

# Instruction Manual

## 2291 Guided Radar Level Transmitter





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## **Original instruction manual**

### **Follow the instruction manual**

The instruction manual is part of the product and is an important element of the safety concept.

- ▶ Read and follow the instruction manual.
- ▶ Always keep the instruction manual available of the product.
- ▶ Pass on the instruction manual to all subsequent users of the product.

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## 1 Intended use

The Level Transmitter uses the Time Domain Reflectometry (TDR) measuring principle and two-wire technology for level measurement. It is designed for measuring the distance, level and volume of liquids, pastes, slurries and powder products. The device is applicable in tank, silo, rigid pipe, reaction vessel and level reference vessel.

The device is HART capable; it can be programmed using the GF Signet configuration software Eview2 which is available on [www.gfps.com/level](http://www.gfps.com/level)

**Please note:** All display units also can be programmed directly without any additional hardware.

## 2 About this document

### 2.1 Warnings

This instruction manual contains warning notices that alert you to the possibility of injuries or damage to property. Always read and pay attention to these warnings!

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#### **Danger of personal injury!**

Failure to comply leads to a risk of personal injury!

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#### **NOTE**

#### **Risk of damage to property!**

Failure to comply leads to a risk of damage to property (loss of time, loss of data, device fault etc.)!

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## 3 Safety and responsibility

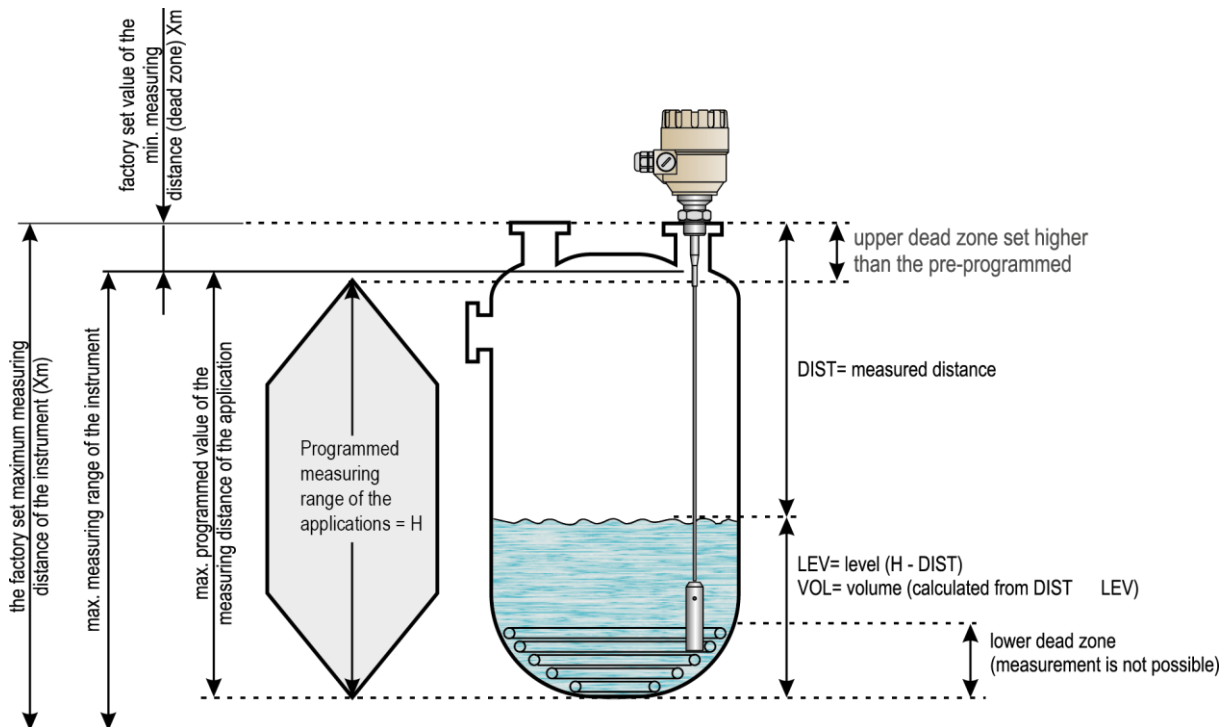
- ▶ Only use the product for the intended purpose, see Intended Use.
- ▶ Do not use any damaged or faulty product. Sort out any damaged product immediately.
- ▶ Have the product and accessories installed only by persons who have the required training, knowledge or experience.
- ▶ Regularly train personnel on all questions regarding the locally regulations applying to occupational safety and environmental protection, especially for pressurize tanks.

## 4 Transport and storage

- ▶ Protect the product against external forces during transport (impacts, knocks, vibrations etc.).
- ▶ Transport and / or store the product unopened in its original packaging.
- ▶ Protect the product from dust, dirt, moisture as well as heat and ultraviolet radiation.
- ▶ Ensure that the product is not damaged either by mechanical or thermal influences.
- ▶ Before assembling, check the product for damage during transport.

## 5 Design and function

### 5.1 Function




### 5.2 Principle of operation

The Type 2291 guided microwave level transmitter uses the TDR (Time Domain Reflectometry) principle. The instrument sends low power ns wide pulses along an electrically conductive rod, cable or coaxial probe with a known propagation speed (the speed of light). As the pulse reaches the surface of the medium or phase of two liquids (altered dielectric constant  $\epsilon_r$ ), a part of it is reflected back to the electronic module. The efficiency of the reflected signal depends on the dielectric constant  $\epsilon_r$  difference of the mediums or layers. (From the plain surface of air-water phase the reflected signal's strength will be approx. 80% of the emitted signal). The reflected pulse is detected as an electrical voltage signal and processed by the electronics. Level distance is directly proportional to the flight time of the pulse. The measured level data is converted into 4-20 mA current and HART signals and is displayed on the LCD display. From the level data further derived measuring values can be calculated such as volume and mass. The TDR technology is unaffected by the other properties of the medium as well as that of the space above it.

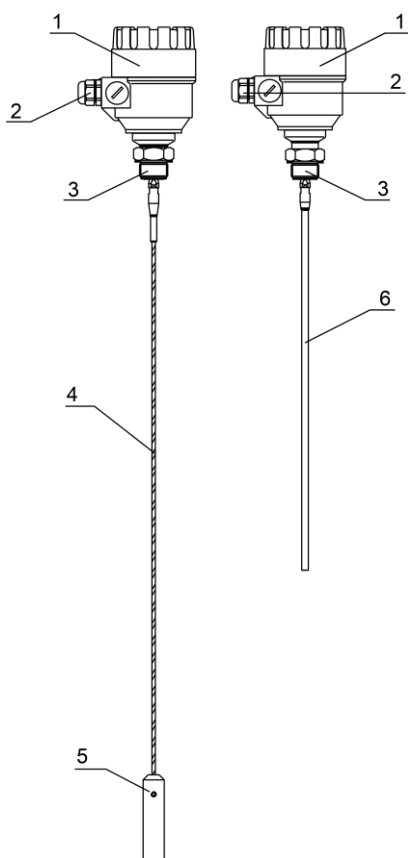
## 6 Technical data

Data		Kv value	
Input data	Measured values	Between the reference point of the unit and reflection plane (material surface), distance, level, and volume	
	Measuring range	Single cable 6 m (19,7 ft), single rod 2 m (6.6 ft)	
Housing		Plastic BPT	
Medium temperature		-30 °C ... +90 °C (-22 °F ... +194 °F)	
Minimal dielectric constant ( $\epsilon_r$ )		1.9	
Medium pressure		- 0.1 ... 1.6 MPa (- 1... 16 bar) max. allowed pressure at 20 °C (68 °F)	
Ambient temperature		With display: -20 °C ... +60 °C (-4 °F... +140 °F)	
Sealing		FPM	
Ingress protection		IP 65 (NEMA 4 - 4X)	
Power supply		18 ... 35 V DC , nominal 24 V DC, Ex version 18 ... 28V	
Output data	Output signals	Analogue: 4 ... 20 mA, (3.9 ... 20.5 mA) passive output, error 22 mA	
		BUS: serial line, HART <sup>®</sup> interface, terminal resistor max. 750 ohm	
		Display: LCD matrix	
	Accuracy	Liquids: $\pm 5$ mm. For probe length $L \leq 10$ m $\pm 0.05\%$ of the range	Under ideal reflection and stabilized temperature conditions.
Resolution		$\pm 3 \mu\text{A}$	
Electrical connection		2 x M20x1.5 metal cable glands Cable diameter: 7 ... 13 mm (Ex), or M20x1.5 plastic cable glands, Cable diameter: 6 ... 12 mm wire cross-section: 0.5 ... 1.5 mm <sup>2</sup> (shielded cable is advised) + 2 x NPT 1/2" for cable gland	
Electrical protection		Class III.	
Mass (housing)		1.5 kg	

**Explosion Protection, Ex markings, Ex limit data**

Type	
Ex marking	 II 1 D iaD A20/21 IP 65 T100°C
Intrinsically safe data	$C_i \leq 10 \text{ nF}$ , $L_i \leq 10 \text{ mH}$ , $U_i \leq 30 \text{ V}$ , $I_i \leq 150 \text{ mA}$ , $P_i \leq 1 \text{ W}$ For Ex transmitter only EEx ia power supply should be used
Ex power supply	$U_o < 30 \text{ V}$ , $I_o < 150 \text{ mA}$ , $P_o < 1 \text{ W}$ , Supply range 18 V ... 30 V

**6.1 Dimensions**



Nr.	Description
1	Housing
2	Cable gland
3	Process connection
4	Mono cable probe
5	Weight
6	Mono rod probe



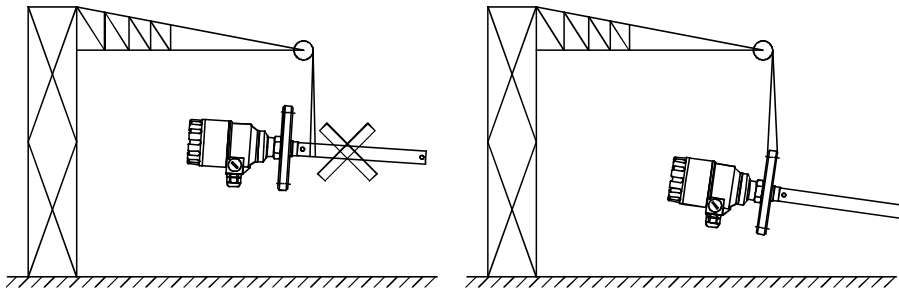
## 7 Installation

### 7.1 Handling and Storage

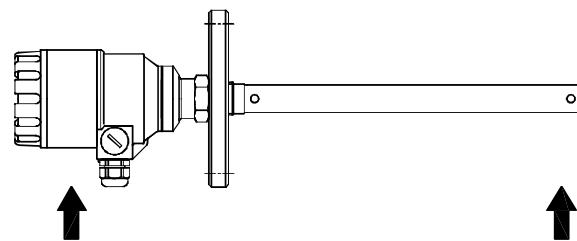
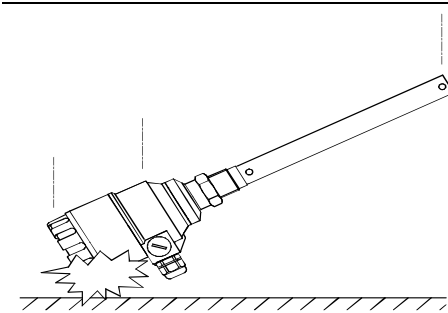


The device will weigh between approximately 1.5 kg or 3 lb, 12 kg or 25 lb.

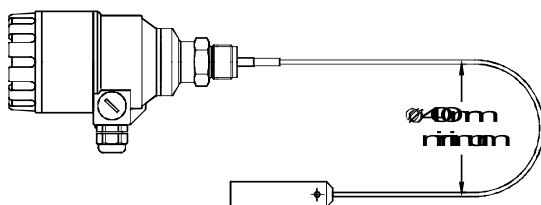
Carry using both hands to lift the device carefully by the converter housing. If necessary, use lifting gear. No attempt should be made to lift the instrument by its probe. Caution: The probe is a critical gauge component. Do not damage - Handle with care!



Avoiding blows - avoid hard blows, jolts, impacts, etc. Caution: fragile electronics

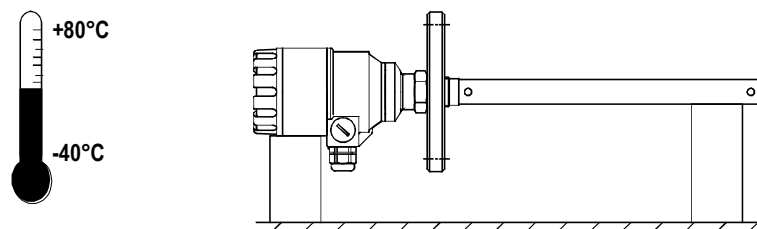


Avoid bending (single rod and coaxial probes) - Support the probe to avoid bending.



#### Avoid cable kinks and fraying

Do not coil the cable less than 400 mm or 16 " in diameter. Cable kinks or fraying will cause measurement errors.



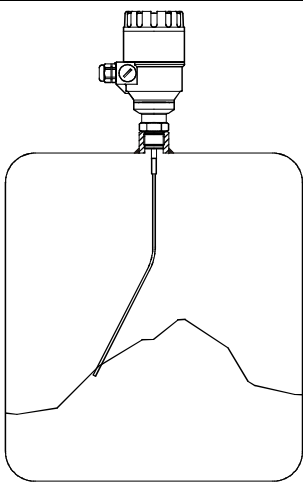
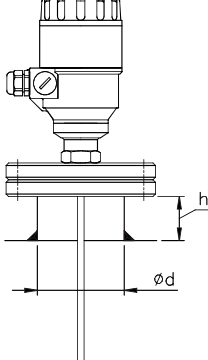
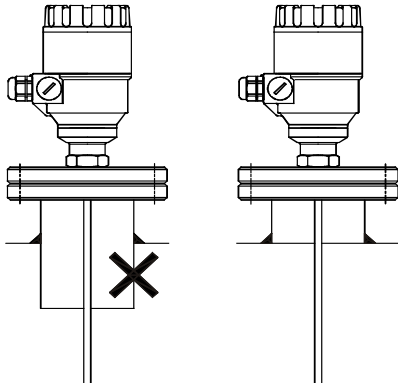
#### Storage temperature

## 7.2 Mounting on the tank

### 7.2.1 Installation instructions: General notes

Prior the installation some consideration is to be made regarding tank fittings and tank shape. Nozzle position in relation to the tank walls and other objects inside the tanks

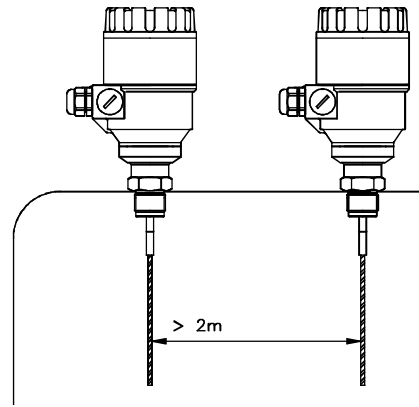
(Warning: this free area will depend on the probe type selected: refer to later on in this section) type of tank roof, i.e. floating, concrete, integral, etc; and base, i.e. conical, etc. Whenever working on an installation, remember to: Disconnect the power supply before starting work. However, the gauge may be installed when the tank contains product.

<p><b>Threaded process connections</b></p> <p>The simplest and most economical way is to mount type 2291 directly on the tank with the 1" BSP or 1" NPT threaded connection.</p>	
<p><b>Nozzle height</b></p> <p>Do not fit a nozzle longer than its diameter, especially for single probes and powder applications.</p> $h \leq \varnothing d$ <p>h = nozzle height and d = nozzle diameter</p>	
<p><b>Nozzles penetrating into tank</b></p> <p>Caution: Do not use nozzles that penetrate into the tank. This will disturb the emitted pulse.</p>	

**Installation of two devices**

If two devices are to be used on the same tank, these should be mounted at a distance of at least 2 m or 6.5 ft away from each other. If not, interferences from the electromagnetic (EM) fields generated by both instruments may cause measurement errors.

Coaxial probes: the outer shell of the probe contains the EM field: no minimum distance required.

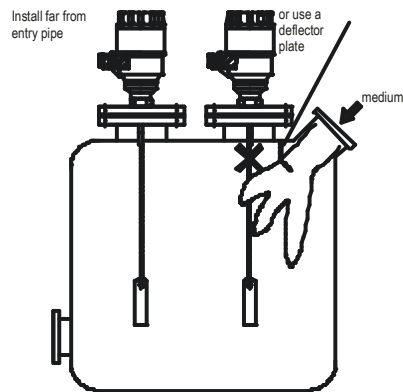


**Process connection and entry pipe**

Caution: Do not put the nozzle close to the entry pipe.

Pouring the product directly onto the probe will give false readings.

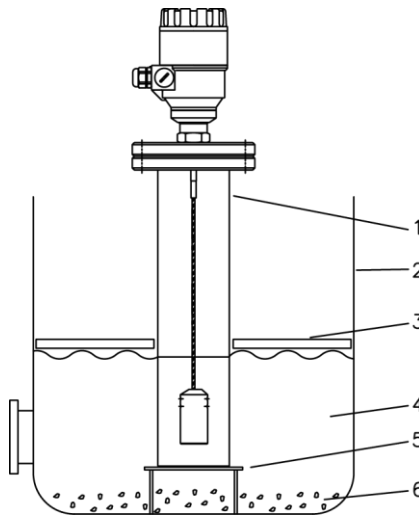
Install deflector plate if impossible to distance gauge from entry pipe.



**Stilling wells**

Tanks with floating roofs for petrochemical applications: Use a stilling well.

- 1 Stilling well
- 2 Tank
- 3 Floating roof
- 4 Product (petroleum applications)
- 5 Well fixed to tank base (no roof deformation)
- 6 Sediment



**Probes: entanglement, straightness and tank bottom clearance**

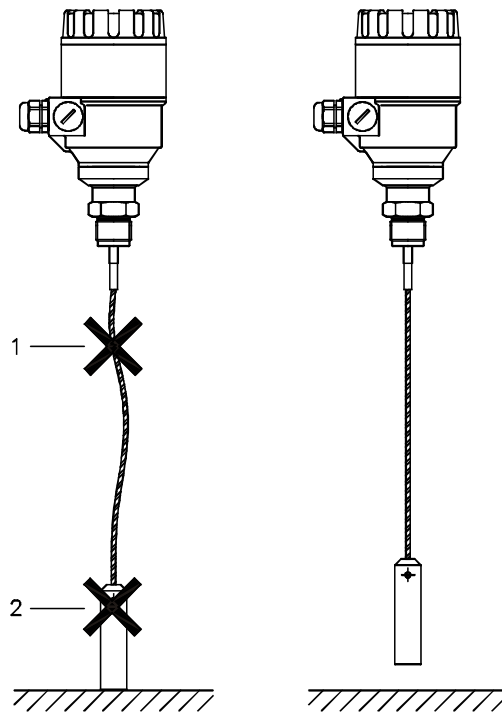
Cable probes must be straight once inserted into the tank.

They must also be far from other objects (e.g. mixers) to avoid entanglement.

In order to maintain the gauge's operating characteristics, it is recommended to avoid touching the tank bottom with the counterweights (for cable probes) or probe end (other types).

Avoid mounting near objects (discontinuities) inside the tank that influence the probe's EM (electromagnetic) field

Install the gauge far from protruding objects such as: heating tubes, sudden changes in tank cross-section, tank wall reinforcements and beams, weld lines and dip-stick pipes, etc.

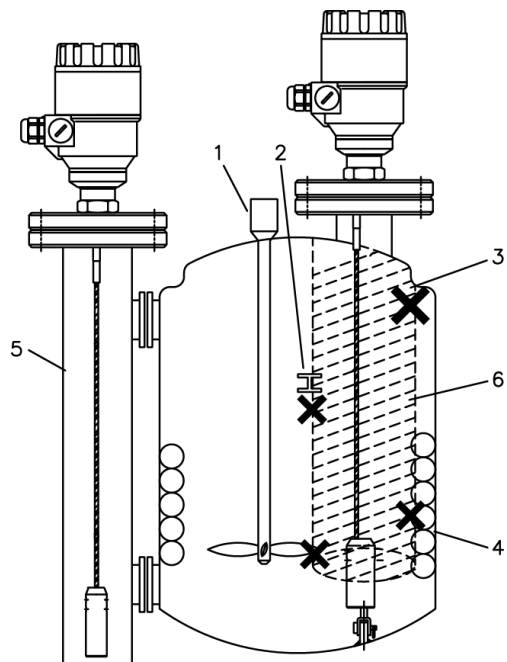


1. Agitator
2. Support beam perpendicular to the pulse direction
3. Abrupt changes in tank cross section
4. Heating tubes
5. Alternative solution: reference chamber - electromagnetic field is within chamber
6. Gauge electromagnetic field: Any intruding metallic object will be detected in this zone if perpendicular to the emitted pulse direction.

Do not fit the gauge near to these objects.

When measuring liquids the use of a stilling well or reference chamber is favorable because it ensures electromagnetic protection for an accurate measuring.

No electromagnetic field outside the reference chamber.



**Use a sunshade if the unit is exposed to direct sunlight.**

**Fastening the probe to the tank bottom**

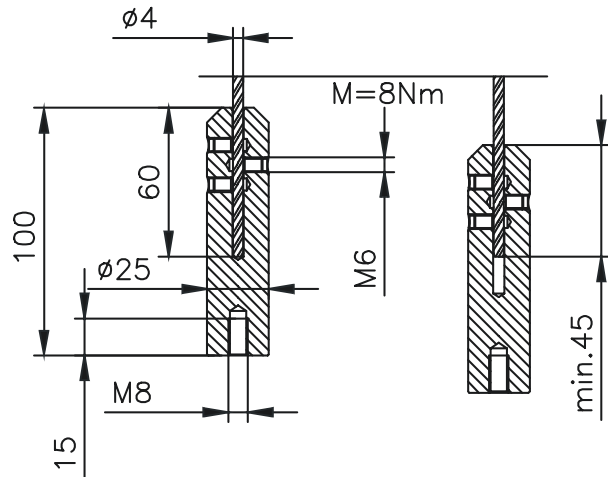
Flexible probes can be fastened with a chuck (ring), turnbuckle or similar fastening device to the tank bottom.

**Shortening cable probes**

If required, the cable probe can be shortened, but this applies only when used in liquids.

**Procedure**

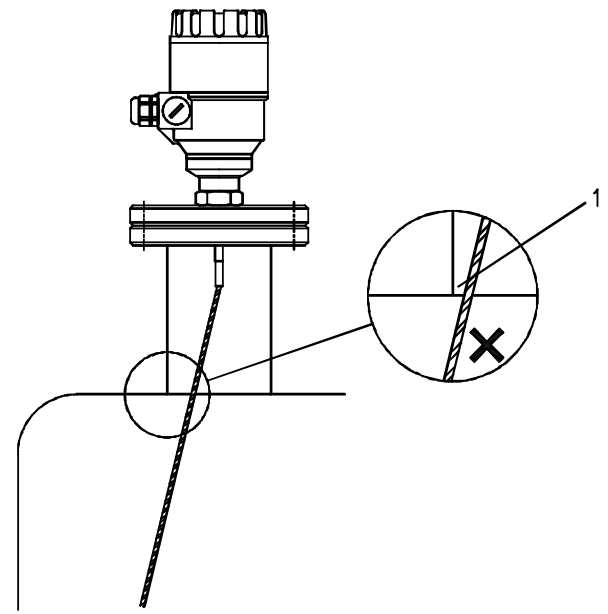
1. Detach socket set screw M6x10 (ISO 4026) with 5 mm Allen (hexagon) key (ISO 2936).
2. Pull cable out of counterweight and shorten to required length using cable cutters to prevent the cable wires and strands from splaying out.
3. Insert cable back into counterweight and tighten down screws
4. Change configuration parameters to new probe length; the reference point is the top edge of the weight.



**7.2.2 Specific installation instructions: Gauge – solid applications**

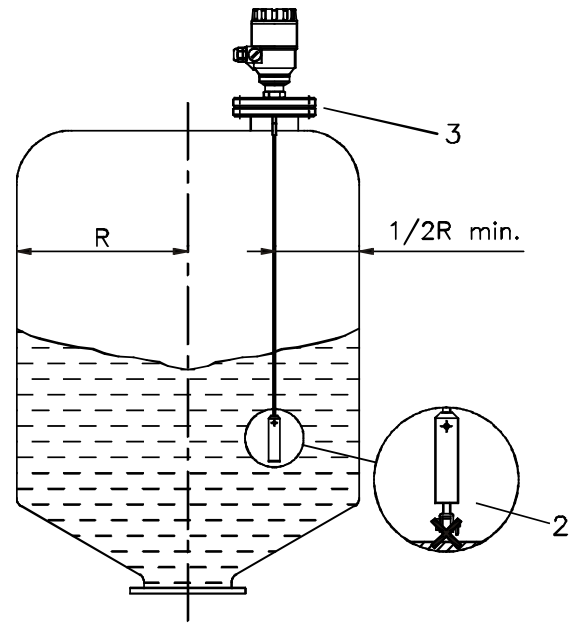
**False readings**

1. Do not let the probe touch the side of the nozzle.



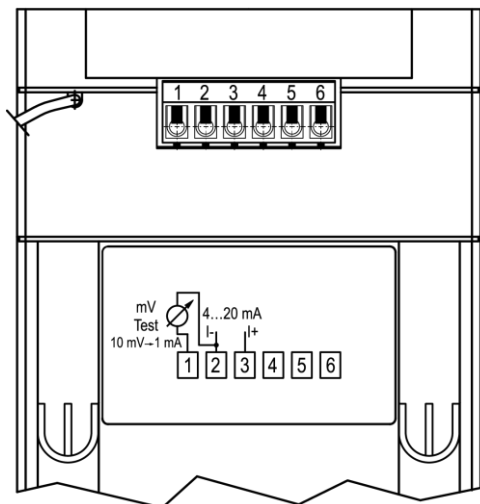
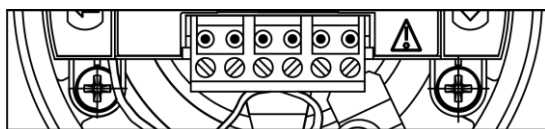
**Conical silo nozzles, false readings and traction on the cable probes**

2. High traction forces:  
We recommend that the probe should not be anchored to avoid excessive traction loads on the cable.
3. Bending and traction:  
Position the connection on the roof at  $\frac{1}{2}$  radiuses of the tank and with minimum nozzle height. This will avoid damage due to bending and traction during emptying.  
Product build-up can occur under the nozzle: this may weaken the pulse.  
Avoid cavities that permit the build-up of deposits.

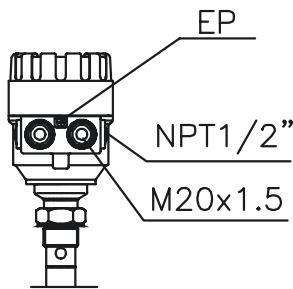


**7.3 Wiring**

**Wiring in non-Ex environment Wiring in non-Ex environment**



No.	Description
1	Detach the cover of the unit
2	Guide the cable into the housing through the cable gland
3	Remove a 4 mm length of isolation from the wires and cut away the free part of the shielding
4	Connect the wires of the current loop to terminals 2 and 3 (any polarity).
5	Pull back the cable till a 10 mm cable length remains in the housing behind the cable gland. Tighten the cable gland using two spanners. Check the connection of wires and the tightness at the cable gland
6	Array the wires in the housing and screw the cover on the housing. The 500V AC insulation test should not be performed on the instrument because of the overvoltage protection of the electronics.

**Connection to the EP network (grounding).**

Screw type terminal (EP) on the housing max. cable cross-section: 4 mm<sup>2</sup>.

The housing of the Type 2291 must be grounded.

Grounding resistance  $R < 1 \text{ Ohm}$

The shielding of the signal cable should be grounded at the control room.

Avoid coupling of electromagnetic noises place the signal cable away from power-current cables.

**Electrostatic discharge (E.S.D.)**

Type 2291 non-Ex and Ex gauge electronics are shielded up to 4 kV against E.S.D.

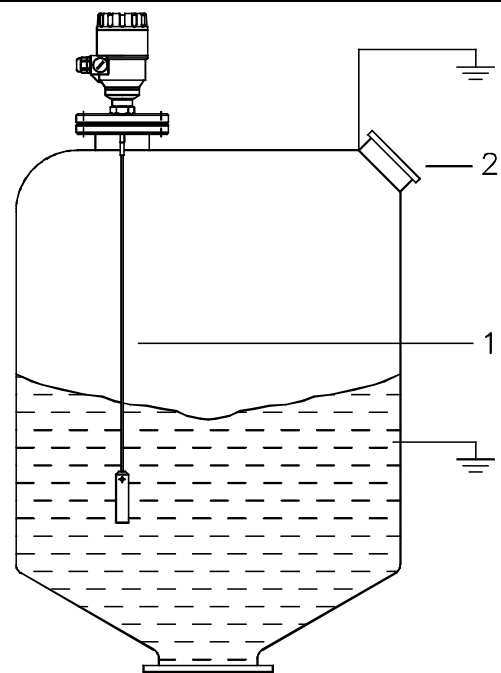
Note: E.S.D. cannot be solved by Type 2291 E.S.D. protection.

It is the customer's responsibility to avoid E.S.D. by grounding the tank, product and probe installation.

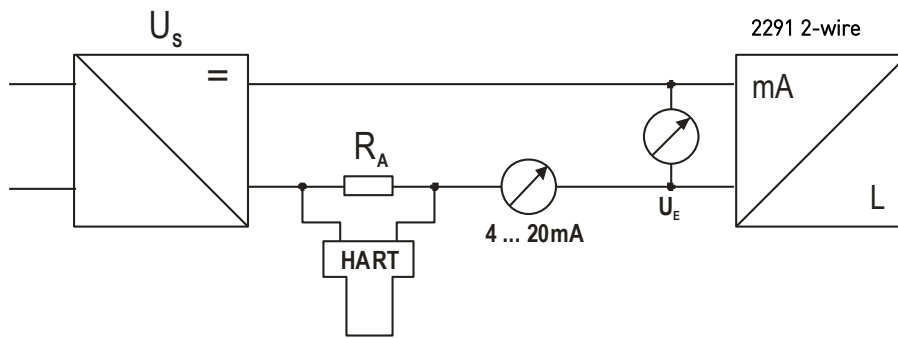
1. Danger of injury

The probe may receive an electrostatic discharge during operation; earth the probe by pushing it against tank wall with a suitably isolated tool just before touching it to avoid receiving a shock.

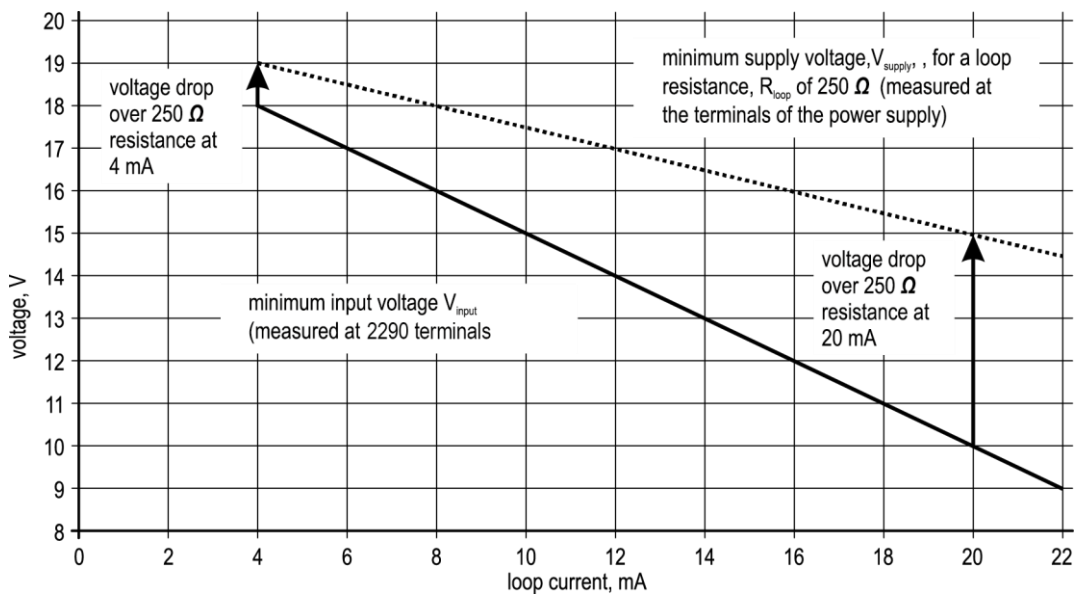
2. Earth the entry pipe and product.



Non-hazardous-duty version



	<b>Power supply</b>
Nominal voltage	24 V DC
Maximum voltage ( $U_{input}$ ):	35 V DC
Minimum voltage ( $U_{input}$ ):	dependent on load impedance, see graph below
<b>Load impedance <math>R_A</math></b>	
Loop resistance, $R_{loop}$	$R_{HART} + R_{cable} + R_{ammeter}$ Ohm
Minimum load impedance $R_A$	0 Ohm
Maximum load impedance $R_A$	750 Ohm
RHART resistance for HART® communication	250 Ohm, recommended



Line A = minimum voltage at the Type 2291 wire terminals

Line B = minimum supply voltage (for voltage drop caused by a 250 Ohm loop resistance)

Example for calculating the power supply: The voltage drop is tested at 22 mA:

$$U_{power\ minimum\ 22} = 22\ mA \times load\ impedance + U_{input\ minimum\ 22}$$

$$U_{power\ minimum\ 22} = 22\ mA \times 250\ Ohm + 10\ V = 5.5\ V + 10\ V = 15.5\ V$$



In order to cover the whole current range, the voltage drop must also be tested at 4 mA:  
 By analogy, the following applies:

$$U_{\text{power minimum } 4} = 4 \text{ mA} \times \text{load impedance} + U_{\text{input minimum } 4}$$

$$U_{\text{power minimum } 4} = 4 \text{ mA} \times 250 \text{ Ohm} + 18 \text{ V} = 1 \text{ V} + 18 \text{ V} = 19 \text{ V}$$

At a load impedance of 250 Ohm a power supply voltage of 19 V is sufficient to energize the current device range of 4 to 20 mA.



**Hazardous-duty version**

Connect the wires of the current loop to terminals 2 and 3 (any polarity).

The intrinsically safe certified device may only be used in conjunction with an other intrinsically safe certified equipment.

All the allowed electrical safety data indicated on the nameplate must be observed.

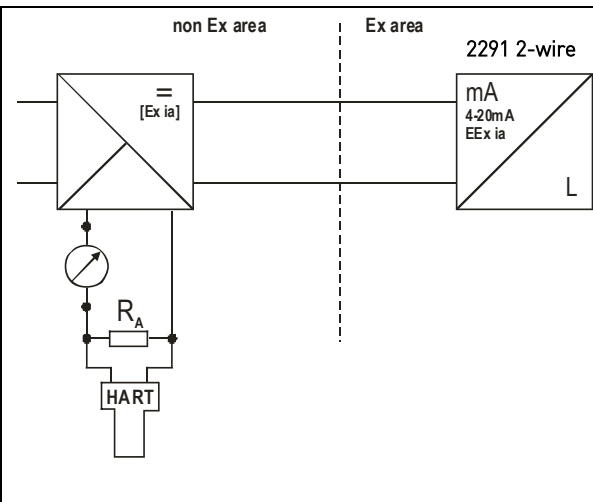
**An 'Ex' repeater power supply unit must be used**

For calculation of the supply voltage the same applies as for the standard non-'Ex' version.

The connected Ex repeater must be HART®-compatible so that it can be operated with the GF Signet Eview 2 communication software.

The HART adapter should be connected to the intrinsically safe input of the Ex repeater!

The units with plastic coating can only be used in IIB gas class hazardous area.



**7.4 Power on and start-up**

The Type 2291 wire is pre-configured in accordance to customer order specifications and measurements can be made immediately. A start-up time of less than 60 seconds should be allowed once the unit is connected and the power is switched on.

If the probe length has been shortened since delivery, please refer to section.

## 8 Programming type 2291

The main parameters of the Type 2291 can be also set using the display unit.

The default display shows the primary measured value (which the output current is calculated from). Besides the numerical display there is a bargraph on the right showing the value of the current output.

Programming is helped by a text-based menu. Navigation in the menu can be done with  $\ominus$  /  $\oplus$  /  $\odot$  /  $\oslash$  buttons.

### 8.1 The display unit

The display unit is a 64x128 dot-matrix LCD display which can be plugged into the transmitter.



The display based on LCD technology, do not expose to continuous direct sunlight to avoid display damage.

If type 2291 is not equipped with a sunshade and ambient temperature exceeds the operating temperature of LCD do not leave the LCD in the instrument!



Display	64x128 Dot-matrix LCD, glyphs, units and bargraph
Ambient temperature	- 20°C...+60°C
Housing material	PBT fiberglass, plastic (DuPont®)

#### 8.1.1 Behavior in manuals programming mode

After power-up Type 2291 shows the measured value on the LCD.

##### Remote mode:

If the instrument senses external HART communication it changes its display mode and shows a "REMOTE MODE" message in the bottom of the display. In this mode the measured values are refreshed according to the queries of the external HART master.

If the HART master does not refresh the display will show the last measured values.

In the absence of display unit the COM LED indicates the HART communication.

If HART communication stops the COM LED turns off after 120 sec.

Entering the menu can be done by pressing the  $\ominus$  button. Scrolling the menu can be done by pressing  $\oplus$  and  $\odot$  buttons.

Enter into selected menu point with  $\ominus$  button. Exit to the previous menu with  $\oplus$  button.

The buttons work only in presence of display unit.

When leaving the Type 2291 in (programming) menu after 30 minutes the instrument automatically returns to measuring mode.

If display unit is removed the instrument instantly returns to measuring mode.

Because manual programming (with display unit) and remote programming (with external HART master, or GF Signet Eview 2 software) cannot be performed at the same time (as both of them act like a HART master) only one programming mode has priority and this is manual programming.

During manual programming the instrument sends the "BUSY" response to the external HART master device. (HART response code 32 - Device is busy)

### 8.1.2 Manual programming

Manu structure

Main menu	BASIC SETUP	OUTPUT SETUP	APPLICATION
Sub-menu	TANK HEIGHT	CURRENT MODE	APPLICATION TYPE
	DEAD ZONE	FAILURE CURRENT	
	CLOSE-END BLOCKING	CURRENT MIN	
	DAMPING TIME	CURRENT MAX	
	PROBE LENGTH	ERROR DELAY	

Changing parameters can be done by selecting a sub-menu and pressing  $\text{E}$  button in two ways:

#### Text-based list:

- Navigation is the same as in menu lists.
- Accept changes with  $\text{E}$  button, cancel changes (and exit) with  $\text{D}$  button.

#### Numerical field:

- Serves for editing a numeric value.
- Editing is helped by a cursor (inverted character).
- Change the value of the selected digit with  $\text{U}$  /  $\text{D}$  buttons  
(There is no under-, and overflow between the characters).
- Selecting a digit can be done using the  $\text{D}$  button.
- Accept changes with  $\text{E}$  button.
- After accepting the parameter change the Type 2291 checks the parameter and downloads it.
- If parameter is incorrect the CHECK/WRITE FAILED! message appears.

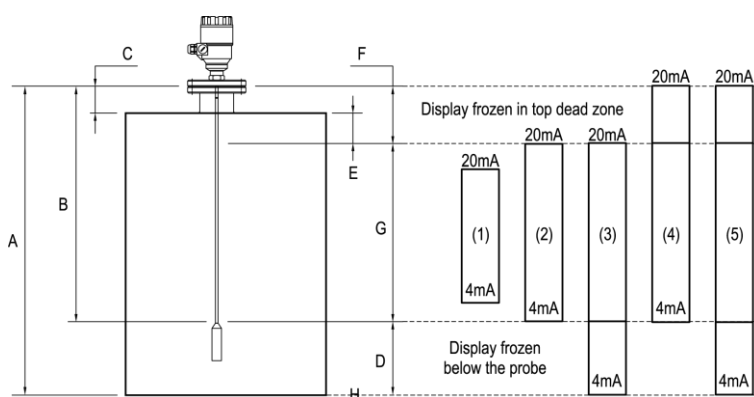
## 8.2 Characteristics

This subsection explains:

- the four principle configurations for setting up a measurement scale and what the user should be aware of in each case;
- what happens when the tank is full or empty;
- what is the level threshold and how to modify it
- what happens when level is measured when more than one product in the tank;

### The measurement scale:

Five possible configurations for analogue current output – with “Level” selected in the EView 2 configuration software.



Nr.	Description
A	Tank height
B	Probe length
C	Detection delay
D	Non-measurable zone
E	Minimum distance between non-measurable zone and dead zone
F	Upper dead zone
G	Measuring range
H	Reference point at tank bottom

The configurations described below are illustrated in the above diagram

1. The “current output” range is smaller than the max. possible measuring range

2. The “current output” range is equal to the measuring range:

Scale min.: 4 mA = tank height – probe length + H

Scale max.: 20 mA = tank height – dead zone

3. The “current output” range is greater than the measuring range:

Scale min.: 4 mA = 0.0

Scale max.: 20 mA = tank height – dead zone

4. The “current output” range is greater than the measuring range:

Scale min.: 4 mA = tank height – probe length + H

Scale max.: 20 mA = tank height

### 5. The “current output” range is greater than the measuring range:

Scale min.: 4 mA = 0.0

Scale max.: 20 mA = tank height

**NOTE:** The reference point for distance measurements is the bottom of the flange face.

## 8.2.1 Gauge operating logic when the reflection is lost

The product reflection pulse is usually lost when the level is in the top dead zone or near the bottom of the tank. The diagram below shows the action taken by the gauge depending on where the last reflection was lost.

### Zone 1 : Dead and detection delay zones

- Marker “Tank full” and “Level lost” is displayed when the product enters the dead zone and no reflection is found.
- This will also occur once the level reflection is within the detection delay zone.
- The gauge assumes the tank is full and displays the maximum level value.
- The gauge searches for a reflection along the entire length of the probe.

### Zone 2 : Full zone (and dead zone)

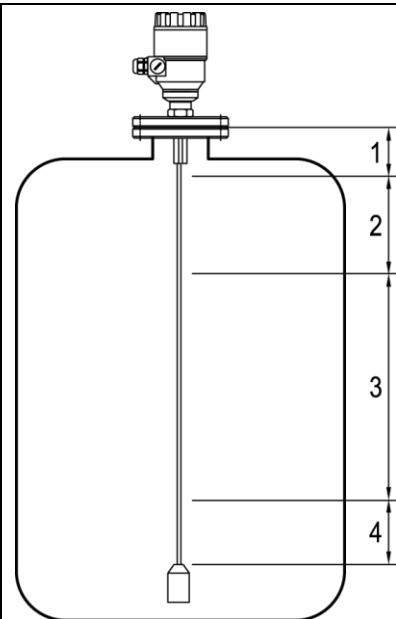
- Marker “Tank full” is displayed in this zone.
- If the gauge loses the signal in this zone, it reacts as in zone 1: the tank is assumed to be full.
- The gauge searches for a reflection along the length of the probe.

### Zone 3 : Central measurement zone

- The gauge searches along the length of the probe for the largest pulse reflection.
- If the pulse is lost the reading freezes at the last value.
- Marker “Level lost” will be displayed.

### Zone 4 : Empty zone

- If the reflection is lost here then the gauge assumes the tank is empty and marker “tank empty” is displayed.
- The gauge searches for a reflection in this zone but makes a search along the entire length of the probe once every minute.
- The reading will remain frozen during this time.
- The short circuit reflection will become larger than product reflection at this time.



### 8.2.2 Gain and voltage amplitude

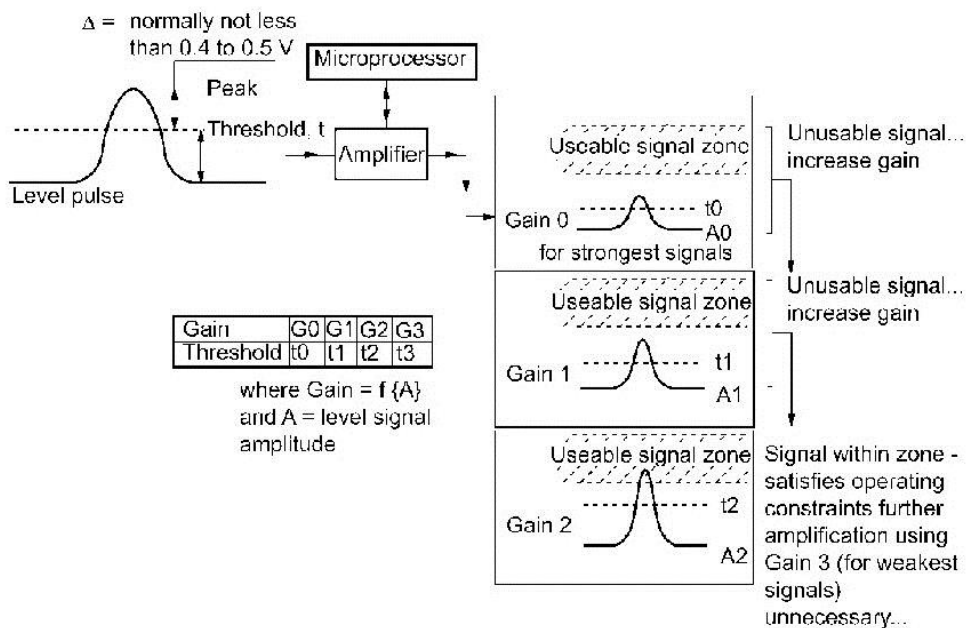
As explained in the measuring principle in the introduction, the level of a product is converted from a return signal (the product reflection) received by the gauge: this signal has taken a certain amount of time to return to the gauge and it has a certain strength / size measured in milli-volts (dependant on the dielectric constant  $\epsilon_r$  of the product).

All pulse signals returning to the gauge electronics block (including flange, obstruction and the product surface reflections) are converted to voltage amplitudes. The gauge's microprocessor looks for part of the largest signal that is over a set voltage amplitude, called the "threshold", and identifies this as the product being measured. For this signal to be usable by the gauge, the microprocessor will amplify the signal by increasing the gain. Once the signal is within a set "working" range, the gauge follows this signal. The gauge registers any changes in time for this part of the signal to return to the converter and translate this into a displayed level or volume.

Gain is a function of voltage amplitude.

This defines the default threshold value when the gauge is searching for the product level. A strong return signal will be given a low gain (i.e. Gain 0 or a small amplification). However, if the signal is very weak, then a Gain of 3 (i.e. high signal amplification) is given.

Example of signal amplification:



The level signal can be optimized by way of two factors:

### Amplification factor

The amplitude of the signals is proportional to the dielectric constant  $\epsilon_r$  of the product. At low amplitudes the signal should be amplified.

The amplification factor is dependent on the dielectric constant  $\epsilon_r$  and on the probe type. The device sets the gain automatically.

The following factors apply to the set gain:

Gain	0	1	2	3
Amplification factor	1.05	2.10	4.37	8.93

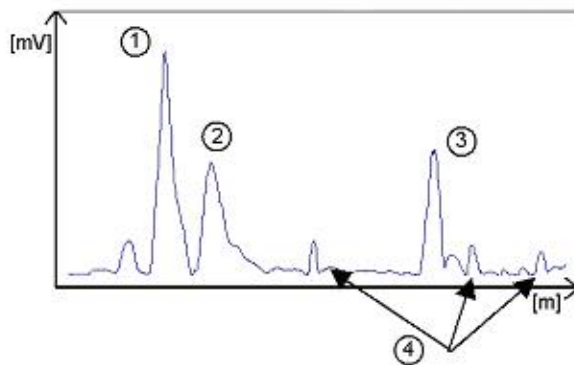
### Level threshold

The level threshold suppresses interference signals so that only the reflections from the product surface (level signal) are shown. The factory setting of the level threshold is suitable for standard applications.

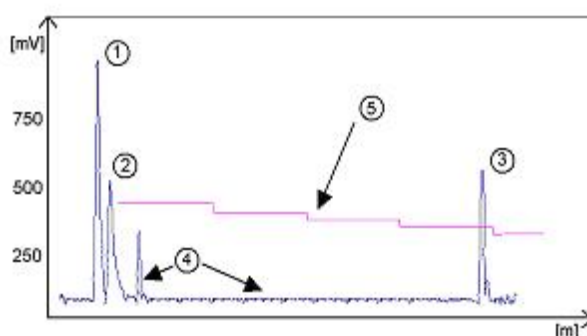
The threshold will need to be adjusted in the case of very low dielectric constants  $\epsilon_r$ , multiple interference reflections or unfavourable installation conditions.

The illustrations below show interference signals when the oscilloscope function is used. These reflections can be due to various causes, e.g. tank internals or multiple reflections within the measuring range.

Even though the interference signals are very weak, the threshold should nevertheless be set to a value above these signals.



Nr.	Description
1	Initial pulse
2	Flange reflection
3	Level signal
4	Interference signal



Nr.	Description
1	Initial pulse
2	Flange reflection
3	Level signal
4	Interference signal
5	Threshold

In the diagram above it can be seen that the level of the threshold is not constant: 400 mV at 1000 mm or 3.3 ft, and only 250 mV at 10000 mm or 33 ft. No attenuation is required at a probe length  $\leq 3000$  mm or 10 ft. The form of the threshold is dependent on attenuation and is automatically adjusted by the device over the measured length.

### Setting the level threshold

If the level threshold is set too high, i.e. it is greater than the amplitude of the level reflection, the device will not find any level even with maximum amplification.

If the level threshold is set too low, i.e. it is below the amplitude of some of the interference signals, the device will identify and indicate one of these interference signals as a level reflection only if the tank is empty.

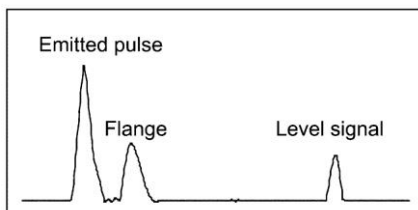
Precise setting of the level threshold is especially important when the dielectric constant  $\epsilon_r$  is low.

To set, the level (amplitude of the reflection) must be known. A level of 500 mm or 20" is ideal. The level threshold should be half-way between the invalid interference signals and the level reflection signal.

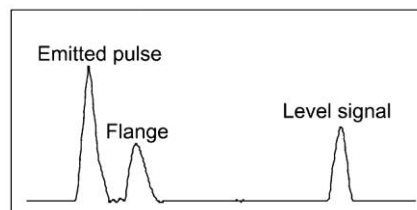
The reflection from the probe tip, which is clearly identifiable at a low  $\epsilon_r$  value, does not need to lie below the level threshold.

### 8.2.3 Typical signal trends

The following diagrams show characteristic signals that have been recorded with the oscilloscope function.



Rod or cable probe with gain 1



Rod or cable probe with gain 2

The signal from coaxial probes does not include the flange reflection, due to the mechanical setup which does not produce any change in impedance at the flange.

The amplitude of reflection from the product surface increases as the level rises and decreases as the level falls

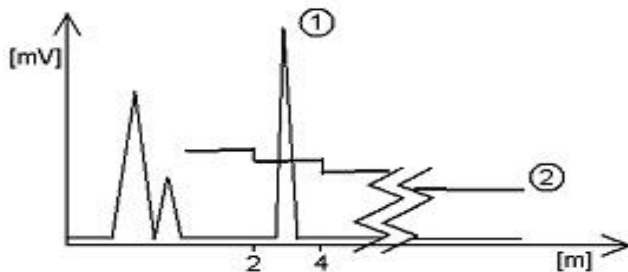


### 8.2.4 Automatic adjustment

To maintain a sufficiently strong reflection signal, the gain is adjusted automatically.

When the amplitude of the level reflection decreases, the gain will increase to compensate for the loss in signal amplitude. Gain and level threshold thus maintain the same proportion.

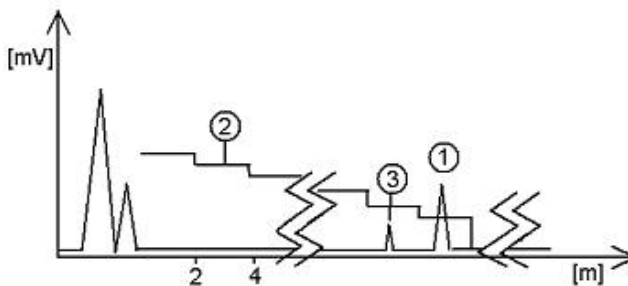
At gain 3, the level signal



Nr.	Description
1	is located between a distance of 2000 and 4000 mm or 6.5 and 13 feet.
2	is the level threshold. This is shown below:

The amplification factor is 3

The level has dropped, increasing the distance between level and flange.



Nr.	Description
1	is located over 4000 mm or 13 feet.
2	threshold
3	interference signals

The interference signals are now below the level threshold [2], whose lower limit is 50 mV.

As in the diagram above, the amplification factor is 3.

In both cases, the automatically adjusted gain of the threshold indicates all signals located above one-half of the amplitude of the level signal.

In the event of operational or installation faults, you can frequently identify the cause of the fault by means of this function and normally eliminate it yourself.

### 8.2.5 Level measurement when more than one phase or layer in the tank

Level can be measured with more than one phase in the tank.

This requires setting a parameter in the factory menu (Fct. 1.1.3: Application Type) to the following measurement mode:

2 liquids, 1 level: For measuring level with two or more phases

1 liquid, 1 level: For measuring one phase or liquid

Characteristics

The level of the top product can be detected

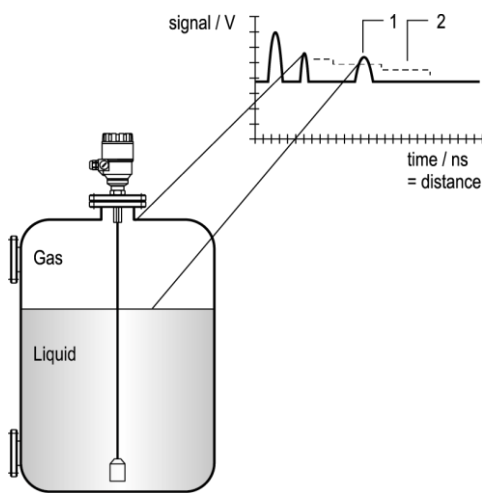
if it has a minimum layer of approximately 100 mm - when measuring a top product with a dielectric constant of  $\epsilon_r = 2.4$ .

The mode "2 liquids, 1 level" permits level to be measured even when more than 2 liquids are present in the tank. The first return signal is identified as being level and the second is ignored.

This mode may be used with all probe types

**Example application 1:**

Level measurement of oil (1 liquid in the tank)

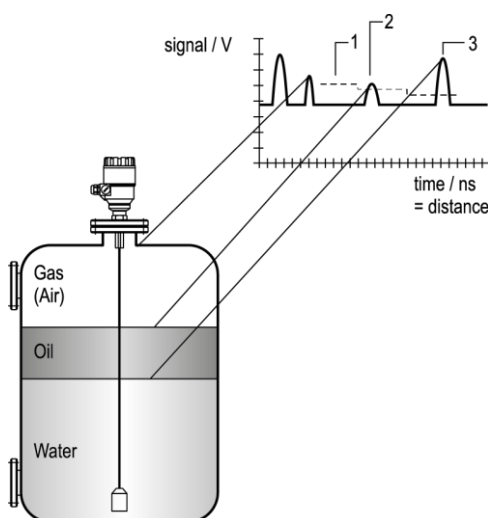


Nr.	Description
1	Level measurement signal
2	Threshold

Application Type set to 1 liquid, 1 level, the wire will search for the return signal with the highest amplitude (i.e. higher than the threshold). It will measure the oil level.

**Example application 2:**

Level measurement when there are 2 liquids (oil/water) in the tank – using a correctly configured gauge



Nr.	Description
1	Threshold
2	Level signal
3	Oil-water interface signal

Application Type set to 2 liquids, 1 level, the wire will search for the first return signal higher than the control threshold. It will correctly measure the oil level (i.e. "level").

## 9 Troubleshooting

Event	Fault	Action
<b>Error messages</b>		
“Tank full” status marker on*, reading frozen at max. or min. value	No fault. The level has reached (and possibly risen above) the top configured measurement limit and is either displaying the maximum (when measuring level) or minimum (when measuring distance) output.	None. Measurements should be normal once the level is in the configured measurement range.
“Tank empty” status marker on*, reading frozen at max. or min. value	No fault. The level has entered the gauge’s bottom dead zone and can no longer detect a return signal. Either the maximum (when measuring distance) or minimum (when measuring level) output is displayed.	None. Measurements should be normal once the level is in the configured measurement range.
“Tank full” and “Level lost” status marker on*, reading frozen at max. or min. value	No fault. The level has entered the gauge’s top dead zone and can no longer detect a return signal.	Empty the tank below the top measurement range limit and check the measurement.
“Level lost” status marker on*, reading is frozen	The instrument has lost the level signal, has searched but not yet found the return pulse. This may occur if the pulse has dropped below the threshold. Parasite signals from the flange or obstructions in the tank may render the gauge unable to identify the correct signal.	Ensure that tank is emptied below maximum level and check the measurement.
“Reference not found” status marker on*	Occurs when there is a problem with the time base on the HF board.	Please contact GF Piping Systems.
“Level lost” and “Reference not found” status markers on*, reading frozen	The probe has received an electrostatic discharge.	The gauge will search for the level again and resume readings. If the reading remains frozen then the signal converter may have been damaged by ESD and may need replacing. Please contact GF Piping Systems
“Flange not found” status marker on*	The signal converter has been incorrectly configured to measure with a cable or rod probe when it is equipped with a coaxial probe.	Contact GF Piping Systems for the corrective procedure.

Event	Fault	Action
<b>Error messages</b>		
	This may be also due to installation on a long nozzle which has the effect of attenuating the flange pulse.	
"Delay out of limits" status marker on*, reading is frozen.	The emitted pulse has not been detected. The gauge will not work until it has been found	Contact GF Piping Systems for the corrective procedure.
"Delay out of limits" status marker on*, reading is frozen.	The emitted pulse has not been detected. The gauge will not work until it has been found.	The signal converter may need replacing. Please contact GF Piping Systems.
"Negative voltage error"*	Occurs when there is a problem with the time base on the HF board.	Please contact GF Piping Systems.
"VC01 voltage error" *		
"VC02 voltage error" *		
"Reprogramming FPGA" *		

\* Gauge connected to GF Signet EView2 software.

Event	Fault	Action
<b>General operation</b>		
Instrument is not accurate with a product that has a high dielectric constant. A constant offset is observed when taking measurements.	Tank height is not correct.	Check current output and tank height parameters. If the signal converter has been replaced, verify that factory calibration parameters are still the same. Ask GF Piping Systems for the factory calibration sheet (if not supplied) and the password for access to the factory menu.
The Type 2291 2-wire indicates an incorrect level value.	The Type 2291 2-wire measures a non-valid reflection.	Check the tank for obstructions and verify that the probe is clean. In the case the indicated level is close to the nozzle, increase the detection delay and the dead zone with the same ratio or increase the threshold level if the full measurement range is essential. The threshold level must be adjusted so that it masks the

Event	Fault	Action
<b>General operation</b>		
		<p>disturbances. It also gives enough margin for detection of the level pulse.</p> <p>Very large pulses along the measurement signal (same amplitude as the initial pulse) can be caused by a probe which is touching the nozzle or the tank side (see section 1.3.5). Ensure that no contact is possible.</p>
<p>Instrument is not accurate when there are two or more phases in the tank.</p>	<p>The instrument may be incorrectly configured for this type of application i.e. it is measuring the interface instead of the level.</p>	<p>Contact GF Piping Systems for the corrective procedure or refer to the Service Manual. Check if application type had been set to: Application Type is set to "2 liquids, 1 level". Check also that there is a layer of more than 100 mm of top product above the bottom product.</p>

Event	Fault	Action
<b>Electrical Connections and Communication Output</b>		
<p>Current Output value &lt; 4 mA.</p>	<p>No power supply</p> <p>Connection of the device is incorrect.</p> <p>The calibration of the current output is incorrect.</p>	<p>Check the power supply</p> <p>Check the connection between the device and the power supply.</p> <p>Execute the calibration if you have authorized access or contact GF Piping Systems Service centre.</p>
<p>Reads 22 mA.</p>	<p>An error has occurred.</p>	<p>This happens in case the range 4-20 mA / error 22 mA is selected. Check the status of the device by selecting the marker window (F8) or enter the status (4.0) menu of the HART® communicator.</p>
	<p>The device is in its start-up phase</p>	<p>Wait 50 seconds.</p> <p>If the current value drops to a value between 4 and 20 mA, and goes immediately back to 22 mA, contact your GF Piping Systems Service Centre.</p>

## 10 Repair and Maintenance

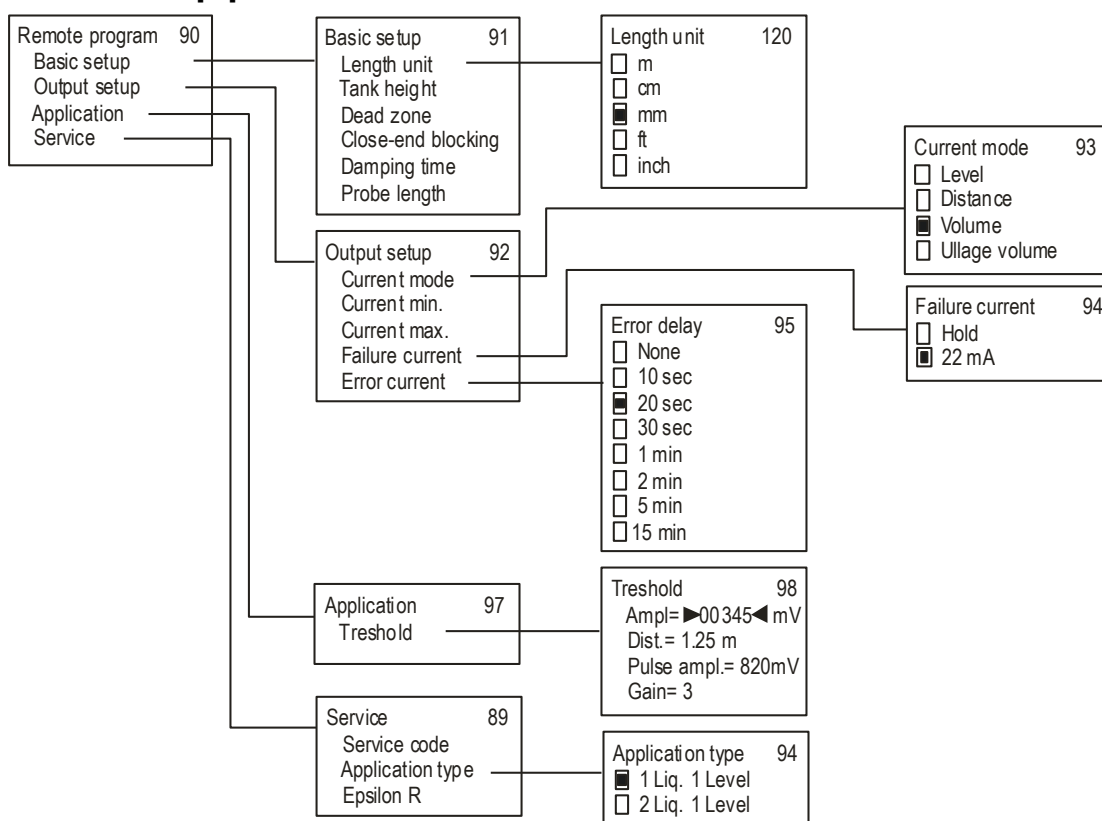
Type 2291 does not require maintenance on a regular basis. In some very rare instances, however, the probe may need a cleaning from deposited material. This must be carried out gently, without damaging the probe. Repairs during or after the warranty period are carried out exclusively at the Manufacturers. The equipment sent back for repairs should be cleaned or neutralized (disinfected) by the User.

## 11 Accessories

The level transmitter must be operated in intrinsically safe circuit only.

The metal enclosure of the unit must be connected to the EP circuit.

## 12 Set-up parameters



Parameters in the Service Menu are read-only parameters. Changing of these parameters require the service code of the instrument.

## 13 Disposal

- ▶ Before disposing of the different materials, separate them into recyclable materials, normal waste and special waste.
- ▶ Comply with local legal regulations and provisions when recycling or disposing of the product, individual components and packaging.
- ▶ Comply with national regulations, standards and directives.



A product marked with this symbol must be taken to a separate collection point for electrical and electronic devices. If you have any questions regarding disposal of the product, please contact your national agent for GF Piping Systems.



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