Technical Information
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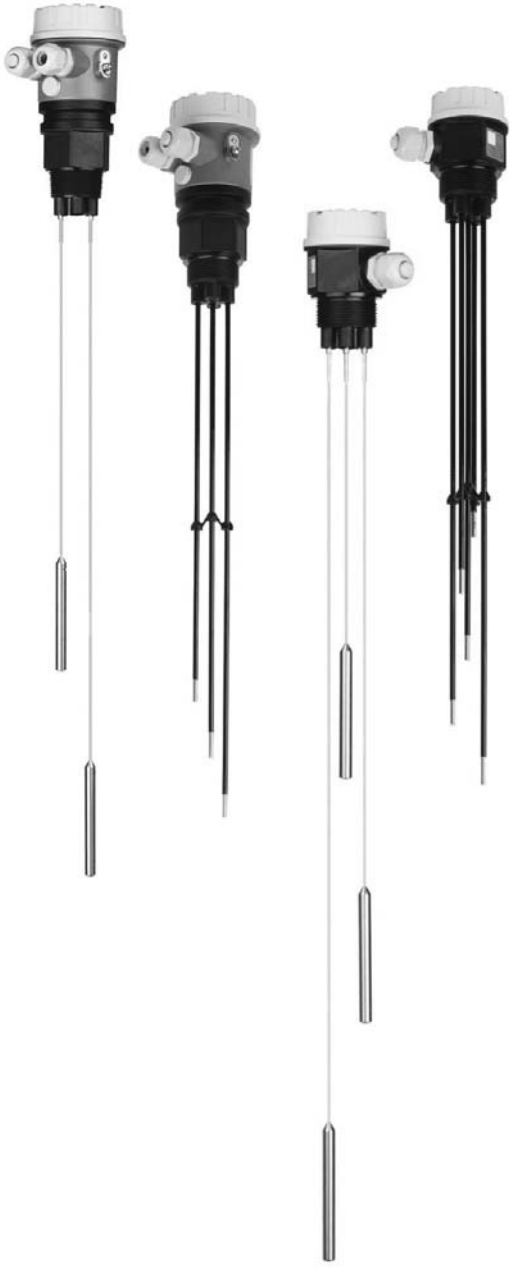
196653 08/10 01

Conductive Limit Switch LKL-P1, LKL-P2

Level limit switch for multiple point detection in conductive liquids



Applications

The LKL-P* level limit switch is used in conductive liquids (as of 10 µS/cm) for conductive level limit detection.

Depending on the number of measuring points (up to 5 rods or ropes), measuring tasks such as overfill protection, dry running protection, two-point control of pumps or multiple point detection can be implemented with only one process connection.

Your benefits

- Detect up to five point levels with one probe
- Two-point control and additional MAX- and MIN-detection
- Option between rod or rope version for optimum adaptation to the application
- Flexible instrumentation:
  - with built-in electronic insert, either transistor (PNP) or relay output
  - for connection to a separate transmitter power supply unit
- No adjustment required; standard setting for the most common conductive liquids
- No moving parts in the tank:
  - long service life
  - reliable operation with no wear or blockages
- WHG approval
- Simple adaptation to different conductivities

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Function and system design

Measuring principle

An alternating voltage exists between the rod probes in an empty tank. As soon as the conductive liquid in the tank creates a connection between the ground probe rod and, for example, the MAX probe rod, a measurable current flows and the LKL-P* switches. With point level detection, the LKL-P* switches back as soon as the liquid clears the MAX probe.

With two-point control, the LKL-P* does not switch back until the MAX and MIN probe is cleared. Using alternating voltage prevents corrosion of the probe rods and electrolytic destruction of the product.

The material used for the tank walls is not important for measurement because the system is designed as a closed potential-free circuit between the probe rods and the electronics.

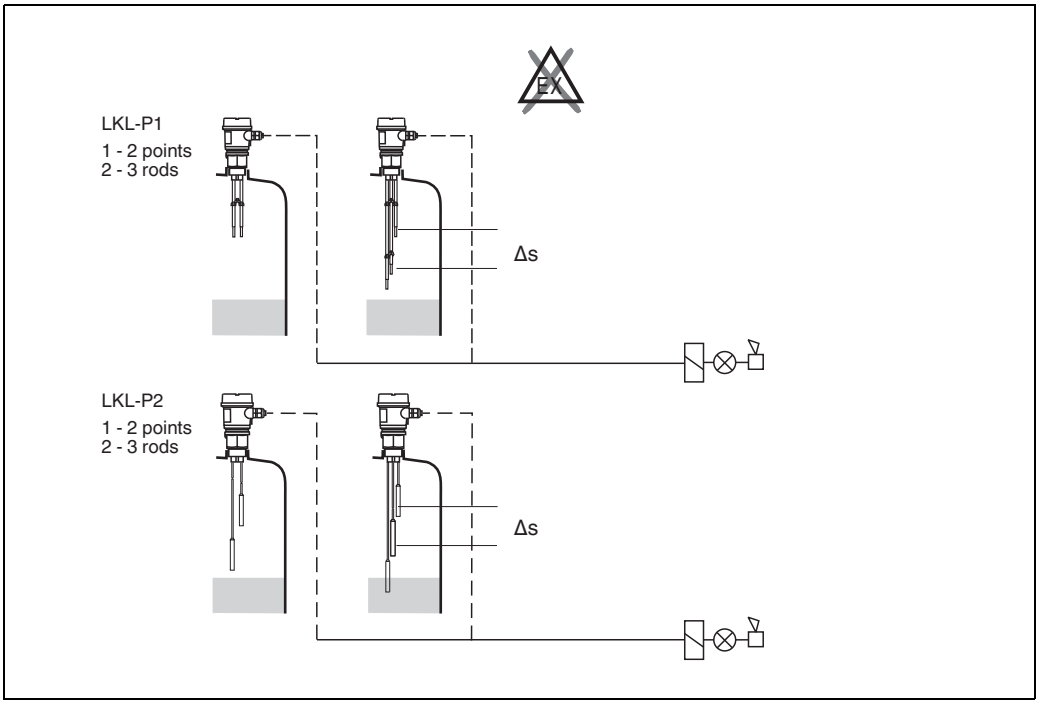
There is absolutely no danger if the probe rods are touched during operation.

Measuring system

Probes with integrated electronic insert (compact instrumentation version)

The measuring system consists of:

- LKL-P1 with rods or LKL-P2 with ropes and an electronic insert
- Control units, switches or signal transmitters, e. g. process control systems PLC, relays, etc.



Independent of the tank material

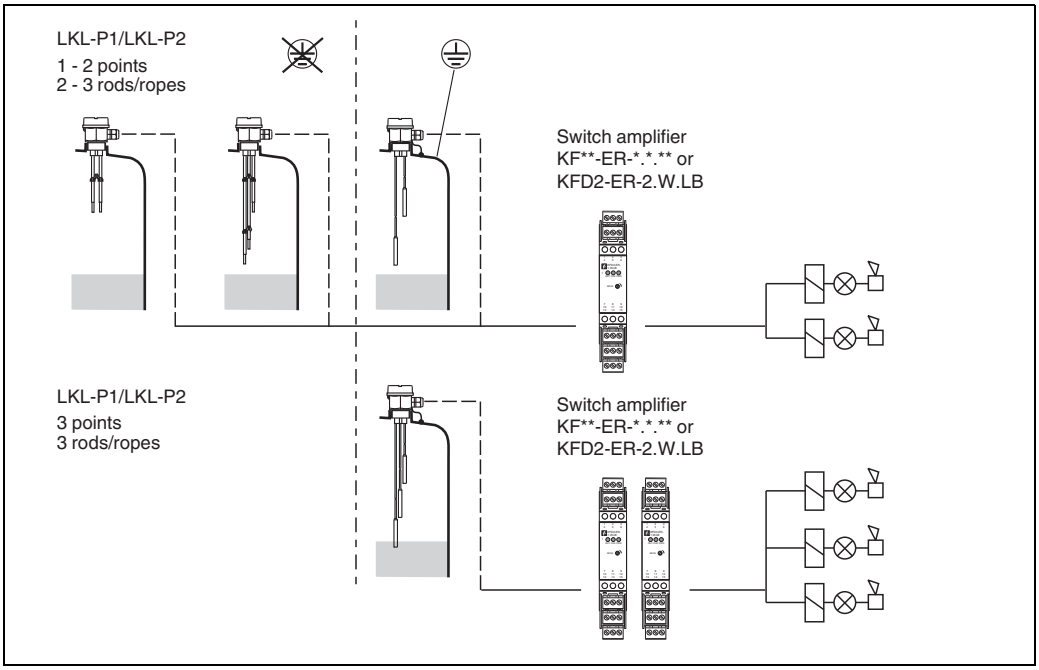
Note!

The compact instrumentation version with three probes or rods is always used in Δs mode.

Probes without integrated electronic insert (separate instrumentation version) for one or two point detection respectively

The measuring system consists of:

- LKL-P1, LKL-P2 with two/three rods or ropes
- One or two switch amplifiers
- Control units, switches or signal transmitters, e. g. process control systems PLC, relays, etc.

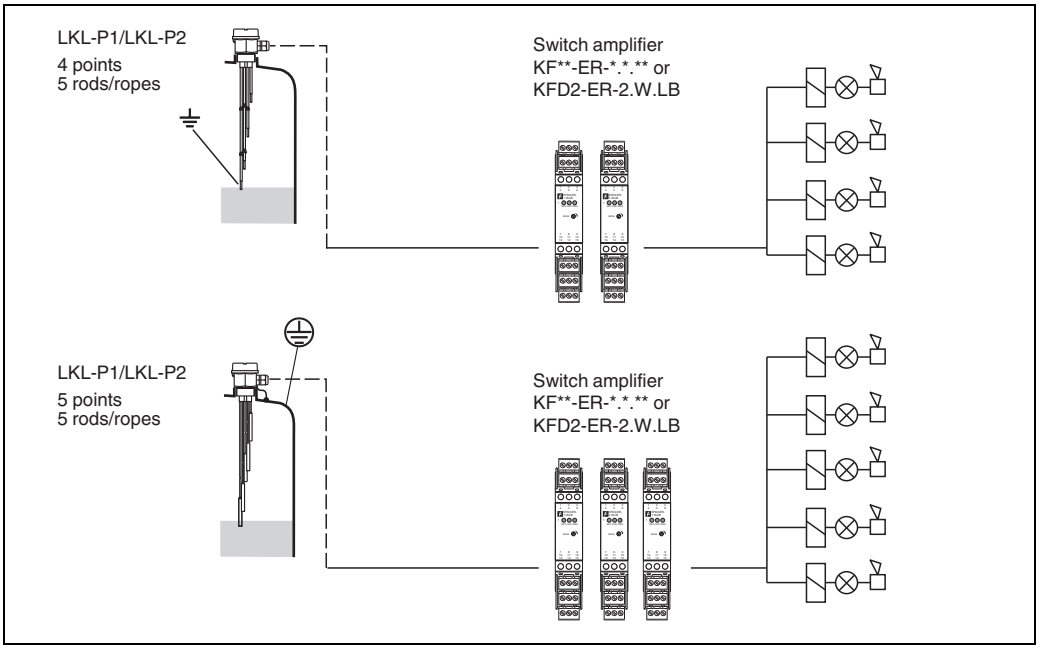


Switch points dependent on the tank material

Probes without integrated electronic insert for multiple point detection

The measuring system consists of:

- LKL-P1, LKL-P2 with five rods or ropes
- Two or three switch amplifiers
- Control units, switches or signal transmitters, e. g. process control systems PLC, relays, etc.



Switch points dependent on the tank material

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Input

Measured variable

Resistance change between two conductors caused by the presence or absence of a conductive liquid.

Measuring range (application)

The measuring range is dependent on the mounting location of the probes.
Rod probes can have a max. length of 4000 mm and rope probes up to 15000 mm.

Input signal

Probes covered →a measurable current is flowing between the probes.
Probes uncovered →there is no measurable current flowing between the probes.

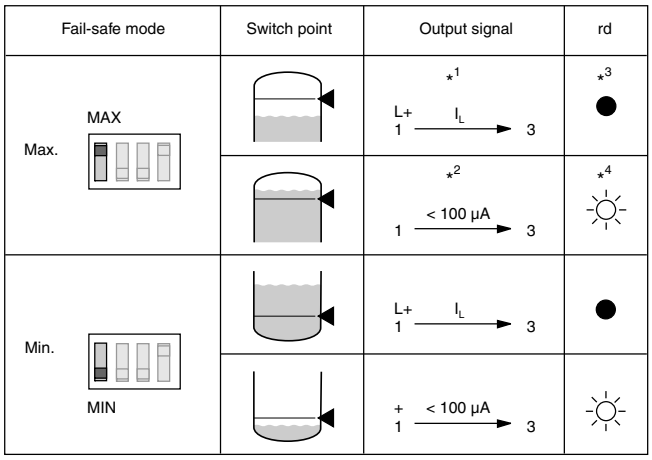
Output

Electronic insert E5 (FEW52), DC-PNP

Output signal

Three-wire DC version

Preferred in conjunction with programmable logic controllers (PLC).
Positive signal at the switch output of the electronics (PNP).
The output is blocked after the point level is reached.



*1 = load current (connected); *2 residual current (disconnected); *3 LED not lit; *4 LED lit

If the probe is covered and the red LED flashes continuously, the sensitivity was set to high. Set a smaller sensitivity to ensure a safe switch point even if the conductivity of the medium varies slightly.

Fail-safe mode

Selecting the correct fail-safe mode ensures that the output always runs in quiescent current fail-safe.

- MAX fail-safe: the output voltage is 0 V if the switch point is exceeded (probe covered), a fault occurs or the power supply fails.
- MIN fail-safe: the output voltage is 0 V if the switch point is undershot (probe uncovered), a fault occurs or the power supply fails.

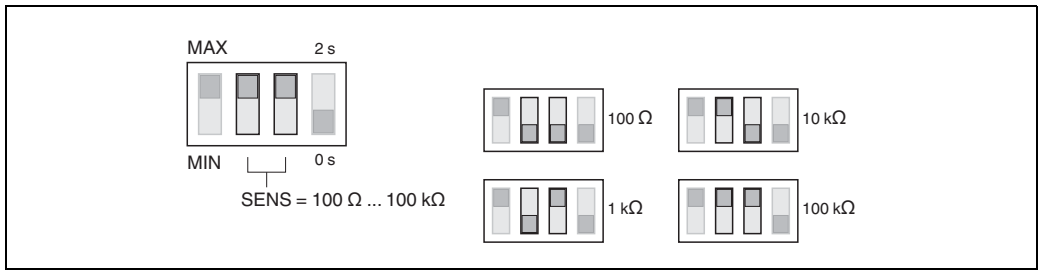
Switching delay

A switching delay of 2.0 s can be activated or deactivated via a DIL switch.
If the switching delay is set to 0 s, the device switches after approx. 0.3 s.

Sensitivity

The device operates in one of four sensitivity levels (100 Ω, 1 kΩ, 10 kΩ oder 100 kΩ) The sensitivity level can be set with two DIL switches (SENS).

Setting on delivery: 100 Ω (highest sensitivity)



Signal on alarm

In the event of a power failure or a damaged probe: < 100 µA

Load

The load is switched via a transistor (PNP).

Cycled overload and short-circuit protection,

continuous ≤200 mA (short-circuit proof).

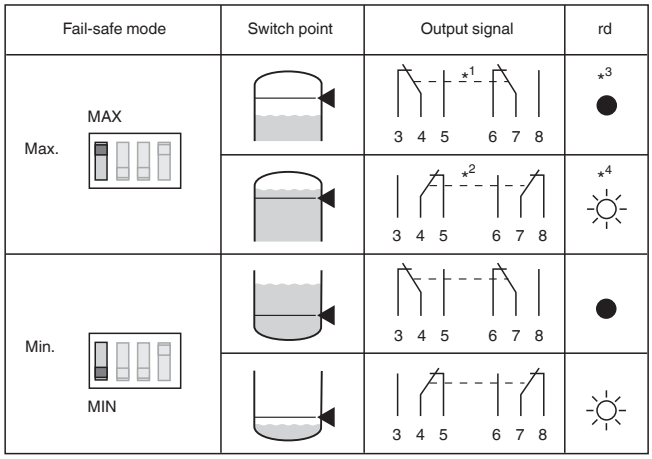
Residual voltage at transistor at I_{max} < 2.9 V

Electronic insert WA (FEW54), relay

Output signal

AC/DC connection with relay output

When connecting a device with high inductance, a spark barrier must be fitted to protect the relay contact. A fine-wire fuse (load-dependent) protects the relay contact in the event of a short-circuit. Both relay contacts switch simultaneously.



*1 = relay energised; *2 relay de-energised; *3 LED not lit; *4 LED lit

If the probe is covered and the red LED flashes continuously, the sensitivity was set to high. Set a smaller sensitivity to ensures a safe switch point even if the conductivity of the medium varies slightly.

Fail-safe mode

Selecting the correct fail-safe mode ensures that the relay always runs in quiescent current fail-safe.

- MAX fail-safe: the relay de-energizes when the switch point is exceeded (probe covered), a fault occurs or the power supply fails.
- MIN fail-safe: the relay de-energizes when the switch point is undershot (probe uncovered), a fault occurs or the power supply fails.

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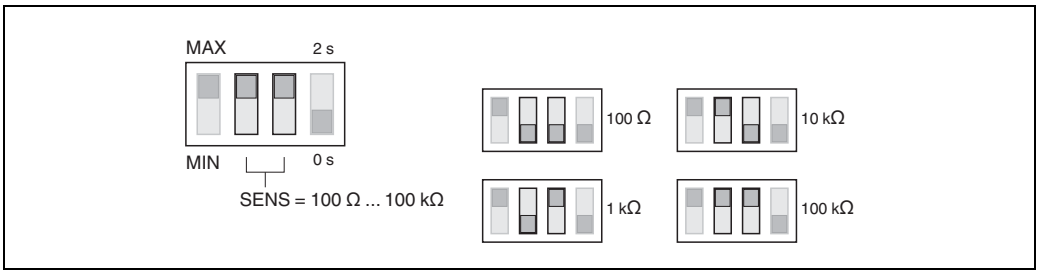
Sensitivity

The device operates in one of four sensitivity levels (100 Ω, 1 kΩ, 10 kΩ oder 100 kΩ) The sensitivity level can be set with two DIL switches (SENS).

Setting on delivery: 100 Ω (highest sensitivity)



Switching delay

A switching delay of 2.0 s can be activated or deactivated via a DIL switch.

If the switching delay is set to 0 s, the device switches after approx. 0.3 s.

Signal on alarm

Output signal in the event of a power failure or a damaged probe: relay de-energized.

Load

Loads are switched via 2 potential-free change-over contacts.

I~ max. 4 A, U~ max. 253 V;

P~ max. 1000 VA, cos φ = 1, P~ max. 700 VA, cos φ > 0.7;

I– max. 4 A to 30 V, I– max. 0.2 A to 150 V.

When connecting a functional extra-low voltage circuit with double insulation in accordance with IEC 1010: the sum of the relay output and power supply voltages is max. 300 V.

Galvanic isolation

All input channels, output channels and relay contacts are galvanically isolated from each other.

Electronic insert N1 (FEW58), NAMUR

Output signal

For connecting to switch amplifiers acc. to NAMUR (IEC 60947-5-6)

Output signal jump from high to low current on point level (**H-L edge**).

Fail-safe mode	Level	Output signal	LEDs green	LEDs yellow
Max.		+ 2 — 2.2 mA … 6.5 mA — 1	☼	☼
		+ 2 — 0.4 mA … 1.0 mA — 1	☼	●
Min.		+ 2 — 2.2 mA … 6.5 mA — 1	☼	☼
		+ 2 — 0.4 mA … 1.0 mA — 1	☼	●

☼ = lit ☼ = flashes ● = unlit

Fail-safe mode

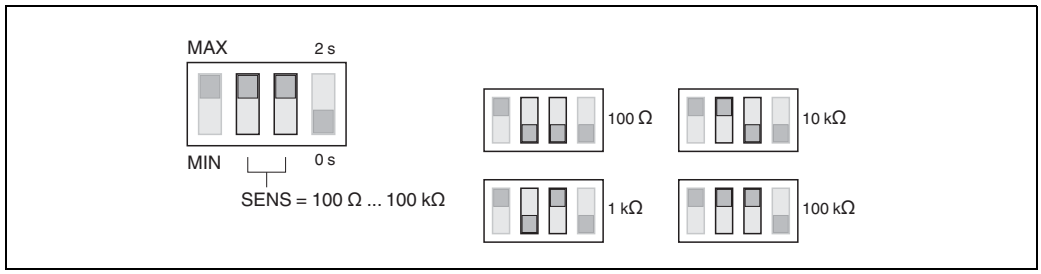
Selecting the correct fail-safe mode ensures that the relay always runs in quiescent current fail-safe.

- MAX fail-safe: the output signal is < 1.0 mA when the switch point is exceeded (probe covered), a fault occurs or the power supply fails.
- MIN fail-safe: the output signal is < 1.0 mA when the switch point is undershot (probe uncovered), a fault occurs or the power supply fails.

Sensitivity

The device operates in one of four sensitivity levels (100 Ω, 1 kΩ, 10 kΩ oder 100 kΩ) The sensitivity level can be set with two DIL switches (SENS).

Setting on delivery: 100 Ω (highest sensitivity)



Switching delay

A switching delay of 2.0 s can be activated or deactivated via a DIL switch.

If the switching delay is set to 0 s, the device switches after approx. 0.3 s.

Load

Refer to data sheet of the connected switch amplifier acc. to NAMUR (IEC 60947-5-6)

Cable monitoring

For probes without an electronic insert, an additional printed circuit board must be installed in the housing, which enables cable monitoring. It is always switched or connected between rod/rope 1 and 2.

Note!

When using switch amplifiers (transmitters) that do not support cable monitoring, these must be removed.

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Power Supply

Electrical connection (wiring diagrams)

Compact instrumentation with E5 (FEW52)

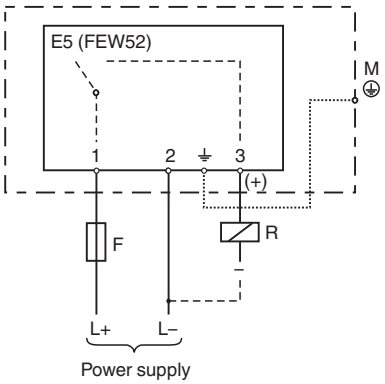
Transistor circuit for load

The load connected to terminal 3 is switched by a transistor, contactless and therefore without bouncing. In normal switching status, terminal 3 has a positive signal.

The transistor is blocked in the event of a level alarm or a power failure.

Protection against voltage peaks

When connecting a device with high inductance, always connect a voltage limiter.



Connecting the FEW52 electronic insert.

- F: Fine-wire fuse 500 mA, semi-time lag
- M: Ground connection to protective earth

Supply voltage E5 (FEW52)

- Supply voltage: U= 10.8 V ... 45 V
- Load connection: open collector; PNP
- Switching voltage: max. 45 V
- Connected load, continuous: max. 200 mA
- Protected against reverse polarity

Power consumption

- P < 1.1 W

Current consumption

- I < 25 mA (without load)

Compact instrumentation with WA (FEW54)

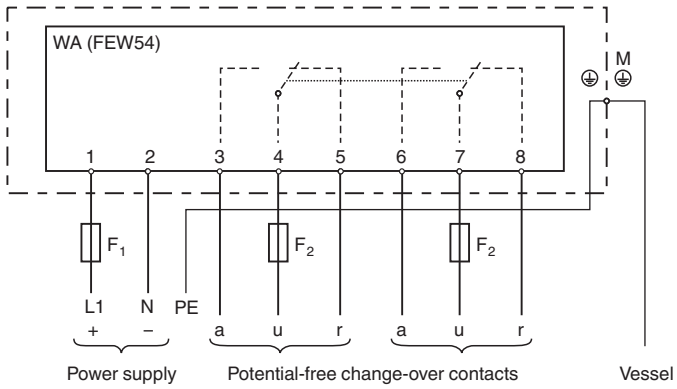
Relay contact circuit for load

The connected load is switched via potential-free relay contacts (change-over contact).

In the event of a level alarm or a power failure, the relay contacts break the connections between terminals 3 and 4 and terminals 6 and 7. The relays always switch simultaneously.

Protection against voltage peaks and short-circuits

When connecting a device with high inductance, fit a spark barrier to protect the relay contact. A fine-wire fuse (load-dependent) can protect the relay contact in the event of a short-circuit.



Connecting the FEW54 electronic insert.

- F_1: Fine-wire fuse 500 mA, semi-time lag
- F_2: Fine-wire fuse to protect the relay contact, load-dependent
- M: Ground connection to protective earth (PE)

Supply voltage WA (FEW54)

- Supply voltage: U⎓ 20 V … 55 V DC or U~ 20 V … 253 V AC, 50/60 Hz
- Peak inrush current: max. 2 A, max. 400 µs
- Output: two potential-free change-over contacts
- Contact load capacity: U~ max. 253 V, I~ max. 4 A, U⎓ 30 V/4 A; 150 V/ 0.2 A

Power consumption

- P < 2.0 W

Current consumption

- 60 mA

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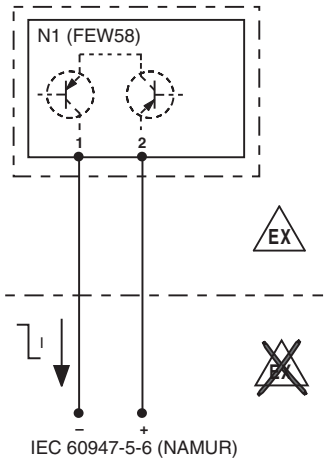
Compact instrumentation with N1 (FEW58)

To be used with a separate switch amplifier acc. to IEC 60947-5-6 (NAMUR);
Output signal jump from high to low current on point level (**H-L-edge**).

Signal transmission on a two-wire line: H-L-edge 2.2 mA ... 6.5 mA/0.4 mA ... 1.0 mA

When using a multiplexer the cycle time must be set to a minimum of 2 s.



Connecting the FEW58 electronic insert.

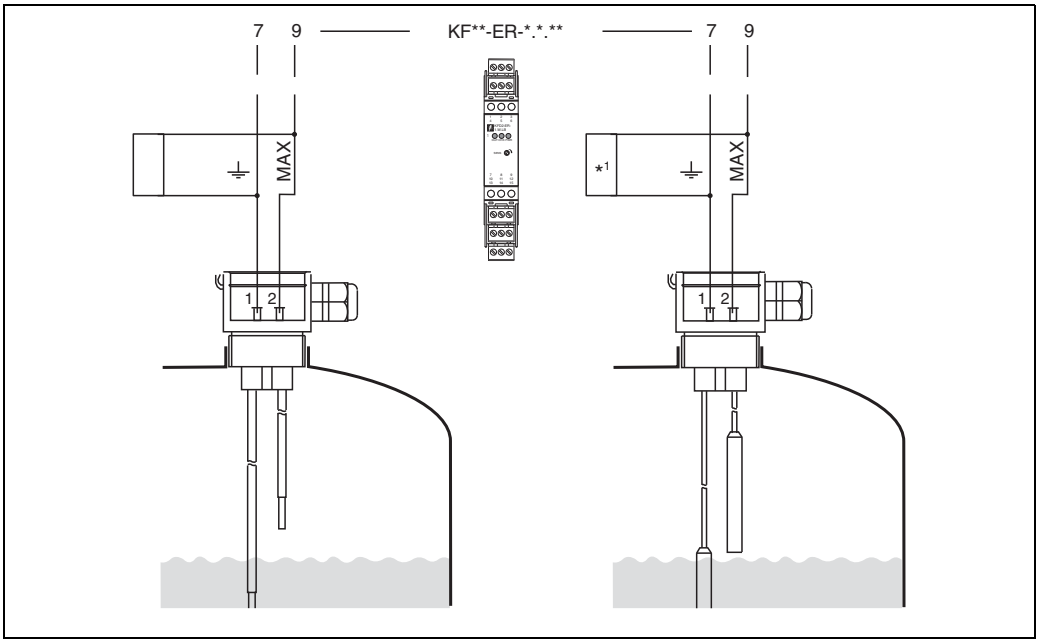
Supply voltage N1 (FEW58)

Refer to data sheet of the connected switch amplifier acc. to NAMUR (IEC 60947-5-6)

Signal on alarm

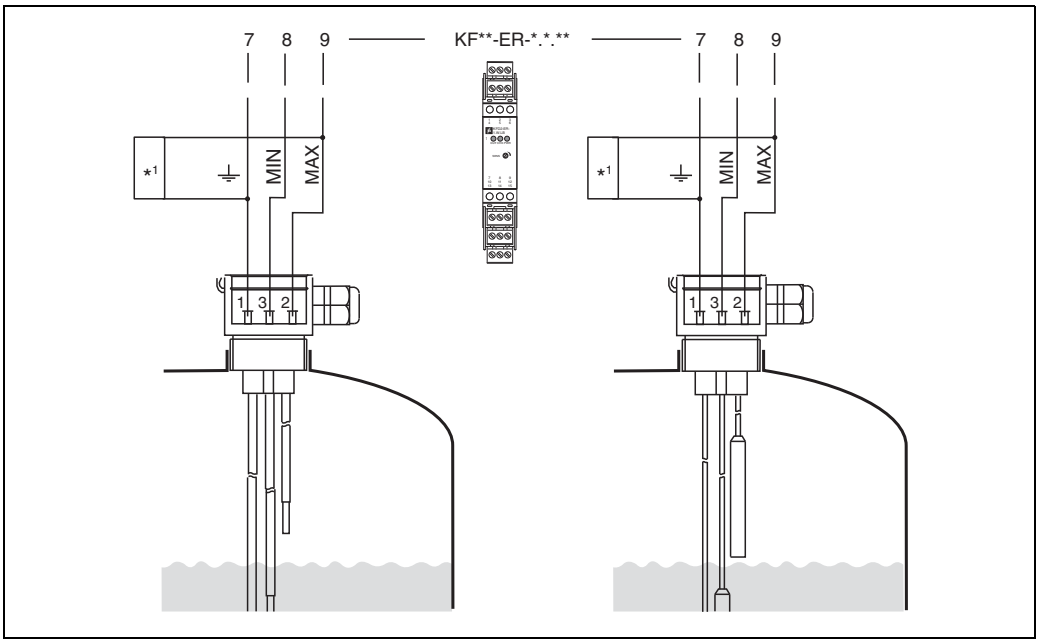
- Output signal with damaged sensor: < 1.0 mA

Separate instrumentation for two-rod or two-rope probes with cable monitoring



*1 Printed circuit board for cable monitoring (only required for probes with WHG certification.) The power supply and evaluation are provided by switch amplifiers.

Separate instrumentation for three-rod or three-rope probes with cable monitoring



*1 Printed circuit board for cable monitoring (only required for probes with WHG certification.) The power supply and evaluation are provided by a switch amplifier.

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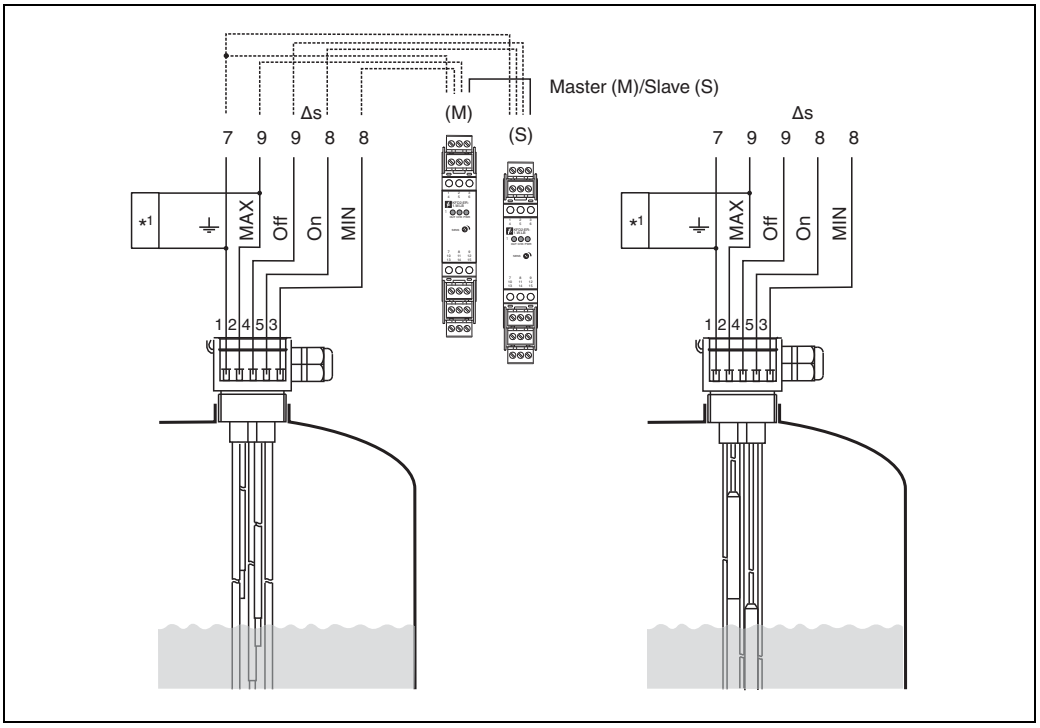
Separate instrumentation for five-rod or five-rope probes with cable monitoring



*1 Printed circuit board for cable monitoring (only required for probes with WHG certification.) The power supply and evaluation are provided by a switch amplifier.

Cable entry

M20 x 1.5

- Degree of protection: IP66
- Quantity in F24 housing: 1 (separate instrument version)
- Quantity in F16 housing: 2 (compact instrument version)

½ NPT

- Quantity in F24 housing: 1 (separate instrument version)
- Quantity in F16 housing: 2 (compact instrument version)
- Conductor cross-section (including wire end sleeve): 2.5 mm

Cable specifications

Use a commercially available cable (25 Ω per wire).

Accuracy with built-in electronic insert

Reference operating conditions	• Ambient temperature: 23 °C (296 K) • Medium temperature: 23 °C (296 K) • Medium viscosity: medium must release the probe again (drain off). • Medium pressure p_e: 0 bar • Probe installation: vertically from above
Measuring error	± 10 % at 100 Ω ... 100 kΩ ± 5 % at 1 kΩ ... 10 kΩ
Repeatability	± 5 % at 100 Ω ... 100 kΩ ± 1 % at 1 kΩ ... 10 kΩ
Hysteresis	-10 % for the MAX probe, in reference to the switch point. Δs function disabled.
Switch-on delay	< 3 s
Influence of ambient temperature	< 0.05 %/K

Installation conditions

Installation instructions

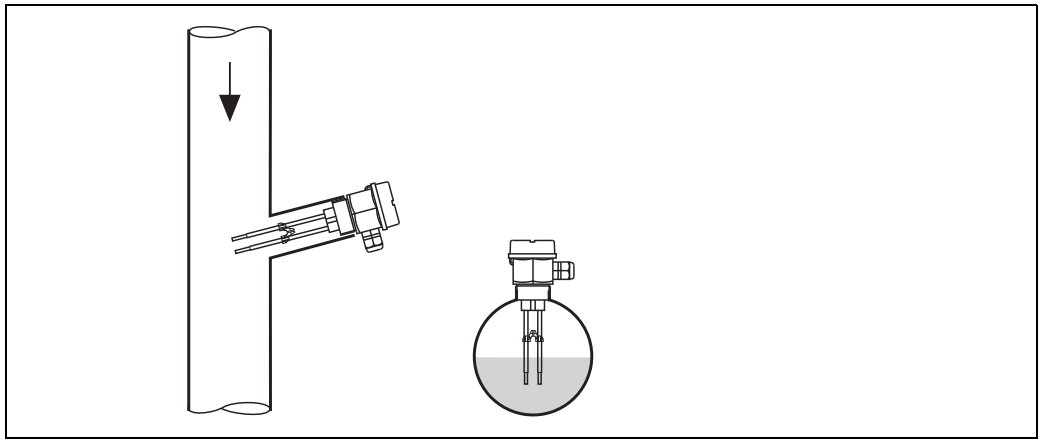
Mounting location

Tanks

The rod and rope probes are mounted predominantly in tanks.

Piping (partially filled)

Two-rod probes can be used in piping as, for example, dry running protection for pumps.



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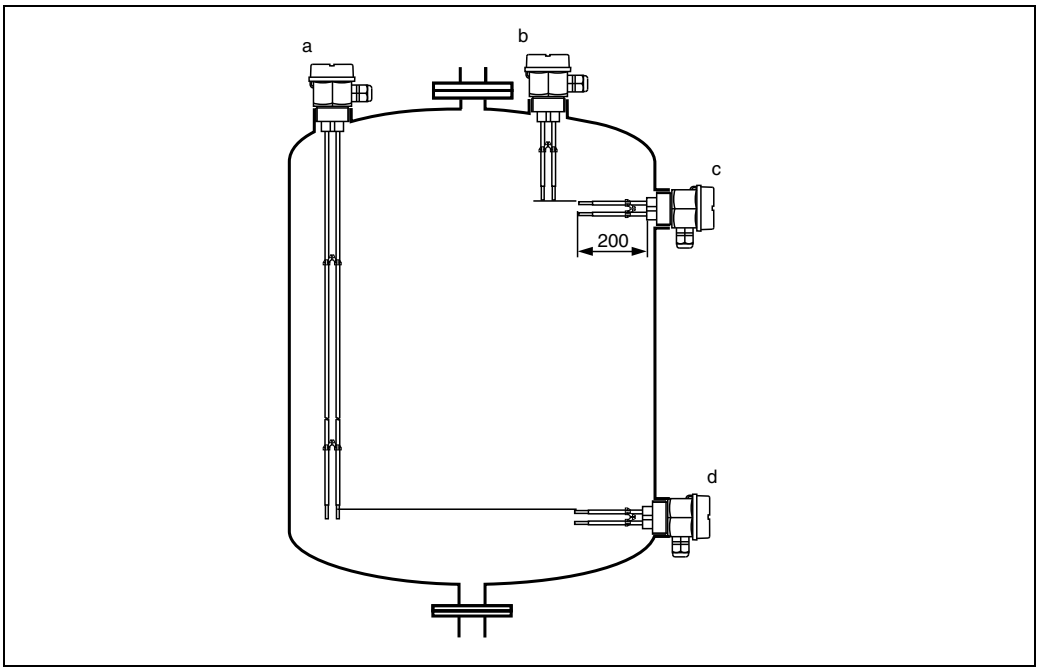
Orientation

Rod probes

Point level detection



a. Vertical mounting, MIN-detection; Probe length set to the point level required;
(Rods must not come into contact with the tank!)

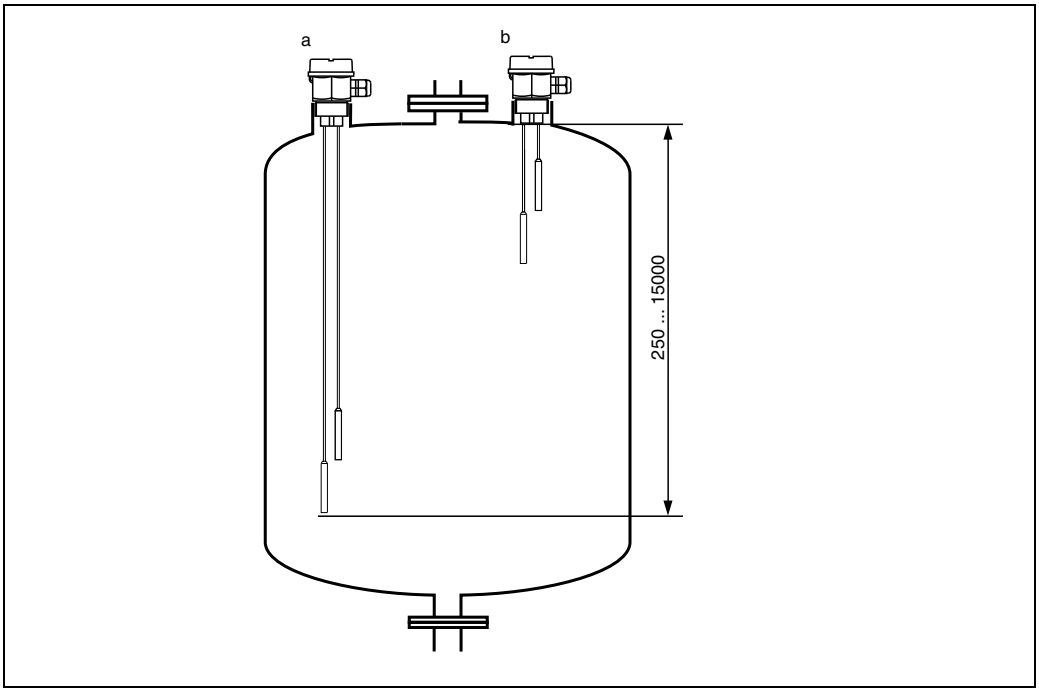
b. Vertical mounting, MAX-detection; Probe length set to the point level required

c. Lateral mounting, MAX-detection; Maximum probe length 200 mm (only applies to two-rod probes).

d. Lateral mounting, MIN-detection; Maximum probe length 200 mm (only applies to two-rod probes).

Rope probes

Point level detection

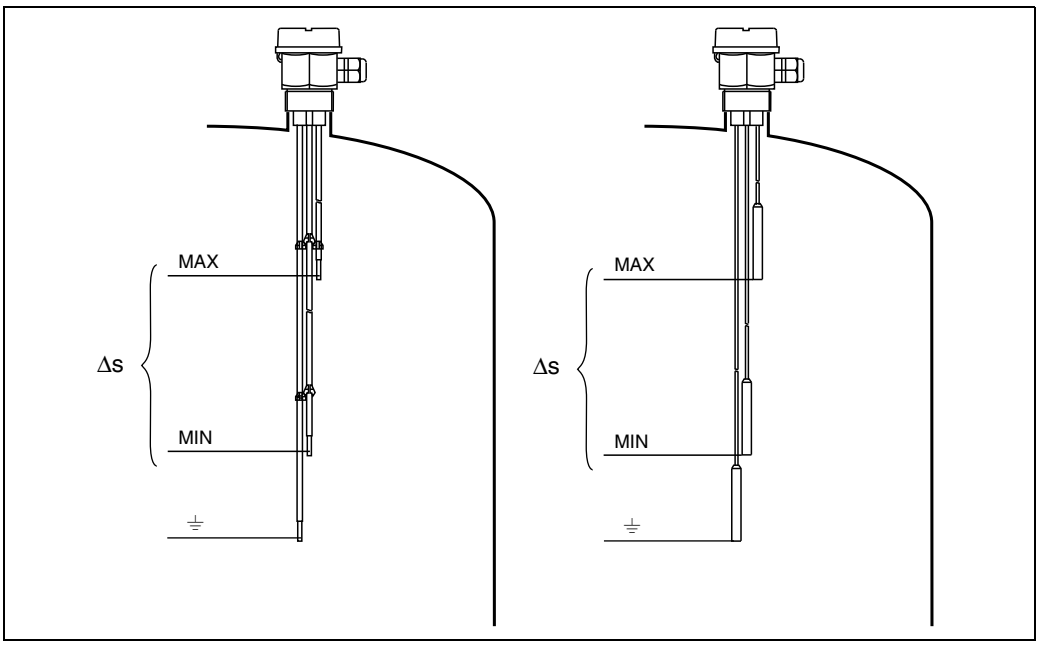


a. Vertical mounting, MIN-detection; Rope length set to the point level required;
(Rope ends must not come into contact with the tank!)

b. Vertical mounting, MAX-detection; Rope length set to the point level required.

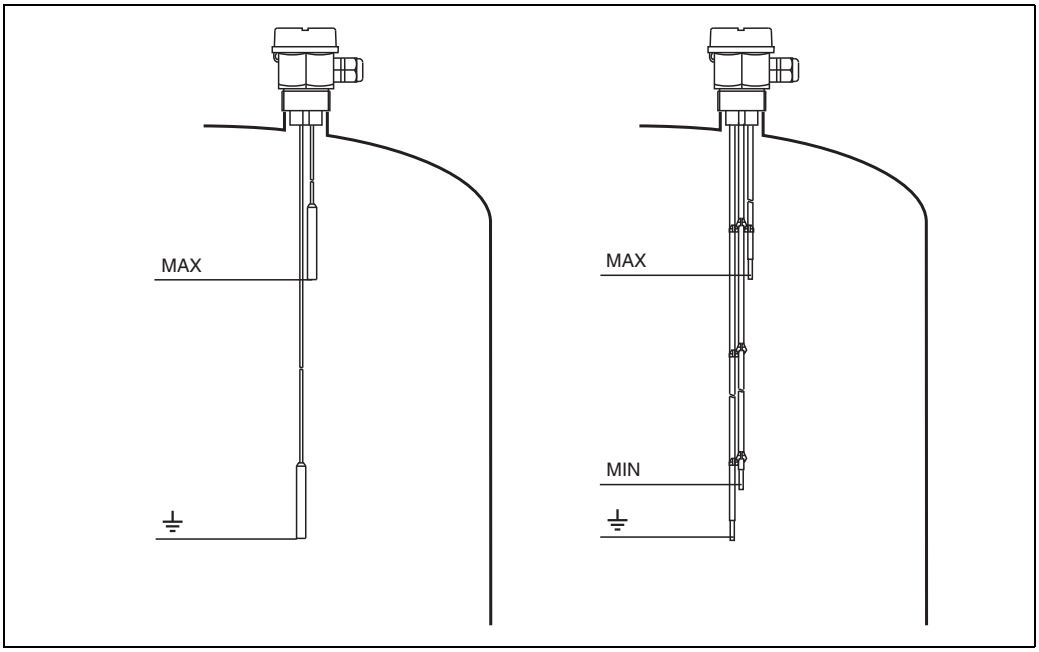
Example applications

Point level detection: Two-point control (Δs)



Two-point control (Δs) e.g. pump control

Point level detection: MAX-detection or MAX- and MIN-detection



Point level detection (MAX),
MAX- and MIN-detection for compact instrumentation version only possible with Δs.

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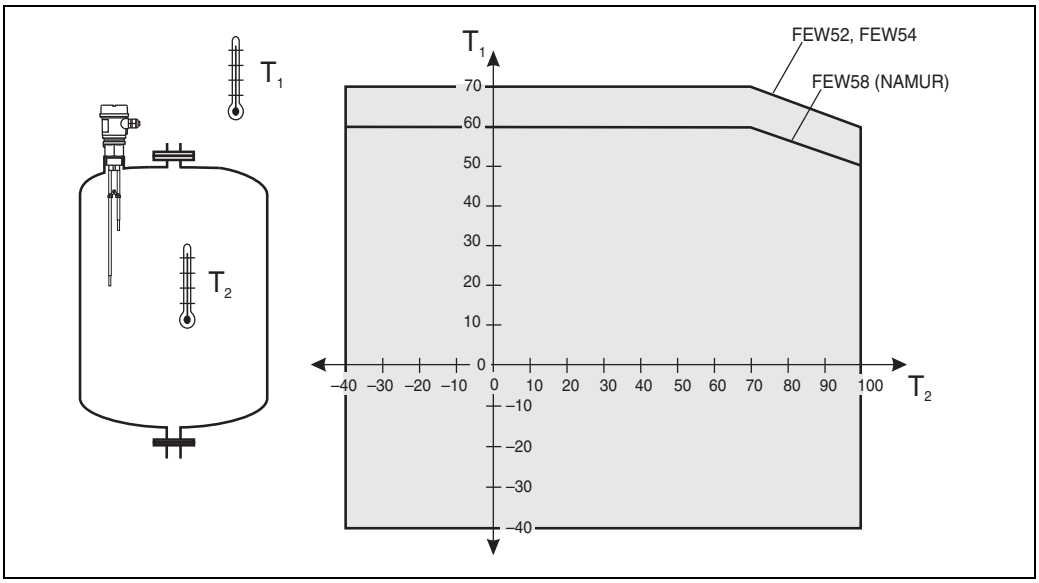
Environment

Ambient temperature range	**Non-hazardous area** -40 °C ... 70 °C (233 K ... 343 K) -40 °C ... 60 °C (233 K ... 333 K) (for FEW58 NAMUR)
Storage temperature	-40 °C ... 80 °C (233 K ... 353 K)
Climate class	Tropicalized as per DIN 60068, part 2-38
Degree of protection	IP66
Shock resistance	Practical test
Vibration resistance (at min. rod length)	DIN 60068-2-64 / IEC 68-2-64: 20 to 2000 Hz, 1 $(m/s^2)^2/Hz$
Electromagnetic compatibility	• Interference Emission to EN 61326, Electrical Equipment Class B Interference Immunity to EN 61326, Annex A (Industrial) • Use for separate instrumented probes a screened cable between the probe and the switch amplifier.

Process

Environment

Permissible ambient temperature T_1 at the housing as a function of the measuring material temperature T_2 in the vessel:



Note!
For separate instrumented devices (without FEW5*) there are no restrictions in the indicated temperature range.

Conductivity	≥ 10 µS
Limiting medium pressure range	-1 bar ... 10 bar

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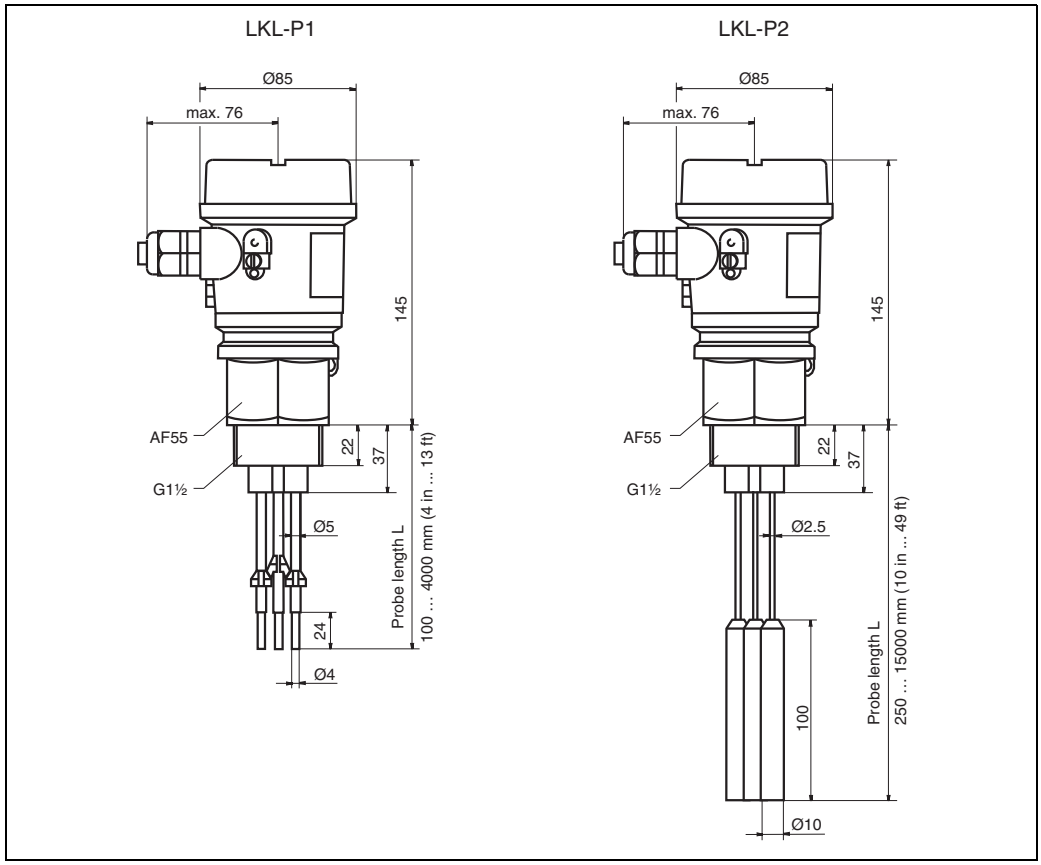
Mechanical construction

Note!

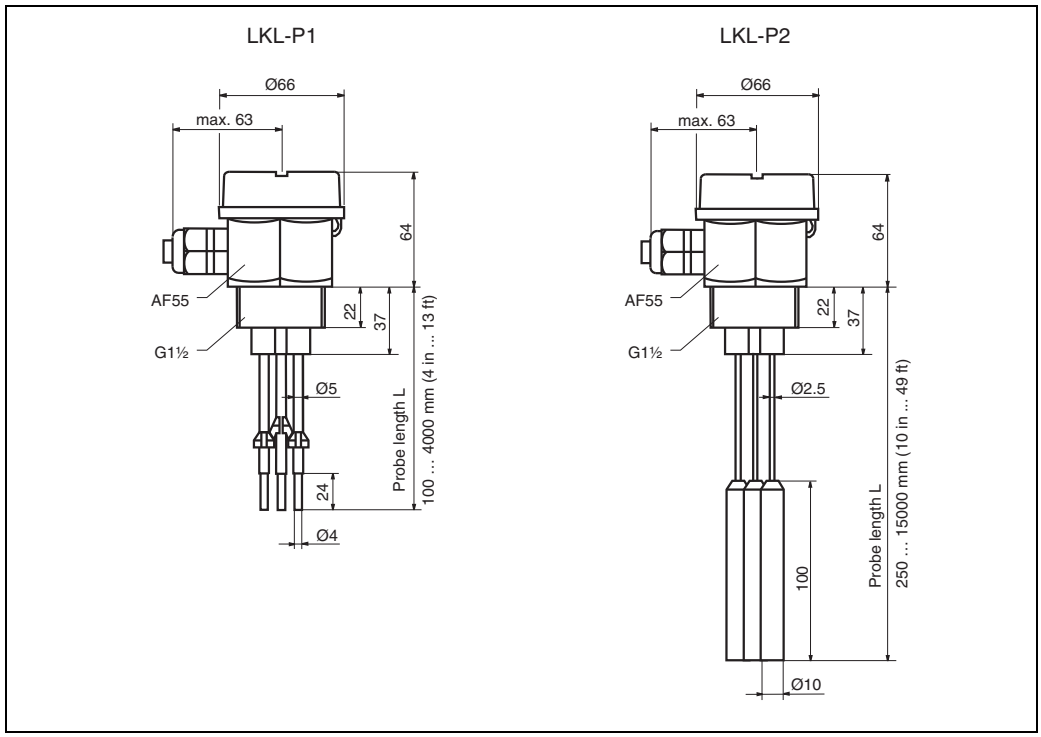
All dimensions in mm! (100 mm = 3.94 in)

Design, dimensions

Rod and rope version with G 1 ½" (compact instrument version with electronic insert)



Rod and rope version with G 1 ½" (separate instrument version without electronic insert)



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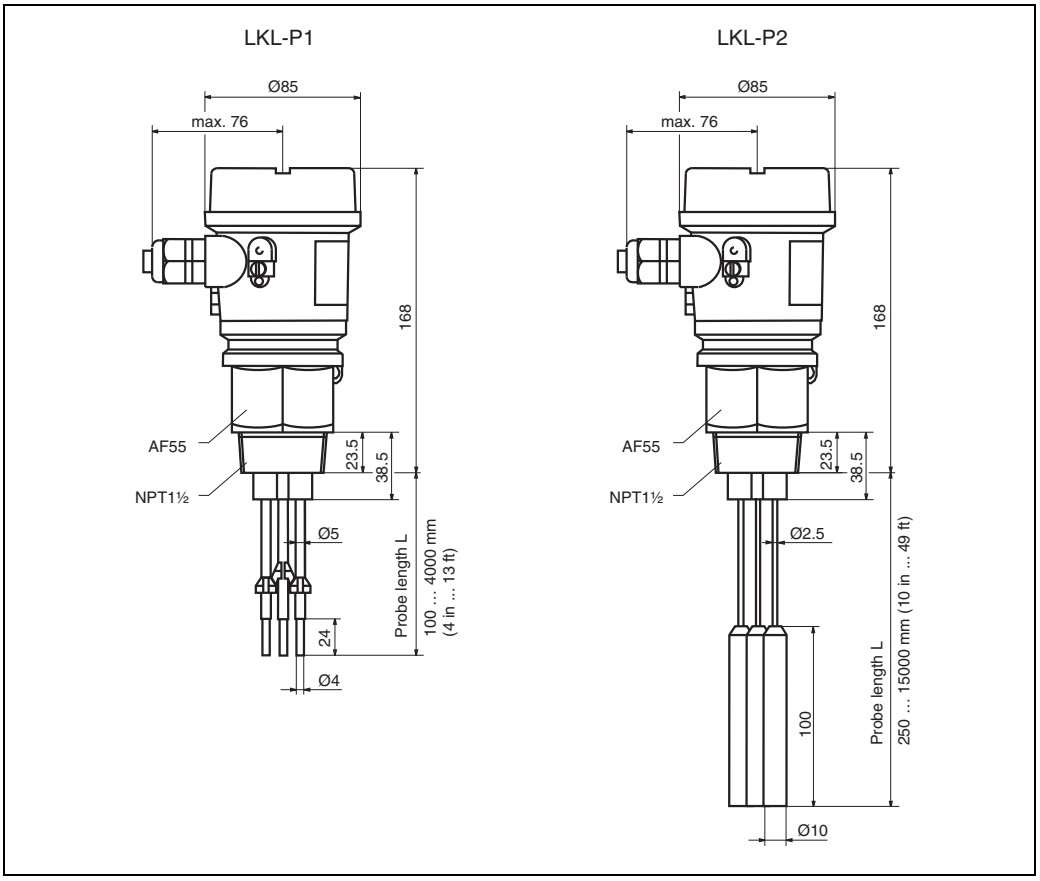
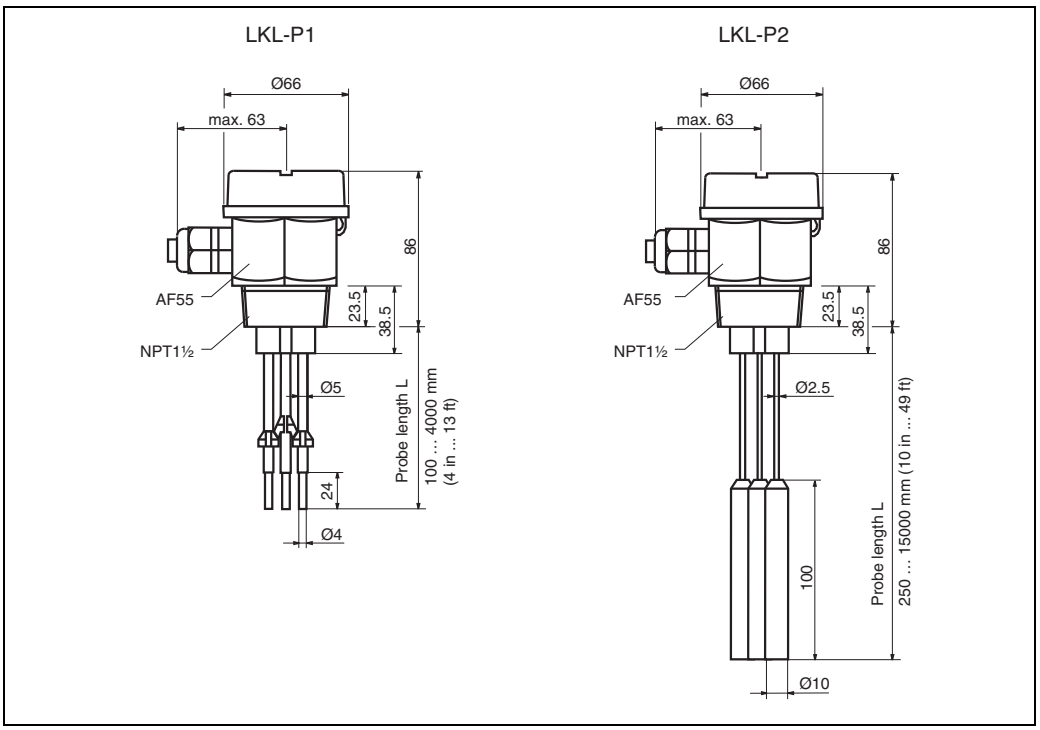
Rod and rope version with NPT 1 ½" (compact instrument version with electronic insert)



Rod and rope version with NPT 1 ½" (separate instrument version without electronic insert)



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Weight

Separate instrumentation version

Rod, 1 m (3.28 ft) long

LKL-P1 with 2, 3 or 5 rods: 415 g, 530 g, 760 g

Rope, 1 m (3.28 ft) long

LKL-P2 with 2, 3 or 5 ropes: 390 g, 470 g, 640 g

Compact instrumentation version

Rod, 1 m (3.28 ft) long

LKL-P1 with 2 or 3 rods: 600 g, 720 g

Rope, 1 m (3.28 ft) long

LKL-P2 with 2 or 3 ropes: 710 g, 800 g

Material

Wetted

Seal between probe rod/probe rope and process connection: EPDM

Spacer: PP

Flat seal for process connection: elastomer fiber, (asbestos-free)

Process connections:

- G 1 ½: PPS
- NPT 1 ½: PPS

Probe rods:

- Rod: 316L (1.4404) or carbon fiber
- Insulation: PP

Probe ropes:

- Rope: 316Ti (1.4571)
- Insulation: FEP
- Weight: 316L (1.4435)

Not wetted

Housing:

- Plastic housing F24 (separate instrumentation)
  - Housing: PPS
  - Cover: PBT
- Polyester housing F16: PBT-FR with PBT-FR cover or with PA12 transparent cover,
  - Cover seal: EPDM
  - Adapter: PBT-FR
  - Nameplate, glued: polyester foil (PET)
  - Pressure compensation filter: PBT-GF20

Ground terminal on housing (outside): 304 (1.4301)

Cable gland: polyamide (PA)

Fitted electrodes

Rod probes

Compact instrumentation version: 2 or 3 rods; separate instrumentation version: 2, 3 or 5 rods

- Diameter without insulation: 4 mm (0.16 in)
- Maximum rod length: 4000 mm (13 ft)
- Minimum rod length: 100 mm (3.9 in)
- Thickness of insulation: 0.5 mm (0.02 in)
- Length of non-insulated area (tip of rod): 20 mm (0.78 in)
- Extraction forces (parallel probe rod): 1000 N

Rope probes

Compact instrumentation version: 2 or 3 rods; separate instrumentation version: 2, 3 or 5 rods

- Diameter without insulation: 1 mm (0.4 in)
- Maximum rope length: 15000 mm (49 ft)
- Minimum rope length: 250 mm (9.8 in)
- Thickness of insulation: 0.75 mm (0.03 in)
- Weight length: 100 mm (not insulated)
- Weight diameter: 10 mm (0.4 in)
- Extraction forces (parallel probe rod): 500 N

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Human interface

Operating elements

E5 (FEW52), WA (FEW54), N1 (FEW58)

- One DIL switch for MIN or MAX safety
- One DIL switch for 0 s or 2 s switching delay
- Two DIL switches for setting the measuring ranges 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ

Display elements

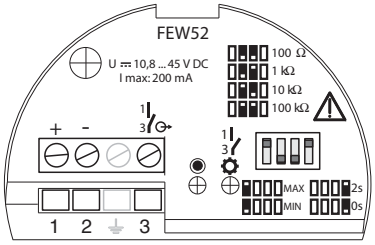
Separate instrumentation version

Dependent on the connected switch amplifier.

Compact instrumentation version

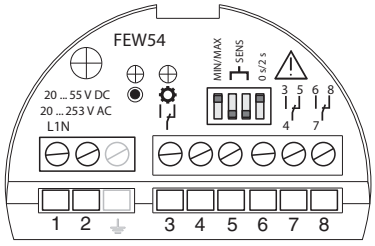
E5 (FEW52)

- One red light emitting diode: fault message, switching status
- One green light emitting diode: operation



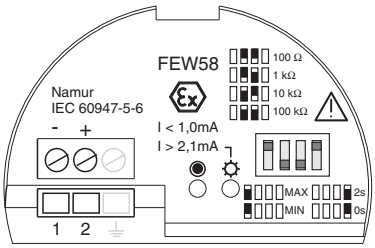
WA (FEW54)

- One red light emitting diode: fault message, switching status
- One green light emitting diode: operation



N1 (FEW58)

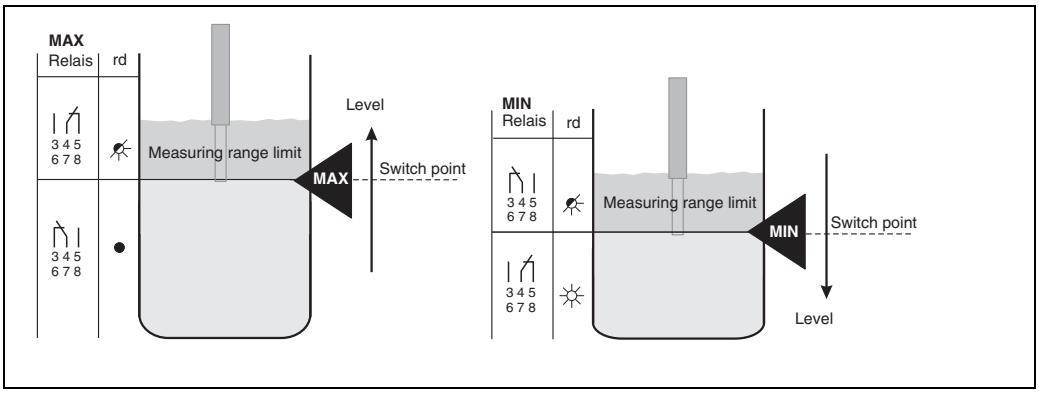
- One red light emitting diode: fault message, switching status
- One green light emitting diode: operation



Note!

For E5 (FEW52), WA (FEW54)

If the probe is covered and the red LED flashes continuously, the sensitivity was set to high. Set a smaller sensitivity to ensures a safe switch point even if the conductivity of the medium varies slightly.



Certificates and approvals

CE mark	The device meets the legal requirements of the EC directives. Pepperl+Fuchs confirms that the device has been successfully tested by applying the CE mark.
Overfill protection	Z-65.13-378 (overspill protection in acc. with WHG) Z-65.40-379 (leak detection system)
Other standards and guidelines	• Directive 73/23/EWG (Low Voltage Directive): EN 61010-1 • Directive 89/336/EG (EMV): – emitted interference to EN 61326, class B equipment – interference immunity to EN 61326, annex A (industrial sector) • Directive 94/9 EG (ATEX): EN 50014, EN 50020 • Electromagnetic compatibility: NE 21 • Protection degree: EN 60529 • Climate class: EN 60068, part 2-38 • Vibration resistance: EN 60068-2-64
Ex approval	TÜV 03 ATEX 2295, for additional certificates see www.pepperl-fuchs.com All explosion protection data are given in a separate documentation (see "Supplementary documentation") which is available upon request.
Ex-Type of protection	⟨Ex⟩ II 2G EEx ia/ib IIC T6 (TÜV 03 ATEX 2295) (output N1 (FEW58)) ⟨Ex⟩ II 3G EEx nA/C (L) IIC T6 (output E5 (FEW52), WA (FEW54))

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Ordering information

Product structure

Certificates
NA For non-hazardous areas
WH Overspill protection WHG with leakage approval
EB Ex II 2G EEx ia/ib IIC T6
EC Ex II 3G EEx nA/C (L) IIC T6

Additional equipment
N without additional equipment
Y Special version

Electrical output
NA without electronic insert (separate instrumentation)
XX Electronics retrofittable
E5 FEW52, PNP output, 10.8 ... 45V DC
WA FEW54, relay output, 20 ... 253 V AC
N1 FEW58, NAMUR

Housing, cable entry
P1 Housing synthetic, IP66, M20 x 1.5
P2 Housing synthetic, IP66, NPT 1/2"
P3 Housing synthetic, IP66, G 1/2"

Probe length
A mm, probe length 100 mm ... 4000 mm*
B inch, probe length*
C 1000 mm
D 2000 mm

Quantity and rod type
2 2 rods, 316L
3 3 rods, 316L
5 5 rods, 316L

Process connection
G5 G 1 1/2" ISO 228 thread, PPS
N5 NPT 1 1/2" ANSI thread, PPS

Version
1 Rod version, 100 ... 4000 mm

* Price is independent from length.

Certificates
NA For non-hazardous areas
WH Overspill protection WHG with leakage approval
EB Ex II 2G EEx ia/ib IIC T6
EC Ex II 3G EEx nA/C (L) IIC T6

Additional equipment
N without additional equipment
Y Special version

Electrical output
NA without electronic insert (separate instrumentation)
XX Electronics retrofittable
E5 FEW52, PNP output, 10.8 ... 45V DC
WA FEW54, relay output, 20 ... 253 V AC
N1 FEW58, NAMUR

Housing, cable entry
P1 Housing synthetic, IP66, M20 x 1.5
P2 Housing synthetic, IP66, NPT 1/2"
P3 Housing synthetic, IP66, G 1/2"

Probe length
A mm, probe length 250 mm ... 15000 mm*
B inch, probe lenght*

Quantity and rope type
2 2 ropes, 316Ti
3 3 ropes, 316Ti
5 5 ropes, 316Ti

Process connection
G5 G 1 1/2" ISO 228 thread, PPS
N5 NPT 1 1/2" ANSI thread, PPS

Version
2 Rope version, 100 ... 4000 mm

* Price is independent from length

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Accessories

Lock nut	LKL-Z10, G 1 ½", AF60
Mounting bracket	LZ-1204, G 1 ½"
Electronic insert	E5 (FEW52): output PNP 10.8 V DC ... 45 V DC WA (FEW54): output relay 20 V AC ... 253 V AC, 20 V DC ... 55 V DC N1 (FEW58): output NAMUR (IEC 60947-5-6)

Supplementary Documentation

Operating instructions	KA203O (LKL-P* without electronic insert) KA204O (LKL-P* with integrated electronic insert)
Safety informations	SI230O (TÜV 03 ATEX 2295), N1 (FEW58) SI226O (⟨Ex⟩ II 3G EEx nA/C (L) IIC T6), E5 (FEW52), WA (FEW54)
Approvals	ZE043O overspill protection in acc. with WHG (Z-65.13-378) ZE257O leak detection system (Z-65.40-379)
Supplementary information	EC-Type Examination Certificate, Statement of Conformity, Declaration of Conformity and instructions have to be observed. For information see www.pepperl-fuchs.com.

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