



EMI – TEST REPORT

- Human Exposure -

Type / Model Name : FFZ-radio module; eP 2.0 Master

Product Description : Truck anchor for distance measurements to a person tag

Applicant : Jungheinrich AG

Address : Friedrich-Ebert-Damm 129

22047 HAMBURG, GERMANY

Manufacturer : ACD Elektronik GmbH

Address : Engelberg 2

88480 ACHSTETTEN, GERMANY

Test Result according to the standards listed in clause 1 test standards:

POSITIVE

Test Report No. : **T43580-02-01FX**

01. October 2019

Date of issue



Deutsche
Akkreditierungsstelle
D-PL-12030-01-01
D-PL-12030-01-02

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.

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ATTACHMENT A1 and A2 as separate supplement

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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**.

OET Bulletin 65, 65A, 65B Edition 97-01, August 1997 – Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.

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

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 Photo documentation of the EUT – See ATTACHMENT A1 and A2

2.2 Equipment type, category

Portable UWB, BLE, NFC Device

2.3 Short description of the equipment under test (EUT)

The EUT is one of 4 anchors, mounted on a truck. These anchors are communicating with the truck via CAN-bus and with one person tag via UWB. The operator wears the person tag on the body. After an initial pairing process between the EUT and the person tag (by NFC or UWB), the 4 anchors can localize the position of the person tag related to a truck fixed coordinate system. If there are no obstacles, the truck follows the EUT (in driving direction).

Number of tested samples: 1
Serial number: 186800000221
Firmware version: V2.07
UWB driver version: V2.5.9

EUT configuration:

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

2.4 Variants of the EUT

There are two variants of the EUT. The only difference between the two variants is the number of buttons on the radio control unit. The manufacturer assures that there are no modifications of the radio components.

2.5 Operation frequency and channel plan

UWB is working at 3993.6 MHz

BLE is working in the frequency range 2400 MHz to 2483.5 MHz

NFC is working at 13.56 MHz.

2.6 Antennas

UWB: The EUT uses an integrated antenna.

BLE: The EUT uses an integrated antenna.

NFC: The EUT uses an integrated dantenna.

2.7 Power supply system utilised

Power supply voltage, V_{nom} : 24 V DC

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3 TEST RESULT SUMMARY

FCC Rule Part	Description	Result
KDB 447498, 7.1	MPE	not applicable
KDB 447498, 4.3.1	SAR exclusion consideration	passed
KDB 447498, 7.2	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 : 31 May 2019

Testing concluded on : 14 June 2018

Checked by:

Tested by:

Klaus Gegenfurtner
Teamleader Radio

Franz-Xaver Schrettenbrunner
Radio Team

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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 / 11.2003 „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.

Measurement Type	Range	Confidence Level	Calculated Uncertainty
AC power line conducted emissions	0.15 MHz to 30 MHz	95%	± 3.29 dB
EBW and OBW	2400 MHz to 3000 MHz	95%	$\pm 2.5 \times 10^{-7}$
Maximum peak conducted output power	2400 MHz to 3000 MHz	95%	± 0.62 dB
Power spectral density	2400 MHz to 3000 MHz	95%	± 0.62 dB
Conducted Spurious Emissions	9 kHz to 10000 MHz	95%	± 2.15 dB
Conducted Spurious Emissions	10000 MHz to 40000 MHz	95%	± 3.47 dB
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	± 3.53 dB
Radiated Spurious Emissions	30 MHz to 1000 MHz	95%	± 3.71 dB
Radiated Spurious Emissions	1000 MHz to 10000 MHz	95%	± 2.34 dB
Field strength of the fundamental	100 kHz to 100 MHz	95%	± 3.53 dB

5 HUMAN EXPOSURE

5.1 Maximum peak conducted output power

5.1.1 Test result

UWB 1:

EIRP = rated output power + tune up tolerance + gain = -35 dBm/MHz + 2.77 dB + 3.62 dBi = **-28.61 dBm/MHz**

Bluetooth low energy:

The output power of the device is taken from the power measurement in the test report 268252-1 of the test laboratory SGS Fimko.

2402 MHz: EIRP = conducted power + tune up tolerance + gain = 0.54 dBm + 1.22 dB + 0.5 dBi = **2.26 dBm**

NFC:

Calculation of EIRP level

The calculation of the EIRP level of the fundamental frequency of the EuT is done according to KDB 412172 D01 subclause 1.3.1 formula (1). The used field strength is taken from testreport T43580-01-00WP issued by CSA Group Bayern GmbH.

Values according to report subclause 1.1.2.2:

Fieldstrength: 51.4 dBμV/m at a test distance of 3 m

Used formula: $EIRP = (E \times d)^2 / 30$

where EIRP = equivalent isotropically radiated power in watts

E = electrical field strength in V/m

d = measurement distance in meters

calculation: $EIRP = (371.53 \times 10^{-6} \times 3)^2 / 30 \text{ W} = 41.41 \times 10^{-9} \text{ W}$

Result: EIRP = 0.0000414 mW

Threshold limits according to KDB447498

According to Appendix C:

For 50MHz and testdistance <5mm a threshold of 474 mW is listed. Compared with the transmitting power of the EuT in RFID mode with 0.0000414mW.

Remarks: As worst case the power values are not averaged over time.

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5.2 Maximum permissible exposure (MPE)

Remarks: Not applicable. Because the separation distance is below 20 cm. Therefore, a SAR test
exclusion consideration was made.

5.3 Co-location and Co-transmission**Applicable standard:**

OET Bulletin 65, Edition 97-01, Section 2: Multiple-transmitter sites and Complex Environments

The FCC's MPE limits vary with frequency. Therefore, in mixed or broadband RF fields where several sources and frequencies are involved, the fraction of the recommended limit (in terms of power density or square of the electric or magnetic field strength) incurred within each frequency interval should be determined, and the sum of all fractional contributions should not exceed 1.0, or 100 % in terms of percentage.

The requirements are **FULFILLED**.

Remarks: Not applicable. Because the separation distance is below 20 cm. Therefore, a SAR test
exclusion consideration for simultaneous transmission was made.

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5.4 SAR test exclusion considerations

5.4.1 Applicable standard

According to RF exposure guidance:

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.

5.4.2 Determination of the standalone SAR test exclusion threshold

For UWB:

The minimum separation distance results from the application of the EUT which is handled by hand. This distance is assumed to $\leq 5 \text{ mm}$ from antenna to the hand of the user. According to 4.1 f), the value for the minimum test separation distance is set to **5 mm**.

The formula under 4.3.1 a) for 100 MHz to 6 GHz and test separation distances $\leq 50 \text{ mm}$ for standalone equipment is used to determine the threshold level:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}]$.

The max conducted average power is according to the equipment (UWB module):

Rated output spectral density:		-35.00 dBm/MHz
Measured UWB EBW:		688 MHz
Rated output power:	0.22 mW	-6.62 dBm
Tune-up tolerance:	2.77 dB	
Maximum output power:	-3.85 dBm	0.41 mW
Antenna gain max:	3.62 dBi	
Maximum EIRP:	-0.2 dBm	0.95 mW
Minimum distance r:	5.0 mm	

Channel frequency (MHz)	A (mW)	Threshold level	Limit 1g	Limit 10g	Margin 1g	Margin 10g
3993.6	0.41	0.16	3.0	7.5	-2.84	-7.34

Conclusion: The Threshold level is much lower than the limit, SAR measurement is not necessary.

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For BLE:

The minimum separation distance results from the application of the EUT which is handled by hand. This distance is assumed to $\leq 5 \text{ mm}$ from antenna to the hand of the user. According to 4.1 f), the value for the minimum test separation distance is set to **5 mm**.

The formula under 4.3.1 a) for 100 MHz to 6 GHz and test separation distances $\leq 50 \text{ mm}$ for standalone equipment is used to determine the threshold level:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}].$$

The max conducted average power is according to the equipment (BLE module):

Rated output power:	1.13 mW	0.5 dBm
Tune-up tolerance:	1.22 dB	
Maximum output power:	1.76 dBm	1.5 mW
Antenna gain max:	0.50 dBi	
Maximum EIRP:	2.26 dBm	1.7 mW
Minimum distance r:	5.00 mm	

Channel frequency (MHz)	A (mW)	Threshold level	Limit 1g	Limit 10g	Margin 1g	Margin 10g
2402	1.5	0.46	3.0	7.5	-2.5	-7.0

Conclusion: The Threshold level is much lower than the limit, SAR measurement is not necessary.

Remarks: None.

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For NFC:

The minimum separation distance results from the application of the EUT which is handled by hand. This distance is assumed to $\leq 5 \text{ mm}$ from antenna to the hand of the user. According to 4.1 f), the value for the minimum test separation distance is set to **5 mm**.

The formula under 4.3.1 a) for 100 MHz to 6 GHz and test separation distances $\leq 50 \text{ mm}$ for standalone equipment is used to determine the threshold level:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}].$$

The max conducted average power is according to the equipment (NFC module):

Maximum EIRP: -43.9 dBm 0.0000414 mW
 Minimum distance r: 5.0 mm

Channel frequency (MHz)	A (mW)	Threshold level	Limit 1g	Limit 10g	Margin 1g	Margin 10g
13.56	0.0000414	0.000001	3.0	7.5	-3.00	-7.50

Conclusion: The Threshold level is much lower than the limit, SAR measurement is not necessary.

Remarks: None.

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5.4.3 Determination of the SAR test exclusion threshold for simultaneous transmission

When all modules are active the ratios of the transmitters are summed and have to be < 1 .

Transmitter	Rated output power (mW)	Threshold at 5 mm (mW)	Ratio
UWB	0.34	8	0.04
BLE	1.5	11	0.14
NFC	0.0000414	474	0

Level UWB module + level BLE module + NFC module

$$0.04 + 0.14 + 0 = 0.18 < 1$$

Conclusion: The Threshold level is lower than the limit, SAR measurement is not necessary. All modules can be co-located without exceeding SAR limits.

The requirements are **FULFILLED**.

Remarks: None.
