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01.02.zz (Device firmware)

Special Documentation
Proline Prosonic Flow G 500

Heartbeat Verification + Monitoring application package HART

HART COMMUNICATION PROTOCOL

Endress+Hauser
People for Process Automation

Table of contents

1 Certification

1.1 Traceability according to ISO 9001

Heartbeat Verification verifies the requirement for the measuring device within the specified measuring tolerance with a confirmed total test coverage over the service life of the device. It thus fulfills the requirements for traceable verification according to ISO 9001:2015, Clause 7.1.5.2 Measurement traceability.

The certificate issued by an independent body (TÜV SÜD Industrieservices GmbH) is available via: *Device Viewer* (www.endress.com/deviceviewer): Enter serial number from nameplate.

1.2 TÜV certificate

Heartbeat Technology with Heartbeat Diagnostics and Heartbeat Verification is a test method integrated into the measuring device for the diagnosis and verification of measuring devices in the application over the service life of the device. The test is based on reference values that are incorporated in the measuring device, traceable from the factory and redundant in the device.

1.2.1 Test principles

- IEC 61508-2:2010-04, Annex C
- IEC 61508-3:2010-04, Clause 6
- ISO 9001:2015, Clause 7.1.5 Resources for monitoring and measuring

1.2.2 Test results

Heartbeat Verification confirms on demand that the device is functioning with the specified total test coverage (TTC). 95% (Total Test Coverage)

Heartbeat Technology fulfills the requirement for traceable verification according to ISO 9001:2015, Clause 7.1.5.2 Measurement traceability. According to the standard, the user is responsible for specifying the verification interval in accordance with requirements.

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

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

Measuring device	Documentation code
Prosonic Flow G 500	BA01836D

Certification	Documentation code
Manufacturer declaration Prosonic Flow 300/500	HE_01410

2.5 Registered trademarks

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

3 Product features and availability

3.1 Product features

Heartbeat Technology offers diagnostic functionality through continuous self-monitoring, the transmission of additional measured variables to an external Condition Monitoring system and the in-situ verification of measuring devices 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. It is determined under the following basic 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

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 later on as a retrofit kit:
Order code for "Application package", option EB "Heartbeat Verification + Monitoring"

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

3.2.2 Activation

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.

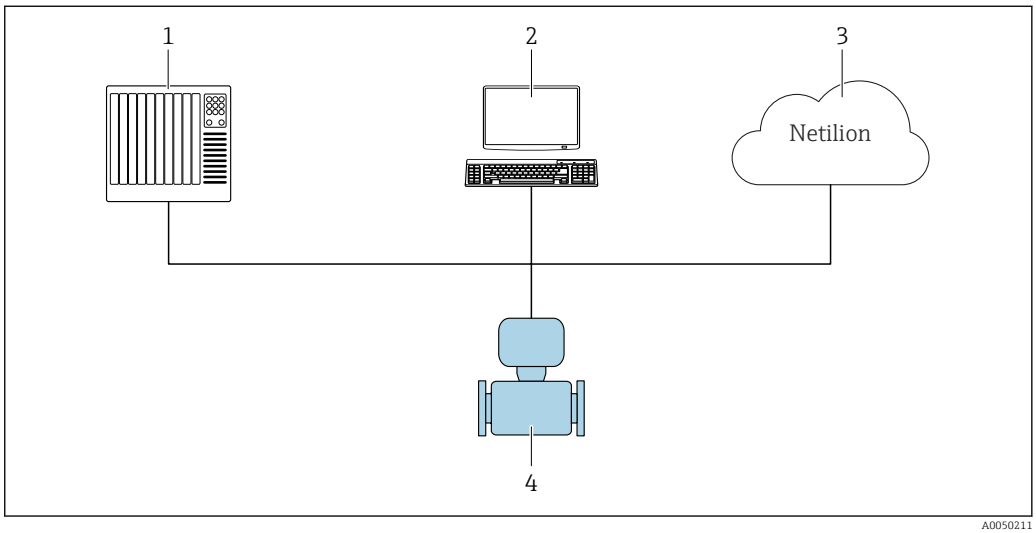
For detailed information on "Activating application packages via the software license code", see Installation Instructions EA01164D

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, the automation infrastructure (e.g. PLC) or the Netilion cloud platform.

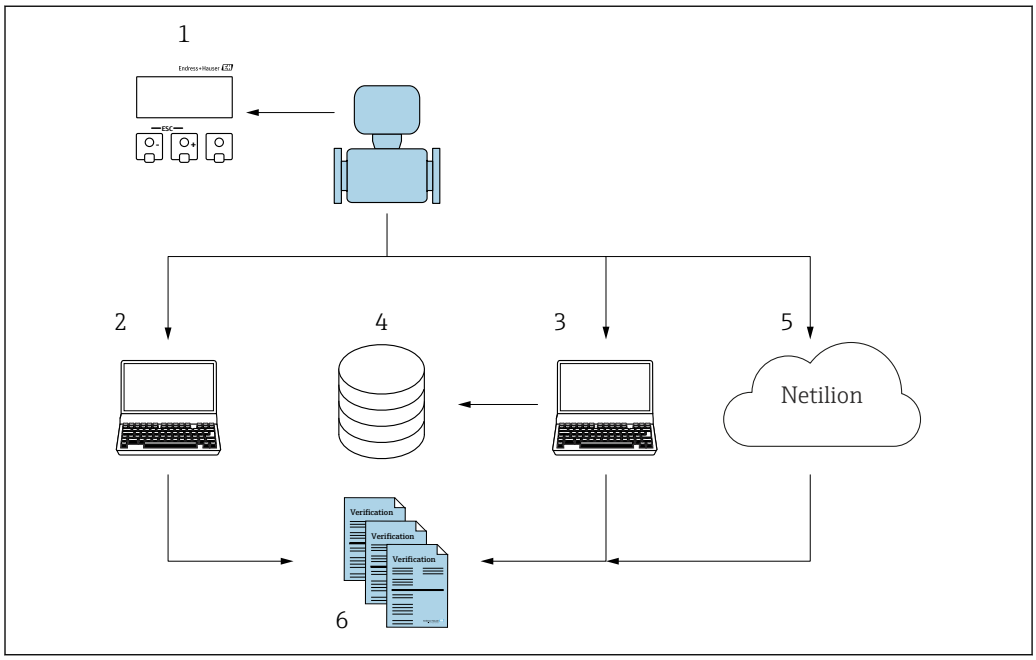


1 *General screen layout*

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

For more information on Netilion: www.endress.com → Downloads

4.1 Performing the 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 **Heartbeat Verification** via one of the following interfaces:
- System integration interface of a higher-level system
- Local display
- WLAN interface
- CDI-RJ45 service interface (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 generated with the help of the device DTM, web server integrated in the measuring device or Endress+Hauser's FieldCare 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 evaluation purposes, for example to extend recalibration intervals .

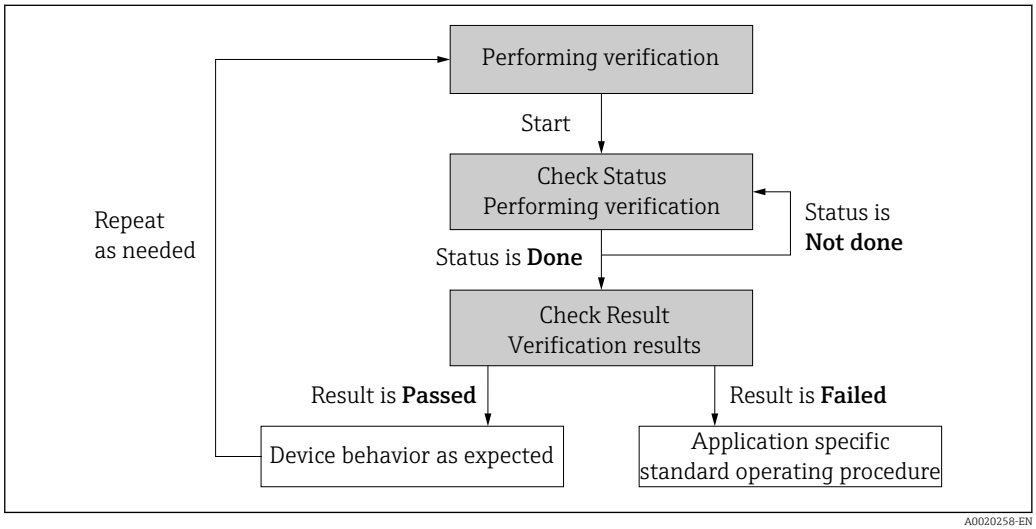
Data exchange can take place automatically or be triggered by a user.

4.2 Integration in the PLC system

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

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

The following procedure must be implemented for this purpose:



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

4.3 Data availability for the user

The data from the **Heartbeat Monitoring** function and the **Heartbeat Verification** function can be made available in different ways.

4.3.1 Device

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

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

4.3.2 Asset management system

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

Heartbeat Verification
- Start verification in the operating menu.
- Read out, archive and document the verification results including detailed results with flow verification DTM and devices DTM.

4.3.3 PLC system

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

Heartbeat Verification
- Start verification.
- The user can read the verification result (pass/fail) in the system.

4.3.4 Netilion cloud platform

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

Heartbeat Verification
- Start verification.
- Read out, archive and document the verification results including detailed results using 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:
- Availability of 8 storage locations for parameter data sets
- New verification results overwrite old data following the FIFO [1] principle

The results can be documented in the form of a verification report using the web server integrated in the measuring device the Endress+Hauser FieldCare asset management software 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 and a **Heartbeat Verification** performed. The results of the verification can be displayed and a verification report can be created.

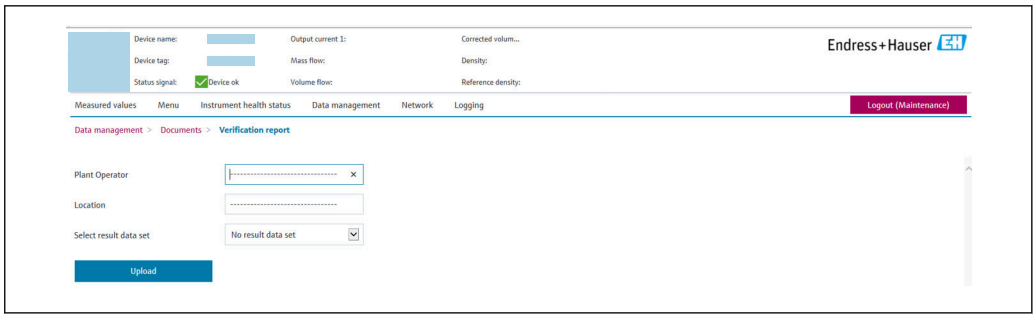
Printing a verification report

A verification report is created in PDF format.

Prerequisite: A verification has already been performed.

User interface in the Web browser following login:

1) First In – First Out



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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.

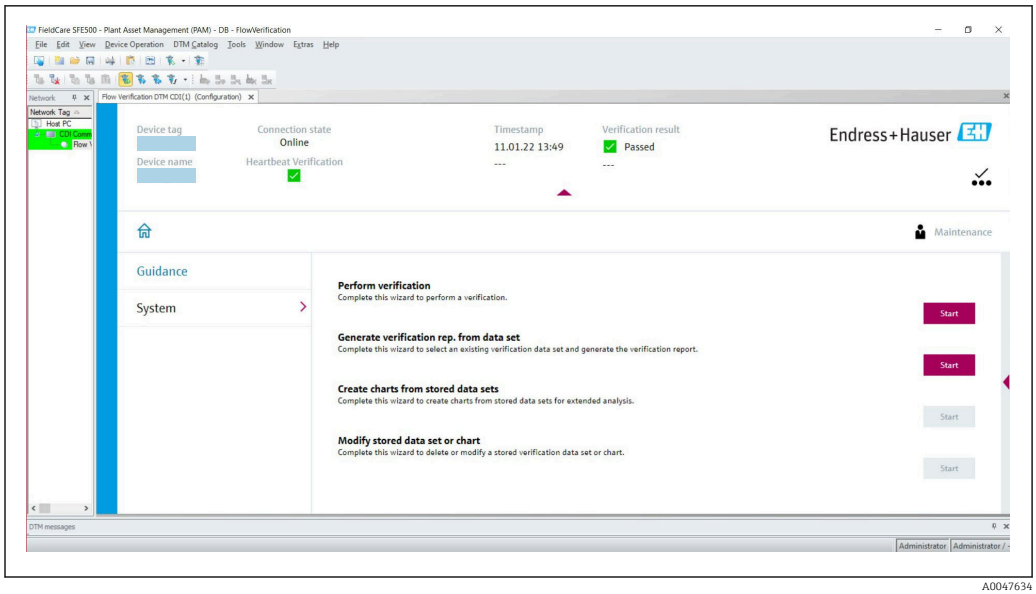
4.4.2 Data management via device DTM

Thanks to the device DTM the device can be operated and a **Heartbeat Verification** performed. The results of the verification can be displayed and a verification report can be created.

4.4.3 Data management via Flow Verification DTM

The Flow Verification DTM allows you to perform a **Heartbeat Verification**. The results of the verification can be displayed and a verification report can be created.

The Flow Verification DTM offers advanced capabilities for managing and visualizing the results.

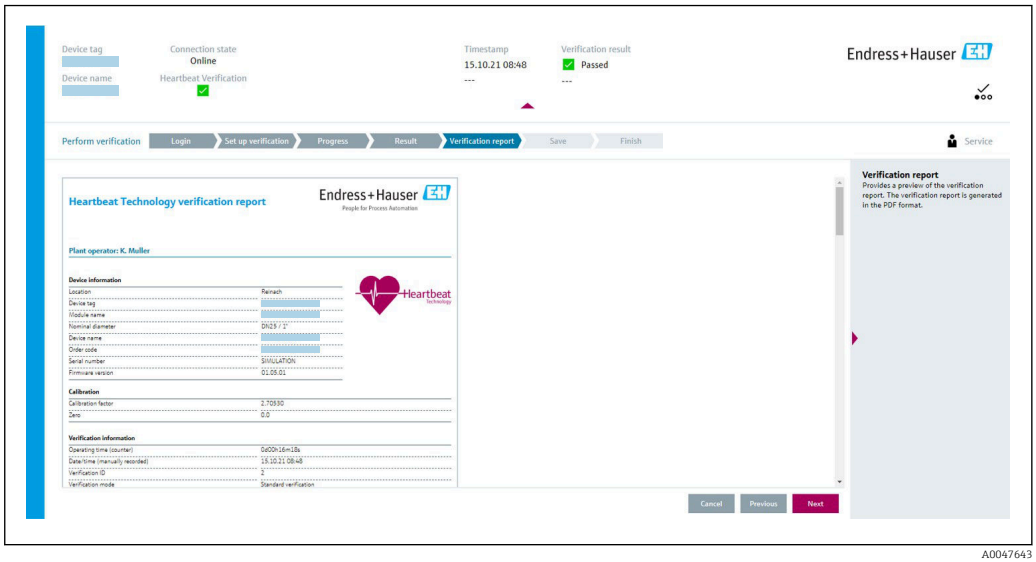


2 *"Flow Verification DTM" home page in FieldCare SFE500*

A wizard guides the user through four different processes step by step with help text.

Entry point	Process description
Perform verification *Online connection to the device required.*	Perform verification and generate a verification report.
Generate verification report using a verification data set ▪ from the device (online) ▪ from archive (offline)	Select the existing verification data set and create the verification report.
Create charts for selected diagnostic parameters from stored verification data sets	Create charts for selected diagnostic parameters from archived verification data sets for the purpose of advanced analysis and trending.
Maintain stored verification data sets or chart templates	Delete or modify archived verification data sets or chart templates.

Perform verification



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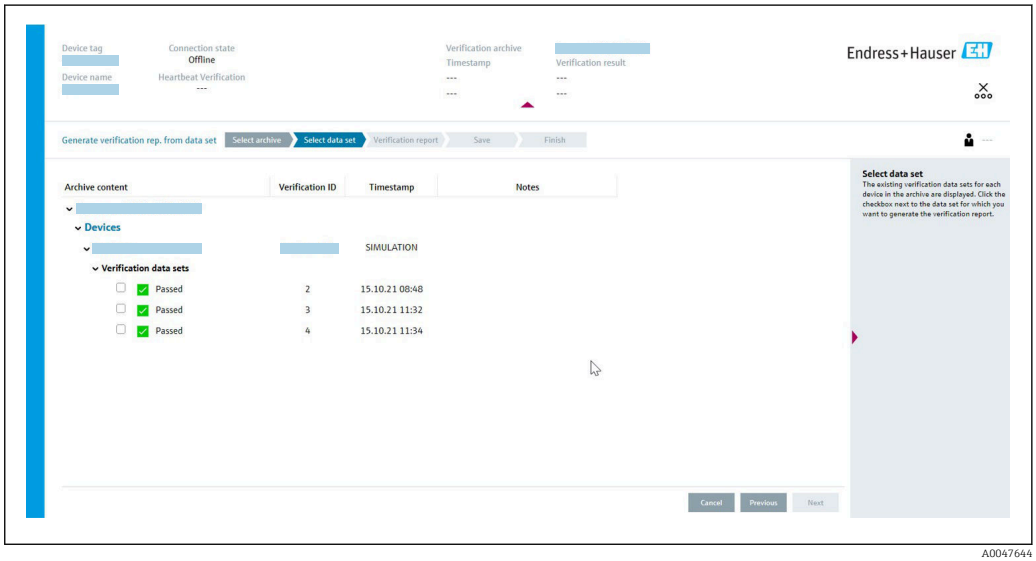
3 *Example: Verification report displayed after verification has been performed*

Online connection to the device required.

Generate verification report using a verification data set



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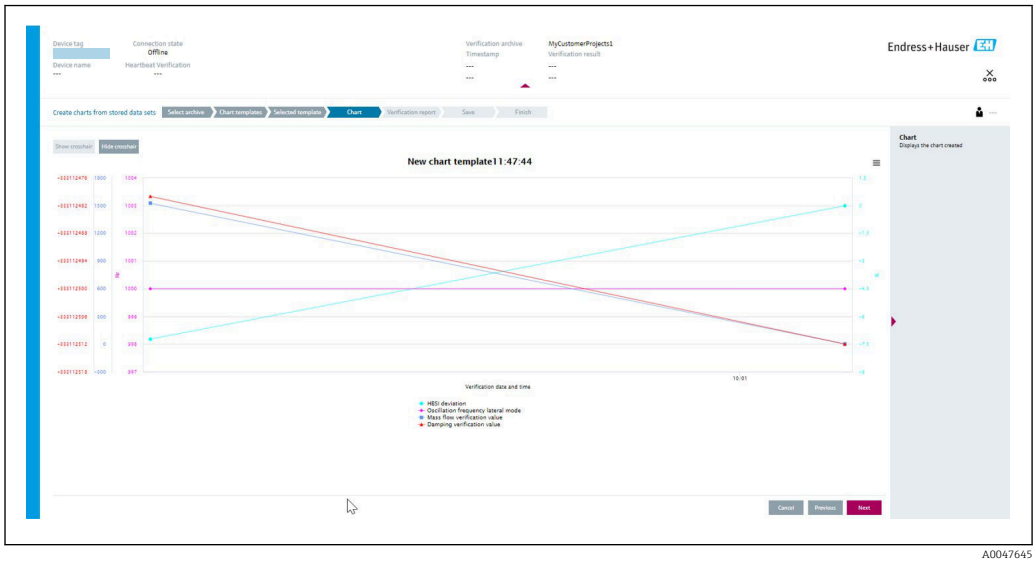
4 *Example: Generating verification report using a verification data set*

Read the verification data set from
- Device: Online connection to device required.
- Archive: Offline operation sufficient.

Creating charts for selected diagnostic parameters from stored verification data sets



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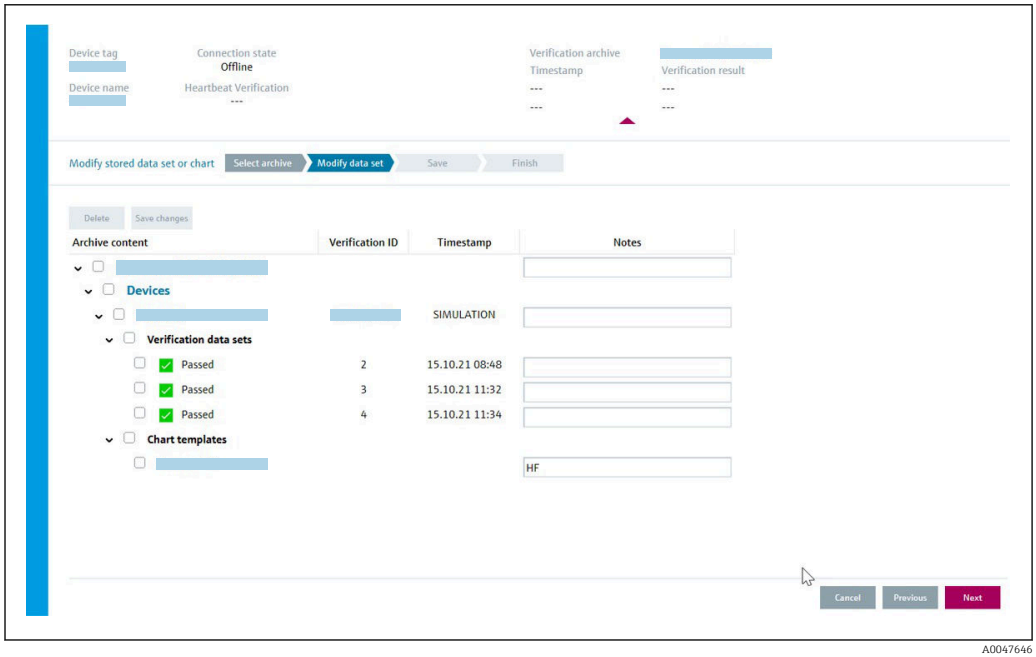
5 *Example: Create charts you have edited yourself for selected diagnostic parameters from stored verification data sets*

You can create your own templates.

Maintaining stored verification data sets or chart templates



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6 *Example: Deleting or modifying stored verification data sets 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 archived on a PC with the Asset Management Software DeviceCare or FieldCare on a PC. Based on this data, a verification report is generated automatically to ensure that traceable documentation of the verification results is available.

Heartbeat Technology offers two options for performing Heartbeat Verification:
- standard verification → 19
  Verification is performed by the device without manual checking of external measured variables.
- Extended verification → 23
  Verification includes the entry of external measured variables.

5.1 Performance characteristics

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

The standard verification also checks the following analog 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
- Double pulse output, active and passive
- Relay output

The extended verification supports a check of the following output modules by means of simulation and measurement using external measuring equipment:
- 4 to 20 mA current output, active and passive
- Pulse/frequency output, active and passive

The test is based on reference values 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 requirements for traceable verification according to DIN EN ISO 9001:2015, Clause 7.1.5.2 a Measurement traceability. According to the standard, the user is responsible for specifying the verification interval in accordance with requirements.

5.2 Commissioning

The configuration (factory reference) required as part of **Heartbeat Verification** is permanently stored in the measuring device.

When verification is performed in the application, the current measuring device situation is compared with 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 an initial situation in the measuring device life cycle up until the 8th verification. From the 9th verification onwards, a printout of the verification reports or an upload of the data using the Flow Verification DTM is recommended to avoid losing the data from the previous verifications.

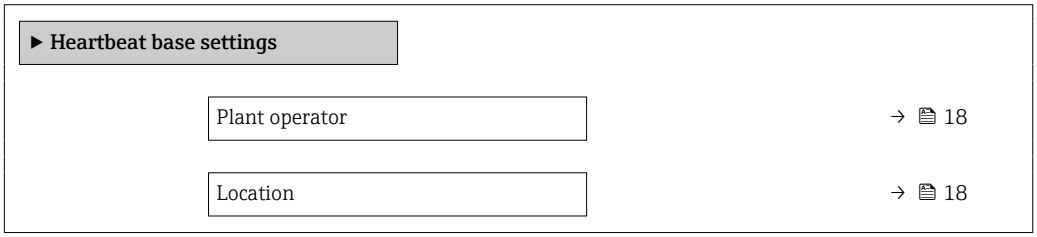
5.2.1 Recording reference data

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

Operation continues while the reference data are being recorded.

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

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



Parameter overview with brief description

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

5.3 Operation

5.3.1 General information

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

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.

5.3.2 Initial verification

▶ When commissioning the measuring device:
Perform an initial verification so you can save the results as an initial situation in the measuring device life cycle. As of the 9th verification, printing the verification reports or uploading the data using the Flow Verification DTM is recommended.

Initial verification can be performed in 2 ways:
- Standard verification → 19
- Extended verification → 23

5.3.3 Device behavior and interpretation

Result is "Passed"

All test results are within the specifications.

If the calibration factor matches 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 by identifying the test group with a "Failed" verification.
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.
- A category is assigned to the relevant diagnostic message of the outputs in the **Diagnostic configuration** submenu.
  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.

For detailed information on diagnostics and troubleshooting and for diagnostics information and associated remedial measures, see 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 (→ 🖹 22):
- 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 (→ 22):
- Passed
  All the verification tests were successful.
- Not done
  A verification has not yet been performed on this measuring device.
- Failed
  One or more verification tests were not successful → 19.

- The overall result of the last verification can always be accessed in the menu.
- Navigation:
  Diagnostics → Heartbeat Technology → Verification results
- Detailed information on the verification result (test groups and test status) are shown in the verification report in addition to the overall verification result → 34.
- 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" submenu

Navigation
"Diagnostics" menu → Heartbeat Technology → Performing verification

▶ Performing verification	
Year	→ 22
Month	→ 22
Day	→ 22
Hour	→ 22
AM/PM	→ 22
Minute	→ 22
Verification mode	→ 22
External device information	→ 29
Start verification	→ 22
Progress	→ 22
Measured values	→ 30
Output values	→ 30
Status	→ 22
Overall result	→ 22

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
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 ▪ Busy ▪ Failed ▪ Not done	–
Verification result	–	Displays the overall result of the verification. Detailed description of the classification of the results: → 32	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	–

5.3.5 Extended verification

The extended verification supplements the standard verification with the output of various measured variables. During the verification process, these measured variables are recorded manually with the help of external measuring equipment, for example, and entered in the measuring device → 28. The value entered is checked and verified by the measuring device to ensure that it complies with the factory specifications. A status (Passed or Failed) is issued accordingly and is documented as an individual result of the verification and taken into account in the overall result.

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

Extended verification measured variables

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

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

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

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.

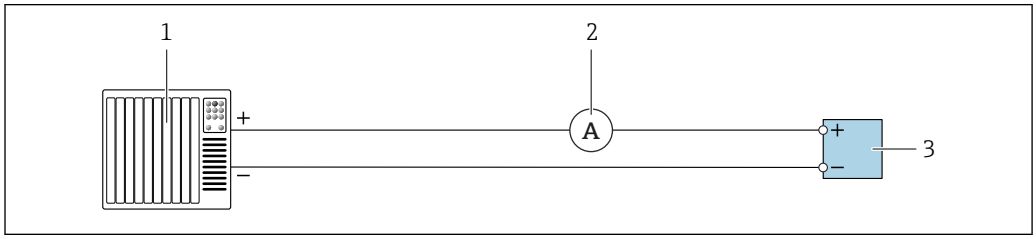
Determining the terminal assignment for the outputs

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

Active current output



7 *Extended verification of the active current output*

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

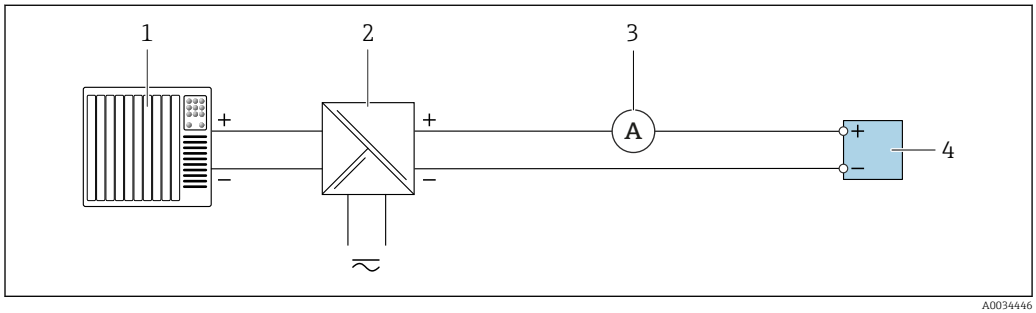
Extended verification of the active current output

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

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

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

Passive current output



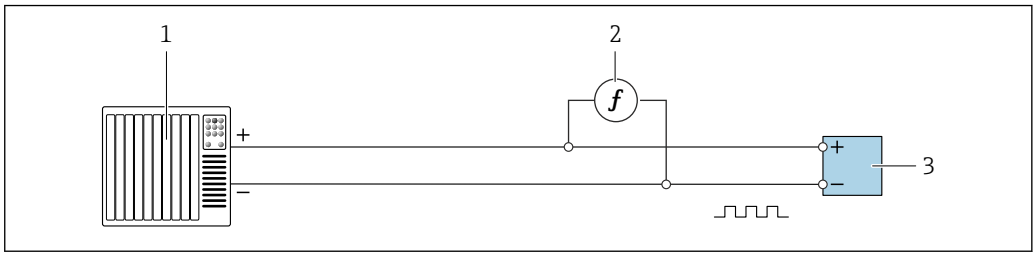
8 *Extended verification of the passive current output*

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

Extended verification of the passive current output

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

Active pulse/frequency/switch output



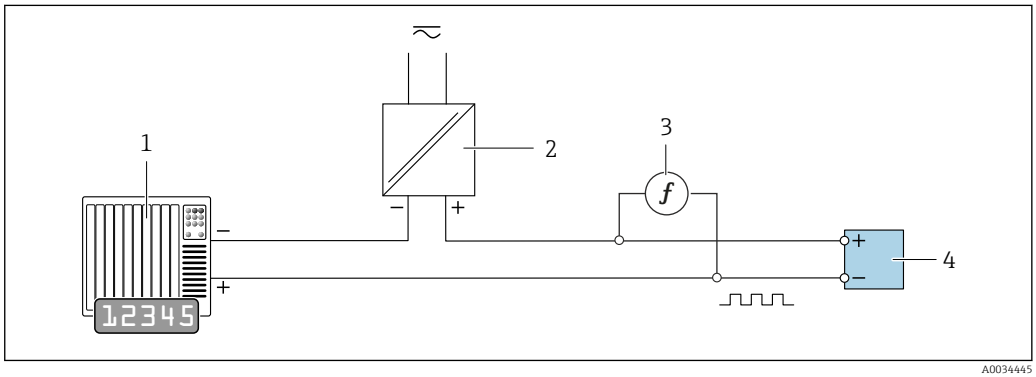
9 *Extended verification of the active pulse/frequency output*

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

Extended verification of the active pulse/frequency output

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

Passive pulse/frequency/switch output



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

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

Extended verification of the passive pulse/frequency output

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

Diagnostic behavior

A diagnostic event signals that the extended verification is being performed:
- The screen alternates between the status signal "C" (Function Check) and the operational display:
  Verification is currently active in the device.
- Different diagnostic behaviors, along with the relevant diagnostic codes, can be displayed depending on the device version.
  The output selected under 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	⚠**C302 Device verification in progress**	

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

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

- The diagnostic behavior can be changed by the user if necessary:
  Expert → System → Diagnostic handling → Diagnostic behavior
  If **Alarm** is selected as the diagnostic behavior, the output of measured values is interrupted in the event of an error and the signal outputs and totalizers adopt the defined alarm condition.
- A category is assigned to the relevant diagnostic message of the outputs in the **Diagnostic configuration** submenu.
  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.

For detailed information on diagnostics and troubleshooting and for diagnostics information and associated remedial measures, see the Operating Instructions → 6.

Performing extended verification

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

NOTICE

If the electrical connections have not been established and the ammeter is not looped in during verification, extended verification is not possible.
- ▶ Establish the electrical connection before starting the extended verification.
- ▶ Loop in ammeter before extended verification starts.

Before verification starts

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

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

1. Enter date and time.

Select the verification mode

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

Further parameter settings

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

The duration of the process and number of outputs depend on the device configuration, 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) shows the value simulated by the device at the selected output → 23

Starting the verification test

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

Displaying the verification status and result

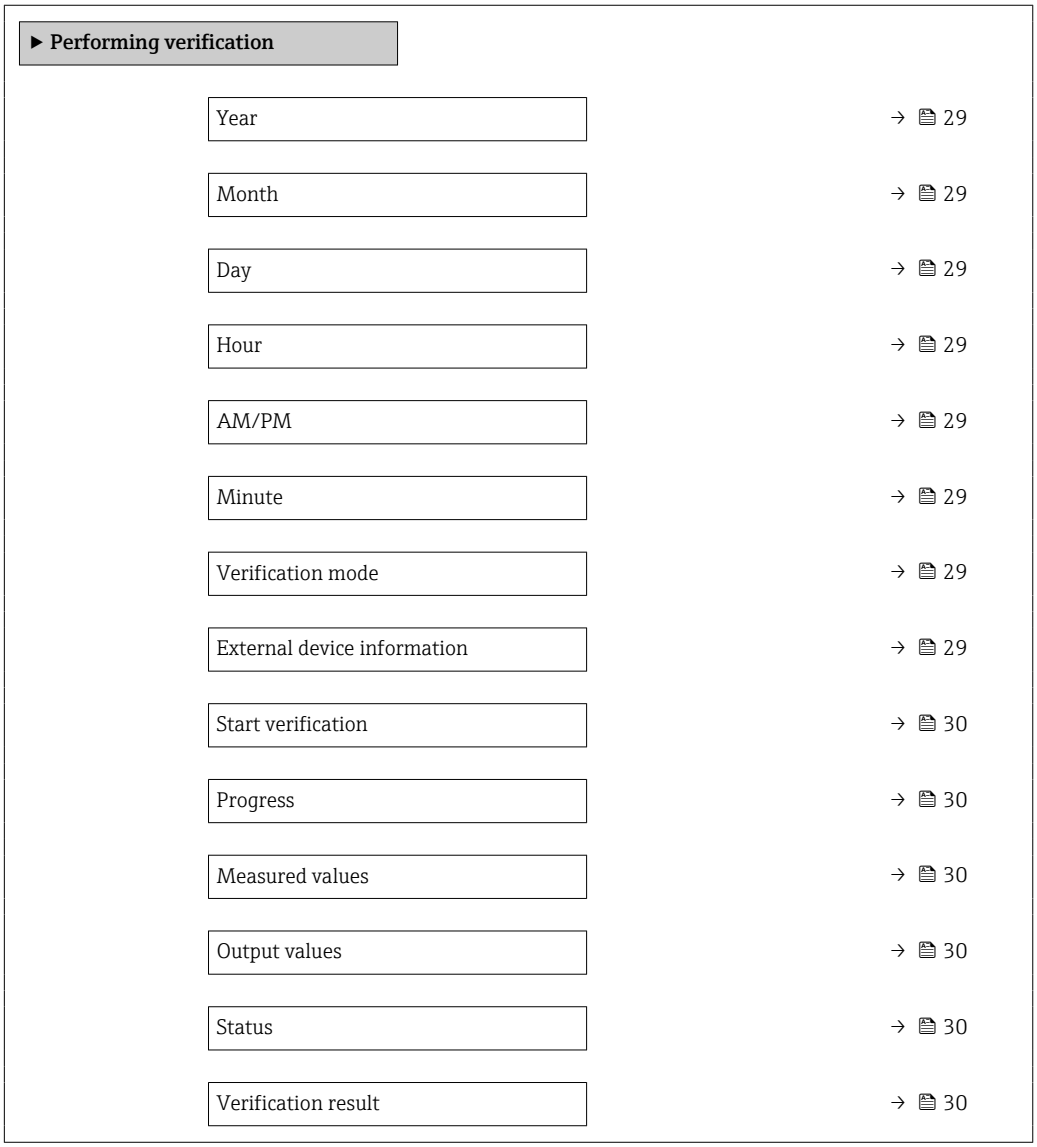
The current status of standard verification is displayed in the **Status** parameter (→ 22):
- Done
  The verification test is finished.
- Busy
  The verification test is running.
- Not done
  A verification has not yet been performed on this measuring device.
- Failed
  A precondition for performing 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 (→ 22):
- Passed
  All the verification tests were successful.
- Not done
  A verification has not yet been performed on this measuring device.
- Failed
  One or more verification tests were not successful → 19.

- The overall result of the last verification can always be accessed in the menu.
- Navigation:
  Diagnostics → Heartbeat Technology → Verification results
- Detailed information on the verification result (test groups and test status) are shown in the verification report in addition to the overall verification result → 34.
- 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" 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. Extended verification Standard verification is extended by the additional entry of external measured variables: **Measured values** parameter.	Extended verification	Standard verification
External device information	With the following conditions: ▪ The **Extended verification** option is selected in the **Verification mode** parameter. ▪ Can be edited if Heartbeat Verification is not active.	Record measuring equipment for extended verification.	Free text entry	–

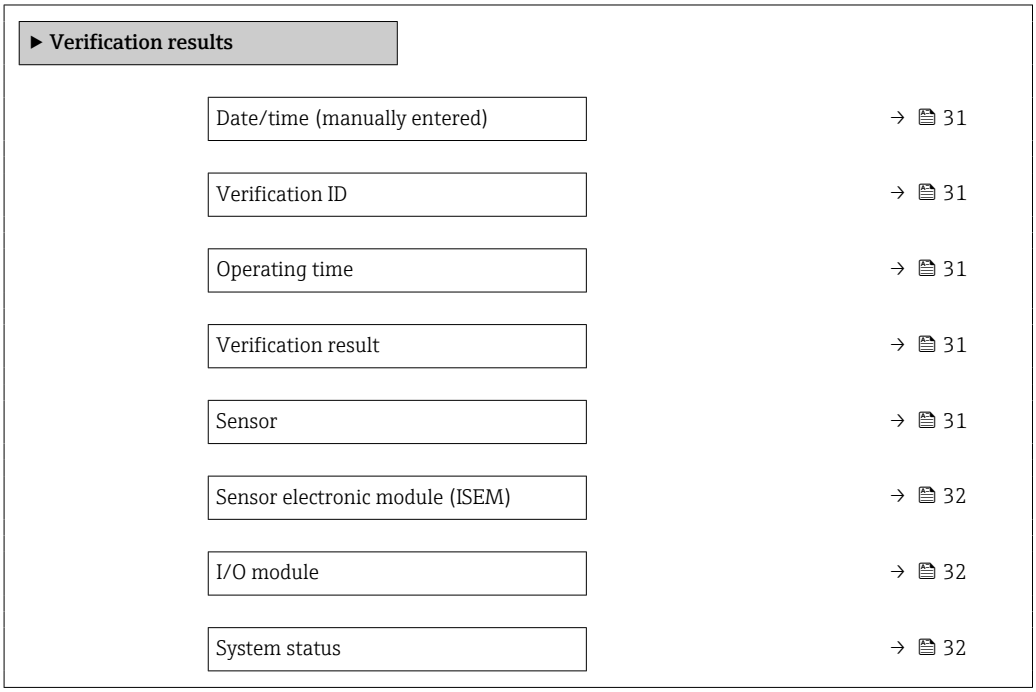
Parameter	Prerequisite	Description	User entry / Selection / User interface	Factory setting
Start verification	–	Start the verification. To carry out a complete verification, select the selection parameters individually. Once the external measured values have been recorded, verification is started using the **Start** option.	▪ Cancel ▪ Output 1 low value * ▪ Output 1 high value * ▪ Output 2 low value * ▪ Output 2 high value * ▪ Output 3 low value * ▪ Output 3 high value * ▪ Output 4 low value * ▪ Output 4 high value * ▪ Frequency output 1 * ▪ Pulse output 1 * ▪ Frequency output 2 * ▪ Pulse output 2 * ▪ Frequency output 3 * ▪ 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 ▪ Output 3 low value ▪ Output 3 high value ▪ Output 4 low value ▪ Output 4 high value ▪ Frequency output 1 ▪ Pulse output 1 ▪ Frequency output 2 ▪ Pulse output 2 ▪ Frequency output 3	Use this function to enter the measured values (actual values) 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 %	–
Output values	–	Displays the simulated output values (target values) for the external measured variables:. ▪ Current output: Output current in [mA]. ▪ Pulse/frequency output: Output frequency in [Hz].	Signed floating-point number	-
Status	–	Displays the current status of the verification.	▪ Done ▪ Busy ▪ Failed ▪ Not done	–
Verification result	–	Displays the overall result of the verification. Detailed description of the classification of the results: → 🖹 32	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	–

* Visibility depends on order options or device settings

5.3.6 Verification results

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

Navigation
"Diagnostics" menu → Heartbeat Technology → Verification results



Parameter overview with brief description

Parameter	Prerequisite	Description	User interface	Factory setting
Date/time (manually entered)	The verification has been performed.	Date and time.	dd.mmmm.yyyy; hh:mm	1 January 2010; 12:00
Verification ID	The verification has been performed.	Displays consecutive numbering of the verification results in the measuring device.	0 to 65 535	0
Operating time	The verification has been performed.	Indicates how long the device has been in operation up to the verification.	Days (d), hours (h), minutes (m), seconds (s)	–
Verification result	–	Displays the overall result of the verification. Detailed description of the classification of the results: → 32	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	–
Sensor	The **Failed** option was shown in the **Overall result** parameter.	Displays the result for the sensor. Detailed description of the classification of the results: → 32	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done

Parameter	Prerequisite	Description	User interface	Factory setting
Sensor electronic module (ISEM)	The **Failed** option was shown in the **Overall result** parameter.	Displays the result for the sensor electronics module (ISEM). Detailed description of the classification of the results: → 32	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done
I/O module	The **Failed** option was shown in the **Overall result** parameter.	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	▪ Not supported ▪ Passed ▪ Not done ▪ Not plugged ▪ Failed	Not done
System status	The **Failed** option was shown in the **Overall result** parameter.	Displays the system condition. Tests the measuring device for active errors. Detailed description of the classification of the results: → 32	▪ Not supported ▪ Passed ▪ Not done ▪ Failed	Not done

Classification of results

Individual results

Result	Description
Failed	At least one individual test in the test group was outside the specifications.
Passed	All individual tests in the test group complied with the specifications. The result is also "Passed" if the result of an individual test is "Check not done" and the result of all other tests is "Passed".
Not done	No test has been performed for this test group. For example, because this parameter is not available in the current device configuration.
Not supported	The result is used for internal purposes.
Not plugged	The result is displayed if no I/O module is plugged into the slot.
Off	The result is displayed if a universal module is plugged into the slot and has not been configured. This is equivalent to the slot in question being "deactivated".

Overall results

Result	Description
Failed	At least one test group was outside the specifications.
Passed	All verified test groups complied with the specifications (result "Passed"). The overall result is also "Passed" if the result for an individual test group is "Check not done" and the result for all other test groups is "Passed".
Not done	No verification was performed for any of the test groups (result for all test groups is "Check not done").

Heartbeat Verification confirms the device function within the specified measuring tolerance on demand. Based on redundant reference values in the device that are traceable from the factory, **Heartbeat Technology** meets the requirements of traceable verification in accordance with DIN EN ISO 9001:2015, Clause 7.1.5.2 a Measurement traceability. According to the standard, the user is responsible for specifying the verification interval in accordance with requirements.

Test groups

Test group	Description
Sensor	Electrical components of the sensor (signals, circuits and cables)
Sensor electronics module (ISEM)	Electronics module for activating and converting the sensor signals
I/O module	Results of the input and output modules installed on the measuring device
System condition	Test for active measuring device errors of "alarm"-type diagnostic behavior

Test groups and individual tests → 34.

The partial results for a test group (e.g. sensor) contain the result of several individual tests. All the individual tests must be passed for the partial result to pass.

The same applies to the overall verification result: All the partial results must pass for the overall verification result to pass. Information on the individual tests is provided in the verification report and in the partial results by test groups, which can be retrieved with the flow verification DTM.

Limit values

I/O module

Output; input	Standard verification	Extended verification
Current output 4 to 20 mA, active and passive	± (100 µA (offset) + 1 % of reading)	▪ Lower value 4 mA: ±1 % ▪ Upper value 20 mA: ±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 ▪ Read back the supply voltage: >24 V – 20 % – 5 % = 18 V (min. 18 V applied)	–
Double pulse output, active and passive	±0.05 %, with a 120 s cycle	Only standard verification possible.
Relay output	The number of switching cycles depends on the hardware.	Only standard verification possible.

5.3.7 Detailed verification results

Partial results by test groups and detailled verification results can be viewed in the verification report and retrieved using the flow verification DTM.

This also applies to the process conditions 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
Volume flow	Current measured value for volume flow
Corrected volume flow	Current measured value for standard volume flow
Mass flow	Current measured value for mass flow
Flow velocity	Current measured value for flow velocity
Speed of sound	Current measured value for sound velocity
Medium temperature	Current measured value for medium temperature
Pressure	Current measured value for pressure
Signal strength	Current measured value for signal strength
Signal to noise ratio	Current measured value for signal to noise ratio
Acceptance rate	Current measured value for acceptance rate
Turbulence	Current measured value for turbulence
Flow asymmetry	Current measured value for flow asymmetry
Electronics 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/corrective measures; service ID
Sensor connection and converter resonance	Monitoring of electrical connection between amplifier and converter.	▪ Failed ▪ Passed ▪ Check not done	882, 887
Temperature sensor	Test the temperature sensor (open, short-circuit). Only applies if the sensor has been ordered.	▪ Failed ▪ Passed ▪ Check not done	213, 214
Measuring cell (only if ordered)	Testing of pressure cell (connection between measuring cell and electronics, pressure cell electronics).	▪ Failed ▪ Passed ▪ Check not done	816, 817, 876, 877, 878
Signal quality	Monitoring of signal strength and signal to noise ratio.	▪ Failed ▪ Passed ▪ Check not done	–
Signal strength and sound velocity	For multi-path measuring devices only: The relative signal strength and relative sound velocity. Comparison with limit values.	▪ Failed ▪ Passed ▪ Check not done	–

Sensor electronics module (ISEM)

Parameter/individual test	Description	Result/limit value	Interpretation/cause/corrective measures; service ID
Reference clock	Monitoring of the reference clock in the measuring device circuit.	▪ Fail ▪ Pass ▪ Check not done	212
Transmission circuit	Monitoring of the transmission voltage and multiplexer.	▪ Fail ▪ Pass ▪ Check not done	–
Amplifier circuit	Monitoring of the noise and the amplifier deviation.	▪ Fail ▪ Pass ▪ Check not done	–
Measuring circuit	Measurement of the transit time of a test signal. Two or more different transit time values are tested.	▪ Fail ▪ Pass ▪ Check not done	612

System condition

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

Input/Output

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Current output (4-20mA) standard verification	The measuring device simulates a current value at the output. This current is returned via an A/D converter. The current at the reference resistor is proportional to the simulated current of the 4-20 mA signal.	▪ Failed ▪ Passed ▪ Check not done Value range: ±300 µA	▪ Check the current loop for an open circuit. ▪ Check the current loop for high impedance (e.g. as a result of contact corrosion).
Current output (4-20mA), extended verification	The measuring device simulates a current value at the output. Enter the external measurement via the "Heartbeat Verification" wizard.	▪ Failed ▪ Passed ▪ Check not done Value range: ▪ Low value 4 mA: ±300 µA ▪ High value 20 mA: ±300 µA	▪ Record measured values again and enter. ▪ Check whether the output is outside the specifications. ▪ Replace the I/O module.
Pulses, extended verification	The measuring device simulates a specific number of pulses. Enter the external measurement via the "Heartbeat Verification" wizard.	▪ Failed ▪ Passed ▪ Check not done Pulses: ▪ Simulation: 1 pulse/s ▪ Pulse width = 100 ms ▪ For 1000 pulses, ±10 Impulse	▪ Record measured values again and enter. ▪ Check whether the output is outside the specifications. ▪ Replace the I/O module.
Frequency, extended verification	The measuring device simulates a specific frequency. Enter the external measurement via the "Heartbeat Verification" wizard.	▪ Failed ▪ Passed ▪ Check not done Value range: ±0.1 % Based on target value	▪ Record measured values again and enter. ▪ Check whether the output is outside the specifications. ▪ Replace the I/O module.

I/O modules

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Output 1 to n	Check of all the input and output modules installed at the measuring device → 17	No value range ▪ Passed ▪ Failed ▪ Not done Limit values → 33	**Causes** ▪ Output values out of specification ▪ I/O modules defective **Measures** ▶ Check cabling. ▶ Check connections. ▶ Check load (current output). ▶ Replace the I/O module.

5.3.8 Heartbeat Technology verification report

The verification results can be documented via the web server, DeviceCare or FieldCare operating tools in the form of a verification report → 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 measuring devices.

First page: identification
Measuring point identification, identification of the verification results and confirmation of completion:
- Plant 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: standard verification or extended verification
- Overall verification result:
  - Overall result of the verification "Passed": All the results have been "Passed"
  - Overall result of the verification "Failed": One or more individual results have been "Failed"

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

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
- Corrected volume flow
- Mass flow
- Flow velocity
- Sound speed
- Medium temperature
- Process pressure
- Signal strength
- Signal to noise ratio
- Acceptance rate
- Turbulence
- Flow asymmetry
- Electronics temperature

As a prerequisite for the validity of the verification report, the **Heartbeat Verification** feature must be activated on the measuring device concerned and must have been performed by an operator tasked to carry out this job by the customer. Alternatively, an Endress+Hauser service technician or a service provider authorized by Endress+Hauser can be tasked with performing the verification.

Individual test groups and description of individual tests: → 34

5.3.9 Interpreting and using the verification results

Heartbeat Verification uses the self-monitoring function of the Proline devices 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.

During this process, device-internal parameters that are correlated with flow measurement are checked (secondary measured variables, comparative values).

If a verification is passed, this confirms that the comparative values checked are within the factory specification and that the measuring device is working correctly. At the same time, the calibration factor of the sensor can be traced via the verification report. To ensure that the measuring device complies with the factory specification, this value must correspond to thatof 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 and the specified total test coverage TTC.

Recommended course of action if the result of a verification is "Failed"

If the result of a verification is **Failed**, it is advisable to begin by repeating the verification.

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

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

the current process conditions to those of the previous verification in order to identify any deviations.

The process conditions for the previous verification are documented on the last page of the verification report or can be called up using the flow verification DTM → 34.

Stabilize or stop flow, ensure that process temperature is stable, drain the sensor if possible.

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.

For detailed information on diagnostics and troubleshooting and for diagnostics information and associated remedial measures, see the Operating Instructions → 6.

6 Heartbeat Monitoring

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

6.1 Commissioning

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

6.1.1 Description of the monitoring measured variables/parameters

The following diagnostic parameters can be assigned to the various outputs of the measuring device .

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

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

6.1.2 Configuration of the outputs and local display

With the application package "Heartbeat Verification + Monitoring", the user has additional monitoring parameters available → 39 . The following examples illustrate how a monitoring measured variable is assigned to a current output or is shown on the local display.

Example: Configuring the current output

Select the monitoring measured variable for current output

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

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

Example: Configuring the local display

Select the measured value that is shown on the local display

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

6.2 Operation

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

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

Condition Monitoring focuses on measured variables that indicate a change in the performance of the device brought about by process-specific influences. There are two difference categories of process-specific influences:
- Temporary process-specific influences that impact the measuring function directly and therefore result in a higher level of measuring uncertainty than would normally be expected (e.g. measurement of multiphase fluids). These process-specific influences generally do not affect the integrity of the device but do impact measuring performance temporarily.
- Process-specific influences that only impact the integrity of the sensor over the medium term but that also bring about a gradual change in the measuring performance (e.g. abrasion, corrosion or buildup in the 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:
- Buildup in the sensor
- Corrosive or abrasive fluids
- Multi-phase fluids (gas content in liquid fluids)
- Wet gases
- Applications in which the sensor is exposed to a programmed amount of wear.

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

6.2.1 Overview of the monitoring parameters

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

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

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