



Washington Laboratories, Ltd.

MPE TEST REPORT

for the
Payload Module

Report# 16431-01 -01 Rev 2

Prepared for:
ReconRobotics
5251 West 73rd Street Suite A
Edina, MN 55439

Prepared By:
Washington Laboratories, Ltd.
4840 Winchester Blvd., Suite 5
Frederick, Maryland 21703



Certificates and reports shall not be reproduced except in full, without the written permission of Washington Laboratories, Ltd



MPE Test Report
for the
ReconRobotics
Payload Module

MARCH 25, 2020

WLL Report# 16431-01 -01 Rev 2

Prepared by:

A handwritten signature in black ink that reads "John P. Repella".

John P. Repella
Manager, EMC & Wireless Services

Reviewed by:

A handwritten signature in blue ink that reads "Steven D. Koster".

Steven D. Koster
President



ABSTRACT

This report has been prepared on behalf of ReconRobotics to document the findings of the maximum permissible exposure evaluation on the ReconRobotics Payload Module.

The purpose of this evaluation is to establish a minimum safe distance as per the RF exposure requirements as defined in FCC §1.1307 & §1.1310 and in RSS-102.

This report documents the results of testing to the requirements of:

- CFR Title 47 Volume 1 Practice and Procedure; (1.1307) Environmental Assessments
- RSS-102 Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

The Evaluation was performed by Washington Laboratories, Ltd, 4840 Winchester Blvd., Suite 5, Frederick, MD 21703. Washington Laboratories, Ltd. has been accepted as an EMC Conformity Assessment Body (CAB) under the United States/European Union Memorandum of Agreement. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory.

Revision History	Description of Change	Date
Rev 0	Initial Release	March 25, 2020
Rev 1	After comments.	March 30, 2020
Rev 2	Removed 75 MHz Part 95 assessment. Applied KDB447498	April 17, 2020



TABLE OF CONTENTS

Abstract	iii
Table of Contents.....	iv
List of Tables.....	v
List of Figures.....	v
List of Photographs.....	v
1 Introduction.....	1
2 Requirements	2
2.1 Transmitter Categories.....	2
2.1.1 Fixed Installations	2
2.1.2 Mobile Devices.....	2
2.1.3 Portable Devices.....	2
2.2 Exposure Categories.....	2
2.2.1 Occupational/Controlled Exposure.....	2
2.2.2 General Population/Uncontrolled Exposure.....	3
3 Device Summary.....	5
4 Radio Frequency Radiation Exposure Evaluation	6



LIST OF TABLES

Table 1: MPE Limits(FCC).....	3
Table 2: MPE Limits(ISED).....	4
Table 3: Device Summary of the Operator Control Unit 3	5
Table 4: Transmitter MPE Calculation Summary(FCC)	7

LIST OF FIGURES

No table of figures entries found.

LIST OF PHOTOGRAPHS

No table of figures entries found.

1 INTRODUCTION

This report has been prepared on behalf of ReconRobotics Payload Module

Transmitter to show compliance with the RF exposure requirements as defined in FCC §1.1307 & §1.1310 and in RSS-102.

Testing supporting this evaluation was performed at Washington Laboratories, Ltd, 4840 Winchester Blvd., Suite 5, Frederick, MD 2170. Washington Laboratories, Ltd. has been accepted as an EMC Conformity Assessment Body (CAB) under the United States/European Union Memorandum of Agreement. Washington Laboratories, Ltd. is accredited with ANAB under Testing Certificate AT-1448.

2 REQUIREMENTS

2.1 TRANSMITTER CATEGORIES

2.1.1 Fixed Installations

A fixed location means that the device, including its antenna, is physically secured at a permanent location and is not able to be easily moved to another location. Additionally, distance to humans from the antenna is maintained to at least 2 meters.

2.1.2 Mobile Devices

A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to be generally used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structures and the body of the user or nearby persons. Transmitters designed to be used by consumers or workers that can be easily re-located, such as a wireless modem operating in a laptop computer, are considered mobile devices if they meet the 20-centimeter separation requirement. The FCC rules for evaluating mobile devices for RF compliance are found in 47 CFR §2.1091.

2.1.3 Portable Devices

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. Portable device requirements are found in Section 2.1093 of the FCC's Rules (47 CFR§2.1093).

2.2 EXPOSURE CATEGORIES

The limits for exposure are determined by the type of situation in which the individual is exposed. Table 1 lists the limits for the particular environment.

2.2.1 Occupational/Controlled Exposure

In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. Awareness of the potential for RF exposure in a workplace or similar environment can be provided through specific training as part of a RF safety program. If appropriate, warning signs and labels can also be used to establish such awareness by providing prominent information on the risk of potential exposure and instructions on methods to minimize such exposure risks.

2.2.2 General Population/Uncontrolled Exposure

The general population / uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general-public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity. Warning labels placed on low-power consumer devices such as cellular telephones are not considered sufficient to allow the device to be considered under the occupational/controlled category and the general population/uncontrolled exposure limits apply to these devices.

Table 1: MPE Limits(FCC)

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	6
300–1500	N/A	N/A	f/300	6
1500–100,000	N/A	N/A	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	N/A	N/A	f/1500	30
1500–100,000	N/A	N/A	1	30

Table 2: MPE Limits(ISED)

Frequency Range(MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m2)	Reference Period (minutes)
Limits for General Population/Uncontrolled Exposure				
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	$0.158 f^{0.5}$	$4.21 \times 10^{-4} f^{0.5}$	$6.67 \times 10^{-5} f$	$616000/f^{1.2}$
Note: f is frequency in MHz.				
*Based on nerve stimulation (NS). ** Based on specific absorption rate (SAR).				

Frequency Range(MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m2)	Reference Period (minutes)
Limits for Occupational/Controlled Exposures				
0.003-1023	170	180	-	Instantaneous*
0.1-10	-	$1.6/f$	-	6**
1.29-10	$193/f^{0.5}$	-	-	6**
10-20	61.4	0.163	10	6
20-48	$129.8/f^{0.25}$	$0.3444/f^{0.25}$	$44.72/f^{0.5}$	6
48-100	49.33	0.1309	6.455	6
100-6000	$15.60 f^{0.25}$	$0.04138 f^{0.25}$	$0.6455 f^{0.5}$	6
6000-15000	137	0.364	50	6
15000-150000	137	0.364	50	$616000/f^{1.2}$
150000-300000	$0.354 f^{0.5}$	$9.40 \times 10^{-4} f^{0.5}$	$3.33 \times 10^{-4} f$	$616000/f^{1.2}$
f in MHz, * Based on nerve stimulation, ** Based on specific absorption rate(SAR)				

3 DEVICE SUMMARY

Table 2 below summarizes the criteria used to evaluate the Payload Module

Table 3: Device Summary of the Payload Module

Transmitter Category:	Unlicensed
Exposure Category:	General Population/Uncontrolled Exposure
Antenna Gain:	4dBi for the 2.4GHz radio
Power Output (dBm):	20.855dBm @2405MHz
Evaluation Distance:	20 cm
Frequency Range:	2405-2480MHz
FCC Limit:	0.2mW/cm ² , 1mW/cm ²
ISED Limit:	0.129mW/cm ² , 0.536mW/cm ²

4 RADIO FREQUENCY RADIATION EXPOSURE EVALUATION

The highest RF output power of the unit was measured and recorded. According to §1.1310 of the FCC rules, the power density limit for General Population/Uncontrolled Exposure is 1mW/cm² for the 2.4Ghz radio and 0.2mW/cm² for the 75MHz radio. According to RSS-102 of the ISED rules, the power density limit for General Population/Uncontrolled Exposure is 0.537mW/cm² for the 2.4GHz radio and 0.129mW/cm² for the 75MHz radio.

The MPE shall be calculated at 20cm to show compliance with the power density limit. The following formula was used to calculate the Power Density:

$$S = \frac{PG}{4\pi R^2}$$

Where:

S = Power Density

P = Output Power at the Antenna Terminals

G = Gain of Transmit Antenna (linear gain-isotropic)

R = Distance from Transmitting Antenna

Table 4: Transmitter MPE Calculation Summary (FCC)

The Payload module would normally be used within 20 cm of the body when installed in the OCU3. Assessment for extremity SAR and Body SAR exclusions are provided below.

Portable, use by the hands:

As per KDB 447498, section 4.3(a):

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:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)] · [SQRTf(GHz)] ≤ 3.0 for 1-g SAR, and ≤ 7.5 for 10-g extremity SAR,30 where SQRT f(GHz) is the RF channel transmit frequency in GHz.

Output power is 20.9 dBm = 123mW

Hence,

$$(123 \text{ mW} / \text{mm}) \times (\text{SQRT}(2.48)) \leq 7.5$$

or

$$(123 \text{ mW} / \text{mm}) = 4.83$$

$$(123 \text{ mW} / 4.83) = 25.4 \text{ mm}$$

Therefore, the module's transmit antenna can be used within 26 mm of the hands, without requiring a SAR test.

Portable, use by the body:

As per KDB 447498, section 4.3a):

$$(123 \text{ mW/mm}) \times (\text{SQRT}(2.48)) \leq 3.0$$

$$(123 \text{ mW/mm}) \times 1.5748 \leq 3.0$$

$$(123 \text{ mW/mm}) = 1.905$$

$$(123 \text{ mW}/1.905) = 64 \text{ mm} > 50 \text{ mm}$$

Distance is greater than 50 mm, must proceed to 4.3b)

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

Power allowed at numeric threshold for 50 mm: $50 \times 1.905 = 95 \text{ mW}$

Test separation distance is 200 mm. Hence,

$$95 \text{ mW} + (200-50) \times 10 = 1595 \text{ mW} > 123 \text{ mW}$$

Separation distance, X at 123 mW:

$$95 + (X-50) \times 10 = 123 \text{ mW}$$

$$X = ((123-95) \times 1) + 50$$

$$X = 52.8 \text{ mm}$$