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Test Report

Report Number:

F231200E3 2nd version

Equipment under Test (EUT):

Cerabar PMP43

Applicant:

Endress+Hauser SE+Co. KG

Manufacturer:

Endress+Hauser SE+Co. KG



References

- [1] **CFR 47 Rule part 1** Practice and Procedure
- [2] **CFR 47 Rule part 2** Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
- [3] **KDB 447498 D04 Interim General RF Exposure Guidance v01**

Test Result

The requirements of the tests performed as shown in the overview (clause 4) were fulfilled by the equipment under test. The complete test results are presented in the following.

“Passed” indicates that the equipment under test conforms with the relevant limits of the testing standard without taking any measurement uncertainty into account. However, the measurement uncertainty is calculated and shown in this test report.

Tested and written
by:

Signature

Reviewed and
approved by:

Signature

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1 Identification

1.1 Applicant

| | |
|--|-------------------------------|
| Name: | Endress+Hauser SE+Co. KG |
| Address: | Hauptstr. 1 79689 Maulburg |
| Country: | Germany |
| Name for contact purposes: | Mr. Florian SEIDLER |
| Phone: | +49 7622-28-0 |
| eMail address: | florian.seidler@endress.com |
| Applicant represented during the test by the following person: | - |

1.2 Manufacturer

| | |
|---|-------------------------------|
| Name: | Endress+Hauser SE+Co. KG |
| Address: | Hauptstr. 1 79689 Maulburg |
| Country: | Germany |
| Name for contact purposes: | Mr. Florian SEIDLER |
| Phone: | +49 7622-28-0 |
| eMail address: | florian.seidler@endress.com |
| Manufacturer represented during the test by the following person: | - |

1.3 Test Laboratory

The tests were carried out by:

PHOENIX TESTLAB GmbH
Königswinkel 10
32825 Blomberg
Germany

accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) according to DIN EN ISO/IEC 17025:2018. The accreditation is only valid for the scope of accreditation listed in the annex of the certificate D-PL-17186-01-00. FCC Test Firm Designation Number DE0004, FCC Test Firm Registration Number 469623, CAB Identifier DE0003 and ISED# 3469A.

1.4 EUT (Equipment under Test)

| | |
|----------------------------|---------------------------|
| Test object: * | Pressure measuring device |
| Model name: * | Cerabar PMP43 |
| Model number: * | PMP43 |
| Order number: * | NA |
| FCC ID: * | LCGPMX43 |
| IC certification number: * | 2519A-PMX43 |
| PMN: * | PMP43 |
| HVIN: * | PMP43-1 |
| FVIN: * | NA |

| | EUT number |
|---------------------|--|
| | 1 |
| Serial number: * | W1000C01225 |
| PCB identifier: * | Display Board: 71599584 Mainboard: 71439136 Terminal Board: 71508546 |
| Hardware version: * | 01.00.00 |
| Software version: * | S140 V7.2.0 (Soft device) |

* Declared by the applicant

One EUT was used for all tests.

Note: PHOENIX TESTLAB GmbH does not take samples. The samples used for tests are provided exclusively by the applicant.

1.5 Technical Data of Equipment

| General EUT data | | | |
|-----------------------|-------------------------------|-------------------------------|-------------------------------|
| Power supply EUT: * | DC | | |
| Supply voltage EUT: * | $U_{Nom} = 24 \text{ V}_{DC}$ | $U_{Min} = 12 \text{ V}_{DC}$ | $U_{Max} = 30 \text{ V}_{DC}$ |
| Temperature range: * | -40°C to +85°C | | |

| Bluetooth® low energy frequencies | | | |
|-----------------------------------|----------|------------|----------|
| Channel 00 | 2402 MHz | Channel 01 | 2404 MHz |
| Channel 02 | 2406 MHz | Channel 03 | 2408 MHz |
| ... | ... | ... | ... |
| ... | ... | ... | ... |
| Channel 18 | 2438 MHz | Channel 19 | 2440 MHz |
| ... | ... | ... | ... |
| ... | ... | ... | ... |
| Channel 36 | 2474 MHz | Channel 37 | 2476 MHz |
| Channel 38 | 2478 MHz | Channel 39 | 2480 MHz |

| Bluetooth® low energy radio mode | | |
|----------------------------------|---------------------------------|----------------------------|
| Fulfils radio specification: *1 | Bluetooth® low energy (BLE) 5.2 | |
| Radio chip: *1 | Nordic nRF52840 (SoC) | |
| Antenna type: *1 | PCB IFA Antenna | |
| Antenna name: *1 | n/a | |
| Antenna gain: *2 | -2.2 dBi | |
| Type of modulation: *1 | BLE (1 Mbps PHY) | GFSK |
| | BLE (2 Mbps PHY) | GFSK |
| | BLE (500 kbps coded PHY) | GFSK |
| | BLE (125 kbps coded PHY) | GFSK |
| Operating frequency range: *1 | BLE (1 Mbps PHY) | 2402 – 2480 MHz |
| | BLE (2 Mbps PHY) | 2402 – 2480 MHz |
| | BLE (500 kbps coded PHY) | 2402 – 2480 MHz |
| | BLE (125 kbps coded PHY) | 2402 – 2480 MHz |
| Number of channels: *1 | BLE (1 Mbps PHY) | 40 (2 MHz channel spacing) |
| | BLE (2 Mbps PHY) | 40 (2 MHz channel spacing) |
| | BLE (500 kbps coded PHY) | 40 (2 MHz channel spacing) |
| | BLE (125 kbps coded PHY) | 40 (2 MHz channel spacing) |

*1 declared by the applicant

*2 based on the antenna test report F231200E4 by Phoenix TESTLAB GmbH

1.6 Dates

| | |
|---------------------------------|------------|
| Date of receipt of test sample: | 24.01.2024 |
|---------------------------------|------------|

2 Evaluation Method

2.1 RF exposure test exemptions for single sources

2.1.1 General Exemption CFR 47 §1.1307(b)(3)(i)(A)

The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

2.1.2 SAR Based Exemption CFR 47 §1.1307(b)(3)(i)(B)

The available maximum time-averaged power of effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz inclusive.

For the following separation distances [d] and frequency ranges P_{th} is given by the following formulas

| | 0.5 cm ≤ d ≤ 20cm | 20 cm < d ≤ 40 cm |
|-----------------------|---|---|
| 0.2 GHz ≤ f < 1.5 GHz | $P_{th}(mW) = ERP_{20cm} \left(\frac{d}{20} \right)^x$ $ERP_{20cm} (mW) = 2040f$ $x = -\log_{10} \left(\frac{60}{ERP_{20cm}\sqrt{f}} \right)$ | $P_{th}(mW) = ERP_{20cm}$ $ERP_{20cm} (mW) = 2040f$ |
| 1.5 GHz ≤ f ≤ 6 GHz | $P_{th}(mW) = ERP_{20cm} \left(\frac{d}{20} \right)^x$ $ERP_{20cm} (mW) = 3060$ $x = -\log_{10} \left(\frac{60}{ERP_{20cm}\sqrt{f}} \right)$ | $P_{th}(mW) = ERP_{20cm}$ $ERP_{20cm} (mW) = 3060$ |

2.1.3 MPE Based Exemption CFR 47 §1.1307(b)(3)(i)(C)

By using Table 1 and the minimum separation distance (d in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, d must be at least $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

| RF Source frequency [MHz] | Threshold ERP [W] |
|---------------------------|-------------------------------------|
| 0.3 -1.34 | 1920 d ² |
| 1.34 – 30 | 3450 d ² /f ² |
| 30 – 300 | 3.83 d ² |
| 300 – 1500 | 0.0128 d ² /f |
| 1500 - 100000 | 19.2 d ² |

d: Minimal separation distance from antenna to the user

2.1.4 Stand alone MPE evaluation limits

The human exposure to RF emissions from such devices could be evaluated based on the MPE limits adopted by the FCC for electric and magnetic field strength and / or power density. The limits for General Population / Uncontrolled Exposure are given in the following table from CFR 47 §1.1310(e):

| Frequency range [MHz] | Electric field strength (E) [V/m] | Magnetic field strength (H) [A/m] | Power density (S) [mW/cm ²] | Averaging time [min] |
|---|---|---|--|-------------------------|
| (i)Limits for Occupational/Controlled Exposure | | | | |
| 0.3 – 3.0 | 614 | 1.63 | *(100) | ≤6 |
| 3.0 – 30 | 1842/f | 4.89/f | *(900/f ²) | <6 |
| 30 – 300 | 61.4 | 0.163 | 1.0 | <6 |
| 300 – 1,500 | | | f/300 | <6 |
| 1,500 – 100,000 | | | 5 | <6 |
| (ii)Limits for General Population / Uncontrolled Exposure | | | | |
| 0.3 – 1.34 | 614 | 1.63 | *(100) | < 30 |
| 1.34 – 30 | 824/f | 2.19/f | *(180/f ²) | < 30 |
| 30 – 300 | 27.5 | 0.073 | 0.2 | < 30 |
| 300 – 1500 | | | f/1500 | < 30 |
| 1500 – 100,000 | | | 1.0 | < 30 |

Note: f = frequency in MHz; * Plane – wave equivalent power density

The power density is calculated as follows:

$$S = \frac{P \cdot G \cdot D}{4 \cdot \pi \cdot d^2}$$

Where:

P: conducted power

G: Antenna gain (linear)

D: Duty Cycle

d: Minimal separation distance from antenna to the user

2.2 RF exposure test exemptions for simultaneous transmission sources

2.2.1 1 mW Test Exemption for simultaneous transmission sources

As discussed in CFR 47 §1.1307(b)(3)(ii)(A) [1] the 1 mW exemption intended for single transmitters may be also applied to simultaneous transmission conditions, within the same host device, according one of the following criteria:

- a. When the maximum available power each individual transmitting antenna with the same time averaging period is ≤ 1 mW, and the nearest parts of the antenna structures of the simultaneously operating transmitters are separated by at least 2 cm
- b. When the aggregate maximum available power of all transmitting antennas is ≤ 1 mW in the same time-averaging period

This exemption may not be combined with any other exemption.

2.2.2 Simultaneous transmission SAR based and MPE based test exemptions

Although this is not a module integration in the sense of product approval, the procedure for simultaneous transmission specified in KDB 447498 D04 Interim General RF Exposure Guidance v01 [3] in chapter 2.2 was taken into account:

According to the RF exposure KDB 447498 D04 General RF Exposure Guidance v01 [3] in chapter 2.2.2: This case is described in detail in CFR 47 §1.1307(b)(3)(ii)(B) and covers the situations where both SAR-based and MPE-based exemption may be considered for test exemption in fixed, mobile, or portable device exposure conditions. For these cases, a device with multiple RF sources transmitting simultaneously will be considered an RF exempt device if the condition of the following formular is satisfied.

$$\sum_{i=1}^a \frac{P_i}{P_{th,i}} + \sum_{i=1}^b \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^c \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$$

For these test exemptions to apply, the maximum output power, duty factor, and other applicable parameters used in the standalone ERP determination tests, must be the same, or corresponding to a more conservative choice, than those required for simultaneous transmission.

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0 , according to calculated/estimated, numerically modelled, or measured field strengths or power density. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to the MPE limit at the test frequency.

2.2.3 Test exemption based on the SAR to Peak Location Separation Ratio

When the ERP-based condition in the previous section does not apply, a test exemption may be still applicable based on the SAR to peak location separation ratio (SPLSR) procedure.

In this case, the simultaneously transmitting antennas in each operating mode and exposure condition combination must be considered one pair at a time to determine the SPLSR that qualifies for the additional test exemption.

This ratio is defined as:

$$SPLSR = (SAR_1 + SAR_2)^{\frac{1.5}{R_i}}$$

Where: SAR_1 and SAR_2 = highest reported SAR or estimated SAR values for the two sources in the pair i, and R_i is their distance in mm.

When $SPLSR \leq 0.0.4$ (rounded to two decimal digits), for all antenna pairs in the configuration, then the device qualifies for 1 g SAR test exemption.

When 10 g SAR applies (e.g. for extremities) the corresponding test exemption condition is $SPLSR \leq 0.10$.

If any antenna pair does not qualify for simultaneous transmission SAR test exemption, then the device must be tested for SAR compliance, according to the enlarged zoom scan and volume scan post-processing procedures in KDB Pub. 865664 D01.

3 Results of evaluation

3.1 Used evaluation methods

| RF Exposure test exemptions for single sources | | | |
|--|---|----------------|---------|
| Used | Method | See sub-clause | Comment |
| <input type="checkbox"/> | General Exemption acc. CFR 47 §1.1307(b)(3)(i)(A) | 2.1.1 | - |
| <input type="checkbox"/> | SAR Based Exemption acc. CFR 47 §1.1307(b)(3)(i)(B) | 2.1.2 | - |
| <input checked="" type="checkbox"/> | MPE Based Exemption acc. CFR 47 §1.1307(b)(3)(i)(C) | 2.1.3 | - |
| <input type="checkbox"/> | MPE Calculation | 2.1.4 | - |

| RF Exposure test exemptions for simultaneous transmission sources | | | |
|---|--|----------------|--------------------------|
| Used | Method | See sub-clause | Comment |
| <input checked="" type="checkbox"/> | Not applicable | | No simultaneous possible |
| <input type="checkbox"/> | 1 mW test Exemption acc. 2.2.1 [3] | 2.2.1 | - |
| <input type="checkbox"/> | SAR Based Exemption acc. 2.2.2 [3] | 2.2.2 | |
| <input type="checkbox"/> | MPE Based Exemption acc. 2.2.2 [3] | 2.2.2 | |
| <input type="checkbox"/> | SAR to Peak location separation ratio acc. 2.2.3 [3] | 2.2.3 | |

3.2 BLE 2.4 GHz Emissions

The following information are based on Test-Report F231200E2 of PHOENIX TESTLAB GmbH

MPE Based Exemption CFR 47 §1.1307(b)(3)(i)(C)

| P _{con} [dBm] incl. Tuneup | P _{con} [mW] incl. Tuneup | Ant. Gain [dBi] | Cable Antenuation [dB] | P _{e.i.r.p} [dBm] | P _{e.i.r.p} [mW] | P _{e.r.p} [dBm] | P _{e.r.p} [mW] |
|---|---|--------------------|------------------------------|-------------------------------|------------------------------|-----------------------------|----------------------------|
| 6.5 | 4.47 | -2.2 | 0 | 4.3 | 2.69 | 2.15 | 1.64 |

| Frequency [GHz] | Wavelength λ [cm] | $\lambda/2\pi$ [cm] | d [cm] | d > $\lambda/2\pi$ |
|--------------------|---------------------------------|------------------------|-----------|--------------------|
| 2.48 | 12.0884056 | 1.9239295 | 20 | fulfilled |

| Frequency [GHz] | d [cm] | Threshold ERP [mW] | P _{e.r.p.} [mW] | Result |
|--------------------|-----------|-----------------------|-----------------------------|-----------------|
| 2.48 | 20 | 768 | 1.64 | exempted |

The separation distance d is larger than the wavelength divided by 2π . Therefore, the MPE Exemption could be used.

MPE Calculation

| P _{con} [dBm] incl. Tuneup | P _{con} [mW] incl. Tuneup | Ant. Gain [dBi] | Cable Antenuation [dB] | P _{e.i.r.p} [dBm] | P _{e.i.r.p} [mW] | P _{e.r.p} [dBm] | P _{e.r.p} [mW] |
|---|---|--------------------|------------------------------|-------------------------------|------------------------------|-----------------------------|----------------------------|
| 6.5 | 4.47 | -2.2 | 0 | 4.3 | 2.69 | 2.15 | 1.64 |

| Frequency [MHz] | P _{e.i.r.p} [mW] | Duty cycle D [%] | Distance d [cm] | S [mW/cm ²] | S _{limit} [mW/cm ²] | Result |
|--------------------|------------------------------|------------------------|-----------------------|----------------------------|---|-----------------|
| 2.48 | 2.69 | 98 | 20 | 0.0005 | 1 | exempted |

Due to the fact that for separation distances larger than d the Power Density S is below S_{limit} this emission is exempted from SAR Evaluation

4 Conclusion

The EUT complies in all operational modes to the limits given in CFR 47 §1.1310(e)1 in a separation distance of 20 cm.

5 Report History

| Report Number | Date | Comment |
|-----------------------------------|------------|---|
| F231200E3 | 21.11.2024 | Initial Test Report |
| F231200E3 2 nd Version | 05.12.2024 | Corrected mistake in the contents table on page 4 |
| - | - | - |

----- end of test report -----