**xFCC 47 CFR PART 15 SUBPART B & C**
**INDUSTRY CANADA RSS-210 ISSUE 8**

# CERTIFICATION TEST REPORT

**Platform Transceiver**

**MODEL NUMBER: Platform**

**FCC ID: 2AE4KBUD001**
**IC: 20769-BUD001**

**REPORT NUMBER: 10667825B**

**ISSUE DATE: October 29, 2015**

*Prepared for*
**Five Element Robotics**
**1333 Compus Parkway**
**Wall, NJ 07753**
**US**

*Prepared by*
**UL LLC**
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**Northbrook, IL 60062**
**TEL: (847) 272-8800**

NVLAP Lab code: 100414-0

## Revision History

| Rev. | Issue Date | Revisions | Revised By |
|---|---|---|---|
| -- | 2015-10-29 | Initial Issue | BM |

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# 1. ATTESTATION OF TEST RESULTS

**COMPANY NAME:** Five Element Robotics
1333 Compus Parkway
Wall, NJ 07753
US

**EUT DESCRIPTION:** Robot Platform radio board

**MODEL:** Platform

**SERIAL NUMBER:** Non-Serialized

**DATE TESTED:** August 2015 – September 2015

| APPLICABLE STANDARDS | |
|---|---|
| **STANDARD** | **TEST RESULTS** |
| CFR 47 Part 15 Subpart B & C | Pass |
| INDUSTRY CANADA RSS-210 Issue 8 Annex 8 | Pass |
| INDUSTRY CANADA RSS-GEN Issue 4 | Pass |

UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL LLC based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

**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 LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government.

Approved & Released For
UL LLC By:

Michael Ferrer
EMC Engineer
UL LLC

Tested By:

Bart Mucha
EMC Enginner
UL LLC

# 2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with ANSI C63.10-2013, FCC CFR 47 Part 2, FCC CFR 47 Part 15, RSS-GEN Issue 4 and RSS-210 Issue 8, ICES-003 Issue 5.

# 3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 333 Pfingsten Road, Northbrook, IL 60062 USA.

UL NBK is accredited by NVLAP, Laboratory Code 100414-0. The full scope of accreditation can be viewed at http://ts.nist.gov/

# 4. CALIBRATION AND UNCERTAINTY

## 4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

## 4.2. SAMPLE CALCULATION

Sample Calculations
Radiated Field Strength and Conducted Emissions data contained within this report is calculated on the following basis:
Field Strength (dBuV/m) = Meter Reading (dBuV) + AF (dB/m) - Gain (dB) + Cable Loss (dB)
Conducted Voltage (dBuV) = Meter Reading (dBuV) + Cable Loss (dB) + LISN IL (dB)
Conducted Current (dBuA) = Meter Reading (dBuV) + Cable Loss (dB) - Transducer Factor (dBohms)

## 4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

| Test | Range | Equipment | Uncertainty k=2 |
|---|---|---|---|
| Radiated Emissions | 30-200MHz | Bicon 10m Horz | 4.27dB |
| Radiated Emissions | 30-200MHz | Bicon 10m Vert | 4.28dB |
| Radiated Emissions | 200-1000MHz | LogP 10m Horz | 3.33dB |
| Radiated Emissions | 200-1000MHz | LogP 10m Vert | 3.39dB |
| Radiated Emissions | 1-6GHz | Horn | 5.02dB |
| Radiated Emissions | 6-18GHz | Horn | 5.34dB |
| Radiated Emissions | 18-26GHz | Horn | 6.60dB |

Uncertainty figures are valid to a confidence level of 95%.

# 5. EQUIPMENT UNDER TEST

## 5.1. DESCRIPTION OF EUT

The EUT is a consumer robotic device that implements a 2.4GHz 802.15.4 transceiver via the Atmel ATMEGA256RFR2 microcontroller. The EUT pairs with a portable transmitter to achieve a follow behavior.

## 5.2. MAXIMUM OUTPUT E-FIELD STRENGTH

The transmitter has a maximum output peak E-field as follows:

| Frequency Range (MHz) | Mode | Output AV E-field Strength (dBuV/m) @ 3m |
|---|---|---|
| 2405-2480 | GFSK | 88.48 |

## 5.3. DESCRIPTION OF AVAILABLE ANTENNAS

Part Number: Ceramic Chip Antenna by Johanson Technology 2450AT18D0100E

Antenna Peak Gain: 1.5dBi

## 5.4. SOFTWARE AND FIRMWARE

The firmware installed in the EUT (transmitter) during testing was version 1.0.

The firmware installed in the EUT (platform) during testing was version 0.9.17.

The test utility software used during testing was FCCTest revision 1.0.

## 5.5. WORST-CASE CONFIGURATION AND MODE

The transmitter will be positioned in single orientation during normal use.

## 5.6. DESCRIPTION OF TEST SETUP

**SUPPORT EQUIPMENT**

| Support Equipment List | | | | |
|---|---|---|---|---|
| **Description** | **Manufacturer** | **Model** | **Serial Number** | **FCC ID** |
| *Battery | Generic | Generic | - | - |
| **Power Supply | TRIAD | WSU180-2000 | - | |
| * used as temprary soruce to power the tramsitter board | | | | |
| ** only used to recharge the product, device is not trasmitting while charging. | | | | |

**I/O CABLES**

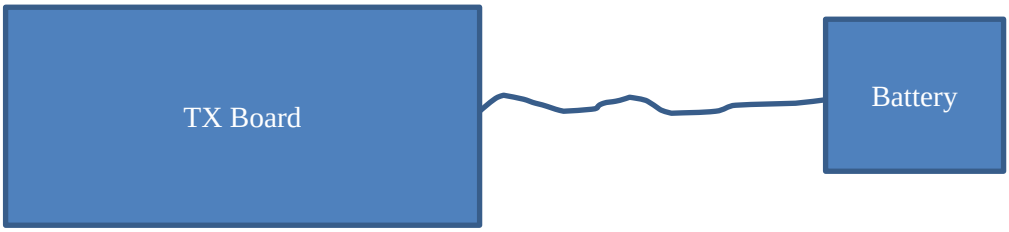
| I/O Cable List | | | | | | |
|---|---|---|---|---|---|---|
| **Cable No** | **Port** | **# of identical ports** | **Connector Type** | **Cable Type** | **Cable Length (m)** | **Remarks** |
| 1 | DC | 1 | round | 2-wire | 1m | cable between supply and the EUT |

**TEST SETUP**

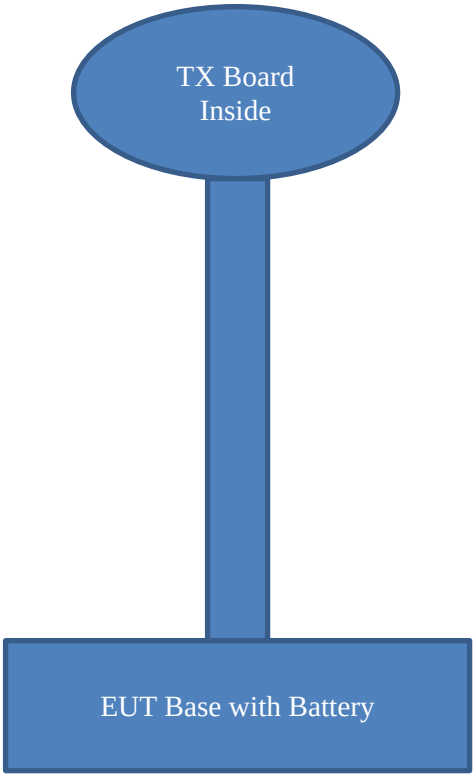
The board was tested as stand alone component. Some testing was repeated when installed in the host.

**SETUP DIAGRAM FOR TESTS**

Setup of device for stand alone testing.




Setup for device when inside intended host



# 6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

| Test Equipment List | | | | | |
|---|---|---|---|---|---|
| **Description** | **Manufacturer** | **Model** | **EMC No.** | **Cal Date** | **Cal Due** |
| Radiated Software | UL | UL EMC | Ver 9.5, July 22, 2014 | | |
| Conducted Software | UL | UL EMC | Ver 9.5, May 17 2012 | | |
| EMI Test Receiver | Rohde & Schwarz | ESU | EMC4323 | 20141216 | 20151231 |
| EMI Test Receiver | Rohde & Schwarz | ESCI | EMC4328 | 20141830 | 20151231 |
| Bicon Antenna | Electro-Metrics | EM6912A | EMC4070 | 20141014 | 20151031 |
| Log-P Antenna | Chase | UPA6109 | EMC4313 | 20141119 | 20151130 |
| Loop Antenna | EMCO | 6502/1 | EMC4026 | 20150420 | 20160430 |
| Antenna Array | UL | BOMS | EMC4276 | 20141201 | 20151231 |
| Spectrum Analyzer | Agilent | N9030A (PXA) | EMC4360 | 20141219 | 20151219 |
| | | | | | |
| Description | Manufacturer | Model | Identifier | Cal. Date | Cal. Due Date |
| EMI Test Receiver | Rohde & Schwarz | ESR | EMC4377 | 20150423 | 20160423 |
| Transient Limiter | Electro-Metrics | EM7600-2 | EMC4224 | N/A | N/A |
| HighPass Filter | Solar Electronics | 2803-150 | 885551 | N/A | N/A |
| Attenuator | HP | 8494B | 2831A00838 | N/A | N/A |
| LISN - L1 | Solar | 8602-50-TS-50-N | EMC4052 | 20150109 | 20160110 |
| LISN - L2 | Solar | 8602-50-TS-50-N | EMC4064 | 20150109 | 20160110 |
| | | | | | |
| | | | | | |

# 7. TEST RESULTS

## 7.1.1. 99% and 20dB BANDWIDTH

**LIMITS**

None; for reporting purposes only.

**TEST PROCEDURE**

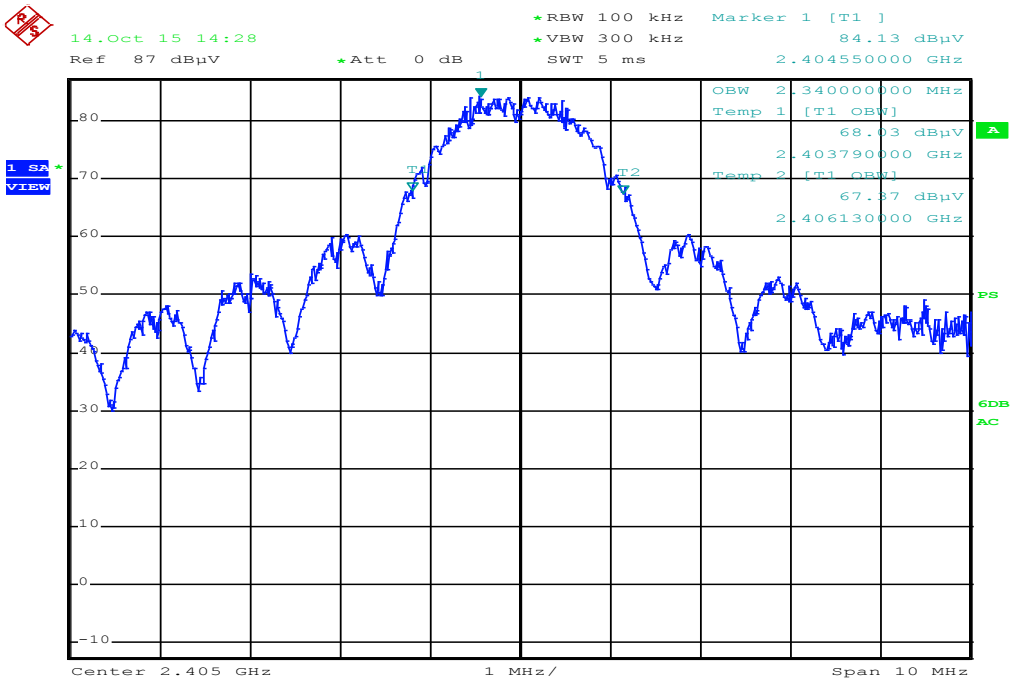
The transmitter output is connected to the spectrum analyzer. The RBW is set to 1% to 3% of the 99 % bandwidth. The VBW is set to 3 times the RBW. The sweep time is coupled. The spectrum analyzer internal 99% bandwidth function is utilized.

**RESULTS**

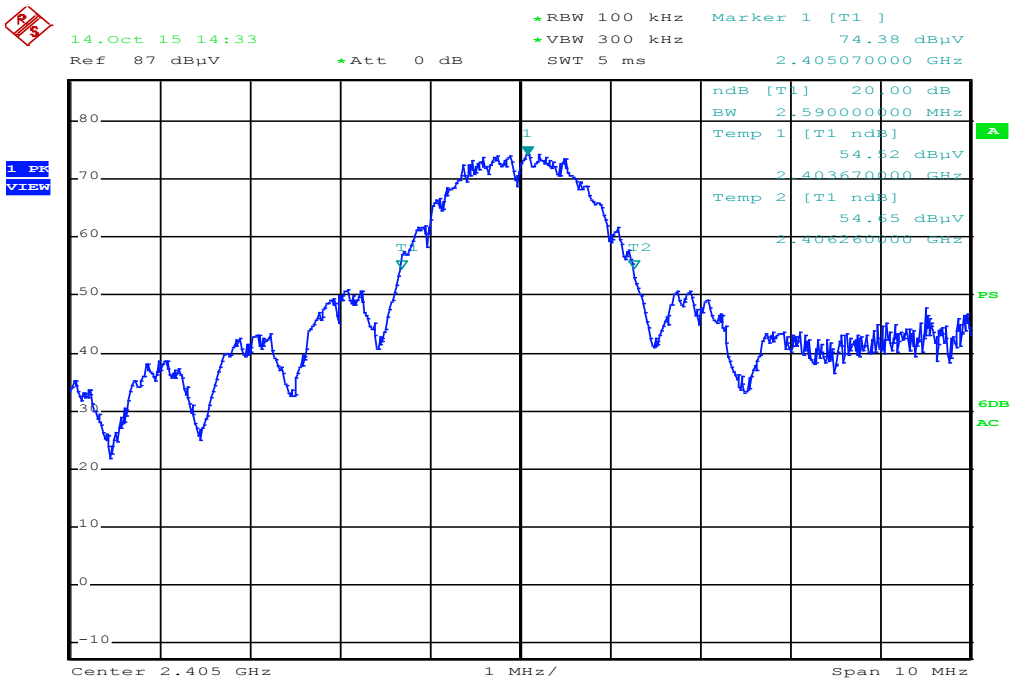
| Channel | Frequency (MHz) | 99% Bandwidth (MHz) | 20dB Bandwidth (MHz) |
|---|---|---|---|
| Low | 2405 | 2.34 | 2.59 |
| Middle | 2445 | 2.41 | 2.6 |
| High | 2480 | 2.49 | 2.62 |

**Low Channel**

99% Bandwidth

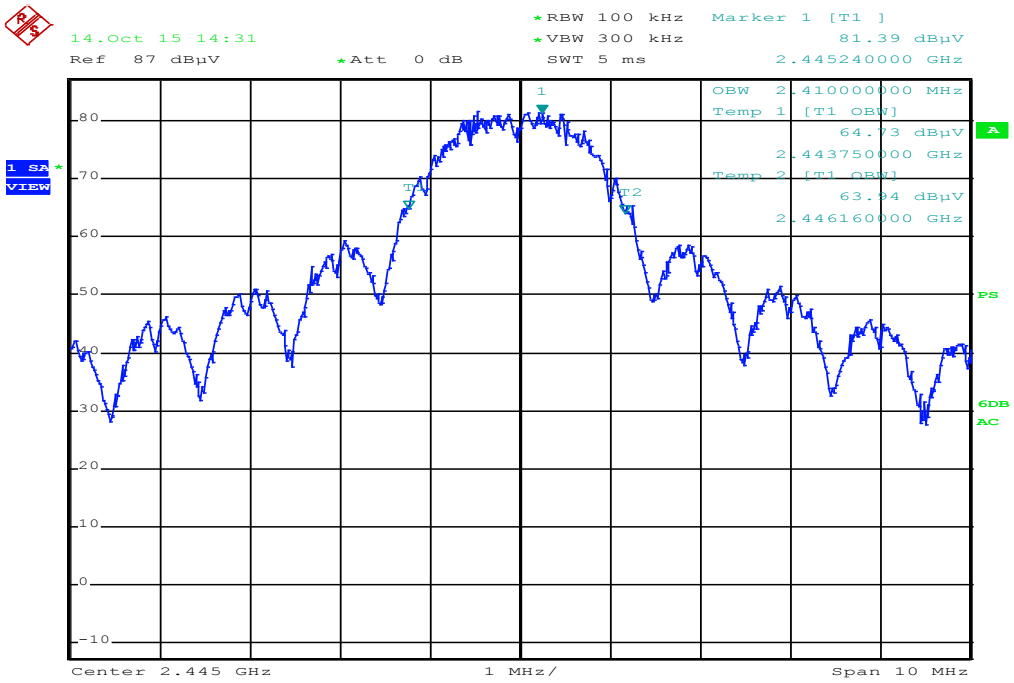



20dB Bandwidth

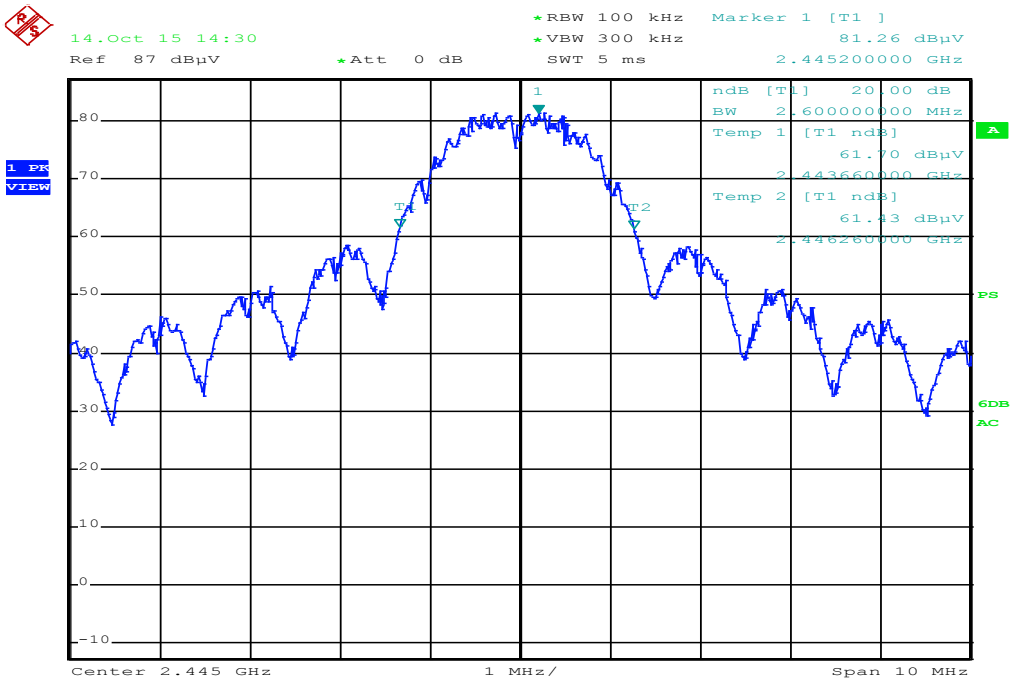


**Middle Channel**

99% Bandwidth

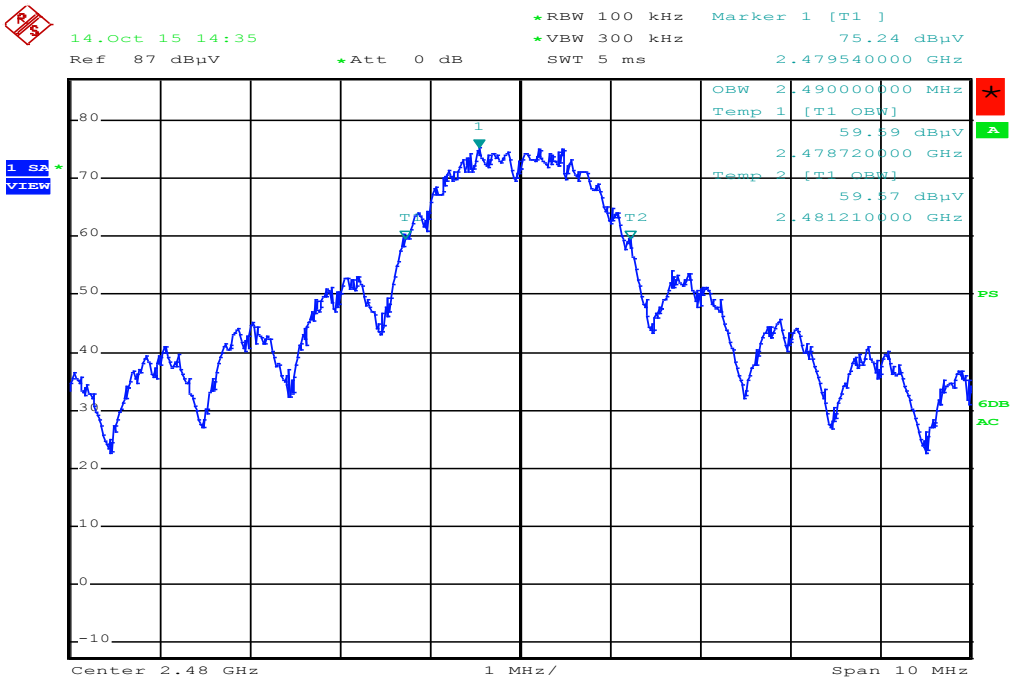



20dB Bandwidth

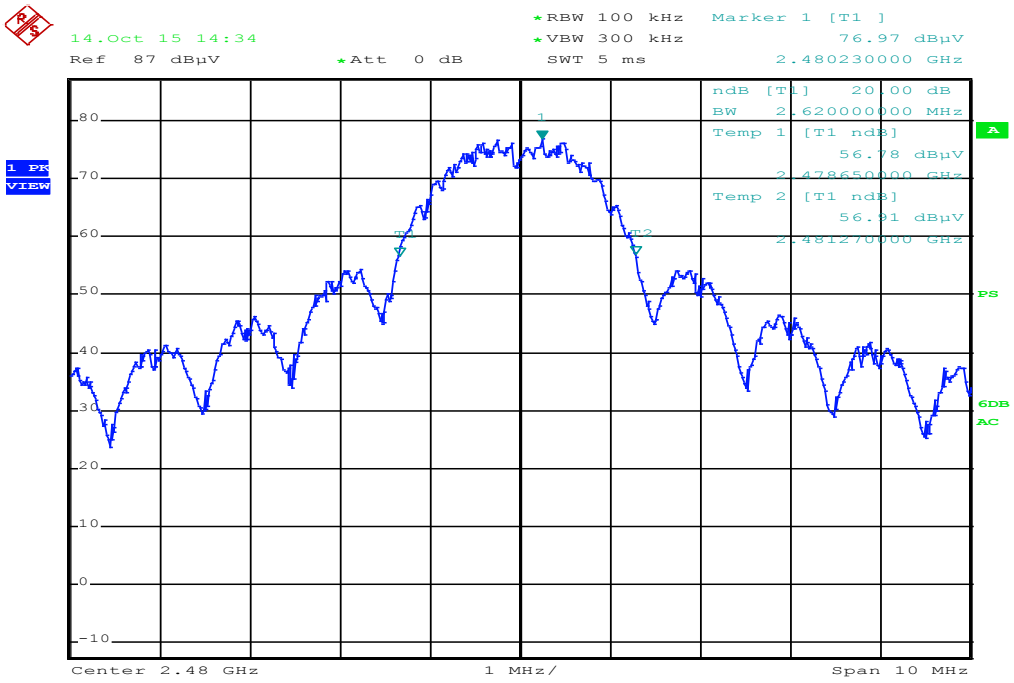


**High Channel**

99% Bandwidth




20dB Bandwidth



## 7.2. RADIATED EMISSIONS

**LIMIT**

IC RSS-210, A2.9
FCC 15.249

Operation within the bands 902–928 MHz, 2400–2483.5 MHz, 5725–5875 MHZ, and 24.0–24.25 GHz.
(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

| Fundamental frequency | Field strength of fundamental (millivolts/meter) | Field strength of harmonics (microvolts/meter) |
|---|---|---|
| 902–928 MHz | 50 | 500 |
| 2400–2483.5 MHz | 50 | 500 |
| 5725–5875 MHz | 50 | 500 |
| 24.0–24.25 GHz | 250 | 2500 |

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in § 15.209, whichever is the lesser attenuation.

| Frequency (MHz) | Field strength (microvolts/meter) | Measurement distance (meters) |
|---|---|---|
| 0.009–0.490 | 2400/F(kHz) | 300 |
| 0.490–1.705 | 24000/F(kHz) | 30 |
| 1.705–30.0 | 30 | 30 |
| 30–88 | 100 ** | 3 |
| 88–216 | 150 ** | 3 |
| 216–960 | 200 ** | 3 |
| Above 960 | 500 | 3 |

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54–72 MHz, 76–88 MHz, 174–216 MHz or 470–806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

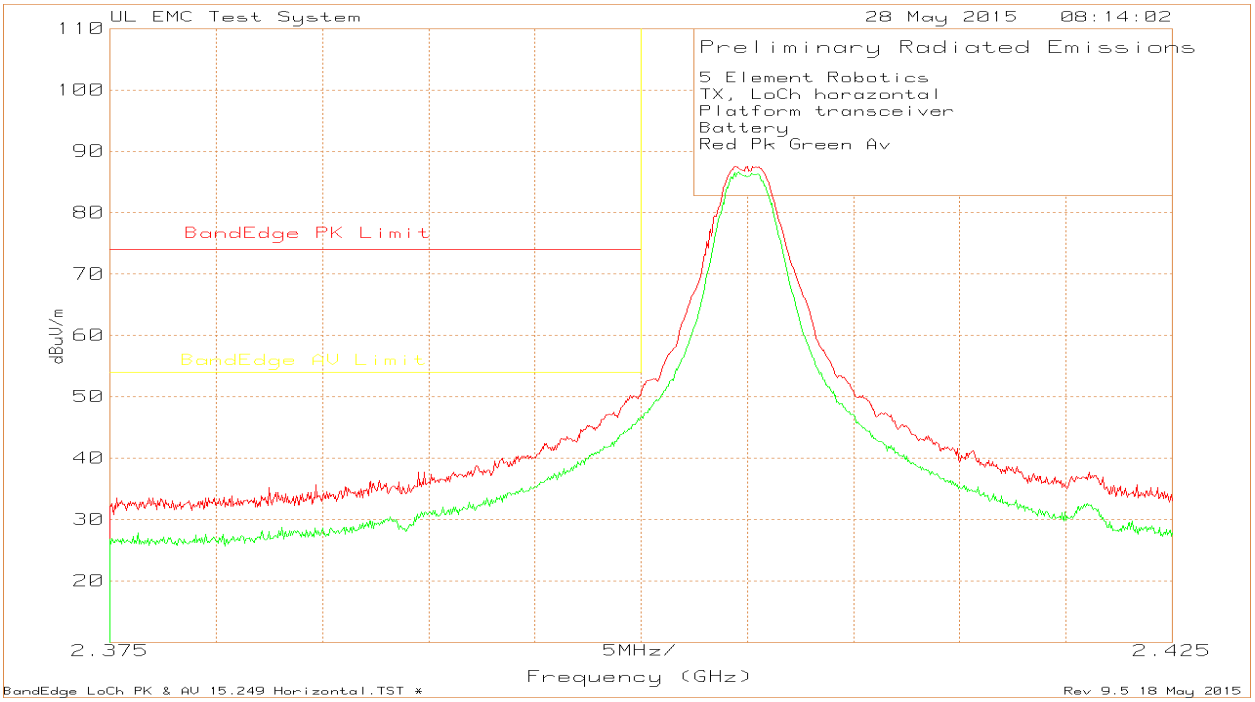
**RESULTS**

## 7.2.1. FUNDAMENTAL FREQUENCY RADIATED EMISSION

| 5 Element Robotics | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Platform transceiver | | | | | | | | | | |
| Test Frequency (GHz) | Meter Reading (dBuV) | Detector | Antenna Factor dB/m | Path Factor dB | Level dBuV/m | Limit FCC 15.249 dBuV/m @ 3m | Margin dB | Azimuth [Degs] | Height [cm] | Polarity |
| 2.405 | 117.8 | Pk | 21.8 | -51.81 | 87.79 | 114 | -26.21 | 147 | 100 | H |
| 2.4045 | 117.27 | RMS AV | 21.8 | -51.83 | 87.24 | 94 | -6.76 | 147 | 100 | H |
| 2.405 | 116.03 | Pk | 21.8 | -51.81 | 86.02 | 114 | -27.98 | 91 | 106 | V |
| 2.4044 | 115.67 | RMS AV | 21.8 | -51.83 | 85.64 | 94 | -8.36 | 91 | 106 | V |
| | | | | | | | | | | |
| 2.445 | 116.08 | Pk | 21.9 | -51.28 | 86.7 | 114 | -27.3 | 212 | 193 | H |
| 2.4444 | 115.69 | RMS AV | 21.9 | -51.28 | 86.31 | 94 | -7.69 | 212 | 193 | H |
| 2.4449 | 113.42 | Pk | 21.9 | -51.28 | 84.04 | 114 | -29.96 | 262 | 100 | V |
| 2.4444 | 113.05 | RMS AV | 21.9 | -51.28 | 83.67 | 94 | -10.33 | 262 | 100 | V |
| | | | | | | | | | | |
| 2.4803 | 118.16 | Pk | 22 | -51.68 | 88.48 | 114 | -25.52 | 213 | 213 | H |
| 2.4795 | 117.35 | RMS AV | 22 | -51.66 | 87.69 | 94 | -6.31 | 213 | 213 | H |
| 2.4802 | 116.39 | Pk | 22 | -51.68 | 86.71 | 114 | -27.29 | 262 | 103 | V |
| 2.4795 | 116.02 | RMS AV | 22 | -51.67 | 86.35 | 94 | -7.65 | 262 | 103 | V |

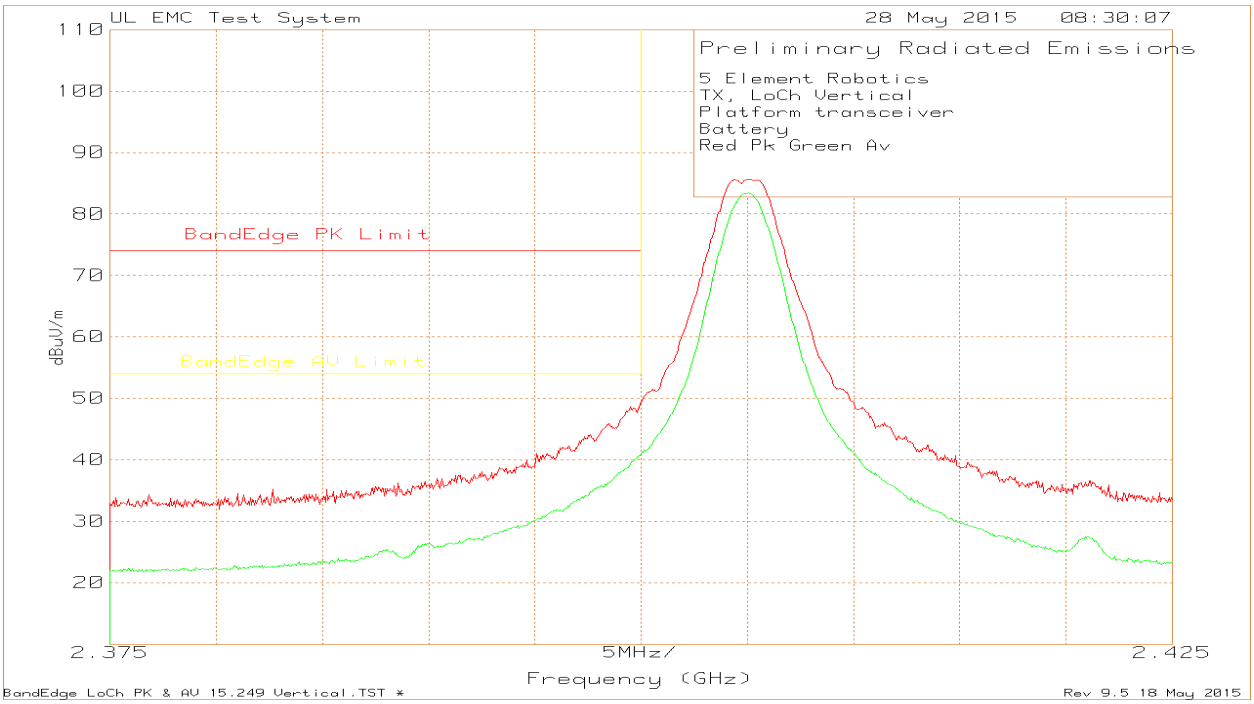
## 7.2.2. TRANSMITTER RESTRICTED BAND EDGES

### RESTRICTED BANDEDGE (LOW CHANNEL, HORIZONTAL)



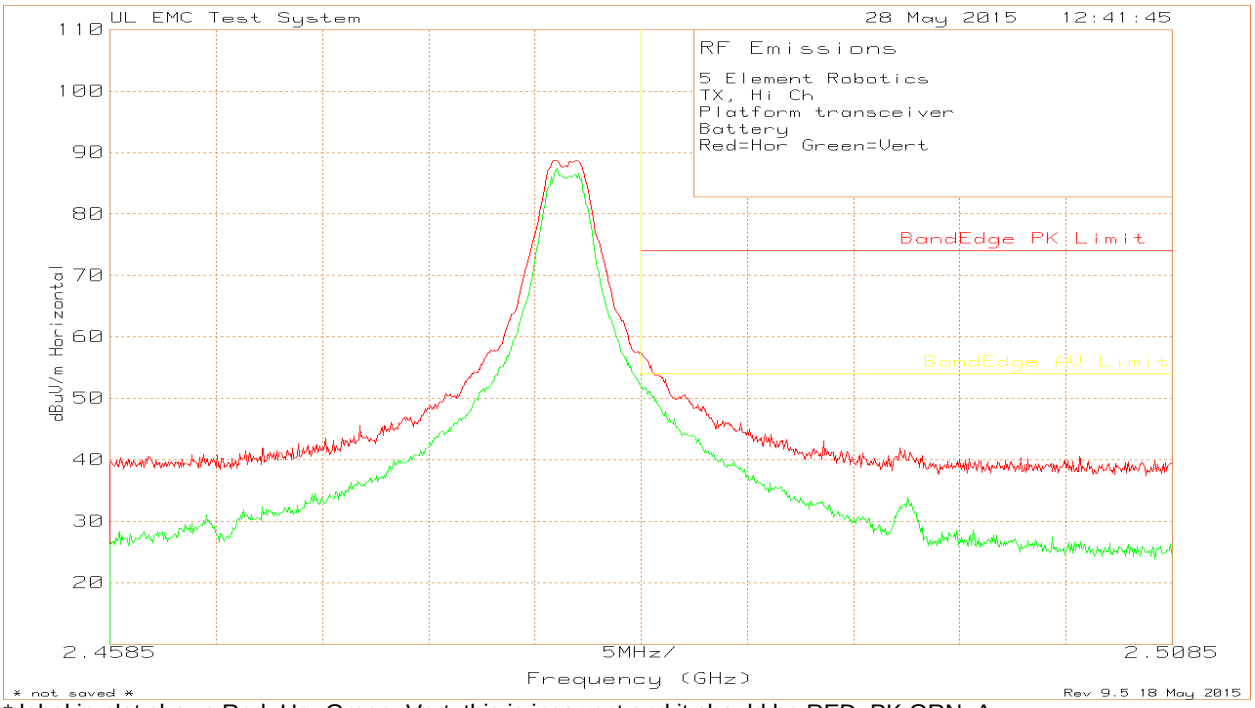

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 Element Robotics | | | | | | | | | | | | | |
| TX, LoCh horazontal | | | | | | | | | | | | | |
| Platform transceiver | | | | | | | | | | | | | |
| Battery | | | | | | | | | | | | | |
| Red Pk Green Av | | | | | | | | | | | | | |
| Trace Markers | | | | | | | | | | | | | |
| Marker No. | Test Frequency (GHz) | Meter Reading (dBuV) | Detector | Antenna Facotr dB/m | Path Factor dB | Level dBuV/m | Peak Limit dBuVm | Margin (dB) | Average Limit dBuV/m | Margin (dB) | Azimuth [Degs] | Height [cm] | Polarity |
| Peak | | | | | | | | | | | | | |
| 1 | 2.405 | 117.6 | Pk | 21.8 | -51.81 | 87.59 | - | - | - | - | 147 | 100 | H |
| 6 | 2.4 | 80.85 | Pk | 21.8 | -51.93 | 50.72 | 74 | -23.28 | 54 | -3.28 | 147 | 100 | H |
| 7 | 2.4 | 80.28 | Pk | 21.8 | -51.93 | 50.15 | 74 | -23.85 | 54 | -3.85 | 147 | 100 | H |
| 8 | 2.4001 | 81.28 | Pk | 21.8 | -51.93 | 51.15 | - | - | - | - | 147 | 100 | H |
| Average | | | | | | | | | | | | | |
| 2 | 2.4052 | 116.39 | AV | 21.8 | -51.8 | 86.39 | - | - | - | - | 147 | 100 | H |
| 3 | 2.4 | 76.88 | AV | 21.8 | -51.93 | 46.75 | 74 | -27.25 | 54 | -7.25 | 147 | 100 | H |
| 4 | 2.4 | 76.65 | AV | 21.8 | -51.93 | 46.52 | 74 | -27.48 | 54 | -7.48 | 147 | 100 | H |
| 5 | 2.4001 | 76.83 | AV | 21.8 | -51.93 | 46.7 | - | - | - | - | 147 | 100 | H |
| PK - Peak Detector | | | | | | | | | | | | | |
| AV - Average Detector | | | | | | | | | | | | | |

## RESTRICTED BANDEDGE (LOW CHANNEL, VERTICAL)




| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 Element Robotics | | | | | | | | | | | | | |
| TX, LoCh Vertical | | | | | | | | | | | | | |
| Platform transceiver | | | | | | | | | | | | | |
| Battery | | | | | | | | | | | | | |
| Red Pk Green Av | | | | | | | | | | | | | |
| Trace Markers | | | | | | | | | | | | | |
| Marker No. | Test Frequency (GHz) | Meter Reading (dBuV) | Detector | Antenna Facotr dB/m | Path Factor dB | Level dBuV/m | Peak Limit dBuVm | Margin (dB) | Average Limit dBuV/m | Margin (dB) | Azimuth [Degs] | Height [cm] | Polarity |
| Peak | | | | | | | | | | | | | |
| 1 | 2.405 | 115.67 | Pk | 21.8 | -51.81 | 85.66 | - | - | - | - | 91 | 106 | V |
| 6 | 2.4 | 79.38 | Pk | 21.8 | -51.93 | 49.25 | 74 | -24.75 | 54 | -4.75 | 91 | 106 | V |
| 7 | 2.4 | 79.36 | Pk | 21.8 | -51.93 | 49.23 | 74 | -24.77 | 54 | -4.77 | 91 | 106 | V |
| 8 | 2.4001 | 79.8 | Pk | 21.8 | -51.93 | 49.67 | - | - | - | - | 91 | 106 | V |
| Average | | | | | | | | | | | | | |
| 2 | 2.4051 | 113.42 | AV | 21.8 | -51.81 | 83.41 | - | - | - | - | 91 | 106 | V |
| 3 | 2.4 | 70.98 | AV | 21.8 | -51.93 | 40.85 | 74 | -33.15 | 54 | -13.15 | 91 | 106 | V |
| 4 | 2.4 | 70.85 | AV | 21.8 | -51.93 | 40.72 | 74 | -33.28 | 54 | -13.28 | 91 | 106 | V |
| 5 | 2.4001 | 71.21 | AV | 21.8 | -51.93 | 41.08 | - | - | - | - | 91 | 106 | V |
| PK - Peak Detector | | | | | | | | | | | | | |
| AV - Average Detector | | | | | | | | | | | | | |

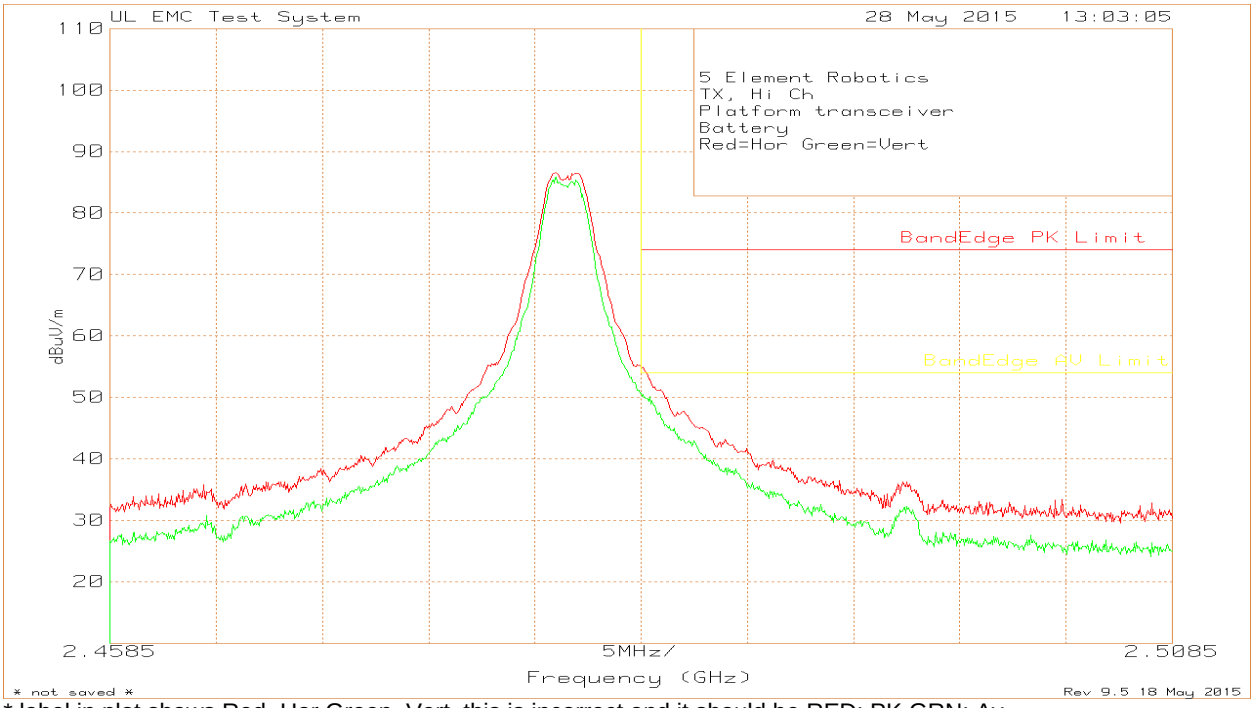
## RESTRICTED BANDEDGE (HIGH CHANNEL, HORIZONTAL)




* label in plot shows Red=Hor Green=Vert, this is incorrect and it should be RED: PK GRN: Av

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 Element Robotics | | | | | | | | | | | | | |
| TX, Hi Ch | | | | | | | | | | | | | |
| Platform transceiver | | | | | | | | | | | | | |
| Battery | | | | | | | | | | | | | |
| Red=Hor Green=Vert | | | | | | | | | | | | | |
| Trace Markers | | | | | | | | | | | | | |
| Marker No. | Test Frequency (GHz) | Meter Reading (dBuV) | Detector | Antenna Facotr dB/m | Path Factor dB | Level dBuV/m | Peak Limit dBuVm | Margin (dB) | Average Limit dBuV/m | Margin (dB) | Azimuth [Degs] | Height [cm] | Polarity |
| Peak | | | | | | | | | | | | | |
| 2 | 2.4795 | 110.05 | Pk | 22 | -43.3 | 88.72 | - | - | - | - | 213 | 213 | H |
| 3 | 2.4835 | 78.8 | Pk | 22.1 | -43.4 | 57.49 | 74 | -16.51 | - | - | 213 | 213 | H |
| 4 | 2.4835 | 78.79 | Pk | 22.1 | -43.4 | 57.48 | - | - | - | - | 213 | 213 | H |
| 5 | 2.4836 | 78.58 | Pk | 22.1 | -43.4 | 57.27 | 74 | -16.73 | - | - | 213 | 213 | H |
| Average | | | | | | | | | | | | | |
| 1 | 2.4796 | 117.1 | AV | 22 | -51.7 | 87.43 | - | - | - | - | 213 | 213 | H |
| 6 | 2.4835 | 81.83 | AV | 22.1 | -51.7 | 52.19 | - | - | 54 | -1.81 | 213 | 213 | H |
| 7 | 2.4835 | 81.58 | AV | 22.1 | -51.7 | 51.94 | 74 | -22.06 | 54 | -2.06 | 213 | 213 | H |
| 8 | 2.4836 | 81.41 | AV | 22.1 | -51.7 | 51.77 | 74 | -22.23 | 54 | -2.23 | 213 | 213 | H |
| PK - Peak Detector | | | | | | | | | | | | | |

**RESTRICTED BANDEDGE (HIGH CHANNEL, Vertical)**

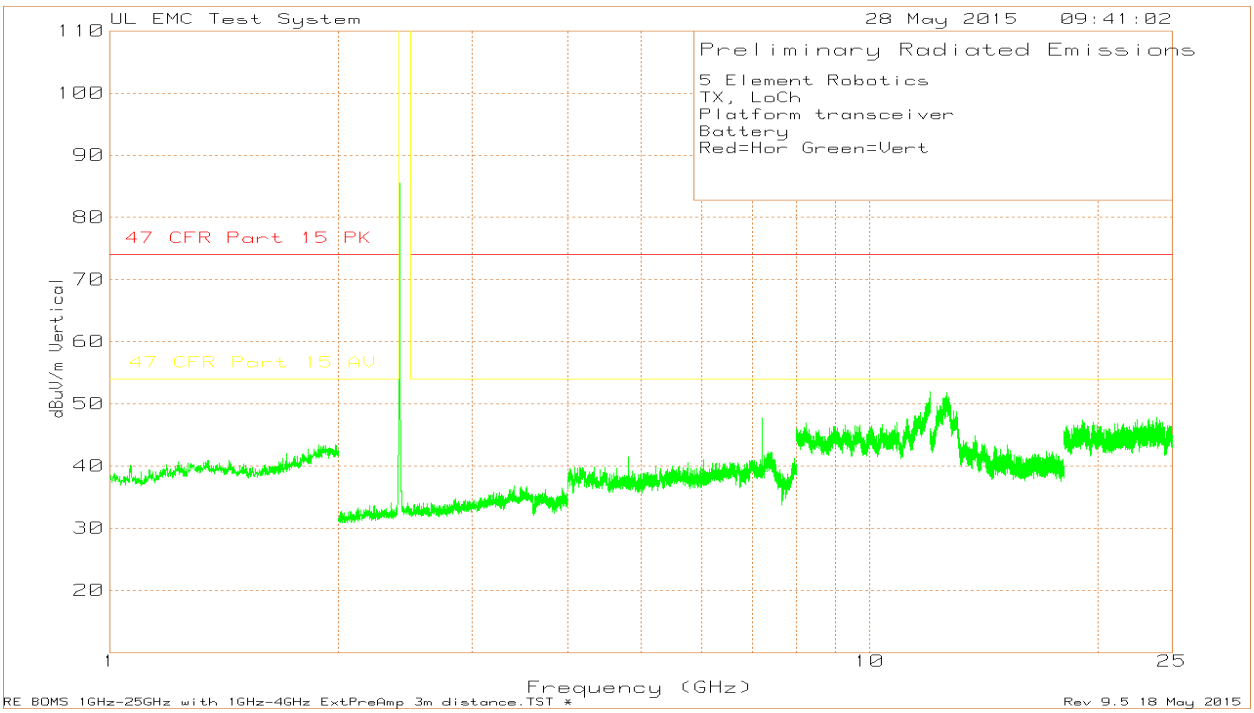


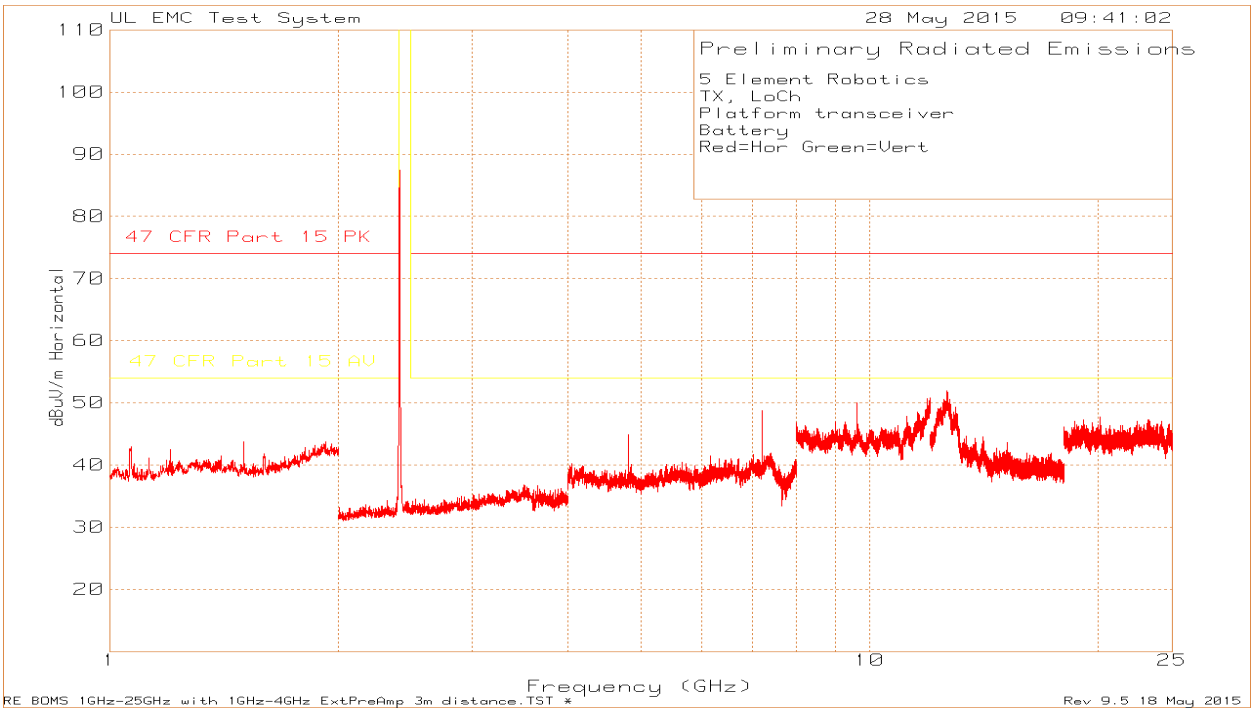

* label in plot shows Red=Hor Green=Vert, this is incorrect and it should be RED: PK GRN: Av

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 Element Robotics | | | | | | | | | | | | | |
| TX, Hi Ch | | | | | | | | | | | | | |
| Platform transceiver | | | | | | | | | | | | | |
| Battery | | | | | | | | | | | | | |
| Red=Hor Green=Vert | | | | | | | | | | | | | |
| Trace Markers | | | | | | | | | | | | | |
| Marker No. | Test Frequency (GHz) | Meter Reading (dBuV) | Detector | Antenna Facotr dB/m | Path Factor dB | Level dBuV/m | Peak Limit dBuVm | Margin (dB) | Average Limit dBuV/m | Margin (dB) | Azimuth [Degs] | Height [cm] | Polarity |
| Peak | | | | | | | | | | | | | |
| 1 | 2.4795 | 116.15 | Pk | 22 | -51.66 | 86.49 | - | - | - | - | 262 | 103 | V |
| 6 | 2.4835 | 84.71 | Pk | 22.1 | -51.74 | 55.07 | - | - | - | - | 262 | 103 | V |
| 7 | 2.4835 | 84.66 | Pk | 22.1 | -51.74 | 55.02 | 74 | -18.98 | - | - | 262 | 103 | V |
| 8 | 2.4836 | 84.46 | Pk | 22.1 | -51.74 | 54.82 | 74 | -19.18 | - | - | 262 | 103 | V |
| Average | | | | | | | | | | | | | |
| 2 | 2.4795 | 115.47 | AV | 22 | -51.67 | 85.8 | - | - | - | - | 262 | 103 | V |
| 3 | 2.4835 | 80.38 | AV | 22.1 | -51.74 | 50.74 | 74 | -23.26 | 54 | -3.26 | 262 | 103 | V |
| 4 | 2.4835 | 80.38 | AV | 22.1 | -51.74 | 50.74 | - | - | 54 | -3.26 | 262 | 103 | V |
| 5 | 2.4836 | 79.81 | AV | 22.1 | -51.74 | 50.17 | 74 | -23.83 | 54 | -3.83 | 262 | 103 | V |
| PK - Peak Detector | | | | | | | | | | | | | |
| AV - Average Detector | | | | | | | | | | | | | |

## 7.2.3. HARMONICS AND SPURIOUS EMISSIONS ABOVE 1GHz

**Low Channel, board alone, scan**

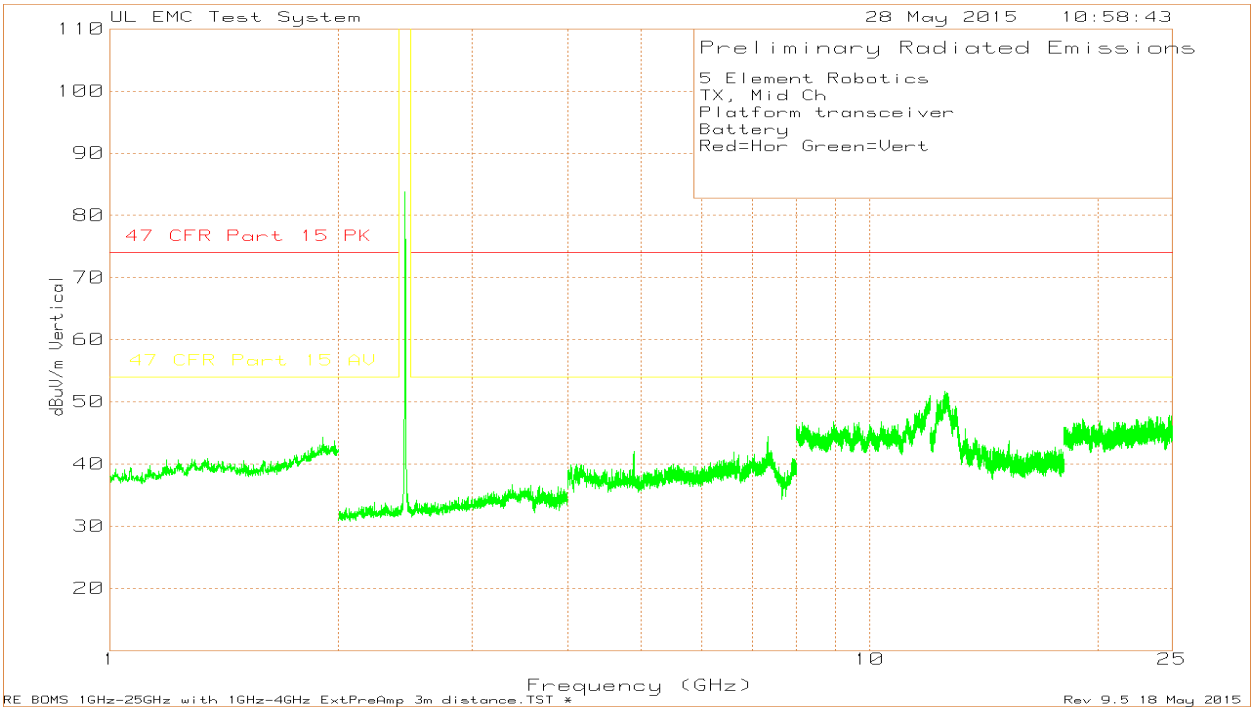


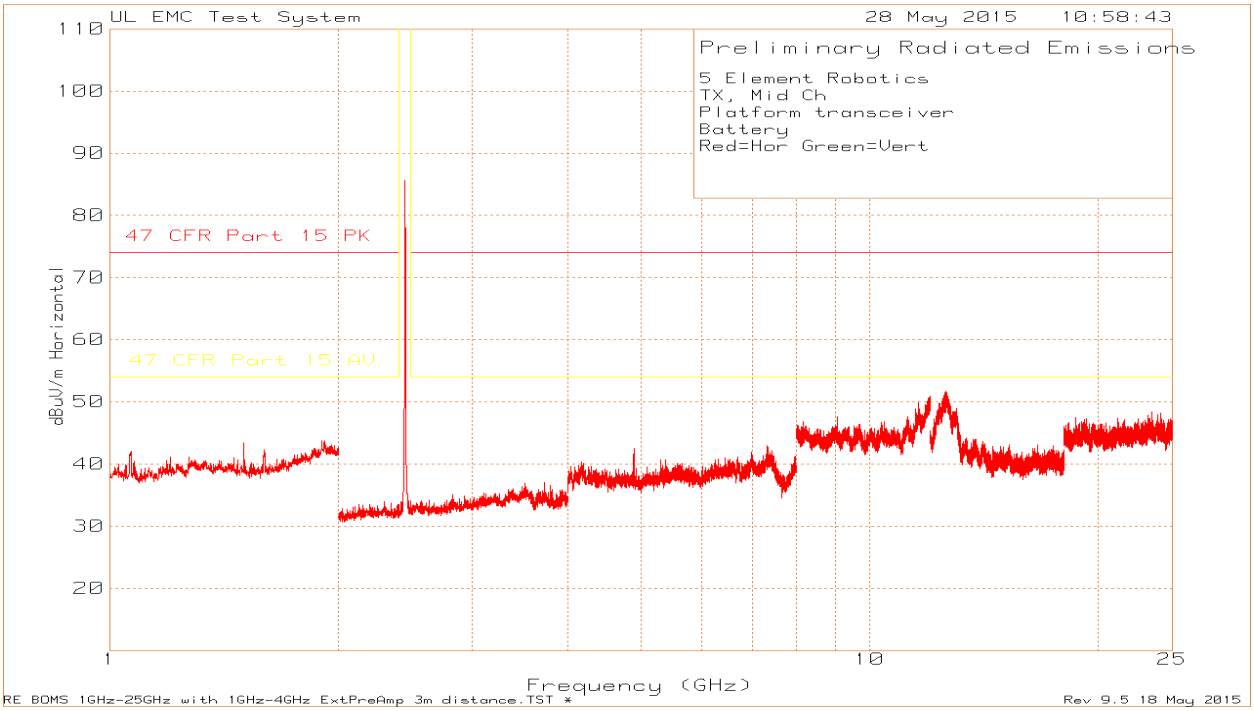



**Low Channel, board alone, data**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 Element Robotics | | | | | | | | | | | | | |
| TX, LoCh | | | | | | | | | | | | | |
| Platform transceiver | | | | | | | | | | | | | |
| Battery | | | | | | | | | | | | | |
| Red=Hor Green=Vert | | | | | | | | | | | | | |
| Trace Markers | | | | | | | | | | | | | |
| Marker No. | Test Frequency (GHz) | Meter Reading (dBuV) | Detector | Antenna Facotr dB/m | Path Factor dB | Level dBuV/m | Peak Limit dBuVm | Margin (dB) | Average Limit dBuV/m | Margin (dB) | Azimuth [Degs] | Height [cm] | Polarity |
| 1 | 2.404 | 117.46 | Pk | 21.8 | -51.84 | 87.42 | - | - | - | - | 0-360 | 150 | H |
| 3 | 4.811 | 67.71 | Pk | 27.7 | -50.55 | 44.86 | 74 | -29.14 | 54 | -9.14 | 0-360 | 149 | H |
| 4 | 7.214 | 65.7 | Pk | 29.8 | -46.73 | 48.77 | 74 | -25.23 | 54 | -5.23 | 0-360 | 149 | H |
| 5 | 9.618 | 62.04 | Pk | 36.4 | -48.38 | 50.06 | 74 | -23.94 | 54 | -3.94 | 0-360 | 150 | H |
| 2 | 2.404 | 115.59 | Pk | 21.8 | -51.84 | 85.55 | - | - | - | - | 0-360 | 100 | V |
| 6 | 4.809 | 64.38 | Pk | 27.7 | -50.57 | 41.51 | 74 | -32.49 | 54 | -12.49 | 0-360 | 100 | V |
| 7 | 7.214 | 64.62 | Pk | 29.8 | -46.73 | 47.69 | 74 | -26.31 | 54 | -6.31 | 0-360 | 150 | V |
| Pk - Peak detector | | | | | | | | | | | | | |
| Radiated Emission Data | | | | | | | | | | | | | |
| | Test Frequency (GHz) | Meter Reading (dBuV) | Detector | Antenna Facotr dB/m | Path Factor dB | Level dBuV/m | Peak Limit dBuVm | Margin (dB) | Average Limit dBuV/m | Margin (dB) | Azimuth [Degs] | Height [cm] | Polarity |
| | 7.2135 | 68.29 | Pk | 29.8 | -46.73 | 51.36 | 74 | -22.64 | - | - | 216 | 158 | H |
| | 7.2134 | 65.79 | RMS AV | 29.8 | -46.72 | 48.87 | - | - | 54 | -5.13 | 216 | 158 | H |
| | 7.2133 | 66.63 | Pk | 29.8 | -46.72 | 49.71 | 74 | -24.29 | - | - | 172 | 100 | V |
| | 7.2133 | 63.82 | RMS AV | 29.8 | -46.72 | 46.9 | - | - | 54 | -7.1 | 172 | 100 | V |
| | 9.618 | 66.8 | Pk | 36.4 | -48.38 | 54.82 | 74 | -19.18 | - | - | 236 | 161 | H |
| | 9.6177 | 63.32 | RMS AV | 36.4 | -48.38 | 51.34 | - | - | 54 | -2.66 | 236 | 161 | H |
| | 9.6179 | 64.45 | Pk | 36.4 | -48.38 | 52.47 | 74 | -21.53 | - | - | 318 | 165 | V |
| | 9.6179 | 59.23 | RMS AV | 36.4 | -48.38 | 47.25 | - | - | 54 | -6.75 | 318 | 165 | V |
| Pk - Peak detector | | | | | | | | | | | | | |
| RMS AV - AVerage Detector | | | | | | | | | | | | | |

**Middle Channel, board alone, scan**

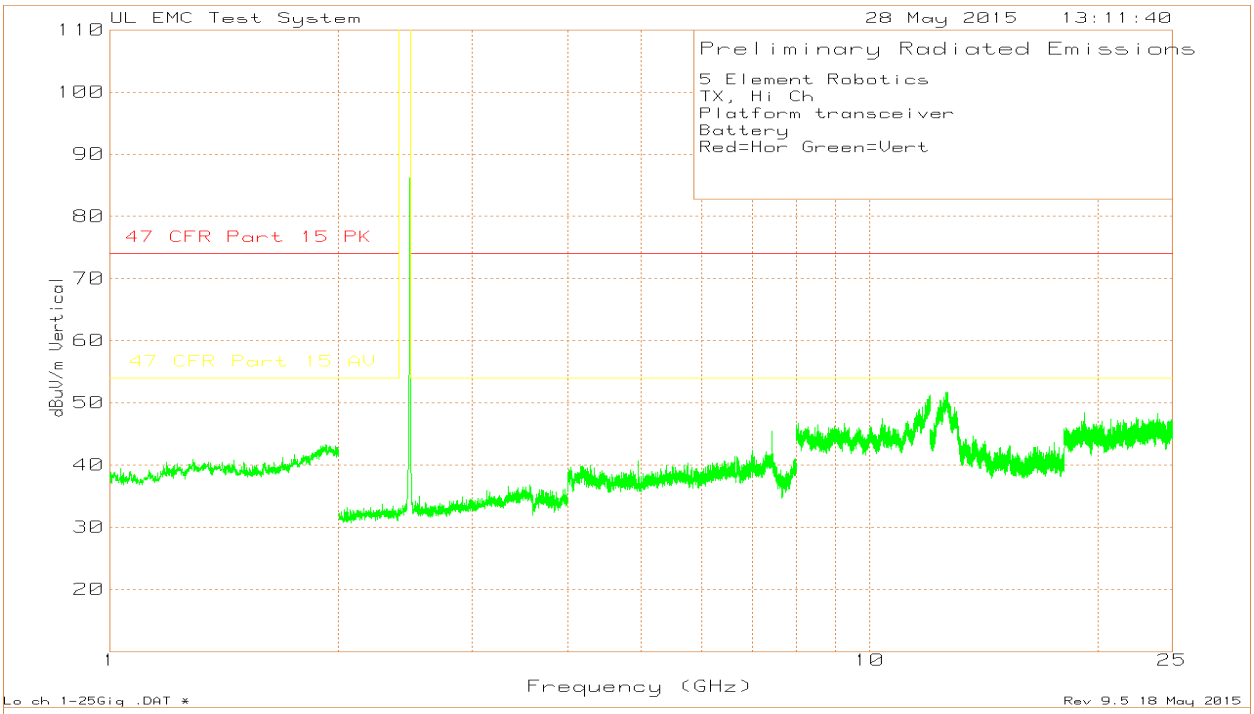


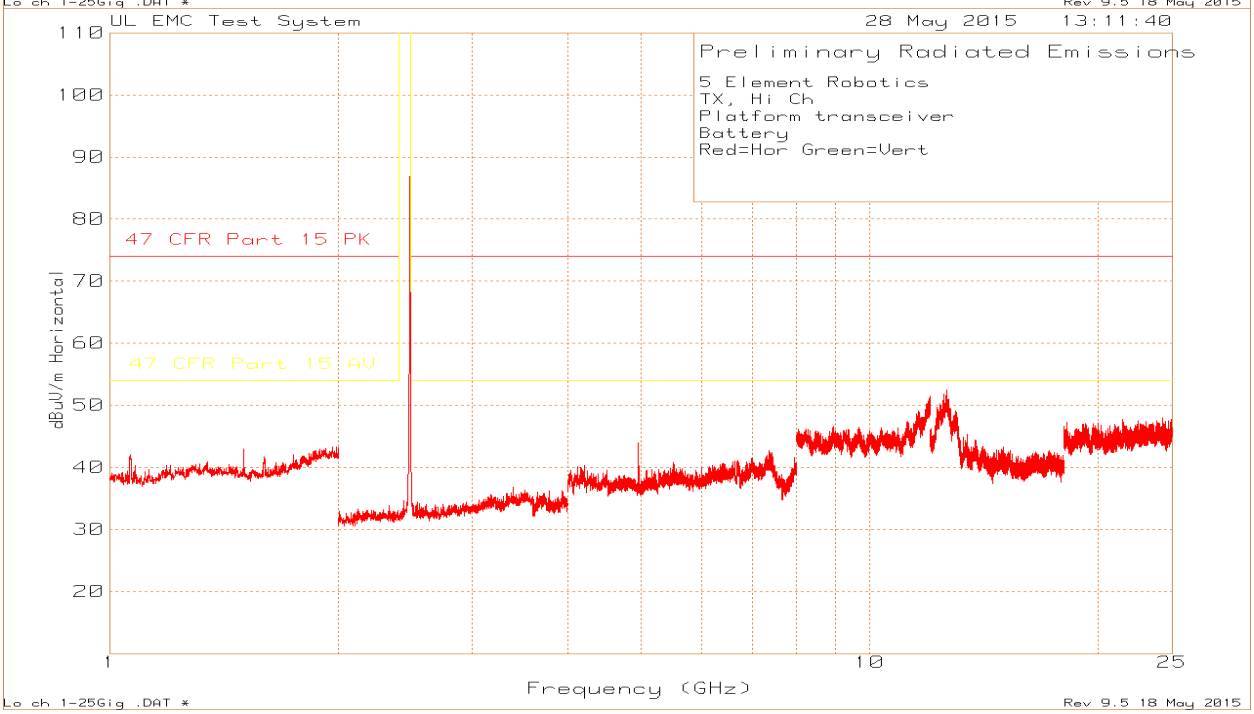



**Middle Channel, board alone, data**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 Element Robotics | | | | | | | | | | | | | |
| TX, Mid Ch | | | | | | | | | | | | | |
| Platform transceiver | | | | | | | | | | | | | |
| Battery | | | | | | | | | | | | | |
| Red=Hor Green=Vert | | | | | | | | | | | | | |
| Trace Markers | | | | | | | | | | | | | |
| Marker No. | Test Frequency (GHz) | Meter Reading (dBuV) | Detector | Antenna Facotr dB/m | Path Factor dB | Level dBuV/m | Peak Limit dBuVm | Margin (dB) | Average Limit dBuV/m | Margin (dB) | Azimuth [Degs] | Height [cm] | Polarity |
| 1 | 2.444 | 115.04 | Pk | 21.9 | -51.28 | 85.66 | - | - | - | - | 0-360 | 150 | H |
| 2 | 4.891 | 65.22 | Pk | 27.7 | -50.42 | 42.5 | 74 | -31.5 | 54 | -11.5 | 0-360 | 149 | H |
| 6 | 7.334 | 58.2 | Pk | 30.7 | -45.91 | 42.99 | 74 | -31.01 | 54 | -11.01 | 0-360 | 149 | H |
| 3 | 2.444 | 113.21 | Pk | 21.9 | -51.28 | 83.83 | - | - | - | - | 0-360 | 100 | V |
| 4 | 4.891 | 64.72 | Pk | 27.7 | -50.42 | 42 | 74 | -32 | 54 | -12 | 0-360 | 150 | V |
| 5 | 7.337 | 59.61 | Pk | 30.7 | -45.9 | 44.41 | 74 | -29.59 | 54 | -9.59 | 0-360 | 150 | V |
| Radiated Emission Data | | | | | | | | | | | | | |
| | Test Frequency (GHz) | Meter Reading (dBuV) | Detector | Antenna Facotr dB/m | Path Factor dB | Level dBuV/m | Peak Limit dBuVm | Margin (dB) | Average Limit dBuV/m | Margin (dB) | Azimuth [Degs] | Height [cm] | Polarity |
| | 7.3363 | 62.86 | Pk | 30.7 | -45.9 | 47.66 | 74 | -26.34 | - | - | 184 | 100 | V |
| | 7.3363 | 58.9 | RMS AV | 30.7 | -45.9 | 43.7 | - | - | 54 | -10.3 | 184 | 100 | V |
| | 7.3363 | 63.15 | Pk | 30.7 | -45.9 | 47.95 | 74 | -26.05 | - | - | 236 | 209 | H |
| | 7.3363 | 58.63 | RMS AV | 30.7 | -45.9 | 43.43 | - | - | 54 | -10.57 | 236 | 209 | H |
| Pk - Peak detector | | | | | | | | | | | | | |
| RMS AV - AVerage Detector | | | | | | | | | | | | | |

**High Channel, board alone, scan**

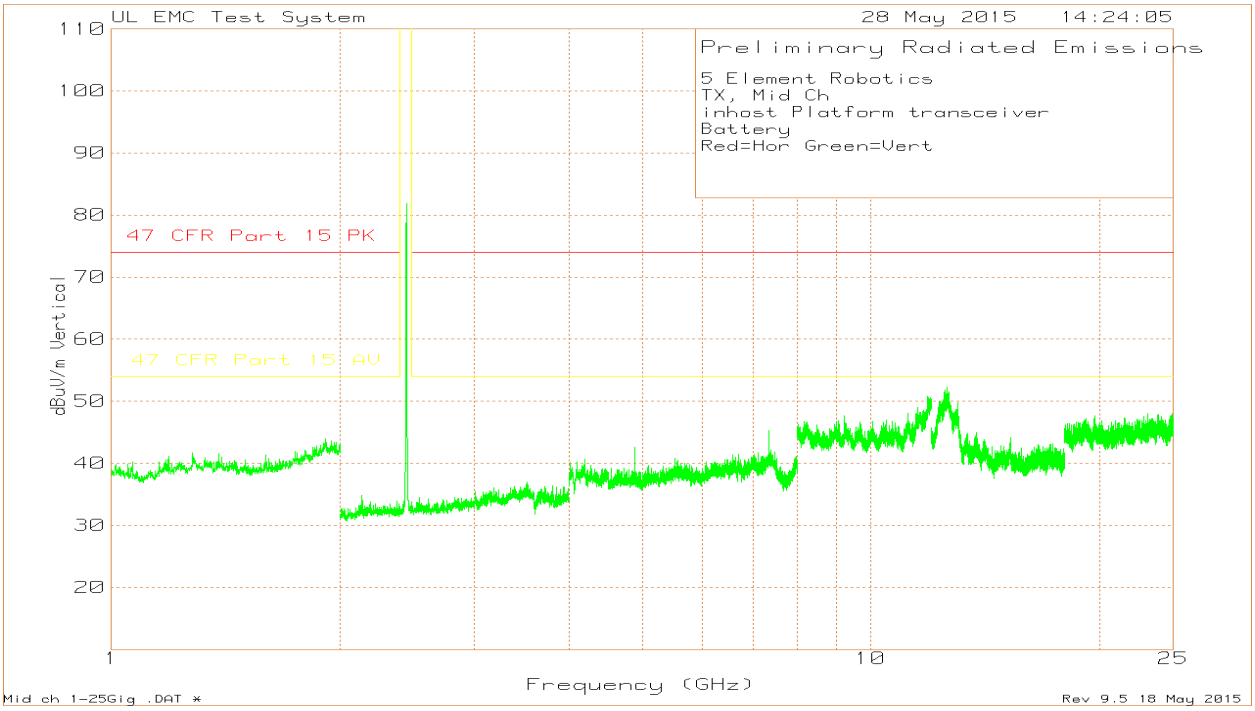


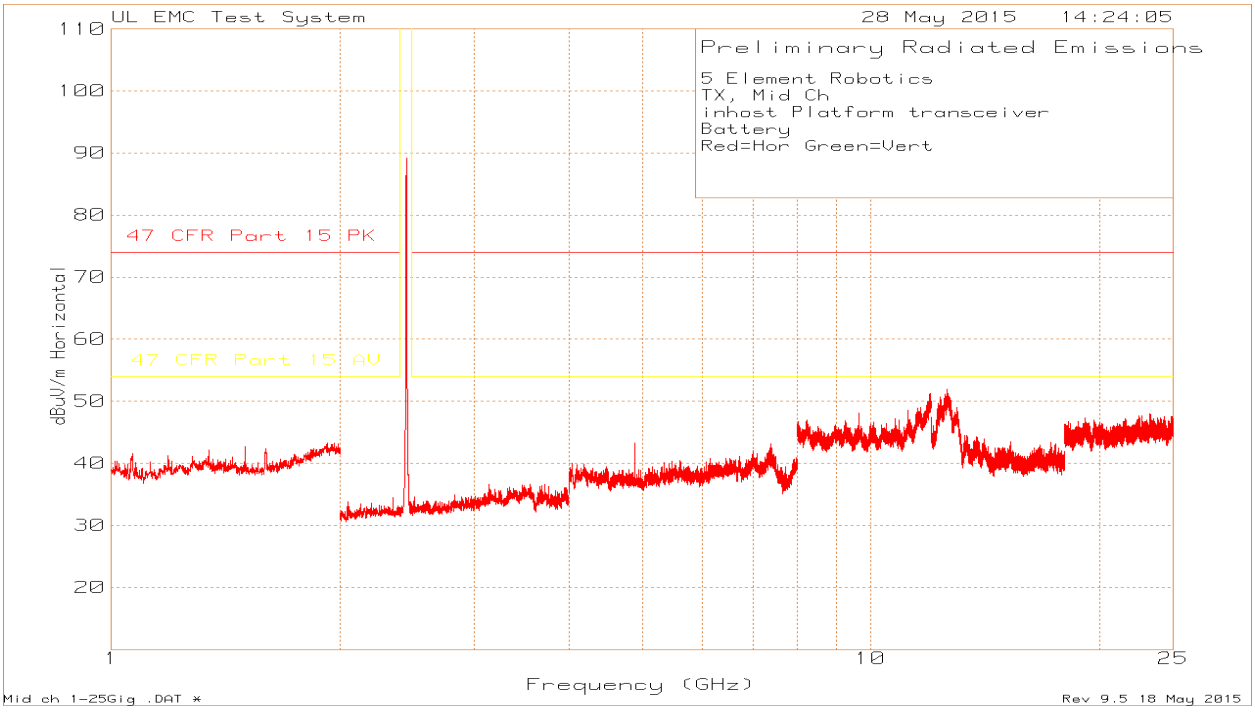



**High Channel, board alone, data**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 Element Robotics | | | | | | | | | | | | | |
| TX, Hi Ch | | | | | | | | | | | | | |
| Platform transceiver | | | | | | | | | | | | | |
| Battery | | | | | | | | | | | | | |
| Red=Hor Green=Vert | | | | | | | | | | | | | |
| Marker No. | Test Frequency (GHz) | Meter Reading (dBuV) | Detector | Antenna Facotr dB/m | Path Factor dB | Level dBuV/m | Peak Limit dBuVm | Margin (dB) | Average Limit dBuV/m | Margin (dB) | Azimuth [Degs] | Height [cm] | Polarity |
| 1 | 2.48 | 116.54 | Pk | 22 | -51.67 | 86.87 | - | - | - | - | 0-360 | 150 | H |
| 2 | 4.961 | 66.62 | Pk | 27.8 | -50.74 | 43.68 | 74 | -30.32 | 54 | -10.32 | 0-360 | 149 | H |
| 5 | 2.479 | 115.84 | Pk | 22 | -51.66 | 86.18 | - | - | - | - | 0-360 | 100 | V |
| 3 | 4.961 | 63.66 | Pk | 27.8 | -50.74 | 40.72 | 74 | -33.28 | 54 | -13.28 | 0-360 | 150 | V |
| 4 | 7.439 | 61.61 | Pk | 30.6 | -46.79 | 45.42 | 74 | -28.58 | 54 | -8.58 | 0-360 | 100 | V |
| Pk - Peak detector | | | | | | | | | | | | | |
| Radiated Emission Data | | | | | | | | | | | | | |
| | Test Frequency (GHz) | Meter Reading (dBuV) | Detector | Antenna Facotr dB/m | Path Factor dB | Level dBuV/m | Peak Limit dBuVm | Margin (dB) | Average Limit dBuV/m | Margin (dB) | Azimuth [Degs] | Height [cm] | Polarity |
| | 7.4381 | 63.78 | Pk | 30.6 | -46.76 | 47.62 | 74 | -26.38 | - | - | 184 | 100 | V |
| | 7.4383 | 60.42 | RMS AV | 30.6 | -46.77 | 44.25 | - | - | 54 | -9.75 | 184 | 100 | V |
| | 7.4381 | 63.02 | Pk | 30.6 | -46.76 | 46.86 | 74 | -27.14 | - | - | 224 | 230 | H |
| | 7.4385 | 58.43 | RMS AV | 30.6 | -46.77 | 42.26 | - | - | 54 | -11.74 | 224 | 230 | H |
| Pk - Peak detector | | | | | | | | | | | | | |
| RMS AV - AVerage Detector | | | | | | | | | | | | | |

**Middle Channel, board installed in host, scan**



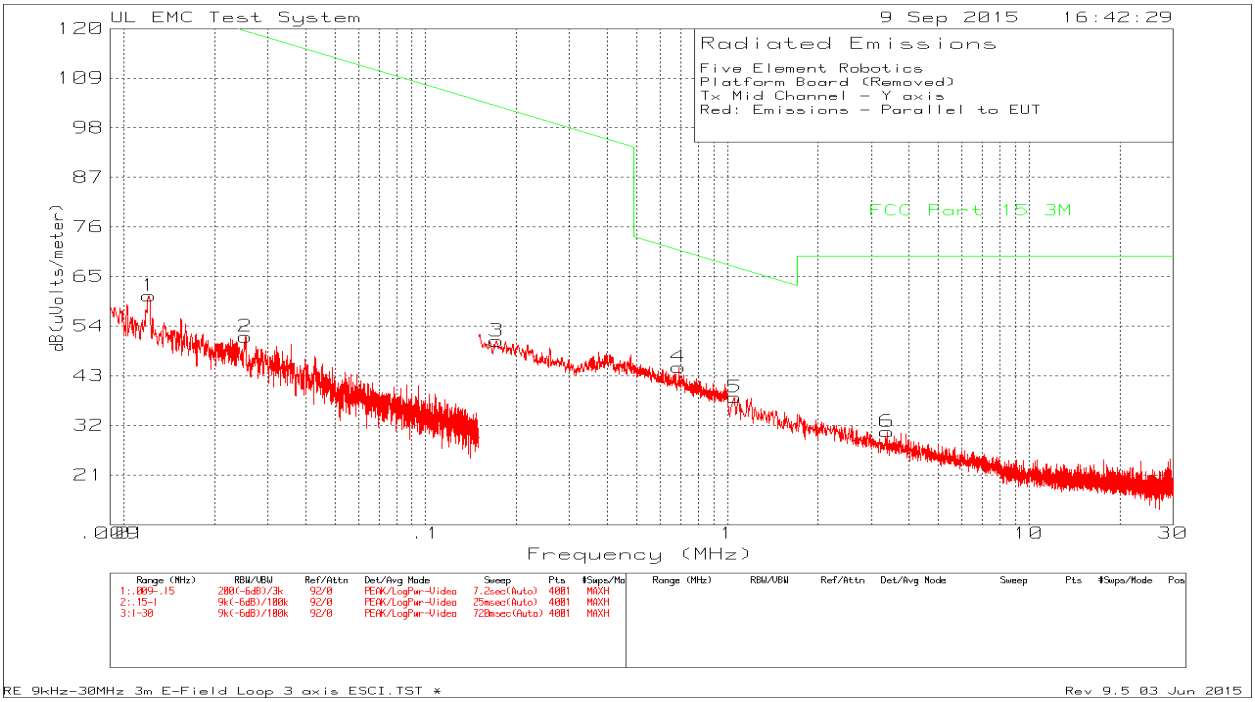



**Middle Channel, board installed in host, data**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 Element Robotics | | | | | | | | | | | | | |
| TX, Mid Ch | | | | | | | | | | | | | |
| inhost Platform transceiver | | | | | | | | | | | | | |
| Battery | | | | | | | | | | | | | |
| Red=Hor Green=Vert | | | | | | | | | | | | | |
| Trace Markers | | | | | | | | | | | | | |
| Marker No. | Test Frequency (GHz) | Meter Reading (dBuV) | Detector | Antenna Facotr dB/m | Path Factor dB | Level dBuV/m | Peak Limit dBuVm | Margin (dB) | Average Limit dBuV/m | Margin (dB) | Azimuth [Degs] | Height [cm] | Polarity |
| 1 | 2.444 | 118.52 | Pk | 21.9 | -51.28 | 89.14 | - | - | - | - | 0-360 | 100 | H |
| 3 | 4.889 | 66.02 | Pk | 27.7 | -50.42 | 43.3 | 74 | -30.7 | 54 | -10.7 | 0-360 | 101 | H |
| 2 | 2.445 | 111.21 | Pk | 21.9 | -51.28 | 81.83 | - | - | - | - | 0-360 | 100 | V |
| 4 | 4.891 | 65.28 | Pk | 27.7 | -50.42 | 42.56 | 74 | -31.44 | 54 | -11.44 | 0-360 | 150 | V |
| 5 | 7.334 | 60.55 | Pk | 30.7 | -45.91 | 45.34 | 74 | -28.66 | 54 | -8.66 | 0-360 | 150 | V |
| Pk - Peak detector | | | | | | | | | | | | | |

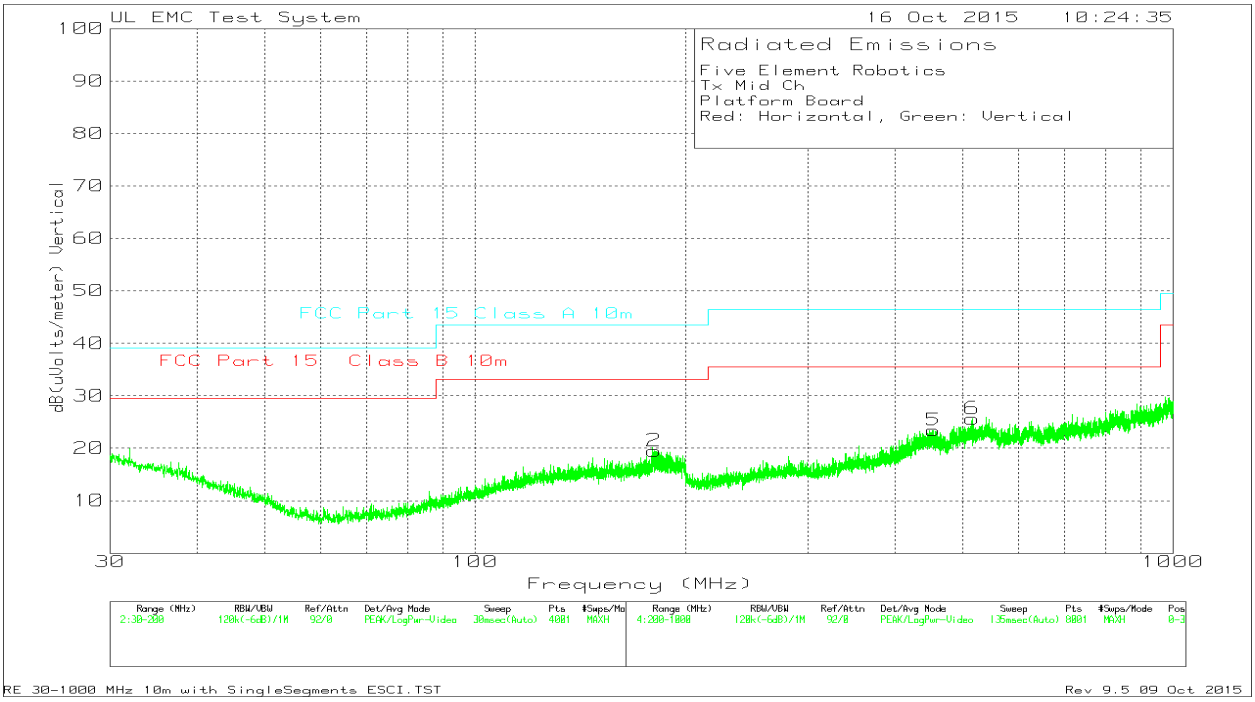
## 7.2.4. WORST-CASE BELOW 1 GHz

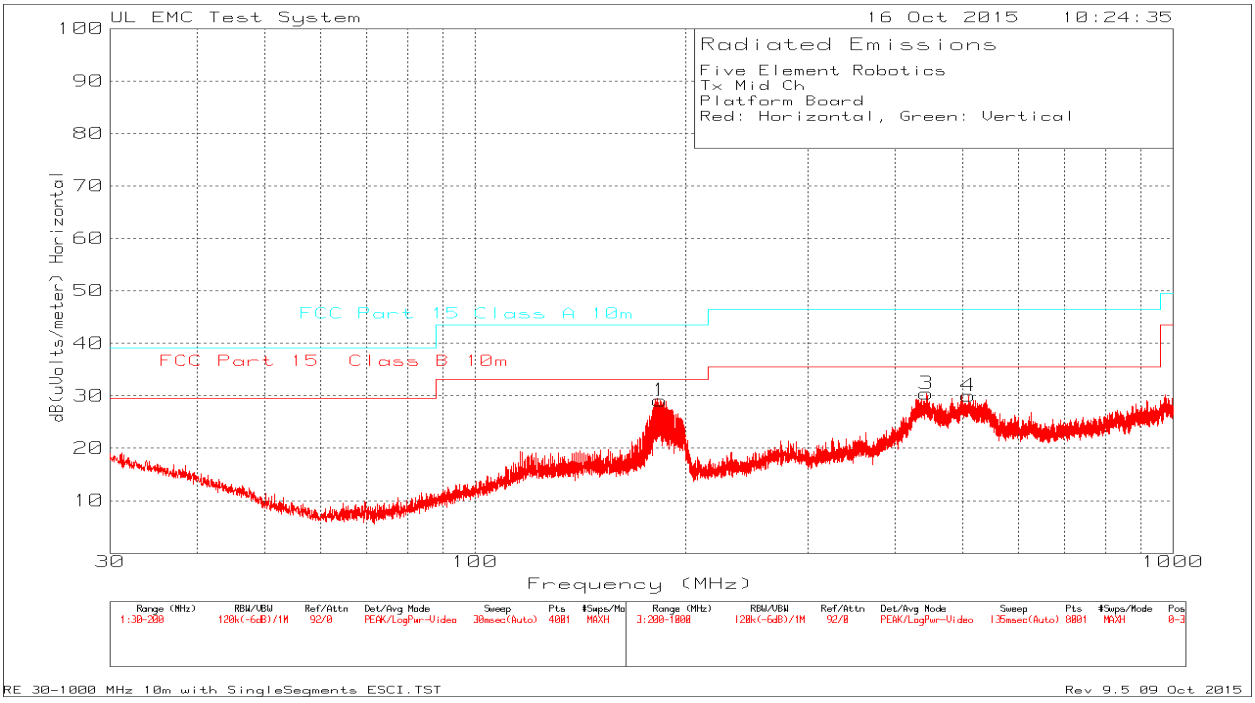
**9kHz – 30MHz**




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Five Element Robotics | | | | | | | | | |
| Platform Board (Removed) | | | | | | | | | |
| Tx Mid Channel - Y axis | | | | | | | | | |
| Red: Emissions - Parallel to EUT | | | | | | | | | |
| Trace Markers | | | | | | | | | |
| Marker No. | Test Frequency (MHz) | Meter Reading (dBuV) | Detector | Antenna Factor dB/m | Path Factor dB | Level dBuV/m | FCC Part 15 3M Limit dBuV/m | Margin (dB) | Azimuth [Degs] |
| 1 | 0.012115 | 40.54 | Pk | 20.2 | 0 | 60.74 | 125.92 | -65.18 | 0-360 |
| 2 | 0.02531 | 35.38 | Pk | 16.3 | 0 | 51.68 | 119.52 | -67.84 | 0-360 |
| 3 | 0.17215 | 38.61 | Pk | 12.1 | 0 | 50.71 | 102.88 | -52.17 | 0-360 |
| 4 | 0.69102 | 32.9 | Pk | 12 | 0 | 44.9 | 70.81 | -25.91 | 0-360 |
| 5 | 1.058 | 25.52 | Pk | 12.6 | 0.1 | 38.22 | 67.11 | -28.89 | 0-360 |
| 6 | 3.38525 | 18.5 | Pk | 12 | 0.1 | 30.6 | 69.54 | -38.94 | 0-360 |
| Pk - Peak detector | | | | | | | | | |

**30MHz – 1GHz**



| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Five Element Robotics | | | | | | | | | | | |
| Tx Mid Ch | | | | | | | | | | | |
| Platform Board | | | | | | | | | | | |
| Red: Horizontal, Green: Vertical | | | | | | | | | | | |
| Trace Markers | | | | | | | | | | | |
| Marker No. | Test Frequency (MHz) | Meter Reading (dBuV) | Detector | Antenna Factor dB/m | Path Factor dB | Level dBuV/m | Limit FCC Part 15 Class B 10m dBuV/m | Margin (dB) | Azimuth [Degs] | Height [cm] | Polarity |
| 1 | 184.1475 | 42.18 | Pk | 16.1 | -29.2 | 29.08 | 33.07 | -3.99 | 0-360 | 398 | H |
| 2 | 180.62 | 32.89 | Pk | 15.9 | -29.3 | 19.49 | 33.07 | -13.58 | 0-360 | 399 | V |
| 3 | 443.3 | 41.02 | Pk | 16.9 | -27.5 | 30.42 | 35.57 | -5.15 | 0-360 | 199 | H |
| 4 | 509.3 | 39.12 | Pk | 17.9 | -27 | 30.02 | 35.57 | -5.55 | 0-360 | 199 | H |
| 5 | 453.7 | 33.73 | Pk | 17.1 | -27.4 | 23.43 | 35.57 | -12.14 | 0-360 | 199 | V |
| 6 | 516.1 | 34.83 | Pk | 18.1 | -27.3 | 25.63 | 35.57 | -9.94 | 0-360 | 103 | V |
| Pk - Peak detector | | | | | | | | | | | |
| Radiated Emission Data | | | | | | | | | | | |
| | Test Frequency (MHz) | Meter Reading (dBuV) | Detector | Antenna Factor dB/m | Path Factor dB | Level dBuV/m | Limit FCC Part 15 Class B 10m dBuV/m | Margin (dB) | Azimuth [Degs] | Height [cm] | Polarity |
| | 182.2655 | 41.87 | Qp | 16 | -29.3 | 28.57 | 33.07 | -4.5 | 66 | 342 | H |
| | 443.08216 | 37.54 | Qp | 16.9 | -27.5 | 26.94 | 35.57 | -8.63 | 37 | 218 | H |
| | 507.37863 | 36.87 | Qp | 17.7 | -27.2 | 27.37 | 35.57 | -8.2 | 342 | 171 | H |
| Qp - Quasi-Peak detector | | | | | | | | | | | |