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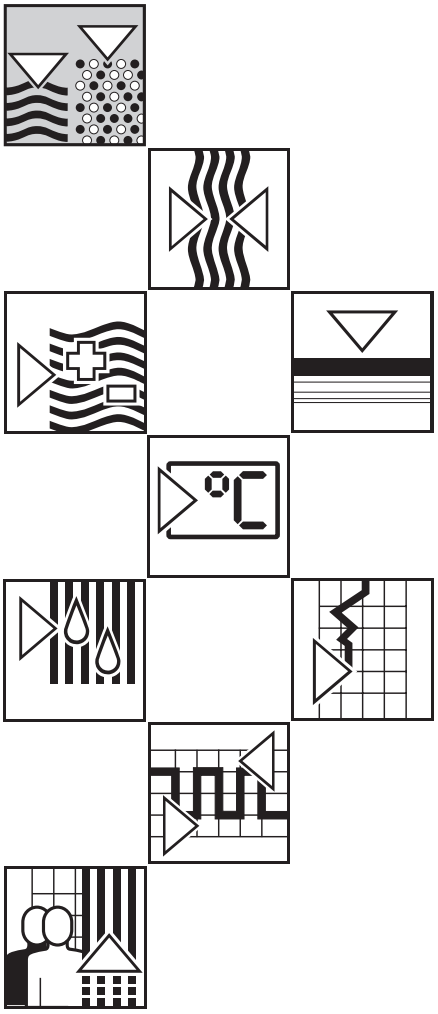
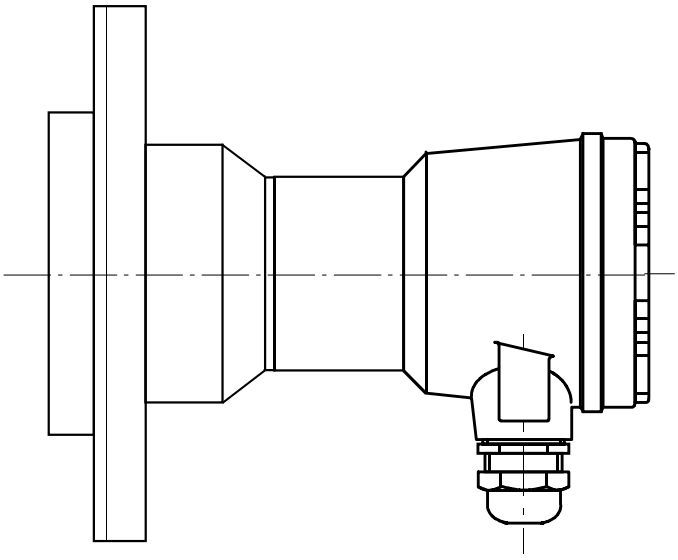
nivocompact
FTC 431
Level Limit Switch

Operating Instructions





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Nothing beats know-how

Contents

Applications

The Nivocompact FTC 431 is used for limit detection in silos containing bulk solids (for minimum or maximum level indication).
It is mounted laterally for maximum detection of heavy material or minimum detection of light material.

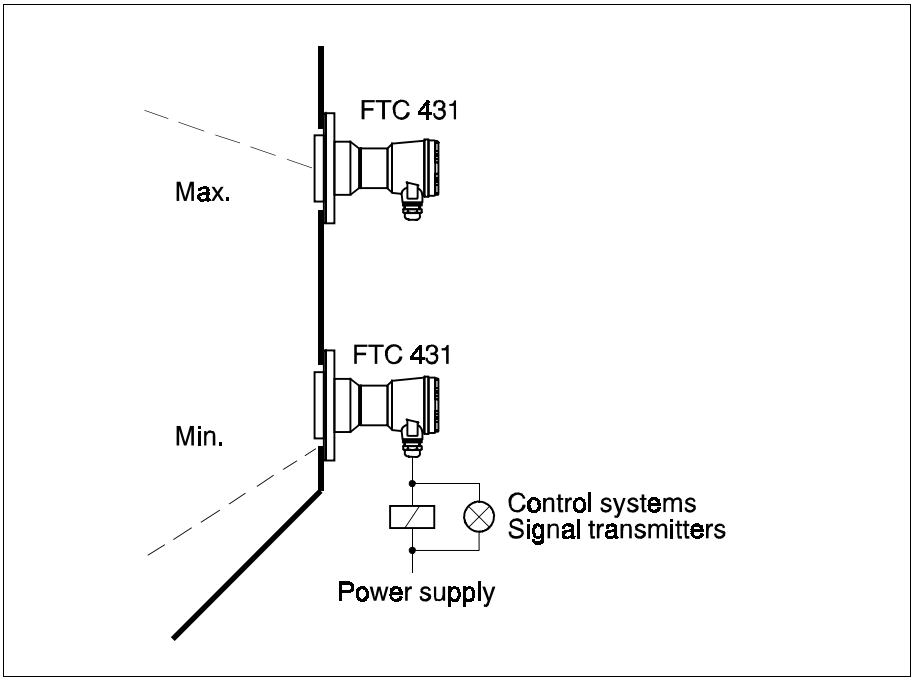


Fig. 1
Limit detection in bulk solid silos with the capacitive level limit switch Nivocompact FTC 431.

Application Examples

Sand	Glass aggregate	Gravel	Moulding sand
Lime	Ore, crushed	Plaster	Aluminium shavings
Cement	Grain	Pumice	Sugar beet chips
Dolomite	Flour	Kaolin	Fodder

and similar bulk solids

Note:
Bulk solids should have dielectric constants $\varepsilon_r \geq 3.0$.

Please contact us for advice if the dielectric constant of the bulk solid is not known.

The Measuring System

The Nivocompact is an electronic switch.
The entire measuring system consists of:
- Nivocompact FTC 431
- power supply and
- connected control systems, switches, signal transmitters (e.g. process control systems, PLC, relays, microcontactors, lamps, sirens etc.)

Technical Data

Operating Data

- Operating temperature in silo: –20 °C…+60 °C
- Operating pressure p_e, depending on operating temperature: up to 6 bar
- Max. permissible load on disk probe: up to 60 N/cm^2, frontal, depending on temperature
- Minimum dielectric constant ε_r of material: 3.0
- Ambient temperature for housing: –20 °C…+60 °C
- Storage temperature: –40 °C…+85 °C

Probe

- Material of disk probe: steel, insulated with PP

Process Connection

- Flange: aluminium flange with PP cladding on vessel side, to fit with counter flange DN 50, PN 16 to DIN 2502, inside diameter widened from DN 50 to ø 101 mm.

Housing Versions

- Aluminium housing, IP 55
- Synthetic housing in PBTP, IP 66

Protection standard of entire instrument: IP 50
(Protection IP… to DIN 40050)

Cable Gland

- Housing IP 55: standard PG in nickel-plated brass with NBR gasket for cable diameter 7…10 mm.
- Housing IP 66: water-tight PG in polyamide with Neoprene-CR gasket for cable diameter 5…12 mm.

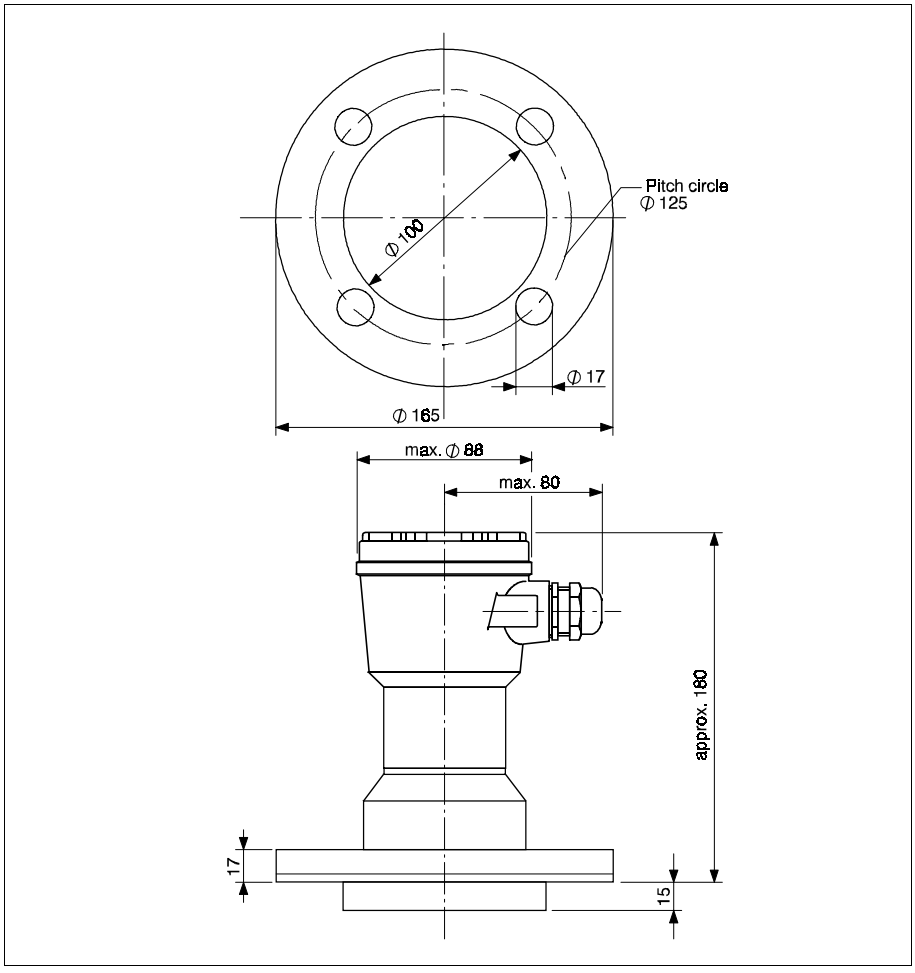


Fig. 2
Dimensions FTC 431.

Electronic Inserts

- Terminal connections: for max. 2.5 mm^2
- Measuring frequency: approx. 750 kHz
- Switching delay: approx. 0.5 s
- Minimum/maximum fail-safe switching: selectable with rotary switch
- Switching indication: red LED

Electronic Insert EC 20 for AC (Two-Wire Connection)

- Power supply U~: 21 V...250 V, 50/60 Hz
- Connected loads, short-term (max. 40 ms): max. 1.5 A;
  max. 375 VA at 250 V;
  max. 36 VA at 24 V
- Maximum voltage drop: 11 V
- Connected loads, continuous: max. 350 mA;
  max. 87 VA at 250 V;
  max. 8.4 VA at 24 V
- Minimum load current at 250 V:10 mA (2.5 VA)
- Minimum load current at 24 V: 20 mA (0.5 VA)
- No-load current (rms): < 5 mA

Electronic Inserts EC 22 and EC 23 for DC (Three-Wire Connection)

- Power supply U =: 10 V...55 V
- Superimposed AC voltage U_{pp}: max. 5 V
- Current consumption : max. 15 mA
- Load connection: Open Collector; PNP (EC 22) or NPN (EC 23)
- Switching voltage: max. 55 V
- Connected load, short-term (max. 1 s): max. 1 A
- Connected load, continuous: max. 350 mA
- Residual current with transistor blocked: < 100 µA
- Protected against reverse polarity

Electronic Insert EC 24 for DC and AC (Relay Output)

- Power supply U =: 20 V...200 V
  or
  Power supply U~:21 V...250 V, 50/60 Hz
- Current consumption (rms): max. 5 mA
- Peak inrush current: max. 200 mA, max. 5 ms
- Pulse current: max. 50 mA, max. 5 ms
- Pulse frequency: approx. 1.5 s
- Output: potential-free change-over contact
- Contact load capacity:
  U~ max. 250 V, I~ max. 6 A,
  P~ max. 1500 VA ($\cos\varphi = 1$) or P~ max. 750 VA, $\cos\varphi \geq 0.7$
  U= max. 250 V, I = max. 6 A, P = max. 200 W
- Operating life: min. 10^5 switchings at max. contact load
- Additional delay: max. 1.5 s

EMC

Electromagnetic compatibility according to EN 61326-1 (1997).
Class A device.

Type Key

See Page 9 for specification key and order code.

Subject to modification.

Function

The disk probe and flange (or metallic silo wall) form the two electrodes of a capacitor with a high frequency voltage between them.
The limit value is based on the principle of a discharge circuit.
As long as the probe is in air with a dielectric constant of $\varepsilon_r = 1$, then the discharge time constant is $\tau = R \times C_A$, where is R the resistance of the circuit and C_A the capacitance of the capacitor formed by the probe and silo wall.
If bulk material with a higher dielectric constant moves into the electrical field between the probe and silo wall, then the capacitance C_A increases and with it the time constant.
The change in the time constant is evaluated and the Nivocompact is activated according to its switching mode.
The Nivocompact is insensitive to low build-up on the probe and silo wall as long as the material does not form a bridge between the probe and wall.

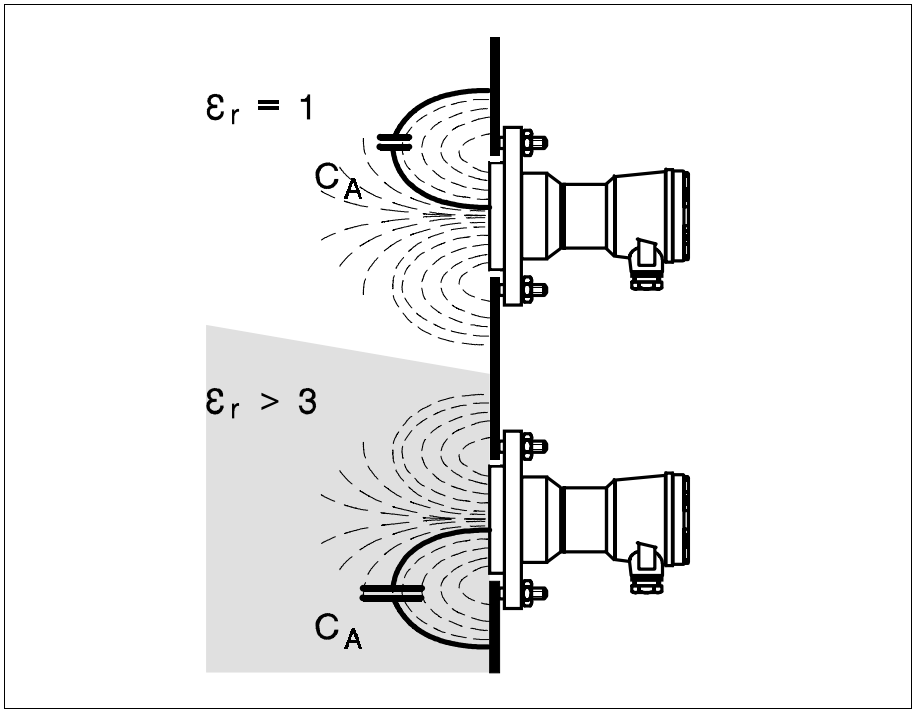


Fig. 3
The capacitor consisting of the silo wall and probe.

The built-in feature for minimum/maximum fail-safe switching allows the Nivocompact to be used in all applications requiring high operational safety:

Maximum Fail-Safe: The circuit is blocked if the probe is covered or the power supply fails.

Minimum Fail-Safe: The circuit is blocked if the probe is uncovered or the power supply fails.

A red LED on the electronic insert indicates switching status.

See also Fig. 16 in Section »Fail-Safe Switching«, Page 18.

Installation

Project Planning

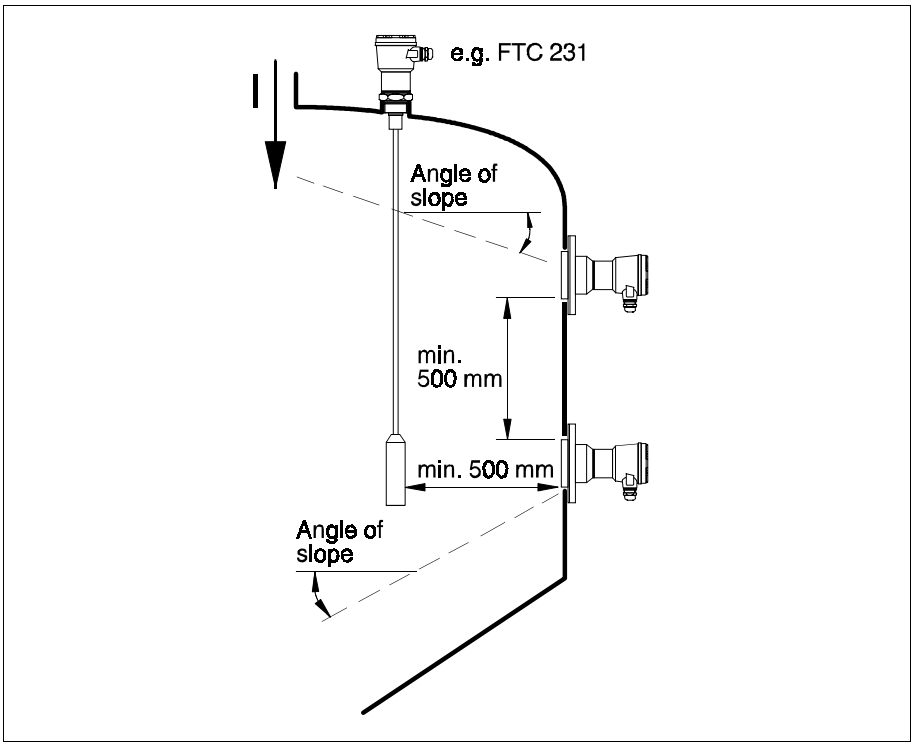


Fig. 4
General information for installing the capacitive Nivocompact FTC 431 level limit switch.

Material and Construction of Silo

The FTC 431 can be installed in silos with walls made of metal, synthetic or wood. The aluminium flange forms the counter electrode to the disk probe. Mounting should only be on square silos which have straight walls or on round silos with large diameters.

Filling the Silo

The filling curtain should not be directed onto the probe.

Distance Between Probes

If more than one probe is mounted in a silo, then a minimum distance of 0.5 m must be allowed for in order to avoid mutual interference.

Angle of Material Flow

Note the angle of the material mound or the outlet funnel when determining the measuring point.

Operating Temperature and Load

The mechanical strength of the disk probe is reduced at very high or low temperatures. The Nivocompact FTC 431 should therefore only be used for minimum detection with light bulk materials (mounted in vertical silo walls) or for maximum detection.

Measuring Point

The Nivocompact FTC 431 (Protection IP 50) is designed for mounting in dry areas.

The disk probe has a diameter of 100 mm.
Cut into the silo wall so that the disk probe fits exactly.
The 15 mm thick disk probe should be completely flush with the inside wall of the silo.

Examples for Mounting

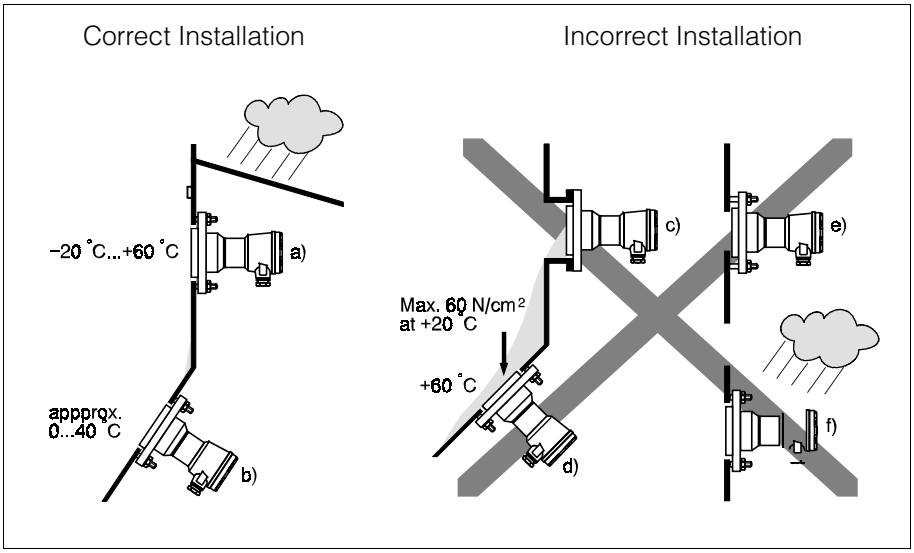


Fig. 5
Take note of application examples in order to avoid errors when installing.

Correct Installation

a) Indoors or under a protective roof.
Area cut out of the silo wall is as large as the disk probe.
Probe surface flush with the internal wall of the silo.
b) In a steel outlet cone where no material can gather.
Reduced working temperature range for this position!

Incorrect Installation

c) Mounting pipe too long, material builds up in it.
d) In an area where there is a deposit or build-up of the material.
The temperature is too high for this position.
e) Area cut out of silo wall too small.
f) Outdoors without protective roof.

Mounting Examples

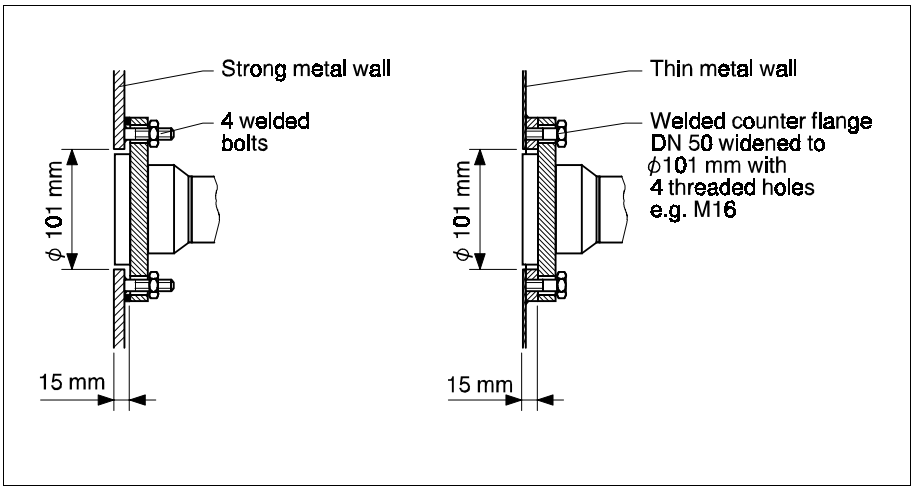


Fig. 6
Flush mounting with the internal silo wall.

Mounting

Preparation

Compare the order code on the nameplate of your instrument with the order specification key to ensure that the correct instrument is being installed.

FTC 431, capacitive level limit switch with disk probe ø 100 mm

Housing
A Aluminium housing, IP 55
K PBTP synthetic housing, IP 66
Y Special version - please check!

Electronic Insert
1 21 V…250 V, 50/60 Hz (EC 20)
Two-wire AC connection
2 PNP 10 V…55 V= (EC 22)
Three-wire DC connection
3 NPN 10 V…55 V (EC 23)
Three-wire DC connection
4 Relay, 21 V…250 V AC/200 V= (EC 24)
AC or DC connection
with relay output (change-over contact)
9 Special version - please check!

FTC 431 | | | **Order code on nameplate**

Installation

With the silo under pressure or with pneumatic conveying of powdery solids: place a suitable gasket between the flange and silo.

Turn the flange so that the cable gland of the housing for the electrical connection is pointing in the right direction.

Turn the mounting screws on the flange so that an even pressure is exerted around it.

Connection

Wiring Connection

Main Features of the Different Electronic Inserts

The last number of the order code on the nameplate identifies which type of electronic insert is mounted in the Nivocompact FTC 431:

1=Electronic Insert EC 20
Two-wire AC voltage 21 V…250 V
Electronic switch, max. 350 mA

2=Electronic Insert EC 22
Three-wire DC 10 V…55 V
Transistor circuit, load connection PNP, max. 350 mA

3=Electronic Insert EC 23
Three-wire DC 10 V…55 V
Transistor circuit, load connection NPN, max. 350 mA

4=Electronic Insert EC 24
with potential-free relay output
AC power supply 21 V…250 V or
DC power supply 20 V…200 V

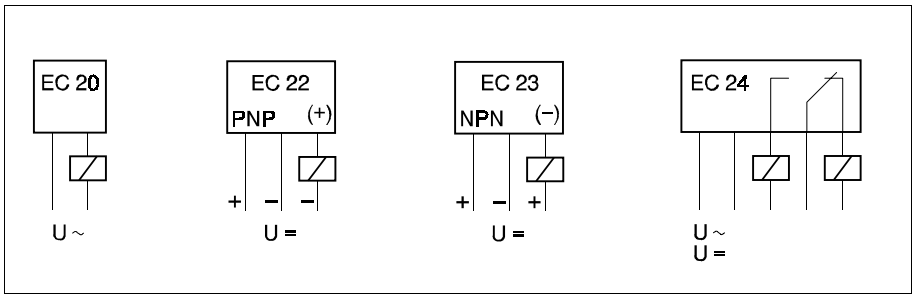


Fig. 7
Electrical connections available with the different electronic inserts.

Load Limit Values

Note the limit values of the loads to which you want to connect the Nivocompact. Exceeding the load can destroy the electronic insert (or the relay contact in the EC 24).

Fuse

Ensure that the rating of the fine-wire fuse corresponds to the maximum load to be connected.
The fine-wire fuse does not protect the electronic insert of the Nivocompact FTC.

Diameter of Wiring

Because of the small current used, only small diameter cabling is required. Standard cabling with diameters of 0.5 mm^2 to max. 1.5 mm^2 is recommended.

Grounding

The Nivocompact must be grounded to give reliable operation free from interference. This is done by either connecting it to a grounded silo with metal walls or to the earth conductor PE.

Connecting the Nivocompact with Electronic Insert EC 20 for AC (Two-Wire Connection)

Connecting in Series to a Load

The level limit switch Nivocompact with electronic insert EC 20 must - like all switches - be connected in series with the load (e.g. relays, microcontactors, lamps) to the power supply.

Direct connection to the power supply without any intermediate load connected (short-circuit) will result in immediate and permanent damage to the electronic insert.

The load can be connected to Terminal 1 or 2 of the electronic insert.
It is unimportant whether L1 is connected to Terminal 1 or 2.

Power Voltage

The voltage across Terminal 1 and 2 of the electronic insert must be at least 21 V.
The power voltage must be correspondingly higher to compensate for the voltage drop across the connected load.

Load Cutoff

Note that loads connected in series are not completely disconnected from the power supply if the electronic switch in the electronic insert of the Nivocompact »disconnects« (blocks) with level alarm.
Because of the current requirements of the electronics, a small »no-load current« still flows through the connected load.
When the load is a relay with a very small retaining current, then it is possible that the relay does not de-energise. In this case connect an additional load in parallel to the relay, e.g. a resistor or signal lamp.

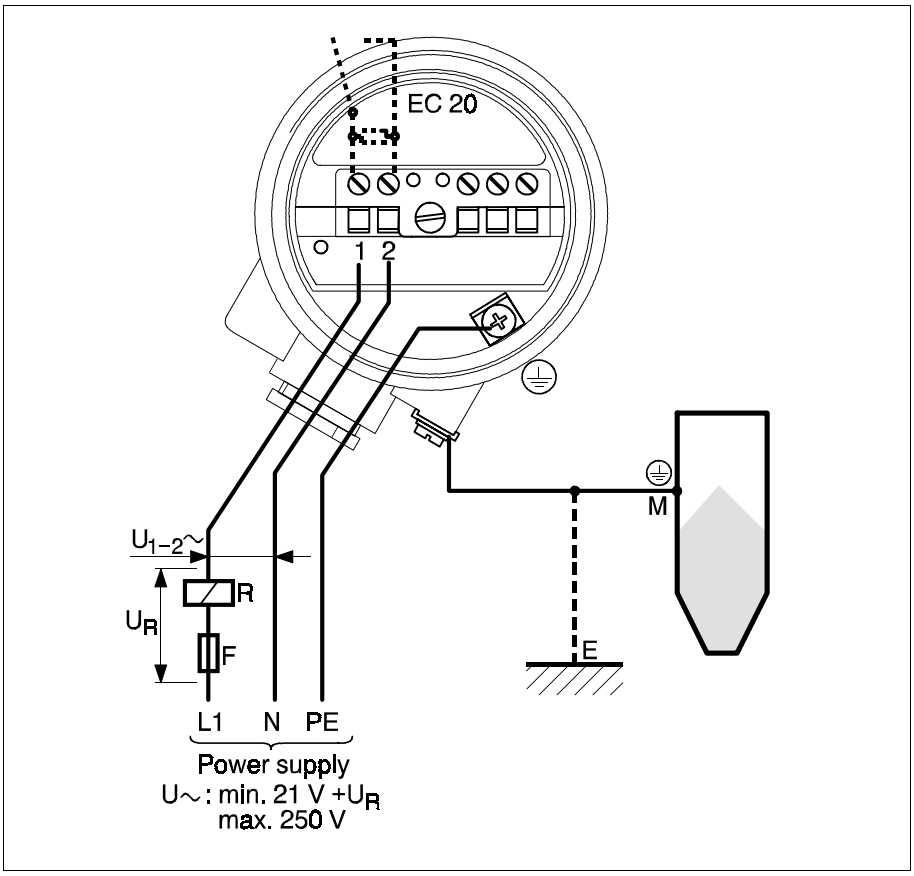


Fig. 8
Connecting the Nivocompact with electronic insert EC 20

U_{1-2}~:21 V ... 250 V across Terminals 1 and 2 of the EC 20
R: Connected (external) load, e.g. relay
F: Fine-wire fuse, load-dependent
U_R: Voltage drop across the load and the and the fine-wire fuse
M: Ground connection to metal silo
E: Ground

Connecting the Nivocompact with Electronic Insert EC 22 (Three-Wire PNP) for DC

Transistor Circuit for Load

The load connected to Terminal 3 is switched by a transistor, contactless and therefore without bounce.

Terminal 3 has a **positive** signal in normal switching mode.

The transistor is blocked on level alarm or with a power failure.

Protection Against Voltage Peaks

When connecting to an instrument with a high inductance:
a voltage limiter should be connected.

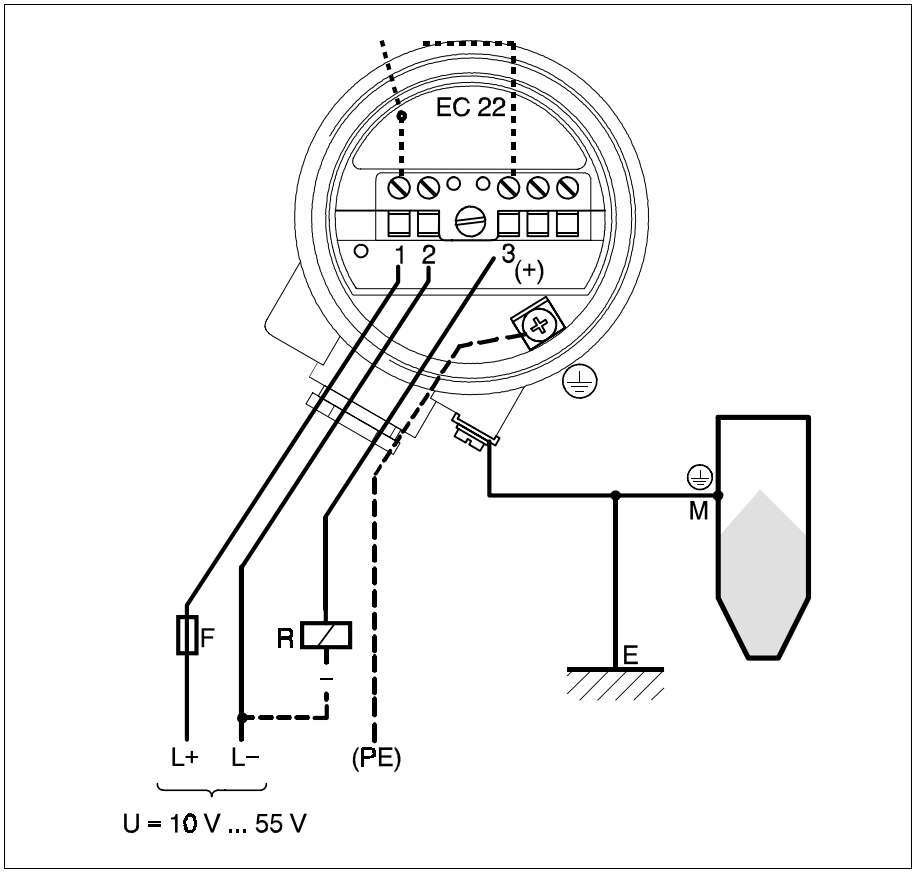


Fig. 9
Connecting the Nivocompact with electronic insert EC 22 (PNP connection)

F: Fine-wire fuse, load-dependent
R: Connected load, e.g. PLC, PCS, relay
M: Ground connection to metal silo
E: Ground

Connecting the Nivocompact with Electronic Insert EC 23 (Three-Wire NPN) for DC

Transistor Circuit for Load

The load connected to Terminal 3 is switched by a transistor, contactless and therefore without bouncing.

Terminal 3 has a **negative** signal in normal switching mode.

The transistor is blocked on level alarm or with a power failure.

Protection Against Voltage Peaks

When connecting to an instrument with a high inductance:
a voltage limiter should be connected.

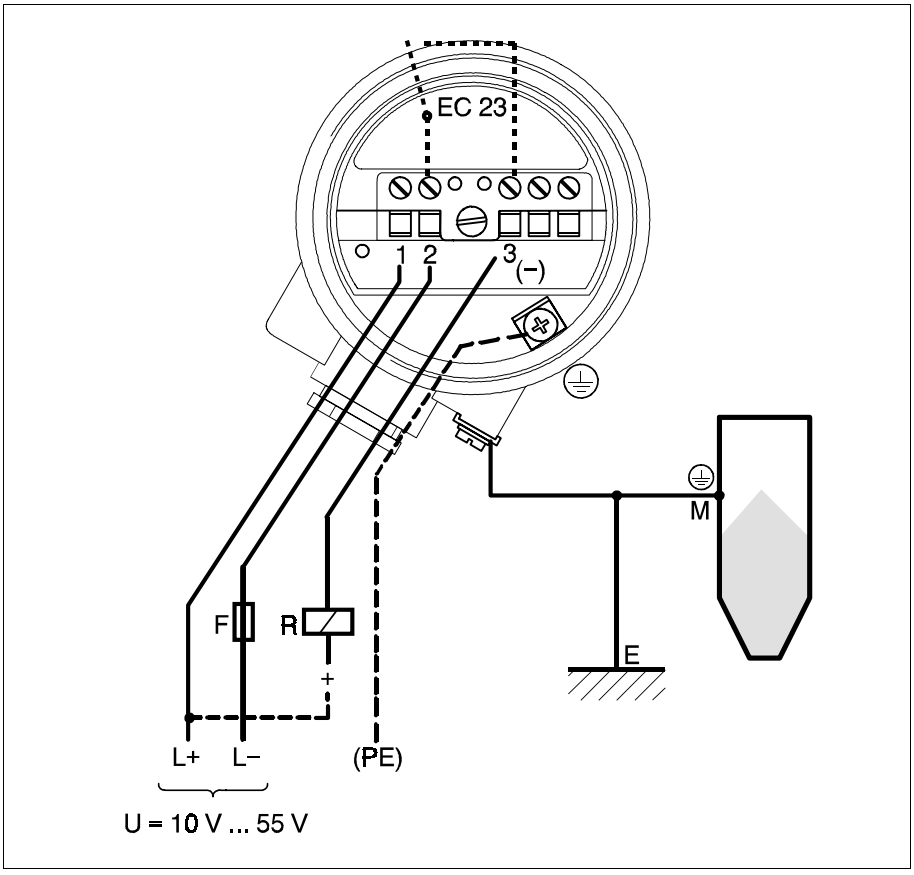


Fig. 10
Connecting the Nivocompact with electronic insert EC 23 (NPN connection)

F: Fine-wire fuse, load-dependent
R: Connected load, e.g. PLC, PCS, relay
M: Ground connection to metal silo
E: Ground

Connecting the Nivocompact with Electronic Insert EC 24 (Relay Output) for DC and AC

Power Supply

With AC, it is unimportant whether L1 or N is connected to Terminal 1.
With DC, it is unimportant whether L+ or L– is connected to Terminal 1.

Relay Contact for Load

The load is connected over a potential-free relay contact (change-over contact).
The relay contacts breaks the connection between Terminal 3 and Terminal 4 on level alarm or power failure.

Protection Against Voltage Peaks and Short-Circuiting

Protect the relay contact by connecting a spark barrier to instruments with high inductance.
A fine-wire fuse (load-dependent) can protect the relay contact if a short-circuit occurs.

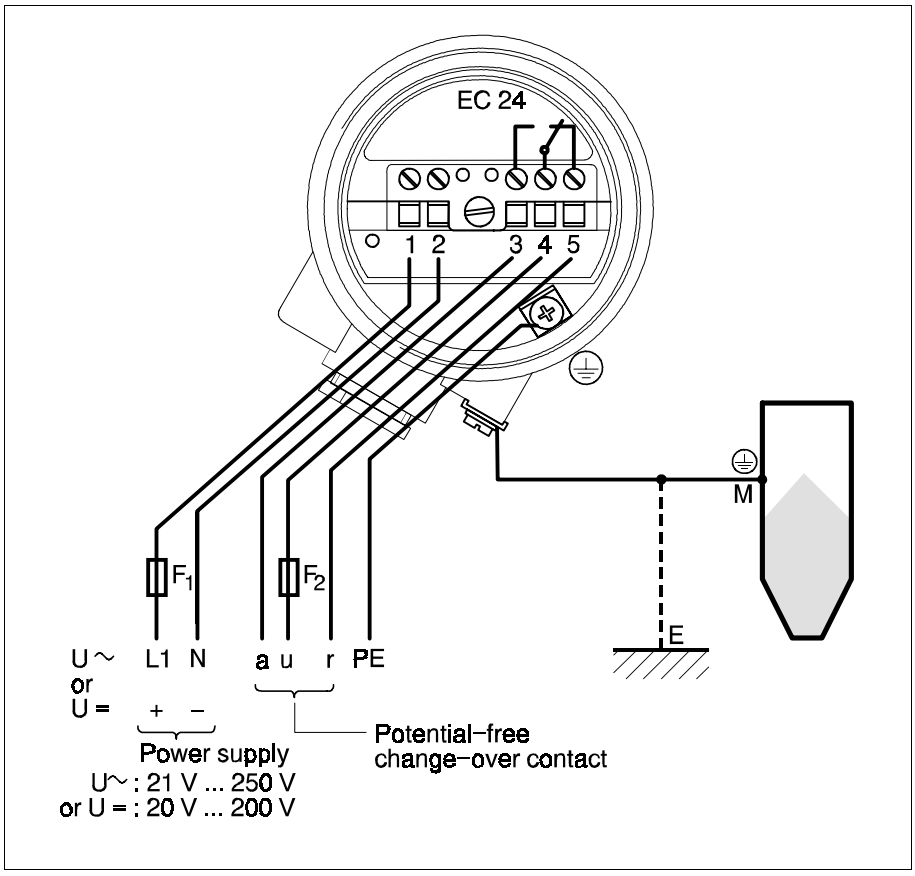


Fig. 11
Connecting the Nivocompact with electronic insert EC 24 (relay output)
F_1: Fine-wire fuse 200 mA, semi-time lag recommended
F_2: Fine-wire fuse to protect the relay contact, load-dependent
M: Ground connection to metal silo
E: Ground

Wiring on-Site

Tools Required for Connection

- Open-end spanner 22 AF
- Screwdrivers, blade width 3.5 mm and 10 mm or Phillips screwdrivers PZD 1 and PZD 2
- Usual electrical tools

Before connecting, make sure that the power supply used is the same as that stated on the nameplate of the electronic insert.

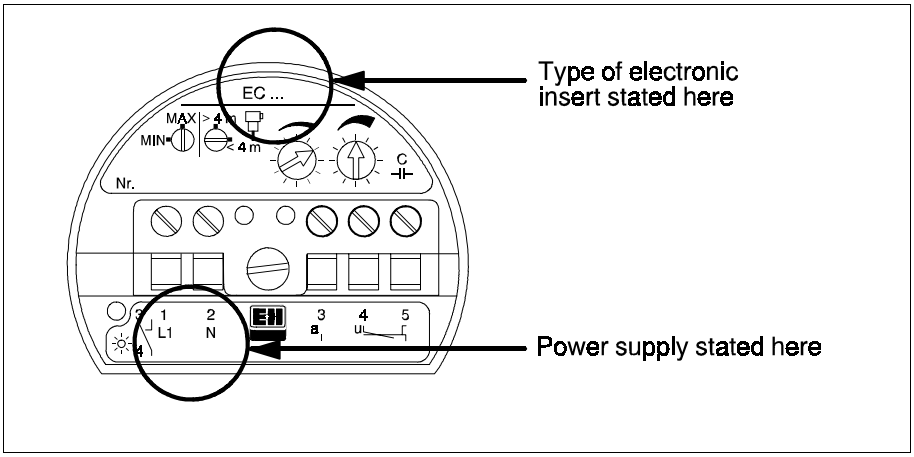


Fig. 12
Note the power voltage stated on the nameplate!

Electrical Connections

Connect the Nivocompact according to the appropriate diagram Fig. 8 to Fig. 11.

The gasket in the standard cable gland is designed for cable diameters from 7 mm to 10 mm.
A suitable gasket must also be used for other cable diameters.

You can seal with the "water-tight" cable gland with cables having diameters from 5 mm to 12 mm.

When mounting on a silo with metallic walls:
Ensure that there a short ground connection from the Nivocompact housing to the silo.

Calibration

Tools Required for Calibration

- Screwdriver with blade width approx. 3 mm
- Screwdriver with blade width approx. 5 mm

The rotary switch and adjusting elements for calibration are in the electronic insert in the housing.

Directly beside these calibration elements are the power connections with voltages up to 250 V.
Use an insulated (electrician's) screwdriver only or else tape over the terminals with insulating tape before calibration.

Capacitance Calibration

For capacitance calibration, the silo must be empty or the level of material must be at least 200 mm below the probe.

- Turn on the power supply.
- Carry out the calibration according to the sequence of diagrams Fig. 13 to Fig. 15.

Capacitance Calibration, Initial Settings

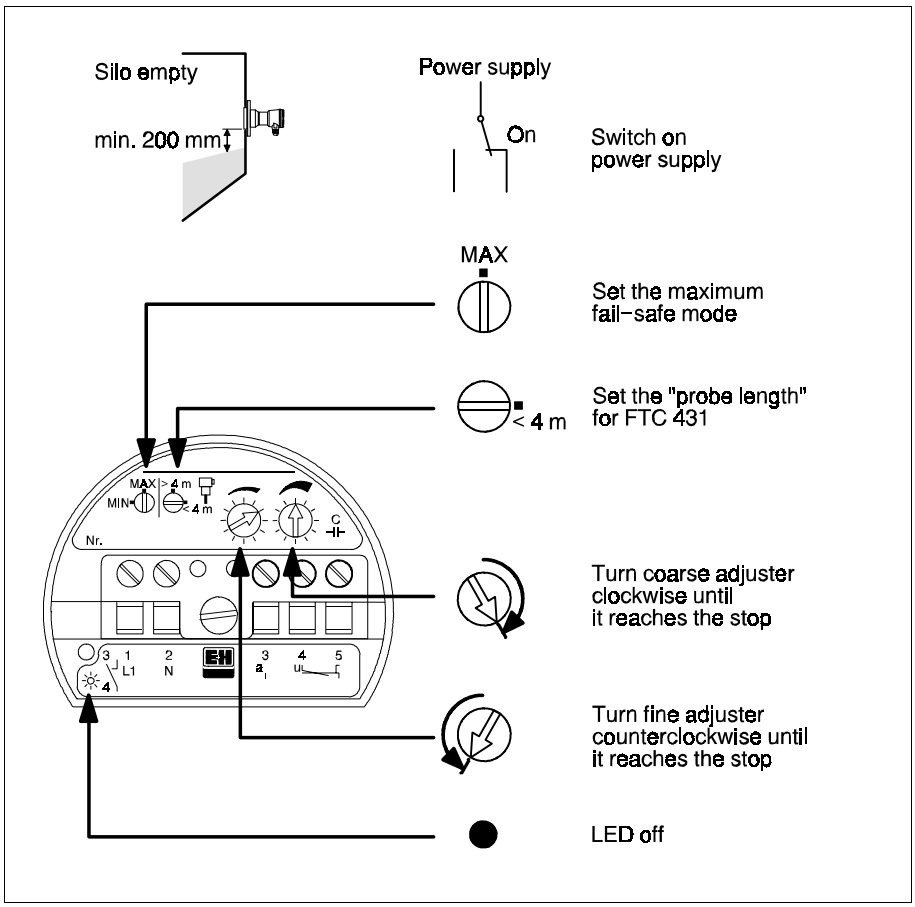


Fig. 13
These controls must be set before the capacitance calibration.

Capacitance Calibration

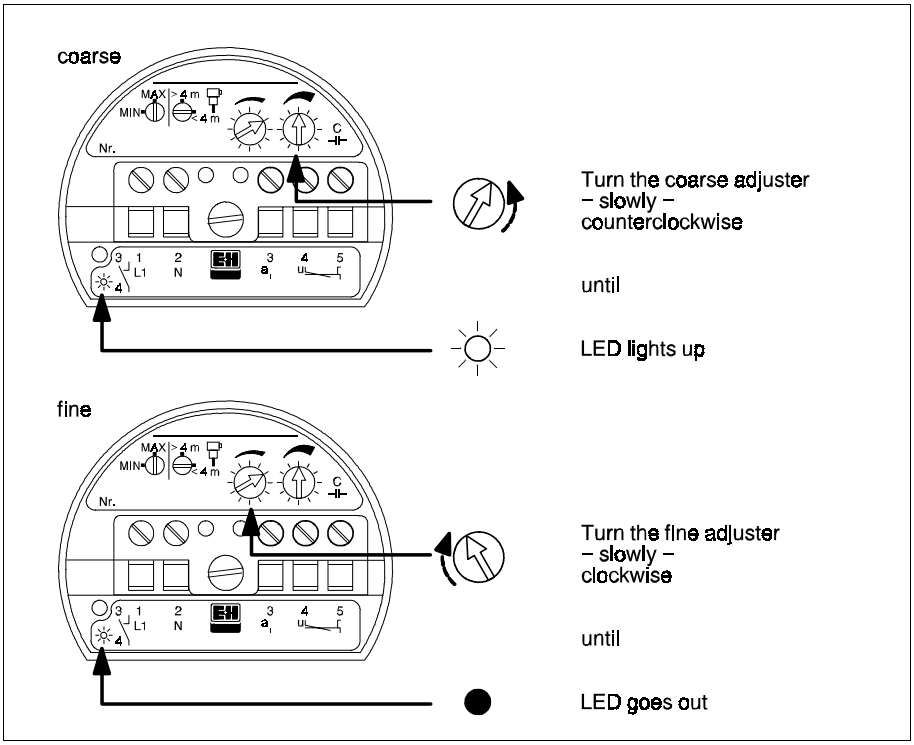
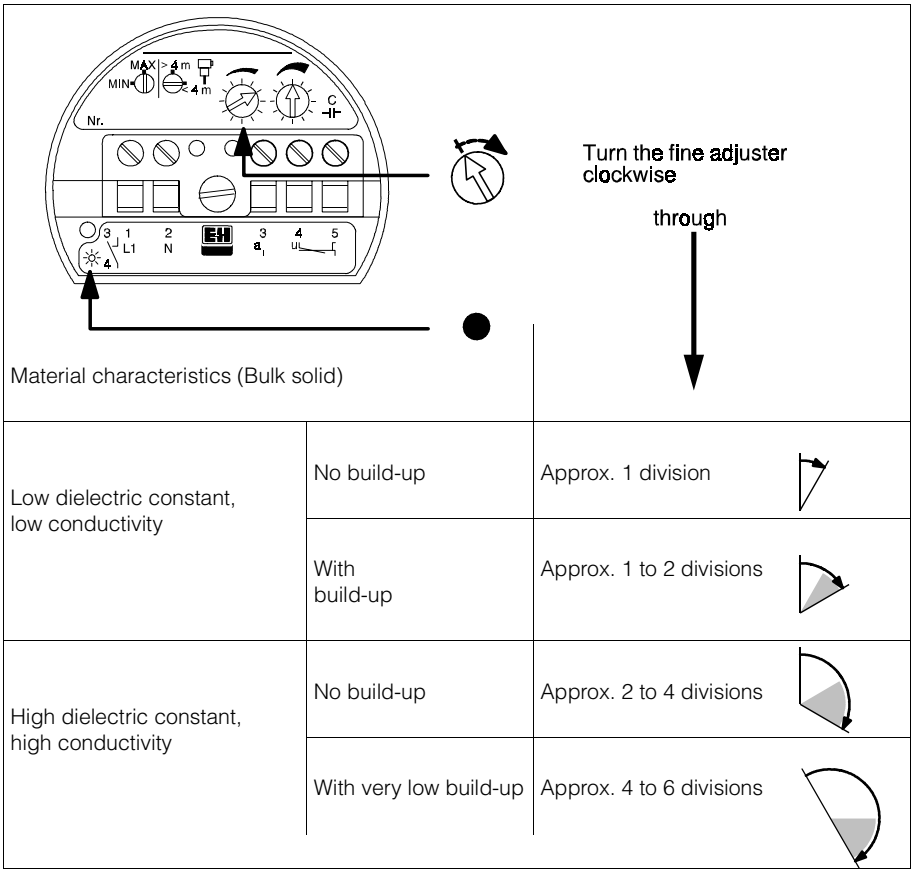


Fig. 14
Capacitance calibration must be carried out both slowly and carefully.

Adjusting for Material Characteristics



Material characteristics (Bulk solid)		
Low dielectric constant, low conductivity	No build-up	Approx. 1 division
	With build-up	Approx. 1 to 2 divisions
High dielectric constant, high conductivity	No build-up	Approx. 2 to 4 divisions
	With very low build-up	Approx. 4 to 6 divisions

Fig. 15
Accurate adjustment ensures high switching reliability.

When the probe is covered with non-conductive bulk solid having a low dielectric constant, then the Nivocompact only switches when the disk probe is completely covered with the material.
The degree of covering depends on the calibration.
Turning the fine calibrating element clockwise causes the Nivocompact to become less sensitive.

Safety Switching

By using the rotary switch, select the fail-safe mode for your particular application:

- Maximum fail-safe: The current circuit is blocked if the probe is covered or the power supply fails.
- Minimum fail-safe: The current circuit is blocked if the probe is uncovered or the power supply fails.

Changing the fail-safe mode also changes the LED status indication.

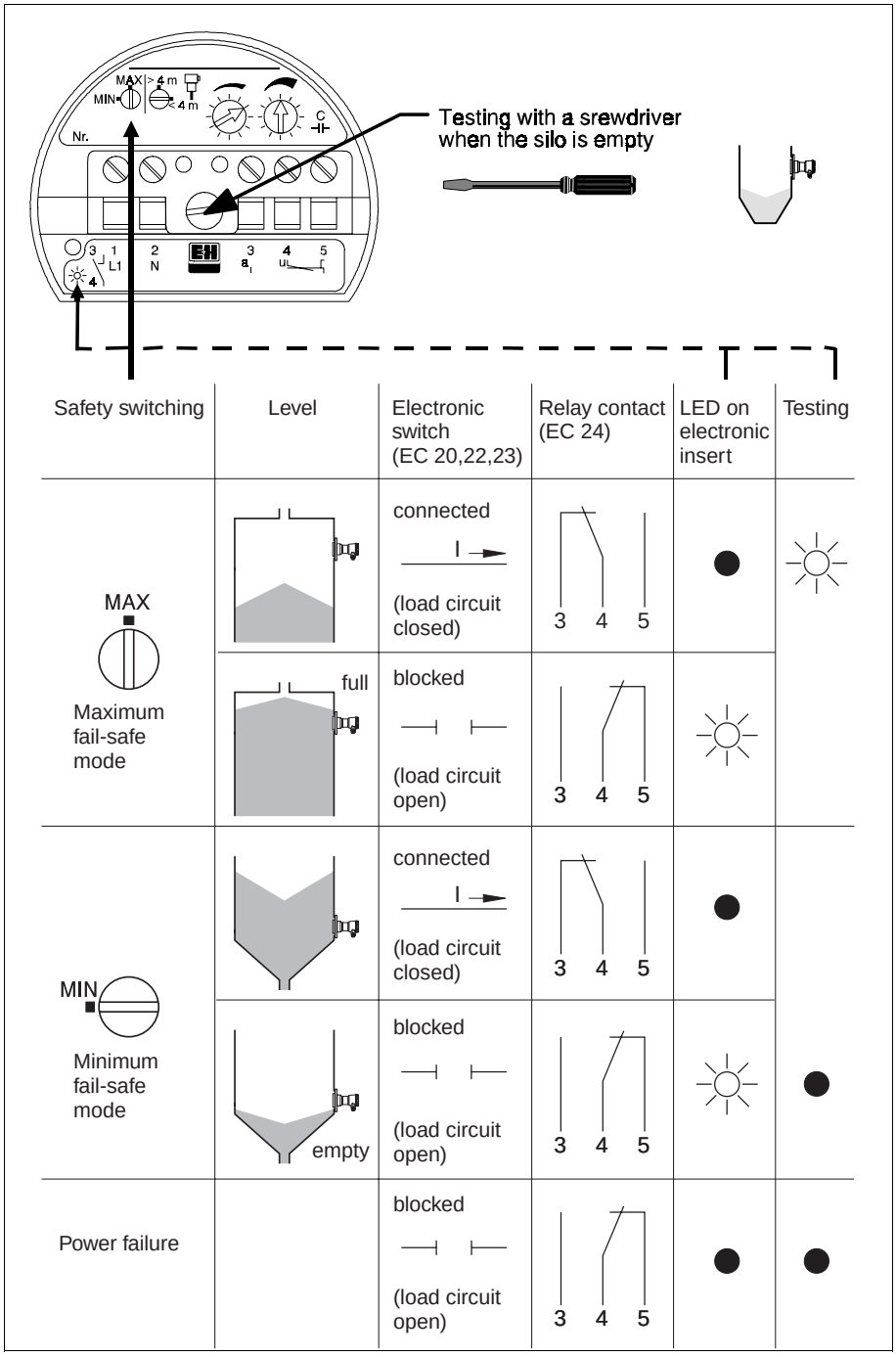


Fig. 16
Selecting the fail-safe mode and function.

Function Control

With the probe uncovered, touch the central retaining screw of the electronic insert with a screwdriver, holding it by the insulated handle. This simulates the bulk solid covering the probe.
The LED indicates a change of status.

This is only a function control test of the instrument.
Please also check for the correct operation for limit detection by filling and emptying the silo at the installation point!

Final Points

Screw the housing cover securely down after connection and calibration so that the standards comply to Protection IP 50.

Maintenance

The capacitive level limit switch Nivocompact FTC 431 requires no maintenance when correctly installed and used properly under the normal conditions specified by the system.

When cleaning and checking the silo:
- Examine the probe to check for damage to the insulation
- Remove material build-up

With initial but persistent low material build-up:
Recalibrate the Nivocompact after material build-up has occurred.

Troubleshooting

When an error is indicated, first check to make sure that
- The Nivocompact is properly connected
- There is a good ground connection to the silo with metallic walls
- A power supply exists at the terminals
- All instruments connected are operating correctly
- In the case of the electronic insert EC 20, the minimum required load of the connected instruments is at least present
- The correct fail-safe mode has been chosen
- Calibration has been carried out correctly (see Calibration)

Carry out a function control (see above)

Refer to the Error Tables , Fig. 17 and Fig. 18.

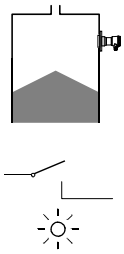
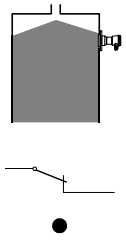
Error with maximum fail-safe mode		Possible causes
Probe free (level below maximum) but with electronic switch blocked LED on		- Water condensing on the disk probe - High material build-up on the disk probe - Probe insulation damaged - Water in housing - Water in the disk probe
Probe covered (level above maximum) but with electronic switch connected LED off		- Dielectric constant of the material too small - Different (or drier) material now in silo than expected on calibration

Fig. 17
Troubleshooting with maximum fail-safe mode.

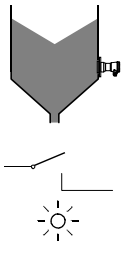
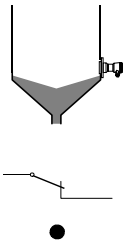
Error with minimum fail-safe mode		Possible causes
Probe covered (level above minimum) but with electronic switch blocked LED on		- Dielectric constant of the material too small - Different (or drier) material now in silo than expected on calibration - Material has formed cavities
Probe free (level below minimum) but with electronic switch connected LED off		- Water condensing on the disk probe - High material build-up on the disk probe - Probe insulation damaged - Water in housing - Water in the disk probe

Fig. 18
Troubleshooting with minimum fail-safe mode.

Guarantee

Our guarantee terms are included with the documents accompanying delivery. Copies may also be obtained from the agent responsible.
Any modification carried out within the instrument during the guarantee period invalidates the terms of the guarantee.

Replacement of Parts

Replacing the Electronic Insert

Switch off all sources of power to the Nivocompact.

Removal

- Remove all electrical connections to the electronic insert
- Loosen the central screw in the electronic insert
- Lift out the electronic insert from the housing using the handle

Insertion

- Push the new electronic insert carefully into the plug in the housing
- Tighten the central screw
- Connect up the electrical wires

Calibration

- Switch on the power supply
- Turn the switch for probe length to the same position as it was on the old electronic insert
- Carry out a new capacitance calibration with an empty silo
- Select the same fail-safe mode as for the previous electronic insert

Returning Parts for Repair

If a Nivocompact FTC 431 cannot be repaired and needs to be sent back to Endress+Hauser, then please note the following:

Cleaning the Probe

Remove all material residue attached to the probe.
This is especially important as the material may be of a dangerous nature e.g. corrosive, poisonous, carcinogenic, radioactive etc.
Please return parts only after they have been thoroughly cleaned of dangerous materials. Check in particular scratches and the possibility of diffusion through plastic material.

Stating Material and Defect

When returning the probe, please state exactly the material in which it was used and its characteristics.
A brief description of the error will also help us to diagnose the reason for it and at the same time lower your costs.

Thank you for your cooperation.

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