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Valid as of version
01.00.zz (Device firmware)

Special Documentation
Proline Prowirl 200

Heartbeat Verification application package
PROFINET with Ethernet-APL

ethernet-apl™
advanced physical layer

Endress+Hauser
People for Process Automation

Table of contents

1 Certification

Certification is issued by an independent certification body.

The following requirements are certified:
- Inspection method
- Test principles
- Test results with total test coverage (TTC) specified
- Traceable verification according to DIN EN ISO 9001:2015, Section 7.1.5/7.1.5.2 a)

Requirements according to DIN EN ISO 9001
Heartbeat Technology™ also meets the requirements for traceable verification according to DIN EN ISO 9001: 2015 - Section 7.1.5/7.1.5.2 a) "Control of monitoring and measuring equipment". According to the standard, the user is responsible for specifying the verification interval in a manner that complies with requirements.

Further information on the documentation .

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

2.3.1 Safety symbols

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

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

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

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

2.3.2 Symbols for certain types of information

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

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:
- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

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

Measuring device	Documentation code
Prowirl D 200	BA02133D
Prowirl F 200	BA02132D
Prowirl O 200	BA02134D
Prowirl R 200	BA02135D

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

2.5 Registered trademarks

Ethernet-APL™
Registered trademark of the PROFIBUS Nutzerorganisation e.V. (PROFIBUS User Organization), Karlsruhe, Germany

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Registered trademarks of DuPont Performance Elastomers L.L.C., Wilmington, DE USA

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Registered trademark of Garlock Sealing Technologies, Palmyar, NY, USA

3 Product features and availability

3.1 Product features

Heartbeat Technology offers diagnostic functionality by means of continuous self-monitoring as well as in-situ verification of flowmeters in the application.

The test scope achieved using these diagnostic and verification tests is expressed 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 that are not captured by the device diagnostics can falsify the measured value that is output or interrupt the output of measured values.

Heartbeat Technology checks the device function within the specified measuring tolerance with a defined TTC. The defined TTC is indicated in the product-specific TÜV certificate (TÜV = Technical Inspection Association).

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

3.2 Availability of the application package

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

The availability of the Heartbeat Verification application package with the **EB** option 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 displays the packages that are currently activated.

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"

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

3.2.2 Activation

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

Expert → System → Administration

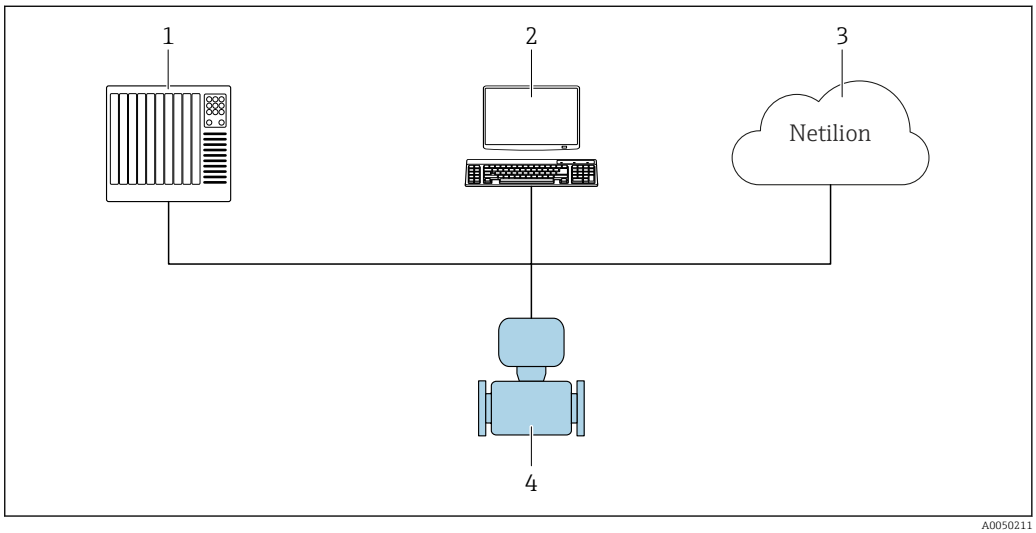
- Enter the activation code.
  - The application package is available.
    The **Software option overview** parameter displays the packages that are currently activated.

3.2.3 Access

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

4 System integration

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

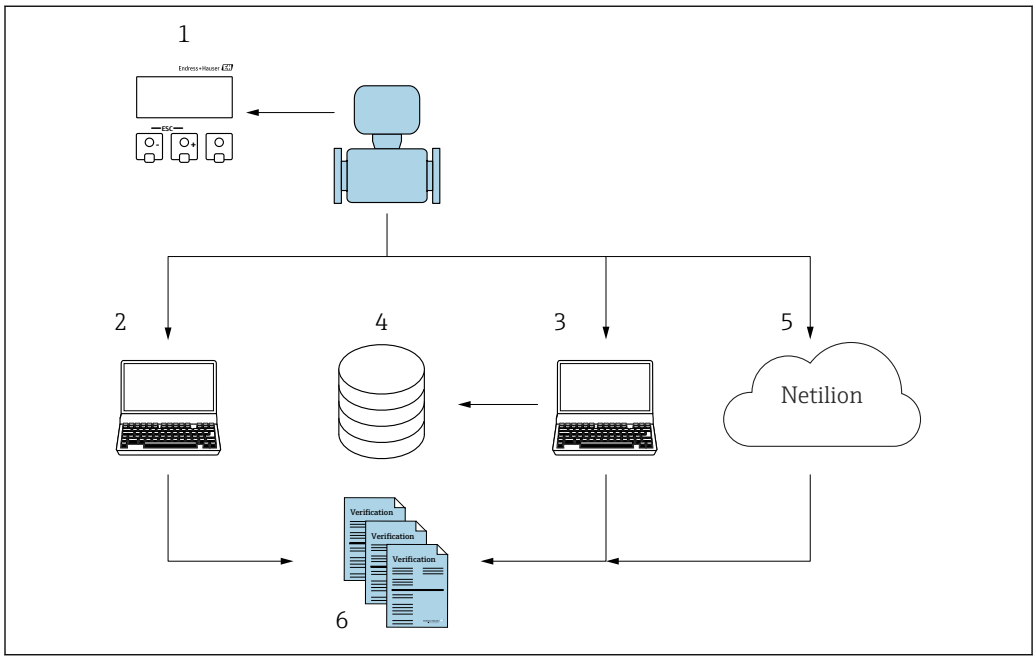


1 General screen layout

1 PLC
2 Asset management system
3 Netilion cloud platform
4 Measuring device

More documentation on Netilion is available:
In the Download Area of the Endress+Hauser website:
www.endress.com → Downloads

4.1 Performing verification and creating a verification report



1 *Local display*
2 *Web browser*
3 *FieldCare*
4 *Data archive (via Flow Verification DTM)*
5 *Netilion cloud platform*
6 *Verification report*

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

The device must be accessed externally from a higher-level system via the system integration interface in order to start a verification and signal the verification result (Passed or Failed). It is not possible to start the verification via an external status signal and relay the results to a higher-level system via the status output.

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

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

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

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

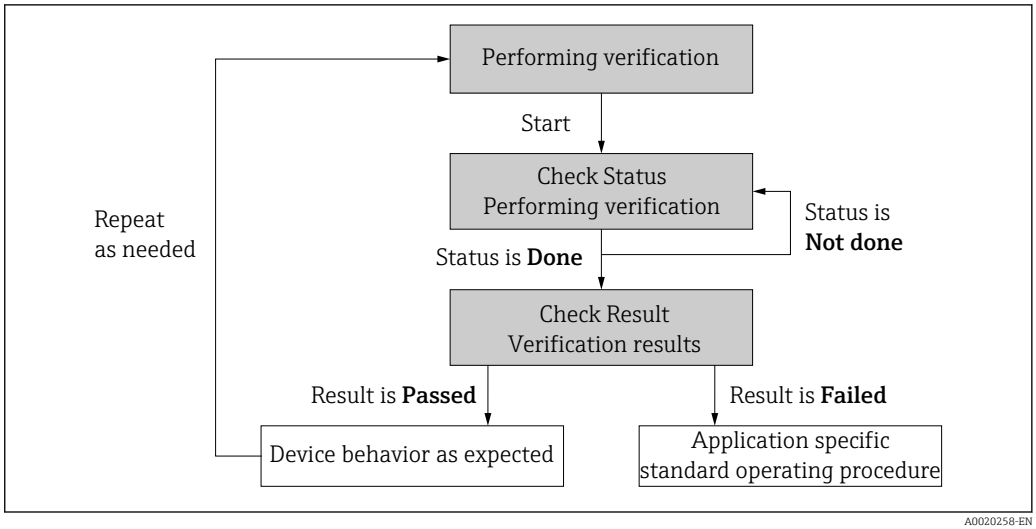
Data exchange can take place automatically or be triggered by a user.

4.2 Integration into the PLC system

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

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

The following procedure must be implemented for this purpose:



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

4.3 Data availability for the user

The data from the **Heartbeat Verification** function can be made available in a variety of ways.

4.3.1 Device

Heartbeat Verification
- Start verification
- Read out the last verification result

4.3.2 Asset management system

Heartbeat Verification
- Start verification in the operating menu
- Upload, archive and document the verification results including detailed results with Flow Verification DTM

4.3.3 PLC system

Heartbeat Verification
- Start verification
- The user can read the verification result in the system

4.3.4 Netilion cloud platform

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

4.4 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 records
- 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, the Endress+Hauser asset management software, FieldCare, and Netilion Health.

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

4.4.1 Data management via Web browser

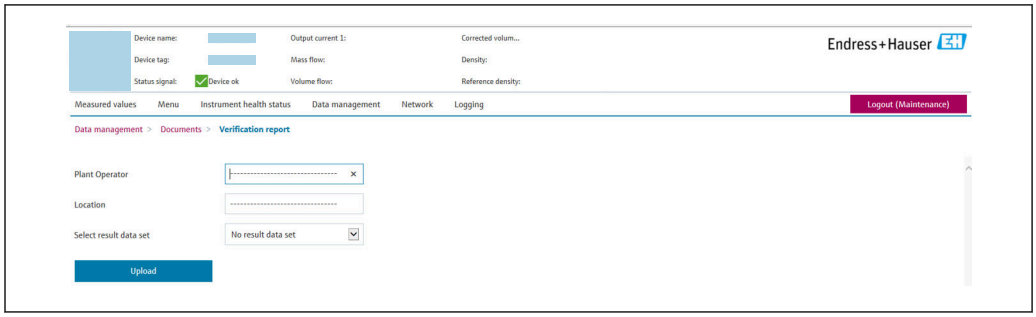
Thanks to the integrated Web server the device can be operated and configured via a Web browser. In addition, it is possible to query the results of the verification and create a verification report.

Printing a verification report

A verification report is created in PDF format.

Prerequisite: A verification has already been performed.

User interface in the Web browser following login:



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

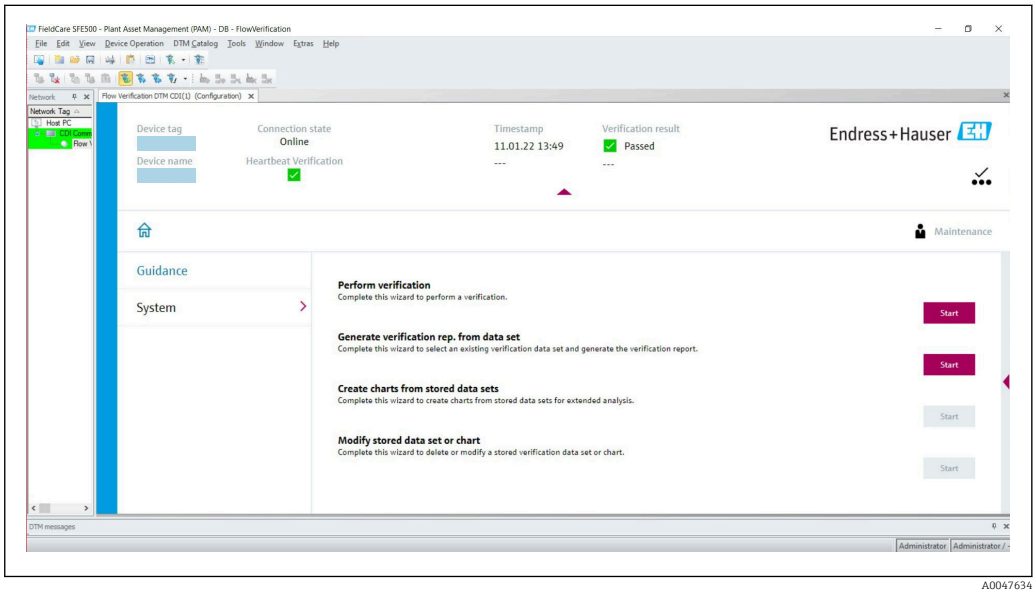
1) First In – First Out

4.4.2 Data management via device DTM

With the device DTM, it is possible to operate the device and perform**Heartbeat Verification**. The results that are generated are displayed as a verification report and saved in PDF format.

4.4.3 Data management via Flow Verification DTM

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



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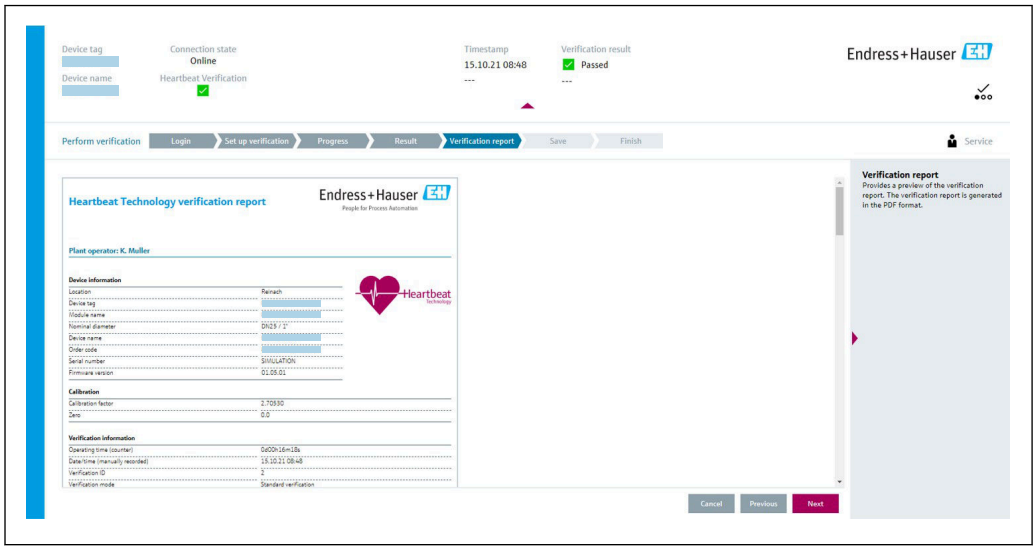
2 *Home page of "Flow Verification DTM" in FieldCare SFE500*

A wizard with help text guides you step-by-step through four different procedures.

Starting point	Description of procedure
Perform verification *Online connection to device required.*	Perform verification and create a verification report.
Create the verification report using a verification data record ▪ from the device (online) ▪ from the archive (offline)	Select an existing verification data record and create the verification report.
Create charts on selected diagnostic parameters from saved verification data records	Create charts on selected diagnostic parameters from archived verification data records for advanced analyses and trending.
Manage saved verification data records or chart templates	Delete or change archived verification data records or chart templates.

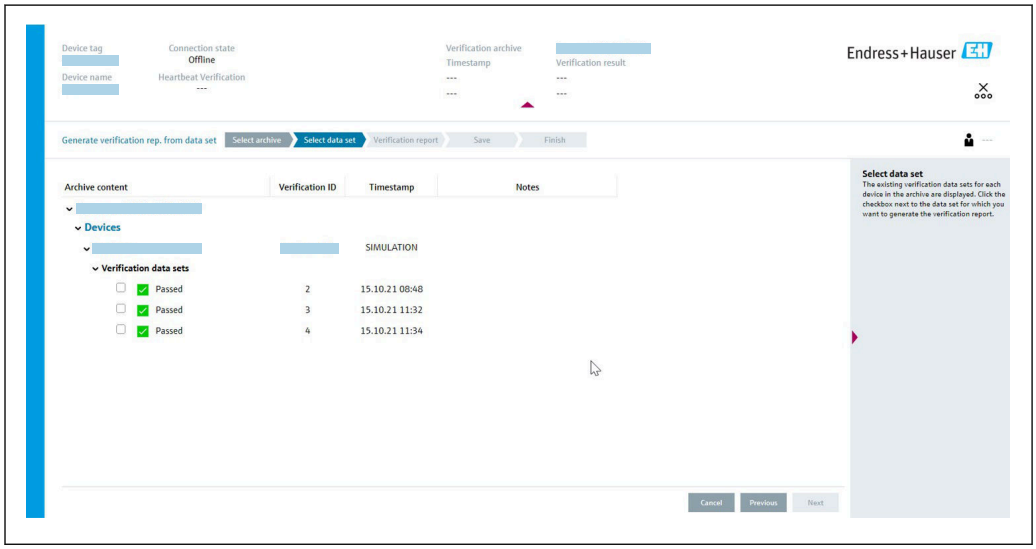
Perform verification



3 *Example: Displaying the verification report after performing verification*

Online connection to device required.

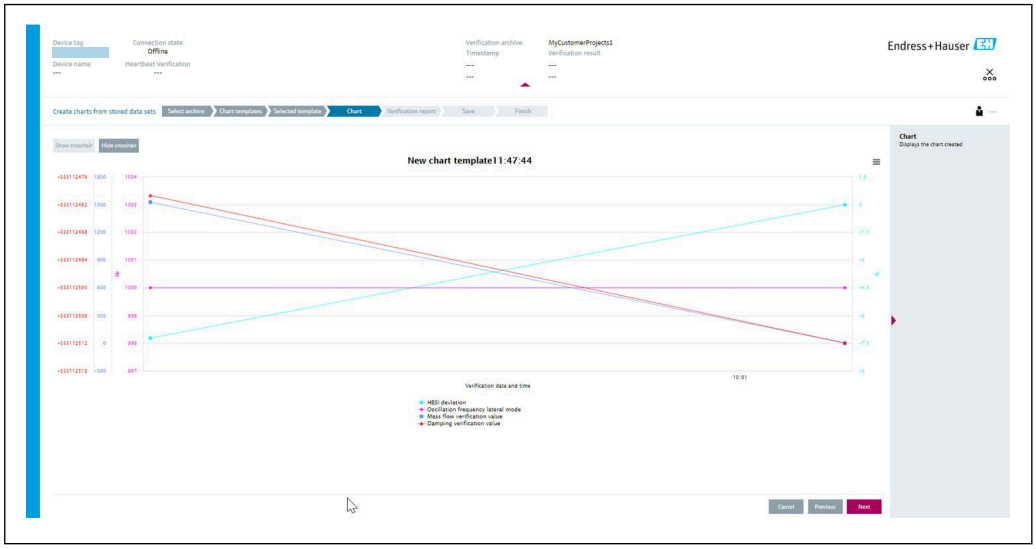
Creating the verification report using a verification data record



4 *Example: Creating the verification report using a verification data record*

Reading in the verification data record from the
- Device: Online connection to device required.
- Archive: Offline use sufficient.

Creating charts on selected diagnostic parameters from saved verification data records



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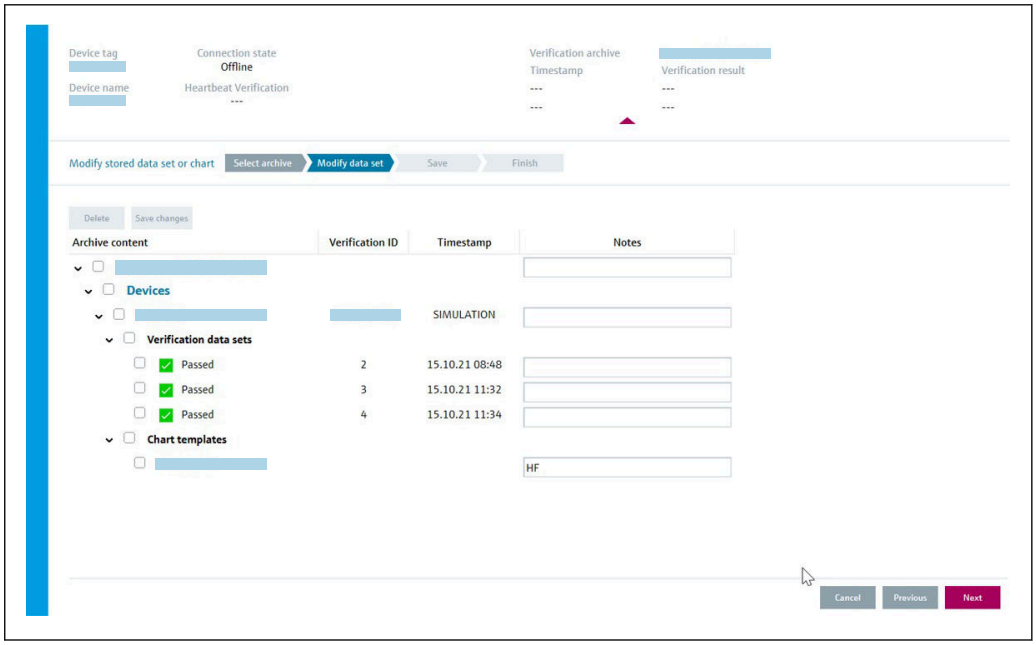
5 *Example: Creating self-edited charts on selected diagnostic parameters from saved verification data records*

It is possible to create templates.

Managing saved verification data records or chart templates



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6 *Example: Deleting or changing saved verification data records or chart templates*

5 Heartbeat Verification

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

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

Heartbeat Technology offers two ways to perform Heartbeat Verification:
Standard verification → 18
Verification is performed by the device without manual checking of external measured variables.

5.1 Performance characteristics

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

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

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

5.2 Commissioning

The configuration (factory reference) required as part of **Heartbeat Verification** is recorded during calibration at the factory and is permanently stored in the measuring device. When verifying in the application, the current situation of the measuring device is compared against this factory reference.

Recommendation: During the process of commissioning the measuring device, an initial verification (and all additional verifications during the life cycle) is performed under process or reference conditions → 12.

The results are saved as the initial situation in the life cycle of the measuring device up to the 8th verification. From the 9th verification, it is recommended to upload the results using the verification DTM so that the data of the previous verifications is not lost.

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	→ 17
Location	→ 17

Parameter overview with brief description

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

5.3 Operation

5.3.1 General information

In the case of measuring devices that are used in safety-related applications according to IEC 61508, the SIL mode must be disabled in order to use the **Heartbeat Verification** feature.

For further information on **Heartbeat Technology** in safety-related applications, see Special Documentation, Functional safety manual.

5.3.2 Initial verification

- When commissioning the measuring device:
  An initial verification is performed to archive the results as the initial situation in the life cycle of the measuring device. From the 9th verification onwards, an upload using the verification DTM is recommended.

Verification is performed with standard verification → 18

5.3.3 Device behavior and interpretation

Result is "Passed"

All test results are within the specifications.

If the calibration factor and the 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 is "Failed"

One or more test results are outside the specifications.

If the result of the verification is "Failed", take the following measures:

1. Establish defined and stable process conditions.
   ↳ Ensure a constant process temperature.
   Avoid wet gases, two-phase mixtures, pulsating flow, pressure shock and very high flow rates.

2. Repeat verification.
   ↳ Repeat verification "Passed"
   If the result of the second verification is "Passed", the result of the first verification can be ignored. In order to identify possible deviations, compare the current process conditions with the process conditions of a previous verification.

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

1. Take remedial action on the basis of the verification results and the diagnostic information of the measuring device.
   ↳ The cause of the error can be narrowed down if the test group that "Failed" the verification is identified.
2. Provide Endress+Hauser Service with the verification result with the current process conditions.
3. Check the calibration or 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.

5.3.4 Standard verification

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

Diagnostic behavior

The device signals that standard verification is being performed: ⚠**C302 Device verification in progress** diagnostic message
- Factory setting for diagnostic behavior: warning
- The device continues to measure.
- The last good value is output intermittently for 10 seconds.
- The signal outputs and totalizers are not affected.
- Test duration: approx. 60 seconds.

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

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

Performing standard verification

Before verification starts

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

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

1. Enter date and time.

Select the verification mode

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

Starting the verification test

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

Displaying the verification status and result

The current status of standard verification is displayed in the **Status** parameter (→ 21):
- 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) → 17.

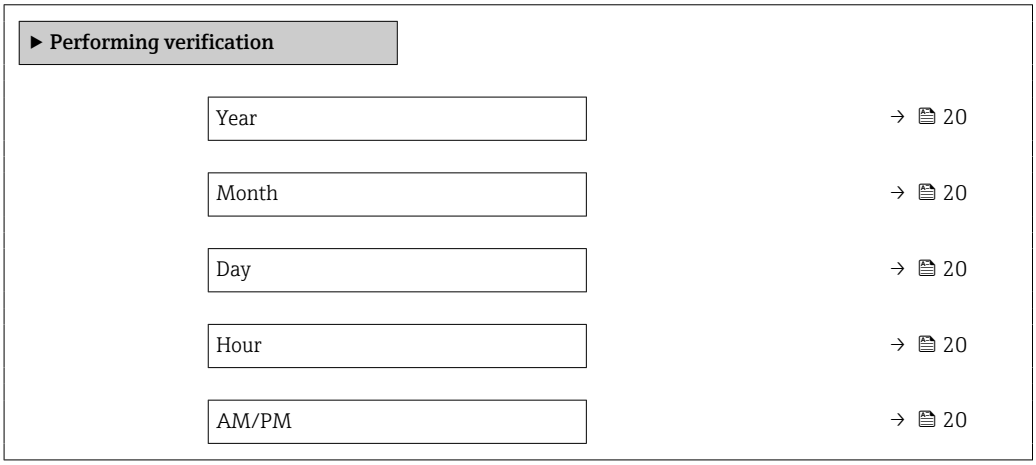
The result of the verification is displayed in the **Overall result** parameter (→ 21):
- Passed
  All the verification tests were successful.
- Not done
  A verification has not yet been performed on this measuring device.
- Failed
  One or more verification tests were not successful → 17.

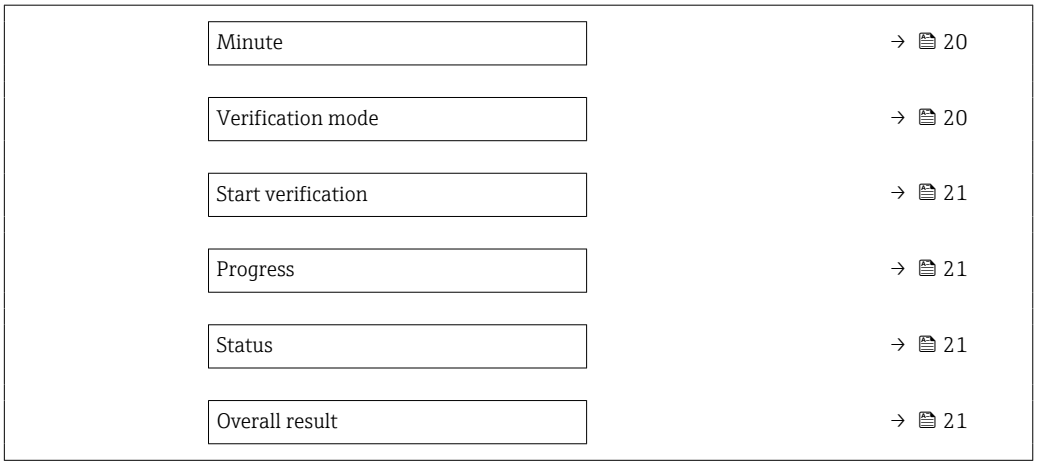
- The overall result of the last verification can always be accessed in the menu.
- Navigation:
  Diagnostics → Heartbeat Technology → Verification results
- Detailed information on the verification result (test groups and test status) are shown in the verification report in addition to the overall result → 23.
- If the device does not pass the verification, the results are saved nonetheless and indicated in the verification report.
- This facilitates a targeted search for the cause of the fault → 17.

"Performing verification" submenu

Navigation

"Diagnostics" menu → Heartbeat Technology → Performing verification





Parameter overview with brief description

Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
Year	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 1): enter the year verification is performed.	9 to 99	21
Month	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 2): enter the month verification is performed.	▪ January ▪ February ▪ March ▪ April ▪ May ▪ June ▪ July ▪ August ▪ September ▪ October ▪ November ▪ December	January
Day	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 3): enter the day verification is performed.	1 to 31 d	1 d
Hour	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 4): enter the hour verification is performed.	0 to 23 h	12 h
AM/PM	Can be edited if Heartbeat Verification is not active. The **dd.mm.yy hh:mm am/pm** option or the **mm/dd/yy hh:mm am/pm** option is selected in the **Date/ time format** parameter (2812).	Entry for date and time (field 5): enter the morning or afternoon.	▪ AM ▪ PM	AM
Minute	Can be edited if Heartbeat Verification is not active.	Entry for date and time (field 6): enter the minute verification is performed.	0 to 59 min	0 min
Verification mode	Can be edited if Heartbeat Verification is not active.	Select the verification mode. Standard verification Verification is performed automatically by the device and without manual checking of external measured variables.	Standard verification	Standard verification

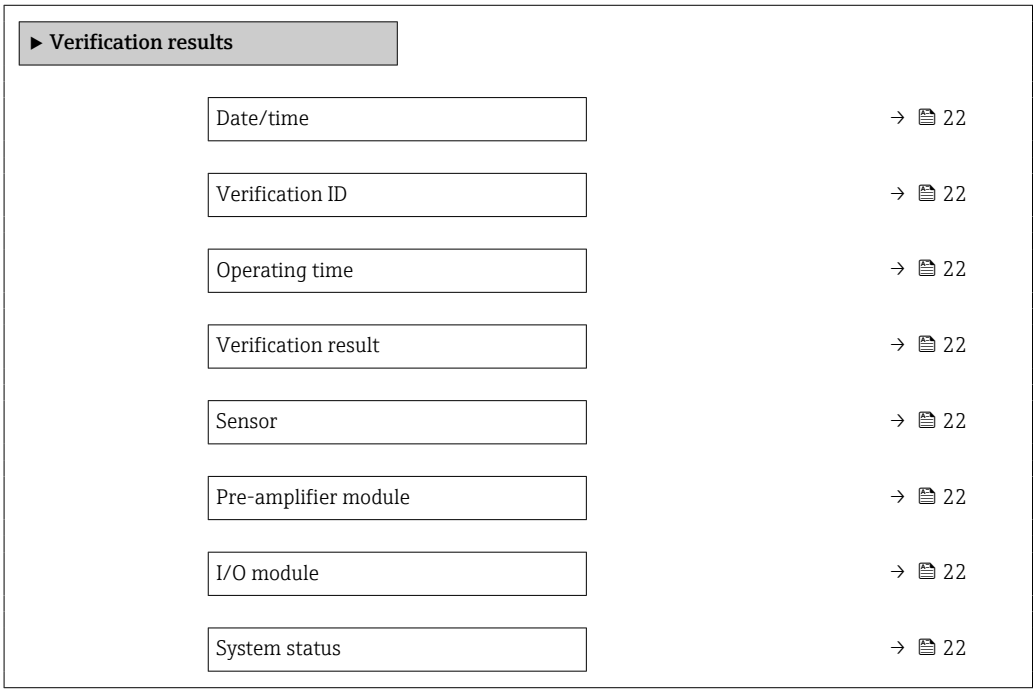
Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
Start verification	–	Start the verification. Start the verification with the **Start** option.	▪ Cancel ▪ Start	Cancel
Progress	–	Shows the progress of the process.	0 to 100 %	–
Status	–	Displays the current status of the verification.	▪ Done ▪ 0% ▪ Failed ▪ Not done	–
Verification result	–	Displays the overall result of the verification. Detailed description of results classification: → 🖹 23	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	–

5.3.5 Verification results

Access to the verification results:
In the operating menu via the operating tool
Diagnostics → Heartbeat Technology → Verification results

Navigation
"Diagnostics" submenu → Heartbeat → Verification results

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



Parameter overview with brief description

Parameter	Prerequisite	Description	User interface	Factory setting
Date/time	The verification has been performed.	Date and time.	dd.mmmm.yyyy; hh:mm	1 January 2010; 12:00
Verification ID	The verification has been performed.	Displays consecutive numbering of the verification results in the measuring device.	0 to 65 535	0
Operating time	The verification has been performed.	Indicates how long the device has been in operation up to the verification.	Days (d), hours (h), minutes (m), seconds (s)	–
Verification result	–	Displays the overall result of the verification. Detailed description of results classification: → 23	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	–
Sensor	The **Failed** option is shown in the **Overall result** parameter.	Displays the result for the sensor. Detailed description of results classification: → 23	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done
Pre-amplifier module	The **Failed** option is shown in the **Overall result** parameter.	Displays the result for the sensor electronics module (ISEM). Detailed description of results classification: → 23	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done
I/O module	The **Failed** option is shown in the **Overall result** parameter.	Displays the result for I/O module monitoring of the I/O module. ▪ For pulse output: Accuracy of the pulses (for external verification only) ▪ For frequency output: Accuracy of the frequency (for external verification only) **Heartbeat Verification** does not check the digital inputs and outputs and does not output any result for them. Detailed description of results classification: → 23	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done
System status	The **Failed** option is shown in the **Overall result** parameter.	Displays the system condition. Tests the measuring device for active errors. Detailed description of results classification: → 23	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done

Classification of results

Individual results

Result	Description
Failed	At least one individual test in the test group was outside the specifications.
Passed	All individual tests in the test group complied with the specifications. The result is also "Passed" if the result of an individual test is "Check not done" and the result of all other tests is "Passed".
Not done	No test has been performed for this test group.

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. Based on redundant references in the device which are traceable from the factory, **Heartbeat Technology** meets all the requirements concerning traceable device verification according to DIN ISO 9001: 2015 Chapter 7.1.5.2 a).

Test groups

Test group	Description
Sensor	Electrical and mechanical components of the sensor (mechanical integrity of DSC sensor, temperature signals, circuits and cabling)
Pre-amplifier module	Electronics module for converting the sensor signals (checking of measuring paths for temperature and flow measurement)
Main electronics module	Checking the supply voltage
System condition	Test for active measuring device errors of "alarm"-type diagnostic behavior

For more information on the test groups and individual tests → 23.

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 results which can be accessed with the Flow Verification DTM.

5.3.6 Detailed verification results

Individual results according to test groups and detailed verification results can be called up via the Flow Verification DTM.

This also applies for the process conditions that are determined at the time of verification.

Process conditions

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

Process conditions	Description
Process temperature	Current measured value for process temperature
Volume flow	Current measured value for volume flow
Flow velocity	Current measured value for flow velocity
Process pressure (internal/ external)	Current measured value for process pressure (internal/external)
DSC sensor temperature PT1 [1)]	Current measured value for temperature of the first PT1000 sensor of the DSC sensor
DSC sensor temperature PT2 [1)]	Current measured value for temperature of the second PT1000 sensor of the DSC sensor
Pre-amplifier temperature	Current measured value for temperature in pre-amplifier
Electronic temperature	Current measured value for the electronic temperature in the transmitter
Pressure cell temperature	Current measured value for temperature in the pressure cell
Terminal voltage value	Current measured value for terminal voltage

1) Only available for option "Mass (integrated temperature measurement)" or option "Mass (integrated pressure/temperature measurement)"

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
DSC sensor	Checking of DSC sensor (mechanical integrity of DSC sensor)	No value range ▪ Passed ▪ Failed ▪ Not done	Gap capacity or difference not within the specified range **Causes** Holes/cracks from corrosion, overloading, etc. **Measures** ► Check process. ► Replace DSC sensor.
Temperature sensor [1]	Checking of the two PT1000 sensors of the DSC sensor	No value range ▪ Passed ▪ Failed ▪ Not done	**Causes** ▪ Temperature sensor is defective ▪ Temperature outside specification **Measures** ► Check application-related temperature limit values (T_{min}, T_{max}). ► Check temperature sensor connection. ► Check contact between the DSC sensor and pre-amplifier. ► Dry or clean contacts. ► Replace DSC sensor.
Pressure cell [2]	Checking of pressure cell	No value range ▪ Passed ▪ Failed ▪ Not done	**Causes** Electronics pressure cell, cable or connector defective **Measures** ► Check limit values for pressure and temperature. ► Check pressure cell connection. ► Replace the pressure cell. ► Replace the cable.

1) Only available for option "Mass (integrated temperature measurement)" or option "Mass (integrated pressure/temperature measurement)"
2) Only available for option "Mass (integrated pressure/temperature measurement)"

Pre-amplifier

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Reference clock	Monitoring of the reference clock for flow measurement	No value range ▪ Passed ▪ Failed ▪ Not done	**Causes** Pre-amplifier or main electronics defective
DSC sensor measuring path	Checking of DSC sensor measuring path	No value range ▪ Passed ▪ Failed ▪ Not done	⊗**F351 Pre-amplifier defective** diagnostic message **Causes** Incorrect reference capacity measurement.
Temperature measuring path (mass flow only)	Checking of temperature measuring path	No value range ▪ Passed ▪ Failed ▪ Not done	⊗**F350 Pre-amplifier defective** diagnostic message **Causes** Incorrect temperature measurement and electronics unit defective.
DSC sensor signal processing	▪ Checking of overall DSC signal processing chain in the pre-amplifier module ▪ Checking of vortex frequency and vortex amplitude	No value range ▪ Passed ▪ Failed ▪ Not done	⊗**F370 Pre-amplifier defective** diagnostic message **Causes** Reference vortex frequency or reference vortex amplitude and vortex measuring path incorrect.

Main electronics module

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Supply voltage	Checking of internal supply voltage on main electronics	No value range ▪ Passed ▪ Failed ▪ Not done	⊗**F270 Main electronic failure** diagnostic message **Causes** Electronics defective **Measures** ▶ Replace main electronics.
Terminal voltage	Checking of current terminal voltage at the transmitter	No value range ▪ Passed ▪ Failed ▪ Not done	**Causes** Terminal voltage out of specification. **Measures** ▶ Check terminal voltage. ▶ Increase terminal voltage.

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.

5.3.7 Verification report

The results of the verification can be documented in the form of a verification report via the web server or the FieldCare operating tool → 12. 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 compensated calibration factor 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: standard 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 → 23
  - Sensor
  - Pre-amplifier module
  - Main electronics module
  - System condition

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

Last page: process conditions
Information on the process conditions that applied during the verification:
- Volume flow
- Flow velocity
- Process temperature
- Process pressure (internal/external)
- DSC sensor temperature PT1
- DSC sensor temperature PT2
- Pre-amplifier module

- Electronics temperature
- Pressure cell temperature
- Terminal voltage 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.

Individual test groups and description of individual tests: → 23

Data management with Web server and FieldCare (Flow Verification DTM): → 12

5.3.8 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 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 comparative values checked are within the factory specification and that the measuring device is working correctly. At the same time, zero point and calibration factor of the sensor can be traced via the verification report. To ensure that the measuring device complies with the factory specification, these values must correspond to those of the last calibration or repeat calibration.

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

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.

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

The process conditions for the previous verification are documented on the last page of the verification report or can be called up using the Flow Verification DTM → 23.

Additional remedial measures if the result of a verification is "Failed"

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

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

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