



Level



Pressure



Flow



Temperature



Liquid  
Analysis



Registration



Systems  
Components



Services



Solutions

## Level measurement

Product overview for applications in liquids and bulk solids

# Level measurement by Endress+Hauser

1953



1968



1983



1998



2004



2006



1962



1969



1993



2002



2005



2007

## Milestones in level measurement

1953  
Capacitive probes for level measurement

1962  
First radiometric measuring line

1968  
Soliphant – first vibronic point level switch for bulk solids

1969  
First sonic sensor for continuous level measurement

1983  
Liquiphant – first vibronic point level switch for liquids

1993  
Micropilot – first level radar for non-contact measurement

1998  
Levelflex – first guided level radar for the present world market leader

2002  
Fieldgate – worldwide remote inquiry, diagnosis and configuration of sensors

2004  
Guided level radar for 400°C (750°F) and 400bar (5,8psi)

2005  
Micropilot – level radar for bulk solids

2006  
Micropilot – level radar with increased measured value

2007  
Liquiphant M Density – clever: vibronic for quality measurement

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# 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](http://www.endress.com)



Endress+Hauser is a family enterprise with a staff of more than 8,000 world-wide and sales of € 1,21 million. Our global presence with 19 production sites (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  $-200^{\circ}\text{C}$  to  $+400^{\circ}\text{C}$  ( $-328^{\circ}\text{F}$  to  $+752^{\circ}\text{F}$ ) and from  $-1\text{bar}$  to  $+400\text{bar}$  ( $-14.5\text{psi}$  to  $5,802\text{psi}$ ). Examples come from all industry sectors from the chemical, petrochemical and energy industries to the pharmaceutical, food and environmental 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.

## Level instrumentation

Point level and levels in liquids and bulk solids use eight measurement principles with 11 different product families.



# The right measuring principle for every application

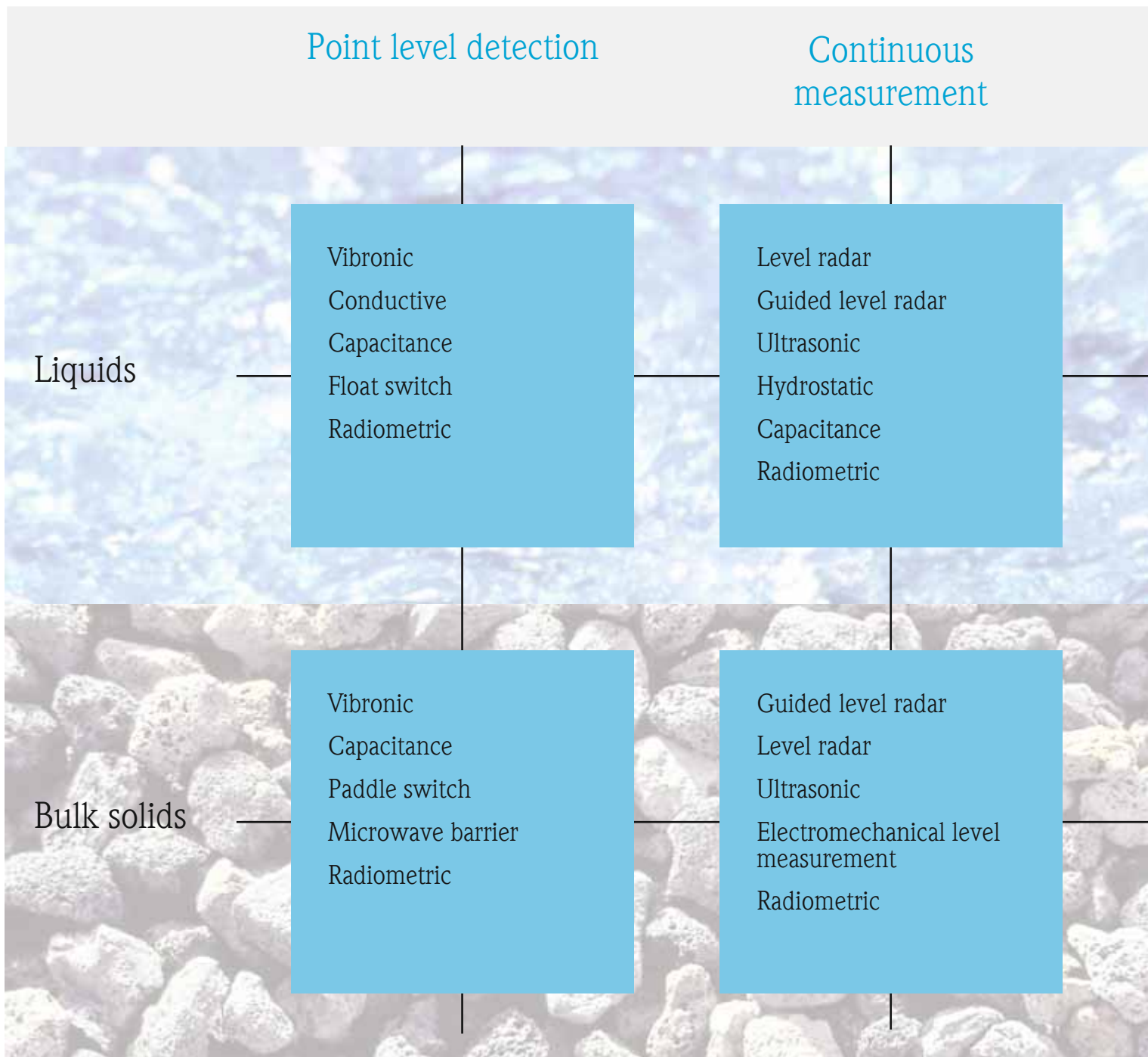
Level measurement applications in liquids including liquefied gases, bulk solids are divided into four areas: Continuous measurement, point level detection, density and interface measurement. The overview contains the measuring principles suitable for each area.

## 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  $\pm 1\text{mm}$  ( $\pm 1/16''$ ).



**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**

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

Density and concentration measurement

Interface measurement

Vibronic  
Coriolis  
Radiometric

Guided level radar  
Capacitance  
Radiometric

Vibronic  
(solids in water)  
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, water/waste water and primary industry.

Time of flight principles can be selected into three categories: Free radar with Micropilot, guided radar with Levelflex and ultrasonic with Prosonic.





FMR240

FMR244



FMP40

FMP45



FMU40

FMU90

FDU91

### 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
- Micropilot S offers highest accuracy according OIML R85 Edition 2008 and is approved for custody transfer applications

### 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
- Easy commissioning due to precalibrated sensor

### 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



With more than 30 years' experience in microwave technology, Endress+Hauser offers a wealth of application know-how in all industries.



As the market leader with over 220,000 guided level radar instruments installed, Endress+Hauser has the most extensive application experience in the market.



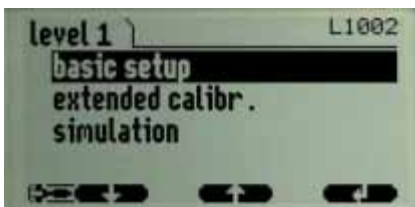
More than 40 years of successful development, production and marketing of ultrasonic instruments as well as more than 650,000 applications underline the competence of Endress+Hauser.

# Time of Flight method

## Three measuring principles – one operating philosophy

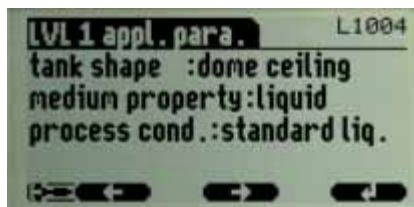
### Uniform operation

The uniform operating philosophy of all level instruments of Endress+Hauser facilitates fast and easy configuration.



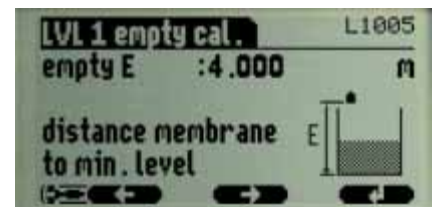
#### Menu-guided commissioning

The uniform operating standard for Endress+Hauser's three different Time of Flight measurements utilizes a plain text display to guide you simply and safely through configuration and commissioning. Integrated help text and clear error instructions reduce search times. In obtaining information on the application (storage, buffer, agitator) and tank geometries, the PulseMaster eXact software sets the required parameter automatically at the instrument.



#### Plausibility check

The envelope curve representation (echo curve) on the instrument display facilitates fast and safe plausibility checks on site and also in hazardous areas. No additional equipment (e.g. laptop) is required. Even in sophisticated measuring tasks, the software provides robust analysis algorithms and input proposals based on the experience of our service technicians.



#### Communication protocols

Configuration, diagnosis and documentation may be comfortably handled from the control room via the HART® signal which is superimposed on the current signal (4...20mA) already in standard design. The optional communication protocols of PROFIBUS® and FOUNDATION™ fieldbus facilitate simple digital integration into visualization and distributed control systems.

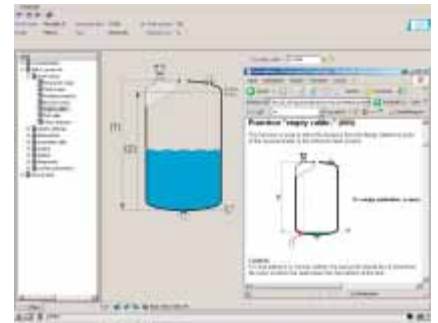
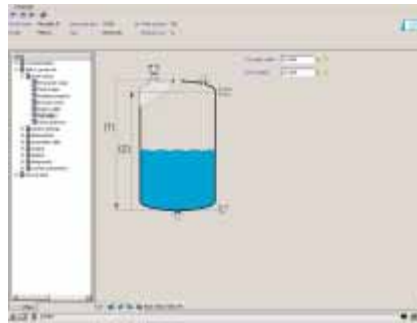
#### Advantages at a glance

- Fast and safe commissioning with step-by-step menu-guided operation in local languages
- Envelope curve – you see what the instrument sees
- Simple plausibility check on site
- Comfortable configuration from the control room



# Configuration, diagnosis and documentation

From the control room



## FieldCare operating software

This software comes free of charge with every Time of Flight instrument purchased. It allows for remote configuration via your PC and is normally connected via HART® or a digital fieldbus. The Time of Flight software tool offers additional benefits, including:

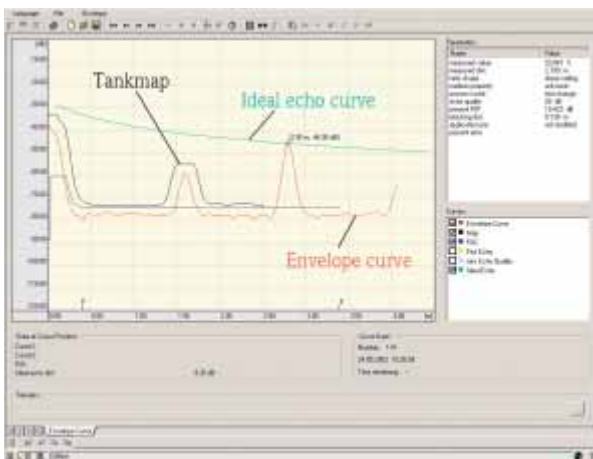
- Menu-guided configuration with graphic support and online help
- Simple and safe diagnosis via extensive envelope curve analysis, graphic evaluation assistance and event-driven data recording
- Detailed measuring point documentation

## Configuration

First, the connection from the PC to the instrument is established with the support of the connection assistant. The configuration editor then guides you from basic calibration through to measuring point optimization. The software menu is structured in a similar way to the display but offers context-dependent help text for additional support. Clearly structured diagrams assist in the entry of respective parameters. Of course, all instrument information may be stored (uploaded) and, if required, rewritten into the instrument (downloaded).

## Measuring point documentation

FieldCare operating software generates documentation in PDF format. All of the information, i. e. all instrument parameters and the envelope curves, are represented. The documentation cover sheet can be individually designed, e. g. bearing a company logo or photograph. The memory-saving PDF format simplifies electronic archiving.



## Diagnostic functions

The graphic representation of the envelope curve and the various analysis functions are an integral part of the ToF software and facilitate easy diagnosis of all aspects of the measuring point. They permit, for example, an assessment of the signal quality and therefore, reliability of measurements, the analysis of process influences or the storage (also time or event-controlled) and retrieval of envelope curves.

The most important parameters are displayed by the envelope curve.

# Radar level measurement

## Micropilot M/S

### 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

- Non-contact measurement, free of wear and tear, that can be used in extreme process conditions
- Vapors or dusty media have no effect on the measurement
- Safe measurement in vessels with changing product
- Reliable measurement due to advanced dynamics signal strength
- Best signal identification by Pulse Master eXact software algorithms

#### 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 3mm (0.12")

#### 6GHz

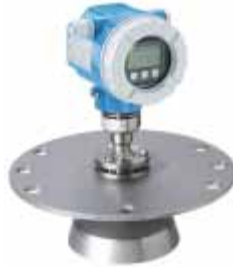
- Low impairment through boiling, turbulent surfaces as well as condensate, build-up or foam



FMR240



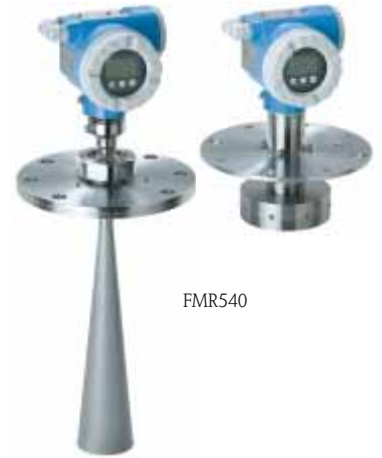
FMR245



FMR250



FMR244



FMR540

### Micropilot M in liquids

Two-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
- Antistatic rod antenna

### Micropilot M in bulk solids

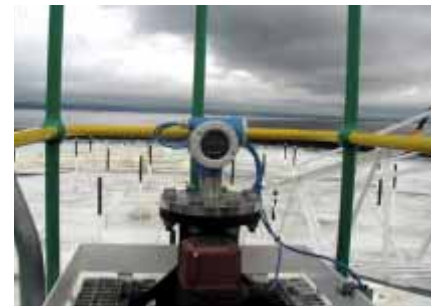
Two-wire radar level gauge for powders and bulk solids.

- 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 15m (49ft)

### Micropilot S

Radar level device for precision measurement in inventory management (tank gauging).

- Accuracy better than 1mm (0.04in) in 40m (131ft) measuring range
- Approved for custody transfer
- Numerous national calibration certificates



		Micropilot M					Micropilot S		
Type		FMR230	FMR231	FMR240	FMR244	FMR245	FMR250	FMR530/532/533	FMR540
Measuring range	m	20		40 (optional 70)			70	40	
	ft	65		131 (optional 229)			229	131	
Temperature	°C	-60...+400	-40...+150	-40...+150	-40...+130	-40...+200	-40...+200	-40...+200	
	°F	-76...+752	-40...+302	-40...+302	-40...+266	-40...+302	-40...+392	-40...+392	
Pressure	bar	-1...+160	-1...+40	-1...+40	-1...+3	-1...+16	-1...+16	-1...+64	-1...+16
	psi	-14.5...+2,320	-14.5...+580	-14.5...+580	-14.5...+43.5	-14.5...+232	-14.5...+232	-14.5...+928	-14.5...+232
Accuracy	mm	±10		±3			±15	±1	
Output		4...20mA/HART®, PROFIBUS® PA, FOUNDATION™ fieldbus					4...20mA/HART®		



# 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.

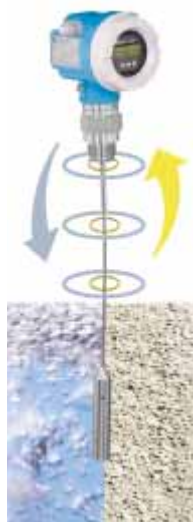
#### Advantages at a glance

- 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 chambers



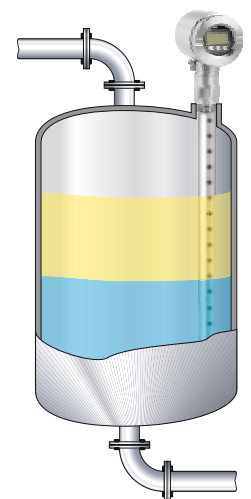
#### Functional principle

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 (DK). At the interface to a second medium with a higher DK, 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. The Levelflex measures both the total level and the interface level simultaneously and highly accurate.





FMP40



FMP41C



FMP43



FMP45

### Leviflex FMP40

- Rod version: replaces traditional measurement methods in liquids, e.g. bubblers or floaters
- Rope version: predominantly in powdery to granular bulk solids
- Coaxial version: unaffected by all baffles in liquid tanks

### Leviflex FMP41C

- PFA/PTFE-coated rod and rope probe.
- For aggressive and corrosive liquids
  - Meets the hygiene requirements of FDA-listed materials and process connections

### Leviflex FMP43

- For applications with special hygiene requirements.
- Front-flush and gapless design according to ASME-BPE
  - Metallic probes electro-polished up to 0.38µm and low delta-ferrit content
  - Other media-contacting parts are FDA-listed and tested according to USPCI.VI
  - Approval according to 3A and EHEDG

### Leviflex FMP45

- High pressure/high temperature probe for liquids.
- Ideal replacement for mechanical methods in bypasses, e.g. displacers
  - Second gastight feedthrough guarantees safe process sealing in toxic media
  - Gas phase compensation



		Leviflex								
Type		FMP40			FMP41C		FMP43	FMP45		
		Rope probe	Rod probe	Coaxial probe	Rope probe	Rod probe	Rod probe	Rope probe	Rod probe	Coaxial probe
Measuring range	m	35	4	4	30	4	4	35	4	4
	inch	1,378	157	157	1,181	157	157	1,378	157	157
Temperature	°C	-40...+150			-40...+200		-20...+150	-200...+400		
	°F	-40...+302			-40...+392		-4...+302	-328...+752		
Pressure	bar	-1...+40			-1...+40		-1...+16	-1...+400		
	psi	-14.5...+580			-14.5...+580		-14.5...+232	-14.5...+5,802		
Min. Dk value		1.6	1.6	1.4	1.6	1.6	1.6	1.6	1.6	1.4
Output		4...20mA/HART®, PROFIBUS® PA, FOUNDATION™ fieldbus								



TIIS PED



FDA



ABS

# Ultrasonic level measurement

## Prosonic T/M/S

### 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.



#### 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

#### 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.







FMU30



FMU43



FMU41



FMU90

FMU95

FDU93

FDU91

FDU91F

FDU90

### Prosonic T

Two-wire ultrasonic 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 channel) / FMU95 (5/10 channel)								
		1 1/2"	2"						FDU90	FDU91	FDU91F	FDU92	FDU93	FDU95	FDU96		
Measuring range	liquid	m	5	8	5	8	10	15	20	3	10	10	20	25			
		ft	16	26	16	26	32	49	65	9.8	32	32	65	82			
range	solids	m	2	3.5	2	3.5	5	7	10	1.2	5	5	10	15	45	70	
		ft	6.6	11	6.6	11	16	23	32	3.9	16	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								



# Capacitance level measurement

## Liquicap T/M

### 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 measurements 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



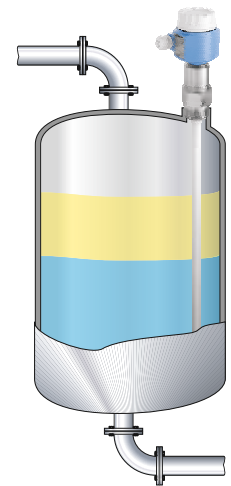
#### Functional principle

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 (DK) cause very small changes of the capacitance value in level measurement while media with a high DK produce respectively large capacitance changes. In many interface applications, the medium with the lower DK 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.





### 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)

### Liquicap M

For continuous level measurement and interface measurement in liquids.

- No calibration required for conductive liquids
- 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	
		FMI21		FMI51	FMI52
Type		FMI21		FMI51	FMI52
Design		Rod probe		Rod probe	Rope probe
Measuring range	m	2.5		4	10
	ft	8		13	32.8
Temperature	°C	-40...+100		-80...+200	-80...+200
	°F	-40...+212		-112...+392	-112...+392
Pressure	bar	-1...+10		-1...+100	-1...+100
	psi	-14.5...+145		-14.5...+1,450	-14.5...+1,450
Output		4...20mA		4...20mA/HART®, PFM	



# Electromechanical level measurement

## Silopilot T/M

### 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.



#### 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)

#### 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).





FMM20



FMM50



### 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 (300°F) and 1.1bar abs. (16psi)
- Small design

### 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	15/32	35/70
	ft	50/100	110/230
Temperature	°C	-20...+150	-20...+230
	°F	-4...+300	-4...+440
Pressure (abs.)	bar	0.8...1.1	0.8...3
	psi	12...16	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)

### 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 S, Deltabar S

### 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

- Tried and tested measuring principle for temperatures up to 400°C (752°F) and pressures up to 400bar (5,802psi)
- 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:

$$P = h \cdot \rho \cdot g$$

P = Pressure

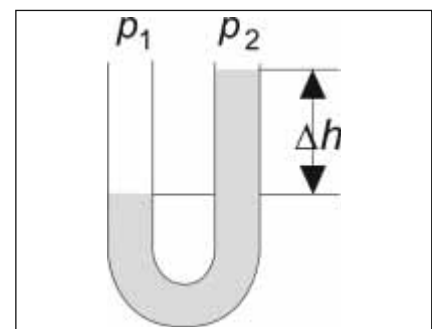
h = Level

g = Gravity (constant)

$\rho$  = 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.





FMX167  
FMX21



FMB70 with  
separate  
housing

FMB70



PMD75

PMD55

FMD78

### 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 M/S

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 M/S

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 M/S				Deltabar M/S			
<b>Type</b>		FMX167/FMX21	FMB51	FMB52	FMB53	FMB70	PMD55	PMD75	FMD77	FMD78
<b>Measuring range</b>	bar	0.1...20	0.1...10				up to 40		up to 16	up to 40
	psi	1.5...300	1.5...150				up to 600		up to 240	up to 600
<b>Temperature</b>	°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		
<b>Sensor</b>		Ceramics	Contite (Metal)				Metal			
<b>Accuracy (%)</b>		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)			
<b>Output</b>		4...20mA, 4...20mA/HART®		4...20mA/HART®, PROFIBUS® PA, FOUNDATION™ fieldbus						



TIIS

PED



KTW



FDA



# 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.

### 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

### 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.



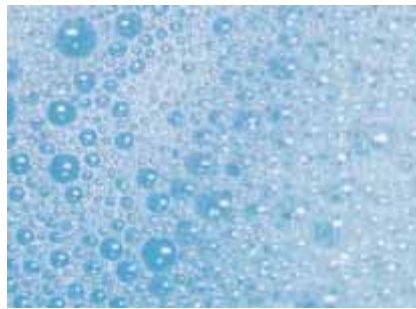
## Universal in any medium

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<sup>2</sup>/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

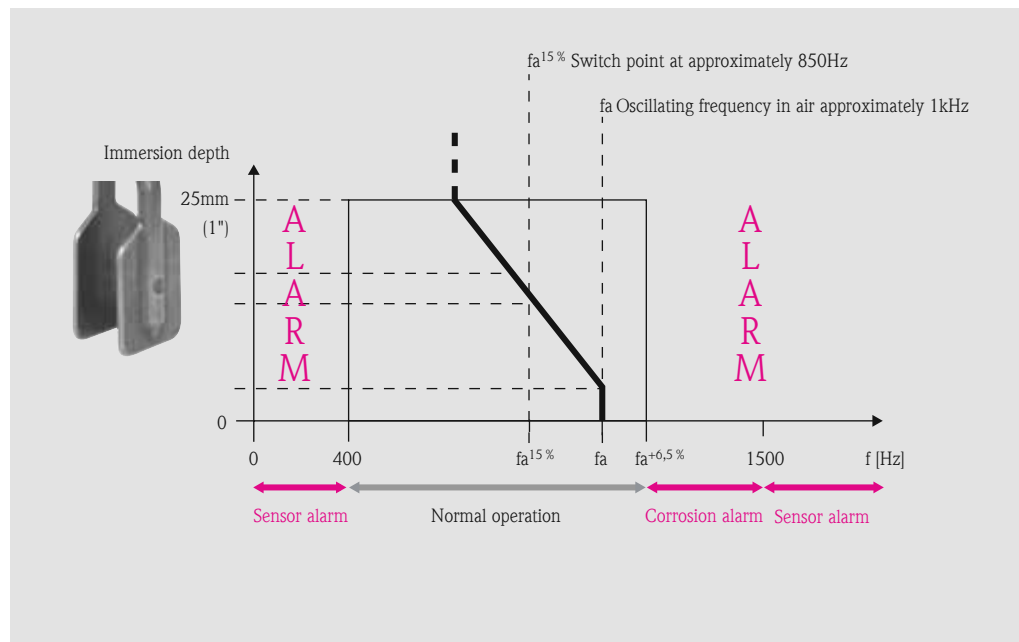
By choosing vibronic point level switches, the process benefits from having no mechanical moving parts and calibration is not required. Together with integrated automatic monitoring, this leads to a system which has gained recognition in process automation because of its reliability.

# 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.



#### 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

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.



Frequency change due to build-up (minimum alarm)

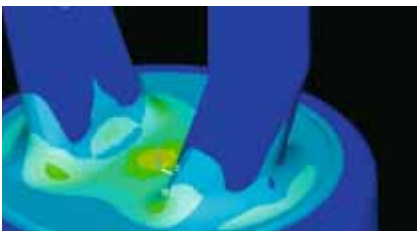
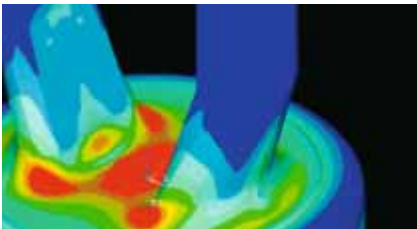


Frequency change due to corrosion (maximum alarm)

# Vibronic level measurement

## Competence in liquids

Safe measurement in demanding applications



Above: Fissures in V4A steel  
Below: Stability in Duplex steel (Liquiphant S HT)

### 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 Liquiphant hygiene line meets food requirements with polished sensors, respective connections and stainless steel housings.

- The large selection of common connections, e.g. sanitary, Varivent, DRD, Triclamp, NEUMO etc., guarantees conformity.
- The stainless steel housing is characterized by its chemical resistance to aggressive cleaning agents. Moreover, it offers the benefits of no dead space, due resistance and easy cleaning.

### 3.1 certified materials

Process safety and reproducibility are terms which are becoming increasingly important. Therefore, Endress+Hauser offers all parts in contact with the medium, i.e. sensor and welding supplies, in 3.1 certified materials.



Liquiphant S  
Welded feedthrough



Liquiphant M  
Feedthrough O-ring sealed

### Second process separation

A pressure, gas or diffusion-tight feedthrough as second line of defense prevents the medium from escaping into the atmosphere. Liquiphant M offers this second line of defense as an option and in Liquiphant S FTL70/71, it comes as standard.

### Antistatic coating

Different sensor materials are frequently used in chemical processes or mixed material storage. Wherever stainless steel is not sufficiently resistant, plastic coating is used to protect instruments against corrosion. The operator is responsible for the prevention of electrostatic charging. Coating of the parts in contact with the medium with a conductive surface (PFA) prevents electrostatic charging of the sensor.

# Vibronic level measurement

## Liquiphant T/M/S

### 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), WHG-certified leakage monitoring and overspill protection through to protective equipment in plant parts subject to Safety Integrity Levels (SIL).

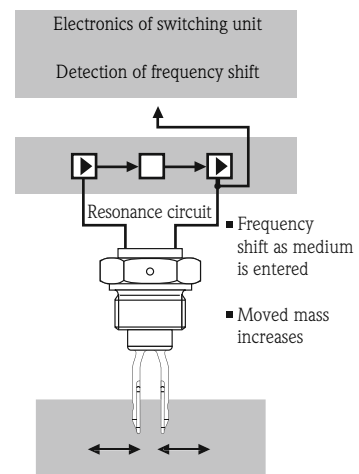


#### Advantages at a glance

- Unaffected by medium properties such as conductivity, dielectric constant, viscosity, pressure and temperature
- Highest degree of reliability and service life, even under extreme process conditions
- Tried and tested instruments

#### Functional principle

A tuning fork sensor is excited to its resonant frequency. The drive works piezoelectrically. The oscillating frequency or the amplitude changes as the fork enters the medium. The change is analyzed and translated into a switching signal.





FTL20  
E//direct



FTL20H  
E//direct



FTL50



FTL50H



FTL51C



FTL70



FDL60

### Liquiphant T

Compact instrument for simple and hygienic applications.

- Very small instrument dimensions
- Hygienic stainless steel design
- External function testing

### Liquiphant M

Diverse instrument variants in a modular system.

- Different construction lengths
- Process connections, housings
- Numerous electronic interfaces
- Special designs
- Density measurement

### Liquiphant S

For the highest process requirements and safety.

- Process temperatures up to 280°C (536°F)
- Recurrent examination according to WHG is not required (FDL60/61)
- Functional safety SIL3



Type	Liquiphant T		Liquiphant M			Liquiphant S	
	FTL20	FTL20H	FTL50/51	FTL50H/51H	FTL51C	FTL70/71	FDL60/61
Sensor length	mm	38	65/148...6,000		148...3,000	65/148...6,000	130/220...6,000
	inch	1.5	2.6/5.8...236		5.8...118	2.6/5.8...236	5/8.7...236
Temperatur	°C	-40...+150	-50...+150			-60...+280	-40...+150
	°F	-40...+300	-58...+300			-76...+536	-40...+300
Pressure	bar	-1...+40	-1...+100	-1...+64	-1...+40	-1...+100	-1...+40
	psi	-14.5...+580	-14.5...+1,450	-14.5...+930	-14.5...+580	-14.5...+1,450	-14.5...+580
Process connections	G ½", ¾", 1"		G ¾", 1", Flange DIN/EN, ANSI, JIS			G 1", Flange DIN/EN, ANSI, JIS	
	Hygiene		Hygiene				
Output	AC, DC, ASI-Bus		AC, DC, AC/DC relay, NAMUR, 8/16mA, PFM, PROFIBUS® PA				PFM



# Vibronic level measurement

## Soliphant T/M

### 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).

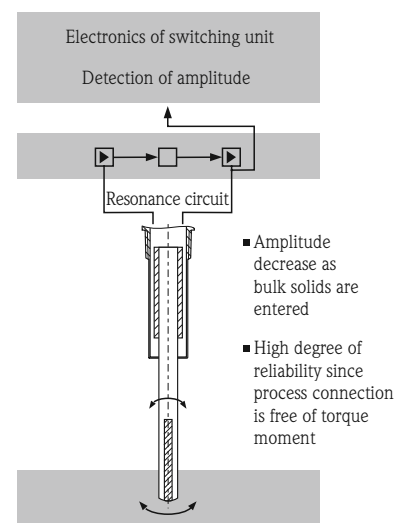


#### Advantages at a glance

- Unaffected by medium properties such as conductivity, dielectric constant, pressure and temperature
- Large range of applications due to fork and single-rod oscillation system
- Highest degree of reliability and service life, even under extreme process conditions

#### 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 incorrect switching due to jamming medium
- Unaffected by external vibration due to detached drive

**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)	FTM50	FTM51 (tube)	FTM52 (rope)
Sensor length	mm	250	500/1,000/1,500	145/200	300...4,000	750...20,000
	inch	9	20/40/60	5.7/8	12...160	30...800
Temperature	°C	-40...+150		-50...+280		-40...+80
	°F	-40...+300		-60...+540		-40...+170
Pressure	bar	-1...+25		-1...+6		-1...+2
	psi	-14.5...+360		-14...+90		-14...+30
Density	g/l	From 200		From 10		
	lbs/ft <sup>3</sup>	From 12		From 0.6		
Output		DC, AC/DC relay		AC, DC, AC/DC relay, 8/16mA, NAMUR, PFM		



# Capacitance level measurement

## Minicap, Nivector, Solicap M/S, Liquicap M

### 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

El/direct



FTI55



FTI56



FTI77



FTI51



FTI52

### 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

### 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)

### 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	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	Front-flush	5.5	20...236	8...157	20...790	8...40 sword 20...790 rope	4...236
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		



# Conductive level measurement

## Liquipoint T, Probes

### Point level detection in liquids

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



#### Advantages at a glance

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

#### Liquipoint T, Probes

Modular probe system for optimum adaptation to the application.

- 1 to 5 rod and rope probes
- Compact or separate instrumentation
- Front-flush solution for pipes

#### 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 conductivity which can be calibrated amounts to 5µS/cm.

		Liquipoint T		Probes		
Type		FTW31 rod	FTW32 rope	FTW360	11371	11961Z
Measuring range	mm	100...4,000	250...15,000	Front-flush	50...2,000	150...2,000
	inch	4...157	10...590		2...79	6...79
Temperature	°C	-40...+100		-20...+100	-10...+100	-200...+250
	°F	-40...+212		-4...+212	14...212	-328...+482
Pressure	bar	-1...+10		-1...+10	-1...+10	-1...+160
	psi	-14.5...+145		-14.5...+145	-14.5...+145	-14.5...+2,320
Process connections		G 1½"		G ¾"	G ½"	
Output		DC, AC/DC relay, NAMUR, switching unit FTW325		AC/DC relay	Switching unit FTW325	



# Float switch

## Liquifloat T

### 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.



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.

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

#### 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



# 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").



- Diverse instrument designs allow for use under different application conditions.
- Slip clutch prevents impact on the paddle
  - Reinforced instrument design (lateral load max. 1500N) for coarse-grained bulk solids



#### Advantages at a glance

- Simple and cost-effective
- Tried and tested in operation

#### 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
Type		FTE30
Sensor length	mm inch	75...2,000 2.8...79
Temperature	°C °F	-20...+80 -4...176
Pressure	bar psi	-0.5...+0.8 -7...+11.6
Process connections		G 1 1/2"
Output		Potential-free change-over contact



# Microwave barrier

## Soliwave M

### 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.



Soliwave M 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 explosion hazards (dust, gas)

#### Functional principle

The absorption of microwaves is used for the supervision of limit values in microwave barriers. The microwave sender 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

- Front-flush, non-contact measurement
- No wear and tear or maintenance with long service life
- Easy installation and commissioning

		Soliwave M
Type		FQR50/FDR50
Measuring range	mm	300...20,000
	inch	12...780 (distance sender-receiver)
Temperature	°C	-40...+70
	°F	-40...+150 in direct installation, otherwise as desired
Measuring range	bar	0.8...4.8
	psi	12...70 in direct installation, otherwise as desired
Process connections		R 1½", 1½" NPT, assembly clamps, flange
Output		Potential-free change-over contact in Nivotester FTR325 switching unit



# Radiometric level measurement

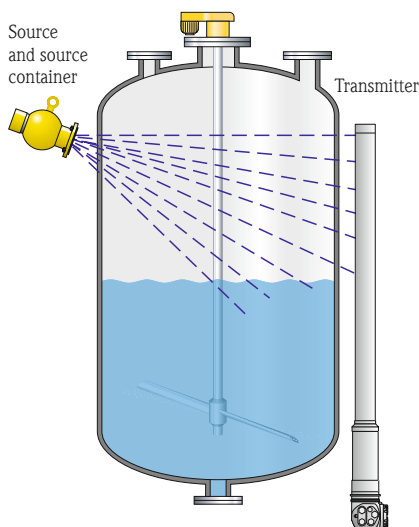
## Gammapilot M

Point level detection, level,  
density and interface measurement

As early as 1962, the first Endress+Hauser radiometric measuring lines were launched. Since then, more than four 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
- Overspill protection WHG



### Functional principle

The gamma source, a cesium or cobalt isotope, emits electromagnetic radiation which is attenuated as it passes through matter. A transmitter is mounted on the other 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 of the product
- In density and interface measurement - by changes in absorption. In maximum density, part of the radiation still reaches the transmitter.



### 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.



Comparison of source sizes



FHG65

### Gamma-Modulator FHG65

For effective suppression of background and extraneous radiation (e.g. from non-destructive materials testing). The Gammapiilot M can separate useful signals from parasitic radiation by its modulated radiation. This enables continuing measurements which increases plant availability and the safety of measurements.



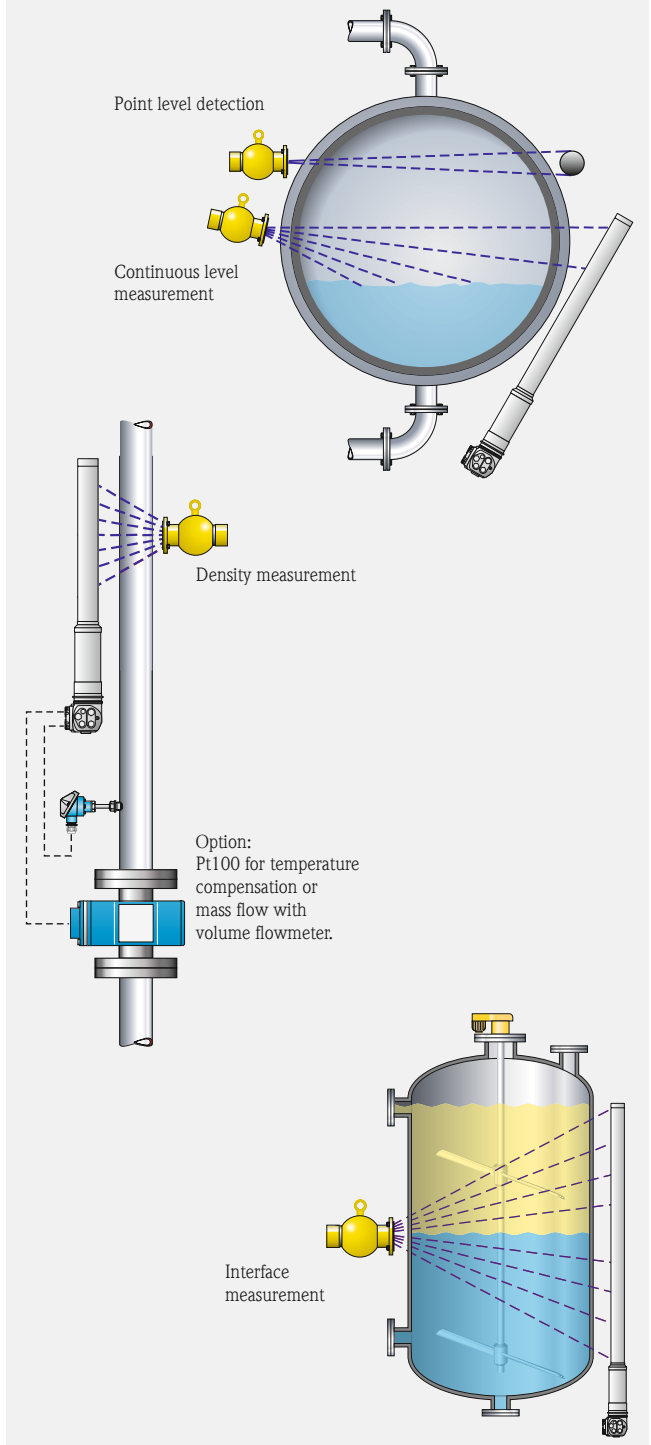
FMG60

### Gammapiilot M

The variable transmitter concept with NaI crystal or plastic scintillators in different lengths guarantees optimum adaptation to individual applications. The transmitter contains a scintillator, photomultiplier and switching unit.

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

### Measuring tasks



### Support through competence – from planning through to realization

- Comprehensive consultation by our Gamma Project Team (GPT) specialists
- Source and activity calculation using Applicator, Endress+Hauser's product design and selection program



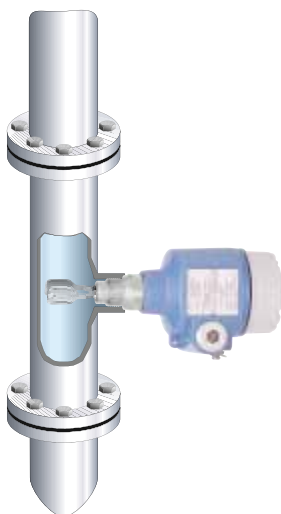
## Vibronic – Liquiphant M Density

### 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

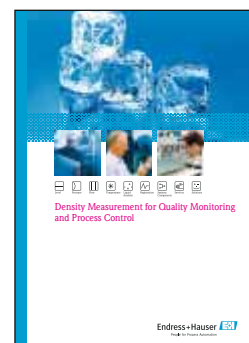
- Costly laboratory avoid
- Process monitoring and controlling in situ and online
- Complying with tolerances is to increase quality
- Industry independent
- Any unit you require (°Plato, °Brix, °Baumé,...)



#### 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 (CP024F00en)



# Density measurement for quality monitoring and process control



	Liquiphant M	Coriolis – Promass	Radiometric – Gammapiilot M
Advantages	<ul style="list-style-type: none"> <li>Large number of process connection to choose from: univelsal usage</li> <li>Useable in hygienic applications</li> <li>Calculation of customer specific units e.g °Brix, °Plato, °Baumé etc. possible</li> <li>Up to 5 Liquiphant densitysensors can be connect to the density computer FML621</li> </ul>	<ul style="list-style-type: none"> <li>Maximum process dependability, because density, temperature and mass flow are all measured directly</li> <li>Approval for custody-transfer applications</li> <li>No maintenance necessary</li> </ul>	<ul style="list-style-type: none"> <li>Straightforward retrofitting without process interruption; the pipes do not have to be opened</li> <li>No maintenance necessary</li> </ul>
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/5800psi	Independent
Accuracy	0.002g/cm <sup>3</sup>	0.0005g/cm <sup>3</sup>	±0.001g/cm <sup>3</sup>
Reproducibility	0.0007g/cm <sup>3</sup>	0.00025g/cm <sup>3</sup>	±0.0005g/cm <sup>3</sup>
Units of density	Normdensity, °Brix, °Baumé, °Plato, Volumen%, concentration etc. with 2D and 3D tables. Formulaeditor to calculate customerspecific 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/cm <sup>3</sup> , g/l, lb/gal, concentration, % masse, °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, TIIS, NEPSI, 3A, EHEDG, CRN	ATEX, FM, CSA, TIIS, SIL2, 3A, EHEDG, IECEx	ATEX, FM, CSA, IECEx, TIIS, NEPSI
Additional information	Connect of temperatur- 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	<ul style="list-style-type: none"> <li>Gasbubbles or build-up at the sensor fork</li> <li>Fluid velocity &gt; 2m/s in pipes</li> <li>Viscosity &gt; 350mPa·s</li> </ul>	<ul style="list-style-type: none"> <li>Not for non-homogeneous mediums</li> <li>Only for pipe diameters up to DN 250</li> </ul>	<ul style="list-style-type: none"> <li>Not with degasification in the medium</li> </ul>



TIIS



FDA

CRN

ANACE  
THE COMPASS SOCIETY

# Interface measurement

## Separate the best from the rest

### Suitable measuring principles for your individual interface application

It is not the instrumentation but your application which is most important. We provide the optimum interface measurement solution in relation to your process requirements. Different media, densities and temperature fluctuations, emulsion layers or solids?

Is the total level consistent or variable, and if so, in which range? Is the total level supposed to be available as a measured variable in addition to interface measurement?

The answers to these questions are highly relevant for the correct instrument selection. We offer you transparency in relation to possibilities, physical limits and commissioning of the individual measuring principles. Guided Radar, Capacitance or Radiometry – we guide you through the sizing process.

#### Functional principle



#### Capacitance

In capacitance measurement, the probe forms a capacitor together with the tank while the medium in the tank and the probe insulation constitute the dielectric.

Media with a low dielectric constant (DK) cause very small changes of the capacitance value in level measurement while media with a high DK produce respectively large capacitance changes. In many interface applications, the medium with the lower DK 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. In order to make use of this effect, the DK of the two media must be sufficiently different.

#### Guided radar

In guided radar level measurement, high-frequency pulses are coupled to a probe and guided along the probe. The pulses are reflected from the product surface, received by the electronic evaluation unit and converted into level information.







As the high frequency pulses meet the medium surface, only a part of the emitted pulse is reflected. Particularly in case of media with a low upper DK, the other part penetrates the medium. At the interface to a second medium with a higher DK, 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.

#### Radiometrics

Since the radiometric measuring principle measures in a non-invasive manner, it is suited to all applications in which other methods fail, for example due to extreme process conditions or mechanical, geometric or construction conditions.

The gamma source emits radiation; it is attenuated as it passes through the tank wall and the medium. A detector is mounted on the opposite side of the tank or pipe and converts the radiation into an electric signal. The measuring effect results from the absorption of the radiation by the product to be measured. For interface measurement, the radiation of media with different densities is also differently attenuated. If the transmitter is calibrated to the medium with the lower density using wet calibration and then to the medium with the higher density, a correlation for the measurement of the interface layer automatically results.

# The fine difference: The right solution for every phase

Measuring task	Measuring principle	Features	Application limits / conditions
 <ul style="list-style-type: none"> <li>■ Clean interface liquid / liquid</li> </ul>	<p><b>Guided radar</b> <b>Levelflex M</b></p> 	<ul style="list-style-type: none"> <li>■ Simultaneous acquisition of interface layer and total level</li> <li>■ Very accurate measurement</li> <li>■ No wet calibration required</li> <li>■ Not affected by the density of the medium</li> <li>■ Direct replacement of displacers in existing displacer chambers</li> <li>■ Applications up to 400°C / 400bar (752°F / 5800psi)</li> <li>■ Probes can be shortened (rod)</li> </ul>	<ul style="list-style-type: none"> <li>■ DK of the upper medium may be max. 10</li> <li>■ Difference of the DKs between the two media must be &gt; 10</li> <li>■ Emulsion layer up to max. 50mm (2in) allowable</li> <li>■ Probe length up to 10m (33ft) (larger on request)</li> <li>■ For interface measurement, the thickness of the upper phase must be min. 60mm (2.4in)</li> </ul>
 <ul style="list-style-type: none"> <li>■ Interface liquid / liquid also with emulsion</li> </ul>	<p><b>Capacitance</b> <b>Liquicap M</b></p> 	<ul style="list-style-type: none"> <li>■ Tried and tested instrumentation</li> <li>■ No wet calibration required (FieldCare software tool)</li> <li>■ Not affected by the density of the medium</li> <li>■ Unproblematic use in emulsion layers</li> <li>■ Ideal for very small measuring ranges</li> <li>■ Extremely fast response time</li> <li>■ Applications up to 200°C / 100bar (392°F/1450psi)</li> </ul>	<ul style="list-style-type: none"> <li>■ Difference of the dielectric constant (DK) between the two media must be &gt; 10</li> <li>■ The upper medium may not be conductive</li> <li>■ Accuracy impairment in case of nonconductive build-up on the probe</li> <li>■ The smaller the vessel the higher the influence of DK changes in the upper medium</li> <li>■ The total level is not measured</li> <li>■ Probe length up to 10m (33ft)</li> </ul>
 <ul style="list-style-type: none"> <li>■ Interface liquid / liquid also with emulsion</li> <li>■ Interface liquid / solid</li> <li>■ Multiphase measurement</li> </ul>	<p><b>Radiometrics</b> <b>Gammapiilot M</b></p> 	<ul style="list-style-type: none"> <li>■ Non-invasive and maintenance-free measuring method</li> <li>■ Unaffected by pressure / temperature</li> <li>■ Only slight influence by build-up</li> <li>■ Unproblematic use in emulsion layers</li> <li>■ Solutions for multiphase measurements using several sources / detectors</li> </ul>	<ul style="list-style-type: none"> <li>■ Wet calibration necessary</li> <li>■ Density changes of the medium influences accuracy</li> <li>■ The total level is not measured (possible with further source / detector)</li> </ul>



## Certified quality

### The Product Center for level and pressure

Continuous level measurement of bulk solids and liquids, safe point level detection and pressure measurement in tanks and pipes constitute central tasks of process engineering.

At Endress+Hauser Maulburg in Germany and the affiliated production sites in Kassel, Stahnsdorf (Germany), Greenwood (USA), Suzhou (China) and Aurangabad (India), everything revolves around level and pressure instrumentation. A staff of over 1,700 produce more than 795,000 instruments for level measurement and point level detection, pressure and differential pressure measurement on 16 production lines every year.



### 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 6000 liter, used to simulate the most difficult applications, the Endress+Hauser Test Center also has an accredited EMC laboratory.

#### Advantages at a glance

- Measurements are traceable and reproducible at any time
- Combined theoretical and practical instrument safety
- Accredited EMC laboratory according to EN 45001 requirements

### 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, airports.

Endress+Hauser offers complete inventory management systems for such applications.





## Safety starts with selection

### Applicator

#### 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.

#### Advantages at a glance

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

#### 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

<http://www.products.endress.com/applicator>



#### Overspill protection according to WHG

§ 19 of the German Water Ecology Act (Wasserhaushaltsgesetz WHG) stipulates overspill protection for all storage tanks with inflammable and non-inflammable liquids constituting a water hazard (storage, filling, transfer). In addition, it is recommended for all process tanks (production, treatment, usage). According to the law, the function of overspill protection facilities must be tested at least once a year. Level instruments with corrosion monitoring – this includes the whole Liquiphant family – are exempt from this inspection. Instruments with PFM technology (Pulse Frequency Modulation) have been certified with further qualifications by TÜV and DIBT<sup>1</sup>. This saves time and money in terms of annual inspections. 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 overspill protection.

<sup>1</sup> Deutsches Institut für Bautechnik (German Institute for Civil Engineering)

#### WHG-Tool

The WHG calculation tool is available for simple design and clear documentation of an overspill protection facility. It is based on ZG-ÜS approval principles.

#### Safety-oriented instrumentation with SIL

The process industry demands the highest degree of safety and reliability from the components of distributed control systems (DCS). Endress+Hauser is the leading provider of SIL-certified instruments (Safety Integrity Level) in level, pressure, flow and temperature sensor technology.

The safety level required for a process plant is classified according to the international IEC 61511 standard and depends on the risk inherent in the plant.

The international standard for functional safety, IEC 61508, describes the guidelines for instruments in protective functions in order to reduce the risks for people, the environment and the plant. A DCS protection facility usually consists of an instrument, a control part and an actuator. Both standards subdivide plants and equipment into four safety categories – from SIL1 for low risks through to SIL4 for very high risks.

# Design of a level application

Vital information for choosing the right instrument

<b>Date</b>	<input style="width: 100%;" type="text"/>														
<b>Task</b>	Continuous measurement	<input type="checkbox"/>												Measurement during filling/discharging	<input type="checkbox"/>
	Interface measurement*	<input type="checkbox"/>													
	Foam height continually	<input type="checkbox"/>													
	Point level detection	Min.	<input type="checkbox"/>	Max.	<input type="checkbox"/>	Overfilling	<input type="checkbox"/>								
	Two-point control	<input type="checkbox"/>													
	Foam recognition point level	<input type="checkbox"/>													
	Density / concentration	<input type="checkbox"/>												Others	<input style="width: 100%;" type="text"/>
<b>Media</b>	1 (emulsion) 2*														
<b>liquid</b>	<input type="checkbox"/>	<input type="checkbox"/>												<b>Media</b>	<input type="checkbox"/>
Density	<input type="checkbox"/>	<input type="checkbox"/>												<b>bulk solids</b>	<input type="checkbox"/>
Conductivity	<input type="checkbox"/>	<input type="checkbox"/>												Bulk density	<input type="checkbox"/>
Dielectric constant	<input type="checkbox"/>	<input type="checkbox"/>												Grain size	<input type="checkbox"/>
Viscosity	<input type="checkbox"/>	<input type="checkbox"/>												Dielectric constant	<input type="checkbox"/>
Resistance	<input type="checkbox"/>	<input type="checkbox"/>												Flow properties	<input type="checkbox"/>
	<input type="checkbox"/>	<input type="checkbox"/>												Abrasive	<input type="checkbox"/>
Process temperature	<input type="checkbox"/>	<input type="checkbox"/>												Process temperature	<input type="checkbox"/>
Process pressure	<input type="checkbox"/>	<input type="checkbox"/>												Process pressure	<input type="checkbox"/>
<b>Place of installation (sketch)</b>							<b>Further requirements (Type)</b>								
<ul style="list-style-type: none"> <li>■ Tank: form, height, width, diameter, material, baffles (agitator, struts etc.), surface of medium (calm, turbulent)</li> <li>■ Nozzle: height, width, position on tank, process connection</li> <li>■ Pipe: diameter, measurement position (e.g. elbow)</li> <li>■ Sensor: measuring range, length, installation position (top, side)</li> </ul>							Environment factors, site conditions, approvals (ATEX zones, WHG, EHEDG, SIL etc.), process atmosphere (vapors, steam, condensate, dust), 3.1 material, requested accuracy, medium is changed by process/ during time (build-up), filling/discharging								
<div style="border: 1px solid #ccc; width: 100%; height: 100%;"></div>							<div style="border: 1px solid #ccc; width: 100%; height: 100%;"></div>								

# Your comments





## 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 service
- Repair shop service
- Training
- Helpdesk
- Online documentation
- Calibration services

**Endress+Hauser Service:**  
Global, competent, reliable



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