

Special Documentation

Proline Promag 800

Heartbeat Verification + Monitoring application package
Modbus RS485



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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). 90% (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
	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 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
Promag W 800	BA02080D

2.5 Registered trademarks

Modbus®

Registered trademark of SCHNEIDER AUTOMATION, INC.

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):

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

λ_{TOT} : Rate of all theoretically possible failures

λ_{du} : Rate of undetected dangerous failures

Only the dangerous undetected failures 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:

- Simulation operation not active
- Settings for diagnostic behavior correspond to factory settings

3.2 Availability

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

3.2.1 Order code

If ordering directly with the device or subsequently as a retrofit kit:

Order code for "Application package", option EB "Heartbeat Verification + Monitoring"

The availability of the application package can be checked as follows:

- Order code with breakdown of the device features on the delivery note
- Call up the Device Viewer via the website www.endress.com/deviceviewer: Enter the serial number from the nameplate and check if the order code is displayed.
- In the operating menu System → Software configuration : 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.



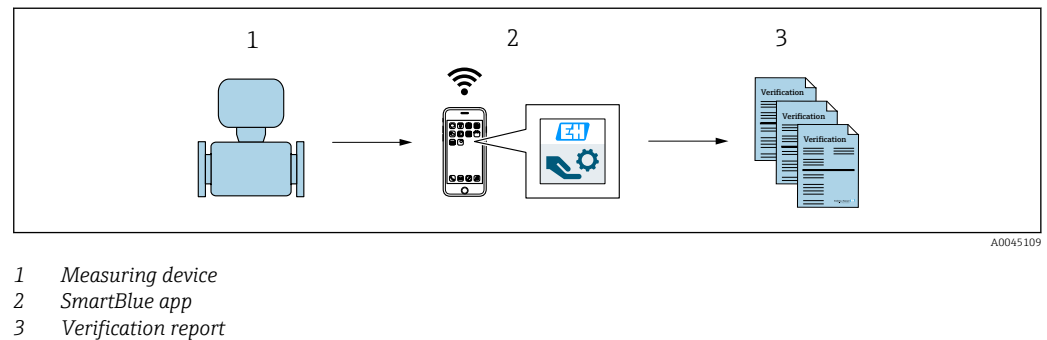
For detailed information on "Activating application packages via the software license code", see Installation Instructions EA01164D

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 only via the SmartBlue app.



Run **Heartbeat Verification** via the following interfaces:

- SmartBlue app
- System integration interface of a higher-level system via MODBUS → 28

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 (3 data records) are saved in the device and provided in the form of a verification report.

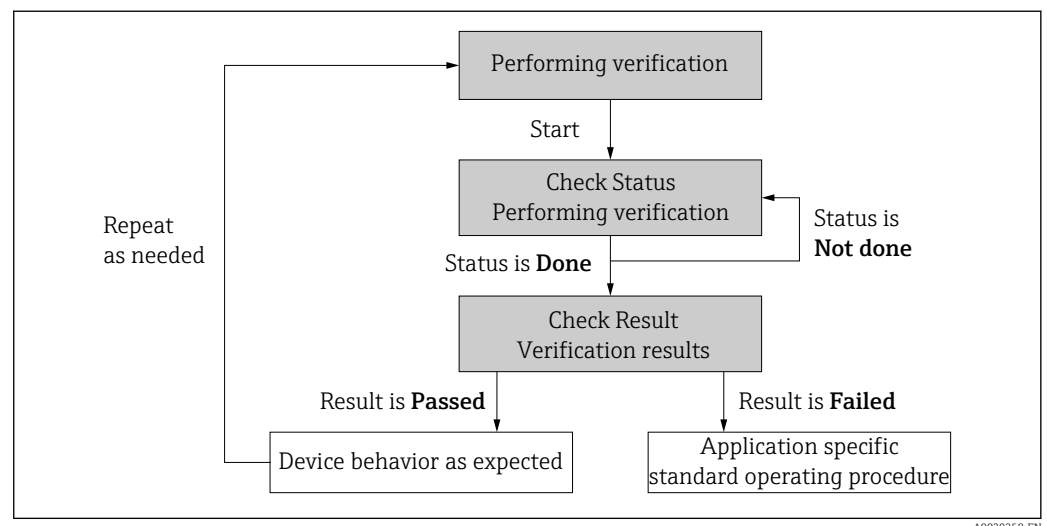
Verification reports are managed and shared via a mobile terminal (smartphone, tablet).

Verification reports can be generated using the SmartBlue app.

4.1 Integration in the PLC system

The verification function integrated in the measuring device can be activated by the SmartBlue App and the results checked.

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**.

4.2 Data availability for the user

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

4.2.1 Device

Heartbeat Monitoring

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

Heartbeat Verification

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

4.2.2 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.

4.2.3 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.

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 SmartBlue App 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 → 13

Verification is performed by the device without manual checking of external measured variables. Standard verification is selected if the process is not to be interrupted.

- Extended verification → 15

Verification includes the entry of external measured variables. Extended verification is selected if verification of the output with the current output signal does not suffice for the test specifications that need to be met or if verification of the output is not offered in the standard verification process.

5.1 Performance characteristics

Heartbeat Verification is performed on demand and supplements permanent self-monitoring with additional checks (coil circuit measurement, shot control circuit, electrode signal integrity).

Extended verification supports checking of the following output modules:

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 recorded during calibration at the factory and 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: An initial verification when commissioning the device (and all other verifications during the life cycle) should be performed under process or reference conditions.

Up until the third verification, the results are saved as an initial situation in the life cycle of the measuring device; from the fourth verification onwards, an upload using the Verification DTM is recommended.

5.2.1 Recording reference data

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

Navigation

"Diagnostics" menu → Heartbeat Technology → Heartbeat base settings

► Heartbeat base settings

Plant operator

→ 12

Location

→ 12

Partially filled pipe

→ 12

Parameter overview with brief description

Parameter	Description	User entry / Selection
Plant operator	Enter plant operator.	Character string comprising numbers, letters and special characters (32)
Location	Enter the location where the measuring device is mounted. Information appears in the verification report.	Character string comprising numbers, letters and special characters (32)
Partially filled pipe	Indicate, if the measuring tube is partially filled during the verification process in order to avoid evaluating the EPD electrode cable.	No Yes

5.3 Operation

5.3.1 General information

 The **Heartbeat Verification** function can be used only once every 48 hours on a custody-transfer (CT) measuring device in the custody transfer mode.

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 The SmartBlue App is recommended for this purpose.

Initial verification can be performed in 2 ways:

- Standard verification → 13
- Extended verification → 15

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 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 in progress: **△C302 Device verification in progress** diagnostic message

Test duration: approx. 10 seconds



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 automatically with the current operating time and the verification results and also appear in the verification report.

Select the verification mode

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

Starting the verification test

2. In the **Start verification** parameter, select the **Start** option.
 - ↳ While the verification is being performed, the progress of the verification is indicated as a % in the **Progress** parameter.

Displaying the verification status and result

The current status of standard verification is displayed in the **Status** parameter (→  15):

- 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) →  12.

The result of the verification is displayed in the **Overall result** parameter (→  15):

- 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 →  12.
-  ■ 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 →  21.
 - 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 →  12.

"Performing verification" submenu

Navigation

"Diagnostics" menu → Heartbeat Technology → Performing verification

► Performing verification

Plant operator

Location

Partially filled pipe

Verification mode

External device information

Start verification

Output values

Measured values

→  15

→  15

→  15

→  15

→  15

→  15

→  15

→  15

Status	→ 15
Date/time	→ 15
Progress	→ 15
Verification result	→ 15

Parameter overview with brief description

Parameter	Description	User entry / Selection / User interface
Plant operator	Enter plant operator.	Character string comprising numbers, letters and special characters (32)
Location	Enter the location where the measuring device is mounted. Information appears in the verification report.	Character string comprising numbers, letters and special characters (32)
Partially filled pipe	Indicate, if the measuring tube is partially filled during the verification process in order to avoid evaluating the EPD electrode cable.	■ No ■ Yes
Verification mode	Select verification mode.	■ Standard verification ■ Extended verification
External device information	Enter unique information e.g. serial number of the used measuring equipment.	Character string comprising numbers, letters and special characters (32)
Start verification	Start verification.	■ Cancel ■ Pulse output 1 * ■ Pulse output 2 * ■ Pulse output 3 * ■ Start
Output values	Shows the simulated value dependent on the selected output.	Signed floating-point number
Measured values	Enter the displayed value of the external measuring equipment.	Signed floating-point number
Status	Shows the actual status.	■ Done ■ Busy ■ Failed ■ Not done
Date/time	Displays the date and time of the verification.	Character string comprising numbers, letters and special characters
Progress	Shows the progress of the process.	0 to 100 %
Verification result	Shows the overall result of the verification.	■ Not supported ■ Passed ■ Not done ■ Failed

* Visibility depends on order options or device settings

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 and entered via the SmartBlue app (e.g. current value at pulse output). 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.

During extended verification, permanently predefined output signals are simulated, which do not represent the current measured value. To measure the simulated signals, it may be

necessary to set the higher-level process control system to a safe state beforehand. In order to perform a verification, the pulse/frequency/switch output must be enabled and assigned to a measured variable.

Extended verification measured variables

- Output 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

Frequency measuring uncertainty	±0.1 %
Frequency resolution	1 Hz
Temperature coefficient	0.0075 %/°C

Connecting the measuring equipment in the measuring circuit

 WARNING

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

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

Determining the terminal assignment for the outputs

The terminal assignment depends on the specific device version.

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

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

Diagnostic behavior

A diagnostic event signals that the extended verification is in progress:

- 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.
However, in all cases, the output selected under the **Start verification** parameter is displayed:

Output 1...n low value option, Output 1...n high value option

Diagnostic code	Diagnostic behavior	Options in Start verification
C493	Simulation pulse output 1 to n active	Pulse output 1...n
C302	 C302 Device verification in progress	

 An extended verification 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
 Test duration: approx. 10 seconds



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.

Before verification starts



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

Select the verification mode

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

Further parameter settings

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

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

The value displayed in the **Output values** parameter (→ 15) shows the value simulated by the device at the selected output → 16

Starting the verification test

7. In the **Start verification** parameter, select the **Start** option.
 - ↳ While the verification is being performed, the progress of the verification is indicated as a % in the **Progress** parameter.

Displaying the verification status and result

The current status of standard verification is displayed in the **Status** parameter (→ 15):

- 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) → 12.

The result of the verification is displayed in the **Overall result** parameter (→  15):

- 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 →  12.
-  ■ 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 →  21.
 - 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 →  12.

"Performing verification" submenu

Navigation

"Diagnostics" menu → Heartbeat Technology → Performing verification

► Performing verification		
Plant operator		→  15
Location		→  15
Partially filled pipe		→  15
Verification mode		→  15
External device information		→  15
Start verification		→  15
Output values		→  15
Measured values		→  15
Status		→  15
Date/time		→  15
Progress		→  15
Verification result		→  15

Parameter overview with brief description

Parameter	Description	User entry / Selection / User interface
Plant operator	Enter plant operator.	Character string comprising numbers, letters and special characters (32)
Location	Enter the location where the measuring device is mounted. Information appears in the verification report.	Character string comprising numbers, letters and special characters (32)
Partially filled pipe	Indicate, if the measuring tube is partially filled during the verification process in order to avoid evaluating the EPD electrode cable.	■ No ■ Yes
Verification mode	Select verification mode.	■ Standard verification ■ Extended verification
External device information	Enter unique information e.g. serial number of the used measuring equipment.	Character string comprising numbers, letters and special characters (32)
Start verification	Start verification.	■ Cancel ■ Pulse output 1 ■ Pulse output 2 ■ Pulse output 3 ■ Start
Output values	Shows the simulated value dependent on the selected output.	Signed floating-point number
Measured values	Enter the displayed value of the external measuring equipment.	Signed floating-point number
Status	Shows the actual status.	■ Done ■ Busy ■ Failed ■ Not done
Date/time	Displays the date and time of the verification.	Character string comprising numbers, letters and special characters
Progress	Shows the progress of the process.	0 to 100 %
Verification result	Shows the overall result of the verification.	■ Not supported ■ Passed ■ Not done ■ Failed

5.3.6 Verification results

Access to the verification results:

In the operating menu via the operating tool

Diagnostics → Heartbeat Technology → Verification results

Navigation

"Diagnostics" menu → Heartbeat Technology → Verification results

► Verification results		
Date/time	→	📄 20
Verification ID	→	📄 20
Operating time	→	📄 20
Verification result	→	📄 20
Sensor	→	📄 20

Electronic module	→ 20
Input/output	→ 20
System status	→ 20
Select result dataset	

Parameter overview with brief description

Parameter	Description	User interface
Date/time	Displays the date and time of the verification.	Character string comprising numbers, letters and special characters
Verification ID	Shows the verification ID that identifies the dataset. It is also displayed in the verification report.	0 to 65 535
Operating time	Indicates how long the device has been in operation.	Days (d), hours (h), minutes (m), seconds (s)
Verification result	Shows the overall result of the verification.	■ Not supported ■ Passed ■ Not done ■ Failed
Sensor	Shows the overall result for the "sensor" test group.	■ Not supported ■ Passed ■ Not done ■ Failed
Electronic module	Shows the overall result for the electronic module 'test group'.	■ Not supported ■ Passed ■ Not done ■ Failed
Input/output	Shows the overall result for the 'Input/output' test group.	■ Not supported ■ Passed ■ Not done ■ Failed
System status	Shows the result of the system condition monitoring.	■ Not supported ■ Passed ■ Not done ■ Failed

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 verification 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 verification 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.

For more information on the test groups and individual tests →  21.

 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 , which can be retrieved with the flow verification DTM.

Limit values*I/O module*

Input; Output	Standard verification	Extended verification
Pulse/frequency/switch output, active and passive	-	■ Pulse: $\pm 0.3\%$ ■ Frequency: $\pm 0.3\%$

5.3.7 Detailed verification results

Partial results by test groups and detailed verification results can be viewed in the verification report and retrieved using the SmartBlue App.

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.

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
Coil current stability	Monitoring the correct adjustment of the coil current.	No value range - Passed - Failed - Not done	EMC interference
Coil resistance	Monitoring of the coil resistance.	No value range - Passed - Failed - Not done	- Faulty connections: check the outer connection parts, clamp connections and connecting cables - Process temperature too high - Coil in the sensor is defective
Electrode circuit 1	Monitoring of the impedance in electrode circuit 1.	No value range - Passed - Failed - Not done	Electrode cable is defective  The test is not performed if the measuring tube is empty Status indicated: "Not done"
Electrode circuit 2	Monitoring of the impedance in electrode circuit 2.	No value range - Passed - Failed - Not done	Electrode cable is defective  The test is not performed if the measuring tube is empty Status indicated: "Not done"
EPD electrode circuit	Monitoring of the impedance in the EPD circuit.	No value range - Passed - Failed - Not done	EPD cable is defective  The test is not performed if the measuring tube is empty Status indicated: "Not done"

Electronics module

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Current ADC24 value	Checks if the ADC24 value measured is in the valid range.	No value range - Passed - Failed - Not done	Electronics module defective Replace the electronics module
Supply voltage	All the relevant supply voltages are checked. Monitoring of the supply voltage for the sensor electronics module guarantees that the system is functioning correctly.	No value range - Passed - Failed - Not done	Electronics module defective Replace the electronics module
Internal voltages	The most important internal voltages are monitored at the electronics module. Objective: The internal voltages must be checked to ensure correct functioning of the system. A minimum and a maximum value is specified in each case.	No value range - Passed - Failed - Not done	Electronics module defective Replace the electronics module
Linearity	Monitoring of flowmeter circuit with regard to gain and linearity.	No value range - Passed - Failed - Not done	Electronics module defective Replace the electronics module
Reference voltage	Monitoring of reference voltages in flowmeter circuit and exciter circuit	No value range - Passed - Failed - Not done	Electronics module defective Replace the electronics module
Hold voltage feedback	The configured hold voltage is fed back to ensure the secure and constant functioning of the hold voltage.	No value range - Passed - Failed - Not done	Electronics module defective Replace the electronics module

Parameter/individual test	Description	Result/limit value	Interpretation/cause/remedial measures
Overvoltage feedback	The overvoltage is fed back to ensure the secure and constant functioning of the overvoltage.	No value range ■ Passed ■ Failed ■ Not done	Electronics module defective
Overvoltage circuit	Monitoring of overvoltage.	No value range ■ Passed ■ Failed ■ Not done	Electronics module defective
CPU clock rate	Checks to ensure that there is no significant deviation in the CPU clock rate.	No value range ■ Passed ■ Failed ■ Not done	Electronics module defective

System condition

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

5.3.8 Verification report

The verification results can be documented via the SmartBlue app in the form of a verification report →  9. 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 (and following pages if applicable): identification

Measuring point identification, identification of the verification results and confirmation of completion:

- System operator
 - Customer reference
- Device information
 - Information on the place of operation (tag) and the current configuration of the measuring point
 - Management of the information in the device
 - Display on the verification report
- Calibration
 - Information on the calibration factor and zero point setting for the sensor
 - These values must correspond to those from the last calibration or repeat calibration in order to comply with factory specifications
- Verification information
 - The operating time and verification ID are used to uniquely assign the verification results for the traceable documentation of the verification
 - Storage and display of the manual date and time entry as well as the current operating time in the device
 - Verification mode: standard verification or extended verification
- Overall verification result
 - Overall result of the verification passed if all of the individual results are passed

Third page (and following pages if applicable): test results

Details on the individual results for all test groups:

- System operator
- Test groups →  21
 - Sensor
 - Electronics module
 - System

Fourth page: measured values

Numerical representation of all recorded values:

- System operator
- Test object
- Unit
- Current: measured value
- Min.: lower limit
- Max.: upper limit

Last page: process conditions

Information on the process conditions that applied during the verification:

- Volume flow
- Conductivity
- 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.

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). 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 →  21.

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

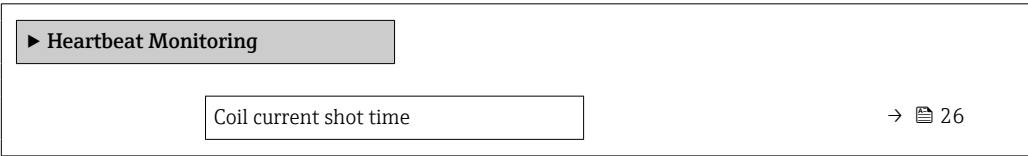
For commissioning, the measured variables relevant for monitoring are assigned to the outputs. Once commissioning has been completed, these variables are continuously available at the outputs.

Activating and deactivating the monitoring feature

The transmission of monitoring-specific measured variables is switched on or off in the operating menu:

Navigation

"Diagnostics" menu → Heartbeat Technology → Heartbeat Monitoring



Parameter overview with brief description

Parameter	Description	User interface
Coil current shot time	Shows the rise time of the coil current for the buildup of the magnetic field.	Signed floating-point number

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.

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

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. These target applications are:

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

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

6.2.1 Interpretation of 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
Coil current shot time	At constant process temperatures, a change can indicate a possible build-up of magnetite or an increase in the magnetite content of the medium. Strong external magnetic fields influence this value too.

7 Modbus RS485 Register Information

7.1 Notes

7.1.1 Structure of the register information

The individual parts of a parameter description are described in the following section:

Navigation: navigation path to the parameter					
Parameter	Register	Data type	Access type	User interface/ Selection/User entry	→ 
Name of parameter	Indicated in decimal numerical format	- Float length = 4 byte - Integer length = 2 byte - String length, depending on parameter	Possible type of access to parameter: - Read access via function codes 03, 04 or 23 - Write access via function codes 06, 16 or 23	Options List of the individual options for the parameter - Option 1 - Option 2 - Option 3 ⁽⁺⁾  ⁽⁺⁾ = Factory setting depends on country, order options or device settings User entry Specific value or input range for the parameter	Page number information and cross-reference to the standard parameter description

NOTICE

If non-volatile device parameters are modified via the MODBUS RS485 function codes 06, 16 or 23, the change is saved in the EEPROM of the measuring device.

The number of writes to the EEPROM is technically restricted to a maximum of 1 million.

- Make sure to comply with this limit since, if it is exceeded, data loss and measuring device failure will result.
- Avoid constantly writing non-volatile device parameters via the MODBUS RS485.

7.1.2 Address model

The Modbus RS485 register addresses of the measuring device are implemented in accordance with the "Modbus Applications Protocol Specification V1.1".

In addition, systems are used that work with the register address model "Modicon Modbus Protocol Reference Guide (PI-MBUS-300 Rev. J)".

Depending on the function code used, a number is added at the start of the register address with this specification:

- "3" → "Read" access
- "4" → "Write" access

Function code	Access type	Register in accordance with "Modbus Applications Protocol Specification"	Register in accordance with "Modicon Modbus Protocol Reference Guide"
03 04 23	Read	XXXX Example: mass flow = 2007	3XXXX Example: mass flow = 32007
06 16 23	Write	XXXX Example: reset totalizer = 6401	4XXXX Example: reset totalizer = 46401

7.2 Overview of the operating menu

The following tables provide an overview of the structure of the Heartbeat Technology operating menu along with the parameters. The page reference indicates where the associated description of the submenu or parameter can be found.

Navigation

"Diagnostics" menu → Heartbeat Technology

► Heartbeat Technology		
► Performing verification		→ 30
Plant operator		→ 30
Location		→ 30
Partially filled pipe		→ 30
Verification mode		→ 30
External device information		→ 30
Start verification		→ 30
Output values		→ 30
Measured values		→ 30
Status		→ 30
Date/time		→ 30
Progress		→ 30
Verification result		→ 30
► Verification results		→ 31
Date/time		→ 31
Verification ID		→ 31
Operating time		→ 31
Verification result		→ 31
Sensor		→ 31
Electronic module		→ 31

Input/output	→ 31
System status	→ 31
Select result dataset	→ 31
► Heartbeat Monitoring	→ 31
Coil current shot time	→ 31

7.3 Register information

7.3.1 "Performing verification" submenu

Navigation: Heartbeat Technology → Performing verification					
Parameter	Register	Data type	Access	Selection / User entry / User interface	→ 31
Plant operator	3414 to 3429	String	Read / Write	Character string comprising numbers, letters and special characters (32)	12
Location	3430 to 3445	String	Read / Write	Character string comprising numbers, letters and special characters (32)	12
Partially filled pipe	37517	Integer	Read / Write	0 = Yes 1 = No	12
Verification mode	2366	Integer	Read / Write	0 = Standard verification 1 = Extended verification	15
External device information	20493 to 20508	String	Read / Write	Character string comprising numbers, letters and special characters (32)	15
Start verification	2270	Integer	Read / Write	0 = Cancel 1 = Start 20 = Pulse output 1 * 22 = Pulse output 2 * 24 = Pulse output 3 *	15
Output values	5516 to 5517	Float	Read	Signed floating-point number	15
Measured values	5512 to 5513	Float	Read / Write	Signed floating-point number	15
Status	2079	Integer	Read	0 = Failed 1 = Done 3 = Not done 8 = Busy	15
Date/time	29656 to 29666	String	Read	Character string comprising numbers, letters and special characters	15
Progress	6797	Integer	Read	0 to 100 %	15
Verification result	2355	Integer	Read	0 = Failed 2 = Passed 3 = Not done 250 = Not supported	15

* Visibility depends on order options or device settings

7.3.2 "Verification results" submenu

Navigation: Heartbeat Technology → Verification results					
Parameter	Register	Data type	Access	Selection / User entry / User interface	→ 
Date/time	29748 to 29758	String	Read	Character string comprising numbers, letters and special characters	20
Verification ID	2315	Integer	Read	0 to 65 535	20
Operating time	3346	String	Read	Days (d), hours (h), minutes (m), seconds (s)	20
Verification result	2355	Integer	Read	0 = Failed 2 = Passed 3 = Not done 250 = Not supported	15
Sensor	2384	Integer	Read	0 = Failed 2 = Passed 3 = Not done 250 = Not supported	20
Electronic module	2385	Integer	Read	0 = Failed 2 = Passed 3 = Not done 250 = Not supported	20
Input/output	2386	Integer	Read	0 = Failed 2 = Passed 3 = Not done 250 = Not supported	20
System status	5790	Integer	Read	0 = Failed 2 = Passed 3 = Not done 250 = Not supported	20
Select result dataset	--	Integer	Read / Write		

7.3.3 "Heartbeat Monitoring" submenu

Navigation: Heartbeat Technology → Heartbeat Monitoring					
Parameter	Register	Data type	Access	Selection / User entry / User interface	→ 
Coil current shot time	2465 to 2466	Float	Read	Signed floating-point number	26



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