

Test report

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Human Exposure test report

171026-AU02+W03



Industry
Canada

PowerBox-Systems GmbH

Remote Control

Core



The test result refers exclusively to the model tested.
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EMV **TESTHAUS** GmbH

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Accreditation:



Deutsche
Akkreditierungsstelle
D-PL-12155-01-00

Test Firm Type "accredited": Valid until 2019-06-05
MRA US-EU, FCC designation number: DE0010
BnetA-CAB-02/21-02/5 Valid until 2023-11-26

Recognized on March 14th, 2019 by the
Department of Innovation, Science and Economic Development (ISED) Canada
as a wireless testing laboratory
CAB identifier: DE0011

Location of Testing:

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The technical accuracy is guaranteed through the quality management of the
EMV **TESTHAUS** GmbH.



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1 Test regulations

<i>Standard</i>	<i>Title</i>
RSS-102 Issue 5 March 2015	Spectrum Management and Telecommunications Radio Standards Specification Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands)
SPR-002 Issue 1 September 2016	Spectrum Management and Telecommunications Supplementary Procedure Supplementary Procedure for Assessing Compliance with RSS-102 Nerve Stimulation Exposure Limits
Safety Code 6 (2015)	Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz
IEEE C95.3-2002 (R2008) Approved December 11, 2002 Reaffirmed June 12, 2008	IEEE Recommended Practice for Measurements and Computations of Radio Frequency Electromagnetic Fields With Respect to Human Exposure to Such Fields, 100 kHz–300 GHz
KDB 680106 D01 May 31, 2013 (published by the Federal Communications Commission FCC)	RF Exposure Considerations for Low Power Consumer Wireless Power Transfer Applications
OET Bulletin 65, 65A, 65B Edition 97-01, August 1997	Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields
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 device
KDB 447498 D01 v06	Mobile and portable devices RF Exposure procedures and equipment authorisation policies, October 23, 2015.
KDB 865664 D01	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



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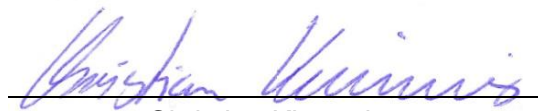
2 Summary of test results

<i>Standard</i>	<i>Result</i>	<i>Remark</i>
RSS-102 Issue 5 March 2015	Passed	---
KDB 447498 D01 v06	Passed	

Straubing, June 6, 2019



Konrad Graßl
Head of radio department
EMV **TESTHAUS** GmbH



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3 Equipment under test (EUT)

Product type: Remote Control
Model Name: Core
Applicant: PowerBox-Systems GmbH
Manufacturer: PowerBox-Systems GmbH
Serial number: Prototype
FCC ID: 2ASCM-PBXCORE
IC certification number: 24594 - PBXCORE
Frequency range: 2400 MHz – 2483.5 MHz
Operating frequencies: 2402 MHz – 2467 MHz
Number of RF-channels: 65
Short description: The EUT is a control system for model airplanes which is working in the 2.4 GHz band.
Antenna types: PCB antenna
 detachable not detachable
Power supply: Battery supply
nominal voltage: 7.2 V
Type of device: Body-supported device
 Body-worn (or body-mount) radio
 Limb-Worn device
 other
Separation distance: ≤ 20 cm limbs
 > 20 cm body
Evaluated against exposure limits: General public use
 Controlled use

4 Photographs of EUT

See 171026-AU02+W01 Annex B of EMV Testhaus GmbH.



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5 FCC

5.1 Individual consideration of RF exposure , except WPT

Result: Test passed Test not passed

5.1.1 Data of equipment under test (EUT)

Note: The data for the RF technology is taken out of the Test report 171026-AU02+W01 of the test laboratory EMV Testhaus GmbH

RF technology 1

Maximum antenna gain:	5 dBi
Maximum conducted output power:	17.06 dBm at 2402 MHz
Maximum equivalent isotropically radiated power:	22.06 dBm
Tune-up tolerance:	2 dB
Applicable duty cycle:	as worst case not applied
Separation distance to the limbs:	60 mm
Separation distance to the body:	230 mm



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5.1.2 Evaluation for separation distance ≤ 20 cm

5.1.2.1 Limits for separation distance ≤ 20 cm

This estimation follows the general guidelines for RF Exposure according to KDB 447498.

As noted in §2.103(b) For purposes of this section, a portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user.

According §2.1093 (d)(i)(2): The SAR limits for general population/uncontrolled exposure are 0.08 W/kg, as averaged over the whole body, and a peak spatial-average SAR of 1.6 W/kg, averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the parts of the human body treated as extremities, such as hands, wrists, feet, ankles, and pinnae, where the peak spatial-average SAR limit is 4 W/kg, averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). Exposure may be averaged over a time period not to exceed 30 minutes to determine compliance with general population/uncontrolled SAR limits.

Limit and equation according KDB 447498:

$$[(\text{max. power mW}) / (\text{distance, mm})] \cdot [\sqrt{f} (\text{GHz})] \leq 7.5 \text{ for 10-g Extremity SAR}$$

$$[(\text{max. power mW}) / (\text{distance, mm})] \cdot [\sqrt{f} (\text{GHz})] \leq 3.0 \text{ for 1-g Body SAR}$$

a) For 100 MHz to 6 GHz and test separation distances ≤ 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f}(\text{GHz})] \leq 3.0 \text{ for 1-g SAR, and } \leq 7.5 \text{ for 10-g extremity SAR, where}$$

- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation³¹
- The result is rounded to one decimal place for comparison
- The values 3.0 and 7.5 are referred to as numeric thresholds in step b) below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm, and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 4.1 f) is applied to determine SAR test exclusion.

b) For 100 MHz to 6 GHz and test separation distances > 50 mm, the 1-g and 10-g SAR test exclusion thresholds are determined by the following (also illustrated in Appendix B):³²

1) {[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm) · (f(MHz)/150)]} mW, for 100 MHz to 1500 MHz

2) {[Power allowed at numeric threshold for 50 mm in step a)] + [(test separation distance – 50 mm) · 10]} mW, for > 1500 MHz and ≤ 6 GHz

c) For frequencies below 100 MHz, the following may be considered for SAR test exclusion (also illustrated in Appendix C):³³

1) For test separation distances > 50 mm and < 200 mm, the power threshold at the corresponding test separation distance at 100 MHz in step b) is multiplied by $[1 + \log(100/f(\text{MHz}))]$



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- 2) For test separation distances ≤ 50 mm, the power threshold determined by the equation in c) 1) for 50 mm and 100 MHz is multiplied by $\frac{1}{2}$
- 3) SAR measurement procedures are not established below 100 MHz.
- When SAR test exclusion cannot be applied, a KDB inquiry is required to determine SAR evaluation requirements for any SAR test results below 100 MHz to be acceptable.³⁴

5.1.2.2 Results

Exposure to the limbs

Separation distance (mm)	Channel Frequency (MHz)	rated power + tolerance (dBm)	rated power + tolerance (mW)	Limit 10-g SAR	Percentage %
60	2402	24.1	257.04	490.0	52.5

Note: As worst case calculation no duty cycle correction was applied.



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5.1.3 Evaluation for separation distance > 20 cm

5.1.3.1 Limits for separation distance > 20 cm

This estimation follows the general guidelines for RF Exposure according to KDB 447498.

As noted in §2.1091(b) a mobile device is defined as “a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a **separation distance of at least 20 centimeters** is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons.”

According to §2.1091(c) the limits to be used for evaluation are defined in §1.1310.

As specified in §1.1310(d)(2) at operating frequencies less than or equal to 6 GHz, the limits for maximum permissible exposure (MPE), derived from whole-body SAR limits and listed in Table 1 of §1.1310(e) may be used.

Table 1 below shows the limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(A) 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 - 1500			f/300	6
1500 - 100000			5	6
(B) 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 - 100000			1.0	30

Table 1: Limits for maximum permissible exposure (MPE) according to table 1 of §1.1310(e)

Notes:

1. f = frequency in MHz.
2. * = Plane-wave equivalent power density.



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5.1.3.2 Results

Exposure to the body

Separation distance (mm)	Channel frequency (MHz)	Rated power + tolerance (dBm)	Rated power + tolerance (mW)	P_d (mW/cm ²)	Limit P_d (mW/cm ²)	Percentage %
230	2402	24.1	257.040	0.051	1.0	5.11

Note: As worst case calculation no duty cycle correction was applied.



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6 Canada

6.1 Individual consideration of RF exposure , except the frequency range 3 kHz up to 10 MHz

Result: Test passed Test not passed

6.1.1 Data of equipment under test (EUT)

Note: The data for the RF technology 1 is taken out of the Test report 171026-AU02+W01 of the test laboratory EMV Testhaus GmbH

RF technology 1

Maximum antenna gain:	5 dBi
Maximum conducted output power:	17.06 dBm at 2402 MHz
Maximum equivalent isotropically radiated power:	22.06 dBm
Tune-up tolerance:	2 dB
Applicable duty cycle:	as worst case not applied
Separation distance to the limbs:	60 mm
Separation distance to the body:	230 mm



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6.1.2 Evaluation for separation distance ≤ 20 cm

6.1.2.1 Exemption Limits for Routine Evaluation – SAR Evaluation for separation distance ≤ 20 cm

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.

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



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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	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 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.

Output power level shall be the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power. For controlled use devices where the 8 W/kg for 1 gram of tissue applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 5. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5. If the operating frequency of the device is between two frequencies located in Table 1, linear interpolation shall be applied for the applicable separation distance. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required.

For medical implants devices, the exemption limit for routine evaluation is set at 1 mW. The output power of a medical implants device is defined as the higher of the conducted or e.i.r.p to determine whether the device is exempt from the SAR evaluation.



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6.1.2.2 Results

Separation distance (mm)	Channel frequency (MHz)	rated power + tolerance + gain (dBm)	rated power + tolerance + gain (mW)	Limit 10-g SAR (mW)	Percentage %
60	2402	24.1	257.04	772.5	33.3

Note: As worst case calculation no duty cycle correction was applied.



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6.1.3 Evaluation for separation distance > 20 cm

6.1.3.1 Limits

Appropriate RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment) can be found in table 4 of RSS-102, section 4:

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m ²)	Reference Period (minutes)
0.003-10	83	90	-	Instantaneous*
0.1-10	-	0.73/f	-	6**
1.1-10	87/f ^{0.5}	-	-	6**
10-20	27.46	0.0728	2	6
20-48	58.07/f ^{0.25}	0.1540/f ^{0.25}	8.944/f ^{0.5}	6
48-300	22.06	0.05852	1.291	6
300-6000	3.142 f ^{0.3417}	0.008335 f ^{0.3417}	0.02619 f ^{0.6834}	6
6000-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/f ^{1.2}
150000-300000	0.158 f ^{0.5}	4.21 x 10 ⁻⁴ f ^{0.5}	6.67 x 10 ⁻⁵ f	616000/f ^{1.2}

Note: f is frequency in MHz.

*Based on nerve stimulation (NS).

** Based on specific absorption rate (SAR).

Table 2: RF field strength limits according to table 4 of RSS-102

6.1.3.2 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

According to RSS 102 Clause 2.5.2:

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.



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6.1.3.3 Results

Remark: Exemption limit according to RSS 102 Clause 2.5.2 was applied

Separation distance (mm)	Channel frequency (MHz)	Rated power + tolerance (dBm)	Rated power + tolerance (mW)	Exemption Limit (mW)	Percentage %
230	2402	24.1	257.040	2676.0	9.61

Note: As worst case calculation no duty cycle correction was applied.



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7 Revision history

<i>Revision</i>	<i>Date</i>	<i>Issued by</i>	<i>Description of modifications</i>
0	2019-06-06	Konrad Graßl	First edition



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