These intelligent transmitters are designed to perform measurements for liquid level, interface or density of liquids. The measurement is based on the Archimedes buoyancy principle. Easy remote configuration and supervision with PC or Universal Handterminal is possible. The devices also can be operated conventionally using local keys. The transmitters are approved for use in hazardous areas.

**FEATURES**

- Communication HART or FoxCom
- Conventional operation with local keys
- Easy adaptation to the measuring point without calibration at the workshop
- Back-documentation of measuring point
- Continuous self-diagnostics
- Configurable safety value
- Software lock for local keys and reconfiguration
- Simulation of analog output for loop-check
- Local display in %, mA or physical units
- Signal noise suppression by Smart Smoothing
- Linear or customized characteristic
- Process temperature from −196 °C to +400 °C
- Materials for use with aggressive media
- Micro sintermetal sensor technology
- Separate mounting of sensor and amplifier with remote amplifier mounting kit

Repair and maintenance must be carried out by qualified personnel!
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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

2 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.
2.1 Measuring principle

(see VDI/VDE Guideline 3519, sheet 1 “Verdrängermethode”)

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 \( F_A \) 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 \( \rho_1 \)
- \( \rho_1 \): Average density of heavier medium
- \( \rho_2 \): 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 (for HART and FoxCom (from Serial No. 93/...))

Signal proportional to buoyancy force

Mains filter

50/60 Hz

Damping

Damping

Sensor fingerprint data

Sensor calibration

Zero calibration

Smart smoothing

Transfer function

Measuring span

Linear or square-root-extracted

Measuring span

Phys. unit

% PV

Customized calibration

Setpoint

Linear, square-root-extracted or customized

Phys. unit

PV

Substitute value

mA

Display

% mA

Selection

Alignment

D/A-converter

On/Off

Low flow cut-off

% mA

50/60 Hz

Characteristic PV

PV

mA

mA

%) calibration ex factory

Digital Output

PV

Analog output

AA

%) calibration ex factory
The transmitter is identified with three labels. The transmitter nameplate 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. The TAG No. label 2 with the Tag No. is located underneath (as an option).

Data on the permissible static pressure and the displacer are documented on the adjustment data label 7 on the sensor housing.

### 3.1 Transmitter nameplate 1

Device specification, Model Code

<table>
<thead>
<tr>
<th>MESSUMFORMER / TRANSMITTER</th>
<th>Model: 144LD</th>
<th>...A4.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID No. for special version</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 3.2 Tag No. label 2

Directly fixed or attached.

LID 09/16

### 3.3 Amplifier nameplate 3

Amplifier Ident No. Type of protection

Without / with explosion protection

With explosion protection

Type of protection

ELECTRICAL TRANSMITTER

With explosion protection, Type of protection “Explosionproof” FM / CSA
3.4 Adjustment data label

Matching the displacer:
Take care of correct matching of transmitter and displacer while mounting. Each transmitter is calibrated to the respective displacer according to the ordering data in the factory. Each displacer is marked with the TAG No. or, if not known, with the last three digits of serial number of the respective transmitter.
If this identification is non-legible, displacer data can be determined by measuring and comparison with the data label of transmitter (one label with the adjustment data is located on the inside and another one on the outside of the cover of the sensor housing).

Example:

<table>
<thead>
<tr>
<th>VERSCHIEBER / IMMERS. BODY / PLONGEUR</th>
<th>LÄNGE / LENGTH / LONGUEUR</th>
<th>L = 1000 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLUMEN / VOLUME</td>
<td></td>
<td>V = 707 cm³</td>
</tr>
<tr>
<td>GEWICHTSKRAF / WEIGHT</td>
<td>F₀ = 1,471 kg</td>
<td></td>
</tr>
<tr>
<td>MAX. DRUCK / MAX. PRESSURE</td>
<td>F = 0,764 kg</td>
<td></td>
</tr>
</tbody>
</table>

AUSGANG / OUTPUT / SORTIE 4 - 20 mA

Length L: Length of displacer
          (= measured length) in mm

Volume V: 0.25 · L · d² · π  (L and d in cm !)
          L = Length of displacer = measured length
          d = Diameter of displacer

Weight force FG: To be determined by weighing [kg]

3.5 Sensor label

Additional on ex-proof devices.
(Example:)

3.6 Boiler label

Boiler label with nominal pressure, material, permissible pressure and temperature load, serial no., etc

Location of labels:

*) Attention! 1 kg generates a force of 9.807 N
4 MOUNTING

The transmitter is directly built onto the vessel or alternatively on a side-mounted displacer chamber (e.g. 104DC).

During installation, the permissible static pressure and the ambient temperature range must be observed. (see chap. 3.6 Boiler label).

4.1 High medium temperatures

The permissible ambient temperature must be limited for some applications with high medium temperatures:

If condensing media with a high heat capacity are used (e.g. saturated steam about 300 °C), or if the wafer body has a heating jacket and is heated with thermal oils (approx. 300 °C), the ambient temperature directly at the sensor housing and at the amplifier must not exceed 50 °C.

If the maximum permissible temperatures (sensor housing 120 °C, amplifier 85 °C, LCD indicator 70 °C) are exceeded, all parts which radiate heat must be insulated (wafer body, displacer chamber, vessel), to ensure that no heat radiation reaches the housing of the sensor or the amplifier. Direct sunlight on the sensor and the amplifier housing should be avoided.

Heating jackets of wafer bodys are designed for PN 25 / Class 300.

4.2 Mounting on top of the vessel

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 at least 5 ... 10 mm.

4.3 Mounting on the side of the vessel

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 on 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 protection cage or tube 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 as per WHG and / or VbF, the remarks in the product specifications PSS EML0610 A and in the certificates or approvals must be observed.
4.4 Mounting the wafer body

Place the seal 139 on the connecting flange 140. Insert displacer in displacer chamber or vessel. Hold wafer body 132 above connecting flange. Engage eyelet 132 of displacer chain in notch in transmission lever 133 and fit wafer body onto connecting flange.

In order to make mounting easier, mounting bracket 132 is secured with a stud 142 to connecting flange 140. It is advisable to preassemble a stud by screwing a nut 143 onto thread. 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 131 to be firmly in position.

Place seal 139 on wafer body. Place blind flange 141 on wafer body so that holes in blind flange and connecting flange 140 are aligned. Blind flange can be equipped with vent plug 144.

Leave stud 142 in mounting bracket 132 and insert remaining seven studs. Screw on nuts and tighten gently. Unscrew nut 143 and pull stud downwards.

1) When using an electrically non-conducting soft gasketing, the wafer body must be grounded, see chap. 5.2.
4.5 Displacer 104DE

Ensure correct matching of transmitter and displacer while mounting. Each transmitter is calibrated to 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 cover of the sensor housing. See also chap. 3 "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 (see Product Specifications PSS EML0610 A).

Jointed displacer elements

Displacers of length over 3 meters (1 m for PTFE) are jointed (multi-section) displacer elements. The displacer elements are screwed together and secured with the wire clip 131 to avoid bending or damage during insertion into the vessel. The elements of displacers with \( \phi < 13 \text{ mm} \) are not screwed together; they are secured with hook and eyelet 152. Additional securing is not necessary 1).

### Displacer 104DE

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### Recommended tightening torque

(Prestressed to 70% of minimum yield point at 20 °C)

<table>
<thead>
<tr>
<th>Studs</th>
<th>M16</th>
<th>M20</th>
<th>M24</th>
<th>M27</th>
<th>M30</th>
<th>M36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque [Nm]</td>
<td>95</td>
<td>185</td>
<td>310</td>
<td>450</td>
<td>630</td>
<td>1080</td>
</tr>
</tbody>
</table>

**Note:**

Studs and nuts material depends on material of wafer body and temperature of process medium. These parts are delivered by FOXBORO ECKARDT in accordance with the table below unless otherwise specified in the order.

<table>
<thead>
<tr>
<th>Wafer body material</th>
<th>Temperature of measuring medium</th>
<th>Studs *)</th>
<th>Nuts *)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel C 22.8</td>
<td>-10 ... +350°C</td>
<td>GA</td>
<td>G</td>
</tr>
<tr>
<td>Steel 15 Mo 3</td>
<td>-10 ... +500°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>316L (1.4404)</td>
<td>-10 ... +400°C</td>
<td>A2-70</td>
<td></td>
</tr>
<tr>
<td>316L (1.4404)</td>
<td>-60 ... +400°C</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*) Identification Studs GA; A2-70 ≤ M30
   A2-50 > M30

   Nuts: G; A2-70 ≤ M20
   A2-50 > M20

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.

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 (Mat. No. 1.4310, max operating temperature 250°C) or Hastelloy C (max operating temperature 350 °C).

Use in Zone 0 or as overfill protection as per VbF and / or WHG 1)

Mechanics
Displacers of more than 3 m length must be secured against oscillating when used in Zone 0. When used as overfill protection as per VbF and / or 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 and / or as overfill protection as per VbF, 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 the ground may not exceed $10^6$ Ω.

1) Please see corresponding certificates for further details
5 ELECTRICAL CONNECTION

5.1 Signal wire connection

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

Transmitters supplied without cable gland, the cable gland used has to conform to possible Ex. requirements. This is the user’s responsibility.

Actions:
- Tighten 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.
- Proper installation of cable gland has to be observed.
- Screw 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"

5.2 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 gasketing, the wafer body must be grounded by wire E with the connection flange.
6 COMMISSIONING

Generally installation and adherence to safety regulations have to be checked prior to start-up. After correct installation, signal wire connection (Supply voltage > 12 V) and opening of any existing isolating valves, the transmitter is ready for operation. If necessary the configuration of lower range value, upper range value and damping has to be checked. Protect environment; do not allow measuring substance to escape. Catch and dispose properly.

Checking of output signal
For checking purposes an ampere meter has to be switched into output circuit.

Checking of calibration

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. An exception is the measuring range with elevation. The lower range value 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 \( F_0 \) 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 \( F_0 \) 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 \( F_{100} \) 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 8, “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.
8 CALIBRATION OF TRANSMITTER

Zero point, lower and upper range value and damping of transmitter are factory calibrated according to the order. Therefore, no calibration is necessary at start-up.

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)

The operating data is stored in the transmitter in accordance with the order.

If the actual operating data deviates from the order calibration becomes necessary.

The transmitter is designed for a displacer weight force of max. 2.500 kg \(^1\) and a buoyancy force of 2 N to 20 N.

8.1 Calibration via local keys

Operation and function of keys

The two local keys 0% and 100% are used to set lower and upper range value, initial value of analog output and damping.

Amplifier housing with key

After lifting the key protection cap \(A\) insert a screwdriver or pin (\(\phi \leq 3\) mm) into hole \(B\) and press down to second pressure point.

Both keys have two assigned functions, dependent on pressing time.

Zero

Press key 0% less than 3 sec: Output signal is set to Zero (4 mA).

Lower range value

Lower range value of analog output:

The output signal is adjusted to 4 mA if the key 0% is pressed longer than 5 sec.

Upper range value

The output signal is adjusted to 20 mA if the key 100% is pressed more than 5 sec.

Damping

The damping is 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. If the key 100% is pressed less than 3 sec. Further acting of key 100% stepwise sets damping.

After damping selection, confirm by briefly pressing key 0%.

(Damping can be set between 0 and 32 s via Handterminal or PC.)

---

1) Attention! 1 kg generates a force of 9.807 N
Calibration and check of lower range value and upper range value

Equipment:
- Stabilized power supply DC 24 V, 30 mA
- Local display configurated with mA resp. % or multimeter
- Screw driver (Ø ≤ 3 mm)
- Set of weights, for weight force up to 2.5 kg ¹) (Precision weight-class M1)
- Weighing pan ²) to be suspended in place of displacer

Actions:
- Put transmitter in operational position and connect transmitter.

Lower range value
- Put on weights for lower range value (F₀) ²).
- Press key 0% more than 5 sec.
- Measuring span remains unchanged.

Upper range value
- Put on weights for upper range value (F₁₀₀).
- Press key 100% more than 5 sec.
- Lower range value remains unchanged.

Wet Calibration
If process conditions for 0 % and 100 % can be set during installation it is also possible to calibrate installed transmitter.

Equipment:
- Local display configurated with mA resp. % or multimeter
- Screw driver (Ø < 3 mm)

Actions:
- Set conditions (e.g. level) for lower range value.
- Press key 0 % less than 5 sec.
- Set conditions (e.g. level) for upper range value
- Press key 100 % more than 5 sec.

"Warm-up" before calibration
To keep the measuring error at extremely high (or extremely low) process temperatures minimal, it is recommended to have the transmitter reach first the operating temperature. Then tighten the 4 screws 181 (M8 hexagon socket screw, 6 mm A/F with 25 Nm, crosswise) and thereafter set lower range value.

1) Attention! 1 kg generates a force of 9.807 N
2) The weight of weighing pan + chain must be taken into account
8.2 Hardware write protection  
(Starting Ser. No. 93/...)

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.
8.3 Calibration via Display Keys
(from Serial No. 93/...)

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
either HART or FOXCOM communication protocols.)

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

8.3.4 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 re-
locates 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 “Can-
cel”.

Alphanumeric Input

If the menu requests an alpha-numerical input, the present-
ly 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 string is transferred by activating
key ENTER.
Abbreviations:
E ENTER button
N NEXT button
(with autorepeat: i.e. long, continuous 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.

8.3.2.4 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.

8.3.2.3 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.

8.3.2.6 Menu node “DONE”
DONE - Cancel substitute value
WAIT - Cancel changes
SAVING - Save changes
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 / STANDARD”**
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 characteristic 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 – 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 suppressed (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”
Calibration 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 (0%- and 100%-button) of transmitter

Menu node “KEYS / DISABLE”
Selective blocking of external keys of transmitter.

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”
Select the noise suppression filter 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 has 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, entry 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 timeout
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 LOCAL DISPLAY

In the digital transmitter, a 5 digit LCD is displays in %, mA or physical units.
The local display can only be activated by configuration via handterminal HT991 or PC.
See Master Instruction
for HT991: MI EMO0110 A
for PC: MI EMO0112 A
The PV indication can also be activated via keys at the display.

Note:
Subsequent installation or replacement of LCD display by original parts is not a repair or change as defined in ElexV, if performed by authorized personnel

9.1 Installation of local display
(See figure amplifier electronics in chapter 10)

Actions:
- If provided remove cover lock 24.
- Unsscrew housing cover 25.
- Remove electronic housing 62.
- (First of all strip off snap hook D, to avoid damaging the connector of the display electronic) Bend snap hook D from top with suitable srew driver with care outwards and pull out amplifier board 61 at one side. Strip off also snap hook E and take off the whole amplifier board 61 by pulling at the connector board F.
- If necessary pull out terminal block 52 and 54.
- Lock amplifier board 61 with display unit 62 in new electronic housing.
- Pull O-Ring 65 over electronic housing 62.
- If necessary replug terminal block 52 and 54.
- Completely insert electronic housing with display unit 62 and level into amplifier housing 21.
The LCD housing can be mounted turned in 90 °-steps.
- Screw front housing cover 25 with O-ring 26. Reinstall cover lock 24 if present.
10 MAINTENANCE, REPAIR

The safety requirements must be observed.

**Attention Calibration Data! (Fingerprint Data)**

This data determined in the factory are allocated to the respective transmitter parts (sensor cell + torque tube + wafer body).

For delivery of the 144LD these values are loaded in the amplifier (software).

a) In case of amplifier exchange this fingerprint data may be transmitted to the new amplifier, respectively can be provided by manufacturer (floppy disk).

This requires the PC20 Software ("Factory setting")

b) When exchanging torque tube or sensor cell manufacturer has to determine new fingerprint data if full accuracy of zero point and span at alternating ambient temperatures is to be maintained.

c) If torque tube only is exchanged the existing fingerprint data can be used. Only minor worsening of temperature behavior is to be expected.

d) When exchanging the sensor cell, a temperature error of up to 3-fold has to be anticipated if no new fingerprint data is read in.

Fingerprint data may be ordered from manufacturer by stating the sensor cell code (5 digits, e.g. GFEHG). The sensor cell code is inscribed directly on the sensor cell.

10.1 Visual inspection

The transmitter normally does not require any maintenance.

For routine maintenance it is not necessary to disconnect the entire transmitter from the connecting flange 140.

For a visual inspection of state and cleanliness of the displacer chamber 147, the displacer itself and its suspension open the blind flange 141 as shown in figure below.

10.2 Sensor check

Workshop work (see figure amplifier electronics)

- Disconnect transmitter from current.
- If provided, remove cover lock 24.
- Unscrew front housing cover 25.
- Unscrew local display 56 resp. support plate 58 resp. pull out electronic housing 62.
- Take off terminal block 52.
- Resistor check:

  - R1 between gray and yellow = 3.375 kΩ to 4.875 kΩ
  - R2 between yellow and brown = 3.375 kΩ to 4.875 kΩ
  - R3 between gray and green = 3.375 kΩ to 4.875 kΩ
  - R4 between green and brown = 3.375 kΩ to 4.875 kΩ
  - R₁₀ between red and red = 50 Ω to 150 Ω

  The resistors R1, R2, R3 and R4 must be within a tolerance band of ± 6 Ω from one another.

If the measured values deviate from these values the sensor element has to be replaced.

10.3 Amplifier check

The device can be checked via LCD or PC Software (see Chapter 6 "Commissioning").
10.4 Replacement of amplifier electronics or sensor

**Workshop activity**
Sensor and / or amplifier electronics replacement by a set of original parts is no repair in the sense of Elex V if performed by authorized personnel.

**Note:**
Take steps to prevent the damaging of sensor and amplifier electronics when working at sensitive electrostatic components.

Make sure that sensor element and amplifier both meet the required certificate of conformity. After replacement of amplifier or sensor element fingerprint data have to be downloaded to amplifier. Lower and upper range value have to be readjusted (s. Chapt 8).

**Procedure for exchange of amplifier electronics** (see figure amplifier electronics)
- If provided remove cover lock 24.
- Unscrew front housing cover 25.
- Pull out electronic housing 62 and take off terminal blocks 52 and 54 from amplifier board 61.
- Carefully remove snap hook of electronic housing 62 by means of suitable tool and take off amplifier board 61. (see chap. 9.1)
- Lock amplifier board 61 in electronic housing 62 and re-plug terminal block 52 and 54.
- Return electronic housing 62 with hooded O-ring 65 and entirely flat into amplifier housing 21.
- Install front housing 25 with O-ring 26 and install cover lock 24 (if provided).
10.5 Replacing displacer

- Suspend new displacer 150 in place of old one. Please also refer to chap. 4.5 “Displacer 104DE”.

- Unscrew two hexagon socket screws 123 and rotate amplifier 20 clockwise 180°. Be careful not to pull amplifier forward. It is recommended that the screws be then loosely refitted.

- Unscrew cover 125 of sensor housing (if seal sticks, lift it off with screw driver). Enter the changed data of displacer on the adjustment label (see chapter 3).

Calibration with local keys

Lower range value

- For level measurements the vessel must be empty. For interface or density measurements the displacer must be completely immersed in the upper or lighter liquid. Press local key 0% less than 5 sec for zero calibration. (Analog and digital signal are setted to zero.)

Upper range value

- Fill vessel to upper range level until displacer is completely immersed. For interface measurements flooding with heavier liquid is necessary and for density measurements with the highest density. Set output signal to 20 mA by pressing local key 100% for more than 5 sec.

- Re-attach cover of sensor tightly. Make sure it is properly sealed! (IP 66)

- Turn amplifier back to its standard position and screw tightly.

- Any additional corrections can be made with the local key 0% for lower range value.

   The procedure for calculating the weight force is described in chapter 11.

Calibration via Hand Terminal or PC

- Level is without influence. Only values determined for lower range value and upper range value are entered.

   Or calibration with weights (see chap. 12 ), workshop task.
10.6 Dismantling sensor section

Workshop task
Required tools:
Hexagon socket spanner 5 mm A/F and 4 mm A/F (shortened), Set spanner 9 mm A/F and 6 mm A/F, Ring spanner 9 mm A/F, Screw driver

- Unscrew cover 125 of sensor housing (if seal sticks, lift it off with screw driver).
- Slightly loosen two nuts 9 mm A/F which secure connecting rod 160 to clamping lever 135.
- Loosen two hexagon socket screws 161 one or two turns. Remove clamping lever.
  Be careful not to damage connecting rod.

Caution:
Be careful not to damage the sensor cell 121 and connecting rod!
Pull electrical leads out of bushing.

- Unscrew the three hexagon socket screws 162.
- Pull off entire base plate 163. To do so, screw two of the three hexagon socket screws 162 unscrewed previously into threaded holes 164.

Sensor section dismantled
(standard)

Sensor section dismantled
(high pressure version)
10.7 Assembling the sensor section

Workshop task

Required tools:
Clamping fixture, e.g., vise, constant voltage source 5 V, digital multimeter measuring range 20 mV (resolution 1 µV), hexagon socket spanner 5 mm A/F and 4 mm A/F (reduced), spanner extension, O-ring grease.

Clamp wafer body horizontally in the clamping fixture.

- Fit greased O-ring 168 on shoulder of heat sink 169.
- Fit and align sensor housing 167 and attach with four hexagon socket screws 166, M6 x 30 crosswise.
- Fit insulating washer 165 with the flat side facing the heat sink.
  Check ball bearing 170 for free running.

Sensor (standard)

- Take base plate 163 with sensor cell in the hand. Insert the leads through the duct inside housing. Slide base plate over torque rod 171 and shaft of sealing cone 172 by pressing gently and align.

- Only applies to sensor for Zone 0 and overfill protection as per VbF (otherwise continue on next page):
  For safety reasons, gap reducing bush 177 must be inserted in the torque tube between sealing cone 172 and torque rod 171.

Sensor (explosion proof version)
- Use only original gap reducing bush! Through inspection hole 179 it is possible to recognize whether gap reducing bush is installed with the mounted device.

- Draw tight the three hexagon socket screws 162 (M 6x40 (use the span with the extended lever arm). Connect sensor cell as shown in the test circuit. Note output voltage of the sensor cell (typical value range ± 0.3 mV).

Sensor cell in test circuit

- Fit clamping lever 135. Be careful not to bend connecting rod 160 (ensure that connecting rod does not touch inside of threaded sleeve).

- Insert adjusting pin (or twist drill), dia. 5 mm, in alignment hole 173. Press clamping lever 135 against this pin and tighten hexagon socket screw 160 4 mm A/F (gently at first). Choose clearance between clamping lever and ball bearing so that there is no or little change in output signal of sensor cell (clearance is approx. 1 mm). Then clamping lever will not touch connecting rod.

- Then tighten hexagon socket screws alternately (reduced hexagon socket spanner), so that the two parts of the clamping lever are parallel and the left-hand lever 135 just touches the inserted adjustment pin.

Tightening of
- top screw: clearance is reduced.
- bottom screw: clearance is increased.

10.8 Replacement of connecting rod of sensor cell

- Screwed end 174 between connecting rod 160 and sensor cell 121 is secured with medium strength Loctite. By applying heat from a soldering iron or similar heat source, connecting rod can be unscrewed. Then the replaced connecting rod should be fitted using a drop of Loctite on the threads. Be careful not to damage connecting rod.

10.9 Setting connecting rod of sensor cell

Workshop task
Required tools:
- Constant voltage source 5 V; digital multimeter measuring range 20 mV (Resolution 1 µV), ring spanners 9 mm A/F; fork wrench 9 mm A/F

- Set up transmitter in its operational position and open housing. Connect sensor cell as shown in test circuit.
- Note measuring value of output voltage.
- Set weight force 200 g (including scale pan).
- Tighten nuts 175, 176 on connecting rod manually, so that output voltage corresponds to previously noted measuring value.

If left-hand nut 175 is tightened, voltage is increased. If right-hand nut 176 is tightened, voltage is reduced.

Be careful not to damage connecting rod.
The connecting rod should not touch thread sleeve.

- Tighten left and right-hand nuts 175, 176 uniformly with a ring spanner and a fork wrench 9 mm A/F.
The measured voltage should then no longer deviate more than ± 0.1 mV of the noted measuring value.

Sensor cell cable colours
10.10 Removal of heat sink

Workshop task
The sensor section must first be dismantled before heat sink can be unscrewed.
- Unscrew the four hexagon socket screws 181 and remove heat sink 182, spacer rings 183, metal washer 184 and insulating washer 185.

10.11 Mounting of heat sink

Workshop task
- Insert the four hexagon socket screws M8 x 35 through the holes in the wafer body flange.
- Fit insulating washer 185, metal washer 184 and spacer rings 183 over barrels of the screws as shown in the picture. Fit greased O-ring 187. Fit heat sink with holes 186 downwards, and screw tight (torque force 25 Nm, crosswise) all four hexagon socket screws.

10.12 Dismantling torque tube

Workshop task
Note:
Sensor section and heat sink must first be removed before torque tube can be dismantled.
- Unscrew transmission lever 133 at the hexagonal end 7 mm A/F and remove from wafer body.
- Unscrew sleeve nut 191 36 mm A/F.
Torque tube 134 can then be pulled out.
10.13 Mounting torque tube

Workshop task
Since the transmission lever and the torque tube are not exactly perpendicular, the threaded hole for the transmission lever must be inclined at exactly the right angle when the torque tube is fitted.

- After mounting the position of the threaded hole can be determined on the basis of the notch 192 in the journal of the torque tube since this notch and the threaded shaft are parallel.
- Screw in transmission lever and tighten (7 mm A/F).
- Apply high-temperature-resistant lubricant to thread and inside of the sleeve nuts, and tighten sleeve nuts to torque of 120 - 130 Nm (36 mm A/F).
- Be careful to provide clearance of approx. 7 mm between transmission lever and top wall when no load is placed on torque tube. Screw in stop plug 193.

10.14 Dismantling wafer body bearing

Workshop task
- Unscrew top plug 193 30mm A/F, and loosen nut 195 of the wafer body bearing with a socket spanner. Do not unscrew entirely! The complete bearing can then be removed.

Socket spanner

10.15 Mounting wafer body bearing

Workshop task
The wafer body bearing comprises: clamping washer 196, bearing bushing 197 and nut 195.
- Fit wafer body bearing into wafer body as shown below.
- Align bearing by sliding bearing bushing and turning clamping washer so that journal 198 does not quite touch bearing bushing when no load is placed on torque tube (displacer detached).
- Then tighten nut, so that clamping washer and bearing bushing do not move (use a socket spanner).

Hold clamping washer in place with screwdriver when tightening nut. Apply a high-temperature resistant lubricant to the thread of stop plug 193.
### 11 DIMENSIONING OF DISPLACER

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

**Displacer length = measuring range**

<table>
<thead>
<tr>
<th>Measurement type</th>
<th>Weight forces</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Liquid level</strong></td>
<td>( F_0 = F_G )</td>
</tr>
<tr>
<td>( \rho_2 ) is negligible</td>
<td>( \rho_1 ) is negligible if ( \rho_2 = \text{gas at atmospheric pressure} ) or with ratio ( \rho_2 : \rho_1 ) less than 0.5 %</td>
</tr>
</tbody>
</table>

\( \rho_1 \) [kg/m³] Liquid density
\( \rho_2 \) [kg/m³] Density of gas or lighter liquid
\( g \) [m/s²] Local acceleration due to gravity \( ( \text{e.g.} 9.807 \text{ m/s}^2) \)
\( L \) [m] Displacer length
\( h_0 \) [m] Lower range value
\( h_b \) [m] Measuring span

### Displacer length > measuring range (without elevation)

<table>
<thead>
<tr>
<th>Measurement type</th>
<th>Weight forces</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Liquid level</strong></td>
<td>( F_0 = F_G )</td>
</tr>
<tr>
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</tr>
</tbody>
</table>

### Displacer length > measuring range (with elevation)

<table>
<thead>
<tr>
<th>Measurement type</th>
<th>Weight forces</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Liquid level</strong></td>
<td>( F_0 = F_G \cdot V \cdot g \cdot \frac{h_0}{L} )</td>
</tr>
<tr>
<td>( \rho_2 ) is negligible</td>
<td>( \rho_1 ) is negligible if ( \rho_2 = \text{gas at atmospheric pressure} ) or with ratio ( \rho_2 : \rho_1 ) less than 0.5 %</td>
</tr>
</tbody>
</table>

**Attention:** 1 kg generates a force of 9.807 N
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 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 $F_0$ does not exceed 25 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:

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

- $D$ = Outside diameter of displacer in mm
- $F_A$ = Buoyancy force of displacer in N
- $g$ = Acceleration due to gravity (9.807 m/s²)
- $\rho_1$ = Density of heavier liquid in kg/m³
- $\rho_2$ = Density of gas or lighter liquid in kg/m³
- $L$ = Measuring span in mm

Example:
Measuring span: 1.500 m
$\rho_1$ = 1000 kg/m³
$\rho_2$ = negligible
12 SAFETY REQUIREMENTS

See document:
"Safety Operating Instructions 140 Series"
13 DIMENSIONS

144LD up to PN 250 / Class 1500

---

<table>
<thead>
<tr>
<th>LH</th>
<th>RH</th>
</tr>
</thead>
</table>

---

2  Tag No. label
3  Amplifier nameplate
8  Sensor label
21 Amplifier housing
22 Connecting compartment
35 Alternate connection
70 Amplifier housing - separating point
120 Sensor
128 Heat sink
131 Wafer body
132 Mounting bracket
142 Protective tube for displacer
150 Displacer
193 Screw plug

LH Left Hand = mounting amplifier to wafer body “Left hand mounted” (Model Code L)
RH Right Hand = mounting amplifier to wafer body “Right hand mounted” (Model Code R)

---

Table of versions

<table>
<thead>
<tr>
<th>Version</th>
<th>Sealings</th>
<th>DN 80 / 3 inch</th>
<th>DN 100 / 4 inch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>c</td>
<td>d</td>
</tr>
<tr>
<td>DIN</td>
<td>Form E DIN 2526</td>
<td>140</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Form N DIN 2512</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Form L DIN 2696</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANSI</td>
<td>Raised Face (RF)</td>
<td>140</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>ANSI B16.5</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Ring Joint Face (RJF)</td>
<td>140</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>ANSI B16.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
14 SUPPLY OF TRANSMITTER

14.1 General
For safety requirements see document: “Safety Operating Instructions 140 Series”

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 / FOXCOM / 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

<table>
<thead>
<tr>
<th>Application</th>
<th>Supply (recommended)</th>
</tr>
</thead>
<tbody>
<tr>
<td>without communication</td>
<td>direct, MT228</td>
</tr>
<tr>
<td>HART</td>
<td>direct, MT228</td>
</tr>
<tr>
<td>FOXCOM analog</td>
<td>direct, MT228</td>
</tr>
<tr>
<td>FOXCOM digital</td>
<td>I/A-System, MT228</td>
</tr>
</tbody>
</table>

14.2 Overview of application types

Supply via power supply unit (Fig. 1)

Direct supply (Fig. 2)

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

Direct supply with communication (Fig. 4)

Direct supply via control system (Fig. 5)

14.2.1 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)

14.2.2 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:

$$R_{B\text{max}} = \left( U_{\text{max}} - 12 \right) / I_{\text{max}}$$

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

$I_{\text{max}}$: 12 mA for transmitter in FOXCOM digital mode, 23 mA for all other transmitters (HART and FoxCom)
14.2.3 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. (FOXBORO ECKARDT power supply units capable for communication, as MT228, already have respective loads).

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

Standard values

<table>
<thead>
<tr>
<th>Communication</th>
<th>HART</th>
<th>FOXCOM analog</th>
<th>FOXCOM digital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min. load</td>
<td>250 Ω</td>
<td>200 Ω</td>
<td>200 Ω</td>
</tr>
<tr>
<td>Max. capacity of line</td>
<td>&lt; 200 nF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. length of line</td>
<td>ca. 3300 m</td>
<td>1800 m</td>
<td>600 m</td>
</tr>
</tbody>
</table>

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 2) - 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.

14.2.4 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.

14.2.5 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) Depending on the communication protocol (HART or FOXCOM) different software tools can be used.

HART: PC20, ABO991, TSP991 or WPP991
FOXCOM: PC20, PC10

2) Both communication protocols need different modems.