

Special Documentation Cerabar and Deltabar

Application package
Heartbeat Verification + Monitoring
PROFIBUS PA



1 About this document

1.1 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.

1.2 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

1.3 Symbols

1.3.1 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 potentially dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

CAUTION

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

NOTICE

This symbol alerts you to a potentially harmful situation. Failure to avoid this situation can result in damage to the product or something in its vicinity.

1.3.2 Symbols for certain types of information and graphics

Tip

Indicates additional information

Reference to another section

1, 2, 3 Series of steps

1, 2, 3, ...

Item numbers

Bluetooth® wireless technology

Wireless data transmission between devices over a short distance via radio technology.

1.4 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.

1.5 Registered trademarks

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2 Product features and availability

2.1 Product features

The Heartbeat Verification + Monitoring application package 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 devices in the application.

The test scope achieved using the diagnostic and verification tests is expressed as the **total test coverage** (TTC). The total test coverage 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 dangerous undetected failures

The dangerous undetected failures are not diagnosed by the device diagnostics. If these failures occur, they can falsify the measured value that is displayed or interrupt the output of measured values.

Heartbeat Technology confirms that the device is functioning within the specified measuring tolerance with a defined TTC.

The TTC is at least:

95 % for PROFIBUS communication



The current value for the TTC depends on the configuration and integration of the measuring instrument. It is determined under the following basic conditions:

- **Simulation** parameter **Off** option
- Settings for diagnostic behavior correspond to factory settings

2.2 Availability

You can order the application package either together with the device or at a later stage with order code XM35ACP. More information on the order code is available from the website www.endress.com or from an Endress+Hauser sales organization.

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

- Order code with breakdown of the device features on the delivery note
- On the web using the Device Viewer: enter the serial number from the nameplate and check whether the order code is displayed
- In the operating menu: here you can see if the application package is enabled.
Navigation: System → Software configuration → Software option overview

2.2.1 Activation code

If ordered at a later date, a conversion kit will be supplied. This includes a tag with modified device data and an activation code.

Enter the activation code in the operating menu:

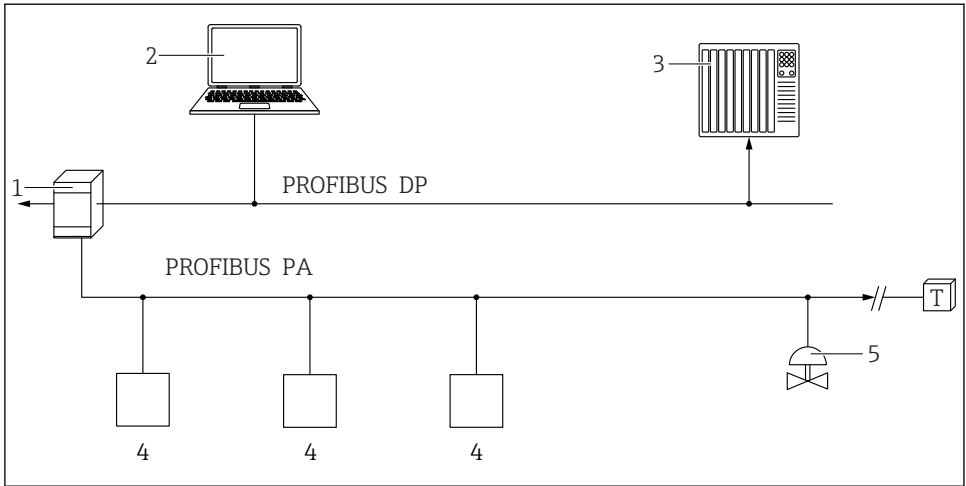
Navigation: System → Software configuration → Activate SW option

2.2.2 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.

3 System integration

Heartbeat Technology functions can be used via an asset management system and also via the automation infrastructure (e.g. PLC).



A0050944

- 1 Segment coupler
- 2 Computer with PROFIBUS and operating tool (e.g. DeviceCare/FieldCare)
- 3 PLC (programmable logic controller)
- 4 Transmitter
- 5 Additional functions (valves etc.)

Perform Heartbeat Verification using one of the following interfaces:

- System integration interface of a higher-level system
- Service interface (CDI = Endress+Hauser Common Data Interface)
- Local display (optional)
- Bluetooth® wireless technology (optional)

External access to the device in order to start a verification and signal the verification result (**Passed** option or **Failed** option) must be performed by a higher-level system via a system integration interface. It is not possible to start the verification via an external status signal and relay the results to a higher-level system via the status output.

The detailed results of the verification are saved in the device and provided in the form of a verification report. The last result in each case is saved in the device.

Verification reports can be created using the FieldCare Plant Asset Management Software, DeviceCare, or the SmartBlue app and FieldXpert.

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

Heartbeat Verification

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

Heartbeat Monitoring

- Configuration of the monitoring function: specify which monitoring parameters are output continuously via the system integration interface.
- The user can read the monitoring measured variables in the operating menu.

3.2 Data management

The result of a verification is saved as a non-volatile parameter set in the measuring device memory. Previous data are overwritten by new verification results. Only the last result is saved.

3.2.1 Verification report

Printing the Verification report

The Verification report is output in PDF format.



Prerequisite: A verification has already been performed.

3.2.2 File management

Netilion Library

Heartbeat verification reports can be saved in Netilion with the Netilion Library (www.netilion.endress.com). They can be uploaded by notebook, smartphone or a Field Xpert tablet.

The verification reports are then:

- online
- automatically assigned to their digital twin
- easier to find
- always readily available

4 Heartbeat Verification

Heartbeat Verification is performed on demand and supplements permanent self-monitoring with additional checks. During verification, the system checks whether the device components comply with the factory specifications. Both the sensor and the electronics modules are included in the tests.

Heartbeat Verification confirms the device function within the specified measuring tolerance on demand with a total test coverage TTC (Total Test Coverage) as a percentage.

Heartbeat Verification meets the requirements for metrological traceability in accordance with ISO 9001:2015 Section 7.1.5.2).

The result of verification is either **Passed** or **Failed**. The verification data are stored in the device using the FIFO method (First In – First Out) and optionally archived using the asset management software FieldCare on a PC or in the Netilion Library. Based on this data, a

verification report is generated automatically to ensure that traceable documentation of the verification results is available.

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

4.1 Device behavior and interpretation

■ Result: **Passed**

All test results are within the specification.

■ Result: **Failed**

One or more test results are **Out of specification (S)**.



Recommendations in the event of a verification with the verification result: Failed

If a verification returns the result **Failed**, repeat the verification. In doing so, follow the measures below:

- Create defined and stable process conditions in order to rule out process-specific influences as much as possible.
- Compare current process conditions with those of the previous verification to identify possible deviations.
- Take remedial action based on the diagnostic information of the device.

The cause of the error can be narrowed down by identifying the test group that has a **Failed** verification.



Measurement operation continues throughout the entire verification process.

4.2 Verification

Perform verification:

1. Navigation: Guidance → Heartbeat Technology → Heartbeat Verification
2. Select the **Start verification** option.

Show status:

- Navigation: Diagnostics → Heartbeat Technology → Heartbeat Verification → Status

Show result:

1. Navigation: Guidance → Heartbeat Technology → Heartbeat Verification
2. Select the **Show results** option.

4.3 Verification results

Access to the verification results via:

- SmartBlue app
- DTM-based tools (e.g. FieldCare or DeviceCare)
- Field Xpert

4.3.1 Classification of verification results

Individual result:

-  **Failed**
At least one individual test in the test group was **Out of specification (S)**.
-  **Passed**
All individual tests in the test group complied with the specifications.
The result is **Passed** even if the result of an individual test is **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 or activated in the current device configuration.

Overall result:

-  **Failed**
At least one test group has **Failed**.
-  **Passed**
All verified test groups were within the specification.
The overall result is **Passed** even if the result of individual test groups is **Not done** and the result of all other tests is **Passed**.



Heartbeat Verification confirms on demand that the device is functioning within the specified measuring tolerance with a total test coverage (TTC) specified as a percentage.

4.4 Verification report

The verification results can be documented via DTM-based tools, the SmartBlue app or Field Xpert in a verification report. Since the verification results are automatically and uniquely identified with the Operating time, they are suitable for the traceable documentation of the verification of devices.

The following information is provided on each report page for unique identification:

- Serial number
- Device tag
- Operating time (Verification)
- Plant operator (customer reference)

4.4.1 Verification report, section 1

Measuring point identification, presentation of the overall verification result and confirmation of completion:

- **Device information**
(Information on place of installation, Device tag, Device name, Order code, Firmware version, Hardware version)
- **Calibration / Configuration**
(Information on device configuration such as Zero adjustment offset, sensor traceability, CRC device configuration)
- **Verification information**
(Operating time (Verification), Date/time Heartbeat Verification and verification ID used to uniquely assign the verification results for the traceable documentation of the verification)
- **Verification result**
(The Overall result of the verification is **Passed** if all individual results are **Passed**)

4.4.2 Verification report, section 2

Details on the individual results for the following test groups:

- Verification pre-condition
- Mainboard module
- Sensor module

4.4.3 Verification report, section 3

Details with values for the individual tests from section 2.

4.4.4 Verification report, section 4

Additional data and information that can influence the assessment of the measurement results or the appraisal of the process conditions:

- Process condition (at the time of verification)
- Device history
- Sensor history

4.5 Test criteria for the test objects

Verification pre-condition

Check: **System status** parameter

Function: Checks active measurement device errors at diagnostical behavior "Alarm". If an active error is detected, then verification will be performed but the overall result will always be "Failed".

Mainboard module

- Check: **Software integrity** parameter
Function: Checks whether the function blocks of the software are executed in the correct order.
- Check: **RAM check** parameter
Function: Checks the correct function of the RAM (Random Access Memory).
- Check: **ROM check** parameter
Function: Checks the correct function of the ROM memory (Read-Only-Memory).

Sensor module

- Check: **Sensor integrity** parameter / **Membrane integrity** parameter¹⁾
Function: Checks the integrity of the sensor. The scope of the check depends on the type of sensor.
- Check: **Statistical Sensor Diagnostics** parameter
Function: Checks whether the current measured values are within the programmed signal/signal noise limit values. Only visible if enabled.
- Check: **Analog path integrity** parameter
Function: Performs a traceable check on whether the current measurement path properties of the production state are within the permissible tolerance range. This test can only be reliably carried out at a sensor temperature between –10 to +40 °C (14 to 104 °F). If the result is **Failed**, recalibration or sensor replacement is recommended. If the result is **Not done**, either the sensor temperature is not within the permitted range at the time of verification or the sensor used is not traceable at that time.

4.6 Additional verification information



Additional data and information that can influence the assessment of the measurement results or evaluation of the process conditions.

The following parameters are information values only and do not include an evaluation with respect to **Passed/Failed**.

Process conditions at the time of the verification

Current value as well as minimum and maximum permitted values for:

- Sensor pressure
- Zero adjustment offset (current value only)
- Electronics temperature
- Sensor temperature
For traceable testing according to ISO 9001, the sensor temperature must be between –10 to +40 °C (14 to 104 °F).

Device history

Information on whether the device was operated within its specification. Current value as well as minimum and maximum values for:

- Electronics temperature
- Sensor temperature

Sensor history

- Counter for **Sensor temperature** parameter and **Sensor pressure** parameter
Function: number of times the specified limits are overshoot or undershot
- Counter for **Sensor temperature** parameter and **Sensor pressure** parameter: user-defined limit values
Function: number of times the defined limits are overshoot or undershot
- Counter for power-on
Function: number of device reboots
- Counter Baseline creation SSD
Function: Specifies how often the baseline has been rebuilt.

1) The membrane integrity cannot be checked on all sensors

5 Heartbeat Monitoring

Several Heartbeat Monitoring wizards are available. Furthermore, additional monitoring parameters can be displayed and used for predictive maintenance or application optimization.

5.1 "SSD: Statistical Sensor Diagnostics" wizard

A statistical analysis of the raw pressure signal (SSD) can detect a variety of unwanted process anomalies.

5.1.1 Areas of application

The areas of application are all process anomalies that deviate from the programmed standard operation and affect the signal noise. Typical applications include blocked piping, incorrect valve position following maintenance, or air pockets in water-based media, for example.

A number of conditions must be met for successful detection in the application:

- Signal noise should always be present, e.g. flow applications.
- There should be an adequate ratio of signal noise to actual pressure. This is usually the case in differential pressure applications with Deltabar, but rare in high-pressure applications with Cerabar.
- Process dynamics should be at a minimum so a usable baseline can be created.

A number of prerequisites are checked during baseline creation or commissioning to ensure correct operation.

5.1.2 Commissioning

As the wizard does not interfere with cyclic communication, the SSD configuration can be performed during operation.

The settings must be adapted to the process conditions to ensure the device functions in line with user needs. Build the **Current Baseline signal** and **Current Baseline noise** parameters under recurrent process conditions. The diagnostic function is only active if the current process conditions are within the signal baseline bandwidth that is to be defined. If the current process conditions are outside the programmed process conditions, e.g. at the weekend or during system start-up, statistical analysis does not take place. Unwanted messages are avoided in this way.

The following parameters must be configured:

Current Baseline signal

Arithmetic average of the pressure signal (25 measured values). Perform under recurrent process conditions. This measured variable is analyzed in order to characterize the process conditions in the normal state. If process conditions are outside the defined limits, the function is set to the **Idle** option.

Baseline Signal Lower Control Line and Baseline Signal Upper Control Line

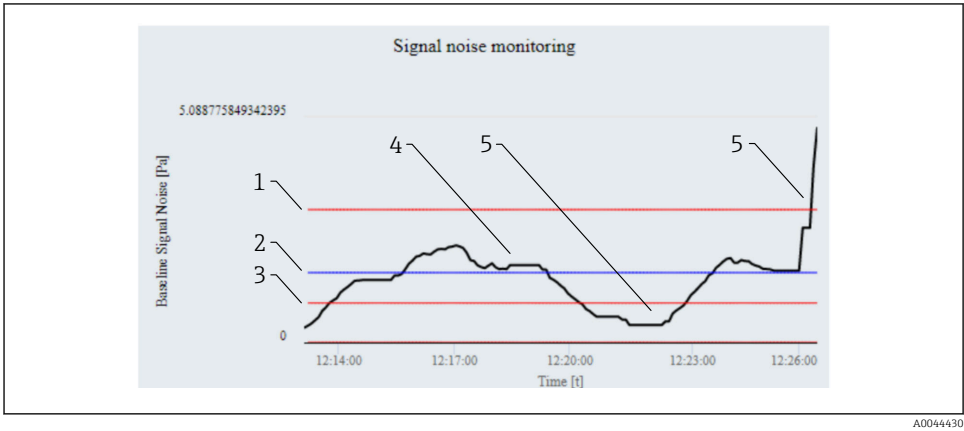
Defines the bandwidth above (UCL) or below (LCL) the baseline in which statistical analysis or anomaly detection is "**Active**".

Perform under recurrent process conditions. The recorder function and/or the min/max values in the Wizard can be used to specify as narrow a bandwidth as possible. The value must be > 0.

Current Baseline noise

The signal noise is determined with this process value.

The interquartile range indicates the width of the interval that contains the middle 50 % of the measuring points. This measured variable is analyzed in order to detect process anomalies.



- 1 Upper signal noise threshold
- 2 Current Baseline signal
- 3 Lower signal noise threshold
- 4 Current signal noise
- 5 Anomaly

Baseline Signal Noise Lower Control Line and Baseline Signal Noise Upper Control Line

Ideally, these limit values are defined by actively simulating the process anomaly that is to be detected. For example, the valve for the differential pressure transmitter can be closed in order to simulate a blocked pipe. It is possible to define the limit value at precisely this point using the recorder function. If this is not possible, the user can define the LCL and UCL values that were produced when the signal baseline was built. Deviations and process anomalies can be identified on the basis of this "normal" state.

Signal Noise Baseline Min

For differential pressure if the two impulse lines are blocked.

"Sample rate" parameter

Specifies the scan rate depending on the process conditions (frequency of transmission of measurement data points for analysis).

- **Fast** option: homogeneous, stable process (factory setting)
One measured value every 200 milliseconds
- **Medium** option: dynamic process
One measured value every second
- **Slow** option: extremely dynamic, variable process
One measured value every 2 seconds.

The time required to build the baseline depends on the scan rate and can take between 3 minutes (**Fast** option setting) and up to several minutes (**Slow** option setting).

Default setting. **Fast** option

Only choose different settings if it is not possible to build a baseline with the **Fast** option setting.

Status information

Different status parameters are displayed in order to assess the current process conditions and the monitoring function:

- System status
- Signal noise status
- Signal status

"SSD Monitoring delay time" parameter

Period of time for which the "Out of range" status must be active before an event report is issued. This is necessary when short-term conditions are present.

Example: pump start-up phase which the user wants to ignore in order to avoid unwanted event messages.

"Diagnostic behavior" parameter

In addition to the NE107 category (default setting: Maintenance required (M)), the event behavior defines how the detected "Process anomaly" event is to be communicated:

- Logbook entry only: no digital or analog transmission of the report
- Warning: current output unchanged
Message is output digitally (factory setting)
- Off: no logbook entry and no digital communication of the message is output

The message is always shown on the display. If an event is detected (overrange, signal noise) and the measured value returns to the permitted range due to the process conditions, the warning is no longer active in the device.

Enable/Disable

Enable or disable SSD.

After selecting "Disable", no statistical sensor diagnosis takes place. No diagnostic messages are output.

5.2 "Process window" wizard

Using user-defined limit values, undesired installation and application anomalies can be detected with this Wizard. Pressure shocks < 20 ms are detected here. Therefore it is possible to quantify thermal or mechanical stress on the device or in the process.

5.2.1 Areas of application

- **Temperature:**
Defective trace heating system or insulation, frozen process connections or empty condensate pipes.
- **Pressure:**
Pressure shocks from valves closing quickly, pulsating flow, other unwanted process events that generate dynamic pressure peaks.

5.2.2 Commissioning

The following parameters must be configured.

"High alert value" parameter/"Low alert value" parameter for min./max. temperature

Set range.

If this limit value is exceeded or undercut, a diagnostic event is generated. There is no hysteresis.

Factory setting: limit values as specified in the Technical Documentation

"High alert value" parameter/"Low alert value" parameter for min./max. pressure

Set range.

If this limit value is exceeded or undercut, a diagnostic event is generated. There is no hysteresis.

Factory setting: LRL/URL.

"High alert value" parameter/ "Low alert value" parameter for min./max. scaled variable

Specify the range. A diagnostic event is generated if this limit value is exceeded or undershot. This only appears when scaled variable is selected.

"502 Diagnostic behavior" parameter

In addition to the NE107 category (default setting: Maintenance required (M)), the diagnostic behavior defines how the detected "Process anomaly" event is to be communicated:

- Logbook entry only: no digital or analog communication of the report
- Warning: current output unchanged
Message is output digitally (factory setting)
- Alarm: Current output adopts the configured alarm current
- Off: no logbook entry and no digital communication of the message output. The counter function is retained.



The message is always shown on the display if **Alarm** option or **Warning** option is selected. No message appears on the display if **Logbook entry only** option or **Off** option is selected. If a process anomaly event (out of range, temperature) is recognized and the measurement returns to the permitted range afterwards due to the process conditions, the warning is no longer active in the device. Up to 100 events are saved in the logbook.

Disable/Enable

Specify whether the function should be activated. If the **Disable** option option is selected, no analysis and therefore no event reporting take place.

5.2.3 Analysis

The number of times values were over/under range can be used to quantify the mechanical or thermal stress of the measuring point. This information is available in the menu "**Diagnostics** menu → **Minimum/maximum values** submenu" and can be read out acyclically.

5.3 Monitoring data

The following graphic shows which modules are available to the device for cyclic data exchange. Cyclic data exchange is performed with an automation system.

Module name	Slot number
Analog input 1	1
Analog input 2	2
Analog input 3	3
Analog input 4	4
Analog input 5	5
Analog input 6	6
Digital input 1	7
Digital input 2	8
Analog output 1	9

Function block	Name
Analog input 1 to 6 (AI)	Pressure
	Scaled variable
	Sensor temperature

	Sensor pressure
	Electronics temperature
	Median of pressure signal
	Noise of pressure signal
Digital input 1 to 2	SSD: Statistical Sensor Diagnostics
	Process window
Analog output 1	Value display



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