



RF - TEST REPORT

- Human Exposure -

Type / Model Name : BMW FBD5

Product Description : UWB+BLE CAN gateway for comfort access function in vehicles

Applicant : Continental Automotive GmbH

Address : Siemensstraße 12
93055 REGENSBURG, GERMANY

Manufacturer : Continental Automotive GmbH

Address : Siemensstraße 12
93055 REGENSBURG, GERMANY

<p>Test Result according to the standards listed in clause 1 test standards:</p>	<p>POSITIVE</p>
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<p>Test Report No. : T46614-00-09FX</p>	<p>14. June 2021 Date of issue</p>
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Deutsche
Akkreditierungsstelle
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FCC ID: KR5FBD5 IC: 7812D-FBD5

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ATTACHMENT A1 and A2 as separate supplement

The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test results without the written permission of the test laboratory.

1 TEST STANDARDS

The tests were performed according to following standards:

FCC Rules and Regulations Part 1, Subpart I - Procedures Implementing the National Environmental Policy Act of 1969

Part 1, Subpart I, Section 1.1310	Radiofrequency radiation exposure limits
Part 1, Subpart 2, Section 2.1091	Radiofrequency radiation exposure evaluation: mobile devices .
Part 1, Subpart 2, Section 2.1093	Radiofrequency radiation exposure evaluation: portable devices .
KDB 447498 D01 v06	RF Exposure procedures and equipment authorisation policies for mobile and portable devices, October 23, 2015.
KDB 865664 D01 v01r04	SAR Measurement Requirements for 100 MHz to 6 GHz, August 7, 2015.
ANSI C95.1: 2005	IEEE Standard for Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
RSS-102, issue 5, March 2015, incl. Amendment 1, February 2021	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
Health Canada Notice, January 2021	Localized human exposure limits for radiofrequency fields in the range of 6 GHz to 300 GHz
ETSI TR 100 028 V1.3.1: 2001-03,	Electromagnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the Measurement of Mobile Radio Equipment Characteristics—Part 1 and Part 2

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2 EQUIPMENT UNDER TEST

2.1 Information provided by the Client

Please note, we do not take any responsibility for information provided by the client or his representative which may have an influence on the validity of the test results.

2.2 Sampling

The customer is responsible for the choice of sample. Sample configuration, start-up and operation is carried out by the customer or according his/her instructions.

2.3 Photo documentation of the EUT – See ATTACHMENT A1 and A2

2.4 Equipment type, category

BLE device, UWB device, portable exposure conditions

2.5 Short description of the equipment under test (EUT)

The FBD5 is a wireless UWB and BLE transceiver with CAN gateway for comfort access function in vehicles. Two FBD5 anchors are mounted under the headliner of a vehicle. UWB is used for ranging, BLE for data transfer and security features.

Four additional anchors (FBD5s, as described in an associated filing for FCC ID: KR5FBD5S) are mounted at the outer body of a vehicle and provide UWB functionality for ranging purposes.

The anchors are connected to a central control unit and paired with a smartphone or wearable ID tag. The FBD5 can also communicate among each other for an initialization procedure. After initialization and training procedure the distance between FBD5 and smartphone or ID tag is measured and the position in relation to the vehicle is determined. The vehicle is unlocked, locked or started in case the smartphone or ID tag is in a permitted area around or inside the vehicle.

EUT configuration:

(The CDF filled by the applicant can be viewed at the test laboratory.)

2.6 Variants of the EUT

There are no variants

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2.7 Operation frequency and channel plan

The operating frequency is 2400 MHz to 2483.5 MHz for BLE and 3100 MHz to 10600 MHz for UWB.

Channel plan BT-Standard 802.15.1:

Channel	Frequency	Channel	Frequency
37	2402	18	2442
0	2404	19	2444
1	2406	20	2446
2	2408	21	2448
3	2410	22	2450
4	2412	23	2452
5	2414	24	2454
6	2416	25	2456
7	2418	26	2458
8	2420	27	2460
9	2422	28	2462
10	2424	29	2464
38	2426	30	2466
11	2428	31	2468
12	2430	32	2470
13	2432	33	2472
14	2434	34	2474
15	2436	35	2476
16	2438	36	2478
17	2440	39	2480

Channel plan UWB:

Channel number	f _c (MHz)
Channel 5	6489.6
Channel 6	6988.8
Channel 8	7488.8
Channel 9	7987.2

2.8 Transmit operating modes

For BLE

The EUT uses GFSK modulation and may provide following data rates:

- 500 kbps
- 1000 kbps

(kbps = *kilobits per second*)

For UWB

Modulation: variable pulse position modulation (PPM) in combination with binary phase shift keying (BPSK).

Data rate: 6.8 Mbit/s

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2.9 Antennas

The following antennas shall be used with the EUT:

BLE

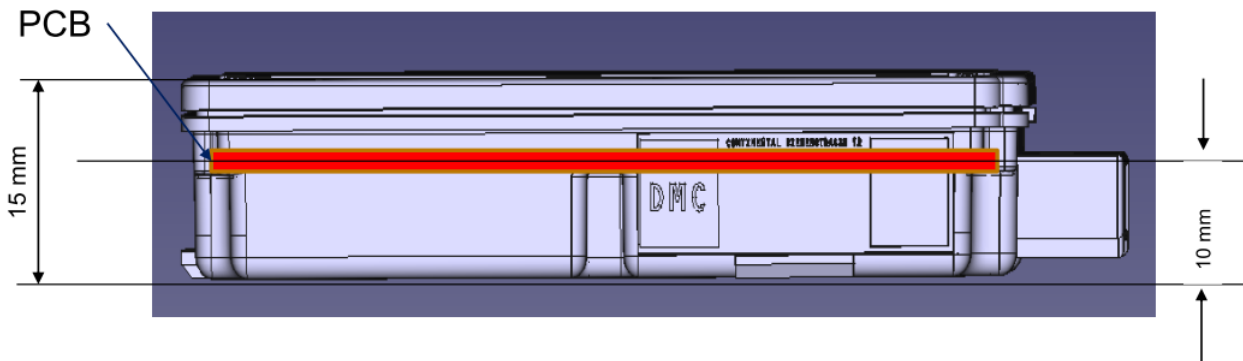
Number	Characteristic	Type	Plug	f-range (GHz)	Max. Gain (dBi)
1	Omni	PCB antenna	none	2.4 - 2.4835	+3.3

UWB

Number	Characteristic	Type	Plug	f-range (GHz)	Max. Gain (dBi)
1	Omni	PCB antenna	none	3.1 – 10.6	+5.9
2	Omni	PCB antenna	none	3.1 – 10.6	+5.4

2.9.1 Minimum separation distance between the radiating element(s) and any person

The applicant has provided the following drawing which indicates the inherent minimum separation distance between the radiating element(s) and any person:



As shown on the drawing above, the inherent minimum separation distance between the radiating element(s) and any person is stated as being 10 mm.

2.10 Power supply system utilised

Power supply voltage, V_{nom} : 12 VDC
 Power supply voltage (alternative) : 6 – 16 VDC

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3 TEST RESULT SUMMARY

FCC KDB publication	RSS Rule Part	Description	Result
KDB 447498, 4.3.1	RSS 102, 2.5.1	SAR test exclusion consideration	passed
KDB 447498, 4.3.2	--	SAR test exclusion consideration	passed
KDB 447498, 7.2	RSS102, 3.2	Co-location, Co-transmission	passed

3.1 Final assessment

The equipment under test fulfills the EMI requirements cited in clause 1 test standards.

Date of receipt of test sample : acc. to storage records

Testing commenced on : 04 August 2020

Testing concluded on : 15 April 2021

Checked by:

Tested by:

Klaus Gegenfurtner
Teamleader Radio

Franz-Xaver Schrettenbrunner
Radio Team

4 TEST ENVIRONMENT

4.1 Address of the test laboratory

**CSA Group Bayern GmbH
Ohmstrasse 1-4
94342 STRASSKIRCHEN
GERMANY**

4.2 Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature: 15-35 °C

Humidity: 30-60 %

Atmospheric pressure: 86-106 kPa

4.3 Statement of the measurement uncertainty

The data and results referenced in this document are true and accurate. It is noted that the expanded measurement uncertainty corresponds to the measurement results from the standard measurement uncertainty multiplied by the coverage factor $k = 2$. The true value is located in the corresponding interval with a probability of 95 %. The measurement uncertainty was calculated for all measurements listed in this test report acc. to CISPR 16-4-2 / 2011 + A1 / 2014 „Uncertainties, statistics and limit modelling – Uncertainty in EMC measurements“ and is documented in the quality system acc. to DIN EN ISO/IEC 17025. For all measurements shown in this report, the measurement uncertainty of the test laboratory, CSA Group Bayern GmbH, is below the measurement uncertainty as defined by CISPR. Therefore, no special measures must be taken into consideration with regard to the limits according to CISPR. Furthermore, component and process variability of devices similar to that tested may result in additional deviation. The manufacturer has the sole responsibility of continued compliance of the device.

4.4 Conformity Decision Rule

The conformity decision rule is based on the ILAC G8 published at the time of reporting.

5 HUMAN EXPOSURE

5.1 FCC SAR test exclusion considerations

5.1.1 Applicable standard

According to FCC Part 15, Section 15.247(i):

Systems operating under the provisions of this section shall be operated in a manner that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

5.1.2 Determination of the standalone SAR test exclusion threshold for the BLE transmitter

As shown in section 2.9.1 of this RF exposure evaluation, the minimum and inherent separation distance between the radiating element(s) of the EUT and any person is 10 mm (0.01 meters).

The threshold for 1-g is determined since this is considered to be the worst-case approach for RF exposure evaluation.

Rated output power:	3.1 dBm	2.0 mW
Tune-up tolerance:	1.50 dB	
Maximum output power:	4.6 dBm	2.9 mW
Antenna gain max:	3.3 dBi	
Maximum EIRP:	7.9 dBm	6.1 mW
Minimum distance r:	10 mm	

The formula under 4.3.1 a) for 100 MHz to 6 GHz for standalone equipment is used to determine if the EUT meets the SAR test exclusion criterion in a standalone configuration.

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (10 \text{ mm})] * [\sqrt{f(\text{GHz})}] \leq 3.0;$$

When considering conducted RF output power (including tune-up tolerance):

$$[(2.9 \text{ mW}) / (10 \text{ mm})] * [\sqrt{(2.480)}] = 0.46 \text{ (limit is } \leq 3.0)$$

When considering EIRP (including tune-up tolerance):

$$[(6.1 \text{ mW}) / (10 \text{ mm})] * [\sqrt{(2.480)}] = 0.96 \text{ (limit is } \leq 3.0)$$

Conclusion: The EUT meets the SAR test exclusion criterion in a standalone configuration.

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5.1.3 UWB transmitter

The max conducted average power of the EUT is measured with a power meter.

Averaged conducted power: -27.5 dBm 0.002 mW
 Tune-up tolerance: + 1.5 dB
 Antenna gain: + 5.9 dB

EIRP: -20.1 dBm 0.010 mW

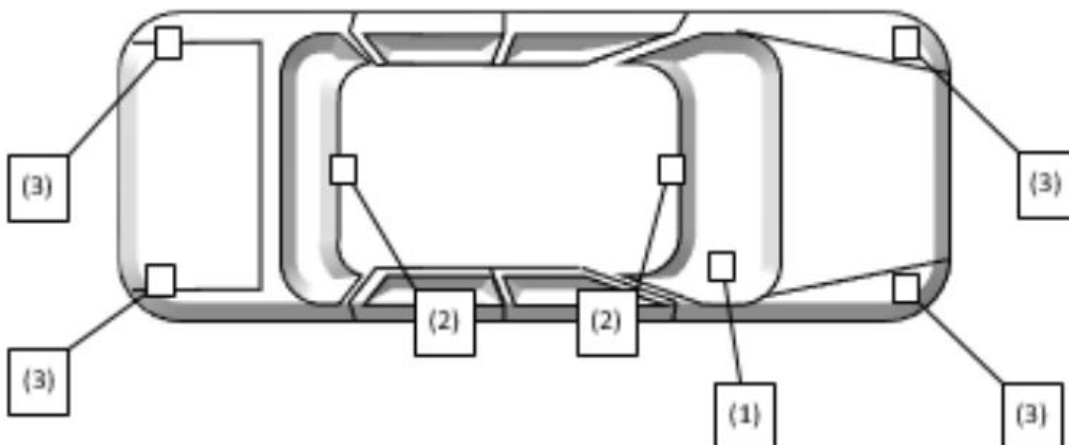
According to TCB Workshop November 2019 RF Exposure Policy Updates dated November 13th 2019, specifically slide 11:

Test exclusion based on 1 mW may be used now with the portable device $f > 6$ GHz FCC MPE power density limits.

Conclusion: The device is compliant with the Test Exclusion requirement of 1 mW.

5.1.4 Determination of the test exclusion threshold for simultaneous transmission

The EUT is intended to be used in vehicles. A maximum of 2 EUT's may be fitted into the vehicle at the following locations indicated by the positions (2):



Four other devices are fitted in the positions indicated by (3). These devices are described in a corresponding filing for FCC ID: KR5FBD5S. Each of these devices contains an UWB transmitter similar to the UWB transmitter as described in this filing, except that these devices, as described in a corresponding filing for FCC ID: KR5FBD5S, do not contain a BLE transmitter.

The total system thus may contain 6 UWB transmitters and 2 BLE transmitters. While it is physically impossible that a person may be exposed to RF electromagnetic fields from all transmitters simultaneously and at the same close distance the following is considered for simultaneous transmissions in the total system:

The UWB transmitter as described in this filing, given its conducted RF output power of 0.00283 mW (including tune-up tolerance) and EIRP of 0.010 mW (including tune-up tolerance), is excluded from routine RF exposure evaluation in a stand-alone configuration.

The UWB transmitter as described in the filing for FCC ID: KR5FBD5S, given its conducted RF output power of 0.00283 mW (including tune-up tolerance) and EIRP of 0.011 mW (including tune-up tolerance), is also excluded from routine RF exposure evaluation in a stand-alone configuration.

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The aggregate RF output power (including tune-up tolerances) for 6 UWB transmitters (2 UWB transmitters as described in this filing and 4 UWB transmitters as described in the filing for FCC ID: KR5FBD5S), assuming simultaneous transmission conditions, would be $6 \times 0.00283 \text{ mW} = 0.01698 \text{ mW}$ (conducted, 1.698% of the 1 mW exclusion limit) and $(4 \times 0.011 \text{ mW}) + (2 \times 0.010 \text{ mW}) = 0.064 \text{ mW}$ (EIRP, 6.4% of the 1 mW exclusion limit).

Conclusion 1: A system consisting of 6 UWB transmitters which transmit simultaneously (2 transmitters as described in this filing and 4 transmitters as described in the filing for FCC ID: KR5FBD5S) is still excluded from routing RF exposure evaluation as per “TCB Workshop November 2019 RF Exposure Policy Updates dated November 13th 2019, specifically slide 11” because the aggregate RF output power (either conducted or EIRP) is at 1.698% and 6.4% respectively of the 1 mW exclusion limit.

The total system contains 2 devices which also contain a BLE transmitter as described in this filing. Please find below a summary of the worst-case RF exposure evaluation results (based on conducted RF output power and EIRP) for simultaneous transmissions of the 2 devices which contain a BLE transmitter. Pursuant to section 4.3.2 b) of KDB publication 447498 D01 General RF Exposure Guidance v06 the estimated SAR values have been calculated based on a separation distance of 10 mm between the radiating element(s) and any person while assuming a conservative limit of 0.4 W/kg.

Transmitter Number	Transmitter Model number	Conducted power on channel mW (incl. tune-up tolerance)	Separation distance mm	Frequency GHz	Factor for 1g SAR x	SAR estimate W/kg	
1	FBD5	2.900	10.0	2.4800	7.5	0.06089233	
2	FBD5	2.900	10.0	2.4800	7.5	0.06089233	
Total SAR estimate						0.122	W/kg
Limit						0.400	W/kg
Total SAR estimate as a percentage of the limit						30.446	%

Transmitter Number	Transmitter Model number	EIRP on channel mW (incl. tune-up tolerance)	Separation distance mm	Frequency GHz	Factor for 1g SAR x	SAR estimate W/kg	
1	FBD5	6.100	10.0	2.4800	7.5	0.12808386	
2	FBD5	6.100	10.0	2.4800	7.5	0.12808386	
Total SAR estimate						0.256	W/kg
Limit						0.400	W/kg
Total SAR estimate as a percentage of the limit						64.042	%

Conclusion 2: When combining the calculated percentages of the exclusion limits the total would be 32.14% of the limits when considering conducted RF output power and 70.44% of the limits when considering EIRP. The separation distance for the UWB transmitters is not relevant since the 1 mW exclusion limit is valid for any given separation distance between the radiating element(s) and any person, the 10 mm separation distance used in the SAR estimation calculations for the two BLE transmitters is the inherent separation distance between the radiating element(s) of the device and any person which is ensured by the design of the enclosure. For details of the 4 UWB only transmitters see the corresponding filing for FCC ID: KR5FBD5S.

Remarks: None

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5.2 ISED exemption limits for routine evaluation - SAR evaluation
5.2.1 Applicable standard
BLE

According to RSS-102, item 2.5.1:

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1.

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance 4, 5

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤ 300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤ 300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	88 mW	195 mW	213 mW
835	80 mW	92 mW	177 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

4 The exemption limits in Table 1 are based on measurements and simulations of half-wave dipole antennas at separation distances of 5 mm to 25 mm from a flat phantom, providing a SAR value of approximately 0.4 W/kg for 1 g of tissue. For low frequencies (300 MHz to 835 MHz), the exemption limits are derived from a linear fit. For high frequencies (1900 MHz and above), the exemption limits are derived from a third order polynomial fit.

5 Transmitters operating between 0.003-10 MHz, meeting the exemption from routine SAR evaluation, shall demonstrate compliance to the instantaneous limits in Section 4.

The upper operating frequency of the BLE transmitter is 2480 MHz, the inherent separation distance between the radiating element(s) and any person, as shown in section 2.9.1 of this RF exposure evaluation, is 10 mm. Through linear interpolation the limit for SAR test exclusion on 2480 MHz is 6.97 mW.

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UWB

Health Canada Notice: Localized human exposure limits for radiofrequency fields in the range of 6 GHz to 300 GHz, January 2021.

Table 2: Reference Levels for local electromagnetic field exposure above 6 GHz up to 300 GHz:

Exposure scenario	Exposure duration (t)	Local incident energy density [kJ/m ²]	Local incident power density [W/m ²]
Controlled Environment	0 sec < t < 360 sec	$275/f_G^{0.177} \times 0.36[0.05+0.95(t/360)^{0.5}]$	n/a
	t ≥ 6 min	n/a	$275/f_G^{0.177}$
Uncontrolled Environment	0 sec < t < 360 sec	$55/f_G^{0.177} \times 0.36[0.05+0.95(t/360)^{0.5}]$	n/a
	t ≥ 6 min	n/a	$55/f_G^{0.177}$

Local incident power density limit at EUT's frequency of 6.5 GHz 39.5 W/m²
 Local incident power density limit at EUT's frequency of 8 GHz 38.1 W/m²

5.2.2 Conclusion according RSS-102, section 2.5.1, and "Notice: Localized human exposure limits for radiofrequency fields in the range of 6 GHz to 300 GHz, January 2021"

BLE

Maximum output power BLE: **6.1 mW EIRP and 2.9 mW conducted (including tune-up tolerances is < 6.97 mW;**

UWB

The max conducted average power of the EUT is measured with a power meter.

Averaged conducted power: -27.5 dBm 0.002 mW
 Tune-up tolerance: + 1.5 dB
 Antenna gain: + 5.9 dB

EIRP: **-20.1 dBm 0.010 mW**

According to the manufacturer, and as shown in section 2.9.1 of this RF exposure evaluation, the minimum and inherent separation distance between the radiating element(s) of the EUT and any person is 10 mm (0.01 meters).

EIRP (W)	S (W/m ²)	Limit S (W/m ²)	Margin (W/m ²)	Exposure ratio (%)
0.000010	0.00796	38.1	-38.1	0.00

The requirements are **FULFILLED**.

Remarks: None.

5.3 Co-location and Co-transmission for ISED

5.3.1 Applicable standards:

According to KDB 447498 D01 section 7.2

Antennas that qualify for standalone SAR test exclusion must apply the estimated standalone SAR to determine simultaneous transmission test exclusion.

- a) The $[\sum \text{ of (the highest measured or estimated SAR for each standalone antenna configuration, adjusted for maximum tune-up tolerance) / 1.6 W/kg}] + [\sum \text{ of MPE ratios}] \leq 1.0$.
- b) The SAR to peak location separation ratios of all simultaneously transmitting antenna pairs operating in portable device exposure conditions are all ≤ 0.04 , and the $[\sum \text{ of MPE ratios}] \leq 1.0$.

5.3.2 Determination of Co-Location

Transmitter 1 (BLE):

According to Notice 2016-DRS001:

The estimate SAR value is calculated based the following equation:

(maximum power level including tune-up tolerance for transmitter A / maximum power level of exemption at the same frequency and distance) * 0.4W/kg

Thus, the estimated SAR value is $(6.1 \text{ mW} / 6.97 \text{ mW}) \times 0.4 \text{ W/kg} = \mathbf{0.35 \text{ W/kg}}$.

The sum of the highest measured or estimated SAR is $0.35 \text{ W/kg} / 1.6 \text{ W/kg} = \mathbf{21.9 \%}$

Transmitter 2 (UWB):

The exposure ratio of the transmitter is **0.0%** (see section 5.2.2).

Sum of Exposure ratios

Fraction of BLE transmitter: 21.9 %
 Fraction of UWB transmitter: 0.0 %

Transmitter 1 + Transmitter 2 $\leq 100 \%$
 $21.9 \% + 0.0 \% = \mathbf{21.9 \% \leq 100 \%}$

The requirements are **FULFILLED**.

Remarks: None.

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6 USED TEST EQUIPMENT AND ACCESSORIES

All test instruments used are calibrated and verified regularly. The calibration history is available on request.

Test ID	Model Type	Equipment No.	Next Calib.	Last Calib.	Next Verif.	Last Verif.
CPC 3	NRP18T	02-02/07-19-001	02/11/2021	02/11/2020		

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