Instruction

MI EML0710
December 2021

244LD LevelStar Intelligent Buoyancy Transmitter for Level, Interface and Density – HART® and FOUNDATION Fieldbus

Schneider Electric™

Contents

Figures

Tables

Important Information

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this manual or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of either symbol to a "Danger" or "Warning" safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER
DANGER indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING
WARNING indicates a hazardous situation which, if not avoided, **could result in** death or serious injury.

⚠ CAUTION
CAUTION indicates a hazardous situation which, if not avoided, **could result in** minor or moderate injury.

NOTICE
NOTICE is used to address practices not related to physical injury.

Please Note

Electrical equipment should be installed, operated, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction, installation, and operation of electrical equipment and has received safety training to recognize and avoid the hazards involved.

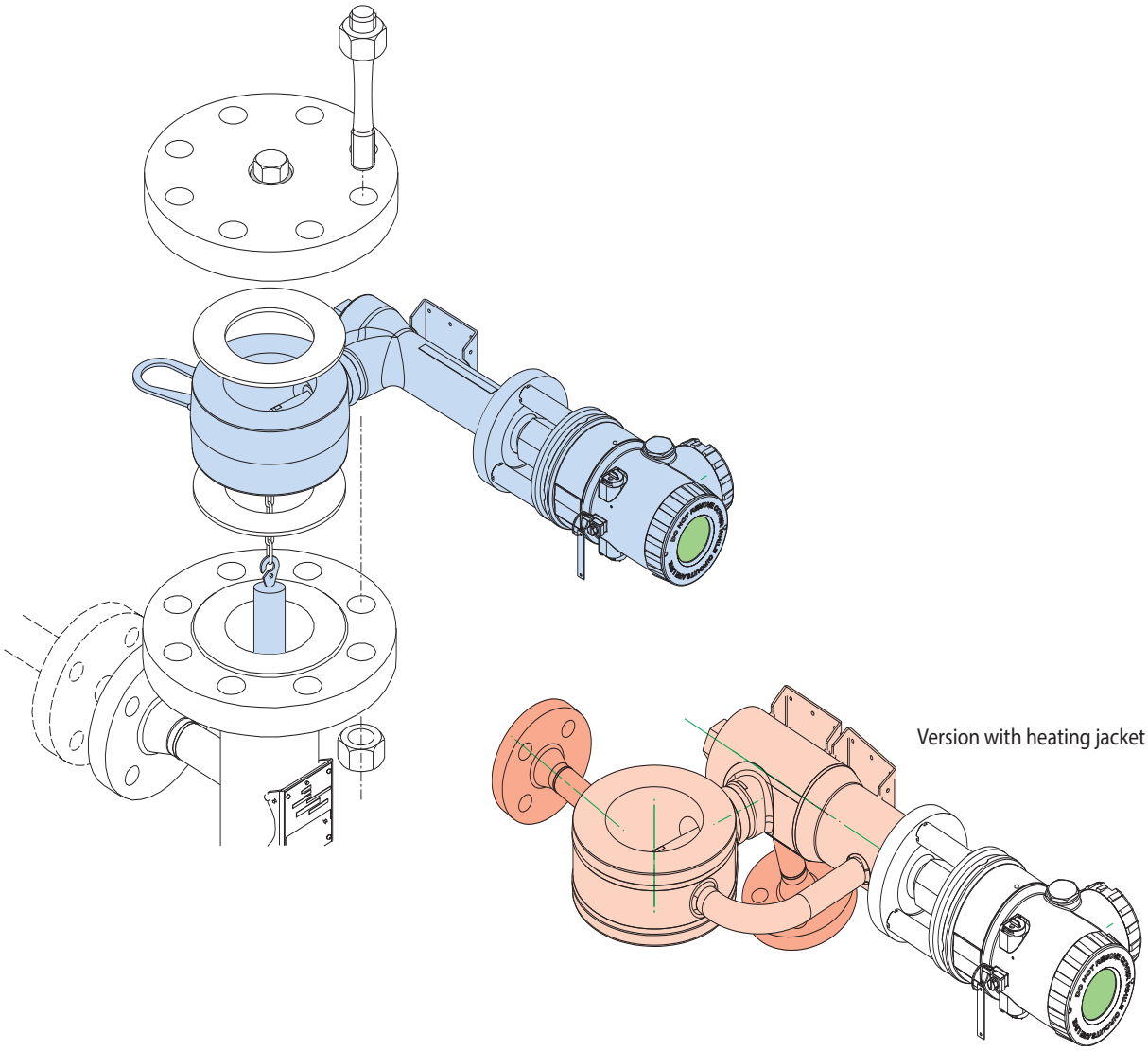
Introduction

The intelligent transmitter 244LD LevelStar is designed to perform continuous measurements for liquid level, interface, or density of liquids in the process of all industrial applications. The measurement is based on the proven Archimedes buoyancy principle and thus extremely robust and durable. Measuring values can be transferred analog and digital. Digital communication facilitates complete operation and configuration via PC or control system. Despite extreme temperatures, high process pressure and corrosive liquids, the 244LD measures with consistent reliability and high precision. It is approved for installations in contact with explosive atmospheres.

Features

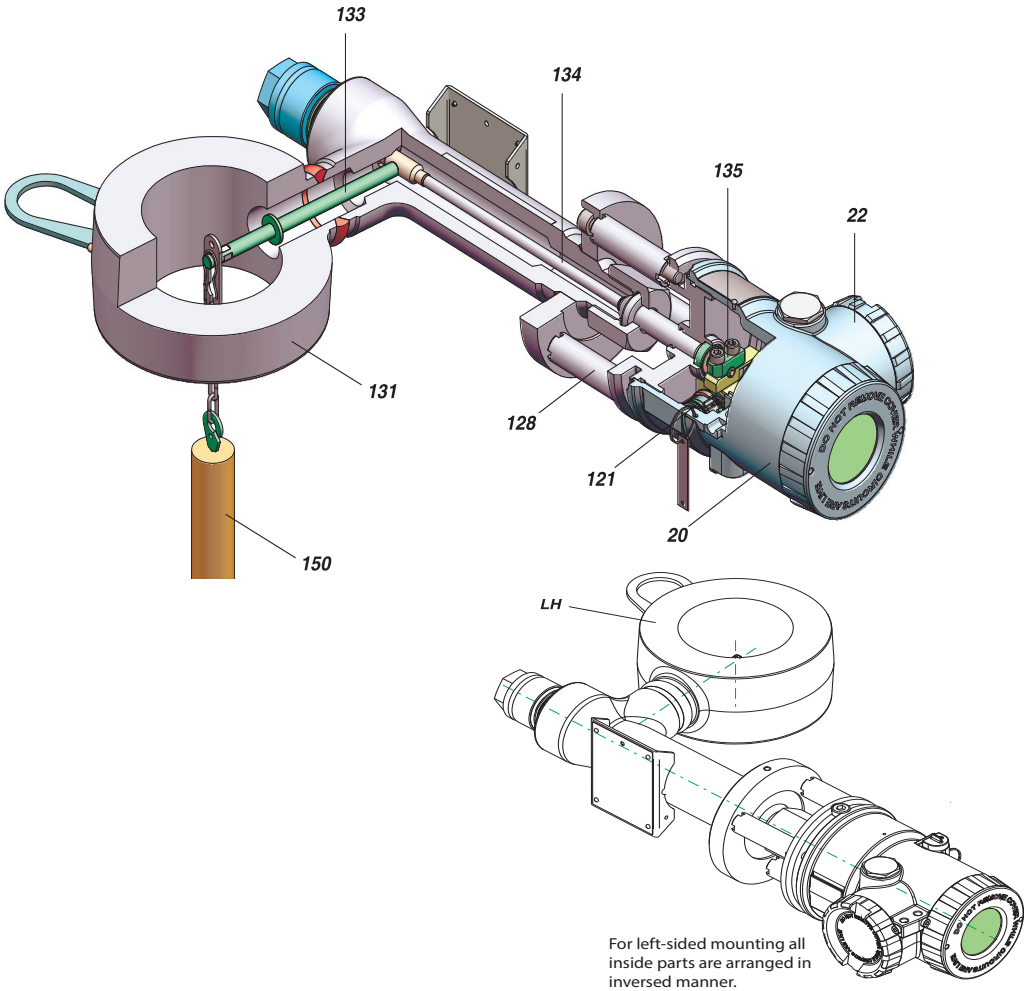
- HART® 7 Protocol, 4 to 20 mA, or FOUNDATION Fieldbus
- Easy configuration using PACTware™ and DTM
- Multilingual full text graphic LCD
- IR communication as a standard
- Easy adaptation to the measuring point without calibration at the workshop
- Linear or customized characteristic
- 32 points linearisation for volumetric measurement
- Continuous self-diagnostics
- Configurable safety value
- Local display in %, mA, or physical units
- Process temperature from –196 °C to +500 °C
- Materials for use with aggressive media
- Micro sintermetal sensor technology

Figure 1. 244LD Mounted on top of a Displacer Chamber



Design

Figure 2. Design



20	Amplifier
22	Terminal compartment
121	Sensor
128	Heat sink
131	Wafer body with torque tube
133	Transmission lever
134	Torque tube
135	Clamping lever
150	Displacer with suspension chain
LH	Version for left-hand mounting

Method of Operation

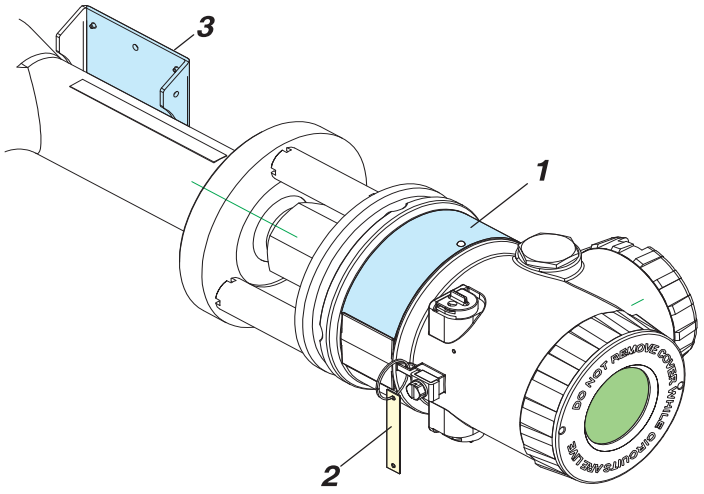
The buoyancy force of the displacer **150** is transferred via transmission lever **133** and torque tube **134** to operating rod of the sensor, where it acts on free end of sensor element **121**. Four thin film metal strain gauge elements are sputtered onto sensor element, which change their resistance in the ratio of the tensile or pressure tension. These four thin film metal strain gauge elements are connected as a Wheatstone full bridge supplied from amplifier.

The voltage at the diagonal bridge section which is proportional to the effective weight is fed to the electronic amplifier as an input signal. This voltage is converted via the electronic amplifier into the 4 to 20 mA or digital two-wire output signal. The amplifier is supplied by the signal current circuit in two-wire mode.

Identification

The transmitter is identified with several labels.

Figure 3. Identification of Labels

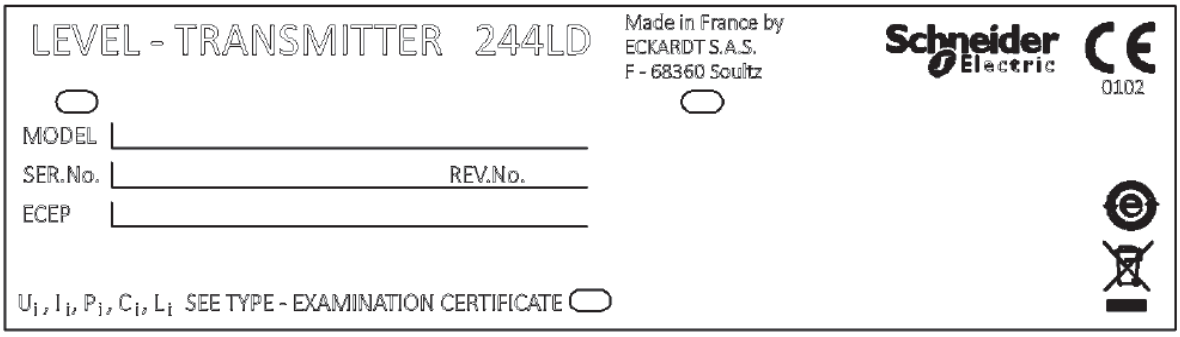


Transmitter Nameplate 1

The transmitter nameplate shows the Model Code of transmitter, the serial number and certification data.

(Example)

Figure 4. Transmitter Nameplate



ECEP: ID Number for special version

Tag Number Label 2

(Example)

Attached to amplifier

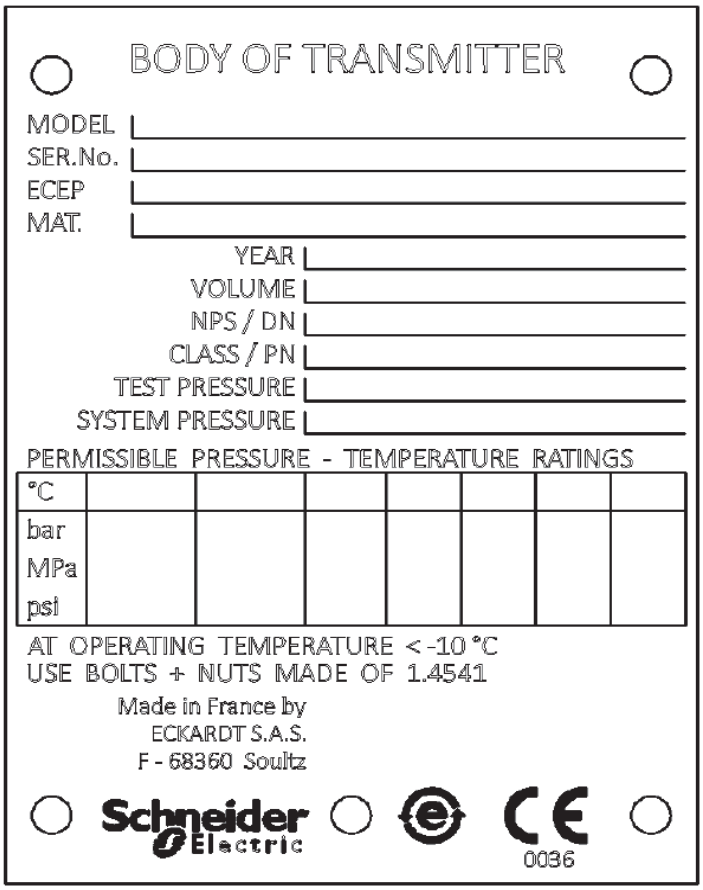
LID 09/16

Optional label with devices according to NACE-Standard. With attached Tag Number label, on the rear side of label.

Boiler Label 3

Boiler label with nominal pressure, material, permissible pressure and temperature load, serial number, etc.

Figure 5. Boiler Label



Adjustment Data Label

Matching the Displacer

Take care of correct matching of transmitter and displacer at mounting. Each transmitter is calibrated to the respective displacer according to the ordering data in the factory. Each transmitter/displacer pair has adjustment data labels to help prevent mismatch.

Torque Tube Material Label

Refers to the material of the torque tube and is attached at the edge of the flange.

Thread Label

In the version with NPT threads, near the cable gland is a label describing the type of thread.

Mounting

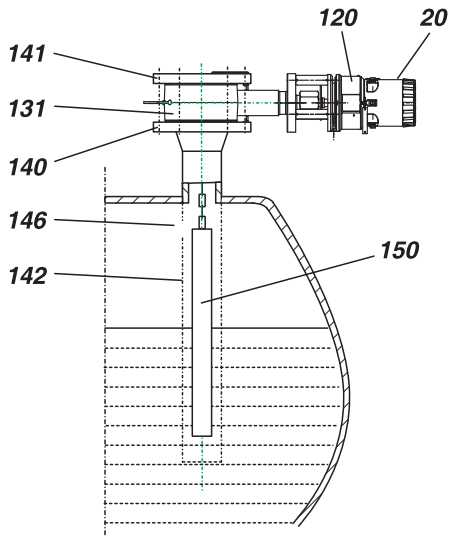
The 244LD LevelStar is directly built onto the vessel or alternatively on a side mounted displacer chamber (e.g. 204DC). During installation, the permissible static pressure and the ambient temperature range must be observed. (see “Boiler Label 3” for more information).

High Medium Temperatures

It is important to help ensure that the max. permissible temperature of the electronics housing of 85 °C and that of the internal sensor/measuring cell of 120°C is not exceeded. For explosion-proof equipment, the information in the product specifications PSS EML0710 and in the certificates or approvals must be observed.

Mounting on Top of the Vessel

Figure 6. Mounting on Top of the Vessel

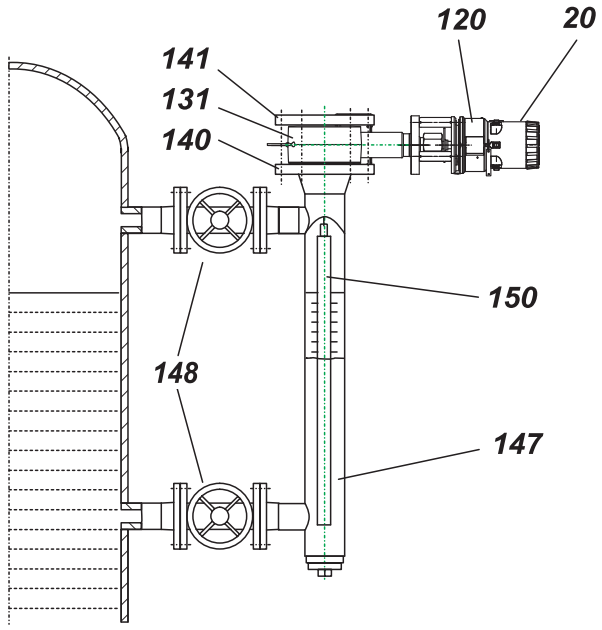


20	Amplifier	**141**	Blind flange
120	Sensor housing	**142**	Protection cage / tube
131	Wafer body	**146**	Venting hole
140	Connecting flange	**150**	Displacer 204DE

If the vessel contains a turbulent liquid a protection cage / tube should be used. It has a venting hole **146** above the maximum liquid level. Between the protection cage / tube **142** and the displacer **150** must be a gap of 5 to 10 mm.

Mounting in a Side Level/Displacer Chamber

Figure 7. Mounting in a Side Level/Displacer Chamber



147 Displacer chamber 204DC
148 Shut-off valve

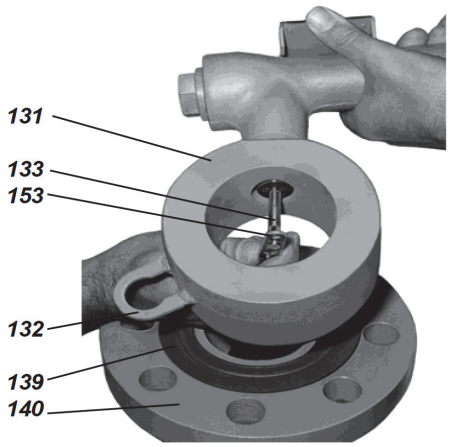
When used in Zone 0, fittings resistant to flame penetration must be used.

NOTE

Mount the vessel with suitable bolts and seals (not included in the scope of delivery). Ensure that the displacer chamber is exactly vertical. Between the protection cage or tube and the displacer must be a gap of 5 to 10 mm.

Mounting the Wafer Body

Figure 8. Mounting the Wafer Body

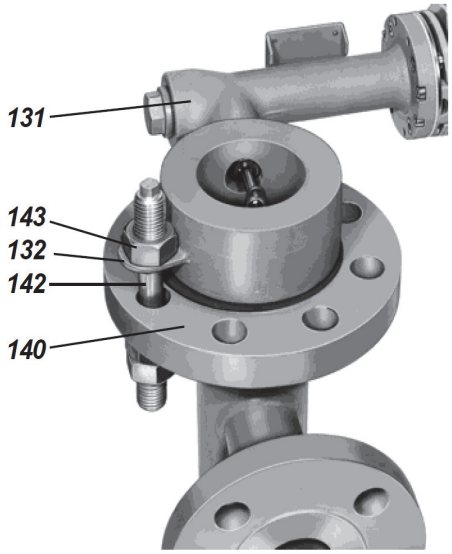


1. Place the seal **139**(1) on the connecting flange **140**. Insert displacer in displacer chamber or vessel. Hold 244LD LevelStar **131** above connecting flange. Engage eyelet **153** of displacer chain in notch in transmission lever **133** and fit wafer body onto connecting flange. See Figure 8.

NOTICE
POTENTIAL EQUIPMENT DAMAGE
Do not drop the appended displacer and Avoid jerky load.
Failure to follow these instructions can result in equipment damage.

2. Set 244LD LevelStar to the mounting flange.

Figure 9. Setting the 244LD LevelStar



1. When using an electrically non-conducting soft gasket, the wafer body must be grounded.

3. In order to make mounting easier, mounting bracket **132** is secured with a stud **142** to connecting flange 140. You must preassemble a stud by screwing a nut **143** onto thread.
4. Insert this stud through the top of mounting bracket and connecting flange. Screw sufficient number of nuts onto thread and reduced shaft from underneath for the wafer body to be firmly in position.
5. Place seal **139**(1) on wafer body. Place blind flange **141** on wafer body so that holes in blind flange and connecting flange **140** are aligned. Insert remaining studs. Screw on nuts and tighten gently.
6. Unscrew nut **143** and pull stud downwards.
7. Tighten the nuts on all bolts with the appropriate wrench. Proceed crosswise to avoid jamming.

Recommended tightening torque (Pre-stressed to 70% of minimum yield point at 20°C)							
Mat.	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**	**M36**
A2-70	40 Nm	95 Nm	185 Nm	310 Nm	450 Nm	630 Nm	1080 Nm
1.7225 1.7709 (8.8)	50 Nm	120 Nm	250 Nm	435 Nm	630 Nm	860 Nm	1500 Nm

— NOTE

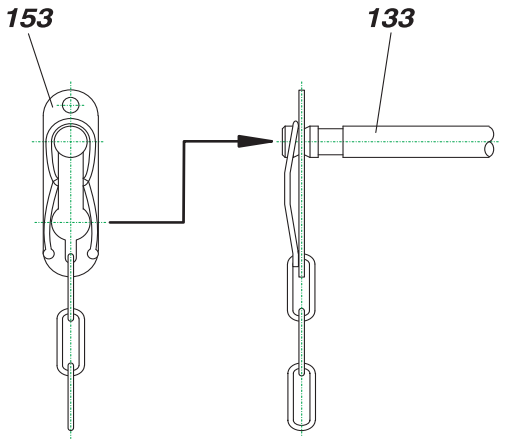
Studs and nuts material depends on material of wafer body and temperature of process medium.

Note for displacers with diameters less than 30 mm

Displacers with diameters < 30 mm can also be suspended when the wafer body has already been mounted. As an aid to installation, a wire can be pulled through the hole in the eyelet **153**.

The displacer is lowered through the wafer body with this wire, past the transmission lever and into the displacer chamber or vessel. The eyelet must then be hooked onto the notch **133** in the transmission lever. Finally remove the wire.

Figure 10. Displacers with diameters less than 30 mm



Displacer 204DE

Ensure correct matching of transmitter and displacer while mounting. Each transmitter is calibrated to the respective displacer according to ordering data in the factory. See “Adjustment Data Label” for more information.

Replacing Displacer

Enter the changed data of displacer on the adjustment label, see “Adjustment Data Label”.

Pressure Rating

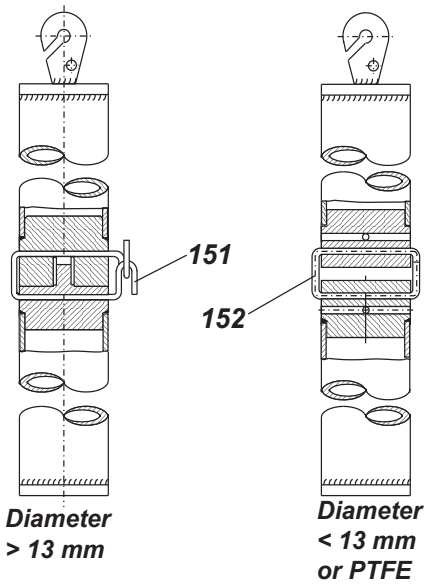
The displacer must be designed for the pressure rating of the vessel – however, at least to the operating pressure – and ordered accordingly. Here the maximum possible temperature must be taken into consideration. Displacers made of PTFE are made from solid material, and are, therefore, suitable for all pressures.

Divided Displacers

Displacers with a length of more than 3 m (1 m with PTFE) are divided. The displacer elements are screwed together and secured with the wire clip **151** to avoid bending or damage during insertion into the vessel. The elements of displacers with Ø < 13 mm are not screwed together; they are secured with hook and eyelet **152**. Additional securing is not necessary [1]

Lengths < 350 mm or > 3000 mm, and density ranges <100 kg/m^3 or >2000 kg/m^3 on request.

Figure 11. Divided Displacers

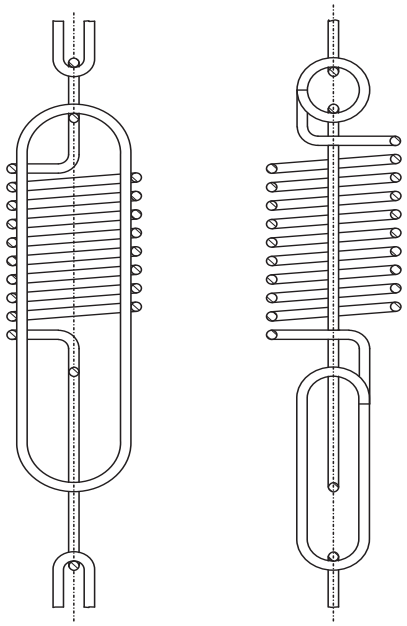


1. When used in Zone 0, the eyelets must also be welded.

Damping Element

In operating conditions with strong external vibrations - e.g. nearby compressor stations - the damping element (Option -D) should be used.

Figure 12. Damping Element for the Displacer



It is hooked onto the suspension chain of the displacer in place of 7 chain links (105 mm). This spring is specially matched to the resonance frequency of the displacer and is made of stainless steel 1.4310 (operating temperature up to 250 °C) or Hastelloy C (operating temperature up to 350 °C).

Use in Zone 0 Mechanics

When used in Zone 0, displacers must be secured against oscillating when

- displacer made of metal, explosion group IIC
- displacer made of metal, explosion group IIB/A, length > 3 m
- displacer made of PTFE+25% carbon, IIC/B/A, length > 3 m

The displacer is to be attached in such a way that it is not in the main filling jet stream.

Potential Equalization

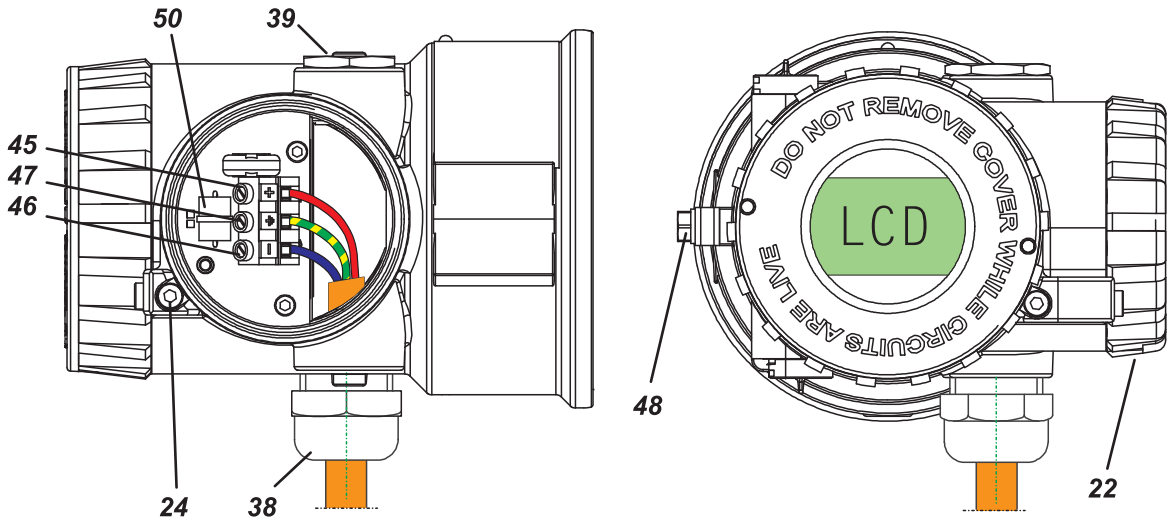
When used in Zone 0, only displacers of metal or PTFE +25% carbon may be used. A potential equalization line must be mounted as an electrical bypass of the displacer suspension(s) if the residual displacer weight is < 10 N, or if more than 6 contact points are present.

To help protect from electrostatic ignition, a connection to the transmitter with good conductivity must be ensured. The volume resistance between the lower end of the displacer and ground may not exceed 1 MOhm.

Electrical Connection

Signal Wire Connection

Figure 13. Signal Wire Connection



22 Connecting compartment cover
24 Cover lock
38 Cable gland (permitted cable diameter 6 to 12 mm)
39 Cover screw
45 Connection terminal "+" wire cross
46 Connection terminal "–" section
47 Ground terminal max. 2.5 mm² Test sockets (Ø 2 mm) integrated in terminal block
48 External ground terminal
50 Overvoltage protection (if present)

Guide cable through cable gland **38** from the bottom; observe especially the shielding.

Check mounting cable glands if threads are matching, otherwise housing can be damaged. Cable gland **38** and cover screw **39** are interchangeable.

Connect input signal to terminals **45** (+) and **46** (–). The screw terminals are suitable for wire cross sections of 0.3 to 2.5 mm^2. For selection of the cable, refer to recommendation for cable types according to the IEC 1158-2.

NOTE

Transmitters are supplied without a cable gland. Select a gland that conforms to applicable Ex requirements.

NOTE

For explosion proof devices follow reference for cable gland and cover screw in document "Safety Instructions 240 Series".

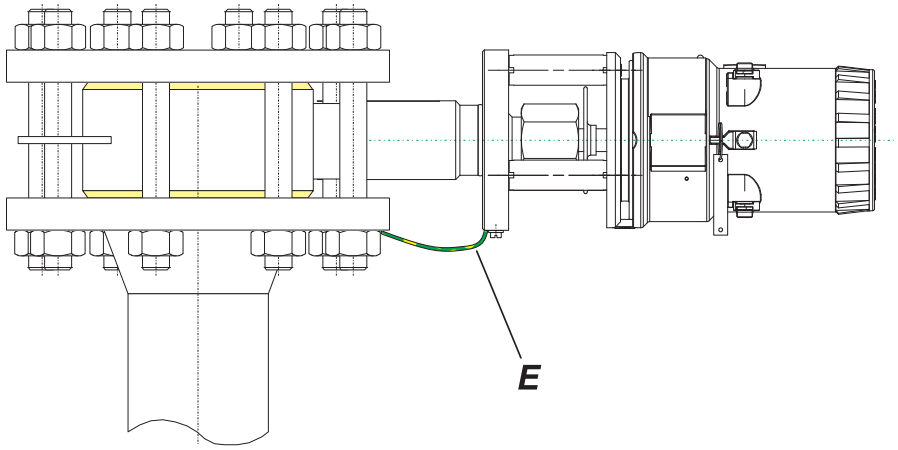
Actions

- Loosen cover lock **24** (if provided) and unscrew cover **22**.
- Guide cable through cable gland and connect to terminals **45**, **46**, and **47**.
- If necessary connect external ground terminal **48**.
- Screw cover **22** and install cover lock **24** (if provided).

Ground

If connection to ground is necessary (e.g. potential equalization, protection of electromagnetic influence), ground terminal **47** or external ground terminal **48** must be connected. When using an electrically non-conducting gasket, the wafer body must be grounded by wire **E** with the connection flange.

Figure 14. Connection to ground when using an electrically non-conducting gasket



Commissioning and Decommissioning

In any case, installation and safety regulations have to be checked prior to commissioning. See document EX EML 0010 A: “Safety Operating Instructions”

After correct installation and connection to power supply unit, the transmitter is ready for operation:

U > 12 V dc (HART)®

If necessary the configuration of lower range value, upper range value and damping has to be checked. With HART® an ampmeter can be attached into the output current loop for check.

Decommissioning

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

Prior to decommissioning take precautions to avoid disturbances:

- Observe Ex. protection.
- Switch off power supply.
- Take precaution while using hazardous process media.
- With toxic or harmful process media, observe relevant safety regulations.

Failure to follow these instructions will result in death or serious injury.

Before dismantling the transmitter, the procedure should be followed:

1. Depressurize vessel or displacer chamber.
2. Drain off measuring medium in displacer chamber.
3. Protect the environment; do not allow measuring substance to escape. Catch and dispose them properly.

The procedure for dismantling the transmitter is the reverse of that described for mounting.

Setting of Transmitter

Zero, lower range value, upper range value and damping of the transmitter are set by manufacturer as specified in the order:

- Dimensions of displacer: Length, density, weight
- Setting Lower Range Value by weight F0:
  - without Zero elevation = 0;

- with Zero elevation = Value of elevation

- Upper Range Value corresponding to buoyancy force of displacer. Refer to "Dimensioning of Displacer".
- Output Range and unit

Therefore, calibration at start-up is not necessary. Operating data and displacer data are stored in the transmitter according to the order. Configuration becomes necessary if this data deviates from the stored values. In case the order does not include this data, the transmitter is supplied as follows:

- displacer weight =1.500 kg buoyancy
- force = 5.884 N (0.600 kg)
- indication = 0 to 100 %
- damping = 8 sec (90 % time)

Setting via HART® Protocol

- Setting with PC, PACTware™ and DTM
- Setting with HART Communicator

Setting via Operating Push Buttons

Setting can be done by means of the push buttons at the transmitter, see "Setting via Local Keys and LCD".

Warm-up prior Calibration and Zero Point Corrections

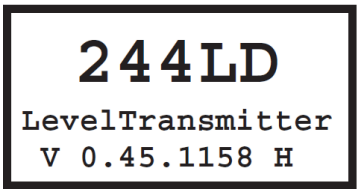
During final assembly at the manufacturer, ZeroBasic is adjusted. For this, the displacer data are entered from which the 244LD automatically calculates the zero point in "Auto Range" mode.

We recommend performing the ZeroCorrect function at commissioning. In this case, the transmitter is brought up to operation temperature ("hot Adjustment") and subsequently the zero point. So the detected measurement error for the process temperatures (either very high or very low) is kept small. Inaccuracies during installation are taken into account. The function can be performed by the DTM or locally on the LCD and push buttons (Menu 4 PV offset).

If required, it may be necessary to activate or deactivate a zero point correction. For this, the SpecialZero function is provided. It is used to compensate a zero shift as a result of the influence of high or low medium temperature (e.g., during the start of the process). This function is only accessible via the DTM. For details about the DTM, follow the instructions on the screen.

Starting Operation

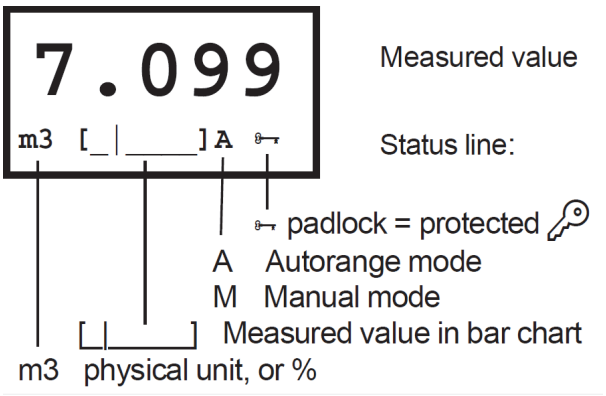
After starting (after power-on) the logo is briefly displayed, then device information.



Device Type

Measuring task
Version

and then the operational view.



The operational view is the display in normal operation.

Manual Mode and Autorange Mode

When ordering, the customer has stated range and the density of the measuring medium (or the densities of the media). Using this data the real displacer was manufactured.

The default mode is set to `Autorange` for a displacer. The displacer data (diameter, length, weight) and the density of the media were stored before delivery via FDT / DTM in the 244LD LevelStar. From this data, PV-offset and Upper Range Value URV are calculated automatically, which allows an immediate operation without any additional calibration in the field.

However, if the manual method is preferred, the values can be entered manually.

In Manual mode the classic method is possible to take over the respective values of the buoyancy forces with the operating conditions for 0% (with level: empty vessel) and 100% (with level: full vessel).

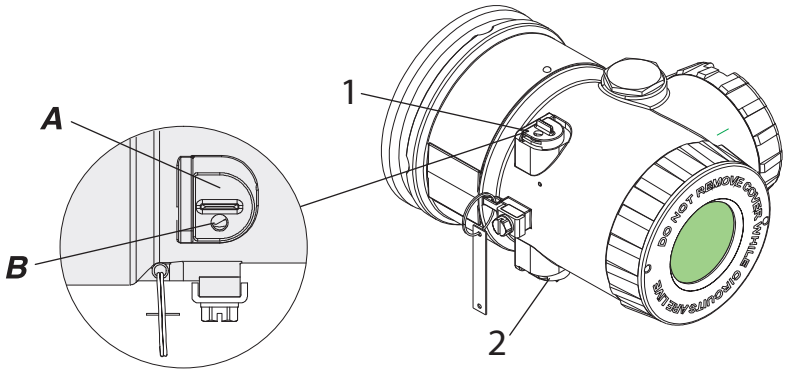
NOTE

The operation of the transmitter is described with local keys. For the setting of all values and special functions we recommend the use of the FDT DTM technology. This requires only a PC (notebook), a modem and the FDT software (PACTware™). The operation is done using the FDT DTM technology. If you use local keys, not all features are accessible. You can download the software from the Schneider Electric website.

Setting via Local Keys and LCD

The operating parameters and settings can be viewed on site and in some cases changed. For local operation a full graphic LCD is available and 2 buttons on the outside of housing. Inside the unit there are no other controls.

Figure 15. Setting via local keys and LCD



1 = Left button
2 = Right button

After shifting the key protection cap A, insert screw driver pin (Ø < 3 mm) into hole B and press down to the second pressure point.

Starting from the operational view,

- the **2** button switches to details of the operating values
- the **1** button switches to the menu selection,

For more information, see Figure 16.

NOTE

If no button is pressed within 5 minutes, the display returns automatically to the operational view.

Changing values

Linear Adjustment

Linear adjustment is used for example in PV-offset, damping and LCD contrast:

The current value is displayed. With button **2** MORE the value is increased. If the largest value is reached, starts again from beginning with the smallest value. The button has auto repeat. Stop with button **1** DONE. After that, even queried whether the change should be saved.

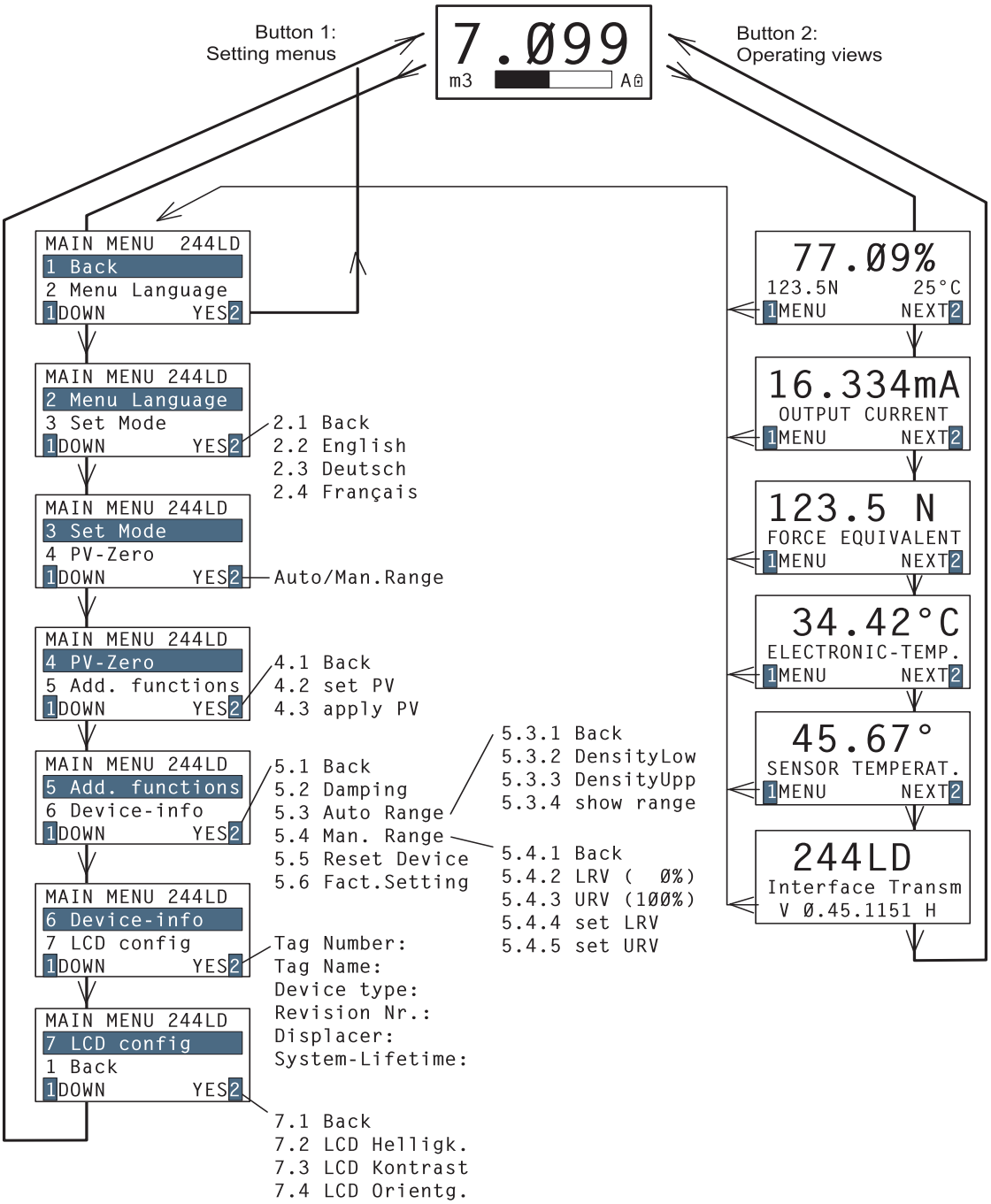
Numerical Adjustment

Numerical Adjustment is used for example in measuring range values:

The current value is displayed, and the first digit (or sign) is selected. Each time the button **1** CHANGE is pressed the number is counted up, until the desired number is reached. With button **2** NEXT the next number is marked and can be changed, etc. After that, even queried whether the change should be saved.

Operational View

Figure 16. Operational View



Menu List

Table 1. Menu List

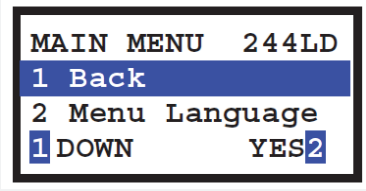
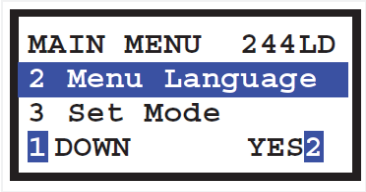
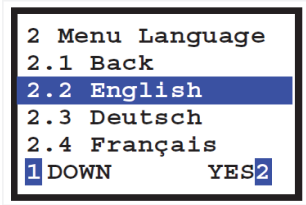
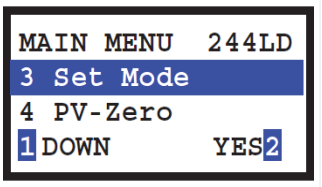
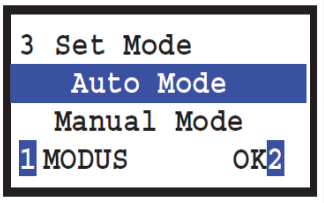
Menu	Description
Menu 1: Back	
	Back to Operational view. Note: When selecting YES **2** it goes back to the operating view. All sub-menus start with a “Back” feature that lets you come back to the previous menu.
Menu 2: Menu Language	
	With YES **2** it goes to language selection.
	There are 3 menu languages, standard English, German and French. From the factory, active language is always English. With **1** DOWN the desired language is selected and becomes active with confirming with YES **2**. All texts are now displayed in the chosen language. Then it goes automatically back to the Main menu.
Menu 3: Set Mode	
	With YES 2 it goes to Autorange or Manual selection. See “Setting via Local Keys and LCD”.
	With **1** MODE you switch from Autorange to Manual Mode. If this is to expect a change in the output value, a message appears. After confirming with OK **2** back to the main menu. Switching from Manual- to Autorange Mode: Requires reset to factory settings, if manual set data allows no calculations. See Menu 5.6.

Table 1. Menu List (Continued)

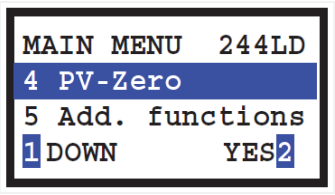
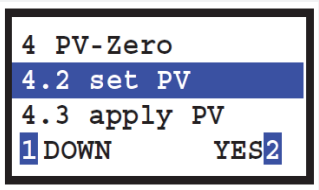
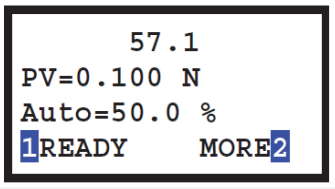
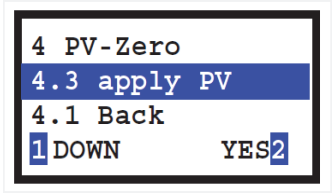
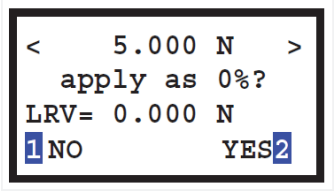
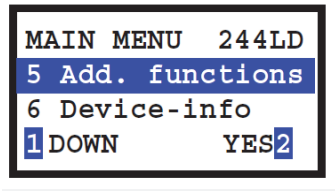
Menu	Description
Menu 4: Setting PV-Offset	
	With YES 2 it goes to setting PV-Offset.
	With YES 2 PV-Offset can be set, regardless of the mode Autorange or Manual.
	Setting on Linear adjustment in 0.1% increments, see “Setting via Local Keys and LCD”. The expected impact of the change can be seen on the primary variables in the second line. The resulting automatically calculated PV-offset is displayed on the third line to observe the change and possibly return to the former value.
	With YES 2 the current process value (Level: Displacer is not in the medium) is taken over as the physical zero point. **Note**: This menu item is only for manual mode and therefore the auto range mode is locked (indicated by a padlock symbol).
	By confirmation with YES 2 the current value will be saved as Lower Range Value.
Menu 5: Additional Functions	
	With YES 2 it goes to the following sub menus:

Table 1. Menu List (Continued)

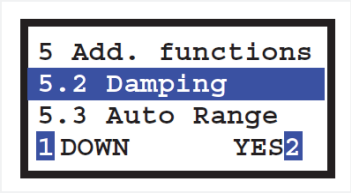
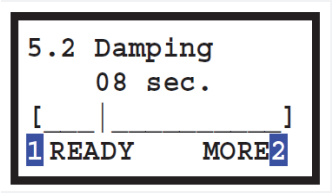
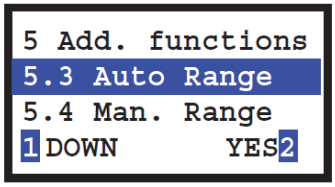
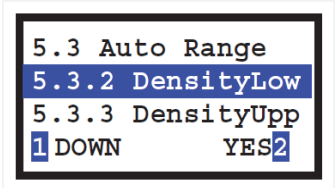
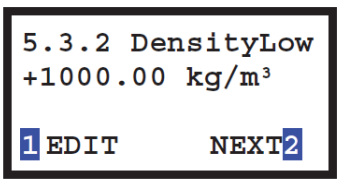
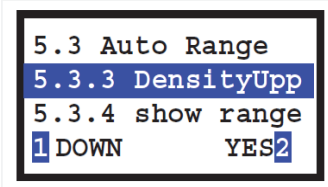
Menu	Description
	With YES 2 it goes to setting the damping.
	At first the current value is displayed. The value can now be adjusted with the MORE 2 button in steps of 1 second Linear adjustment, see “Setting via Local Keys and LCD”. Then back to the menu.
	With YES 2 it goes to the Range setting in the Autorange mode. In Autorange mode, the densities can be changed and then immediately taken into account in the automatic calculation.
	With YES 2 to enter the density of the lower medium.
	The value is entered using Numerical adjustment, see “Setting via Local Keys and LCD”. Finally, the value must be confirmed and is saved. If density of lower medium is lighter than the density of upper medium, an error message appears, and the value is not stored.
	With YES 2 to enter the density of the upper medium. (Proceed as with lower density.) Note: For Level measurement the value is 0.000.

Table 1. Menu List (Continued)

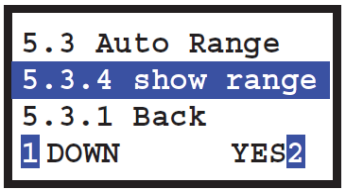
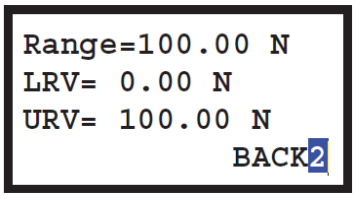
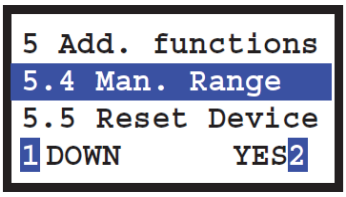
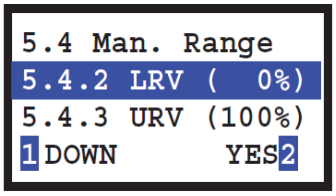
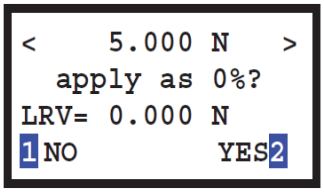
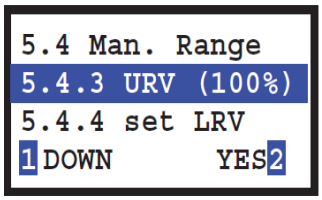
Menu	Description
	With YES 2 the current Measuring range is displayed:
	Measuring range Lower Range Value Upper Range Value With BACK 2 back to previous menu.
	With YES 2 it goes to the Range setting in Manual mode. After setting the operating conditions for 0% (at level: vessel empty) or 100% (at level: vessel full) each take over the value of the buoyancy force. Or by values input at 0% and 100%. Note: Feature is only available in Manual mode, Autorange mode is locked (padlock icon in the LCD).
	LRV - take over the Lower Range Value (0%) With YES 2 the following display appears:
	By confirmation with YES 2 the current value is saved as Lower Range Value.
	URV - take over the Upper Range Value (100%) (Proceed as with Lower Range Value.)

Table 1. Menu List (Continued)

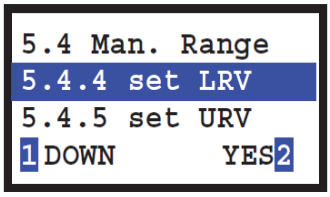
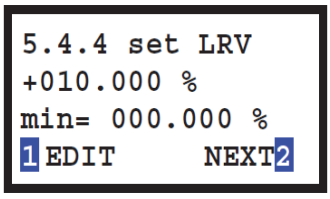
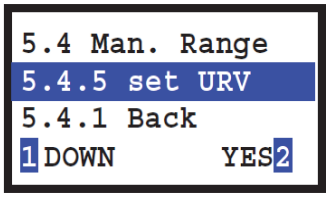
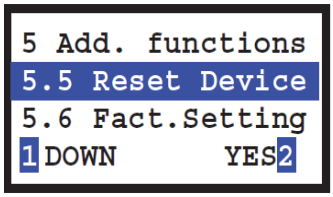
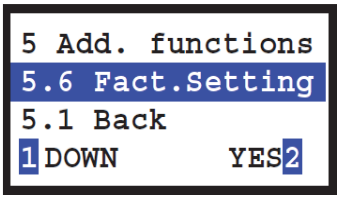
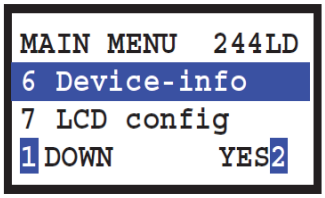
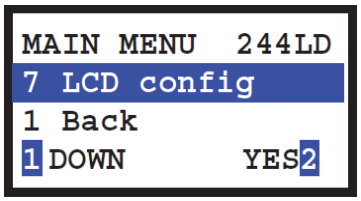
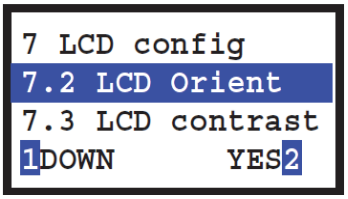
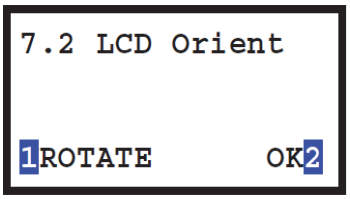
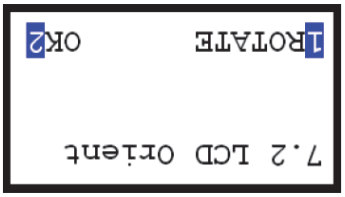
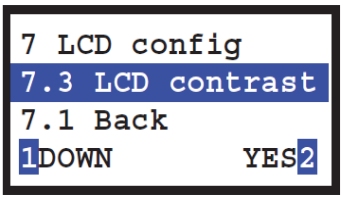
Menu	Description
	LRV - enter the Lower Range Value (0%) With YES 2 the following display appears:
	The value is entered using Numerical adjustment, see “Setting via Local Keys and LCD”. In the third line, the minimum value is displayed. Finally, the value must be confirmed and is then stored as Lower Range Value.
	URV - enter the Upper Range Value (100%) (Proceed as with Lower Range Value.)
	With YES 2 it goes to function selection. After a further confirmation the reset of electronics is running. Same effect as Power-on.
	With YES 2 it goes to function selection. Note: All custom settings are reset to the factory-defined state and is lost.
Menu 6: Device Information	
	YES 2 displays the data stored in the transmitter, such as ▸ Tag Number ▸ Tag Name ▸ Device type ▸ Revision Nr ▸ Displacer data ▸ System-Lifetime

Table 1. Menu List (Continued)

Menu	Description
Menu 7: LCD Configuration	
	With YES 2 it goes to settings for the LCD:
	With YES 2 it goes to selection of LCD orientation:
 	With 1 ROTATE is the text "on the feet". With confirming with OK 2 it goes back to the menu.
	With YES 2 the LCD contrast is adjusted. Linear adjustment, see “Setting via Local Keys and LCD”.

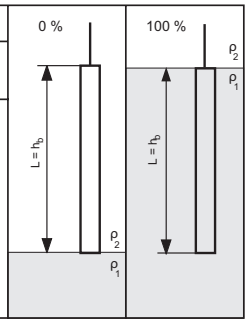
Dimensioning of Displacer

Calculating Weight Forces

(also see VDI/VDE-Guideline 3519, sheet 1)

Displacer Length = Measuring Range

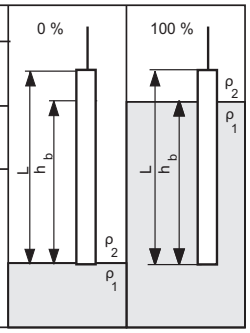
Measurement type	Weight forces	
	Lower range value = 0 % output signal	Upper range value = 100 % output signal
Liquid level (ρ_2 = negligible) 1)	$F_0 = F_G$	$F_{100} = F_G - V \cdot g \cdot \rho_1$
Interface (ρ_2 = not negligible)	$F_0 = F_G - V \cdot g \cdot \rho_2$	
Density (ρ_2 = min. density, ρ_1 = max. density)		



Displacer Length > Measuring Range

(without elevation)

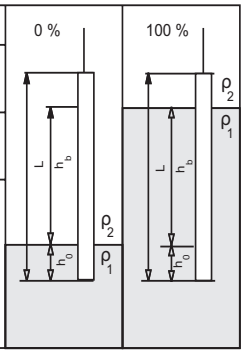
Measurement type	Weight forces	
	Lower range value = 0 % output signal	Upper range value = 100 % output signal
Liquid level (ρ_2 = negligible) 1)	$F_0 = F_G$	$F_{100} = F_G - V \cdot g \cdot \rho_1 \frac{h_b}{L}$
Interface (ρ_2 = not negligible)	$F_0 = F_G - V \cdot g \cdot \rho_2$	$F_{100} = F_G - V \cdot g \left(\rho_1 \frac{h_b}{L} + \rho_2 \frac{L - h_b}{L} \right)$



Displacer Length > Measuring Range

(with elevation)

Measurement type	Weight forces	
	Lower range value = 0 % output signal	Upper range value = 100 % output signal
Liquid level (ρ_2 = negligible) 1)	$F_0 = F_G - V \cdot g \cdot \rho_1 \frac{h_0}{L}$	$F_{100} = F_G - V \cdot g \cdot \rho_1 \frac{h_0 + h_b}{L}$
Interface (ρ_2 = not negligible)	$F_0 = F_G - V \cdot g \left(\rho_1 \frac{h_0}{L} + \rho_2 \frac{L - h_0}{L} \right)$	$F_{100} = F_G - V \cdot g \left(\rho_1 \frac{h_0 + h_b}{L} + \rho_2 \frac{L - h_b - h_0}{L} \right)$



F_G	[N]	Weight force of displacer in atmosphere	ρ_1	[kg/m³]	Liquid density
F_0	[N]	Weight force action on suspension point of displacer at lower range value	ρ_2	[kg/m³]	Density of gas or lighter liquid
F_{100}	[N]	Weight force action on suspension point of displacer at upper range value	g	[m/s²]	Local acceleration due to gravity (e.g. 9.807 m/s²)
F_A	[N]	Buoyancy force of displacer (FA = F0 - F100)	L	[m]	Displacer length
V	[m³]	Displacer volume (specified on data label in cm³)	h_0	[m]	Lower range value
			h_b	[m]	Measuring span

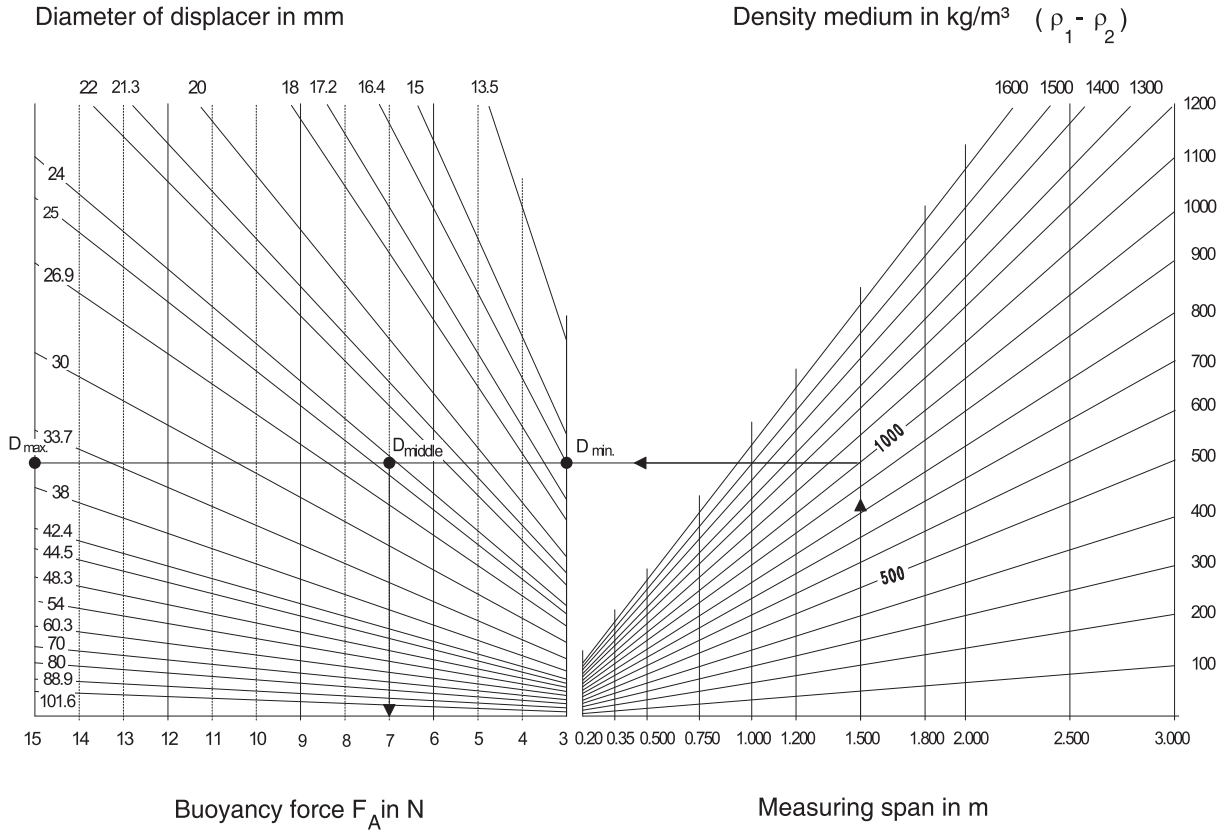
1) ρ_1 is negligible if ρ_2 = gas at atmospheric pressure or with ratio $\rho_2 : \rho_1$ less than 0.5%

NOTE

1 kg generates a force of 9.807 N

Graph for Determining Displacer Diameter

Figure 17. Graph for Determining Displacer Diameter



Measuring Span

The transmitter is designed for a buoyancy force measuring span of minimum 2 up to maximum 20 N.

Weight Force

The maximum weight of the displacer F_A max. is 25 N for level measurements. For density or interface measurements, the displacer must be dimensioned so that after deducting F_A of the lighter process media, the remaining force F0 does not exceed 25 N.

Determining Displacer Diameters

For optimum use of the transmitter, the displacer should be dimensioned so that the greatest possible buoyancy force is generated over the measuring range. On the other hand, the maximum possible diameter of the displacer must be taken into consideration.

In the above graph the displacer diameter can easily be estimated dependent on the measuring span and the buoyancy force.

The following equation can be used to exactly dimension the displacer:

$$D = 1000 \sqrt{\frac{4\ F_A}{\pi\ g\ (\ \rho_1 - \rho_2\ )\ L}} \qquad [\,mm\,]$$

D = Outside diameter of displacer in mm

F_A = Buoyancy force of displacer in N

g = Acceleration due to gravity (9.807 m/s^2)

ρ_1 = Density of heavier liquid in kg/m^3

ρ_2 = Density of gas or lighter liquid in kg/m^3

L = Measuring span in m

Example:

Measuring span: 1.500 m

ρ_1 = 1000 kg/m^3

ρ_2 = negligible

Measuring Principle

(see VDI/VDE Guideline 3519, sheet 1)

Any body immersed into a liquid is subject to Archimedian buoyancy force which depends on the liquid density. This is exploited to determine liquid level, density and interface level by suspending a displacer with constant cylindric shape into a liquid. Changes in buoyancy forces are proportional to liquid level changes and are converted to a measuring signal.

The displacer is fully immersed for density and interface level measurement.

The following applies in general to the buoyancy force acting on the displacer:

$F_A = V_x \cdot \rho_1 \cdot g + (V - V_x) \cdot \rho_2 \cdot g$

F_A: Buoyancy force

V : Volume of displacer

V_x : Volume of medium displaced by measuring body with density ρ_1

ρ_1 : Average density of heavier medium

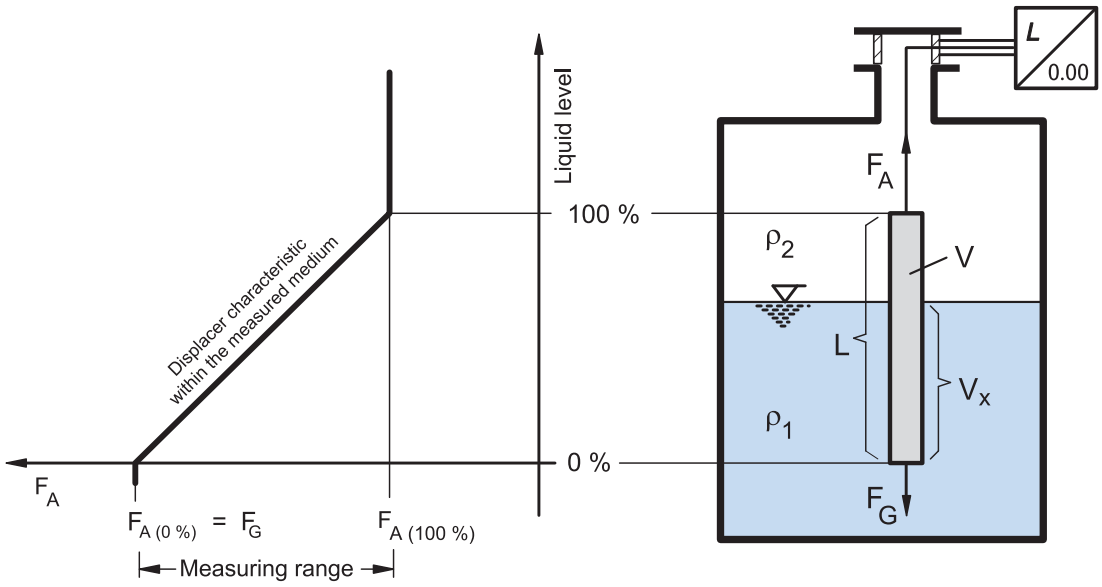
ρ_2 : Average density of lighter medium

g : Local acceleration due to gravity

F_G : Displacer body weight force

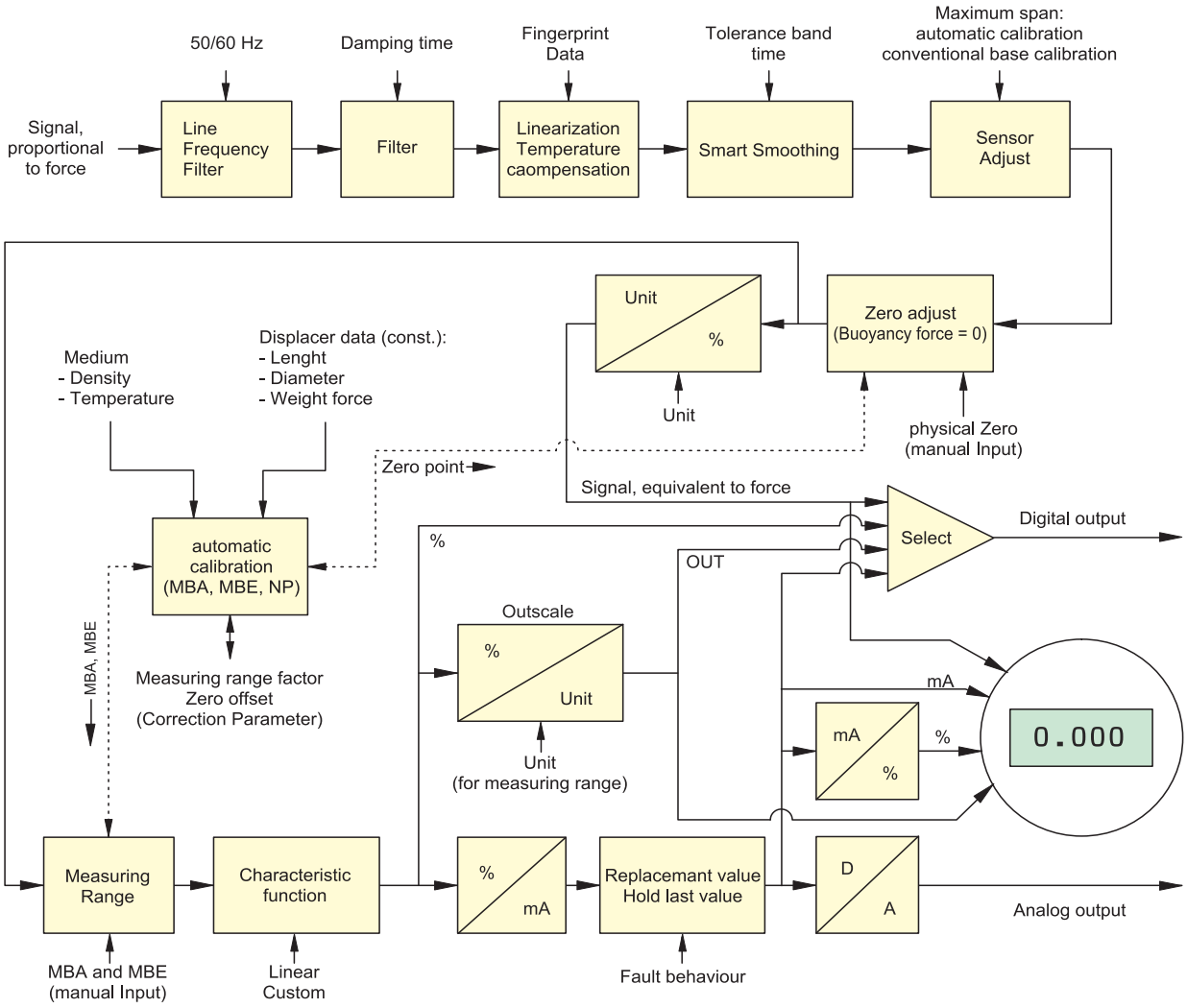
The force acting on the transmitter is inversely proportional to liquid level changes.

Figure 18. Measuring Principle



Block Diagram with HART® Communication

Figure 19. Block diagram with HART® Communication



Explanations to Block diagrams

Sensor

The force sensor is a Wheatstone bridge of four metal strain gauge elements and a Ni100 resistor for temperature measurement.

Line Frequency Suppression Filter

This is the selection to filter the noise signal 50 Hz or 60 Hz.

Linearization and Temperature Compensation of Sensor characteristic

The sensor signal is linearized and temperature-compensated by the included sensor temperature. Linearization takes place via the so-called fingerprint data, which are determined during the production for each sensor. In factory the fingerprint data are loaded into the amplifier.

Smart Smoothing

In factory the Smart Smoothing Band is set to 2% of sensor range. The Integration Time of the average value is set to 10 seconds.

Figure 20. Smart Smoothing - Static

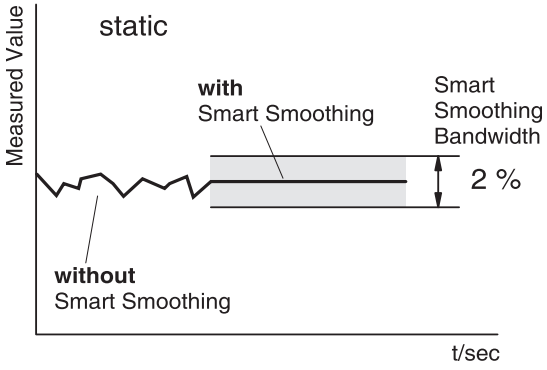
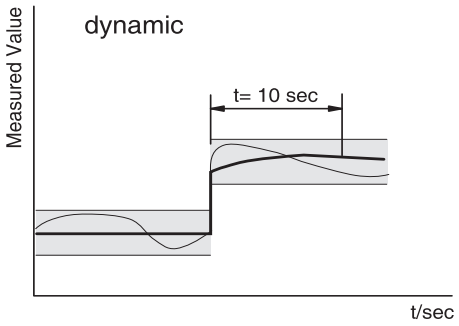


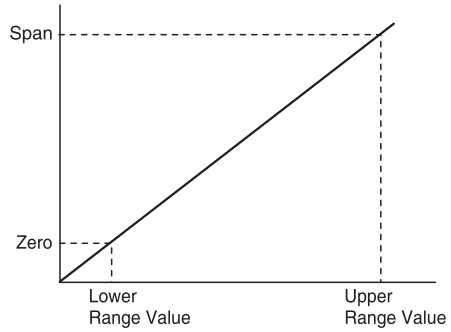
Figure 21. Smart Smoothing - Dynamic



Sensor Adjustment

Zero and span of force sensor are adjusted in factory. It is possible to calibrate Zero (situation alignment) with the external keys.

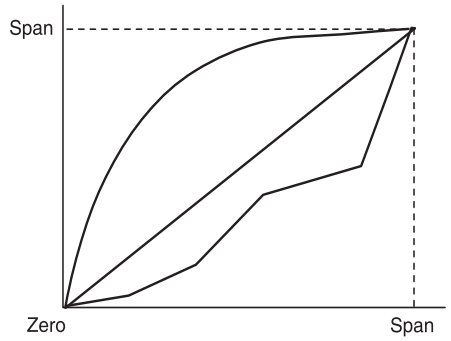
Figure 22. Sensor Adjustment



Transfer function / Characteristic

The characteristics are available as linear and customized. With "customized" there are 32 x/y-values available. Standard with Level is linear.

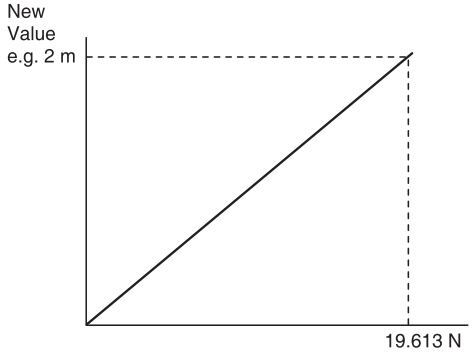
Figure 23. Transfer function / Characteristic



Measured Value Setting

Define the measured value and unit.

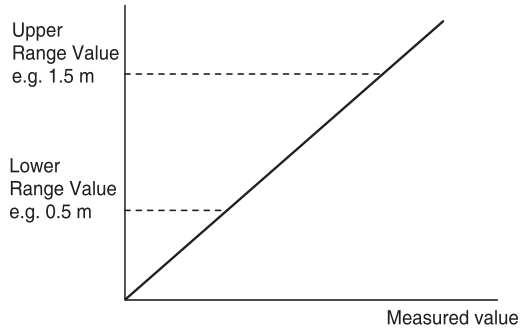
Figure 24. Measured Value Setting



Setting of Range

The measuring range is the range between Lower Range Value and Upper Range Value. Lower Range Value is the weight of the displacer. Lower Range Value without elevation is 0. With elevation, the value of elevation has to be entered.

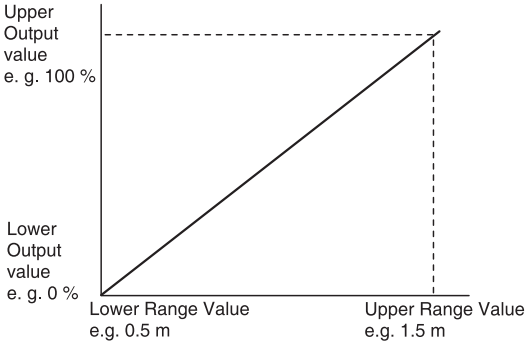
Figure 25. Setting of Range



Setting of Output Value

The output value is the measured value between Lower Range Value and Upper Range Value. Value and unit are freely selectable. The replacement value affects the output.

Figure 26. Setting of Output Value



Replacement / Substitute Value (HART® only)

In case of a detected error, output holds last value or gives a configurable Replacement value. If the detected error does not exist any longer, then last value and / or Replacement value is taken back (automatically or manually).

Multi-drop (HART® only)

With FDT-DTM or a Hand held Terminal it is possible to switch HART® Amplifier between analog and Multi-drop. With HART® mode Multi-drop, the output has a digital signal, the measured value is modulated to a 4 mA DC signal. FDT-DTM Software enables to simulate the measured value and to write output values directly to the output.

Filter

The output signal is damped. Damping time is set from 0 to 32 seconds.

Supply of Transmitter

General

Depending on the transmitter application varying demands are made on the supply. See "Overview of Application Types" for more information. The wire diagrams are shown in the following figures.

The power supply units for different applications (direct / via power supply unit of transmitters, HART® / without communication, intrinsically / not intrinsically) are listed in the following table.

All listed supply devices are available for intrinsically safe and/or non-intrinsically safe application.

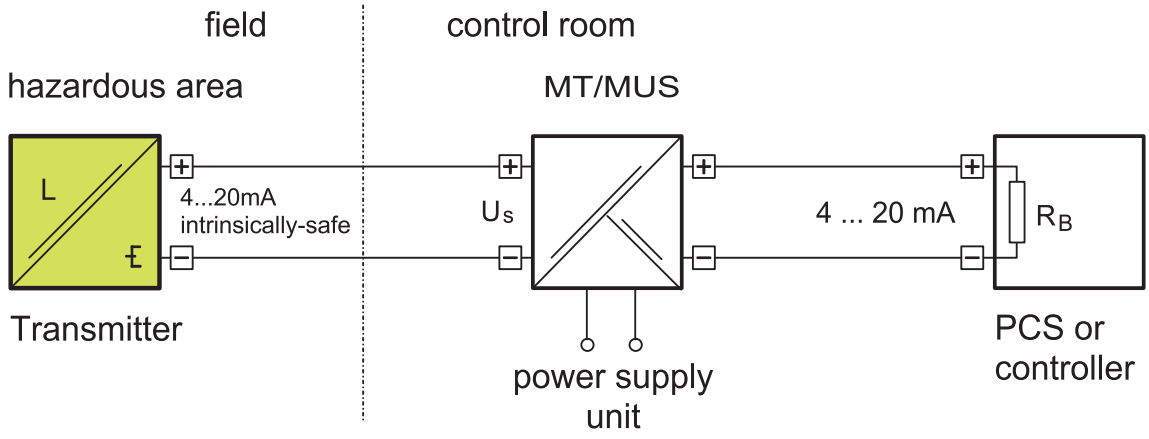
Application and associated supply:

Application	Supply (recommended)
without communication	direct, Universal Ex-Barrier
HART®	direct, Universal Ex-Barrier

Overview of Application Types

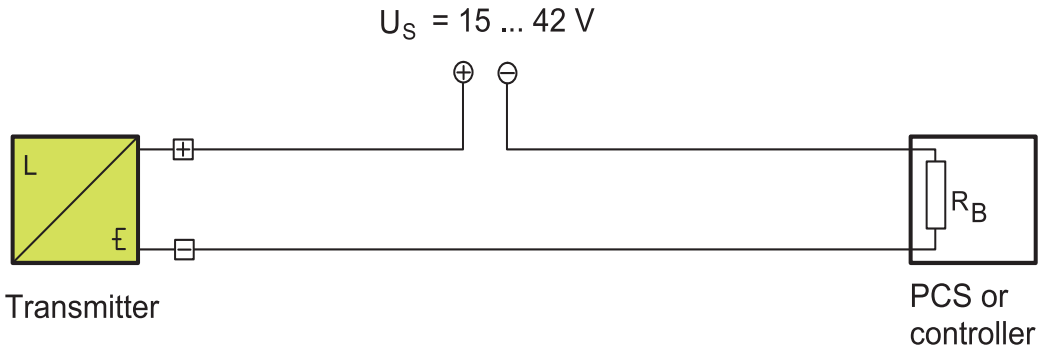
Supply via Power Supply Unit

Figure 27. Supply via Power Supply Unit



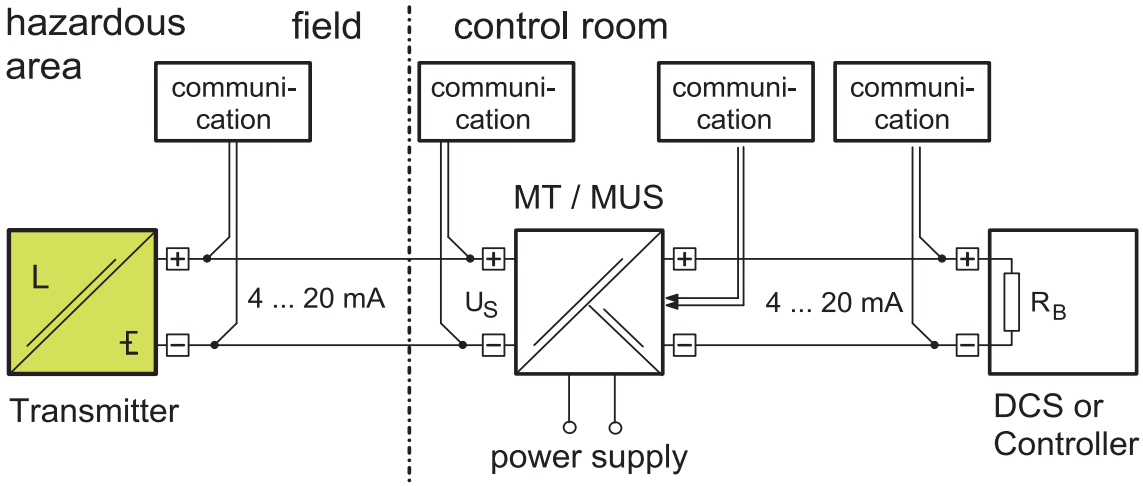
Direct Supply

Figure 28. Direct Supply



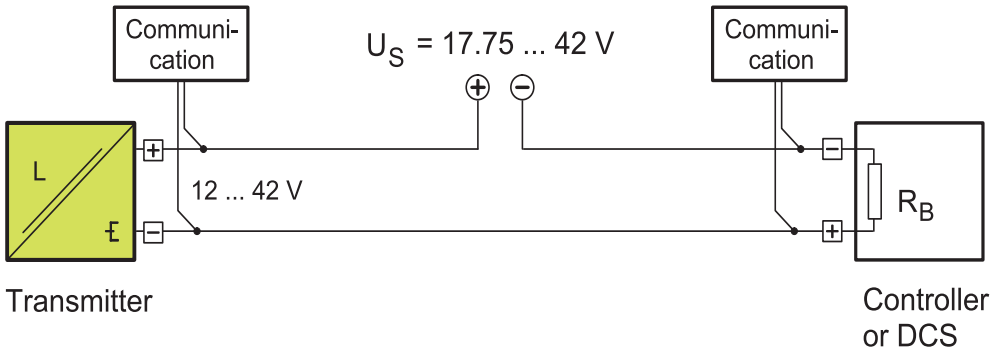
Supply via Power Supply Unit with Communication

Figure 29. Supply via Power Supply Unit with Communication



Direct Supply with Communication

Figure 30. Direct Supply with Communication



Direct Supply with Communication is

- 42 V for non-Ex as shown in Figure 30
- 24 V for PA/FF ATEX
- 30 V for HART Ex
- 32 V for PA/FF/HART CSA approval

Supply via Power Supply Unit

This supply is for normal use. Interferences are prevented due to galvanic separation of measurement loop, load, and power supply in the power supply unit. See Figure 27.

Direct Supply

This most simple version can be recommended only for single galvanically separated supply or measurement loops. See Figure 28.

$R_{Bmax} = (U_{max} – 12\ V) / I_{max}$

U_{max}: max. permitted voltage (according to product specifications), depends on type of transmitter and explosion protection.

I_{max}: 23 mA HART®

Communication

In contrast to conventional operating mode in the two-wire loop a minimal load for all communication modes has to be available. If this load is selected too low, the communication is short-circuited. Additionally, the line lengths have to be limited to the maximum permitted values for the respective communication.

Standard values:

Communication	HART®
Min. load	250 Ohm
Max. capacity of line	< 200 nF
Max. length of line	~ 3300 m

The respective wiring diagram is shown in Figure 29.

Figure 30 shows the respective wiring diagram without power supply unit for galvanically separated loops. The operating tool HART Communicator or PC with PACTware™ and DTM can be connected to the labeled positions. Depending on the application the regulations for explosion protection have to be observed also for the operating tools.

Intrinsically Safe Application

For intrinsically safe application generally the use of a respective power supply unit is recommended. Wiring should be done as per respective national and international standards and regulations - as described in “Supply via Power Supply Unit”. If communication is required also, the guidelines have to be observed. In addition, the application of the operating tools and their permitted limit values are to be observed.

Error Messages on LCD Display and the DTM Screen

Table 2. Error Messages on LCD display and on the DTM screen

Message Text	I_{out}	Instrument State	Possible Cause	Action	Remarks
INT CALIB FAILED INT CALIB INVAL (a)			Not implemented in LevelStar	No	
SENSOR INVALID	FailSafe 24 mA	Safety related ▸ Level measurement not usable ▸ HART-communication via modem and IR service port is available.	Measuring Cell failure ▸ Electronic internal diagnosis detects invalid measuring cell values ▸ Wrong sensor/electronic replace procedure	▸ Check and compare code on sensor to be in accordance with Fingerprint Data code loaded. ▸ Repeat factory Basic Calibration ▸ Check sensor wire connection ▸ Load right finger print data, then restart the device and finally do sensor calibration (Sensor Trim)	Do not change electronic module from instrument A to B. Should be carried out by experienced personal only. Additional know how and experience required for correction procedure.
OUT OF SENS LIMIT			Not implemented in LevelStar	No	
SENS TEMP LIMIT	FailSafe 24 mA	Safety & process related Temperature is lower -60 °C or higher +150 °C HART-communication via modem and IR service port is available.	Specified temperature limits exceeded	▸ Read out data via DTM ▸ Check Status and Extended Status message information accordingly ▸ Check temperature of environment ▸ Check process temperature ▸ Check temp sensor (Ni 100 element) inside measuring cell Change sensor if necessary	In case instrument output is on Fail Safe safety value check Failsafe configuration.
	3.8 .. 20.5 mA	Indicated as Status Message only. Temperatures limits			
ELEC TEMP LIMIT		Warning message: Device is not in safe mode.	▸ Electronic Temperature out of limits. ▸ Temperature is between -40°C to -60°C or 89°C to 105°C	Ambient or process temperature is too low/high	
MEAS RANGE INVAL (b)			Not implemented in LevelStar	No	

Table 2. Error Messages on LCD display and on the DTM screen (Continued)

Message Text	I_{out}	Instrument State	Possible Cause	Action	Remarks
PV OUT OF LIMIT		Warning message: Device is not in safe mode	PV out of limits (<-30 % or >110 %)	▸ Check displacer weight ▸ Check measure range and zero point	
VAR OUT OF LIMIT OUT OF LIMITS (a)		See “TEXTS ARE WRONG” or “DIAGNOSTIC ERROR”	This error message is a reaction of the “TEXTS ARE WRONG” or “DIAGNOSTIC ERROR”	See “TEXTS ARE WRONG” or “DIAGNOSTIC ERROR”	
ANALOG OUT SATUR CURR OUT OF LIMIT (a)		Warning message for I_{out} out of limits. Device is not in safe mode.	The output current is out of limits: 3,8 mA (-1,25 %) and 20,5 mA (103, 123 %)	Check measure range	
CURRENT FIXED		Warning message: Device is not in safe mode	Output current is fixed (for example current calibration or critical error)	No	
COLD START		Warning message: Device is not in safe mode	Shows that the device was restarted during the safety mode	No	
CONFIG. CHANGED		Warning message: Device is not in safe mode	Configuration has been changed	The message can be reset with DTM or HHT with “reset status” function	
OUT OF MEAS RANG	3.8 .. 20.5 mA	Warning message: Device is not in safe mode	PV is out of measure range	check measure range	
FINGER PRINT ERR		Warning message: Device is not in safe mode	The raw is >15 % or < -115 %	▸ Check displacer weight ▸ Check finger print data	The device is not in normal operation. Sensor calibration is missing.
LANG TEXT ERROR TEXTS ARE WRONG (a)		Warning message: Device is not in safe mode Device is not yet calibrated	internal problem with the language texts	▸ restart the electronic ▸ try to download the third language via DTM	
DIAG INCOMPLETE DIAGNOSTIC ERROR (a)	Fail safe 24 mA	Device is in SIL mode: ▸ Level measurement not usable ▸ HART-Communication via Modem and IR service port is available.	Diagnostic function (s) was not executed.	Execute sensor calibration	
		Warning message: Device is not in SIL mode			

Table 2. Error Messages on LCD display and on the DTM screen (Continued)

Message Text	I_{out}	Instrument State	Possible Cause	Action	Remarks
DISPL. TOO LIGHT	Fail safe 24 mA	No Level Measurement Instrument in Safe Mode Safety related for FW-Versions <= 7.69.5 or in SIL mode	▸ Sensor value above 10 % of upper max. Span limit (> 110 %). ▸ Displacer weight remaining < 0.500 kg ▸ Displacer is driven upwards by excessively streaming process fluid ▸ Displacer is too light ▸ Displacer is missing or has dropped	▸ Ensure displacer is hooked up correctly. ▸ Ensure displacer is hanging free ▸ Ensure displacer is in defined measure range position inside chamber or vessel	From FW-Version >= 8.X, the DTM Fail Safe menu will offer the possibility to configure whether fail safe function for Displacer Too Light will be activated or not
	20.5 mA	Indicated as Status Message only for FW-Versions >= 8.X or not in SIL mode			
NO FACT SETTINGS		Warning message: Device is not in safe mode	Not all factory calibrations were executed	Make all calibrations and store it as factory	
LOOP CURRENT ERR ILL LOOP CURRENT (a)	Fail safe 24 mA	NAMUR43 related ▸ Level measurement not usable ▸ HART-Communication via Modem and IR service port is available.	Measured and digital current value has reached a deviation of 1.0 %	▸ Perform User mA-Calibration in DTM to recalculate the current diagnostic reference values ▸ Output damping or Smart Smoothing damping must be at least 1 sec. ▸ Change electronic	
	Fail safe 3.6 mA	For FW-Versions <= 7.69.5, see the description of the error message "PWR SPPLY INSUFF"			
SENS. CURRENT ERR	Fail safe 24 mA	▸ Level measurement not usable ▸ HART-communication via modem and IR service port is available.	▸ Sensor current failure ▸ Sensor defect	▸ Check sensor wire connection ▸ change sensor ▸ change electronic	
SENS REF ERROR	Fail safe 24 mA	▸ Level measurement not usable ▸ HART-communication via modem and IR service port is available.	Sensor Reference voltage failure (Electronic failure)	change electronic	
TEMP SENS FAILED TEMP -SENS INVAL (a)	Fail safe 24 mA	▸ Level measurement not usable ▸ HART-communication via modem and IR service port is available.	Temperature measurement failure (Measuring cell internal NI 100 temp. sensor failure)	change electronic or sensor	
EL TEMP SENS ERR	Fail safe 24 mA	▸ Level measurement not usable ▸ HART-communication via modem and IR service port is available.	Temperature is < -60°C or > 105°C	change electronic	

Table 2. Error Messages on LCD display and on the DTM screen (Continued)

Message Text	I_{out}	Instrument State	Possible Cause	Action	Remarks
WATCHDOG ERROR	Fail safe 24 mA Fail safe 3.6 mA	▸ Level measurement not usable ▸ HART-communication via modem and IR service port is available.	Watchdog has detected a failure (hardware or software related)	▸ check FW-Version and update to the latest one ▸ if FW >= 7.69.5, exchange electronic	
ADC GAIN ERROR	Fail safe 24 mA	▸ Level measurement not usable ▸ HART-communication via modem and IR service port is available.	A/D Converter failure	▸ Start a new sensor calibration ▸ Check FW-Version and update to the latest one ▸ if FW => 8.xx.x, exchange electronic	
INT REF ERROR 100 OHM ERROR (a)	Fail safe 24 mA	▸ Level measurement not usable ▸ HART-communication via modem and IR service port is available.	electronic defect	change electronic	
ADC BIT ERROR	Fail safe 24 mA	▸ Level measurement not usable ▸ HART-communication via modem and IR service port is available.	electronic defect	change electronic	
SYS OFFSET ERROR	Fail safe 24 mA	▸ Level measurement not usable ▸ HART-communication via modem and IR service port is available.	▸ Electronic defect ▸ Sensor recalibration (Sensor Trim) required after the electronic change	▸ Perform recalibration (Sensor Trim) ▸ Change electronic if recalibration is not solving the issue	
HART MODEM FAIL HART MODEM FIRMW (a)	Fail safe 24 mA	For FW-Versions <= 7.69.5 For FW-Versions >= 8.x	▸ No HART modem firmware download ▸ HART-modem chip is defect	▸ download a new modem firmware ▸ change the electronic	Internal microchip communication test failed during internal diagnosis routine
PWR SPPLY INSUFF	Fail safe 3.6 mA	▸ Level measurement not usable ▸ HART-communication via modem and IR service port is available	▸ Supplied power is too low to generate the required current. ▸ Typical error value on LCD = 1111.11	▸ Check power supply ▸ Check connection compartment ▸ Measure supplied voltage at transmitter terminals in failure state. ▸ Assure loop arrangement and power supply in use is fulfilling the demands according to PSS EML0710 G-(en) 244LD.	In case the current delivered by the power supply is insufficient the transmitter is not able to drive the current required. According to NAMUR the output has to go to a low failsafe value = 3.6 mA.
HI_ALARM (b)		Warning message: Device is not in safe mode	PV is over the Hi-Alarm limit	check measure range or your process	

Table 2. Error Messages on LCD display and on the DTM screen (Continued)

Message Text	I_{out}	Instrument State	Possible Cause	Action	Remarks
HI_HI_ALARM (b)		Warning message: Device is not in safe mode	PV is over the Hi-Hi-Alarm limit	check measure range or your process	
LO_ALARM (b)		Warning message: Device is not in safe mode	PV is over the Lo-Alarm limit	check measure range or your process	
LO_LO_ALARM (b)		Warning message: Device is not in safe mode	PV is over the Lo-Lo-Alarm limit	check measure range or your process	

a. = Firmware version < 8.XXX

b. ** = Firmware version = 9.XXX

Schneider Electric Systems USA, Inc.
70 Mechanic Street
Foxboro, MA 02035
United States of America
http://www.se.com

Global Customer Support
Inside U.S.: 1-866-746-6477
Outside U.S.: 1-508-549-2424
https://pasupport.schneider-electric.com

Copyright 2010-2021 Schneider Electric Systems USA, Inc. All rights reserved.

The Schneider Electric brand and any trademarks of Schneider Electric SE or its subsidiaries are the property of Schneider Electric SE or its subsidiaries. All other trademarks are the property of their respective owners.

DOKT 556 588 241 i
FD-MI-L-004-EN 1221