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Zerv, Inc.
MPE REPORT

SCOPE OF WORK
MPE CALCULATION
ON THE ZERVERB

REPORT NUMBER
104685025LEX-002

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DOCUMENT CONTROL NUMBER
Non-Specific EMC Report Shell Rev. December 2017

MPE TEST REPORT

Report Number: 104685025LEX-002
Project Number: G104685025

Report Issue Date: 8/25/2021

Product Name: ZerverB

Standards: FCC Part 1.1310 Limits for Maximum Permissible Exposure (MPE)

RSS-102 Issue 5 RF Field Strength Limits for Devices Used by the General Public

Tested by:
Intertek Testing Services NA, Inc.
731 Enterprise Drive
Lexington, KY 40510
USA

Client:
Zerv, Inc.
965 W Chicago Ave.
Chicago, IL 60642
USA

Report prepared by

Brian Lackey, Staff Engineer

Report reviewed by

Bryan Taylor, Team Leader

Table of Contents

1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested **complies** with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

2 Test Summary

Section	Test full name	Result
9	FCC Part 1.1310 Limits for Maximum Permissible Exposure (MPE) (Limits for General Population / Uncontrolled Exposure)	Pass
	RSS-102 Issue 5 RF Field Strength Limits (For Devices Used by the General Public)	Pass

3 Client Information

This product was tested at the request of the following:

Client Information	
Client Name:	Zerv, Inc.
Address:	965 W Chicago Ave. Chicago, IL 60642 USA
Contact:	Frank Annerino
Telephone:	+1 (847) 302-2906
Email:	Frank.annerino@zervinc.com
Manufacturer Information	
Manufacturer Name:	Zerv, Inc.
Manufacturer Address:	965 W Chicago Ave. Chicago, IL 60642 USA

4 Description of Equipment under Test and Variant Models

Equipment Under Test	
Product Name	ZerverB
Model Number	Zerv0001
Serial Number	06472B78-DB4C0D42
Receive Date	7/27/2021
Test Start Date	7/27/2021
Test End Date	8/18/2021
Device Received Condition	Good
Test Sample Type	Production
Input Rating	5-24VDC 50mA
Software Used By EUT	V0.0.0.21
Embedded Modules	LoRa: Semtech Corporation SX1262IMLTRT BLE: Nordic Semi NRF52840-QIAA-R
Antennas Used by the EUT (provided by client)	LoRa: Yageo ANTX150P118B09153, 1.9dBi gain BLE External Antenna: Yageo ANTX100P001B24003, 4.4dBi gain BLE Internal Antenna: Johanson Technology Inc 2450AT18B100E, 0.5dBi gain
Test Channels	LoRa: 903.0MHz, 908.5MHz, 914.9MHz BLE: 2402MHz, 2440MHz, 2480MHz
Description of Equipment Under Test (provided by client)	
The Zerver B is an access control device that allows users to utilize their mobile phones, via Bluetooth, to enter secured doors that are controlled by an RFID reader.	

4.1 Variant Models:

There were no variant models covered by this evaluation.

5 Embedded Modules, Antenna Gains, and Output Power (Provided by Client):

The LoRa transmitter was a Semtech Corporation SX1262IMLTRT. The antenna for the LoRa transmitter was a Yageo ANTX150P118B09153 patch antenna with 1.9dBi gain. The output power of the LoRa transmitter was measured and reported in Intertek report 104685025LEX-001.

The Bluetooth Low Energy transmitter was a Nordic Semi NRF52840-QIAA-R. The Bluetooth Low Energy transmitter used an internal or external antenna. The internal antenna was a Johanson Technology Inc 2450AT18B100E chip antenna with 0.5dBi gain. The external antenna was a Yageo ANTX100P001B24003 patch antenna with 4.4dBi gain. The output power of the Bluetooth Low Energy transmitter was taken from its datasheet, provided by Nordic Semi.

6 FCC Limits

§ 1.1310: The criteria listed in table 1 shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in §1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of §2.1093 of this chapter.

Part 1.1310 Limits for Maximum Permissible Exposure (MPE)

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 Exposures				
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
1500–100,000	.....	.....	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
1500–100,000	.....	.....	1.0	30

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

NOTE 1 TO TABLE 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

NOTE 2 TO TABLE 1: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

7 RSS-102 Issue 5 Exposure Limits:

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m^2)	Reference Period (minutes)
0.003-10[21]	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	$0.158\ f^{0.5}$	$4.21 \times 10^{-4}\ f^{0.5}$	$6.67 \times 10^{-5}\ f$	$616000/f^{1.2}$

Note: f is frequency in MHz.
* Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

8 Test Procedure

An MPE evaluation for was performed in order to show that the device was compliant with the general population exposure limits from FCC §2.1091 and RSS-102 Issue 5. The maximum power density was calculated for each transmitter band at a separation distance of 20cm using the maximum declared output power including tune up tolerance.

For each transmitter the maximum RF exposure at a 20 cm distance using the formula:

$$ConductedPower_{mW} = 10^{ConductedPower(dBm)/10}$$

$$PowerDensity = \frac{ConductedPower_{mW} \times Ant.Gain}{4\pi \times (20_{cm})^2}$$

For transmitters that could operate simultaneously, the MPE to limit ratio for each was calculated and then summed. If the sum of the MPE to limit ratios was less than 1, that specific combination of transmitters was deemed to comply.

9 Results:

The calculated maximum power density at 20cm distance was equal to or less than the required limits for general population exposure for FCC Part 1.1310 and RSS-102 Issue 5.

FCC MPE Data

Duty Cycle	100 (%)							
Separation Dist.	20 (cm)							
Operating Mode	**Frequency (MHz)**	**Max Cond. Power (Inc. Tolerance) (dBm)**	**Duty Cycle Adjusted Cond. Output Power (dBm)**	**Antenna Gain (dB)**	**MPE Value (mW/cm^2)**	**MPE Limit (mW/cm^2)**	**Margin to Limit (mW/cm^2)**	**MPE / Limit Ratio (for Co-Location)**
Bluetooth, Internal Antenna	2400	8	8	0.5	0.0014	1.0000	0.9986	0.0014
Bluetooth, External Antenna	2400	8	8	4.4	0.0035	1.0000	0.9965	0.0035
LoRa	902	20	20	1.9	0.0308	0.6013	0.5705	0.0512

The worst case co-location condition is with the LoRa transmitting and the Bluetooth Low Energy with external antenna transmitting. The combined MPE ratio is:

0.0035 + 0.0512 = 0.0547

Since the combined MPE ratio is less than 1, the device is deemed to comply with multiple transmitter requirements.

RSS-102 Issue 5 MPE Data

Duty Cycle	100 (%)							
Separation Dist.	20 (cm)							
Operating Mode	**Frequency (MHz)**	**Declared Max Cond. Power (Inc. Tolerance) (dBm)**	**Duty Cycle Adjusted Cond. Output Power (dBm)**	**Antenna Gain (dB)**	**MPE Value (W/m^2)**	**MPE Limit (W/m^2)**	**Margin to Limit (W/m^2)**	**MPE / Limit Ratio (for Co-Location)**
Bluetooth, Internal Antenna	2400	8	-0.08	0.5	0.0022	5.3478	5.3456	0.0004
Bluetooth, External Antenna	2400	8	8	4.4	0.0346	5.3478	5.3132	0.0065
LoRa	902	20	20	1.9	0.3081	2.7398	2.4317	0.1125

The worst case co-location condition is with the LoRa transmitting and the Bluetooth Low Energy with external antenna transmitting. The combined MPE ratio is:

0.0065 + 0.1125 = 0.1190

Since the combined MPE ratio is less than 1, the device is deemed to comply with multiple transmitter requirements.

10 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	8/25/2021	104685025LEX-002	BL	BCT	Original Issue