Level Pressure Flow Temperature Liquid Analysis Registration Systems Components Services Solutions

The Maintenance Guide

Tips and reference information to keep your installed base up and running

Endress+Hauser

People for Process Automation

maintenance guide

Because your success is important to us…

Tips & advice

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This ‘Maintenance Guide’ has been produced to provide reference information for your production, metrology and maintenance teams. Developed by our experts, it contains reminders on the measuring principles and provides answers to frequently asked questions. And we have included lots of tips to help you make better use of your installed base!

Keep a copy on your desk all year round!

At your service

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Tips & advice

Helping you to get the most out of your installed base

Contents

Installation | Commissioning | Operations | Migration | Re-engineering

Our contribution to your success goes far beyond the sale of instrumentation. Every day our experts help you to solve installation, commissioning, operations, migration or re-engineering problems.

In this 'Tips & advice' section, they have gathered a wide selection of useful information that will help you anticipate the most common problems, helping you to maintain your instrument availability.

Please remember that our experts are always on hand to help – so feel free to call us at any time. We are at your service!

Useful definitions

Metrology

Accuracy of a measurement
Proximity of the agreement between the result of measurement and a true value of the reference.

Adjustment
The adjustment is the operation of bringing a measuring instrument into a state of performance suitable for its use.

Note: Adjustment may be automatic, semiautomatic or manual.

Calibration
Calibration is the process of comparing values displayed by the device to be calibrated with corresponding reference values (standards). The result of this operation is documented in a calibration certificate.

Check
For the purposes of this document, we will define a check as an act of conditional maintenance. According to European Standard EN 306, conditional maintenance is preventive maintenance based on monitoring of the proper functioning of the device and/or the critical parameters associated with its functioning, including any action which may be required as a result. The results of this operation allow the user to confirm the conformity of the instrument at the various control points in the procedure. The results are documented in a certificate of proper functioning.

Maintenance (to EN 13306)

Down time
Time interval during which an item is in a non-operative state.

Inspection
Check for conformity by measuring, observing, testing or gauging the relevant characteristics of an item.

Note: In general, inspection can be carried out before, during or after other maintenance activities.

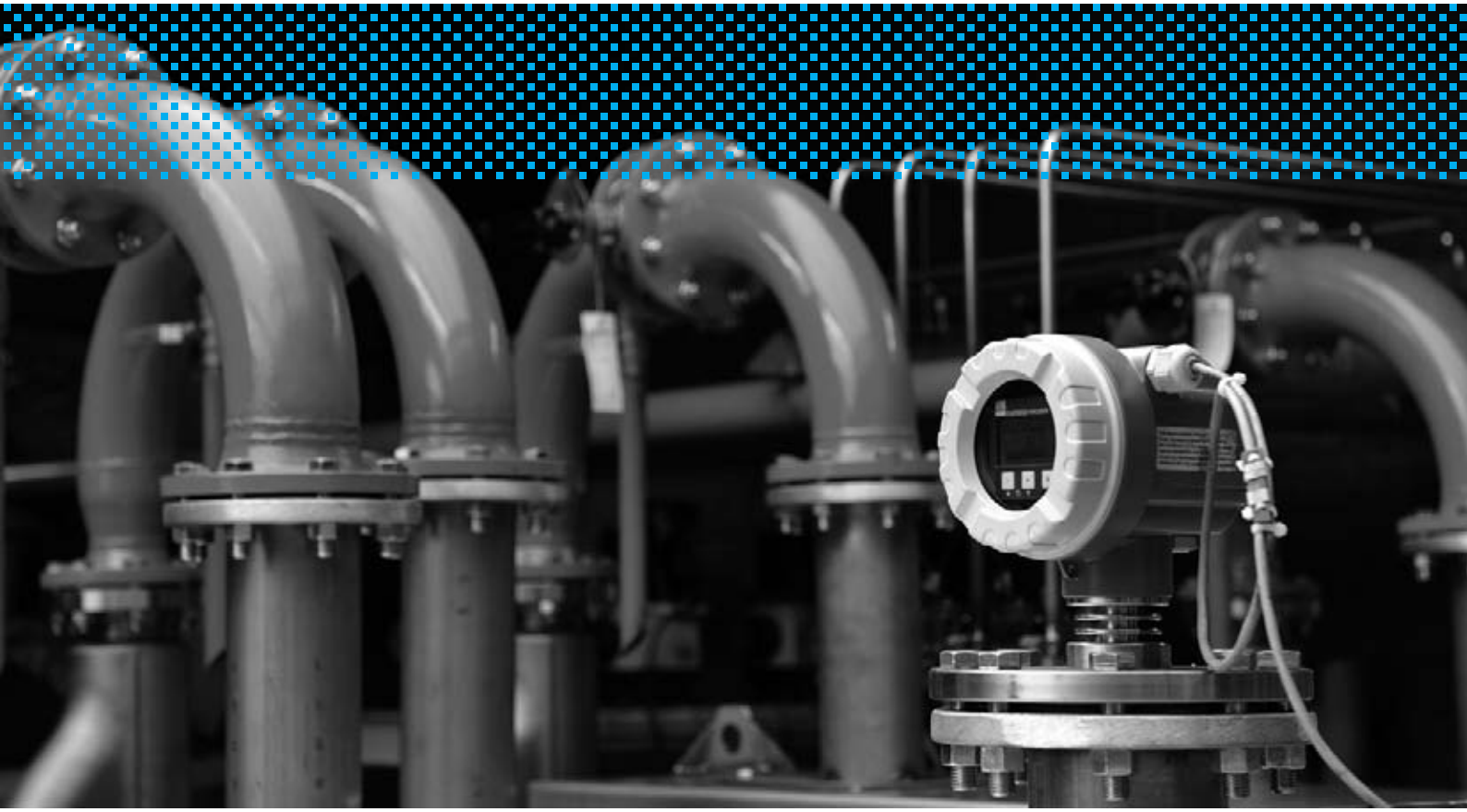
Life cycle
Time period that commences with the initiation of the concept and terminates with the disposal of the item.

Preventive maintenance
Maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning of an item.

Routine maintenance
Regular or repeated elementary maintenance activities that usually do not require special qualification, authorization or tools.

Note: Routine maintenance may include, for example, cleaning, tightening of connections, checking liquid level, lubrication, etc.

Level measurement



“Installation is the key”

“ToF (Time of Flight) and capacitive instruments are the most popular Endress+Hauser level devices.

ToF instruments share common concepts allowing simplified commissioning, operation and maintenance. However, as the installation conditions are of utmost importance, especially regarding the nozzle, we have included a reminder of these essential installation conditions in this guide.

For capacitive level measurement instruments, the situation is different: due to the physical principle, the key point is the connection to the ground, especially in case of a non-conductive tank.

As in all other sections, we have also recapped the most frequently asked questions. With this information, you will be able to prevent or resolve the vast majority of potential problems yourself!

There is also plenty of useful information to help you get the best from your instruments throughout their life cycle.

Note: If you are intending to replace one of your capacitive devices, please contact us. Each migration project has to be examined carefully.

We also offer training sessions in a classroom or on site. See ‘Training’ in the ‘At your service’ section.

You will find several videos covering these topics at www.endress.com/videos

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Basics

Information common to all types of level measurement devices

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Ultrasonic level measurement
Specific information p. 21

Capacitance level measurement
Specific information p. 26

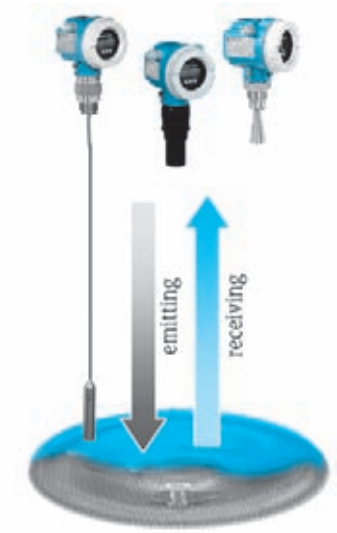


Fig. 1 : The Time of Flight principle.

The Time of Flight (ToF) principle

Radar, guided radar and ultrasonic level measurement instruments are 'downward-looking' measuring systems that operate according to the Time of Flight (ToF) principle. What is measured is the distance from the reference point to the product surface. Pulses (microwave or ultrasound) are emitted by the instrument, reflected by the product surface, received by the electronic evaluation unit and converted into level information. The distance between the device and the product surface is calculated by $d = (c \cdot t)/2$

Blocking distance
The span may not extend into the blocking distance (BD). Level echoes from the blocking distance cannot be evaluated due to the transient characteristics of the sensor (see box for more details).

Envelope curve
ToF instruments emit individual pulses in quick succession and scan their reflection again with a fluctuating delay. The amounts of energy received are arranged according to their Time of Flight. The graphic representation of this sequence is called an 'envelope curve'. A stylized envelope curve is displayed in fig. 3 and 4.

The envelope curve can be monitored on the built-in display. For this purpose, the function 'envelope curve' must be selected in the operating menu. Sub-menus then allow for adjustments of the envelope curve display. In addition, a laptop or personal computer with the Endress+Hauser software FieldCare, in combination with a necessary interface, can be used to display and evaluate an envelope curve.

ZOOM: Why is there a blocking distance?

The device is either emitting or receiving waves but cannot do both at the same time. In case of an obstacle located within the area between positions 1 and 2, the resulting echo would be surrounded by the residual vibration and could not be differentiated. As it is impossible to differentiate the echo within this area, the level to be measured must not approach the membrane. This distance is the blocking distance (BD).

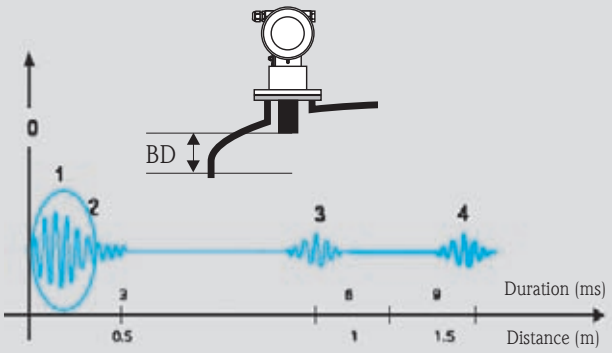


Fig. 2 (example of an ultrasonic level measurement)
T0: Start of the emitted impulsion. An alternating current whose frequency corresponds to the system's resonance makes crystals oscillate.
T1: End of the emitted impulsion. Membrane continues to vibrate during 1ms and then switches to the receiving position.
T2: The residual membrane vibration is weakened enough to reflect an echo and to differentiate it.
T3: The echo comes back after 6 ms meaning the total distance represents 2m/6.56ft. Therefore the product surface is located 1m under the probe.
T4: Double reflection echo or numerous reflections can sometimes be observed.

Customer map
For radar and ultrasonic level measurement instruments, it is necessary to map out interference reflections created inside the tank. This map is based on the factory map and preferably done with an empty tank. This way, all eventual interference reflections caused by installations in the tank are detected and stored in the memory.

A customer map is recorded over the actual factory map. The customer map covers all additional reflections from inside the tank (see fig. 5). Only significant echoes will then exceed the customer map and be evaluated. The mapping can also be performed up to the level or a defined distance, even if the tank is not empty. However, if the level drops below the mapping distance, additional reflections can interfere with the measurement.

Setup - configuration of level instruments

General note:
Respecting installation conditions is of key importance for level measurement. Furthermore, it is necessary to configure the measuring point to achieve correct measurement.

The 'basic setup' covers 95% of the situations. A generic screen is shown on fig. 7. Specific setup procedures are detailed on the pages dedicated to radar, guided radar and ultrasonic devices.

All Endress+Hauser ToF level measurement devices have the same display.
The display of the process value and the configuration of the device occur locally by means of a large 4-line alphanumeric display with plain text information. The menu-guided system with integrated help texts ensures quick and safe commissioning (see fig. 3).
To access the display, the cover of the electronic compartment may be removed even in hazardous area (IS and XP).

The VU331 liquid crystal display (LCD) can be removed to ease operation by simply pressing the snap-fit (see fig. 6). It is connected to the device by means of a 500mm/19.7" cable. The display allows configuration via three keys directly at the instrument. All device functions can be set via a menu system. The menu consists of function groups and functions. Within a function, application parameters can be read or adjusted. The user is guided through a complete configuration procedure.

You can also configure your ToF instruments from your PC. Remote commissioning, including documentation of the measuring point and in-depth analysis functions, is supported via FieldCare software. More information on FieldCare can be found at
www.products.endress.com/fieldcare

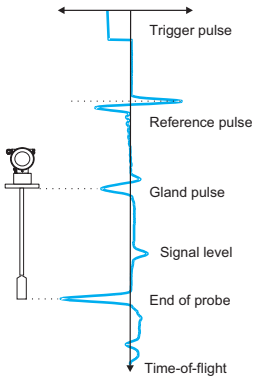


Fig. 3: Schematic envelope curve with a guided radar instrument.

The envelope curve contains the following signals in chronological order:
- Trigger pulse. This starts recording the envelope curve.
- Reference pulse. This is produced in the HF module and is used as a mark from which all distances are measured.
- Negative gland pulse (fiducial). This stems from the transmitter pulse gland to the probe
- Level echo and any interference echoes
- End of probe signal (LN). This is
  – Negative for unattached or insulated tie-down probe ends
  – Positive for grounded tie-down probe ends.

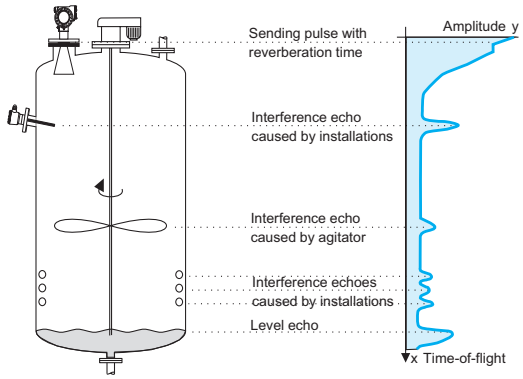


Fig. 4: Example of a tank (equipped with a radar instrument) with a schematic envelope curve.

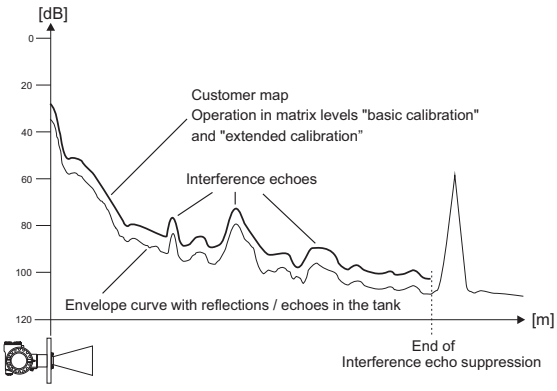


Fig. 5: Customer map.

Save time and resources…
Our service team can set up any Endress+Hauser level measurement device for you to ensure you immediately get the best from your instrument.
(See **'Device Commissioning'** in the 'At your service' section).

Operation and maintenance

Routine maintenance

ToF devices have no moving parts thus require very little maintenance. However, because of their criticality to the quality, some instruments need to be inspected or/and calibrated periodically.

Defining the right maintenance frequency taking several parameters into account is an expert's job. Endress+Hauser can also help you with this task!

To test the 4-20mA loop:
- The 2-wire, 4-20mA with HART version includes test sockets for testing of the signal current (see fig. 8).
- On the 4-wire versions (Levelflex and Prosonic), there are two terminals situated at the front of the electronic module (see fig. 9).

Checking the measurement (all devices)

Configuration of the level measurement instrument is often undertaken during the commissioning phase. In the majority of cases this is sufficient.
In some cases it is useful to make additional checks of your level measurement in order to:
- Validate the measured value related to the real level in the tank
- Eliminate interference echoes emitted by the installations in an empty tank (for ToF devices)

If level measurement instruments are to be recalibrated following an operational phase, this is often done by gauging the capacity of a container in liters, so there is no need to remove the device from the process. We can provide you with specific advice on this.

Maintenance planning

Do you know exactly which part of your installed instrumentation base is **critical to the operation** of the plant and how you could maintain or calibrate it more efficiently? Are you sure that your present actions are minimizing the risks of **unplanned breakdowns**? Are you sure that your present actions are the most **cost-effective**?

With Endress+Hauser's Installed Base Audit, our service consultant will help you to quickly find an answer to these questions and move forward in a controlled manner to a maintenance plan which improves plant reliability while reducing costs…
(See **'Maintenance and calibration consulting'** in the 'At your service' section).

Maintenance performing

In case your internal resources have neither the time, the skill levels nor the right tools to efficiently perform your maintenance, Endress+Hauser **service contracts** provide you with the flexibility to decide the right level of maintenance support you require.

We provide regular checks on your equipment and warranty extensions for your complete peace of mind and cost control. From regular support to partnership agreements, we offer four distinct levels of service…
(See **'Maintenance services'** in the 'At your service' section).

Corrective maintenance - spare parts

The more critical your instrument to your process, the shorter the acceptable repair time.
- Thanks to the TOF concept, most parts can be easily replaced by the user (also for Ex) thus allowing quick repair: display, electronic module, antenna.
- Tags on each component allow easy identification of spares.
- An installation manual is provided with every spare part.

In case of a highly critical instrument, you might consider stocking a complete new instrument.

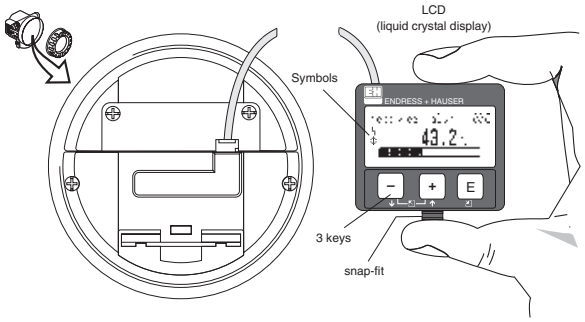


Fig. 6: On-site operation with VU331.

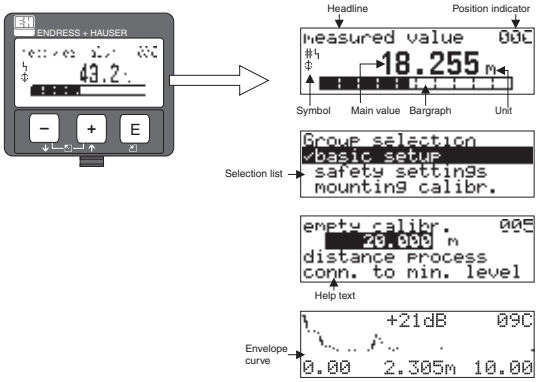


Fig. 7: The 'Basic Setup' covers 95% of the situations.

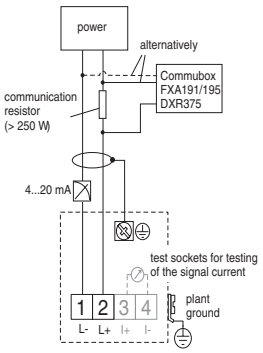


Fig. 8: Terminal assignment - 2-wire, 4-20mA with HART.

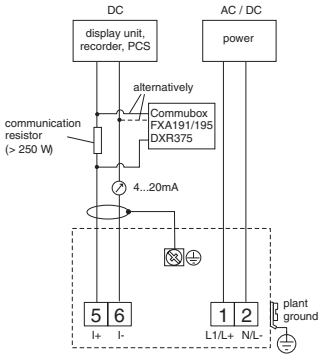
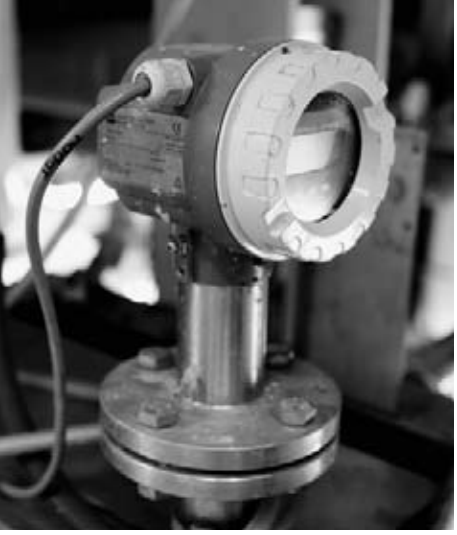


Fig. 9: Terminal assignment - 4-wire, AC/DC power, 4-20mA with HART.



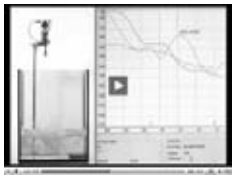
Radar level measurement

Micropilot series

It has been already several years since Micropilot M instruments constitute the main part of the current range of radar level measurement. FMR230 (horn antenna) and FMR231 (rod antenna) instruments use 6 GHz waves, while FMR240 (horn antenna, FMR244 (horn antenna encapsulated in PTFE), FMR245 (flat antenna) and FMR250 (radar level measurement on solids) use 26 GHz waves.

In this section, you will find essential information and advice that will help you to perform the optimum follow-up of your Micropilot M instruments throughout their lifecycle. Please read 'Basics' first (pages 8 to 10).

90% of the success of the setup depend on proper installation



Videos available at
www.endress.com/videos

Micropilot series - overview

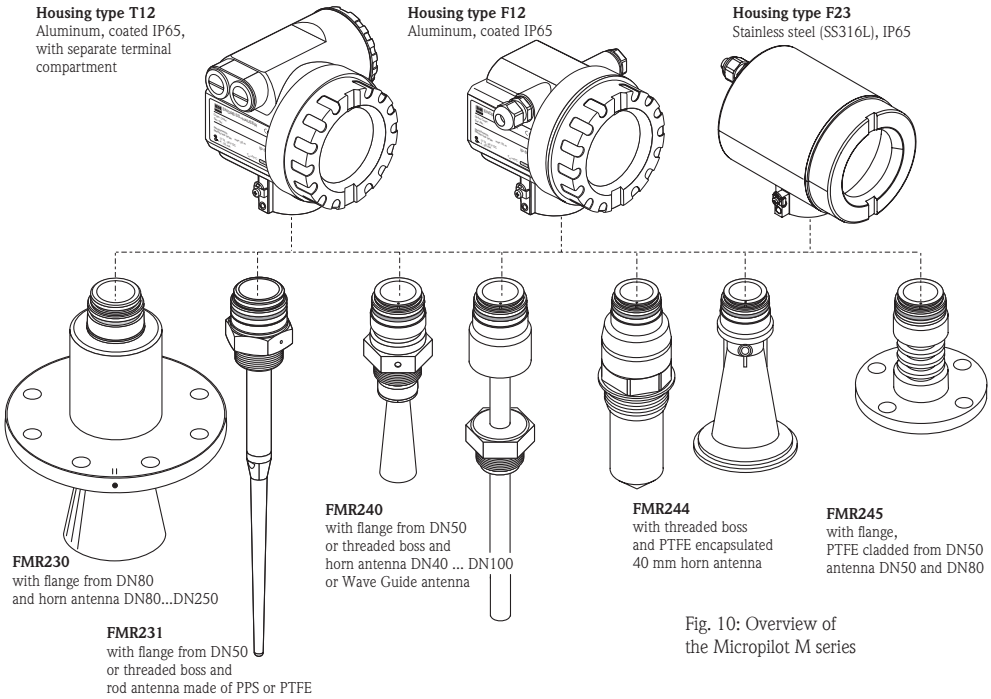


Fig. 10: Overview of the Micropilot M series

Measuring principle

The Micropilot is a 'downward-looking' measuring system, operating based on the Time of Flight method. It measures the distance from the reference point (process connection) to the product surface. Radar impulses are emitted by an antenna, reflected off the product surface and received again by the radar system.

Input (see fig. 11)
The reflected radar impulses are received by the antenna and transmitted into the electronics. A microprocessor evaluates the signal and identifies the level echo caused by the reflection of the radar impulse at the product surface. The unambiguous signal identification is accomplished by the PulseMaster® eXact software, based on many years of experience with Time of Flight technology.
The distance D to the product surface is proportional to the time of flight t of the impulse: $D = c \cdot t/2$, with c being the speed of light.
Based on the known empty distance E, the level L is calculated:
$L = E - D$

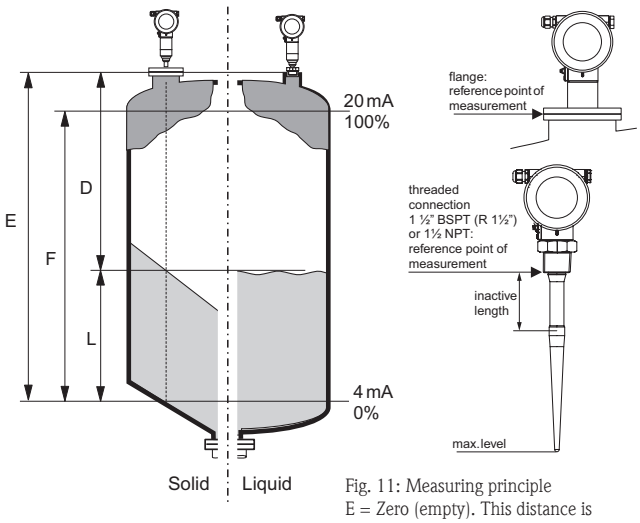
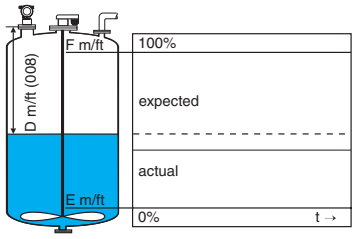
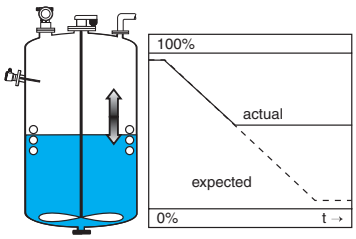
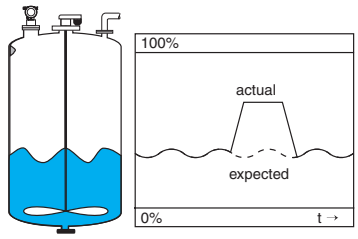
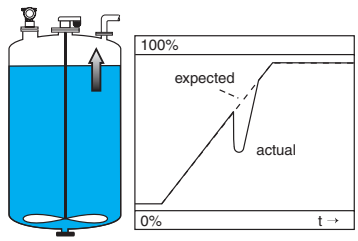
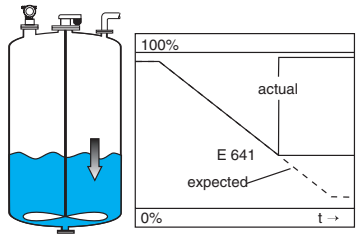


Fig. 11: Measuring principle
E = Zero (empty). This distance is calculated from the reference point
F = Span (full).

Operation and maintenance

See ‘Basics’ for general information on the maintenance of level devices (page 10).

Guidelines to fix application errors

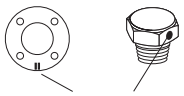
Error	Output	Possible cause	Solution
A warning or alarm has occurred	Depending on the configuration	→	1. See table of error messages in the instruction manual BA221F
Measured value (00) is incorrect		Measured distance (008) OK? yes →	1. Check empty calibr. (005) and full calibr. (006). 2. Check linearization: → Level/ullage (040) → Max. scale (046) → Diameter vessel (047) → Check table
		no ↓ Measurement in bypass or stilling well? yes →	1. Is bypass or stilling well selected in tank shape (002)? 2. Is the pipe diameter (007) correct?
		no ↓ An interference echo may have been evaluated. yes →	1. Carry out tank mapping → Basic setup
No change of measured value on filling/emptying		Interference echo from installations, nozzle or extension on the antenna →	1. Carry out tank mapping → Basic setup 2. If necessary, clean the antenna 3. If necessary, select a better mounting position 4. If necessary due to wide interference echoes, set function detection window (047) to “off”
If the surface is not calm (e.g. filling, emptying, agitator running), the measured value jumps sporadically to a higher level		Signal is weakened by the rough surface – the interference echoes are sometimes stronger. →	1. Carry out tank mapping → Basic setup 2. Set the process cond. (004) to “turb. surface” or “agitator” 3. Increase the output damping (058) 4. Optimize the orientation 5. If necessary, select a better mounting position and/or a larger antenna
During filling/emptying the measured value jumps downwards		Multiple echoes yes →	1. Check the tank shape (002), e.g. “dome ceiling” or “horizontal cyl” 2. In the range of the blocking dist. (059) there is no echo evaluation → Adapt the value 3. If possible, do not select central installation position 4. Perhaps use a stilling well
E 641 (loss of echo)		Level echo is too weak. Possible causes: ■ Rough surface due to filling/emptying ■ Agitator running ■ Foam yes →	1. Check application parameters (002), (003) and (004) 2. Optimize alignment 3. If necessary, select a better installation position and/or larger antenna

Installation conditions

Because most problems reported by users are due to incorrect installation and/or initial calibration, here is a reminder of the essential points that must be considered.

Alignment of installed device according to electrical field

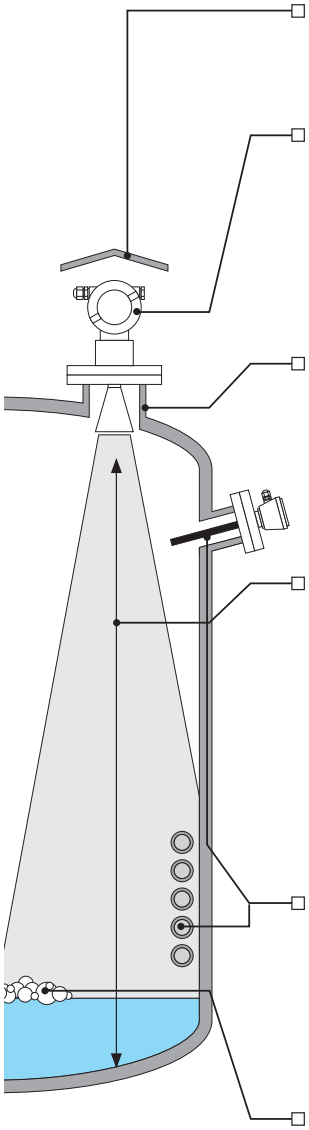
A signal beam is always composed of an electrical and a magnetic field, oriented at 90° towards each other.
The marker point on the threaded boss or the flange marks a virtual horizontal extension of the antenna incoupling, thus the polarization of the electrical field in the signal beam. An optimization of the measurement can be achieved by turning the threaded boss or the flange (thus the electromagnetic field). Matrix field 056 displays a value [dB] that allows a judgment of the alignment.



The marking is stamped on the flange or threaded boss.

Fig. 12
See 'Alignment of installed device according to electrical field' on pages 13 and 14.

Installation in tank (free space)



Weather protection cover
- Always recommended for outside installation to avoid strong temperature changes of electronics

Installation
- Not in the center
- Not above the fillstream
- Distance to wall ~1/6 of the tank diameter, at least, however, 30cm/12" (6GHz), or 15cm/6" (26GHz)
- If these conditions cannot be met: use stilling well

Nozzle ⚠
- Horn antenna should protrude from the nozzle, otherwise use antenna extension.
- The inactive part of the rod antenna should be longer than the height of the nozzle, otherwise contact us.

Measuring range
- Measurement is possible up to the tip of the antenna, on principle, however the end of the measuring range should not be closer than 50mm/2" to the tip of the antenna because of corrosion and build-up formation.
- The measuring range starts where the radar beam meets the tank bottom. With dish bottoms or conical outlets, the level cannot be detected below this point.

Tank installations
- Avoid any installations such as limit switches, temperature sensors, etc. within the signal beam.
- Symmetrical installations, e.g. vacuum rings, heating coils, flow breakers, etc. may impair measurement.

Formation of foam
- Radar pulses may be absorbed by foam.

Fig. 13

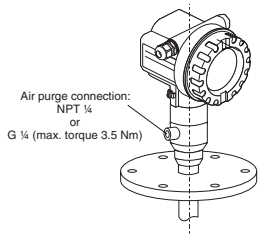


Figure 14: FMR250 integrated air purge connection.

Special instructions for FMR250
In extremely dusty applications, the integrated air purge connection can prevent clogging of the antenna (see fig. 14). Pulsed operation is recommended (max. pressure of purge air: 6 bar abs / 87 psi). In case of permanent operation, recommended pressure range of the purge air is 200 to 500 mbar (2.9 to 7.25 psi). Make sure to use dry purge air.

Beam angles
The larger the antenna diameter the smaller the beam angle (see table 1 below).

	FMR230			FMR231	FMR244	
Size of antenna	DN150 /6"	DN200 /8"	DN250 /10"	Rod antenna	DN40 /1.5"	DN80 /3"
Beam angle	23°	19°	15°	30°	23°	10°

	FMR240				FMR245	
Size of antenna	DN40 /1.5"	DN50 /2"	DN80 /3"	DN100 /4"	DN50 /2"	DN80 /3"
Beam angle	23°	18°	10°	8°	18°	10°

Table 1

Alignment of installed device according to electrical field

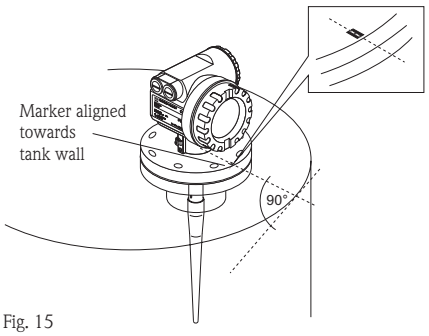


Fig. 15

Optimum mounting position - special instructions

FMR245

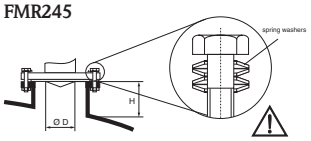


Fig. 16

Size of antenna	50mm /2"	80mm /3"
D	48mm /1.9"	75mm /3"
H	< 500mm / <20"	< 500mm / <20"

FMR250

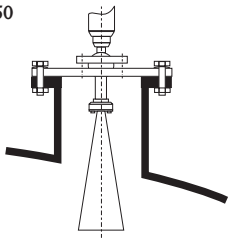
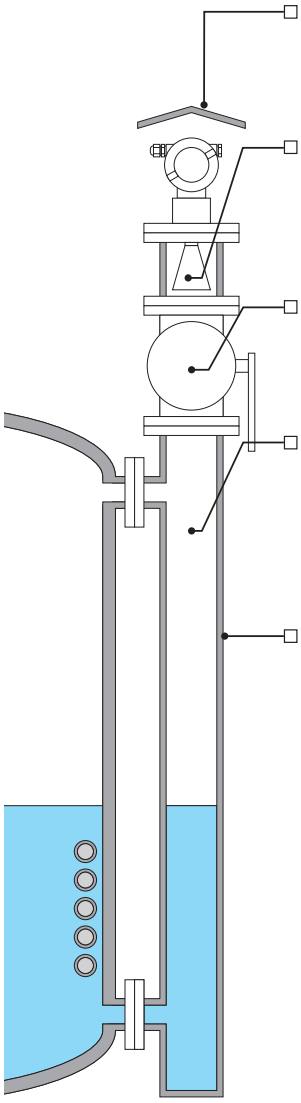


Fig. 17

The horn antenna should protrude from the nozzle. If this is not possible for mechanical reasons, larger nozzle heights can be accepted.

Installation in a bypass



Weather protection cover
- Always recommended for outside installation to avoid strong temperature changes of electronics.

Optimum horn size
- Select the largest possible horn antenna. In case of in-between sizes (e.g. 95mm/3.7") use the next larger antenna and adapt it mechanically.

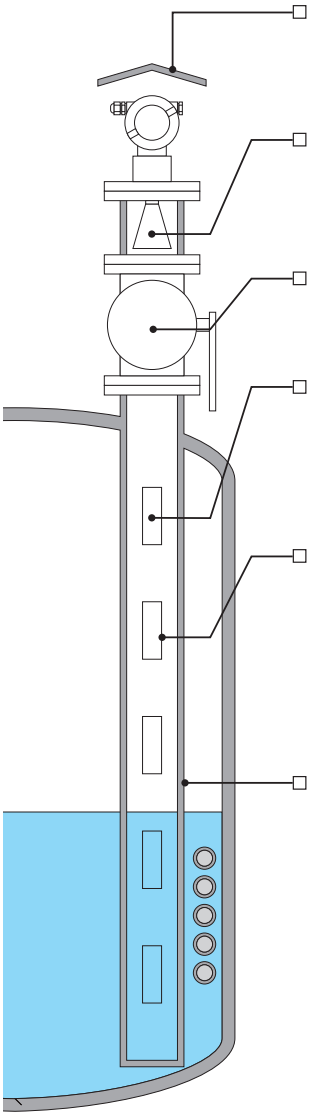
Ball valve
- Measurements through an open ball valve with full passage are possible.

Measuring range
- Measurement is possible up to the tip of the antenna, in principle, however, the end of the measuring range should not be closer than 50 mm/2" to the tip of the antenna because of corrosion and build-up formation.

Recommendations for the bypass
- Metallic (without plastic or enamel coating).
- The bypass pipe must be smooth inside (average roughness Ra ≤6.3µm).
- Constant diameter.
- In transition, caused for example by ball valves or joining of individual pipe pieces, gaps of max. 1mm/0.04" are permitted.

Fig. 18

Installation in a stilling well



Weather protection cover
- Always recommended for outside installation to avoid strong temperature changes of electronics.

Optimum horn size
- Select the largest possible horn antenna. In case of in-between sizes (e.g. 95mm/3.7") use the next larger antenna and adapt it mechanically.

Ball valve
- Measurements through an open ball valve with full passage are possible.

Measuring range
- Measurement is possible up to the tip of the antenna, in principle, however, the end of the measuring range should not be closer than 50mm/2" to the tip of the antenna because of corrosion and build-up formation.

Slots / holes
- As few holes / slots as possible.
- Slot width or hole diameter max 1/10 of pipe diameter.
- Deburred.
- Length and number do not affect the measurement.
- Slots / holes 180° offset (not 90°).

Recommendations for stilling wells
- Metallic (without enamel coating, plastic upon request).
- Constant diameter.
- Welding seam as even as possible and placed in the axis of the slots.
- The stilling well must be smooth inside (averaged roughness Ra ≤ 6.3µm).
- Do not weld through the wall of the pipe, the inside of the pipe must remain smooth.
- In transition, caused for example by ball valves or joining of individual pipe pieces, gaps of max. 1mm/0.04" are permitted.

Fig. 20

Alignment of installed device according to electrical field (bypass)

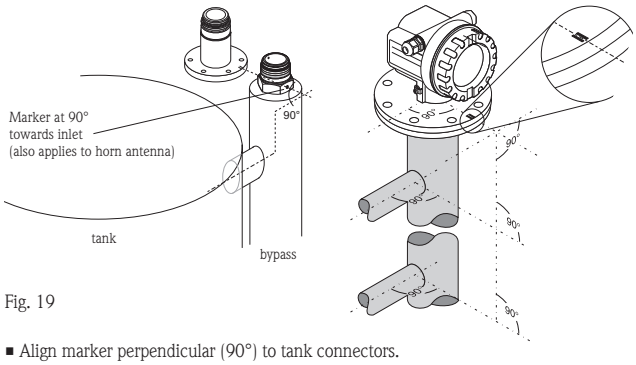


Fig. 19

- Align marker perpendicular (90°) to tank connectors.
- The marker is always exactly in the middle between two bolt-holes in the flange.
- After mounting, the housing can be turned 350° in order to simplify access to the display and the terminal compartment.
- The horn must be aligned vertically.
- Measurements can be performed through an open full bore ball valve without any problems.

Alignment of installed device according to electrical field (stilling well)

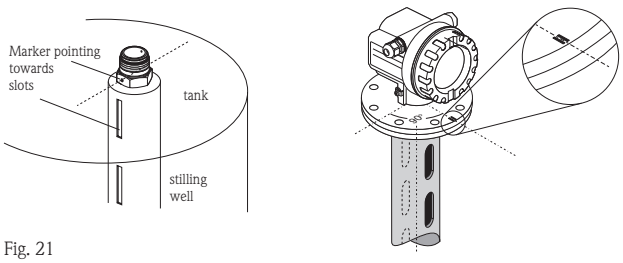
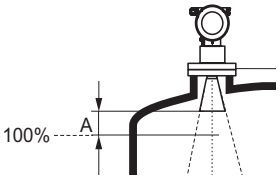


Fig. 21

- Align marker toward slots.
- The marker is always exactly in the middle between two bolt-holes in the flange.
- After mounting, the housing can be turned 350° in order to simplify access to the display and the terminal compartment.
- Measurements can be performed through an open full bore ball valve without any problems.

Blocking distance
In principle it is possible to measure up to the tip of the antenna with FMR230/231/240/244/245 and 250. However, due to considerations regarding corrosion and build-up, the end of the measuring range should not be installed any closer than A (see fig. 22) to the tip of the antenna.



	A
FMR 230/231/240	50mm (2")
FMR 244	150mm (6")
FMR 245	200mm (8")
FMR 250	400mm (16")

Fig. 22: Blocking distance

Setup

The 'Basic Setup' menu enables a quick and simple commissioning. The software helps the user to enter the main parameters which cover 95% of the cases. By entering the data carefully you will avoid many problems. (See figure 23).

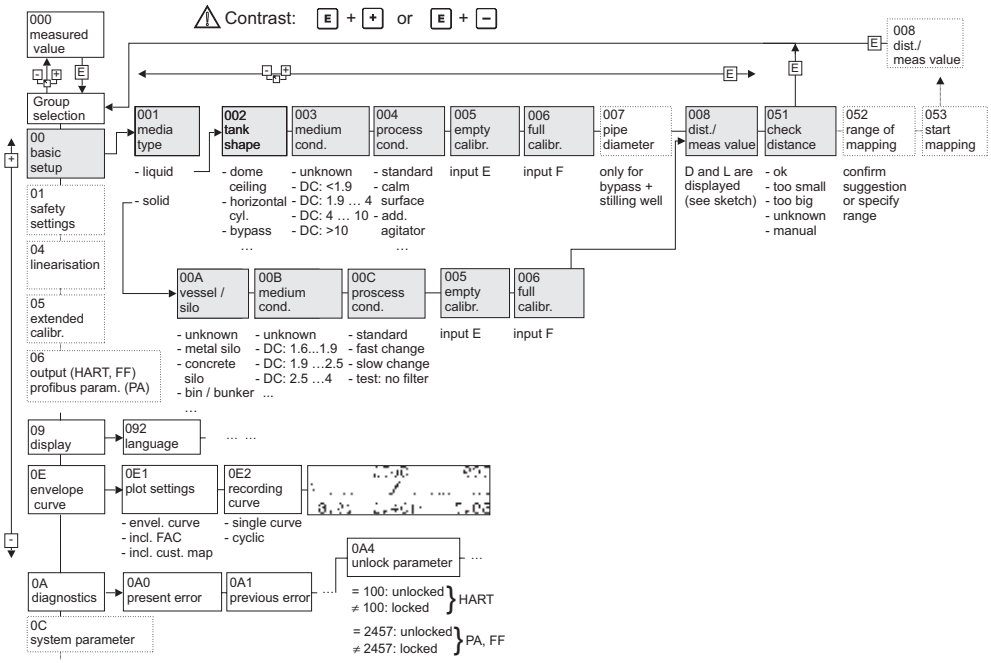


Fig. 23: 'Basic Setup' for Micropilot M devices

Spare parts

Special instructions for all radar devices
The replacement of either the electronic module or the HF module requires a reprogramming. Some of the default parameters have to be modified. The relevant procedure is delivered with the new module.

Instrument and spare parts availability
All Micropilot devices are currently in production.

Re-engineering

Instruments that operate at 26GHz used to be used in storage applications.

However, thanks to the recent redevelopment, from software version 1.05.xx, the new 26GHz instruments can now be used in process applications. Please consult us.

Instruments that operate at 6GHz are for use in more demanding applications (with turbulent surface or foam formation).

See also our online Applicator tool:
https://wapps.endress.com/applicator

For further information about the status of your instrument, use our Device Viewer:
www.services.endress.com/device-viewer

Guided radar level measurement

Levelflex series

The current Levelflex guided radar range includes both Levelflex M FMP4x range and new Levelflex FMP5x range. Due to the recent availability of the FMP5x family, we decided to briefly introduce it to you and to keep maintenance information for the next issue of this Maintenance Guide.

In this section we aim to provide efficient help to Levelflex M FMP4x users throughout the life cycle. Please read 'Basics' first (pages 8 to 10).

Measuring principle

High-frequency pulses are injected into a probe and led along the probe. The pulses are reflected by the product surface, received by the electronic evaluation unit and converted into level information.

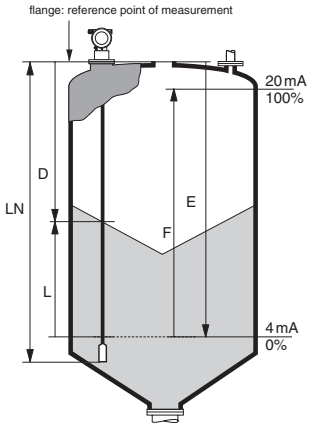


Fig. 24: Measuring principle

The distance D to the product surface is proportional to the Time of Flight t of the impulse: $D = c \cdot t/2$, with c being the speed of light. Based on the known empty distance E, level L is calculated: $L = E - D$
Reference point for E see fig. 24.
The Levelflex comes with functions to suppress interference echoes (e.g. internals and struts).

Note: The dielectric constant (DC) of the medium has a direct impact on the degree of reflection of the high-frequency pulses.

Levelflex M FMP4x series - overview

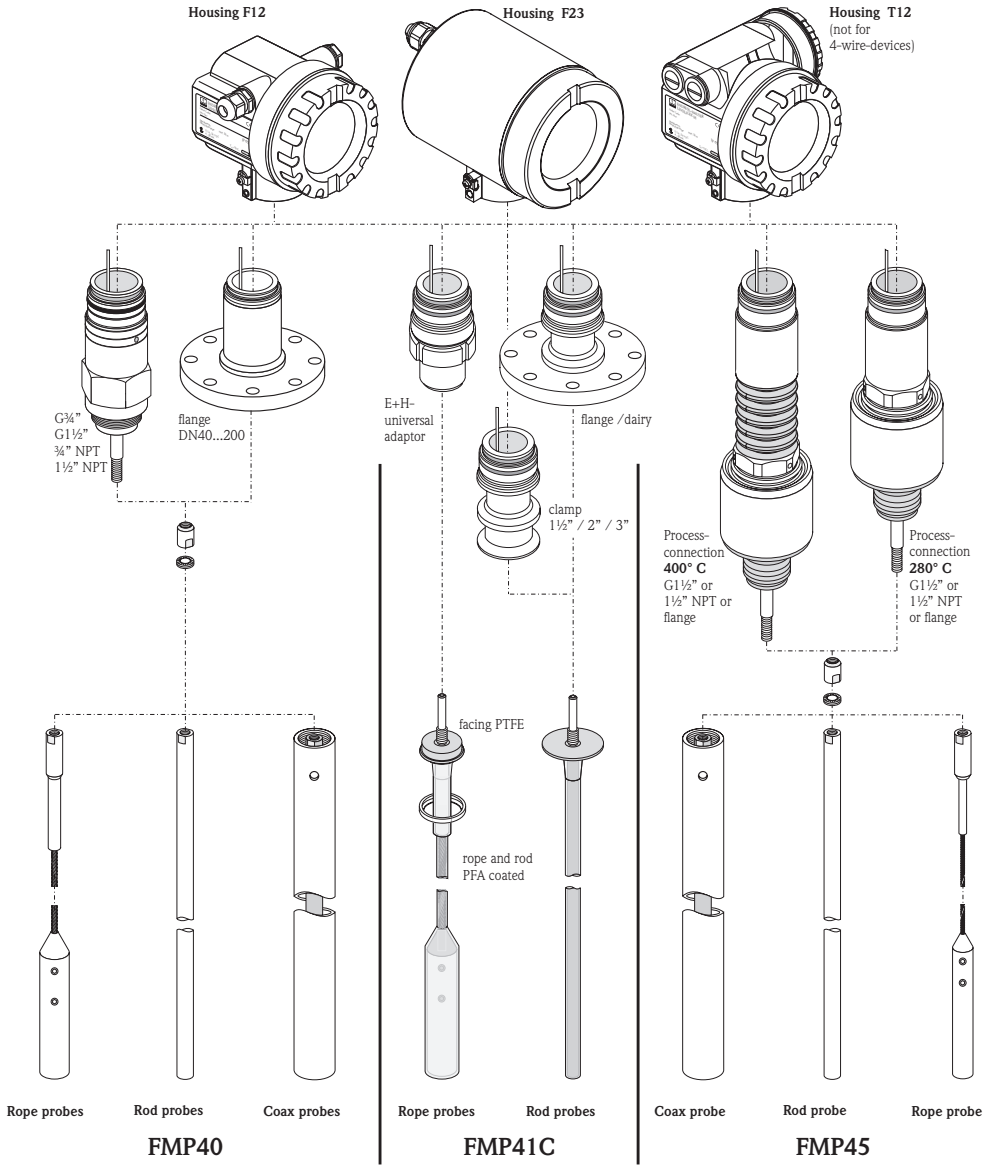


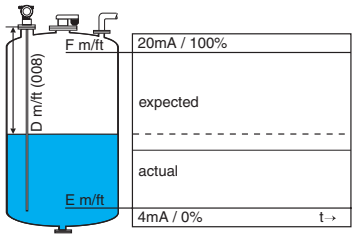
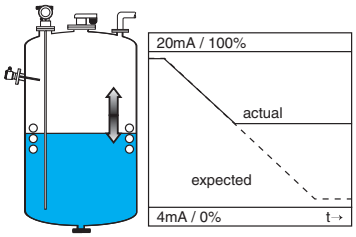
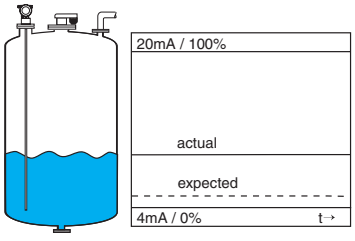
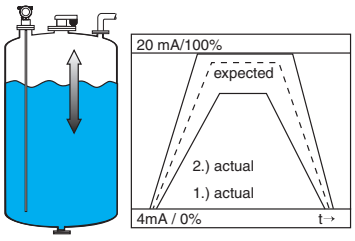
Fig. 25: Overview of the Levelflex M series

Consider blocking distances and pay attention to the nozzle.

Videos available at
www.endress.com/videos

Operation and maintenance See 'Basics' for general information on the maintenance of level devices (page 10).

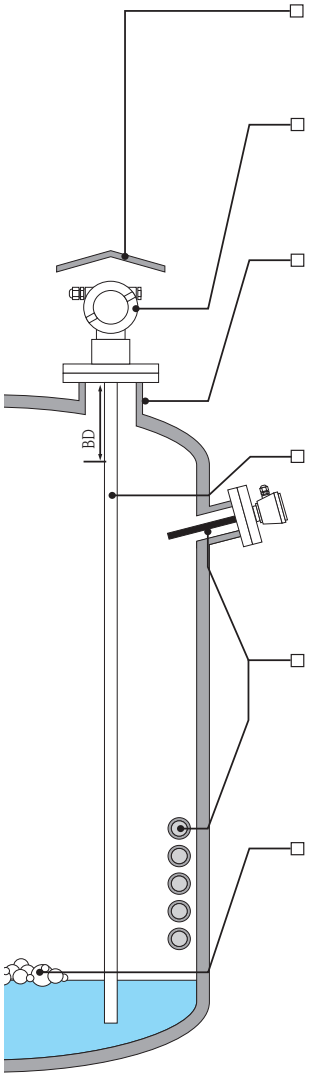
Guidelines to fix application errors

Error	Output	Possible cause		Solution
A warning or alarm has occurred.	Depending on the configuration.			1. See table of error messages in the instructions manual BA245F.
Measured value (00) is incorrect.		Measured distance (008) OK?	yes →	1. Check empty calibr. (005) and full calibr. (006). 2. Check linearization: → Level/ullage (040) → Max. scale (046) → Diameter vessel (047) → Check table
		no ↓		
		An interference echo may have been evaluated.	yes →	1. Carry out tank mapping → Basic setup
No change of measured value on filling/emptying.		Interference echo from tank internals, nozzle or build-up on the probe.	⟶	1. Carry out tank mapping → Basic setup 2. If necessary, clean the probe 3. If necessary, select a better mounting position
Device displays a level when the tank is empty.		Incorrect probe length.	⟶	1. Carry out automatic probe length detection when the tank is empty. 2. Carry out mapping over entire probe when the tank is empty (probe free!).
Measured value incorrect (slope error in the entire measuring range).		Tank properties incorrect.	yes →	LN < 4m and 'Aluminum tank' tank properties selected → Calibration not possible → Selection → Select standard → Thresholds too high
		Medium properties incorrect.	yes →	Select lower medium properties.

Installation conditions

Because most problems reported by users are due to incorrect installation and/or initial calibration, here is a reminder of the essential points that must be considered.

Installation in a tank (measurement in liquids)



Weather protection cover
- Always recommended for outside installation to avoid strong temperature changes of electronics.

Installation
- Not in the center.
- Not above the fillstream.
- Any wall distance, avoid wall contact.

Nozzle
- Nozzles diameters of 50mm/2” to 150mm/6” and nozzle heights up to 150mm/6” are preferred.
- For rope probes in nozzles with > 150mm/6” in height, an HMP40 rod extension must be used.

Measuring range
- Smallest measuring range: 300mm /12”.
- Largest measuring range: 35m/110ft (larger upon request).

Tank installations
- Distance to obstacles min. 300mm /12”.
- During commissioning interference echo can be suppressed.

Turbulent surface / foam
- Turbulent surfaces do not affect measurement.
- Foam layers of up to approx. 100mm /4” do not affect measurement. Higher foam thickness may result in too small readings.

Fig. 26

Upper blocking distance
The upper blocking distance (UB) is the minimum distance from the reference point of the measurement (mounting flange) to the maximum level. Within the blocking distance, a reliable measurement cannot be guaranteed.

New FMP5x devices include factory settings for the blocking distance:
- with coax probes: 0mm (0”).
- with rod and rope probes up to 8m (26ft): 200mm (8”).
- with rod and rope probes exceeding a length of 8m (26ft): 0.025 * (length of probe).

Depending on the application these settings can be changed.

Lower blocking distance
At the lowest part of the probe an exact measurement is not possible. The following measuring error is present in the vicinity of the probe end.

If ε_r (dielectric coefficient) value is less than 7 for rope probes, then measurement is not possible in the area of the straining weight (0 to 10”/ 250mm from end of probe). (See table).

Installation in a stilling well or a bypass

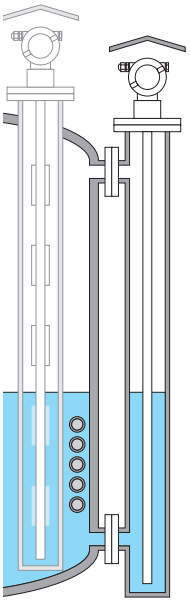


Fig. 27

Weather protection cover
- Always recommended for outside installation to avoid strong temperature changes of electronics.

Bypass / measuring tubes
- Metallic pipe.
- No special requirements of bypass pipe or stilling well.
- Welding seams protruding internally up to approx. 5mm/0.2” do not impair measurement.

Installation in concrete silos
Installation should be made flush with the lower edge. Alternatively, the probe can also be installed into a pipe that must not protrude over the lower edge of the silo ceiling. The pipe should be kept at a minimum length.
The centering disk should be used for tube diameter > 150mm/6” to prevent build-up in the inner part of the tube.

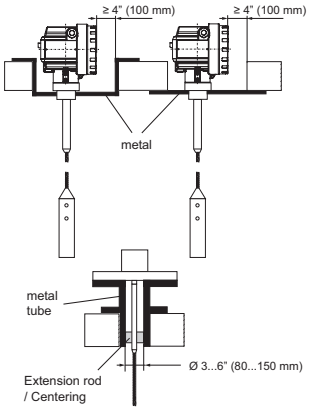


Fig. 28

Installation in plastic containers
The guided radar measuring principle requires a metal surface at the process connection. When installing the rod and rope probes in plastic silos, where the silo cover is made of plastic or wood, the probes must either be mounted in a ≥ DN50/2” metal flange, or a metal sheet with diameter of ≥ 200mm/8” must be mounted under the screw-in piece.

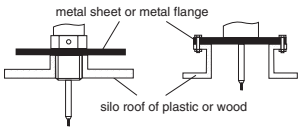
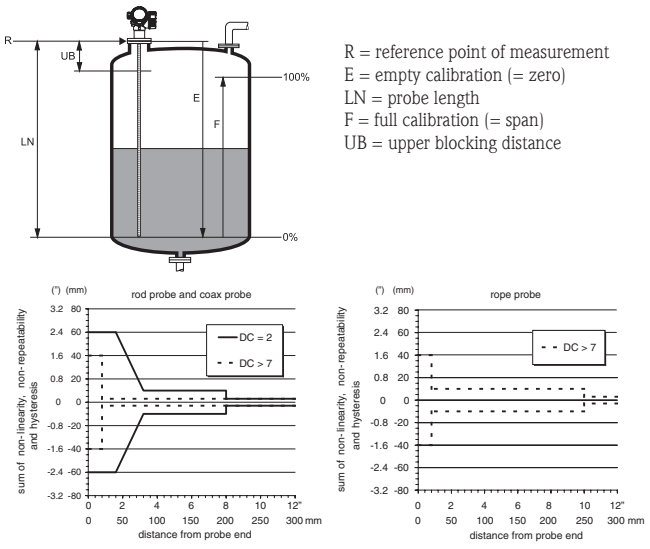


Fig. 29



R = reference point of measurement
E = empty calibration (= zero)
LN = probe length
F = full calibration (= span)
UB = upper blocking distance

Fig. 30: Measuring error in the vicinity of the probe end

Installation in a tank (measurement in solids)

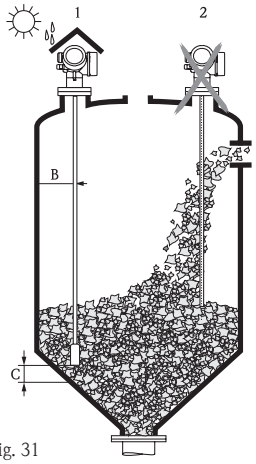


Fig. 31

Weather protection cover (1)
- Always recommended for outside installations (solar radiation and rain).

Installation
- Do not install rod and rope probes in the filling curtain. [2]
- Install rod and rope probes at a distance to the wall [B], so that in case of build-up on the wall a distance to the probe of at least 100mm/4" remains.
- Install rod and rope probes with the largest possible distance to baffles. In case of distances <300mm/12", an interference echo suppression must be included in commissioning.
- When rod and rope probes are installed in plastic vessels, the minimum distance of 300mm/12" is also applicable to metallic parts outside of the vessel.
- Rod and rope probes must not be in contact with metal vessel walls or bottoms.
- The minimum distance of the probe end to the bottom of the vessel is applicable [C]: >10mm/0.4".
- Avoid bending the rope probe sharply during installation or operation (e. g. by product movements against the wall of the silo) by the selection of a suitable point of installation.

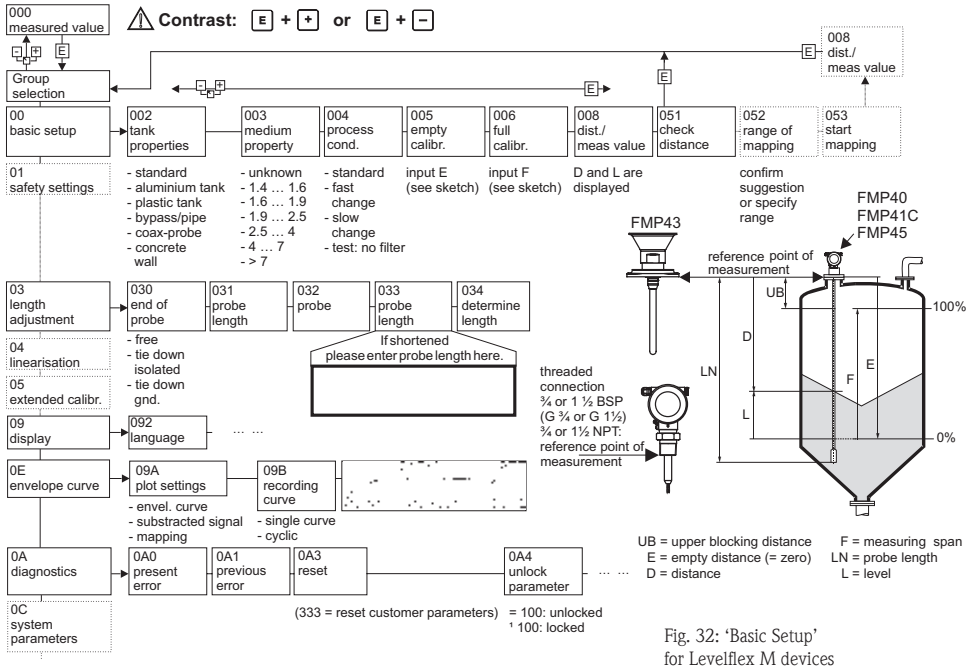


Fig. 32: 'Basic Setup' for Levelflex M devices

Setup

The 'Basic Setup' menu enables quick and simple commissioning. The software helps the user to enter the main parameters that cover 95% of cases. By entering the data carefully, many problems are avoided. (See figure 32).

Map and subtracted signal

In order to suppress interference signals, the envelope curve (see Basics) is not directly evaluated in the Levelflex M. Instead, the mapping curve is first subtracted from it. Level echoes are sought in the resulting subtracted signal.

Subtracted signal =
Envelope curve - Mapping curve

The mapping curve is intended to be as good a map as possible of the probe and the empty tank or silo. Ideally, only signals from the product are then left in the subtracted signal. A mapping curve ('the factory map') is included in the Levelflex M on delivery. For rod probes it spans the entire probe length, for rope probes only the first 1.5m/5ft.

Once the device has been installed, a customer map should be recorded in the empty tank or over as much free space as possible, so that each individual environment of the probe is mapped as well as possible. The 'extended calibration' function group (05) is used to record the customer map. Depending on the range of this customer map, it overwrites part or all of the factory map.

For rope probes, there is also a dynamic map. This does not explicitly need to be recorded, rather it constantly adapts itself to the (changing) properties of the probe environment during ongoing operation. The dynamic map is valid beyond the range of the static map.

Spare parts

Special instructions for all radar devices
The replacement of either the electronic module or the HF module requires a reprogramming. Some of the default parameters have to be modified. The relevant procedure is delivered with the new module.

Instrument and spare parts availability
All Levelflex devices are currently in production.

For further information, use our Device Viewer:
www.services.endress.com/device-viewer

New Levelflex FMP5x family

The new Leveflex FMP5x range was developed according to the latest standards in security, accuracy and efficiency.

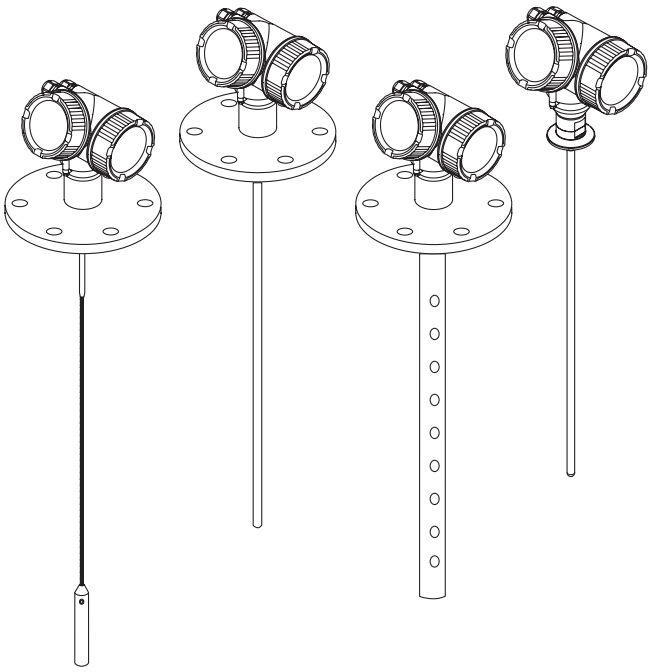


Fig. 33

- FMP50: Cost-effective basic device for supply and storage applications and utility processes.
- FMP51: Premium device for level and interface measurement in liquids.
- FMP52: Premium device with coated probe for the use in aggressive liquids. Wetted parts FDA listed materials.
- FMP53: Premium device for the highest hygiene requirements. ASME BPE and USP Class VI compliant.
- FMP54: Premium device for high-temperature and high-pressure applications, mainly in liquids.
- FMP55: Premium device with coated multiparameter probe for interface measurement in the oil & gas, chemical and power industry.
- FMP56: Cost-effective basic device for common bulk solids applications in small silos and tanks.
- FMP57: Premium device for level measurement in bulk solids.

Maintenance advantages at a glance

Installation
- No special tool required
- Reverse polarity protection
- Modern, detachable terminals
- Main electronics protected by a separate connection compartment

Commissioning
- Fast, menu-guided commissioning in only 6 steps
- Plain text display in national languages reduces the risk of error or confusion
- Direct local access of all parameters
- Short instruction manual integrated into the device

Operation
- Multi-echo tracking: Increased echo rate and analysis as well as automatic suppression of interfering echoes
- Diagnostics in accordance with NAMUR NE107

Maintenance
- HistoROM: Data backup for instrument settings and measured values
- Exact instrument and process diagnosis to assist in fast decision-making with clear details concerning remedial solutions
- Intuitive, menu-guided operating concept in national languages saves costs for training, maintenance and operation
- Housing cover can be opened in hazardous areas

Video about the new Levelflex family available at www.endress.com/videos

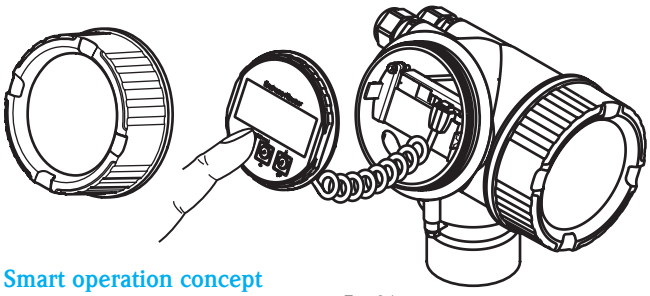


Fig. 34

Smart operation concept for flow and level

Endress+Hauser has standardized and harmonized its new 2-wire device concept for flow and level devices.

Video about our 2-wire concept available at www.endress.com/videos

Migration

Although the FMP4x familiy is still available, the table below provides information in preparation for the migration from FMP4x to FMP5x devices.

	Liquids				Solids
Levelflex M	FMP40	FMP41C	FMP43	FMP45	FMP40
New Levelflex	FMP50/51	FMP52	FMP53	FMP54	FMP56/57

Table 2: Successors of Levelflex M FMP4x devices

Ultrasonic level measurement

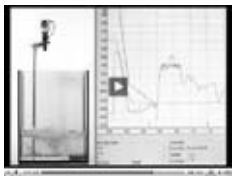
Prosonic series

The current Prosonic ultrasonic transmitter range includes the Prosonic M FMU40/41/42/43/44 and Prosonic S FMU90. With this section we aim to:

- **Provide help to Prosonic M users**
- **Answer the most frequently asked question by Prosonic S FMU86x users and give them key information to successfully migrate to FMU90.**

Please read 'Basics' first (pages 8 to 10).

The installation of the sensor and the presence of foam or bubbles have a strong impact on the measurement.



Videos available at
www.endress.com/videos

Measuring principle

The Prosonic M sensor emits ultrasonic pulses in the direction of the product surface. There, they are reflected back and received by the sensor. The Prosonic M measures the time t between pulse emission and reception. The instrument uses time t (and the velocity of sound c) to calculate distance D between the sensor membrane and the product surface:
$D = c \cdot t/2$
As the device knows the empty distance E from a user entry, it can calculate the level as follows: $L = E - D$
An integrated temperature sensor compensates changes in the velocity of sound caused by temperature changes.

Interference echo suppression

The interference echo suppression feature of Prosonic M ensures that interference echoes (e.g. from edges, welded joints and installations) are not interpreted as level echoes.

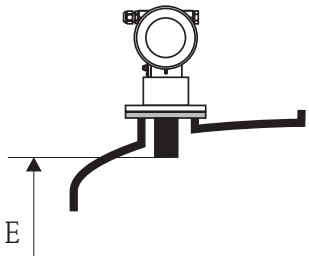
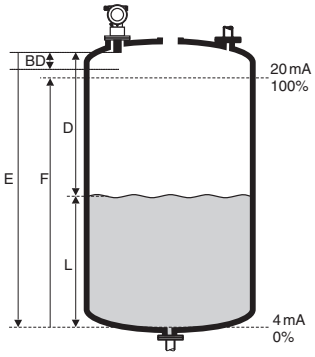


Fig. 35: Measuring principle
F = span (full distance)
E = empty distance
D = distance from sensor membrane to the product surface
BD = blocking distance
L = level



Prosonic M series - overview

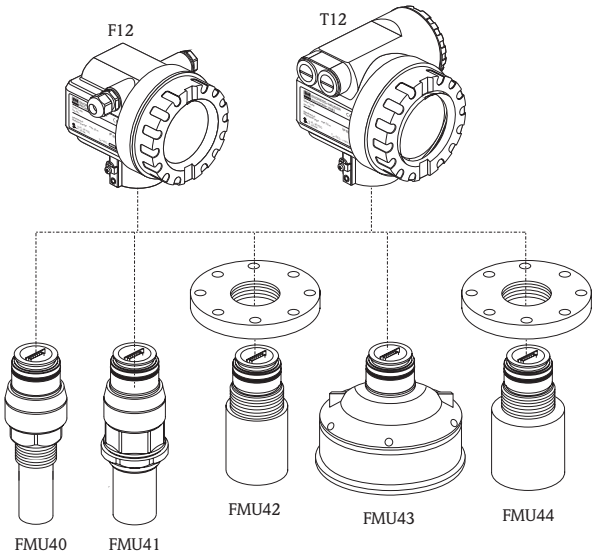


Fig. 36

Prosonic S FMU90 - overview

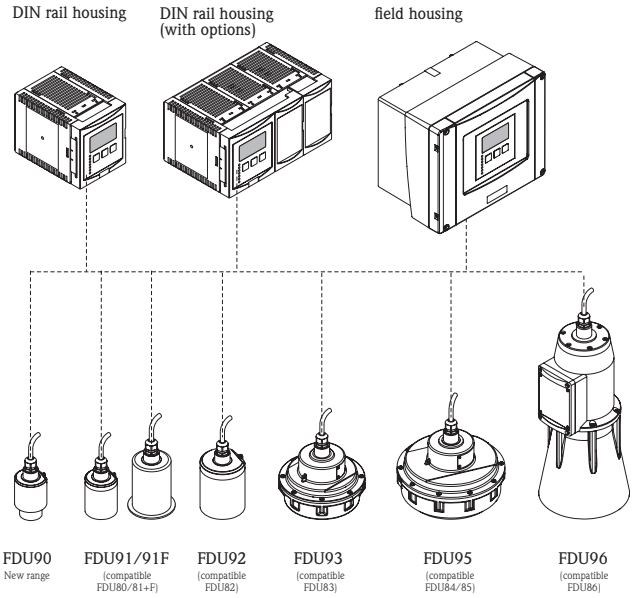
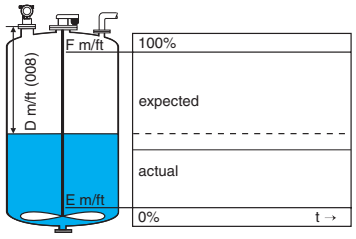
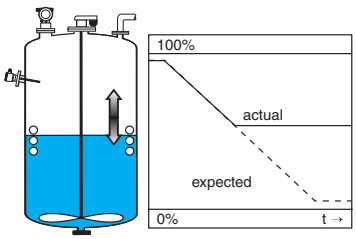
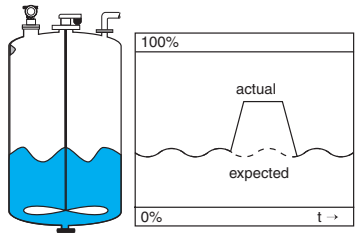
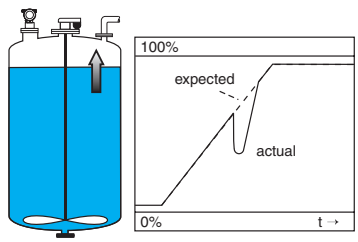


Fig. 37

Operation and maintenance See 'Basics' for general information on the maintenance of level devices (page 10).

Guidelines to fix application errors

Error	Output	Possible cause		Solution
Measured value (00) is incorrect.		Measured distance (008) OK?	yes →	1. Check empty calibr. (005) and full calibr. (006). 2. Check linearization: → Level/ullage (040) → Max. scale (046) → Diameter vessel (047) → Linearization table
		no ↓		
		An interference echo may have been evaluated.	yes →	1. For measurements in bypass or stilling well: Select the relevant option in the 'tank shape' (002) function. 2. Carry out interference echo suppression.
No change of measured value on filling/emptying.		Interference echo from tank internals or build-up on the probe.	→	1. Carry out interference echo suppression. 2. Clean sensor if necessary. 3. If necessary, select better installation position. 4. If necessary due to wide interference echoes, set function 'detection window' (0A7) to 'off'.
With an uneven surface (e.g. filling, emptying, running agitator) the measured value may jump sporadically to higher levels.		Signal is weakened by the rough surface – the interference echoes are sometimes stronger.	→	1. Carry out interference echo suppression. 2. Set the process cond. (004) to 'calm surface' or 'add. agitator'. 3. Increase output damping (058). 4. If necessary, select a different installation position and/or a larger sensor.
On filling/emptying the measured value drops.		Multiple echoes	→	1. Check tank shape (002), e.g. 'dome ceiling' or 'horizontal cyl.'. 2. If possible, do not select a central installation position. 3. Perhaps use a stilling well.

Installation conditions

Because most problems reported by users are due to incorrect installation and/or initial calibration, here is a reminder of the essential points that must be considered.

Installation in a tank

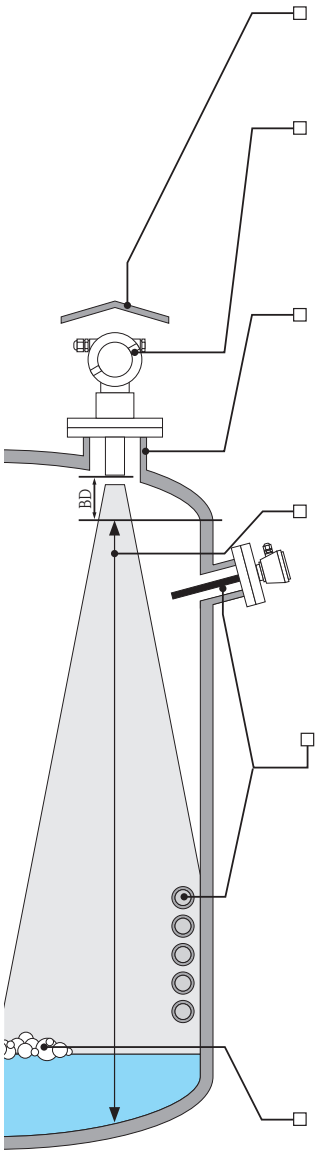


Fig. 38

Weather protection cover
- Always recommended for outside installation to avoid strong temperature changes of electronics.

Installation
- Not in the center
- Not above the fillstream
- Distance to wall: ~1/6 of the tank diameter (min. 30cm/12")
- If these conditions cannot be met: check stilling well

Nozzle
- The sensor membrane should be below the nozzle, if this is not possible, please compare the dimensions of the nozzle with the table below.
- Please contact Endress+Hauser if nozzle dimensions are different.

Measuring range
- Measurement is possible up to the blocking distance (BD) of the sensor.
- The measuring range begins where the ultrasonic beam meets the tank bottom. With dish bottoms or conical outlets, the level cannot be detected below this point.

Tank installations
- Avoid any installations like limit switches, temperature sensors, etc. within the signal beam (see table).
- Symmetrical installations, i.e. heating coils, flow breakers, etc can also interfere with the measurement.

Optimization options
- Use a sensor with a smaller beam angle.
- A stilling well or a sound guiding tube can always be used to avoid interference. Please clarify buildup tendency of the medium.

Formation of foam
- Ultrasonic signals may be absorbed by foam.
- The surface of foam can reflect. Solution: trial measurement with ultrasonics or e.g. hydrostatic measurement.

Installation in a stilling well

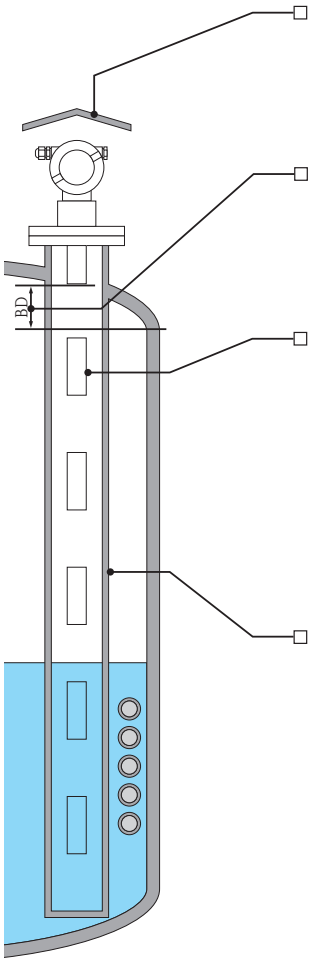


Fig. 39

Weather protection cover
- Always recommended for outside installation to avoid strong temperature changes of electronics.

Measuring range
- Measurement is possible up to the blocking distance (BD) of the sensor.

Slots / holes
- Slot width or diameter of holes max. 1/10 of pipe diameter
- Deburred
- Length and number do not affect the measurement
- At least one ventilation hole (> 10mm/ 0.4") is to be provided in the blocking distance of the sensor

Recommendations for stilling wells
- Any rigid pipe (metal, glass, plastics)
- The stilling well must be smooth inside
- Constant diameter
- Do not weld through the wall of the pipe, the inside of the pipe must remain smooth
- The assembly of individual pipe pieces may only cause a gap of max. 1mm/0.04"
- Recommended minimum inner diameter > 80mm/3"
  Please observe sensor dimensions to choose the right inner diameter

Blocking distance

Span F may not extend into blocking distance BD. Level echoes from the blocking distance cannot be evaluated due to the transient characteristics of the sensor. (See 'Basics' for more details)

Max. nozzle length	Sensor type						
	FMU40	FMU41	FMU42	FMU44	FDU91	FDU91F	FDU92
DN 50/2"	76mm/3"						
DN 80/3"	240mm /9.5"	240mm /9.5"	254mm /10"		330mm /13"	330mm /13"	
DN 100/4"	305mm/12"	305mm/12"	305mm/12"		381mm/15"	381mm/15"	
DN 150/6"	406mm /16"	406mm /16"	406mm /16"	406mm /16"	406mm /16"	406mm /16"	406mm /16"
Beam angle	11°	11°	11°	11°	9°	12°	11°
BD	10°	14°	16°	20°	12°	12°	16°

Table 3: Recommended nozzle dimensions, nozzle length from sensor diaphragm, beam angle (3 dB)

Installation in a tank - level measurement in bulk solids

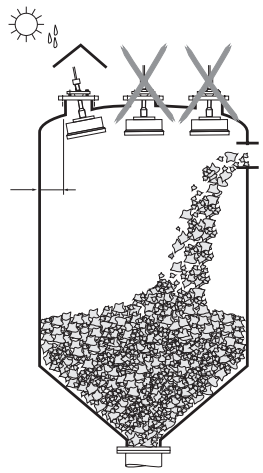


Fig. 40

Weather protection cover
- Always recommended for outside installations (solar radiation and rain).

Installation
- Not in the center
- Not above the filling curtain
- Distance to wall: ~1/6 of the tank diameter (min. 20cm/7.9")
- If two or more sensors are used in one vessel, please use separate instrumentation (FMU90/95 + FDU9x)

Nozzle
- The sensor membrane should be below the nozzle, if this is not possible, please compare the dimensions of the nozzle with the table below.

Measuring range
- Measurement is possible up to the blocking distance (BD) of the sensor.
- The measuring range begins where the ultrasonic beam meets the tank bottom. With dish bottoms or conical outlets, the level cannot be detected below this point.

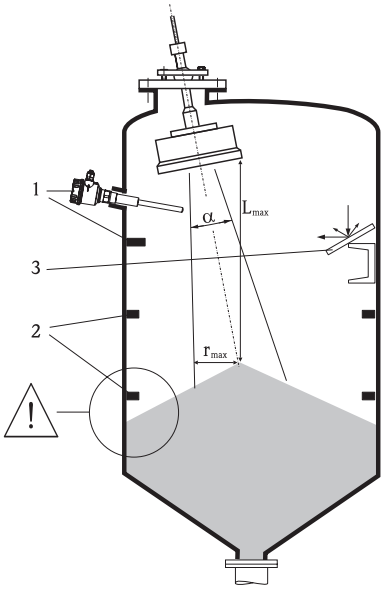


Fig. 41

Silo baffles
- Make sure that baffles [1] like limit switches, struts, etc. are not within the beam cone (see the beam angle table).
- Symmetrically arranged baffles [2], e. g. discharge aids etc. may impair measurements.

Optimization options
- Use a sensor with a smaller beam angle. The smaller the beam angle, the lower the occurrence of interfering echoes.
- Interference echo suppression: electronic suppression of interfering echoes optimizes the measurement.
- Plates installed at an angle [3] disperse the signal and can avoid interfering echoes.

Alignment
- Serves the avoidance of interfering reflections and improved measurements since the measurement can be aligned to the angled surface (accessory FAU40 or assembly bracket).

	Sensor type											
	FMU40	**FMU41**	**FMU42**	**FMU43**	**FMU44**	**FDU90**	**FDU91**	**FDU91F**	**FDU92**	**FDU93**	**FDU95**	**FDU96**
Beam angle α	11°	11°	9°	6°	11°	12°	9°	12°	11°	4°	5°	6°
L_{max}(m/ft)	2/6	3.5/11	5/16	7/22	10/32	1.2/3.9	5/16	5/16	10/32	15/49	45/150	70/230
r_{max}(m/ft)	0.19/0.6	0.34/1.1	0.39/1.3	0.37/1.2	1.96/6.4	0.13/0.4	0.39/1.3	0.53/1.7	0.96/3.1	0.52/1.7	1.96/6.4	3.6/11.8
Blocking distance BD (m/ft)	0.25/0.8	0.35/1.15	0.4/1.3	0.6/2	0.5/1.6	0.07/0.23	0.3/1	0.3/1	0.4/1.3	0.6/2	0.7/2.3*	1.6/5.2

* 0.9/2.9 in case of high temperatures (150°C/302°F)

Table 4: Beam angle and blocking distance according to the sensor type

	Max. nozzle length in mm/inch (L)											
Nozzle Ø	**FMU40**	**FMU41**	**FMU42**	**FMU43**	**FMU44**	**FDU90**	**FDU91**	**FDU91F**	**FDU92**	**FDU93**	**FDU95**	**FDU96**
DN 50/2"	80/3.15					50[2]/1.97[2]						
DN 80/3"	240/9.45	240/9.45	250/9.84			390[1]/15.4[1] 250[2]/9.84[2]	340/13.4	250/9.84*				
DN 100/4"	300/11.8	300/11.8	300/11.8	300/11.8		390[1]/15.4[1] 300[2]/11.8[2]	390/15.4	300/11.8*				
DN 150/6"	400/15.8	400/15.8	400/15.8	300/11.8	400/15.8	400[1]/15.8[1] 300[2]/11.8[2]	400/15.8	300/11.8*	400/15.8			
DN 200/8"	400/15.8	400/15.8	400/15.8	300/11.8	400/15.8	400[1]/15.8[1] 300[2]/11.8[2]	400/15.8	300/11.8*	400/15.8	520/20.5		
DN 250/10"	400/15.8	400/15.8	400/15.8	300/11.8	400/15.8	400[1]/15.8[1] 300[2]/11.8[2]	400/15.8	300/11.8*	400/15.8	520/20.5	630/24.8	
DN 300/12"	400/15.8	400/15.8	400/15.8	300/11.8	400/15.8	400[1]/15.8[1] 300[2]/11.8[2]	400/15.8	300/11.8*	400/15.8	520/20.5	630/24.8	800/31.5
Beam angle	11°	11°	9°	6°	11°	12°	9°	12°	11°	4°	5°	6°
BD (m/ft)	0.25/0.8	0.35/1.15	0.4/1.3	0.6/2	0.5/1.6	0.07/0.23	0.3/1	0.3/1	0.4/1.3	0.6/2	0.7/2.3*	1.6/5.2

Table 5: Recommended nozzle dimensions, nozzle length from sensor beam angle

* Applicable to flush flange installation, for assembly via G/NPT 1" starting DN100 see FDU91
[1] Mounted at backside thread of the Sensor FDU90
[2] Mounted at frontside thread of the Sensor FDU90

Setup

The 'Basic Setup' menu enables quick and simple commissioning. The software helps the user to enter the main parameters that cover 95% of cases. By entering the data carefully, many problems are avoided.

Customer map
It is required to map out interference reflections created inside the tank. This map is based on the factory map and preferably done with an empty tank. This way, all eventual interference reflections caused by installations in the tank are detected and stored in the memory.

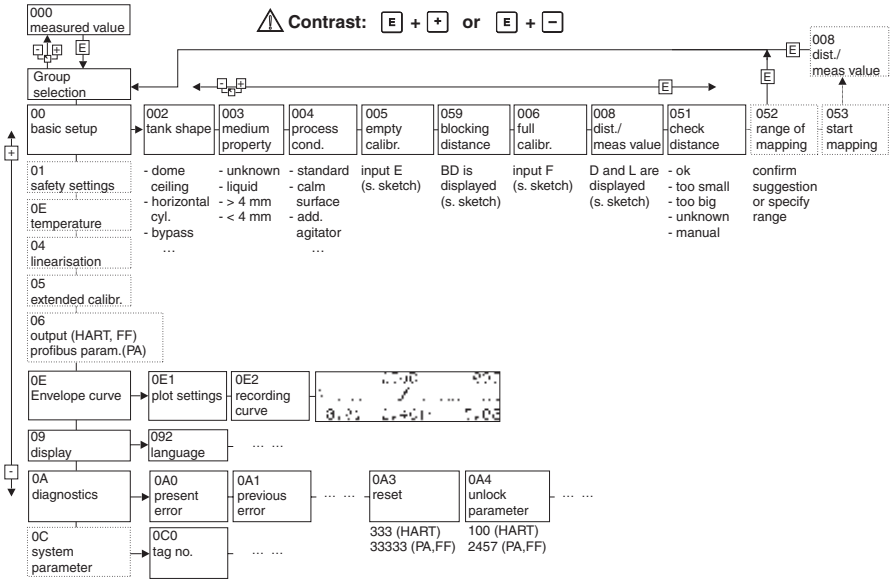


Fig. 42: 'Basic Setup' for Prosonic M devices

Spare parts

Instrument and spare parts availability
See table.

Warning: the sensors FDU83/84/85/86 with an ATEX, FM or CSA certificate are not certified for connectiion to the FMU 90 transmitter. In addition, the new FDU9x sensors cannot be used with FMU86x transmitters.

Migration

The new FMU90 transmitters associated to FDU9x sensors replace FMU86x transmitters and FDU8x sensors.

The FMU90 transmitter is fully compatible with the FDU8x transmitters and can be used in association with FDU8x sensors.

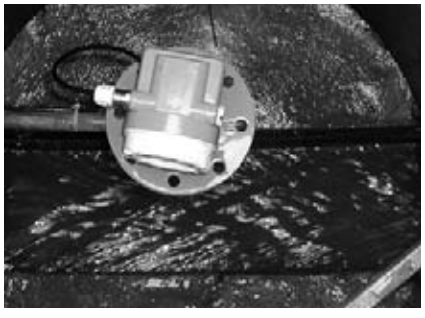
Re-engineering

The 2-channel version of FMU90 is flexible: each channel can either be used for flow measurement or level measurement, thus allowing three combinations: level + level, level + flow and flow + flow.

Your instrument	Spare parts availability	New generation
FMU86x	YES - until 03/2012	FMU90
FDU8x	NO - since 08/2010	FDU9x
FMU23xA	NO - since 12/2010	FMU30
FMU23xE	NO - since 12/2010	FMU30

For further information, use our Device Viewer:
www.services.endress.com/device-viewer

Table 6: Instrument and spare parts availability

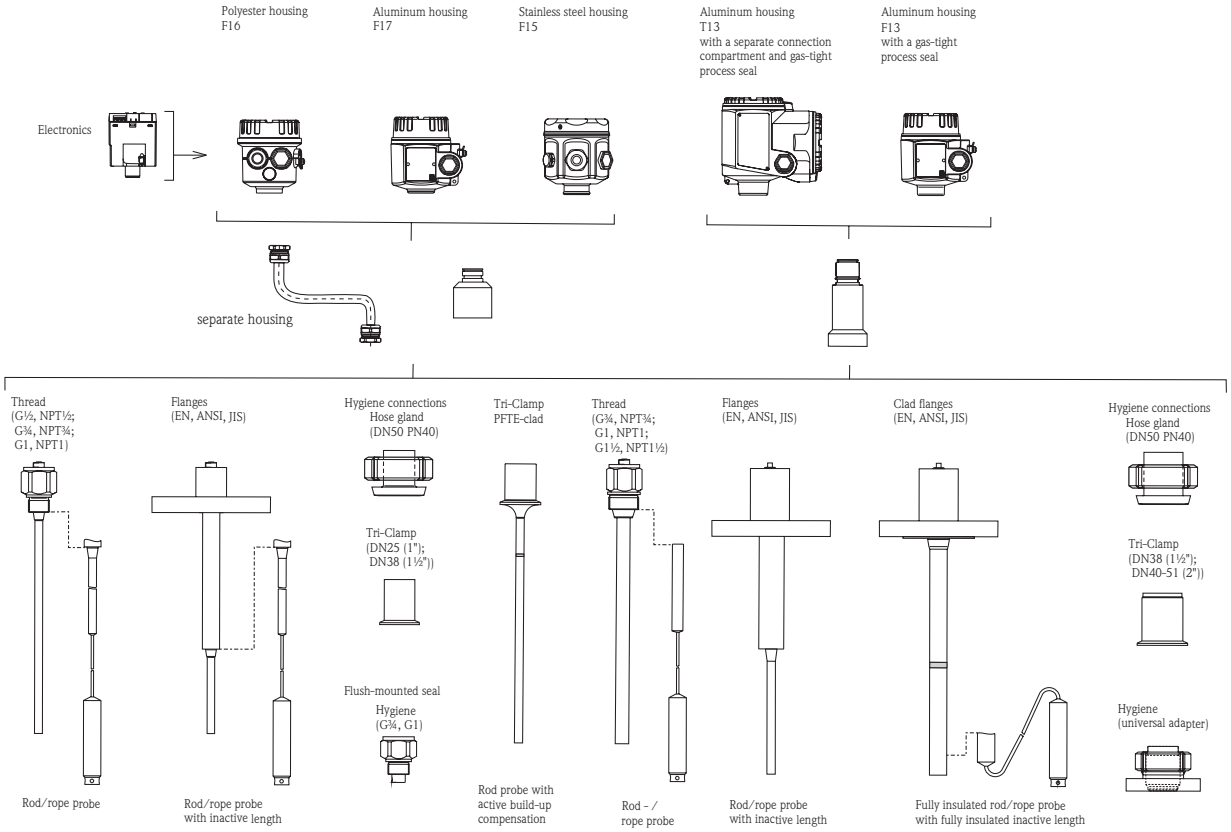


Capacitive level measurement

The current Endress+Hauser range of capacitive sensors includes:
- **Level measurement for liquids: Liquicap T FMI21 and Liquicap M FMI51/52**
- **Level detection for liquids: Liquicap M FTI51/52**
- **Level detection for solids: Solicap M FTI55/56, Solicap S FTI77, Nivector FTC968 and Minicap FTC260/262**

In this section we provide a concise reminder of the main guidelines for optimal use of capacitive sensors. In addition, you will find useful tips and advice for Liquicap M users.

Overview (example: Liquicap M FTI5x) Fig. 43



Measuring principle

The principle of capacitive level measurement is based on the change in capacitance of the capacitor due to the change in the level formed by the probe and the container wall (conductive material). When the probe is in the air (1), a low initial capacitance is measured.

When the container is filled, the capacitance of the capacitor increases the more the probe is covered (2), (3). As of a conductivity of 100µs/cm, the measurement is independent of the value for the dielectric constant (DK) of the liquid. As a result, fluctuations in the DK value do not affect the measured value display. Furthermore, the system also prevents the effect of medium build-up or condensate near the process connection for probes with an inactive length.

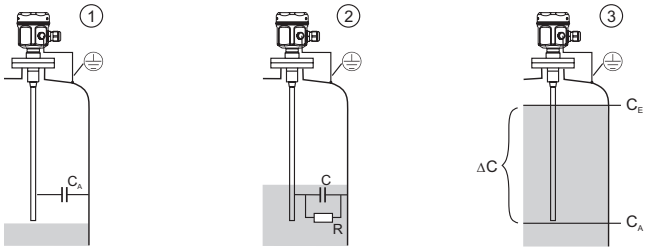
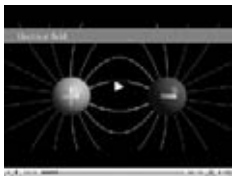


Fig. 44: Measuring principle
R: Conductivity of liquid
C: Capacitance of liquid
CA: Initial capacitance (probe not covered)
CE: Final capacitance (probe covered): change in capacitance
ΔC: Change in capacitance

Ensure good connection to the ground in any case.



Videos available at
www.endress.com/videos

A ground tube is used as a counter electrode for containers made of non-conductive materials.

Phase-selective measurement
The electronic evaluation of the container capacitance works along the principle of phase-selective measurement. In this process, the amount of alternating current and the phase shift between the voltage and current is measured.

With these two characteristic quantities, the capacitive idle current can be calculated by the medium capacitor and the real current by the medium resistance. Conductive build-up stuck to the probe rod/rope acts like additional medium resistance and causes an error in measurement. As the size of the medium resistance can be determined with phase-selective measurement, an algorithm is used to compensate the build-up on the probe. Thus, Liquicap M has build-up compensation.

Operation and maintenance

Operation
The display can be used to configure directly at the device via three keys. All device functions can be set via menu operation. The menu consists of function groups and functions. Application parameters can be read or set in the functions. You can also operate directly on the electronic insert (FEI50H: see fig. 45) or remotely with FieldCare software.

External cleaning
When externally cleaning Liquicap M, make sure that the cleaning agent used does not attack or corrode the housing surface or seals.

Seals
The process seals of the sensor should be replaced periodically, especially when using molded seals (aseptic version)! The intervals between seal replacement depend on the frequency of the cleaning cycles and on the fluid and cleaning temperature.

Possible measuring errors
Is the measured value incorrect on an FMI5x device?

1. Verify empty and full calibration.
2. Clean probe if necessary, verify probe.
3. If necessary, alter for better installation position of probe (do not mount in a filling curtain).
4. Check ground from process connection to tank wall. Resistance measurement < 1Ω See fig. 46 for more details.
5. Check probe insulation (resistance measurement) > 800kΩ (only possible for conductive media).

How to proceed when a fault occurs at the electronic insert (FTI5x)? In the event of faults during commissioning or operation of the device,

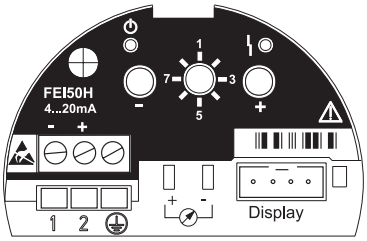


Fig. 45: Local operation directly on the electronic insert
- Green LED (operational status)
- Red LED (fault message)
- Key (-)
- Key (+)
- Mode switch
  1 : Operation
  2 : Empty calibration
  3 : Full calibration
  4 : Measuring modes
  5 : Measuring range
  6 : Self-test
  7 : Reset (factory settings)
  8 : Upload sensor EEPROM
- 4…20mA current pick-off, e.g. for full/empty calibration with multimeter. (No need to disconnect circuit!)
- Display connection

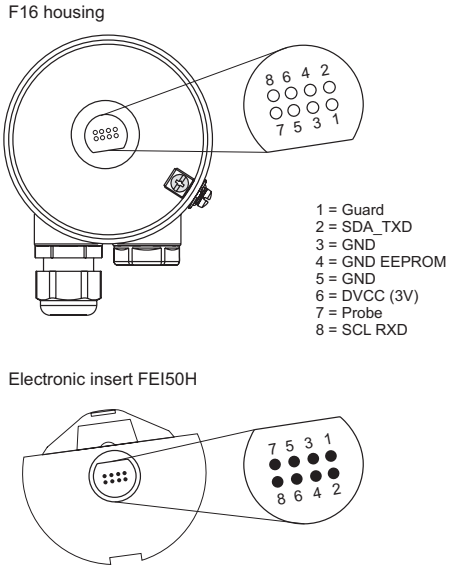


Fig. 46: Connections

you have the option to carry out fault diagnostics on the electronic insert. This function is supported by the electronic inserts FEI51, FEI52, FEI54, FEI55.

The diagnostics provide information about the operating status of the device. The results of the diagnostics are displayed by LEDs 1, 2, 4 and 5. If the diagnostics detect multiple faults, these are shown according to their priority. A serious fault (e.g. priority 3) is always displayed before a less serious fault (e.g. priority 5). See error table in chapter 9 of BA299 Operating Instructions.

Installation conditions

Because most problems reported by users are due to incorrect installation and/ or initial calibration, here is a reminder of the essential points that must be considered.

Instructions for the installation in a tank
See fig. 47

Adjustment
An adjustment is necessary for non-conductive liquids or if the ε_r of a non-conductive medium has changed.

Full/empty calibration
You may use the 4 to 20 mA current pick-off, e.g. for full/empty calibration with multimeter. (No need to disconnect circuit!)

Calibration is necessary only at start-up. There will be no drift afterwards.

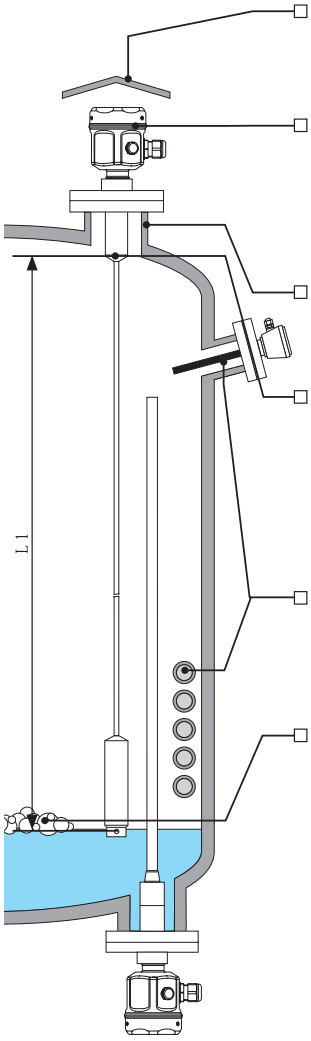
Calibration - Liquicap M FMIxx
For conductive liquids (>100 µS/cm), the probe is calibrated at the factory to the probe length ordered (0% to 100%).
For non-conductive liquids (<1 µS/cm), 0% calibration is performed at the factory. Only the 100% calibration has to be carried out on site.

Calibration - Liquicap M FTIxx and Solicap M FTIxx
Calibration at the detection point has to be carried out on site.

Spare parts

Instrument and spare parts availability
See table 9

Note: Once Liquicap M or the FEI50H electronic insert has been replaced, the calibration values must be transferred to the replacement device.
=> When the probe is replaced, the calibration values in the electronic insert are to be transferred to the probe DAT module.
=> When the electronic insert is replaced, the calibration values of the probe DAT module are to be transferred to the electronics.
Measuring can continue without having to carry out a new calibration.



Weather protection cover
- Always recommended for outside installation to avoid strong temperature changes of electronics.

Installation
- Not above the fillstream.
- Establish proper ground connection between sensor and tank wall.
- Use ground tube in non-conductive tanks (e. g. of plastic material).

Nozzle
- Use inactive length for installation in a nozzle.

Measuring range
- Measuring range L 1 possible from the tip of the probe to the process connection.
- Particularly suited to small tanks in fast filling and discharging operations.

Tank installations
- Obstacles do not affect the measurement.

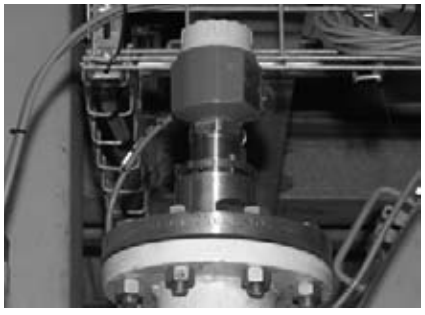
Foam
- In slight foam formation, the 'Build-up compensation' mode may be selected.

Fig. 47: Installation in a tank

Your instrument	Spare parts availability	New generation
Multicap family	NO - since 12/2010	Consult us
11500Z	NO - since 12/2010	FMP54, FTL70

For further information, use our Device Viewer:
www.services.endress.com/device-viewer

Table 7: Instrument and spare parts availability



Flow metering

Installation and setup require special care

Flowmeters are so reliable that users consult us primarily during installation and commissioning – and very often it is not for several years that users come back to us. It is true that there are certain issues due to aging, but others can be resolved by recalibration. From time to time we also find that the flowmeter has been used for an application other than that for which it had been selected, at the risk of it being unsuited to this application, and creating a long term problem. Finally, we observe that many apparently maintenance-related problems prove to be installation and setup problems.

This guide serves as a reminder of the few operating constraints and installation conditions for flowmeters. We have also recapped the most frequently asked questions. With this information, you will be able to prevent or resolve the vast majority of potential problems yourself!

There is also plenty of useful information to help you get the best from your instruments throughout their life cycle… and prepare for renewing your equipment gradually."

For those who wish to go further in mastering this subject, Endress+Hauser has published the 'Flow Handbook', a genuine flow measurement bible.

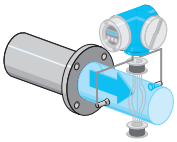
You will also find several videos covering this topic at www.endress.com/videos.

We also offer training sessions, in classroom and on site. See 'Training' in the 'At your service' section.

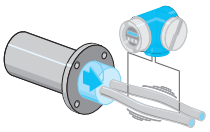
Contents

Basics

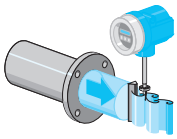
Information common to any type of flowmeter



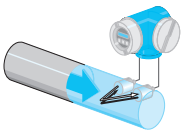
Electromagnetic flowmeters
Specific information p. 34



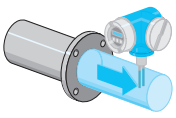
Coriolis mass flowmeters
Specific information p. 37



Vortex flowmeters
Specific information p. 40



Ultrasonic flowmeters
Specific information p. 42



Thermal mass flowmeters
Specific information p. 44

Compliance with installation requirements would avoid most reported errors!

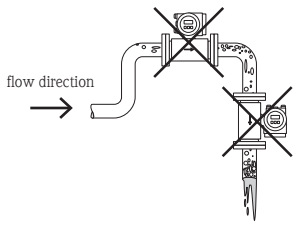


Fig. 1

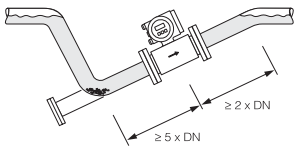


Fig. 2: Installation in a siphon

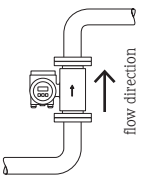


Fig. 3: Ideal mount for a flowmeter

Installation requirements overview

The specification of ANY flowmeter is based on an ideal installation. Installation guidelines for all technologies exist. They should be viewed as MINIMUM requirements:

- **The flowmeter must remain completely full at all times.** This is of utmost importance for filling or dosing applications, since many flowmeters (except mass flowmeters) measure the fluid's velocity, assuming that the whole section is full of liquid. If the flowmeter is not completely full, then measurement errors are larger. Please note that this rule even applies to mass flowmeters.

- **Installation at the highest point of pipework**
  - Installation at the top of a piping system poses a risk that air will collect and negatively influence the performance (fig.1).
  - Avoid installing directly upstream of a free pipe outlet in a vertical pipe as air will potentially rise up through the flowmeter causing measuring errors.
  - The flowmeter should be installed in a lower part of the pipe work. This ensures enough head pressure to avoid cavitation and the meter will always remain full.

- **Installation in a siphon** Sometimes it cannot be ensured that the pipe is always full (i.e. wastewater pipes). This could lead to measuring errors or situations where the flowmeter will not work at all.
  - The flowmeter should then be installed in a siphon (fig.2).
  - If solids are carried with the fluid it is recommended to plan a cleaning access. A U-tube or a sloping pipe might provide simple solutions.

Advice: the ideal mount for a flowmeter is in a fluid riser vertical pipe (fig.3)
- The meter must be installed with sufficient straight pipe upstream.
- See technology-specific installation conditions for further details (mainly vortex, ultrasonic and thermal mass flowmeter).

- **Wiring**

Take care with the instrument wiring, especially when the transmitter is mounted remotely.

Ensure correct tightening of the wires and cable glands. In case of humid atmosphere, check that water cannot get into the flowmeter.

Further requirements may apply for one particular technology. **Please check specific installation conditions for EMF*, mass flowmeters etc. in the next sections.**

- **Integration to PROFIBUS networks**

Cabling and termination are the source of most reported problems. Please refer to the pages 'PROFIBUS DP/PA networks' in the 'Field communication' section.

Setup - configuration

- **General note:**

If the installation and wiring conditions have been closely observed initially, you can be certain of getting correct measurements from the instrument's first activation. Configuration will only serve to optimize the operating parameters of the quantities measured (current output setup, etc.).

- **Since 2007, all Endress+Hauser flowmeters belong to the Proline family and thus offer QUICK SETUP.**

QUICK SETUP enables quick and easy configuration of the device's main functions (units, outputs, etc).

You can also configure your flowmeters from your PC using our configuration and asset management tool called FieldCare.

Our service organization can set up any Endress+Hauser flowmeter for you and thus ensure you immediately get the most out of your instrument. (See **'Device commissioning'** in the 'At your service' section).

*EMF: Electromagnetic flowmeter

Flowmeters connected to a PROFIBUS network

Inspection of the flowmeter pipe

Functional check using the FieldCheck tool

Flowmeters mounted in a fluid riser vertical pipe

Operation and maintenance

In most applications, when correctly selected and installed, Endress+Hauser flowmeters require very little maintenance as they are designed without any moving mechanical parts. Nevertheless, due to their criticality to quality, some flowmeters need to be inspected or/and calibrated periodically. Defining the right maintenance frequency taking several parameters into account is an expert's job. Endress+Hauser can also help you with this task!

Periodic inspection to assure reliability of the application

After a flowmeter has been operating for a period of time, users may falsely believe that just because the flowmeter signal is stable it is correct – but this might not be the case. Even an indicated flow that appears to be within acceptable limits may be inaccurate and may then affect the quality of the final product.

Pipe inspections

- Deposits in the pipe can cause a slow drift of measured values at meter output that is not detected and rectified.
- According to the type of flowmeter, anything that alters the shape or diameter of the sensor could cause errors in the readings.

Due to the effects of sedimentation or deposition, a periodical cleaning of the flowmeter pipe might be necessary.

Calibration

Intrinsically our flowmeters offer long-term stability and repeatability of your measurements. Nevertheless we recommend periodic calibration for the measurement points that are critical to the process and thus are important to control the quality of your product. From on-site to accredited services, you can be sure to find the right method by finding the right balance between the flowmeter downtime and the calibration uncertainty.

Calibration can be performed by Endress+Hauser either on-site or in our accredited laboratories.
(See **'Calibration services'** in the 'At your service' section).

Inspection of seals and gaskets

In some processes, operational needs necessitate the use of frequent cleaning or sterilization in place (CIP or SIP). The flowmeter seals and gaskets should then be carefully chosen and frequently replaced to avoid risks of leakage, contamination and even process failure.

Routine maintenance

The need for routine maintenance is defined according to the importance of the flowmeter in the process.

Flowmeters can be checked in a variety of ways:

- The most common maintenance seems to be the use of electrical devices for simple checking of the input and output function of the transmitter.
- They may be checked using a flow simulator in the field so that problems can be identified. For any flowmeter belonging to the Proline family (see next page) we recommend the use of our FieldCheck® smart signal simulator which facilitates on-site verification. The user may effect either a manual simulation of the flowmeter functions or a full check of the flowmeter, of its electronics only or of its sensor only. The tool incorporates procedures for automatically checking all the electronic operations (linearity of the amplifier, the analog outs and frequency) on the one hand, and all the sensor operations on the other (magnetic field and measuring electrode integrity). With FieldCare software, the user can upload the test results to a PC, incorporate them in a certificate, print them or archive them, thus meeting the requirements of quality procedures.

Moreover, this solution combined with calibration could allow users to reduce the calibration frequencies and thereby reduce maintenance costs.

FieldCheck is presented on page 33.

Maintenance planning

Do you know exactly which part of your installed instrumentation base is **critical to the operation** of the plant and how you could maintain or calibrate it more efficiently? Are you sure that your present actions are minimizing the risks of **unplanned breakdowns**? Are you sure that your present actions are the most **cost-effective**?

With Endress+Hauser's Installed Base Audit, our service consultant will help you to quickly find an answer to these three questions and move forward in a controlled manner to a maintenance plan that improves plant reliability while reducing costs.
(See **'Maintenance and calibration consulting'** in the 'At your service' section).

Maintenance performing

If you do not have the time or the right tools to efficiently perform your maintenance, an Endress+Hauser **service contract** can provide the appropriate level of maintenance support you require.

We provide regular checks of your equipment and warranty extensions providing you with complete peace of mind and cost control. From regular support to partnership agreements, we offer four distinct levels of service…
(See **'Maintenance services'** in the 'At your service' section).

Corrective maintenance

The more critical your instrument is to your process, the shorter the acceptable time for repair.
Thanks to the Proline concept (see opposite), flowmeters offer a modular design; one of the outcomes is that most parts can be easily replaced thus allowing quick repair. …

Improved efficiency in the repair process is another way to reduce downtimes. Our training sessions help you to quickly diagnose any failure and to apply the most appropriate repair method. (See **'Training'** in the 'At your service' section).

Spare parts stock
For any flowmeter belonging to the Proline family (see next page), we suggest you keep a full set of electronic inserts in stock. In case of a highly critical instrument, you might also consider stocking a complete new instrument.
To easily select the right spare part, we recommend the use of our Spare Part Finding Tool.

Our specialists can help you to define the criticality of all your measuring instruments (even for other makes). They will apply a structured methodology adapted to your own application. (See **'Maintenance and calibration consulting'** service in the 'At your service' section).

Instrument and spare parts availability
You will find detailed information in the next sections (EMF, mass flowmeters etc.)

Proline flowmeters

A range of instruments designed to make your life easier!

Proline flowmeters provide you with several benefits throughout their life cycle:

- Unified components and spare parts minimize storage costs
- Time-saving by easily replaceable components without recalibration
- Multi-option control with local display or configuration software (such as FieldCare), locally through the service interface or by digital communication from a control center. Note that FieldCare is now the standard configuration software and replaces FieldTool and TofTool.
- Better plant availability on account of self-diagnosis functions, data backup (S-DAT, T-DAT), standardized spare parts concept etc.
- 'Quick Setups' and standardized configuration routines for user convenience
- FieldCheck for testing flowmeters in-line

Permanent self-diagnosis
All Proline flowmeters have continuous self-diagnosis during operation. Faults, if they occur, are clearly displayed.

The Proline family

Electromagnetic flowmeters
- Promag 10
- Promag 23
- Promag 50
- Promag 51
- Promag 53
- Promag 55

Mass flowmeters
- Promass 40
- Promass 80
- Promass 83
- Promass 84

Vortex flowmeters
- Prowirl 72
- Prowirl 73

Ultrasonic flowmeters
- Prosonic Flow 90
- Prosonic Flow 91
- Prosonic Flow 93
- Prosonic Flow 92F

Thermal mass flowmeters
- t-mass 65

Data storage / data transfer
All device parameters and settings are securely stored on these data memory modules in the form of:
- T-DAT for transmitter data (at Promag 53, 55 and 23, Promass 83, Prosonic Flow 91, 92F, and 93 and T-mass 65)
- S-DAT for sensor data (all devices)

FieldCheck®

Smart signal simulator

With FieldCheck, meter verification can be carried out without the removal of the Proline flowmeter from the pipe. Where ISO 9000 requires frequent test cycles, FieldCheck is an economical alternative to calibration.

Modular concept

All Endress+Hauser flowmeters are based on unified electronics and operating concepts. The modular Proline device concept provides the user with obvious advantages, e.g. in service situations:

- Minimization of spare parts costs through standardized components.
- Time-saving with easily replaceable meter electronics, without the need for resetting.
- Individual retrofitting of flowmeters for application-specific modifications.

Time-saving 'Quick Setups'

The Quick Setup menus make commissioning fast and straightforward. It guides you step by step through all the operation-relevant parameters. Quick Setups are available as follows:

- For standard commissioning
- For metering pulsating flow
- For metering gas flow (Coriolis)
- For filling and dosing applications
- For sensor installation and wall thickness measurement (ultrasonic)
- For configuring the fieldbus interface

Designed especially for flowmeter verification*, FieldCheck® simulates sensor signals to test and evaluate the behavior of an item of equipment. It can also, thanks to its checking procedures, test proper flowmeter functioning – be it to meet in-house criteria or regulatory requirements. The check and test results obtained with FieldCheck can then be stored in a database and printed out for subsequent use, e.g. in connection with certification by audit organizations.

Main advantages

- All Endress+Hauser Proline flowmeters can be tested directly on-site, without removal of the instrument.
- Simultaneous verification of process outputs (current, frequency).
- Large, clear, multivariable displays.
- Expanded functionality with the FieldCare software program: reading and printing of test results (verification certificates).

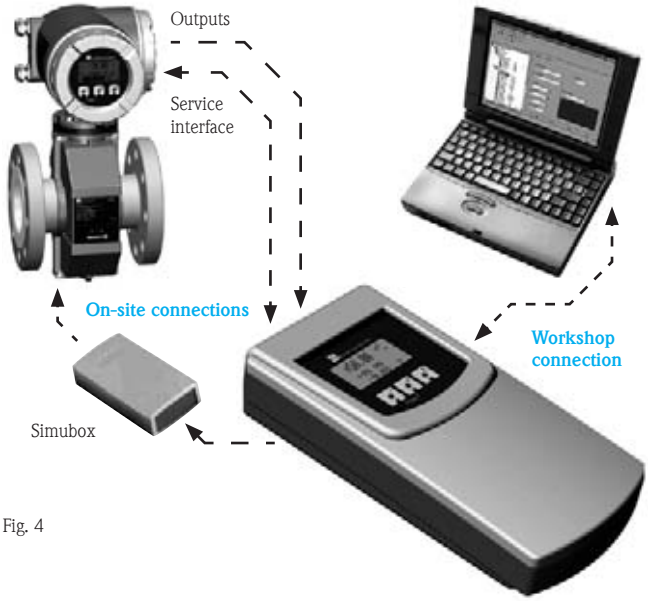


Fig. 4

On-site functional check of a flowmeter using the FieldCheck.

How does it work?

FieldCheck comprises a signal generator, connector cables and 'Simubox' adapters for connection to the various types of flowmeters (see picture).

The user may effect:

- A manual simulation of the flowmeter functions. The generator simulates a flow based on several freely programmable profiles. This allows the user to check the behavior of the outs towards the device, or the supervision system, without any actual flow in the pipe.
- A full check of the flowmeter, of its electronics only or of its sensor only (see photo). The tool incorporates procedures for automatically checking all the electronic operations (linearity of the amplifier, the analog outs and frequency) on the one hand, and all the sensor operations on the other (magnetic field and measuring electrode integrity).

We can provide checks on your Proline flowmeters as on-site service for your installed devices. Our specialist staff will carry out all the test functions directly in the installation.

Your benefits:

- Cost savings by providing the inspection equipment
- No familiarization required by operating personnel
- Test certificate as record and proof of the simulation and verification

FieldCare is presented on www.automation.endress.com/fieldcare

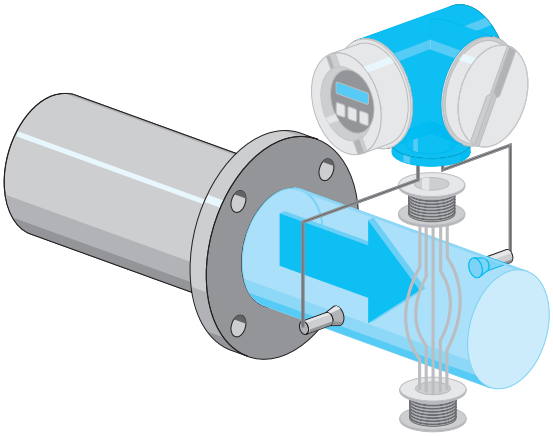
Electromagnetic flowmeters
Promag series

The current Endress+Hauser range of electromagnetic flowmeters (EMF) includes Proline Promag 10, 23, 50, 51, 53 and 55.

In this section, you will find essential information and advice that will help you to perform the optimum follow-up of your Promag electromagnetic flowmeters throughout their lifecycle.

Videos available at
www.endress.com/videos

The meter must remain completely full at all times.



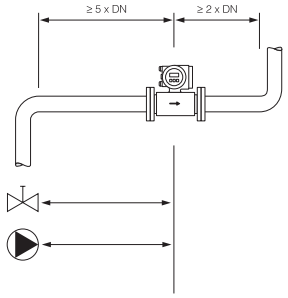


Fig. 5: Recommended straight lengths

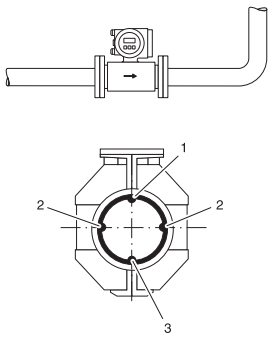


Fig. 6: Orientation in case of Empty Pipe Detection (1)

Measuring principle

To measure flow based on Faraday's law of induction an alternating magnetic field is produced with coils of copper wire. A controlled coil current ensures that the magnetic field strength remains constant during the measurement. The length of the conductor (the distance between the two measuring electrodes at the internal diameter of the measuring tube) is also a constant value. The only variable in Faraday's equation is the flow velocity of the passing fluid. The generated voltage is exactly proportional and linear to the velocity of the fluid. An EMF does not measure volume but velocity. The induced voltage of a general purpose EMF at Endress+Hauser equals approx. 300µV per m/s velocity.

Installation conditions

In addition to installation guidelines for all technologies (see 'Basics'), the particular installation requirements of an EMF are:

Inlet and outlet runs
The meter must be installed with sufficient straight pipe up- and downstream.
If possible, install the sensor well clear of fittings such as valves, T-pieces, elbows, etc. Compliance with the following requirements for the inlet and outlet runs is necessary in order to ensure measuring accuracy:

- Inlet run ≥ 5 x DN
- Outlet run ≥ 2 x DN

When installed a short distance from a profile disturbance an EMF will suffer measuring errors due to the disturbed flow profile entering the meter. The flowmeter should therefore be installed according to the installation recommendation with sufficient straight pipe up- and downstream. The recommended straight lengths are measured from the center of the flowmeter. This means in small diameter there is often enough straight length within the device itself.

If the Empty Pipe Detection is used the correct sensor orientation must be considered (see figure 5).
The empty pipe detection electrode must be at the highest point of a horizontally installed EMF. If the EMF must be installed in a horizontal pipe, the transmitter/terminal housing must be located on top of the pipe. Then the EPD electrode is at the highest point of the pipe and will function correctly. In applications where a partially filled pipe is unlikely the orientation of the electrodes does not matter.

The grounding of the EMF must be in accordance with the guidelines (see FAQs). For further information please refer to the corresponding chapter in the Operating Manual.

Setup - configuration

All Proline flowmeters feature a 'Quick Setup' program to make standard commissioning easy.

Our service organization can set up any Endress+Hauser flowmeter for you and thus ensure you immediately get the most out of your instrument. (See **'Device commissioning'** in the 'At your service' section).

EMF mounted horizontally

EMF mounted vertically

EMF with remote electronics

EMF mounted in a siphon

Operation and Maintenance

Preventive maintenance

How can you minimize the risks of failure or drift of your measurement point?
Having no moving parts, EMFs require very little preventive maintenance.
Process conditions may affect your flowmeters' lifetime or accuracy (abrasive products, soiling of the electrodes, effects from high temperatures or high temperature cycles (e.g. SIP), vibration, aggressive chemical products etc).
If you face one of these situations, you can drastically decrease the risk of process downtime by planning periodical checks and calibrations. Another topic requires particular attention: the seals on H sensors (hygienic or small diameter) which are exposed to repeated cleaning or sterilization (CIP/SIP) may quickly deteriorate. Ensure that they are regularly replaced.

To control the functional integrity of the Promag we use special tools that provide thorough checks of the internal parameters of the electronics including elements of the sensor (See full description of FieldCheck® on page 33).

Our service contracts can include such verifications – once a year is recommended.
(See **'Maintenance services'** in the 'At your service' section).

Note: a measurement consistency check may be obtained by means of comparison with a non-intrusive ultrasonic flowmeter. This is, however, not a calibration.

Abrasive fluids

Is your flowmeter used to measure abrasive fluids (e.g. phosphates in the mining industry)? We suggest to:
- Use a sensor with a a natural rubber liner to minimize the impact of abrasion.
- Turn the meter by 45° every 6 months in case of an horizontal installation.

This reduces wear due to solids settling to a higher concentration because of the low velocity.

Calibration

Calibration frequency should be in line with the operating conditions. Device calibration procedures and intervals depend on:
- The precision required for the application
- Its criticality to the process, the legislative constraints imposed.

So it is important to define the calibration intervals and the maximum permissible error of a measurement point.
The main factors influencing flowmeter drift are:
- The process conditions (fluid type, product temperature etc.)
- The ambient conditions in which the sensors are fitted (ambient temperature, moisture).

In the knowledge that calibration frequencies should be optimized over time in line with the operating histories, you need to set an initial frequency. Hereafter you will find a table of recommendations to help you define this frequency, taking into account the process conditions and ambient conditions:

Note:
- For abrasive or corrosive fluids, the calibration frequency must be lowered according to the wear.
- These calibration recommendations are no substitute for the maintenance operations required to keep the device in perfect working condition.

Calibration can be performed by Endress+Hauser either on-site or in our accredited laboratories.
(See **'Calibration services'** in the 'At your service' section).

Instrument and spare parts availability

Your instrument	Spare parts availability	New generation
Promag 30/33	NO - since 12/2007	Promag 10/50/53
Promag 39F/H	NO - since 09/2007	Promag 50/53
Dosimag A	NO - since 12/2010	Dosimag 5BH
Promag 35S	NO - since 12/2010	Promag 55S

For further information, use our Device Viewer:
www.services.endress.com/device-viewer

Table 1: Instrument and spare parts availability

Spare parts stock

For any flowmeter belonging to the Proline family, we suggest you keep a full set of electronic inserts in stock.

Migration

Endress+Hauser's new generations of electromagnetic flowmeters are Promag 10 and Promag 5X series. These new instruments offer new ways to carry out preventive verification (see FieldCheck on page 33). They can substitute all Endress+Hauser's previous instruments.

The old generation primarily includes the Promag 30, Promag 33 and Promag 35.

- With which device should you replace your Promag 30? For identical applications, the answer would be the Promag 10, which is much more user-friendly and easy to use. In addition, you will only need to stock a single electronics board.
- With which device should you replace your Promag 33? For standard applications it would be its designated successor, the Promag 50. For special applications, the Promag 53 offers a broader range of options and better measurement uncertainty. Promag 53 also includes passive or active pulse output, similar to Promag 33.
- With which device should you replace your Promag 35? Replace with the Promag 55, typically for applications involving high-load fluids (paper mill, mining extraction, etc.)

Please call our sales force for more information.

For a more in-depth analysis of your current installed base, we can help you with our **'Installed Base Audit'** service. (See **'Maintenance and calibration consulting'** in the 'At your service' section).

Re-engineering

You wish to apply an EMF to a different application than the one for which it had been selected? Please take the following advice into account.

No or low conductivity

If a fluid has a rather low conductivity, an EMF can not be used. The following liquids can NOT be measured because their conductivity is too low: vegetable or mineral oil, de-mineralized water, hydrocarbons/solvents, etc. (see graphics)
However, if these liquids are mixed with even a low quantity of a conductive liquid, an EMF might be used.
To apply an EMF successfully the fluid must have a minimum conductivity of: >5 µS/cm for Promag 50/53/55 (55 also for water) >20 µS/cm for water applications in general >50 µS/cm for Promag 23/10.

Solid content in a fluid

Since the influence of solids depends heavily on concentration, mixture, particle characteristics and other parameters, expert knowledge is required to select and size the best fitting model and options. Two typical influences must be considered:

- Excessive signal noise due to solids requires a high performing transmitter (Promag 55).

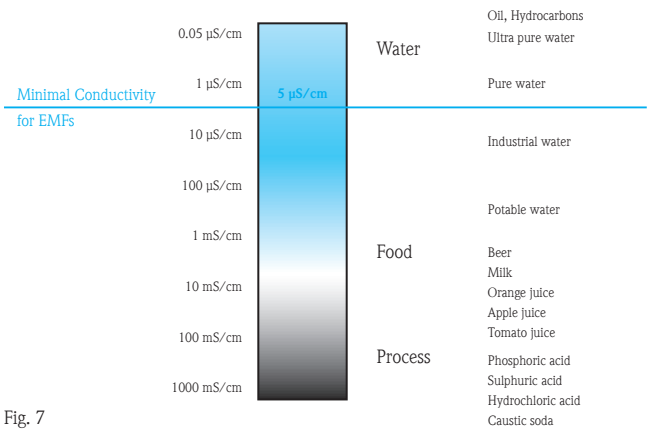


Fig. 7

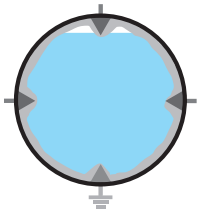


Fig. 8: The effect of build-up on the electrodes

- For abrasive slurries suitable liners and electrode designs/ materials must be chosen.
- Install the sensor as far as possible from any potential source of disturbance.

Temperature range

All available liner materials are isolating plastics or rubbers with a limited operating temperature. This is the limiting factor for the applicability of EMFs.

Build-up / ECC

While an EMF is very tolerant regarding build-up on the measuring tube, there are limitations. A layer on the electrodes will eventually lead to a reduced flow signal and the device might stop functioning.

If the build-up is conductive (e.g. magnetite in heating water systems), it is possible to use an electronic solution: ECC (electrode clean circuit) keeps the measuring electrodes clean and free from build-up.

Measuring range

You also need to check that the flowmeter's measuring range fits the application. In case of a different pipe diameter, a certain flow rate is required at minimum flow so that the flowmeter operates with the expected accuracy. The Applicator software allows you to check the device's accuracy over the measuring range. Applicator is available online at https://wapps.endress.com/applicator

Again consider proper installation and setup.

Coriolis mass flowmeters
Promass series

The current Endress+Hauser range of mass flowmeters includes Proline Promass 40, 80, 83, 84 and the new two-wire device Promass E 200.

In this section, you will find essential information and advice that will help you to get the most out of your Promass flowmeters throughout their lifecycle.

Videos available at
www.endress.com/videos

Ensure that cavitation does not occur!

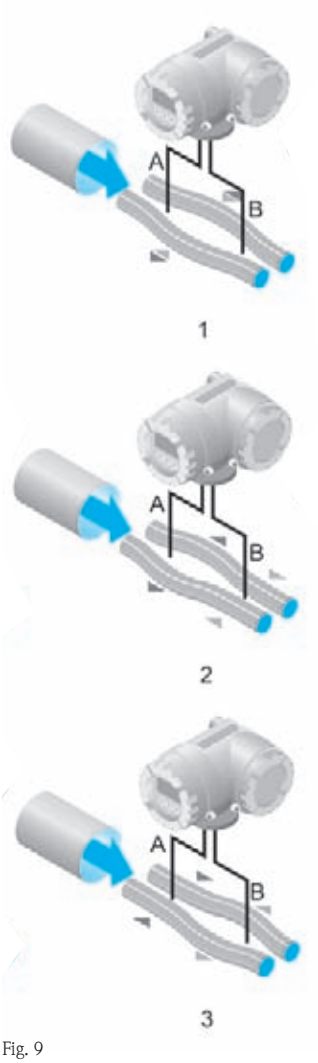


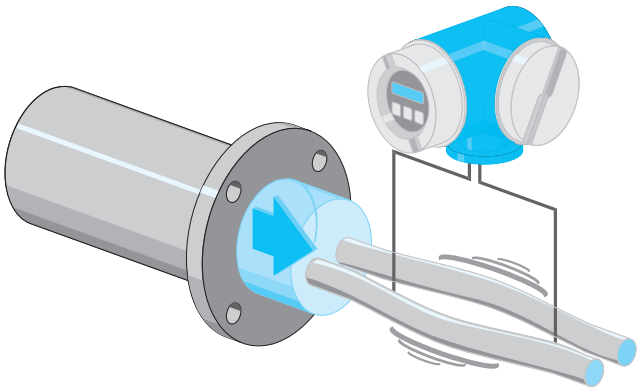
Fig. 9

Measuring principle

The measuring principle is based on the controlled generation of Coriolis forces. These forces are always present when both translational and rotational movements are superimposed.

$$FC = 2 \cdot \Delta m\ (v \cdot \omega)$$

FC = Coriolis force
Δm = moving mass
ω = rotational velocity
v = radial velocity



The amplitude of the Coriolis force depends on the moving mass Δm, its velocity v in the system, and thus the mass flow. Instead of a constant rotational velocity ω, the Promass sensor uses oscillation.

In the Promass E, F and M sensors, two parallel measuring tubes containing flowing fluid oscillate in antiphase, acting like a tuning fork. The Coriolis forces produced at the measuring tubes cause a phase shift in the tube oscillations (see illustration):

- At zero flow, in other words when the fluid is at a standstill, the two tubes oscillate in phase (1).
- Mass flow causes deceleration of the oscillation at the inlet of the tubes (2) and acceleration at the outlet (3).

The phase difference (A-B) increases with increasing mass flow. Electrodynamic sensors register the tube oscillations at the inlet and outlet.

System balance is ensured by the antiphase oscillation of the two measuring tubes. The measuring principle operates independently of temperature, pressure, viscosity, conductivity and flow profile.

Note: For Promass H, I, P and S, the system balance required for proper measurement is created by exciting an eccentrically arranged swinging mass to antiphase oscillation. This patented TMB (Torsion Mode Balanced) system guarantees perfect measurements, even in changing process and environmental conditions.

The measuring tube is continuously excited at its resonance frequency. A change in the mass and thus the density of the oscillating system (consisting of the measuring tube and fluid) results in a corresponding, automatic adjustment in the oscillation frequency. Resonance frequency is thus a function of fluid density. The microprocessor utilizes this relationship to obtain a density signal.

The temperature of the measuring tube is determined in order to calculate the compensation factor due to temperature effects. This signal corresponds to the process temperature and is also available as an output.

...

Coriolis mass flowmeter with remote electronics

Commissioning and configuration with FieldCare

Mobile flow rig for on-site calibration

Installation conditions

In addition to installation guidelines for all technologies (see 'Basics'), please note specific installation requirements for a mass flowmeter:

When using a bent measuring tube and horizontal installation, the position of the sensor has to be matched to the fluid properties!

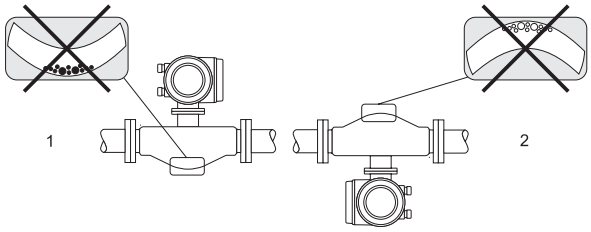


Fig. 10
Horizontal installation for sensors with a bent measuring tube
1 Not suitable for fluids with entrained solids. Risk of solids accumulating.
2 Not suitable for outgassing fluids. Risk of air accumulating.

System pressure

It is important to ensure that cavitation does not occur because it would influence the oscillation of the measuring tube. No special measures need to be taken for fluids that have properties similar to water under normal conditions.
In the case of liquids with a low boiling point (hydrocarbons, solvents, liquefied gases) or in suction lines, it is important to ensure that pressure does not drop below the vapor pressure and that the liquid does not start to boil. It is also important to ensure that the gases that occur naturally in many liquids do not outgas. Such effects can be prevented when system pressure is sufficiently high.
Therefore, the following locations should be preferred for installation:
- Downstream from pumps (no danger of vacuum)
- At the lowest point in a vertical pipe

Recommended measuring ranges: limiting flow

Please refer to the 'Measuring range' section of the 'Technical Information' documentation. Select nominal diameter by optimizing between required flow range and permissible pressure loss. See the 'Measuring range' section for a list of maximum possible full scale values.
- The minimum recommended full scale value is approx. 1/20 of the maximum full scale value.
- In most applications, 20 to 50% of the maximum full scale value can be considered ideal.
- Select a lower full scale value for abrasive substances such as fluids with entrained solids (flow velocity <1 m/s).
- For gas measurement the following rules apply:

– Flow velocity in the measuring tubes should not be more than half the sonic velocity (0.5 Mach).
– The maximum mass flow depends on the density of the gas: formula shown below.

Measuring ranges for gases

The full scale values depend on the density of the gas. Use the formula below to calculate the full scale values:
$m_{max(G)} = m_{max(F)} \cdot \rho_{(G)} / \mathbf{X}$ [kg/m³]

Promass F, M, I, S and P	X new*	X old*
DN8	60	160
DN15	80	160
DN25, 40, 50	90	160
DN80	110	160
DN100	130	160
DN150, 250	200	250

Promass E	X new*	X old*
DN8	85	225
DN15	110	225
DN25, 40, 50	125	225

Tables 2 and 3

* X new is valid starting with amplifier hardware 2.00.00/software 3.00.00 or later. For any older hardware/software use value X old

$m_{max(G)}$ = Maximum full scale value for gas [kg/h]
$m_{max(F)}$ = Maximum full scale value for liquid [kg/h]
$\rho_{(G)}$ = Gas density in [kg/m³] at operating conditions
Here, $m_{max(G)}$ can never be greater than $m_{max(F)}$.

Mounting location

No special precautions need to be taken for fittings which create turbulence (valves, elbows, T-pieces etc.), as long as no cavitation occurs. Entrained air or gas bubbles in the measuring tube can result in an increase in measuring errors. Therefore, avoid the following mounting locations in the pipe installation:
- Highest point of a pipeline - risk of air accumulating.
- Directly upstream of a free pipe outlet in a vertical pipeline.

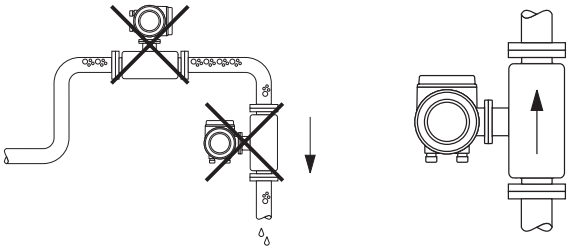


Fig. 11

Note : We recommend vertical orientation with upward direction of flow. When fluid is not flowing, entrained solids will sink down and gases will rise away from the measuring tube. The measuring tubes can be completely drained and protected against build-up of solids.

Setup - configuration

All Proline flowmeters feature a 'Quick Setup' program for straightforward commissioning. Promass 83 provides an application-specific Quick Setup program.

Operation and maintenance

Preventive maintenance

Having no moving parts, mass flowmeters require very little preventive maintenance. Nevertheless, many process conditions may affect your Promass' lifetime and accuracy: corrosive and abrasive mediums, high temperature on the electronic and stress by vibrations for the whole device. Furthermore, the accuracy of the measurement may be affected by the deposit of medium in the measure pipe, inhomogeneous mediums, gas bubbles and solids. Are you facing one of these situations? By planning periodical checks you will drastically decrease the risk of process downtime.

There are two simple ways to check a mass flowmeter:

1 - Zero point adjustment

All measuring devices are calibrated to state-of-the-art technology. The zero point determined in this way is imprinted on the nameplate. Calibration takes place under reference conditions. Therefore, a zero point adjustment is generally not required! Experience shows that the zero point adjustment is advisable only in special cases:

- When the highest measuring accuracy is required and the flow rates are very low.
- Under extreme process or operating conditions (e.g. very high process temperatures or highly viscous fluids).

How to check the zero point?

- First you have to set the low flow cutoff to 0 and close the pipe.
- Then check the zero-point in the display, while the flow in the pipe is definitely 0. In this state, the display has to show a value close to the 'zero' stability of the sensor and has to be stable.

2 - Compare the displayed and real densities

You only have to know the density of the medium that is in the pipe (e.g. d water = 0.998kg/dm^3 at 20°C). You must not stop the flow. Compare the displayed density to the density of the medium. The displayed value has to be stable and accurate in the possible tolerance threshold.
If one of these two methods gives a wrong result, please contact us.
Note: To get a good result with these two methods, it is necessary to have no air or gas bubbles in the liquid.

During operation, the meter is permanently in 'self-diagnosis' mode; therefore either severe process conditions or meter faults will be indicated. Over and above that, we use special tools that provide complete checks of the internal parameters of the electronics including elements of the sensor. (See full description of FieldCheck on page 33).

Our service contracts can include such verifications – once a year is recommended. (See **'Maintenance services'** in the 'At your service' section).

Calibration

See 'Basics' (page 29) and also page 33 for information regarding calibration of flowmeters.

Calibration can be performed by Endress+Hauser either on site or in our accredited laboratories (see **'Calibration services'** in the 'At your service' section).

Instrument and spare parts availability

Your instrument	Spare parts availability	New generation
Promass 60F/I/M	NO - since 12/2008	Promass 80
Promass 63F/I/M	NO - since 12/2010	Promass 83
Promass 80/83/84M	YES - until 12/2016	*

* According to application: Promass 80/83/84 F/I/S or CNG mass

For further information, use our Device Viewer:
www.services.endress.com/device-viewer

Table 4: Instrument and spare parts availability

Spare parts stock

For any flowmeter belonging to the Proline family, we suggest you keep a full set of electronic inserts in stock.

Migration

Promass 60 and 63 flowmeters must be replaced by the Promass 80 and 83 respectively. The electronic board must be changed at the same time. Endress+Hauser provides upgrade kits including mechanical parts and a new type plate.

The new Promass E 200 for mass flow and density measurement is a true 4-20mA loop powered device and is an excellent alternative to old generations e.g m-point + ZL6072 and Promass F/I/M + DZL363.

Video about our 2-wire concept available at www.endress.com/videos

Re-engineering

Check that the flowmeter's measuring range fits the application. In case of a different pipe diameter, a certain flow rate is required at minimum flow so that the flowmeter operates with the expected accuracy. The Applicator software allows you to check the device's accuracy over the measuring range. Applicator is available online at https://wapps.endress.com/applicator

Again consider proper installation and setup.

New Promass E 200 for mass flow and density measurement

Vortex flowmeters

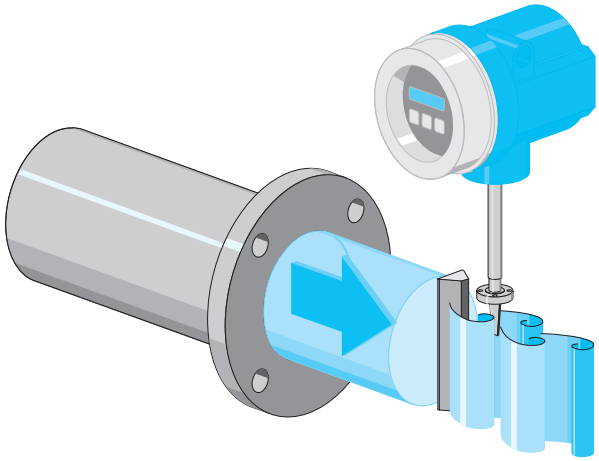
Prowirl series

The current Endress+Hauser range of vortex flowmeters includes Proline Prowirl 72 and 73.

In this section, you will find essential information and advice that will help you to perform the optimum follow-up of your Prowirl vortex flowmeters throughout their lifecycle.

Videos available at
www.endress.com/videos

Take care of inlet and outlet runs.



Measuring principle

Vortex shedding flowmeters work on the principle of the Karman vortex street. When a fluid flows past a bluff body, vortices are alternately formed and shed on both sides with opposite senses of rotation. These vortices each generate a local low pressure. The pressure fluctuations are recorded by the sensor and converted to electrical pulses. The vortices develop very regularly within the application limits of the device. Therefore, the frequency of vortex shedding is directly proportional to the volume flow.

The K-factor is used as the proportional constant: K-Factor = pulses / unit volume (dm^3).

Within the application limits of the device, the K-factor only depends on the geometry of the device. It is independent of the fluid velocity and its properties' viscosity and density. In this way, the K-factor is also independent of the type of fluid to be measured, regardless of whether this is steam, gas or liquid. The primary measuring signal is already digital (frequency signal) and a linear function of the flow. After manufacturing the meter, the K-factor is determined in the factory by means of calibration and is not subjected to any long term drift or zero point shift.

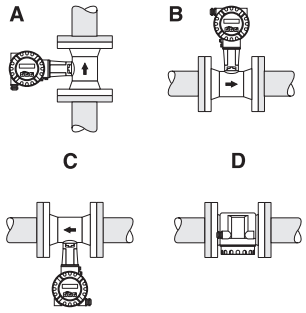
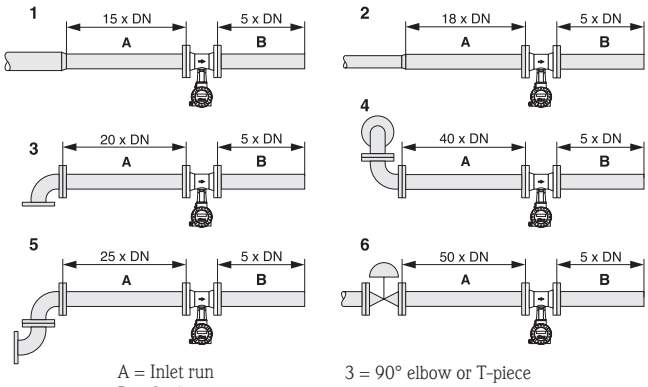


Fig. 12: Recommended orientations



A = Inlet run
B = Outlet run
1 = Reduction
2 = Extension
3 = 90° elbow or T-piece
4 = 2 x 90° elbow, 3-dimensional
5 = 2 x 90° elbow
6 = Control valve

Fig. 13: Inlet and outlet runs

Installation conditions

Vortex meters require a fully developed flow profile as a prerequisite for correct volume flow measurement. For this reason, please note the following points when installing the device:

- Welds, burrs and gaskets should not protrude into the pipe inside the inlet and outlet runs. This is very important in order to ensure that the flow profile is free of secondary disruptions.
- The nominal diameter and pipe inside diameter have to be as close as possible.

Note: The Reynolds number must be >20.000 to ensure linear performance. You can check it at https://wapps.endress.com/applicator

Orientation (see fig. 12)
The device can generally be installed in any position in the piping. For liquids, upward flow is preferred in vertical pipes to avoid partial pipe filling (see orientation A). Temperature may affect the long term reliability of electronic modules. Thus:

- In the case of hot fluids (e.g. steam or fluid temperature ≥ 200°C/ 392°F), select orientation C or D so that the permitted ambient temperature of the electronics is not exceeded.
- Orientations B and D are recommended for very cold fluid (e.g. liquid nitrogen).

The use of the remote version is recommended for cryogenic applications

Orientation for applications with hot water

The arrow indicated on the device must always point in the direction of flow in all mounting orientations.

Caution!
- If fluid temperature is ≥ 3200°C/ 392°F, orientation B is not permitted for the wafer version (Prowirl 72W) with a nominal diameter of DN100 /4" and DN150/6".
- In case of vertical orientation and downward flowing liquid, the piping always has to be completely filled.

Inlet and outlet runs (fig. 13)
As a minimum, the inlet and outlet runs shown below must be observed to achieve the specified accuracy of the device. The longest inlet run shown must be observed if two or more flow disturbances are present. Note: A specially designed perforated plate flow conditioner can be installed if it is not possible to observe the inlet runs required.

Piping insulation
When insulating, please ensure that a sufficiently large area of the housing support is exposed. The uncovered part serves as a radiator and protects the electronics from overheating (or undercooling).
The maximum insulation height permitted is illustrated in the diagrams. These apply equally to both the compact version and the sensor in the remote version.

Perfect centering
The centering rings supplied with the wafer style meters are used to mount and center the instrument.

Setup - configuration

All Proline flowmeters are equipped with a 'Quick Setup' program to make standard commissioning easy. In case of vortex flowmeters, the Quick Setup can configure the device according to the application (liquid, gas, steam).

Our service team can set up any Endress+Hauser flowmeter for you and thus ensure you immediately get the most out of your instrument. (See **'Device commissioning'** in the 'At your service' section).

Operation and maintenance

The measuring range depends on the fluid and the nominal diameter. Do not work outside the measuring range.

For steam and gas applications, if temperature and pressure vary during the process and mass flow measurement is required, you need to compensate volume flow by pressure and temperature using a flow computer.

In steam pipes, it is essential to avoid any steam, water or pressure shock on the meter.

Measurement with low flow velocities (Re < 4000) is not possible.

Preventive maintenance
The device does not contain any moving parts and requires no particular maintenance.We recommend periodic checking of the instrument by means of the FieldCheck simulator. (See full description of FieldCheck on page 33).

Our service contracts can include such verifications – once a year is recommended. (See **'Maintenance services'** in the 'At your service' section).

Calibration
See 'Basics' (page 29) and also page 33 for calibration information.

Calibration of flowmeters can be performed by Endress+Hauser either on site or in our accredited laboratories. (See **'Calibration services'** in the 'At your service' section).

Note: On-site calibration is only possible for liquid applications. Factory calibration also uses only water as fluid. The water calibration is also valid for gas and steam measurement, based on the measuring principle.

Instrument and spare parts availability

For further information, use our Device Viewer www.services.endress.com/device-viewer

Spare parts stock
For any flowmeter belonging to the Proline family, we suggest you keep a full set of electronic inserts in stock.

Migration

Prowirl 72 is fully compatible with Prowirl 77. Please consult us regarding migration from Prowirl 70H.

Re-engineering

Please take into account the following limitations when considering using a vortex flowmeter for a new application:
- Pulsating flow and swirl have a detrimental effect on measuring accuracy.
- Long inlet and outlet runs are necessary, depending on the type of fitting upstream.
- Vortex is not adapted for highly viscous liquids.
- Measurement with low flow velocities is not possible.

The Applicator software allows you to check the device's accuracy over the measuring range. Applicator is available at https://wapps.endress.com/applicator

Your instrument	Spare parts availability	New generation
Prowirl 70F/W/D	NO - since 12/2008	Prowirl 72/73 F/W
Prowirl 70H	NO - since 12/2009	Prowirl 72F
Prowirl 77F/W	NO - since 12/2008	Prowirl 72/73 F/W

Table 5: Instrument and spare parts availability

Ultrasonic flowmeters

Prosonic Flow series

The current Endress+Hauser range of ultrasonic flowmeters includes:
- **Proline Prosonic Flow 91 and 93 'clamp on' flowmeters**
- **Prosonic Flow 92 F Inline flowmeter**
- **Prosonic Flow 93T portable 'clamp on' flowmeter**

In this section, you will find essential information and advice to obtain the best from ultrasonic devices throughout their lifecycle.

Videos available at
www.endress.com/videos

Common features

Measuring principle

Prosonic Flow operates on the principle of transit time difference. An acoustic (ultrasonic) signal is transmitted in both directions from one measuring sensor to the other. As the signal propagation velocity of the waves is less when the waves travel against the direction of flow than along the direction of flow, a transit time difference occurs. This difference is directly proportional to the flow velocity. Prosonic Flow calculates the flow from the pipe cross-sectional area and the measured transit time difference.

$v \sim \Delta t \qquad Q = v \cdot A$

v = flow velocity
Δt = transit time difference
v = volume flow
A = pipe cross-sectional area

In addition to the volume flow, the system measures the sound velocity in the liquid. The sound velocity can be used to distinguish different liquids or as a measure of product quality.

Setup - configuration

All Proline flowmeters are equipped with a 'Quick Setup' program to make standard commissioning easy. In case of ultrasonic flowmeters, you need to know precisely the pipe material, the pipe external diameter, the pipe thickness and the type of fluid.

The values of some fluids are available as factory presets. For other fluids, the sound velocity in the fluid is required. The Quick Setup will then help you configure the transmitter and will give you the exact positioning of the sensors.

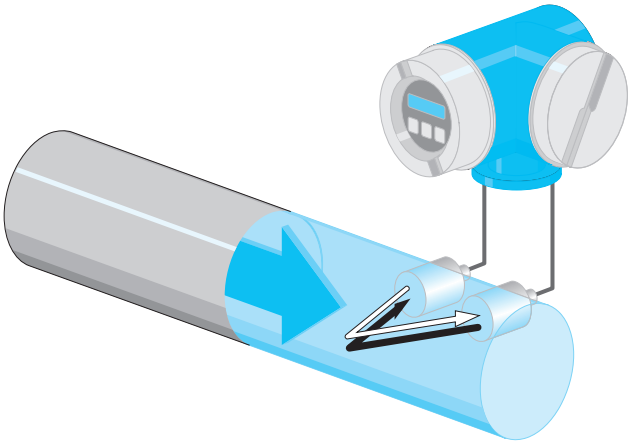
Operation and maintenance

Take care of the sensor cable: if it gets twisted, the measurement will be affected and replacements are relatively expensive.

Preventive maintenance
- Periodically check that the connectors are tight enough.
- Ensure that the sensor's position is kept constant.
- Coupling medium should be periodically changed in case of important variations of the temperature.

On-site verification is possible with the FieldCheck simulator (see page 33). The 'service' test block offers a simple way to test the function of both sensors as well as the electronics and sensor cables' functionality.

Our service contracts can include such verifications – once a year is recommended.
(See **'Maintenance services'** in the 'At your service' section)



Calibration
See 'Basics' (page 29) and also page 33 for calibration information. According to quality constraints, you may wish to periodically calibrate your instrument. Ultrasonic flowmeters can be calibrated on a flow rig. Please note that the conditions are different from the process conditions.

Calibration of flowmeters can be performed by Endress+Hauser either on site or in our accredited laboratories. (See **'Calibration Services'** in the 'At your service' section).

Instrument and spare parts availability
See table below.

Spare parts stock
For any flowmeter belonging to the Proline family, we suggest you keep a full set of electronic inserts and sensors in stock. Note: changing the sensor does not affect the electronics; no recalibration is necessary.

Your instrument	Spare parts availability	New generation
DMU93	NO - since 12/2007	Prosonic Flow 91/93
Prosonic Flow 90	YES - until 12/2013	Prosonic Flow 91/93

For further information, use our Device Viewer:
www.services.endress.com/device-viewer

Table 6: Instrument and spare parts availability

Standard horizontal installation of a clamp-on device

Prosonic Flow 93T used for the measurement consistency check of an electromagnetic flowmeter

Installation on coated pipes

Inline versions (2 pictures)

Tips for 'clamp on' devices

Installation conditions

Pipe material

The pipe material should be as homogeneous as possible, either metallic or synthetic, and must conduct sound waves. Recommended materials: cast iron (with or without cement liner) stainless steel, carbon steel, PVC, PE, GRP (composite material), fibrocement.
Note: If the pipe material does not conduct sound waves (e.g. granular concrete), use insertion sensors instead of clamp on sensors.

Mounting location

Correct measuring is possible only if the pipe is full. Avoid the following locations:

- Highest point of a pipeline – risk of air accumulating.
- Directly upstream of a free pipe outlet in a vertical pipe.

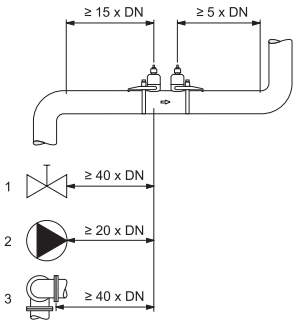


Fig. 14: Inlet and outlet runs
1 = Valve, 2 = Pump, 3 = Two pipe bends in different directions

Inlet and outlet runs

If possible, install the sensor well clear of fittings such as valves, T-pieces, elbows, etc.
Compliance with the following requirements for the inlet and outlet runs is recommended in order to ensure measuring accuracy (see figure 14).

Orientation

See figure 15.

Coupling medium

A coupling medium is required to ensure the acoustic coupling between the sensor and the piping. This is applied to the sensor surface during commissioning. Periodic replacement of the coupling medium is usually not required. Prosonic Flow 93 offers a coupling medium monitoring function as part of its 'Extended Diagnostics' software package. This function outputs the signal strength as a limit value.

Note: with proper mounting, uncertainty will be less than 2%.

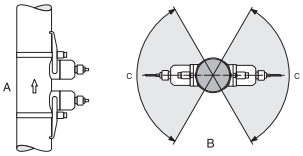
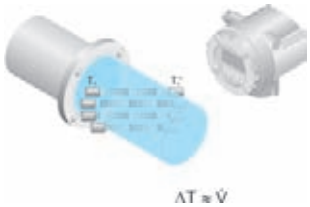


Fig. 15: Orientation
View A shows the recommended orientation with upward direction of flow.
View B shows the recommended installation range (C ≤ 120°) in a horizontal installation position

Tips for 'inline' devices

Measuring principle



A Prosonic Flow inline flowmeter measures the flow rate of the passing fluid by using sensor pairs located on opposite sides of the meter body and at an angle so that one of the sensors in the pair is slightly downstream.

Installation conditions

Inlet and outlet runs

If possible, install the sensor well clear of fittings such as valves, T-pieces, elbows, etc.
As a minimum, the inlet and outlet runs shown below must be observed to achieve the specified accuracy of the device. The longest inlet run shown must be observed if two or more flow disturbances are present. (see figure 16).

Orientation

Make sure that the direction of the arrow on the nameplate of the sensor matches the direction of flow (direction of fluid flow through the pipe). See figure 17.

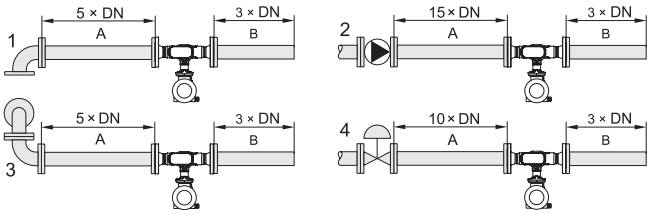


Fig. 16: Inlet and outlet runs
Minimum inlet and outlet runs with various flow obstructions.
A = Inlet run, B = Outlet run, 1 = 90° elbow or T-piece, 2 = Pump, 3 = 2 × 90° elbow, out of plane, 4 = Control valve
The upstream values given in the graph are for the 3 and 4-path meters, the 2-path meters require twice the upstream values indicated.

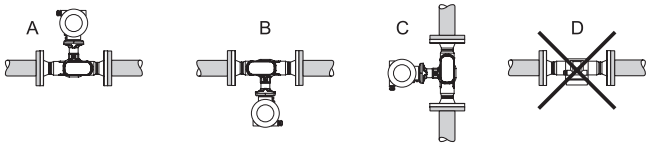


Fig. 17: Orientation
Orientations A, B and C recommended, orientation D only recommended under certain circumstances

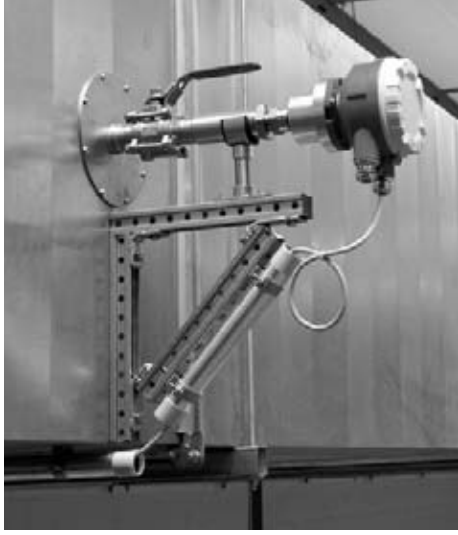
Thermal mass flowmeters

t-mass series

The current Endress+Hauser range of thermal mass flowmeters includes Proline t-mass 65.

In this section, you will find essential information and advice that will help you to perform the optimum follow-up of your thermal mass flowmeters throughout their lifecycle.

Videos available at
www.endress.com/videos

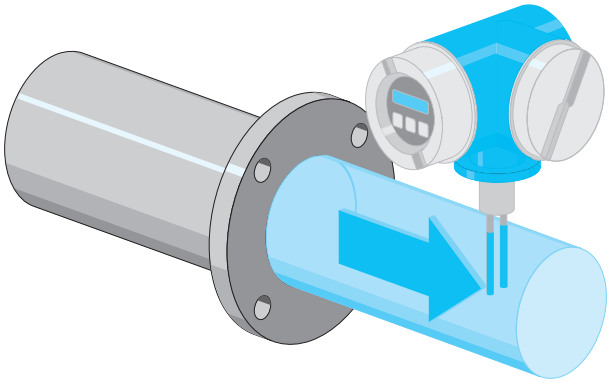


t-mass insertion version mounted on a low pressure air pipe

Ensure the sensor is mounted at 90° to the flow direction and avoid condensation.

Measuring principle

The thermal principle operates by monitoring the cooling effect of a gas stream as it passes over a heated transducer (Pt100). Gas flowing through the sensing section passes over two Pt100 RTD transducers one of which is used conventionally as a temperature sensing device, while the other is used as a heater. The temperature sensor monitors the actual process values while the heater is maintained at a constant differential temperature above this by varying the power consumed by the sensor. The greater the mass flow, the greater the cooling effect and power required to maintain the differential temperature. The measured heater power is therefore a measure of the gas mass flow rate.



These devices need to be programmed for a certain gas or gas mixture. In the factory, calibration is performed on air, using a highly accurate and state-of-the-art flow rig. The integrated 'gas engine' determines mass flow for the gas application.

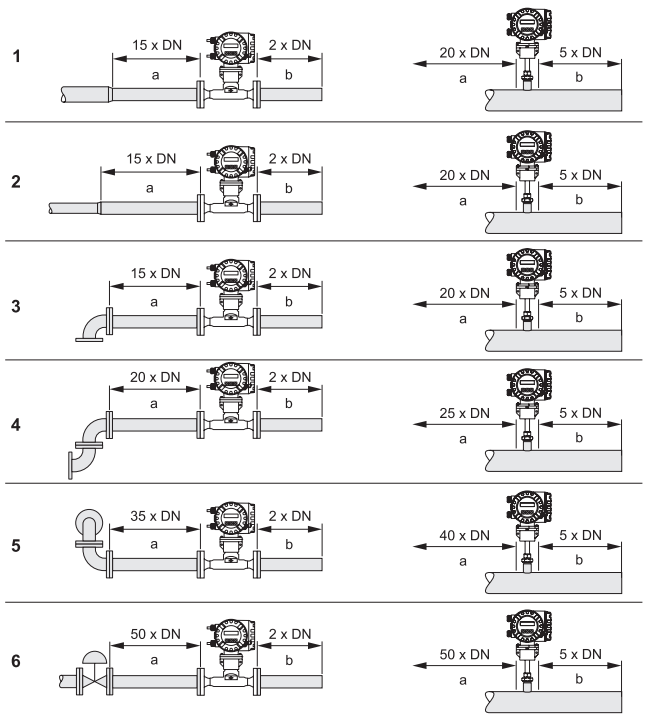


Fig. 18: Minimum inlet and outlet runs

A = Inlet run
B = Outlet run
1 = Reduction
2 = Extension
3 = 90° elbow or T-piece
4 = 2 x 90° elbow, 3-dimensional
5 = 2 x 90° elbow
6 = Control valve

Installation conditions

Like Vortex flowmeters, thermal mass flowmeters require a fully developed flow profile as a prerequisite for correct flow measurement.

Pipework requirements

Good installation practice should be followed at all times:

- Cleaned pipe and flange welded joints.
- Correctly sized gaskets.
- Correctly aligned flanges and gaskets.
- The use of seamless pipe immediately upstream of the flowmeter.
- The use of pipework with a matching internal diameter to that of the flowmeter to ensure that no step disturbance greater than 1mm/0.04" can occur at the meter inlet or outlet, 3mm/0.12" for diameters > DN200/8".

As a general comment, anything that disturbs the smoothness of the internal pipe wall should be eliminated; the goal should be a smooth, uninterrupted internal surface. For further information please refer to ISO 14511.

t-mass being calibrated on a gas calibration flowrig

Endress+Hauser's new gas calibration flow rig

t-mass measuring nitrogen consumption

Air injection regulation in the pond of aeration (wastewater)

Inlet and outlet runs
If possible, install the sensor well clear of fittings such as valves, T-pieces, elbows, etc.
Compliance with the following requirements for the inlet and outlet runs is recommended in order to ensure measuring accuracy (see figure 18). It is recommended to install a perforated plate flow conditioner if the recommended inlet runs are not available.

Orientation
The device can generally be installed in any position in the piping. In the case of wet/dirty gases, upward flow is preferred in vertical pipes to minimize condensation/contamination on or around the sensing element. In particular, where free condensation can occur (e.g. biogas), the sensor should be mounted to prevent water collecting on or around the sensing elements (e.g. do not install the sensor at a low point in the installation without adequate drainage).
Make sure that the direction arrow on the sensor matches the direction of flow (direction of fluid flow through the pipe).
Note: The best accuracy is obtained only if the gas is dry and clean.

Setup - Configuration

The sensor is provided fully calibrated with an S-DAT.
Each meter is programmed to individual requirements, i.e. in particular the gas type or gas composition and calibrated with air. The necessary information is requested before delivery. Thus commissioning is quite simple.

Requested information:
- Gas type if not air (composition if more than one gas in % Mole).
- Gas pressure.
- Line size - internal diameter.
- 20mA range required.
- Flow engineering units (kg/h, Nm^3/h etc).

'DELIVERY SETTINGS' are the programmed parameters (factory settings plus customer specific settings) originally delivered with the device.

The Quick Setup menu contains the default settings that are adequate for commissioning. You may use the Quick Setup in order to change parameters or to use the device on a different application.

Operation and maintenance

Preventive maintenance
Full compatibility with FieldCheck (see page 33) allows on-site verification.

Calibration
See 'Basics'.

The sensor's aging directly impacts the measurement. Aging may be sped up in case of build-up due to solids deposit, of shock on any of the transducers or of abrasion due to the presence of impurities in the gas. In all cases, we recommend having the device calibrated once a year.

The t-mass flowmeters are designed to support in-situ calibration using a reference meter signal (mobile rig), thus saving time and cost by reducing the need for factory re-calibration. An adjustment may complete the calibration work. Please discuss your specific requirements with your Endress+Hauser service representative.

For higher precision, t-mass 65 flowmeters can be calibrated with an ISO/IEC 17025 accredited specific gas flow rig.

Calibration of flowmeters can be performed by Endress+Hauser either on site or in our accredited laboratories. (see **'Calibration'** in the 'At your service' section)

Corrective maintenance
See 'Basics' (page 31).
You can change the sensor and the transmitter on site. Thanks to S-DAT and T-DAT, no further programming is necessary.

Instrument and spare parts availability
See table below.

Spare parts stock
For any flowmeter belonging to the Proline family, we suggest you keep a full set of electronic inserts in stock.

Your instrument	Spare parts availability	New generation
t-mass AT70	YES	t-mass 65

Table 7: Instrument and spare parts availability

Migration

Thermal mass flowmeter t-mass AT70 is being phased out. With the brand new 65F/I series, Endress+Hauser offers full interchangeability. What about the interchangeability with existing sensors?

From the mechanical side:
- The t-mass 65I available process connections are G 1" and NPT 1"
- The t-mass 65F face-to-face length is identical to the AT70

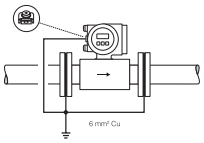
From the electrical side: the 65F/I series can be supplied with 24V DC, allowing total interchangeability with AT70.

Re-engineering

Besides the utilities, t-mass 65F/I series is ideally suited for air injection regulation in the pond of aeration of a wastewater treatment plant. See 'Installation conditions' before you decide to change the device's application. Use the 'gas engine' software to change the gas mixture.

Frequently asked questions

How to achieve proper potential equalization?
Perfect measurement requires that the medium and the sensor have the same electrical potential. Most Promag sensors have a standard installed reference electrode which guarantees the required connection and makes additional potential matching measures unnecessary.
Special cases are mentioned in the Operating Manual. In particular the case of plastic pipes and isolating lined pipes.
In exceptional cases it is possible that, due to the grounding plan of a system, large matching currents flow over the reference electrodes. This can lead to destruction of the sensor. In such cases, e.g. for fiberglass or PVC piping, it is recommended that you use additional ground disks for potential matching.



Grounding should be ensured at first installation; nevertheless in some cases it may be corrected later.

How to connect a flowmeter to a programmable logic controller (PLC) and then make them communicate?
- Correct electrical wiring. Use a specific cable to connect the sensor to the transmitter (Please read carefully '4.1 Wiring – connecting the remote version' in the Promag 50 Operation Manual).
- Ensure full compatibility between the emitter and the receiver by a proper parameterization of the pulse/frequency output according to your PLC's settings.
  Go to the programming matrix at level '(4207) Output signal' and select:
  0 = PASSIVE - POSITIVE
  1 = PASSIVE - NEGATIVE
  2 = ACTIVE - POSITIVE
  3 = ACTIVE - NEGATIVE
  Factory setting: PASSIVE-POSITIVE
  See also the Proline Promag 53 operating manual, p.68 for more explanation.

What is the unlocking code for my instrument?
Name of device: e.g. '0050' or '50' for Promag 50

How do I set the end of the 4 to 20 mA output scale?
- Go to the 'current output' menu
- Go to the '20mA end of scale' box

How do I set the pulse output?
- Go to the 'pulse output/frequency' menu
- Go to the 'pulse value' box

How do I wire the pulse output on a Promag 50?
- Connect the 24V DC to the + terminal of the pulse output
- Retrieve the signal on terminal 25 (Input/Output terminal numbers).

What to do when faced with measurement drift over time?
- Remove the measuring tube and clean it
- Return it to the workshop so that it can undergo the calibration bench procedure

Coil current fault?
- Make sure that all the connectors are correctly clipped onto the electronics boards
- If so: return the complete device to the workshop

The instrument counts at zero flow. What should I do?
- Probable cause: air transit
- Calibrate DPP with tube empty and tube full
- Activate 'product presence detection' and 'low flow cutoff' functions

Note: See 'Process parameters menu' in the Operating Instructions.

The measurement exhibits peaks or fluctuating values. The measurement is unstable. What should I do?
- Check the installation conditions
- Make sure that the pipe is completely filled (no air in the unit)
- High or low fluid load?
- Make sure there are no air bubbles
- Electrical connection: if electronics separate: earth connection? Synthetic pipe?

With the PROFIBUS version, are different values displayed on the display and the PLC?
- Go to the communication menu
- Validate the 'set unit to bus' box.

Note: this is also valid after any programming alteration.

How do I test the pulse output?
- For the test, set a pulse period of 1 second
- Connect a diode mode multimeter to the unwired (+) and (-) terminals
- The value changes can be seen on the multimeter (one step = 1 s): Equipment OK

How do I test the current output?
- Connect a milliammeter to the unwired terminals 26 (+) and 27 (-)
- Go to the 'current output' menu
- Activate the 'current simulation' box
- Define the current to be simulated in the 'sim. curr. value' box

There is a high measurement error. What should I do?
- Check the installation conditions
- Make sure that the pipe is completely filled (no air in the unit)
- Is the set-up correct?

The Promass shows Error#587, 701 or 702 and the measurement is unstable or wrong. What is the reason for that?
Perhaps the pipe is only partly filled or the pressure is low and gas bubbles are in the medium. Please check:
- Is the pipe completely filled?
- Are there gas bubbles in the medium?

The solution: increase the pressure.

Liquid analysis

We are always there for you!

Analysis devices typically require more maintenance than the other measurement principles. As a consequence, the maintenance staff that takes care of a plant generally knows exactly what has to be done. The major improvements are due to the growing importance of digital communication, resulting in numerous benefits for maintenance personnel.

Concerning the calibration of analysis devices, it is important to remember that for some measuring parameters calibration and adjustment in comparison to a buffer solution is impossible, either because no buffer solution exists (e.g. chlorine) or because a buffer solution would not be representative of the chemical matrix of the process (e.g. COD with spectral absorption principle). In these situations calibration and adjustment have to be performed in conjunction with laboratory analysis. Therefore you will require these specialist skills in-house or you can entrust a specialized partner such as Endress+Hauser with this service.

As most reported questions concern either the use of an Endress+Hauser device itself or troubleshooting (generally due to the application), this guide serves as a reminder of the different principles used in liquid analysis. You will also find some recommendations related to maintenance intervals to help you keep your instruments 'fit'!

In addition to this, we have included expert approaches to diagnosis and frequently asked procedures to help you make the right diagnosis and take the correct actions in case of trouble.

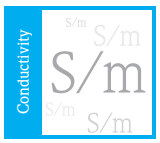
As experts, we also offer training sessions, in classroom and on site. We would be glad to meet with you and help you go one step further. See 'Training' in the 'At your service' section.

Contents

Basics

Information common to all types of liquid analysis devices

pH/ORP measurement
Specific information p. 50



Conductivity measurement
Specific information p. 55

Turbidity measurement
Specific information p. 58

Chlorine measurement
Specific information p. 61

Oxygen measurement
Specific information p. 64

Digital communication makes life easier

With digital communication between sensors and transmitters, many problems concerning information exchange between analog devices are now things of the past. The Memosens systems provide safety and operating comfort in analytical measuring technology – something users and producers have been striving for for generations.

One transmitter for all parameters
The heart of the new Endress+Hauser liquid analysis platform is Liquiline CM442. Liquiline CM442 is a multiparameter and multichannel controller. It is suitable for all parameters: pH, ORP, conductivity, dissolved oxygen, turbidity, nitrate, SAC, chlorine and ammonium. All sensors speak the same language based on the Memosens protocol.

Main benefits
- Time saving due to easy sensor exchange with pre-calibrated Memosens sensors and pre-commissioned controller.
- Easy to use, simple to maintain – standardized operation and maintenance strategy
- Reduction of maintenance and stock costs

The same benefits apply to the new samplers (Liquistation CSF48 and Liquiport CSP44) since they include the same hardware and software.

Our aim is to facilitate your daily work (commissioning, operation and calibration) by maximizing uniformity for highest process safety at low costs.

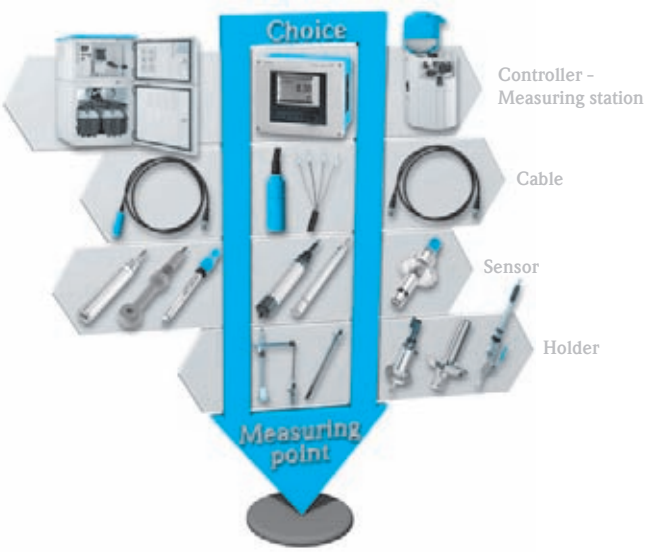
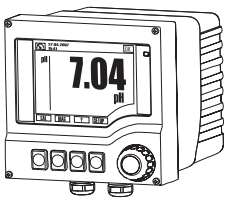


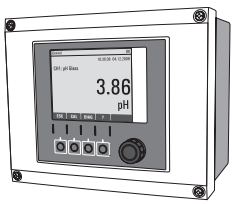
Fig. 1: Memosens systems enable simplified selection and uniform operation and maintenance strategy

The current range of transmitters (analog and digital)

- **Liquiline CM442** The multiparameter and multichannel controller is suitable for all Memosens sensors and digital sensors with Memosens protocol.
- **Liquiline CM42** The high-performance two-wire transmitter can be used in hazardous and non-hazardous locations. Version for pH/ORP, conductivity, dissolved oxygen – easy switch of parameters via sensor modules.
- **Liquisys** The four-wire transmitter is available with a field or panel-mounted housing. Version for pH/ORP, conductivity, dissolved oxygen, turbidity and chlorine.



Liquiline CM42



Liquiline CM442

Advantages of Memosens digital communication

Memosens connector
- No more metallic contact between cable and sensor.
- Completely tight: no more problems with humidity, corrosion, dirtiness.
- Quick connection system.
- Autoclavable and sterilisable.

Cable characteristics
- No special cable necessary.
- Cable length is no longer an issue.
- No high impedance junction box required to extend the cable.

Total galvanic separation
- No more electromagnetic interferences.
- No interference between the process potential and the transmitter.

Data transfer monitoring
- Emission of an alarm if signal is broken.

Sensors equipped with memory
- Calibration data is stored directly in the sensor's head.
- Sensor interrogation for predictive maintenance as the working time, maximum and minimum values of main parameter and temperature found, etc.

Simplified calibration
- All sensors are pre-calibrated in factory.
- Cleaning and calibration of the sensor can be done easily in laboratory in optimal conditions.
- Laboratory pre-calibrated sensors can be quickly and simply replaced to minimize downtime.

Centralized management of sensors and data

Designed for Memosens systems, Memobase is a database and software that allows you to manage your data and sensors centrally thus offering numerous benefits:
- More precise calibration in the laboratory under ideal conditions by trained personnel
- Reduction of process costs and downtime through sensor replacement by non-trained personnel
- Standby times of trained personnel are minimized (weekends, night shifts)
- Traceable documentation of all sensor and process-related data

Documentation of complete sensor life cycle
- From commissioning to scrapping
- Automatic data transfer upon calibration
- With lab calibration system Liquiline M CM42
- For pH glass and ISFET electrodes

Filter functions for Memosens data
Memobase allows a complete documentation of sensor history:
- Information about measuring system
- Calibrations
- Trends of calibration data (slope, zero point)
- Process conditions

Memosens data management
- Manage the complete life cycle of a sensor from delivery to scrapping
- Trace the calibration history
- Log the sensor load data, e.g. over all operating hours and operating hours under extreme process conditions
- Export the data to Excel, html

Memosens sensor management
- Assignment of sensors to dedicated measuring points by TAG number or group of TAG numbers
- Deactivation of scrapped sensors in the database
- Outside marking of sensors with Memoclip

Check of Memosens chains

Memocheck Plus CYP01D
This tool enables simple qualification of the measuring loop:
- With five plug-in heads each simulating a fixed, defined sensor status for a dedicated type of sensor
- Reading of all relevant calibration and process data after simulation at predefined pH and temperature values
- Each plug-in head has passed a stringent test on a computerized inspection unit and a quality certificate is issued

Concept of CYP01D
- Kit of five Memosens simulation caps. Example: pH pH 0 (T° -10°C); pH 4 (T° 25°C); pH 7 (T° 60°C); pH 10 (T° 90°C) and pH 14 (T° 135°C).
- Each cap has its own serial number
- Non-Ex and Ex versions

Memocheck CYP02D
This service tool enables a quick and easy check of the measuring loop by simulating fixed sensor status in order to:
- Check the digital data transfer during commissioning
- Solve troubleshooting in the running process

Some combinations available:
pH 7 (glass) + pH 4 (glass)
pH (glass) + pH (Isfet)
pH (glass) + ORP
pH (glass) + dissolved oxygen
pH (glass) + conductive conductivity

Memocheck Sim CYP03D
This tool enables the simulation of measured values of all digital sensors (Memosens sensors with inductive plug-head and fixed-cable sensors with Memosens protocol)
- Operates with Liquiline CM442 and Liquiline M CM42
- Full loop check capability
- Programmable continuous simulation sequences
- Simulation of fixed-cable sensors with CYK10
- Non-Ex version and ATEX for Liquiline M CM42

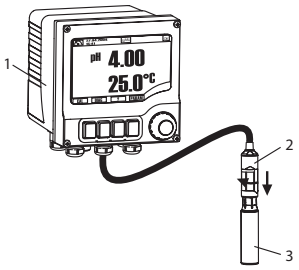


Fig. 2: Measuring system with Memocheck Plus CYP01D
1 Transmitter with Memosens technology, e.g. Liquiline M CM42
2 Memosens coupling
3 Memocheck Plus CYP01D

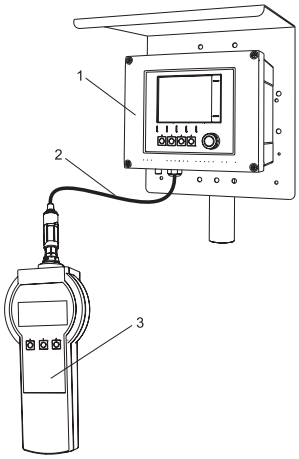


Fig. 3: Measuring system with Memocheck Sim CYP03D
1 Transmitter with Memosens technology, e.g. Liquiline CM442
2 Memosens data cable CYK10
3 Memocheck Sim CYP03D

Video about Memosens and Liquiline available at www.endress.com/videos

pH and ORP measurement
Electrodes and transmitters

A complete pH or ORP measuring system includes:
- **Analog (CPSxx and CPFxx series) or a digital (CPSxxD and CPFxxD series) sensor**
- **Transmitter (Liquisys M CPM223/253, Mycom S CPM153, Liquiline CM42 and CM442)**
- **Special measuring cable**
- **Assembly**

In this section, you will find essential information and advice on how to obtain the best from pH and ORP measuring systems throughout their lifecycle.

You can carry out many tasks by yourself.

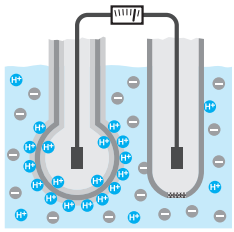


Fig. 4: Potentiometric measuring principle: potential build-up during pH measurement with glass electrodes

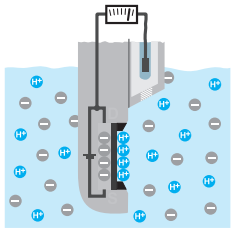


Fig. 5: Ion-selective measuring principle: the current between source and drain of the semiconductor element depends on the charge at the base and thus directly on the pH value

pH measurement - potentiometric measuring principle

This principle is based on a pH-sensitive glass membrane on which hydrogen ions accumulate, thereby causing electrical potential to build-up.

The method of pH measurement using glass electrodes is a potentiometric measurement method. Since glass is an electric insulator, transmitters for analog pH measurement must have an extremely high input impedance. In the case of Memosens electrodes, signals are transmitted without interference. The measuring effect is based on a pH-sensitive glass membrane whose surface reacts to the acid content of the solution with a specific voltage. This voltage is then measured relative to a reference element made of silver/silver chloride (Ag/AgCl) which remains constant.

Glass pH electrodes using the potentiometric method
- Sensors with a Teflon diaphragm and gel reference (CPS11D/11)
- Sensors with a ceramic diaphragm and liquid reference (CPS41D/41)
- Sensors with a ceramic diaphragm and gel reference (CPS71D/71)
- Sensors with an open diaphragm and gel reference (CPS91D/91)

pH measurement - ion-selective measuring principle

The ISFET is a simple transistor which is isolated from the gate by an isolator. Hydrogen ions can accumulate on this gate.

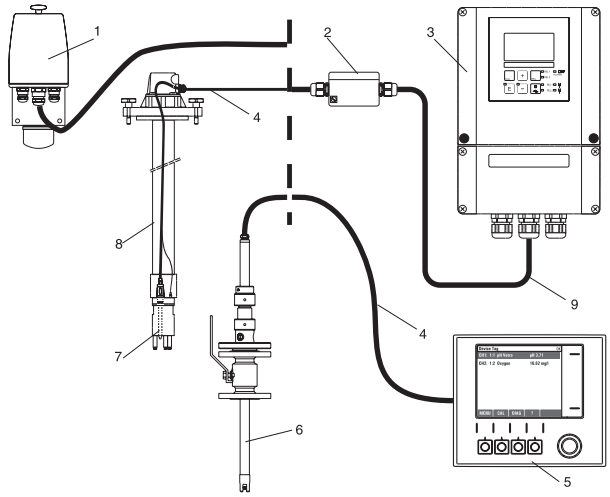


Fig. 6: Example of a complete measuring system
1 Flow assembly CPA250
2 Junction box VBA
3 Liquisys M CPM253 transmitter
4 Measuring cable e.g. CPK9
5 Liquisys M CPM223 transmitter
6 Retractable assembly Cleanfit W CPA450
7 Electrode, e.g. Orbisint CPS11
8 Immersion assembly CPA111
9 Extension cable
Options: extension cable, junction box VBA or VBM

The pH value can also be measured with an ion-selective field effect transistor (ISFET). It is, in effect, a simple transistor with a source and drain that are separated from the base by a semiconductor. Hydrogen ions from the medium may accumulate here. The resulting positive charge on the outside is 'mirrored' on the inside of the base where a negative charge occurs. This makes the semiconductor channel conductive. The lower the pH value of the liquid, the more H+ ions accumulate on the base and the more current can measurably flow between the source and drain. The accumulation of protons is a purely electrostatic effect. As a result, the sensor material does not change and the need for recalibration is by no means as frequent as with glass electrodes. Since there is no gel-like layer, ISFET electrodes are also suitable for pH measurement in media with a low proportion of water.

Glass-free pH electrodes using the ISFET method
- Glass-free sensors with diverse reference systems (CPS441D/441/471D/471/491D/491)

The influences on pH measurement
- Temperature influences at two levels. First on the electrode slope sensitivity. Temperature compensation serves to bring back this sensitivity from its value at the operating temperature to its value at the reference temperature 25°C /77°F. Secondly temperature influences on pH: the pH of a fluid will not be the same at 90°C/194°F as at

15°C/59°F. With Liquiline and Mycom S, you can compensate the medium's temperature.
- Contamination of the reference element
- Electrical phenomena
- Heterogeneous media
- Soiling
- Aggressive chemical products

ORP measurement – measuring principle

ORP measurement also uses the potentiometric measuring principle.

The ORP value is an indicator of the oxidizing or reducing properties of a process medium and is measured in mV. In aqueous media, the measuring range is between -1,500mV and +1,500mV. A precious metal electrode (gold or platinum) acts as the measuring electrode. As is the case with pH measurement, the electrochemical potential is measured against a silver/silver chloride reference (Ag/AgCl) and indicated in mV.
All ORP pairs in a process make up the oxidation reduction potential. As such, in contrast to pH measurement, the ORP value is a sum parameter that cannot be assigned quantitatively to the individual ORP pairs.
Even though only one sum parameter is measured, ORP measurement is an effective and low-cost method that can be used for chromate detoxification, cyanide detoxification or to measure the metering of oxidants for disinfection purposes.

The ORP value can also be indicated as a percentage. Here, two characteristic mV values are assigned to a 20% and an 80% value, making it possible to detect activities pertaining to chemical reactions and also of reaction end points.

ORP electrodes
- Standard sensor Orbisint CPS12D/12 for long-term monitoring in water treatment, detoxification or the chemical industry
- High-performance sensor Ceraliquid CPS42D/42 for chemical industry, detoxification, water treatment, power stations; for media that tend to form build-up, and fast-changing medium compositions
- Hygienic sensor Ceragel CPS72D/72 for food industry, fermenter, biotechnology with rapidly changing oxidation reduction potential
- Sensor for suspensions Orbipore CPS92D/92 for paper and pulp industry

Installation conditions for pH/ORP sensors

Do not install the electrode upside down (see fig. 7).
The inclination angle must be at least 15° from the horizontal. A smaller inclination angle is not permitted as such an inclination results in the formation of air cushions. This might impair the contact of reference and metal lead.
Caution!
- Make sure that the assembly's threaded connection for the electrode is clean and working properly before installing the electrode.
- Hand tighten the electrode (3Nm)! (This value only applies to installation in Endress+Hauser assemblies.)
- Follow the installation instructions detailed in the operating instructions of the assembly.

Cabling
- Cable should not be longer than 50m/164ft. (CPK7, CPK9, CYK71); for longer distances use Memosens technology as this has no limit on cable length (up to 100m).
- The cabling should not be interrupted (avoid any temporary connection). If an extension is necessary, use a high impedence junction box (VBM).

Connecting analog pH and ORP sensors
The pH and ORP analog sensors can be connected either symmetrically or asymmetrically.

Advantages of symmetrical measurement (fig. 8):
- No leak current since the reference and the pH/ORP electrode is connected with high resistance
- Safe measurement under difficult process conditions (strong flowing and high-resistance media, partially soiled diaphragm)

Advantage of asymmetrical measurement (fig. 8bis):
- Use of assemblies without potential matching possible

Caution! In the case of a symmetrical connection, the potential matching pin must be connected and always immersed in the medium.

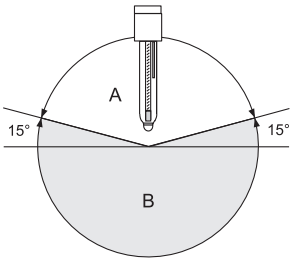


Fig. 7: Electrode installation; inclination angle min. 15° from the horizontal

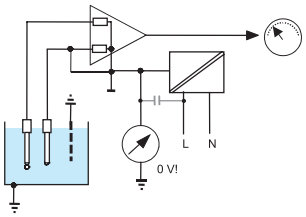


Fig. 8: Asymmetrical connection

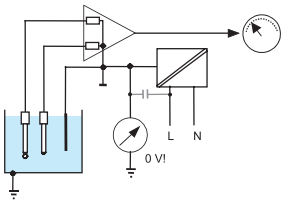


Fig. 8bis: Symmetrical connection

Operation and maintenance

To ensure the safe transmission of measured values from analog systems, double-shielded measuring cables are required to prevent electromagnetic interference. With Memosens technology, the sensor data is stored directly in the sensor head and transmitted with a standard bus cable of low impedance.

The advantages of Memosens technology are particularly evident in pH measuring technology. Problems with moisture are a thing of the past. In addition to excellent transmission reliability, for the first time ever a system is available that can detect a cable break or other interruptions in the measuring signal. This, in turn, significantly reduces process downtime.

Preventive maintenance

Maintenance work at the transmitter includes:
- Cleaning of assembly and sensor
- Cable and connection check
- Calibration and adjustment

Cleaning glass pH and redox electrodes

There are five levels of cleaning:
- Level 1: use water + sponge
- Level 2: use water + soap (presence of grease)
- Level 3 (ORP only): carefully clean the metal pins or surfaces mechanically (polish under water using ultra fine abrasive paper).
- Level 4: use diluted hydrochloric acid HCl (3 to 5%) and rinse with clean water.
  Note! After chemical cleaning, the ORP sensor can require several hours conditioning time. Therefore check the calibration after a day.
- Level 5: use specific products to clean contamination (see the following list).

- **Oily and greasy films:** Clean with detergent and water or any solvent such as alcohol, acetone.
- **Inorganic layers:** Immerse the electrode for 15 mins in diluted hydrochloric acid or soda (max 5%).
- **Lime and metal hydroxide layers:** Dissolve layers with diluted hydrochloric or citric acid (max 10%).
- **Layers containing sulphide:** Use mixture of hydrochloric acid (max 10%) saturated with urea.
- **Layers containing proteins:** Immerse the electrode in a mixture of hydrochloric acid (max 10%) saturated with pepsin (8500 units) at 37°C/98.6°F.

Note! Always rinse carefully with plenty of clear water and wipe with a soft cloth.

Cable and connection check

- Check cables and connections for moisture, cuts or kinks.
- Check electrical continuity: establish a short-circuit between two wires at one end of the cable (e.g. between 'Measure' and 'Ref'). Measure the resistance at the other end (should be 0.1 Ω/m).
- Detection of insulation default: disconnect both ends of the cable and measure the impedance between the wires with an insulation meter that measures with 1000V (should be R = ∞).

Calibration of analog systems

Use the CAL key to access the 'calibration' function group. Use this function group to calibrate the sensor. The calibration can take place in a number of ways:
- By measuring in two buffer solutions with known pH value.
- By entering data for the slope and zero point adjustment.
- By entering an offset value.
- In the case of ORP measurement, by entering the mV value or two different % values.

pH electrode adjustment

1) Clean the electrode with water (or specific product).
2) First immerse the electrode in a pH 7 buffer solution.
   - In the case of an automatic temperature compensation, the temperature sensor must be immersed in the medium.
   - In the case of a symmetrical connection, the potential matching pin must be connected and always immersed in the medium.
   - Enter the actual buffer value in the transmitter (at current temperature).
   - Keep the electrode immersed for a few seconds before you validate the measurement.
   - Rinse the glass bulb with clean water (do not rub it: you might generate electrostatic charges!).
3) Immerse the electrode in the second buffer solution (pH 4, 9, etc) and start again at step 2.
4) Rinse the electrode with clean water.

ORP electrode adjustment

1) Clean the electrode with water.
2) Immerse the electrode in a buffer solution (220mV or 460mV).
   - Measure the container's temperature.
   - In the case of a symmetrical connection, the potential matching pin must be connected and always immersed in the medium.
   - Keep the electrode immersed for 1 minute before you validate the measurement.
3) Enter the actual buffer value in the transmitter (at current temperature).
4) Rinse the electrode with clean water.

Check of the slope after calibration of a pH electrode

The theoretical slope is 59.16 mV/pH. The practical slope of a new electrode is 57 to 60 mV/pH.
- If the slope is ≤ 55 mV/pH, the electrode must be cleaned.
- If the slope is ≤ 50 mV/pH, the electrode must be checked and replaced if needed.
- If the slope is ≤ 45 mV/pH, the transmitter displays an error message: the electrode must be replaced.

Checking a transmitter - analog technology (for digital technology, see Memosens)

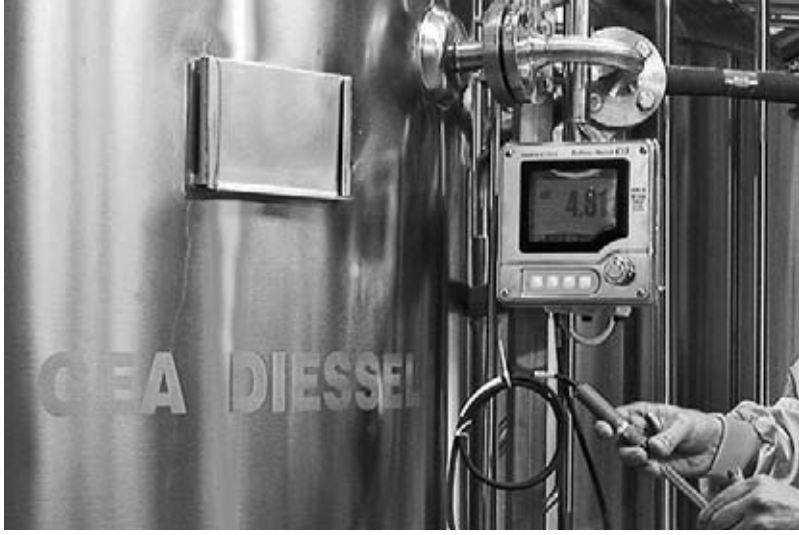
Bypass the pH input by connecting the 'Measure' terminal to the 'Reference' terminal (+ the 'PA' terminal in case of a symmetrical connection). As the pH meter input has a potential of 0mV, the display should indicate the zero value of the last calibration (i.e. around pH7). You need a pH simulator if you wish to test the whole scale. A pH simulator consists of a simple voltage generator (-500 to +500mV).

Regeneration of a pH electrode whose response time is too long:

Use a mixture of nitric acid (10%) and ammonium fluoride (50 g/l). Rinse with clean water then wipe with a soft cloth.

Storage of an electrode

Store in a dry place between 10 to 30°C/50 to 86°F. Always keep a glass electrode hydrated (if possible in KCl 3 mol/l). Electrodes are always delivered with a cap that contains a sponge saturated with a special liquid in order to avoid dessication of the bulb.



Easier maintenance with Memosens technology

Easy handling
Sensors with Memosens technology have integrated electronics that allow calibration data to be saved along with additional information such as total hours of operation and operating hours at very high temperatures. When the sensor is connected, the calibration data is automatically transferred to the transmitter and used to calculate the current pH or ORP potential. Storing the calibration data in the sensor allows for calibration and adjustment away from the measuring point.

The result:
- The sensors can be calibrated under optimum external conditions in the measuring lab. Wind and weather do not affect either the calibration quality or the operator.
- The measuring point availability is dramatically increased by the quick and easy replacement of pre-calibrated sensors.
- The transmitter does not need to be installed close to the measuring point but can be placed in the control room.
- Maintenance intervals can be defined based on all stored sensor load and calibration data and predictive maintenance is possible.
- The sensor history can be documented on external databases and evaluation programs at any time. Thus, the current application of the sensors can be made to depend on their previous history.

Memocal T - dedicated calibration tool
Memocal T is a calibration instrument for your laboratory:
- pH measurement using digital sensors
- Wet or numeric calibration (3m/9.8ft of cable)
- Readout of all software and hardware version numbers including sensor serial number

Corrective maintenance

Diagnosis of common troubleshooting: see table 1

Generic approach to diagnose troubleshooting
We suggest five steps:
1) Check that the sensor is correct for the application
2) Check the installation (cabling), the configuration and the hydraulic mounting
3) Take the environment (electromagnetic, electrical, moisture, sun) into account
4) Consider the metrological level
5) Find out which component is out of order

1) Installation
- Configuration of analog systems (symmetrical or asymmetrical) has to be coherent with connection.

Problem / Possible cause	Action
Calibration is impossible	
Bulb and/or diaphragm soiled	Clean it
Bulb broken	Replace electrode
Cabling error or defective cable	Check and replace if needed
Buffer solution out-of-date or contaminated	Change buffer solution
Measurement is unstable	
Incorrect connection	Check cable and connections
Interference	Use double-armored cable; check connection of the armor plating to the ground; change cable path
Current or parasitic potential in the product (for analog systems only)	In case of asymmetrical measurement, connect the product to the ground; switch to symmetrical measurement
Slow sensor response	
Electrode soiled	Clean it
Sensor aging	Test the measurement chain with a simulator; replace the electrode
Display blocked on a fixed value	
Insulation default and/or short-circuit on the cable	Test with a pH simulator or an insulation meter
Moisture on the connectors	Check and dry
Crack on the inside tube (short-circuit between measurement and reference)	Replace electrode
Reduction of the reference element (current circulation)	
Insulation default and/or short-circuit on the cable	Test with a pH simulator or an insulation meter
Moisture on the connectors	Check and dry
Incoherence between configuration and connection (symmetrical/asymmetrical) (for analog systems only)	Check

Table 1: Diagnosis of common troubleshooting

- Review the programming matrix.
- Consider the installation conditions of the electrode.

2) Environment
- Is the sensor installed inside or outside? Is it protected from sunlight?
- Take the electrode out of its environment and check it in another environment.
- Electromagnetic phenomena: check the cables and the connection to the ground.
- Does temperature vary a lot? If yes, check that temperature compensation is active.
- Moisture: visual check of the junction boxes watertightness, look for moisture or oxidation on the connectors, etc.

3) Metrological level
Is there a drift, is the measurement unstable or incorrect?
- Is the electrode soiled? Then clean the electrode (see previous page).
- Check the electrode in a well known medium with the actual configuration data of the transmitter. If there is a drift, return to the factory configuration. If this is not sufficient, apply the procedure to adjust an electrode manually (see previous page). Read the slope and the zero point. Depending on the value of the slope you may need to clean or replace the electrode.

4) Which component is out of order?
Electrode check:
- Visual check of the outside condition (damaged, cracked, bulb broken, corrosion, abrasion, oxidation or moisture on the connector, etc.)
- Visual check of the inside condition (Is KCl still transparent? Has the reference thread reduced? Is the internal glass tube damaged?)

Cable check: see page 52
Transmitter check: see page 52

Instrument and spare parts availability
See table on the right.

Spare parts stock
We recommend that you always keep a new electrode in stock.

For how to select buffer solutions and cables:
see list on the right.

Migration

How to use a Memosens electrode with your current pH transmitter?
Upgrade kits are available for any Liquisys M CPM 223/253 (from version 2.5 upwards), Mycom S CPM153 and Liquiline CM42. This upgrade can be done either by a service engineer on site or you can send it back to the Endress+Hauser service department.

Your instrument	Spare parts availability	New generation
Mypro CPM431	NO - since 10/2010	Liquiline CM42
Mypro CLM431	NO - since 10/2010	Liquiline CM42
Mycom CPM152	NO - since 12/2007	CPM153

For further information, use our Device Viewer:
www.services.endress.com/device-viewer

Table 2: Instrument and spare parts availability

List of consumables

Buffer solutions for pH electrodes
Technical buffer solutions, accuracy 0.02pH, acc. to NIST/DIN
- pH 4.0 red, 250mL, order no. CPY20-C02A1
- pH 4.0 red, 1000mL, order no. CPY20-C10A1
- pH 7.0 green, 250mL, order no. CPY20-E02A1
- pH 7.0 green, 1000mL, order no. CPY20-E10A1
- pH 9.2 blue, 250mL, order no. CPY20-I02A1
- pH 9.2 blue, 1000mL, order no. CPY20-I10A1

Technical buffer solutions for single use, accuracy 0.02pH, acc. to NIST/DIN
- pH 4.0 red, 20 x 18mL, order no. CPY 20-C01A1
- pH 7.0 green, 20 x 18mL, order no. CPY 20-E01A1

Redox solutions
- +220mV, pH 7.0, 100mL (0.026 US gal); order no. CPY3-0
- +468mV, pH 0.1, 100mL (0.026 US gal); order no. CPY3-1

KCl-electrolyte solutions for liquid filled electrodes
- 3.0 mol, T=-10...100°C (14 ... 212°F), 100mL (3oz), order no. CPY4-1
- 3.0 mol, T=-10...100°C (14 ... 212°F), 1000mL (30oz), order no. CPY4-2
- 1.5 mol, T=-30...100°C (-22 ... 266°F), 100mL (3oz), order no. CPY4-3
- 1.5 mol, T=-30...100°C (-22 ... 266°F), 1000mL (30oz), order no. CPY4-4

List of accessories

Special cables
- CPK1 special measuring cable for pH/ORP electrodes with GSA plug-in head.
- CPK9 special measuring cable for sensors with TOP68 plug-in head, for high-temperature and high-pressure applications, IP 68.
- CYK10 Memosens data cable for digital pH sensors with Memosens technology (CPSxxD).
- CPK12 special measuring cable for pH/ORP glass electrodes and ISFET sensors with TOP68 plug-in head.

List of tools

- Memocheck Sim CYP03D is a service tool that simulates and controls the contactless, digital signal transmission. Freely configurable measured values, errors and calibration values.
- Memocheck CYP02D is a service tool for quick checkof two predefined sensor status.
- Memocheck Plus CYP01D is a tool for qualification of the measuring system during plant qualification.

Conductivity measurement
Sensors and transmitters

A complete conductivity measuring system includes:
- **Analog (Condumax W CLS12/13/15/16/19/21, Indumax CLS50/52/54) or digital (Condumax W CLS15D/16D/21D, Indumax CLS50D) conductivity sensor**
- **Transmitter (Liquisys M CLM223/253, Liquiline CM42 and CM442, Mycom CLM153)**
- **Special measuring cable**
- **Assembly**

In this section, you will find essential information and advice on how to obtain the best from conductivity measuring systems throughout their lifecycle.

Always take care of the temperature!

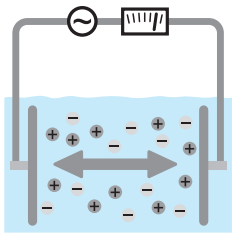


Fig. 9: Conductive measuring principle: two electrodes are located opposite from one another – as in a capacitor.

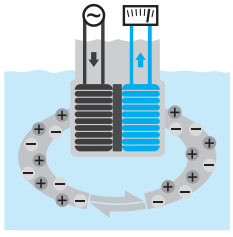


Fig. 10: Inductive measuring principle: a magnetic alternating field induces an electrical voltage in the medium.

Conductive measuring principle

An alternating voltage is applied to two electrodes located in the medium. The conductivity value is calculated according to Ohm's law.

The electrical conductivity of liquids is determined using a measuring arrangement incorporating two electrodes located opposite from one another - as is the case in a capacitor. The electrical resistance R, or its reciprocal value - the conductance value G - are measured following Ohm's law. From this, the specific conductivity κ (Greek; kappa) is calculated using the cell constant k, which describes the geometry of the individual electrode arrangement:
$\kappa = k \cdot G = k / R$

The cell constant k usually has the unit cm^{-1} and is specified by the manufacturer for each sensor. With an ideal plate capacitor, the cell constant is:
k = electrode spacing / electrode surface

Conductivity sensors using the conductive method
- High-temperature sensor Condumax CLS12/13 for industrial and power plant applications (boiler feedwater)
- Pure and ultrapure water sensor Condumax CLS15D/ CLS15
- Hygienic sensor Condumax CLS16D/16
- Low-cost sensor Condumax CLS19 for pure and ultrapure water
- Drinking water and wastewater sensor Condumax CLS21D/21

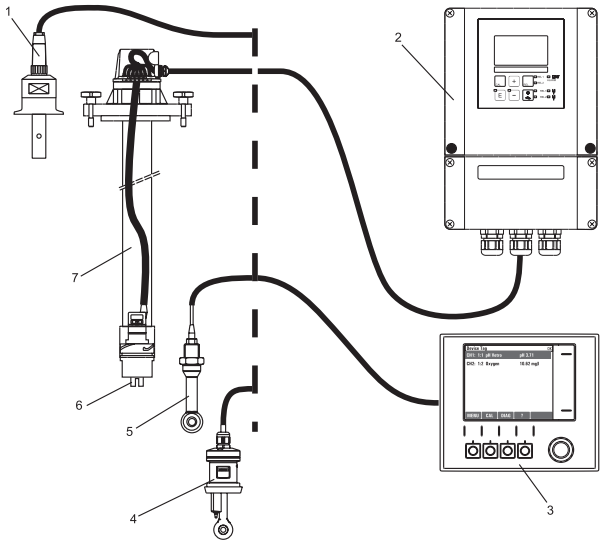


Fig. 11: Example of a complete measuring system
1 Conductive sensor CLS15
2 Liquisys M CLM253 transmitter
3 Liquiline CM442 transmitter
4 Inductive sensor CLS52 or CLS54
5 Inductive sensor CLS50D
6 Conductive sensor CLS21
7 Immersion assembly CLA111
Options: extension cable, junction box VBA or VBM

Inductive measuring principle

Based on an alternating magnetic field that induces an electrical current in the medium which generates a magnetic field in the secondary coil.

In the case of inductive conductivity measurement, a transmitter coil generates a magnetic alternating field that induces an electrical voltage in the medium. This sets the positively or negatively charged ions in the liquid in motion and an electrical alternating current flows through the liquid. This current produces a magnetic alternating field in the receiver coil. The induction current produced in the coil in this way is evaluated by the electronics system and used to calculate the conductivity.

Conductivity sensors using the inductive method
- Robust sensor Indumax CLS50D/50 for concentration measurements for acids, bases and salts, product monitoring, wastewater treatment
- Hygienic sensors Indumax CLS52/54 for food and life sciences industry

Installation conditions for inductive conductivity measurement

For CLS52 and CLS54, the medium should flow through the conical measuring channel in the indicated direction.

Installation of the sensor in pipes with horizontal (middle) and vertical (right) flow directions. (see fig. 12)

- In narrow installation conditions, the ion flow in the medium is affected by the pipe walls. This effect is compensated by the so-called installation factor.
- The installation factor can be entered in the transmitter or the cell constant can be corrected by multiplication with the installation factor to ensure correct measurement. The value of the installation factor depends on the diameter and the conductivity of the pipe as well as the sensor distance from the wall. If the distance from the wall is sufficient (a > 15mm/0.12in, from DN 65/2½"), it is not necessary to consider the installation factor (f = 1.00). If the distance from the wall is smaller, the installation factor increases in case of electrically insulating pipes (f > 1) and decreases in case of electrically conductive pipes (f < 1). The installation factor can be measured using calibration solutions or be approximately determined from a diagram (see fig. 13).
- To compensate residual coupling in the cable and between the two sensor coils, perform a zero calibration in air ('air set') before installing the sensor. For further information, refer to the transmitter Operating Instructions.
- Choose immersion depth b of the sensor in the medium such that the coil body is completely immersed (see fig. 14). The pipe has to be completely filled with water. Gas bubbles will have an influence on the displayed value (avoid installation in an open falling tube).

Operation and maintenance

Maintenance work includes:

- Cleaning of assembly and sensor
- Cable and connection check (see 'pH' section)
- Calibration

Cleaning the conductivity sensors

Please clean contamination on the sensor as follows: carefully clean with a synthetic brush and, if needed, with diluted hydrochloric acid (5%). Then rinse carefully with plenty of clear water.

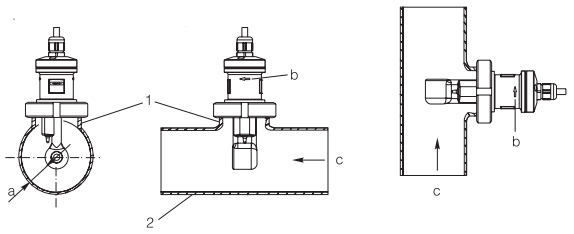


Fig. 12: Installation of a CLS52 inductive sensor in pipes with horizontal (middle) and vertical (right) flow directions
b Indicator arrow for the flow direction
c Flow direction
1 Welding neck
2 Pipe

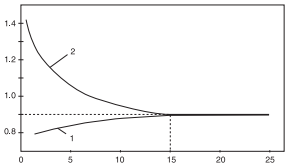


Fig. 13: Dependence of installation factor f on wall distance a
1 Conductive pipe
2 Insulating pipe

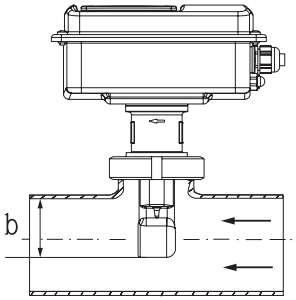


Fig.14: Consider the immersion depth

Calibration of conductive measurement systems

Three different types are possible:

- Calibration by measurement in a calibration solution with a known conductivity.
- Calibration by entering the exact cell constant of the conductivity sensor (given by a quality certificate).
- Calibration by comparison to a reference device (e.g. CONCAL).

Calibration of inductive measurement systems

Two different types are possible:

- Calibration by measurement in a calibration solution with a known conductivity.
- Calibration by comparison to a reference device.

If removing your conductivity transmitter from process for 1 to 2 weeks is acceptable, the best method is to send the instrument to one of our calibration facilities. We provide calibration certificates.
(See **'Calibration services'** in the 'At your service' section).

Check of inductive sensors

Testing sending and receiving coils: Ohmic resistance should be approx. 5 to 7Ω and inductivity approx. 260 to 450mH (at 2kHz). Shunt between sensor coils is not allowed. The measured resistance should be > 20MΩ. Test with ohmmeter between red coaxial cable and white coaxial cable.

Check of transmitter (inductive sensors)

- Conductivity can be checked with standard resistors, e.g. with decade resistors. For conductivity simulation, pull a cable through the cleaned sensor opening and check the display versus the table printed in the transmitter Operating Instructions.
- For temperature simulation, connect the decade resistor instead of the temperature sensor Pt100, using a three-wire arrangement, i.e. connection to terminals 11 and 12, with a bridge from 12 to 13. Check the temperature display versus the table printed in the transmitter Operating Instructions.

To check a transmitter with conductive sensors, please refer to your Operating Instructions.

Our service team can perform such verifications.
(See **'Maintenance services'** in the 'At your service' section)

Instrument and spare parts availability

See table below.

Consumables stock

The calibration solutions must be stored in a dry place and used within a year.

For how to select calibration solutions and cables: see the list on next page.

Your instrument	Spare parts availability	New generation
CLD431/CLM431	NO - since 10/2010	Liquiline CM42
Mycom CLM152	NO - since 12/2007	CLM153

For further information, use our Device Viewer:
www.services.endress.com/device-viewer

Table 3: Instrument and spare parts availability

List of consumables

Calibration solutions
Precision solutions, traceable to SRM (standard reference material) by NIST, for qualified calibration of conductivity measuring systems according to ISO with temperature table:

- CLY11-A, 74 µS/cm (reference temperature 25°C/77°F), 500mL (16.9 fl oz), order no. 50081902
- CLY11-B, 149.6 µS/cm (reference temperature 25°C/77°F), 500mL (16.9 fl oz), order no. 50081903
- CLY11-C, 1.406 mS/cm (reference temperature 25°C/77°F), 500mL/0.13 US gal, order no. 50081904
- CLY11-D, 12.64 mS/cm (reference temperature 25°C/77°F), 500mL/0.13 US gal, order no. 50081905
- CLY11-E, 107.0 mS/cm (reference temperature 25°C/77°F), 500mL/0.13 US gal, order no. 50081906

List of accessories

Measuring cables (for conductive sensors)

- CYK71 measuring cable: non-terminated cable for the connection of sensors (e.g. conductivity sensors) or the extension of sensor cables – sold by the meter, order numbers:
  non-Ex version, black: 50085333
  Ex version, blue: 51506616
- CYK10 Memosens data cable: cable for digital conductivity sensors, ordering according to product structure

Measuring cables (for inductive sensors)

- CLK5 measuring cable: Extension cable for connecting CLS52 and transmitter via the VBM junction box – sold by the meter, order no. 50085473

List of tools

- Memocheck Sim CYP03D is a service tool that simulates and controls the non-contact, digital signal transmission. Freely configurable measured values, errors and calibration values.
- Memocheck CYP02D is a service tool for quick checkof two predefined sensor status.
- Memocheck Plus CYP01D is a tool for qualification of the measuring system during plant qualification.

CONCAL and CONDUCAL calibration sets

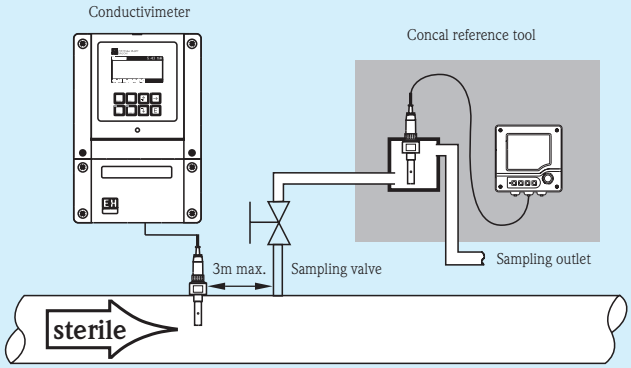


Fig.15

CONCAL is a conductivity calibration set for ultrapure water applications, factory-calibrated with certificate, traceable to SRM of NIST and DKD. CONCAL is suitable for comparative measurement in ultrapure water applications
up to 20 µS/cm (50.8 µS/inch) and temperature < 100°C/212°F.

CONDUCAL is a conductivity calibration set using a Memosens reference chain.

Our service team can perform the periodic recalibration of ultrapure conductivity measurement systems. Please contact us.

Turbidity measurement
Sensors and transmitters

A complete turbidity measuring system includes:
- **Analog turbidity sensor (Turbimax W CUS31/41/65) with a special measuring cable or a digital sensor (Turbimax CUS51D)**
- **Transmitter (Liquisys M CUM223/253, CUM740 and Liquiline CM442)**
- **Assembly**

In this section, you will find essential information and advice on how to obtain the best from turbidity measuring systems throughout their lifecycle.

Take care when cleaning the optics.

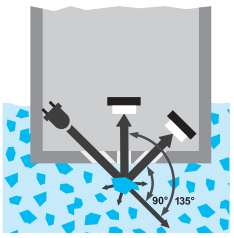


Fig. 16: Scattered light methods: the scattered light generated by solid particles is measured at 90° and 135°.

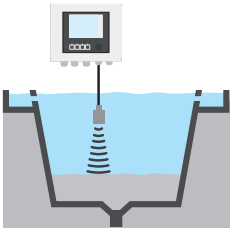


Fig. 17: Ultrasonic measurement: a piezoelectric crystal generates an ultrasonic signal that reaches solid particles and comes back to the receiver.

Measuring principle

Optoelectronic measuring principle

A beam of light is directed through the medium and scattered by elements with a greater optical density.

Scattered light methods
The 90-degree scattered light method in accordance with ISO 7027 / EN 27027 measures turbidity values under standardized, comparable conditions mainly in the low turbidity range. The 135-degree scattered light method is optimized for the measurement of high turbidities. With both methods, the solid particles in the medium cause the incident light to scatter. The scattered light thus generated is measured using scattered light detectors. The turbidity of the medium is calculated from the amount of scattered light. A temperature signal is recorded and transmitted in addition to the turbidity signal. Digital filter functions with interference signal suppression and automatic sensor monitoring make measurements even more reliable.

Four-beam alternating light method
The method is based on two lights and four detectors. Long-life light emitting diodes are employed as monochromatic light sources. These light emitting diodes are pulsed at a frequency of several kHz so as to eliminate any effects of extraneous light. With each light signal, two measuring signals are detected at the four detectors. Eight measuring signals in total are processed in the sensor and converted to solid concentrations. The four-beam alternating light method allows users to compensate for any fouling and aging of optical components.

Turbidity sensors using the optoelectronic measuring principle

- Online turbidimeters Turbimax CUE21 and CUE22 for drinking water and treated process water

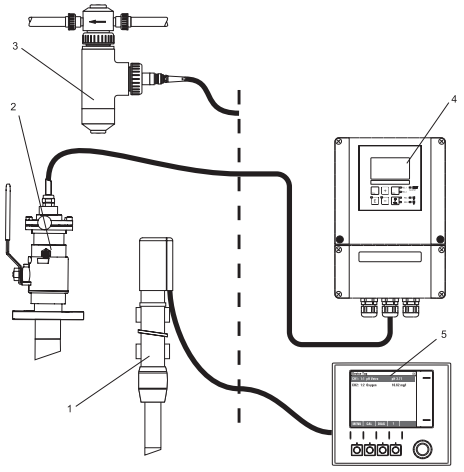


Fig. 18: Example of a complete measuring system
1 Immersion assembly CYA611
2 Retractable assembly CUA451
3 Assembly with gas bubble trap
4 Liquisys CUM253
5 Liquiline CM442

- Analog sensor Turbimax W CUS31 for drinking and industrial water
- Analog sensor Turbimax W CUS41 for all wastewater applications
- Digital sensor Turbimax CUS51D for all wastewater applications

Sludge level measurement

uses either the optoelectronic (four-beam) or the ultrasonic method.

Ultrasonic measurement
In the ultrasonic method, a piezoelectric crystal is encased in a flat cylindrical plastic body. When the crystal is excited with voltage it generates a sonar signal. In the process, ultrasonic waves are emitted to scan the separation zones. The measured variable is the time the emitted ultrasonic signal needs to reach the solid particles in the separation zone and return again to the receiver.

Availalble systems for sludge measurement

- Optoelectronic system CUC101
- Ultrasonic system CUS71D/CM442

The influences on turbidity measurement

The measurement is altered by:
- Change of sludge type
- Flow variation
- Presence of air or foam bubbles, suspended particles deposit
- Backscatter (which results in a higher signal) due to the installation of the sensor in piping or very close to a wall
- Deposits on the sensor optics

Installation conditions

Pipe installation (see fig. 19)

- The pipeline diameter must be at least DN 100/4" if reflective materials (e.g. stainless steel) are used.
- Install the sensor in places with uniform flow conditions and not in places where air may collect or foam bubbles form or where suspended particles may settle.
- The best installation location is in the ascending pipe. Installation is also possible in the horizontal pipe, but should be avoided in the down pipe.
- Mount the sensor surface against the medium flow (self-cleaning effect).

Installation in flow assemblies

- If possible, install the flow assembly vertically so that the medium flows to the sensor from below. Alternatively, the assembly can also be installed horizontally.
- Two sensor orientations are possible for horizontal installation (fig. 20):
  - parallel to the medium flow
  - against the medium flow
- Orientation parallel to the medium flow is required when using the CUR 3 spray head.
- Orientation against the medium flow is used to increase the self-cleaning effect in heavily-soiled media (> 15 FNU). The wall reflection is negligible here due to the high absorption tendency.

CUS 31-xxE, CUS 31-xxS and CUS51D sensors can be used for turbidities < 5 FNU. However, CUS51D is not designed for potable water.

Operation and maintenance

Maintenance work includes:
- Cleaning of assembly and sensor
- Cable and connection check
- Calibration

Cleaning the turbidity sensors

Deposits on the sensor optics may result in inaccurate measurement. Therefore the sensor must be cleaned at regular intervals. The intervals are specific to each installation and must be determined during operation. Clean the optics with the following agents depending on the type of soiling:

- **Limestone deposits:** Short treatment with commercial deliming agent
- **Oily and greasy soiling:** Cleaning agents based on water-soluble surfactants (e.g. household dish detergents)
- **Other types of soiling:** With water and brush

Warning:
- Do not touch the optics with sharp-edged objects.
- Do not scratch the optics.

Clean the sensor mechanically using a soft brush. Then rinse thoroughly with water.

Calibration and adjustment

Note: The sensor contains all the calibration data.

- In the FNU operating mode, the sensor is factory calibrated with formazine traceable to ISO 7027.
- In the ppm operating mode, the calibration data records for Kaolin and SiO_2 are derived from the FNU data records.
- In the % operating mode, the calibration data records are set to the average of various residual concrete waters. They are preset in such a way that correct values are displayed for average clarity. However, the settings do not follow a standard currently applicable.
- In the g/L operating mode also, the sensor is not calibrated to a fixed value as no standard is directly applicable. You must carry out a calibration because the media of the various applications differ too greatly here.

The calibration data are saved directly in the sensor. Therefore:
- Recalibration is not required in the event of a power failure.
- Recalibration is not required when the transmitter is replaced.
- Customer-specific recalibration is required, however, when the sensor is replaced.

Three calibration data records are saved in the sensor for each of the four main operating modes.

When do you need to calibrate? Three-point sensor calibration is the standard calibration. It is absolutely essential:

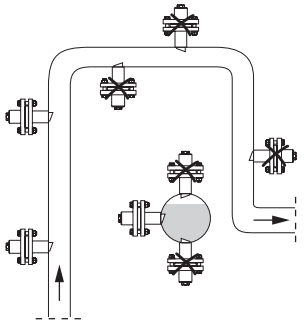


Fig. 19: Tube implantation

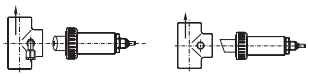


Fig. 20: Installation in flow assemblies
Parallel sensor orientation
Sensor orientation against the medium flow

- When commissioning the sensor in sludge applications.
- When changing to another sludge type.

Three-point sensor calibration is not necessary:
- When commissioning the sensor in the drinking water area (sensor has been calibrated for drinking water applications in the factory).
- For residual concrete water. Density measurement for determining the concentration of residual concrete water is based on %–data records. They are preset in such a way that

correct values are displayed for average clarity. One-point calibration is often sufficient to adjust the system in the event of deviating values.
- When recalibrating with the same sludge type. One-point calibration suffices here if the degrees of lightness and clarity, for example, do not differ too greatly.

Performing three-point calibration (on site)

You should perform the calibration in the turbidity/ solids concentration range in which you plan to measure. The overall calibration characteristic of the measuring chain is determined using three samples of known turbidity or known solids content.

Calibration with a very dark, high-absorption medium returns small slopes while light, clear media return big slopes.
You can create the requisite probes by diluting a medium sample. In general, very good calibration results are achieved with a concentration gradation of 10%, 33% and 100%. The following condition must be met for the calibration:
Sample A > 1.1 x sample B > 1.1 x sample C (see fig. 21)

You can send us the sensor and flow assembly for adjustment on a calibration bench according to ISO70027. You will be issued a quality certificate.

Installation adjustment

In installation adjustment, backscatter from the immediate sensor environment is compensated. Installation adjustment must be performed with a medium whose turbidity is lower than 2 FNU or 5 ppm.

Checking the measuring point

The system CUS51D + CM442 can be simulated using the Memocheck Sim CYP03D.

The sensors CUS31 and CUS41 cannot be simulated as they contain the complete data processing and all the measured values are transmitted to CUM223/253 using the digital interface RS 485. Therefore a functional sensor is required for the measuring point test.
Method for testing a measuring point:
- Check that device is operable and that the display reacts appropriately, e.g. by pressing the PLUS key.
- Check the current outputs by carrying out a current simulation (Field O3(2)).
- Measure the sensor operating voltage: approx. 10 to 16V at terminals 87 (+) and 88 (–).
- The cause for an incorrect voltage may be present either at the device or at the sensor.
  – Replace the sensor.
  – If the sensor operating voltage is still too low replace the power supply module LSGA/LSGD (make sure to use the appropriate version).
- Sensor operating voltage is o.k. but no measured turbidity value even with a new sensor. Replace the transmitter module MKT1.

Our service team can perform such verifications.
(See **'Maintenance services'** in the 'At your service' section)

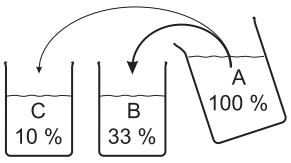


Fig. 21: Making the samples for a three-point calibration
A Original sample
B 1 part sample A + 2 parts water
C 1 part sample A + 9 parts water

Instrument and spare parts availability

For further information, use our Device Viewer:
www.services.endress.com/device-viewer

For how to select and order accessories:

see the following list.

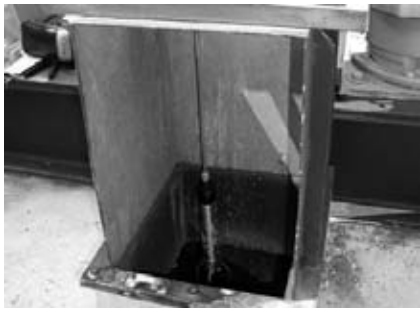
List of accessories

Measuring cables
- CYK81 measuring cable: non-terminated measuring cable for extension of sensor cables of e.g. Memosens, CUS31/CUS41 - two wires, twisted pair with shield and PVC sheath (2 x 2 x 0.5mm² + shield) - sold by the meter, order no. 51502543

Other accessories
- CUY 22 check unit for CUS 31 and CUS 41 for checking the stability of the sensor, order no. 51504477
- CUY 31 service kit 3 spare wiper arms for CUS 31-Wxx: The CUS 31-W sensor is equipped with a rubber wiper for removing deposits from the sensor carrier plate. Order no. 50089252
- Calibration kit for CUE 21 Values: 0.02 NTU; 10.0 NTU and 1000 NTU order no. 51518580
- Replacement basin including transducer for ultrasonic cleaning, order no. 51518576
- Flow assembly Flowfit CUA250 for CUS31/CUS41: Please contact us

List of tools

- Memocheck Sim service tool that simulates and controls the non-contact, digital signal transmission ref. CYP03D



Disinfection

Chlorine measurement

Sensors and transmitters

A complete chlorine measuring system includes:
- **Analog (CCS120/140/141/240/241) or a digital (CCS142D) chlorine sensor**
- **Transmitter (Liquisys M CCM223/253, Liquiline CM442)**
- **Special measuring cable**
- **Assembly**
- **Reference measuring instrument for determination of free chlorine according to the DPD method**

In this section, you will find essential information and advice on how to obtain the best from chlorine measuring systems throughout their lifecycle.

The measurement is strongly influenced by pH, temperature and flow.

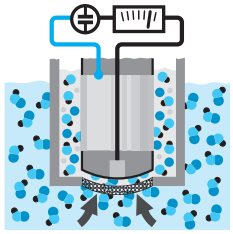


Fig. 22: Amperometric principle: chlorine dioxide diffuses through the membrane and is reduced at the gold cathode.

Measuring principle

Chlorine is reduced at the gold electrode. The electron acceptance is proportional to the concentration of chlorine.

The sensors work in accordance with the amperometric principle in a membrane-covered cell. How they work can be described using the example of chlorine dioxide measurement:
The sensor features a metallic cathode, which is separated from the medium by a thin membrane. Chlorine dioxide coming from the medium diffuses through this membrane and is reduced at the gold cathode. The circuit is completed by means of the silver anode and the electrolyte.
The electron reduction at the cathode is proportional to the concentration of chlorine dioxide in the medium. The transmitter converts this current to the appropriate display value. With chlorine dioxide, this process works in a wide pH and temperature range.
The situation with free available chlorine is somewhat different. Here, hypochlorous acid diffuses through the membrane and produces a reaction. The presence of hypochlorous acid in the medium depends on the pH value. This dependency is compensated by means of pH measurement in the flow assembly and balancing in the transmitter.
Total chlorine measurement is more complicated. In addition to hypochlorous acid, chloramines also play a part in a complex system of reactions.

Sensors for disinfection using the amperometric principle

Sensors for free available chlorine:
- CCS140 for recreational water and industrial water
- CCS141 for drinking water
- Digital Memosens sensor CCS142D for drinking water, process water, industrial water and wastewater

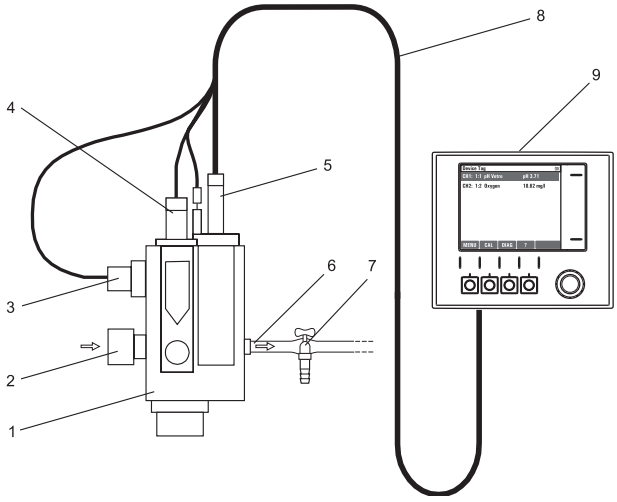


Fig. 23: Measuring system in the flow mode (example)
1 CCA250 flow assembly
2 Medium inlet
3 Inductive proximity switch for flow monitoring
4 Mounting place for pH/ORP sensors
5 Chlorine sensor
6 Medium outlet
7 Sampling tap
8 Fixed measuring cable
9 Transmitter

Sensors for chlorine dioxide:
- CCS240 for recreational water and industrial water
- CCS241for drinking water

Sensor for total chlorine:
- CCS120 for drinking water, recreational water, industrial water and wastewater

The influences on chlorine measurement

The measurement is influenced by:
- pH value
- Flow
- Temperature

Installation conditions

Installation in flow assembly CCA250

The flow assembly CCA250 is designed for on-site installation of the measuring cell. In addition to the chlorine measuring cell, a pH and ORP electrode can be installed.
A needle valve regulates the flow within the range of 30 to 120 L/hr (7.9 to 31.7 gal/hr).

If the measured water is fed back into a surge tank, pipeline or the like, ensure that the generated back pressure on the measuring cell does not exceed 1 bar/14.5 psi and remains

constant. Negative pressure at the measuring cell, e.g. by feedback of measured water to the suction side of a pump, must be avoided.

Operation and maintenance

Maintenance work at the transmitter includes:
- Calibration
- Cleaning of assembly and sensor
- Cable and connection check

Reference measurement according to the DPD method
The calibration of the measuring system requires a colorimetric reference measurement according to the DPD method. Free chlorine reacts with diethyl-p-phenylenediamine(DPD) by producing a red dye, the intensity of the red color being proportional to the chlorine concentration.
The intensity of the red dye is measured by a photometer (e.g. CCM182, see accessories) and displayed as chlorine concentration.

An important fact must be kept in mind: The DPD method is not a selective measuring method for free chlorine alone, but other oxidants present in the medium can also be registered (see DIN38408, part 5, section 4). Moreover, the measuring range of the photometers has a lower limit and does not permit measurements in the very low trace range. In addition to the chlorinated probe, a sample of the medium without added chlorine should be checked by a DPD measurement if possible. The measured value must lie near zero and differ significantly from the chlorinated sample.

The measured water is always buffered to a pH value of 6.3 with the DPD method, so the measurement is independent of the pH value of the measured water.
Caution: The DPD method cannot be applied if organic chlorination agents are used. In this case it causes a higher measured value compared to the actual free active chlorine value (cf. also note in DIN38408, part 4, section 5).

Calibration (CCS142D)
The sensor reading must be stable (no drifts or unsteady values for at least 5 minutes). This is normally fulfilled when:
- The polarization period is finished.
- The flow is constant and within the correct range.
- The sample medium and the sensor are at the same temperature.
- The pH value is within the admissible range.

A zero-point adjustment is not required thanks to the zero stability of the membrane-covered sensor.
If you, however, wish to perform a zero-point adjustment, operate the sensor in chlorine-free water for at least 15 min.

For slope calibration, perform the following steps:
1. Ensure a constant pH value and temperature of the medium.
2. Take a sample for DPD measurement. The sampling location has to be close to the installed sensor. Use the sampling tap if available.
3. Enter the measured value into the transmitter (see Operating Instructions of the transmitter).
4. After initial installation of the sensor, check the calibration by DPD measurement 24 hours later. Carry out a slope calibration every time the membrane or electrolyte is changed.

Maintenance of chlorine sensors
Corrective maintenance for chlorine sensors and assemblies is described in the operating instructions. Use and refer to the operating instructions relating to your measuring system.

Routine check for CCS140/141/142D
- Check the measurement at regular intervals, dependent on the respective conditions, at least once a month.
- Perform recalibration if required.
- If the membrane is visibly soiled, remove the measuring cell from the flow assembly. Only clean the membrane mechanically with a gentle water jet or for some minutes in 1 to 10% hydrochloric acid (observe safety regulations!) without chemical additives. Chemicals reducing the surface tension must not be used.
- Replace a heavily soiled or damaged membrane.
- Refill the measuring cell with electrolyte once per season or every 12 months. Depending on the chlorine content on site, this period can be reduced or extended.

Regenerating the sensor
During measurement, the electrolyte in the sensor is gradually exhausted by chemical reactions. The silver chloride layer, applied to the anode at the factory, continues to grow during sensor operation. This has no effect on the reaction taking place at the cathode. A change in color of the silver chloride layer, however, indicates effects on the reaction at the cathode. Therefore, ensure by visual inspection that the grey-brown color of the anode has not changed. If the anode color has changed, e.g. if it is spotted, white or silvery, the sensor must be regenerated. Send it to the manufacturer for this purpose.

Reconditioning the sensor
Long-term operation (> three months) in chlorine-free media, i.e. with very low sensor currents, may lead to a deactivation of the sensor. This deactivation is a continuous process that results in a lower slope and longer response times.
After long-term operation in a chlorine-free medium, the sensor must be reconditioned. You need the following materials for reconditioning:
- Demineralized water
- Polishing sheet (see 'Accessories')
- Beaker
- Approx. 100ml (3.381fl oz) of chlorine bleaching lye NaOCl approx. 13%, pharmaceutical quality (available at chemical stores or pharmacies).

Maintenance of pH/ORP sensors (version EP)
See pH/ORP section.

Maintenance pH connecting lines and junction boxes (EP)
Check the cables and connections for moisture. Moisture is indicated by a sensor slope that is too small. If no more display is possible or if the display is fixed at pH7, please check the following components:
- Sensor head
- Sensor connector
- pH measuring cable
- Junction box, if fitted
- Extension cable

Caution! If there is moisture in the measuring cable, the cable must be replaced!

A shunt in the cable of > 20MΩ can no longer be measured with normal multimeters but is damaging for the pH measurement. A reliable test can be carried out with a usual commercial insulation meter:
- Make sure to disconnect the pH measuring cable from the sensor and device!
- If you are using a junction box, check the infeed and outfeed measuring cable separately.
- Check the cable with 1000V DC (at least with 500V DC) testing voltage.
- If the cable is intact, the insulation resistance > 100GΩ.
- If the cable is defective (moist), there is flashover. The cable must be replaced.

Test and simulation Chlorine sensors

Chlorine sensors work according to the amperometric principle and supply very small direct current as measuring signals. A chlorine sensor can be simulated by a DC source. Due to the small currents, however, the simulation is highly sensitive. Lines should be screened and the simulator grounded. You will find typical slope values in the table hereafter.

Sensor	Typical slope value*
CCS120	≈ 115nA per mg Cl/l
CCS140	≈ 25nA per mg Cl/l
CCS141	≈ 80nA per mg Cl/l
CCS240	≈ 100nA per mg ClO_2/l
CCS241	≈ 350nA per mg ClO_2/l
CCS142D-A	-25nA per mg/l
CCS142D-G	-80nA per mg/l

* At 25°C/77°F

Table 4

Temperature measurement

The transmitter uses the NTC sensor of the chlorine sensor to measure the temperature. Due to the relatively high sensor resistance, a two-wire connection is sufficient. Simulation can take place with a normal decade resistor. The following table contains some simulation values.

Temperature	NTC simulation value
0°C/32°F	29.490kΩ
10°C/50°F	18.787kΩ
20°C/68°F	12.268kΩ
25°C/77°F	10.000kΩ
30°C/86°F	8.197kΩ
40°C/104°F	5.594kΩ

Table 5

pH/ORP measurement

Simulation takes place with a pH/mV simulator or an mV voltage source.
(see pH/ORP section)

Flow monitoring

Use and refer to the operating instructions relating to your measuring system.

Our service team can perform such verifications.
(See **'Maintenance services'** in the 'At your service' section).

Instrument and spare parts availability

For further information, use our Device Viewer:
www.services.endress.com/device-viewer

For how to select and order accessories:

see the following list.

List of consumables

For measurement of chlorine CCS140, CCS141 and CCS142D
- Set of 2 replacement cartridges CCY14-WP, order no 50005255
- Electrolyte (50 mL) CCY14-F, order no 50005256
- Polishing sheets COY31-PF, 10 pieces for cleaning of the gold cathode, order no. 51506973
- Service kit CCS14x: 2 replacement cartridges, filling electrolyte 50ml, polishing sheets, order no. 71076921

For measurement of chlorine dioxide CCS240 and CCS241
- Set of 2 replacement cartridges CCY14-WP, order no 50005255

For measurement of total chlorine CCS120
- Electrolyte (50mL), order no 51516343
- Kit containing 2 membranes and electrolyte (50mL), order no 51517284

List of accessories

Calibration accessories
- Photometer CCM182; microprocessor-controlled photometer for chlorine, pH value, cyanuric acid; Chlorine measuring range: 0.05 to 6 mg/L
  pH measuring range: 6.5 to 8.4, order no CCM182-0

Measuring cables
- CMK measuring cable: cable for the CCS 140, 141, 240 and 241, order no. 50005374
- CYK71 measuring cable: non-terminated cable for the connection of sensors or the extension of sensor cables, sold by the meter, order numbers:
  non-Ex version, black: 50085333
  Ex version, blue: 51506616
- CYK10 Memosens data cable: cable for CCS142D, ordering according to product structure
- CYK81 measuring cable: non-terminated measuring cable for extension of sensor cables of e.g. Memosens sensors, two wires, twisted pair with shield and PVC sheath (2 x 2 x 0.5mm² + shield), sold by the meter, order no.: 51502543

List of tools

- Memocheck Sim CYP03D is a service tool that simulates and controls the non-contact, digital signal transmission. Freely configurable measured values, errors and calibration values.
- Memocheck CYP02D is a service tool for quick check of two predefined sensor status.
- Memocheck Plus CYP01D is a tool for qualification of the measuring system during plant qualification.

Dissolved oxygen

Oxygen measurement

Sensors and transmitters for dissolved oxygen

A complete dissolved oxygen measuring system includes:
- **Analog (Oxymax COS31/41/61/71) or a digital (Oxymax COS22D/51D/61D) oxygen sensor**
- **Transmitter (Liquisys M COM223/253, Liquiline CM42 and CM442)**
- **Special measuring cable**
- **Immersion, flow or retractable assembly**

In this section, you will find essential information and advice to obtain the best from dissolved oxygen measuring systems throughout their lifecycle.

Periodically clean and check the system.

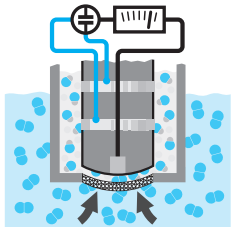


Fig. 24: Amperometric principle: oxygen permeates into the electrolyte through the membrane and is converted to a current.

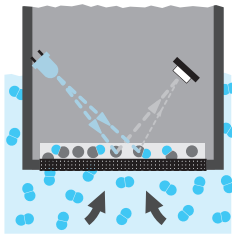


Fig. 25: Optical principle: oxygen molecules adapt to the marker molecules and decrease the fluorescence light emitted

Measuring principle

Amperometric principle

Oxygen reaches the working electrode via a membrane and is reduced to hydroxide at the cathode.

When performing measurements according to the amperometric principle, the sensor comprises a working electrode and a counterelectrode in the simplest version of the two-electrode system. Both are surrounded by an electrolytic liquid in a common chamber. A membrane provides the link to the medium or process: oxygen permeates from the medium into the electrolyte through the membrane and is reduced at the working electrode. The resulting current response is in direct proportion to the oxygen partial pressure.
The current is converted in the downstream transmitter and displayed to the user in the familiar units of oxygen saturation, concentration (in mg/l or ppm) and oxygen partial pressure. In more complex three-electrode systems, an extra electrode is used (the reference electrode) to accurately control and regulate the internal condition of the sensor. This sensor demonstrates a high level of long-term stability.

Oxygen sensors using the amperometric principle

- Hygienic sensor Oxymax COS22D – Digital sensor for food, pharmaceuticals, energy, chemicals, inertization
- Water sensor Oxymax COS41 – Analog sensor for water treatment
- All-round sensor Oxymax COS51D – Digital sensor for water and wastewater

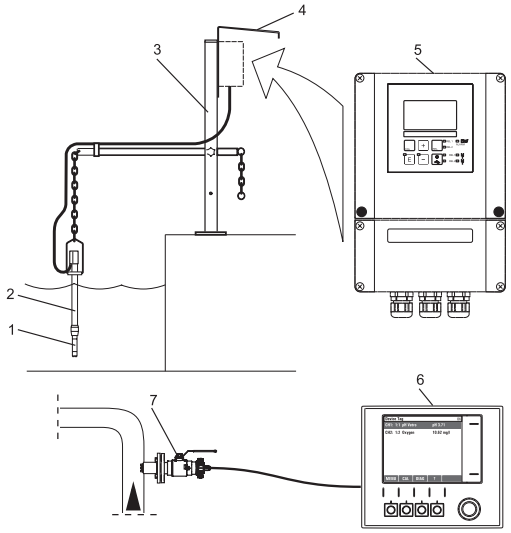


Fig. 26: Examples of complete measuring systems
1 Oxygen sensor
2 Immersion assembly CYA611
3 Universal hanging assembly holder CYH101
4 Weather protection cover CYY101
5 Liquisys M COM253 transmitter
6 Liquiline CM442 transmitter
7 Retractable assembly COA451

Fluorescence quenching principle (optical)

Marker molecules are excited by a green light and respond with a red fluorescent light. Oxygen molecules quench the fluorescent light.

With the fluorescence quenching method, a layer that is permeable to oxygen also forms the junction with the process. This layer contains just as many oxygen molecules as the medium (the partial pressure of the oxygen is just as high in the medium as in the layer). It is separated from the optics at the sensor by means of a substrate that is permeable to light. The layer contains marker molecules that are optically excited with a green light and respond with a red fluorescence light. Oxygen molecules adapt to these marker molecules and decrease (quench) the fluorescence light emitted. The reduction in fluorescence light is connected to the oxygen partial pressure, both in terms of the amplitude and the duration. The light signal is converted in the downstream transmitter and made available to the user in the familiar units of oxygen saturation, concentration (in mg/l or ppm) and oxygen partial pressure, just as with the amperometric sensor.

Oxygen sensors using the optical principle

- Optical sensor Oxymax COS61 – Water, wastewater, fish farming; digital signal processing in the sensor
- Memosens sensor Oxymax COS61D – Water, wastewater, fish farming; digital signal processing in the sensor

Operation and maintenance

Maintenance work includes:
- Cleaning of assembly and sensor
- Cable and connection check
- Calibration and adjustment

Cleaning the sensor

To ensure reliable measurement, the sensor must be cleaned at regular intervals.
Depending on the type of soiling, proceed as follows:

- **Salt deposits**
  Immerse the sensor in drinking water or in 1-5% hydrochloric acid for a few minutes. Afterwards, rinse it well with plenty of water.
- **Dirt particles on the sensor body (not on the membrane!)**
  Clean the sensor body mechanically with water and a suitable brush.
- **Dirt particles on the membrane cap or the membrane**
  Clean the membrane with water and a soft sponge.

After cleaning, rinse the sensor well with plenty of clean water.

Cleaning the optics

The optics only need to be cleaned if the medium has penetrated through a defective fluorescence cap.
To clean it, proceed as follows:
1. Unscrew the protection guard and fluorescence cap from the sensor head.
2. Carefully clean the optical surface with a soft cloth until the buildup is fully removed.
3. Clean the optics with drinking or distilled water.
4. Clean the optics and screw on a new fluorescence cap.
Caution! The optical surface may not be scratched or damaged in any way!

Calibration and adjustment

To access the 'Calibration' function group, press the CAL key on your transmitter. This function group is used to calibrate and adjust the measuring point. The sensor is calibrated in air or in the medium.
Note!
- At first start-up, sensor calibration of amperometric sensors is absolutely essential in order for the measuring system to be able to generate accurate measuring values.
- The optical oxygen sensor COS61 does not need a calibration at first start-up.

Calibration and adjustment of amperometric systems

Calibration is a means of adapting the transmitter to the characteristic values of the sensor. As no zero calibration is required for the sensor, a single-point calibration is carried out in the presence of oxygen.
The sensor requires calibration after:
- first commissioning
- replacing a membrane or electrolyte
- cleaning the cathode
- long breaks in operation without power supply
- typical time intervals dependent on operating experience

Three different types of calibration are possible:
- Calibration in water.
- Calibration in air
- Calibration by comparison to a reference device

Calibration in air is the easiest method of calibration.

Calibration and adjustment in air

1. Remove the sensor from the medium.
2. Clean the outside of the sensor with a damp cloth, then dry the sensor membrane e.g. with a tissue.
3. If the sensor is removed from a closed pressure system with a process pressure greater than atmospheric pressure:
– Open the membrane cap to equilibrate the pressure and clean the cap if necessary.
– Replace the electrolyte filling and close the membrane cap again.
– Wait for the polarization time to end.
4. Then wait while the sensor adjusts to the temperature of the ambient air. This takes about 20 minutes. Check that the sensor is not in direct sunlight during this time.
5. If the measured value displayed on the transmitter is stable, carry out the calibration in accordance with the Operating Instructions of the transmitter.
6. Place the sensor in the medium again.

Note: Calibration and adjustment in air is only possible if air temperature ≥ – 5°C/23°F. Make sure you comply with the instructions for calibration in the Operating Instructions of the transmitter.

The calibration intervals depend heavily on:
- The application and
- The installation position of the sensor.

The following methods help you determine the time intervals between calibrations:
1. Check the sensor one month after it has been put into operation by taking it out of the fluid, drying it and then measuring the oxygen saturation index in air after 10 minutes.
Decide based on the results:
a. If the measured value is not at 102% SAT (for an amperometric system) or not at 100.6% SAT (for an optical system), you have to calibrate the sensor.
b. Otherwise, double the length of time to the next inspection.
2. Proceed as per Point 1 after two, four and/or eight months.
This way you can determine the optimum calibration interval for your sensor.

Calibration and adjustment of optical systems

Calibration is a means of adapting the transmitter to the characteristic values of the sensor. Normally, sensor calibration is seldom necessary. It is necessary after changing the fluorescence cap.

The slope calibration of the oxygen sensor COS61 will be performed in air or in air saturated water. The calibration of the zero point will be performed in nitrogen or in oxygen-free water (water enriched with zero solution).

The sensor identifies unassisted the slope calibration (75 to 140% SAT) and the calibration of the zero point (0 to 10% SAT). No further

selection is necessary. These limits are valid for the three types of calibration 'air', 'water' and 'ref'.

Maintenance intervals

Amperometric sensor: suggested maintenance intervals*

Weekly: clean the sensor.
Monthly: calibration in air.
Annually: clean the gold cathode with specific abrasive paper and change the electrolyte, the membrane, and the O-ring.

Optical sensor: suggested maintenance intervals*

Weekly: clean the sensor.
Annually: change the sensor cap and the O-ring and calibrate in air.

* intervals may differ according to the application

Changing the electrolyte and the membrane (Amperometric sensors)

See fig. 27 and the list of consumables.

Simple check of the measuring function

1. Remove the sensor from the medium.
2. Clean and dry the membrane.
3. After about 10 minutes, measure the oxygen saturation index in air (without recalibration).
4. The measured value should be at
   - 102% SAT for an amperometric system
   - 100.6% SAT for an optical system

Simple check of the zero point

Place the sensor in a recipient which can be hermetically closed.
Add fresh water and sodium bisulphite (Na_2SO_3) as powder ('zero calibration solution', order number 50001041)
Close hermetically and let the powder dissolve for 1 to 2 hours.
The measured value should be at 0.3% SAT (current is < 1nA).

Our service team can perform such verifications (see **'Mantenance services'** in the 'At your service' section)

Spare parts stock

Amperometric system:
We recommend you keep membranes and electrolyte filling in stock.
Optical system:
We recommend you keep a sensor cap in stock.

Instrument and spare parts availability

For further information, you can use our Device Viewer:
www.services.endress.com/device-viewer

For how to select and order accessories:
see the following list.

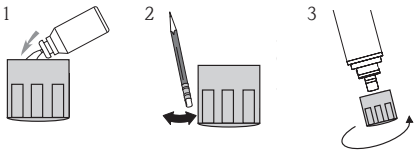


Fig. 27: Changing the electrolyte and the membrane (Amperometric sensors)

List of accessories

Measuring cables for sensors COS21D
- Cable for COS21D; length: 5m - order no. CYK10-A051; length: 10m - order no. CYK10-A101

Measuring cables for sensors COS21
- COK21; length: 3m - order no. 51505870; length: 10m - order no. 51505868

Measuring cables for sensors COS31 and COS71 with TOP68 connector
- COK31; length: 1.5m (4.92ft) - order no. 51506820; length: 7m (22.97ft) - order no. 51506821; length: 15m (49.22ft) - order no. 51506822

List of consumables

For measurement of dissolved oxygen COS3, COS4
- COY3-WP Set of 2 cartridges with pretensioned membrane, order no. 50053348
- COY3-F Electrolyte filling (10 doses of 5ml), order no. 50053349
- COY3-TR Trapezoidal seal (supplied in packs of 3), order no. 50080252

For measurement of dissolved oxygen Oxymax H COS21, COS21D
- Electrolyte for COS21D,version COS21D-A, order no. 51505873 version COS21D-B, order no 51518701, version COS21D-C, order no. 51518703
- Electrolyte for COS21, order no. 51505873

For measurement of dissolved oxygen Oxymax W COS31, COS41
- COY31-WP Set of 2 cartridges - std response, order no. 51506976
- COY31S-WP Set of 2 cartridges - fast response, order no. 51506977
- COY31-OR Sealing ring (supplied in packs of 3), order no. 51506985
- COY31-PF Polishing foil (supplied in packs of 6), order no. 51506973
- Zero calibration solution, order no. 50001041
- COY31-Z Accessory kit - standard response (containing 1 x COY3-F, 1 x COY31S-WP, 1 x COY3-OR and 1 x COY31-PF), order no. 51506784
- COY3-S-Z Accessory kit - fast response (containing 1 x COY3-F, 1 x COY31-WP, 1 x COY3-OR and 1 x COY31-PF), order no. 51506785

For oxygen measurement with optical sensor COS61
- Sensor cap, order no. 51518598
- Set of 2 sealing rings, order no. 51518597

List of tools

- Memocheck Sim CYP03D is a service tool that simulates and controls the non-contact, digital signal transmission. Freely configurable measured values, errors and calibration values.
- Memocheck CYP02D is a service tool for quick check of two predefined sensor status.
- Memocheck Plus CYP01D is a tool for qualification of the measuring system during plant qualification.

Online analyzers and photometric measurement

The current Endress+Hauser range of analyzers includes:
- **The Stamolys range of colorimetric analyzers for ammonium, iron, manganese, chlorine, silica, etc.**
- **The STIP analyzers for BOD (biological oxygen demand), TOC (total organic carbon), COD (chemical oxygen demand), toxicity and multiparameter UV analyzers.**
- **The multiparameter controller Liquiline CM442 with new Memosens sensor Viomax CAS51D (nitrates and SAC - spectral absorption coefficient).**

In this section, you will find essential information and advice that will help you to perform the optimum follow-up of your analysis devices throughout their lifecycle.

Periodic maintenance is essential.

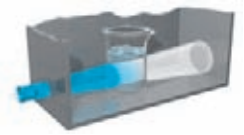


Fig. 28: Photometry measuring principle

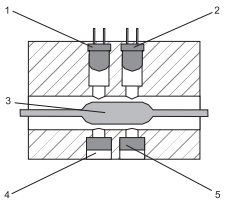


Fig. 29: Stamolys analyzers design
1 Reference LED
2 Emitter LED
3 Sample
4 Reference detector
5 Measuring detector

Photometry measuring principle

Light is shone through the aqueous sample. The light intensity is attenuated by the coloration of the constituent substances. Every substance has a characteristic coloration. The more there is of this substance in the water, the more these light beams are attenuated. Detectors measure the attenuation of light at a coloration typical for this substance. A reference measurement (sample without chemicals) is performed before every measurement so that interferences caused by inherent color, turbidity or contamination can be compensated for. The concentration of the substance is ascertained using this information.

When using colorimetric analyzers, a reagent is added to the water sample to chemically 'dye' the substance that is to be analyzed.

Stamolys analyzers design

After sample conditioning, the analyzer sample pump conveys a part of the filtrate to a mixing vessel. The reagent pump adds reagent at a specific ratio. As a result of the reaction, the sample turns a characteristic color. The photometer determines the sample's absorption of an emitted light at a specific wavelength.
The wavelength is parameter specific. The absorbance is proportional to the concentration of the specified parameter in the sample. Additionally, the absorption of a reference light is determined to receive a genuine measuring result. The reference signal is subtracted from the measuring signal to prevent any effects due to turbidity, contamination and aging of the LEDs.
The temperature in the photometer is controlled automatically so that the reaction is reproducible and takes place within a short period of time.

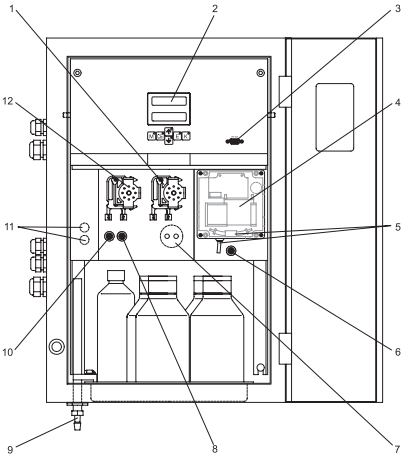


Fig. 30: Typical Stamolys analyzer (housing version, without hoses)
1 Reagents pump, inlet from canister
2 Display
3 Serial interface RS 232
4 Photometer optical cell
5 Static mixer (acc. to version)
6 Valve V4 (version with sample outlet right side only)
7 Dosage loop (with CA71SI only)
8 Valve V2
9 Sample resp. reagents mix outlet (left or right acc. to version)
10 Valve V1
11 Channel switch
12 Sample pump

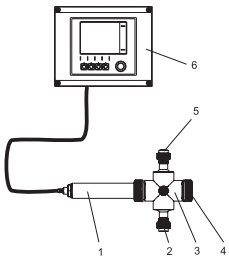


Fig. 31: Viomax CAS51D photometric sensor for SAC or nitrate measurement Measuring system with flow assembly (example)
1 Sensor Viomax CAS51D
2 Inlet
3 Flow assembly Flowfit CYA251
4 Sealing cap
5 Outlet
6 Transmitter Liquiline CM442

Installation conditions

- Ambient temperature : 5 to 40°C (41 to 104°F)
- Below the condensation limit, the device must be installed in clean rooms
- The device is IP43 and must be protected from rain and frost.
- Outdoor installation is only possible with protective devices (customer supplied)

Operation and maintenance

Maintenance intervals

See table below.

All maintenance duties that have to be carried out during normal operation of the analyzer are explained below (intervals may differ according to the application).

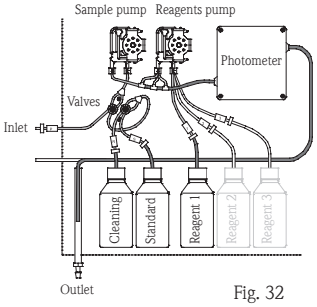


Fig. 32

Time interval	Duty	Who?
Weekly	■ Check and note calibration factor (for service purposes). ■ Move valve hoses into their position and spray with silicone (extends the service life).	User
Monthly	■ Flush the sample tubing system with 12.5% bleaching lye (sodium hypochlorite) and reflush thoroughly with water. ■ Replace reagents and standard solutions, if required. ■ Clean the sample collector.	User
Every 3 months	(in addition to all the actions described above) ■ Spray pump hoses with silicone spray (order no. 51504155). ■ Replace pump hoses. ■ Check manually the different parts (pump, etc.).	User
Every 6 months	(in addition to all the actions described above) ■ Replace all hoses and 'T' connectors.	User or Endress+Hauser service in the scope of a service contract
Annually	(in addition to all the actions described above) ■ Replace the static mixer (order no. 51512101). ■ Replace the photometer optical cell (if necessary).	Endress+Hauser service in the scope of a service contract

Table 6

For Stamolys analysers, it is advisable to use support from Endress+Hauser in the scope of a service contract. This support is even compulsory for STIP analyzers.

For the annual inspection of Stamolys analyzers, please provide the maintenance kit relating to your analyzer (order no. CAV740-xxx, see the following list) and also a can of demineralized water.

Calibration

Please refer to the Operating Instructions relating to your Stamolys analyzer.

Instrument and spare parts availability

For how to select reagents and other consumables:
See the list below.

Your instrument	Spare parts availability	New generation
Stamosens CNM750	until 09.2015	Liquiline CM442
Stamosens CSM750	until 09.2015	Liquiline CM442
Stamosens CNS70	until 09.2015	Viomax CAS51D
Stamosens CSS70	until 09.2015	Viomax CAS51D

For further information, use our Device Viewer:
www.services.endress.com/device-viewer

Table 7: Instrument and spare parts availability

List of consumables and reagents (Stamolys range)

for CA71AM (ammonium)
Active reagent set A1+A2, 1L each - order no. CAY140-V10AAE
Inactive reagent set A1+A2, 1L each - order no. CAY140-V10AAH
Cleaning solution, 1L - order no. CAY141-V10AAE
Standard sol. 5 mg/l NH_4-N, 1L - order no. CAY142-V10C05AAE
Standard sol. 10 mg/l NH_4-N, 1L - order no. CAY142-V10C10AAE
Standard sol. 15 mg/l NH_4-N, 1L - order no. CAY142-V10C15AAE
Standard sol. 20 mg/l NH_4-N, 1L - order no. CAY142-V10C20AAE
Standard sol. 30 mg/l NH_4-N, 1L - order no. CAY142-V10C30AAE
Standard sol. 50 mg/l NH_4-N, 1L - order no. CAY142-V10C50AAE
Maintenance kit CAV740 - order no. CAV740-2A
Standards under 5 mg/l not available, because of the low stability

for CA71PH (phosphate) - standard documents, ready to use
Active reagent set P1 + P2, 1L each (A) - order no. CAY240-V10AAE
Inactive reagent set P1 + P2, 1L each (A) - order no. CAY240-V10AAH
Active reagent set P1 + P2, 1L each (B) - order no. CAY243-V10AAE
Cleaning solution, 1L (A) - order no. CAY241-V10AAE
Standard sol. 1 mg/L PO_4-P, 1L (A) - order no. CAY242-V10C01AAE
Standard sol. 1.5 mg/L PO_4-P , 1L (A) - order no. CAY242-V10C03AAE
Standard sol. 2 mg/L PO_4-P, 1L (A) - order no. CAY242-V10C02AAE
Standard sol. 5 mg/L PO_4-P, 1L(B) - order no. CAY242-V10C05AAE
Standard sol. 10 mg/L PO_4-P, 1L (B) - order no. CAY242-V10C10AAE
Standard sol. 15 mg/L PO_4-P, 1L (B) - order no. CAY242-V10C15AAE
Standard sol. 20 mg/L PO_4-P, 1L (B) - order no. CAY242-V10C20AAE
Standard sol. 25 mg/L PO_4-P, 1L (B) - order no. CAY242-V10C25AAE
Standard sol. 30 mg/L PO_4-P, 1L (B) - order no. CAY242-V10C30AAE
Standard sol. 40 mg/L PO_4-P, 1L (B) - order no. CAY242-V10C40AAE
Standard sol. 50 mg/L PO_4-P, 1L (B) - order no. CAY242-V10C50AAE
Maintenance kit CAV740 - order no. CAV740-1A
(A) = for CA70PH-A, (B) = for CA70PH-B

for CA71NO (nitrite)
Reagent, 1L - order no. CAY343-V10AAE
Cleaning solution, 1L - order no. CAY344-V10AAE
Standard sol. 250 mg/L NO_2-N, 0.5L (821.5 mg/L NO_2)
- order no. CAY345-V05C25AAE
Maintenance kit CAV740 - order no. CAV740-1A

for CA71CR (chromate)
Reagent set CR1+CR2, 1L each - order no. CAY846-V10AAE
Standard sol. 1.00 mg/L CrVI, 1L - order no. CAY848-V10C10AAE
Standard sol. 2.00 mg/L CrVI, 1L - order no. CAY848-V10C20AAE
Maintenance kit CAV740 - order no. CAV740-1A

for CA71SI (silicate)
Reagent set SI1+SI2+SI3, 1L each - order no. CAY640-V10AAE
Cleaning solution, 1L - order no. CAY641-V10AAE
Standard sol. 0ppb, 1L - order no. CAY642-V10C00AAE
Standard sol. 50ppb, 1L - order no. CAY642-V10C50AAE
Standard sol. 100ppb, 1L - order no. CAY642-V10C01AAE
Standard sol. 500ppb, 1L - order no. CAY642-V10C05AAE
Standard sol. 1000ppb, 1L - order no. CAY642-V10C10AAE
Maintenance kit CAV740 - order no. CAV740-4A

for CA71AL (aluminum) - standard documents, ready to use
Active reagent set AL1+AL2+AL3, 1L each - order no. CAY940-V10AAE
Standard sol.100 µg/L Al, 1L - order no. CAY942-V10C10AAE
Standard sol. 250 µg/L Al, 1L - order no. CAY942-V10C25AAE
Standard sol. 500 µg/L Al, 1L - order no. CAY942-V10C50AAE
Maintenance kit CAV740 - order no. CAV740-1A

for CA71FE (iron)
Reagent set FE1, 1L - order no. CAY840-V10AAE
Standard sol. 500 µg/L Fe, 1L - order no. CAY842-V10C05AAE
Standard sol. 2 mg/L Fe, 1L - order no. CAY842-V10C20AAE
Maintenance kit CAV740 - order no. CAV740-1A

for CA71MN (manganese)
Reagent set MN1+MN2+MN3, 1L each - order no. CAY843-V10AAE
Cleaning solution, 1L - order no. CAY844-V10AAE
Standard solution 100 µg/l Mn, 1L - order no. CAY845-V10C10AAE
Standard solution 500 µg/l Mn, 1L - order no. CAY845-V10C50AAE
Maintenance kit CAV740 - order no. CAV740-1A

for CA71CU (copper)
Reagent set CU1+CU2, 1L each - order no. CAY850-V10AAE
Standard sol. 1.00 mg/L Cu, 1L - order no. CAY852-V10C10AAE
Standard sol. 2.00 mg/L Cu, 1L - order no. CAY852-V10C20AAE
Maintenance kit CAV740 - order no. CAV740-1A

for CA71HA (hardness)
Reagent set HA1+HA2, 1L each - order no. CAY743-V10AAE
Standard sol. 10 mg/L $CaCO_3$, 1L - order no. CAY745-V10C10AAE
Standard sol. 20 mg/L $CaCO_3$, 1L - order no. CAY745-V10C20AAE
Standard sol. 50 mg/L $CaCO_3$, 1L - order no. CAY745-V10C50AAE
Maintenance kit CAV740 - order no. CAV740-2A

for CA71CL (chlorine)
Reagent set CL1+CL2 (free), 1L each - order no. CAY543-V10AAE
Reagent set CL1+CL2 (total), 1L each - order no. CAY546-V10AAE
Cleaning solution, 1L - order no. CAY544-V10AAE
Maintenance kit CAV740 - order no. CAV740-1A
Maintenance kit CAV740 - order no. CAV740-4A

for the maintenance
Silicon spray - order no. 51504155

for other analyzers
Filter element for CAT430/431 - order no. 51509236
Hose set for CAT430 - order no. 51509225
Filter membrane (2 pcs.) for CAT411 - order no. 51511288

Water samplers

The current Endress+Hauser range includes:
- **The stationary water samplers ASP Station 2000 and Liquistation CSF48**
- **The portable water samplers Liquiport 2000 and Liquiport CSP44**

In this section, you will find essential information and advice on how to obtain the best from these devices throughout their lifecycle.

Keep wear parts in stock.

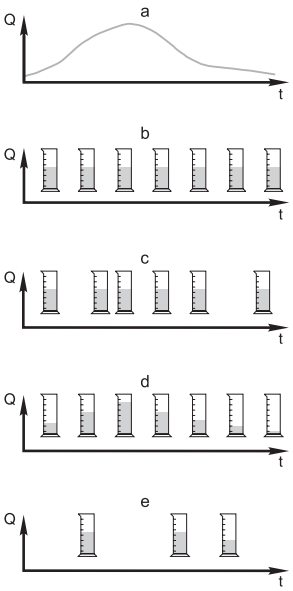


Fig. 33: Sampling control (CSF48 and CSP44 samplers)
a. Flow curve
b. Time proportional sampling: Constant time constant volume (CTCV) A constant sampling volume is taken at steady intervals.
c. Flow proportional sampling: Variable time constant volume (VTCV) A constant sampling volume is taken at variable intervals (depending on the inflow volume).
d. Flow proportional sampling/time override: Constant time variable volume (CTVV) A variable sampling volume (the sampling volume depends onthe inflow) is taken at steady time intervals.
e. Event-controlled sampling Sampling is triggered by an event (e.g. pH limit value). Sampling can be time-paced, flow-paced, or time/flow-paced, or single samples can be taken.

Measuring principle

The ASP station 2000 and the Liquistation CSF48 are stationary samplers for fully automated sampling, defined distribution and thermostatic storage of liquid media. The Liquiport 2000 and CSP44 are portable devices.

Sampling control (fig.33)
Sampling is triggered by an event (e.g. pH limit value). Sampling can be time-paced, flow-paced, or time/flow-paced, or single samples can be taken. Single and multiple samples can also be grouped in a program in addition to the sampling methods listed. Furthermore, the software allows interval sampling, switchover and event functions. The latter permit up to 24 subprograms to be active simultaneously for a variety of applications. A sampling table makes it possible for users to program the bottle assignment, time interval and sample volume. Signals for external control can be connected via two analog inputs and two binary inputs in the standard version of the device.

Installation conditions

- Position the device on a level surface.
- Protect the device against additional heat (e.g. radiators or sun).
- Protect the device against mechanical vibration and strong magnetic fields.

Hydraulic connection	Liquiport 2000	ASP Station 2000
Maximum suction height	6m/19.7ft (optional: 8m/26.2ft)	6m/19.7ft (optional: 8m/26.2ft)
Maximum hose length	30m/98.4ft	30m/98.4ft.
Hose connection diameter	10mm/0.39”	13mm, 16mm or 19mm (0.51”, 0.63” or 0.75”) internal diameter
Suction velocity	> 0.5 m/s (1.64 ft/s), to EN 25667	> 0.5 m/s (1.64 ft/s), to EN 25667

Hydraulic connection	Liquiport CSP44	Liquistation CSF48
Maximum suction height	8m/26ft	Vacuum pump: standard 6m/20ft, optional 8m /26ft - Peristaltic pump: standard 8m /26ft
Maximum hose length	30m/98.4ft	30m/98.4 ft
Hose connection diameter	10mm/3/8” internal diameter	Vacuum pump: internal diameter of 10mm (3/8”), 13mm (1/2”), 16mm (5/8”) or 19mm (3/4”) Peristaltic pump: internal diameter of 10mm (3/8”)
Intake speed	> 0.5 m/s (1.6 ft/s) in accordance with EN 25667, ISO 5667 > 0.6 m/s (1.9 ft/s) in accordance with Ö 5893 (Austrian standard), US EPA	> 0.5 m/s (1.6 ft/s) for ≤ 13mm (1/2”) ID, in accordance with EN 25667, ISO 5667 > 0.6 m/s (1.9 ft/s) for 10mm (3/8”) ID, in accordance with Ö 5893 (Austrian standard), US EPA

Table 8: Hydraulic connection

- Ensure that air can circulate unhindered at the back of the cabinet. Do not position the device directly against a wall (the distance between the wall and the rear side of the cabinet should be at least 100mm/3.94in).
- Do not position the cabinet directly above the inflow channel to the wastewater treatment plant (sulphurous vapors!).

Hydraulic connection
See table 8.

Sampling point
- Do not connect the sampling hose to pressurized systems
- Fit a filter if the medium contains large and abrasive solids
- Always install the hose in the flow direction
- Always choose a representative sampling point (turbulent flow; not at the channel base)

Commissioning

Quick commissioning of the Liquistation CSF48

After having switched on the power supply:

- Chose the language (Menu > Language).
- Then enter in > 'Setup' then 'General settings'.
- Change the TAG if needed.
- Then enter in > 'Date/hour' and set those parameters.
- Then enter in > 'Sample' to set the characteristics of the bottles and of the sampling.
- Then enter in > 'Inputs' and set them if necessary (example: flowmeter input to sample according to a volume).
- Then enter in > 'Outputs' and set them if necessary.
- Then enter in > 'Sampling programs' then 'Setup program'. In the 'Setup program' menu, it is possible either to modify the pre-existing program, or to duplicate it to modify it after, or to create a new one. Each program can be renamed.

Beware! The input affectations are shown only if they were set into Menu > Setup > General settings > Inputs.

To reset to default values: Menu > Diagnostics > System test/Reset > Factory default values.

In case of alarm, the screen turns red. Check the 'Diagnostic' menu to get the error message.

Operation and maintenance

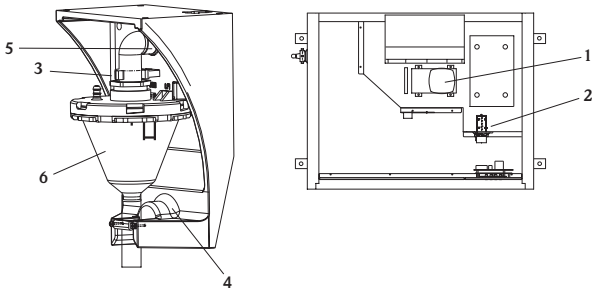
Cleaning

Use only a safe cleaning agent that will not damage the mechanical and electrical equipment. For the cabinet body, we recommend a stainless steel cleaner. For any parts conveying media, use water or soap. Thorough, regular cleaning of the parts which convey media is essential for reliable operation. You can mount and disassemble all the parts which convey media easily and without tools. (Please refer to the Operating Instructions related to your device).

- Thorough, regular cleaning of the dosing unit is essential for reliable operation.
- The sample compartment has a permeable inner plastic shell. Once you have removed the bottle trays, the distribution pan and the tap (open the connector of the distribution drive), you can clean the whole sample compartment easily using a water hose.
- Depending on the ambient conditions (e.g. high level of dust formation), you should purge the ventilator and the liquefier with compressed air at regular intervals.

Hint (ASP 2000): Since software version V4.16 it is possible to use the 'HOLD' function for the time of the maintenance. The program will run at this time in the background (for more information, see chapter 5.1 in the Operating Instructions)

Table 9: Maintenance intervals (ASP Station 2000)



Period of time	Part to be changed
Every 6 months	■ The dosing chamber Acryl (6) (order no. 50072149)
Every year	■ The seal set for dosing system (5) (order no. 50079747) ■ The membrane hose clamp (4) (order no. 51002657) ■ The air filter (3) (order no. 50086064)
Every 2 years	■ The air manager (2) (order no. 51003139)* ■ The seals of the vacuum pump (1) (order no. 51003140)

* It is recommended to have this done by our field service engineers.

Hint (CSF48): The modular cooling unit is easy to exchange if needed.

Maintenance intervals

See table 9. In addition to this,

- The lid should be checked for leakage and cleaned every 6 months.
- The conductivity probes have to be checked for corrosion once a year.

Note: these are average figures and should be adapted to your application. See the FAQs on the next page.

Simple checks for your sampler

As a sampler has a lot of moving mechanical parts, it is recommended to check it periodically (twice a year is a minimum). In order to comply with ISO 5667-10, you have to prove three criteria:

- The cooling temperature inside the sampler is kept at a max of 4°C/39.2°F.
- The suction air flow rate should be higher than 0.5m/s (1.64ft/s). This can be controlled by means of a manometer (<-0.6 bar /8.7 psi).

- The sampling volume repeatability is ± 5 %.

To carry out this check in optimal conditions, you need several tools like a thermometer, a chronometer, a manometer and measuring glasses.

All these operations can be part of a maintenance contract where our skilled technical engineers deliver specific certificates which prove your sampler's compliance to the local authorities.
(See **'Maintenance Services'** in the 'At your service' section).

Checking the new samplers
The new generation (Liquistation CSF48 and Liquiport CSP44) enables the complete chain to be simulated using Memocheck Sim CYP03D.

Spare parts stock
Several parts of the sampler have to be considered as wear parts and thus should be kept in stock (see 'Maintenance intervals').

Instrument and spare parts availability
See table below.

How to select the main spare parts:
see the following list.

Your instrument	Spare parts availability	New generation
Liquibox D	until 01.2014	Liquibox D2 (RPB10)
Liquibox A	until 01.2014	Liquibox A2 (RPB10)
Liqui-Compact A/A2	until 01.2013	Liquiport 2000 (RPT20)
ASP Port A/A2	until 01.2014	Liquiport 2000 (RPT20)
ASP Port D/D2	until 01.2014	Liquiport 2000 (RPT20)
ASP Station A/A2	until 01.2014	ASP Stat. 2000 (RPS20)
ASP Station D/D2	until 01.2014	ASP Stat. 2000 (RPS20)

For further information, use our Device Viewer:
www.services.endress.com/device-viewer

Table 10: Instrument and spare parts availability

List of the main spare parts (ASP Station 2000)

- Vacuum pump
  single head / KNF023, order no. RPS20X-PC
  double head / KNF023.1, order no. RPS20X-PE
- Seals set
  for KNF023, order no. 51003140
  (You need two sets for KNF023.1)
- Dosing chamber, Acryl 200mL, order no. 50072149
- Flange with dosing tube 200mL, order no. 50090342
- Silicon hose, for distribution 15 x 2, l = 1m, order no. 50031916
- Dosing bracket cpl., including hose clamp, order no. RPS20X-DA
- Membrane, order no. 51002657
- Air filter, order no. 50086064
- Air manager, order no. 51003139
- Seal set for dosing system, order no. 50079747
- Tap drive, order no. 51003682
- Dosing system, 200mL, order no. RPS20X-DC
- LF probe, order no. RPS20X-DD
- Pneumatic hoses, order no. RPS20X-PA
- Controller/CPU ASP 2000, 1 program, order no. RPS20X-1CA

List of the main spare parts (Liquistation CSF48, vacuum pump)

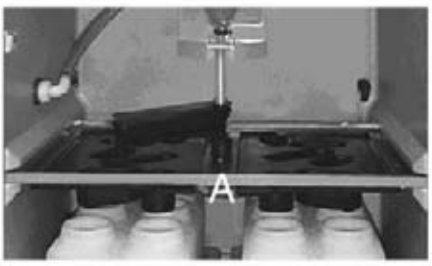
- Fastening clips for suction hose, 10 pcs, order no. 71113508
- Internal intake hose, complete, including 110° angular piece, 90° hose connection nipple, thread adapter nut 1" PP, 2 x fastening clips, 3 x O-rings, order no. 71111048
- Feedthrough, sample infeed ID 13 with cylinder pin, order no. 71110853
- Dosing pipe 350ml with O-ring, order no. 71110628
- Glass dosing chamber, 350ml, with fixing ring and O-ring, order no. 71103168
- Plastic dosing chamber, 350ml, with O-ring, order no. 71103173
- Conductive dosing chamber flange, with conductivity sensors, insulation sleeves and O-ring, order no. 71102985
- Capacitance dosing chamber flange, complete, order no. 71103166
- Dosing chamber inlet with sealing ring, intermediate ring and pipe clamp, order no. 71111006
- Air filter for vacuum pump, 2 pcs Hose, silicone, 320mm (12.6"), order no. 71103283
- Seal set for dosing chamber, order no. 71103176
- Dosing hose to distributor, 2 pc set, order no. 71111188
- Dosing hose to distributor, 25 pc set, order no. 71111189

Frequently asked questions

When do I have to calibrate the distribution tap?
- When the tap motor was replaced.
- When the error message 'tap calibration' appears on the display.

How to calibrate the distribution tap?

1 Switch the device on.
2 Under 'SET/SERVICE/ CALIBRATION', select the item 'DIST.TAB'.
3 When you select 'START', the tap turns and stops just before the calibration position.
4 At the controller, keep selecting '1step' until the arrow on the front side of the tap is located exactly in the notch in the middle of the distribution pan (point A). In the pick list, select the menu option 'SAVE'.
5 The tap is calibrated.



Then quit all sub menus (press 'ESC') and come back to the main menu. Press 'AUTO' and check that the tap goes to the right position. Otherwise, try the procedure again. If the second attempt also fails, replace the tap motor.

Fig. 34

'ERROR : AIR MANAGER'
Replace the air manager. If the error remains, test by exchanging the mainboard RPS20X-GA (version without RS485), or RPS20X-GB (version with RS485) and/or the connection cable distribution tap drive (order no. RPS20X-VC).

'ERROR : Conductivity 2'
There are three conductivity probes in the dosing funnel lid. During the suction process, the sample liquid first reaches the longer conductivity probes (item A and B). In this way, the filling of the dosing funnel is detected and the suction process is stopped. If the conductivity probes 1 (item A and B) fail, safety switch off takes place by means of the shorter conductivity probe 2 (item C).

Contact on probe 2 may be due to:
- Condensation or dirt on the probes contacts.
- A faulty connection.

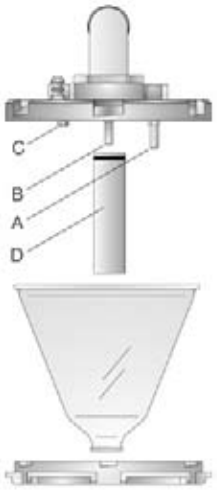


Fig. 35: Level detection synopsis
Item A : Conductivity probe (long)
Item B : Conductivity probe (long)
Item C : Conductivity probe (short)
Item D : Dosing pipe

In any case, the first step consists of cleaning the dosing system
- Clean the flange on both sides. If the probes are too oxidized, exchange the flange (order no. 50090342).
- Clean, if necessary exchange the dosing tube (order no. 50042898) and exchange the seals (order no. 50079747).
- Clean the pins situated at the dosing bracket, exchange dosing bracket if there is too much oxidation (order no. RPS20X-DA).
- Clean the contacts behind the dosing bracket (cable and tightening screws), exchange dosing bracket, if there is too much oxidation (order no. RPS20X-DA).
- Clean the distribution motor connector situated against the sampler background wall above the distribution. Exchange the connection cable distribution tap drive (order no. RPS20X-VC) if it is too oxidized.
- If the suction height is small (< 1.5m/4.9ft) and the diameter of the suction hose is < ¾" this error can occur. Then use a suction hose ¾" or bigger.

Tips for the ASP Station 2000

How to connect the passive pulse output of a Endress+Hauser Proline electromagnetic flowmeter to enslave an ASP Station 2000?
- Connect terminal 24 at the flowmeter to terminal 2 of connector X2 at the ASP 2000.
- Connect terminal 25 at the flowmeter to terminal 4 of connector X2 at the ASP 2000.

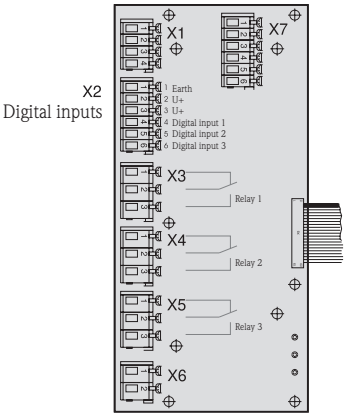


Fig. 36

My sampler is enslaved to an electromagnetic flowmeter and the sampling does not operate any more…
- Simulate the pulses by shunting terminals 2 and 4 of connector X2 by means of a cable.
- Check if there is a direct voltage between terminals 1 and 2 of connector X2.

Tips for the Liquistation CSF48

How to connect the passive pulse output of a Endress+Hauser Proline electromagnetic flowmeter to enslave an Liquistation CSF48?
- The connections for the sampler controller are in the controller housing.

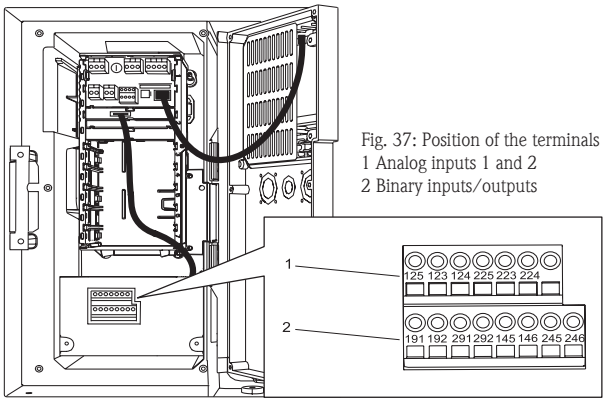


Fig. 37: Position of the terminals
1 Analog inputs 1 and 2
2 Binary inputs/outputs

- Assign analog inputs 1 or 2 according to your device

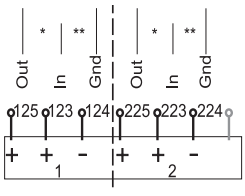


Fig. 38: Assignment of analog inputs 1 and 2
* Analog input for passive devices (2-wire transmitter)
Out + In terminals (125/123 or 225/223)
** Analog input for active devices (4-wire transmitter)
In + Gnd terminals (123/124 or 223/224)

- Two binary inputs and two binary outputs easy to configure

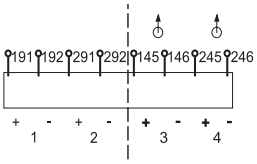


Fig. 39: Assignment of the two binary inputs (191/192 and 291/292) and the two binary outputs (145/146 and 245/246)

Frequently asked questions related to liquid analysis devices

pH

I have a tolerance between the laboratory and the inline measurements which is > 0.3 pH. The labor electrode and the inline electrode are in the same probe. If the tolerance is ± 0.2 pH is it OK?
If this influence is to be compensated for, the temperature coefficient of the measuring solution must be known. This value must be determined in the laboratory since different measuring solutions have different ion compositions and concentrations.
The values thus determined can be entered in hi-tech measuring instruments (medium temperature compensation, Liquiline CM42) and used in computing the pH value.

Practical significance of this:
- The temperature of the measuring solution must always be specified for pH values to be processed by process control systems.
- pH comparisons are only valid for identical medium temperatures.

Conductivity

I have a tolerance between the laboratory and the inline measurements…
1. Alpha is not the same.
2. Temperature is not the same.
3. The probe is not the same.

Solution: Always measure without compensation in the same probe.

Chlorine

I have a tolerance between DPD and the inline measurements…
1. pH is not compensated (fluctuations higher than ±0.1 pH must be compensated).
2. The pH value is unstable.
3. pH > 8.7
4. The temperature is unstable.
5. There is an interference of iron, copper, manganese or high concentration of combined chlorine to the DPD measurement.
6. Organic chlorination chemicals were used instead of inorganic chlorination chemicals.

Dissolved oxygen measurement
Typical failures, methods of detection and failure removal

Typical errors in DO measurement
1. Membrane rupture monitoring
2. Measuring value deviates from a reference meter (e.g. handheld instrument)
3. Degradation of the reference electrode
4. Error possibilities on a handheld meter

1. Membrane rupture monitoring
- Sensors COS3/31 include conductivity measurement between the stainless steel body and an inner electrode (see picture).

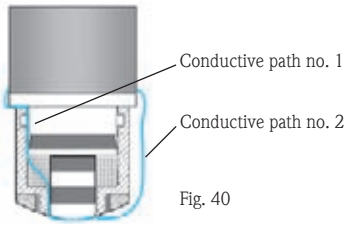


Fig. 40

- Step 1 detects looseness on conductive path no. 1 (membrane rupture)

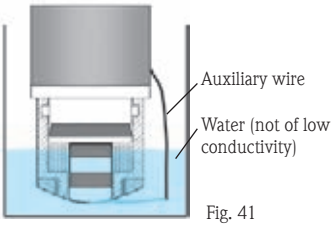


Fig. 41

- Step 2 detects looseness on conductive path no. 1+2

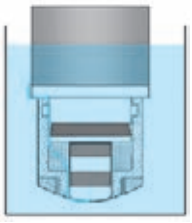


Fig. 42

If there was no alarm on conductive path no. 1 it is clear that an alarm occurring now relates to conductive path no. 2.

2. DO sensor functionality check
- Perform calibration in air (see page 65).
- Perform 'simple check of the zero point' (see page 66).

3. Degradation of the reference electrode
Sensors produced before April 2000 can be subject to AgBr degradation when exposed to a medium containing a high amount of H_2S / NH_3.
Typical behavior: Signal increase up to overflow within 1-3 hours. (Check on a recorder if possible!)

Remedy: Repair at Endress+Hauser.

4. Error possibilities on a handheld meter
- Some sensor types of handheld meters include very thin membranes (e.g. 12.5µm) for fast response. Therefore, handheld sensors need high flow (e.g. 20-30 cm/s (7.87 - 11.8 in/s)).
- Insufficient flow on handheld meters results in a too low signal. Make sure that there is sufficient flow. Move or stir the sensor if necessary.
- Due to the fast response, those handheld sensors show too high signals when immersed into aeration basins with small bubble aeration.

Solution: immerse the sensor upside down (e.g. attached to a stick of wood or similar).

Pressure measurement

Proper commissioning ensures peace of mind

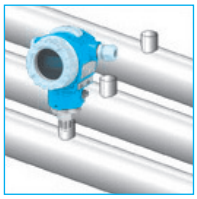
Pressure measurement uses various principles and can, according to the application, serve to calculate a flow rate or a level. Thus these devices are in frequent use in a broad scope of applications.

Most of the reported questions occur during commissioning. Therefore we have decided to focus on this on the following pages. In 95% of the cases, proper installation and cabling enables immediate operation!

You will also find plenty of useful information to help you get the best from your instruments throughout their lifecycle and prepare for renewing your equipment gradually.

Contents

Basics



Absolute/relative pressure transmitters
Specific information p. 79

Differential pressure transmitters
Specific information p. 81

Hydrostatic pressure transmitters
Specific information p. 83

The current Endress+Hauser range of pressure measurement devices includes:
- The Cerabar S and M absolute/relative pressure transmitters
- The Deltabar S and M differential pressure transmitters
- The Deltapilot S and M hydrostatic pressure transmitters

Note: T-class devices are not subject to maintenance and therefore not included in this guide.

In this 'Basics' section, we have put together:
- Information on installation and maintenance that is relevant to all types of pressure sensors
- Information on configuration and maintenance that is common to all sensors of the S series

Information common to all types of pressure sensors

Maintenance of pressure sensors

Pressure measurement instruments require minimum maintenance as they are insensitive to the medium and have no moving parts. We recommend you periodically perform a visual check of the devices:
- Check the cap and housing's condition
- Check the diaphragm's condition
- Check the cable gland is watertight
- Ensure there is no condensation inside the housing
- Check the connections to the electronic module

Note: Do not clean or touch diaphragm seals with hard or pointed objects.

Seal for flange mounting (fig. 1)

The seal is not allowed to press on the diaphragm as this could affect the measurement result.

Calibration

Hydrostatic pressure measurement sensors need calibration at start-up.
All pressure sensors require periodic calibration; the calibration's frequency depends on the expected precision.
Calibration can be performed either on-site or in the laboratory (for greater precision and/or for accredited calibration).

Endress+Hauser can help you calculate the right calibration frequency and perform calibration either on site or in accredited laboratories.
(See **'Calibration services'** in the 'At your service' section).

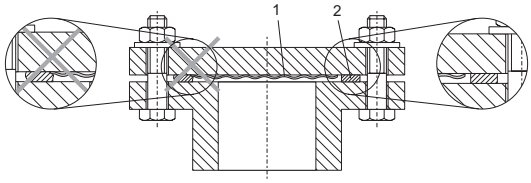


Fig. 1: Mounting the versions with flange or diaphragm seal
1 Diaphragm 2 Seal

Maintenance planning

Do you know exactly which part of your installed instrumentation base is **critical to the operation** of the plant and how you could maintain or calibrate it more efficiently? Are you sure that your present actions are minimizing the risks of **unplanned breakdowns**? Are you sure that your present actions are the most **cost-effective**?
We can help you to find an answer to these questions and move forward in a controlled manner to a maintenance plan that improves plant reliability while reducing costs…
(See **'Maintenance & calibration consulting'** in the 'At your service' section).

Maintenance performing

In case you don't have the manpower, the right skills or the right tools to efficiently perform your maintenance, with Endress+Hauser **service contracts**, you decide the right level of maintenance support you require. We provide regular checks on your equipment and warranty extensions providing you with complete peace of mind and cost control. From regular support to partnership agreements, we offer four distinct levels of service…
(See **'Maintenance services'** in the 'At your service' section).

Corrective maintenance

The more critical your instrument is to your process, the shorter the acceptable time for repair. Thanks to the Endress+Hauser's spare part concept, most parts can be easily replaced by the user thus allowing quick repair.

Being more efficient in the repair process is another way to reduce downtimes. Our training sessions help you to diagnose quickly any failure and to apply the most appropriate repair method. (See **'Training'** in the 'At your service' section).

Spare parts stock

On each part you will find a sticker with the part number, for easy spare parts ordering.
For each device type, we suggest you keep a full set of electronic inserts in stock.
In case of a highly critical instrument, you might also consider stocking a complete new instrument.

Re-engineering

Want to use an instrument for a new application? We can help you check the relevant parameters. See our online Applicator tool.
https://wapps.endress.com/applicator

‘S’ series common features

As members of the Evolution range, Cerabar S, Deltabar S and Deltapilot S use the same electronic modules (for HART output, for PROFIBUS output etc), the same housings, caps, display, terminal compartment, mounting set and Histo-ROM. Only the sensor is specific. This allows a consistent spare parts stock reduction.

Setup & configuration

Cerabar S, Deltabar S and Deltapilot S use the same interface for operation with or without display (see details on fig. 3).

Quick Setup enables quick and easy configuration of the device’s main functions (units, outputs…). The Extended Setup menu gives access to advanced configuration features.
You can also configure the device from a PC using FieldCare software.

Wiring

See fig. 4

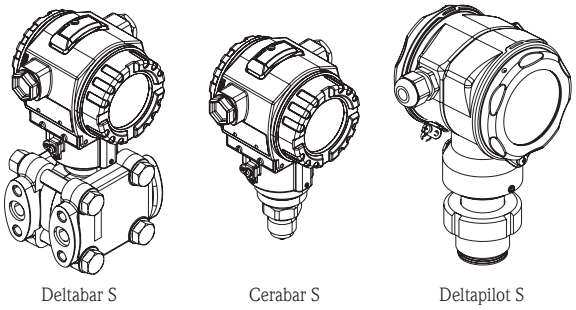


Fig. 2: Overview of the ‘S’ series

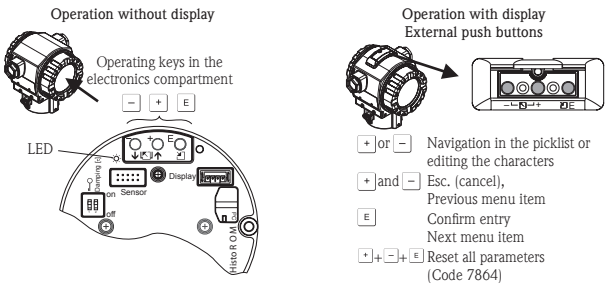


Fig. 3: Operation with or without display

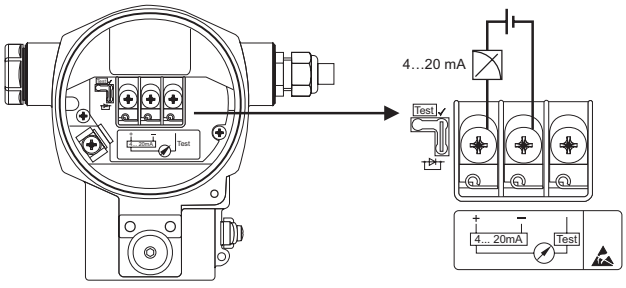


Fig. 4: Electrical connection 4-20mA HART

Taking 4-20mA test signal

A 4-20mA signal may be measured via the positive and test terminal without interrupting the measurement.
The minimum supply voltage of the device can be reduced by simply changing the position of the jumper. As a result, operation is also possible with lower voltage sources. Observe the position of the jumper in accordance with the following table (fig. 5).

Save time and resources…
Our service team can set up any Endress+Hauser level measurement device for you and thus ensure you immediately get the best from your instrument.
(see **‘Device commissioning’** in the ‘At your service’ section)

Operation and maintenance

Load – analog and HART devices

Load diagram, observe explosion protection. (see fig. 6)

Jumper position for test signal	Description
	– Taking 4-20mA test signal via plus and test terminal: possible. (Thus, the output current can be measured without interruption via the diode.) – Delivery status – minimum supply voltage: 11.5V DC
	– Taking 4-20mA test signal via plus and test terminal: not possible. – minimum supply voltage: 10.5V DC

Fig. 5

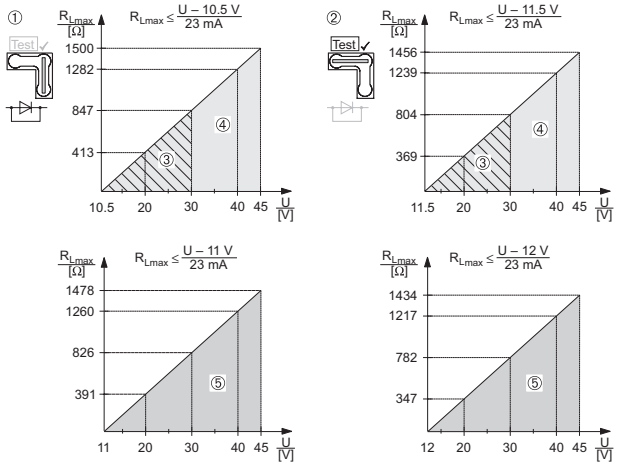


Fig. 6: Load diagram
1 Jumper for the 4-20mA test signal inserted in ‘Non-test’ position
2 Jumper for the 4-20mA test signal inserted in ‘Test’ position
3 Supply voltage 10.5 (11.5) to 30V DC for 1/2 G, 1 GD, 1/2 GD, FM IS, CSA IS, IECEx ia, NEPSI Ex ia and TIIS Ex ia
4 Supply voltage10.5 (11.5) to 45V DC for devices for non-hazardous areas, 1/2 D, 1/3 D, 2 G EEx d, 3 G EEx nA, FM XP, FM DIP, FM NI, CSA XP, CSA Dust-Ex, NEPSI Ex d, TIIS Ex d
5 Supply voltage 11 (12) to 45V DC for PMC71, EEx d[ia], NEPSI Ex d[ia] and TIIS Ex d[ia]
R_{Lmax} Maximum load resistance
U Supply voltage

‘M’ series common features

Cerabar M, Deltabar M and Deltapilot M use the same electronic modules (for HART output, for PROFIBUS output, etc.), the same housings, caps, display, terminal compartment, mounting set. Only the sensor is specific. This allows a consistent spare parts stock reduction.

Setup & Configuration

Cerabar M, Deltabar M and Deltapilot M use the same interface for operation with or without display (see details on fig. 8).

You can configure these devices from a handheld terminal e.g. Field Xpert or DXR375. You can also configure these devices from a PC using FieldCare software.

Wiring

See fig. 9

Taking 4-20mA test signal

A 4-20mA test signal may be measured via the test terminals without interrupting the measurement. To keep the corresponding measured error below 0.1%, the current measuring device should exhibit an internal resistance of < 0.7Ω.

Save time and resources…
Our service team can set up any Endress+Hauser level measurement device for you and thus ensure you immediately get the best from your instrument.
(see **‘Device commissioning’** in the ‘At your service’ section)

Operation and maintenance

Load – analog and HART devices

Load diagram for non-Ex devices. (see fig. 10)

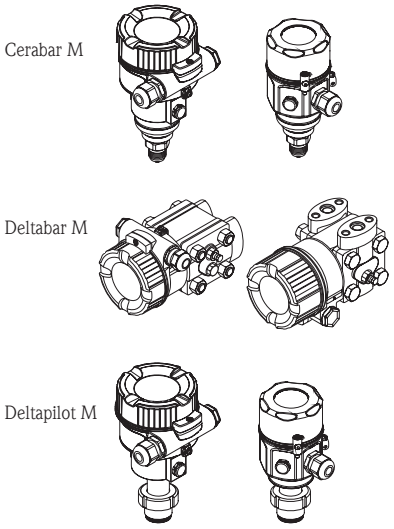


Fig. 7: Overview of the ‘M’ series

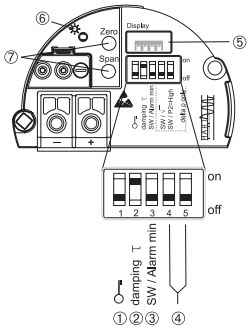


Fig. 8: Operation without operating menu
The operating keys and DIP switches are located on the electronic insert in the device. The picture shows an HART electronic insert.
1 DIP switch for locking/unlocking parameters relevant to the measured value
2 DIP switch for switching damping on/off
3 DIP switch for alarm current SW / Alarm Min (3.6mA)
4 DIP switch (not used)
5 Slot for optional local display
6 Green LED to indicate successful operation
7 Operating keys for lower range value (zero) and upper range value (span)

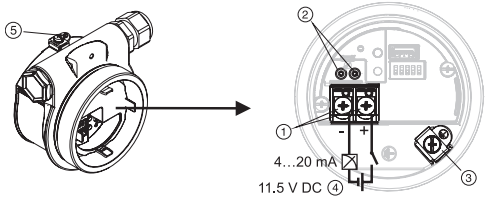
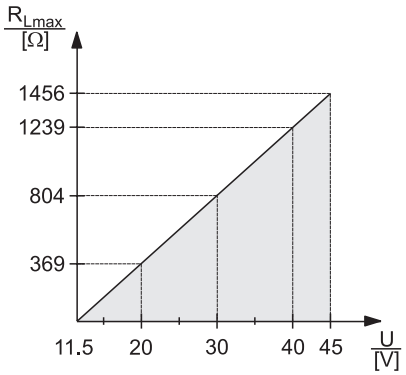


Fig. 9: Electrical connection 4-20mA HART
1 Terminals for supply voltage and signal
2 Test terminals
3 Grounding terminal
4 Supply voltage: 11.5-45V DC (versions with plug connectors: 35V DC)
5 External ground terminal



$$R_{Lmax} \leq \frac{U - 11.5\ V}{0.023\ A}$$

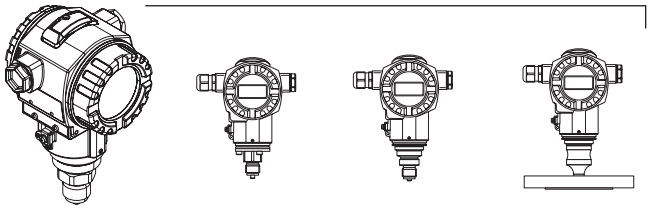
Fig. 10: Load diagram
Supply voltage 11.5-45V DC (versions with plug-in connector 35V DC) for other types of protection and for uncertified device versions
R_{Lmax} Maximum load resistance
U Supply voltage
Note: When operating via a handheld terminal or via a PC with an operating program, a minimum communication resistance of 250Ω must be taken into account.

Absolute/relative pressure transmitters

Cerabar series

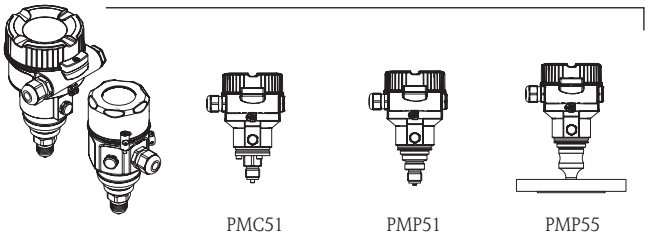
The current Endress+Hauser range of absolute/relative pressure transmitters includes Cerabar M (PMC and PMP5X) and S (PMC and PMP7X) series. In this section you will find essential information and advice that is specific to this type of pressure sensor, enabling optimum follow-up throughout lifecycle.
Please read 'Basics' first (pages 76 to 78).

Cerabar S series - overview



PMC71 PMP71 PMP75

Cerabar M series - overview



PMC51 PMP51 PMP55

With capacitance measuring cell and ceramic process isolating diaphragm (Ceraphire®)

With piezoresistive measuring cell and metal welded process isolating diaphragm

With diaphragm seal

Fig. 11

Measuring principle

Ceramic measuring diaphragm (PMCxx devices)
The ceramic sensor is a dry sensor, i.e. the process pressure acts directly on the robust ceramic diaphragm and deflects it. A pressure-dependent change in capacitance is measured at the electrodes of the ceramic carrier and the diaphragm. The measuring range is determined by the thickness of the ceramic diaphragm.

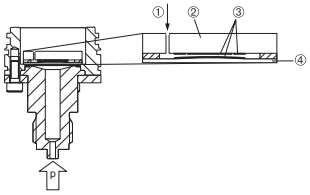


Fig. 12: Ceraphire® ceramic sensor
1. Atmospheric vent (gauge pressure only)
2. Ceramic substrate
3. Electrodes
4. Ceramic diaphragm

Video about ceramic measuring diaphragm available at www.endress.com/videos

Metallic measuring diaphragm (PMPxx devices)

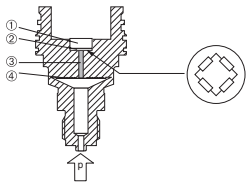
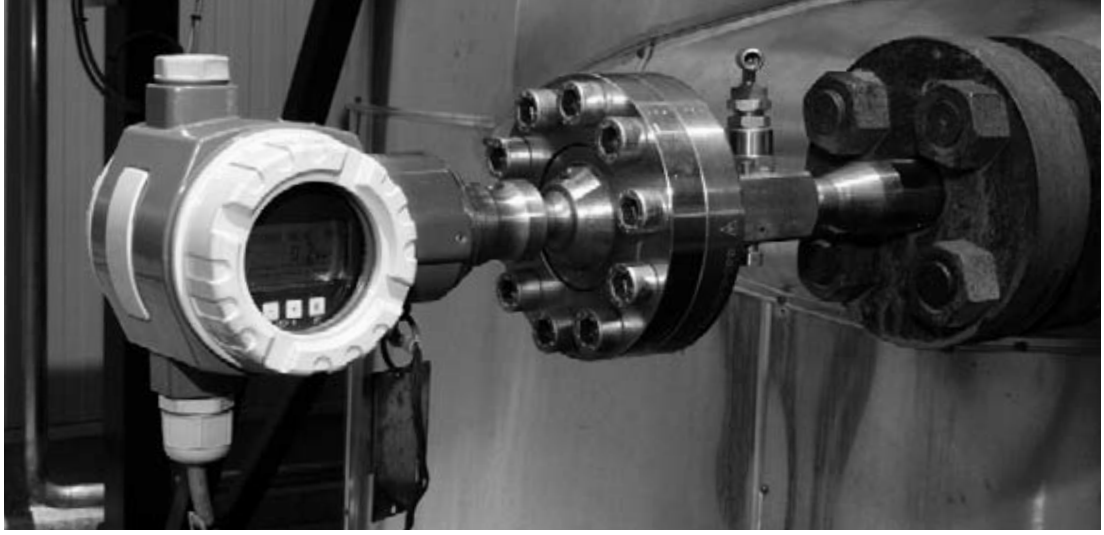


Fig. 13: Metal sensor
1. Measuring element
2. Measuring diaphragm with Wheatstone bridge
3. Channel with fill fluid
4. Process diaphragm, metal separating diaphragm

For PMP51/PMP71
The operating pressure deflects the separating diaphragm and a fill fluid transfers the pressure to a resistance measuring bridge (semi-conductor technology). The pressure-dependent change of the bridge output voltage is measured and processed further.

For PMP55/PMP75
The operating pressure acts on the diaphragm of the diaphragm seal and is transferred to the separating diaphragm of the sensor by a diaphragm seal fill fluid. The process membrane is deflected and a fill fluid transfers the pressure to a resistance measuring bridge. The pressure-dependent change of the bridge output voltage is measured and processed further.



Installation instructions for devices without diaphragm seals

Pressure measurement in gases

Mount the sensor with shut-off device above the tapping point so that the condensate can flow into the process.

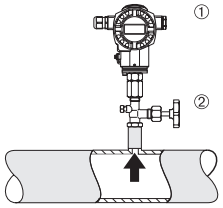


Fig. 14: Measuring arrangement for pressure measurement in gases
1. Cerabar S/M
2. Shut-off device

Pressure measurement in steams

- Mount the sensor with syphon below the tapping point. The syphon reduces the temperature to almost ambient temperature.
- Fill the syphon with fill fluid before commissioning.

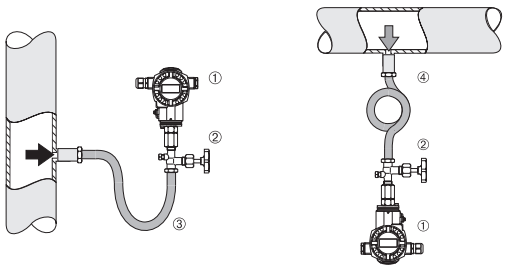


Fig. 15: Measuring arrangement for pressure measurement in steams
1. Cerabar S/M
2. Shut-off device
3. U-shaped syphon
4. Circular syphon

Pressure measurement in liquids

Mount the sensor below or at the same level as the tapping point.

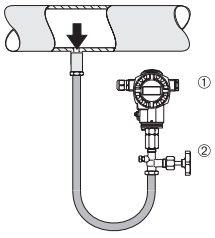


Fig. 16: Measuring arrangement for pressure measurement in liquids
1. Cerabar S/M
2. Shut-off device

Level measurement

- Mount Cerabar S/M below the lowest measuring point.
- Do not mount the device at the following positions: in the fill flow, in the tank outlet or at a point in the container which could be affected by pressure pulses from the agitator.
- The calibration and functional test can be carried out more easily if you mount the device after a shut-off device.

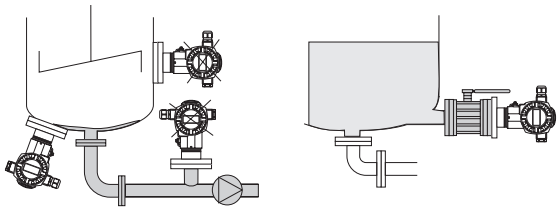
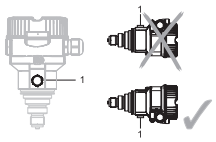


Fig. 17: Measuring arrangement for level

Special instructions for PMP51/71, PMC51/71

If a heated Cerabar is cooled during the cleaning process (e.g. by cold water), a vacuum develops for a short time, whereby moisture can penetrate the sensor through the pressure compensation (1). If this is the case, mount the Cerabar with the pressure compensation (1) pointing downwards. Keep the pressure compensation and GORE-TEX® filter (1) free from contamination.



Operation and maintenance

See 'Basics' for general information on the maintenance of pressure sensors (page 76).

Instrument and spare parts availability

Your instrument	Spare parts availability	New generation
PMC731	NO - since 12/2010	PMC71
PMP731	NO - since 12/2010	PMP71
PMP635	NO - since 12/2010	PMP75
PMC631	NO - since 12/2010	PMP75

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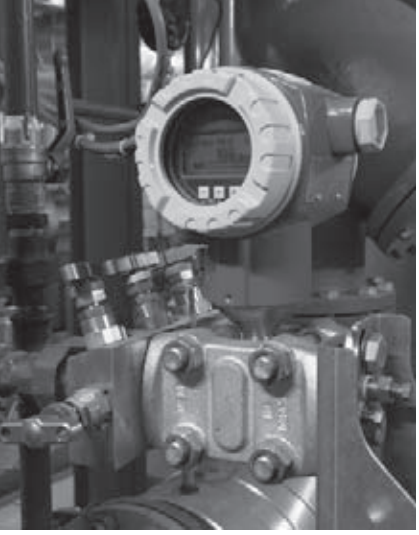
Table 1: Instrument and spare parts availability



Differential pressure measurement

Deltabar series

**The current Endress+Hauser range of differential pressure measurement includes Deltabar M and S series.
In this section you will find essential information and advice that is specific to this type of pressure sensor, enabling optimum follow-up throughout the lifecycle.
Please read 'Basics' first (pages 76 to 78).**

Deltabar S series - overview

Deltabar M

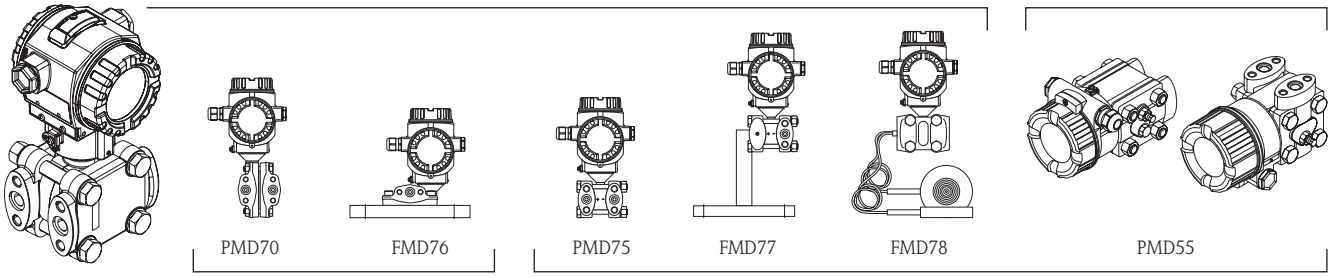


Fig. 18

Measuring principle

Metallic measuring diaphragm (PMD55, PMD75, FMD77 and FMD78 devices)
The separating diaphragms (3/9) are deflected on both sides by the acting pressures. A filling oil (4/8) transfers the pressure to a resistance circuit bridge (semi-conductor technology). The differential-pressure-dependent change of the bridge output voltage is measured and further processed. The pressure-dependent change of the bridge output voltage is measured and processed further.

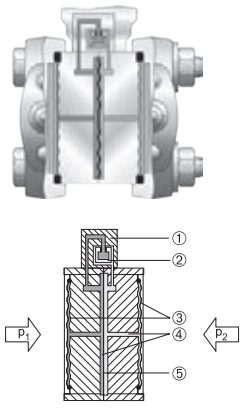
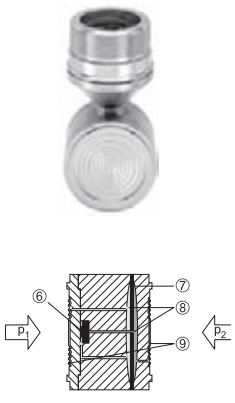


Fig. 19: Metal measuring cell 10 mbar and 30 mbar
1. Sensing element
2. Silicon diaphragm
3. Separating diaphragm
4. Filling oil
5. Integrated overload protection



Metal measuring cell as of 100 mbar
6. Sensing element
7. Overload diaphragm/middle diaphragm
8. Filling oil
9. Separating diaphragm

Ceramic measuring diaphragm (PMD70 and FMD76 devices)
The ceramic measuring cell is based on the principle of a plate capacitor with an electrode on (1) and a movable electrode on the interior of the diaphragm (3). Standard silicone oil or mineral oil filling oils for this measuring cell.
A differential pressure (p1 ≠ p2) causes a corresponding deflection of both diaphragms. Both capacitance values are converted and are fed to the microprocessor of the transmitter as a digital signal.

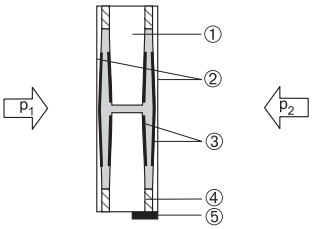


Fig. 20: Ceramic sensor
1. Meter body
2. Diaphragm
3. Electrodes
4. Glass frit fixes the diaphragm onto the meter body
5. Temperature sensor

Installation instructions

Main installation requirements regarding the most frequently used applications:

Flow measurement in liquids with PMD55/PMD70/PMD75

- Mount the Deltabar S below the measuring point so that the impulse piping is always filled with liquid and gas bubbles can run back into the process piping.
- When measuring in media with solid parts, such as dirty liquids, installing separators and drain valves is useful for capturing and removing sediment.

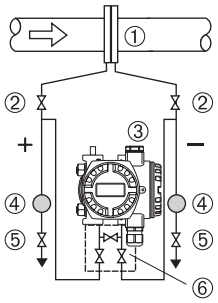


Fig. 21: Measuring layout for flow measurement in liquids with PMD75
1. Orifice plate or pitot tube
2. Shut-off valves
3. Deltabar S, here PMD75
4. Separator
5. Drain valves
6. Three-valve manifold

Level measurement in a closed tanks with PMD55/PMD75
(pressure piping)

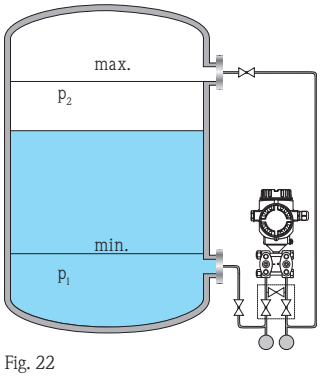


Fig. 22

- Mount the Deltabar S/M below the lower measuring connection so that the impulse piping is always filled with liquid.
- Always connect the minus side above the maximum level.
- A condensate trap ensures constant pressure on the negative side.
- Generally speaking, the installation of separators and discharge valves makes sense to collect deposits, pollution or liquids in pressure piping and to remove them.
- Calibrate at operating temperature.

Level measurement in a closed tank with FMD78
(capillary diaphragm seals)

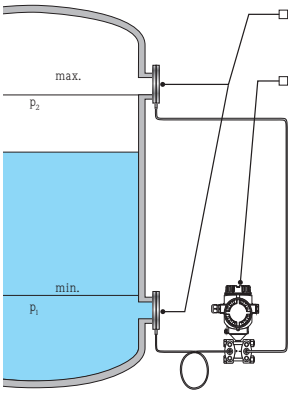


Fig. 23

- Level measurement is only safeguarded between the upper edge of the lower and the lower edge of the upper diaphragm seal.
- In vacuum applications, it is recommended to install the pressure transmitter below the lower diaphragm seal. This will avoid a vacuum load of the diaphragm seal caused by the presence of filling oil in the capillaries.

Optimizing measures

- In order to avoid additional pressure fluctuations and a defective instrument, the capillaries should be installed free of vibrations.
- The capillaries may not be installed in the vicinity of heating or cooling pipes which would impair exact measuring results.
- It is recommended to insulate the capillaries in a colder or warmer environment.
- In case of two-sided diaphragm seal systems, the ambient temperature and the length of both capillaries should be identical.
- Two identical diaphragm seals (e. g. diameter, material, etc.) should always be used for the minus and plus side.

Operation and maintenance

See 'Basics' for general information on the maintenance of pressure sensors (page 74).

Instrument and spare parts availability

Your instrument	Spare parts availability	New generation
PMD230	NO - since 12/2010	PMD70
PMD235	NO - since 12/2010	PMD75
FMD230	NO - since 12/2010	FMD76
FMD630	NO - since 12/2010	FMD77
FMD633	NO - since 12/2010	FMD78

For further information, use our Device Viewer:
www.services.endress.com/device-viewer

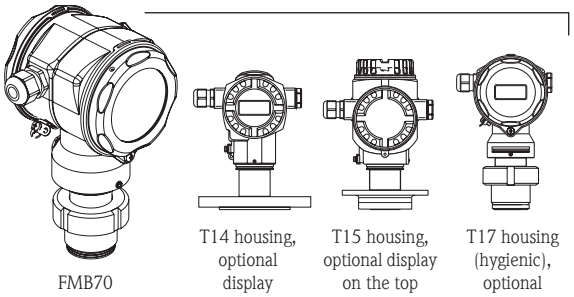
Table 2: Instrument and spare parts availability

Hydrostatic pressure measurement

Deltapilot series

The current Endress+Hauser range of differential pressure measurement includes Deltapilot M (FMB50, 51, 52 and 53) and S (FMB70) series. In this section you will find essential information and advice that is specific to this type of pressure sensor, enabling optimum follow-up throughout lifecycle.
Please read 'Basics' first (pages 76 to 78).

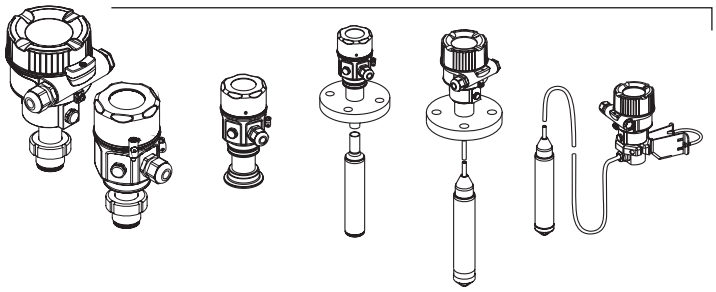
Deltapilot S



FMB70 | T14 housing, optional display on the side | T15 housing, optional display on the top | T17 housing (hygienic), optional display on the side

Fig. 24

Deltapilot M series - overview



FMB50 Compact version | FMB51 Rod version | FMB52 Cable version | FMB53 Cable version with mounting clamp

Measuring principle

Due to its weight, a liquid column creates hydrostatic pressure. If the density is constant, the hydrostatic pressure depends solely on the height h of the liquid column (see fig. 25).

The CONTITE™ measuring cell works on the principle of the gauge pressure sensor. In contrast to conventional gauge pressure sensors, the precision measuring element (2) in the CONTITE™ measuring cell is absolutely protected between the process diaphragm (3) and the measuring diaphragm (1). Thanks to this hermetic sealing of the measuring element, the CONTITE™ measuring cell is absolutely insensitive to condensate, condensation and aggressive gases. The pressure applied is transferred from the process diaphragm to the measuring element by means of an oil without any loss in pressure.

Two temperature sensors are arranged between the process diaphragm and the measuring element which measures the distribution of temperature in the cell. The electronics can compensate any measuring errors resulting from fluctuations in temperature with these measured temperature values.

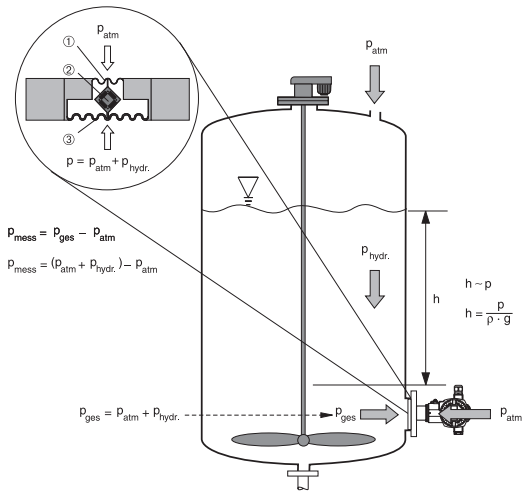
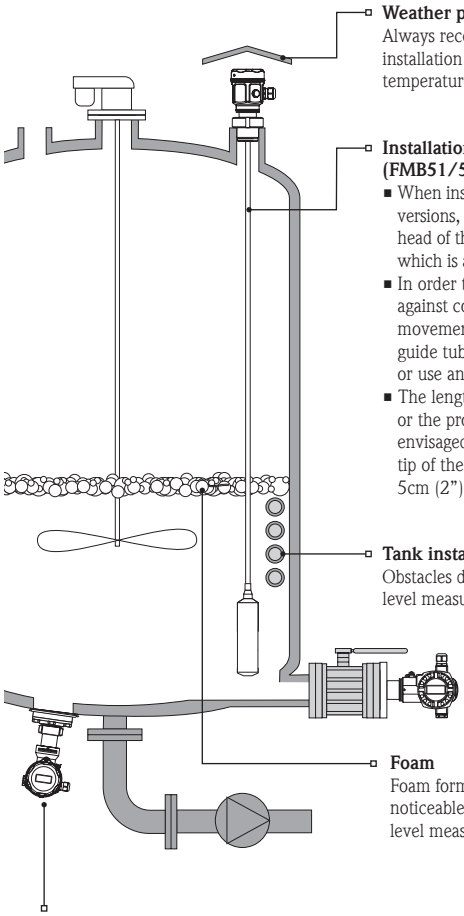


Fig. 25: Deltapilot S hydrostatic level measurement and measuring principle
1. Measuring diaphragm
2. Measuring element
3. Process diaphragm (separating diaphragm)

g Gravitational acceleration
h Level height
p_{tot} Total pressure = hydrostatic pressure + atmospheric pressure
p_{atm} Atmospheric pressure
$p_{hydr.}$ Hydrostatic pressure
p_{meas} Measured pressure in the measuring cell = hydrostatic pressure
ρ Density of fluid

Installation instructions



Weather protection cover
Always recommended for outside installation to avoid strong temperature changes of electronics.

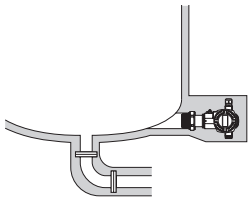
Installation from the top (FMB51/52)
- When installing rod and rope versions, please ensure that the head of the probe is at a location which is as free of flow as possible.
- In order to protect the probe against contact by lateral movements, install probe in a guide tube (preferably of plastics) or use an anchoring device.
- The length of the carrier cable or the probe rod depends on the envisaged level zero point. The tip of the probe should be at least 5cm (2") below that.

Tank installations
Obstacles do not affect hydrostatic level measurement.

Foam
Foam formation does not have any noticeable influence on hydrostatic level measurement.

Installation from below (FMB50, FMB70)
- Always install the instrument below the lowest measuring point.
- It is recommended to install the pressure transmitter behind a stop valve to facilitate easy cleaning and functioning checks.
- Do not install the instrument in the following positions:

– in the flow of product as it is filled
– in the tank outlet
– at a location in the tank which might be affected by the pressure impulses of the agitator



- In case of media which might cure as they cool down, the instrument must be included in the insulation.

Operation and maintenance

See 'Basics' for general information on the maintenance of pressure sensors (page 76).

Note: Do not clean or touch the sensor membrane with hard or pointed objects.

Corrective maintenance

Changing the sensor's electronic module Deltapilot M/S requires no calibration.

Instrument and spare parts availability

Your instrument	Spare parts availability	New generation
DB50L	YES - until 10/2012	FMB50/70
DB50S	YES - until 10/2012	FMB50/70
DB50A	YES - until 10/2012	FMB50/70
DB51	YES - until 06/2014	FMB51
DB52	YES - until 06/2014	FMB52
DB53	YES - until 06/2014	FMB53

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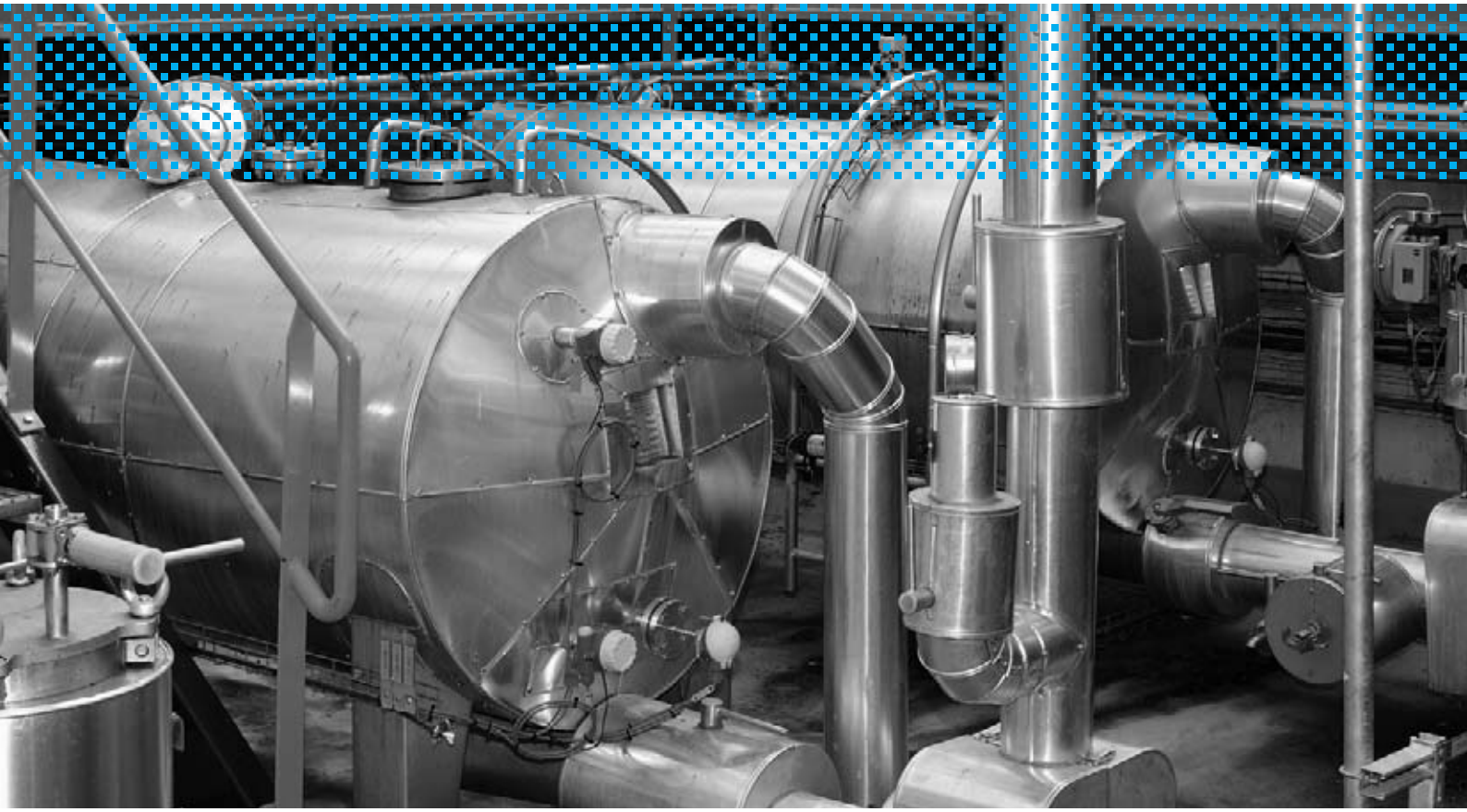
Table 3: Instrument and spare parts availability

Temperature measurement



Calibration: finding the right balance

Temperature is the most frequently measured parameter in the process industry.

Maintenance of temperature measurement consists mostly of periodic calibration. This is why we have focused on calibration in the following pages.

Please note that transmitters such as TMT162 include advanced diagnostics functions (e.g. drift or corrosion detection) that can increase the system's performance and availability.

You will also find plenty of useful information to help you get the best from your instruments throughout their life cycle and prepare you for renewing your equipment gradually.

As experts, we also offer training sessions, in classroom and on site. We would be glad to meet with you and help you to go one step further. See 'Training' in the 'At your service' section .

Video about our competence in temperature available at www.endress.com/videos

Contents

Basics

Information common to all types of temperature sensors

The current Endress+Hauser range of temperature measurement devices includes:
- **The family of RTD (resistance temperature detectors) thermometers**
- **The family of TC (thermocouples) thermometers**

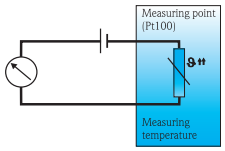


Fig. 1: Measuring principle of RTD sensors

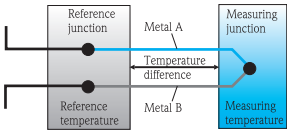


Fig. 2: Measuring principle of thermocouples

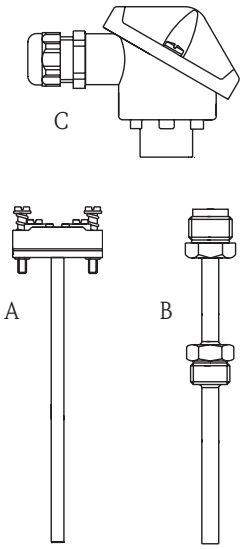


Fig. 3: Construction of temperature sensors
A Insert
B Thermowell
C Terminal head

Measuring principle

RTD sensors
(See figure 1)
In RTD-sensors the electrical resistance changes with a change in temperature. They are suitable for the measurement of temperatures between -200°C/ -328°F and approx. 800°C /1472°F and stand out due to high measurement accuracy and long-term stability. The resistance sensor element most frequently used is a Pt100 which has a nominal value of 100Ω at 0°C/32°F. Pt100 sensors are manufactured in different formats:
- Wire wound ceramic sensors: A spiral of platinum wire is wound and embedded in ceramic powder within a capillary and is fed to the outside by platinum wires.
- Thin film sensors: A platinum layer is vaporized on a ceramic plate (sputtered). The connection wires and the platinum layer are encapsulated in glass.

As standard, Endress+Hauser RTD sensors fulfill IEC 60751 accuracy class A.

TC thermocouples
(See figure 2)
A thermocouple is a component made of two different metals connected with each other at one end. An electrical potential (electromotive force) is caused due to the Seebeck effect at the open end if the connection and the free ends are exposed to different temperatures. With the help of the so-called thermocouples reference tables (see IEC 50584), the temperature at the connection (measuring junction) can be concluded. Thermocouples are suitable for temperature measurement in the range of 0°C to 1800°C (32°F to 3272°F). They stand out due to the fast response time and high vibration resistance.

The mechanical construction of a thermometer used in process plants is the same for resistance thermometers and thermocouples and consists of the following components:
- Measurement insert with ceramic terminal block or head transmitter (A)
- Thermowell: The thermowell is the process wetted component of the thermometer (B)
- Process connection: The process connection is the connection between the process and the thermometer.
- Neck: The neck is the extension between connection head and process connection / thermowell.
- Connection head with cable glands: The connection head is fitted to the thermowell or the neck of the thermometer.

Insert
(See figure 3)
First step of Pt100 protection consists in making an insert. This will be used for installation in the final assembly and has the advantage of being interchangeable. The insert normally consists of a mineral insulated cable, Ø 3 or 6mm (0.12" or 0.24"), including 4 or 6 copper or nickel wires embedded in stone hard pressed MgO powder, surrounded by a very thin sheath made of stainless steel. On one end of the stem the sensing element is welded to the wires and encapsulated; the sensitive zone of an insert has a length of about 25mm /0.98" from the closed end (tip). On the other end a ceramic terminal board or a free wires connection system is mounted on a metal flange; the spring loaded mounting screws, integral with the metal flange, guarantee the insert coupling to the terminal housing and a tight contact between the insert end tip and the thermowell.
Inserts are generally equipped with single or double resistance sensing elements.
Twin resistors are normally used to split the destination of the output signals.
The use of a double sensing element to increase the measuring point reliability is not recommended because the two elements are embedded in the same point: therefore, when a mechanical or electrical cause damages the insert construction, the complete resistor might be damaged also. This can be solved with two independent thermometers.

Thermowell
A second protection of thermometer assembly consists of installing the insert in appropriate metal thermowells (i.e. thermowells or pockets).

This component is normally required for medium and heavy duty applications but it can be employed also for light duty services whenever the insert replacement is possible without any plant shut-down.
In order to reduce the sensor response time lag due to thermowells, tapered end constructions are available.
The thermometer thermowell can be mounted in tanks or pipes by means of threaded, flanged or welded connections. Since the thermowell is the component that comes into contact with the process, exact specification is most important as it determines the lifetime of the assembly. The appropriate selection depends upon the chosen method of mounting, the space available, the pressure, the temperature, the flow speed and the nature of the product.
Among different international and corporate standards, DIN 43772 defines a series of standard thermowell designs including:

- Threaded thermowells type 2G or 3G
- Flanged thermowells type 2F or 3F
- Weld-in thermowells type 4.

Terminal head

A terminal head is recommended to protect the connections between the insert and the external circuit wires. The heads are normally provided with two connections, one for the thermowell and one for the electrical output wiring.

This component can provide a protective housing for built-in transmitters or can act as a junction box if remote mounted transmitters/receivers are used. The head allows a complete compact thermometer assembly and makes it easier for insert replacement.
A wide choice of terminal heads includes general purposes, heavy duty, explosion-proof and sanitary applications. A widely used version of connection heads is constructed in light metal alloy, usually aluminum, and conforms to DIN standard 50446 type B. The Endress+Hauser metallic heads are delivered with gaskets to withstand a temperature of 130°C/266°F). Some connection heads can include a built-in transmitter and/or an indicator: in this case the temperature has to be checked considering the electronic device limits.

Installation instructions

Immersion length

The thermometers should be inserted in the medium where the temperature has to be measured at such a depth that a good compromise between different measuring problems is obtained.

- The heat conducted into sensors from environment may alter the temperature of the sensing tip: for this reason a small sensing element is preferable.
- The thermometer/thermowell process connection may introduce a thermal drift due to heat dissipation through the connection mass that can affect the correct measurement: this problem can be solved with a longer immersion length.
- Process requirements should also be considered to guarantee a representative measuring point for sensing and for control efficiency.
- For a correct temperature measurement the thermowell/thermometer immersion length must be at least 20 times its diameter (30 times if not MI cable type). Shorter immersion lengths can be specified but the thermometer requires an external (process connection, neck and connection head) thermal insulation.
- Furthermore, if a calibration certificate is requested, the probe design (length and diameter) has to be defined also according to the certification laboratory size requirements.

Pipe installations

(See figure 4 and 5)
In small diameter pipes the most suitable immersion length can often be achieved only by installing the assembly at an angle to the pipe axis or in bends. In this case the inserted assembly must be mounted against the flow.

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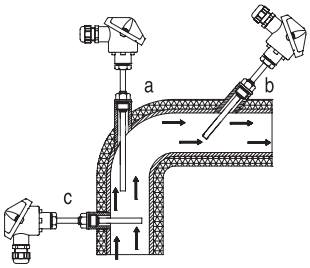


Fig. 4: Pipe installations:
a) at elbows, against the flow
b) in smaller pipes, leant against the flow
c) perpendicular to the flow

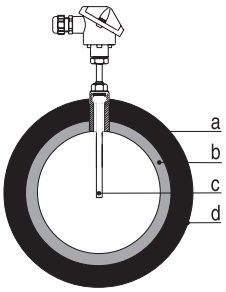


Fig. 5: Thermal insulation examples:
a) insulating material
b) pipe
c) thermowell with insert
d) external plate

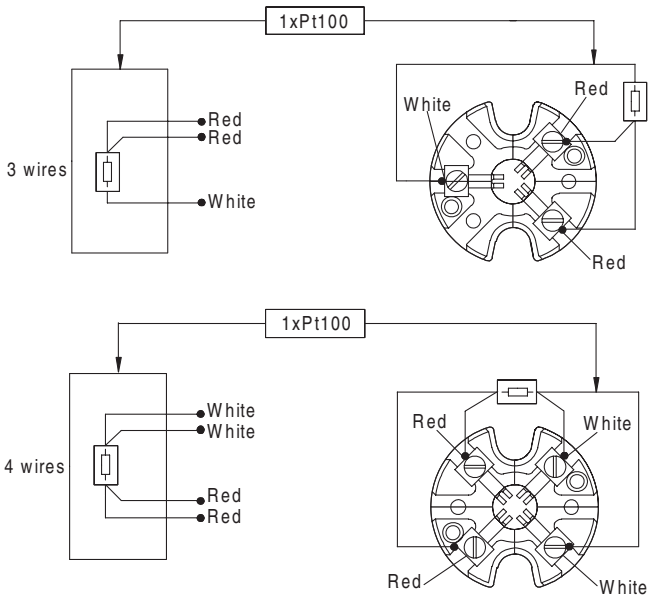
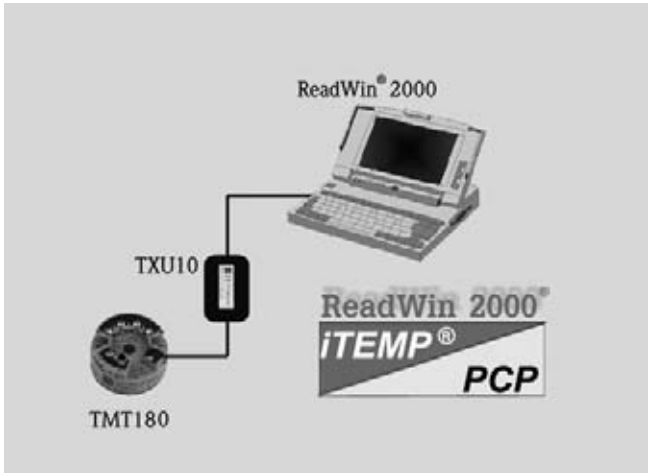


Fig. 6: Internal wiring of Pt100 inserts



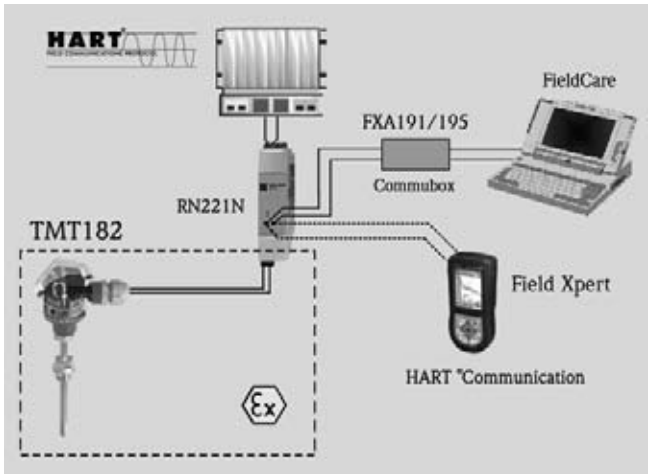


Fig. 7: Device configuration

Internal wiring of Pt100 inserts

According to IEC751, three configurations are possible:

- '2 wire' configuration: This configuration generates an error which equals to twice the resistance of the wire. This configuration is not recommended, except when high nominal resistances (e.g. Pt1000) are in use.
- '3 wire' configuration: This configuration introduces a compensation which reduces the error to approx. zero. This configuration is commonly used in the industry today.
- '4 wire' configuration: Recommended and provided as a standard connection for the single Pt100, this configuration excludes additional errors in every condition. Generally in the '4 wire' configuration there is a higher guarantee of accuracy.

The TPR insert series is available in two basic versions (see fig. 6). The connections of the first one, with free wires for mounting of in-head transmitters, are shown on the left side of the figure, while the connections of the second one, with ceramic terminal block, are shown on the right side of the figure. On the left side, the internal wiring of Pt100 is shown.

Resistances and tolerances IEC 60751 standard

Nominal resistance is the specified resistance value at a given temperature. Thermometers of 100Ω nominal resistance value at 0°C/32°F shall be classified according to degree of conformity with the values of the complete reference table of temperature vs. Ω for Pt100 resistance elements.
Class A and B tolerances are given in the following table. Class A tolerances shall not be applied to Pt100 resistance thermometers at temperatures above 450°C/842°F and it is valid only for 3 and 4 wires thermometers.

Class	Tolerance (°C)
A	0.15 + 0.002 |t|
B	0.3 + 0.005 |t|

Notes:
|t| = modulus of temperature in °C regardless of sign.
Tolerance value for each temperature point can be calculated with the above formula.
Example: class A tolerance value at -50°C = 0.15 + 0.002 x 50 = 0.25°C

Tolerance values vary with the temperature.

We recommend the use of the '4 wire' configuration combined with class A tolerance for high measurement precision.

Device configuration (see fig.7)

- PCP (PC-programmable): Online configuration with TXU10 SETUP connector, socket and ReadWin® 2000 operating software.
- HART: HART signal for on-site or centralized device set-up using the handheld Field Xpert (SFX100) or a PC. Operation, visualization and maintenance at the PC using FieldCare, AMS, PDM or ReadWin® 2000 software.
- FOUNDATION Fieldbus: Operation, visualization and maintenance at the PC using FieldCare or AMS.
- PROFIBUS PA: Operation, visualization and maintenance at the PC using FieldCare, AMS or PDM.

Operations and maintenance

Maintenance mostly consists of periodic calibration. We also recommend that you periodically check (visually) the installation's watertightness.

Thermometer calibration

A calibration means the determination of a deviation compared to a reference that shows a known uncertainty. So when calibrating, the 'right' value of the measurement is predefined by a reference with which the measurement to be calibrated is compared. In the case of thermometers, this happens either at the defined fixed points of the international temperature scale (ITS90) or by

the comparison with a standard reference thermometer. So a redundant sensor cannot replace any calibration, because both measurements may drift and neither of the two sensors are a traceable reference.

An accredited calibration is carried out under strict compliance with national or international norms and guidelines. The normals and gauges used as well as the calibration process and algorithms of the evaluation and measuring accuracy calculation were checked, approved and confirmed in the accreditation authority approval. The compliance is regularly supervised by an accreditation authority by audits and tests. In Europe, the national accreditation authorities have united themselves within the EU (e.g. DKD: Germany, SIT: Italy; SCS: Switzerland) to the EA (European Cooperation of Accreditation).

The factory calibration is carried out dependent on production norms and sets of rules or according to the requirements of the customers. The results are documented in a calibration certificate. All test equipment used is traceable to national/international standards. The measurement accuracy of a device is not influenced by a calibration. On the contrary, during an adjustment (defined on page 8) a measurement device is adjusted and calibrated in such a way that the measurement deviation does not exceed predetermined error limits (defined by the user). The following are part of any adjustment: trim, offset and sensor-transmitter matching.

How often must a thermometer be calibrated? At which intervals is recalibration required?

How often a thermometer should be recalibrated depends on:

- The user's requirements regarding precision.
- Which thermal (maximum temperature, possible thermo shocks, frequent changes of temperature etc.) or mechanical strains (vibrations, jolts etc.) the thermometer will be exposed to.
- Legal requirements.

As we know, RTDs are affected by aging, i.e. their characteristic curve drifts slightly. This drifting is usually particularly marked with new devices, while later on a certain stabilization is observed. Therefore, calibration should be performed more often in the beginning (about every 3–6 months). Later on, having gained experience with the drifting behavior of one special thermometer, the recalibration intervals may be prolonged (about every 9–12 months).

Thermocouples: The user might be recommended (if a particularly high precision of measurement is required) to buy a TC calibrated by us and to recalibrate it theirself, every 2-3 months in the beginning.

If the TC turns out to be stable, after some time the calibration cycles may certainly be prolonged to 9-12 months. It depends entirely on the individual case. After all, drifting is different with every TC, therefore general recommendations regarding calibration cycles cannot be made. If precision is of major importance, the customer will have to monitor the drift theirself and then decide how often the TC needs to be recalibrated – or not.

Note: with nearly all transmitters drift can be compensated via ReadWin® 2000 ('sensor matching').

Spare parts

The insert, the thermowell, the terminal head and the transmitter can be exchanged if necessary.

Migration

You will find detailed information regarding the new generations of temperature sensors in the following table.

Old generation	New	Description	Spare part availability
TST10/TST111/TST221	TR10	RTD sensor	No
TST42	TR24	RTD sensor	No
TST425	TR25	RTD sensor	No
TST11/TST211	TR11	RTD sensor	No
TST12/TST221	TR12	RTD sensor	No
TST13/TST131	TR13	RTD sensor	No
TST140/TST141	TR15	RTD sensor	No
TST288	TR88	RTD sensor	Until 01/2013
TST44N	TR44	RTD sensor	No
TST14	TR45	RTD sensor	No
TST74	TR47	RTD sensor	No
TST76	TR48	RTD sensor	No
TST262	TR62	RTD sensor	No
TST264			Until 01/2013
TST266	TR66	RTD sensor	Until 10/2013
TET100	TPR100	RTD sensor, measurement insert	No
TET102			No
TET105			No
TSC110S	TC10	Thermocouple	No
TSC130S	TC13	Thermocouple	No
TSC140T	TC15	Thermocouple	No
TSC288	TC88	Thermocouple	No
TSC262/TSC264	TC62	Thermocouple	Until 10/2012
TSC266	TC66	Thermocouple	Until 10/2012
TEC100/TEC105	TPC100	Thermocouple, measurement insert	No
TMT136/TMT137	TMT180	Head transmitter	No
TMD831	TMT181	Head transmitter	No
TMD832	TMT82	Head transmitter	No
TMD834	TMT84	Head transmitter	No
TMT184	TMT84	Head transmitter	No
TMD842	TMT112 TMT122	Transmitter DIN rail transmitter	No
TMD833	TMT162	Field transmitter	No
TMT165	TMT162	Field transmitter	No
TMT165	TMT85	Head transmitter	No
TMT182	TMT82	Head transmitter	No
TMD833T	TMT162R	Compact thermometer, RTD sensor and field transmitter	No
TMD833C	TMT162C	Compact thermometer, thermocouple and field transmitter	No
TA10	TW10	Thermowell	No
TA11	TW11	Thermowell	No
TA12	TW12	Thermowell	No
TA13	TW13	Thermowell	No
TA573/TA574	TW15	Thermowell	No
TA250	TW251	Thermowell	No

Note: these dates are periodically updated on www.endress.com

Table 1: Instrument and spare parts availability

Re-engineering

Want to use an instrument for a new application? We can help you check the relevant parameters. See our online Applicator tool.
https://wapps.endress.com/applicator

Frequently asked questions

The PLC doesn't display the right temperature value…

- Check the Pt100 signal using an Ohmmeter.
- Thermocouple:
  - Is the right thermocouple selected?
  - Is the right temperature for the reference junction used?
  - Is the right extension or compensating cable used?
- Ensure that both 4-20mA ranges of the transmitter and the PLC correspond.
- Check or calibrate the thermometer.
- Check the installation (see fig. 4 and 5 on the previous pages).

I have no communication to the transmitter from Readwin® 2000…

- Ensure that your transmitter can communicate.
- Is the latest version of Readwin® 2000 installed in the PC? You can download it from www.readwin2000.com
- Ensure that the power supply is min. 9 V for TMT181 and TMT121.
- For TMT82, TMT112, TMT122 (HART), TMT142, TMT162 (HART) and TMT182 (HART), switch of the 'FIFO active' setting. In order to do this proceed as follows:
  - Windows NT® Version 4.0:
    Using the menu 'START'/'SETTINGS'/'SYSTEM CONTROL'/'CONNECTIONS' select the menu point 'COM-Port'.
    Switch off the 'FIFO active' command off using the menu path 'SETTINGS'/'EXPANDED'.
  - Windows® 2000:
    Select 'Advanced settings for COM1' from the 'START'/'SETTINGS'/'SYSTEM CONTROL'/'SYSTEM'/'HARDWARE'/'DEVICE MANAGER'/'CONNECTIONS (COM and LPT)'/'COMMUNICATION CONNECTION (COM1)'/'CONNECTION SETTINGS'/'ADVANCED' menu. Deactivate 'Use FIFO buffer'.
  - Windows® XP:
    Select 'Port settings' from connections Port (Com 1)/'START'/'SETTING'/'SYSTEM'/'HARDWARE'/'DEVICE MANAGER'/'PORTS (COM and LPT)'/'COMMUNICATION PORT (COM1)'/'PORT SETTING'/'ADVANCED' menu.
    Deactivate 'Use FIFO buffer'.
- For TMT82/112/122/142/182 (HART products) and TMT162 (HART version only), ensure that the load resistance at the Commubox's terminals equals 250Ω. If the loop is overloaded (due to the PLC's impedance or the presence of a recorder) the load resistance can be much higher thus reducing the signal's intensity.
- You are using TXU10:
  - Is the USB driver installed in the PC? The driver is stored on the Readwin® 2000 CD-ROM. You can download the latest version from www.readwin2000.com
  - To install the driver you need 'admin' rights on your PC.
  - Also take care of the selected communication port:
    From Windows®, 'START'/'CONTROL PANEL'/'SYSTEM'/'HARDWARE/'DEVICE MANAGER'/'PORTS'
    From this window, use the port number that corresponds to the connected communication interface (FXA195 if you are using a HART modem).

Recorders

The advantages of paperless recorders

Today, maintenance of strip chart recorders is considered too high. The need for many consumables (paper and pens) and the fact that data isn't stored electronically are a real inconvenience in the process world.

This is why electronic (paperless) recorders have rapidly become very popular. Whereas the first generation stored the data on diskettes, the new range uses Compact Flash or Secure Digital cards for even more reliability and storage capacity.

As paperless recorders are maintenance-free, in the following pages we focus on suggestions for improved operation.

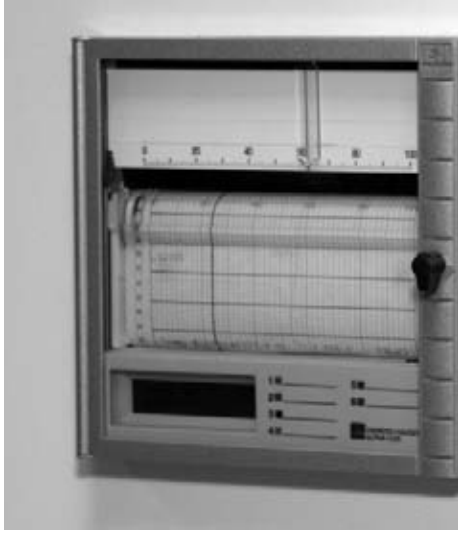
Nevertheless paper recorders still constitute a pretty large part of the market and Endress+Hauser will keep providing consumables for its recorders.

As experts, we also offer training sessions, in classroom and on site. See 'Training' in the 'At your service' section.

Contents

Basics

Information common to any type of modern recorders



The current Endress+Hauser range of recorders includes:
- **Ecograph T RSG30 multi-channel electronic (paperless) recorder**
- **Memograph M RSG40 system compatible data manager with a unique safety concept for critical applications. Compliant with the high FDA requirements laid down in 21 CFR Part 11.**

Measuring principle and main features

The electronic recorders carry out the electronic acquisition, display, recording, analysis, remote transmission and archiving of analog and digital input signals.

Communication
- Communication interfaces available: USB, RS232, RS485, Ethernet, PROFIBUS DP and MODBUS (RSG40)

Input/Outputs
- Galvanically isolated universal inputs (U, I, TC, RTD, frequency and pulse < 10kHz)
- Digital input (high/low)
- Digital output (relay)
- Mathematical channels for calculations

Display of measured values
- Electronic recorders are easy to program via the 'Set up' window or from a PC
- Display of historical data on site
- Display of statistics
- Various display modes

Memory (fig.1)
- Redundant memory ensures safe data recording: internal Flash memory + CF (CompactFlash)(RSG30) or SD (Secure Digital) cards and USB stick + data transfer to a PC (RSG40).

Note: Please use the original memory cards from Endress+Hauser, as these are industrially proved.

Analysis/archiving
- Long-term archiving is carried out at the PC, whereby the data is transferred to the database, via Ethernet or serially to the PC.
- Using the supplied PC software package, the devices can be operated, read-out and the measurement data can be archived and visualized.

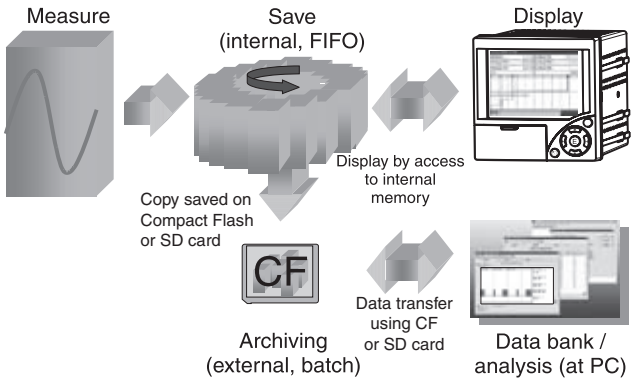


Fig. 1: Measuring system on new generation recorders

- New generation (RSG30/ RSG40): To achieve and analyze a higher amount of data, we recommend the FDM software (Filed Data Manager) that supports a SQL database.

21 CFR 11
- Memograph M together with ReadWin® 2000 fulfill the requirements of 21 CFR 11 concerning electronic documents and electronic signature.

Installation instructions

Installation
The front side seal should be correctly positioned to ensure watertightness and avoid any problems due to condensation.

The rear should also be protected against humidity.

Electrical connection
- Please cable the unit with care. Many reported errors come from wrong connections. We remind you that the terminal diagram is printed on the rear of the recorder.
- Please use shielded cables.

Surge arrester
We recommend the use of surge arrester(s) (HAW56x family) to protect the instrumentation against overvoltage.

Setup

Setup can be performed at the unit by using the 'Set up' window at main menu. However, set up using a PC is much simpler.

Setup using a PC
You can use the PC software ReadWin® 2000 provided with the device to put the device into service / configure it via PC.

You can also download the latest software version directly from the internet under the following address: www.readwin2000.com
For further information on ReadWin®2000, refer to the operating manual of the software (BA137R/09).

Advantages of configuration via PC:
- The device data is saved in a database and can be accessed again at any time.
- Text entries can be carried out more quickly and efficiently by keyboard.
- Measured values can also be read out, archived and displayed on the PC with this program.

Operations and maintenance

Electronic recorders are maintenance-free.

Using the 'screensaver' mode increases the display's lifetime.

Tips for safe and comfortable operation
- Use Readwin® 2000 to analyze and print the recorded data. Note: the operating instructions documentation related to Readwin® 2000 is available on the accompanying CD.

- Use the 'Safely remove CF/SD/USB' function (on Ecograph T and Memograph M) to ensure safe removal of the memory card: all internal access is ended and you receive a message when the card can be safely removed. To prevent possible loss of data, this function must be the only method used to remove the card.

Data transfer to the PC (see fig.2)

We recommend to periodically transfer the recorded measured data and the configuration data to a PC. Data can be transferred to the installed PC software in one of the following ways:

- Using USB, RS232/485 or Ethernet. Communication and download of data to PC using the function 'Read out -> Read measured values using interface/Modem'.
- Save the data to CompactFlash in the unit using the function: for RSG40 'Extras -> SD Card -> ...' or 'Extras -> USB Stick -> ...', for RSG30 'Main menu -> CompactFlash (CF) functions -> Update CF'
  Now insert the memory card into the PC and read the data using the function 'Read out -> Read out measured values using PC card drive'.
- Read out the memory card with the PC software: in principle the values can be read out directly from the memory card. The connection to the unit is made by RS232/RS485, Ethernet or USB. Start the provided PC software. Select 'Read out -> Read out memory card by interface/modem'. Select the appropriate unit from the PC database. Select 'Unit -> open unit(s)'. The connection is established. Select the appropriate file on the memory card and confirm with 'OK'. The measured values are read out. The measured values remain on the memory card.

We recommend the following procedure for saving data:

- Always have a memory card inserted
- Periodically read out the memory card with the PC software
- Protect access to the recorder's configuration via your personal code or a password (21 CFR 11) to prevent unintentional modification.

Note: the data on the memory card is compressed (10 to 1).

Calibration

Calibration must only be carried out by skilled and trained personnel. Malfunctions are possible if calibration is not performed correctly!

Spare parts stock

We recommend to keep a power supply board in stock if you have no surge arrester installed to protect the instrumentation.

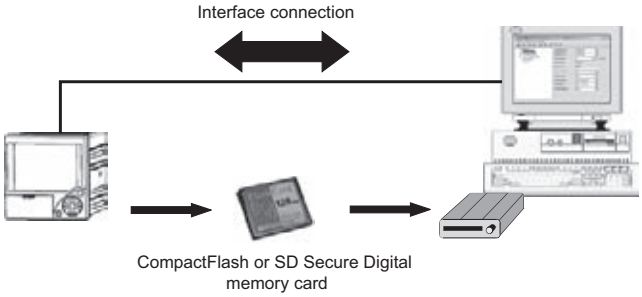


Fig. 2: Data transfer to the PC

Migration

The shift to electronic recorder offers many advantages:

- Economical: electronic recording replaces strip chart recorder, saves on consumables
- Versatile: up to 6 (RSG30) or 20 (RSG40) universal inputs record all measuring signals
- Clear layout: multi-colored display, digital, bargraph and curve display
- Compact: low installation depth, saves space and money
- Safe: reliable data archiving with internal memory and separate memory card (mechanically locked) on the recorders. No data loss even in the event of power failure!
- Communication interfaces: see table 1 (next page)
- Available worldwide: integrated web server function for remote monitoring e.g. with Endress+Hauser Fieldgate Viewer®
- Reliable: inputs are galvanically isolated from the system
- Complete: ReadWin® 2000 PC software package delivered with the recorder for professional, tamper-proof data processing
- Flexible: direct access to archived data also with MS® Excel or in ReadWin® 2000 for example

Re-engineering

Want to use an instrument for a new application? We can help you check the relevant parameters. See our online Applicator tool.
https://wapps.endress.com/applicator

Recorder	USB	RS232	RS485	Ethernet	PROFIBUS DP	MODBUS RTU	MODBUS TCP	MODBUS Master RS485
Ecograph T RSG30	■	■	■	■				
Memograph M RSG40	■	■	■	■	■	■	■	■

Table 1: Communication interfaces available

Old generation	New	Description	Spare parts availability
RSG12	RSG40	Paperless recorder	Until 01/2017
RSG20	RSG30	Paperless recorder	Until 01/2013
RSG22	RSG30	Paperless recorder	Until 01/2013
RSG24	RSG40	Paperless recorder	Until 01/2013
RSG10	RSG40	Paperless recorder	Until 01/2014

Note: These dates are periodically updated on www.endress.com

Frequently asked questions

How to start with Readwin® 2000? (see also BA137R)
- Create a unit 'Group/plant'
- 'Unit\Display/Change unit setup/Add new unit\Unit group plant'

How to insert and configure the unit? (see also BA137R)
- 'Unit\Display/Change unit setup/Add new unit\Unit\ Add new unit'

How to store and display measured values on the PC?
There are two ways to read out data:
- Via the Compact Flash card
  Click 'Read out/Read out measured values using PC card drive' then 'New unit' and give it a name. Data will then be transferred.
- Via the interface
  Click 'Read out/Read out measured values using interface/modem' then 'New unit' and give it a name. Data will then be transferred.

To display the data, click 'Display/Display measured values from database'
Choose the unit to be displayed, then the data timescale etc.

How to export data from Readwin® 2000 to Excel®?
- To display the data, click 'Display/Display measured values from database'
  Choose the unit to be displayed, then the data timescale etc.
- Click 'Tabular' at the bottom left of the screen then click on the 'Display' tag at the top left then choose 'Save table' (choose .txt or .xls file format)

How long can we store measured values on the external and internal memories?
Please refer to your device's operating instructions.

The display of the % of external memory is not correct after read out to a PC…
The displayed percentage will be refreshed after the first new memory block is sent to the external memory.

I have no communication via USB to the recorder…
- Is the USB driver installed in the PC? You can download the latest version from www.readwin2000.com
- To install the driver you need admin rights on your PC
- Also take care of the selected communication port: From Windows®, 'START'/'CONTROL PANEL'/'SYSTEM'/'HARDWARE/'DEVICE MANAGER'/'PORTS'
  From this window, use the port number that corresponds to the connected communication interface (FXA195 if you are using a HART modem).

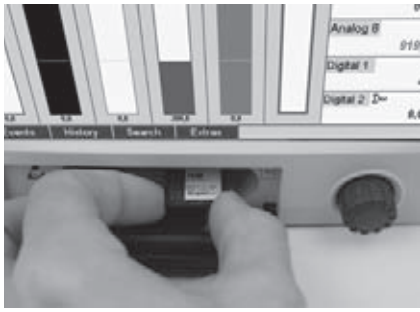
Will the database of measured values be deleted after an update of Readwin® 2000?
No.

Will the configuration and the measured values be deleted after a software update of the unit?
Yes. Please read out and save data before.

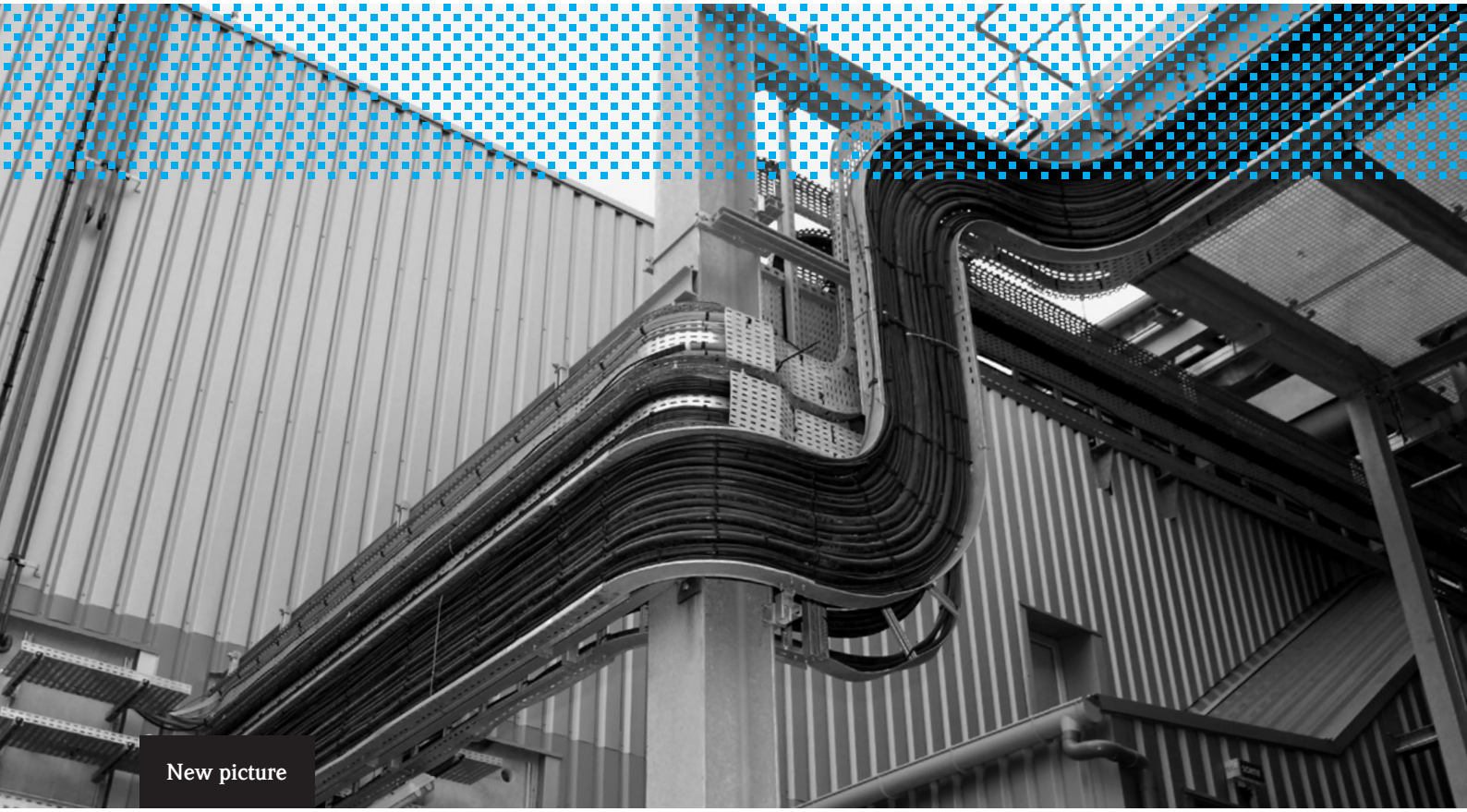
Can I define different levels of user rights in Readwin® 2000?
Yes: 'Extras\Program options\Set-up\Security\Password protection' must be activated.

The terminals on the rear side of the unit are missing…
Only the terminals that correspond to the options you have ordered are delivered.

Installation of the operating software
Please do not install the operating software in the 'Program' folder if you have only restricted admin rights. Install the operating software e.g. under C:\ReadWin32



Field communication



An introduction to the maintenance of fieldbus networks

The use of digital communication and fieldbus networks provides many advantages for maintenance.

Digital instrumentation allows simultaneous, bidirectional exchange of data with controllers and computers. Once the instruments have been installed, they can be parametrized remotely, from a workshop, a control room or at any point in the network with a laptop – very convenient in the case of hazardous environments or difficult access. This is even easier since WirelessHART devices are available.

For troubleshooting, the diagnosis can also be performed in the same way, even over long distances, thanks to gateways or modems.

We have issued 'Guidelines for planning and commissioning' for both PROFIBUS and FOUNDATION Fieldbus networks. For further details, please refer to Operating Instructions manuals BA034S (PROFIBUS) and BA013S (FOUNDATION Fieldbus). You can download these documents from our website.

As experts, we also offer training sessions at our training center or on site. We will be glad to meet you and help you improve your knowledge of digital communication. See 'Training' page in the 'At your service' section.

Video about FDT available at www.endress.com/videos

Contents

Networks using the HART protocol

46%* of the 69.2 million devices installed worldwide by the end of 2010 were HART-enabled devices. As a result, HART (Highway Addressable Remote Transmitter) is a global industrial standard with an installed base of 32 million devices* in 2010.

HART is a smart technology, i.e. it supports simultaneous communication over two channels on the same wire including power supply for the devices:

- An analog 4-20mA signal ensures the fastest possible data transfer of control signal
- HART digital signals provide for read/write access to all device data

Typical architectures

HART is a master-slave protocol for point-to-point and multidrop communication. Several architectures are possible to meet all kinds of requirements (see Fig. 1 from left to right):

- Point-to-point parametrization and diagnosis via Field Xpert
- Point-to-point asset management using FieldCare
- Point-to-point or centralized parametrization and diagnosis via multiplexer using Field Xpert (with WLAN or Bluetooth connection) or FieldCare
- Centralized plant asset management via remote I/O (with DTM) using FieldCare
- Centralized plant asset management via Fieldgate FXA520 (for remote access) using FieldCare

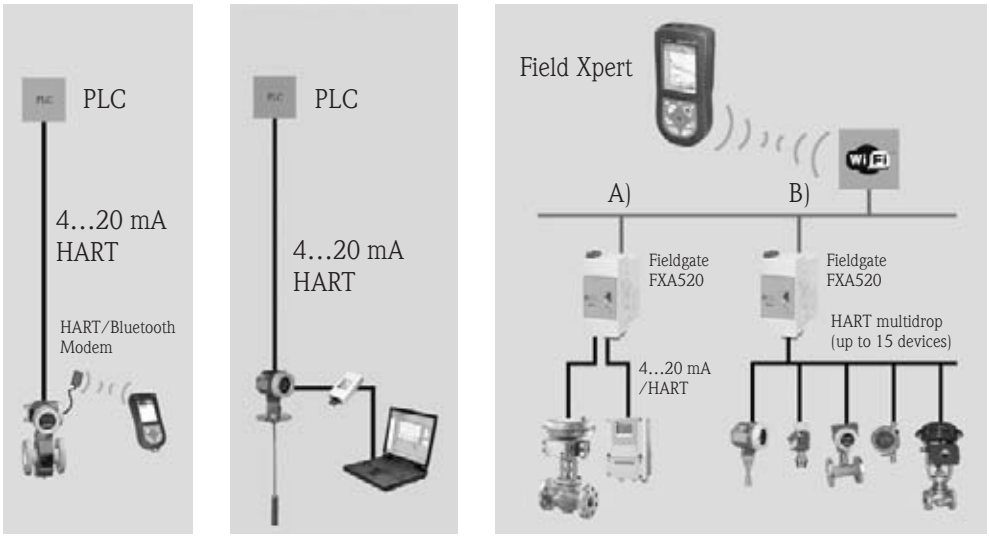


Fig. 1: Typical HART architectures

System integration

HART determines how data is to be presented and transferred between master and slave. Three command classes are defined:

- Universal commands offer a basic set of functions and are supported by all HART instruments.
- Common practice commands offer functions that are optional but that are supported by many HART instruments.
- Manufacturer-specific commands are for proprietary functions not covered by the HART specification, e.g. linearization, advanced diagnosis functions, etc.

Burst mode

Some HART devices support the optional burst communication mode. Burst mode enables faster communication (3–4 data updates per second). In burst mode, the master instructs the slave device to continuously broadcast a standard HART reply message (e.g., the value of the process variable). The master receives the message at the higher rate until it instructs the slave to stop bursting.

Frequency shift keying

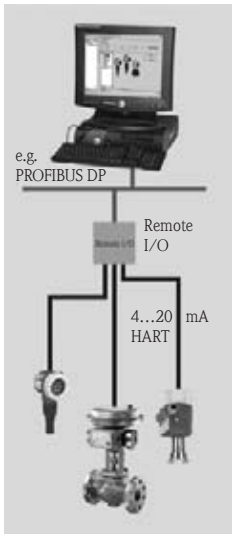
The HART communication protocol is based on the Bell 202 telephone communication standard and operates using the frequency shift keying (FSK) principle. The digital signal is made up of two frequencies – 1,200Hz and 2,200Hz representing bits 1 and 0, respectively. Sine waves of these two frequencies are superimposed on the direct current (DC) analog signal cables to provide simultaneous analog and digital communications. Because the average value of the FSK signal is always zero, the 4–20mA analog signal is not affected. The digital communication signal has a response time of approximately 2–3 data updates per second without interrupting the analog signal.

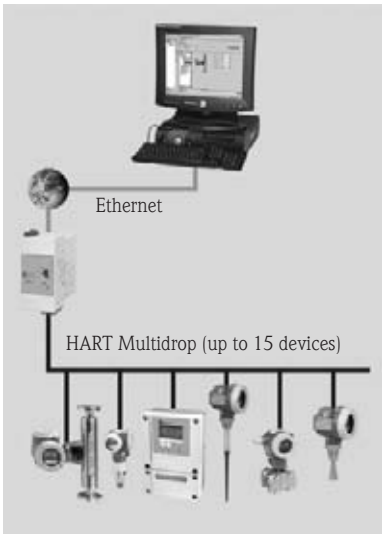
Basic parameter set

Thanks to the common practice commands, all HART devices offer a basic parameter set that ensures interchangeability and fulfils the requirements for process control and asset management. The parameters include:

- Device identification (device tag, supplier, device type and revision, device serial number).
- Calibration data (upper and lower range values, upper and lower sensor limits, process value damping, last calibration date).
- Process variables (primary variable plus secondary measurements and multi-variable parameters).

* According to a recent study by the ARC Advisory Group
For more information on HART® technology, please visit: www.hartcomm.org





Device Descriptions (DDs)
HART uses DDs to describe the parameter set carried by the device to the HART master. Device configuration tools use either DD or FDT technology, both based on the original HART DDs.

Electronic Device Description
EDDs are the successors of DDs and are used in Asset Management Solution (AMS), Process Device Manager (PDM), 375 Field Communicator and other DD supported applications. In the future, Field Xpert will also support enhanced graphics in the Device Description. Endress+Hauser provides EDDs for all its devices and also supports their integration in Emerson AMS and Siemens PDM applications.

Field Device Tool
Field Device Tool provides protocol-independent operation of digital field devices. It maps all device functions, including advanced diagnostics such as Time of Flight envelope curves.

The information is contained in a Device Type Manager (DTM), a software module that runs in a FDT frame application, e.g.:
- FieldCare
- Yokogawa FieldMate
- PACTware
- ABB Composer, Control Builder, Fieldbus builder, etc.
- Invensys I/A Series
- Other FDT frame applications

Endress+Hauser fully supports FDT technology and offers DTMs for all Endress+Hauser devices.

Installation instructions

Standard 4-20mA cables are used. A minimum loop impedance of 250Ω is required for digital communication.

Set-up

Device Parametrization using FieldCare
FieldCare supports HART e.g. via Fieldgate FXA520, via FXA195 HART/USB modem or via a HART remote I/O or multiplexer with CommDTM. It can configure all intelligent field devices in your plant, including devices without a native DTM and supports you in managing them. By using status information, it also provides a simple but effective means of checking their health. FieldCare ensures that devices can be integrated and configured quickly and easily, with the transparency demanded by Good Manufacturing Practice.

Nested communication with iDTM-HART
Currently there are two different technologies for device integration available: FDT/DTM (Field Device Tool/Device Type Manager) and EDDL (Electronic Device Description Language). iDTM-HART (interpreter Device Type Manager) combines both technologies effectively and allows the integration of HART devices in FieldCare that have no appropriate DTM at hand. HART devices from about 90 manufacturers are supported so that you can choose the best device for your application.

iDTM-HART is handled in FieldCare as any other DTM

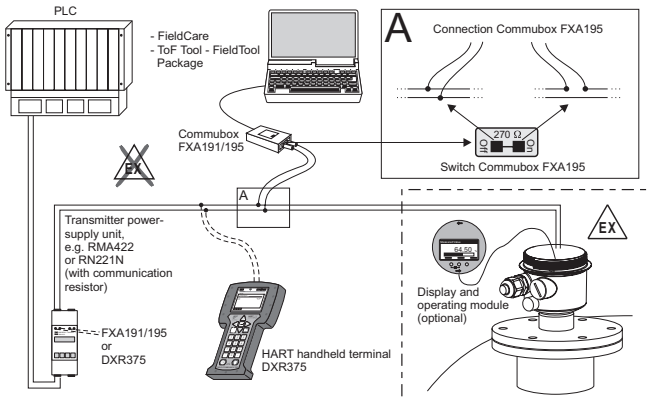


Fig. 2: The measuring system.
The communication resistor (270Ω) integrated in the Commubox FXA195 (see A) should not be connected in parallel to a power supply point greater than 15V. If the communication resistor is used, it should always be looped into the 4-20mA circuit.

and available within seconds in online mode. It is based on an EDD (Electronic Device Description) interpreter of the HART Communication Foundation (HCF) and contains over 600 registered HART EDDs of the HCF Library, which is updated regularly.

iDTM-HART combines basic device functionality with the familiar DTM user interface. EDD-based devices can use nested communication thanks to FDT.

Device parametrization using Field Xpert
Every parameter is easy to find and to configure. If the location of a specific function is unknown, the integrated Function Finder locates it in all HART devices. This is especially useful with complex devices with many parameters.

More information on FieldCare at:
www.automation.endress.com/fieldcare

More information on Field Xpert on page 107.

Our service organization can set up any Endress+Hauser device for you to ensure you immediately get the best from your instrument.
(See **'Device commissioning'** in the 'At your service' section).

Operations and maintenance

As the HART signal modulates the 4-20mA current, if the latter operates, the former should also operate. You just need to check the presence of the current with a multimeter.

Device Xpert offers the range of diagnosis supported by the Device Description (DD). Basic information such as device status can be seen at a glance, making diagnosis easy.

Diagnosis

If you are facing a problem during commissioning or troubleshooting of a HART device, you can solve it as follows:

- By using a Commubox FXA195, you should see the instrument from FieldCare, otherwise there is a problem with the cabling.
- Ensure that the load resistance at the Commubox's terminals equals 250Ω. If the loop is overloaded (due to the controller's impedence or the presence of a recorder) the load resistance can be much higher thus reducing the signal strength.
- Switch off the 'FIFO active' setting. In order to do this, proceed as follows:
  - Windows® XP:
    Select 'Port settings' from connections Port (Com 1)/'START'/'SETTING'/'SYSTEM'/'HARDWARE'/'DEVICE MANAGER'/'PORTS (COM and LPT)'/'COMMUNICATION PORT (COM1)'/'PORT SETTING'/'ADVANCED' menu. Deactivate 'Use FIFO buffer'.

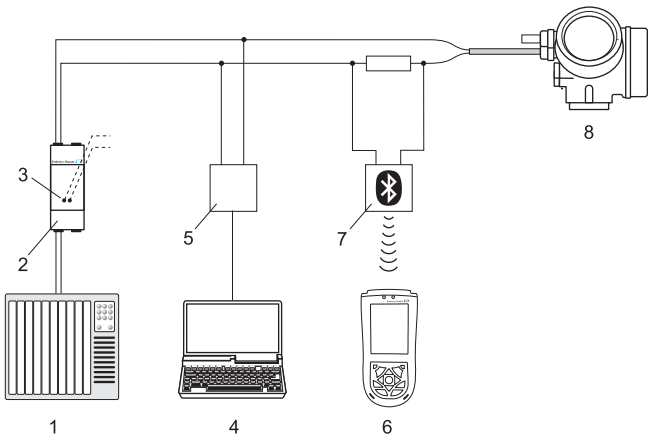
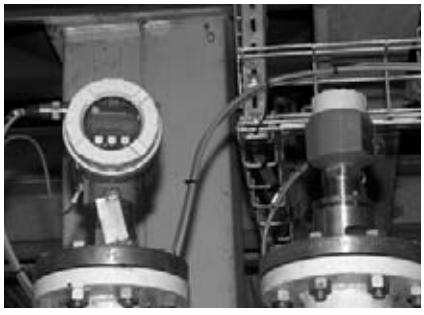


Fig. 3: Options for remote operation via HART protocol
1 PLC (programmable logic controller)
2 Transmitter power supply unit, e.g. RN221N (with communication resistor)
3 Connection for Commubox FXA195
4 Computer with operating tool (e.g. FieldCare, AMS Device Manager, SIMATIC PDM)
5 Commubox FXA195 (USB)
6 Field Xpert SFX100
7 VIATOR Bluetooth modem with connecting cable
8 Transmitter

- Also take care of the selected communication port:
  From Windows®, 'START'/'CONTROL PANEL'/'SYSTEM'/'HARDWARE/'DEVICE MANAGER'/'PORTS'
  From this window, use the port number that corresponds to the connected communication interface (FXA195 if you are using a HART modem).
- Check the minimum voltage required for your HART communicating transmitter(s); the voltage (usually 16V) is related to the device.
- Make sure you have the right DD / DTM installed in your configuration software

Re-engineering

Our 'Projects' teams can help you from the start of your revamping project. Please contact us.



WirelessHART

WirelessHART is the wireless standard of the HART Communication Foundation for use in process automation. It adds wireless capabilities to the HART protocol while maintaining compatibility with existing HART devices, commands and tools.

WirelessHART protocol

The HART protocol has until now used the wired 4-20mA loop with a superimposed digital signal as as physical layer. Although full digital communication is available in multidrop mode, the majority of transmitters are connected to analog I/O cards and digital communication is used only for parametrization, diagnosis and maintenance purposes.

WirelessHART now allows for the wireless transmission of HART data. For worldwide use, WirelessHART utilizes the 2.4GHz Band (IEEE 802.15.4 wireless network) as physical layer. The WirelessHART devices form a mesh network in which every device is not just a measurement point, but also a repeater. This results in a wider range for the whole network as well as increased reliability through redundant communication paths.

A WirelessHART network comprises (see fig. 4):

- Wireless field devices
- Non-wireless field devices enhanced by using a WirelessHART adapter
- Gateways that enable communication between devices and host applications
- Network and Security Manager software responsible for configuring, managing and monitoring the network

The Endress+Hauser solution includes a gateway and an adapter (see next page).

The Fieldgate SWG70 is the master device in the WirelessHART network. Acting as network manager, it recognizes other devices wanting to join the network. It makes contact with each in turn and initiates the procedures required for them to join. The network organizes itself without any intervention on the part of the user.

Fieldgate SWG70 also acts as security manager.

Finally and most important, it collects the data sent by the network participants, converting it into a form which can be used by other systems connected to it.

Installation instructions

Positioning

Please consider the following points when planning a WirelessHART network:

- The positioning is good when the network participants are within the antenna's emission angle (see fig. 5).
- The most power is in the horizontal plane, decreasing to 50% at an angle of 39°. Almost no signal will be radiated directly above and below the antenna.
- The height differences between wireless devices in a network should not be too big.
- The schematic is valid only for an antenna placed outdoors with no metal surfaces nearby.

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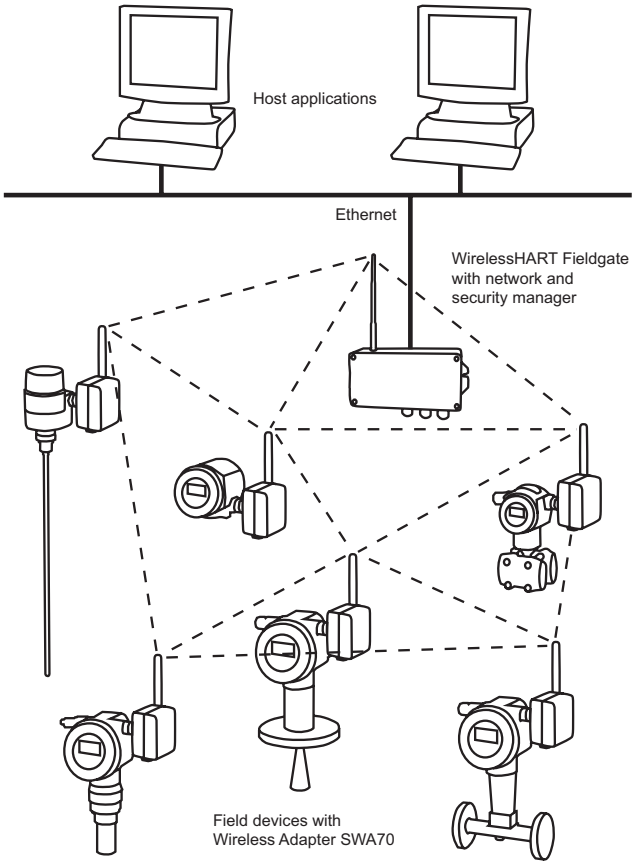


Fig. 4: WirelessHART network
The network may comprise three types of devices:

- WirelessHART gateway (e.g. Fieldgate SWG70)
- WirelessHART field devices
- WirelessHART adapters (either connected to 4-20mA/HART devices or acting as repeaters)

In a mesh network, all devices communicate with each other, allowing alternative communication paths should the shortest path be broken.

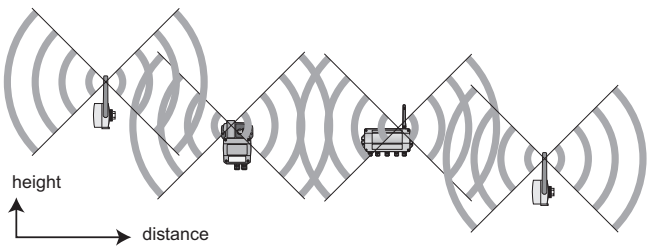


Fig. 5: Good positioning

For more information on WirelessHART technology, please visit: www.hartcomm.org

Set-up

There are two ways to set up Fieldgate SWG70: via web server or via FieldCare. The Fieldgate SWG70 has an integral web server that can be used to set up and monitor both the SWG70 and the network. The structure of the parameter blocks and parameters is identical to that of the Fieldgate SWG70 DTM. Connection to the web server is established via an internet browser.

FieldCare Setup via FieldCare differs from the web server in that it is also possible to parameterize the WirelessHART adapter SWA70 as well as any connected HART devices. A prerequisite is that the field devices already have the same join key and network identifier as the Fieldgate SWG70 and have joined the network. Attached devices can be configured via their DTMs.

For more information, please refer to WirelessHART Fieldgate SWG70 Operating Instructions (BA064S).

Operations and maintenance

Network optimization

a) Verify connections:
Check that each device has joined the network and is communicating properly. If you cannot establish a connection to a device, the device is probably too far away or an obstacle blocks the radio waves. In this case, add an additional device to bridge the gap.

b) Make sure that each device has a minimum of two neighbors.

c) Eliminate bottlenecks:
If all messages sent by several devices have to pass through a single device to get to the gateway, the network has a bottleneck. This means that if this device fails, whole parts of the network get cut off from communication because there is no alternative path to route messages. To eliminate a bottleneck, add at least one device near the bottleneck to provide redundant communication paths (see fig. 6).

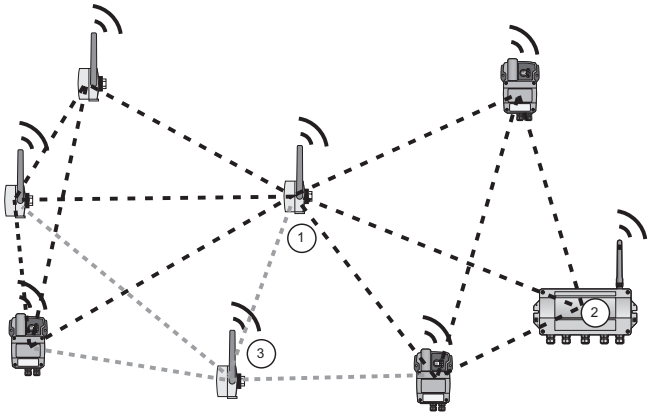


Fig.6: Eliminating a bottleneck by adding a device
1 Device situated at a bottleneck
2 Fieldgate
3 Additional adapter adds alternative routes

WirelessHART solutions from Endress+Hauser

Endress+Hauser WirelessHART solutions allow users to make a quantum leap in plant availability and transparency.

WirelessHART adapter

The WirelessHART adapter SWA70 is a battery-powered interface module that connects HART and 4-20mA devices to a WirelessHART network.

Features and benefits

- HART devices quickly upgraded to WirelessHART technology
- One 4-20mA or up to four HART devices can be connected (in multidrop mode) to one adapter
- Burst mode and event notification supported for adapter and connected devices
- Remote and difficult-to-access HART devices connected to the plant control room without expensive cables
- Tanks and silos integrated at minimal cost into e.g. SupplyCare Inventory Control software
- Endress+Hauser and third party devices maintainable with open FieldCare Plant Asset Mangement software
- Network configuration also done within FieldCare Plant Asset Management software
- Supports configuration with FDT and DD-based network tools

WirelessHART fieldgate

The Fieldgate SWG70 serves as a gateway device for WirelessHART networks. It enables WirelessHART devices to communicate with each other and manages security and connectivity. Fieldgate converts and stores wireless device data in a format that is compatible with other systems. It has Ethernet and serial interfaces for connection to host applications such as SCADA tools.

Features and benefits

- Gateway, network manager and network access point capabilities according to the WirelessHART specification: works with all WirelessHART adapters and devices
- RS-485 and Ethernet interfaces with support of HART and Modbus: network data easily integrated into existing system
- Configuration and parameterization via FDT/DTM, EDDL or a web interface: clear presentation of network, measured values and diagnosis information
- Local or remote antenna options: easily adapted to local installation conditions

PROFIBUS DP/PA networks

With more than 40 million devices installed at the end of 2010 and with over 5.4 million of these in the process industries, PROFIBUS has established itself as the leading communication technology in the field of process automation. PROFIBUS can be used in all industrial automation applications: process automation, factory automation, motion control and safety.

The technology was introduced in the early 1990s and has been developed continuously ever since. PROFIBUS DP and PROFIBUS PA technologies are specified in the international standards EN 50170 and IEC 61158 and are suitable for replacement of discrete and analog signals in control systems.

Typical PROFIBUS DP/PA architecture (Fig. 7)

The process is controlled by a process control system or a programmable logic controller (PLC). The control system or PLC serves as a Class 1 master. It uses the cyclic services to acquire measurements and output control commands. The asset management program, e.g. FieldCare, serves as a Class 2 master. It uses the acyclic services and serves to parameterize the bus participants during installation and normal operation.

The PROFIBUS DP system is used to handle the communication at the control level. Drives, remote I/Os, etc may all be found on the bus. At this level, field devices such as Promass and Promag flowmeters are externally powered.

PROFIBUS DP ensures that data is quickly exchanged, whereby in mixed PROFIBUS DP/PA systems the baud rate supported by the segment coupler can be a limiting factor.

PROFIBUS PA is used at field level. A segment coupler or link serves both as interface to the PROFIBUS DP system and as power supply for the PROFIBUS PA field devices. Depending upon the type of segment coupler, the PROFIBUS PA segment can be installed in safe or hazardous areas.

PROFIBUS PA and DP have the same communication protocol.

Transmission standards

PROFIBUS supports three different transmission technologies: RS485, fiber optics and MBP (Manchester Coding/Bus Powered). Both RS485 and MBP make provision for intrinsically safe transmission in hazardous areas.

The maximum length of a DP network ranges from 1200m (copper, RS485) to several kilometers (fiber optics) for a transmission rate range from 9.6 kBit/s to 12 MBit/s. The maximum length of a PA network using MBP (Manchester Coding/Bus Powered) is 1900m in a safe area and 1000m in a hazardous area. The transmission rate is 31.25 kBit/s.

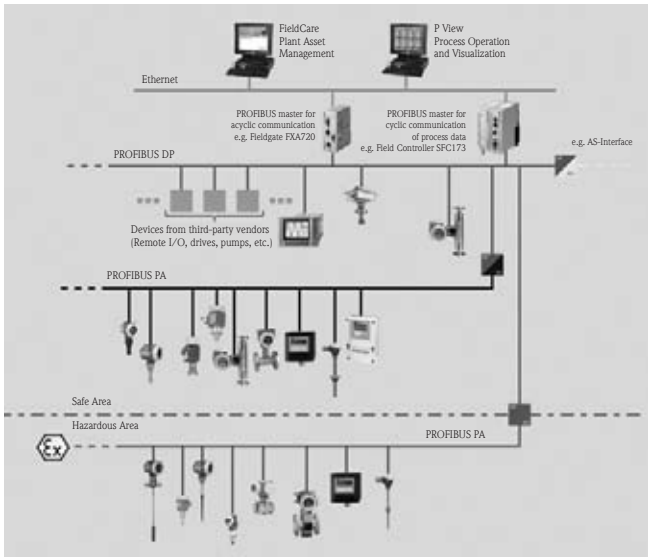


Fig. 7: typical architecture of a Profibus DP/PA network

System integration

Devices are integrated into a PROFIBUS network using two files:

- General Station Data file (GSD): describes the communication behavior and supported features of a PROFIBUS device. The GSD file includes the format of input/output data that may be exchanged cyclically between the device and the master as well as diagnostic data as plain text*.
- Electronic Device Description (EDD): is used in parametrization or in asset management tools to adjust the device. The EDD contains information on the device parameters.

Where an FDT-frame is used for acyclic configuration of the device, another type of file is used:

- Device Type Manager (DTM): is a software component used for accessing specific functions of a field device via a user interface, for parametrization, diagnosis and maintenance of the device as well as for the integration in FDT engineering tools or control systems.

Installation instructions

PROFIBUS is considered a very robust way of communication. Nevertheless, wiring, cabling and shielding is a crucial part of the installation and as every form of digital communication, this has to be performed carefully.

For more information, you can download our 'Guidelines for planning and commissioning Profibus DP/PA field communication' (ref. BA034S) from www.endress.com
* GSD files may be downloaded from www.endress.com

For more information on PROFIBUS technology, please visit: www.profibus.com

Cabling
When installing a PROFIBUS network, particular attention must be paid to the cabling. This covers both choice of cabling and the way in which the cables are laid in the plant. By careful routing, e.g. avoidance of potential sources of intense electromagnetic interference, use of metal trays or separation of power and bus cables in the cable tray, a significant contribution can be made to the fault-free running of the bus.
Note: never use PROFIBUS DP cables for cabling PA devices and vice versa.

Termination (PROFIBUS PA)
The start and end of every PROFIBUS PA segment must have a bus terminator. For non-hazardous areas, some T-boxes have an integrated terminating element that can be switched in when required. If this is not the case, a separate terminator must be used.
- The segment coupler at the beginning of the segment has a built-in terminator.
- The terminator in the T-box at the end of the segment must be switched in, or a separate terminator must be used.
- Currently, T-boxes with switchable terminators are not allowed in explosion hazardous areas. However, this will change in the near future.
- For a segment with a tree architecture, the bus ends at the device that is the farthest from the segment coupler.
- If the bus is extended by the use of a repeater, then the extension must also be terminated at both ends.

Termination (PROFIBUS DP)
The start and end of the PROFIBUS DP segment must be terminated. Some connectors that are available on the market are fitted with terminating resistors that must be switched in.
Note: branches are allowed in PROFIBUS PA segments but not in PROFIBUS DP segments.

Set-up

General instructions
- The bus parameters and baud rate must be set when the PLC is configured. The baud rate to be set depends upon the segment coupler used.
  - Pepperl+Fuchs SK1: 93.75 kBit/s
  - Siemens coupler: 45.45 kBit/s
  - PA-link (Siemens IM 153/157): freely selectable
  - Pepperl+Fuchs SK2 and SK3: freely selectable
- The bus parameters require adjustment
- As PROFIBUS DP is sensitive to polarity, line A and B should never be reversed.

Device parametrization using FieldCare
FieldCare supports PROFIBUS, e.g. via ControlCare SFC173 controller, Fieldgate FXA720 or other PROFIBUS communication interfaces with CommDTM. FieldCare can configure all intelligent field devices in your plant and supports you in managing them. By using status information, it also provides a simple but effective means of checking their health. FieldCare ensures that devices can be integrated and configured quickly and easily, with the transparency demanded by Good Manufacturing Practice.

Our service organization can set up any Endress+Hauser device for you to ensure you immediately get the best from your instrument.
(see **'Device commissioning'** in the 'At your service' section)

Operations and maintenance

Since FOUNDATION fieldbus H1 and PROFIBUS PA use the same electrical signal and encoding, only the protocol differs – 'low level' maintenance is identical in both networks.

Diagnosis
If you are facing a problem during the commissioning or troubleshooting of a PROFIBUS device, you can solve it as follows:

1) Checking the cabling infrastructure
Checking the cabling infrastructure should be one of your first troubleshooting steps. In addition to testing the actual cabling, you should also test the cabling of the equipotential bonding. An error in the equipotential bonding can result in communication malfunctions. Since errors in the equipotential bonding are very difficult to locate, you should check all equipotential bonding connections.

2) Checking the connection of DP/PA slaves
The quality of the wiring should be checked at the slave's side and at the junction box's side. On a PROFIBUS DP bus, communication losses may be caused by:
- A cable inversion (the PROFIBUS DP bus is polarized)
- The presence of a PA device
- A short-circuit

As a PROFIBUS PA bus is not polarized, communication losses may be caused by:
- The presence of a DP device
- A short-circuit

3) Verifying bus terminators
For the bus connection two types of errors can occur, both of which cause a signal reflection:
- Too many terminators are switched on.
- One (or more) terminator is missing.

The reflection strength depends on the error.
Note: Combining three resistors, a PROFIBUS DP terminator differs from a PROFIBUS PA terminator that combines a resistor and a capacitor.

4) Verifying PROFIBUS station addresses
PROFIBUS stations that incorporate setting of the

address over PROFIBUS are often delivered with a pre-set address of 126. It is important that no two devices have the same address on the network otherwise communication is impossible.

The address of a PROFIBUS station can be set in one of two ways:

- A local binary dip switch on the device. The new address will be valid after switching on the device.
- Software setting of device address over the PROFIBUS network using a configuration tool (called a Class 2 master) e.g. FieldCare.

5) Checking PA networks

There are three ways for checking PROFIBUS MBP (PA) wiring: using a multimeter, a Pepperl+Fuchs SK3 with the ADM or the lateste version of the PROCENTEC Profitrace.

With the multimeter it is possible to detect and locate errors such as:

- Simple inversion in the data lines
- Interruption of one of the two data lines
- Cable shielding interruption
- Short circuit between the data lines
- Short circuit between the data lines and the cable shield

In addition, the DC voltage on the PROFIBUS MBP (PA) cable should also be measured. This should be at least 9V and not more than 32V at each station. A typical value for non-hazardous installations is 19V. For intrinsically safe installations where there is an explosion hazard, the value should not be more than 13.5V.

6) Oscilloscope measurements

Oscilloscope measurements are a very effective means of troubleshooting PROFIBUS. With a little practice different statements about errors and signal quality can be derived from the signals displayed. You can also use the ProfiTrace network analyzer.

In order to check the PROFIBUS DP signal, we recommend to use a battery-powered oscilloscope tuned on DC mode. See details on fig. 8.

For PROFIBUS PA, switch to AC mode. See details on fig. 9.

See the FAQs at the end of this section.

Re-engineering

Our 'Projects' teams can help you from the start of your revamping project. Please contact us.

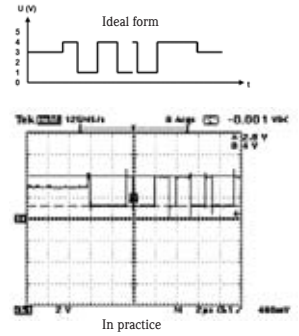


Fig. 8: PROFIBUS DP
The signals are transmitted concurrently on both cores. However, the signal on data line B is transmitted reversed to data line A.

a) Measuring data line A against data ground

b) Measuring data line B against data ground

c) Measuring data line B against data line A (shows you the actual signal waveform on the PROFIBUS)

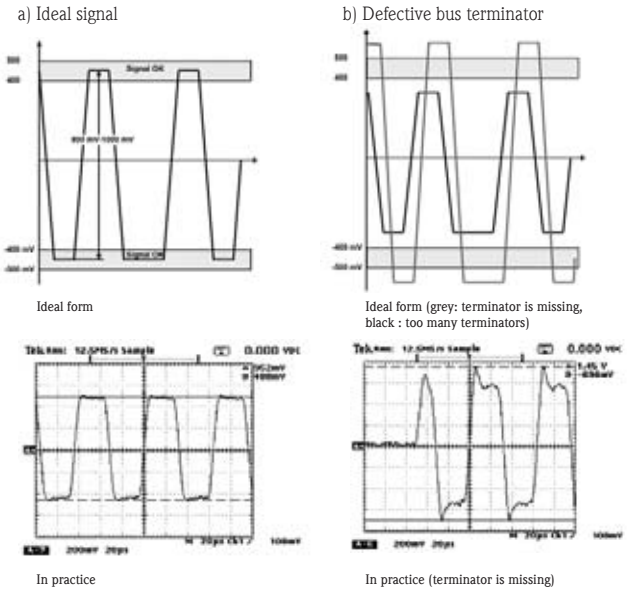
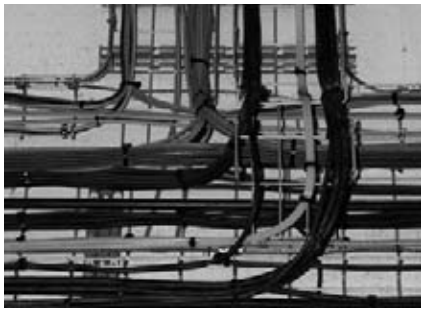


Fig. 9: PROFIBUS PA
a) Ideal signal. Note: The signal's amplitude may slightly differ from one bus end to another.

b) Defective bus terminator

c) Signal affected by noise due to: bad connection quality, bad connection of shields, static due to devices



FOUNDATION fieldbus networks

With FOUNDATION fieldbus, field device data becomes an integral part of the control and operating system. The technology provides the optimum interface for planning and maintenance programs running in your plant.

FOUNDATION fieldbus is an open fieldbus standard to IEC 61158 and IEC 61784-1 (Part 5). The FOUNDATION fieldbus system architecture is designed to promote interoperability between and among devices of different manufacturers. The standard specifies two communication levels:

- A high speed communication level (HSE) on which traffic between controllers, computers, frequency converters and other instruments is handled.
- A low speed communication level (H1) on which traffic between the process sensors and actuators is handled.

For more information, you can download our 'FOUNDATION fieldbus Overview' (BA013S) from www.endress.com

Typical FOUNDATION fieldbus architecture (Fig. 10)

Since FOUNDATION fieldbus supports both a high speed and low speed network, two architectures exist. These provide the same basic functionality but differ in the physical layer. The H1 layer is IEC 61158-2 based and the high speed layer uses High Speed Ethernet (HSE). Linking devices, bridges or gateways interface the communication between the two levels.

Transmission standards

FOUNDATION fieldbus HSE uses the Ethernet 100BASE-T standard. FOUNDATION fieldbus H1, the IEC 61158-2 standard, defines four cable types: A, B, C and D, allowing different maximum permissible bus lengths of 1900m (6232ft), 1200m (3936ft), 400m (1312ft) and 200m (656ft) respectively (in the case of a safe area application). The transmission rate is 31.25 kBit/s. Type A is recommended.

System integration

Devices are integrated into a FOUNDATION fieldbus network using two files:

- Common File Format (CFF): is a software file used by the host to map the detailed FF capabilities of a device without requiring its physical presence (offline project).
- Device Description (DD): provides an extended description of each object in the Virtual Field Device (VFD) and includes information needed for a control system or host to understand the meaning of data in the VFD. The DDs are composed of two files: the .SYM file which is a symbol file in text format, and the .FFO file which gives a detailed description of the device.

Where an FDT frame is used for configuration of the device, an additional file is required:

- Device Type Manager (DTM): is a software component used for accessing specific functions of a field device via a user interface for parametrization, diagnosis and maintenance of the device as well as for the integration in FDT engineering tools or control systems.

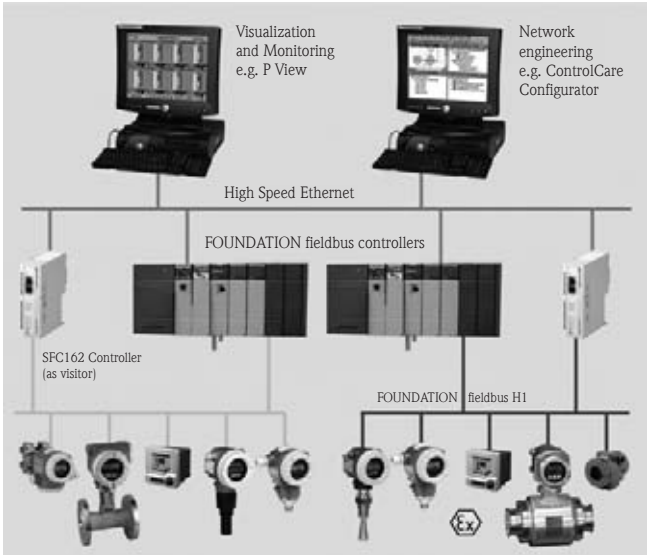


Fig. 10: standard Foundation fieldbus architecture

Function blocks

Every FOUNDATION fieldbus device has function blocks:

- Resource block: describes the attributes of the fieldbus device, e.g. device name, manufacturer and serial number.
- Transducer block: contains all device information such as calibration data and sensor type. A device may have several transducer blocks, e.g. diagnostic, process variable or display.
- Analog input block: puts the process variable including status information on the fieldbus. It ensures that all devices publish their information in exactly the same way. Discrete input, analog output and discrete output blocks have the same respective function for switches, actuators and for e.g. reset functions on a flowmeter.
- Control blocks: allow control to be performed by fieldbus devices. Manufacturers are free to implement the blocks they prefer. For example, Endress+Hauser offers PID control, input selection, etc. according to the application for which the device is designed.

For more information on function blocks handling, you can download our guideline ref. BA00062S from www.endress.com.

Installation instructions

Cabling and termination are the sources of most of the reported problems, see below.

For more information on FOUNDATION fieldbus technology, please visit: www.fieldbus.org

Cabling
When installing a FOUNDATION fieldbus H1 segment, particular attention must be paid to the cabling. This covers both choice of cabling and the way in which the cables are laid in the plant. By careful routing, e.g. avoidance of potential sources of intense electromagnetic interference, use of metal trays or separation of power and bus cables in the cable tray, a significant contribution can often be made to the fault-free running of the bus. Similarly, the number of network branches should be kept as low as possible.

Termination
- The start and end of every FOUNDATION fieldbus H1 segment must be fitted with a bus terminator. For buses with a branched structure, the end of the bus is considered to be the network node that is farthest removed from the start of the segment. For non-hazardous areas, some T-boxes have an integrated terminating element that can be switched in when required.
- If the bus is extended by the use of a repeater, then the extension must also be terminated at both ends.
- Max. four repeaters are allowable between a participant and the linking device (or H1 I/O card).

Limitations on spurs
The cable between the T-box/ junction box and the field device is called a spur. Spurs longer than 1m (3.3ft) are counted in the total cable length. The maximum length of the individual spurs is dependent upon the number of participants.

Set-up

There are several ways to set up a FOUNDATION fieldbus device, whereby the following points must be considered:
- All device parameters are mapped in the controller: a parameter changed directly at a device may be overwritten on project download if this change has not been registered by the controller.
- To prevent accidental changes, all FOUNDATION fieldbus devices have a hardware write lock that must be disabled before configuration.

Device parametrization using an engineering tool
A FOUNDATION fieldbus system allows both offline and online configuration of devices from the engineering tool, e.g. ControlCare Application Designer, NI_FBUS Configurator, Delta V, etc. All blocks, i.e. resource, transducer, I/O and control are accessible.

Device parametrization using a handheld
Field Xpert, FC375 or FC475 can be used to configure device resource, transducer and I/O blocks. The new configuration must always be uploaded to the controller (via the engineering tool). For more information on Field Xpert, see page 107.

Device parametrization using FieldCare
FieldCare supports FOUNDATION fieldbus, e.g. via ControlCare SFC162 controller (as visitor), Softing FF Gateway or other FF linking devices with CommDTM. Today Endress+Hauser provides its own DTMs for all FOUNDATION fieldbus devices from 2010 onwards. These offers device diagnosis based on the NAMUR NE 107 recommendation. Moreover, with more than 400 registered devices from about 80 manufacturers, the specific iDTMs-FOUNDATION fieldbus catalog allows full, quick and transparent parametrization capabilities.

Our service organization can set up any Endress+Hauser device for you to ensure you immediately get the best from your instrument.
(see **'Device commissioning'** in the 'At your service' section)

System configuration
A FOUNDATION fieldbus project is engineered offline with the tool provided by the control system, e.g. Application Designer. This allows a network of virtual devices to be built up and a control strategy to be created by linking the device function blocks together. The engineering tool is also used to parameterize the control blocks.

During commissioning of the plant, the project is put online, and the actual devices in the plant are assigned to their virtual counterparts in the offline project. The project is then downloaded to the controller(s) in the network. FOUNDATION fieldbus supports distributed control systems (DCS), which have several controllers connected together by the HSE backbone and even down to the device.

Operations and maintenance

Since FOUNDATION fieldbus H1 and PROFIBUS PA use the same electrical signal and encoding, only the protocol differs, 'low level' maintenance is identical in both networks. FOUNDATION fieldbus HSE can be fixed in the same way as an industrial Ethernet network.

Diagnosis
If you are facing a problem during the commissioning or troubleshooting of a FOUNDATION fieldbus H1 device, you can solve it as follows:

1) Checking the cabling infrastructure
Checking the cabling infrastructure should be one of your first troubleshooting steps. In addition to testing the actual cabling, you should also test the cabling of the equipotential bonding. An error in the equipotential bonding can result in communication malfunctions. Since errors in the equipotential bonding are very difficult to locate, you should check all equipotential bonding connections.

2) Checking the connection of FOUNDATION fieldbus H1 slaves

The quality of the wiring should be checked at the device's side and at the junction box's side. As a FOUNDATION fieldbus H1 bus is not polarized (device dependent), communication losses may be caused by a short-circuit or a bad shielding connection.

3) Verifying bus terminators

For the bus connection two types of errors can occur:

- Too many terminators are switched on.
- One (or two) terminator is missing.

4) FOUNDATION fieldbus station addresses

There are dedicated address ranges set for the FOUNDATION fieldbus stations:

- Addresses 0 to15 are reserved.
- Addresses 16 to 247 are available for permanent devices. Some host systems may further subdivide this range. This range is typically shortened to reduce cycle time.
- Addresses 248 to 251 are available for devices with no permanent address such as new devices or decommissioned devices.
- Addresses 252 to 255 are available for temporary devices, such as handhelds.

FOUNDATION fieldbus stations are identified on the network through their:

- Tag name
- Device ID (which is unique)
- Bus address

Using a handheld (e.g. Field Xpert or DXR375) or FieldCare, you can configure the tag, address and specific parameters of FOUNDATION fieldbus devices from the field. After connection to the host network, this data must be matched and uploaded to the controller using the engineering tool.

5) Measurement with a multimeter

With the multimeter it is possible to detect and analyze problems such as:

- Interruption of one of the two data lines
- Cable shielding interruption
- Short circuit between the data lines
- Short circuit between the data lines and the cable shield

Measurement with a multimeter is one possibility available for checking FOUNDATION fieldbus wiring.

In addition, the DC voltage on the FOUNDATION fieldbus cable should also be measured. This should be at least 9V and not more than 32V at each station. A typical value for non-hazardous installations is 19V. For intrinsically safe (FISCO) installations where there is an explosion hazard, the value should not be more than 13.5V.

6) Oscilloscope measurements

Oscilloscope measurements are very effective ways of troubleshooting FOUNDATION fieldbus. With a little practice different statements about errors and signal quality can be derived from the signals displayed. You can also use analyzers such as FieldConnex from Pepperl+Fuchs, FBT6 etc.

In order to check the FOUNDATION fieldbus signal, we recommend using a battery-powered oscilloscope tuned on AC mode to ensure that the grounding of the oscilloscope is not disturbing the measurement. See details on fig. 11.

See the FAQs at the end of this section.

Re-engineering

Our 'Projects' teams can help you from the start of your revamping project. Please contact us.

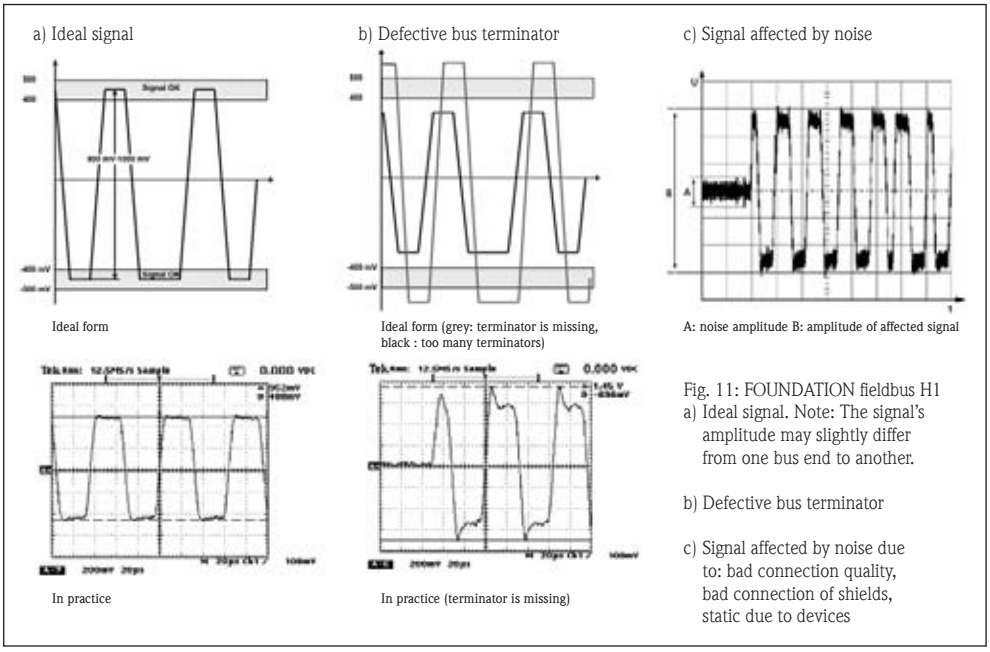
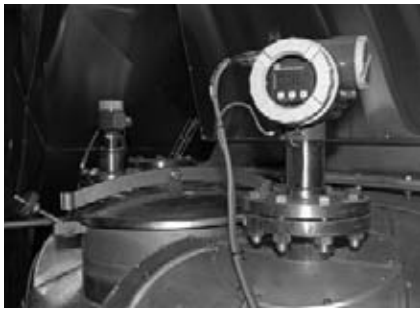


Fig. 11: FOUNDATION fieldbus H1
a) Ideal signal. Note: The signal's amplitude may slightly differ from one bus end to another.

b) Defective bus terminator

c) Signal affected by noise due to: bad connection quality, bad connection of shields, static due to devices



Tools

Endress+Hauser service teams use tools that have been designed for specific commissioning and maintenance tasks. Commubox FXA195 and Field Xpert are also available for maintenance teams.

Commubox FXA195

The Commubox FXA195 connects intrinsically safe smart transmitters with HART protocol to the USB port of a personal computer. This makes the remote commissioning and operation of the transmitters possible via Endress+Hauser's operating program FieldCare.

HART/USB conversion

- Intrinsically safe interface for smart transmitters.
- Converts HART protocols to USB signals.
- Power is supplied via the USB port.
- Reactionless in accordance with IEC 61508 for connection to 4-20mA SIL 2 loops.

PROFIusb

PROFIusb is a PROFIBUS PC interface. PROFIusb gives you high performance access to PROFIBUS, allowing you to perform such tasks as network configuration or device parameterization in PROFIBUS systems. PROFIusb acts as a PROFIBUS master class 1 or class 2 at all data transfer rates up to 12Mbits/s.

PROFIBUS/USB conversion

- Converts PROFIBUS protocols to USB signals.
- Power is supplied via the USB port.
- The bus line to which you connect PROFIusb is not extended. You thereby avoid reflection-induced noise.

Field Xpert

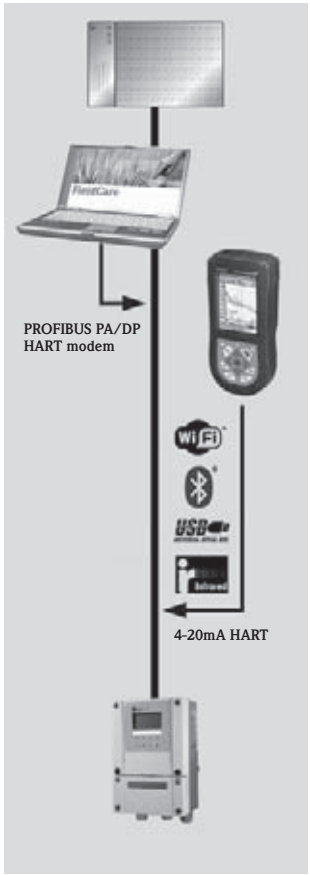


Fig. 12

Configuration/ parameterization of HART devices

- High performance industrial PDA meeting needs and requirements of the process industry
- Operates both inside and outside of explosion hazardous areas
- Protection from static electricity, water and dust with shockproof housing
- Device Xpert - Configuration Software: Supports all registered HART devices
- Connectivity to WiFi, Bluetooth, USB, InfraRed
- MS Windows Mobile 5 operating system

Frequently asked questions

PROFIBUS networks - Commissioning

How can I assign an address to a device?
- With the exception of the analysis device Mypro, all Endress+Hauser devices have an address switch that allows hardware or software addressing.
- Software address changes can be made via the PROFIdtmDPV1 CommDTM of FieldCare, the DPV1-DDE server of Commuwin II or any other PROFIBUS operating tool. See also Chapter 6.6 of BA034S.

Where is the device termination switch?
PROFIBUS PA:
- There is no termination switch on the device itself.
- The bus is terminated by using a separate terminator or a T-piece/junction box with a switchable terminating element.

PROFIBUS DP:
- Termination switches are located in the devices. We recommend the use of PROFIBUS connectors with integrated terminators (in cabinet). If you use the termination of the plugs, the termination of the segment is lost as soon as you unplug them. The best way would be to use external terminations, as in here the plugs are usually not pulled. The same is valid for terminations inside of the devices. If the device gets damaged or replaced, the termination is gone at least for this timeframe.

When a device is added to the bus, the segment fails.
If too many devices are connected to the bus, the segment can fail. The segment coupler supplies a defined maximum output current to the segment. Every device requires a particular basic current (see Chapter 5.3 of BA034S). If the sum of the basic currents exceeds the output current of the coupler, the bus becomes unstable.
- Diagnosis: Measure the voltage at the device farthest from the segment coupler (should be > 9V DC).
- Remedy: Reduce the electrical load on the segment concerned, i.e. one or more devices must be disconnected.

PROFIBUS PA slave with address 2 cannot be found.
- If a Siemens DP/PA-link Type IM 153/157 is used, the internal address must be taken into consideration. On the PROFIBUS PA side, the link has the fixed internal address 2. For this reason, the addresses 1 and 2 may not be assigned to any of the PROFIBUS PA slaves connected to the link.
- Two devices (slave or master) have the same address. Disconnect the slave with address 2 from the bus and check whether there are others on the bus with the same address (e.g. with FieldCare). Readdress as appropriate. Check the settings of the PROFIBUS master as to whether the address 2 has been allocated twice.

PROFIBUS networks - PLC planning

The measured value in Siemens S7 PLCs is always zero
- The function module SFC 14 must be used. The SFC 14 ensures that for e.g. 5 bytes can be consistently loaded into the SPS. If the SFC 14 is not used, only 4 bytes can be consistently loaded into the Siemens S7.
- Newer versions of the S7 series can access the I/O buffer directly. The SFC 14 is no longer required.
- Check that cyclic communication to the device is active.

The measured value at the device display is not the same as that of the PLC.
The parameters PV_SCALE and OUT_SCALE are not set correctly.
OUT_SCALE_Min. = PV-Min.
OUT_SCALE_Max. = PV-Max.
Instructions on how to adjust the parameters PV_SCALE and OUT_SCALE in the function block can be taken from the device operating instructions.
Note: we recommend that you use FieldCare for this adjustment.

PROFIBUS networks - Data transmission

How is data transferred to the PLC?
- The measured values are transmitted in 5 byte long data blocks. 4 bytes are used to transmit the measured value. The fifth byte contains standardized status information. Error codes for Endress+Hauser device faults, e.g. E 641, are not transmitted with the status.
- For limit switches, the information is transmitted in two bytes: signal condition and status information.

How can the PLC switch on the positive zero return of the Promag 53?
Via the output word of the cyclic services.

How can the totalizer of the Promag 53 / Promass 83 be reset?
Via the output word of the cyclic services for the totalizer in question, see corresponding operating manual.

How can I suppress a measured value in cyclic communication?
By using the placeholder 'EMPTY_MODULE' or 'FREE_PLACE' during configuration. Note: You have to set the 'EMPTY_MODULE' placeholders in the hardware configuration to keep the order of the slots. Some systems may not work if this is not set correctly.

How can I write a value to the local display?
By using the Display_Value model from the GSD (if supported). General note: You can refer to Chapters 7.2 and 7.3 of BA034S (PROFIBUS) for more details.

PROFIBUS networks - Using FieldCare

FieldCare cannot open connection to the PROFIBUS PA devices...
FieldCare is a Class 2 master that allows the transmission of acyclic values. The PROFIBUS-DP baud rate to be set depends upon the segment coupler used. FieldCare is synchronized with the PLC's parameters.

The connection to the devices can not be opened.
- If the PLC and FieldCare are used in parallel, the bus parameters must be mutually compatible. The bus parameters must be identical for all connected masters.
  If FieldCare is used, the Token Rotation Time (TTR) calculated by the PLC configuration tool must be increased by 20,000 bit times and the corresponding value entered in the FieldCare PROFIBUS configuration and in the PLC.
- The HSA parameter (Highest Station Address) must permit the FieldCare address. The HSA specifies the highest address permitted for active participants (masters) on the bus. Slaves can have a higher address.
- Is the FieldCare address free or is it being used by another device?
- Have the drivers and cards been correctly installed? Is the green LED on the TAP of the Proficard or PROFIusb lit?

A device does not appear in the live list.
- Device is not connected to segment.
- Address used twice.

Device cannot be fully operated.
- The device version is not supported by FieldCare. An appropriate DTM is necessary. The default parameters of the PROFIBUS PA profile are offered.

FOUNDATION fieldbus networks - Technology

Where can I find the DDs?
DDs can be found at www.fieldbus.org, www.endress.com or the specific DCS vendor's website. (To be recommended, as the DD files can differ slightly. The DD from the DCS vendor has been tested and approved by that vendor for use in a particular version of the DCS. Additional DCS specific drivers may be required.)

A DD from www.fieldbus.org or www.endress.com cannot be installed in the DCS.
Use the DD from the DCS vendor's website.

The backup LAS function cannot be activated in DeltaV.
Download the DD from www.easydeltav.com

Can I integrate any Endress+Hauser device into any DCS?
Yes for the major DCSs! However, there are specific commissioning issues (e.g. preconfiguration) with every DCS. Please ask for more information from Endress+Hauser for the DCS considered.

I can't find any FF-specific parameters in the device manual.
FF-specific parameters are described in the following Endress+Hauser manual: BA013S/04/en

FOUNDATION fieldbus networks - In work

The parameters are not displayed very well. I cannot interpret the meaning of the parameters.
If available, install specific PAM Tool drivers and applications e.g. Emerson AMS drivers or Yokogawa PRM Device Viewer Files.

I cannot find all the parameters for a basic set-up. Where can I find them?
In the transducer block. The easiest way is to use Methods. Methods contains automated procedures for set-up, diagnostics, etc.

I cannot find the envelope curve module in the DD or device online via the FF interface.
For the new generation of devices, the envelope curve can be read out with FieldCare through the Service interface or the ControlCare SFC162 controller (as visitor). For the older generation, the envelope curve can only be read out through the Service interface.

I cannot access HistoRom data via the FF interface.
HistoRom data can only be read out with FieldCare through the Service interface.

How to replace a device?
Use pre-defined routines in the DCS or use FieldCare and the DCS database reconciliation (Delta V) or DCS database equalization (Yokogawa).

Can I replace a device without touching the DCS?
No. You have to set a tag and make a download with the DCS. In the DCS from Emerson, there is the possibility for an automatic replacement.

Can I replace a device with a device with a higher device revision?
In general, yes, but manual work is needed.

FOUNDATION fieldbus networks - Troubleshooting

The transducer block cannot be set to AUTO.
Check the mode of the resource block (AUTO) and the settings in the transducer block (Config. error).

Analog input block can not be set to AUTO Mode.
Check the scaling, linearization and channel settings (and units for DeltaV). It could be that this block is not included in the schedule.

My device is not working properly. In the transducer block I can only see 'Block Error. Maintenance Needed.'
Look for the parameters 'Actual Error' and 'Last Actual Error'. These parameters can be found in the diagnostic transducer block.

Communication between the device and the DCS doesn't seem stable. What should I do?
Find out if the FF communication is OK (termination, signal quality, lost pass token telegrams) or if the device was set up incorrectly (e.g. bad PV status because of bad echoes on a level device).

Can you recommend any diagnostic tools?
Several tools are available. There are software oscilloscopes, test handhelds and diagnostic modules. Check with Endress+Hauser for more information.

At your service

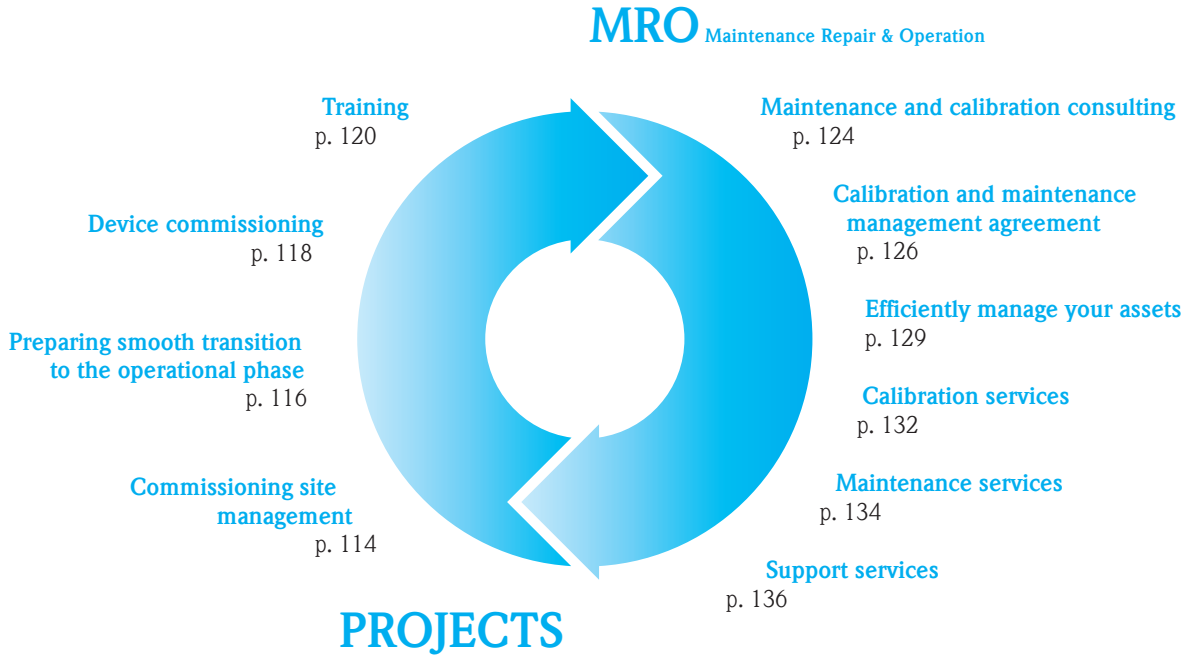
Experienced and qualified people whatever the level of support

Contents

Services throughout your plant's life cycle

Endress+Hauser's life cycle approach to service means that we're with you every step of the way: from initial project preparation in the engineering phase right through to effective maintenance practices during the MRO phase.

As your long-term partner, we pride ourselves in taking an active part in your success – read on to discover how our complete service portfolio will help you achieve your goals.



Project services

Starting production on time to quickly meet your goals

The Endress+Hauser project team has four main goals:
1. **Execute commissioning as efficiently as possible**
2. **Deliver quality workmanship**
3. **Provide professional documentation**
4. **Provide efficient knowledge transfer**

The key to any successful project is to have the right people following the right plan. Understanding that every commissioning project is unique in some way, an integral step in the process is to define a commissioning strategy. The right strategy will optimize the commissioning process while implementing a tools infrastructure that will allow you to maximize plant uptime and reduce maintenance costs over the lifecycle of your assets.

Poor handover on capital projects has a lasting impact on new operations
One of the keys to a successful handover is having critical documentation at your fingertips. The documentation is normally stored in a CMMS or a lifecycle management tool. Endress+Hauser's strategy is to take advantage of the work that is done during the commissioning phase and efficiently use it to create a package that will become the documentation cornerstone for the maintenance and operations group. Our solution is effective as a stand-alone or can be easily integrated into your IT landscape.

Having the right people on the job
Endress+Hauser has well trained, technically qualified service engineers equipped with the right tools to efficiently manage all of the challenges they will face throughout the project. For international projects, Endress+Hauser has a global team of qualified people.

In addition, Endress+Hauser has experienced Site Project Managers that can manage the instrumentation from installation to start-up and optimization. This team will also help with staff training to manage the assets during the operational phase or assist with a strategy where Endress+Hauser takes on partial or full responsibility for management of your installed base.

Endress+Hauser commissioning teams have access to our strong internal technical resources to quickly resolve any issues on site and links to our worldwide network and databases for instrumentation and controls.

Proven results

Production starts on time at Connacher
"Endress+Hauser has been highly responsive from the quoting of equipment through to commissioning and start-up. The staff has been helpful, knowledgeable and supportive…"

Dean Bannister, Instrument Technologist at AMEC BDR, Canada

Commissioning management for ArcelorMittal
"Above all, what counts in the relationship with Endress+Hauser is the 'human quality'. We need solutions – and not people who simply pass the buck, blaming problems on other people…"

Mr Divol, Project Manager at ArcelorMittal Fos-sur-Mer, France

All under control at the Aitik mine
"Besides Endress+Hauser's own instruments, 3,000 products made by third party manufacturers have also been included in the W@M Portal. This helps us to keep engineering under control…"

Michael Sirkka, Technician at Aitik Mine, New Boliden, Sweden

Commissioning site management

Achieving efficient plant commissioning while minimizing costs

Starting production on time and meeting operational targets is essential. Therefore a competency is required to manage and control the plant commissioning phases, providing a value added service that will help to achieve overall project targets including saving both time and money.

Typical commissioning and operational challenges

- Realizing start-up timing objectives
- Compliance to Health & Safety, environmental and quality standards
- Ensure optimum performance of the production process from the start
- Lack of resources and inadequacy of instrumentation/solution knowledge
- Meet project budget expectations
- Seamless transition into plant operational phase

How does Endress+Hauser meet these requirements?

We engage the right level of expertise at the right time to meet project deliverables. Our on-site resource is strongly linked and has access to the Endress+Hauser organization to ensure all issues on site are resolved quickly and effectively. The site manager coordinates with all other contractors and provides status reports on commissioning progress. All commissioning and instrumentation documentation is coordinated for a seamless transition and handover to the plant operational staff at time of start-up.

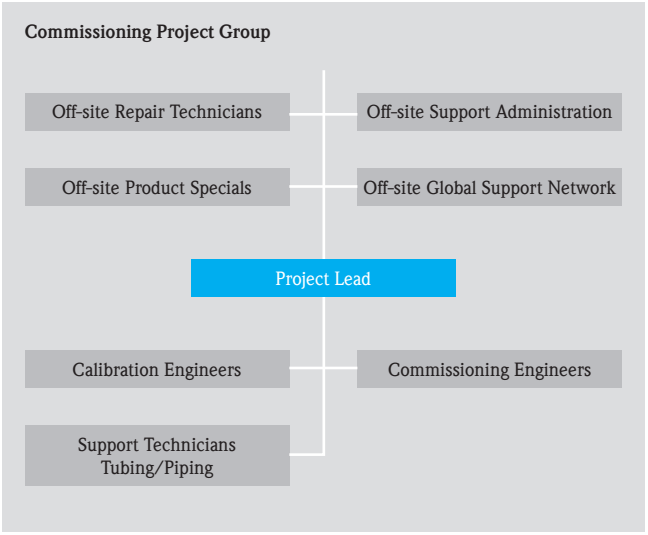
Typical project scope for plant commissioning and start-up site management includes managing the full I/O for instruments, digital points and third party devices. This service can also include management of installation (mechanical and electrical), training, system commissioning, logistics, technical support and any other relevant requirements linked to commissioning.

Working closely with you we will:

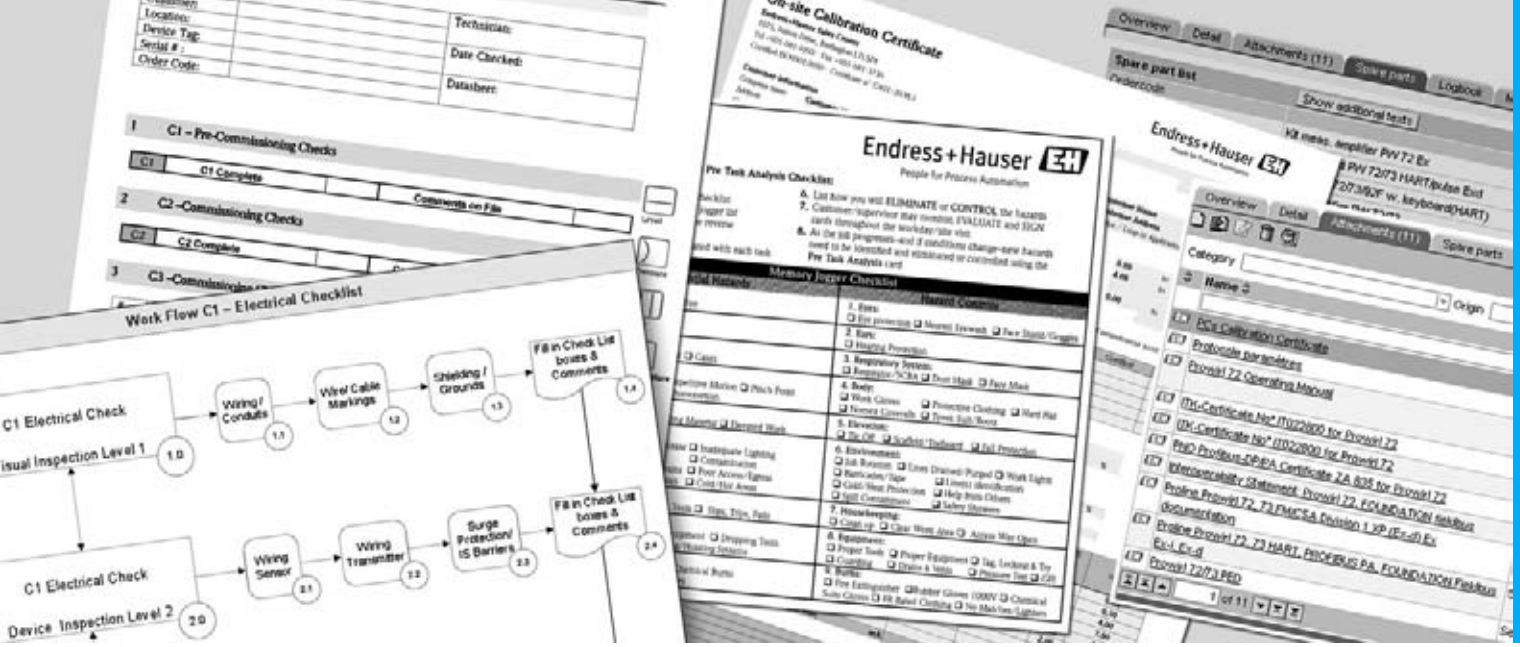
- Look for ways to speed up the commissioning process
- Propose ways to avoid project delays
- Define QA/QC processes
- Define the scope of supply
- Define a life cycle management strategy
- Define project and maintenance documentation
- Identify all required tooling
- Manage and control project commissioning issues

Coordination & Reporting

The Endress+Hauser commissioning team will coordinate with all the project groups to enable the most efficient transfer of information for commissioning activities. The Endress+Hauser commissioning staff will report to the 'project lead' on-site, and our commissioning site manager will handle all reporting and scheduling activities for the group. The commissioning site manager will liaise with the other site contractors and project manager(s) to facilitate commissioning timelines and issue resolution with the other stakeholders.



Our commissioning team will consist of 'project leads' for on-site management, service engineers & calibration engineers for commissioning at site and additional support from the head office for administration and technical issues, including our vast network of instrumentation and control specialists worldwide.



Commissioning site management involves a lot of documentation: W@M – Life Cycle Management enables project data structuring.

The complete package...
Endress+Hauser will strive to provide EPCs and end users with a commissioning documentation package that meets or exceeds expectations. The commissioning turnover package for the project will contain the basic data required for the optimal operation and management of the plant's instrumentation and controls infrastructure. The turnover package will include the following documents:

1. As-left device settings
2. As-built loop drawings
3. As-built P&IDs
4. Original and/or on-site calibration and verification certificates
5. Additional documents as required for the IQ/OQ protocol

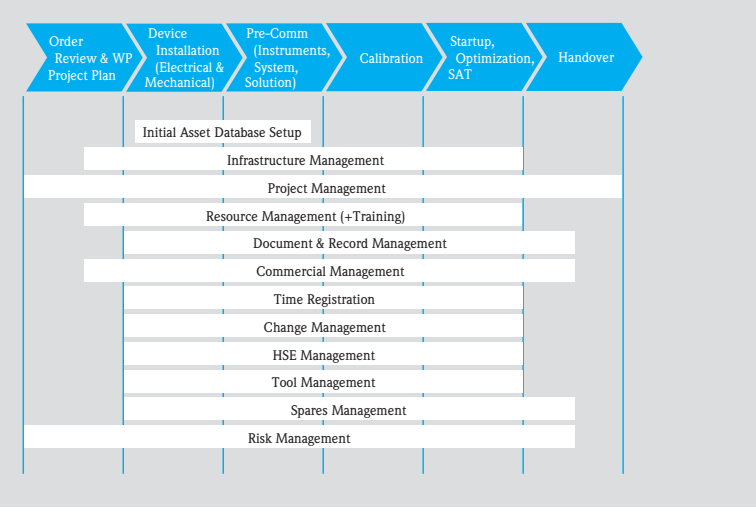
... for smooth transition to the operations phase
Endress+Hauser's W@M Portal or W@M Enterprise is our documentation solution. This format allows for greater detail and access to all device information, e.g. manuals, commissioning parameters, spare part information, service/ troubleshooting information, technical information, etc.

The flexibility of the W@M Portal allows for the plant's criticality matrix to be defined during the commissioning phase and for operations staff to have access all the manufacture information for Endress+Hauser devices and imported information for all third party devices. What's more, W@M has the ability to interface with other CMMS software or software related to plant maintenance activities.

Your benefits

- Safe, efficient and effective management of the commissioning process
- Consistent on-site presence with access to key resources to meet project commissioning quality, budget and timing targets
- Shared responsibility for project risk
- Partner that has strong motivation to ensure instrumentation is commissioned optimally for operation over its entire life cycle
- Coordination of training and documentation for a seamless handover to the operational staff

Discover how to speed up your commissioning project while achieving a smooth transition to the operational phase...



Project commissioning with W@M Life Cycle Management

Speed up your commissioning project while achieving a smooth transition to the operational phase with Endress+Hauser's Plant Asset Management platform

Commissioning the instrumentation and electrical components in a large project can be a daunting task if a well-defined process is not established. One often over-looked aspect of this process is to ensure all the necessary documentation is in place for the operational staff at start-up. In addition to potential start-up delays related to missing and inaccessible documents, the task to collect this data in the operational phase is much more costly, incomplete and inaccurate.

Endress+Hauser's Plant Asset Management solutions use a combination of tools to support commissioning workflows to not only correctly configure and calibrate the instrumentation but also to seamlessly link this information with other instrument-relevant documentation in one platform that is easily accessible for customers and their systems.

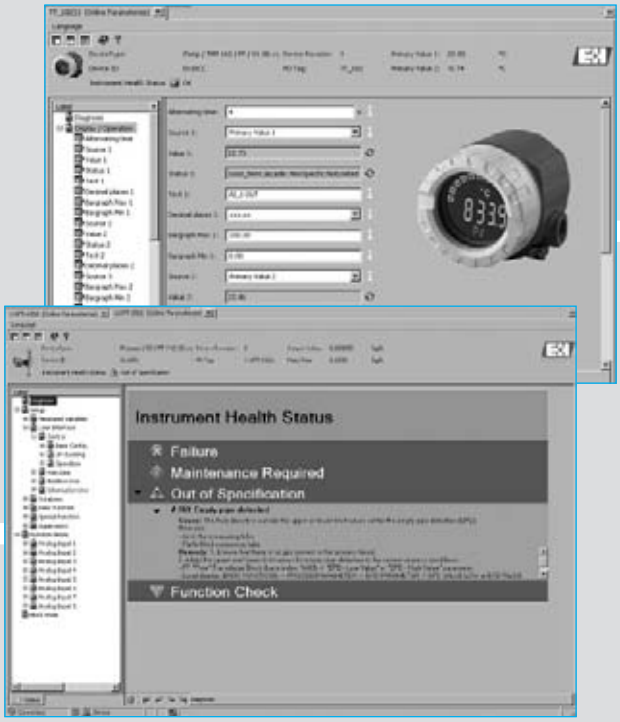
Here is a typical use case example to speed up your commissioning project:

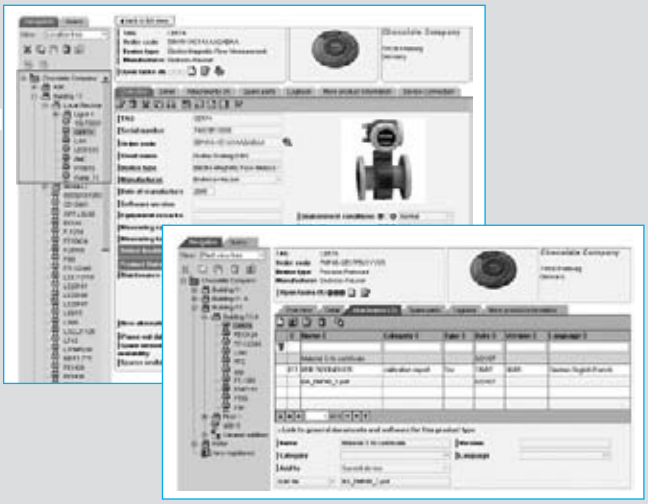
Configuration/parameterization of field devices
As many commissioning and maintenance actions require direct intervention at the measuring point, Endress+Hauser uses handheld tools, amongst others a Personal Digital Assistant (PDA), to increase productivity and improve the quality of the data collection. After the reception of the instruments list from engineering, this mobile tool serves as an asset collection tool to easily organize and populate all the assets and related data according to the plant topology.

This offers the opportunity to shorten data entry time – not only to save money, but to speed up the entire process of plant commissioning and start-up. Project quality is therefore ensured through standardized data collection and storage, providing accurate documentation for quality control audits at any time. The information once organized is then used to efficiently plan the work to be completed in FieldCare which allows managing configuration of all registered HART and/or FOUNDATION Fieldbus devices.

Storage of device data for future optimized preventive maintenance
Once all the devices are set up with the FieldCare configuration and asset management tool, configurable and printable reports of device settings, plant configuration, loop checks are generated and stored under the device tag.

By using status information and initiating regular communication with the monitored devices and checking device diagnosis and performance information, FieldCare optimizes maintenance tasks offering clear diagnostic information for fast reaction to any problems.





Centralized access to all life cycle device information facilitates maintenance
Operators and maintenance technicians need to have complete, accurate, comprehensive and timely information about their physical assets in order to use them effectively and safely during the operations phase. The device information produced during the commissioning phase by using FieldCare is stored in the W@M Portal or W@M Enterprise application, providing a historical record of device settings. Thus, the W@M data for a specific instrument can be displayed by simply clicking on the instrument node in FieldCare. The configured device data is available over the entire life cycle, which helps to optimize further device replacement during the operations phase.

This information can be integrated into your CMMS system and Endress+Hauser's CompuCal calibration management system so that all life cycle asset information is accessible in one place.

W@M allows archiving of all device data and documentation: hook-up diagrams, installation and commissioning reports, calibration certificates, P&ID, electrical connection diagrams, IQ/OQ documentations, operating manuals, etc can be easily added to W@M during the commissioning process to streamline the transition to the operational phase.

Jämtkraft reduces costs of ownership
"With the tree structure in FieldCare, finding the right instrument is easy. And the Key Performance Indicators in the W@M Portal show us exactly where we should focus our maintenance efforts…"

Anders Gjerstad,
Instruments Manager at Jämtkraft

Further information on W@M Life Cycle Management and FieldCare at:
www.automation.endress.com/asset-management

Device commissioning

Getting your process up and running – on time and on budget!

Correct commissioning of process instrumentation is of paramount importance for optimum performance. What's more, with the demands on your engineering and maintenance staff higher than ever before, time, human resource and specific skills become critical factors when a project is nearing completion.

Device commissioning typically includes a check of the installation and mounting and cabling of your installed instrument. We power up the instrument, perform its complete configuration and give the users all the necessary training to achieve optimum operation. Finally, everything is documented in a detailed report.

Commissioning packages offer cost-effective solutions to all cases:

Standard commissioning is the ideal start-up solution for instruments with common features and functionality in standard applications:

- **Cost and time saving** – Optimum set-up by qualified people means less effort and potential reduction of time loss for your teams.
- **Efficient transfer of knowledge** – On-site instruction during commissioning is a quick and practical method to pass on information on how to set-up and operate instrumentation.
- **Extended warranty** – Choose Endress+Hauser to commission your instruments and open the door to extended warranty!

Extended commissioning is the best start-up solution for sophisticated instruments in complex applications and/or with additional documentation requirement:

- **Peace of mind** – Optimization and confirmation of the performance of the measuring point in order to minimize breakdown potential.
- **No investment needed** – Provision of specific tools and software provides traceable reference and ensures optimum performance and functionality.
- **Conformity to the internal standards** – Detailed reports and backup files for every device guarantee traceability.

Advanced commissioning is the solution if a complete system check from field to your control room is required:

- **Totally reliable measurement results up to system level** – Complete multi-point check from sensor to the system ensures the correct signal integration into the system, including conformity statement.
- **Loop validation included in the individual device report and the backup files**
- **Installation Qualification of your device** – Experienced and qualified service engineers will support your requirements.

Competence ensures success
With more than 50 years' experience in process instrumentation and a global team of experts at your disposal, you can rely on us for all your commissioning needs.

Endress+Hauser service technicians perform the set-up of the instruments according to defined Standard Operating Procedures (SOP) – this ensures constant performance quality whatever the location and whatever the technician. They are trained to application-specific regulatory requirements and are keen to share their application know-how with your staff.

Our teams use special tools designed to ensure quick and efficient commissioning of instruments and confirm the function of the device through the delivery of standardized reports.

Full traceability of certificates
After Endress+Hauser has performed the commissioning service, a full report is issued detailing equipment set-up and advising on future maintenance requirements. The reports and documents are stored either on your server or on the Endress+Hauser's servers accessed via Internet on the W@M Portal. The documents are available shortly after the job is performed.

Commissioning packages that meet your needs whatever the application

Component	Standard commissioning	Extended commissioning	Advanced commissioning
Mounting/wiring check	✓	✓	✓
Environmental conditions	✓	✓	✓
Configuration	✓	✓	✓
Output value check	✓	✓	✓
On-site instruction	✓	✓	✓
Provision of device set-up parameter files	✓	✓	✓
Service report (i.e. MSE report)	✓	✓	✓
Instrument conformity		✓	✓
Functional test		✓	✓
Device related extended report		✓	
Loop test			✓
Device related advanced report			✓
Instrument warranty extension	Optional	Optional	Optional
Typical application	Conventional continuous measuring points such as: ■ Level ■ Flow ■ Pressure ■ Temperature etc.	Complex measurements or specific applications such as: ■ Photometric analyzer ■ Automated pH system ■ Density measurement ■ Concentration measurement ■ Samplers ■ Tank linearization, etc.	Instruments with digital communication networks such as: ■ FOUNDATION Fieldbus ■ PROFIBUS PA/DP ■ Ethernet ■ HART

Training

Mastering instrumentation and fieldbus networks to maintain your competitive edge

People provide an essential contribution to your company's overall performance. This is all the more true for people who are invested in production processes and maintenance.

Endress+Hauser trainers put all of their expertise at your disposal, helping you to produce more, at a higher quality, in a safe and profitable manner.

Training is essential to fulfill your commitments:
- It allows you to get the best from your measurement devices and thus optimize your investment.
- Thanks to a better knowledge of the instrumentation's behavior, your technicians will be able to minimize downtime.
- A better knowledge of appropriate maintenance methods will contribute to make your assets durable.

We conduct training sessions to your needs and where it is most convenient (at your site, in your local Endress+Hauser sales center or in specialized tranining centers). Competent and totally equipped, our trainers ensure an efficient knowlegde transfer to your teams.

Training sessions for commissioning and maintenance engineers

How do you improve or update your personnel's skills in process automation? With the continuous updates of the production processes, many challenges are faced by your people, such as:
- **Selecting the most efficient device for your application by considering all required regulations and legislations such as ATEX, SIL, FDA, IFS…**
- **Maintaining and optimizing critical measurement points**
- **Finding untapped opportunities to improve**

Our specialists will provide your maintenance staff with the technical product knowledge they require to run the plant efficiently and cost-effectively.

Training is performed in-house or on-site. Your maintenance personnel will benefit from professional, up-to-date and hands-on training, using a range of working instruments.

The training programme will be pre-defined according to your requirements and participants will receive supplementary literature and a certificate of attendance.

We provide training for:
- Engineers and technicians
- Plant operators
- Maintenance engineers
- New recruits, apprentices, refresher courses

Training topics include:
- Theoretical and hands-on knowledge
- Installaton advice
- Start-up and maintenance diagnostics
- Troubleshooting tips
- Practical exercises using a range of working instruments

Your main benefits
- Get the best out of your equipments
- Extend your assets' life cycle through increased maintenance knowledge
- Reduce breakdown time thanks to qualified people
- Increase your personnel's efficiency

For more information please contact your local sales center.

Fieldbus technology training

Endress+Hauser places great score on having trained fieldbus engineers and technicians. They are well prepared to offer you advice and support on the implementation of fieldbus systems at your plant and are also available to help with information on specific fieldbus devices.

The same support is also offered to you at our training center in Reinach, Switzerland, at your local sales center or at your site. Courses are arranged by your local sales center and can be customized to your specific requirements.

PROFIBUS training

- PROFIBUS technology
  - Basic
  - Advanced
  - Professional
- Certified* PROFIBUS PA Engineer
  - Theory and practice on PROFIBUS PA
  - Parts on PROFIBUS DP
  - Final exam for certificate

FOUNDATION Fieldbus training

- FOUNDATION Fieldbus technology
  - Basic
  - Advanced
  - Professional
- Certified** FOUNDATION fieldbus Engineer
  - Theory and practice on FOUNDATION Fieldbus
  - Final exam for certificate

Take a virtual tour of our fieldbus test and competence center 'System World' in Reinach, Switzerland: www.fieldbuslab.endress.com

*recognized by PROFIBUS International
**recognized by Fieldbus Foundation

Application Training Center

Offering consulting, services and complete automation solutions, Endress+Hauser ensures that as the 'People for Process Automation', we have a real understanding of our customers' applications.

To meet this requirement our Application Training Center in Reinach, Switzerland. The sub processes of an industrial production are replicated and offer fully functional modules. This creates a very realistic training environment from the sensor up to the control system.

A mix of professional trainers and technicians with extensive practical experience in the field guarantee up-to-date information and high quality knowledge transfer.

The training portfolio covers:
- Basics of process control
- Basics of process automation
- Process automation: mixing, blending and CIP
- Plant Asset Management
- Measurement technology and PAM in life sciences
- Energy monitoring

For more information please contact your local sales center or visit www.endress.com/atc

MRO services

Maintenance Repair & Operation

Revealing the true sense of partnership

How can we help you to perform your work in a more convenient way? We can support you at three different levels according to your needs:

- With consulting services, looking at your situation with fresh eyes, we provide our expertise to identify the areas of improvements and to help you to take a step back and look at things from a distance. We also bring you the recommendations to manage and perform efficiently your maintenance and calibration activities. By collecting the relevant data, the optimization services allow you to improve either your maintenance business process or the manufacturing process.
- If you consider outsourcing management activities, the relationship with Endress+Hauser can range from simple 'supplier' up to 'strategic partnership'. A Service Agreement allows you to focus on your core activities and eliminate a smaller or larger part of these challenges by outsourcing well defined tasks or even responsibilities. These can range from simple loop checks and instrument calibration right through to partial functions of maintenance management.
- Of course, we can offer a whole range of execution services based on our maintenance and calibration competence. These services have the objective to keep the original or promised performance of your application.

Due to increasing demands linked to quality industry standards (such as ISO 9002.4.10b, GAMP, IFS 5.0), customers within the process industry are requesting that suppliers document their quality efforts from start to finish. With calibration being our core competence for more than 50 years, we are in the best position to define calibration cycles on quality critical measurement points.

Where plant productivity is at stake, fast resolution to any potential production downtime is required to minimize costs. Our maintenance and support services are on hand to quickly diagnose, repair or even exchange a complete device to keep your processes up and running!

Our objective is to sustainably generate outstanding value for our users. Our Added Value Services mostly use existing competences of the Endress+Hauser Group such as metrology, system and IT know-how and excellent skilled people! We use our competence to work on third party equipment as well as our own products.

Proven results

ALGAR accesses manufacturer-level information
"Every time equipment-specific details are required, I realize how powerful and time-efficient this web-based portal is. The way this was implemented was nothing short of effortless."

Herve Laforest, Maintenance Coordinator at the Algar plant (Connacher)

JAMTKRAFT makes sustainable investment
"We need to use the tools available to make our work easier. This is why we have opted to invest in a technology which makes us feel we're very well equipped for the future."

Johan Storm, Maintenance System Manager at Jämtkraft

One-stop shop saves time and money at Coca-Cola Beverages
"Endress+Hauser calibrates 66 measuring points from a wide variety of manufacturers, some up to four times a year… We are very satisfied with the service."

Rolf Bieri, Executive Producer of Coca Cola in Brüttisellen, Switzerland

Our strengths at a glance

- In-depth knowledge of instrumentation maintenance, maintenance management and consulting capabilities for the best solution to the broader problem
- Qualified and motivated people, a robust organization, a sustainable global partner
- Innovative technologies for an efficient and seamless approach (e.g. remote access and business process integration)
- A mature, well developed and globally available metrological competence for reliable performance
- Information provided through Endress+Hauser's own web-based collaborative platform W@M (Web-enabled Asset Management) reduces overhead costs
- A standardized global approach for processes and tools to perform our service portfolio with the same quality all over the world. This approach is supported by a service management system that integrates all of our systems and processes into one complete framework, enabling us to work as a single unit with unified objectives.

Competence of the Staff behind the Services Worldwide – in numbers

- More than 800 dedicated service staff including 150 highly trained and qualified calibration technicians around the world
- More than 19 ISO 17025 accreditations in calibration (in laboratory or on-site) delivered by different accreditation bodies (COFRAC, A2LA, SCS, DKD, EMA,...)
- More than 100,000 calibrations (on-site or laboratory) performed every year by our service centers

Heineken takes care of critical instrumentation
"With the W@M Portal, we are able to cross-check the criticality of our instruments versus their maintainability and to use this to determine suitable maintenance strategies for each instrument."

Steve Sherborne, Maintenance Manager at Heineken UK Limited, United Kingdom

Auditable documentation for Punica
"Auditors also pay more attention to verification measures for individual measuring points. In this respect, much progress has been made in recent years in the calibration of measuring points."

Dr. Birte Gerken, Quality Manager at Punica Getränke GmbH, Germany

A maintenance strategy for the instrumentation at Nestlé Waters Supply Est
"We now have a clear view of our installed base and have implemented a relevant maintenance plan. We also reduced the number of types of sensors…"

Mr Antoine, Methods Officer at Nestlé Waters Supply Est, France

Maintenance and calibration consulting

Auditing and analyzing your installed base of process instrumentation

Do you want to minimize your maintenance efforts, reduce the complexity of your installed base and be supported in terms of quality and safety requirements?

Endress+Hauser's maintenance and calibration expertise can help you to achieve these objectives, and much more…

Your primary benefit is a clear view and status of your installed base. Thanks to the inventory, you get an exhaustive database providing traceability for your installed instrumentation.

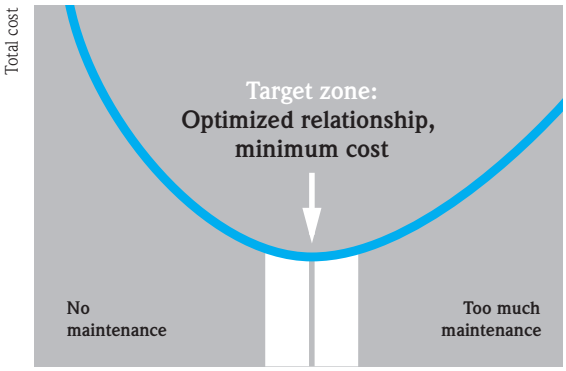
By involving your production, quality and maintenance departments' representatives, our consultant delivers you the keys for making the right decisions in terms of focusing your maintenance and calibration efforts according to your available resources and production requirements.

This service called Installed Base Audit reduces the complexity of an older plant that includes different makes of equipment and large variety of instrument types.

According to your needs, consulting services can help you to reach various additional objectives:

- Reduction of **spare parts stocks**
- **Competence analysis** of your maintenance and metrology personnel
- **Optimization of methods and intervals** for maintenance and calibration
- Minimization of **process downtime**
- Definition of a **complete maintenance and calibration plan** with all master data to fill a plant asset management system.
- Availability of **extended documentation online**, including quality evidences for internal and external **audits**, calibration certificates, people qualification, etc.
- Get a clear proposal for a scheduled **replacement plan** by providing order codes, pricing and logisitical solutions for longer term etc.

Just tell us what you need!



Finding the right balance
Our objective is to help you reach the optimum point where the overall costs are at their minimum level. We understand that too little maintenance and no back-up can result in costly downtime, but on the other hand, too much maintenance is unnecessary and leads to additional expense.

Achieving efficient data management
Installed Base Audit gives you an access to the W@M Portal. The data collected during the on-site inventory are presented here in a structured format. The W@M Portal also includes additional information linked to the serial number of the instrument.

Towards a maintenance plan with Installed Base Audit

Step 1 - Collecting data in the plant

Equipped with a dedicated Personal Digital Assistant, the Endress+Hauser audit technician **collects** and **records**:

- **Instrument data** (serial number, tag, order code, manufacturer, type and model, location, age, measuring principle, process conditions)
- **Application data** (pressure, temperature, medium)

Step 2 - Revealing process critical instruments

During a meeting involving the production, quality and maintenance departments, our consultant asks the right questions in order **to define the critical measuring points** and the maintainability of all your installed instrumentation. Each measuring point is then assigned with the **criticality level** (High, Medium, Low).

Step 3 - Highlighting potential improvements

Our consultant **studies the data collected during steps 1 and 2** and provides the status report giving you an overview of the status of your installed base with global improvement recommendations regarding the different areas of your maintenance activities (preventive and corrective maintenance, standardization, migration).

Step 4 - Analysis and recommendations

Based on the maintenance activities you decided to develop in the step 3, our consultant completes a **thorough study** of the activities to improve. He then defines the **recommendations** for maintenance improvements

Step 5 - Presentation of the results and action plan

Your Endress+Hauser consultant will present you with a **detailed analysis** and the different options available for maintenance optimization. This meeting leads to **the definition of an action plan**. At the conclusion of step 5, we deliver the final **Installed Base Report.**

Calibration and maintenance management agreement

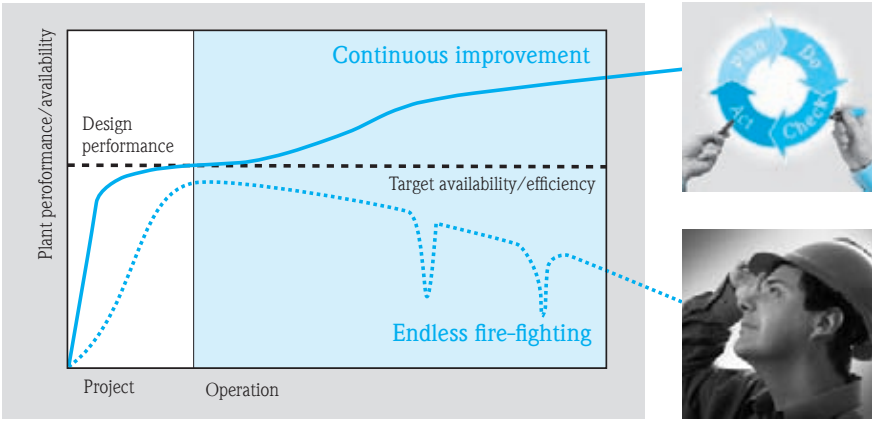
Discover ‘the next level of maintenance’

Relieve your calibration and maintenance headaches and trust us with the management of your activities, freeing you up to focus on your core business – with total peace of mind!

Plant managers seek to continuously improve their operation’s competitiveness by improving productivity and flexibility while maintaining regulatory compliance. Therefore the demands on the maintenance of the plant’s automation system are rising.

The management challenges include a high degree of cost pressures, step-wise tightening of regulations, a lack of skilled people ready to work in a process plant and the complexity of a multi-vendor installed base with a mix of new and old technologies.

On top of that, the typical plant asset management systems in place are often not suited to the management of automation components: either they were installed to take care of complete assemblies and lack the crucial master data of the automation components or they don’t support the business processes required, such as calibration management.



Outsourcing contributes to your bottom line

In order to better focus on their core activities more and more companies try to achieve the outsourcing of maintenance and/or calibration function(s). If you are in this position, you can select from two types of maintenance suppliers: those who concentrate solely on cost reduction, and those who take maintenance to the next level. Usually, ‘next level’ means maintenance that improves sustainably and continuously the operational equipment effectiveness.

Endress+Hauser has opted for this next level where the focus is no longer only on maintaining but also on improving your maintenance/calibration and manufacturing processes. It is not just about cost savings but also about contributing to your bottom line. This outsourcing model is a unique and strategic partnership where both partners can also jointly commit on targeted metrics achievable through a continuous improvement program.

Maintenance and calibration entrusted to true specialists
When you choose a service level agreement, Endress+Hauser takes over the full maintenance and/or calibration function of the field instrumentation of your plant.

As your single point of contact, Endress+Hauser manages multi-vendor support and subcontractors who maintain other components of the control loops such as valves, drives or other system components. By driving this function, Endress+Hauser offers a maintenance/calibration program that turns routine maintenance activities into a profit source by focusing on maintenance costs optimization and quality improvement.

Once both partners have agreed on an effective and efficient corrective and preventive maintenance program to optimize the plant's manufacturing operations, the maintenance team uses standardized workflows to manage the maintenance and calibration function, enabled by a planning and execution system.

A clear view of the activities
This Plant Asset Management system allows transparency and clarity of information about the activities that Endress+Hauser team is performing on-site. If requested, the relevant data sources are integrated in your ERP system, for example to close your work orders or to enhance the accounting.

This data integration is the start to getting the complete picture and the key to facilitate your decision-making process. The connection between of your ERP to the W@M collaboration platform allows to share Key Performance Indicators (KPIs) and other key data, including up-to-date and complete information on all your Endress+Hauser and other suppliers' assets. The Endress+Hauser contract manager is therefore able to continuously identify, analyze and improve existing processes within the maintenance organization to meet new goals and objectives.

Partnership for continuous improvement
This partnership development generally takes place when the maintenance and the calibration management services are developed to set the strategy for maintenance and reliability at the site. Due diligence is performed for finance, human resources (HR), health and safety, mutual responsibility (incl. liability), technical issues, including any agreed performance objectives. The partnership agreement is signed prior to the initiation of the implementation phase. During this phase, systems and networks are installed, the new maintenance organization is announced and implementation plans are finalized for HR, facilities, supply management and accounting.

The maintenance agreement execution phase begins with start-up and training, and the introduction of any new processes. The management process governs the relationship, and the introduction of continuous improvement programs can help improve performance on site.

Via this performance-based partnership, we work with you to achieve a common goal. The results are measurable in terms of cost savings, performance improvements and higher quality.

Proven results

Heineken Netherlands subcontracts instrumentation workshop
"With the current performance of Endress+Hauser, there are a number of advantages that make it possible for us to fully concentrate on our core business…"

Ron Verweij, Maintennace Engineer at Heineken Den Bosch, The Netherlands

LyondellBasel outsources metrology activities
At its Marseille site, Endress+Hauser manages and performs 900 metrological interventions. "Today, people at the production become conscious of the benefits of metrology…"

Mr Porta Y Santacreu, Metrology department coordinator in Marseille, France

Calibration management service supported by a proven process

Step 1 - Kick-off meeting

In cooperation with the customer, the definition of the measuring points to be calibrated, the presentation of the tasks and processes and the creation of the work breakdown structure is carried out.

This allows optimization of calibration scheduling, resulting in a reduction of downtime.

Step 2 - Perform calibration job

On-site calibration is performed by specialized and highly trained staff. For you this means reliable advice, optimum instrument **performance** and true **cost-effectiveness**.

All around the world, Endress+Hauser service engineers are trained and qualified to execute calibrations in line with your quality requirements. (See p. 132 'Calibration services')

Step 3 - Analysis of calibration results

After calibration, results are gathered and analyzed, providing an overview of the job performed and qualification of **metrological performance** and **installed base 'health'**.

Out of the figures we provide advices to optimize calibration strategy in the plant.

Step 4 - Documentation management

In addition to calibration certificates, a W@M Portal is created and populated.

All records are included such as master list, SOP, Calibration Masterplan report, qualifications, accreditations…

Step 5 - Review meeting

This meeting brings the opportunity to review the job performed, identify any weak spots and define improvements for future.

Improvements are documented in an action list and used for the next review meeting.

Proven results

A comprehensive calibration strategy guarantees that quality standards are met
"Endress+Hauser offers utmost flexibility when carrying out calibrations. Measures which are decided upon can be implemented without delay."

Thomas Eggimann, Head of repair shop at GABA International AG, Switzerland

Efficient calibration and maintenance management supported by suitable Plant Asset Management platform

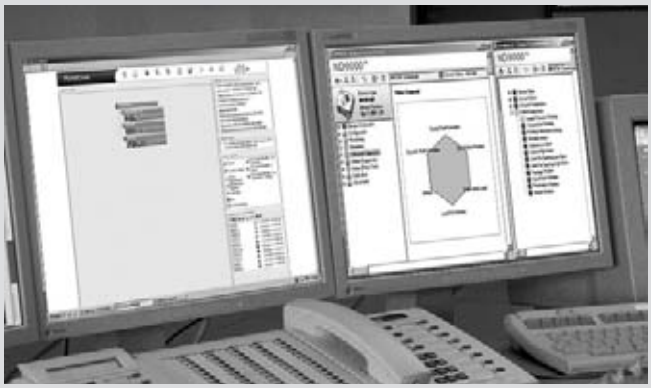
The more that is known about your plant's assets, the easier it is to avoid expensive production shutdowns.

Preventive maintenance including calibration, i.e. regular replacement of devices regardless of their condition can be extremely expensive, while fail and replace strategies can lead to unscheduled shut-downs, particularly if a component has been phased out and there is no identical replacement. Within the scope of a calibration and maintenance management agreement, our Plant Asset Management Platform offers the ideal tools to efficiently manage your assets while meeting your quality requirements.

By monitoring the condition of critical plant components with FieldCare, a predictive maintenance strategy can be evolved, which helps extend their service life and reduces maintenance costs. In addition, calibration is key to gain confidence that the instrument measurement is accurate and within the limits you need to produce a quality product. Nevertheless, calibration can be a major cost factor if not managed properly. Requirements for detailed and traceable records mean that much time can be lost with inefficient manual paperwork processes. By managing the calibration and maintenance activities with Compucal, Endress+Hauser takes care to continuously fulfill the highest quality demands from your auditors, while reducing complexity, time and associated costs.

Poor asset information management has a huge impact on operating costs. Therefore timely, complete, consistent and compliant asset and activity information about the performed activities is key to monitor progress and overall performance. This may require that your plant asset management system be connected with the information sources of Endress+Hauser's Plant Asset Management platform.

Depending on the scope of our partnership agreement, the following use cases could be combined and monitored to meet your performance objectives and to ultimately increase your competitiveness:



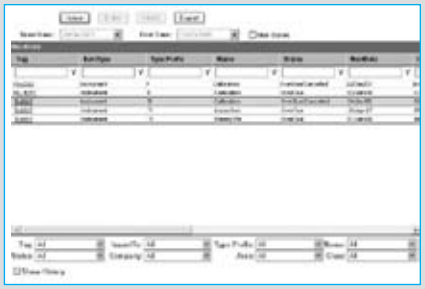
Predict your maintenance

Predictive maintenance makes most sense where the failure or malfunction of devices leads to unsafe conditions, loss of quality or a shutdown of the plant. Examples are overspill protection of hazardous materials or devices with a control function. The health of such measuring points must be continuously monitored, so that any tendency to failure can be countered before a critical situation develops.

Condition Monitoring with NAMUR color-coded status information and a valve diagnosis map help to quickly identify and resolve maintenance requirement. Viewable from any work station via a web browser, the plant overview allows quick localization of device alerts.

→

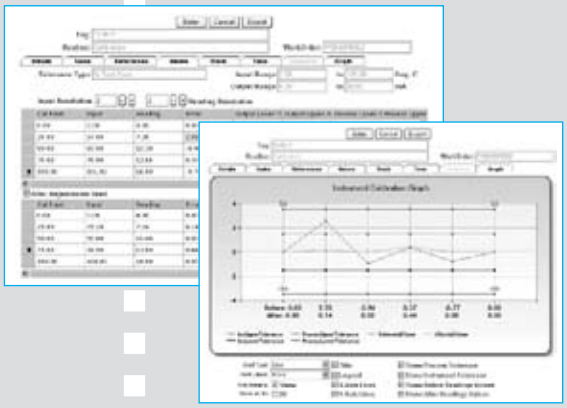
Efficient maintenance and calibration management



Planning and scheduling
Select ‘Due Routine’ from the work screen list. The work screen displays the technician’s current workload and provides easy access to technical information.

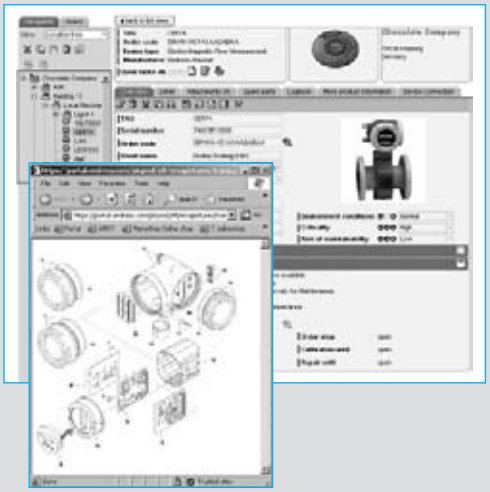
Issue calibration
Add additional tasks, assign reference instruments and issue the work order. Issue scheduled or unplanned work orders for instruments and loops for both calibration and maintenance activities. Once the calibration is issued, the work order including the relevant data is sent to the mobile reference tools used by our technician.

Carry out the work
Carry out the work according to the Standard Operating Procedure.



Automatic filling of calibration results
Once the work is performed, the calibration and maintenance data is sent back to CompuCal. This is color-coded for easy recognition of failures, e.g. yellow for re-adjustment (percentage of process tolerance) and red for deviations when errors exceed process tolerance values. Calibration results may be displayed immediately in graphical form for checking.

Verify data and close
Prior to the data entry being closed, the calibration data entered is verified by the supervisor.

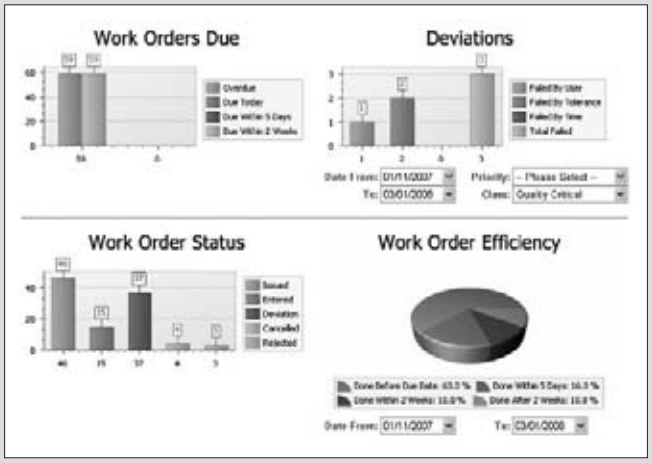


Streamline your processes

Maintenance organizations fail not because of the people themselves but because the people lack the systems, process, methodologies and disciplines to be successful. Operators and maintenance technicians need to have complete, accurate, comprehensive and timely information about their physical assets in order to use them effectively and safely. In practice many loose up to 70% of their day hunting for asset information. Information management, therefore, is fundamental to improving performance.

Endress+Hauser’s W@M Life Cycle Management concept allows users direct access to the equipment records of over 20 years of instrument production. Simply by typing in the device serial number you can access:

- Common equipment record giving details of the device you have purchased
- Automatic registration of all device events and related documentation to get its full history during its life cycle
- Spare parts list for the device
- Current availability of the a device with risk analysis and replacement strategy for phase-out products
- Certificates, operating manuals, device drawings etc.



The KPI (key performance indicators) dashboard in CompuCal enables the quality manager to check the calibration status at a glance.

Enrich your business systems through relevant data integration

Like business managers, plant managers demand real-time data integration and visibility to execute critical business decisions. To be successful, your organization must run its operations effectively and efficiently – which requires the ability to analyze operational performance. If you can't see how you're performing, how do you know you are making the right business decisions? You need to be certain that you can take appropriate actions to build upon your successes, initiate any corrective measures, and effectively plan proactive actions for the future.

It is why integrating data, connecting information and people through efficient technologies to business processes are today an important business strategy to ensure a smooth and seamless plant workflow.

Endress+Hauser offers a range of services to enrich your business systems with integration of relevant information. The Business Process Integration (BPI) approach enables the transfer of information between different IT platforms, as it is common to use different business systems these days.

It connects the systems to make it easy to retrieve relevant information and critical data when required. It improves the business performance regarding to quality, safety and reliability and reduces the maintenance costs. It can also provide remote access capabilities through a highly secure connection between your business systems and ours, allowing our experts to provide continuous support to maximize plant uptime and deliver innovative support services.

Thanks to BPI, Endress+Hauser is able to integrate data into Plant Asset Management, CMMS systems and ERP environments enabling you to optimize your business processes by integrating and sharing key data across various departments. W@M (Web-enabled Asset Management) is used as the collaborative platform to visualize and share Key Performance Indicators and other relevant kind of information, including up-to-date, timely, complete, consistent and compliant plant asset information.

Endress+Hauser officially collaborates with SAP AG in Dresden, Germany, helping to foster research and development in the process industry
Endress+Hauser and SAP are working together to facilitate information exchange, helping to make the information more valuable to our customers, for example through condition monitoring and predictive maintenance.

One of our major goals is to overcome the typical limitations of the automation pyramid model – data confinement and complexity – to map and access all relevant asset information in the plant. We would like to achieve it via open, scalable, lean and secure process automation and IT platforms and prove that real-time asset data with transaction information may be merged and transformed in more than one place, in fact wherever it makes sense, and make information accessible whenever it is needed.

Further information on W@M Life Cycle Management, FieldCare and CompuCal at:

www.automation.endress.com/asset-management

Proven results

Kolb saves time with W@M-Ultimo integration
"The link between Ultimo and W@M Portal saves us a lot of time. We see this immediately, both in finding information and in management of all asset information…"

Jorn Mulders, Instrumentation Technician at Kolb Netherlands

The single source for inventory control, calibration and documentation
"The W@M portal will act as a centralized measuring device database for follow-up audits. The database basically maintains itself…"

Thorsten Woyand, Coordinator Technical Support at Punica Getränke GmbH, Germany

Information technologies are vital to correctly manage assets
"Endress+Hauser's highly experienced and certified calibration and maintenance people combined with the innovative Plant Asset Management system bring worldwide maximum value to our customers."

Stefan Schulze – Endress+Hauser
Product manager Tools and Software

Calibration services

A complete range of calibration services to suit your requirements

Does the instrumentation that controls your quality-critical processes need regular checking, validation and calibration? Do you need a cost-effective service that is fast, high quality, traceable and accredited? Do you need clear and concise calibration certificates?

Endress+Hauser covers all these critical aspects and can perform and advise on all aspects of calibration from in-situ testing through to fully accredited factory calibration. We calibrate your equipment at just the right time to ensure optimal process performance at minimum cost.

Endress+Hauser performs instrument calibrations across a variety of measuring principles. We even extend our calibration service to third party equipment to reduce time, effort and cost in terms of coordination and documentation.

Accredited facilities

Thanks to accredited laboratories installed in our factories and our service organization, we can offer the accredited calibration of:

- Flow: SCS (CH) + A2LA (US)+ ASNITE (J) + CNAS (CN) + EMA (MX) accreditation
- Pressure: DKD (DE) + SCS (CH) accreditation
- Temperature: SIT (I) + COFRAC (F) + DKD (DE) + SCS (CH) accreditation
- Humidity: COFRAC (F) accreditation
- Voltage, current: COFRAC (F) accreditation

On-site calibration

Having also invested in mobile reference tools and in the deployment of a powerful service organization in many countries, Endress+Hauser can also perform on-site calibration of the following parameters:

- Flow
- Pressure
- Temperature
- pH
- Weight
- Density
- Time
- Length
- Speed
- Conductivity
- Voltage, current

Please contact your local sales center to discuss specific requests.

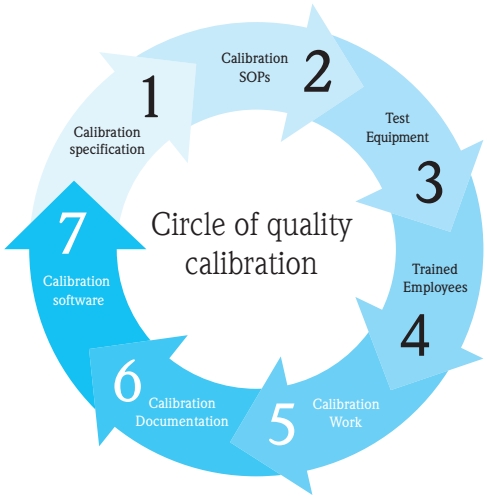
Parameter	Equipment type	Calibration location	
		On-site	Laboratory
Temperature	▪ Resistance thermometer ▪ Probe + temperature transmitter ▪ Probe + display	✔	✔
Pressure	▪ Manometers ▪ Pressure sensors ▪ Pressure transmitters	✔	✔
Flow	▪ Electromagnetic flowmeters ▪ Vortex flowmeters ▪ Coriolis flowmeters ▪ Ultrasonic flowmeters ▪ Thermal flowmeters ▪ Mechanical flowmeters	✔	✔
Conductivity	Conductivity measuring chain including cell, transmitter and cable	✔	
pH	pH measuring chain including cell, transmitter and cable	✔	
Other parameters	On request, we can calibrate other parameters. Please contact your local Endress+Hauser sales center for further information.		

1

Calibration specification
Endress+Hauser will help you to establish your metrology plan by fixing your calibration specifications per parameter (maximum permissible errors, periodicities) or by defining the right reference tools according to their uncertainty.
Together, we will work out which parameters have to be calibrated on site and, in the case of high accuracy requirements, which need calibrating in the laboratory.

2

Calibration SOPs
We offer a full range of Standard Operating Procedures to support our on-site work. SOPs ensure that our work is repeatable all over the world. We also provide site-specific SOP's noting which measuring parameters have to be calibrated on-site and in case of high acccuracy requirements, which need calibrating in the laboratory.



3

Test equipment
Local service centers provide a one-stop calibration and repair service to a wide range of test, measurement and process control instrumentation. So whether you need pressure, analytical, temperature or flow calibration, look no further.
All of our facilities are traceable to national and international standards. This means you are guaranteed the highest level of service compliant with the ISO 17025 standard.

4

Trained employees
On-site calibration is performed by specialist, highly trained staff. This relieves your in-house maintenance staff from routine time-consuming tasks and allows them to focus on improving plant availability. For you this means reliable advice, optimum performance of your instruments and true cost-effectiveness. Our service engineers are trained in accordance to GMP and we can offer full validation services if required.

5

Calibration work
All of our primary calibration facilities operate and are accredited to ISO 17025 and are located around the world. We own and operate more calibration laboratories than any other instrumentation supplier. As a leading supplier of field instrumentation we not only can calibrate but also quickly and efficiently adjust, repair or replace equipment that is failing to meet the specified criteria. Our specialists have the necessary skills and equipment to calibrate all makes of instruments.

6

Calibration documentation
We support our service with certified and traceable documentation.
A calibration certificate compliant with the ISO 17025 standard is issued. It details all required data in form that is easy to understand. Importantly, it also satisfies all relevant authorities.

7

Calibration management software
Compucal is a high performance scheduling and electronic software tool that helps to control the scheduling activity around your installed base, providing traceable and auditable records.

Proven results

One-stop shop saves time and money at Coca-Cola Beverages
"Endress+Hauser calibrates 66 measuring points from a wide variety of manufacturers, some up to four times a year… We are very satisfied with the service."

Rolf Bieri, Executive Producer of Coca Cola in Brüttisellen, Switzerland

Gerolsteiner puts its trust in the manufacturer
"Endress+Hauser's calibration service is defined by the high level of professionalism and expertise. These strengths are very much in evidence throughout the entire service capabilities of Endress+Hauser"

Guido Moll, Coordinator Calibration Management at Gerolsteiner Brunner

Auditable documentation for Punica
"Auditors also pay more attention to verification measures for individual measuring points. In this respect, much progress has been made in recent years in the calibration of measuring points."

Dr. Birte Gerken, Quality Manager at Punica Getränke GmbH, Germany

Maintenance services

Evidence of total support

It would be nonsense to offer you a whole range of value added services if we weren't able to sustain you in case of trouble or emergency!

Total support from Endress+Hauser means that we strive to prevent any breakdown caused by process instrumentation and, if need be, minimize downtime through quick diagnosis and prompt repair.

Technical support

Within the scope of the technical support, we offer for our products, softwares and solutions a broad spectrum of services tailored to your needs. Our technical support specialists advise and support you if you have any questions concerning functions, handling and application of our assets installed in your plant.

You will benefit from:
- Easier and quicker diagnosis
- Reduction of carbon footprint by avoiding an on-site vist
- Recommendations for products and software installation
- Advice on the regular maintenance of our equipment

A dedicated phone line and a system that records your calls ensures reliability, traceability and efficiency.

Preferential processing of urgent cases, availability outside working hours, support via remote diagnosis can also be proposed within the framework of an agreement.

For more information on our remote capability, see p. 128.

On-site diagnosis and repair

Our team of dedicated troubleshooters are always on hand for situations of breakdown and on-site repair. At their disposal are special tools that help them provide fast and efficient diagnosis and repair.

Within the scope of a service level agreement, we offer call-out times dependent upon your level of urgency.

Workshop services

Sending back an instrument to our workshop is an opportunity to benefit from various services such as technical checks, preventive maintenance, repair followed by functional or even metrological tests and laboratory calibration.

Our goal is to have your instrument returned to you within five working days after the receipt date in our workshop. If the standard turnaround time is not acceptable, we can propose an emergency service in the scope of a service level agreement.

Returning material

Ensure safe and secure return of instruments from the outset
Typically for repairs, laboratory calibrations or wrong orders/deliveries you will need to return your instrument(s) to us.

Because we value your time and strive to minimize possible downtime, we provide guidance to ensure that your request is registered and processed as soon as possible, sometimes even before we physically receive your return.

In order to guarantee that your returned device is proactively taken into consideration and handled according to safety standards, you might have to provide important information such as safety statement certificate for example.

The requirements for safe returns may differ according to device type or country legislation.

You will find detailed information at **www.services.endress.com/return-material** or you can call our technical support for more information.

Preventive maintenance

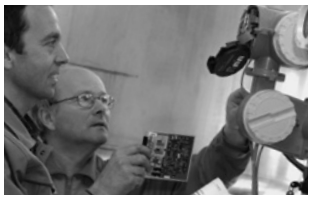
With Endress+Hauser service contracts, you decide the right level of maintenance support you require. We provide regular checks on your equipment and warranty extensions providing you with complete peace of mind and cost control. From regular support to partnership agreements, we offer four distinct levels of service:

Preventive service
We test and certify the operating integrity of the equipment to ensure optimum performance and full compliance to specific regulatory requirements. Periodic checks according to our Standard Operating Procedures (SOP) can be combined with annual replacement of worn parts or consumables, telephone support during non-opening hours. An independent report confirms the instrument's performance and reliability.

Your benefits
- The necessary maintenance tasks to ensure an optimal instrument performance
- The delivery of documented reports to ensure you comply to audited quality procedures

Extended service
In addition to the features of the preventive service, we guarantee to support all contracted instruments. This covers any call-out costs for travel and time on-site. Furthermore, commissioning costs for new instruments under contract agreement will be covered by Endress+Hauser.

Your additional benefits
- Reliable back-up and instrument operation between preventive maintenance visits
- Any pre-arranged extra visits for the commissioning of newly contracted equipment are included in the costs



Total service
In addition to the features of the extended contract, we cover any costs for spare parts in the event of equipment failure. As an option, we can support all the contracted instruments for on-site repairs within a predefined quick response time.

Your additional benefits
- Commissioning spares call-out covered
- Complete control of your maintenance budget

Tailor-made service
Peace of mind, reliability and security of your installed base - we can help you to achieve all these with a tailor-made service agreement. In consultation with you, we define and agree a scheduled package of services and guarantee we meet all your maintenance needs and provide a bespoke service solution. For example, this kind of contract can include calibration activites, remote services, maintenance of software updates etc.

Your additional benefits
- Endress+Hauser support services perfectly complement your internal resources.

Support services

Keep your application up-to-date and running at optimum

Reliable, up-to-date application is a critical part of your process. Is yours getting the attention it deserves?
We have all been confronted with software-related system problems – and all experienced how it can completely cripple our processes.

Instead of focusing on our core business, we get distracted with trying to solve IT problems that should ideally be resolved by experts. The solution? Entrusting Endress+Hauser with the support of your software and hosted applications.

Rapid and professional
To get the most out of your Endress+Hauser application, simply choose the level of support you need. All our packages include professional service and software updates:

- **Software Update Support Service**: the ideal way to keep your software solutions continually up-to-date.
- **Application Support Service**: a wider scope of support for your application with your choice of appropriate response time.

Your benefits with Endress+Hauser
Our support services will:
- Reduce your operating costs and increase your efficiency
- Achieve a quick return on your investment through support and regular software updates
- Minimize the time and effort involved in solving your application issues
- Minimize your risk of process interruption

Endress+Hauser's vast product expertise can help your organization to quickly resolve even the most complex application-related issues and thereby keep operations functioning efficiently.

The information below provides food for thought when considering a support service that will guarantee that the newest hardware is integrated, all available operating systems are supported and that your application can still be supported. What you get is direct access to competent support when you need it.

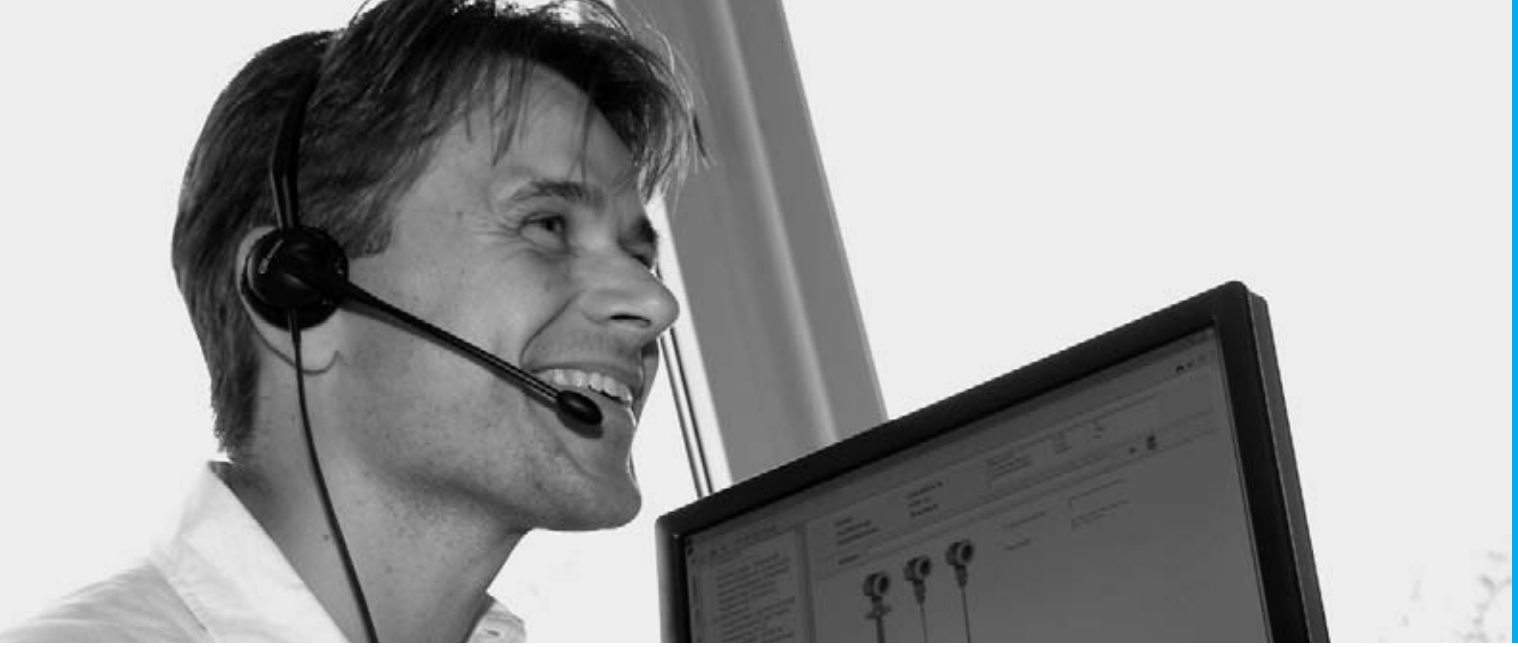
A typical crisis scenario
The four-year-old PC on which your preferred PAM software was running crashes… what now? Can you still find the same PC hardware? Probably not. What about your operating system? Try finding a PC running Windows XP when Windows 7 is today's standard!

The settings you were using were probably based on a serial interface. Can you switch it to the current standard USB interface or even imagine having it with Bluetooth or wireless technologies?

Constantly up-to-date software
The latest software helps you to commission new instruments! Having the latest software drivers (DTMs) for your Endress+Hauser devices running in FieldCare can help you commission the device as fast as possible. The result is a faster start-up time for your process and, in turn, your plant.

We deliver the latest driver packages as soon as they are released. Simply insert the DVD you receive as part of our support service for FieldCare and update the existing driver library with the new DTM package.

Tailor-made support
Your personal guide through today's technology jungle! Regardless of the infrastructure system components you connect through, our support service provides the necessary information to establish a successful connection to your intelligent components, for e.g. the correct bus parameters of a PROFIBUS topology or the configuration setting of a remote I/O driver during setting up a project within FieldCare.Our support service could also help if your automation infrastructure prompts you to access the HART or PROFIBUS information vertically through the corresponding system components.



Get the most out of your system and processes with Endress+Hauser solutions

Software Update Support Service – what does this cover?
Following the initial release of a major software version, a software update is developed to enhance, modify or fix any minor issues associated with the initial release. Endress+Hauser's Update Support Service ensures that you always get the latest update of your software.

With FieldCare software for example, the update includes new frames and DTM updates. By having the latest DTM update, you minimize the risk of a process interruption during device configuration. Moreover, phone and email support is provided for update-related information.

Application Support Service
Application Support Service includes all the features of the Update Support Service plus technical support for usage and configuration for your application.

With our Application Support Service, you get a rapid response to any questions you may have related to your FieldCare software such as how to handle projects, how to create device documentation and even how to link to the W@M database and to establish a W@M connection. Better still, you can also choose the response time that best fits your requirements (see table below).

Features	Software Update Support Service	Application Support Service
Applicable for	**Software**	**Solution**
Software update	✓	✓ (if applicable)
Support by phone and/or email	✓	✓
Support availability 8 hours a day, 5 days a week	✓	✓
Guaranteed response time	Within **1** working **day**	Within **1 hour***
Support availability 8 or 24 hours a day, 7 days a week		Optional
Direct contact to expert team		✓
Assistance for installation, use and configuration of the supported application		✓
Direct contact for on-site field service planning		✓

* 2 hours outside working hours

Maximize uptime through cost-effective support

Reducing our carbon footprint and supporting a sustainable environment is a growing concern for Endress+Hauser. And we know that many companies that call upon our services share this concern. This is why we are heavily investing in remote capability.

Endress+Hauser support services with remote capability provide secure, direct connections between your Endress+Hauser applications and our experts teams. Remote technical support is an innovative service that helps maximize system uptime and improve your business processes.

Seamless support for your solutions via remote capability
Through in-depth knowledge of instrumentation services and automation solutions, Endress+Hauser develops long-term and reliable partnerships with companies that employ the same strategy. We combine our strengths and competence in understanding your business challenges and translate them into support services with real benefits. Whenever possible, we utilize state-of-art IT platforms such as W@M, remote access with support of KPI dashboards to provide a cost-effective, efficient and sustainable way with the smallest carbon footprint and that delivers a great experience.

These support services with remote capability contribute to generate value regarding cost savings, enhanced application support, workflow efficiencies with increased operational usage time and improved experience, such as quicker problem solving via remote connection to our customer service system.

With equipment diagnostic information at their fingertips, our technical support team can quickly understand the scope of a support issue, and significantly reduce the resolution time. Endress+Hauser support services are therefore an economically sound approach to supplementing on-site maintenance personnel. Preventing asset failures and quickly resolving those that may occur, increases the overall system reliability, availability, and operational performance.

For more information, please contact your local Endress+Hauser sales center.

Three complementary tools to help with everyday problems

- The Maintenance Guide: this manual is the reference text for your production, metrology and maintenance teams. Keep a printed copy on your desk all year round and have a shortcut to the PDF version on your computer desktop for quick reference. The content is updated on a regular basis.
- 'Maintenance Today' is a magazine for all instrument users and anyone with responsibility for quality issues. Printed once or twice a year, it contains a selection of in-depth articles, case studies and useful information. It provides guidance on handling the challenges and developments you are likely to meet, and on choosing the tools and services best adapted to your needs.
- 'Maintenance Actions' is a handy collection of information sheets dealing with a specific subject of direct relevance to your day-to-day operations. Each sheet identifies your option(s) for immediate action. We publish several sheets each year.

Find these maintenance publications at
www.services.endress.com/maintenance_publications

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