

# Special Documentation

## Cerabar PMC71B, PMP71B

## Deltabar PMD75B, PMD78B

## PROFINET with Ethernet-APL

Application package  
Heartbeat Verification + Monitoring



# 1 About this document

## 1.1 Document function

This manual is 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



Warning of radioactive substances or ionizing radiation sources



#### **Permitted**

Procedures, processes or actions that are permitted



#### **Preferred**

Procedures, processes or actions that are preferred



#### **Forbidden**

Procedures, processes or actions that are forbidden



#### **Tip**

Indicates additional information



Reference to documentation



Reference to page



Reference to graphic



Notice or individual step to be observed

1., 2., 3.

Series of steps



Result of a step



Operation via local display



Operation via operating tool



Write-protected parameter

1, 2, 3, ...

Item numbers

A, B, C, ...

Views

 →  **Safety instructions**

Observe the safety instructions contained in the associated Operating Instructions

## 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.

This documentation is not a substitute for the Operating Instructions supplied with the device.

Detailed information: Operating Instructions, additional documentation, Device Viewer.

This documentation is an integral part of the Operating Instructions for the device.

## 1.5 Registered trademarks

**ethernet-apl™**

- Ethernet-APL ADVANCED PHYSICAL LAYER
- Registered trademark of the PROFIBUS Nutzerorganisation e.V. (Profibus User Organization), Karlsruhe - Germany

## 2 Product features and availability

### 2.1 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 total test coverage is calculated using the following formula for random errors (calculation based on FMEDA as per IEC 61508):

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

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

$\lambda_{du}$ : Rate of dangerous undetected failures

The undetected dangerous 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 PROFINET communication



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** parameter **Off** option
- 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](http://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:

Order code 540 "Application package", option 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 ([www.endress.com/deviceviewer](http://www.endress.com/deviceviewer)): enter the serial number from the nameplate and check whether the order code is displayed
- In the operating menu: The menu indicates whether the application package is activated.

### **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.

#### **Menu path for entering the activation code**

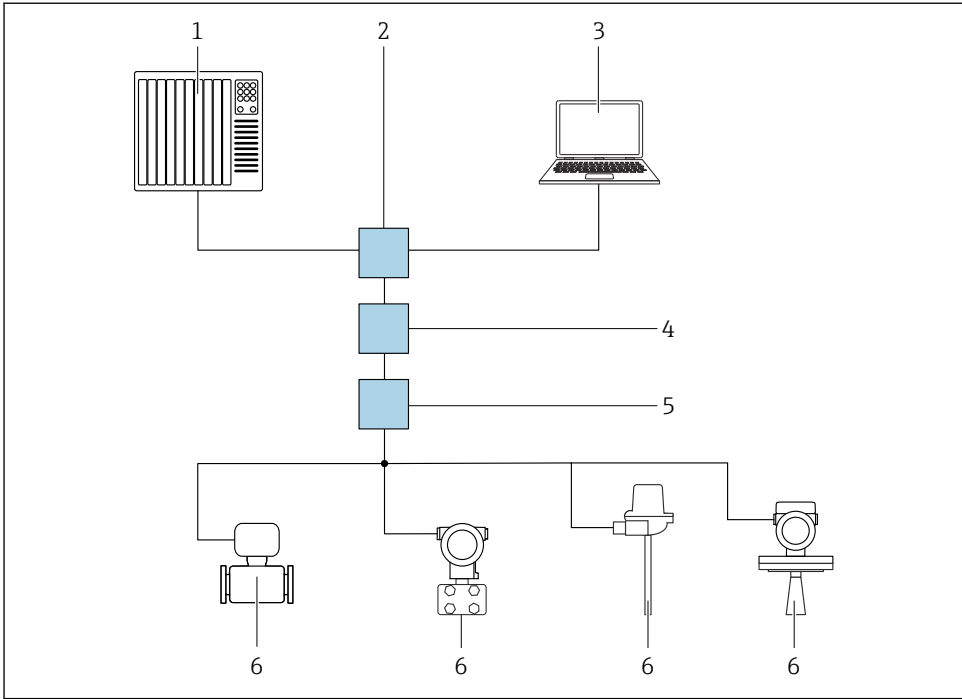
System → Software configuration → Activate SW option

### **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 functions are available on the web server and can be used either via an Asset Management System or the automation infrastructure (e.g. PLC).



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 1 Options for remote operation via PROFINET with Ethernet-APL network: star topology

- 1 Automation system, e.g., Simatic S7 (Siemens)
- 2 Ethernet switch
- 3 Computer with Web browser (e.g., Microsoft Edge) for accessing the integrated device Web server or computer with operating tool (e.g., FieldCare, DeviceCare, SIMATIC PDM) with iDTM Profinet Communication
- 4 APL power switch (optional)
- 5 APL field switch
- 6 APL field device

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)
- Web server
- PROFINET cyclic or acyclic
- Onsite display (optional)
- Bluetooth (optional)

External access to the device in order to start a verification and signal the result (**Passed** option or) **Failed** option must be performed by a higher-level system via a system integration interface. The Heartbeat verification can be started cyclically via PROFINET by the BinaryOutput Block. The results are signaled via the BinaryInput Block in slot 80.

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 Plant Asset Management Software FieldCare, DeviceCare, the web server or SmartBlue app and FieldXpert.

### 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. Previous data are Verification results overwritten by new data; only the last result is saved.

#### 3.2.1 Verification report

##### Verification report must be pressed

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 uses the self-monitoring function of the measuring 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.

Heartbeat Verification checks the device function on demand with the total test coverage (TTC) specified in Section 2.1. The result of the verification is "Passed" or "Failed". The verification data are saved in the device and, optionally, are archived on a PC with the FieldCare asset management software. Based on this data, a verification report is generated automatically to ensure that traceable documentation of the verification results is available.

## 4.1 Operation

### 4.1.1 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)".

#### Verification result Failed

If the result of a verification is **"Failed" option**, repeat the verification.

Consider the following measures when doing so:

1. Establish defined and stable process conditions in order to rule out process-specific influences as much as possible.
2. Compare current process conditions with those of the previous verification to identify possible deviations.
3. 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 with a "Failed" verification.



Operation continues during the entire Heartbeat Verification.

### 4.1.2 Verification

#### Performing verification

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

#### Displaying the status

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

#### Displaying the result

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



### 4.1.3 Verification results

Access to the verification results via:

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

#### 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.

### 4.1.4 Verification report

The results of the verification can be documented via DTM-based tools or the SmartBlue app Verification report in the form of a verification report. Since the Verification results 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)

## 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 Empty calibration, Full calibration, Medium type, Medium group , CRC device configuration)
- **Verification information**  
(Operating time (Verification) for unique assignment of the Verification results for the purpose of 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 of the following test groups:

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

### 4.1.5 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).
- Check: **Module voltages**  
Function: Checks whether the internal module voltages are within the permitted range.

| Module voltage | Permitted range    |
|----------------|--------------------|
| 1.20 V         | 1.0988 to 1.2012 V |
| 1.35 V         | 1.2818 to 1.4512 V |
| 1.80 V         | 1.7088 to 1.8912 V |
| 3.30 V         | 3.1180 to 3.4720 V |
| 8.25 V         | 7.1270 to 9.2730 V |

## Sensor module

- Check: **Sensor integrity** parameter / **Membrane integrity** parameter<sup>1)</sup>  
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.

### 4.1.6 Additional verification information

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

- Display **Sensor temperature** parameter  
Function: current temperature and permitted min/max range.
- Display **Signal to noise ratio** parameter  
Shows the signal-to-noise ratio of the Ethernet-APL connection. Value > 21 dB is good and greater than 23 dB very good. Possible causes of poor signal quality are EMC influences (shielding), poor contacts, poor or incorrect line.

1) The membrane integrity cannot be checked on all sensors

## Device history

Information on whether the device was operated within its specification. Current value and min/max values for:

- Sensor pressure
- Electronics temperature
- Sensor temperature
- Ethernet failure counter

Shows all detected Ethernet failures (Total Number of failed received packets + Number of failed sent packets) since the device was started.

## Sensor history

- Counter **Sensor temperature** parameter, **Sensor pressure**  
Function: number of times the specified limits are overshoot or undershot
- Counter **Sensor temperature** parameter, **Sensor pressure**: user-defined limits  
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: number of programmed baselines

# 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

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:

- A 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 "Idle".

### **Baseline Signal Lower Control Line and Baseline Signal Upper Control Line**

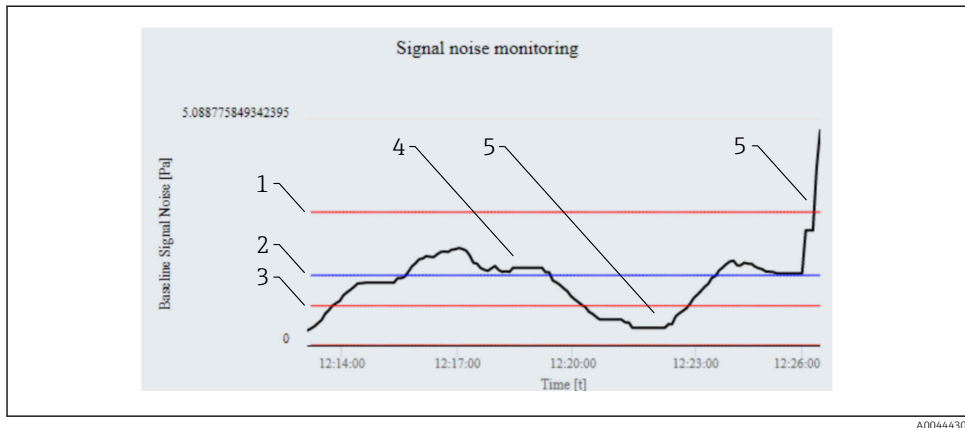
Defines the bandwidth above (UCL) or below (LCL) the baseline in which statistical analysis or anomaly detection is "**Active** option".

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 threshold
- 2 Baseline
- 3 Lower 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** setting) and up to several minutes (**Slow** setting). The factory setting is **Fast**. Only choose different settings if it is not possible to build a baseline with the **Fast** 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 median status

### "SSD Monitoring Delay Time" parameter

Time during which the "Out of range" status must apply before an event message is displayed. Required if conditions are present for a short time. 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 (factory setting: "M" maintenance required), the event level specifies how the recognized "Process anomaly" event is to be communicated:

- Logbook entry: no digital or analog communication of the message
- Warning: current output is not changed  
Message is output digitally (factory setting)
- Alarm: not allowed
- Off: no logbook entry and no digital communication of the message output

The message is always shown on the display. If a process anomaly event (out of range, signal noise) 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.

### Enable / Disable

Specify whether the SSD function should be activated. If "**Disable**" is selected, an analysis is not performed and no event message is displayed.

## 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.

Temperature min/max. limit value

Specify the range. An event is generated if this limit value is exceeded or undershot. Factory setting: limit values as specified in the Technical Information. There is no hysteresis here.

Pressure min/max. limit value

Specify the range. An event is generated if this limit value is exceeded or undershot. Factory setting: LRL/URL. There is no hysteresis here.

Scaled variable min/max

Specify the range. An event is generated if this limit value is exceeded or undershot. Only displayed if 'Scaled variable' is selected.

Event level

In addition to the NE107 category (factory setting: "M" maintenance required), the event level specifies how the recognized "Process anomaly" event is to be communicated:

- Logbook entry: no digital or analog communication of the message
- Warning: current output is not changed  
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 it is configured as "Alarm" or "Warning ". If it is configured as "Logbook" or "Off", no message is shown on the display. 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.

Enable/disable

Specify whether the function should be activated. If "Disable" is selected, an analysis is not performed and no event message is displayed.

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.

| Device                         |      | Direction<br>Data flow | Control system |
|--------------------------------|------|------------------------|----------------|
| Module                         | Slot |                        |                |
| Analog input (Pressure)        | 1    | →                      | PROFINET       |
| Analog input (Scaled variable) | 20   | →                      |                |



|                                                    |     |   |  |
|----------------------------------------------------|-----|---|--|
| Analog input (Sensor temperature)                  | 21  | → |  |
| Analog input (Sensor pressure)                     | 22  | → |  |
| Analog input (Electronics temperature)             | 23  | → |  |
| Analog input (Median of pressure signal)           | 24  | → |  |
| Analog input (Noise of pressure signal)            | 25  | → |  |
| Binary input (Heartbeat Technology)                | 80  | → |  |
| Binary input (SSD: Statistical Sensor Diagnostics) | 81  | → |  |
| Binary output (Heartbeat Technology)               | 210 | ← |  |

Binary input Sensor diagnostics Slot 81

| Bit | Function                      | Description                             |
|-----|-------------------------------|-----------------------------------------|
| 0   | Process alert pressure        | Process alert pressure detected.        |
| 1   | Process alert scaled variable | Process alert scaled variable detected. |
| 2   | Process alert temperature     | Process alert temperature detected.     |
| 3   | Low signal noise detected     | Low signal noise detected               |
| 4   | High signal noise detected    | High signal noise detected              |
| 5   | Min signal noise detected     | Min signal noise detected               |
| 6   | Out of range signal detected  | Out of range signal detected            |
| 7   | -                             | -                                       |

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