Technical
Information
TI 205F/00/en

Capacitance Limit Detection
nivocompact FTC 131 Z, FTC 331 Z

Compact level limit switches for bulk solids suitable for use in combustible dusts

Left:
Nivocompact FTC 131 Z
with rod probe

Centre:
Nivocompact FTC 331 Z
with rope probe

Right:
Nivocompact FTC 331 Z
with rope probe
and screening

Application
The Nivocompact FTC is designed for limit detection in silos filled with flammable bulk solids (minimum or maximum level indication).
Both versions can be adapted for optimum operation in a wide variety of applications:

FTC 131 Z with rod probe ø 18 mm, for mounting laterally or from above. Mainly for maximum detection of fine-grained or powdery bulk solids. Also for minimum detection in small silos or for light bulk solids.

FTC 331 Z with rope probe ø 12 mm, for mounting from above.
For maximum and minimum detection, including heavy bulk solids.

Incorrect switching caused by condensate and material build-up on the roof of the silo can be avoided by using the Nivocompact FTC 331 Z with screening.

Features and Benefits
- Complete unit consisting of probe with plug-in electronic insert:
  - Simple mounting, low installation costs
  - For automation and control systems (PLC, PCS, PC, relays, contactors, etc.)
- No moving parts in the silo:
  - no wear, long operating life
  - no maintenance
- Simple calibration
- Probes easily shortened:
  - for various limit values
  - less stocks required

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The Power of Know How

Application Examples

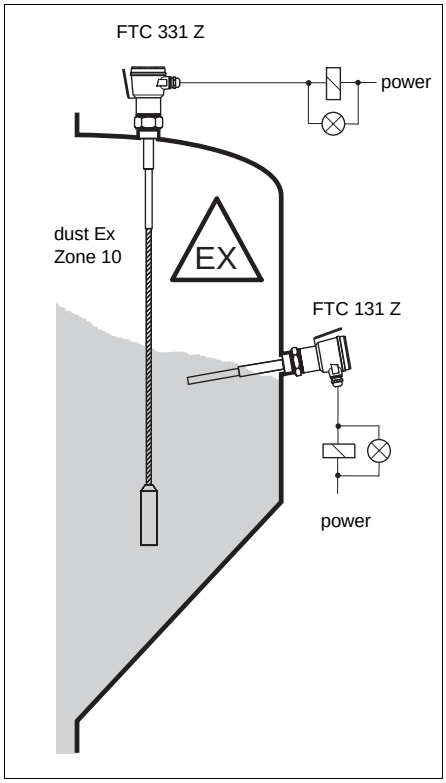
Sugar Grain
Coal Flour
and similar bulk solids.

Note:
Bulk solids should have relative dielectric constants $\varepsilon_r \geq 2.5$.

Measuring System

The Nivocompact is a complete electronic switch. The entire measuring system consists of only:

- Nivocompact FTC
- power supply and
- connected control systems, switches, signal transmitters
  (e.g. process control systems, PLC, relays, microcontactors, lamps, sirens, etc.)

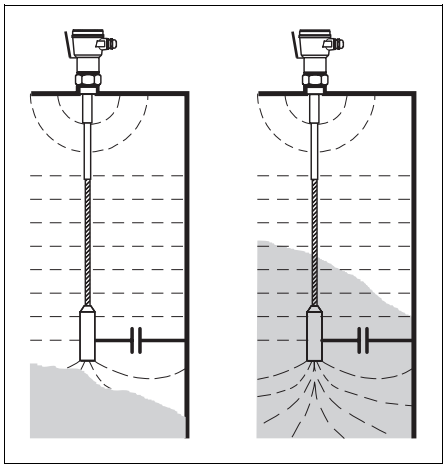


Examples of the capacitance level limit switches Nivocompact FTC 131 Z, FTC 331 Z in use

Operation

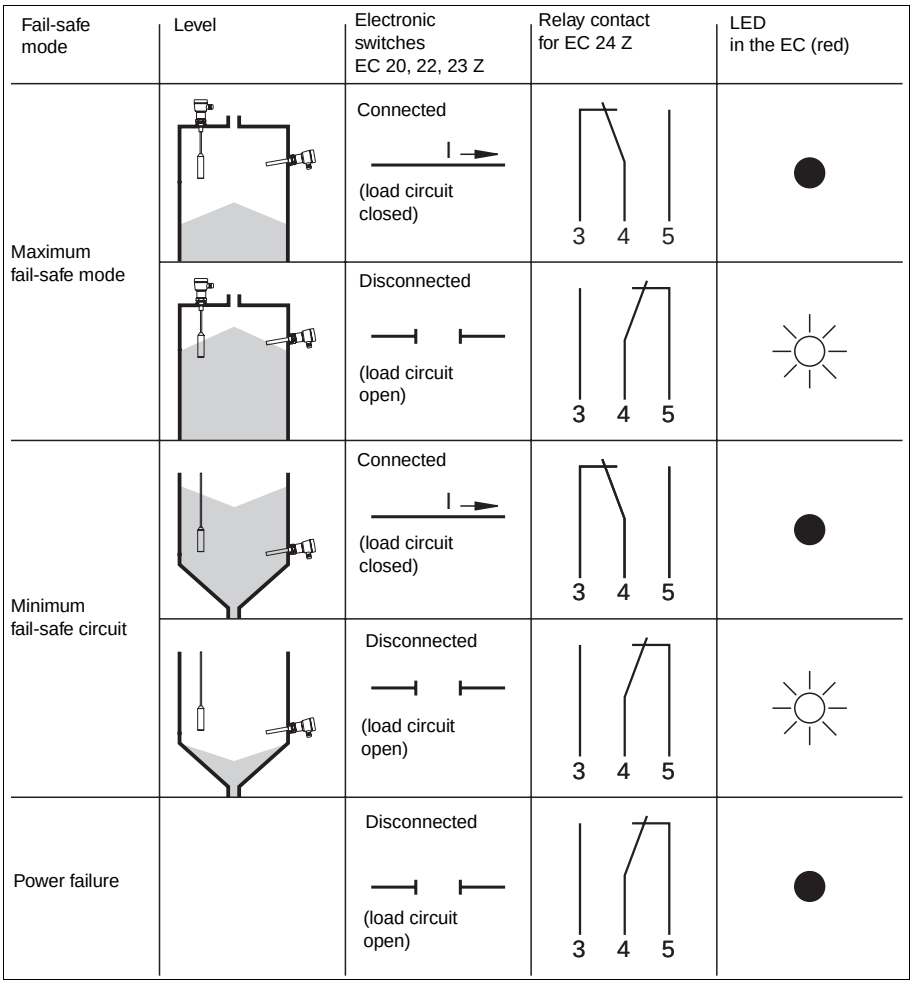
The probe (rod or rope) and the silo wall form the two electrodes of a capacitor, between which a high frequency voltage is generated.
As long as the probe is in air with a dielectric constant of $\varepsilon_r = 1$, then the capacitor has a low initial capacitance.
The switch point is calibrated so that the Nivocompact indicates "silo empty" with the initial capacitance.
If bulk material with a dielectric constant of $\varepsilon_r \geq 2.5$ covers the probe, then the capacitance increases and the Nivocompact indicates "silo full".

The Nivocompact is extremely insensitive to build-up on the probe and the silo wall as long as the material does not form a bridge between the probe and wall (e.g. on the threaded boss).



The capacitor consisting of the silo wall and probe

Fail-Safe Mode



Function according to fail-safe mode and level

A simple switch allows the Nivocompact to be used in all applications requiring high operational safety (quiescent current mode):

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

A red LED on the electronic insert indicates switching status.

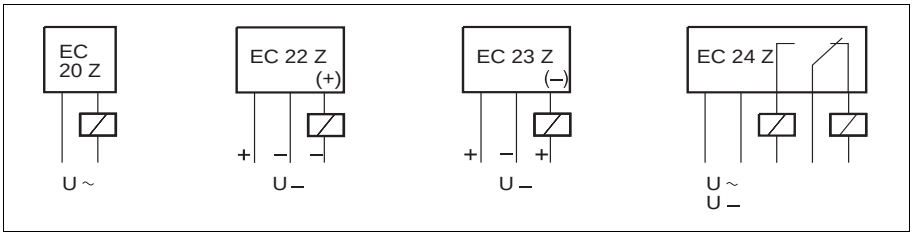
Inserts

Electronic Insert EC 20 Z
Two-wire AC connection,
21 V…250 V,
Electronic switch, max. 350 mA

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

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

Electronic Insert EC 24 Z
With potential-free relay output,
AC voltage operation 21 V…250 V
or DC voltage operation 20 V…125 V



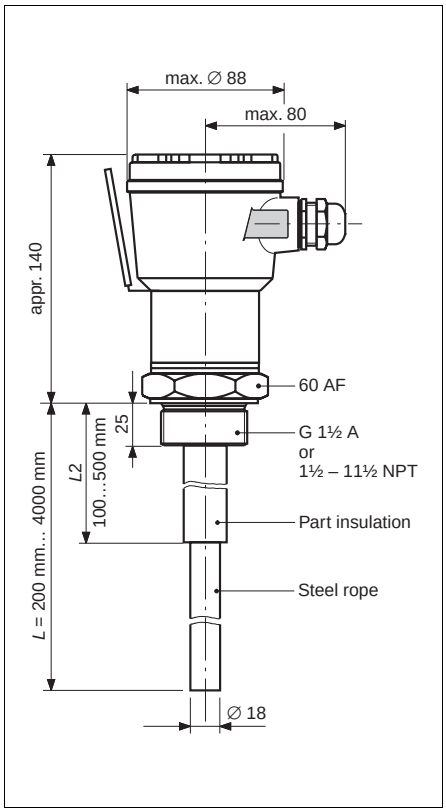
Electrical connections for different electronic inserts

Probes

Nivocompact FTC 131 Z
Rod probe, ø 18 mm
Probe length 200 mm ... 4000 mm

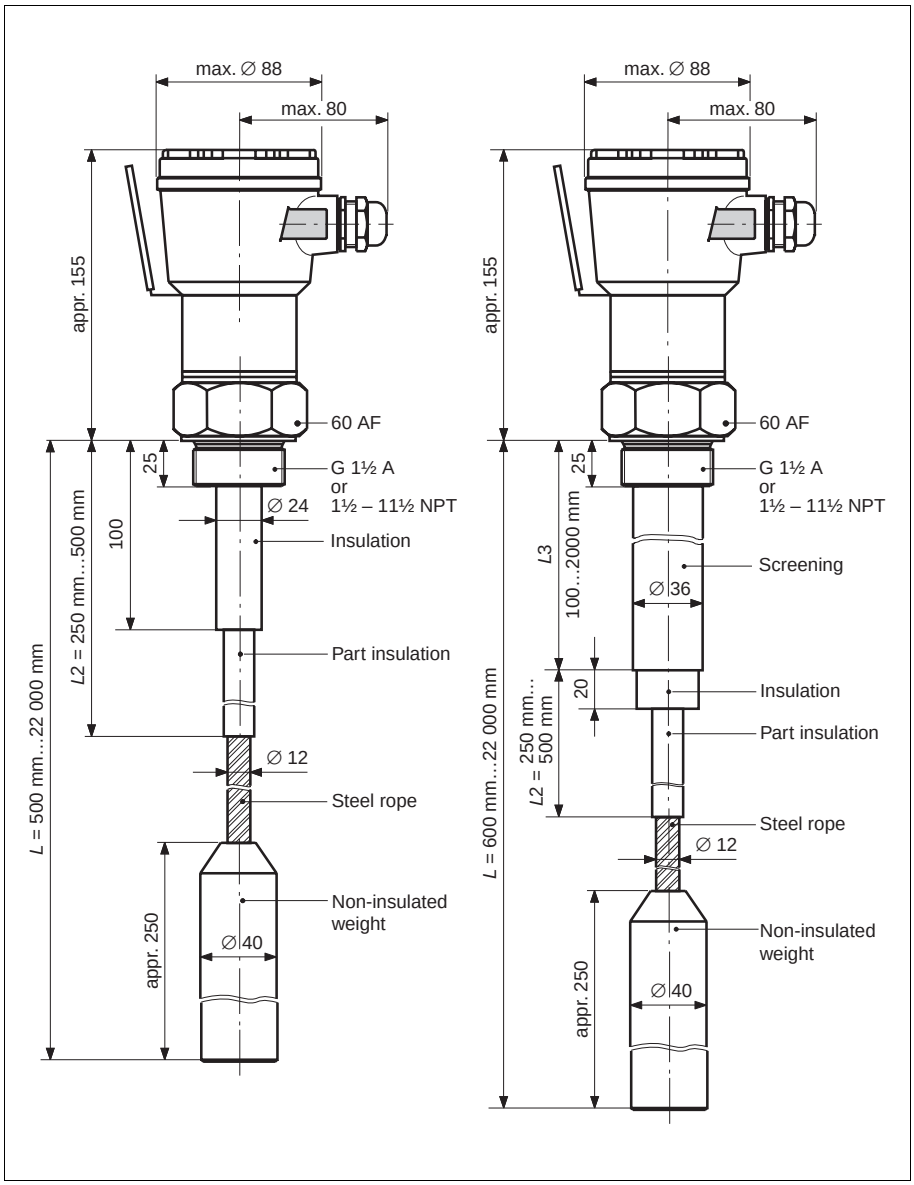
Nivocompact FTC 331 Z
Rope probe, ø 12 mm
Probe length max. 22 m
Tensile load max. 4 t

Nivocompact FTC 331 Z
With screening against condensation or material build-up on the silo roof.
Length of screening max. 2 m
Rope probe, ø 12 mm
Probe length max. 22 m
Tensile load max. 4 t



Dimensions
Nivocompact FTC 131 Z
with rod probe

100 mm = 3.94 in
1 in = 25.4 mm



Left:
Dimensions
Nivocompact FTC 331 Z
with rope probe

Right:
Dimensions
Nivocompact FTC 331 Z
with rope probe
and screening

Installation
General Information

Filling the Silo
The filling curtain should not be directed onto the probe.

Angle of Material Mounds
Note the angle of the material mounds and the outlet funnel when determining the measuring point or probe length.

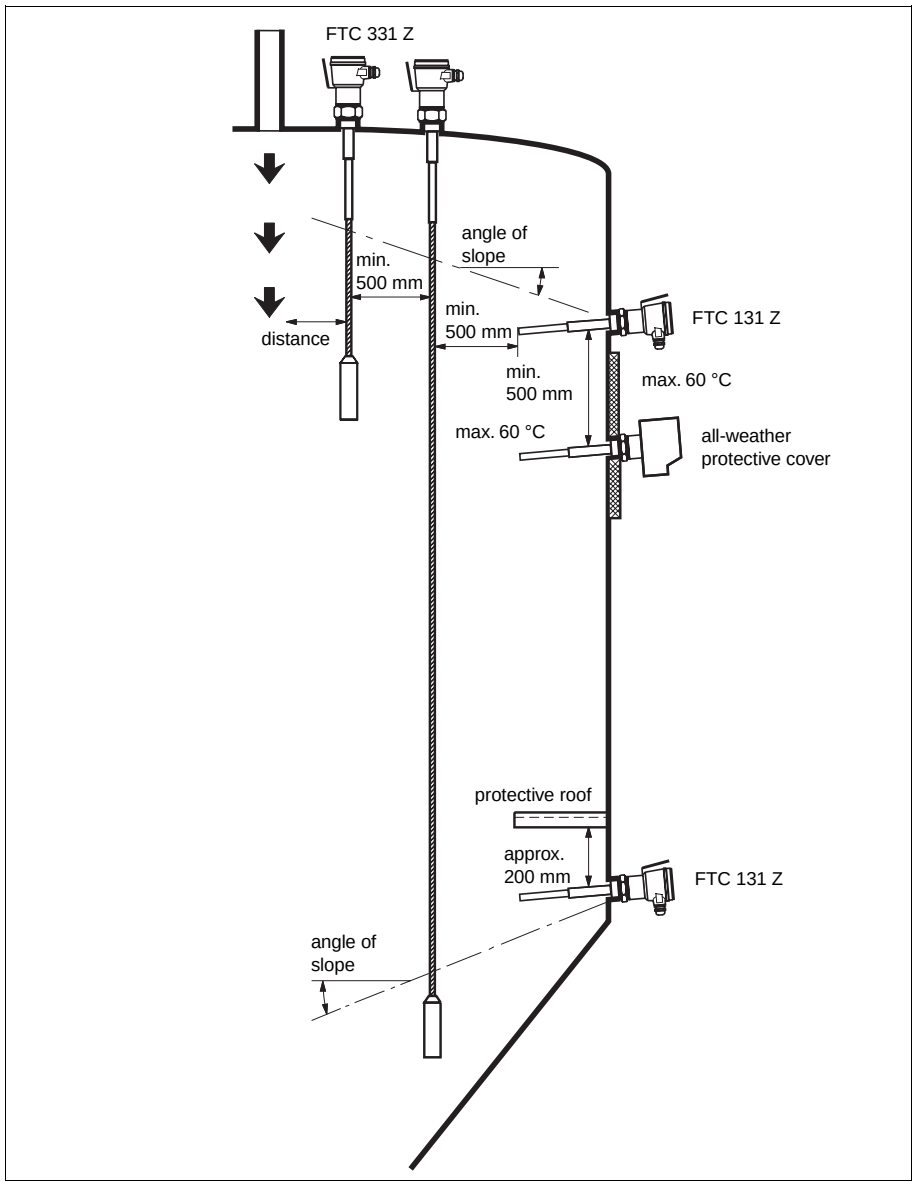
Distance Between Probes
If more than one probe is mounted in a silo, then a minimum distance of 0.5 m must be allowed for in order to avoid mutual interference.

Threaded Socket for Mounting
Use the shortest threaded socket when mounting the Nivocompact.
Condensation can form in long threaded sockets and interfere with correct operation of the probe.

Heat Insulation
Insulation can prevent condensation near the threaded boss and so reduce build-up and the danger of incorrect switching.

Installation in the Open
A protective all-weather cover as an accessory protects the Nivocompact with the aluminium housing from excessive temperatures and from condensation which may form in the housing due to large temperature variations.

Explosion Protection
All local regulations and instructions given in certificates must be observed when mounting in dust explosion hazardous areas.

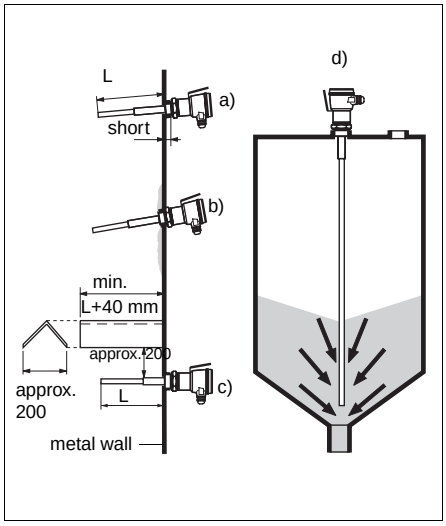


General information
for installing
the Nivocompact FTC
capacitance
level limit switch

Installation
Nivocompact FTC 131 Z

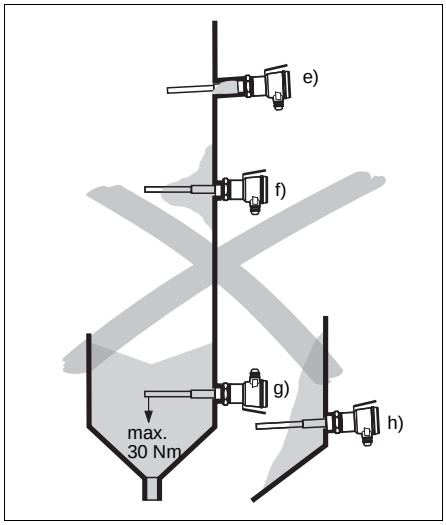
Silo with metal walls

Correct Installation



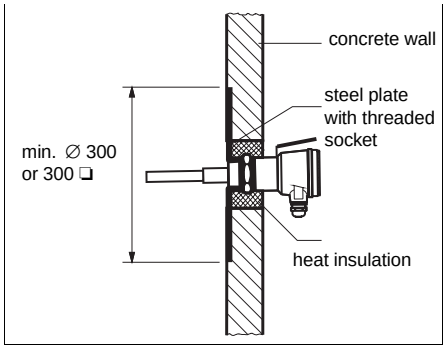
a) Maximum probe length L for lateral mounting approx. 500 mm. Short threaded socket (ideally 25 mm = half standard length socket).
b) Light build-up on the silo wall: threaded socket welded internally. The probe tip is sloping downwards so that material falls off more easily.
c) Protective roof to protect against collapsing mounds or high strain on the rod probe caused by material discharge with the Nivocompact FTC131 Z used for minimum detection.
d) Centre the rod probe accurately to prevent lateral strain on the probe caused by material discharge.

Incorrect Installation



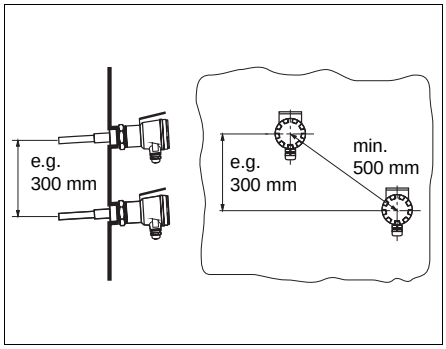
e) Threaded socket too long. Material can settle and lead to incorrect switching.
f) Incorrect switching caused by high build-up on the silo wall is best avoided by mounting the Nivocompact FTC 331 Z with rope probe in the roof of the silo.
g) High strain on the rod probe due to material discharge. The FTC 331 Z is recommended. Cable gland pointed upwards can allow moisture to enter.
h) In areas where material can settle, the instrument cannot recognise an "empty" silo. The FTC 331 Z is recommended.

Silo with concrete walls



This mounting example shows a steel plate as counter-electrode.
Heat insulation prevents condensation and build-up on the steel plate.

For small differences in level



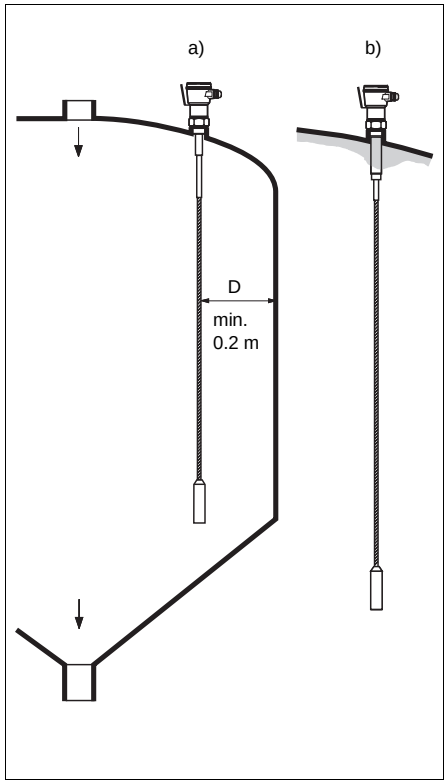
The minimum distance required can be maintained by staggered mounting.

Installation
Nivocompact FTC 331 Z

Silo with
metal walls

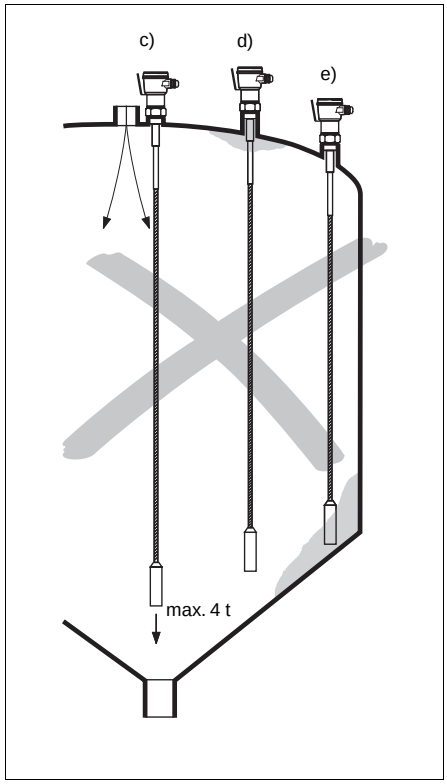
Distance D between the probe and the wall is approx. 10 % and 25 % of the diameter of the silo

Correct Installation



a) The correct distance from the silo wall, the filling curtain and the material outlet.
For reliable switching with products having low dielectric constants, mount the probe very close to the wall (not for use with pneumatic filling systems).
For pneumatic filling systems, the distance of the probe from the wall should not be too small as the probe may swing against it.
b) Nivocompact FTC 331 Z with screening against condensation and material build-up on the silo roof.

Incorrect Installation



c) The probe can be damaged by the filling curtain if mounted too close to the inlet.
When mounted near the centre of the outlet, the high tensile forces present at this point may damage the probe or subject the silo roof to excessive strain.
d) Threaded socket too long.
Condensation and dust may penetrate and cause incorrect switching.
e) Too close to the silo wall:
The probe touches the build-up.
This can result in incorrect switching.

Silo Roof

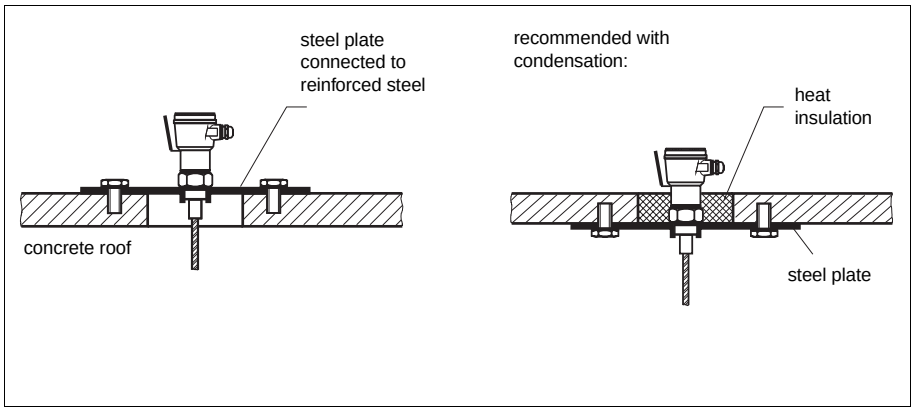
Ensure that the silo roof is strong enough to withstand the forces generated!
Long rope probes can be subject to very high tensile forces which may occur at the material outlet.
These depend on the type of outlet, the length of the probe, the installation point of the probe and the material itself:
- for free flowing bulk materials 1000 ... 10000 N (100 kg ... 1 t),
- for heavy, powdery bulk materials which tend to form build-up up to 100000 N (10 t).

Coarse-Grained Material

The Nivocompact FTC 331 Z should only be used for maximum detection in silos with very coarse or abrasive material.

Distance Between Probes

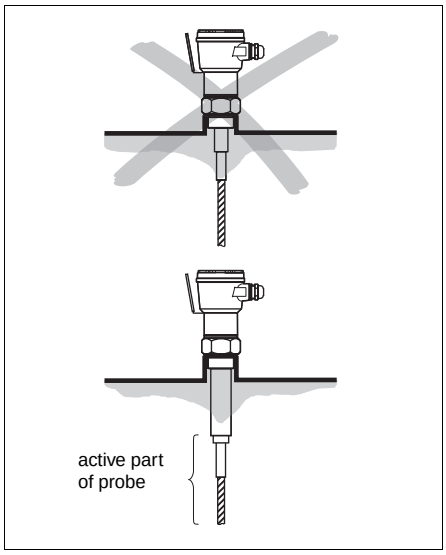
A minimum distance of 0.5 m between probes must be maintained to ensure that there is no mutual interference. This also applies to all Nivocompact units which are mounted in adjacent silos with non-conducting walls.



Silo with
concrete walls

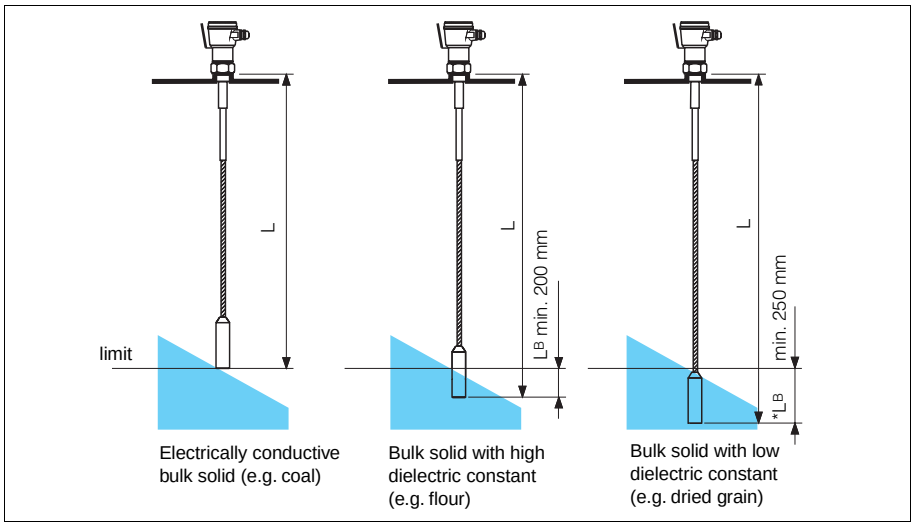
The 25 mm long threaded socket should project into the silo so as to minimise effects due to condensation and material build-up.

Heat insulation prevents condensation and build-up on the steel plate.



Recommended:
Use the FTC 331 Z
with screening

Screening prevents the effects of moisture and build-up between the active part of the probe and the silo roof



Different probe lengths

* L_B (covered length):
For non-conductive materials with low dielectric constants, the rope probe must be approx. 5 % (or minimum 250 mm) longer than the distance from the roof of the vessel to the switch point. If it is not possible to select the correct L_B for minimum detection with very long probes, then a special version with a "butterfly weight" can be supplied as an accessory. The increased surface area of this weight ensures that there is a large enough change in capacitance when the probe is covered by material. An L_B of 250 mm is normally sufficient.

Wiring General Information

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 Z).

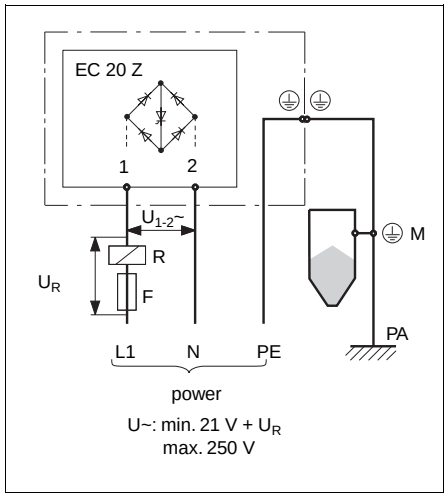
Fuse
Ensure that the rating of the fine-wire fuse corresponds to the maximum load to be connected. The fine-wire fuse does not protect the electronic insert of the Nivocompact FTC.

Diameter of Wiring
Because of the small current used, only small diameter cabling is required. Low-cost cabling with diameters of 0.5 mm^2 to a maximum of 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 or reinforced concrete walls or to the protective ground PE.
If a counter- electrode is connected to a plastic silo, then there must be a short ground connection from the Nivocompact to the counter- electrode.

Explosion Protection
All local regulations and instructions given in certificates must be observed especially in regard to the creation of an equipotential plane (earth bonding).

Connecting the EC 20 Z



Connecting the Nivocompact with EC 20 Z electronic insert

U_{1-2}~: 21 V… 250 V across Terminals 1 and 2 of the EC 20 Z

R: connected (external) load, e.g. relay

F: fine-wire fuse, load-dependent

M: ground connection to silo or to counter electrode

U_R: voltage drop between the load R and the fine-wire fuse

PA: Earth bonding and ground

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

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

Connection 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 cut-off
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 "cuts off" (blocks) on a level alarm. Because of the current requirements of the electronics, a small "residual current" still flows through the external load.
If the load is a relay with a very small retaining current, then the relay may not de-energise. In this case connect an additional load in parallel to the relay, e.g. a resistor or signal lamp.

Connecting the EC 22 Z, EC 23 Z

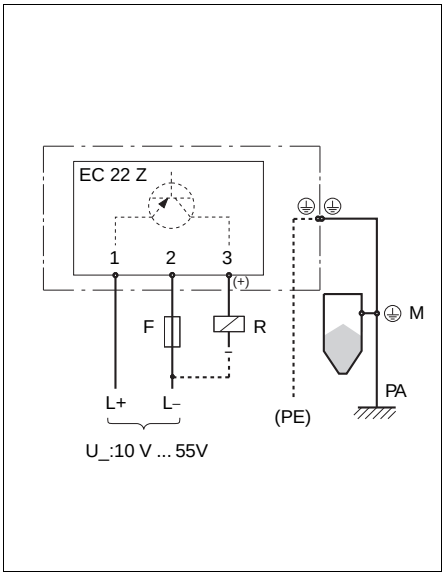
Connecting the Nivocompact with EC 22 Z electronic insert PNP connection

F: fine-wire fuse, 20 mA medium slow-blow fuse recommended

R: connected load, e.g. PLC, PCS, relay

M: ground connection to silo or to counter electrode

PA: Earth bonding and grounding



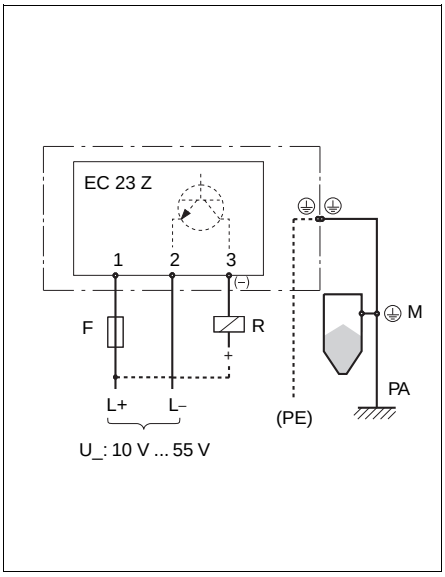
Connecting the Nivocompact with EC 23 Z electronic insert NPN connection

F: fine-wire fuse, 20 mA medium slow-blow, fuse recommended

R: connected load, e.g. PLC, PCS, relay

M: ground connection to the silo or to counter electrode

PA: Earth bonding and grounding



Connecting the Nivocompact with Electronic Insert EC 22 Z (Three-Wire PNP) or Electronic Insert EC 23 Z (Three-Wire NPN) for DC Voltage

Transistor circuit for load

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

EC 22 Z:
Terminal 3 has a positive signal with normal switching.

EC 23 Z:
Terminal 3 has a negative signal with normal switching.

The transistor is blocked on level alarm or power failure.

Protection against short-circuiting

The load circuit is protected against overload and short-circuiting (pulsed overload protection).
The transistor is blocked on overload or short circuit.

Protection against voltage peaks

Connecting to an instrument with a high inductance:
A voltage limiter should be connected.

Connecting the EC 24 Z

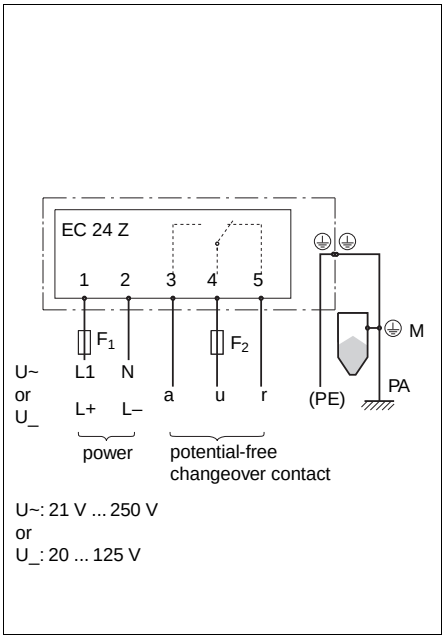
Connecting the Nivocompact with EC 24 Z electronic insert Relay output

F1: fine-wire fuse 200 mA, medium slow-blow, recommended

F2: fine-wire fuse to protect the relay contact, load-dependent

M: ground connection to silo or to counter electrode

PA: Earth bonding and grounding



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

Relay contact for load

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

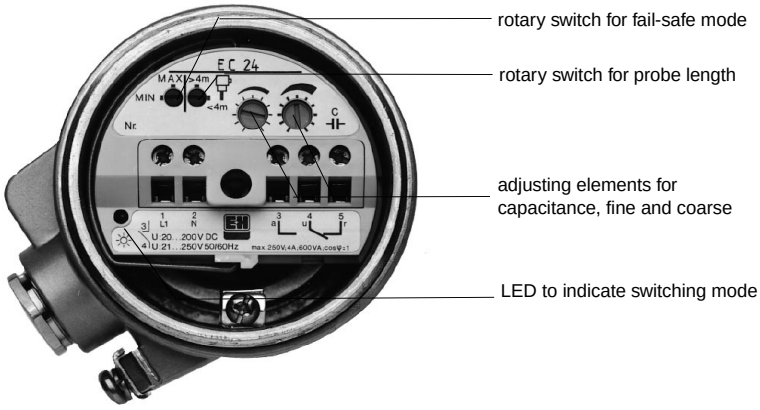
Protection against voltage peaks and short-circuiting

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

Calibration and Adjustment

For calibrating, the Nivocompact should be adjusted to the capacitance value of the capacitor formed by the probe and wall of the silo.
You can also select the fail-safe mode required for your particular application.

Calibration with an empty silo requires little handling of the electronic insert.



Operating elements on the electronic insert

Technical Data

Operating Data
Operating temperature in silo:
–20°C ... +60°C (0 ... 140°F)
Operating pressure p_e:
max. 10 bar (150 psi)
Dielectric constant ε_r of the material:
min. 2.5
Operating temperature for the housing: –20°C ... +60°C
Storage temperature: –40°C ... +85°C

Probes
FTC 131 Z: rod probe, ∅ 18 mm, length max. 4 m
FTC 331 Z: rope probe, ∅ 12 mm, length max. 22 m
Tensile load on probes:
Rod probe max. 30 Nm lateral
Rope probe max. 40 kN vertical
Probe length tolerances:

Probe length	Tolerance
to 1 m	+0 mm, –5 mm
to 3 m	+0 mm, –10 mm
to 6 m	+0 mm, –20 mm
to 22 m	+0 mm, –30 mm

Process Connections
Parallel thread:
G $1^1/_2$ A acc. to DIN ISO 228/I
Tapered thread:
NPT $1^1/_2$ - $11^1/_2$ acc. to ANSI B1.20.1
Material: steel or stainless steel 1.4571 (= SS 316 L)

Housing Versions

A
Aluminium housing with standard cable gland Pg 16,
Protection IP 55

B
Aluminium housing with waterproof cable gland Pg 16,
Protection IP 66

K
Polyester housing with waterproof cable gland Pg 16
Protection IP 66

Cable Gland
Housing IP 55: standard Pg in nickel-plated brass with NBR seal for cable diameter 7...10 mm.

Housing IP 66: water-tight Pg in polyamide with Neoprene-CR seal for cable diameter 5 ... 12 mm.

Electronic Inserts
Terminal connections: for max. 1.5 mm^2

Measuring frequency:
approx. 750 kHz
for short probes up to 4 m,
switchable to approx. 450 kHz
for long probes

Initial capacitance, adjustable:
to approx. 400 pF

Switching delay: approx. 0.5 s

Minimum/Maximum fail-safe mode:
selectable by rotary switch

Switching indication: red LED

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

Power supply U~:
21 V…250 V, 50/60 Hz

Connected load, short-term
(max. 40 ms): max. 1.5 A,
max. 375 VA with 250 V,
max. 36 VA with 24 V

Maximum voltage drop: 11 V

Connected loads, continuous:
max. 350 mA;
max. 87 VA with 250 V,
max. 8,4 VA with 24 V

Minimum load current with 250 V:
10 mA (2.5 VA)

Minimum load current with 24 V:
20 mA (0.5 VA)

No-load current (rms.): < 5 mA

Electronic Inserts
EC 22 Z and EC 23 Z
for DC Voltage
(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, continuous:
max. 350 mA

Peak inrush current:
max. 1.2 A, max. 20 µs

Parallel capacitance to load:
max. 500 nF

Protection against short-circuiting and
overload:
Response level approx. 550 mA

Residual current with blocked transistor:
< 100 µA

Protected against reverse polarity

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

Power supply U_: 20 V…125 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 changeover contact

Contact load capacity:
U~ max. 250 V, I~ max. 4 A,
P~ max. 1000 VA ($\cos \varphi = 1$) or
P~ max. 350 VA ($\cos \varphi \geq 0.7$)
U- max. 100 V, I- max. 4 A,
P- max. 100 W

Operating life: min. 10^5 switchings at
max. contact load

Additional switching delay:
max. 1.5 s

Subject to modification

Product Structure Nivocompact FTC 131 Z

FTC 131 Z, capacitance level limit switch with rod probe

Certificate, Approval — **Weight**

E Dust Ex Zone 10

Process Connection / Material

G1 Thread G 1 1/2 A / steel	0.5kg
G2 Thread G 1 1/2 A / 1.4571	0.5kg
H1 Thread NPT 1 1/2" / steel	0.5kg
H2 Thread NPT 1 1/2" / 1.4571	0.5kg

Partial Insulation, Material and Length L2

A Insulation PE, 100 mm ... 500 mm

Probe, Material and Length L

1 Rod steel, 200 mm ... 4000 mm	2.2kg/m
2 Rod 1.4571, 200 mm ... 4000 mm	2.2kg/m

Housing / Cable Gland (Protection)

B Aluminium housing (IP 66) / Pg 16 (IP 66)	0.4kg
K Polyester housing (IP 66) / Pg 16 (IP 66)	0.3kg

Electronic Insert

1 EC 20 Z	0.2 kg
2 EC 22 Z	0.2kg
4 EC 24 Z	0.2kg

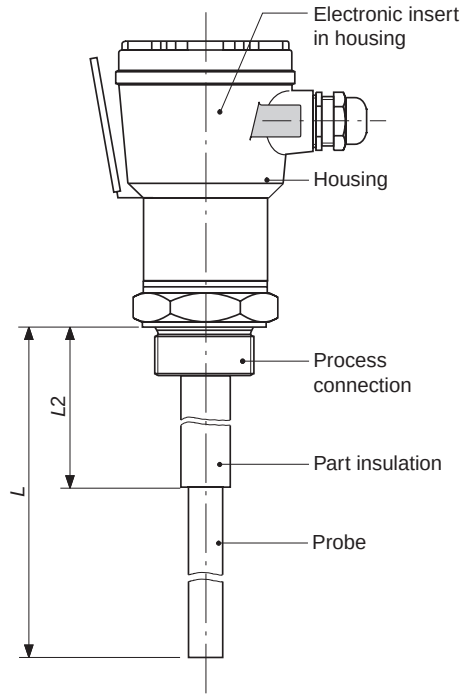
FTC 131 Z--	E		A				Product designation	Total weight		kg

Various modules for assembling the level limit switch Nivocompact FTC 131 Z with rod probe.

Recommended lengths:

Probe length L for material with ε_r > 2.5:
- with lateral mounting in a metal silo or steel reinforced concrete silo approx. 350 mm;
- with vertical mounting min. 5% longer than the distance between the silo roof and the switch point

Partial insulation L2:
- with dry material min. 100 mm;
- with moist material min. 200 mm, max. 500 mm, depending on build-up,
- min. 100 mm shorter than the probe length



Product Structure Nivocompact FTC 331 Z

FTC 331 Z, capacitance level limit switch with rope probe

Certificate, Approval — **Weight**

E Dust Ex Zone 10

Process Connection / Material

G1 Thread G 1 1/2 A / steel	0.6kg
G2 Thread G 1 1/2 A / 1.4571	0.6kg
H1 Thread NPT 1 1/2" / steel	0.6kg
H2 Thread NPT 1 1/2" / 1.4571	0.6kg

Screening, Material and Length L3

A No screening	
B Screening steel, 100 mm ... 2000 mm	2.7kg/m
C Screening 1.4571, 100 mm ... 2000 mm	2.7kg/m

Partial insulation, Material and Length L2

A Insulation polyolefin, 250 mm ... 500 mm

Probe, Material and Length L

2 Rope steel, 500 mm *... 22000 mm	0.7kg/m
3 Rope 1.4571, 500 mm *... 22000 mm	0.7kg/m

*with screening min. 600 mm

Weight

A Cast iron	1.9kg
B 1.4571	1.9kg

Housing / Cable Gland (Protection)

B Aluminium housing (IP66) / Pg 16 (IP 66)	0.4kg
K Polyester housing (IP66) / Pg 16 (IP 66)	0.3kg
R Aluminium housing, coated (IP 66) / Pg 16 (IP 66)	0.4kg

Electronic Insert

1 EC 20 Z	0.2kg
2 EC 22 Z	0.2kg
4 EC 24 Z	0.2kg

F TC 331 Z	E			A					Product designation	Total weight		kg

Various modules for assembling the level limit switch Nivocompact FTC 331 Z with rope probe.

Left: FTC 331 Z without screening

Right: FTC 331 Z with screening against condensation and material build-up on the process connection

Recommended lengths:

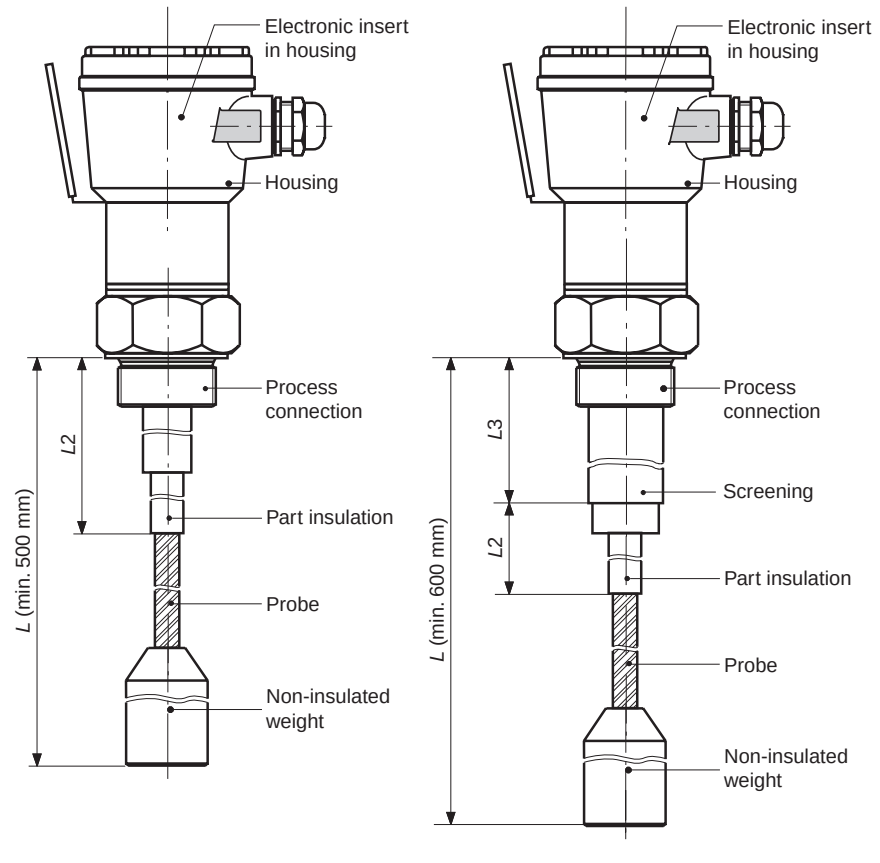
Probe length L for material with ε_r > 2.5: min. 250 mm longer than the distance between the silo roof and the limit point

Partial insulation length L2 :

250 mm to 500 mm, depending on condensation and material build-up

Screening length L3

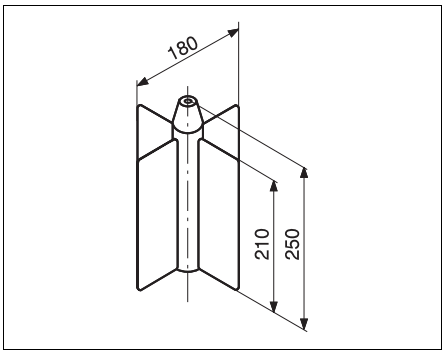
- min. up to 100 mm beneath silo roof
- for large temperature differences high humidity and strong build up min. 300 mm beneath silo roof



Accessories

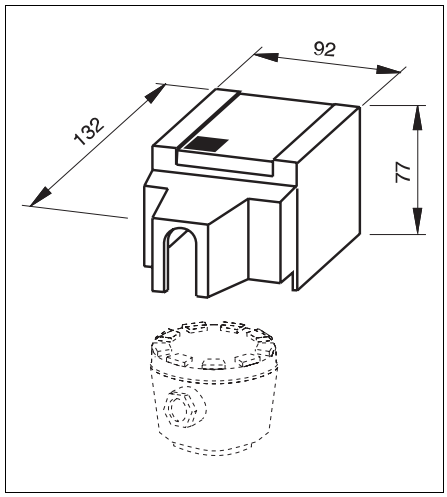
- Seal for thread G $1^1/_2$ A:
  in elastomer/fibre (asbestos-free), supplied

- Butterfly weight for FTC 331 Z
  Material: steel
  Weight: approx. 3.2 kg



Dimensions of the butterfly weight (accessory).
This weight provides a larger capacitance difference for rope probes.

- Protective all-weather cover
  for aluminium housing
  Material: polyamide



Dimensions of the all-weather cover (accessory).
This cover prevents condensation in the housing.

Supplementary Documentation

Certificates
Two approval certificates have been issued for the level limit switches Nivocompact FTC 131 Z and FTC 331 Z for use in combustible dusts Zone 10:

☐ Design approval certificate
BVS 93.Y.8004 B (Germany)
for the probes;
- the rod probe for FTC 131 Z corresponds to the partially insulated probe 11450 ZS;
- the rope probe for FTC 331 Z corresponds to the partially insulated probe 21265 S.

and

☐ Certificate of conformity
PTB No. Ex-92.C.2167 X for electronic inserts with intrinsically safe probe circuits.

These certificates can be ordered under the following documentation order numbers:

☐ ZE 088F/00/d
Test design certificate

☐ ZE 089F/00/d
Certificate of conformity

(In German)

Details When Ordering

☐ **FTC 131 Z:**
Product code (see Page 13)
Length L of probe
Length L2 of partial insulation

☐ **FTC 331 Z:**
Product code (see Page 14)
Length L of the probe
Length L2 of partial insulation
Length L3 of screening

Other Instruments for Measuring Level in Combustible Dusts

- ☐ Vibration limit switch *Soliphant II* for fine-grained bulk solids

- ☐ Electromechanical level measurement system *Silopilot* for continuous level measurement in very high silos containing coarse- and fine-grained bulk solids

- ☐ Capacitance probes with separate electronics for limit detection and continuous level measurement

Documentation for your particular application can be sent to you on request.

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