

# FCC Part 15C & RSS-247 Measurement and Test Report

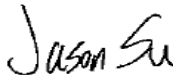


For

LM Technologies Ltd.

Unit19, Spectrum House, 32-34, Gordon House Road, London, NW5 1LP,

United Kingdom

**FCC ID: VVX-LM931-XXXX & IC: 10531A-LM931XXXX**

|   |   |
|---|---|
| <b>FCC Rule(s) &amp; IC Standards:</b>  | <u>FCC Part 15.247</u><br><u>RSS-247 Issue 1 (2015-05)</u>  |
| <b>Product Description:</b>   | <u>Bluetooth Smart Module 4.1 – LM931</u>   |
| <b>Tested Model:</b>  | <u>LM931-XXXX</u>   |
| <b>Report No.:</b>  | <u>STR16068011I</u>   |
| <b>Tested Date:</b>   | <u>2016-06-02 to 2016-06-13</u>   |
| <b>Issued Date:</b>   | <u>2016-06-13</u>   |
| <b>Tested By:</b>   | <u>Jason Su / Engineer</u>       |
| <b>Reviewed By:</b>   | <u>Silin Chen / EMC Manager</u>  |
| <b>Approved &amp; Authorized By:</b>  | <u>Jandy so / PSQ Manager</u>    |
| <b>Prepared By:</b>   |   |
| <b>Shenzhen SEM.Test Technology Co., Ltd.</b><br>1/F, Building A, Hongwei Industrial Park, Liuxian 2nd Road,<br>Bao'an District, Shenzhen, P.R.C. (518101)<br>Tel.: +86-755-33663308 Fax.: +86-755-33663309 Website: www.semtest.com.cn |   |

Note: This test report is limited to the above client company and the product model only. It may not be duplicated without prior permitted by Shenzhen SEM.Test Technology Co., Ltd.

**TABLE OF CONTENTS**

|  |           |
|--|-----------|
| <b>1. GENERAL INFORMATION</b>                  | <b>3</b>  |
| 1.2 TEST STANDARDS                             | 4         |
| 1.3 TEST METHODOLOGY                           | 4         |
| 1.4 TEST FACILITY                              | 4         |
| 1.5 EUT SETUP AND TEST MODE                    | 5         |
| 1.6 MEASUREMENT UNCERTAINTY                    | 5         |
| 1.7 TEST EQUIPMENT LIST AND DETAILS            | 6         |
| <b>2. SUMMARY OF TEST RESULTS</b>              | <b>7</b>  |
| <b>3. RF EXPOSURE</b>                          | <b>8</b>  |
| 3.1 STANDARD APPLICABLE                        | 8         |
| 3.2 TEST RESULT                                | 8         |
| <b>4. ANTENNA REQUIREMENT</b>                  | <b>9</b>  |
| 4.1 STANDARD APPLICABLE                        | 9         |
| 4.2 EVALUATION INFORMATION                     | 9         |
| <b>5. POWER SPECTRAL DENSITY</b>               | <b>10</b> |
| 5.1 STANDARD APPLICABLE                        | 10        |
| 5.2 TEST PROCEDURE                             | 10        |
| 5.3 ENVIRONMENTAL CONDITIONS                   | 10        |
| 5.4 SUMMARY OF TEST RESULTS/PLOTS              | 10        |
| <b>6. 6DB BANDWIDTH</b>                        | <b>13</b> |
| 6.1 STANDARD APPLICABLE                        | 13        |
| 6.2 TEST PROCEDURE                             | 13        |
| 6.3 ENVIRONMENTAL CONDITIONS                   | 13        |
| 6.4 SUMMARY OF TEST RESULTS/PLOTS              | 13        |
| <b>7. RF OUTPUT POWER</b>                      | <b>16</b> |
| 7.1 STANDARD APPLICABLE                        | 16        |
| 7.2 TEST PROCEDURE                             | 16        |
| 7.3 ENVIRONMENTAL CONDITIONS                   | 16        |
| 7.4 SUMMARY OF TEST RESULTS/PLOTS              | 16        |
| <b>8. FIELD STRENGTH OF SPURIOUS EMISSIONS</b> | <b>17</b> |
| 8.1 STANDARD APPLICABLE                        | 17        |
| 8.2 TEST PROCEDURE                             | 17        |
| 8.3 CORRECTED AMPLITUDE & MARGIN CALCULATION   | 18        |
| 8.4 ENVIRONMENTAL CONDITIONS                   | 18        |
| 8.5 SUMMARY OF TEST RESULTS/PLOTS              | 19        |
| <b>9. OUT OF BAND EMISSIONS</b>                | <b>26</b> |
| 9.1 STANDARD APPLICABLE                        | 26        |
| 9.2 TEST PROCEDURE                             | 26        |
| 9.3 ENVIRONMENTAL CONDITIONS                   | 27        |
| 9.4 SUMMARY OF TEST RESULTS/PLOTS              | 27        |
| <b>10. CONDUCTED EMISSIONS</b>                 | <b>33</b> |
| 10.1 TEST PROCEDURE                            | 33        |
| 10.2 BASIC TEST SETUP BLOCK DIAGRAM            | 33        |
| 10.3 ENVIRONMENTAL CONDITIONS                  | 33        |
| 10.4 TEST RECEIVER SETUP                       | 34        |
| 10.5 SUMMARY OF TEST RESULTS/PLOTS             | 34        |
| 10.6 CONDUCTED EMISSIONS TEST DATA             | 34        |

## 1. GENERAL INFORMATION

### Client Information

Applicant: LM Technologies Ltd.  
Address of applicant: Unit19, Spectrum House, 32-34, Gordon House Road,  
London, NW5 1LP, United Kingdom  
Manufacturer: LM Technologies Ltd.  
Address of manufacturer: Unit19, Spectrum House, 32-34, Gordon House Road,  
London, NW5 1LP, United Kingdom

| General Description of EUT  |                                    |
|---|------------------------------------|
| Product Name:   | Bluetooth Smart Module 4.1 – LM931 |
| Brand Name:   | LM Technologies                    |
| Model No.:  | LM931-XXXX                         |
| Rated Voltage:  | DC 3.3V                            |
| Rated Current:  | /                                  |
| <i>Note: The test data is gathered from a production sample provided by the manufacturer.</i> |                                    |

| Technical Characteristics of EUT  |                      |
|-----------------------------------|----------------------|
| Bluetooth Version:                | V4.1                 |
| Frequency Range:                  | 2402-2480MHz         |
| RF Output Power:                  | 8.752dBm (Conducted) |
| Data Rate:                        | 1Mbps                |
| Modulation:                       | GFSK                 |
| Quantity of Channels:             | 40                   |
| Channel Separation:               | 2MHz                 |
| Type of Antenna:                  | Chip Antenna         |
| Antenna Gain:                     | 2dBi                 |
| Lowest Internal Frequency of EUT: | 32.768kHz            |

## 1.2 Test Standards

The following report is prepared on behalf of the LM Technologies Ltd. in accordance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 of the Federal Communication Commissions rules, and RSS-Gen Issue 4 section 8.3, 8.8, 8.9, 8.10 and RSS-247 Issue 1 of the Industry Canada rules..

The objective is to determine compliance with FCC Part 15, Subpart C, and section 15.203, 15.205, 15.207, 15.209 and 15.247 of the Federal Communication Commissions rules, and RSS-Gen Issue 4 section 8.3, 8.8, 8.9, 8.10 and RSS-247 Issue 1 of the Industry Canada rules.

**Maintenance of compliance** is the responsibility of the manufacturer. Any modification of the product, which result in lowering the emission, should be checked to ensure compliance has been maintained.

## 1.3 Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard for Testing Unlicensed Wireless Devices, and ANSI C63.4-2014, American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the range of 9 kHz to 40 GHz. The measurement guide KDB 558074 D01 v03r05 for digital transmission systems shall be performed also.

## 1.4 Test Facility

### **FCC – Registration No.: 934118**

Shenzhen SEM.Test Technology Co., Ltd. EMC Laboratory has been registered and fully described in a report filed with the (FCC) Federal Communications Commission. The acceptance letter from the FCC is maintained in our files and the Registration is 934118.

### **Industry Canada (IC) Registration No.: 11464A**

The 3m Semi-anechoic chamber of Shenzhen SEM.Test Technology Co., Ltd. has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 11464A.

### **CNAS Registration No.: L4062**

Shenzhen SEM.Test Technology Co., Ltd. is a testing organization accredited by China National Accreditation Service for Conformity Assessment (CNAS) according to ISO/IEC 17025. The accreditation certificate number is L4062. All measurement facilities used to collect the measurement data are located at 1/F, Building A, Hongwei Industrial Park, Liuxian 2<sup>nd</sup> Road, Bao'an District, Shenzhen, P.R.C (518101).

### 1.5 EUT Setup and Test Mode

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. All testing shall be performed under maximum output power condition, and to measure its highest possible emissions level, more detailed description as follows:

| Test Mode List |             |                           |
|----------------|-------------|---------------------------|
| Test Mode      | Description | Remark                    |
| TM1            | GFSK(BLE)   | 2402MHz, 2442MHz, 2480MHz |

| EUT Cable List and Details |            |                     |                        |
|----------------------------|------------|---------------------|------------------------|
| Cable Description          | Length (m) | Shielded/Unshielded | With / Without Ferrite |
| /                          | /          | /                   | /                      |

| Special Cable List and Details |            |                     |                        |
|--------------------------------|------------|---------------------|------------------------|
| Cable Description              | Length (m) | Shielded/Unshielded | With / Without Ferrite |
| /                              | /          | /                   | /                      |

| Auxiliary Equipment List and Details |              |       |               |
|--------------------------------------|--------------|-------|---------------|
| Description                          | Manufacturer | Model | Serial Number |
| Notebook                             | Lenovo       | E10   | LR-63C8R      |

### 1.6 Measurement Uncertainty

| Measurement uncertainty        |            |                     |
|--------------------------------|------------|---------------------|
| Parameter                      | Conditions | Uncertainty         |
| RF Output Power                | Conducted  | $\pm 0.42\text{dB}$ |
| Occupied Bandwidth             | Conducted  | $\pm 1.5\%$         |
| Power Spectral Density         | Conducted  | $\pm 1.8\text{dB}$  |
| Conducted Spurious Emission    | Conducted  | $\pm 2.17\text{dB}$ |
| Conducted Emissions            | Conducted  | $\pm 2.88\text{dB}$ |
| Transmitter Spurious Emissions | Radiated   | $\pm 5.1\text{dB}$  |

## 1.7 Test Equipment List and Details

| No.       | Description       | Manufacturer    | Model     | Serial No. | Cal Date   | Due Date   |
|-----------|-------------------|-----------------|-----------|------------|------------|------------|
| SEMT-1072 | Spectrum Analyzer | Agilent         | E4407B    | MY41440400 | 2015-06-17 | 2016-06-16 |
| SEMT-1031 | Spectrum Analyzer | Rohde & Schwarz | FSP30     | 836079/035 | 2015-06-17 | 2016-06-16 |
| SEMT-1007 | EMI Test Receiver | Rohde & Schwarz | ESVB      | 825471/005 | 2015-06-17 | 2016-06-16 |
| SEMT-1008 | Amplifier         | Agilent         | 8447F     | 3113A06717 | 2015-06-17 | 2016-06-16 |
| SEMT-1043 | Amplifier         | C&D             | PAP-1G18  | 2002       | 2015-06-17 | 2016-06-16 |
| SEMT-1011 | Broadband Antenna | Schwarz beck    | VULB9163  | 9163-333   | 2015-06-17 | 2016-06-16 |
| SEMT-1042 | Horn Antenna      | ETS             | 3117      | 00086197   | 2015-06-17 | 2016-06-16 |
| SEMT-1121 | Horn Antenna      | ETS             | 3116B     | 00088203   | 2015-06-17 | 2016-06-16 |
| SEMT-1069 | Loop Antenna      | Schwarz beck    | FMZB 1516 | 9773       | 2015-06-17 | 2016-06-16 |
| SEMT-1001 | EMI Test Receiver | Rohde & Schwarz | ESPI      | 101611     | 2015-06-17 | 2016-06-16 |
| SEMT-1003 | L.I.S.N           | Schwarz beck    | NSLK8126  | 8126-224   | 2015-06-17 | 2016-06-16 |
| SEMT-1002 | Pulse Limiter     | Rohde & Schwarz | ESH3-Z2   | 100911     | 2015-06-17 | 2016-06-16 |
| SEMT-1035 | Coaxial Cable     | /               | 0M4RFC    | AMP-SW(A)  | 2016-06-16 | 2017-06-15 |
| SEMT-1036 | Coaxial Cable     | /               | 2M0RFC    | 966-AMP(A) | 2016-06-16 | 2017-06-15 |
| SEMT-1037 | Coaxial Cable     | /               | 5M0RFC    | CLAMP(DP)  | 2016-06-16 | 2017-06-15 |
| SEMT-1038 | Coaxial Cable     | /               | 2M4RFC    | LISN(CE)   | 2016-06-16 | 2017-06-15 |
| SEMT-1039 | Coaxial Cable     | /               | 1M0RFC    | SW-ESVB(A) | 2016-06-16 | 2017-06-15 |

## 2. SUMMARY OF TEST RESULTS

| <b>FCC Rules</b>                                      | <b>Description of Test Item</b>   | <b>Result</b> |
|---|-----------------------------------|---------------|
| § 2.1093  | RF Exposure                       | Compliant     |
| § 15.203; § 15.247(b)(4)(i)<br>§ RSS-Gen Issue 4, 8.3 | Antenna Requirement               | Compliant     |
| § 15.205<br>§ RSS-Gen Issue 4, 8.10                   | Restricted Band of Operation      | Compliant     |
| § 15.207(a)<br>§ RSS-Gen Issue 4, 8.8                 | Conducted Emission                | Compliant     |
| § 15.247(e)<br>§ RSS-247 Issue 1, 5.2(2)              | Power Spectral Density            | Compliant     |
| § 15.247(a)(2)<br>§ RSS-247 Issue 1, 5.2(1)           | 6 dB Bandwidth                    | Compliant     |
| § 15.247(b)(3)<br>§ RSS-247 Issue 1, 5.4(4)           | RF Output Power                   | Compliant     |
| § 15.209(a)<br>§ RSS-Gen Issue 4, 8.9                 | Radiated Emission                 | Compliant     |
| § 15.247(d)<br>§ RSS-247 Issue 1, 5.5                 | Band Edge (Out of Band Emissions) | Compliant     |

N/A: not applicable

### **3. RF Exposure**

---

#### **3.1 Standard Applicable**

According to § 1.1307 and § 2.1093, the portable transmitter must comply the RF exposure requirements.

#### **3.2 Test Result**

This product complied with the requirement of the RF exposure, please see the RF Exposure Report.



## **4. Antenna Requirement**

---

### **4.1 Standard Applicable**

According to FCC Part 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.

According to RSS-Gen 8.3, a transmitter can only be sold or operated with antennas with which it was certified. A transmitter may be certified with multiple antenna types. An antenna type comprises antennas having similar in-band and out-of-band radiation patterns.

### **4.2 Evaluation Information**

This product has a chip antenna, fulfill the requirement of this section.

## 5. Power Spectral Density

### 5.1 Standard Applicable

According to 15.247(a)(1)(iii), 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.

According to RSS-247 5.2(2), The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

### 5.2 Test Procedure

According to the KDB 558074 D01 v03r05, the test method of power spectral density as below:

- a) Set analyzer center frequency to DTS channel center frequency.
- b) Set the span to 1.5 times the DTS bandwidth.
- c) Set the RBW to:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
- d) Set the VBW  $\geq 3 \times \text{RBW}$ .
- e) Detector = peak.
- f) Sweep time = auto couple.
- g) Trace mode = max hold.
- h) Allow trace to fully stabilize.
- i) Use the peak marker function to determine the maximum amplitude level within the RBW.
- j) If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

### 5.3 Environmental Conditions

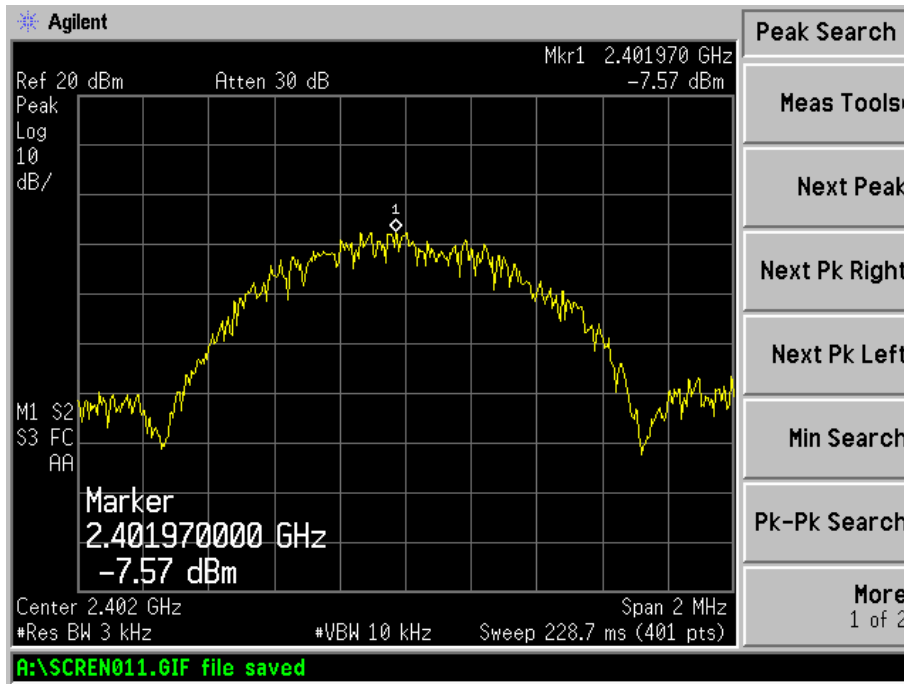
|                    |           |
|--------------------|-----------|
| Temperature:       | 26° C     |
| Relative Humidity: | 54%       |
| ATM Pressure:      | 1011 mbar |

### 5.4 Summary of Test Results/Plots

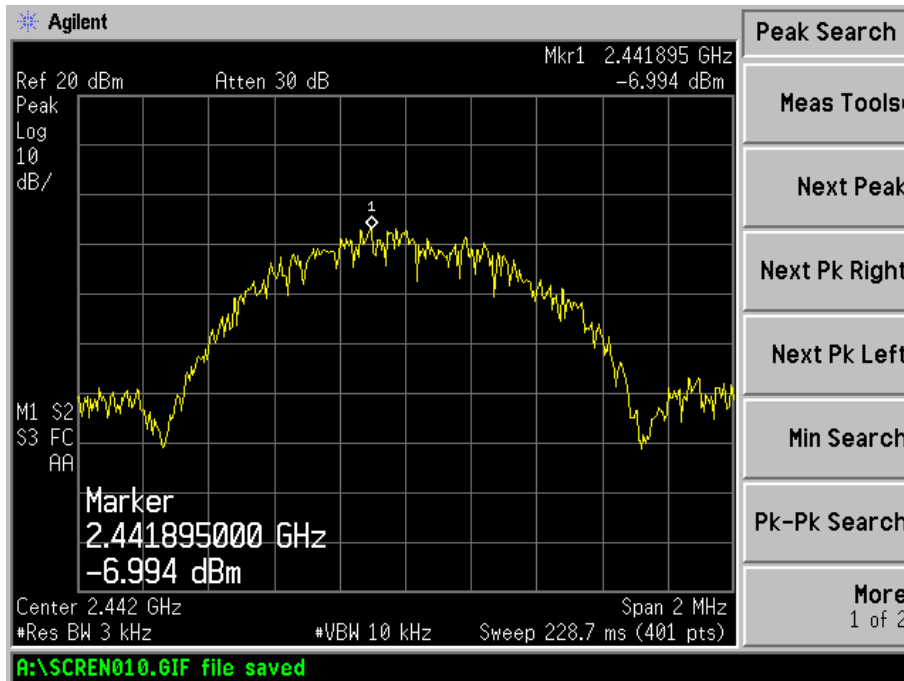
| Test Mode | Test Channel MHz | Power Spectral Density dBm/3kHz | Limit dBm/3kHz |
|-----------|------------------|---------------------------------|----------------|
| GFSK(BLE) | 2402             | -7.570                          | 8              |
|           | 2442             | -6.994                          | 8              |
|           | 2480             | -6.517                          | 8              |

Please refer to the following test plots:

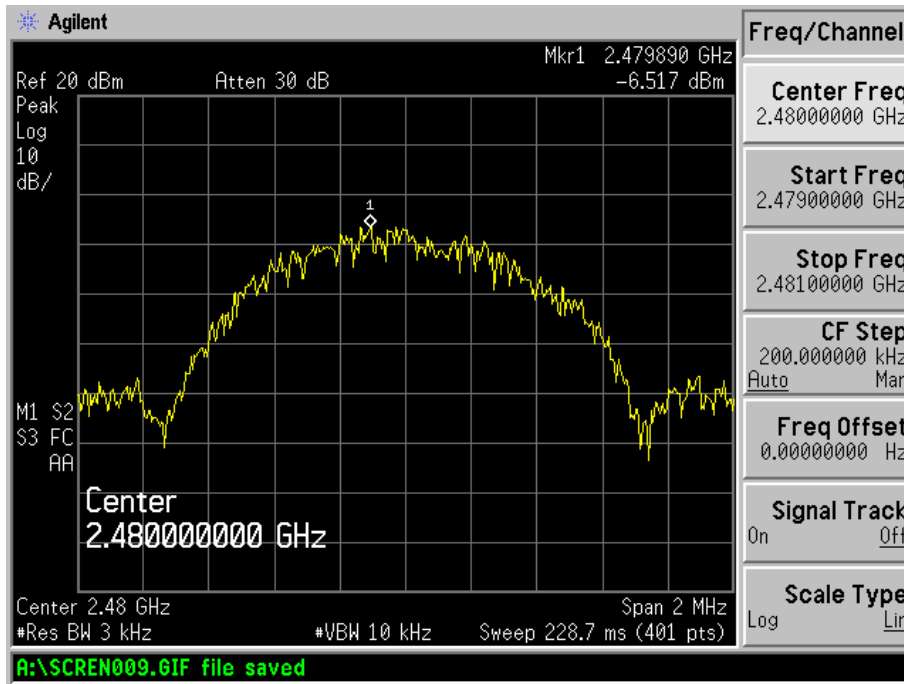
Low Channel



Middle Channel



High Channel



## 6. 6dB Bandwidth

### 6.1 Standard Applicable

According to 15.247(a)(2). Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

According to RSS-247 5.2(1), the minimum 6 dB bandwidth shall be 500 kHz.

### 6.2 Test Procedure

- a) Set RBW = 100 kHz.
- b) Set the video bandwidth (VBW)  $\geq 3 \times$  RBW.
- c) Detector = Peak.
- d) Trace mode = max hold.
- e) Sweep = auto couple.
- f) Allow the trace to stabilize.
- g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

### 6.3 Environmental Conditions

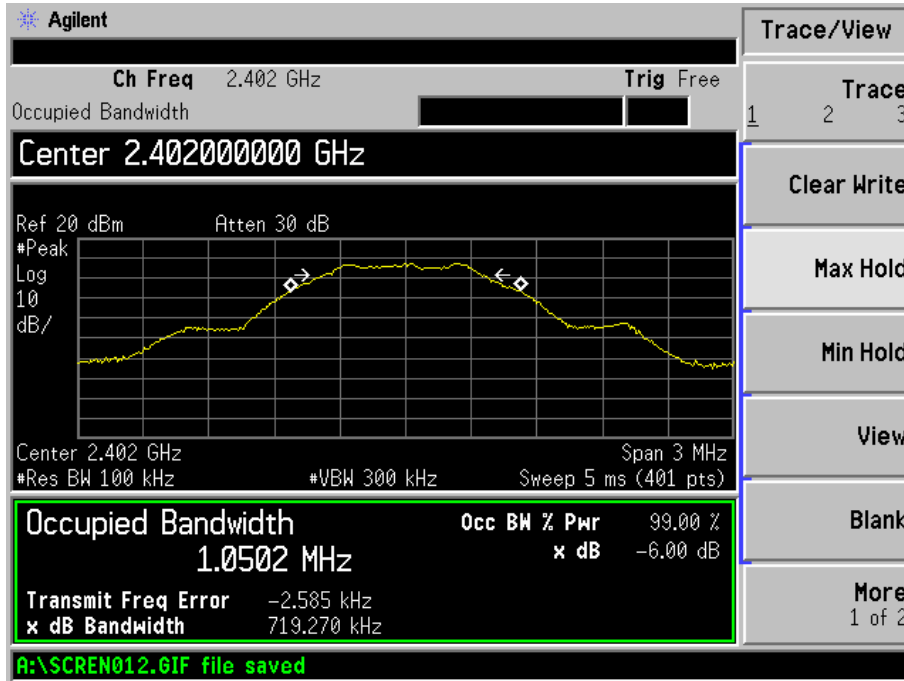
|                    |           |
|--------------------|-----------|
| Temperature:       | 25° C     |
| Relative Humidity: | 53%       |
| ATM Pressure:      | 1018 mbar |

### 6.4 Summary of Test Results/Plots

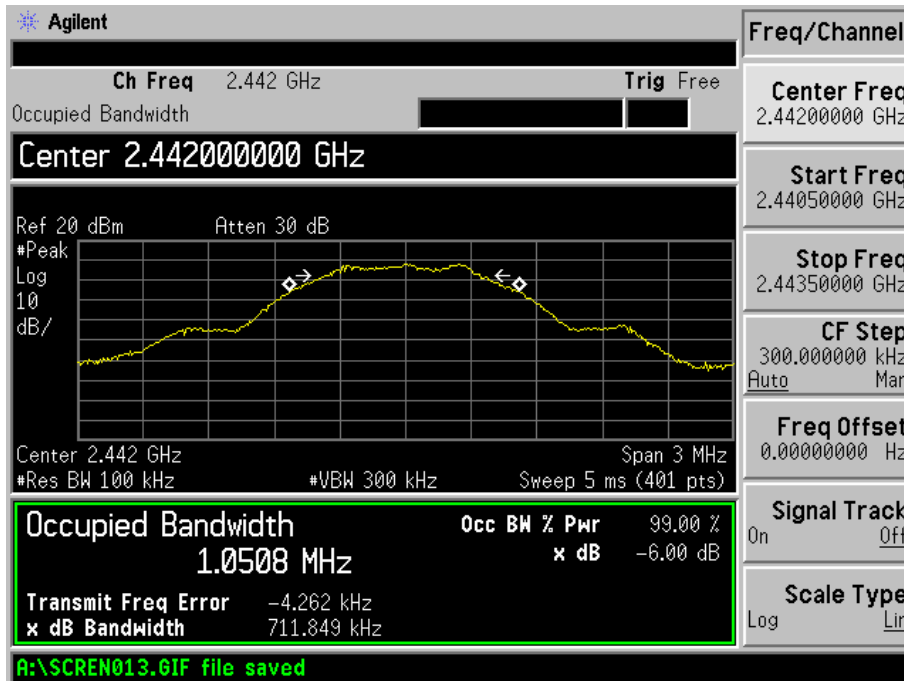
| Test Mode | Test Channel MHz | 6 dB Bandwidth kHz | 99% Bandwidth kHz | Limit kHz  |
|-----------|------------------|--------------------|-------------------|------------|
| GFSK(BLE) | 2402             | 719.270            | 1050.2            | $\geq 500$ |
|           | 2442             | 711.849            | 1050.8            | $\geq 500$ |
|           | 2480             | 721.660            | 1052.1            | $\geq 500$ |

Please refer to the following test plots:

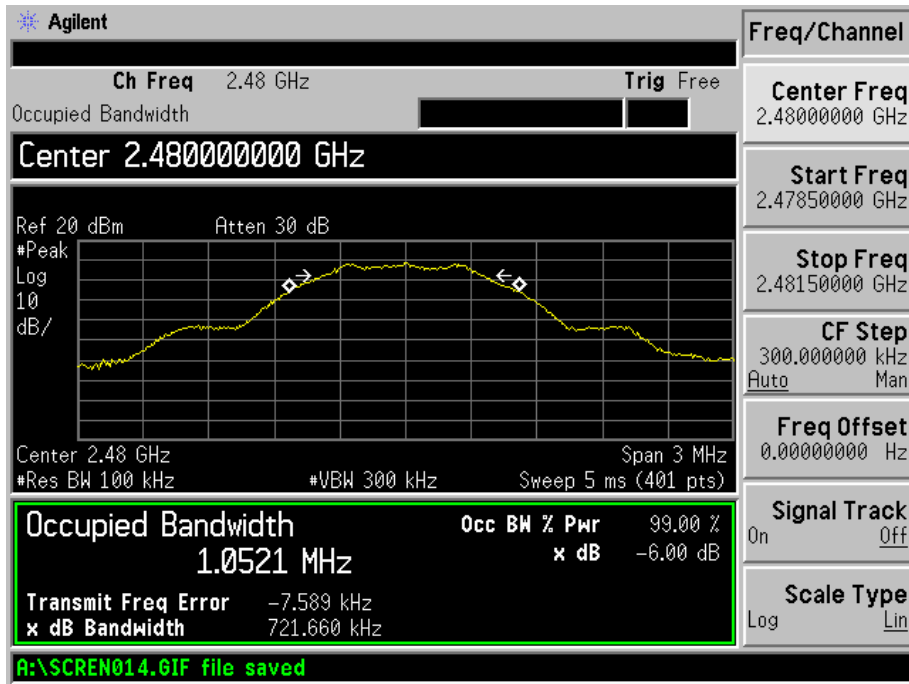
For BLE  
Low Channel:



Middle Channel:



High Channel:



## 7. RF Output Power

### 7.1 Standard Applicable

According to 15.247(b)(3). For systems using digital modulation in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands: 1 Watt.

According to RSS-247 5.4 (4), For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W.

### 7.2 Test Procedure

According to section KDB-558074 D01 v03r05 section 9.1.1, this procedure shall be used when the measurement instrument has available a resolution bandwidth that is greater than the DTS bandwidth.

- a) Set the RBW  $\geq$  DTS bandwidth.
- b) Set VBW  $\geq 3 \times$  RBW.
- c) Set span  $\geq 3 \times$  RBW
- d) Sweep time = auto couple.
- e) Detector = peak.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use peak marker function to determine the peak amplitude level.

### 7.3 Environmental Conditions

|                    |           |
|--------------------|-----------|
| Temperature:       | 26° C     |
| Relative Humidity: | 57%       |
| ATM Pressure:      | 1011 mbar |

### 7.4 Summary of Test Results/Plots

| Test Mode | Frequency<br>MHz | Reading<br>dBm | Output Power<br>mW | Limit<br>mW |
|-----------|------------------|----------------|--------------------|-------------|
| GFSK(BLE) | 2402             | 8.752          | 7.502              | 1000        |
|           | 2442             | 8.260          | 6.699              | 1000        |
|           | 2480             | 8.602          | 7.248              | 1000        |

*Note: the antenna gain of 2dBi less than 6dBi maximum permission antenna gain value based on 1 watt peak output power limit.*



## 8. Field Strength of Spurious Emissions

### 8.1 Standard Applicable

According to §15.247(d) and RSS-247 5.5, 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)/RSS-GEN is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a)/RSS-GEN, must also comply with the radiated emission limits specified in §15.209(a)/RSS-GEN.

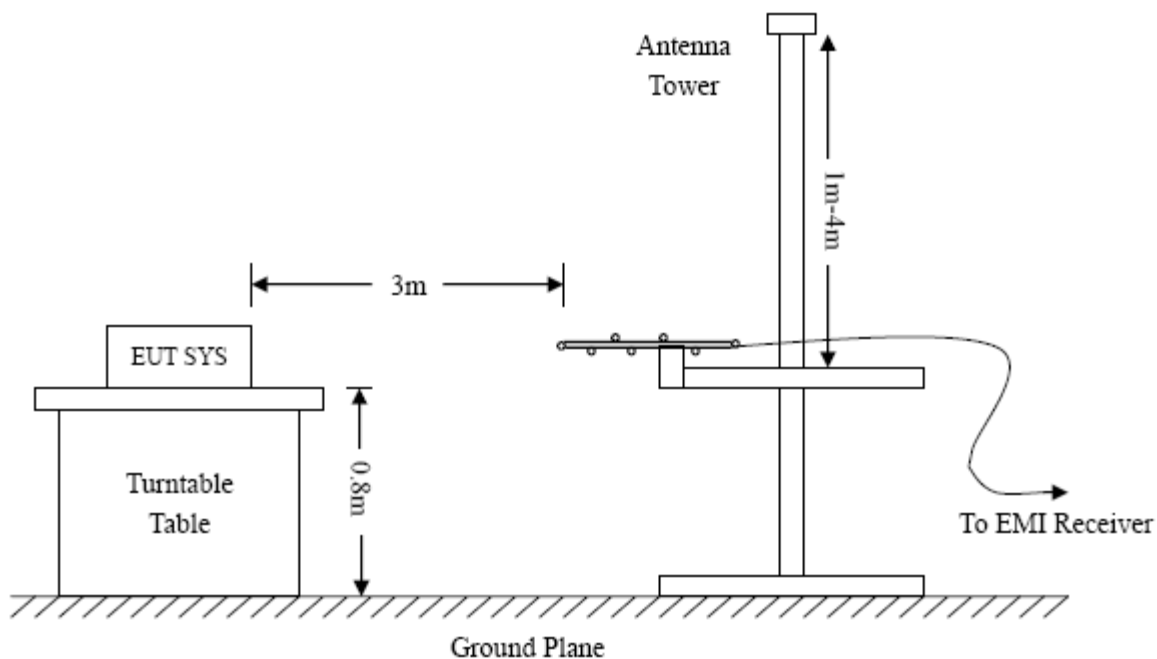
The emission limit in this paragraph is based on measurement instrumentation employing an average detector. The provisions in §15.35 for limiting peak emissions apply. Spurious Radiated Emissions measurements starting below or at the lowest crystal frequency.

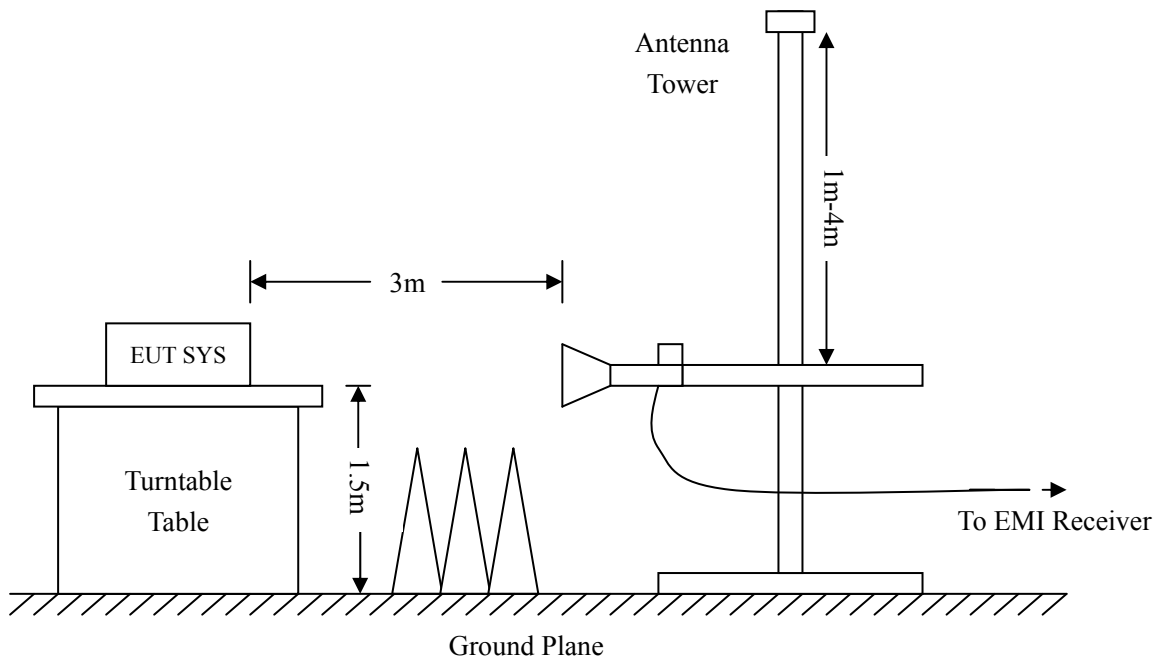
### 8.2 Test Procedure

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.205 15.247(a) and FCC Part 15.209 and RSS-Gen, 8.9 and 8.10 Limit.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle.

The spacing between the peripherals was 10 cm.





Frequency :9kHz-30MHz  
 RBW=10KHz,  
 VBW =30KHz  
 Sweep time= Auto  
 Trace = max hold  
 Detector function = peak

Frequency :30MHz-1GHz  
 RBW=120KHz,  
 VBW=300KHz  
 Sweep time= Auto  
 Trace = max hold  
 Detector function = peak, QP

Frequency :Above 1GHz  
 RBW=1MHz,  
 VBW=3MHz(Peak), 10Hz(AV)  
 Sweep time= Auto  
 Trace = max hold  
 Detector function = peak, AV

### 8.3 Corrected Amplitude & Margin Calculation

The Corrected Amplitude is calculated by adding the Antenna Factor and the Cable Factor, and subtracting the Amplifier Gain from the Amplitude reading. The basic equation is as follows:

$$\text{Corr. Ampl.} = \text{Indicated Reading} + \text{Ant. Factor} + \text{Cable Loss} - \text{Ampl. Gain}$$

The “**Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -6dB $\mu$ V means the emission is 6dB $\mu$ V below the maximum limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Corr. Ampl.} - \text{FCC Part 15 and RSS-GEN Issue 4, 8.9 Limit}$$

### 8.4 Environmental Conditions

|                    |           |
|--------------------|-----------|
| Temperature:       | 25 °C     |
| Relative Humidity: | 52%       |
| ATM Pressure:      | 1012 mbar |

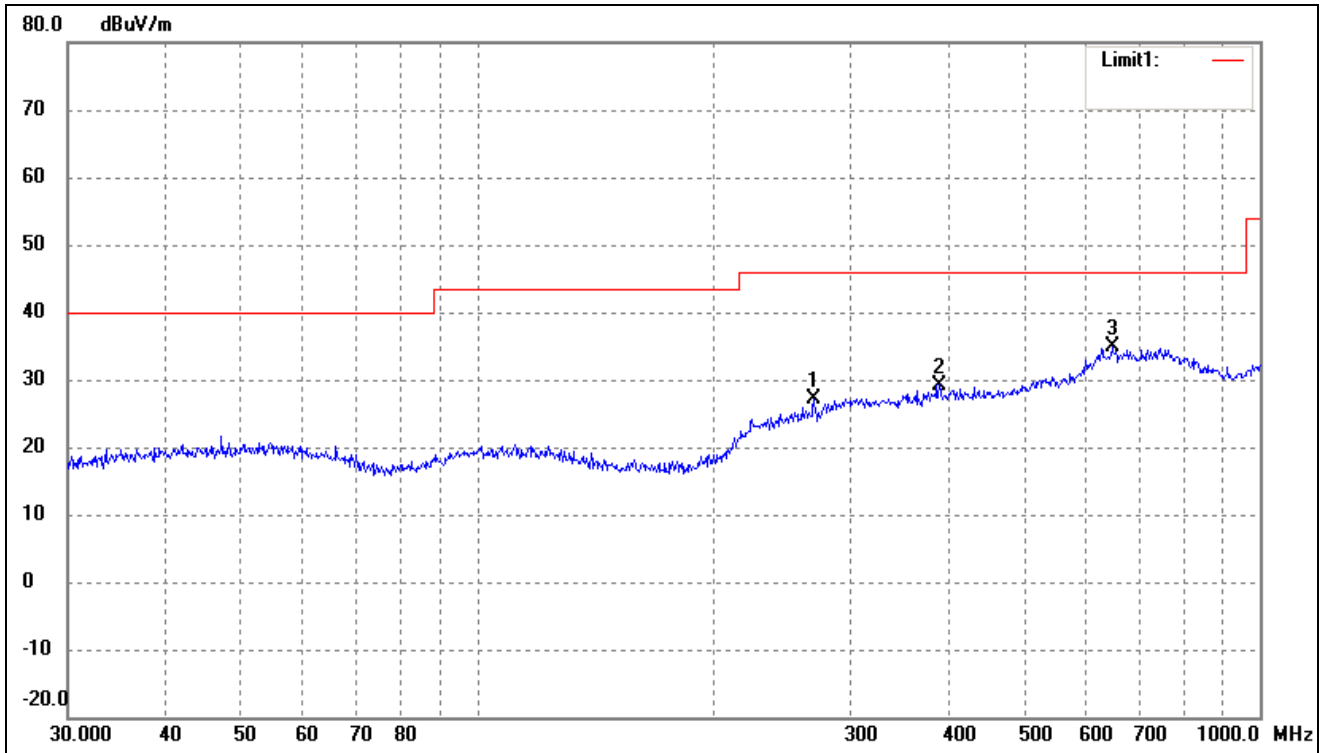
### 8.5 Summary of Test Results/Plots

According to the data below, the FCC Part 15.205, 15.209 and 15.247 and RSS-247 Issue 1 standards, and had the worst cases:

*Note: this EUT was tested in 3 orthogonal positions and the worst case position data was reported.*

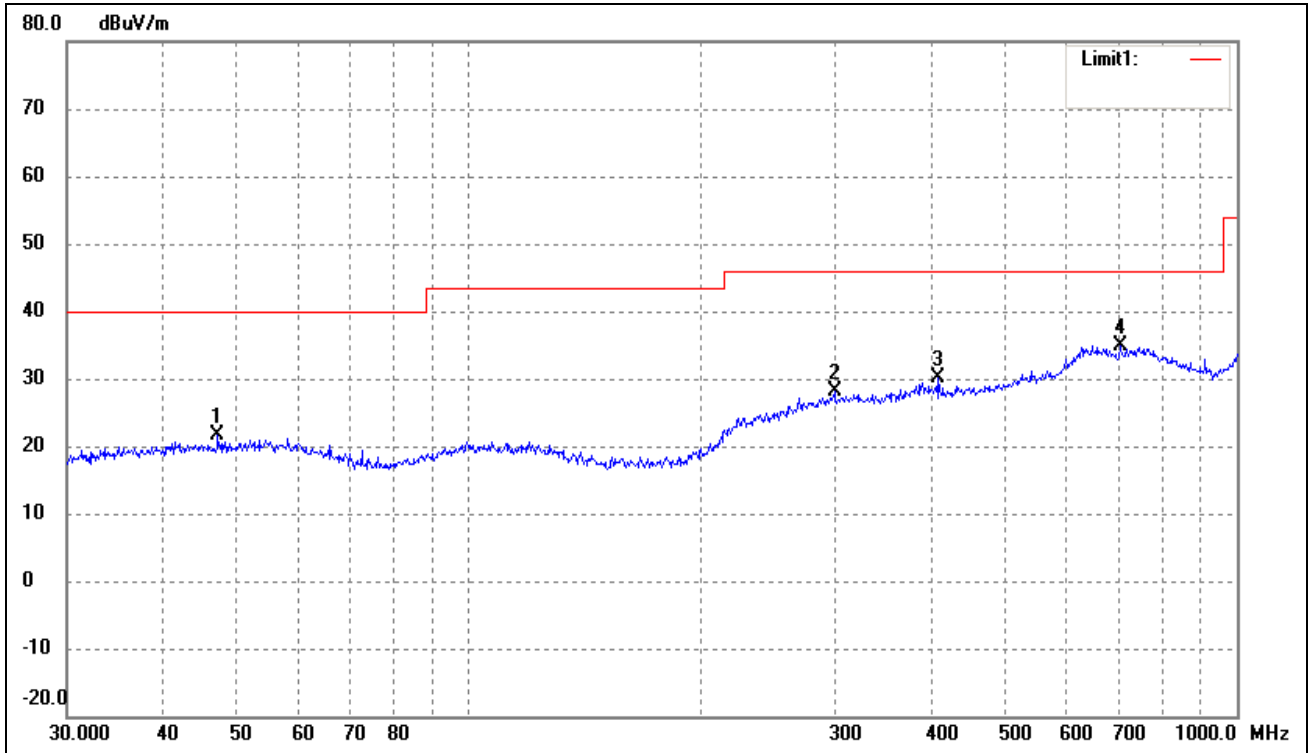
#### Plot of Radiated Emissions Test Data

EUT: Bluetooth Smart Module 4.1 – LM931  
 Tested Model: LM931-XXXX  
 Operating Condition: Transmitting-Low channel (2402MHz)  
 Comment: DC 3.3V  
 Test Specification: Horizontal



| No. | Frequency (MHz) | Reading (dBuV/m) | Correct (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Degree (°) | Height (cm) | Remark |
|-----|-----------------|------------------|--------------|-----------------|----------------|-------------|------------|-------------|--------|
| 1   | 269.4284        | 16.73            | 10.37        | 27.10           | 46.00          | -18.90      | 144        | 100         | peak   |
| 2   | 389.3549        | 17.05            | 12.20        | 29.25           | 46.00          | -16.75      | 15         | 100         | peak   |
| 3   | 647.3856        | 16.95            | 17.90        | 34.85           | 46.00          | -11.15      | 65         | 100         | peak   |

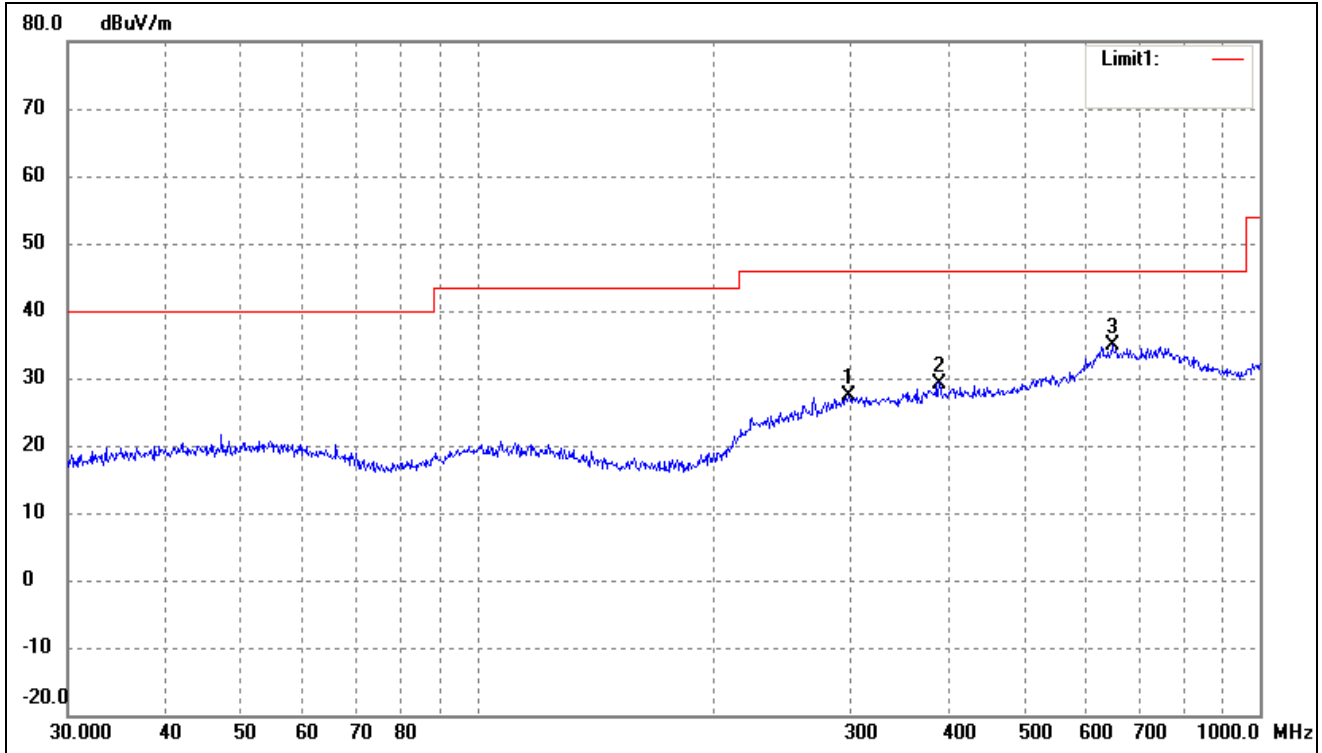
Test Specification: Vertical



| No. | Frequency (MHz) | Reading (dBuV/m) | Correct (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Degree (°) | Height (cm) | Remark |
|-----|-----------------|------------------|--------------|-----------------|----------------|-------------|------------|-------------|--------|
| 1   | 47.1599         | 16.73            | 4.96         | 21.69           | 40.00          | -18.31      | 154        | 100         | peak   |
| 2   | 299.3158        | 16.14            | 11.92        | 28.06           | 46.00          | -17.94      | 77         | 100         | peak   |
| 3   | 408.9460        | 17.73            | 12.33        | 30.06           | 46.00          | -15.94      | 98         | 100         | peak   |
| 4   | 704.2261        | 17.53            | 17.32        | 34.85           | 46.00          | -11.15      | 215        | 100         | peak   |

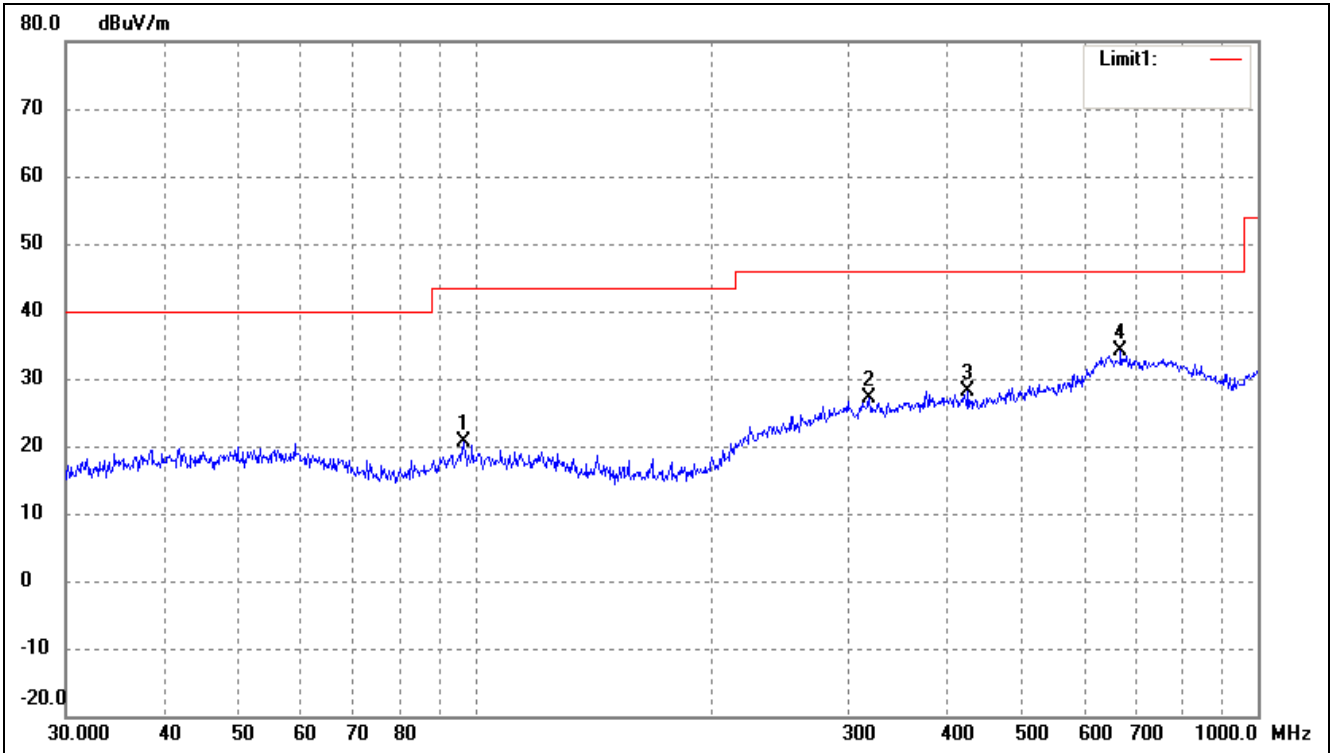
**Plot of Radiated Emissions Test Data**

EUT: Bluetooth Smart Module 4.1 – LM931  
 Tested Model: LM931-XXXX  
 Operating Condition: Transmitting-Middle channel (2442MHz)  
 Comment: DC 3.3V  
 Test Specification: Horizontal



| No. | Frequency (MHz) | Reading (dBuV/m) | Correct (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Degree (°) | Height (cm) | Remark |
|-----|-----------------|------------------|--------------|-----------------|----------------|-------------|------------|-------------|--------|
| 1   | 298.2681        | 15.56            | 11.89        | 27.45           | 46.00          | -18.55      | 178        | 100         | peak   |
| 2   | 389.3549        | 17.05            | 12.20        | 29.25           | 46.00          | -16.75      | 55         | 100         | peak   |
| 3   | 647.3856        | 16.95            | 17.90        | 34.85           | 46.00          | -11.15      | 69         | 100         | peak   |

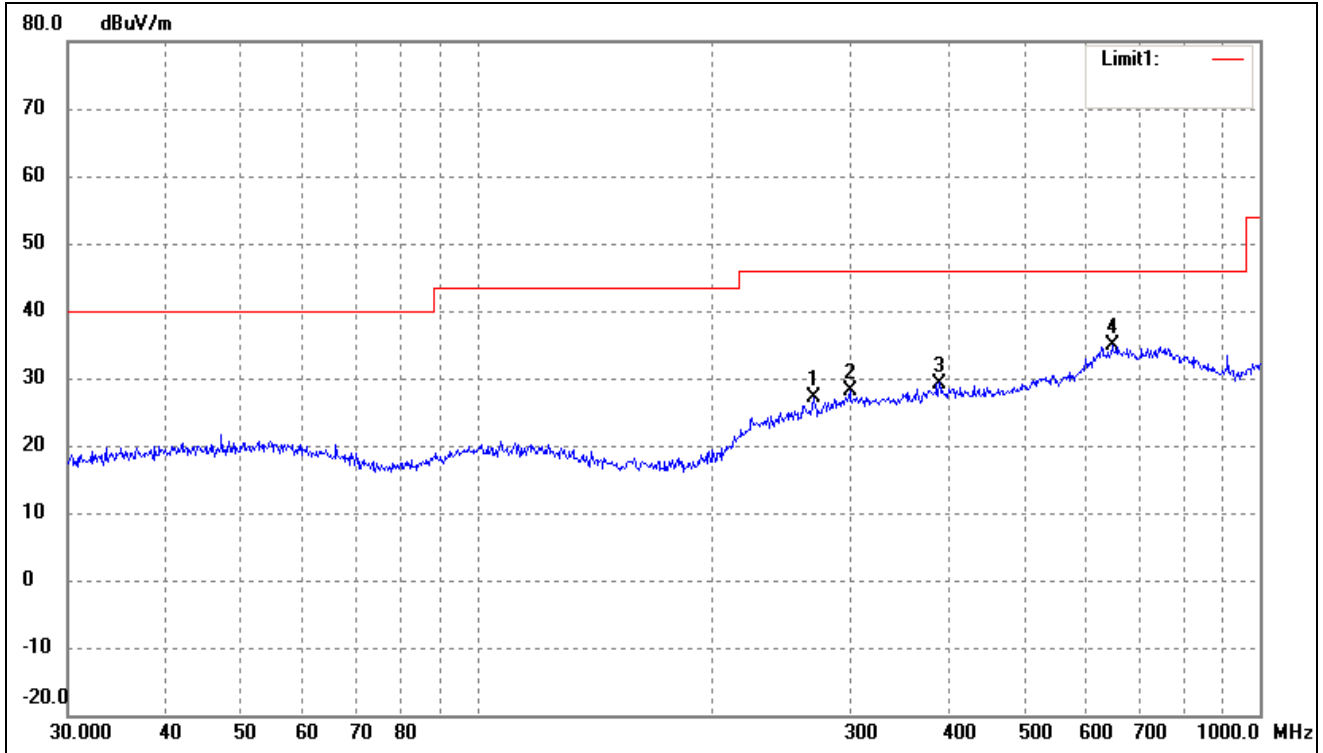
Test Specification: Vertical



| No. | Frequency (MHz) | Reading (dBuV/m) | Correct (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Degree (°) | Height (cm) | Remark |
|-----|-----------------|------------------|--------------|-----------------|----------------|-------------|------------|-------------|--------|
| 1   | 96.7749         | 16.20            | 4.46         | 20.66           | 43.50          | -22.84      | 175        | 100         | peak   |
| 2   | 318.8170        | 15.26            | 11.95        | 27.21           | 46.00          | -18.79      | 56         | 100         | peak   |
| 3   | 426.5210        | 15.94            | 12.08        | 28.02           | 46.00          | -17.98      | 201        | 100         | peak   |
| 4   | 668.1423        | 16.06            | 18.03        | 34.09           | 46.00          | -11.91      | 151        | 100         | peak   |

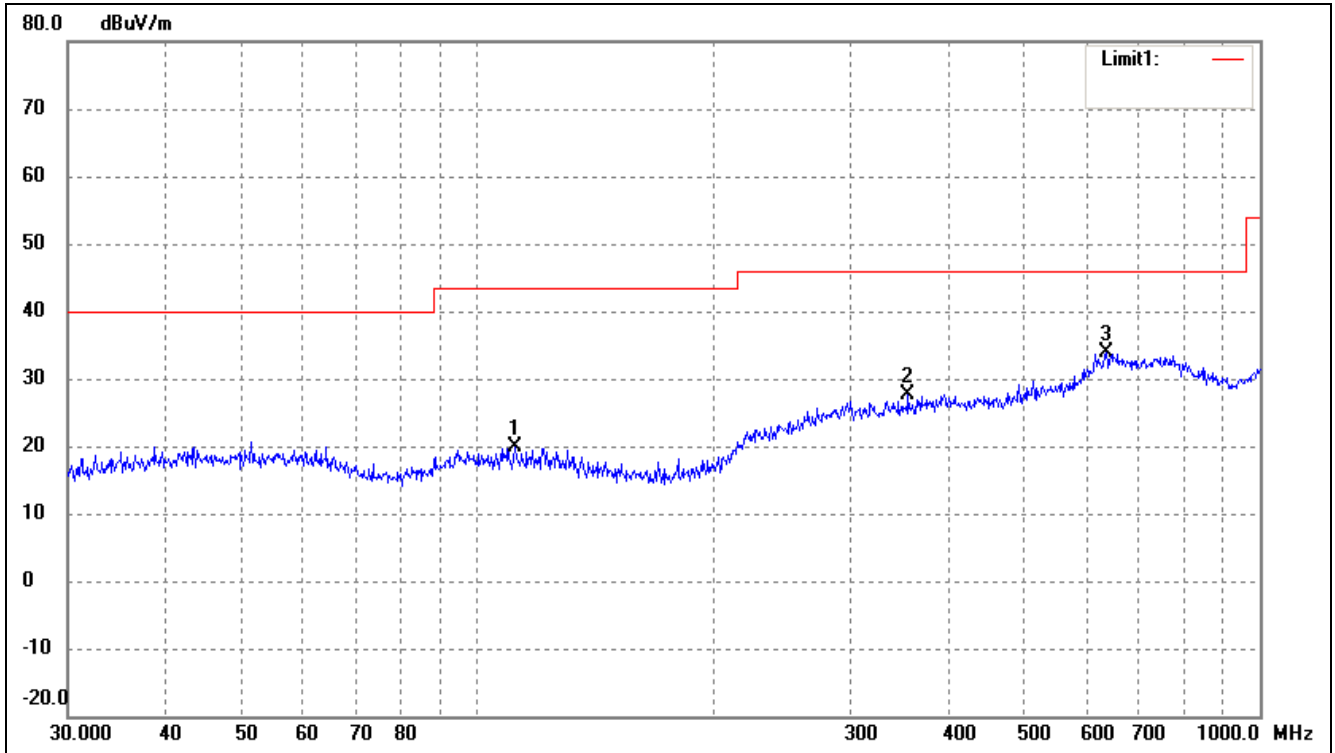
**Plot of Radiated Emissions Test Data**

EUT: *Bluetooth Smart Module 4.1 – LM931*  
 Tested Model: *LM931-XXXX*  
 Operating Condition: *Transmitting-High channel (2480MHz)*  
 Comment: *DC 3.3V*  
  
 Test Specification: *Horizontal*



| No. | Frequency (MHz) | Reading (dBuV/m) | Correct (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Degree (°) | Height (cm) | Remark |
|-----|-----------------|------------------|--------------|-----------------|----------------|-------------|------------|-------------|--------|
| 1   | 269.4284        | 16.73            | 10.37        | 27.10           | 46.00          | -18.90      | 87         | 100         | peak   |
| 2   | 299.3158        | 16.14            | 11.92        | 28.06           | 46.00          | -17.94      | 45         | 100         | peak   |
| 3   | 389.3549        | 17.05            | 12.20        | 29.25           | 46.00          | -16.75      | 66         | 100         | peak   |
| 4   | 647.3856        | 16.95            | 17.90        | 34.85           | 46.00          | -11.15      | 12         | 100         | peak   |

Test Specification: Vertical



| No. | Frequency (MHz) | Reading (dBuV/m) | Correct (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Degree (°) | Height (cm) | Remark |
|-----|-----------------|------------------|--------------|-----------------|----------------|-------------|------------|-------------|--------|
| 1   | 111.7380        | 14.92            | 4.86         | 19.78           | 43.50          | -23.72      | 185        | 100         | peak   |
| 2   | 355.4273        | 15.82            | 11.78        | 27.60           | 46.00          | -18.40      | 56         | 100         | peak   |
| 3   | 636.1340        | 16.02            | 17.93        | 33.95           | 46.00          | -12.05      | 198        | 100         | peak   |



*Spurious Emissions Above 1GHz*
*Transmitting: BLE mode:*

| Frequency<br>(MHz)     | Reading<br>(dBuV/m) | Correct<br>dB | Result<br>(dBuV/m) | Limit<br>(dBuV/m) | Margin<br>(dB) | Polar<br>H/V | Detector |
|------------------------|---------------------|---------------|--------------------|-------------------|----------------|--------------|----------|
| Low Channel-2402MHz    |                     |               |                    |                   |                |              |          |
| 4804                   | 61.51               | -3.59         | 57.92              | 74                | -16.08         | H            | PK       |
| 4804                   | 50.11               | -3.59         | 46.52              | 54                | -7.48          | H            | AV       |
| 7206                   | 59.99               | -0.52         | 59.47              | 74                | -14.53         | H            | PK       |
| 7206                   | 44.16               | -0.52         | 43.64              | 54                | -10.36         | H            | AV       |
| 4804                   | 59.21               | -3.59         | 55.62              | 74                | -18.38         | V            | PK       |
| 4804                   | 48.64               | -3.59         | 45.05              | 54                | -8.95          | V            | AV       |
| 7206                   | 60.16               | -0.52         | 59.64              | 74                | -14.36         | V            | PK       |
| 7206                   | 44.22               | -0.52         | 43.70              | 54                | -10.30         | V            | AV       |
| Middle Channel-2442MHz |                     |               |                    |                   |                |              |          |
| 4884                   | 58.10               | -3.49         | 54.61              | 74                | -19.39         | H            | PK       |
| 4884                   | 47.21               | -3.49         | 43.72              | 54                | -10.28         | H            | AV       |
| 7326                   | 58.34               | -0.47         | 57.87              | 74                | -16.13         | H            | PK       |
| 7326                   | 43.21               | -0.47         | 42.74              | 54                | -11.26         | H            | AV       |
| 4884                   | 60.16               | -3.49         | 56.67              | 74                | -17.33         | V            | PK       |
| 4884                   | 49.19               | -3.49         | 45.7               | 54                | -8.30          | V            | AV       |
| 7326                   | 60.14               | -0.47         | 59.67              | 74                | -14.33         | V            | PK       |
| 7326                   | 45.10               | -0.47         | 44.63              | 54                | -9.37          | V            | AV       |
| High Channel-2480MHz   |                     |               |                    |                   |                |              |          |
| 4960                   | 64.21               | -3.41         | 60.8               | 74                | -13.20         | H            | PK       |
| 4960                   | 49.56               | -3.41         | 46.15              | 54                | -7.85          | H            | AV       |
| 7440                   | 53.39               | -0.42         | 52.97              | 74                | -21.03         | H            | PK       |
| 7440                   | 44.14               | -0.42         | 43.72              | 54                | -10.28         | H            | AV       |
| 4960                   | 57.58               | -3.41         | 54.17              | 74                | -19.83         | V            | PK       |
| 4960                   | 44.27               | -3.41         | 40.86              | 54                | -13.14         | V            | AV       |
| 7440                   | 59.61               | -0.42         | 59.19              | 74                | -14.81         | V            | PK       |
| 7440                   | 43.92               | -0.42         | 43.5               | 54                | -10.50         | V            | AV       |

*Note: Testing is carried out with frequency rang 9kHz to the tenth harmonics, other than listed in the table above are attenuated more than 20dB below the permissible limits or the field strength is too small to be measured.*

---

## 9. Out of Band Emissions

---

### 9.1 Standard Applicable

According to §15.247 (d) and RSS-247 5.5 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)/RSS-GEN is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a)/RSS-GEN, must also comply with the radiated emission limits specified in §15.209(a)/RSS-GEN.

### 9.2 Test Procedure

According to the KDB 558074 D01 v03r05, the band-edge radiated test method as follows:

Set span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation (2310MHz to 2420MHz for low bandedge, 2460MHz to 2500MHz for the high bandedge)

RBW = 1MHz, VBW = 1MHz for peak value measured

RBW = 1MHz, VBW = 10Hz for average value measured

Sweep = auto; Detector function = peak/average; Trace = max hold

All the trace to stabilize, set the marker on the emission at the bandedge, or on the highest modulation product outside of the band, if this level is greater than that at the bandedge. Enable the marker-delta function, then use the marker-to-peak function to move the marker to the peak of the in-band emission. Those emission must comply with the 15.209 limit for fall in the restricted bands listed in section 15.205. Note that the method of measurement KDB publication number: 913591 may be used for the radiated bandedge measurements.

According to the KDB 558074 D01 v03r05, the conducted spurious emissions test method as follows:

1. Set start frequency to DTS channel edge frequency.
2. Set stop frequency so as to encompass the spectrum to be examined.
3. Set RBW = 100 kHz.
4. Set VBW  $\geq$  300 kHz.
5. Detector = peak.
6. Trace Mode = max hold.
7. Sweep = auto couple.
8. Allow the trace to stabilize (this may take some time, depending on the extent of the span).
9. Use peak marker function to determine maximum amplitude of all unwanted emissions within any 100 kHz bandwidth.

Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) are attenuated by at least the minimum requirements specified in section 8.1. Report

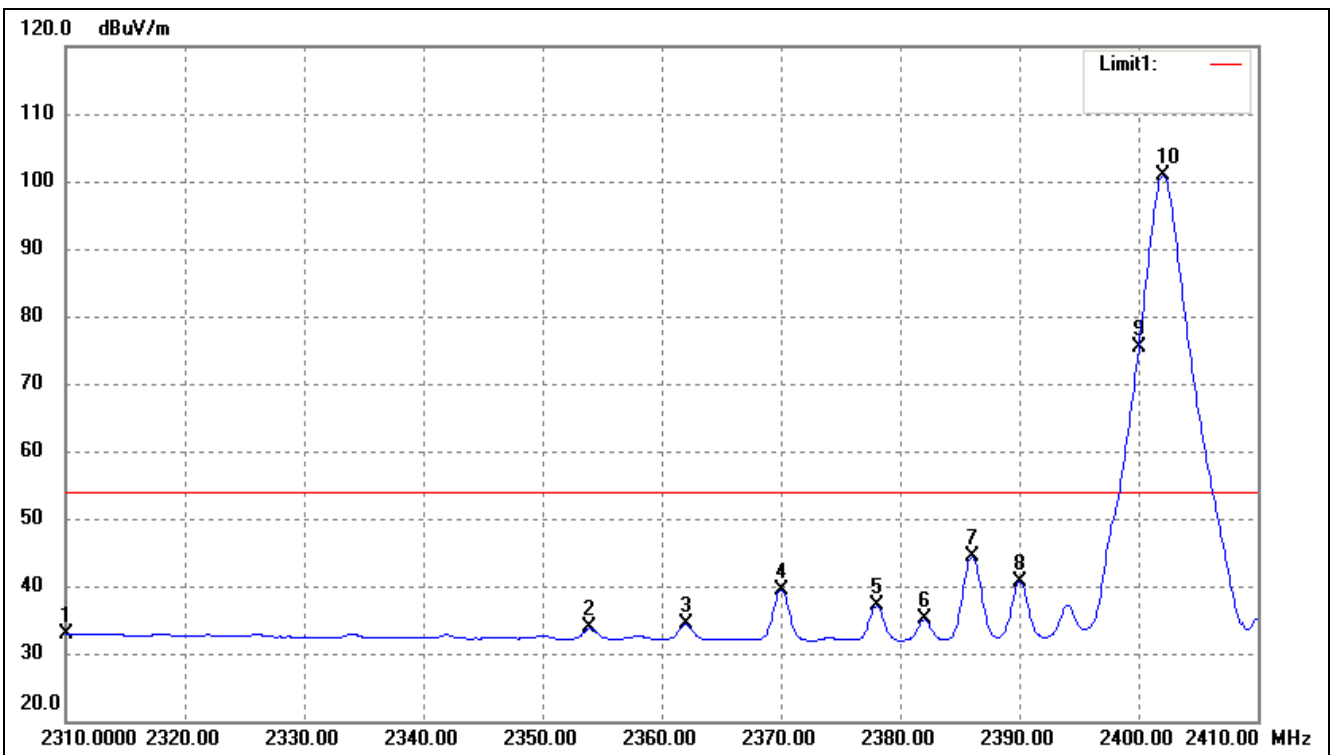
the three highest emissions relative to the limit.

### 9.3 Environmental Conditions

|                    |           |
|--------------------|-----------|
| Temperature:       | 23°C      |
| Relative Humidity: | 54%       |
| ATM Pressure:      | 1011 mbar |

### 9.4 Summary of Test Results/Plots

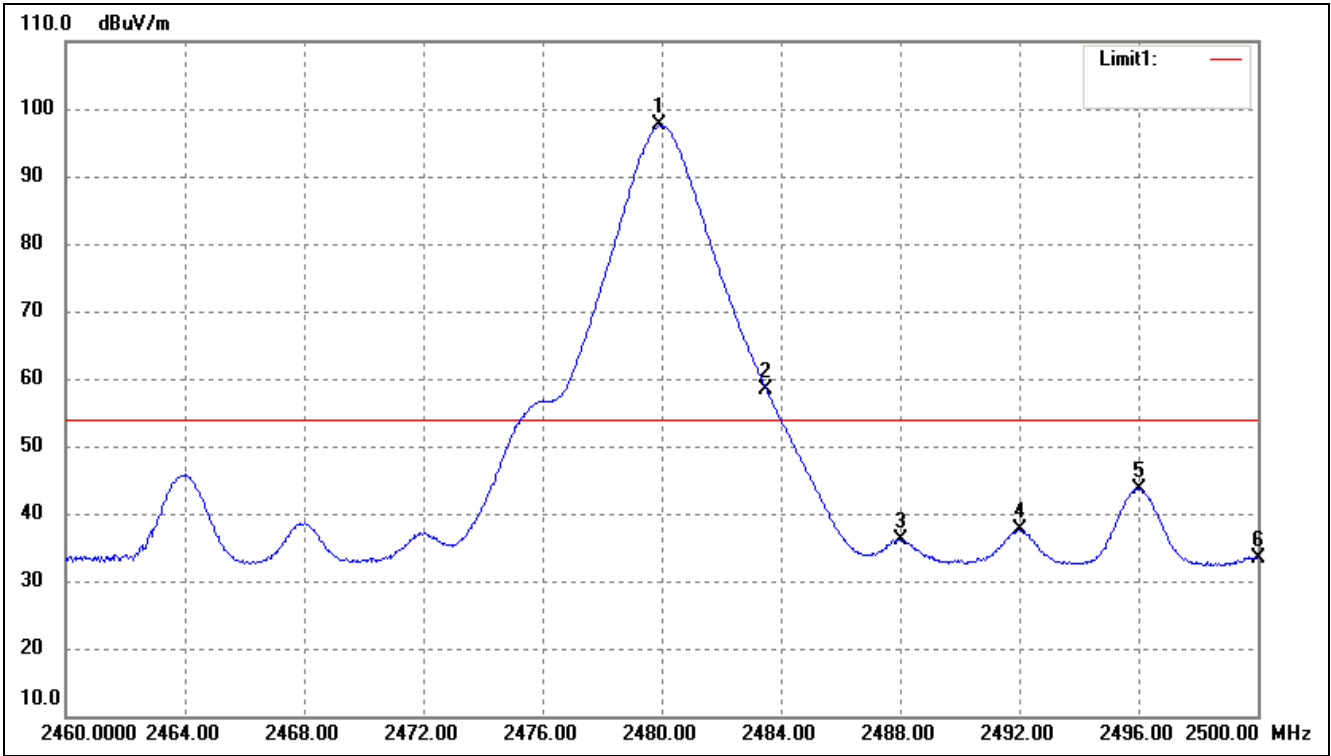
Bandedge (Radiated)  
 Lowest Bandedge-BLE  
 Vertical (Worst case)



| No. | Frequency (MHz) | Reading (dBuV/m) | Correct (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark           |
|-----|-----------------|------------------|--------------|-----------------|----------------|-------------|------------------|
| 1   | 2310.000        | 36.23            | -3.35        | 32.88           | 54.00          | -21.12      | Average Detector |
|     | 2310.000        | 50.30            | -3.35        | 46.95           | 74.00          | -27.05      | Peak Detector    |
| 2   | 2353.900        | 37.63            | -3.86        | 33.77           | 54.00          | -20.23      | Average Detector |
|     | 2354.100        | 51.31            | -3.86        | 47.45           | 74.00          | -26.55      | Peak Detector    |
| 3   | 2362.000        | 38.28            | -3.95        | 34.33           | 54.00          | -19.67      | Average Detector |
|     | 2362.500        | 52.32            | -3.96        | 48.36           | 74.00          | -25.64      | Peak Detector    |
| 4   | 2370.100        | 43.41            | -4.05        | 39.36           | 54.00          | -14.64      | Average Detector |
|     | 2370.400        | 52.72            | -4.05        | 48.67           | 74.00          | -25.33      | Peak Detector    |
| 5   | 2378.000        | 41.17            | -4.15        | 37.02           | 54.00          | -16.98      | Average Detector |

|   |          |       |       |       |       |        |                  |
|---|----------|-------|-------|-------|-------|--------|------------------|
|   | 2378.100 | 52.42 | -4.15 | 48.27 | 74.00 | -25.73 | Peak Detector    |
| 6 | 2382.000 | 39.22 | -4.19 | 35.03 | 54.00 | -18.97 | Average Detector |
|   | 2382.000 | 51.05 | -4.19 | 46.86 | 74.00 | -27.14 | Peak Detector    |
| 7 | 2386.000 | 48.51 | -4.23 | 44.28 | 54.00 | -9.72  | Average Detector |
|   | 2385.800 | 54.34 | -4.23 | 50.11 | 74.00 | -23.89 | Peak Detector    |
| 8 | 2390.000 | 44.95 | -4.29 | 40.66 | 54.00 | -13.34 | Average Detector |
|   | 2390.000 | 54.31 | -4.29 | 50.02 | 74.00 | -23.98 | Peak Detector    |

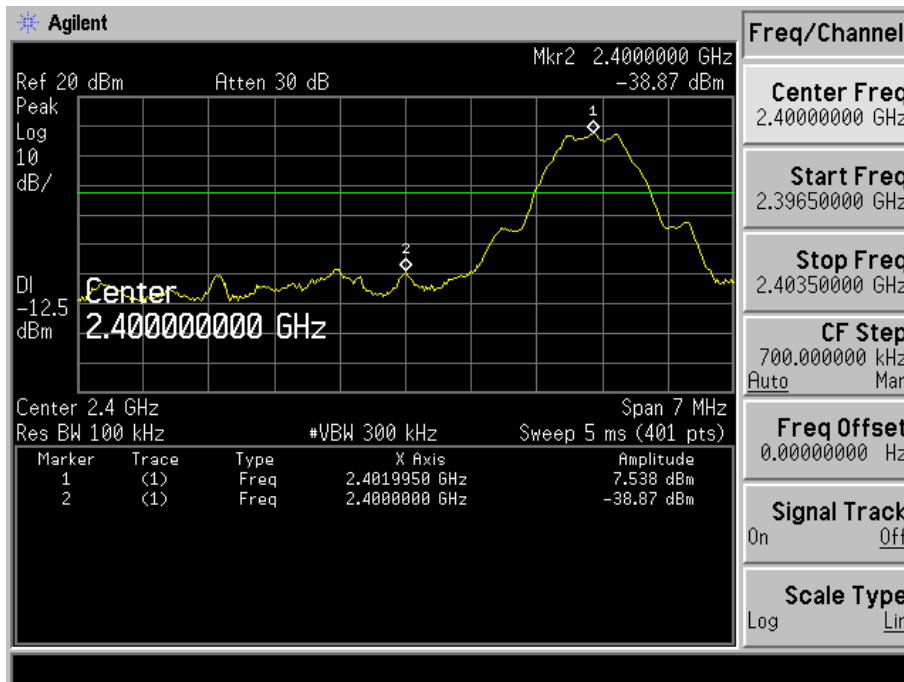
Highest Bandedge-BLE  
Vertical (Worst case)



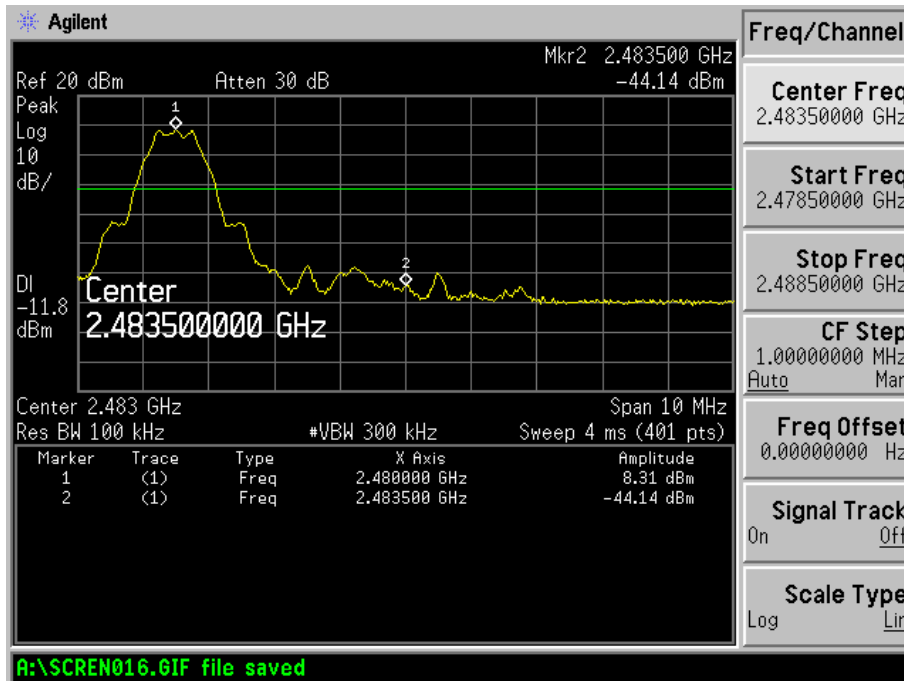
| No. | Frequency (MHz) | Reading (dBuV/m)  | Correct (dB) | Result (dBuV/m) | Limit (dBuV/m) | Margin (dB) | Remark           |
|-----|-----------------|-------------------|--------------|-----------------|----------------|-------------|------------------|
| 1   | 2479.920        | 101.87            | -4.36        | 97.51           | /              | /           | Average Detector |
|     | 2479.760        | 106.81            | -4.36        | 102.45          | /              | /           | Peak Detector    |
| 2   | 2483.500        | Delta = 64.36 dBc |              | 33.15           | 54.00          | -20.85      | Average Detector |
|     | 2483.500        |                   |              | 38.09           | 74.00          | -35.91      | Peak Detector    |
| 3   | 2488.000        | 40.56             | -4.35        | 36.21           | 54.00          | -17.79      | Average Detector |
|     | 2488.080        | 51.71             | -4.35        | 47.36           | 74.00          | -26.64      | Peak Detector    |
| 4   | 2492.000        | 42.00             | -4.34        | 37.66           | 54.00          | -16.34      | Average Detector |
|     | 2492.000        | 52.39             | -4.34        | 48.05           | 74.00          | -25.95      | Peak Detector    |
| 5   | 2496.040        | 47.98             | -4.35        | 43.63           | 54.00          | -10.37      | Average Detector |
|     | 2495.960        | 54.67             | -4.35        | 50.32           | 74.00          | -23.68      | Peak Detector    |
| 6   | 2500.000        | 37.82             | -4.34        | 33.48           | 54.00          | -20.52      | Average Detector |
|     | 2500.000        | 48.73             | -4.34        | 44.39           | 74.00          | -29.61      | Peak Detector    |

Bandedge (Conducted)

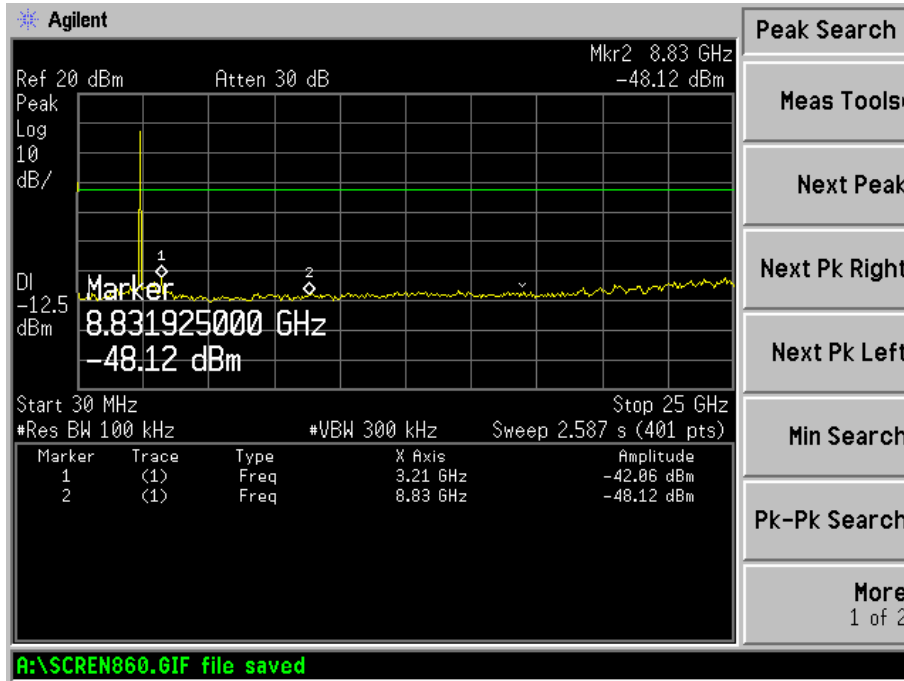
Lowest



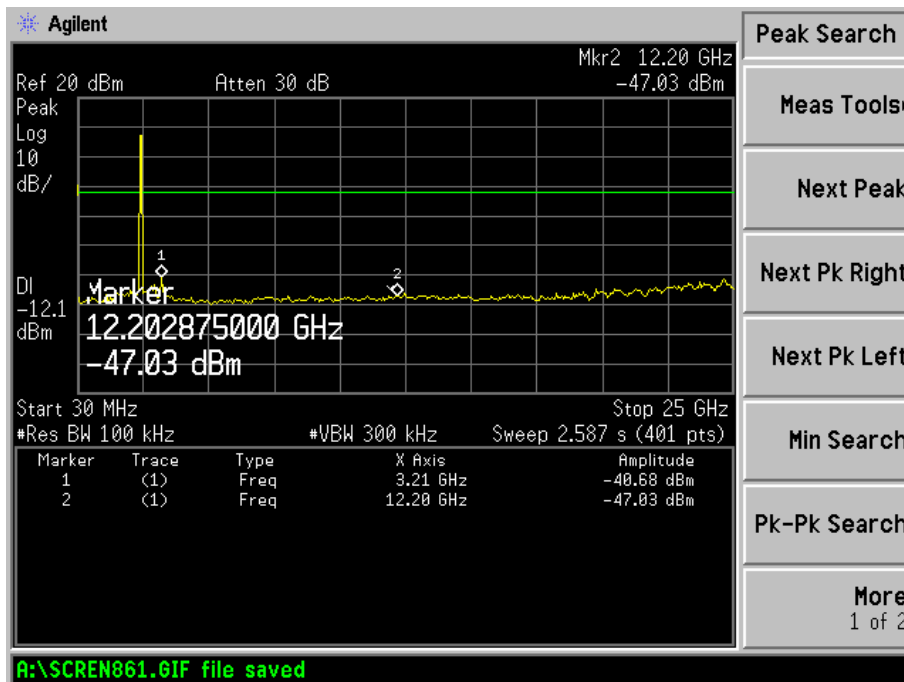
Highest



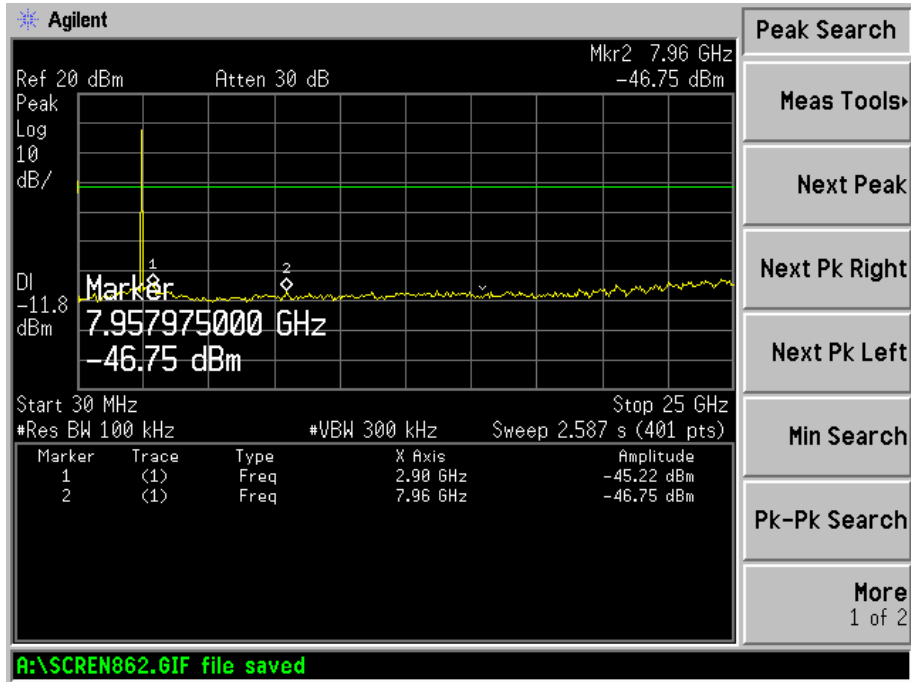
Conducted Spurious Emission  
Lowest Channel



Middle Channel



High Channel





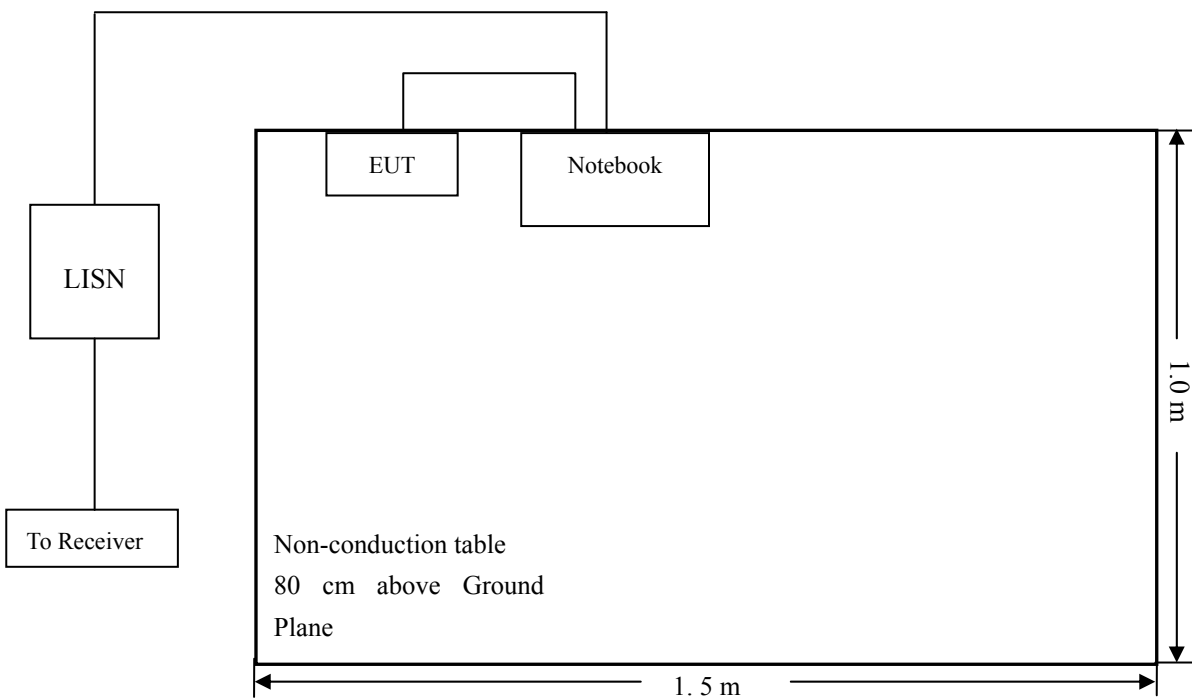
## 10. Conducted Emissions

### 10.1 Test Procedure

The setup of EUT is according with per ANSI C63.4-2014 measurement procedure.

The external I/O cables were draped along the test table and formed a bundle 30 to 40 cm long in the middle. The spacing between the peripherals was 10 cm.

### 10.2 Basic Test Setup Block Diagram



### 10.3 Environmental Conditions

|                    |           |
|--------------------|-----------|
| Temperature:       | 25 °C     |
| Relative Humidity: | 52%       |
| ATM Pressure:      | 1012 mbar |

## 10.4 Test Receiver Setup

During the conducted emission test, the test receiver was set with the following configurations:

Start Frequency ..... 150 kHz  
Stop Frequency..... 30 MHz  
Sweep Speed ..... Auto  
IF Bandwidth..... 10 kHz  
Quasi-Peak Adapter Bandwidth ..... 9 kHz  
Quasi-Peak Adapter Mode ..... Normal

## 10.5 Summary of Test Results/Plots

According to the data in section 10.6, the EUT complied with the FCC Part 15.207 and RSS-Gen 8.8 Conducted margin for this device, with the *worst* margin reading of:

**-9.25 dB at 0.1700 MHz** in the **Neutral, Peak** detector, 0.15-30MHz

## 10.6 Conducted Emissions Test Data

**Plot of Conducted Emissions Test Data**

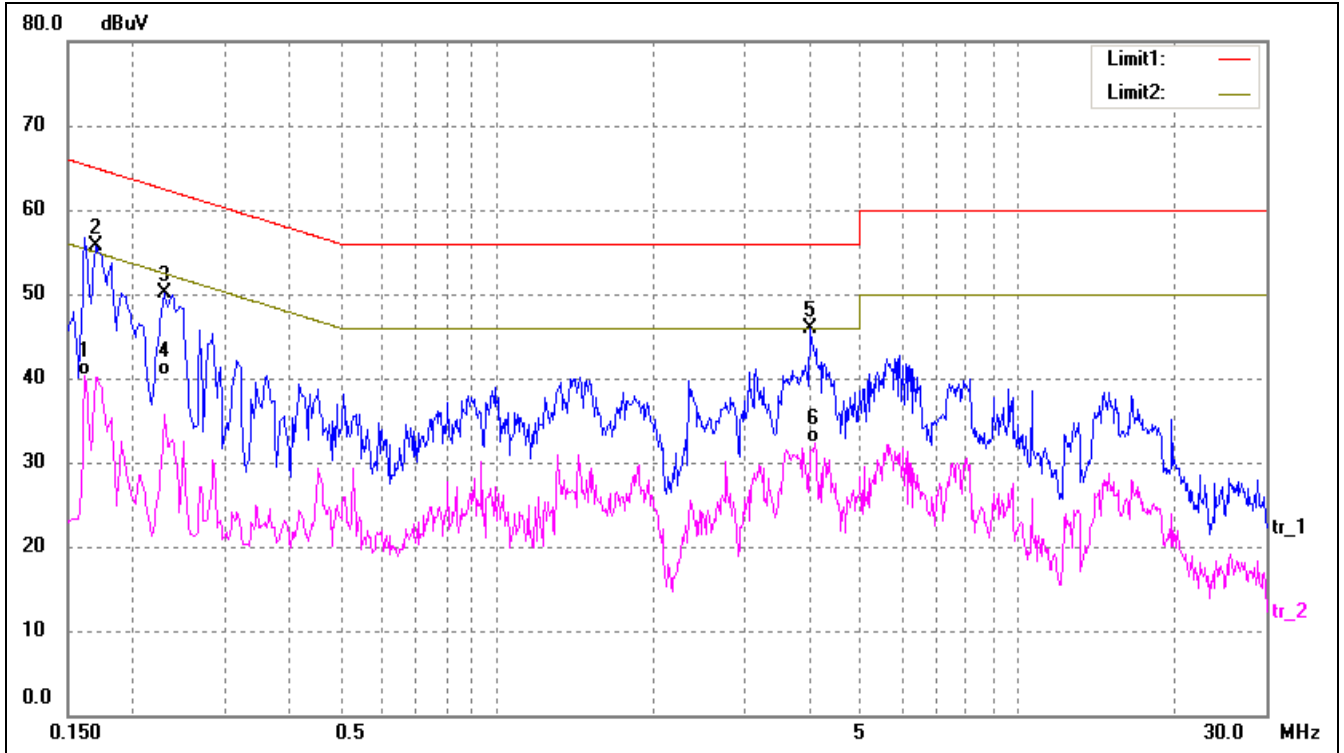
EUT: Bluetooth Smart Module 4.1 – LM931

Tested Model: LM931-XXXX

Operating Condition: Transmitting

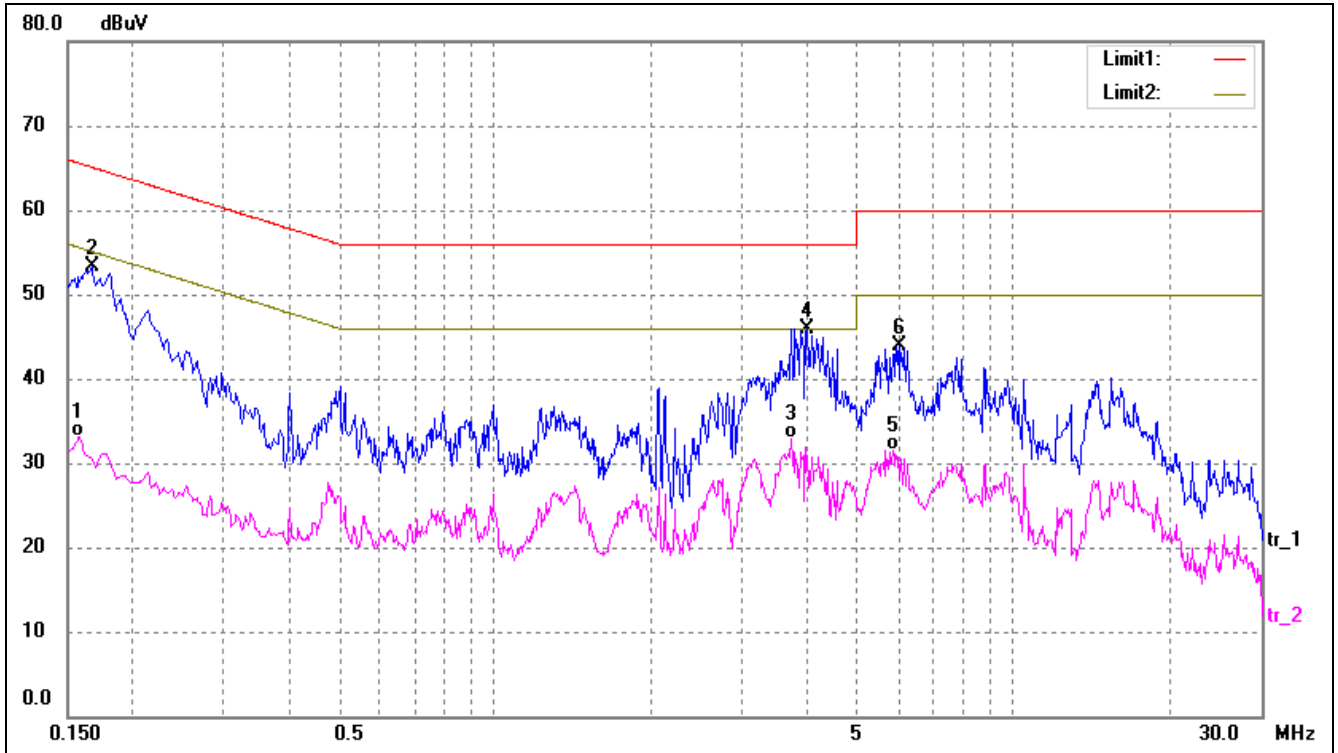
Comment: AC 120V/60Hz; Notebook USB 5V

Test Specification: Neutral



| No. | Frequency (MHz) | Reading (dBuV) | Correct (dB) | Result (dBuV) | Limit (dBuV) | Margin (dB) | Detector |
|-----|-----------------|----------------|--------------|---------------|--------------|-------------|----------|
| 1   | 0.1620          | 30.84          | 9.50         | 40.34         | 55.36        | -15.02      | AVG      |
| 2*  | 0.1700          | 46.21          | 9.50         | 55.71         | 64.96        | -9.25       | peak     |
| 3   | 0.2300          | 40.69          | 9.50         | 50.19         | 62.45        | -12.26      | peak     |
| 4   | 0.2300          | 30.84          | 9.50         | 40.34         | 52.45        | -12.11      | AVG      |
| 5   | 4.0060          | 35.72          | 10.10        | 45.82         | 56.00        | -10.18      | peak     |
| 6   | 4.0820          | 22.24          | 10.11        | 32.35         | 46.00        | -13.65      | AVG      |

Test Specification: Line



| No. | Frequency (MHz) | Reading (dBuV) | Correct (dB) | Result (dBuV) | Limit (dBuV) | Margin (dB) | Detector |
|-----|-----------------|----------------|--------------|---------------|--------------|-------------|----------|
| 1   | 0.1580          | 23.67          | 9.50         | 33.17         | 55.57        | -22.40      | AVG      |
| 2   | 0.1668          | 43.72          | 9.50         | 53.22         | 65.12        | -11.90      | peak     |
| 3   | 3.7380          | 22.87          | 10.06        | 32.93         | 46.00        | -13.07      | AVG      |
| 4*  | 3.9860          | 35.88          | 10.10        | 45.98         | 56.00        | -10.02      | peak     |
| 5   | 5.8500          | 21.15          | 10.26        | 31.41         | 50.00        | -18.59      | AVG      |
| 6   | 6.0500          | 33.63          | 10.27        | 43.90         | 60.00        | -16.10      | peak     |

\*\*\*\*\* END OF REPORT \*\*\*\*\*