

# Special Documentation

## **Proline Promass 200**

Heartbeat Technology Application Package



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# 1 Document information

## 1.1 Document function

The document is part of the Operating Instructions and serves as a reference for application-specific parameters, providing a detailed explanation of each individual parameter of the operating menu.

## 1.2 Using this document

### 1.2.1 Information on the document structure

 For the alignment of parameters with short descriptions according to the **Display/Operation, Setup, Diagnostics** menu structure, Operating Instructions manual for the device.

 For information about the operating philosophy, see the "Operating philosophy" chapter in the device's Operating Instructions

## 1.3 Used Symbols

### 1.3.1 Symbols for certain types of information

| Symbol                                                                                          | Meaning                                                                                                                        |
|-------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <br>A0011193 | <b>Tip</b><br>Indicates additional information.                                                                                |
| <br>A0011194 | <b>Reference to documentation</b><br>Refers to the corresponding device documentation.                                         |
| <br>A0011195 | <b>Reference to page</b><br>Refers to the corresponding page number.                                                           |
| <br>A0011196 | <b>Reference to graphic</b><br>Refers to the corresponding graphic number and page number.                                     |
| <br>A0013140 | <b>Operation via local display</b><br>Indicates navigation to the parameter via the local display.                             |
| <br>A0013143 | <b>Operation via operating tool</b><br>Indicates navigation to the parameter via the operating tool.                           |
| <br>A0013144 | <b>Write-protected parameter</b><br>Indicates a parameter that can be locked against changes by entering a user-specific code. |

### 1.3.2 Symbols in graphics

| Symbol             | Meaning      |
|--------------------|--------------|
| 1, 2, 3 ...        | Item numbers |
| A, B, C, ...       | Views        |
| A-A, B-B, C-C, ... | Sections     |

## 1.4 Documentation

This manual is a Special Documentation; it does not replace the Operating Instructions included in the scope of supply.

For detailed information, refer to the Operating Instructions and other documentation on the CD-ROM provided or visit "[www.endress.com/deviceviewer](http://www.endress.com/deviceviewer)".

The Special Documentation is an integral part of the following Operating Instructions:

| Sensor    | HART     | PROFIBUS PA |
|-----------|----------|-------------|
| Promass E | BA01027D | BA01133D    |
| Promass F | BA01112D | BA01113D    |



This Special Documentation is available:

- On the CD-ROM supplied with the device (depending on the device version ordered)
- In the Download area of the Endress+Hauser internet page:  
[www.endress.com](http://www.endress.com) → Download

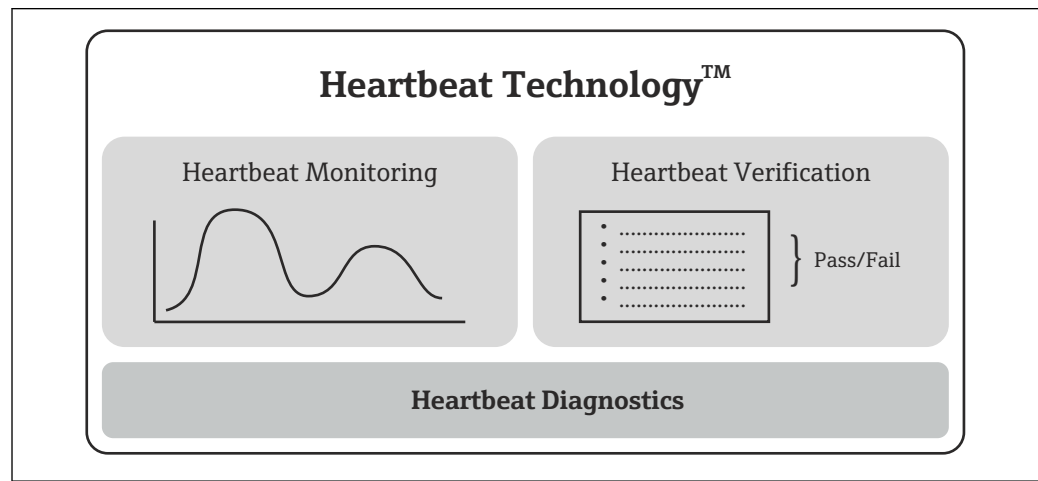
### 1.4.1 Content and scope

This Special Documentation contains descriptions of the additional parameters and technical data that are available with the Heartbeat Technology application package.

## 2 Product features and availability

### 2.1 Product features

Proline flowmeters with Heartbeat Technology offer diagnostic functions through continuous self-monitoring (**Heartbeat Diagnostics**), the transmission of additional measured variables to an external Condition Monitoring system (**Heartbeat Monitoring**) and the in-situ verification of flowmeters in the application (**Heartbeat Verification**).



 1 Heartbeat Technology: Overview of modules and correlated functions

**Heartbeat Diagnostics** is a basic function of all the Proline measuring devices.

The **Heartbeat Monitoring** and **Heartbeat Verification** modules are optional (→  7).

#### 2.1.1 Heartbeat Diagnostics

The **Heartbeat Diagnostics** function provides information on the device status and is represented in the form of status signals (device diagnostics). **Heartbeat Diagnostics** is a basic function of all the Proline measuring devices.

For more information on diagnostics, see the "Diagnostics and troubleshooting" section of the Operating Instructions.

#### 2.1.2 Heartbeat Monitoring

Continuous output of monitoring measured values for monitoring in an external Condition Monitoring system. The measured values are transmitted to a Condition Monitoring system via the outputs provided on the measuring device.

#### 2.1.3 Heartbeat Verification

The functionality of the device is checked on demand. The results of the check are saved as a data set in the measuring device and documented in the form of a verification report.

 It is recommended to use the **Heartbeat Verification** function for the first time directly as part of the commissioning routine (→  15).

## 2.2 Availability (product list and order option)

Heartbeat Technology is available for all Proline measuring principles. This enables the use of the function for the entire installed base of Proline flowmeters.



Please contact your Endress+Hauser sales organization for further information.

### Order option

**Heartbeat Diagnostics** is a basic function of all the Proline measuring devices.

The **Heartbeat Monitoring** and **Heartbeat Verification** modules are optional and are indicated as order options in the product price list:

Order feature "Application Package", **EB** "Heartbeat Verification + Monitoring" option

If this order option is selected, the functionalities for **Heartbeat Monitoring** and **Heartbeat Verification** are already available in the device on leaving the factory. It is also possible to upgrade to this function during the life cycle of the measuring device.



Heartbeat Technology is compatible with all the system integration options. Interfaces with digital communication are required to access the data saved in the measuring device. The speed of data transmission depends on the type of communication interface used.



Please contact your Endress+Hauser service or sales organization for further information regarding product availability and upgrades to existing measuring devices.

For information on how to enable the function (→  15).

## 3 Product description

### 3.1 Overview

The "Heartbeat Verification + Monitoring" application package can be used to verify the functionality of the device in the application (**Heartbeat Verification**); the measuring device can also be used to output additional measured variables to an external Condition Monitoring system (**Heartbeat Monitoring**).

This Special Documentation complements the Operating Instructions and describes the additional functions that are available when the "Heartbeat Verification + Monitoring" option is ordered. The Special Documentation is an integral part of the Operating Instructions.

Proline measuring devices with Heartbeat Technology have an integrated self-monitoring system that monitors the entire measuring chain from the sensor to the outputs. This integrated self-monitoring system supplies additional information (measured variables) for the direct assessment of the state of the measuring device, and information on process influences that affect the measuring function and performance.

The information gathered during self-monitoring is made available by the **Heartbeat Diagnostics**, **Heartbeat Monitoring** and **Heartbeat Verification** functions in a variety of ways (→  6):

- The **Heartbeat Diagnostics** function supplies continuous information about the state of the measuring device. It is represented in the form of status signals (device diagnostics).
- With **Heartbeat Monitoring** it is possible to output additional monitoring-specific measured values for monitoring in an external Condition Monitoring system during continuous operation. The measured values are transmitted to a Condition Monitoring system via the outputs provided on the measuring device.
- The flowmeter is verified on demand using the **Heartbeat Verification** function. The results of the check are documented as a data set in the measuring device and in the form of a verification report. The result of the verification is a statement on the condition of the device: **Pass** or **Fail**.

### 3.2 Detailed product description

#### 3.2.1 Heartbeat Diagnostics

##### Purpose

With the **Heartbeat Diagnostics** function, information on the status of the measuring device is generated on the basis of continuous self-monitoring and represented in the form of status signals (device diagnostics). The diagnostic data are classified and contain information on the cause of the error and remedial measures.

##### Aim

Continuously output status signals via the operating interfaces and to the higher-level system (system integration).

##### Advantages

- Continuous monitoring and integration with the higher-order system ensure that information on the condition of the measuring device is available in real time and processed in time.
- Remedial measures are provided for each diagnostic event to ensure that problems can be rectified quickly.

##### Customer and industry requirements

The status signals are classified in accordance with VDI/VDE 2650 and NAMUR Recommendation NE 107.

For more information on diagnostics, see the "Diagnostics and troubleshooting" section of the Operating Instructions.

### 3.2.2 Heartbeat Monitoring

#### Purpose

Condition Monitoring is defined as the continuous monitoring of flowmeter measured variables in an external system. This is different from the continuous self-monitoring performed by the device, which forms the basis for device diagnostics. On the basis of continuous self-monitoring, **Heartbeat Monitoring** makes additional monitoring-specific measured values available. A range of measured variables is provided that relates to the measuring performance of the flowmeter.

The analysis of these continuous measured variables in a Condition Monitoring system makes it possible to assess these measured variables from the perspective of the application. Device diagnostics assesses measured variables with regard to the condition of the measuring device (system integrity, operation outside of manufacturer's specifications) and with regard to any restrictions or interruptions in the measuring function due to unsuitable process conditions. The purpose of **Heartbeat Monitoring**, on the other hand, is to use additional measured variables in the context of the application. Therefore the measured variables are interpreted in the Condition Monitoring system as opposed to interpretation by the flowmeter. The flowmeter only serves to supply the information.

#### Aim

To monitor the application, relevant monitoring-specific measured values are transmitted to a Condition Monitoring system via the outputs provided at the measuring device. The monitoring-specific measured values are assessed in the Condition Monitoring system and used to control measures in the area of maintenance (such as cleaning) or process optimization. Ideally these measures can be implemented before the process safety or product quality of the application is affected.

Possible applications for Promass Condition Monitoring include:

- Formation of buildup in the sensor
- Corrosive or abrasive fluids
- Multi-phase fluids (gas content in liquid fluids)
- Wet gases
- Applications in which the sensor is exposed to a programmed amount of wear

#### Advantages

- Measured variables preprocessed in the measuring device are made available for easy integration into the Condition Monitoring system.
- Early detection of changes (trends) to ensure plant availability and product quality.
- Use of information for the proactive planning of measures (cleaning).
- Identification of undesirable process conditions as the basis to optimizing the facility and the processes.

#### Customer and industry requirements

- For a product to have a high level of quality, the process quality must be monitored continuously and the quality of flow measurement must remain constant.
- High system availability requires the prevention of unscheduled downtime and short turnaround times for repair work – proactive, forward planning is a prerequisite for this.

### 3.2.3 Heartbeat Verification

#### Purpose

**Heartbeat Verification** uses the self-monitoring function of the Proline flowmeters to check the measuring device functionality. Verification is performed on demand. During the verification process, the system checks whether the measuring device components comply with the factory specifications. Both the sensor and the electronic modules are included in the tests. The results of the check are saved as a data set in the measuring device and documented in the form of a verification report, if required. The request for verification can come from a higher-order system via the system integration interface. The overall result of the device function test (**Pass/Fail**) can also be relayed to this higher-order

system. The result of the verification is a statement on the condition of the measuring device: **Pass** or **Fail**. Data interpretation by the user is not required.

#### Aim

To confirm the consistent quality of the measurement in the life cycle of the product by periodically checking the measuring device functionality. Creation of traceable documentation of the condition of the measuring device in the life cycle of the products.

#### Advantages

- The functionality is integrated in the measuring device and therefore available via all the operating and system integration interfaces. No onsite presence is required to use the function, thereby saving time and making the function easily available at any time.
- As the measuring device interprets and documents the results of the verification itself (**Pass/Fail**), no special knowledge is required on the part of the user.
- The documentation of the verification (verification report) can be used to prove quality measures to a third party.
- The use of the **Heartbeat Verification** function as a method to test Proline measuring devices in the application means it can replace other maintenance tasks (periodic check, repeat calibration) or be used to extend the testing intervals.

#### Customer and industry requirements

- Compliance with ISO 9001 (measuring points relevant to quality)
- Testing of measuring points with regard to energy monitoring, utilities and greenhouse gas emissions
- Testing of measuring points as regards billing
- Proof testing as part of functional safety (SIL)

## 3.3 Performance characteristics

Heartbeat Technology™ carries out checks on the measuring device which increase the reliability of the measured value output.

### 3.3.1 Heartbeat Diagnostics

Heartbeat Diagnostics carries out diagnostic tests in the electronics modules based on continuous self-monitoring. The test scope achieved using these diagnostic tests is referred to as Total Test Coverage – TTC.

The TTC is expressed by the following formula for random errors (calculation based on FMEDA as per IEC 61508):

$$TTC = (\lambda_{TOT} - \lambda_{du}) / \lambda_{TOT}$$

$\lambda_{TOT}$ : Rate of all theoretically possible failures

$\lambda_{du}$ : Rate of undetected dangerous failures

Only dangerous undetected failures are not identified by the instrument diagnosis and, if they occur, can distort the measured value that is output or interrupt the output of measured values.

Heartbeat Diagnostics checks the device function within the specified measuring tolerance using a defined TTC.

For the Promass 200, the TTC is 92 %. If SIL operation is activated, this increases to 97 %.



If the SIL mode is enabled, continuous diagnostics for the 4 to 20 mA current output is active; this increases the TTC.

For further information on the SIL mode, refer to the "Functional Safety Manual"



The current value for TTC depends on the configuration and integration of the measuring device. The values specified above presuppose the following basic conditions:

- Integration of measuring device for measured value output via 4 to 20mA HART output
- Simulation operation not active
- Error behavior current output set to **Minimum alarm** or **Maximum alarm**. The switching unit must identify both alarms.
- The settings for the diagnostic behavior correspond to the factory settings.

### 3.3.2 Heartbeat Verification

Heartbeat Verification is carried out on demand and, by means of additional checks, complements the diagnostics performed during diagnosis: internal verification also checks the 4 to 20 mA current output, and external verification supports the testing of all output modules.

This reduces the proportion of failures which are not detected during diagnosis ( $\lambda_{du}$ ): using the Heartbeat Verification test sequences described, an additional 5 % of these failures can be detected.

## 3.4 Proof-test

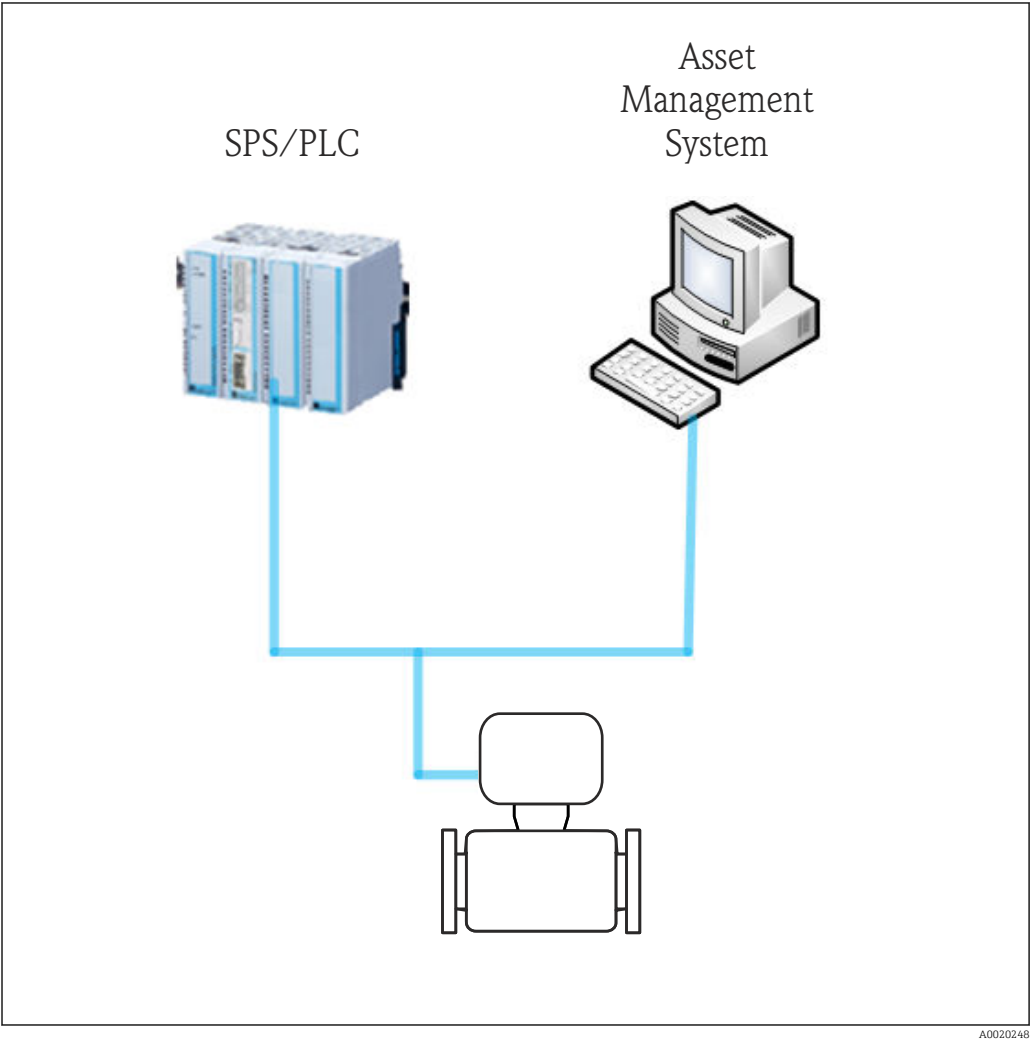
Proline measuring devices allow proof testing to be carried out in their installed state using Heartbeat Verification.

For further information on proof testing, see the Functional Safety Manual

## 4 System integration

For basic information on system integration, see the "System integration" section of the Operating Instructions.

The Heartbeat Technology functions are available via the digital interfaces. The functionalities can be used via an asset management system and the automation infrastructure (e.g. PLC).



A0020248

Here, data exchange can be either automated or performed by a user.

### 4.1 Automated data exchange

| Heartbeat Diagnostics                                                                                                                   | Heartbeat Monitoring                                                                                                                                                          | Heartbeat Verification                                                                                                                          |
|-----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>Analyze field device diagnostics</li><li>Diagnostic events for integration with the PLC</li></ul> | <ul style="list-style-type: none"><li>Continuous trend analysis</li><li>Additional monitoring of measured variables for processing in a Condition Monitoring system</li></ul> | <ul style="list-style-type: none"><li>Instrument check via self-monitoring</li><li>Start verification and upload verification results</li></ul> |

#### 4.1.1 Automated data exchange: Heartbeat Monitoring

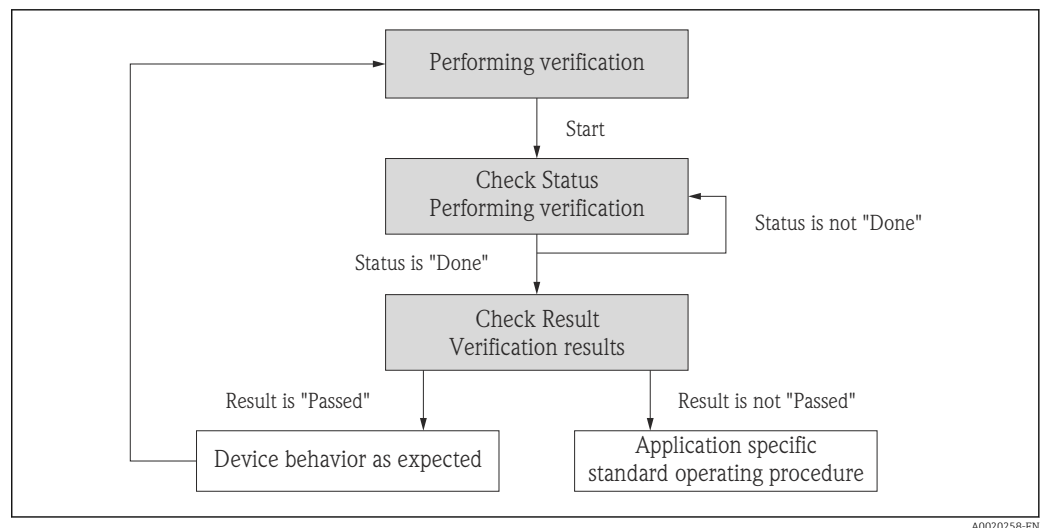
The following procedure describes the work flow that is principally involved in the automated handling of the **Heartbeat Monitoring** function, and the use of data for Condition Monitoring:

- The host application configures the cyclic services of the field device for **Heartbeat Monitoring**
- The field device communicates PVs (process variables) from **Heartbeat Monitoring**
- The host application analyzes the **Heartbeat Monitoring** PVs (e.g. trends, limit value monitoring)
- The host application initiates application-specific standard operating procedures (e.g. a "Maintenance Required" alarm is signaled or maintenance instructions are triggered)

 The fieldbus-specific implementation (Modbus RS485, EtherNet/IP, HART, PROFIBUS DP) is described in the "Technical data" section of the Operating Instructions under "Output".

#### 4.1.2 Automated data exchange: Heartbeat Verification

The self-monitoring function integrated in the measuring device can be activated by a control system and the results can be checked. The following procedure must be implemented for this purpose:



- **Verification performance:**  
The verification is started using the "Start verification" parameter.
- **Verification status:**  
On completion of the verification, the value of the "Status" parameter changes to **"Done"**.
- **Verification result:**  
The overall result of the verification is indicated in the "Overall result" parameter. Different application-specific measures must be performed by the system depending on the result, e.g. a "Maintenance Required" alarm is triggered if **"Passed"** is not displayed as the result.

4.2 Data exchange performed by the user (asset management system)

| Heartbeat Diagnostics                                                                                                                                                                      | Heartbeat Monitoring                   | Heartbeat Verification                                                                                                                                                                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>Identify remedial measures</li><li>Information on the cause of the error and remedial measures are provided in the asset management system</li></ul> | Configuration of the monitoring system | <ul style="list-style-type: none"><li>Instrument verification via self-monitoring</li><li>Start verification</li></ul> Upload, archive and document verification results including detailed results |

 Data exchange performed by the user is described in the "Commissioning" (→  15), "Operation" (→  18) and "Heartbeat Technology – integration" (→  32) sections.

## 5 Commissioning

### 5.1 Availability

If the optional package for **Heartbeat Monitoring** and **Heartbeat Verification** was ordered for the flowmeter from the factory, the function is already available when the measuring device is delivered to the customer. The function is accessed via the operating interfaces of the measuring device, via the Web server or Endress+Hauser's FieldCare asset management software. No particular measures are required to put the function into operation.

Ways to check function availability in the measuring device:

- Using the serial number:  
W@M Device viewer <sup>1)</sup> → Order code "Heartbeat Verification + Monitoring", option **EB**
- In the operating menu:  
Check whether the function is indicated in the operating menu: Diagnostics → Heartbeat  
If the "Heartbeat" option is available the function is activated.

If the function cannot be accessed in the measuring device, the optional package was not selected. It is then possible to upgrade to this function during the life cycle of the measuring device. On most flowmeters it is possible to activate the function without having to upgrade the firmware.

#### 5.1.1 Activation without firmware upgrade

You require a conversion kit from Endress+Hauser to enable the function without upgrading the firmware. Among other things, this kit contains an activation code which must be entered via the operating menu to activate the "Heartbeat Verification + Monitoring" function.

The activation function is available under "Setup → Advanced setup → Enter access code".

Once activated, the **Heartbeat Monitoring** and **Heartbeat Verification** modules are permanently available in the measuring device.

Activation without firmware upgrade is possible as of the following firmware versions:

- HART: 01.03.zz
- FOUNDATION Fieldbus: 01.00.zz
- PROFIBUS DP: 01.00.zz
- PROFIBUS PA: 01.00.zz

#### 5.1.2 Firmware upgrade before activation

If you have a measuring device that requires a firmware upgrade before it can be activated, please contact your Endress+Hauser service organization.

This function requires service-level access to the device.

A firmware upgrade is required for measuring devices with earlier firmware versions (see "5.1.1 Activation without firmware upgrade").



Please contact your Endress+Hauser service or sales organization for further information regarding product availability and upgrades to existing measuring devices.

### 5.2 Heartbeat Diagnostics

The diagnostics functions are part of the basic features of Proline flowmeters: See the "Diagnostics and troubleshooting" section of the Operating Instructions.

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1) [www.endress.com/deviceviewer](http://www.endress.com/deviceviewer)

## 5.3 Heartbeat Monitoring

**Heartbeat Monitoring** is put into operation by activating the monitoring function and assigning the measured variables, which are relevant for monitoring from the point of view of the application, to the outputs on the measuring device. Once commissioning is completed, the selected monitoring-specific measured variables are continuously available at the outputs.

### Activating/deactivating the monitoring function

The transmission of monitoring-specific measured variables is switched on or off in the operating menu:

(→  18)

### 5.3.1 Parameter selection: Outputs

The monitoring-specific parameters listed below can be assigned to the outputs for continuous transmission to a Condition Monitoring system.

 Some parameters are only available if the "Heartbeat Monitoring" function is enabled in the measuring device.

| Parameter                | Description                                                                                    | Value range                                                                               |
|--------------------------|------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| Oscillation damping      | Mechanical damping of the measuring tubes/tube in A/m                                          | 0 to 100 000                                                                              |
| Carrier pipe temperature | Temperature of the sensor carrier tube in the set system unit                                  | −60 to +200 °C                                                                            |
| Electronic temperature   | Temperature of the electronics in the set system unit                                          | −50 to +90 °C                                                                             |
| Oscillation frequency    | Oscillation frequency of the measuring tube/tubes in Hz                                        | Depends on the sensor type, version and nominal diameter (see Service Checklist SH01003D) |
| Oscillation amplitude    | Relative mechanical oscillation amplitude of the measuring tube/tubes in % of the target value | 0 to 150 %                                                                                |
| Signal asymmetry         | Relative deviation of the signal amplitude between the inlet and outlet sensor in %            | ±10 %<br>(In the event of a defect: ±200 %)                                               |

 For information on using the parameters and interpreting the measurement results (→  41).

## 5.4 Heartbeat Verification

It is not necessary to commission the **Heartbeat Verification** function. The configuration (factory reference) required as part of **Heartbeat Verification** is recorded during calibration at the factory and is permanently stored in the measuring device. When verifying in the application, the current situation of the measuring device is compared against this factory reference.

 It is advisable to perform an initial verification when commissioning the measuring device or directly after activating the **Heartbeat Verification** function and to save the results as the initial situation in the life cycle of the measuring device (→  18).

### 5.4.1 Recording of customer and location

It is possible to manually record reference data relating to the customer and the location. If this function is used, these reference data appear in the verification report.

Reference data are recorded in the operating menu:

- "Setup → Advanced setup → Heartbeat setup → Heartbeat base settings → Customer"
- "Setup → Advanced setup → Heartbeat setup → Heartbeat base settings → Location"
- "Expert → Diagnostics → Heartbeat → Heartbeat base settings → Customer"
- "Expert → Diagnostics → Heartbeat → Heartbeat base settings → Location"

## 6 Operation

### 6.1 Heartbeat Diagnostics

The diagnostics functions are part of the basic features of Proline flowmeters.

For more information on diagnostics, see the "Diagnostics and troubleshooting" section of the Operating Instructions.

### 6.2 Heartbeat Monitoring

#### Activating/deactivating the monitoring function

Once the device has been commissioned successfully, the continuous transmission of monitoring-specific measured variables to the outputs is switched on or off in the operating menu:

- "Setup → Advanced setup → Heartbeat setup → Heartbeat monitoring"
- "Expert → Diagnostics → Heartbeat → Heartbeat monitoring"

### 6.3 Heartbeat Verification

#### 6.3.1 Initial verification

It is advisable to perform an initial verification when commissioning the measuring device and to save the results as the initial situation in the life cycle of the measuring device.

#### 6.3.2 Product features

For basic information on the product features of **Heartbeat Verification**(→  8). Refer to this section of the manual before continuing device operation.

#### 6.3.3 Operation – performing a verification

Verification is performed on demand and started in the operating menu or via the Verification-DTM.

Access via operating menu:

- "Diagnostics → Heartbeat → Performing verification"
- "Expert → Diagnostics → Heartbeat → Performing verification"

Access via FieldCare DTM:

"Heartbeat → Performing verification"

#### Verification types

The measuring device can be verified internally or externally.

- Internal: Verification is performed automatically by the device and without manual checking of external measured variables.
- External: Similar to internal verification but with the entry of external measured variables. During the verification process, measured variables are recorded manually with the help of external measuring equipment and entered into the measuring device (e.g. actual current at output). The value entered is checked and verified by the measuring device to ensure that it complies with the factory specifications. A **(Pass/Fail)** status is indicated, and this is documented as a partial result of the verification process and taken into account in the overall result.

### Measured variables for external verification

- Output current (current output):  
Measured values are simulated by the flowmeter for each output that is physically present at the measuring device. A "Low Value" and a "High Value" are simulated in each case. Both measured values are entered at the flowmeter.
- Output frequency (pulse/frequency output):  
Measured values are simulated by the flowmeter for each output that is physically present at the measuring device.
  - Simulation value frequency output: Maximum frequency
  - Simulation value pulse output: Simulated frequency depending on the pulse width configured
 For additional information, see the "Configuring pulse/frequency/switch output" section in the Operating Instructions.

### Diagnostic behavior

A diagnostic event signals that verification is being performed: Event "302 – Device verification active". The status signal switches to "C – Function check".

Factory setting: Warning. The output of measured values resumes; in the meantime, a "last valid value" is output. The signal outputs and totalizers are not affected.

The diagnostic behavior can be reconfigured by the user if necessary: If set to alarm, measured value output is interrupted, and the signal outputs and totalizers adopt the defined alarm condition.

This diagnostic behavior is valid for internal and external verification.

For additional information on the diagnostic behavior, see the "Diagnostics and troubleshooting" section in the Operating Instructions.

### Recommendations for the measuring equipment

|                                  |        |
|----------------------------------|--------|
| DC current measuring uncertainty | ±0.1 % |
| DC current resolution            | 1 µA   |
| Frequency measuring uncertainty  | ±0.1 % |
| Frequency resolution             | 0.1 Hz |



These recommendations include the influence of ambient temperature.

### Performing external verification



Permanently predefined output signals are simulated during external verification of the outputs. These output signals do not represent the current measured value. This may have an effect on the higher-level system. In order to perform a verification, the current output and the pulse/frequency/switch output must be assigned to a measured variable.

Terminal assignment

|                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                        |
| <p>Maximum number of terminals<br/>Terminals 1 to 6:<br/>Without integrated overvoltage protection</p>                                                                                                                                    | <p>Maximum number of terminals for order code for "Accessory mounted", option NA "Overvoltage protection"</p> <ul style="list-style-type: none"><li>■ Terminals 1 to 4:<br/>With integrated overvoltage protection</li><li>■ Terminals 5 to 6:<br/>Without integrated overvoltage protection</li></ul> |
| <p>1 Output 1 (passive): supply voltage and signal transmission<br/>2 Output 2 (passive): supply voltage and signal transmission<br/>3 Input (passive): supply voltage and signal transmission<br/>4 Ground terminal for cable shield</p> |                                                                                                                                                                                                                                                                                                        |

Signal transmission 4-20 mA HART with additional inputs and outputs

| Order code for "Output" | Terminal numbers       |       |                                         |       |                                 |       |
|-------------------------|------------------------|-------|-----------------------------------------|-------|---------------------------------|-------|
|                         | Output 1               |       | Output 2                                |       | Input                           |       |
|                         | 1 (+)                  | 2 (-) | 3 (+)                                   | 4 (-) | 5 (+)                           | 6 (-) |
| Option A                | 4-20 mA HART (passive) |       | –                                       |       | –                               |       |
| Option B <sup>1)</sup>  | 4-20 mA HART (passive) |       | Pulse/frequency/switch output (passive) |       | –                               |       |
| Option C <sup>1)</sup>  | 4-20 mA HART (passive) |       | 4-20 mA (passive)                       |       | –                               |       |
| Option D <sup>1)</sup>  | 4-20 mA HART (passive) |       | Pulse/frequency/switch output (passive) |       | 4-20 mA current input (passive) |       |

1) Output 1 must always be used; output 2 is optional.

PROFIBUS PA signal transmission, pulse/frequency/switch output

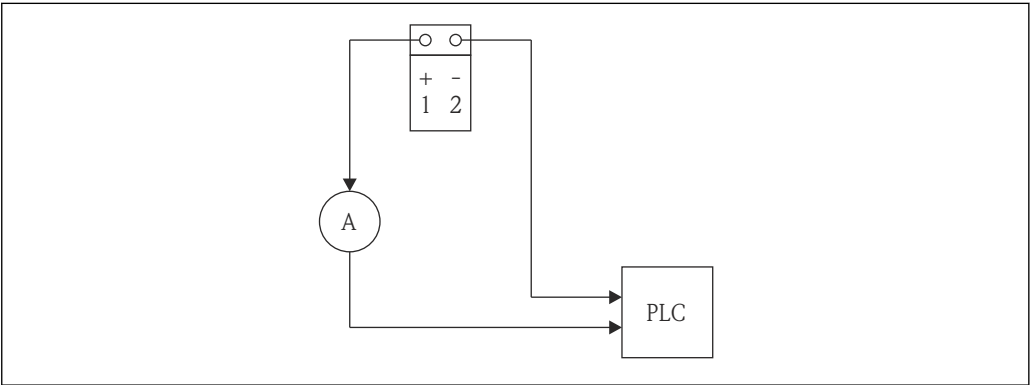
|                                                                                                                              |                                                                                                               |
|------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
|                                                                                                                              |                                                                                                               |
| <p>Maximum number of terminals</p>                                                                                           | <p>Maximum number of terminals for order code for "Accessory mounted", option NA "Overvoltage protection"</p> |
| <p>1 Output 1: PROFIBUS PA<br/>2 Output 2 (passive: pulse/frequency/switch output<br/>3 Ground terminal for cable shield</p> |                                                                                                               |

| Order code for "Output"       | Terminal numbers |       |                                         |       |
|-------------------------------|------------------|-------|-----------------------------------------|-------|
|                               | Output 1         |       | Output 2                                |       |
|                               | 1 (+)            | 2 (-) | 3 (+)                                   | 4 (-) |
| Option <b>G</b> <sup>1)</sup> | PROFIBUS PA      |       | Pulse/frequency/switch output (passive) |       |

1) PROFIBUS PA with integrated reverse polarity protection.

*Verification of current output*

For verification purposes, an ammeter is connected to the output.



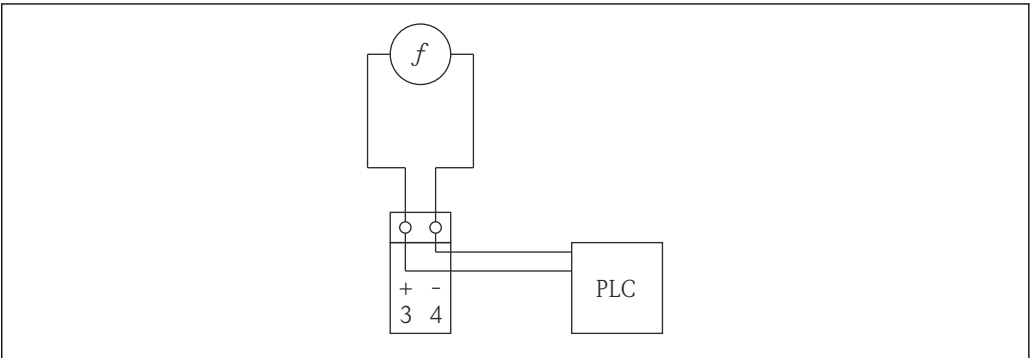
A0021365

2 External verification of current output: Looping in of an ammeter (A)

Current values are simulated during external verification. These are recorded by the measuring equipment and entered at the flowmeter.

*Verification of the pulse/frequency/switch output*

- For verification purposes, a frequency meter is connected to the output and the actual frequency recorded. For measurement purposes, it is necessary to connect the output to a power supply unit.
- During verification, a frequency value is simulated for pulse and frequency output.



A0021367

3 External verification of pulse/frequency output: Parallel connection of frequency measuring device (f)

Frequency values are simulated during external verification. These are recorded by the measuring equipment and entered at the flowmeter.

To record the measured variables for external verification, the user receives instructions from the measuring device (see the following screenshot).

Date / Time

23.10.2013 12:37

Verification mode

External verification

External device information

Fluke 3327

Start verification

Output 1 low value

Status

Not done

Measured values

4.052

Output values

4.0000

Overall result

Passed

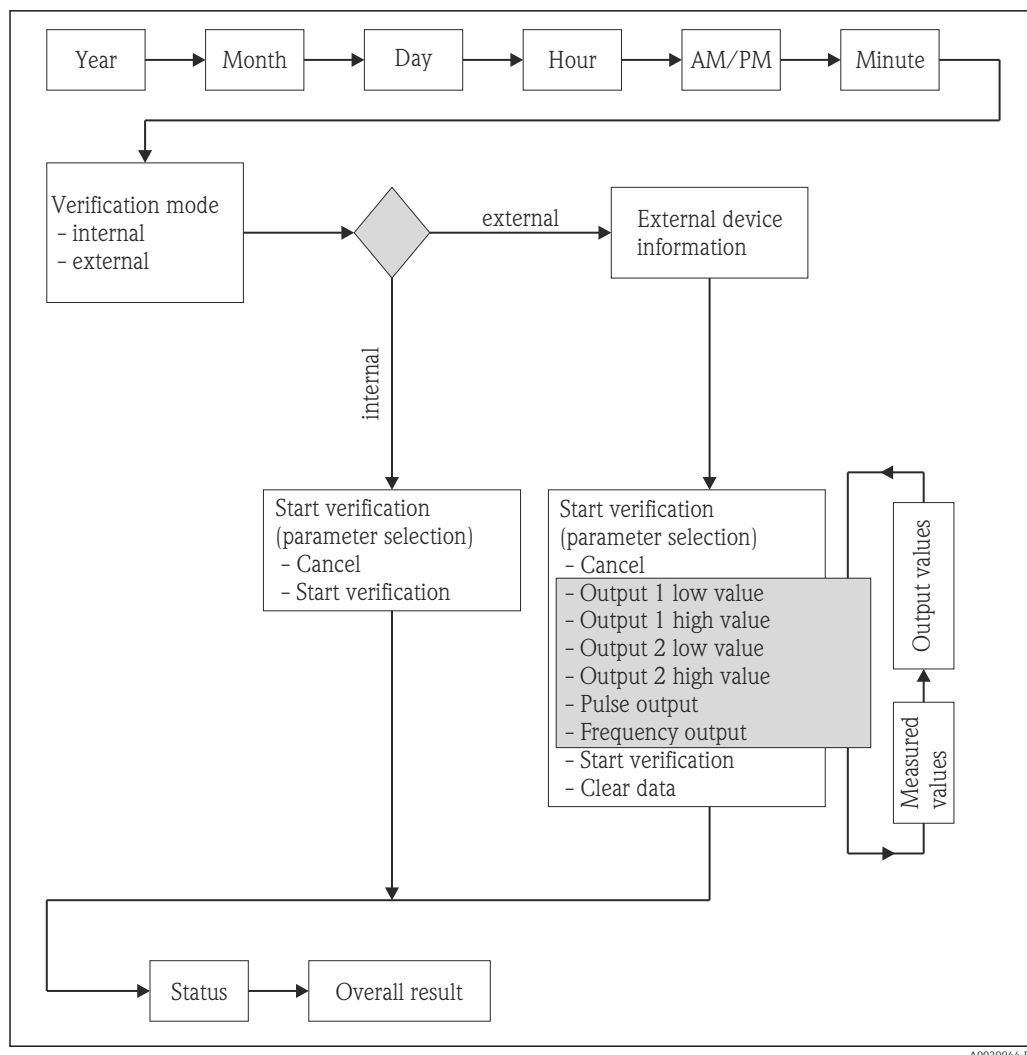
A0021360

Parameters for "Performing verification/Start"

| Parameter         | Description                                                                                                                                                                                                                                                                                                                   | Selection/<br>User entry                                                                                                                                                                                                  | Default setting |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| Year              | Entry for date and time (field 1):<br>Year verification is performed                                                                                                                                                                                                                                                          | 9...99                                                                                                                                                                                                                    | 10              |
| Month             | Entry for date and time (field 2):<br>Month verification is performed                                                                                                                                                                                                                                                         | <div><div>January</div><div>February</div><div>March</div><div>April</div><div>May</div><div>June</div><div>July</div><div>August</div><div>September</div><div>October</div><div>November</div><div>December</div></div> | January         |
| Day               | Entry for date and time (field 3): Day<br>verification is performed                                                                                                                                                                                                                                                           | 1...31                                                                                                                                                                                                                    | 1               |
| Hour              | Entry for date and time (field 4): Hour<br>verification is performed                                                                                                                                                                                                                                                          | <div><div>1...12</div><div>0...23</div></div>                                                                                                                                                                             | 12              |
| AM/PM             | Entry for date and time (field 5): Morning<br>or afternoon                                                                                                                                                                                                                                                                    | <div><div>AM</div><div>PM</div></div>                                                                                                                                                                                     | AM              |
| Minute            | Entry for date and time (field 6): Minute<br>verification is performed                                                                                                                                                                                                                                                        | 0...59                                                                                                                                                                                                                    | 0               |
| Verification mode | Selecting verification mode: <div><div>Internal: Verification is performed automatically by the device and without manual checking of external measured variables.</div><div>External: Similar to internal verification but with the entry of external measured variables (see also "Measured values" parameter).</div></div> | <div><div>Internal</div><div>External</div></div>                                                                                                                                                                         | Internal        |

| Parameter                   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Selection/<br>User entry                                                                                                                                                                                                                                                                           | Default setting |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| Information external device | Measuring equipment recording for external verification.<br> The option appears only if the <b>External</b> option has been selected in the "Verification mode" parameter.                                                                                                                                                                                                                                                                                           | Free text entry                                                                                                                                                                                                                                                                                    | –               |
| Start verification          | Start the verification<br> The option appears only if the <b>Internal</b> option has been selected in the "Verification mode" parameter.                                                                                                                                                                                                                                                                                                                             | <ul style="list-style-type: none"> <li>■ Cancel</li> <li>■ Start</li> </ul>                                                                                                                                                                                                                        | Cancel          |
| Start verification          | Start the verification<br>To carry out a complete verification, the selection parameters must be selected individually. Once the external measured values have been recorded, verification is started using "Start verification".<br> The option appears only if the <b>External</b> option has been selected in the "Verification mode" parameter.                                                                                                                  | <ul style="list-style-type: none"> <li>■ Cancel</li> <li>■ Output 1 lower value</li> <li>■ Output 1 upper value</li> <li>■ Output 2 lower value</li> <li>■ Output 2 upper value</li> <li>■ Pulse output</li> <li>■ Frequency output</li> <li>■ Start verification</li> <li>■ Clear data</li> </ul> | Cancel          |
| Measured values             | Entry of external measured variables. Entries are made with the help of a wizard. <ul style="list-style-type: none"> <li>■ Current in [mA]</li> <li>■ Frequency in [Hz]</li> </ul>                                                                                                                                                                                                                                                                                                                                                                    | –                                                                                                                                                                                                                                                                                                  | –               |
| Output values               | References for external measured variables. <ul style="list-style-type: none"> <li>■ Current output: Output current in [mA]</li> <li>■ Pulse/frequency output: Output frequency in [Hz]</li> </ul>                                                                                                                                                                                                                                                                                                                                                    | –                                                                                                                                                                                                                                                                                                  | –               |
| Status                      | Verification status <ul style="list-style-type: none"> <li>■ Done: The last verification is finished and the device is ready for the next verification</li> <li>■ Busy: The verification is running</li> <li>■ Failed: A precondition for performing the verification is not met. The verification cannot be started (e.g. due to unstable process parameters)</li> <li>■ Not done: A verification has never been performed on this measuring device</li> </ul>                                                                                       | <ul style="list-style-type: none"> <li>■ Done</li> <li>■ Busy</li> <li>■ Failed</li> <li>■ Not done</li> </ul>                                                                                                                                                                                     | Done            |
| Overall result              | Overall result of the verification <ul style="list-style-type: none"> <li>■ Failed: At least one test group was outside the specifications.</li> <li>■ Passed: All verified test groups complied with the specifications (result "Passed"). The overall result is also "Passed" if the result for an individual test group is "Check not done" and the result for all other test groups is "Passed".</li> <li>■ Check not done: No verification was performed for any of the test groups (result for all test groups is "Check not done").</li> </ul> | <ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul>                                                                                                                                                                                             | Check not done  |

### Performing the verification: sequence of steps



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### Notes on the external verification of the outputs

Parameter selection:

- The module to be verified (parameter selection) is selected in the "Start verification" menu and confirmed with the enter key.
- The value measured with the measuring equipment is entered in the "Measured values" menu.

These two steps are repeated for all the modules. External verification is completed by selecting the "Start" parameter. This verifies the entire measuring point and checks whether the external input values are valid.



The entry for the date and time is saved in addition to the current operating time and the results of the verification and also appears in the verification report.

### 6.3.4 Verification results

The results of the verification can be called up via the operating menu or via the FieldCare Verification-DTM.

Access via operating menu:

- "Diagnostics → Heartbeat → Verification results"
- "Expert → Diagnostics → Heartbeat → Verification results"

Access via FieldCare DTM:  
 "Heartbeat → Verification results"

#### Parameter/Test group verification results

| Parameter/Test group    | Description                                                                                                                                                                                    | Selection/<br>User entry/<br>Partial result                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Default setting |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| Date/time               | Entry for date and time in real time                                                                                                                                                           | User entry                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 0               |
| Verification ID         | Consecutive numbering of the verification results in the measuring device <sup>1)</sup>                                                                                                        | –                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | –               |
| Operating time          | Operating time of the measuring device at the time of verification <sup>1)</sup>                                                                                                               | –                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | –               |
| Overall result          | Overall result of the verification                                                                                                                                                             | <ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Check not done  |
| Sensor                  | Result for sensor test group                                                                                                                                                                   | <ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Check not done  |
| Main electronics module | Partial result, main electronics module                                                                                                                                                        | <ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Check not done  |
| I/O module              | Result for I/O module test group<br>I/O module monitoring<br>For current output:<br>Accuracy of the current<br>For frequency output:<br>Accuracy of frequency (for external verification only) | <ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul> <div>  Limit value for current output (for internal verification only):           <ul style="list-style-type: none"> <li>■ ±1 %</li> <li>■ ±300 µA</li> </ul> </div> <div>  Limit value for current output (for external verification only):           <ul style="list-style-type: none"> <li>■ ±1 %</li> <li>■ ±10 µA</li> </ul> </div> <div>  Limit value for frequency output (for external verification only):           <ul style="list-style-type: none"> <li>■ ±0.1 %</li> </ul> </div> | Check not done  |

1) Is automatically recorded by the measuring device

#### Classification of results

- Failed: At least one individual test in the test group was outside the specifications.
- Passed: All individual tests in the test group complied with the specifications. The result is also "Passed" if the result of an individual test is "Check not done" and the result of all other tests is "Passed".
- Check not done: No test has been performed for this test group.

**Classification of overall results**

- Failed: At least one test group was outside the specifications.
- Passed: All verified test groups complied with the specifications (result "Passed"). The overall result is also "Passed" if the result for an individual test group is "Check not done" and the result for all other test groups is "Passed".
- Check not done: No verification was performed for any of the test groups (result for all test groups is "Check not done").

**Test groups**

- Sensor: Electrical components of the sensor (signals, circuits and cables)
- Main electronics module: Verification of supply voltage and electronic module for exciting and converting the sensor signals
- I/O electronics module: Results of input and output modules installed at the measuring device  
During internal verification, the actual current at the output is relayed back and compared with the set point.  
Only the 4-20 mA HART output is verified.  
During external verification, all 4-20 mA current and pulse/frequency outputs are verified.

For more information on the test groups and individual tests (→  26).

**Interpretation**

The results for a test group (e.g. sensor) contain the result of several individual tests. All the individual tests must be passed for the test group to pass. The same applies for the overall result: All the test groups must pass for the overall result to be "passed". Information on the individual tests is provided in the verification report and in the detailed verification results which can be accessed via the Verification-DTM.

**6.3.5 Detailed verification results**

The detailed verification results and process conditions at the time of the verification can be accessed via the FieldCare Verification-DTM.

- Verification results: "VerificationDetailedResults → VerificationSensorResults"
- Process conditions: "VerificationDetailedResults → VerificationActualProcessConditions"

The detailed verification results listed below provide information on the results of the individual tests within a test group.

*Parameters for "Detailed verification results"*

| Parameter/individual test         | Description                                                                                        | Result/limit value                                       |
|-----------------------------------|----------------------------------------------------------------------------------------------------|----------------------------------------------------------|
| "Sensor" test group               |                                                                                                    |                                                          |
| Pickup coil                       | Condition of the pickup coil: Intact/not intact (short-circuit/interruption)                       | No value range<br>Passed / Failed                        |
| Measuring tube temperature sensor | Condition of the measuring tube temperature sensor: Intact/not intact (short-circuit/interruption) | No value range<br>Passed / Failed                        |
| Carrier tube temperature sensor   | Condition of the carrier tube temperature sensor: Intact/not intact (short-circuit/interruption)   | No value range<br>Passed / Failed                        |
| Sensor coil symmetry              | Monitoring of the signal amplitude between the inlet and outlet sensor                             | No value range<br>Passed / Failed                        |
| Lateral mode frequency            | Monitoring of the oscillation frequency of the measuring tube/tubes                                | Depends on the sensor type, version and nominal diameter |
| Sensor circuit leakage            | Leak current in the sensor circuit                                                                 | No value range<br>Passed / Failed                        |

| Parameter/individual test             | Description                                                                                                                       | Result/limit value                                                                                                                         |
|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| "Main electronics module" test group  |                                                                                                                                   |                                                                                                                                            |
| Zero point monitoring                 | Monitoring of the zero point for flow measurement                                                                                 | No value range<br>Passed / Failed                                                                                                          |
| Reference clock                       | Monitoring of the reference clock for flow measurement                                                                            | No value range<br>Passed / Failed                                                                                                          |
| Reference temperature                 | Temperature measurement monitoring                                                                                                | No value range<br>Passed / Failed                                                                                                          |
| Supply voltage                        | In the main electronics unit the internal supply voltages are monitored to ensure that they do not breach their permitted limits. | No value range<br>Passed / Failed                                                                                                          |
| "Input/Output" test group (HART only) |                                                                                                                                   |                                                                                                                                            |
| Information external device           | Description of the measuring equipment that is used for external verification.                                                    | –                                                                                                                                          |
| ► Slot 1 module type                  | Module type for I/O module 1                                                                                                      | <ul style="list-style-type: none"> <li>■ Current output</li> <li>■ Pulse</li> <li>■ Frequency</li> <li>■ Switch</li> <li>■ None</li> </ul> |
| Output 1                              | Verification result for I/O module 1                                                                                              | No value range<br>Passed / Failed                                                                                                          |
| ► Output 1 actual value 1             | Lower measured value for I/O module 1                                                                                             | 3.59 mA                                                                                                                                    |
| ► Output 1 actual value 2             | Upper measured value for I/O module 1                                                                                             | 22.5 mA                                                                                                                                    |
| ► Slot 2 module type                  | Module type for I/O module 2                                                                                                      | <ul style="list-style-type: none"> <li>■ Current output</li> <li>■ Pulse</li> <li>■ Frequency</li> <li>■ Switch</li> <li>■ None</li> </ul> |
| Output 2 (Current output)             | Verification result for I/O module 2                                                                                              | No value range<br>Passed / Failed                                                                                                          |
| ► Output 2 actual value 1             | Lower measured value for I/O module 2                                                                                             | 3.59 mA                                                                                                                                    |
| ► Output 2 actual value 2             | Upper measured value for I/O module 2                                                                                             | 22.5 mA                                                                                                                                    |
| Output 2 (Pulse, Frequency)           | Verification result for I/O module 2                                                                                              | No value range<br>Passed / Failed                                                                                                          |
| ► Output 2 actual value 1             | Actual measured value for I/O module 2                                                                                            | Pulse: Depending on the pulse width configured<br>Frequency: Maximum frequency                                                             |

Furthermore, the current process conditions at the time of verification are recorded, thereby improving the comparability of the results.

#### Process conditions

| Process conditions           | Description, value range                         |
|------------------------------|--------------------------------------------------|
| Mass flow verification value | Actual measured value for mass flow              |
| Density verification value   | Current measured value for density               |
| Damping verification value   | Actual measured value for measuring tube damping |

| Process conditions                     | Description, value range                                                   |
|----------------------------------------|----------------------------------------------------------------------------|
| Process temperature verification value | Current measured value for process temperature (temperature in the sensor) |
| Electronic temperature                 | Current measured value for the electronic temperature in the transmitter   |

### 6.3.6 Verification report

The results of the verification can be documented in the form of a verification report using the FieldCare asset management software. The verification report is created on the basis of the data set saved in the measuring device after verification. As the verification results are automatically and uniquely identified with the verification ID and the operating time, they are suitable for the traceable documentation of the verification of flowmeters.

#### Creating the verification report

(→  33)

#### Content of the verification report

The verification report is a two-page report. The first page contains information to identify the measuring point and the verification result and confirms that verification has been performed.

- Customer: Customer reference
- Device information: Information on the place of operation (tag) and the current configuration of the measuring point. This information is managed in the measuring device and included in the verification report.
- Calibration: Information on the calibration factor and zero point setting for the sensor. To ensure that the measuring device complies with the factory specification, these values must correspond to those of the last calibration or repeat calibration.
- Verification information: The operating time and verification ID are used to uniquely assign the verification results for the traceable documentation of the verification. The manual entry for the date and time is saved in addition to the current operating time in the measuring device and also appears in the verification report.
- Verification results: Overall result of the verification. The verification is only passed if all the test groups pass. The results for the test groups are indicated on the second page of the report.
- Validity – Disclaimer: As a prerequisite for the validity of the verification report, the **Heartbeat Verification** function must be activated on the measuring device concerned and must have been performed by an operator tasked to carry out this job by the customer. Alternatively, an Endress+Hauser service technician or a service provider authorized by Endress+Hauser can be tasked with performing the verification.

Verification report

**Endress+Hauser**   
People for Process Automation

### Verification report flowmeter

|                                    |                                     |           |
|------------------------------------|-------------------------------------|-----------|
| <b>Plant operator</b>              |                                     | Mr. Smith |
| <b>Device information</b>          |                                     |           |
| <b>Location</b><br>Location 14     | <b>Device tag</b><br>M-745          |           |
| <b>Module name</b><br>Promass E    | <b>Nominal diameter</b><br>DN25     |           |
| <b>Device name</b><br>Promass 200  | <b>Order code</b><br>8E2B25-725     |           |
| <b>Serial number</b><br>1234567890 | <b>Firmware version</b><br>01.03.00 |           |
| <b>Calibration</b>                 |                                     |           |
| <b>Calibration factor</b><br>1.15  | <b>Zero point</b><br>10             |           |

|                                          |                                                              |
|------------------------------------------|--------------------------------------------------------------|
| <b>Verification information</b>          |                                                              |
| <b>Operating time</b><br>12d15h32min12 s | <b>Date/time</b><br>01.12.2010/12:00                         |
| <b>Verification ID</b><br>17             |                                                              |
| <b>Verification results</b>              |                                                              |
| <b>Overall result*</b>                   | <span style="color: red; font-weight: bold;">✖</span> Failed |
| <b>Detailed results</b>                  | See next page                                                |

\*Overall result: Result of the complete device functionality test via Heartbeat Technology

**Notes**

Validity of the verification report is only given:

- For devices with the Heartbeat Verification enabled software option
- For verifications, carried out by the Endress+Hauser Service, or an authorized Endress+Hauser service provider

---

 Date

---

 Operator's signature

---

 Inspector's signature

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

Seite 1/2

The second page of the verification report lists the individual test groups and the individual test group results. For information on the meaning of the individual test groups and a description of the individual tests (→  26)

Verification report

Endress+Hauser   
People for Process Automation

Verification report flowmeter

For serial number: 1234567890  
Detailed results of verification ID: 17

|                                   |                                                                                                      |
|-----------------------------------|------------------------------------------------------------------------------------------------------|
| Sensor                            |  Passed           |
| Pickup coil                       |  Passed           |
| Measuring tube temperature sensor |  Passed           |
| Carrier tube temperature sensor   |  Passed           |
| Pickup coil symmetry              |  Passed           |
| Frequency lateral mode            |  Passed           |
| Sensor circuit leakage            |  Passed           |
| Main electronic module            |  Failed           |
| Zero point tracking               |  Passed           |
| Reference clock                   |  Failed           |
| Reference temperature             |  Check not done |
| I/O module                        |  Passed         |

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A0022397-EN

Verification report

Endress+Hauser   
People for Process Automation

Verification report flowmeter

For serial number: 1234567890  
Detailed results of verification ID: 17

|                                   |                                                                                                       |
|-----------------------------------|-------------------------------------------------------------------------------------------------------|
| Sensor                            |  Passed            |
| Pickup coil                       |  Passed            |
| Measuring tube temperature sensor |  Passed            |
| Carrier tube temperature sensor   |  Passed            |
| Pickup coil symmetry              |  Passed            |
| Frequency lateral mode            |  Passed            |
| Sensor circuit leakage            |  Passed            |
| Main electronic module            |  Failed            |
| Supply voltage                    |  Passed*           |
| Zero point tracking               |  Passed            |
| Reference clock                   |  Failed           |
| Reference temperature             |  Check not done  |
| I/O module                        |  Passed          |
| Output 1                          |  Passed*         |
| Output 2                          |  Check not done* |

\*External verification

Information about the external verification  
Fluke 2354, Cal: 10.0.2012, F. Maier

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

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A0022398-EN

 6    Verification report, external verification (Page 2)

Data management with FieldCare Verification-DTM  
(→  33)

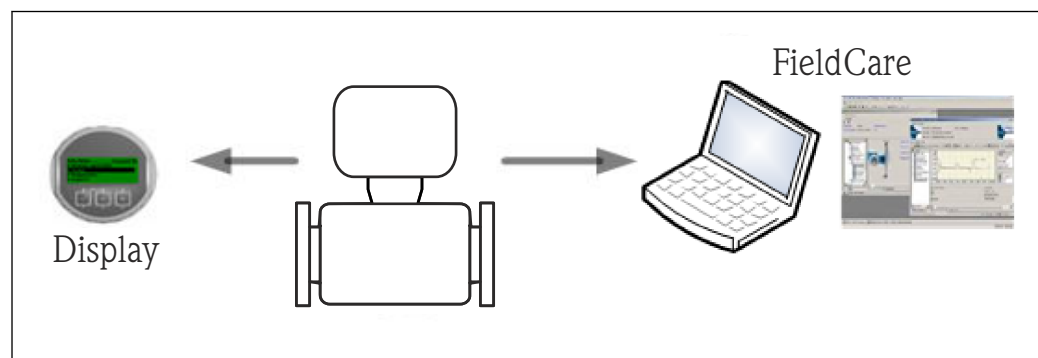
## 7 Function

### 7.1 Self-monitoring using Heartbeat Technology

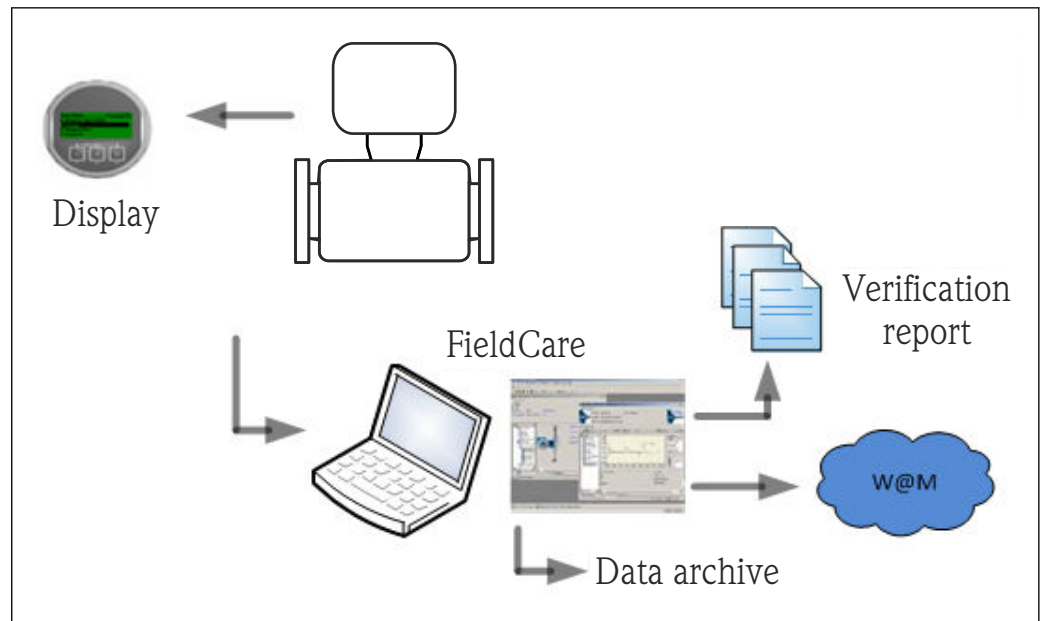
The Heartbeat Technology function is based on reference values that are recorded during the factory calibration, or on series-specific limit values. Device-internal parameters (measuring points) that are correlated with flow measurement (secondary measured variables, comparative values) are recorded during the calibration. The reference values for these parameters are stored permanently in the measuring device and act as the basis for Heartbeat Technology and particularly for the **Heartbeat Verification** function integrated in the measuring device. Throughout the life cycle of the flowmeter, the **Heartbeat Verification** function checks whether the measuring points deviate from the reference condition defined at the time of the calibration and indicates if the deviation is outside the factory specification. The validity of the testing method is additionally ensured by redundant components and signal feedback (feedback loop). This ensures that any component drift is detected.

### 7.2 Heartbeat Technology - integration

The Heartbeat Technology function is accessible via all the operating interfaces.



In addition, it is possible to access the function via the system integration interface, allowing the device to be used without onsite presence in the field. Via the process control system or asset management system, it is possible to periodically check the measuring point with a minimum amount of effort.



A0020774-EN

The creation of verification reports is supported by Endress+Hauser's FieldCare asset management software. The FieldCare DTM module for verification also offers the possibility of archiving the verification results and reports to create traceable documentation.

W@M (Web-enabled asset management) from Endress+Hauser is an open information system for lifecycle management – device documentation and administration: project configuration, system integration, operation, maintenance and repair.

## 7.3 Heartbeat Verification – data management

The results of a **Heartbeat Verification** are saved as a non-volatile parameter set in the measuring device memory.

Eight storage areas are available for parameter sets.

New verification results overwrite older data on a "first in – first out" basis.

The results can be documented in the form of a verification report via Endress+Hauser's FieldCare asset management software. In addition to the option of printing out the results in a verification report, FieldCare also offers a DTM for archiving the results of the verification. Furthermore, with FieldCare it is also possible to export data from these archives and to analyze trends in the verification results (line recorder function). For details see the "Description of the Verification-DTM" section.

### 7.3.1 Data management with Verification DTM

#### Description

A special DTM for **Heartbeat Verification** is also available in addition to the standard device DTM. This Verification-DTM offers advanced capabilities for performing the verification and managing the results.

### Basic functions

The following basic functions are provided:

|                                                                                               |                                                                                                               |
|-----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| <br>A0020273 | Start uploading the verification data sets from the measuring device to the asset management tool (FieldCare) |
| <br>A0020274 | Reset the DTM to the initial state                                                                            |
| <br>A0020275 | Open saved archive files                                                                                      |
| <br>A0020276 | Save data sets to an existing archive file or initial saving of data sets to a new archive file               |
| <br>A0020277 | Save the data sets under a new file name; a new archive file is created in this case                          |
| <br>A0020278 | Create a verification report in PDF format                                                                    |

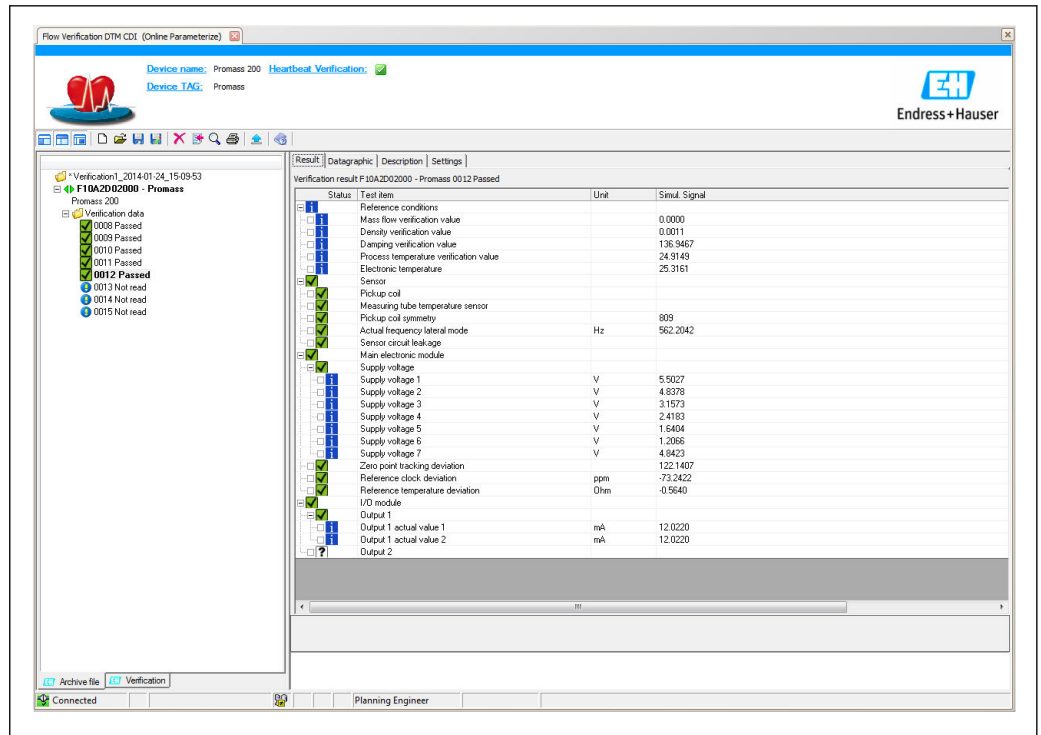
### DTM header

The following basic functions are provided:

|                                                                                                 |                                                                                                    |
|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|
| <br>A0020272 | The header refers to the top display area of the DTM. It contains information about the device TAG |
|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|

### "Upload" function

Upload the data from the measuring device to the asset management software. This is initiated via the  icon. This function transmits selected data sets, which are saved in the measuring device, to the asset management software and visualizes them.



A0022781-EN

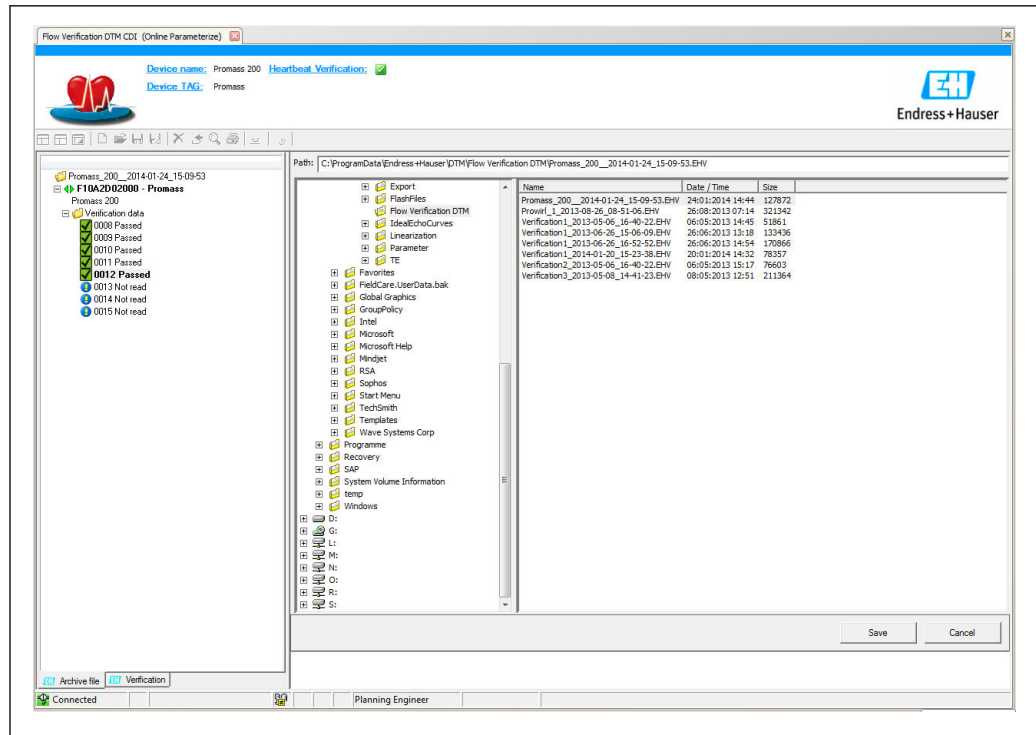
## Verification results

Details for the verification results are displayed in the "Data area". The data area is split into three tabs:

- "Results": Status, test group and detailed results including limit values
- "Data graphic": Visualization of results as a trend curve
- "Description": Additional descriptions and information entered by the user

## Saving to an archive file

Once uploaded, the data can be saved to an archive file. This is initiated via the  or  icons, and a file with the extension ".EHV" is generated. This file is used to archive the data. It can be read and interpreted by every asset management system with an installed Verification-DTM and is therefore also suitable for analysis by a third party (e.g. Endress+Hauser service organization).



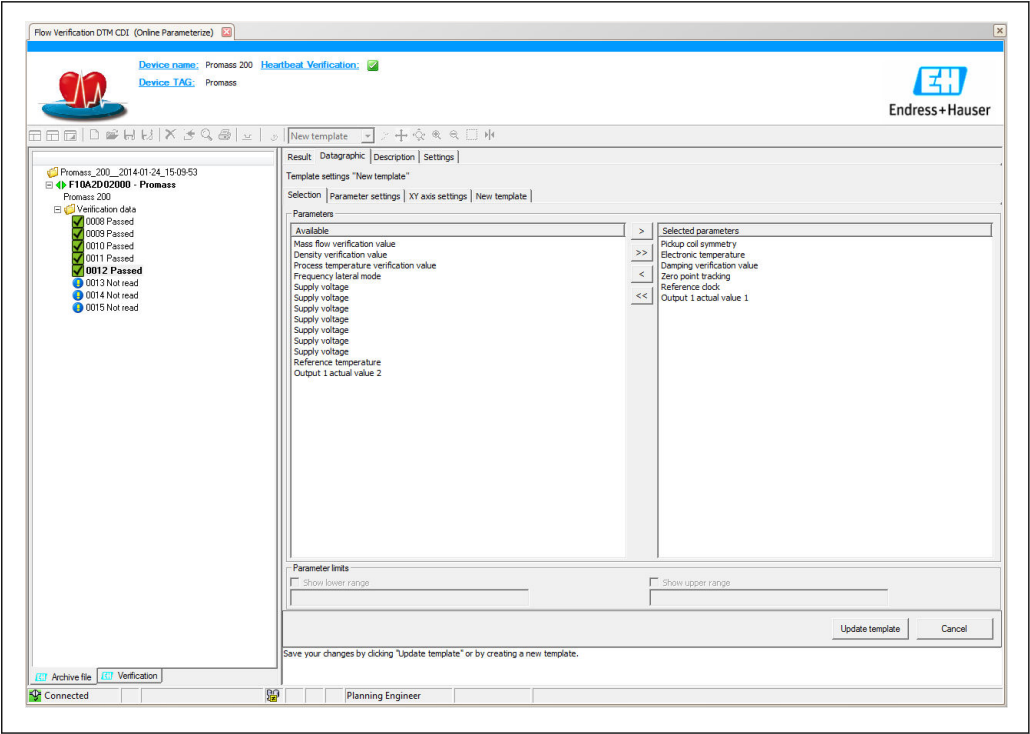
A0022782-EN

### Opening archive files

Archive files that are already available can be opened via the  function. Here the archive data are loaded in the Verification-DTM.

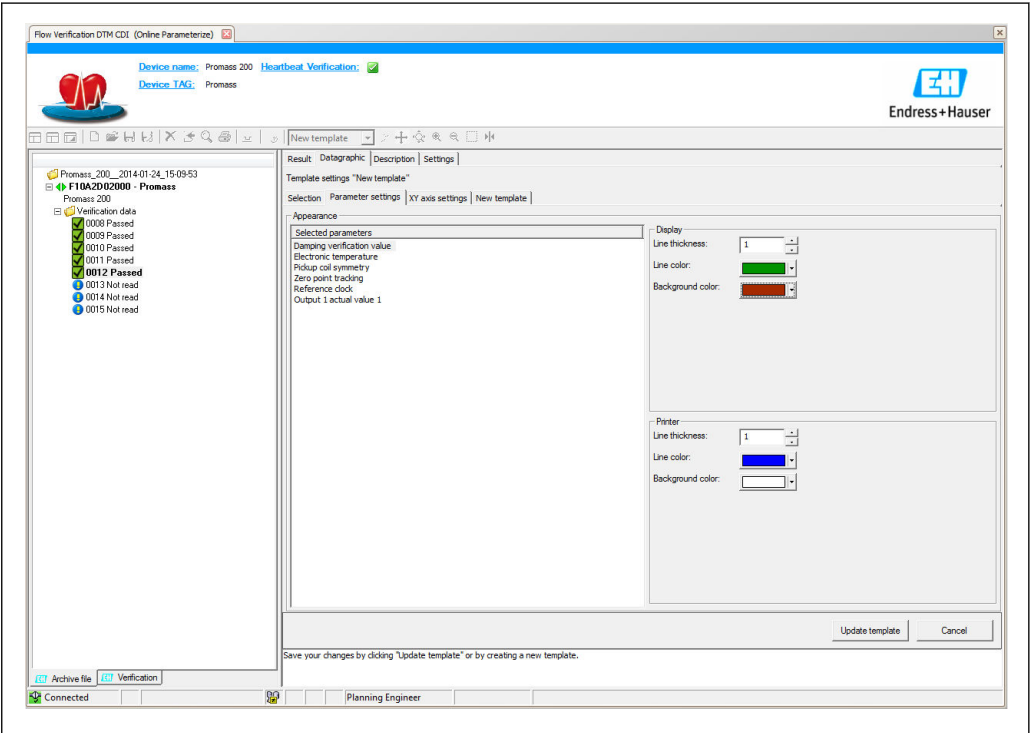
### Visualization and trend analysis

The verification data can be visualized in the "Data graphic" tab in the data area. The data saved in the archive are visualized as a graph over time. For this purpose, any of the data available can be selected.



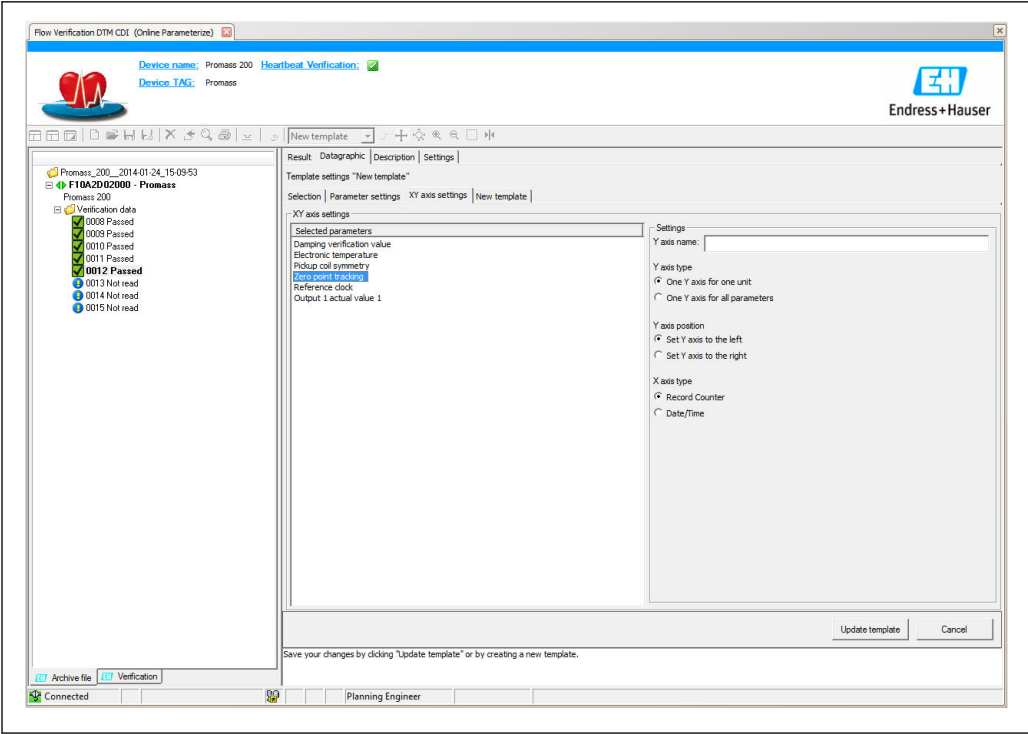
A0022783-EN

7 "Selection": Select the desired parameters using the parameter list



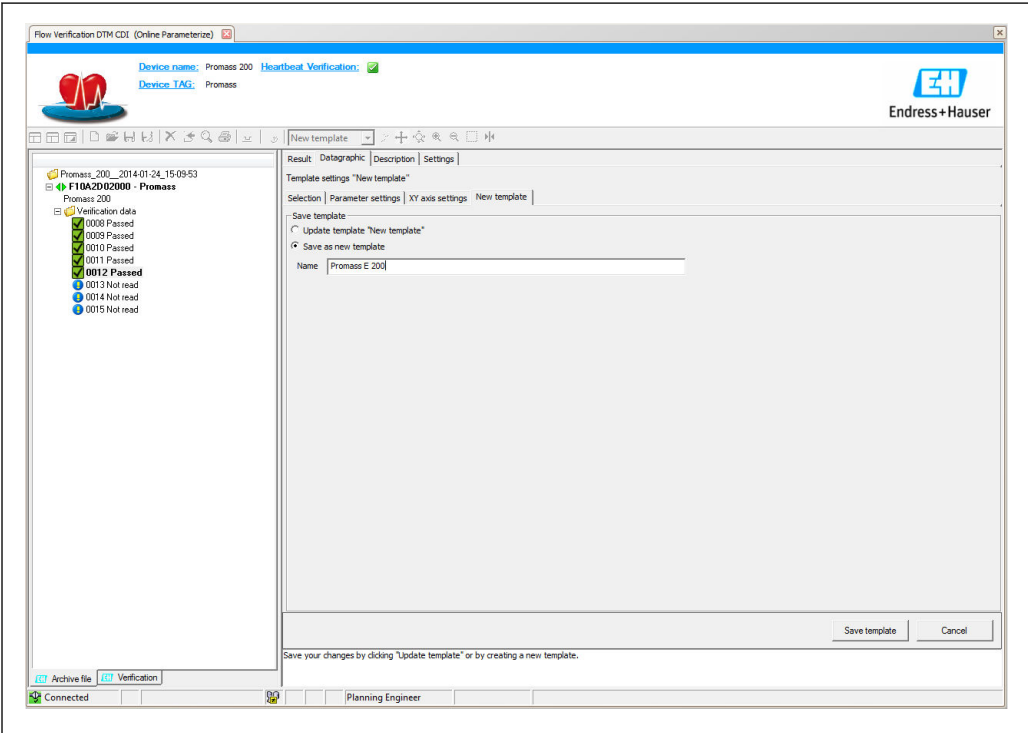
A0022784-EN

8 "Parameter settings": Assign the properties for visualization in the graph



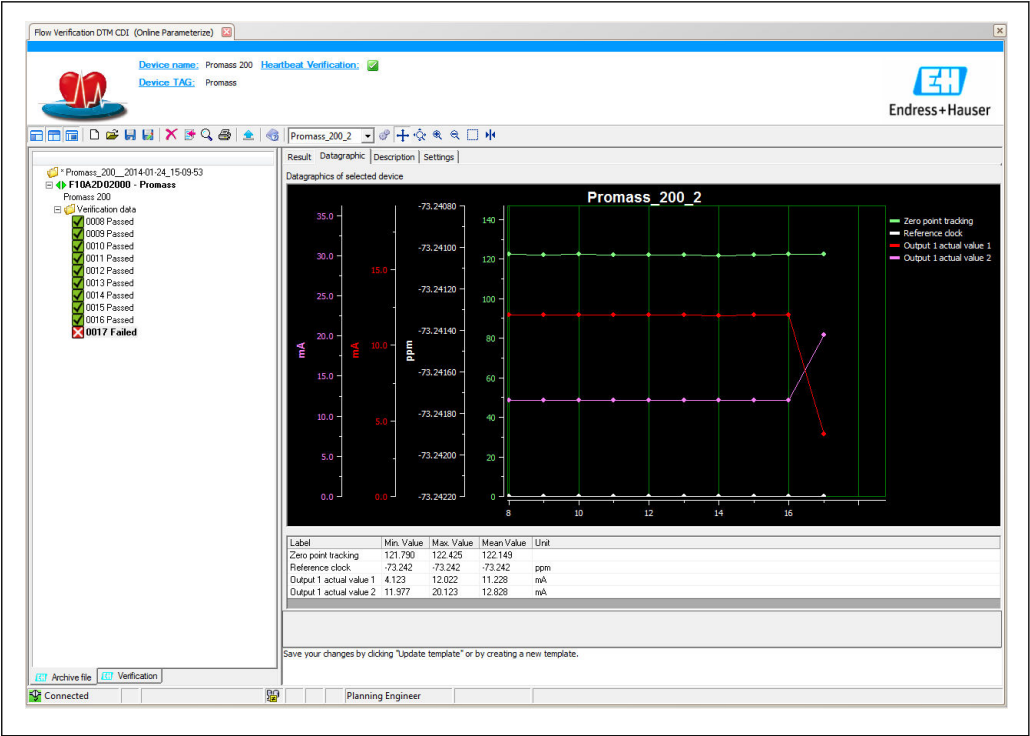
A0022785-EN

9 "Y-axis settings": Assign the parameters to the y-axis



A0022787-EN

10 "New template, update template": Adds the selected parameter configuration to the template; "New template, save as new template": Saves the selected parameter configuration under a new template name



A0022790-EN

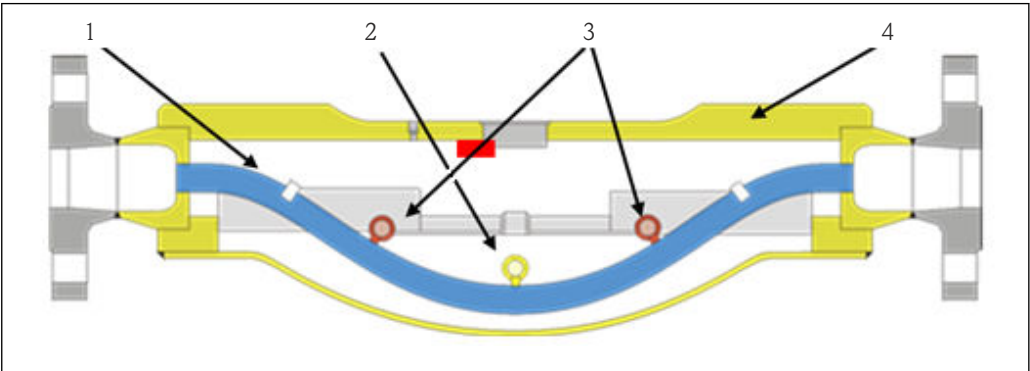
11 "Trend visualization": Template shows the data in chronological order; the data points are referenced by the verification ID (X-axis), the Y-axis is displayed as defined in the configuration

### Creating a verification report

A data set can be selected using the  function and used to create a verification report.

## 7.4 Modules

Self-monitoring of the measuring device using Heartbeat Technology comprises the measuring chain from the sensor to the outputs. The table below lists the individual modules (test groups) and possible and recognized causes of errors.



A0020246

12 Model of a Promass sensor

- 1 Temperature sensor
- 2 Electrodynamical excitation system
- 3 Electrodynamical pick-ups
- 4 Sensor ground

*Sensor module*

| Sensor module/test group | Test and recognized causes of errors                                                                                                                                                                                                                                                                                        |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sensor                   | Electrical testing of electrodynamic excitation system, electrodynamic pick-ups and temperature sensors.<br>Testing of resistance and insulation: Detection of signal interruption, damping problems, short circuits, contact corrosion, wiring problems, mechanical damage, moisture inside the sensor and poor grounding. |

*Electronic module*

| Electronic module/test group | Test and recognized causes of errors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Main electronics module      | <ul style="list-style-type: none"> <li>■ Testing of supply voltages</li> <li>■ Detection of drift and aging of electronic components due to environmental or process influences (temperature, vibration etc.)</li> <li>■ Testing of signal processing</li> </ul> <p>Testing</p> <ul style="list-style-type: none"> <li>■ Monitoring of zero point, gain and linearity of measuring circuit in sensor electronic module</li> <li>■ Redundant reference clock monitoring and reference temperature monitoring in the electronic module</li> </ul> |
| I/O module                   | Signal feedback for the first current output. Detection of drift and aging of analog output module due to environmental or process influences (temperature, radiation, vibration etc.)                                                                                                                                                                                                                                                                                                                                                          |

## 8 Application examples

### 8.1 Diagnostics

For information about the standard functions, see the "Diagnostics and troubleshooting" section of the Operating Instructions.

### 8.2 Condition Monitoring

#### 8.2.1 Definition of Condition Monitoring

(→  8)

#### 8.2.2 Focus and target applications

Condition Monitoring focuses on measured variables which indicate a change in the performance of the measuring device brought about by process-specific influences. There are two difference categories of process-specific influences:

Transient process-specific influences that impact the measuring function directly and therefore result in a higher level of measuring uncertainty than would normally be expected (e.g. Measurement of multiphase fluids). These process-specific influences generally do not affect the integrity of the measuring device but do impact measuring performance temporarily.

Flowmeters with **Heartbeat Monitoring** offer a range of parameters that are particularly suitable for monitoring specific, application-related influences. These target applications are:

- Formation of buildup in the sensor
- Corrosive or abrasive fluids
- Multi-phase fluids (gas content in liquid fluids)
- Wet gases
- Applications in which the sensor is exposed to a programmed amount of wear

The results of Condition Monitoring must always be interpreted in the context of the application. The parameters available with **Heartbeat Monitoring**, however, display a specific behavioral pattern for the applications listed above. This is explained in greater detail in the following chapters.

### 8.3 Heartbeat Monitoring

The benefits of **Heartbeat Monitoring** are in direct correlation with the recorded data selection and their interpretation. Good data interpretation is critical for deciding whether a problem has occurred and when and how maintenance should be scheduled/performed (good knowledge of the application is required). The elimination of process effects that cause misleading warnings/interpretation must also be ensured. For this reason it is important to compare the recorded data against a process reference.

### 8.3.1 Overview

This section describes the interpretation of certain monitoring-specific parameters in the context of the application.

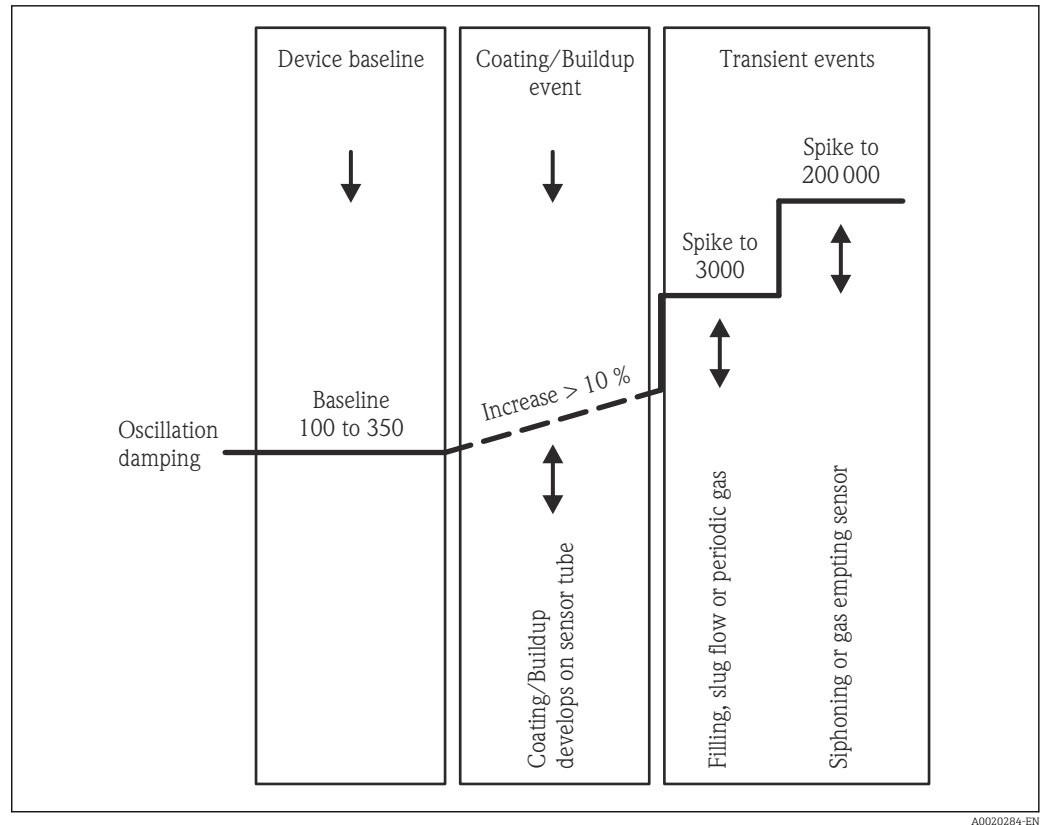
| Monitoring parameter   | Possible reasons for deviation                                                                                                                                                                                                                                                                                                                                                               |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Mass flow              | If the mass flow can be kept constant and can be repeated, a deviation from the reference indicates a zero point shift.                                                                                                                                                                                                                                                                      |
| Density                | A deviation from the reference may be caused by a change in the resonance frequency of the measuring tube, e.g. due to coating/buildup in the measuring tube, corrosion or abrasion.                                                                                                                                                                                                         |
| Reference density      | The reference density values can be interpreted in the same way as the density values. If it is not possible to keep the liquid temperature entirely constant, you can analyze the reference density (density at a constant temperature, e.g. at 20 °C) instead of the density. Make sure that the parameters required for calculating the reference density have been configured correctly. |
| Temperature            | Use this diagnostics parameter to check the functionality of the temperature sensor.                                                                                                                                                                                                                                                                                                         |
| Oscillation damping    | A deviation from the reference state can be caused by a change in the measuring tube damping, e.g. by mechanical changes (formation of coating or buildup, fouling, corrosion, abrasion).                                                                                                                                                                                                    |
| Signal asymmetry       | Use this parameter to determine whether the sensor signals are symmetrical.                                                                                                                                                                                                                                                                                                                  |
| Electronic temperature | Indication of high ambient temperatures or heat transfer from the process, e.g. due to installation conditions (pipework not insulated).                                                                                                                                                                                                                                                     |

### 8.3.2 Oscillation damping

Oscillation damping is an indicator of the state of the oscillation system. A change in the oscillation damping under reference conditions is an indicator of mechanical changes to the measuring tube that can be caused by coating/buildup, fouling or corrosion. It can also indicate multiphase conditions. Oscillation damping is a variable that reacts in a linear manner to sensor excitation. Typical values range from between 70 to sometimes more than 500 000, e.g. for processes with multiphase fluids.

Tube damping fluctuation can be split into two groups:

- Gradual changes appear over a longer period and are typical of coating/buildup, fouling, abrasion or corrosion.
- Temporary changes are spikes in oscillation damping which can be caused by multiphase fluids.



13 Typical behavior in the event of coating/buildup

#### Interpretation

- During commissioning and process start-up, a device baseline for oscillation damping is established. This device baseline is determined by the sensor type and application. Depending on the properties of the medium, a different baseline may establish itself. This baseline value is the reference value used for monitoring oscillation damping in the lifetime of the flowmeter. The "Oscillation damping" parameter is always analyzed with reference to this baseline.
- The formation of coating/buildup in a sensor causes a gradual and sustained change in the oscillation damping.
- Random spikes in the oscillation damping values are probably due to the temporary process effects caused by entrained gas, or pipes running full or empty, and should be ignored.

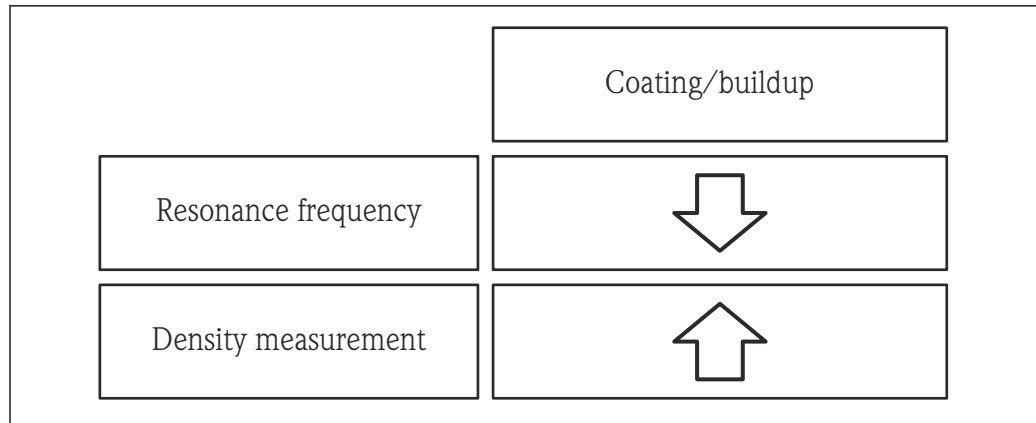
### 8.3.3 Application in the event of coating/build-up

If it emerges that the process causes coating/build-up in the Promass measuring tubes, **Heartbeat Monitoring** can be used for this application.

#### Relevant monitoring parameters

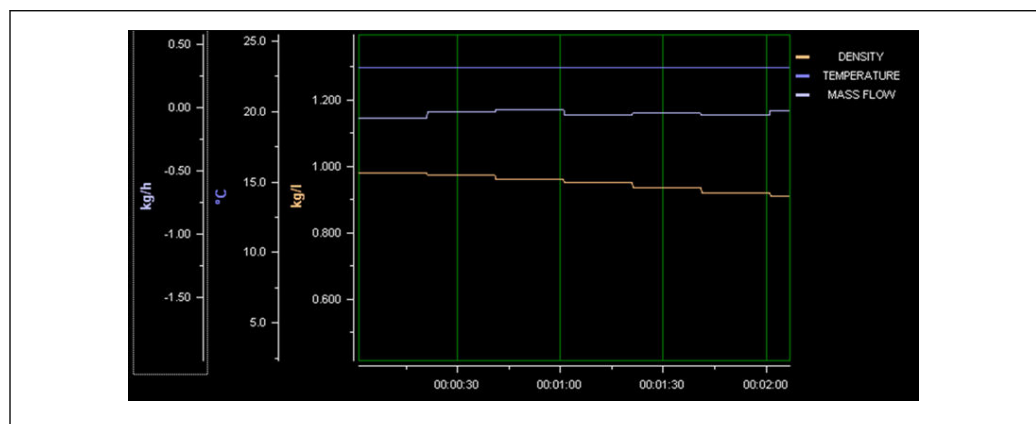
##### Density

Mechanical changes to the tubes cause a shift in the (natural) resonance frequency. If the frequency drops, coating/build-up will form in the tubes.



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Each Promass line size has a characteristic resonance frequency in air and water which correlates with the density. In the process, we have to define what density values exist during commissioning. We can then monitor them over the process to see if there is a drift or adjust our tolerance to provide an indication of process conditions (such as coating/buildup formation), for example to trigger a cleaning. This is explained in the graphic below:



A0020296

### Oscillation damping

Oscillation damping is a number that defines the ratio of the excitation current to the oscillation amplitude of the tubes. Therefore, oscillation damping is a numerical expression of the distance the tube oscillates and the drive power required in milliamperes to set the tube in motion. Oscillation damping provides an exponentially higher number compared to density measurement, which enables better detection of process-related changes. Many process applications need to isolate transient events which could compromise the detection of buildup or deposit formation. If a Promass sensor is commissioned in a process application, a sustained increase in oscillation damping will take place.

### Interpretation

As coating/buildup forms, the measuring tube gets heavier. The Promass recognizes this effect. The power supplied to the exciter current increases and the amplitude distance that must be maintained in the Coriolis measurement and that is expressed as oscillation damping, needs to increase. A 10% increase in oscillation damping results in an estimated one percent offset in mass flow rate, while a decrease in resonance frequency of only 1 Hz is reported. The effects of buildup or deposit formation can cause a change in mass flow accuracy and a corresponding density change, resulting in a higher error overall for the volumetric flow.

### 8.3.4 Application in the event of corrosion and abrasion

If there is evidence or the suspicion that the process is causing corrosion or abrasion in the measuring tubes of the Promass, **Heartbeat Monitoring** can be used for this application.

Suspicion that the process is causing corrosion in the measuring tubes of the Promass. A user-defined variation level is used to trigger an alarm so that the tube can be replaced before a failure occurs.

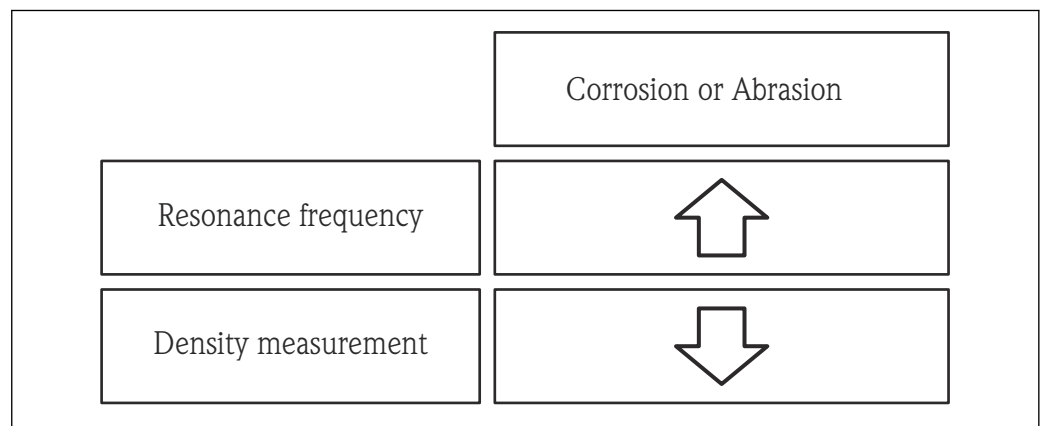
The customer has a system which relies on a Promass for product transfer. This device undergoes a cleaning cycle seven times a day. The customer expects the measuring device's tube system to fail over time, creating a potential operator and disposal hazard. The customer would therefore prefer to replace the measuring system when an obvious drift in the tube reference condition occurs. The condition of the measuring device after cleaning provides a baseline reference value. Any excessive deviation from this value can indicate a change in the sensor.

#### Relevant monitoring parameters

The following parameters can give an indication of corrosion or abrasion:

##### Density

Mechanical changes to the tubes cause a shift in the (natural) resonance frequency. If the frequency increases, the tubes are eroded or corroded.



A0020295-EN

Each Promass nominal width has a characteristic resonance frequency in air and water which correlates with the density. In the process, we have to define what density values exist during commissioning. We can then monitor them over the process to see if there is a drift or adjust our tolerance to provide an indication of process conditions, such as corrosion or abrasion.

##### Oscillation damping

Oscillation damping is a number that defines the ratio of the excitation current to the oscillation amplitude of the tubes. Therefore, oscillation damping is a numerical expression of the distance the tube oscillates and the drive power required in milliamps to set the tube in motion. Oscillation damping allows an exponentially higher number compared to density measurement, which enables better detection of process-related changes. Many process applications need to isolate transient events which could compromise the detection of buildup or deposit formation. If a Promass sensor is commissioned in a process application, a sustained increase in oscillation damping will take place.

##### Sensor asymmetry

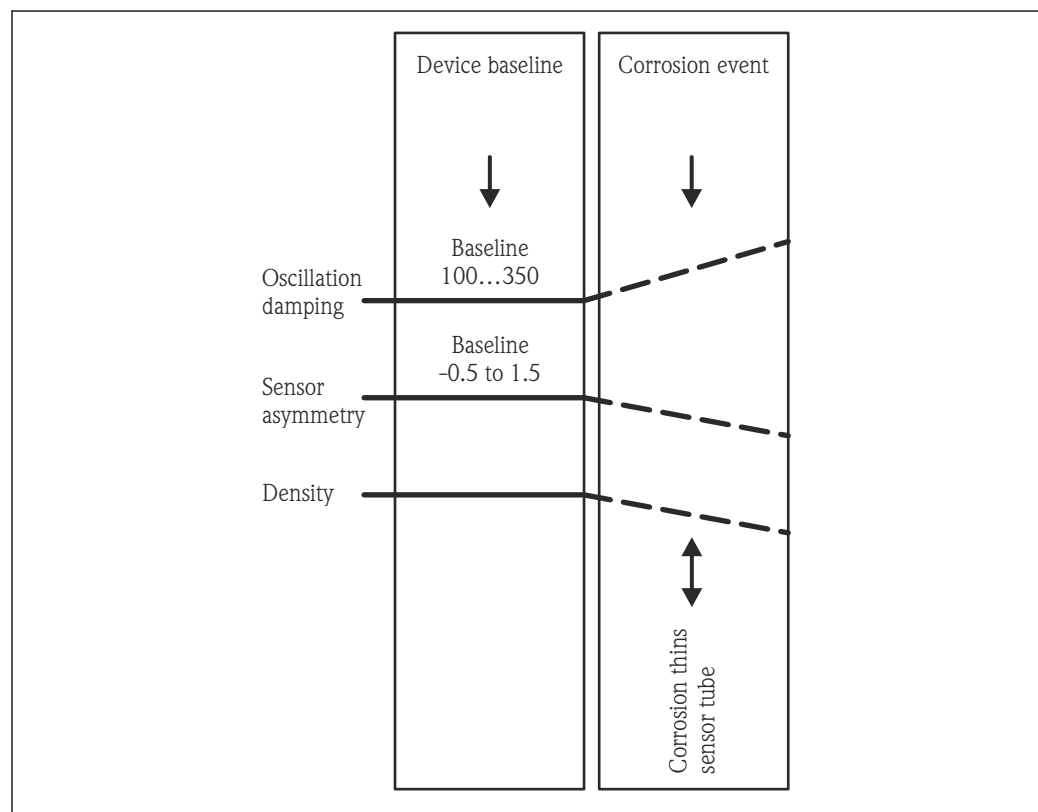
Corrosion or abrasion is never uniform from one end of the measuring tube to the other. Even the tubes in a dual-tube system do not display the same corrosion or abrasion patterns. Abrasion often occurs at the inlet, i.e. in areas of higher fluid velocity. Corrosion attacks the weak points of a measuring system and occurs at welds (flow splitters etc.). The sensor asymmetry value can be used to determine if the sensor balance and

symmetrical movement between the inlet and outlet pickup points have changed. Since this system is manufactured as a mass balanced system, corrosion or abrasion will affect the balance. The impact of sensor symmetry, or the "sensor asymmetry value", is the electrochemical deviation (change) from the original sensor balancing baseline. This makes it possible to compare the baseline against process-related effects that indicate corrosion or abrasion in a Promass sensor.

### Interpretation

A review of the meter, e.g. on a quarterly basis, will indicate a slow deviation from the reference condition (situation at the time of commissioning).

Application example: Increase in oscillation damping of  $> 2\%$ , increase in sensor asymmetry of more than  $150\%$ .



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Recommendation: A change in the "Oscillation damping" or "Sensor asymmetry" values would also be a reason for a **Heartbeat Verification** to be performed on the measuring device to ensure a failure is not imminent.

### 8.3.5 Application with multiphase media

If there is evidence or the suspicion that multiphase conditions are present in the process, **Heartbeat Monitoring** can be used for the following applications:

- Entrained air in liquid (gas content in liquid media)
- Wet gas

**The example shown below relates to applications with air entrained in liquids:**

Relevant monitoring parameters:

#### Oscillation damping

An increase in oscillation damping coupled with a rapid change in oscillation damping is an indicator of multiphase conditions in the process (particularly gas content in liquid media), as these conditions cause increased damping in the measuring tube. The changes

in the oscillation damping are caused by the variable gas concentration and distribution of the gas in the liquid.

## 8.4 Heartbeat Verification

### 8.4.1 Scope of the test

**Heartbeat Verification** uses the self-monitoring function of the Proline flowmeters to check the measuring device functionality. During the verification process, the system checks whether the measuring device components comply with the factory specifications. Both the sensor and the electronic modules are included in the test.

Compared to flow calibration, which incorporates the entire measuring device and assesses the flow measuring performance directly (primary measured variable), **Heartbeat Verification** checks the function of the measuring chain from the sensor to the outputs.

Here, the function checks device-internal parameters that are correlated with flow measurement (secondary measured variables, comparative values). The check is based on reference values that were recorded during the factory calibration.

### 8.4.2 Interpreting and using the verification results

If a verification is passed, this confirms that the comparison values that are checked are within the factory specification and that the measuring device is working correctly. At the same time, the zero point and calibration factor of the sensor are documented and traceable in the verification report. To ensure that the measuring device complies with the factory specification, these values must correspond to those of the last calibration or repeat calibration.



Confirmation of compliance with the flow specification can only be achieved through validation of the primary measured variable (flow) by means of recalibration or proving.

Recommended course of action if the result of a verification is "Failed":

If the result of a verification is "Failed", it is advisable to begin by repeating verification.

This applies in particular if the individual tests of the "Sensor" test group are affected, as a process-specific influence is then possible.

In this case, it is advisable to compare the current process conditions to those of a previous verification (→  26) to identify any deviations. To inhibit process-related influences as much as possible, the ideal solution is to create defined and stable process conditions and then to repeat verification:

Stabilize or stop flow, ensure that process temperature is stable, drain the sensor if possible.

Recommended remedial action if the result of the verification is "Failed":

■ Calibrate the measuring device

The calibration has the advantage that the "as found" measuring device state is recorded and the actual measured error is determined.

■ Direct remedial measures

Take remedial action on the basis of the verification results and the diagnostic information of the measuring device. Narrow down the possible cause of the error by identifying the test group that failed the verification.

| Test group              | Possible cause of error and recommendation                                                                                                                                                                                                                                                                   |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sensor                  | Electrical components of the sensor (signals, circuits and cables): <ul style="list-style-type: none"> <li>■ Wiring for remote installation</li> <li>■ Grounding of sensor</li> <li>■ Defect in the sensor → replace</li> </ul>                                                                              |
| Main electronics module | Drift or aging of electronic components due to environmental or process influences (temperature, vibration etc.)<br>Electronic module drift or defect → replace                                                                                                                                              |
| I/O electronic module   | <b>Internal verification</b><br>Signal feedback in 4 to 20mA HART current output:<br>Detection of drift and aging due to environmental or process influences (temperature, radiation, vibration etc.)<br><br><b>External verification</b><br>External testing of all active outputs at the measuring device. |

For more information on other possible causes and remedial measures, see the "Diagnostics and troubleshooting" section of the Operating Instructions.

## 9 Glossary and terminology

|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Measuring device       | Flowmeter in its entirety                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Sensor                 | Entire sensor system. This comprises the measuring tube, the electrodynamic pick-ups, the excitation system, the wiring, the temperature sensors etc. inside the sensor housing.                                                                                                                                                                                                                                                                                                                                                         |
| Process interface      | Mechanical interface between the flow sensor and the medium under measurement. The process interface is technology-specific: e.g. it is the measuring tube in the case of the Coriolis flowmeter, and the measuring tube liner in the case of electromagnetic flowmeters etc.<br>Note: A deterioration in the process interface due, for example, to excess pressure, thermal shock, corrosion, abrasion or coating/buildup may mean that the measurement is outside of the specification, or may result in a dangerous operating state. |
| FieldCare              | Software-based asset management system from Endress+Hauser. FieldCare is used for the documentation and analysis of the verification results.                                                                                                                                                                                                                                                                                                                                                                                            |
| On-board               | Built-in device functionality. An on-board functionality enables on-line and in-line checks.                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| On-line                | During an on-line check, the measuring device continues to perform its designated function. In any event, the process does not need to be interrupted for an on-line check. On-line checks can be continuous, periodical or event-controlled (e.g. following power-up).                                                                                                                                                                                                                                                                  |
| In-situ                | An in-situ check implies that the measuring device does not need to be removed from the application in order to perform the specific check. A reference condition can be established during the in-situ check (e.g. measuring tube filled with water or empty pipe condition). The test is usually performed on demand (e.g. <b>Heartbeat Verification</b> ).                                                                                                                                                                            |
| Internal references    | Heartbeat Technology based on references that are incorporated into the measuring device (flowmeter electronics). References are technology-specific.                                                                                                                                                                                                                                                                                                                                                                                    |
| Flow calibration       | This is the process which establishes a relation between the values of a flow standard (also known as a calibration rig) with its known measuring uncertainties, and the corresponding values of the flowmeter with its associated measuring uncertainties.<br> Calibration may be performed with or without adjustment of the calibration factor.                                                                                                    |
| Verification           | This involves proving that a flowmeter complies with manufacturer specifications regarding functionality. It also serves as confirmation that the technical characteristics of the measuring device have been implemented, thereby increasing confidence in the measured variable (flow).<br> Verification must not be confused with calibration.                                                                                                     |
| Validation             | A verification, whereby the manufacturer specifications are deemed adequate for the intended application.                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Heartbeat Verification | A dedicated embedded instrumentation, the objective of which is to monitor the functionality of different components of the flowmeter in accordance with manufacturer specifications. It uses internal diagnostic tools to check flowmeter functionality based on factory references and corresponding specifications.<br> <b>Heartbeat Verification</b> is not a calibration system.                                                                 |
| Verification report    | Document in which the results of the <b>Heartbeat Verification</b> are recorded.                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Quantitative check     | Check with a result that can be measured as "absolute or relative (additional) measuring uncertainty", e.g. a reference drift is proportional to the change of the actual flow.                                                                                                                                                                                                                                                                                                                                                          |
| Qualitative check      | This is a check with a result that generally does not correlate to an additional measuring uncertainty, e.g. the effect of coating/buildup at the process interface to the flow can depend on the type and uniformity of the coating/buildup.                                                                                                                                                                                                                                                                                            |
| Off-line time          | Off-line time is defined as a limited period of time in which a measuring device is unable to work normally (output actual process data) as it is busy with other tasks (e.g. performing a verification).                                                                                                                                                                                                                                                                                                                                |

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Data set                  | A data set permanently saves a collection of information that comprises the verification results, including the ID, time stamp, device parameters etc. A range of <b>Heartbeat Verification</b> data sets are stored internally in Proline flowmeters.                                                                                                                                                                                                                                                                                                                                   |
| Metrological traceability | <p>Characteristic of a measurement result based a reference using a documented and unbroken chain of calibrations.</p> <p> Each of these calibrations must be linked either to an international measurement standard or a national measurement standard for the intended quantity, in order to have a measuring uncertainty, a clear measurement procedure, accredited technical competence, metrological traceability to the SI (international system of units) and defined calibration intervals.</p> |
| Condition Monitoring      | The concept of Condition Monitoring is based on regular or continuous recording of the system status by measuring and analyzing meaningful measured variables. For the purpose of Condition Monitoring, <b>Heartbeat Monitoring</b> continuously provides measured variables in an external condition monitoring system.                                                                                                                                                                                                                                                                 |

## 10 Registered trademarks

**HART®**

Registered trademark of the HART Communication Foundation, Austin, USA

**PROFIBUS®**

Registered trademark of the PROFIBUS User Organization, Karlsruhe, Germany

**Microsoft®**

Registered trademark of the Microsoft Corporation, Redmond, Washington, USA

**Applicator®, FieldCare®, Field Xpert™, HistoROM®, Heartbeat Technology®**

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