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Valid as of version
01.00.zz (Device firmware)

Special Documentation
Proline Prosonic Flow 100 HART

Heartbeat Verification + Monitoring application package

Endress+Hauser
People for Process Automation

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1 Manufacturer's Declaration

Products Solutions Services

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Manufacturer Declaration

Endress+Hauser Flowtec AG, Kägenstrasse 7, 4153 Reinach

Declares as a manufacturer that the flow meters of the product lines

Proline Prosonic Flow E 100 (9E1B)

with the application package Heartbeat Technology complies with the following requirements:

Heartbeat Technology™ 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 Technology*™ includes Heartbeat Diagnostics and Heartbeat Verification.

Referenced documents:
IEC 61508-2:2010 Appendix C
IEC 61508-3:2010 Section 6
ISO 9001:2008, Section 7.6 a), Control of monitoring and measuring equipment

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

Heartbeat Technology™ complies with the requirements for traceable verification according to ISO 9001:2008 – Section 7.6 a) "Control of monitoring and measuring equipment". In accordance with this standard, the user is responsible for providing a definition of the verification interval that satisfies the particular requirements.

Reinach, October 12th, 2017

Endress+Hauser Flowtec AG

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Head of Division Quality Management

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Endress+Hauser
People for Process Automation

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2 About this document

2.1 Document function

This manual is Special Documentation; it does not replace the Operating Instructions pertaining to the device. It serves as a reference for using the Heartbeat Technology function integrated in the measuring device.

2.2 Content and scope

This documentation contains a description of the additional parameters and technical data that are provided with the **Heartbeat Verification + Monitoring** application package.

It provides detailed information on:
- Application-specific parameters
- Advanced technical specifications

2.3 Symbols used

2.3.1 Safety symbols

Symbol	Meaning
DANGER	**DANGER!** This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.
WARNING	**WARNING!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in serious or fatal injury.
CAUTION	**CAUTION!** This symbol alerts you to a dangerous situation. Failure to avoid this situation can result in minor or medium injury.
NOTICE	**NOTE!** 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
	**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
	Result of a step
	Operation via local display

Symbol	Meaning
	Operation via operating tool
	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:
- The *W@M Device Viewer* : Enter the serial number from the nameplate (www.endress.com/deviceviewer)
- The *Endress+Hauser Operations App*: Enter the serial number from the nameplate or scan the 2-D matrix code (QR code) on the nameplate.

This documentation is not a substitute for the Operating Instructions supplied with the device.

The Operating Instructions and additional documentation contain all detailed information on the device:
- Internet: www.endress.com/deviceviewer
- Smart phone/tablet: *Endress+Hauser Operations App*

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

Measuring device	Documentation code
Prosonic Flow E 100	BA01769D

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

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 undetected dangerous 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 TTC is at least 95%.

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.

3.2 Availability

The **Heartbeat Verification + Monitoring** application package can be ordered directly with the device.

It is available subsequently via an activation code. Detailed information on the order code in question is available from your local Endress+Hauser sales center or on the product page of the Endress+Hauser website: www.endress.com.

The availability of the **Heartbeat Verification + Monitoring** application package with the **EB** option can be checked as follows:
- Order code with breakdown of the device features on the delivery note
- In the W@M Device Viewer (www.endress.com/deviceviewer)
  Enter the serial number from the nameplate and check in the device information whether the option **EB** "Heartbeat Verification + Monitoring" appears under the order code for "Application packages".
- In the operating menu:
  The software options currently enabled are displayed in the **Software option overview** parameter.
  Expert → System → Administration

3.2.1 Order code

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

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 access code that must be entered via the operating menu.

Setup → Advanced setup → Enter access code

- ▶ Enter the access code.
  - ↳ The application package is available.

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.

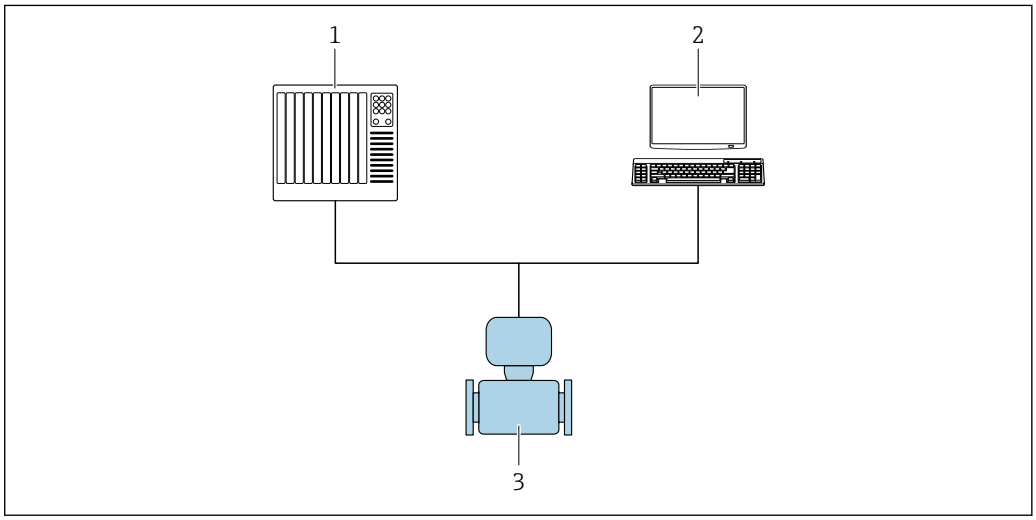
4 System integration

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

Heartbeat Verification is performed via the following interfaces:
- System integration interface of a higher-level system
- Service interface (CDI-RJ45)

To start a verification and signal the result (Passed or Failed) the device must be accessed externally 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.

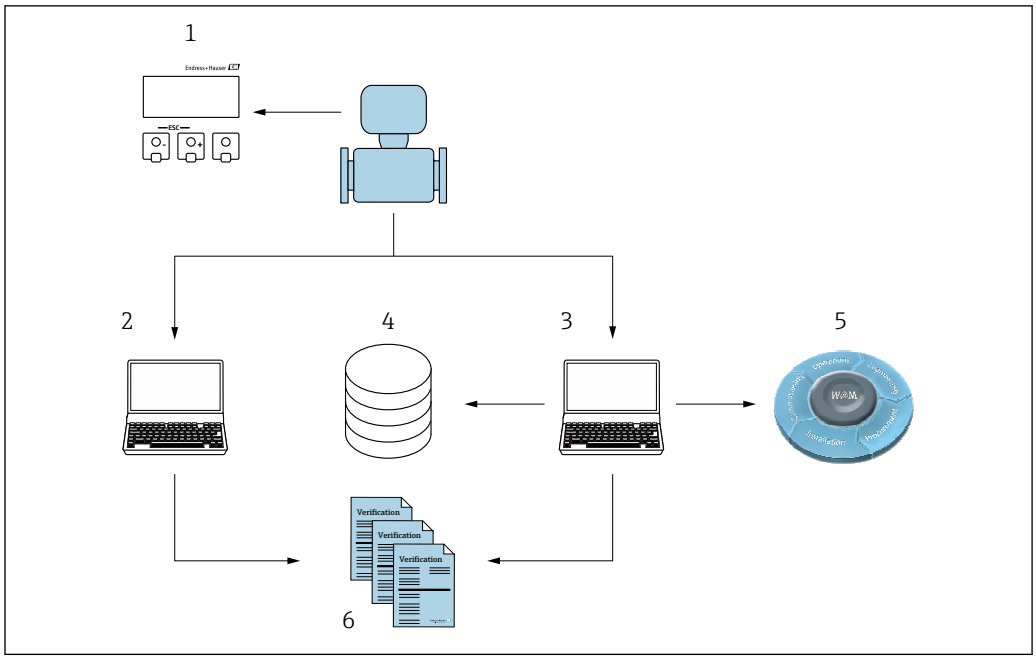
The detailed results of the verification (8 data records) are saved in the device. These results can be downloaded in the form of a verification report using the Web server integrated in the device.



1 PLC
2 Asset Management System
3 Measuring device

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

For more information on system integration, see the Operating Instructions → 6



1 *Local display*
2 *Web server*
3 *FieldCare*
4 *Data archive*
5 *W@M*
6 *Verification report*

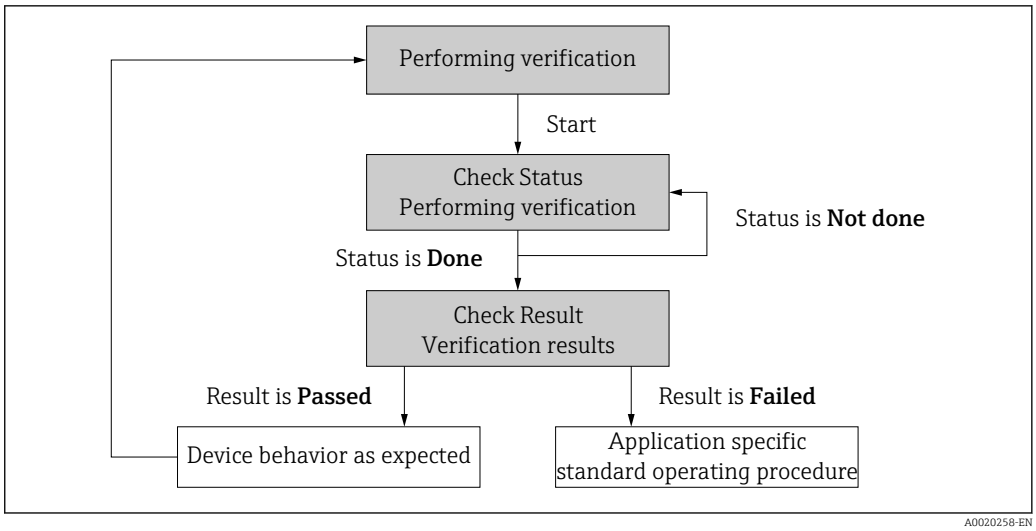
The creation of verification reports is supported by both the Web server integrated in the measuring device and by Endress+Hauser's FieldCare asset management software. With the Flow Verification DTM, FieldCare also offers the possibility of archiving the verification results to create traceable documentation.

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.

4.1 Automated data exchange

- Instrument check via self-monitoring
- Start the verification and read out the verification results

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



Performing a verification

- Start the verification via 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" alert is triggered if **Failed** is displayed as the result.

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

Heartbeat Monitoring
Monitoring configuration: Specify which monitoring parameters should be output continuously via the system integration interface.

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

4.3 Data management

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

The results can be documented in the form of a verification report via the Web server or Endress+Hauser's FieldCare asset management software.

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)

1) First In – First Out

4.3.1 Data management via Web browser

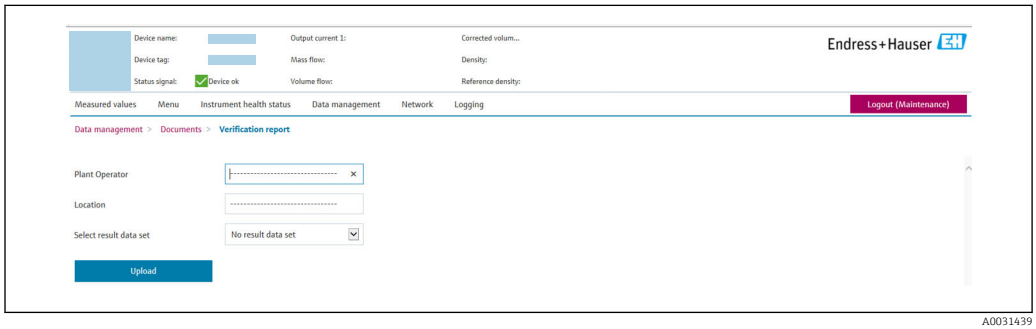
Thanks to the integrated Web server the device can be operated and configured via a Web browser. In addition, it is possible to query the results of the verification and create a verification report.

Print verification report

A verification report is created in PDF format.

Prerequisite: A verification has already been performed.

Web browser interface after login:



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1. In the menu, select the **Data Management**, **Documents** and **Verification Report** tabs one after the other.
   ↳ The Web browser opens the entry field for printing verification reports.
2. Enter the necessary information in the **Customer** and **Location** fields.
   ↳ The information entered here appears in the verification report.
3. In the **Sel. result set.** field (select result data set), select the desired data set with the verification results.
   ↳ The verification data sets are identified by the time stamp in the drop-down menu.
   If a verification has not been performed, the message "No result data set" is displayed here.
4. Click the **Upload** field.
   ↳ The Web server generates a verification report in PDF format.

4.3.2 Data management via Flow Verification DTM

A verification can be performed and a verification report printed via the DeviceDTM.

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

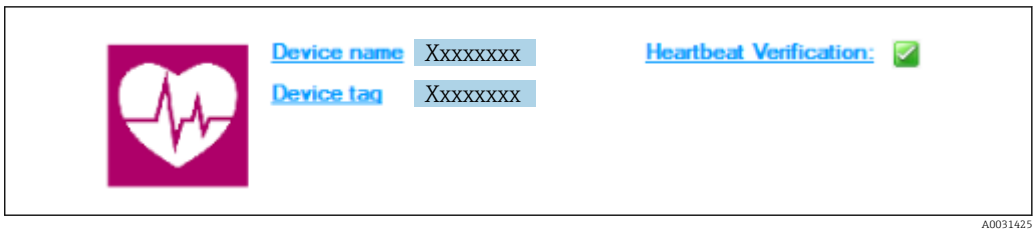
Basic functions

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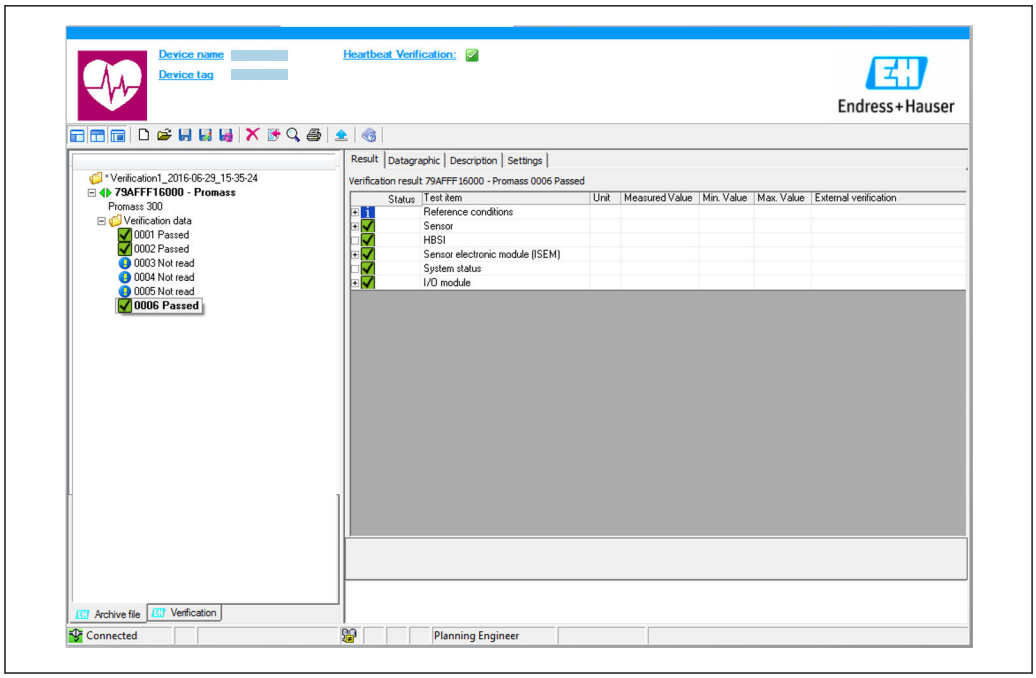
- Top display area of the DTM
- Contains the following information:
  - Measuring device
  - Device tag
- Indicates whether verification is active: ☑

Reading out data

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



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1 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.

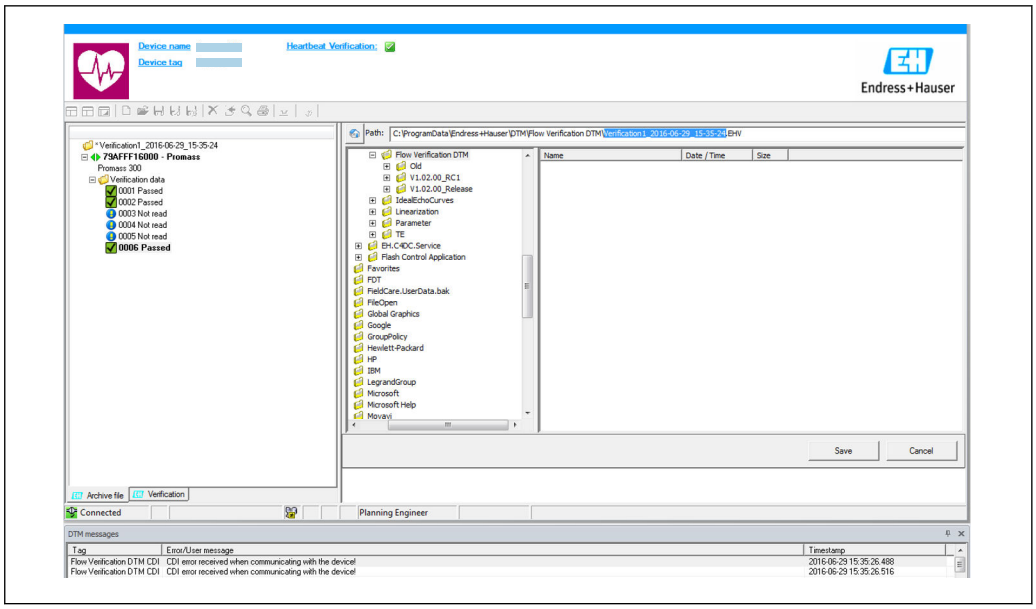
Verification results

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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2 *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 every 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

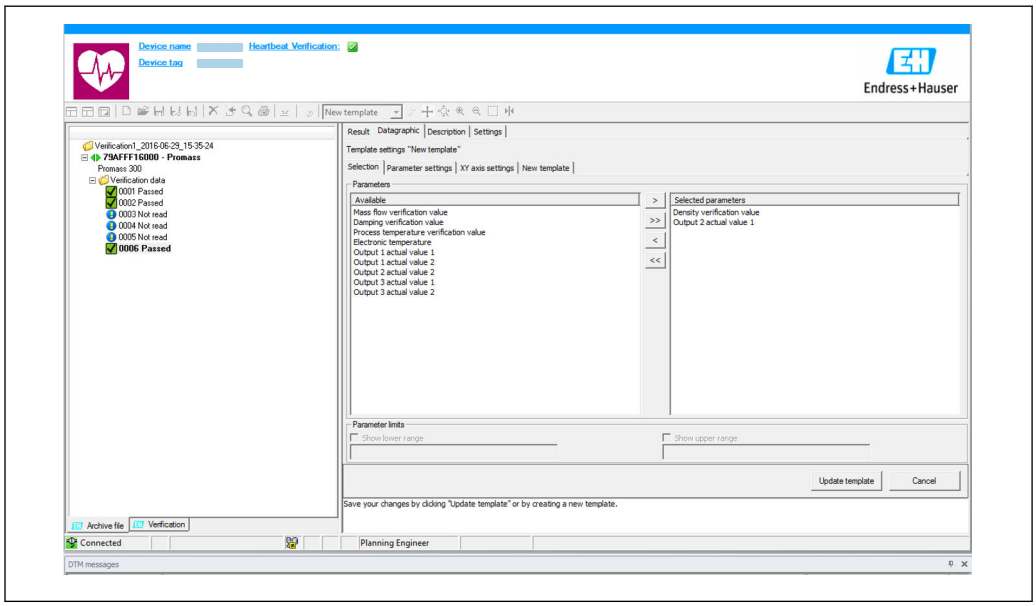
Open archive files already available.

- 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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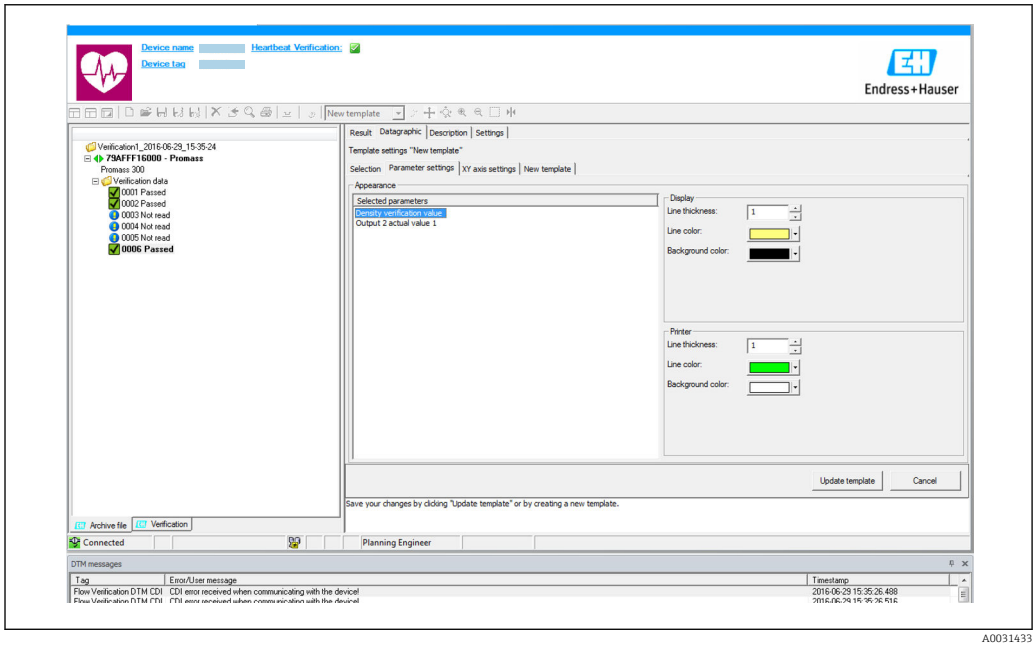
3 *Sample graphic*

► Select the measured variables using the list displayed.

Visualizing a graph



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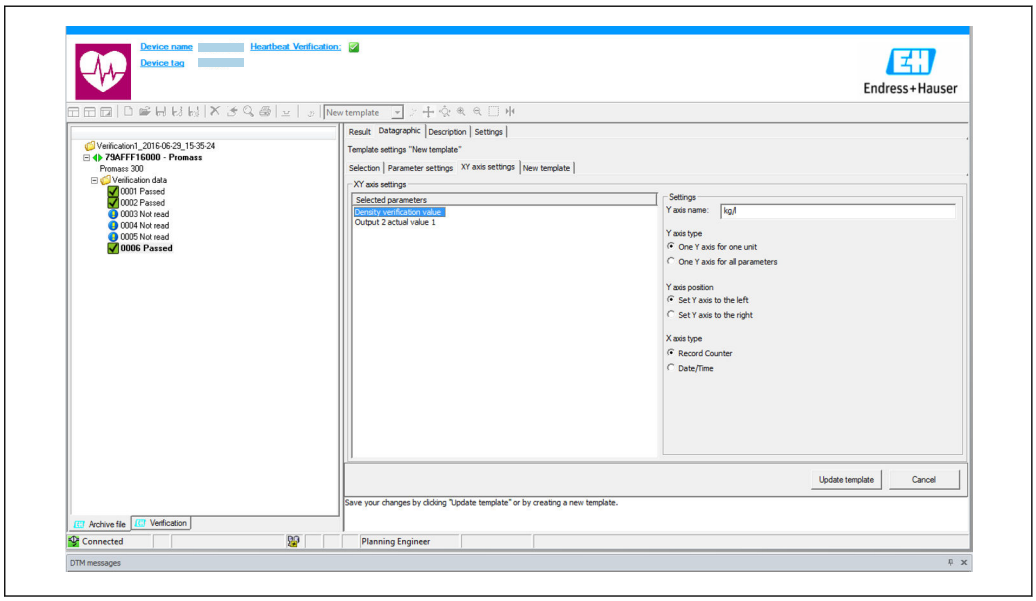
4 *Sample graphic*

► Assign properties for visualization of the graph.

Configuring the Y-axis



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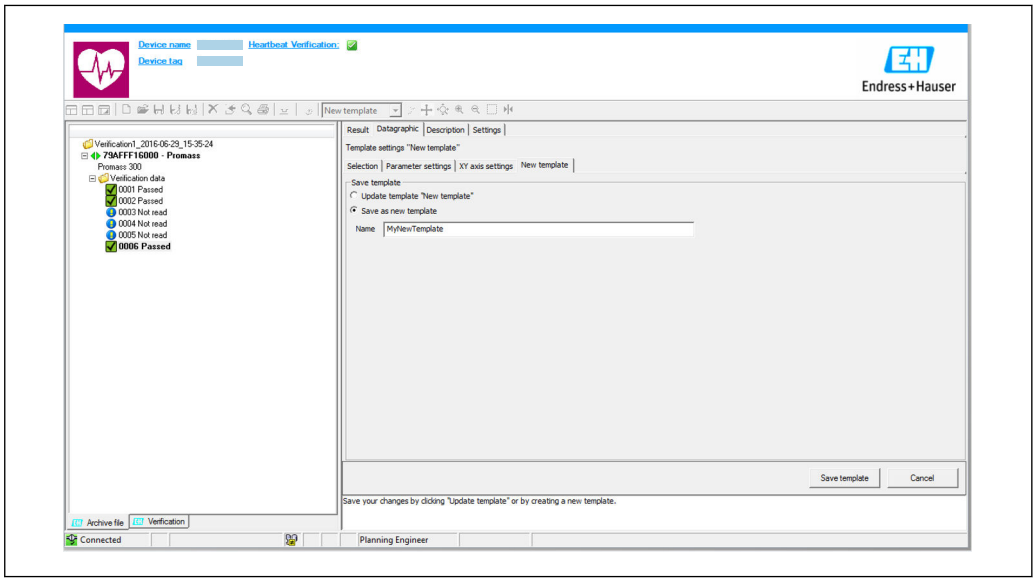
5 *Sample graphic*

- Assign the measured variables of the Y-axis.

Update template or create new template



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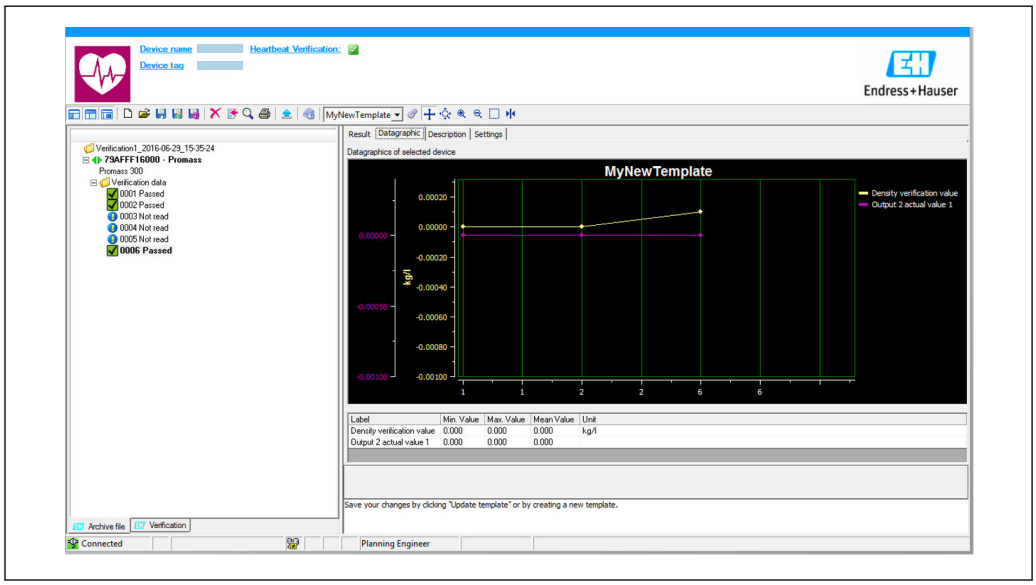
6 *Sample graphic*

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

Showing the visualization trend



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7 *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 functionality on demand and verifies whether the measuring device is working correctly and complying with specifications. The result of the verification is "pass" or "fail". 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.

Therefore Heartbeat Verification also supports the documentation of proof tests as per IEC 61511-1. For details, see the Functional Safety Manual.

Heartbeat Technology offers two ways to perform Heartbeat Verification:
- Internal verification → 🖹 21
  Verification is performed by the device without manual checking of external measured variables.
- External verification → 🖹 24
  Verification includes the entry of external measured variables.

5.1 Performance characteristics

Heartbeat Verification is performed on demand and complements the self-monitoring function, which is performed constantly, with other tests.

The internal verification checks the following inputs and outputs:
- 4-20 mA current output, passive
- Pulse/frequency output, passive
- 4-20 mA current input, passive
- 4-20 mA current output
- Pulse/frequency output

External verification supports verification of the following output modules:
- 4-20 mA current output, passive
- Pulse/frequency output, passive
- 4-20 mA current output
- Pulse/frequency output

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).

Confirmed by TÜV Industry Service: **Heartbeat Technology** meets the requirement for traceable verification according to DIN EN ISO 9001: 2008 Chapter 7.6 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 the initial situation in the measuring device life cycle.

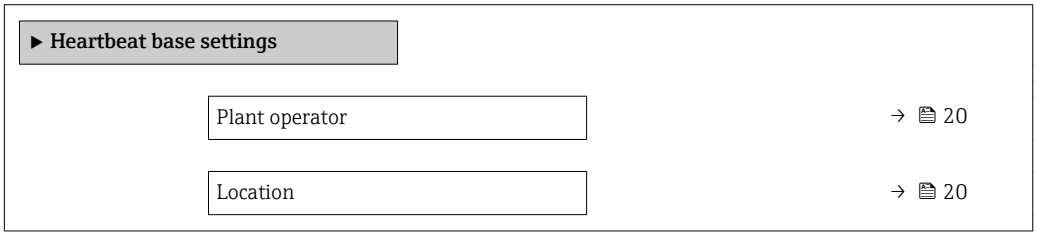
5.2.1 Recording reference data

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 → 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 Performing the verification

Initial verification

▶ When commissioning the measuring device:
Perform an initial verification to save the results as the initial situation in the measuring device life cycle.

Initial verification can be performed in 2 ways:
- Internal verification → 21
- External verification → 24

Start verification

Access to the verification parameters:
- Via the operating menu or Web browser:
  - Diagnostics → Heartbeat → Performing verification
  - Expert → Diagnostics → Heartbeat → Performing verification
- Via FieldCare (Flow Verification DTM):
  Heartbeat → Performing verification

▶ Open the **Performing verification** wizard (→ 22).

Measurement continues while the verification is being carried out. The signal outputs and totalizers are not affected.

Signs that external verification is being performed:
- Diagnostic message ⚠**C302 Device verification active**
- Status signal changes to **C** (function check)
- Diagnostic behavior **Warning** (factory setting)
  - The diagnostic behavior can be reconfigured by the user if necessary.
  - If the diagnostic behavior is **Alarm**: The output of measured values is interrupted and the signal outputs and totalizers adopt the defined alarm condition.

Device behavior and interpretation

Result Passed
- All test results are within the specifications.
- If the calibration factor and zero point match the factory settings, there is a high degree of certainty that the measuring device complies with the specification for flow.
- Verification generally delivers the result Passed in most applications.

Result Failed

One or more test results are outside the specifications.

1. Repeat verification.
   ↳ If the result of the second verification is Passed, the result of the first can be ignored.
2. In order to identify possible variations, compare the current process conditions with those of a previous verification.
3. Ensure defined and stable process conditions to rule out process-specific influences as much as possible.
4. Repeat verification.
5. If the verification repeatedly delivers a Failed result, take the following measures:
6. 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.
7. 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 if the test group that Failed the verification is identified.

5.3.2 Internal verification

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

Diagnostic behavior

A diagnostic event signals that internal verification is being performed:
- Event diagnostic message ⚠**C302 Device verification active**
- Factory setting: warning.
  - The device continues to measure.
  - A "last valid value" is displayed intermittently
  - The signal outputs and totalizers are not affected
- Test duration: approx. 30 seconds

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.

Performing internal verification

Before verification starts

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.

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 **Internal verification** option.

Start 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 internal verification is indicated in the **Status** parameter (→ 24):
- 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 precondition for performing the verification has not been met, the verification cannot start (e. g. due to unstable process parameters) → 21.

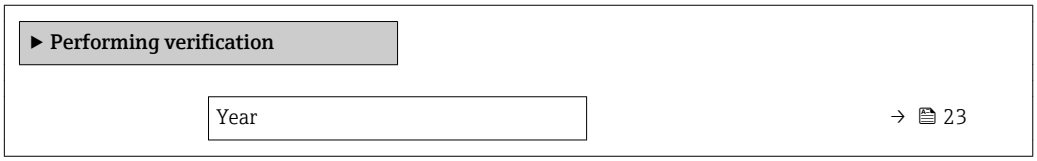
The result of the verification is displayed in the **Overall result** parameter (→ 24):
- Passed
  All the verification tests were successful.
- Not done
  A verification has not yet been performed on this measuring device.
- Failed
  One or more verification tests were not successful → 21.

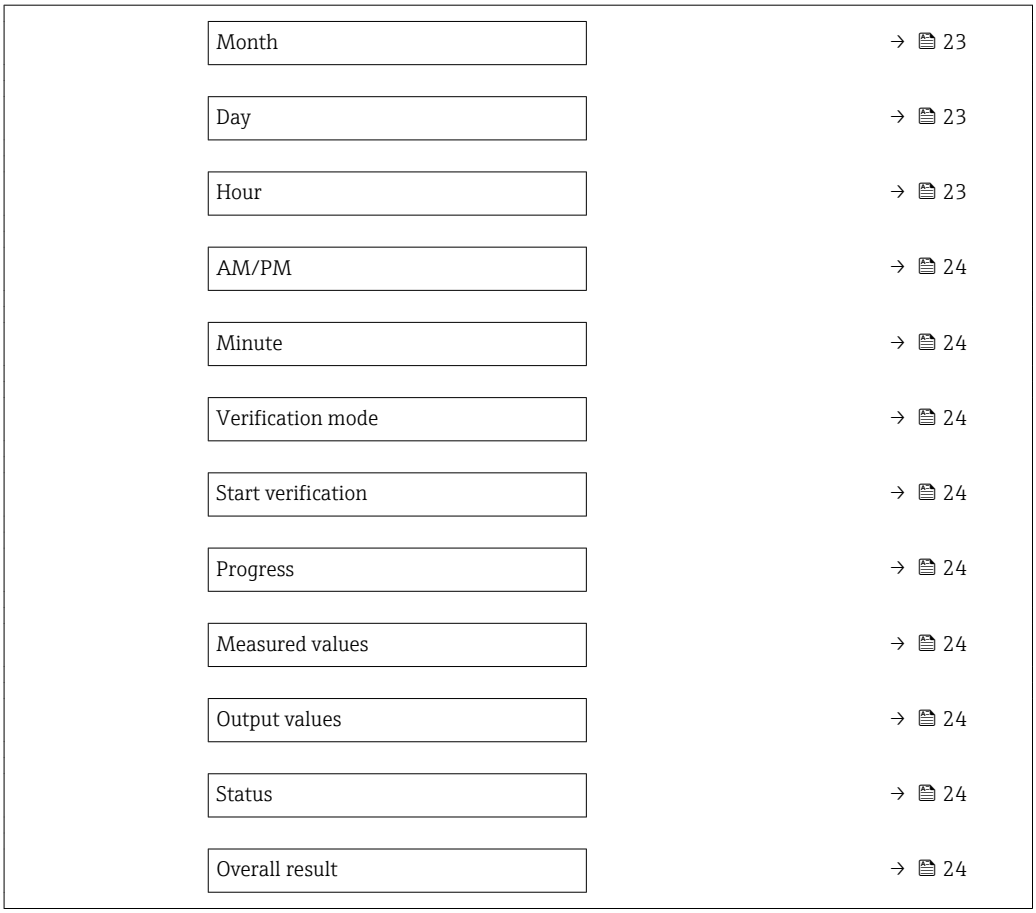
- The overall result of the last verification can always be accessed in the menu.
- Navigation:
  Diagnostics → Heartbeat → Verification results
- Detailed information on the result of the verification (test groups and test status) is also provided in the verification report in addition to the overall result .
- If the device does not pass the verification, the results are saved nonetheless and indicated in the verification report.
- This helps users to perform a targeted search for the cause of the error → 21.

"Performing verification" wizard

Navigation

"Diagnostics" submenu → Heartbeat → 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

Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
AM/PM	Can be edited if Heartbeat Verification is not active. In the **Date/time format** parameter (2812), the **dd.mm.yy hh:mm am/pm** option or the **mm/dd/yy hh:mm am/pm** option is selected.	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 verification mode. Internal verification Verification is performed automatically by the device and without manual checking of external measured variables.	Internal verification	Internal verification
Start verification	–	Start verification. Start the verification with the **Start** option.	▪ Cancel ▪ Start	Cancel
Progress	–	Shows the progress of the process.	0 to 100 %	0 %
Measured values	One of the following options is selected in the **Start verification** parameter (→ 🖹 24): ▪ 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. ▪ Current output: Output current in [mA]. ▪ 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	–
Overall result	–	Displays the overall result of the verification. Detailed description of the classification of the results: → 🖹 30	▪ Passed ▪ Not done ▪ Failed	–

5.3.3 External verification

In an external verification, an internal verification is performed and various measured variables are also output. During the verification process, these measured variables are recorded manually with the help of external measuring equipment and entered into the measuring device (e. g. actual value at current output). The value entered is checked and verified by the measuring device to ensure that it complies with the factory specifications.

A status of (Passed or Failed) follows, accordingly, and is documented as an individual result of the verification and evaluated in the overall result.

Permanently predefined output signals are simulated during external verification of the outputs. These output signals do not represent the current measured value. To measure the simulated signals, it can 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.

Measured variables for external verification

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→ 6.

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.

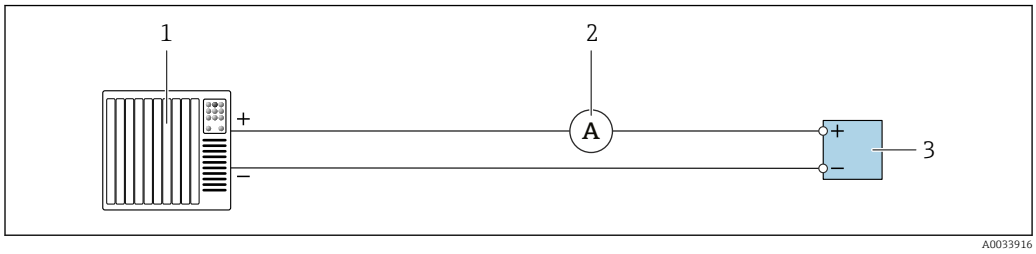
Determining the terminal assignment for the outputs

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 the terminal assignment, see the Operating Instructions for the device → 6

Active current output



8 External verification of active current output

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

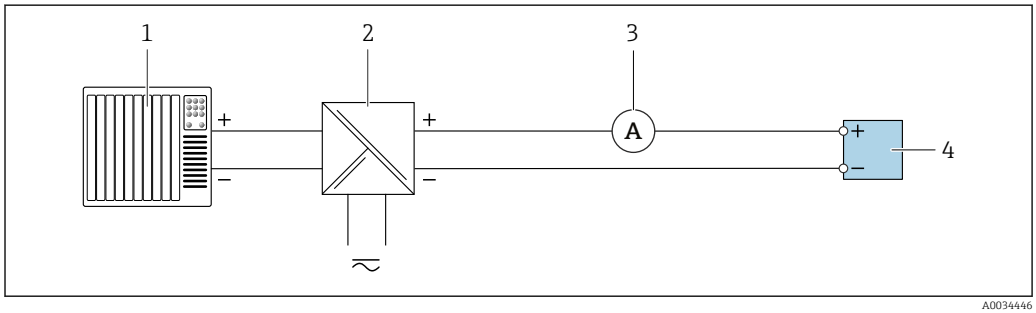
External verification of active current output

▶ 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



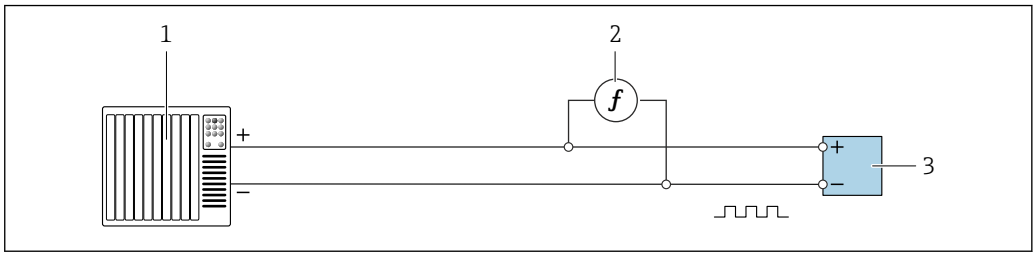
9 External verification of passive current output

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

External verification of 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



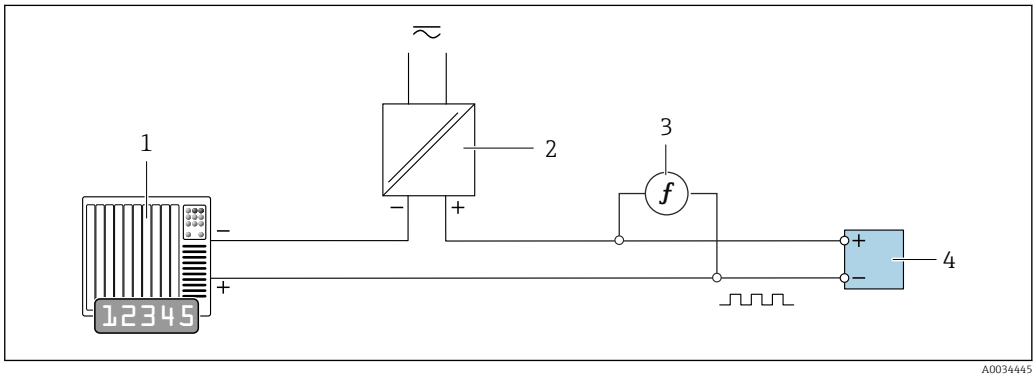
10 *External verification of active pulse/frequency output*

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

External verification of active pulse/frequency output

- Connect the frequency meter in parallel to the pulse/frequency output of the transmitter

Passive pulse/frequency/switch output



11 *External verification of passive pulse/frequency output*

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

External verification of 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 external 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 the **Start verification** parameter is displayed in all cases:
  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	**Device verification active**	

The following diagnostic event appears on the display (part 2 of the external verification) as soon as the **Start** option is selected in the **Start verification** parameter:
- Event diagnostic message ⚠**C302 Device verification active**
- Factory setting: warning.
  - The device continues to measure.
  - A "last valid value" is displayed intermittently
  - The signal outputs and totalizers are not affected
- Test duration: approx. 60 seconds

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.

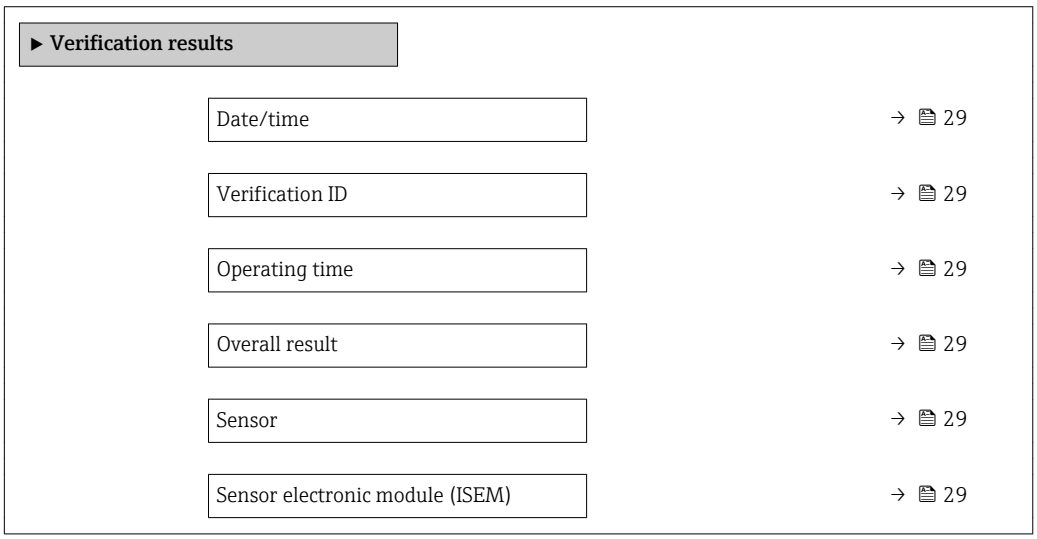
For detailed information on the diagnostics, see the Operating Instructions → 6.

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 → Verification results
– Expert → Diagnostics → Heartbeat → Verification results

Navigation
"Diagnostics" submenu → Heartbeat → Verification results

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



I/O module	→ 29
System status	→ 29

Parameter overview with brief description

Parameter	Prerequisite	Description	User interface	Factory setting
Date/time	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)	–
Overall result	–	Displays the overall result of the verification. Detailed description of the classification of the results: → 30	▪ Passed ▪ Not done ▪ Failed	–
Sensor	In the **Overall result** parameter, the **Failed** option is displayed.	Displays the result for the sensor. Detailed description of the classification of the results: → 30	▪ Passed ▪ Not done ▪ Failed	Not done
Sensor electronic module (ISEM)	In the **Overall result** parameter, the **Failed** option is displayed.	Displays the result for the sensor electronics module (ISEM). Detailed description of the classification of the results: → 30	▪ Passed ▪ Not done ▪ Failed	Not done
I/O module	In the **Overall result** parameter, the **Failed** option is displayed.	Displays the 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) ▪ Current input: Accuracy of the current ▪ Double pulse output: Accuracy of the pulses ▪ Relay output: Number of switching cycles Detailed description of the classification of the results: → 30	▪ Passed ▪ Not done ▪ Failed	Not done
System status	In the **Overall result** parameter, the **Failed** option is displayed.	Displays the system condition. Tests the measuring device for active errors. Detailed description of the classification of the results: → 30	▪ 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").

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

Heartbeat Verification confirms the device function within the specified measuring tolerance on demand with a TTC [2] > 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

Test group	Description
Sensor	Electrical components of the sensor (signals, circuits and cables)
Sensor electronics module (ISEM)	Electronic module for activating and converting the sensor signals
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 .

For more information on the test groups and individual tests .

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.

2) Total Test Coverage

Limit values

I/O module

Input; Output	Internal verification	External verification
Current output	▪ ±1 % ▪ ±300 µA	Lower value 4mA and upper value 20mA: ▪ ±1 % ▪ ±300 µA
Pulse output	Only external verification is possible.	Simulation: 1 pulse/s, pulse width 100 ms, with 1000 pulses ±10 pulses
Frequency output	Only external verification is possible.	±0.1 %

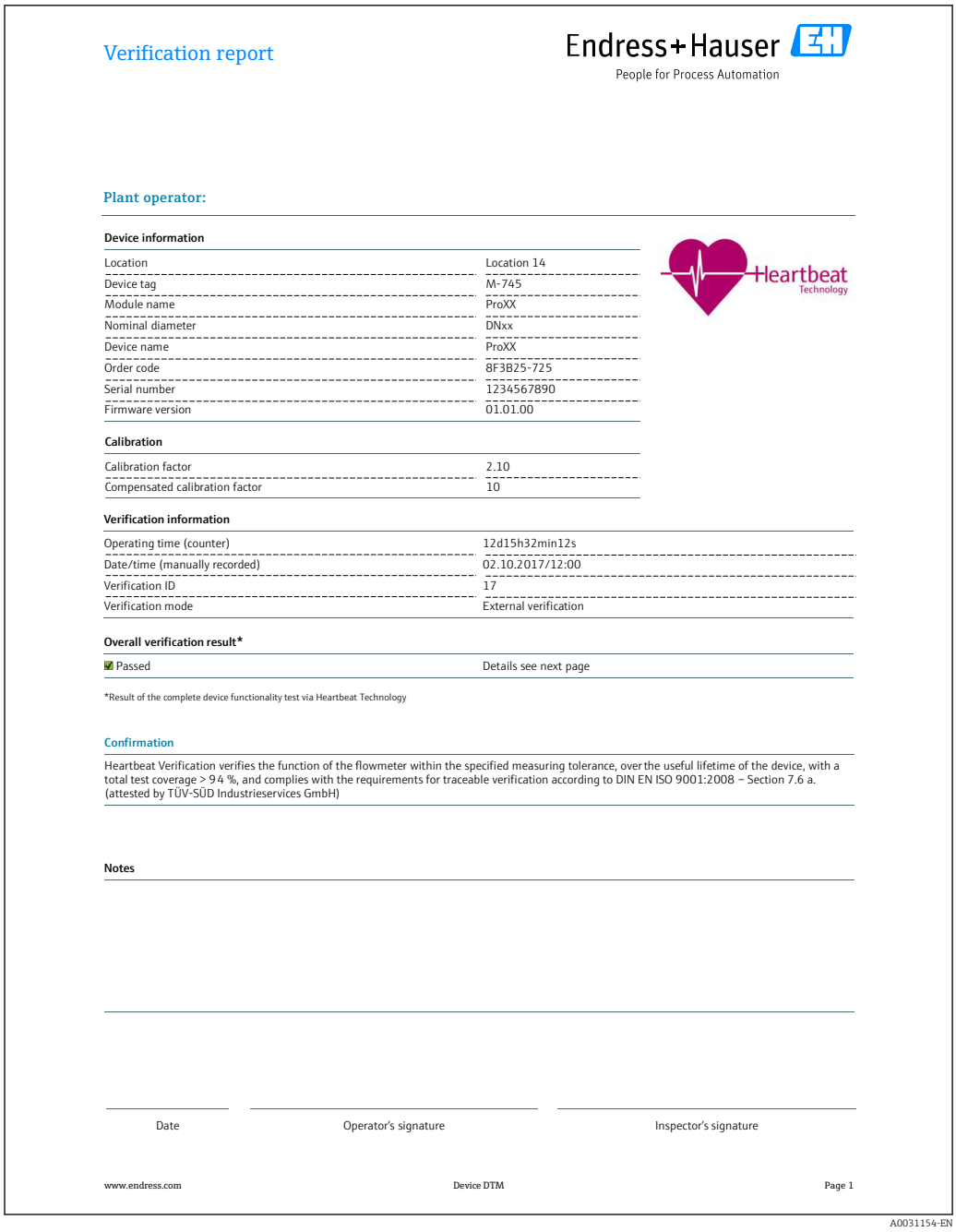
5.3.5 Verification report

The results of the verification can be documented in the form of a verification report via the Web server or FieldCare operating tool . 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
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 and zero point setting for the sensor
  - These values must correspond to those from the last calibration or repeat calibration in order to comply with factory specifications
- 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: internal or external verification
- Overall verification result
  Overall result of the verification passed if all of the individual results are passed

Second page
Details on the individual results for all test groups:
- System operator
- Test groups
  - Sensor
  - Main electronics module
  - System condition
  - I/O module

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:

Device information

Location	Location 14
Device tag	M-745
Module name	ProXX
Nominal diameter	DNxx
Device name	ProXX
Order code	8F3B25-725
Serial number	1234567890
Firmware version	01.01.00

Heartbeat Technology

Calibration

Calibration factor	2.10
Compensated calibration factor	10

Verification information

Operating time (counter)	12d15h32min12s
Date/time (manually recorded)	02.10.2017/12:00
Verification ID	17
Verification mode	External verification

Overall verification result*

☑ Passed	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 > 94 %, and complies with the requirements for traceable verification according to DIN EN ISO 9001:2008 – Section 7.6 a. (attested by TÜV-SÜD Industrieservices GmbH)

Notes

Date | Operator's signature | Inspector's signature

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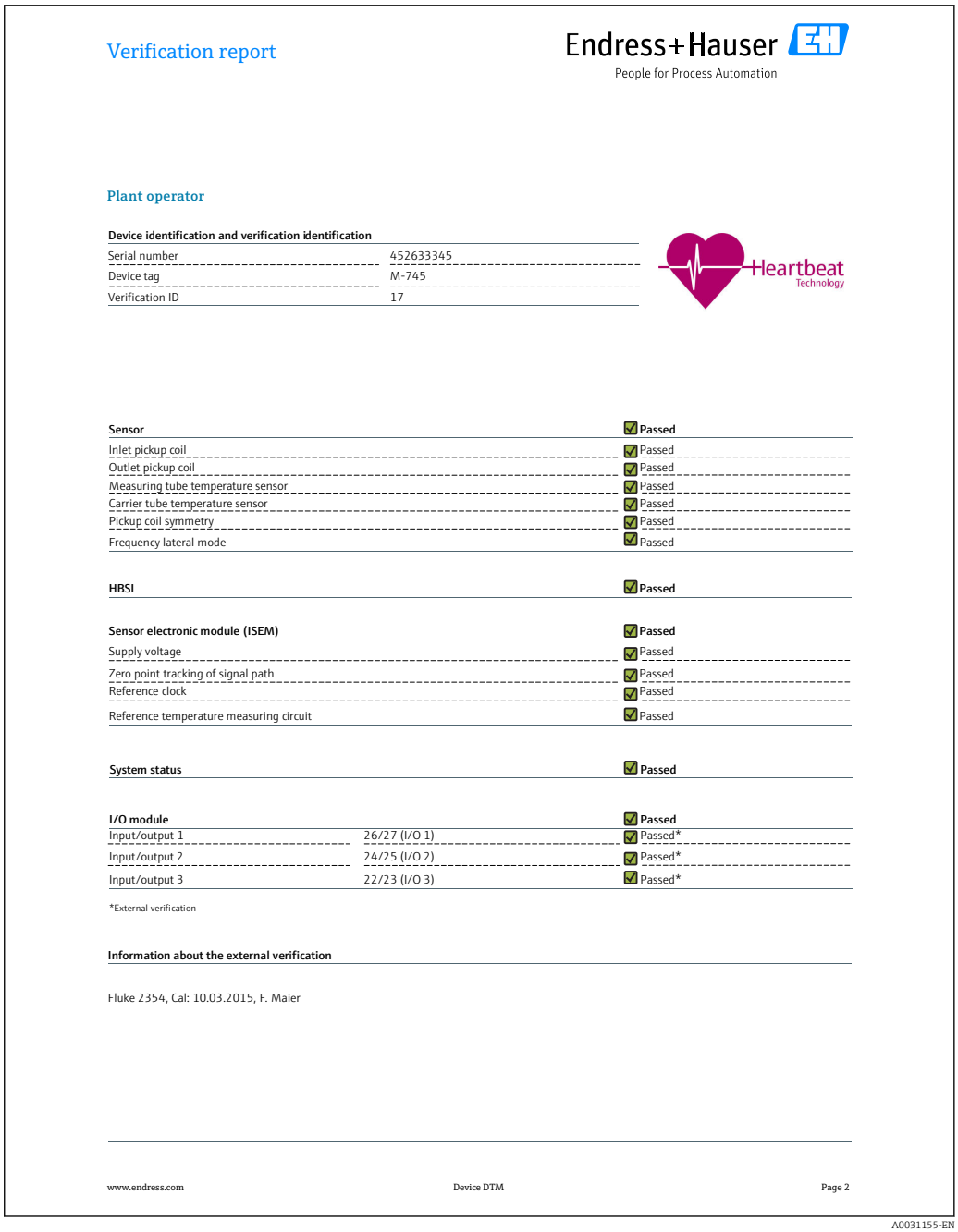
12 *Example of a verification report (Page 1)*

The remaining pages of the verification report list the individual test groups and the individual test group results.

Individual test groups and description of individual tests:



Verification report

Endress+Hauser
People for Process Automation

Plant operator

Device identification and verification identification

Serial number	452633345
Device tag	M-745
Verification ID	17

Heartbeat Technology

Sensor		**Passed**
Inlet pickup coil		Passed
Outlet pickup coil		Passed
Measuring tube temperature sensor		Passed
Carrier tube temperature sensor		Passed
Pickup coil symmetry		Passed
Frequency lateral mode		Passed
HBSI		**Passed**
Sensor electronic module (ISEM)		**Passed**
Supply voltage		Passed
Zero point tracking of signal path		Passed
Reference clock		Passed
Reference temperature measuring circuit		Passed
System status		**Passed**
I/O module		**Passed**
Input/output 1	26/27 (I/O 1)	Passed*
Input/output 2	24/25 (I/O 2)	Passed*
Input/output 3	22/23 (I/O 3)	Passed*

*External verification

Information about the external verification

Fluke 2354, Cal: 10.03.2015, F. Maier

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13 *Example of a verification report (Page 2)*

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

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

5.3.6 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.

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

- Confirmation of compliance with the flow specifications with a total test coverage of 100 % is only possible by verifying the primary measured variable (flow) by recalibrating or by proving the value.
- **Heartbeat Verification** confirms the device function within the specified measuring tolerance on demand with a TTC [3] > 95 %.

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.
In this case, it is advisable to compare the current process conditions to those of a previous verification to identify any deviations. To inhibit process-related influences as much as possible, the ideal solution is to establish defined and stable process conditions and then to repeat the verification.
Stabilize or stop flow, ensure that process temperature is stable, drain the sensor if possible.

Recommended remedial action if the result of the verification is **Failed**:
- Calibrate the measuring device
  The calibration has the advantage that the "as found" measuring device state is recorded and the actual measured error is determined.
- Direct remedial measures
  Take remedial action on the basis of the verification results and the diagnostic information of the measuring device. Narrow down the possible cause of the error by identifying the test group that **failed** the verification.

For detailed information on the diagnostics, see the Operating Instructions → 6.

3) Total Test Coverage

6 Heartbeat Monitoring

With Heartbeat Monitoring, additional measured values are output continuously and monitored in an external Condition Monitoring system so that changes 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 deposit buildup or wear as a result of corrosion.

6.1 Commissioning

To commission the device, the measured variables which are relevant for monitoring are assigned to the outputs. Once commissioning is completed, these monitoring-specific measured variables are continuously available at the outputs.

Activating and deactivating the monitoring feature
The transmission of monitoring-specific measured variables is switched on or off in the operating menu:
→ 37

6.1.1 Description of the monitoring measured variables/parameters

The monitoring-specific measured variables listed below 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.

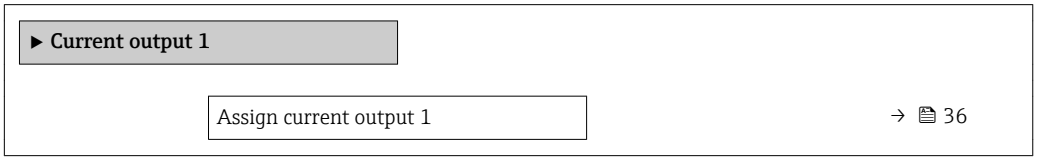
Measured variable	Description	Value range
Signal strength	The signal strength of the ultrasonic signal received. Multi-path measuring devices: The minimum of all the signal strengths measured is monitored.	0 to 120 dB
Acceptance rate	The acceptance rate is the ratio of the number of ultrasonic signals 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%
Asymmetry	Multi-path measuring devices only: Displays the asymmetry of the flow profile.	-100% to 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

Additional measured variables are available to the user with the "Heartbeat Verification + Monitoring" application package.

Example: Configuring the current output

Navigation
"Setup" menu → Current output

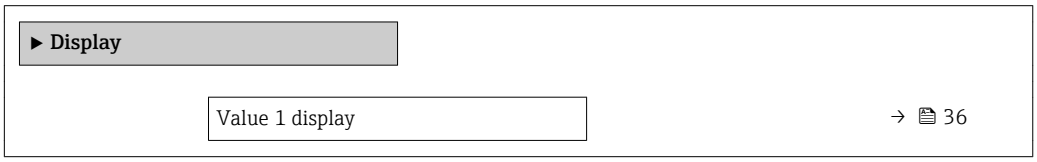


Parameter overview with brief description

Parameter	Description	Selection	Factory setting
Assign current output 1	Select process variable for current output.	▪ Off ▪ Volume flow ▪ Mass flow ▪ Sound velocity ▪ Flow velocity ▪ Temperature ▪ Acceptance rate ▪ Signal strength ▪ Signal to noise ratio ▪ Turbulence ▪ Signal asymmetry	Volume flow

Example: Configuring the local display

Navigation
"Setup" menu → Display



Parameter overview with brief description

Parameter	Description	Selection	Factory setting
Value 1 display	Select the measured value that is shown on the local display.	▪ Mass flow ▪ Sound velocity ▪ Flow velocity ▪ Temperature ▪ Volume flow ▪ Signal strength ▪ Current output 1 ▪ Signal to noise ratio ▪ Turbulence ▪ Signal asymmetry ▪ Acceptance rate ▪ Totalizer 1 ▪ Totalizer 2 ▪ Totalizer 3	Volume flow

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 which indicate a change in the performance of the measuring device brought about by process-related 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 which only impact the integrity of the sensor over the medium term but which also bring about a gradual change in the measuring performance (e.g. abrasion, corrosion or the formation of buildup in the sensor). 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:
- Formation of buildup in the sensor
- Corrosive or abrasive fluids
- Multi-phase fluids (gas content in liquid fluids)
- Wet gases
- Applications in which the sensor is exposed to a programmed amount of wear.

The results of Condition Monitoring must always be interpreted in the context of the application.

6.2.1 Overview of the monitoring parameters

This section describes the interpretation of certain monitoring-specific parameters in the context of 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. ▪ Formation of buildup. ▪ Particles in the flow. ▪ A damaged or defective converter.
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.

Monitoring parameter	Possible reasons for deviation
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.
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.
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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