# ENGINEERING TEST REPORT

**XBee3**
**Model: XBEE3, HVIN: XBEE3**
**IC: 1846A-XBEE3**

*Applicant:*

**Digi International Inc**
9350 Excelsior Blvd. Suite 700
Hopkins, MN 55343
USA

***In Accordance With***

**Industry Canada, RSS-247, Issue 2**
**Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices**

**UltraTech's File No.: 19DIGI159_ICRSS247B**

| | |
|---|---|
| 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: December 16, 2019 | |
| Report Prepared by: Dan Huynh<br><br>Issued Date: December 16, 2019 | Tested by: Hung Trinh<br><br>Test Dates:<br>September 26, 27& 30, 2019<br>October 1, 2019 |

- *The results in this Test Report apply only to the sample(s) tested, and the sample tested is randomly selected.*
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# EXHIBIT 1. INTRODUCTION

## 1.1. SCOPE

| | |
|---|---|
| **Reference:** | Industry Canada RSS-247, Issue 2 |
| **Title:** | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |
| **Purpose of Test:** | Class II Permissive Change:<br>▪ Add additional antenna to the approved antennas list |
| **Test Procedures:** | ▪ ANSI C63.4<br>▪ FCC KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02<br>▪ RSS-247, Issue 2; RSS-Gen, Issue 5 |
| **Environmental Classification:** | [ x ] Commercial, industrial or business environment<br>[ ] Residential environment |

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

None.

## 1.3. NORMATIVE REFERENCES

| Publication | Year | Title |
|---|---|---|
| RSS-Gen, Issue 5<br>Amendment 1 | 2018<br>2019 | General Requirements for Compliance of Radio Apparatus |
| RSS-247, Issue 2 | 2017 | Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices |
| RSS-102, Issue 5 | 2015 | Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands) |
| ICES-003, Issue 6 | 2016 | Information Technology Equipment (Including Digital Apparatus) - Limits and Methods of Measurement |
| 47 CFR Parts 0-19 | 2019 | 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 |
| FCC, KDB Publication No. 558074 D01 15.247 Meas Guidance v05r02 | 2019 | GUIDANCE FOR COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEM, FREQUENCY HOPPING SPREAD SPECTRUM SYSTEM, AND HYBRID SYSTEM DEVICES OPERATING UNDER SECTION 15.247 OF THE FCC RULES |

## EXHIBIT 2. PERFORMANCE ASSESSMENT

### 2.1. CLIENT INFORMATION

| Applicant | |
|---|---|
| **Name:** | Digi International Inc |
| **Address:** | 9350 Excelsior Blvd. Suite 700<br>Hopkins, MN 55343<br>USA |
| **Contact Person:** | Scott Wilken<br>Phone #:(952) 912-4965<br>Fax #: (952) 912-4952<br>Email Address: scott.wilken@digi.com |

| Manufacturer | |
|---|---|
| **Name:** | Digi International Inc |
| **Address:** | 9350 Excelsior Blvd. Suite 700<br>Hopkins, MN 55343<br>USA |
| **Contact Person:** | Scott Wilken<br>Phone #:(952) 912-4965<br>Fax #: (952) 912-4952<br>Email Address: scott.wilken@digi.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:** | Digi International Inc |
| **Product Name:** | XBee3 |
| **Model Name or Number:** | XBEE3 |
| **Serial Number:** | Test Sample |
| **Type of Equipment:** | Digital Transmission System (DTS) |
| **Input Power Supply Type:** | External DC Power Supply |
| **Primary User Functions of EUT:** | 802.15.4 connectivity of embedded systems, BLE connectivity |

## 2.3. EUT'S TECHNICAL SPECIFICATIONS

| Transmitter | |
|---|---|
| **Equipment Type:** | Mobile<br>Base station (fixed use) |
| **Intended Operating Environment:** | Commercial, industrial or business environment |
| **Power Supply Requirement:** | 3.3V (nominal) |
| **RF Output Power Rating:** | +19.60 dBm maximum conducted power |
| **Operating Frequency Range:** | 2402 - 2480 MHz (for 1 Mbps operating mode)<br>2404 - 2478 MHz (for 2 Mbps operating mode) |
| **RF Output Impedance:** | 50 Ω |
| **Duty Cycle:** | Continuous |
| **Modulation Type:** | GFSK |
| **Antenna Connector Types:** | Integral antenna, U.FL, RF Pad |

## 2.4. ASSOCIATED ANTENNA DESCRIPTIONS

| Manufacturer | Antenna Type | P/N | Maximum Gain (dBi) |
|---|---|---|---|
| Taoglas | Patch | FXP74.07.0100A | 4 |

## 2.5. LIST OF EUT'S PORTS

| Port Number | EUT's Port Description | Number of Identical Ports | Connector Type | Cable Type (Shielded/Non-shielded) |
|---|---|---|---|---|
| 1 | RF port | 1 | Integral antenna, U.FL or RF Pad | Shielded cable (N/A for integral antenna) |
| 2 | DC supply and I/O port | 1 | Castellated Pads | Direct connection (no cable) |

## 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: | Digi International |
| Model Name or Number: | N/A |
| Serial Number: | N/A |
| Connected to EUT's Port: | Module pin signals |

## 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 from Test Jig |

### 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 as described with the test results. |

| **Transmitter Test Signals** | |
|---|---|
| **Frequency Band(s):** | 2402 - 2480 MHz (for 1 Mbps operating mode)<br>2404 - 2478 MHz (for 2 Mbps operating mode) |
| **Frequency(ies) Tested:** | 1 Mbps operating mode:<br>2402 MHz, 2440 MHz, 2480 MHz<br><br>2 Mbps operating mode:<br>2404 MHz, 2440 MHz, 2470 MHz, 2472 MHz, 2474 MHz, 2476 MHz, 2478 MHz |
| **RF Power Output:**<br>(measured maximum output power at antenna terminals) | 19.60 dBm Maximum Peak (91.20 mW) |
| **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 ANAB File No.: AT-1945.

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

| ISED Rules | Test Requirements | Compliance (Yes/No) |
|---|---|---|
| RSS-Gen, Section 6.4 | External Controls | Yes |
| RSS-Gen, Section 3.4 and RSS-102 | Radio Frequency Exposure | Yes |
| RSS-Gen, Section 7.3 | Receiver Radiated Emissions | N/A |
| RSS-Gen, Section 7.4 | Receiver Conducted Emissions | N/A |
| RSS-Gen, Section 8.8 | AC Power Line Conducted Emissions | N/A |
| ICES-003, Issue 6 | Information Technology Equipment (Including Digital Apparatus) - Limits and Methods of Measurement | N/A |
| RSS-247, Section 5.2(a) | 6 dB Bandwidth | N/A |
| RSS-247, Section 5.2(b) | Transmitter Power Spectral Density | N/A |
| RSS-247, Section 5.4 | Transmitter Output Power and e.i.r.p. | Yes |
| RSS-247, Section 5.5 | Unwanted Emissions | Yes |

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

None.

# EXHIBIT 5. TEST DATA

## 5.1. TRANSMITTER OUTPUT POWER AND EIRP [RSS-247, SECTION 5.4]

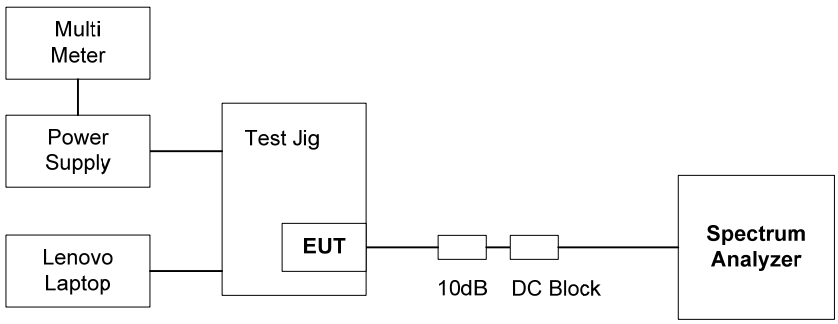
### 5.1.1. Limit(s)

**Section 5.4(d):** 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. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

### 5.1.2. Method of Measurements & Test Arrangement

KDB 558074 D01 15.247 Meas Guidance v05r02, Section 8.3.1.1 RBW ≥ DTS bandwidth

### 5.1.3. Test Arrangement



### 5.1.4. Test Data

Remarks:

1) The highest channel to test for BLE 2Mbps is 2478 MHz; 2480 MHz is an advertising channel operating only at 1Mbps.

2) The stack of Silicon Labs limits some channels output power internally, the approximate BLE output power reduction as shown in the following table.

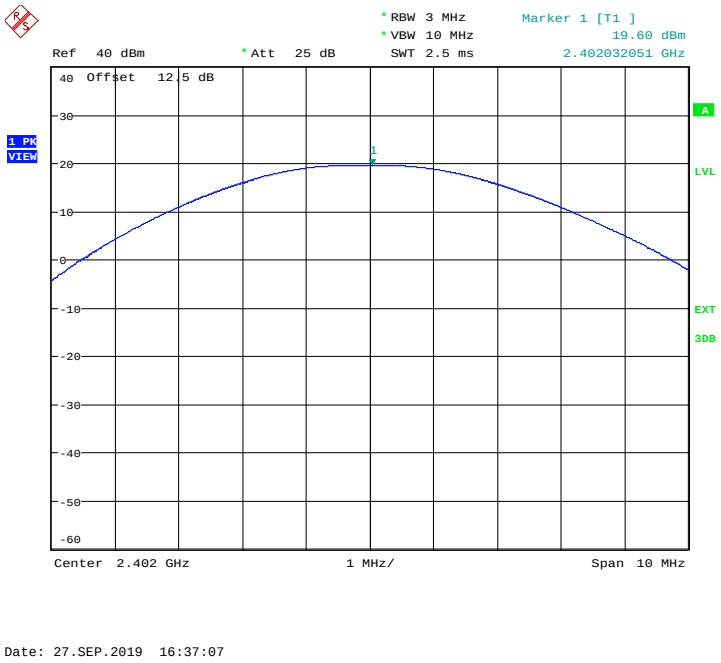
**Approximate BLE Output Power Reductions from Maximum by EFR32 Stack**

| Channel/Data Rate | 1Mbit/s | 2Mbit/s |
|---|---|---|
| 2470MHz | None | None |
| 2472MHz | None | 1.5 dB |
| 2474MHz | None | 4 dB |
| 2476MHz | 1.5 dB | 7 dB |
| 2478MHz | 4 dB | 11 dB |
| 2480MHz | None | None |

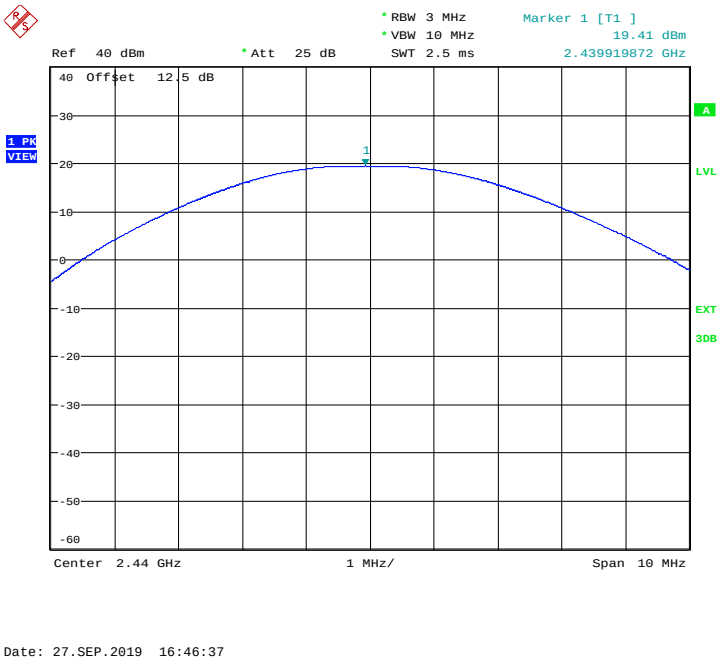
**Maximum Peak Conducted Power at Power Setting 200**

| Modulation | Power Setting | Data Rate (Mbps) | Channel | Frequency (MHz) | Maximum Peak Conducted Power (dBm) | Peak Power Limit (dBm) |
|---|---|---|---|---|---|---|
| GFSK | 200 | 1 | 00 | 2402 | 19.60 | 30 |
| | | | 19 | 2440 | 19.41 | 30 |
| | | | 39 | 2480 | 19.48 | 30 |
| | | 2 | 01 | 2404 | 19.54 | 30 |
| | | | 19 | 2440 | 19.45 | 30 |
| | | | 34 | 2470 | 19.44 | 30 |
| | | | 35 | 2472 | 18.71 | 30 |
| | | | 36 | 2474 | 15.81 | 30 |
| | | | 37 | 2476 | 12.73 | 30 |
| | | | 38 | 2478 | 8.34 | 30 |

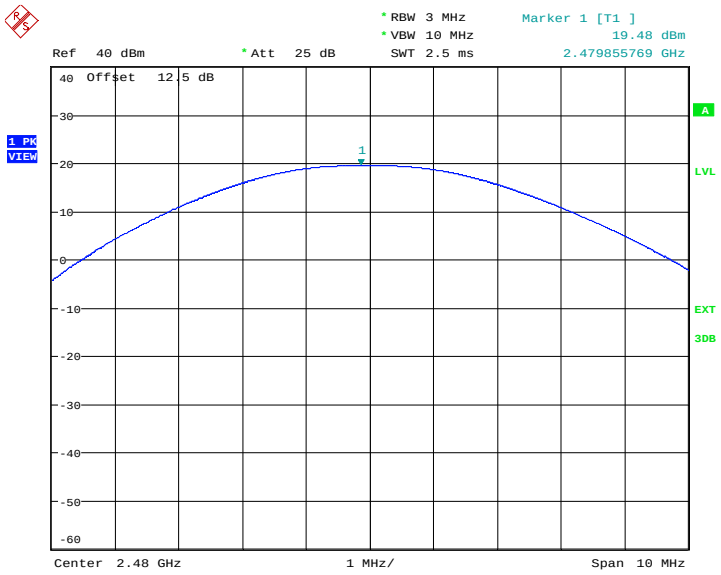
**Plot 5.1.4.1.** Maximum Peak Conducted Output Power, GFSK Modulation, Power Setting 200, 1 Mbps, Ch 00, 2402 MHz



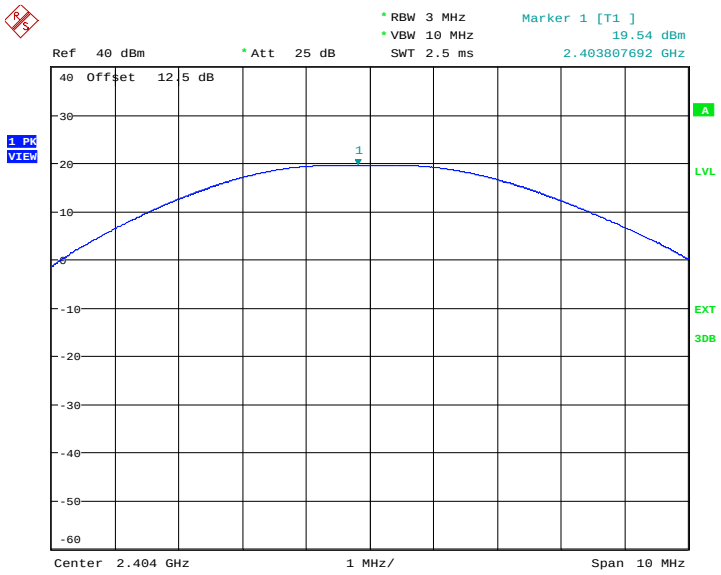

**Plot 5.1.4.2.** Maximum Peak Conducted Output Power, GFSK Modulation, Power Setting 200, 1 Mbps, Ch 19, 2440 MHz



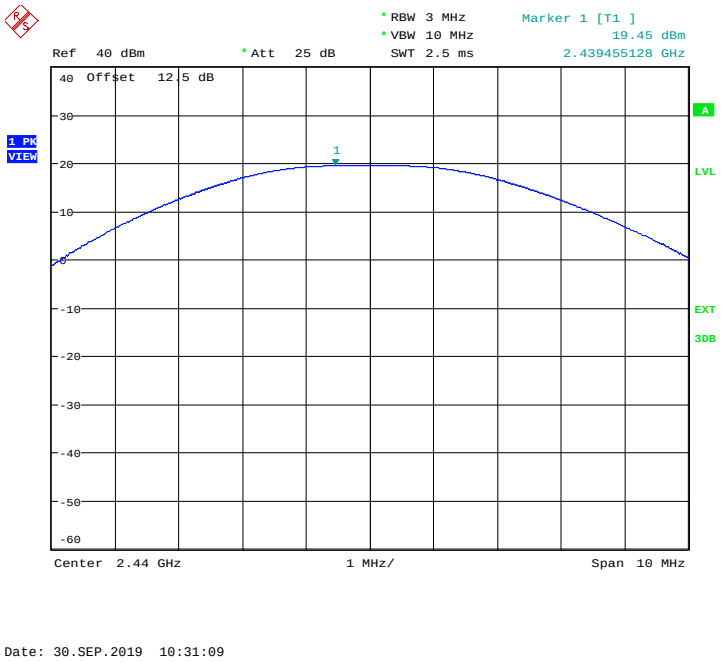
**Plot 5.1.4.3.** Maximum Peak Conducted Output Power, GFSK Modulation, Power Setting 200, 1 Mbps, Ch 39, 2480 MHz



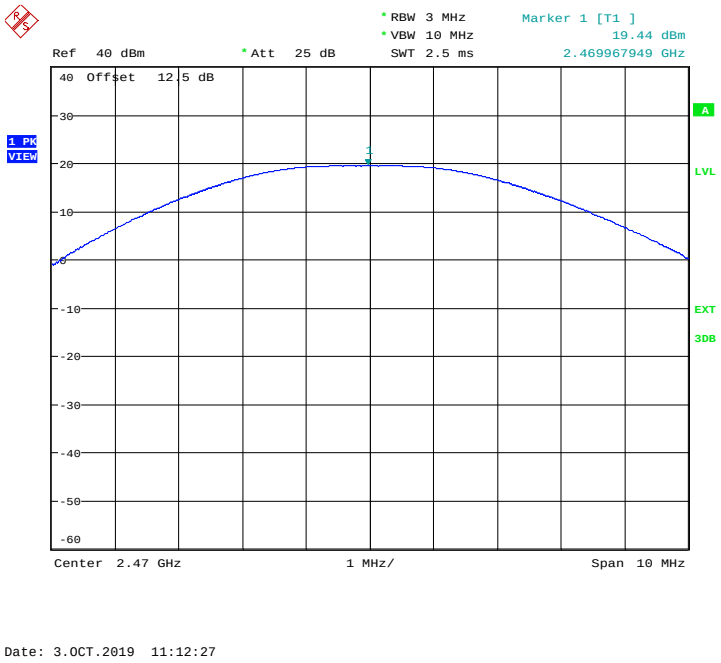

**Plot 5.1.4.4.** Maximum Peak Conducted Output Power, GFSK Modulation, Power Setting 200, 2 Mbps, Ch 01, 2404 MHz



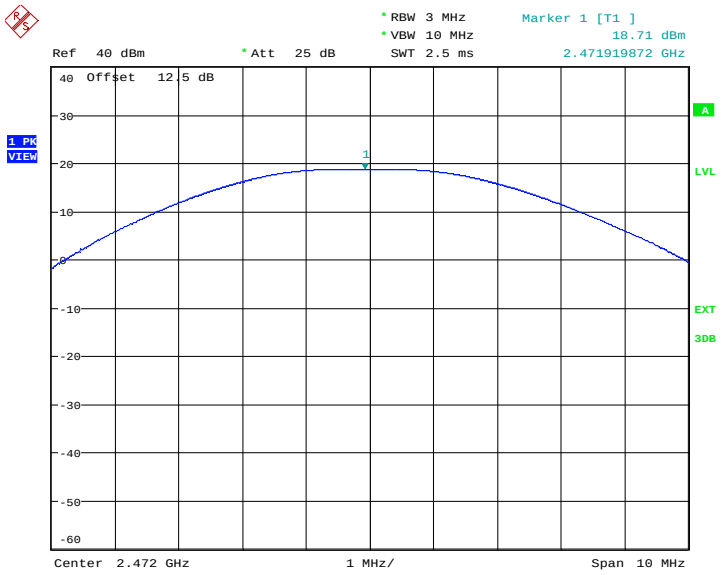
**Plot 5.1.4.5.** Maximum Peak Conducted Output Power, GFSK Modulation, Power Setting 200, 2 Mbps, Ch 19, 2440 MHz



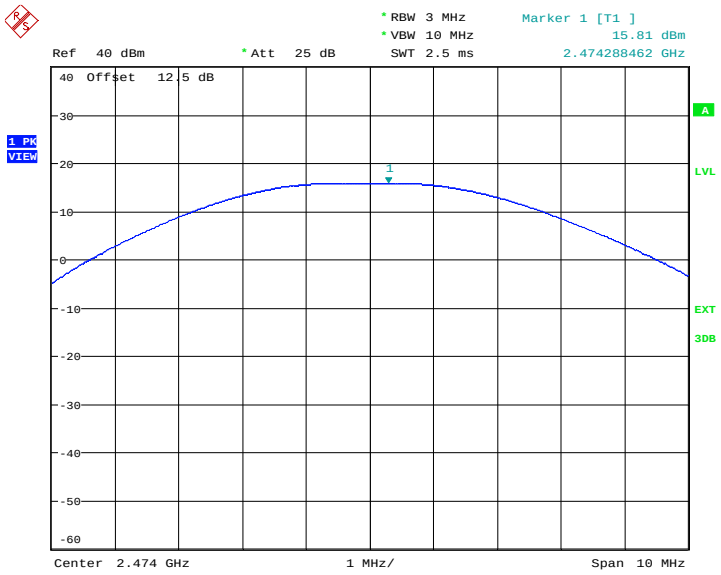

**Plot 5.1.4.6.** Maximum Peak Conducted Output Power, GFSK Modulation, Power Setting 200, 2 Mbps, Ch 34, 2470 MHz



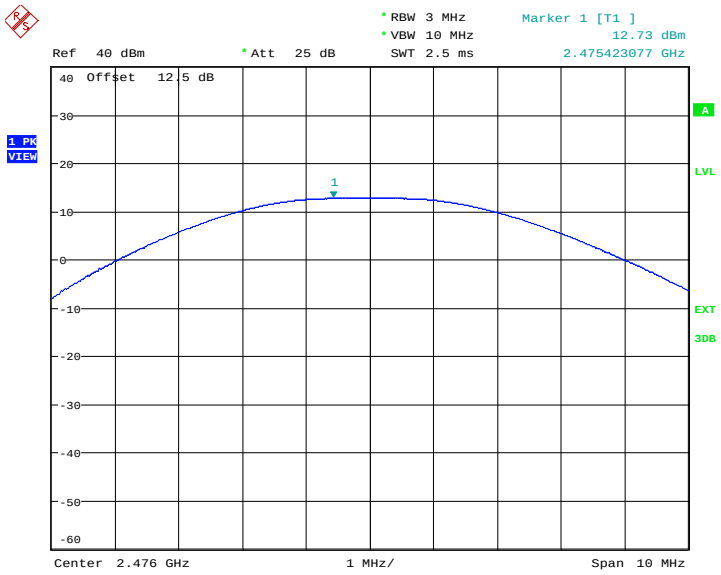
**Plot 5.1.4.7.** Maximum Peak Conducted Output Power, GFSK Modulation, Power Setting 200, 2 Mbps, Ch 35, 2472 MHz



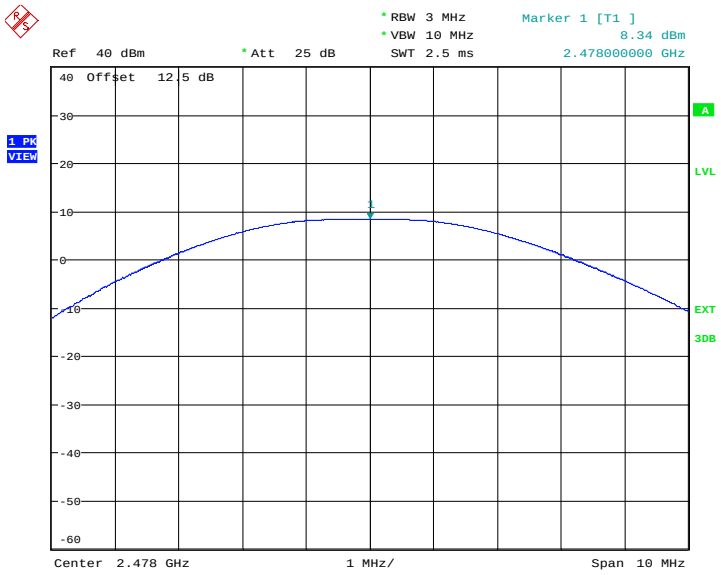

**Plot 5.1.4.8.** Maximum Peak Conducted Output Power, GFSK Modulation, Power Setting 200, 2 Mbps, Ch 36, 2474 MHz



**Plot 5.1.4.9.** Maximum Peak Conducted Output Power, GFSK Modulation, Power Setting 200, 2 Mbps, Ch 37, 2476 MHz




**Plot 5.1.4.10.** Maximum Peak Conducted Output Power, GFSK Modulation, Power Setting 200, 2 Mbps, Ch 38, 2478 MHz



## 5.2. UNWANTED EMISSIONS (RADIATED) [RSS-247, SECTION 5.5]

### 5.2.1. Limit(s)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

**RSS-Gen, Section 8.10 Restricted Frequency Bands**

Restricted frequency bands, identified in table 7, are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following conditions related to the restricted frequency bands apply:

(a) The transmit frequency, including fundamental components of modulation, of licence-exempt radio apparatus shall not fall within the restricted frequency bands listed in table 7 except for apparatus compliant with RSS-287, *Emergency Position Indicating Radio Beacons (EPIRB), Emergency Locator Transmitters (ELT), Personal Locator Beacons (PLB), and Maritime Survivor Locator Devices (MSLD)*.

(b) Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6.

(c) Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

**RSS-Gen Table 5 - General Field Strength Limits at Frequencies Above 30 MHz**

| Frequency (MHz) | Field Strength (microvolts/m at 3 metres) |
|---|---|
| 30 - 88 | 100 |
| 88 - 216 | 150 |
| 216 - 960 | 200 |
| Above 960* | 500 |

**Table 6 – General Field Strength Limits at Frequencies Below 30 MHz**

| Frequency | Magnetic field strength (H-Field) (µA/m) | Measurement distance (m) |
|---|---|---|
| 9 - 490 kHz [1] | 6.37/F (F in kHz) | 300 |
| 490 - 1705 kHz | 63.7/F (F in kHz) | 30 |
| 1.705 - 30 MHz | 0.08 | 30 |
| **Note 1:** The emission limits for the ranges 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector. | | |

**RSS-Gen Table 7 – Restricted Frequency Bands***

| MHz |
|---|
| 0.090-0.110 |
| 2.1735-2.1905 |
| 3.020-3.026 |
| 4.125-4.128 |
| 4.17725-4.17775 |
| 4.20725-4.20775 |
| 5.677-5.683 |
| 6.215-6.218 |
| 6.26775-6.26825 |
| 6.31175-6.31225 |
| 8.291-8.294 |
| 8.362-8.366 |
| 8.37625-8.38675 |
| 8.41425-8.41475 |
| 12.29-12.293 |
| 12.51975-12.52025 |
| 12.57675-12.57725 |
| 13.36-13.41 |
| 16.42-16.423 |
| 16.69475-16.69525 |
| 16.80425-16.80475 |
| 25.5-25.67 |
| 37.5-38.25 |
| 73-74.6 |
| 74.8-75.2 |
| 108-138 |
| 156.52475-156.52525 |
| 156.7-156.9 |

| MHz |
|---|
| 240-285 |
| 322-335.4 |
| 399.9-410 |
| 608-614 |
| 960-1427 |
| 1435-1626.5 |
| 1645.5-1646.5 |
| 1660-1710 |
| 1718.8-1722.2 |
| 2200-2300 |
| 2310-2390 |
| 2655-2900 |
| 3260-3267 |
| 3332-3339 |
| 3345.8-3358 |
| 3500-4400 |
| 4500-5150 |
| 5350-5460 |
| 7250-7750 |
| 8025-8500 |

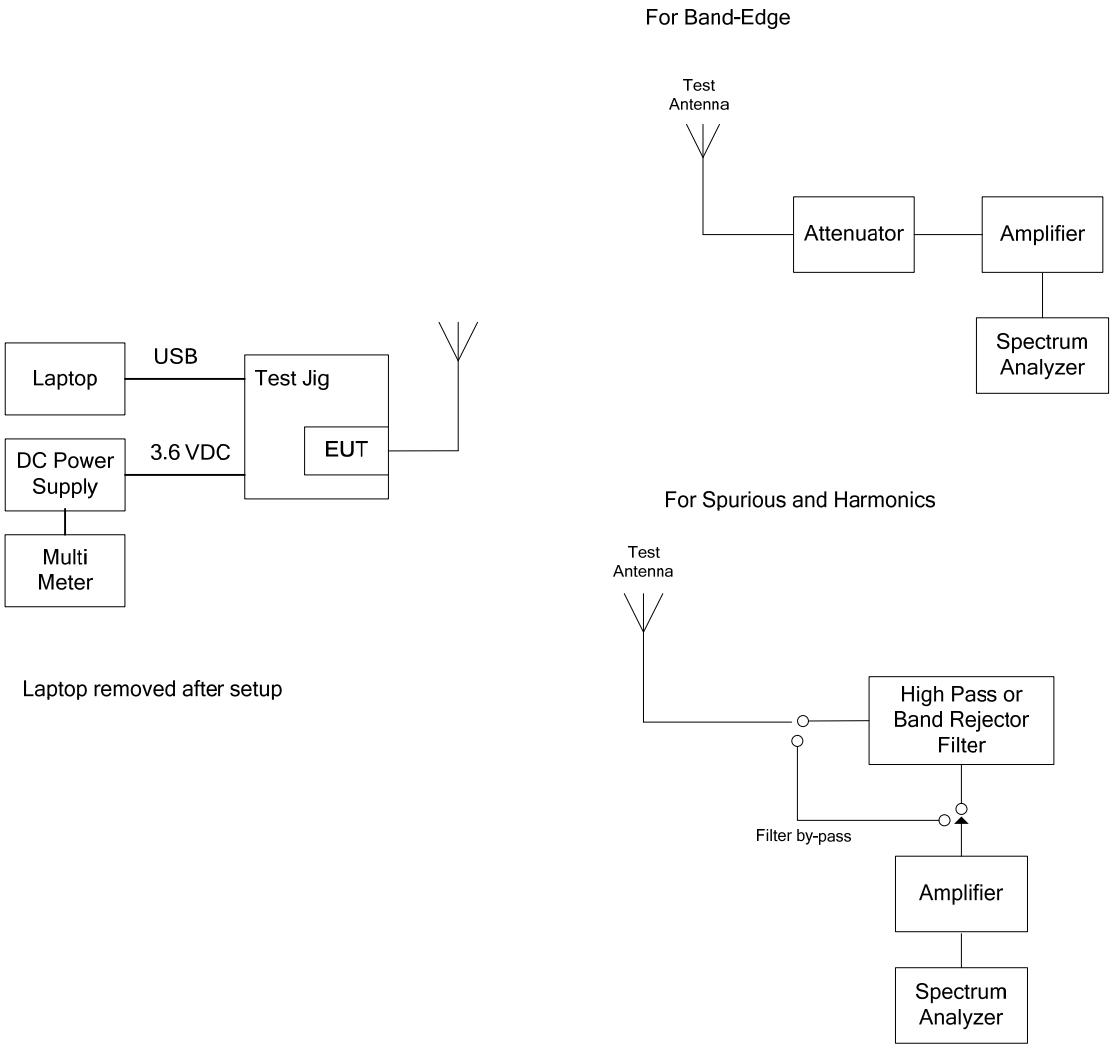
| GHz |
|---|
| 9.0-9.2 |
| 9.3-9.5 |
| 10.6-12.7 |
| 13.25-13.4 |
| 14.47-14.5 |
| 15.35-16.2 |
| 17.7-21.4 |
| 22.01-23.12 |
| 23.6-24.0 |
| 31.2-31.8 |
| 36.43-36.5 |
| Above 38.6 |

***** Certain frequency bands listed in table 7 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

### 5.2.2. Method of Measurements

KDB 558074 D01 15.247 Meas Guidance v05r02, Sections 8.5, 8.6 and 8.7 (ANSI C63.10-2013 Clauses 11.11, 11.12 and 11.13)

### 5.2.3. Test Arrangement



### 5.2.4. Test Data

**Remark(s):**

- All spurious emissions that are in excess of 20 dB below the specified limit shall be recorded.
- EUT shall be tested in three orthogonal positions.
- The following test data represent the worst-case derived from exploratory tests.

#### 5.2.4.1. Spurious Radiated Emission

| | |
|---|---|
| Fundamental Frequency: | 2402 MHz |
| Power Setting: | 200 |
| Data Rate: | 1 Mbps |
| Frequency Test Range: | 30 MHz – 25 GHz |

| Frequency (MHz) | RF Peak Level (dBµV/m) | RF Avg Level (dBµV/m) | Antenna Plane (H/V) | Limit RSS-Gen Table 5 (dBµV/m) | Limit RSS-247 Section 5.5 (dBµV/m) | Margin (dB) | Pass/ Fail |
|---|---|---|---|---|---|---|---|
| 2402 | 109.68 | -- | V | -- | -- | -- | -- |
| 2402 | 113.15 | -- | H | -- | -- | -- | -- |
| 4804 | 56.30 | 49.72 | V | 54.0 | 93.2 | -4.3 | Pass* |
| 4804 | 58.70 | 52.31 | H | 54.0 | 93.2 | -1.7 | Pass* |

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

| | |
|---|---|
| Fundamental Frequency: | 2440 MHz |
| Power Setting: | 200 |
| Data Rate: | 1 Mbps |
| Frequency Test Range: | 30 MHz – 25 GHz |

| Frequency (MHz) | RF Peak Level (dBµV/m) | RF Avg Level (dBµV/m) | Antenna Plane (H/V) | Limit RSS-Gen Table 5 (dBµV/m) | Limit RSS-247 Section 5.5 (dBµV/m) | Margin (dB) | Pass/ Fail |
|---|---|---|---|---|---|---|---|
| 2440 | 114.22 | -- | V | -- | -- | -- | -- |
| 2440 | 114.78 | -- | H | -- | -- | -- | -- |
| 4880 | 51.26 | 43.04 | V | 54.0 | 94.8 | -11.0 | Pass* |
| 4880 | 53.17 | 44.64 | H | 54.0 | 94.8 | -9.4 | Pass* |
| 7320 | 54.22 | 39.74 | V | 54.0 | 94.8 | -14.3 | Pass* |
| 7320 | 51.92 | 38.27 | H | 54.0 | 94.8 | -15.7 | Pass* |

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

| | |
|---|---|
| Fundamental Frequency: | 2480 MHz |
| Power Setting: | 200 |
| Data Rate: | 1 Mbps |
| Frequency Test Range: | 30 MHz – 25 GHz |

| Frequency (MHz) | RF Peak Level (dBµV/m) | RF Avg Level (dBµV/m) | Antenna Plane (H/V) | Limit RSS-Gen Table 5 (dBµV/m) | Limit RSS-247 Section 5.5 (dBµV/m) | Margin (dB) | Pass/ Fail |
|---|---|---|---|---|---|---|---|
| 2480 | 113.36 | -- | V | -- | -- | -- | -- |
| 2480 | 113.75 | -- | H | -- | -- | -- | -- |
| 4960 | 53.02 | 43.97 | V | 54.0 | 93.8 | -10.0 | Pass* |
| 4960 | 52.45 | 44.69 | H | 54.0 | 93.8 | -9.3 | Pass* |
| 7440 | 52.26 | 39.05 | V | 54.0 | 93.8 | -15.0 | Pass* |
| 7440 | 51.80 | 38.84 | H | 54.0 | 93.8 | -15.2 | Pass* |

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

| | |
|---|---|
| Fundamental Frequency: | 2404 MHz |
| Power Setting: | 200 |
| Data Rate: | 2 Mbps |
| Frequency Test Range: | 30 MHz – 25 GHz |

| Frequency (MHz) | RF Peak Level (dBµV/m) | RF Avg Level (dBµV/m) | Antenna Plane (H/V) | Limit RSS-Gen Table 5 (dBµV/m) | Limit RSS-247 Section 5.5 (dBµV/m) | Margin (dB) | Pass/ Fail |
|---|---|---|---|---|---|---|---|
| 2404 | 109.58 | -- | V | -- | -- | -- | -- |
| 2404 | 113.01 | -- | H | -- | -- | -- | -- |
| 4808 | 57.12 | 46.83 | V | 54.0 | 93.0 | -7.2 | Pass* |
| 4808 | 57.15 | 46.85 | H | 54.0 | 93.0 | -7.2 | Pass* |

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

| | |
|---|---|
| Fundamental Frequency: | 2440 MHz |
| Power Setting: | 200 |
| Data Rate: | 2 Mbps |
| Frequency Test Range: | 30 MHz – 25 GHz |

| Frequency (MHz) | RF Peak Level (dBµV/m) | RF Avg Level (dBµV/m) | Antenna Plane (H/V) | Limit RSS-Gen Table 5 (dBµV/m) | Limit RSS-247 Section 5.5 (dBµV/m) | Margin (dB) | Pass/ Fail |
|---|---|---|---|---|---|---|---|
| 2440 | 109.55 | -- | V | -- | -- | -- | -- |
| 2440 | 114.97 | -- | H | -- | -- | -- | -- |
| 4880 | 51.69 | 39.10 | V | 54.0 | 95.0 | -14.9 | Pass* |
| 4880 | 52.15 | 40.00 | H | 54.0 | 95.0 | -14.0 | Pass* |

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

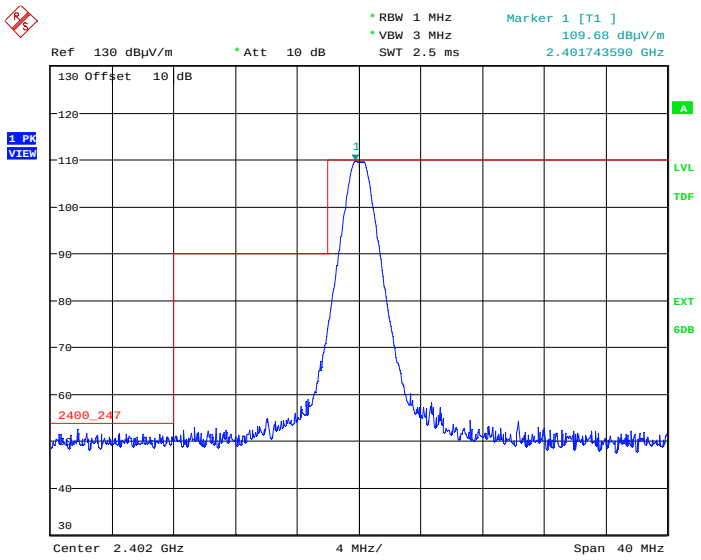
| | |
|---|---|
| Fundamental Frequency: | 2478 MHz |
| Power Setting: | 200 |
| Data Rate: | 2 Mbps |
| Frequency Test Range: | 30 MHz – 25 GHz |

| Frequency (MHz) | RF Peak Level (dBµV/m) | RF Avg Level (dBµV/m) | Antenna Plane (H/V) | Limit RSS-Gen Table 5 (dBµV/m) | Limit RSS-247 Section 5.5 (dBµV/m) | Margin (dB) | Pass/ Fail |
|---|---|---|---|---|---|---|---|
| 2478 | 101.56 | -- | V | -- | -- | -- | -- |
| 2478 | 100.61 | -- | H | -- | -- | -- | -- |
| 4956 | 50.19 | 37.63 | V | 54.0 | 81.6 | -16.4 | Pass* |
| 4956 | 48.99 | 35.67 | H | 54.0 | 81.6 | -18.3 | Pass* |

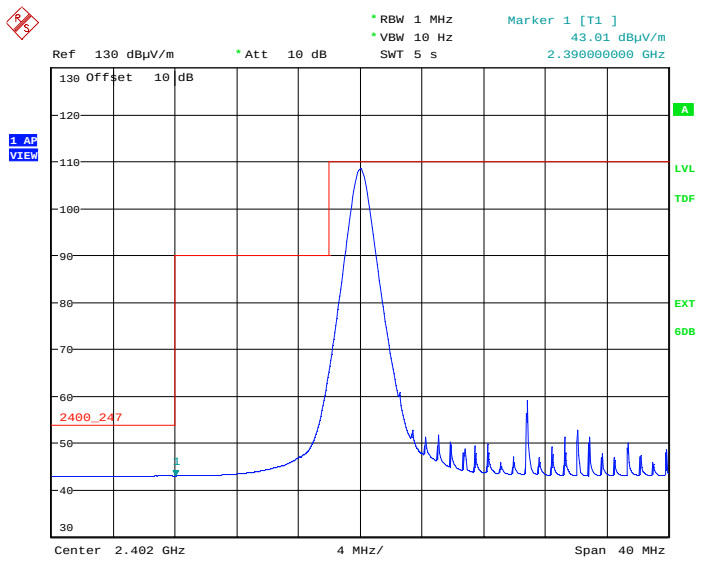
All other spurious emissions and harmonics are more than 20 dB below the applicable limit.

### 5.2.4.2. Band-Edge Radiated Emissions

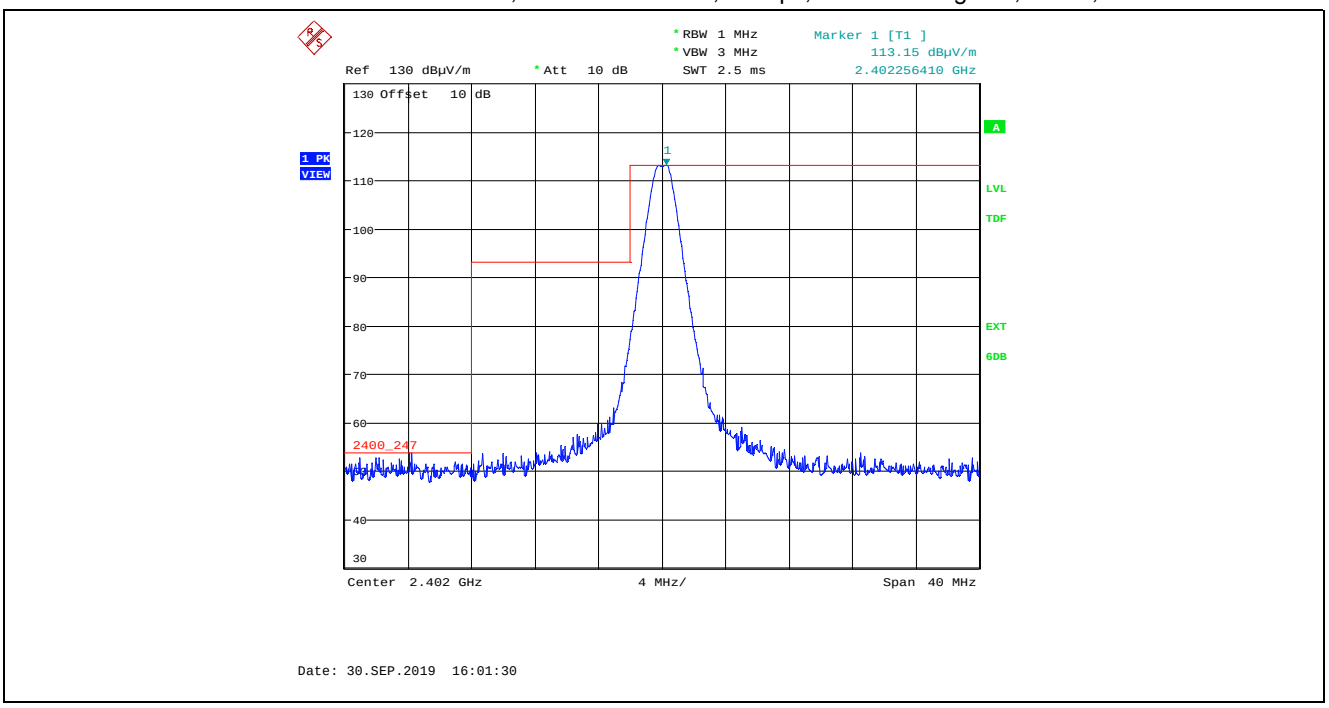
**Plot 5.2.4.2.1.** Band-Edge Radiated Emissions, Lower Band- edge, Peak Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 1 Mbps, Power Setting 200, Ch 00, 2402 MHz



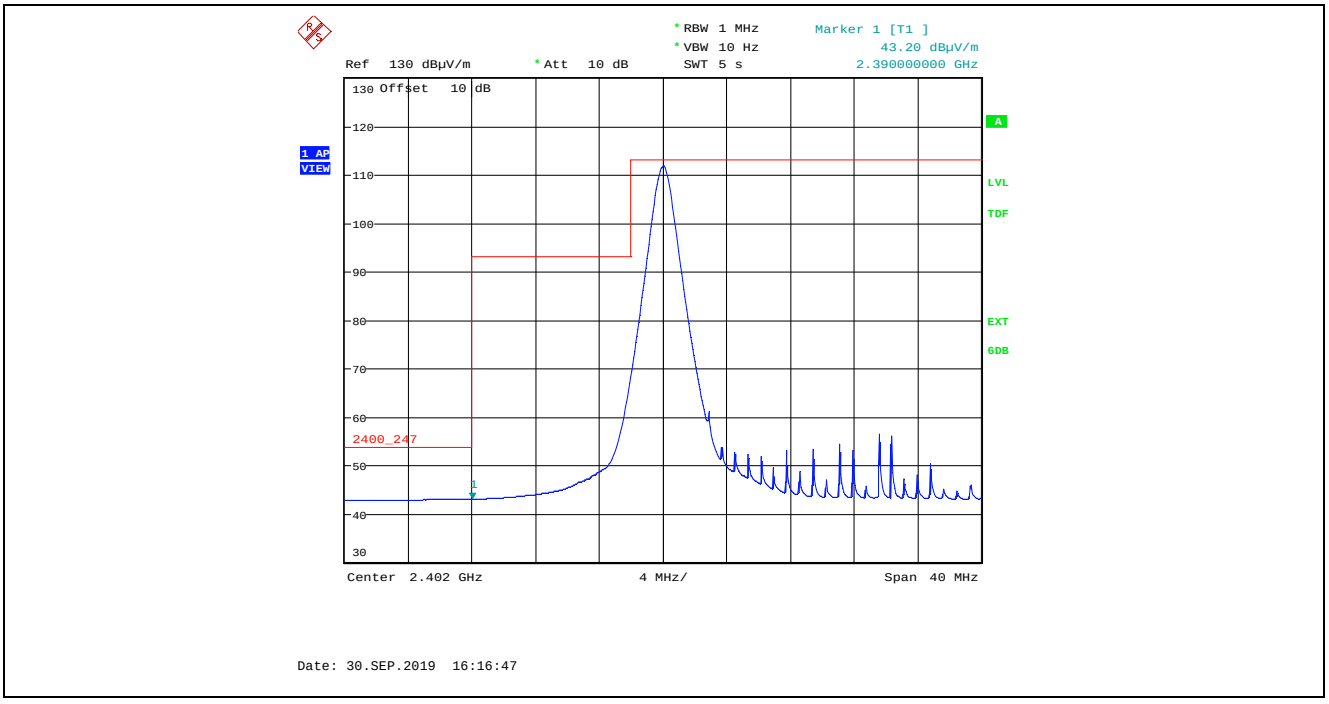

**Plot 5.2.4.2.2.** Band-Edge Radiated Emissions, Lower Band- edge, Average Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 1 Mbps, Power Setting 200, Ch 00, 2402 MHz



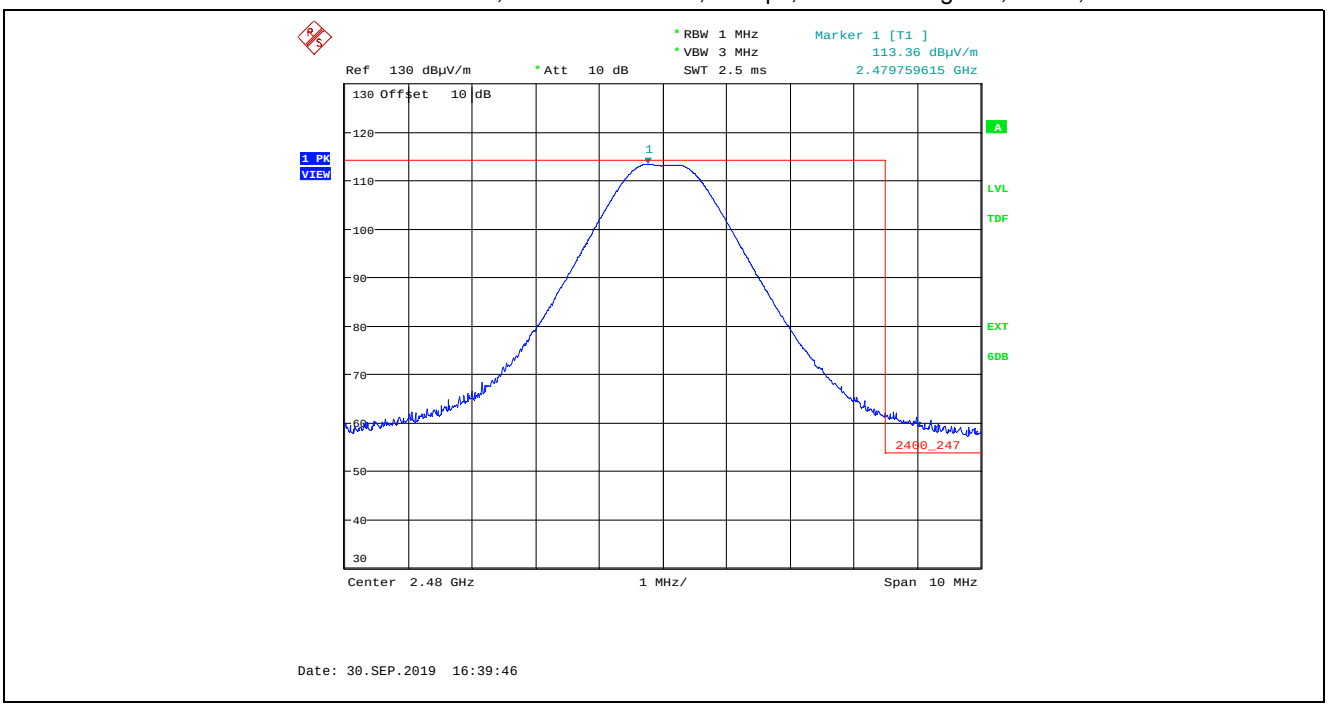
**Plot 5.2.4.2.3.** Band-Edge Radiated Emissions, Lower Band-edge, Peak Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 1 Mbps, Power Setting 200, Ch 00, 2402 MHz



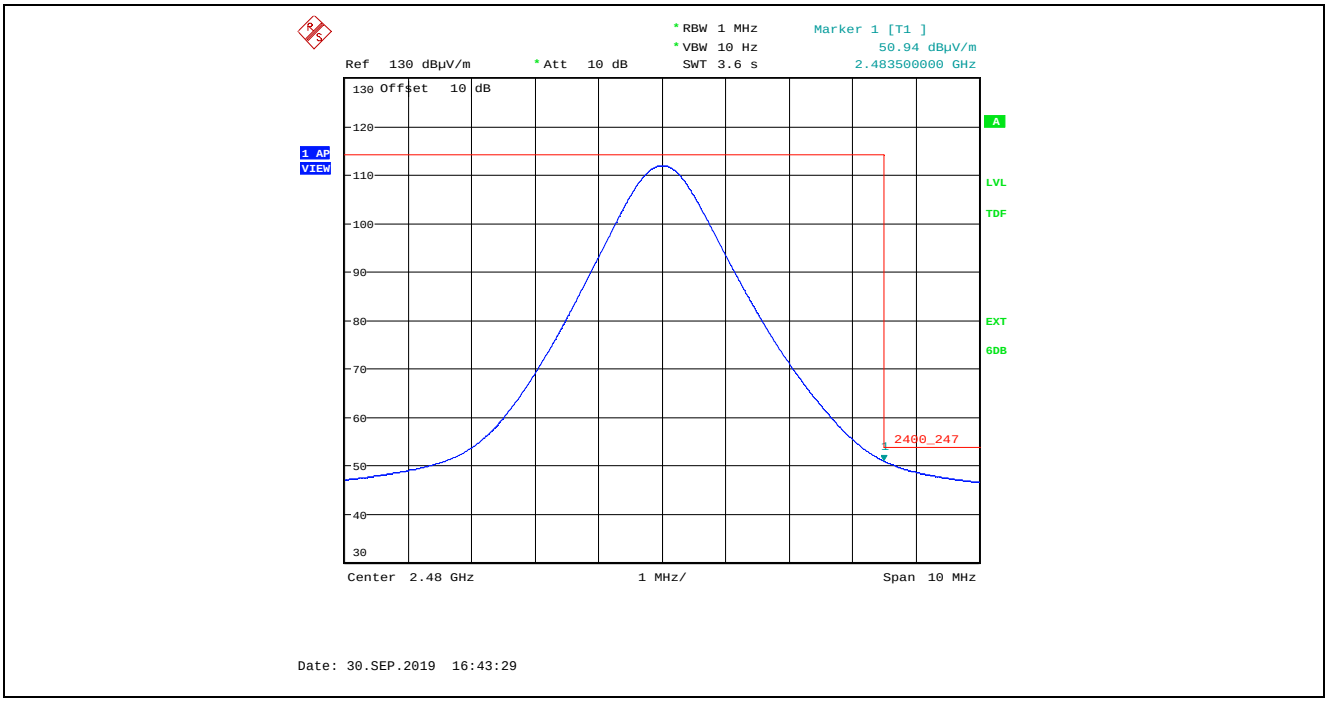

**Plot 5.2.4.2.4.** Band-Edge Radiated Emissions, Lower Band-edge, Average Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 1 Mbps, Power Setting 200, Ch 00, 2402 MHz



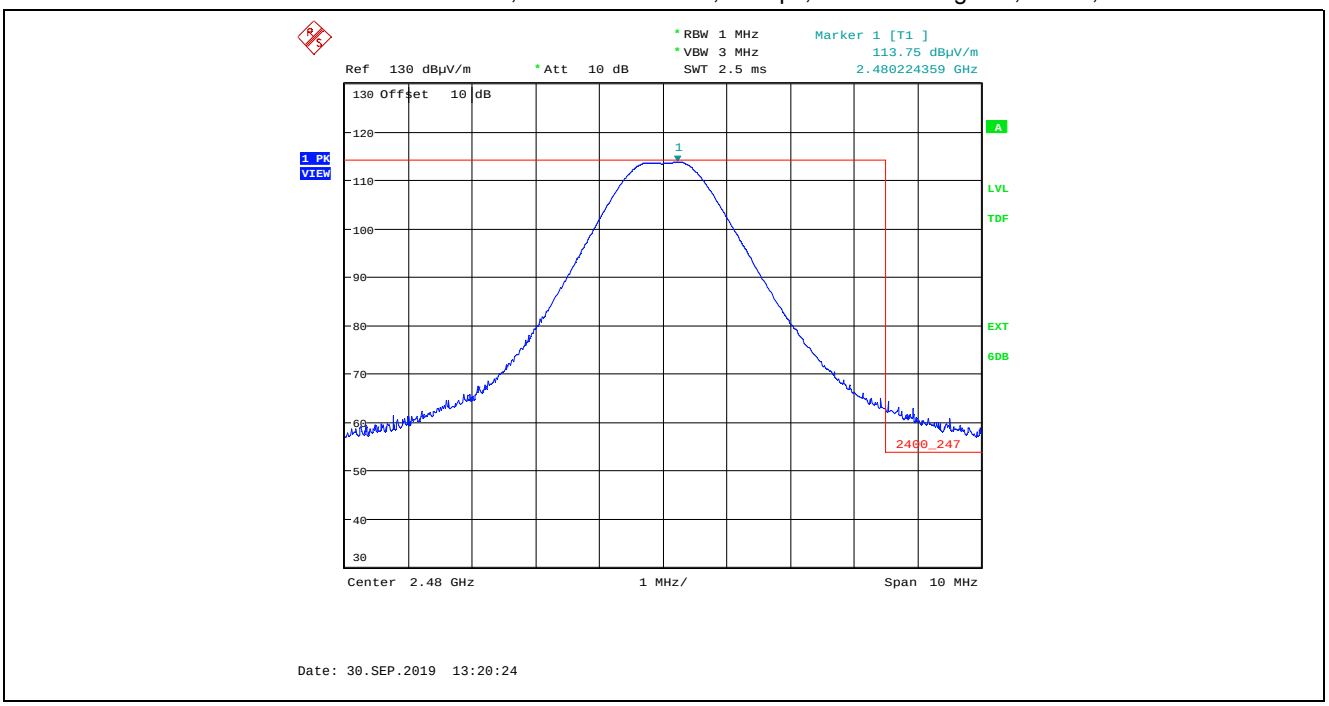
**Plot 5.2.4.2.5.** Band-Edge Radiated Emissions, Higher Band-edge, Peak Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 1 Mbps, Power Setting 200, Ch 39, 2480 MHz



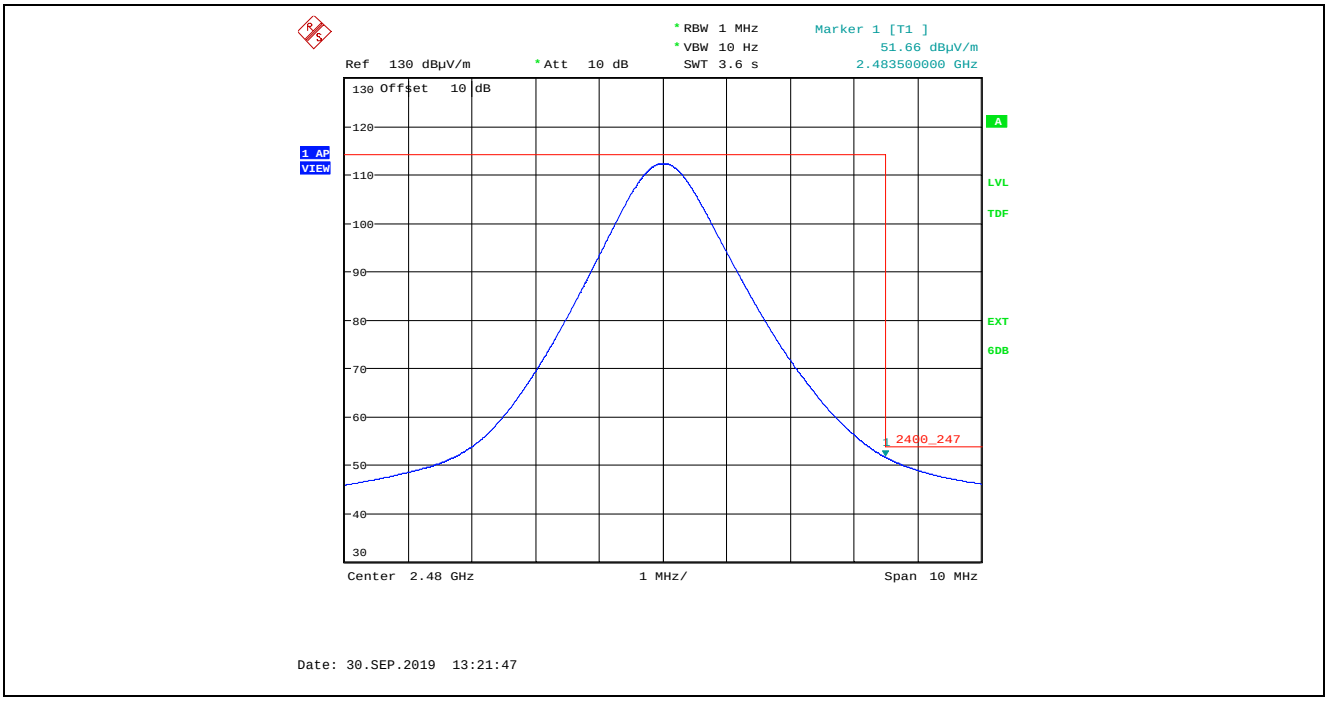

**Plot 5.2.4.2.6.** Band-Edge Radiated Emissions, Higher Band-edge, Average Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 1 Mbps, Power Setting 200, Ch 39, 2480 MHz



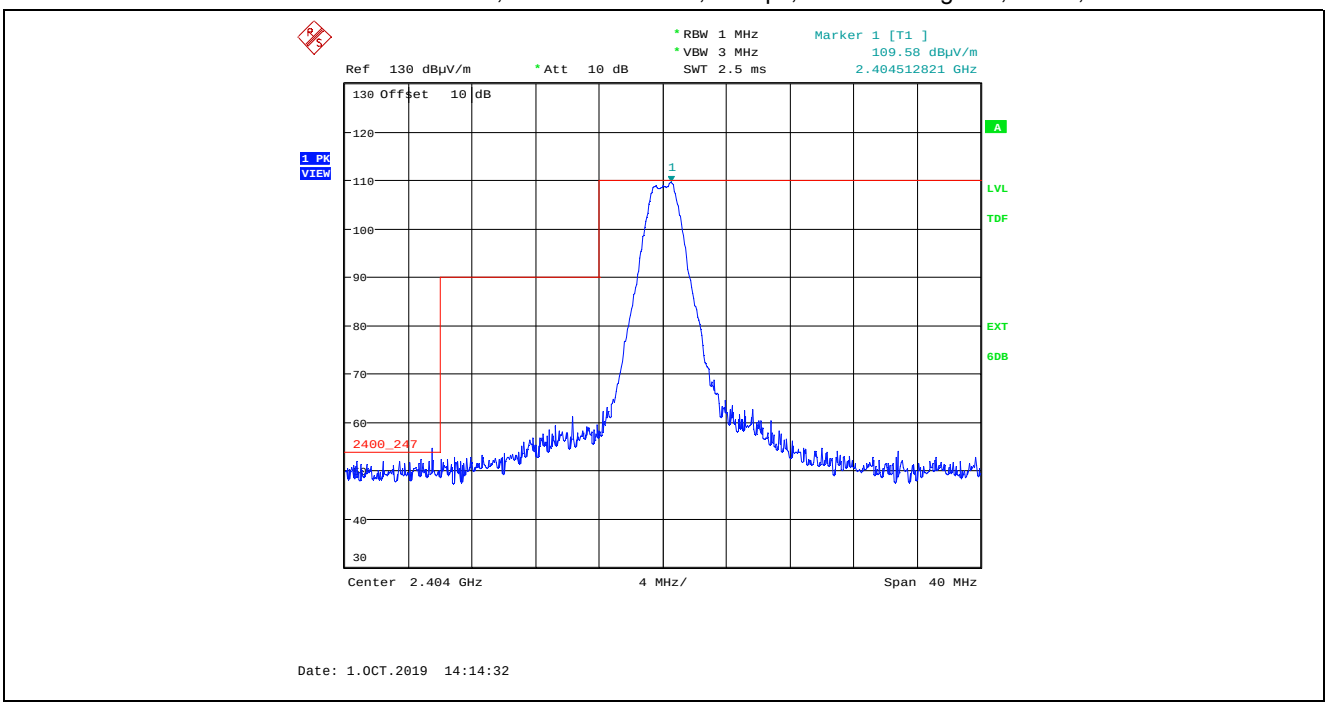
**Plot 5.2.4.2.7.** Band-Edge Radiated Emissions, Higher Band-edge, Peak Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 1 Mbps, Power Setting 200, Ch 39, 2480 MHz



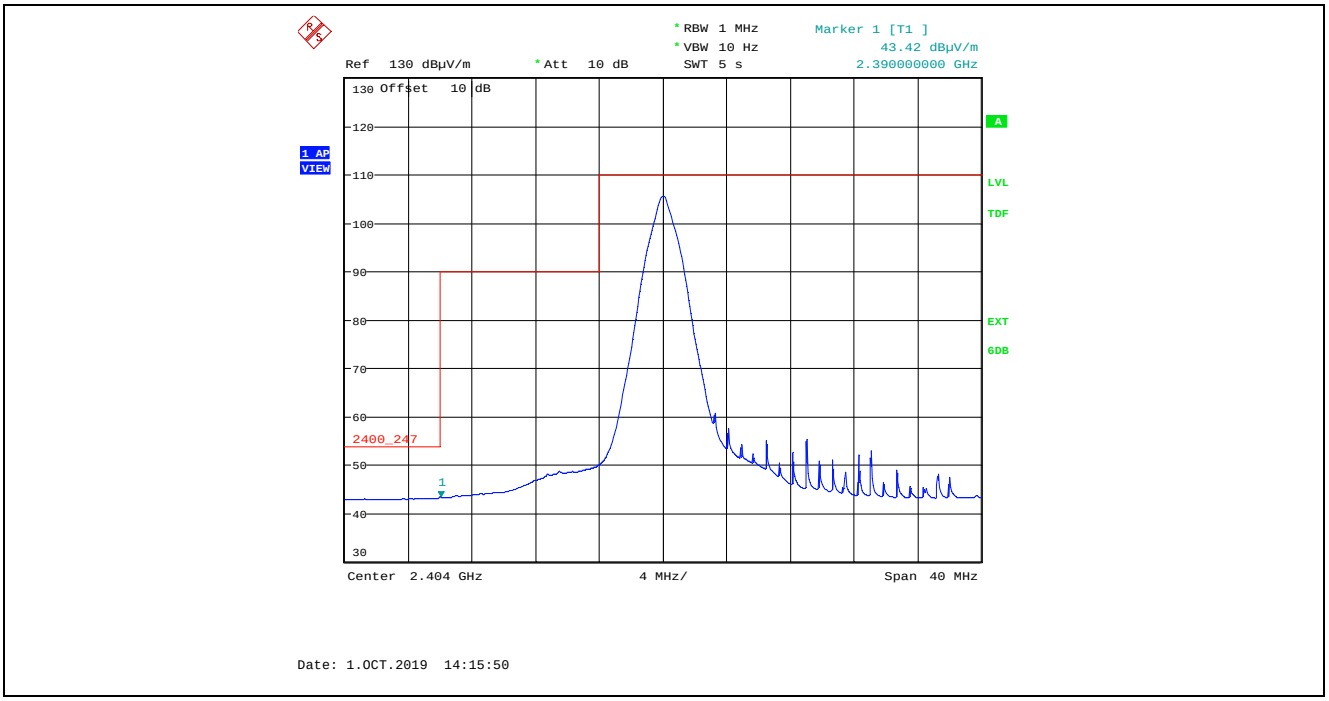

**Plot 5.2.4.2.8.** Band-Edge Radiated Emissions, Higher Band-edge, Average Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 1 Mbps, Power Setting 200, Ch 39, 2480 MHz



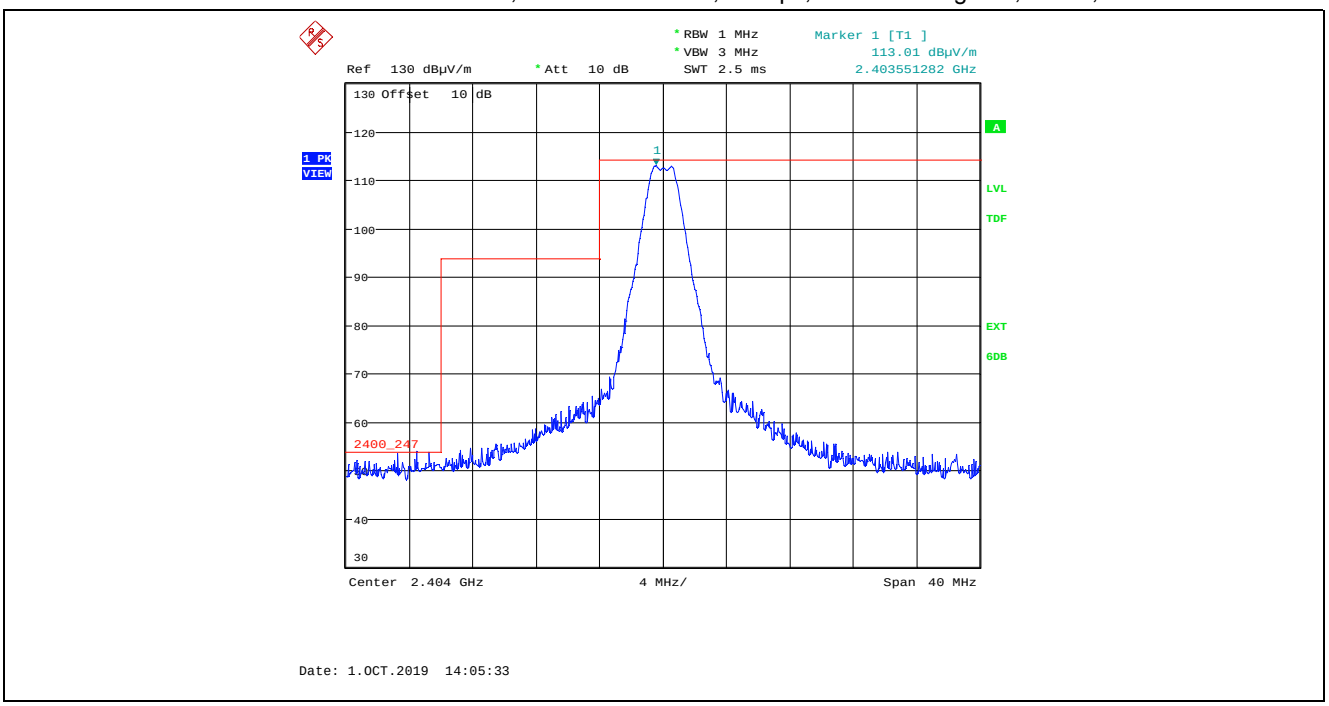
**Plot 5.2.4.2.9.** Band-Edge Radiated Emissions, Lower Band-edge, Peak Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 01, 2404 MHz



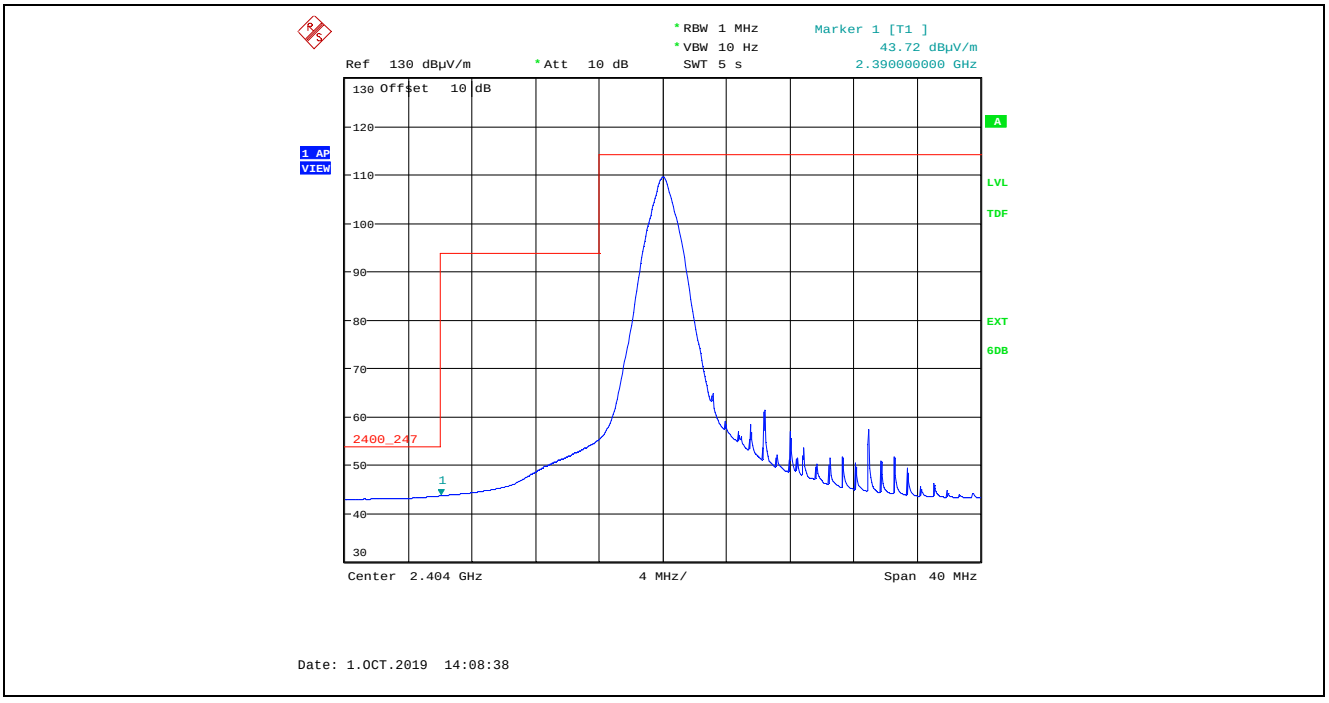

**Plot 5.2.4.2.10.** Band-Edge Radiated Emissions, Lower Band-edge, Average Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 01, 2404 MHz



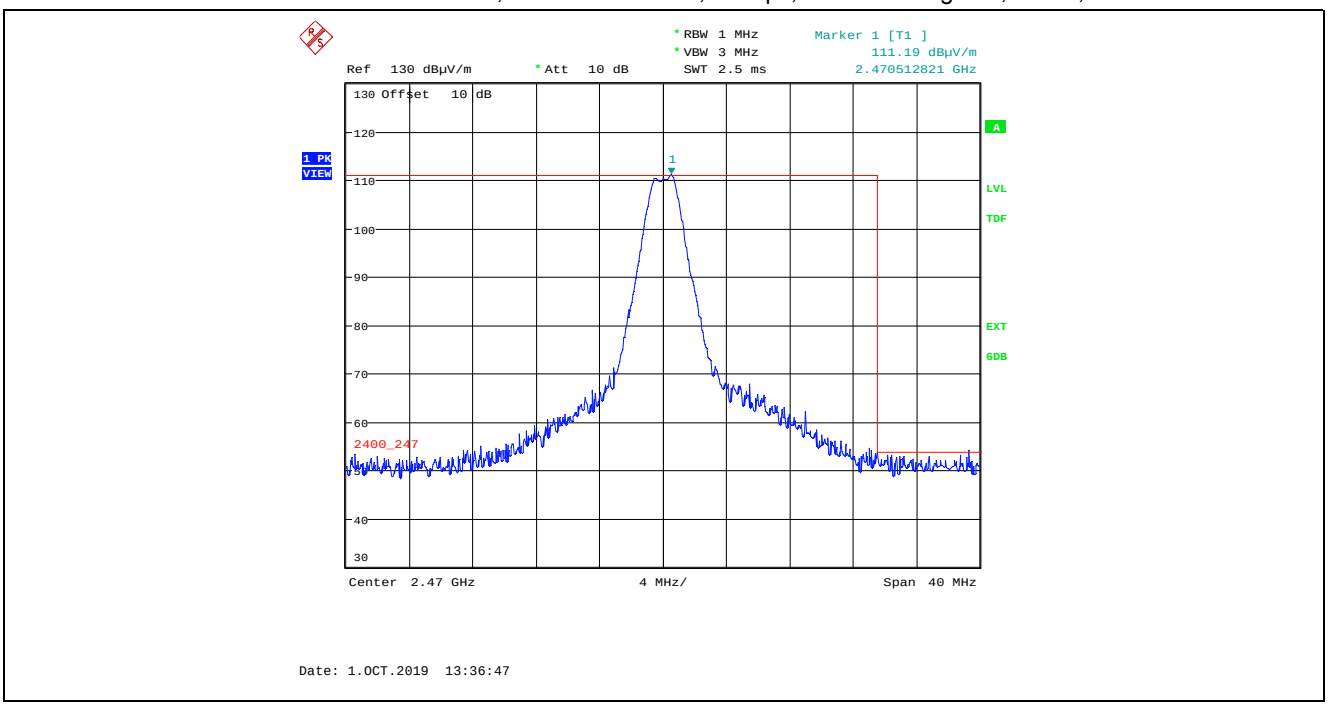
**Plot 5.2.4.2.11.** Band-Edge Radiated Emissions, Lower Band-edge, Peak Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 01, 2404 MHz



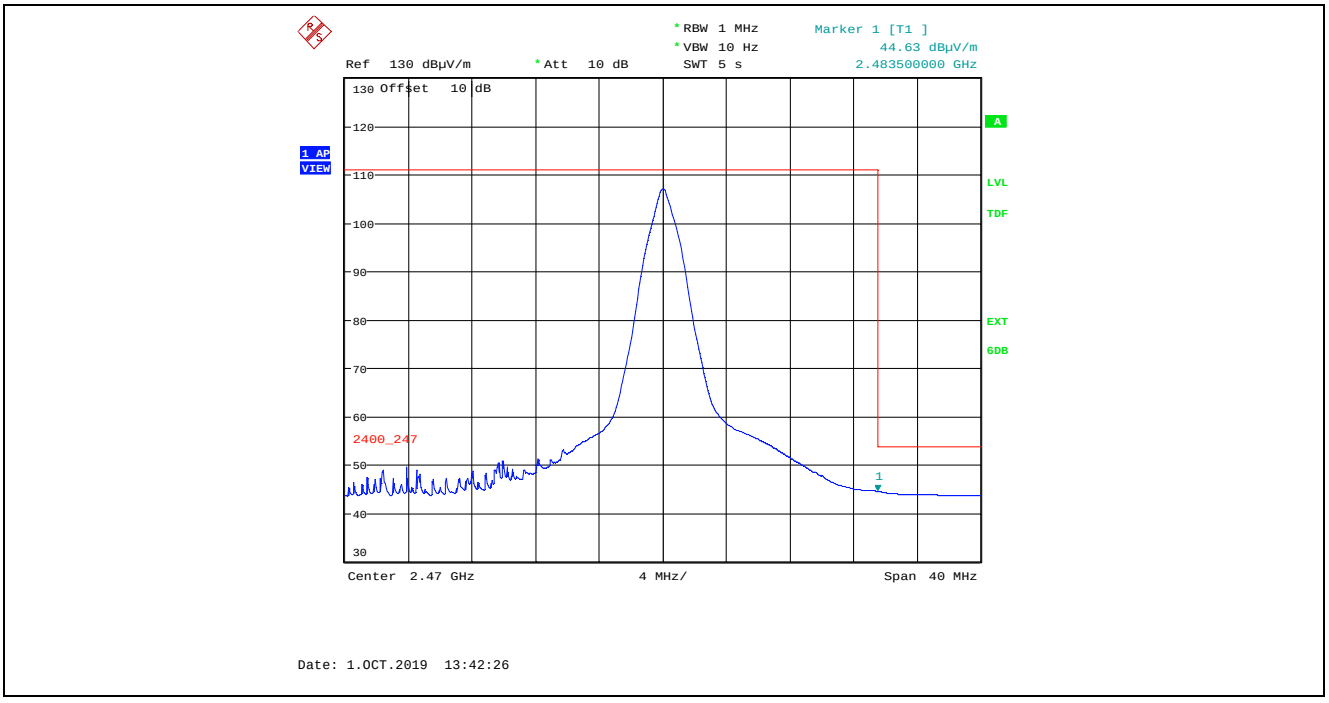

**Plot 5.2.4.2.12.** Band-Edge Radiated Emissions, Lower Band-edge, Average Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 01, 2404 MHz



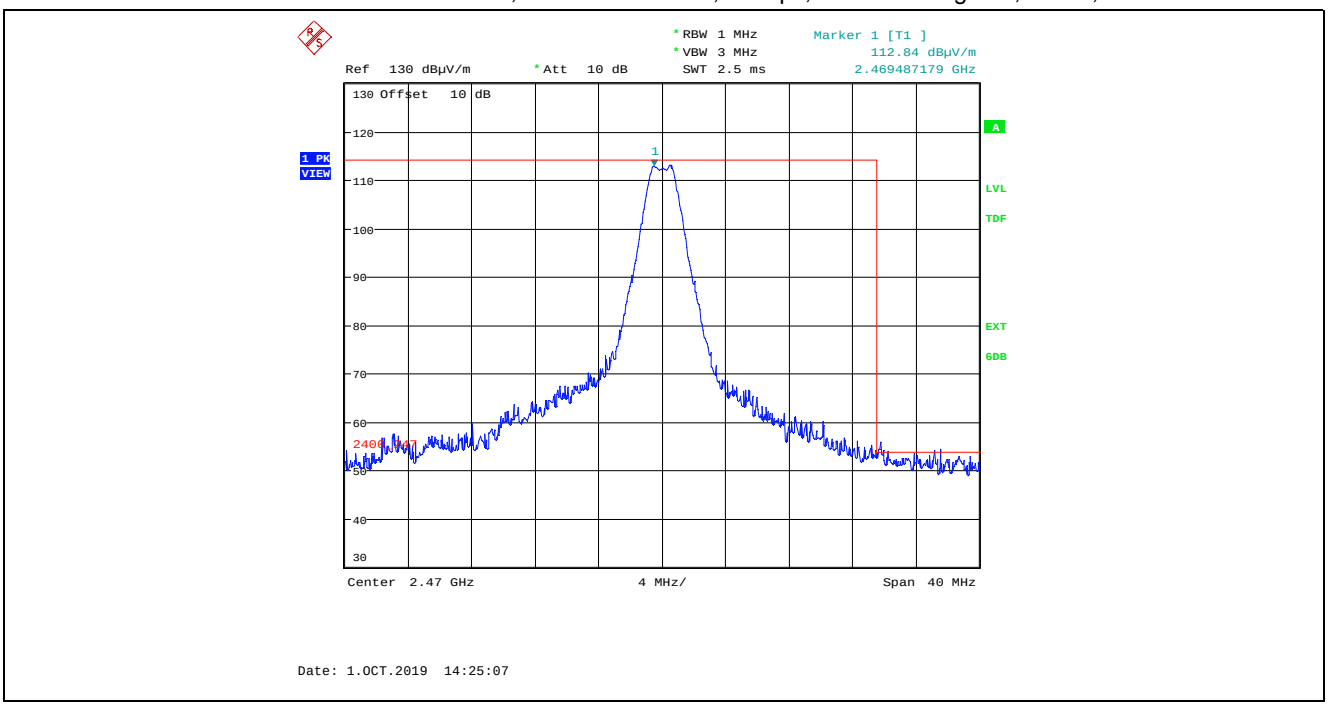
**Plot 5.2.4.2.13.** Band-Edge Radiated Emissions, Higher Band-edge, Peak Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 34, 2470 MHz



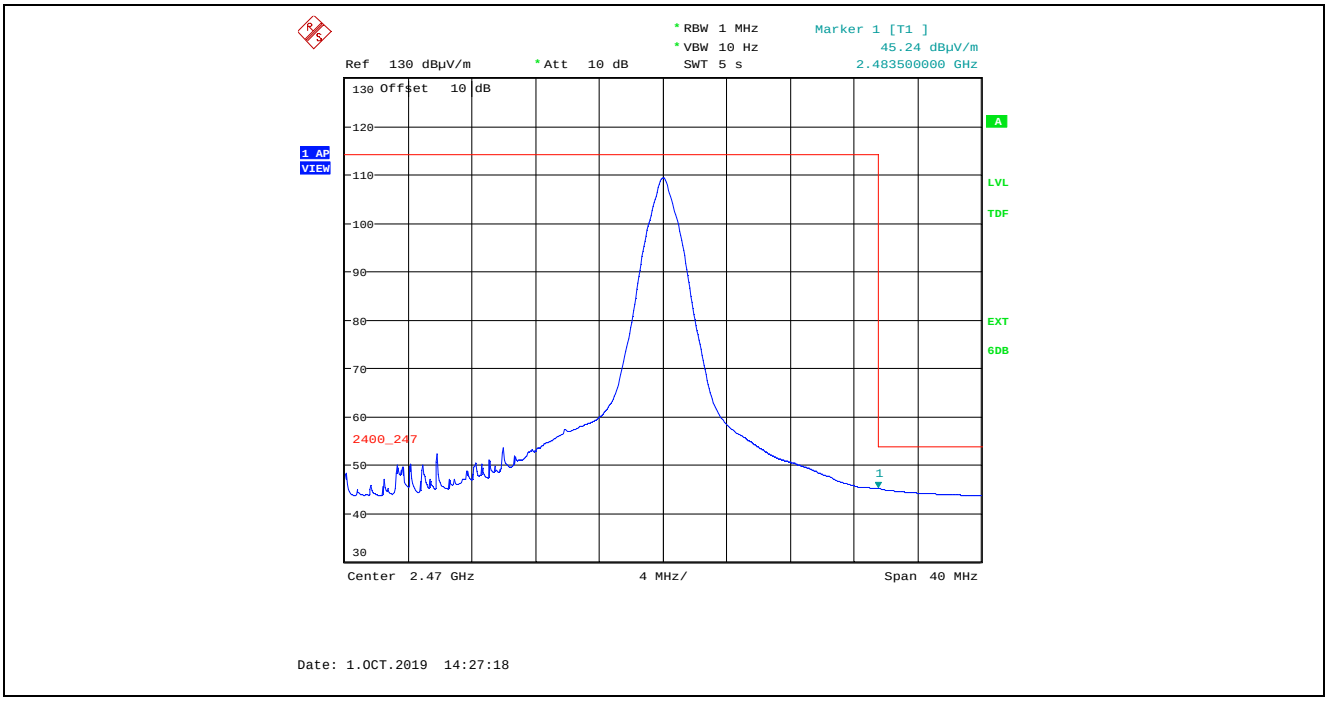

**Plot 5.2.4.2.14.** Band-Edge Radiated Emissions, Higher Band-edge, Average Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 34, 2470 MHz



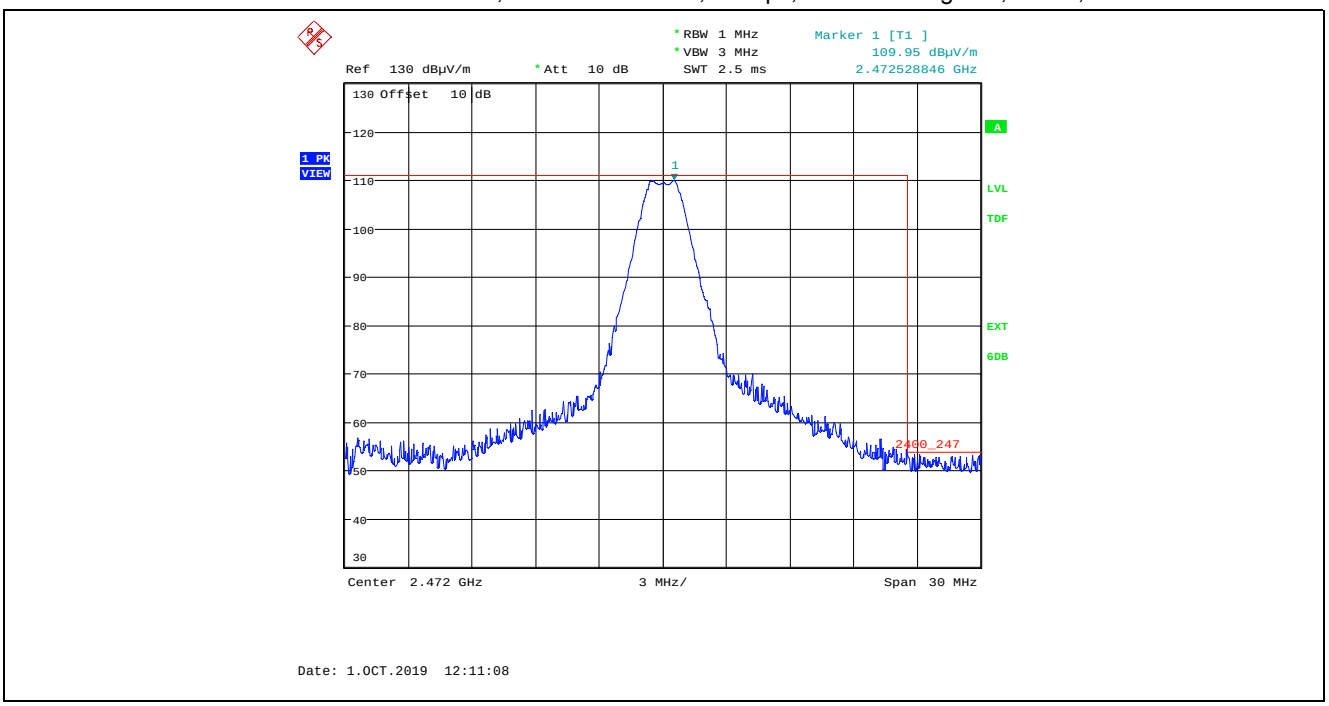
**Plot 5.2.4.2.15.** Band-Edge Radiated Emissions, Higher Band-edge, Peak Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 34, 2470 MHz



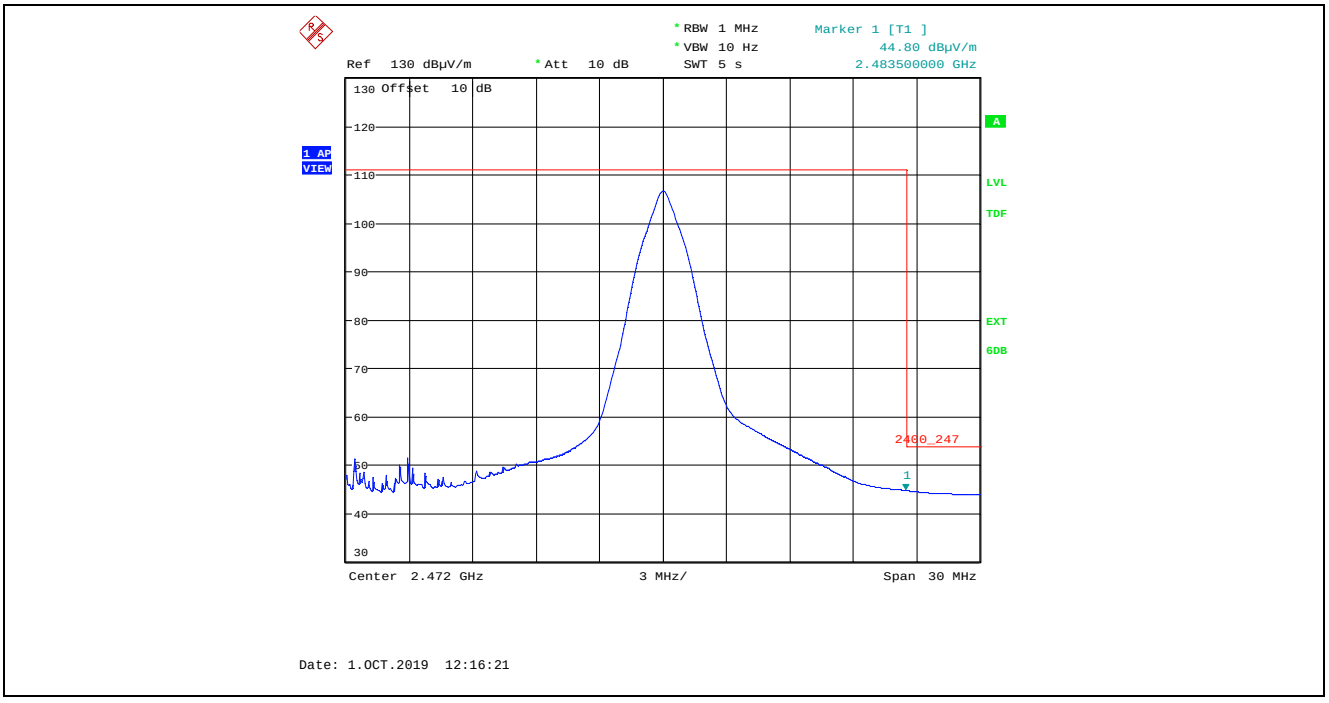

**Plot 5.2.4.2.16.** Band-Edge Radiated Emissions, Higher Band-edge, Average Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 34, 2470 MHz



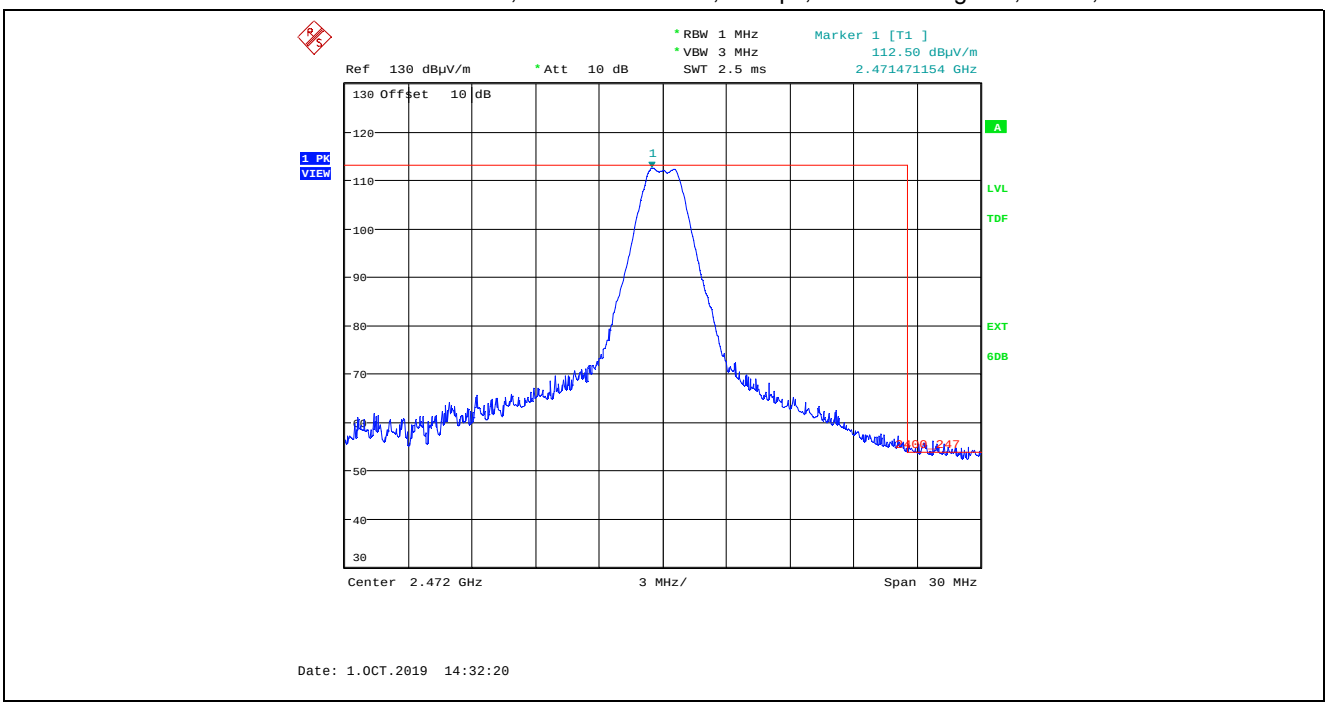
**Plot 5.2.4.2.17.** Band-Edge Radiated Emissions, Higher Band-edge, Peak Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 35, 2472 MHz



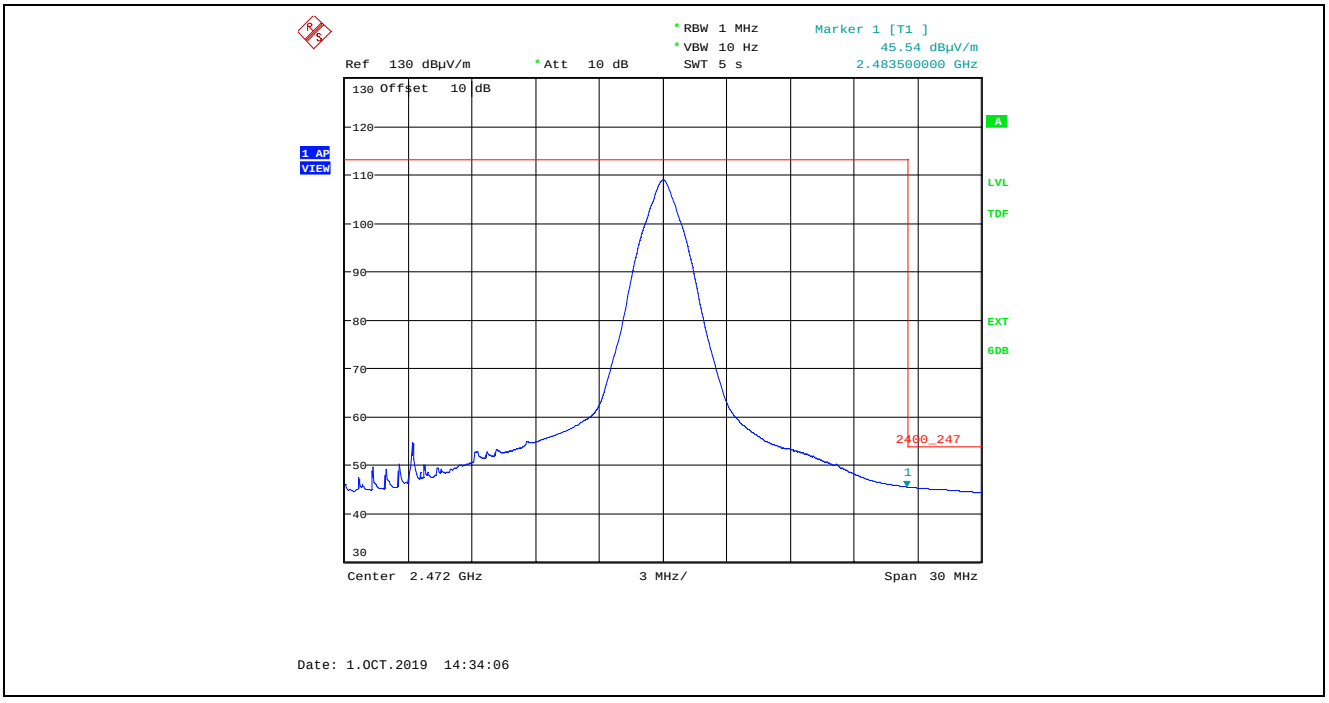

**Plot 5.2.4.2.18.** Band-Edge Radiated Emissions, Higher Band-edge, Average Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 35, 2472 MHz



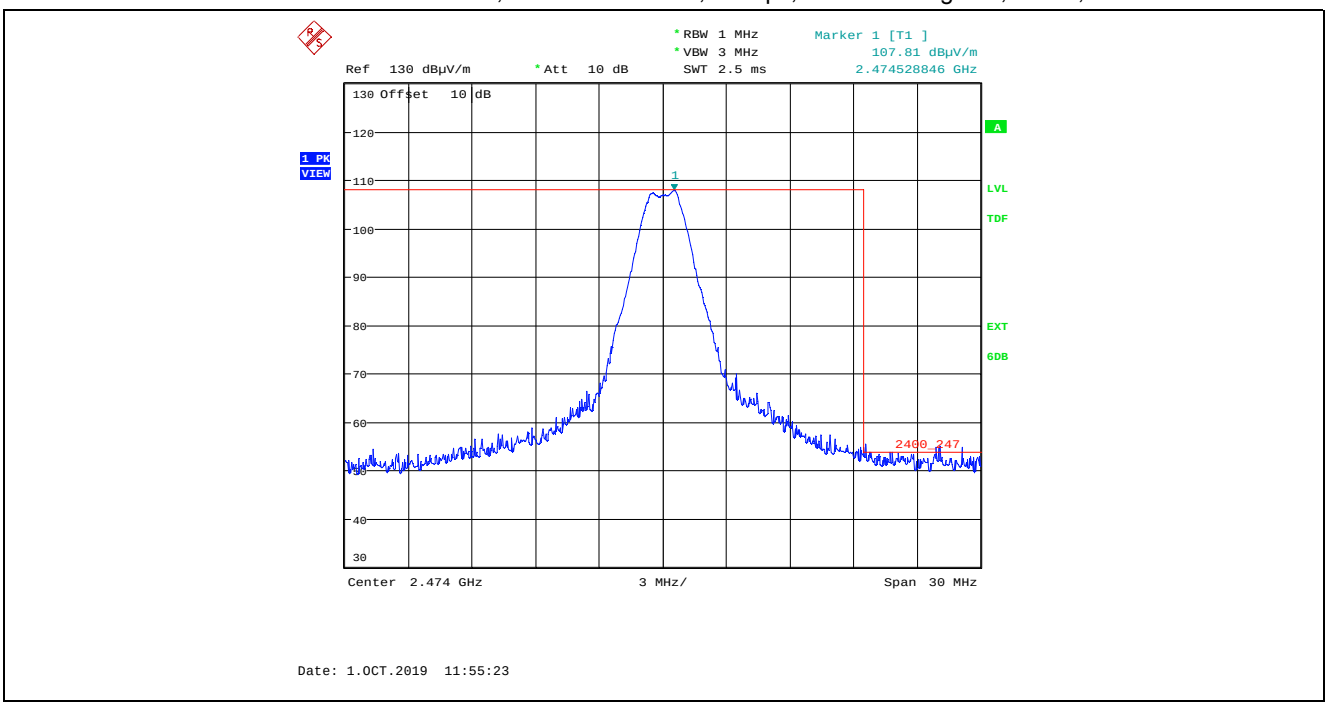
**Plot 5.2.4.2.19.** Band-Edge Radiated Emissions, Higher Band-edge, Peak Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 35, 2472 MHz



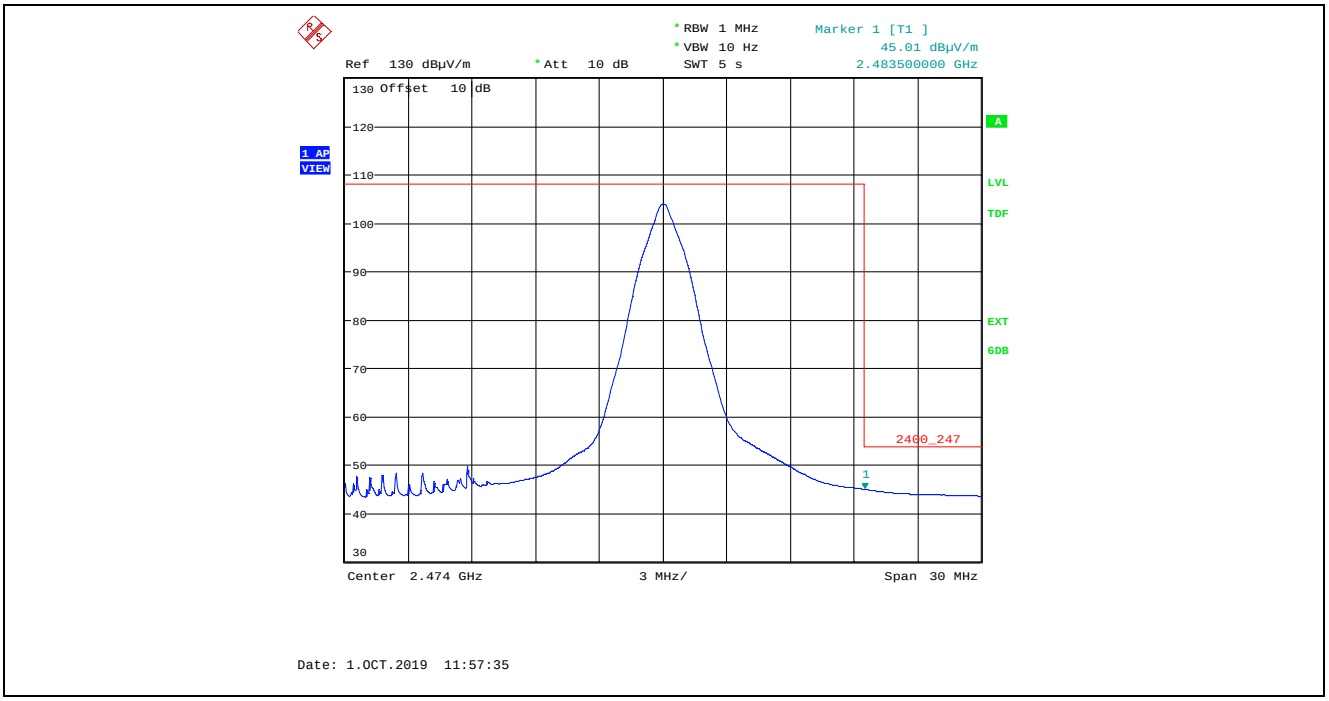

**Plot 5.2.4.2.20.** Band-Edge Radiated Emissions, Higher Band-edge, Average Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 35, 2472 MHz



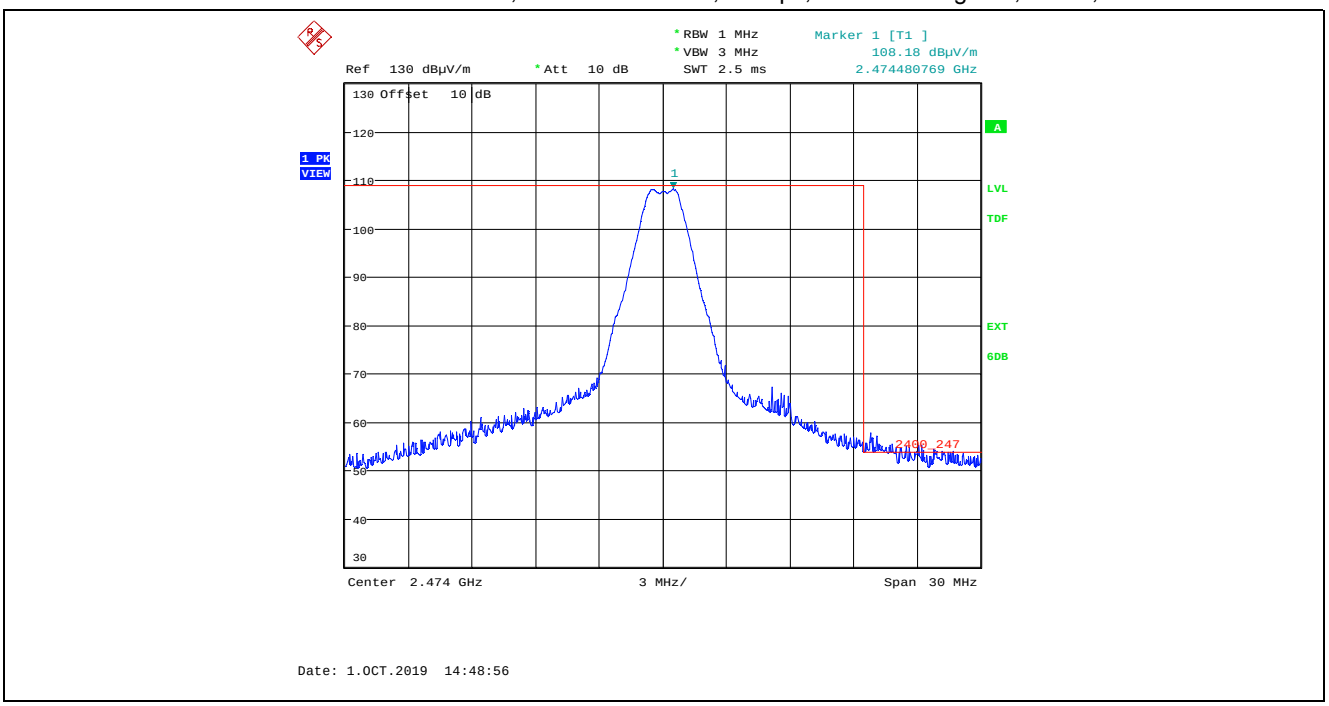
**Plot 5.2.4.2.21.** Band-Edge Radiated Emissions, Higher Band-edge, Peak Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 36, 2474 MHz



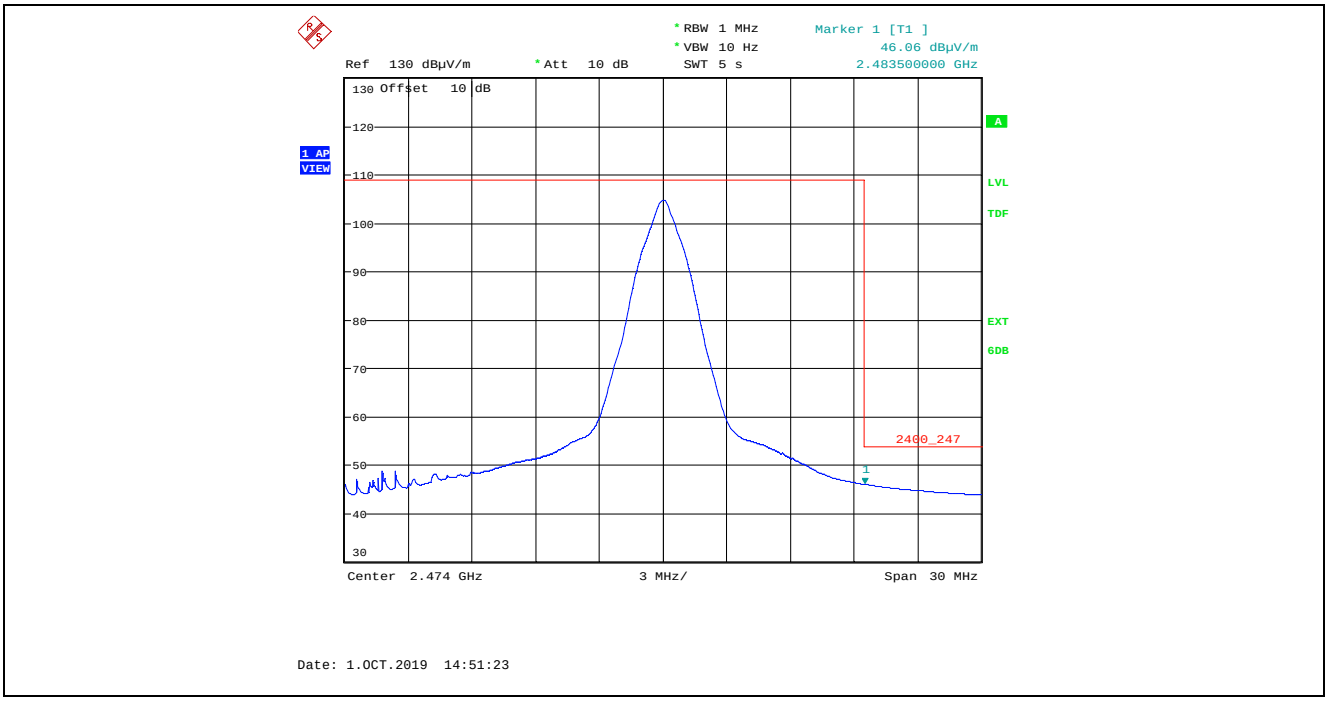

**Plot 5.2.4.2.22.** Band-Edge Radiated Emissions, Higher Band-edge, Average Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 36, 2474 MHz



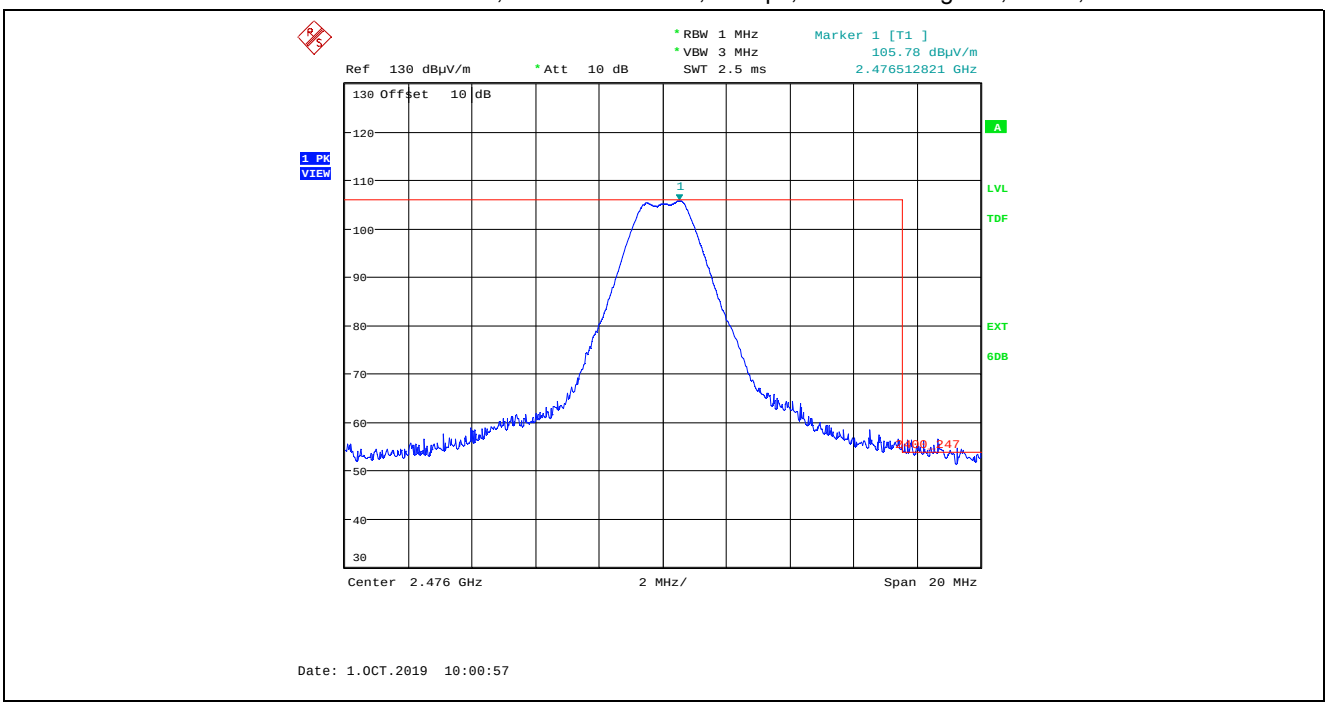
**Plot 5.2.4.2.23.** Band-Edge Radiated Emissions, Higher Band-edge, Peak Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 36, 2474 MHz



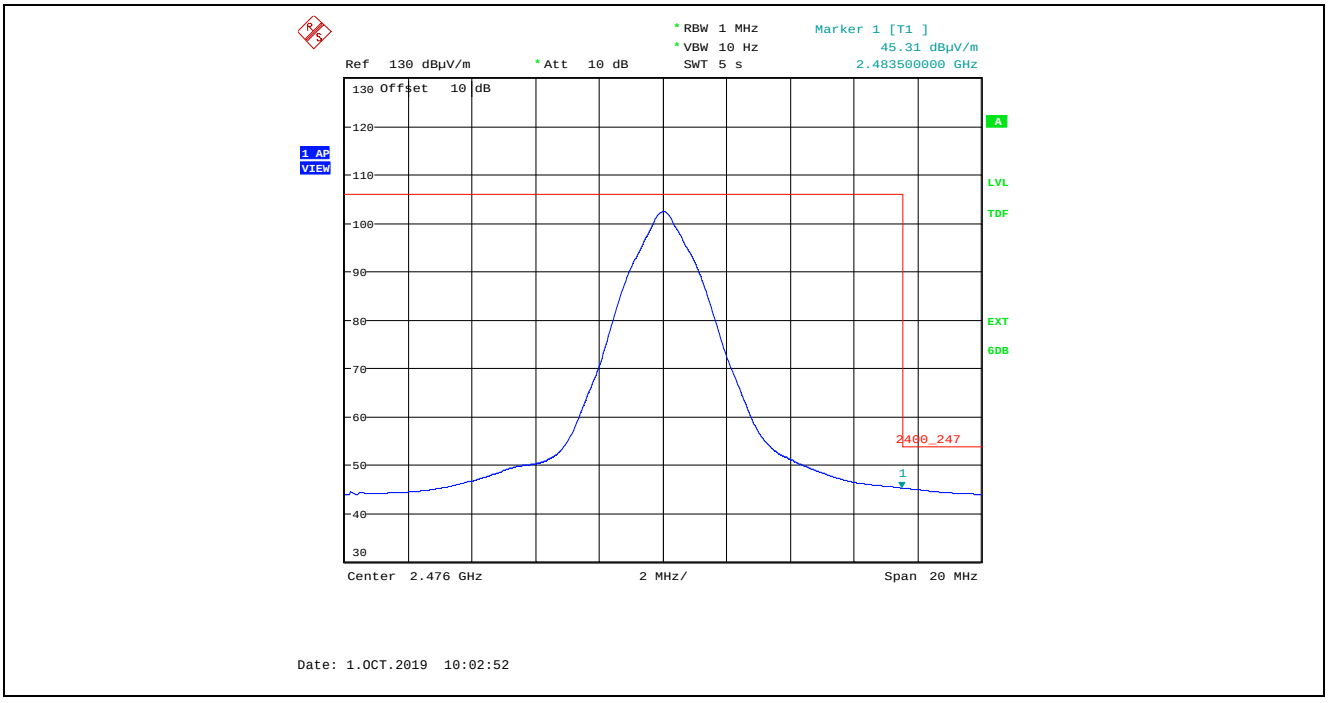

**Plot 5.2.4.2.24.** Band-Edge Radiated Emissions, Higher Band-edge, Average Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 36, 2474 MHz



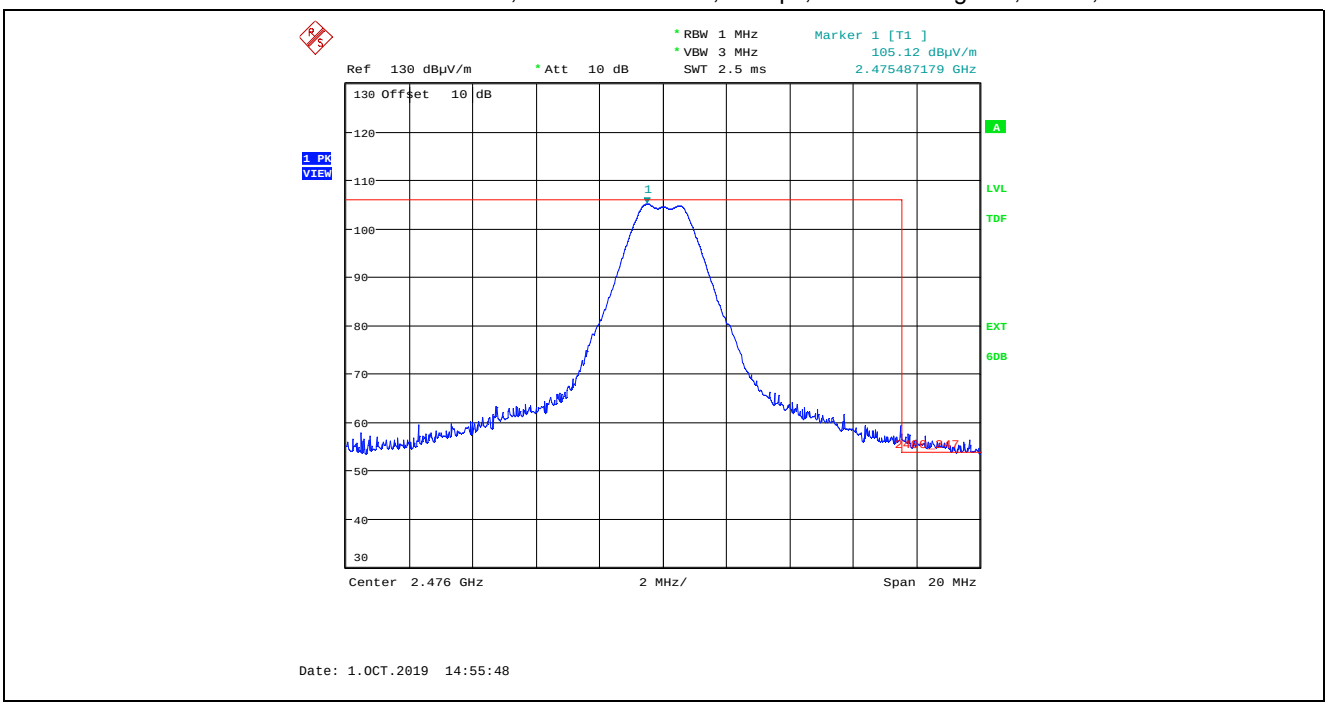
**Plot 5.2.4.2.25.** Band-Edge Radiated Emissions, Higher Band-edge, Peak Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 37, 2476 MHz



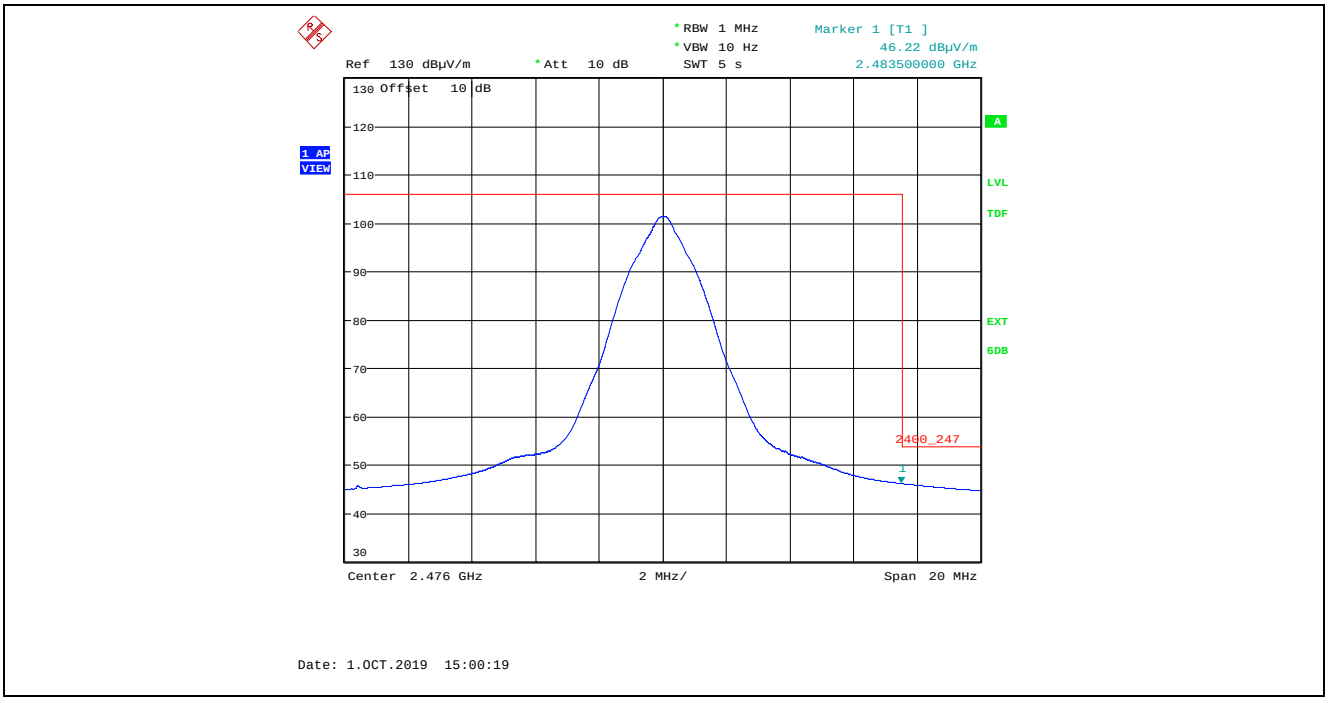

**Plot 5.2.4.2.26.** Band-Edge Radiated Emissions, Higher Band-edge, Average Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 37, 2476 MHz



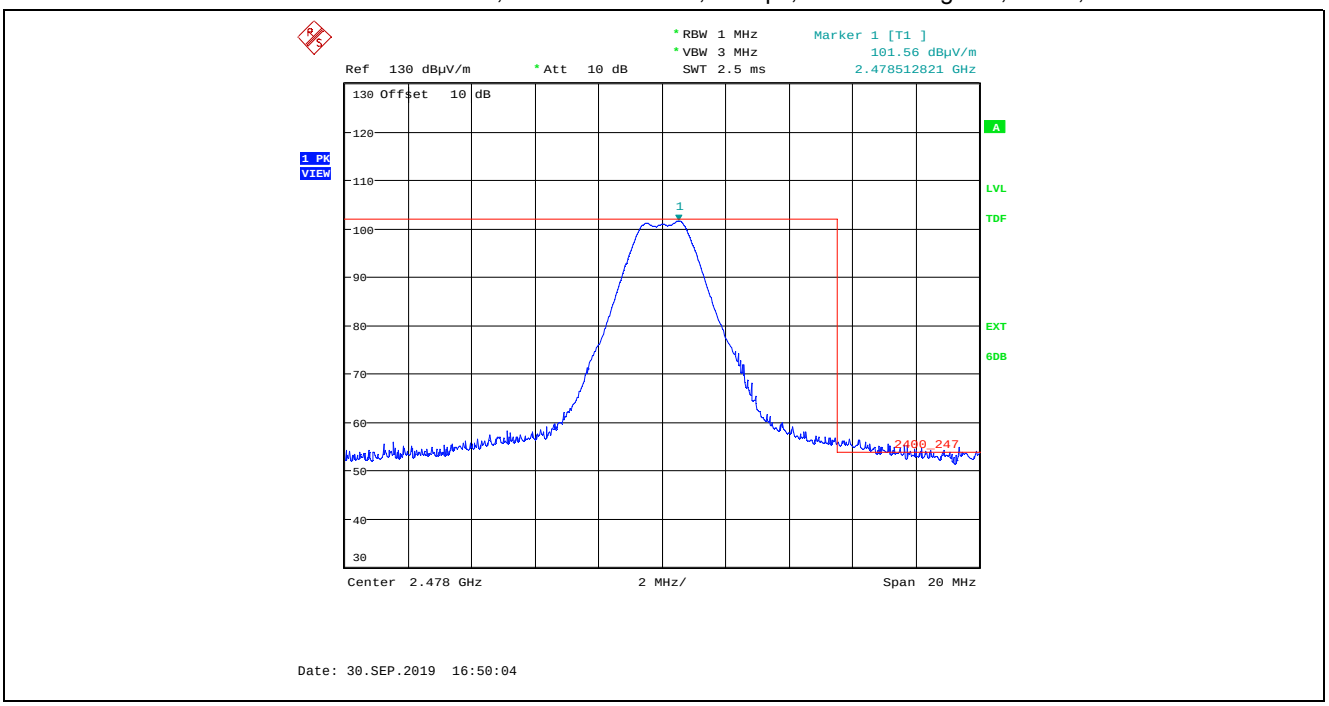
**Plot 5.2.4.2.27.** Band-Edge Radiated Emissions, Higher Band-edge, Peak Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 37, 2476 MHz



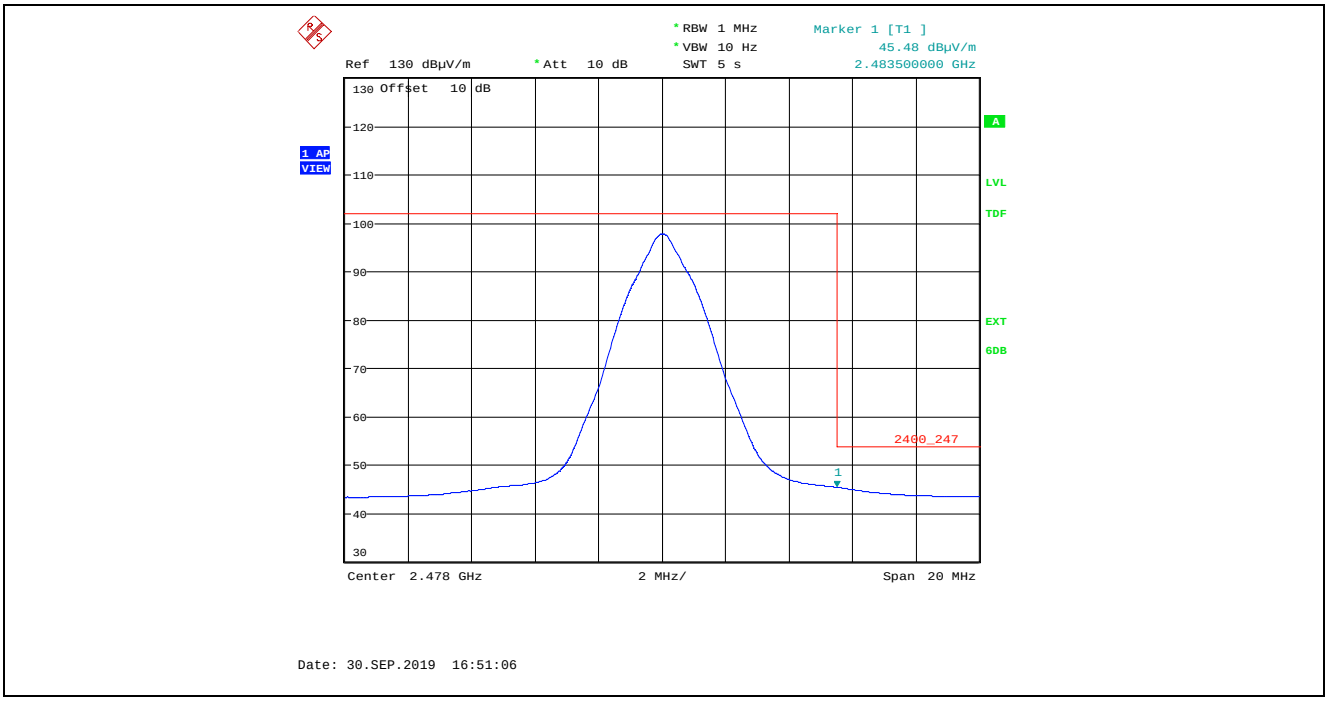

**Plot 5.2.4.2.28.** Band-Edge Radiated Emissions, Higher Band-edge, Average Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 37, 2476 MHz



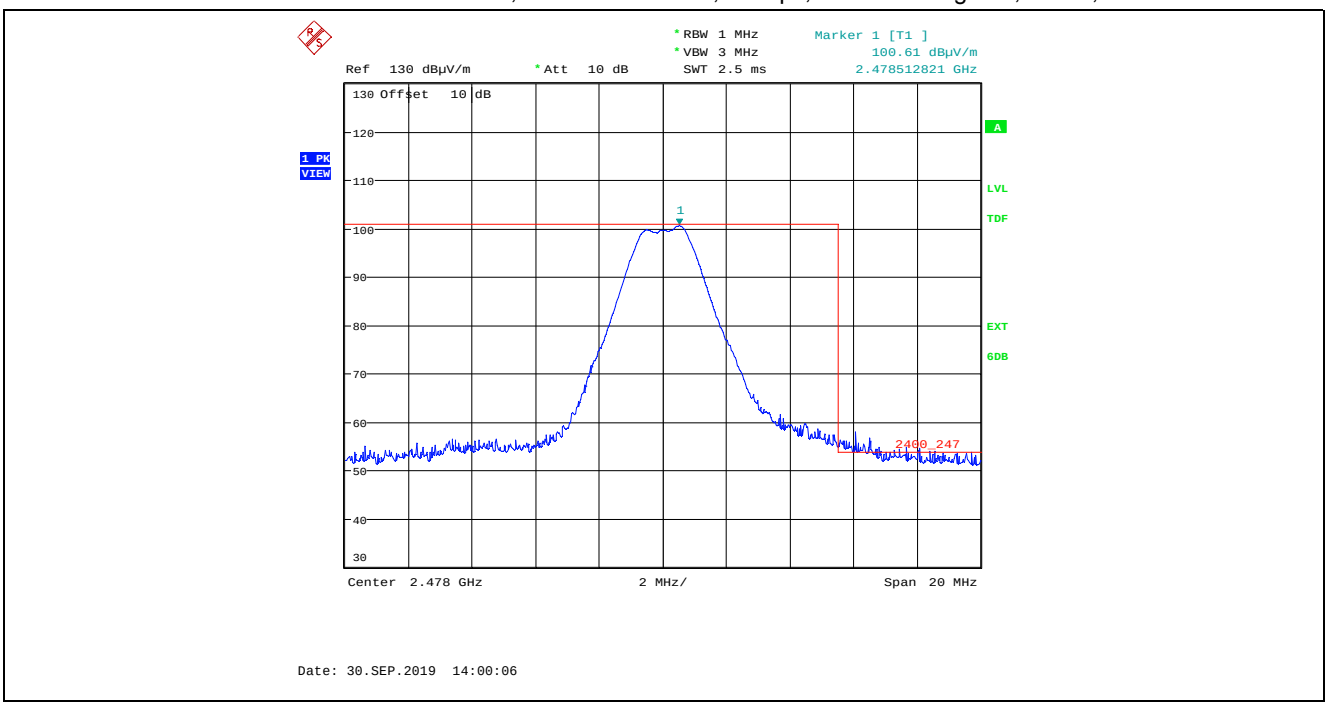
**Plot 5.2.4.2.29.** Band-Edge Radiated Emissions, Higher Band-edge, Peak Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 38, 2478 MHz



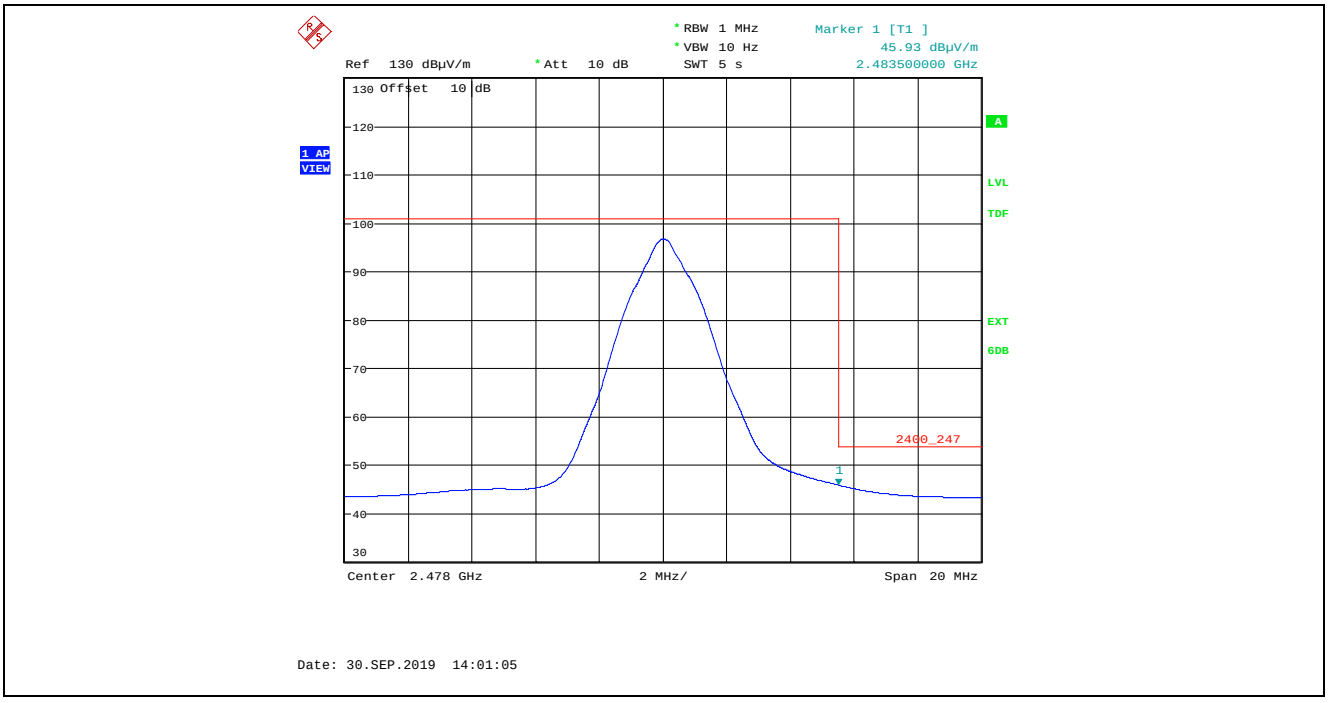

**Plot 5.2.4.2.30.** Band-Edge Radiated Emissions, Higher Band-edge, Average Detector
Rx Antenna in Vertical Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 38, 2478 MHz



**Plot 5.2.4.2.31.** Band-Edge Radiated Emissions, Higher Band-edge, Peak Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 38, 2478 MHz




**Plot 5.2.4.2.32.** Band-Edge Radiated Emissions, Higher Band-edge, Average Detector
Rx Antenna in Horizontal Polarization, GFSK Modulation, 2 Mbps, Power Setting 200, Ch 38, 2478 MHz



## 5.3. EXPOSURE OF HUMANS TO RF FIELD [RSS-Gen, SECTION 3.4 & RSS-102]

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 RSS-102

**Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)**

| Frequency Range (MHz) | Electric Field (V/m rms) | Magnetic Field (A/m rms) | Power Density ($W/m^2$) | Reference Period (minutes) |
|---|---|---|---|---|
| 0.003-10[21] | 83 | 90 | - | Instantaneous* |
| 0.1-10 | - | $0.73/f$ | - | 6** |
| 1.1-10 | $87/f^{0.5}$ | - | - | 6** |
| 10-20 | 27.46 | 0.0728 | 2 | 6 |
| 20-48 | $58.07/f^{0.25}$ | $0.1540/f^{0.25}$ | $8.944/f^{0.5}$ | 6 |
| 48-300 | 22.06 | 0.05852 | 1.291 | 6 |
| 300-6000 | $3.142 f^{0.3417}$ | $0.008335 f^{0.3417}$ | $0.02619 f^{0.6834}$ | 6 |
| 6000-15000 | 61.4 | 0.163 | 10 | 6 |
| 15000-150000 | 61.4 | 0.163 | 10 | $616000/f^{1.2}$ |
| 150000-300000 | $0.158 f^{0.5}$ | $4.21 \times 10^{-4} f^{0.5}$ | $6.67 \times 10^{-5} f$ | $616000/f^{1.2}$ |

**Note:** $f$ is frequency in MHz.
*Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

### 5.3.1. 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

### 5.3.2. RF Evaluation

| Frequency (MHz) | EIRP (dBm) | EIRP (W) | Evaluation Distance, r (m) | Power Density, S ($W/m^2$) | MPE Limit ($W/m^2$) | Margin ($W/m^2$) |
|---|---|---|---|---|---|---|
| 2402 | 23.60 | 0.229 | 0.2 | 0.456 | 5.351 | -4.895 |

## EXHIBIT 6. TEST EQUIPMENT LIST

| Test Instruments | Manufacturer | Model No. | Serial No. | Frequency Range | Cal. Due Date |
|---|---|---|---|---|---|
| Spectrum Analyzer | Rohde & Schwarz | FSU26 | 200946 | 20Hz–26.5 GHz | Jul 25, 2020 |
| Attenuator | Hewlett Packard | 8493C | 0465 | DC–26.5 GHz | See Note 1 |
| DC Block | Hewlett Packard | 11742A | 12460 | 0.045 – 26.5 GHz | See Note 1 |
| DC Power Supply | HQ Power | PS613U | NSN | 0-30VDC | See Note 1 |
| Multi-meter | Fluke | 8842A | 5021295 | 20mV - 1kV | Oct 23, 2019 |
| EMI Receiver | Rohde & Schwarz | ESU40 | 100037 | 20Hz–40 GHz | Mar 15, 2020 |
| RF Amplifier | Com-Power | PAM-0118A | 551052 | 0.5 – 18 GHz | Jul 26, 2019 |
| RF Amplifier | Hewlett Packard | 84498 | 3008A00769 | 1 – 26.5 GHz | May 15, 2020 |
| Biconilog Antenna | EMCO | 3142B | 1575 | 26-2000 MHz | May 10, 2020 |
| Horn Antenna | EMCO | 3155 | 6570 | 1 – 18 GHz | Oct 11, 2020 |
| Horn Antenna | ETS-Lindgren | 3160-09 | 001183858 | 18 – 26.5 GHz | Oct 27, 2020 |
| High Pass Filter | K & L | 11SH10-4000/T12000 | 4 | Cut off 2.4 GHz | See Note 1 |
| Band Reject Filter | Micro-Tronics | BRM50701 | 105 | Cut off 2.4-2.483 GHz | See Note 1 |
| Note 1: Internal Verification/Calibration check | | | | | |

## 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. 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** |