# FCC Test Report

FOR:

## Whistle Labs Inc.

Model Name:

Whistle 3

Product Description:

Pet GPS tracker and activity monitor.

FCC ID: S8W-W03A
IC ID: 10959A-W03A

Per:

47 CFR Part 15.247 (DTS)
RSS-247 Issue 1 & RSS-Gen Issue 4

**REPORT #:** EMC-WHIST-003-16001-15-247-BTLE-Rev1

**DATE:** Dec. 22, 2016

**A2LA Accredited**

**IC recognized # 3462B-1**


***CETECOM* Inc.**
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*CETECOM* Inc. is a Delaware Corporation with Corporation number: 2905571

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## 1 Assessment

The following device was evaluated against the applicable criteria specified in FCC rules Parts 15.247 of Title 47 and IC standard RSS-247 Issue 1, Section 5 of the Code of Federal Regulations.

No deviations were ascertained.

| Company | Description | Model # |
|---|---|---|
| Whistle LLC. | A device to track pet location and monitor pet activities. | Whistle 3 |

**Responsible for Testing Laboratory:**

| Date | Section | Name | Signature |
|---|---|---|---|
| Dec 22, 2016 | Compliance | Franz Engert (Compliance Services Manager ) | Digitally signed by Franz Engert DN: cn=Franz Engert, c=US, o=CETECOM, ou=Complience, email=franz.engert@cetecom.com |

**Responsible for the Report:**

| Date | Section | Name | Signature |
|---|---|---|---|
| Dec 22, 2016 | Compliance | James Donnellan (Sr. EMC Engineer) | James Donnellan Digitally signed by James Donnellan DN: cn=James Donnellan, c=US, o=Cetecom Inc., ou=Compliance, email=james.donnellan@cetecom.com Date: 2016.12.22 18:21:03 -08'00' |

# 2 Administrative Data

## 2.1 Identification of the Testing Laboratory Issuing the EMC Test Report

| | |
|---|---|
| **Company Name:** | CETECOM Inc. |
| **Department:** | Compliance |
| **Address:** | 411 Dixon Landing Road<br>Milpitas, CA 95035<br>U.S.A. |
| **Telephone:** | +1 (408) 586 6200 |
| **Fax:** | +1 (408) 586 6299 |
| **Test Engineer** | James Donnellan |
| **Project Manager** | Ruther Navarro |

## 2.2 Identification of the Client

| | |
|---|---|
| **Applicant's Name:** | Whistle Labs INC |
| **Street Address:** | 1355 Market St. #210. |
| **City/Zip Code** | San Francisco, CA, 94103 |
| **Country** | USA |

## 2.3 Identification of the Manufacturer

| | |
|---|---|
| **Manufacturer's Name:** | Whistle Labs INC |
| **Manufacturers Address:** | 1355 Market St. #210. |
| **City/Zip Code** | San Francisco, CA, 94103 |
| **Country** | USA |

# 3 Equipment Under Test (EUT)

## 3.1 EUT Specifications

| | |
|---|---|
| **Model No:** | Whistle 3 |
| **HW Version :** | EVT 2 |
| **SW Version :** | 0.0.1-C150591-S |
| **FCC-ID :** | S8W-W03A |
| **IC-ID:** | 10959A-W03A |
| **HVIN:** | Pet GPS tracker and activity monitor. |
| **PMN:** | Whistle 3 |
| **Product Description:** | A device to track pet location and monitor pet activities. |
| **Frequency Range / number of channels:** | Nominal band: 2400 – 2483.5;<br>Center to center: 2402(ch 0) – 2480(ch 39), 40 channels |
| **Type(s) of Modulation:** | Bluetooth version 4.0, Low Energy, using Dynamic Sequence Spread Spectrum with GFSK modulation. |
| **Modes of Operation:** | GFSK |
| **Integrated Module Info:** | Texas Instruments. TI CC2640 |
| **Antenna Information as declared:** | FPC Antenna.<br>Gain 2.4 GHz 1dB |
| **Max. Output Power:** | Conducted Power -0.96 dBm (Peak) |
| **Power Supply/ Rated Operating Voltage Range:** | Dedicated Battery Pack (Li-ion)<br>Vmin: 3.3VDC/ Vnom: 3.8VDC / Vmax: 4.4VDC<br>(5V Charging Voltage) |
| **Operating Temperature Range** | -20 ºC to 60 ºC |
| **Other Radios included in the device:** | Cellular.<br>Wifi.<br>GPS. |
| **Sample Revision** | ☐Prototype Unit; ☐Production Unit; ■Pre-Production |

### 3.2 EUT Sample details

| EUT # | Serial Number | HW Version | SW Version | Notes/Comments |
|---|---|---|---|---|
| 1 | W03-000146 | EVT 2 | 0.0.1-C150591-S | Radiated Emissions Measurements |
| 2 | W03-00010F | EVT 2 | 0.0.1-C150591-S | Conducted Measurements |

### 3.3 Accessory Equipment (AE) details

| AE # | Type | Model | Manufacturer | Serial Number |
|---|---|---|---|---|
| 1 | A charging dock with a USB cable Connector | N/A | Whistle Labs Inc. | N/A |

### 3.4 Ancillary Test Equipment (ATE) details

| ATE # | Type | Model | Manufacturer | Serial Number | Notes |
|---|---|---|---|---|---|
| 1 | Laptop | Latitude | DELL | BW21LQ | Used to Set channel. |
| 2 | AC Charger | PE98ED | Amazon | PA-1050-07AZ | 5W USB Charger |

### 3.5 Test Sample Configuration

| EUT Set-up # | Combination of AE used for test set up | Comments |
|---|---|---|
| 1 | EUT1 + AE1 + ATE 2 | The radio of the EUT was stimulated directly in a test mode not accessible by the end user via USB connection with the ATE1 laptop utilizing a GUI. After which The ATE1 was removed and the EUT transmitted a modulated BT LE signal on a specified channel. To maintain battery power the AE1 and ATE2 was used as needed. |
| 2 | EUT1 + ATE1 | The radio of the EUT was stimulated directly in a test mode not accessible by the end user via USB connection with the ATE1 laptop utilizing a GUI. The EUT transmitted a modulated BT LE signal on a specified channel. The BT LE radio transmission was verified with a spectrum analyzer during the course of testing. |

## 4 Subject of Investigation

The objective of the measurements done by CETECOM Inc. was to assess the performance of the EUT per the relevant requirements specified in FCC rules Part 15.247 of Title 47 of the Code of Federal Regulations.

This test report is to support a request for new equipment authorization under the
**FCC ID: S8W-W03A** and **IC ID: 10959A-W03A.**

Testing procedures are based on "GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER §15.247; April 8, 2016" by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division and ANSI C63.10 (2013).

## 5 Measurement Results Summary

| Test Specification | Test Case | Temperature and Voltage Conditions | Mode | Pass | Fail | NA | NP | Result |
|---|---|---|---|---|---|---|---|---|
| **§15.247(e) RSS-247 5.2(1)** | Power Spectral Density | Nominal | Bluetooth LE | ■ | ☐ | ☐ | ☐ | Complies |
| **§15.247(a)(1) RSS-247 5.2(2)** | Emission Bandwidth | Nominal | Bluetooth LE | ■ | ☐ | ☐ | ☐ | Complies |
| **§15.247(b)(1) RSS-247 5.4(4)** | Maximum Conducted Output Power and EIRP | Nominal | Bluetooth LE | ■ | ☐ | ☐ | ☐ | Complies |
| **§15.247/15.209/15.205 RSS-Gen 8.9/ 8.10** | Band edge compliance-Restricted Band Edges | Nominal | Bluetooth LE | ■ | ☐ | ☐ | ☐ | Complies |
| **§15.247(d) RSS-247 5.5** | Band edge compliance-Unrestricted Band Edges | Nominal | Bluetooth LE | ■ | ☐ | ☐ | ☐ | Complies |
| **§15.247(d) §15.209 RSS-Gen 6.13** | TX Spurious emissions-Radiated | Nominal | Bluetooth LE | ■ | ☐ | ☐ | ☐ | Complies |
| **§15.207(a) RSS Gen 8.8** | AC Conducted Emissions | Nominal | Bluetooth LE | ■ | ☐ | ☐ | ☐ | Complies |

**Note**: NA= Not Applicable; NP= Not Performed.

# 6 Measurements

## 6.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus, with 95% confidence interval (in dB delta to result), based on a coverage factor k=1.

Radiated measurement:

| | Uncertainty in dB Radiated <30MHz | Uncertainty in dB Radiated 30MHz - 1GHz | Uncertainty in dB Radiated > 1GHz |
|---|---|---|---|
| **Standard Deviation k=1** | **2.48** | **1.94** | **2.16** |
| **95% Confidence Interval in dB** | **4.86** | **3.79** | **4.24** |
| **95% Confidence Interval in dB in Delta to Result** | **+/-2.5 dB** | **+/-2.0 dB** | **+/- 2.3dB** |

Conducted measurement:
150 kHz to 30 MHz ±0.7 dB (LISN)
RF conducted measurement ±0.5 dB

According to TR 102 273 a multiplicative propagation of error is assumed for RF measurement systems. For this reason the RMS method is applied to dB values and not to linear values as appropriate for additive propagation of error. Also used: http://physics.nist.gov/cuu/Uncertainty/typeb.html. The above calculated uncertainties apply to direct application of the Substitution method. The Substitution method is always used when the EUT comes closer than 3dB to the limit.

## 6.2 Environmental Conditions During Testing:

The following environmental conditions were maintained during the course of testing:

- Ambient Temperature: 20-25°C
- Relative humidity: 40-60%

Deviating test conditions are indicated at individual test description where applicable.

## 6.3 Dates of Testing:

2016-09-15 to 2016-10-21

## 6.4 Additional Test Information

Testing is performed according to the guidelines provided in FCC publication (KDB) FCC KDB 558074 D01 V03R05, *GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER §15.247* and according to relevant parts of ANSI 63.10 (2013) as detailed below.

# 7 Measurement Procedures

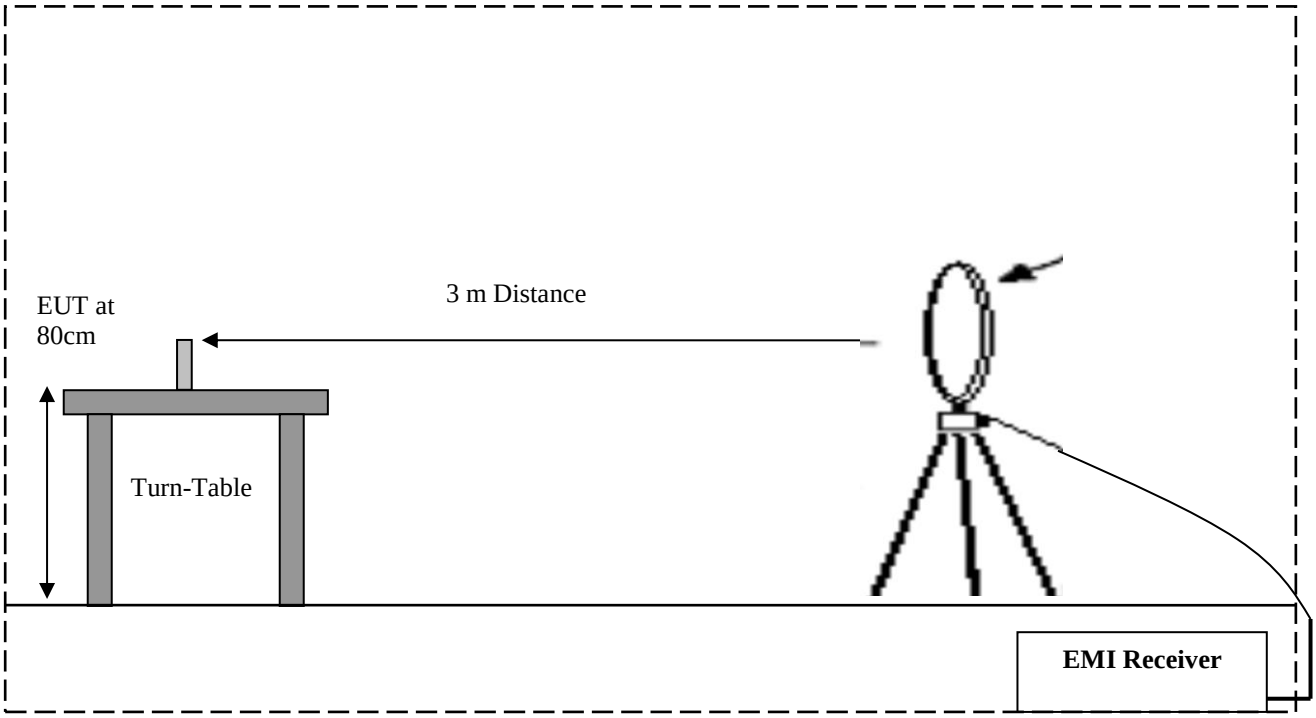
## 7.1 Radiated Measurement

The radiated measurement is performed according to:

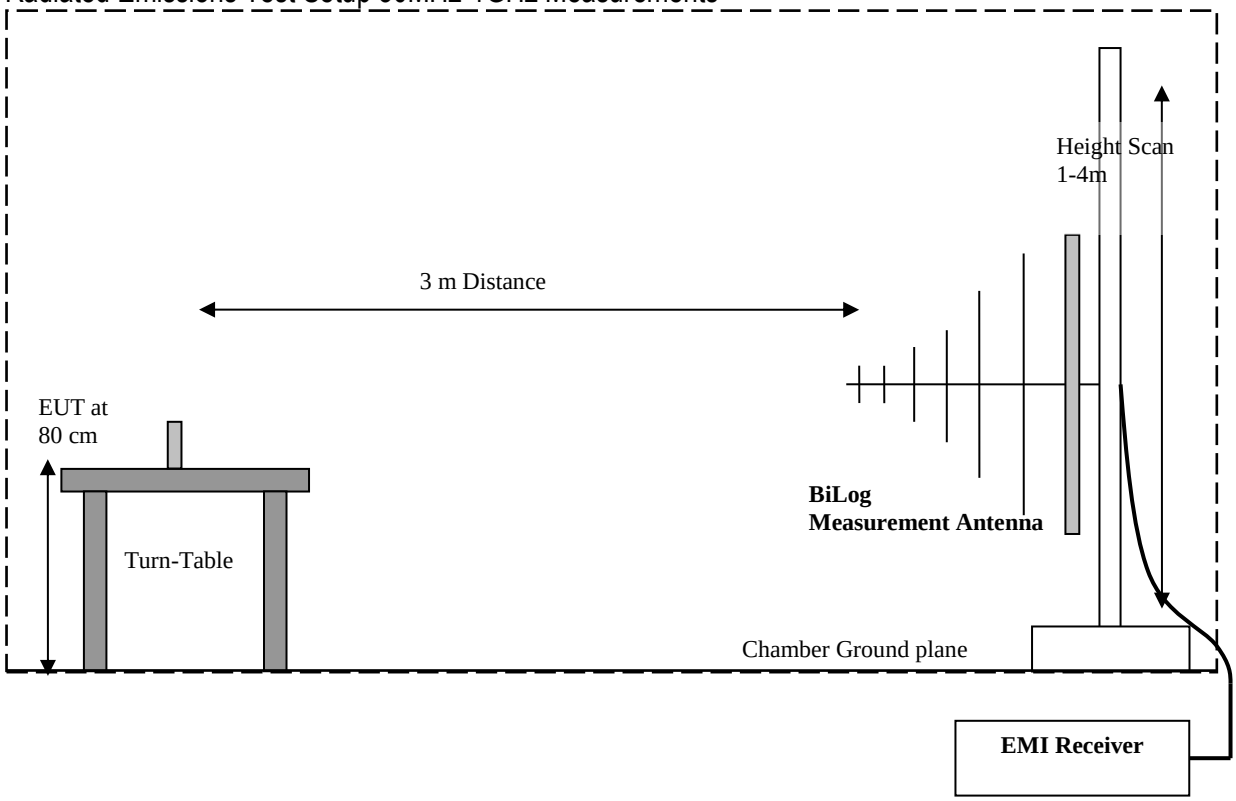
ANSI C63.10 (2013)

- The exploratory measurement is accomplished by running a matrix of 16 sweeps over the required frequency range with R&S Test-SW EMC32 for 4 positions of the turntable, two orthogonal positions of the EUT and both antenna polarizations. This procedure exceeds the requirement of the above standards to cover the 3 orthogonal axis of the EUT. A max peak detector is utilized during the exploratory measurement. The Test-SW creates an overall maximum trace for all 12 sweeps and saves the settings for each point of this trace. The maximum trace is part of the test report.
- The 10 highest emissions are selected with an automatic algorithm of EMC32 searching for peaks in the noise floor and ensuring that broadband signals are not selected multiple times.
- The maxima are then put through the final measurement and again maximized in a 90deg range of the turntable, fine search in frequency domain and height scan between 1m and 4m.
- The above procedure is repeated for all possible ways of power supply to EUT and for all supported modulations.
- In case there are no emissions above noise floor level only the maximum trace is reported as described above.
- The results are split up into up to 4 frequency ranges due to antenna bandwidth restrictions. A magnetic loop is used from 9 kHz to 30 MHz, a Biconilog antenna is used from 30 MHz to 1 GHz, and two different horn antennas are used to cover frequencies up to 40 GHz.

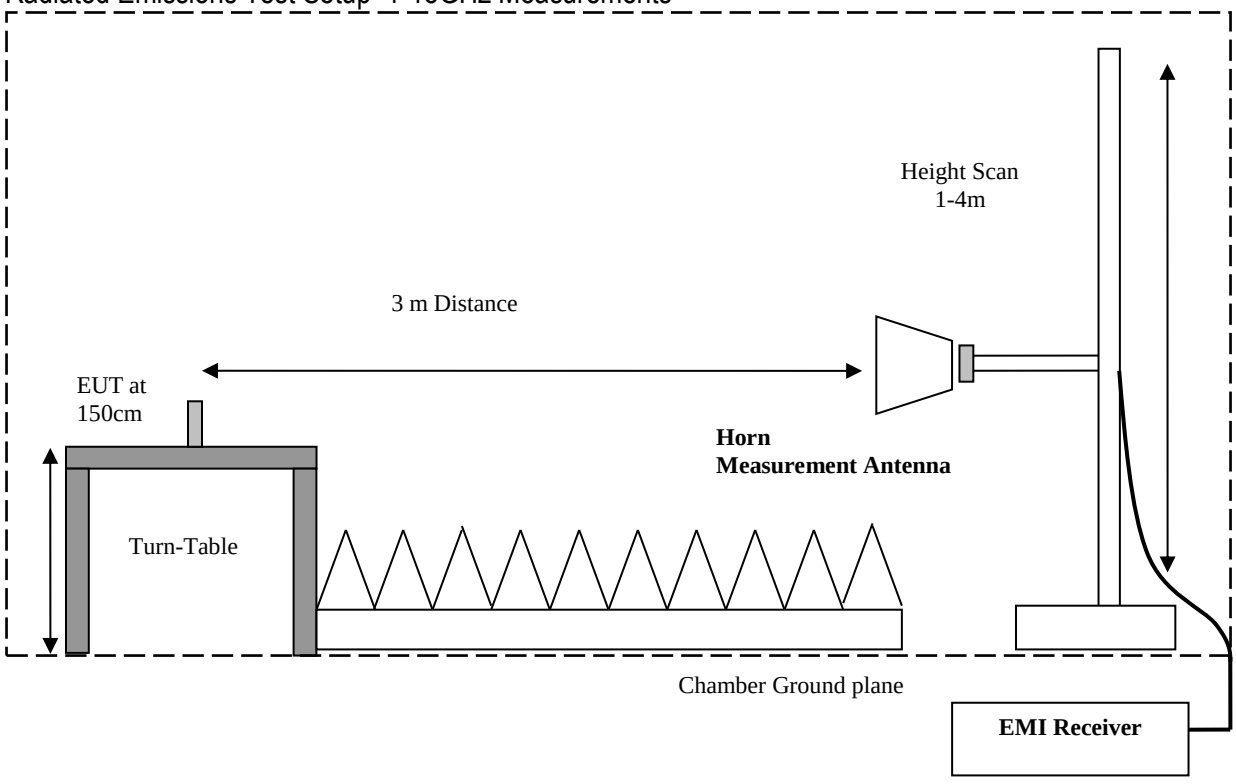
Radiated Emissions Test Setup below 30MHz Measurements



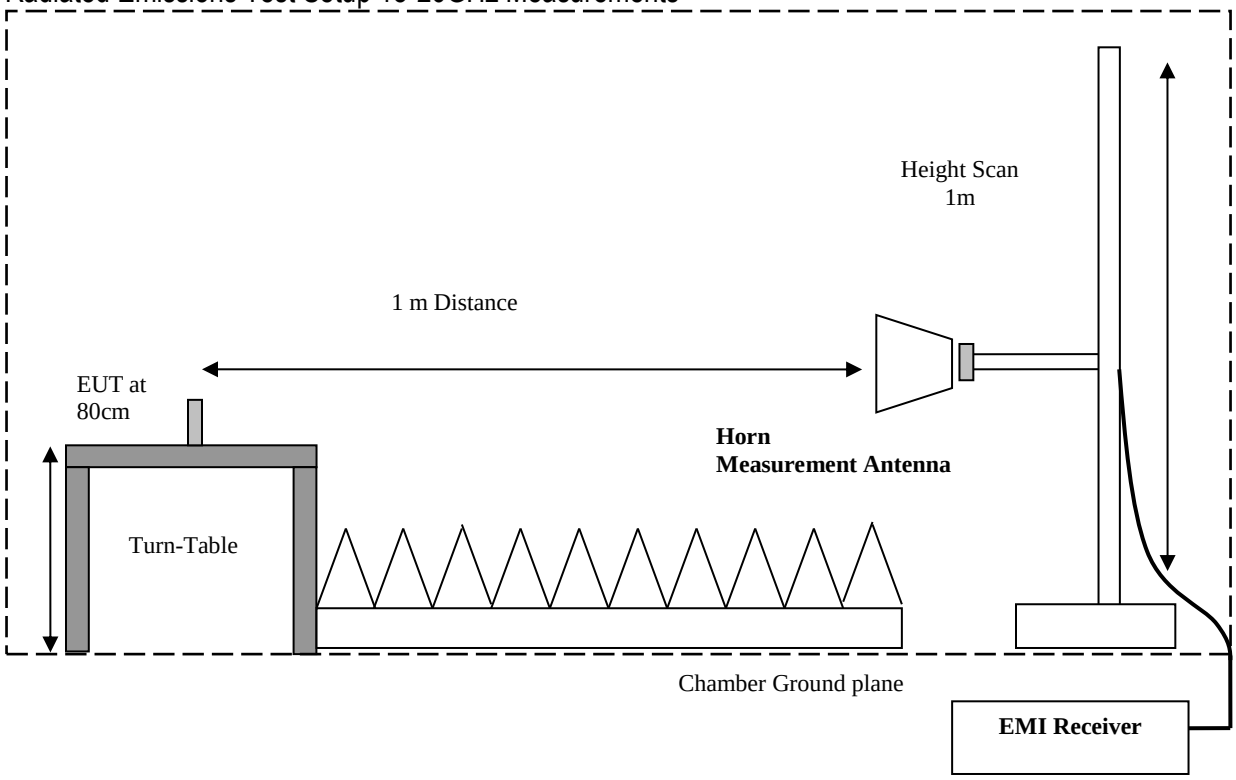
Radiated Emissions Test Setup 30MHz-1GHz Measurements




Radiated Emissions Test Setup 1-18GHz Measurements



Radiated Emissions Test Setup 18-26GHz Measurements



### 7.1.1 Sample Calculations for Field Strength Measurements

Field Strength is calculated from the Spectrum Analyzer/ Receiver readings, taking into account the following parameters:

1. Measured reading in dBµV
2. Cable Loss between the receiving antenna and SA in dB and
3. Antenna Factor in dB/m

All radiated measurement plots in this report are taken from a test SW that calculates the Field Strength based on the following equation:

FS (dBµV/m) = Measured Value on SA (dBµV)- Cable Loss (dB)+ Antenna Factor (dB/m)

Example:

| Frequency (MHz) | Measured SA (dBµV) | Cable Loss (dB) | Antenna Factor Correction (dB) | Field Strength Result (dBµV/m) |
|---|---|---|---|---|
| 1000 | 80.5 | 3.5 | 14 | 98.0 |

## 7.2 Power Line Conducted Measurement Procedure

AC Power Line conducted emissions measurements performed according to:

ANSI C63.10 (2013)

# 8 Test Result Data

## 8.1 Maximum Conducted Peak Output Power

### 8.1.1 Measurement settings

Conducted measurements were taken according to ANSI C63.10 Section 11.9.1.1 using equipment number 19 in section 9.

### 8.1.2 Limits:

**Maximum Conducted Output Power:**
FCC §15.247 (b)(3): 1W
IC RSS-247 issue 1, Section 5.4(4): 1W (30dBm)

**EIRP:**
IC RSS-247 issue 1, annex 8.4(2): 4W (36 dBm)

### 8.1.3 Test conditions and setup:

Equipment number 18 in section 9 of this report was used for this test case.

| Ambient Temperature | EUT Set-Up # | EUT operating mode | Antenna Gain |
|---|---|---|---|
| 22.3° C | 1 | GFSK continuous fixed channel | 1.0 |

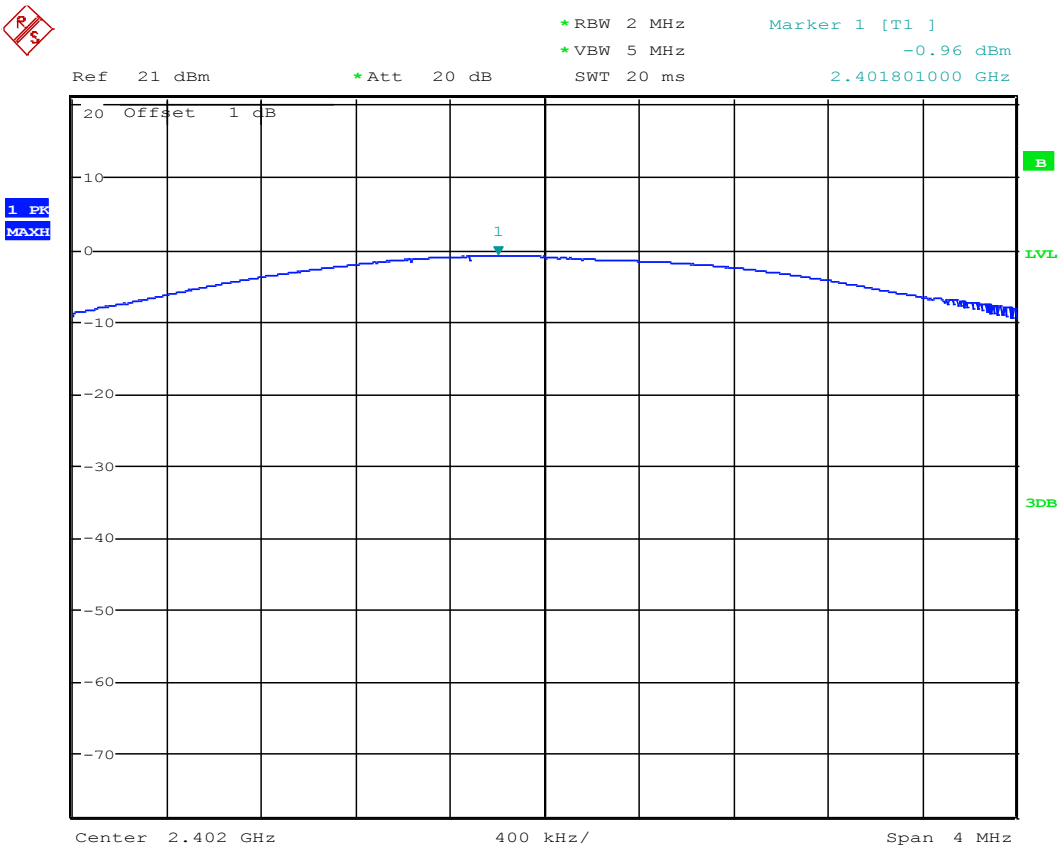
Cable Loss = 0.8 dB

### 8.1.4 Measurement result:

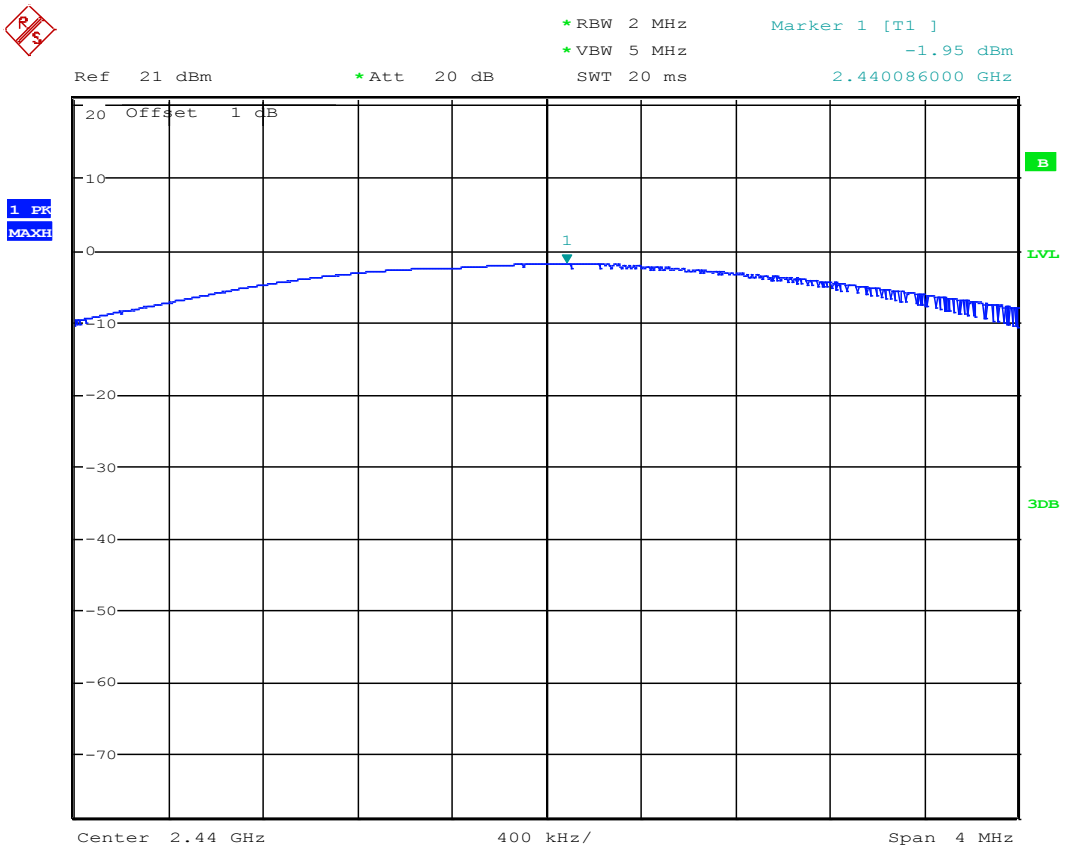
| Frequency (MHz) | Conducted Peak Output Power (dBm) | Limit (dBm) | Antenna Gain (dBi) | EIRP (dBm) | Limit (dBm) | Result |
|---|---|---|---|---|---|---|
| 2402 | -0.96 | 30 | 1.0 | 0.04 | 36 | Pass |
| 2440 | -1.95 | 30 | 1.0 | -0.95 | 36 | Pass |
| 2480 | -3.48 | 30 | 1.0 | -2.48 | 36 | Pass |

### 8.1.5 Measurement Plots:

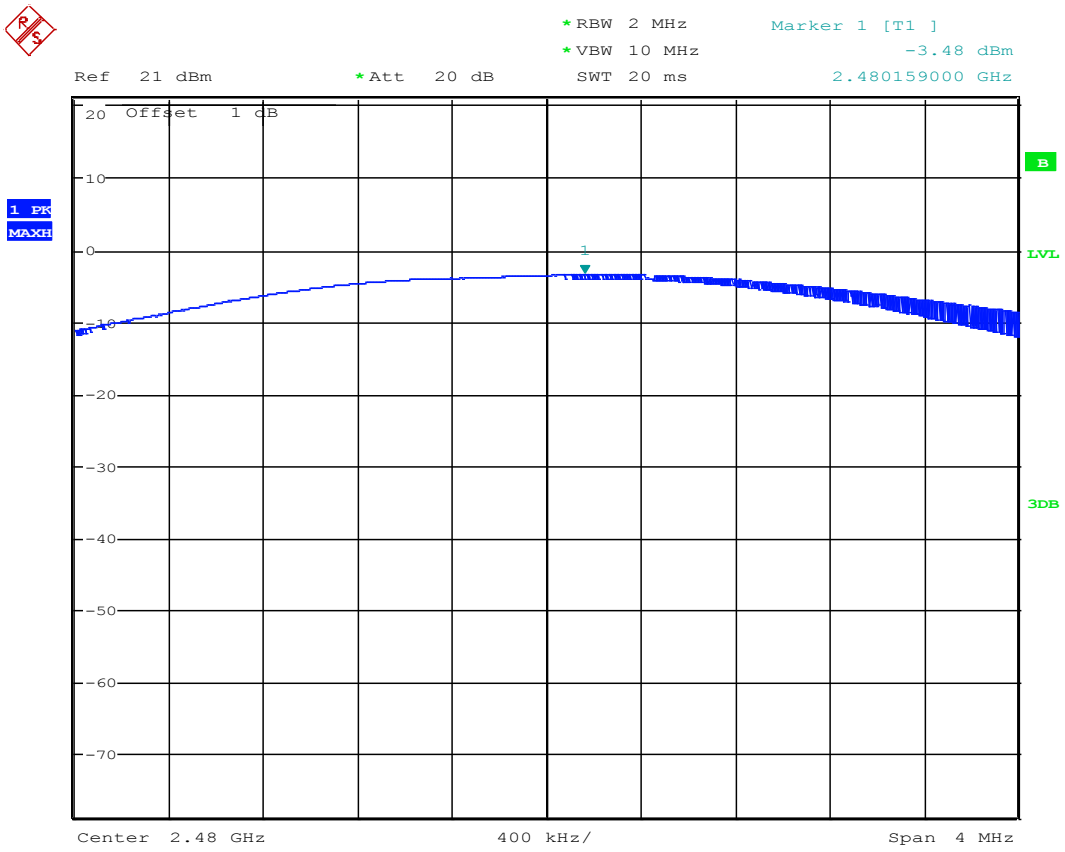
#### 8.1.5.1 Channel 0 (2402 MHz)



### 8.1.5.2 Channel 19 (2440 MHz)



### 8.1.5.3 Channel 39 (2480 MHz)



## 8.2 Power Spectral Density

### 8.2.1 Limits:

§ 15.247 (e) & RSS-247 Section 5.2 (2)

For digitally modulated systems, the peak power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

### 8.2.2 Test Conditions:

| Ambient Temperature | EUT Set-Up # | EUT operating mode | Power Input |
|---|---|---|---|
| 23° C | 1 | Tx | 3.7 VDC |

Cable Loss= 0.8 dB

### 8.2.3 Measurement procedure:

Conducted measurements were taken according to ANSI C63.10-2013 Section 11.10.2, using a spectrum analyzer. (Equipment number 18 in section 9)

### 8.2.4 Test Data:

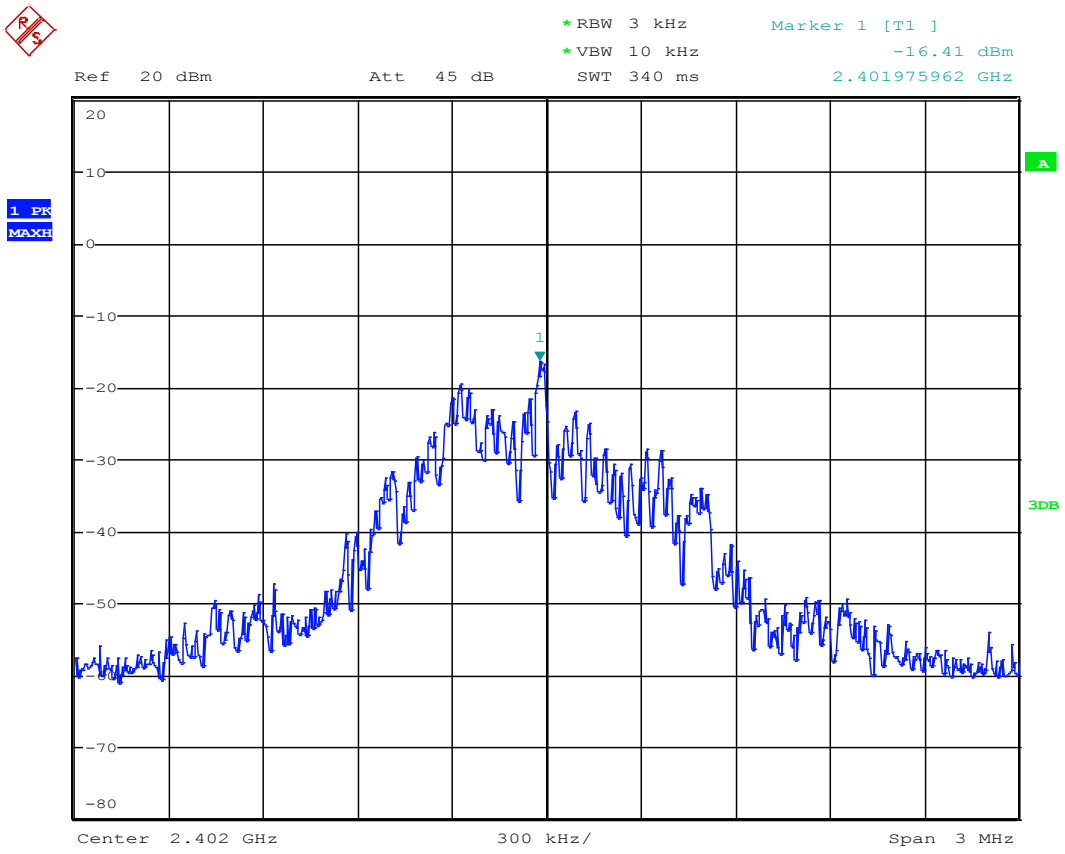
| Power Spectral Density (dBm) | | | |
|---|---|---|---|
| Limit = 8 dBm | Frequency (MHz) | | |
| Mode | 2402 Channel 0 | 2440 Channel 19 | 2480 Channel 39 |
| BT LE | -16.41 | -17.7 | -18.84 |

### 8.2.5 Measurement Result

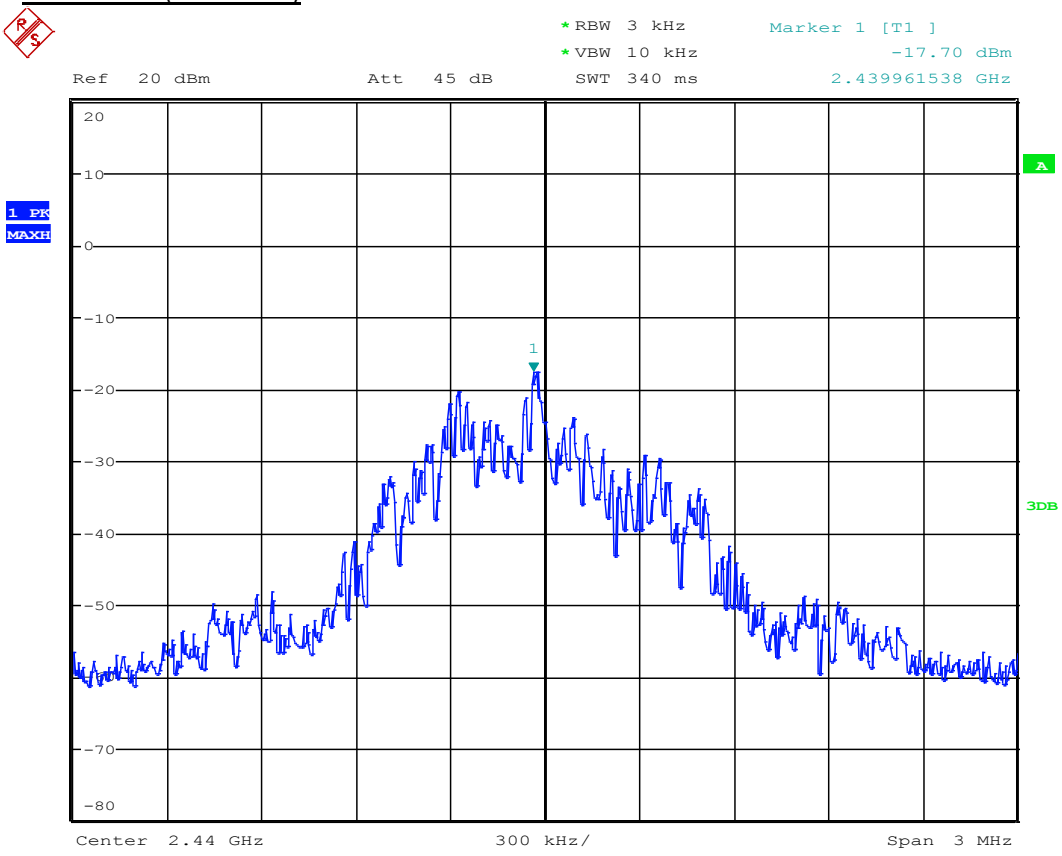
Pass.

### 8.2.6 Measurement Plots:

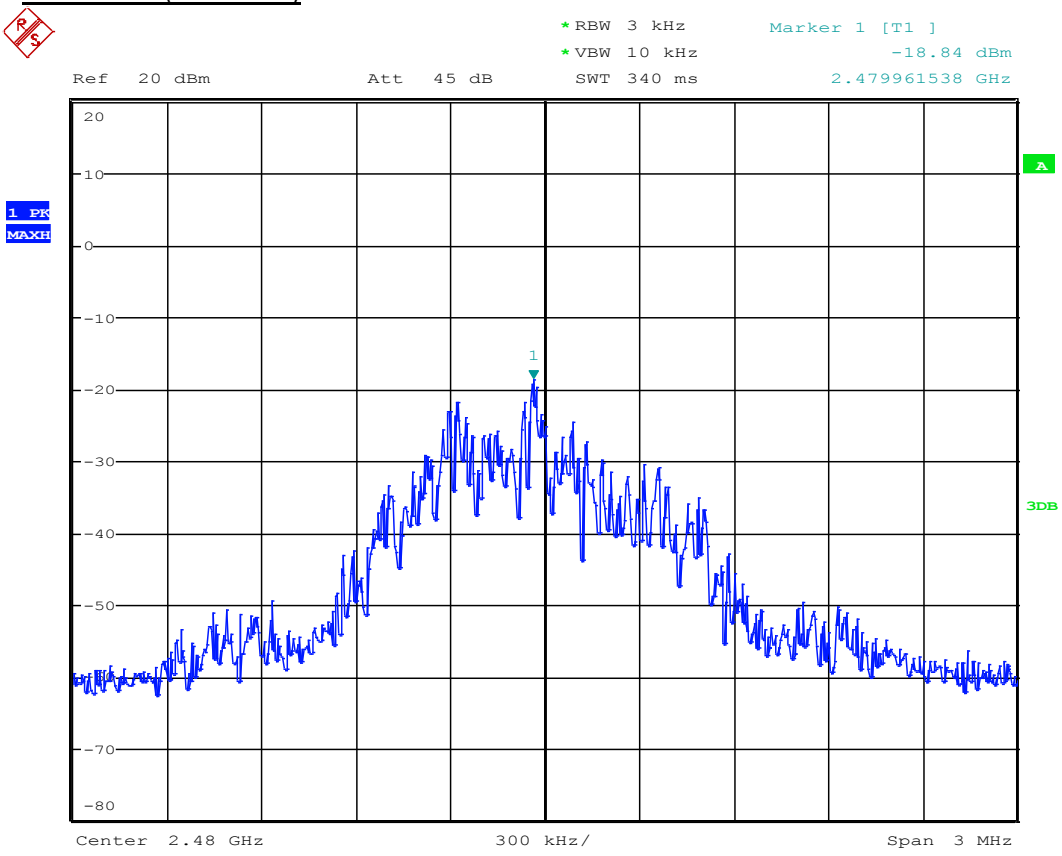
#### 8.2.6.1 Channel 0 (2402 MHz)



### 8.2.6.2 Channel 19 (2440 MHz)



### 8.2.6.3 Channel 39 (2480 MHz)



## 8.3 Compliance at Restricted and Non-Restricted Bandedges

### 8.3.1 Limits:

**§15.247/15.209/15.205 & RSS-Gen 8.9/ 8.10**

(a) Only spurious emissions are permitted in any of the frequency bands listed below:

| 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 | 2690 - 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 | | | |

(b) Except as provided in paragraphs (d) and (e) of this section, the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in § 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in § 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in § 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in § 15.35 apply to these measurements.

*PEAK LIMIT= 74dBµV/m

*AVG. LIMIT= 54dBµV/m

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

### 8.3.2 Measurement Procedure:

Conducted measurements were taken according to ANSI C63.10-2013 Section 11.11.1 for non restricted frequency bands and ANSI C63.10-2013 Section 11.12.2 for restricted frequency bands, using a spectrum analyzer (Equipment number 18 in section 9).

Since restricted band edge tests have been performed by the conducted method the measurements shown in the plots are adjusted by the duty cycle correction factor (RMS measurements only), Cable loss, External Attenuation and the declared maximum antenna gain for the comparison with the dBm value of the restricted band limits for 3m distance (peak = 74dBµV/m relates to -21.2 dBm; average = 54dBµV/m relates to -41.2 dBm).

**Correction Factors (applied to measurement as offset):**
Antenna Gain- 0.9 dBi
Cable Loss- 0.8 dB
Duty Cycle Correction Factor (Section 8.3.5.1) – 1.8 dB

### 8.3.3 Measurement Result

Pass.

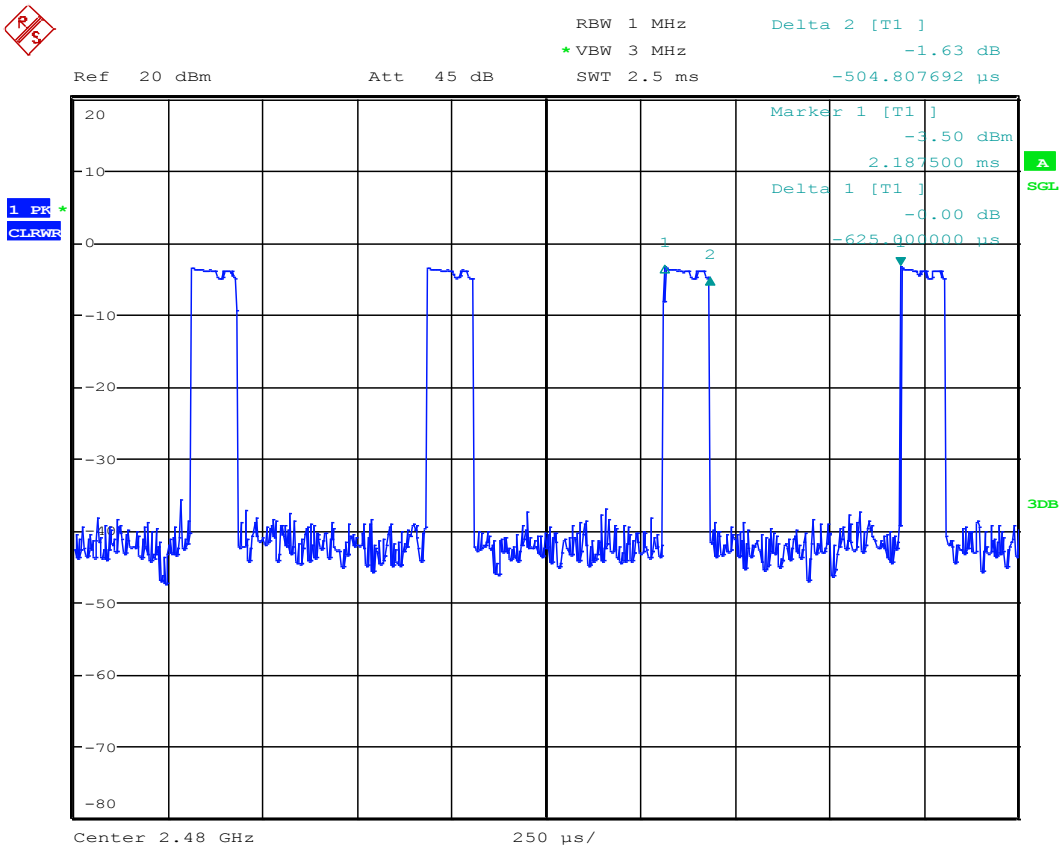
### 8.3.4 Test Data:

| Mode: BT LE | Modulation: GFSK | Test Channel: 39 | | |
|---|---|---|---|---|
| Lower Restricted Band / Frequency Range: 2483.5 MHz – 2500 MHz | | | | |
| Measured Frequency Range (MHz) | Measured Emission Level (dBm) | Limit Peak/Average (dBm) | Margin (dB) | Result |
| 2310-2390 | -35.25 (Peak) | -21.2 (Peak) | 14 | Pass |
| 2310-2390 | -73.93 (RMS) | -41.2 (RMS) | 32.73 | Pass |

| Mode: BT LE | Modulation: GFSK | Test Channel: 39 | | |
|---|---|---|---|---|
| Upper Restricted Band / Frequency Range: 2483.5 MHz – 2500 MHz | | | | |
| Measured Frequency Range (MHz) | Measured Emission Level (dBm) | Limit Peak/Average (dBm) | Margin (dB) | Result |
| 2483.5-2500 | -25.63 (Peak) | -21.2 (Peak) | 4.43 | Pass |
| 2483.5-2500 | -68.53 (RMS) | -41.2 (RMS) | 27.33 | Pass |

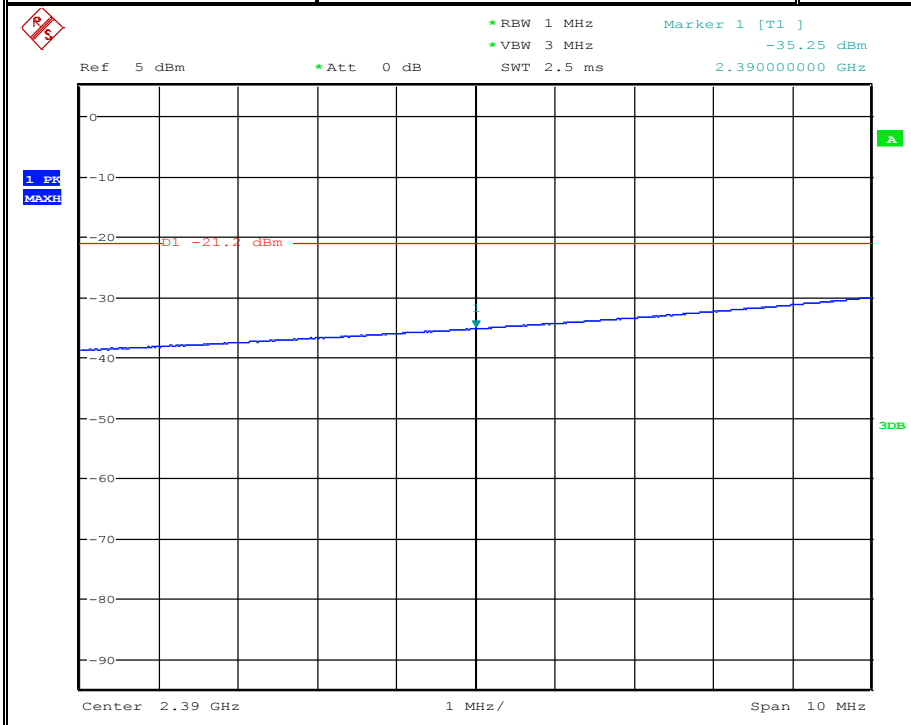
### 8.3.5 Band Edge Measurement Plots:

8.3.5.1 BT LE Continuous Transmit Mode Measured Duty cycle



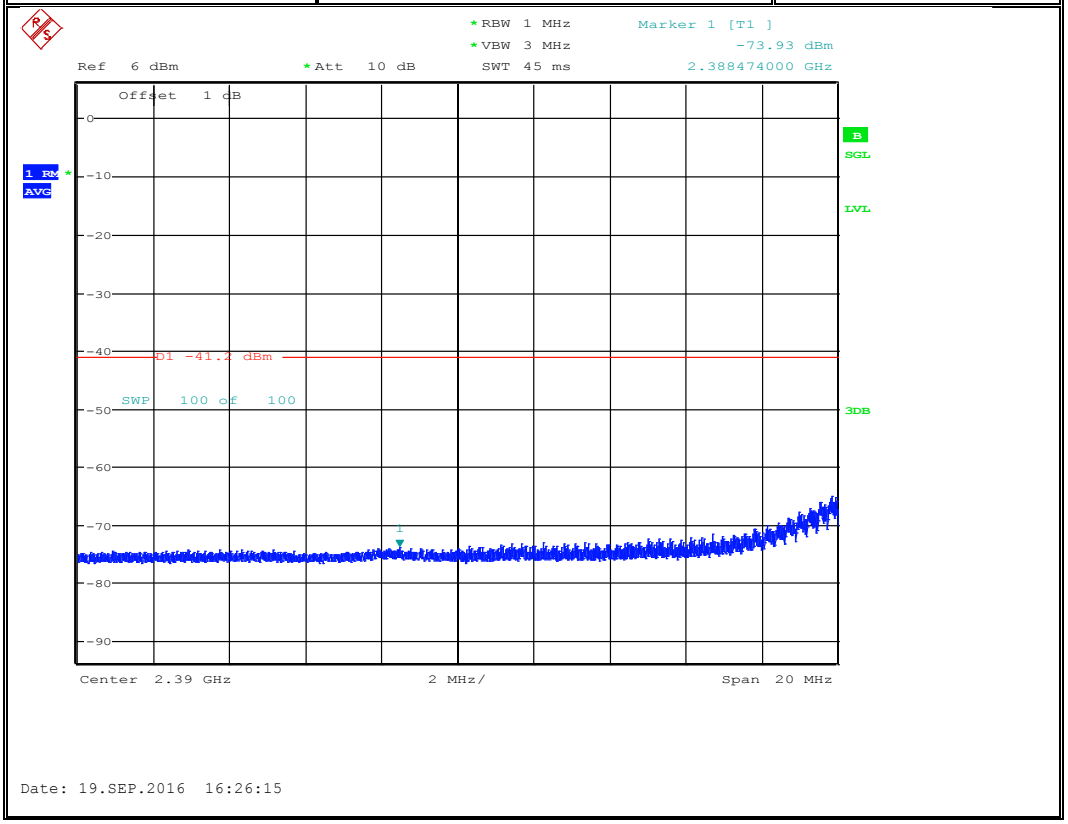

Duty Cycle= 625-504/625.0=0.193= 19.4%
Duty Cycle Correction Factor = 10*log(1/0.19) = 7.1 dB

| Lower Restricted Band Edge (2.4GHz) Emission Peak Detector | | |
|---|---|---|
| **Ch. 0 / 2402 MHz** | **Mode: BT LE** | **Modulation: GFSK** |

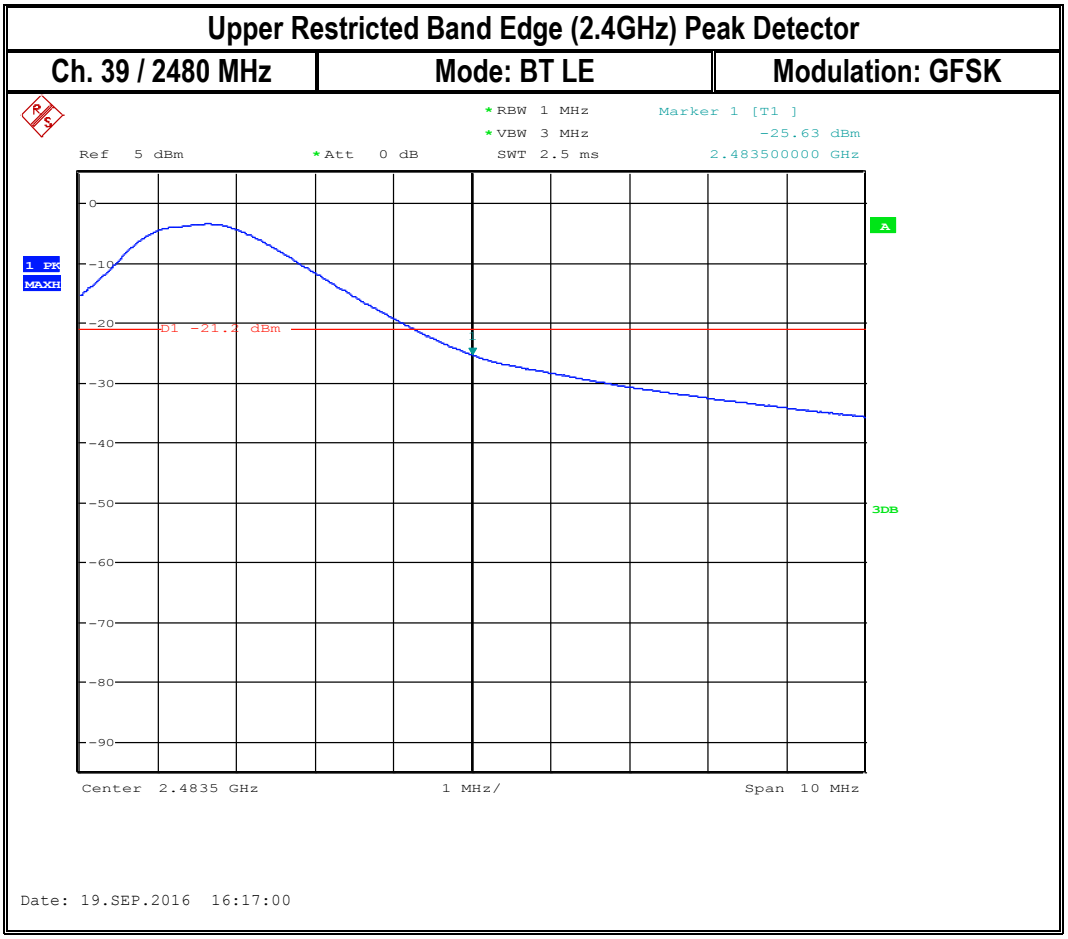


## Lower Restricted Band Edge (2.4GHz) RMS Detector

| Ch. 1 / 2402 MHz | Mode: BT LE | Modulation: GFSK |
|---|---|---|

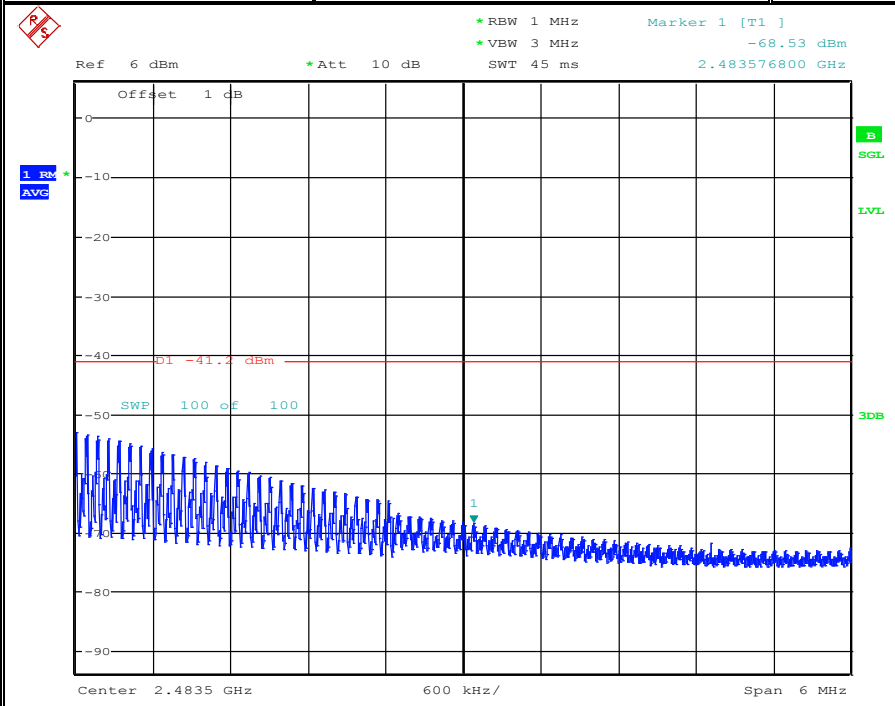


### 8.3.5.2 BT LE Upper Restricted Band Edge



## Upper Restricted Band Edge (2.4GHz) RMS Detector

| Ch. 39 / 2480 MHz | Mode: BT LE | Modulation: GFSK |
|---|---|---|



## 8.4 DTS Bandwidth

### 8.4.1 Limits:

§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.

RSS-247 Section 5.2 (1)
The minimum 6 dB bandwidth shall be 500 kHz.

### 8.4.2 Test Conditions:

Tnom: 22 °C; Vnom: 3.7V

### 8.4.3 Measurement procedure:

Conducted measurements were taken according to ANSI C63.10-2013 Section 11.8 for DTS Bandwidth using a spectrum analyzer (Equipment number 18 in section 9).

### 8.4.4 Test Result: 2.4 GHz Band

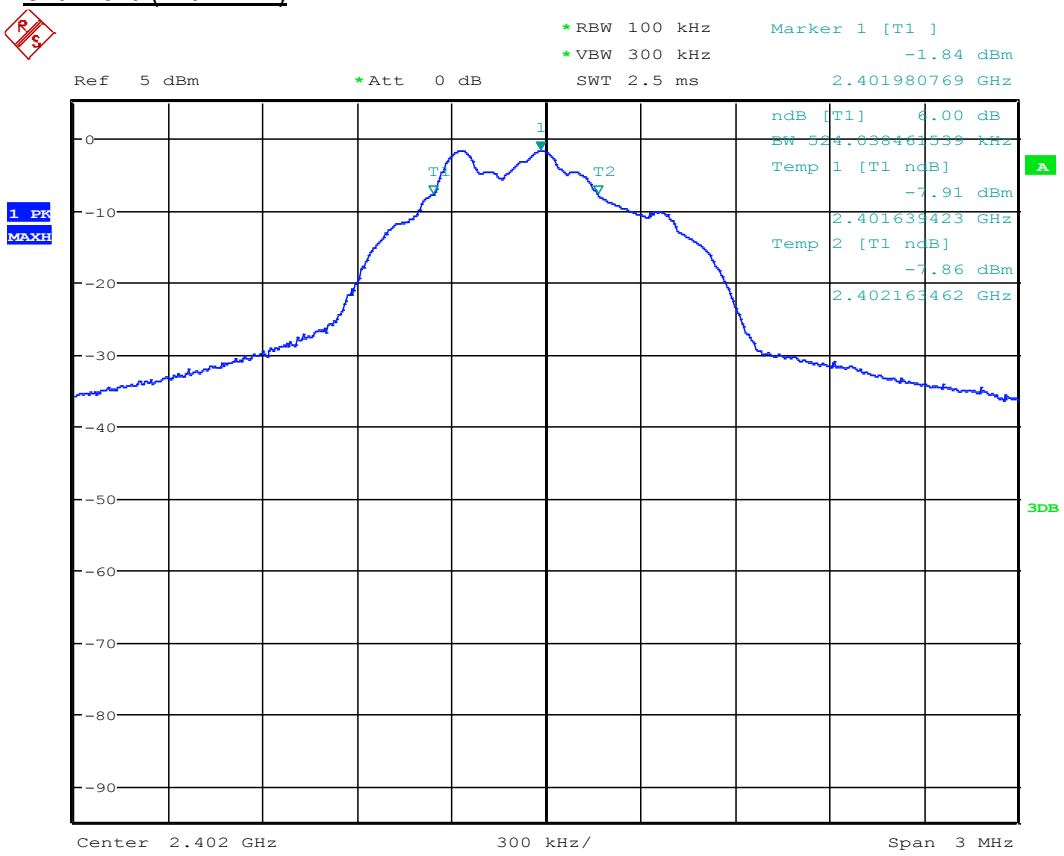
| DTS Bandwidth (KHz) | | | |
|---|---|---|---|
| **Mode** | **2402 Channel 0** | **2440 Channel 19** | **2480 Channel 39** |
| **BT LE** | 524.0 | 524.0 | 533.0 |

### 8.4.5 Measurement Result

Pass.

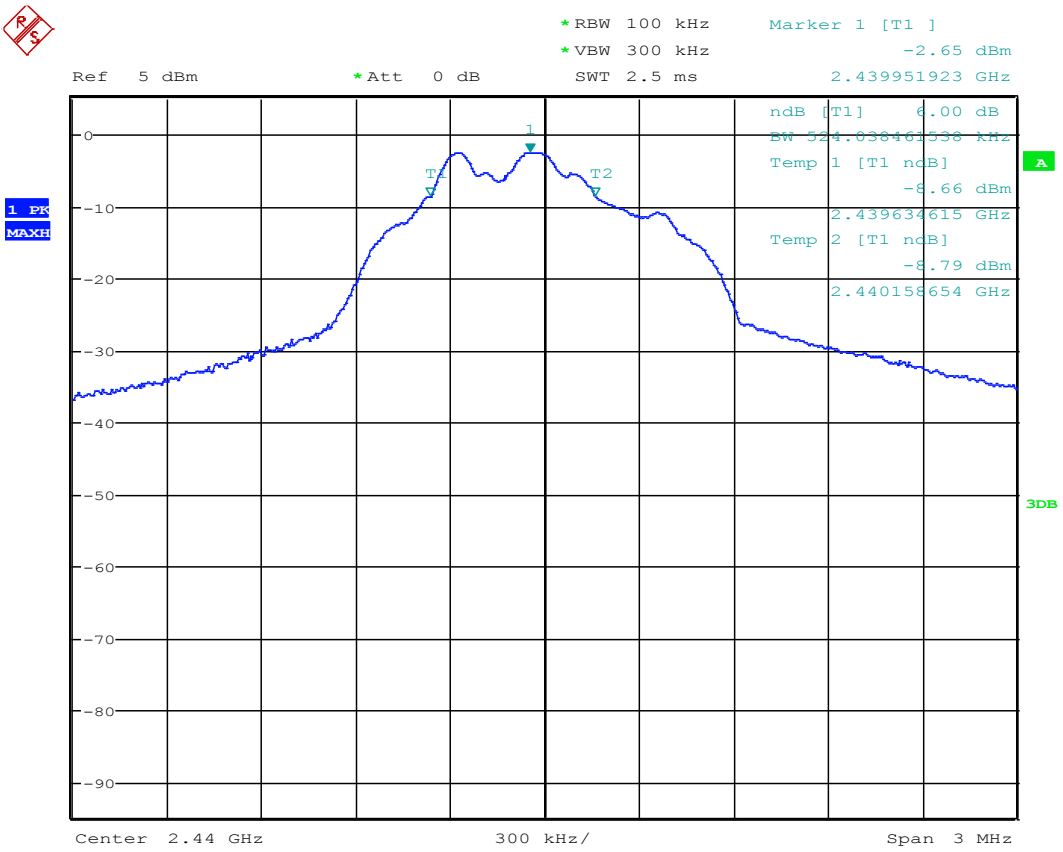
## 8.4.6 Measurement Plots

### 8.4.6.1 Channel 0 (2402 MHz)



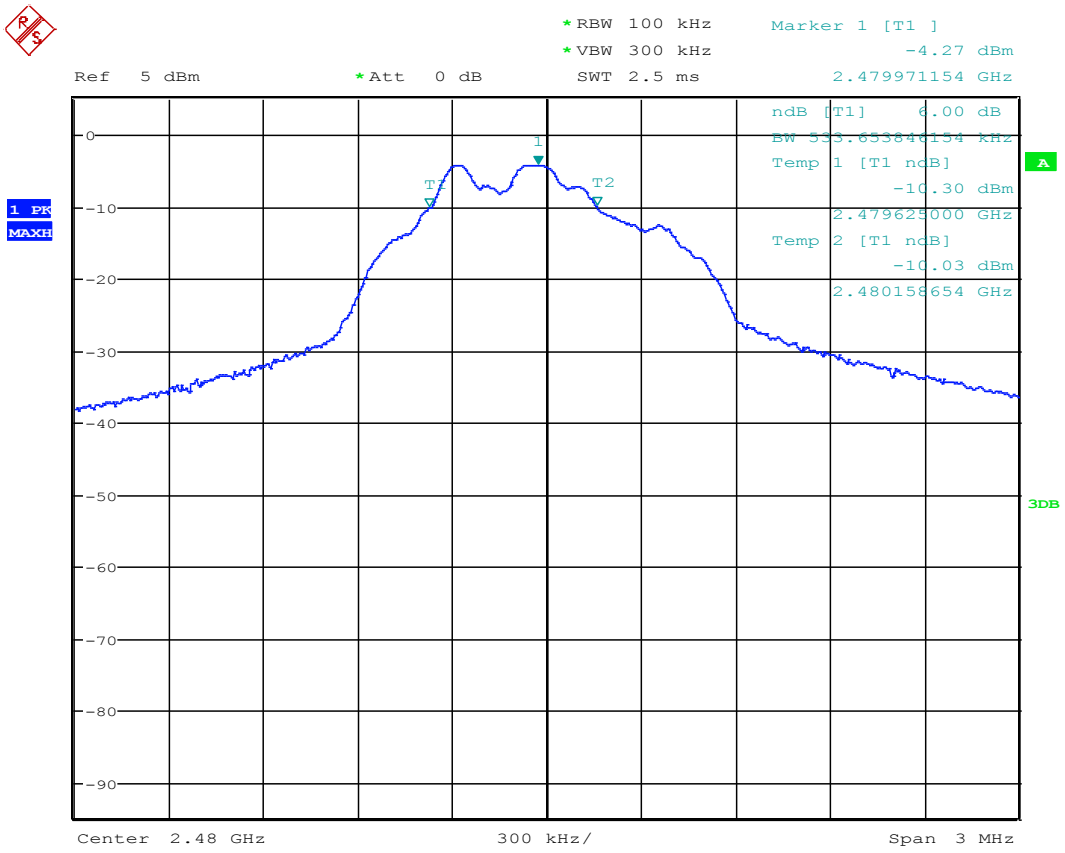

Date: 19.SEP.2016 16:35:58

### 8.4.6.2 Channel 19 (2440 MHz)




Date: 19.SEP.2016 16:38:49

### 8.4.6.3 Channel 39 (2480 MHz)




Date: 19.SEP.2016 16:40:18

## 8.5 Radiated Transmitter Spurious Emissions and Restricted Bands

### 8.5.1 Measurement according to ANSI C63.10 (2013)

**Analyzer Settings:**
Frequency = 9 KHz – 30 MHz
RBW = 9 KHz
Detector: Peak

Frequency = 30 MHz – 1 GHz
Detector = Peak / Quasi-Peak
RBW=120 KHz (<1GHz)

Frequency > 1 GHz
Detector = Peak / Average
RBW= 1MHz

Plots reported here represent the worst case emissions for horizontal and vertical antenna polarizations and for three orientations of the EUT. Unless mentioned otherwise, the emissions outside the limit lines in the plots are from the transmit signal.

### 8.5.2 Limits: §15.247/15.205/15.209 & RSS-Gen 8.9/ 8.10 (restricted bands)

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

| 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 | 2690 - 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 | | | |

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).
*PEAK LIMIT= 74dBµV/m
*AVG. LIMIT= 54dBµV/m

**Table 1:**

| Frequency of emission (MHz) | Field strength @ 3m (µV/m) | Field strength @ 3m (dBµV/m) |
|---|---|---|
| 30–88 | 100 | 40dBµV/m |
| 88–216 | 150 | 43.5 dBµV/m |
| 216–960 | 200 | 46 dBµV/m |
| Above 960 | 500 | 54 dBµV/m |

**Table 2:**

| Frequency of emission (MHz) | Field strength (µV/m) / (dBuV/m) | Measurement Distance (m) |
|---|---|---|
| 0.009–0.490 | 2400/F(kHz) / --------- | 300 |
| 0.490–1.705 | 24000/F(kHz) / -------- | 30 |
| 1.705–30.0 | 30 / (29.5) | 30 |

Radiated spurious emissions shall be measured for the transmit frequencies, transmit power, and data rate for the lowest, middle and highest channel in each frequency band of operation and for the highest gain antenna for each antenna type, and using the appropriate parameters and test requirements described in 5.4.
**The highest (or worst-case) data rate shall be recorded for each measurement.**

For testing at distance other than the specified in the standard, the limit conversion is calculated by using 40 dB/decade extrapolation factor as follow:

Conversion factor (CF) = 40 log (D/d) = 40 log (300m / 3m) = 80dB

### 8.5.3 Test conditions and setup:

Please see section 7.1 for detailed test setup. Equipment numbers 1-16 in section 9 of this report were used for this test case in a semi-anechoic chamber.

| Ambient Temperature | EUT Set-Up # | EUT operating mode |
|---|---|---|
| 23° C | 1 | GFSK continuous fixed channel |

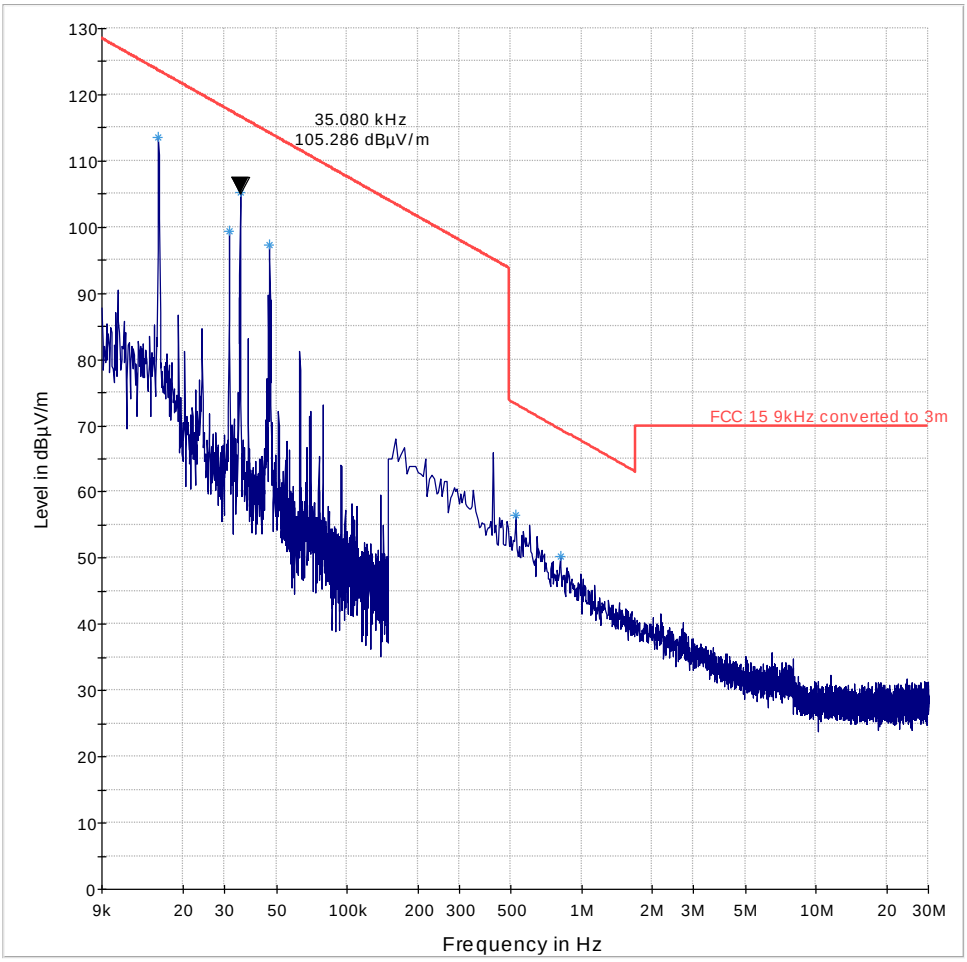
### 8.5.4 Measurement result:

| Channel # | Scan Frequency | Limit | Result |
|---|---|---|---|
| Low (0) | 30 MHz-18 GHz | See section 8.5.5 | Pass |
| Mid (19) | 9 kHz – 26 GHz | See section 8.5.5 | Pass |
| High (39) | 30 MHz-18 GHz | See section 8.5.5 | Pass |

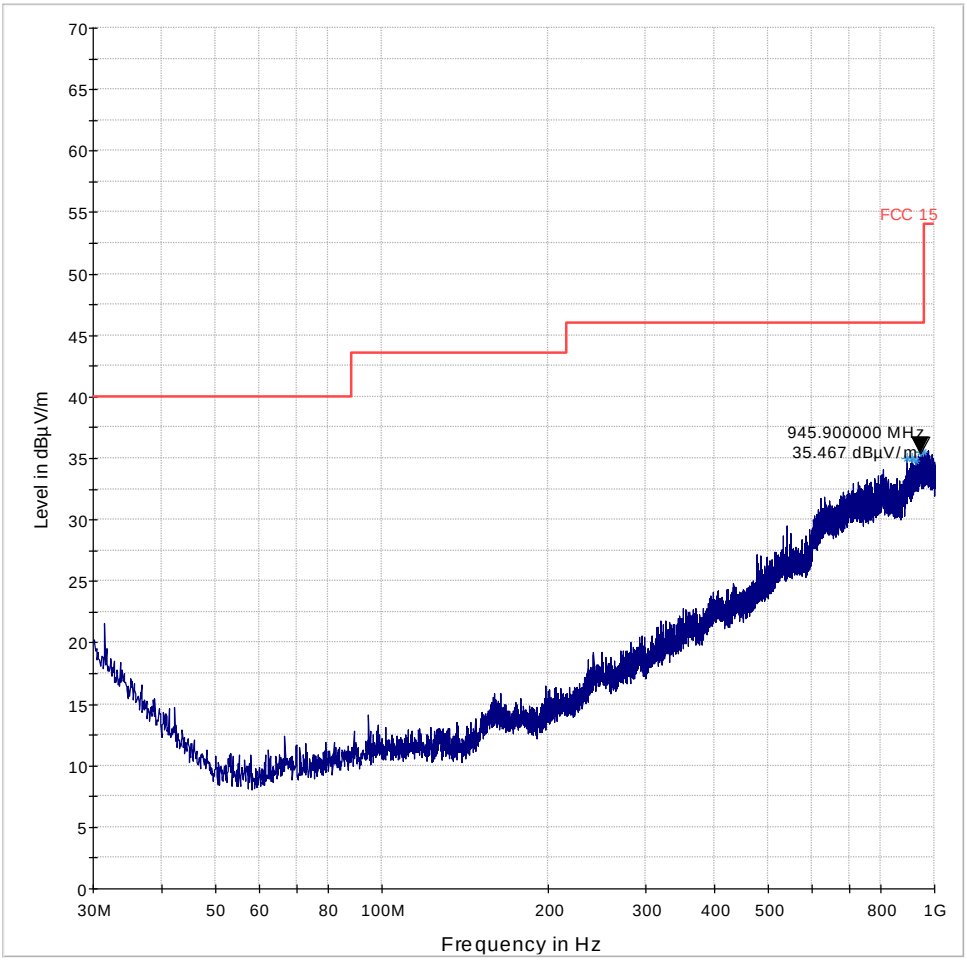
### 8.5.5 Measurement Plots:

Plots reported here represent the worst case emissions for horizontal and vertical antenna polarizations and for three orientations of the EUT.

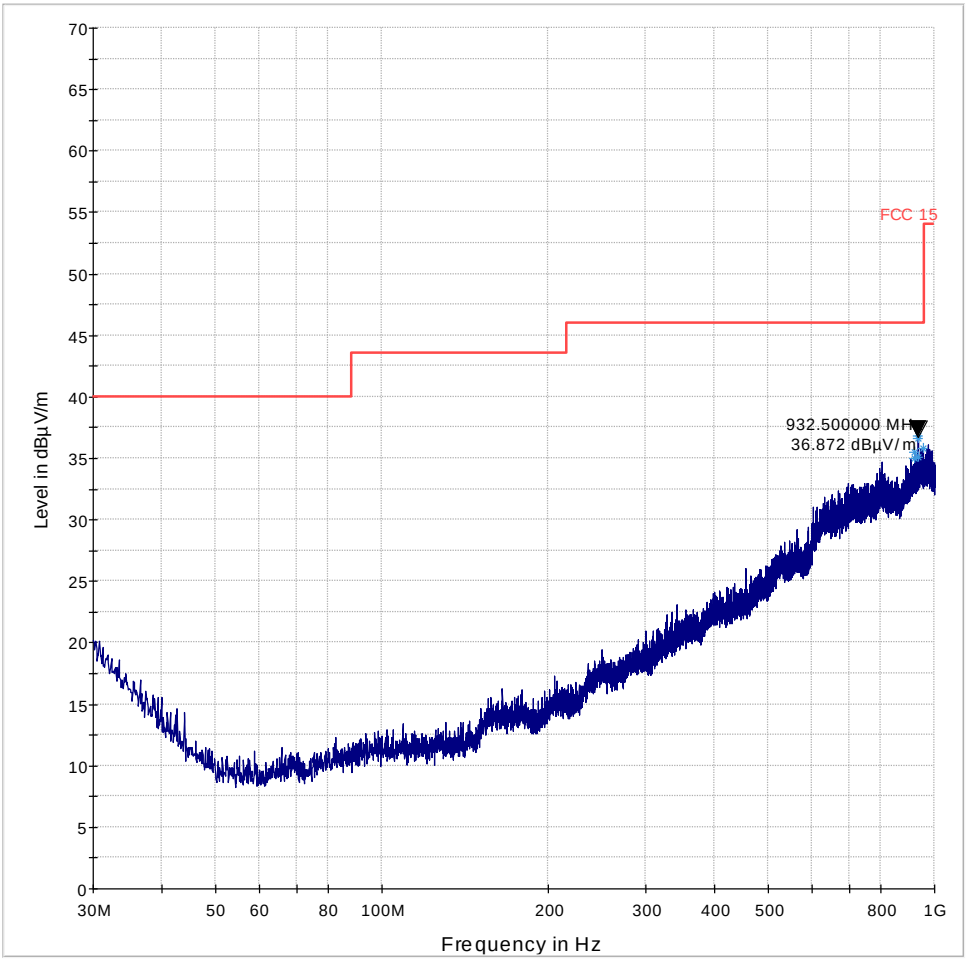
| TX Radiated Spurious Emissions: 9kHz – 30MHz | | | |
|---|---|---|---|
| Ch. 19 | Mode: Bluetooth LE | Modulation: GFSK | Data Rate: 1 Mbps |



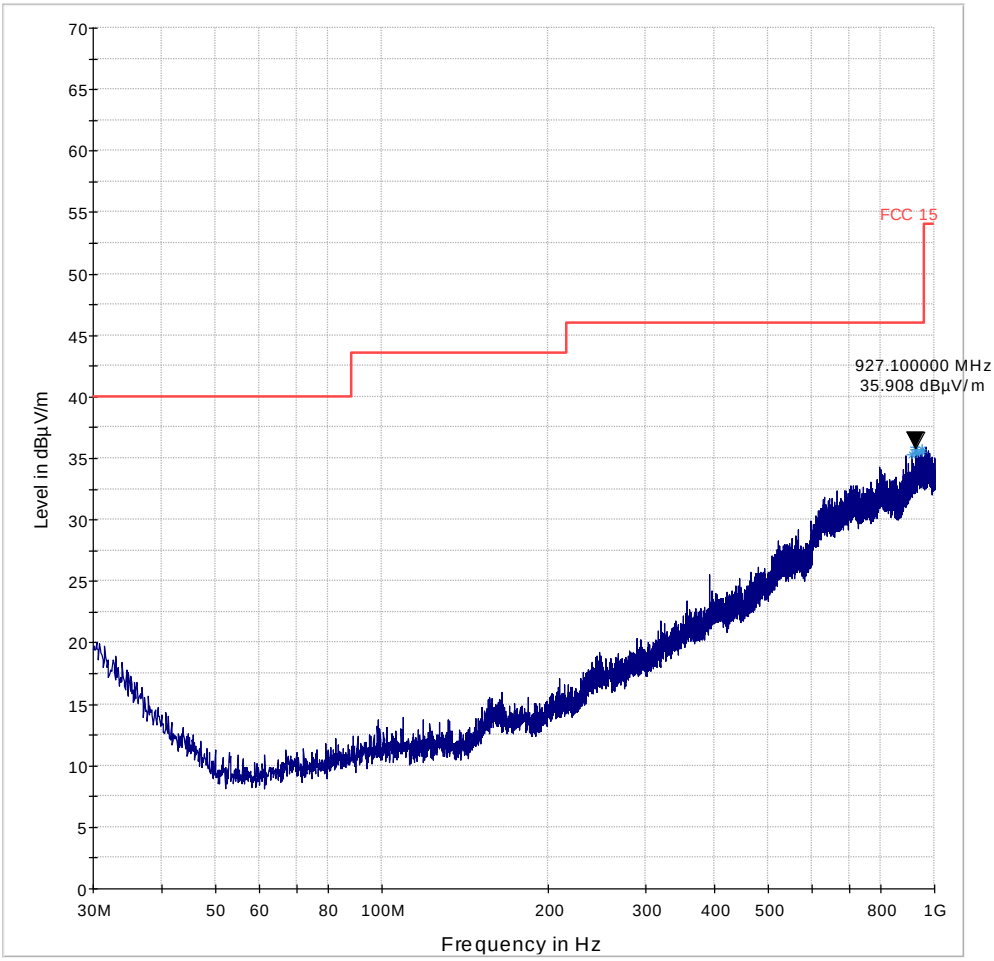
| TX Radiated Spurious Emission: 30 MHz – 1GHz | | | |
|---|---|---|---|
| Ch. 0 | Mode: Bluetooth LE | Modulation: GFSK | Data Rate: 1 Mbps |



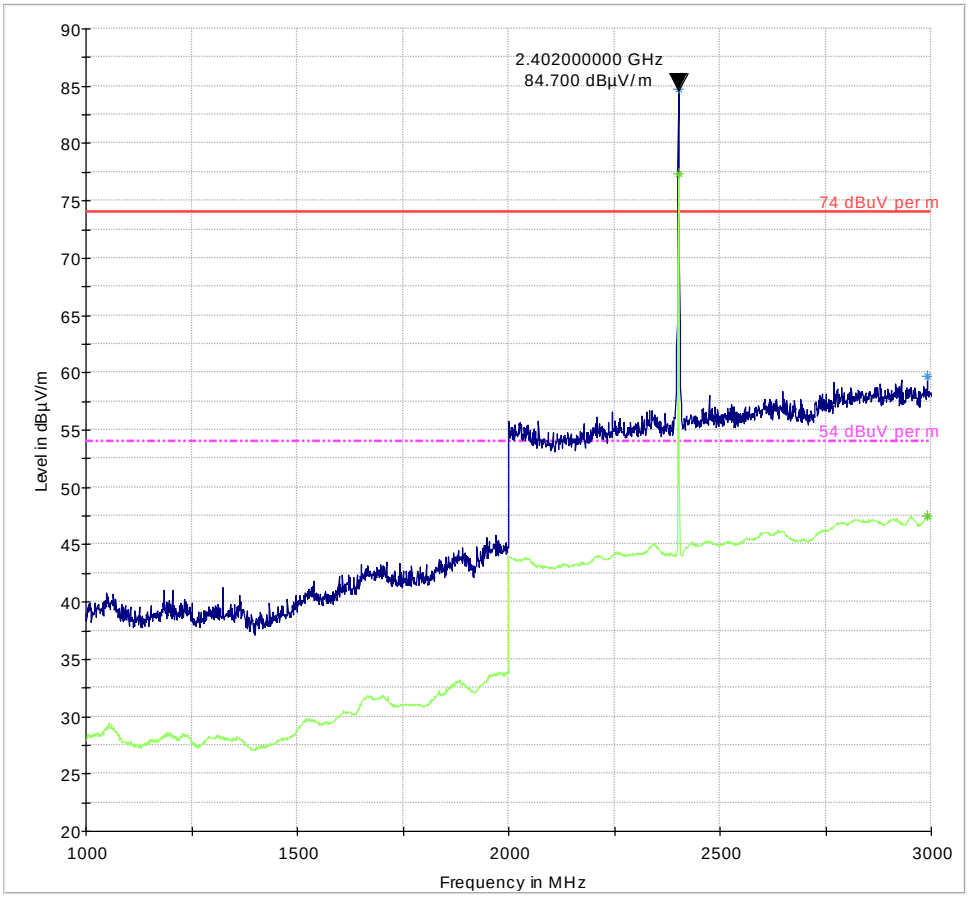
| TX Radiated Spurious Emission: 30 MHz – 1GHz | | | |
|---|---|---|---|
| Ch. 19 | Mode: Bluetooth LE | Modulation: GFSK | Data Rate: 1 Mbps |



| TX Radiated Spurious Emission: 30 MHz – 1GHz | | | |
|---|---|---|---|
| Ch. 39 | Mode: Bluetooth LE | Modulation: GFSK | Data Rate: 1 Mbps |

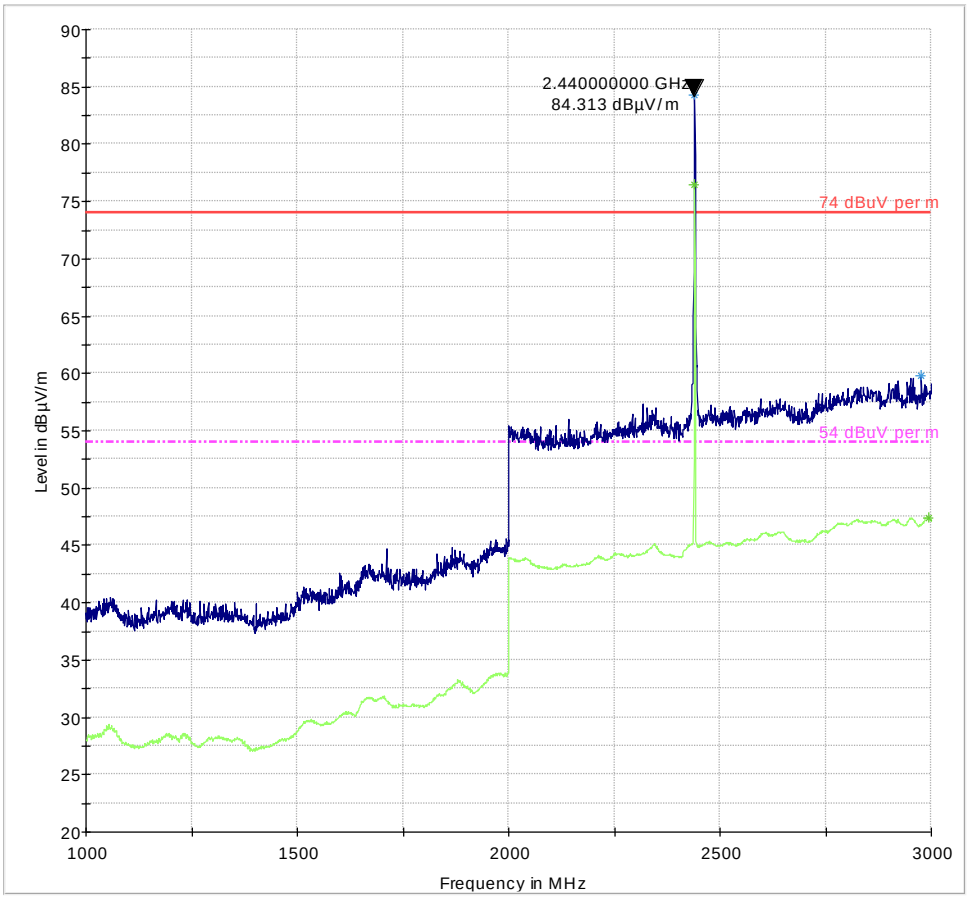


| TX Radiated Spurious Emission: 1 GHz – 3 GHz | | | |
|---|---|---|---|
| Ch. 0 | Mode: Bluetooth LE | Modulation: GFSK | Data Rate: 1 Mbps |



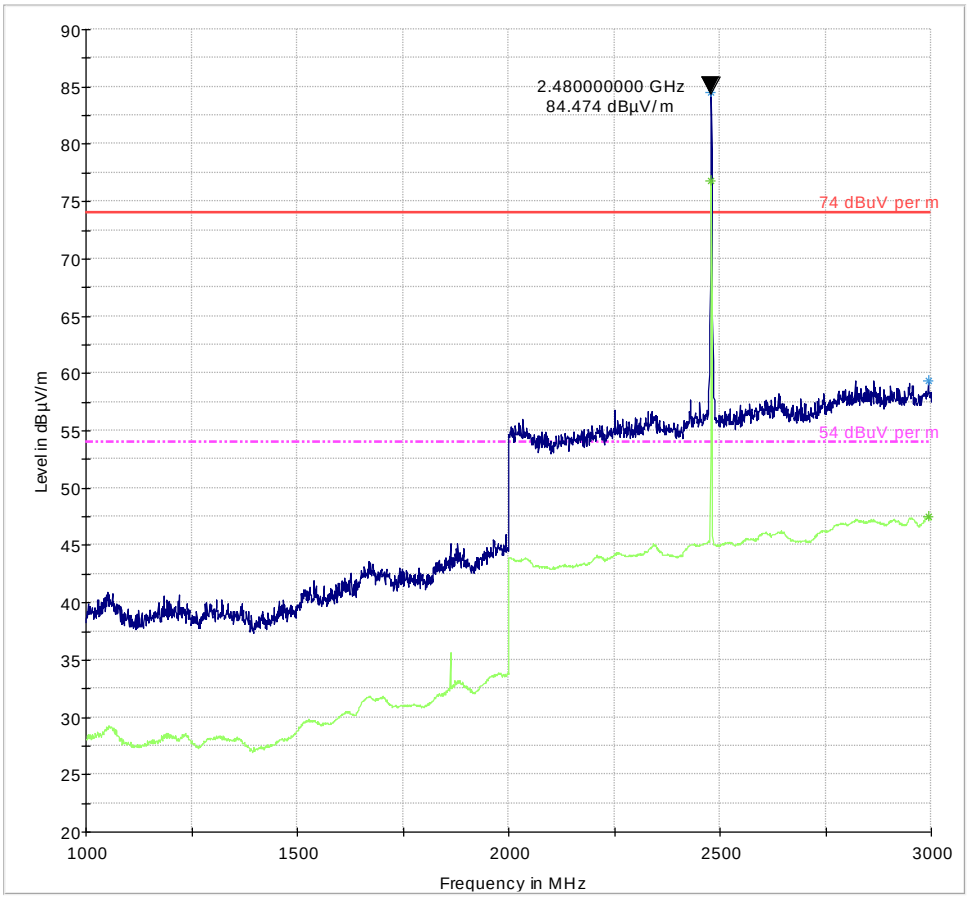

Note: Emission above limit is the Transmit Signal

| TX Radiated Spurious Emission: 1 GHz – 3 GHz | | | |
|---|---|---|---|
| Ch. 19 | Mode: Bluetooth LE | Modulation: GFSK | Data Rate: 1 Mbps |



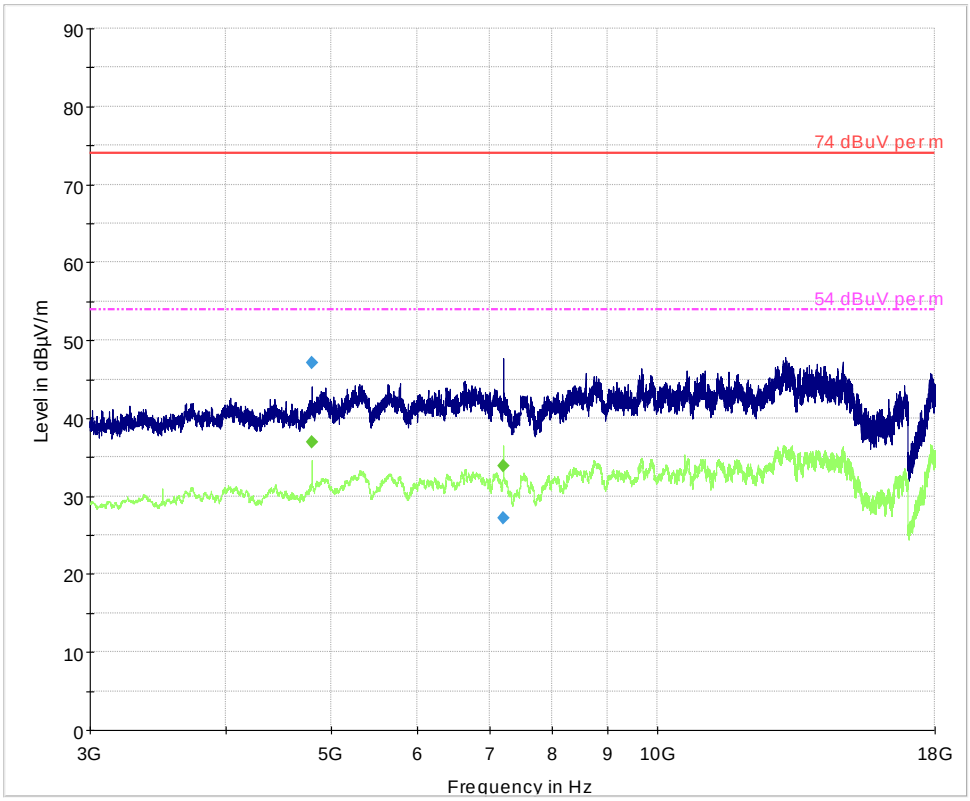

Note: Emission above limit is the Transmit Signal

| TX Radiated Spurious Emission: 1 GHz – 3 GHz | | | |
|---|---|---|---|
| Ch. 39 | Mode: Bluetooth LE | Modulation: GFSK | Data Rate: 1 Mbps |

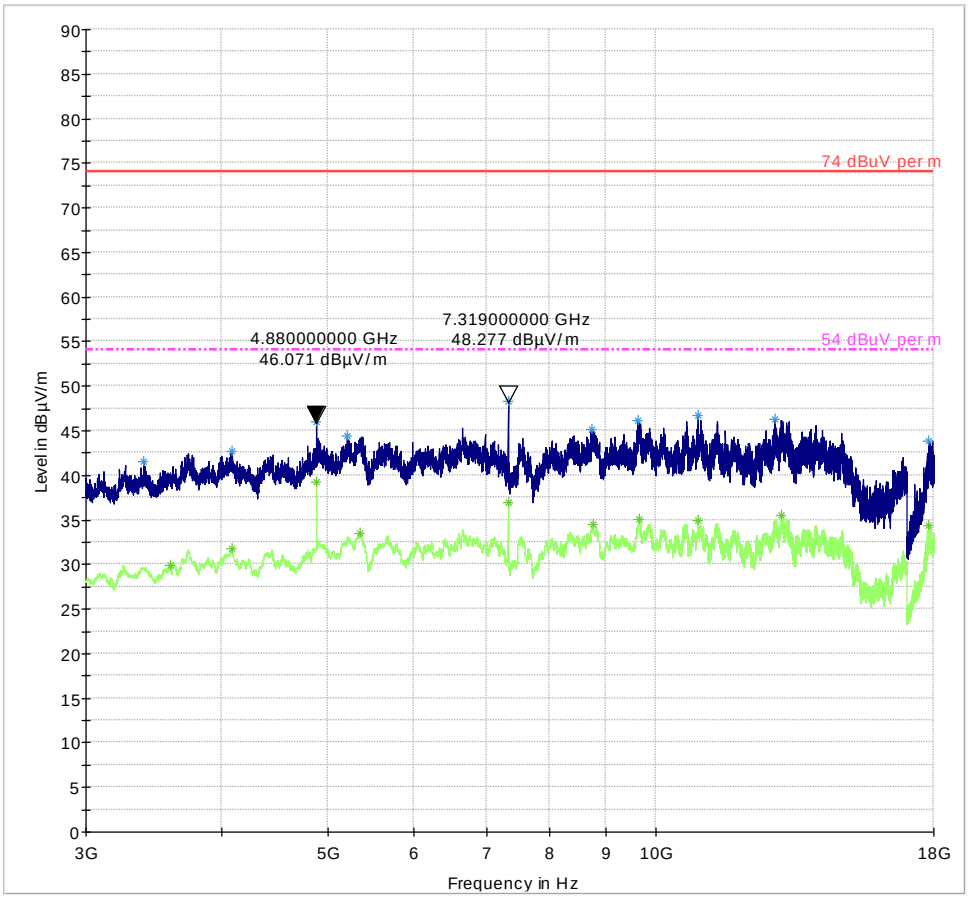



Note: Emission above limit is the Transmit Signal

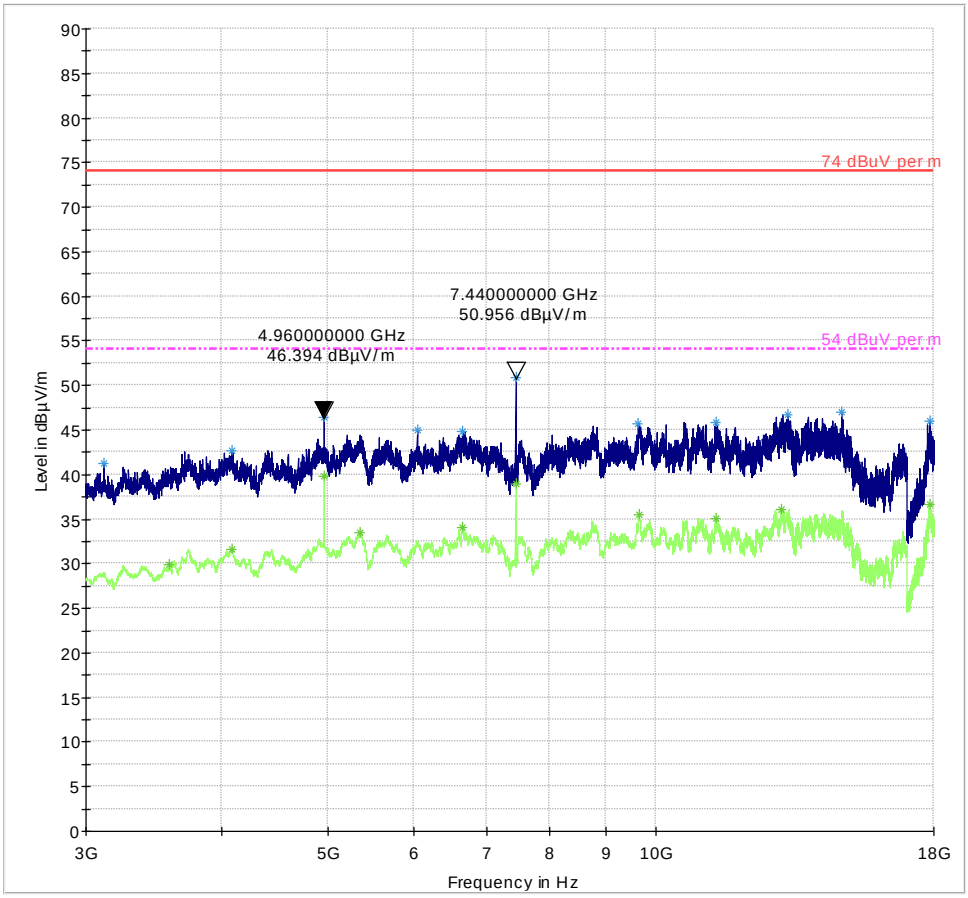
| TX Radiated Spurious Emission: 3 GHz – 18 GHz | | | |
|---|---|---|---|
| Ch. 0 | Mode: Bluetooth LE | Modulation: GFSK | Data Rate: 1 Mbps |



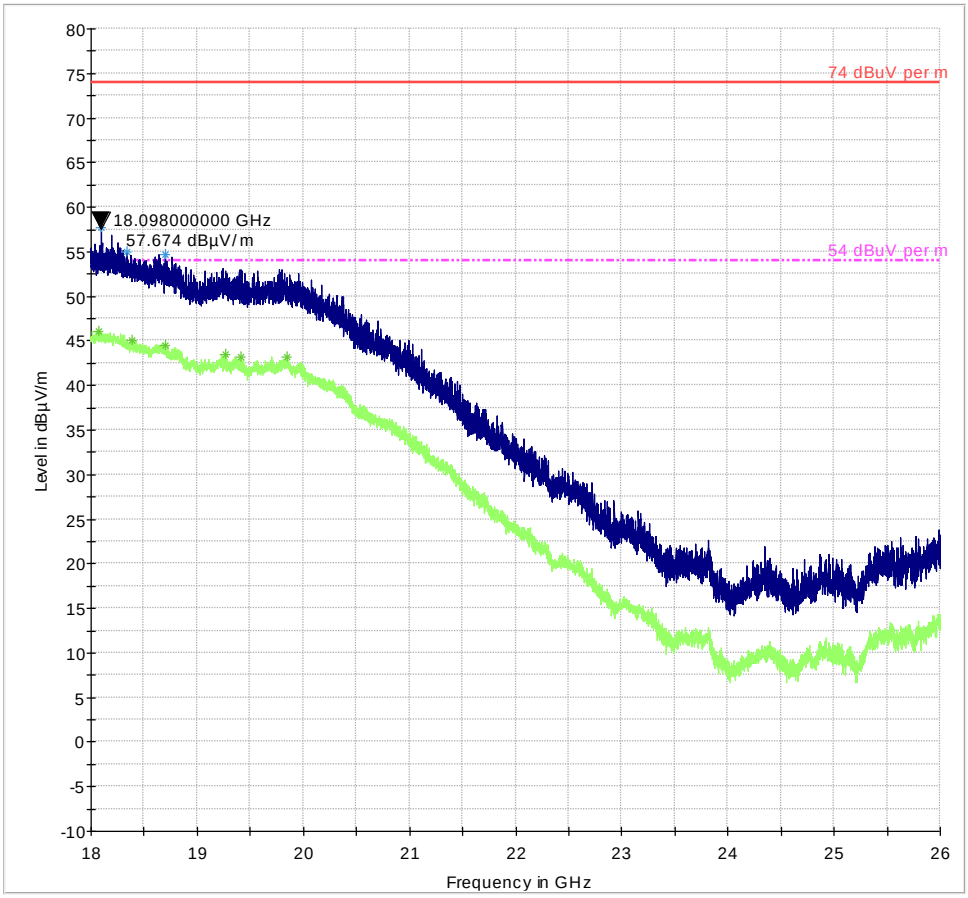
| TX Radiated Spurious Emission: 3 GHz – 18 GHz | | | |
|---|---|---|---|
| Ch. 19 | Mode: Bluetooth LE | Modulation: GFSK | Data Rate: 1 Mbps |



| TX Radiated Spurious Emission: 3 GHz – 18 GHz | | | |
|---|---|---|---|
| Ch. 39 | Mode: Bluetooth LE | Modulation: GFSK | Data Rate: 1 Mbps |



| TX Radiated Spurious Emission: 18 GHz – 26 GHz | | | |
|---|---|---|---|
| Ch. 19 | Mode: Bluetooth LE | Modulation: GFSK | Data Rate: 1 Mbps |



## 8.6 AC Power Line Conducted Emissions

### 8.6.1 Measurement according to ANSI C63.10 (2013)

**Analyzer Settings:**
RBW = 9 KHz (CISPR Bandwidth)
Detector: Peak / Average for Pre-scan
Quasi-Peak/Average for Final Measurements

### 8.6.2 Limits: §15.207 & RSS-Gen 8.8

(a) Except as shown in paragraphs (b) and (c) of this section of the CFR, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table (1), as measured using a 50 μH/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between frequency ranges.

**Table 1:**

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

*Decreases with the logarithm of the frequency.

### 8.6.3 Test conditions and setup:

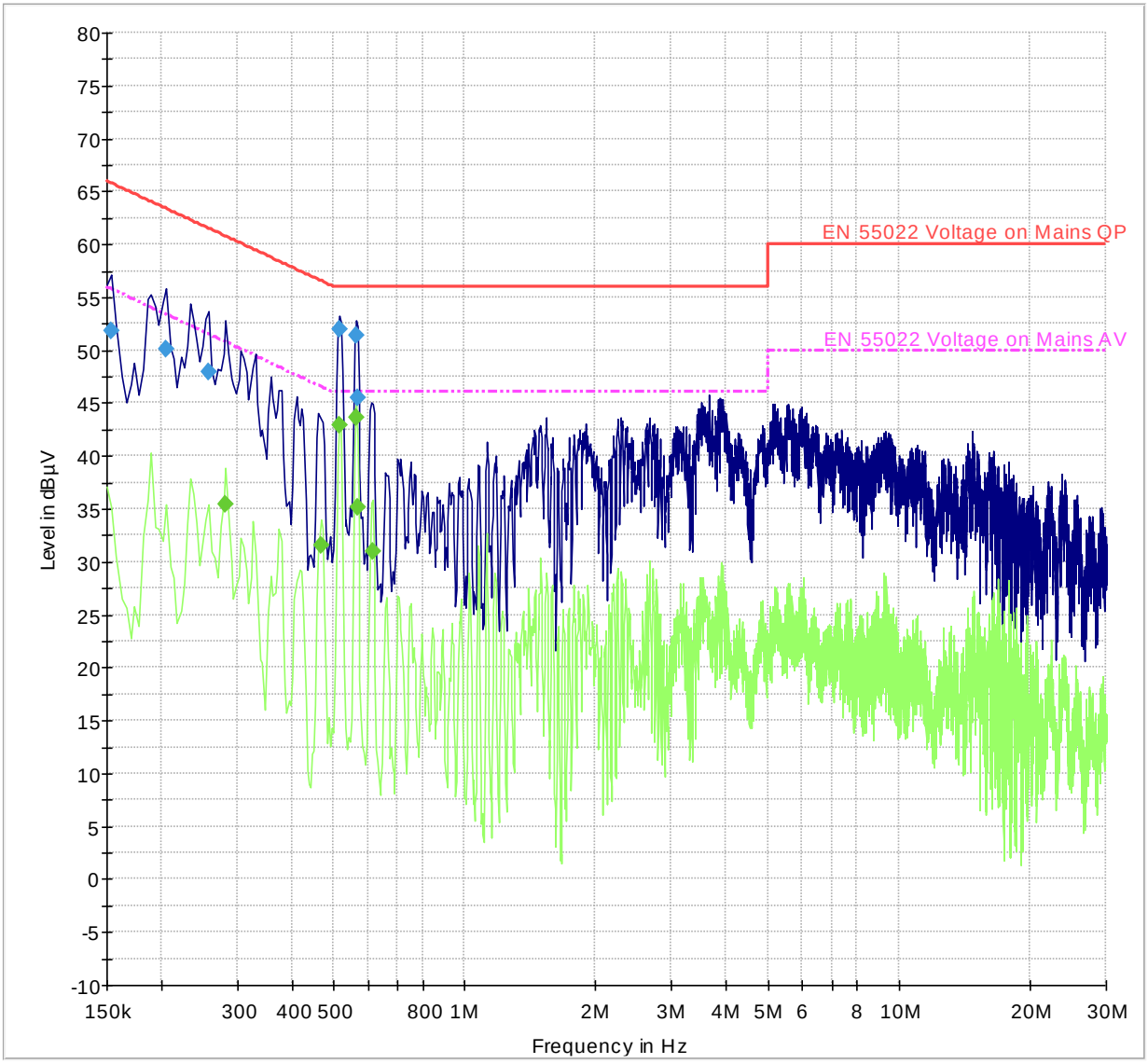
Equipment numbers 9, 17 in section 9 of this report were used for this test case.

| Ambient Temperature (C) | EUT Set-Up # | EUT operating mode | Power line (L1, L2, L3, N) | Power Input |
|---|---|---|---|---|
| 22 | 1 | GFSK continuous fixed channel | Line & Neutral | 110V / 60Hz |

### 8.6.4 Measurement Result:

| Plot # | Port | EUT Set-Up #: | EUT operating mode | Scan Frequency | Limit | Result |
|---|---|---|---|---|---|---|
| 1 | AC Mains | 1 | BT LE | 150 kHz – 30 MHz | See section 8.2.2 | Pass |

### 8.6.5 Measurement Plots:




EN 55022 Voltage on Mains QP
Preview Result 1-PK+
Final Result 1-QPK
EN 55022 Voltage on Mains AV
Preview Result 2-AVG
Final Result 2-AVG

# Final Result 1

| Frequency (MHz) | QuasiPeak (dBµV) | Meas. Time (ms) | Bandwidth (kHz) | PE | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 0.154000 | 51.8 | 500.0 | 9.000 | GND | L1 | 8.5 | 13.9 | 65.8 | |
| 0.206000 | 50.1 | 500.0 | 9.000 | GND | L1 | 6.8 | 13.2 | 63.4 | |
| 0.258000 | 48.0 | 500.0 | 9.000 | GND | L1 | 5.2 | 13.5 | 61.5 | |
| 0.514000 | 51.9 | 500.0 | 9.000 | GND | L1 | 2.0 | 4.1 | 56.0 | |
| 0.562000 | 51.3 | 500.0 | 9.000 | GND | L1 | 1.8 | 4.7 | 56.0 | |
| 0.566000 | 45.5 | 500.0 | 9.000 | GND | L1 | 1.8 | 10.5 | 56.0 | |

# Final Result 2

| Frequency (MHz) | Average (dBµV) | Meas. Time (ms) | Bandwidth (kHz) | PE | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) | Comment |
|---|---|---|---|---|---|---|---|---|---|
| 0.282000 | 35.4 | 500.0 | 9.000 | GND | L1 | 4.5 | 15.4 | 50.8 | |
| 0.466000 | 31.6 | 500.0 | 9.000 | GND | L1 | 2.2 | 15.0 | 46.6 | |
| 0.514000 | 42.9 | 500.0 | 9.000 | GND | L1 | 2.0 | 3.1 | 46.0 | |
| 0.562000 | 43.6 | 500.0 | 9.000 | GND | L1 | 1.8 | 2.4 | 46.0 | |
| 0.566000 | 35.1 | 500.0 | 9.000 | GND | L1 | 1.8 | 10.9 | 46.0 | |
| 0.614000 | 31.0 | 500.0 | 9.000 | GND | L1 | 1.6 | 15.0 | 46.0 | |

## 9 Test Equipment And Ancillaries Used For Testing

| Item Name | Equipment Type | Manufacturer | Model | Serial # | Calibration Cycle | Last Calibration Date |
|---|---|---|---|---|---|---|
| Antenna Biconilog 3142E | Biconlog Antenna | EMCO | 3142E | 166067 | 3 years | 6/14/2014 |
| Antenna Horn 3115 SN 35111 | Horn Antenna | EMCO | 3115 | 35111 | 3 years | 7/24/2015 |
| Antenna Loop 6512 | Loop (Passive) | ETS Lindgren | 6512 | 00164698 | 3 years | 7/22/2014 |
| LISN FCC-LISN-50-25-2-08 | LISN | FCC | FCC-LISN-50-25-2-08 | 8014 | 2 Years | 3/26/2015 |
| Antenna Horn 3116 | Horn Antenna | ETS Lindgren | 3116 | 70497 | 3 years | 7/22/2015 |
| Digital Barometer | Compact Digital Barometer | Control Company | 35519-055 | 91119547 | 2 Years | 4/7/2015 |
| Spectrum Analyzer FSU26 #2 | Spectrum Analyzer | R&S | FSU26 | 200065 | 3 years | 7/4/2015 |
| Thermometer Humidity TM320 | Thermometer Humidity | Dickson | AY1072 | 0528 | 1 Year | 11/02/2016 |

Equipment used meets the measurement uncertainty requirements as required per applicable standards for 95% confidence levels.
Calibration due dates, unless defined specifically, falls on the last day of the month.
Items indicated “N/A” for cal status either do not specifically require calibration or is internally characterized before use.

## 10 Revision History

| Date | Report Name | Changes to report | Report prepared by |
|---|---|---|---|
| Dec 14, 2016 | EMC-WHIST-003-16001-15-247-BTLE | Initial Version | J Donnellan |
| Dec 22, 2016 | EMC-WHIST-003-16001-15-247-BTLE-Rev1 | Updated Table Section 9. | J Donnellan |