

Special Documentation

Proline Promag 300

PROFIBUS DP

Heartbeat Verification + Monitoring application package



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1 Certification

BESCHEINIGUNG ♦ ATTESTATION ♦ 証明書 ♦ СВИДЕТЕЛЬСТВО ♦ CONSTANCIA ♦ ATTESTAZIONE

ATTESTATION

The Certification Body of
TÜV SÜD Industrie Service GmbH
Business Area Energy and Systems



Industrie Service

confirms that the product

**Proline Promag 300,
Proline Promag 500
with Heartbeat Technology™**

manufactured by

**Endress + Hauser Flowtec AG
Kägenstraße 7
4153 Reinach BL
Switzerland**

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.

Test specifications:

DIN EN IEC 61508-2:2011-02, Appendix C
DIN EN IEC 61508-3:2011-02, Section 6
DIN EN ISO 9001:2008, (Section 7.6 a), Control of monitoring and measuring equipment

Test results:

Heartbeat Verification verifies the function of Proline Promag 300 / Proline Promag 500 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 DIN EN 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.

This Attestation is based on report no.: TR.2065342.014.17, Rev.1, dated October 26, 2017.

Munich, October 26, 2017

Hausmann

Katrin Hausmann
Certification Body Energy and Systems



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TUV®

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2 About this document

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 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
	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:

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

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

Measuring device	Documentation code
Promag H 300	BA01865D
Promag P 300	BA01853D
Promag W 300	BA01940D



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 → Downloads

2.5 Registered trademarks

PROFIBUS®

Registered trademark of the PROFIBUS User Organization, Karlsruhe, Germany

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):

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

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 the TTC depends on the configuration and integration of the measuring device. The values indicated above were determined under the following conditions:

- Integration of the 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** and evaluation unit recognizes both alarms
- Settings for diagnostic behavior correspond to factory settings

3.2 Availability

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
- On the Web using the Device Viewer (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

A retrofit kit is supplied if the application package is ordered subsequently. This kit includes a tag plate with device data and an activation code.



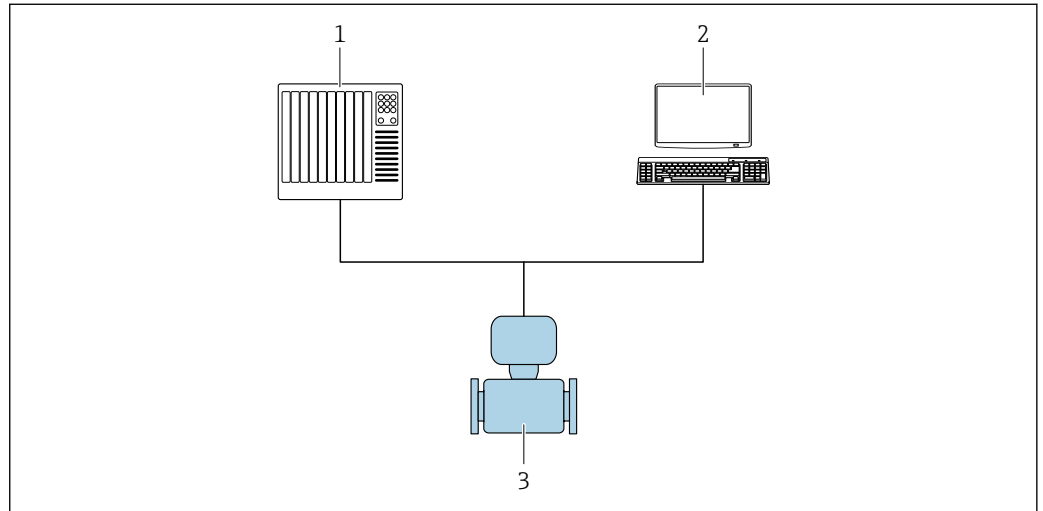
For detailed information on "Activating application packages via the software license code", see Installation Instructions EA01164D

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.

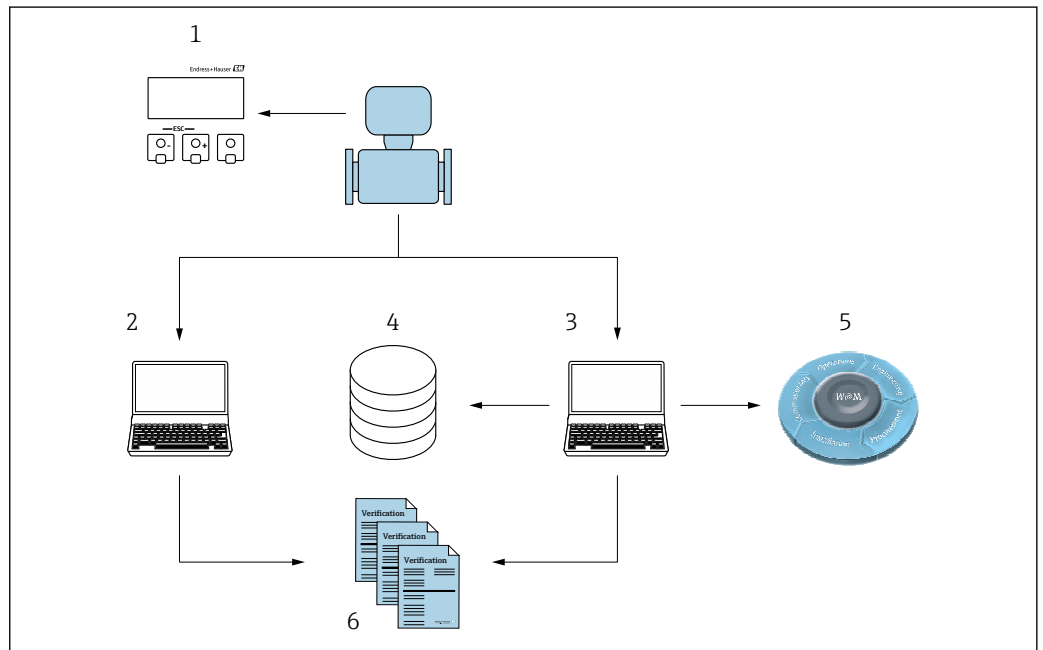
4 System integration

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).



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- 1 PLC
- 2 Asset Management System
- 3 Measuring device



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- 1 Local display
- 2 Web browser
- 3 FieldCare
- 4 Data archive
- 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
- Common Data Interface (CDI)

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 and provided in the form of a verification report.

Verification reports can be created using 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 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.

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

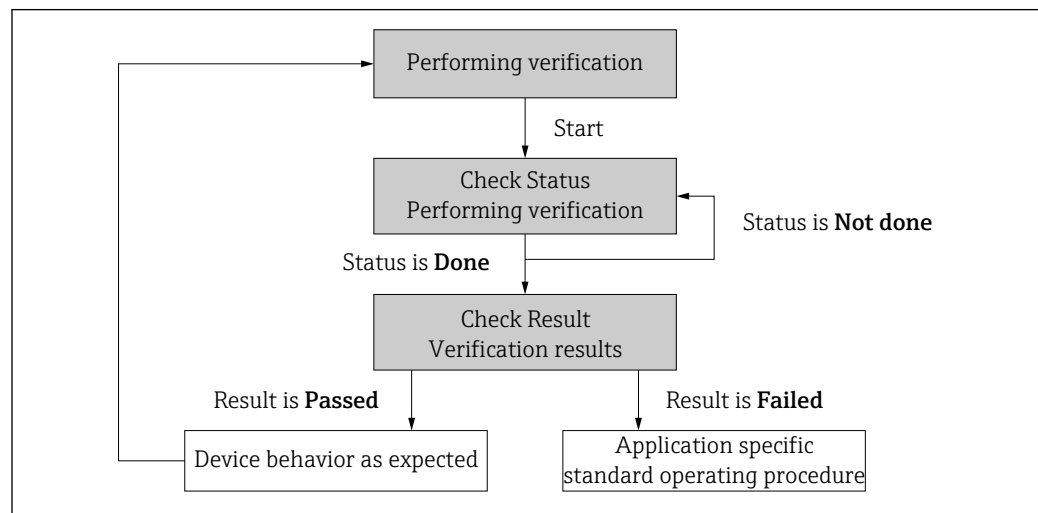
4.1 Automated data exchange

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

The verification function integrated in the measuring device can be activated by a control system and the results can be checked.

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

The following procedure must be implemented for this purpose:



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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

The user can read the monitoring measured variables in the operating menu.

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
- 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)

4.3.1 Data management via Web browser

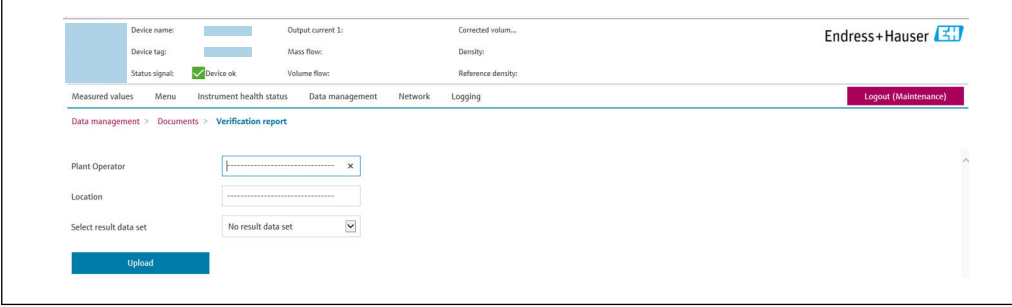
Thanks to the integrated Web server the device can be operated and configured via a Web browser. In addition, it is possible to query the results of the verification and create a verification report.

Print verification report

A verification report is created in PDF format.

 Prerequisite: A verification has already been performed.

User interface in the Web browser following login:



The screenshot shows the Endress+Hauser web interface. At the top, there are fields for Device name, Device tag, Status signal (showing a green checkmark and 'Device ok'), Output current 1, Mass flow, Volume flow, Corrected volum..., Density, and Reference density. Below these is a navigation bar with links: Measured values, Menu, Instrument health status, Data management, Network, and Logging. A 'Logout (Maintenance)' button is on the right. The 'Data management' link is highlighted, and a breadcrumb trail shows 'Data management > Documents > Verification report'. The main content area has three input fields: 'Plant Operator' (with a clear button), 'Location', and 'Select result data set' (with a dropdown menu showing 'No result data set' and a checkmark). An 'Upload' button is at the bottom left. The Endress+Hauser logo is in the top right corner.

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.

4.3.2 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

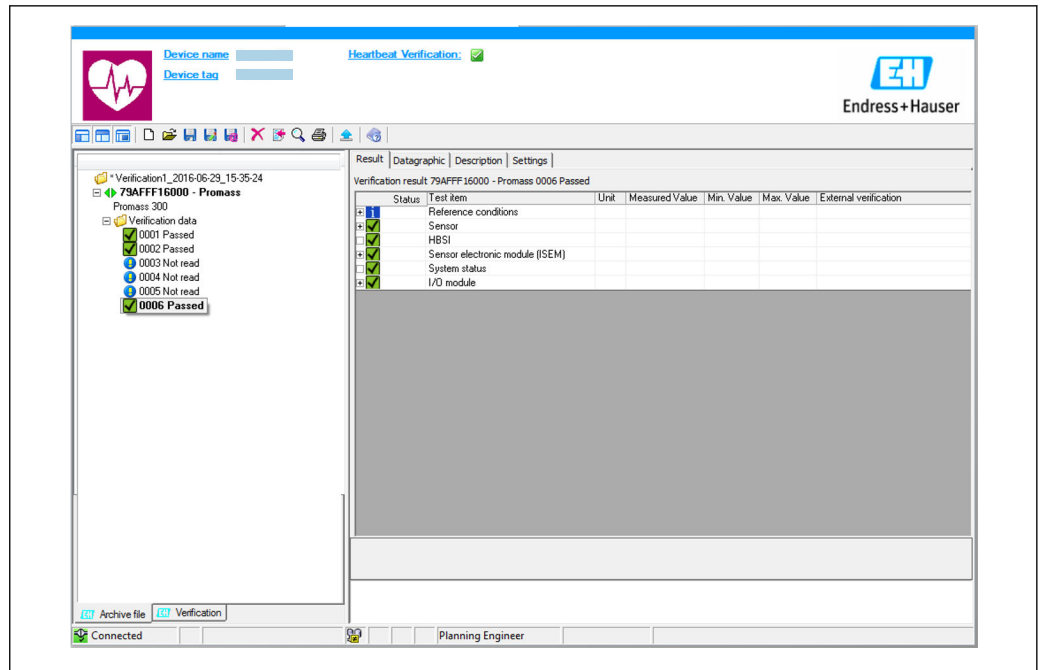
	Device name	Xxxxxxxx	Heartbeat Verification: 
	Device tag	Xxxxxxxx	

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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

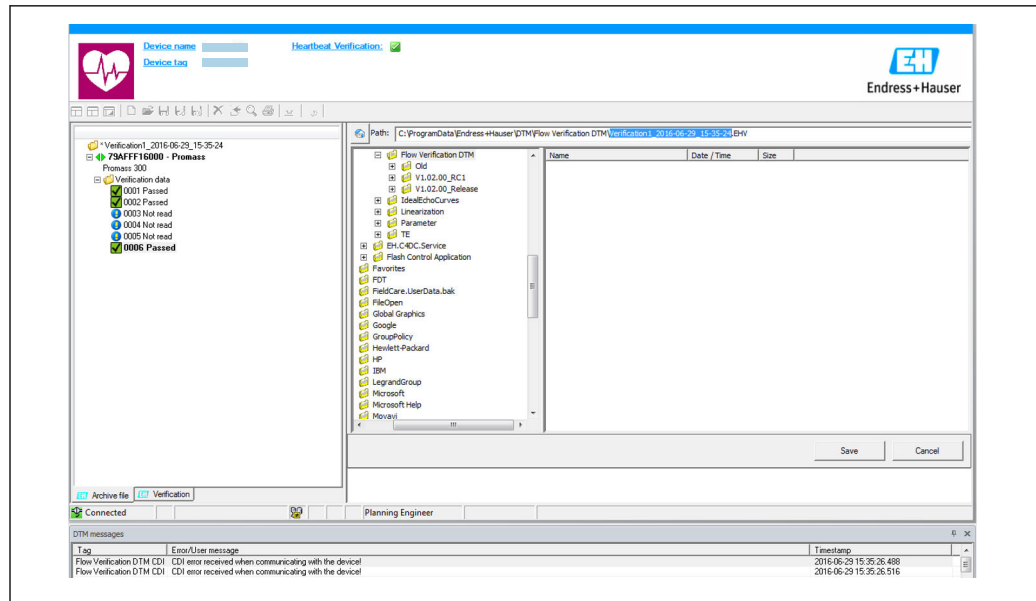
Details for the verification results are displayed in the data area.

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 or .
- ↳ 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

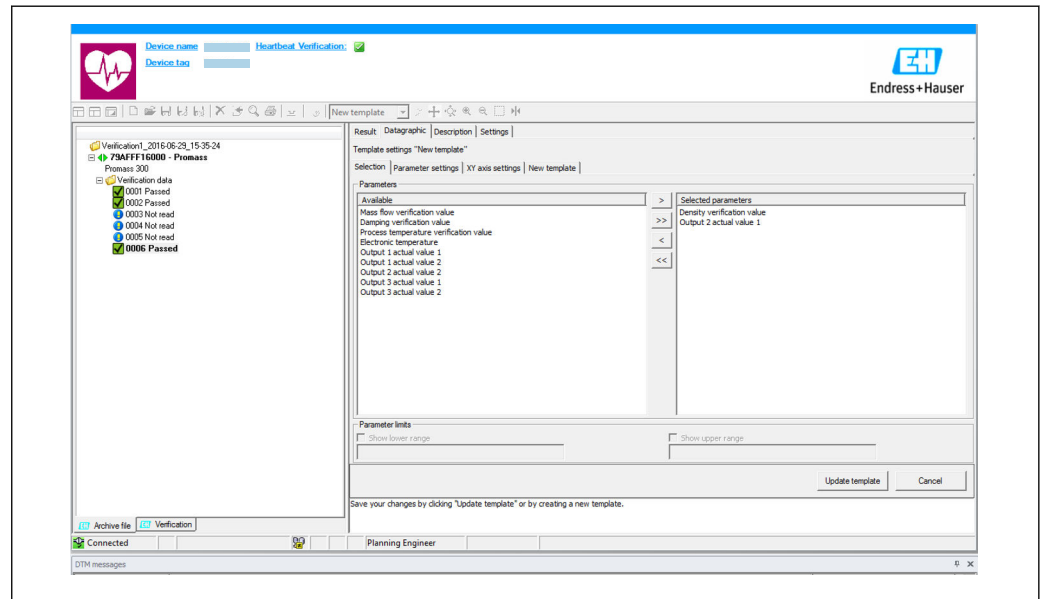
Open archive files already available.

- 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

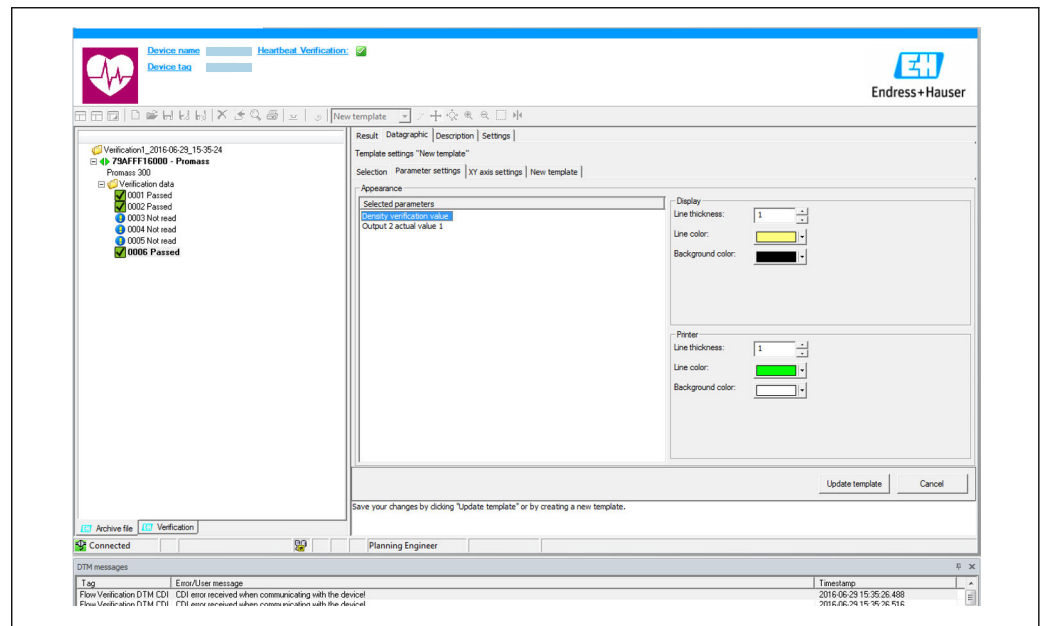


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3 Sample graphic

- Select the measured variables using the list displayed.

Visualizing a graph

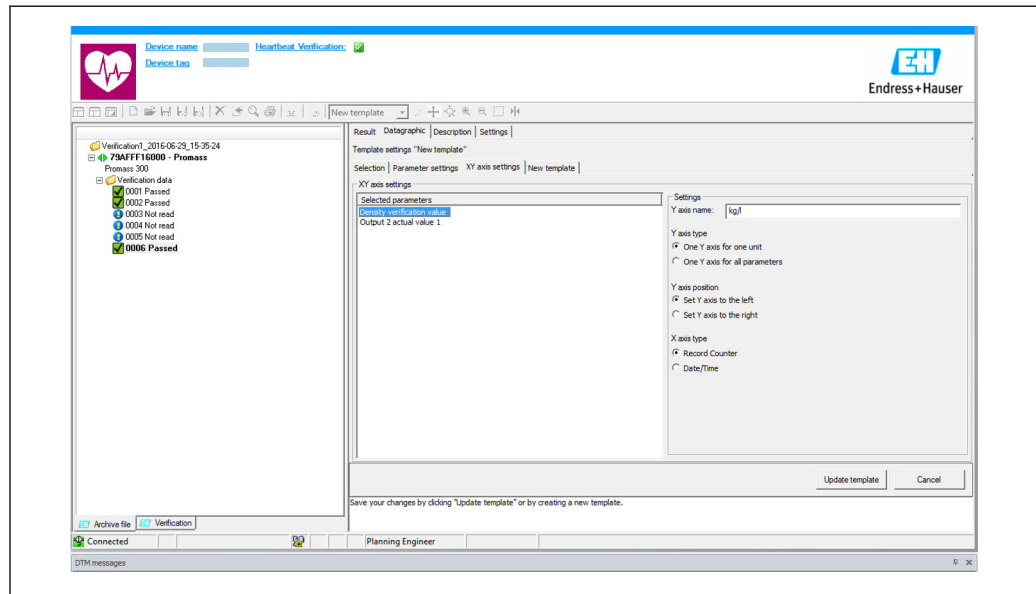


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4 Sample graphic

- Assign properties for visualization of the graph.

Configuring the Y-axis

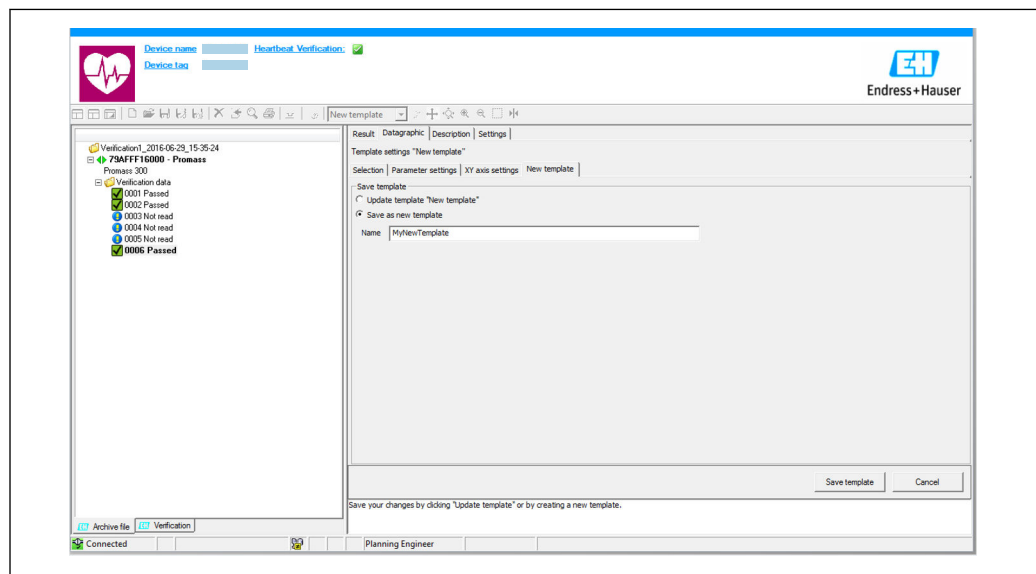


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5 Sample graphic

- Assign the measured variables of the Y-axis.

Update template or create new template

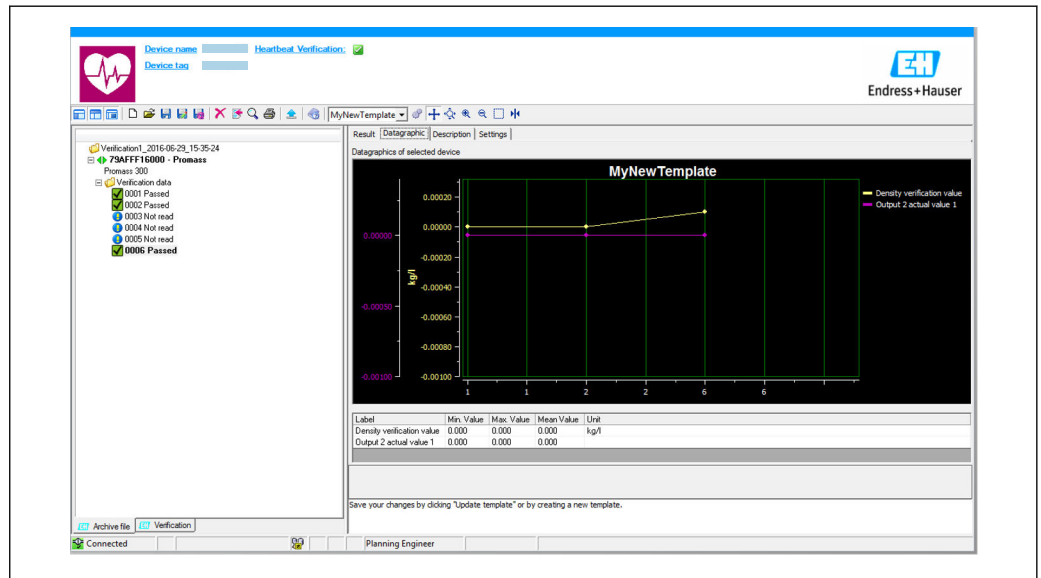


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6 Sample graphic

- 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 function within the specified measuring tolerance on demand with a total test coverage (TTC) of > 95%. 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.

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 → 20

Verification is performed by the device without manual checking of external measured variables.

- External verification → 23

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 additionally checks the following inputs and outputs:

- 4 to 20 mA current output, active and passive
- Pulse/frequency output, active and passive
- 4 to 20 mA current input, active and passive
- Relay output

External verification supports verification of the following output modules:

- 4 to 20 mA current output, active and passive
- Pulse/frequency output, active and passive

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.

 Recommendation: Perform initial verification when commissioning the device. The results are then saved 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.

Navigation

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

Navigation

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

▶ Heartbeat base settings

Plant operator

→ 19

Location

→ 19

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 notes

The Heartbeat Verification function can be used without restriction on a custody-transfer (CT) measuring device in the custody transfer mode.

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 → 20
- External verification → 23

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. 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.

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 (→  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 precondition 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 → 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 →  33.
 - 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 →  19.

"Performing verification" wizard

Navigation

"Diagnostics" submenu → Heartbeat → 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	→  22

Progress	→  23
Measured values	→  30
Output values	→  30
Status	→  23
Overall result	→  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. 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

Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
Progress	–	Shows the progress of the process.	0 to 100 %	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: →  32	■ Passed ■ Not done ■ Failed	–

5.3.3 External verification

External verification is similar to the internal verification function but additionally outputs a number of different measured variables. 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.

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

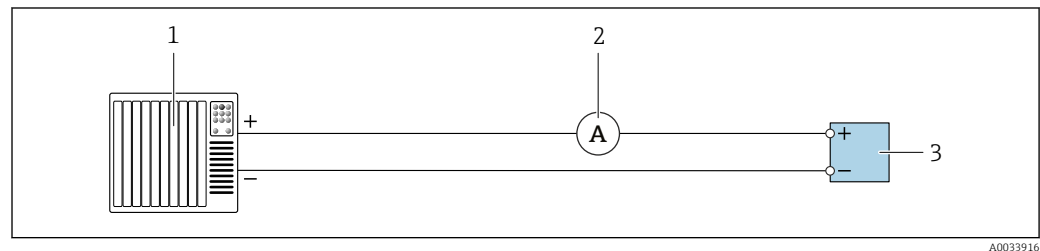
The terminal assignment depends on the specific device version.

To determine the device-specific terminal assignment:

- See the adhesive label in the terminal cover
- Check the operating menu via the local display, Web browser or operating tool
 - Setup → I/O configuration → I/O module 1 to n terminal numbers
 - Expert → I/O configuration → I/O module 1 to n terminal numbers

 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

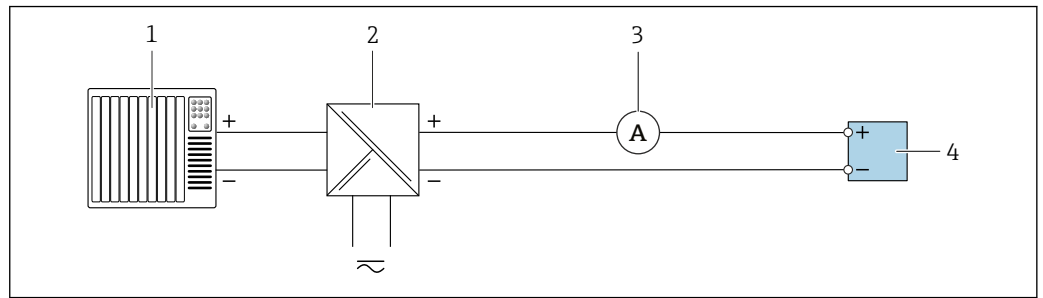
- 1 Automation system with current input (e. g. PLC)
- 2 Ammeter
- 3 Transmitter

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

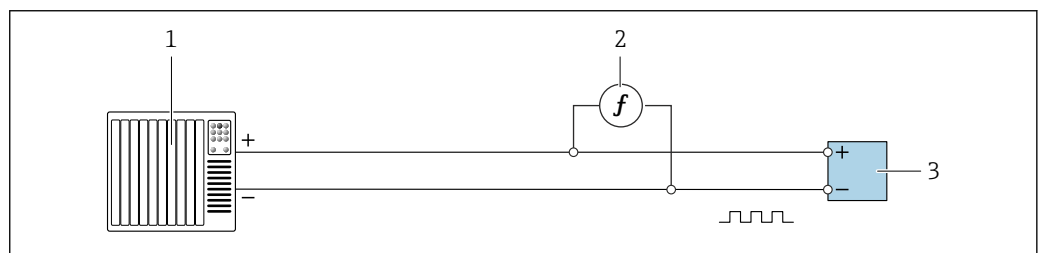
A0034446

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

A0033911

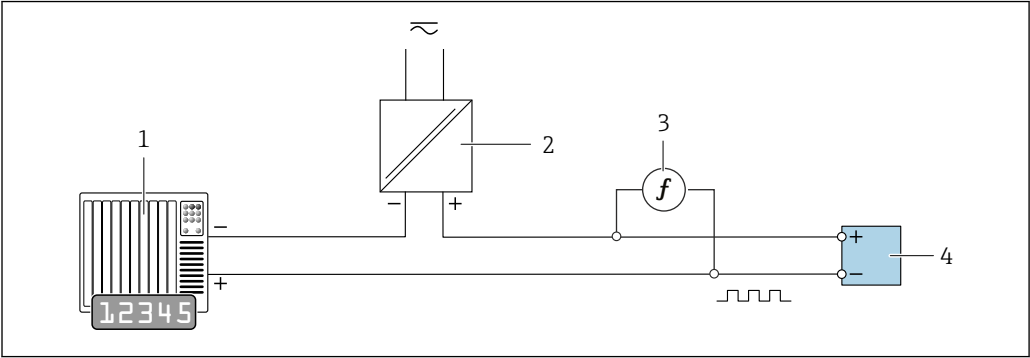
10 External verification of active pulse/frequency output

- 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, 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	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.

Performing external verification

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

NOTICE

External verification is not possible if no connection has been established and the ammeter is looped in during verification.

- ▶ Establish a connection before external verification starts.
- ▶ Loop in ammeter before external verification starts.

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.



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.

Select the verification mode

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

Further parameter settings

3. In the **External device information** parameter, enter a unique ID (e. g. serial number) for the measuring equipment used (max. 32 characters).
4. In the **Start verification** parameter, select one of the available options (e. g. the **Output 1 low value** option).
5. In the **Measured values** parameter, enter the value displayed 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, on whether the output is switched on and on whether the output is active or passive.

The value displayed in the **Output values** parameter (→ 30) indicates the value simulated by the device at the selected output. → 24.

Start 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.

Displaying the verification status and result

The current status of the internal verification is indicated 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 precondition 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 → 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 →  33.
 - 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 →  19.

"Performing verification" wizard

Navigation

"Diagnostics" submenu → Heartbeat → Performing verification

► Performing verification

Year

→  29

Month

→  29

Day

→  29

Hour

→  29

AM/PM

→  29

Minute

→  29

Verification mode

→  29

External device information

→  30

Start verification

→  30

Progress	→ 30
Measured values	→ 30
Output values	→ 30
Status	→ 30
Overall result	→ 30

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. 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. External verification Similar to internal verification but with the entry of external measured variables: Measured values parameter.	External verification	Internal verification

Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
External device information	With the following conditions: - In the Verification mode parameter (→ 22), the External verification option is selected. - Can be edited if verification status is not active.	Record measuring equipment for external verification.	Free text entry	–
Start verification		Start verification. To carry out a complete verification, select the selection parameters individually. Once the external measured values have been recorded, verification is started using the Start option.	- Cancel - Output 1 low value - Output 1 high value - Output 2 low value - Output 2 high value - Output 3 low value - Output 3 high value - Frequency output 1 - Pulse output 1 - Frequency output 2 - Pulse output 2 - Double pulse output - Start	Cancel
Measured values	One of the following options is selected in the Start verification parameter (→ 22): - Output 1 low value - Output 1 high value - Output 2 low value - Output 2 high value - Frequency output 1 - Pulse output 1	Displays the references for the external measured variables. - Current output: Output current in [mA] - Pulse/frequency output: Output frequency in [Hz] - Double pulse 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
Progress	–	Shows the progress of the process.	0 to 100 %	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: → 32	- Passed - Not done - Failed	–

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

► Verification results		
Date/time	→ 	31
Verification ID	→ 	31
Operating time	→ 	31
Overall result	→ 	31
Sensor	→ 	31
Sensor electronic module (ISEM)	→ 	31
I/O module	→ 	32
System status	→ 	32

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 65535	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: →  32	■ 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: →  32	■ 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: →  32	■ Passed ■ Not done ■ Failed	Not done

Parameter	Prerequisite	Description	User interface	Factory setting
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 frequency output: Accuracy of frequency - 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: →  32	- Passed - Not done - Not plugged - 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: →  32	- 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.
Not used	The result is used for internal purposes.
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.
Not plugged	The result is displayed if no I/O module is plugged into the slot.

Overall results

Result	Description
Failed	At least one test group was outside the specifications.
Not used	The result is used for internal purposes.
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".

Result	Description
Not done	No verification was performed for any of the test groups (result for all test groups is "Check not done").
Not plugged	The result is displayed if no I/O module is plugged into the slot.

 **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 exciting the sensor and converting
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

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 individual test group results which 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, active and passive	■ ±1 % ■ ±100 µA (offset)	■ Lower value 4mA: ±1 % ■ Upper value 20mA: ±0.5 %
Pulse/frequency/switch output, active and passive	±0.05 %, with a 120 s cycle	■ Pulse: ±0.3 % ■ Frequency: ±0.3 %
Current input 4 to 20 mA, active and passive	■ -20 %: 24 V - 20 % = 19.2 V ■ In addition: -5 %: 19.2 V - 5 %	Only internal verification is possible.
Double pulse output, active and passive	±0.05 %, with a 120 s cycle	Only internal verification is possible.
Relay output	The number of switching cycles depends on the hardware	Only internal verification is possible.

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"

2) Total Test Coverage

Process conditions

To increase the comparability of the results, the process conditions that apply at the time of verification are recorded.

Process conditions	Description, value range
Verification value conductivity	Actual measured value for medium conductivity (if switched on)
Process temperature verification value	Actual measured value for medium temperature(if available)
Verification value volume flow	Actual measured value for volume flow
Electronic temperature	Current measured value for the electronic temperature in the transmitter

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/remedial measures
Shot time symmetry	Monitoring of symmetry in the exciter circuit for coil current shot times while both field polarities are changed.	No value range - Passed - Failed - Not done	- EMC interference - Defective H-bridge in the amplifier
Holding voltage symmetry	Monitoring of symmetry in holding voltages of exciter circuit for setting the coil current for both field polarities.	No value range - Passed - Failed - Not done	- EMC interference - Defective H-bridge in the amplifier
Coil current loss	Monitoring of the coil current path for leak current. Comparison of incoming and outgoing currents.	No value range - Passed - Failed - Not done	Sensor short-circuit. Check entire sensor system: - Check for moisture (e.g. condensation) - Check for faulty sensor and cable connections or interfaces - Check coils
Coil current stability	Monitoring the correct adjustment of the coil current.	No value range - Passed - Failed - Not done	EMC interference
Coil resistance	Monitoring of the coil resistance.	No value range - Passed - Failed - Not done	- Faulty connections: check the outer connection parts, clamp connections and connecting cables - Process temperature too high - Coil in the sensor is defective
Electrode circuit 1	Monitoring of the impedance in electrode circuit 1.	No value range - Passed - Failed - Not done	Electrode cable defective  The test is not performed if the measuring tube is empty Status indicated: "Not done"
Electrode circuit 2	Monitoring of the impedance in electrode circuit 2.	No value range - Passed - Failed - Not done	Electrode cable defective  The test is not performed if the measuring tube is empty Status indicated: "Not done"
EPD electrode circuit	Monitoring of the impedance in the EPD circuit.	No value range - Passed - Failed - Not done	EPD cable defective  The test is not performed if the measuring tube is empty Status indicated: "Not done"

Sensor electronics module (ISEM)

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Supply voltage	All the relevant supply voltages are checked. Monitoring of the supply voltage for the sensor electronics module guarantees that the system is functioning correctly.	No value range - Passed - Failed - Not done	Sensor electronics module (ISEM) defective Replace sensor electronics module (ISEM)
Linearity and reference voltage	- Monitoring of flowmeter circuit with regard to gain and linearity. - Monitoring of reference voltages in flowmeter circuit and exciter circuit	No value range - Passed - Failed - Not done	Sensor electronics module (ISEM) defective Replace sensor electronics module (ISEM)
Offset electrode signal amplifier	Monitoring of flow measurement amplifier with regard to zero point.	No value range - Passed - Failed - Not done	Sensor electronics module (ISEM) defective Replace sensor electronics module (ISEM)
Hold voltage feedback	The configured hold voltage is fed back to ensure the secure and constant functioning of the hold voltage.	No value range - Passed - Failed - Not done	Sensor electronics module (ISEM) defective Replace sensor electronics module (ISEM)
Overvoltage feedback	The overvoltage is fed back to ensure the secure and constant functioning of the overvoltage.	No value range - Passed - Failed - Not done	Sensor electronics module (ISEM) defective
Electronic current loss	Monitoring of the coil current path for leak current.	No value range - Passed - Failed - Not done	Sensor electronics module (ISEM) defective
Coil current measurement	Monitoring of low-side current measurement.	No value range - Passed - Failed - Not done	Sensor electronics module (ISEM) defective
Overvoltage circuit	Monitoring of overvoltage.	No value range - Passed - Failed - Not done	Sensor electronics module (ISEM) defective
Electrode signal integrity	Monitoring of input stage, sensor and electrode cable.	No value range - Passed - Failed - Not done	One of the electrode signals is missing. This can be due to the following: - Sensor electronics module (ISEM) defective - Faulty connection to the sensor - Electrode short-circuit or open circuit - Sensor defective

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.

I/O modules

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Output 1 to n	Checking of all the input and output modules installed at the measuring device →  18	No value range ■ Passed ■ Failed ■ Not done  Limit values →  33	Causes ■ Output values out of specification. ■ I/O modules defective. Corrective action ▶ Check cabling. ▶ Check connections. ▶ Check load (current output). ▶ Replace the I/O module.

5.3.6 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: identification

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: test results

Details on the individual results for all test groups:

- System operator
- Test groups
 - Sensor
 - Main electronics module
 - System condition
 - I/O module

From third page onwards: measured values and visualization

Numerical values and graphic representation of all the values recorded including the process conditions with the following information:

- System operator
- Test object
- Unit
- Current: measured value

- Min.: lower limit
- Max.: upper limit
- Visualization: graphic representation of the deviation from the optimum value

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	ProXXX
Nominal diameter	DNxx
Device name	ProXXX
Order code	XXXXXX-XXX
Serial number	1234567890
Firmware version	01.01.00

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

www.endress.com

Device DTM

Page 1

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 12 Example of a verification report (Page 1: identification)

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

Sensor

✓ Passed

Shot time symmetry	✓ Passed
Hold voltage symmetry	✓ Passed
Coil current loss	✓ Passed
Coil current stability	✓ Passed
Coil resistance	✓ Passed
Electrode circuit 1	✓ Passed
Electrode circuit 2	✓ Passed
Electrode EPD circuit	✓ Passed

Sensor electronic module (ISEM)

✓ Passed

Supply voltage	✓ Passed
External reference voltage	✓ Passed
Linearity and reference voltage	✓ Passed
Offset of electrode measuring circuit	✓ Passed
Hold voltage feedback	✓ Passed
Shot voltage feedback	✓ Passed
Electronic current loss	✓ Passed
Coil circuit measurement	✓ Passed
Shot control circuit	✓ Passed
Electrode signal integrity	✓ 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*
Input/output 4	20/21 (I/O 4)	☐ Not plugged

*External verification

Information about the external verification

Fluke 2354, Cal: 10.03.2015

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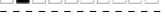
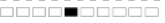
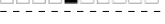
Device DTM

Page 2

A0034799-EN

 13 *Example of a verification report (Page 2: test results)*

-  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

Verification report					
Endress+Hauser  People for Process Automation					
Plant operator:					
Device identification and verification identification					
Serial number		1234567890			
Device tag		M-745			
Verification ID		17			
					
Test item	Unit	Actual	Min.	Max.	Visualization
Sensor					
Shot time symmetry deviation		0.9997	0.9000	1.1000	
Hold voltage symmetry deviation		1.0000	0.9000	1.1000	
Coil current loss deviation	%	0.0000	-10.000	10.0000	
Coil current offset	%	-0.02	-0.1	0.1	
Coil current deviation	%	0.00	-0.1	0.1	
Coil resistance value	Ohm	85.9	50.0	240.0	
Electrode impedance 1	Ohm	100.00			
Electrode impedance 2	Ohm	100.00			
EPD electrode impedance	Ohm	100.00			
E1/E2 electrode impedance on E1	Ohm	100.00			
E1/E2 electrode impedance on E2	Ohm	100.00			
Sensor electronic module (ISEM)					
External reference voltage 1	V	NaN			
Linearity and reference voltage 1		1.0000			
Linearity and reference voltage 2		1.0000			
Measuring point offset		0.0000	-100.00	100.000	
Hold voltage feedback value	%	-9.63	-10.0	10.0	
Shot voltage feedback value	%	0.00	-20.0	20.0	
Electronic current loss deviation	%	0.00	-10.000	10.0000	
Coil circuit value	%	-0.17	-1.0	1.0	
Shot control circuit value	%	0.00	-10.0	10.0	
Electrode signal integrity deviation	%	0.00	-40.0	40.0	
System status					

14 Example of a verification report (from Page 3 onwards: measured values and visualization)

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). The check is based on reference values that were recorded during the factory calibration.

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. 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.

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

6.1 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.

Heartbeat Monitoring enables additional monitoring values to be displayed in continuous operation mode.

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. These target applications are:

- Fluids containing magnetite
- Multi-phase fluids (gas content in liquid fluids)
- Applications in which the sensor is exposed to a programmed amount of wear
- Applications with cathodic protection systems
- Applications with pipes that are not grounded

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

6.1.1 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
Noise	A change can be an indicator of multi-phase fluids (gas content in liquid fluids or a change in the solids content of the fluid) or changing electrical conductivity. This value allows conclusions to be drawn about the process.
Coil current shot time	At constant process temperatures, a change can indicate a possible buildup of magnetite or an increase in the magnetite content of the fluid. Strong external magnetic fields influence this value too.
Reference electrode potential against PE	This diagnostic value describes the voltage between the fluid and the protective ground. This value is of significance if the measuring device with the reference electrode contacting the fluid is disconnected from the protective ground.

 The monitoring measured variables listed below can be displayed locally but cannot be assigned to the outputs of the measuring device. The local display is used to diagnose process situations that could affect the measurement quality or the integrity of the measuring device.

Navigation

"Diagnostics" menu → Heartbeat → Monitoring results

Navigation

"Expert" menu → Diagnostics → Heartbeat → Monitoring results

► Monitoring results

Noise

Coil current shot time

Reference electrode potential against PE

Parameter overview with brief description

Parameter	Description	User interface
Noise	Indicates the degree to which the differential signal from both measuring electrodes is dispersed.	0 to $3.0 \cdot 10^{+38} \mu V$
Coil current shot time	Indicates the rise time of the coil current for the buildup of the magnetic field.	2 to 500 ms
Reference electrode potential against PE	Displays the voltage of the reference electrode in relation to the potential of the measuring tube.	-30 to +30 V

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