

# Special Documentation

## **Proline Promag 200**

Heartbeat Verification application package



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# 1 Document information

## 1.1 Document function


This document is part of the Operating Instructions and serves as a reference for application-specific parameters and notes.

It provides detailed information on:

- Every individual parameter in the operating menu
- Advanced technical specifications
- General principles and application tips

## 1.2 Using this document








### 1.2.1 Information on the document structure

 For information on the arrangement of the parameters in accordance with the menu structure **Operation** menu, **Setup** menu, **Diagnostics** menu along with a short description, see the Operating Instructions for the device.

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

## 1.3 Symbols used

### 1.3.1 Symbols for certain types of information

Symbol	Meaning
	<b>Tip</b> Indicates additional information.
	<b>Reference to documentation</b> Refers to the corresponding device documentation.
	<b>Reference to page</b> Refers to the corresponding page number.
	<b>Reference to graphic</b> Refers to the corresponding graphic number and page number.
	<b>Operation via local display</b> Indicates navigation to the parameter via the local display.
	<b>Operation via operating tool</b> Indicates navigation to the parameter via the operating tool.
	<b>Write-protected parameter</b> 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 documentation is not a substitute for the Operating Instructions supplied with the device.

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)".

This documentation is an integral part of the following Operating Instructions:

Sensor	HART	FOUNDATION Fieldbus	PROFIBUS PA
H	BA01110D	BA01377D	BA01375D
P	BA01111D	BA01378D	BA01376D



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

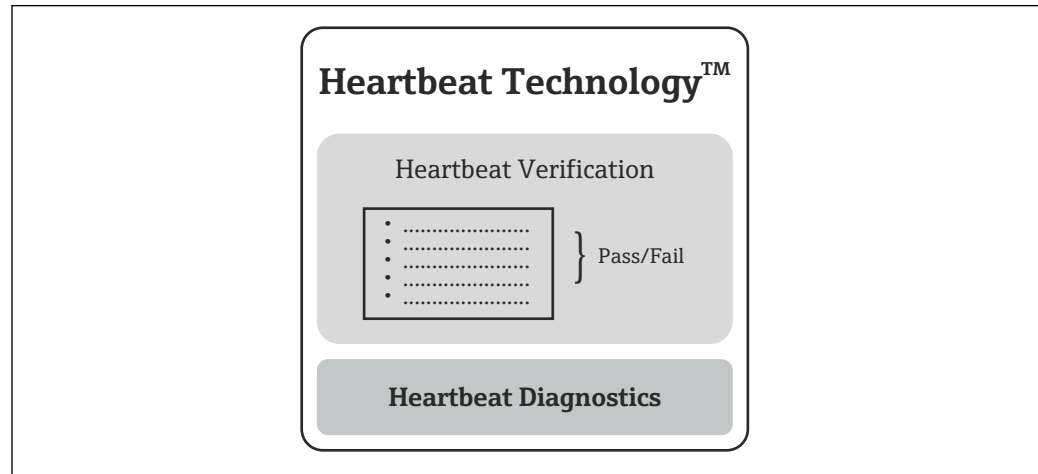
### 1.4.1 Content and scope

This 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 functionality through continuous self-monitoring (**Heartbeat Diagnostics**) as well as in-situ verification of flowmeters in the (**Heartbeat Verification**) application.



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 1 *Heartbeat Technology: Overview of modules and correlated functions*

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

The **Heartbeat Verification** module is optionally available →  6.



#### 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 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 →  13.

## 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 Verification** module is available as an order option in the product price list: Order characteristic "Application packages", **EB** "Heartbeat Verification" option

If this order option is selected, **Heartbeat Verification** functionality is available in the measuring 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 →  13 →  13.

## 3 Product description

### 3.1 Overview

Using the "Heartbeat Verification" application package, the device functionality can be verified in the application (**Heartbeat Verification**).

This documentation complements the Operating Instructions and describes the additional functions that are available when the "Heartbeat Verification" option is ordered. The 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** 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).
- 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 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 Promag 200, the TTC is 95%. If SIL operation is activated, this increases to 96%.

 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 percentage of the failures undetected by diagnosis ( $\lambda_{du}$ ).

## 3.4 Proof-test

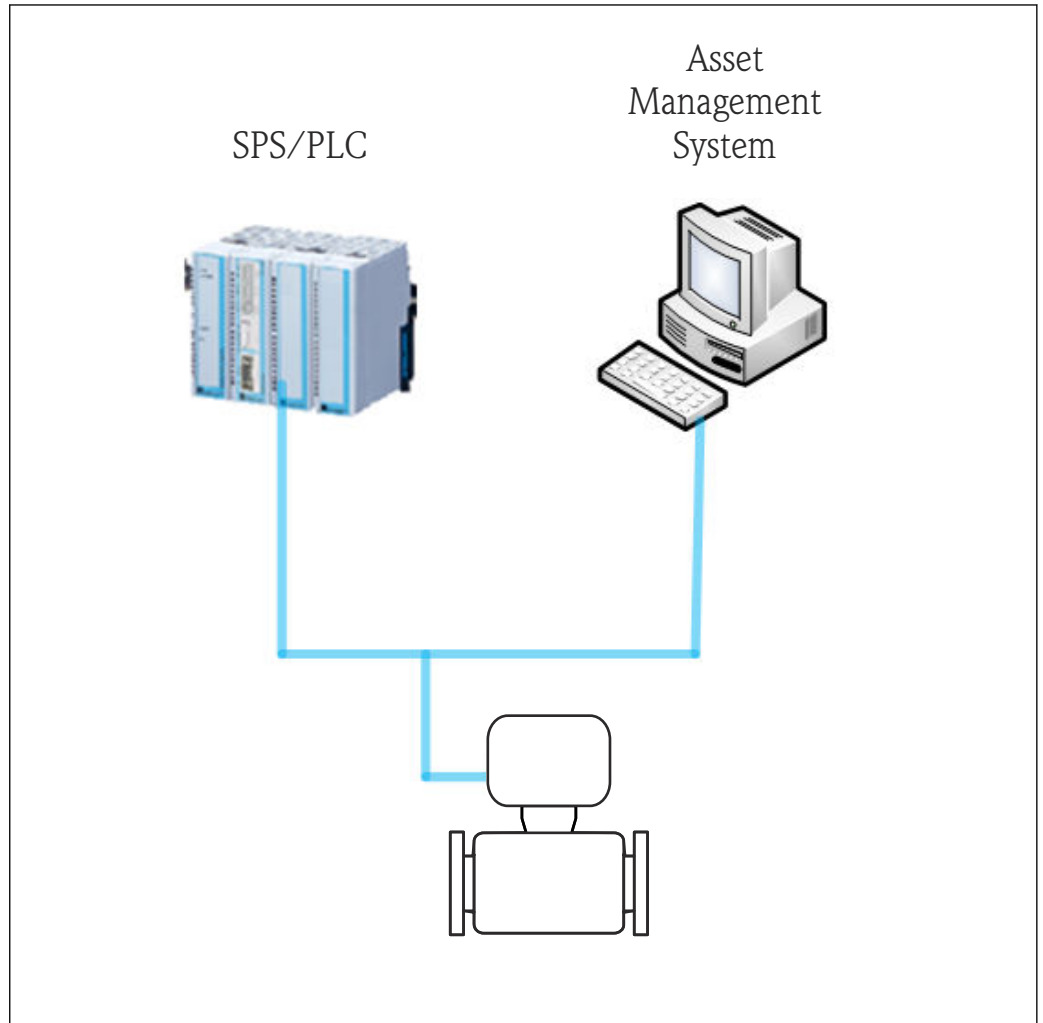
Proline measuring devices allow proof testing to be carried out in their installed state using Heartbeat Verification.

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).



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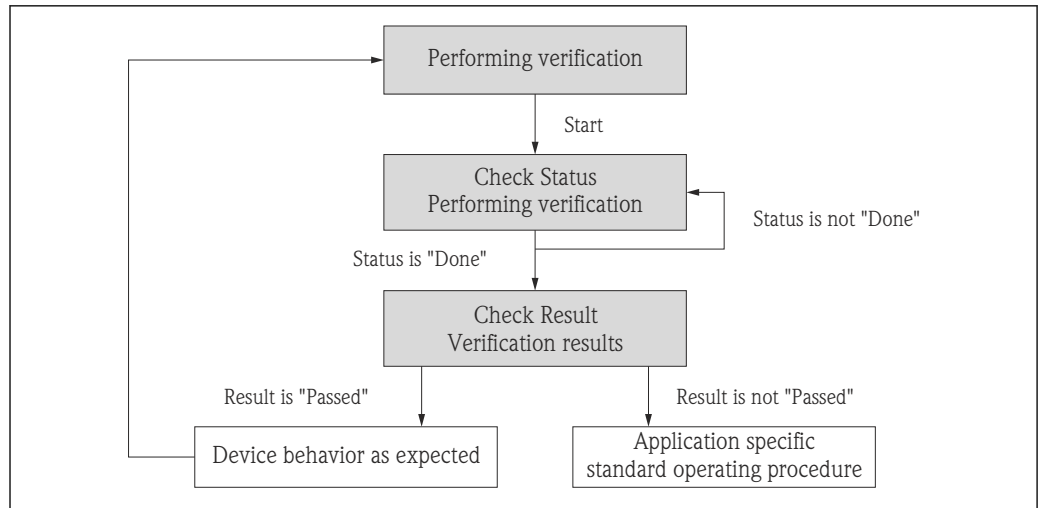
Here, data exchange can be either automated or performed by a user.

### 4.1 Automated data exchange

Heartbeat Diagnostics	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>▪ Instrument check via self-monitoring</li> <li>▪ Start verification and upload verification results</li> </ul>

#### 4.1.1 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:



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- 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 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>	<ul style="list-style-type: none"> <li>■ Instrument verification via self-monitoring</li> <li>■ Start verification Upload, archive and document verification results including detailed results</li> </ul>

**i** Data exchange performed by the user is described in the "Commissioning" → 13, "Operation" → 15 and "Heartbeat Technology – integration" → 29 sections.

## 5 Commissioning

### 5.1 Availability

If the optional **Heartbeat Verification** package was ordered for the flowmeter ex works, the function is available when the measuring device is delivered to the customer. The function is accessed via the operating interfaces of the measuring device or via 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", 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

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

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

- HART: 01.01.zz
- FOUNDATION Fieldbus: 01.00.zz
- PROFIBUS PA: 01.00.zz

#### 5.1.2 Activation

For activation, a conversion kit from Endress+Hauser is required. This kit contains an activation code which must be entered via the operating menu in order to activate the "Heartbeat Verification" function.

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

Once activated, **Heartbeat Verification** is permanently available in the measuring device.

Activation is possible with all firmware versions:

### 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.



### 5.3 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

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

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 →  15.

### 5.3.1 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 Verification

#### 6.2.1 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.

#### 6.2.2 Product features

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

#### 6.2.3 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"

Measurement is interrupted briefly while the verification is being carried out. The output of measured values resumes; in the meantime, a "last valid value" is output. The interruption lasts for a maximum of 2 to 3 minutes, depending on the sensor type. The interruption to operation is indicated by a diagnostic message as well as a "Function check" status signal, see also "Diagnostic behavior" section →  16.

#### 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	±0.2 %
DC current resolution	10 µA
Frequency measuring uncertainty	±0.1 %
Frequency resolution	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*

*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)		–	

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



Signal transmission for FOUNDATION Fieldbus, pulse/frequency/switch output

<p style="text-align: right; font-size: small;">A0013570</p>	<p style="text-align: right; font-size: small;">A0018161</p>
<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: FOUNDATION Fieldbus                  2 Output 2 (passive: pulse/frequency/switch output)                  3 Ground terminal for cable shield</p>	

Order code for "Output"	Terminal numbers			
	Output 1		Output 2	
	1 (+)	2 (-)	3 (+)	4 (-)
Option E <sup>1) 2)</sup>	FOUNDATION Fieldbus		Pulse/frequency/switch output (passive)	

- 1) Output 1 must always be used; output 2 is optional.
- 2) FOUNDATION Fieldbus with integrated reverse polarity protection.

PROFIBUS PA signal transmission, pulse/frequency/switch output

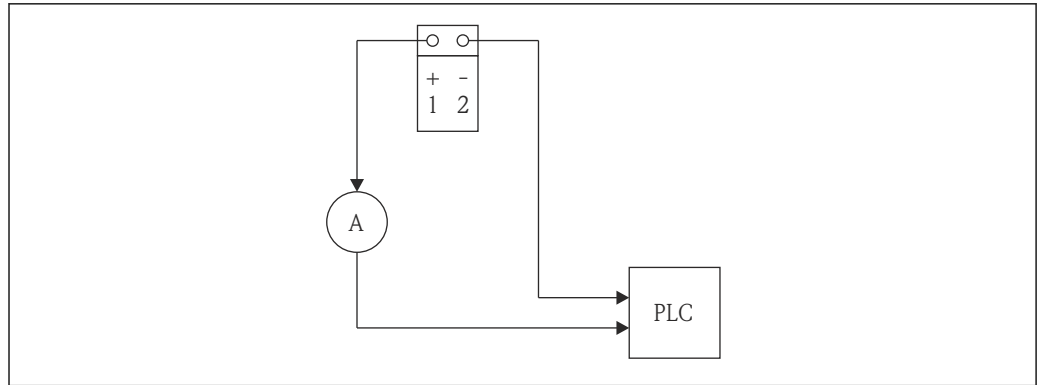
<p style="text-align: right; font-size: small;">A0013570</p>	<p style="text-align: right; font-size: small;">A0018161</p>
<p>Maximum number of terminals</p>	<p>Maximum number of terminals for order code for "Accessory mounted", option NA "Overvoltage protection"</p>
<p>1 Output 1: PROFIBUS PA                  2 Output 2 (passive: pulse/frequency/switch output)                  3 Ground terminal for cable shield</p>	

Order code for "Output"	Terminal numbers			
	Output 1		Output 2	
	1 (+)	2 (-)	3 (+)	4 (-)
Option G <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. The ammeter is looped into the circuit. To do so, it is necessary to break the existing connection to the higher-level system for a brief period of time.



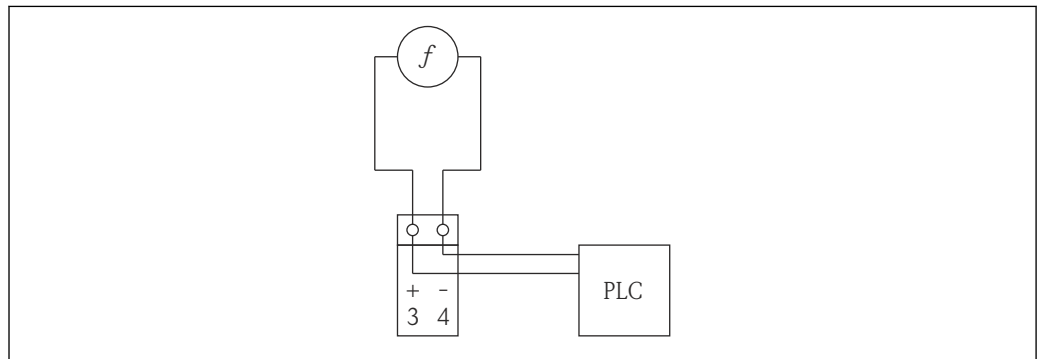
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2 External verification of current output: Looping in of an ammeter (A)

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.



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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

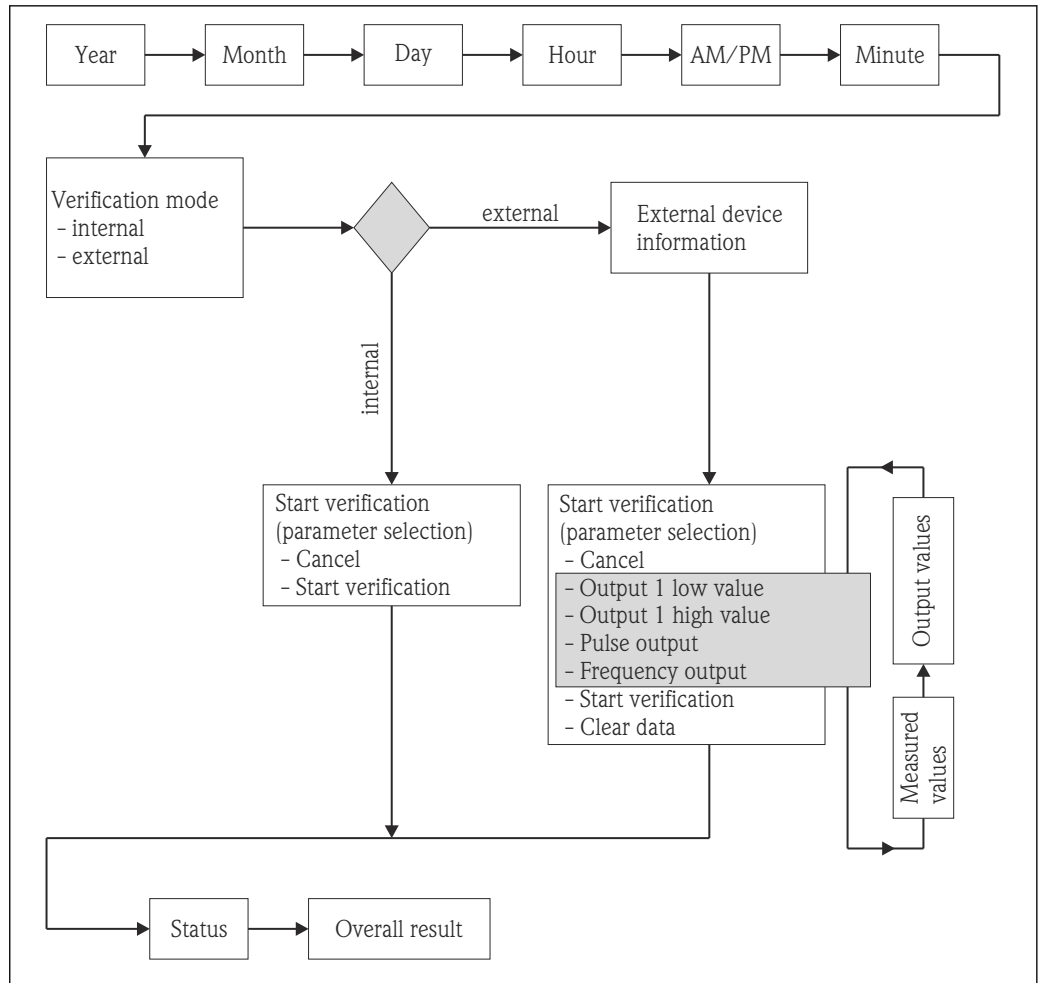
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*Parameters for "Performing verification/Start"*

Parameter	Description	Selection/ User entry	Factory setting
Year	Entry for date and time (field 1): Year verification is performed	9...99	10
Month	Entry for date and time (field 2): Month verification is performed	<ul style="list-style-type: none"> <li>▪ January</li> <li>▪ February</li> <li>▪ March</li> <li>▪ April</li> <li>▪ May</li> <li>▪ June</li> <li>▪ July</li> <li>▪ August</li> <li>▪ September</li> <li>▪ October</li> <li>▪ November</li> <li>▪ December</li> </ul>	January
Day	Entry for date and time (field 3): Day verification is performed	1...31	1
Hour	Entry for date and time (field 4): Hour verification is performed	<ul style="list-style-type: none"> <li>▪ 1...12</li> <li>▪ 0...23</li> </ul>	12
AM/PM	Entry for date and time (field 5): Morning or afternoon	<ul style="list-style-type: none"> <li>▪ AM</li> <li>▪ PM</li> </ul>	AM
Minute	Entry for date and time (field 6): Minute verification is performed	0...59	0
Verification mode	Selecting verification mode: <ul style="list-style-type: none"> <li>▪ Internal: Verification is performed automatically by the device and without manual checking of external measured variables.</li> <li>▪ External: Similar to internal verification but with the entry of external measured variables (see also "Measured values" parameter).</li> </ul>	<ul style="list-style-type: none"> <li>▪ Internal</li> <li>▪ External</li> </ul>	Internal

Parameter	Description	Selection/ User entry	Factory setting
External device information	Measuring equipment recording for external verification.  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  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 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".  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>▪ Pulse output</li> <li>▪ Frequency output</li> <li>▪ Start verification</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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**i 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.

- i** 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.

**6.2.4 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/ User entry/ Partial result	Factory 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>	0 to 65 535	0
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 electronic 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 I/O module monitoring For current output: Accuracy of the current For frequency output: 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> <p> Limit value for current output (for internal verification only):</p> <ul style="list-style-type: none"> <li>■ ±1 %</li> <li>■ ±300 µA</li> </ul> <p> Limit value for current output (for external verification only):</p> <ul style="list-style-type: none"> <li>■ ±1 %</li> <li>■ ±10 µA</li> </ul> <p> Limit value for frequency output (for external verification only):</p> <p>±0.1 %</p>	Check not done
System	Test measuring device system condition	<ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul>	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.
- System condition: test for active measuring device errors of "alarm"-type diagnostic behavior.

For more information on the test groups and individual tests →  23.

**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.

**6.2.5 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"*

Individual test	Description	Result/limit value
<b>"Sensor" test group</b>		
Coil current shot time	Monitoring of symmetry in the exciter circuit for coil current shot times while both field polarities are changed	<ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul>
Coil hold voltage	Monitoring of symmetry in holding voltages of exciter circuit for driving the coil current for both field polarities	<ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul>
<b>"Main electronics module" test group</b>		
Supply voltage	In the main electronics unit the internal supply voltages are monitored to ensure that they do not breach their permitted limits	<ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul>
Reference voltage	Monitoring of reference voltages in flowmeter circuit and exciter circuit	<ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul>

Individual test	Description	Result/limit value
Electrode measurement circuit	Monitoring of flow measuring circuit with regard to gain	<ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul>
Excitation circuit	Monitoring of coil current measurement	<ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul>
Measuring resistor	Monitoring of measuring resistor	<ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul>
"System Condition" test group		
"Input/Output" test group (only HART)		
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	Current output
Output 1	Verification result for I/O module 1	<ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul>
▶ 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>■ Pulse</li> <li>■ Frequency</li> <li>■ Switch</li> <li>■ None</li> </ul>
Output 2 (pulse, frequency)	Verification result for I/O module 2	<ul style="list-style-type: none"> <li>■ Failed</li> <li>■ Passed</li> <li>■ Check not done</li> </ul>
▶ Output 2 actual value 1	Lower measured value for I/O module 2	Pulse: depends on the set pulse width 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
Verification value volume flow	Actual measured value for volume flow
Electronic temperature	Current measured value for the electronic temperature in the transmitter

## 6.2.6 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

→  30




### 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 Promag



**Endress+Hauser**  
People for Process Automation

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**Plant Operator: Mr. Smith**

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**Device Information**

Location	Location 14
Device tag	M-745
Module name	Promag P
Nominal diameter	DN25
Device name	Promag 200
Order code	5P2B25-725
Serial number	1234567890
Firmware version	01.01.00

**Calibration**

Calibration factor	1.15
Zero point	10


**Verification Information**

Operating time (counter)	12d15h32min12s
Date/time (manually recorded)	01.12.2010/12:00
Verification ID	17

**Overall Verification Result\***

Failed Details see next page

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



**Heartbeat  
Technology**

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**Confirmation**

Heartbeat Verification verifies the function of the flowmeter within the specified measuring tolerance, over the useful lifetime of the device, with a total test coverage > 95 %, and complies with the requirements for traceable verification according to DIN EN ISO 9001:2008 – Section 7.6 a.

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**Notes**

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Date

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Operator's signature

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Inspector's signature

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4 Verification report (Page 1)

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 → 23

Verification Report Promag



Plant Operator: Mr. Smith


Device Identification and Verification Identification

Serial number	452633345
Device tag	M-745
Verification ID	17



<b>Sensor</b>	<input checked="" type="checkbox"/> Passed
Coil current shot time	<input checked="" type="checkbox"/> Passed
Coil hold voltage	<input checked="" type="checkbox"/> Passed
<b>Main electronic module</b>	<input checked="" type="checkbox"/> Failed
Supply voltage	<input checked="" type="checkbox"/> Passed
Reference voltage	<input checked="" type="checkbox"/> Failed
Gain of electrode measuring circuit	<input checked="" type="checkbox"/> Passed
Exciter current circuit	<input checked="" type="checkbox"/> Passed
Measuring shunt	<input checked="" type="checkbox"/> Passed
<b>System status</b>	<input checked="" type="checkbox"/> Passed
<b>I/O module</b>	<input checked="" type="checkbox"/> Passed

Verification Report Promag

**Endress+Hauser**   
People for Process Automation

**Plant Operator: Mr. Smith**

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**Device Identification and Verification Identification**

  
**Heartbeat  
Technology**

Serial number	452633345
Device tag	M-745
Verification ID	17

<b>Sensor</b>	<input checked="" type="checkbox"/> <b>Passed</b>
Coil current shot time	<input checked="" type="checkbox"/> Passed
Coil hold voltage	<input checked="" type="checkbox"/> Passed
<b>Main electronic module</b>	<input checked="" type="checkbox"/> <b>Failed</b>
Supply voltage	<input checked="" type="checkbox"/> Passed
Reference voltage	<input checked="" type="checkbox"/> Failed
Gain of electrode measuring circuit	<input checked="" type="checkbox"/> Passed
Exciter current circuit	<input checked="" type="checkbox"/> Passed
Measuring shunt	<input checked="" type="checkbox"/> Passed
<b>System status</b>	<input checked="" type="checkbox"/> <b>Passed</b>
<b>I/O module</b>	<input checked="" type="checkbox"/> <b>Passed</b>
Output 1	<input checked="" type="checkbox"/> Passed*
Output 2	<input type="checkbox"/> Check not done*

\*External verification


**Information about the External Verification**

Fluke 2354, Cal: 10.0.2012, F. Maier

www.endress.com
Page 2

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 6 Verification report, external verification (Page 2)

**Data management with FieldCare Verification-DTM**

→  30

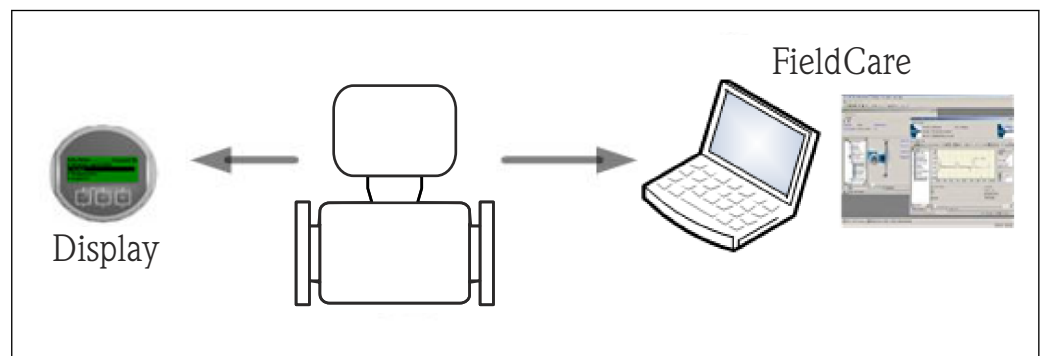
## 7 Function

### 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.

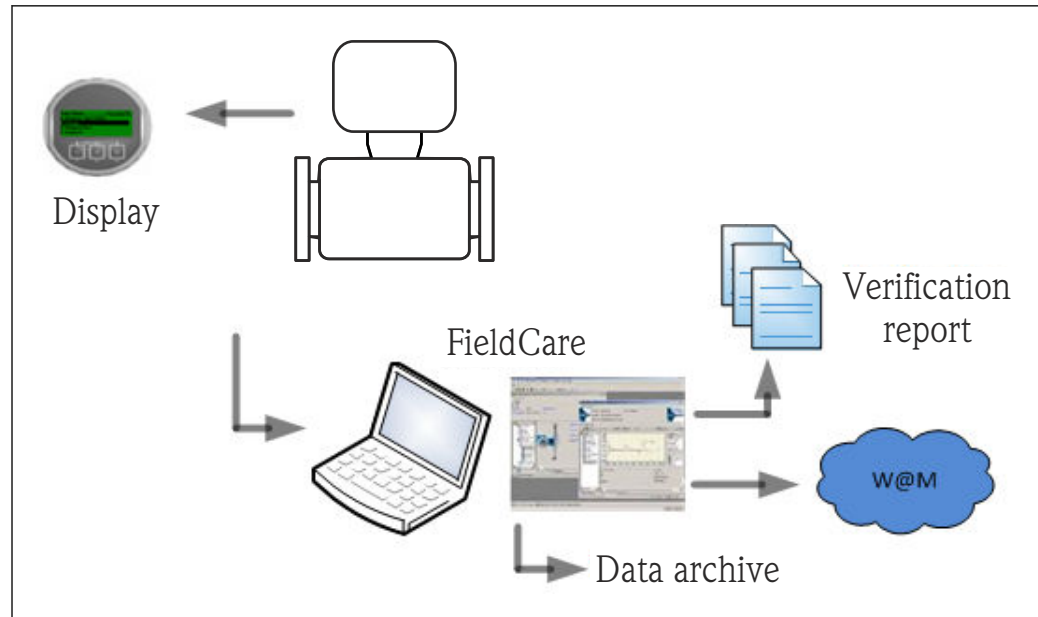
### 7.2 Heartbeat Technology - integration

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



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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.



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:


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

**DTM header**

The following basic functions are provided:

 <small>A0020887</small>	The header refers to the top display area of the DTM. It contains information about the device TAG
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**"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.

Status	Test Name	Unit	Signal	Min. Value	Max. Value
✓	Sensor				
✓	Coil current shot time	1.0002			
✓	Coil hold voltage	0.9922			
✓	Coil current	1.0048			
✓	Sensor electronic module				
✓	Reference voltage				
✓	Actual reference voltage drift 1	1.0000			
✓	Actual reference voltage drift 2	1.0000			
✓	Linearity of electrode measuring circuit				
✓	Actual linearity for operation point 1	0.9997			
✓	Actual linearity for operation point 2	0.0142			
✓	Actual linearity for operation point 3	1.0000			
✓	Actual linearity for operation point 4	0.0138			
✓	Offset of electrode measuring circuit	1.8907			
✓	I/O module				



A0020888-EN

### Verification results

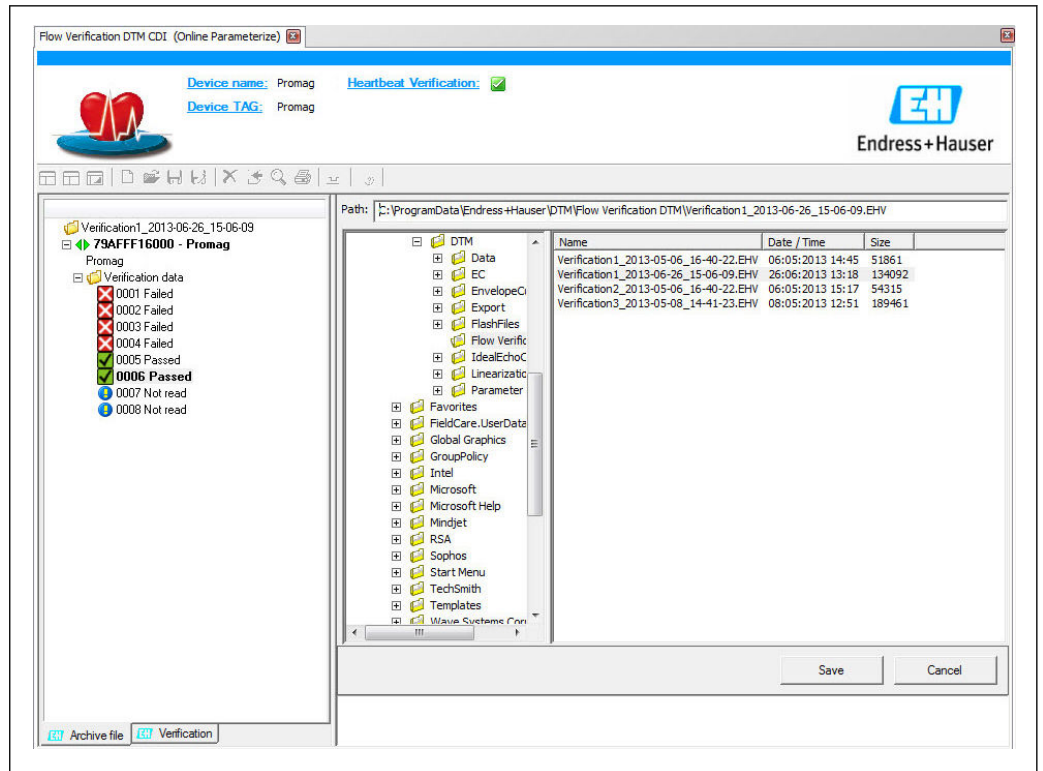
Details for the verification results are displayed in the "Data area". The data area is split into three tabs:

- "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).





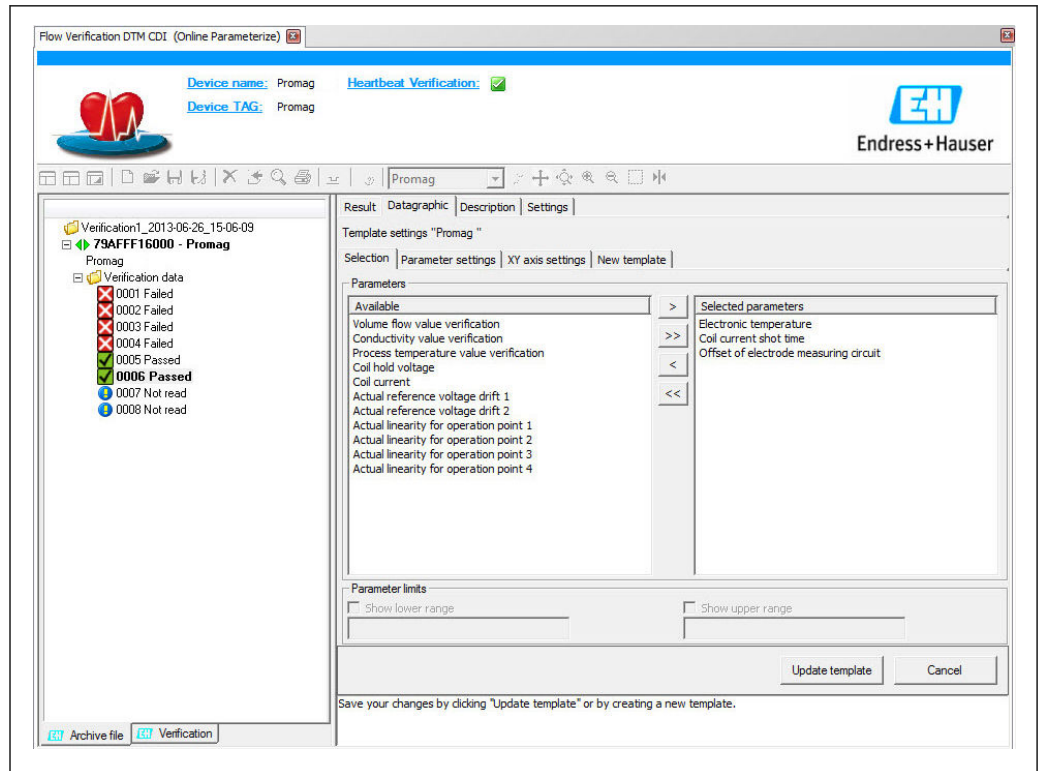
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### Opening archive files

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

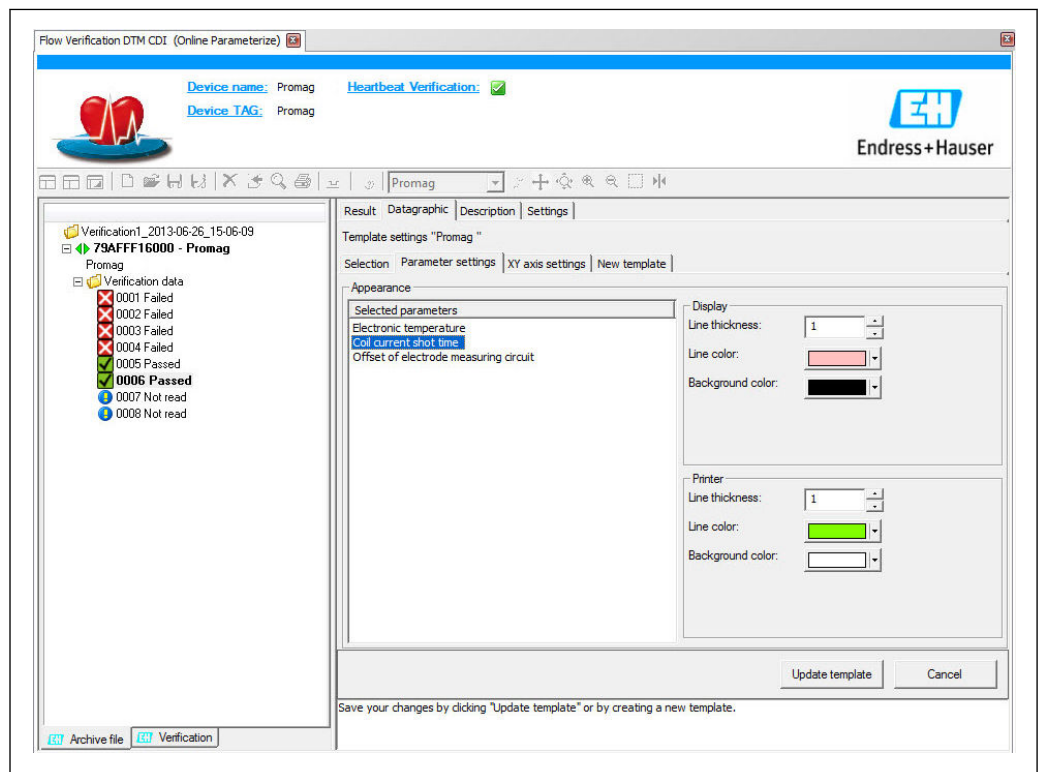
### Visualization and trend analysis

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.



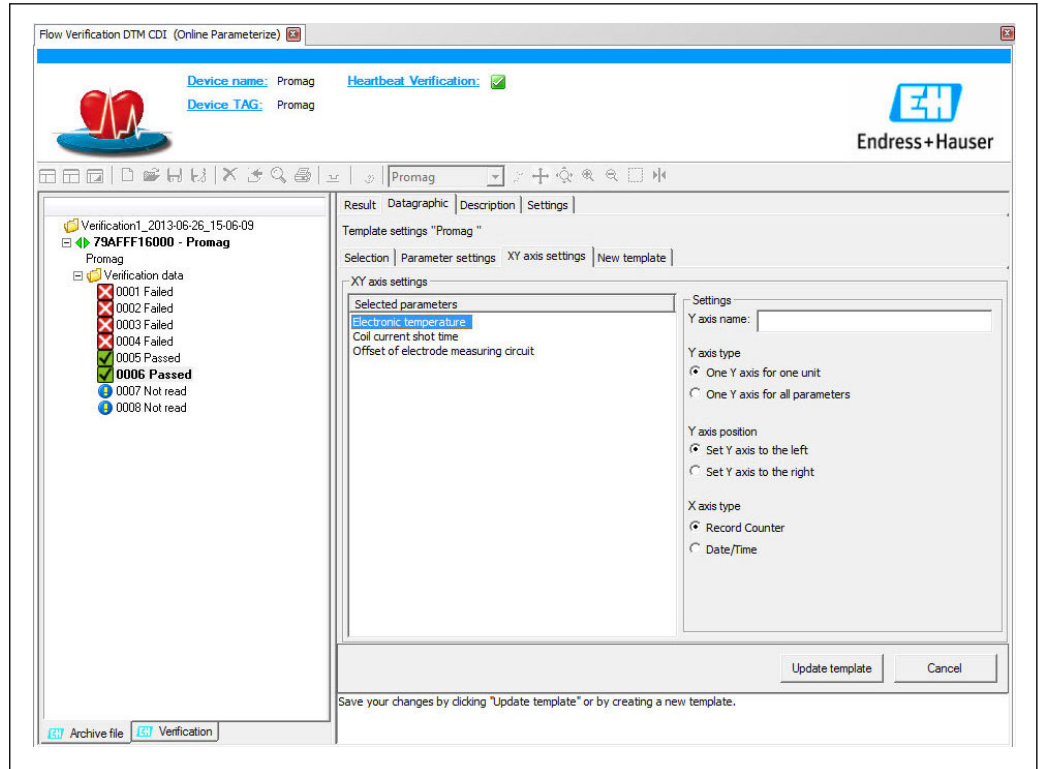
A0020892-EN

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



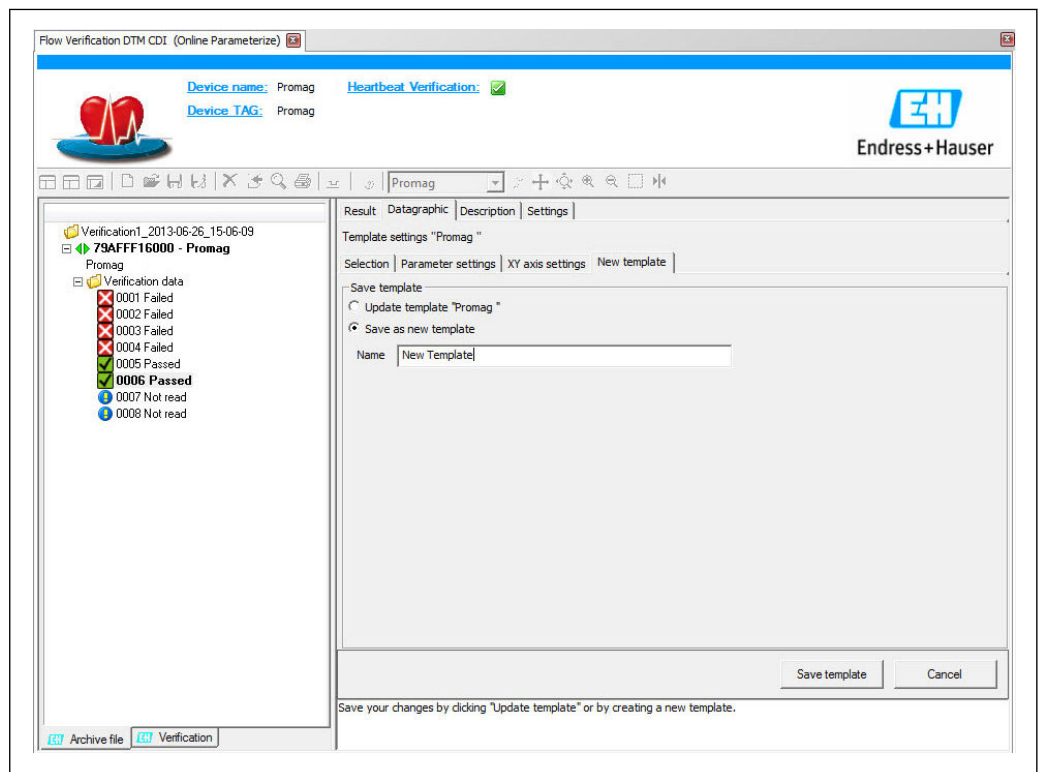
A0020893-EN

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



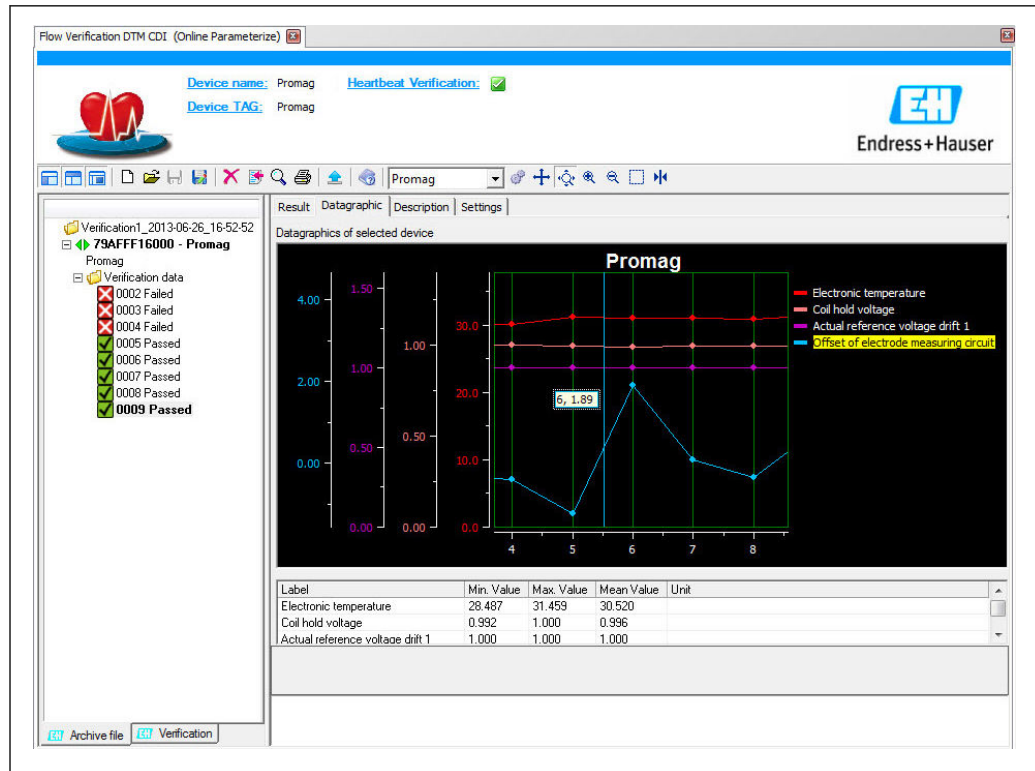
A0020894-EN

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



A0020895-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



A0020896-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.

#### Sensor module

Sensor module/test group	Test and recognized causes of errors
Sensor	Electrical testing of excitation system Testing of symmetry of coil current shot times and their required voltages for both field polarities  Establishing an external magnetic field

*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 Heartbeat Verification

#### 8.2.1 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.

#### 8.2.2 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 →  23 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.) Electronic module drift or defect → replace
I/O electronic module	<b>Internal verification</b> Signal feedback in 4 to 20mA HART current output: Detection of drift and aging due to environmental or process influences (temperature, radiation, vibration etc.)  <b>External verification</b> External testing of all active outputs at the measuring device.
System condition	Test for active measuring device errors of "alarm"-type diagnostic behavior.  For information on the diagnostic behavior, see the "Diagnostics and troubleshooting" section of the Operating Instructions.

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.
FieldCare	Software-based asset management system from Endress+Hauser. FieldCare is used for the documentation and analysis of the verification results.
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.  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).  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.  <b>Heartbeat Verification</b> is not a calibration system.
Verification report	Document in which the results of the <b>Heartbeat Verification</b> are recorded.
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	Characteristic of a measurement result based a reference using a documented and unbroken chain of calibrations.  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.
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

### **FOUNDATION™ Fieldbus**

Registration-pending trademark of the Fieldbus Foundation, Austin, Texas, USA

### **Microsoft®**

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

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

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