Technical
Information
TI 134F/00/en

Capacitance Limit Detection
nivocompact FTC 731, FTC 831

Compact level limit switches for bulk solids with no calibration required









Application
The Nivocompact FTC… is used for limit detection in silos containing bulk solids. (Minimum or maximum level indication.) With the rod and rope probe versions, it can cover almost any measuring application.
It can also be used in the food processing industry.

FTC 731 with rod probe for mounting from all sides.

Advantages:
- No calibration required; the Nivocompact operates independently of material characteristics when the bulk solid has a dielectric constant $\varepsilon_r \geq 2.0$:
  – cost-effective start-up
- Extremely insensitive to build-up:
  – high operating reliability
- 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 silo:
  – no wear
  – long operating life
  – no maintenance

FTC 831 with rope probe for mounting from above.

Endress+Hauser
The Power of Know How

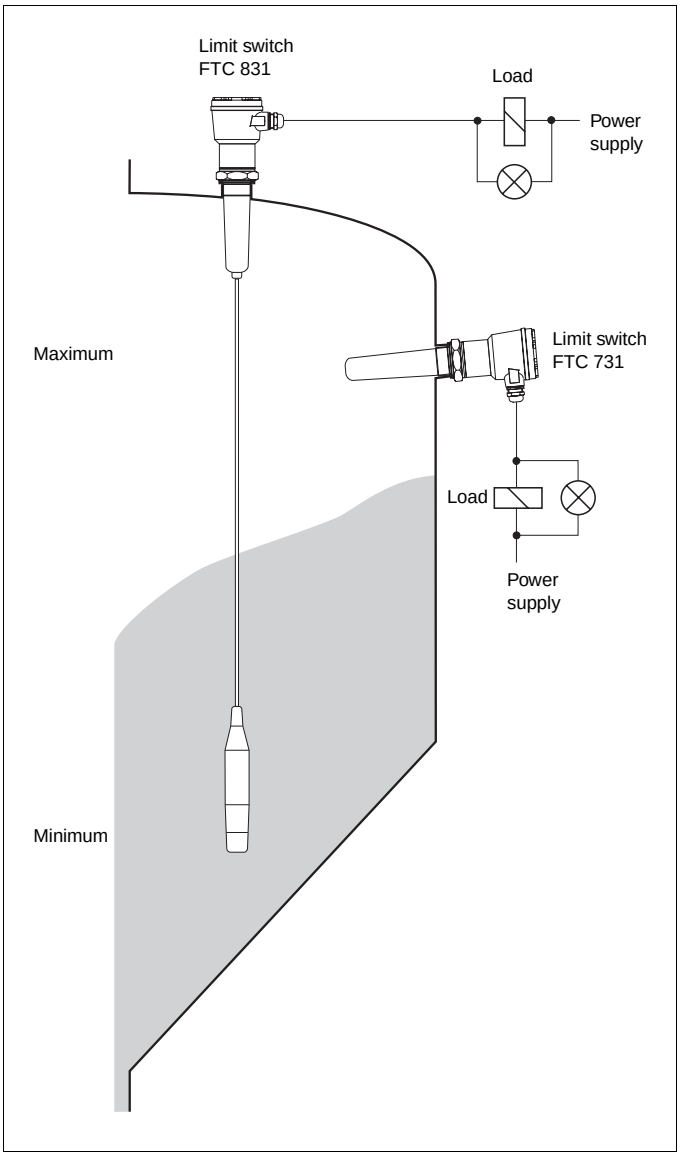
Application Examples

Plastic granulates
Lime
Plaster
Cement
Kaolin
and similar bulk solids

Grain
Flour
Spices
Semolina
Fodder

Note:
Bulk solids should have dielectric constants $\varepsilon_r \geq 1.6$.

The Complete Measuring System



Limit detection in silos with bulk solids

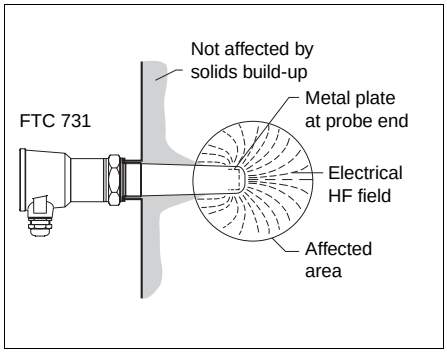
The Nivocompact is an electronic switch. The entire measuring system consists of:

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

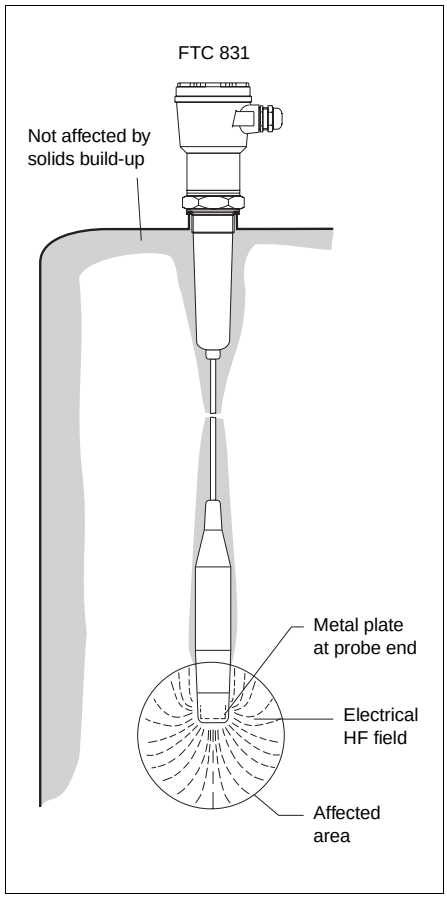
Operation

A metal plate at the end of the probe situated inside the insulation, and the area around it (e.g. silo wall) constitute 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 end of the probe is in air with a dielectric constant $\varepsilon_r = 1$, then the discharge time constant is $\tau = R \times C_A$ where R is the resistance of the circuit and C_A the capacitance of the capacitor formed by the probe end and its surroundings.

If a material with a dielectric constant $\varepsilon_r \geq 2.0$ moves into the high frequency electrical field at the end of the probe, then the capacitance C_A increases and with it the time constant τ.
This change in the time constant is evaluated and the Nivocompact is activated according to its switching mode.



Operation of the Nivocompact FTC 731 with rod probe is not affected by material build-up even when several centimetres thick.



The operation of the Nivocompact FTC 831 with rope probe is totally unaffected by material build-up on the walls of the silo.

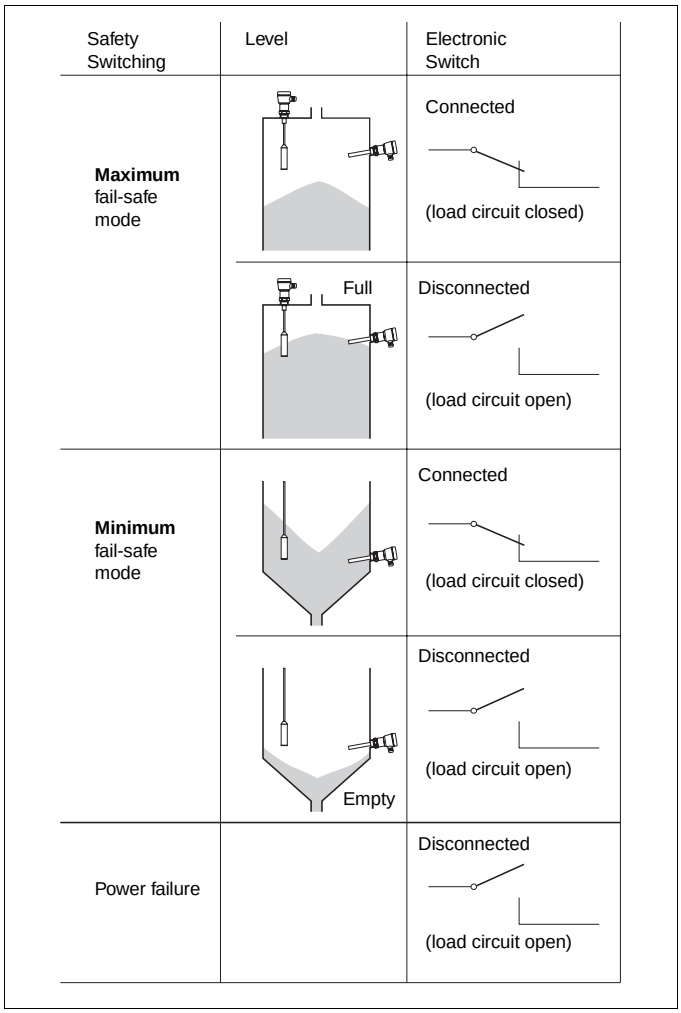
Fail-Safe Mode

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

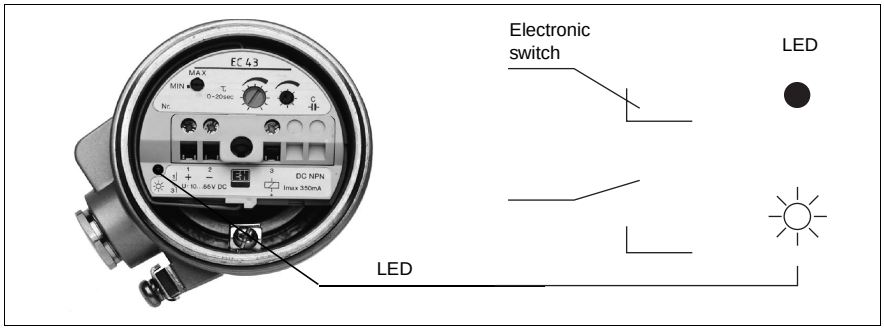
- Maximum Fail-Safe:
  The circuit is blocked
  if the probe is covered
  or the power supply fails.

- 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 the switching status.



The electronic switch operates according to the fail-safe switching and the level.

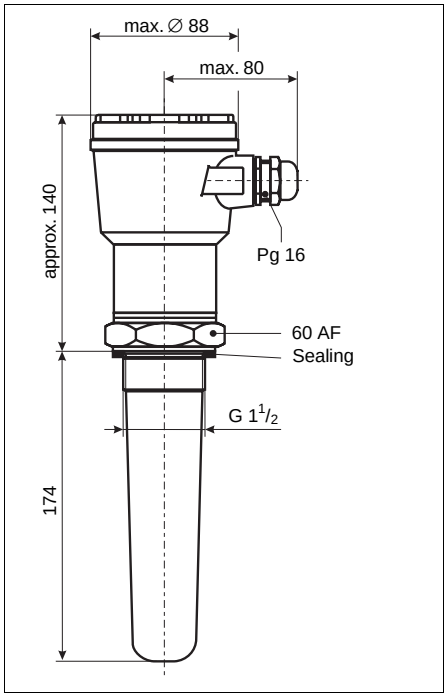


The LED indicates switching status.

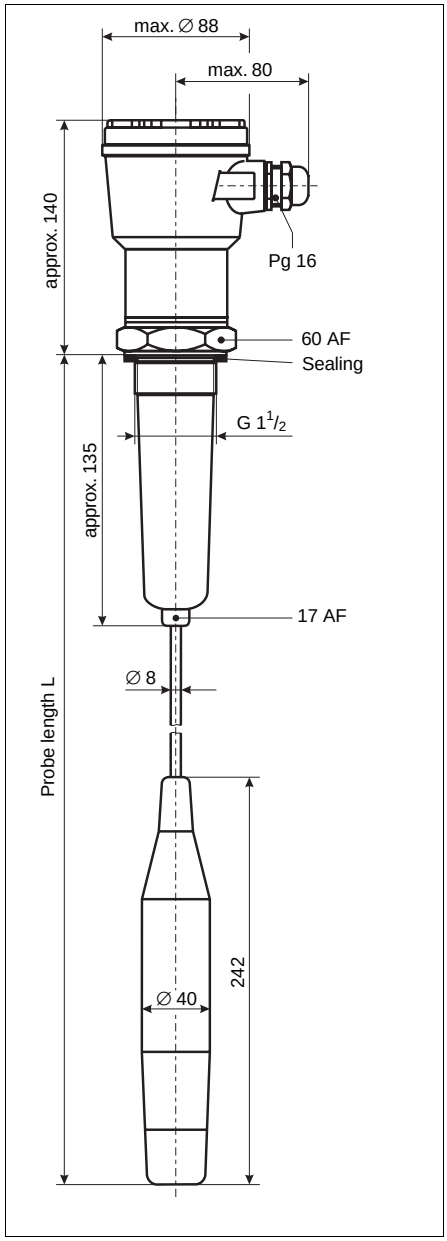
Basic Differences Between Probes

Nivocompact FTC 731
Rod probe: ø approx. 35 mm
Insulation: probe and threaded boss in fibreglass reinforced polyester
Probe length: 174 mm
Lateral load: max. 4000 N
Operating pressure: max. 6 bar
Operating temperature: max. 100 °C

Nivocompact FTC 831
Rope probe: ø 8 mm
Insulation: PE
Probe length: max. 20 m
Tensile load: max. 2500 N
Operating pressure: max. 6 bar
Operating temperature: max. 60 °C



Dimensions of the Nivocompact FTC 731



Dimensions of the Nivocompact FTC 831

Installation, General Information

Material of the Silo
The Nivocompact FTC 731 or FTC 831 can be installed in silos made of various materials (e.g. metal, plastic, concrete).

Installation in the Open
The protective sun 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.

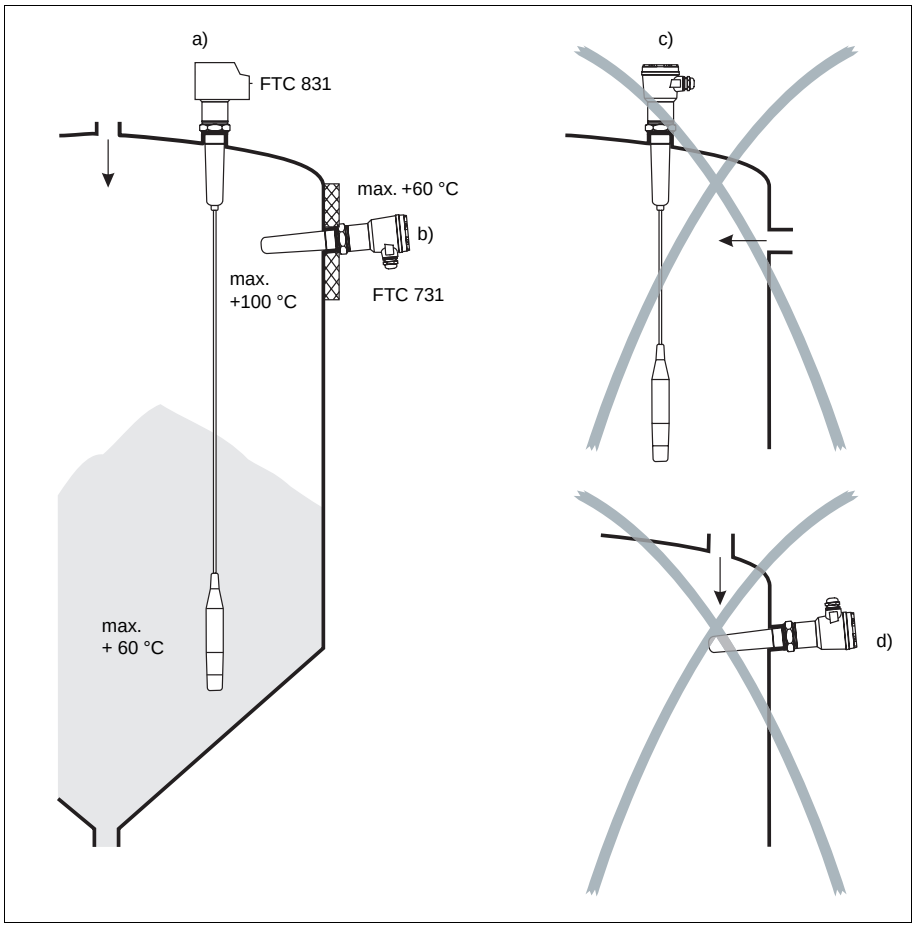
Installation Point
Note the angle of material flow or the outlet funnel when determining the measuring point.

The Nivocompact switches (also with bulk solids with very small dielectric constants) when the probe end is covered by material by a few centimetres or when the material descends a few centimetres below the probe end.

The filling stream should not be directed onto the probe.

Correct Installation

Incorrect Installation



a) protective sun cover for mounting in the open.

b) heat insulation on the silo wall with high temperatures in the silo.

c) Inflowing material can damage the probe.

d) The filling curtain can cause error switching.

Cable gland pointed upwards can allow moisture to enter.

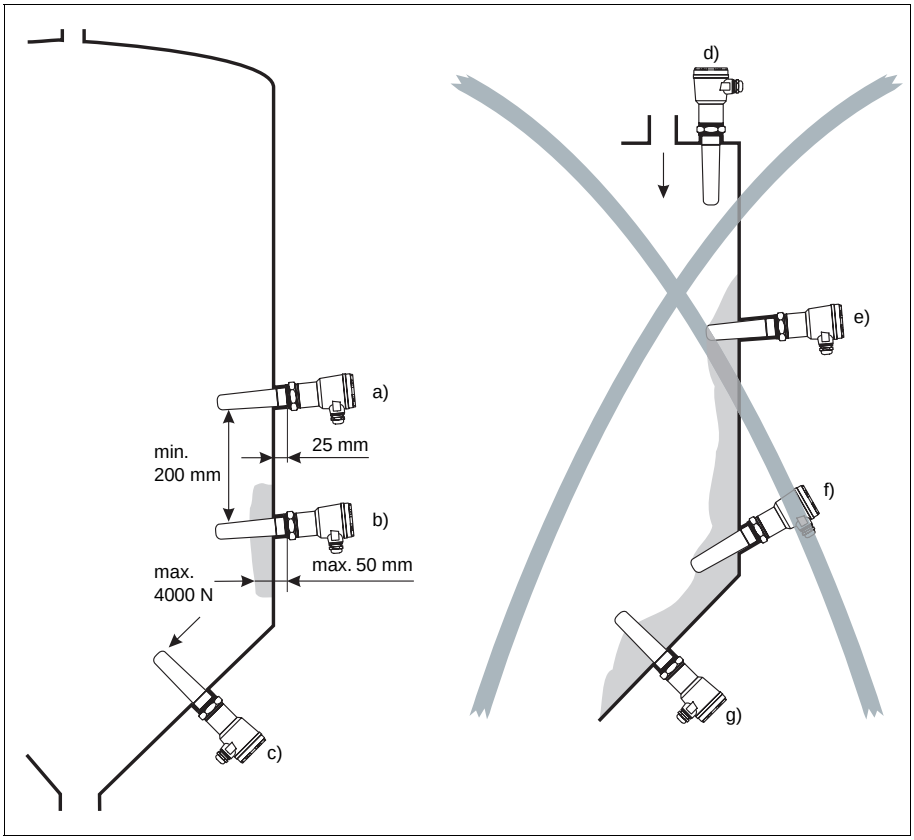
Installation
Nivocompact FTC 731

Minimum distance
A minimum distance of 200 mm between the probe ends of two Nivocompact FTC 731 instruments must be maintained to ensure that there is no mutual interference.
The distance between the probe end of a Nivocompact FTC 731 and a metal wall must be at least 120 mm.

Resistance to Load
Note the maximum lateral load of the probe rod when using it for minimum detection

Correct Installation

Incorrect Installation



a) The probe tip points slightly downwards so that material can slide off more easily;

   with short threaded socket (half socket length = 25 mm);

   with minimum distance of 200 mm to the next Nivocompact FTC 731 or FTC 831.

b) Threaded socket + silo wall + material build-up is a maximum 50 mm thick so that no calibration is required before start-up.

c) Minimum detection in the outlet cone is only possible with easy gliding, free-flowing bulk materials.

d) Probe end too near a wall (under the 120 mm minimum distance)

e) Threaded socket too long with material build-up on the silo wall. *

f) In area where material is deposited in silo.*

g) Poor gliding characteristics of material causes material bridges.*

* The Nivocompact FTC 831 is recommended.

Project Planning Nivocompact FTC 831

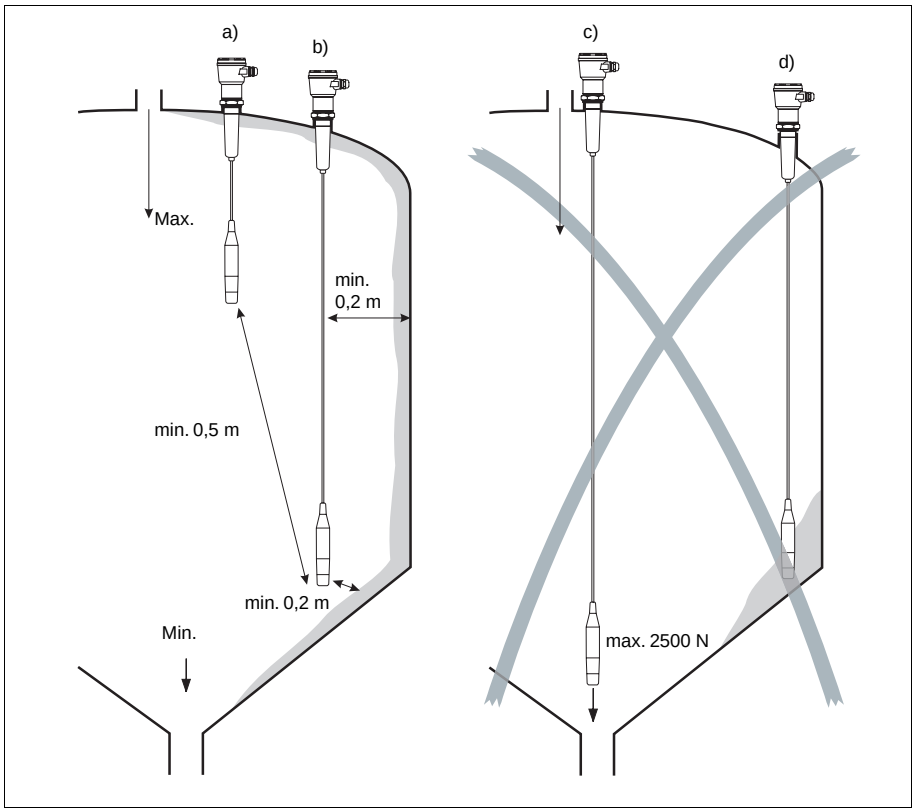
Minimum distance
A minimum distance of 500 mm between the probe ends of two Nivocompact FTC 831 instruments must be maintained to ensure that there is no mutual interference; this also applies to all FTC 831 probes which are mounted next to one another in silos with non-conducting walls.
The distance between the probe end of an FTC 831 to the probe end of the next FTC 731 must also be at least 500 mm.

The distance from the probe end of a Nivocompact FTC 831 to the silo wall or to any material build-up must be at least 200 mm.
To ensure that no error switching occurs when the probe is slightly swinging, the distance of the probe to the silo wall should be correspondingly greater, especially with pneumatic conveying systems.

Resistance to Load
With minimum detection, take note of the maximum load of the rope and the strength of the silo roof.
Very high tensile forces may occur at the material outlet especially with heavy, powdery bulk materials which tend to form build-up.
These forces are significantly greater in the middle of the silo over material discharge point than at the silo walls.

Correct Installation

Incorrect Installation



a) Sufficient distance from the material inlet and to the next probe.

b) Sufficient distance to the silo wall and to material deposited on the silo wall.

c) 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) Too near silo wall;
When swinging gently, the probe can hit the wall or touch any build-up which may have formed.
This can result in error switching.

Main Differences of the Electronic Inserts

Electronic Insert EC 3•
for Nivocompact FTC **7**31

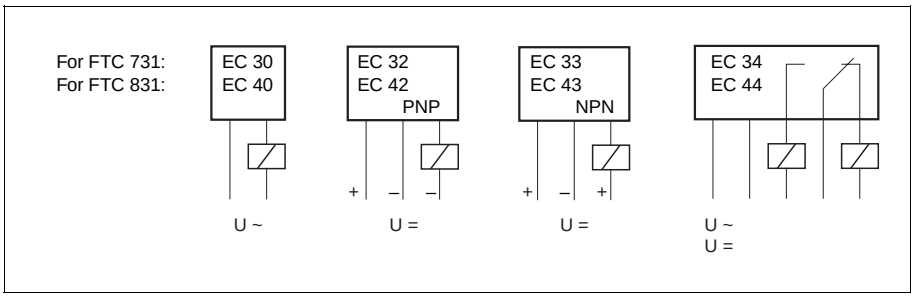
Electronic Insert EC 4•
for Nivocompact FTC **8**31

Electronic Insert EC 30/40
Two-wire AC connection
21 V…250 V
Electronic switching, max. 350 mA

Electronic Insert EC 32/42
Three-wire DC connection
10 V…55 V
Transistor circuit,
load connection PNP, max. 350 mA

Electronic Insert EC 33/43
Three-wire DC connection
10 V…55 V
Transistor circuit,
load connection NPN, max. 350 mA

Electronic Insert EC 34/44
with potential-free relay output
AC voltage operation
21 V…250 V or
DC voltage operation
20 V…200 V



Electrical connections available with the different electronic inserts.

Wiring Connections 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 43 or EC 44).

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.

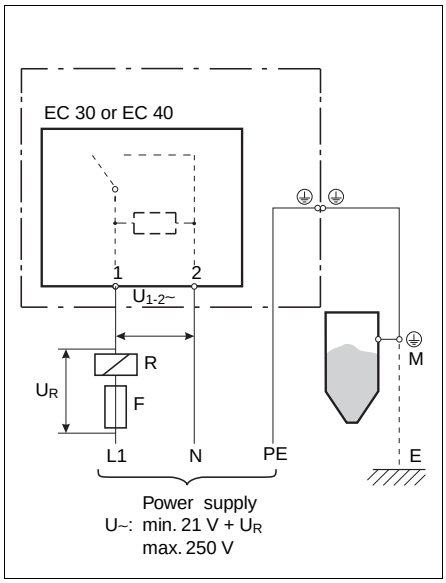
Diameter of Wiring
Because of the small current used, only small diameter cabling is required.
Low-cost cabling with diameters of 0.5 mm^2 to max. 1.5 mm^2 is recommended.

Earth Connection, Grounding
For the Nivocompact to operate safely and interference-free, it must be grounded either by connection to the grounded silo with metal or steel concrete walls or by connection to the protective cable PE.
The ground connection outside on the housing must in all cases be connected to an electrically conductive part of the silo or conductive and grounded components near to the silo. This is to ensure that if the silo is made of non-conductive material, then a good counter potential to the probe is maintained.

Connecting the EC 30 (FTC 731) EC 40 (FTC 831)

Connecting the Nivocompact with the electronic insert EC 30 or EC 40 for AC voltages (two-wire connection).

$U_{1\text{-}2\sim}$: 21 V… 250 V across terminals 1 and 2 of the EC 30 or EC 40
R: Connected (external) load, e.g.relay
F: Fine-wire fuse, load-dependent
M/E: Ground connection to silo or ground
U_R: Voltage between the load R and the fine-wire fuse F



Connecting a Nivocompact with an Electronic Insert for AC voltage (Two-wire connection)

Connecting in series to the load
A Nivocompact level limit switch with this electronic insert must
- like all switches - be connected in series with the load (e.g. relays, miniature contactors, lamps) to the power supply.

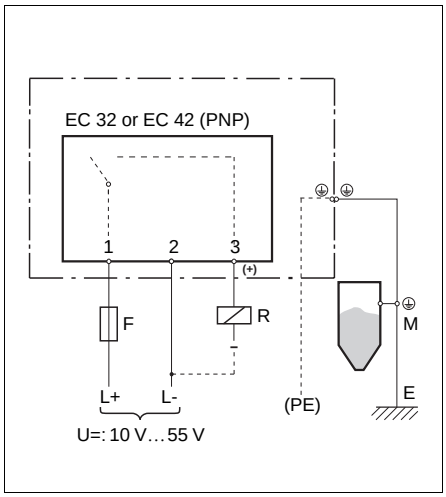
Connection voltage
The voltage across terminal 1 and 2 of the electronic insert must be at least 21 V.
The power voltage must be correspondingly higher to compensate for the voltage drop across the connected load.

Load 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 cuts off (blocks) with the level alarm. Because of the current requirements of the electronics, a small residual current still flows through the connected load. When 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 32, EC 33 (FTC 731) EC 42, EC 43 (FTC 831)

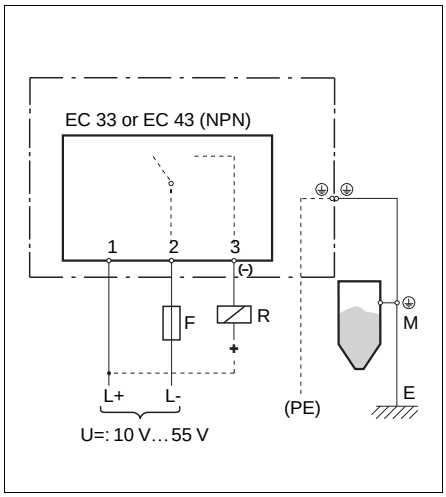
Connecting the Nivocompact with electronic insert EC 32,42 for three-wire DC connection PNP

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



Connecting the Nivocompact with electronic insert EC 33, 43 for three-wire DC connection NPN

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



Connecting the Nivocompact with the Electronic Insert for Three-Wire DC Connection

Transistor circuit for the load
The load connected to terminal 3 is switched by a transistor, contactless and therefore without bouncing.

EC 32, EC 42 (PNP):
Terminal 3 has a positive signal with normal switching.

EC 33, EC 43 (NPN):
Terminal 3 has a negative signal with normal switching.

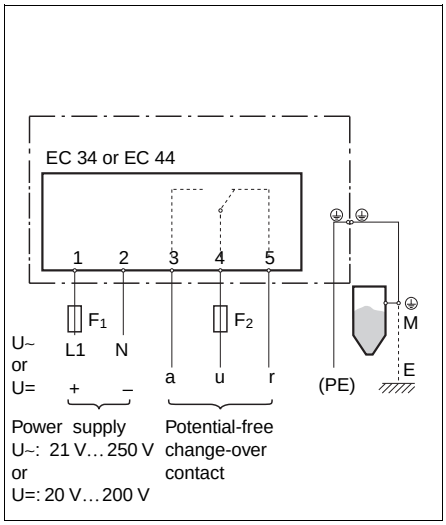
The transistor is blocked on level alarm (and with power failure).

Protection against voltage peaks
Connecting to an instrument with a high inductance:
a voltage limiter should be connected.

Connecting the EC 34 (FTC 731) EC 44 (FTC 831)

Connecting the Nivocompact with electronic insert for DC and AC ; with 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/E: Ground connection to silo or ground



Connecting the Nivocompact with the Electronic Insert for DC and AC Voltages; with Relay Output

Relay contact for load
The load is connected over a potential-free relay contact (change-over contact).
The relay contact breaks the connection between terminal 3 and terminal 4 on level alarm or with a 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.

Adjustment Modes

Set the fail-safe mode switch on the electronic insert of the Nivocompact FTC 731 or FTC 831 to your particular application.

A switching delay can be selected between 0.5 s and 20 s.

Operating elements on the electronic insert

Technical Data

Operating Data

Nivocompact	FTC 731 with Rod Probe	FTC 831 with Rope Probe
Operating temperature in silo	–20 °C…+100 °C with dry material up to+60 °C with moist material	–20 °C…+ 60 °C
Operating pressure p_e in silo	up to 6 bar	
Max. permissible load on the probe	4000 N lateral	2500 N vertical

- Grain size of bulk solid: up to approx. 10 mm
- Minimum relative dielectric constant ε_r of bulk solid: 2.0 (factory-set, no adjustment required)
- Minimum adjustment of dielectric constant ε_r of the bulk solid: 1.6
- Ambient temperature for the housing: –20 °C…+60 °C
- Storage temperature: –40 °C…+85 °C

Probes

Nivocompact	FTC 731	FTC 831
Construction	Rod probe,, tapered	Rope Probe with electronics at end of probe
Process connection	Parallel thread G 11/2A conf. to DIN ISO 228/I	
Material of process connection	fibreglass-reinforced polyester (PBTP)	
Material of probe	fibreglass-reinforced polyester (PBTP)	supporting steel rope braiding and electronics coated with PE
Insulation from bulk solid	Fully insulated	
Probe length tolerances	< 2 mm	Probe length / Tolerance up to 1 m / +0 mm, –5 mm up to 3 m / +0 mm, –10 mm up to 6 m / +0 mm, –20 mm up to 20 m / +0 mm, –30 mm

Housings Versions

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

B
Aluminium housing with water-tight cable gland PG 16,
Protection IP 66

R
Aluminium housing with synthetic coating, for aggressive atmospheres;
with water-tight cable gland PG 16,
Protection IP 66

K
Synthetic housing in PBTP with water-tight cable gland PG 16,
Protection IP 66

Cable Gland

Housing IP 55: standard PG in nickle-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. 2.5 mm^2

Measuring frequency: approx. 1.6 MHz

Switching delay:
approx. 0.5 s…approx. 20 s, selectable

Minimum/Maximum Fail-Safe Switching:
selectable with rotary switch

Switching indication: red LED

Electronic Inserts EC 30 and EC 40 for AC Voltage (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 with 250 V;
max. 36 VA with 24 V

Maximum voltage drop: 11 V

Connected load, 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)

Residual current (eff.): < 5 mA

Electronic Inserts EC 32, EC 33, EC 42 and EC 43 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 32,EC 42) or
NPN (EC 33,EC 43)

Switching voltage: max. 55 V

Connected load, short-term (max. 1 s): max. 1 A

Connected load, continuous:
max. 350 mA

Protected against reverse polarity

Electronic Inserts EC 34 and EC 44 for DC and AC Voltages (Relay Output)

Power supply U =: 20 V...200 V
or power supply U ~:
21 V...250 V, 50/60 Hz

Current consumption (eff.): 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 switching delay:
max. 1.5 s

Subject to modification

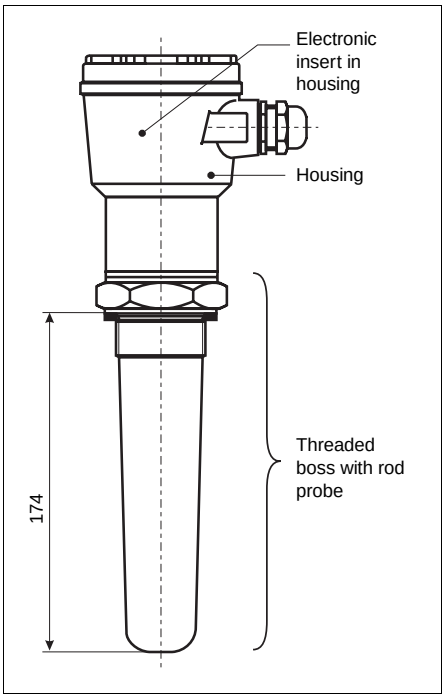
Order Specification Key Nivocompact FTC 731

FTC 731 capacitance level limit switch with rod probe

		Weight
	Threaded boss with rod probe	0.28 kg
	Housing	
B	Aluminium housing, IP 66	0.42 kg
K	PBTP synthetic housing, IP 66	0.31 kg
Y	Others on request	
	Electronic Insert (mounted in housing)	
1	21 V..250 V, 50/60 Hz (EC 30) Two-wire AC connection	0.17 kg
2	PNP 10 V..55 V= (EC 32) Three-wire DC connection	0.17 kg
4	Relay, 21…250 V AC/200 V= (EC 34) AC or DC connection with relay output (change-over contact)	0.17 kg
9	Others on request	

FTC 731 [ ] [ ] **Order code** **Total weight** [ ] **kg**

The Nivocompact FTC 731 is designed using these basic modules.



Order Specification Key Nivocompact FTC 831

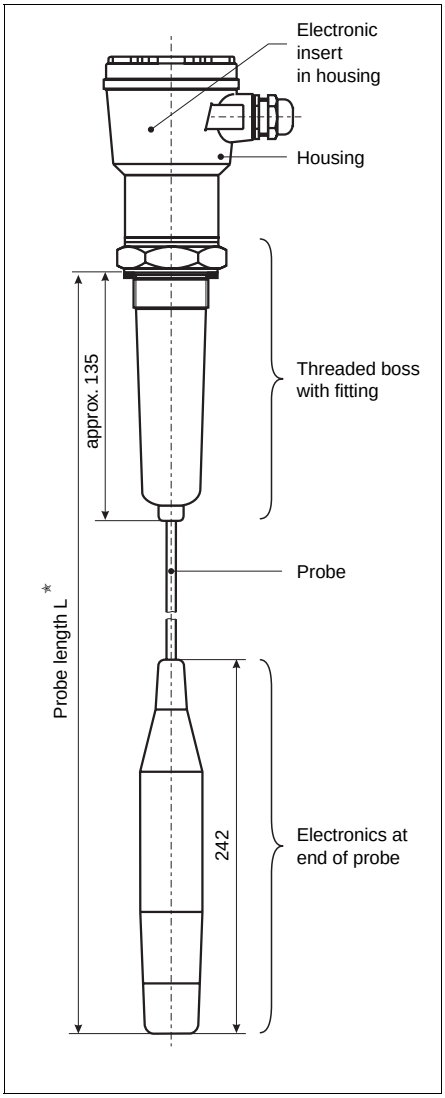
FTC 831 capacitance level limit switch with rod probe

		Weight
	Threaded boss with fitting and electronics at the end of the sensor	0.65 kg
Probe		
1	...mm probe length*	
	Probe lengths from 500 to 20000 mm available	0.09 kg/m
2	2.500 mm (basic length, can be shortened)	0.23 kg
6	6.000 mm (basic length, can be shortened)	0.54 kg
9	Others on request	
Housing		
B	Aluminium housing, IP 66	0.42 kg
K	PBTP synthetic housing, IP 66	0.31 kg
Y	Others on request	
Electronic Insert (mounted in housing)		
1	21 V..250 V, 50/60 Hz (EC 40) Two-wire AC connection	0.17 kg
2	PNP 10 V..55 V= (EC 42) Three-wire DC connection	0.17 kg
4	Relay, 21…250 V AC/200 V= (EC 44) AC or DC connection with relay output (change-over contact)	0.17 kg
9	Others on request	

FTC 831				**Order code**		**Total weight**		**kg**			

Please state probe length in mm*

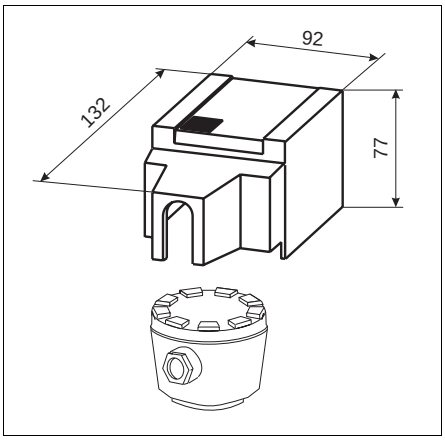
The Nivocompact FTC 831 is designed using these basic modules.



* We recommend you ordering the probe at the length required as this will save time and costs involved when shortening.
For later use, spare instruments should be ordered in basic lengths.

Accessories

- Seal for thread G 1 1/2 A;
  in elastomer/fibre (asbestos-free) supplied.
- Protective sun cover
  for aluminium housing
  Material: polyamide



Dimensions of protective sun cover (accessory).
This cover prevents condensation in the housing.

Supplementary Documentation

☐ Nivocompact FTC 231, FTC 331
with rope probe;
for especially high resistance to loads.
Technical Information TI 133F/00/en

☐ Nivocompact FTC 431
with disk probe;
for applications where the probe must not protrude into the silo.
Technical Information TI 136F/00/e

Details When Ordering

☐ Order code
☐ Probe length for FTC 831
☐ or special version
☐ Accessories
(e.g. protective sun cover)

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