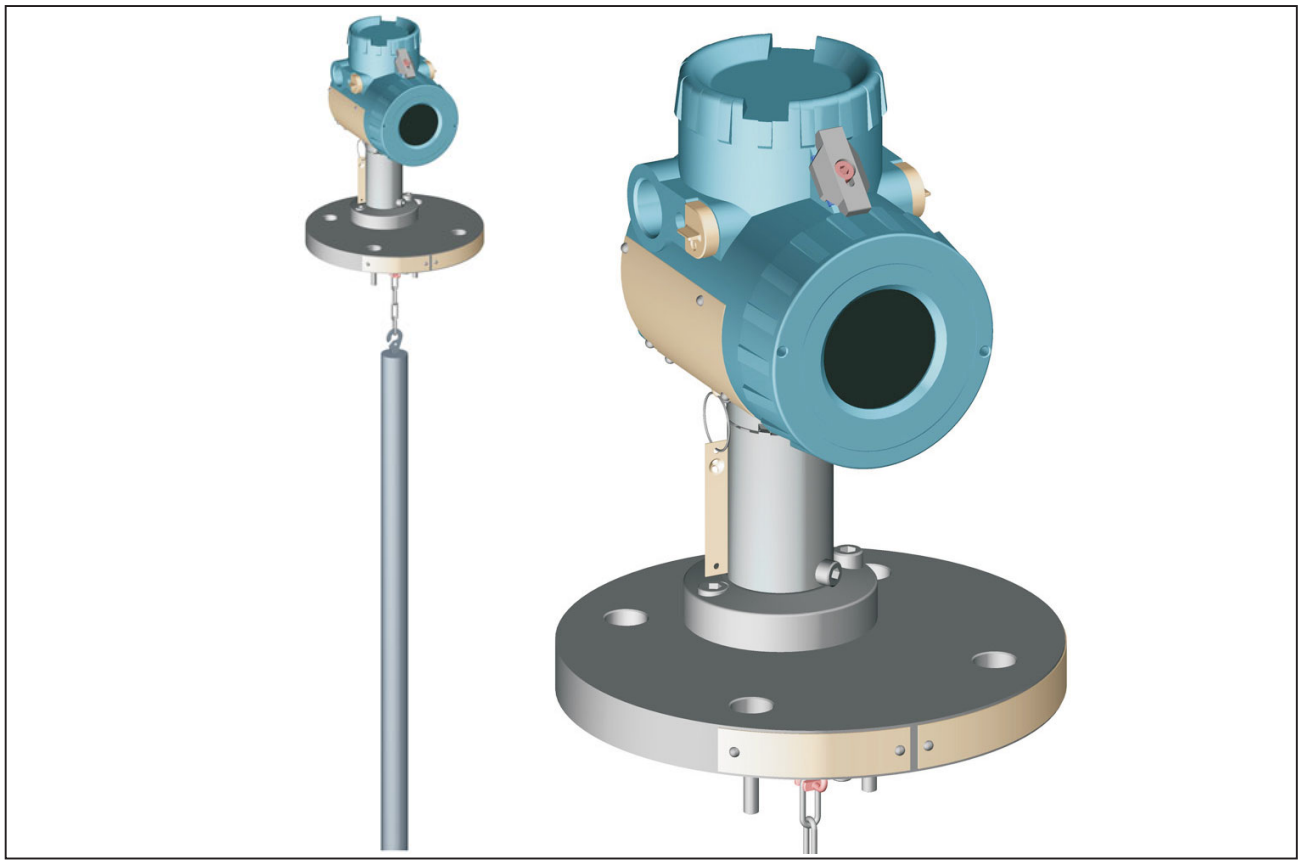
244LVP Intelligent Buoyancy Transmitter for Liquid Level, Interface and Density



The intelligent transmitter 244LVP 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. The 244LVP measures with consistent reliability and high precision. For installations in contact with explosive atmospheres up to Zone 0, certificates are available. The 244LVP combines the abundant experience of FOXBORO ECKARDT with most advanced digital technology.

FEATURES

- Communication HART (4-20 mA)
- Conventional operation with local keys
- Easy adaptation to the measuring point without calibration at the workshop
- Backdocumentation of measuring point
- Configurable safety value
- Software lock against unauthorized operation
- Simulation of analog output for loop-check
- Local display in %, mA or physical units
- Signal noise suppression by Smart Smoothing
- Continuous self-diagnostics
- Linear or customized characteristic
- Process temperature from –50 °C to +150 °C
- Static pressure up to PN 40
- Micro sintermetal sensor technology

Repair and maintenance must be carried out by qualified personnel!

FOXBORO ECKARDT

CONTENTS

Further documentation:

Master Instruction
MI EML0610 B-(en) / MI EML1610 B-(en)
144LD / 144LVD
Intelligent Buoyancy Transmitters
Communication with HART Protocol

Master Instruction
MI EMO0110 A-(en)
HT991 Universal Hand terminal for HART Devices

Master Instruction
MI EMO0120 A-(en)
ABO991 Display and User Interface for HART devices
WPP991 Write Protection Program

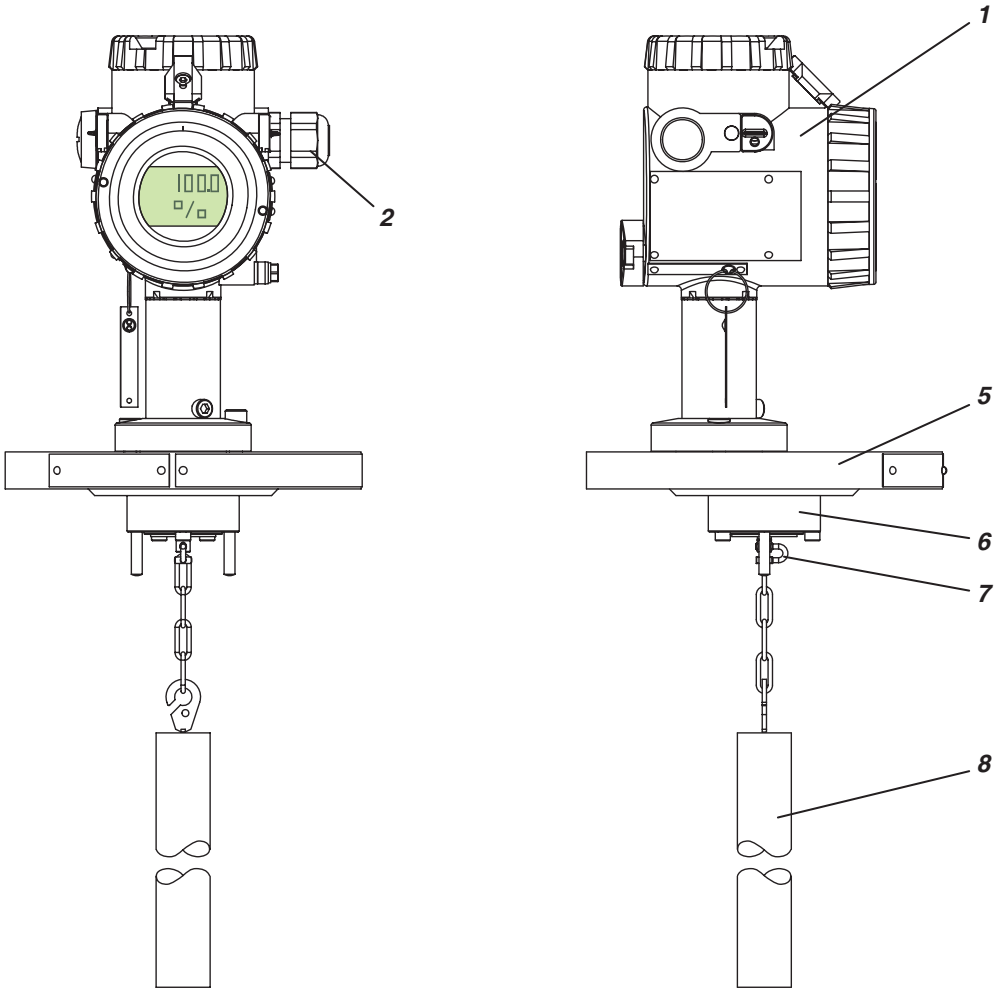
Master Instruction
MI EML0610 C-(en) / MI EML1610 C-(en)
144LD / 144LVD
Intelligent Buoyancy Transmitters
Communication with FOXCOM Protocol

HHT Instruction Book 3372
I/A Series Hand Held Terminal

PC10 Instruction Book 3466
Intelligent Transmitter Configurator

1 DESIGN

The transmitter is based on a modified pressure measuring cell. The sensor is a flexure beam, which is mechanically linked to the measuring diaphragm, so the measuring cell also can be used for force measurement. The static pressure in vessel does not influence the measurement.



1 Amplifier
2 Cable gland (as ordered)
5 Process connection flange
6 Sensor
7 Suspension fixture
8 Displacer

2 METHOD OF OPERATION

The buoyancy force of the displacer acts directly on the flexure beam. Four thin film metal resistors are sputtered onto the sensor element, which change their resistance in the ratio of the tensile or pressure tension.
These four thin film metal resistors 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.
See also chap 2.2 Block diagram.

2.1 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.

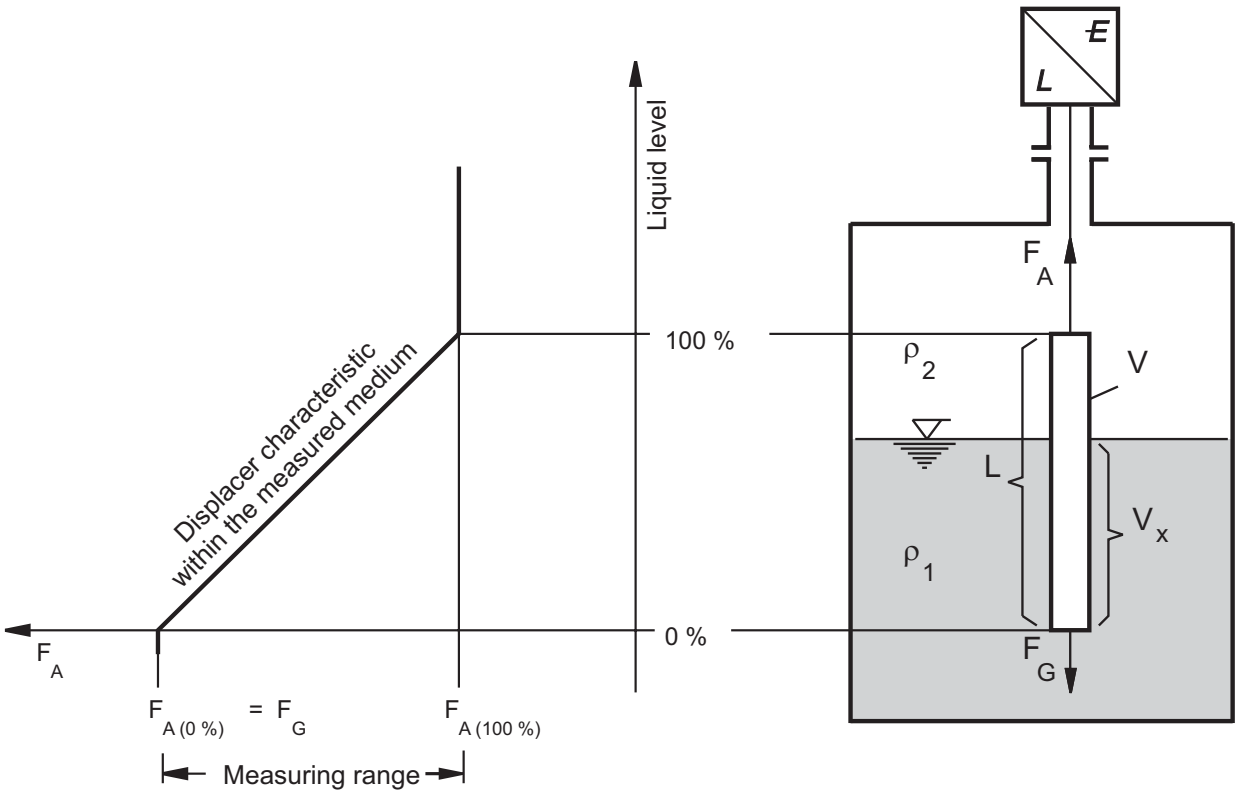
Changes in buoyancy forces are proportional to liquid level changes and are converted to a measuring signal.
The displacer is fully immersed for density and interface level detection. It is important that the position of the displacer changes as little as possible over the measuring range.

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

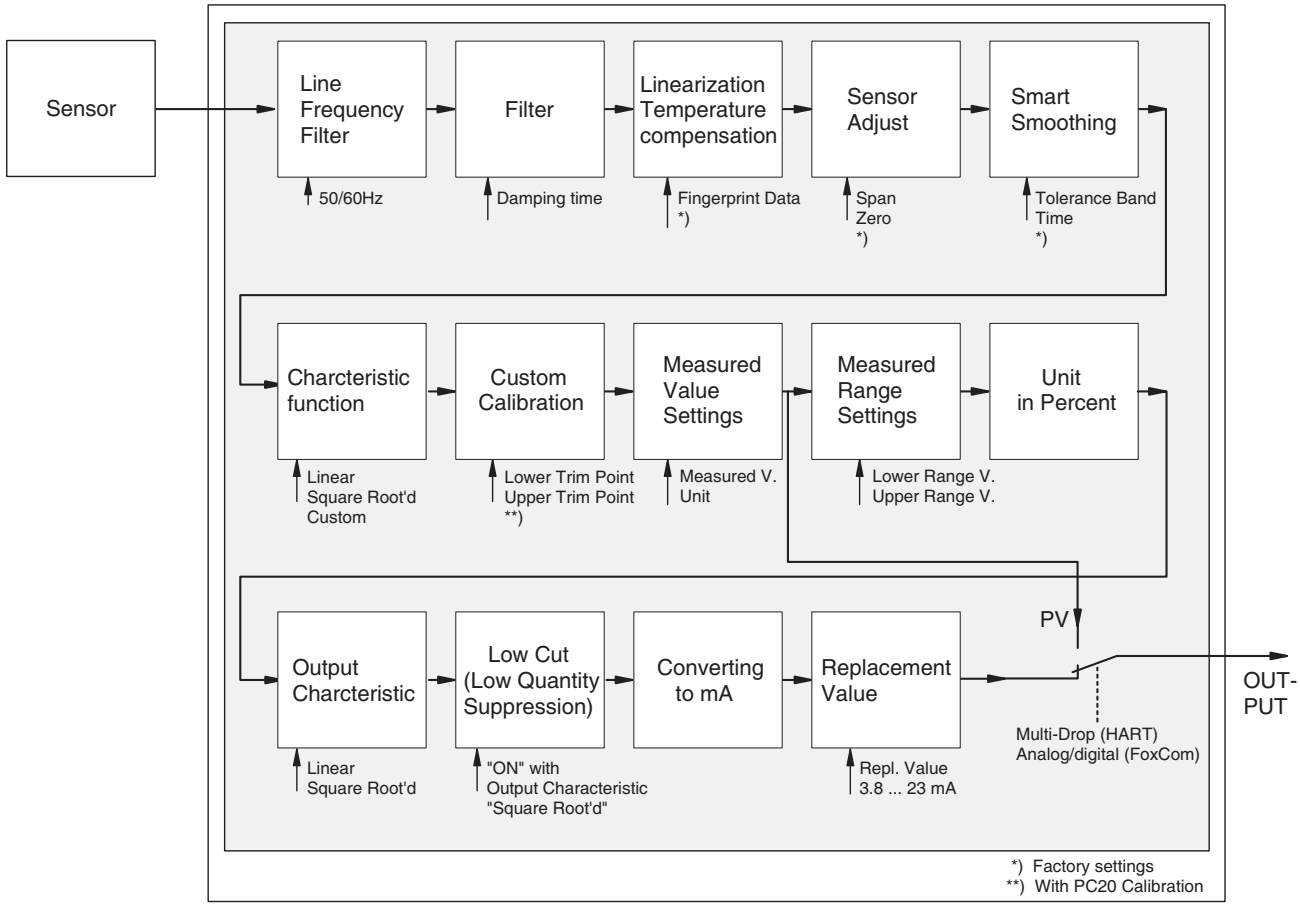
$$F_A = V_x \cdot \rho_1 \cdot g + (V - V_x) \cdot \rho_2 \cdot g$$

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.



2.2 Block diagram with HART

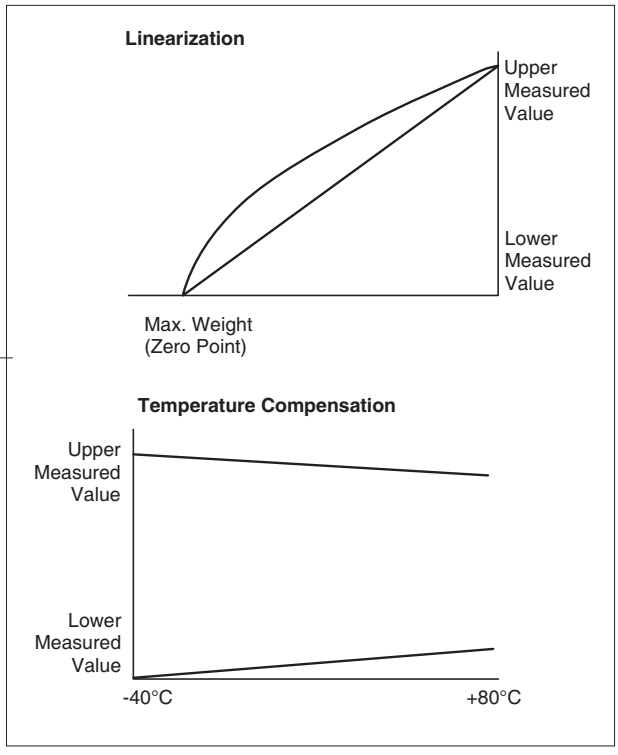


2.3 Explanations to Block diagrams

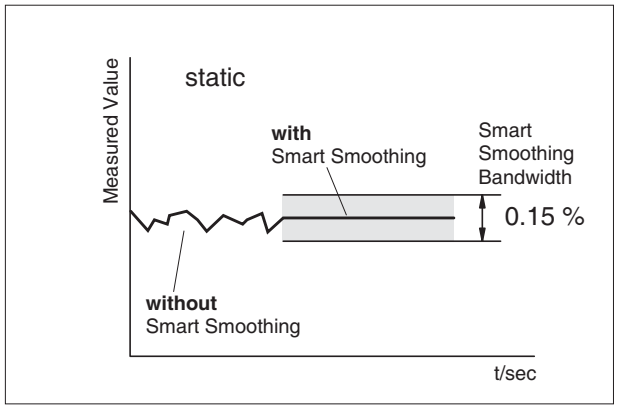
Sensor
The force sensor is a Wheatstone bridge of four metal strain gauge elements and a Ni100 resistor for temperature measurement. For calibration the sensor is loaded with weights, in order to determine the characteristic of the sensor.
The Lower Range Value is determined by a small buoyancy force (high weight), Upper Range Value by a larger buoyancy force (lower weight).

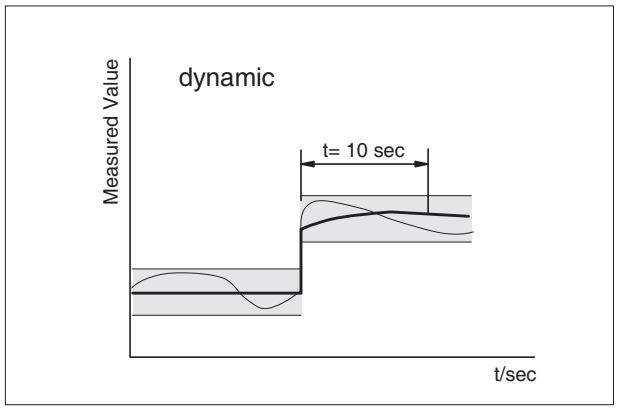
Linearization and Temperature compensation of Sensor characteristic
The sensor signal is linearized and temperature-compensated by the included sensor temperature. Linearization takes place via the so-called fingerprint data, which are determined during the production for each sensor. In factory the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

Line Frequency Suppression Filter
There is the selection to filter the noise signal 50 Hz or 60 Hz.

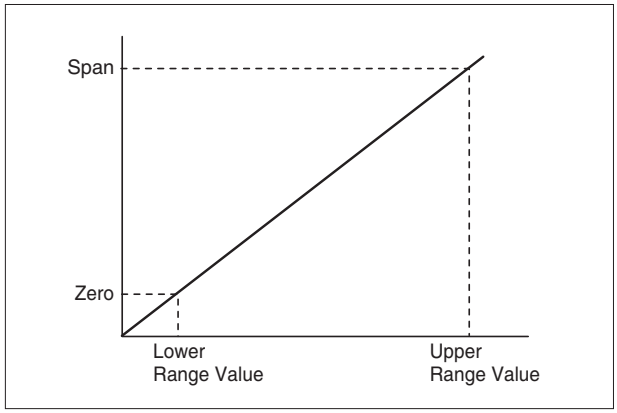


Smart Smoothing
In factory the Smart Smoothing Band is set to 0.15 % of sensor range. The Integration Time of the average value is set to 10 sec.

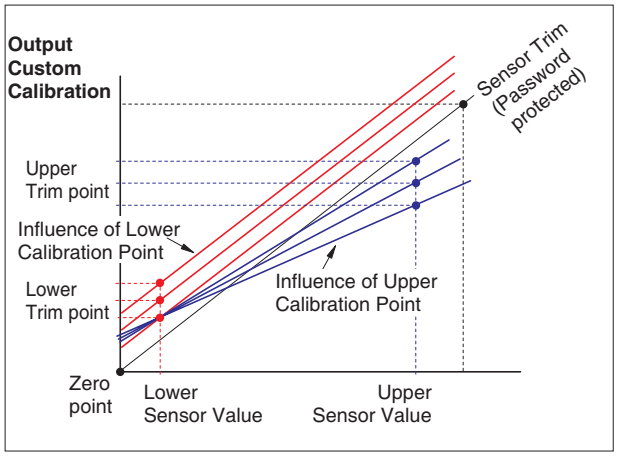




Sensor Adjustment
Zero and span of force sensor are adjusted in factory.
It is possible to calibrate Zero (situation alignment) with the external 0% key (see 8.3).

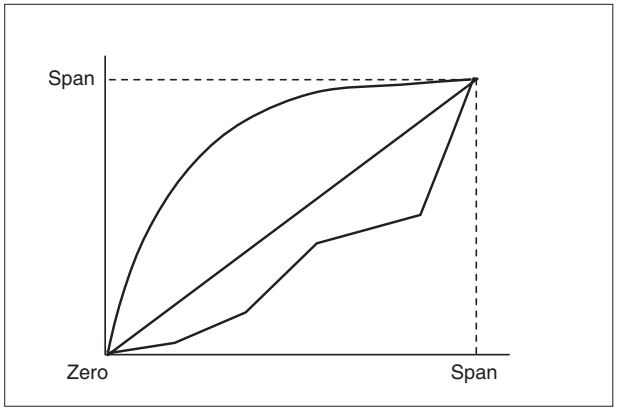


Custom Calibration
The user has the possibility with this function of calibrating the transformer according to his conceptions. By giving of a lower and upper measured value the transfer characteristic is again adjusted. This custom calibration can be reset to factory calibration.

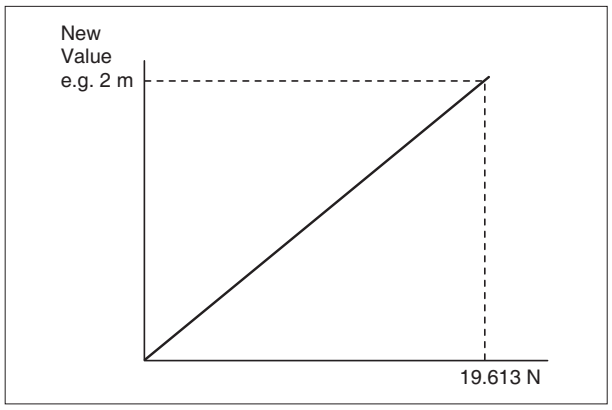


We only recommend a custom calibration with either lower plus upper calibration or an exclusive upper calibration.

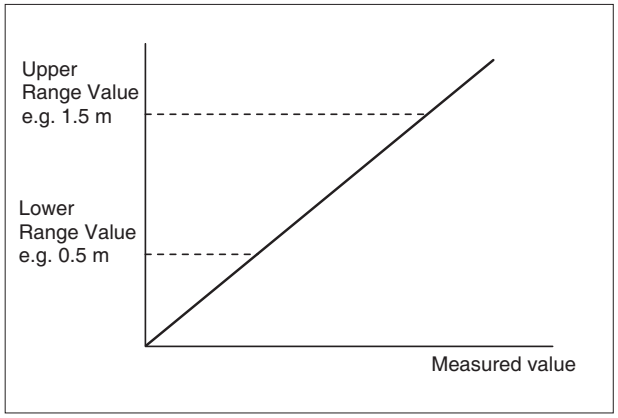
Transfer function / Characteristic
The characteristics are available linear, root-extracted and customized. With "customized" there are 32 x/y- values available. Standard with Level is “linear”.



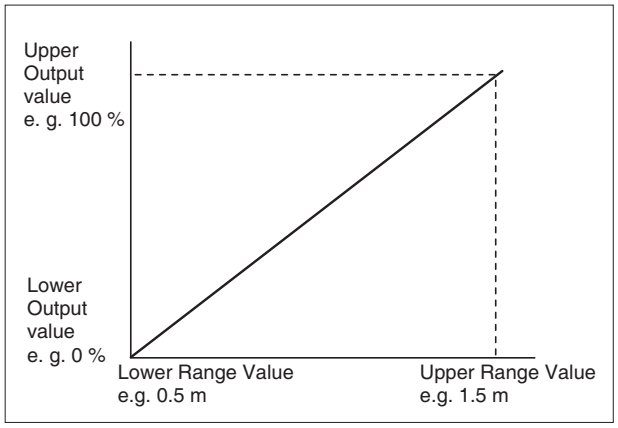
Measured Value Setting
The user can define measured value and unit.



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.



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.



Low Quantity Suppression
Setting On or Off for low quantity suppression with root-extracted output. With Level, low quantity suppression is always 0.

Output characteristic
The Output characteristic can be root- extracted.

Replacement / Substitute Value
In case of error output holds last value or gives a configurable Replacement value.

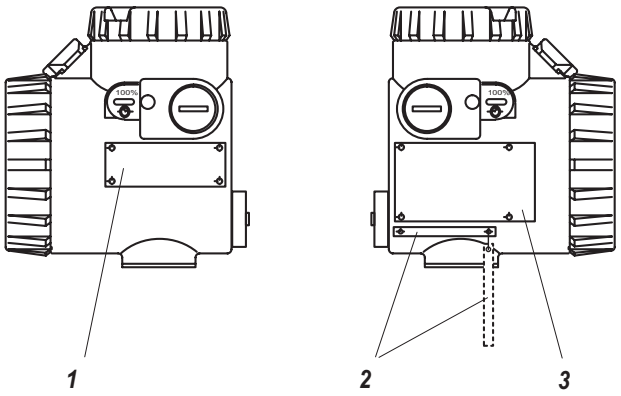
If the error does not exist any longer, then "last value" and/ or replacement value is taken back (automatic or manuell).

Multi-drop
With PC20 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.

PC20 Software enables to simulate the measured value and to write output values directly to the output.

Filter
The output signal is damped; damping time ist setable from 0 to 32 sec (90%).

3 IDENTIFICATION



The transmitter is identified with three labels. The transmitter nameplate ***3.1*** shows the Model Code of the transmitter, which clearly describes the device. The certificate data and the serial No. are entered on the amplifier nameplate ***3.3***. The TAG No. label ***3.2*** with the Tag No. is located underneath (optional). Data about the permissible static pressure and the displacer are documented on the data label ***3.4*** on the process connection flange.

3.1 Transmitter nameplate

(Example)

Device specification, Model Code

MESSUMFORMER / TRANSMITTER

MODEL 244LVP - SS8C1BMHZZZ

-

-

ECEP - REV.Nr. -

ID No. for special version

3.2 Tag No. label

(Example)

Directly fixed or attached

LID 09/16

3.3 Amplifier nameplate

(Examples)

VERSTÄRKER / AMPLIFIER

EBE SER.No.

0102

KOMMUNIKATION

☐ 4 ... 20 mA ☐ FOXCOM IT1 ☐ PROFIBUS acc. FISCO

☐ HART ☐ FOXCOM IT2 ☐ FF FIELDBUS H1

HILFSENERGIE / POWER SUPPLY AUSGANG / OUTPUT

invensys

Made in Germany by
FOXBORO ECKARDT GmbH
D - 70376 STUTTGART

FOXBORO ECKARDT

Without explosion protection

VERSTÄRKER / AMPLIFIER

EBE SER.No.

0102

KOMMUNIKATION

☐ 4 ... 20 mA ☐ FOXCOM IT1 ☐ PROFIBUS acc. FISCO

☐ HART ☐ FOXCOM IT2 ☐ FF FIELDBUS H1

PTB Nr. ATEX TYPE

Pi Ui Ii Ci Li Tamb siehe Betriebsanleitung / see Instruction Manual

invensys FOXBORO ECKARDT

Made in Germany by
FOXBORO ECKARDT GmbH
D - 70376 STUTTGART

With explosion protection acc. to ATEX

ELECTRICAL TRANSMITTER

SER. No. OUTPUT mA

IS FOR CL I; DIV 1, GRPS A, B, C & D; CL II, DIV 1, GRPS E, F & G; CL III; HAZARDOUS LOCATIONS
SEE DRAW.
WARNING: SUBSTITUTION OF COMPONENTS MAY IMPAIR INTRINSIC SAFETY.

Ex ia

FM APPROVED

SUITABLE FOR CL I, DIV 2, GP A, B, C, D; SUITABLE FOR CL II, DIV 2, GP F & G; SUITABLE FOR CL III; **WARNING:** DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS. WARNING-EXPLOSION HAZARD-SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS 1, DIVISION 2. TYPE 4X
CSA and FM: T4A @ 40°C MAX AMB; CSA: T3C @ 85 °C; T4 @ 60 °C MAX AMB
FM: T4 @ 85°C MAX AMB
(4)
DC 12 - 30 V

FOXBORO ECKARDT invensys

With explosion protection acc. to FM/CSA

3.4 Displacer and pressure rating

(Example)

When ordered with a displacer, the transmitter is supplied with an application nameplate mounted at the circumference of the process connection flange.

VERDRÄNGER / DISPLACER

LÄNGE / LENGTH 1000 mm

VOLUMEN / VOLUME 1314 cm^3

GEWICHT / WEIGHT 12. 384 N

TÜ SW

PN 40

DRUCK-TEMP. BEREICH - 30 +50 +120 °C

PRESSURE-TEMP. RATINGS 40 35 bar

BAUJAHR / YEAR 2004

INHALT / VOLUME 0. 3 LITER

WERKSTOFF / MATERIAL 1. 4404

Displacer specification per order

Temperature and pressure ratings

Nominal pressure

maximum static pressure at 120 °C

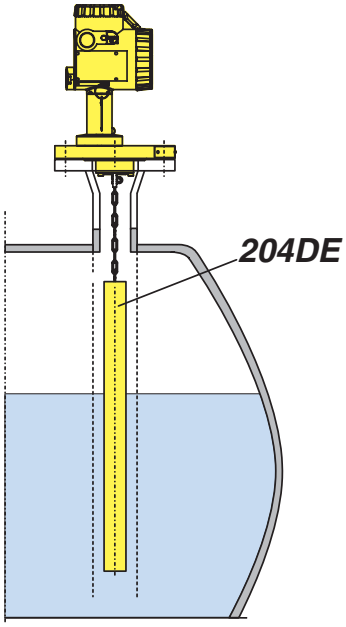
Flange material

4 MOUNTING

The transmitter is directly built onto the vessel or alternatively on a side-mounted displacer chamber 204DC.
During installation, the permissible static pressure and the ambient temperature range must be observed (see chapter 3, “Identification”).

Note:
Proceed with caution during all installation work.
Do not damage the diaphragm!
Do not drop the suspended displacer!
Avoid jointing!

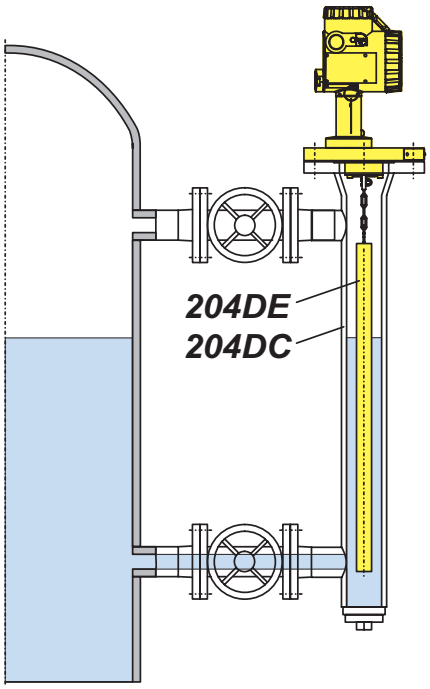
4.1 Mounting on top of the vessel



Transmitter at Connection flange
Displacer 204DE in protection cage / tube

If the vessel contains a turbulent liquid a protection cage / tube should be used. If a tube is used, make sure there is a venting hole above maximum process level. Between the protection cage / tube and the displacer must be a gap of at least 5 ... 10 mm.

4.2 Mounting on the side of the vessel



Transmitter and Shut-off device
Displacer 204DE in Displacer Chamber 204DC

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

If the chamber has not already been mounted by the customer, it must be mounted to the vessel with suitable bolts and seals (not included in the scope of delivery). Be sure that the displacer chamber is exactly vertical.

Between the chamber and the displacer must be a gap of at least 5 ... 10 mm.

NOTE:

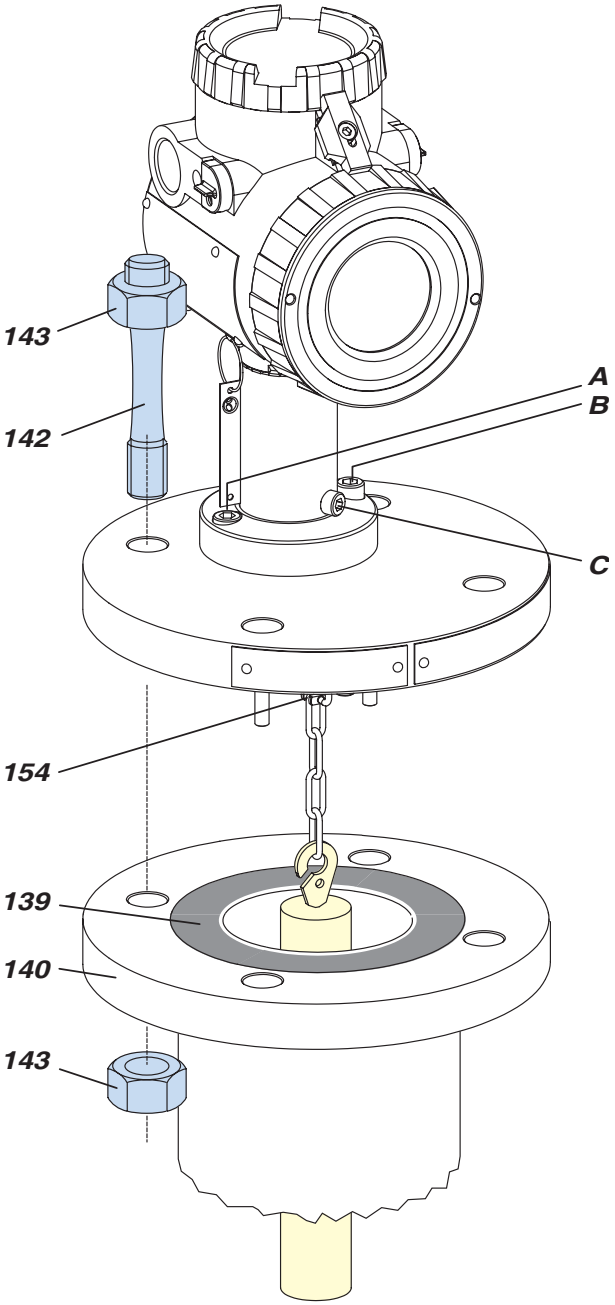
For explosion-proof devices or devices with certification as overfill protection according to WHG, the remarks in the product specifications PSS EML1710 A and in certificates or approvals must be observed.

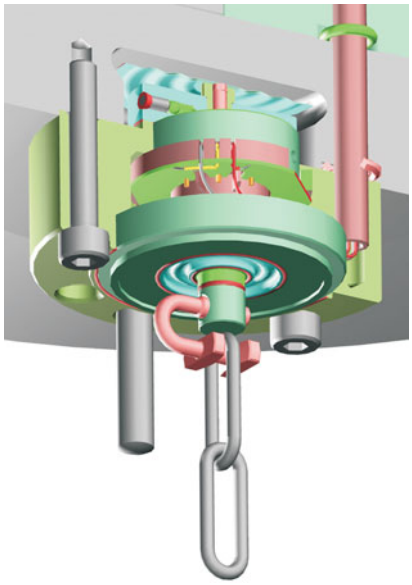
4.3 Transmitter mounting

Ensure correct matching of transmitter and displacer while mounting. Each transmitter is calibrated for use with the respective displacer according to ordering data in the factory. Each displacer is marked with the TAG No. or, if not known, with the last three digits of the serial number of the respective transmitter. The corresponding displacer data (length, volume and weight) are specified on the adjustment data labels mounted on the process connection flange. See also chapter 3 "Identification".

Fit installation seal ***139*** on the flange ***140*** on the container side. Always use a new seal. The seal must be suitable for the flange size and the measured medium.

Attach displacer to suspension fixture ***154*** of transmitter. Long displacers can be placed in the container ahead of time. Multi-section displacers see chapter 4.4.





Carefully place transmitter and displacer onto the container flange ***140*** . Make sure the seal is accurately positioned. **Avoid impacts and jolting under all circumstances.** Tighten studs ***142*** and nuts ***143*** . Apply recommended torque (see tables below).

For comfortable reading the LCD, the upper section can be turned around nearly 360 degrees. For this loosen the screws ***A*** and ***B*** (but do not remove!)(SW5) and turn upper section into desired direction. Tighten again screws ***A*** and ***B***.
The high screw ***B*** is stop for screw ***C***. Thus it to prevent endlessly turning round of upper section that could damage the inside wires.

Rated pressure		Threaded bolt at rated diameter		
PN	Class	DN 80 / 3"	DN 100 / 4"	DN 70
16	150	M16	M16	–
40	300	M16 / M20	M20	–

Recommended torque (pre-stressed to 70 % of minimum yield point at 20 °C)									
Studs	Mat.	M16	M20	M24	M27	M30	M33	M36	M39
Tightening torque [Nm]	A2 *)	80	150	140	210	290	330	420	560
	GA	115	220	370	545	770	1000	1300	1750

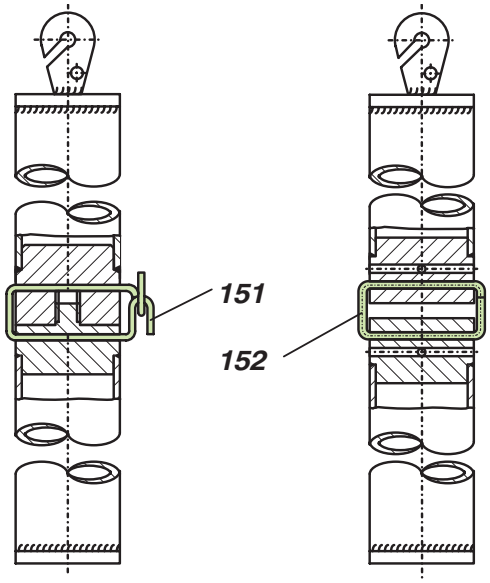
*) Yield point for material A2 (acc. to DIN 267)	≤ M20	450 N/mm²
	M24 to M30	250 N/mm²
	> M30	210 N/mm²

4.4 Displacer 204DE

Important
Displacer and transmitter must be matched properly during installation (see chapter 4.3).

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
(see Product Specifications PSS EML1710 A).

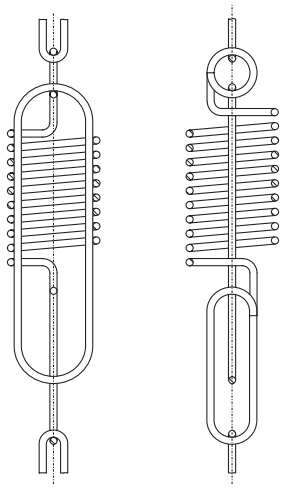
Jointed displacer elements
Displacers of length over 3 meters are jointed (multi-section) displacer elements. The displacer elements are screwed together and secured with the wire clip ***151*** to avoid bending or damage during insertion into the vessel. The elements of displacers with Ø < 13 mm are not screwed together; they are secured with hook and eyelet ***152*** . Additional securing is not necessary [1].



diameter
> 13 mm

diameter
< 13 mm
or PTFE

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



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 (material 1.4310, max. operating temperature 250 °C).

Use in Zone 0 or as overfill protection acc. to WHG [2]

Mechanics
Displacers of more than 3 m length must be secured against oscillating when used in Zone 0.

When used as overfill protection according to WHG, the displacer must always be installed with guidance. Guidance devices over 3 m long must also be secured against bending.

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 avoid the danger of 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 10^6 Ω.

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

2) Please see corresponding certificates for further details

5 ELECTRICAL CONNECTION

5.1 Signal wire connection

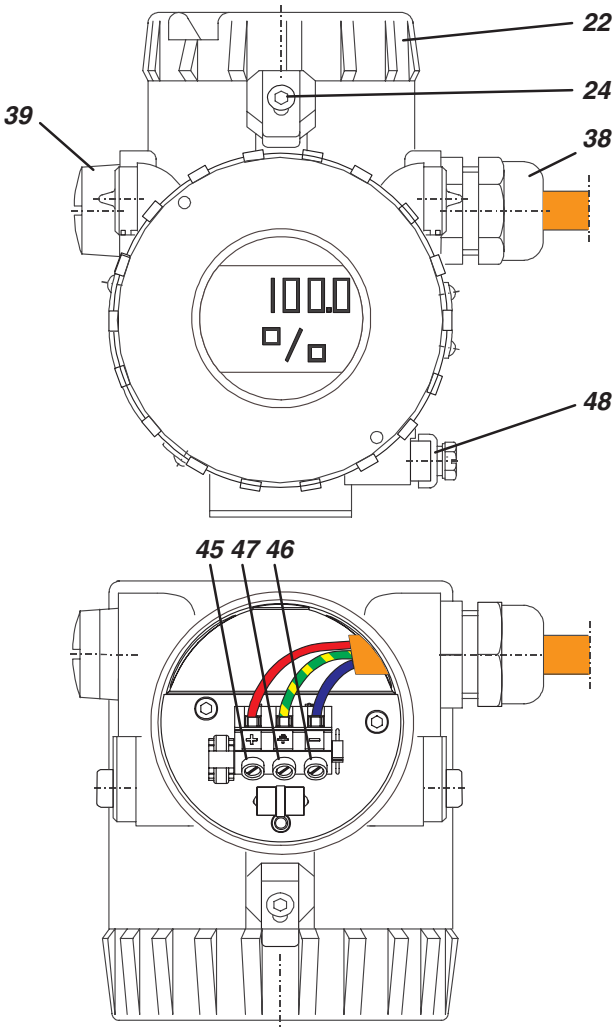
At both sides of the amplifier housing is a threaded hole (threads as ordered) for cable gland ***38*** or cover screw ***39*** .

The used cable glands have to conform to any Ex requirements. User assumes responsibility.

Actions:

- Remove cover lock ***24*** (if provided) and unscrew top housing cover ***22*** .
- Lead cable through screwed gland and connect with terminals ***45***, ***46*** and ***47*** .
- If necessary connect external ground ***48*** .
- Screw top housing cover ***22*** and install cover lock ***24*** (if provided).

Note
For explosion-proof devices follow reference for cable gland and cover screw in document
"Safety Operating Instructions 140 Series"



22 Top housing cover
24 Cover lock
38 Cable gland for cable with Ø 6 to 12 mm
39 Cover screw
48 External ground
50 Overvoltage protection (if present)
45 Connection terminal [1] **+**
46 Connection terminal [1] **–**
47 Ground terminal [1]

[1] wire cross section max. 2.5 mm²

6 COMMISSIONING

Principally, installation and safety regulations have to be checked prior to commissioning.
After correct installation, signal wire connection and product connection, the transmitter is ready for operation. If necessary the configuration of lower range value, upper range value and damping has to be checked.
Protect the environment; do not allow measuring substance to escape. Catch and dispose them properly.

Checking the settings

Checking the lower range value for level measurement
For level measurements, the weight F_G of the displacer is equal to the weight force F_0 for the lower range value (LRV). An exception is the measuring range with elevation. The lower range value (LRV) can be checked with a free-hanging displacer and a completely empty vessel.

Checking the lower range value for measuring range with elevation
The lower range value (LRV) F_0 can only be checked by specifying the vessel level corresponding to F_0 or by specifying the weight for F_0 (workshop task).

Checking the lower range value for interface and density
The lower range value (LRV) F_0 can be checked with the following methods:

- Displacer is completely immersed in the liquid with the lower density
- by specifying the weight force for F_0 with weights (in the workshop)

Upper range value
The upper range value (URV) F_{100} can be checked with the following methods:
- by producing the corresponding level, interface or density, provided the specified operating densities are correct.
- by specifying the weight force for F_0 with weights (in the workshop).

Damping
Damping of 8 sec is set at factory. If necessary, this value can be checked on devices with an LCD indicator and changed locally.

Correction of lower range value, upper range value, damping, see chapter 9, "Calibration of Transmitter".

7 DECOMMISSIONING

Prior to decommissioning take precautions to avoid disturbances:
- Observe Ex. protection.
- Switch off power supply.
- Caution with hazardous process media!
  With toxic or harmful process media, observe relevant safety regulations.

Before dismantling the transmitter, the procedure below should be followed:
- Depressurize vessel or displacer chamber.
- Drain off measuring medium in displacer chamber.
- 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.

Note:
Proceed with caution during all installation work.
Do not damage the diaphragm!
Do not drop the suspended displacer!
Avoid jointing!

8 CALIBRATION OF TRANSMITTER

Zero, lower range value, upper range value and damping of the transmitter are set by manufacturer as specified in the order.
Therefore, calibration at start-up is not necessary.
In case the order does not include this data, the transmitter is supplied as follows:

displacer weight force	=	1.500 kg
buoyancy	=	5.884 N (0.600 kg)
indication	=	%
damping	=	8 sec (63 % time)

Operating data and displacer data are stored in the transmitter according to the order.
Calibration becomes necessary if this data deviates from the values stored.

The transmitter is designed for a displacer weight force of max. 2.5 kg [1] and a buoyancy force of 2 N to 20 N. The lower range value F_0 must be within the range 2 kg to 2.5 kg. [1]

Calibration of devices via operating push buttons
Calibration can be done by means of the push buttons at the transmitter if the amplifier housing has

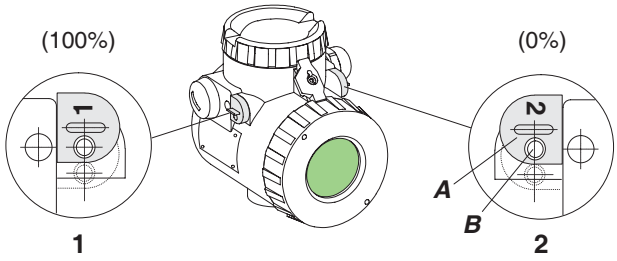
- either external push buttons, see Chap. 8.1 ”Calibration via local keys”
- or display with internal push buttons, see Chap. 8.3 “Calibration via display keys”.

Calibration via HART Protocol
- Calibration with Handterminal HT991
- Calibration with PC, Display and User Interface ABO991/PC20
- Basic calibration with PC and Transmitter Service Program TSP991
  (necessary if sensor or amplifier are changed).

8.1 Calibration via local keys

Operation and local key functions
The two local keys 1 and 2 are used to set up zero, lower range value, upper range value and damping.

Amplifier housing with local keys



After shifting the key protection cap ***A*** insert screw driver or pin (∅ ≤ 3 mm) into hole ***B*** and press down to the second pressure point.
Both keys have two assigned functions, dependent on length of pressing time.

Zero
Press key 2 less than 3 sec. Analog and digital signale are set to zero.

Lower range value
Setting lower range value of analog output:
The output signal is adjusted to 4 mA if the key 2 is pressed more than 5 sec.

Upper range value
The output signal is adjusted to 20 mA if the key 1 is pressed more than 5 sec.

Damping [2]
The damping is (electrically) set to 8 s by manufacturer.
With the local keys damping can be adjusted between 0 and 8 s (63 % time).
The local display shows the current damping value, when the key 1 is pressed less than 3 sec. Further acting of key 1 stepwise sets the damping.
After damping selection, confirm by short acting key 2.
(With Hand Terminal or PC, damping can be set between 0 and 32 s.)

1) Attention! 1kg generates a force of 9.807 N

2) Damping is only adjustable with push buttons if local display is provided.

Setup of lower and upper range value

Workshop task

Equipment:
- Power supply DC 24V, 30 mA
- Local display configured with mA resp. % or multimeter
- Screw driver (Ø < 3 mm)
- Set of weights, for weight force up to 2.5 kg [1)]
- Weighing pan [2)] to be suspended in place of displacer

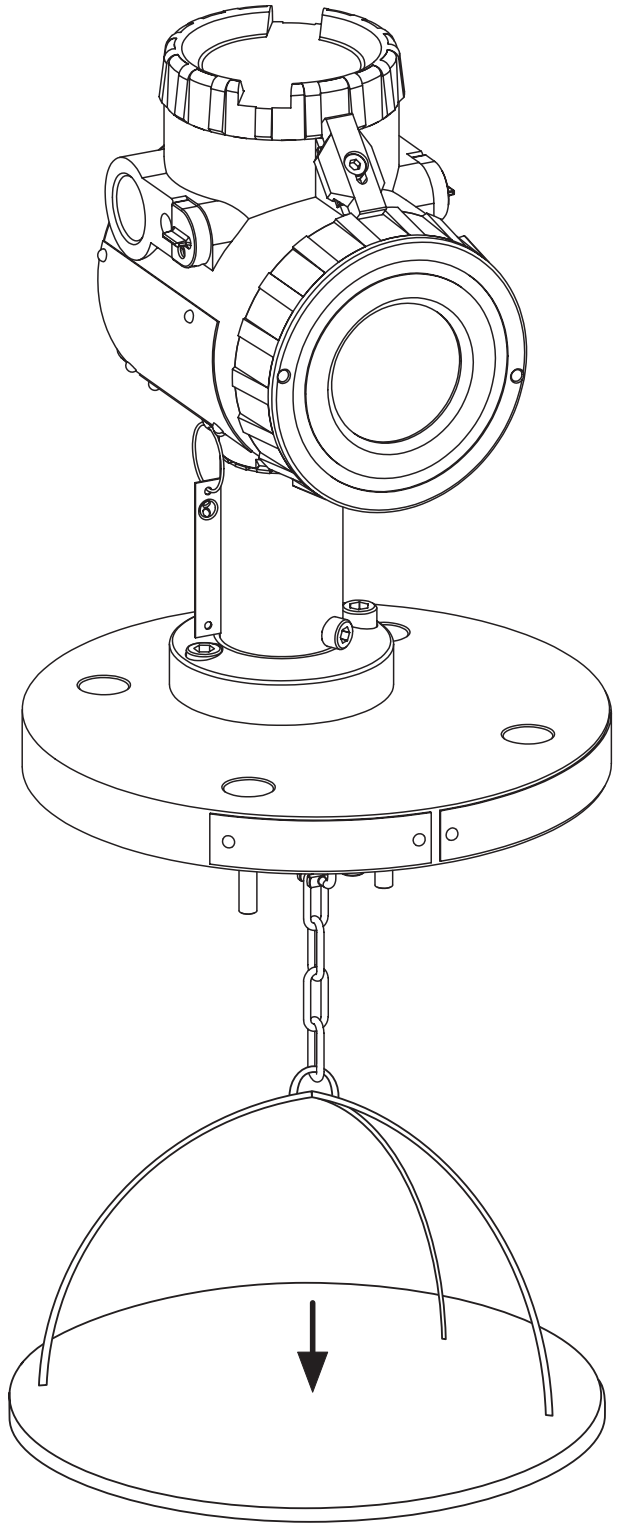
Actions:
– Put transmitter in operational position and connect transmitter.
– Put on weights for lower range value (F_0) [2)].
– Adjustment of lower range value (4 mA) by adopting the present value.
Press key 2 more than 5 sec.
– Put on weights for upper range value (F_{100}).
– Adjustment of upper range value (20 mA) by adopting present value.
Press key 1 more than 5 sec.

Wet calibration

If process conditions for lower range value and upper range value can be set during installation it is possible to calibrate installed transmitter.

Equipment:
- Power supply DC 24V, 30 mA
- Local display configured with mA resp. % or multimeter
- Screw driver (Ø < 3 mm)

Actions:
– Set conditions (e. g. level) for lower range value.
– Adjustment of lower range (4 mA) value by adopting present value.
Press key 2 more than 5 sec.
– Set conditions (e.g. level) for upper range value.
– Adjustment of upper range value (20 mA) by adopting present value.
Press key 1 more than 5 sec.



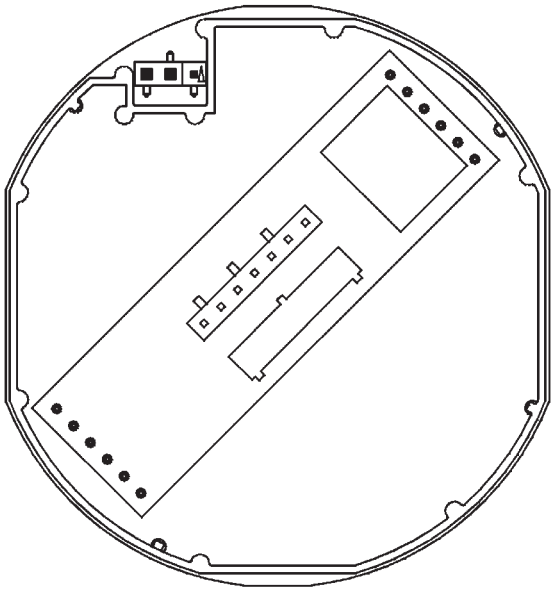
1) Attention! 1 kg generates a force of 9.807 N
2) The weight of weighing pan must be taken into account

8.2 Hardware write protection

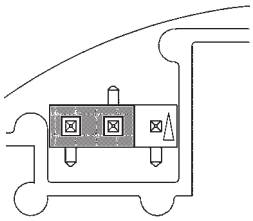
The hardware write protection prevents the changing of the configuration of the transmitter. To enable writing on the transmitter, the jumper has to be plugged as shown in the figure below.

Note:
If no jumper is set, the transmitter is write protected.

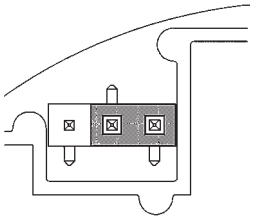
Pins for jumper



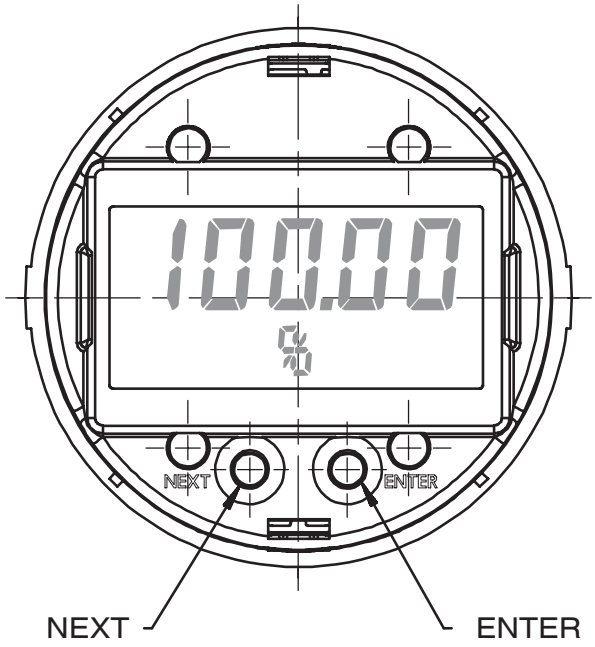
No write protection



Write protection



8.3 Calibration via Display Keys



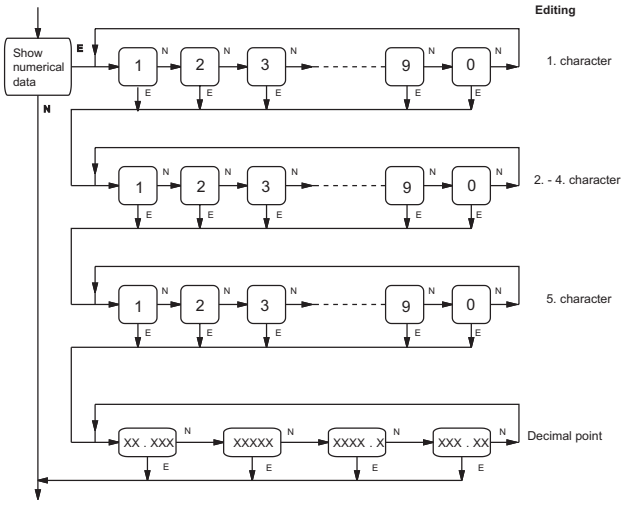
The most important configurations and calibrations can be performed as per menu directly at the transmitter via two keys (NEXT and ENTER).
(The menu structure is identical for the I/A 140 Series with HART communication protocols.)

Note:
Observe limitations for opening of housing in hazardous areas. See Document "Safety Operating Instructions 140 Series".

Selection in Menu

In selecting a sub-menu the presently selected menu point will be shown first. The following menu point is selected; it is accepted by pressing ENTER.

Numerical Input



If the menu requests numerical input the current value and name are displayed.

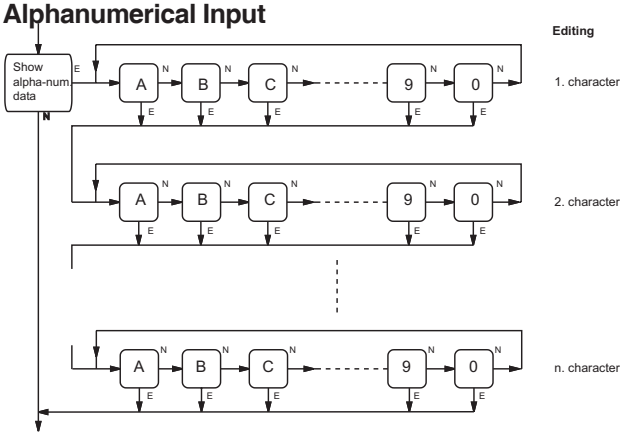
By actuating key NEXT the menu position is exited without changing the value.

Following pressing ENTER the value may be changed by pressing key NEXT and upward counting of the blinking number (‘1’ follows ‘0’). ENTER switches to the following position.

Following change and/or activating of all characters (max. 5 digits) input of the decimal point is requested. Key NEXT relocates decimal point. By pressing ENTER the value has been transferred.

Upon transfer the value range is checked. In case of faulty input a blinking error signal is actuated for about 3 seconds (see “ Error signals”) and is branched to menu node “Cancel”.

Alphanumerical Input



If the menu requests an alpha-numerical input, the presently selected characteristic chain is shown.

By actuating key NEXT this menu position is exited without changing the value.

Following pressing ENTER the value may be changed by pressing key NEXT and upward counting of the blinking characteristic (‘A’ follows ‘0’). ENTER switches to the following position.

Following change and/or activation of all characters (max. 5 characters) the character chain is transferred by activating key ENTER.

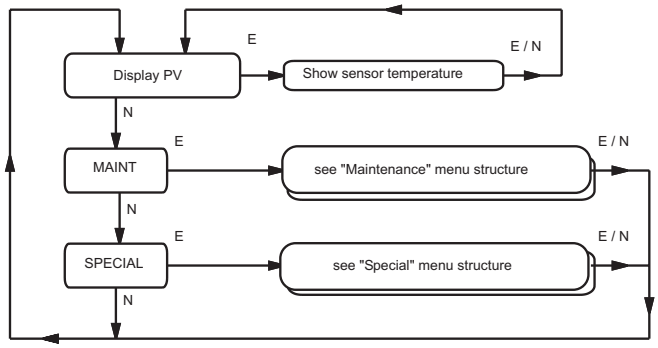
Abbreviations:

E ENTER button
N NEXT button
(with autorepeat: i.e. long, continous actuation corresponds to multiple single actuations
LRL Lower Range Limit
LRV Lower Range Value
PV Primary Variable
URL Upper Range Limit
URV Upper Range Value

Menu structure

The highest menu level offers sub-menus “Display PV”, “Maintenance” and “Special” .

8.3.1 Menu node “Display measurement value”



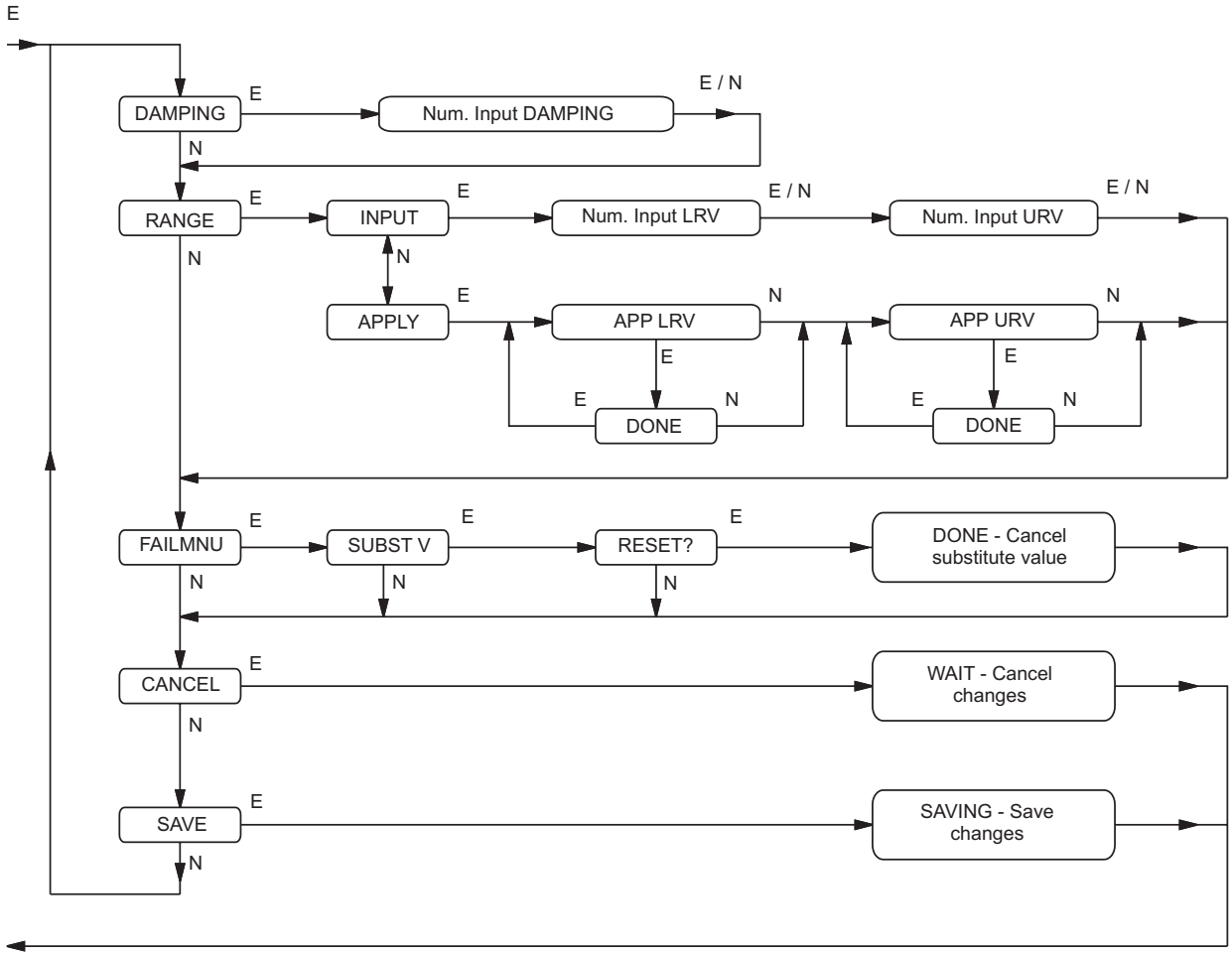
Display according to the configuration in menus “Special” - “Others”:

1. No display
2. Display of PV value and physical unit
3. Display of PV value (in %) regarding LRV and URV (in %)
4. Display PV value (in mA) regarding LRV und URV (in mA)

“Display sensor temperature”
Sensor temperature shown in °C.

8.3.2 Menu node “MAINT”

Branching to “Maintenance" menu (no protection by password).



8.3.2.1 Menu node “DAMPING”

Configuration of PV damping.

Menu node “Numerical Input DAMPING”
Display / Input of PV damping (phys. unit ‚SEC‘). The rated value range is 0 ... 32 seconds.

8.3.2.2 Menu node “RANGE”

Configuration of LRV and URV of PV. It is possible to choose between input (INPUT) or default (APPLY) of LRV and URV. The rated value range is LRL...URL.

Menu node “INPUT / Numerical input LRV”
Configuration of LRV by input.

Menu node “INPUT / Numerical input URV”
Configuration of URV by input.

Menu node “APPLY / APP LRV”
Configuration of LRV by default (current PV is indicated). LRV is taking over by pressing ENTER button.

Menu node “APPLY / APP URV”
Configuration of URV by default (current PV is indicated) URV is taking over by pressing ENTER button.

8.3.2.3 Menu node “FAILMNU”

Branching to “Failure menu”.

Menu node “SUBST V / RESET?”
Manual take back of configured substitute value. If substitute value is taken back automatically this menu is out of operation.

8.3.2.4 Menu node “CANCEL”

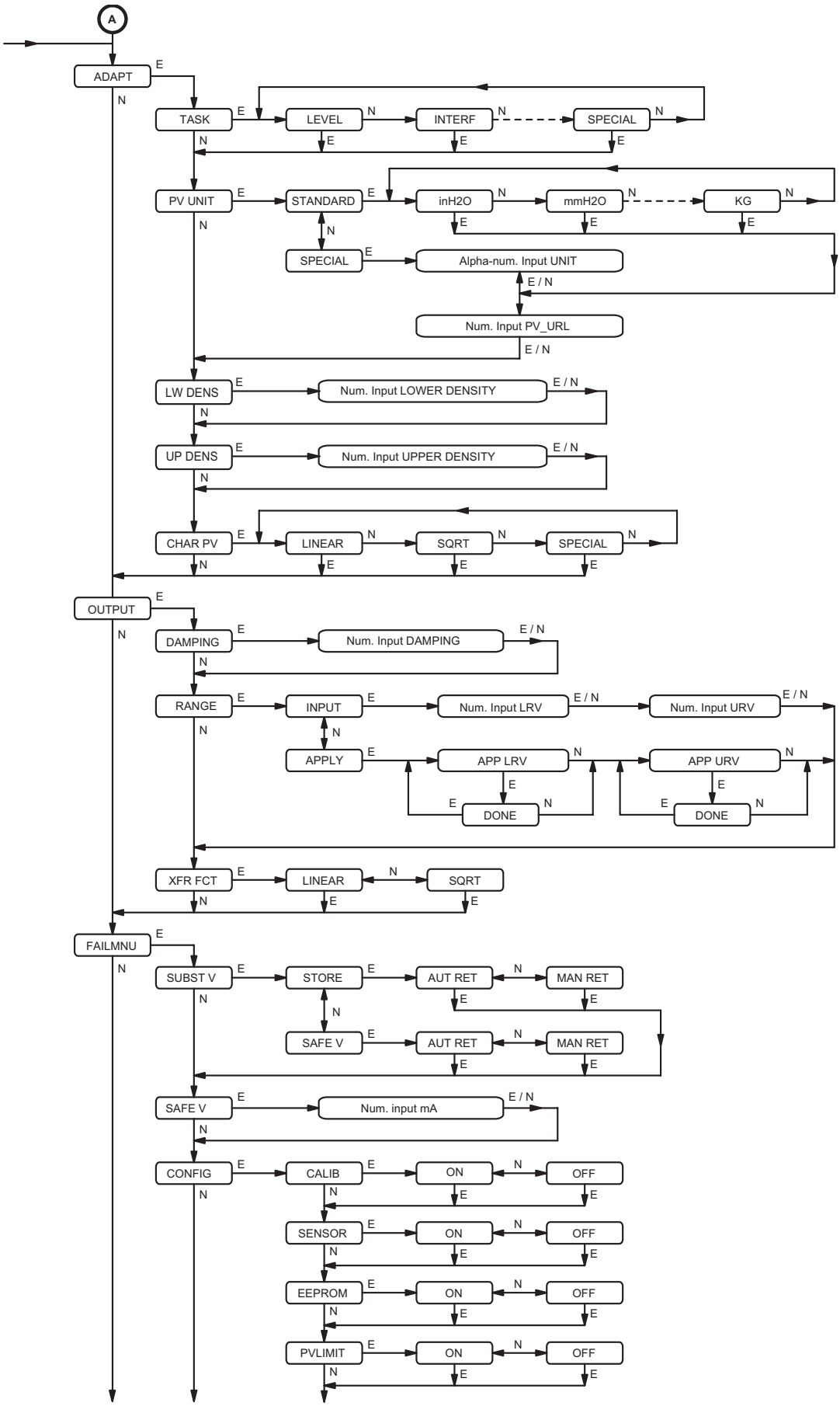
By pressing ENTER button all changes are taken back.

8.3.2.5 Menu node “SAVE”

By pressing ENTER button all changes are stored.

8.3.3 Menu node “SPECIAL”

Branching to “Special" menu. In contrast to the “Maintenance" menu it is possible to make extensive configuration and calibration. Optional it is possible to configure protection by password.



8.3.3.1 Menu node "ADAPT"

Branching to configuration for adaptation of sensor measurement value.

Menu node "TASK"

Configuration of measurement task. Selection of measuring task in menu. The configured measuring task is of a purely informative character and has no effect on the functionality of the transmitter.

Menu node "PV UNIT / STANDRD"

Configuration of standard unit for PV. Selection of the unit in menu. If the new unit can be derived from the old one (e.g. mbar to bar) or if there is a change from unit '%' to a pressure unit, an implicit conversion from LRV, URV, LRL and URL takes place. The calculated URL is displayed, but cannot be changed. In case old and new units are not identical, URL=0.0 is set and has to be entered.

Menu node "PV UNIT/ SPECIAL"

Configuration of a special unit PV. It is possible to define a unit with max. 6 characters (see chap. "Alpha-numeric input"). If old and new units are identically, the current URL is displayed and can be changed. If old and new unit are not identically URL is setted to '0.0' and must be entered.

Menu node "LW DENS" and "UP DENS"

Configuration of density (lower density and/or upper density) of the measuring product. The configured density is in the unit 'kg/m3' and is of a purely informative nature having no effect on the functionality of the transmitter.

Menu node "CHAR PV"

Configuration of transmitting characteristic of PV. Selection of characteritic in the menu.
LINEAR – linear characteristic
SQRT – square-root extracted characteristic
SPECIAL – customized characteristic
Value pairs X/Y associated with characteristic 'SPECIAL' cannot be entered via display menu.

8.3.3.2 Menu node "OUTPUT"

Branching for configuration of current output of transmitter.

Menu node "DAMPING" and "RANGE"

see "MAINT"

Menu node "XFR FCT"

Configuration of the transfer function of the current output. Selection of transfer function in menu.

8.3.3.3 Menu node "FAILMNU"

Branching in the failure menu.

Menu node "SUBST V / STORE"

Configuration of the behavior during 'Store last Value'. In case of an error, the transmitter maintains the last valid output current until the error is eliminated (automatic return AUT RET) or until the substitute value is manually returned (MAN RET).

Menu node "SUBST V / SAFE V"

Configuration of the behavior of the substitute value. In case of an error, the transmitter changes the output current to a configured substitute value and maintains the output current until the error is eliminated (automatic return AUT RET) or until the substitute value is manually returned (MAN RET).

Menu node "SAFE V"

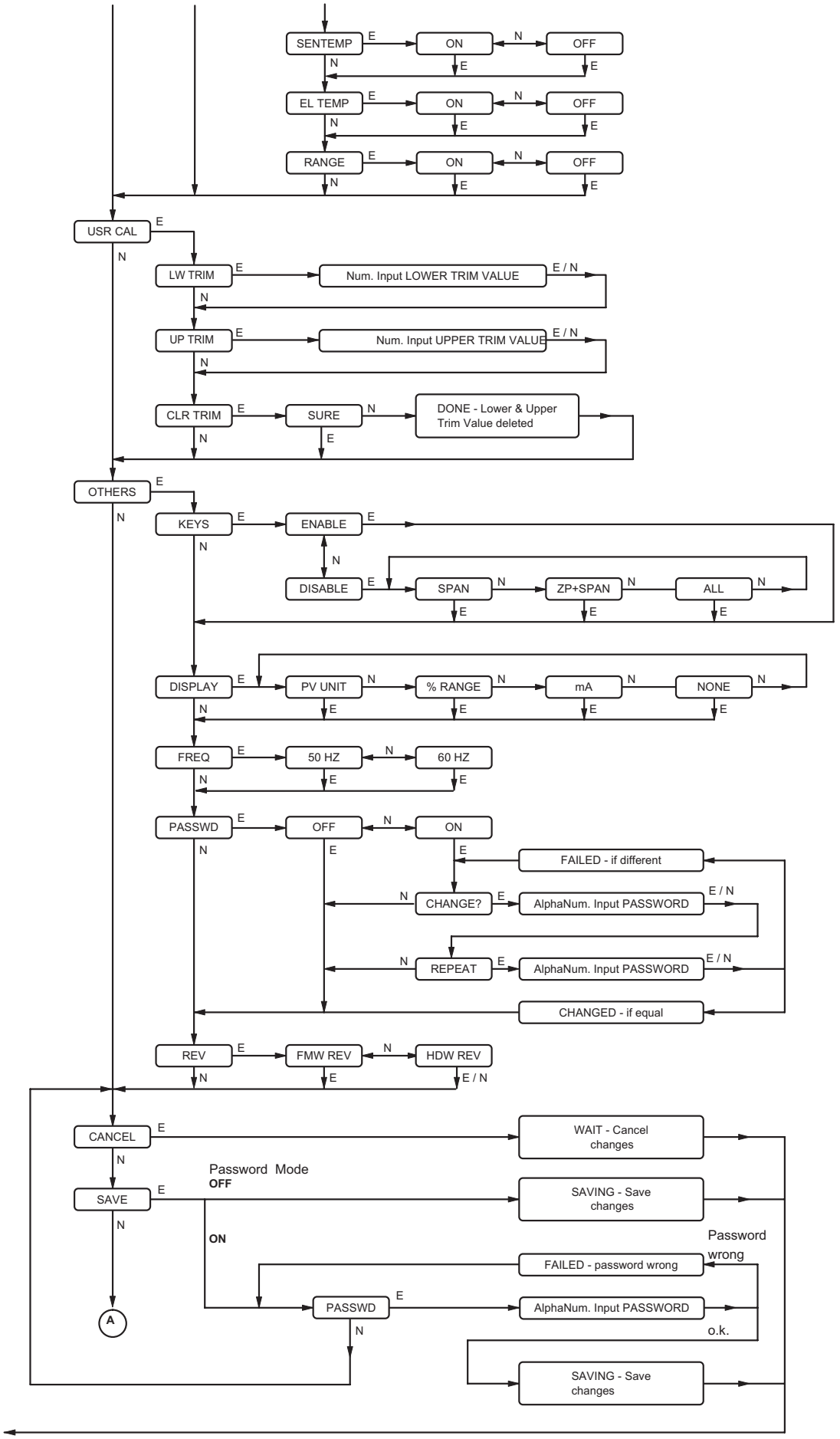
Configuration of the substitute value. The permissible value range is 3.6 to 23 mA. This value is of significance only if the "Substitute value" is configured instead of ' Store last value'. During an error this configured value becomes the output current of the transmitter.

Menu node "CONFIG"

Branching for configuration of malfunctions messages. There are seven areas where a malfunction signal can either be activated (ON) or supressed (OFF).

1. CALIB	Internal calibration failed
2. SENSOR	Pressure peaks of ± 150 % of nominal range
3. EEPROM	Write EEPROM impossible
4. PVLIMIT	PV ± 110 % of nominal range
5. SENTEMP	Sensor temperature out of limits
6. EL TEMP	Electronic temperature outside – 45 °... 85 °C)
7. RANGE	Configured measuring range invalid

Menu node "SPECIAL" (continued)



8.3.3.4 Menu node "USR CAL"

Branching to user calibration of PV.

Menu node "LW TRIM"

Calibration of lower trimpoint. Indication of measuring value corresponding to the lower trimpoint and entry of value. Following entry of trimpoint the transmitter calculates, based on trimpoint and measuring value, a new zeropoint for its transmitting characteristics.

Menu node "UP TRIM"

Calibriation of upper trimpoint. Indicating measuring value corresponding to upper trimpoint and input of value. Following input of trimpoint transmitter calculates a new zeropoint and new end for its transfer characteristics based on trimpoint and measuring value.

Menu node "CLRTRIM"

Delete user calibration (clear trimpoints).

8.3.3.5 Menu node "OTHERS"

Menu node "KEYS / ENABLE"

Release of all functions of external keys (1- and 2- key) of transmitter.

Menu node "KEYS / DISABLE"

Selective blocking of external keys of transmitter.

SPAN	URV configuration blocked
ZP+SPAN	LRV + URV configuration blocked
ALL	all functions blocked

Menu node "DISPLAY"

Configuration of measurement diagram in display.

PV UNIT	Display of value and unit of PV
% RANGE	Display of percent value of PV
MA	Display of mA value of PV
NONE	No display

Menu node "FREQ"

Adapt the trouble suppression to the line frequency

Menu node "PASSWD"

Branching into password administration. It is possible to secure storing of changes in the "SPECIAL" menu by a password interrogation, i.e. password interrogation may be activated (ON) or deactivated (OFF). It is possible to change the password during activated password interrogation. Dual input affects the change.

Menu node "REV"

Display of firmware and hardware revisions.

8.3.3.6 Menu node "CANCEL"

Taking back all changes by pressing ENTER.

8.3.3.7 Menu node "SAVE"

During deactivated password interrogation all changes are stored by pressing ENTER. During activated password interrogation it is necessary to enter the correct password (the old password hast to be used in the configuration of a new password) to store all changes .

8.3.4 Error messages

The following error messages are possible:

BADDAMP	invalid range of damping
BAD LRV	invalid range of LRV
BAD URV	invalid range of URV
BADSPAN	span | upper trim point – lower trim point | < 2 % of max. admissible span of measurement
BAD PAR	invalid range of upper or lower trim point
BADPROC	invalid value of upper or lower trim point
BAD URL	invalid range of URL
BAD MA	invalid range of output current
WR PROT	transmitter is write protected

If one of this errors occurs, it will not be accepted. Break-off by activating CANCEL.

8.3.5 Warning messages

A configuration triggering a warning will be accepted and can be assumed via SAVE.

Warnings are:

WRNSPAN	observe extended technical data for turn down > 1:20 (TI EMP0600G-(en))
WRN URV-	invalid range of URV due to indirect configuration.

8.3.6 Monitoring of time

By entering menu node "MAINT" the monitoring of all keys in menus "Maintenance" and "Special" will be started for 120 seconds which will be restarted with each pressing of keys.

By exceeding the monitoring time all previous changes will be canceled and the menu is branching to menu node "Display PV".

Only the menu steps associated to menu nodes "USR CAL" and "APPLY" are not monitored.

9 SAFETY REQUIREMENTS

9.1 General requirements

This instrument satisfies the conditions for safety class III according to EN 61010-1 (rsp. IEC 1010-1).

Any work on electrical parts must be done by qualified personnel if any power supply is connected to the instrument.

The transmitter has to be used for its designated purpose, correctly installed and powered. National application regulations have to be observed, e.g. DIN VDE 0100 or DIN VDE 0800 in the Federal Republic of Germany.

The instrument has to be operated with safety extra-low voltage SELV or SELV-E.

Safety measures provided in the transmitter may become ineffective if the instrument is not operated in accordance with the master instructions.

Limitation of power supplies for fire protection have to be observed as per EN 61010-1, appendix F (resp. IEC 1010-1).

Safety class IP66

To meet enclosure IP66 requirements, the screwed cable gland and all O-rings in the housing cover must be correctly installed.

Mounting location
Protect transmitter against direct and extreme sun and/or heat exposure.
Observe the permitted ambient temperatures

Process media
For dealing with process media observe the relevant safety requirements.

Caution with oxygen:
Danger of fire!
Therefore special attention has to be paid for oxygen measurement:

- Only use transmitters suitable for oxygen measurement!
- Only use equipment free of oil and grease!
- Check whether all parts in contact with oxygen are free of oil and grease.

Software
Trouble-free operation in connection wit the transmitter operating ensured only with software released by FOXBORO ECKARDT GmbH.

9.2 Explosion protection

(Only if ordered accordingly)

Technical data for explosion protection see Product Specifications PSS EML1710 A.

For installations in contact with explosive atmospheres, all relevant national regulations and installation regulations must be observed, e.g. in the Federal Republic of Germany Elex V and DIN VDE 0165.

Attention:
When repairing explosion-proof equipment, observe the national regulations.
Use only original spare parts when making repairs.

The following applies to the Federal Republic of Germany: Repairs involving parts required for explosion-proofing must either be carried out by the manufacturer or by authorized personnel and confirmed by certificate.

Attention:
Before you open housings in hazardous areas, be sure that it is allowed. The responsibility for this is with the user.

Cable gland
With protection type “EEx d” and instruments with certificate FM resp. CSA “explosionproof” the screw hole is 1/2 - 14 NPT or M20 x 1.5 (according to ANSI/ASME B1.20.1).

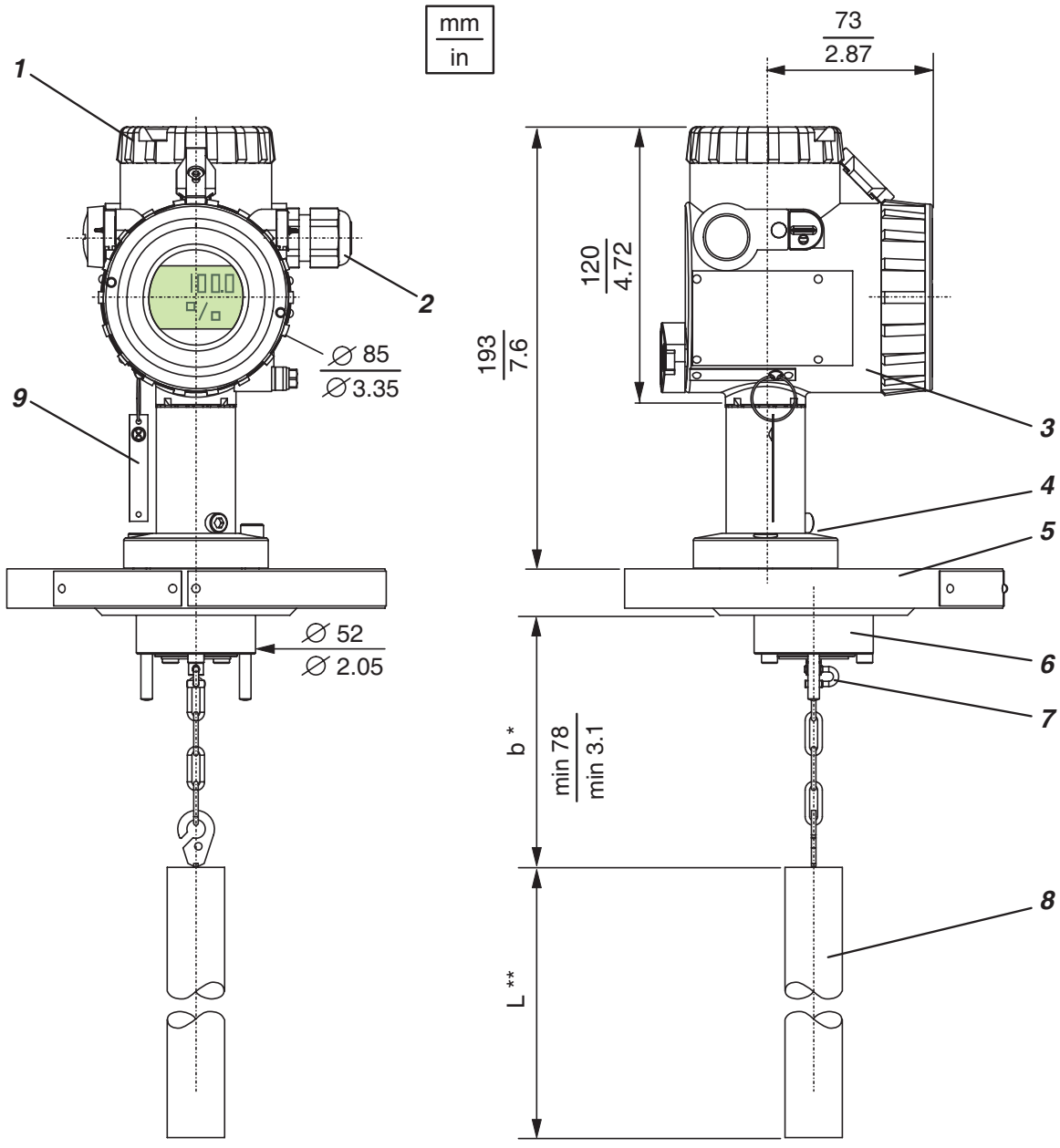
“EEx d” certified instruments must be connected via cable glands resp. tube systems which satisfy the requirements of EN 50018 (05.78) Part 12.1 and 12.2 and have a separate certification.
An opening not used must be closed according to Part 12.5 of EN 50018 (05.78).

Instruments with type of protection FM resp. CSA “explosionproof” must be connected via suitable tube and wire systems. A sealing box shall be installed within 45 cm (18 inches) of the enclosure. Openings not used have to be closed with the attached cover screw.

Cover lock
With type “EEx d” protection all housing covers have to be secured against unintentional opening.
Devices with FM or CSA “explosionproof” or ATEX “EEx d” housing covers may only be opened at disconnected power supply.

10 DIMENSIONS

DN 50 and DN 80 up to PN 40 (2 inch and 3 inch up to Class 150 and Class 300)



1 Top housing cover
2 Cable entry with cable gland
3 Amplifier housing
4 Disconnection of sensor from the amplifier
5 Connection flange (according to DIN / ANSI)
6 Measuring cell
7 Suspension
8 Displacer 204DE
9 Steel label with Tag.No.

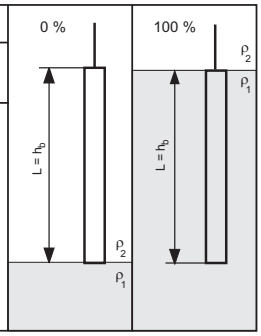
* Suited to the dimensions of FOXBORO ECKARDT - displacer, other lengths on order.
** L = length of displacer

11 DIMENSIONING OF DISPLACER

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

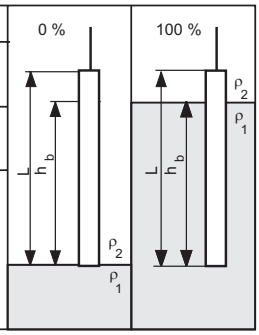
Displacer length = measuring range

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)		



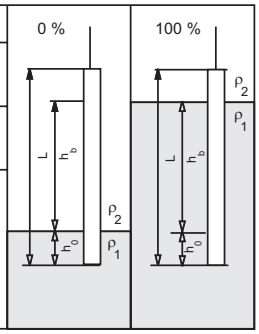
Displacer length > measuring range (without elevation)

Measurement type	Weight forces	
	Lower range value = 0 % output ssignal	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)	$F_0 = F_G - V \cdot g \left(\rho_1 \frac{h_0}{L} + \rho_2 \frac{L - h_0}{L} \right)$	$F_{100} = F_G - V \cdot g \left(\rho_1 \frac{h_0 + h_b}{L} + \rho_2 \frac{L - h_b - h_0}{L} \right)$



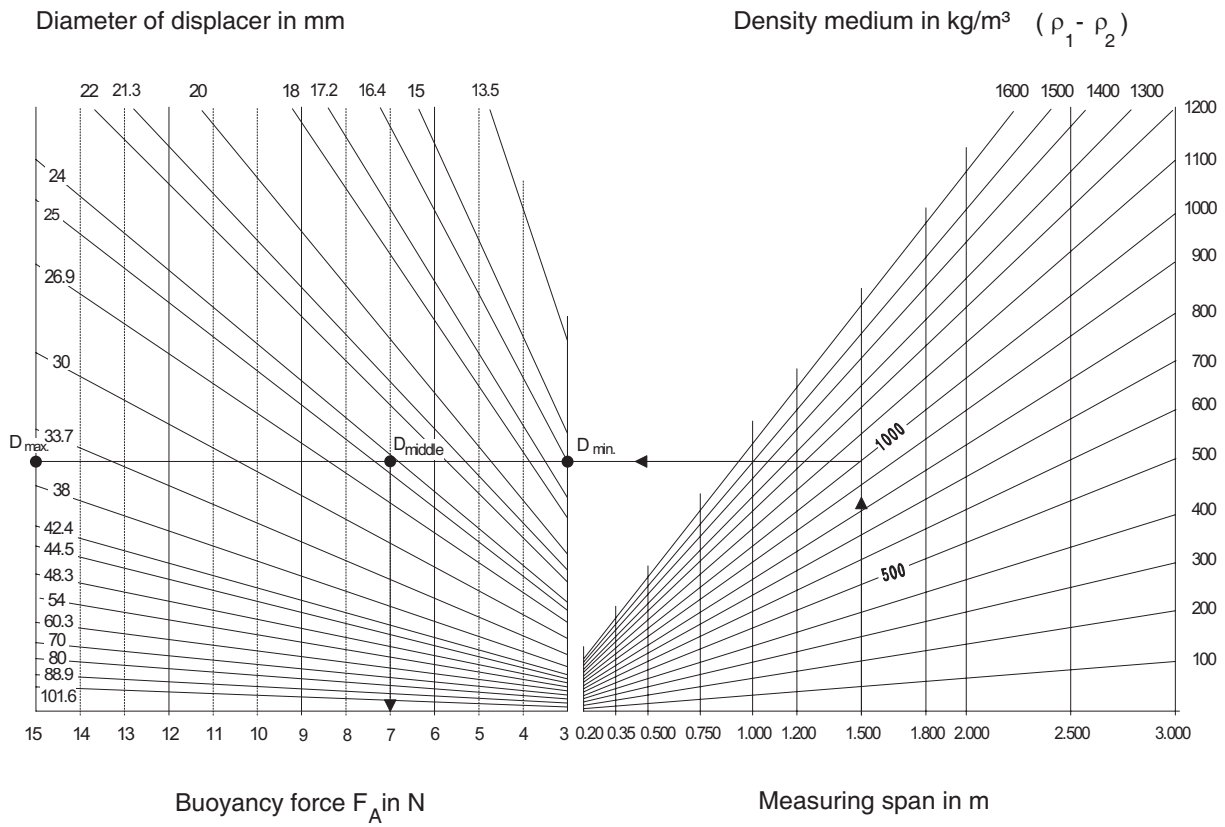
F_G [N] Weight force of displacer in atmosphere
F_0 [N] Weight force action on suspension point of displacer at lower range value
F_{100} [N] Weight force action on suspension point of displacer at upper range value
F_A [N] Buoyancy force of displacer ($F_A = F_0 - F_{100}$)
V [m³] Displacer volume (specified on data label in cm³!)

ρ_1 [kg/m³] Liquid density
ρ_2 [kg/m³] Density of gas or lighter liquid
g [m/s²] Local acceleration due to gravity (e.g. 9.807 m/s²)
L [m] Displacer length
h_0 [m] Lower range value
h_b [m] Measuring span

Attention: 1 kg generates a force of 9.807 N

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

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_G max. is 40 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 F_0 does not exceed 40 N.

Determining displacer diameters
To make 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:

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

- D = Outside diameter of displacer in mm
- F_A = Buoyancy force of displacer in N
- g = Acceleration due to gravity (9.807 m/s²)
- ρ_1 = Density of heavier liquid in kg/m³
- ρ_2 = Density of gas or lighter liquid in kg/m³
- L = Measuring span in mm

Example:

Measuring span:	1.500 m
ρ_1 =	1000 kg/m³
ρ_2 =	negligible

14 SUPPLY OF TRANSMITTER

12.1 General

For safety requirements see chapter 11. Specialties during operation in explosion protected areas see chapter 11.2..

Depending on the transmitter application varying demands are made on the supply. The different operating modes are explained in the following chapters. The wire diagram is shown in Figures 1 to 5.

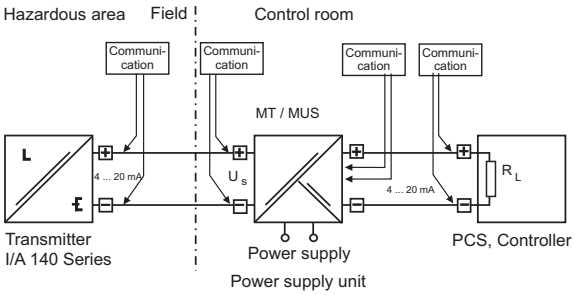
The power supply units for different applications (direct / via power supply unit of transmitters, HART / without communication, intrinsically / not intrinsically) are listed in the following table.

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

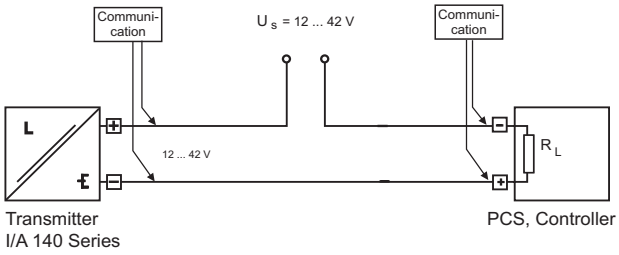
Application and asssociated supply

Application	Supply (**recommended**)
without communication	direct, **MT228**, MUS925, MUS80, **MUS924**
HART	direct, **MT228, MUS925**

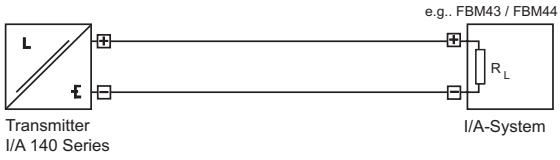
Supply via power supply unit with communication (Fig. 3)



Direct supply with communication (Fig. 4)

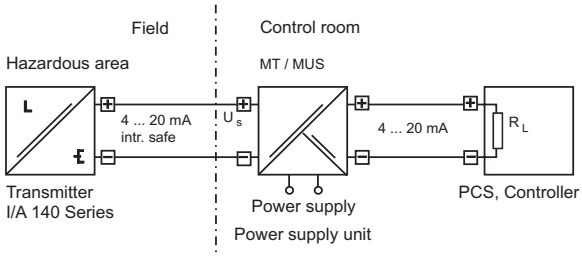


Direct supply via control system (Fig. 5)

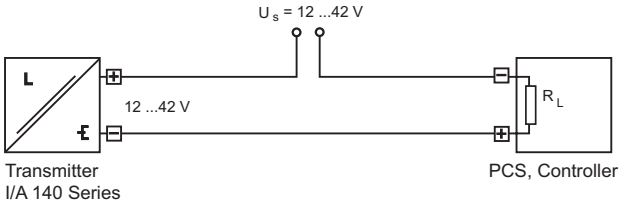


12.2 Overview of application types

Supply via power supply unit (Fig. 1)



Direct supply (Fig. 2)



12.2.1 Supply via power supply unit

This supply is the normally one used and is recommend. Interferences are prevented due galvanic separation of measurement loop, load and power supply in the power supply unit (see fig. 1)

12.2.2 Direct supply

This most simple version can be recommended only for single galvanically separated supply or measurement loops (see fig. 2)

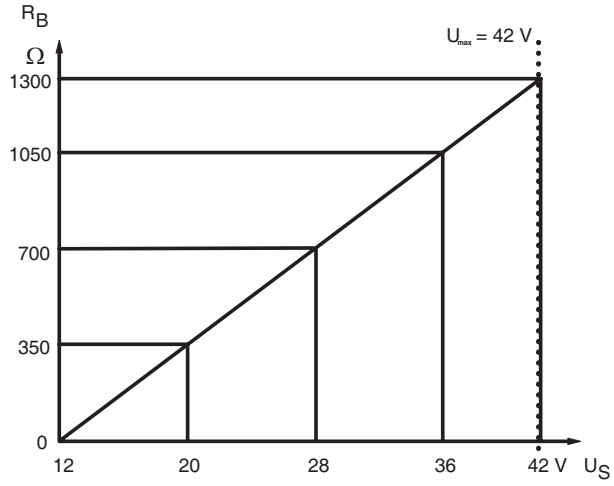
The max. load impedance is calculated per:

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

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

I_{max}: 23 mA for transmitter with HART communication

Permissible load depending on supply voltage. Example of a non intrinsically safe 140 series HART transmitter (Fig. 6)



12.2.3 Communication

In contrast to convential 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.
(FOXBORO ECKARDT power supply units capable for communication (MT228, MUS925) already have respective loads).

Additionally, the line lenghts have to be limited to the max. permitted values for the respective communication

Standard values

Communication	HART		
Min. load	250 Ω		
Max. capacity of line	< 200 nF		
Max. length of line	ca. 3300 m		

The respective wiring diagram is shown in Figure 3.

Figure 4 shows the respective wiring diagram without power supply unit for galvanically separated loops. The operating tool - handterminal, PC with software [1)] and modem - 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!

12.3.4 Operating via I/A System

For operation via control system the devices have to be wired as shown in Figure 3 or 5. If a FBM43 or FBM44 is used in combination with a power supply unit - e.g. for intrinsically-safe applications - the non-supplying input (+ and -) of the module has to be used.

12.2.5 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 of chapter “Communication” have to be observed. In addition, the application of the operating tools and their permitted limit values are to be observed.

1) Software tools for HART: PC20, ABO991, TSP991 or WPP991
For further informations see respective documentation

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