# ENGINEERING TEST REPORT

**Bluetooth Module – Range Extender**
**Model: BLERANGEX**
**FCC ID: 2AFYY-BLERANGEX**

*Applicant:*

**Embedded Sense Inc.**
5155 Spectrum Way, Unit 17
Mississauga, Ontario
Canada L4W 5A1

***In Accordance With***

**Federal Communications Commission (FCC)**
**Part 15, Subpart C, Section 15.247**
**Digital Modulation Systems (DTS) Operating in 2400 – 2483.5 MHz Band**

**UltraTech's File No.: 16EMSI040_FCC15C247DTS**

| | |
|---|---|
| This Test report is Issued under the Authority of<br>Tri M. Luu<br>Vice President of Engineering<br>UltraTech Group of Labs<br><br>Date: September 7, 2016 | |
| Report Prepared by: Dan Huynh<br><br>Issued Date: September 7, 2016 | Tested by: Hung Trinh<br><br>Test Dates: August 15-17, 2016 |

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
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**UltraTech**

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 91038 | 1309 | 46390-2049 | NVLAP LAB CODE 200093-0 | AT-1945 | SL2-IN-E-1119R | CA2049 | TL363_B | TPTDP DA1300 |

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# EXHIBIT 1. INTRODUCTION

## 1.1. SCOPE

| | |
|---|---|
| **Reference:** | FCC Part 15, Subpart C, Section 15.247 |
| **Title:** | Code of Federal Regulations (CFR), Title 47 – Telecommunication, Part 15 – Radio Frequency Devices |
| **Purpose of Test:** | Equipment Certification for Digital Modulation Systems (DTS) Transmitter Operating in the Frequency Band 2400-2483.5 MHz. |
| **Test Procedures:** | ▪ ANSI C63.4<br>▪ ANSI C63.10<br>▪ FCC KDB Publication No. 558074 D01 DTS Meas Guidance v03r05 |
| **Environmental Classification:** | [x] Commercial, industrial or business environment<br>[x] Residential environment |

## 1.2. RELATED SUBMITTAL(S)/GRANT(S)

None.

## 1.3. NORMATIVE REFERENCES

| Publication | Year | Title |
|---|---|---|
| 47 CFR Parts 0-19 | 2016 | Code of Federal Regulations (CFR), Title 47 – Telecommunication |
| 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 |
| ANSI C63.10 | 2013 | American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices |
| CISPR 22 &<br>EN 55022 | 2008-09, Edition 6.0<br>2006 | Information Technology Equipment - Radio Disturbance Characteristics - Limits and Methods of Measurement |
| CISPR 16-1-1<br>+A1<br>+A2 | 2006<br>2006<br>2007 | Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-1: Measuring Apparatus |
| CISPR 16-1-2<br>+A1<br>+A2 | 2003<br>2004<br>2006 | Specification for radio disturbance and immunity measuring apparatus and methods. Part 1-2: Conducted disturbances |
| FCC, KDB Publication No. 558074 D01 DTS Meas Guidance v03r05 | 2016 | Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247 |

# EXHIBIT 2. PERFORMANCE ASSESSMENT

## 2.1. CLIENT INFORMATION

| Applicant | |
|---|---|
| **Name:** | Embedded Sense Inc. |
| **Address:** | 5155 Spectrum Way, Unit 17<br>Mississauga, Ontario<br>Canada L4W 5A1 |
| **Contact Person:** | Mr. Frank Gerlach<br>Phone #: 905-282-1750<br>Fax #: 905-282-9691<br>Email Address: fgerlach@embeddedsense.com |

| Manufacturer | |
|---|---|
| **Name:** | Embedded Sense Inc. |
| **Address:** | 5155 Spectrum Way, Unit 17<br>Mississauga, Ontario<br>Canada L4W 5A1 |
| **Contact Person:** | Mr. Frank Gerlach<br>Phone #: 905-282-1750<br>Fax #: 905-282-9691<br>Email Address: fgerlach@embeddedsense.com |

## 2.2. EQUIPMENT UNDER TEST (EUT) INFORMATION

The following information (with the exception of the Date of Receipt) has been supplied by the applicant.

| | |
|---|---|
| **Brand Name:** | Embedded Sense Inc. |
| **Product Name:** | Bluetooth Module – Range Extender |
| **Model Name or Number:** | BLERANGEX |
| **Serial Number:** | Test Sample |
| **Type of Equipment:** | Digital Transmission System (DTS) |
| **Input Power Supply Type:** | External DC Power Supply |
| **Primary User Functions of EUT:** | Any application utilizing Bluetooth Low Energy with extended range. |

## 2.3. EUT'S TECHNICAL SPECIFICATIONS

| Transmitter | |
|---|---|
| **Equipment Type:** | • Portable<br>• Mobile<br>• Base Station (fixed use) |
| **Intended Operating Environment:** | ▪ Commercial, industrial or business environment<br>▪ Residential environment |
| **Power Supply Requirement:** | 3.0 - 3.6. VDC |
| **RF Output Power Rating:** | 14.49 dBm Peak |
| **Operating Frequency Range:** | 2402 -2480 MHz |
| **RF Output Impedance:** | 50 Ω |
| **Duty Cycle:** | Continuous |
| **Modulation Type:** | GFSK |
| **Antenna Connector Types:** | Integral PCB Trace |

## 2.4. ASSOCIATED ANTENNA DESCRIPTIONS

| Antenna Type | Maximum Gain (dBi) |
|---|---|
| PCB Trace antenna | 0 |

## 2.5. LIST OF EUT'S PORTS

| Port Number | EUT's Port Description | Number of Identical Ports | Connector Type | Cable Type (Shielded/Non-shielded) |
|---|---|---|---|---|
| No I/O port. | | | | |

## 2.6. ANCILLARY EQUIPMENT

The EUT was tested while connected to the following representative configuration of ancillary equipment necessary to exercise the ports during tests:

| Ancillary Equipment # 1 | |
|---|---|
| Description: | Test Jig |
| Brand name: | Embedded Sense Inc. |
| Model Name or Number: | N/A |
| Connected to EUT's Port: | I/O Port |

# EXHIBIT 3. EUT OPERATING CONDITIONS AND CONFIGURATIONS DURING TESTS

## 3.1. CLIMATE TEST CONDITIONS

The climate conditions of the test environment are as follows:

| | |
|---|---|
| Temperature: | 21 to 23 $^{o}$C |
| Humidity: | 45 to 58% |
| Pressure: | 102 kPa |
| Power Input Source: | 3.6 VDC |

## 3.2. OPERATIONAL TEST CONDITIONS & ARRANGEMENT FOR TESTS

| | |
|---|---|
| **Operating Modes:** | The transmitter was operated in a continuous transmission mode with the carrier modulated as specified in the Test Data. |
| **Special Test Software:** | Test software provided by the Applicant to operate the EUT at each channel frequency continuously and in the range of typical modes of operation. |
| **Special Hardware Used:** | Test Jig |
| **Transmitter Test Antenna:** | The EUT is tested with the antenna fitted in a manner typical of normal intended use as integral antenna equipment as described with the test results. |

| **Transmitter Test Signals** | |
|---|---|
| **Frequency Band(s):** | 2402 - 2480 MHz |
| **Frequency(ies) Tested:** | 2402 MHz, 2440 MHz, 2480 MHz |
| **RF Power Output:**<br>(measured maximum output power at antenna terminals) | 14.49 dBm Peak |
| **Normal Test Modulation:** | GFSK |
| **Modulating Signal Source:** | Internal |

# EXHIBIT 4. SUMMARY OF TEST RESULTS

## 4.1. LOCATION OF TESTS

All of the measurements described in this report were performed at Ultratech Group of Labs located in the city of Oakville, Province of Ontario, Canada.

- AC Power Line Conducted Emissions were performed in UltraTech's shielded room, 24'(L) by 16'(W) by 8'(H).

- Radiated Emissions were performed at the Ultratech's 3-10 TDK Semi-Anechoic Chamber situated in the Town of Oakville, province of Ontario. This test site been calibrated in accordance with ANSI C63.4, and found to be in compliance with the requirements of Sec. 2.948 of the FCC Rules. The descriptions and site measurement data of the Oakville 3-10 TDK Semi-Anechoic Chamber has been filed with FCC office (FCC File No.: 91038) and Industry Canada office (Industry Canada File No.: 2049A-3). Expiry Date: 2017-04-02.

## 4.2. APPLICABILITY & SUMMARY OF EMC EMISSION TEST RESULTS

| FCC Section(s) | Test Requirements | Compliance (Yes/No) |
|---|---|---|
| 15.203 | Antenna requirements | Yes |
| 15.207(a) | AC Power Line Conducted Emissions | Yes |
| 15.247(a)(2) | 6 dB Bandwidth | Yes |
| 15.247(b)(3) | Peak Conducted Output Power - DTS | Yes |
| 15.247(d) | Band-Edge and RF Conducted Spurious Emissions at the Transmitter Antenna Terminal | Yes |
| 15.247(d), 15.209 & 15.205 | Transmitter Spurious Radiated Emissions | Yes |
| 15.247(e) | Power Spectral Density | Yes |
| 15.247(i), 1.1307, 1.1310, 2.1091, 2.1093 | RF Exposure | Yes |

## 4.3. MODIFICATIONS INCORPORATED IN THE EUT FOR COMPLIANCE PURPOSES

None.

# EXHIBIT 5. TEST DATA

## 5.1. POWER LINE CONDUCTED EMISSIONS [§15.207(a)]

### 5.1.1. Limit(s)

The equipment shall meet the limits of the following table:

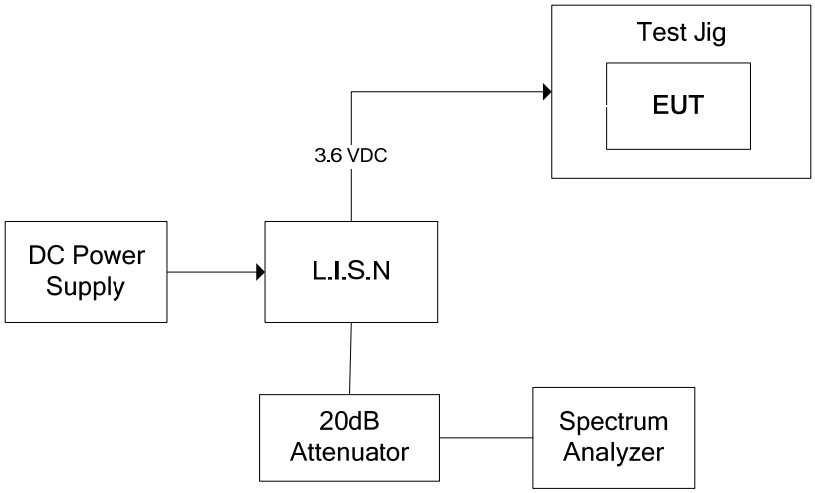
| Frequency of emission (MHz) | Conducted Limits (dBμV) | |
|---|---|---|
| | Quasi-peak | Average |
| 0.15–0.5 .....…….. | 66 to 56* ..... | 56 to 46* |
| 0.5–5 .....…….. | 56 ..... | 46 |
| 5-30 …….. | 60 ..…….. | 50 |

*Decreases linearly with the logarithm of the frequency

### 5.1.2. Method of Measurements

ANSI C63.4

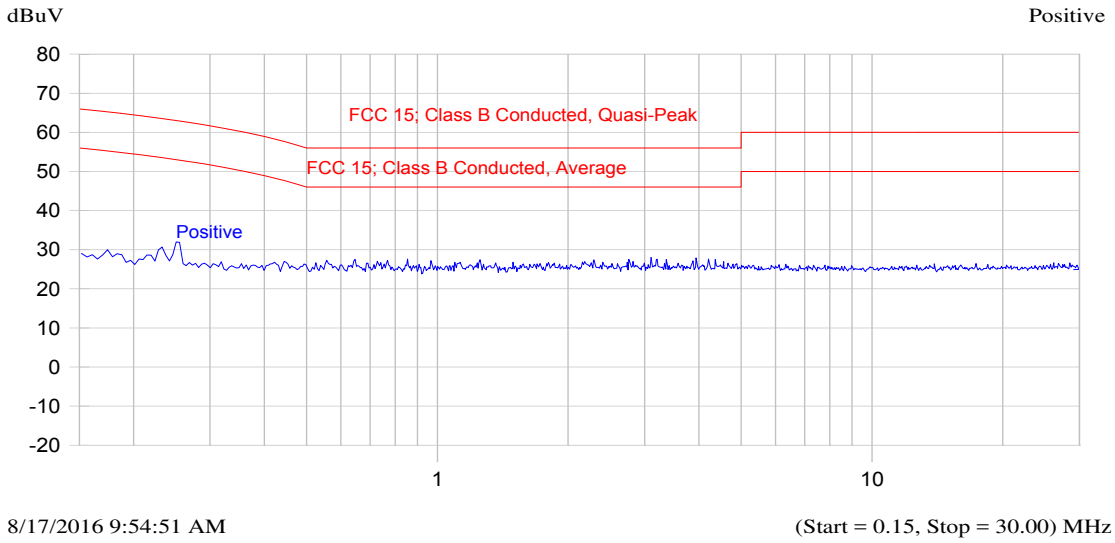
### 5.1.3. Test Arrangement



## 5.1.4. Test Data

**Plot 5.1.4.1.** Power Line Conducted Emissions; Line Voltage: 3.6 VDC; Line Tested: Positive

**Current Graph**

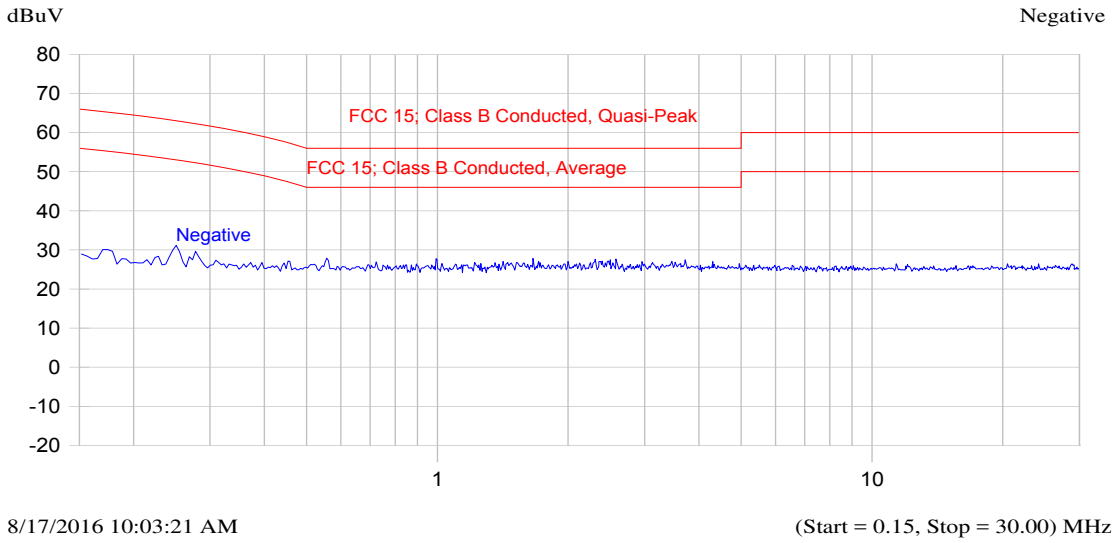



**Current List**

| Frequency MHz | Peak dBuV | QP dBuV | QP-QP Limit dB | Avg dBuV | Avg-Avg Limit dB | Trace Name |
|---|---|---|---|---|---|---|
| 0.249 | 38.5 | 33.8 | -29.3 | 26.9 | -26.2 | Positive |

**Plot 5.1.4.2.** Power Line Conducted Emissions; Line Voltage: 3.6 VDC; Line Tested: Negative

**Current Graph**




**Current List**

| Frequency MHz | Peak dBuV | QP dBuV | QP-QP Limit dB | Avg dBuV | Avg-Avg Limit dB | Trace Name |
|---|---|---|---|---|---|---|
| 0.246 | 37.9 | 32.3 | -30.8 | 25.1 | -28.0 | Negative |

## 5.2. OCCUPIED BANDWIDTH [§ 15.247(a)(2)]

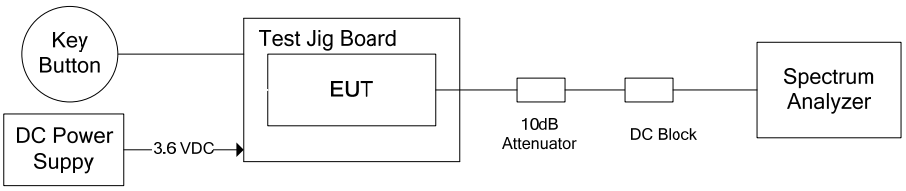
### 5.2.1. Limit(s)

The minimum 6 dB bandwidth shall be at least 500 kHz.

### 5.2.2. Method of Measurements

KDB 558074 D01 DTS Meas Guidance v03r05, Section 8.2, Option 2.

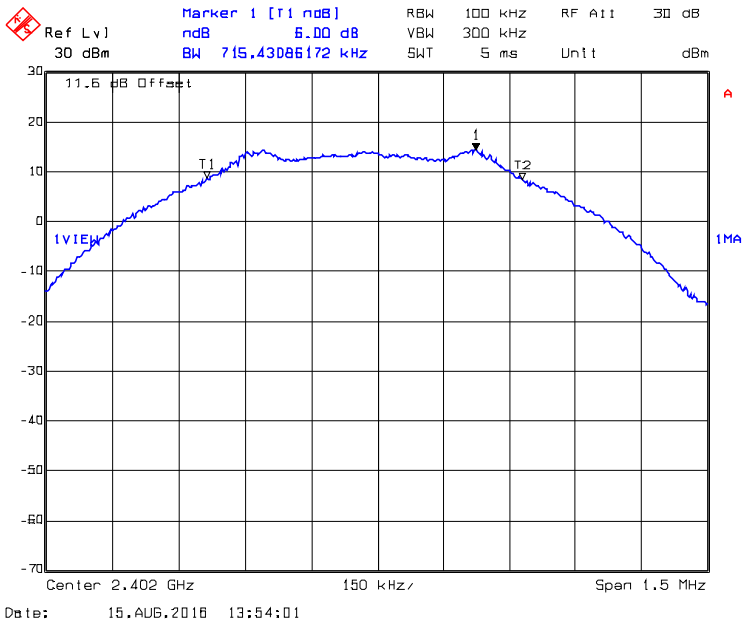
### 5.2.3. Test Arrangement



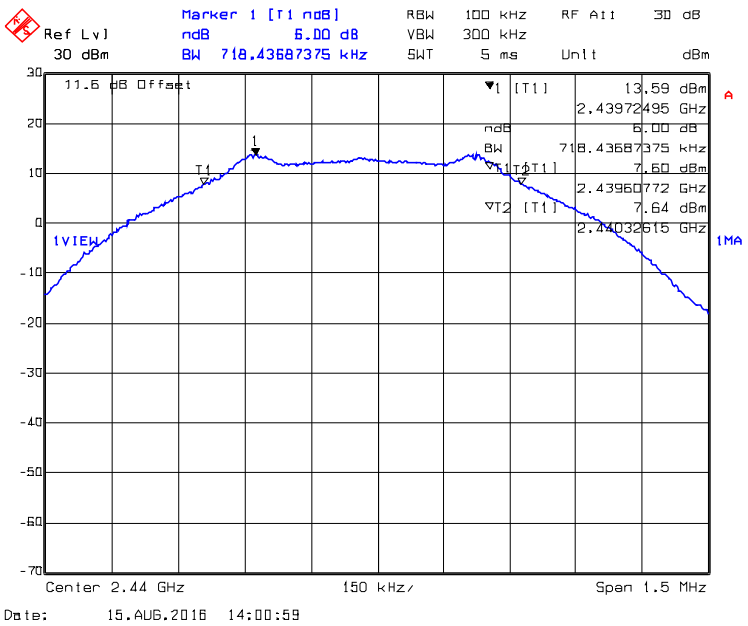

### 5.2.4. Test Data

| Channel | Frequency (MHz) | Modulation | 6dB BW (kHz) | Min. Limit (kHz) |
|---|---|---|---|---|
| 1 | 2402 | GFSK | 715.43 | 500 |
| 20 | 2440 | GFSK | 718.44 | 500 |
| 40 | 2480 | GFSK | 721.44 | 500 |

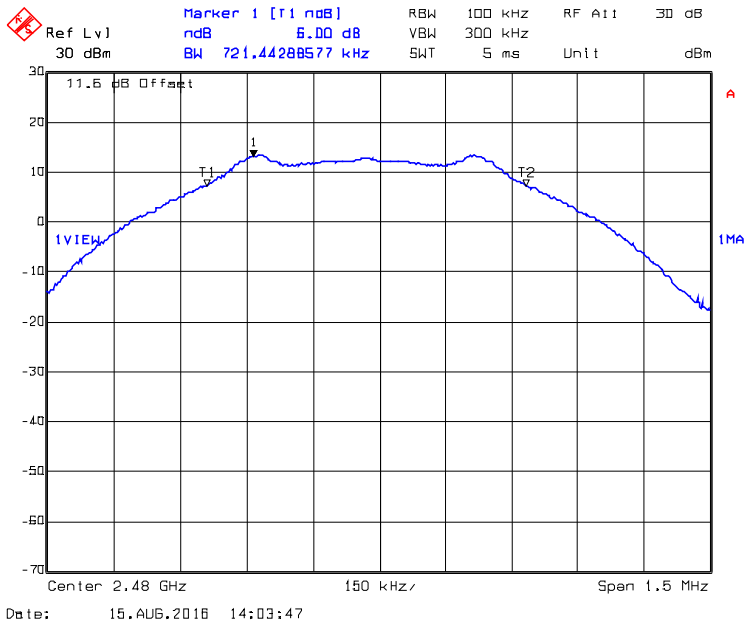
**Plot 5.2.4.1.** 6 dB Bandwidth, Bandwidth, Channel 1, 2402 MHz, GFSK, 1Mbps, 250 kHz Deviation




**Plot 5.2.4.2.** 6 dB Bandwidth, Bandwidth, Channel 20, 2440 MHz, GFSK,1 Mbps, 250 kHz Deviation



**Plot 5.2.4.3.** 6 dB Bandwidth, Bandwidth, Channel 40, 2480 MHz, GFSK, 1 Mbps, 250 kHz Deviation



## 5.3. PEAK CONDUCTED OUTPUT POWER - DTS [§ 15.247(b)]

### 5.3.1. Limit(s)

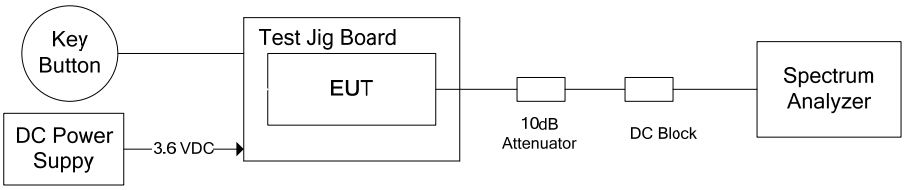
**§ 15.247(b)(3):** For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.

**§ 15.247(b)(4)**: The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, 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.

### 5.3.2. Method of Measurements & Test Arrangement

KDB 558074 D01 DTS Meas Guidance V03r05, Section 9.1.1.

### 5.3.3. Test Arrangement

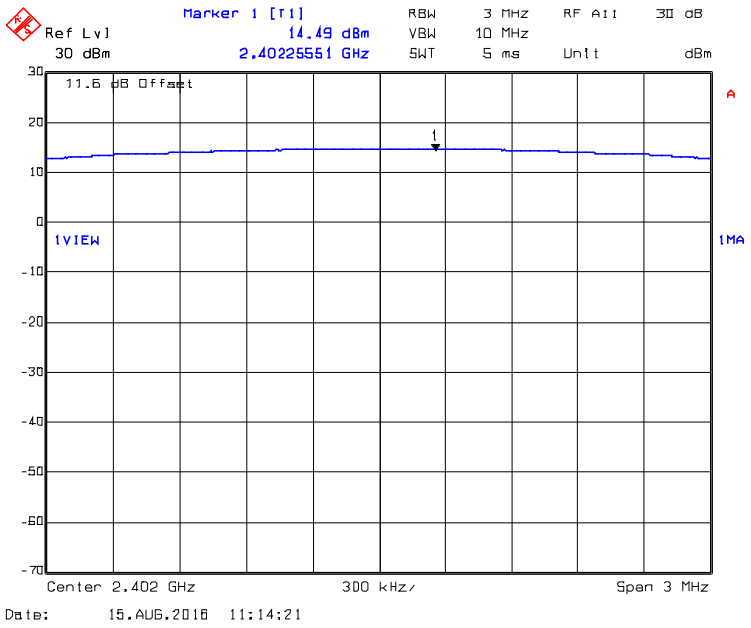



### 5.3.4. Test Data

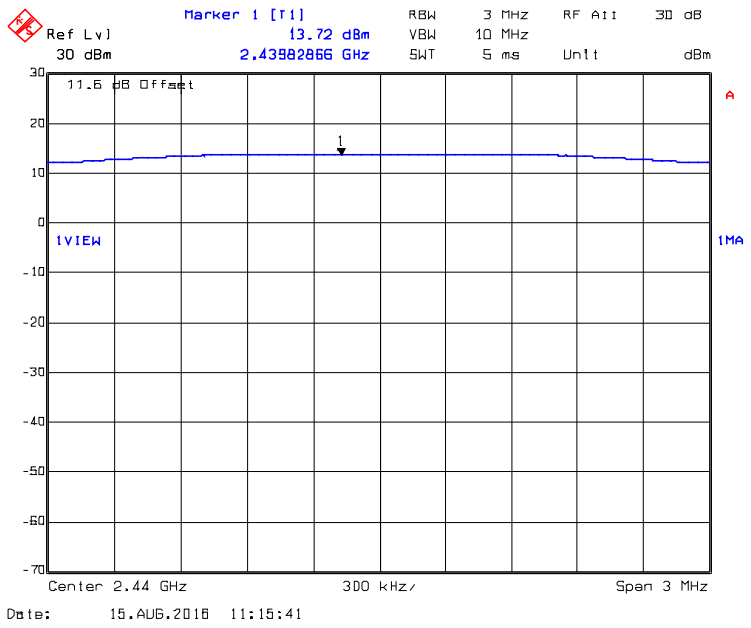
| Channel | Frequency (MHz) | Modulation | Peak Power (dBm) | EIRP* (dBm) |
|---|---|---|---|---|
| 1 | 2402 | GFSK | 14.49 | 14.49 |
| 20 | 2440 | GFSK | 13.72 | 13.72 |
| 40 | 2480 | GFSK | 13.34 | 13.34 |

* EIRP = Peak Power + Max. Antenna Gain in dBi (0 dBi)

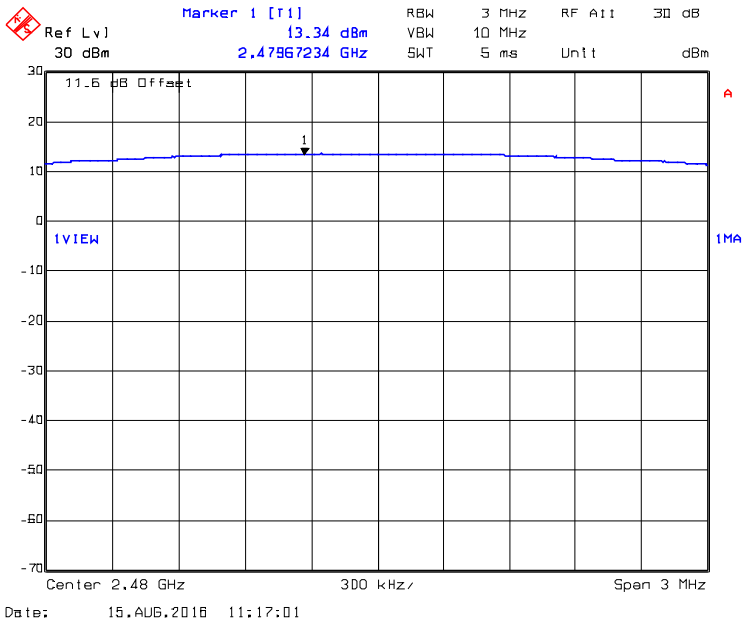
**Plot 5.3.4.1.** Maximum Peak Conducted Output Power, Channel 1, 2402 MHz, GFSK, 1Mbps, 250 kHz Deviation




**Plot 5.3.4.2.** Maximum Peak Conducted Output Power, Channel 20, 2440 MHz, GFSK,1 Mbps, 250 kHz Deviation



**Plot 5.3.4.3.** Maximum Peak Conducted Output Power, Channel 40, 2480 MHz, GFSK, 1 Mbps, 250 kHz Deviation



## 5.4. TRANSMITTER SPURIOUS RADIATED EMISSIONS AT 3 METERS [§§ 15.247(d), 15.209 & 15.205]

### 5.4.1. Limit(s)

**§ 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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

**Section 15.205(a) - Restricted Bands of Operation**

| MHz | MHz | MHz | GHz |
|---|---|---|---|
| 0.090–0.110 | 16.42–16.423 | 399.9–410 | 4.5–5.15 |
| [1] 0.495–0.505 | 16.69475–16.69525 | 608–614 | 5.35–5.46 |
| 2.1735–2.1905 | 16.80425–16.80475 | 960–1240 | 7.25–7.75 |
| 4.125–4.128 | 25.5–25.67 | 1300–1427 | 8.025–8.5 |
| 4.17725–4.17775 | 37.5–38.25 | 1435–1626.5 | 9.0–9.2 |
| 4.20725–4.20775 | 73–74.6 | 1645.5–1646.5 | 9.3–9.5 |
| 6.215–6.218 | 74.8–75.2 | 1660–1710 | 10.6–12.7 |
| 6.26775–6.26825 | 108–121.94 | 1718.8–1722.2 | 13.25–13.4 |
| 6.31175–6.31225 | 123–138 | 2200–2300 | 14.47–14.5 |
| 8.291–8.294 | 149.9–150.05 | 2310–2390 | 15.35–16.2 |
| 8.362–8.366 | 156.52475–156.52525 | 2483.5–2500 | 17.7–21.4 |
| 8.37625–8.38675 | 156.7–156.9 | 2655–2900 | 22.01–23.12 |
| 8.41425–8.41475 | 162.0125–167.17 | 3260–3267 | 23.6–24.0 |
| 12.29–12.293 | 167.72–173.2 | 3332–3339 | 31.2–31.8 |
| 12.51975–12.52025 | 240–285 | 3345.8–3358 | 36.43–36.5 |
| 12.57675–12.57725 | 322–335.4 | 3600–4400 | ([2]) |
| 13.36–13.41. | | | |

[1] Until February 1, 1999, this restricted band shall be 0.490–0.510 MHz.
[2] Above 38.6

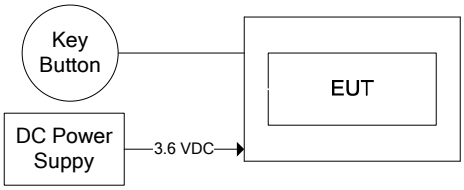
**Section 15.209(a) - Field Strength Limits within Restricted Frequency Bands**

| Frequency (MHz) | Field Strength (microvolts/meter) | Measurement Distance (meters) |
|---|---|---|
| 0.009 - 0.490 | 2,400 / F (kHz) | 300 |
| 0.490 - 1.705 | 24,000 / F (kHz) | 30 |
| 1.705 - 30.0 | 30 | 30 |
| 30 – 88 | 100 | 3 |
| 88 – 216 | 150 | 3 |
| 216 – 960 | 200 | 3 |
| Above 960 | 500 | 3 |

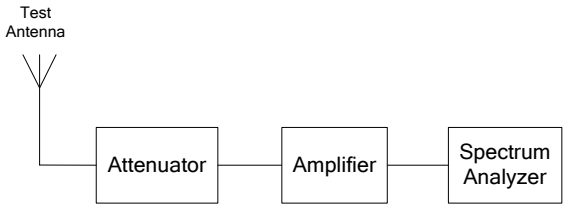
### 5.4.2. Method of Measurements

ANSI C63.10 and ANSI 63.4 procedures.

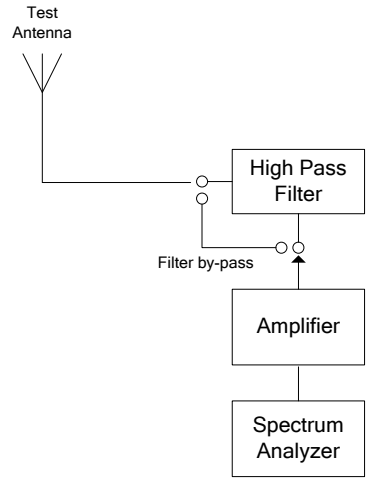
### 5.4.3. Test Arrangement




For Band-Edge




For Spurious and Harmonics



### 5.4.4. Test Data

**Remark(s):**
- All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.
- EUT tested in three orthogonal positions.

#### 5.4.4.1. EUT with 0 dBi PCB Trace Antenna

##### 5.4.4.1.1. Spurious Radiated Emissions

| | |
|---|---|
| Fundamental Frequency: | 2402 MHz |
| Measured Conducted Power: | 14.49 dBm |
| Frequency Test Range: | 30 MHz – 25 GHz |

| Frequency (MHz) | RF Peak Level (dBµV/m) | RF Avg Level (dBµV/m) | Antenna Plane (H/V) | Limit 15.209 (dBµV/m) | Limit 15.247 (dBµV/m) | Margin (dB) | Pass/ Fail |
|---|---|---|---|---|---|---|---|
| 2402 | 108.09 | -- | V | -- | -- | -- | -- |
| 2402 | 108.06 | -- | H | -- | -- | -- | -- |
| 4804 | 55.28 | 49.79 | V | 54.0 | 88.1 | -4.2 | Pass* |
| 4804 | 55.20 | 49.73 | H | 54.0 | 88.1 | -4.3 | Pass* |
| All other spurious emissions and harmonics are more than 20 dB below the applicable limit. | | | | | | | |

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

| | |
|---|---|
| Fundamental Frequency: | 2440 MHz |
| Measured Conducted Power: | 13.72 dBm |
| Frequency Test Range: | 30 MHz – 25 GHz |

| Frequency (MHz) | RF Peak Level (dBµV/m) | RF Avg Level (dBµV/m) | Antenna Plane (H/V) | Limit 15.209 (dBµV/m) | Limit 15.247 (dBµV/m) | Margin (dB) | Pass/ Fail |
|---|---|---|---|---|---|---|---|
| 2440 | 107.28 | -- | V | -- | -- | -- | -- |
| 2440 | 105.25 | -- | H | -- | -- | -- | -- |
| 4880 | 56.16 | 50.75 | V | 54.0 | 87.3 | -3.3 | Pass* |
| 4880 | 55.01 | 48.22 | H | 54.0 | 87.3 | -5.8 | Pass* |
| 7320 | 52.46 | 39.79 | V | 54.0 | 87.3 | -14.2 | Pass* |
| 7320 | 55.16 | 39.42 | H | 54.0 | 87.3 | -14.6 | Pass* |
| All other spurious emissions and harmonics are more than 20 dB below the applicable limit. | | | | | | | |

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

| | |
|---|---|
| Fundamental Frequency: | 2480 MHz |
| Measured Conducted Power: | 13.34 dBm |
| Frequency Test Range: | 30 MHz – 25 GHz |

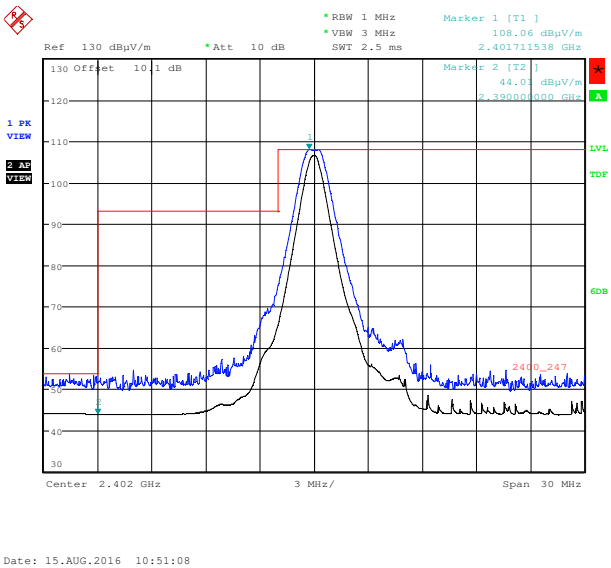
| Frequency (MHz) | RF Peak Level (dBµV/m) | RF Avg Level (dBµV/m) | Antenna Plane (H/V) | Limit 15.209 (dBµV/m) | Limit 15.247 (dBµV/m) | Margin (dB) | Pass/ Fail |
|---|---|---|---|---|---|---|---|
| 2480 | 110.50 | -- | V | -- | -- | -- | -- |
| 2480 | 107.15 | -- | H | -- | -- | -- | -- |
| 4960 | 52.98 | 45.65 | V | 54.0 | 90.5 | -8.4 | Pass* |
| 4960 | 53.15 | 45.82 | H | 54.0 | 90.5 | -8.2 | Pass* |
| 7440 | 56.02 | 41.11 | V | 54.0 | 90.5 | -12.9 | Pass* |
| 7440 | 55.89 | 40.25 | H | 54.0 | 90.5 | -13.8 | Pass* |

All other spurious emissions and harmonics are more than 20 dB below the applicable limit.

*Field strength of emissions appearing within restricted frequency bands shall not exceed the limits in § 15.209.

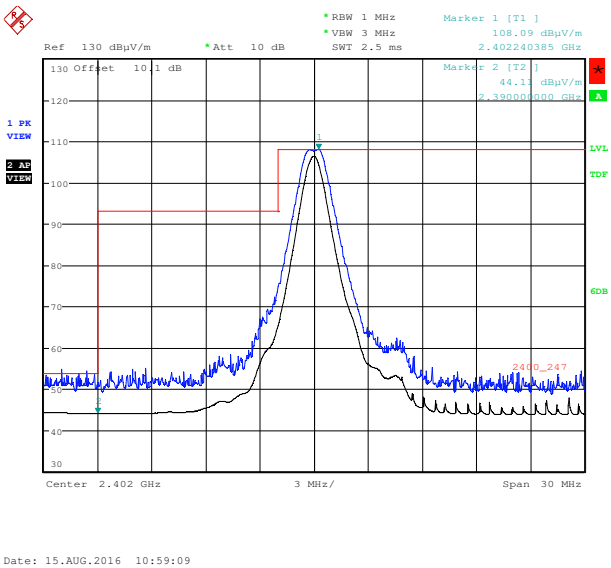
## 5.4.4.1.2. Band –Edge RF Radiated Emissions

**Plot 5.4.4.1.2.1.** Band-Edge RF Radiated Emissions at 3 m, Horizontal Polarization
Low End of Frequency Band



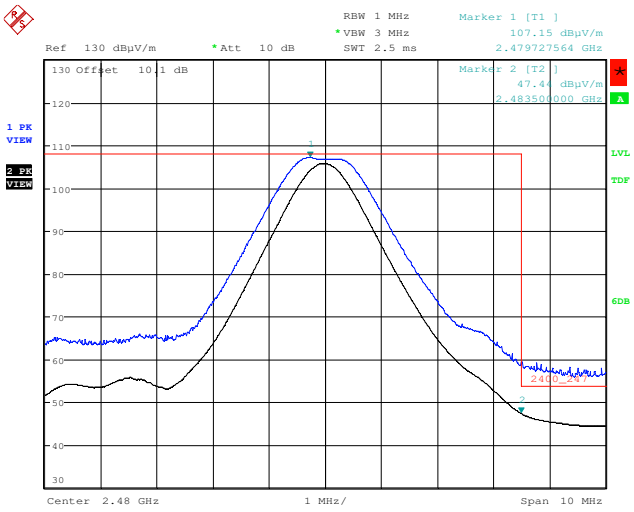

Trace 1: RBW = 1 MHz, VBW = 3 MHz; Trace 2: RBW = 1 MHz, VBW = 10 Hz
Analyzer Filter Type EMI (6dB), Detector Max Peak, Max Hold

**Plot 5.4.4.1.2.2.** Band-Edge RF Radiated Emissions at 3 m, Vertical Polarization
Low End of Frequency Band



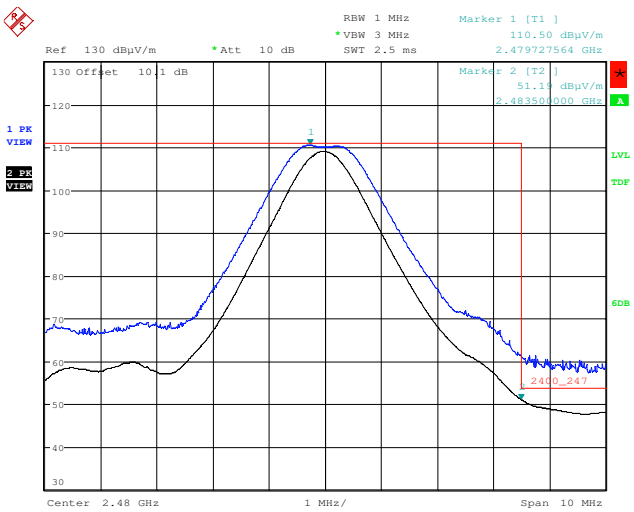

Trace 1: RBW = 1 MHz, VBW = 3 MHz; Trace 2: RBW = 1 MHz, VBW = 10 Hz
Analyzer Filter Type EMI (6dB), Detector Max Peak, Max Hold

**Plot 5.4.4.1.2.3.** Band-Edge RF Radiated Emissions at 3 m, Horizontal Polarization
High End of Frequency Band




Trace 1: RBW = 1 MHz, VBW = 3 MHz; Trace 2: RBW = 1 MHz, VBW = 10 Hz
Analyzer Filter Type EMI (6dB), Detector Max Peak, Max Hold

**Plot 5.4.4.1.2.4.** Band-Edge RF Radiated Emissions at 3 m, Vertical Polarization
High of Frequency Band




Trace 1: RBW = 1 MHz, VBW = 3 MHz; Trace 2: RBW = 1 MHz, VBW = 10 Hz
Analyzer Filter Type EMI (6dB), Detector Max Peak, Max Hold

## 5.5. POWER SPECTRAL DENSITY [§ 15.247(e)]

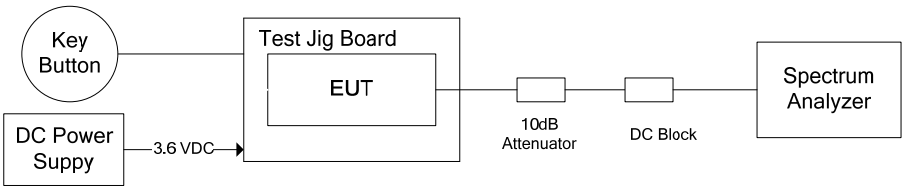
### 5.5.1. Limit(s)

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.

### 5.5.2. Method of Measurements

KDB 558074 D01 DTS Meas Guidance v03r05, Section 10.2 Peak PSD.

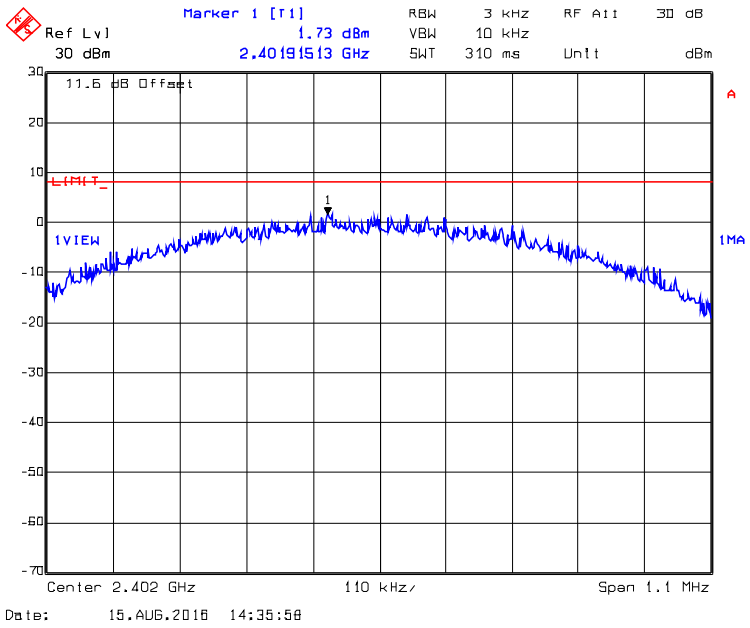
### 5.5.3. Test Arrangement



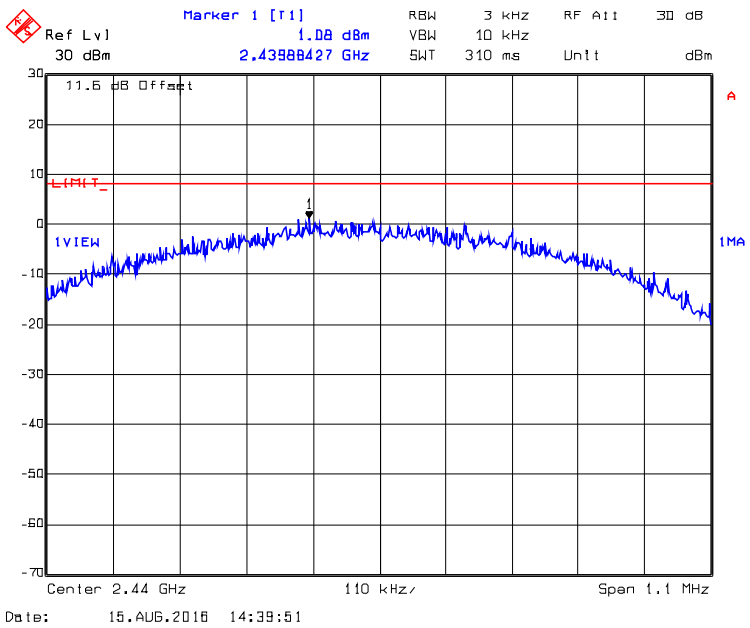

### 5.5.4. Test Data

| Channel | Frequency (MHz) | Modulation | PSD (dBm) | Limit (dBm) |
|---|---|---|---|---|
| 1 | 2402 | GFSK | 1.73 | 8 |
| 20 | 2440 | GFSK | 1.08 | 8 |
| 40 | 2480 | GFSK | 0.33 | 8 |

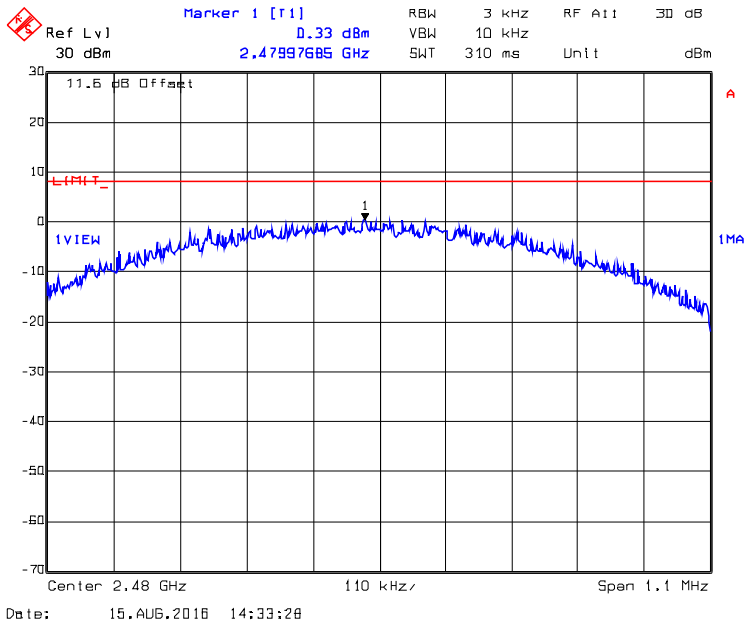
**Plot 5.5.4.1.** Power Spectral Density, Bandwidth Channel 1, 2402 MHz, GFSK, 1 Mbps, 250 kHz Deviation




**Plot 5.5.4.2.** Power Spectral Density, Bandwidth Channel 20, 2440 MHz, GFSK, 1 Mbps, 250 kHz Deviation



**Plot 5.5.4.3.** Power Spectral Density, Bandwidth Channel 40, 2480 MHz, GFSK, 1 Mbps, 250 kHz Deviation



## 5.6. RF EXPOSURE REQUIRMENTS [§§ 15.247(i), 1.1310 & 2.1091]

### 5.6.1. Limits

§ **1.1310:** The criteria listed in the following table shall be used to evaluate the environmental impact of human exposure to radio-frequency (RF) radiation as specified in 1.1307(b).

**Limits for Maximum Permissible Exposure (MPE)**

| Frequency range (MHz) | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density ($mW/cm^2$) | Averaging time (minutes) |
|---|---|---|---|---|
| **(A) Limits for Occupational/Controlled Exposures** | | | | |
| 0.3-3.0 | 614 | 1.63 | *(100) | 6 |
| 3.0-30 | 1842/f | 4.89/f | *($900/f^2$) | 6 |
| 30-300 | 61.4 | 0.163 | 1.0 | 6 |
| 300-1500 | | | f/300 | 6 |
| 1500-100,000 | | | 5 | 6 |
| **(B) Limits for General Population/Uncontrolled Exposure** | | | | |
| 0.3-1.34 | 614 | 1.63 | *(100) | 30 |
| 1.34-30 | 824/f | 2.19/f | *($180/f^2$) | 30 |
| 30-300 | 27.5 | 0.073 | 0.2 | 30 |
| 300-1500 | | | f/1500 | 30 |
| 1500-100,000 | | | 1.0 | 30 |

f = frequency in MHz
* = Plane-wave equivalent power density

Note 1: Occupational/controlled limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.

Note 2: General population/uncontrolled exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or can not exercise control over their exposure.

### 5.6.2. Method of Measurements

**Calculation Method of Power Density/RF Safety Distance**:

$$S = \frac{PG}{4\pi \cdot r^2} = \frac{EIRP}{4\pi \cdot r^2}$$

Where, P: power input to the antenna in mW
EIRP: Equivalent (effective) isotropic radiated power.
S: power density mW/cm$^2$
G: numeric gain of antenna relative to isotropic radiator
r: distance to centre of radiation in cm

### 5.6.3. RF Evaluation

#### 5.6.3.1. Standalone

| For Portable Application | | | | |
|---|---|---|---|---|
| Pursuant to FCC KDB 447498 D01 General RF Exposure Guidance v06, Section 4.3.1. Standalone SAR test exclusion considerations<br>a) For 100 MHz to 6 GHz and *test separation distances* ≤ 50 mm, the 1-g and 10-g *SAR test exclusion thresholds* are determined by the following:<br>[(*max. power of channel, including tune-up tolerance, mW*) / (*min. test separation distance, mm*)] · [$\sqrt{f_{(GHz)}}$] ≤ 3.0 for 1-g SAR, and ≤ 7.5 for 10-g extremity SAR, where $f_{(GHz)}$ is the RF channel transmit frequency in GHz | | | | |
| **Max. power of channel, including tune-up tolerance, mW** | **Min. test separation distance, mm** | **$f_{(GHz)}$** | **Calculated 1-g (head or boby) SAR test exclusion threshold** | **1-g (head or boby) SAR test exclusion threshold limit** |
| 28.119 | 20 | 2.480 | 2.2 | 3.0 |
| Conclusion: The EUT qualify for SAR test exclusion at an evaluated separation distance of 20 mm, the calculated 1-g SAR test exclusion threshold is 2.2 < 3.0. | | | | |

### 5.6.3.2. Co-location for Mobile Device

Pursuant to KDB 447498 D01 General RF Exposure Guidance v06, Section 7.2:

*Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0, according to calculated/estimated, numerically modeled, or measured field strengths or power density.*

**The maximum calculated MPE ratio of the EUT with 0 dBi PCB Trace Antenna**

| Frequency (MHz) | EUT EIRP (dBm) | EUT EIRP (mW) | Evaluation Distance (cm) | Power Density ($mW/cm^2$) | FCC MPE Limit ($mW/cm^2$) | MPE Ratio |
|---|---|---|---|---|---|---|
| 2402 | 14.49 | 28.119 | 20 | 0.00559 | 1.0 | 0.00559 |

The maximum calculated MPE ratio for the EUT with 0 dBi PCB Trace Antenna is 0.00559, this configuration can be co-located with other antennas provided the sum of the MPE ratios for all the other simultaneous transmitting antennas incorporated in a host device is $\leq$ 1.0 - 0.00559 $\leq$ 0.99441.

## EXHIBIT 6. TEST EQUIPMENT LIST

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range | Cal. Due Date |
|---|---|---|---|---|---|
| Spectrum Analyzer | Hewlett Packard | HP 8593EM | 3412A00103 | 9 kHz–26.5 GHz | 09 Apr 2017 |
| Attenuator | Pasternack | PE7010-20 | - | DC–2 GHz | 03 Feb 2017 |
| L.I.S.N | EMCO | 3825/2 | 2209 | 0.10 -100 MHz | 29 Sep 2016 |
| DC Power Supply | Xantrex | HPD 60-5SX | 63903 | 0 – 60 VDC | Cal on use |
| Spectrum Analyzer | Rohde & Schwarz | FSEK30 | 100077 | 20Hz–40 GHz | 21 Nov 2016 |
| Attenuator | Pasternack | 7024-20 | 6 | DC–26.5 GHz | Cal on use |
| DC Block | Hewlett Packard | 11742A | 12460 | 0.045 – 26.5 GHz | Cal on use |
| Spectrum Analyzer | Rohde & Schwarz | FSU26 | 200946 | 20Hz–26.5 GHz | 21 Jul 2018 |
| RF Amplifier | Hewlett Packard | 84498 | 3008A00769 | 1 – 26.5 GHz | 05 May 2017 |
| Attenuator | Pasternack | 7024-10 | 4 | DC–26.5 GHz | Cal on use |
| Horn Antenna | EMCO | 3155 | 5955 | 1 – 18 GHz | 21 Apr 2017 |
| EMI Receiver | Rohde & Schwarz | ESU40 | 100037 | 20 Hz–40 GHz | 08 May 2017 |
| RF Amplifier | Com-Power | PAM-0118A | 551016 | 0.5 – 18 GHz | 14 Jul 2017 |
| Biconilog | EMCO | 3142 | 9601-1005 | 26-1000 MHz | 12 May 2017 |
| Horn Antenna | EMCO | 3160-09 | 118385 | 18 – 26.5 GHz | 04 Aug 2016 |
| High Pass Filter | K & L | 11SH10-4000/T12000 | 4 | Cut off 2400 MHz | Cal on use |

# EXHIBIT 7. MEASUREMENT UNCERTAINTY

The measurement uncertainties stated were calculated in accordance with the requirements of CISPR 16-4-2 @ IEC:2003 and JCGM 100:2008 (GUM 1995) – Guide to the Expression of Uncertainty in Measurement.

## 7.1. LINE CONDUCTED EMISSION MEASUREMENT UNCERTAINTY

| | **Line Conducted Emission Measurement Uncertainty (9 kHz – 30 MHz):** | **Measured** | **Limit** |
|---|---|---|---|
| **$u_c$** | **Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{i=1}^{m} u_i^2(y)}$ | **± 1.44** | **± 1.8** |
| **U** | **Expanded uncertainty U:** $U = 2u_c(y)$ | **± 2.89** | **± 3.6** |

## 7.2. RADIATED EMISSION MEASUREMENT UNCERTAINTY

| | **Radiated Emission Measurement Uncertainty @ 3m, Horizontal (30-1000 MHz):** | **Measured (dB)** | **Limit (dB)** |
|---|---|---|---|
| **$u_c$** | **Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{i=1}^{m} u_i^2(y)}$ | **± 2.39** | **± 2.6** |
| **U** | **Expanded uncertainty U:** $U = 2u_c(y)$ | **± 4.79** | **± 5.2** |

| | **Radiated Emission Measurement Uncertainty @ 3m, Vertical (30-1000 MHz):** | **Measured (dB)** | **Limit (dB)** |
|---|---|---|---|
| **$u_c$** | **Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{i=1}^{m} u_i^2(y)}$ | **± 2.39** | **± 2.6** |
| **U** | **Expanded uncertainty U:** $U = 2u_c(y)$ | **± 4.78** | **± 5.2** |

| | **Radiated Emission Measurement Uncertainty @ 3 m, Horizontal & Vertical (1 – 18 GHz):** | **Measured (dB)** | **Limit (dB)** |
|---|---|---|---|
| **$u_c$** | **Combined standard uncertainty:** $u_c(y) = \sqrt{\sum_{i=1}^{m} u_i^2(y)}$ | **± 1.87** | **Under consideration** |
| **U** | **Expanded uncertainty U:** $U = 2u_c(y)$ | **± 3.75** | **Under consideration** |