Special Documentation
Proline Prosonic Flow B 200

Heartbeat Technology Application Package

Endress+Hauser

People for Process Automation

Table of contents

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 the arrangement of the parameters as per the **Operation** menu, **Setup** menu, **Diagnostics** menu, along 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
	Tip Indicates additional information.
	Reference to documentation Refers to the corresponding device documentation.
	Reference to page Refers to the corresponding page number.
	Reference to graphic Refers to the corresponding graphic number and page number.
	Operation via local display Indicates navigation to the parameter via the local display.
	Operation via operating tool Indicates navigation to the parameter via the operating tool.
	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 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".

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

Sensor	HART
Prosonic Flow B	BA01031D

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

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

The **Heartbeat Monitoring** and **Heartbeat Verification** modules are optional → 🖺 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).
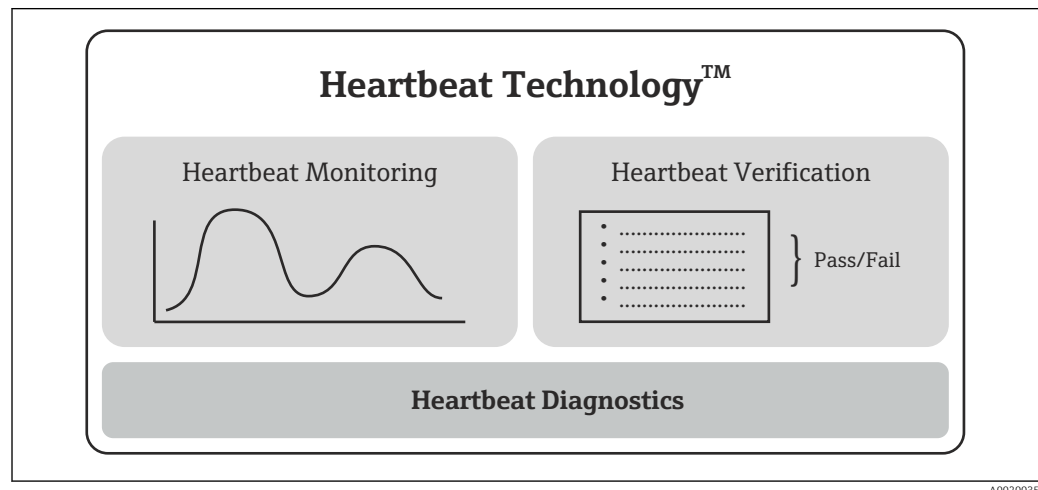
For more information on diagnostics, see the "Diagnostics and troubleshooting" section of the Operating Instructions.

2.1.2 Heartbeat Monitoring

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

2.1.3 Heartbeat Verification

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

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

2.2 Availability (product list and order option)

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

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

Order option
Heartbeat Diagnostics is a basic function of all the Proline measuring devices.
The **Heartbeat Monitoring** and **Heartbeat Verification** modules are optional and are indicated as order options in the product price list:
Order feature "Application Package", **EB** "Heartbeat Verification + Monitoring" option

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

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

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

For information on how to enable the → 🔖 15 and function.

3   Product description

3.1   Overview

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

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

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

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

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 measures to rectify the error.

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

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

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

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

3.2.2 Heartbeat Monitoring

Purpose

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

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

Aim

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

Possible applications of Condition Monitoring:
– Multi-phase fluids (gas content in liquid fluids)
– Applications in which the sensor is exposed to a programmed amount of wear

Advantages

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

Customer and industry requirements

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

3.2.3 Heartbeat Verification

Purpose

Heartbeat Verification uses the self-monitoring function of the Proline flowmeters to check the measuring device functionality. Verification is performed on demand. During the verification process, the system checks whether the measuring device components comply with the factory specifications. Both the sensor and the electronic modules are included in the tests. The results of the check are saved as a data set in the measuring device and documented in the form of a verification report, if required. The request for verification can come from a higher-order system via the system integration interface. The overall result of the device function test can also be relayed to this higher-order system. The result of the verification provides information about the condition of the measuring device. Data interpretation by the user is not required.

Aim

To confirm the consistent quality of the measurement in the life cycle of the measuring device by periodically checking the measuring device functionality. To create traceable

documentation of the condition of the measuring device in the life cycle of the measuring device.

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

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):

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

λ_{TOT}:	Rate of all theoretically possible failures
λ_{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.

The TTC is >95 % for Prosonic Flow B 200.

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.
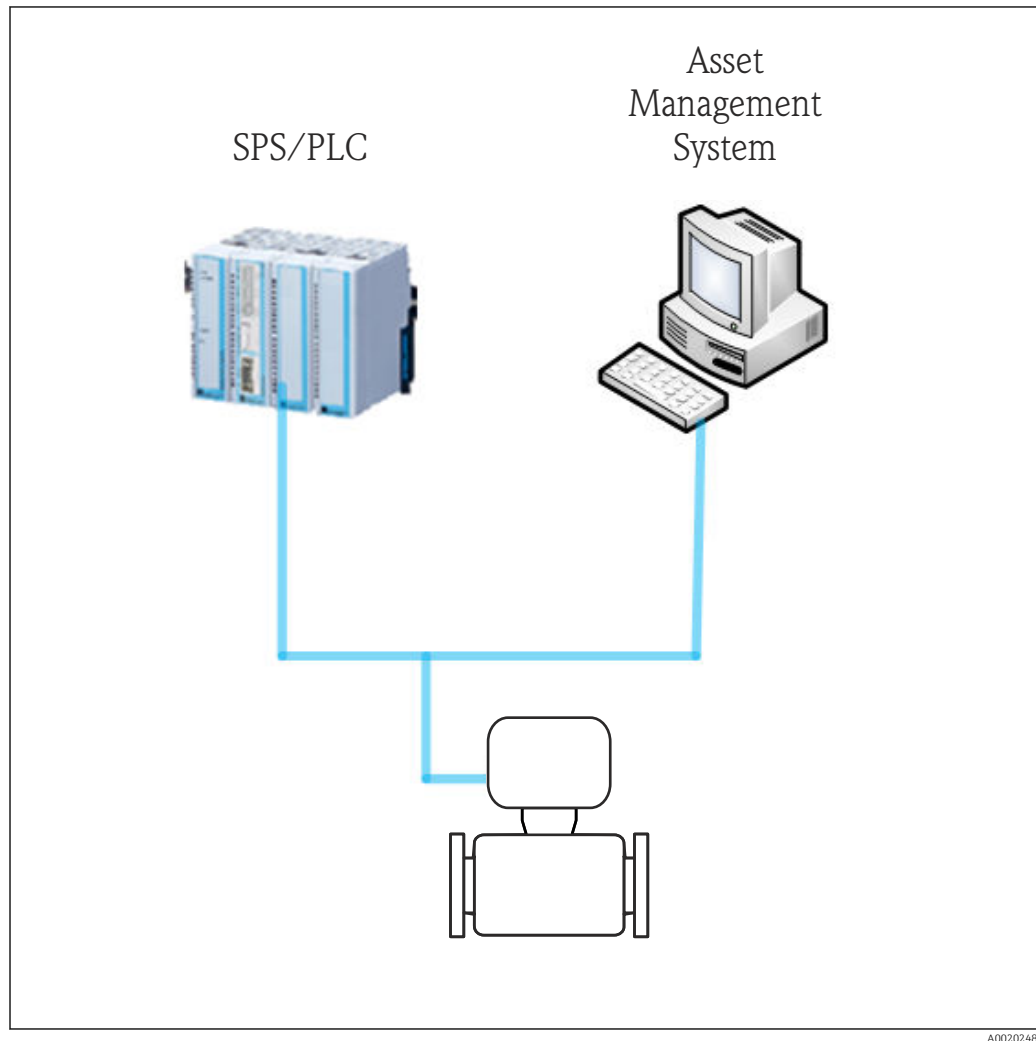
3.3.2   Heartbeat Verification

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 (λ_{du}).

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).

Data exchange can take place automatically or be triggered by a user.

4.1   Automated data exchange

Heartbeat Diagnostics	Heartbeat Monitoring	Heartbeat Verification
■ Analyze field device diagnostics ■ Diagnostic events for integration with the PLC	■ Continuous trend analysis ■ Additional monitoring of measured variables for processing in a Condition Monitoring system	■ Instrument check via self-monitoring ■ Start verification and upload verification results

### 4.1.1   Automated data exchange: Heartbeat Monitoring

The following procedure describes the work flow that is principally involved in the automated handling of the **Heartbeat Monitoring** function, and the use of data for Condition Monitoring:
- The host application configures the cyclic services of the field device for **Heartbeat Monitoring**
- The field device communicates PVs (process variables) from **Heartbeat Monitoring**
- The host application analyzes the **Heartbeat Monitoring** PVs (e.g. trends, limit value monitoring)
- The host application initiates application-specific standard work instructions (e.g. triggering maintenance requirement or maintenance instructions)

The fieldbus-specific implementation (HART) is described in the "Technical data" section of the Operating Instructions under "Output".

4.1.2   Automated data exchange: Heartbeat Verification

The self-monitoring function integrated in the measuring device can by activated by a control system and the results can be checked. The following procedure must be implemented for this purpose:
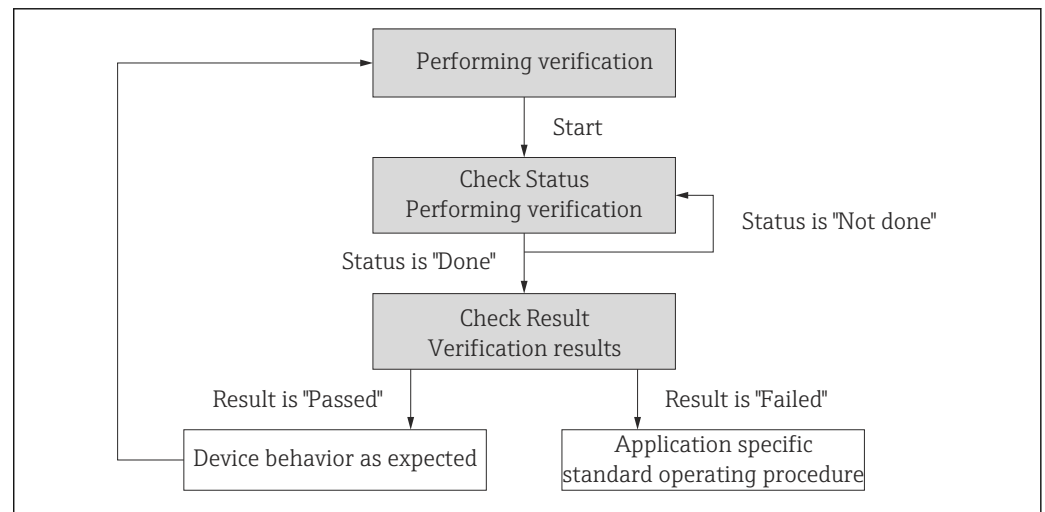
- Verification performance:
  The verification is started using the "Start verification" parameter.
- Verification status:
  On completion of the verification, the value of the "Status" parameter changes to "**Done**".
- Verification result:
  The overall result of the verification is indicated in the "Overall result" parameter. Different application-specific measures must be performed by system routines depending on the result, e.g. a "Maintenance Required" alarm is triggered if **Failed** is displayed as the result.

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

Heartbeat Diagnostics	Heartbeat Monitoring	Heartbeat Verification
• Identify remedial measures • Information on the cause of the error and remedial measures are provided in the asset management system	Configuration of the monitoring system	• Instrument verification via self-monitoring • Start verification Upload, archive and document verification results including detailed results

Data exchange by the user is described in the "Commissioning" → 🖱 15, "Operation" → 🖱 18 and "Heartbeat Technology – Integration" → 🖱 33 sections.

5   Commissioning

5.1   Availability

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

Ways to check function availability in the measuring device:
- Using the serial number:
  W@M Device Viewer [1] → Order code, option **EB** "Heartbeat Verification + Monitoring"
- In the operating menu:
  Check whether the function appears in the operating menu: "Diagnostics" submenu → Heartbeat.
  If the "Heartbeat" option is available the function is activated.

If the function is not available 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 change the firmware.

5.1.1   Activation without firmware upgrade

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

The function can be activated under "Setup" menu → Advanced setup → Enter access code.

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

Activation without firmware upgrade is possible as of the following firmware versions: HART: 01.02.zz

5.1.2   Firmware upgrade before activation

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

This function requires service-level access to the device.

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

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

5.2   Heartbeat Diagnostics

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

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1)   www.endress.com/deviceviewer

5.3 Heartbeat Monitoring

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

5.3.1 Parameter selection: Outputs

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

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

Parameter	Description	Value range
Acceptance rate	The acceptance rate is the ratio of the number of ultrasonic signals accepted for the calculation of the flow and the number of all the ultrasonic signals transmitted. Multi-path measuring devices: The minimum of all the acceptance rates measured is monitored.	0 to 100%
Turbulence	The turbulence is the relative standard deviation of the measured transit time difference. Multi-path measuring devices: The maximum of all the turbulences measured is monitored.	0 to 100%
Signal strength	The signal strength of the ultrasonic signal received. Multi-path measuring devices: The minimum of all the signal strengths measured is monitored.	0 to 120 dB
Signal to noise ratio	The signal to noise ratio is the ratio between the desired ultrasonic signal and the undesired interference signals that are simultaneously received at the receiver. Multi-path measuring devices: The minimum of all the signal-to-noise ratios measured is monitored.	0 to 100 dB
Asymmetry	Multi-path measuring devices only: Displays the asymmetry of the flow profile.	-100% to 100%

ⓘ For information on using the parameters and interpreting the measurement results → 🗎 43.

5.4 Heartbeat Verification

It is not necessary to commission the **Heartbeat Verification** function.

5.4.1 Recording of customer and location

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

Reference data are recorded in the operating menu:
- "Setup" menu → Advanced setup → Heartbeat setup → Heartbeat base settings → Plant Operator
- "Setup" menu → Advanced setup → Heartbeat setup → Heartbeat base settings → Location
- "Expert" menu → Diagnostics → Heartbeat → Heartbeat base settings → Plant Operator
- "Expert" menu → Diagnostics → Heartbeat → Heartbeat base settings → Location

6   Operation

6.1   Heartbeat Diagnostics

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

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

6.2   Heartbeat Monitoring

Monitoring is always switched on for Proline Prosonic Flow B 200.

6.3   Heartbeat Verification

6.3.1   Initial verification

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

> ℹ️ If verification is started during the first 60 minutes following commissioning, measured value output is interrupted for a period of up to two minutes.

6.3.2   Product features

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

6.3.3   Operation – performing a verification

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

Access via operating menu:
• "Diagnostics" submenu → Heartbeat → Performing verification
• "Expert" menu → Diagnostics → Heartbeat → Performing verification

Access via FieldCare DTM:
"Heartbeat" submenu → Performing verification

Measurement is generally not interrupted while the verification is being carried out. The only exception is when verification is performed for the first time → 📖 18.

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. Measure the simulated current values and enter them 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
    Measure the simulated frequency and pulse output values and enter them at the flowmeter.
    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.

Only use intrinsically safe measuring equipment in hazardous zones!

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

Maximum number of terminals
Terminals 1 to 6:
Without integrated overvoltage protection
	Maximum number of terminals for order code for
	"Accessory mounted", option NA "Overvoltage
	protection"
	• *Terminals 1 to 4:*
	  With integrated overvoltage protection
	• *Terminals 5 to 6:*
	  Without integrated overvoltage protection

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

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.
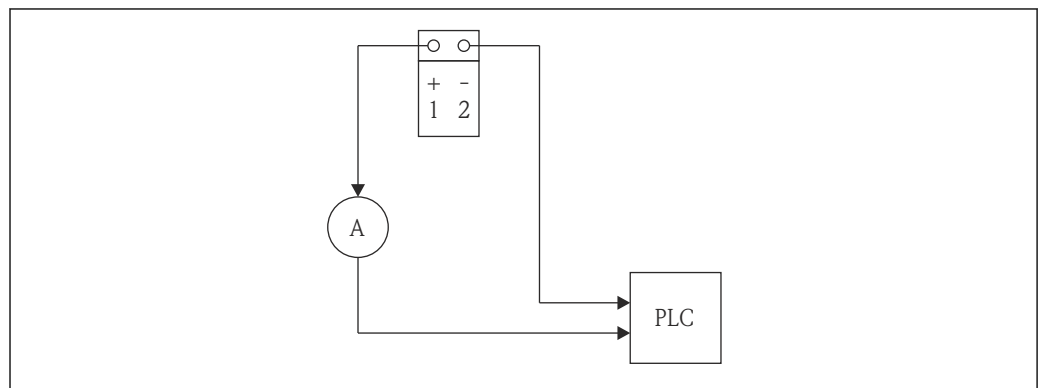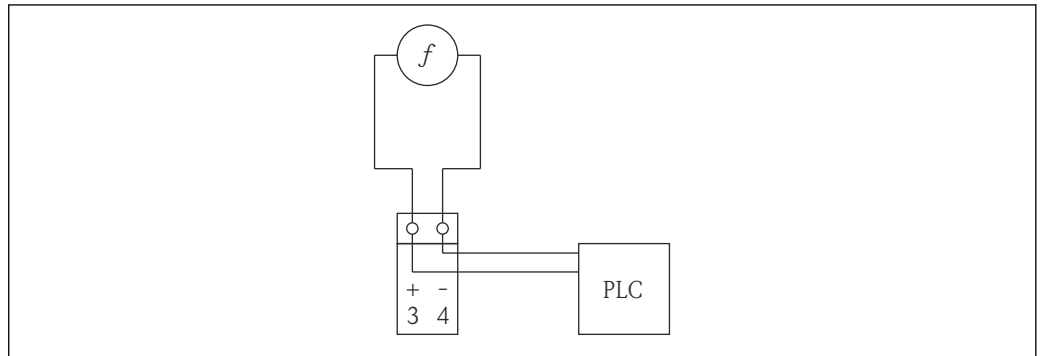

⊡ *2   External verification of current output: Looping in of an ammeter (A)*

Current values are simulated during external verification. Record these values with the measuring equipment and enter them at the flowmeter.

Verification of the pulse/frequency/switch output
For verification purposes, connect a frequency meter to the output and measure the actual frequency. For the measurement, it is necessary to connect the output to a power supply unit.
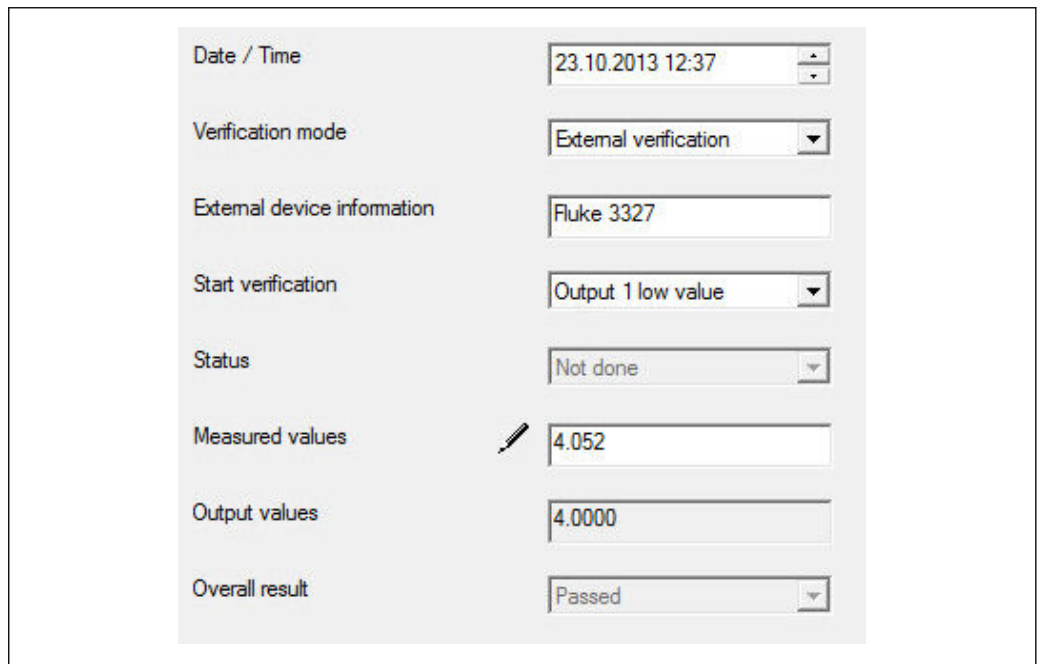

A0021367

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

Frequency values are simulated during external verification. Record these values with the measuring equipment and enter them at the flowmeter.

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

A0021360

Parameters for "Performing verification/Start"

Navigation
"Diagnostics" submenu → Heartbeat → Performing verification

Navigation
"Expert" menu → Diagnostics → Heartbeat → Performing verification

Parameter overview with brief description

Parameter	Prerequsite	Description	User entry / Selection / User interface	Factory setting
Year	Can be edited if verification status is not active.	Entry for date and time (field 1): enter the year verification is performed.	9 to 99	10
Month	Can be edited if verification status is not active.	Entry for date and time (field 2): enter the month verification is performed.	• January • February • March • April • May • June • July • August • September • October • November • December	January
Day	Can be edited if verification status is not active.	Entry for date and time (field 3): enter the day verification is performed.	1 to 31 d	1 d
Hour	Can be edited if verification status is not active.	Entry for date and time (field 4): enter the hour verification is performed.	0 to 23 h	12 h
AM/PM	Can be edited if verification status is not active and if 12-hour counting is active.	Entry for date and time (field 5): enter the morning or afternoon.	• AM • PM	AM
Minute	Can be edited if verification status is not active.	Entry for date and time (field 6): enter the minute verification is performed.	0 to 59 min	0 min
Verification mode	For the following order code: "Application package", option EB "Heartbeat Verification" Can be edited if verification status is not active.	Choice of verification mode: 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).	• Internal verification • External verification	Internal verification
External device information	With the following conditions: • In the **Verification mode** parameter (→ 🗎 22), the **External verification** option is selected. • Can be edited if verification status is not active.	Record measuring equipment for external verification.	Free text entry	–
Start verification	–	Start 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".	• Cancel • Output 1 low value • Output 1 high value • Output 2 low value • Output 2 high value • Frequency output • Pulse output • Start	Cancel

Parameter	Prerequsite	Description	User entry / Selection / User interface	Factory setting
Measured values	In the **Start verification** parameter (→ 🕮 22), one of the following options is selected: ▪ Output 1 low value ▪ Output 1 high value ▪ Output 2 low value ▪ Output 2 high value	Displays the references for the external measured variables. ▪ Current output: Output current in [mA]. ▪ Pulse/frequency output: Output frequency in [Hz].	Signed floating-point number	0
Output values	–	Displays the references for the external measured variables. ▪ Current output: Output current in [mA]. ▪ Pulse/frequency output: Output frequency in [Hz].	Signed floating-point number	0
Overall result	For the following order code: "Application package", option EB "Heartbeat Verification" ℹ The software options currently enabled are displayed in the **Software option overview** parameter.	Overall result of the verification. Failed: At least one test group was outside the specifications. Passed: All verified test groups complied with the specifications (even if "Check not done" is the result for a test group). Check not done: No verification was performed for any of the test groups.	▪ Failed ▪ Not used ▪ Passed ▪ Not done	Not done

Performing the verification: sequence of steps
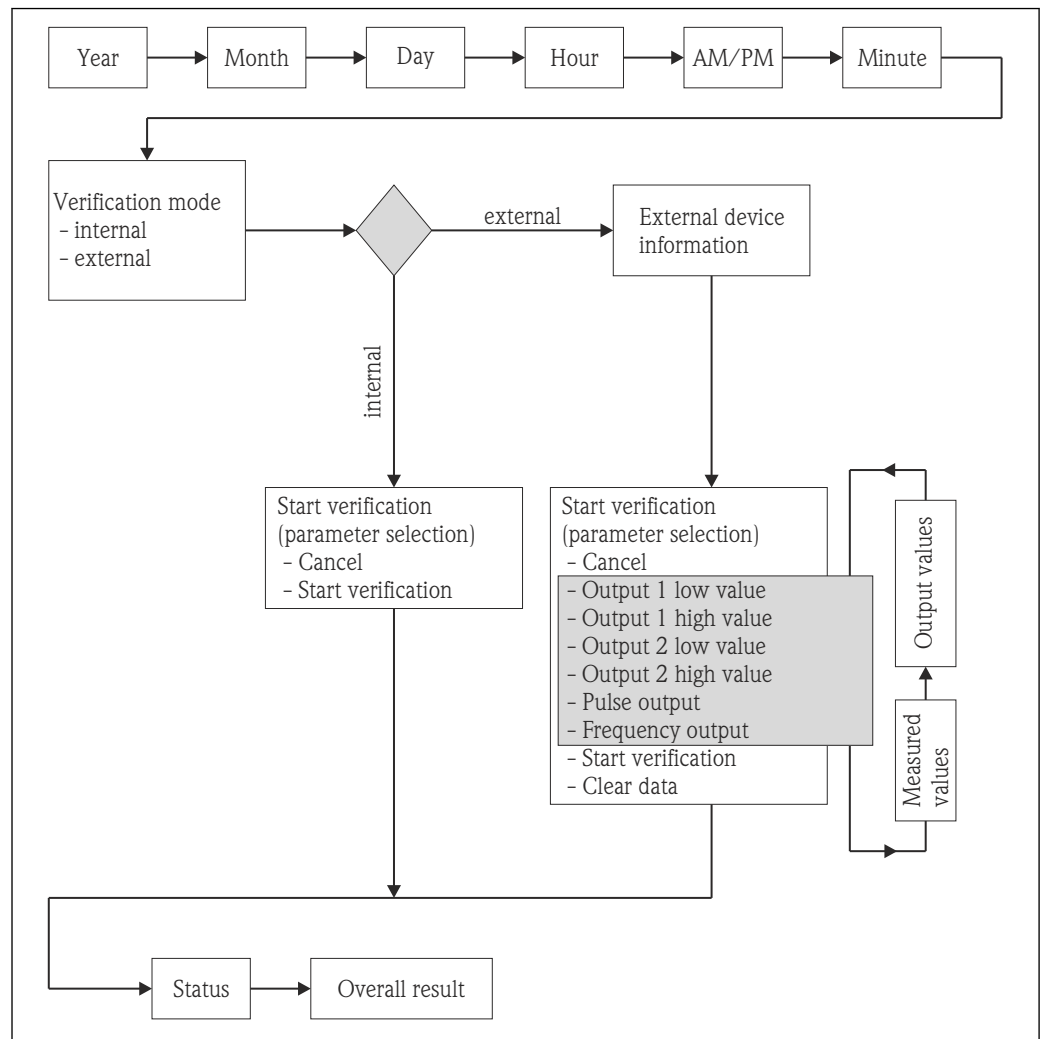
A0020944-EN

ℹ️ **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.

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

6.3.4   Verification results

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

Access via operating menu:
- "Diagnostics" submenu → Heartbeat → Verification results
- "Expert" menu → Diagnostics → Heartbeat → Verification results

Access via FieldCare DTM:
"Heartbeat" submenu → Verification results

Parameter/Test group verification results

Navigation
"Diagnostics" submenu → Heartbeat → Verification results

Navigation
"Expert" menu → Diagnostics → Heartbeat → Verification results

Parameter overview with brief description

Parameter	Prerequisite	Description	User interface	Factory setting
Date/time	The verification has been performed.	Entry for date and time in real time.		0
Verification ID	The verification has been performed.	Consecutive numbering of the verification results in the measuring device.	0 to 65 535	0
Operating time	The verification has been performed.	Indicates how long the device has been in operation.	Days (d), hours (h), minutes (m), seconds (s)	
Overall result	For the following order code: "Application package", option EB "Heartbeat Verification" ℹ The software options currently enabled are displayed in the **Software option overview** parameter.	Overall result of the verification. Failed: At least one test group was outside the specifications. Passed: All verified test groups complied with the specifications (even if "Check not done" is the result for a test group). Check not done: No verification was performed for any of the test groups.	• Failed • Not used • Passed • Not done	Not done
Sensor	In the **Overall result** parameter, the **Failed** option is displayed.	Result for sensor test group.	• Failed • Not used • Passed • Not done	Not done
Main electronic module	In the **Overall result** parameter, the **Failed** option is displayed.	Result for main electronics module.	• Failed • Not used • Passed • Not done	Not done

Parameter	Prerequsite	Description	User interface	Factory setting
I/O module	In the **Overall result** parameter, the **Failed** option is displayed.	Result for I/O module monitoring of the I/O module. • For current output: Accuracy of the current • For pulse output: Accuracy of pulses (for external verification only) • For frequency output: Accuracy of frequency (for external verification only)	• Failed • Passed • Check not done Limit value for current output (for internal verification only): • ±1 % • ±300 µA Limit value for current output (for external verification only, for 4 mA and for 20 mA): • ±1 % • ±300 µA Limit value for pulse output (for external verification only): Simulation: 1 pulse/s, pulse width 100 ms, with 1000 pulses ±10 pulses Limit value for frequency output (for external verification only): ±0.1 %	Not done
System status	In the **Overall result** parameter, the **Failed** option is displayed.	Tests the measuring device for active errors.	• Failed • Not used • Passed • Not done	Not done

Classify results

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").

> ℹ️ If a result is classified as "Check not done", the output concerned has not been used.

> ℹ️ Heartbeat Verification confirms the device function within the specified measuring tolerance on demand with a total test coverage (TTC) of > 95%. Based on redundant references in the device which are traceable from the factory, Heartbeat Technology meets all the requirements concerning traceable device verification according to DIN EN ISO 9001:2008.

Test groups
- Sensor: Sensor connection and converter resonance, temperature sensor, signal quality, signal strength and sound velocity
- Main electronics module: Verification of reference clock, transmission circuit, amplifier circuit, measuring circuit
- I/O electronics module: The test result for the I/O modules available.
  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: Tests whether an active measuring device error is pending at the measuring device.

For more information on the test groups and individual tests → 🖹 27.

ℹ 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.

6.3.5 Detailed verification results

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

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

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

Parameters for "Detailed verification results"

Individual test	Description	Result/limit value
"Sensor" test group		
Sensor connection and converter resonance	Monitoring of electrical connection between amplifier and converter.	• Failed • Passed • Check not done
Temperature sensor	Test the temperature sensor (open, short-circuit). Only applies if the sensor has been ordered.	• Failed • Passed • Check not done
Signal quality	Monitoring of anticipated signal strength, signal strength and signal to noise ratio. Comparison with limit values.	• Failed • Passed • Check not done
Signal strength and sound velocity	Only for multi-path measuring devices: the relative signal strength and relative sound velocity. Comparison with limit values.	• Failed • Passed • Check not done
"Main electronics module" test group		
Reference clock [1]	Monitoring of the reference clock in the measuring device circuit.	• Failed • Passed • Check not done
Transmission circuit	Monitoring of the transmission voltage and multiplexer.	• Failed • Passed • Check not done
Amplifier circuit	Monitoring of the noise and the amplifier deviation.	• Failed • Passed • Check not done

Individual test	Description	Result/limit value
Measuring circuit	Measurement of the transit time of a test signal. Two or more different transit time values are tested.	• Failed • Passed • Check not done Value range: -100 to +100 %
"System Condition" test group		
System condition	Tests whether active errors are pending.	• Failed • Passed • Check not done
"Input/Output" test group (only HART)		
Current output (4 to 20mA) internal verification	The measuring device simulates a current value at the output. This current is returned via an A/D converter. The current at the reference resistor is proportional to the simulated current of the 4-20 mA signal.	• Failed • Passed • Check not done Value range: • ±1 % • ±300 µA

Current output (4 to 20mA) external verification	The measuring device simulates a current value at the output. This current is returned via an A/D converter. The current at the reference resistor is proportional to the simulated current of the 4-20 mA signal.	• Failed
		• Passed
		• Check not done
		Value range:
		• Low value 4 mA:
		  – ±1 %
		  – ±300 µA
		• High value 20 mA:
		  – ±1 %
		  – ±300 µA

External pulse verification	The measuring device simulates a specific number of pulses. Enter the external measurement via the "Heartbeat Verification" wizard.	• Failed • Passed • Check not done Pulses: • Simulation: 1 pulse/s • Pulse width = 100 ms • For 1000 pulses, ±10 pulses
External frequency verification	The measuring device simulates a specific frequency. Enter the external measurement via the "Heartbeat Verification" wizard.	• Failed • Passed • Check not done Value range: ±0.1 % Based on target value

1)   Only for HART: the reference clock can only be monitored with version 01.01.00 and higher. Measuring devices with version 01.00.00 cannot monitor the reference clock.

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
Verification value pressure	Current measured value for pressure
Verification value sound velocity	Current measured value for sound velocity
Verification value flow velocity	Current measured value for flow velocity
Verification value acceptance rate	Current measured value for acceptance rate
Verification value turbulence	Current measured value for turbulence
Verification value signal strength	Current measured value for signal strength
Verification value asymmetry	Current measured value for asymmetry

Process conditions	Description, value range
Verification value gas type	Actual gas type
Verification value temperature	Current measured value for temperature
Electronic temperature	Current measured value for the electronic temperature in the transmitter

6.3.6 Verification report

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

Creating the verification report
→ 🖴 34

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 indicated 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.

Verification Report Prosonic Flow

Endress+Hauser

People for Process Automation

Plant Operator: Mr. Smith

Device Information

Location	Location 14
Device tag	M-745
Module name	Prosonic Flow B
Nominal diameter	DN50
Device name	Prosonic Flow 200
Order code	9B2B25-725
Serial number	1234567890
Firmware version	01.02.00

Heartbeat
Technology

Calibration

Calibration factor	0.98
Zero point	10

Verification Information

Operating time (counter)	12d15h32min12s
Date/time (manually recorded)	01.03.2015/12:00
Verification ID	17

Overall Verification Result*

☒ Failed	Details see next page

*Result of the complete device functionality test via Heartbeat Technology

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.

Notes

Date	Operator's signature	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 → 🖺 27

Verification Report Prosonic Flow

Endress+Hauser
People for Process Automation

Plant Operator: Mr. Smith

Device Identification and Verification Identification

Serial number	452633345
Device tag	M-745
Verification ID	17

Heartbeat
Technology

Sensor	✅ **Passed**
Sensor connection and transducer resonance	✅ Passed
Temperature sensor	✅ Passed
Signal quality	✅ Passed
Signal strength and sound velocity	✅ Passed
Main electronic module	❌ **Failed**
Reference clock	✅ Passed
Transmitter circuit	✅ Passed
Amplifier circuit	❌ Failed
Measuring circuit	↯ Check not done
System status	✅ **Passed**
I/O module	✅ **Passed**

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🖼 5   *Verification report, internal verification (Page 2)*

Verification Report Prosonic Flow

Endress+Hauser

People for Process Automation

Plant Operator: Mr. Smith

Device Identification and Verification Identification

Serial number	452633345
Device tag	M-745
Verification ID	17

**Heartbeat
Technology**

Sensor	✅ **Passed**
Sensor connection and transducer resonance	✅ Passed
Temperature sensor	✅ Passed
Signal quality	✅ Passed
Signal strength and sound velocity	✅ Passed
Main electronic module	❌ **Failed**
Reference clock	✅ Passed
Transmitter circuit	✅ Passed
Amplifier circuit	❌ Failed
Measuring circuit	⬛ Check not done
System status	✅ **Passed**
I/O module	✅ **Passed**
Output 1	✅ Passed*
Output 2	⬛ Check not done*

*External verification

Information about the External Verification

Fluke 2354, Cal: 10.03.2015, F. Maier

A0026264-EN

⊡ 6   *Verification report, external verification (Page 2)*

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.

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.
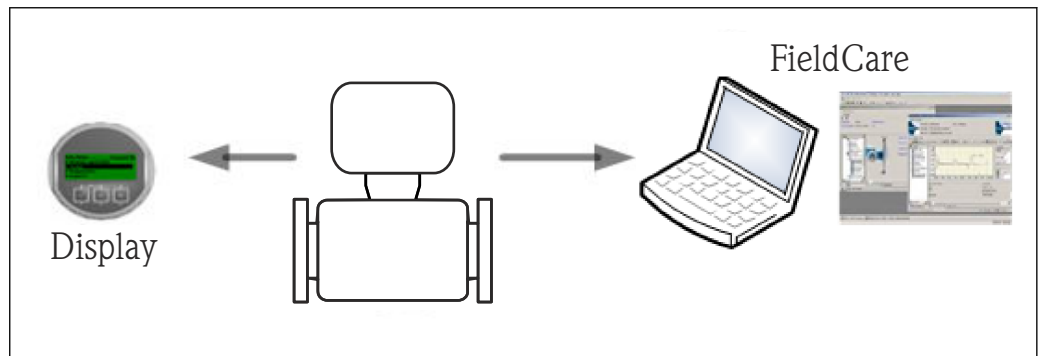
A0020773-EN

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.
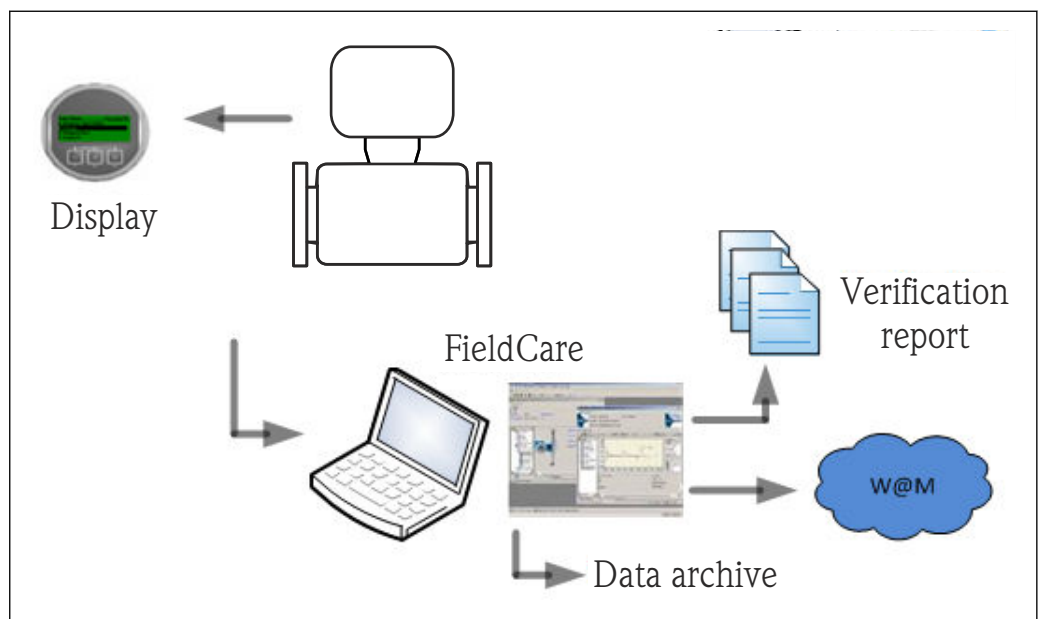
A0020774-EN

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.

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.

ℹ️ Some extended functionalities can only be accessed via Service. This requires the user to enter the service code.

Basic functions

The following basic functions are provided:

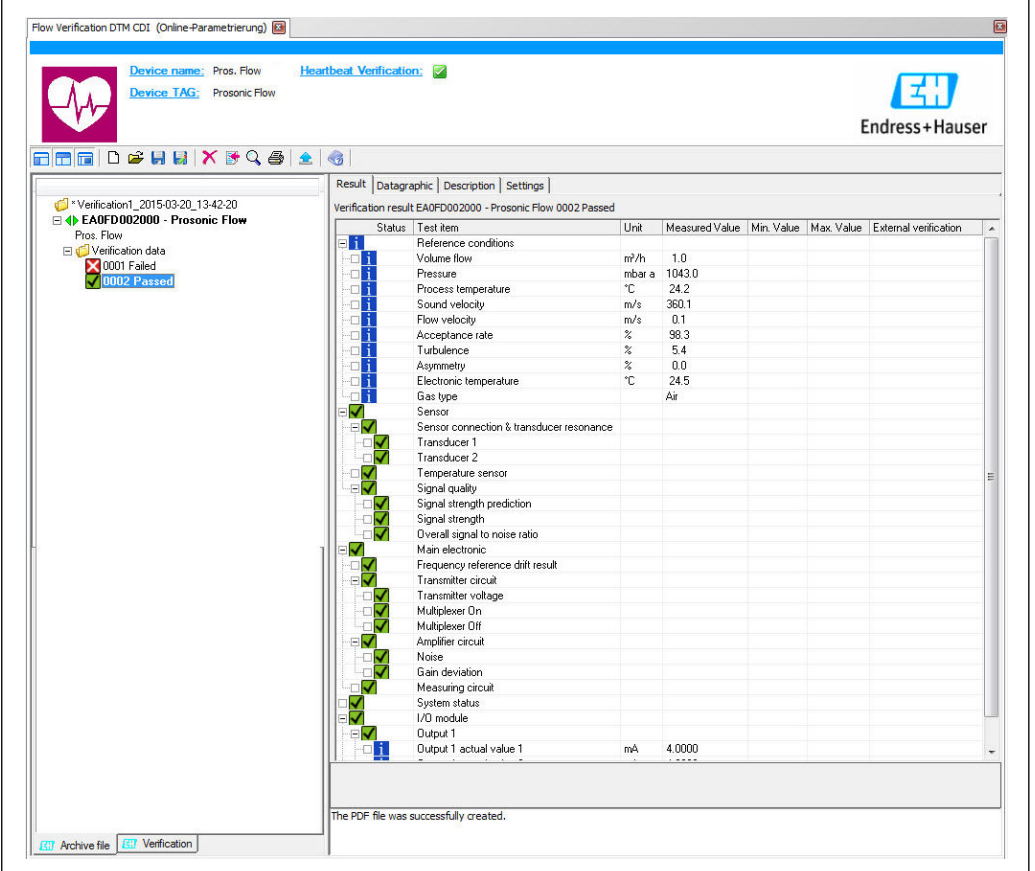|	
A0020273	Start uploading the verification data sets from the measuring device to the asset management tool (FieldCare)
A0020274	Reset the DTM to the initial state
A0020275	Open saved archive files
A0020276	Save data sets to an existing archive file or initial saving of data sets to a new archive file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

DTM header

The following basic functions are provided:

Device name: Pros. Flow Device TAG: Prosonic Flow A0026062	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.

A0026064-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).
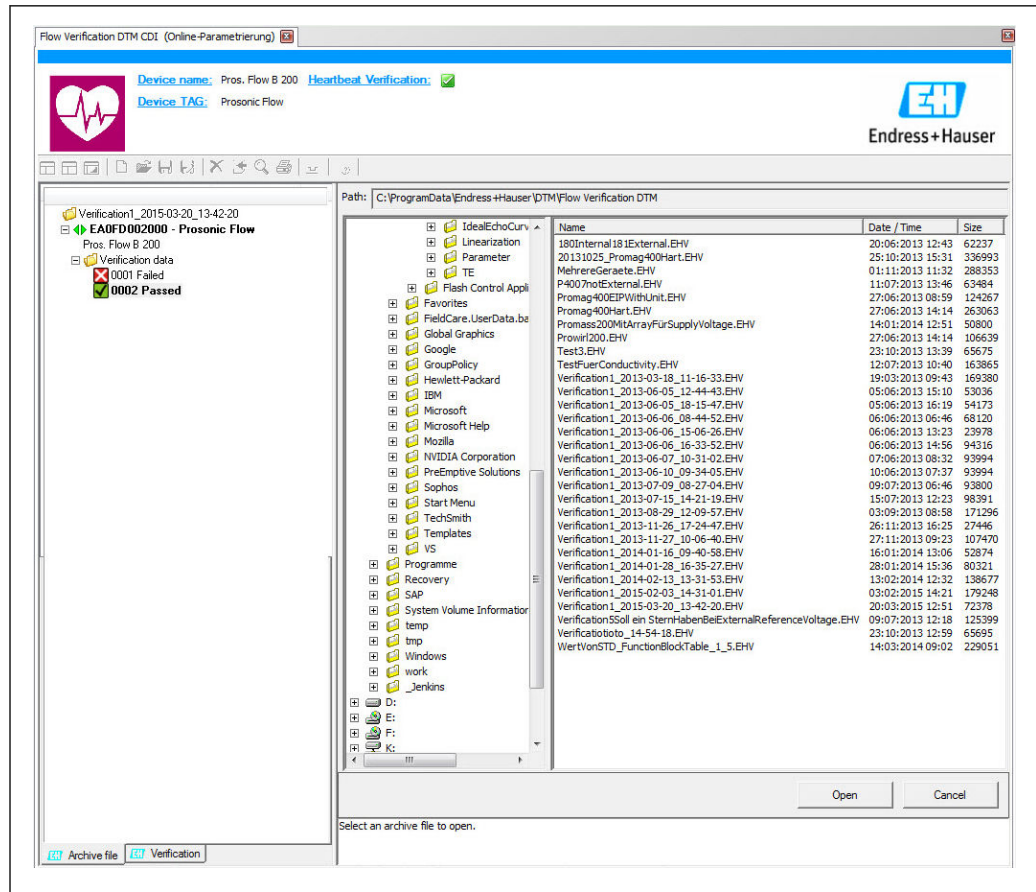
A0026067-EN

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.
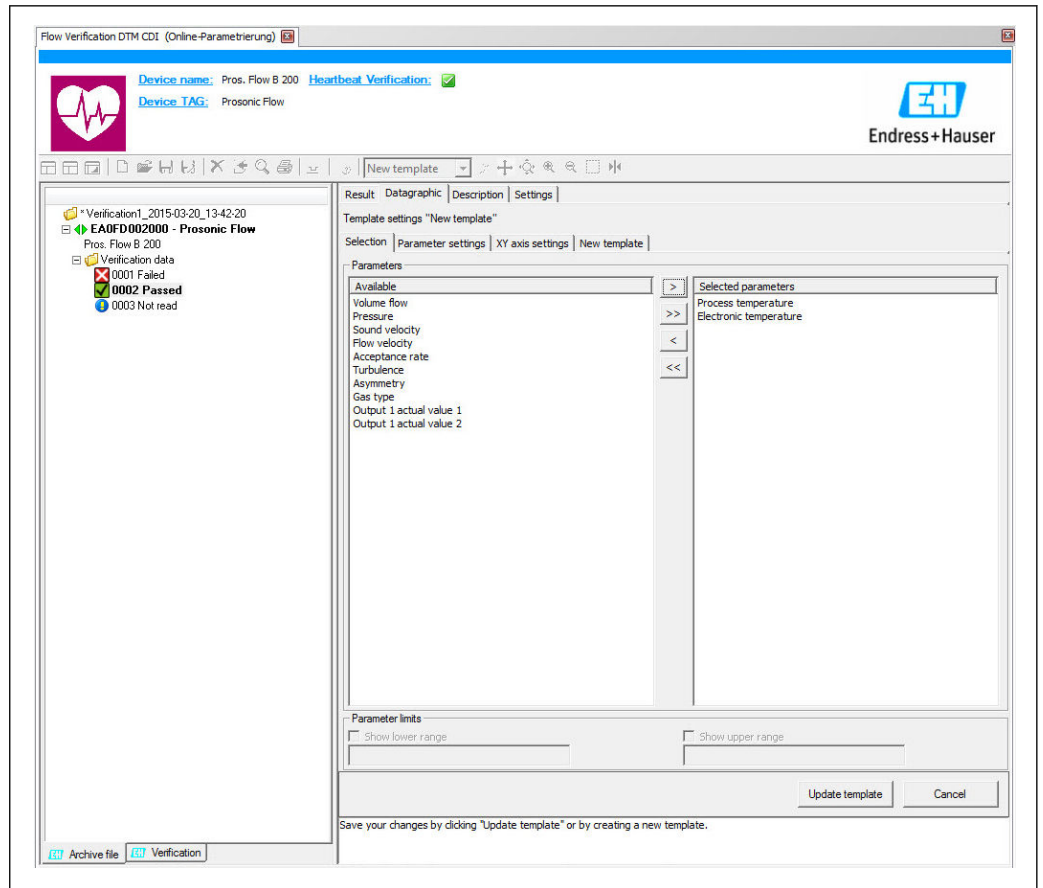
A0026070-EN

🖼 *7   "Selection": Select the desired parameters using the parameter list*
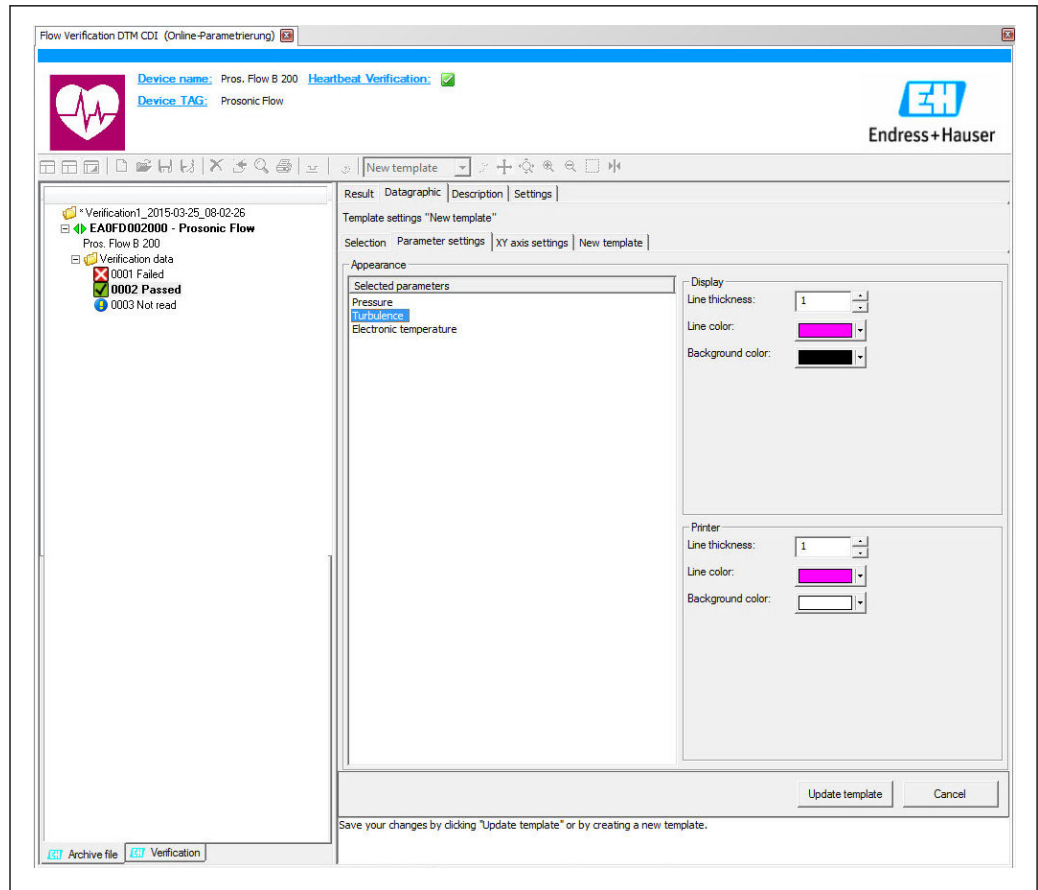
⊡ 8   "Parameter settings": Assign the properties for visualization in the graph
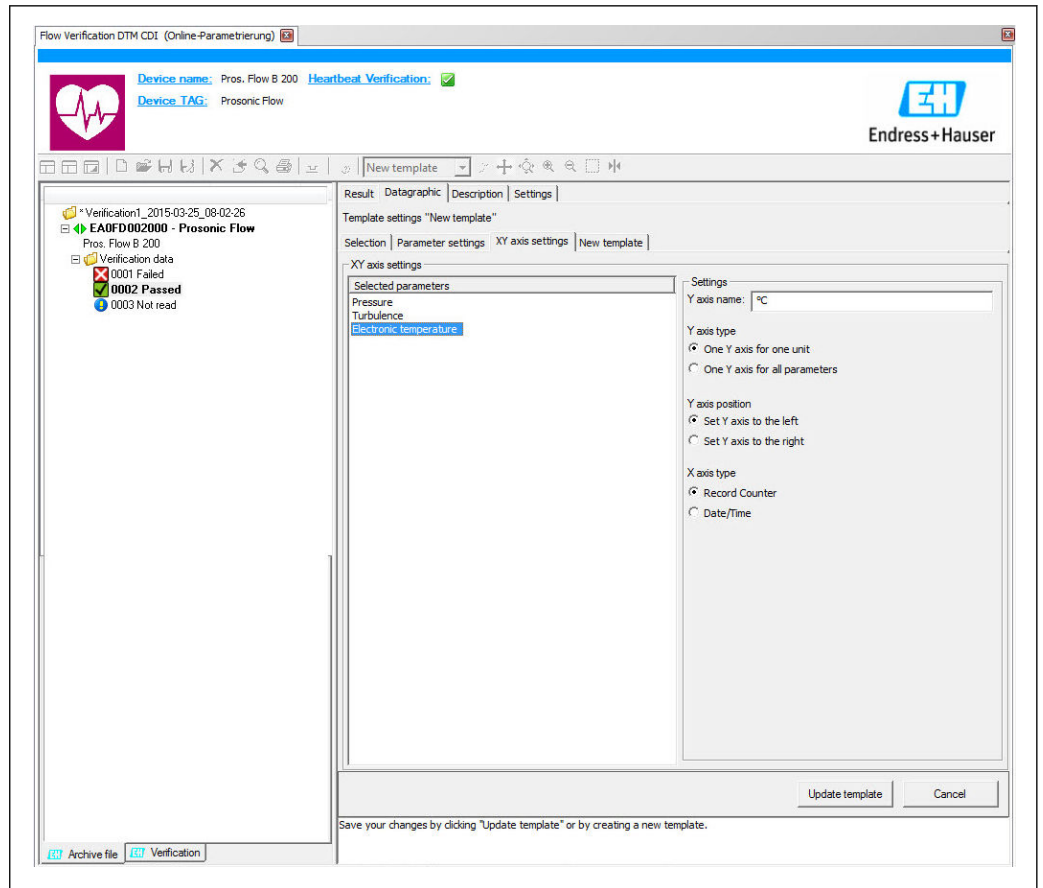
🖼 *9   "Y-axis settings": Assign the parameters to the y-axis*
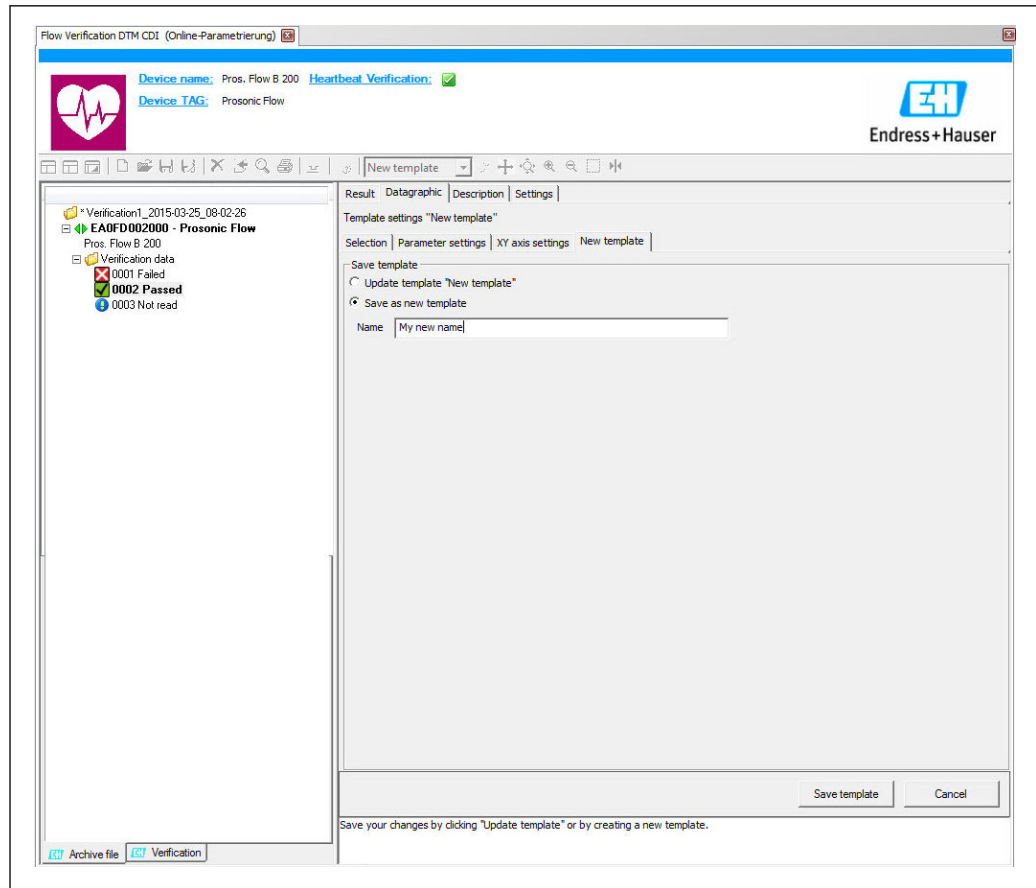
A0026098-EN

🔲 *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*

A0026072-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	• Monitoring of the condition of the ultrasonic converter with regard to the signal quality. • Monitoring of electrical connection between amplifier and converter. • Monitoring of electrical connection between amplifier and temperature sensor (optional – only in conjunction with biogas analysis).

Electronic module

Electronic module/test group	Test and recognized causes of errors
Main electronics module	• Detection of drift and aging of electronic components due to environmental or process influences (temperature, vibration etc.) • Testing of signal processing • Redundant reference clock monitoring
I/O module	**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.). **External verification** External testing of all active outputs at the measuring device.

8   Application examples

8.1   Diagnostics

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

8.2   Condition Monitoring

8.2.1   Definition of Condition Monitoring

→ 🖺 8

8.2.2   Focus and target applications

Condition Monitoring focuses on measured variables which indicate a change in the performance of the measuring device brought about by process-specific influences. There are two difference categories of process-specific influences:
- Transient process-specific influences that impact the measuring function directly and therefore result in a higher level of measuring uncertainty than would normally be expected (e.g. measurement of multiphase fluids). These process-specific influences generally do not affect the integrity of the measuring device but do impact measuring performance temporarily.
- Process-specific influences which only impact the integrity of the sensor over the medium term but which also bring about a gradual change in the measuring performance. These influences also affect the integrity of the measuring device on the long term.

Flowmeters with **Heartbeat Monitoring** offer a range of parameters that are particularly suitable for monitoring specific, application-related influences. These target applications are:
- Multi-phase fluids (gas content in liquid fluids)
- Applications in which the sensor is exposed to a programmed amount of wear

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

8.3   Heartbeat Monitoring

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

8.3.1   Overview

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

Monitoring parameter	Possible reasons for deviation
Acceptance rate	The acceptance rate is a measure of the number of successful ultrasonic measurements. • If the acceptance rate drops, this can be an indicator of interference in the flow. Interference can be caused by components in the process line, e.g. by other measuring devices or seals projecting into the process line. • Medium pulsation or discontinuous flow can also reduce the acceptance rate. • An excessively high medium velocity or a poor signal to noise ratio can be other reasons for a reduced acceptance rate.
Turbulence	The turbulence is a measure of the dispersion of the measured value. If the dispersion is too high, this can also influence the acceptance rate. • As with the acceptance rate, the reasons for a high level of turbulence are pulsation of the medium, discontinuous flow or interference in the process line. • An excessively high medium velocity or a poor signal to noise ratio can also be reasons for the high level of turbulence.
Signal strength	The signal strength can be affected by the process. An excessively low signal strength can be caused by: • A medium with an attenuating effect. • Formation of buildup. • Particles in the flow. • A damaged or defective converter.
Signal to noise ratio	If the signal to noise ratio is too low, this generally results in a lower acceptance rate and increasing turbulence. • Excessively high signal damping causes the signal to noise ratio to deteriorate. This is accompanied by an excessively low signal strength. Excessively high signal damping can be caused by the medium, e.g. dry CO_2, particles in the medium or the formation of buildup on the converter. • If the signal strength is OK but the signal to noise ratio is deteriorating, a contaminated or flooded converter could be the cause.
Asymmetry	The asymmetry can increase as a result of interference in the flow or non-symmetrical flow. Possible causes include: • The inlet run is too short. • Components in the process line, e.g. other measuring devices or seals projecting into the process line.

8.4   Heartbeat Verification

8.4.1   Scope of the test

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

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.

8.4.2   Interpreting and using the verification results

If a verification is passed, this confirms that the comparison values that are checked are within the factory specification and that the measuring device is working correctly. At the

same time, the zero point and calibration factor of the sensor are documented and traceable in the verification report. To ensure that the measuring device complies with the factory specification, these values must correspond to those of the last calibration or repeat calibration.

Confirmation with 100% total test coverage for 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 against the conditions of a previous verification → 🖹 27 to identify any differences. 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	• Defect, drift and deterioration and aging of ultrasonic converters. • Defective electrical connection between amplifier and converter. • Defective electrical connection between amplifier and temperature sensor. Recommendation: • Clean the ultrasonic converters • Replace the ultrasonic converters • Replace the sensor cables • Check the cabling of the temperature sensor
Main electronics module	• Defect, drift and aging of electronic components due to environmental or process influences (temperature, vibration etc.) • Reference clock drift Electronic module drift or defect → replace
I/O electronics module	**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.). **External verification** External testing of all active outputs at the measuring device. I/O module drift or defect → replace
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. **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. ℹ 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). ℹ 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. ℹ **Heartbeat Verification** is not a calibration system.
Verification report	Document in which the results of the **Heartbeat Verification** 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 **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. ℹ 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®
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Microsoft®
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