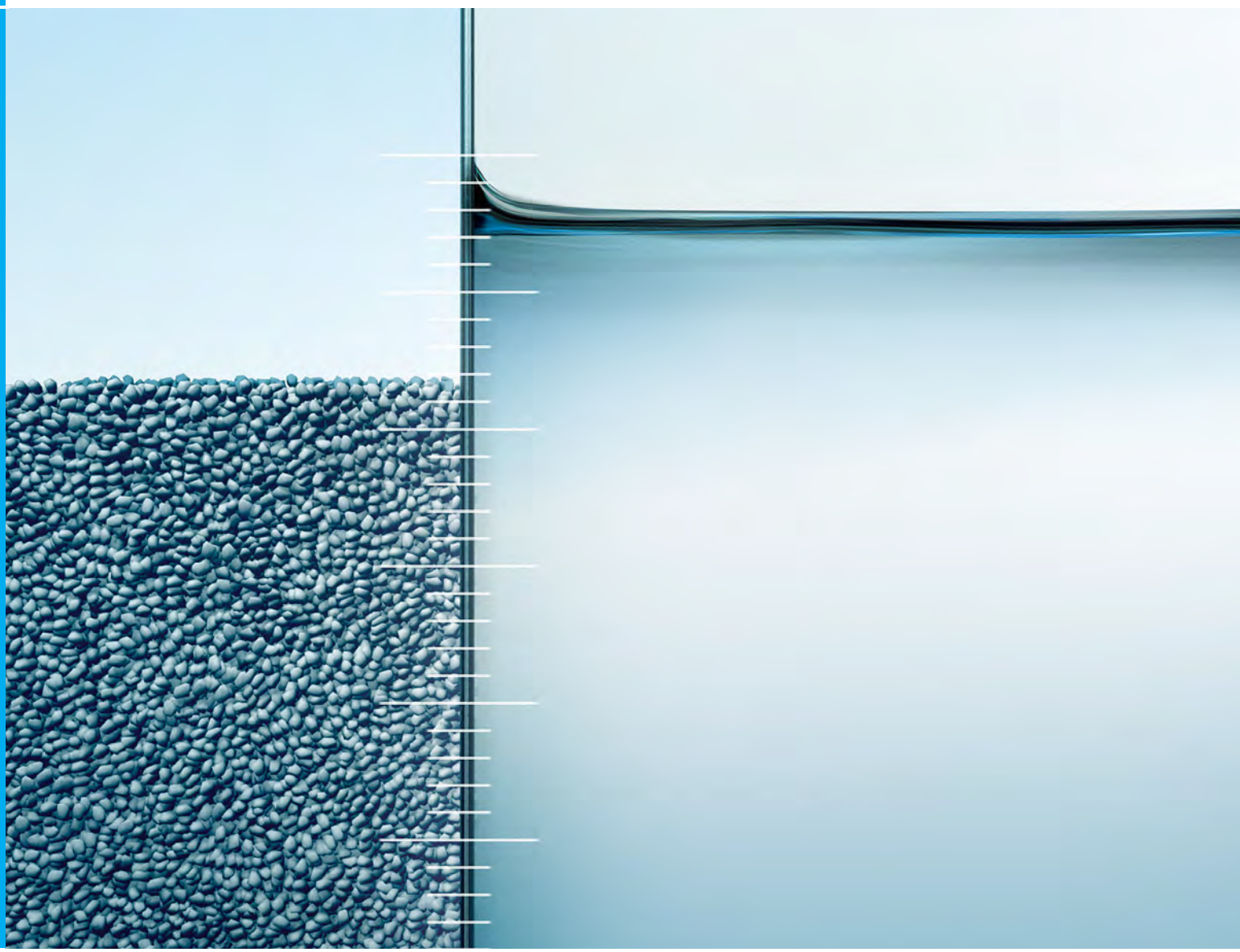
Level measurement

Product overview for applications in liquids and bulk solids



Endress+Hauser

People for Process Automation

Endress+Hauser – People for Process Automation

What is Endress+Hauser's complete product offering?
Our competence in products, solutions and services is always appreciated. We have developed from a supplier of instrumentation to a provider of complete systems with the goal of serving our customers throughout the entire life cycle of their plants and to increase their industrial productivity. Wherever level, pressure, flow, temperature, analytical and recording data are needed and systems, components and solutions are used, companies appreciate the experience of Endress+Hauser. This is one of the reasons why we are a leading global provider of measurement, control and automation solutions for process industry production and logistics.

Curious?
www.endress.com

Endress+Hauser is a family enterprise with a staff of round about 10,000 world-wide and sales of more than 1.5 billion Euro.
Our global presence with production facilities (Product Centers) in Europe, Asia, India and the US, as well as sales and service organizations worldwide in almost every country, ensures constant communication with our customers. This enables Endress+Hauser to consistently support the competitiveness of our customers with the highest degree of quality, safety and efficiency.
Continuous optimization of our processes and the use of innovative technology enable us to extend the frontiers of measurement, control and automation engineering and to find safe and efficient solutions for the benefit of our customers.
We ensure the compatibility of our processes with the environment to save energy and resources.

All this also makes our customers confident that they will be able to rely on us in the future as **'People for Process Automation'!**

Level measurement – still leading the way

Constant product quality, plant safety and economic efficiency – these are important aspects for any level measuring point.
Levels in liquids, pastes, bulk solids or liquefied gases are often measured in tanks, silos or movable containers. Applications range from −196°C to +450°C (−321°F to +842°F) and from −1bar to +400bar (−14.5psi to 5,800psi). Examples come from all industry sectors from the chemical and petrochemical industries, the pharmaceutical and life science industries, water/waste water or the food and energy industries.

The broad range of measuring principles available means that finding the ideal solution is easy. No principle is suited to all application areas. Therefore measuring systems must be selected that work reliably under the conditions of a particular application and, at the same time, meet the economic situations in the future.

As the market leader in level measurement, Endress+Hauser supports you from planning and commissioning through to the maintenance of your measuring point. In addition, we assist you in automation, asset management and the visualization of process data.

Endress+Hauser Operations App

The app offers fast access to up-to-date product information and device details e.g. order code, availability, spare parts, successor products for old devices and general product information - wherever you are, whenever you need it.
Simply enter the serial number or scan the data matrix code on the device to download the information.

Available on the App Store

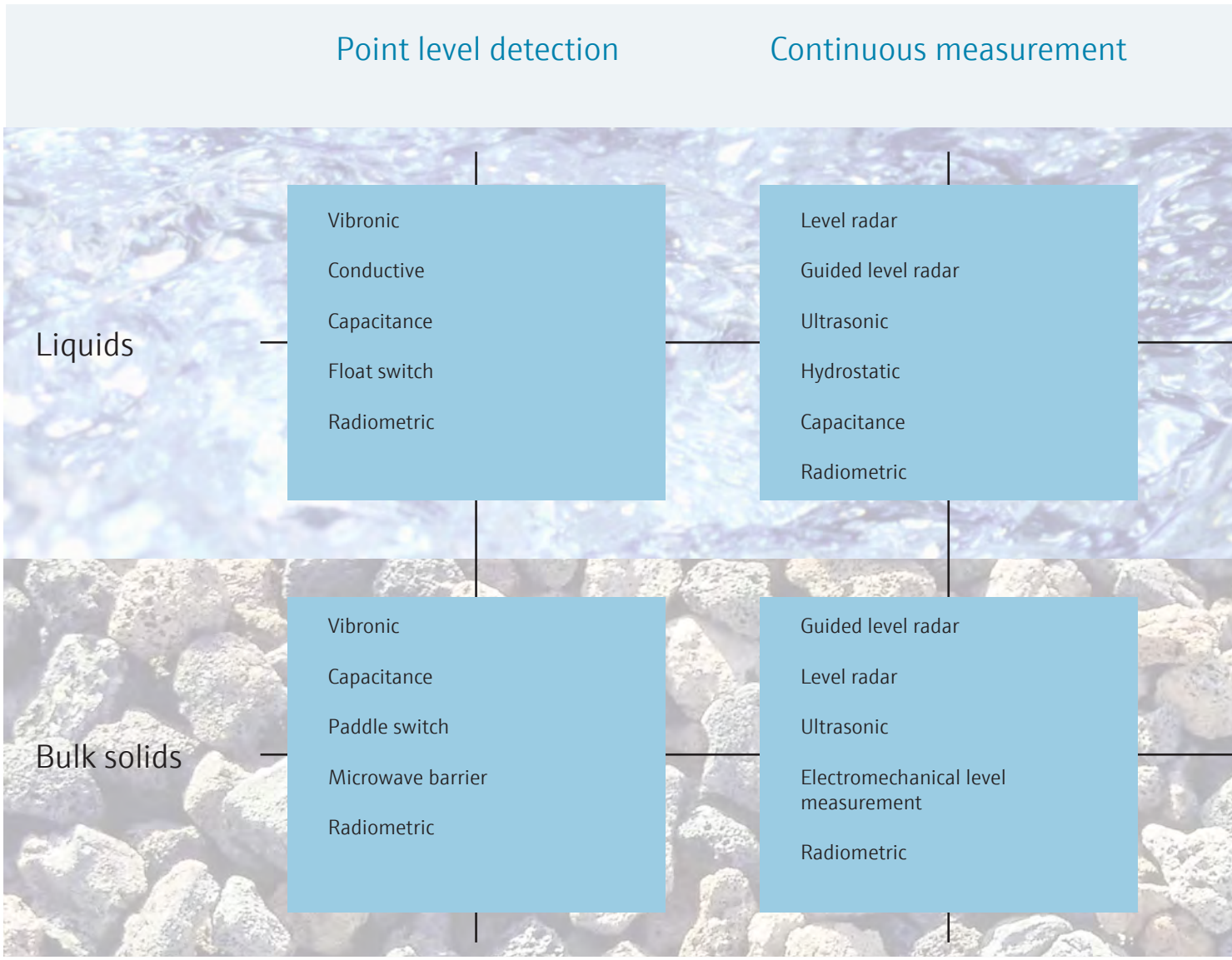
Scan the QR-Code

The right measuring principle for every application

Level measurement applications in liquids including liquefied gases and bulk solids are divided into four areas: Continuous measurement, point level detection, density and interface measurement. The overview contains the measuring principles suitable for each area.

Point level detection
The essential tasks are to avoid overfilling or excessive emptying of tanks and to protect pumps from running dry. In point level detection, fast and safe functioning and high reproducibility are of great importance.

Continuous measurement
Continuous level measurement determines the level of media – it actually measures the length. Apart from direct level measurement in meters (2-70m / 6-230ft possible), the product volume in a tank may be determined indirectly. This must take the geometric form and dimensions of the tank as well as medium properties into consideration. Inventory management applications often demand a high accuracy of ±1mm (±1/16").



Interface measurement
Liquid mixtures are here in focus. Clean interfaces, emulsions or complex mixtures, including solids... for each application we find a suitable solution.

Density / Concentration
Not point level, but quality of the media is here determined by known measuring principles. Through data acquisition of density / concentration, other variables can be calculated. Reproducibility and quality are the key words.

Interface measurement

Guided level radar

Capacitance

Radiometric

Vibronic
(solids in water)

Radiometric

Density and concentration measurement

Vibronic

Coriolis

Radiometric

Time-of-Flight method

Three measuring principles – one philosophy

Level measurement in the most diverse applications
Radar pulses or ultrasonic waves are emitted by a sender, reflected by the product surface and again detected by a receiver. From the Time-of-Flight (ToF) of the pulse, the distance between the sender and the surface is determined using the known velocity of propagation. The level can be calculated from this value taking the tank height into consideration.

Advantages at a glance

- No mechanical moving parts, resulting in low maintenance costs
- High accuracy due to independence of medium properties like density and conductivity
- No calibration required in changing media

The three Time-of-Flight principles
Radar technology is well established in different continuous level measurement tasks of liquids and solids. Mostly in the chemical, oil & gas, life sciences, water/waste water and primary industry.
Time-of-Flight principles can be selected into three categories:

- Guided level radar – Levelflex
- Level radar – Micropilot
- Ultrasonic – Prosonic

Levelflex
Guided level radar for measurement in liquids and bulk solids.

- Measurement independent of the medium surface (foam, angled surface, turbulence)
- Measurement independent of obstructions and vessel layout
- Measurement in dusty atmospheres
- Quick, menu-guided commissioning
- Plain text display in national languages
- Intelligent data management

Micropilot
Non-contact radar level measurement in liquids and bulk solids.

- Optimum adaptation to the application using two frequencies (6 and 26GHz)
- High temperatures and pressures as well as gas layers do not impair measurement
- Safe measurement also in case of build-up, dust and filling noise
- Highest accuracy according OIML R85 and approved for custody transfer applications

Prosonic
Non-contact ultrasonic measurement in tanks, basins and agitators, on stock piles and conveyor belts.

- Integrated temperature sensor for Time-of-Flight compensation
- Easy and fast commissioning due to preset application parameters
- Compact or separated instrumentation as desired
- Cost-effective solution for a wide variety of applications

Over 1 million installed Time-of-Flight measurement devices

As the market leader with over 250,000 guided level radar instruments installed, Endress+Hauser has the most extensive application experience in the market.

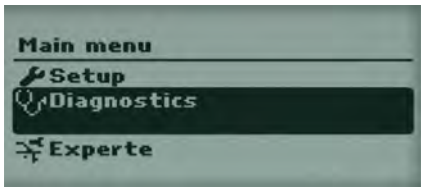
With more than 30 years experience in microwave technology and more than 300,000 installed radar devices, Endress+Hauser offers a wealth of application know-how in all industries.

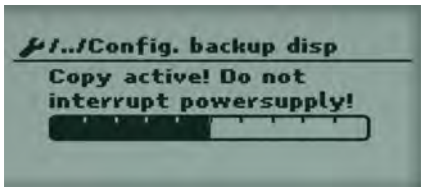
More than 40 years of successful development, production and marketing of ultrasonic instruments as well as more than 650,000 applications underline the competence of Endress+Hauser.

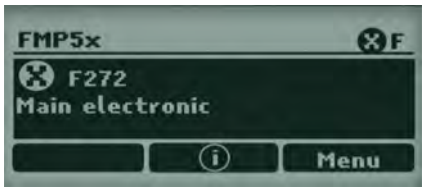
Time-of-Flight method

Operation and diagnosis

Directly at the instrument
The uniform operating philosophy for all Endress+Hauser instruments facilitates fast and easy parameterizing.







Menu-guided commissioning
The new uniform HMI operating standard for all Endress+Hauser instruments facilitates intuitive, safe and menu-guided operation supported by a graphic multiline plain text display. Users are thus easily and quickly guided through parameterizing and commissioning. The new operating concept differentiates three user groups:
- Plant operators
- Maintenance staff
- Experts

The different operating levels enable targeted and easy access to required parameters.

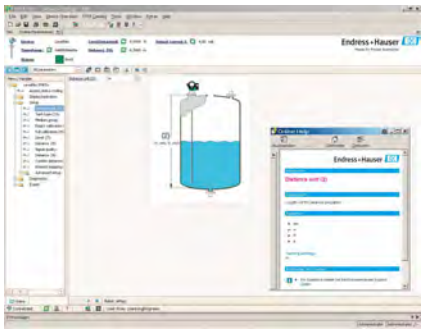
HistoROM
The new generation of Time-of-Flight measuring methods offers the intelligent HistoROM data management concept. HistoROM constitutes a memory component in which all parameter settings are automatically stored. In addition, the display features storage capacities and can thus be used as a HistoROM backup or as a data carrier to copy device configurations. The intelligent HistoROM data management thus offers:
- Increased data security
- High degree of plant availability
- Easy multiplication of measuring configurations
- No costly reparameterizing in case of an electronic exchange

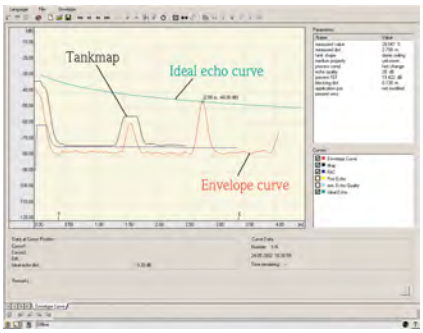
Diagnosis
The NAMUR outlines fundamental aspects of self-monitoring and diagnosis of field instruments in its NE 107 recommendation. The new instrument generation of the Time-of-Flight measuring principle has implemented these requirements. The exact instrument and process diagnosis and its categorizing according to NE 107 (in combination with a full-text help function in case of a failure) facilitates time-saving and targeted repair work.
The integrated event logbook records failure modes and instrument accesses stating the time of events.

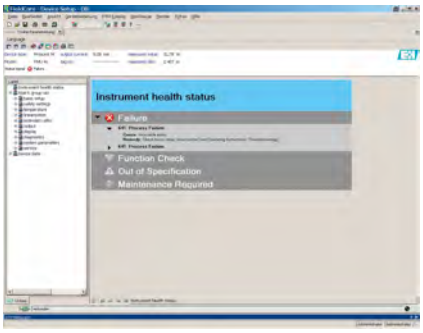
Advantages at a glance
- Fast and safe commissioning by self-explanatory, menu-guided operation in national languages
- Envelop curve – you see what the instrument sees. Easy plausibility check on site
- Additional display memory to secure HistoROM data and easy multiplication of measuring points
- No costly reparameterizing in electronics exchange

Parameterizing, diagnosis and documentation

Directly from the control room







FieldCare operating software

This software facilitates “remote control” via PC and comes free of charge with every instrument. The connection to the PC is standards via HART® or a digital fieldbus. In comparison to the operation at the instrument display, the following additional benefits result:

- Menu-guided parameterizing with graphic support and online help
- Detailed measurement point documentation
- Easy and safe diagnosis by extensive envelope curve analysis, graphic evaluation tool and event-controlled data recording

Parameterizing and documentation

The menu structure in the FieldCare software corresponds to the operation via the display but offers additional parameterizing support through help texts and clearly structured diagrams. Of course all of the instrument information can be stored (uploaded) and, if required, returned to the instrument (downloaded). The FieldCare operating software also facilitates complete documentation of the connected instruments in PDF format. This simplifies archiving of the instrument documentation. All of the information, i.e. all instrument parameters and envelope curves, is displayed. The cover sheet of this documentation may be individually designed, e.g. with customer company logo or photograph.

Diagnosis

Numerous analysis functions and diagnosis options form an essential part of the FieldCare operating software. The initial page contains current information concerning the instrument status (corresponding to NAMUR NE107). This helps to quickly identify failures and the given remedy information supports a safe end easy correction. The graphic visualization of the envelop curve and different instruments parameters allows, e.g., an assessment of signal quality and thus the reliability of the measurement as well as an analysis of process influences. In addition, the new generation of the Time-of-Flight measuring principle can give out information, e.g. the signal strength, directly via an output for further processing.

Guided radar level measurement

Levelflex

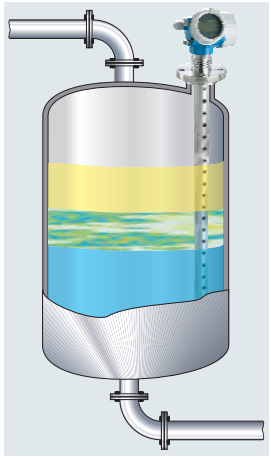
Measurement in liquids and bulk solids
Guided radar pulse measurement is suited to both bulk solids (rope probes) and liquids (rod and coaxial probes). The surface condition of the medium is of minor importance due to the safe guidance of the reflected waves. Different angled surfaces or outflow funnels, as they occur in bulk solids, do not influence measurement. Reliable measurement is also safeguarded in turbulent liquid surfaces or foam formation. Guided radar can also be employed for interface measuring.

Advantages at a glance

- Hard- and software developed according to IEC 61508 for SIL2 (Min./Max./range) respectively SIL3 (homogeneous redundancy)
- Highest process safety due to Multi-Echo Tracking
- Safe measurement in bulk solids and in applications with strong dust formation
- Reliable measurement in liquids with turbulent surfaces and foam formation
- Simple commissioning due to precalibrated sensor
- High reliability due to automatic probe monitoring
- Ideally for the direct replacement of displacers in existing displacer chamber

Functional principle
The Levelflex uses high-frequency radar pulses guided along a probe. The characteristic impedance changes as pulses meet the surface of the medium and part of the transmitted pulses is reflected.
The time between transmission and reception of the reflected pulse is measured and analyzed by the instrument and provides a direct value for the distance between the process connection and the medium surface.

Functional principle interface measurement
A part of the radar impulse permeates media with a low dielectric constant (DC). At the interface to a second medium with a higher DC, the pulse is reflected a second time. Taking the delayed Time-of-Flight of the pulse through the upper medium into consideration, the distance to the interface layer can now also be determined. If interfaces are clearly defined, the Levelflex interface version measures simultaneously both the overall level and the interface. In case of emulsion layers, Levelflex FMP55 Multiparameter offers safe measured value detection with the simultaneous emission of the level and interface signal by the worldwide first combination of the capacitance and guided radar principle in one instrument.



Levelflex FMP50
For basic applications in liquids; rod and rope version.
Levelflex FMP51
The standard sensor in liquids; rod, rope and coax version.
Levelflex FMP52
For aggressive liquids; rod and rope version.
Levelflex FMP53
For hygienic sensitive applications; rod version.

Levelflex FMP54
High pressure/high temperature probe for level measurement in liquids; rod, rope and coax version.
- High diffusion resistance by ceramic coupling and graphite seal
- Ideal replacement for mechanical methods in bypasses, e.g. displacers
- Hot steam resistant

Levelflex FMP55
For applications with emulsion layer; rod, rope and coax version.
- Simultaneous output of the level and interface signal
- Second line of defense (gastight feedthrough)
- Automatically calculation of the DC value of the upper media.

Levelflex FMP56
The basic sensor for solid applications; rope version.
Levelflex FMP57
The standard sensor for level measurement in solids; rod and rope version.
- Extremely robust, even under high tensile forces
- Appropriate for high solid silos

		Levelflex						
Type		FMP50/51/52/53	FMP54			FMP55 Multiparameter		FMP56/57
			Rod	Coax	Rope	Coax	Rod, rope	
Measuring range	**m**	0.3…45 depending on probe	0.3…10	0.3…6	1…45	0.3…6	0.3…10	0.3…45 depending on probe
	ft	1…148 depending on probe	1…33	1…20	3.2…148	1…20	1…33	1…148 depending on probe
Temperature	**°C**	–50…+200 depending on probe	–196…+450			–50…+200		–40…+150 depending on probe
	°F	–58…+392 depending on probe	–320…+842			–58…+392		–40…+302 depending on probe
Pressure	**bar**	–1…+40 depending on probe	–1…+400			–1…+40		–1…+16
	psi	–14.5…+580 depending on probe	–14.5…+5,800			–14.5…+580		–14.5…+232
Min. DC value		1.4/1.6	1.4/1.6			1.6		1.4
Output		4…20mA/HART®, PROFIBUS® PA, FOUNDATION™ fieldbus, PFS						
Approvals								

Radar level measurement

Micropilot

Non-contact measurement in liquids and bulk solids
Radar level measurement is a safe solution for liquids under extreme process conditions (pressure, temperature) and vapors. The development of this measuring principle led to its use in bulk solid applications, since it is unaffected by dust and noise.

Advantages at a glance

- Hard- and software developed according to IEC 61508 for SIL2 (Min./Max. range) respectively SIL3 (homogeneous redundancy)
- Highest process safety due to Multi-Echo Tracking evaluation
- Non-contact measurement, free of wear and tear, that can be used in extreme process conditions
- Vapors or dusty media have no affect on the measurement
- Safe measurement in vessels with changing product
- Reliable measurement due to advanced dynamics signal strength

Functional principle
Micropilot uses high-frequency radar pulses which are emitted from an antenna and reflected by the product surface. The Time-of-Flight t_0 of the reflected radar pulses is directly proportional to the path traveled **d**.

$$d = c \frac{t_0}{2}$$

c = speed of light 300,000km/s

Taking the tank geometry into consideration, the level can be calculated from this value.

Measuring frequencies
The frequencies used by radar instruments are approximately 6 and 26GHz.

26GHz
- Unaffected by tank baffles due to small beam angles starting at 4°
- High accuracy starting from ±2mm (0.08")

6GHz
- Lower impairment through strong condensate, build-up or foam

FMR51 FMR52

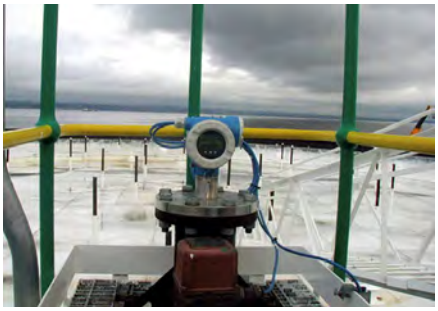
Micropilot in liquids
Two/four-wire radar level gauge for storage and process applications.
- Different antenna designs, suitable for aggressive media
- Flush fitting for hygiene applications
- Gastight feedthrough for toxic and aggressive media

FMR56 FMR57

Micropilot in bulk solids
Two/four-wire radar level gauge for powders and bulk solids.
- Parabolic antenna for large measuring ranges up to 70m (229ft)
- Integrated purging air connection
- Alignment device for adjustment to product surface
- Plastic antenna for simple solid applications up to 30m (98ft)

FMR532 FMR540

Micropilot S
Radar level device for precision measurement in inventory management (tank gauging).
- Accuracy better than 1mm (0.04") in 40m (131ft) measuring range
- Approved for custody transfer
- Numerous national calibration certificates
- Highest accuracy according OIML R85 and approved for custody transfer applications



		Micropilot							Micropilot S	
Type		FMR50	FMR51	FMR52	FMR53	FMR54	FMR56	FMR57	FMR530/532/533	FMR540
Measuring range	m/ ft	30/98 (optional 40/131)	40/131 (optional 70/230)	40/131 (optional 60/197)	20/65	20/65	30/98	70/230	40/131	
Temperature	°C °F	−40...+130 −40...+266	−196...+450 −321...+842	−40...+200 −40...+392	−40...+150 −40...+302	−196...+400 −321...+752	−40...+80 −40...+176	−40...+400 −40...+752	−40...+200 −40...+392	
Pressure	bar psi	−1...+3 −14.5...+43.5	−1...+160 −14.5...+2,320	−1...+16 −14.5...+232	−1...+40 −14.5...+580	−1...+160 −14.5...+2,320	−1...+3 −14.5...+43.5	−1...+16 −14.5...+232	−1...+64 −14.5...+928	−1...+16 −14.5...+232
Accuracy	mm	±2	±2	±2	±6	±6	±3	±3	±1	
Output		4...20mA/HART®, PROFIBUS® PA, FOUNDATION™ fieldbus							4...20 mA/HART®	
Approvals		Ex FM SP TIIS SIL Ü EHEDG 3A FDA PTB NMi GL ABS NK								

Ultrasonic level measurement

Prosonic

Non-contact measurement in liquids, pastes and bulk solids
The ultrasonic method is a tried and tested, as well as cost-effective, solution for level measurement in liquids and bulk solids. Instruments are available as compact or separate versions. This measuring principle is characterized by easy planning and assembly, fast and safe commissioning, a long service life and reduced maintenance costs. Typical applications include abrasive and aggressive media, even in rough ambient conditions, but also tasks in water and waste water engineering.

Functional principle
The Prosonic family works with ultrasonic pulses which are reflected from the medium surface by the density change between air and the medium. The time between transmission and reception of the pulse is measured and analyzed by the instrument and provides a direct value for the distance between the sensor membrane and the medium surface.

Advantages at a glance

- Unaffected by product properties, e. g. dielectric constant, density or moisture
- Easy and fast commissioning due to preset application parameters
- Calibration without filling or discharging

FMU30

FMU43 FMU41

FMU90 FMU95

FDU93 FDU91 FDU91F FDU90

Prosonic T
Two-wire device with compact design.
- For simple applications in open tanks and storage tanks

Prosonic M
Two-wire or four-wire device with compact design.
- For sophisticated level measurement in liquids and bulk solids in storage tanks, agitators, on stockpiles and conveyor belts

Prosonic S
Ultrasonic measuring system for demanding applications, consisting of a transmitter (in a top-hat rail or field housing) and a sensor.
- Level measurement
- Flow measurement in open channels
- Pump and screen control
- Monitoring of crushers and conveyor belts
- 1, 2, 5 or 10 sensors may be connected

			Prosonic T		Prosonic M					Prosonic S						
Type			FMU30		FMU40	FMU41	FMU42	FMU43	FMU44	FMU90 (1/2-Kanal) / FMU95 (5/10-Kanal)						
			1½"	2"						FDU90	FDU91	FDU91F	FDU92	FDU93	FDU95	FDU96
Measuring range	liquid	m	5	8	5	8	10	15	20	3	10		20	25		
		ft	16	26	16	26	32	49	65	9.8	32		65	82		
	solids	m	2	3.5	2	3.5	5	7	10	1.2	5		10	15	45	70
		ft	6.6	11	6.6	11	16	23	32	3.9	16		32	49	147	230
Temperature		°C	–20...+60		–40...+80					–40...+80	–40...+105		–40...+95		–40...+150	
		°F	–4...+140		–40...+176					–40...+176	–40...+221		–40...+203		–40...+302	
Pressure (abs.)		bar	0.7...3		0.7...3		0.7...2,5			0.7...4				0.7...3	0.7...1.5	0.7...3
		psi	10...43.5		10...43.5		10...37			10...58				10...43.5	10...22	10...43.5
Output			4...20mA		4...20mA/HART®, PROFIBUS® PA, FOUNDATION™ fieldbus					4...20mA/HART®, PROFIBUS® DP 1, 3 or 6 relays or up to 4 switch inputs						
Approvals																

Capacitance level measurement

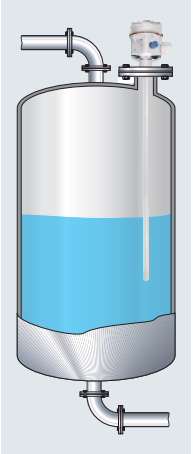
Liquicap

Continuous measurement in liquids
Capacitance level measurement covers a wide range of applications which are not limited to process engineering. Simple and cost-effective probes offer a wealth of possibilities for level monitoring in liquids, particularly in small tanks, build-up forming media and extremely high temperatures. Certain interface measurings can also be solved with capacitance probes.

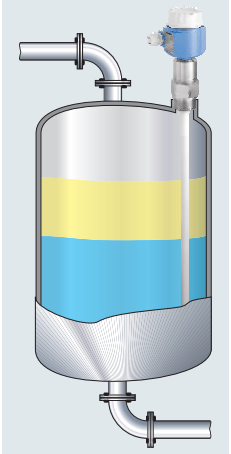
Advantages at a glance

- Accurate measurement in small tanks due to short response times
- Measurement from probe end to process connection, no blocking distance
- Technology tried and tested in millions of applications
- Interface measurement independent of emulsion layers

Functional principle
The principle of capacitance level measurement is based on capacity change. An insulated probe (rod or rope) and the tank form a capacitor whose capacitance depends on the product level: an empty tank has a low, a filled tank a high capacitance. The measured capacitance is proportional to the level.



Functional principle interface measurement
Media with a low dielectric constant (DC) cause very small changes of the capacitance value in level measurement while media with a high DC produce respectively large capacitance changes. In many interface applications, the medium with the lower DC is on top, e. g. oil on water. The upper medium provides only a minimum contribution to the overall capacitance value – only the water level (the interface layer) is thus issued as level.



FMI21

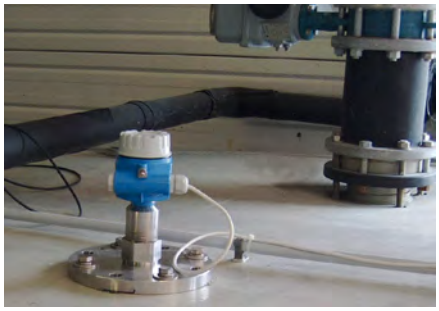
Liquicap T
Cost-effective continuous level measurement for conductive liquids from 30µS.

- Safe functioning unaffected by tank geometry
- Calibration not required (0% / 100% preset)
- Corrosion-resistant materials (e. g. carbon fiber)

FMI51 FMI52

Liquicap M
For continuous level measurement and interface measurement in liquids.

- No calibration for conductive liquids required
- Especially suited to small tanks (measurement from the tip of the probe to the process connection, fast measurement)
- Integrated build-up compensation provides stable measured values



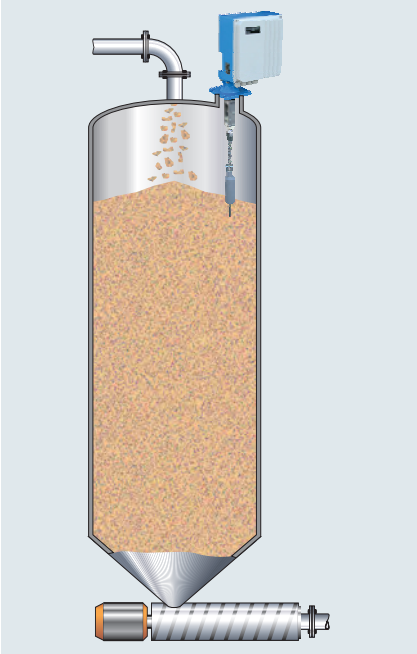
		Liquicap T	Liquicap M	
Type		FMI21	FMI51	FMI52
Design		Rod probe	Rod probe	Rope probe
Measuring range	**m** **ft**	2.5 8	4 13	10 32.8
Temperature	**°C** **°F**	–40...+100 –40...+212	–80...+200 –112...+392	–80...+200 –112...+392
Pressure	**bar** **psi**	–1...+10 –14.5...+145	–1...+100 –14.5...+1,450	–1...+100 –14.5...+1,450
Output		4...20mA	4...20mA/HART®, PFM	
Approvals				

Electromechanical level measurement

Silopilot

Measurement in bulk solids
Old seafarers used a weight on a rope to test the depth to the bottom of the sea. In industrial level measurement, the basic idea of sounding is still utilized in the electromechanical level system. Where other measurement methods are limited, applications involving bulk solids predominantly use electromechanical level measurements.

Functional principle
A sensing weight is let down on a measuring tape via a counter wheel. The tensile force of the weight is reduced as it hits the product surface. This is recognized, the direction of rotation of the motor reversed and the tape rewound. As the sensing weight moves downwards, the revolutions of the wheel are counted using a non-contact method. Every count pulse corresponds to a defined length. The level is obtained by subtracting this length from the overall length (tank height).



Advantages at a glance

- Tried and tested, reliable measurement up to 70m (230ft)
- Safe measurement in extremely dusty environments
- Robust system with high tensile force prevents breakdown due to an immersed weight
- Compact instrument with 4...20mA current output as well as additional freely programmable signal outputs (e. g. counting pulses, relays)

FMM20

Silopilot T
Low cost device for level measurement in bins or silos with dusty, fine-grained or coarse-grained bulk solids or in tanks with liquids.
- Process conditions up to 150°C (302°F) and 1.1bar abs. (16psi)
- Small design

FMM50

Silopilot M
Levels may be measured in bins or silos with dusty, fine-grained or coarse-grained bulk solids or in tanks with liquids.
- Process conditions up to 230°C (440°F) and 3bar abs. (43psi)

Sensing weights
Optimum adaptation to applications:
Normal weight, umbrella weight, bag, cage weight, oval float, bell weight

		Silopilot T	Silopilot M
Type		FMM20	FMM50
Measuring range	m ft	15/32 50/100	35/70 110/230
Temperature	°C °F	–20...+150 –4...+302	–20...+230 –4...+440
Pressure (abs.)	bar psi	0.8...1.1 12...16	0.8...3 12...40
Tensile force (N)		150	200/500
Output		4...20mA, 2 relays (option of 4 relays)	4...20mA, 2 relays (option of 6 relays)
Zulassungen		⟨Ex⟩	

Measured value display / instrument operation
Configuration is effected via a large 4-line plain text display that also indicates the current measured value.
- Fast, safe commissioning with menu guidance
- Manual start key

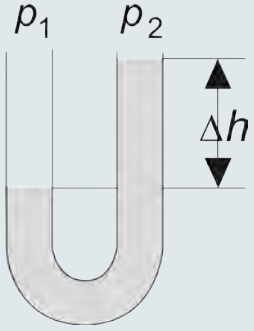
Hydrostatic level measurement

Waterpilot, Deltapilot, Deltabar

Level measurement in liquids
Hydrostatic pressure sensors for level measurement may be used in almost all liquid media, from water through to pastes and sludges. Even under difficult process conditions, these sensors may be adjusted to the application in an optimum fashion. Differential pressure transmitters are used for level measurement in pressurized tanks and also in abrasive and corrosive media.

Advantages at a glance

- Established measuring principle for temperatures up to 400°C (752°F) and pressures up to 400bar (5,800psi)
- Easy engineering
- Unaffected measurement with tank baffles or surface foam
- Hygiene instrument designs



Functional principle
Hydrostatic level measurement is based on the determination of hydrostatic pressure generated by the height of the column of fluid. The pressure is calculated on basis of the following formula:
P = h*ρ*g
P = Pressure
h = Level
g = Gravity (constant)
ρ = Specific weight (density)

In constant medium density, the height (h) is the only variable in this equation.
The pressure is thus a direct level measurement. Hydrostatic pressure sensors either consist of a dry capacitive measuring diaphragm of ceramics or a piezoresistive sensor with a metal diaphragm.

Waterpilot
Rode probe for level measurement in fresh water, waste water, saltwater.

- Robust housing with probe diameters of 22/29/42mm (0.9/1.2/1.7")
- High accuracy
- Integrated temperature sensor
- Materials conforming to potable water requirements

Deltapilot
Contite measuring cell – waterproof, condensate-resistant, high long-term stability.

- Hygienic instrument design for foods and pharmaceuticals
- Safe two-chamber housing
- Reliable measurement at temperature changes
- Compact-, as well as rod and rope version

Deltabar
Applications in pressurized tanks, e. g. in the chemical and petrochemical industry.

- Robust sensor technology with high overload resistance
- High accuracy and long-term stability
- Fault and performance monitoring from the measuring cell through to the electronics

		Waterpilot	Deltapilot					Deltabar				
Type		FMX167/FMX21	FMB50	FMB51	FMB52	FMB53	FMB70	PMD55	PMD75	FMD72	FMD77	FMD78
Measuring range	**bar**	0.1...20	0.1...10					up to 40		up to 10	up to 16	up to 40
	psi	1.5...300	1.5...150					up to 600		up to 150	up to 240	up to 600
Temperature	**°C**	–20...+70	–10...+80				–10...+135	–40...+120	–40...+125		–70...+400	
	°F	–4...+158	14...176				14...+275	–40...+248	–40...+257		–94...+752	
Sensor		Ceramics	Contite (Metal)					Metal				
Accuracy (%)		0,2 (option of 0.1)	0,2 (option of 0.1)				0.1	0.1 (option of 0.075)	0.075 (option of 0.05)	*up to 0.05 **up to 0.07	0.075 (option of 0.05)	
Output		4...20mA, 4...20mA/HART®	4...20mA/HART®, PROFIBUS® PA, FOUNDATION™ fieldbus									
Approvals		Ex FM CSA TIIS PED SIL Ü KTW EHEDG 3A FDA NSF										

* Single sensor ** System

Vibronic level measurement

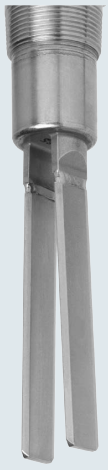
One measuring principle for many different applications

Point level detection has become an indispensable variable in process engineering. Float switches, capacitance, inductive, radiometric and ultrasonic switches are among those used for this purpose. The application and medium limitations of purely mechanical or purely electronic systems prompted Endress+Hauser to combine both systems into one measuring principle – the vibronic point level switches for liquids and bulk solids. State-of-the-art development tools such as the Finite Element Method, new production technologies and constant development have made a mechatronic success story of these point level switches.

A new field of application of vibronic is the measurement of density and concentration. That's how variety of the principle proves it self once again.

Technology
Mechanically oscillating systems excited to their resonant frequency are generally used as vibronic point level switches. For example, this may be a tuning fork forming an electromechanical resonator, along with electronics and a piezoelectric crystal.

Point level switches for liquids register the frequency shift which occurs as the fork is submerged in liquid.
The frequency change of the fork – which is analog to the density of the medium – is also converted into density and concentration information.



In point level switches for bulk solids, damping of the oscillation is recognized and a switching signal is issued if it falls below a certain amplitude.

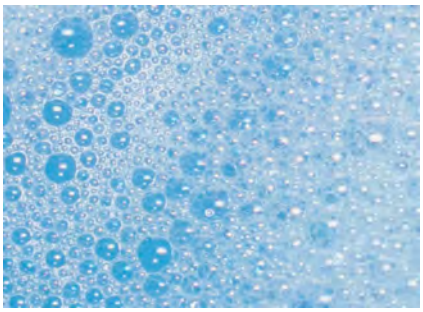
Advantages at a glance

- Reliable in more than 3.5 million applications worldwide
- Safe operation due to mechatronics
- May be used in all industries independent of media

Universal in any medium

With the invention of the vibronic principle more than 40 years ago, Endress+Hauser pointed the way to the future for safe and reliable level monitoring worldwide. Within a very brief period of time, the Liquiphant and Soliphant ranges became classics. More than 3.5 million measuring points globally underline the competence and know-how in point level detection in bulk solids and liquids. Quality and the highest degree of application safety are the mainstay of Endress+Hauser.

Universally applicable
- in changing media



Universally applicable
- in the presence of air bubbles and foam (foam is not recognized as liquid)
- for the detection of solids under water

Universally applicable
- in all pumpable liquids up to a viscosity of 10,000mm^2/s (cSt)
- because of the independence of flow properties of bulk solids

Bimorph or stack drive, the heart of the Endress+Hauser vibronic point level switch

In any industry
A decisive advantage of the vibronic principle is its mode of operation. Point levels are recognized and remain unaffected by the physical properties of the medium such as conductivity, dielectric constant, viscosity, changes in density, pressure or temperature. In addition, turbulence, foam or bubbles do not impair the operation. These unique performance features allow Liquiphant and Soliphant to be used in all process engineering industries.

The most important industries include
- Chemical/Petrochemical industry
- Pharmaceuticals/Life Sciences
- Foods
- Environment
- Energy
- Primaries

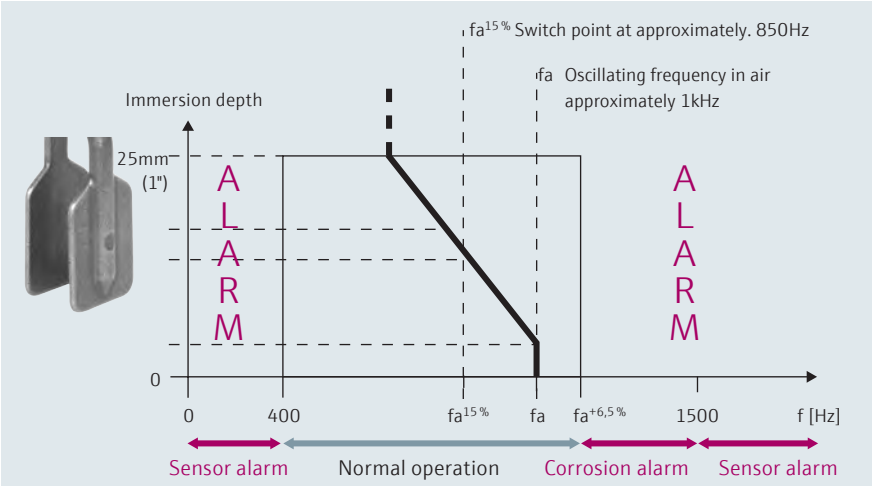
By choosing vibronic point level switches, the process benefits from having no mechanical moving parts and calibration is not required. Together with integrated automatic monitoring, this leads to a system which has gained recognition in process automation because of its reliability.

Vibronic level measurement

Permanent self-monitoring

Intelligent sensor without calibration
Compared to other measuring principles such as conductivity probes or float switches, Endress+Hauser's vibronic point level switches offer a decisive advantage – frequency analysis. This provides automatic self-monitoring of the oscillating system. A change in frequency beyond a permitted value indicates an irregularity in the oscillating system, e. g. corrosion or build-up. The instrument then switches in a safety-oriented manner. All of the Liquiphant and Soliphant M range incorporate this feature.

Each oscillating system has its own characteristic frequencies. These specific instrument parameters must be available during the entire period of operation, if required. Intelligent, electronic components are firmly coupled to the oscillating system and safeguard the availability of these parameters at any time. As electronics are exchanged, the new electronics are automatically informed on the parameters of the oscillating system. The instrument is self-calibrating. Time-consuming, manual instrument calibration, e. g. by potentiometer, is unnecessary.



Advantages at a glance

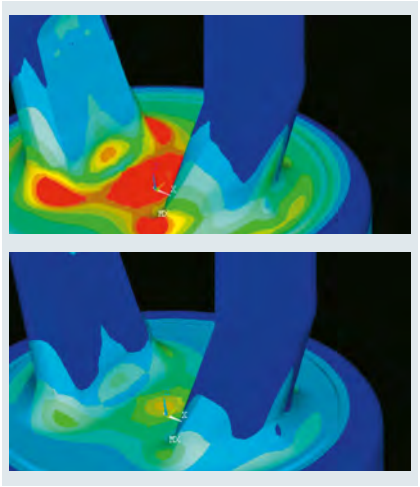
- Safety-oriented switching without calibration – also in case of an error
- Frequency monitoring and thus, automatic monitoring is included in every Liquiphant or Soliphant M instrument

Build-up on the fork

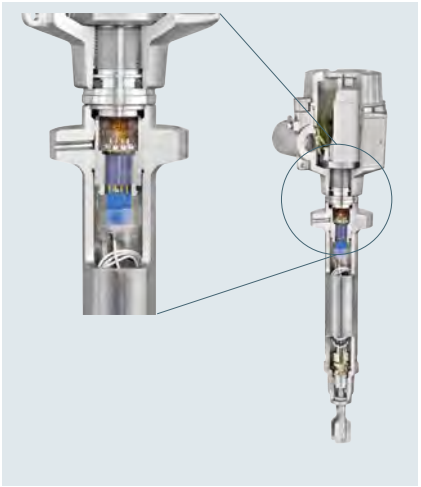
Corrosion of the fork

Competence in liquids

Safe measurement in demanding applications



Above: Limit load of mild steel
Below: Stability in duplex steel
(Liquiphant S HT)



Liquiphant S - cut model with gastight glass feedthrough

Increased process temperatures

Point level measurement at process temperatures up to 280°C (536°F) – or 300°C (572°F) for maximum 50 hours – do not present any problems for Liquiphant S FTL70/71! In process temperatures above 200°C (392°F), the requirements of materials and the development of instruments increase drastically. Extreme requirements can only be realized by careful selection of suitable materials using innovative technologies and load simulation. Perfectly matched materials are required for permanent and reliable performance in extreme temperature fluctuations.

Hygiene design

The food and life sciences industries place high demands on plants and instruments. A hygiene design, suitable materials and good cleanability are important basic prerequisites. International and national guidelines, norms and standards control the requirement of such plants and instruments.
The point level switches of the Liquiphant hygiene line cope with these challenges. Electropolished and degreased surfaces, aseptic process connections, easy cleanability of housing and sensor (CIP/SIP), approved materials – the hygiene line meets these requirements in every respect.

3.1 Certified materials

Process safety and traceability are important pillars in all hygiene processes. Therefore, Endress+Hauser offers the option of certified material qualities for all parts in contact with the process, i.e. sensors and welding accessories. A 3.1 material certificate according to EN 10204 confirms the composition of materials. Different sealing materials are also available for welding accessories.

Second line of defense

Liquiphant can be equipped with a mechanical second line of defense. The process connection, usually a thread or flange, separates the process atmosphere (temperature, pressure, aggressiveness, toxicity) from the environment. Passive faults, for example localized corrosion or mechanical damage of the tuning fork, may cause leaking toxic process media.
A pressure or gas-diffusion-tight feedthrough prevents this safely and reliably as a second line of defense. The Liquiphant second line of defense is a glass seal set in metal. It ensures the electrical connection to the fork drive and is arranged behind the process connection in a pressure-tight (O-ring) or even diffusion-tight (welded) manner.

Vibronic level measurement

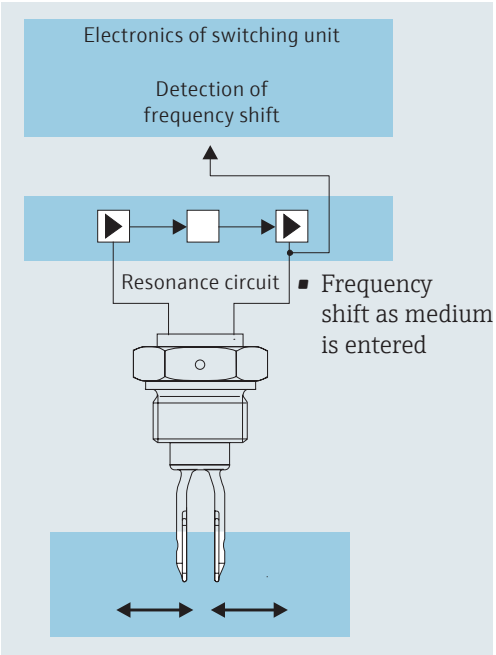
Liquiphant

Point level detection in liquids
The instruments of the Liquiphant family reliably monitor the point level of all pumpable liquids in tanks and pipes. There are numerous applications from simple operational point level detection (minimum and maximum control), certified leakage monitoring and overfill prevention through to protective equipment in plant parts subject to Safety Integrity Levels (SIL2/3).

Advantages at a glance

- Universal use – unaffected by medium properties such as conductivity, dielectric constant, viscosity, pressure and temperature
- Free of calibration and maintenance
- Functional safety SIL2/3
- Accurate switch-point

Functional principle
A tuning fork sensor oscillates at its resonant frequency. The drive works piezoelectrically. The oscillating frequency changes as the fork enters the medium. The change is analyzed and translated into a switching signal.



FTL20

FTL20H

Liquiphant T
Compact instrument for simple and hygienic applications.
- Very small instrument dimensions
- Hygienic stainless steel design
- External function testing

FTL50

FTL51

FTL51C

FTL50H

FTL51H

Liquiphant M
Diverse instrument variants in a modular system.
- Different construction lengths, process connections, housings
- Numerous electronic interfaces
- Functional safety SIL2/3
- Density measurement

FTL70

FTL71

FTL80

Liquiphant S
For the highest process requirements and safety.
- Process temperatures up to 280°C (536°F)

Liquiphant FailSafe
- Proof test may be omitted for up to 12 years
- Functional safety SIL3

		Liquiphant T		Liquiphant M			Liquiphant S	Liquiphant FailSafe
Type		FTL20 Process	FTL20H Hygiene	FTL50/51 Process	FTL51C Coated	FTL50H/51H Hygiene	FTL70/71 Process	FTL80/81/85 Process
Design		Compact		Compact/ rod extension	Rod extension	Compact/ rod extension	Compact/ rod extension	Compact/ rod extension
Temperature	°C	–40...+150		–50...+150			–60...+280	–60...+280
	°F	–40...+302		–58...+302			–76...+536	–76...+536
Pressure	bar	–1...+40		–1...+64/+100	–1...+40	–1...+64	–1...+100	–1...+100
	psi	–14.5...+580		–14.5...+930/+1,450	–14.5...+580	–14.5...+930	–14.5...+1,450	–14.5...+1,450
Process connections		G ½", ¾", 1"		G ¾", 1", Flange DIN/EN, ANSI, JIS				G 1", Flange DIN/EN, ANSI, JIS
Wetted parts		316L/1.4435		316L/1.4435 Alloy C22	Coating ECTFE, PFA, Enamel	316L/1.4435	316L/1.4435 Alloy C22	316L/1.4435, 318L/1.4462, Alloy C22, coating ECTFE, PFA, Enamel
Output		AC, DC, ASi-Bus		AC, DC, AC/DC relay, NAMUR, 8/16mA, PFM, PROFIBUS® PA				4...20mA + LIVE_Signal
Approvals								

Vibronic level measurement

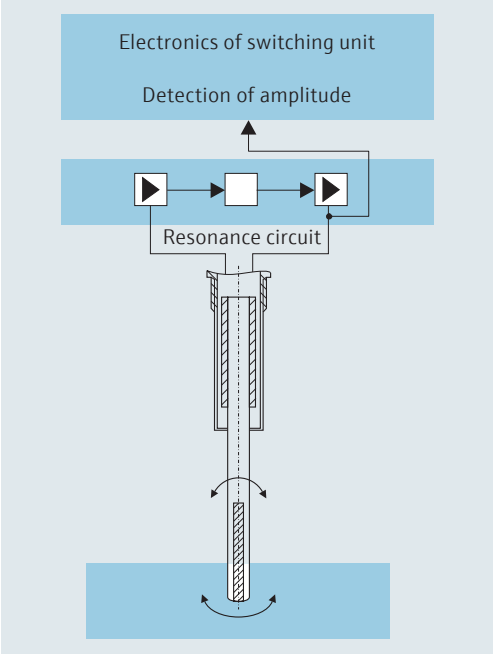
Soliphant

Point level detection in bulk solids
The Soliphant range offers robust point level switches for applications in powdery, fine-grained and lumpy bulk solids and solids with low density, e. g. caused by fluidizing. The different designs allow application diversity – Soliphant can even be used in hazardous areas. Typical examples are found in primaries (cement, plaster), the chemical industry (plastic granules, detergents), the food industry (flour, sugar) and animal feed production (wheat, corn).

Advantages at a glance

- Universal use – independent of the medium
- No mechanically moved parts – free of maintenance, no wear and tear
- Easy, fast commissioning (no calibration required)
- Permanent self-monitoring
- Build-up and abrasion monitoring

Functional principle
A single-rod or fork oscillating system is used as sensor in the Soliphant family. The oscillating system (single rod/fork) is excited to its resonant frequency. The oscillation amplitude is damped as the product covers the sensor.
Maintenance and calibration or specific settings are not required. External vibration or flow properties of the medium do not impair measurement.



Soliphant T
Compact single-rod sensor or with tube extension.
- No adjustment, simple commissioning
- Unaffected by external vibration and build-up

Soliphant M
Diverse instrument variants combined into a modular system.
- Different construction lengths (tube, rope version)
- Process connections, housings
- Numerous electronic interfaces
- Option of polished and coated sensor surface (protection against corrosion, abrasion or build-up)
- Special designs

Further applications
- Filling nozzle disconnection at a loading station
- Solids detection under water

		Soliphant T		Soliphant M		
Type		FTM20	FTM21 (tube extension)	FTM50	FTM51 (tube extension)	FTM52 (rope extension)
Sensor length	**mm** **inch**	250 9	500/1,000/1,500 20/40/60	145/200 5.7/8	300...4,000 12...160	750...20,000 30...800
Temperature	**°C** **°F**	–40...+150 –40...+302		–50...+280 –60...+540		–40...+80 –40...+170
Pressure	**bar** **psi**	–1...+25 –14.5...+360		–1...+25 –14.5...+360		–1...+6 –14.5...+87
Bulk density	**g/l** **lbs/ft³**	From 200 From 12		From 10 From 0.6		
Output		DC-PNP, AC/DC relay		AC, DC, AC/DC relay, 8/16mA, NAMUR, PFM		
Approvals						

Capacitance level measurement

Minicap, Nivector, Solicap, Liquicap

Point level detection in liquids and bulk solids
Capacitance level measurement covers a wide range of applications which are not limited to process engineering. Simple and cost-effective probes offer many possibilities for point level detection in liquids and bulk solids. This measuring principle is particularly suited to applications involving aggressive media and heavy build-up.

Advantages at a glance

- Tried and tested technology
- Universally adaptable probes
- Reliable performance also in viscous media or heavy build-up

Functional principle
The capacitance level measurement principle is based on the capacity change of a capacitor due to a change in level.
The probe (rod or rope) and the silo wall form the two electrodes of a capacitor. As product enters the electric field between the probe and the silo wall, the capacity increases. This capacity change is analyzed and leads, with the appropriate setting, to switching.

The sensors are largely unaffected by low build-up formation as long as the product does not create a bridge between the probe and the silo wall. Probes with active build-up compensation are used for media prone to strong build-up.

FTC968

FTC260

Nivector, Minicap
Preferred in small tanks with powdery to fine-grained bulk solids.
- Calibration not required
- Small, compact design
- Easy sensor exchange in full silo by protector
- Integrated active build-up compensation

FTI55

FTI56

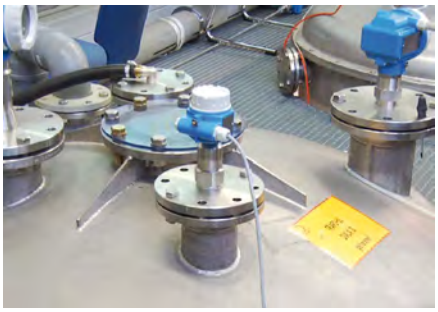
FTI77

Solicap M/S
Robust instrument design for fine-grained to coarse-grained bulk solids.
- Build-up compensation
- High tensile loads up to 60kN for rope probes
- High lateral loads up to 800Nm for sword probes
- Process temperatures up to 400°C (752°F)

FTI51

FTI52

Liquicap M
Modular probe system for applications in highly viscous liquids.
- Temperatures from −80°C up to +200°C (−112°F to +392°F)
- Reliable point level detection due to active build-up compensation
- Interface detection
- Two-point control (pump control)



		Nivector	Minicap		Solicap M		Solicap S	Liquicap M	
Type		FTC968	FTC260	FTC262	FTI55	FTI56	FTI77	FTI51	FTI52
Design		Compact	Compact	Rope probe	Rod probe	Rope probe	Sword probe / rope probe	Rod probe	Rope probe
Sensor length	mm	Flush mounted	140	500...6,000	200...4,000	500...20,000	200...1,000 sword 500...20,000 rope	100...6,000	420...12,000
	inch		5.5	20...236	8...157	20...790	8...40 sword 20...790 rope	4...236	16.5...472
Temperature	°C	−20...+80	−40...+120	−40...+80	−50...+180		−50...+400	−80...+200	
	°F	−4...+176	−40...+248	−40...+176	−58...+356		−58...+752	−112...+392	
Pressure	bar	−1...+6	−1...+25	−1...+6	−1...+25		−1...+10	−1...+100	
	psi	−14.5...+87	−14.5...+363	−14.5...+87	−14.5...+363		-14.5...+145	−14.5...+1,450	
Output		DC, AC	DC, AC/DC relay		DC, AC/DC relay, 8/16mA, PFM, 2-wire, 3-wire, NAMUR			DC, AC/DC relay, 8/16mA, PFM, 2-wire, 3-wire, NAMUR	
Approvals		IECEx, Ex NEPSI, TIIS, SIL, Ex, FM APPROVED, SA, EHEDG, A3, Ü, FDA, GL							

Conductive level measurement

Liquipoint

Point level detection in liquids
The conductive measuring principle offers the possibility for simple, safe detection of a limit value in conductive liquids. The measuring principle performs well for a wide range of applications, from secure inventories (minimum quantity) and the avoidance of tank overflow through to two-point and multi-point control (pump control).

Functional principle
A change in resistance between two conductors (electrodes) due to the presence or absence of a medium leads to a switching signal. In single-rod probes, the metallic tank wall serves as a counter electrode. If the probe is not covered, the resistance between probe and wall is theoretically infinite. As the medium covers the probe (conductive connection to the tank), the resistance assumes a finite value. A current flows and is translated into a switching signal. The smallest medium conductibility which can be calibrated amounts to 5µS/cm.

Liquipoint
Modular probe system for optimum adaptation to the application.
- 1 to 5 rod and rope probes
- Compact or separate instrumentation
- Flush mounted solution for pipes

Advantages at a glance

- Simple, cost-effective measuring principle
- Multi-point detection with one process connection
- Liquid food applications with FDA-compliant materials

		Liquipoint		
Type		FTW31 rod	FTW32 rope	FTW33
Measuring range	mm inch	100...4,000 4...157	250...15,000 10...590	Flush mounted
Temperature	°C °F	−40...+100 −40...+212		−20...+150 −4...+302
Pressure	bar psi	−1...+10 −14.5...+145		−1...+25 −14.5...+362.5
Process connections		G 1½"		Hygiene
Output		DC, AC/DC relay, NAMUR, switching unit FTW325		DC-PNP
Approvals		Ex Ü FDA		EHEDG 3A

Float switch

Liquifloat

Point level detection in liquids
This measuring principle is a simple and cost-effective procedure for point level detection in liquids. It is predominantly used as a level alarm in open basins, e. g. in sewerage treatment plants.

FTS20

Liquifloat
Different sensor/cable materials, e. g. PP, PVC, PUR and CSM, allow application in oily or aggressive liquids, and it can also be used in hazardous areas.

Functional principle
The tilting motion of the switch as it floats up and down on the surface of the liquid is detected by an integrated switch and triggers the switching operation. The float switch has two output options, a NAMUR switching signal or a change-over contact.

Advantages at a glance

- Simple and cost-effective
- Different connection cables for specific liquids

		Liquifloat T
Type		FTS20
Temperature	°C °F	–20...+85 –4...+185
Pressure	bar psi	3 43.5
Medium density	g/cm³	From 0.8
Output		NAMUR, change-over contact
Approvals		Ex

Paddle switch

Soliswitch

Point level detection in bulk solids
The universally usable paddle point level switch is employed as a full, empty and requirement alarm in silos with bulk solids. It is ideal for flowing bulk solids up to a grain size of 50mm (2").

Functional principle
The principle is based on the moment of resistance change of a rotating paddle in air or a medium. The electrically driven, slowly rotating paddle (frequency = 1Hz) is on the level of the selected limit. The rising product brakes the rotation, the hinge-mounted drive system changes its position and triggers a microswitch. As the level moves down, the drive returns to its original position by spring force and the microswitch restarts the motor.

Soliswitch
Diverse instrument designs allow for use under different application conditions.
- Slip clutch prevents impact on the paddle

Advantages at a glance

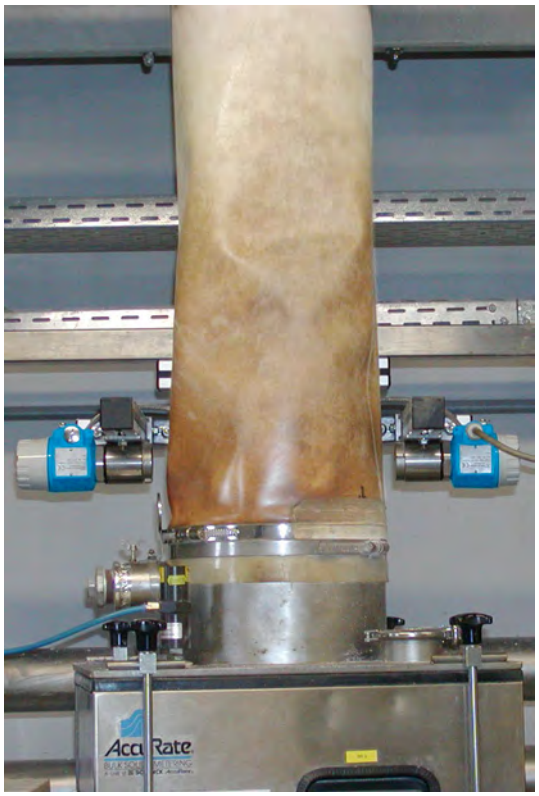
- Automatic rotation monitoring (optional)
- Recognition of failures without dismantling the instrument
- Easy installation
- Robust plastic housing with transparent cover
- Cover securing device
- Density setting without any tools

		Soliswitch
Type		FTE20
Sensor length	mm inch	75...2,000 2.8...79
Temperature	°C °F	–20...+80 –4...+176
Pressure	bar psi	–0.5...+1.8 –7...+26.1
Process connections		1½" (G, NPT), 1¼ NPT, ¾ G
Output		Potential-free change-over contact
Approvals		FM APPROVED, SA, Ex

Microwave barrier

Soliwave

Non-contact point level detection in bulk solids
In many cases where contact methods are limited, microwave barriers are the appropriate solution. They avoid jamming, indicate point levels, solve positioning and counting tasks, provide non-contact measurement and are thus, free of wear and tear. Typical products to be measured are wood chips, paper and carton chips, lime, pebbles, sand or even bags and complete boxes.



FQR56 FDR56

Soliwave
Soliwave detects from outside through a tank wall that can be penetrated by microwaves or through a window. Therefore, it is immaterial whether bulk solids are granulated, as light as feathers, abrasive, aggressive, powdery or come in large lumps.

- Unaffected by process conditions
- Applications in hazardous area (dust)

Functional principle
The absorption of microwaves is used for the supervision of limit values in microwave barriers. The microwave emitter and receiver form a radiation barrier. A narrow beam runs through the tank on the level which is to be monitored. As soon as the medium enters the radiation area, the microwave signal is damped so that only a small part reaches the receiver. This is recognized and used for triggering the switching signal. This is true, on principle:
High density = high damping
Low density = low damping

Advantages at a glance

- Adjustable sensitivity
- Flush mounted, non-contact measurement
- No wear and tear or maintenance with long service life
- Easy installation and commissioning
- Indication of the signal strength
- Automatical adjustment function
- On-site display and simulation

		Soliwave	
Type		FQR56/FDR56	
Measuring range	**m** **feet**	0,3...100 1...328	(distance emitter-receiver)
Temperature	**°C** **°F**	-40...+70 -40...+158	in direct installation, otherwise as desired
Pressure absolute	**bar** **psi**	0,5...6,8 7...98	in direct installation, otherwise as desired
Process connections		R 1½", 1½" NPT, assembly clamps, flange	
Output		- Potential-free change over contact - Solid-State-Relais - 4...20mA	
Approvals		Ex	

Radiometry

Gammapilot

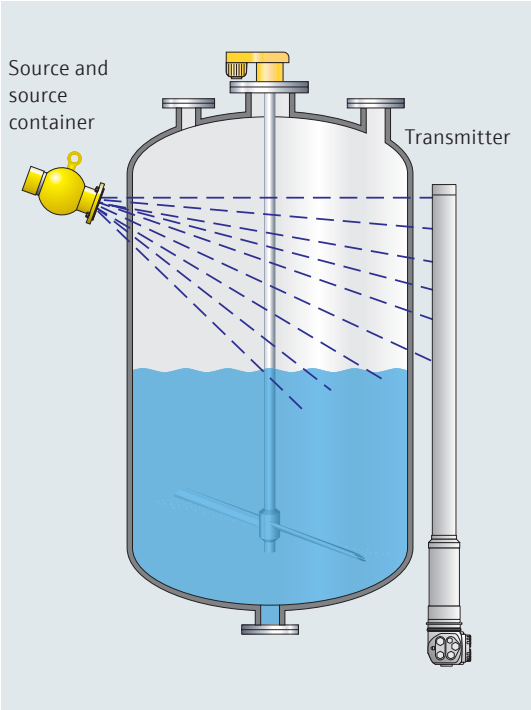
Point level detection, level, density and interface measurement
As early as 1962, the first Endress+Hauser radiometric measuring lines were launched. Since then, five decades have passed and this measuring principle is still providing decisive advantages. Radiometric instrumentation is used where other measuring principles fail due to extreme process conditions or because of mechanical, geometric or construction conditions.

Advantages at a glance

- Four measuring tasks in one measuring principle
- Non-contact, external measurement for the highest degree of safety and reliability under the most extreme process conditions
- Functional safety according to SIL2/3 and IEC 61508
- Standardized communication via HART®, PROFIBUS® PA or FOUNDATION™ fieldbus
- Overfill prevention WHG

Functional principle
The gamma source, a caesium or cobalt isotope, emits electromagnetic radiation which is attenuated as it passes through materials. A transmitter is mounted on the opposite side of the tank or pipe which converts the radiation received into an electric signal. The intensity of this signal is essentially determined by the source – transmitter distance as well as the existing material thickness and its density.
The actual measurement effect results from the absorption of radiation by the product to be measured:

- In applications involving level or point level – by total absorption through the product
- In density and interface measurement - by changes in absorption. In maximum density, part of the radiation still reaches the transmitter.



FQG61/
FQG62

Source in the source container
Different source intensities (activities) are available for various applications. The source is installed in the source container. Different overall dimensions provide optimum radiation protection.

FQG60

QG2000

Comparison of source sizes

FHG65

Gamma-Modulator FHG65
For effective suppression of background and extraneous radiation (e. g. from non-destructive materials testing). The Gammapilot M can separate useful signals from interference radiation by its modulated radiation. This enables continuing measurements which increases plant availability and releability.

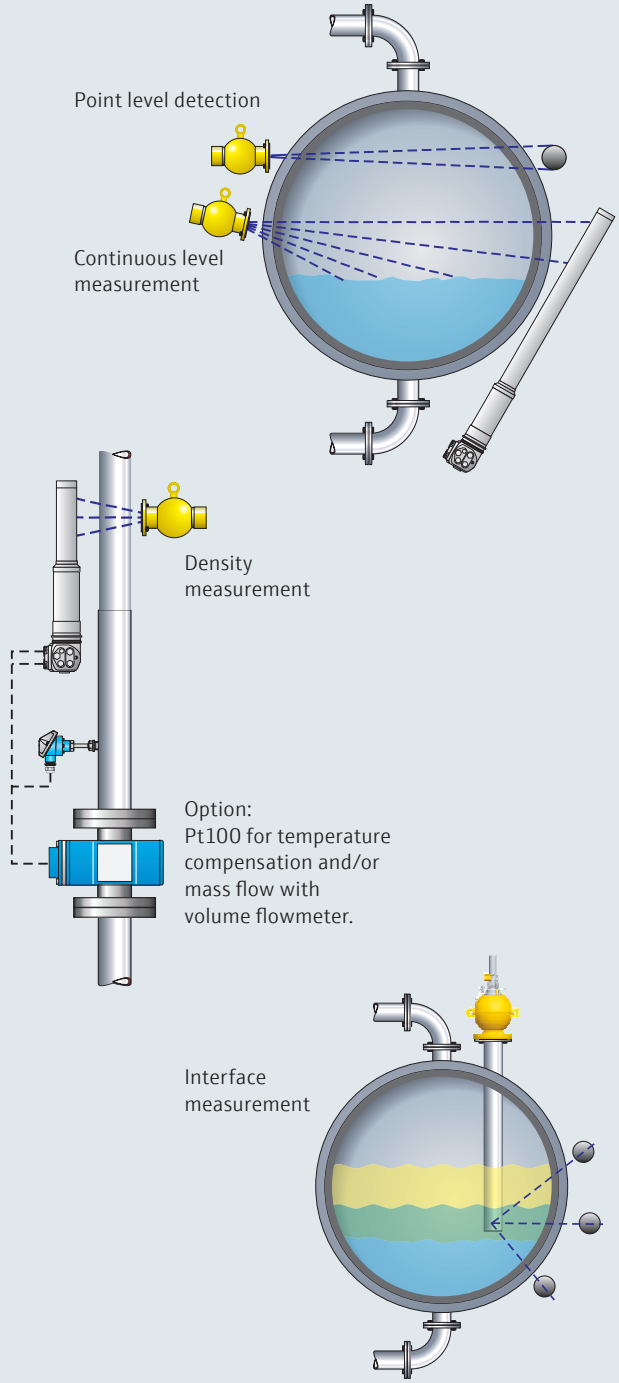
FTG20

Gammapilot FTG20
Radiometric point level detection with easy alignment. The transmitter doesn´t need a external reader and convinces with separate electronic-housing with simple commissioning on-site without complex installations at the tank.

FMG60

Gammapilot M FMG60
The variable transmitter concept with Nal crystal or plastic scintillators in different lengths guarantees optimum adaptation to individual applications. The transmitter contains a scintillator, photomultiplier and evaluation unit.

Measuring tasks



	Gammapilot M		
Type	FMG60		
Sensor length or measuring range (mm)	Density 50 2"	Point level 200/400 8/16"	Level / interface 400...2,000 / 16...80" with cascade mode as desired
Temperature	No limitation (noninvasive, extraneous)		
Pressure	No limitation (noninvasive, extraneous)		
Output	4...20mA/HART®, PROFIBUS® PA, FOUNDATION™ fieldbus, pulses for cascade mode		
Approvals			

Support through competence – from planning to realization

- Comprehensive consultation by our Gamma Project Team specialists
- Source and activity calculation using Applicator, Endress+Hauser's selection and sizing tool

Density / Concentration

Vibronic – Liquiphant M Density

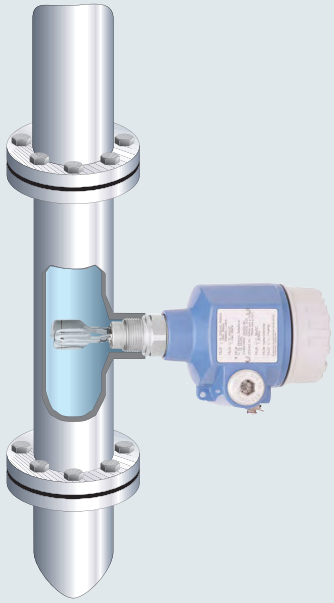
Quality measurement in liquids
With an individual developed electronic, the process approved vibronic principle is usable for density measurement. Overdosing preliminary, interim and final products, determining the exact density or concentration, monitoring quality and controlling process – all these activities constitute a reason for the density measurement of the medium. Using the vibronic principle, Endress+Hauser offers you the possibility of determining density and concentration in a simple and fast manner across industries.

Advantages at a glance

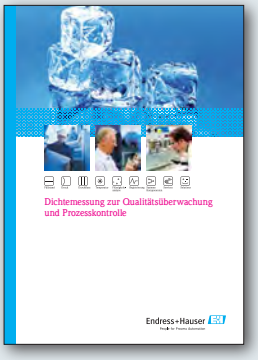
- Costly laboratory avoid
- Process monitoring and controlling in situ and online
- Complying with tolerances is to increase quality
- Industry independent
- Any unit you require (°Plato, °Brix, °Baumé,...)

Functional principle

A sensor in form of a tuning fork is excited on its resonance frequency. The drive works piezoelectrically. The oscillating frequency changes in liquids.
Different media has different density / concentration, therefore, we have different oscillating frequencies. Those signals will be evaluated and converted into quality information by Liquiphant M Density.



More information you can find in the brochure:
Density Measurement for Quality Monitoring and Process Control (CP00024F/00/EN)



Density measurement for quality monitoring and process control

	 Liquiphant M	 Coriolis – Promass	 Radiometry – Gammapilot M
Advantages	▪ Large number of process connection to choose from: universal usage ▪ Useable in hygienic applications ▪ Calculation of customer specific units e.g °Brix, °Plato, °Baumé etc. possible ▪ Up to 5 Liquiphant density sensors can be connect to the density computer FML621	▪ Maximum process dependability, because density, temperature and mass flow are all measured directly ▪ Approval for custody-transfer applications ▪ No maintenance necessary	▪ Straightforward retrofitting without process interruption; the pipes do not have to be opened ▪ No maintenance necessary ▪ Can be used in Newtonian as well as in Non-Newtonian fluids/media
Installation options	Direct in tanks and pipes	Direct measurement in the pipe	From outside through the pipe, in the bypass or tank
Process temperature	0…+80°C/32…+176°F	-50…+200°C/-58…+392°F (-200…+350°C/-328…+662°F optional)	Independent
Process pressure	25bar/363psi	400bar/5,800psi	Independent
Accuracy	0.002g/cm³	0.0005g/cm³	±0.001g/cm³
Reproducibility	0.0007g/cm³	0.00025g/cm³	±0.0005g/cm³
Units of density	Norm density, °Brix, °Baumé, °Plato, Volumen%, concentration etc. with 2D and 3D tables. Formula editor to calculate customer specific units	Standard density, standard volume flow and totalizing, % mass, % volume, alcohol tables (for mass and volume), target flow and carrier flow, °Brix, °Plato, °Baumé, °API, etc.	g/cm³, g/l, lb/gal, concentration, % mass, °Brix, °Baumé, °API, etc.
Output/ communication	4…20mA, relay, Ethernet, PROFIBUS®	4…20mA, HART®, PROFIBUS® PA/DP, FOUNDATION™ fieldbus, MODBUS	4…20mA, HART®, PROFIBUS® PA, FOUNDATION™ fieldbus
Approvals	ATEX, FM, CSA, IECEx, TIIS, NEPSI, 3A, EHEDG, CRN, FDA	ATEX, FM, CSA, TIIS, SIL2, 3A, EHEDG, IECEx	ATEX, FM, CSA, IECEx, TIIS, NEPSI
Additional information	Connect of temperature- and pressure transmitter for compensation	Approvals for applications in custody transfer (PTB, NMI, EAM/METAS, BEV)	With interface for a Pt100 temperature sensor for temperature compensation
Application limits	▪ Gas bubbles or build-up at the sensor fork ▪ Fluid velocity > 2m/s in pipes ▪ Liquids with high viscosity > 350mPa·s	▪ Not for non-homogeneous mediums ▪ Only for pipe diameters up to DN 250	▪ Not with degasification in the medium

Interface measurement

Separate the best from the rest

Interface measurement for any application
Your application is of prime significance because the instrument serves the application and is only selected once the general setting is known. You get the optimum interface measurement solution in relation to your process requirements from us.

Precise interface measurement is important in continuous and dynamic processes. Is the overall level constant or variable, and if so, in which range? Should the overall level be available as a measured value in addition to the interface measurement. Does emulsion occur during measurement?
The answers to such questions have a strong influence on the correct selection of instrumentation. We offer you transparency in relation to options, application limits and commissioning of the individual measuring principles. Guided radar, multiparameter, capacitance instrumentation or radiometry – we support you in your application.

Functional principles

Guided radar
As the pulses impact the medium surface, only part of the sending pulse is reflected. Especially in media with a low dielectric constant (DC), the other part penetrates the medium. As the signal enters the lower medium with a higher dielectric constant (DC) it is reflected once more. Taking the delayed Time-of-Flight of the pulse through the upper medium into consideration the distance to the interface is determined in addition.

Multiparameter
The name of the innovation in interface measurement is FMP55 Multiparameter. This instrument combines the advantages of the capacitance and guided radar measuring principles. Emulsion layers may cause signal losses in interface detection in guided radar measurements. Only Levelflex FMP55 Multiparameter can guarantee safe measured values for both the interface and the overall level with this unique, redundant measuring system.

Capacitance
Media with a small dielectric constant (DC) cause very small changes of the capacitance value while media with a high DC produce respectively large capacitance changes in level measurement. In many interface applications, the medium with the smaller DC value is on top, e.g. in hydrocarbon on water. The upper medium merely provides a minimum contribution to the overall capacitance value – the issued level thus only refers to the water level (the interface).

Radiometry
The gamma source which is usually installed inside the tank emits radiation which is attenuated as it penetrates the container wall and the medium. Outside of the container, a detector converts the radiation received into an electric signal. The measuring effect results from the fact that different interfaces absorb (attenuate) the radiation differently. If the transmitter has been calibrated to the media by wet calibration once, a correlation to the measurement of the interface results automatically.

The application determines the sensor

Measuring task	Measuring principle	Features / Advantages	Application limits / Conditions
 ▪ Clear interface liquid / liquid	**Guided radar** Levelflex FMP51/52/54 	▪ Simultaneous acquisition of interface layer and total level if clear interface ▪ No wet calibration required ▪ Not affected by the density of the medium ▪ Applications up to 450°C / 400bar (842°F / 5,800psi) ▪ Probes can be shortened (rod/rope)	▪ DC of the upper medium may be max. 10 ▪ Difference of the DCs between the two media must be > 10 ▪ Emulsion layer up to max. 50mm (2") allowable ▪ For interface measurement, the thickness of the upper phase must be min. 80mm (3.15")
 ▪ Clear interface liquid / liquid ▪ Interface with emulsion layer liquid / liquid	**Multiparameter** Levelflex FMP55 	▪ Simultaneous acquisition of interface layer and overall level, also in case of emulsions ▪ Independent of medium density ▪ Wet calibration not required ▪ Applications up to 200°C (392°F) ▪ PTFE-coated probe	▪ DC value changes of the upper medium affect the accuracy ▪ DC value of the upper medium may be max. 10 ▪ DC value difference between both media must be >10 ▪ For interface layer measurement, the thickness of the upper phase must be minimum 80mm (3.15")
 ▪ Interface with emulsion layer liquid / liquid	**Capacitance** Liquicap FMI51/52 	▪ Tried and tested instrumentation ▪ No wet calibration required ▪ Not affected by the density of the medium ▪ Unproblematic use in emulsion layers ▪ Ideal for very small measuring ranges ▪ Applications up to 200°C / 100bar (392°F/1,450psi)	▪ Difference of the dielectric constant (DC) between the two media must be > 10 The upper medium may not be conductive ▪ Accuracy impairment in case of nonconductive build-up on the probe ▪ The smaller the vessel the higher the influence of DC changes in the upper medium ▪ The total level is not measured
 ▪ Interface with emulsion layer liquid / liquid ▪ Interface liquid / solid ▪ Multiple layer interface liquid / solid	**Radiometry** Gammapilot FMG60  	▪ Non-invasive and maintenance-free measuring method ▪ Unaffected by pressure and temperature ▪ Only slight influence by build-up ▪ Unproblematic use in emulsion layers ▪ Solution for multiphase interface layers using several detectors	▪ Density changes of the medium influences accuracy ▪ The total level is not measured (possible with further source and detector) ▪ Calibration with media necessary

Certified quality

Test Center
The Endress+Hauser Test Centre (internationally accredited test centre: DATECH, FM, CSA) has three laboratories for device safety, application technology and electromagnetic compatibility.

The various test units make it possible to ensure and improve the reliability and quality of Endress+Hauser devices under realistic test conditions. In addition, the devices for new applications can be tested in advance in parallel with development.
In the various 'durability tests', they are exposed to extreme conditions as can be expected in real applications. These include dust tests (explosion protection), abrasion and friction tests, climate tests (heat and cold), mechanical load tests and spray water leak tests.

In addition to a fully automated tank test plant with a capacity of 6,000 liter, used to simulate the most difficult applications, the Endress+Hauser Test Center also has an accredited EMC laboratory.

Calibration
Quality has many components. On a company radar reference section, instruments are calibrated (if requested, under the supervision of a Bureau of Standards officer) with an absolute accuracy of 0.5mm (2 sigma value) based on the international OIML R85 requirements. This calibration is recognized by numerous national calibration authorities (PTB, NMi, BEV etc.) and constitutes the basis for the employment of the instruments in actual custody transfer applications, e. g. tank farms, ports or airports.
Endress+Hauser offers complete inventory management systems for such applications.

Overfill prevention according to WHG
§ 19 of the German Water Ecology Act (Wasserhaushaltsgesetz WHG) stipulates overfill prevention for all storage tanks with inflammable and non-inflammable liquids constituting a water hazard (storage, filling, transfer).
Function testing is performed by pressing a key on the switching unit in the control room. As a certified professional operation in accordance with § 19 WHG, Endress+Hauser supports you in all issues concerning overfill prevention.

Advantages at a glance

- Measurements are traceable and reproducible at any time
- Combined theoretical and practical instrument safety
- Accredited EMC laboratory according to EN 45 001 requirements

Safety starts with selection

Selection and Sizing Tool for your Planning Processes
Applicator is a tool which makes the engineering process extremely reliable and economically efficient. It facilitates both fast and targeted product selection and simple, application-oriented sizing. Applicator of Endress+Hauser does not pose further questions but provides qualified answers to the challenges of the planning process you face every day.

The fast way to your Applicator
Applicator of Endress+Hauser may be used free of charge both via the Internet and in form of a CD. You can order the CD version quite conveniently online

www.products.endress.com/applicator

Advantages at a glance

- Planning reliability
- Timesaving
- Safe project data
- Flexibility in work processes

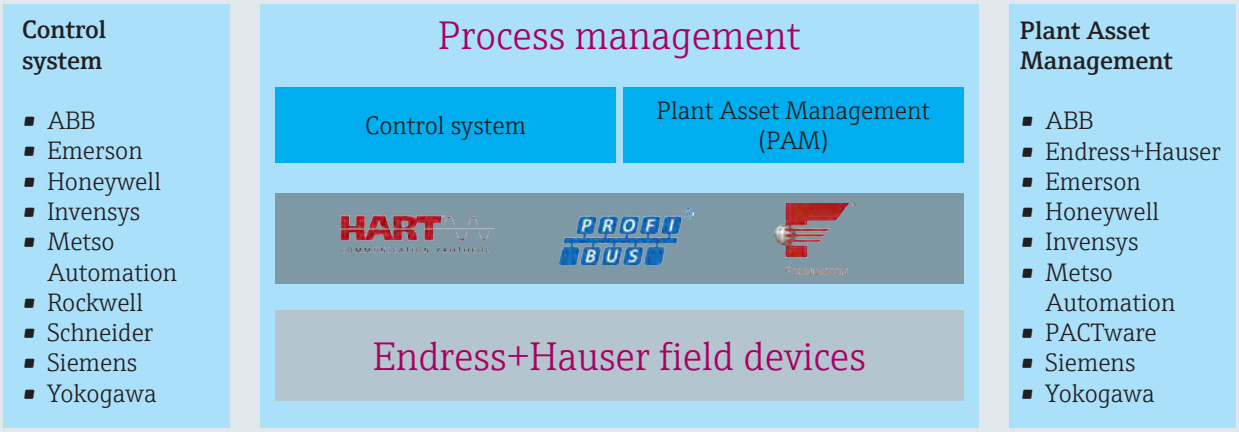
Smooth integration thanks to digital communication

Endress+Hauser offers you all common electronics variants. Apart from the classic analog electronics (output 4...20mA), as the most basic variant, digital electronics variants are also available:

- PROFIBUS® PA electronics for the complete integration into digital industrial bus systems. Simplified instrument identification, brief uploading and downloading times during commissioning, diagnostic functionalities according to NAMUR NE107 and the smooth integration help to reduce costs and downtimes to a minimum.
- FOUNDATION™ fieldbus offers easy testing of instruments, important additional information and diagnostic functionalities according to NAMUR NE107 as well as smooth system integration which increases the availability and safety of your plant.
- HART® electronics (output 4...20mA with superimposed HART® protocol) for additional functionalities and diagnostic functions.

All digital electronics may be smoothly integrated into your control systems and can be configured via a PC and the universal FieldCare operating program as well as via all common PAM systems.
The integration capability of the instruments is tested at the Endress+Hauser system laboratory thus ensuring their system independence. Endress+Hauser also offers training opportunities directed especially to the integration of instruments into respective control systems.

Integration of Endress+Hauser field devices into automation architectures



Operating cost savings due to instrument diagnosis

Plant asset management is one of the most important trends in process industry. Thanks to digital communication protocols, all current Endress+Hauser instruments support the diagnostic categories according to NAMUR NE107. The pertaining classification of failures into four categories ensures that the right information is transmitted to the right persons at the right time. This avoids operating failures, improves the maintenance cycle and finally reduces costs.

The correct use of diagnostic information can save operating costs in specific applications. Endress+Hauser level instrumentation has been equipped with numerous items of such information which may be very easily managed via a plant asset management system.

- Build-up on the sensor is detected by the analysis of the “Relative Echo Amplitude” (predictive maintenance). Maintenance cycles can thus be planned in a significantly improved manner. In the same way, foam formation is detected in the process which, in turn, permits conclusions concerning the quality of the process or medium (process diagnosis).
- The supply voltage can be continually recorded and monitored during the verification of the field instrument installation. This, in turn, permits valuable conclusions concerning clamp corrosion and ensures the uninterrupted operation of the instrument (predictive maintenance).

Worldwide service close to you

Wherever you are situated, your local Endress+Hauser organization or regional customer support office will provide the exact performance you need, be it commissioning, repairs, on-site support, training or maintenance and calibration services.

As one of the largest networks of service experts in process automation, it is our desire to help you discover new opportunities and potentials for maximum benefit and minimum operating risk. We see ourselves as your fair partner in this task, providing the right advice and recommendations to ensure constant reduction of costs and risks.

At a glance

- Commissioning and installation
- Project management
- Preventive maintenance
- Maintenance contracts
- Spare part and repair shop service
- Training
- Helpdesk
- Online documentation
- Calibration services

Endress+Hauser Service:
Global, competent, reliable

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People for Process Automation