

# FCC Part 15.247 RF TEST REPORT



|                           |                                                                                                                    |
|---------------------------|--------------------------------------------------------------------------------------------------------------------|
| Test Report Number.....   | PFE-18100201-LC-FCC-RF-LEAP Rev1.1                                                                                 |
| Applicant.....            | <b>Phase IV Engineering</b><br> |
| Applicant Address.....    | 2820 Wilderness Place Suite C, Boulder, CO 80301                                                                   |
| Product Name.....         | Leap 2.4GHz RF Module                                                                                              |
| Model Number.....         | 44-100312-00, 44-100312-01                                                                                         |
| FCC ID.....               | N4TLEAP1000                                                                                                        |
| Date of EUT received..... | 10/18/2018                                                                                                         |
| Date of Test.....         | 10/18/2018-11/14/2018                                                                                              |
| Report Issue Date.....    | 11/20/2018                                                                                                         |
| Test Standards.....       | 47CFR Part 15.247: 2018                                                                                            |

Issued By:

## Vista Laboratories

1261 Puerta Del Sol, San Clemente, CA 92673 USA

[www.vista-compliance.com](http://www.vista-compliance.com)

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Tested by:



Sherwin Lee/Test Engineer

Approved By:



David Zhang/Technical Manager

|                       |                                    |
|-----------------------|------------------------------------|
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| <b>Product:</b>       | Leap 2.4GHz RF Module              |
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## Laboratory Introduction

Vista Labs is an A2LA accredited 17025 compliant regulatory compliance testing laboratories (Cert. number: 4848-01) strategically located in Orange County, providing services in the electrical and telecommunication industries. Vista labs is also recognized testing facility for Australia (ACMA), Chinese Taipei (BSMI), Chinese Taipei (NCC), Hong Kong (OFCA), Israel (MOC), Korea (RRA), Singapore (IMDA), Vietnam (MIC), etc.

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As your partner, Vista investigates appropriate test standards, develops test plans, performs troubleshooting & failure analysis, reviews documentation, and provides test reports for a complete compliance testing and certification package.



### 17025 Product Testing Accreditation Certificate

|                       |                                    |
|-----------------------|------------------------------------|
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## REVISION HISTORY

| Revision | Issue Date | Description                                                      | Note |
|----------|------------|------------------------------------------------------------------|------|
| Original | 11/06/2018 | Original release                                                 | N/A  |
| Rev1.0   | 11/14/2018 | Add below 30MHz test data and update equipment information, etc. | N/A  |
| Rev1.1   | 11/20/2018 | Update EUT information and procedure description                 | N/A  |
|          |            |                                                                  |      |
|          |            |                                                                  |      |

|                       |                                    |
|-----------------------|------------------------------------|
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## 1 General Information

### 1.1 Applicant

|                              |                                                  |
|------------------------------|--------------------------------------------------|
| <b>Applicant:</b>            | Phase IV Engineering                             |
| <b>Applicant address:</b>    | 2820 Wilderness Place Suite C, Boulder, CO 80301 |
| <b>Manufacturer:</b>         | Phase IV Engineering                             |
| <b>Manufacturer Address:</b> | 2820 Wilderness Place Suite C, Boulder, CO 80301 |

### 1.2 Product information

|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Product Name</b>              | LEAP 2.4GHz RF Module                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Model Number</b>              | On-board antenna version model: 44-100312-00<br>Off-board antenna version model: 44-100312-01                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Serial Number</b>             | N/A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Frequency Band</b>            | 2405-2470MHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Type of modulation</b>        | DSSS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Equipment Class/ Category</b> | DTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Maximum output power</b>      | 18.532 dBm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Antenna Information</b>       | Internal PIFA Antenna (Amotech #AMAN301512ST01), Gain: 3.4 dBi<br>Folded Dipole Long (#ANT-2.4-CW-HW), Gain: 3.2 dBi<br>Folded Dipole Short (#W24-RSMA-M), Gain: 2.15 dBi<br>Monopole (#HG2407RD-RSP), Gain: 7 dBi<br>Yagi (#HG2412SY-NF), Gain: 12 dBi                                                                                                                                                                                                                                                                                                                                    |
| <b>Clock Frequencies</b>         | N/A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Port/Connectors</b>           | U.FL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Input Power</b>               | 3.3 VDC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Power Adapter Manu/Model</b>  | N/A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Power Adapter SN</b>          | N/A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Hardware version</b>          | Rev2.3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Software version</b>          | N/A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Simultaneous Transmission</b> | N/A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Additional Info</b>           | <p>This radio module has two hardware version, one with on-board chip antenna and the other one with off-board external antennas. 4 different external antennas were tested.</p> <p>On-board antenna version is with C20, L3 and L4 populated which serve as impedance matching, RF path selection and filtering purpose; these components are not required for Off-board antenna version thus being removed.</p> <p>An FCC inquiry (Tracking Number 923500) was sent to FCC and response was received to confirm that both hardware version can be certified with an original filing.</p> |

|                       |                                    |
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### 1.3 Power level setting

| Antenna               | Channel | Frequency (MHz) | Power Level Setting |
|-----------------------|---------|-----------------|---------------------|
| Internal PIFA Antenna | 1-24    | 2405-2470       | 20                  |
| Folded Dipole Long    | 1-24    | 2405-2470       | 20                  |
| Folded Dipole Short   | 1-24    | 2405-2470       | 20                  |
| Monopole              | 1-24    | 2405-2470       | 20                  |
| Yagi                  | 1-23    | 2405-2465       | 20                  |
| Yagi                  | 24      | 2470            | 15                  |

Note: Power level setting for Yagi antenna at 2470MHz is 15 only in order to meet FCC restricted band edge requirement. Applicant shall ensure the correct setting is used by end user.

### 1.4 Test standard and method

|                      |                                                          |
|----------------------|----------------------------------------------------------|
| <b>Test standard</b> | 47CFR Part 15.247: 2018                                  |
| <b>Test method</b>   | ANSI C63.10: 2013<br>558074 D01 15.247 Meas Guidance v05 |

### 1.5 Test purpose and statement

The purpose of this test report is intended to demonstrate the compliance of product listed in section 1.2, received from company listed in section 1.1, to the requirements of standard and method listed in section 1.3. Based on our test results, we conclude that the product tested complies with the requirements of the standards indicated.

|                       |                                    |
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## 2 Test site information

|                             |                                                 |
|-----------------------------|-------------------------------------------------|
| <b>Lab performing tests</b> | <b>Vista Laboratories</b>                       |
| <b>Lab Address</b>          | 1261 Puerta Del Sol, San Clemente, CA 92673 USA |
| <b>Phone Number</b>         | +1 (949) 393-1123                               |
| <b>Website</b>              | www.vista-compliance.com                        |

| Test condition | Test Engineer | Test Environment        | Test Date               |
|----------------|---------------|-------------------------|-------------------------|
| RF conducted   | Sherwin Lee   | 23.5°C / 58.2%/996 mbar | 10/18/2018 – 10/26/2018 |
| Radiated       | Sherwin Lee   | 23.5°C / 58.2%/996 mbar | 10/18/2018 – 11/14/2018 |

## 3 Modification of EUT

For RF conducted measurement purposes, the internal antenna port of the test sample was removed and replaced with an external SMA connector; the external antenna port was unmodified because it has a direct port to connect to. A short serial wire cable was soldered onto the PCB for sending commands from the laptop to the EUT to enable RF testing mode; the special test firmware is used for testing purpose.

For radiated measurement, a short serial wire cable was soldered onto the PCB for sending commands from the laptop to EUT to enable RF test mode; the special test firmware is used for testing purpose. No other physical modification was made.

## 4 Test configuration and operation

### 4.1 EUT test configuration

The EUT is powered by a 3.3 VDC power supply. It is connected to a test laptop through a serial cable and receives test commands for RF measurement. Radio test software is used to send commands to EUT to enable the RF test mode.

### 4.2 EUT test mode

| Radio               | Channel   | Data Rates | Frequency (MHz) |
|---------------------|-----------|------------|-----------------|
| 2.4 GHz Transceiver | 1 (Low)   | 250 kbps   | 2405            |
| 2.4 GHz Transceiver | 18 (Mid)  | 250 kbps   | 2440            |
| 2.4 GHz Transceiver | 24 (High) | 250 kbps   | 2470            |

|                       |                                    |
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### 4.3 Supporting Equipment

| Index | Description     | Model   | S/N           | Brand | Remark |
|-------|-----------------|---------|---------------|-------|--------|
| 1     | Laptop          | P29G003 | G1H5102       | Dell  | N/A    |
| 2     | DC Power Supply | DP712   | DP7B194900487 | RIGOL | N/A    |
|       |                 |         |               |       |        |
|       |                 |         |               |       |        |
|       |                 |         |               |       |        |

### 4.4 EUT setup diagram



### 4.5 EUT operation

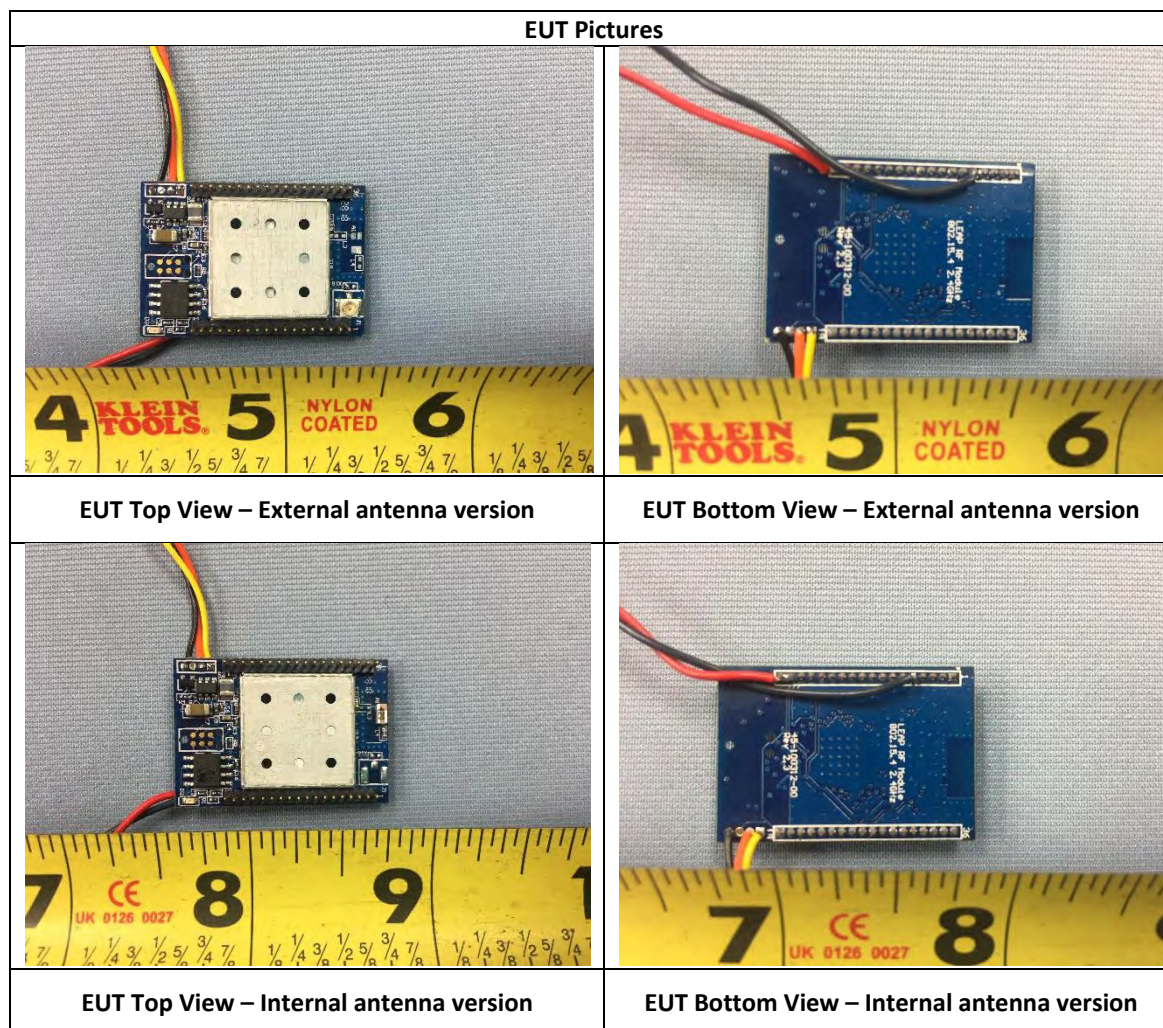
Radio test software is used to send command to EUT to enable the RF test mode.

### 4.6 Test software

| Index | Description           | Remark                                                                      |
|-------|-----------------------|-----------------------------------------------------------------------------|
| 1     | RadioTest.exe         | Serial utility software to send command to device for running RF test mode. |
| 2     | EMISoft Vasona 6.0049 | EMC/Spurious emission test software used during testing                     |
|       |                       |                                                                             |
|       |                       |                                                                             |

## 5 EUT and test setup pictures

### 5.1 EUT pictures

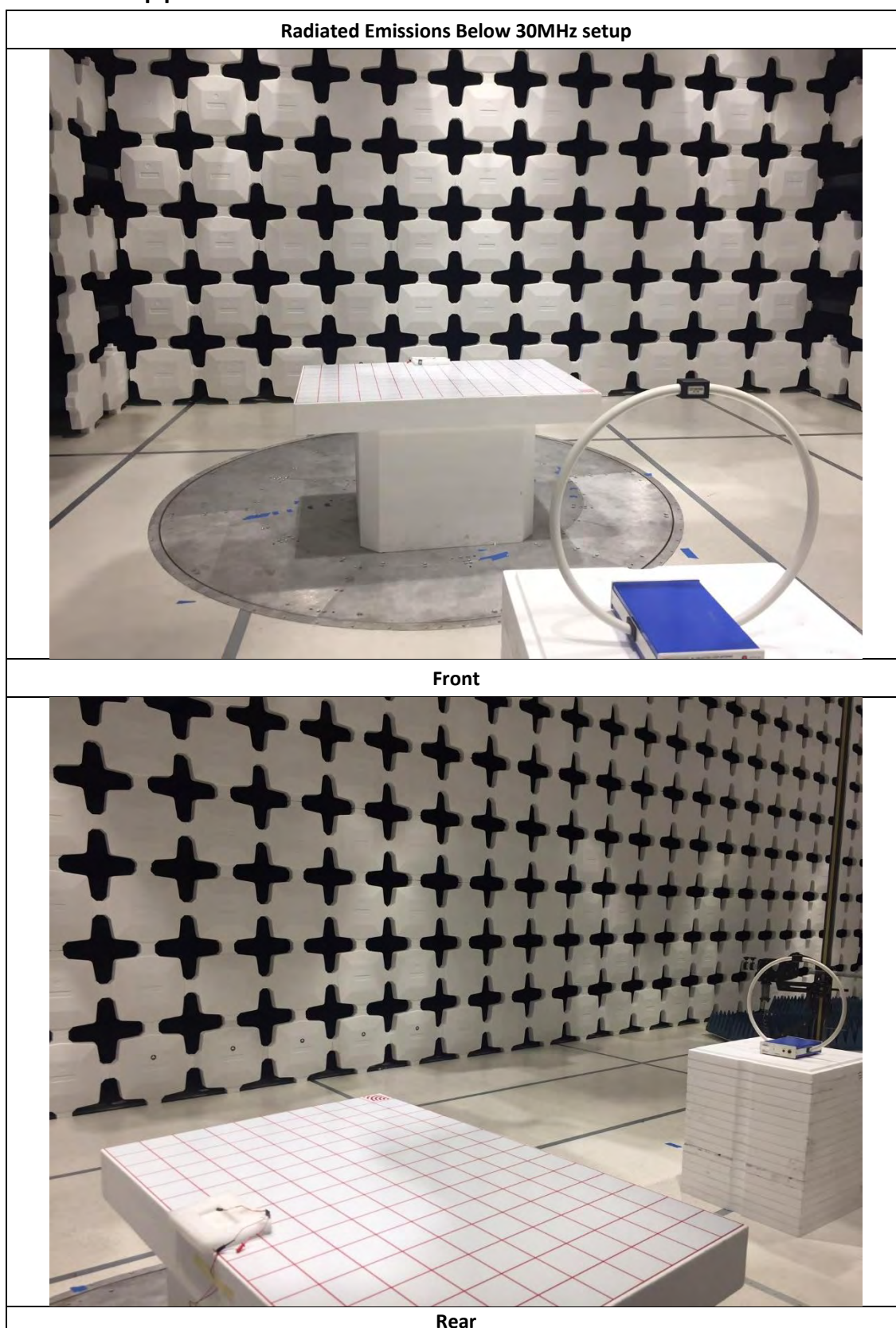


|                       |                                    |
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| External Antenna                             |                                              |
|----------------------------------------------|----------------------------------------------|
|                                              |                                              |
| Yagi antenna (with U.FL connector)           | Monopole antenna (with RP-SMA connector)     |
|                                              |                                              |
| Folded Dipole, Long (with RP-SMA connector)  | Folded Dipole, Short (with RP-SMA connector) |
|                                              |                                              |
| RF coupling cable (RP-SMA connector) - Front | RF coupling cable (RP-SMA connector) - Top   |

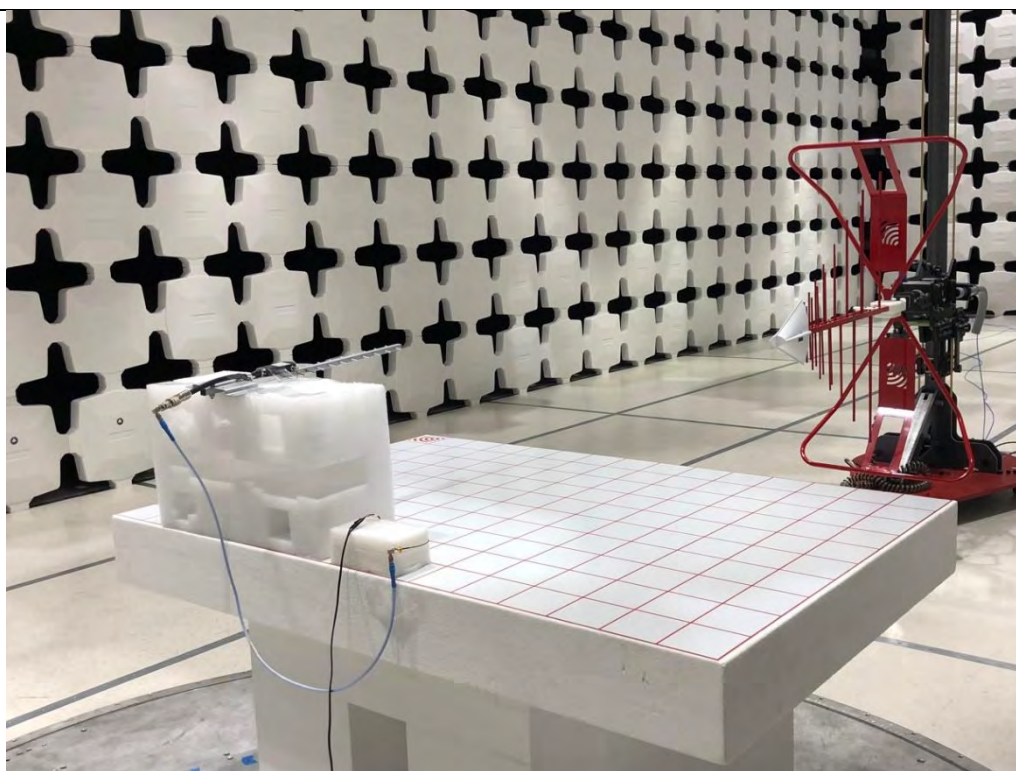
## 5.2 EUT test setup pictures



**Radiated Emissions Below 1GHz setup (Yagi antenna)**



**Front**



**Rear**

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**Product:** Leap 2.4GHz RF Module

**Model Number:** 44-100312-00, 44-100312-01

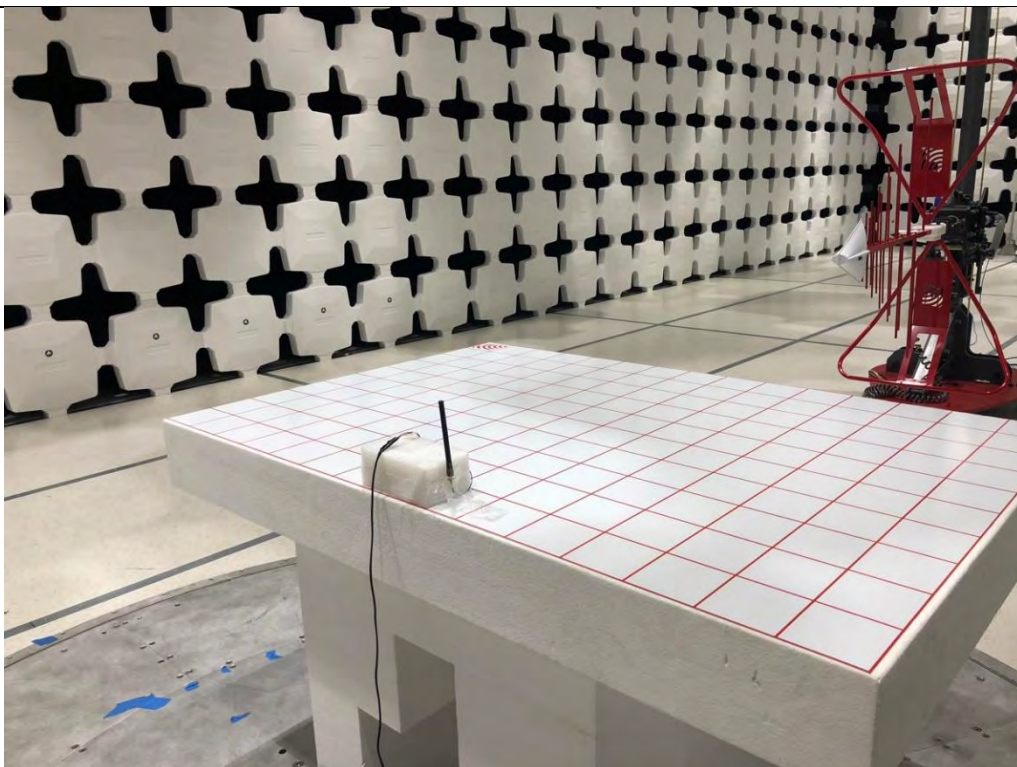


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**Radiated Emissions Below 1GHz setup (monopole antenna)**



**Front**



**Rear**

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**Product:** Leap 2.4GHz RF Module

**Model Number:** 44-100312-00, 44-100312-01

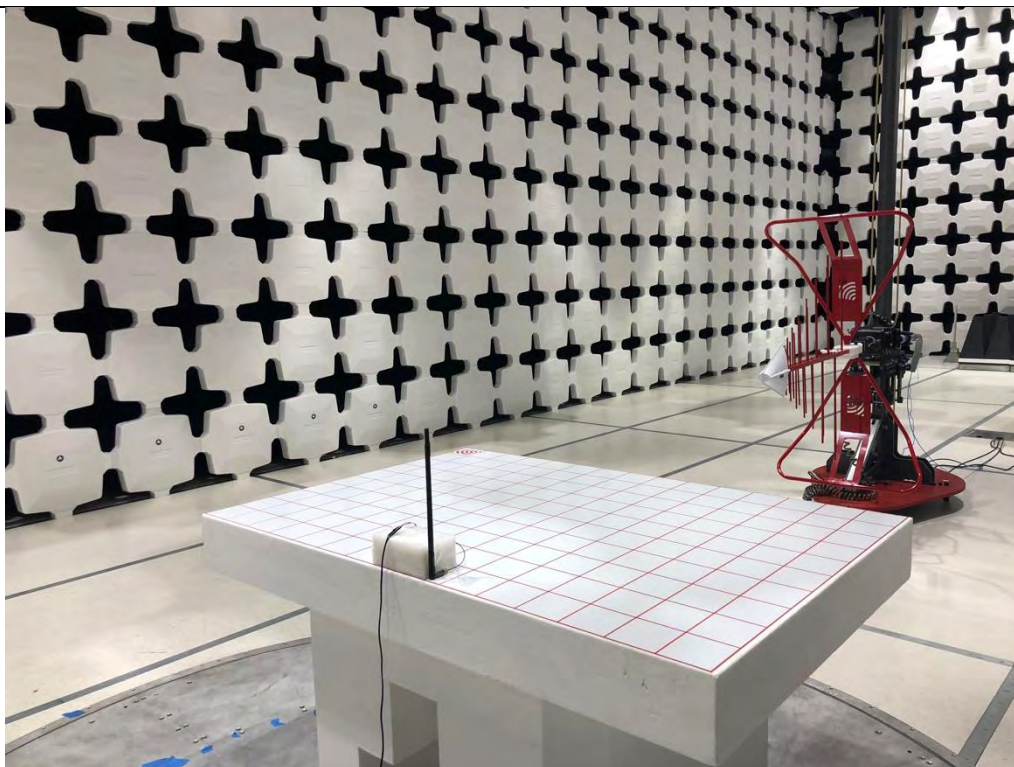


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**Radiated Emissions Below 1GHz setup (folded dipole antenna, long)**



**Front**



**Rear**

**Report Number:** PFE-18100201-LC-FCC-RF-LEAP Rev1.1

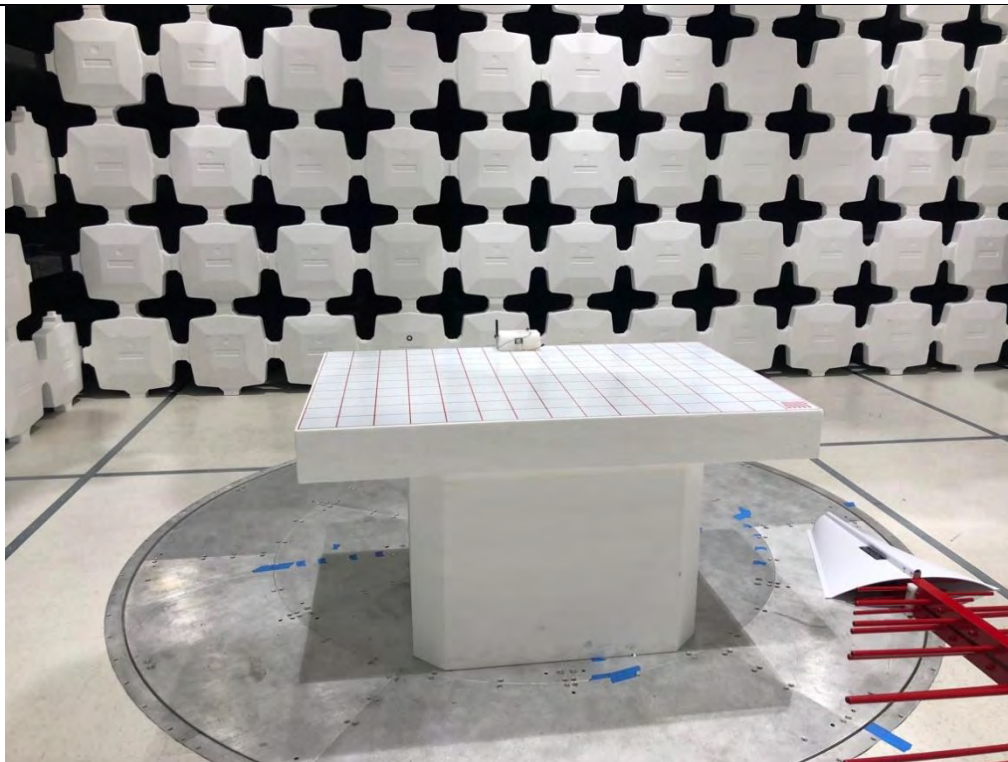
**Product:** Leap 2.4GHz RF Module

**Model Number:** 44-100312-00, 44-100312-01

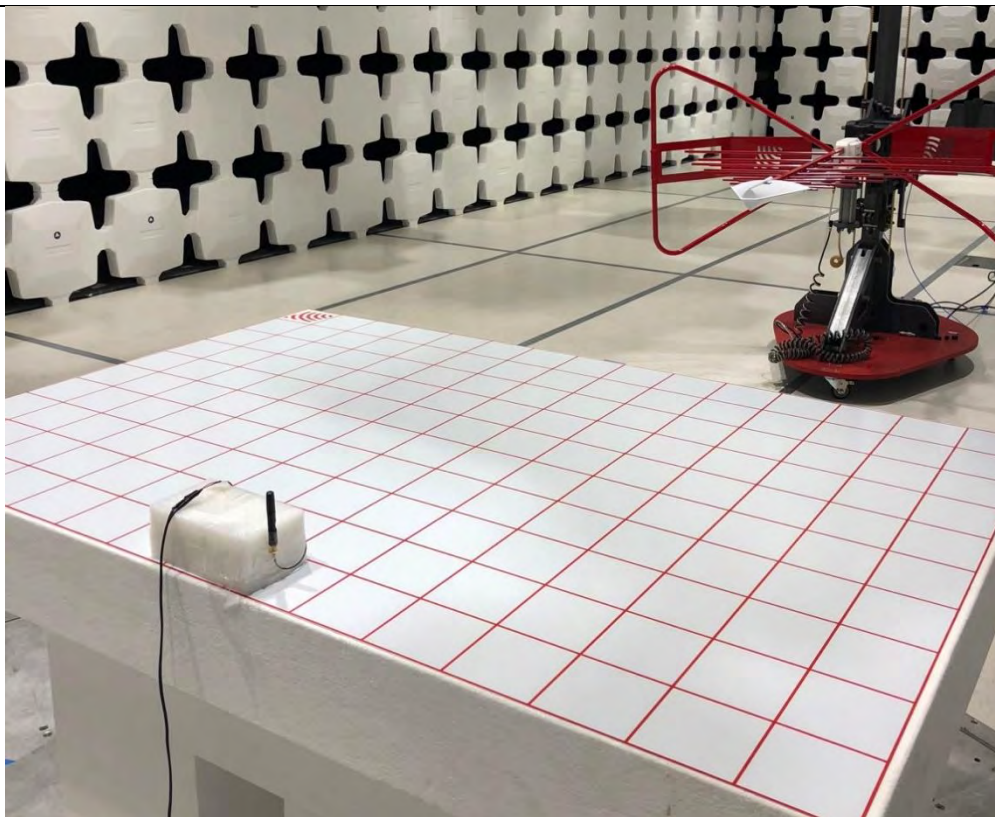


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**Radiated Emissions Below 1GHz setup (folded dipole antenna, short)**



**Front**



**Rear**

**Report Number:** PFE-18100201-LC-FCC-RF-LEAP Rev1.1

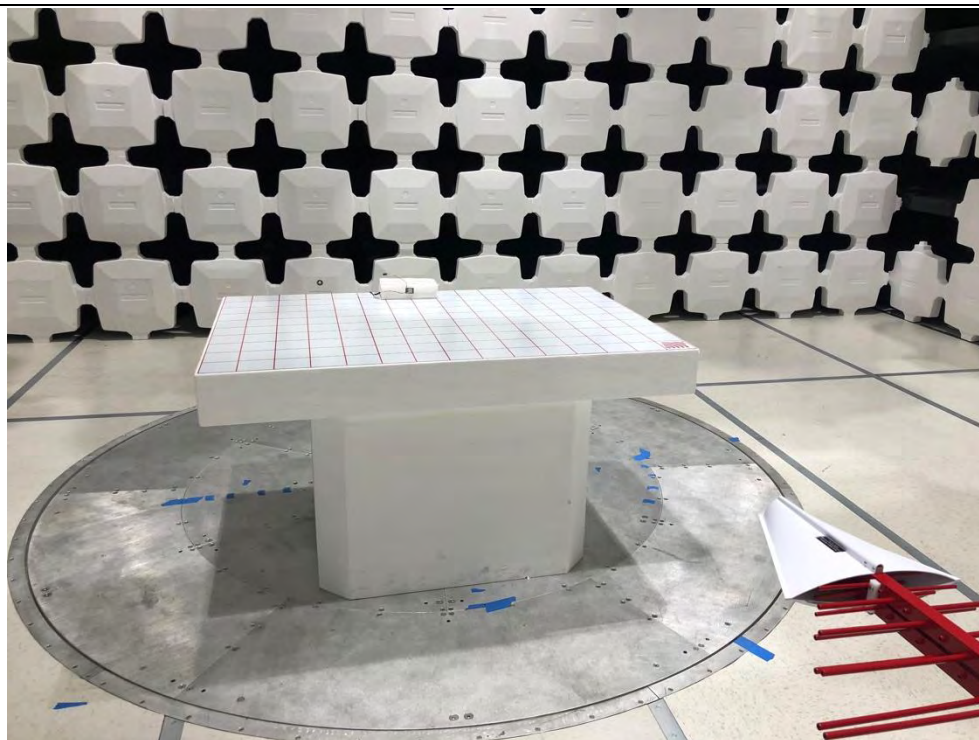
**Product:** Leap 2.4GHz RF Module

**Model Number:** 44-100312-00, 44-100312-01

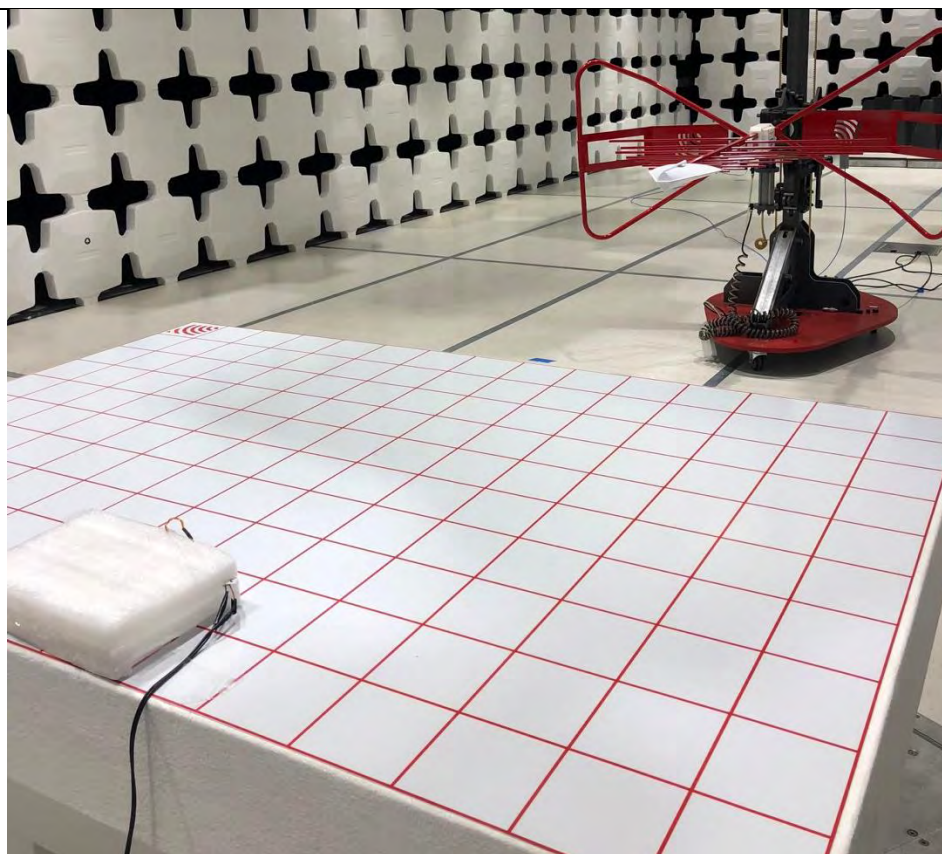


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**Radiated Emissions Below 1GHz setup (internal antenna)**

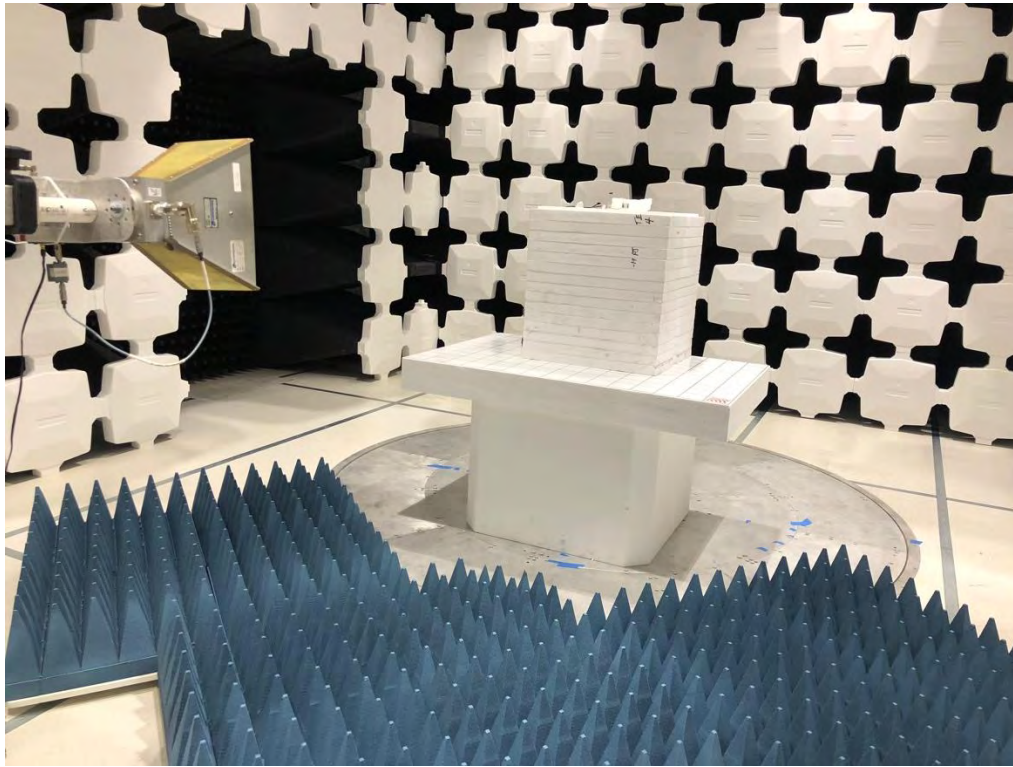


**Front**

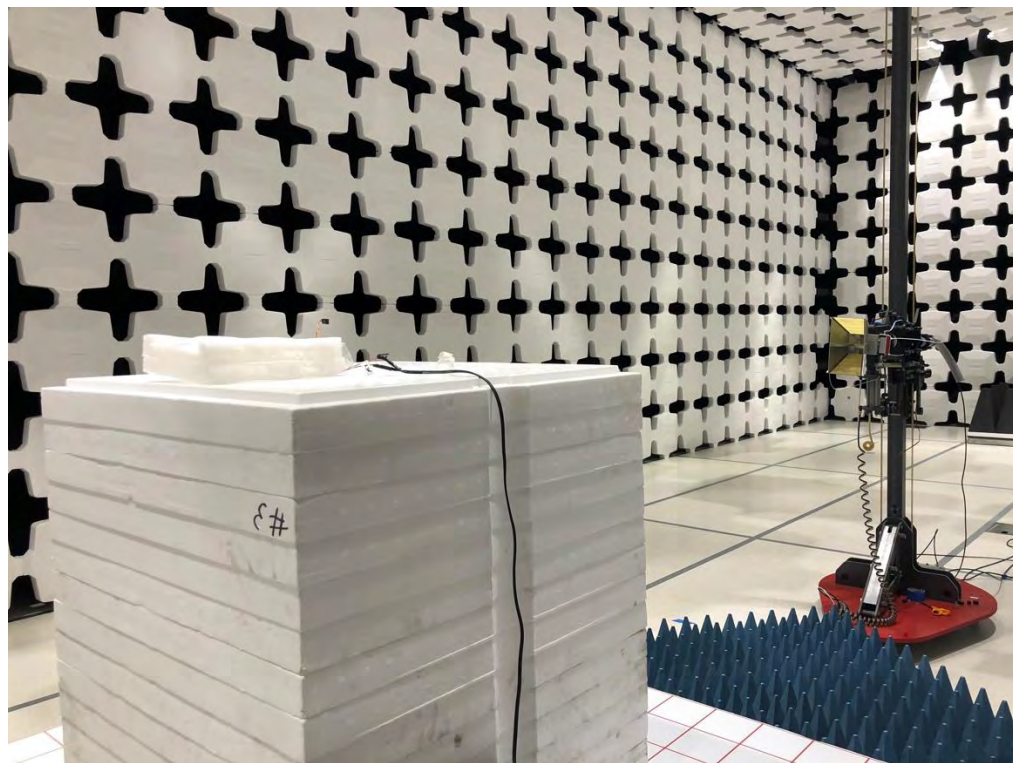


**Rear**

**Radiated Emissions Above 1GHz setup (internal antenna)**



**Front**



**Rear**

**Report Number:** PFE-18100201-LC-FCC-RF-LEAP Rev1.1

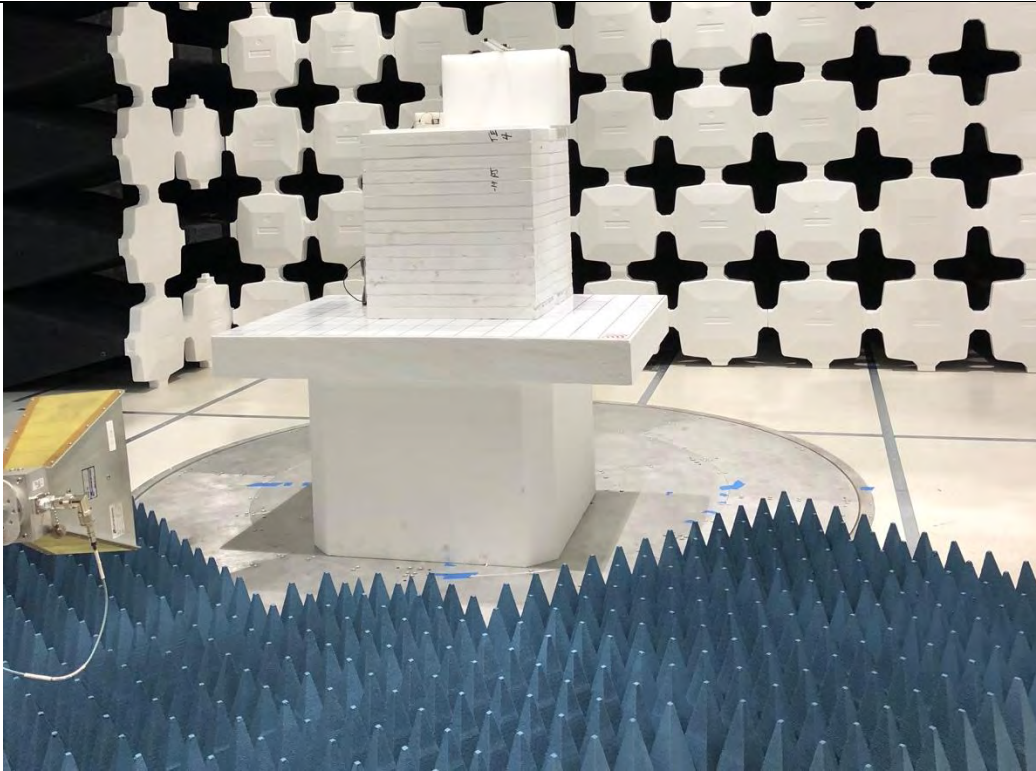
**Product:** Leap 2.4GHz RF Module

**Model Number:** 44-100312-00, 44-100312-01

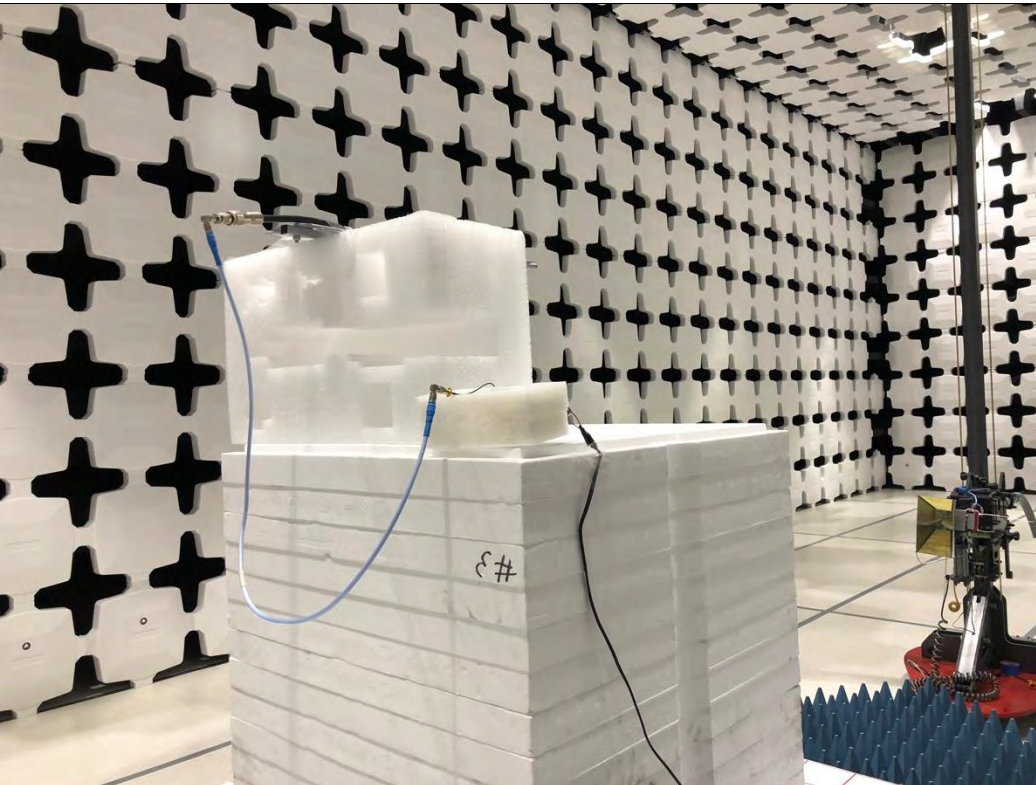


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**Radiated Emissions Above 1GHz setup (Yagi antenna)**



**Front**



**Rear**

**Report Number:** PFE-18100201-LC-FCC-RF-LEAP Rev1.1

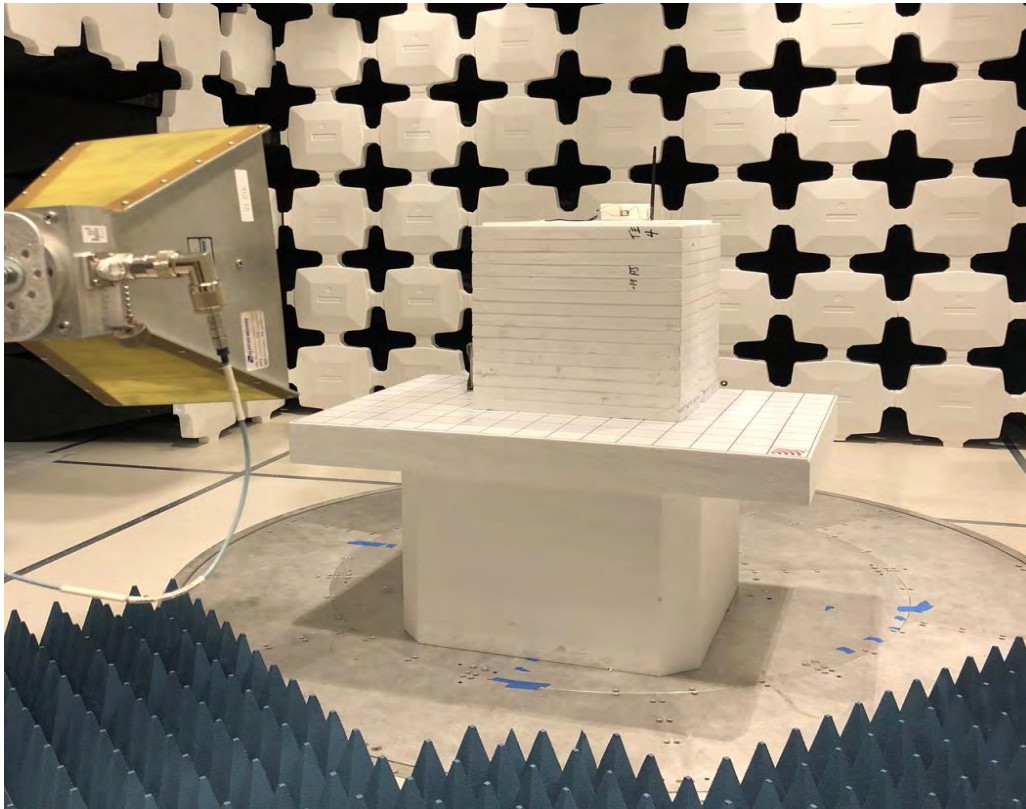
**Product:** Leap 2.4GHz RF Module

**Model Number:** 44-100312-00, 44-100312-01

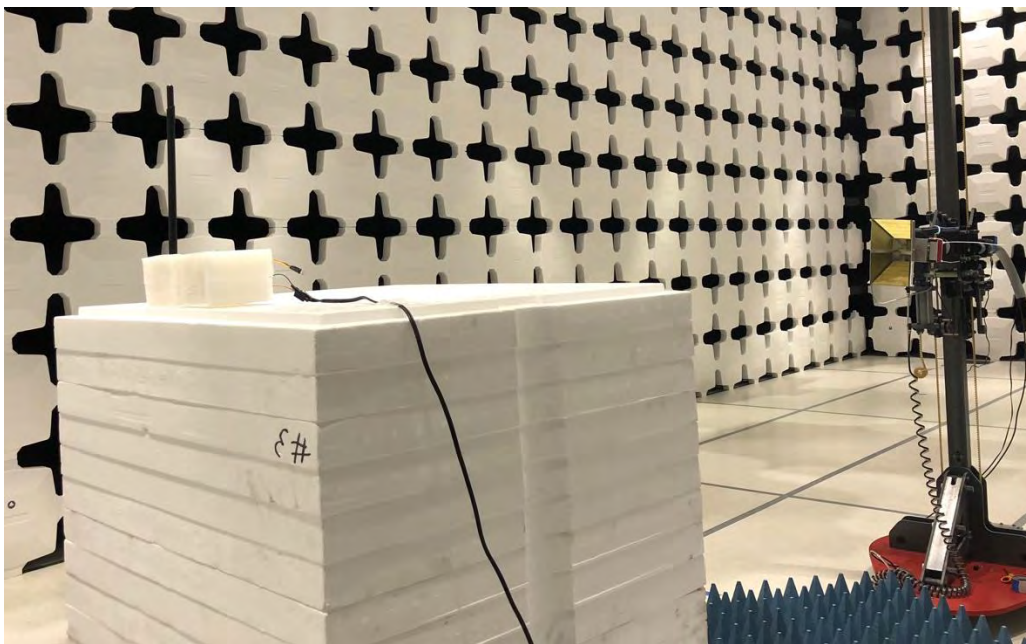


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**Radiated Emissions Above 1GHz setup (folded dipole, long)**

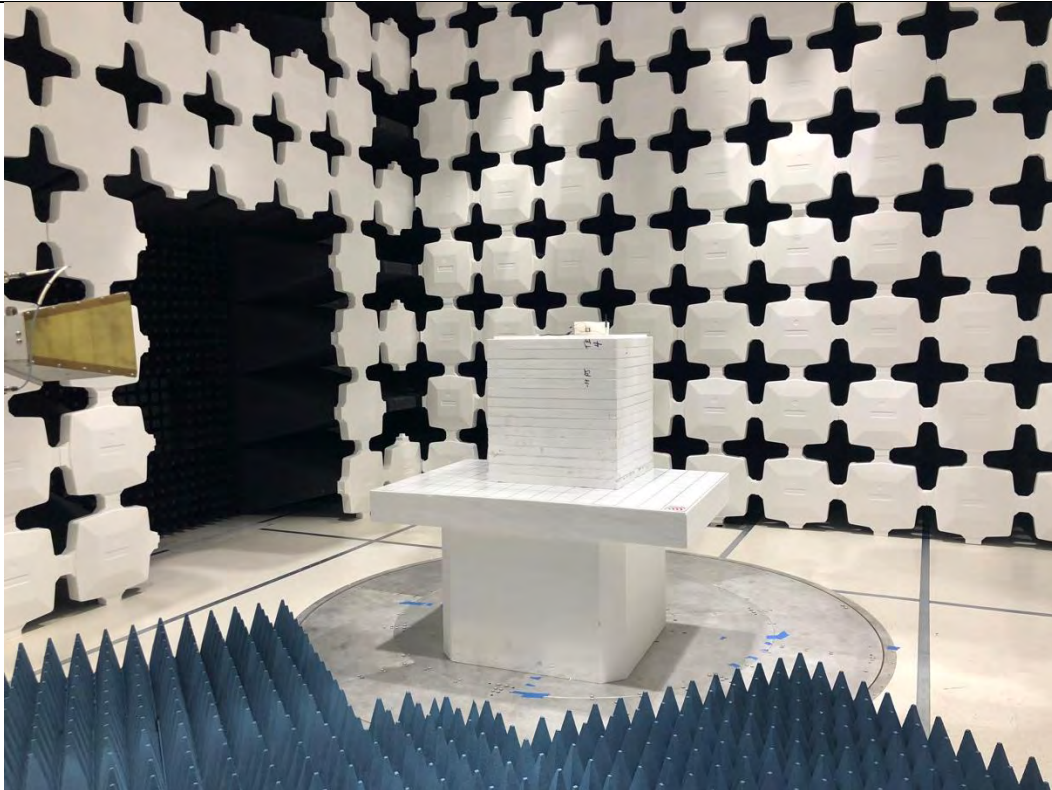


**Front**

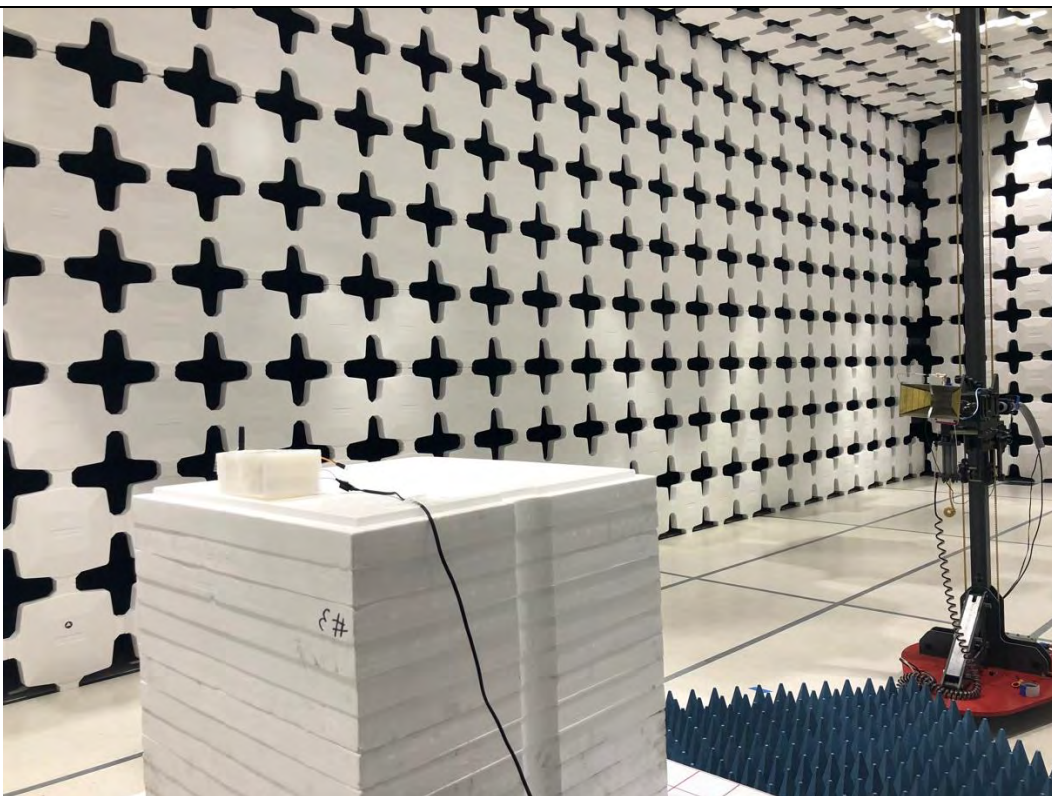


**Rear**

Radiated Emissions Above 1GHz setup (folded dipole, short)



Front

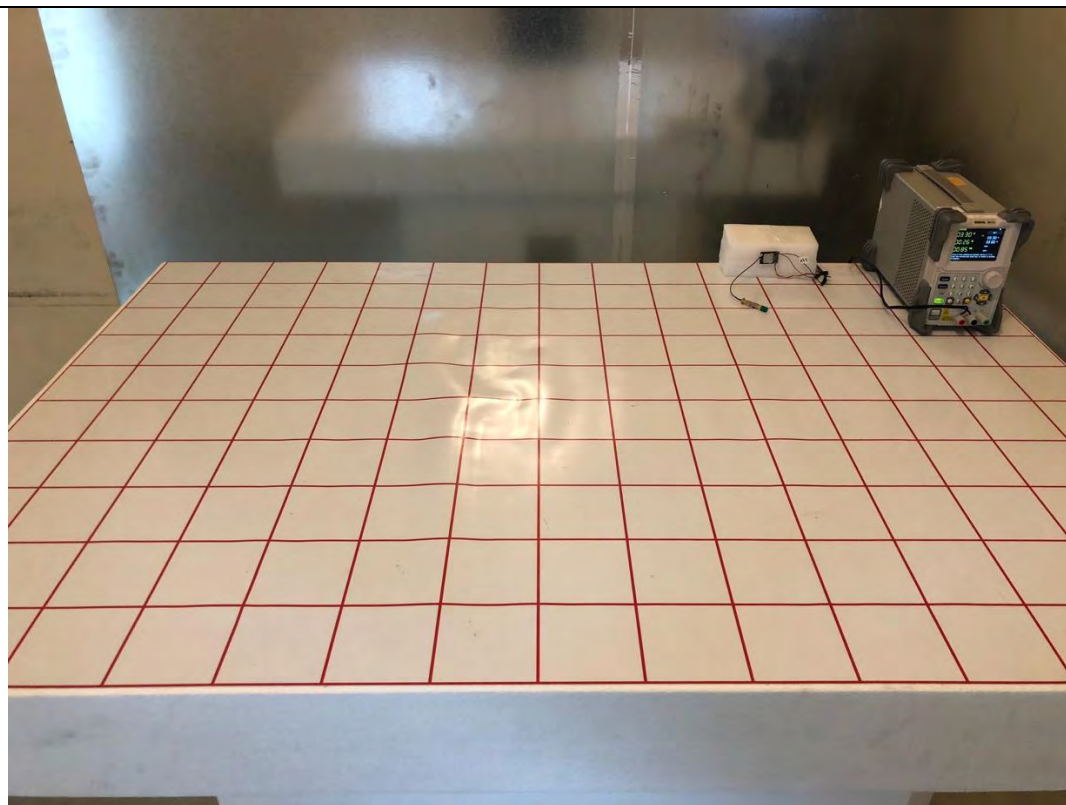


Rear

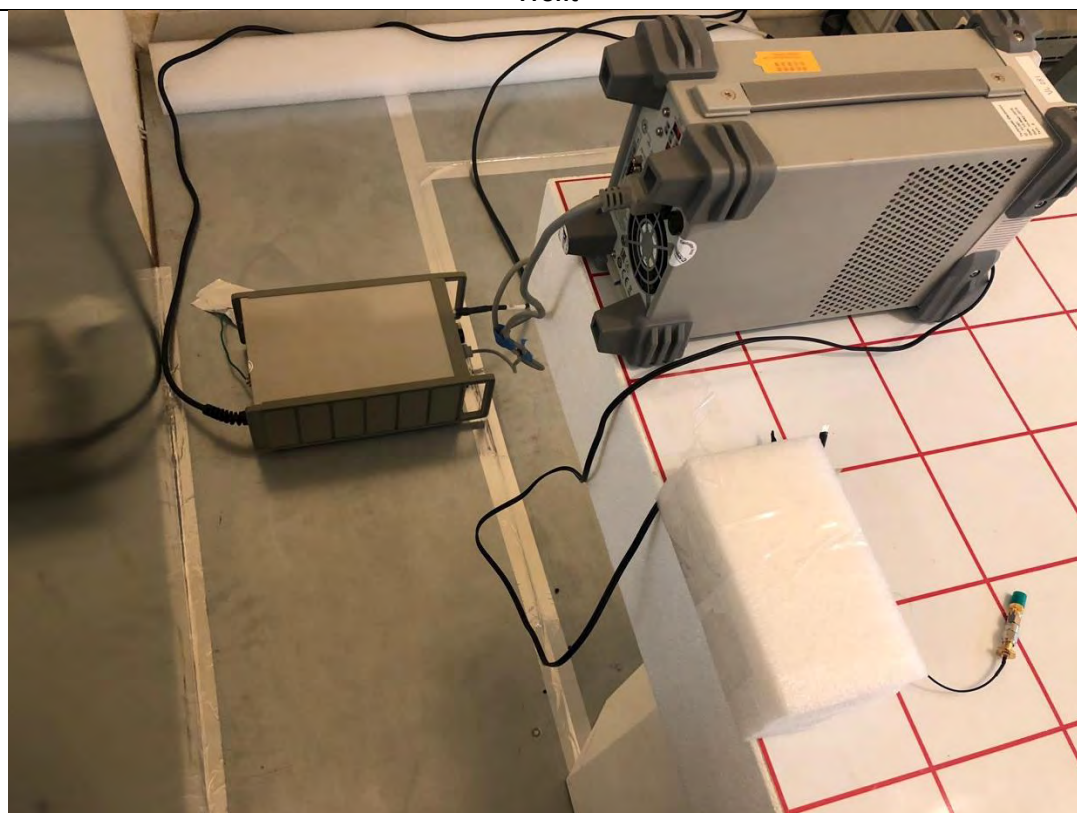
|                       |                                    |
|-----------------------|------------------------------------|
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### Conducted Emissions



Front



Rear

|                       |                                    |
|-----------------------|------------------------------------|
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## 6 Test Summary

| FCC Rules                          | Test Item                                                               | Test standard     | Section in report | Verdict |
|------------------------------------|-------------------------------------------------------------------------|-------------------|-------------------|---------|
| §15.203                            | Antenna Requirement                                                     | 47CFR Part 15.247 | 8.1               | Pass    |
| §15.247 (a)(2)                     | DTS (6 dB) Channel Bandwidth                                            | 47CFR Part 15.247 | 8.2               | Pass    |
| §15.247(b)(3)                      | Conducted Maximum Output Power                                          | 47CFR Part 15.247 | 8.3               | Pass    |
| §15.247(e)                         | Power Spectral Density                                                  | 47CFR Part 15.247 | 8.4               | Pass    |
| §15.247(d)                         | Conducted Band-Edge & Unwanted Emissions                                | 47CFR Part 15.247 | 8.5               | Pass    |
| §15.205,<br>§15.209,<br>§15.247(d) | Radiated Emissions & Unwanted Emissions into Restricted Frequency Bands | 47CFR Part 15.247 | 8.6               | Pass    |
| §15.207 (a)                        | AC Power Line Conducted Emissions                                       | 47CFR Part 15.207 | 8.7               | Pass    |
|                                    |                                                                         |                   |                   |         |

Note: N/A

## 7 Uncertainty of Measurement

| Test item                          | Measurement Uncertainty (dB) |
|------------------------------------|------------------------------|
| RF Output Power (Conducted)        | ±1.2 dB                      |
| Power Spectral Density             | ±0.9 dB                      |
| Unwanted Emission (Conducted)      | ±2.6 dB                      |
| Occupied Channel Bandwidth         | ±5 %                         |
| Radiated Emission (9KHz-30MHz)     | ±3.5 dB                      |
| Radiated Emission (30MHz-1GHz)     | ±4.6 dB                      |
| Radiated Emission (1-18GHz)        | ±4.9 dB                      |
| Radiated Emission (18-40GHz)       | ±3.5 dB                      |
| Conducted Emissions (150KHz-30MHz) | ±3.6 dB                      |

|                       |                                    |
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## 8 Test summary and result

### 8.1 Antenna Requirement

#### 8.1.1 Requirement

Per § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

#### 8.1.2 Result

Analysis:

The EUT has an option of using the internal antenna, or an external antenna.

- For the internal antenna version, the EUT uses an Amotech PIFA chip antenna that is soldered and permanently attached onto the PCB.
- For the external antenna version, the EUT has a provision for connection to an external antenna, using a unique U.FL connector, and was tested with a Yagi, monopole, and folded dipole antennas provided by the applicant. No other external antennas are to be used with the EUT.
- All dipoles antennas will be equipped with unique RP-SMA connector. RF cables with unique RP-SMA and U.FL connector will be used to provide coupling between antenna and module.
- For Yagi antenna, it will have an adapter and RF cable permanently connected with industrial epoxy, "Loctite" or solder to make the connection permanent prior to delivering to OEM Integrator or Host Manufacturer. the connector type on the final assembly will be U.FL.

Conclusion:

EUT complies with antenna requirement in § 15.203.

|                       |                                    |
|-----------------------|------------------------------------|
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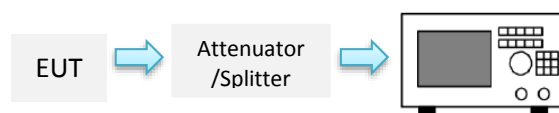


## 8.2 DTS (6 dB) Bandwidth

### 8.2.1 Requirement

Per § 15.247 (a)(2), systems using digital modulation techniques may operate in the 902-928MHz, 2400-2483.5MHz, and 5725-5850MHz bands. The minimum 6 dB bandwidth shall be at least 500 KHz.

### 8.2.2 Test setup



### 8.2.3 Test Procedure

According to section 8.2, option 2, in KDB 558074 D01 DTS Meas Guidance v05 and subclause 11.8 of ANSI C63.10-2013:

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described above (i.e., RBW = 100 kHz, VBW  $\geq 3 \times$  RBW, peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be  $\geq 6$  dB.

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW)  $\geq 3 \times$  RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Use automatic bandwidth measurement capability on instrument to obtain BW result.

|                       |                                    |
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## 8.2.4 Test Result

External Antenna version

| Radio   | Output Power Setting | Test Frequency (MHz) | Measured Bandwidth (KHz) | Minimum Bandwidth (KHz) | Result |
|---------|----------------------|----------------------|--------------------------|-------------------------|--------|
| 2.4 GHz | 20                   | 2405                 | 1675                     | 500                     | Pass   |
|         | 20                   | 2440                 | 1674                     | 500                     | Pass   |
|         | 20                   | 2470                 | 1677                     | 500                     | Pass   |
|         | 15*                  | 2470                 | 1674                     | 500                     | Pass   |

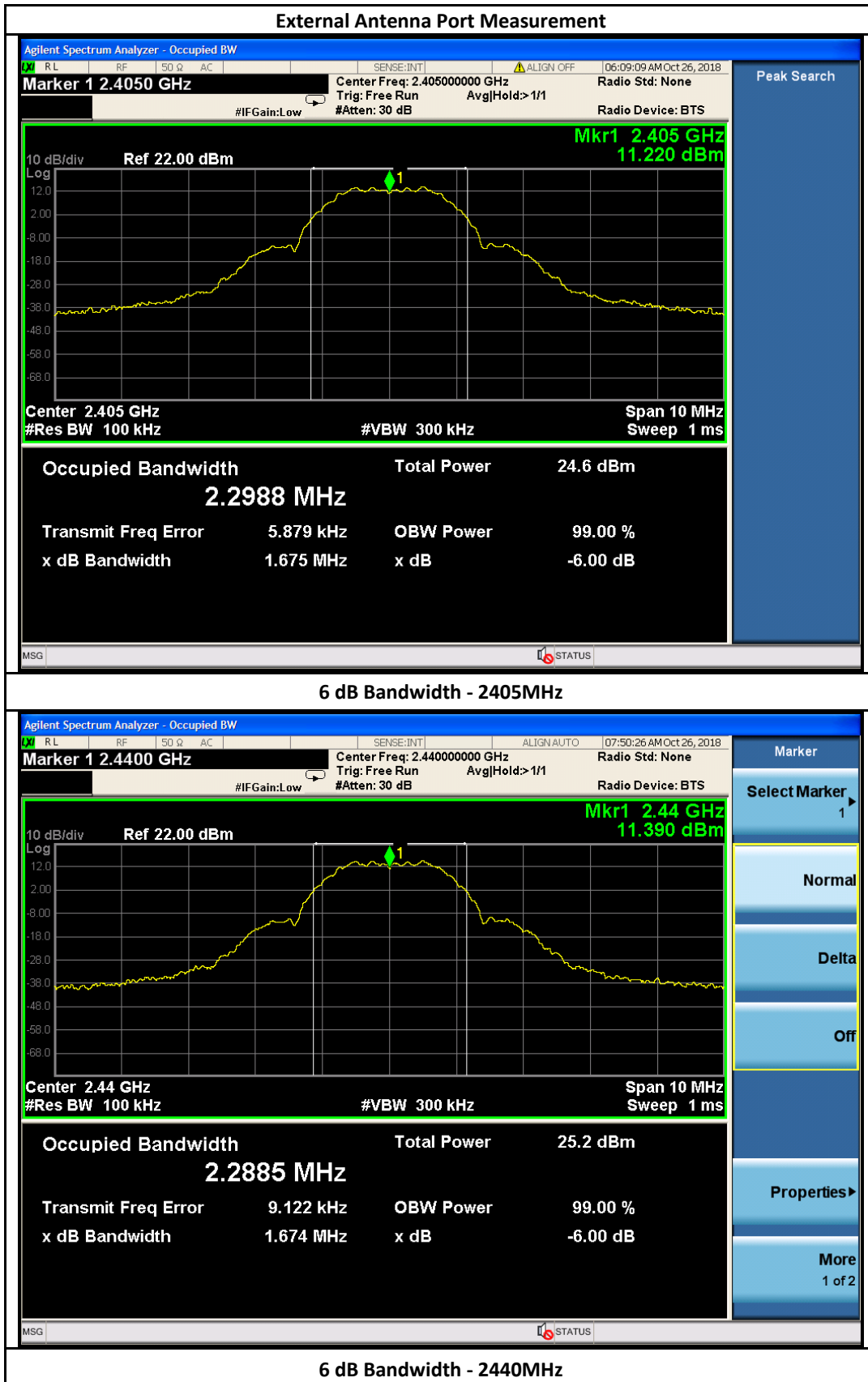
\*The lower output power setting is to be used for the Yagi antenna only at 2470MHz.

Internal Antenna version

| Radio   | Output Power Setting | Test Frequency (MHz) | Measured Bandwidth (KHz) | Minimum Bandwidth (KHz) | Result |
|---------|----------------------|----------------------|--------------------------|-------------------------|--------|
| 2.4 GHz | 20                   | 2405                 | 1680                     | 500                     | Pass   |
|         | 20                   | 2440                 | 1677                     | 500                     | Pass   |
|         | 20                   | 2470                 | 1675                     | 500                     | Pass   |



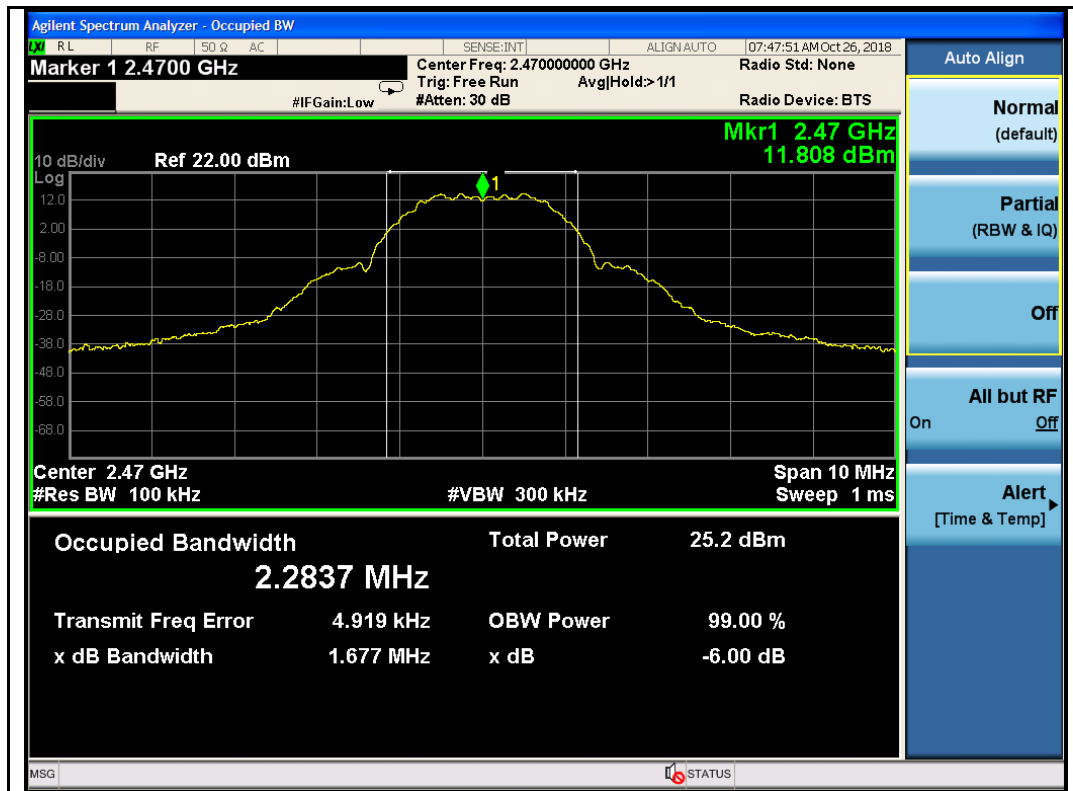
## 8.2.5 Test Plots



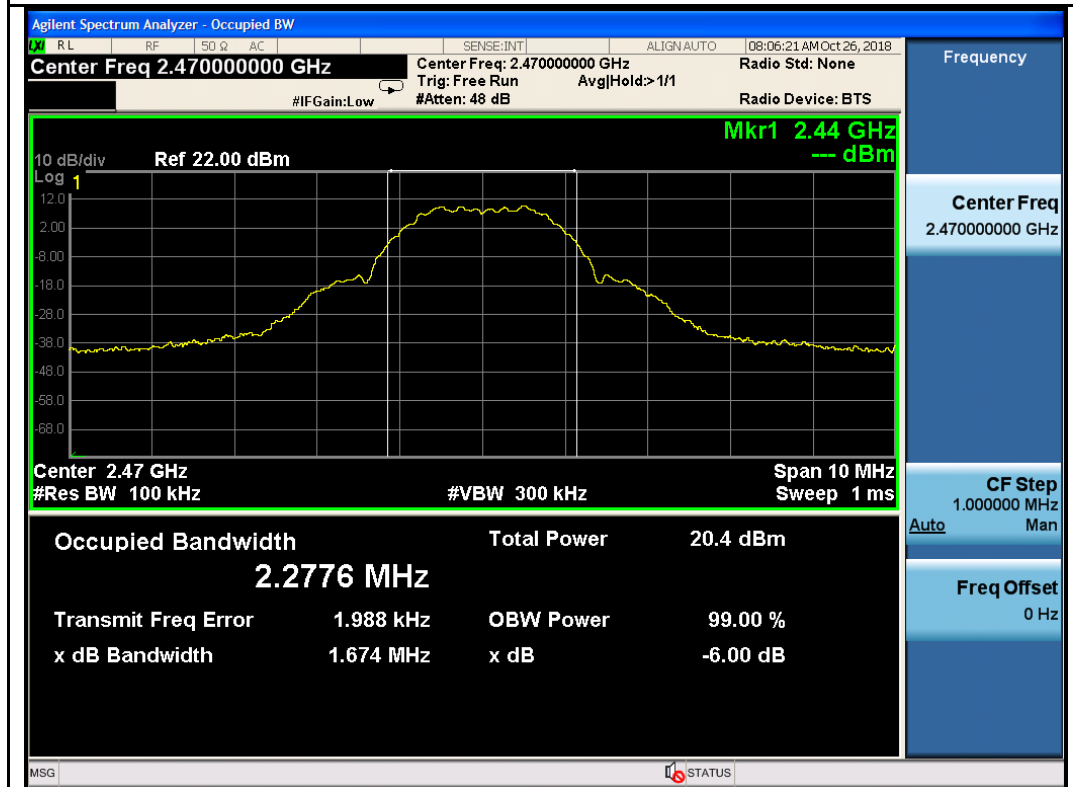
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#### 6 dB Bandwidth - 2470MHz



#### 6 dB Bandwidth - 2470MHz (15 dBm output power level setting for Yagi antenna)



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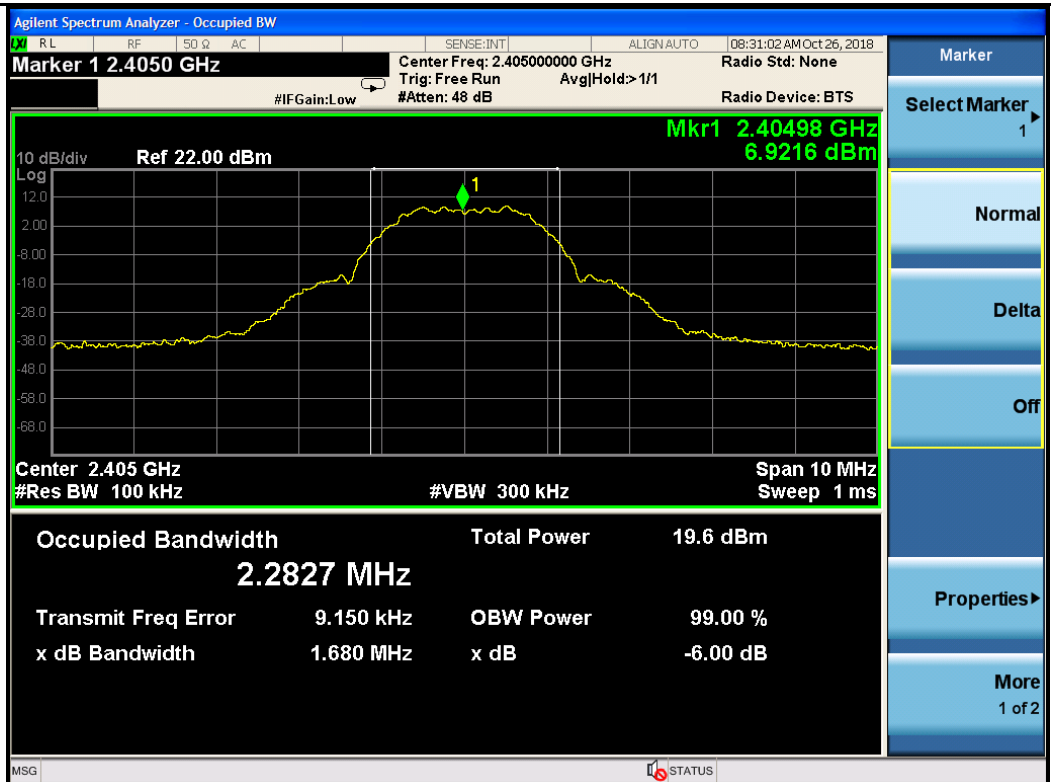
Model Number: 44-100312-00, 44-100312-01



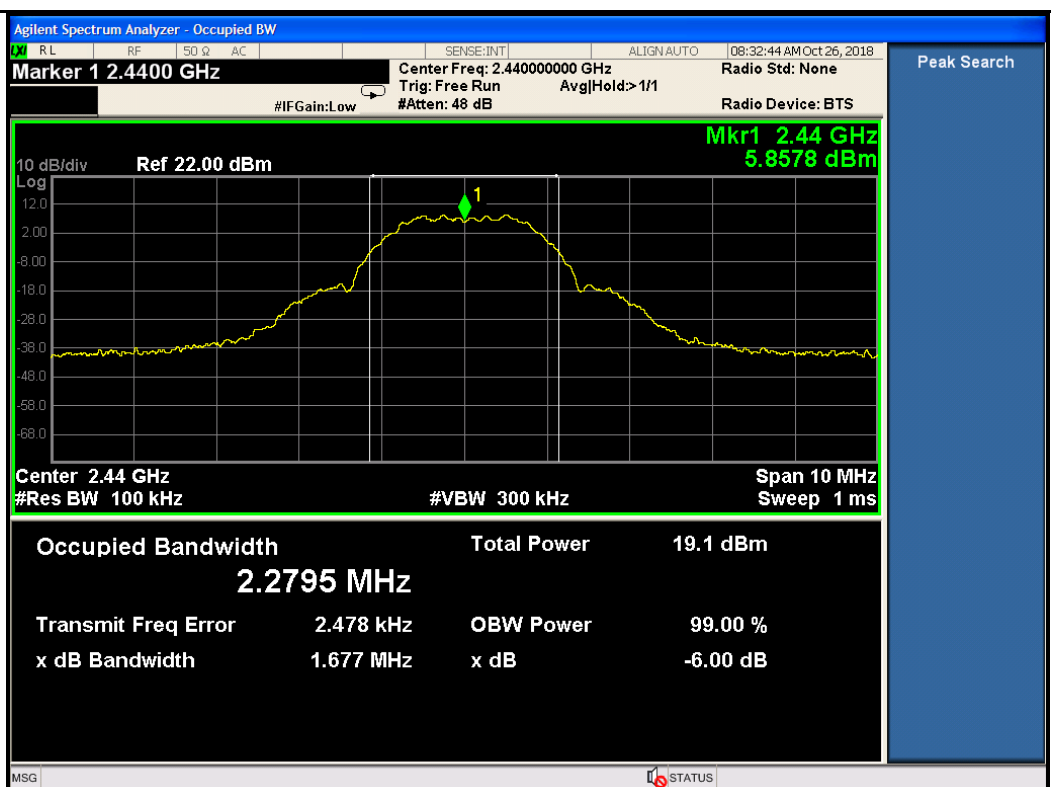
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### Internal Antenna Port Measurement



### 6 dB Bandwidth - 2405MHz



### 6 dB Bandwidth - 2440MHz



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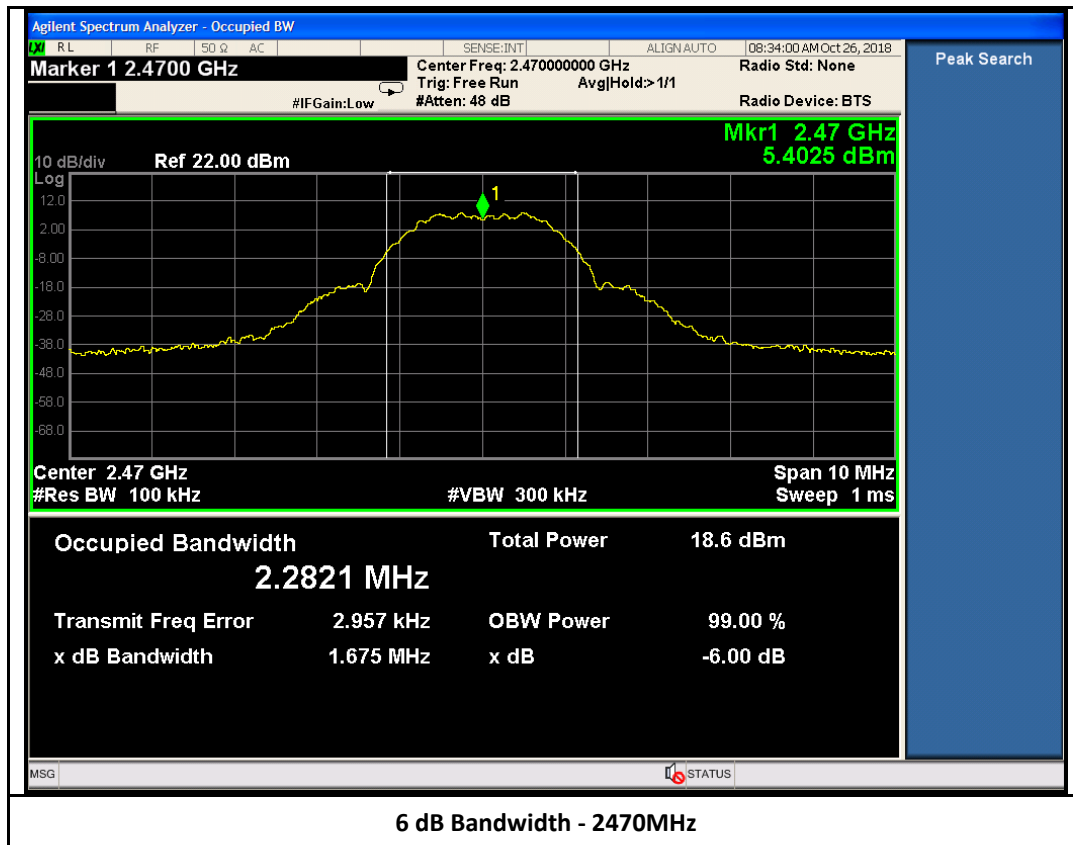
Product: Leap 2.4GHz RF Module

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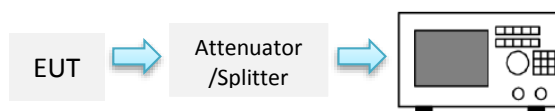
### 8.3 Maximum Output Power

#### 8.3.1 Requirement

Per § 15.247 (b)(3), for systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: the maximum output power is 1 Watt.

Per § 15.247 (b)(4), if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

#### 8.3.2 Test setup



#### 8.3.3 Test Procedure

According to section 8.3.1.1 RBW ≥ DTS bandwidth, in KDB 558074 D01 DTS Meas Guidance v05 and subclause 11.9.1.1 of ANSI C63.10-2013:

1. Set the RBW ≥ DTS bandwidth.
2. Set VBW ≥ 3 X RBW.
3. Set span ≥ 3 X RBW
4. Sweep time = auto couple.
5. Detector = peak.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use peak marker function to determine the peak amplitude level.

#### 8.3.4 Conducted output power limit calculation

Per FCC requirement, if antenna gain exceeds 6 dBi, conducted output power limit shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

| Antenna type        | Antenna gain (dBi) | Amount exceeding 6 dBi (dB) | Original output power limit (dBm) | New output power limit (dBm) |
|---------------------|--------------------|-----------------------------|-----------------------------------|------------------------------|
| Internal PIFA       | 3.4                | N/A                         | 30                                | 30                           |
| Folded Dipole Long  | 3.2                | N/A                         | 30                                | 30                           |
| Folded Dipole Short | 2.15               | N/A                         | 30                                | 30                           |
| Monopole            | 7                  | 1                           | 30                                | 29                           |
| Yagi                | 12                 | 6                           | 30                                | 24                           |

|                       |                                    |
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### 8.3.5 Test Result

#### Folded Dipole Antennas

| Radio   | Output Power Setting | Test Frequency (MHz) | Measured Output Power (dBm) | Maximum Output Power (dBm) | Result |
|---------|----------------------|----------------------|-----------------------------|----------------------------|--------|
| 2.4 GHz | 20 dB                | 2405                 | 18.047                      | 30                         | Pass   |
|         | 20 dB                | 2440                 | 18.446                      | 30                         | Pass   |
|         | 20 dB                | 2470                 | 18.532                      | 30                         | Pass   |

#### Yagi Antenna

| Radio   | Output Power Setting | Test Frequency (MHz) | Measured Output Power (dBm) | Maximum Output Power (dBm) | Result |
|---------|----------------------|----------------------|-----------------------------|----------------------------|--------|
| 2.4 GHz | 20 dB                | 2405                 | 18.047                      | 24                         | Pass   |
|         | 20 dB                | 2440                 | 18.446                      | 24                         | Pass   |
|         | 15 dB                | 2470                 | 13.591                      | 24                         | Pass   |

#### Monopole Antenna

| Radio   | Output Power Setting | Test Frequency (MHz) | Measured Output Power (dBm) | Maximum Output Power (dBm) | Result |
|---------|----------------------|----------------------|-----------------------------|----------------------------|--------|
| 2.4 GHz | 20 dB                | 2405                 | 18.047                      | 29                         | Pass   |
|         | 20 dB                | 2440                 | 18.446                      | 29                         | Pass   |
|         | 20 dB                | 2470                 | 18.532                      | 29                         | Pass   |

#### Internal Antenna

| Radio          | Output Power Setting | Test Frequency (MHz) | Measured Output Power (dBm) | Maximum Output Power (dBm) | Result |
|----------------|----------------------|----------------------|-----------------------------|----------------------------|--------|
| 2.4 GHz Module | 20 dB                | 2405                 | 15.279                      | 30                         | Pass   |
|                | 20 dB                | 2440                 | 15.019                      | 30                         | Pass   |
|                | 20 dB                | 2470                 | 14.785                      | 30                         | Pass   |

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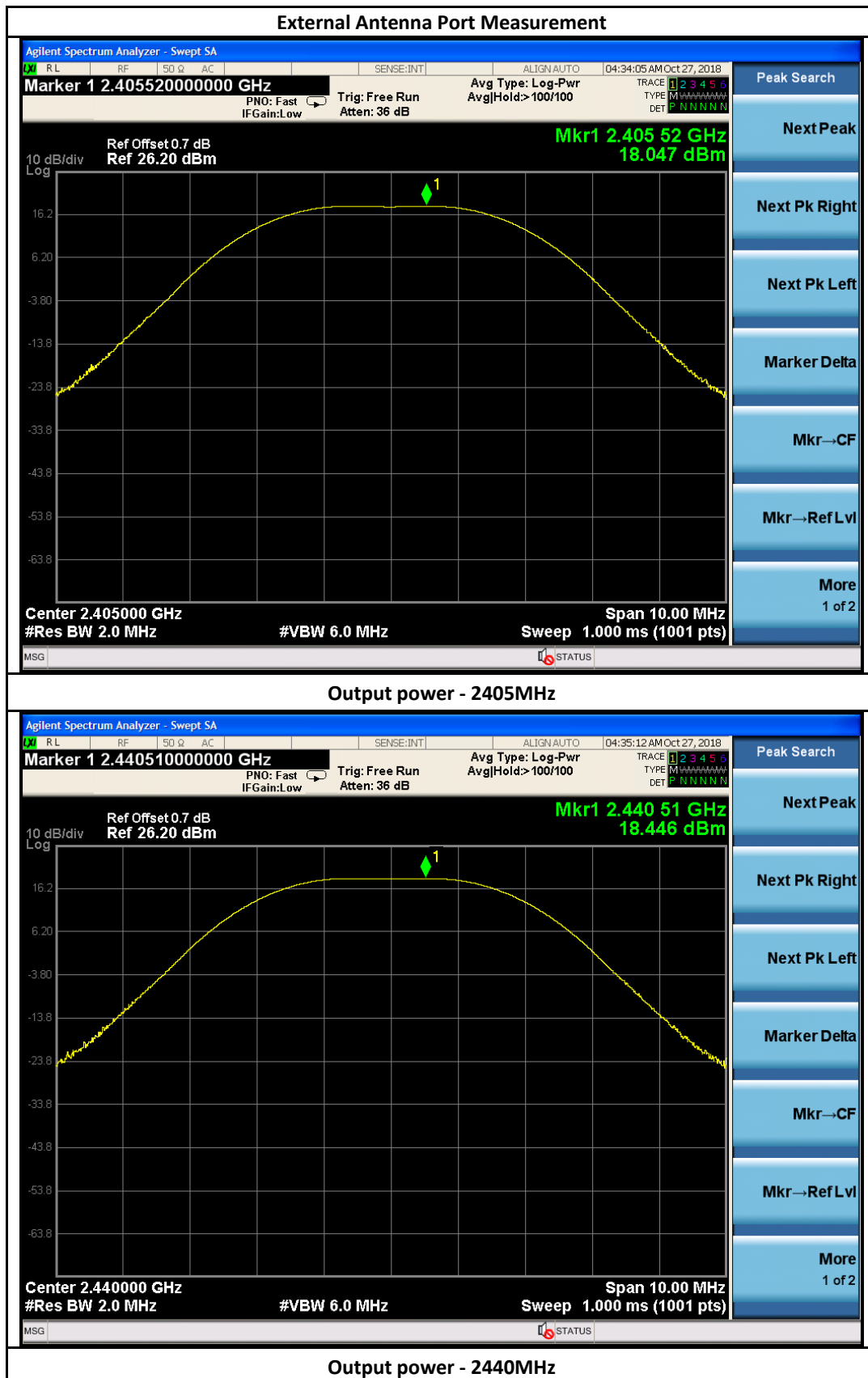
Model Number: 44-100312-00, 44-100312-01



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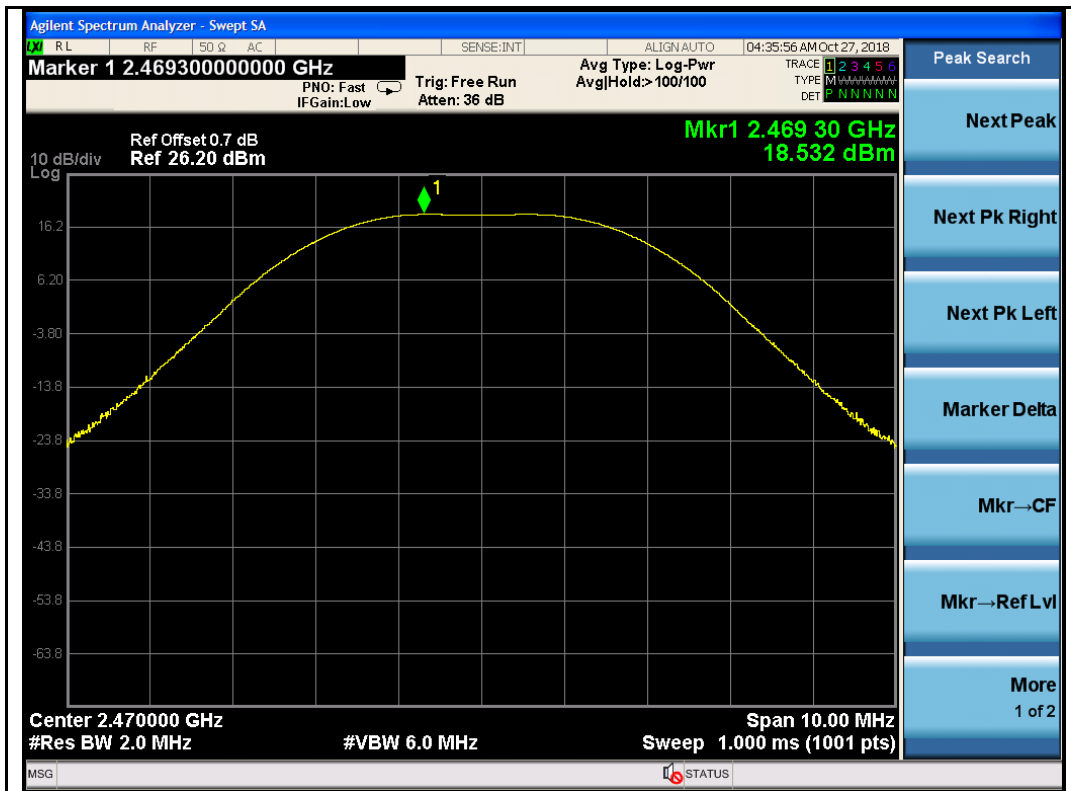
### 8.3.6 Test Plots



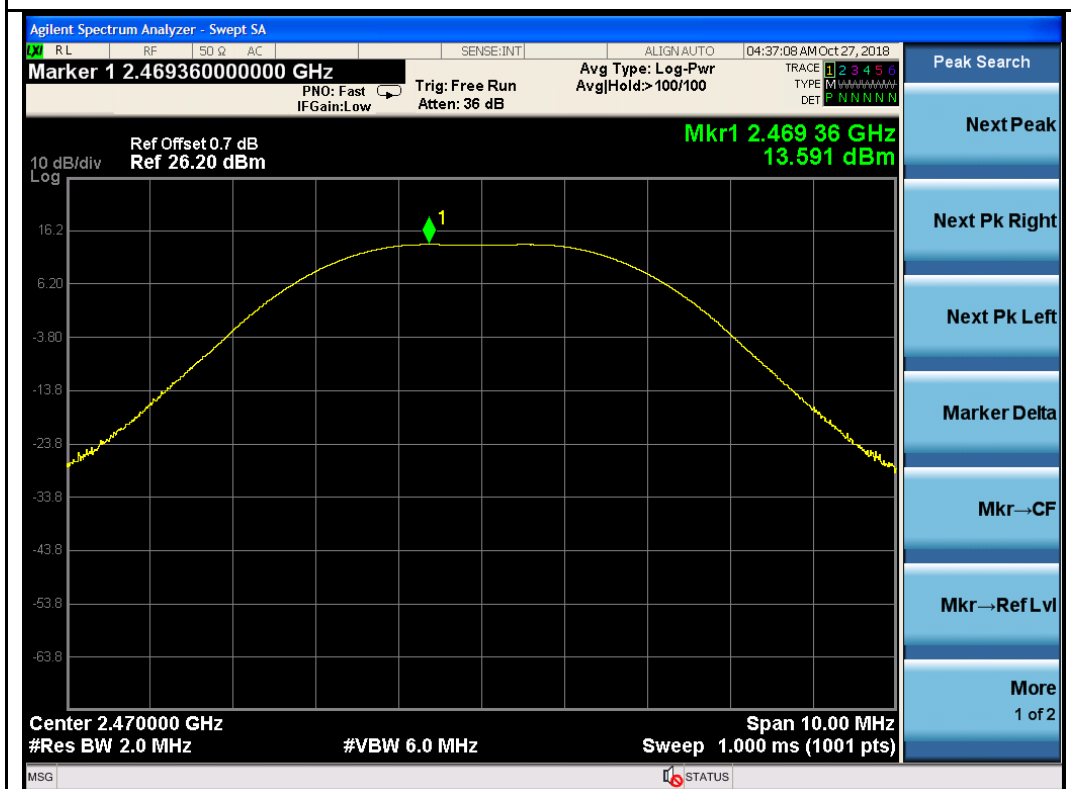
Report Number: PFE-18100201-LC-FCC-RF-LEAP Rev1.1  
 Product: Leap 2.4GHz RF Module  
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Output power - 2470MHz



Output power - 2470MHz (15 dBm output power level setting for Yagi antenna)



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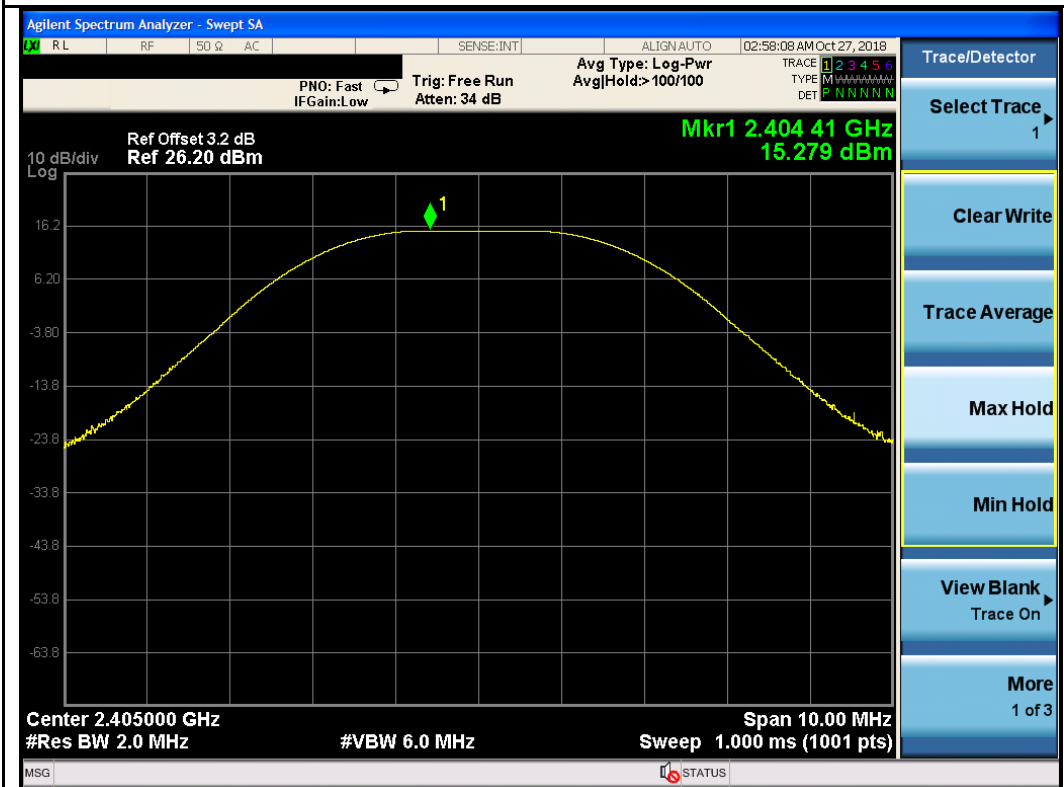
Model Number: 44-100312-00, 44-100312-01



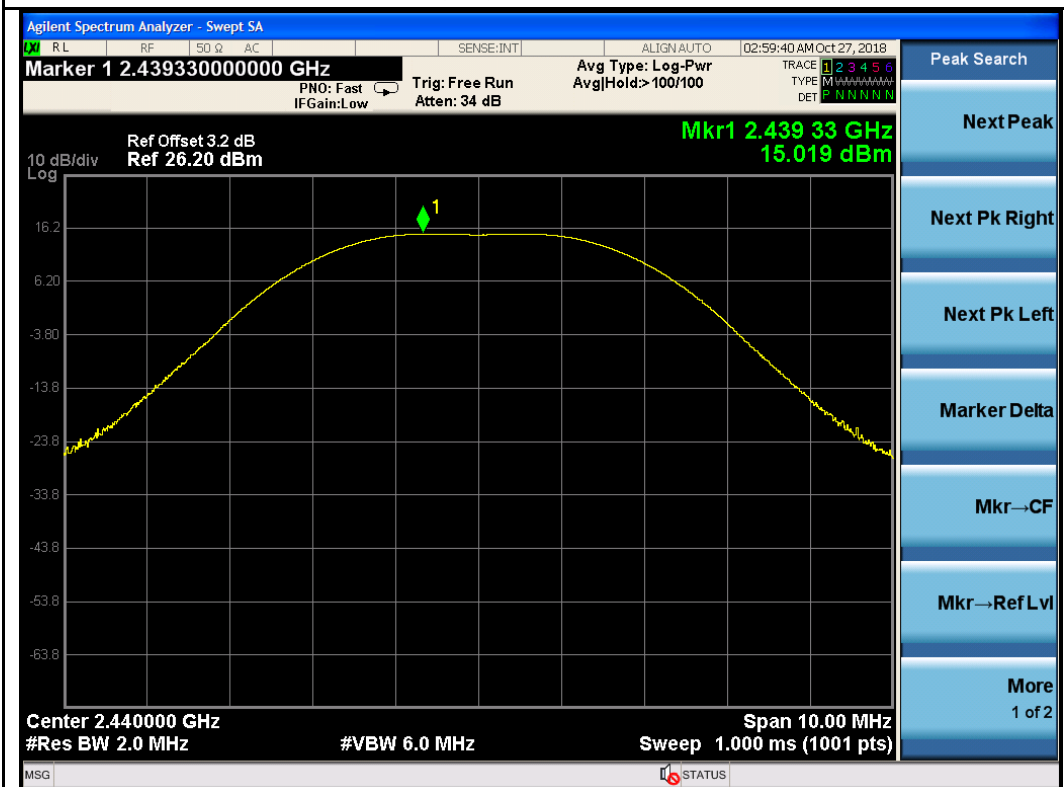
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### Internal Antenna Port Measurement



### Output power - 2405MHz



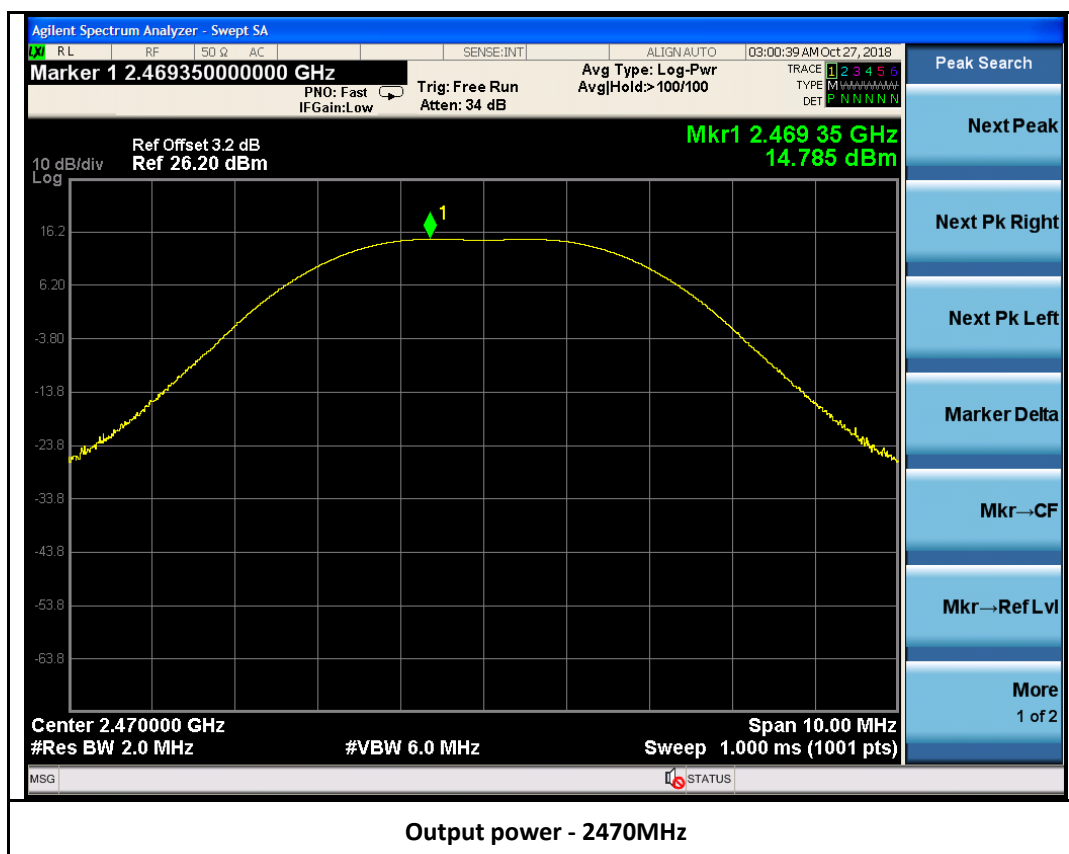
### Output power - 2440MHz



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| <b>Product:</b>       | Leap 2.4GHz RF Module              |
| <b>Model Number:</b>  | 44-100312-00, 44-100312-01         |

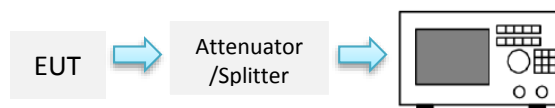


## 8.4 Power Spectral Density

### 8.4.1 Requirement

Per § 15.247 (e), for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power is used to determine the power spectral density.

### 8.4.2 Test setup



### 8.4.3 Test Procedure

According to section 8.4 in KDB 558074 D01 DTS Meas Guidance v05 and subclause 11.10.2 PKPSD of ANSI C63.10-2013:

1. Set analyser centre frequency to DTS channel centre frequency.
2. Set the span to 1.5 X DTS bandwidth.
3. Set the RBW to:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
4. Set the VBW  $\geq 3 \times \text{RBW}$ .
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

### 8.4.4 Power spectral density limit calculation

Per FCC requirement, if antenna gain exceeds 6 dBi, PSD limit shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

| Antenna type        | Antenna gain (dBi) | Amount exceeding 6 dBi (dB) | Original PSD limit (dBm/3KHz) | New PSD limit (dBm/3KHz) |
|---------------------|--------------------|-----------------------------|-------------------------------|--------------------------|
| Internal PIFA       | 3.4                | N/A                         | 8                             | 8                        |
| Folded Dipole Long  | 3.2                | N/A                         | 8                             | 8                        |
| Folded Dipole Short | 2.15               | N/A                         | 8                             | 8                        |
| Monopole            | 7                  | 1                           | 8                             | 7                        |
| Yagi                | 12                 | 6                           | 8                             | 2                        |

#### 8.4.5 Test Result

##### Folded Dipole Antennas

| Radio   | Output Power Setting | Test Frequency (MHz) | Measured Output Power (dBm/3KHz) | Maximum Output Power (dBm/3KHz) | Result |
|---------|----------------------|----------------------|----------------------------------|---------------------------------|--------|
| 2.4 GHz | 20 dB                | 2405                 | 1.614                            | 8                               | Pass   |
|         | 20 dB                | 2440                 | 1.712                            | 8                               | Pass   |
|         | 20 dB                | 2470                 | 2.052                            | 8                               | Pass   |

##### Monopole Antenna

| Radio   | Output Power Setting | Test Frequency (MHz) | Measured Output Power (dBm/3KHz) | Maximum Output Power (dBm/3KHz) | Result |
|---------|----------------------|----------------------|----------------------------------|---------------------------------|--------|
| 2.4 GHz | 20 dB                | 2405                 | 1.614                            | 7                               | Pass   |
|         | 20 dB                | 2440                 | 1.712                            | 7                               | Pass   |
|         | 20 dB                | 2470                 | 2.052                            | 7                               | Pass   |

##### Yagi Antenna

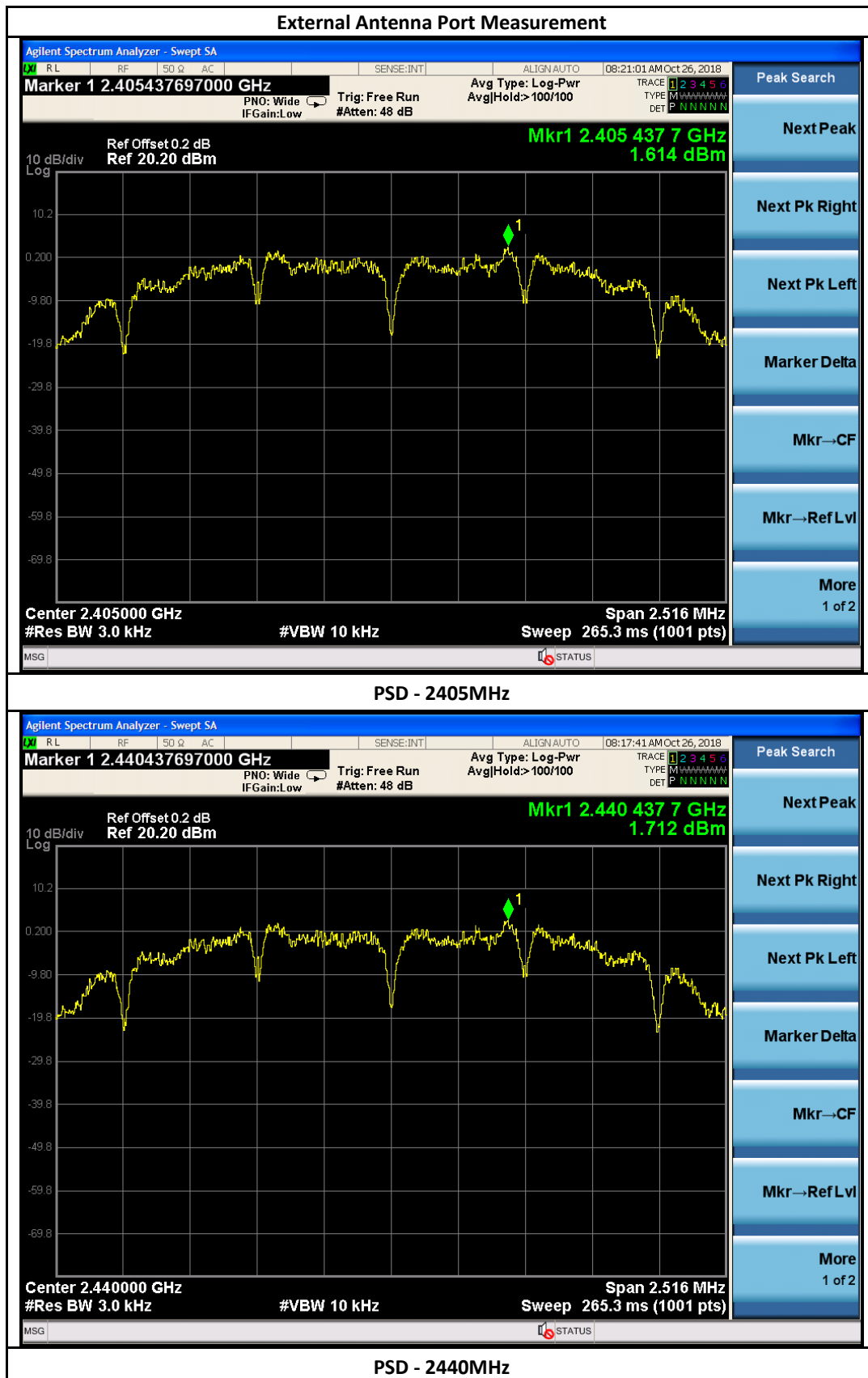
| Radio   | Output Power Setting | Test Frequency (MHz) | Measured Output Power (dBm/3KHz) | Maximum Output Power (dBm/3KHz) | Result |
|---------|----------------------|----------------------|----------------------------------|---------------------------------|--------|
| 2.4 GHz | 20 dB                | 2405                 | 1.614                            | 2                               | Pass   |
|         | 20 dB                | 2440                 | 1.712                            | 2                               | Pass   |
|         | 15 dB                | 2470                 | -1.840                           | 2                               | Pass   |

##### Internal Antenna

| Radio   | Output Power Setting | Test Frequency (MHz) | Measured Output Power (dBm/3KHz) | Maximum Output Power (dBm/3KHz) | Result |
|---------|----------------------|----------------------|----------------------------------|---------------------------------|--------|
| 2.4 GHz | 20 dB                | 2405                 | 0.196                            | 8                               | Pass   |
|         | 20 dB                | 2440                 | 0.008                            | 8                               | Pass   |
|         | 20 dB                | 2470                 | -0.295                           | 8                               | Pass   |



#### 8.4.6 Test Plots



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#### PSD - 2470MHz



#### PSD - 2470MHz (15 dBm output power level setting for Yagi antenna)



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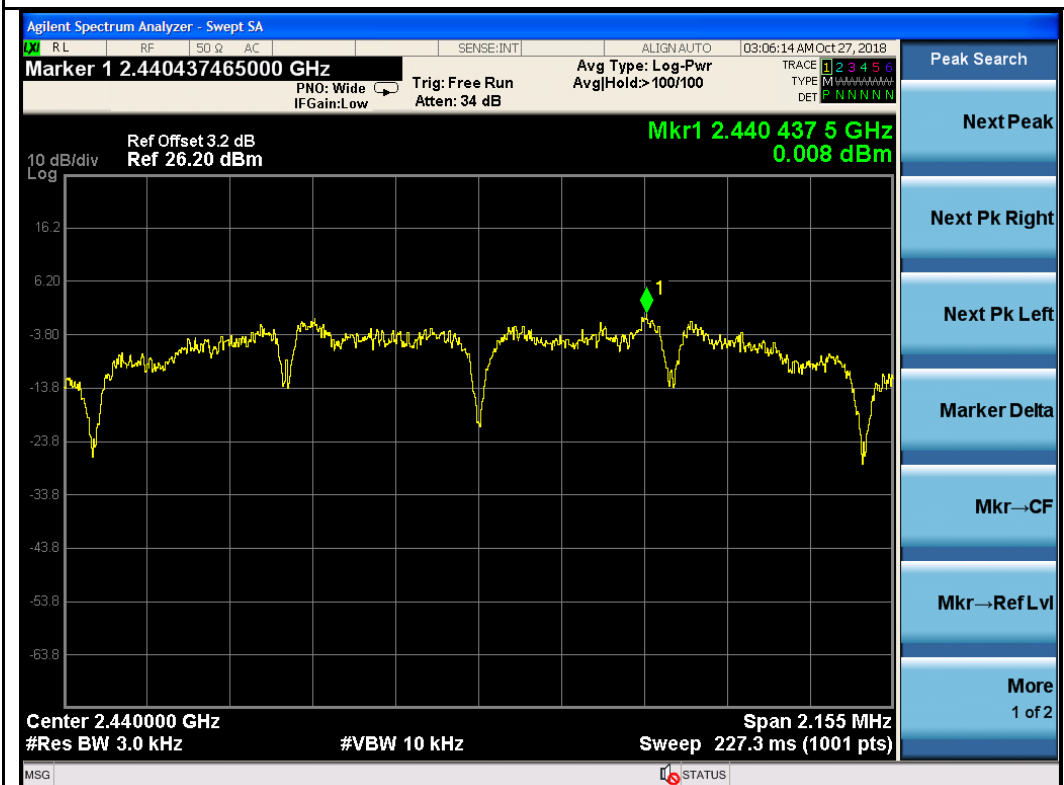
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### Internal Antenna Port Measurement



### PSD - 2405MHz



### PSD - 2440MHz

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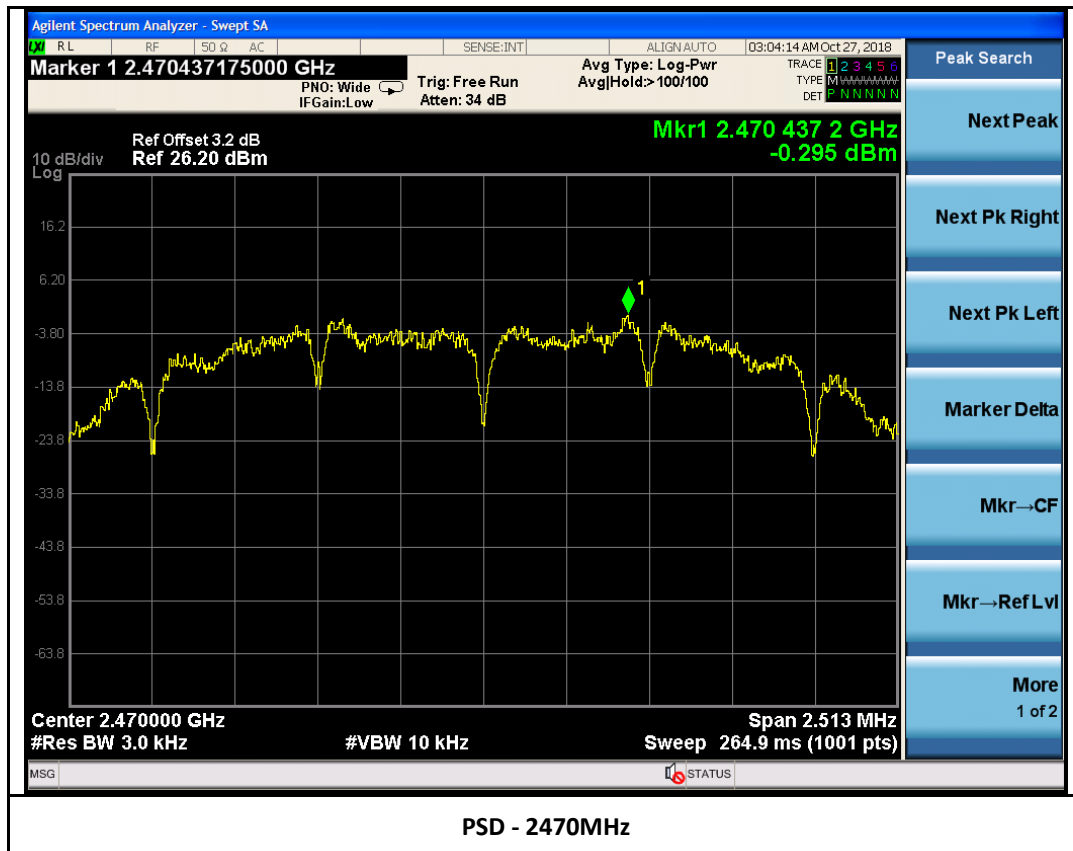
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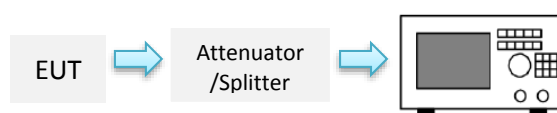


## 8.5 Conducted Band-Edge & Unwanted Emissions Measurement

### 8.5.1 Requirement

Per § 15.247 (d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

### 8.5.2 Test setup



### 8.5.3 Test Procedure

According to section 8.5 Emission level measurement, in KDB 558074 D01 DTS Meas Guidance v05 and subclause 11.11.3 in ANSI C63.10-2013:

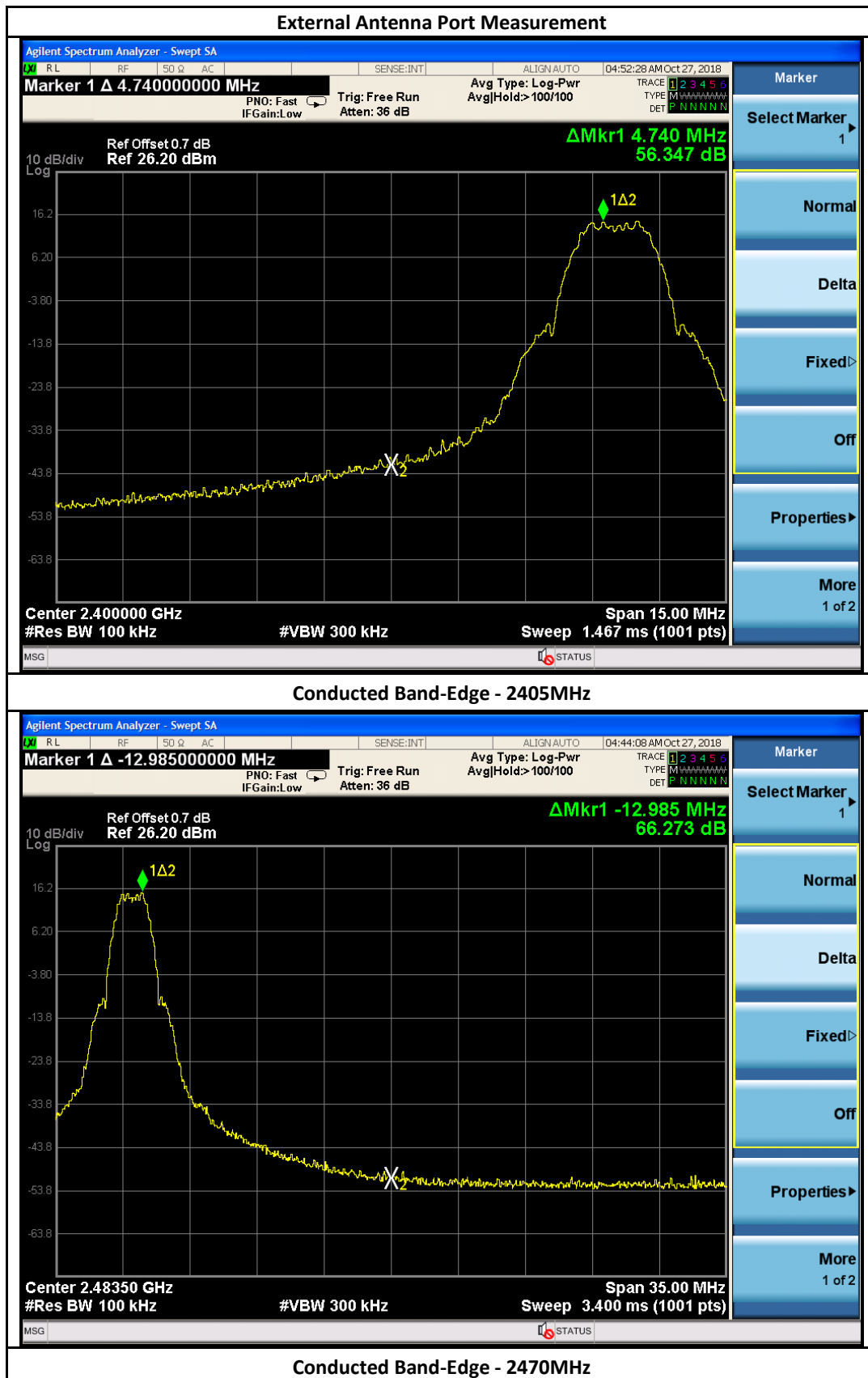
1. Set the center frequency and span to encompass frequency range to be measured.
2. Set the RBW = 100 kHz.
3. Set the VBW  $\geq 3 \times$  RBW.
4. Detector = peak.
5. Sweep time = auto couple.
6. Trace mode = max hold.
7. Allow trace to fully stabilize.
8. Use the peak marker function to determine the maximum amplitude level.

### 8.5.4 Test Result

See test plots



### 8.5.5 Test Plots



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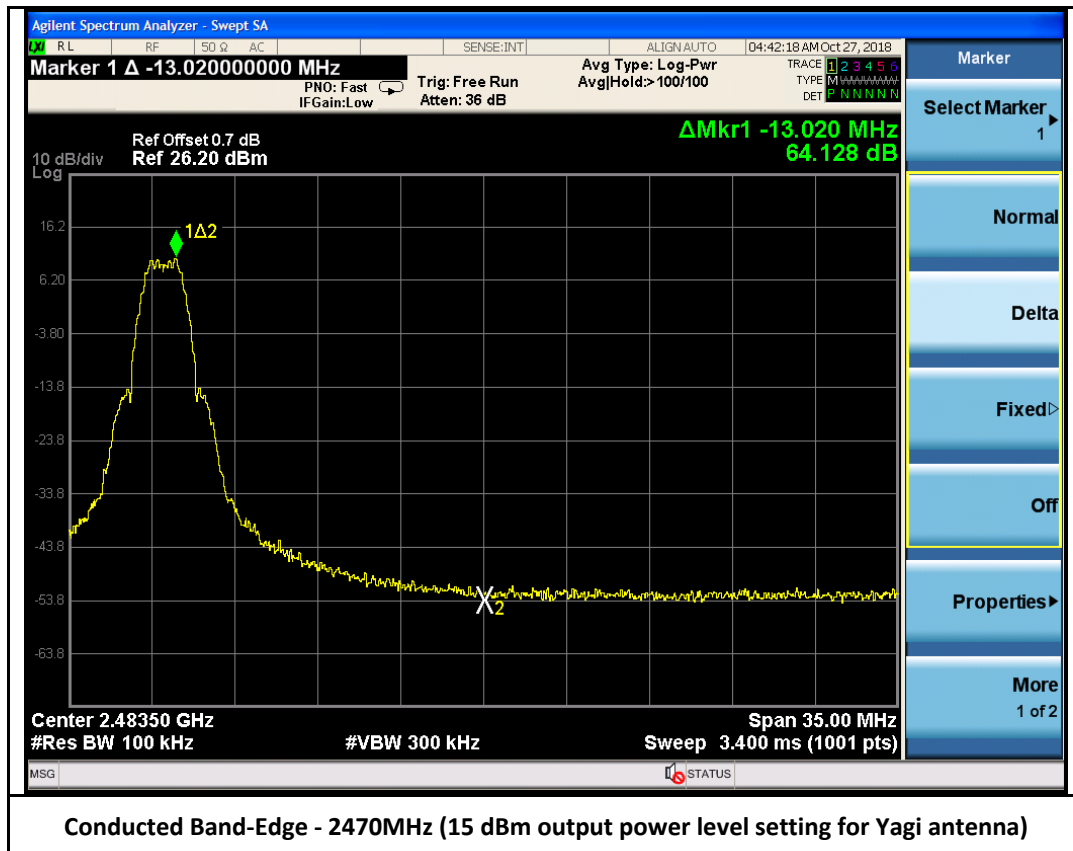
Product: Leap 2.4GHz RF Module

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#### Conducted Unwanted Emission - 2405MHz



#### Conducted Unwanted Emission - 2440MHz



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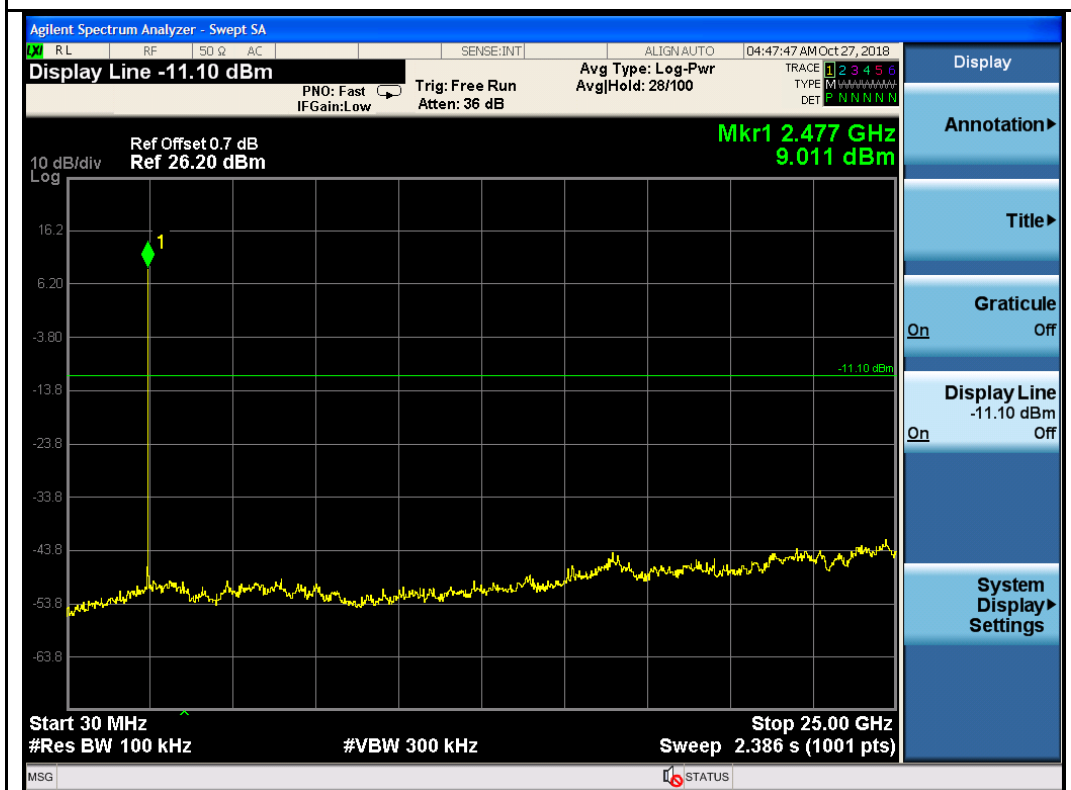
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### Conducted Unwanted Emission - 2470MHz



### Conducted Unwanted Emission - 2470MHz (15 dBm output power level setting for Yagi antenna)



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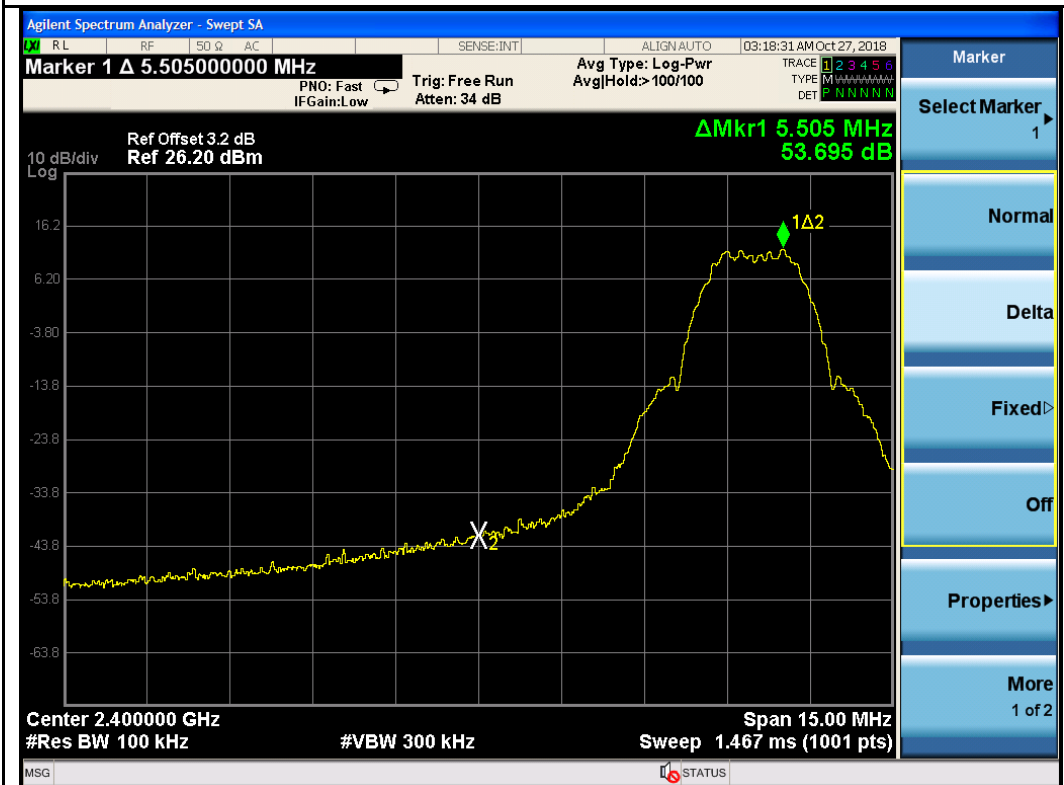
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Model Number: 44-100312-00, 44-100312-01

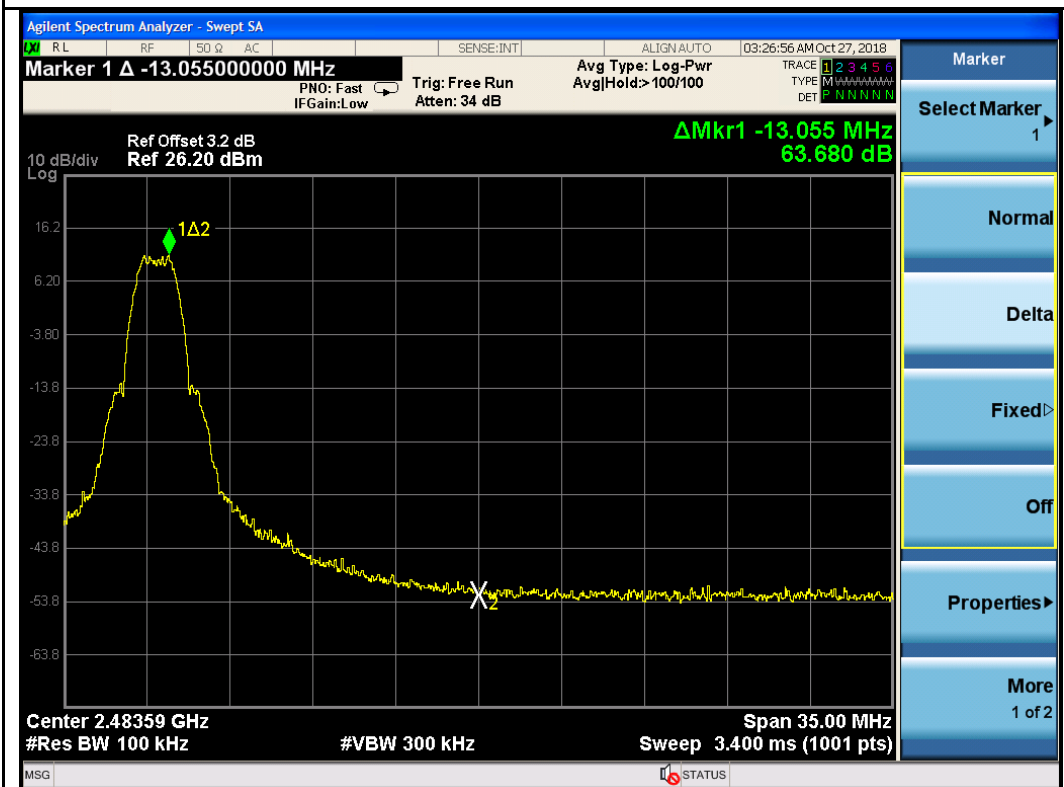


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### Internal Antenna Port Measurement



### Conducted Band-Edge - 2405MHz



### Conducted Band-Edge - 2470MHz



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### Conducted Unwanted Emission - 2405MHz



### Conducted Unwanted Emission - 2440MHz



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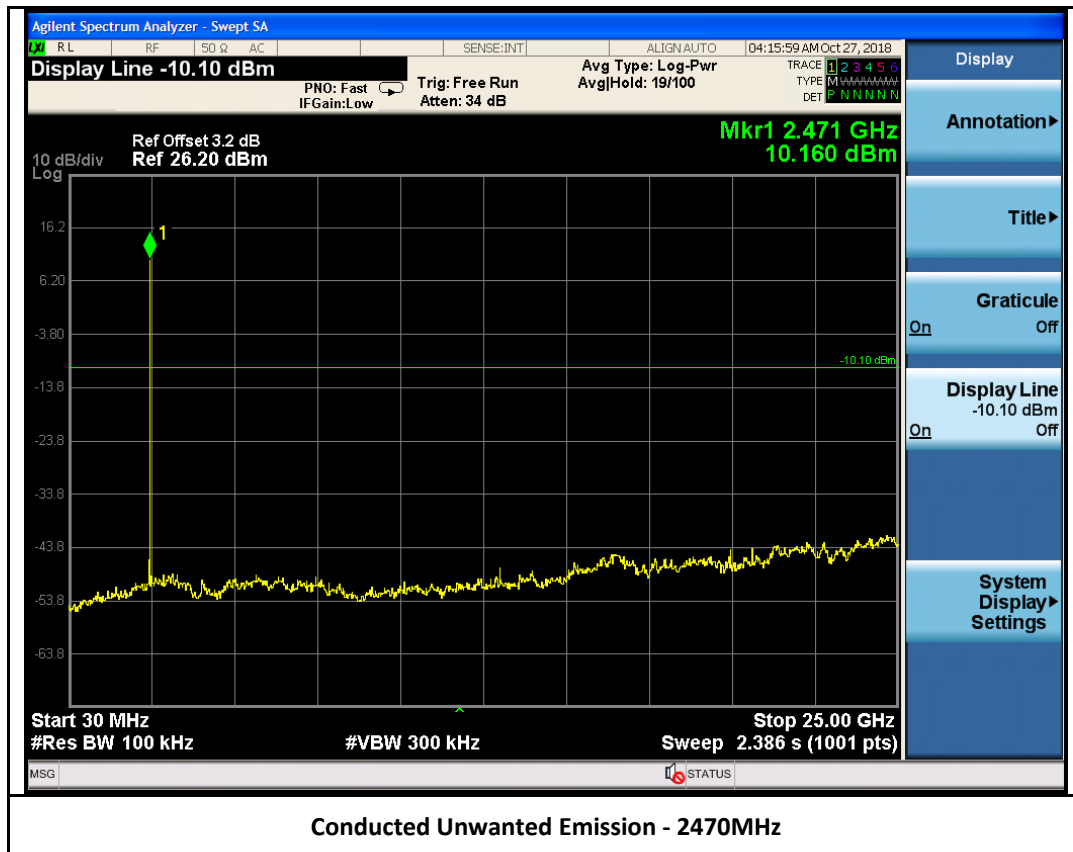
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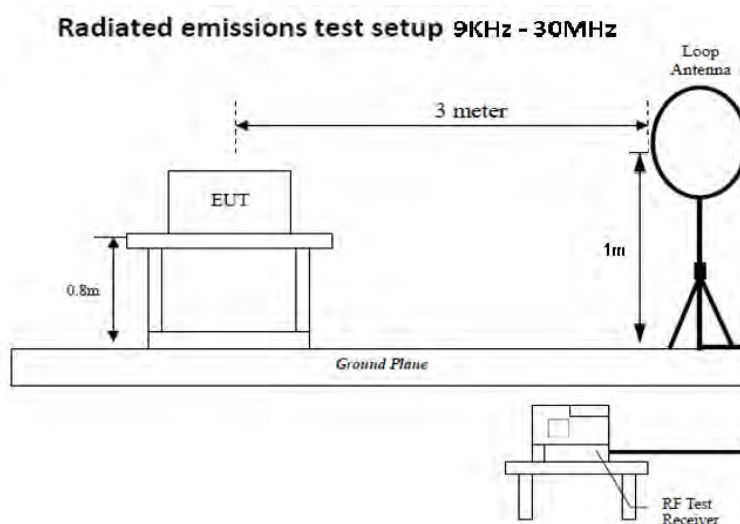
## 8.6 Radiated Band-Edge & Spurious Emissions into Restricted Frequency Bands

### 8.6.1 Requirement

Per § 15.247 (d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

| Frequency range (MHz) | Field Strength ( $\mu\text{V/m}$ ) |
|-----------------------|------------------------------------|
| 0.009~0.490           | 2400/F(KHz)                        |
| 0.490~1.705           | 24000/F(KHz)                       |
| 1.705~30.0            | 30                                 |
| 30 – 88               | 100                                |
| 88 – 216              | 150                                |
| 216 960               | 200                                |
| Above 960             | 500                                |

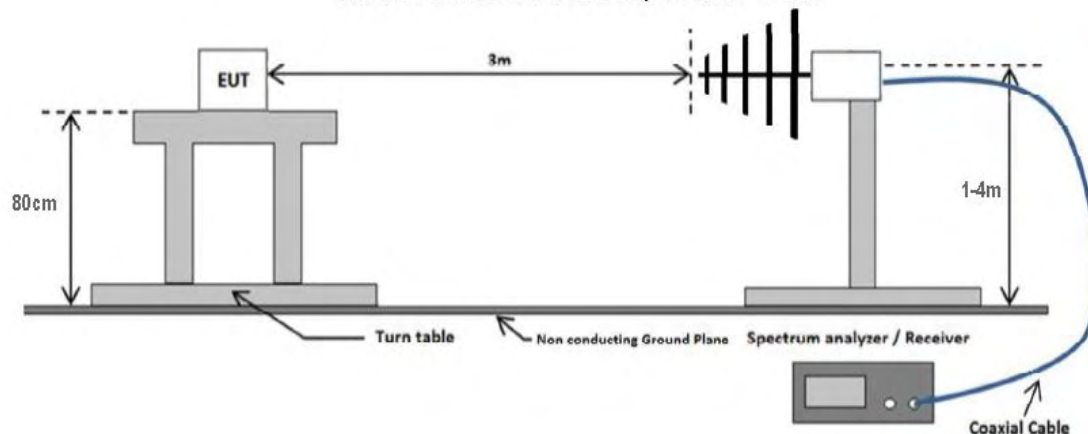
### 8.6.2 Test setup



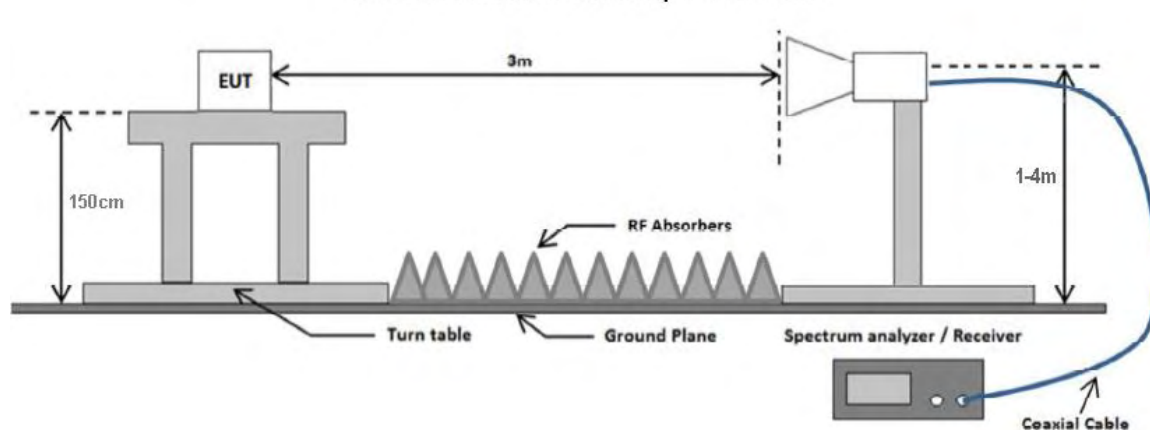
|                       |                                    |
|-----------------------|------------------------------------|
| <b>Report Number:</b> | PFE-18100201-LC-FCC-RF-LEAP Rev1.1 |
| <b>Product:</b>       | Leap 2.4GHz RF Module              |
| <b>Model Number:</b>  | 44-100312-00, 44-100312-01         |



**Radiated emissions test setup 30 MHz - 1 GHz**



**Radiated emissions test setup above 1 GHz**



|                       |                                    |
|-----------------------|------------------------------------|
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### 8.6.3 Test Procedure

According to section 8.6 in KDB 558074 D01 DTS Meas Guidance v05 and subclause 11.12.2.7 Radiated spurious emission measurements in ANSI C62.10-2013 as well as the procedures for maximizing and measuring radiated emissions that are described in ANSI C63.10 was followed. Boresight antenna mast was used during the scanning to point to EUT to maximize the emission. The process will be repeated in 3 EUT orientations.

1. The EUT was switched on and allowed to warm up to its normal operating condition.
2. The test was carried out at the selected frequency points obtained from the EUT characterization. Maximization of the emissions, was carried out by rotating the EUT, changing the antenna polarization, and adjusting the antenna height in the following manner:
  - a. Vertical or horizontal polarization (whichever gave the higher emission level over a full rotation of the EUT) was chosen.
  - b. The EUT was then rotated to the direction that gave the maximum emission.
  - c. Finally, the antenna height was adjusted to the height that gave the maximum emission.
3. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 300 Hz for frequency below 150KHz.
4. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 10 kHz for frequency between 150KHz – 30MHz.
5. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-Peak detection at frequency between 30MHz - 1GHz.
6. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and video bandwidth is 3MHz with Peak detection for Peak and average measurement at frequency above 1GHz.
7. Steps 2 and 3 were repeated for the next frequency point, until all selected frequency points were measured.

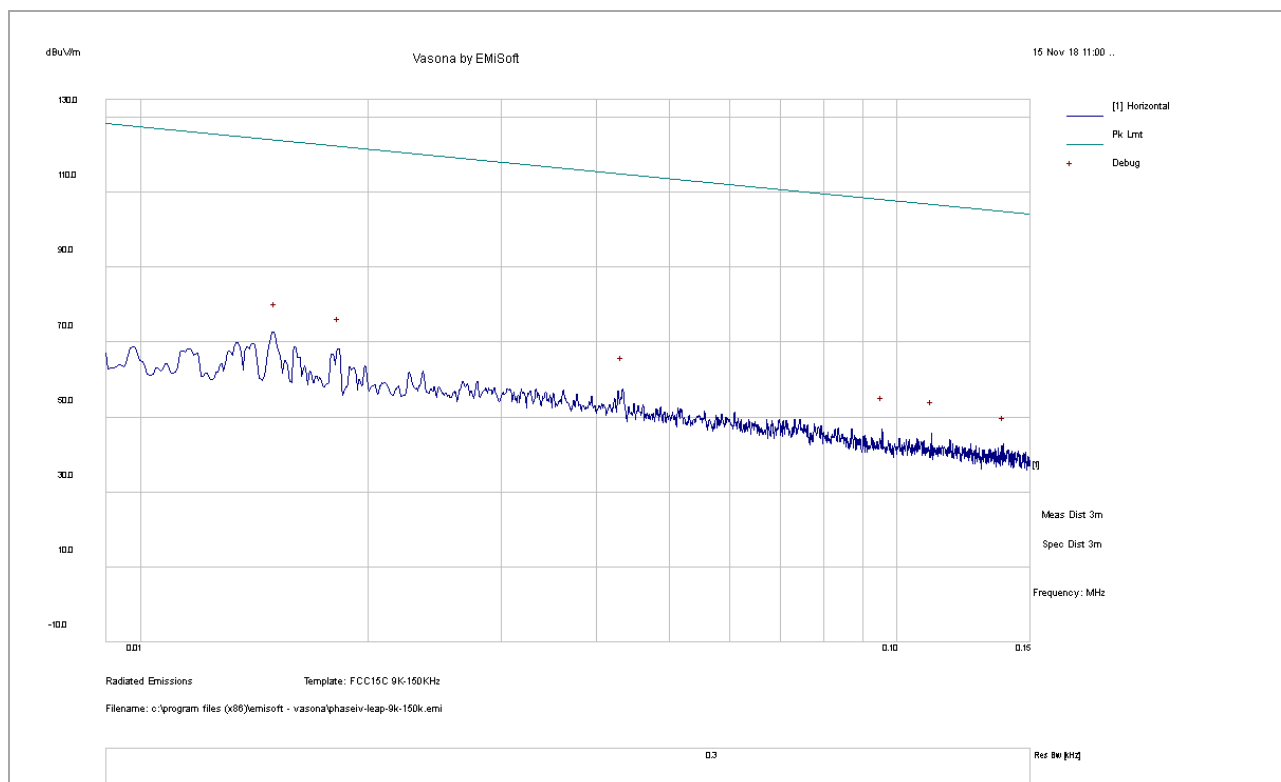
|                       |                                    |
|-----------------------|------------------------------------|
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## 8.6.4 Test Result

### 9KHz – 150KHz test result

|                               |                                  |                        |                    |
|-------------------------------|----------------------------------|------------------------|--------------------|
| <b>Test Standard:</b>         | <b>47CFR 15.209</b>              | <b>Mode:</b>           | <b>2440MHz</b>     |
| <b>Frequency Range:</b>       | <b>Below 150KHz</b>              | <b>Test Date:</b>      | <b>11/14/2018</b>  |
| <b>Antenna Type/Polarity:</b> | <b>Loop / 0 deg &amp; 90 deg</b> | <b>Test Personnel:</b> | <b>Sherwin Lee</b> |
| <b>Remark:</b>                | <b>Internal antenna</b>          | <b>Test Result:</b>    | <b>Pass</b>        |



| Frequency MHz | Raw dB | Cable dB | AF dB | Level dBuV/m | Det | Pol deg | Height cm | Table cm | Limit dBuV/m | Margin dB |
|---------------|--------|----------|-------|--------------|-----|---------|-----------|----------|--------------|-----------|
| 0.015         | 60.54  | 0.35     | 10.84 | 71.73        | PK  | 0       | 100       | 182      | 124.05       | -52.32    |
| 0.018         | 56.28  | 0.37     | 11.16 | 67.81        | PK  | 0       | 100       | 12       | 122.35       | -54.54    |
| 0.043         | 43.87  | 0.46     | 13.04 | 57.36        | PK  | 0       | 100       | 10       | 114.86       | -57.50    |
| 0.096         | 35.33  | 0.54     | 10.78 | 46.65        | PK  | 0       | 100       | 0        | 108.00       | -61.35    |
| 0.111         | 34.04  | 0.55     | 11.00 | 45.59        | PK  | 0       | 100       | 38       | 106.69       | -61.10    |
| 0.138         | 29.81  | 0.57     | 11.00 | 41.38        | PK  | 0       | 100       | 90       | 104.79       | -63.41    |

Note: 1) Both 0 deg and 90 deg setup of the loop antenna have been verified and the worst case result is presented here.

2) All different antenna versions have been verified and the worst case result is presented here.

3) EUT was tested in 3 orientations.



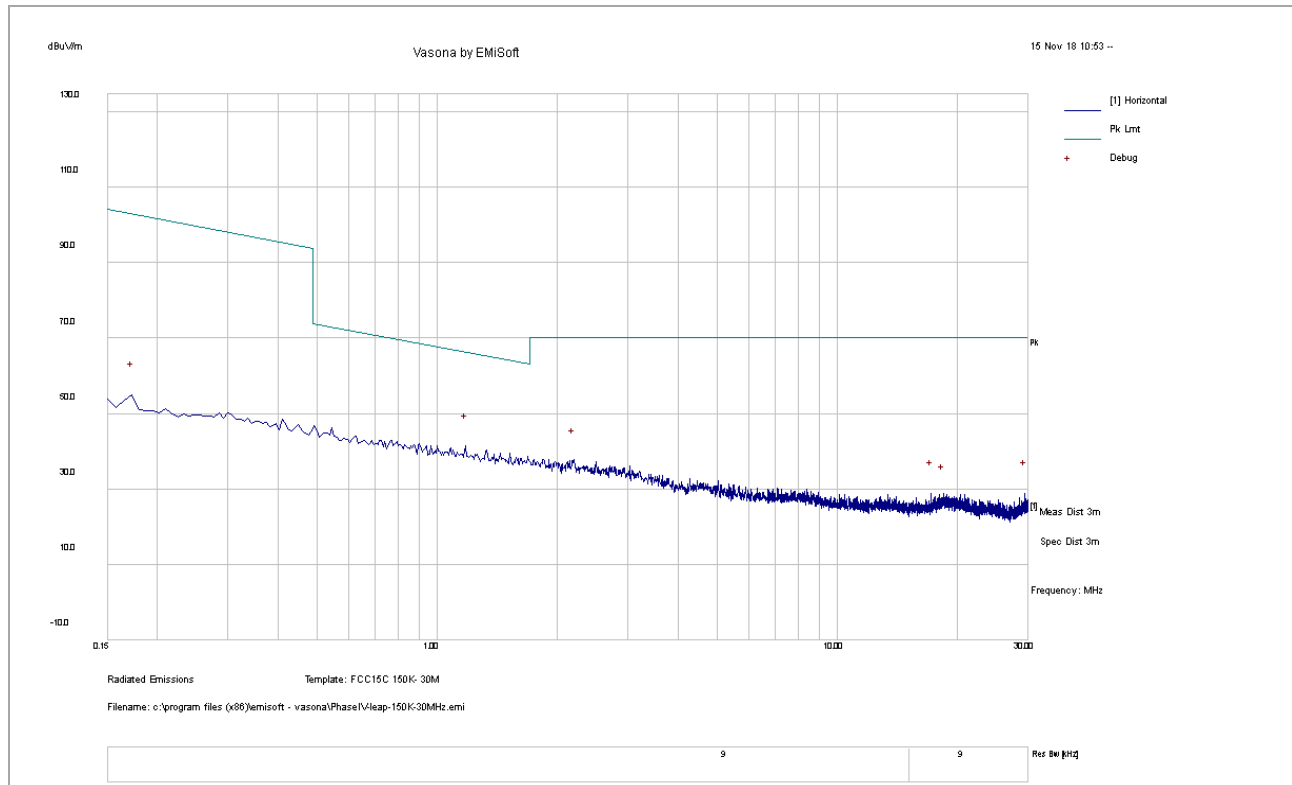
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### 150KHz – 30MHz test result

|                               |                                  |                        |                    |
|-------------------------------|----------------------------------|------------------------|--------------------|
| <b>Test Standard:</b>         | <b>47CFR 15.209</b>              | <b>Mode:</b>           | <b>2440MHz</b>     |
| <b>Frequency Range:</b>       | <b>150KHz – 30MHz</b>            | <b>Test Date:</b>      | <b>11/14/2018</b>  |
| <b>Antenna Type/Polarity:</b> | <b>Loop / 0 deg &amp; 90 deg</b> | <b>Test Personnel:</b> | <b>Sherwin Lee</b> |
| <b>Remark:</b>                | <b>N/A</b>                       | <b>Test Result:</b>    | <b>Pass</b>        |



| Frequency MHz | Raw dB | Cable dB | AF dB | Level dBuV/m | Det | Pol deg | Height cm | Table cm | Limit dBuV/m | Margin dB |
|---------------|--------|----------|-------|--------------|-----|---------|-----------|----------|--------------|-----------|
| 0.173         | 43.25  | 0.60     | 11.00 | 54.85        | PK  | 0       | 100       | 62       | 102.84       | -47.99    |
| 1.179         | 27.48  | 0.79     | 12.97 | 41.24        | PK  | 0       | 100       | 88       | 66.17        | -24.93    |
| 2.184         | 23.15  | 0.85     | 13.18 | 37.18        | PK  | 0       | 100       | 13       | 70.00        | -32.82    |
| 17.180        | 13.54  | 1.60     | 13.61 | 28.76        | PK  | 0       | 100       | 102      | 70.00        | -41.24    |
| 18.399        | 12.10  | 1.68     | 13.92 | 27.70        | PK  | 0       | 100       | 9        | 70.00        | -42.30    |
| 29.416        | 14.98  | 2.20     | 11.49 | 28.67        | PK  | 0       | 100       | 360      | 70.00        | -41.33    |

Note: 1) Both 0 deg and 90 deg setup of the loop antenna have been verified and the worst case result is presented here.

2) All different antenna versions have been verified and the worst case result is presented here.

3) EUT was tested in 3 orientations.



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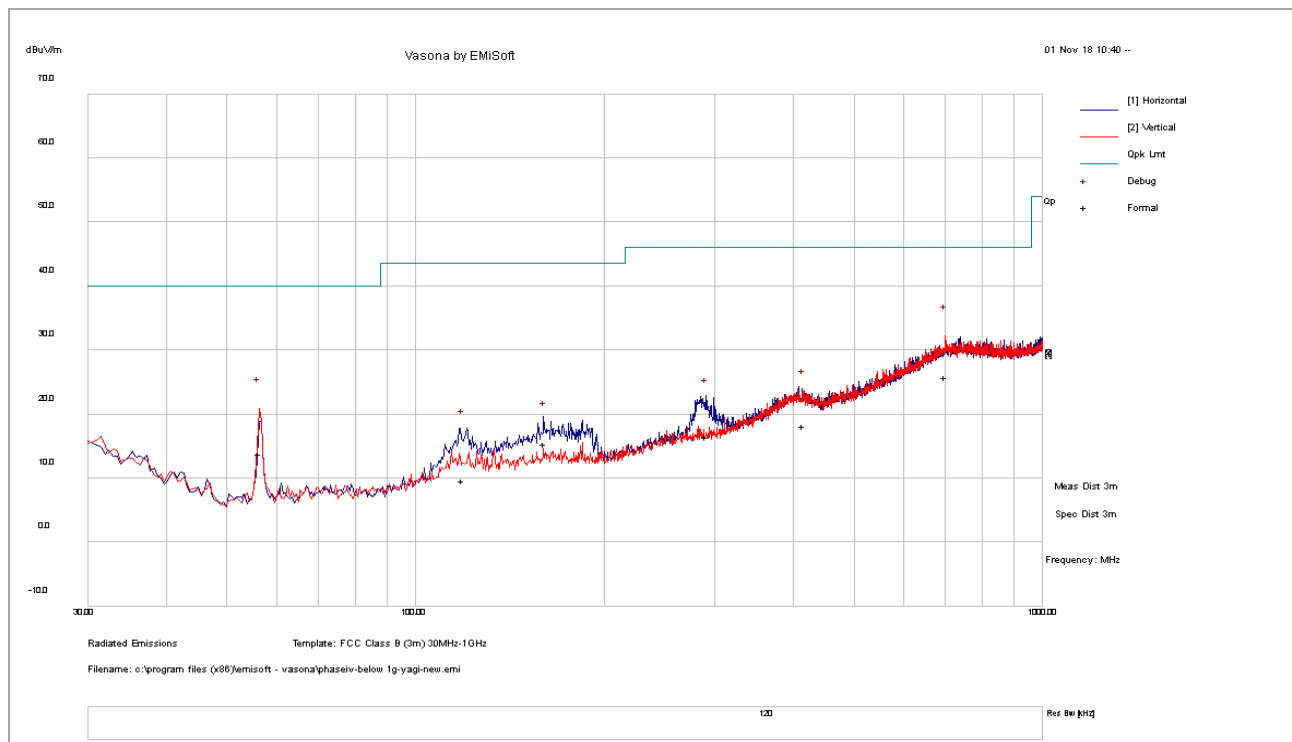
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**Model Number:** 44-100312-00, 44-100312-01



### 30-1000MHz test result for Yagi antenna

|                               |                             |                        |                    |
|-------------------------------|-----------------------------|------------------------|--------------------|
| <b>Test Standard:</b>         | <b>47CFR 15.209</b>         | <b>Mode:</b>           | <b>2440MHz</b>     |
| <b>Frequency Range:</b>       | <b>30-1000MHz</b>           | <b>Test Date:</b>      | <b>11/01/2018</b>  |
| <b>Antenna Type/Polarity:</b> | <b>Bi-Log/Hor &amp; Ver</b> | <b>Test Personnel:</b> | <b>Sherwin Lee</b> |
| <b>Remark:</b>                | <b>N/A</b>                  | <b>Test Result:</b>    | <b>Pass</b>        |



| Frequency MHz | Raw dB | Cable dB | AF dB  | Level dBuV/m | Det | Pol deg | Height cm | Table cm | Limit dBuV/m | Margin dB |
|---------------|--------|----------|--------|--------------|-----|---------|-----------|----------|--------------|-----------|
| 56.43         | 35.71  | 2.93     | -24.71 | 13.92        | QP  | V       | 399       | 286      | 40           | -26.08    |
| 118.93        | 29.05  | 3.86     | -23.19 | 9.71         | QP  | H       | 384       | 57       | 43.5         | -33.79    |
| 160.85        | 33.34  | 4.36     | -22.34 | 15.36        | QP  | H       | 119       | 62       | 43.5         | -28.14    |
| 290.59        | 29.75  | 5.6      | -18.82 | 16.54        | QP  | H       | 150       | 354      | 46           | -29.46    |
| 414.71        | 25.57  | 6.32     | -13.64 | 18.25        | QP  | H       | 224       | 44       | 46           | -27.75    |
| 700.03        | 24.98  | 7.31     | -6.43  | 25.87        | QP  | V       | 324       | 28       | 46           | -20.13    |

Note: For below 1GHz, all different channel and modes were verified but only the worst case result is shown here. EUT was tested in 3 orientations.

|                       |                                    |
|-----------------------|------------------------------------|
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| <b>Model Number:</b>  | 44-100312-00, 44-100312-01         |

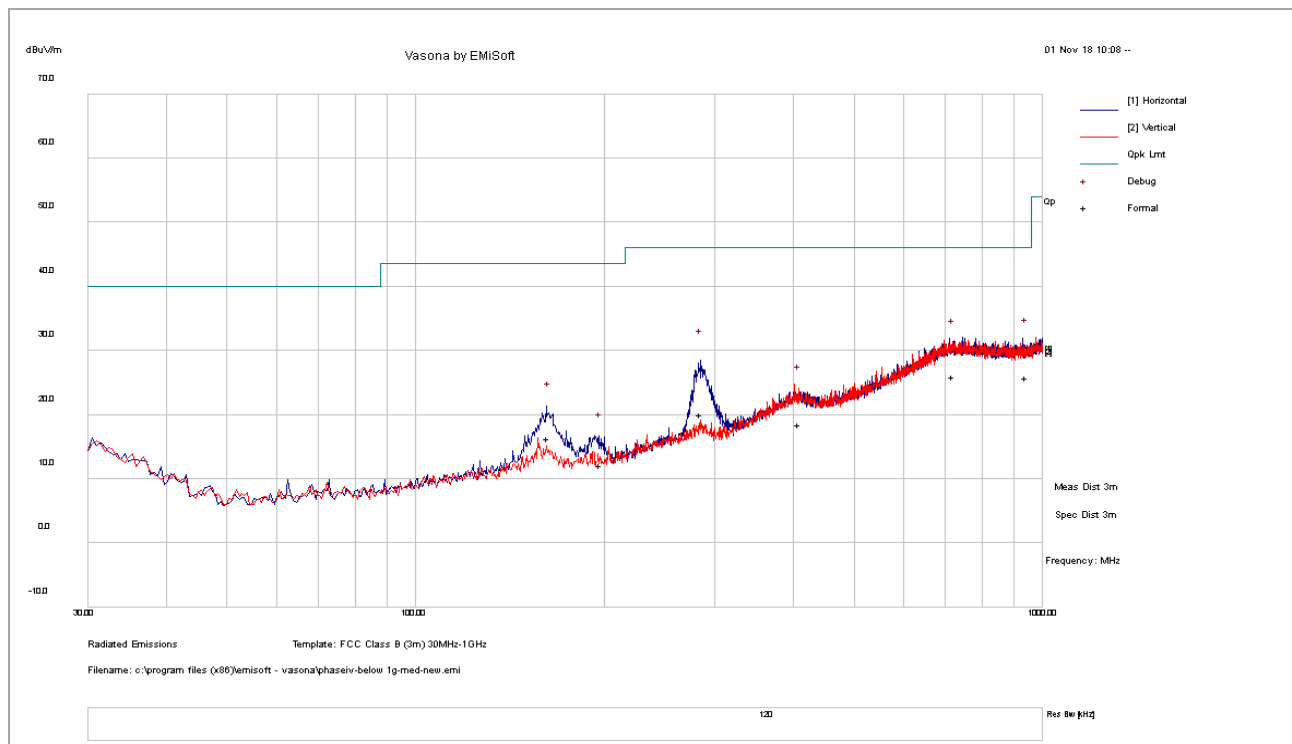


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Testing Cert #4848-01

### 30-1000MHz test result for monopole antenna

|                        |                  |                 |             |
|------------------------|------------------|-----------------|-------------|
| Test Standard:         | 47CFR 15.209     | Mode:           | 2440MHz     |
| Frequency Range:       | 30-1000MHz       | Test Date:      | 11/01/2018  |
| Antenna Type/Polarity: | Bi-Log/Hor & Ver | Test Personnel: | Sherwin Lee |
| Remark:                | N/A              | Test Result:    | Pass        |



| Frequency MHz | Raw dB | Cable dB | AF dB  | Level dBuV/m | Det | Pol deg | Height cm | Table cm | Limit dBuV/m | Margin dB |
|---------------|--------|----------|--------|--------------|-----|---------|-----------|----------|--------------|-----------|
| 162.81        | 34.21  | 4.38     | -22.31 | 16.27        | QP  | H       | 188       | 170      | 43.5         | -27.23    |
| 196.87        | 29.33  | 4.7      | -21.85 | 12.19        | QP  | H       | 115       | 26       | 43.5         | -31.31    |
| 284.40        | 33.46  | 5.55     | -18.88 | 20.14        | QP  | H       | 152       | 356      | 46           | -25.86    |
| 408.04        | 25.65  | 6.34     | -13.54 | 18.45        | QP  | V       | 280       | 136      | 46           | -27.55    |
| 719.31        | 25.23  | 7.3      | -6.5   | 26.03        | QP  | H       | 314       | 317      | 46           | -19.97    |
| 940.52        | 24.88  | 7.77     | -6.79  | 25.85        | QP  | H       | 321       | 198      | 46           | -20.15    |

Note: For below 1GHz, all different channel and modes were verified but only the worst case result is shown here. EUT was tested in 3 orientations



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**Model Number:** 44-100312-00, 44-100312-01

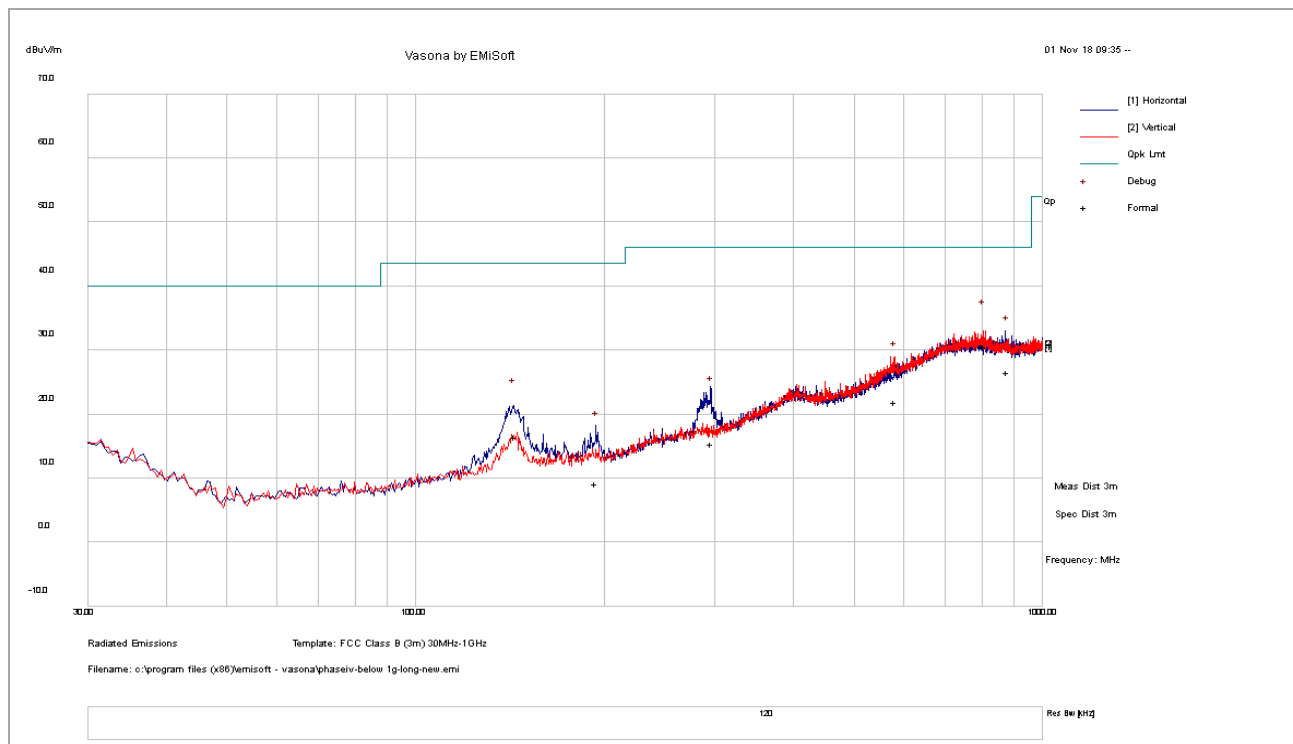


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Testing Cert #4848-01

### 30-1000MHz test result for folded dipole (long) antenna

|                               |                             |                        |                    |
|-------------------------------|-----------------------------|------------------------|--------------------|
| <b>Test Standard:</b>         | <b>47CFR 15.209</b>         | <b>Mode:</b>           | <b>2440MHz</b>     |
| <b>Frequency Range:</b>       | <b>30-1000MHz</b>           | <b>Test Date:</b>      | <b>11/01/2018</b>  |
| <b>Antenna Type/Polarity:</b> | <b>Bi-Log/Hor &amp; Ver</b> | <b>Test Personnel:</b> | <b>Sherwin Lee</b> |
| <b>Remark:</b>                | <b>N/A</b>                  | <b>Test Result:</b>    | <b>Pass</b>        |



| Frequency MHz | Raw dB | Cable dB | AF dB  | Level dBuV/m | Det | Pol deg | Height cm | Table cm | Limit dBuV/m | Margin dB |
|---------------|--------|----------|--------|--------------|-----|---------|-----------|----------|--------------|-----------|
| 144.03        | 34.88  | 4.18     | -22.63 | 16.42        | QP  | H       | 257       | 192      | 43.5         | -27.08    |
| 194.29        | 26.34  | 4.68     | -21.88 | 9.15         | QP  | H       | 350       | 0        | 43.5         | -34.35    |
| 297.18        | 28.48  | 5.66     | -18.75 | 15.39        | QP  | H       | 129       | 101      | 46           | -30.61    |
| 580.86        | 25.35  | 6.97     | -10.41 | 21.92        | QP  | H       | 228       | 86       | 46           | -24.08    |
| 805.29        | 30.22  | 7.26     | -6.79  | 30.69        | QP  | V       | 149       | 70       | 46           | -15.31    |
| 878.38        | 26.16  | 7.53     | -7.14  | 26.56        | QP  | H       | 103       | 300      | 46           | -19.44    |

Note: For below 1GHz, all different channel and modes were verified but only the worst case result is shown here. EUT was tested in 3 orientations



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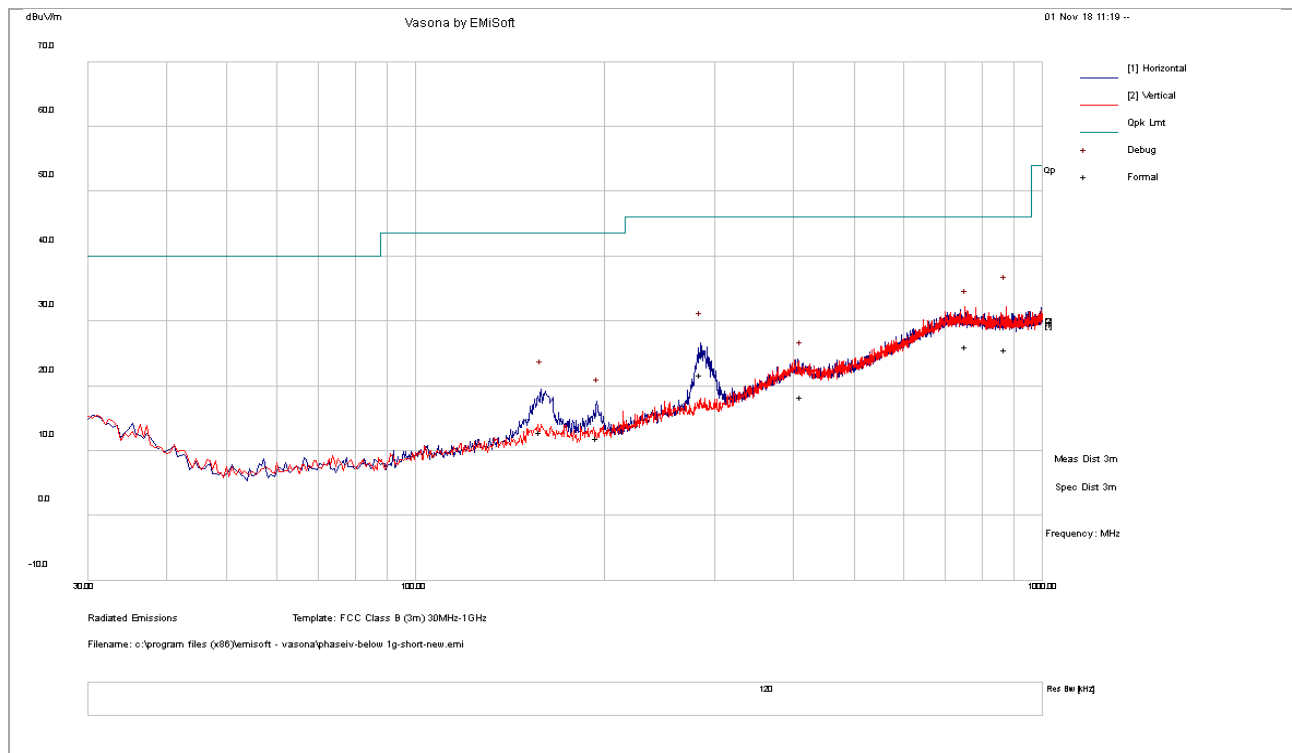
**Report Number:** PFE-18100201-LC-FCC-RF-LEAP Rev1.1  
**Product:** Leap 2.4GHz RF Module  
**Model Number:** 44-100312-00, 44-100312-01



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### 30-1000MHz test result for folded dipole (short) antenna

|                               |                             |                        |                    |
|-------------------------------|-----------------------------|------------------------|--------------------|
| <b>Test Standard:</b>         | <b>47CFR 15.209</b>         | <b>Mode:</b>           | <b>2440MHz</b>     |
| <b>Frequency Range:</b>       | <b>30-1000MHz</b>           | <b>Test Date:</b>      | <b>10/20/2018</b>  |
| <b>Antenna Type/Polarity:</b> | <b>Bi-Log/Hor &amp; Ver</b> | <b>Test Personnel:</b> | <b>Sherwin Lee</b> |
| <b>Remark:</b>                | <b>N/A</b>                  | <b>Test Result:</b>    | <b>Pass</b>        |



| Frequency MHz | Raw dB | Cable dB | AF dB  | Level dBuV/m | Det | Pol deg | Height cm | Table cm | Limit dBuV/m | Margin dB |
|---------------|--------|----------|--------|--------------|-----|---------|-----------|----------|--------------|-----------|
| 158.14        | 31     | 4.34     | -22.39 | 12.95        | QP  | H       | 258       | 41       | 43.5         | -30.55    |
| 195.04        | 29.09  | 4.69     | -21.87 | 11.91        | QP  | H       | 108       | 0        | 43.5         | -31.59    |
| 284.92        | 35.06  | 5.56     | -18.88 | 21.74        | QP  | H       | 101       | 105      | 46           | -24.26    |
| 412.05        | 25.55  | 6.33     | -13.6  | 18.28        | QP  | H       | 103       | 0        | 46           | -27.72    |
| 754.01        | 25.46  | 7.28     | -6.62  | 26.12        | QP  | H       | 202       | 132      | 46           | -19.88    |
| 872.81        | 25.19  | 7.51     | -7.11  | 25.59        | QP  | V       | 128       | 349      | 46           | -20.41    |

Note: For below 1GHz, all different channel and modes were verified but only the worst case result is shown here. EUT was tested in 3 orientations



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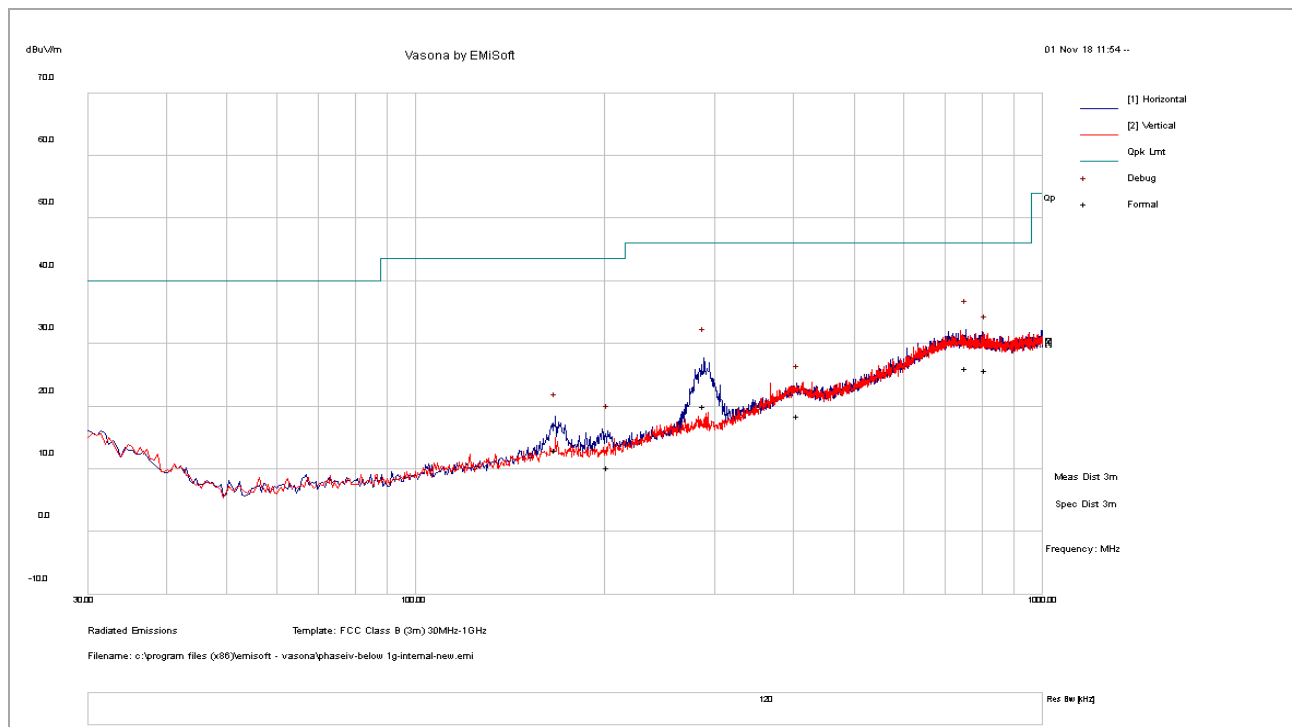
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**Product:** Leap 2.4GHz RF Module  
**Model Number:** 44-100312-00, 44-100312-01



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### 30-1000MHz test result for internal antenna

|                               |                             |                        |                    |
|-------------------------------|-----------------------------|------------------------|--------------------|
| <b>Test Standard:</b>         | <b>47CFR 15.209</b>         | <b>Mode:</b>           | <b>2440MHz</b>     |
| <b>Frequency Range:</b>       | <b>30-1000MHz</b>           | <b>Test Date:</b>      | <b>10/20/2018</b>  |
| <b>Antenna Type/Polarity:</b> | <b>Bi-Log/Hor &amp; Ver</b> | <b>Test Personnel:</b> | <b>Sherwin Lee</b> |
| <b>Remark:</b>                | <b>N/A</b>                  | <b>Test Result:</b>    | <b>Pass</b>        |



| Frequency MHz | Raw dB | Cable dB | AF dB  | Level dBuV/m | Det | Pol deg | Height cm | Table cm | Limit dBuV/m | Margin dB |
|---------------|--------|----------|--------|--------------|-----|---------|-----------|----------|--------------|-----------|
| 167.04        | 30.94  | 4.43     | -22.25 | 13.11        | QP  | H       | 124       | 14       | 43.5         | -30.39    |
| 202.67        | 27.19  | 4.76     | -21.65 | 10.3         | QP  | H       | 272       | 360      | 43.5         | -33.2     |
| 288.03        | 33.31  | 5.58     | -18.84 | 20.05        | QP  | H       | 155       | 1        | 46           | -25.95    |
| 406.96        | 25.63  | 6.35     | -13.53 | 18.45        | QP  | H       | 127       | 40       | 46           | -27.55    |
| 754.09        | 25.46  | 7.27     | -6.62  | 26.11        | QP  | H       | 169       | 46       | 46           | -19.89    |
| 813.23        | 25.3   | 7.29     | -6.83  | 25.76        | QP  | H       | 376       | 129      | 46           | -20.24    |

Note: For below 1GHz, all different channel and modes were verified but only the worst case result is shown here. EUT was tested in 3 orientations



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| <b>Model Number:</b>  | 44-100312-00, 44-100312-01         |



# 1GHz – 25GHz Test Result for Internal Antenna

## Test Mode: 2405MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margin dB | Pass /Fail |
|-----------|----------|------------|-------|--------------|------------|-----|--------|-----|--------------|-----------|------------|
| 1276.14   | 44.84    | 4.09       | -11.7 | 37.23        | Peak       | V   | 299    | 287 | 74           | -36.77    | Pass       |
| 1276.14   | 31.15    | 4.09       | -11.7 | 23.54        | Average    | V   | 299    | 287 | 54           | -30.46    | Pass       |
| 4813.11   | 38.81    | 6.87       | -5.53 | 40.15        | Peak       | V   | 185    | 95  | 74           | -33.85    | Pass       |
| 4813.11   | 27.22    | 6.87       | -5.53 | 28.56        | Average    | V   | 185    | 95  | 54           | -25.44    | Pass       |
| 13809.19  | 33.61    | 13.58      | 5.57  | 52.75        | Peak       | V   | 280    | 200 | 74           | -21.25    | Pass       |
| 13809.19  | 21.36    | 13.58      | 5.57  | 40.51        | Average    | V   | 280    | 200 | 54           | -13.5     | Pass       |
| 14340.84  | 32.56    | 14.5       | 8.36  | 55.42        | Peak       | H   | 100    | 280 | 74           | -18.58    | Pass       |
| 14340.84  | 20.34    | 14.5       | 8.36  | 43.2         | Average    | H   | 100    | 280 | 54           | -10.8     | Pass       |

## Test Mode: 2440MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB  | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margin dB | Pass /Fail |
|-----------|----------|------------|--------|--------------|------------|-----|--------|-----|--------------|-----------|------------|
| 1224.31   | 50.51    | 4          | -11.86 | 42.65        | Peak       | H   | 144    | 102 | 74           | -31.35    | Pass       |
| 1224.31   | 32.73    | 4          | -11.86 | 24.87        | Average    | H   | 144    | 102 | 54           | -29.14    | Pass       |
| 4878.99   | 46.14    | 6.89       | -5.55  | 47.49        | Peak       | H   | 104    | 289 | 74           | -26.51    | Pass       |
| 4878.99   | 36.68    | 6.89       | -5.55  | 38.03        | Average    | H   | 104    | 289 | 54           | -15.97    | Pass       |
| 14343.37  | 31.77    | 14.5       | 8.37   | 54.64        | Peak       | H   | 109    | 27  | 74           | -19.36    | Pass       |
| 14343.37  | 20.25    | 14.5       | 8.37   | 43.12        | Peak       | H   | 109    | 27  | 54           | -10.88    | Pass       |

## Test Mode: 2470MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB  | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margin dB | Pass /Fail |
|-----------|----------|------------|--------|--------------|------------|-----|--------|-----|--------------|-----------|------------|
| 1225.32   | 18.17    | 4          | -11.86 | 10.31        | Peak       | V   | 302    | 103 | 74           | -63.69    | Pass       |
| 1225.32   | 6        | 4          | -11.86 | -1.86        | Peak       | V   | 302    | 103 | 54           | -55.86    | Pass       |
| 13807.21  | 33.23    | 13.58      | 5.56   | 52.37        | Peak       | V   | 140    | 216 | 74           | -21.63    | Pass       |
| 13807.21  | 21.54    | 13.58      | 5.56   | 40.68        | Average    | V   | 140    | 216 | 54           | -13.32    | Pass       |
| 14347.29  | 30.97    | 14.51      | 8.38   | 53.86        | Peak       | H   | 158    | 289 | 74           | -20.14    | Pass       |
| 14347.29  | 19.81    | 14.51      | 8.38   | 42.7         | Average    | H   | 158    | 289 | 54           | -11.3     | Pass       |
| 17482.32  | 17.49    | 17.15      | 10.97  | 45.62        | Peak       | H   | 338    | 24  | 74           | -28.39    | Pass       |
| 17482.32  | 5.74     | 17.15      | 10.97  | 33.86        | Peak       | H   | 338    | 24  | 54           | -20.14    | Pass       |

Note: EUT was tested in 3 orientations



Electromagnetic Compatibility  
Radio Frequency  
Product Certification  
International Approval

1261 Puerta Del Sol  
San Clemente, CA, 92673  
+1 (949) 393-1123  
[www.vista-compliance.com](http://www.vista-compliance.com)

|                       |                                    |
|-----------------------|------------------------------------|
| <b>Report Number:</b> | PFE-18100201-LC-FCC-RF-LEAP Rev1.1 |
| <b>Product:</b>       | Leap 2.4GHz RF Module              |
| <b>Model Number:</b>  | 44-100312-00, 44-100312-01         |



### 1GHz – 25GHz Test Result for Yagi Antenna

#### Test Mode: 2405MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margin dB | Pass /Fail |
|-----------|----------|------------|-------|--------------|------------|-----|--------|-----|--------------|-----------|------------|
| 14346.73  | 32.31    | 14.51      | 8.38  | 55.2         | Peak       | H   | 380    | 219 | 74           | -18.8     | Pass       |
| 14346.73  | 19.9     | 14.51      | 8.38  | 42.79        | Average    | H   | 380    | 219 | 54           | -11.21    | Pass       |
| 17183.03  | 21.62    | 16.78      | 10.65 | 49.05        | Peak       | V   | 201    | 247 | 74           | -24.95    | Pass       |
| 17183.03  | 9.61     | 16.78      | 10.65 | 37.04        | Average    | V   | 201    | 247 | 54           | -16.96    | Pass       |

#### Test Mode: 2440MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margin dB | Pass /Fail |
|-----------|----------|------------|-------|--------------|------------|-----|--------|-----|--------------|-----------|------------|
| 14335.48  | 32.73    | 14.48      | 8.35  | 55.56        | Peak       | H   | 294    | 360 | 74           | -18.44    | Pass       |
| 14335.48  | 20.39    | 14.48      | 8.35  | 43.22        | Average    | H   | 294    | 360 | 54           | -10.78    | Pass       |
| 17490.32  | 21.63    | 17.16      | 11.08 | 49.87        | Peak       | V   | 104    | 262 | 74           | -24.13    | Pass       |
| 17490.32  | 9.78     | 17.16      | 11.08 | 38.02        | Average    | V   | 104    | 262 | 54           | -15.98    | Pass       |

#### Test Mode: 2470MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margin dB | Pass /Fail |
|-----------|----------|------------|-------|--------------|------------|-----|--------|-----|--------------|-----------|------------|
| 11073.57  | 34.68    | 12.59      | 2.6   | 49.87        | Peak       | H   | 151    | 18  | 74           | -24.13    | Pass       |
| 11073.57  | 22.69    | 12.59      | 2.6   | 37.89        | Average    | H   | 151    | 18  | 54           | -16.12    | Pass       |
| 14334.19  | 32.52    | 14.48      | 8.34  | 55.35        | Peak       | V   | 224    | 257 | 74           | -18.65    | Pass       |
| 14334.19  | 20.27    | 14.48      | 8.34  | 43.1         | Average    | V   | 224    | 257 | 54           | -10.9     | Pass       |

Note: EUT was tested in 3 orientations

|                       |                                    |
|-----------------------|------------------------------------|
| <b>Report Number:</b> | PFE-18100201-LC-FCC-RF-LEAP Rev1.1 |
| <b>Product:</b>       | Leap 2.4GHz RF Module              |
| <b>Model Number:</b>  | 44-100312-00, 44-100312-01         |



### 1GHz – 25GHz Test Result for Folded Dipole Antenna (Long)

#### Test Mode: 2405MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margi n dB | Pass /Fail |
|-----------|----------|------------|-------|--------------|------------|-----|--------|-----|--------------|------------|------------|
| 4809.03   | 48.3     | 6.87       | -5.53 | 49.64        | Peak       | H   | 178    | 292 | 74           | -24.36     | Pass       |
| 4809.03   | 40.2     | 6.87       | -5.53 | 41.54        | Average    | H   | 178    | 292 | 54           | -12.46     | Pass       |
| 14346.54  | 31.99    | 14.51      | 8.38  | 54.88        | Peak       | H   | 222    | 328 | 74           | -19.12     | Pass       |
| 14346.54  | 19.73    | 14.51      | 8.38  | 42.62        | Average    | H   | 222    | 328 | 54           | -11.38     | Pass       |
| 14558.51  | 30.85    | 15.02      | 7.11  | 52.99        | Peak       | V   | 294    | 232 | 74           | -21.01     | Pass       |
| 14558.51  | 18.87    | 15.02      | 7.11  | 41.01        | Average    | V   | 294    | 232 | 54           | -12.99     | Pass       |

#### Test Mode: 2440MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margi n dB | Pass /Fail |
|-----------|----------|------------|-------|--------------|------------|-----|--------|-----|--------------|------------|------------|
| 1329.67   | 43.82    | 4.18       | -11.7 | 36.31        | Peak       | V   | 334    | 54  | 74           | -37.69     | Pass       |
| 1329.67   | 32.5     | 4.18       | -11.7 | 24.99        | Average    | V   | 334    | 54  | 54           | -29.01     | Pass       |
| 4878.68   | 47.01    | 6.89       | -5.55 | 48.35        | Peak       | H   | 100    | 276 | 74           | -25.65     | Pass       |
| 4878.68   | 37       | 6.89       | -5.55 | 38.35        | Average    | H   | 100    | 276 | 54           | -15.66     | Pass       |
| 14333.61  | 32.18    | 14.48      | 8.34  | 55           | Peak       | V   | 160    | 286 | 74           | -19        | Pass       |
| 14333.61  | 20.13    | 14.48      | 8.34  | 42.95        | Average    | V   | 160    | 286 | 54           | -11.05     | Pass       |

#### Test Mode: 2470MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margi n dB | Pass /Fail |
|-----------|----------|------------|-------|--------------|------------|-----|--------|-----|--------------|------------|------------|
| 1275.88   | 48.42    | 4.09       | -11.7 | 40.82        | Peak       | V   | 312    | 301 | 74           | -33.18     | Pass       |
| 1275.88   | 32.18    | 4.09       | -11.7 | 24.58        | Average    | V   | 312    | 301 | 54           | -29.42     | Pass       |
| 4965.79   | 39.62    | 6.91       | -5.68 | 40.84        | Peak       | V   | 131    | 308 | 74           | -33.16     | Pass       |
| 4965.79   | 28.02    | 6.91       | -5.68 | 29.24        | Average    | V   | 131    | 308 | 54           | -24.76     | Pass       |
| 14261.72  | 30.35    | 14.3       | 8.12  | 52.77        | Peak       | V   | 310    | 203 | 74           | -21.23     | Pass       |
| 14261.72  | 18.08    | 14.3       | 8.12  | 40.51        | Average    | V   | 310    | 203 | 54           | -13.49     | Pass       |
| 14715.82  | 29.93    | 15.4       | 6.09  | 51.42        | Peak       | H   | 240    | 0   | 74           | -22.58     | Pass       |
| 14715.82  | 17.12    | 15.4       | 6.09  | 38.6         | Average    | H   | 240    | 0   | 54           | -15.4      | Pass       |

Note: EUT was tested in 3 orientations

|                       |                                    |
|-----------------------|------------------------------------|
| <b>Report Number:</b> | PFE-18100201-LC-FCC-RF-LEAP Rev1.1 |
| <b>Product:</b>       | Leap 2.4GHz RF Module              |
| <b>Model Number:</b>  | 44-100312-00, 44-100312-01         |



# 1GHz – 25GHz Test Result for Folded Dipole Antenna (Short)

## Test Mode: 2405MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB  | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margin dB | Pass /Fail |
|-----------|----------|------------|--------|--------------|------------|-----|--------|-----|--------------|-----------|------------|
| 1224.29   | 57.16    | 4          | -11.86 | 49.3         | Peak       | V   | 115    | 275 | 74           | -24.7     | Pass       |
| 1224.29   | 33.23    | 4          | -11.86 | 25.37        | Average    | V   | 115    | 275 | 54           | -28.63    | Pass       |
| 4809.04   | 46.89    | 6.87       | -5.53  | 48.23        | Peak       | V   | 125    | 344 | 74           | -25.78    | Pass       |
| 4809.04   | 38.41    | 6.87       | -5.53  | 39.75        | Average    | V   | 125    | 344 | 54           | -14.25    | Pass       |
| 14334.03  | 32.71    | 14.48      | 8.34   | 55.53        | Peak       | H   | 400    | 274 | 74           | -18.47    | Pass       |
| 14334.03  | 20.33    | 14.48      | 8.34   | 43.16        | Average    | H   | 400    | 274 | 54           | -10.84    | Pass       |

## Test Mode: 2440MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB  | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margin dB | Pass /Fail |
|-----------|----------|------------|--------|--------------|------------|-----|--------|-----|--------------|-----------|------------|
| 1224.37   | 45.1     | 4          | -11.86 | 37.24        | Peak       | V   | 377    | 294 | 74           | -36.77    | Pass       |
| 1224.37   | 32.6     | 4          | -11.86 | 24.74        | Average    | V   | 377    | 294 | 54           | -29.27    | Pass       |
| 4878.82   | 49.33    | 6.89       | -5.55  | 50.67        | Peak       | V   | 100    | 324 | 74           | -23.33    | Pass       |
| 4878.82   | 40.29    | 6.89       | -5.55  | 41.63        | Average    | V   | 100    | 324 | 54           | -12.37    | Pass       |
| 14333.22  | 32.03    | 14.48      | 8.34   | 54.85        | Peak       | H   | 336    | 307 | 74           | -19.15    | Pass       |
| 14333.22  | 20.19    | 14.48      | 8.34   | 43.01        | Average    | H   | 336    | 307 | 54           | -10.99    | Pass       |

## Test Mode: 2470MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB  | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margin dB | Pass /Fail |
|-----------|----------|------------|--------|--------------|------------|-----|--------|-----|--------------|-----------|------------|
| 1977.94   | 45.4     | 4.44       | -10.59 | 39.25        | Peak       | H   | 333    | 352 | 74           | -34.75    | Pass       |
| 1977.94   | 33.4     | 4.44       | -10.59 | 27.26        | Average    | H   | 333    | 352 | 54           | -26.74    | Pass       |
| 4961.79   | 43.09    | 6.91       | -5.7   | 44.31        | Peak       | V   | 108    | 150 | 74           | -29.7     | Pass       |
| 4961.79   | 31.58    | 6.91       | -5.7   | 32.8         | Average    | V   | 108    | 150 | 54           | -21.2     | Pass       |
| 14335.33  | 32.3     | 14.48      | 8.35   | 55.13        | Peak       | H   | 372    | 0   | 74           | -18.87    | Pass       |
| 14335.33  | 20.35    | 14.48      | 8.35   | 43.18        | Average    | H   | 372    | 0   | 54           | -10.82    | Pass       |

Note: EUT was tested in 3 orientations

|                       |                                    |
|-----------------------|------------------------------------|
| <b>Report Number:</b> | PFE-18100201-LC-FCC-RF-LEAP Rev1.1 |
| <b>Product:</b>       | Leap 2.4GHz RF Module              |
| <b>Model Number:</b>  | 44-100312-00, 44-100312-01         |



### 1GHz – 25GHz Test Result for Folded Dipole Antenna (Long)

#### Test Mode: 2405MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margi n dB | Pass /Fail |
|-----------|----------|------------|-------|--------------|------------|-----|--------|-----|--------------|------------|------------|
| 4813.07   | 27.08    | 6.87       | -5.53 | 28.42        | Average    | V   | 175    | 243 | 54           | -25.58     | Pass       |
| 4813.07   | 38.73    | 6.87       | -5.53 | 40.07        | Peak       | V   | 175    | 243 | 74           | -33.93     | Pass       |
| 14344.9   | 19.8     | 14.51      | 8.37  | 42.68        | Average    | H   | 156    | 345 | 54           | -11.32     | Pass       |
| 14344.9   | 32.16    | 14.51      | 8.37  | 55.04        | Peak       | H   | 156    | 345 | 74           | -18.96     | Pass       |
| 14495.33  | 17.85    | 14.87      | 7.61  | 40.33        | Average    | H   | 306    | 174 | 54           | -13.67     | Pass       |
| 14495.33  | 29.98    | 14.87      | 7.61  | 52.46        | Peak       | H   | 306    | 174 | 74           | -21.54     | Pass       |

#### Test Mode: 2440MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB  | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margi n dB | Pass /Fail |
|-----------|----------|------------|--------|--------------|------------|-----|--------|-----|--------------|------------|------------|
| 1320.54   | 33.94    | 4.17       | -11.67 | 26.44        | Average    | V   | 171    | 307 | 54           | -27.56     | Pass       |
| 1320.54   | 48.75    | 4.17       | -11.67 | 41.25        | Peak       | V   | 171    | 307 | 74           | -32.75     | Pass       |
| 4878.9    | 38       | 6.89       | -5.55  | 39.34        | Average    | V   | 101    | 327 | 54           | -14.66     | Pass       |
| 4878.9    | 47.1     | 6.89       | -5.55  | 48.44        | Peak       | V   | 101    | 327 | 74           | -25.56     | Pass       |
| 14332.6   | 34.5     | 26.7       | 8.34   | 49.52        | Average    | H   | 125    | 294 | 54           | -4.48      | Pass       |
| 14332.6   | 31.61    | 14.48      | 8.34   | 54.43        | Peak       | H   | 125    | 294 | 74           | -19.57     | Pass       |
| 14494.98  | 17.83    | 14.87      | 7.61   | 40.31        | Average    | H   | 281    | 13  | 54           | -13.69     | Pass       |
| 14494.98  | 29.76    | 14.87      | 7.61   | 52.24        | Peak       | H   | 281    | 13  | 74           | -21.76     | Pass       |

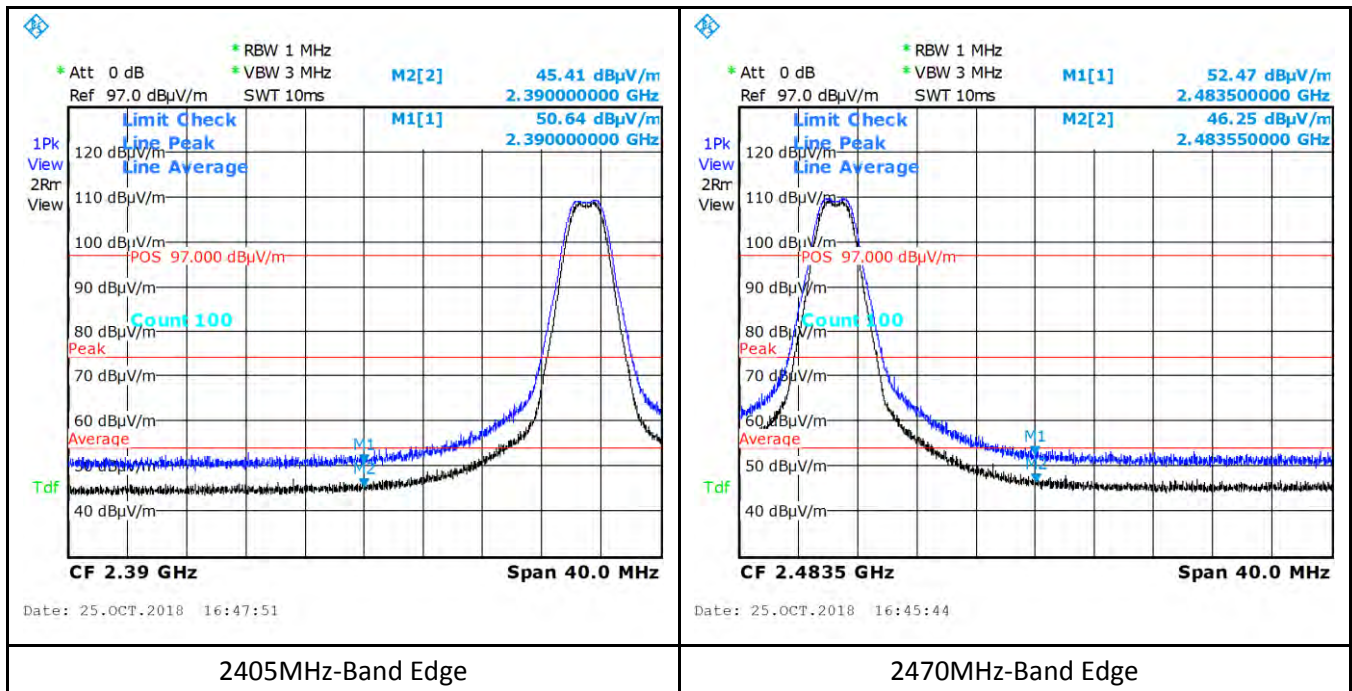
#### Test Mode: 2470MHz

| Freq. MHz | Raw dBuV | Cable Loss | AF dB  | Level dBuV/m | Meas. Type | Pol | Hgt cm | Deg | Limit dBuV/m | Margi n dB | Pass /Fail |
|-----------|----------|------------|--------|--------------|------------|-----|--------|-----|--------------|------------|------------|
| 1625.26   | 43.61    | 4.45       | -11.89 | 36.18        | Peak       | V   | 138    | 55  | 74           | -37.82     | Pass       |
| 1625.26   | 31.11    | 4.45       | -11.89 | 23.68        | Average    | V   | 138    | 55  | 54           | -30.32     | Pass       |
| 4961.56   | 44.93    | 6.91       | -5.7   | 46.14        | Peak       | V   | 113    | 339 | 74           | -27.86     | Pass       |
| 4961.56   | 34.25    | 6.91       | -5.7   | 35.46        | Average    | V   | 113    | 339 | 54           | -18.54     | Pass       |
| 14322.8   | 31.19    | 14.45      | 8.31   | 53.96        | Peak       | H   | 323    | 33  | 74           | -20.04     | Pass       |
| 14322.8   | 19.04    | 14.45      | 8.31   | 41.8         | Average    | H   | 323    | 33  | 54           | -12.2      | Pass       |

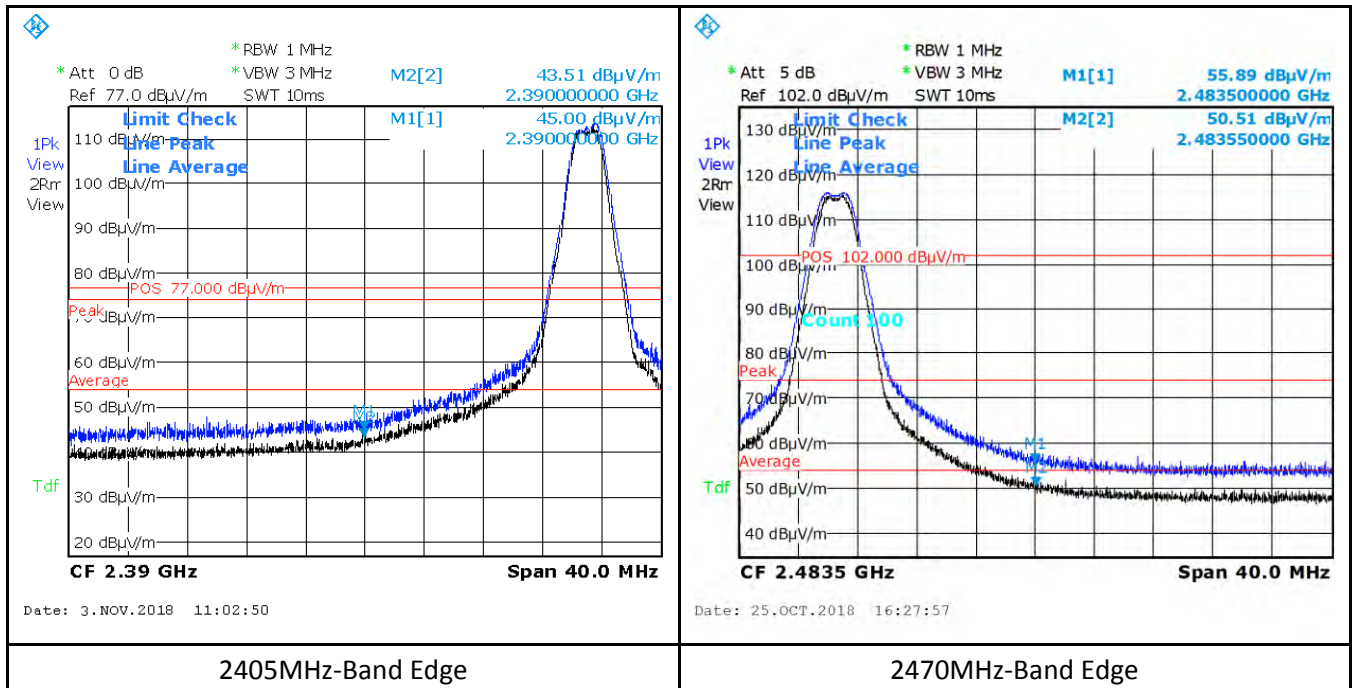
Note: EUT was tested in 3 orientations



### Radiated Band Edge Measurement Result for Internal Antenna

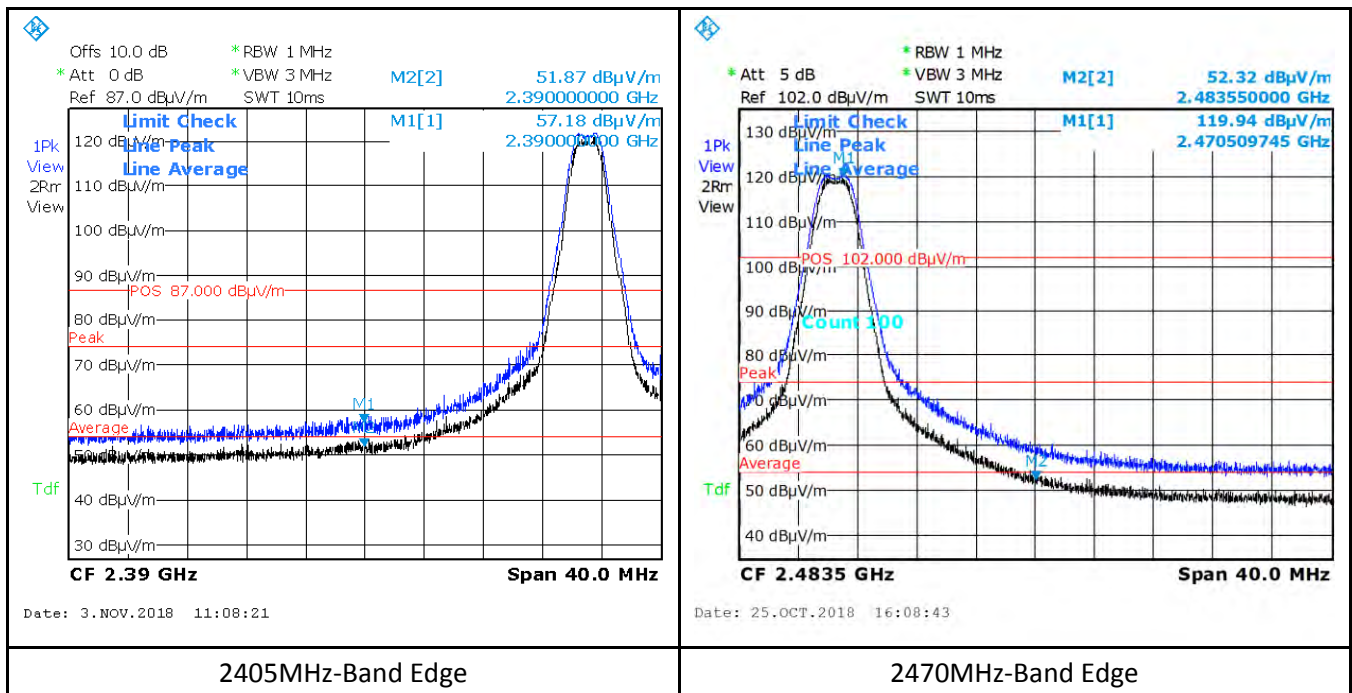


### Radiated Band Edge Measurement Result for Monopole Antenna



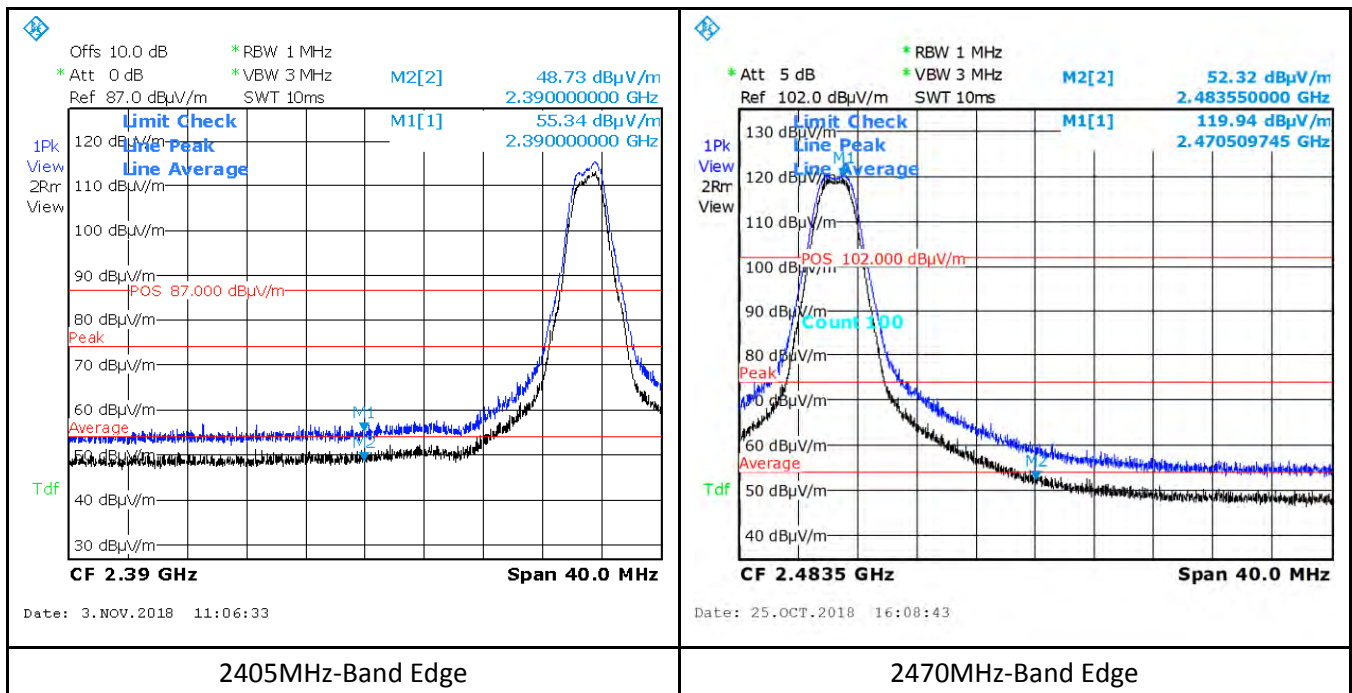


## Radiated Band Edge Measurement Result for Yagi Antenna



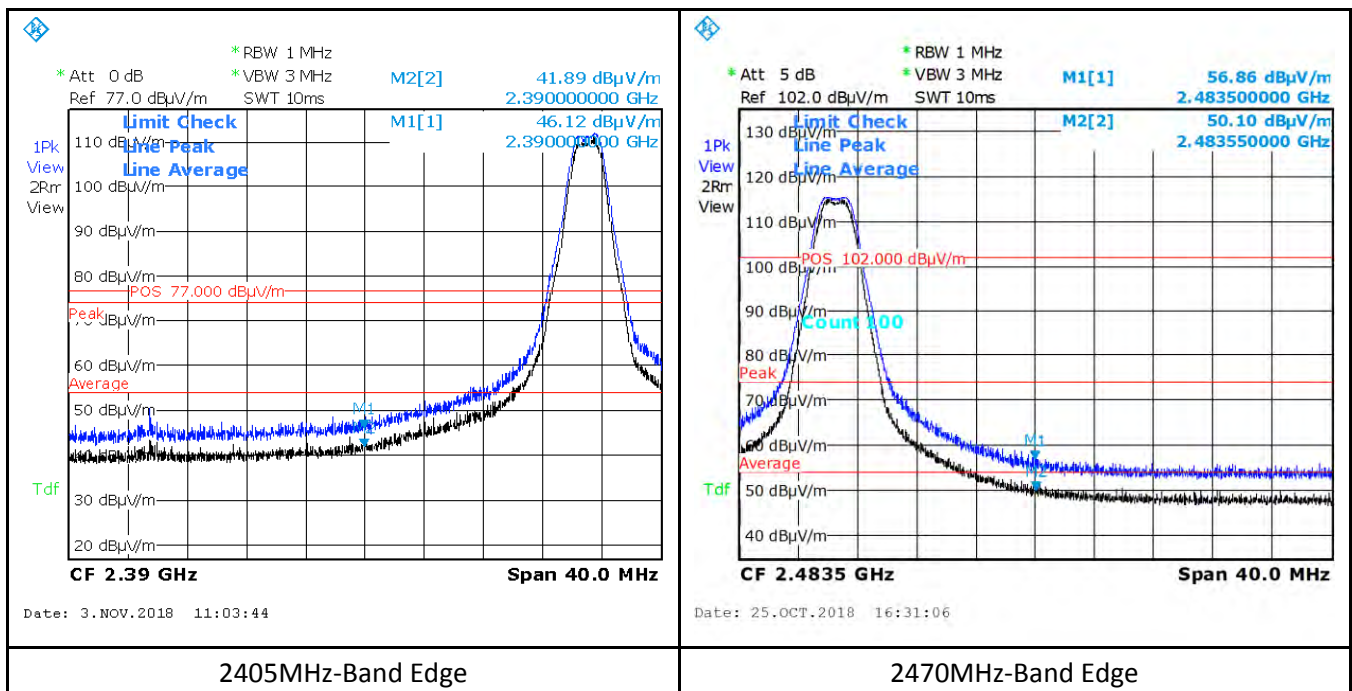
Note: Both Horizontal and vertical polarities were investigated.

### Radiated Band Edge Measurement Result for Folded Dipole Antenna (Long)



Note: Both Horizontal and vertical polarities were investigated.

### Radiated Band Edge Measurement Result for Folded Dipole Antenna (Short)



Note: Both Horizontal and vertical polarities were investigated.

## 8.7 Conducted Emissions

### 8.7.1 Requirement

Per § 15.207 (a), an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50  $\mu$ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

**Limits for Conducted Emissions at the Mains Ports**

| Section         | Frequency ranges (MHz) | Limit (dBuV) |         |
|-----------------|------------------------|--------------|---------|
|                 |                        | QP           | Average |
| Class B devices | 0.15 – 0.5             | 66 – 56      | 56 – 46 |
|                 | 0.5 – 5                | 56           | 46      |
|                 | 5 - 30                 | 60           | 50      |

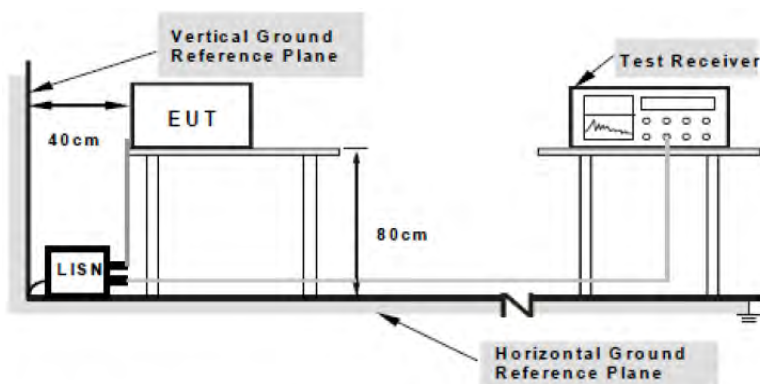
NOTE 1 The lower limit shall apply at the transition frequencies.

**Limits for Conducted Emissions at the Telecommunication Ports**

| Section         | Frequency ranges (MHz) | Limit (dBuV) |         |
|-----------------|------------------------|--------------|---------|
|                 |                        | QP           | Average |
| Class B devices | 0.15 – 0.5             | 85 – 74      | 74 – 64 |
|                 | 0.5 – 5                | 74           | 64      |

NOTE 1 The limits decrease linearly with the logarithm of the frequency in the range 0.15 MHz to 0.5 MHz  
NOTE 2 The voltage disturbance limits are derived for use with an impedance stabilization network (ISN) which presents a common mode (asymmetric mode) impedance of 150  $\Omega$  to the telecommunication port under test (conversion factor is 20 log<sub>10</sub> 150 / I = 44 dB).

### 8.7.2 Test setup



Note: 1. Support units were connected to second LISN.  
2. Both of LISNs (AMN) are 80cm from EUT and at least 80cm from other units and other metal planes support units.

|                       |                                    |
|-----------------------|------------------------------------|
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| <b>Product:</b>       | Leap 2.4GHz RF Module              |
| <b>Model Number:</b>  | 44-100312-00, 44-100312-01         |



### 8.7.3 Test Procedure

1. The EUT and supporting equipment were set up in accordance with the requirements of the standard on top of a 1.5m x 1m x 0.8m high, non-metallic table.
2. The power supply for the EUT was fed through a 50Ω/50μH EUT LISN, connected to filtered mains.
3. The RF OUT of the EUT LISN was connected to the EMI test receiver via a low-loss coaxial cable.
4. All other supporting equipment was powered separately from another main supply.
5. The EUT was switched on and allowed to warm up to its normal operating condition.
6. A scan was made on the NEUTRAL line (for AC mains) or Earth line (for DC power) over the required frequency range using an EMI test receiver.
7. High peaks, relative to the limit line, were then selected.
8. The EMI test receiver was then tuned to the selected frequencies and the necessary measurements made with a receiver bandwidth setting of 10 kHz. For FCC tests, only Quasi-peak measurements were made; while for CISPR/EN tests, both Quasi-peak and Average measurements were made
9. All possible modes of operation were investigated. Only the worst case emissions were measured and reported. All other emissions were relatively insignificant.

#### Note:

- 1) The AC line conducted emission was tested with antenna port terminated.
- 2) The AC line conducted emission was verified on both version boards and the worst case result tested with external antenna version is presented here.

**Report Number:** PFE-18100201-LC-FCC-RF-LEAP Rev1.1  
**Product:** Leap 2.4GHz RF Module  
**Model Number:** 44-100312-00, 44-100312-01



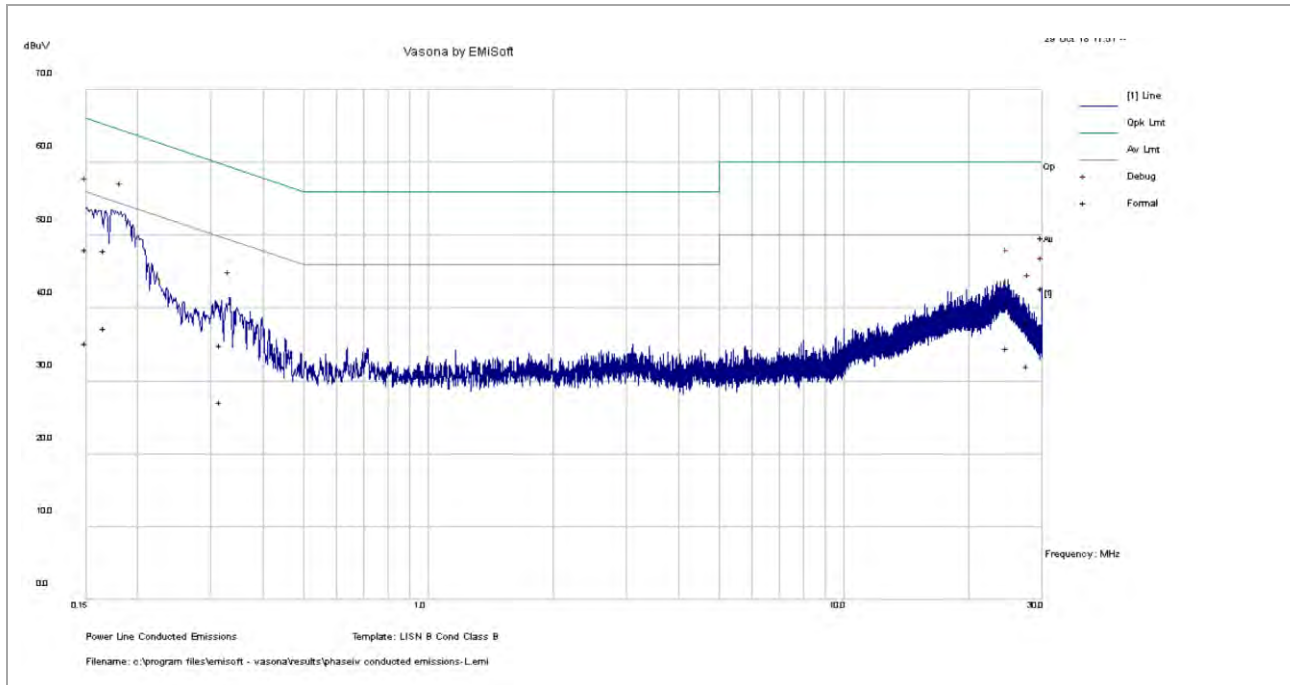
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Testing Cert #4848-01

## 8.7.4 Test Result

### Live Line

|                               |                                 |                        |                    |
|-------------------------------|---------------------------------|------------------------|--------------------|
| <b>Test Standard:</b>         | <b>47CFR 15.207</b>             | <b>Mode:</b>           | <b>Line</b>        |
| <b>Frequency Range:</b>       | <b>0.15-30MHz</b>               | <b>Test Date:</b>      | <b>10/29/2018</b>  |
| <b>Antenna Type/Polarity:</b> | <b>N/A</b>                      | <b>Test Personnel:</b> | <b>Sherwin Lee</b> |
| <b>Remark:</b>                | <b>External antenna version</b> | <b>Test Result:</b>    | <b>Pass</b>        |



| Frequency (MHz) | Raw (dBuV) | Cable Loss (dB) | Factors (dB) | Level (dBuV/m) | Meas. Type | Line | Limit (dBuV/m) | Margin (dB) | Pass /Fail |
|-----------------|------------|-----------------|--------------|----------------|------------|------|----------------|-------------|------------|
| 0.15            | 24.9       | 10.1            | 0.3          | 35.2           | AV         | Line | 56             | -20.8       | Pass       |
| 0.15            | 37.78      | 10.07           | 0.25         | 48.11          | QP         | Line | 65.99          | -17.89      | Pass       |
| 0.16            | 27         | 10.1            | 0.3          | 37.3           | AV         | Line | 55.1           | -17.8       | Pass       |
| 0.16            | 37.53      | 10.08           | 0.25         | 47.86          | QP         | Line | 65.11          | -17.25      | Pass       |
| 0.31            | 16.78      | 10.09           | 0.27         | 27.14          | AV         | Line | 49.79          | -22.65      | Pass       |
| 0.31            | 24.57      | 10.09           | 0.27         | 34.93          | QP         | Line | 59.79          | -24.86      | Pass       |
| 24.74           | 15         | 10.85           | 14.77        | 40.62          | QP         | Line | 60             | -19.38      | Pass       |
| 24.74           | 8.85       | 10.85           | 14.77        | 34.46          | AV         | Line | 50             | -15.54      | Pass       |
| 27.80           | 13.19      | 10.89           | 13.86        | 37.94          | QP         | Line | 60             | -22.06      | Pass       |
| 27.80           | 7.36       | 10.89           | 13.86        | 32.11          | AV         | Line | 50             | -17.89      | Pass       |
| 29.99           | 19.1       | 10.93           | 12.72        | 42.76          | AV         | Line | 50             | -7.24       | Pass       |
| 29.99           | 26.07      | 10.93           | 12.72        | 49.72          | QP         | Line | 60             | -10.28      | Pass       |



Electromagnetic Compatibility  
 Radio Frequency  
 Product Certification  
 International Approval

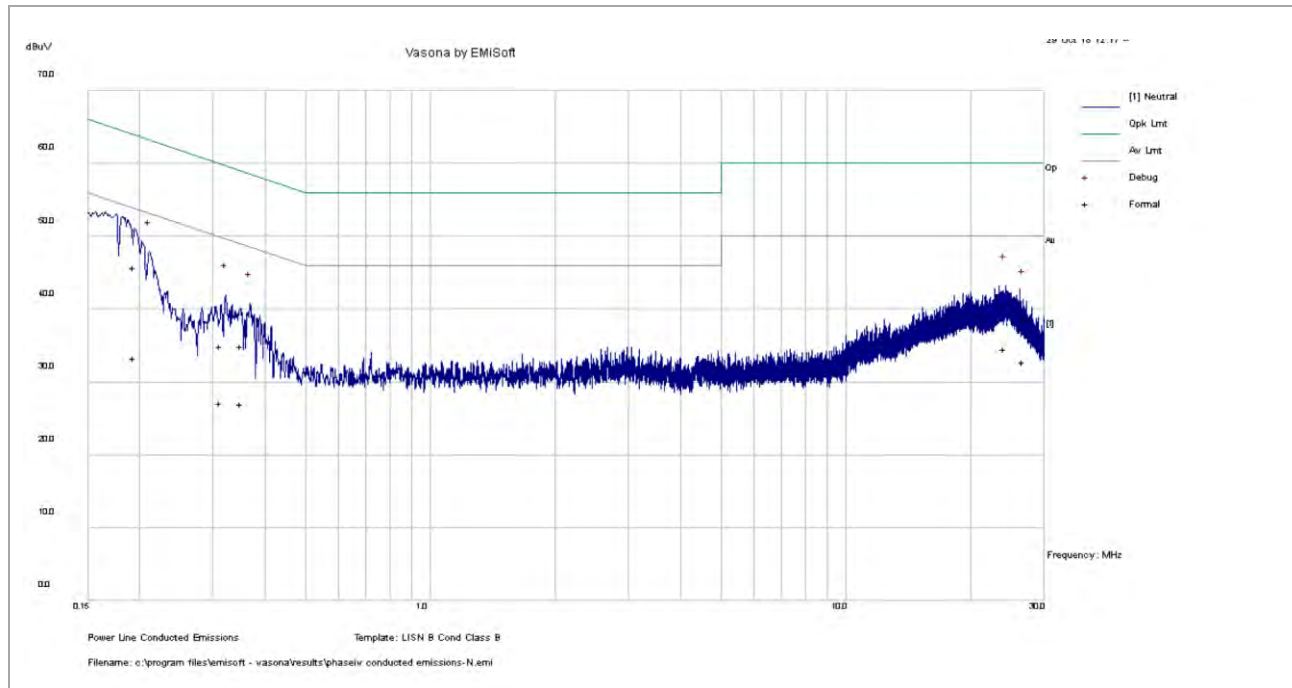
1261 Puerta Del Sol  
 San Clemente, CA, 92673  
 +1 (949) 393-1123  
[www.vista-compliance.com](http://www.vista-compliance.com)

|                       |                                    |
|-----------------------|------------------------------------|
| <b>Report Number:</b> | PFE-18100201-LC-FCC-RF-LEAP Rev1.1 |
| <b>Product:</b>       | Leap 2.4GHz RF Module              |
| <b>Model Number:</b>  | 44-100312-00, 44-100312-01         |



## Neutral Line

|                               |                                 |                        |                    |
|-------------------------------|---------------------------------|------------------------|--------------------|
| <b>Test Standard:</b>         | <b>47CFR 15.207</b>             | <b>Mode:</b>           | <b>Neutral</b>     |
| <b>Frequency Range:</b>       | <b>0.15-30MHz</b>               | <b>Test Date:</b>      | <b>10/29/2018</b>  |
| <b>Antenna Type/Polarity:</b> | <b>N/A</b>                      | <b>Test Personnel:</b> | <b>Sherwin Lee</b> |
| <b>Remark:</b>                | <b>External antenna version</b> | <b>Test Result:</b>    | <b>Pass</b>        |



| Frequency (MHz) | Raw (dBuV) | Cable Loss (dB) | Factor s (dB) | Level (dBuV/m) | Meas. Type | Line    | Limit (dBuV/m) | Margin (dB) | Pass /Fail |
|-----------------|------------|-----------------|---------------|----------------|------------|---------|----------------|-------------|------------|
| 0.19            | 35.43      | 10.08           | 0.26          | 45.76          | QP         | Neutral | 63.89          | -18.13      | Pass       |
| 0.19            | 23         | 10.1            | 0.3           | 33.3           | AV         | Neutral | 53.9           | -20.6       | Pass       |
| 0.31            | 24.54      | 10.09           | 0.27          | 34.9           | QP         | Neutral | 59.89          | -24.99      | Pass       |
| 0.31            | 16.8       | 10.09           | 0.27          | 27.16          | AV         | Neutral | 49.89          | -22.73      | Pass       |
| 0.35            | 24.6       | 10.1            | 0.27          | 34.96          | QP         | Neutral | 58.95          | -23.99      | Pass       |
| 0.35            | 16.69      | 10.1            | 0.27          | 27.06          | AV         | Neutral | 48.95          | -21.89      | Pass       |
| 24.14           | 14.63      | 10.84           | 14.99         | 40.46          | QP         | Neutral | 60             | -19.54      | Pass       |
| 24.14           | 8.63       | 10.84           | 14.99         | 34.45          | AV         | Neutral | 50             | -15.55      | Pass       |
| 26.68           | 13.49      | 10.87           | 14.26         | 38.62          | QP         | Neutral | 60             | -21.38      | Pass       |
| 26.68           | 7.64       | 10.87           | 14.26         | 32.78          | AV         | Neutral | 50             | -17.22      | Pass       |



## 9 Test instrument list

| Equipment                        | Manufacturer    | Model                  | Serial Number | Cal. Date  | Cal. Due   |
|----------------------------------|-----------------|------------------------|---------------|------------|------------|
| Semi-Anechoic Chamber            | ETS-Lindgren    | 10M                    | VL001         | 5/11/2018  | 5/11/2019  |
| Shielding Control Room           | ETS-Lindgren    | Series 81              | VL006         | N/A        | N/A        |
| Spectrum Analyzer                | Keysight        | N9020A                 | MY50110074    | 5/4/2018   | 5/4/2019   |
| EMC Test Receiver                | R&S             | ESL6                   | 100230        | 5/7/2018   | 5/7/2019   |
| LISN (9KHz – 30MHz)              | EMCO            | 3816/2                 | 9705-1066     | 5/4/2018   | 5/4/2019   |
| Bi-Log Antenna                   | ETS-Lindgren    | 3142E                  | 217921        | 11/15/2017 | 11/15/2018 |
| Horn Antenna (1-18GHz)           | Electro-Metrics | EM-6961                | 6292          | 5/2/2018   | 5/2/2019   |
| Horn Antenna (18-40GHz)          | Com-Power       | AH-840                 | 101109        | 5/2/2018   | 5/2/2019   |
| Preamplifier                     | RF Bay, Inc.    | LPA-10-20              | 11180621      | 5/10/2018  | 5/10/2019  |
| True RMS Multi-meter             | UNI-T           | UT181A                 | C173014829    | 5/10/2018  | 5/10/2019  |
| Temp / Humidity / Pressure Meter | PCE Instruments | PCE-THB 40             | R062028       | 5/9/2018   | 5/9/2019   |
| RF Attenuator                    | Pasternack      | PE7005-3               | VL061         | 5/10/2018  | 5/10/2019  |
| Preamplifier<br>100KHz - 40GHz   | Aeroflex        | 33711-392-<br>77150-11 | 064           | 5/10/2018  | 5/10/2019  |
| EM Center Control                | ETS-Lindgren    | 7006-001               | 160136        | N/A        | N/A        |
| Turn Table                       | ETS-Lindgren    | 2181-3.03              | VL002         | N/A        | N/A        |
| Boresight Antenna Tower          | ETS-Lindgren    | 2171B                  | VL003         | N/A        | N/A        |
| Loop Antenna (9k-30MHz)          | Com-Power       | AL-130                 | 121012        | 5/9/2018   | 5/9/2019   |
| RE test cable(below 6GHz)        | Vista           | RE-6GHz-01             | RE-6GHz-01    | 5/10/2018  | 5/10/2019  |
| RE test cable (1-18GHz)          | PhaseTrack      | II-240                 | RE-18GHz-01   | 5/10/2018  | 5/10/2019  |
| RE test cable (>18GHz)           | Sucoflex        | 104                    | 344903/4      | 5/10/2018  | 5/10/2019  |
| Pulse limiter                    | Com-Power       | LIT-930A               | 531727        | 5/15/2018  | 5/15/2019  |
| CE test cable #1                 | FIRST RF        | FRF-C-1002-001         | CE-6GHz-01    | 5/10/2018  | 5/10/2019  |
| CE test cable#2                  | FIRST RF        | FRF-C-1002-001         | CE-6GHz-02    | 5/9/2018   | 5/9/2019   |