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71659152
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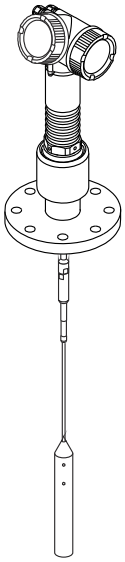
Special Documentation
Levelflex FMP54

Safety instructions for steam boiler approval
Guided level-radar as part of a limiting device for low level water and high level water



Application

Guided level-radar as part of limiting device for low level water and/or high level water and control in 2-wire and 4-wire version for liquids in tanks to meet the particular requirements as per EN 12952-11 and EN 12953-9.

The measuring device fulfils the requirements concerning
- Electrical safety as per IEC/EN 61010-1
- Functional safety as per IEC 61508
- Explosion protection (depending on the version)
- Electromagnetic compatibility as per EN 61326 and NAMUR recommendation NE 21

Your benefits

- Used as part of a limiting device as per EN 12952-11/EN 12953-9 for FMP54 (certified by TÜV NORD CERT)
- Continuous measurement
- Measurement is virtually independent of product properties
- Measurement is possible even at strongly agitated surfaces and foam
- Easy commissioning

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Introduction

General information on steam boiler applications is available in brochure CP00041F "Level measurement in steam boilers".

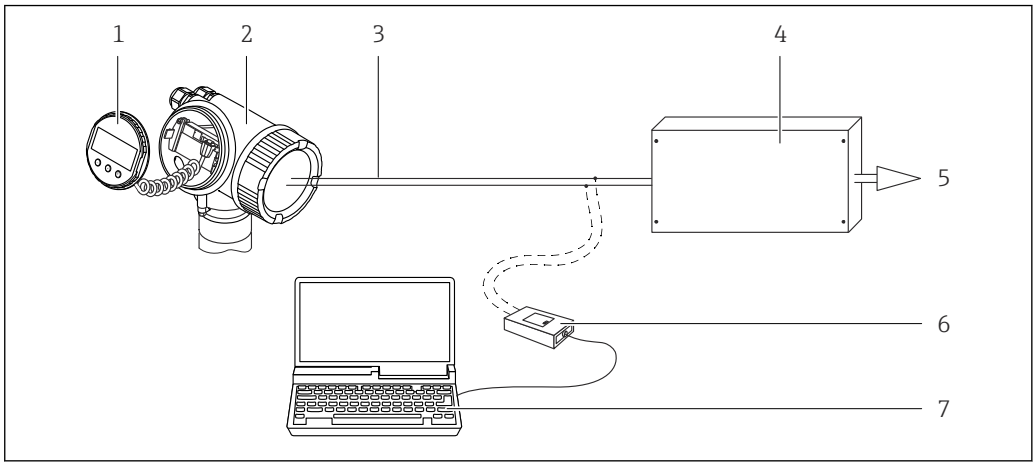
The devices may only be installed and commissioned by suitable and trained staff. Maintenance work and adjustments may only be performed by authorized staff who have received special training.

The nameplate indicates the technical characteristics of the devices. Devices without a device-specific nameplate must not be commissioned or operated!

Structure of the measuring system

System components

The measuring system's devices are displayed in the following diagram (example).



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1 Display module
2 Levelflex FMP54
3 4 to 20 mA
4 Logic unit, e.g. PLC, limit signal transmitter, ...
5 Actuator
6 Commubox FXA195
7 Computer with operating tool (FieldCare)

An analog safety signal (4 to 20 mA) proportional to the level is generated in the transmitter. This is sent to a downstream logic unit (e.g. PLC, limit signal transmitter, etc.) where it is monitored to determine whether it overshoots or undershoots a specified limit value.

For fault monitoring, the logic unit must recognize both HI-alarms (≥ 21 mA) and LO-alarms (≤ 3.6 mA).

System description/function

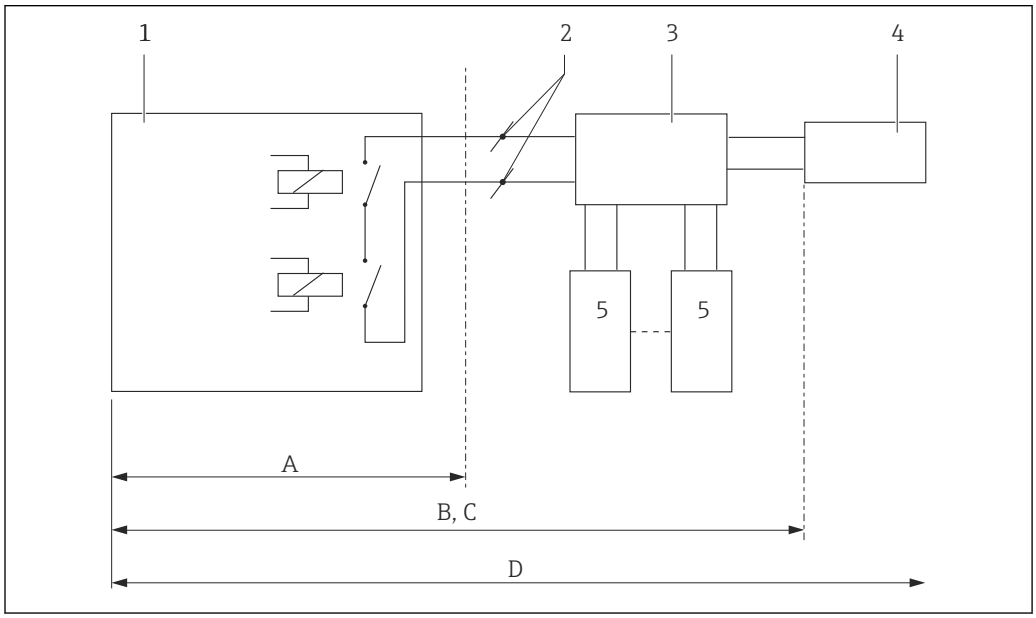
The Levelflex is a "downward-looking" measuring system that functions according to the ToF method (ToF = Time of Flight). The distance from the reference point (process connection of the measuring device) to the product surface is measured. High-frequency pulses are injected to a probe and led along the probe. The pulses are reflected by the product surface, received by the electronic evaluation unit and converted into level information. This method is also known as TDR (time domain reflectometry).

The level measuring device records the minimum or maximum level in a tank for the generation of steam using the time-of-flight measurement method in accordance with the scope of EN 12952-11 and EN 12953-9.

For low level water and/or high level water and control or regulation as part of a safety system, the Levelflex FMP54 is used as part of a limiting device.

Levelflex FMP54 can be used in a 2-wire and 4-wire version (both versions with overlying HART communication).

The protection function for the entire boiler is covered by an additional safety system and actuator.



A Scope of EN 12952-11, EN 12953-9
B Protection system as per 3.40 of EN 50156-1
C Scope of EN 12952-7, EN 12953-6
D Scope of the functional test
1 Limiter (limiting device)
2 Output connections of the limiter
3 Complete safety system (protection system as per EN 50156-1)
4 Power supply
5 Limiter

Safety system

- Self-monitoring
- With redundancy
- With diversity
- A suitable combination of the above

Limiter (limiting device)

Can consist of
- Measuring sensor
- Bypass(es)/external pressure chamber(s)
- Timing relay(s)
- Testing equipment and
- Other associated devices for function and failsafe limiters
- Protective tube (in boiler)/Stilling well
- Actuator

Permitted device types

The details in these instructions relate to the device versions listed below and are valid as of the specified software and hardware version. Unless otherwise specified, all subsequent versions can also be used for limiting devices.

Levelflex FMP54

Feature	Designation	Version
010	Approval	all
020	Power supply; Output	A, B [1], C [2], K
030	Display; Operation	all
040	Housing	B, C

Feature	Designation	Version
050	Electrical Connection	all
060	Probe	all
090	Seal	all
100	Process Connection	all
500	Additional Option Language	all
540	Application Package	all
550	Calibration	all
570	Service	all
580	Test; Certificate	all
590	Additional Approval	LX An additional selection of any further versions is possible
600	Probe Design	all
610	Accessory Mounted	all
620	Accessory Enclosed	all
850	Firmware Version	If no version is selected here, the latest approved SIL-able SW is supplied. Alternatively, the following SW version may be selected: ▪ 71 01.03.zz, HART 7, DevRev04 ▪ 74 01.02.zz, HART 6, DevRev03 ▪ 75 01.01.zz, HART 6, DevRev02

1) For this version with one current output and one switching output, only the current output (terminals 1 and 2) is suitable for safety functions. The switching output can, if necessary, be wired for non-safety-oriented purposes.
2) For this version with 2 current outputs, only the first output (terminals 1 and 2) is suitable for safety functions. The second output can, if necessary, be wired for non-safety-oriented purposes.

Valid firmware version: as of 01.01.18

Valid hardware version (electronics): as of delivery date January 2012

Documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

The following documentation may be available depending on the device version ordered:

Document type	Purpose and content of the document
Technical Information (TI)	**Planning aid for your device** The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.
Brief Operating Instructions (KA)	**Guide that takes you quickly to the 1st measured value** The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.
Operating Instructions (BA)	**Your reference document** These Operating Instructions contain all the information that is required in the various life cycle phases of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning, through to troubleshooting, maintenance and disposal.

Document type	Purpose and content of the document
Description of Device Parameters (GP)	**Reference for your parameters** The document provides a detailed explanation of each individual parameter. The description is aimed at those who work with the device over the entire life cycle and perform specific configurations.
Safety Instructions (XA)	Depending on the approval, safety instructions for electrical equipment in hazardous areas are also supplied with the device. The Safety Instructions are a constituent part of the Operating Instructions. Information on the Safety Instructions (XA) that are relevant for the device is provided on the nameplate.
Supplementary device-dependent documentation (SD/FY)	Always comply strictly with the instructions in the relevant supplementary documentation. The supplementary documentation is a constituent part of the device documentation.

Supplementary documentation

- TI01001F
- BA01001F
- GP01000F
- SD00326F, SIL Declaration of Conformity
- SD01071F, Project Planning Information

Installation and commissioning

Installation instructions/ engineering

At least two probes are required in redundancy for the measurement of the maximum and minimum level in a steam generator (voting 1oo2, "one out of two"). To increase availability, it is recommended that three probes be installed in a voting 2oo3 ("two out of three").

The devices can be installed directly in the tank or in a bypass.

A rod probe of suitable length can be used if the limiter is installed in a stilling well (protective tube) or bypass (≤ DN150) provided by the customer. A coaxial probe must be used if the limiter is freely installed in the boiler or in stilling well or bypass (≥ DN150).

The devices must be arranged, installed and protected in such a way that their function is not hampered by:

- Foam and turbulence in the boiler water
- Buildup of dirt
- Mechanical influences during operation (e.g. vibrations)
- Position changes in relation to the protective tube or other electrodes, which could lead to a shortcircuit

Behavior during normal operation and in case of error

The integrated broken probe detection function must be enabled.

Voting 1oo2

During normal operation
If the limit value (low level water/high level water) to be monitored is reached, at least one of the sensors shows a message on the display).

In case of error

- In the event of a dangerous detected device failure (e.g. error current): The system is no longer single-fault safe. Immediate action is necessary!
- In the event of a dangerous undetected device failure: The device is no longer single-fault safe. Immediate action is necessary!
  - Failure detection by comparing signals or
  - Failure detection by performing recurrent function testing

Voting 2oo3

During normal operation
If the limit value (low level water/high level water) to be monitored is reached, at least two of the sensors show a message on the display.

In case of error
- In the event of a dangerous detected device failure (e.g. error current): The system is still single-fault safe (1oo2). Repair or change the defective sensor!
- In the event of a dangerous undetected device failure: : The system is still single-fault safe (1oo2). Repair or change the defective sensor!
  - Failure detection by comparing signals (1-2, 2-3, 3-1) or
  - Failure detection by performing recurrent function testing

Some diagnostics are self holding, which means that after elimination of the fault, the error message is still present. The fault must then be acknowledged manually after checking or replacing the probe(s) by short interruption of the power supply or by choosing the **Restart device** option at Setup → Advanced setup → Administration → Device reset (0000).

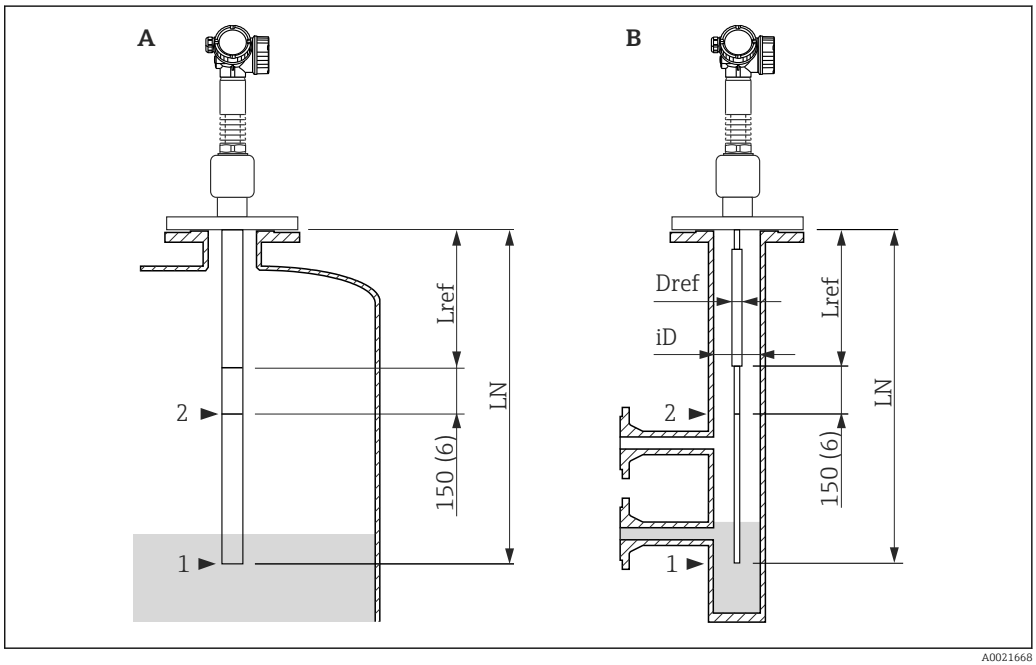
Errors that occur during commissioning or measuring are displayed immediately as plain-text errors on the display. In addition, a unique error code is also output. A description of the error codes is provided in the Operating Instructions.

If two or more system or process errors occur, the error with the highest priority is the one shown on the display! Additional pending diagnostic messages can be shown in the **Diagnostic list** submenu.

Gas phase compensation

If the device version with automatic time-of-flight compensation in steam applications is used, the guidelines on reference length and safety distance to the maximum level (high level water) must be adhered to:
- reference length L_{ref} = 300 mm (11.8 in) or 550 mm (21.7 in) (depending on the device version)
- safety distance = 150 mm (6 in)

The useable measuring range of the level probe is between the end of the probe (MIN) and the safety distance (MAX; 150 mm (6 in) below reference length L_{ref}). The information specified in the relevant Technical Information must be observed.



Unit of measurement mm (in)

A Coax probe
B Rod probe
Lref Reference distance
LN Probe length
iD Inner diameter of the pipe
Dref Diameter of the probe rod
1 MIN
2 MAX

Coax probes with reference reflection can be installed in all tanks (freely in the tank or in a bypass). Coax probes are ready-mounted and calibrated ex works.

Rod probes are only recommended if a coax probe cannot be installed (e.g. where the diameter of the bypass is very small).

Rod probes with reference reflection are only suitable for installation in stilling wells and bypasses. The diameter D_{ref} of the probe rod in the range of reference distance L_{ref} must be appropriately selected in relation to the pipe internal diameter iD. The pipe must be cylindrical in the range of reference distance L_{ref}. Changes in the cross-section, e.g. at flange connections, must not exceed 5 % of internal diameter iD.

After installation, the settings must also be checked, and adjusted if necessary, by qualified staff.

Installation conditions

Further details are described in the corresponding Operating Instructions

Available in the Download Area of the Endress+Hauser website (www.endress.com/downloads).

Installation and wiring

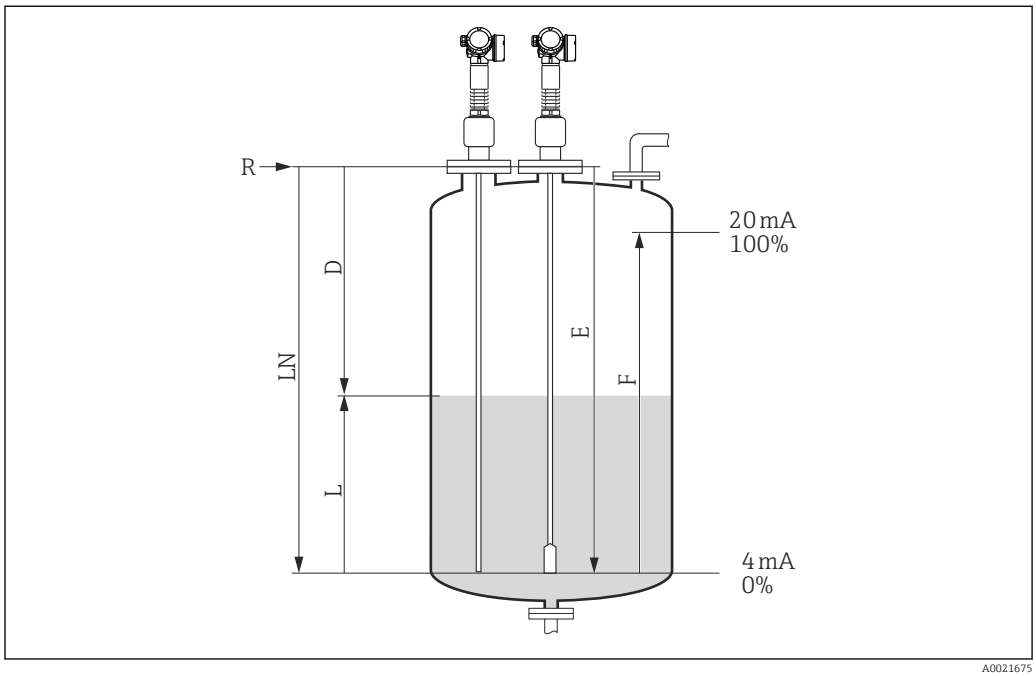
Correct installation is a prerequisite for safe operation of the device.

Orientation

The angle of inclination of the probe must not exceed 30 °. The length of the probe is limited to 1 000 mm (40 in) if installed in a slanted position.

Commissioning

Configuration of a level measurement



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R Reference point of the measurement
LN Length of probe
D Distance
L Level
E Empty calibration (= Zero point)
F Full calibration (= Span)

Configuring level measurement

Numbers in brackest are the direct-access-id of menues or parameters which can be used in DeviceCare or FieldCare.

1. Navigation: Setup → Distance unit (0551)
   ↳ Select Distance unit
2. Navigation: Setup → Operating mode (1046)
   ↳ Select **Level** option

3. Navigation: Setup → Tank type (1175)
   ↳ Select Bin type
4. Navigation: Setup → Tube diameter (1117)
   ↳ Enter Inner diameter of the stilling well or bypass pipe.
5. Navigation: Setup → Medium group (1208)
   ↳ Select Medium group. (**Water based (DC >= 4)** option or **Others** option = DK ≥ 1.9.
6. Navigation: Setup → Empty calibration (2343)
   ↳ Enter **E** (Distance between process connection and minimum level (0%).)
7. Navigation: Setup → Full calibration (2308)
   ↳ Enter **F** (Distance between minimum level (0%) and maximum level (100%).)
8. Navigation: Setup → Level (2319)
   ↳ Displays Currently measured level **L**
9. Navigation: Setup → Distance (1124)
   ↳ Displays Distance between lower edge of flange or thread and medium surface.
10. Navigation: Setup → Signal quality (1047)
    ↳ Displays the signal quality of the level echo
11. Compare the displayed distance to the real distance in order to start the recording of the mapping curve.
    ↳ Navigation: Setup → Confirm distance (1045)

- Coax probes are precalibrated, threrefore, a reference check is not required
- For rod probes with gas phase compensation: BA01001F

The integrated broken probe detection function must be enabled!
If this function is switched off, it can be enabled
Navigation: Expert → Sensor → Sensor diagnostics → Broken probe detection (1032)
Select **On** option

Parameter configuration for safety-related applications

Further details are described in the corresponding Functional Safety Manual

Available in the Download Area of the Endress+Hauser website (www.endress.com/downloads).

Operation

The level sensor can be operated for more than 24 hours without supervision as part of a limiting device. Adhere to the conditions as per EN 12952-7, section 7.3.9 in this regard. 72-hour operation or operation without supervision are thus also covered.

Parameter configuration for safety-related applications

Further details are described in the corresponding Functional Safety Manual

Available in the Download Area of the Endress+Hauser website (www.endress.com/downloads).

Behavior of device

Behavior of device during operation and in case of error

Device behavior in locked state

After locking, additional diagnostics are active and critical parameters in the safety path are set to safe values. Therefore, device behavior in the " locked state" may deviate from the "nonlocked state". If a test phase takes place before the system is finally put into production, it is recommended that this test phase be run in the locked state in order to obtain the most conclusive results possible.

Device behavior when switched on

When switched on, the device runs through a diagnostic phase lasting approx. 20 s. During this time, the current output is at error current. For 5 s during the diagnostic phase, this current is ≤ 3.6 mA.

After that, depending on the setting of the **Start-up mode** parameter, the current is:
- at the MIN value: ≤ 3.6 mA
- at the MAX value: ≥ 21 mA

During the diagnostic phase, no communication is possible via the service interface (CDI) or via HART.

Behavior of device on demand

The device outputs a current value corresponding to the limit value to be monitored. This value must be monitored and processed further in an attached logic unit.

Device response in the event of alarms or warnings

Fault current

In the event of an alarm, the output current is set to the configured value of ≤ 3.6 mA or ≥ 21 mA.

In some cases (e.g. failure of power supply, a cable open circuit and faults in the current output itself, where the error current ≥ 21 mA cannot be set), output currents ≤ 3.6 mA irrespective of the configured fault current can occur. In some other cases (e.g. short circuit of cabling), output currents ≥ 21 mA can occur irrespective of the configured fault current.

For alarm monitoring, the logic unit must therefore be able to recognize both HI-alarms (≥ 21 mA) and LO-alarms (≤ 3.6 mA).

Alarm and warning messages

Additional information is provided by the alarm and warning messages in the form of error codes and associated clear text messages.

The following table shows the correlation between the error code and the current output:

Error code (BA01001F)	Current output (message type)	Note
Fxxx	≥ 21 mA or ≤ 3.6 mA	xxx = three-digit number
Mxxx	corresponding to measuring mode	xxx = three-digit number
Cxxx	corresponding to measuring mode	xxx = three-digit number
Sxxx	corresponding to measuring mode	xxx = three-digit number
Exceptions:		
M272	≥ 21 mA or ≤ 3.6 mA	Main electronic failure
C484	≥ 21 mA or ≤ 3.6 mA	Simulation failure mode
S942	≥ 21 mA or ≤ 3.6 mA	In safety distance

When locking is active on the device, additional diagnostics are activated (e.g. a comparison between the readback-current with the nominal value). If one of these diagnostics results in an error message (e.g. F803 loop current) and the locking is then deactivated, the error message remains while the error persists, even if the diagnostics is no longer active in the unlocked state. In this case, the device must be disconnected briefly from the power supply (e.g. by unplugging the terminals). When the device is then restarted, a self-check is carried out, and the error message is reset where applicable.

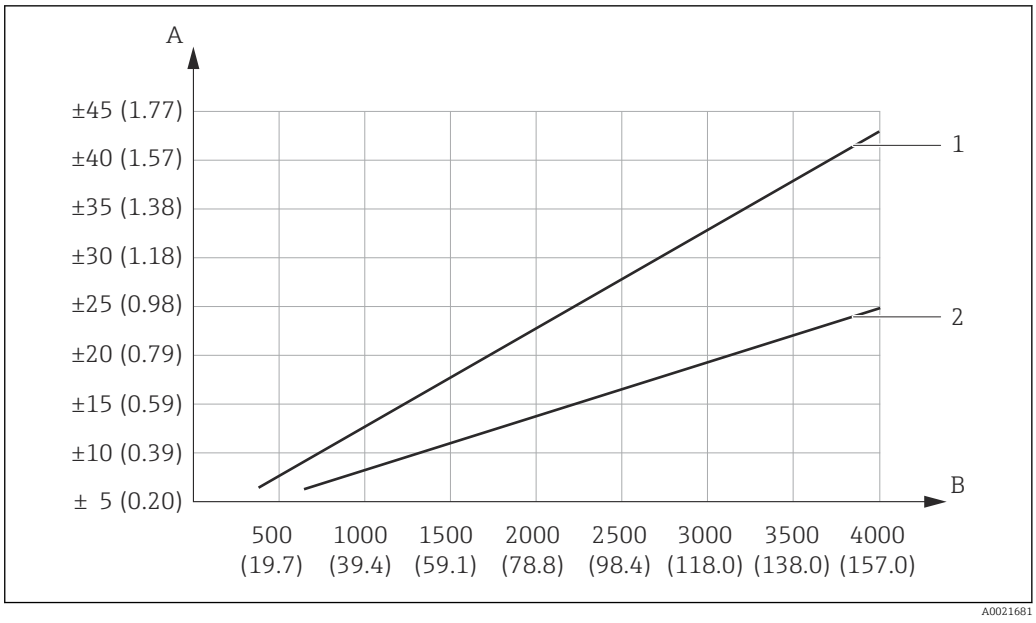
Error of measurement

The measured error (full scale) is 2 % for use of Levelflex FMP54 as part of limiting device.

Under the influence of the gas phase, the propagation speed of the measuring signals changes with the result that a greater error of measurement is to be expected as the pressure increases. A level that is too low is displayed systematically.

The impact on the measuring signal can be compensated with the gas phase compensation option (Feature 540 "Application Package", version "EF", "EG").

If the gas phase compensation option is used, the greater the reference distance L_{ref} and smaller the measuring range, the higher the accuracy under reference operating conditions:



A measuring error
B distance liquid/flange
1 reference distance L_{ref} = 300 mm (11.8 in)
2 reference distance L_{ref} = 550 mm (21.7 in)

If there are fast changes in pressure, there may be an additional error, since the measured reference distance is filtered with the time constant of the level measurement. Furthermore, states of non-equilibrium (e.g. caused by heating) can lead to density and pressure gradients in the medium as well as to condensation of steam at the probe. As a result, levels that are somewhat different may be measured at different places in the tank. Application-specific influences of this type can increase the specified error of measurement (typically up to a factor 2 to 3).

Maintenance

⚠ CAUTION

During operation, the device is hot. Steam or hot water can come out when the probe is released!

Risk of burns/scalds

- ▶ Only carry out installation and maintenance work when the device has cooled down!
- ▶ Only disassemble the device when the boiler pressure is 0 bar (0 psi)!

To ensure process safety during configuration, testing and maintenance work on the device alternative monitoring measures must be taken.

Further details are described in the corresponding Operating Instructions

Available in the Download Area of the Endress+Hauser website (www.endress.com/downloads).

Checking device operativeness

The operativeness and safety of the limiter must be checked at regular intervals.

Perform the proof-test so that correct functioning of the limiting device is verified in combination with all components. To do this, check the measurement and trip function, e.g. by reducing or increasing the water level.

Further details are described in the corresponding Functional Safety Manual

Available in the Download Area of the Endress+Hauser website (www.endress.com/downloads).

Repairs

Further details are described in the corresponding Functional Safety Manual

Available in the Download Area of the Endress+Hauser website (www.endress.com/downloads).

Certificates

Current certificates and approvals for the product are available at www.endress.com on the relevant product page:

1. Select the product using the filters and search field.
2. Open the product page.
3. Select **Downloads**.

Related certificate

TÜV NORD - Certificate
- Tested in accordance with:
  - EN 12952-11:2007
  - EN 12953-9:2007
- **Registered No. 44 799 13761302**

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