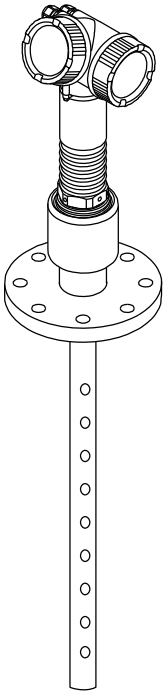
SD01071F/00/EN/02.24
71660422

Planning instructions for steam boiler approval **Levelflex FMP54**

Guided level radar as a limiting device for low water and high water levels



Endress+Hauser
People for Process Automation

Table of contents

Introduction

Supplementary device documentation

Documentation	Contents	Comment
SD00349F	Levelflex FMP54 – Guided level radar as a limiting device for low water and high water levels	Safety instructions for steam boiler approval
SD00326F	Levelflex FMP50/51/52/53/54/55/56/57 – Guided level radar for liquids and bulk solids with 4 to 20 mA output signal	Functional Safety Manual
TI01001F	Levelflex FMP51, FMP52, FMP54 – Guided level radar Level and interface measurement in liquids	Technical Information

Wiring scheme options

The following standards define the requirements for the equipment of steam boiler systems, in particular for water level limiters for low water levels (LWL) and high water levels (HWL):
- EN 12952-7: "Water-tube boilers and auxiliary installations - Part 7: Requirements for equipment for the boiler"
- EN 12953-6: "Shell boilers - Part 6: Requirements for equipment for the boiler"

The standards EN 12952-11, section 4.1.1 and EN 12953-9, section 4.1.1 stipulate that:
A limiter must be designed in such a way that a single error in any of the assigned components does not result in the loss of the safety function.

For this reason, the following wiring scheme options are possible:

Architecture	Number of FMP54
1oo2	▪ 2x FMP54
2oo3	▪ 3x FMP54

In general, for system availability reasons, the wiring scheme with three Levelflex devices is recommended.

Thanks to a signal comparison, "Predictive maintenance" is also possible, regardless of the safety function!

Typical examples of wiring schemes

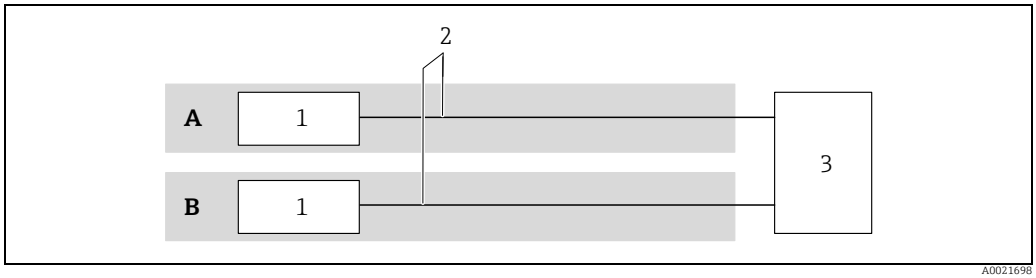
The following diagrams show some (schematic) examples of the wiring scheme for the FMP54 when used in limiting devices.

Where the devices are used as both controllers and limiters:
Absence of reaction as per EN 12952-11 or EN 12953-9, section 4.1.2:
Limiters must function independently of each other and independently of the control equipment, except in cases where the safety function cannot be compromised by these other devices.

Extract from VDI/VDE 2180-3, section 2.2.1:
It is advisable to have a strict division between the protection functions and the functions of the PCS operating and monitoring equipment. If, however, there is an overlap, there must be no feedback from the non-safety-related component to the protection function.

1oo2 architecture

Example 1a + 1b



A0021698

A *Channel 1*
B *Channel 2*

1a: 1x low water level (LWL), 1x high water level (HWL)

1 Levelflex FMP54 (2-wire/4-wire)
2 4 to 20 mA wire
3 Safety PLC
1oo2 architecture:
– 1x low water level (LWL)
– 1x high water level (HWL)
– Signal comparison recommended

1b: 2x low water level (LWL), 1x high water level (HWL)

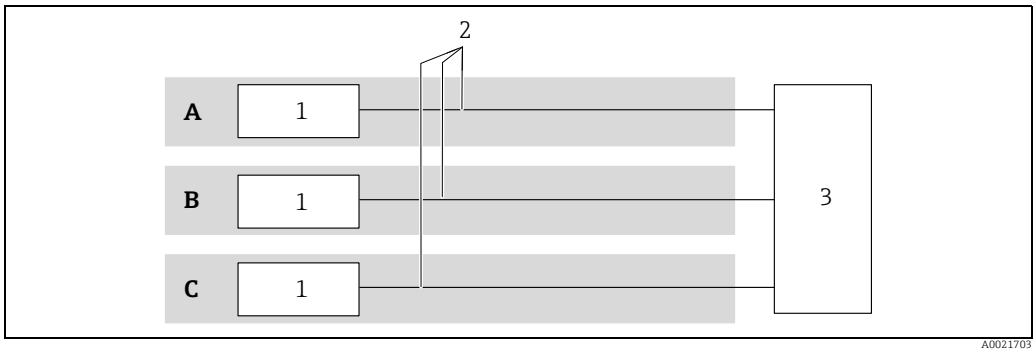
1 Levelflex FMP54 (2-wire/4-wire)
2 4 to 20 mA wire
3 Safety PLC
1oo2 architecture:
– 2x low water level (LWL)
– 1x high water level (HWL)
– Signal comparison necessary (comparison of channel 1 with channel 2)

2oo3 architecture

This allows a possibly defective device to be replaced by blocking it off (bypass solution) while continuing to operate the boiler. The has the benefit of increased availability.

Alternatively, in the case of in-boiler instrumentation, a 1oo2 wiring scheme can be used until the next scheduled shutdown.

Example 2a + 2b



A *Channel 1*
B *Channel 2*
C *Channel 3*

2a: 1x low water level (LWL), 1x high water level (HWL), increased availability

1 Levelflex FMP54 (2-wire/4-wire)
2 4 to 20 mA wire
3 Safety PLC
2oo3 architecture:
- *1x low water level (LWL)*
- *1x high water level (HWL)*
- *Signal comparison recommended*

2b: 2x low water level (LWL), 1x high water level (HWL), increased availability

1 Levelflex FMP54 (2-wire/4-wire)
2 4 to 20 mA wire
3 Safety PLC
1oo2 architecture:
- *2x low water level (LWL)*
- *1x high water level (HWL)*
- *Signal comparison necessary*
  (Comparison of channel 1 with channel 2, comparison of channel 2 with channel 3, comparison of channel 1 with channel 3)

Application example

The following topics serve as the basis for key questions concerning the design of the system.
An example is provided in each case for illustration purposes.

This procedure can be applied in the same way to other applications.

Function

Key question:
What is the required function ?

Example:
A limiting function (2x low water level (LWL), 1x high water level (HWL)) is required as well as a control function.

Choosing the wiring scheme

Key question:
How will the individual devices in the safety system be wired?

Example:
In this example, the simplest possible instrumentation is favoured.

For this reason, the number of devices should be kept as small as possible.
A 1oo2 architecture is chosen as the wiring scheme in accordance with example 1b.

Alternatively, a 2oo3 wiring scheme could have been chosen here, which affords increased availability.

Mounting location

Key question:
Will the devices be installed directly in the boiler or in a bypass?

Example:
To achieve the simplest possible instrumentation, they should be installed directly in the boiler.

Alternatively, bypass instrumentation could have been chosen which, in the event of a revision, allows the measuring device to be closed off and replaced without switching off the system.

Key question:
Is gas phase compensation required?

Example:
The boiler is operated at 264 °C (507 °F) and 50 bar (750 psi). The measured error without gas phase compensation would, according to the table (→ TI01001F), be 9.2% of the measured distance.
The normal water level is 1200 mm (47.2 in) below the flange (reference point of FMP54). The measured error would therefore be 1200 mm (47.2 in) x 9.2% = 110 mm (4.33 in).

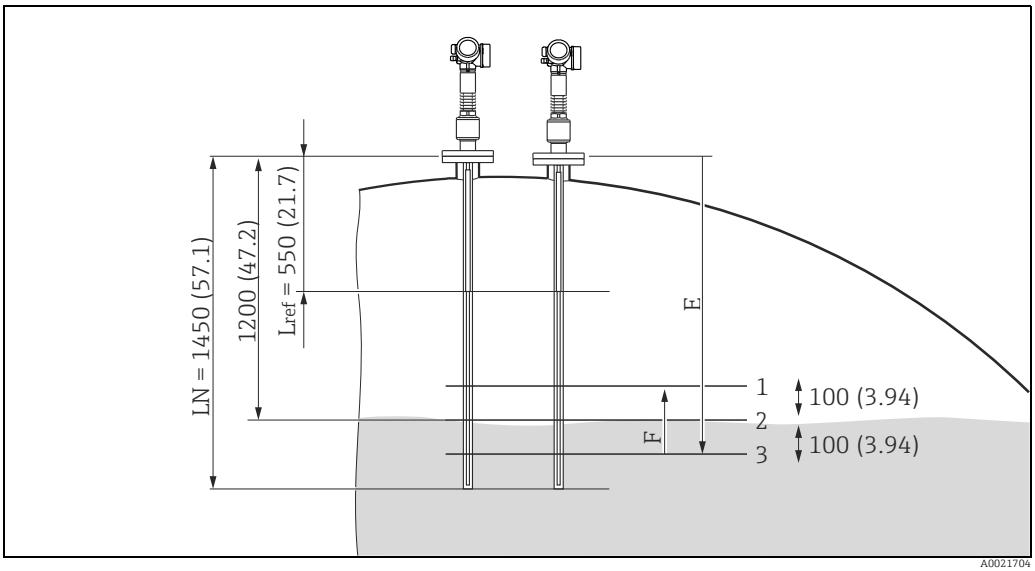
With gas phase compensation and using a reference length of 550 mm (21.7 in), the expected measured error at the same temperature is only 9 mm (0.35 in). Using a reference length of 300 mm (11.8 in), it is only 15 mm (0.59 in).
Due to the higher level of accuracy, gas phase compensation with a reference length of 550 mm (21.7 in) is chosen in this case. In this situation, where the devices are installed freely in the boiler, the use of coaxial probes is required.

Measuring range and switch points

Key question:
Where will the switch points and the control range be in relation to the mounting flange?

Example:
In this example, the normal water level is 1200 mm (47.2 in) below the flange. The high water level (HWL) and the low water level (LWL) are each at a distance of 100 mm (3.94 in) from the normal water level (NWL).

The control range shall be between the high water level (HWL) and the low water level (LWL).
The reference distance (Lref) of 550 mm (21.7 in) is at a sufficient distance from the high water point.
The probe length selected is 1450 mm (57.1 in), which is somewhat greater than the low water level (LWL). This is because higher measurement uncertainties occur directly at the probe tip.



Dimensions: mm (in)
LN Probe length
Lref Reference distance

1 High water level (HWL)
2 Normal water level (NWL)
3 Low water level (LWL)

E Empty calibration
F Full calibration

When selecting the switch points (HWL and LWL), the following measured errors must be taken into account and added on:
- The application-related measurement uncertainty due to the gas phase is 9 mm (0.35 in).
- The measurement uncertainty of the safety-related output signal of the FMP54 is 2% of the span. Therefore, 2% x 2 x 100 mm (3.94 in) = 4 mm (0.16 in).

In the application example, this results in a possible measurement uncertainty of 13 mm (0.51 in).

The switch point for the low water level (LWL) must therefore be set to:
100 mm (3.94 in) – 13 mm (0.51 in) = 87 mm (3.43 in) below the normal water level (NWL).
And the switch point for the high water level (HWL) must be set to:
100 mm (3.94 in) – 13 mm (0.51 in) = 87 mm (3.43 in) above the normal water level (NWL).

FMP54 setup

Both FMP54 devices must be calibrated in exactly the same way:

- Empty calibration: 1200 mm (47.2 in) + 100 mm (3.94 in) = 1300 mm (51.2 in)
- Full calibration: 2 x 100 mm (3.94) = 200 mm (7.87 in)

Commissioning

Commissioning is carried out in accordance with the description in SD00349F, "Installation and commissioning" section.

If no further parameter settings are required, commissioning can be done in what is called "increased safety mode". This has the advantage that there is no need to change the level in the boiler during commissioning. Instead, it is sufficient to

- carry out an automated "device test"
- simulate distance values which are slightly above or below the high water level (HWL) and low water level (LWL) switch points, in order to test the function of the entire safety system

Ideally, the correct function of the actuator should be verified directly at the same time. This should be done initially while the first Levelflex operates as normal and the distance value is simulated at the second Levelflex, and subsequently while the second Levelflex operates as normal and the distance value is simulated at the first Levelflex. If the switch points are exceeded by one or both devices, this must cause the actuator to be switched (1oo2 wiring scheme).
As no application-related measured errors occur during a distance simulation, only the measurement uncertainties of the safety-related output signal of the FMP54 need to be taken into account i.e. 4 mm (0.16 in). Therefore, to test the LWL switch point at a distance of 1.283 mm (50.5 in) from the flange, the safety function must not yet be activated by a distance simulation value of 1.283 mm (50.5 in) − 4 mm (0.16 in) = 1.279 mm (50.4 in).
A distance simulation value of 1.283 mm (50.5 in) + 4 mm (0.16 in) = 1.287 mm (50.7 in) must cause the safety function to be activated. The same applies to the HWL switch point.

The Levelflex FMP54 is included in the test using both procedures (testing with and without actuator). Separate testing of its current output is therefore not required.

Proof-test

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

Perform the test so that correct functioning of the limiting device is verified in combination with all components. To do this, the measurement and activation function must be tested by lowering or raising the water level (→ SD00349F).

Procedure for this example:
Fill up to the HWL point 100 mm (3.94 in) above the normal water level (NWL), and verify that the safety function is activated for the high water level (HWL). Also, reduce to LWL point 100 mm (3.94 in) below the normal water level (NWL), and verify that the safety function is activated for the low water level (LWL).
Premature activation is permitted within the error limits, as the switch points have been set in a safety-oriented manner.

During testing it must be ensured that a dangerous system condition cannot occur.

If the functional capability is implemented through simulation, the requirements of the relevant standards must also be fulfilled.

For example, EN 12952-7, section 4.5.2 (for water tube boilers):
"It must be possible to carry out functional testing of the limiter at all times for each operating status, e.g. through simulation. If part of the functional test requires that the disconnecting and switching off of the heating system be delayed, the time delay must not exceed the value set by the manufacturer. For boilers with water level limiters, the time delay must not exceed the time taken for the water level to drop from the lowest water level monitored to the lowest water level (LWL) permitted during maximum continuous output..."

www.addresses.endress.com

Endress+Hauser

People for Process Automation