

# Special Documentation

## Liquiphant FTL43

Application package  
Heartbeat Verification + Monitoring  
HART



# 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

#### CAUTION

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

#### DANGER

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

#### NOTICE

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

#### WARNING

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

### 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 data transmission between devices over a short distance.

## 1.4 Documentation



For an overview of the scope of the associated Technical Documentation, refer to the following:

- *Device Viewer* ([www.endress.com/deviceviewer](http://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

### HART®

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

### Bluetooth®

The *Bluetooth*® word mark and logos are registered trademarks owned by the Bluetooth SIG, Inc. and any use of such marks by Endress+Hauser is under license. Other trademarks and trade names are those of their respective owners.

# 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 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):

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

$\lambda_{TOT}$ : Rate of all theoretically possible failures

$\lambda_{du}$ : 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 %.



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

- Integration of measuring instrument for measured value output via 4 to 20 mA HART output
- **Simulation** parameter **Off** option
- **Failure behavior current output** parameter set to the **Min.** option or **Max.** option and evaluation unit detects both alarms
- Settings for diagnostic behavior correspond to factory settings

## 2.2 Availability

You can order the Heartbeat Verification + Monitoring application package either together with the device or at a later stage with order code XM35ACL. More information on the order code is available from the website [www.endress.com](http://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:

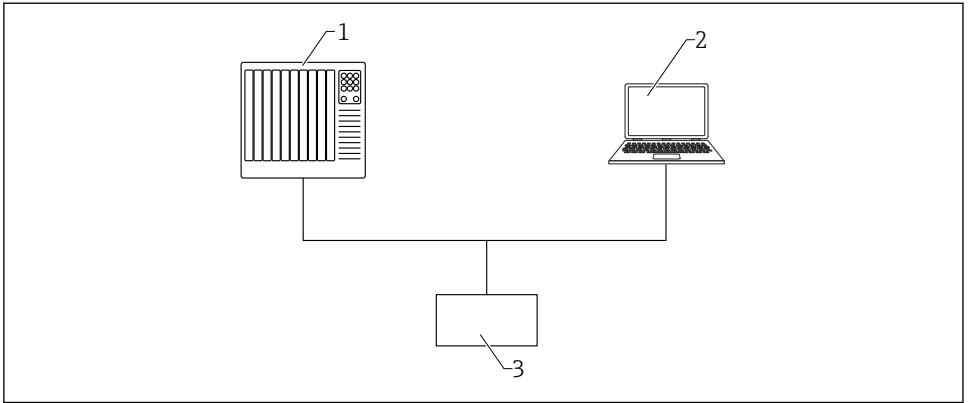
Navigation: System → Software configuration → Activate SW option

### 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.

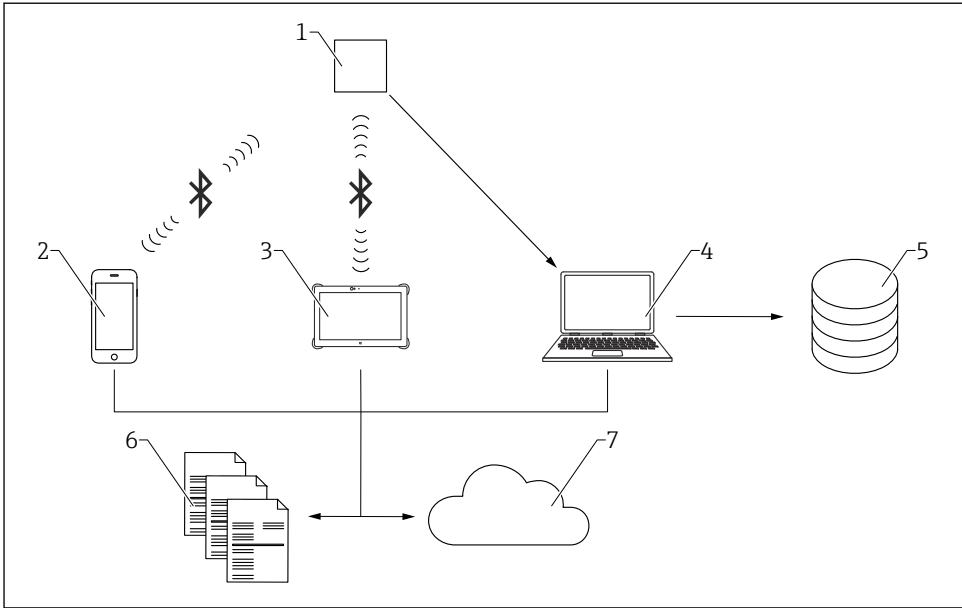
## 3 System integration

The functions of Heartbeat Technology are accessible through digital interfaces and can be used both via an asset management system and via the automation infrastructure (e.g. PLC).



A0040019

- 1 PLC
- 2 Asset management system
- 3 Device



A0047321

- 1 Device
- 2 Mobile terminals with SmartBlue app
- 3 Field Xpert
- 4 DTM-based tools, e.g. FieldCare or DeviceCare etc.
- 5 Data archive
- 6 Verification report
- 7 Netilion Library

Perform Heartbeat Verification using one of the following interfaces:

- System integration interface of a higher-level system
- Bluetooth (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 or DeviceCare plant asset management software, or the SmartBlue app and Field Xpert.

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

### Heartbeat Verification

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

### Heartbeat Monitoring via HART or Bluetooth

- 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](http://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 on request within the specified measuring tolerance with a total test coverage TTC (Total Test Coverage) in percent.

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 measures 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.



Operation continues during the entire Heartbeat Verification.

## 4.2 Verification

### Perform verification:

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

### Show status:

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

### Show result:

- ▶ Navigation: Guidance → Heartbeat Technology → Heartbeat Verification → Verification result → Verification result






## 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 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 results of the verification 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/section for unique identification:

- Serial number
- Device tag
- Operating time (Verification)

#### 4.4.1 Verification report, Section 1

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

- Plant operator
  - Customer reference
- Device information
  - Information on the place of operation
  - Device name
  - Management of the information in the device
  - Firmware version, Hardware version
- Calibration
  - Parameter configuration: Density setting, Safety function, CRC device configuration
- Verification information
  - Operating time (Verification) 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:

- Device and verification information
- 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 conditions (at the time of verification)
  - HART signal quality
  - Temperature of sensor electronics
  - Electronics temperature
- Device history
  - Date/time Heartbeat Verification
  - Electronics temperature
  - Temperature of sensor electronics
  - Terminal voltage
- Sensor history
  - Counter for switch-on procedures
  - Sensor frequency at delivery status.
  - Upper warning frequency
  - Upper alarm frequency
  - Stored covered frequency
  - Stored uncovered frequency
- Frequency history  
Last 16 sensor frequencies stored at the time of verification

### 4.5 Verification criteria for the test objects

#### 4.5.1 Verification pre-condition

##### System status

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".

#### 4.5.2 Mainboard module

##### Terminal voltage

Checks whether the voltage at the supply terminals is within the specified limits. Exceeding the maximum terminal voltage can damage the device. If the supply voltage is permanently in the maximum range, the useful life of the device can be reduced. If the terminal voltage falls below the minimum, the device can fail.

##### Terminal voltage value

The Terminal voltage currently applied is measured and compared with the limit values (Minimum terminal voltage and Maximum terminal voltage).

Limit values: 12 to 30 V

##### Output current

The Output current is continuously read back and compared with the configured current in accordance with the measured value.

### Current deviation

Checks whether read-back current at the output matches the current set by the device.

Limit values:  $-0.5$  to  $+0.5$  mA

### Software integrity

Checks whether the function blocks of the software are executed in the correct order. Checks whether certain events are currently present e.g. incrementing of the sequence counter in the mainboard is checked with each new measured value in the sensor module. If this is not the case, **Failed** is displayed.

### RAM check

Checks the correct function of the RAM (Random Access Memory). If a RAM cell is defective, this is detected by the value read back from the RAM cell and **Failed** is displayed.

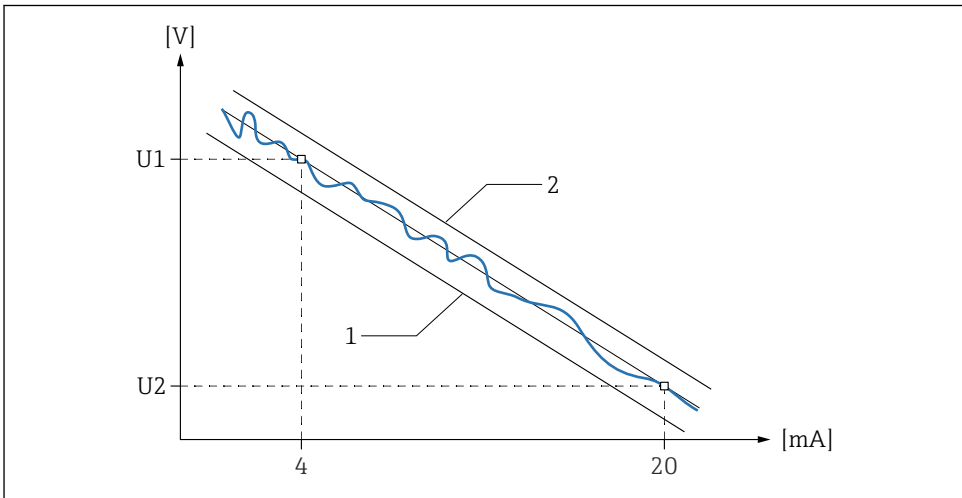
### ROM check

Checks the correct function of the ROM memory (Read-Only-Memory). If the checksum of the tested program code range does not match, **Failed** is output.

### Loop diagnostics

Only visible if the Heartbeat Monitoring functionality Loop diagnostics was enabled via the wizard.

Checks whether the voltage/current values are within range or the voltage/current baseline defined with wizard. "Failed" can indicate faulty power supply or grounding / wiring.



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- 1 Current-voltage baseline
- 1 Clamping voltage lower threshold
- 2 Clamping voltage upper threshold

**"Terminal voltage 1" parameter**

Shows the current terminal voltage that is applied at the output.

The voltage is continuously monitored to ensure it falls within the characteristic band defined by the **Clamping voltage lower threshold** parameter and **Clamping voltage upper threshold** parameter.

**"Timestamp Baseline" parameter**

Shows the operating time counter (time) when the baseline was created.

At this time the upper Terminal voltage (U1) at 4 mA and the lower Terminal voltage (U2) at 20 mA was determined.

**"Resistance Baseline" parameter**

Baseline resistance value (slope of the current-voltage baseline).

**"Supply voltage Baseline" parameter**

Data point of the baseline; voltage at the point where the current-voltage baseline is established.

**"Timestamp previous Baseline" parameter**

Shows the operating time counter (time) when the previous baseline was created.

**"Resistance previous Baseline" parameter**

Previous baseline resistance value (slope of the previous current-voltage baseline).

**"Supply voltage previous Baseline" parameter**

Data point of the previous baseline; voltage at the point where the previous current-voltage baseline was established.

### 4.5.3 Sensor module

**"Sensor integrity" parameter**

The sensor-controller evaluates itself with several diagnostics and transmits the data cyclically to the transmitter-controller. As long as the controller-internal diagnostics, e.g. memory check or program execution, are correct, the integrity of the sensor is confirmed.

**"Fork frequency" parameter**

The sensor-controller evaluates the fork frequency for irregular frequencies. Alarm conditions, e.g. corrosion alarm (fixed threshold values).

**"Fork corrosion/abrasion" parameter**

The sensor-controller evaluates the fork regarding corrosion or abrasion. If fork is covered value is set to "Not done". (Warnings, e.g. corrosion alarm (fixed threshold value)).

**" 946 Advanced sensor monitoring" parameter**

Used to detect excessive external vibrations and other sensor errors (e.g. from pumps, stirring devices, turbulent flows, excessive flow velocities) that can result in measurement errors.

The warning delay is set to 60 s and cannot be changed.

The function can be switched off as follows:

Navigation: Diagnostics → Diagnostic settings → Properties → 946 Advanced sensor monitoring, **Disable** option

## "Process window low" parameter/"Process window high" parameter

Shows result of user defined frequency check. Only visible if enabled.

### 4.6 Further 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**.

#### 4.6.1 Process conditions at the time of verification

- Display HART signal quality  
Function: Share of defective data frames in relation to the total number of data frames received.  
Possible reasons for poor signal quality include:
  - EMC interference
  - Defective device on the same bus
  - Poor contacts
  - Incorrectly dimensioned resistor
- **Temperature of sensor electronics** parameter screen  
Function: Current temperature and permitted MIN/MAX range
- **Electronics temperature** parameter screen  
Function: Current temperature and permitted MIN/MAX range

#### 4.6.2 Device history

##### Terminal voltage value

Shows the current terminal voltage that is applied at the output. Including the Minimum/maximum values achieved since the last reset.

##### "Electronics temperature" parameter

Displays the current temperature of the main electronics. Including the Minimum/maximum values achieved since the last reset.

##### "Temperature of sensor electronics" parameter

Displays the current temperature of the sensor electronics. Including the Minimum/maximum values achieved since the last reset.

#### 4.6.3 Sensor history

##### "Frequency at delivery status" parameter

Function: Sensor frequency at delivery status.

##### "Upper warning frequency" parameter

Function: If the sensor frequency is currently greater than the upper warning frequency, then a warning is generated. The switching output remains in the current state. It is recommended to remove the sensor and check it for corrosion.

##### "Upper alarm frequency" parameter

Function: If the sensor frequency is currently greater than the upper alarm frequency, then an alarm is generated and the switching output switches to the safety related state.

### "Stored covered frequency" parameter

Function: In this parameter the actual sensor frequency can be stored, which is only possible if the fork is covered. The value is displayed on the Heartbeat Technology verification report and can be used as a reference for further/future analyses.

### "Stored uncovered frequency" parameter

Function: In this parameter the actual sensor frequency can be stored, which is only possible if the fork is uncovered. The value is displayed on the Heartbeat Technology verification report and can be used as a reference for further/future analyses.

### Frequency history

Function: Last 16 sensor frequencies at the time of verification are displayed. The last sensor frequency is displayed above. If the Heartbeat Verification was triggered by a communication command, the date "-----" is displayed.

## 4.7 Safety mode wizard



The device can be write-protected via the software using this wizard. The safety-related parameters must be confirmed in the wizard.

1. In the preparation screen, enter the locking code "7452".
2. Go through the wizard step by step.
3. Enter "7452" as the locking code.

The current **CRC device configuration** parameter is saved at the end of the wizard and the device is locked. The **CRC device configuration** parameter is unique and is built based on the current settings of safety relevant parameters.

If a device is unlocked and locked again, the current **CRC device configuration** parameter is compared with the **Stored CRC device configuration** parameter. If there is no difference in the configuration, the device is locked immediately. If there is a difference in the configuration, the safety-related parameter settings must be confirmed again.

## 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 Monitoring parameters

The following monitoring parameters can be assigned to the various outputs of the device for transmission to a condition monitoring system:

- Level limit detection
- Sensor frequency
- State of vibrating fork
- Sensor temperature

- Electronics temperature
- Measured current
- Terminal voltage

### Defining monitoring parameters as HART SV/TV/QV:

1. Navigation: Application → HART output → HART output
2. Select SV/TV/QV assignment.
3. Select monitoring parameters.


## 5.2 "Loop diagnostics" wizard

Using this wizard, changes in the current-voltage loop characteristics (baseline) can be used to detect unwanted installation anomalies such as creep currents caused by terminal corrosion or a deteriorating power supply that can lead to an incorrect 4-20 mA measured value.

### 5.2.1 Areas of application

- Detection of changes in the measuring circuit resistance due to anomalies  
Examples: Contact resistance or leakage currents in wiring, terminals or grounding due to corrosion and/or moisture
- Detection of faulty power supply

### 5.2.2 Loop diagnostics initialization

-  Activate the loop diagnostics during device commissioning.

Navigation: Guidance → Heartbeat Technology → Loop diagnostics → Activate/Deactivate → Loop diagnostics

### Programming the current-voltage baseline

Typically, the voltage at the terminal changes in a linear manner as a function of the analog output current. Following the initial installation, the current-voltage baseline of the measuring circuit is recorded via an active current simulation of 4 or 20 mA.

#### CAUTION

**The current output is simulated. Alarms can be triggered by mistake. The behavior in the control loop can change.**

- ▶ Take appropriate measures.
- ▶ Bridge the PLC if necessary.
- ▶ The baseline cannot be programmed on a write-protected device.

The bandwidth around this characteristic curve (Factory settings 1.5 V) determines when an event is reported.

The current and last baseline of the current-voltage baseline are saved in the device. Reprogram the baseline if changes have been made in the measuring circuit.



## Alarm delay

Period of time for which the alarm status must be active before an event report is issued. Necessary to exclude short-term signal interference. Factory settings: 1 s

## Diagnostic behavior

In addition to the NE107 category (default setting: **Maintenance required (M)** option), the event behavior defines how the detected event **Loop diagnostics** diagnostic message is to be communicated:

- **Logbook entry only** option: No digital or analog transmission of the report
- **Warning** option: Current output remains unchanged; message is output digitally (Factory settings)

The warning is no longer active in the device once the permissible conditions are met again.

## Disable/Enable

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



In some cases, changes in the measuring circuit resistance can only be detected at high output currents. By rebuilding the baseline, characteristic values can be compared and changes detected.

## 5.3 "Process window" wizard

This wizard can be used to monitor the sensor frequency for frequencies that are too low or too high. This can be used for early detection of buildup or corrosion. The limit values can be activated and configured separately.

### 5.3.1 Areas of application

- Detection of changed process conditions
- Detection of early signs of corrosion or buildup on the tuning fork possible

### 5.3.2 Commissioning

#### 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.

#### Process alert frequency too low/Process alert frequency too high

Set limit value(s) for sensor frequency "too low" and/or "too high". An event is generated when the limit value for sensor frequency "too low" is undershot or the limit value for sensor frequency "too high" is exceeded. There is no hysteresis. The verification result is Failed if the limit value is undershot or exceeded.

#### Alarm delay

Period of time during which the Sensor frequency must be below or above the limit value before an event report is displayed. Default setting, 60 s

## Diagnostic behavior

In addition to the NE107 category (default setting: **Maintenance required (M)** option), the event behavior defines how the detected event Process alert frequency too low/Process alert frequency too high is to be communicated:

- **Logbook entry only** option: No digital or analog transmission of the report
- **Warning** option: Current output remains unchanged; report is output digitally (default setting)

The warning is no longer active in the device once the permissible conditions are met again.

## Event in MAX/covered and MIN/uncovered in the Level limit detection mode

- In the **Safety function** parameter, **MAX** option and when the fork is covered, this event will not occur: Process alert frequency too low.
- In the **Safety function** parameter, **MIN** option and when the fork is uncovered, this event will not occur: Process alert frequency too high.





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