

Special Documentation **Liquiphant FTL51B, FTL62, FTL63, FTL64** **HART**

Application package
Heartbeat Verification + Monitoring



1 Document information

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

 Permitted

Procedures, processes or actions that are permitted.

 Forbidden

Procedures, processes or actions that are forbidden.

 Tip

Indicates additional information

   Series of steps

1, 2, 3, ...

Item numbers

1.3.3 Communication-specific symbols

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:

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

1.5 Registered trademarks

HART®

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

2 Product features and availability

2.1 Product features

The Heartbeat Technology 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 referred to as the **Total Test Coverage** (TTC). The TTC is calculated using the following formula for random errors (calculation based on FMEDA as per IEC 61508):

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

λ_{TOT} : Rate of all theoretically possible failures

λ_{du} : Rate of dangerous undetected failures

The undetected dangerous failures are not diagnosed by the device diagnostics. If these failures occur, they can distort 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 94 %.



The current value for the TTC depends on the configuration and integration of the measuring device. The values indicated above were determined under the following conditions:

- Integration of measuring device for measured value output via 4 to 20 mA HART output
- Simulation operation not active
- Error behavior, current output set to **Minimum alarm** or **Maximum alarm** and evaluation unit recognizes both alarms
- Settings for diagnostic behavior correspond to factory settings

2.2 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.

2.2.1 Order code

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

Product Configurator: order code 540 for "Application package", version EH "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
- 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 → Activate SW option

2.2.2 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.

Enter the activation code:

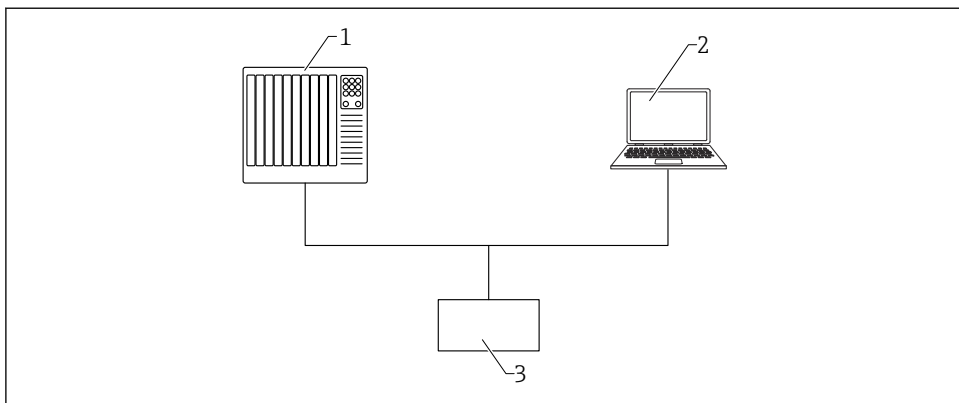
Navigation: System → Software configuration → Activate SW option

2.2.3 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.

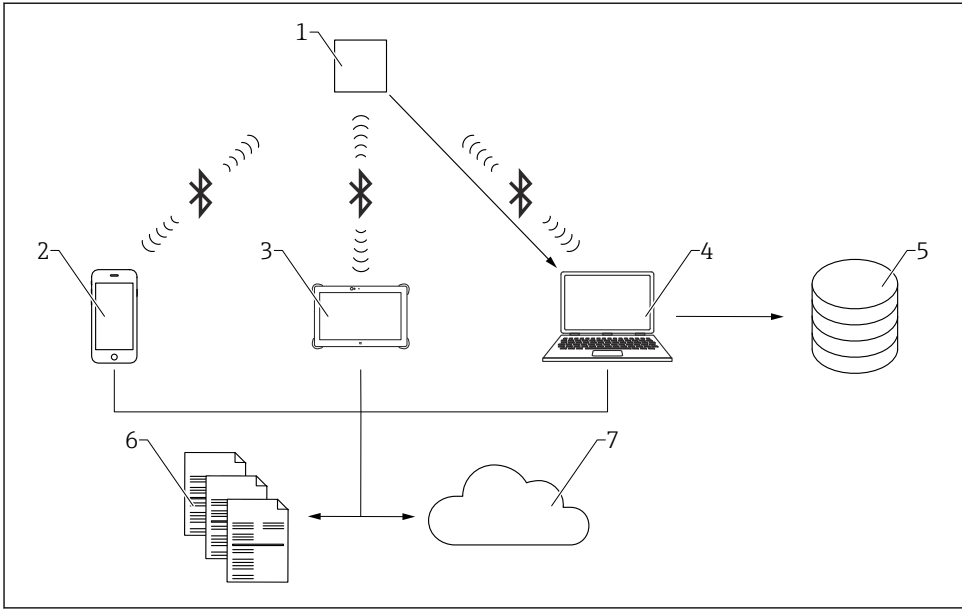
3 System integration

The Heartbeat Technology modules are available via the digital interfaces. The features can be used via an asset management system and also via the automation infrastructure (e.g. PLC).



A0040019

- 1 PLC
- 2 Asset management system
- 3 Device



A0047321

- 1 Device with local display
- 2 Mobile terminals with SmartBlue app
- 3 FieldXpert
- 4 DTM-based tools, e.g. FieldCare, DeviceCare ...
- 5 Data archive
- 6 Verification report
- 7 Netilion Library or W@M Portal

Run the Heartbeat Verification module via one of the following interfaces:

- System integration interface of a higher-level system
- Common Data Interface (CDI)
- Local display (optional)
- Bluetooth (optional)

External access to the device at the start of a verification and to relay the result (**Passed** option or **Failed** option) must be obtained from a higher-order system via the 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 verification report is saved in the device.

Verification reports can be generated using the FieldCare plant asset management software from Endress+Hauser or via DeviceCare, SmartBlue and SMT70.

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

- 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. New verification results overwrite old data following the FIFO ¹⁾ principle.

3.2.1 Verification report

Printing a verification report

The verification report is output in PDF format.



Prerequisite: A verification has already been performed.

3.2.2 File management

W@M Portal

The W@M portal from Endress+Hauser allows Heartbeat verification reports to be saved electronically and assigned to the tested device. This means that they are

- online
- easy to find
- automatically assigned to their digital counterpart
- always readily available.

Netilion Library

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

The verification reports are then

- online
- automatically assigned to their digital counterpart
- even easier to find
- always readily available.

1) First In – First Out

4 Heartbeat Verification

Heartbeat Verification uses the self-monitoring function of the devices to check the device functionality. 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 on demand that the device is functioning within the specified measuring tolerance with a total test coverage (TTC) of 94 %.

Heartbeat Verification meets the requirements for measurement traceability in accordance with (ISO9001:2015 Section 7.1.5.2).

The result of the verification is either **Passed** option or **Failed** option. The verification data is saved in the device and optionally archived on a PC with the FieldCare asset management software. Based on this data, a verification report is generated automatically to ensure the traceable documentation of the verification results.

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

 The measuring mode continues during the entire Heartbeat Verification.

4.1 Performance characteristics

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

The test confirms on demand that the device is functioning with the specified total test coverage (TTC).

4.2 Operation

4.2.1 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).

The cause of the error can be narrowed down by identifying the test group with a "Failed" verification.

4.2.2 Verification

Performing verification

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

Displaying the status

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

Displaying the result

- Navigation: Diagnostics → Heartbeat Technology → Heartbeat Verification → Overall result

4.2.3 Verification results

Access to the verification results via:

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

Classification of results

Individual results:

-  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 in the current device configuration.

Overall results:

-  Failed
At least one test group was "Out of specification (S)".
-  Passed
All verified test groups complied with the specifications (result: "Passed").
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 test coverage of TTC 94 %.

4.2.4 Verification report

The results of the verification can be documented in the form of a verification report via DTM-based tools or the SmartBlue app. The verification report is generated based on the data records saved in the device after verification. As the verification results are automatically and uniquely identified with the operating time, they are suitable for the traceable documentation of the verification of devices.

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".

Verification report, Section 2

Details on the individual results for all test groups:

- Device and verification information
- Test groups
 - Prerequisite for the verification
 - Mainboard module
 - Sensor module

Verification report, Section 3

Details with values for the individual tests from Section 2.

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
 - Sensor temperature
 - Electronics temperature
- Device history
 - Date/time Heartbeat Verification
 - Electronics temperature
 - Sensor temperature
 - Terminal voltage
- Sensor history
 - Counter power on
 - 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

4.2.5 Test criteria for the test objects



This applies to all modes of operation.

Prerequisite for the verification

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: **Terminal voltage** parameter

Function: 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.
- Check: **Output current** parameter

Function: Checks whether read-back current at the output matches the current set by the device.
- 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).
- Check: **Loop diagnostics** parameter
Function: 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. Visible only if activated.

Sensor module

- Check: **Sensor integrity** parameter
Function: 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.
- Check: **Fork frequency** parameter
Function: The sensor-controller evaluates the fork frequency for irregular frequencies. Alarm conditions, e.g. corrosion alarm (fixed threshold values).
- Check: **Fork corrosion/abrasion** parameter
Function: 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)).
- Check: **Process window low** parameter/**Process window high** parameter
Function: Shows result of user defined frequency check. Visible only if activated.

4.2.6 Additional verification information

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
- Display **Sensor temperature** parameter
Function: Current temperature and permitted MIN/MAX range
- Display **Electronics temperature** parameter
Function: Current temperature and permitted MIN/MAX range

Device history

Current value and MIN/MAX values for:

- **Terminal voltage** parameter
- **Sensor temperature** parameter
- **Electronics temperature** parameter

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" submenu

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 display or a communication command, the date "-----" is displayed.



Recommendations 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. Please note the following points in this regard:

- 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.

4.2.7 Heartbeat Technology in safety instrumented systems

The verification (Heartbeat Verification) enables the documentation of the current device diagnosis or device status as a test certificate.

- This supports the documentation of proof tests in accordance with IEC 61511-1, Section 16.3.3, "Documentation of proof tests and inspection".
- The verification is based on automatically executed device-specific test sequences. From a safety point of view, verification cannot replace the proof-testing of a sensor, since random errors are usually not detected.
- Nevertheless, verification can be usefully applied as a step in a proof-test scenario as per NA 106 as a flexible proof-testing strategy.
- The verification report should be regarded as a supplement to the proof-test report.

5 Heartbeat Monitoring

Wizards for loop diagnostics and Process window are available. In addition, other monitoring parameters can be output for use in predictive maintenance or application optimization.

5.1 Commissioning

Assign the monitoring parameters to the outputs for commissioning. After commissioning, these parameters are continuously available at the outputs. The following monitoring parameters can be assigned to the various outputs of the device for continuous transmission to a Condition Monitoring system.

Measured variables:

- **Sensor temperature**
Temperature of sensor electronics in the housing
- **Measured current**
Loop current measured by the device
- **Terminal voltage**
Voltage measured by the device at the terminals

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.

Selecting the measured value that is shown on the local display:

1. Navigation: System → Display
2. Select the measured value.

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: Leakage currents in wiring, terminals or grounding due to corrosion and/or moisture
- Detection of faulty power supply

5.2.2 Commissioning

Programming the current-voltage characteristic (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 characteristic of the measuring circuit is recorded via an active current simulation of 4 or 20 mA. The current-

voltage characteristic is defined by the slope, i.e. the measuring circuit resistance, and the supply voltage point.

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

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 current and last baseline of the current/voltage characteristic are saved in the device. Program the baseline again if planned changes have been carried out in the measuring circuit.

Alarm delay

Period of time for which the "Out of range" status must be present before an event report is issued. This is necessary when short-term conditions are present. Default setting: 1 s

Diagnostic behavior

In addition to the NE107 category (default setting: **Maintenance required (M)** option), the event behavior defines how the detected "measuring circuit anomaly" event is to be relayed:

- **Logbook entry only** option: No digital or analog transmission of the report
- **Warning** option: Current output remains unchanged; report is output digitally (default setting)
- **Alarm**: not permitted

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.

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 is selected, no analysis and therefore no event reporting take place.

Frequency "Process alert frequency too low" parameter/"Process alert frequency too high" parameter

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.

Alarm delay

Period of time for which the Sensor frequency must be below/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)
- **Alarm**: not permitted

If an event is detected and the measured value subsequently returns to the permitted range due to the process conditions, the warning in the device is no longer active.

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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