

Special documentation

Proline Prowirl 200

Heartbeat Technology Application Package

Table of contents

1	Document information	4
1.1	Document function	4
1.2	Using this document	4
1.3	Symbols used	4
1.4	Documentation	5
2	Product features and availability	6
2.1	Product features	6
2.2	Availability (product list and order option)	6
3	Product description	8
3.1	Overview	8
3.2	Detailed product description	8
4	System integration	10
4.1	Automated data exchange	10
4.2	Data exchange performed by the user (asset management system)	11
5	Commissioning	12
5.1	Availability	12
5.2	Heartbeat Diagnostics	12
5.3	Heartbeat Verification	12
6	Operation	14
6.1	Heartbeat Diagnostics	14
6.2	Heartbeat Verification	14
7	Function	28
7.1	Calibration and self-monitoring using Heartbeat Technology	28
7.2	Heartbeat Technology – integration	28
7.3	Heartbeat Verification – data management ...	29
7.4	Modules	34
8	Use cases and applications (and interpretation of results)	36
8.1	Diagnostics	36
8.2	Heartbeat Verification	36
9	Glossary and terminology	38
10	Registered trademarks	39


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 Symbols used

1.3.1 Symbols for certain types of information

Symbol	Meaning
 A0011193	Tip Indicates additional information.
 A0011194	Reference to documentation Refers to the corresponding device documentation.
 A0011195	Reference to page Refers to the corresponding page number.
 A0011196	Reference to graphic Refers to the corresponding graphic number and page number.
 A0013140	Operation via local display Indicates navigation to the parameter via the local display.
 A0013143	Operation via operating tool Indicates navigation to the parameter via the operating tool.
 A0013144	Write-protected parameter 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".

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

Sensor	HART	FOUNDATION Fieldbus	PROFIBUS PA
C	BA01152D	BA01215D	BA01220D
D	BA01153D	BA01216D	BA01221D
F	BA01154D	BA01217D	BA01222D
O	BA01155D	BA01218D	BA01223D
R	BA01156D	BA01219D	BA01224D



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 → Download

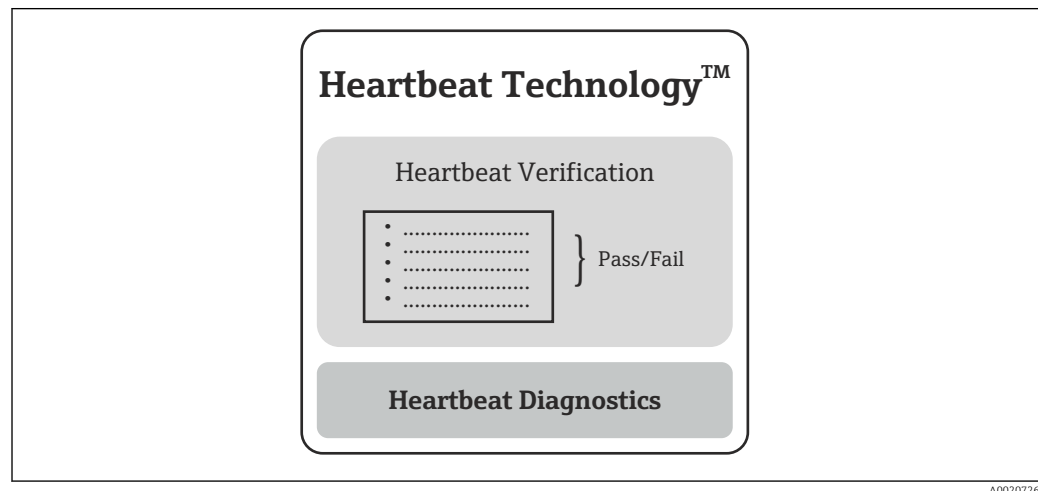
1.4.1 Content and scope

This Special Documentation contains descriptions of the additional parameters and technical data that are available with the Heartbeat Technology application package. All other parameters that are not relevant for Heartbeat Technology are described in the Operating Instructions.

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.



 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 (→  12).

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.

List of currently available Proline Prowirl products:

- Proline Prowirl 200 HART
- Proline Prowirl 200 FOUNDATION Fieldbus
- Proline Prowirl 200 PROFIBUS PA


 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 (→  12).

3 Product description

3.1 Overview

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

This Special Documentation complements the Operating Instructions and describes the additional functions that are available when the "Heartbeat Verification" 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** 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.

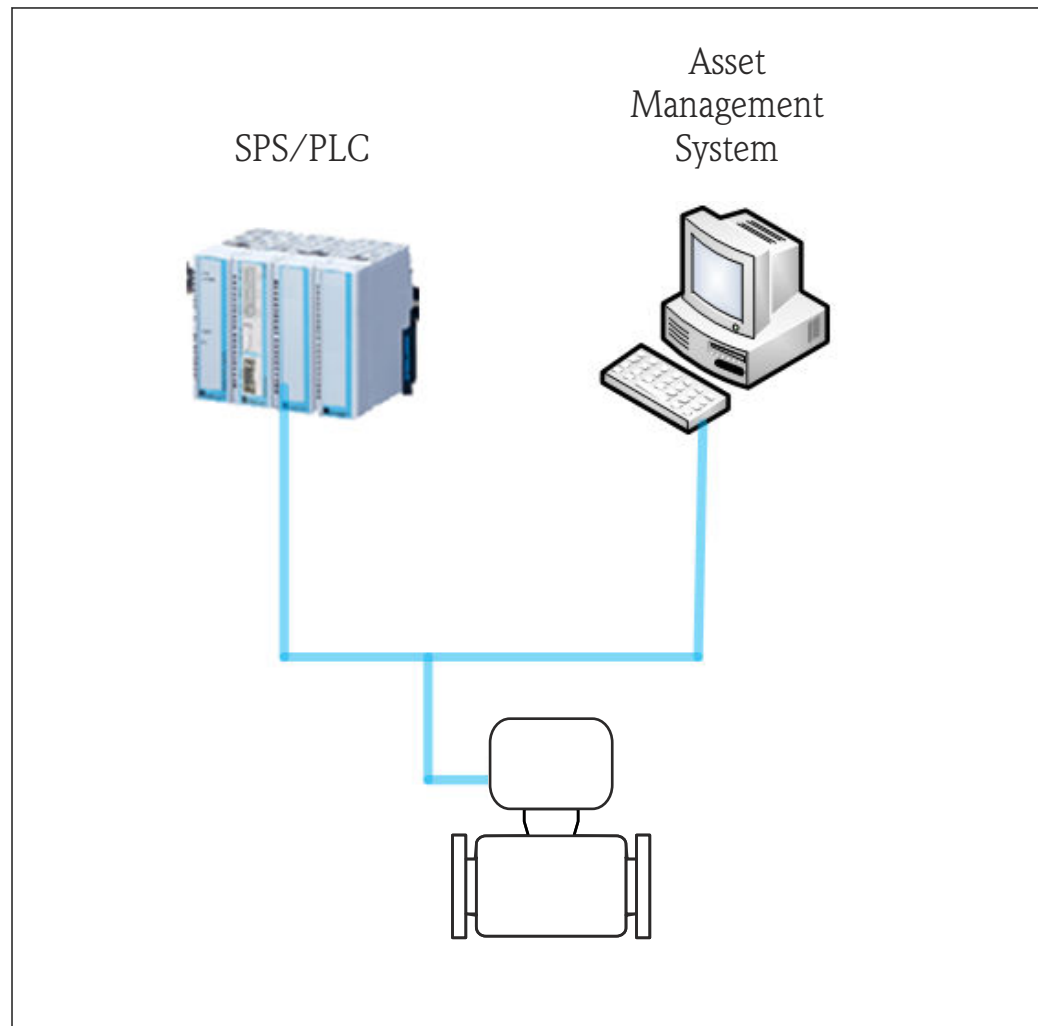
Customer and industry requirements

- 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)

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

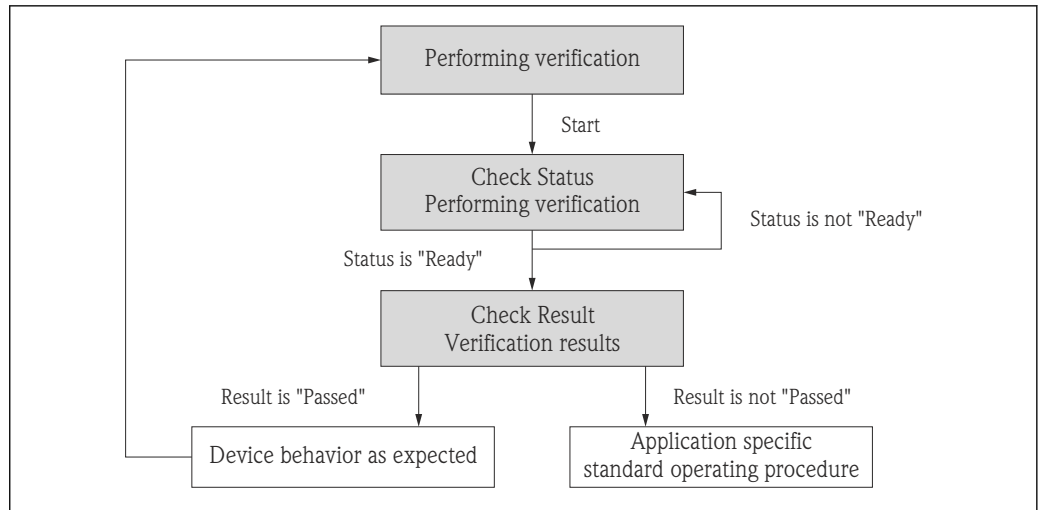
Here, data exchange can be either automated or performed by a user.

4.1 Automated data exchange

Heartbeat Diagnostics	Heartbeat Verification
<ul style="list-style-type: none"> ▪ Analyze field device diagnostics ▪ Diagnostic events for integration with the PLC 	<ul style="list-style-type: none"> ▪ Instrument check via self-monitoring ▪ Start verification and upload verification results

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:



A0020258-EN

- **Verification performance:**
The verification is started using the "Start verification" parameter.
- **Verification status:**
When verification is complete, the value of the "Status" parameter changes to **Ready**.
- **Verification result:**
The overall result of the verification is indicated in the "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"> ▪ Identify remedial measures ▪ Information on the cause of the error and remedial measures are provided in the asset management system 	<ul style="list-style-type: none"> ▪ Instrument verification via self-monitoring ▪ Start verification Upload, archive and document verification results including detailed results

i Data exchange performed by the user is described in the "Commissioning" (→ 12), "Operation" (→ 14) and "Heartbeat Technology – integration" (→ 28) 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 viewer¹⁾ → Order code option **EB** "Heartbeat Verification"
- 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

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 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 (→  14).

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.

1) www.endress.com/deviceviewer

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 the 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.

Requirements for the measuring equipment

DC current measuring uncertainty	±0.2 %
DC current resolution	10 µA
Frequency measuring uncertainty	±0.1 %
Frequency resolution	1 Hz
Temperature coefficient	0.0075 %/°C

Performing external verification

i 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 style="text-align: right; font-size: small;">A0020738</p>	<p style="text-align: right; font-size: small;">A0020739</p>
<p><i>Maximum number of terminals</i> Terminals 1 to 6: Without integrated overvoltage protection</p>	<p><i>Maximum number of terminals for order code for "Accessory mounted", option NA "Overvoltage protection"</i></p> <ul style="list-style-type: none"> ■ Terminals 1 to 4: With integrated overvoltage protection ■ Terminals 5 to 6: Without integrated overvoltage protection
<p>1 Output 1 (passive): supply voltage and signal transmission 2 Output 2 (passive): supply voltage and signal transmission 3 Input (passive): supply voltage and signal transmission 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 ¹⁾	4-20 mA HART (passive)		Pulse/frequency/switch output (passive)		-	
Option C ¹⁾	4-20 mA HART (passive)		4-20 mA (passive)		-	
Option D ¹⁾	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

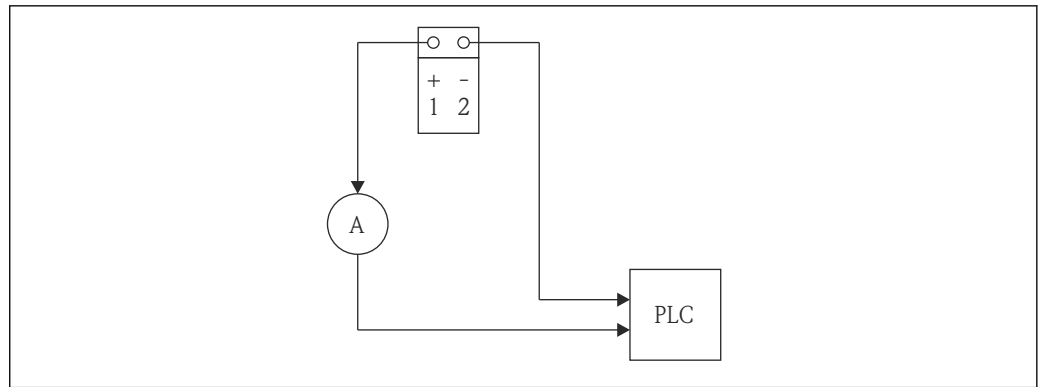
<p style="text-align: right; font-size: small;">A0013570</p>	<p style="text-align: right; font-size: small;">A0018161</p>
Maximum number of terminals	Maximum number of terminals for order code for "Accessory mounted", option NA "Overvoltage protection"
<p>1 Output 1: PROFIBUS PA</p> <p>2 Output 2 (passive: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

Order code for "Output"	Terminal numbers			
	Output 1		Output 2	
	1 (+)	2 (-)	3 (+)	4 (-)
Option G ¹⁾	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.



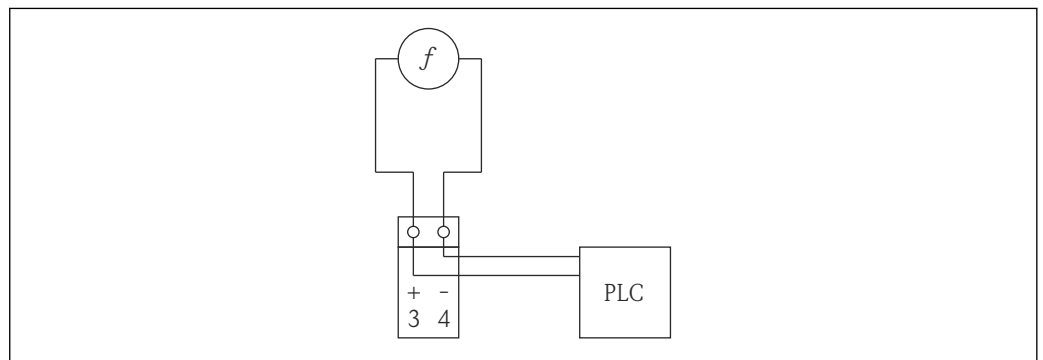
A0021365

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).

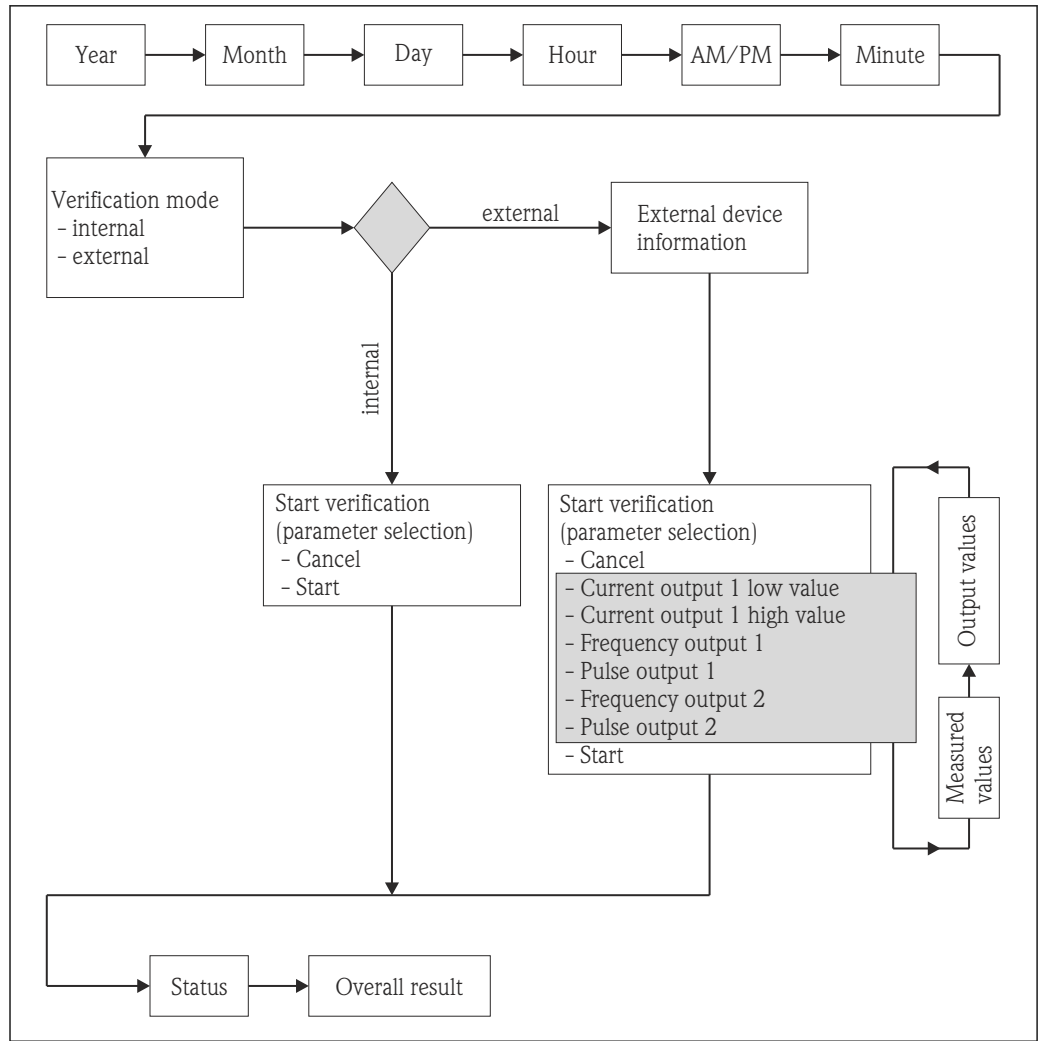
Date / Time	23.10.2013 12:37
Verification mode	External verification
External device information	Fluke 3327
Start verification	Output 1 low value
Status	Not done
Measured values	4.052
Output values	4.0000
Overall result	Passed

A0021360

Parameters for "Performing verification/Start"

Parameter	Description	Selection/ 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"> ▪ January ▪ February ▪ March ▪ April ▪ May ▪ June ▪ July ▪ August ▪ September ▪ October ▪ November ▪ December 	January
Day	Entry for date and time (field 3): Day verification is performed	<ul style="list-style-type: none"> ▪ 1...28 ▪ 29 ▪ 30 ▪ 31 	1
Hour	Entry for date and time (field 4): Hour verification is performed	<ul style="list-style-type: none"> ▪ 1...12 ▪ 0...23 	12
AM/PM	Entry for date and time (field 5): Morning or afternoon	<ul style="list-style-type: none"> ▪ AM ▪ PM 	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"> ▪ 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 (see also "Measured values" parameter). 	<ul style="list-style-type: none"> ▪ Internal ▪ External 	Internal

Parameter	Description	Selection/ User entry	Factory setting
Information external device	Measuring equipment recording for external verification.  The option appears only if the External option has been selected in the "Verification mode" parameter.	Free text entry	–
Start verification	Start the verification  The option appears only if the Internal option has been selected in the "Verification mode" parameter.	<ul style="list-style-type: none"> ■ Cancel ■ Start 	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 External option has been selected in the "Verification mode" parameter.	<ul style="list-style-type: none"> ■ Cancel ■ Current output 1 lower value ■ Current output 1 upper value ■ Frequency output 1 ■ Pulse output 1 ■ Frequency output 2 ■ Pulse output 2 ■ Start 	Cancel
Measured values	Entry of external measured variables. Entries are made with the help of a wizard. <ul style="list-style-type: none"> ■ Current in [mA] ■ Frequency in [Hz] 	–	–
Output values	References for external measured variables. <ul style="list-style-type: none"> ■ Current output: Output current in [mA] ■ Pulse/frequency output: Output frequency in [Hz] 	–	–
Status	Verification status <ul style="list-style-type: none"> ■ Ready: The last verification is finished and the device is ready for the next verification ■ Busy: The verification is running ■ Failed: A precondition for performing the verification is not met. The verification cannot be started (e.g. due to unstable process parameters) ■ Check not done: A verification has never been performed on this measuring device 	<ul style="list-style-type: none"> ■ Ready ■ Busy ■ Failed ■ Check not done 	Ready
Overall result	Overall result of the verification <ul style="list-style-type: none"> ■ 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: Verification was not carried out for any of the test groups (result for all test groups is "Check not done"). 	<ul style="list-style-type: none"> ■ Failed ■ Passed ■ Check not done 	Check not done



i **Comments for external verification of the outputs**

Selection of Parameters:

- In menu "Start verification" the module to be verified is selected (parameter selection) and the selection confirmed by "Enter" key.
- In menu "Measured values" the actual value from the external measuring equipment is entered.

The above two steps are repeated for all modules. The external verification is completed by selecting the parameter "Start". This performs a verification of the complete measuring pint and verifies if 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"

Parameters for "Verification results"

Parameter	Description	Selection/ User entry	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	0...65535	0
Operating time	Operating time of the measuring device at the time of verification	–	–
Result	Overall result of the verification	<ul style="list-style-type: none"> ▪ Failed ▪ Passed ▪ Check not done 	Check not done
Sensor	Result for sensor test group	<ul style="list-style-type: none"> ▪ Failed ▪ Passed ▪ Check not done 	Check not done
Pre-amplifier module	Partial result, pre-amplifier module	<ul style="list-style-type: none"> ▪ Failed ▪ Passed ▪ Check not done 	Check not done
Main electronics module	Partial result, main electronics module	<ul style="list-style-type: none"> ▪ Failed ▪ Passed ▪ Check not done 	Check not done
I/O module	Result for I/O module test group	<ul style="list-style-type: none"> ▪ Failed ▪ Passed ▪ Check not done 	Check not done

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 and mechanical components of sensor (mechanical integrity of DSC sensor, temperature signals, circuits and cabling)
- Pre-amplifier module: Electronics module for converting the sensor signals (checking of measuring paths for temperature and flow measurement)
- Main electronics module: Checking of supply voltage
- I/O electronics module: Results of input and output modules installed at the measuring device
 Only the 4-20 mA HART output is verified during internal verification.
 During external verification, all 4-20 mA current and pulse/frequency outputs are verified.

For more information on the test groups and individual tests (→  22).

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"

Parameter/individual test	Description	Result/limit value
"Sensor" test group		
DSC sensor	Checking of DSC sensor (mechanical integrity of DSC sensor)	<ul style="list-style-type: none"> ■ Failed ■ Passed ■ Check not done
Gap capacity	Checking of gap capacity compared to reference capacity at time of delivery. The deviation must lie within the valid working range. Additional checking of overall capacity of both DSC sensor capacities to ensure that they are within the valid working range and also to check for short-circuit and interruption.	<ul style="list-style-type: none"> ■ $-8 \text{ pF} \leq (C_0 - C_{0\text{Ref}}) \leq +16 \text{ pF}$ and ■ Standard and high-/low-temperature version: $+39 \text{ pF} \leq C_0 \leq +180 \text{ pF}$ ■ High-pressure version $+43 \text{ pF} \leq C_0 \leq +180 \text{ pF}$ ■ Ultra-high-pressure version $+52 \text{ pF} \leq C_0 \leq +180 \text{ pF}$
Gap capacity difference	Checking of DSC sensor symmetry. The difference between the two DSC sensor capacities must be below a permitted limit value.	$\Delta C_{\text{stat}} \leq +4.6 \text{ pF}$
Sensor leak current	Check to see if the sensor membrane or cable duct is defective. An LC value lower than the specified limit value suggests that the membrane is not sealed or that moisture has penetrated through the cable duct.	$LC \leq 50 \%$
Temperature sensor	Verification of both PT1000 sensors in the DSC sensor (only for mass flow option)	<ul style="list-style-type: none"> ■ Failed ■ Passed ■ Check not done
DSC sensor temperature PT1	Checking of temperature measured by first PT1000 sensor to ensure that it is valid. Depending on the actual temperature of the medium and the sensor version, the measured value must lie within the specified measuring range. Additional check for short-circuit and interruption. Without the mass flow option, the default value is checked instead of the measured value.	<ul style="list-style-type: none"> ■ Standard version $-40 \text{ }^\circ\text{C} (-40 \text{ }^\circ\text{F}) \leq TP_{T1} \leq +260 \text{ }^\circ\text{C} (+500 \text{ }^\circ\text{F})$ ■ High-/low-temperature and high-pressure version $-200 \text{ }^\circ\text{C} (-328 \text{ }^\circ\text{F}) \leq TP_{T1} \leq +400 \text{ }^\circ\text{C} (+752 \text{ }^\circ\text{F})$ ■ Ultra-high-pressure version $-50 \text{ }^\circ\text{C} (-58 \text{ }^\circ\text{F}) \leq TP_{T1} \leq +400 \text{ }^\circ\text{C} (+752 \text{ }^\circ\text{F})$

Parameter/individual test	Description	Result/limit value
DSC sensor temperature PT2	Checking of temperature measured by second PT1000 sensor to ensure that it is valid. Depending on the actual temperature of the medium and the sensor version, the measured value must lie within the specified measuring range. Additional check for short-circuit and interruption. Without the mass flow option, the default value is checked instead of the measured value.	<ul style="list-style-type: none"> ▪ Standard version -40 °C (-40 °F) ≤ TP_{T1} ≤ +260 °C (+500 °F) ▪ High-/low-temperature and high-pressure version -200 °C (-328 °F) ≤ TP_{T1} ≤ +400 °C (+752 °F) ▪ Ultra-high-pressure version -50 °C (-58 °F) ≤ TP_{T1} ≤ +400 °C (+752 °F)
"Pre-amplifier" test group		
Reference clock	Monitoring of the reference clock for flow measurement	<ul style="list-style-type: none"> ▪ Failed ▪ Passed ▪ Check not done
Quartz reference frequency drift	Checking of reference clock. If the reference clock deviates from a second reference by more than a permitted limit, the specified measuring uncertainty of the volume flow is no longer guaranteed.	$\Delta f \leq 0.05 \%$
DSC sensor reference	Checking of vortex frequency path	<ul style="list-style-type: none"> ▪ Failed ▪ Passed ▪ Check not done
DSC sensor reference capacity	Checking of reference capacity	+81 pF ≤ C _{Ref} ≤ +91 pF
Temperature measuring path (mass flow only)	Checking of temperature measuring path	<ul style="list-style-type: none"> ▪ Failed ▪ Passed ▪ Check not done
Temperature reference 1	Value of first temperature measuring path	539.2 K ≤ T _{Ref1} ≤ 541.2 K
Temperature reference 2	Value of second temperature measuring path	402.5 K ≤ T _{Ref2} ≤ 404.5 K
DSC sensor measuring path	Checking of DSC sensor measuring path	<ul style="list-style-type: none"> ▪ Failed ▪ Passed ▪ Check not done
Vortex frequency	The simulated reference frequency must not deviate by more than the specified limit.	≤ 0.1 %
Vortex amplitude	The simulated reference amplitude must not deviate by more than the specified limit.	≤ 10 %
"Main electronics module" test group		
Supply voltage	The internal supply voltages in the main electronics unit are monitored to ensure that they do not breach their permitted limits.	<ul style="list-style-type: none"> ▪ Failed ▪ Passed ▪ Check not done
	V _{sup1}	+3.474 V ≤ V _{sup1} ≤ +3.726 V
	V _{sup2}	+3.059 V ≤ V _{sup2} ≤ +3.241 V
	V _{sup3}	+1.226 V ≤ V _{sup3} ≤ +1.439 V
	V _{sup4}	+0.998 V ≤ V _{sup4} ≤ +1.103 V

Parameter/individual test	Description	Result/limit value
"I/O module" test group		
I/O module	I/O module monitoring For current output: Accuracy of the current For frequency output: Accuracy of frequency (for external verification only)  During internal verification, the actual current at the output is relayed back and compared with the set point.	For current output: <ul style="list-style-type: none"> ■ ±1 % ■ ±300 µA For frequency output: ±0.1 %

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
Process temperature verification value	Actual measured value for medium temperature (if available)
Verification value volume flow	Actual measured value for volume flow
Electronics 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


(→  29)

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

Customer		Mr. Smith
Device information		
Location	Device tag	
Location 14	M-745	
Module name	Meter body properties	
Prowirl F	DN25	
Device name	Order code	
Prowirl 200	7F2B25-725	
Serial number	Firmware version	
1234567890	01.00.00	
Calibration		
Calibration factor	Zero point	
1.15	10	

Verification information	
Operating time	Date/time
12d15h32min12 s	01.12.2010/12:00
Verification ID	
17	
Verification results	
Overall result*	❌ Failed
Detailed results	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

Customer's signature

Operator's signature

www.endress.com

Seite 1/2

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 (→ 22)

Verification report

Verification report flowmeter

For serial number: 1234567890

Detailed results of verification ID: 17

Sensor	Passed
DSC sensor	Passed
Temperature sensor	Passed
Pre-amplifier module	Failed
Reference frequency drift	Failed
DSC sensor reference	Check not done
Temperature measuring path	Passed
DSC sensor measuring path	Passed
Main electronic module	Passed
Supply voltage	Passed
I/O module	Passed

People for Process Automation


www.endress.com

Seite 2/2

5 Verification report, internal verification (Page 2)

A0021374-EN

Verification report



Endress+Hauser
People for Process Automation

Verification report flowmeter

For serial number: 1234567890

Detailed results of verification ID: 17

Sensor	✔ Passed
DSC sensor	✔ Passed
Temperature sensor	✔ Passed
Pre-amplifier module	✘ Failed
Reference frequency drift	✘ Failed
DSC sensor reference	? Check not done
Temperature measuring path	✔ Passed
DSC sensor measuring path	✔ Passed
Main electronic module	✔ Passed
Supply voltage	✔ Passed
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

Seite 2/2

A0021375-EN

6 Verification report, external verification (Page 2)

Data management with FieldCare Verification-DTM
 (→ 29)

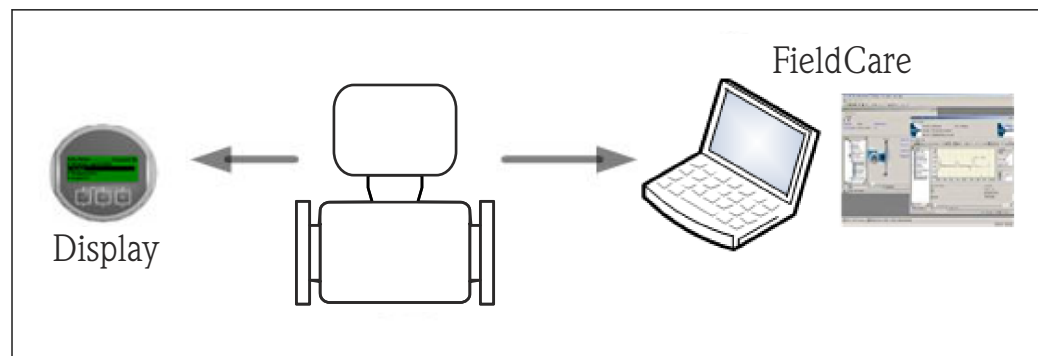
7 Function

7.1 Calibration and self-monitoring using Heartbeat Technology

The Heartbeat Technology function is based on reference values that are recorded during the factory calibration or 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.

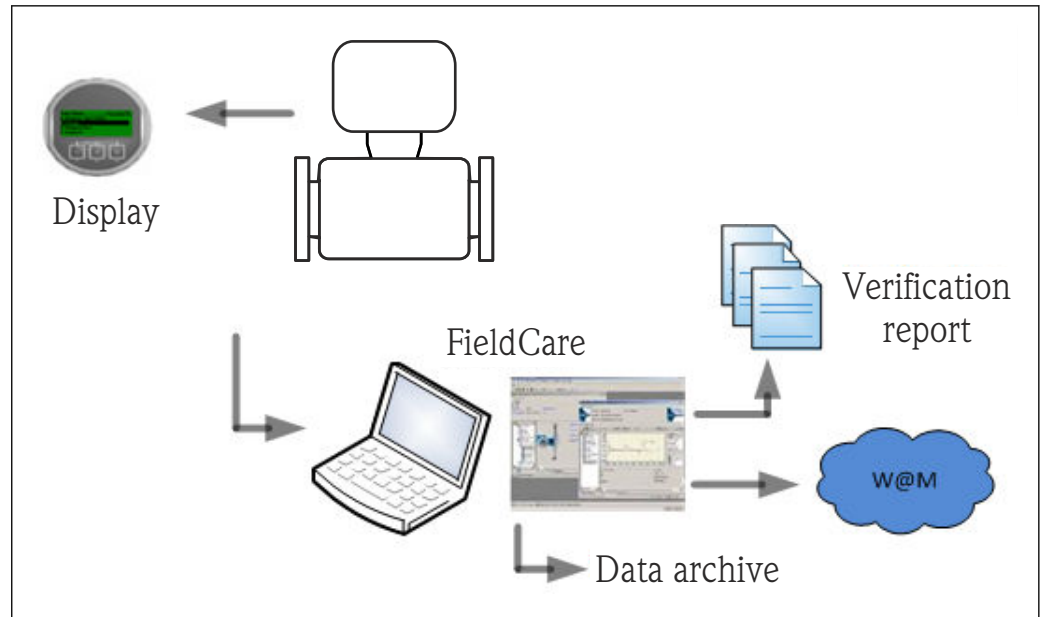
7.2 Heartbeat Technology – integration

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



A0020773-EN

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.

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 the 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>A0021425</small>	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.

Status	Test item	Unit	Simul. Signal	Min. Value	Max. Value
✓	Sensor				
✓	DSC sensor				
✓	Gap capacity		53.2393	52.9070	54.0000
✓	Gap capacity difference		-0.0088	-1.1685	1.1611
✓	Sensor leakage current		0.0000		
✓	Sensor version		Volume flow + temperature		
✓	Temperature sensor				
✓	DSC sensor temperature PT1		22.7493	19.4723	29.9952
✓	DSC sensor temperature PT2		22.4785	19.0887	30.1840
✓	Pre-amplifier module				
✓	Reference frequency drift		0.0370		
✓	DSC sensor reference		88.6230		
✓	Temperature measuring path				
✓	Temperature reference 1		540.2979		
✓	Temperature reference 2		403.6668		
✓	DSC sensor measuring path				
✓	Vortex frequency		205.1282		
✓	Vortex amplitude		1.0025		
✓	Main electronic				
✓	Supply voltage		3.6155		
✓	I/O module				



A0021458-EN

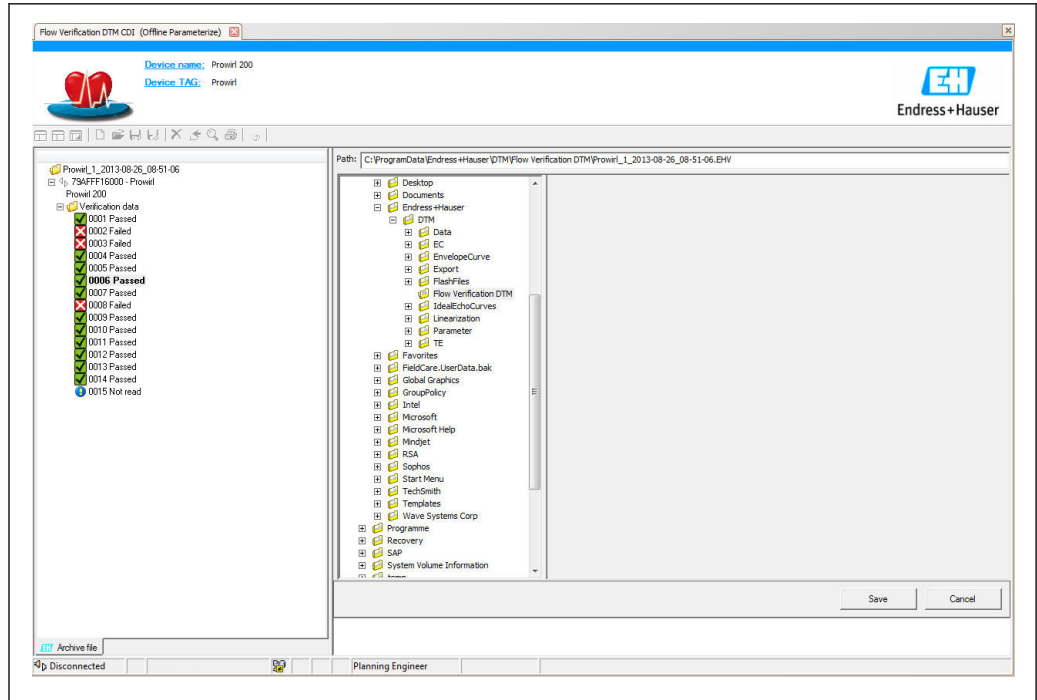
Verification results

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).



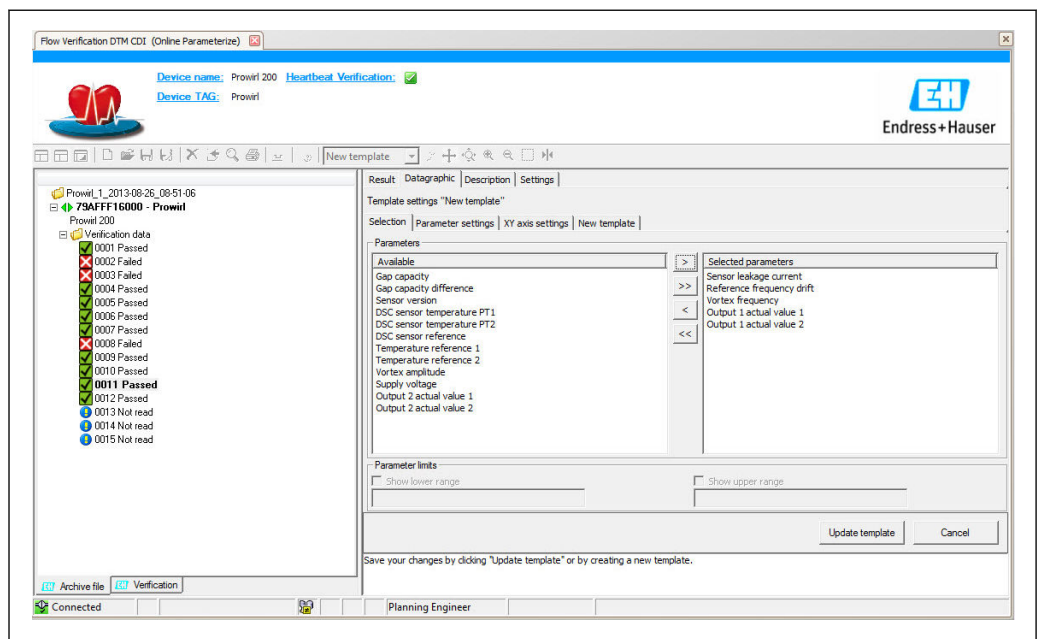
A0021459-EN

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.

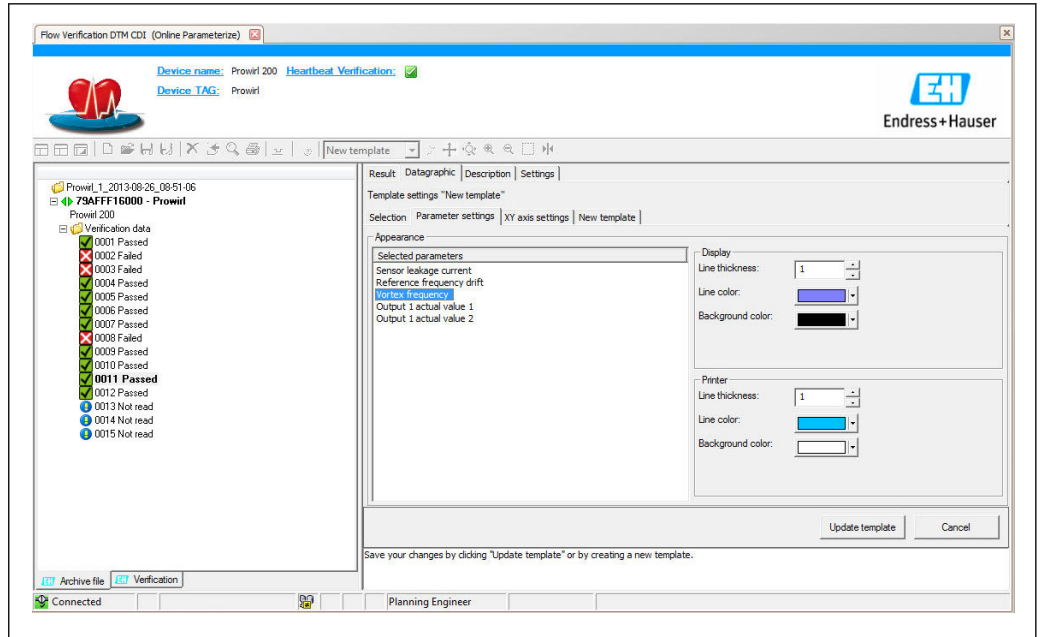
Visualization and trend analysis

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.



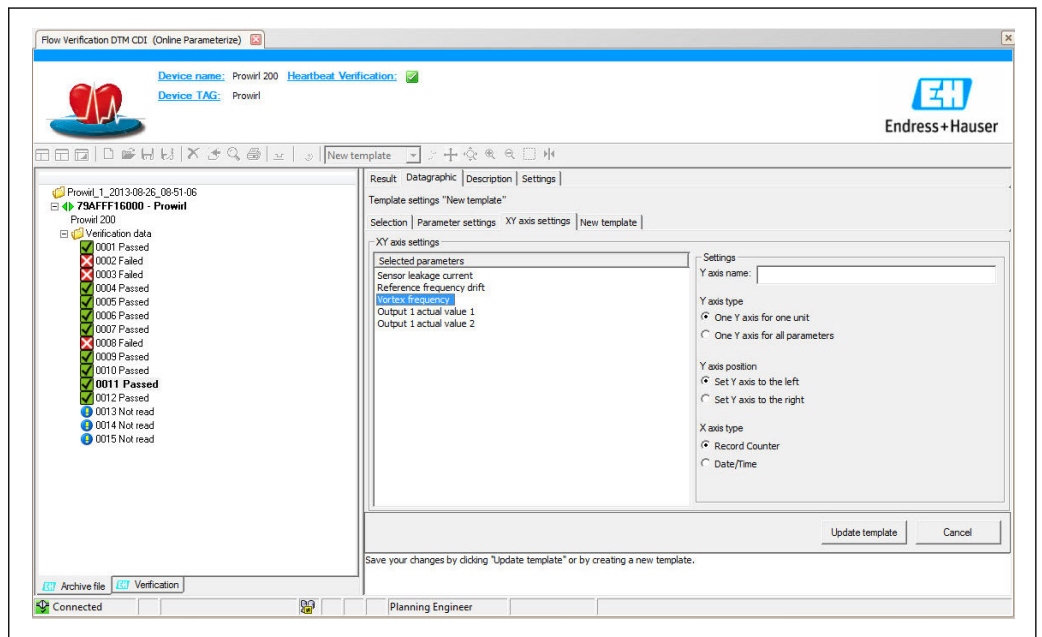
A0021469-EN

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



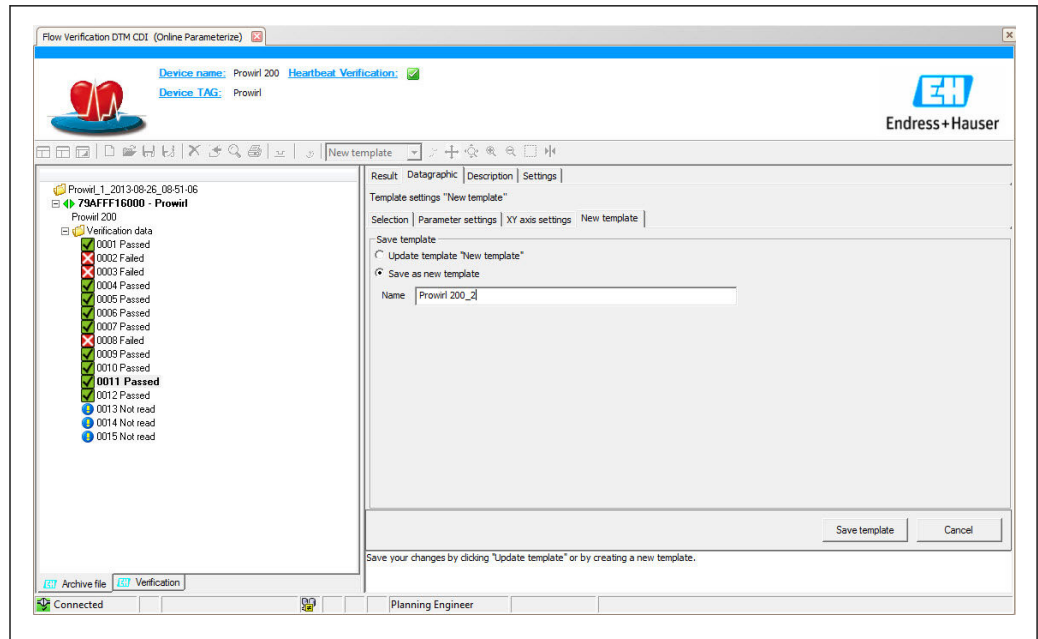
A0021470-EN

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



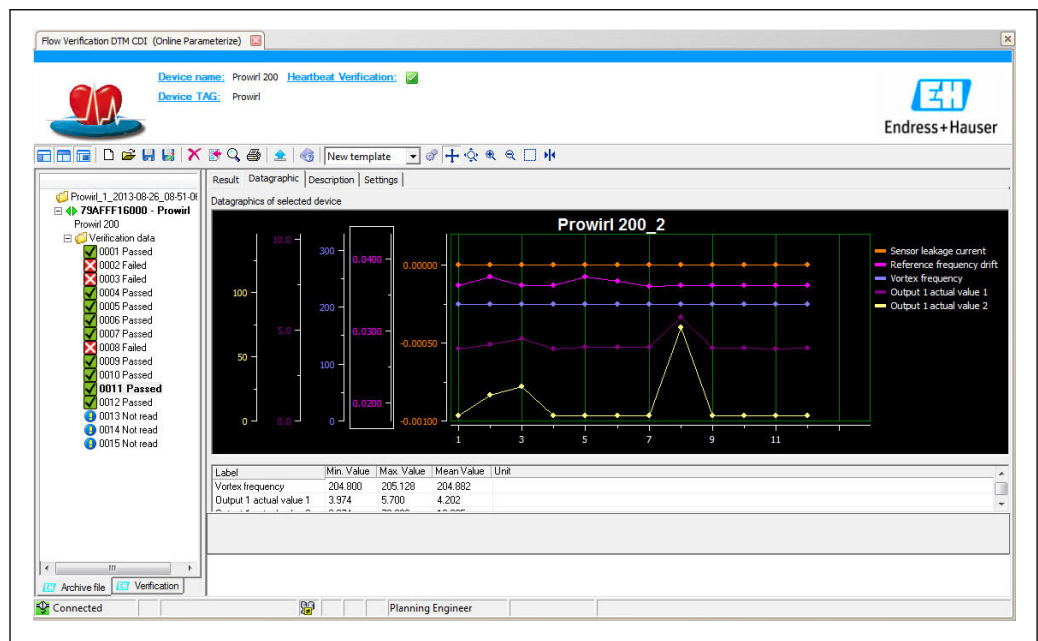
A0021471-EN

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



A0021472-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



A0021473-EN

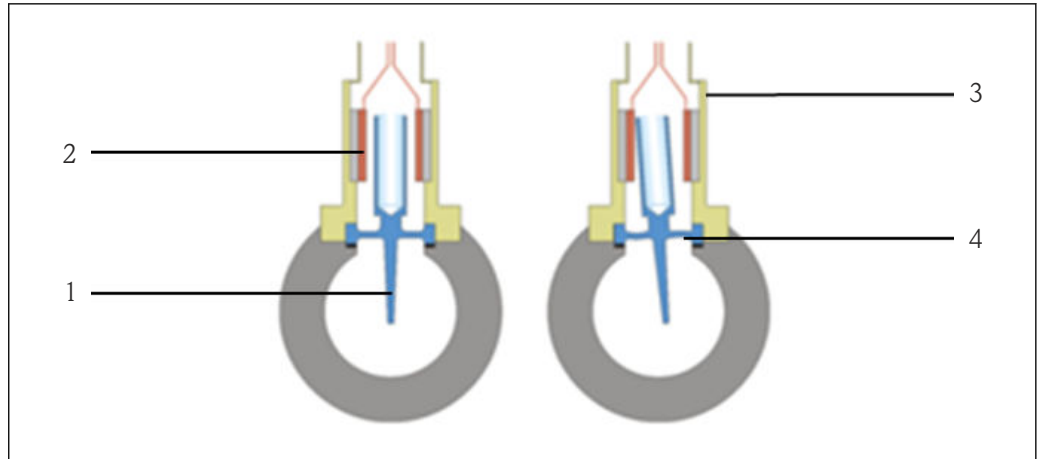
- 11 "Trend visualization": Template shows the data in chronological order; the data points are referenced by the verification ID (X-axis), the Y-axis is displayed as defined in the configuration

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.



A0020776

12 Model of a Prowirl 200 DSC sensor with temperature measurement

- 1 Temperature sensor
- 2 Plate capacitor
- 3 Cable duct
- 4 Sensor membrane

Sensor module

Sensor module/test group	Test and recognized causes of errors
Sensor	Testing of electrical and mechanical integrity of DSC sensor and temperature sensors. Testing of resistance and insulation: Detection of signal interruption, short circuits, contact corrosion, wiring problems, mechanical damage, moisture inside the sensor and poor grounding.
Pre-amplifier module	Detection of drift and aging of electronic components due to environmental or process influences (temperature, vibration etc.) Testing of temperature measuring paths and DSC sensor measuring paths.

Electronics module

Electronic module/test group	Test and recognized causes of errors
Main electronics	<ul style="list-style-type: none"> ■ Testing of supply voltages ■ Detection of drift and aging of electronic components due to environmental or process influences (temperature, vibration etc.) ■ Testing of signal processing
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 Use cases and applications (and interpretation of results)

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 (→  22) 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.





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	DSC sensor defective or there is a contact problem in the connection between the DSC sensor and the pre-amplifier: <ul style="list-style-type: none"> ■ Check connection between DSC sensor and pre-amplifier ■ Replace pre-amplifier and/or DSC sensor
Pre-amplifier module	Drift and aging of electronic components due to environmental or process influences (temperature, vibration etc.) Defect in pre-amplifier → Replace
Main electronics	Drift or aging of electronic components due to environmental or process influences (temperature, vibration etc.) Electronic module drift or defect → replace
I/O electronics module	<p>Internal verification Signal feedback in 4 to 20mA HART current output: Detection of drift and aging due to environmental or process influences (temperature, radiation, vibration etc.)</p> <p>External verification External testing of all active outputs at the measuring device.</p>

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. Heartbeat Verification).
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.  Heartbeat Verification is not a calibration system.
Verification report	Document in which the results of the Heartbeat Verification are recorded.
Dataset	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 Heartbeat Verification 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, Heartbeat Monitoring 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™**

Registered or registration-pending trademarks of the Endress+Hauser Group

www.addresses.endress.com
