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Valid as of version
01.00.zz (Device firmware)

Special Documentation
Proline Prosonic Flow 400

Heartbeat Verification + Monitoring application package HART

HART COMMUNICATION PROTOCOL

Endress+Hauser
People for Process Automation

Table of contents

1 Manufacturer's declaration

Herstellerklärung
Manufacturer Declaration

Endress+Hauser
People for Process Automation

Company: **Endress+Hauser Flowtec AG, Kägenstrasse 7, CH-4153 Reinach**

Product: Proline Prosonic Flow 400

Statement:
We as manufacturer declare that for the above mention product with the application package *Heartbeat Technologie™* complies with the following requirements:

Heartbeat Technologie™ is a test method integrated in the measuring device for the diagnostics and verification of flowmeters when used in a particular application throughout the useful lifetime of the measuring device. Testing is based on internal factory-traceable references which are redundantly reproduced in the device. *Heartbeat Technologie™* includes Heartbeat Diagnostics and Heartbeat Verification.

Referenced documents:
IEC 61508-2:2010 Appendix C
IEC 61508-3:2010 Section 6
ISO 9001:2015, Section 7.1.5/7.1.5.2 a), Monitoring and measuring resources

Result:
Heartbeat Verification verifies the function on demand within the specified measuring tolerance with a total test coverage ("TTC") of TTC > 95%.

Heartbeat Technologie™ complies with the requirements for traceable verification according to ISO 9001:2008 – Section 7.1.5/7.1.5.2 a) "Monitoring and measuring resources". In accordance with this standard, the user is responsible for providing a definition of the verification interval that satisfies the particular requirements.

Reinach, 30. November 2021

Endress+Hauser Flowtec AG

Dr. Mirko Lehmann
Managing Direktor

i.V.
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Senior Expert Functional Safety

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2 Document information

2.1 Document function

This manual is a Special Documentation and does not replace the Operating Instructions included in the scope of supply. It is a part of the Operating Instructions and serves as a reference for using the Heartbeat Technology function integrated in the measuring device.

2.2 Content and scope

This document contains descriptions of the additional parameters and technical data of the application package and detailed explanations regarding:

- Application-specific parameters
- Advanced technical specifications

2.3 Symbols

2.3.1 Safety symbols

⚠ DANGER
This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

⚠ WARNING
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

⚠ CAUTION
This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE
This symbol contains information on procedures and other facts which do not result in personal injury.

2.3.2 Symbols for certain types of Information

Symbol	Meaning
	**Permitted** Procedures, processes or actions that are permitted.
	**Preferred** Procedures, processes or actions that are preferred.
	**Forbidden** Procedures, processes or actions that are forbidden.
	**Tip** Indicates additional information.
	Reference to documentation
	Reference to page
	Reference to graphic
▶	Notice or individual step to be observed
1., 2., 3....	Series of steps

Symbol	Meaning
	Result of a step
 A0028662	Operation via local display
 A0028663	Operation via operating tool
 A0028665	Write-protected parameter

2.3.3 Symbols in graphics

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

2.4 Documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *W@M Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the matrix code on the nameplate

This Special Documentation is available:
In the Download Area of the Endress+Hauser Internet site: www.endress.com → Downloads

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

Measuring device	Documentation code
Prosonic Flow I 400	BA02085D
Prosonic Flow W 400	BA02086D

2.5 Registered trademarks

HART®
Registered trademark of the FieldComm Group, Austin, Texas, USA

3 Product features and availability

3.1 Product features

Heartbeat Technology offers diagnostic functionality through continuous self-monitoring, the transmission of additional measured variables to an external Condition Monitoring system and the in-situ verification of flowmeters in the application.

The test scope achieved using these diagnostic and verification tests is referred to as the **Total Test Coverage** (TTC). The TTC is calculated using 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 dangerous undetected failures

Only the dangerous undetected failures are not diagnosed by the device diagnostics. If these failures occur, they can distort the measured value that is displayed or interrupt the output of measured values.

Heartbeat Technology checks the device function within the specified measuring tolerance with a defined TTC.

The current value for the TTC depends on the configuration and integration of the measuring device. The values indicated above were determined under the following conditions:
- Integration of measuring device for measured value output via 4 to 20 mA HART output
- Simulation operation not active
- Error behavior, current output set to **Minimum alarm** or **Maximum alarm** and evaluation unit recognizes both alarms
- Settings for diagnostic behavior correspond to factory settings

3.2 Availability of the application package

The application package can be ordered together with the device or can be activated subsequently with an activation code. Detailed information on the order code is available via the Endress+Hauser website www.endress.com or from your local Endress+Hauser Sales Center.

3.2.1 Order code

If ordering directly with the device or subsequently as a retrofit kit:
Order code for "Application package", option EB "Heartbeat Verification + Monitoring"

The availability of the application package can be checked as follows:
- Order code with breakdown of the device features on the delivery note
- Call up the Device Viewer via the website www.endress.com/deviceviewer: enter the serial number from the nameplate and check whether the feature is displayed
- In the operating menu Expert → System → Administration : The **Software option overview** parameter indicates whether the application package is enabled

3.2.2 Activation

The **Heartbeat Verification + Monitoring** application package must be enabled in the device if the package is ordered subsequently as a retrofit kit. The retrofit kit contains an activation code that must be entered via the operating menu:

Expert → System → Administration

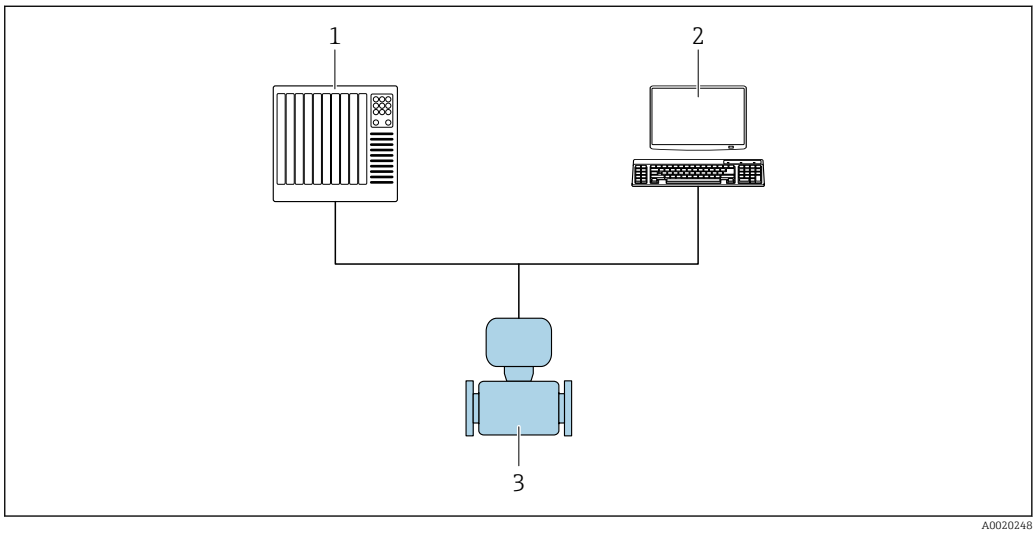
- ▶ Enter the activation code.
  - ↳ The application package is available.
    The **Software option overview** parameter displays the packages that are currently activated.

3.2.3 Access

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

4 System integration

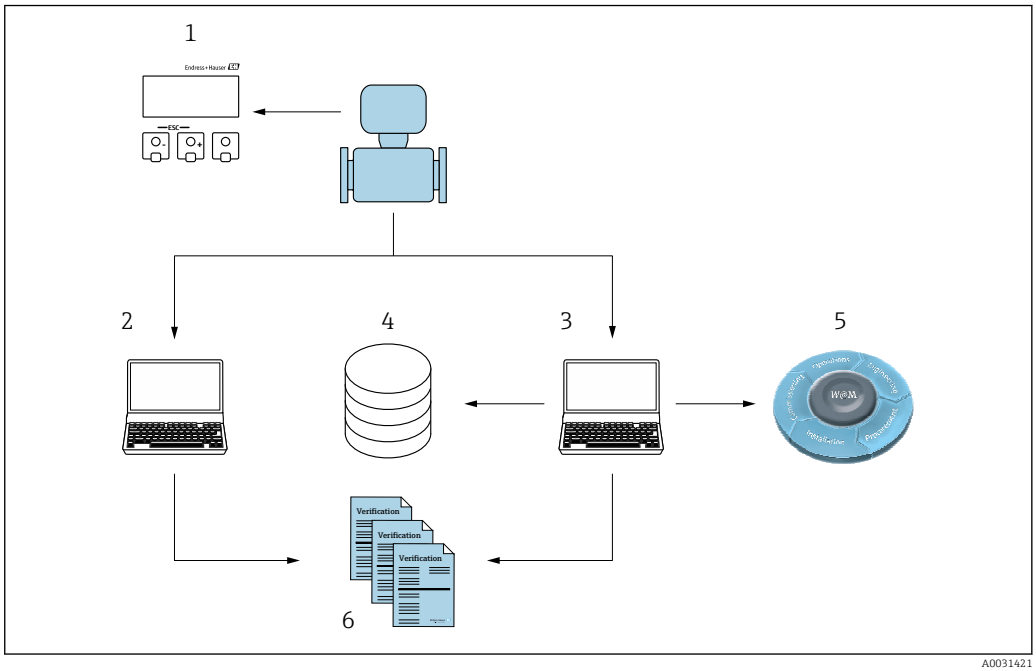
The **Heartbeat Technology** features are available via the local display module and the digital interfaces. The features can be used both via an asset management system and via the automation infrastructure (e.g. PLC).



1 *General layout*

1 PLC
2 Asset management system
3 Measuring device

4.1 Performing verification and creating a verification report



1 Local display
2 Web browser
3 FieldCare
4 Data archive in the device
5 W@M Portal
6 Verification report

Run the **Heartbeat Verification** via one of the following interfaces:
- System integration interface of a higher-level system
- Local display
- WLAN interface
- Service interface CDI-RJ45 (CDI: Common Data Interface)

External access to the device at the start of the verification and to relay the result (Passed or Failed) must be obtained from a higher-level system via the system integration interface. It is not possible to start the verification via an external status signal and relay the results to a higher-level system via the status output.

The detailed results of the verification (8 data records) are saved in the device and provided in the form of a verification report.

Verification reports can be created using the device DTM and the Web server integrated in the measuring device or the FieldCare plant asset management software from Endress+Hauser.

With the Flow Verification DTM, FieldCare also offers the possibility of data management and of archiving the verification results to create traceable documentation.

The Flow Verification DTM also enables trend analysis – i.e. the ability to monitor, compare and track the verification results of all the verifications performed on the device. This can be used for assessment purposes, e.g. to be able to extend recalibration intervals.

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

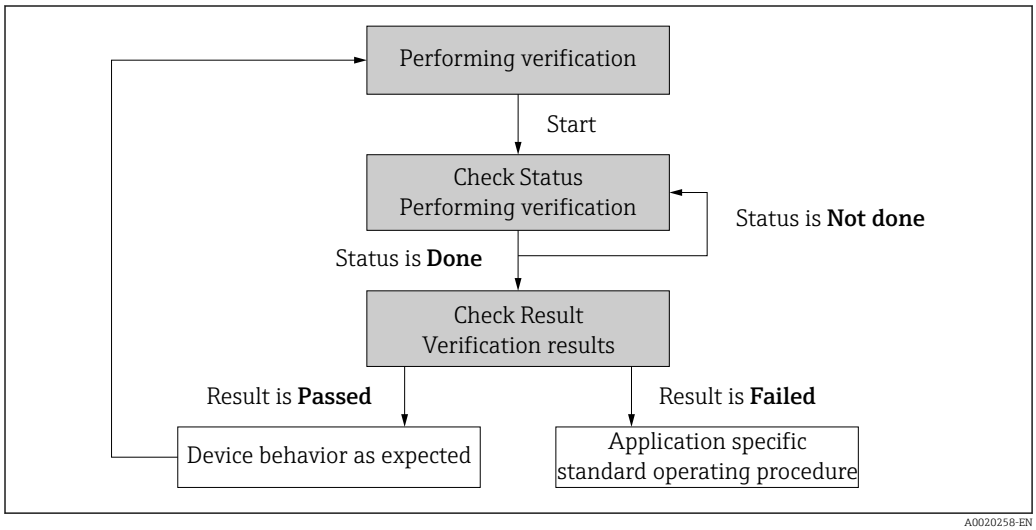
4.2 Automated data exchange

- Instrument check via self-monitoring
- Start verification and verification status

The built-in verification in the measuring device can be initiated via a control system and the results checked.

For further information on "System integration", see the Operating Instructions → 6 (documentation code)

The following procedure must be implemented for this purpose:



Verification result: The overall result of the verification is indicated in the **Overall result** parameter. Depending on the result, different application-specific measures must be performed by system routines, e.g. a "Maintenance Required" alert is triggered if the result is **Failed**.

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

Heartbeat Monitoring
Configuration of the monitoring function: specify which diagnostic parameters are output continuously via the system integration interface.

Heartbeat Verification
- Start verification
- Upload, archive and document the verification results including detailed results

4.4 Data management

The results of a **Heartbeat Verification** are saved as a non-volatile parameter set in the measuring device memory:
- Availability of 8 storage locations for parameter data sets
- New verification results overwrite old data following the FIFO [1] principle

The results can be documented in the form of a verification report using the web server integrated in the measuring device or the Endress+Hauser asset management software FieldCare.

FieldCare also offers additional capabilities with the Flow Verification DTM:
- Archiving of verification results
- Export of data from these archives
- Trend analysis of verification results (line recorder function)

4.4.1 Data management via Web browser

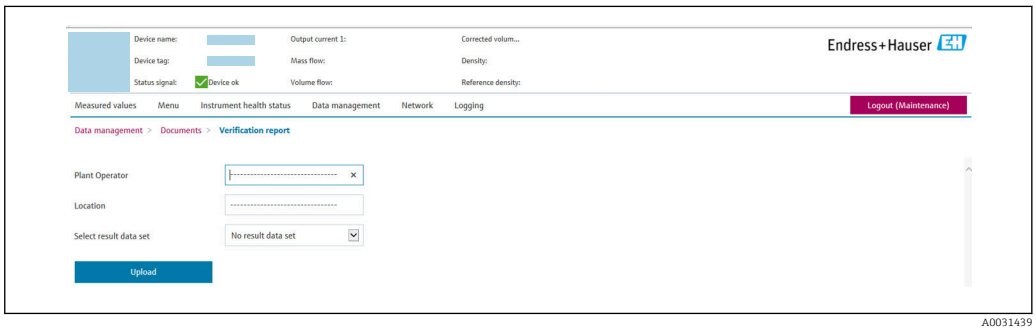
Thanks to the integrated Web server the device can be operated and configured via a Web browser. In addition, it is possible to query the results of the verification and create a verification report.

Printing a verification report

A verification report is created in PDF format.

Prerequisite: A verification has already been performed.

User interface in the Web browser following login:



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1. Click the navigation buttons **Data management** → **Documents** → **Verification report**.
   ↳ The input area for downloading verification reports is displayed.
2. Enter the necessary information in the **Plant operator** and **Location** fields.
   ↳ The information entered here appears in the verification report.

1) First In – First Out

3. Select the result data set.
   ↳ A result data set is indicated as a time stamp in the drop-down list.
   If no verification has been performed, the message "No result data set" is displayed here.
4. Click **Upload**.
   ↳ The Web server generates a verification report in PDF format.

4.4.2 Data management via Flow Verification DTM

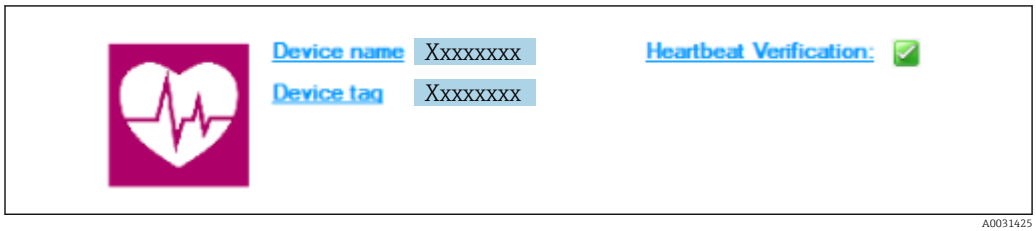
A special DTM (Flow Verification DTM) is available for **Heartbeat Verification**. The Flow Verification DTM offers advanced capabilities for managing and visualizing the results.

Basic functions

The following basic functions are available:

	Read data records from the device
	Create a new archive
	Open saved archive files
	Save data sets to an existing archive file or initial saving of data sets to a new archive file
	Save the data sets under a new file name; a new archive file is created in this case
	Create a verification report in PDF format

Header



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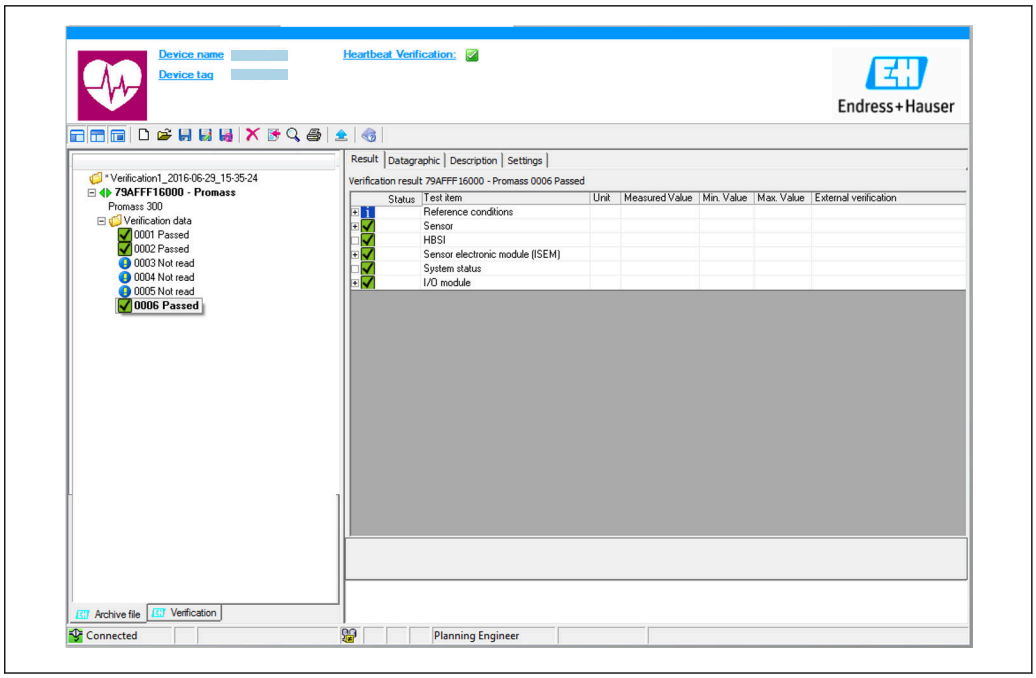
- Top display area of the DTM
- Contains the following information:
  - Measuring device
  - Device tag
- Indicates whether verification is active: ☑

Reading out data

Start uploading the data from the measuring device to the asset management software.



2 *Sample graphic*

- ▶ Click an individual data set.
  - ↳ Selected data sets, which are saved in the measuring device, are transmitted to the asset management software and visualized.

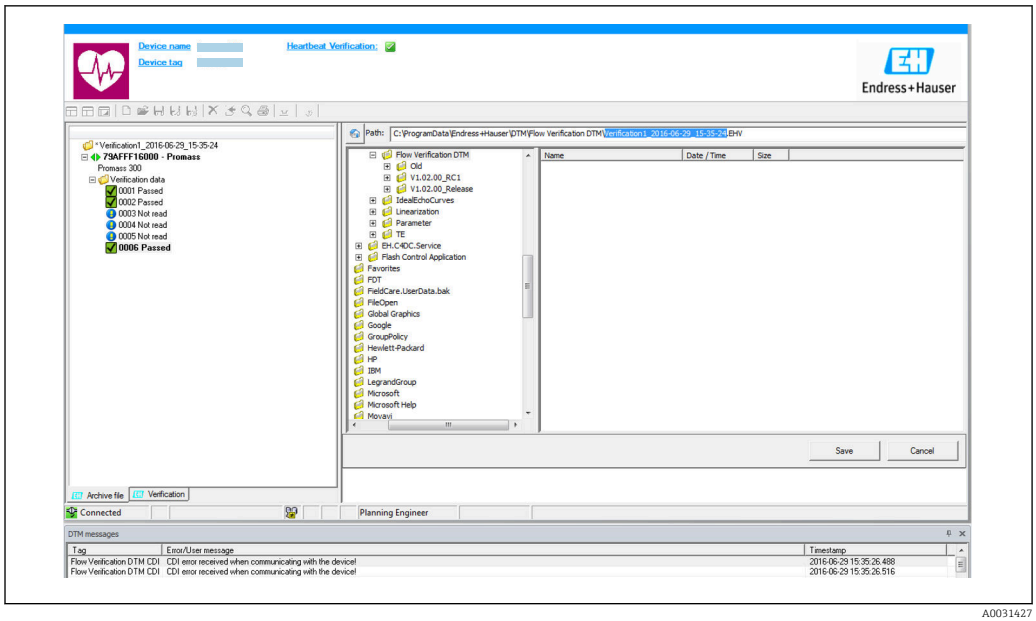
Verification results

Details for the verification results are displayed in the data area.

The data area is split into 3 tabs:
- Result – 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

Save the data to an archive after upload.



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3 Sample graphic

- Click the 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 any asset management system with an installed Flow Verification DTM and is therefore also suitable for analysis by a third party (e.g. Endress+Hauser service organization).

Opening the archive file

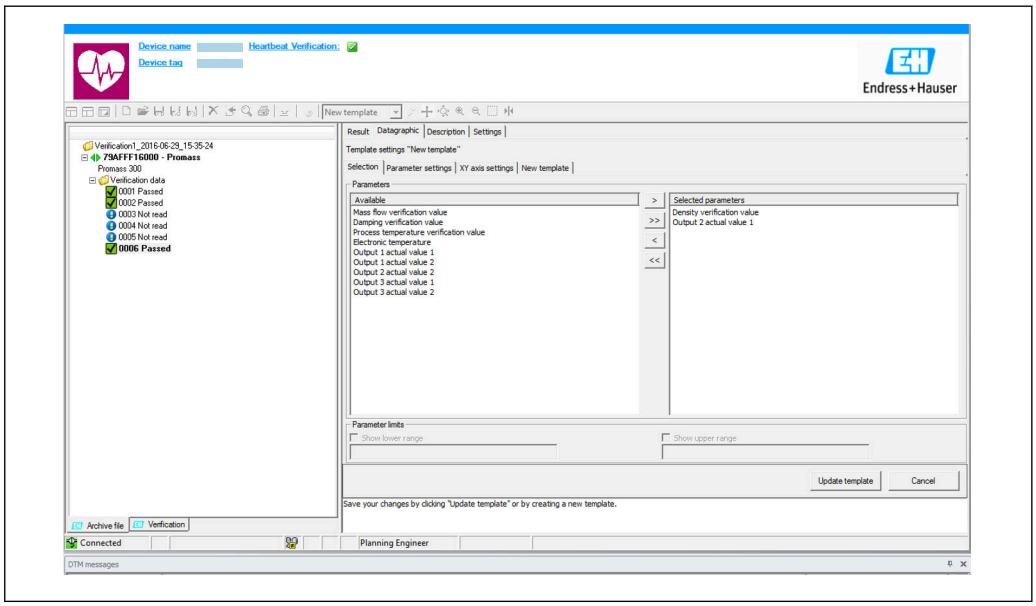
Open archive files already available.

- Click the icon.
  - The archive data are uploaded to the Flow Verification DTM.

Configuring visualization and trending

The verification data can be visualized in the 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.

Selecting the measured variables



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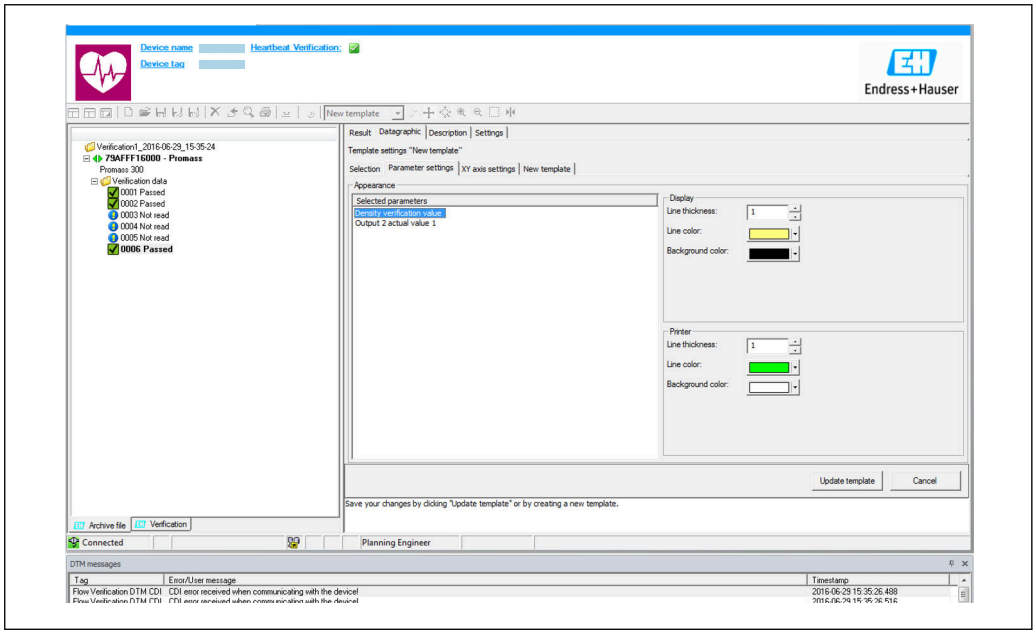
4 *Sample graphic*

- ▶ Select the measured variables using the list displayed.

Visualizing a graph



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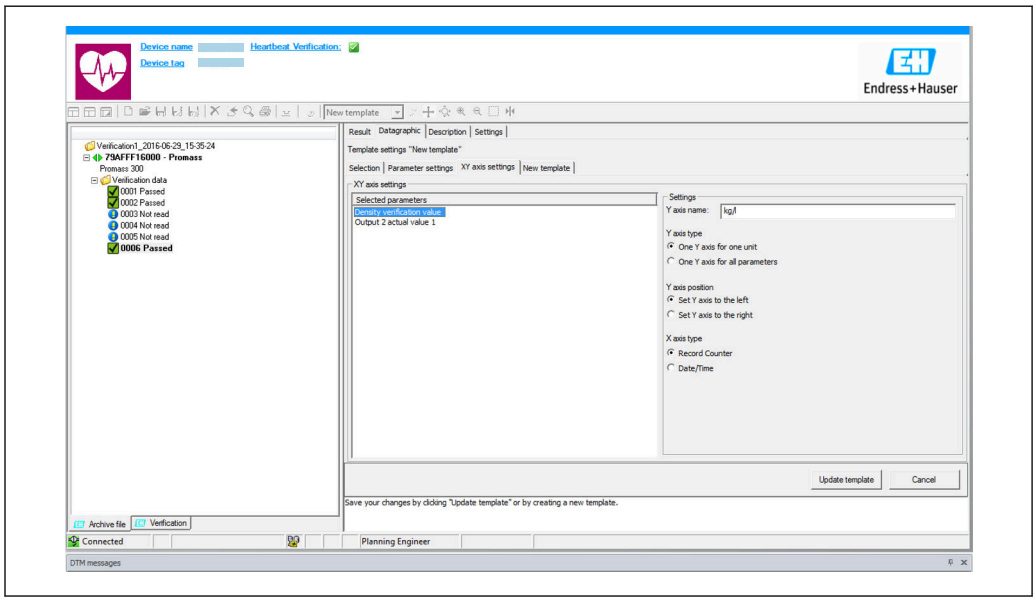
5 *Sample graphic*

- ▶ Assign properties for visualization of the graph.

Configuring the Y-axis



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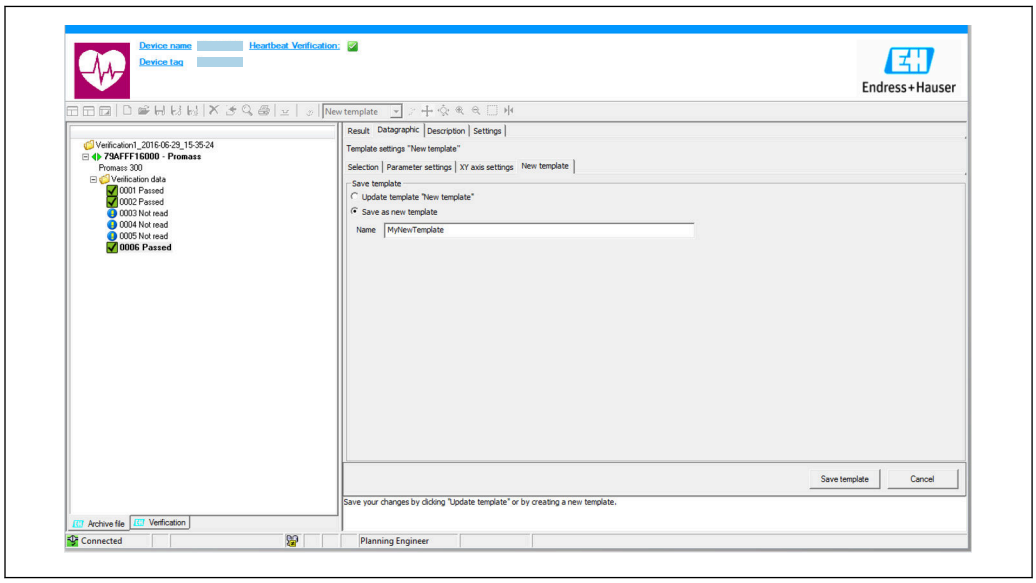
6 *Sample graphic*

- Assign the measured variables of the Y-axis.

Update template or create new template



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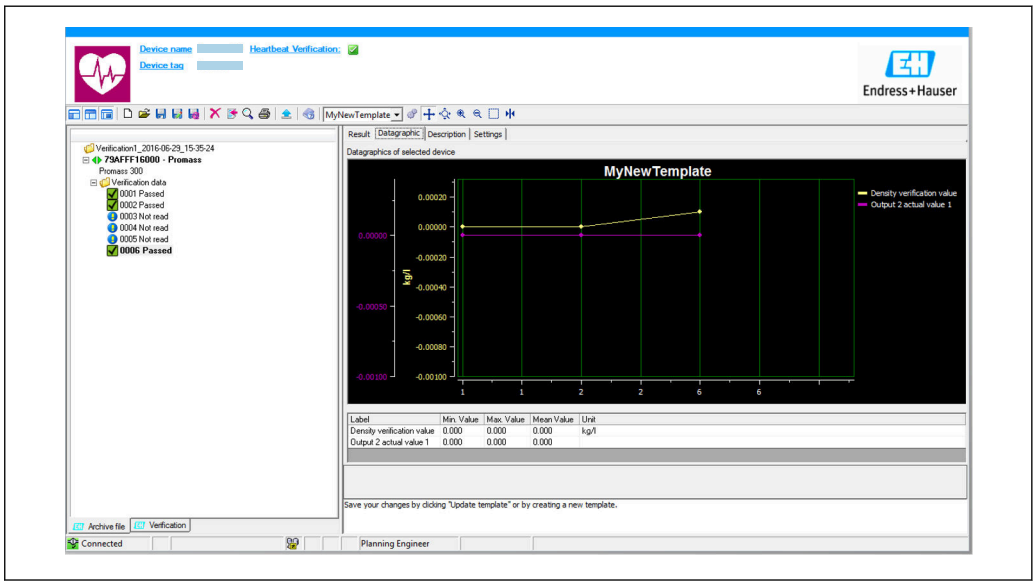
7 *Sample graphic*

- Add a selected parameter configuration to the template or save under a new template name.

Showing the visualization trend



8 *Sample graphic*

- ▶ Display the template.
  - ↳ The template shows the data in chronological order. The data points are referenced by the verification ID (X-axis), the Y-axis displays the parameters defined in the configuration.

Creating a verification report

1. Click the icon.
2. Select the data set.
   - ↳ A verification report is generated.

5 Heartbeat Verification

Heartbeat Verification checks the device function within the specified measuring tolerance on demand. The result of the verification is "Passed" or "Failed".

The verification data are saved in the device and, optionally, are archived on a PC with the FieldCare asset management software . A verification report is generated automatically on the basis of these data to ensure the traceable documentation of the verification results.

Heartbeat Technology offers two ways to perform Heartbeat Verification:
- Standard verification → 20
  Verification is performed by the device without manual checking of external measured variables.
- Extended verification → 23
  Verification also includes the entry of external measured variables.

5.1 Performance characteristics

Heartbeat Verification is performed on demand and supplements permanent self-monitoring with additional checks .

Standard verification additionally checks the following inputs and outputs:
- 4 to 20 mA current output
- Pulse/frequency output
- Reference frequency

The extended verification supports the verification of the following output modules:
- 4 to 20 mA current output
- Pulse/frequency output
- Reference frequency

The verification is based on references that are incorporated in the measuring device, traceable from the factory and redundant in the device. **Heartbeat Verification** confirms on demand the device function with the total test coverage (TTC).

Assessed by an independent body: **Heartbeat Technology** meets the requirement for traceable verification according to DIN EN ISO 9001: 2015 Chapter 7.1.5.2 a) Control of monitoring and measuring equipment.

5.2 Commissioning

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.

▶ When commissioning the measuring device:
  Perform an initial verification to save the results as an initial situation in the life cycle of the measuring device. From the ninth verification onwards, an upload using the Verification DTM is recommended.

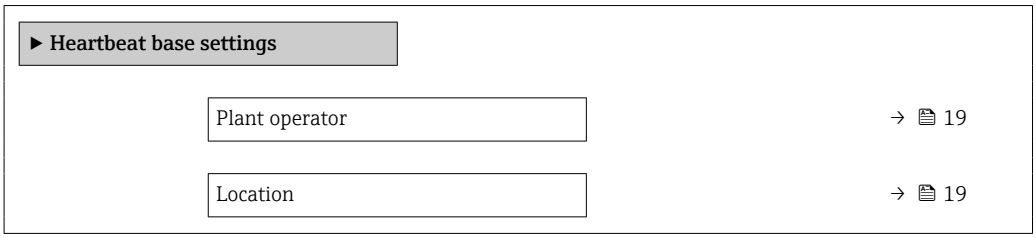
5.2.1 Recording reference data

It is possible to manually record reference data relating to the operator and the location. These reference data appear on the verification report.

Operation continues while the reference data are being recorded.

Navigation
"Setup" menu → Advanced setup → Heartbeat setup → Heartbeat base settings

Navigation
"Expert" menu → Diagnostics → Heartbeat Technology → Heartbeat base settings



Parameter overview with brief description

Parameter	Description	User entry
Plant operator	Enter the plant operator.	Max. 32 characters such as letters, numbers or special characters (e.g. @, %, /)
Location	Enter the location.	Max. 32 characters such as letters, numbers or special characters (e.g. @, %, /)

5.3 Operation

5.3.1 General information

Initial verification

▶ When commissioning the measuring device:
Perform an initial verification to save the results as an initial situation in the life cycle of the measuring device. From the ninth verification onwards, an upload using the Verification DTM is recommended.

Initial verification can be performed in 2 ways:
- Standard verification → 20
- Extended verification → 23

Device behavior and interpretation

Result: "Passed"

All test results are within the specifications.

In general, the verification result in most applications is "Passed".

Result: "Failed"

One or more test results are outside the specifications.

If the verification result is "Failed", take the following action:

1. Establish defined and stable process conditions.
   ↳ Ensure a constant process temperature.
   Avoid pulsating flow, pressure shocks and very high flow rates.
2. Repeat verification.
   ↳ "Passed" again
   If the result of the second verification is "Passed", the result of the first verification can be ignored. In order to identify possible deviations, compare the current process conditions with the process conditions of a previous verification.

If the verification result is "Failed" again, take the following action:

1. Take remedial action on the basis of the verification results and the diagnostic information of the measuring device.
   ↳ The cause of the error can be narrowed down by identifying the test group with a "Failed" verification.
2. Provide Endress+Hauser Service with the verification result with the current process conditions.

5.3.2 Standard verification

Standard verification is performed automatically by the device and without manual checking of external measured variables.

Diagnostic behavior

The device signals that standard verification is in progress: ⚠**C302 Device verification in progress** diagnostic message
- Factory setting for diagnostic behavior: warning
- Test duration: approx. 60 seconds.

- The diagnostic behavior can be changed by the user if necessary:
  Expert → System → Diagnostic handling → Diagnostic behavior
  If **Alarm** is selected as the diagnostic behavior, the output of measured values is interrupted in the event of an error and the signal outputs and totalizers adopt the defined alarm condition.
- In the **Diagnostic configuration** submenu, a category is assigned to the respective diagnostic message of the outputs.
  Expert → Communication → Diagnostic configuration
  If the device does not have outputs, they are output as an error. To ensure that an error is not output, assign the **No effect (N)** option to the outputs that are not present.

Detailed information on diagnostics and troubleshooting and on diagnostic information and associated troubleshooting measures can be found in the Operating Instructions → 📄 6.

Performing standard verification

Before verification starts

The date and time are saved with the current operating time and the verification results and also appear in the verification report.

The **Year** parameter, **Month, Day, Hour, AM/PM and Minute** are used to manually record the data at the time of verification.

1. Enter date and time.

Select the verification mode

2. In the **Verification mode** parameter, select the **Standard verification** option.

Starting the verification test

3. In the **Start verification** parameter, select the **Start** option.
   ↳ While the verification is being performed, the progress of the verification is indicated as a % (bar graph indicator) in the **Progress** parameter.

Displaying the verification status and result

The current status of the standard verification is shown in the **Status** parameter (→ 23):
- Done
  The verification test is finished.
- Busy
  The verification test is running.
- Not done
  A verification has not yet been performed on this measuring device.
- Failed
  A prerequisite for performing the verification has not been met; the verification cannot start (e.g. due to unstable process parameters) → 19.

The result of the verification is displayed in the **Overall result** parameter (→ 23):
- Passed
  All the verification tests were successful.
- Not done
  A verification has not yet been performed on this measuring device.
- Failed
  One or more verification tests were not successful → 19.

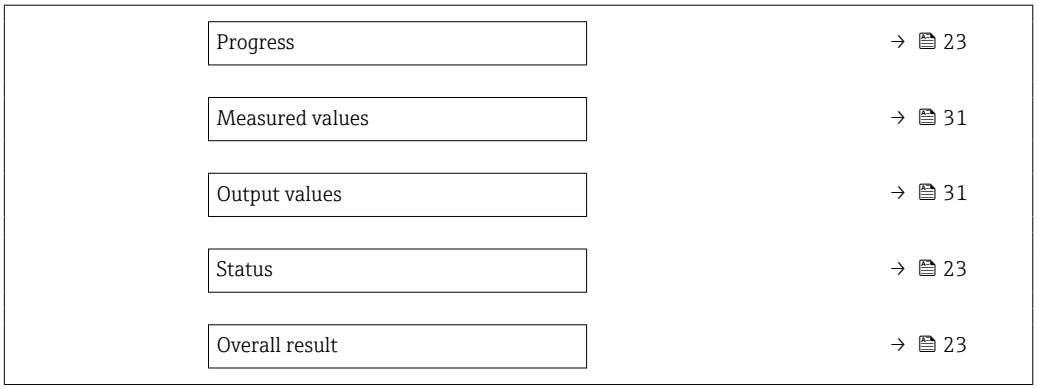
- The overall result of the last verification can always be accessed in the menu.
- Navigation:
  Diagnostics → Heartbeat Technology → Verification results
- Detailed information on the verification result (test groups and test status) are shown in the verification report in addition to the overall result → 34.
- If the device does not pass the verification, the results are saved nonetheless and indicated in the verification report.
- This facilitates a targeted search for the cause of the fault → 19.

"Performing verification" submenu

Navigation

"Diagnostics" menu → Heartbeat Technology → Performing verification

▶ Performing verification	
Year	→ 22
Month	→ 22
Day	→ 22
Hour	→ 22
AM/PM	→ 22
Minute	→ 22
Verification mode	→ 22
External device information	→ 30
Start verification	→ 23



Parameter overview with brief description

Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
Year	Can be edited if Heartbeat Verification 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 Heartbeat Verification 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 Heartbeat Verification 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 Heartbeat Verification 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 Heartbeat Verification is not active. The **dd.mm.yy hh:mm am/pm** option or the **mm/dd/yy hh:mm am/pm** option is selected in the **Date/ time format** parameter (2812).	Entry for date and time (field 5): enter the morning or afternoon.	▪ AM ▪ PM	AM
Minute	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 6): enter the minute verification is performed.	0 to 59 min	0 min
Verification mode	Can be edited if Heartbeat Verification is not active.	Select the verification mode. Standard verification Verification is performed automatically by the device and without manual checking of external measured variables.	▪ Standard verification ▪ Extended verification	Standard verification

Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
Start verification	–	Start the verification. Start the verification with the **Start** option.	▪ Cancel ▪ Start ▪ Start with testkit * ▪ Output 1 low value * ▪ Output 1 high value * ▪ Frequency output 1 * ▪ Pulse output 1 * ▪ Frequency output 2 * ▪ Pulse output 2 *	Cancel
Progress	–	Shows the progress of the process.	0 to 100 %	0 %
Status	–	Displays the current status of the verification.	▪ Done ▪ Busy ▪ Failed ▪ Not done	Done
Verification result	–	Displays the overall result of the verification. Detailed description of results classification:	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done

* Visibility depends on order options or device settings

5.3.3 Extended verification

The extended verification supplements the standard verification with the output of various measured variables and the verification of sensors using test kit [material no. 71097625 for DN 15 to 65 (½ to 2½") or 71528425 for DN 50 to 4000 (2 to 160")]. In the verification process, these measured variables are recorded manually using an external measuring device and entered at the measuring device (e.g. current value at current output). The value entered is checked and verified by the measuring device for compliance with the factory specifications. A status (Passed or Failed) is issued accordingly and is documented as an individual result of the verification and taken into account in the overall result.

During the extended verification of the outputs, permanently pre-defined outputs signals are simulated that do not represent the current measured value. To measure the simulated signals, it may be necessary to set the higher-level process control system to a safe state beforehand. In order to perform a verification, the pulse/frequency/switch output must be enabled and assigned to a measured variable.

Extended verification measured variables
Output current (current output)
- Simulation of the measured values for every output physically present on the device
- Simulation "Low value" and "High value"
- Measurement of the two values
- Entry of the two measured values in the verification screen

Output frequency (pulse/frequency output)
- Simulation of the measured values for every output physically present on the device
- Simulation value pulse output: Simulated frequency depending on the pulse width configured
- Simulation value frequency output: Maximum frequency

For more information on simulation, see the Operating Instructions → 6.

Test kit [2)]

For the extended verification, of the measuring point with a test kit is also possible.

1. In the **Start verification** parameter, select the **Start with testkit** option.
2. Before starting the verification, remove both sensors of a measuring path from the sensor holders on the measuring pipe and secure them on the test blocks. A test kit comprises two test blocks for one pair of sensors.
3. Once the verification is started, the functions of the measuring system (transmitter and sensors) are verified independently of the process conditions at the measuring point using the test kit.
4. The functioning of the sensors and the sensor electronics is recorded in the associated verification report. This verifies the correct, trouble-free functioning of the measuring system, independently of process influences.
5. Once the verification has been performed, the sensors are removed from the test blocks and reinserted into the sensor holders on the measuring pipe of the measuring system. When reinserting, make sure that the sensors are not mixed up and that they are inserted into their original position (upstream, downstream).
6. If coupling pads are used for acoustic coupling, the coupling pads used in the measurement can remain on the sensors and be used for the verification on the test kit and the subsequent re-installation on the measuring point. If coupling gel is used, fresh coupling gel must be applied to the sensors before the sensors are inserted into the test blocks or reinstalled in the sensor holders of the measuring point.

Measuring equipment requirements

Recommendations for the measuring equipment

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

Connecting the measuring equipment in the measuring circuit

⚠ WARNING

Danger to persons from non-approved equipment in the hazardous area!

- ▶ Only use intrinsically safe measuring equipment in hazardous zones.
- ▶ Measure intrinsically safe circuits with approved equipment only.
- ▶ Outputs (passive) for the hazardous area may only be connected to suitable intrinsically safe circuits.

Determining the terminal assignment for the outputs

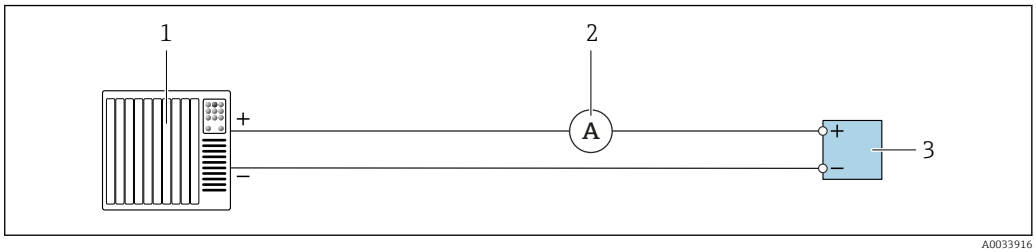
The terminal assignment depends on the specific device version.

To determine the device-specific terminal assignment:
See the adhesive label in the terminal cover

For detailed information on terminal assignment, see the Operating Instructions for the device → 6

2) Not available for the Prosonic Flow I 400

Active current output



9 *Extended verification of the active current output*

1 *Automation system with current input (e.g. PLC)*
2 *Ammeter*
3 *Transmitter*

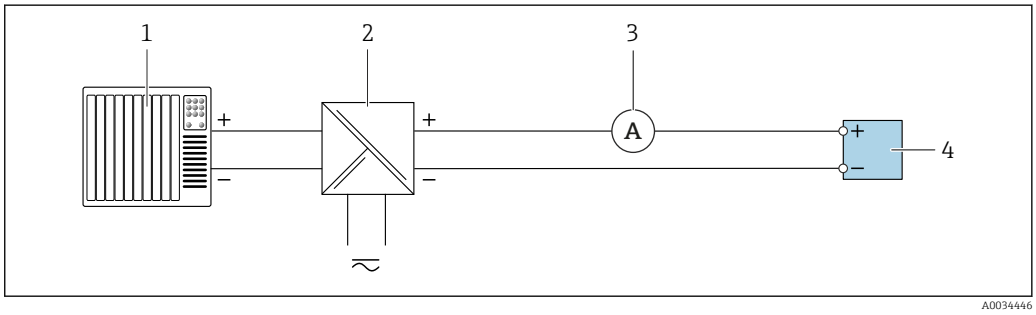
Extended verification of the active current output

▶ Connect the ammeter to the transmitter by looping it in series into the circuit.

If the automation system is switched off, the measuring circuit may be interrupted as a result. It is then not possible to perform a measurement. If this is the case, proceed as follows:

1. Disconnect the output cables of the current output (+/−) from the automation system.
2. Short the output cables of the current output (+ / -).
3. Connect the ammeter to the transmitter by looping it in series into the circuit.

Passive current output



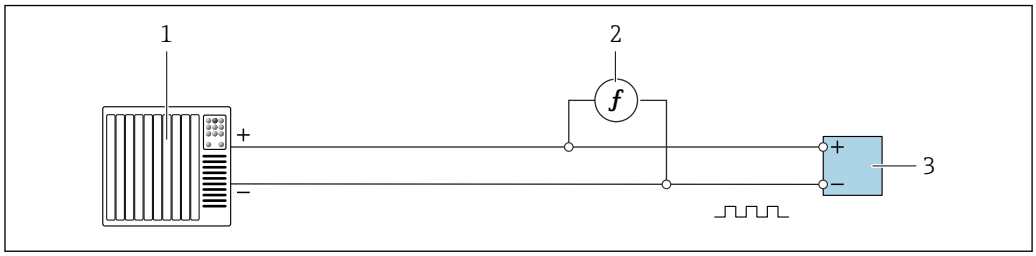
10 *Extended verification of the passive current output*

1 *Automation system with current input (e.g. PLC)*
2 *Power supply unit*
3 *Ammeter*
4 *Transmitter*

Extended verification of the passive current output

1. Connect the ammeter to the transmitter by looping it in series into the circuit.
2. Connect the power supply unit.

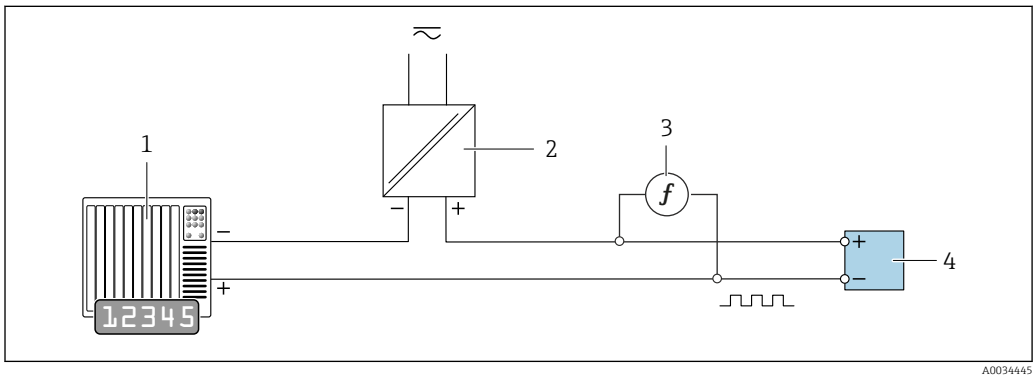
Active pulse/frequency/switch output



11 *Extended verification of the active pulse/frequency output*

1 *Automation system with pulse/frequency input (e.g. PLC)*
2 *Frequency meter*
3 *Transmitter*

Passive pulse/frequency/switch output



12 *Extended verification of the passive pulse/frequency output*

1 *Automation system with pulse/frequency input (e.g. PLC)*
2 *Power supply unit*
3 *Frequency meter*
4 *Transmitter*

Extended verification of the passive pulse/frequency output

1. Connect the power supply unit
2. Connect the frequency meter in parallel to the pulse/frequency output of the transmitter

Diagnostic behavior

A diagnostic event signals that the extended verification is being performed:
- The screen alternates between the status signal "C" (Function Check) and the operational display:
  Verification is currently active in the device.
- Different diagnostic behaviors, along with the relevant diagnostic codes, can be displayed depending on the device version.
  The output selected under **Start verification** parameter is displayed in all cases, however:
  Output 1…n low value option, **Output 1…n high value** option

Diagnostic code	Diagnostic behavior	Options in Start verification
C491	**Current output 1 to n simulation** active	Output 1…n low value Output 1…n high value
C492	**Simulation frequency output 1 to n** active	Frequency output 1…n
C493	**Simulation pulse output 1 to n** active	Pulse output 1…n
C302	⚠**C302 Device verification in progress**	

An extended verification (simulation mode) may be started only if the process plant is not in the automatic mode.

If the **Start** option is selected in the **Start verification** parameter, the following diagnostic event is output on the display (second part of the external verification): ⚠**C302 Device verification in progress** diagnostic message
- Factory setting for diagnostic behavior: warning
- Test duration (all outputs switched on): approx. 60 seconds.

- The diagnostic behavior can be changed by the user if necessary:
  Expert → System → Diagnostic handling → Diagnostic behavior
  If **Alarm** is selected as the diagnostic behavior, the output of measured values is interrupted in the event of an error and the signal outputs and totalizers adopt the defined alarm condition.
- In the **Diagnostic configuration** submenu, a category is assigned to the respective diagnostic message of the outputs.
  Expert → Communication → Diagnostic configuration
  If the device does not have outputs, they are output as an error. To ensure that an error is not output, assign the **No effect (N)** option to the outputs that are not present.

Detailed information on diagnostics and troubleshooting and on diagnostic information and associated troubleshooting measures can be found in the Operating Instructions → 📄 6.

Performing extended verification

A full standard verification is performed in the course of the verification. The validity of the entered and measured values of the outputs is checked. Additional standard verification of the outputs does not take place.

NOTICE

Extended verification is not possible if no connection has been established and the ammeter is looped in during verification.
- ▶ Establish a connection before extended verification starts.
- ▶ Loop in ammeter before extended verification starts.

Before verification starts

The date and time are saved with the current operating time and the verification results and also appear in the verification report.

The **Year** parameter, **Month, Day, Hour, AM/PM and Minute** are used to manually record the data at the time of verification.

1. Enter date and time.

Select the verification mode

2. In the **Verification mode** parameter, select the **Extended verification** option.

Further parameter settings

3. In the **External device information** parameter, enter a unique ID (e.g. serial number) of the measuring equipment used (max. 32 characters).
4. In the **Start verification** parameter, select one of the options available (e.g. the **Output 1 low value** option).
5. In the **Measured values** parameter, enter the value shown on the external measuring equipment.
6. Repeat steps 4 and 5 until all the output options are checked.
7. Adhere to the sequence indicated and enter the measured values.

The duration of the process and number of outputs depend on the device configuration.

The value displayed in the **Output values** parameter (→ 31) shows the value simulated by the device at the selected output → 24

Starting the verification test

8. In the **Start verification** parameter, select the **Start** option.
   ↳ While the verification is being performed, the progress of the verification is indicated as a % (bar graph indicator) in the **Progress** parameter.

For the extended verification of the measuring point with a test kit → 24

Displaying the verification status and result

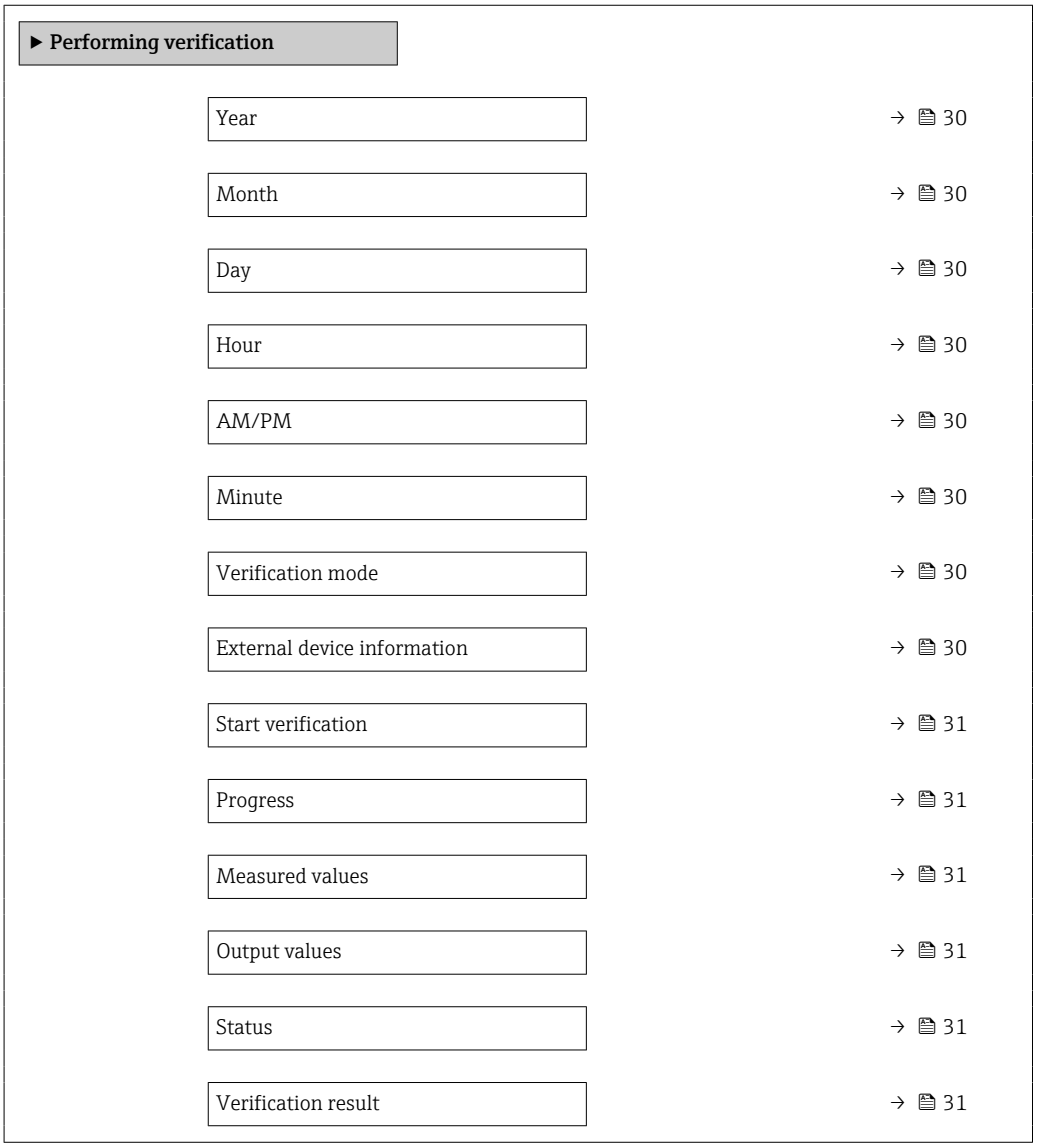
The current status of the standard verification is shown in the **Status** parameter (→ 23):
- Done
  The verification test is finished.
- Busy
  The verification test is running.
- Not done
  A verification has not yet been performed on this measuring device.
- Failed
  A prerequisite for performing the verification has not been met; the verification cannot start (e.g. due to unstable process parameters) → 19.

The result of the verification is displayed in the **Overall result** parameter (→ 23):
- Passed
  All the verification tests were successful.
- Not done
  A verification has not yet been performed on this measuring device.
- Failed
  One or more verification tests were not successful → 19.

- The overall result of the last verification can always be accessed in the menu.
- Navigation:
  Diagnostics → Heartbeat Technology → Verification results
- Detailed information on the verification result (test groups and test status) are shown in the verification report in addition to the overall result → 34.
- If the device does not pass the verification, the results are saved nonetheless and indicated in the verification report.
- This facilitates a targeted search for the cause of the fault → 19.

"Performing verification" submenu

Navigation
"Diagnostics" menu → Heartbeat Technology → Performing verification



Parameter overview with brief description

Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
Year	Can be edited if Heartbeat Verification 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 Heartbeat Verification 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 Heartbeat Verification 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 Heartbeat Verification 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 Heartbeat Verification is not active. The **dd.mm.yy hh:mm am/pm** option or the **mm/dd/yy hh:mm am/pm** option is selected in the **Date/ time format** parameter (2812).	Entry for date and time (field 5): enter the morning or afternoon.	▪ AM ▪ PM	AM
Minute	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 6): enter the minute verification is performed.	0 to 59 min	0 min
Verification mode	Can be edited if Heartbeat Verification is not active.	Select the verification mode. Extended verification Standard verification is extended by the additional entry of external measured variables: **Measured values** parameter.	Extended verification	Standard verification
External device information	With the following conditions: ▪ The **Extended verification** option is selected in the **Verification mode** parameter. ▪ Can be edited if the verification status is not active.	Record measuring equipment for extended verification.	Free text entry	–
External reference voltage 1	–	Use this function to enter the reference voltage. The external reference voltage can be measured at the GND and REF terminals.	Signed floating-point number	2.5 V

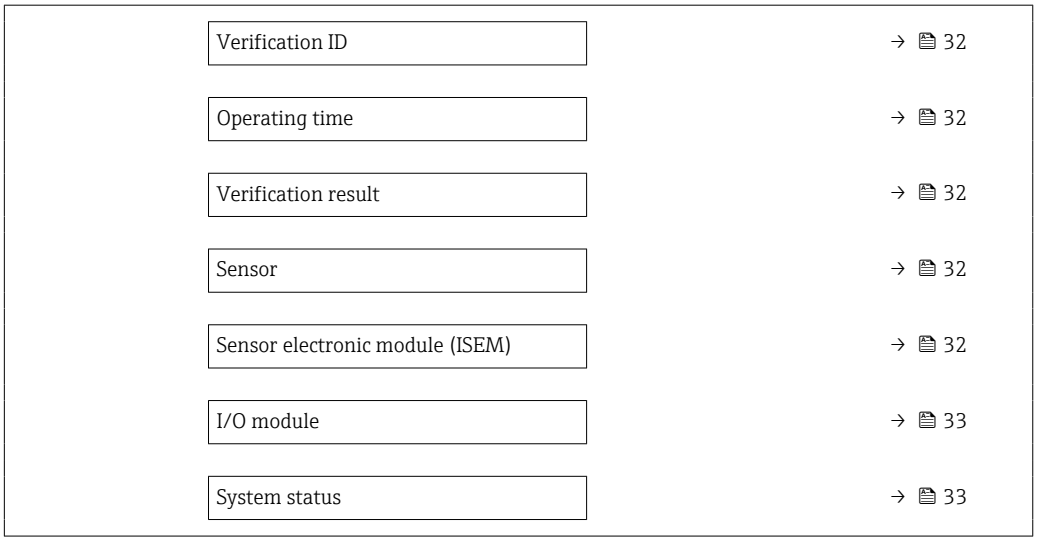
Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
Start verification	–	Start the verification. To carry out a complete verification, select the selection parameters individually. Once the external measured values have been recorded, verification is started using the **Start** option.	▪ Cancel ▪ Start ▪ Start with testkit * ▪ Output 1 low value * ▪ Output 1 high value * ▪ Frequency output 1 * ▪ Pulse output 1 * ▪ Frequency output 2 * ▪ Pulse output 2 *	Cancel
Progress	–	Shows the progress of the process.	0 to 100 %	0 %
Measured values	In the **Start verification** parameter (→ 🖹 23), one of the following options is selected: ▪ Output 1 low value ▪ Output 1 high value ▪ Output 2 low value ▪ Output 2 high value ▪ Frequency output 1 ▪ Pulse output 1 ▪ Frequency output 2 ▪ Pulse output 2	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. Pulse/frequency output: Output frequency in [Hz].	Signed floating-point number	0
Status	–	Displays the current status of the verification.	▪ Done ▪ Busy ▪ Failed ▪ Not done	Done
Verification result	–	Displays the overall result of the verification. Detailed description of results classification:	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done

* Visibility depends on order options or device settings

5.3.4 Verification results

Access to the verification results:
In the operating menu via the local display, operating tool or Web browser
▪ Diagnostics → Heartbeat Technology → Verification results
▪ Expert → Diagnostics → Heartbeat Technology → Verification results

Navigation
"Diagnostics" menu → Heartbeat Technology → Verification results



Parameter overview with brief description

Parameter	Prerequisite	Description	User interface	Factory setting
Date/time (manually entered)	The verification has been performed.	Date and time.	dd.mmmm.yyyy; hh:mm	1 January 2010; 12:00
Verification ID	The verification has been performed.	Displays 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 up to the verification.	Days (d), hours (h), minutes (m), seconds (s)	–
Verification result	–	Displays the overall result of the verification. Detailed description of results classification:	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done
Sensor	The **Failed** option result is shown in the **Overall result** parameter.	Displays the result for the sensor. Detailed description of results classification:	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done
Sensor electronic module (ISEM)	The **Failed** option result is shown in the **Overall result** parameter.	Displays the result for the sensor electronics module (ISEM). Detailed description of results classification:	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done

Parameter	Prerequisite	Description	User interface	Factory setting
I/O module	The **Failed** option result is shown in the **Overall result** parameter.	Displays the result for I/O module monitoring of the I/O module. ▪ For pulse output: Accuracy of the pulses (for external verification only) ▪ For frequency output: Accuracy of the frequency (for external verification only) Detailed description of results classification:	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done
System status	The **Failed** option result is shown in the **Overall result** parameter.	Displays the system condition. Tests the measuring device for active errors. Detailed description of results classification:	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done

Classification of results

Individual results

Result	Description
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".
Not done	No test has been performed for this test group. For example, because this parameter is not available in the current device configuration.

Overall results

Result	Description
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".
Not done	No verification was performed for any of the test groups (result for all test groups is "Check not done").

Heartbeat Verification confirms the device function within the specified measuring tolerance on demand. 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 ISO 9001: 2015 Chapter 7.1.5.2 a).

Test groups

Test group	Description
Sensor	Electrical components of the sensor (signals, circuits and cables)
Sensor electronics module (ISEM)	Electronics module for control and conversion of the sensor signals

Test group	Description
I/O module	Results of the input and output modules installed on the measuring device
System condition	Test for active measuring device errors of "alarm"-type diagnostic behavior

Test groups and individual tests → 34.

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 to 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 the detailed verification resultswhich can be accessed with the Flow Verification DTM.

Limit values

I/O module

Input; Output	Internal verification	External verification
Current output 4 to 20 mA	▪ ±1 % ▪ ±100 µA (offset)	▪ Lower value 4mA: ±1 % ▪ Upper value 20mA: ±0.5 %
Pulse/frequency/switch output	±0.05 %, with a 120 s cycle	▪ Pulse: ±0.3 % ▪ Frequency:±0.3 %

5.3.5 Detailed verification results

The process conditions at the time of verification and the individual test group results can be accessed with the Flow Verification DTM.

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

Process conditions

To increase the comparability of the results, the process conditions that apply at the time of verification are recorded and documented as process conditions on the last page of the verification report.

Process conditions	Description
Volume flow	Current measured value for volume flow
Mass flow	Current measured value for mass flow
Flow velocity	Current measured value for flow velocity
Speed of sound	Current measured value for sound velocity
Signal strength	Current measured value for signal strength
Signal to noise ratio	Current measured value for signal to noise ratio
Acceptance rate	Current measured value for acceptance rate
Turbulence	Current measured value for turbulence
Electronics temperature	Current measured value for the electronic temperature in the transmitter

The process conditions are not shown if a test kit is used.

Individual test group results

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

Sensor

Parameter/individual test	Description	Result/limit value	Interpretation/cause/corrective measures; service ID
Sensor connection and converter resonance	Monitoring of electrical connection between amplifier and converter.	▪ Fail ▪ Pass ▪ Check not done	If the result is "Failed", check the connection between the transmitter and sensors. 882, 887
Signal quality	Monitoring of signal strength and signal to noise ratio.	▪ Fail ▪ Pass ▪ Check not done	If the result is "Failed", check the measuring point configuration, sensor coupling, process conditions (solids contents, gas bubbles etc.).
Test Testkit71097625 [1] (only for the extended verification)	Checking of the runtime and signal strength of the test kit arrangement. Checking of the sensors independently of the process.	▪ Fail ▪ Pass ▪ Check not done	If the result is "Failed", check the connection of the sensors and then repeat the verification. Replace the sensors if all of the verification results of the sensor electronics module (ISEM) are passed.

1) (test block set for Prosonic Flow DN15 to 65) and 71528425 (test block set for Prosonic Flow DN50 to 4000)

Sensor electronics module (ISEM)

Parameter/individual test	Description	Result/limit value	Interpretation/cause/corrective measures; service ID
Reference clock	Monitoring of the reference clock in the measuring device circuit.	▪ Fail ▪ Pass ▪ Check not done	212
Transmission circuit	Monitoring of the transmission voltage and multiplexer.	▪ Fail ▪ Pass ▪ Check not done	607, 921, 609, 608
Amplifier circuit	Monitoring of the noise and the amplifier deviation.	▪ Fail ▪ Pass ▪ Check not done	610, 611, 798, 799, 800, 801, 810, 811, 812
Measuring circuit	Measurement of the transit time of a test signal. Two or more different transit time values are tested.	▪ Fail ▪ Pass ▪ Check not done	612

System condition

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
System condition	System condition monitoring	No value range ▪ Passed ▪ Failed ▪ Not done	**Causes** System error during verification **Corrective action** ▶ Check diagnostic event in the **Event logbook** submenu.

Input/Output

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Current output (4-20mA) standard 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: ±300 µA	▪ Check the current loop for an open circuit. ▪ Check the current loop for high impedance (e.g. as a result of contact corrosion).
Current output (4-20mA), extended 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: ±300 µA ▪ High value 20 mA: ±300 µA	▪ Record measured values again and enter. ▪ Check whether the output is outside the specifications. ▪ Replace the I/O module.
Pulses, extended 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 Impulse	Perform manual function test while verification is active.
Frequency, extended 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	Perform manual function test while verification is active.

I/O modules

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Output 1 to n	Check of all the input and output modules installed at the measuring device → 🖹 18	No value range ▪ Passed ▪ Failed ▪ Not done Limit values → 🖹 34	**Causes** ▪ Output values out of specification ▪ I/O modules defective **Measures** ▶ Check cabling. ▶ Check connections. ▶ Check load (current output). ▶ Replace the I/O module.

5.3.6 Verification report

The verification results can be documented via the web server or FieldCare operating tool in the form of a verification report → 🖹 11. The verification report is created on the basis of the data records saved in the measuring device after verification. As the verification results are automatically and uniquely identified with a verification ID and the operating time, they are suitable for the traceable documentation of the verification of flowmeters.

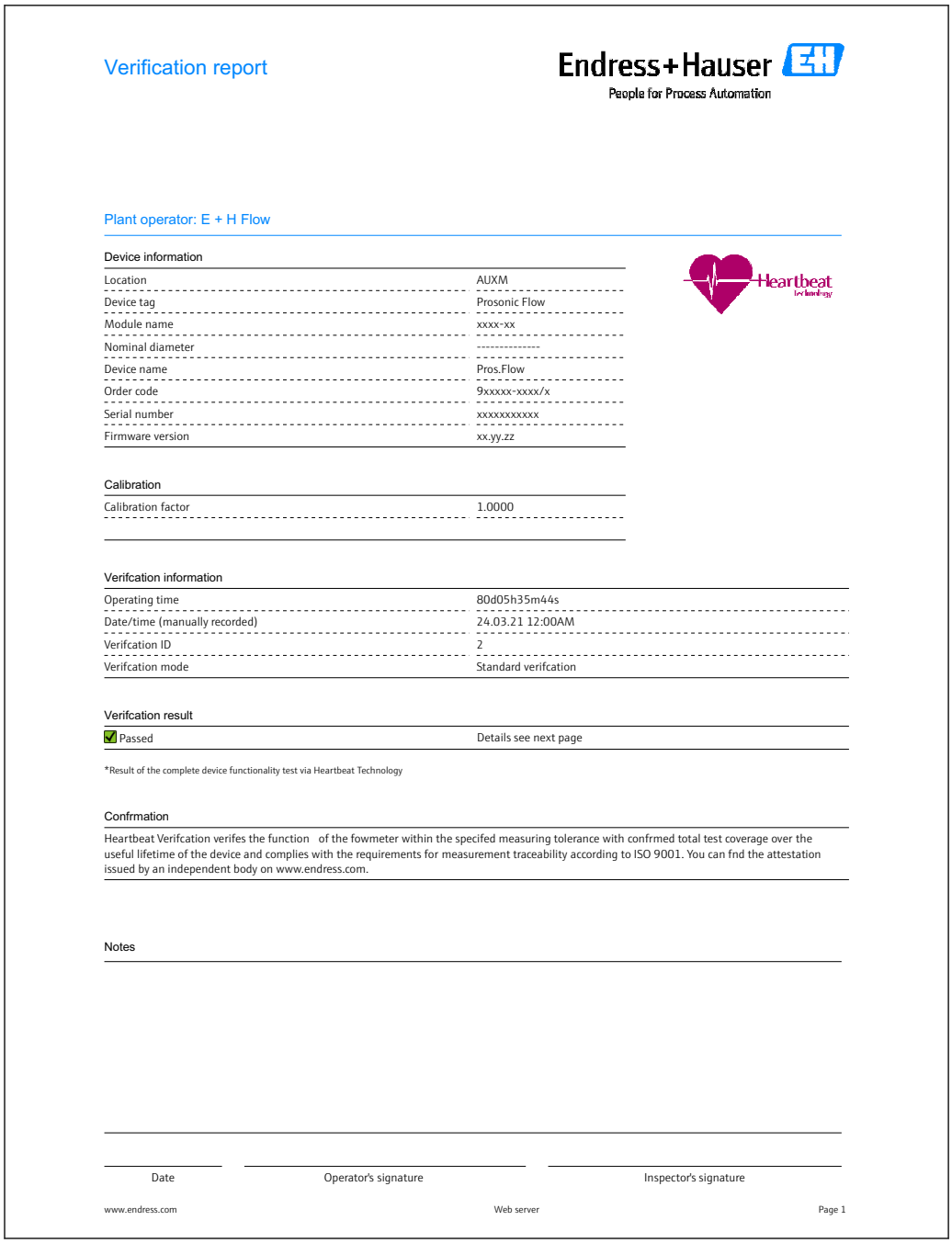
First page: identification → 36
Measuring point identification, identification of the verification results and confirmation of completion:
- System operator
  Customer reference
- Device information
  - Information on the place of operation (tag) and the current configuration of the measuring point
  - Management of the information in the device
  - Display on the verification report
- Calibration
  Information on the calibration factor for the sensor
- Verification information
  - The operating time and verification ID are used to uniquely assign the verification results for the traceable documentation of the verification
  - Storage and display of the manual date and time entry as well as the current operating time in the device
  - Verification mode: standard verification or extended verification
- Overall verification result
  Overall result of the verification passed if all of the individual results are passed

Second page: test results → 36
Details on the individual results for all test groups:
- System operator
- Test groups → 34
  - Sensor
  - Sensor electronics module (ISEM)
  - System condition
  - I/O module

Third page (and subsequent pages, if applicable): measured values and visualization → 36
Numerical values and graphic presentation of all the values recorded:
- System operator
- Test object
- Unit
- Current: measured value
- Min.: lower limit
- Max.: upper limit
- Visualization: graphic presentation of the measured value, within the lower and upper limits.

Last page: process conditions
Information on the process conditions that applied during the verification:
- Volume flow
- Mass flow
- Flow velocity
- Speed of sound
- Signal strength
- Signal to noise ratio
- Acceptance rate
- Turbulence
- Electronics temperature

As a prerequisite for the validity of the verification report, the **Heartbeat Verification** feature 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

Plant operator: E + H Flow

Device information

Location	AUXM
Device tag	Prosonic Flow
Module name	xxxx-xx
Nominal diameter	----------
Device name	Pros.Flow
Order code	9xxxxx-xxxx/x
Serial number	xxxxxxxxxx
Firmware version	xx.yy.zz

Calibration

Calibration factor	1.0000

Verifcation information

Operating time	80d05h35m44s
Date/time (manually recorded)	24.03.21 12:00AM
Verifcation ID	2
Verifcation mode	Standard verifcation

Verifcation result

☑ Passed	Details see next page

*Result of the complete device functionality test via Heartbeat Technology

Confrmation

Heartbeat Verifcation verifes the function of the fowmeter within the specifed measuring tolerance with confrmed total test coverage over the useful lifetime of the device and complies with the requirements for measurement traceability according to ISO 9001. You can fnd the attestation issued by an independent body on www.endress.com.

Notes

Date | Operator's signature | Inspector's signature

www.endress.com Web server Page 1

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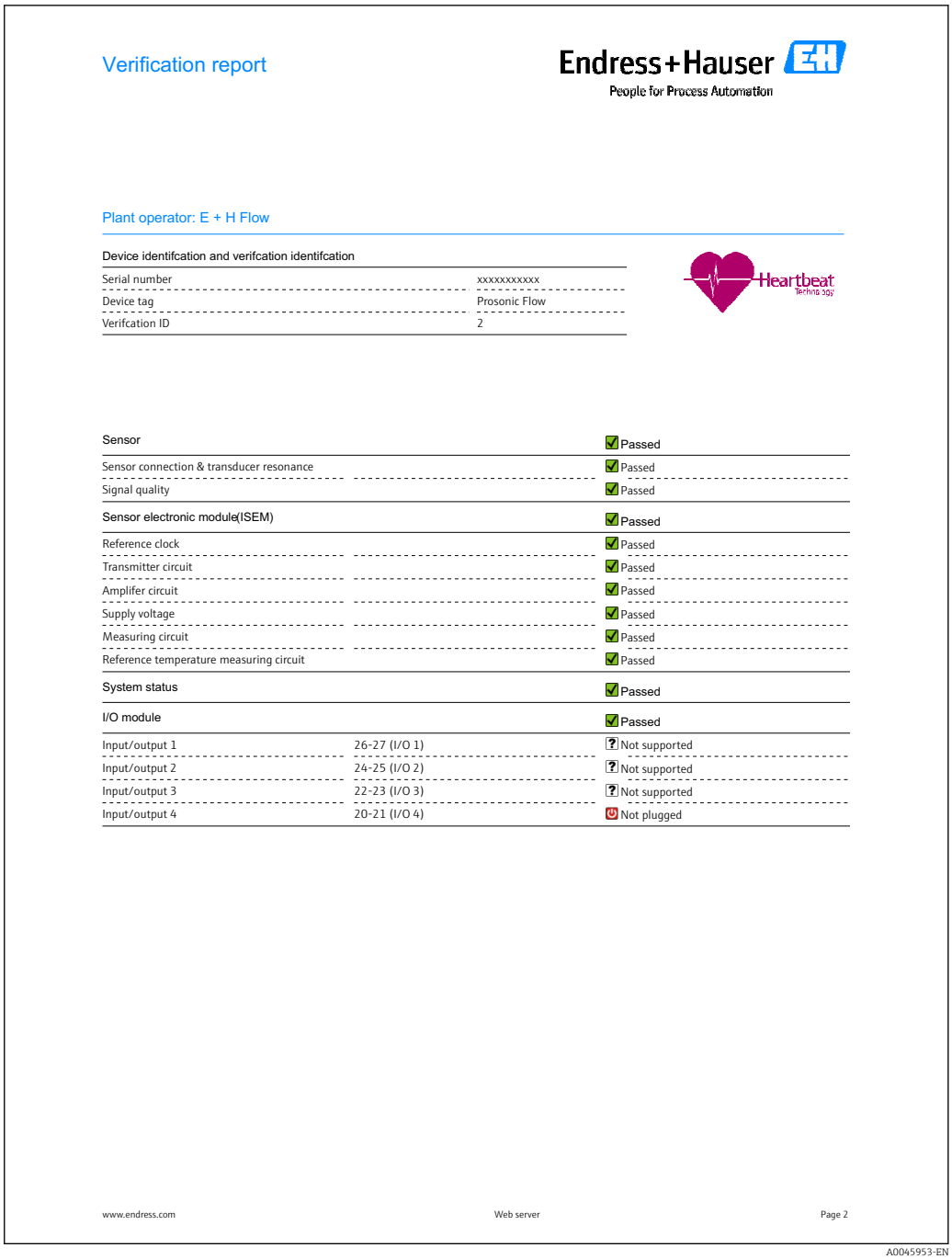
13 Example of a verification report (Page 1: identification → 37)

Individual test groups and description of individual tests: → 34



Verification report

Endress+Hauser
People for Process Automation

Plant operator: E + H Flow

Device identifcation and verifcation identifcation	
Serial number	xxxxxxxxxx
Device tag	Prosonic Flow
Verifcation ID	2

Heartbeat Technology

Sensor		✓ Passed
Sensor connection & transducer resonance		✓ Passed
Signal quality		✓ Passed
Sensor electronic module(ISEM)		✓ Passed
Reference clock		✓ Passed
Transmitter circuit		✓ Passed
Amplifer circuit		✓ Passed
Supply voltage		✓ Passed
Measuring circuit		✓ Passed
Reference temperature measuring circuit		✓ Passed
System status		✓ Passed
I/O module		✓ Passed
Input/output 1	26-27 (I/O 1)	? Not supported
Input/output 2	24-25 (I/O 2)	? Not supported
Input/output 3	22-23 (I/O 3)	? Not supported
Input/output 4	20-21 (I/O 4)	⏻ Not plugged

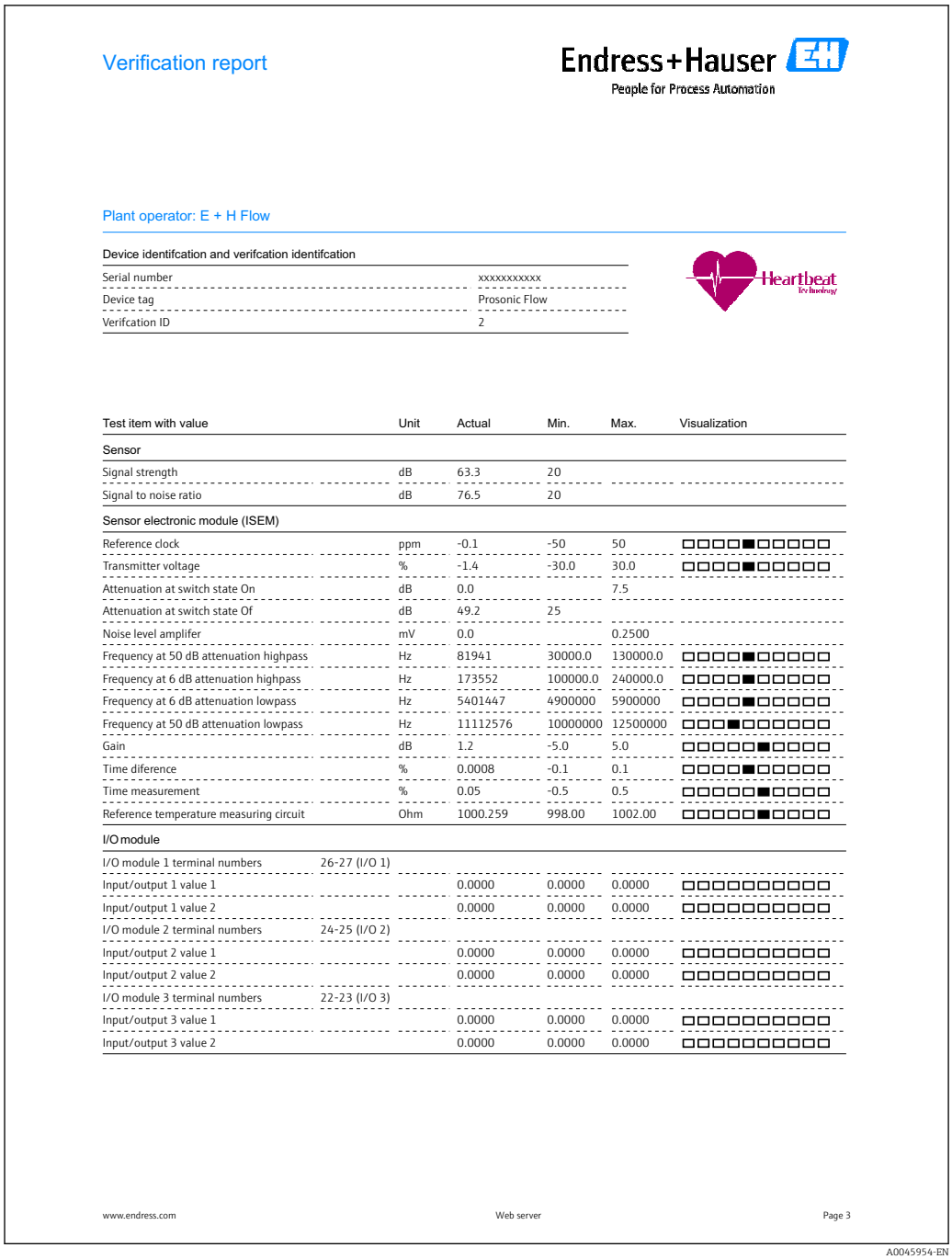
www.endress.com Web server Page 2

A0045953-EN

14 *Example of a verification report (Page 2: test results → 37)*

Comments from the person carrying out the verification appear in the "Information about the Extended Verification" field. It is also recommended for information on the type and serial number of the external testing device used to carry out the extended verification.

Data administration with Web server and FieldCare (Flow Verification DTM): → 11



Verification report

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People for Process Automation

Plant operator: E + H Flow

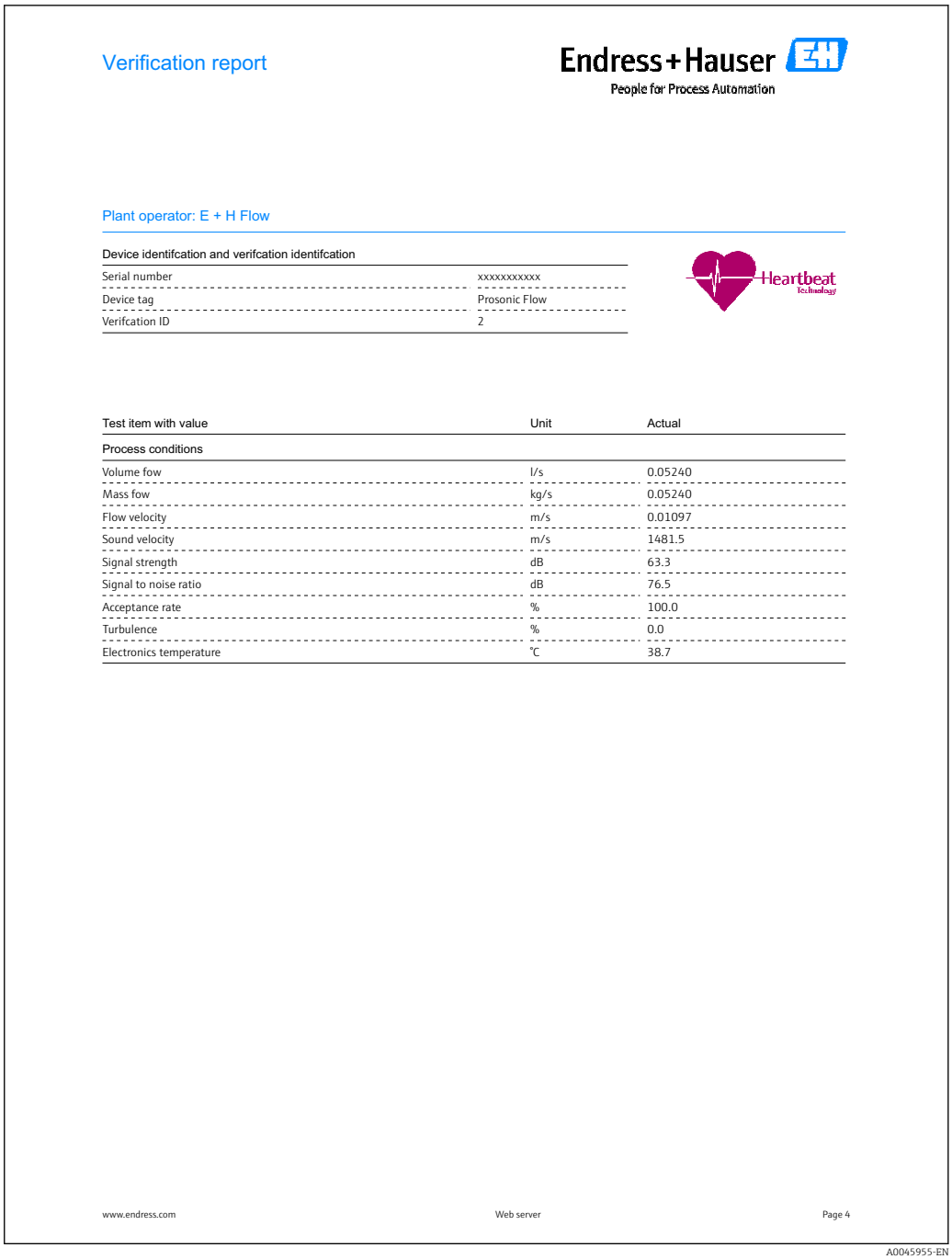
Device identifcation and verifcation identifcation

Serial number	xxxxxxxxxx
Device tag	Prosonic Flow
Verifcation ID	2

Heartbeat Technology

Test item with value		Unit	Actual	Min.	Max.	Visualization
Sensor						
Signal strength		dB	63.3	20		
Signal to noise ratio		dB	76.5	20		
Sensor electronic module (ISEM)						
Reference clock		ppm	-0.1	-50	50	
Transmitter voltage		%	-1.4	-30.0	30.0	
Attenuation at switch state On		dB	0.0		7.5	
Attenuation at switch state Of		dB	49.2	25		
Noise level amplifer		mV	0.0		0.2500	
Frequency at 50 dB attenuation highpass		Hz	81941	30000.0	130000.0	
Frequency at 6 dB attenuation highpass		Hz	173552	100000.0	240000.0	
Frequency at 6 dB attenuation lowpass		Hz	5401447	4900000	5900000	
Frequency at 50 dB attenuation lowpass		Hz	11112576	10000000	12500000	
Gain		dB	1.2	-5.0	5.0	
Time diference		%	0.0008	-0.1	0.1	
Time measurement		%	0.05	-0.5	0.5	
Reference temperature measuring circuit		Ohm	1000.259	998.00	1002.00	
I/O module						
I/O module 1 terminal numbers	26-27 (I/O 1)					
Input/output 1 value 1			0.0000	0.0000	0.0000	
Input/output 1 value 2			0.0000	0.0000	0.0000	
I/O module 2 terminal numbers	24-25 (I/O 2)					
Input/output 2 value 1			0.0000	0.0000	0.0000	
Input/output 2 value 2			0.0000	0.0000	0.0000	
I/O module 3 terminal numbers	22-23 (I/O 3)					
Input/output 3 value 1			0.0000	0.0000	0.0000	
Input/output 3 value 2			0.0000	0.0000	0.0000	

15 Example of a verification report (Page 3: measured values and visualization → 37)



Verification report

Endress+Hauser
People for Process Automation

Plant operator: E + H Flow

Device identifcation and verifcation identifcation	
Serial number	xxxxxxxxxx
Device tag	Prosonic Flow
Verifcation ID	2

Heartbeat technology

Test item with value	Unit	Actual
Process conditions		
Volume fow	l/s	0.05240
Mass fow	kg/s	0.05240
Flow velocity	m/s	0.01097
Sound velocity	m/s	1481.5
Signal strength	dB	63.3
Signal to noise ratio	dB	76.5
Acceptance rate	%	100.0
Turbulence	%	0.0
Electronics temperature	°C	38.7

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16 *Example of a verification report (Page 4: measured values and visualization → 37)*

5.3.7 Interpreting and using the verification results

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 electronics 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.

Here, the function checks device-internal parameters that are correlated with flow measurement (secondary measured variables, comparative values).

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

- Confirmation of compliance with the flow specification with 100 % test coverage can only be obtained by verifying the primary measured variable (flow) by means of calibration or proving.
- **Heartbeat Verification** confirms the device function within the specified measuring tolerance on demand.

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 the verification.

This applies in particular if the individual tests of the **Sensor** test group are concerned, as a process-related influence is then possible.

Ideally, ensure defined and stable process conditions in order to rule out process-specific influences as much as possible. When repeating the verification, it is advisable to compare the current process conditions to those of the previous verification in order to identify any deviations.

- The process conditions of the previous verification are documented on the last page of the verification report or can be accessed using the Flow Verification DTM → 34.
- The process conditions are not shown if a test kit is used.

Additional remedial measures if the result of a 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.

Detailed information on diagnostics and troubleshooting and on diagnostic information and associated troubleshooting measures can be found in the Operating Instructions → 6.

6 Heartbeat Monitoring

With Heartbeat Monitoring, additional measured values are output continuously and monitored in an external Condition Monitoring system so that changes to the measuring device and in the process can be detected at an early stage. The measured variables can be interpreted in a Condition Monitoring system. The information obtained in this way helps users to control measures concerning maintenance or process optimization. Possible applications of Condition Monitoring include the detection of the formation of build-up or wear as a result of corrosion.

6.1 Commissioning

Assign the diagnostic parameters to the outputs for commissioning. After commissioning, the parameters are available at the outputs and in case of digital communication they are generally continuously available.

Enabling or disabling Heartbeat Monitoring
The output of the diagnostic parameters is switched on or off in the operating menu:
→ 📄 44

6.1.1 Description of the monitoring measured variables/parameters

The following diagnostic parameters can be assigned to the various outputs of the measuring device for continuous transmission to a condition monitoring system.

Some measured variables are only available if the **Heartbeat Verification + Monitoring** application package is enabled in the measuring device.

Measured variable	Description	Range of values
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 100 dB
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...100%
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
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%

6.1.2 Configuration of the outputs and local display

With the application package "Heartbeat Verification + Monitoring", the user has additional monitoring parameters available → 📄 43 . The following examples illustrate how a monitoring measured variable is assigned to a current output or is shown on the local display.

Example: Configuring the current output

Select the monitoring measured variable for current output

1. Prerequisite:
   Setup → I/O configuration
   ↳ Configurable I/O module displays the **I/O module type** parameter with **Current output** option
2. Setup → Current output
3. Select the monitoring measured variable for the current output in the **Assign current output** parameter

Navigation
"Setup" menu → Current output → Assign current output

Example: Configuring the local display

Select the measured value that is shown on the local display

1. Setup → Display → Value 1 display
2. Select the measured value.

6.2 Operation

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 or performed (good knowledge of the application is required). The elimination of process effects that cause misleading warnings or interpretation must also be ensured. For this reason it is important to compare the recorded data against a process reference.

With Heartbeat Monitoring it is possible to output additional monitoring-specific measured values for monitoring in an external Condition Monitoring system during continuous operation.

Condition Monitoring focuses on measured variables that indicate a change in the performance of the device brought about by process-specific influences. There are two difference categories of process-specific influences:
- Temporary 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 device but do impact measuring performance temporarily.
- Process-specific influences that only impact the integrity of the sensor over the medium term but that also bring about a gradual change in the measuring performance (e.g. abrasion, corrosion or buildup in the measuring pipe). These influences also affect the integrity of the device on the long term.

Devices with **Heartbeat Monitoring** offer a range of parameters that are particularly suitable for monitoring specific, application-related influences:
- Buildup in the measuring pipe
- Multi-phase fluids (gas content and solids in liquid fluids)
- Special application scenarios must be established together with the client both for indication and for quantification purposes.
- The results of condition monitoring must always be interpreted in the context of the application.

6.2.1 Overview of the monitoring parameters

This section describes the interpretation of certain monitoring parameters in connection with the process and the application.

Monitoring parameter	Possible reasons for deviation
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 ▪ Buildup in the measuring pipe ▪ Particles in the flow ▪ A damaged or defective transducer
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, solids/gas bubbles in the medium or a poor signal to noise ratio can be other reasons for a reduced acceptance rate.
Signal to noise ratio	A signal to noise ratio that is too low usually results in a decreasing acceptance rate, increasing turbulence and increased measurement accuracy. 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. a particle in the medium or buildup in the measuring pipe.
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.

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