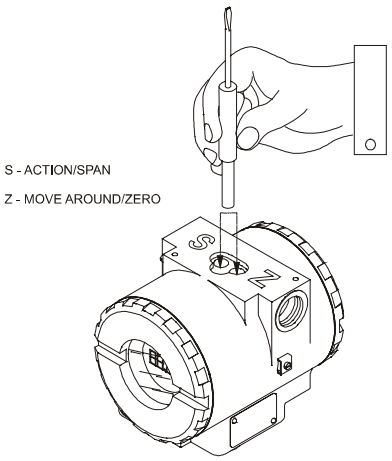


Fig. 4.1 *– Local Zero and Span Adjustment and Local Adjustment Switches*

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. The group of functions displayed depends on the mode selected for the **LD301**, either Transmitter or Controller.

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
	TRANSMITTER MODE	CONTROLLER MODE	
Z	Selects the Lower Range Value	Moves among options in OPERATION and TOTAL	Moves among all the options
S	Selects the Upper Range Value	Activates the selected Functions	Activates the selected Functions

Table 4.2 *- Local Adjustment Description*

NOTE:

For **LD301** versions prior to a **V6.00**, the digital display shall be number 214-0108 as per spare parts list for **LD301** V5.xx.

For **LD301** versions V6.xx, the digital display shall be number 400-0559, as per the updated spare parts list

Simple Local Adjust

The LD301 works differently when a simple local adjustment is selected in the transmitter mode and in the controller mode. In the transmitter mode, the simple local adjustment is used for Zero and Span calibration, and in the controller mode, it restricts the use of the configuration tree to the OPERATION and TOTALIZATION functions.

Zero and Span Reranging

The **LD301** working in the transmitter mode can be very easily calibrated. It requires only Zero and Span adjustment in accordance with the working range.

To make these adjustments, the instrument must be configured as "transmitter" (XMTR).
Via HART configurator or by using item "MODE" in option "CONF" of the local adjustment; the jumpers shall be configured for simple local adjustment. In case the **LD301** 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 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, Fail-safe, Current Trim and Pressure Characterization Trim, Totalization Parameters; 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 - Programming Tree Using Local Adjustment shows the **LD301** available options.

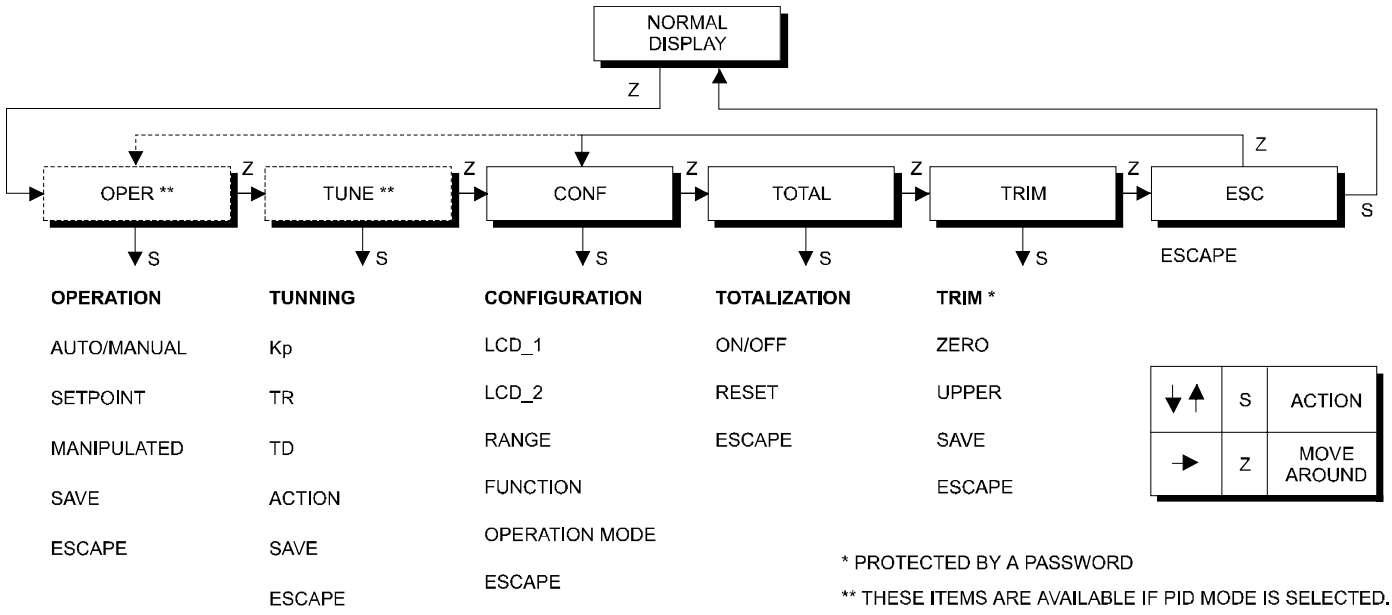


Fig. 4.2 – Local Adjustment Programming Tree – Main Menu

Actuating in (Z) activates local adjustment. In the transmitter mode, options OPER and TUNE are disabled; therefore, the main branch starts at option CONF.

OPERATION (OPER) - Is the option where the operation related parameters of the controller are configured: Auto/Manual, Setpoint and Manual output.

TUNING (TUNE) - Is the option where the PID-Algorithm related parameters are configured: Action, Kp, Tr and Td.

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

TOTALIZATION (TOTAL) - Is the option used to totalize flow in volume or mass units.

TRIM (TRIM) - Is the option used to calibrate the "without reference" characterization and the digital reading.

ESCAPE (ESC) - Is the option used to go back to normal monitoring mode.

OPERATION [OPER]

This adjustment option is applicable to the **LD301** configured in the Controller mode. It allows the control state to be changed from Automatic to Manual and vice versa, and also to adjust the Setpoint and Manipulated Variable values. Figure 4.3 shows branch OPER with the available options.

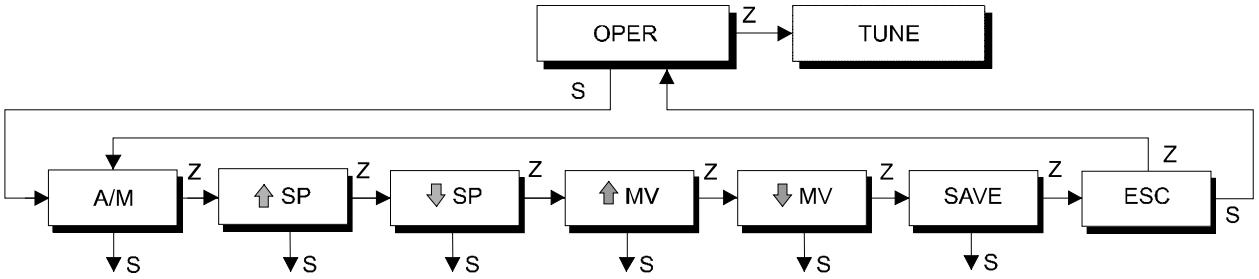
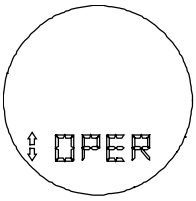


Fig. 4.3 – *Local Adjustment Operating Tree*

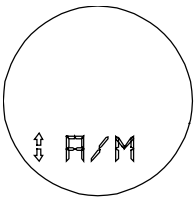
OPERATION BRANCH (OPER)



Z: Moves to the next branch (TUNE).

S: Enters the OPERATION branch, starting with function AUTO/ MA

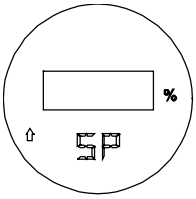
Auto/Manual (A/M)



Z: Moves to the SETPOINT INCREASE function.

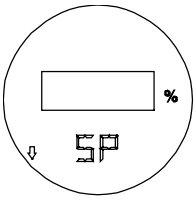
S: Toggles controller status, Automatic to Manual or Manual to Automatic. A and M indicate status.

Setpoint Adjustment (SP)



Z: Moves to the SETPOINT DECREASE function.

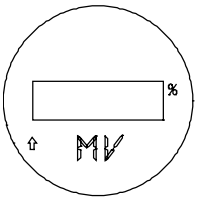
S: Increases the setpoint until the magnetic tool is removed or 100% is reached.



Z: Moves to the MANIPULATED VARIABLE ADJUSTMENT function.

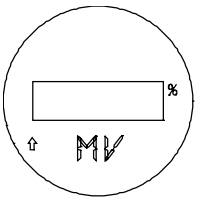
S: Decreases the setpoint until the magnetic tool is removed or 0% is reached.

Manipulated Variable Adjustment (MV)



Z: Moves to the MANIPULATED VARIABLE DECREASE function.

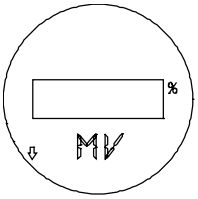
S: Increases the control output until the magnetic tool is removed or the upper output limit is reached.



Z: Moves to the SAVE function.

S: Decreases the control output until the magnetic tool is removed or the lower output limit is reached.

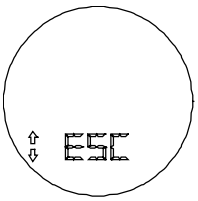
Save (SAVE)



Z: Moves to ESCAPE of the operation menu.

S: Saves the setpoint and Manipulated Variable in the transmitter EEPROM, for use as power on SP and MV.

Escape (ESC)



Z: Moves to the AUTO/ MANUAL function.

S: Escapes to the MAIN menu.

TUNING [TUNE]

This adjustment option is applicable to the **LD301** configured in the Controller mode. It allows the control loop to be tuned, acting on the Proportional, Integral and Derivative terms, and also to alter the PID mode. The implemented algorithm is a PID type, with the following characteristics:

- ✓ The proportional action is given by the Proportional Gain and not by the proportional band. Range: 0 - 100.
- ✓ Integral action is expressed in minutes per repetition. Range: 0 - 999 min/rep.
- ✓ The derivative constant is obtained in seconds. Range 0 - 999 seconds.

It is possible to cancel the Integral and Derivative actions by adjusting Tr and Td, respectively, to 0.

Figure 4.4 shows branch TUNE with the available options.

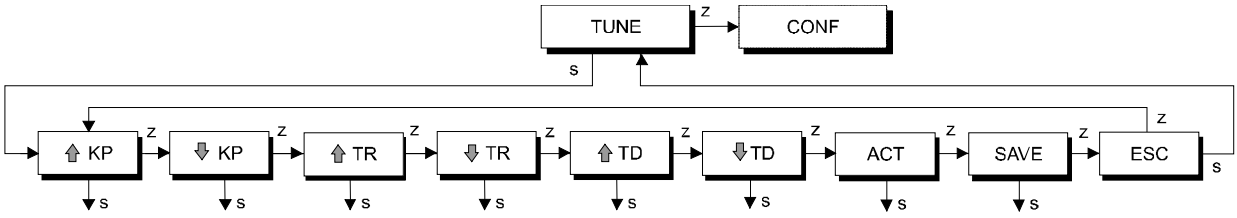
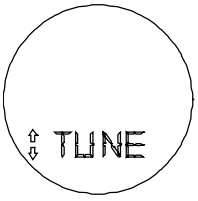


***Fig. 4.4** – Local Adjustment Tuning Tree*

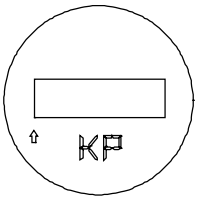
TUNING BRANCH(TUNE)



Z: Moves to the CONFIGURA-TION branch.

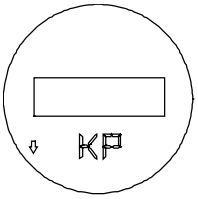
S: Enters the TUNING branch, starting with function KP-AD-JUSTMENT.

Kp - Adjust (KP)



Z: Moves to the PROPORTIONAL GAIN DECREASE function.

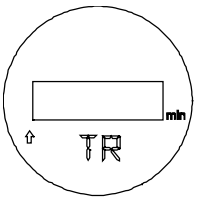
S: Increases the proportional gain until the magnetic tool is removed or 100 is reached.



Z: Moves to the TR_ADJUSTMENT function.

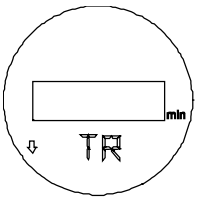
S: Decreases the proportional gain until the magnetic tool is removed or 0.0 is reached.

Tr - Adjust (TR)



Z: Moves to the INTEGRAL TIME DECREASE function.

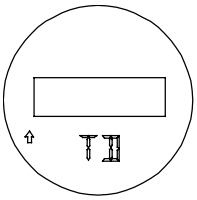
S: Increases the integral time until the magnetic tool is removed or 999 minutes are reached.



Z: Moves to the TD_ADJUSTMENT function.

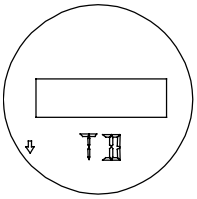
S: Decreases the integral time until the magnetic tool is removed or 0 minutes is reached.

Td - Adjust (TD)



Z: Moves to the DERIVATIVE TIME DECREASE function.

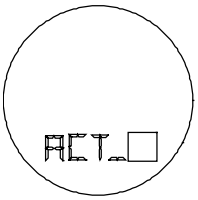
S: Increases the derivative time until the magnetic tool is removed or 999 seconds are reached.



Z: Moves to the ACTION function.

S: Decreases the derivative time until the magnetic tool is removed or 0 seconds is reached.

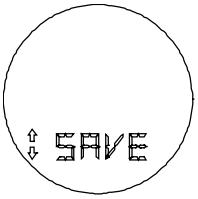
Action (ACT)



Z: Moves to the SAVE function.

S: Toggles the action direct to reverse or reverse to direct.
The far right character of the unit/function-field indicates the present mode:
D = direct action
R = reverse action

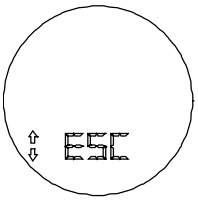
Save (SAVE)



Z: Moves to the ESCAPE to TUNING menu.

S: Saves the KP, TR and TD constants in the transmitter EEPROM.

Escape (ESC)



Z: Moves to the KP-ADJUSTMENT function.

S: Escapes to the MAIN menu.

CONFIGURATION [CONF]

This branch is common for both the Transmitter and the Controller modes. 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 on Display 2.
✓ Working range calibration for the Transmitter and the Controller. 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.
✓ Operational mode selection for the **LD301**: Transmitter or Controller.

Figure 4.5 shows branch CONF with the available options.

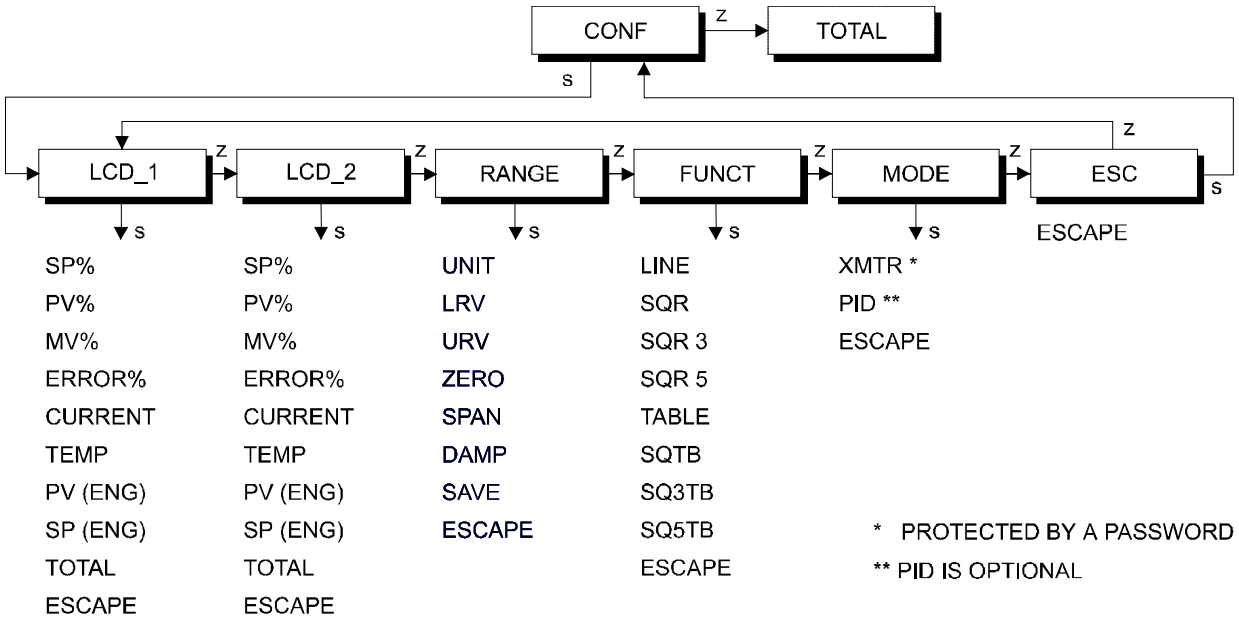
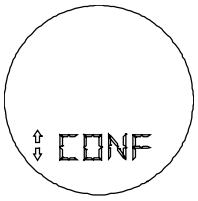


Fig. 4.5 *– Local Adjustment Configuration Tree*

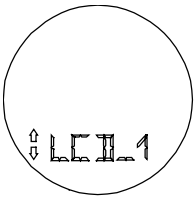
CONFIGURATION BRANCH (CONF)



Z: Moves to the TOTAL branch.

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

Display 1 (LCD_1)

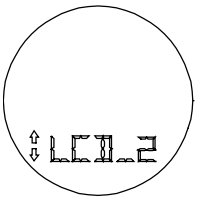


Z: Moves to the function Display 2 (LCD_2).

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**).

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, above.

DISPLAY LCD2/LCD1	DESCRIPTION
SP%	Setpoint (%)
PV%	Process Variable (%)
MV%	Output (%)
ER%	Error (%)
CO	Current - Output (mA)
TE	Sensor Temperature (C)
SP	Setpoint (Eng. unit)
PV	Process Variable (eng. unit)
TO	Totalization
	Nothing (only LCD-2)
ESC	-escape-

Table 4.3 *- Display Indication*

NOTA
In the transmitter mode, only the PV%, CO, TE, TO and PV may be displayed. Besides, it is also possible to select option None for Display 2.

RANGE (RANGE)

Function Calibration (RANGE) presents the calibration options as a tree branch, as described on Figure 4.6.

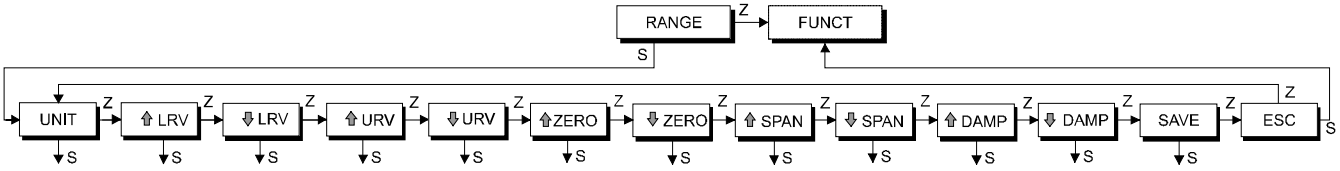
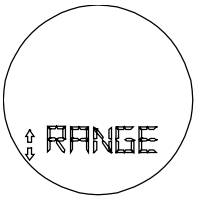


Fig. 4.6 *– Local Range Tree*

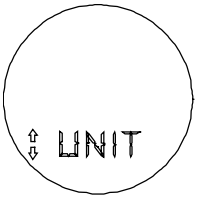
RANGE BRANCH (RANGE)



Z: Moves to the FUNCT function.

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

Unit (UNIT)



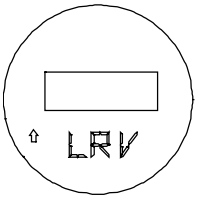
Z: Moves to the LRV function.

S: Starts selection of engineering unit for process variable and setpoint indication. 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^o C
InHg	Inches mercury column at 0^o C
ftH_2O	Feet water column at 20^o C
mmH_2O	millimeter water column at 20^o C
mmHg	millimeter mercury column at 0^o C
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^o C
atm	atmospheres
ESC	-escape-

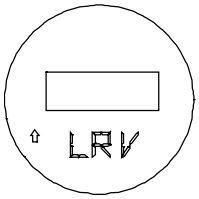
***Table 4.4** – Units*

Lower Range Value Adjustment without Reference (LRV)



Z: Moves to the LRV DECREASE function.

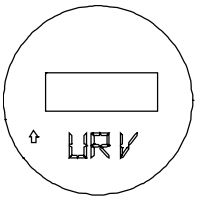
S: Increases the Lower Value until the magnetic tool is removed or the maximum for the Lower Value is reached.



Z: Moves to the URV ADJUSTMENT function.

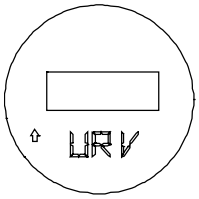
S: Decreases the Lower Value until the magnetic tool is removed or the minimum for the Lower Value is reached.

Upper Range Value Adjust without Reference {URV}



Z: Moves to the URV DECREASE function.

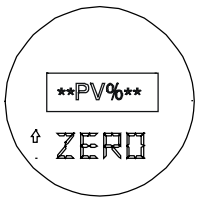
S: Increases the Upper Value until the magnetic tool is removed or the maximum for the Upper Value is reached.



Z: Moves to the ZERO ADJUSTMENT function.

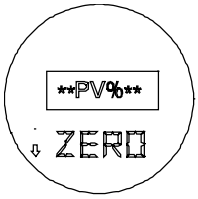
S: Decreases the Upper Value until the magnetic tool is removed or the minimum for the Upper Value is reached.

Zero Adjust with Reference {ZERO}



Z: Moves to the ZERO DECREASE function.

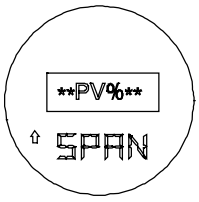
S: Increases output in transmitter mode, decreases the Lower Pressure Value until the magnetic tool is removed or the minimum for the Lower Value is reached. The span is maintained.



Z: Moves to the SPAN ADJUST-MENT function.

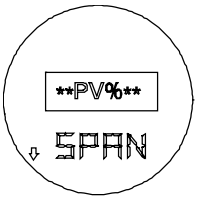
S: Decreases Output in transmitter mode, increases the Lower Pressure Value until the magnetic tool is removed or the maximum for the Lower Value is reached. The span is maintained.

Span Adjust with Reference (SPAN)



Z: Moves to the SPAN DECREASE function.

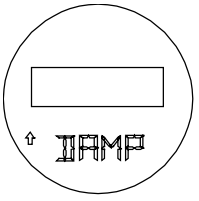
S: Increases the Output in transmitter mode, decreases the Upper Pressure Value until the magnetic tool is removed or the minimum for the Upper Value is reached.



Z: Moves to the DAMPING function.

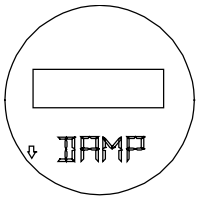
S: Decreases the Output in transmitter mode, increases the Upper Pressure Value until the magnetic tool is removed or the maximum for the Upper Value is reached.

Damping (DAMP)



Z: Moves to the DAMPING DECREASE function.

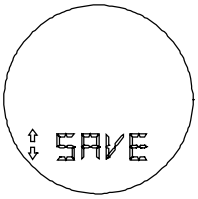
S: Increases the damping time constant until the magnetic toll is removed or 32 seconds are reached.



Z: Moves to the SAVE function.

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

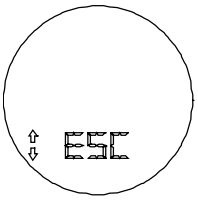
Save (SAVE)



Z: Moves to the ESCAPE of RANGE menu.

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

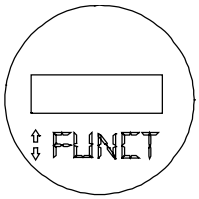
Escape (ESC)



Z: Moves to the UNIT function.

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

Function (FUNCT)



Z: Moves to the MODE function.

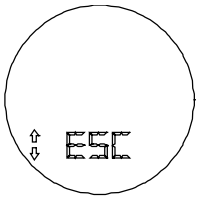
S: Starts selection of input function. After activating (**S**) you can move around the available options in the table below by activating (**Z**).

FUNCTIONS	
DISPLAY	**DESCRIPTION**
LINE	Linear to Pressure
SQR	$\sqrt{x}$
SQR3	$\sqrt{x^3}$
SQR5	$\sqrt{x^5}$
TABLE	16 Point Table
SQTB	$\sqrt{x}$ + 16 Point Table
SQ3TB	$\sqrt{x^3}$ + 16 Point Table
SQ5TB	$\sqrt{x^5}$ + 16 Point Table
ESC	-escape-

Table 4.5 *- Functions*

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

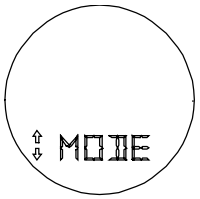
Escape (ESC)



Z: Moves to the LINE function.

S: Escapes to the MODE function.

OPERATION MODE (MODE)



Z: Moves to the ESCAPE to CONF menu.

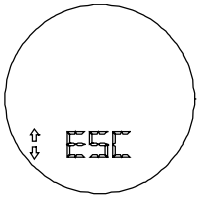
S: This function is protected by a "password," when prompted PSWD, enter the password. The password code consisting and removing the magnetic tool twice in (**S**). The first time, the password value is changed from 0 to 1, and the second time **XMTR/PID** is shown, this s that the password was correct and that the branch will be allowed to handle.

After entering the "password," you can move around the options listed in the table below using (**Z**). T o select the desired option, activate (**S**).

OPERATION MODES	
DISPLAY	**DESCRIPTION**
XMTR	Transmitter
PID	Controller
ESC	- escape -

Table 4.6 *- Operation Modes*

Escape (ESC)



Z: Recycles back to function Display 1 (LCD_1).
S: Escapes to the MAIN menu.

TOTALIZATION [TOTAL]

This branch is common for both the Transmitter and the Controller modes. Totalization parameters are configured via HART Configurator, because it requires a more elaborate human-machine interface, as described on Section 3. The functions available in this branch are directly related with the totalized value, these being stopping or continuing the totalization process and zeroing the totalized value.

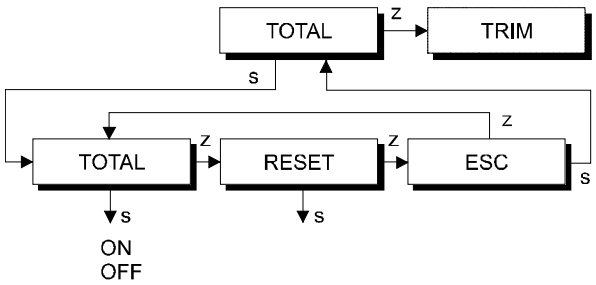
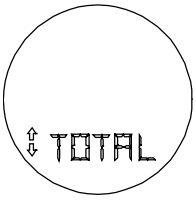


Fig. 4.7 *– Local Totalization Tree*

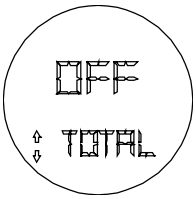
TOTALIZATION BRANCH (TOTAL)



Z: Moves to the TRIM branch.

S: Enters the totalization branch, starting with function Total on/ off.

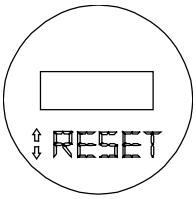
Totalization ON-OFF (TOTAL)



Z: Moves to the RESET function.

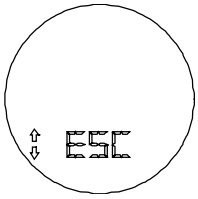
S: Toggles the totalization On to Off or Off to On.

Reset Totalization (RESET)



Z: Moves to the ESCAPE from the totalization menu.

S: Reset the totalization.



Z: Moves to the TOTAL function.
S: Escapes to 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 4.8 shows the options available to run the pressure TRIM.

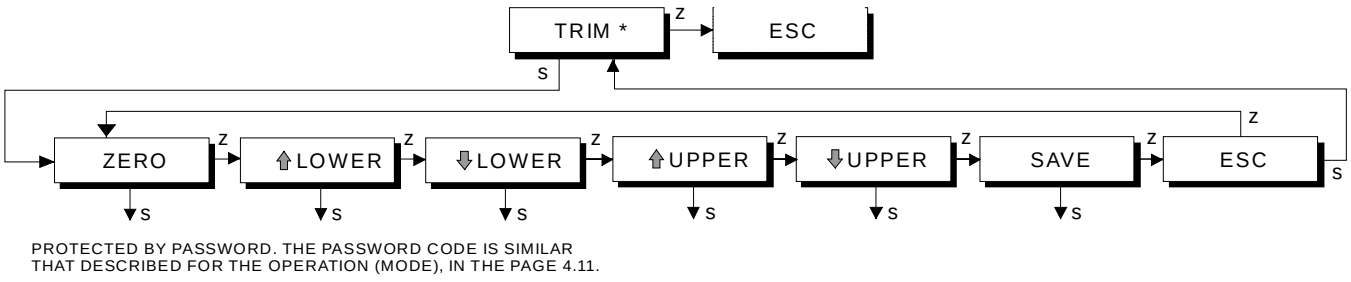
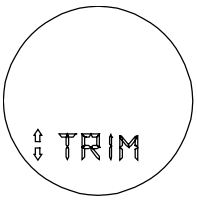


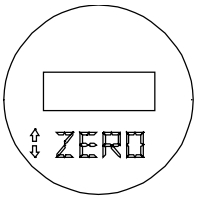
Fig. 4.8 – *Pressure Trim Tree*



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.

Zero Pressure Trim (ZERO)

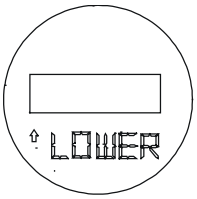


Z: Moves to the LOWER pressure TRIM function.

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

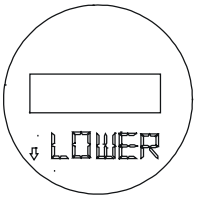
NEW

Lower Pressure Trim (Lower)



Z:Moves to option DECREASES THE LOWER PRESSURE VALUE.

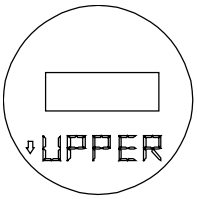
S: Adjusts the transmitter's internal reference, increasing the displayed value that will be interpreted as the Lower Pressure value corresponding to the applied pressure.



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

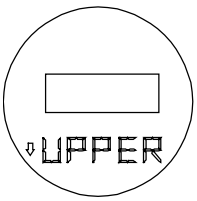
S: Adjusts the transmitter's internal reference, decreasing the displayed value that will be interpreted as the Lower Pressure value corresponding to the applied pressure.

Upper Pressure Trim (UPPER)



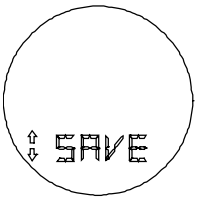
Z: Moves to the decrease upper pressure reading.

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.

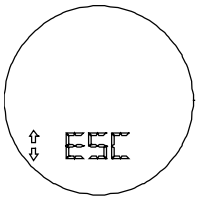
S: Sets the transmitters' internal reference decreasing to the value on de display, which is the reading of the applied pressure.



Z: Moves to the ESCAPE from TRIM menu.

S: Saves the UPPER TRIM point in the transmitter EEPROM.

Escape (ESC)

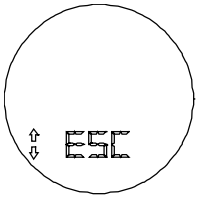


Z: Moves to the ZERO TRIM function.

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

SMAR LD301 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 1.5, 1.6 and 1.7.

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 **LD301** 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.
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).

ERROR MESSAGES	POTENTIAL SOURCE OF PROBLEM
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 LD301 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 (PID). 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 **LD301** 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 5.1 shows transmitter's exploded view and will help you to visualize the following:

Sensor

In order to have access to the sensor (**27**) for cleaning purposes, the transmitter should be removed from its process connections. The transmitter should be isolated from the process by means of manifolds or valves; then, the drain (**23**) must be opened to vent any remaining pressure.

After this, the transmitter may be removed from the standpipe. The flange bolts (**18**) may now be loosened crosswise, one at a time. After removing bolts and flanges (**17**), the isolating diaphragms will be easily accessible for cleaning.

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

The oscillating circuit is a part of the sensor and the replacement of one implies replacing the other. To remove the sensor from the electronic housing, the electrical connections (in the field terminal side) and the main board connector must be disconnected.

Loosen the hex screw (8) and carefully unscrew the electronic housing from the sensor, observing that the flat cable is not excessively twisted.

IMPORTANT:
The transmitters have a stopper that can be released to allow the sensor to rotate more than one turn. See Figure 5.2.

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

ELECTRONIC CIRCUIT

To remove the circuit board (**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.

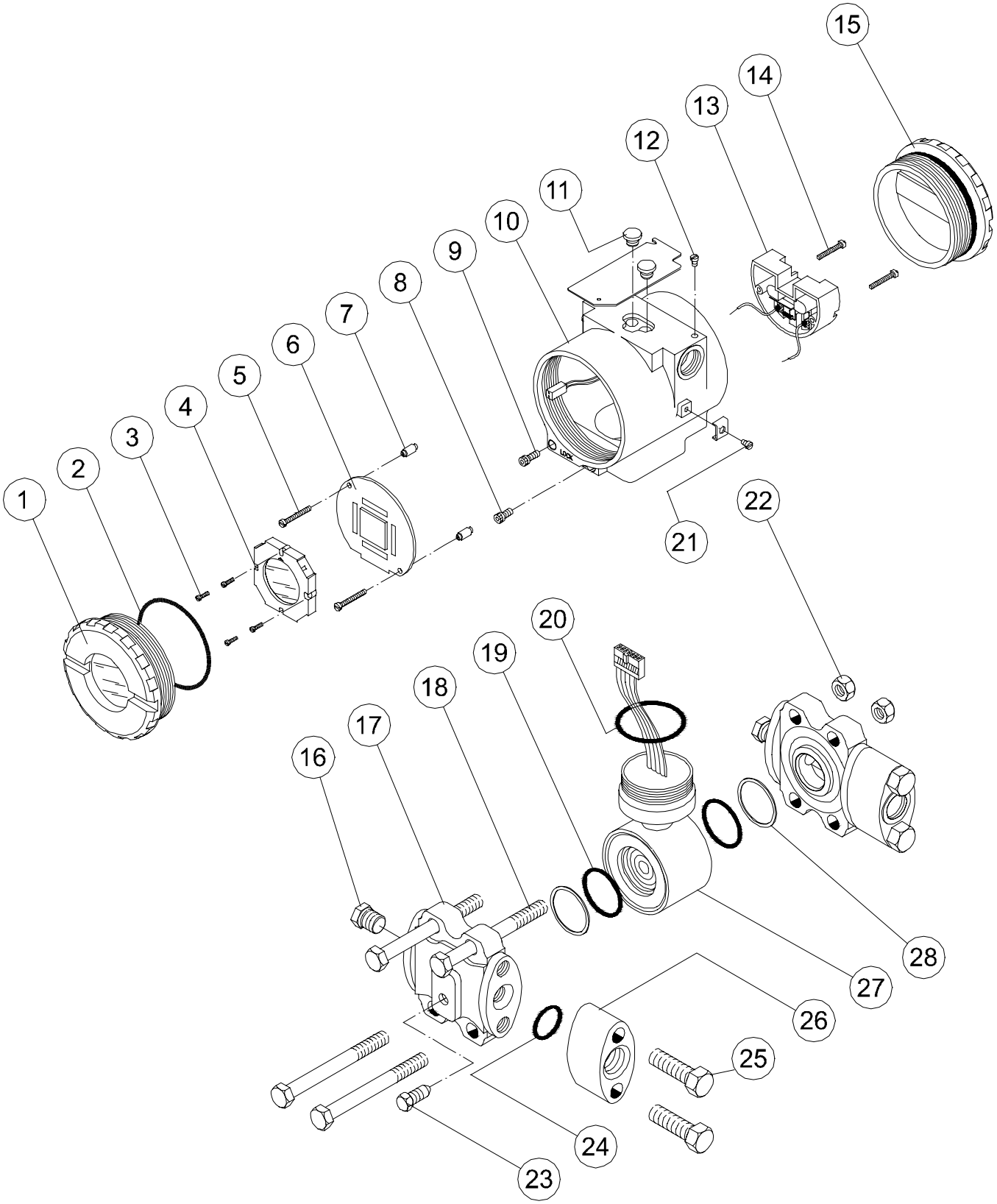


Fig. 5.1 – Exploded View

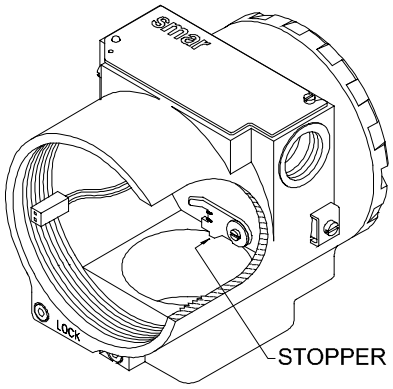


Fig. 5.2 – Sensor Rotation Stopper

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 (**27**), it is recommended to make use of a new set of gaskets (19 & 20) compatible with the process fluid. The bolts, nuts, flanges and other parts should be inspected for corrosion or other eventual damage. Damaged parts should be replaced.

O_RINGS AND BACKUP RINGS FOR HIGH PRESSURE
High pressure transmitters A5, M5, M6 and High static pressure H2, H3, H4, H5 and the sensors with tantalum diaphragm that use Buna-N or Viton O-ring must use a metallic backup Ring (**28**) to prevent extrusion of O-ring. Do not use the backup O-Ring when using Teflon O=Rings or flanges that have Kynar insets (PVDF). Avoid bending the backup ring and inspect it for knits, cuts etc. Be careful when mounting it. The flat side, which shines more than the beveled side shall be mounted against the O-ring (Figure 5.3). For these models, when teflon O_ring is used, it must be a special “SPRING LOADED” O_ring. See the spare parts list for the appropriate part number.

Gaskets should be lightly lubricated with silicone oil before they are fitted into their recesses. Use halogen grease for inert fill applications. The flanges should then be positioned in order to press them in place.

Procedure for tightening the flange screws:

With the flanges holding the O-Rings in place, insert the four bolts (**18**) and tight the nuts (**24**) finger tight, making sure the flanges remain parallel all the time.

- Tighten one nut till the flange seats;
- Tighten the nut diagonally across with a torque of approximately 3 Kgfm (20 ft. lbs);
- Tighten the first nut with the same torque;
- Verify the flanges alignment;
- Check torque on the four bolts.

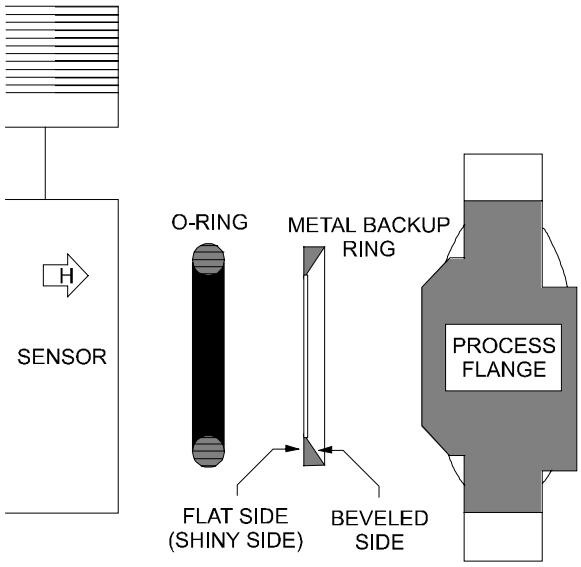


Fig. 5.3 – Backup Ring Mounting

Should the adapters (**26**) have been removed, it is recommended to replace gaskets (**24**) and to connect the adapters to the process flanges before coupling them to the sensor. Optimum torque is 2,5 Kgfm.

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. Then turn it counterclockwise until the cover (**1**) is parallel to the process flange (**17**). 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 Fig. 5.4).

The "**π**" mark indicates up position.

Pass the screws (**5**) through the main board holes (**6**) and the spacers (**7**) as shown on Figure 5.1 and tighten them to the body.

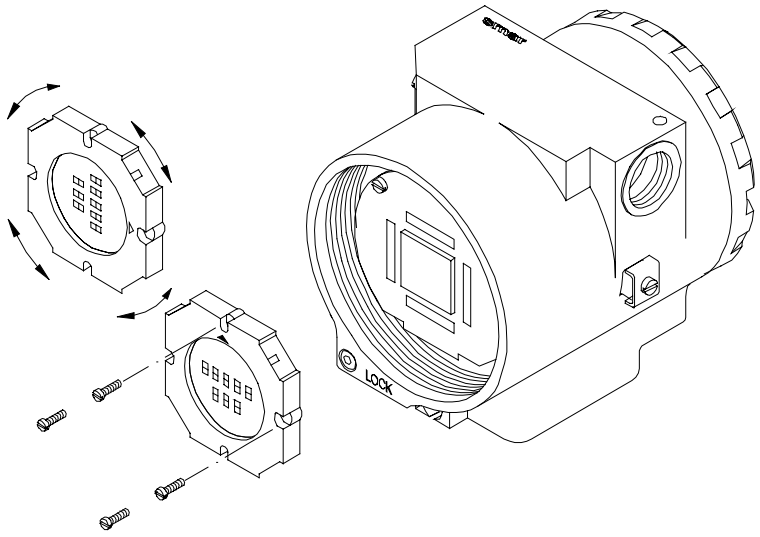


Fig. 5.4 – Four Possible Positions of the Display

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; in the opposite case, the sensor will have the correct information. 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 MAINT/BACKUP/READ 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's serial number, and return it to our factory.
In order to speed up analysis and solution of the problem, the defective item should be returned with a description of the failure observed, with as much details as possible. Other information concerning the instrument operation, such as service and process conditions, is also helpful.

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

SPARE PARTS LIST FOR TRANSMITTER				
DESCRIPTION OF PARTS		**POSITION**	**CODE**	**CATEGORY (NOTE 1)**
HOUSING, Aluminum **(NOTE 2)**	. 1/2 - 14 NPT . M20 x 1.5 . PG 13.5 DIN	10 10 10	204-0130 204-0131 204-0132	
HOUSING, 316 Stainless Steel **(NOTE 2)**	. 1/2 - 14 NPT . M20 x 1.5 . PG 13.5 DIN	10 10 10	204-0133 204-0134 204-0135	
COVER (Includes O-ring)	. Alumínio . Aço Inox 316	1 and 15 1 and 15	204-0102 204-0105	
COVER WITH WINDOW FOR INDICATOR (Includes O-ring)	. Alumínio . Aço Inox 316	1 1	204-0103 204-0106	
COVER LOCKING SCREW		9	204-0120	
SENSOR LOCKING SCREW		8	204-0121	
EXTERNAL GROUND SCREW		21	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	400-0557	A
MAIN BOARD (Display and Mounting Kit not Included) – GLL 1071		6	400-0558	A
MAN BOARD with Mounting Kit and without display - GLL 1071		6	400-0587	A
MAIN FIXATION BOARD KIT (Screws and Spacers)		5 and 7	400-0560	
FLANGE (WITH HOLE FOR DRAIN/VENT)	. Plated Carbon Steel . Stainless Steel 316 . Hastelloy C276 . Monel 400	17 17 17 17	204-0501 204-0502 204-0503 204-0504	
FLANGE (WITHOUT HOLE FOR DRAIN/VENT)	. Plated Carbon Steel . Stainless Steel 316 . Hastelloy C276 . Monel 400	17 17 17 17	204-0511 204-0512 204-0513 204-0514	
BLANK FLANGE (FOR GAGE AND ABSOLUTE MODELS)	. Plated Carbon Steel . Stainless Steel 316	17 17	204-1101 204-1102	
ADAPTER	. Plated Carbon Steel . Stainless Steel 316 . Hastelloy C276 . Monel 400	26 26 26 26	203-0601 203-0602 203-0603 203-0604	
O-RINGS **(NOTE 3)**	. Cover, BUNA-N . Neck, BUNA-N . Flange, BUNA-N . Flange, VITON . Flange, TEFLON . Flange, ETHYLENE/PROPYLENE . Flange, TEFLON spring loaded (for models A5, M5, M6, H2, H3, H4 and H5) **(NOTE 6)** . Adapter, BUNA-N . Adapter, VITON . Adapter, TEFLON . Adapter, ETHYLENE/PROPYLENE	2 20 19 19 19 19 19 24 24 24 24	204-0122 204-0113 203-0401 203-0402 203-0403 203-0404 203-0405 203-0701 203-0702 203-0703 203-0704	B B B B B B B B B B B
BACKUP RING **(NOTE 3)**		28	203-0710	B
TERMINAL HOLDING SCREW	. HOUSING, Aluminum . HOUSING, 316 SS	14 14	304-0119 204-0119	
MAIN BOARD SCREW FOR HOUSING, Aluminum	. Units With indicator . Units Without indicator	5 5	304-0118 304-0117	
MAIN BOARD SCREW FOR HOUSING, 316 SS	. Units With indicator . Units Without indicator	5 5	204-0118 204-0117	
FLANGE BOLT	. Carbon Steel . Stainless Steel 316	18 18	203-0300 203-0310	
FLANGE NUT	. Carbon Steel . Stainless Steel 316	22 22	203-0302 203-0312	
ADAPTER BOLT	. Carbon Steel . Stainless Steel 316	25 25	203-0350 203-0351	
DRAIN/VENT SCREW	. Stainless Steel 316 . Hastelloy C276 . Monel 400	23 23 23	203-1401 203-1402 203-1403	A A A
FLANGE PLUG (STOPPER)	. Stainless Steel 316 . Hastelloy C276 . Monel 400	16 16 16	203-0552 203-0553 203-0554	A A A
MOUNTING BRACKET FOR 2" PIPE MOUNTING **(NOTE 5)**	. Carbon Steel . Stainless Steel 316 . Carbon Steel with bolts, nuts, washers and U-clamp in 316SS	- - -	203-0801 203-0802 203-0803	
LOCAL ADJUSTMENT PROTECTION CAP		11	204-0114	
SENSOR		27	(**NOTE 4**)	B

Note: 1) for category **A**, it is recommended to keep, in stock, 25 parts installed for each set, and for category **B**, 50.
2) Includes Terminal Block, Screws, caps and Identification plate without certification.
3) 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
6) For this type, O-Ring pack has 1 piece.

MODEL LD301	SPARE PART NUMBER FOR DIFFERENTIAL, GAGE, ABSOLUTE AND HIGH STATIC PRESSURE TRANSMITTERS								
COD.	**Type and Range (1)**								
D1	Differential	0,125	to	5	kPa	0,5	to	20	inH_2O
D2	Differential	0,417	to	50	kPa	1,67	to	200	inH_2O
D3	Differential	2,08	to	250	kPa	0,3	to	36	psi
D4	Differential	20,08	to	2500	kPa	3	to	360	psi
M1	Gage	0,125	to	5	kPa	0,5	to	20	inH_2O
M2	Gage	0,417	to	50	kPa	1,67	to	200	inH_2O
M3	Gage	2,08	to	250	kPa	0,3	to	36	psi
M4	Gage	20,8	to	2500	kPa	3	to	360	psi
M5	Gage	0,208	to	25	MPa	30	to	3600	psi
M6	Gage	0,333	to	40	Mpa	48,3	to	5800	psi
A1	Absolute	2	to	5	kPa	14,8	to	37	mmHga
A2	Absolute	2,5	to	50	kPa	0,36	to	7.2	psia
A3	Absolute	2,08	to	250	kPa	0,3	to	36	psia
A4	Absolute	20,8	to	2500	kPa	3	to	360	psia
A5	Absolute	0,208	to	25	MPa	30	to	3600	psia
H2	Differential - High Static Pressure	0,417	to	50	kPa	1,67	to	200	inH_2O
H3	Differential - High Static Pressure	2,08	to	250	kPa	0,3	to	36	psi
H4	Differential - High Static Pressure	20,8	to	2500	kPa	3	to	360	psi
H5	Differential - High Static Pressure	0,208	to	25	MPa	30	to	3600	psi

COD.	**Diaphragm(s) Material and Fill Fluid (2) (3)**	
1	316L SST	Silicone Oil
2	316L SST	Fluorolube Oil
3	Hastelloy C276	Silicone Oil
4	Hastelloy C276	Fluorolube Oil
5	Monel 400	Silicone Oil
7	Tantalum	Silicone Oil
8	Tantalum	Fluorolube Oil
Z	Others – Specify	

LD301	D2	3

(1) Tantalum and Monel diaphragm are not available for Range 1.
(2) Absolute Models are not available with Tantalum Diaphragms or Fluorolube Oil.
(3) Tantalum sensors will be sent with backup rings. They must be used when Viton or Buna-N O-rings are used. Do not use the backup ring when using Teflon O-rings or flanges that have Kynar insets (PVDF).

204-0301- [ ][ ][ ][ ] - [ ][ ][ ] - [ ][ ][ ][ ][ ] - [ ]

SPARE PART NUMBER FOR LEVEL SENSORS

Range

LL	2	Level	0.417	to	50	kPa	5	to	200	inH_2O
LL	3	Level	2.08	to	250	kPa	25	to	36	psi
LL	4	Level	20.8	to	2500	kPa	9	to	360	psi

Diaphragm(s) Material and Fill Fluid (Low Side) (1)

1	316L SST	Silicone Oil
2	316L SST	Fluorolube Oil
3	Hastelloy C276	Silicone Oil **(2)**
4	Hastelloy C276	Fluorolube Oil **(2)**
5	Monel 400	Silicone Oil
7	Tantalum	Silicone Oil
8	Tantalum	Fluorolube Oil
Z	Others – Specify	

Flange(s), Adapter(s) and Drain/Vent Valves Material (Low Side)

C	Plated CS (Drain/Vent in Stainless Steel)
I	316 SST
H	Hastelloy C276 **(2)**
M	Monel 400
N	316 SST (Drain/Vent in Hastelloy C276) **(2)**
Z	Others – Specify

Wetted 0-rings Materials (Low Side)

0	Without 0-rings (Remote Seal)
B	Buna N
V	Viton
T	Teflon
Z	Others – Specify

Drain/Vent Position

0	Without Drain
U	Upper
D	Lower

Note: For better drain/vent operation, the side vent or drain valves are standard. If drain/vent valves are not required, use code 0.

Process Connections (Low Side)

0	1/4 - 18 NPT (Without Adapter)
1	1/2 - 14 NPT (With Adapter)
Z	Others – Specify

Process Connection (High Side)

1	3" 150# (ANSI B16.5 RF)	9	2" 150# (ANSI B16.5 RF)
2	3" 300# (ANSI B16.5 RF)	A	2" 300# (ANSI B16.5 RF)
3	4" 150# (ANSI B16.5 RF)	B	2" 600# (ANSI B16.5 RF)
4	4" 300# (ANSI B16.5 RF)	C	3" 600# (ANSI B16.5 RF)
6	DN 80 PN 25/40	D	4" 600# (ANSI B16.5 RF)
7	DN 100 PN 10/16	E	DN 50 PN 10/40
8	DN 100 PN 25/40	Z	Others - Specify

Flange Material (Level Tap)

2	316 SST
Z	Others – Specify

Extension Length

0	0 mm
1	50 mm (2")
2	100 mm (4")
3	150 mm (6")
4	200 mm (8")
Z	Others – Specify

Diaphragm Materials (High Side)

1	316L SST
2	Hastelloy C276 **(2)**
3	Monel 400 **(3)**
4	Tantalum
Z	Others – Specify

Note: With 316L SST extension

Fill Fluid (High Side)

1	DC200 Silicone Oil
2	Fluorolube Oil
3	DC704 Silicone Oil
A	DC200/350 Silicone Oil - Food Grade
Z	Others – Specify

Optional Items***

H1	316 SST Housing
A1	316 SST Bolts and Nuts
C1	Special Cleaning
ZZ	Special Options – Specify

(1) Tantalum sensors will be sent with backup rings. They must be used when Viton or Buna-N O-rings are used. Do not use the backup ring when using Teflon O=rings or flanges that have Kynar insets (PVDF).
(2) Meets NACE material recommendations per MR-01-75
(3) Fluorolube fill fluid is not available for Monel Diaphragm.

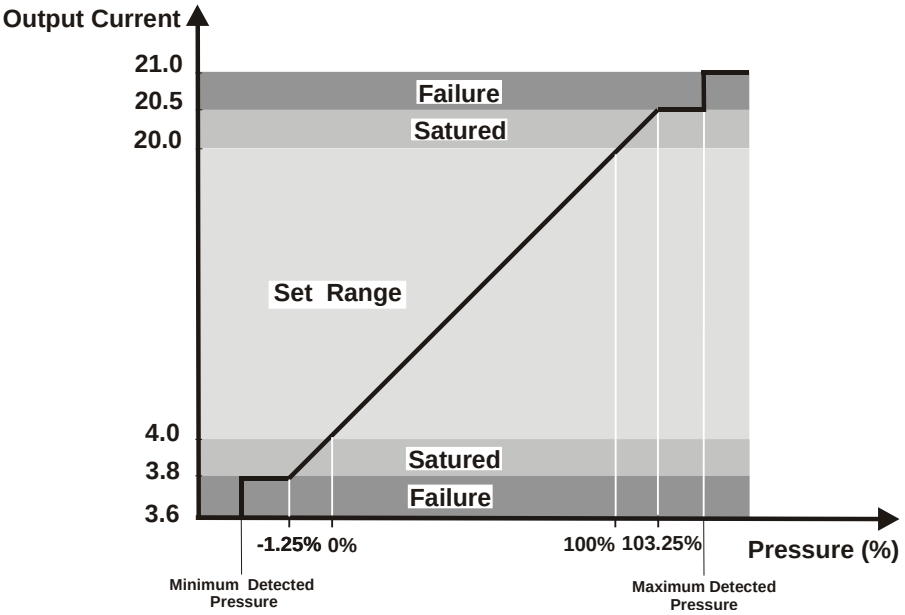
TECHNICAL CHARACTERISTICS

Functional Specifications

Process Fluid
Liquid, gas or vapor.

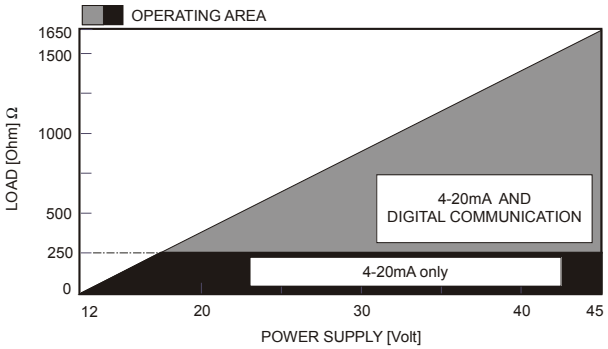
NEW

Output Signal
Two-wire, 4-20 mA controlled according to NAMUR NE43 Specification and with superimposed digital communication (HART Protocol). See the figure below.



Power Supply
12 to 45 Vdc.

Load Limitation

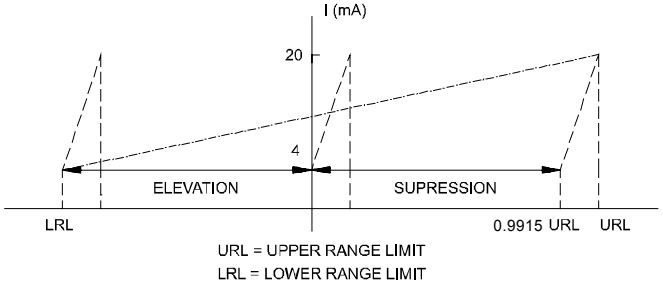


Indicator
Optional 4 1/2-digit numerical and 5-character alphanumerical LCD indicator.

Hazardous Area Certifications
Explosion proof, weather proof and intrinsically safe (CENELEC NEMKO/ATEX, BVS, CSA and FM standards).

Zero and Span Adjustments
Noninteractive, via digital communication.

Zero Adjustment Limits



Calibrated span shall not be less than 0.0085 URL and shall not exceed 2 URL.
Low range value shall not be below LRL.
Upper range value shall not be greater than URL.
(LRL = -URL for all models, except absolute, where LRL, vacuum).

Temperature Limits

Ambient :	-40	to	85°C	(-40	to 185°F)	
Process :	-40	to	100°C	(-40	to 212°F)	(Silicone Oil).
	0	to	85°C	(32	to 185°F)	(Fluorolube Oil).
	-40	to	150°C	(-40	to 302°F)	for LD301L.
	-25	to	85°C	(-13	to 185°F)	(Viton O-Rings).
Storage :	40	to	00°C	(-40	to 212°F)	
Digital Display :	-10	to	60°C	(14	to 140°F)	
	-40	to	85°C	(-40	to 185°F)	without damage.

NEW

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.

Turn-on Time
Performs within specifications in less than 5.0 seconds after power is applied to the transmitter.

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

Overpressure and Static Pressure Limits
From 3.45 kPa abs. (0.5 psia)* to:
8 MPa (1150 psi) for range 1.
16 MPa (2300 psi) for ranges 2, 3 & 4.
32 MPa (4600 psi) for models H & A5.
40 MPa (5800 psi) for model M5.
52 MPa (7500 psi) for model M6.

* except the LD301A model.

Flange Test Pressure: 60 MPa (8570 psi).

For ANSI/DIN Level flanges (LD301L models):

CLASS	RANGE	TEMPERATURE
150 lb	6 psia to 275 psi (-0,6 to 19 bar)	38ºC
300 lb	6 psia to 720 psi (-0,6 to 50 bar)	38ºC
PN10/16	-60 kPa to 1,4 Mpa	120ºC
PN25/40	-60 kPa to 4 MPa	120ºC

These overpressures will not damage the transmitter, but a new calibration may be necessary.

Humidity Limits
0 to 100% RH.

NEW

Damping Adjustment
Through the programmer: adjustable for any value greater than or equal to 0 seconds, added to the sensor response time (0.2 seconds)

Configuration
Can be done through digital communication using the Hart Protocol or, partially, through local adjustment.

Configurator

Hand-Held Terminal Main Features (HT2)
An interface and a program datapack for LD301 are necessary for communication.
EPROM memory: 128 Kbytes, datapack.
Display: 80 characters, 4 lines.
Power supply: 9 Vdc.
Dimensions(LWD): (142 x 78 x 29.3 mm).

Palm V™Organizer
See Palm V™ Organizer 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
0.1 URL ≤ span ≤ URL:
± 0.075 % of span;

0.025 URL ≤ span ≤ 0.1URL:
± 0.0375 [1+0.1 URL/span]% of span;

0.0085 URL ≤ span ≤ 0.025 URL:
± [0.0015 + 0.00465 URL/span]% of span (*).
(*) – Recommended minimum span for Range 1 is 0.025URL

For ranges 5 and 6, Absolute models, diaphragms in Tantalum, Monel or fill fluid in Fluorolube:

0.1 URL ≤ span ≤ URL:
± 0.1 % of span;

0.025 URL ≤ span ≤ 0.1 URL:
± 0.05 [1 + 0.1 URL/span] % of span;

0.0085 URL ≤ span ≤ 0.025 URL:
± [0.01 + 0.006 URL/span]% of span.

For absolute - range 1:
± 0.2 % of span.
Linearity, hysteresis and repeatability effects are included.

Stability
± 0.1% of URL for 24 months for ranges 2, 3, 4, 5 & 6.
± 0.2% of URL for 12 months for ranges 1 & L models.
± 0.25% of URL for 5 years, at 20°C temperature change and up to 70 bar of static pressure.

Temperature Effect
± (0.02% URL +0.1% span) per 20°C (36°F) for ranges 2, 3, 4, 5 & 6.

± (0.05% URL +0.15% span) per 20°C (36°F) for range 1.

For LD301L:

6 mmH_2O/20°C for 4" and DN100.
17 mmH_2O/20°C for 3" and DN80.

Consult for others flanges dimensions an others fill fluid.

Static Pressure Effect
Zero error:

± 0.1% URL per 7 MPa (1000 psi) for ranges 2, 3, 4 & 5
or 3.5 MPa (500 psi) for L models.
± 0.1% URL per 1.7 MPa (250 psi) for range 1.

This is a systematic error that can be eliminated by calibrating at the operating static pressure.

Span error:

Correctable to ±0.2% of reading per 7 MPa (1000 psi) for ranges 2, 3, 4 & 5 or 3.5 MPa (500 psi) for range 1 and L models.

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.

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

Physical Specifications

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

Process Connection
1/4 -18 NPT or 1/2 -14 NPT (with adapter).
For L models see ordering code.

Wetted Parts
. Isolating Diaphragms
316L SST, Hastelloy C276, Monel or Tantalum.

. Drain/Vent Valves and Plug
316 SST, Hastelloy C276 or Monel 400.

. Flanges
Plated carbon steel, 316 SST, Hastelloy C276 or Monel 400.

. Wetted O-Rings (For Flanges and Adapters)
Buna N, Viton™ or PTFE. Ethylene-Propylene on request.

The LD301 is available in NACE MR-01-75 compliant materials.

Nonwetted Parts

. Electronic Housing
Dual compartment, injected aluminum with polyester painting or 316 SST (NEMA 4X, IP67).

. Blank Flange
Plated carbon steel, when the wetted flange is made of this same material, and 316 SST in the other cases.

. Level Flange (LD301L) Material
316 SST.

. Fill Fluid
Silicone or Fluorolube Oil.

. Cover O-Rings
Buna N.

. Mounting Bracket
Plated carbon steel with polyester painting or 316 SST.

. Flange Bolts and Nuts
Plated carbon steel. Grade 7,316 SST or Carbon Steel B7M (For NACE applications).

. Accessories (Bolts, Nuts, Washers and U-Clamp) in Carbon Steel or 316 SST.

. Identification Plate
316 SST.

Mounting
a) Flange mounted for models LD301L.
b) Optional universal mounting bracket for surface or vertical/horizontal (DN 50) 2"-pipe (optional).
c) Via bracket on manifold valve (optional).
d) Directly on piping for closely coupled transmitter/ orifice flange combinations.

Approximate Weights
3.15 kg (7 lb) : all models, except L models.
5.85 to 9.0 kg (13 lb to 20 lb): L models depending on the flanges, extension and materials.

Control Characteristics

PID.
Proportional Gain: 0 to 100.
Integral Time: 0.01 to 999 min/rep.
Derivative Time: 0 to 999 s.
Direct / Reverse Action.
Lower and Upper output limits.
Output rate-of-change limit: 0 to 100%/s.
Power-on safety output.
Antireset windup.
Bumpless Auto/Manual transfer.
Characterization table of the manipulated variable (MV%).

MODEL LD301 — DIFFERENTIAL, GAGE, ABSOLUTE AND HIGH STATIC PRESSURE TRANSMITTERS

COD.	Type and Range (1)								
D1	Differential	0.125	to	5	kPa	0.5	to	20	inH_2O
D2	Differential	0.417	to	50	kPa	1.67	to	200	inH_2O
D3	Differential	2.08	to	250	kPa	0.3	to	36	psi
D4	Differential	20.8	to	2500	kPa	3	to	360	psi
M1	Gage	0.125	to	5	kPa	0.5	to	20	inH_2O
M2	Gage	0.417	to	50	kPa	1.67	to	200	inH_2O
M3	Gage	2.08	to	250	kPa	0.3	to	36	psi
M4	Gage	20.8	to	2500	kPa	3	to	360	psi
M5	Gage	0.208	to	25	Mpa	30	to	3600	psi
M6	Gage	0.333	to	40	Mpa	48.3	to	5800	psi
A1	Absolute	2	to	5	kPa	14.8	to	37	mmHga
A2	Absolute	0.417	to	50	kPa	0.36	to	7.2	psia
A3	Absolute	2.08	to	250	kPa	0.3	to	36	psia
A4	Absolute	20.8	to	2500	kPa	3	to	360	psia
A5	Absolute	0.208	to	25	MPa	30	to	3600	psia
H2	Differential - High Static Pressure	0.417	to	50	kPa	1.67	to	200	inH_2O
H3	Differential - High Static Pressure	2.08	to	250	kPa	0.3	to	36	psi
H4	Differential - High Static Pressure	20.8	to	2500	kPa	3	to	360	psi
H5	Differential - High Static Pressure	0.208	to	25	MPa	30	to	3600	psi

COD.	Diaphragm Material and Fill Fluid (Low Side)	
1	316L SST	Silicone Oil
2	316L SST	Fluorolube Oil
3	Hastelloy C276	Silicone Oil **(2)**
4	Hastelloy C276	Fluorolube Oil **(2)**
5	Monel 400	Silicone Oil
7	Tantalum	Silicone Oil
8	Tantalum	Fluorolube Oil
Z	Others – Specify	

Note: Absolute Models are not available with Fluorolube Oil.
Tantalum and Monel diaphragm are not available for Range 1.

COD.	Flange(s), Adapter(s) and Drain/Vent Valves Material
C	Plated CS (Drain/Vent in Stainless Steel)
I	316 SST
H	Hastelloy C276 **(2)**
M	Monel 400
N	316 SST (Drain/Vent in Hastelloy C276) **(2)**
Z	Others – Specify

COD.	Wetted 0-Rings Materials
0	Without 0-Rings
B	Buna N
V	Viton
T	Teflon
Z	Others – Specify

Note: O-Rings are not available on sides with Remote Seals.

COD.	Drain/Vent Position
0	Without Drain/Vent
U	Upper
D	Lower

Note: For better drain/vent operation, vent valves are strongly recommended.
Drain/Vent valve not available on sides with Remote Seal.

COD.	Local Indicator
0	Without Indicator
1	With Digital Indicator

COD.	Process Connections
0	¼ - 18 NPT (Without Adapter)
1	1/2 - 14 NPT (With Adapter)
9	Seal Remote (Specify)
Z	Others – Specify

COD.	Electrical Connections
0	1/2-14 NPT
A	M20 x 1.5
B	Pg 13.5 DIN
Z	Others – Specify

COD.	Zero and Span Adjustments
1	With Local Adjustments

COD.	Mounting Bracket for 2" Pipe or Surface Mounting
0	Without Bracket
1	Carbon Steel Bracket
2	316 SST Bracket
7	Carbon Steel bracket with 316 SST fasteners

COD.	Optional Items*
H1	316 SST Housing
A1	316 SST Bolts and Nuts
C1	Special Cleaning
ZZ	Special Options - Specify

LD301	-	D2	1	I	-	B	U	1	0	-	0	1	2	-	*

(1)-The range can be extended up to 0.75 LRL and 1.2 URL with small degradation of accuracy.
(2)-Meets NACE material recommendations per MR-01-75
***** Leave it blank for no optional items.

MODEL LD301 — LEVEL TRANSMITTERS

Range

COD.										
L2	Level	1.25	to	50	kPa	5	to	200	inH_2O	**Note:** The upper range limit can be extended up to 1.2 times with a small degradation of accuracy.
L3	Level	2.08	to	250	kPa	8.33	to	1000	inH_2O	
L4	Level	20.8	to	2500	kPa	3	to	360	psi	

Diaphragm Material and Fill Fluid (Low Side)

COD.			COD.		
1	316L SST	Silicone Oil	5	Monel 400	Silicone Oil
2	316L SST	Fluorolube Oil	7	Tantalum	Silicone Oil
3	Hastelloy C276	Silicone Oil **(1)**	8	Tantalum	Fluorolube Oil
4	Hastelloy C276	Fluorolube Oil **(1)**	Z	Others – Specify	

Flange, Adapter and Drain/Vent Valves Material (Low Side)

COD.	
C	Plated CS (Drain/Vent in Stainless Steel)
I	316 SST
H	Hastelloy C276 **(1)**
M	Monel 400
N	316 SST (Drain/Vent in Hastelloy C276) **(1)**
Z	Others – Specify

Wetted 0-Rings Material (Low Side)

COD.	
0	Without 0-Rings (Remote Seal)
B	Buna N
V	Viton
T	Teflon
Z	Others – Specify

Drain/Vent Position (Low Side)

COD.		
0	Without Drain/Vent	**Note:** For better drain/vent operation, the side vent or drain valves are standard. If drain/vent valves are not required, use code 0.
U	Upper	
D	Lower	

Local Indicator

COD.	
0	Without Indicator
1	With Digital Indicator

Process Connection (Low Side)

COD.	
0	1/4 - 18 NPT (Without Adapter)
1	1/2 - 14 NPT (With Adapter)
9	Seal Remote (Specify)
Z	Others – Specify

Electrical Connections

COD.	
0	1/2-14 NPT
A	M20 x 1.5
B	Pg 13.5 DIN
Z	Others – Specify

Zero and Span Adjustments

COD.	
1	With Local Adjustment

Process Connection (High Side)

COD.		COD.	
1	3" 150# (ANSI B16.5 RF)	9	2" 150# (ANSI B16.5 RF)
2	3" 300# (ANSI B16.5 RF)	A	2" 300# (ANSI B16.5 RF)
3	4" 150# (ANSI B16.5 RF)	B	2" 600# (ANSI B16.5 RF)
4	4" 300# (ANSI B16.5 RF)	C	3" 600# (ANSI B16.5 RF)
6	DN 80 PN 25/40	D	4" 600# (ANSI B16.5 RF)
7	DN 100 PN 10/16	E	DN 50 PN 10/40
8	DN 100 PN 25/40	Z	Others - Specify

Flange Material (Level Tap)

COD.	
2	316 SST
Z	Others- Specify

Extension Length

COD.		
0	0 mm	
1	50 mm	(2")
2	100 mm	(4")
3	150 mm	(6")
4	200 mm	(8")
Z	Others - Specify	

Diaphragm Material (High Side)

COD.	
1	316L SST
2	Hastelloy C276 **(1)**
3	Monel 400 **(2)**
4	Tantalum
5	Titanium
Z	Others - Specify

Note: With 316 SST extension.

Fill Fluid (High Side)

COD.	
1	DC200 Silicone Oil
2	Fluorolube Oil
3	DC704 Silicone Oil
A	DC200/350 Silicone Oil - Food Grade
Z	Others – Specify

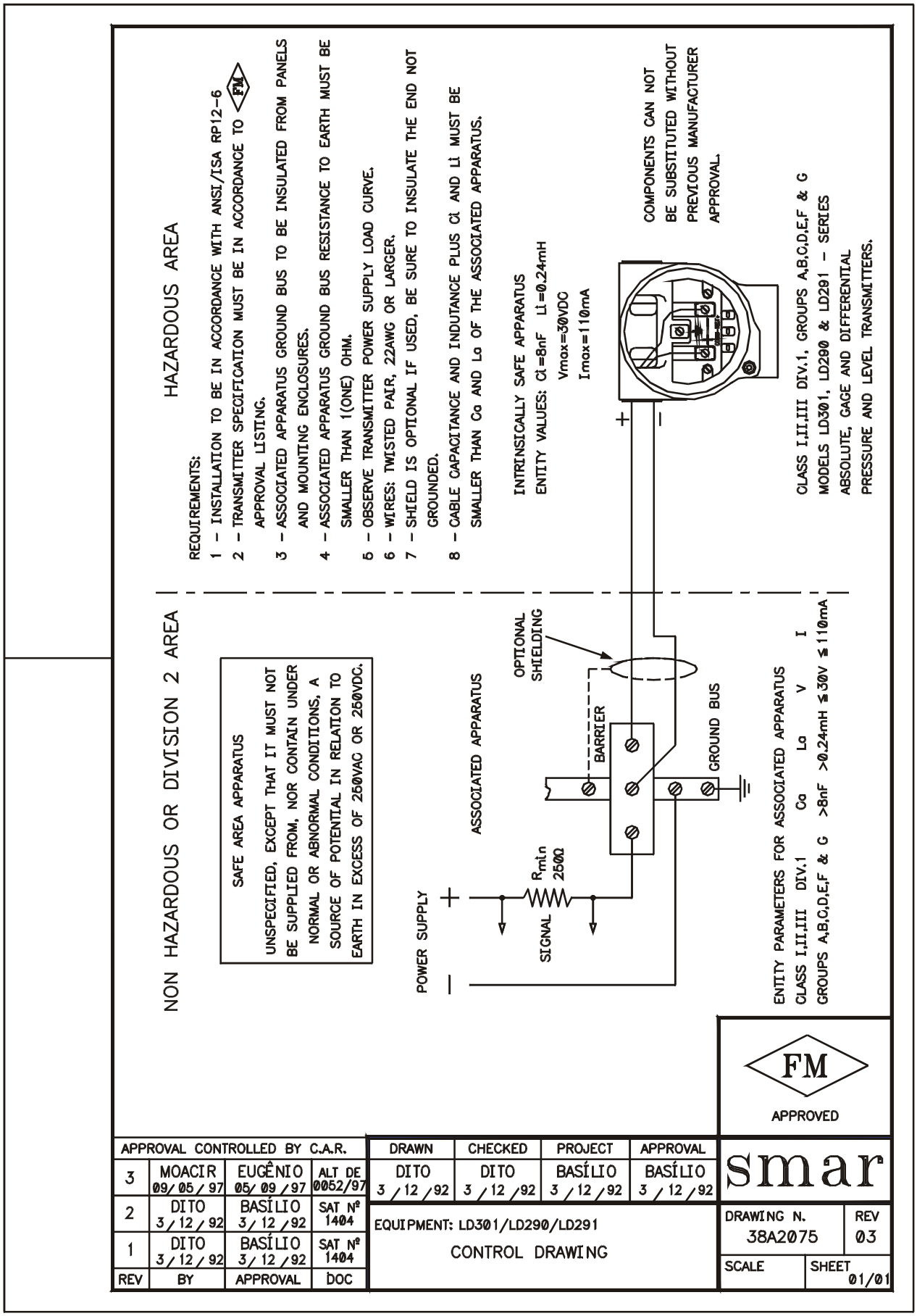
Optional Items*

COD.	
H1	316 SST Housing
A1	316 SST Bolts and Nuts
C1	Special Cleaning
ZZ	Special Options - Specify

LD301	-	L2	1	I	-	B	U	1	0	-	0	1	-	1	2	2	1	1	-	*

(1) Meets NACE material recommendations per MR-01-75.
(2) Fluorolube fill fluid is not available for Monel Diaphragm.
(*) Leave it blank for no optional items.

APPENDIX A


HAZARDOUS AREA
REQUIREMENTS:
1 - INSTALLATION TO BE IN ACCORDANCE WITH ANSI/ISA RP12-6
2 - TRANSMITTER SPECIFICATION MUST BE IN ACCORDANCE TO FM 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.
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
smar
APPROVAL CONTROLLED BY C.A.R.
REV | BY | APPROVAL | DOC
3 | MOACIR 09/05/97 | EUGÊNIO 05/09/97 | ALT DE 0052/97
2 | DITO 3/12/92 | BASÍLIO 3/12/92 | SAT Nº 1404
1 | DITO 3/12/92 | BASÍLIO 3/12/92 | SAT Nº 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
DRAWING N. 38A2075
REV 03
SCALE
SHEET 01/01