



## FCC / IC Test Report

FOR:

Apple Inc.

Model Name:

A1535

Product Description:

Bluetooth Device with BDR, EDR and LE support

FCC ID: BCGA1535

IC ID: 579C-A1535

Per:

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

REPORT #: EMC\_APPLE-144-14001\_A1535\_15.247\_BT\_LE

DATE: 2015-07-31



A2LA Accredited

IC recognized #  
3462B-1

**CETECOM Inc.**

411 Dixon Landing Road ♦ Milpitas, CA 95035 ♦ U.S.A.

Phone: + 1 (408) 586 6200 ♦ Fax: + 1 (408) 586 6299 ♦ E-mail: [info@cetecom.com](mailto:info@cetecom.com) ♦ <http://www.cetecom.com>

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

**TABLE OF CONTENTS**

<b>1</b>	<b>ASSESSMENT.....</b>	<b>3</b>
<b>2</b>	<b>ADMINISTRATIVE DATA .....</b>	<b>4</b>
2.1	IDENTIFICATION OF THE TESTING LABORATORY ISSUING THE EMC TEST REPORT .....	4
2.2	IDENTIFICATION OF THE CLIENT .....	4
2.3	IDENTIFICATION OF THE MANUFACTURER.....	4
<b>3</b>	<b>EQUIPMENT UNDER TEST (EUT).....</b>	<b>5</b>
3.1	EUT SPECIFICATIONS .....	5
3.2	EUT SAMPLE DETAILS .....	6
3.3	ACCESSORY EQUIPMENT (AE) DETAILS.....	6
3.4	TEST SAMPLE CONFIGURATION .....	6
<b>4</b>	<b>SUBJECT OF INVESTIGATION .....</b>	<b>7</b>
<b>5</b>	<b>MEASUREMENT RESULTS SUMMARY .....</b>	<b>7</b>
<b>6</b>	<b>MEASUREMENTS.....</b>	<b>8</b>
6.1	MEASUREMENT UNCERTAINTY .....	8
6.2	ENVIRONMENTAL CONDITIONS DURING TESTING:.....	8
6.3	DATES OF TESTING: .....	8
<b>7</b>	<b>MEASUREMENT PROCEDURES .....</b>	<b>9</b>
7.1	RADIATED MEASUREMENT.....	9
7.2	POWER LINE CONDUCTED MEASUREMENT PROCEDURE .....	11
7.3	RF CONDUCTED MEASUREMENT PROCEDURE .....	11
<b>8</b>	<b>TEST RESULT DATA .....</b>	<b>12</b>
8.1	MAXIMUM PEAK CONDUCTED OUTPUT POWER.....	12
8.2	POWER SPECTRAL DENSITY .....	16
8.3	BAND EDGE AND RESTRICTED BAND COMPLIANCE.....	20
8.4	EMISSION BANDWIDTH 6dB .....	25
8.5	RADIATED TRANSMITTER SPURIOUS EMISSIONS AND RESTRICTED BANDS .....	29
8.6	AC POWER LINE CONDUCTED EMISSIONS .....	42
<b>9</b>	<b>TEST EQUIPMENT AND ANCILLARIES USED FOR TESTING .....</b>	<b>45</b>
<b>10</b>	<b>REVISION HISTORY .....</b>	<b>46</b>

## 1 Assessment

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

No deviations were ascertained.

Company	Description	Model #
APPLE INC	Bluetooth Device with BDR, EDR and LE support	A1535

### Responsible for Testing Laboratory:

Franz Engert

2015-07-31

Compliance

(Compliance Manager)

Date	Section	Name	Signature
------	---------	------	-----------

### Responsible for the Report:

Kris Lazarov

2015-07-31

Compliance

(EMC Engineer)

Date	Section	Name	Signature
------	---------	------	-----------

The test results of this test report relate exclusively to the test item specified in Section 3.

CETECOM Inc. USA does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report may only be reproduced or published in full. Reproduction or publication of extracts from the report requires the prior written approval of CETECOM Inc. USA.

## 2 Administrative Data

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

Company Name:	CETECOM Inc.
Department:	Compliance
Street Address:	411 Dixon Landing Road
City/Zip Code	Milpitas, CA 95035
Country	USA
Telephone:	+1 (408) 586 6200
Fax:	+1 (408) 586 6299
Compliance Manager:	Franz Engert
Responsible Project Leader:	Kris Lazarov

### 2.2 Identification of the Client

Applicant's Name:	Apple Inc.
Street Address:	1 Infinite Loop
City/Zip Code	Cupertino, CA 95014
Country	USA
Contact Person:	Jacqueline Zhai
Phone No.	(408) 620-0616
e-mail:	jacqueline_zhai@apple.com

### 2.3 Identification of the Manufacturer

Manufacturer's Name:	Same as Applicant
Manufacturers Address:	-----
City/Zip Code	-----
Country	-----

### 3 Equipment Under Test (EUT)

#### 3.1 EUT Specifications

<b>Model No:</b>	A1535
<b>HW Version :</b>	1.0
<b>SW Version :</b>	(a) STFW version 0x0804 (b) BT FW version 0x0056
<b>FCC-ID :</b>	BCGA1535
<b>IC-ID:</b>	579C-A1535
<b>HVIN:</b>	A1535
<b>PMN:</b>	A1535
<b>Product Description:</b>	Bluetooth Device with BDR, EDR and LE support
<b>Frequency Range / number of channels:</b>	Nominal band: 2400 – 2483.5; Center to center: 2402(ch 0) – 2480(ch 39), 40 channels
<b>Type(s) of Modulation:</b>	Bluetooth version 4.2, Low Energy, using Dynamic Sequence Spread Spectrum with GFSK modulation.
<b>Modes of Operation:</b>	Bluetooth LE
<b>Antenna Information as declared:</b>	slot antenna max gain (2.484GHz) = 4.34dBi
<b>Max. Output Powers:</b>	Conducted average Power 4.5dBm
<b>Power Supply/ Rated Operating Voltage Range:</b>	lithium battery pack (dedicated) Vmin: 3.0V dc/ Vnom: 3.8V dc / Vmax: 4.3V dc
<b>Operating Temperature Range</b>	0 °C to 35 °C
<b>Other Radios included in the device:</b>	Bluetooth Basic/EDR: GFSK, $\pi/4$ DQPSK, 8DPSK
<b>Sample Revision</b>	<input type="checkbox"/> Prototype Unit <input type="checkbox"/> Production Unit <input checked="" type="checkbox"/> Pre-Production

### 3.2 EUT Sample details

EUT #	Serial Number	HW Version	SW Version	Notes/Comments
1	CC2PT01UGQN7	1.0	(a) STFW version 0x0804 (b) BT FW version 0x0056	Radiated emissions and conducted measurements

### 3.3 Accessory Equipment (AE) details

AE #	Type	Model	Manufacturer	Serial Number
1	Laptop	Apple		
2	USB Power Adapter	Phihong	PSAI05R-050Q	P142302633A1

### 3.4 Test Sample Configuration

EUT Set-up #	Combination of AE used for test set up	Comments
1	EUT#1	The radio of the EUT was stimulated directly in a test mode not accessible by the end user. The measurement equipment was connected to the 50Ohm UFL port of the EUT.
2	EUT#1	The radio of the EUT was stimulated directly in a test mode not accessible by the end user. The internal antenna was connected.
3	EUT#1 + AE#1	The radio of the EUT was stimulated directly in a test mode not accessible by the end user. The internal antenna was connected. The EUT was connected to the AC mains through a Laptop.
4	EUT#1 + AE#2	The radio of the EUT was stimulated directly in a test mode not accessible by the end user. The internal antenna was connected. The EUT was connected to the AC mains through a USB charger.

#### 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 and Radio Standard Specification RSS-247 Issue 1 of Industry Canada.

This test report is to support a request for new equipment authorization under the FCC ID: BCGA1535 and IC ID: 579C-A1535

Testing procedures are based on 558074 D01 DTS Meas Guidance v03r03 - "GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER §15.247; 9-Jun-15" by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.

#### 5 Measurement Results Summary

Test Specification	Test Case	Temperature and Voltage Conditions	Mode	Pass	Fail	NA	NP	Result
§15.247(e) RSS247 5.2(2)	Power Spectral Density	Nominal	Bluetooth LE	■	□	□	□	Complies
§15.247(a)(1) RSS247 5.2(1)	Emission Bandwidth	Nominal	Bluetooth LE	■	□	□	□	Complies
§15.247(b)(1) RSS247 5.4(4)	Maximum Conducted Output Power and EIRP	Nominal	Bluetooth LE	■	□	□	□	Complies
§15.247(d) RSS247 5.5	Band edge compliance Unrestricted Band Edges	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) §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

9 kHz to 30MHz	±2.5 dB (Magnetic Loop Antenna)
30 MHz to 1000 MHz	±2.0 dB (Biconilog Antenna)
1 GHz to 40 GHz	±2.3 dB (Horn Antenna)

Conducted measurement

150 kHz to 30 MHz	±0.7 dB (LISN)
-------------------	----------------

RF conducted measurement	±0.5 dB
--------------------------	---------

### **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%

### **6.3 Dates of Testing:**

7/17/2015 - 7/31/2015



## 7 Measurement Procedures

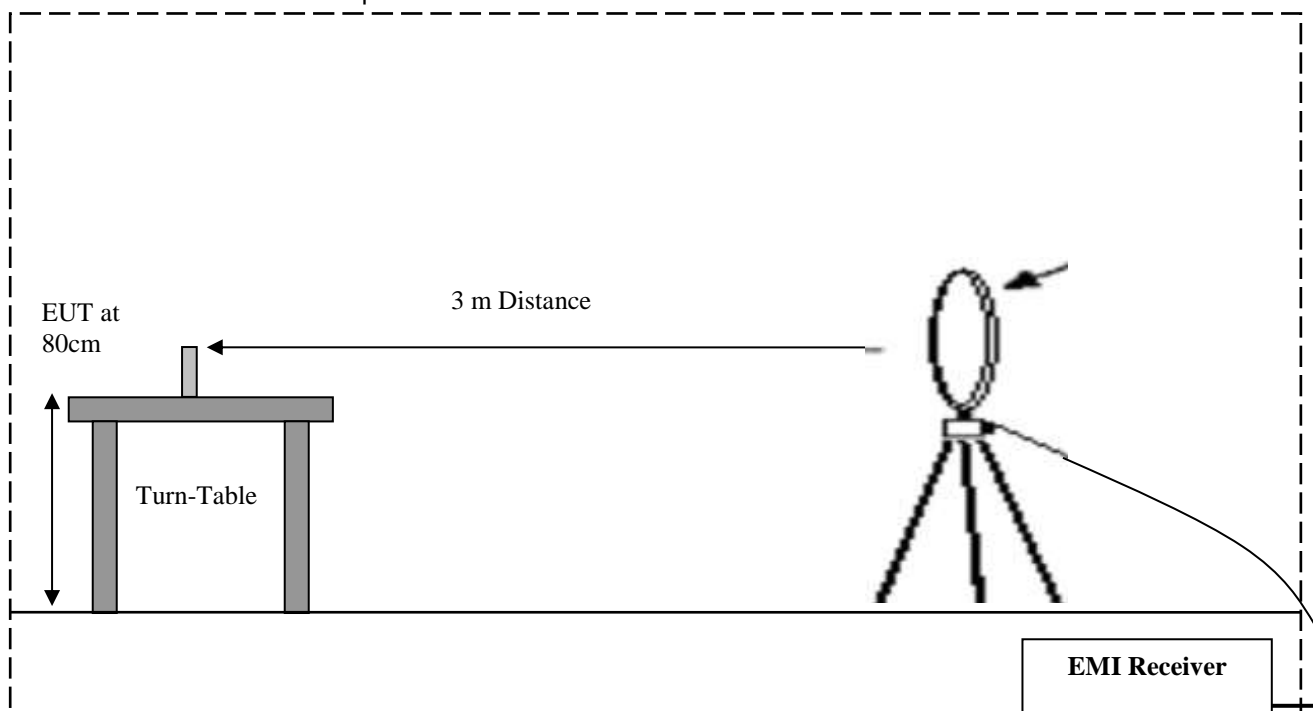
### 7.1 Radiated Measurement

The radiated measurement is performed according to:

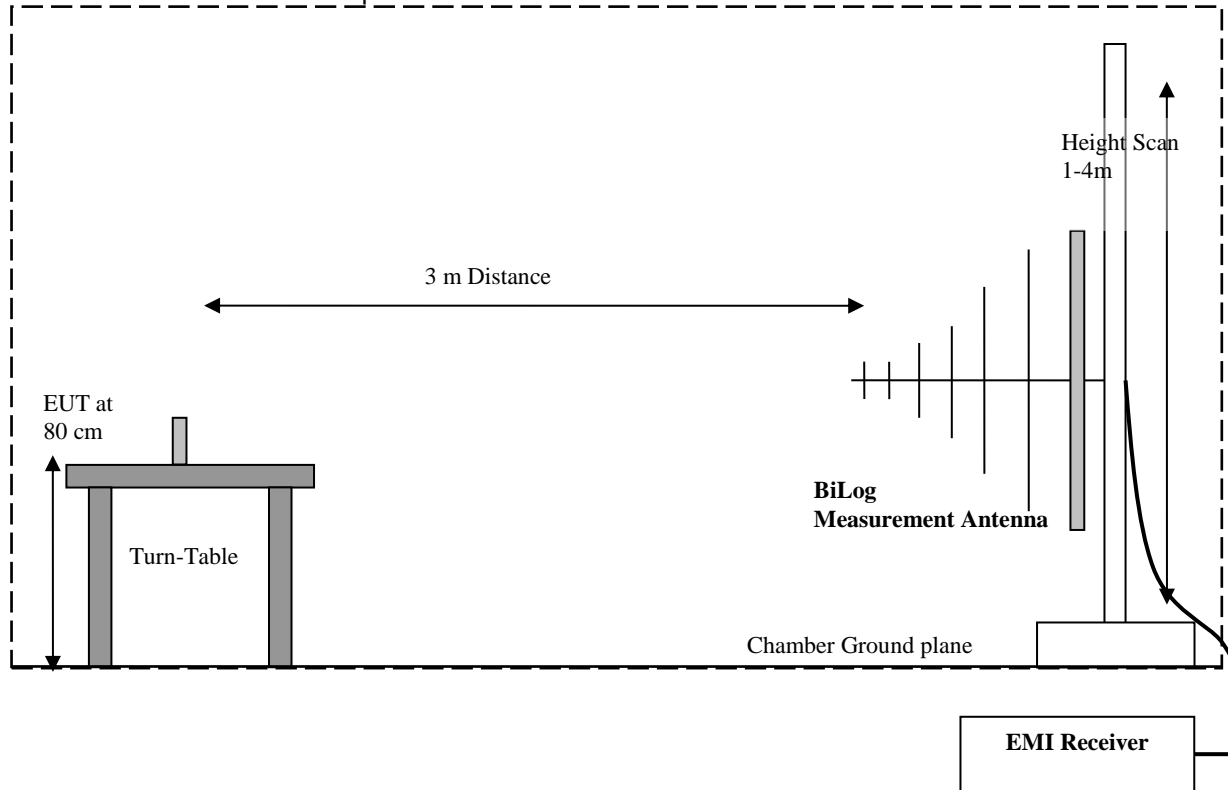
ANSI C63.10 (2013)

- 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.

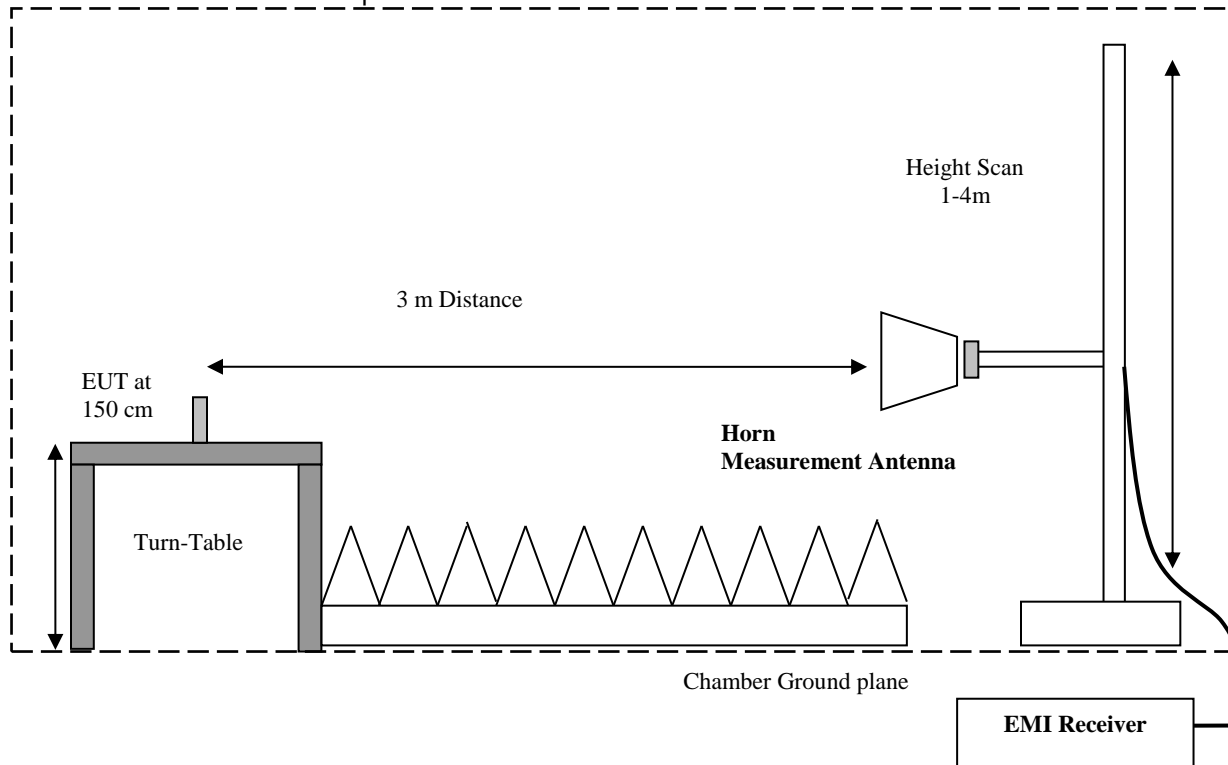
Radiated Emissions Test Setup Below 30MHz Measurements



### Radiated Emissions Test Setup 30MHz-1GHz Measurements



### Radiated Emissions Test Setup Above 1GHz 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 dB $\mu$ V
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.:

$$FS \text{ (dB}\mu\text{V/m)} = \text{Measured Value on SA (dB}\mu\text{V)} - \text{Cable Loss (dB)} + \text{Antenna Factor (dB/m)}$$

Example:

Frequency (MHz)	Measured SA (dB $\mu$ V)	Cable Loss (dB)	Antenna Factor Correction (dB)	Field Strength Result (dB $\mu$ V/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 C63.4 (2009)

## 7.3 RF Conducted Measurement Procedure

Reference: FCC Measurement Guidance v03r03 - "GUIDANCE FOR PERFORMING COMPLIANCE MEASUREMENTS ON DIGITAL TRANSMISSION SYSTEMS (DTS) OPERATING UNDER §15.247; 9-Jun-15" - by the Federal Communications Commission, Office of Engineering and Technology, Laboratory Division.



1. Connect the equipment as shown in the above diagram.
2. Adjust the settings of the SA (Rohde-Schwarz Spectrum Analyzer) to connect the EUT at the required mode of test.
3. Measurements are to be performed with the EUT set to the low, middle and high channels and for worst case modulation schemes.

## 8 Test Result Data

### 8.1 Maximum Peak Conducted Output Power

#### 8.1.1 Measurement according to FCC KDB 558074 D01 V03R03

##### Spectrum Analyzer settings:

Span = approximately 5 times the 20 dB bandwidth

RBW > the 20 dB bandwidth of the emission being measured

VBW ≥ RBW

Sweep = auto

Detector function = peak

Trace = max hold

Use the marker-peak function to set the marker to the peak of the emission.

#### 8.1.2 Limits:

##### Maximum Peak Output Power:

FCC §15.247 (b)(1): 1W

RSS247 5.4(4): 1W

##### EIRP:

IC RSS-247: 4W

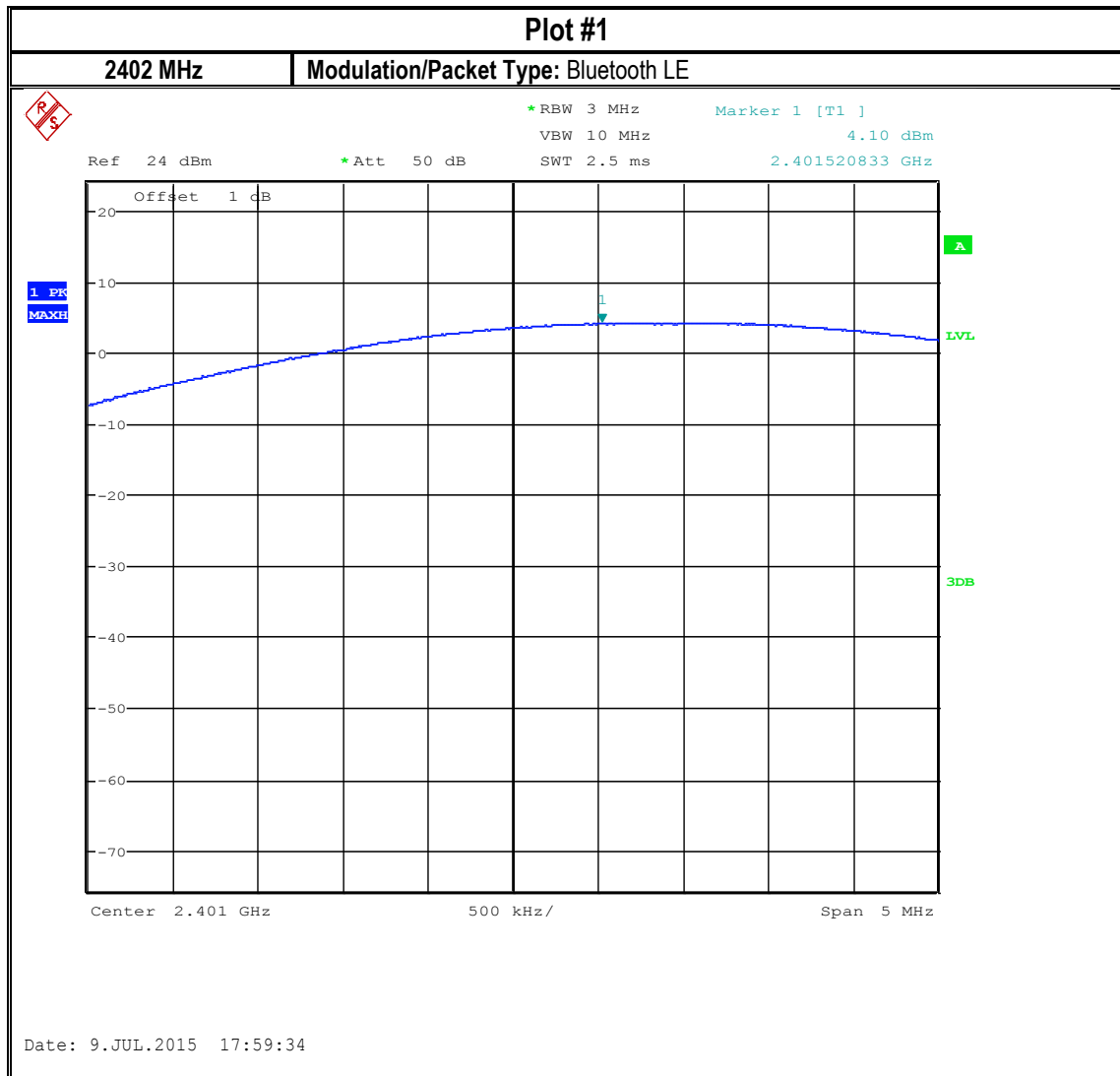
#### 8.1.3 Test conditions and setup:

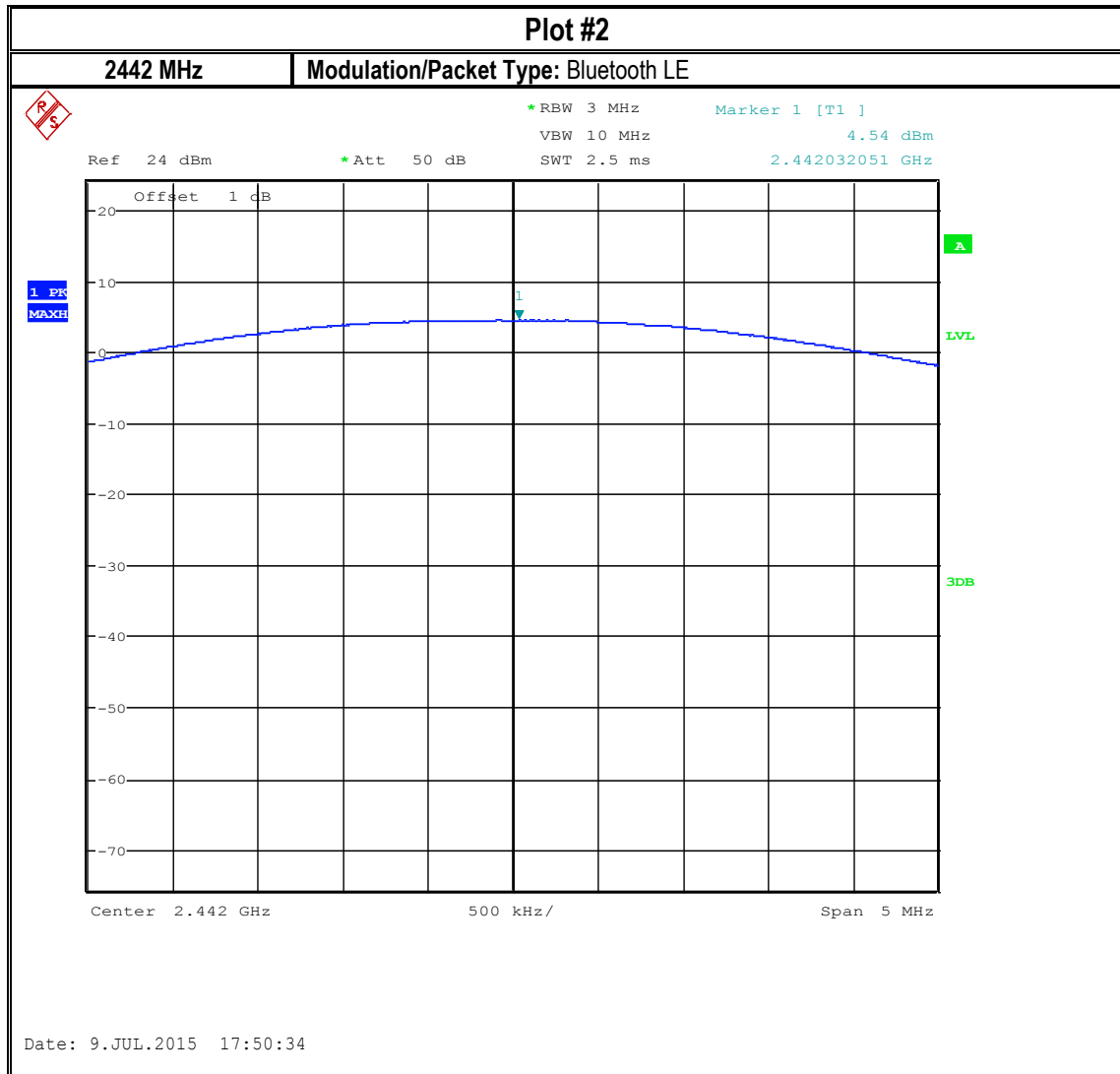
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain (dBi)
22° C	1	GFSK continuous fixed channel	3.3V DC	4.34dBi

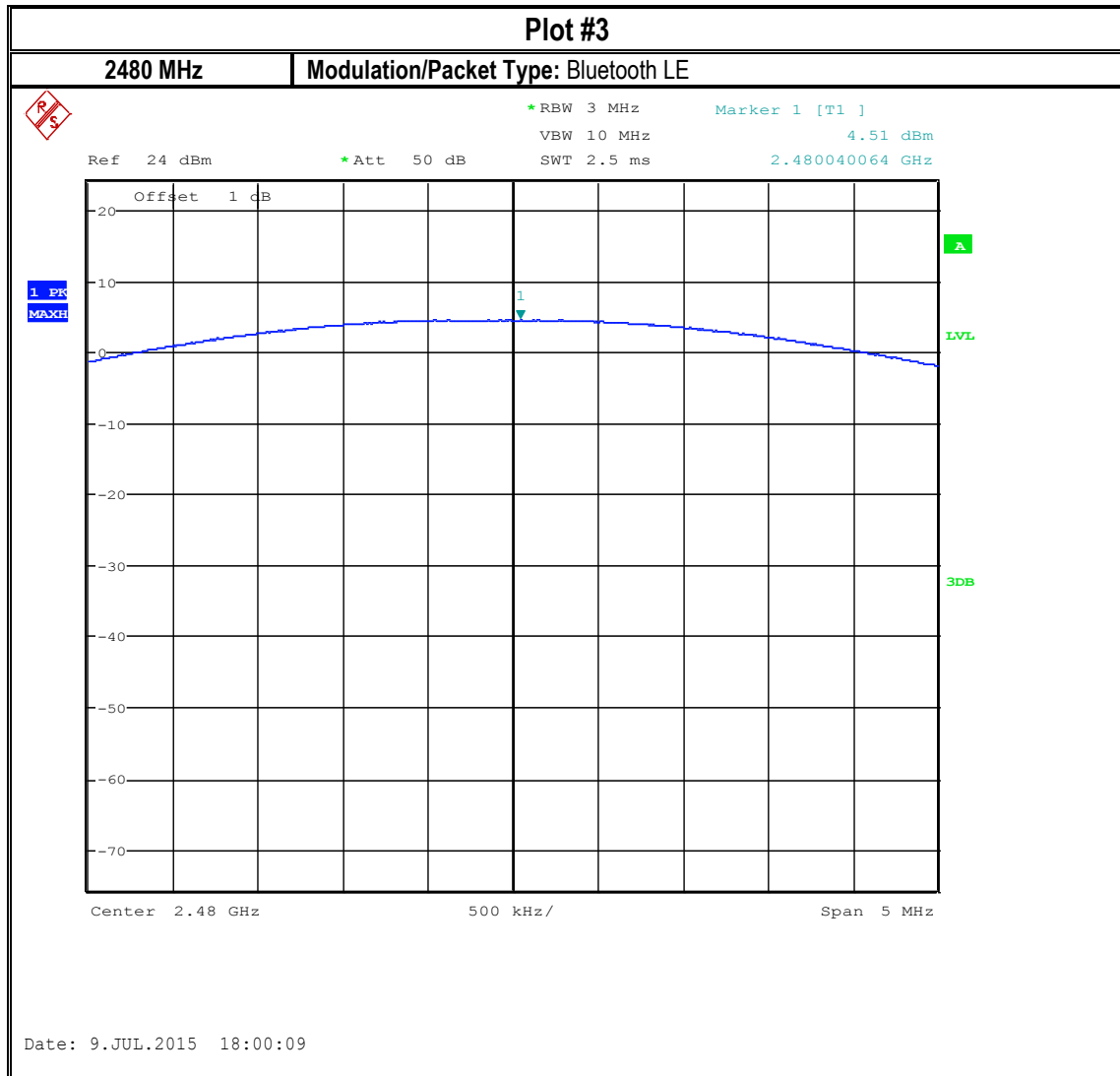
#### 8.1.4 Measurement result:

Plot #	Frequency (MHz)	Maximum Peak Conducted Output Power (dBm)	EIRP (dBm)	Limit (dBm)	Result
1	2402	4.10	8.44	30(Pk) / 36(EIRP)	Pass
2	2441	4.54	8.88	30(Pk) / 36(EIRP)	Pass
3	2480	4.51	8.85	30(Pk) / 36(EIRP)	Pass

### 8.1.5 Measurement Plots:







## 8.2 Power Spectral Density

### 8.2.1 Measurement according to FCC KDB 558074 D01 V03R03

#### Spectrum Analyzer settings for Peak PSD method:

Set analyzer center frequency to DTS channel center frequency.

Set the span to 1.5 times the DTS bandwidth

Set RBW to:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .

Set the VBW  $\geq 3 \times \text{RBW}$ .

Detector = peak.

Sweep time = auto couple.

Trace mode = max hold.

Allow trace to fully stabilize.

Use the peak marker function to determine the maximum amplitude level within the RBW.

If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

### 8.2.2 Limits: §15.247(e) & RSS247 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 8 dBm in any 3 kHz band during any time interval of continuous transmission.

### 8.2.3 Test conditions and setup:

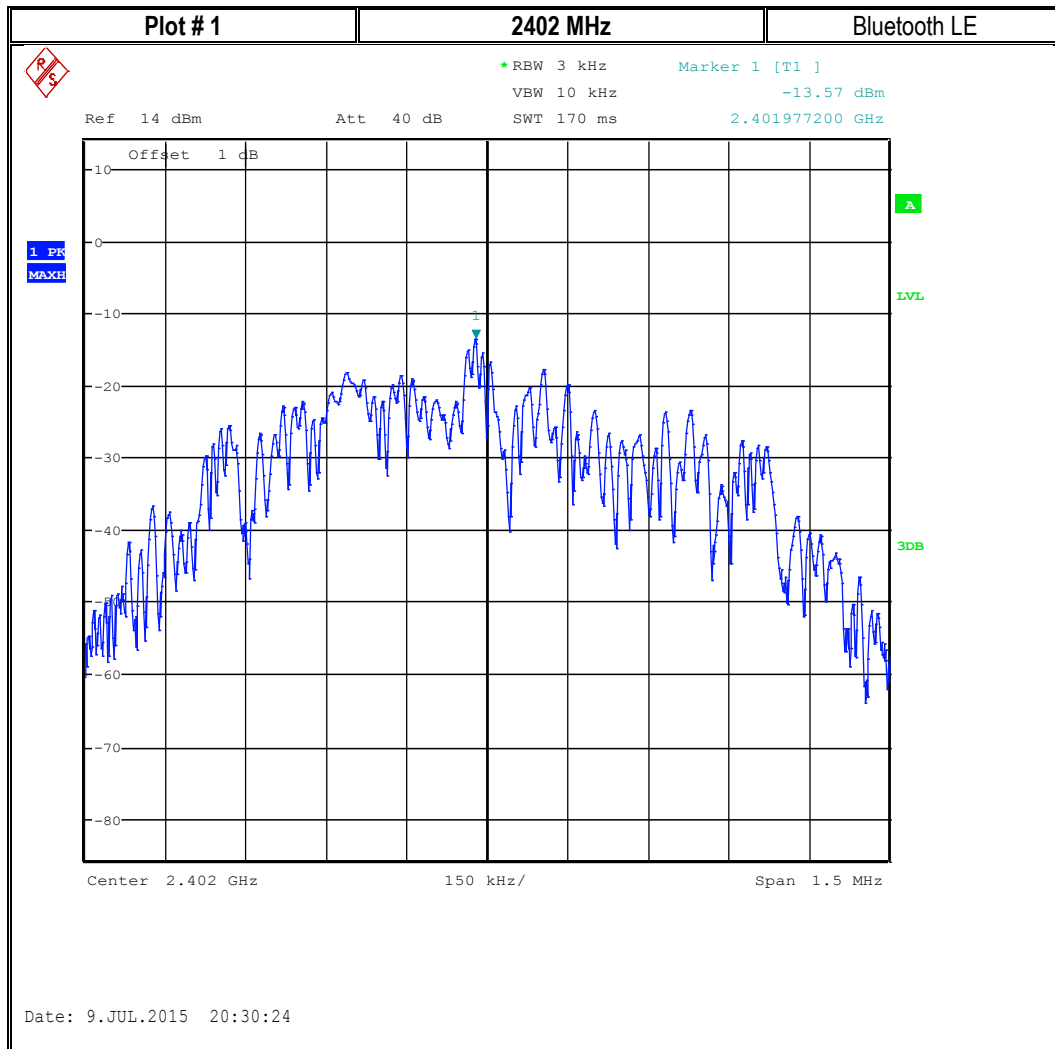
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
22° C	1	GFSK continuous fixed channel	3.3V DC

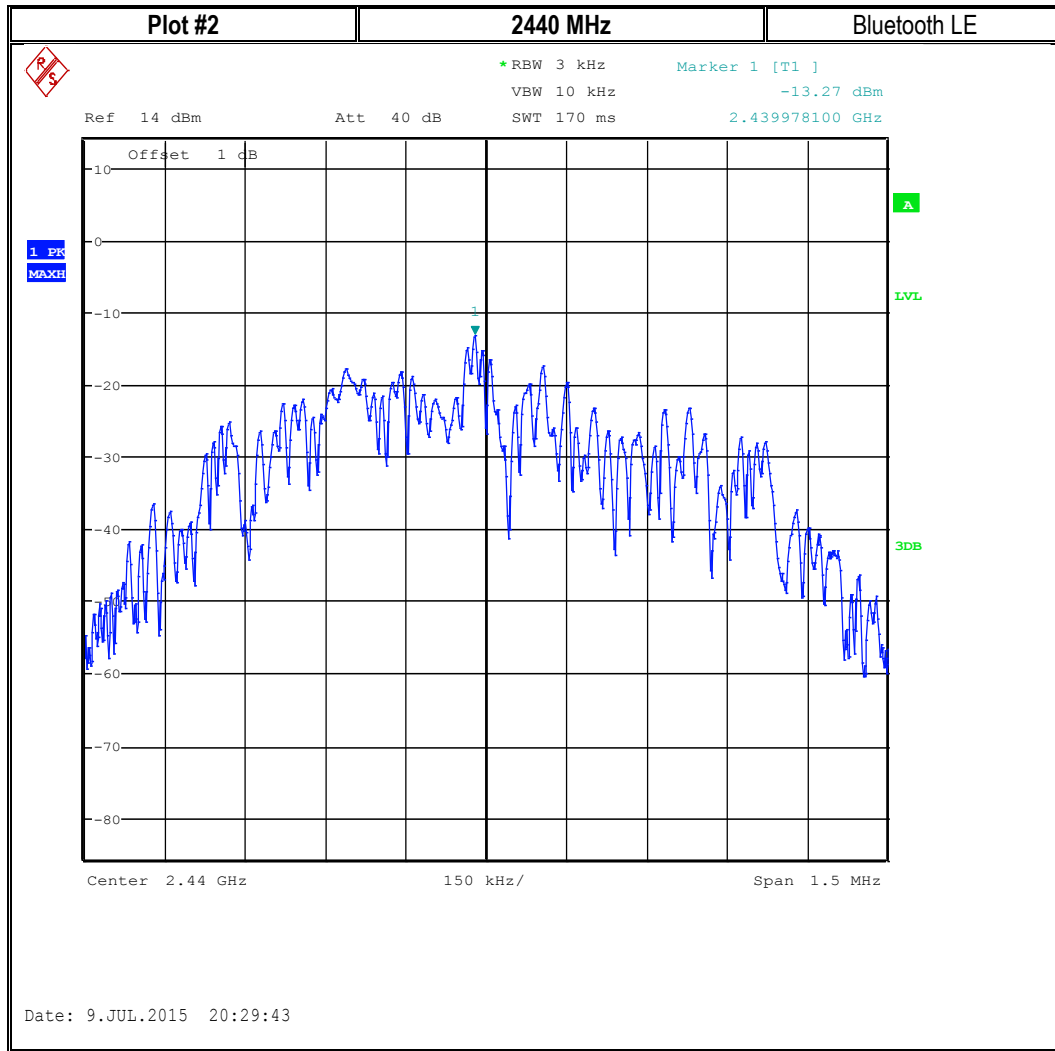
### 8.2.4 Measurement result:

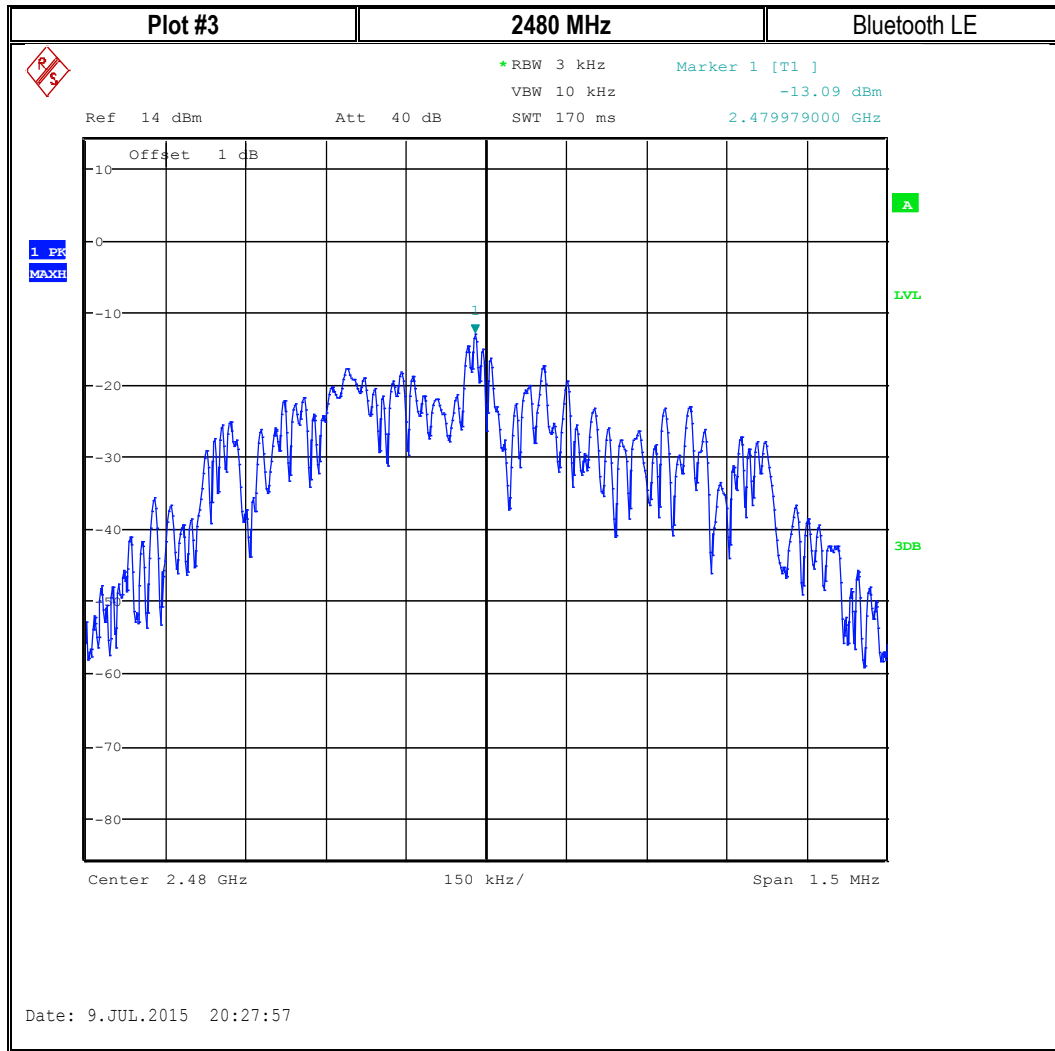
Plot #	Frequency (MHz)	Maximum Power Spectral Density (dBm)	Limit ( dBm / 3 KHz )	Result
1	2402	-13.57	8	Pass
2	2442	-13.27	8	Pass
3	2480	-13.09	8	Pass



## 8.2.5 Measurement Plots:







### 8.3 Band Edge and Restricted Band Compliance

#### 8.3.1 Measurement according to FCC KDB 558074 D01 v03r03

##### Spectrum Analyzer settings for non-restricted band edge:

Span: wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation.

RBW  $\geq$  1% of the span

VBW  $\geq$  RBW

Sweep Time: Auto

Detector = peak

Trace = max hold

Allow the trace to stabilize. Set the marker on the emission at the band edge, or on the highest modulation product outside of the band, if this level is greater than that at the band edge.

##### Spectrum Analyzer settings for restricted band:

Peak measurements are made using a peak detector and RBW=1 MHz, VBW  $\geq$  RBW

#### 8.3.2 Limits restricted band §15.247/15.209/15.205 and RSS-Gen 8.9/8.10

\*PEAK LIMIT= 74dB $\mu$ V/m @3m =-21.23dBm

\*AVG. LIMIT= 54dB $\mu$ V/m @3m =-41.23dBm

Start frequency & stop frequency according to frequency range specified in the restricted band table in FCC section 15.205 & RSS-Gen 8.10

Measurements with a peak detector were used to show compliance to average limits, thus showing compliance to both peak and average limits.

- (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
<sup>1</sup> 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	( <sup>2</sup> )
13.36 - 13.41			

### 8.3.3 Limits non restricted band §15.247(d) and RSS-247 5.5

#### FCC15.247 (d)

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

#### RSS-247 5/5

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30dB instead of 20dB.

### 8.3.4 Test conditions and setup:

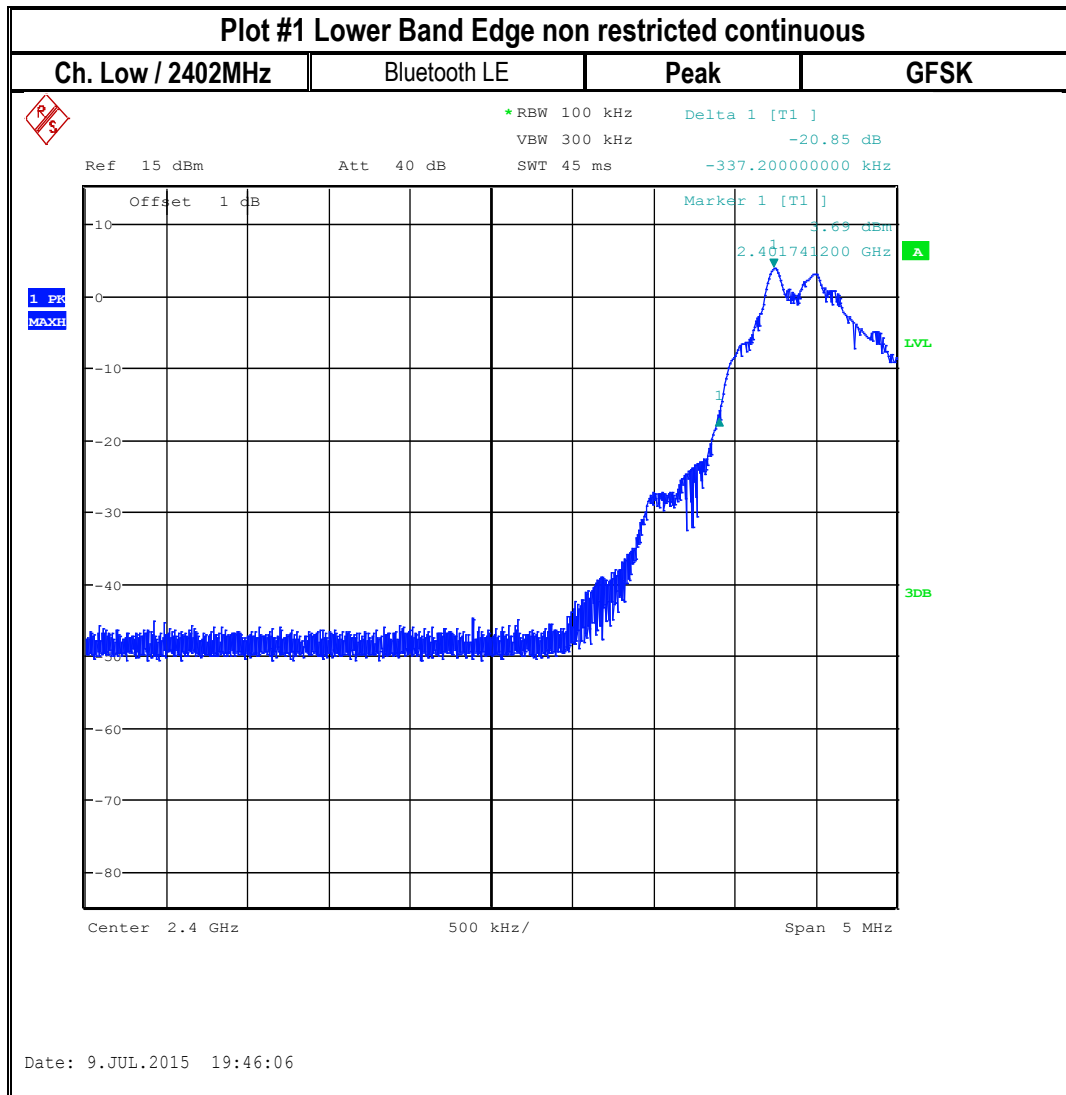
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input	Antenna Gain (dBi)
21.6° C	1	GFSK continuous fixed channel	3.3V DC	4.34

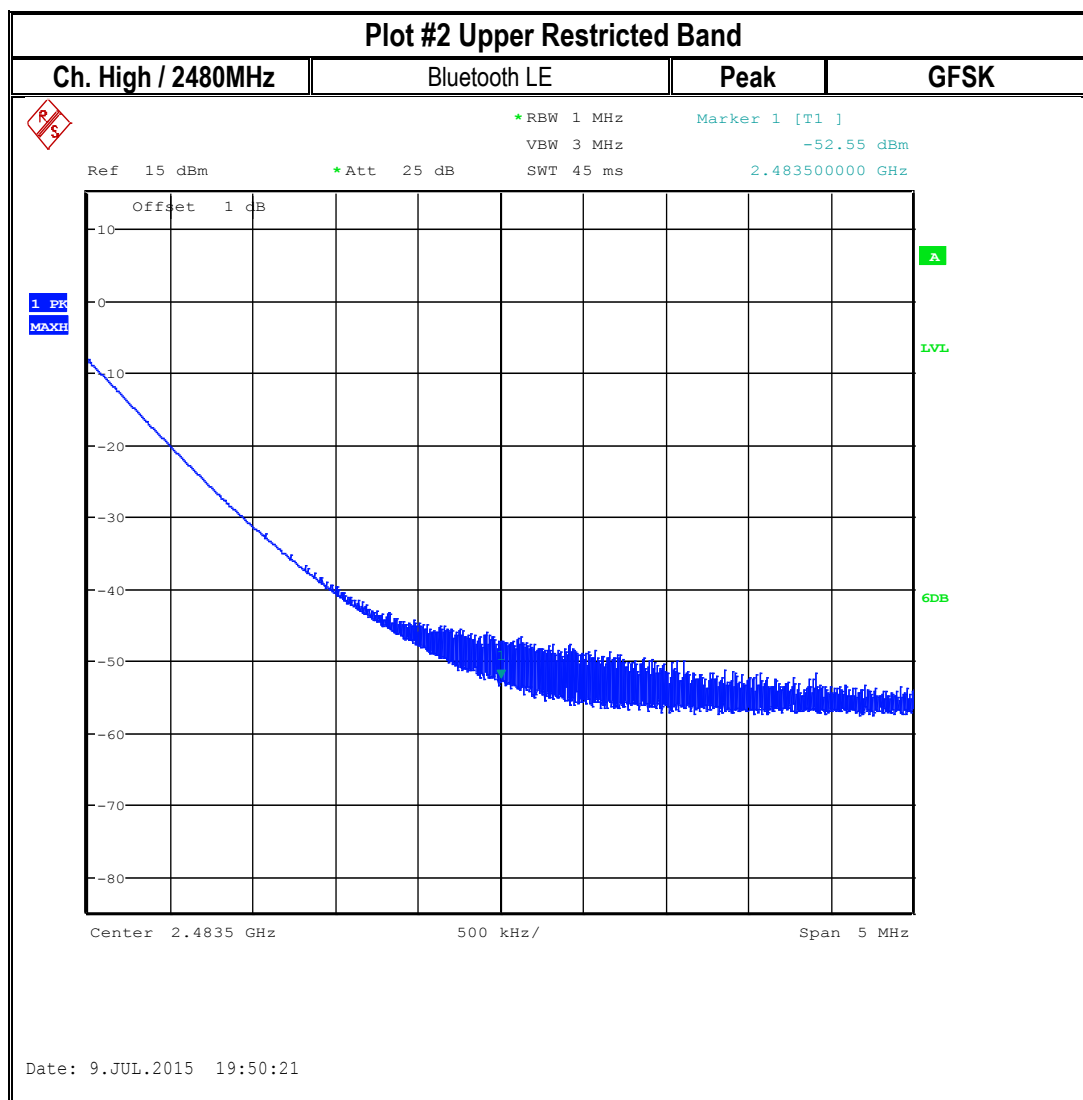
### 8.3.5 Measurement result:

Plot #	Band Edge	Band Edge Delta (dBc)	Limit (dBc)	Result
1	Lower non restricted	> 40dB	20	Pass

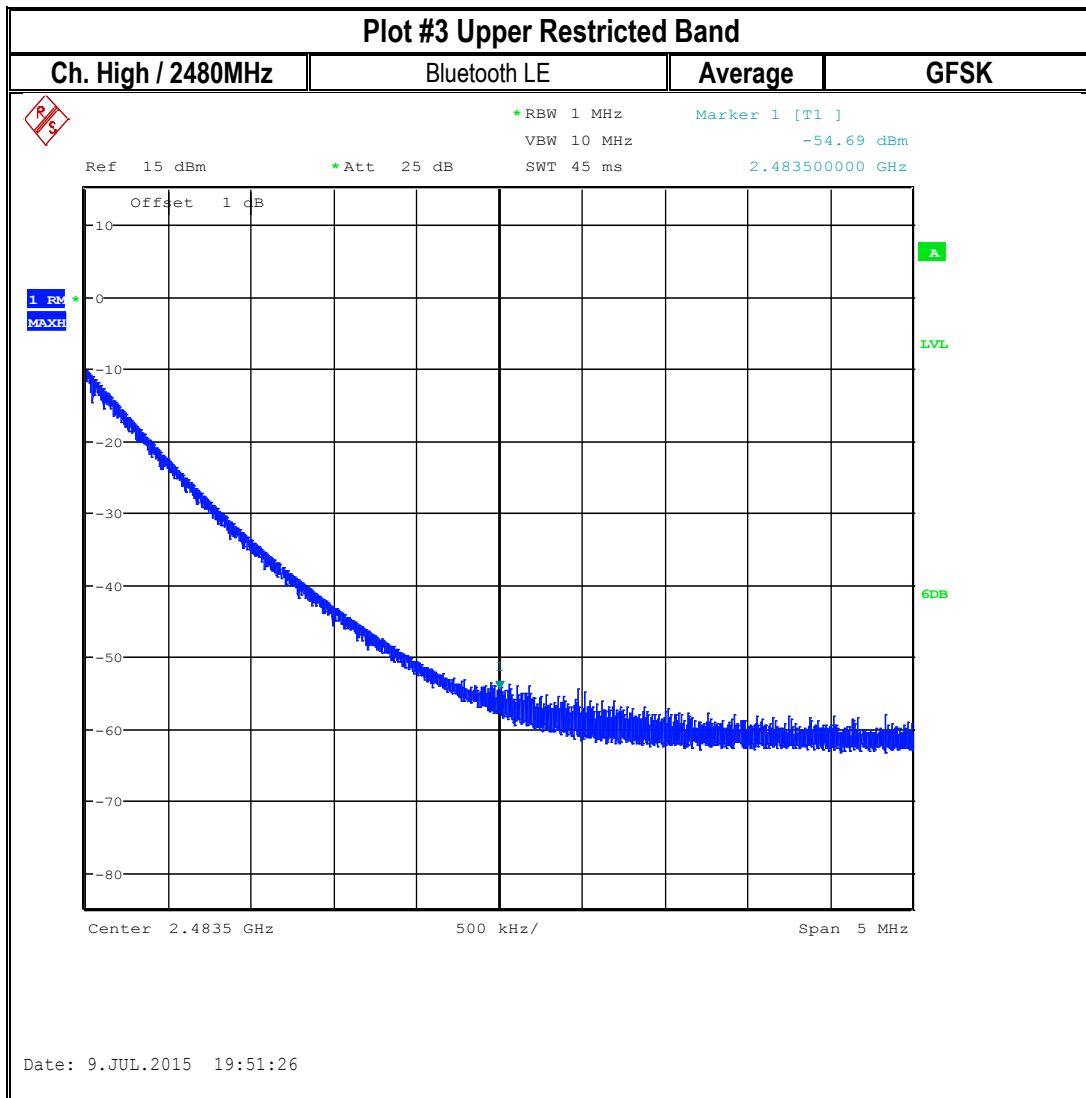
Plot #	EUT operating mode	Band Edge	Measured Value (dBm)	Corrected by Gain (dBm)	Average limit (dBm)	Result
2	GFSK continuous fixed channel	Upper restricted peak	-52.5	-48.2	-41	Pass
3	GFSK continuous fixed channel	Upper restricted average	-54.7	-50.36	-41	Pass

### 8.3.6 Measurement Plots:





**Note:** The Peak detector measurement is passing the average limit with a margin greater than the antenna gain (4.34dBi) that is not included in the offset.



**Note:**            The Peak detector measurement is passing the average limit with a margin greater than the antenna gain (4.34dBi) that is not included in the offset.



## 8.4 Emission Bandwidth 6dB

### 8.4.1 Measurement according to FCC KDB 558074 D01 v03r03

#### Spectrum Analyzer settings:

Set RBW = 100 kHz

Set the video bandwidth (VBW)  $\geq 3 \times$  RBW

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

### 8.4.2 Limits: §15.247(a)(1) and RSS247 5.2(1)

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.

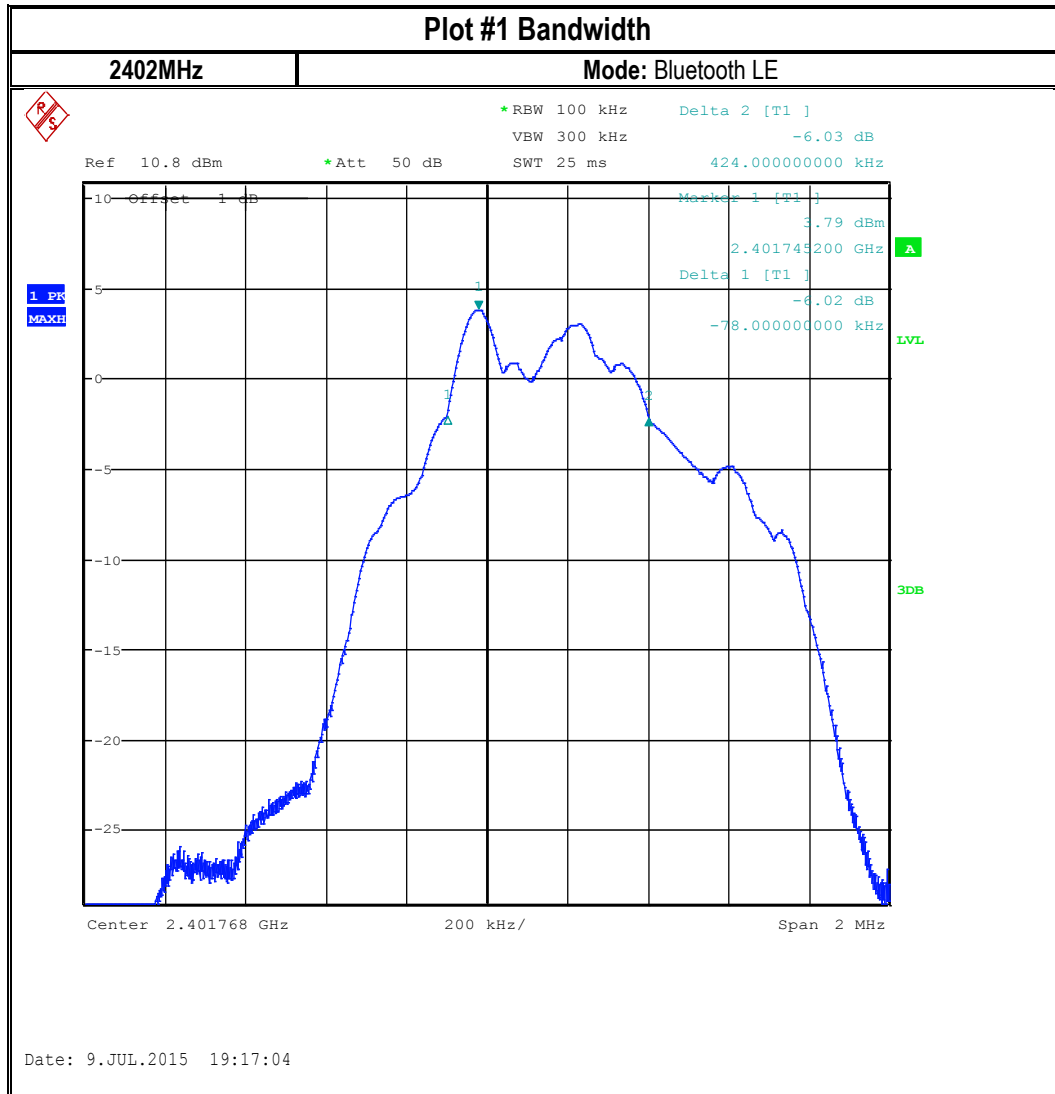
### 8.4.3 Test conditions and setup:

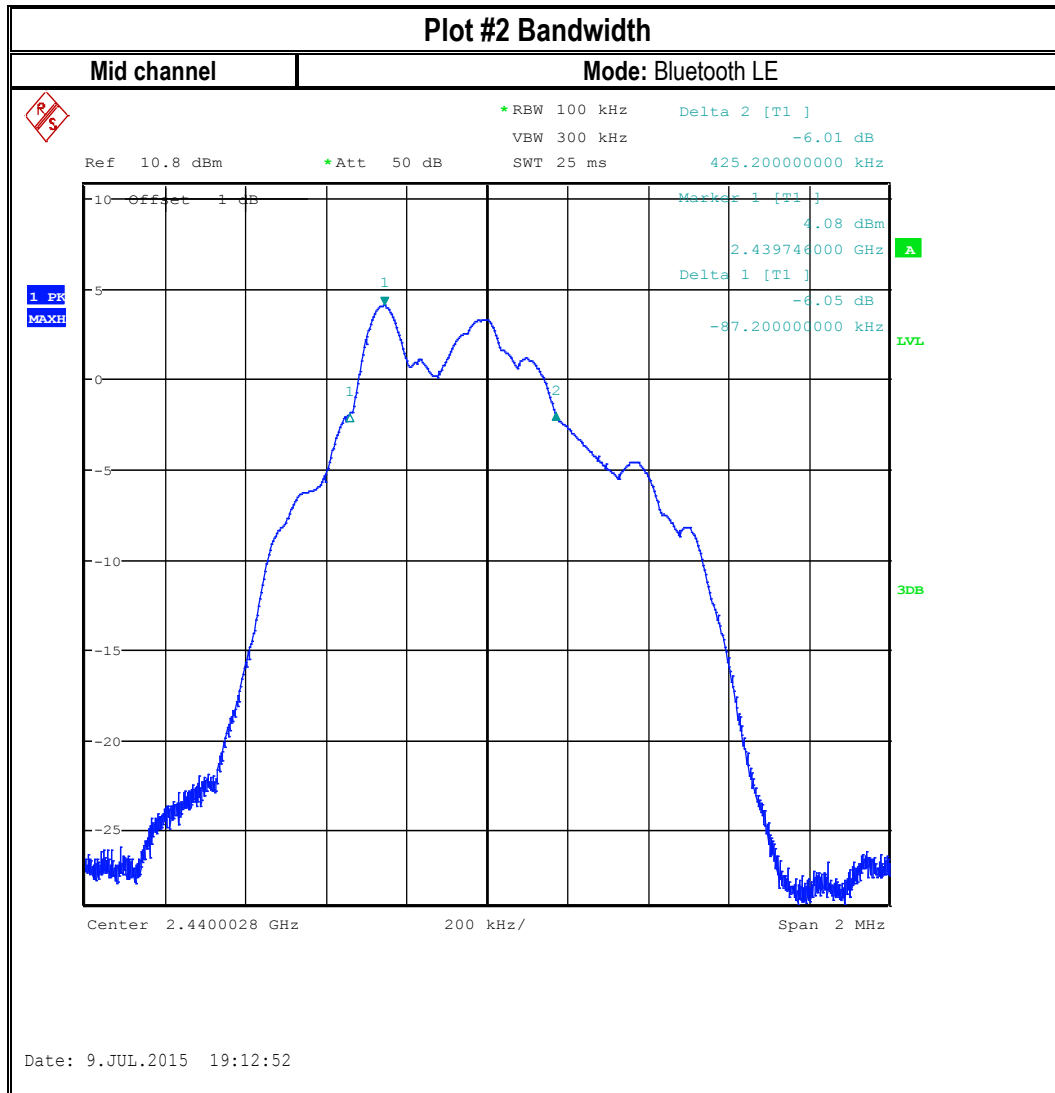
Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
21.6° C	1	GFSK continuous fixed channel	3.3V DC

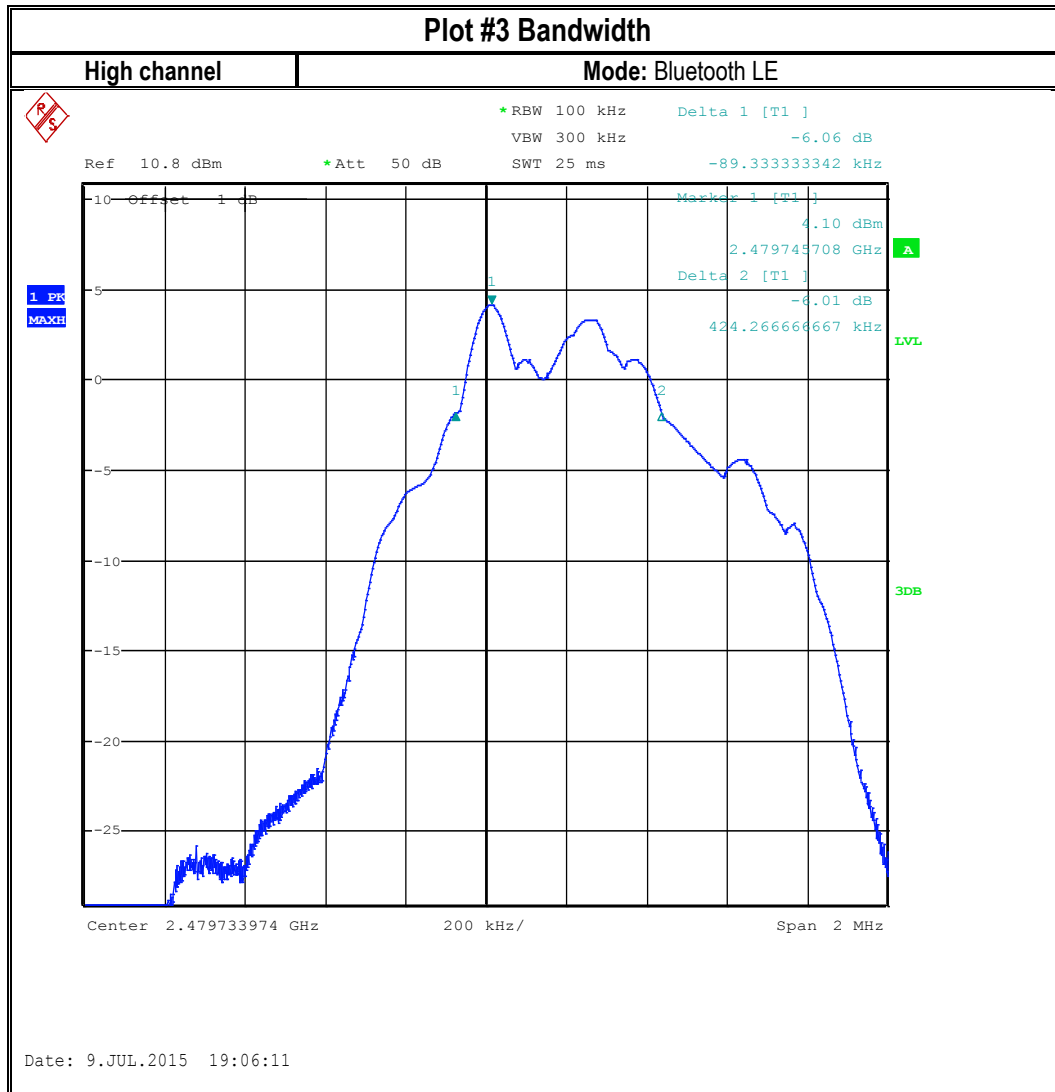
### 8.4.4 Measurement result:

Plot #	Frequency (MHz)	6dB Emissions Bandwidth (MHz)	Limit (MHz)	Result
1	2402	0.502	> 0.5	Pass
2	2442	0.512	> 0.5	Pass
3	2480	0.514	> 0.5	Pass

#### 8.4.5 Measurement Plots:







## 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
<sup>1</sup> 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	( <sup>2</sup> )
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= 74dB $\mu$ V/m\*AVG. LIMIT= 54dB $\mu$ V/m

Table 1:

Frequency of emission (MHz)	Field strength @ 3m ( $\mu$ V/m)	Field strength @ 3m (dB $\mu$ V/m)
30–88	100	40dB $\mu$ V/m
88–216	150	43.5 dB $\mu$ V/m
216–960	200	46 dB $\mu$ V/m
Above 960	500	54 dB $\mu$ V/m

Table 2:

Frequency of emission (MHz)	Field strength ( $\mu$ V/m) / (dB $\mu$ V/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) =  $40 \log (D/d) = 40 \log (300\text{m} / 3\text{m}) = 80\text{dB}$

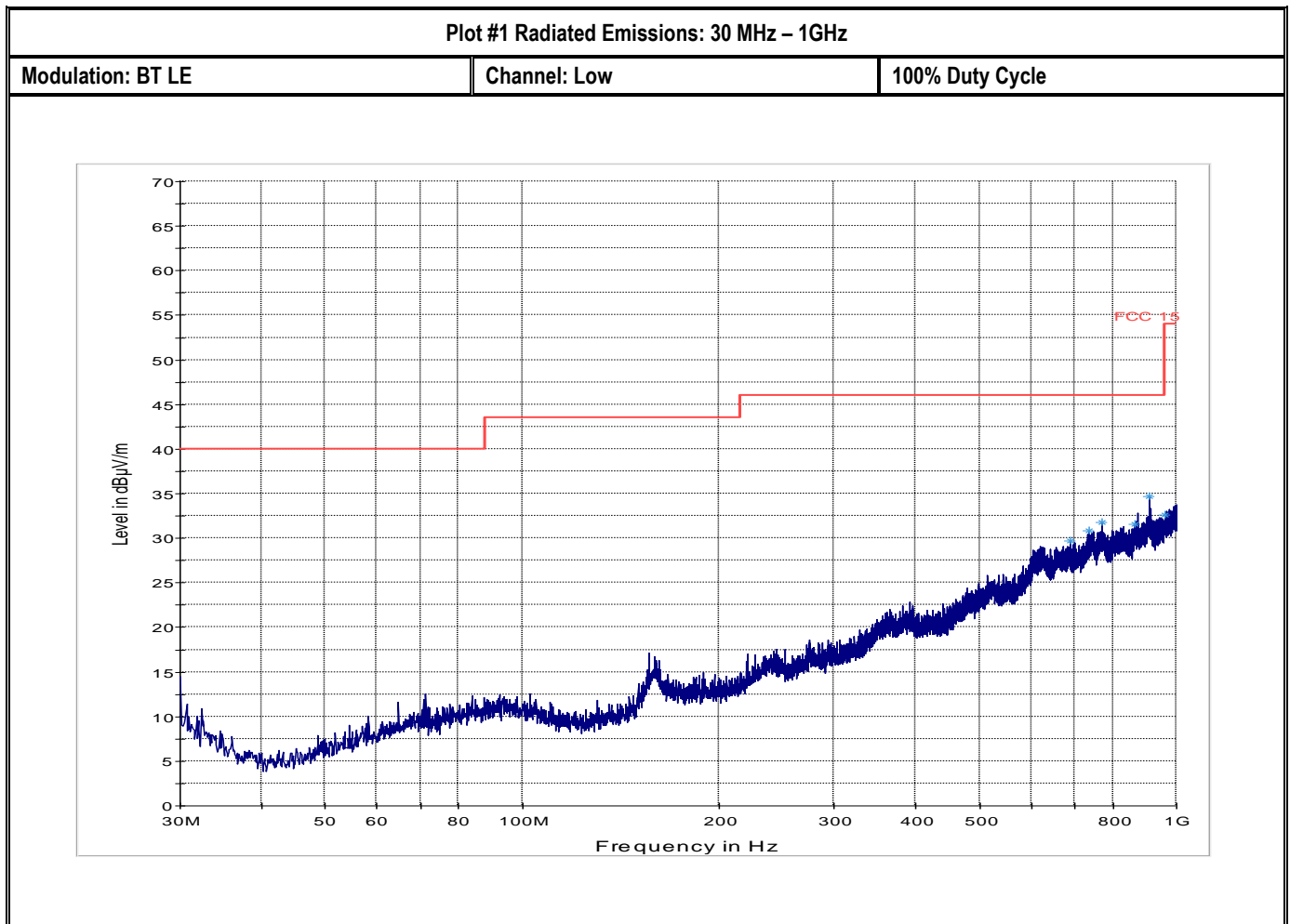
### 8.5.3 Test conditions and setup:

Ambient Temperature	EUT Set-Up #	EUT operating mode	Power Input
21.6° C	2	Continuous TX	3.3V DC

### 8.5.4 Measurement result:

Plot #	Channel #	Scan Frequency	Limit	Result
1-3	0	30 MHz – 18 GHz	See section 8.5.2	Pass
4-8	39	9 kHz – 26 GHz	See section 8.5.2	Pass
9-12	78	30 MHz – 18 GHz	See section 8.5.2	Pass

### 8.5.5 Measurement Plots:

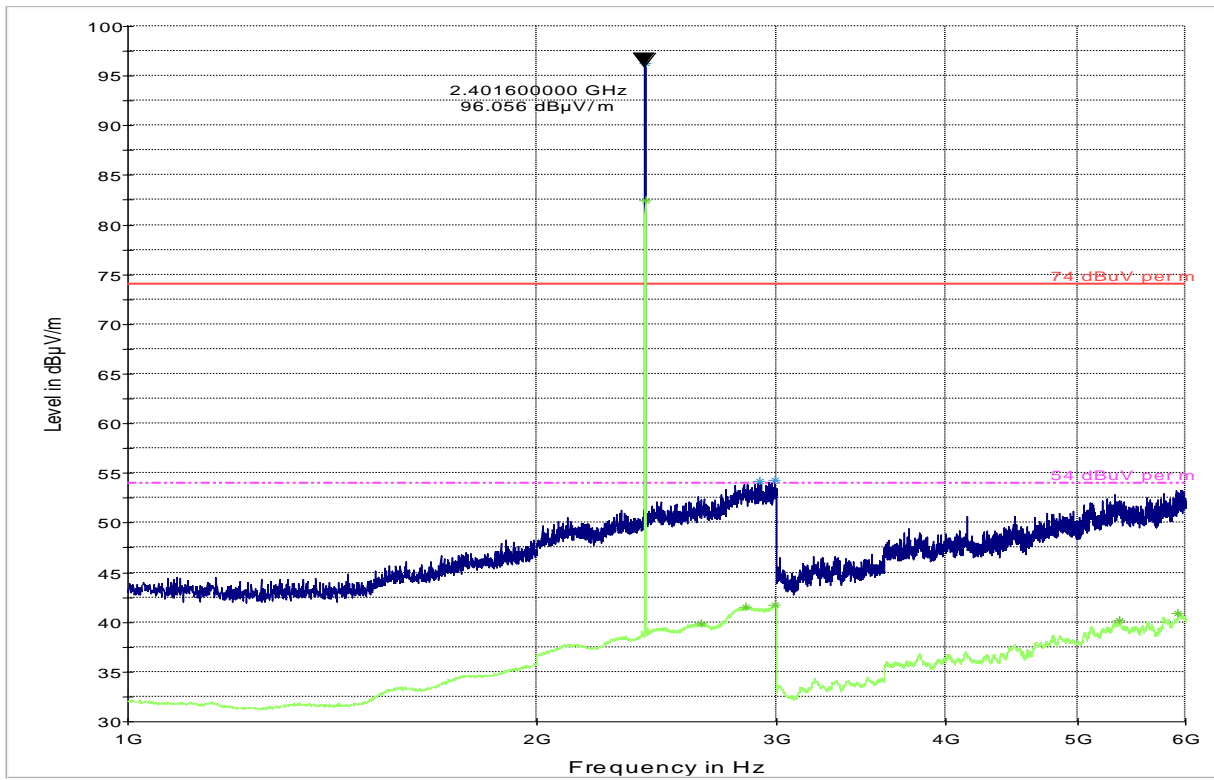


Plot # 2 Radiated Emissions: 1-6 GHz

Modulation: BT LE

Channel: Low

100% Duty Cycle



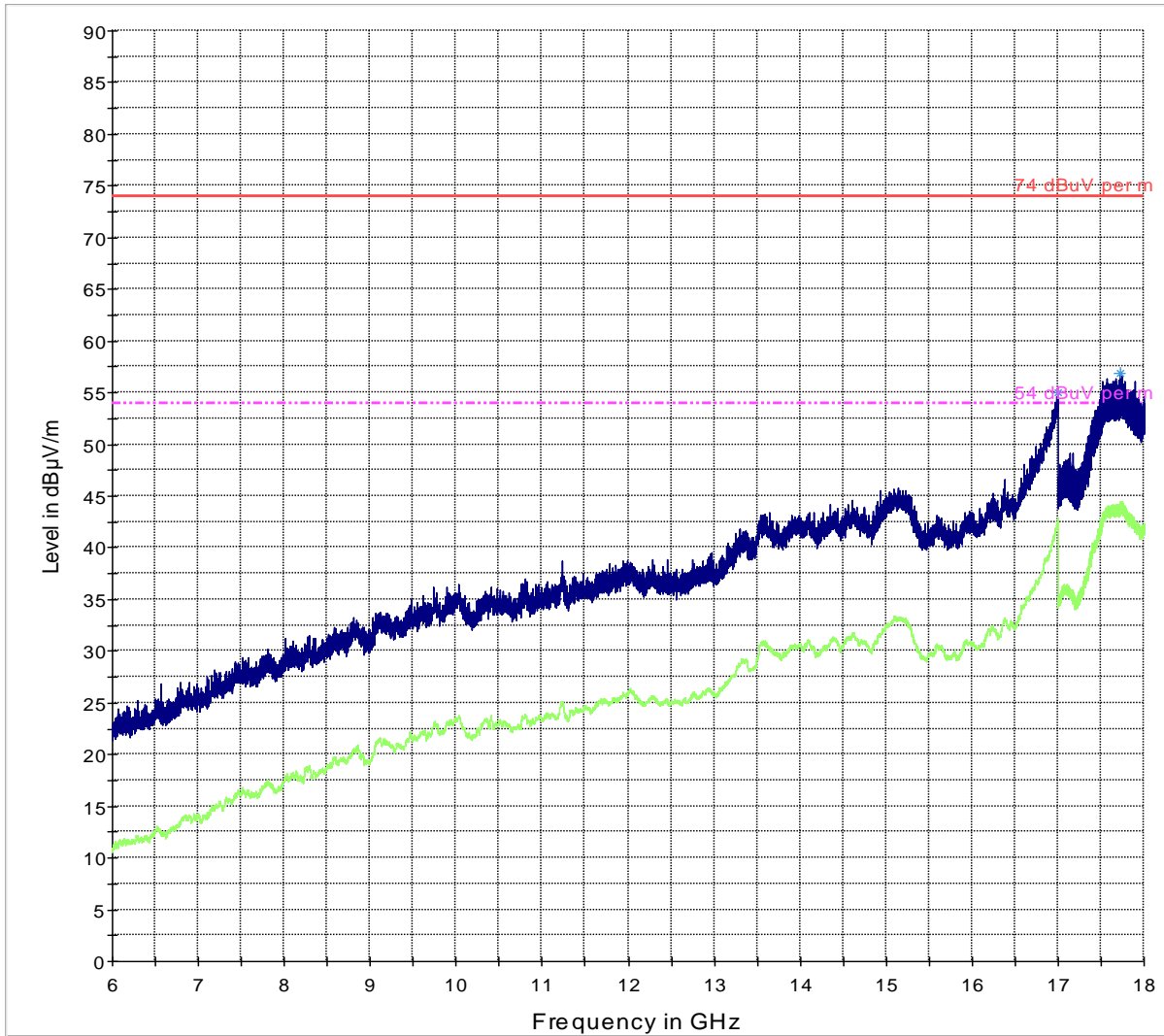


Plot # 3 Radiated Emissions: 6-18 GHz

Modulation: BT LE

Channel: Low

100% Duty Cycle

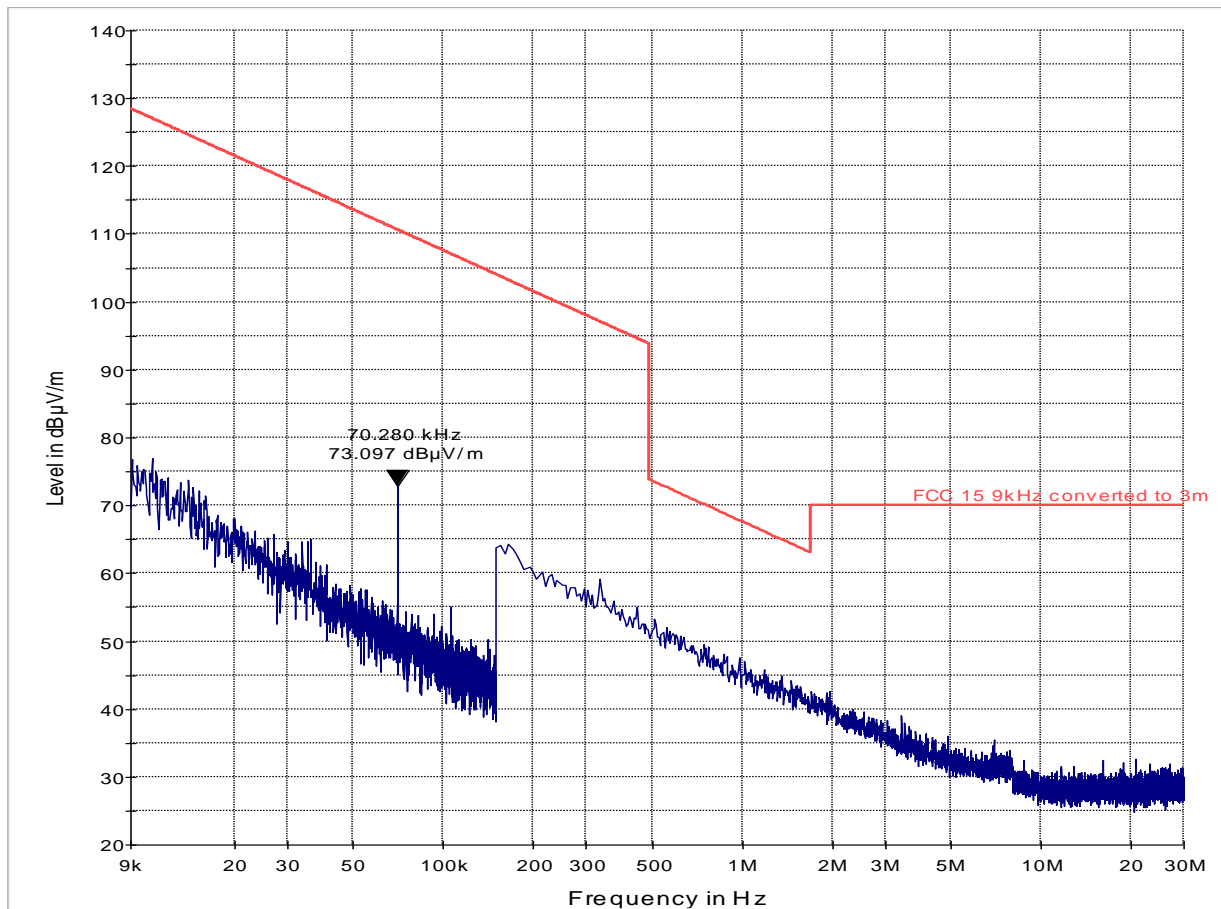


Plot # 4 Radiated Emissions: 9 KHz - 30 MHz

Modulation: BT LE

Channel: Mid

100% Duty Cycle

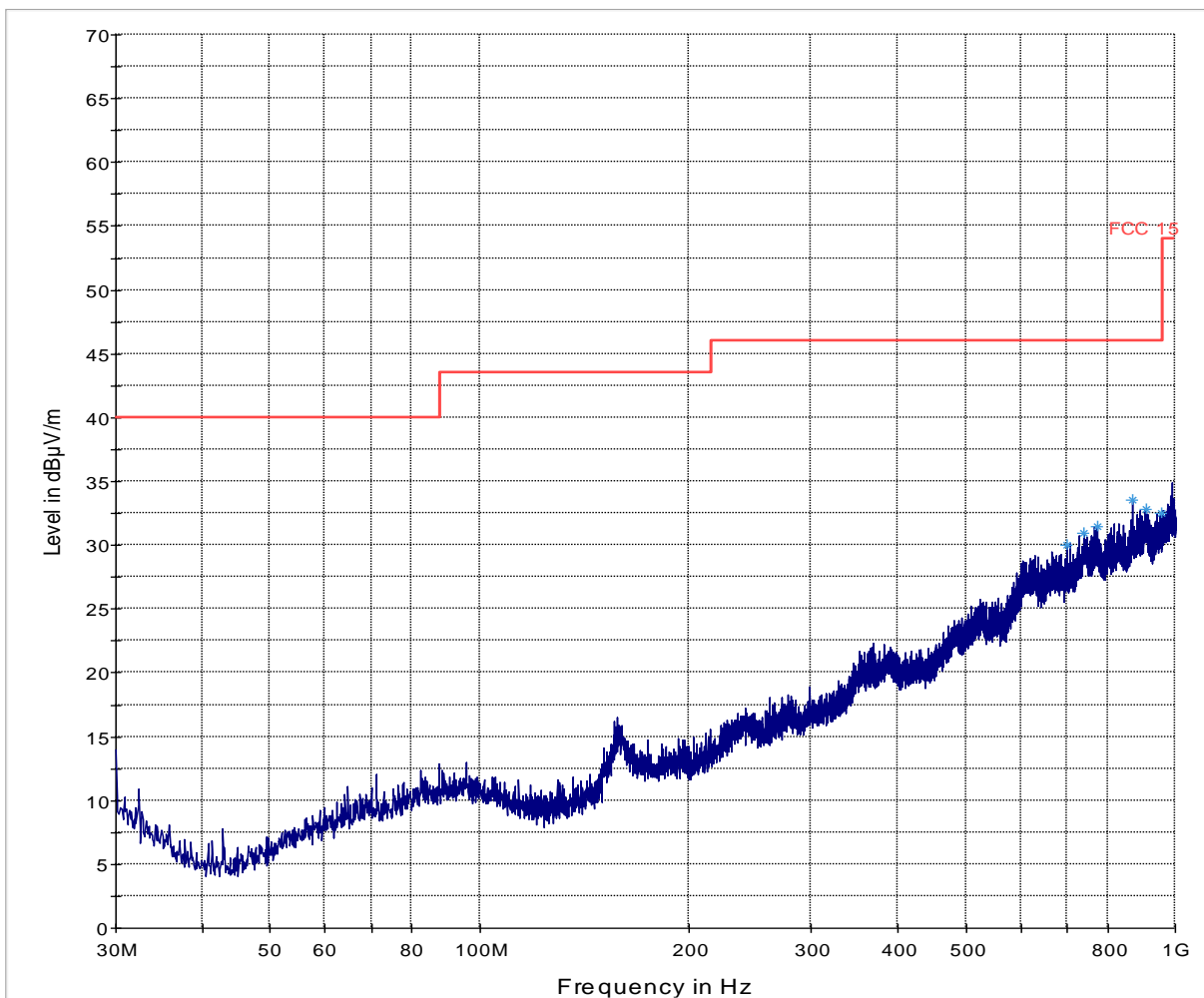


Plot #5 Radiated Emissions: 30 MHz – 1GHz

Modulation: BT LE

Channel: Mid

100% Duty Cycle

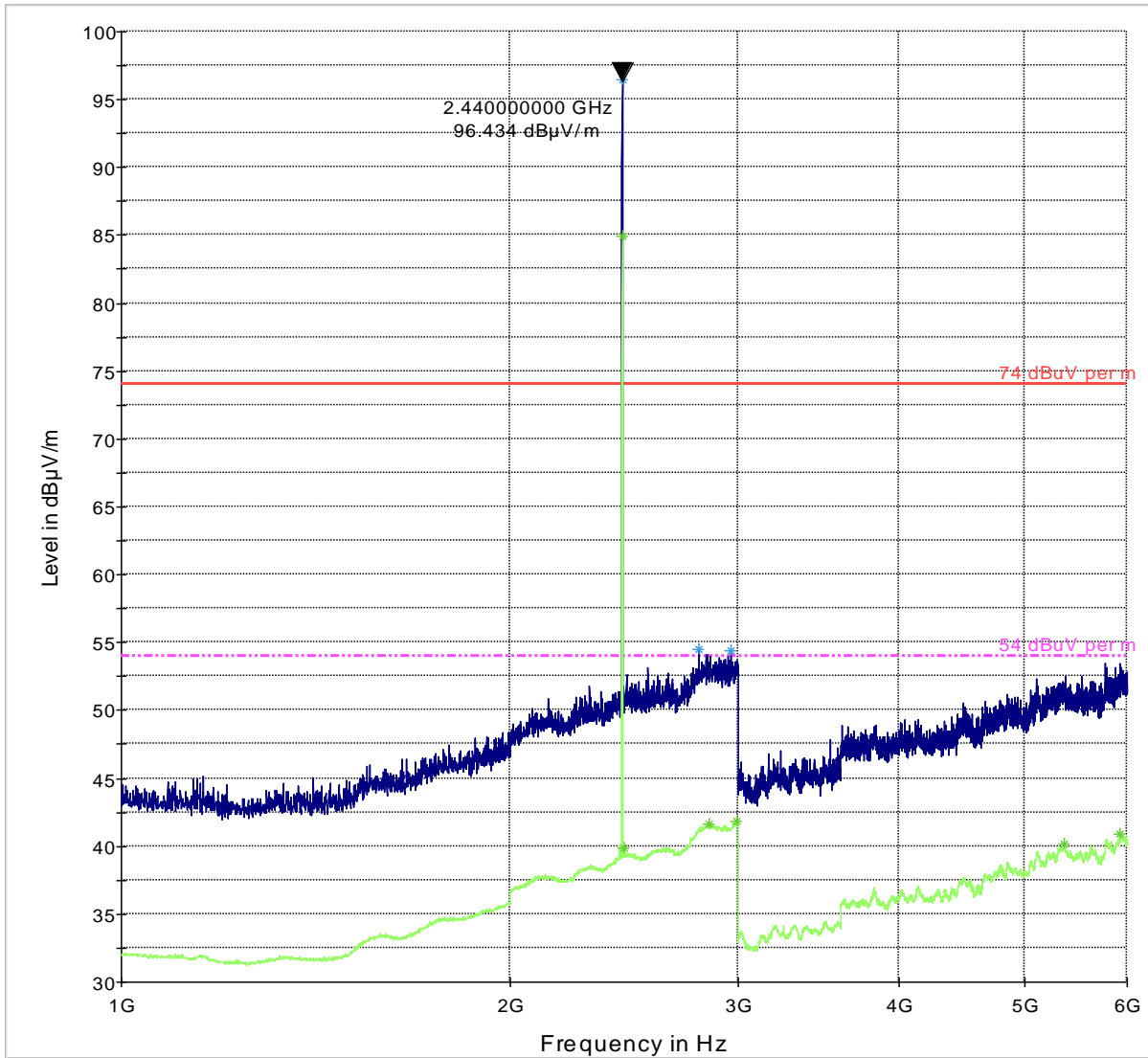


Plot #6 Radiated Emissions: 1-6 GHz

Modulation: BT LE

Channel: Mid

100% Duty Cycle

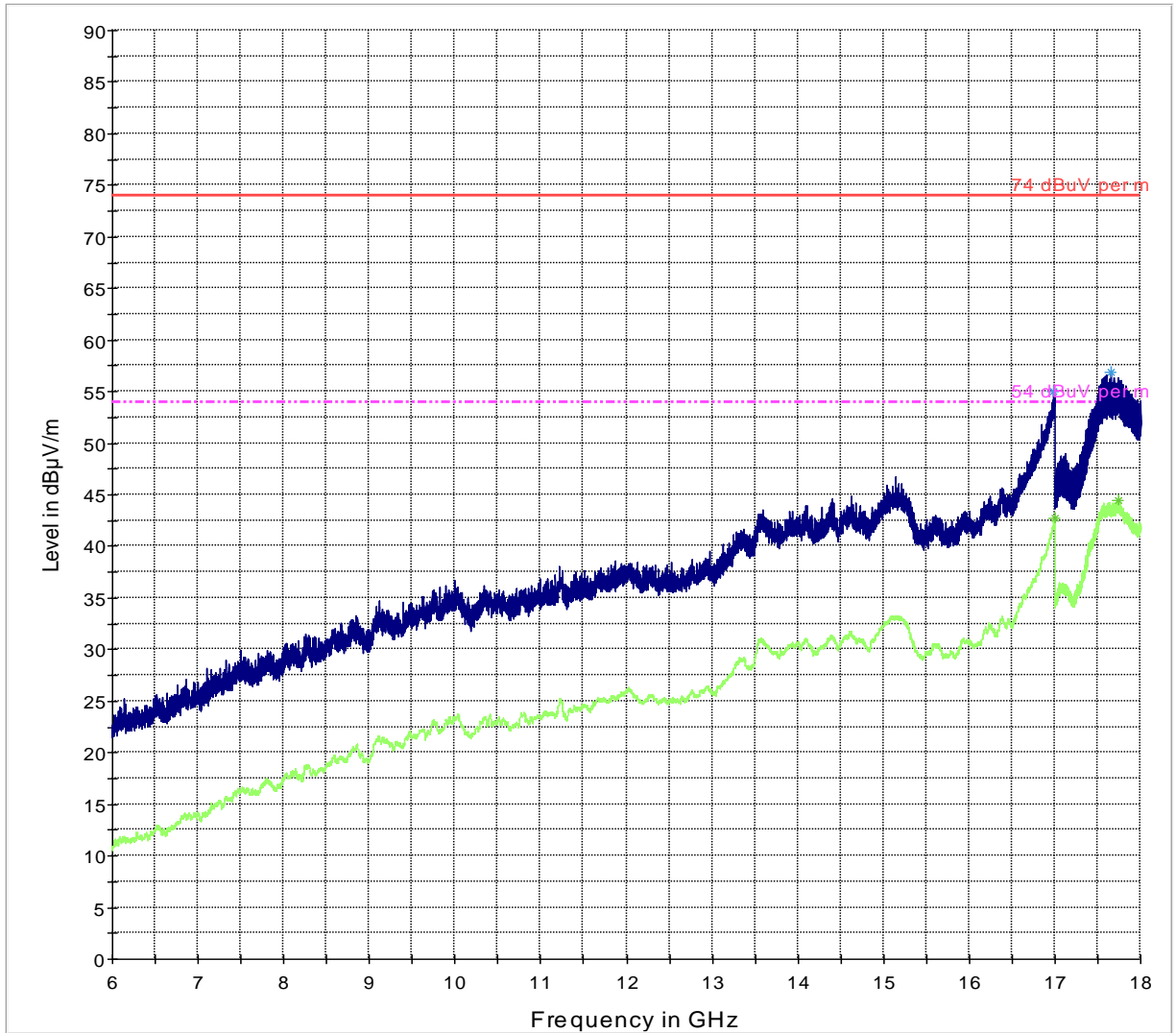


Plot #7 Radiated Emissions: 6-18 GHz

Modulation: BT LE

Channel: Mid

100% Duty Cycle

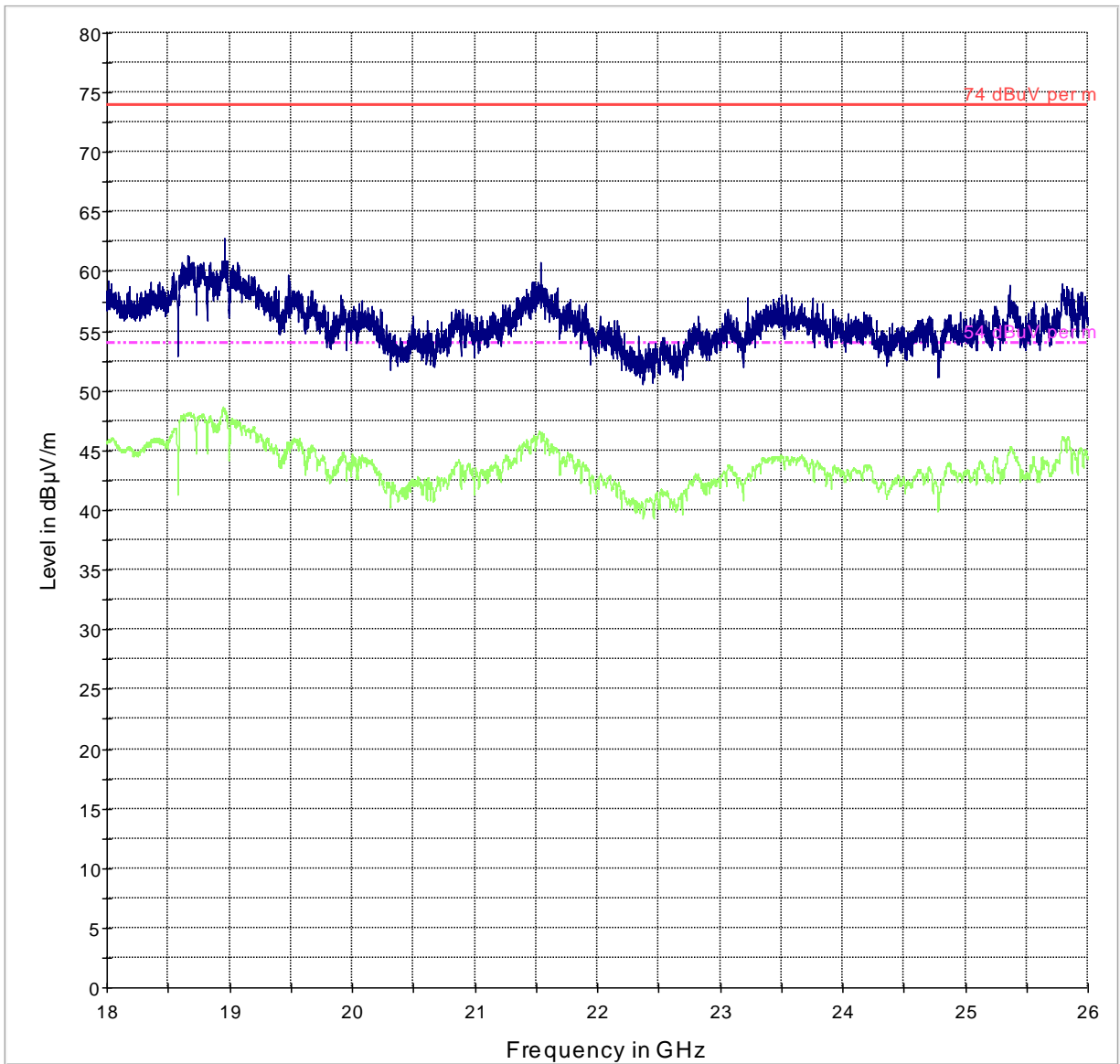


Plot #8 Radiated Emissions: 18-26 GHz

Modulation: BT LE

Channel: Mid

100% Duty Cycle

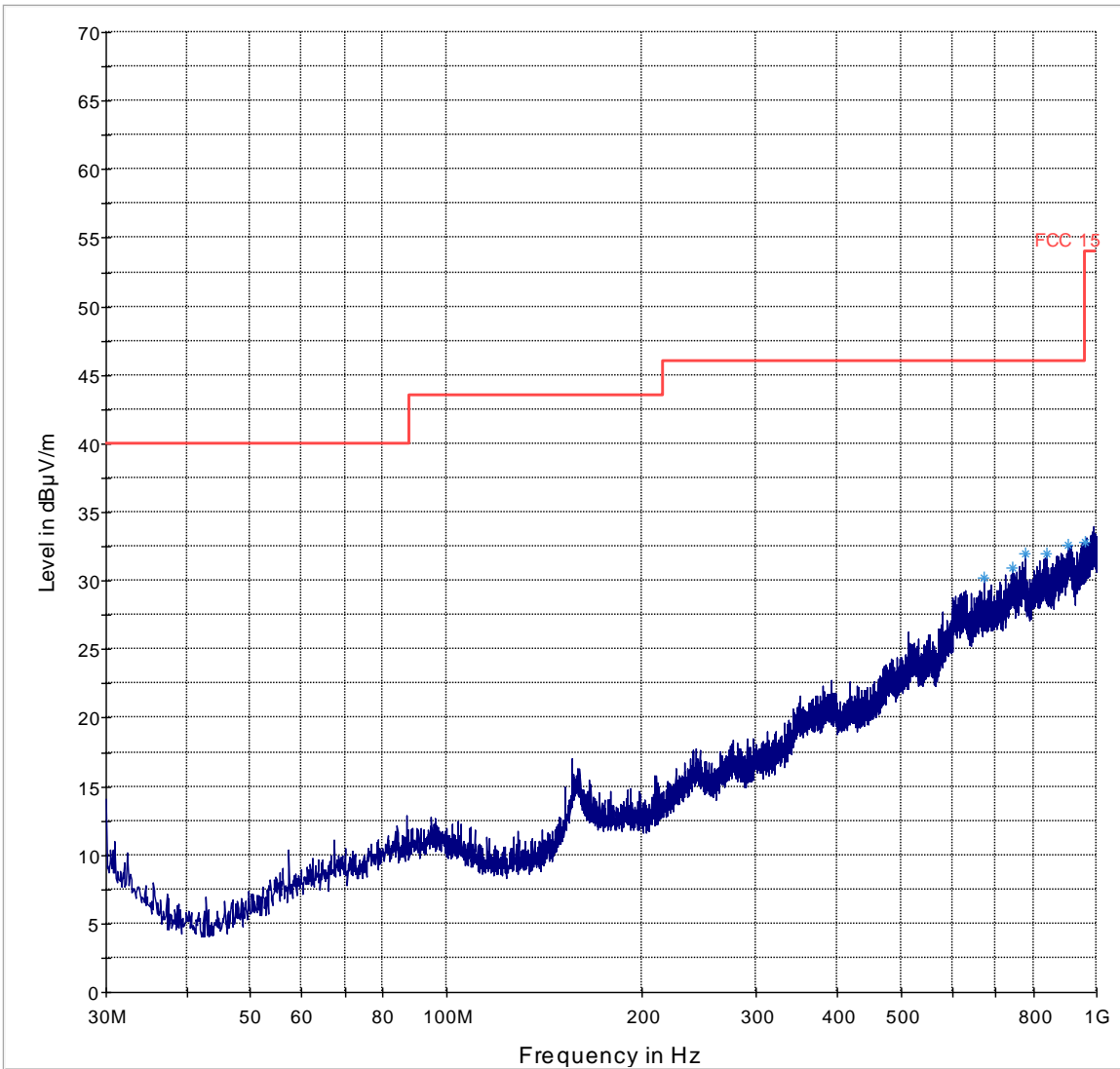


Plot #9 Radiated Emissions: 30 MHz – 1GHz

Modulation: BT LE

Channel: High

100% Duty Cycle

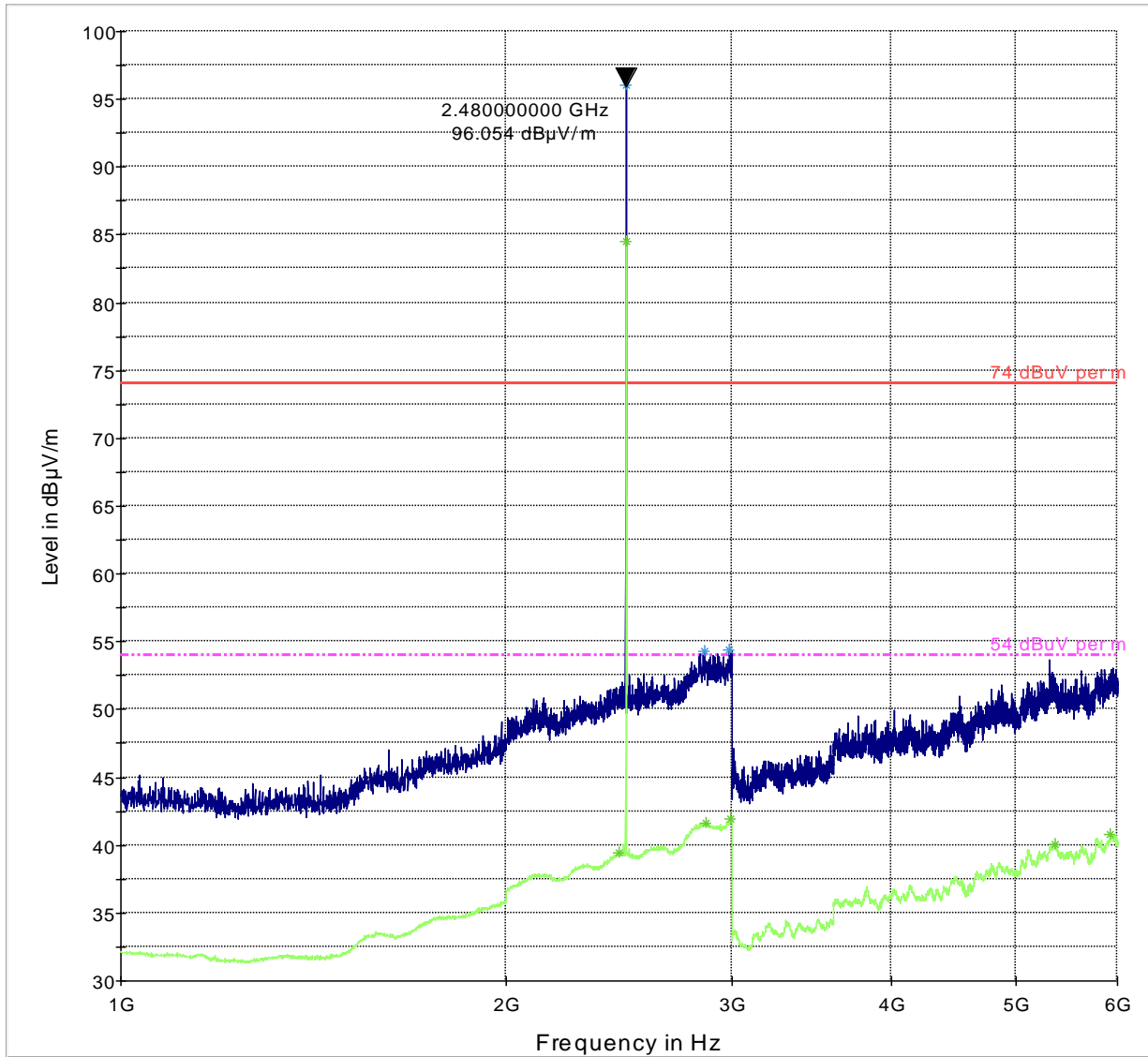


Plot # 10 Radiated Emissions: 1-6 GHz and Restricted Bands

Modulation: BT LE

Channel: High

100% Duty Cycle



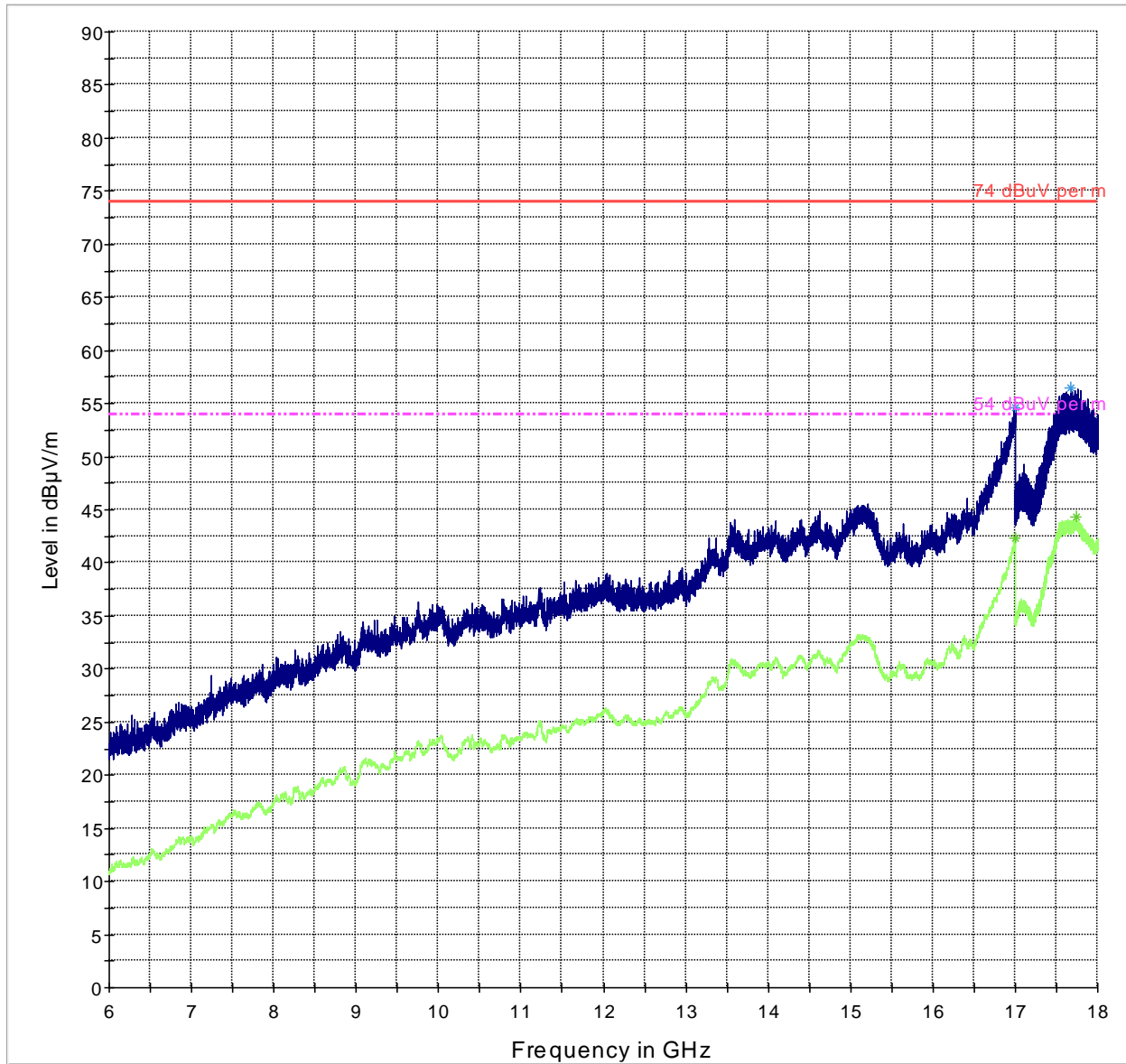


Plot #11 Radiated Emissions: 6-18 GHz

Modulation: GFSK

Channel: High

100% Duty Cycle



## 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(a) & 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  $\mu$ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between frequency ranges.

Table 1:

Frequency of emission (MHz)	Conducted limit (dB $\mu$ V)	
	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:

Ambient Temperature (C)	EUT Set-Up #	EUT operating mode	Power line (L1, L2, L3, N)	Power Input
22	3,4	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	4	1	150 kHz – 30 MHz	See section 8.1.2	Pass
2	AC Mains	3	1	150 kHz – 30 MHz	See section 8.1.2	Pass

## 8.6.5 Measurement Plots:

Plot #1

Emissions Test Data

1 / 1

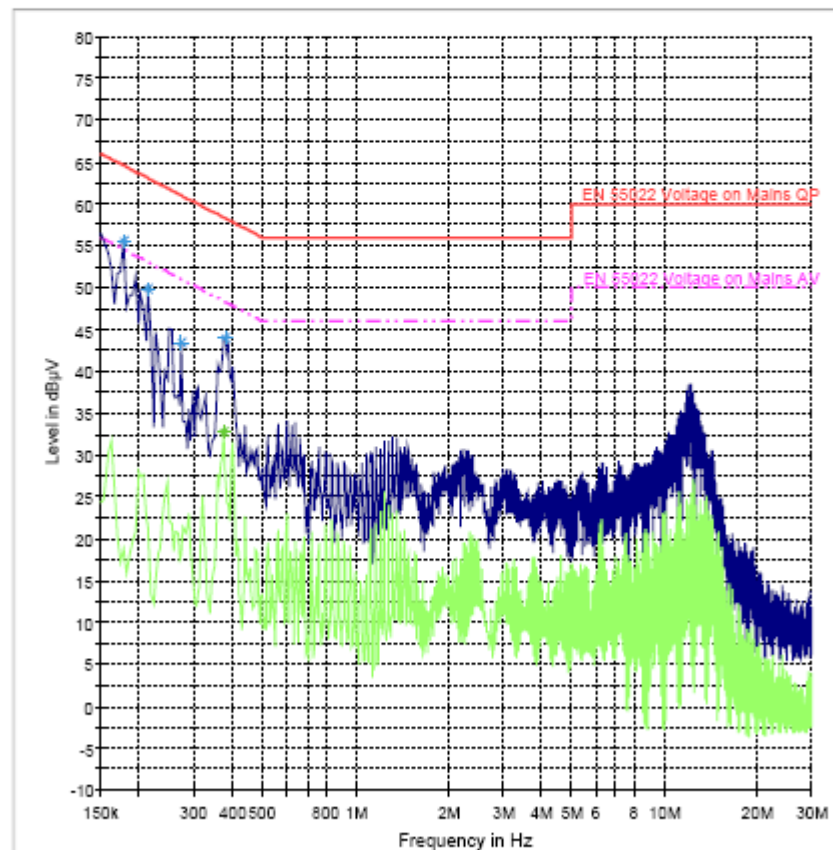


### EUT Information

EUT Name: Z78  
Manufacturer: ACI  
Serial Number: CC2PT01UGQN7  
Hardware Rev:  
Software Rev:  
Comment: AC; LE

*Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.*

CISPR 22 Mains Conducted FCC\_LISN



Test Date: 7/10/2015 1:49:36

Test Engineer: SMOON

Plot #2

Emissions Test Data

1 / 1



**EUT Information**

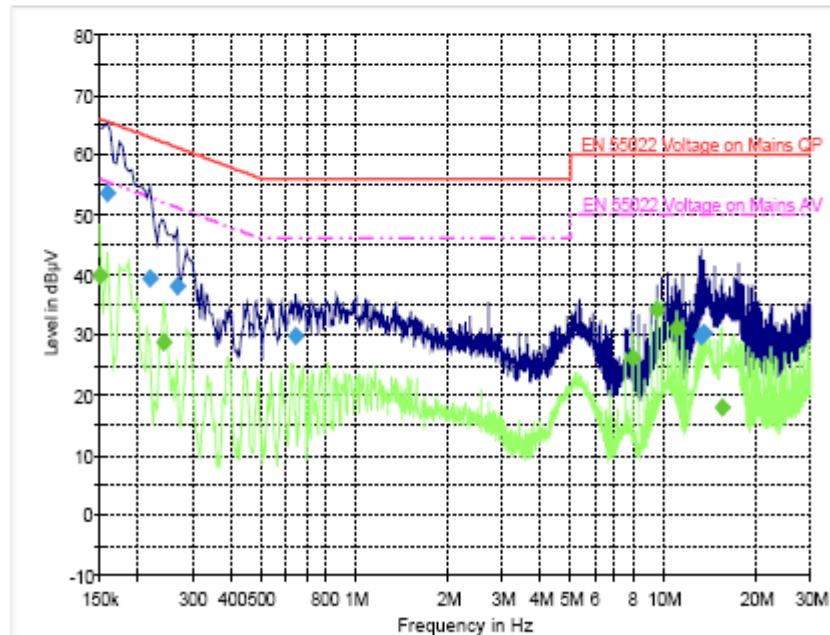
EUT Name: Z78  
 Manufacturer: ACI  
 Serial Number: CC2PT01UGQN7  
 Hardware Rev:  
 Software Rev:  
 Comment: laptop; LE

**Final Result 1**

Frequency (MHz)	QuasiPeak (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	PE	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)	Comment
0.158000	53.6	20.0	9.000	GND	L1	1.0	11.9	65.6	
0.218000	39.3	20.0	9.000	GND	L1	0.8	23.6	62.9	
0.266000	38.2	20.0	9.000	GND	L1	0.6	23.1	61.2	
0.646000	29.8	20.0	9.000	GND	N	0.4	26.2	56.0	
13.246000	29.9	20.0	9.000	GND	L1	0.9	30.1	60.0	
13.602000	30.2	20.0	9.000	GND	L1	0.9	29.8	60.0	

*Disclaimer: Any measurement data within 2dB from the limit line is conditional PASS/FAIL due to measurement uncertainty considerations.*

CISPR 22 Mains Conducted FCC\_LISN



Test Date: 7/10/2015 1:57:00

Test Engineer: SMoon

## 9 Test Equipment And Ancillaries Used For Testing

No.	Equipment Name	Manufacturer	Type/model	Serial No.	Cal Date	Cal Interval
	Turn table	EMCO	2075	N/A	N/A	N/A
	MAPS Position Controller	ETS Lindgren	2092	0004-1510	N/A	N/A
	Antenna Mast	EMCO	2075	N/A	N/A	N/A
	High Pass Filter	5HC2700	Trilithic Inc.	9926013	Part of system calibration	
	High Pass Filter	4HC1600	Trilithic Inc.	9922307	Part of system calibration	
	6GHz High Pass Filter	HPM50106	Microtronics	001	Part of system calibration	
	Pre-Amplifier	JS4-00102600	Miteq	00616	Part of system calibration	
	Relay Switch Unit	Rohde&Schwarz	RSU	338964/001	N/A	N/A
	EMI Receiver/Analyzer	Rohde&Schwarz	ESU 40	100251	July 2015	2 Year
	Spectrum Analyzer	Rohde&Schwarz	FSU	200302	July 2015	2 Years
	1500MHz HP Filter	Filtek	HP12/1700	14c48	N/A	N/A
	2800 MHZ HP Filter	Filtek	HP12/2800	14C47	N/A	N/A
	Pre-Amplifier	Miteq	JS40010260	340125	N/A	N/A
	Binconilog Antenna	EMCO	3141	0005-1186	Apr 2012	4 Years
	Binconilog Antenna	ETS	3149	J000123908	Mar 2014	4 years
	Horn Antenna	EMCO	3115	35114	Mar 2012	4 Years
	Loop Antenna	EMCO	6512	00049838	Apr 2014	4 years
	LISN	R&S	ESH3-Z5	836679/003	Jun 2013	4 Years
	Fast Power Detector 5Ms/s	ETS Lindgren	7002-006	00160034	Sep 2014	2 Years

## 10 Revision History

Date	Report Name	Changes to report	Report prepared by
2015-07-31	EMC-APPLE-144-14001-A1535-15.247-BT-LE	Initial Version	Franz Engert