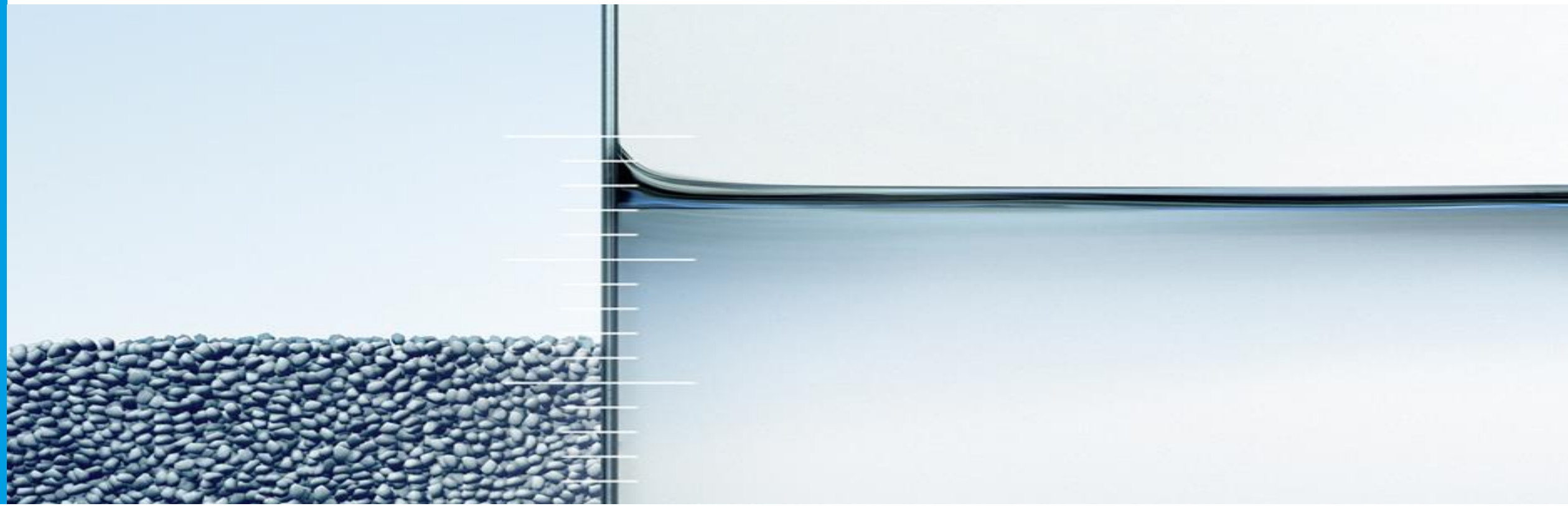
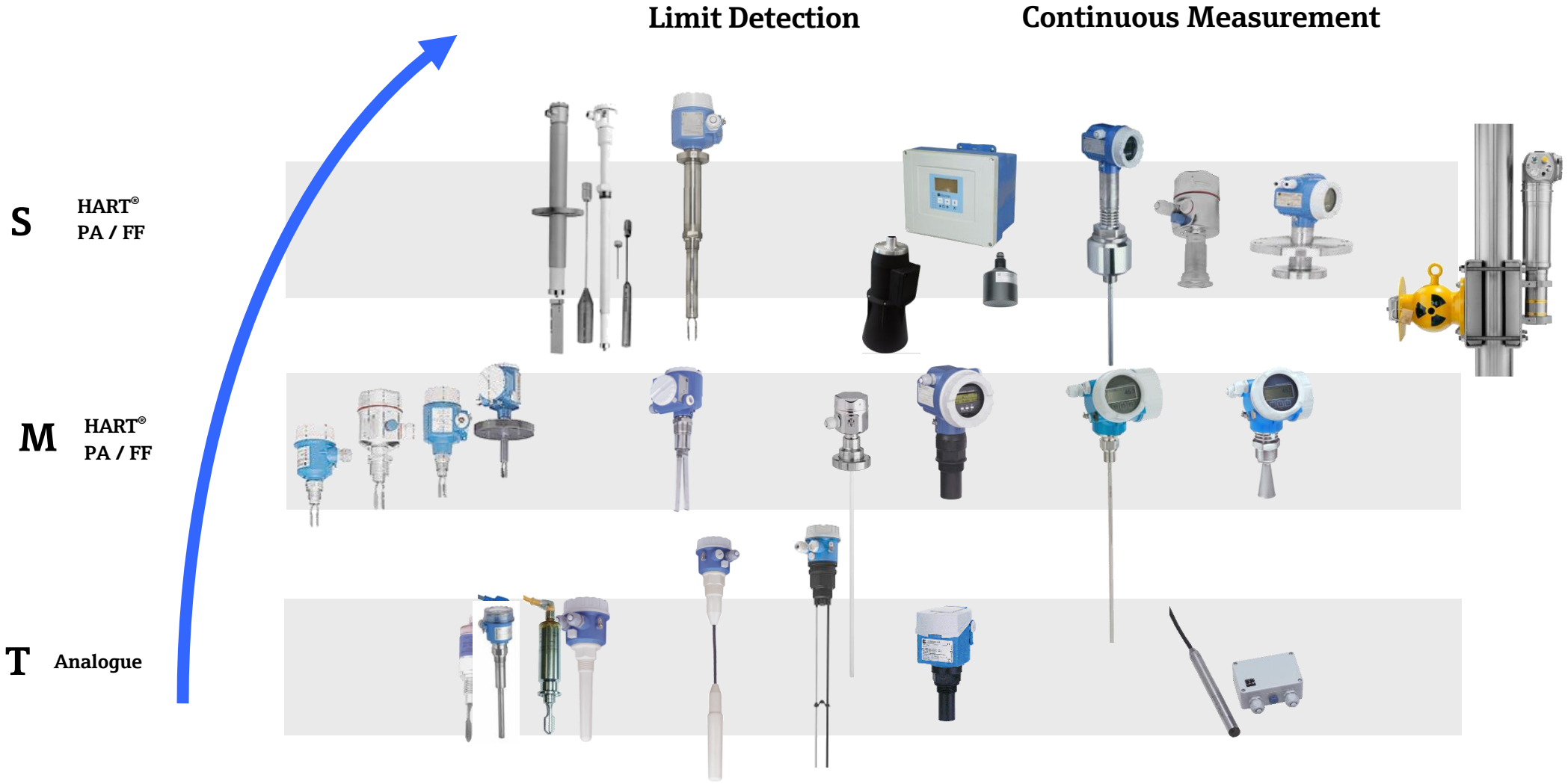
Level Measurement

Endress+Hauser



Level Instruments Portfolio

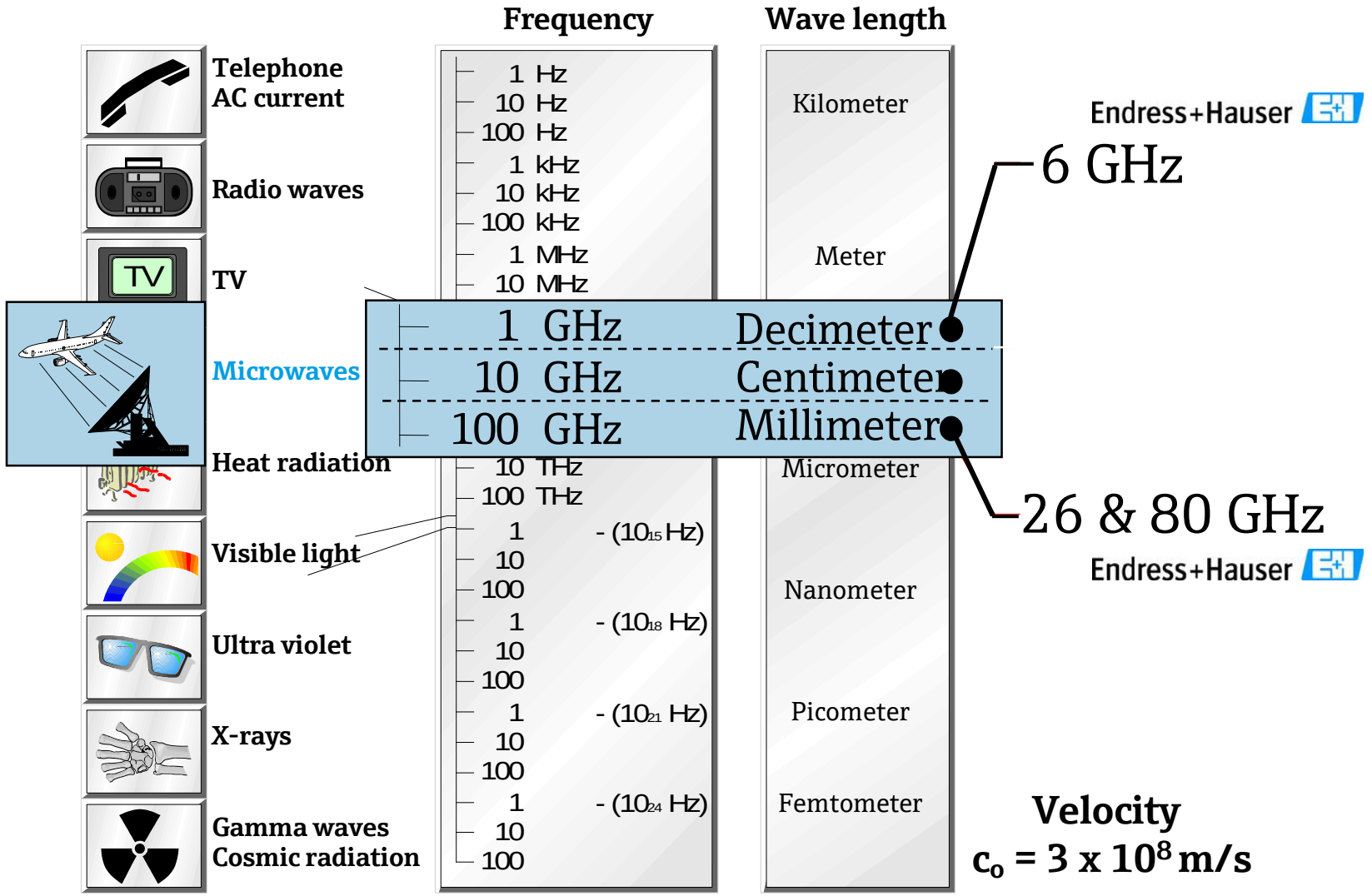


Endress+Hauser

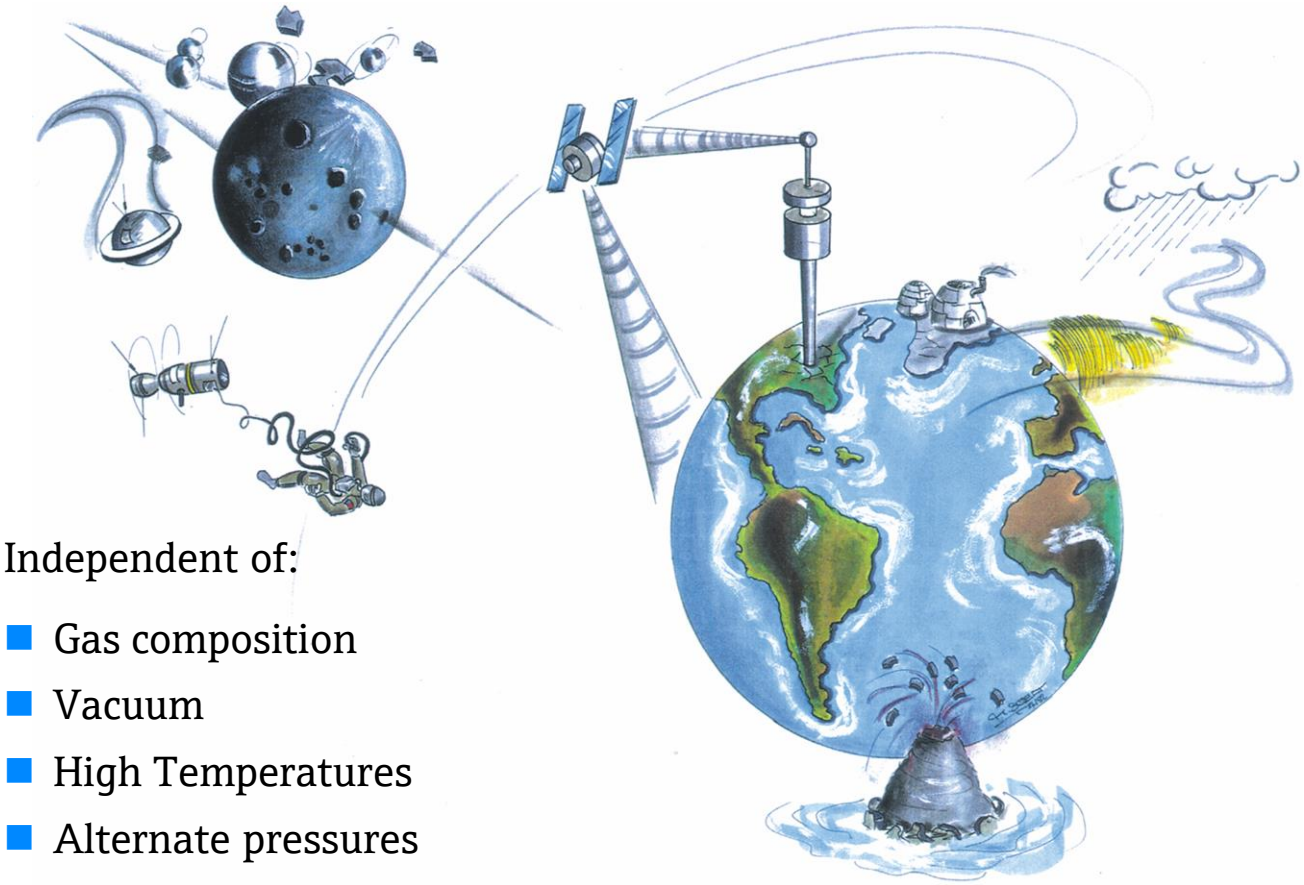
Radar Level Measurement

Micropilot M

Electromagnetic Waves



External Influences on Microwaves



Independent of:

- Gas composition
- Vacuum
- High Temperatures
- Alternate pressures
- Changing density
- Air turbulence

New technology* – New frequency* – What's behind?

*for E+H

GHz

Pulse radar

FMCW radar

In addition to the well known Pulse radar technology, with Micropilot FMR6x the FMCW (Frequency Modulated Continuous Wave) technology is introduced to Endress+Hauser process radars

6 C-band

26 K-band

80 W-band

Micropilot FMR6x is working with a frequency of 80GHz. This new frequency is complementary to FMR5x using 6 and 26GHz wherefore the scope of application for free space radar increases

Characteristics & benefits of the ‘new’ frequency

GHz

80 ¾"

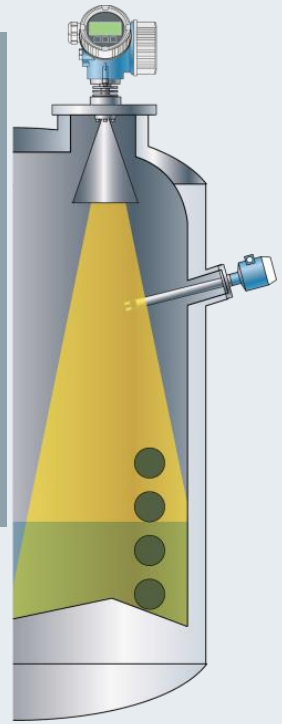
Narrow beam angle &
smaller process connections

6GHz

6" antenna

beam angle of

23°

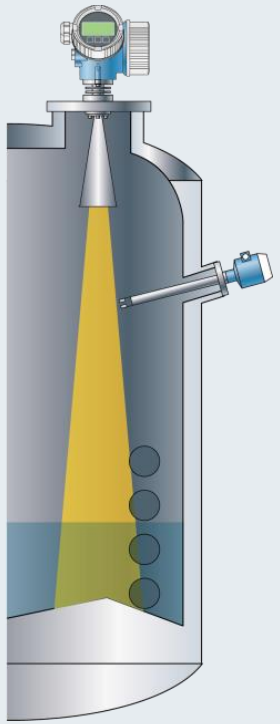


26GHz

3" antenna

beam angle of

10°

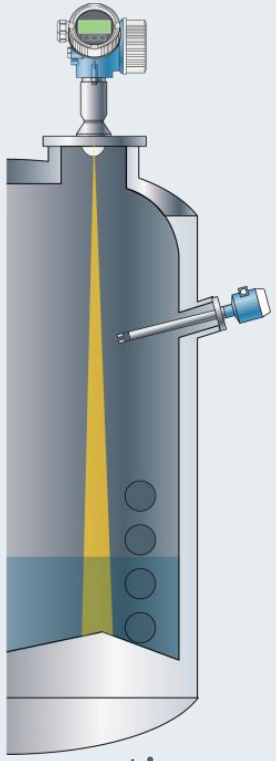


80GHz

3" antenna

beam angle of

3°

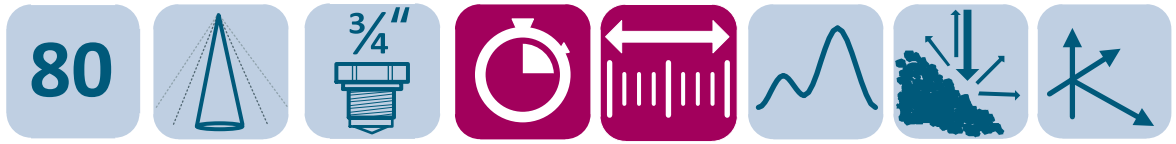


higher frequency → **smaller** beam angle @ **smaller** antenna sizes & process connections

Endress+Hauser

Characteristics & benefits of the ‘new’ frequency

GHz



Easier selection and commissioning & extended measuring range

The small and focused signal beam of 80GHz leads to:

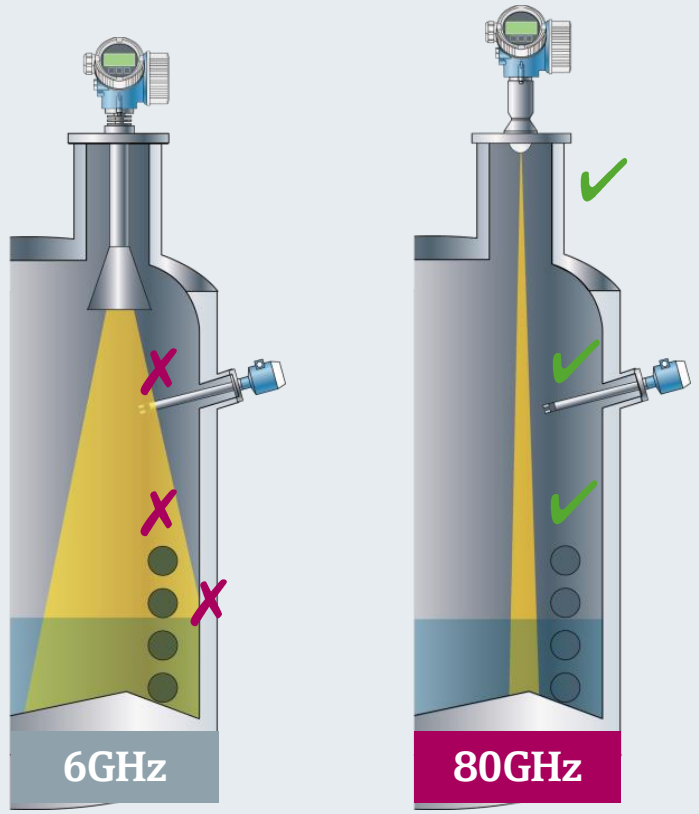
- Less tank wall effects
- Less interference with tank obstacles
- Allows installations in nozzles without antenna extension
- Installations through ball valves

This all results in:

→ Longer measuring ranges are possible and media with lower DC values can be measured since less energy is lost at obstacles

→ The possibility of installations also in demanding tanks or silos with complex geometries, tank obstacles and nozzles

→ Easier commissioning in terms of false echo suppression



Endress+Hauser

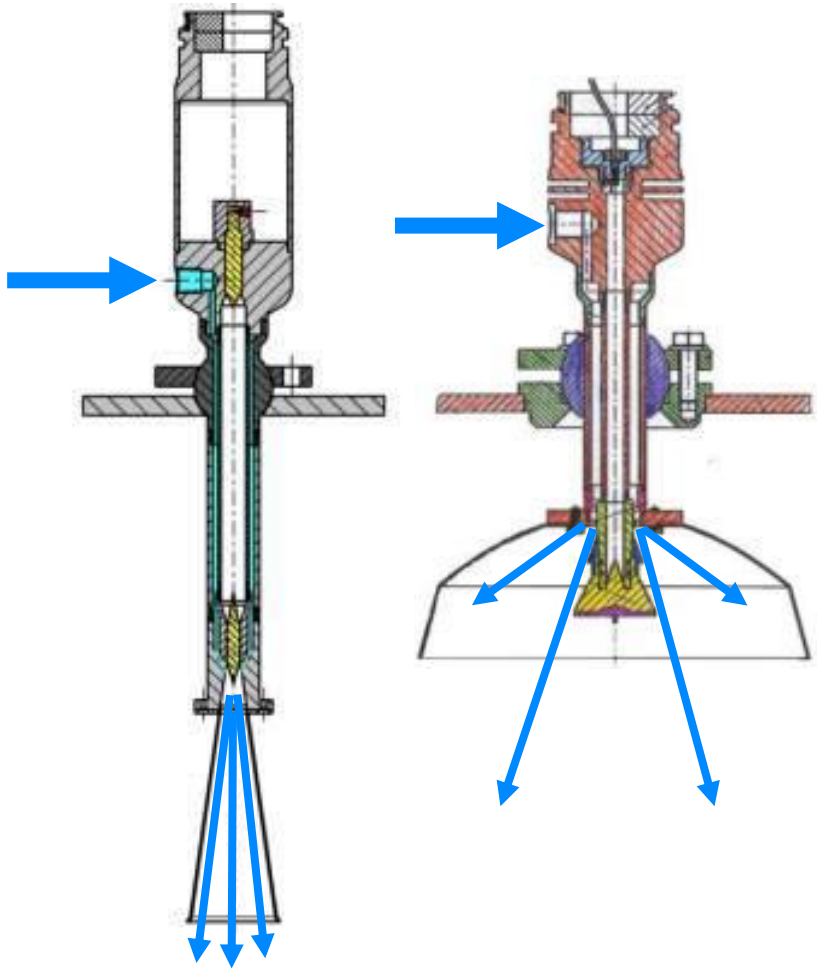
Segmentation in *liquids*

	C-band		K-band				W-band	
liquids								
	Micropilot FMR53	Micropilot FMR54	Micropilot FMR10/FMR20	Micropilot FMR50	Micropilot FMR51	Micropilot FMR52	Micropilot FMR60	Micropilot FMR62
solids								
			Micropilot FMR56	Micropilot FMR57			Micropilot FMR67	

Segmentation in *solids*

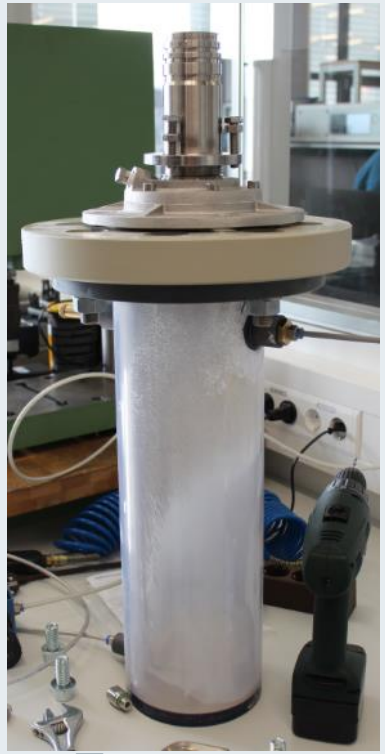
	C-band	K-band	W-band
liquids	 Micropilot FMR53; Micropilot FMR54	 Micropilot FMR10/FMR20; Micropilot FMR50; Micropilot FMR51; Micropilot FMR52	 Micropilot FMR60; Micropilot FMR62
solids		 Micropilot FMR56;  Micropilot FMR57	 Micropilot FMR67

FMR57 – Always with integrated air purge connection

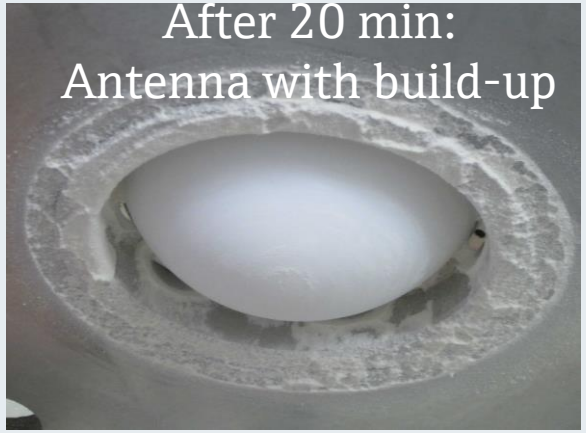


Air purge test

Air purge performance test with medium flour (dry)



Test setup,
circulating flour



Cleaning (movie) sequence:

Dry build up with only minor deposit
thanks to antenna design.
Completely cleaning of antenna
by air purge mechanism.

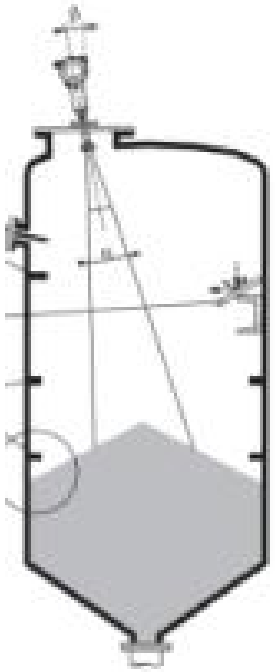
Sensor Positioning

- FMR57:

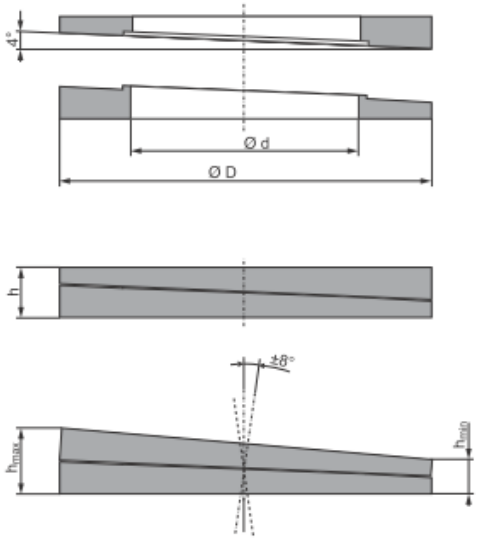
A positioning up to 15° is variable possible with the optional top target positioner

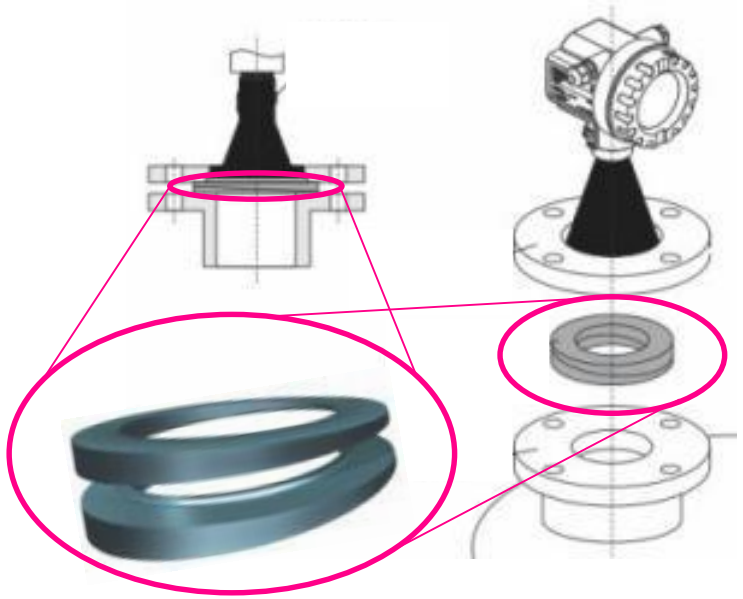
- FMR56:

Adjustable sealing up to 8° FMR56 mounting bracket “free” adaptable to the mounting



Adjustable flange sealing

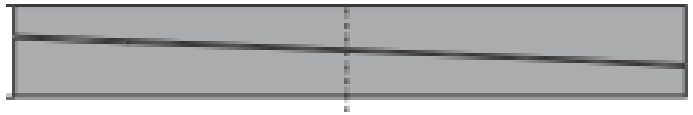


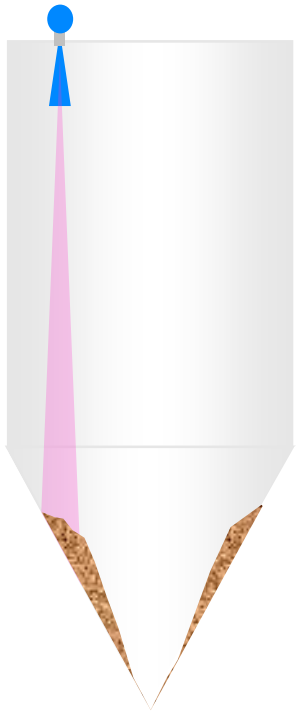


	DN80	DN100	DN150
Material	EPDM		
Process pressure	-0.1bar...0.1bar		
Process temperature	-40°C...+80°C		
Alignment angle	±8°		

Adjustable flange sealing

FMR5x – installation with adjustable flange sealing:

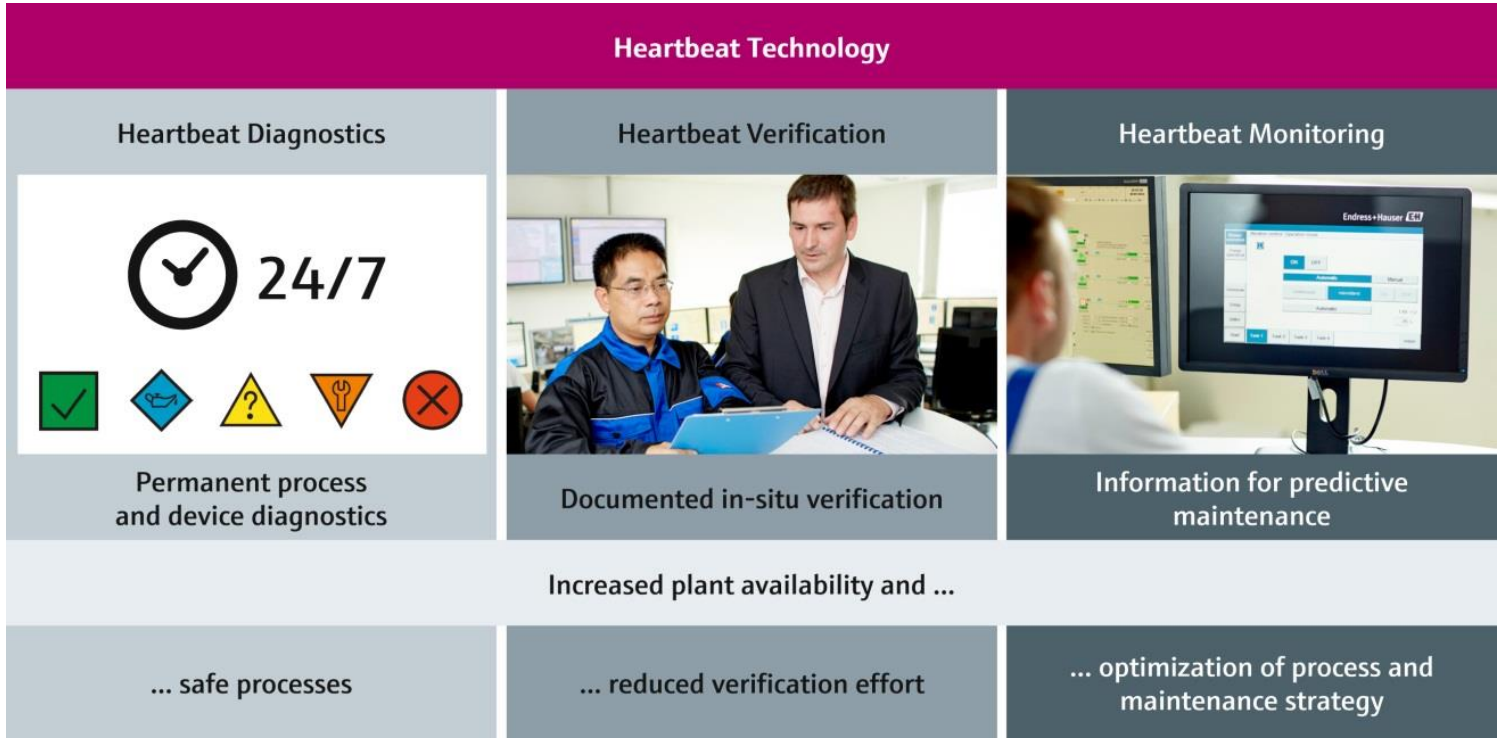




Heartbeat Technology – Description

Heartbeat Technology

- A harmonized concept based on three columns
- To be used to generate **exceptional customer value** and to **differentiate** clearly from competition



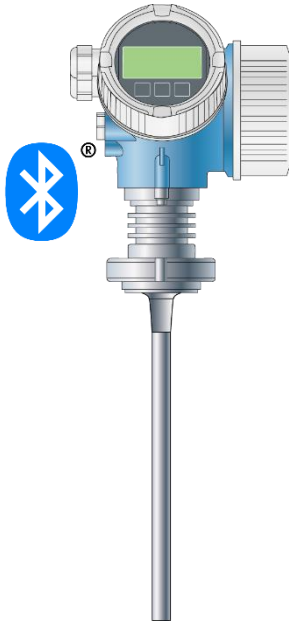
SmartBlue – the Endress+Hauser app

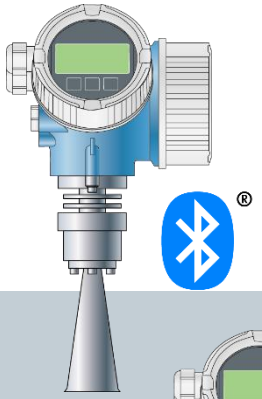
SmartBlue

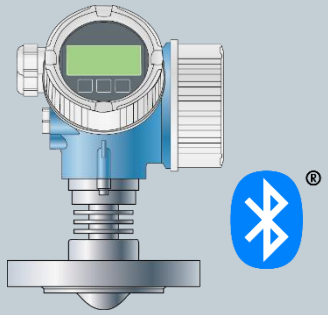
- The universal Endress+Hauser app for commissioning and maintenance of Endress+Hauser field devices
- First time available for **Micropilot FMR10/FMR20**
- Now available for **Micropilot FMR5x/FMR6x, Levelflex FMP5x**, Memosens CM32 and Picomag
- Available for iOS and Android

Download on the App Store

GET IT ON Google Play







Your benefit:

- Time saving mobile access to device, diagnostics and process information even in hazardous areas
- Secure data transmission for fast and reliable configuration and maintenance
- Status of various devices at a glance with the live list allows efficient maintenance

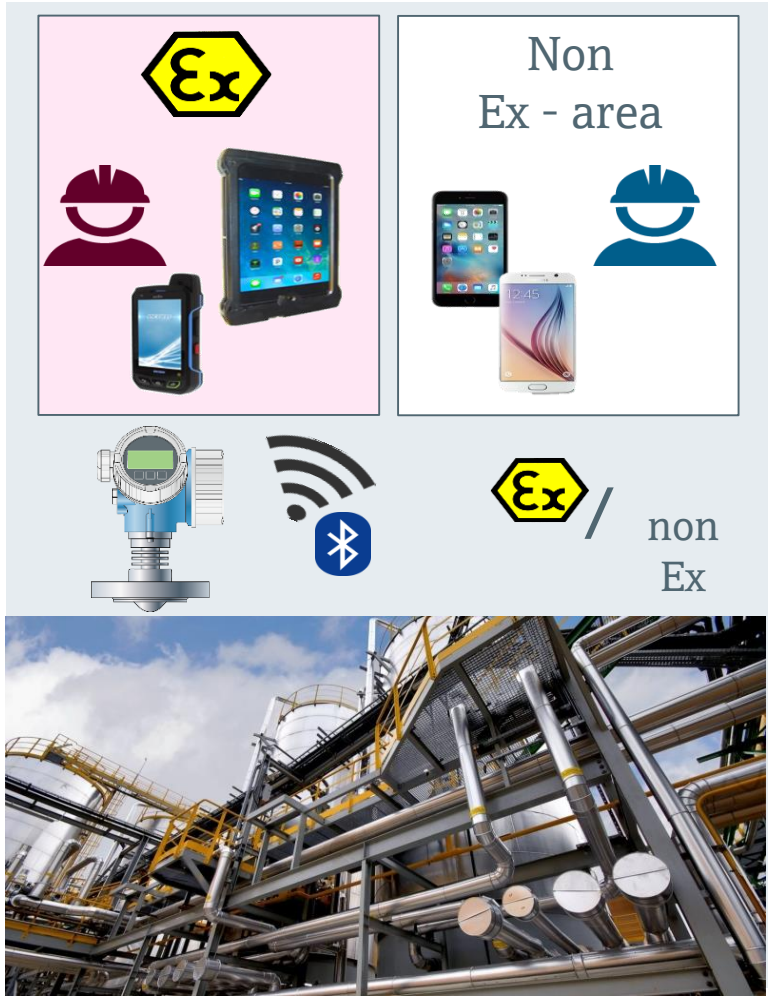
Possibilities for configuration and communication

Wireless remote access via *SmartBlue* app

- Easy & fast commissioning. Connect – set – ready!
  - Operation with standard smartphone – no additional boxes / adapters
  - Menu access with setup directives
  - Maintenance information via signal curve

- Safe and secure access via *Bluetooth*® wireless technology
  - Remote access up to min. 10m (32.8ft)
  - No unauthorized access and manipulation due to encrypted data (reviewed by Fraunhofer Institute) transmission and password protected communication
  - *Bluetooth*® upgrade for your installed base
  - *Bluetooth*® LE (low energy) standard allows usage in hazardous areas

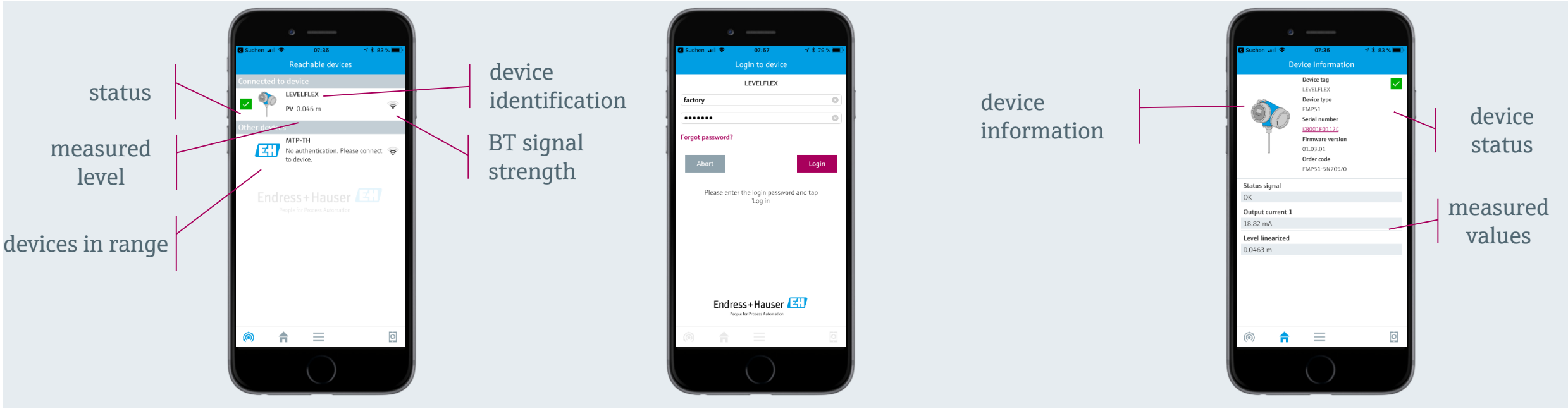
Your benefit:
Simple, safe and secure wireless remote access via *Bluetooth*® – even into hazardous areas or places difficult to reach



Possibilities for configuration and communication

Wireless remote access via *SmartBlue* app

- Live list
  - → indication of reachable devices
  - → quick view on device status, measured value and *Bluetooth*® signal strength
- Password prompt
- Device info
  - → first page after connection
  - → all relevant information in one view



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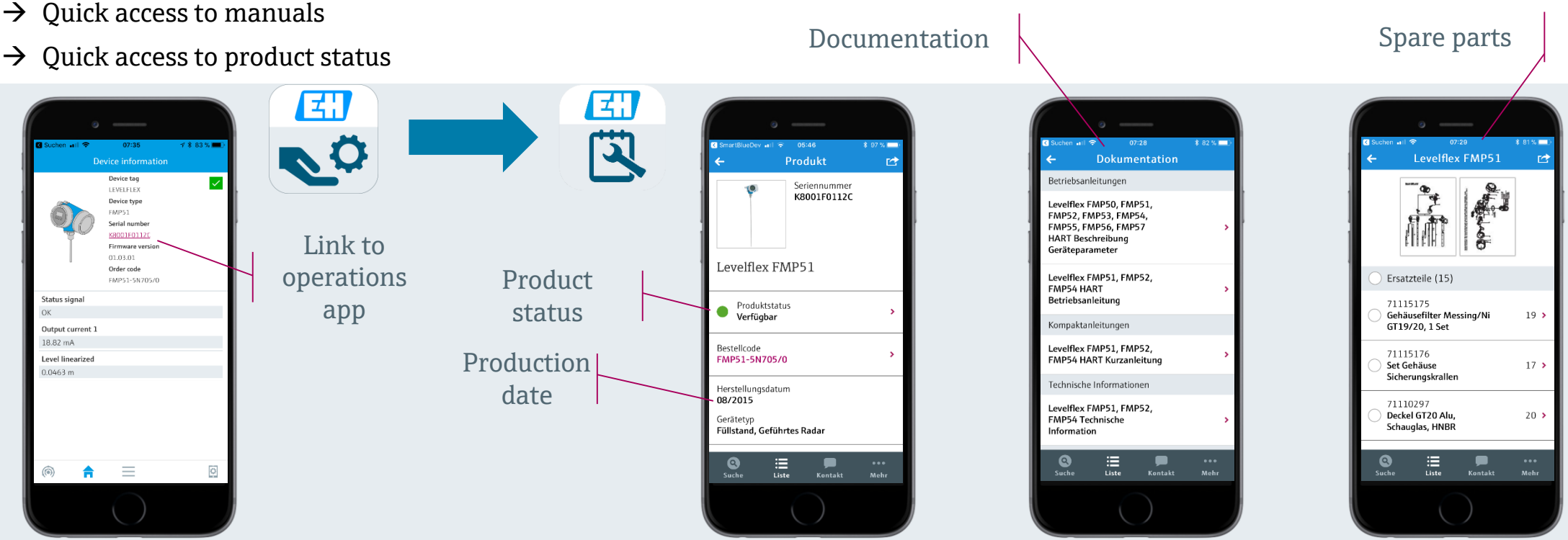
Possibilities for configuration and communication

Wireless remote access via *SmartBlue* app

- Link to **Operations** app
  - → Quick access to spare parts
  - → Quick access to manuals
  - → Quick access to product status
- More information in Engine

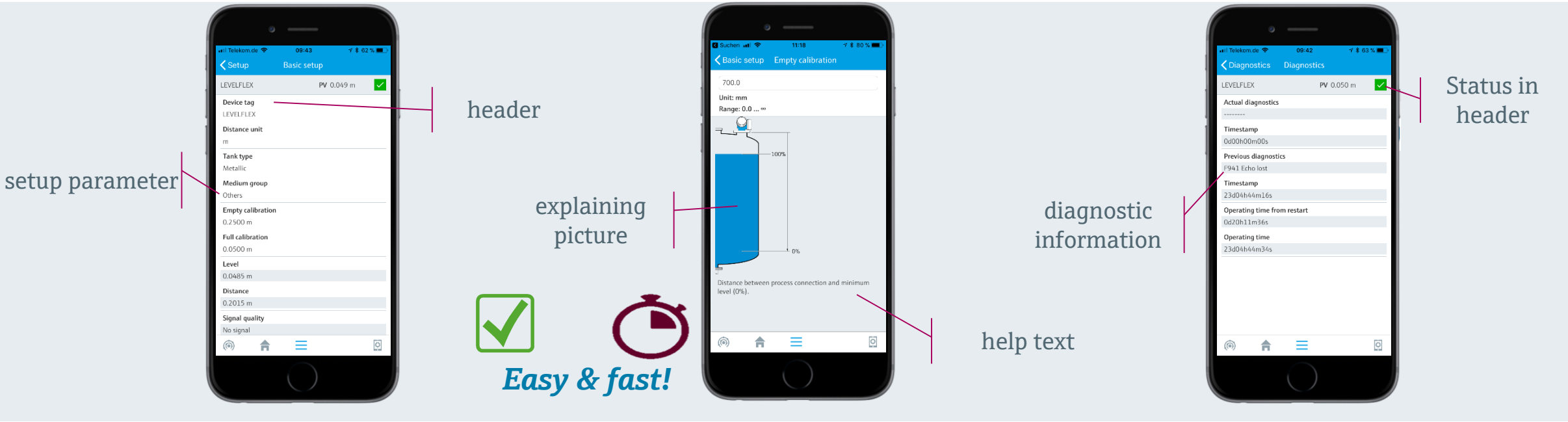


Endress+Hauser

Possibilities for configuration and communication

Wireless remote access via *SmartBlue* app

- Full menu access
  - → easy and fast navigation
  - → detailed help text and picture
- Diagnostic information
  - → status permanently visible in header
  - → detailed diagnostic page



Possibilities for configuration and communication

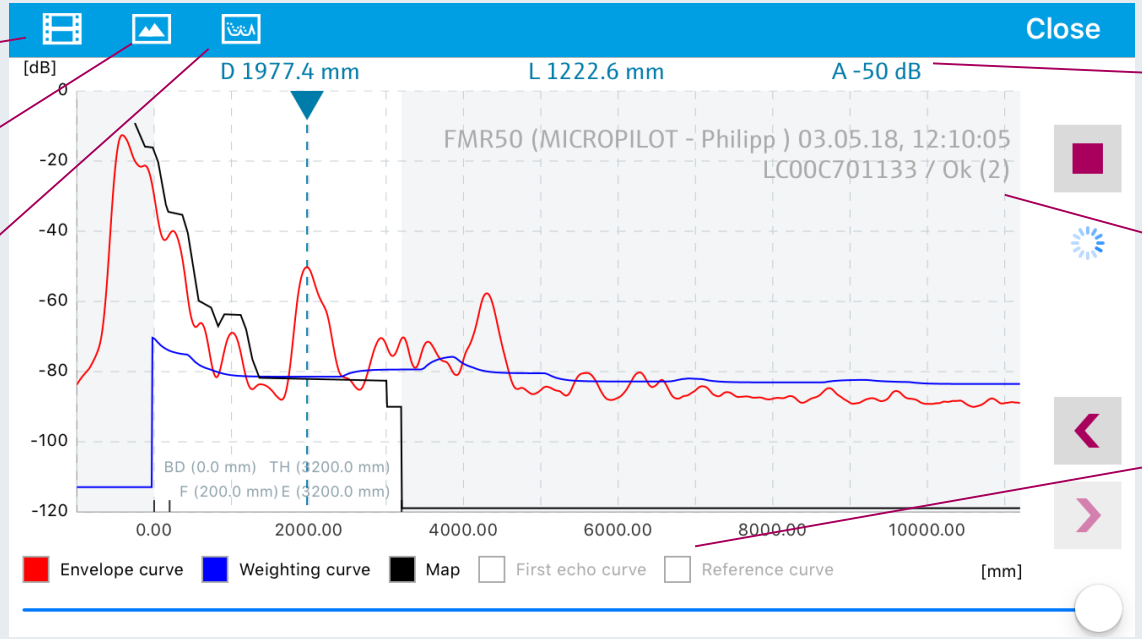
Wireless remote access via *SmartBlue* app

- Diagnostic and maintenance information via signal curve
  → all information available: Level, distance, signal strength, device status
- Easy documentation either via movie sequence or screenshot

document curve sequence as movie

single curve as screenshot

Link to the Mapping Menu



level-, distance- and signal amplitude information

tag, date and device status

Select and deselect curves

Endress+Hauser

Possibilities for configuration and communication

Wireless remote access via *SmartBlue* app

Possibility to share curve data e.g. with your service staff
i.e. via e-mail or message

Applications + Limits

- **Example 1: Solid application**

Application details:
Corn silo, concrete, tall + slim
Medium: corn, DC 4…7
Measuring range: 90m, diameter: 2.5m

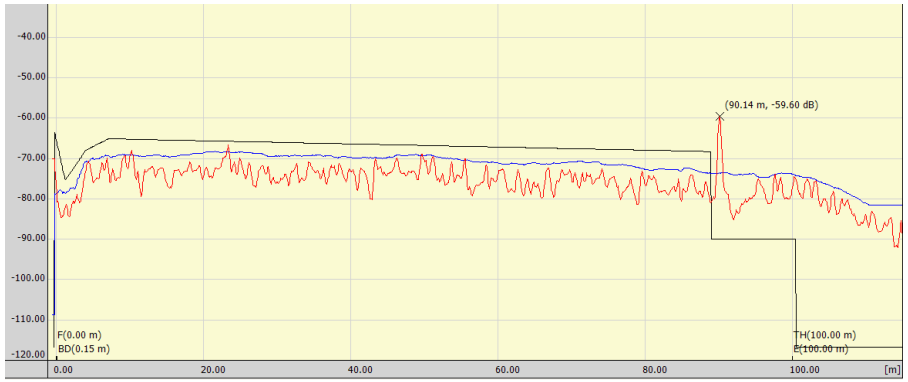
selected

	K-band – 26GHz		W-band – 80GHz	
	FMR56	FMR57	FMR67 drip off	FMR67 flush mounted
Small/medium sized storage silos				
Open bins / piles				
Tall, slim silos		With parabolic antenna ✓		✓
Conveyor belt			Pulse with faster reaction time	Pulse with faster reaction time
Crusher			Pulse with faster reaction time	Pulse with faster reaction time
Alignment possibility	With accessory	Standard option	With accessory	Standard option
Air purge possibilities		integrated	Optional adapter	integrated

	K-band – 26GHz		W-band – 80GHz	
	FMR56	FMR57	FMR67 drip off	FMR67 flush mounted
Accuracy	±3mm	±3mm	±3mm	±3mm
Measuring range	30m	70m	50m	125m ✓
Beam angle	Up to 8°	Up to 3.5° ✓	6°	4° ✓
Digital communication	HART, PA, FF	HART, PA, FF	HART; PA+FF in preparation	HART; PA+FF in preparation

Results:

Reliable level measurement over the whole measuring range with FMR67 and DN80 antenna



Endress+Hauser

Applications + Limits

- **Example 2: Liquid application**

Application details:
Small tank, small process connector
Spray ball cleaning
Height = 0.83mm
Medium: Honey, DC ~24

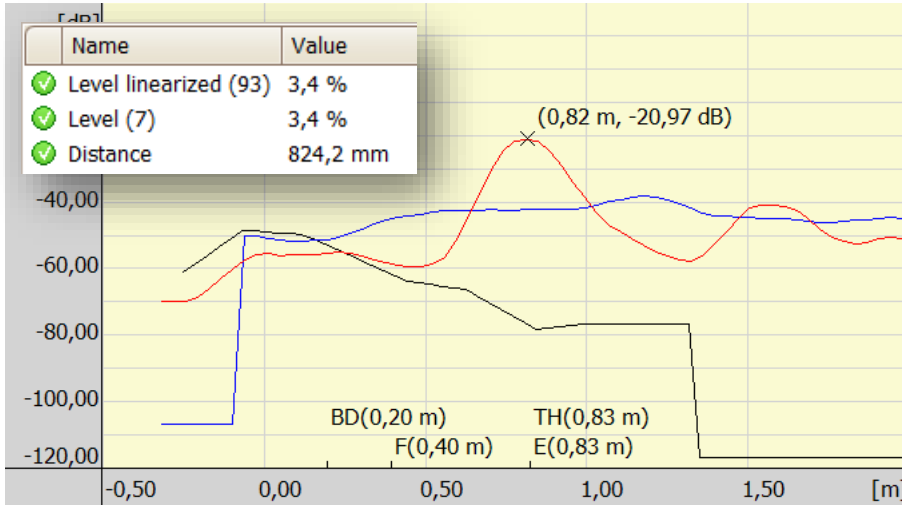
selected

	C-band – 6GHz		K-band – 26GHz				W-band – 80GHz	
	FMR53	FMR54	FMR10/20	FMR50	FMR51	FMR52	FMR60	FMR62
Storage tanks								
Process tanks		Sensitive with many obstacles						
Small tanks								✓
Small process connections	1 ½" thread + inactive length		1 ½" thread	1 ½" thread	1 ½" thread	2" clamp	1 ½" thread	✓
Hygienic fittings								
Nozzle installation	Inactive length available	With antenna extension			With antenna extension			
Ball-valve mounting		In combination with stilling well			In combination with stilling well	In combination with stilling well		
Bypass / Stilling well								
Many obstacles								

	C-band – 6GHz		K-band – 26GHz				W-band – 80GHz	
	FMR53	FMR54	FMR10/20	FMR50	FMR51	FMR52	FMR60	FMR62
Condensation / build-up		6GHz less affected				✓	✓	✓
Low DC			Limit to DC>4		With adv. Dynamics	With adv. Dynamics		
Foam formation					With Adv. Dynamics	With Adv. Dynamics		
Fast level changes								
Turbulent surfaces								
Aggressive media	PTFE plated rod antenna	Sealing related			O-ring related	PTFE plated, flush mounted		PTFE plated, flush mounted

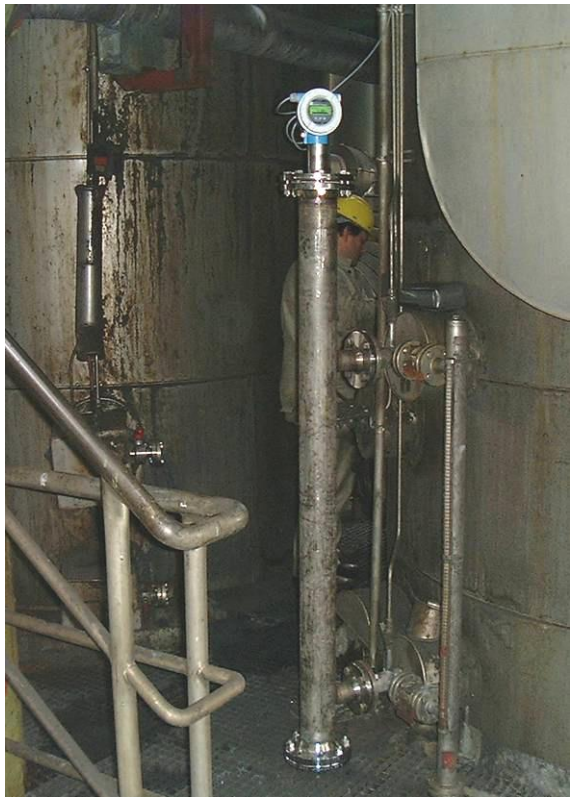
Results:

Fits for small tanks. 80GHz and FMCW helps with detecting minimum quantities. Measurement possible even with honey build-up or at short time after spray-ball cleaning. FMR62 or FMR60 are suitable



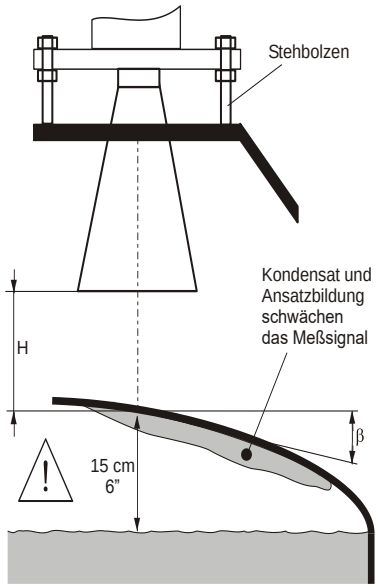
Endress+Hauser

Micropilot M – in Bypass



Micropilot M – Glass Vessel

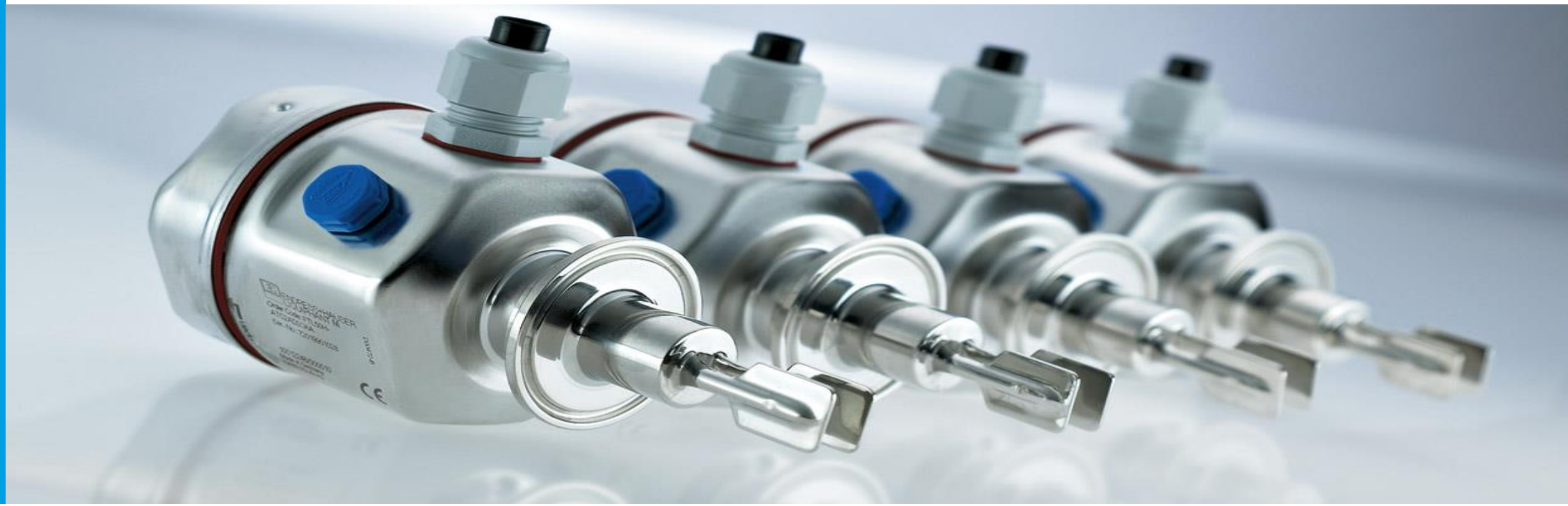
- Product: sensitive flavouring substances
- Glass vessel, Ex-Zone 0/1
- Device: FMR240 DN100 antenna
  Beam angle: 8°
- Micropilot M has a free-field approval: a measurement from outside is no problem.



Endress+Hauser

Limit Detection with Liquiphant

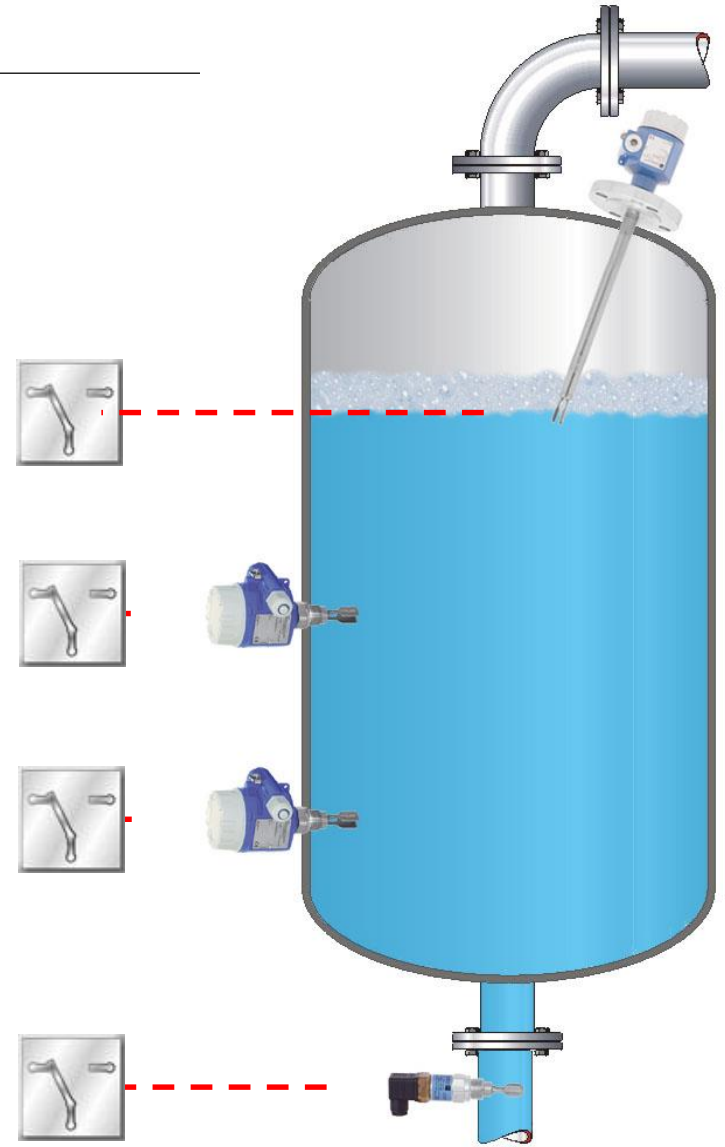
in Liquids using the vibration principle



Measuring Principle

Resonance change of a vibration system whose mass is increased when immersed in a liquid.

The oscillating tines are piezoelectrically excited. A change of the resonant frequency occurs upon immersion in the liquid and is electronically detected and evaluated.

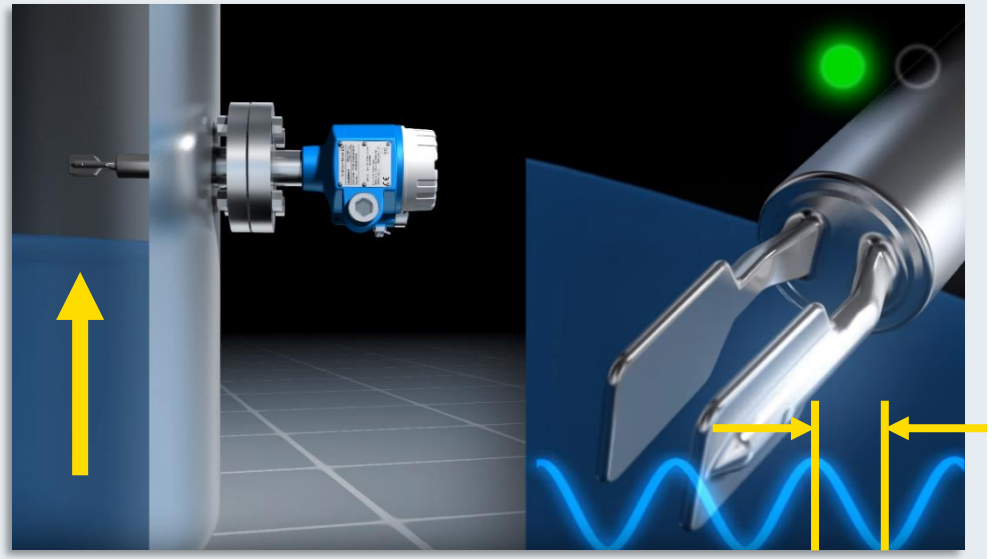


Min./Max. detection
empty message
overspill protection

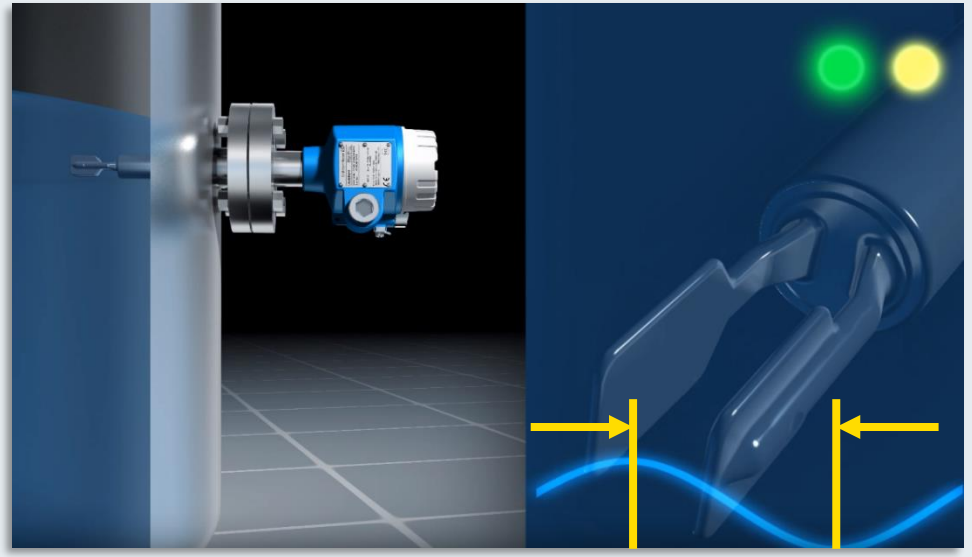
Vibronic technology

- A sensor in form of a tuning fork is excited to its resonance frequency by a piezoelectric drive.
- The frequency changes as liquid covers the fork. This frequency changing is analyzed and converted into a switching output Signal.

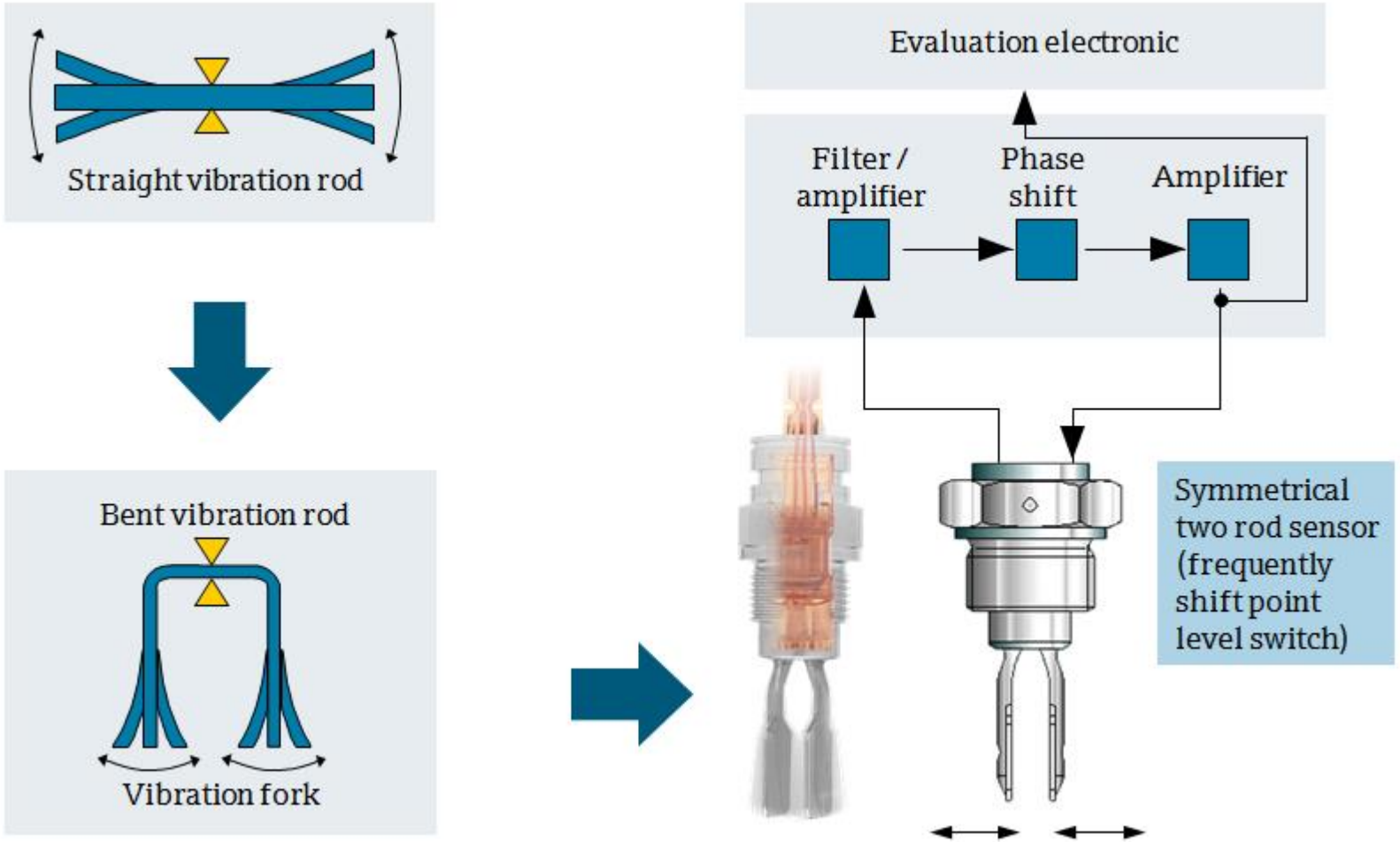
Uncovered



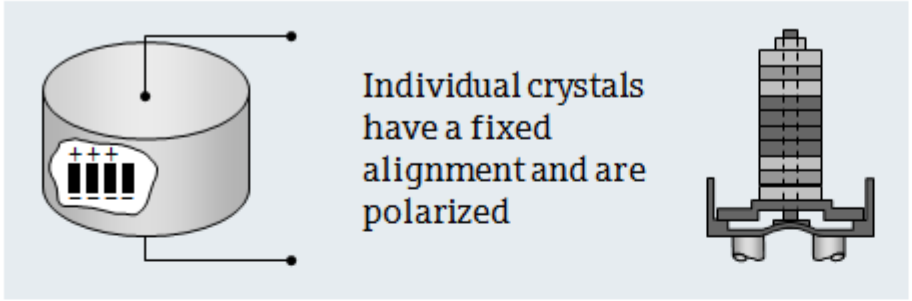
Covered

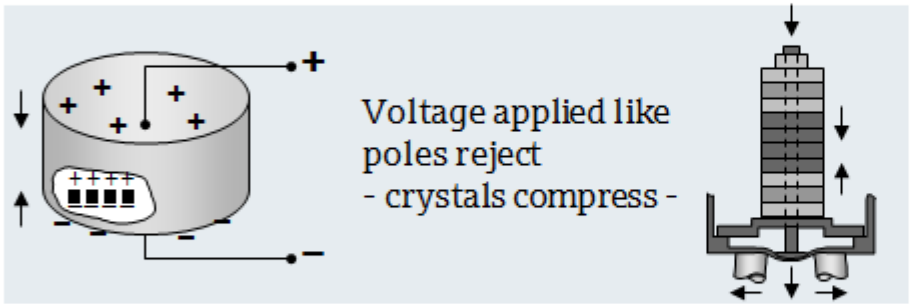


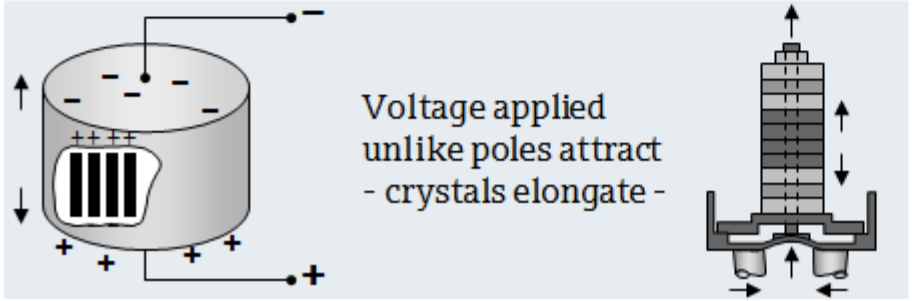
Background information on technology – Function principle



Background information on technology - Piezoelectric effect – Stack drive







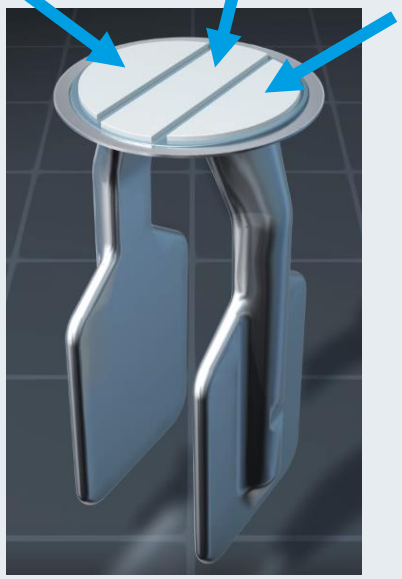
Drive coating

Drive high temperature

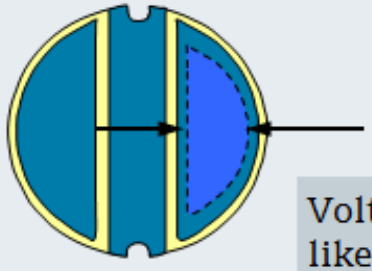
Alternating voltage causes the piezo to expand and contract

Endress+Hauser

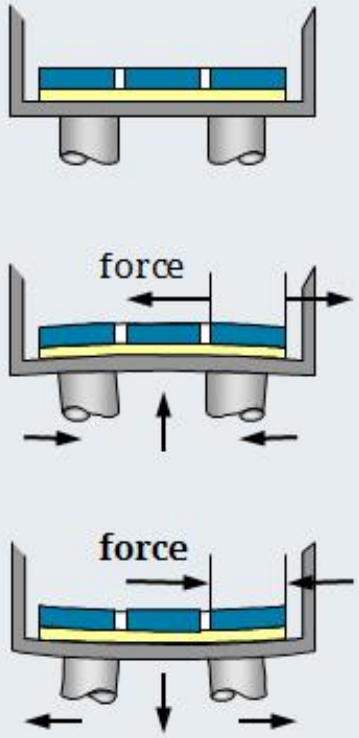
Piezoelectric effect – Bimorph drive



Individual crystals have a fixed alignment and are polarized

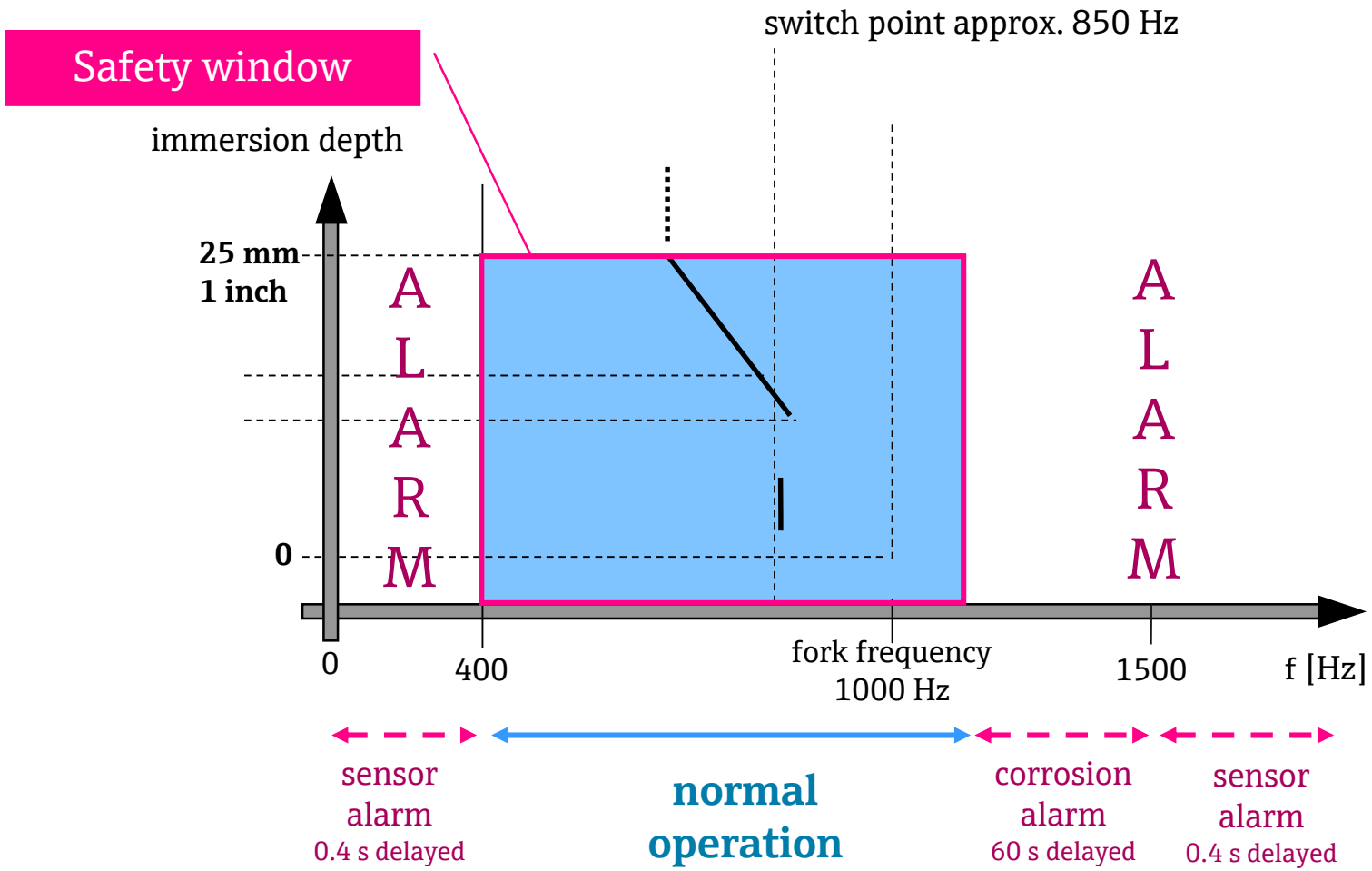


Voltage applied like poles reject - crystals compress -



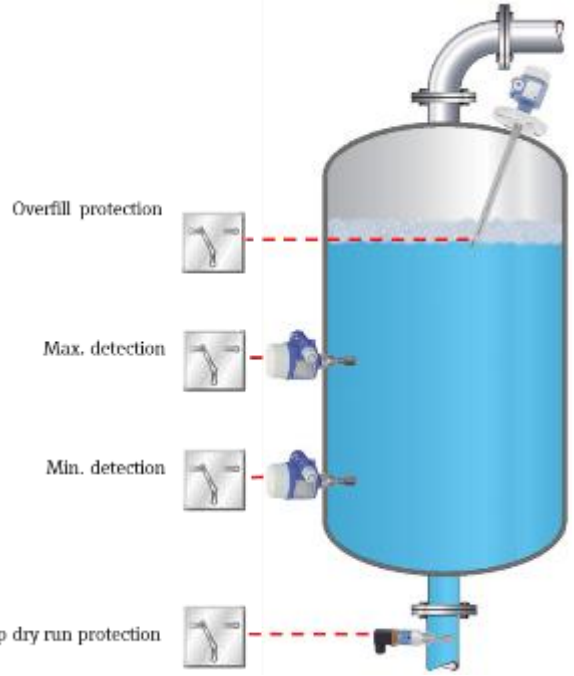
Alternating voltage causes the piezo to expand and contract

Self-Monitoring



Endress+Hauser

Installation



- **Top mounting:**
  for monitoring maximum level
- **Bottom mounting:**
  for monitoring minimum level
- **Side mounting:**
  for monitoring maximum and minimum level
- **Pipe mounting:**
  protecting pumps from running dry

Liquiphant – First choice for most applications

With sales of more than 6 million Liquiphant Endress+Hauser has generated a name for universal, reliable and safe point level switches.

Independent of media properties and changing/ different media

- Build-up

- Suspension
- Air bubbles
- Foam

- Viscosity
- Dielectric permittivity
- Conductivity

- External vibration

- Liquid turbulences

RELIABILITY – Maintenance free due to no moving parts, corrosion resistance and highly tolerant against build up.

UNIVERSALITY – Unaffected by medium properties, mounting position, process pressure and temperature.

Liquiphant: Today's product orientated segmentation

- 40bar
- 150°C
- Hygienic

Liquiphant
FTL31/33

- Hygienic
- Housing compact

- Modular design
- SIL2/3
- NACE listed
- PN64/100
- -50...150°C
- coating

Liquiphant M
FTL41, FTL51B, FTL50/51 and FTL50H/51H/51C

- SIL2/3
- NACE listed
- -60...280°C
- PN100

Liquiphant S
FTL70/71

- SIL3 (MIN/MAX)
- Extended proof test up to 12 years

Liquiphant FailSafe
FTL80/81/85

Operation in Changing Media

Advantage - no calibration required

process chain using the example of a soft drink producer

preliminary products
syrup, basic goods, water

CIP cleaning
acids, lyes

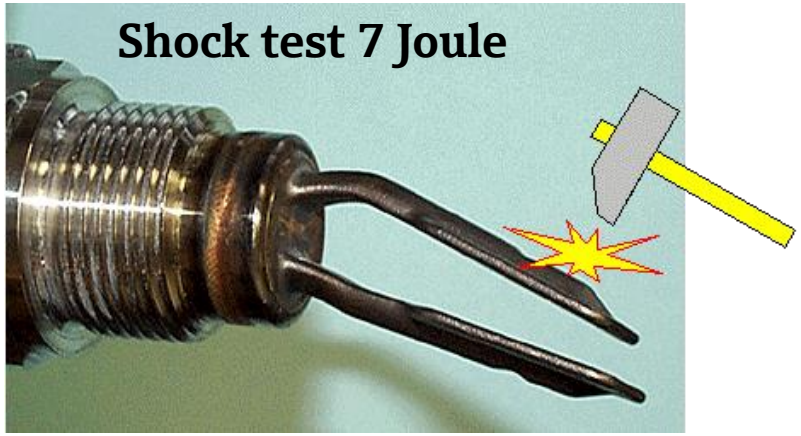
finished products
orange juice, apple juice, ...

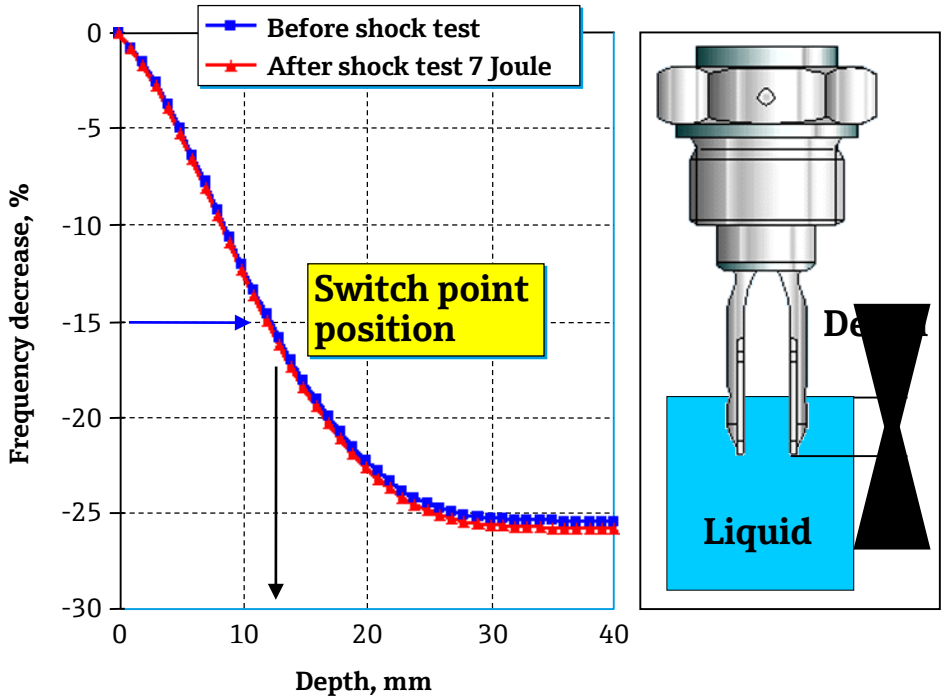
instrument functions independent of dielectric constant, conductivity, viscosity, density, temperature, turbulences

Endress+Hauser

Mechanical stress → Stable measurement!

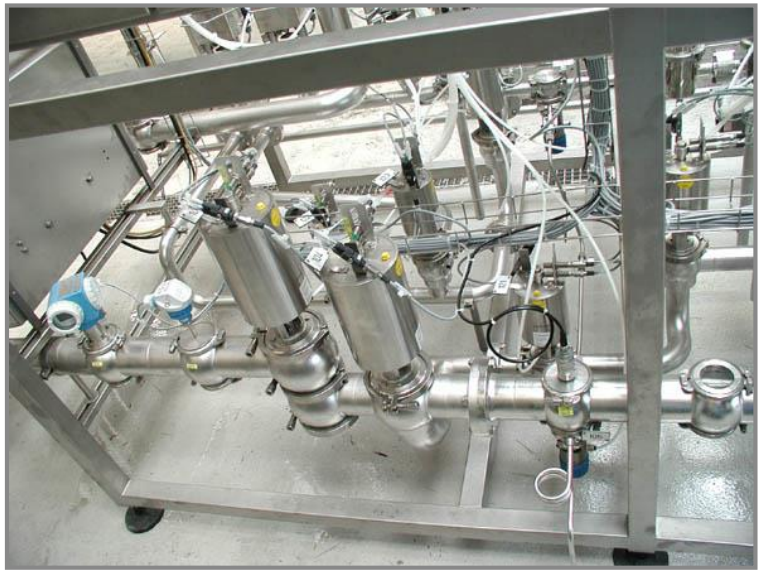
No problem for Liquiphant M, stable switch point

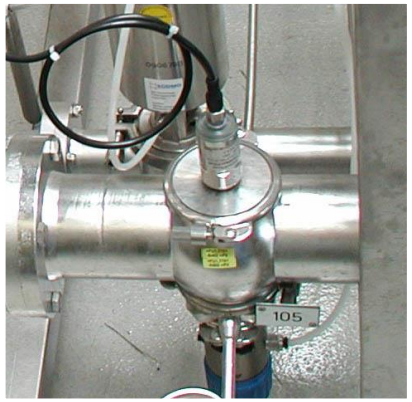




Endress+Hauser

Application Liquiphant-T



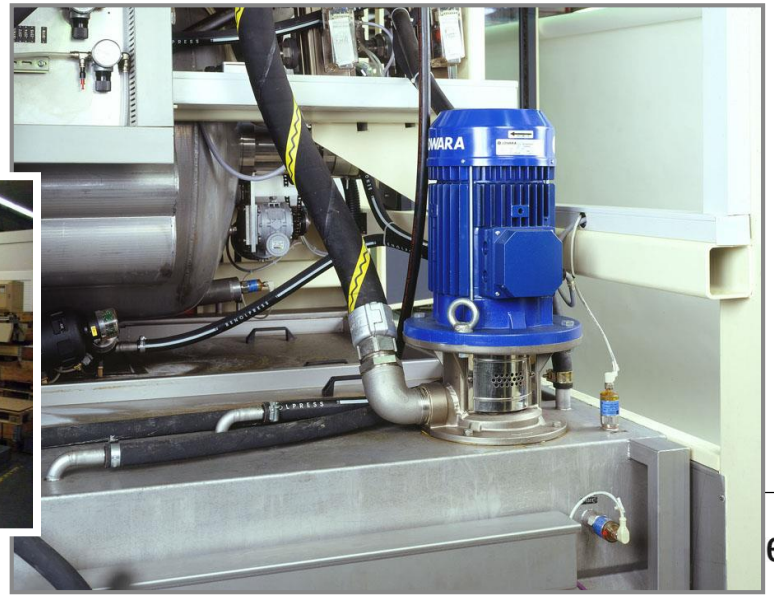


Food Industry

- Production facilities juice

Factory Automation

- Metal washing machines



Application Liquiphant M

Food/Pharmaceutical

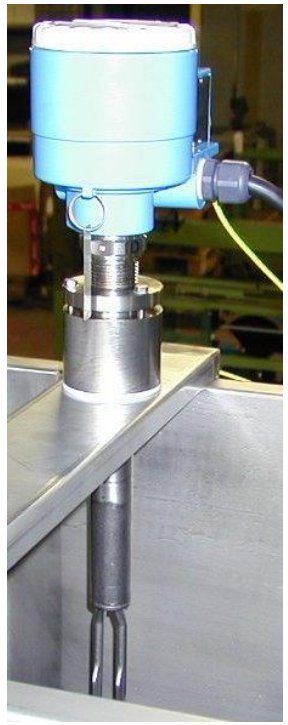
- Hygienic applications

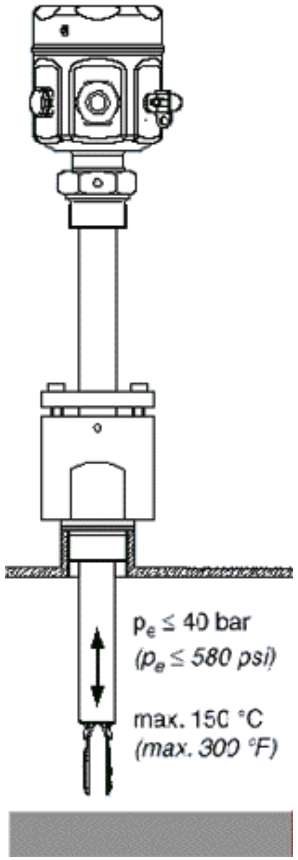
Application Liquiphant M

Food

- Pump protection

Installation with a sliding sleeve





Vacuum ... 40 bar (safety function)

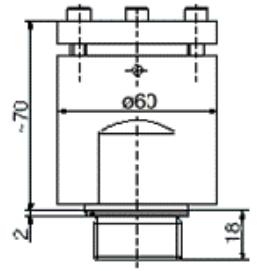
pressure less version

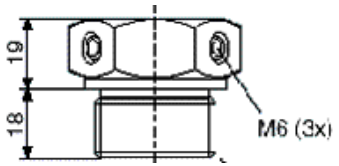
Stainless Steel

Hasteloy

as Accessory

Not with flange version



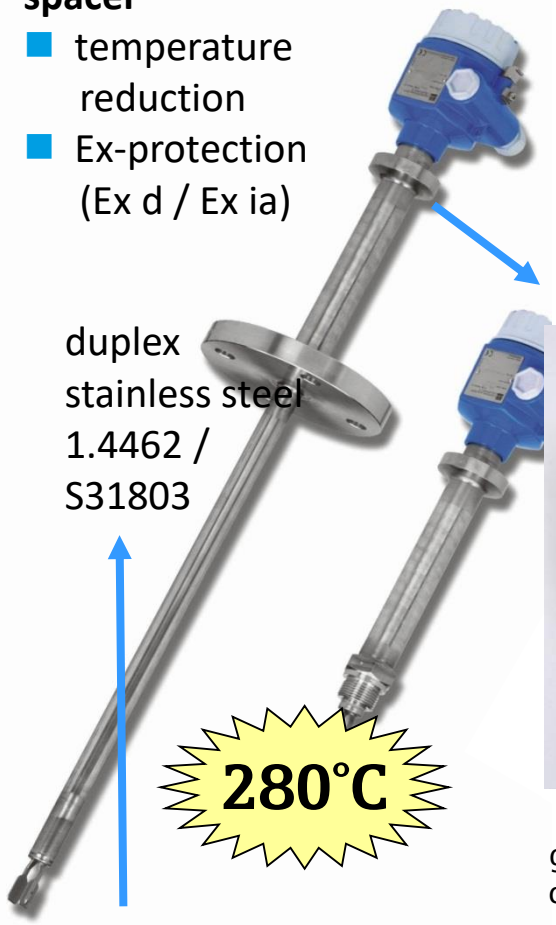


Process Temperatures from -60...+280 °C (-76...+536 °F)

Reliable detection by vibration limit switch

spacer
- temperature reduction
- Ex-protection (Ex d / Ex ia)

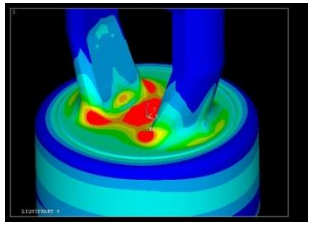
duplex stainless steel 1.4462 / S31803



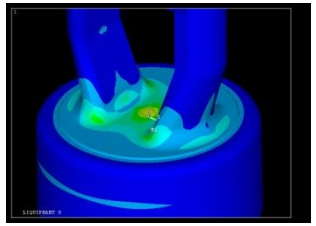
glass-fiber insulated connecting lines and new piezo materials

2nd Line of Defense
- welded diffusion tight feed through
- 80 bar individually tested

matching sensor materials



316 SS: cracks under certain conditions (conventional device)



Duplex steel: no cracks (Liquiphant S)

Limit Detection in an Agitated Tank

Requirement

- high temperature
  up to +230 °C (+446 °F)
- density change do not affect
  the measurement

Solution

Liquiphant S FTL71 as
a top level detection

Coating

of all sensor wetted parts

Liquiphant M

- Enamel
- ECTFE
- PFA - Edlon ™
  - Ruby Red
- PFA (conductive)

➡ **in all media up to +150 °C (300 °F)**

Liquiphant S

- Enamel (up to +200 °C / 392 °F)
- PFA (up to +230 °C / 446 °F)

Corossion alarm!

- Chemical corrosion in strong acids
- Electrochemical corrosion

Alarm with mass losses of:

~ 11 g

~ 0.85 g

~ 0.65 g

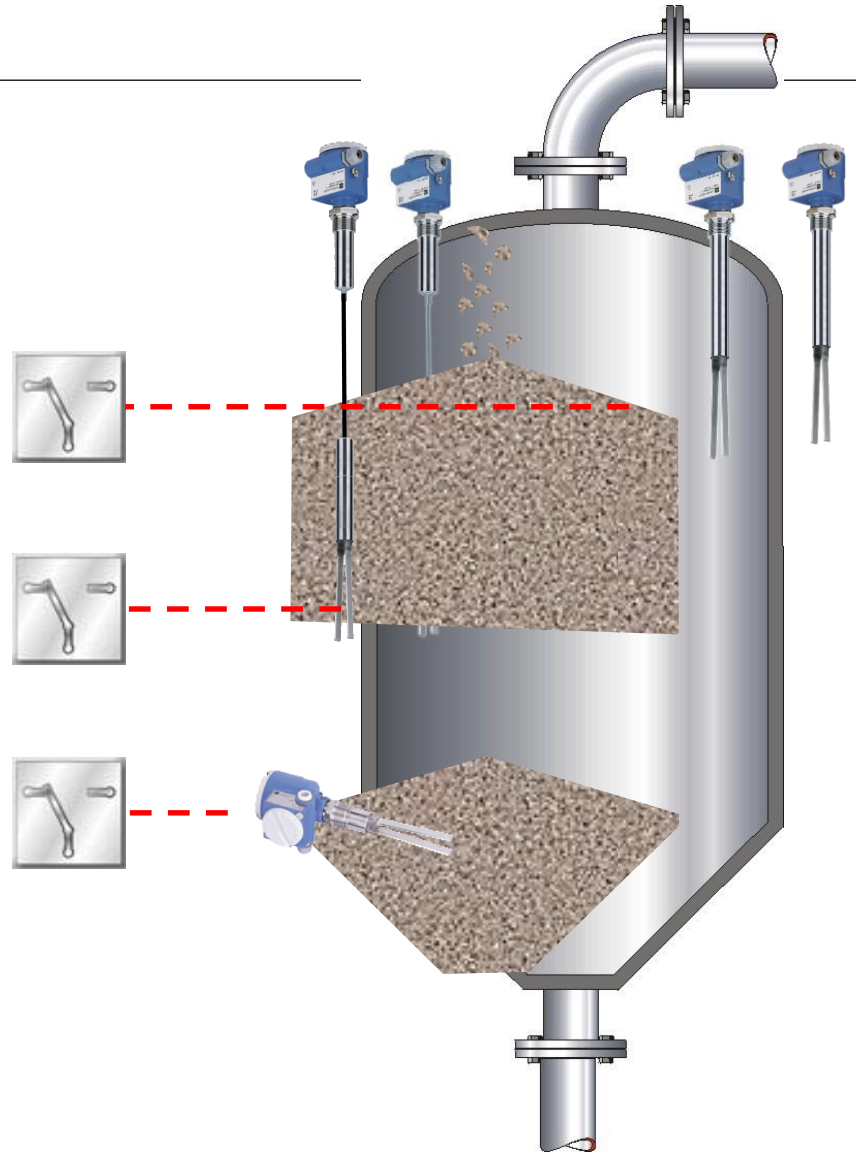
No problem for Liquiphant M, stable switch point

Level Limit Detection

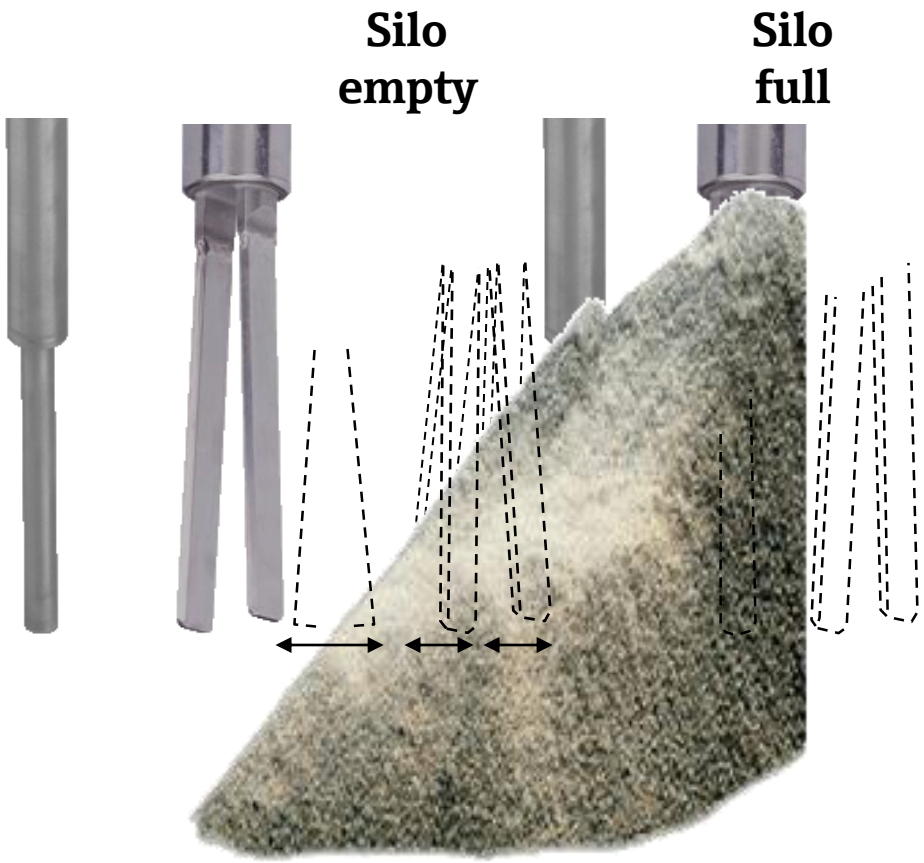
in bulk solids using the vibration principle

Measuring principle

The oscillating tines are piezoelectrically excited.
The amplitude of the vibration is reduced when the tines are covered with media.
The change in amplitude is recognised by the electronic.



Function principle



- In empty silos, i.e. in gases, the fork can freely oscillate.
- Oscillation is however impeded and stopped by bulk solids, i.e. in full containers.

  The tines of the fork are prevented from oscillating by the bulk solids mass. This changes the amplitude of the oscillation. The electronics compare the amplitude with the target value and trigger an electronic switch or relay.

Soliphant family

Soliphant

- > 200 g/l (12 lbs/ft³)
- Compact and tube extension
- DC or relay
- F16 or F18 housing
- Sensor lengths 250, 500, 1000, 1500 mm (9, 20, 40, 60 inch)
- Density setting

Soliphant M

- > 10 g/l (0.7 lbs/ft³)
- -50 °C to 280 °C (-55 °F to 540 °F)
- Short and standard fork length
- 0.8 µm, coated surface selectable
- Compact, rope and tube extension
- DC, relay, AC, NAMUR, 8-16 mA, PFM
- F13, F15, F16, F17, T13 housing
- Separate housing possible
- Sensor length starting 145 mm (5.7 inch) and customised lengths
- Detection of solids under water
- Time delay
- Density setting
- Build-up, corrosion and abrasion monitoring
- Functional safety SIL2 (IEC61508)

Safety considertaions

Safe

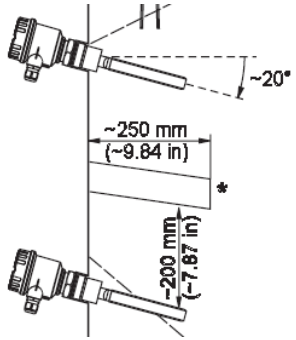
Safer

. . . .

Safety add on #1: abrasion/corrosion alarm

Soliphant M is very resistant against abrasion.

The sensor material, the shape and surface of the fork reduce abrasion.
Abrasion or corrosion of the fork can be recognised by monitoring the frequency. This condition is indicated by the red LED.



Abrasion by wrong installation:

- in the flow of incoming product
- tines parallel to product flow

After prolonged usage:
Fork is still oscillating but shows signs of abrasion.

Protection:

- **Corrosion and abrasion alarm**
- **electropolished version available**

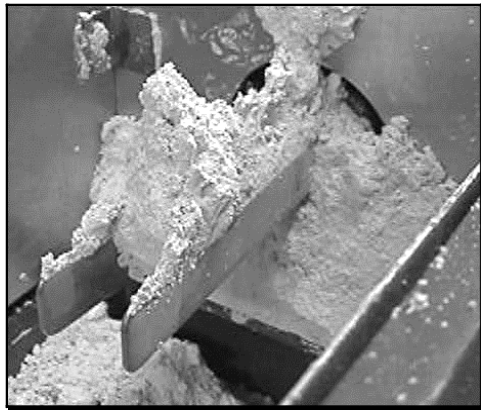
Endress+Hauser

Safety add on#2: build-up

Soliphant has very good build-up compatibility properties.

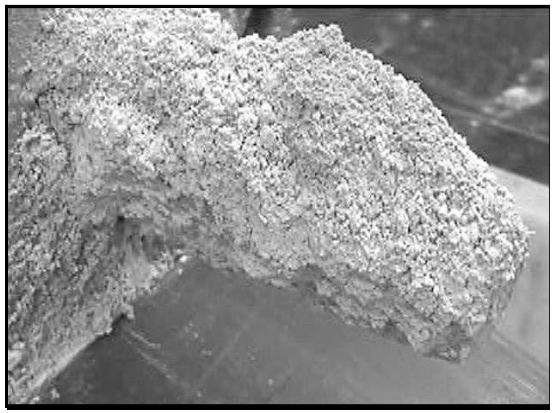
The integrated frequency monitoring enables an indication if the sensor frequency changes because of build-up. Frequencies below the resonance frequency point at sticking, swinging masses (build-up, water, ...).

The following pictures show max. build-up in which Soliphant can still report freely.



Bridging during discharge of dry lime hydrate

Build up formation by moist lime hydrate up to 1.5 cm (0.6 inch)



Maximum build-up formation up to 53 g (1.87 oz)

→ Build-up must be expected in moist dusts and sticky bulk solids.

Areas of applications

For all powdery to fine-grained bulk solids

Foods:

- Grain
- Flour
- Milk powder
- Cocoa
- Sugar
- Animal feed

Plastics:

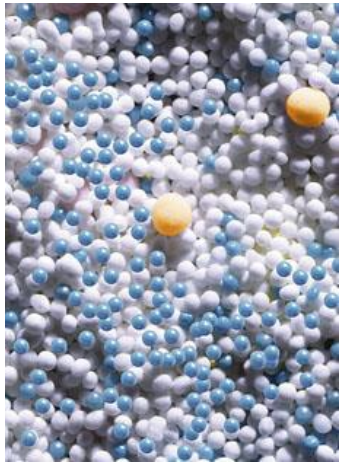
- Styropor
- Pellets
- Recycling material

Energy:

- Fly ash
- Dust

Primaries:

- Detergents
- Colouring powder
- Chalk
- Plaster
- Cement
- Sand



Typical applications

Soliphant in many branches……

Cancer powder

lime

flour

Silica flour in sending vessel – pressure no problem

Application

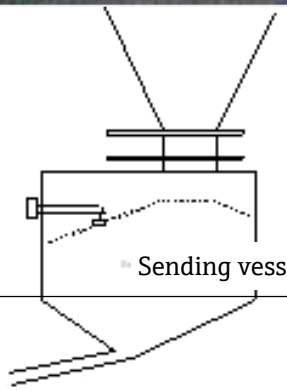
- Silica flour dry, 600 g/l (42 lbt/ft^3) in the sending vessel
- Controls as max alarm the discharging gates

Demands

- Pressure bursts by vibrator
- Process pressure 2 bar (30 psi)
- Lumpy media
- Process temperature +80 °C (170 °F)

Solution

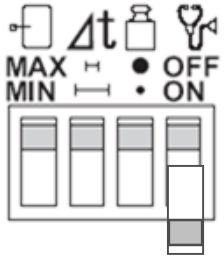
- Soliphant T FTM20 works without problems despite strong bursts



Wheat in process silo – no blocking

Application

- Wheat, dry stored, 600 g/l (42 lbs/ft^3) in process silo
- Temperature +15...+40 °C (+60 °F ... +100 °F)
- Control several times an hour the filling and drain
- Settings
  Min (dry running protection), high bulk density, short switching delay, diagnosis OFF



Demands

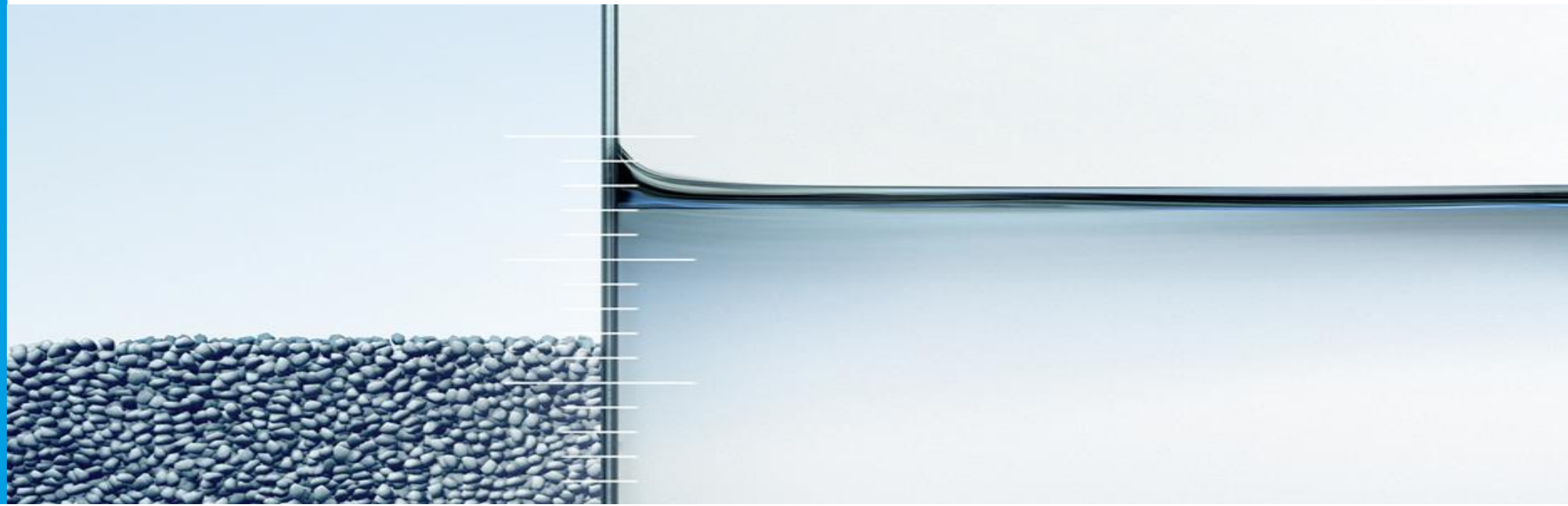
- Abrasion, installed in flow
- Fast switching necessary
- Media that generates blocking

Solution

- Soliphant M FTM51 works well, no blocking

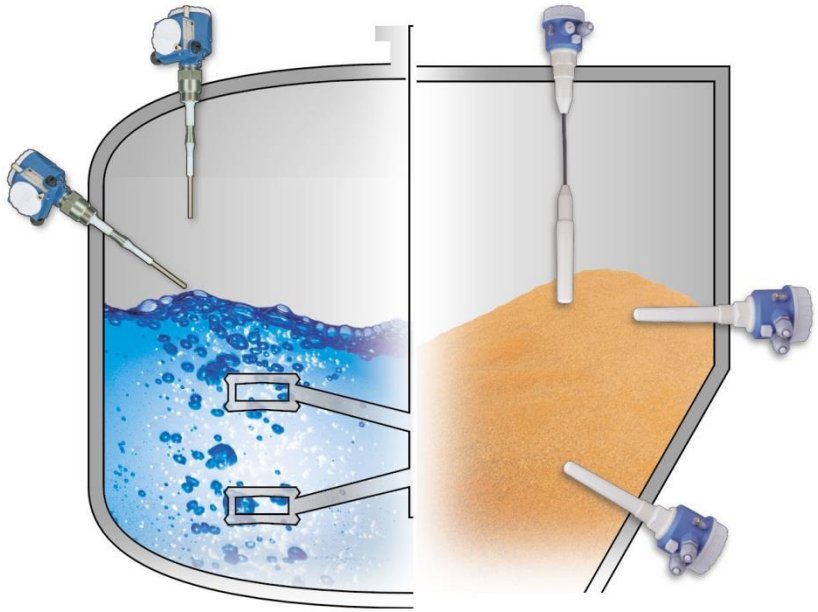
Endress+Hauser

Capacitance



Capacitance Level Measurement

Limit detection



Continuous measurement

Capacitance Principle

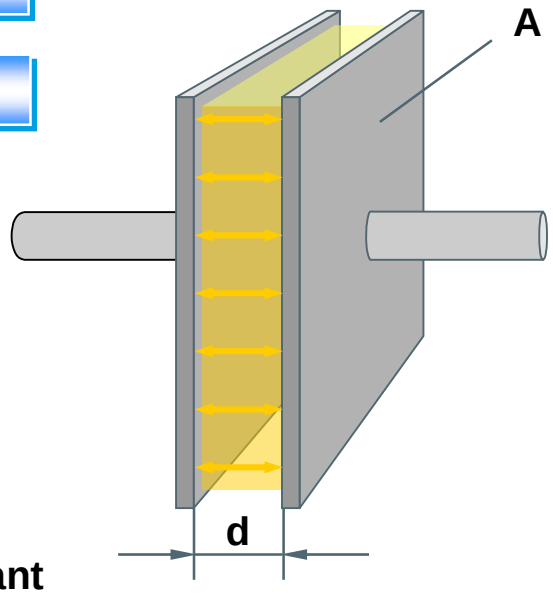
The principle of capacitance level measurement is based on the capacitance change of a capacitor as levels change.

The capacitance of a capacitor is determined by 3 factors:

3

- **Space between electrode surfaces**
- **Area of electrode surfaces (A)**
- **Dielectric between electrodes (e_r)**

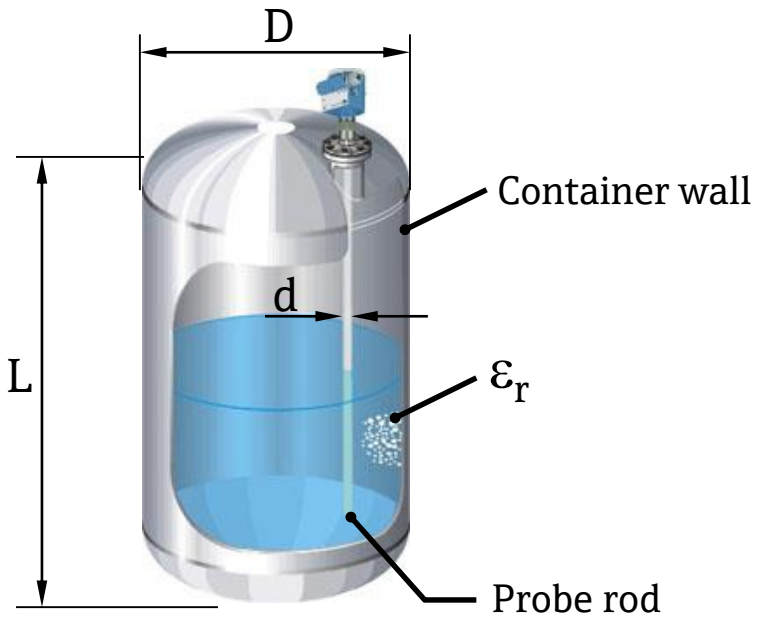
$$C = \frac{\varepsilon_0 \cdot \varepsilon_r \cdot A}{d}$$

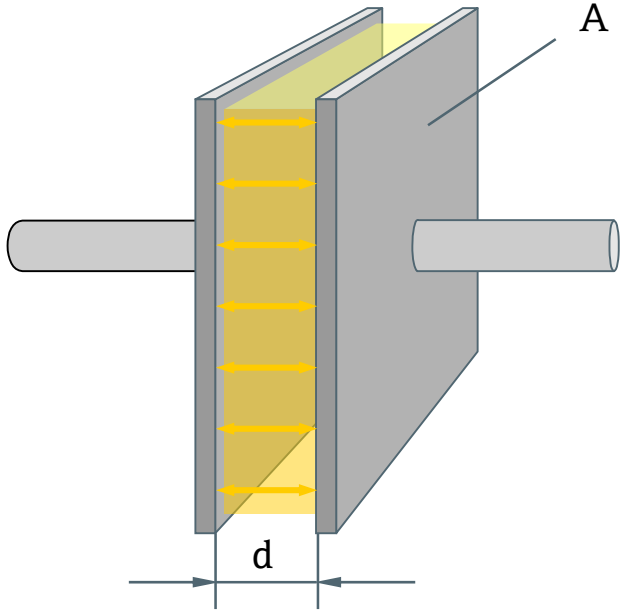


ε_0 : electric field constant
: $8.854*10^{12}$ C/(Vm)

ε_r : relative permittivity, dielectric constant

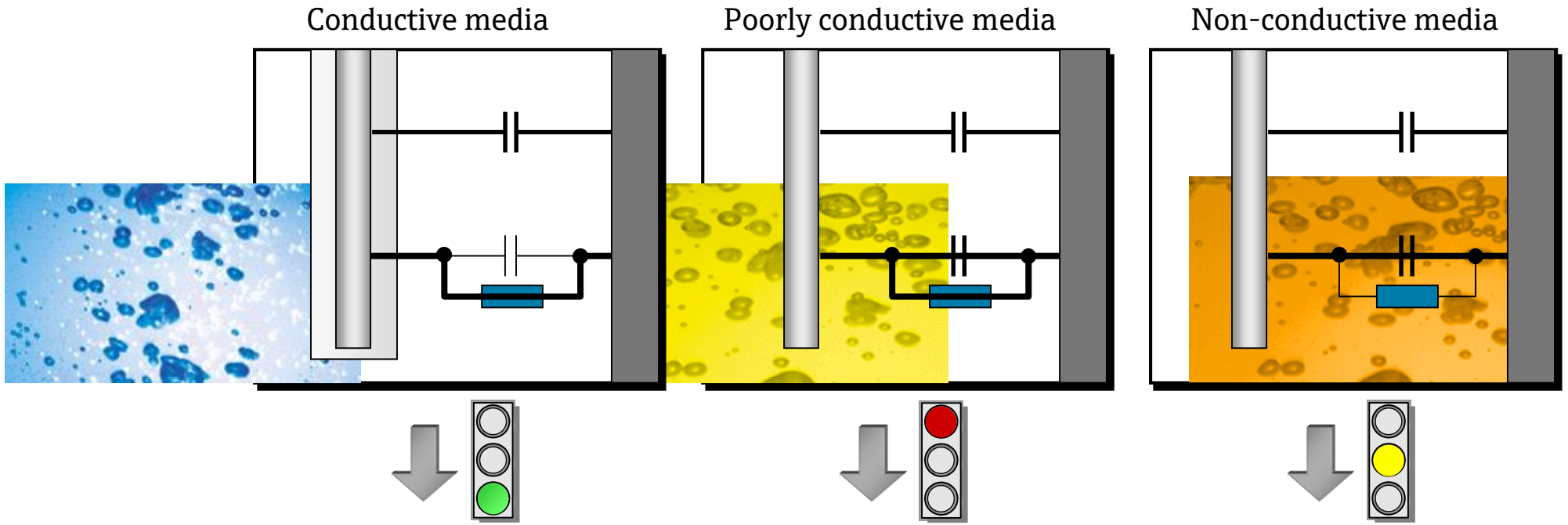
Basic capacitor principle





$$C = \frac{2\pi \cdot \varepsilon_r \cdot \varepsilon_0 \cdot L}{\ln (D/d)}$$

Electric conductivity in continuous measurement In different media

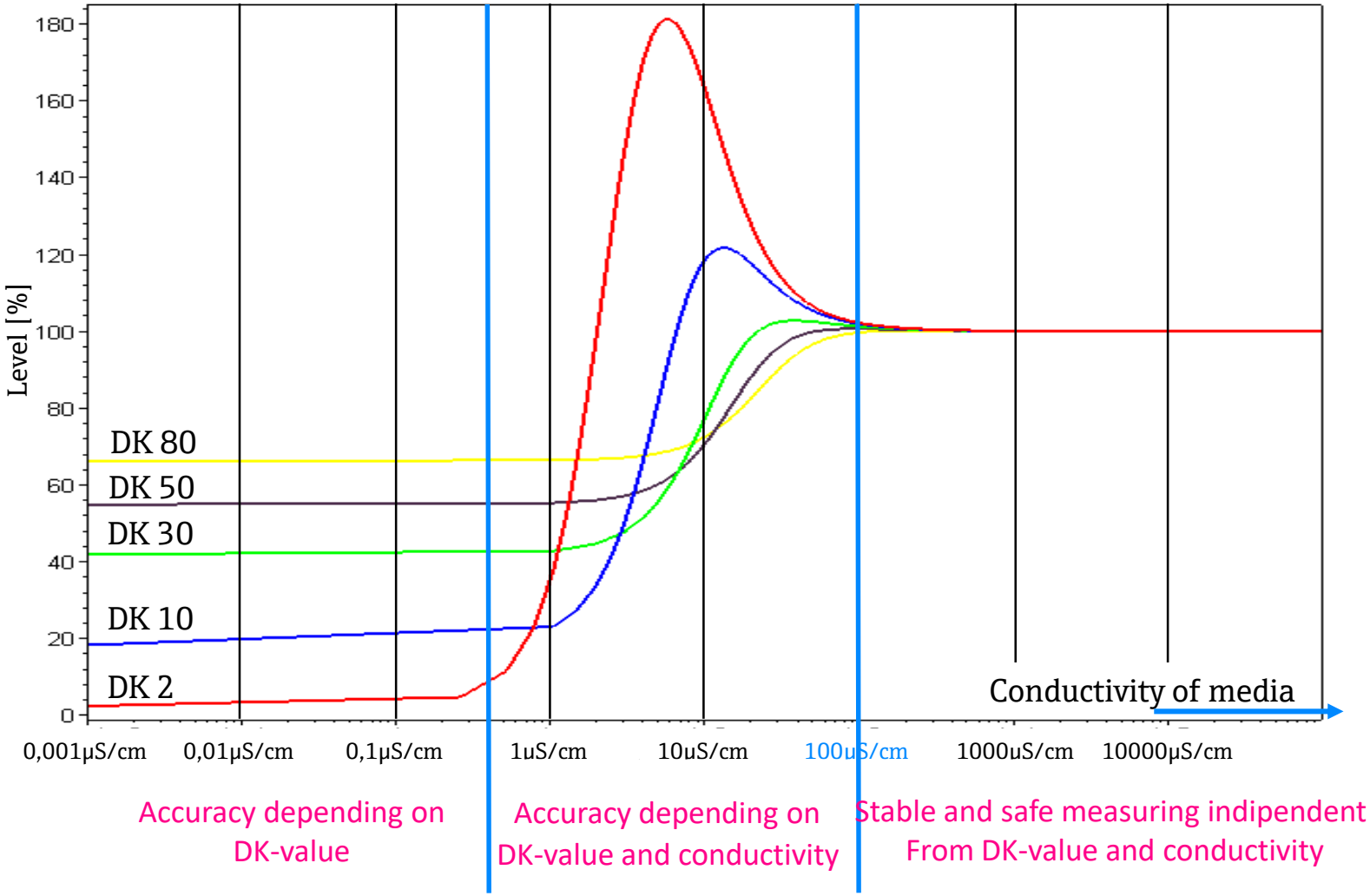


A change of dielectric constant does not influence capacitance since the potential of the container wall passes to the probe. Merely the insulation capacitance is of importance.

Measuring current depends not only on the dielectric constant but also on the conductivity of the medium, which can fluctuate considerably.

Medium must not become conductive by moisture. The dielectric constant of the medium must not change e.g. due to temperature fluctuation, otherwise level cannot be determined reliably.

Influence on measuring value



Endress+Hauser

Probe design – gas tight feed trough

Gastight glass feed through > protection against aggressive or toxic media (optional)

Probe monitoring > predictive maintenance

Liquicap M electronics continually monitor the probe rod and the probe insulation.

Damaged probe insulation causes a leakage current which is detected and triggers an alarm.

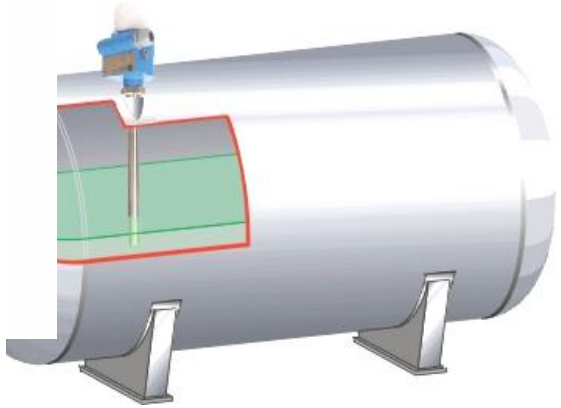
ATTENTION!!
Check probe rod, measured value may be wrong.

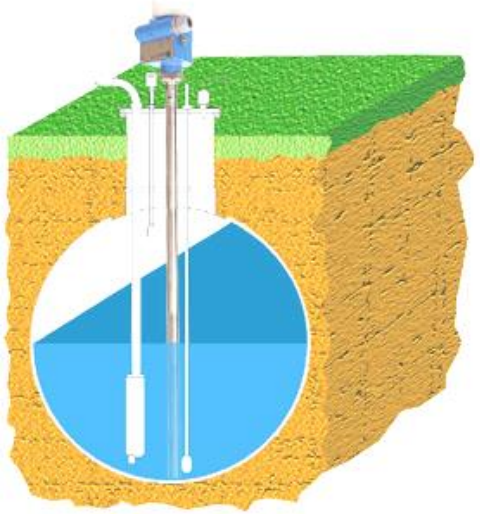
Damaged probe

Ground tube

Applications:

- to increase sensitivity in media with low dielectric constant (factor 5)
- As reference potential in non-metallic containers
- To increase lateral stability in tanks with agitators
- For continuous level measurement in horizontal, cylindrical and spherical tanks

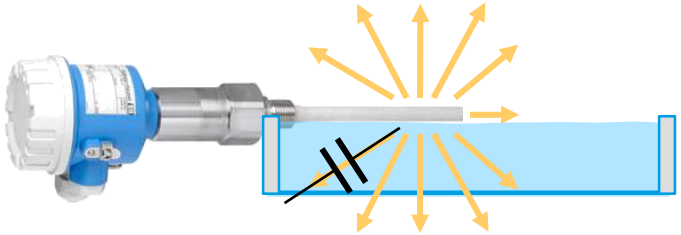




Active build-up compensation for adhesive media (1)

Standard probe generates a homogeneous electric field in all directions for capacity measurement

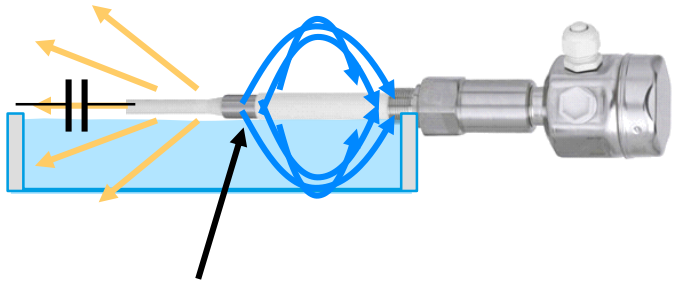
Probe output: covered ✓



- The standard probe measures the capacity homogeneously around the probe rod. In this case, the capacity between the probe rod and the process connection is also measured

Probe with active build-up compensation generates an electric field directed into the tank for capacity measurement

Probe output: covered ✓

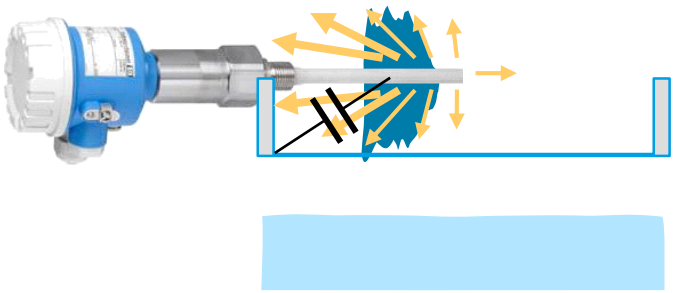


- The active build-up compensation shields the probe rod in relation to the process connectJust ion. Only the capacity between the probe and the opposite tank wall is measured

Active build-up compensation for adhesive media (2)

Standard probe: Error due to build-up

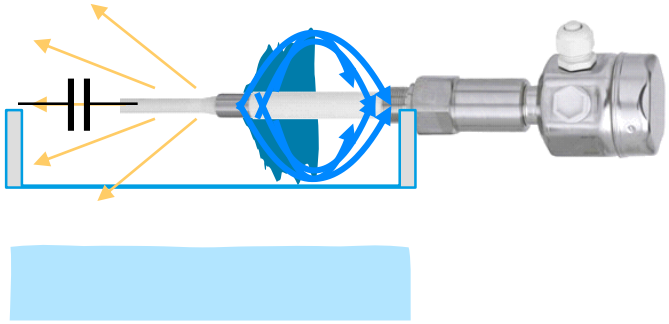
Probe output: covered !!



- In this case, also the capacity between the probe rod and the process connection is measured and the build-up capacity is incorrectly interpreted as “covered”

The active build-up compensation shields the probe in relation to the process connection

Probe output: uncovered ✓



- In this case, only the capacity between the probe rod and the opposite tank wall is measured, i.e. only the air capacity is measured and the capacity between the probe rod and the process connection is compensated

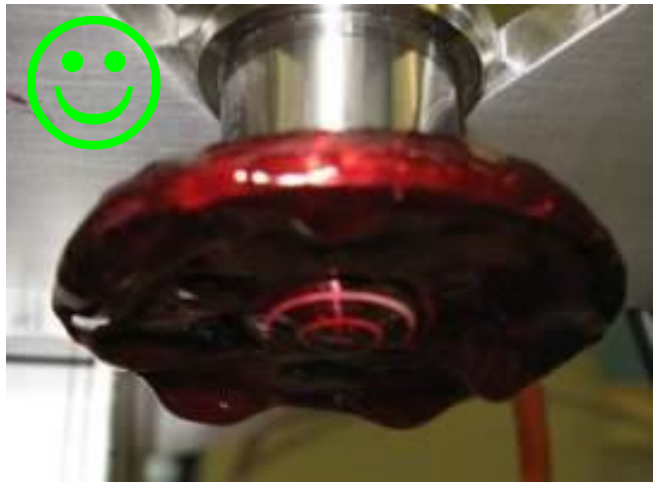
Liquipoint FTW33

Endress+Hauser

Proven-in-use build-up compensation

Liquipoint FTW33

Very good build-up compensation over the entire application range, no customer specific adjustments needed!



Decisive advantages in the installation

Foam or no foam – this is not a question… but a choice

Liquipoint FTW33 can be ordered

- Sensitive to liquids only
- Sensitive to liquids and foam

Endress+Hauser

Applications

Comparison of build-up behavior

Process water

Medium: Process water for microfiber production

- Circulating flow

Tank: PVC tank
Height: 3200mm
Diameter: 2450mm

Probe: FMI51with ground tube
Probe Ø: 12mm
Length: 2000mm

Reference measurement:
Deltapilot S (pressure)

Start of test: 17.03.2005 (week 11)

Tooth paste production

Medium: tooth paste (sticky)

Sensor: FTI51 with active build-up compensation and FEI52 (DC PNP)

Application:
Maximum switch

Targets: build-up performance comparison to “old” Multicap T

Previous measurement:
DC16TES-ABA1B1BN31

Customer feedback: „No problems occurred!“

Kraft Foods (D) – Philadelphia cheese

- Application: MAX detection (overflow) in a hopper
- Device: FTW33-AA4UWRJ
  - M12 plug, thread G1A with O-ring, 316L
  - Additional options: -
- Requirement: Flush-mounted installation ability; reliable point level detection in sticky soft cheese 50…87% fat content

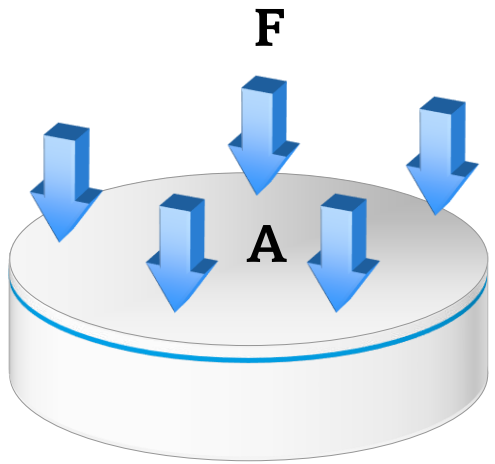
Pressure Measurement

Endress+Hauser
People for Process Automation

Pressure ; What is it ?

Pressure is (beside temperature) the most important physical parameter in process control

Definition acc. to the SI System ISO 1000



$$P = \frac{F}{A} = \frac{\text{Force}}{\text{Area}}$$

Units

$$1\ Pa = \frac{1\ N}{1\ m^2}$$

Pascal

bar

1 bar = 0,1MPa
1 mbar = 100Pa

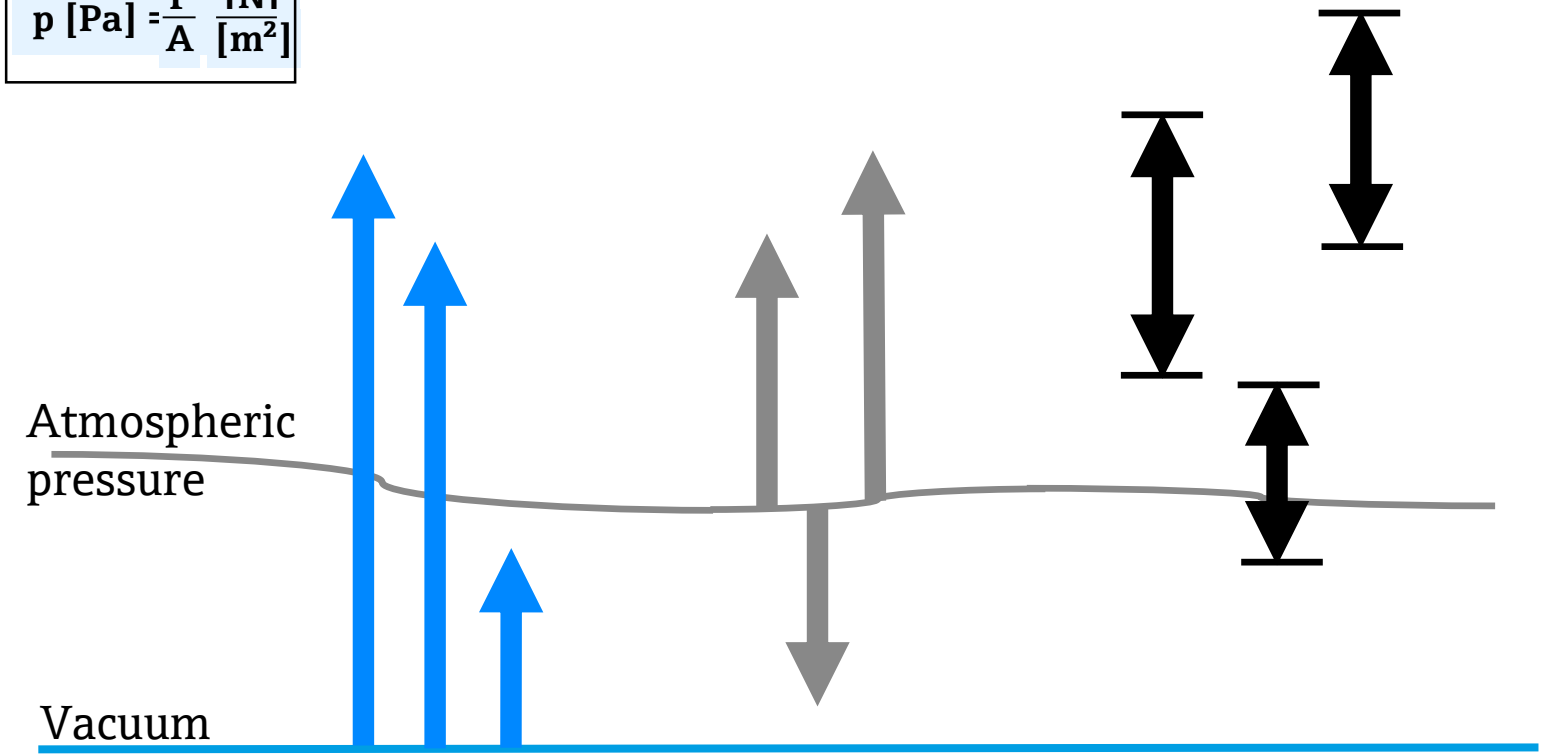
Absolute / Gauge and Differential Pressure

$$p\,[Pa] = \frac{F}{A}\ \frac{[N]}{[m^2]}$$

Absolute pressure

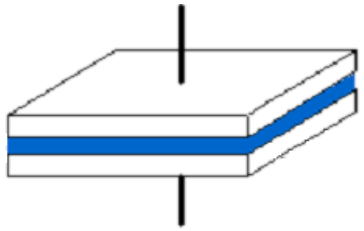
Gauge pressure

Differential pressure

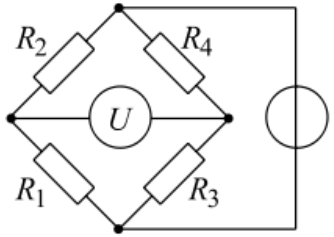


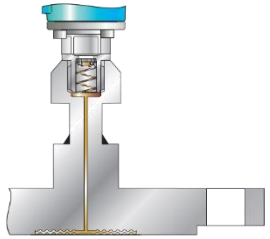
Sensor Technology – different measuring principles

Ceramic (Ceraphire ®)
Capacitive effect

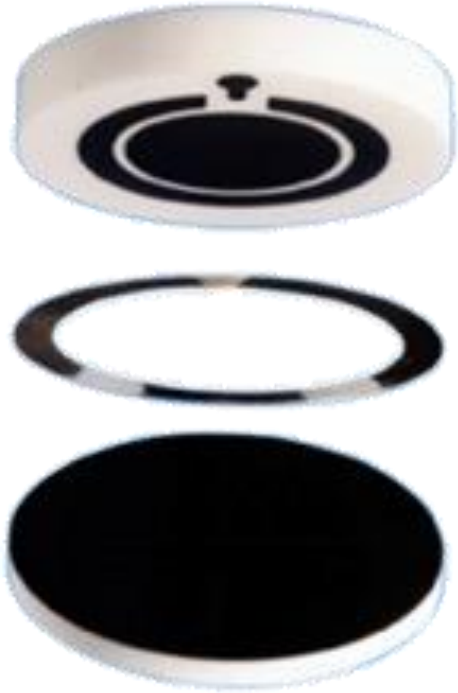


Metal
Piezoresistive effect





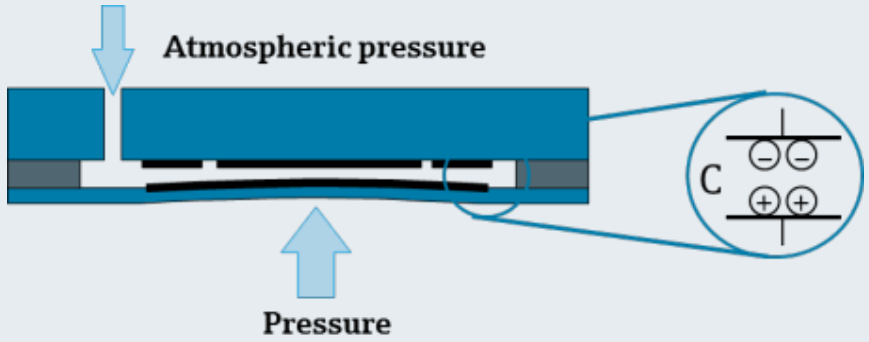
Ceramic Cell



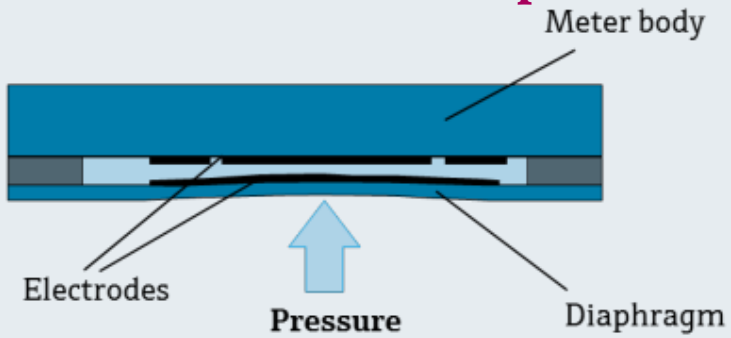
Ceraphire® Ceramic Cell

Working Principle: Capacitive effect

Gauge pressure cell



Absolute pressure cell



Ceraphire®
99.9 %
Al_2O_3

Ceramic body with capacitor plate

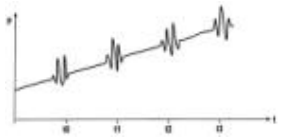
Bracing ring

Ceramic diaphragm with capacitor plate

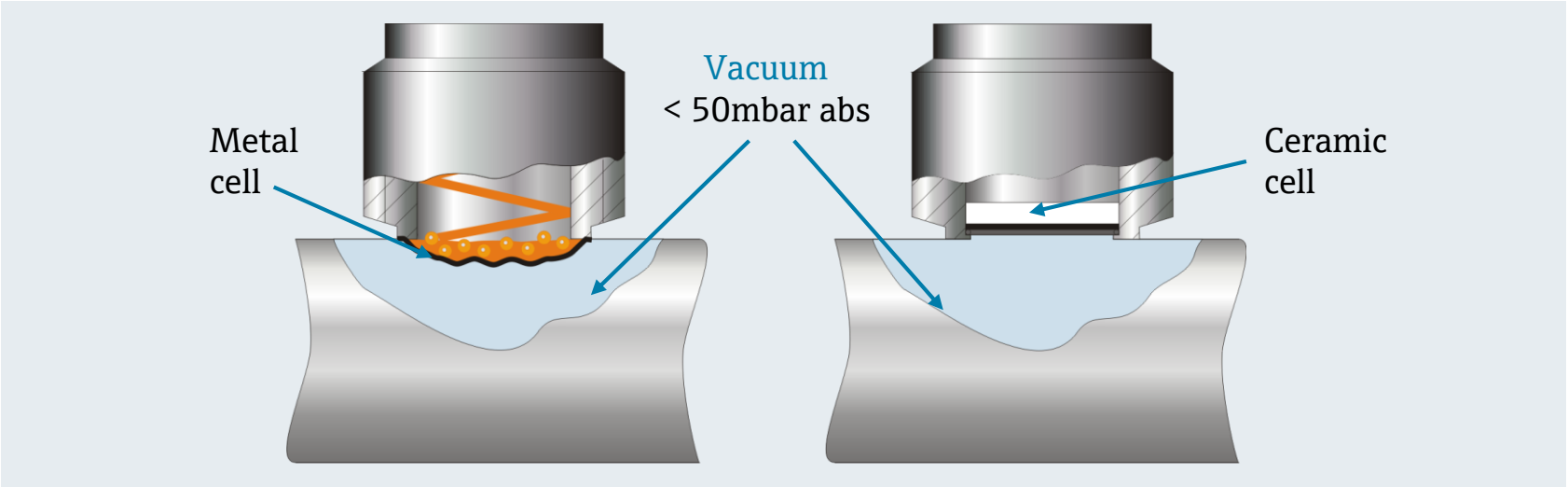
Endress+Hauser

Ceramic cell – Sensor Benefits

- Best for vacuum
  - No filling fluids (gauge sensors)
- Highly corrosion-resistant
- High abrasion-resistant
- High overload protection
- Self-monitoring

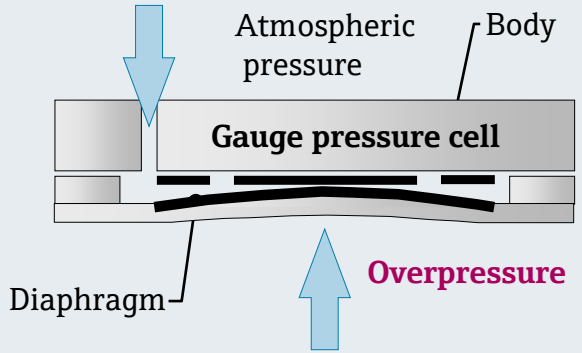


Ceraphire® – Vacuum



- Ceramic cells are sensors without filling fluid, thus
  - No expansion of the filling fluid (oil) – dry cell
  - No boiling effect under vacuum conditions
- Applications for 0.001mbar (0.0145psi) absolute pressure up to 150°C (302°F)
- Ceramic cells are vacuum-tight
  - Design makes the cell fully vacuum-resistant

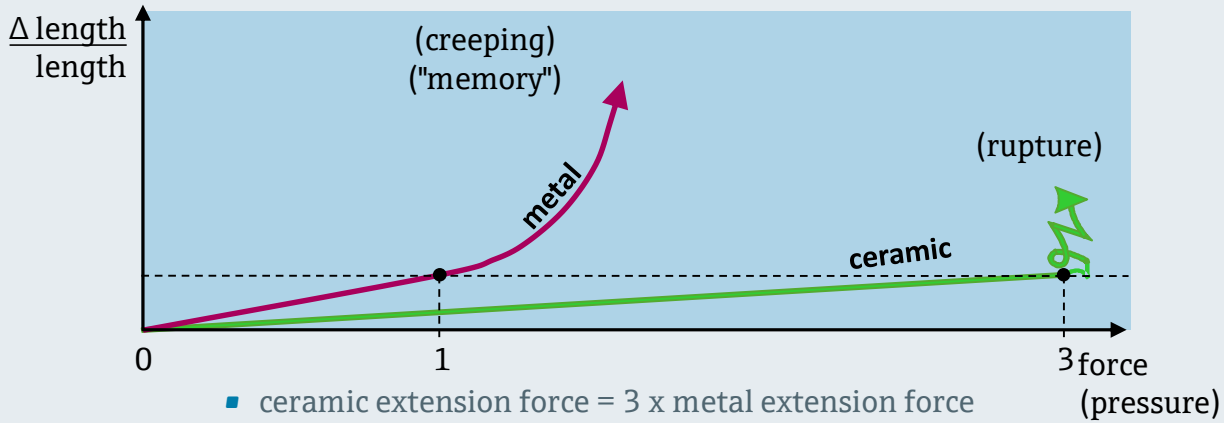
Ceraphire® – Overpressure



In case of overpressure/pressure peaks:

Diaphragm rests against the body absorbing the exceeding pressure.

Metal and ceramic behavior during overpressure

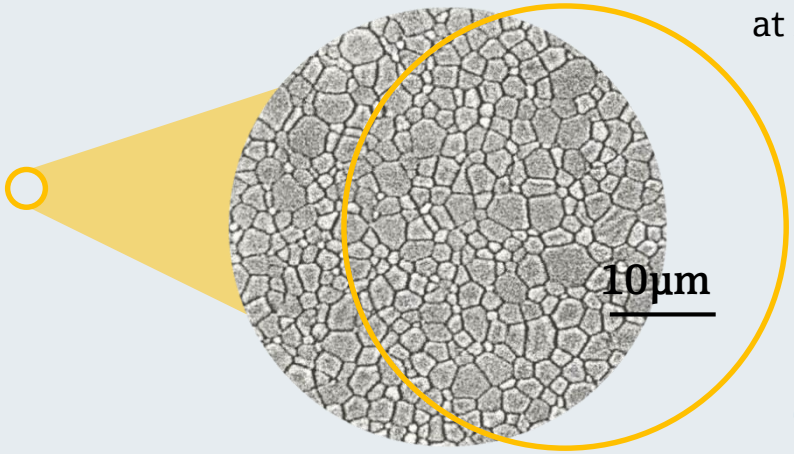


- ceramic extension force = 3 x metal extension force

Endress+Hauser

Ceraphire® – Corrosion

Corrosion resistance



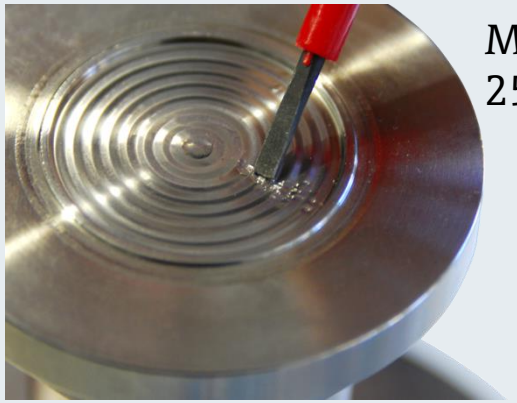
Aluminium oxide crystals sinter at high pressures and high temperatures

Structure of 99.9% Al_2O_3
Surface finish < 0.38µm

→ The high purity provides stronger and more corrosion-resistant technical ceramics.

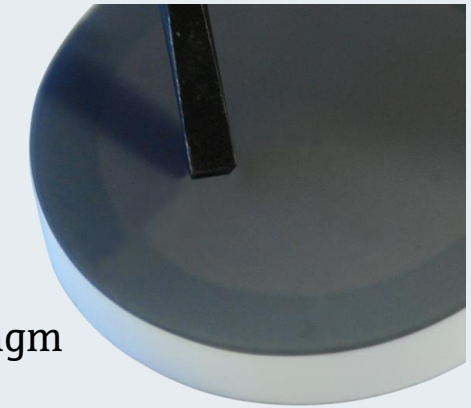
Endress+Hauser

Ceraphire® – Abrasion



Metal diaphragm
25µm...75µm

Ceramic diaphragm
200µm...2.8mm



Why is a ceramic cell the right solution for abrasive applications?

→ Because of its extraordinary hardness and elasticity.

- Ceramics → only diamond is harder
- Ceramics are approx. 22 times harder than stainless steel.
- Ceramics sense pressure even at a thickness of 2.8mm

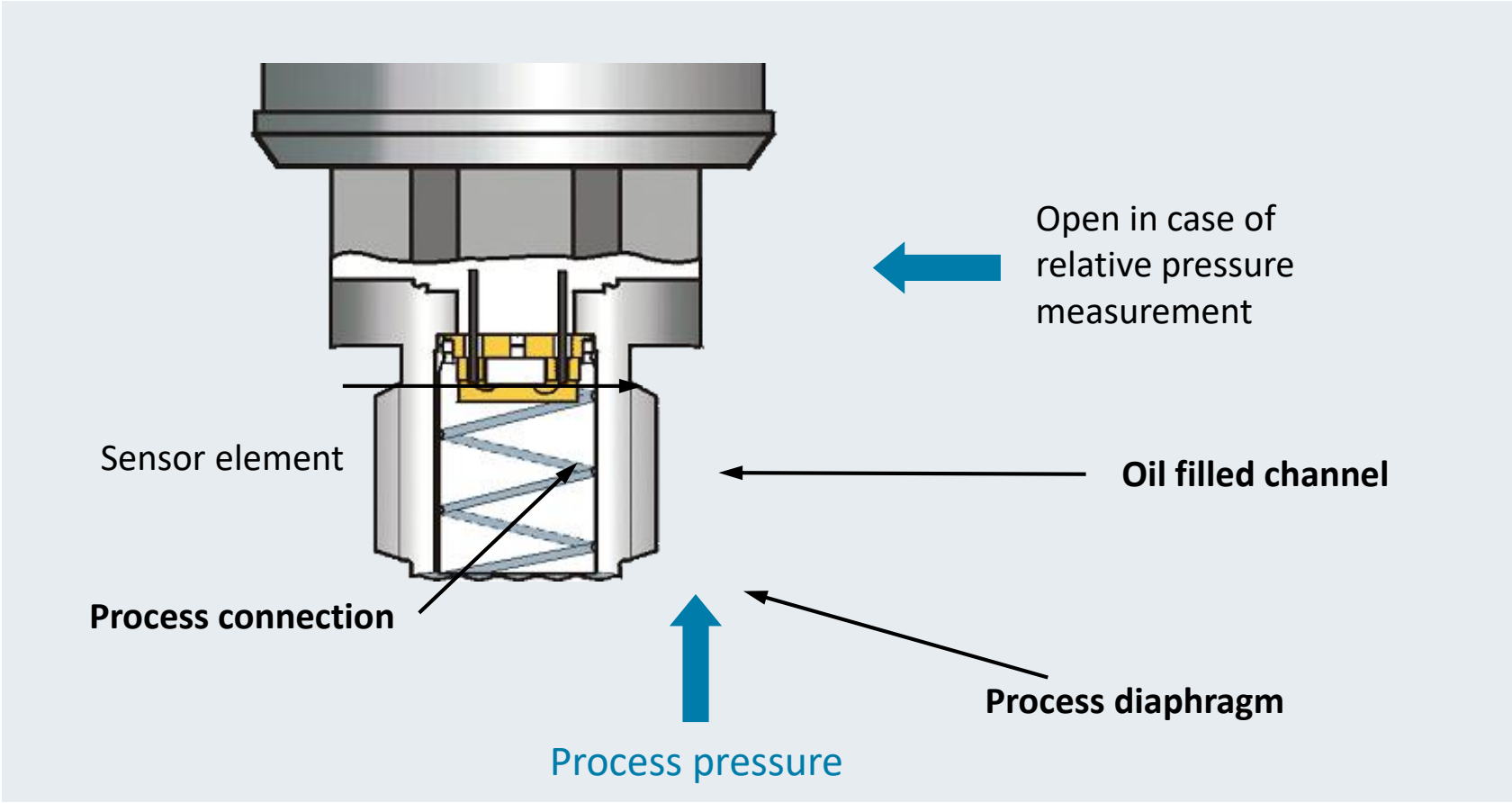
Ceraphire® Ceramic Cell – Limitations

Ceramic Cell – Limitations

- Slow response time after temperature change
- Sealing to process side
- Small process connections not available

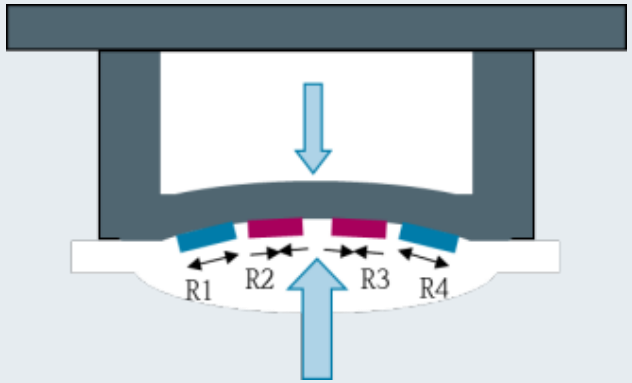
Metal Cell

Composition of a Metal Cell



Metal Cell Basics – Silicon Sensor

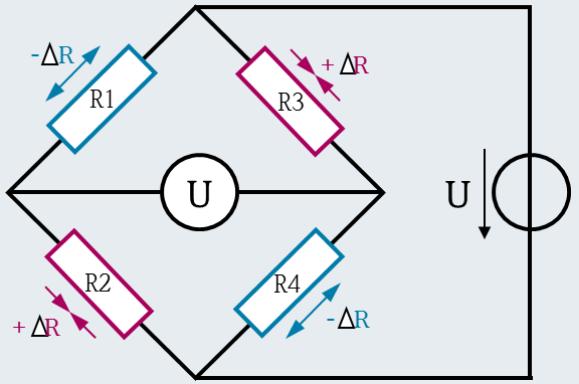
Wheatstone Bridge and piezoresistive effect

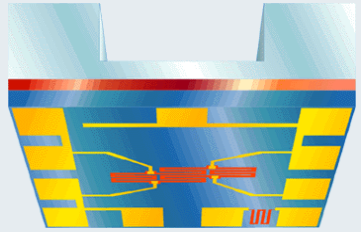


increasing resistance

decreasing resistance

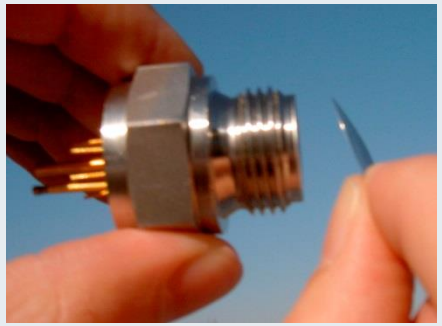
Wheatstone Bridge





Metal Cell – Sensor Benefits

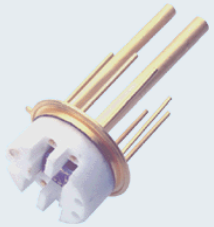
- No sealing to process side
- Small process connections available
- Temperature compensation



Metal Cell – Limitations

Metal Cell – Limitations

- Not suitable for absolute vacuum (oil-filling)
- No abrasion and corrosion resistance
  - thin and sensitive process diaphragm
- Small measuring ranges



New Cerabar and Deltabar – Summary of USPs and additional features

USPs

Heartbeat Technology, e.g. blocked impulse line detection, power diagnostic, membrane breakage detection

Bluetooth connectivity against pressure market leaders

Ceramic measuring cell against pressure market leaders

Display with backlight to indicate transmitter status

Additional features

ISO17025 accredited calibration in production

HistoROM for easy data management

Developed according IEC 61508 for highest safety – **SIL2/3**

Wizards for commissioning, SIL and Heartbeat

Large range of integrated offering, e.g. mounted manifolds, flushing rings, weld spuds, weather protection

CRC checksum to validate and prevent unwanted parameter changes after maintenance

Touch control to operate the device from outside

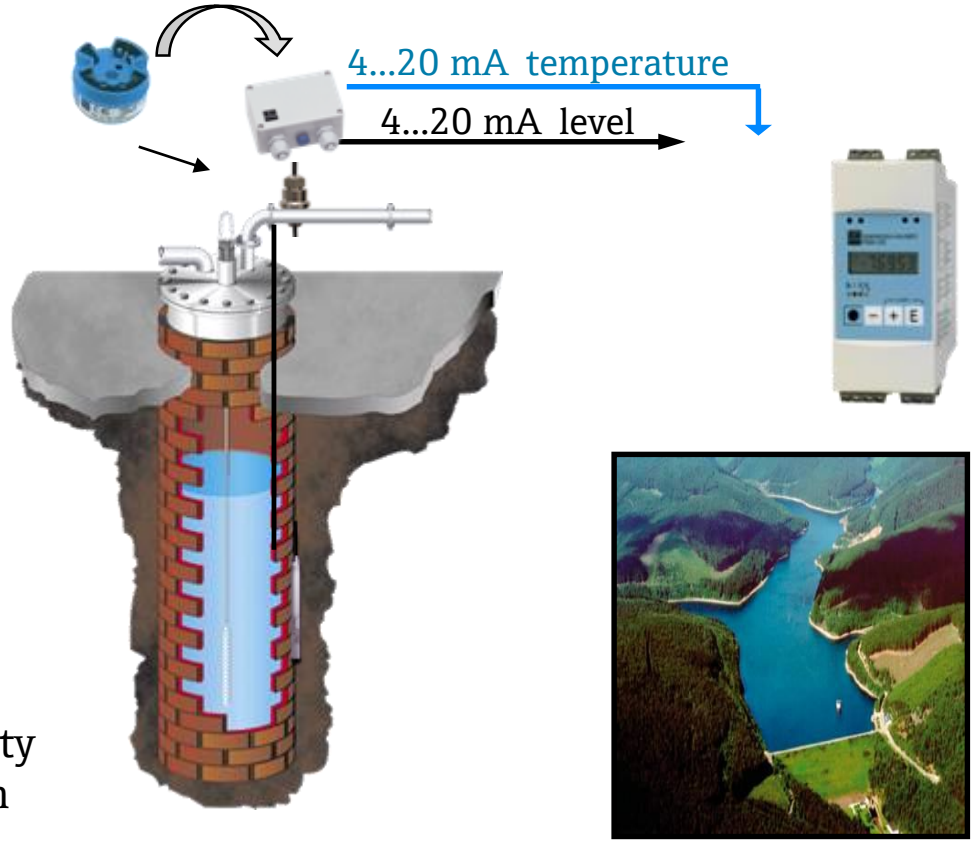
Temperature compensated current output to achieve the highest accuracy

Applications

Applications – Waterpilot

Measurement in deep wells

Provision of potable water supply , Water/waste water application



Requirement

- Potable water – compatible materials
- High long-term stability / reproducibility
- Small probe diameter for installation in sounding pipes

Applications – Deltapilot M

Food industry

Level measurement in a cheese production plant- fully automated

Temperature change through CIP

Requirement

- Waterproof, climate-proof
- Long-term stability also under CIP (Clean in place) conditions
- Hygienic process connection
- Foam cleaning from the outside

Solution

- Deltapilot M FMB50
- Contite measuring cell
- Process connection: Universal adapter 316 L
- EHEDG certification

Applications – Cerabar M

Pharmaceutical industry

vessel for transporting insulin from the reactor to the conditioning plant

Applications – Deltapilot S

Food industry - milk storage tank

wet environment, condensate

Applications

PMD75-A A A 7D 1 1 D A A N U

Air Filter Control, 0 ... 50 mbar

- **Previously optical measurement → no automatic reaction to blocking**
- **Now stable and reliable measurement**

Thank you very much