



Instructions Manual



HART 
COMMUNICATION PROTOCOL

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1 INTRODUCTION

The series LU transmitters are electronic equipment based on the transmission of ultrasonic waves to measure the distance to a liquid or solid in a vessel.

The micro processed electronic circuit offers the following features:

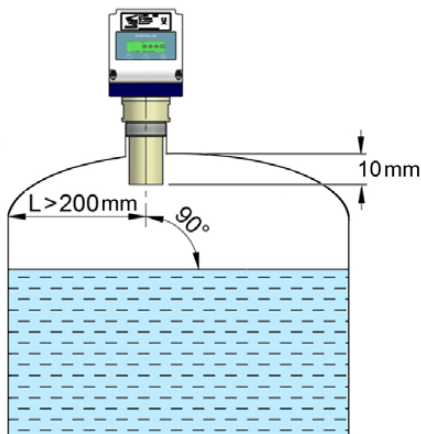
- Emission and reception circuits for the ultrasonic signals, and microprocessor treatment.
- Alarm outputs with programmable hysteresis level.
- Programmable current output proportional to the distance or level.
- HART protocol compatibility (models LU9XH and LU921H).

2 INSTALLATION

2.1 General

To make the instrument to work in the best conditions, it is important that the bottom face of the sensor be installed parallel to the surface of the product to be measured. In the case of liquids, the face of the transducer should be horizontal.

It is important to avoid installing the instrument at the center of the vessel. In some cases may appear unwanted echoes that affect the measurement. The installation at the center is only advantageous in vessels with tapered bottom, since distances can be measured to the bottom.



The transmitters LU should be installed at a minimum distance of the walls of the vessel of about 200 mm, so that they could not give unwanted reflections.

The socket where the instrument is installed should be such that the bottom of the instrument exceeds at least 10 mm below it, as shown in the drawing.

Screw the instrument in the socket with an appropriate key, always by the flats for this purpose. The maximum torque is 25 Nm.



Never use the electronics housing for threading the device to the vessel.

2.2 Measuring range

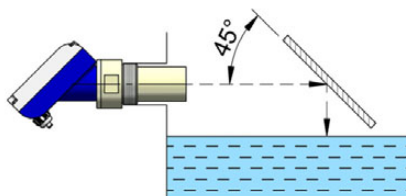
The minimum distance that the instrument can measure is called dead zone. If the product gets closer than that distance, the display indicates dashes instead of the measured value, and the loop current will be 3.6 mA. or 22 mA depending on the

configuration (see section 5.9 in page 19).

In order to reduce the dead zone, a reflector can be installed as shown in the figure.

Model	Dead zone	Max. distance (liquids)	Max. distance (solids)
LU91 / LU91H	0.35 m	6 m	3.5 m
LU93 / LU93H	0.55 m	12 m	7 m
LU921 / LU921H	0.35 m	5 m	2,5 m
LU923	0.55 m	10 m	5 m

It is not desirable that the product reaches the instrument, because build-up can form on



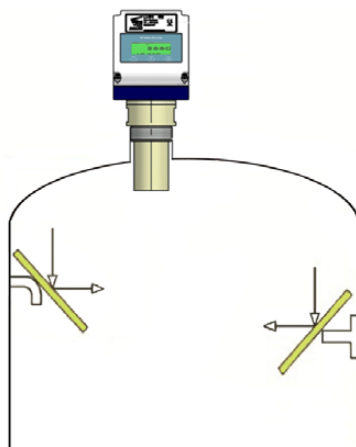
the transducer, that would affect the measurement.

2.3 Obstacles in the vessel

The transmitter must be installed so that the ultrasonic beam can not find anything on its path, as this could lead to unwanted echoes and incorrect measures.

In some cases, inclined reflectors can be placed in front of an obstacle, so that the beam in this region is diverted and the reflected signal do not return to the instrument.

2.4 Filling entries



It is not recommended to install the level meter in the upper zone of a filling entry, because the instrument could detect the level of the jet filling instead of the level of the stored product.

2.5 Foams

Some liquids generate foams when they are in movement. In vessels with agitators, or in the filling processes, important layers can be generated that weaken the reflected signal which is essential for measuring the level.

In a lot of cases the problem of the foam and wave turbulences can be solved by putting a standpipe.

2.6 Standpipe measurement

It can be appropriated in cases of waves or foam. It is based on placing a tube in the tank so that the instrument measures the level inside the tube.

The length of the tube depends on the distance that you want to measure, or the minimum level desired.

The diameter of the tube should be higher than the screw of the instrument (>2 inches or 50 mm).

The standpipe should incorporate a drill top vent with a diameter between 5 and 10 mm.

If the standpipe is composed of several sections, it is necessary that the interior wall is free from defects (welding, edges, etc.) that could be interpreted as a false measurement. In the same way, if the product is capable of leave adherences or inlaid inside the tube, they can lead to erroneous measurements.

3 ELECTRICAL CONNECTION

In order to make the electrical connection of the instrument, the transmitters series LU have a screw terminal strip.

For the electrical installation it is recommended to use multiple conductor cables with individual cable sections in the order of 0.25 to 0.5 mm² in order to make it easier to connect. It is better to maintain the cables connected to the power supply separated from the cables with low level signals (4-20 mA etc.).

Before starting the installation, check that the cable glands are the right size for the cables to be used, this will guarantee the instrument will stay watertight. The PG11 cable glands used are for cables with outside diameters between 6 mm and 10 mm.

Peel the outside insulation to free the inner cables. It is recommended to tin the ends of the wires to avoid loose ends. Pass the cables through the cable glands and screw down in the corresponding positions of the terminal strip. Once the wiring is finished make sure that the cables are well gripped by the cable glands to maintain the degree of protection.

Before starting to install the equipment, check that the supply voltage available is the same as marked on the label of the instrument.

To help in the connecting of the equipment, the description of the terminals is marked on the printed circuit next to the terminal strip.



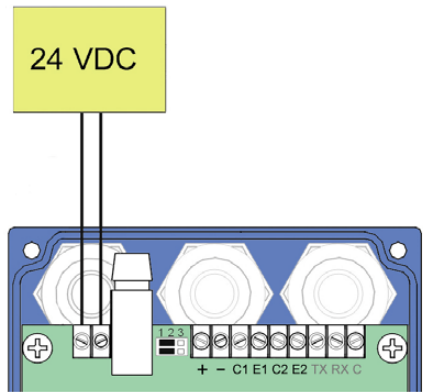
3.1 Power supply and analog output connection (models LU9X)

Models LU9X (LU91, LU93, LU91H, LU93H) are instruments that use 2 wires for the power supply and 2 wires for the analog output. Possible examples of connection can be seen in page 9.

3.1.1 Power supply connection (models LU9X)

Terminal	
—	0 V (-)
—	24 V (+)

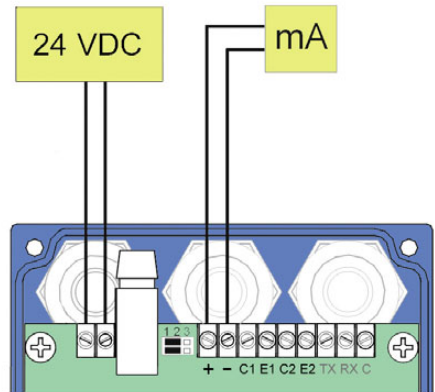
The power supply is provided by a diode bridge that allows connecting it regardless of the polarity .



3.1.2 Analog output connection

Terminal	
+	mA (positive).
-	mA (negative).

The analog output can be either active (default configuration), that means that the receptor must be passive, or passive, what means the receptor must supply the power for the current loop. It is recommended to use a receptor with an input resistance of less than



700 Ω to guarantee correct operation.

To configure the analog output type (active or passive) there are two jumpers situated just behind the terminal strip. For the passive mode the jumpers must be between pins 2 and 3 and for active mode the jumpers must be between pins 1 and 2.

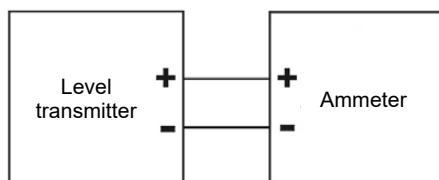
In the case of using HART communication the output mode should be passive. Normally a HART master is active (for more details about the communication and installation with HART, see point 7).

NOTE: The analog output has protection against reversed polarity. Due to another protection against over voltages, if a loop supply voltage of higher than 32 V is connected the equipment may be damaged.

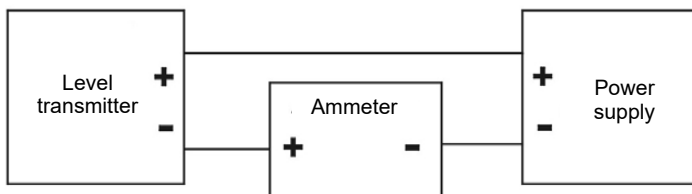


3.2 Power supply and analog output connection (models LU92X)

Models LU92X (LU921, LU923, LU921H) are 2-wire instruments. The connection is made in the terminal block. The positive terminal of the power supply is connected to the



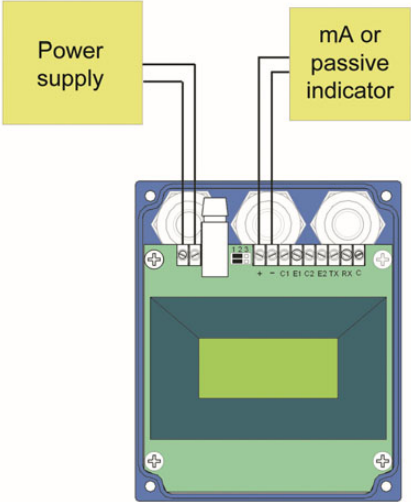
Active output



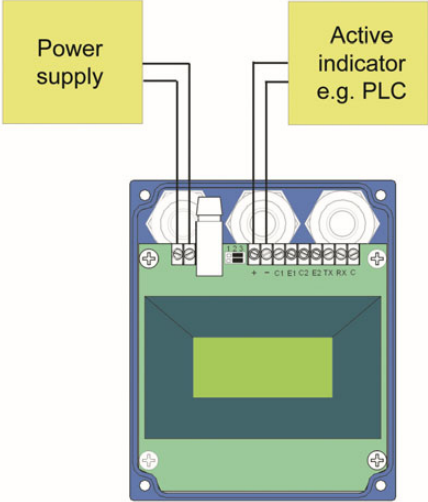
Passive output

Possibilities of connection for the power supply and analog output

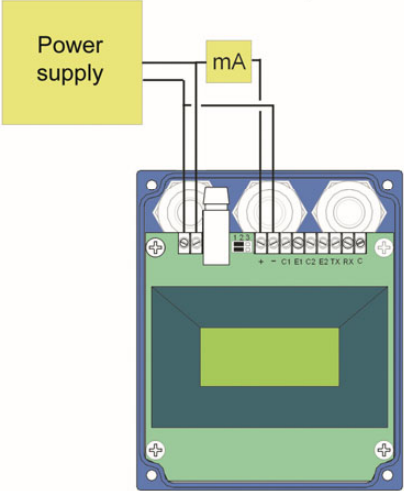
Active output



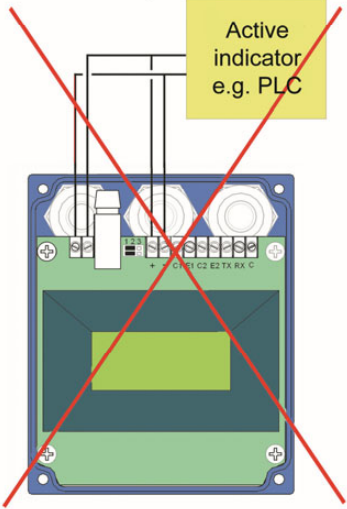
Passive output



Passive output



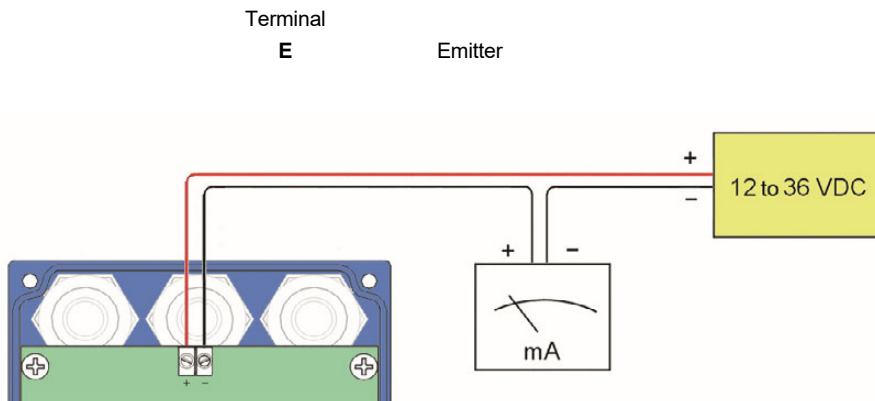
Passive output



mA: Ammeter

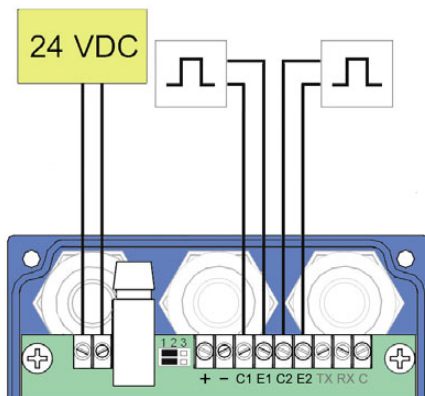
position + and the positive terminal of the load in the position -. The negative terminals of the power supply and the load are connected together. The instrument works in a 2-wire system, that is, the supply and signal line is the same. It is recommended to use a twisted pair wiring or shielded cable to avoid interferences in the current loop.

3.3 Alarm outputs connection (only models LU9X)



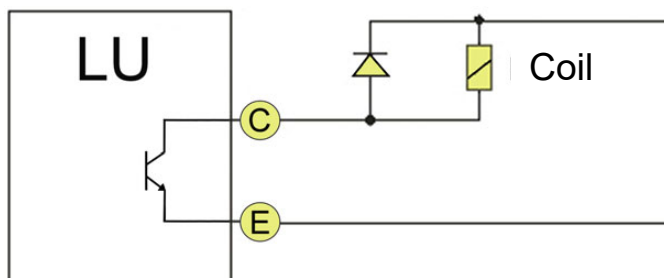
C Collector

The two available alarm outputs are optoisolated. The terminals are the collector and emitter of an NPN bipolar transistor. In the case of using inductive loads, in order to protect the transistor output, it is necessary to use free diodes (see next figure).



3.4 Connection examples

The two usual ways to connect the alarm outputs are NPN or PNP modes, depending on if the load is connected to the positive or negative terminal.



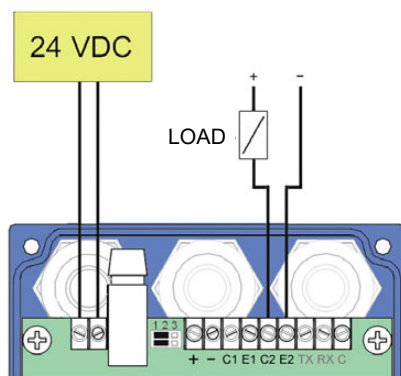
In the following figures, an example of connection for the alarm 2 in NPN and PNP mode can be seen.

NPN connection

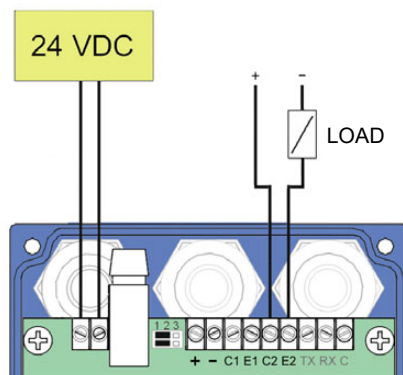
PNP connection

The power supply for the outputs does not need to be the same as the power supply for

the instrument, because they are galvanically isolated. Due to this, the power supplies are



shown separated in the two figures .



If only one power supply is available, there is no problem in sharing the power supply of the instrument with the outputs.

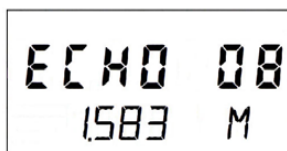
4 OPERATION

The instrument is delivered generally calibrated and programmed to indicate a distance. If you want to change any configuration parameter, the keyboard can be accessed without removing the top cover.

If the instrument has not been previously programmed, or due to an alteration in the data memory, the instrument recovers default factory settings, and the word "PRESET" appear on the display. This indication disappears once the sequence of programming is completed.

4.1 Echo intensity verification

Once the instrument has been installed, the echo intensity can be verified. This intensity depends on the distance to the target, the type of product where the wave is reflected and the conditions of installation.



To check the intensity, just turn on the equipment and press the keys (←) y (□) simultaneously. You will see the following screen:

The echo intensity is displayed on a scale of 0 to 10.

If the distance of the product at the time of verification is longer than half the maximum distance measurement, it is normal that the intensity has a low value.

In the event that the distance is shorter, if the value of the intensity is low, it may be due to two reasons:

- a) That the product has a high absorption coefficient. This means that an important part of the wave is absorbed by the product and is not reflected to the instrument. In this case, the maximum measuring distance will be shorter than specified in the characteristics of the instrument.
- b) That the instrument has not been installed correctly. As the face of the transducer is no longer parallel to the surface of the product, part of the reflected signal does not return to the instrument, thus decreasing the intensity of the echo.

To exit the mode of verification of intensity, press again the keys (←) y (□) simultaneously.

4.2 Display modes

The working screen can indicate three different values. They can be changed by pressing the key (↑).

Distance (d). In this case the screen indicates the distance between the sensor and the surface of the blank where the ultrasonic wave is reflected.

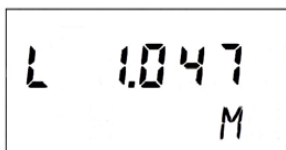
Level (L). It shows the level or height from a reference, usually the bottom of the vessel, to the liquid or solid surface.

In order to show the level correctly, the parameter bottom distance (bd) must be previously programmed (see point 5.2).



Percent (P). It displays the filling percentage between two references, normally the bottom of the tank and the maximum level. These two parameters have to be correctly programmed (see points 5.2 and 5.3).

4.3 Dead zone indication



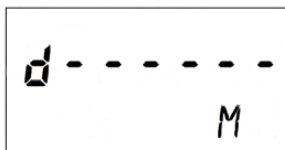
If the measured distance is shorter than the minimum measuring distance, we can say that the product is in the dead zone (see point 2.2). In this case the transmitter can not make a correct measurement.



In this situation the instrument will display 6 dashes instead of the measured value, and the analog signal output will give 3.6 mA or 22 mA depending on how it is programmed (see section 5.9 in page 19), indicating incorrect measurement due to dead zone.

4.4 Echo loss indication

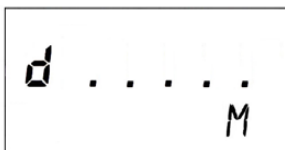
If the distance is longer than the maximum measuring distance, the instrument will not receive reflected signal. It is also possible that if the product is not adequate for ultrasonic measurement, there will be not received signal.



In this case the instrument will display 5 points instead of the measured value, and the analog signal output will give 3.6 mA or 22 mA depending on how it is programmed (see section 5.9 in page 19), indicating incorrect measurement due to echo not found.

5 CONFIGURATION

To change a digit, touching the key (↑) the flashing digit will be incremented. When the value of 9 is reached on the next increment it go to zero. With the key (←) we move to the



next digit to the left. If we are on the seventh digit we go back to the first digit.

When we have the required data on the screen, touching the two keys (↑) & (←) at the same time, the data will be stored into memory and the next screen appears.

If data does not have to be saved, the key (□) is used to jump to the next screen without making any changes in the configuration data even if digits or working modes have been changed.

There are two programming menus. The first one is related to the adaptation of the instrument to the installation. The second allows to change the parameters that affect the behaviour of the instrument.

To enter the first menu, keys (↑) and (←) must be pressed at the same time.

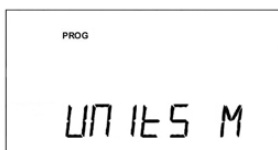
5.1 Measuring units

The instrument can indicate the measured distance or level in meters or feet.

To change the measuring units, press the key (↑).

5.2 Distance to the bottom of the vessel

On the first screen, the distance from the installed instrument to the bottom of the vessel is programmed "bottom distance".

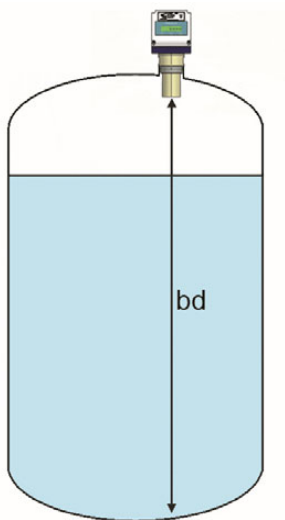


This parameter is necessary if we want the instrument to work in level mode or percentage mode (see section 4.2).

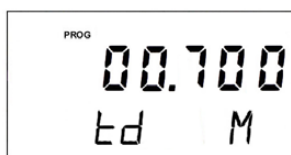


The figure shows the distance bd. The measurement in level or percentage mode shall refer this distance. In a case when a vessel bottom is not flat, we must take the bd distance between the tip of the instrument, and the point that we take as zero level.

5.3 Distance to the top of the vessel



This parameter is necessary if we want the instrument to function in percentage mode (see section 4.2).

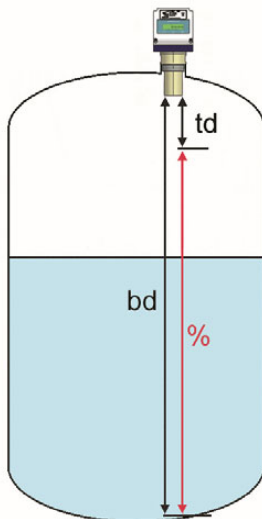


The percentage of filling is calculated taking into account the points distance to the bottom (see section 5.2) and distance to the top, according to the following equation:

$$\% = \frac{(bd - td) - (d - td)}{(bd - td)} \times 100$$

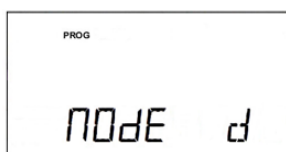
When the distance between the product and the sensor is bd, the displayed percentage is 0%.

When the distance between the product and the sensor is td, the displayed percentage is 100%.



5.4 Default display mode

Display modes of distance and level explained in section 4.2 can be programmed as modes by default. Thus, the instrument will always be working in this mode even if there is a power fail.



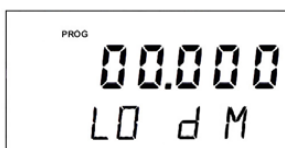
The remaining screens will require the parameters in the chosen mode.

5.5 Current output

Next, the loop current programming screens are displayed.

On the first screen the user can program the level (or distance) at which the instrument will give 4 mA at its output (lower range). Next, the level (or distance) at which it will give 20 mA (upper range) is programmed.

The level "lower range" can be higher than the "upper range" or vice versa.



5.6 Alarms

In these screens we select the actuation points of the two alarms and the level of hysteresis. By level of hysteresis we understand the difference between activation and deactivation of the output. In some cases the level of a vessel is not stable due to waves generated by agitators, etc. To avoid that an alarm output is continuously moving from activate to deactivate state, we must program the points of connection and disconnection.



Alarm 1. Point of activation



Alarm 1. Point of deactivation



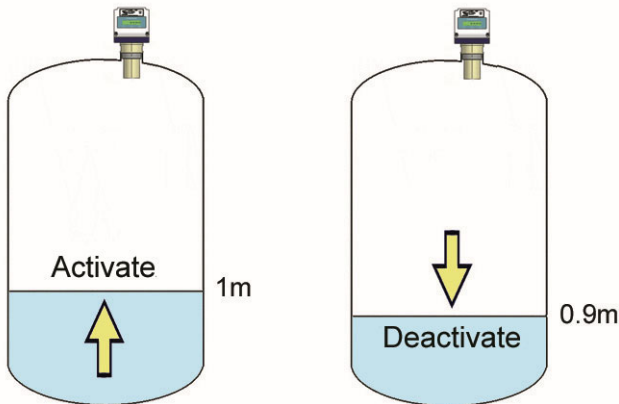
Alarm 2. Point of activation



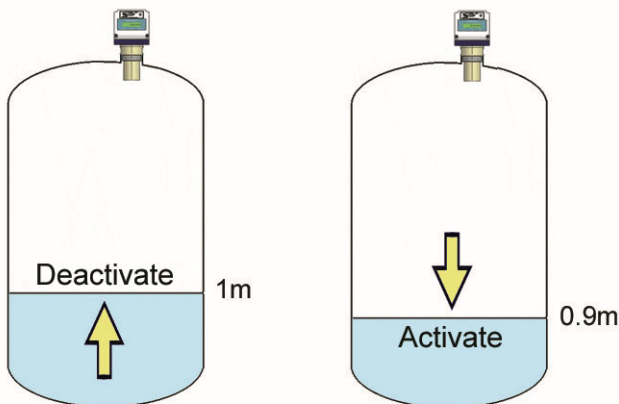
Alarm 2. Point of deactivation

Example

Suppose that the instrument is working in level mode. If the activation point is programmed to 1 m and the deactivation point is programmed to 0.9 m, when the level is zero the output will be off. When the level reaches a height of 1 m the output will go on and it will not go off until the level falls below 0.9 m.



If an activation point of 0.9 m and a deactivation point of 1 m is programmed, when the level is zero the output will be on. When the level reaches a height of 1 m the output will go off and it will not go on until the level falls below 0.9 m.



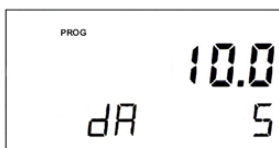
With this screen, the first configuration menu is finished.

To enter to the second menu, press the two keys (↑) y (□) at the same time.

5.7 Filter

The level transmitter has an adaptive filter (damping) to provide stable level and analog output readings.

The configuration of this filter can be very useful in the cases where the readings have some instability (due to waves, foams, solids, etc.).



Only the level indication of the display and the analog output are affected by the filter. The alarm outputs act according to the instant readings. By selecting a filter with a longer or shorter integration time more or less stable readings are provided. It will also affect the response time to small variations of level.

The integration time is selected in seconds, with a minimum value of 0.1 and a maximum value of 20.0 seconds. For example, with an integration time of 15 seconds, the display will indicate the average level over the last 15 seconds from the last update of the display. This doesn't mean that the display is refreshing its data every 15 seconds. The display shows a new value several times per second, indicating an average of the level values of the last 15 seconds.

5.8 Dead zone distance

In some installations it can be useful to increase the dead zone value. For example, in cases of standpipe measurements.



On this screen the dead zone distance in cm can be programmed.

5.9 Dead zone and echo loss alarm

When the measured distance is into the dead zone, the instrument shows an alarm on the current loop. This alarm can be programmed so that its value is either 3.6 mA or 22 mA.



When programming this value, the echo loss alarm value is programmed automatically with the opposite value.

5.10 Hysteresis

When there is a sudden variation of the level then the filter should react as fast as possible to give a correct reading of the new value.

On this screen the level variation in cm necessary to reset the filter can be programmed..



The filter controls for each reading the deviation of the instant level with respect to the average level. If this deviation exceeds the 6% of the average value, the filter will stop acting, indicating the instant value, and will start again the filtering process.

For example, consider an instrument measuring an average level of 2.4 m and the programmed hysteresis is 4 cm..

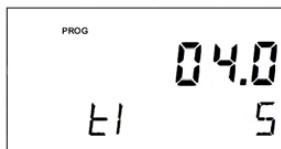
The filter will continue to give average readings whilst the instant measured level is lower than 2.36 m o higher than 2.44 m.

5.11 Switching time

Sometimes objects that interfere the path of the ultrasonic wave can cause wrong readings. An example is the case in which an agitator blades can give unwanted reflected signals.

To avoid this reading, on this screen, the number of seconds that an undesired object must remain so that the instrument interprets it as correct can be programmed.

For example, if the time is set to 6 seconds, an object that interferes the ultrasonic wave



path must remain 6 seconds so that the level meter takes this object into account.

In the series LU level meters, if during a configuration sequence a HART command, which should be attended, is received, the local configuration sequence will not be valid and all the data of that configuration sequence will be lost. The screen will return to the normal working screen and the word "PROG" will be displayed to show that this event has occurred. The word "PROG" will be turned off when touching either of the two keys (↑) or (←).



5.12 Serial number and software version

Touching the three keys at the same time we access a screen where the serial number of the converter is shown.



To see the software version and after that return to the normal working screen touch any key.



6 KEYBOARD DISABLE AND “WRITE PROTECT”.

The instrument has a jumper, placed behind the display on the left, which can be used to avoid changes in the configuration. When the jumper is connected the instrument can be configured by means of the keyboard and via HART. When the jumper is removed, the keyboard is disabled and “Write Protect” is activated for HART, thus avoiding any changes in the configuration.

7 HART COMMUNICATION

Level meters LU9XH y LU921H have a modem for HART communication.



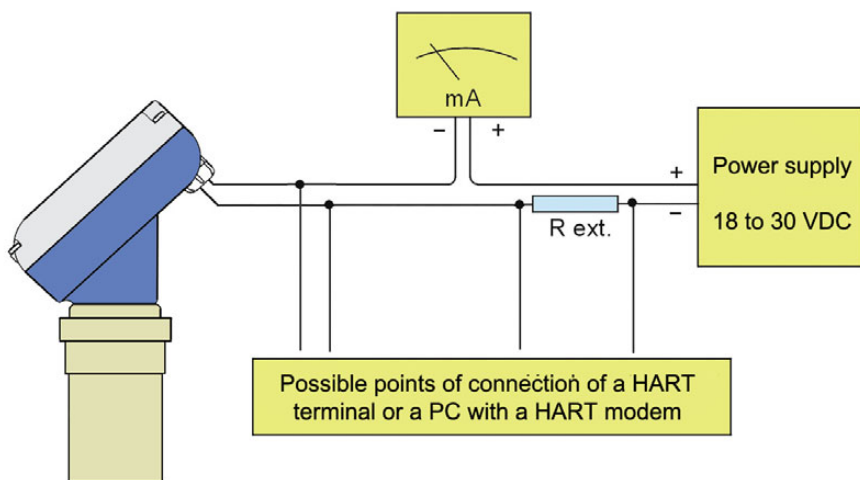
LU transmitters are fully compatible with the **HART Server** software from HART Communication Foundation.

Tecfluid S.A. do not guarantee that the LU transmitters are compatible with the different servers in the market.

When connecting the transmitter, an external resistor (R ext.) should be included. Its minimum value is 200 Ω , and the maximum value depends on the power supply as follows:

The detail of the characteristics with respect to the HART communication are available in the corresponding “Field Device Specification” document.

In order to establish HART communication, it is necessary to connect a terminal or PC with a HART modem, in one of the points indicated in the following figure.



Summary of the main communication characteristics:

Manufacturer, Model and Revision	Tecfluid S.A., level transmitter LU9XH, Rev. 0 Tecfluid S.A., level transmitter LU921H, Rev. 0
Device type	Transmitter
Hart Revision	6.0
Device Description available	No
Number and type of sensors	1, exterior
Number and type of actuators	0
Number and type of host side signals	1, 4 – 20 mA analog
Number of Device Variables	2
Number of Dynamic Variables	1
Mappable Dynamic Variables	Sí
Number of Common Practice Commands	13
Number of Device Specific Commands	6 (mod. LU9XH), 4 (mod. LU921H)
Bits of Additional Device Status	13
Burst mode?	No
Write Protection?	Yes

8 MAINTENANCE

No special maintenance is required .

For cleaning, a humid cloth can be used, and if necessary with a little soap. Solvents or other aggressive liquids which could damage the polycarbonate housing should not be used.

8.1 Fuse (only models LU9X)

In the event that the fuse blows, this should be replaced with a slow blow "T" fuse, size Ø5 x 20 mm and of the same rating as indicated on the label inside the equipment.

9 TECHNICAL CHARACTERISTICS

9.1 Materials

Body: PP, PVDF

Housing: Polycarbonate.

9.2 Process connection

LU91 / LU921: G2 (BSP) thread.

LU93 / LU923: G2 1/2 (BSP) thread.

9.3 Measuring range

LU91: 0.35 m ... 6 m (solids up to 3.5 m)

LU93: 0.55 m ... 12 m (solids up to 7 m)

LU921: 0.35 m ... 5 m (solids up to 2.5 m)

LU923: 0.55 m ... 10 m (solids up to 5 m)

9.4 Power supply

LU9X: 18 ... 30 VDC.

Power consumption: ≤ 1.5 W

LU92X: 12 ... 36 VDC.

Power consumption: maximum 22 mA

9.5 Analog output

4-20 mA or 20-4 mA.

Error of measurement signals of 3.6 mA and 22 mA

9.6 Alarm outputs (only models LU9X)

Optoisolated. Vmax: 30 VDC. Imax: 30 mA.

9.7 Measuring indication

N° of digits:

4 (1 integer and 3 decimals)

Digit size:

7 mm

9.8 General characteristics

Protection rating: IP67

Ambient temperature range: -40 ... +70 °C (display only to 60 °C)

Maximum working pressure: 400 kPa (4 bar)

Resolution: 1 mm

Uncertainty: $< 0.25\%$ of measuring range

Repeatability: $< 0.25\%$ of measuring range

9.89 Electrical characteristics referred to the analog loop and communications

Reception impedance:

Rx $>$ 8,5 M Ω

Cx $<$ 200 pF

Conforms with 89/336/EC Directive

Conforms with 2002/96/EC Directive

Conforms with 97/23/EC Directive

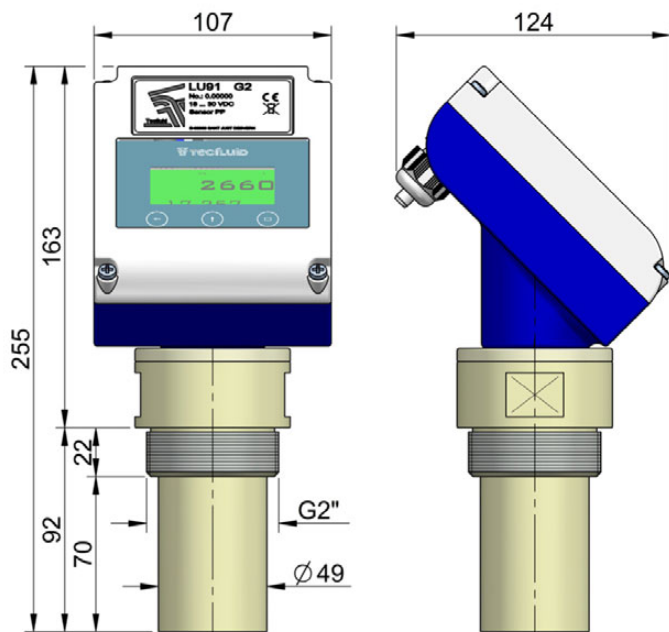


This equipment is considered as being a pressure accessory and **NOT** a safety accessory as defined in the 97/23/EC directive, Article 1, paragraph 2.1.3.

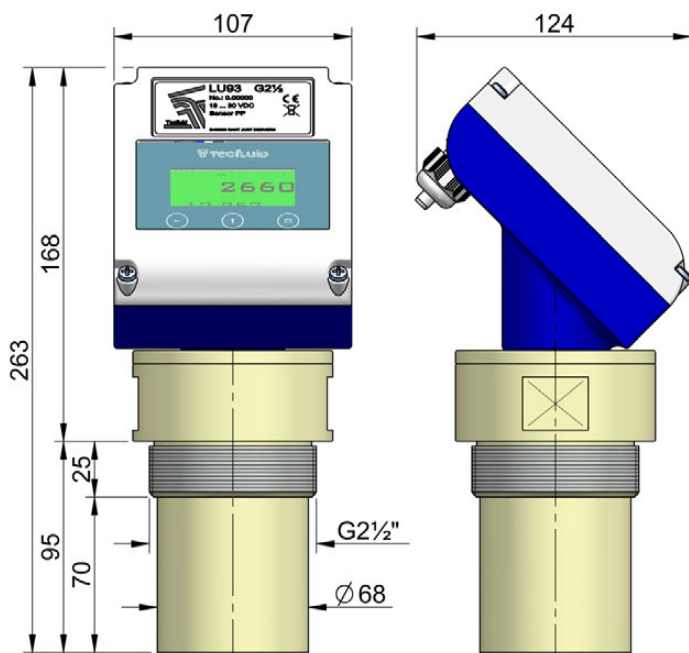


10 DIMENSIONS

LU91
LU921



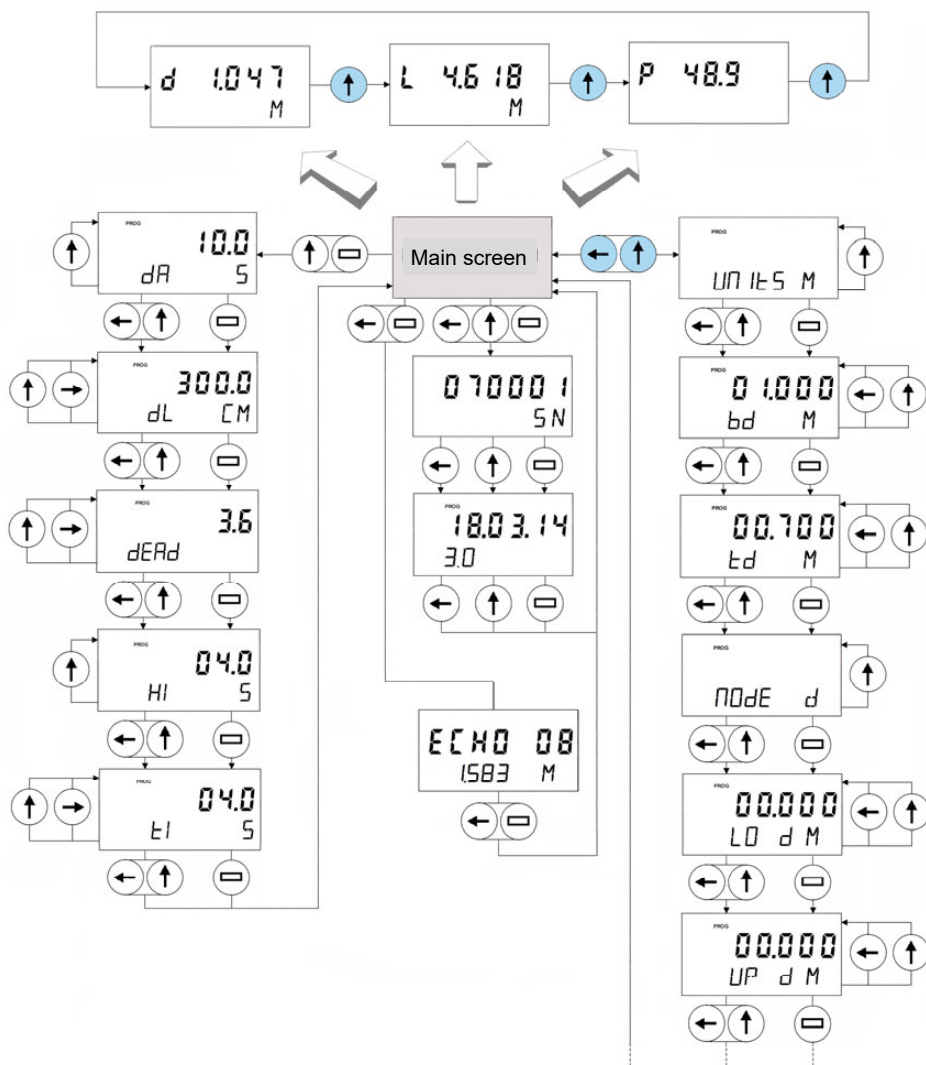
LU93
LU923



11 TROUBLESHOOTING

Problem	Probable cause	Remedy
Dashes on the display	The product is in "dead zone". The distance between the level transmitter and the product is too short.	Separate the level transmitter from the product you want to do the measurement. (see page 4).
	There is an obstacle placed in the dead zone of the instrument.	Separate the level transmitter from the obstacle (see page 4).
Points on the display	The ultrasonic wave reflected from the surface is very weak because the product has a very low index of reflection toward the sensor. It can happen with foams, sands, solids.	Verify that the level transmitter is the adequate for this application.
	Bad installation of the equipment.	Verify that the bottom face of the level transmitter is installed parallel to the surface of the product (see page 4).
	The sensor is out of the allowed measuring range.	Verify that the level transmitter is the adequate for this application.
The display is blank	Power supply is not adequate.	Verify the polarity of the cables of the power supply, check that they are well connected to the terminal block and there is voltage between them.
The measurement is not stable	There may be some objects between the sensor and the product.	Change the position of the level transmitter so that the object is not an obstacle.
	There are waves on the liquid surface.	Increase the duration of the filter (damping) (see page 17).

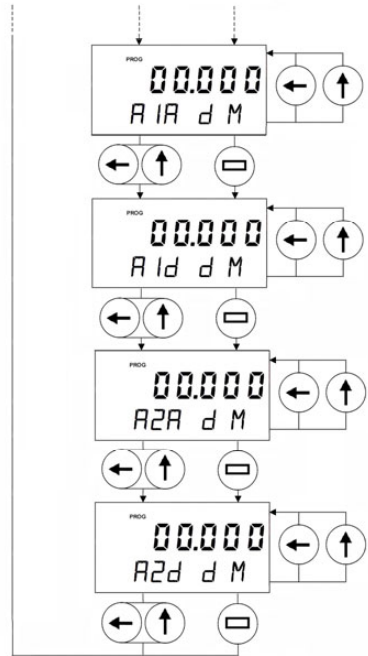
12 CONFIGURATION DIAGRAM



SN: Serial number
dA: Damping
dL: Dead zone distance
dead: Dead zone alarm
Hi: Hysteresis. Window in which the instrument is still filtering
ti: Time needed to accept a change outside the window

Units: Measuring units
bd: Bottom distance
td: Top distance
Mode: Working mode: distance, level or percentage
LO: Value equivalent to 4 mA in the loop current
UP: Value equivalent to 20 mA in the loop current

Only in models LU9X



- A1A:** Value at which the alarm 1 will activate
- A1d:** Value at which the alarm 1 will deactivate
- A2A:** Value at which the alarm 2 will activate
- A2d:** Value at which the alarm 2 will deactivate

WARRANTY

Tecfluid S.A. guarantees all the products for a period of 24 months from their sale, against all faulty materials, manufacturing or performance. This warranty does not cover failures which might be imputed to misuse, use in an application different to that specified in the order, the result of service or modification carried out by personnel not authorized by Tecfluid S.A., wrong handling or accident.

This warranty is limited to cover the replacement or repair of the defective parts which have not damaged due to misuse, being excluded all responsibility due to any other damage or the effects of wear caused by the normal use of the devices.

Any consignment of devices for repair must observe a procedure which can be consulted in the website www.tecfluid.com, "After-Sales" section.

All materials sent to our factory must be correctly packaged, clean and completely exempt of any liquid, grease or toxic substances.

The devices sent for repair must enclose the corresponding form, which can be filled in via website from the same "After-Sales" section.

Warranty for repaired or replaced components applies 6 months from repair or replacement date. Anyway, the warranty period will last at least until the initial supply warranty period is over.

TRANSPORTATION

All consignments from the Buyer to the Seller's installations for their credit, repair or replacement must always be done at freight cost paid unless previous agreement.

The Seller will not accept any responsibility for possible damages caused on the devices during transportation.



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Pressure Equipment Directive 97/23/CE certified by **Lloyd's Register**

ATEX European Directive 94/9/CE certified by



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The technical data described in this manual is subject to modification without notification if the technical innovations in the manufacturing processes so require.