FCC Part 1 Subpart I
FCC Part 2 Subpart J

RF EXPOSURE REPORT

FOR

Internet of Things Wi-Fi Module

HOST MODEL NUMBER: WRD-100

FCC ID: 2AC7Z-ESPWROOM02

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Revision History

Rev.	Issue Date	Revisions	Revised By
V1	7/8/2020	Original issue	
V2	7/24/2020	Updated device description	Dave Weaver

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: MakuSafe Corp.
1201 Maple Street,
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DUT DESCRIPTION: Internet of Things Wi-Fi Module

HOST MODEL: WRD-100

SERIAL NUMBER: N/A

APPLICABLE STANDARDS	
STANDARD	**TEST RESULTS**
FCC PART 1 SUBPART I & PART 2 SUBPART J	Pass

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document.

Approved & Released For
UL Verification Services Inc. By:

Dave Weaver
Operations Leader
UL Verification Services Inc.

2. TEST METHODOLOGY

All calculations were made in accordance with FCC KDB 447498 D01 v06.

3. REFERENCES

Output power, Duty cycle is excerpted from the applicable test reports or client declarations.

4. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, Fremont, California, USA

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0.

5. DEVICE UNDER TEST

5.1. Description

The DUT is an Internet of Things Wi-Fi Module, model number ESPWROOM02. The module is installed into a host whose end use is as an arm band sensor with 802.11 b/g/n WLAN technologies, model number WRD-100.

The WRD-100 is a wearable device that monitors motion, sound, environmental conditions and position within an instrumented workplace to help identify, predict, and prevent risk in workplace environments. When potential safety indicators (high temperature, high risk motion, etc.) are detected, data from sensors in the wearable device and Bluetooth beacon signal strength information (to determine location) are collected and saved to flash memory. The wearable device also supports the ability to record voice memos (up to 15 seconds) to flash memory. After data are saved to flash memory, a Wi-Fi module is powered on, data are sent to a base station via 2.4 GHz Wi-Fi.

5.2. Wireless Technologies and Maximum Output Power

Wireless technologies	Frequency bands	Maximum Output Power (uncorrected for duty cycle)
Wi-Fi 802.11b	2.4 GHz	10.5 dBm (11 mW)
Wi-Fi 802.11g	2.4 GHz	15 dBm (32 mW)
Wi-Fi 802.11n	2.4 GHz	15 dBm (32 mW)

6. DUTY CYCLE POWER CORRECTION

The following table summarizes the data types the MakuSafe wearable device supports, the maximum file size for each data type, and the maximum amount of data that is transmitted over Wi-Fi for each data type:

Data Type	Maximum File Size (bits)	Maximum Data Transmitted over WiFi due to overhead (bits)
Potential Safety Indicator	23,528	32,544
Voice Memo	3,875,544	4,024,000

The DUT minimum data rate of 1 Mb/s (802.11b) is applied conservatively to all Wi-Fi technologies .

6.1. Duty Cycle Calculations

Potential safety indicators are infrequent and voice memos are even more infrequent. However, the following worst-case analysis includes details a scenario where potential safety indicators are continually sent in a 30-minute window and a scenario where voice memos are continually sent in a 30-minute window.

6.1.1. Safety Indicators

The following table includes design details that summarizes the time required to create and send a potential safety indicator.

Parameter	Value
Time to initiate potential safety indicator	1 second*
Time to collect Bluetooth beacon signal strength information (to determine location)	10 seconds*
Maximum WiFi transfer time for potential safety indicator assuming no processing time** Calculation: Maximum Data Transmitted over WiFi due to overhead Minimum WiFi Data Rate (802.11b)	0.033 seconds
Total time to create and send a potential safety indicator	**11.033 seconds**

When a potential safety indicator completes, another one can start immediately. Therefore, due to the design of the MakuSafe wearable device, a maximum of 163 (1800 seconds/11.033 seconds per potential safety indicator) potential safety indicators can be created and transmitted in a 30-minute window.

The WiFi radio only transmits for 0.033 seconds during a potential safety indicator (psi) so the worst-case duty cycle over a 30-minute window is:

[(0.033 sec WiFi transmission per psi) * (163 psi's in 1800 sec)]/(1800 sec) = 0.003

6.1.2. Voice Memos

The following table includes design details that summarizes the time it takes to create and send the largest possible voice memo.

Parameter	Value
Time to initiate voice memo (done by holding a button down)	3 seconds*
Time to record maximum sized voice memo	15 seconds*
Time to collect Bluetooth beacon signal strength information (to determine location)	10 seconds*
Maximum WiFi transfer time for largest voice memo assuming no processing time** Calculation: Maximum Data Transmitted over WiFi due to overhead Minimum WiFi Data Rate (802.11b)	4.024 seconds
Total time to create and send largest voice memo	**32.024 seconds**

When a voice memo completes, another one can start immediately. Therefore, due to the design of the MakuSafe wearable device, a maximum of 56 (1800 seconds/32.024 seconds per voice memo) maximum sized voice memos can be created and transmitted in a 30-minute window.

The WiFi radio only transmits for 4.024 seconds during a voice memo so the worst-case duty cycle over a 30-minute window is:

[(4.024 sec WiFi transmission per psi) * (56 voice memos in 1800 sec)]/(1800 sec) = 0.125

* These times are defined in the wearable device firmware and are not changeable.
** Processing times may be longer, but for the purposes of calculating maximum exposure, the fastest cycle time is being used.

6.2. Output power corrected for Duty Cycle

The duty cycle used for the corrected power measurement is 0.125 as this represents the worst case value.

Wireless technologies	Frequency bands	Maximum Output Power (uncorrected for duty cycle)	Maximum Output Power (corrected for duty cycle)
Wi-Fi 802.11b	2.4 GHz	10.5 dBm (11 mW)	1.4 mW
Wi-Fi 802.11g	2.4 GHz	15 dBm (32 mW)	4.0 mW
Wi-Fi 802.11n	2.4 GHz	15 dBm (32 mW)	4.0 mW

7. STANDALONE SAR TEST EXCLUSION CONSIDERATIONS

From KDB 447498, for transmission frequencies 100 MHz to 6 GHz and test separation distances ≤ 50 mm, the 1-g SAR test exclusion thresholds are determined by the following:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 where:

- f(GHz) is the RF channel transmit frequency in GHz;
- Power and distance are rounded to the nearest mW and mm before calculation;
- For a separation distance of less than 5mm, 5mm is used.

The result is rounded to one decimal place for comparison with the 3.0 threshold.
The table below shows that at the maximum power for all bands and technologies, after accounting for source-based and operational duty cycles, and for a separation distance of 5mm or less, SAR test exclusion applies.

The device was assessed the 1g SAR limits.

RF Air interface	RF Exposure Conditions	Frequency (GHz)	Max output power (mW)	Min. test separation distance (mm)	SAR test exclusion Result*
802.11b	Body-worn	2.450	1	5	0.3
802.11g	Body-worn	2.450	4	5	1.3
802.11n	Body-worn	2.450	4	5	1.3

Conclusion:

*: The computed value is ≤ 3; therefore, this qualifies for SAR test exclusion.

END OF REPORT